USER'S MANUAL

AuditFlow - Flow Measurement System

Smar
First in Fieldbus
- AuditFlow

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AuditFlow

VERSION 5

FOUNDATION

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GLOSSARY

Base Prove Volume (BPV) –Prover volume of calibrated section, according to the calibration certificate. The BPV is used as a reference volume in the proving process of the meter.

Beta (β) – ratio between the diameters of the Orifice and the pipeline, according to the equation: $\beta = d / D$

Coefficient of discharge (C_d) – The Coefficient of discharge of the orifice plate is the ratio between the actual flow and the theoretical flow.

Coefficient of Thermal Expansion (α) – Two coefficients are used in the calculation of the natural gas flow using the orifice plate: the Coefficient of Thermal Expansion of the Pipeline Material (α_1) and the Coefficient of Thermal Expansion of the Orifice Plate Material (α_2).

Flow Computer – Device that supports besides the compensation calculations (correction factors), audit trail, data storage security, restricted access, etc. It also supports fiscal transfer, custody transfer and ticket.

Base Conditions – Some variables refer to the base conditions, that is, to the reference temperature and pressure set by user.

Flow Conditions – Some variables refer to the flow conditions, that is, to the measured temperature and pressure.

Flow Corrector – Equipment/function that corrects the flow measurement compensating by the temperature and pressure, providing a more accurate measurement.

Base Density of Liquids – Measured density, converted to the base conditions of temperature and pressure.

Base Density of Gases (ρ_b) – Base density of the gas, calculated according to the equation:
$\rho_b = (P_b * Mr_{air} * G_i) / [Z_b * R * (T_b + N_5)]$ where: $Mr_{air} = 28{,}9625$ and $N_5 = 273{,}15$

Process Density of Gases ($\rho_{t,p}$) – Process density of the gas, calculated according to the equation:
$\rho_{t,p} = (P_f * Mr_{air} * G_i) / [Z_f * R * (T_f + N_5)]$ where: $Mr_{air} = 28{,}9625$ and $N_5 = 273{,}15$

Real Gas Relative Density (Gr) – Real Gas Relative Density.

Ideal Gas Relative Density (G_i) – Ideal Gas Relative Density.

Heating Value (HV) – Heating value of the gas, used to calculate “Z” in the method Gross 1, and to calculate the energy flow.

Diameter of the Plate Orifice (d) – Diameter of the orifice measured at the reference temperature.

Internal diameter of the pipeline (D) –Internal diameter of the pipeline measured at the reference temperature.

Isentropic exponent (k) – It is a thermodynamic property that establishes the relation between the expansion pressure of the fluid (gas) and the density.

Compressibility Factor (Z) – It corresponds to the gas compressibility, calculated in the process conditions (Z_f) and the base conditions (Z_b).

Combined Correction Factor (CCF) – It results from the multiplication of all correction factors related to temperature and pressure deviations.

Temperature Correction Factor (CTL) – This factor multiplies the volume measured by the meter to convert the volume to the base temperature conditions. This correction is related to the thermal expansion property of the product being measured.

Pressure Correction Factor (CPL) – This factor multiplies the volume measured by the meter to convert the volume to the base pressure conditions. This correction is related to the compressibility property of the product being measured.

Expansion Speed Factor (E_v) – Expansion Speed Factor calculated according to the equation: $E_v = 1 / \mathrm{sqrt}(1 - \beta^4)$

Expansion Factor (Y) – It corrects the flow deviated by an alteration of the density in a constricted fluid through the orifice plate.

K Factor (KF) – Number of pulses generated by the meter per unit of volume.

Nominal K Factor (NKF) – K Factor generated by the meter's manufacturer and used to convert the number of pulses to the indicated volume (IV).

Meter Reading (MR) – Non-resettable totalizer for the indicated volume.

Indicated Mass (IM) – It is the mass measured by the meter, dividing the number of pulses by the nominal K factor.

Measured Mass (MM) – It is the mass measured by meter and corrected by the Calibration Factor (MF). It is obtained dividing the number of pulses by the K factor and then multiplying by MF.

Master meter – It is a premium meter, calibrated by a prover and used to calibrate an operational meter (indirect proving).

Meter factor (MF) – It corrects the indicated volume of the meter to the real volume, in flow conditions (not corrected for the base conditions). It is calculated dividing the Gross Standard Volume of Prover (GSVp) by the Indicated Standard Volume of Meter (ISVm).

Reynolds Number (Re_D) – It is the dimensionless ratio of inertial and viscous forces in a fluid defined by the density of the fluid, the viscosity, the velocity and the pipe diameter.

Meter Accuracy (MA) – It is defined as the reciprocal of the meter factor.

Pressure Weighed Average (PWA) – The pressure measured is weighed by the volume or the mass.

$$PWA = \frac{\Sigma (Pi * Vi)}{Vt}$$

Base Static Pressure (reference) (P_b) – It is the static pressure used as reference.

Process Static Pressure (P_f) – It is the static pressure of the process.

QTR (quantity transaction report) –Report including all necessary information to calculate the corrected volume/mass in the correspondent time.

Audit trail – Compilation and storage of the information necessary to verify the custody transfer quantity, including QTR reports, configuration change reports, alarms/events reports and proving reports.

Restricted Access – The user must provide the password to change parameters or to execute procedures that affect the calculation of corrected volumes

Temperature Weighed Average (TWA) – The temperature measured is weighed by the volume or the mass.

$$TWA = \frac{\Sigma (Ti * Vi)}{Vt}$$

Base temperature (reference) (T_b) – It is the temperature used as reference.

Process Temperature (T_f) – It is the temperature of the process.

Base Flow (Q_b) – Volumetric flow calculated in the base condition, according to the equation:

$Q_b = Q_m / \rho_b$

Process Flow (Q_v) – Volumetric flow calculated in the process condition according to the equation:
$Qv = Q_m \ / \ \rho_{t,p}$

Mass flow (Q_m) – Mass flow calculated according to the equation:
$Q_m = \ \pi/4 * C_d * E_v * Y * d^2 * \mathrm{sqrt}(2 * \rho_{t,p} * \ \Delta P)$

Flow of Energy – Energy Flow.

Velocity (E_v) – It is the mathematical expression that relates the fluid velocity at the upstream pipeline of the meter, to the fluid velocity at the plate orifice.

Viscosity (μ) – It is the absolute viscosity of the gas in the process.

Gross Standard Volume (GSV) – Volume measured by the meter, corrected to the base conditions and also by the meter performance (MF).

Indicated Standard Volume (ISV) – Volume measured by the meter, corrected to the base conditions, not considering the meter performance.

Net Standard Volume (NSV) – Volume measured by the meter, corrected to the base conditions and the meter performance (MF) and discounting the percentage of sediments and water.

Indicated Volume (IV) – It is the volume measured by the meter, dividing the number of pulses by the nominal K factor.

Chapter 1

OVERVIEW

Introduction

The AuditFlow Flow Measurement System was designed for International Standards focusing applications like custody transfer in oil and gas measurements, allocation measurement, operational measurement and/or process control.

There is a special treatment for audit trail. It allows verify the calculations taken place in the FC302, access restriction to parameters which affect the flow calculation and configuration log, reports on occurence of process alarms and events, besides providing the QTR reports. Another important feature to attend the applications mentioned above is the data security to warrant the authenticity of presented data in the reports.

As the AuditFlow system architecture is based on SYSTEM302, many concepts and system components have detailed descriptions in specific manuals. Thus, there are some pre requirements before reading this manual, which are:

- Syscon User Manual
- OLE Server Smar Manual
- Function Blocks Manual

Note
When using Smar Field Devices, the Firmware version must be 3.46 or higher.

System Architecture

The following picture shows a typical system architecture using FC302. Due to hardware modular configuration, as well the Foundation Fieldbus, Modbus RTU and TCP/IP protocol as a builtin feature in the AuditFlow CPU module, a set of architecture and connectivity options is offered to the user.

The flow computer configuration tool is the Syscon, the universal tool for Foundation Fieldbus equipment. Thus, using other manufacturers' equipment, which also support Foundation Fieldbus, is easily integrated to the system, including their own configuration process.

The AuditFlow configuration is based on function block diagram language defined by IEC-6113-3 standard. This configuration language allows the organization of information and block parameters, according to functionality, as well as, easy comprehension of the configuration strategy.

The FCView is the software tool for the operational phase of system, it is used for the monitoring of the main measured and calculated variables and parameter configuration.

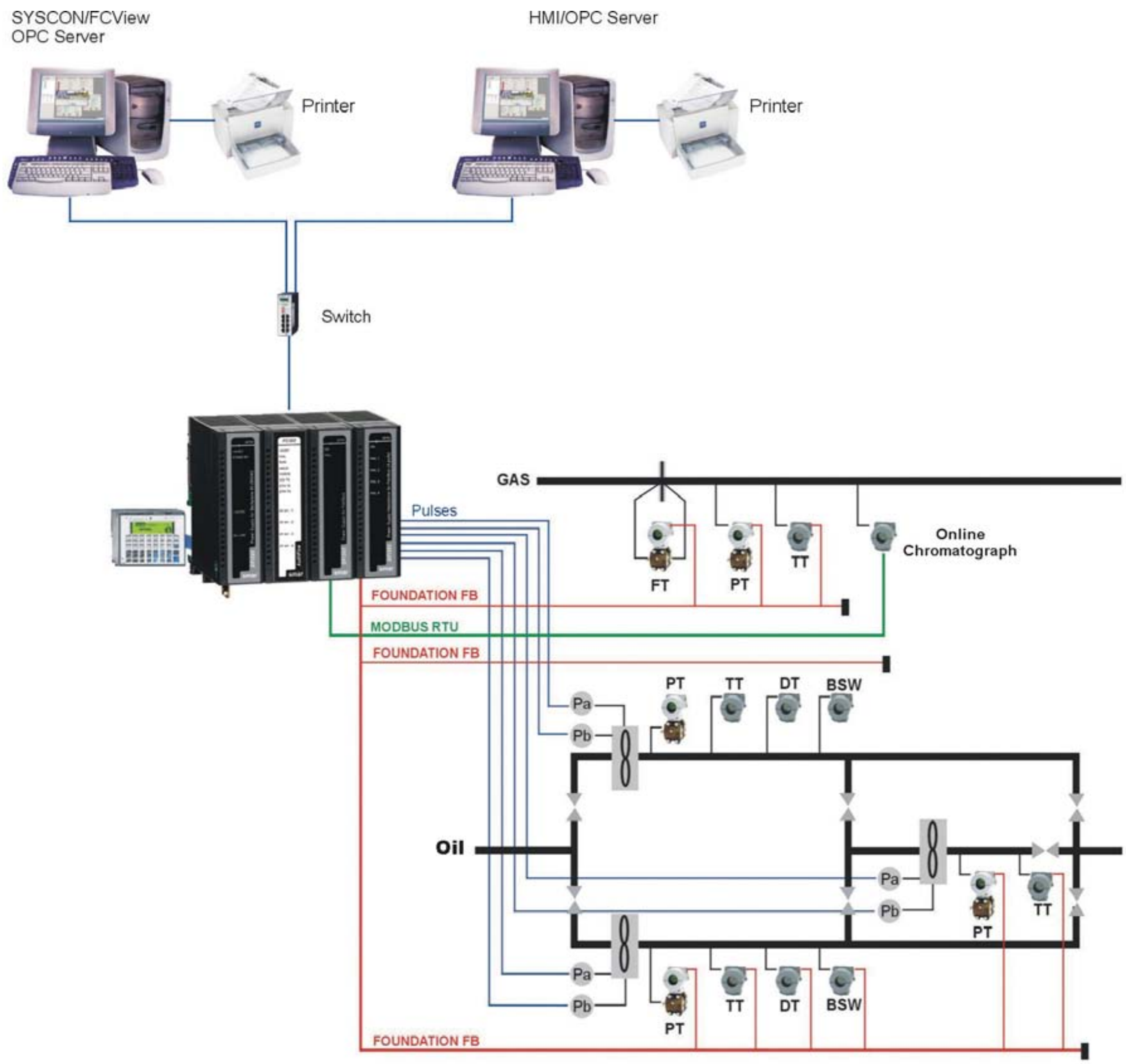
It is also through the FCView, that all necessary information to generate all report types and storage in the data base is obtained from CPU module. Report views and prints in the data base, and other functionalities are also available in FCView.

The AuditFlow has an OPC Server (DFI OLE Server), which allows communication with all available main supervisory softwares in the market..

The interface between AuditFlow and the field instruments can be as follows:

- Communication by Foundation Fieldbus H1 protocol: Among other advantages, the digital transmission of the measured process variables (pressure, differential pressure, temperature, density, flow, etc.) avoids loss of accuracy in D/A and A/D conversions. Monitor/performance possibility in all equipment parameters and mainly, diagnostic information access allowing a preventive maintenance.
- I/O 4-20mA Modules and pulse inputs: The traditional access to measured variables by the field equipment are also available in AuditFlow, being the pulse input the usual input for turbines, positive displacement and Coriolis meters.

- Communication by Modbus RTU / TCP-IP protocol: AuditFlow has a set of function blocks which allows a suitable integration with Modbus devices. Through the EIA-232/485 or Ethernet+TCP/IP media, the AuditFlow can be a Master or Slave Modbus device. The Modbus communication implemented in AuditFlow allows the process variables to be reliably transferred, guaranteeing an adequate updating cycle to these variables, as stated on the API-21.1 and API-21.1 standards, and also, communication status information and the use of an override value, in a failure situation. Examples of applications: reading of natural gas composition through online chromatograph, monitoring of variables through local HMI and reading of multivariable transmitter process variables.



Chapter 2

THEORETICAL AND NORMATIVE DESCRIPTION

Standards used in flow correction and measurement

API - American Petroleum Institute (USA)
IP - Institute of Petroleum (UK)
GPA - Gas Processors Association
AGA - American Gas Association
ANSI - American National Standards
ISO - International Standard Organization

Gas Measurement

Measurement Theory using Orifice Plate

The orifice plate is the primary device that measures the flow based on the differential pressure generated.

The flow measurement based on an orifice plate uses the well-known Physics laws: the Continuity Equation and the Bernoulli Equation.

Flow Calculation Theory using Orifice Plate

In gas measurement based on an orifice plate, the mass flow is calculated first, then dividing it by the base density and the flowing density, to obtain the volumetric flow rates at base condition and flowing condition, respectively.

The compressibility factor (Z) of the Natural Gas is a factor used to estimate the deviation of measured gas from the ideal gas law behavior. This calculation is based on the AGA8 Standard, selecting one of the three methods:

- Gross1 – The calculation is based on: CO_2 percentage, G_r relative density and Heating Value HV, and also on the pressure and temperature values.
- Gross2 – The calculation is based on: CO_2 percentage, N_2 percentage and G_r relative density, and also on the pressure and temperature values.
- Detailed – The calculation is based on the gas composition, and also on the pressure and temperature values.

The following flow calculation is based on the AGA3 Standard (1992) (It is recommended to study the AGA3 Standard - Part 4):

$\beta = d / D$

$$E_v = \frac{1}{\sqrt{1-\beta^4}}$$

$Y = 1 - [(0.41 + 0.35 * \beta^4) / k] * [\Delta P / (N_3 * P_f)]$
Where k = 1,3 , $N_3 = 1000,0$
For incompressible fluids Y = 1.0

$\rho_b = (P_b * Mr_{air} * G_i) / [Z_b * R * (T_b + N_5)]$
$\rho_{t,p} = (P_f * Mr_{air} * G_i) / [Z_f * R * (T_f + N_5)]$
Where : $Mr_{air} = 28,9625$, $N_5 = 273,15$, R = 0,0831451

C_d - Calculated as function of E_v, Y, d, D, β, μ, k, R_{eD}

$$Q_m = \frac{\pi}{4} * C_d * E_v * Y * d^2 * \sqrt{2 * \rho_{t,p} * \Delta P}$$

$Qb = Q_m / \rho_b$
$Qv = Q_m / \rho_{t,p}$

Energy = Qb * HV

Where:
d: diameter of the orifice plate at flowing temperature
D: diameter of the pipeline at flowing temperature
Ev: expansion speed factor
Y: expansion factor
R_{eD} : Reynolds number
Cd: coefficient of discharge
$\rho_{t,p}$: density at flowing temperature and pressure
ρ_b : density at base temperature and pressure
Z_f : compressibility factor – it is calculated through AGA8 using the composition, flowing temperature and pressure
Z_b : compressibility factor – it is calculated through AGA8 using the composition, base temperature and pressure
Qm: mass flow
Qb: volumetric flow rate calculated in base temperature and pressure
Hv: heating value

Compressibility Factor (Zb, Zf) by Detail Characterization Method – AGA8:1992

The compressibility factor (Z) indicates the deviation of the behaviour when comparing natural and ideal gases in the gas general equation:

Equation 1 – AGA8:

$$Z = \frac{PV}{nRT}$$

Where:
P: absolute static pressure of gas
V: gas volume
n: number of moles of gas
Z: compressibility factor of gas
R: gas constant
T: absolute temperature of gas

The equation of state for the Detail Characterization Method is given by the following equation:

Equation 12 – AGA8:

$$Z = 1 + \frac{DB}{K^3} - D\sum_{n=13}^{18} C_n^* T^{-u_n} + \sum_{n=13}^{58} C_n^* T^{-u_n} (b_n - c_n k_n D^{k_n}) D^{b_n} \exp(-c_n D^{k_n})$$

Where:
B: second virial coefficient
K: mixture size parameter
D: reduced density
C_n^*: coefficients which are functions of composition, that is, they don't depend on pressure or temperature
T: absolute temperature
u_n, b_n, c_n, k_n: constants in Table 4 of AGA8 standard

1. **Calculation of the reduced density:**

Equation 13 – AGA8:

$$D = K^3 d$$

Where:
K: mixture size parameter
d: molar density (moles per unit volume) calculated using Brent method, it will be explained later.

2. Calculation of the mixture size parameter (K) using only the gas composition:

Equation 14 – AGA8:

$$K^5 = \left[\sum_{i=1}^{N} x_i K_i^{5/2}\right]^2 + 2\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} x_i x_j (K_{ij}^{5} - 1)(K_i K_j)^{5/2}$$

Where :
K_i : size parameter for ith component – table 5 of the AGA8 standard
K_j : size parameter for jth component – table 5 of the AGA8 standard
K_{ij} : binary interaction parameter for size – table 6 of the AGA8 standard
x_i : mole fraction of ith component
x_j : mole fraction of jth component
N : number of components in the gas misture

3. Calculation of the second virial coefficient using only the gas composition and temperature:

Equation 15 – AGA8:

$$B = \sum a_n T^{-u_n} \sum\sum x_i x_j E_{ij}^{u_n} (K_i K_j)^{3/2} B_{nij}^{*}$$

Where B_{nij} is calculated by the following equation, which depends on the gas composition and temperature:

Equation 16 – AGA8:

$$B_{nij}^{*} = (G_{ij} + 1 - g_n)^{g_n} (Q_i Q_j + 1 - q_n)^{q_n} (F_i^{1/2} F_j^{1/2} + 1 - f_n)^{f_n} (S_i S_j + 1 - s_n)^{s_n} (W_i W_j + 1 - w_n)^{w_n}$$

Where:
B_{nij}^{*} : binary characterization coefficient
a_n , u_n : constants in Table 4 – AGA8
g_n , q_n, f_n, s_n, w_n: constants in Table 4 – AGA8
T : absolute temperature
x_i : mole fraction of component ith in the gas mixture
x_j : mole fraction of component jth in the gas mixture
G_{ij} : binary orientation parameter, according to the following equation
Q_i : quadrupole parameter for ith component (Table 5 – AGA8)
Q_j : quadrupole parameter for jth component (Table 5 – AGA8)
F_i : high temperature parameter for ith component (Table 5 – AGA8)
F_j : high temperature parameter for jth component (Table 5 – AGA8)
S_i : dipole parameter for ith component (Table 5 – AGA8)
S_j : dipole parameter for jth component (Table 5 – AGA8)
W_i : association parameter for ith component (Table 5 – AGA8)
W_j : association parameter for jth component (Table 5 – AGA8)
E_{ij} : second virial coefficient binary energy parameter, according to the following equation
K_i : size parameter for ith component (Table 5 – AGA8)
K_j: size parameter for jth component (Table 5 – AGA8)
N: number of components in gas mixture, FC302 always calculates using 21 components, so N=21.

Equation 17 – AGA8:

$$E_{ij} = E_{ij}^{*} (E_i E_j)^{1/2}$$

Equation 18 – AGA8:

$$G_{ij} = \frac{G_{ij}^{*} (G_i + G_j)}{2}$$

Where:
E_i : characteristic energy parameter for ith component (Table 5 – AGA8)
E_j : characteristic energy parameter for jth component (Table 5 – AGA8)
E_{ij}^{*} : second virial coefficient energy binary interaction parameter

G_i : orientation parameter for ith component (Table 5 – AGA8)
G_j : orientation parameter for jth component (Table 5 – AGA8)
G_{ij}^* : binary orientation parameter (Table 6 – AGA8)

4. Calculation of the coefficient C_n^* (n=13 to 58) depending only on the gas composition:

Equation 19 – AGA8:

$$C_n^* = a_n (G + 1 - g_n)^{g_n} (Q^2 + 1 - q_n)^{q_n} (F + 1 - f_n)^{f_n} U^{u_n}$$

Equation 20 – AGA8:

$$U^5 = \left[\sum_{i=1}^{N} x_i E_i^{5/2} \right]^2 + 2 \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} x_i x_j (U_{ij}^5 - 1)(E_i E_j)^{5/2}$$

Equation 21 – AGA8:

$$G = \sum_{i=1}^{N} x_i G_i + \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} x_i x_j (G_{ij}^* - 1)(G_i + G_j)$$

Equation 22 – AGA8:

$$Q = \sum_{i=1}^{N} x_i Q_i$$

Equation 23 – AGA8:

$$F = \sum_{i=1}^{N} x_i^2 F_i$$

Where :
a_n ,g_n , q_n, u_n, f_n: constants in Table 4 – AGA8
x_i : mole fraction for the ith component in the gas
x_j : mole fraction for the jth component in the gas
E_i : energy parameter for the ith component (Table 5 – AGA8)
E_j : energy parameter for te jth compoenent (Table 5 – AGA8)
U_{ij} : binary interaction parameter for conformal energy (Table 6 – AGA8)
G_i : orientation parameter for the ith component (Table 5 – AGA8)
G_j : orientation parameter for jth component (Table 5 – AGA8)
G_{ij}^* : binary interaction parameter for orientation (Table 6 – AGA8)
Q_i : quadrupole parameter for ith component (Table 5 – AGA8)
Q_j : quadrupole parameter for jth component (Table 5 – AGA8)
F_i : high temperature parameter for ith component (Table 5 – AGA8)
F_j : high temperature parameter for jth component (Table 5 – AGA8)

5. Equation of State for Pressure

The following equation is obtained using the equations 1 and 12 of AGA8 standard.

Equation 24 – AGA8:

$$P = dRT \left[1 + Bd - D \sum_{n=13}^{18} C_n^* T^{-u_n} + \sum_{n=13}^{58} C_n^* T^{-u_n} (b_n - c_n k_n D^{k_n}) D^{b_n} \exp(-c_n D^{k_n}) \right]$$

6. Algorithm for calculation of the compressibility factor (Z) by Detail Characterization Method:

Inputs:
T : absolute pressure
P : absolute static pressure
x_i : gas composition

Sequence of the iteractive method for the calculation of the compressibility factor:

I. Calculation of the mixture size parameter (K), which depends on the gas composition

II. Calculation of B and C_n^* coefficients, according to the items 3 and 4, respectively, which depend on the gas composition and temperature

III. Determination of the molar density (d) using equation 24 – AGA8 and the Brent iteractive method:

- It calculates two densities (RHOL and RHOH) that are the range limits for the determination of the density using the iteractive method;
- Associated with the densities, it calculates the absolute static pressure (PRHOL and PRHOH) according to the densities using the equation 24 – AGA8;
- The first interaction uses the inverse linear interpolation between RHOL and RHOH;
- It calculates the absolute static pressure using the equation 24 – AGA8 with molar density (attempt), the absolute pressure (T) and the parameters K, B and C_n^*. The processing for each interaction uses the equation 24 – AGA8, because the parameters K, B and C_n^* are computed only one time;
- There are two convergence criterions: a) deviation lower than 1E-6 between the computed pressure and the provided pressure (measured static pressure or base pressure) or; b) deviation lower than 1E-6 between the values of molar density (d) of two successive interactions;
- If there is not convergence, it selects the most efficient option for the next interaction between: inverse quadratic interpolation, inverse linear interpolation and bisection. It is necessary to define the maximum number of interactions and the computed value for the molar density for the next interaction is delimited for the calculated range.

IV. When the molar density is solved (d), it calculates the compressibility factor using the equation 12 – AGA8.

Density calculation (ρ) – AGA8

After determining the compressibility factor, it calculates the density at the temperature and pressure which the compressibility factor was computed by using the following equations:

Equation 3 – AGA8:

$$M_r = \sum_{i=1}^{N} x_i M_{ri}$$

Where:
M_r : molar mass of the natural gas
x_i : mole fraction of component i in gas mixture
M_{ri} : molar mass of ith component
N : number of components (21 components)

Equation 4 – AGA8:

$$\rho = M_r d$$

Where:
ρ: mass density (mass per unit volume) at the temperature and pressure in which Z and d were computed
d : molar density (number of moles per unit volume)
M_r : molar mass of the natural gas

The calculations for molar density (d), compressibility factor and mass density (ρ) should be performed for flowing and base conditions. Through the mass density at flowing and base conditions, and the mass flow obtained by using AGA3, it calculates the volumetric flows at flowing (Qv) and base (Qb) conditions for measurements based on differential pressure.

Calculation of relative density (G_r) – AGA8

The relative density (Gr) is the natural gas density divided by air density, both in the same temperature and pressure conditions.

Equation C.3-11 – AGA8:

$$\rho(\mathrm{air}, \mathrm{T_{gr}}, \mathrm{P_{gr}}) = \frac{\mathrm{M_r}(air)}{\frac{\mathrm{R} * \mathrm{T_{gr}}}{\mathrm{P_{gr}}} + B(air, T_{gr})}$$

Where:
T_{gr} = reference temperature for relative density
P_{gr} = reference pressure for relative density
R = gas constant equals to 8.31451 * 10^{-3} J/(Kg-mol*K)
M_r(air) = molar mass of air equals to 28.96256
B(air, T_{gr}) : air second virial coefficientat the temperature T_{gr}

Equation C.3-12 - AGA8:

$$\mathrm{B(air,T_{gr})} = -0{,}12527 + 5{,}91 * 10^{-4} * \mathrm{T_{gr}} - 6{,}62 * 10^{-7} * \mathrm{T_{gr}}^{2}$$

Calculation of relative density (Gr)

Equation C.3-10 - AGA8:

$$\mathrm{G_r}(\mathrm{T_{gr}}, \mathrm{P_{gr}}) = \frac{\rho(\mathrm{T_{gr}}, \mathrm{P_{gr}})}{\rho(\mathrm{air}, \mathrm{T_{gr}}, \mathrm{P_{gr}})}$$

Where:
$\rho(T_{gr}, P_{gr})$: mass density of natural gas at temperature T_{gr} and pressure P_{gr}.
ρ(air, T_{gr}, P_{gr}) : mass density of air at temperature T_{gr} and pressure P_{gr}.

Calculations for gas totalization

According to the API-21.1 standard:

$$Q_{imp} = IMV_{imp} * IV_{imp}$$

$$IMV = 7709.61 * C_d(FT) * E_v * Y * d^2 * \sqrt{\frac{Z_b}{G_r * Z_f * T_f}}$$

$$IV = \sum_{i=1}^{n} \sqrt{P_i * \Delta P_i}$$

Where:
imp : Integral Multiplier Period – frequence that IMV calculations occur. It is based on weighed averages of P, DP and T. FC302 module uses its macro cycle as imp, so it does the calculations frequently.
Q_{imp} : quantity accumulated during imp period
IMV_{imp} : Integral Multiplier Value corresponding to imp period, which it is calculated using the weighed averages of P,DP and T
IV_{imp} : integral value accumulated during the imp period

Liquid Measurement

Temperature Correction Factors (CTL)

Hydrocarbon correction factors

The determination of the base density based on flowing density and temperature are related to odd tables (5, 23, 53 and 59). For the determination of CTL based on base density and temperature is related to even tables (6, 24, 54 and 60).

An algorithm overview is showed:

1. Determination of base density based on flowing density and temperature

It uses two equations. The equation derived from the equation of the coefficient of thermal expansion is showed below:

Equation 1:

$$CTL = \frac{V_b}{V} = \frac{\rho}{\rho_b} = \exp\left[-\alpha_b \Delta t \left(1 + 0.8\alpha_b \Delta t\right)\right]$$

Where:
CTL : correction factor from flowing temperature to base temperature
V_b : volume at base condition
V : volume at flowing condition
ρ : density at flowing condition
ρ_b : density at base condition
α_b : coefficient of thermal expansion at base temperature – this parameter changes with the temperature
Δt : differential temperature (flowing temperature – base temperature)

The next equation shows the relation between the base density and coefficient of thermal expansion at base conditions, whose coefficients K_o and K_1 were determined using non-linear regression for the whole set of experimental points for each product type. This standard supports the liquid hydrocarbon, and separates them in four categories:

A – crude oil
B – generalized products (gasoline, diesel,...)
C – MTBE : special products which provide the coefficient of thermal expansion at base temperature instead of flowing or base density.
D – lubricanting oil

Equation 2:

$$\alpha_b = \frac{K_0 + K_1 \rho_b}{\rho_b^2}$$

The parameters K_o and K_1 are determined according to the following table:

Tables	Product	K_o	K_1	Description
5/6 A, 23/24 A	Crude oil	341.0957	0	T_b=60°F and Kg/m^3
5/6 B, 23/24 B	Gasoline (650-770 kg/m^3)	192.4571	0.24380	
	Interpolation (770.5-787.5 kg/m^3) : A=-1.86840E-3 / B=1489.0670			
	Jet fuel and kerosene (787.53-838.3 kg/m^3)	330.3010	0	
	Diesel, heating oil and fuel oil (839-1075 kg/ m^3)	103.8720	0.27010	
5/6 D, 23/24 D	Lubricanting Oil	0	0.34878	
53/54 A	Crude oil	613.9723	0	T_b=15°C and Kg/m^3
53/54 B	Gasoline (650-770 kg/m^3)	346.4228	0.43880	
	Interpolation (770.5-787.5 kg/m^3) : A=-3.36312E-3 / B=2680.3206			
	Jet fuel and kerosene (787.53-838.3 kg/m^3)	594.5418	0	
	Diesel, heating oil and fuel oil (839-1075 kg/ m^3)	186.9696	0.48620	
53/54 D	Lubricanting Oil	0	0.62780	

Interpolation between the gasoline and kerosene ranges using the equation 3:

$$\alpha_b = A + \frac{B}{\rho_b^2}$$

Note that this procedure is not applied to the MTBE product, because is necessary to provide the coefficient of thermal expansion at base temperature, and then it calculates the correction factor CTL using the equation 1.

Basic procedure to determine the base density:

- Rounding the flowing density and temperature
- It checks if the value is between the range of calculation
- Interactive process which the first try for base density is the flowing density:
    1. It calculates the coefficient of thermal expansion using the equation 2 based on the base density
    2. It calculates the new base density using the equation 1 and the coefficient of thermal expansion at base temperature determined in the previous item.
    3. It checks the convergence based on the variation of base density calculated in this and the previous interaction, determining a maximum number of interactions

    It uses the base density calculated in this interaction for the next interaction. Repeat the sequence from the first item.
- It checks if there was not convergence, out of range, extrapolation range and inside the range.

If the calculation refers to the Table 59 (base temperature at 20°C), so the procedure modifies:

- It calculates the base density at 15°C according to the procedure above, and then the coefficient of thermal expansion at 15°C.
- Using equation 1, it calculates the factor $CTL_{20C\rightarrow 15C}$
- It calculates the base density at 20°C using the following equation

$$\rho_{20C} = \rho_{15C} * CTL_{20C\rightarrow 15C}$$

2. Determination of CTL based on base density and temperature

The procedure for the calculation of CTL based on base density and temperature is:

- Rounding of the base density and temperature
- It checks if the value is inside the calculation range
- It checks if the coefficient of thermal expansion at base temperature (equation 2), except for the MTBE;
- It calculates the CTL (equation 1).
- It checks if extrapolation region or inside the range.

If the calculation refers to the Table 60 (base temperature at 20°C), so the procedure modifies:

- It calculates the base density at 15°C based on base density at 20°C.
- Using the base density at 15°C, it calculates two factors $CTL_{T\rightarrow 15C}$ and $CTL_{20C\rightarrow 15C}$
- It calculates the CTL using the following equation

$$CTL = \frac{CTL_{T\rightarrow 15C}}{CTL_{20C\rightarrow 15C}}$$

Correction factors for water

If the measured product is water, the correction factor for temperature is computed according to the following equation:

USA :

$$CTL_W = 1 - (1.0312E-4 + 7.1568E-6*B)*\Delta t - (1.2701E-6 - 4.4641E-8*B)*\Delta t^2 +$$
$$(1.2333E-9 - 2.2436E-11*B)\Delta t^3$$

Where:

$$B = (\rho_{60} - 999)/7.2$$
$$\Delta t = t - 60$$

SI :

$$CTL_W = 1 - (1.8562E-4 + 1.2882E-5*B)*\Delta t - (4.1151E-6 - 1.4464E-7*B)*\Delta t^2 +$$
$$(7.1926E-9 - 1.3085E-10*B)\Delta t^3$$

Where:

$B = (\rho_{15} - 999)/7.2$

$\Delta t = t - 15$

Correction factor for pressure (CPL)

The compressibility factor is based on the base density, temperature and pressure, according to API-11.2.1., API-11.2.1.M, API-11.2.2., API-11.2.2.M and GPA TP 15 standards (calculation for equilibrium pressure for light hydrocaborn), and it obtains the pressure correction factor (CPL).:

$$F = E.\exp\left(A + Bt + \frac{C + Dt}{\rho_b{}^2}\right)$$

Where:
F: compressibility factor in psi or KPa
t : temperature in Fahrenheit or Celsius
ρ_b : base density in g/cm^3 regardless of the unit system used

Coefficients	API-11.2.1. (USA)	API-11.2.1.M (SI)
A	-1.99470	-1.62080
B	0.00013427	0.00021592
C	0.79392	0.87096
D	0.0023260	0.0042092
E	1E-5	1E-6

$$CPL = \frac{1}{1 - F(P - P_e)}$$

Where:
P : manometric pressure for the liquid
P_e : equilibrium pressure. For the four product types covered by the API-11.2.1 standard have value lower than the atmospheric pressure and by convention it considers the manometric zero pressure.

Correction factors for water
If the product is water or emulsion (crude oil and water), the correction factor for water pressure is calculated following the equation:

CPL_w = 1 / (1 – F * P)

Where:
P: manometric pressure which the water is submitted
F: the compressibility factor is a fixed value for water, according to the API-12.2.3 – Appendix A standard.

F = 3.20E-6 psi^{-1}
F = 4.64E-7 kPa^{-1}

Meter Factor (MF)

The meter factor results from the calibration process, where a reference volume is compared to the volume measured by the meter using the NKF. The MF adjusts the performance of the meter to the liquid measured in the correspondent viscosity, considering the flowing pressure and temperature, wearing and material deposition of the meter.

Flow Correction and Totalization Calculation

Indicated Volume (IV): IV = $\frac{N}{NKF}$
Gross Standard Volume (GSV): GSV = IV * CCF
Net Standard Volume (NSV): NSV = GSV * (1 – SW%)
Combined Correction Factor (CCF): CCF = CTL * CPL * MF

Pressure Correction Factor (CPL): $CPL = \dfrac{1}{1 - F * (P - P_E)}$

Where:
N – Number of pulses generated by the meter
NKF – Nominal K factor
SW% - Sediments and Water percentage
CTL –Temperature Correction Factor
CPL –Pressure Correction Factor
P_E – Equilibrium pressure

Proving Process

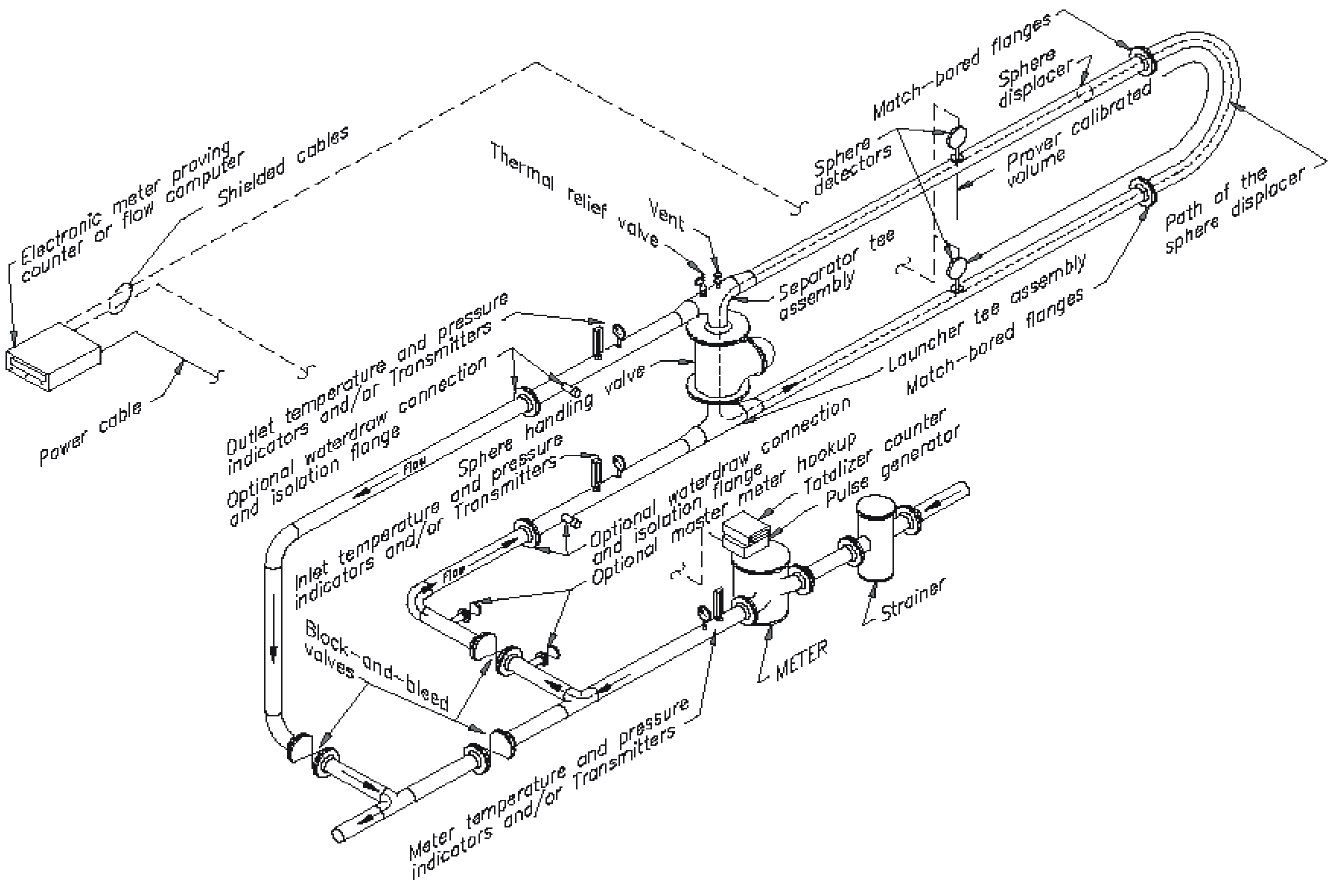
Definition

The turbine calibration process consists of flowing a known volume of liquid (similar to the liquid that will be measured in the process) through the meter and dividing it by the ISV (volume measured by the meter and corrected by the CTL and CPL factors). The result is the meter factor.

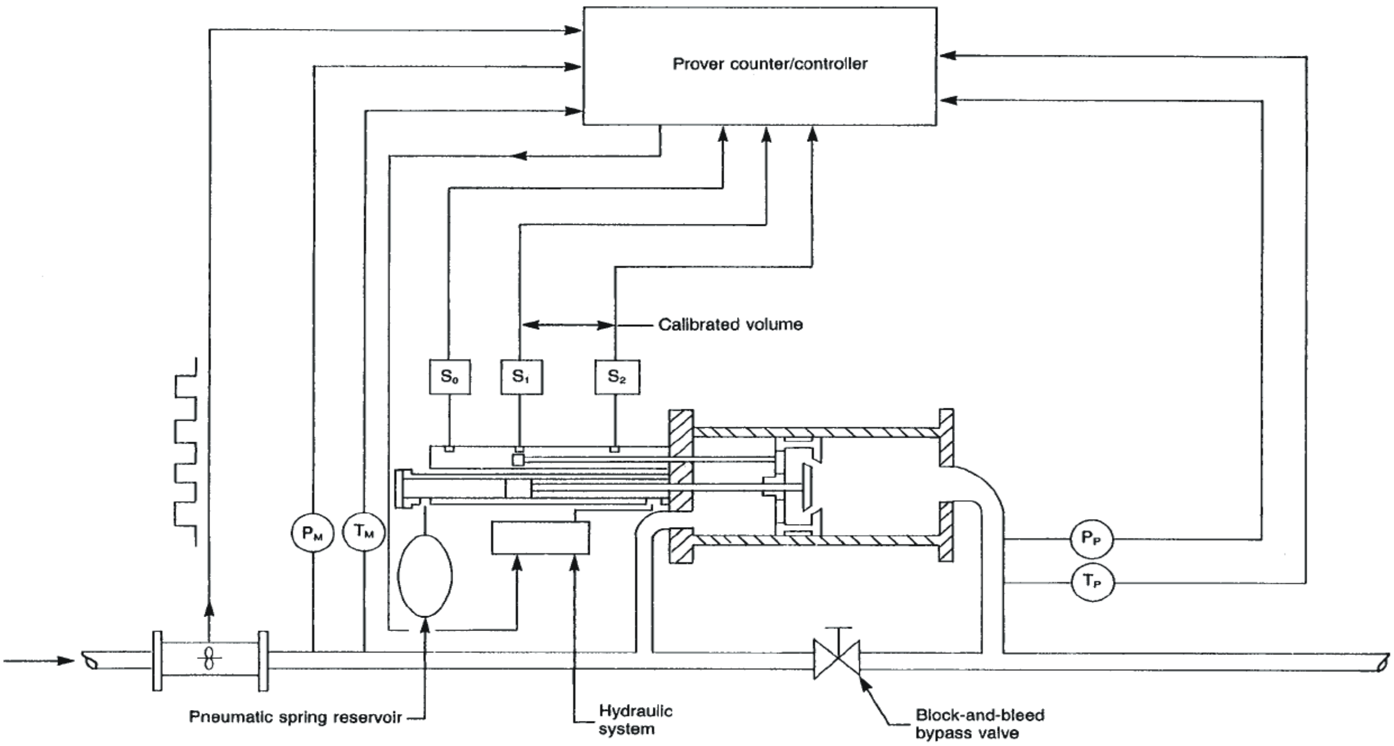
The API-12.2.3 Standard provides the background theory about the proving process. The procedures and equations specify the proving process and also provide the mandatory information for the proving process.

Prover Types

U-Type Prover – Displacement Prover, where an elastomer sphere displaces a known volume in a section of the pipeline (calibrated in specific conditions) delimited by sensors that detect the sphere motion.



Compact Prover – Displacement Prover using a piston. The volume displaced by the moving piston is not enough to generate 10,000 pulses in the meter, so it is necessary to calculate the interpolated number of pulses measured (API-4.6).



Master meter – It is a premium meter used only in the proving process. It can be permanently connected to the process or not. The master is calibrated by a prover, which calibrates the operational meter (indirect calibration method).

Tank Prover – The tank has a volume section calibrated in specific conditions and a scale of reading before and after the tank is emptied (proving batch). The difference is the reference volume that flowed through the meter.

Calculations executed in the proving process

Weighed averages calculation – The correction factors are calculated using the weighed averages (volume in base conditions) of density, temperature and pressure.

Gross standard volume of prover (GSVp) – The volume of the calibrated section of the prover in specific conditions is converted to the flowing conditions, considering the kind of the material used in the prover, corrected by the temperature (CTSp) and pressure (CPSp). The corrected volume corresponds to the volume of the liquid in flowing conditions that flows through the meter, and then this volume is converted to the base conditions considering the product properties, related to the temperature (CTLp) and pressure (CPLp).

- Prover :

GSVp = BPV * CCFp
Where: CCFp = CTSp * CPSp * CTLp * CPLp

- Master meter :

GSVmm = IVmm * CCFmm
Where:

$$IVmm = \frac{Nmm}{NKFmm}$$

CCFmm = CTLmm * CPLmm * MMF

MMF: master meter factor
Nmm: number of pulses measured by the master meter

Indicated Standard Volume (ISVm) Calculation – It is the volume measured by the meter considering only the NKF, and then converted to the base conditions, applying the temperature (CTLm) and pressure (CPLm) correction factors.

ISVm = IVm * CCFm

Where:
IVm = Nm / NKF
CCFm = CTLm * CPLm

Nm: number of pulses measured by the meter during one proving execution.

Meter Factor (MF) Calculation – It is the ratio of GSVp (or GSVmm) divided by ISVm.

$$MF = \frac{GSVp}{ISVm}$$

Acceptability Criteria

The proving process requires several proving batches to be executed in order to accept the process. Some criteria are:

- Any 5 of 6 consecutive proving batches: the best 5 proving batches are selected (the batches closer to the average).
- 5 consecutive batches of 10 consecutive: select 5 consecutive batches or at most 10 consecutive batches that fulfill the required repeatability.
- 5 consecutive batches.
- 3 consecutive batches.

Method

When the calibration uses a prover, there are two possibilities to determine the meter factor (MF):

- Average data: It calculates the weighed average of variables (temperature, pressure and density) for each proving batch accepted and the correction factors are calculated using the average of weighed average: GSVp, ISMm and MF.
- Average Meter factor: For each proving batch, it calculates the correction factors: GSVp, ISVm and IMF.

When the calibration uses a master meter, the only method accepted is the Average meter factor.

Repeatability

The repeatability required from the proving batches for custody transfer is 0.05%. When a master meter is submitted to a proving process, the repeatability required is 0.02%.

The repeatability is calculated as indicated below, according to the selected method:

- Average data :

  $$R\% = \frac{\max Nm - \min Nm}{\min Nm}$$

  Where : Nm –number of pulses of the meter
- Average MF:

  $$R\% = \frac{\max IMF - \min IMF}{\min IMF}$$

MF Calculation

If the repeatability is fulfilled, the MF will be calculated using the selected criteria, it means that some proving batches will be used, while others will be rejected.

Calculation Sequence for different proving configurations – The calculation sequence and the discrimination for intermediate variables are important to obtain the same results, regardless of the flow computer or the calculation system used. The information below are relative to the FC302 implementation:

PV = Prover Volume
PM = Prover Mass
MM = Measured Mass
IM = Indicated Mass
Db = Base density in mass/volume in the correspondent units for mass and volume
Df = Flowing density in mass/volume in the correspondent units for mass/volume

ID	Density Type	Meter Type	Prover Type / Method	Calculation	Supported by FC302 in Appropriation Measurement
1	Flowing density	IV pulse	- Master meter - IV pulse	- CCFmm = CTLmm * CPLmm * MFmm - IVmm = Nmm/NKFmm - GSVmm = IVmm * CCFmm - CCFm = CTLm * CPLm - IVm = Nm / NKFm - ISVm = IVm * CCFm - IMF = GSVmm / ISVm	- CCFmm = [(1-X_w)*CTLo,mm * CPLo,mm +X_w*CTLw,mm * CPLw,mm] * MFmm - IVmm = Nmm/NKFmm - GSVmm = IVmm * CCFmm - CCFm = (1-X_w)*CTLo,m * CPLo,m +X_w*CTLw,m * CPLw,m - IVm = Nm / NKFm - ISVm = IVm * CCFm - IMF = GSVmm / ISVm
2	Flowing density	IV pulse	- Master meter - IM pulse	- CCFmm = CTLmm * CPLmm * MFmm - IMmm = Nmm / NKFmm - IVmm = IMmm / Dfmm - GSVmm = IVmm * CCFmm - CCFm = CTLm * CPLm - IVm = Nm / NKFm - ISVm = IVm * CCFm - IMF = GSVmm / ISVm	No
3	Base density	IM pulse	- Master meter - IV*CTL pulse	- IVmm = Nmm/(NKFmm * CTLmm) - IMmm = IVmm * Dbmm * CTLmm - MMmm = IMmm * MFmm - IMm = Nm / NKFm - IMF = MMmm / IMm	No
4	Flowing density	IM pulse	- Master meter - IM pulse	- IMmm = Nmm/NKFmm - MMmm = IMmm * MFmm - IMm = Nm / NKFm - IMF = MMmm / IMm	- IMmm = Nmm/NKFmm - MMmm = IMmm * MFmm - IMm = Nm / NKFm - IMF = MMmm / IMm
5	Flowing density	IV*CTL pulse	- Master meter - IV pulse	- CCFmm = CTLmm * CPLmm * MFmm - IVmm = Nmm/NKFmm - GSVmm = IVmm * CCFmm - CCFm = CTLm * CPLm - IVm = Nm / (NKFm * CTLm) - ISVm = IVm * CCFm - IMF = GSVmm / ISVm	No
6	Base density	IV*CTL pulse	- Master meter - IV pulse	- CCFmm = CTLmm * CPLmm * MFmm - IVmm = Nmm/NKFmm - GSVmm = IVmm * CCFmm - CCFm = CTLm * CPLm - IVm = Nm / (NKFm * CTLm) - ISVm = IVm * CCFm - IMF = GSVmm / ISVm	No
7	Base density	IV*CTL pulse	- Master meter - IM pulse	- CCFmm = CTLmm * CPLmm * MFmm - IMmm = Nmm/NKFmm - IVmm = IMmm / (Dbmm * CTLmm) - GSVmm = IVmm * CCFmm - CCFm = CTLm * CPLm - IVm = Nm / (NKFm * CTLm) - ISVm = IVm * CCFm - IMF = GSVmm / ISVm	No
8	Flowing density	IV analog input	- Master meter - IV analog input	- CCFmm = CTLmm * CPLmm * MFmm - IVmm = S (Qv,mm * Δt) - GSVmm = IVmm * CCFmm - CCFm = CTLm * CPLm - IVm = S (Qv,m * Δt) - ISVm = IVm * CCFm - IMF = GSVmm / ISVm	- CCFmm = [(1-X_w)*CTLo,mm*CPLo,mm +X_w*CTLw,mm*CPLw,mm] * MFmm - IVmm = S (Qv,mm * Δt) - GSVmm = IVmm * CCFmm - CCFm = (1-X_w)*CTLo,m*CPLo,m +X_w*CTLw,m*CPLw,m - IVm = S (Qv,m * Δt) - ISVm = IVm * CCFm - IMF = GSVmm / ISVm
9	Flowing density	IM analog input	- Master meter - IM analog input	- IMmm = S (Qm,mm * Δt) - MMmm = IMmm * MFmm - IMm = S (Qm,m * Δt)	- IMmm = S (Qm,mm * Δt) - MMmm = IMmm * MFmm - IMm = S (Qm,m * Δt)

ID	Density Type	Meter Type	Prover Type / Method	Calculation	Supported by FC302 in Appropriation Measurement
				- IMF = MMmm / IMm	- IMF = MMmm / IMm
10	Flowing density	IV pulse	- Piston prover - Avg MF	- CCFp = CTSp * CPSp * CTLp * CPLp - GSVp = BPV * CCFp - CCFm = CTLm * CPLm - IVm = Ni / NKFm - ISVm = IVm * CCFm - IMF = GSVp / ISVm	- CCFp = CTSp * CPSp * [(1-X_w)*CTLo,p* CPLo,p +X_w*CTLw,p*CPLw,p] - GSVp = BPV * CCFp - CCFm = (1-X_w)*CTLo,m*CPLo,m +X_w*CTLw,m*CPLw,m - IVm = Ni / NKFm - ISVm = IVm * CCFm - IMF = GSVp / ISVm
11	Flowing density	IV*CTL pulse	- Piston prover - Avg Data	- CCFp = CTSp * CPSp * CTLp * CPLp - GSVp = BPV * CCFp - CCFm = CTLm * CPLm - IVm = Ni(avg) / (NKFm * CTLm) - ISVm = IVm * CCFm - MF = GSVp / ISVm	No
12	Base density	IV pulse	- Piston prover - Avg MF	- CCFp = CTSp * CPSp * CTLp * CPLp - GSVp = BPV * CCFp - CCFm = CTLm * CPLm - IVm = Ni / NKFm - ISVm = IVm * CCFm - IMF = GSVp / ISVm	- CCFp = CTSp * CPSp * [(1-Xw)*CTLo,p*CPLo,p+Xw*CTLw,p*CPLw,p] - GSVp = BPV * CCFp - CCFm = [(1-Xw)*CTLo,m*CPLo,m+Xw*CTLw,m*CPLw,m] - IVm = Ni / NKFm - ISVm = IVm * CCFm - IMF = GSVp / ISVm
13	Base density	IV*CTL pulse	- Piston prover - Avg Data	- CCFp = CTSp * CPSp * CTLp * CPLp - GSVp = BPV * CCFp - CCFm = CTLm * CPLm - IVm = Ni(avg) / (NKFm * CTLm) - ISVm = IVm * CCFm - MF = GSVp / ISVm	No
14	Flowing density	IM pulse	- Piston prover - Avg MF	- CCFp = CTSp * CPSp - PV = BPV * CCFp - PM = PV * Dfp - IMm = Ni / NKFm - IMF = PM / IMm	No
15	Flowing density	IM pulse	- Piston prover - Avg Data	- CCFp = CTSp * CPSp - PV = BPV * CCFp - PM = PV * Dfp - IMm = Ni(avg) / NKFm - MF = PM / IMm	No
16	Base density	IM pulse	- Piston prover - Avg MF	- CCFp = CTSp * CPSp - PV = BPV * CCFp - PM = PV * Dbp * CTLp - IMm = Ni / NKFm - IMF = PM / IMm	No
17	Base density	IM pulse	- Piston prover - Avg Data	- CCFp = CTSp * CPSp - PV = BPV * CCFp - PM = PV * Dbp * CTLp - IMm = Ni(avg) / NKFm - MF = PM / IMm	No
18	Flowing density	- Master meter - IV pulse	- Piston prover - Avg Data	- CCFp = CTSp * CPSp * CTLp * CPLp - GSVp = BPV * CCFp - CCFmm = CTLmm * CPLmm - IVmm = Ni(avg) / NKFmm - ISVmm = IVm * CCFmm - MF = GSVp / ISVmm	- CCFp = CTSp * CPSp * [(1-Xw)*CTLo,p*CPLo,p +Xw*CTLw,p*CPLw,p] - GSVp = BPV * CCFp - CCFmm = (1-Xw)*CTLo,mm*CPLo,mm +Xw*CTLw,mm*CPLw,mm - IVmm = Ni(avg) / NKFmm - ISVmm = IVmm * CCFmm - MF = GSVp / ISVmm
19	Flowing density	- Master meter - IV pulse	- Ball prover bidirectional - Avg data	- CCFp = CTSp * CPSp * CTLp * CPLp - GSVp = BPV * CCFp - CCFmm = CTLmm * CPLmm - IVmm = Ni(avg) / NKFmm - ISVmm = IVm * CCFmm	- CCFp = CTSp * CPSp * [(1-Xw)*CTLo,p*CPLo,p +Xw*CTLw,p*CPLw,p] - GSVp = BPV * CCFp - CCFmm = (1-Xw)*CTLo,mm*CPLo,mm +Xw*CTLw,mm*CPLw,mm] - IVmm = Ni(avg) / NKFmm

ID	Density Type	Meter Type	Prover Type / Method	Calculation	Supported by FC302 in Appropriation Measurement
				- MF = GSVp / ISVmm	- ISVmm = IVmm * CCFmm - MF = GSVp / ISVmm
20	Flowing density	IV pulse	- Tank prover	- CCFp = CTSp * CTLp - GSVp = BPVa * CCFp - CCFm = CTLm * CPLm - IVm = Nm / NKFm - ISVm = IVm * CCFm - IMF = GSVp / ISVm	- CCFp = CTSp * [(1-Xw)*CTLo,p+Xw*CTLw,p] - GSVp = BPVa * CCFp - CCFm = [(1-X_w)*CTLo,m*CPLo,m +X_w*CTLw,m*CPLw,m] - IVm = Nm / NKFm - ISVm = IVm * CCFm - IMF = GSVp / ISVm
21	Flowing density	IV*CTL pulse	- Tank prover	- CCFp = CTSp * CTLp - GSVp = BPVa * CCFp - CCFm = CTLm * CPLm - IVm = Nm / (NKFm * CTLm) - ISVm = IVm * CCFm - IMF = GSVp / ISVm	No
22	Flowing density	IM pulse	- Tank prover	- CCFp = CTSp - PV = BPVa * CCFp - PM = PV * Dfp - IMm = Nm / NKFm - IMF = PM / IMm	No
23	Base density	IV*CTL pulse	- Tank prover	- CCFp = CTSp * CTLp - GSVp = BPVa * CCFp - CCFm = CTLm * CPLm - IVm = Nm / (NKFm * CTLm) - ISVm = IVm * CCFm - IMF = GSVp / ISVm	No
24	Base density	- Master meter - IV pulse	- Tank prover	- CCFp = CTSp * CTLp - GSVp = BPVa * CCFp - CCFmm = CTLmm * CPLmm - IVmm = Nmm / NKFmm - ISVmm = IVmm * CCFmm - IMF = GSVp / ISVmm	- CCFp = CTSp * [(1-Xw)*CTLo,p+Xw*CTLw,p] - GSVp = BPVa * CCFp - CCFmm = (1-X_w)*CTLo,mm*CPLo,mm +X_w*CTLw,mm*CPLw,mm - IVmm = Nmm / NKFmm - ISVmm = IVmm * CCFmm - IMF = GSVp / ISVmm

Equations used for allocation measurement:
According to the API-20.1 standard page 24 for pipe prover and piston prover:

$$MF = \frac{[BPV * (1 - X_w) * CTL_p * CPL_p + BPV * X_w * CTL_w * CPL_w] * CTS_p * CPS_p}{IV_m * (1 - X_w) * CTL_m * CPL_m + IV_m * X_w * CTL_w * CPL_w}$$

For more details about the correction factors applied, it has the following equation

- Pipe prover / Piston prover

$$MF = \frac{BPV * CTS_p * CPS_p * [(1 - X_w) * CTL_{o,p} * CPL_{o,p} + X_w * CTL_{w,p} * CPL_{w,p}]}{IV_m * [(1 - X_w) * CTL_{o,m} * CPL_{o,m} + X_w * CTL_{w,m} * CPL_{w,m}]}$$

Where:
$CTL_{o,p}$: CTL for oil in the prover
$CTL_{w,p}$: CTL for water in the prover
$CTL_{o,m}$: CTL for oil in the meter
$CTL_{w,m}$: CTL for water in the meter
$CPL_{o,p}$: CPL for oil in the prover
$CPL_{w,p}$: CPL for water in the prover
$CPL_{o,m}$: CPL for oil in the meter
$CPL_{w,m}$: CPL for water in the meter
X_w : percentage of water in volume at flowing condition

Master meter :

$$MF = \frac{IV_{mm} * [(1 - X_w) * CTL_{o,mm} * CPL_{o,mm} + X_w * CTL_{w,mm} * CPL_{w,mm}] * MMF}{IV_m * [(1 - X_w) * CTL_{o,m} * CPL_{o,m} + X_w * CTL_{w,m} * CPL_{w,m}]}$$

Where:
$CTL_{o,mm}$: CTL for oil in the master meter
$CTL_{w,mm}$: CTL for water in the master meter
$CTL_{o,m}$: CTL for oil in the meter
$CTL_{w,m}$: CTL for water in the meter
$CPL_{o,mm}$: CPL for oil in the master meter
$CPL_{w,mm}$: CPL for water in the master meter
$CPL_{o,m}$: CPL for oil in the meter
$CPL_{w,m}$: CPL for water in the meter

Audit trail, Field Device Calibration and Data Security

These are the main features of a flow computer that distinguishes it from the devices that only corrects the flow. These functionalities are required by the API-21.1 Standard for gas measurement and the API-21.2 Standard for liquid measurement.

Audit trail must be warranted by storing the information related to the calculations, these information can be checked and the necessary adjustments may be applied in case of failure in the measurement system.

The Standards require audit trail with the following information:

- Configuration log – restricted access to change the parameters that affect the calculation of the corrected flow, saving the identification of changed parameter, the previous value, the new value, date and time of change, and the identification of the user that executed it (this information is an optional item in the Standards listed above).

- QTR Reports (Quantity Transaction Record) – This report must include critical information related to the custody transfer, such as: transferred quantities converted to the base conditions, fluid properties, correction factors, reading values used in the calculation, meter identification, etc.

- Alarm and Event Record – The occurrence and clearance must be registered for process alarm and events. Each record must indicate the description, date and time of the alarm/event. Other important events must be registered, such as: power failure, override input values and diagnostics.

- Proving Reports – Detailed information related to the proving process, such as: weighed averages of the input variables corresponding to each proving batch, correction factors, corrected volume measured by the prover/master meter and the meter, MF calculated, repeatability, information related to the meter, the prover/master meter and the fluid. The API-12.2.3 standard details the proving reports.

The API-21.1 and API-21.2 standards also establish the verification and calibration procedures for field devices. The verification procedure compares the values measured and transmitted to the flow computer in normal operation conditions, using values measured on trackable reference standards. The periodicity of the verification must be shorter than the calibration, and a negative result of the verification may imply a calibration.

Security must be implemented through restricted access, data integrity in the flow computer memory, guarantee of authenticity and data transfer reliability from the flow computer to the reports.

Chapter 3

HARDWARE

WARNING: Failing to fulfill any step described in this chapter may imply system malfunction.

Racks, cables and accessories of AuditFlow system

MODEL	DESCRIPTION
DF0	Blind module to fill empty slots
DF1A	Rack with 4 slots – support to shielded flat cable
DF2	Terminator for the last rack – right side
DF3	Flat cable to connect 2 racks – length 6.5 cm
DF4A	Flat cable to connect 2 racks – length 65 cm
DF5A	Flat cable to connect 2 racks – length 81,5 cm
DF6A	Flat cable to connect 2 racks – length 98 cm
DF7A	Flat cable to connect 2 racks – length 110 cm
DF9	Support for a single module
DF54	Twisted pair cable 100 Base-TX
DF55	Twisted pair cable 100 Base-TX – cross cable – length 2m
DF59	Cable RJ12 used to connect controllers and DF58
DF68	Cable to connect redundant CPUs
DF76	Cable to connect coprocessors
DF78	Rack with 4 slots – It supports Hot Swap of CPUs and redundant I/O access
DF82	Synchronism cable to connect redundant controllers – length 500 mm
DF83	Synchronism cable to connect redundant controllers – length 1800 mm
DF84	IMB Soft Starter
DF90	IMB power cable
DF91	Lateral adapter
DF92	Rack with 4 slots for redundant CPUs, hot swap and diagnostic support
DF93	Rack with 4 slots, with diagnostic
DF96	Terminator for the last rack – left side
DF101	Flat cable to connect racks by left side – length 70 cm
DF102	Flat cable to connect racks by right side – length 65 cm
DF103	Flat cable to connect racks by right side – length 81 cm
DF104	Flat cable to connect racks by right side – length 98 cm
DF105	Flat cable to connect racks by right side – length 115 cm

Installing the system's base with DF92 and DF93 racks

In the following figure is shown the DF93 rack with its components.

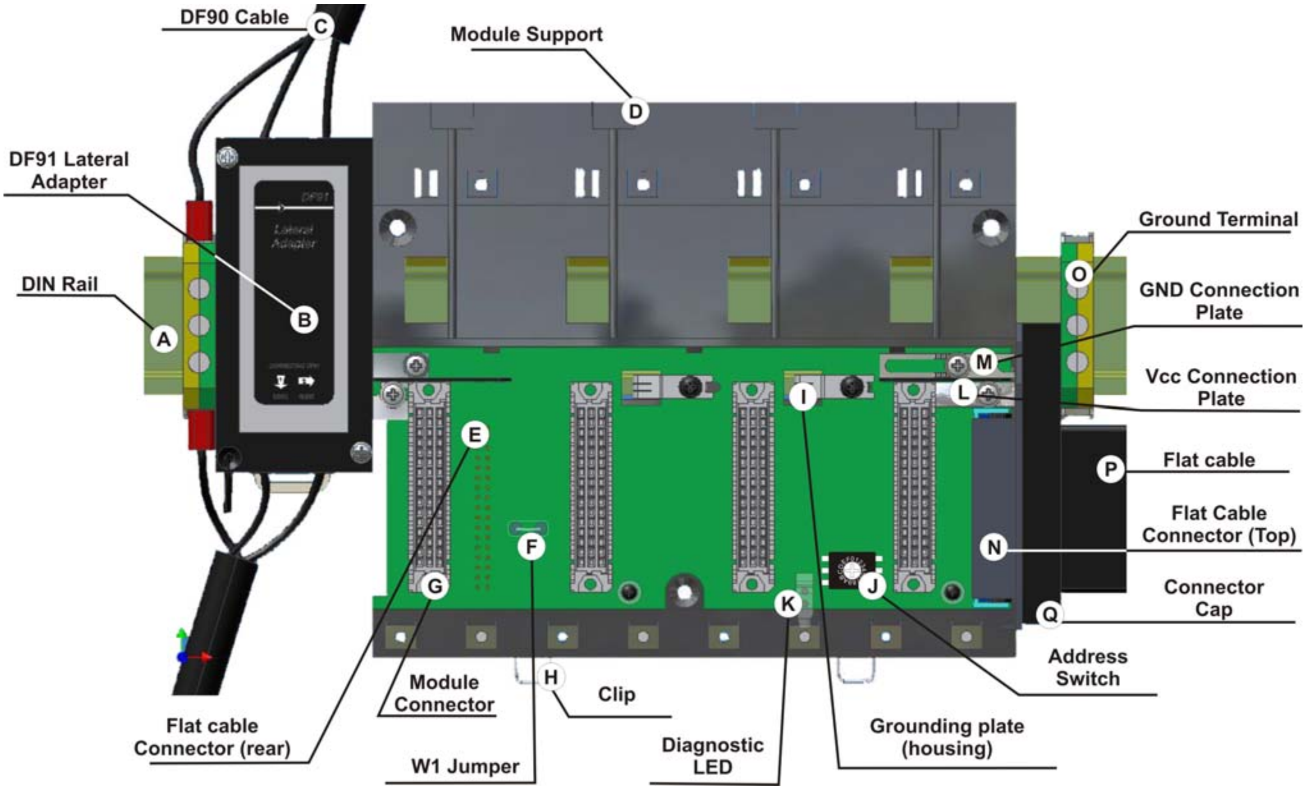


Figure 3. 1 - DF93 components

A – DIN rail- Base for rack connection. It should be tightly fixed to the place where the rack is being mounted.

B – Lateral adapter DF91 – It allows the connection of DF90 cables to rack.

C – DF90 cable– Cable for IMB power transmission. In this cable is the Vcc and GND of IMB and it has to be connected in the rack's left side.

D – Module support - Module holder located in the top of the rack.

E – Flat Cable Connector (rear) – It allows that two racks are interconnected by flat cable (P).
When there is more than one rack in a same DIN rail, the user should proceed as described in the "Connection between adjacent racks" topic.

F –**W1 Jumper –** To disconnect the rack from the power of the previous rack, W1 must be cut, together with the Vcc connection plate (L) of the previous rack. This condition is necessary if a new power supply is inserted from this rack.

G – Module connector – Connector to attach the module's bottom part to the rack.

H – Clips – The metal clips, located in the rack's bottom part, allow attaching the rack to the DIN rail. They must be pulled before fitting the rack on DIN rail, and then, pushed for pieces fixation.

I – Grounding plate (housing)

J – Address switch – When there is more than one rack in same data bus, the addressing switch allows different addresses to each rack.

K – LED for diagnostic – It is used for diagnostic of the rack's voltage.
L – Vcc connection plate – Vcc terminal (for power transmission).

M – GND connection plate - GND terminal (for power transmission).

N – Flat Cable Connector (top) – It allows that two racks are interconnected by flat cable (P).
When there is more than one rack in a same DIN rail, the user should proceed as described in the "Connection between adjacent racks" topic.

O – Ground terminal – It is used to ground the flat cables shield.

P – Flat Cable – Cable used to interconnect the data bus among racks.

Q – Connector cap – To meet the EMC requeriments a protector against ESD must be installed in the flat cables connections, at right.

Installing Racks - DF92 and DF93

The DF92 is used by redundant controllers, and it must be the first rack of IMB. The other racks must be DF93.

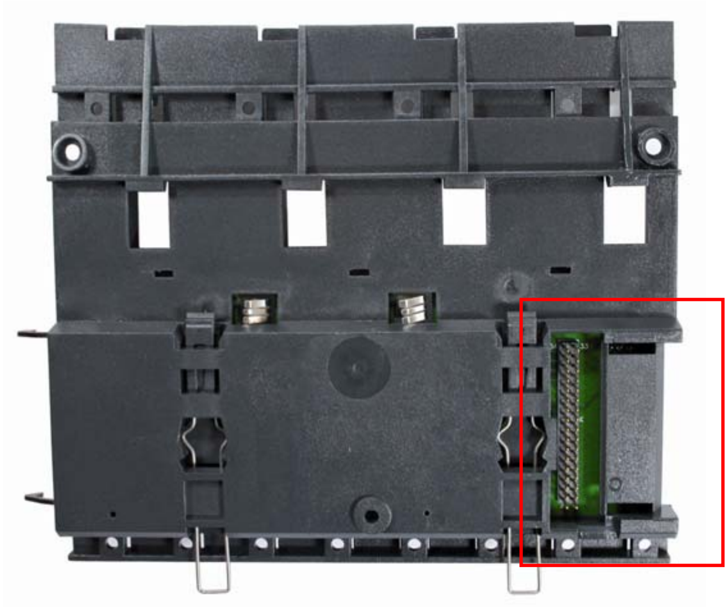


Figure 3. 2 - Rear connector of DF93 rack

IMPORTANT
Remember to leave a space in the DIN rail to install the DF91 and the grounding terminal at rack's left side.

Installing racks in the DIN rail

IMPORTANT
Before installing the rack on DIN rail, connect the flat cable to rear's connector (E) if you will connect this rack to another at left. After connected to the DIN rail is not possible place the flat cable on the rear's rack without remove it.

1. Use a screwdriver (or your fingers) to pull the clips down.
2. Place the back of the rack on the top of the DIN rail edge.
3. Accommodate the rack on the DIN rail and push the clips up. You will hear a click sound when they lock properly.
4. Set the correct address for the DF93 rack using its rotating switch (J). The DF92 rack does not have address switch.

Connection between adjacent racks

1. The adjacent cards to the joining part, between the racks, must be removed allowing access to this operation (racks's third slot, at left and slot 0 of rack, at right).
2. Connect the two racks using DF3 flat cable. This flat cable should already be connected to the connector on the rear's rack at right. And then, connect it to the top connector (N) of the rack at left.
3. Connect the two racks to the power connectors (L and M), moving them with a screwdriver and fixing with screws. Loose the screws only the suficient avoiding them from falling when making the connection. See the next figure.

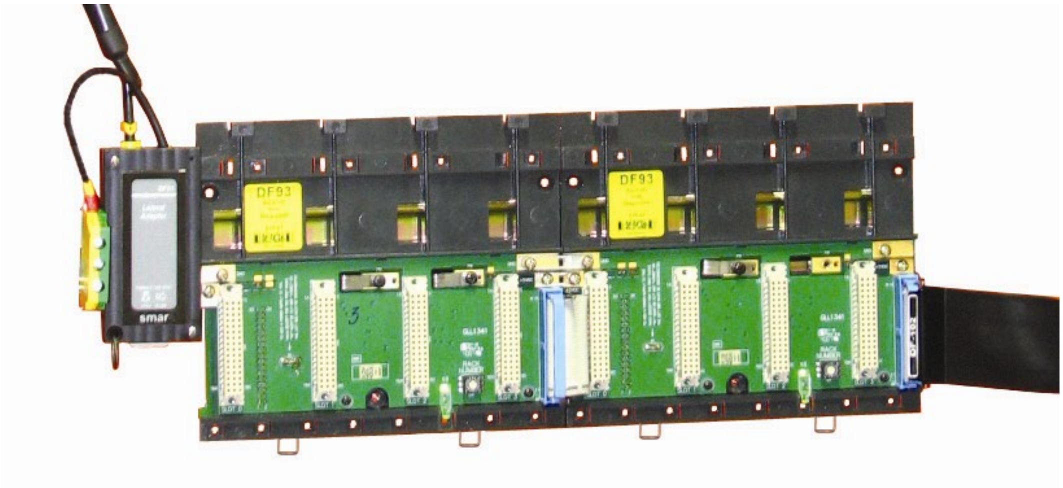


Figure 3. 3 - Connection between adjacent racks

Using the DF91

For further details about DF91 installation, refer to "Expanding the system's power supply – DF90 and DF91" topic.

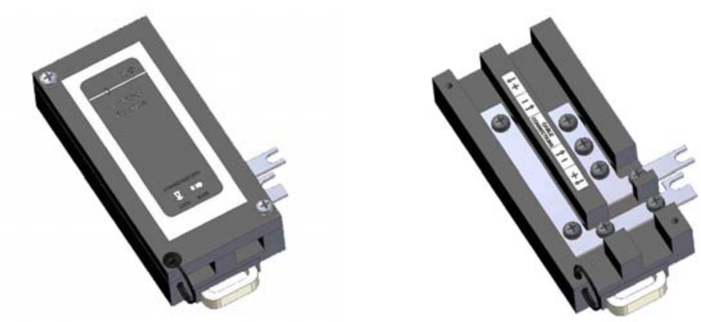


Figure 3. 4 - DF91 details

Left side ESD protection

If the power supply side connector on the left side of the rack (DF92 or DF93) is disconnected, it should be capped with the left side ESD protection for compatibility with the EMC standards. This situation can occur in the left-most rack in systems with a single row of racks or systems with individual racks.

The installation is done screwing the protection in the connection terminals on the left side of the rack. See the following figure.

Figure 3. 5 – Left side ESD protection installed on the rack

This protection is provided along with the DF2 terminator.

Disconnecting racks

1. The adjacent cards to the joining part, between the racks, must be removed allowing access to this operation.
2. Remove the flat cable of top connector (N) of the adjacent rack, at left.
3. Remove the power connections (L and M) of both sides of the rack that will be disconnected. For that, with a screwdriver, release the screws (only the sufficient) and move the connection plates to left until they are completely withdrawn, thus the rack is free to be removed.
4. If the DF91 (B) is connected to rack that will be removed, remove it until the rack to be free.
5. Remove the rear connector (E) after removing the rack from DIN rail.

Installing the expansion flat cables - DF101, DF102, DF103, DF104 and DF105

These flat cables are used when the AuditFlow is expanded in more than one row of racks, i.e., in different DIN rail segments, one below the other.

DF101 - Flat cable to connect racks by left side

It is installed in the rack's rear connectors (E) of the left extremity of each row of racks, interconnecting the rows 2-3, 4-5 and 6-7 (if they exist).

To ground the flat cables shield, use the ground terminal (O) next to flat cables connection. The available terminal, next to each DF91 (B), can be used.

DF102, DF103, DF104 and DF105 - Flat cable to connect racks by right side

They are installed on the upper connectors (N) of the right extremity rack of each row of racks, interconnecting the rows 1-2, 3-4 and 5-6 (if they exist).

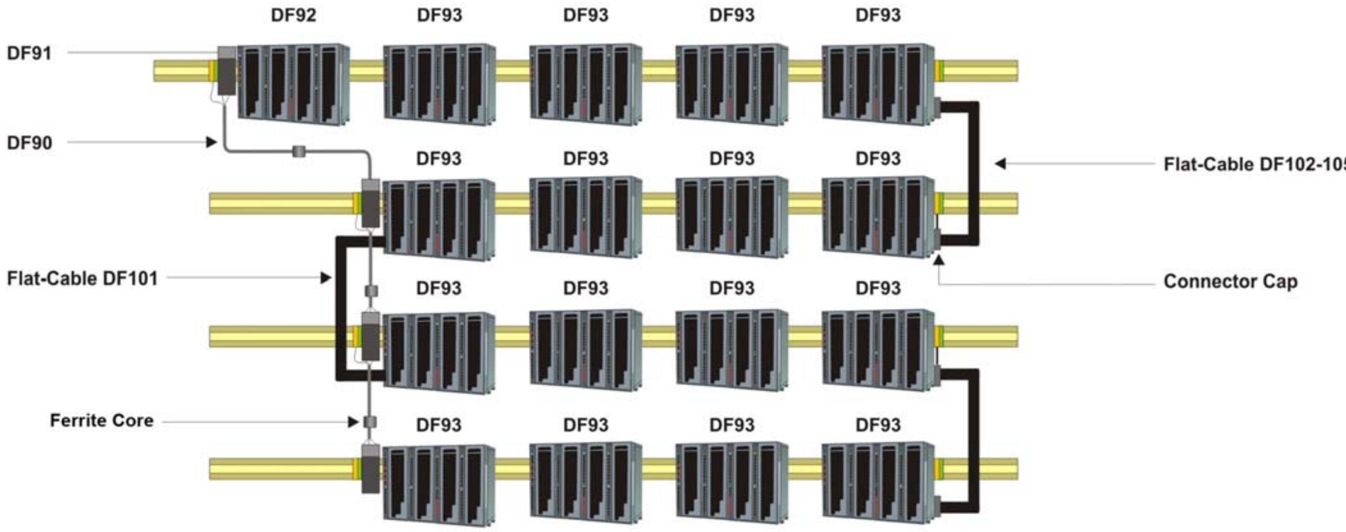


Figure 3. 6 - Illustration - DF101 and DF102-105 Flat cables

To ground the flat cables shield, use the ground terminals (O) next to flat cables connection.

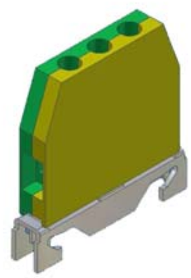


Figure 3. 7 - Ground terminal

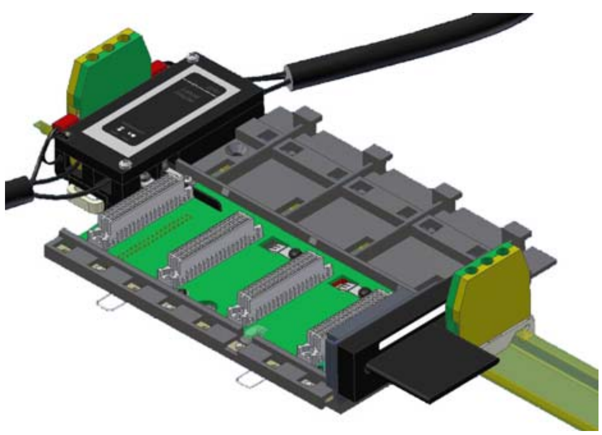


Figure 3. 8 - Ground terminal installed

Flat cables protector (connector cap)

To meet the EMC requirements a protector against ESD has to be installed on the flat cables connection, at right. In the following figure a flat cable protector is shown when it is being installed on the cable connector.

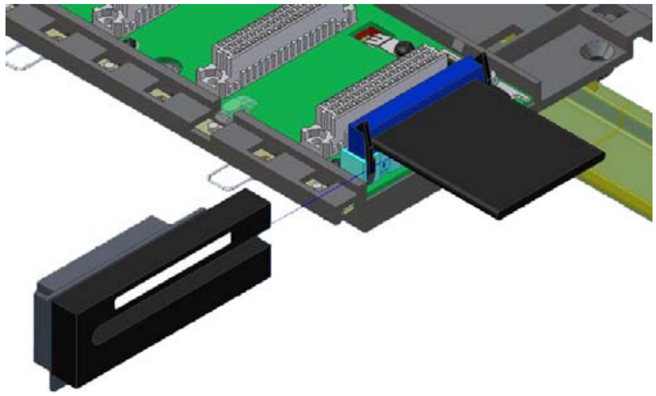


Figure 3. 9 - Installing the connector cap

In the following figure is shown a connector cap installed.

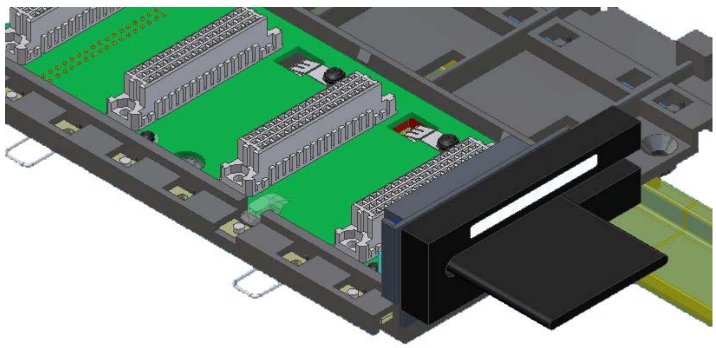


Figure 3. 10 - Connector cap installed

Installing the IMB terminator - DF2 or DF96

Only one of these two terminators types (DF2 or DF96) must to be installed at the end of IMB bus. It will depend on which side the last rack is connected to the system.

DF2 – IMB terminator for right side

It is connected to connector N of the last rack, when it is connected to the others by the left side. See the following figure.

Figure 3. 11 - DF2 terminator installed

For further details about its installation refer to DF2 manual.

DF96 – IMB terminator for left side

It is connected to connector E of the last rack, when it is connected to the others by the right side. See the next figure.

Figure 3. 12 - DF96 terminator

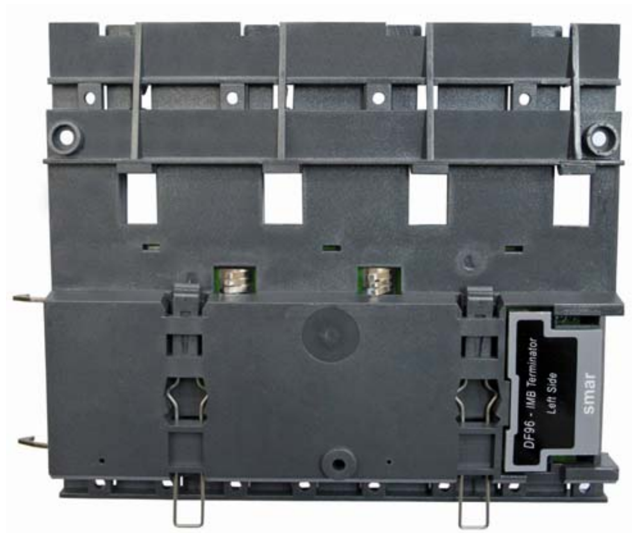


Figure 3. 13 - DF96 terminator installed in the DF93 rack

Summarizing, if the last rack has a flat cable connected by left side, use the DF2 terminator. If the last rack has a flat cable connected by right, use DF96 rack. Both cases depend on the number of row of racks, if it is even or odd.

Expanding the system’s power - DF90 and DF91

This expansion has to be used when the Auditflow is expanded in more than one row of racks, i.e., in different DIN rail segments, one below the other.

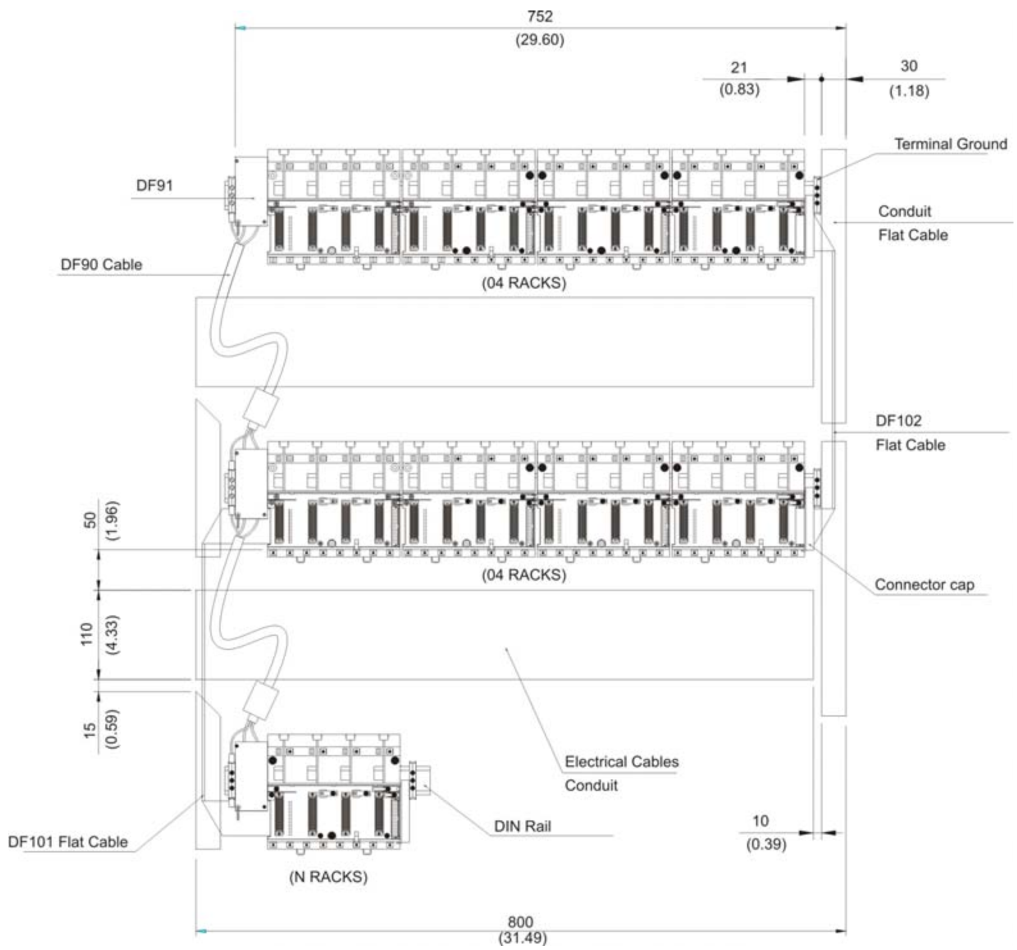


Figure 3. 14 - Example of expanded system

Installing the DF91 in the DIN rail
The DF91 is installed on the rack of the left extremity of each row of racks.

To connect the DF91 to the DIN rail, fix the DF91's rear part in the upper edge of the DIN rail, and then, accommodate the DF91 in the rail, pushing it until you hear a "click" sound.

Figure 3. 15 - DF91 rear part

Connecting the DF91 to rack
The first rack's slot needs to be empty allowing access to this operation.

1. Loose the screws (only the suficient) of the rack's power connector. See the next figure.

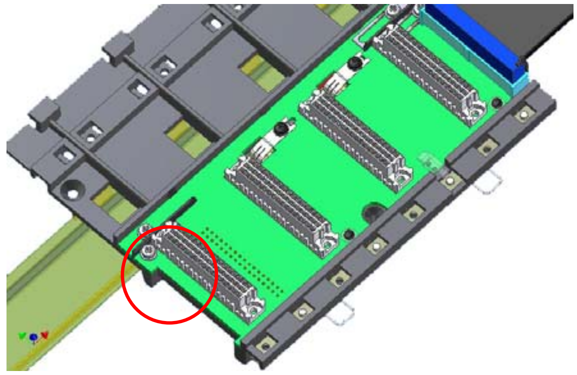


Figure 3. 16 - **Details of screws of the rack’s power connector**

2. Move the DF91 to right up to fix in the screws.
3. Tighten the screws.
4. After connect the DF91 to the rack, install the terminal ground in the left side of DF91, keeping it firm to the rack. This terminal also will be used for grounding of DF90’s shield.

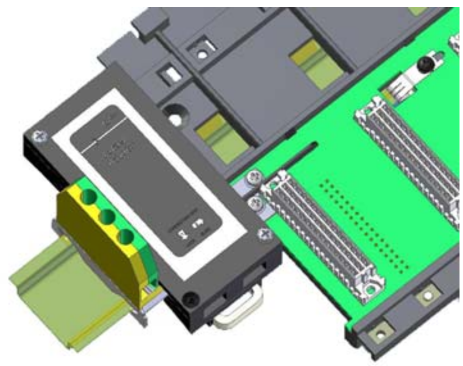


Figure 3. 17 - DF91 connected to rack

Installing DF90

Figure 3. 18 - IMB power cable (DF90)

The cable DF90 must be connected only through DF91, interconnecting two of them. Follow the next steps to execute that procedure.

1. With DF91 already connected to rack, release the cover’s screws, and open it;
2. Release the DF91’s screws indicated by labels (+) and (-);

Figure 3. 19 - DF91 detail

3. Attach the DF90's terminals with the DF91's screws, obeying the polarity indications;
4. Connect the DF90's shield terminal to the ground terminal next to DF91;

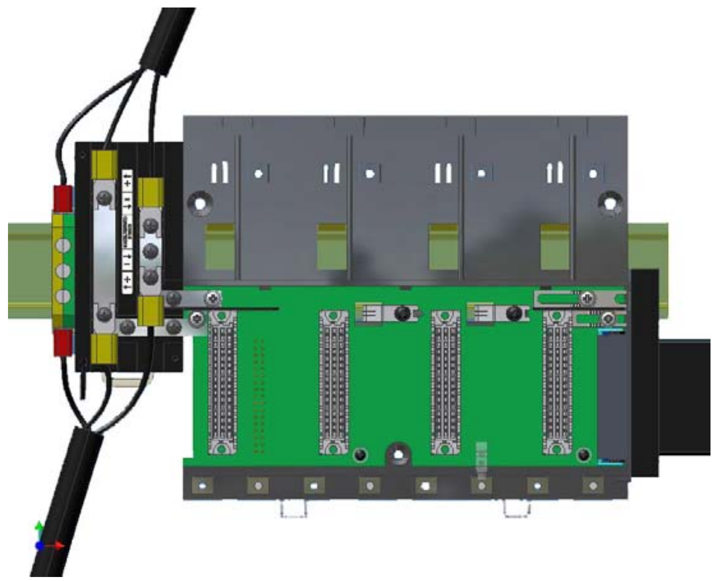


Figure 3. 20 - DF91 installed in the rack

5. Close the DF91 cover and tighten the screws.

Disconnecting DF91 from rack

1. The first card of the rack that will be disconnected must be removed allowing access to this operation;
2. Release (only the sufficient) the connector's screws of rack power, where DF91 is connected;
3. Move the DF91 to left (without separate it from rail) until the DF91's connection plates are out of rack's edge;
4. Tighten again the rack's screws if you will not connect them;
5. To remove the DF91, with a screwdriver, unlock it from DIN rail by pulling down the lock at its bottom part and removing that part from the rail.

Diagnostic resources

The DF93 rack has simple resources, but valuable, for voltage diagnostic in the bus. See the following table.

LED	Status
Off	Without voltage or voltage very low
Red	Insufficient voltage
Green	Sufficient voltage

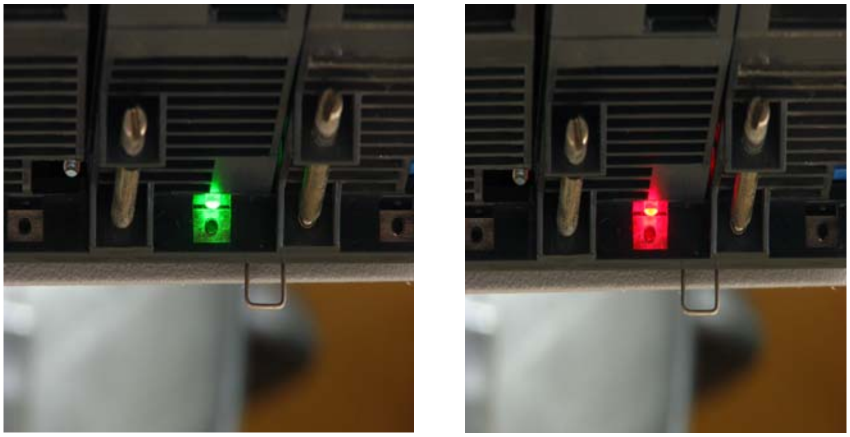


Figure 3. 21 - LEDs for diagnostic in the DF93 rack

Installing the system's base with DF1A and DF78

See below the figures and descriptions of module and rack:

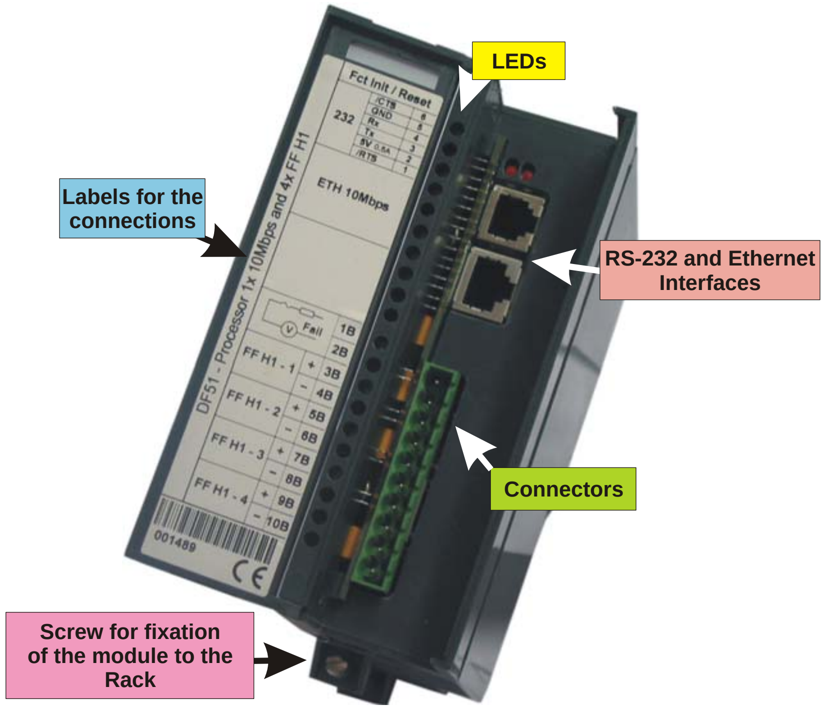


Figure 3. 22 - Module

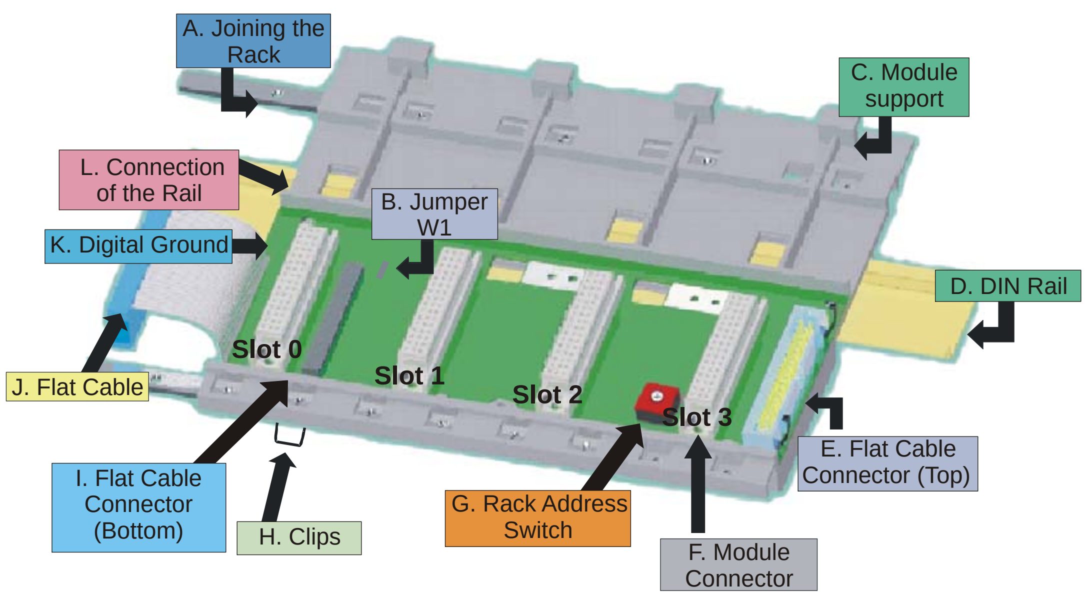


Figure 3. 23 - Rack – DF1A

- **Joining the Rack:** When assembling more than one rack in the same DIN rail, use this metallic piece to interconnect the racks. This connection generates stability to the assembly and makes possible the digital ground connection (K).

- **Jumper W1**: When connected, it allows the rack to be powered by the previous rack.

- **Module support:** Module holder located in the top of the rack.

- **DIN Rail:** base rack connection. It should be tightly fixed to the place where the rack is being mounted.

- **Flat Cable Connector (Top)**: When existing more than one rack in the same DIN rail, they must be hooked up by a flat cable (J) connected to the flat cable connectors (I) and (E).

- **Module Connector:** Bottom connection of the module to the rack.

- **Rack Address Switch:** When using more than one rack in the DIN rail, the rack address switch allows a distinct address to each rack.

- **Clips:** The clips, located above of the rack, allow it to be connected in the DIN rail. It should be pushed down before inserting the rack in the DIN rail and after that pushed up to fix the pieces.

- **Flat Cable Connector (Bottom):** When existing more than one rack in the same DIN rail, they must be hooked up by a flat cable (J) connected to the flat cable connectors (I) and (E).

- **Flat Cable:** Cable used to connect the data bus between the racks.

- **Digital Ground** – When using more than one rack in the same DIN rail, the connection between digital grounds (K) must be reinforced through appropriate metallic piece.

- **Connection of the Rail:** Support that brings the connection between the rack and the DIN rail (D).

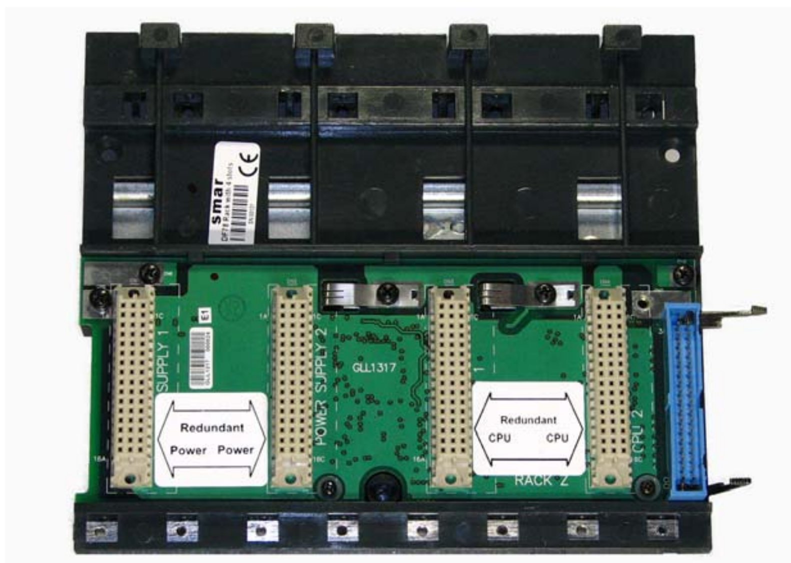


Figure 3. 24 - Rack – DF78

Installing a Rack in the DIN rail

1. In case of only one rack, this fixation can be done as the first step, even before of fixing any module to the rack.
2. Use a screwdriver (or your fingers) to pull the clips (H) down.
3. Place the back of the rack on the top of the DIN rail edge.
4. Accommodate the rack on the DIN rail and push the clips up. You will hear a click sound when they lock properly.
5. Set the correct address for the rack using the rotating switch at the rack.

Adding Racks

A. In case of using more than one rack in the same DIN rail, take a look in the flat cable connections (J) in the top connector of the first rack and in the bottom connector in the second rack, before plugging the new module in the slot 3 of the first rack;
B. Fix one rack to the other through the joining part of the rack (A). Pass the metal connector of one rack to the other and fix with screws;
C. Connect the digital ground (K), using one metallic connection fixed by screws.
D. Do not forget to place a terminator in the last rack. The terminator should be plugged in the flat cable connector (top) (E);
E. Set the address for the new rack using the rotating switch.

Tips for Assembling

If there is more than one rack in the same system:

1. Do the grip in the DIN rail at the end of the assembly.
2. Keep free the slot 3 of the rack to connect the other module through the flat cable connector.
3. Check the addresses configuration (rack address switch), as well as the jumper W1 and the cable of the bus.
4. Remember that to give continuity to the DC power supply to the previous rack, it is necessary to have the jumper W1 connected.
5. Make the amendment of racks and strengthens the digital ground of the hardware.

NOTES
1 - Although any application using DF1A as the first rack can use DF84, the DF84 is only necessary when the controller (FC302) executes local logic with discrete output cards. 2 - When using DF78 rack, DF84 is not necessary (DF78 does not have the P1 connector to install DF84).

Using the Fault Indicator

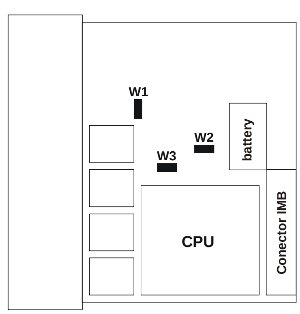
Terminals 1B and 2B of the FC302 can be used as Fault Indicators. These terminals are NC Relays. The NC Relay supports:

0.5 A @ 125 VAC
0.25 A @ 250VAC
2 A @ 30VDC

Usually the FC302 forces this relay to be open, but if the Processor generates a failure condition, the hardware will close the relay. This status can be used in redundant system where the backup Processor checks the relay and indicates the failure condition.

Another possibility is to use these relays to activate an alarm.

Jumpers on the Board



The W1 or Simulate jumper must be ON to activate the Simulate parameter (SIMULATE_D or SIMULATE_P) of the output and input function blocks.

Do not use the W2 and W3 jumpers. These jumpers are only used in the factory during the production of the module.

Improving the Grounding Signal in the AuditFlow (DF1A and DF78 Racks)

Although the rack 1A or DF78 of the **AuditFlow** system is connected by flat-cables that transfer the signal and power supply, it is possible that the grounding signal is degraded in applications using several modules. One solution to stabilize the grounding signal and give the system a better electrical noise immunity is to add an extra cable between the racks. These cables must follow the flat-cable path to avoid grounding loops. The wires must be strengthened and the diameter must be at least AWG18.

For adjacent racks, use the "extension connector" located on the left side of the rack. The user can mount a system with adjacent and non-adjacent racks.

IMPORTANT
Always use the Terminator Board in the last rack.

Non-Adjacent Racks

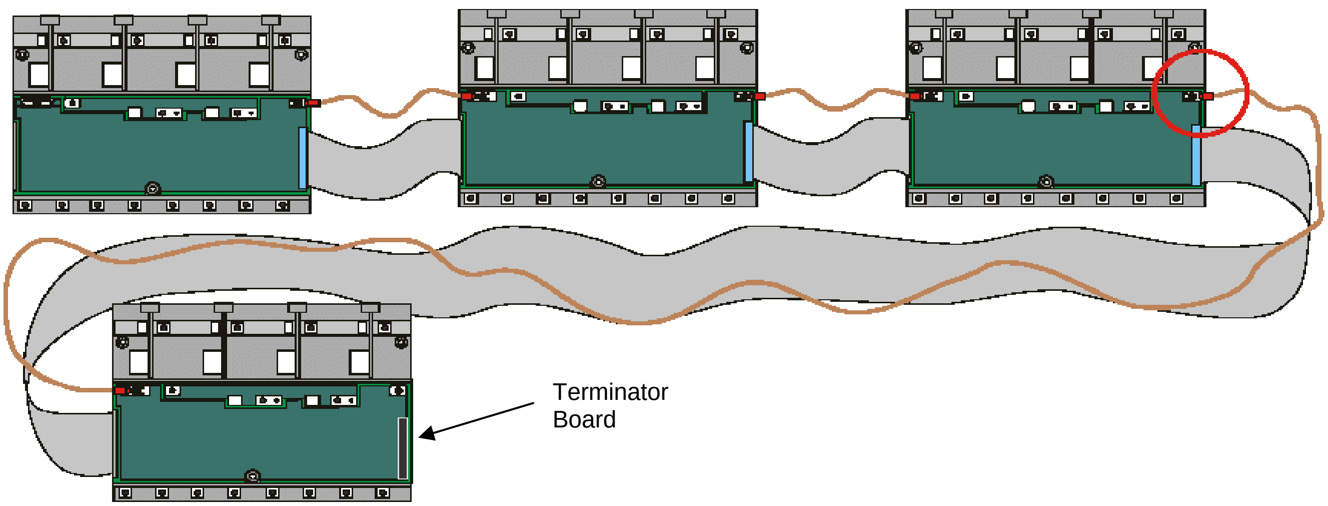


Figure 3. 25 – Non-adjacent racks

The figure below shows the connection of the grounding signal between the racks.

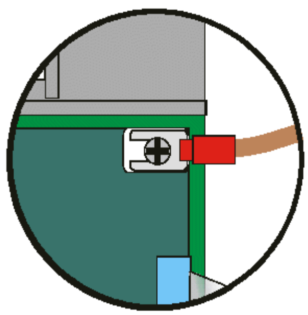


Figure 3. 26 - Connection Detail of the Grounding Signal Cable

Adjacent Racks

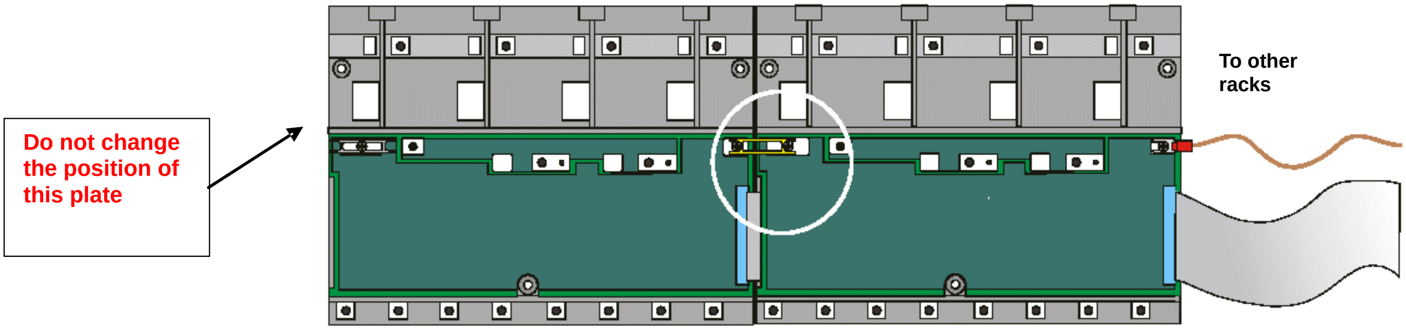
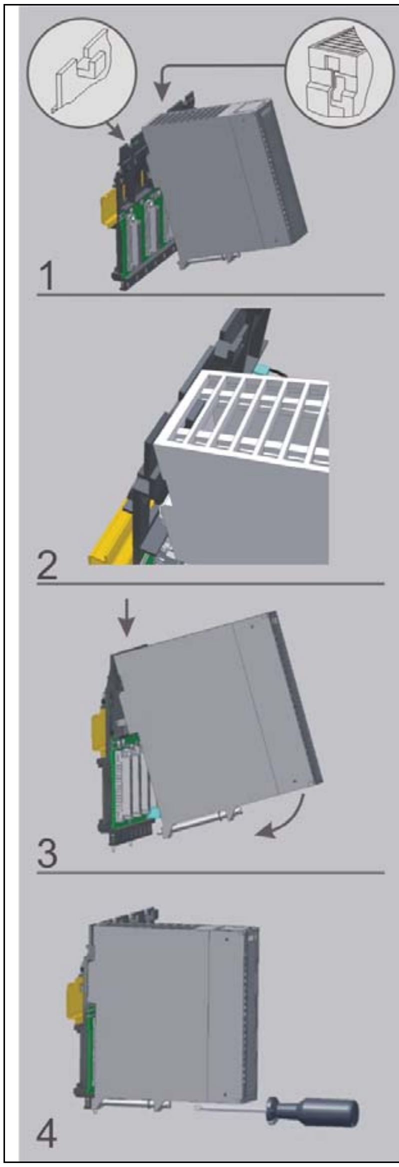


Figure 3. 27 – Connecting Adjacent Racks

Installing the Modules in the Rack

Follow the steps below to install the module in the rack.



1	Attach the top of the module with a 45^{o} inclination to the module support located on the upper part of the rack.
2	Assembling detail.
3	Push the module fixing it to the connector.
4	Next, fix the module to the rack using a screwdriver, and fasten the fixation screw at the bottom of the module.

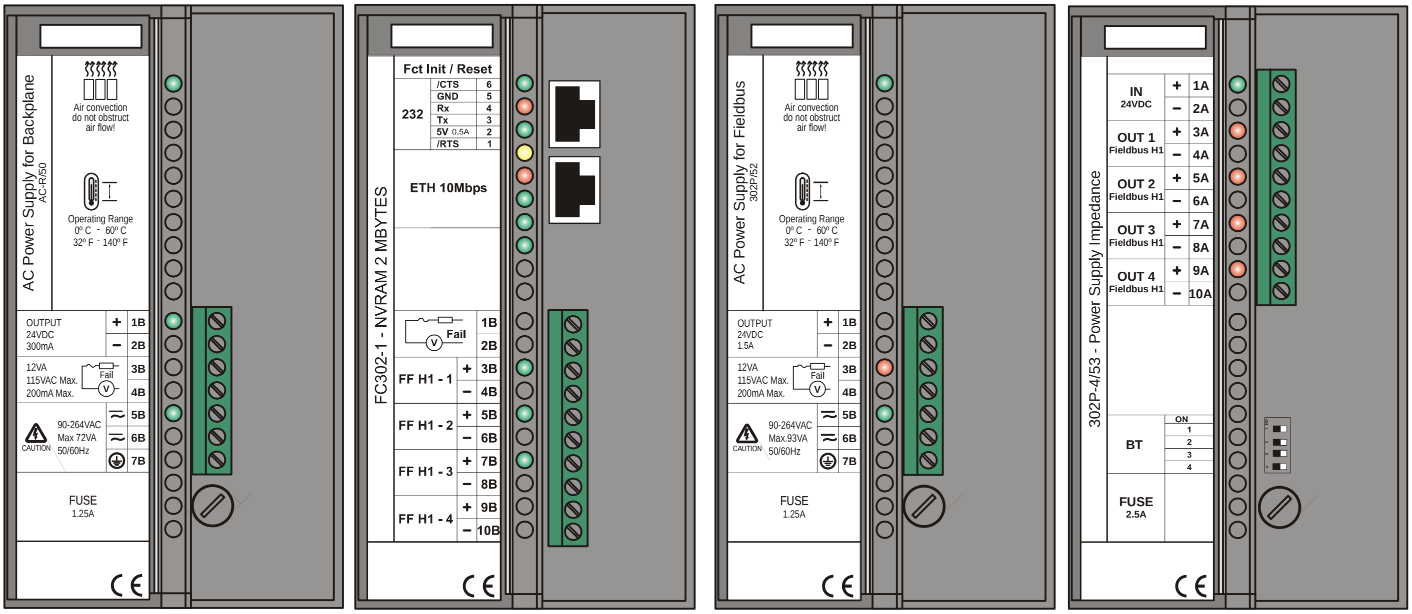
Figure 3. 28 - Installing the module in the rack

Preventing Electrostatic Discharge

ATTENTION
Electrostatic discharges may damage semiconductor electronic components in the printed circuit boards. They usually occur when touching components or connector pins from modules and racks without wearing the appropriate equipment to prevent discharges. It is recommended to take the following precautions: - Before handling modules and racks, remove the electrostatic charge from your body by wearing a proper wristband or touching grounded devices; - Avoid touching electronic components or connector pins from racks and modules.

Installing the Hardware

The figure below shows the front view of the modules:



AuditFlow Typical System (front view - open)

A shielded twisted-pair cable connects the **FC302** to the hub. The **FC302** uses RJ-45 connectors. The installation is simple and easy, and no specific tool or knowledge is required.

The LEDs of the **FC302** indicate the status of the communication. It isn't necessary to shut down the system to connect or disconnect the module. Using hubs/switches, the user can disconnect the device, and the process control or the communication with other nodes will not be interrupted.

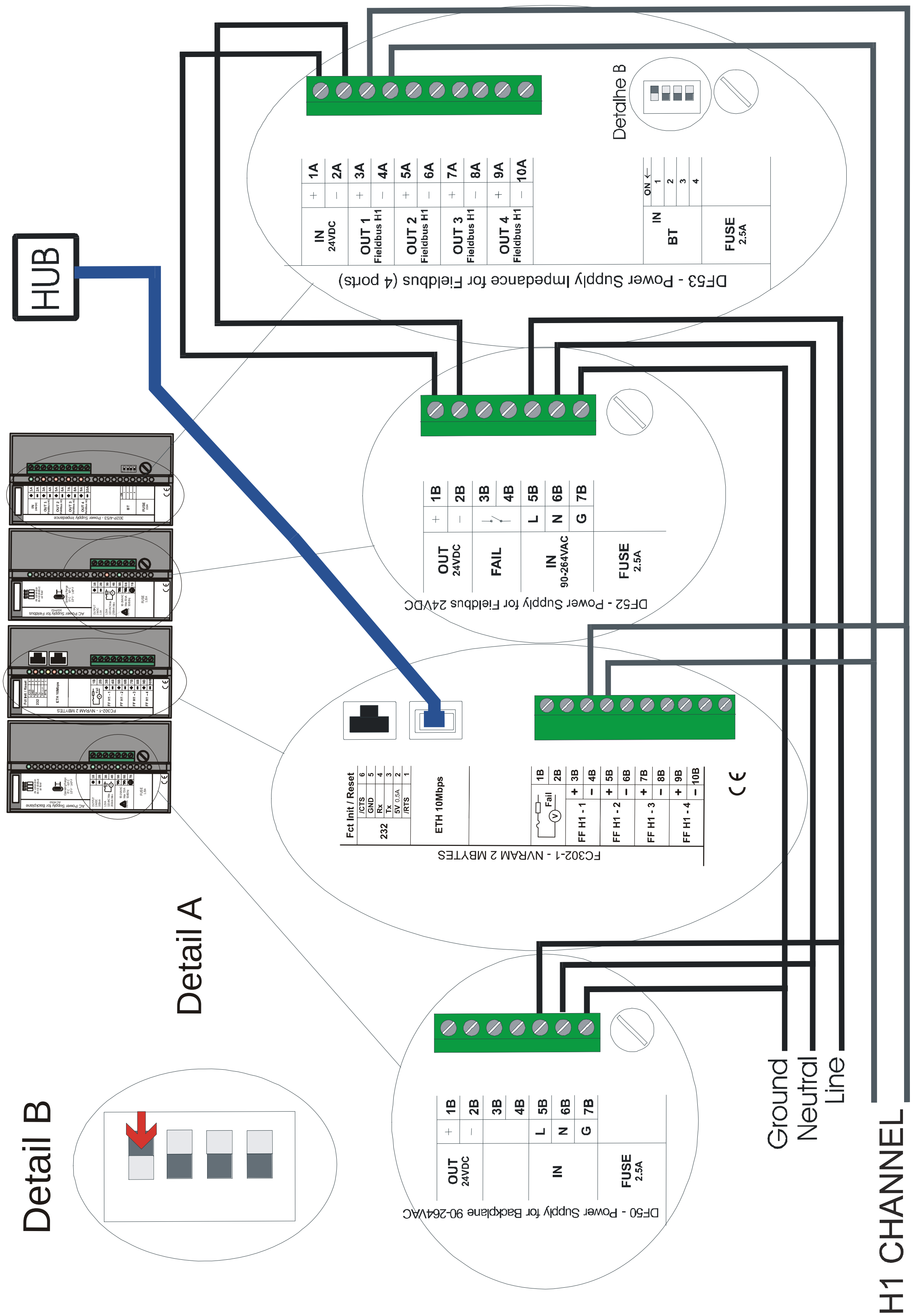
There are two types of connection cables: one for the FC302/HUB connection (DF54 cable) and other for the FC302/PC direct connection (DF55 cable). Refer to the Appendix of this Manual for further details.

The steps below describe the typical installation:

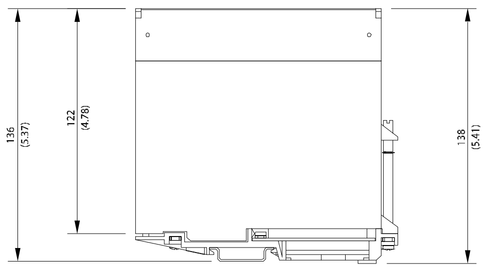
1. Connect the four modules (DF50, FC302, DF52, DF53) and the terminator (DF2) to the Rack (DF1A or DF93);
2. Connect the AC to the DF50 and DF52 input;
3. Connect the DF52 output to the DF53 input;
4. Plug the Ethernet cable (twisted pair cable), connecting the **FC302** to the HUB;
5. Connect the Fieldbus H1 bus to the FF H1 ports of the **FC302** and the DF53;
6. The **FC302** automatically obtains the IP address from the ***DHCP Server***, but if the server is **not** available, the **FC302** will have an initial fixed IP address (this initial IP address can be configured using the FBTools application - see section *Connecting the FC302 to the Subnet*).

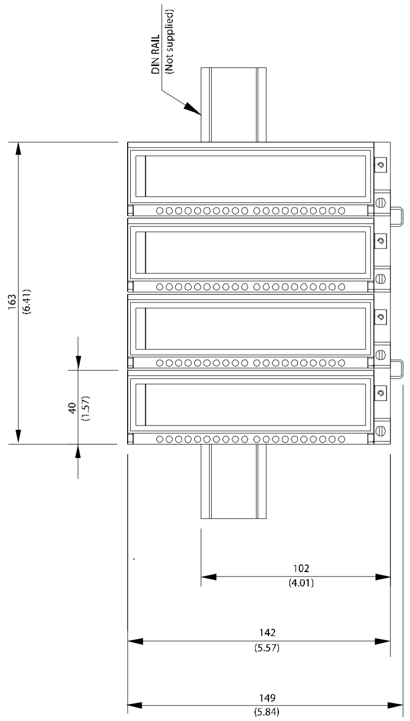
In the following figure, observe that:

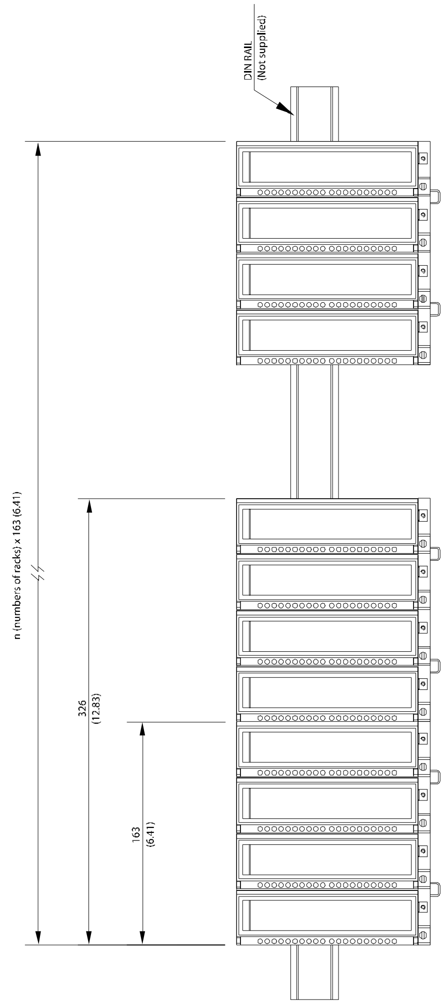
- **Detail A** shows the electrical connections described above, without the rack view (Rack DF1) and the terminator (DF2).
- **Detail B** shows the dip-switches that enable the internal terminator for each Fieldbus H1channel. In this example, there is only one Fieldbus H1 channel, and therefore the switch corresponding to the channel 1 is ON.

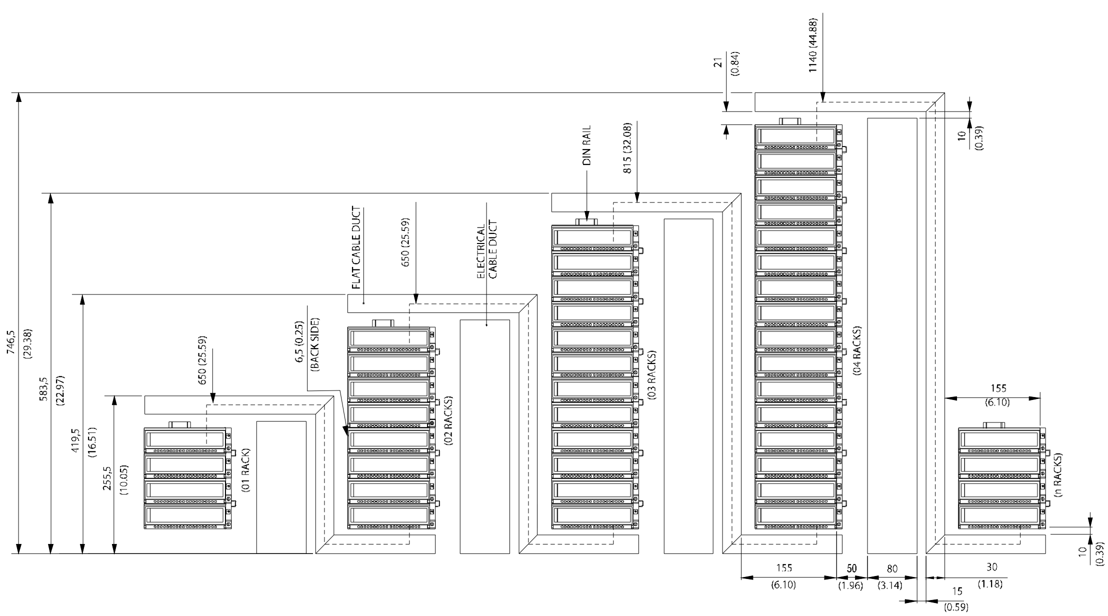

HUB
Detail A
Detail B
Detalhe B
DF53 - Power Supply Impedance for Fieldbus (4 ports)
DF52 - Power Supply for Fieldbus 24VDC
FC302-1 - NVRAM 2 MBYTES
DF50 - Power Supply for Backplane 90-264VAC
Ground
Neutral
Line
H1 CHANNEL

Dimensional Drawings of DF1A Rack and Modules



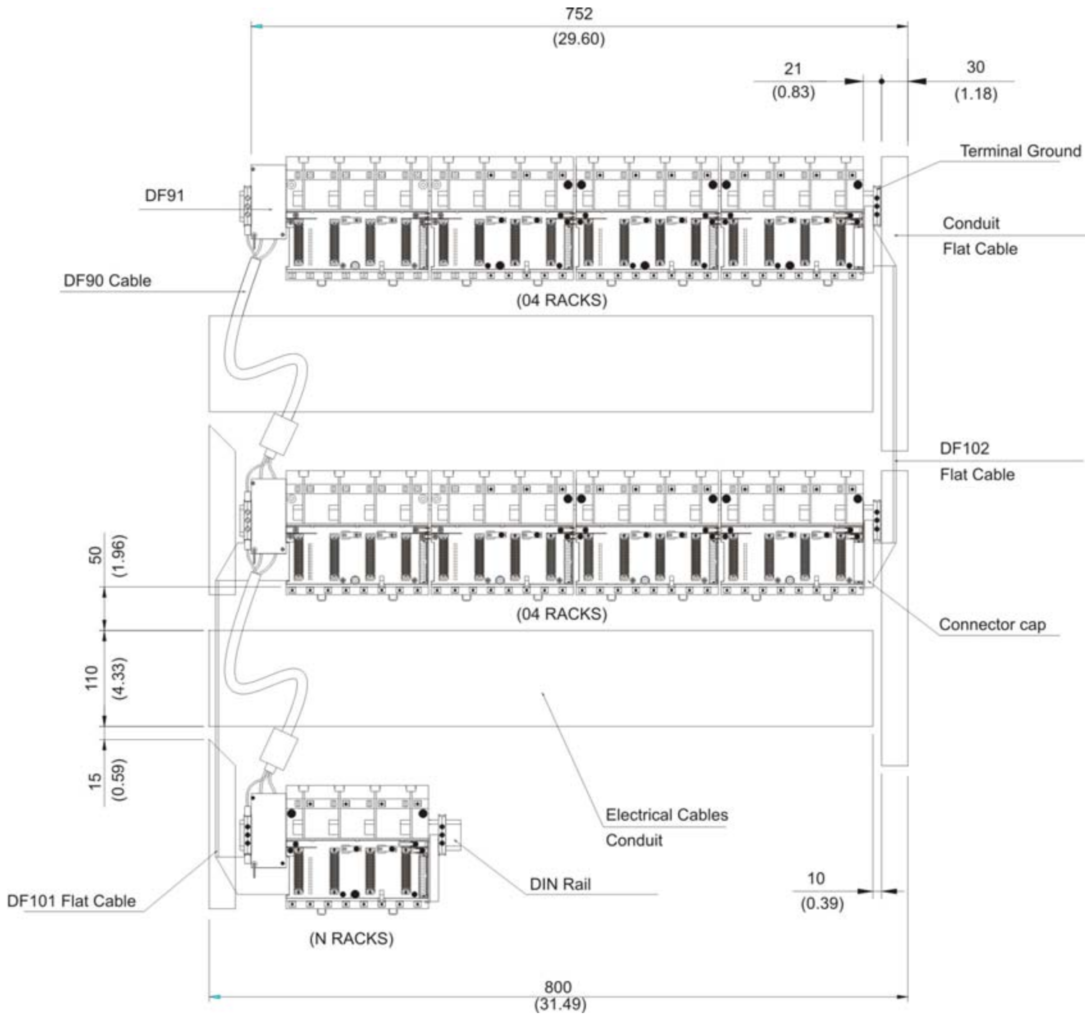


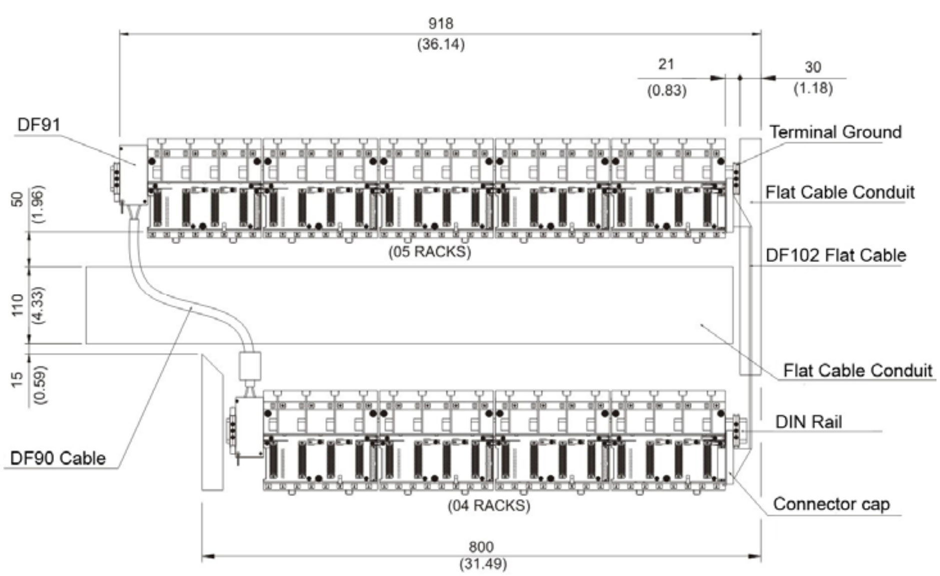




Dimensional Drawings of DF93 and Modules

The following figures show two possible combinations.



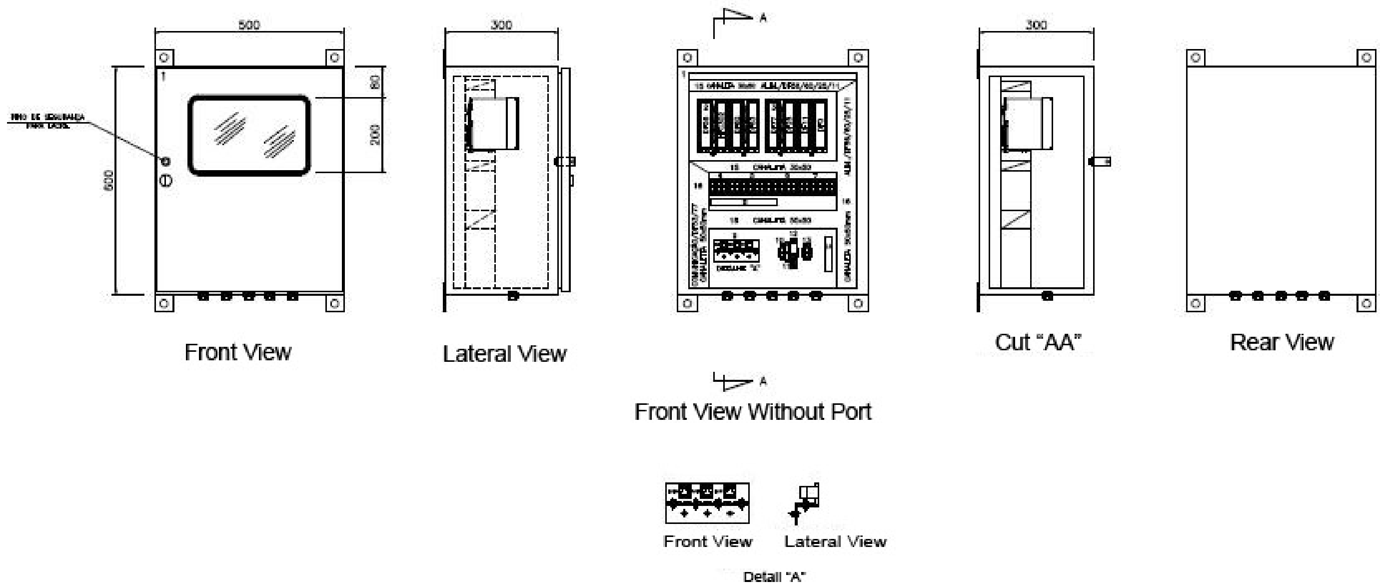


AuditFlow Panel

The AuditFlow system has a panel to cover the electronic of flow computer, which meets the most of the hardware settings and follows the principles indicated in the “Hardware Installation” chapter.

Panel characteristics
- Ingress Protection: IP55
- Material: carbon steel of 1.2 mm
- Painting: gray 7232
- Safety pin to seal
- Wall installation
- Acrylic window
- Cable gland, general circuit breaker and terminal blocks for field signals

Dimensional drawing



Chapter 4

ADDING RACKS

DF1A – Rack with 4 slots

Description

A rack is basically a plastic support for the IMB circuit that carries the connectors where the modules are plugged in. These connectors that fit the modules are called slots.

New racks can be added according to the project requirements. Up to 16 Racks are allowed. Racks can be connected for Local I/O expansion using flat cables (DF3, DF4A ~ DF7A).

Remember that the distance between the first module and the last module of an AuditFlow system, expanded by flat cables cannot exceed 22.97ft (7 meters).

NOTE
Each Rack has a rotating switch to select the address. The possible addresses are **0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.** Note that the “**F**” address is not allowed when I/O is being accessed by HCT function block or DF65 co-processor. The address **“F”** is supported when the I/O access is done through FFB 1131, which can be configured using “LogicView for FFB” software. For further details about FFB1131 block refer to Adding Logic Using Flexible Function Blocks section.

There are restrictions related to the module location on the rack. The restrictions are as follows:

1. The first slot of rack 0 is always reserved for the power supply module.
2. The second slot of rack 0 is always reserved for the controller module.
3. All additional power Supplies need to be placed in the slot 0 of the desired Rack (jumper W1 in the rack must be cut before plugging the power supply).
4. The first rack must have a DF84 terminator when the controller (FC302) executes local logic in discrete output cards.
5. The last rack must have a DF2 terminator installed.

Technical Specifications

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	148.5 x 25 x 163 mm ; (5.85 x 0.98 x 6.42 in)
Weight	0.216 kg

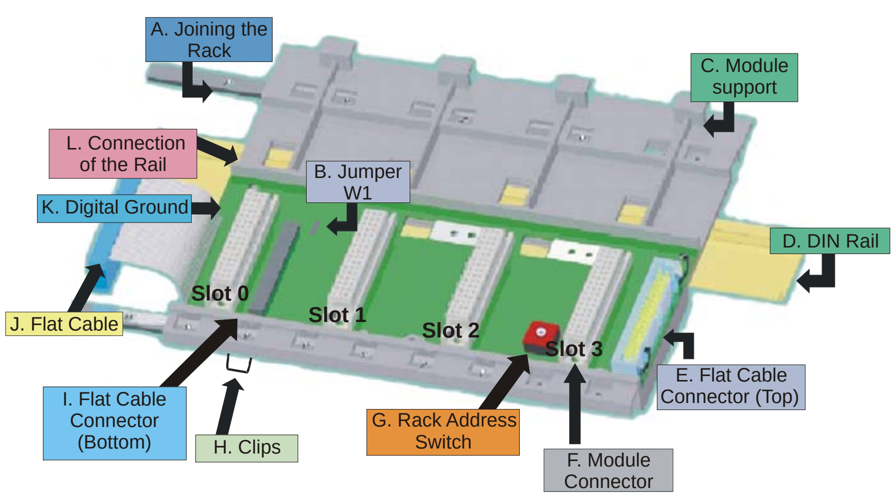


Figure 4. 1 – DF1A Rack

DF78 - Rack with 4 slots for Redundant CPUs

Description

The DF78 rack allows that two CPUs modules access the same I/O. This possibility is used when necessary redundancy and availability to the system. Up to 16 DF1A racks can be connected to DF78. Racks can be connected for Local I/O expansion using flat cables (DF3, DF4A ~ DF7A).

Remember that the distance between the first module and the last module of an AuditFlow system, expanded by flat cables cannot exceed 22.97ft (7 meters).

There are restrictions related to the power supply and controllers position on the DF78 Rack. The restrictions are as follows:

1. The first and second slots of DF78 rack are always reserved for power supply modules.
2. The third and fourth slots on DF78 rack are always reserved for controller modules.

NOTE
Each Rack has a rotating switch to select the address. The possible addresses are **0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.** Note that the "**F**" address is not allowed when I/O is being accessed by HCT function block or DF65 co-processor. The address **"F"** is supported when the I/O access is done through FFB 1131, which can be configured using "LogicView for FFB" software. For further details about FFB1131 block refer to Adding Logic Using Flexible Function Blocks section.

Technical Specifications

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	148.5 x 25 x 163 mm ; (5.85 x 0.98 x 6.42 in)
Weight	0.216 kg

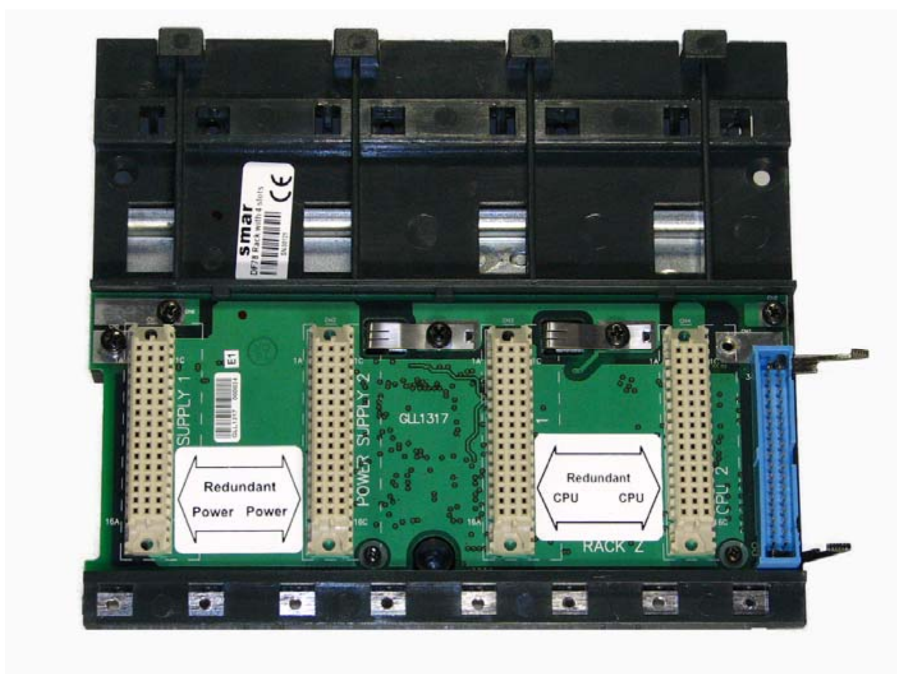


Figure 4. 2 – DF78 Rack

DF93 - Rack with 4 slots (with diagnostic)

Description

The DF93 rack is integral part of the new power system of AuditFlow. Its features provide low voltage drop through the IMB bus, so it is more efficient. Besides, the diagnostics resources of DF93 help in the problems detection minimizing the time stop and maintenance. The diagnostic can be obtained observing the diagnostics LEDs or through the status reading via controller.

The DF93 rack has Vcc and GND terminals at laterals (for power transmission). DF93's finishing avoids short circuits between the Vcc and GND connections at laterals.

As in the previous system, new racks can be added to the AuditFlow system according to the application needs. Up to 16 racks are allowed. The racks can be connected among them (expanding the bus) using flat cables (DF101 to DF107), DF90 (IMB power cable), and DF91 (lateral adapter).

Remember that the distance between the first module and the last module of an AuditFlow system, expanded by flat cables cannot exceed 22.97ft (7 meters).

NOTE
Each Rack has a rotating switch to select the address. The possible addresses are **0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.** Note that the "**F**" address is not allowed when I/O is being accessed by HCT function block or DF65 co-processor. The address **"F"** is supported when the I/O access is done through FFB 1131, which can be configured using "LogicView for FFB" software. For further details about FFB1131 block refer to Adding Logic Using Flexible Function Blocks section.

There are restrictions related to the module location on the rack. The restrictions are as follows:

1. The first slot of rack 0 is always reserved for the power supply module.
2. The second slot of rack 0 is always reserved for the controller module.
3. All additional power supplies need to be placed in the slot 0 of the desired rack (jumper W1 in the rack must be cut and the DF90 cable from the previous racks must be disconnected before plugging the power supply).
4. The first rack must have a DF84 terminator when the controller (FC302) executes local logic in discrete output cards.
5. The last rack must have a terminator installed - DF2 (right side) or DF96 (left side). For further details refer to Hardware section.
6. Grounding terminals must be used.

Technical Specifications

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	148.5 x 25 x 163 mm ; (5.85 x 0.98 x 6.42 in)
Weight	0.216 kg

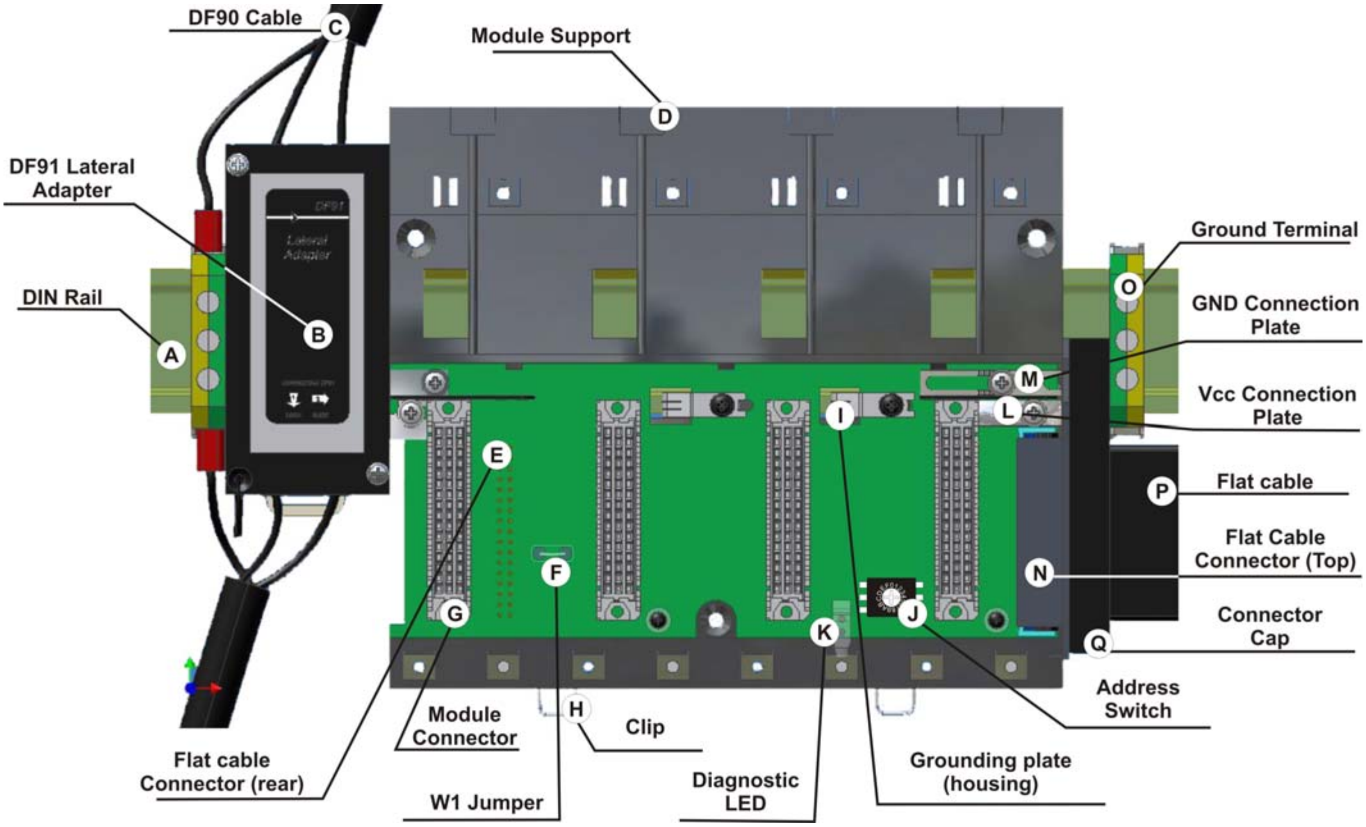


Figure 4. 3 – DF93 Rack

For compatibility with the EMC standards, if the power supply side connector on the left side of the rack is not connected, it should be capped with the left side protection according to the section Hardware, Installing racks - DF92 and DF93 topic. This protection is provided along with the terminator DF2.

DF92 - Rack with 4 slots for redundant CPUs (with diagnostic support)

Description

The DF92 is the new rack for redundant controllers in the IMB. Its function is similar to the DF78, but DF92 is optimized to reduce voltage drop in the IMB, besides it has different pins to connect, in the future, power supplies with more than 3A.

The DF92 rack has Vcc and GND terminals at laterals (for power transmission). DF92's finishing avoids short circuits between the Vcc and GND connections at laterals.

Moreover, the DF92 supports power supplies diagnostics for those that have this feature. It helps in problems detection and giving the desired confidence in the availability offered by redundancy. The diagnostic can be obtained observing the diagnostics LEDs or through the status reading via controller.

The DF92 rack can be connected up to 16 DF93 racks. The racks can be connected among them (expanding the bus) using flat cables (DF101 to DF107), DF90 (IMB power cable) and DF91 (lateral adapter).

Remember that the distance between the first module and the last module of an Auditflow system, expanded by flat cables cannot exceed 22.97ft (7 meters).

There are restrictions related to the module location on the rack. The restrictions are as follows:

1. The first and second slots of DF92 rack are always reserved for power supply modules.
2. The third and fourth slots on DF92 rack are always reserved for controllers' modules.
3. Grounding terminals must be used.

NOTE
Each Rack has a rotating switch to select the address. The possible addresses are **0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F.** Note that the "**F**" address is not allowed when I/O is being accessed by HCT function block or DF65 co-processor. The address **"F"** is supported when the I/O access is done through FFB 1131, which can be configured using "LogicView for FFB" software. For further details about FFB1131 block refer to Adding Logic Using Flexible Function Blocks section.

Technical Specifications

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	148.5 x 25 x 163 mm ; (5.85 x 0.98 x 6.42 in)
Weight	0.216 kg

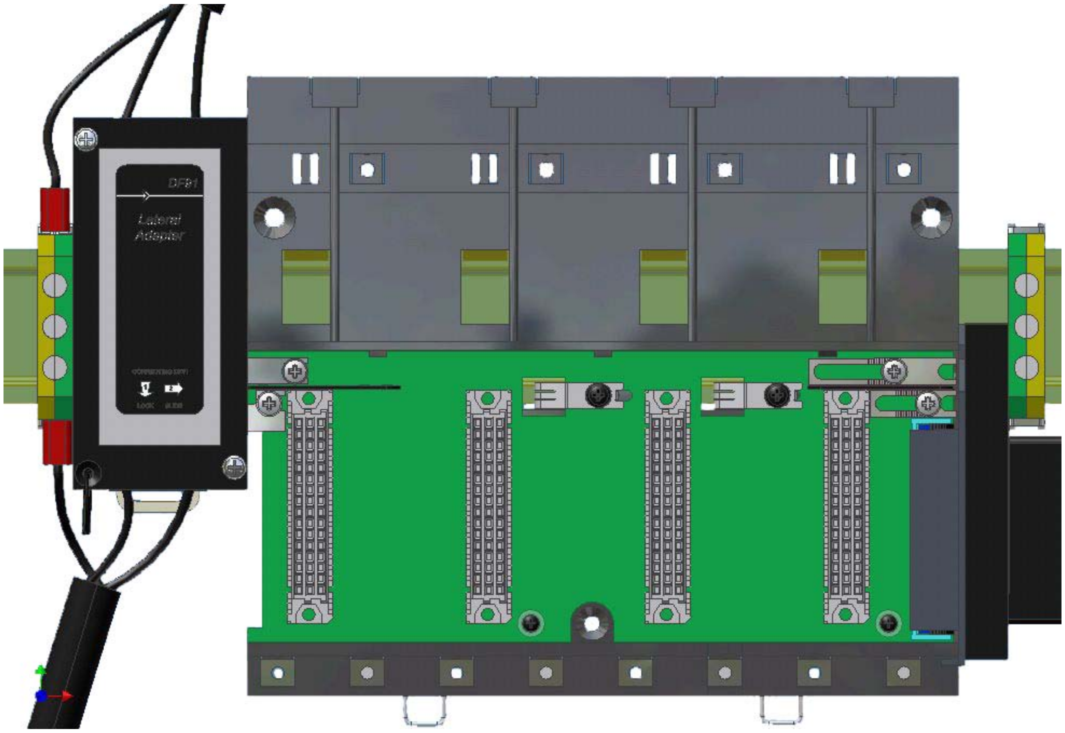


Figure 4. 4 – DF92 Rack

For compatibility with the EMC standards, if the power supply side connector on the left side of the rack is not connected, it should be capped with the left side protection according to the section Hardware, Installing racks - DF92 and DF93 topic. This protection is provided along with the terminator DF2.

Chapter 5

ADDING POWER SUPPLIES

Introduction

There are some recommendations when adding power supply modules to the system which should be considered.

First of all, an overview of the whole system is necessary at this time to better choose the modules (power supply, impedance etc.). Each controller module needs at least one power supply for backplane. The addition of I/Os modules requires new calculations to the power supply.

NOTE
Using ladder logic (FFB 1131), for a better monitoring of the functional state of each used I/O module is recommended to use the **STATUS** block in the logic. Thus the system can be advised if some I/O module have a failure. So that is easier to find a damaged module. Insert and configure this block according to the **LogicView for FFB** manual.

The following table shows the available modules used as power supply, intrinsic safety barrier and fieldbus impedances.

MODEL	DESCRIPTION
DF50	Power Supply for Backplane 90-264 Vac
DF56	Power Supply for Backplane 20-30 Vdc
DF52	Power Supply for Fieldbus 90-264 Vac
DF60	Power Supply for Fieldbus 20-30 Vdc
DF49	Power Supply Impedance for Fieldbus (2 ports)
DF53	Power Supply Impedance for Fieldbus (4 ports)
DF47-12	Intrinsic Safety Barrier for Fieldbus
DF47-17	
DF87	Power Supply for Backplane 20-30 Vdc, 5 A, redundant, with diagnostic

DF50 – Power Supply Module for Backplane (Redundant)

Description

This redundant power supply works independently or together with another redundant power supply module to ensure a constant supply of power to the application.

When two redundant power supplies are used, if one of them fails, the backup will automatically assume the operation. A relay is provided to indicate failure on each power supply giving the user a chance to replace the faulty one.

This module provides two voltage outputs:
a) **5 Vdc @ 3 A:** distributed by Power Lines in the Inter-Module-Bus (IMB) throughout the racks to supply the module circuits;
b) **24 Vdc @ 300 mA:** for external use through the terminals 1B and 2B.

The applied AC voltage, the 5 Vdc and the 24 Vdc are all isolated between them.

Installation and Configuration

For systems based on DF92 and DF93 rack, with DF90 and DF91

Redundant mode options

- **Splitting Power concept:** In this situation, two modules will supply power to a bus segment. If one of them was turned off or fails, the other power supply must be able to supply energy, alone, to the segment.
  The **CH1** jumper (power supply) must be set in **R** position for both modules and **W1** jumper (power supply) must be opened for both modules.

- **Standby concept:** In this case, just one power supply provides energy to the system. If it was turned off or fails, the backup module will assume the operation. In both modules, the jumper **CH1** (power supply) must be set in the **R** position and **W1** jumper (power supply) must be placed only in the backup module.

Expansion of load capacity by adding power supplies or pairs of redundant power supplies
If the system consumption is greater than 3A, it can be subdivided in up to 8 groups sized for consumption of up to 3A each, and each group is individually powered by a power supply, or redundant pair of power supplies. More details on the Power supplies positioning topic.

Power supplies positions in the racks
On **DF92,** the pair of redundant power supplies must be installed in the first and second slots.

On **DF93** is recommended the placement of the redundant pair in the first and second slots, but it can be installed in any slots if necessary.

Configuration of "W1" and "CH1" jumpers
The **DF50 CH1** jumper always must be connected to the **R** position. The **W1** jumper (power supply) must be connected only in the **DF50** modules configured as "backup", in the standby concept, as above mentioned in the redundant mode options.

For systems based on DF1A and DF78 racks

Non-redundant (single module): power consumption **limited** to 3A:
There is an addressing restriction related to the power supply location. The restriction is that the first rack (address 0) must always contain a power supply module at the first slot.
In the power supply module the **CH1** jumper must be set in **E** position.

Non-redundant (more than one module): power consumption **bigger** than 3A:
Additional modules are placed in the bus in parallel, but isolated one of the other. For systems based on **DF1A rack,** the power supplies modules must always be placed at the first rack's slot. The jumper **W1** (in the rack), where is the new power supply module, must be cut. The new power supply module will only supply power to the rack where it is sitting on and to the consecutive ones (never backwards).
In all power supplies modules, the **CH1** jumper must be set in **E** position.

Redundant mode

- **Splitting Power concept:** In this case of redundancy, the user may have two power supplies modules in parallel in first and third slots of rack **DF1A** or in the first and second slots of rack **DF78**. The **CH1** jumper (power supply) must be set in **R** position for both modules and **W1** jumper (power supply) must be opened for both modules. In this situation, the two modules will supply power to the bus.

- **Standby concept:** In this case, the main module must be placed in the first slot and the backup module in the third slot of rack **DF1A** or in the first and second slots of rack **DF78**. In both modules, the **CH1** jumper (power supply) must be set in the position **R** and **W1** jumper (power supply) must be placed only in the backup module.

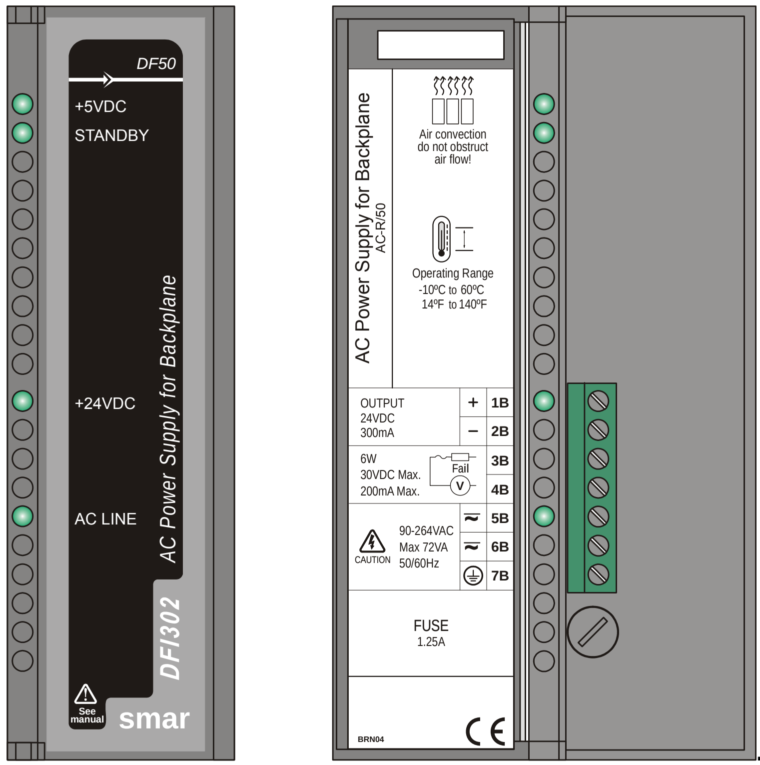


Figure 5. 1 - AC Power Supply Module: DF50

Technical Specifications

INPUTS	
DC	127 to 135 Vdc
AC	90 to 264 VAC, 50/60 Hz (nominal), 47 to 63 Hz (range)
Inrush Current	< 36 A @ 220 Vac [ΔT < 740 us]
Time until Power Fail	6 ms @ 102 Vac (120 Vac – 15%) [Full Load]
Time until Shutdown	27 ms @ 102 Vac; > 200ms @ 220 Vac [Full Load]
Maximum consumption	72 VA
Indicator	AC LINE (Green LED)

OUTPUTS	
a) Output 1 (internal use)	5.2 Vdc +/- 2%
Current	3 A Maximum
Ripple:	100 mVpp Maximum
Indicator	+5 Vdc (Green LED)
Hold up Time	> 40 ms @ 120 Vac [Full Load]
b) Output 2 (external use)	24 Vdc +/- 10%
Current	300 mA Maximum
Ripple	200 mVpp Maximum
Short Circuit Current	700 mA
Indicator	+24Vdc (Green LED)

ISOLATION	
Input signal, internal outputs and the external output are isolated among them.	
Between the outputs and the ground	1000 Vrms
Between the input and output	2500 Vrms

FAILURE RELAY	
Type of Output	Solid state relay, normally closed (NC), isolated
Limits	6 W, 30 Vdc Max, 200 mA Max
Maximum Initial Contact Resistance	<13Ω
Overload Protection	Should be provided externally
Operation Time	5 ms maximum

TEMPERATURE	
Operation	-10 °C to 60 °C (14 ºF to 140 ºF)

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	39.9 x 137.0 x 141.5 mm; (1.57 x 5.39 x 5.57 in)
Weight	0.450 kg

CABLES	
One wire	14 AWG (2 mm^2)
Two wires	20 AWG (0.5 mm^2)

NOTES
1) If the power consumption exceeds the power supplied, the AuditFlow system may operate in an unpredictable manner that may causes damages to the equipment or risk of personal injury. Hence, the power consumption must be calculated correctly and install more power supplies modules, if it is necessary.
2) To increase the service life of your contacts and protect the modules from potential reverse voltage damage, connect externally a clamping diode in parallel with each inductive DC load or connect an RC snubber circuit in parallel with each inductive AC load.
3) The redundancy feature is only guaranteed for racks with GLL1270 Revision 2 or greater. For the models with their revisions less than the mentioned above, the technical support must be consulted in order to check the compatibility.
4) To meet the EMC standards requirements, the wires' length to the failure relay must be less than 30 meters. The power supply of activated load by the failure relay must not be from external network.

DF56 – Power Supply for Backplane (Redundant)

Description

This redundant power supply works independently or with another redundant power supply module to assure a constant power supply to the application. When two redundant power supply modules are used, both split the energy that is needed to supply the system. When one power supply fails, the other, automatically, will assume the operation. Each power supply has a relay to indicate failures allowing the user to replace damage modules.

This module has two voltage outputs:
a) **5 Vdc @ 3A** distributed by power lines in the Inter-Module-Bus (IMB) through racks to supply module circuits;
b) **24 Vdc @ 300 mA** for external use through terminals 1B and 2B.

The DC applied voltage and the 5Vdc and 24 Vdc are isolated.

Installation and Configuration

For systems based on DF92 and DF93 rack, with DF90 and DF91

Redundant mode
Splitting Power concept: In this situation, two modules will supply power to a bus segment. If one of them was turned off or fails, the other power supply must be able to supply energy, alone, to the segment.

Expansion of load capacity by adding power supplies or pairs of redundant power supplies
If the system consumption is greater than 3A, it can be subdivided in up to 8 groups sized for consumption of up to 3A each, and each group is individually powered by a power supply, or redundant pair of power supplies. More details on the Power supplies positioning topic.

Power supplies positions in the racks
On DF92, the pair of redundant power supplies must be installed in the first and second slots.

On DF93 is recommended the placement of the redundant pair in the first and second slots, but it can be installed in any slots if necessary.

Configuration of CH1 jumper
The DF56 **CH1** jumper always must be connected to the **R** position.

For systems based on DF1A and DF78 racks

Single Module: Less than 3 A are required.
There is an address restriction related to the location of the power supply. This restriction is the first rack (address 0) must have a power supply module in the first slot. The **CH1** jumper (power supply) must be set in the **E** position.

More Than One Module: More than 3 A are required.
For systems based on **DF1A rack** the power supplies must be placed in the first slot of the rack. Jumper **W1** on the rack that has the new power supply must be cut. Every new power supply will only supply energy to the rack in which it is located and, with the jumper cut off, it will not supply energy to the previous racks. All modules must have the **CH1** jumper (power supply) set in the **E** position.

Redundant Mode:
In redundant mode, the power supply modules must be placed in the first and third slots of rack **DF1A** or first and second slots of rack **DF78**. In both, the **CH1** jumper (power supply) must be set in the **R** position. In this condition, the power supply modules will split the power. This topology is called “split power mode”.

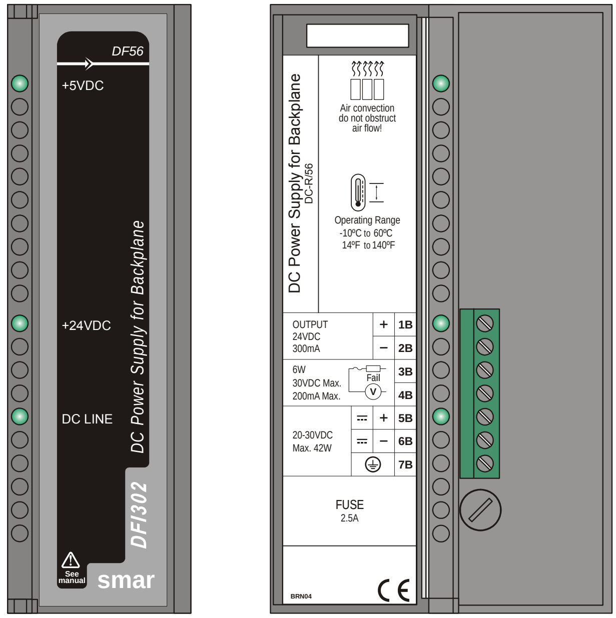


Figure 5.1 - DC Power Supply Module: DF56

Technical Specifications

INPUTS	
DC	20 to 30 Vdc
Inrush Current	< 20.6 A @ 30 Vdc [∆T < 430 us]
Maximum Consumption	42 W
Indicator	DC LINE (Green LED)

OUTPUTS	
a) Output1 (internal use)	5.2 Vdc +/- 2%
Current	3 A Maximum
Ripple	100 mVpp Maximum
Indicator	+5 Vdc (Green LED)
Hold up Time	> 47 ms @ 24 Vdc [Full Load]
b) Output 2 (external use)	24 Vdc +/- 10%
Current	300 mA Maximum
Ripple	200 mVpp Maximum
Short Circuit Current	700 mA
Indicator	+24 Vdc (Green LED)

ISOLATION	
Input signal, internal outputs and the external output are isolated among them.	
Between outputs and ground	500 Vrms
Between input and output	1500 Vrms

FAILURE RELAY	
Type of Output	Solid state relay, normally closed (NC), isolated
Limits	6 W, 30 Vdc Max, 200 mA Max
Maximum Initial Contact Resistance	<13 Ω
Overload Protection	Should be provided externally.
Operation Time	5 ms maximum

TEMPERATURE	
Operation	-10 ºC to 60 ºC (14 ºF to 140 ºF)

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	39.9 x 137.0 x 141.5 mm ; (1.57 x 5.39 x 5.57 in)
Weight	0.450 kg

CABLES	
One wire	14 AWG (2 mm^2)
Two wires	20 AWG (0.5 mm^2)

NOTES
1. If the power consumption exceeds the power supplied, the AuditFlow system may operate in an unpredictable manner that may causes damages to the equipment or risk of personal injury. Therefore, the power consumption must be calculated correctly and a detailed analysis should be performed to define the installation of extra power supply modules. 2. The hardware revisions which are GLL1279 Rev1 and previous revisions do not support redundancy feature. 3. To meet the EMC standards requirements, the wires' length to the failure relay must be less than 30 meters. The power supply of activated load by the failure relay must not be from external network.

DF87 – Power Supply for Backplane (5 A, Redundant, with diagnostic)

Description

This redundant power supply works independently or with another redundant power supply module to assure a constant power supply to the backplane. When two redundant power supply modules are used, both split the energy that is needed to supply the system. When one power supply fails, the other, automatically, will assume the operation.

This module provides a 5 Vdc output voltage, isolated from the input, with capacity of 5 A.

The DF87 has advanced diagnostics, which are indicated by LEDs, and can be read by the controller. It also has a relay that is activated (closed) to indicate failures.

The DF87 has three ranges to signal the diagnostics. The diagnostic signal **OK** means the DF87 is operating in correct range, ensuring that is far from the fault limits. If the DF87 is out of this range, before reaching the limits that stop its operation, warning diagnostics are flagged, allowing intervention before potential failures may occur. If the fault limits are reached, the DF87 stops the operation, disconnecting to the bus. Thus, the failure does not affect the performance of redundancy, the failure relay is activated (closed), and the possible causes of failures are indicated.

Installation and Configuration

Operation without Redundancy
Each DF87 powers one bus segment.

Redundant mode
Two modules will supply power to a bus segment. If one of them was turned off or fails, the other power supply must be able to supply energy, alone, to the segment.

For systems based on DF92 and DF93 rack, with DF90 and DF91

Expansion of load capacity by adding power supplies or pairs of redundant power supplies
If the system consumption is greater than 5A, it can be subdivided in up to 8 groups sized for consumption of up to 5A each, and each group is individually powered by a power supply, or redundant pair of power supplies. More details on the Power supplies positioning topic.

Power supplies positions in the slots
On DF92, the pair of redundant power supplies must be installed in the first and second slots.

On DF93 is recommended the placement of the redundant pair in the first and second slots, but it can be installed in any slots if necessary.

For systems based on DF1A

Expansion of load capacity by adding power supplies or pairs of redundant power supplies

With the DF1A is possible reach up to 3A per slot. If the system consumption is greater than 3A, it can be subdivided in up to 8 groups sized for consumption of up to 3A each, and each group is individually powered by a power supply, or redundant pair of power supplies. More details on the Power supplies positioning topic.

Power supplies positions in the slots

On DF1A, the pair of redundant power supplies must be installed in the first and third slots.

ATTENTION
- The power supply DF87 is not compatible with the DF78 rack. Use the DF92 rack if redundant controllers are needed together with the DF87. - Even using the power supply DF87, the DF1A rack only supports 3A per slot.

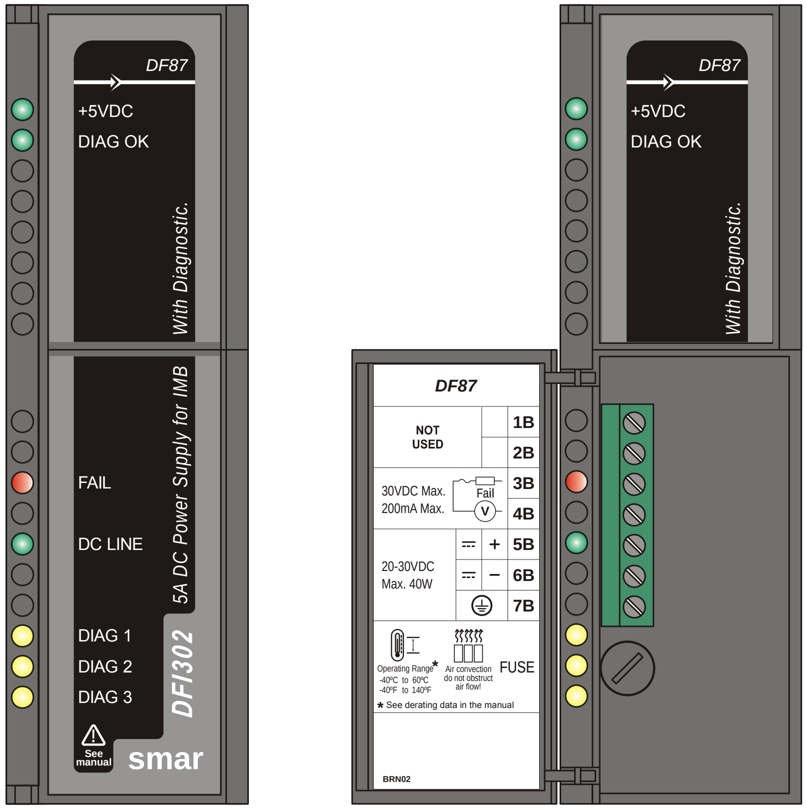


Figure 5.2 - DC Power Supply Module: DF87

Technical Specifications

INPUTS	
DC	20 to 30 Vdc 24 Vdc nominal
Maximum Consumption	40 W (@ 5A output)
Indicator	DC LINE (Green LED)

OUTPUTS	
Output (internal use)	5.2 Vdc +/- 2%
Current	5 A Maximum (See derating curve in the figure 5.6)
Ripple	100 mVpp Maximum
Indicator	+5 Vdc (Green LED)
Hold up Time	> 4.7 ms @ 24 Vdc [Full Load]

ISOLATION	
Between outputs and ground	1500 Vdc
Between input and output	1500 Vdc

FAILURE RELAY	
Type of Output	Solid state relay, normally closed (NC), isolated
Limits	6 W, 30 Vdc Max, 200 mA Max
Maximum Initial Contact Resistance	<13 Ω
Overload Protection	Should be provided externally.
Operation Time	12 ms maximum

TEMPERATURE	
Operation	-40 ºC to 60 ºC (-40 ºF to 140 ºF) (See derating curve in the figure 5.6)

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	39.9 x 137.0 x 141.5 mm ; (1.57 x 5.39 x 5.57 in)
Weight	0,453 Kg

CABLES	
One wire	14 AWG (2 mm^2)
Two wires	20 AWG (0.5 mm^2)

NOTE
To meet the EMC standards requirements, IEC 61326, the wires' length to the failure relay must be less than 30 meters. The power supply of the load activated by the failure relay must not be from external network. If the power cables of the input are greater than 3 m, install the ferrite core "FAIR-RITE V0", attached to the product packing. To install it, involve with the ferrite core all cables that are connected to the 5B, 6B and 7B contacts of the front terminal block near to DF87.

Diagnostics LEDs

The power supply DF87 has the following frontal LEDs, indicating the following situations shown in the figure below.

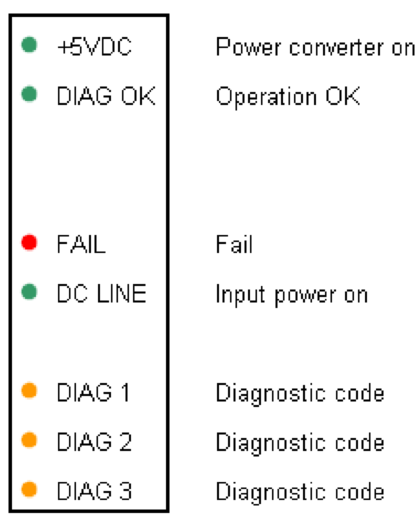
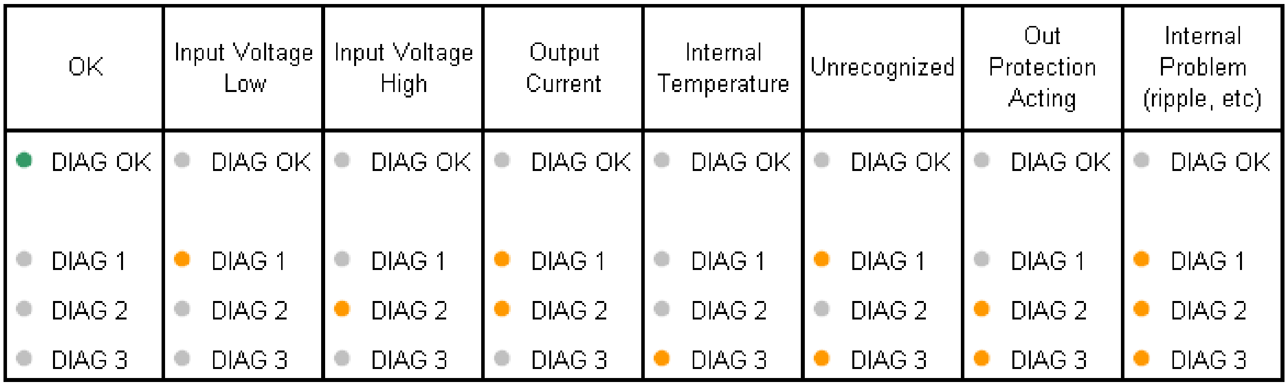


Figure 5.3 - DF87 frontal LEDs

The following is a summary of situations and the status of the LEDs for warning diagnostics, allowing intervention before potential failures may occur in the DF87 power supply.



OK	Input Voltage Low	Input Voltage High	Output Current	Internal Temperature	Unrecognized	Out Protection Acting	Internal Problem (ripple, etc)
DIAG OK	DIAG OK	DIAG OK	DIAG OK	DIAG OK	DIAG OK	DIAG OK	DIAG OK
DIAG 1	DIAG 1	DIAG 1	DIAG 1	DIAG 1	DIAG 1	DIAG 1	DIAG 1
DIAG 2	DIAG 2	DIAG 2	DIAG 2	DIAG 2	DIAG 2	DIAG 2	DIAG 2
DIAG 3	DIAG 3	DIAG 3	DIAG 3	DIAG 3	DIAG 3	DIAG 3	DIAG 3

Figure 5.4 - Diagnostics LEDs

The FAIL LED indicates failure when is ON.

The following graph shows the behavior of the output current within the operation range of the DF87 in environments without artificial ventilation.

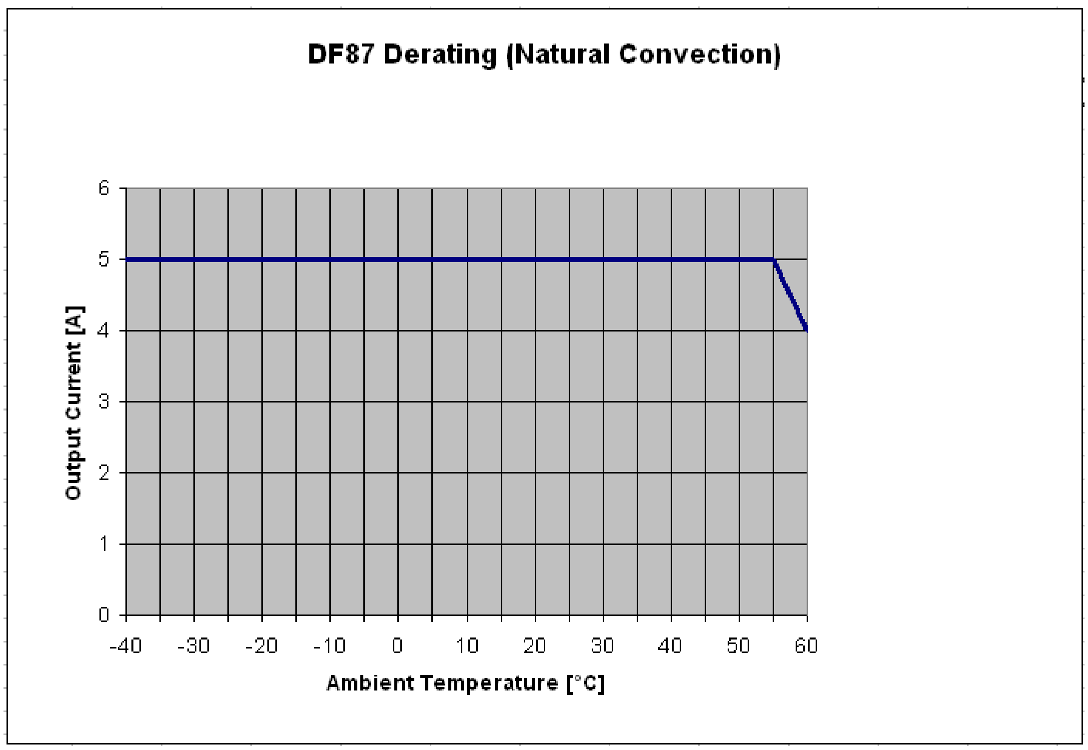


Figure 5.5 - Derating curve of the output current versus temperature, for environments without ventilation

Calculating the Power Consumption

Since the power available in the power supply is limited, it is important to calculate the power consumption of modules in use. The user can create a worksheet to summarize all supplied and required current from each module and associated equipment (such as operator interface).

Example of worksheet with the module's consumption, and some power supplies' specification.

AuditFlow Power Budget

Module	Description	Qty.	Consumption Unit Power (mA)		Total Power (mA)		Supply Unit Power (mA)		Total Power (mA)	
			@24 V	@5 V	@24 V	@5 V	@24 V	@5 V	@24 V	@5 V
FC302	Controller	1	0	550	0	0				
DF11	2*8 DI 24 Vdc		0	80	0	0				
DF12	2*8 DI 48 Vdc		0	80	0	0				
DF13	2*8 DI 60 Vdc		0	80	0	0				
DF14	2*8 DI 125 Vdc		0	80	0	0				
DF15	2*8 DI 24 Vdc (sink)		0	80	0	0				
DF16	2*4 DI 120 Vac		0	50	0	0				
DF17	2*4 DI 240 Vac		0	50	0	0				
DF18	2*8 DI 120 Vac		0	87	0	0				
DF19	2*8 DI 240 Vac	2	0	87	0	174				
DF20	8 switches		0	45	0	0				
DF44	8 AI		0	320	0	0				
DF57	8 AI		0	320	0	0				
DF45	8 Temperature inputs		0	55	0	0				
DF21	16 DO (transistor)		65	70	0	0				
DF22	2*8 DO (transistor)		65	70	0	0				
DF23	8 DO (triac)		0	70	0	0				
DF24	2*8 DO (triac)		0	115	0	0				
DF25	2*4 DO (relay)		134	20	0	0				
DF26	2*4 DO (relay)		134	20	0	0				
DF27	2*4 DO (relay)		134	20	0	0				
DF28	2*8 DO (relay)		180	30	0	0				
DF29	2*4 DO (relay)		134	20	0	0				
DF30	2*4 DO (relay)		134	20	0	0				
DF31	2*4 DO (relay)		134	20	0	0				
DF46	4 AO		180	20	0	0				
DF32	8 DI 24 Vdc, 4 DO (relay)		67	60	0	0				
DF33	8 DI 48 Vdc, 4 DO (relay)		67	60	0	0				
DF34	8 DI 60 Vdc, 4 DO (relay)		67	60	0	0				
DF35	8 DI 24 Vdc, 4 DO (relay)		67	60	0	0				
DF36	8 DI 48 Vdc, 4 DO (relay)		67	60	0	0				
DF37	8 DI 60 Vdc, 4 DO (relay)		67	60	0	0				
DF38	8 DI 24 Vdc, 4 DO (relay)		67	60	0	0				
DF39	8 DI 48 Vdc, 4 DO (relay)		67	60	0	0				
DF40	8 DI 60 Vdc, 4 DO (relay)		67	60	0	0				
DF49	2 Fieldbus Power Impedance		750	0	0	0				
DF53	4 Fieldbus Power Impedance	1	1500	0	1500	0				
TOTAL		**4**			**1500**	**1074**				
DF50		1					300	3000	300	3000
DF52		1					1500	0	1500	0
TOTAL		**6**							**1800**	**3000**

Power supplies positioning

For systems based on DF92 and DF93 racks with DF90 and DF91

A power supply connected to a rack, in a system, provides current to the racks row that are horizontally interconnected to it by their terminals of lateral connections, and vertically through DF90 cables, thus forming a group of rows of racks that use the same power supply.

The system can have only one power supply (or pair of redundant power supplies) or it can be subdivided in several of these groups[1], each one powered by a power supply (or pair of redundant power supplies).

The recommended way to distribute the power is to divide the system in groups of horizontal rows of racks. In this scheme, each power supply must be positioned on the top left of the group of rows of racks that it powers. The rack where is the power supply must be the **W1** jumper cut and the DF90 cable must not be connected to the rows powered by other power supplies (top rows). See in the following figure an example of system powered by two power supplies, each one powers a part of rows represented in green and blue.

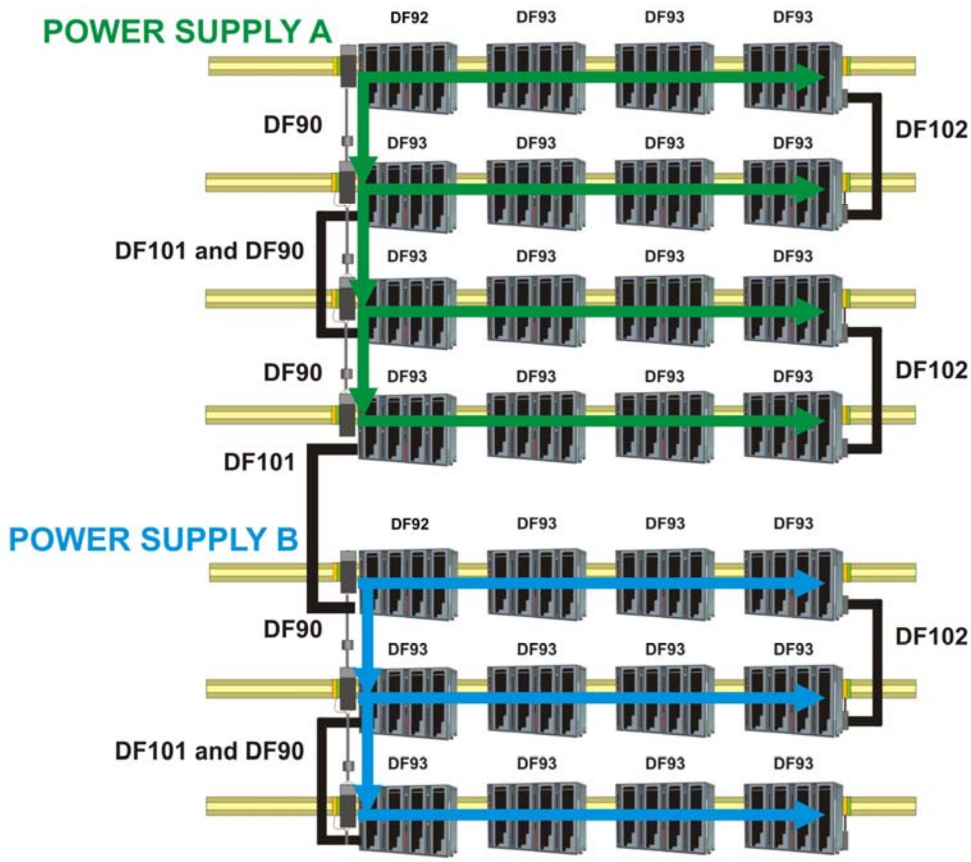


Figure 5.6 - System powered by two power supplies

Note that this system, for greater efficiency, is optimized for power distribution by groups of rows of racks. Thus, a power supply powers a whole number of rows it supports. However, in rare cases, with long rows or many modules with great consumption in the same row, there is the option to add power supplies in the middle of the row, dividing the power within this row. In this case, the power supply added powers only the modules positioned on the right in the same row, up to the end, or even where there is another power supply added. In the rack where the power supply was added, in this scheme, the **W1** jumper must be cut and left lateral connection terminal (+5 Vdc) must be disconnected (collapsed).

In this system, **DF50** and **DF56** must be their **CH1** jumper always configured in **R**, even if they are

[1] Maximum 8 groups allowed when the DF50, DF56 or DF87 power supplies are used.

not in redundant pairs.

ATTENTION
A mixture of these power supplies with the **CH1** configured in **R** and in **E** in any **AuditFlow** system, is not allowed!

On DF92, the pair of redundant power supplies must be installed in the first and second slots.

On DF93 is recommended the placement of the redundant pair in the first and second slots, but it can be installed in any slots if necessary.

The system has diagnostic for voltage level distributed to racks. It also supports modules with great power consumption in any place on the bus. Nevertheless, is recommended to place those modules close to the power supplies, to avoid unnecessary power transmission.

For systems based on DF78 and DF1A Racks

1. Observe the maximum current values from the power supply module specification. The limit for DF50 is 3 A, and for DF87 is 5 A.

2. After the connection with long cables (DF4A, DF5A, DF6A and/or DF7A) you have to put another power supply module in the first slot of the first rack.

3. Use up to 6 modules DF44/DF57 per power supply; always place consecutively the DF44/DF57 and close to the power supply. Because of the high current consumption of the modules DF44/DF57, a not desired voltage drop in the bus can occur if these modules are placed after other modules.

4. When is necessary to add interface modules, such as HI302, MB700, DF58, in the same bus which is used by output and input modules, is recommended that these modules are placed close to the power supply, because in the same way as described in the previous item, a not desired voltage drop in the bus can occur if these modules are placed after other modules.

5. Adding a new power supply module

- Determine the rack where the new power supply will be installed.
- Cut the jumper **W1** of the rack.
- Plug the new power supply at the first slot of the rack (slot 0).
- In this case, the **CH1** jumper of all modules **DF50** must be set in **E** position.

ATTENTION
- The power supply DF87 is not compatible with the DF78 rack. Use the DF92 rack if redundant controllers are needed together with the DF87. - Even using the power supply DF87, the DF1A rack only supports 3A per slot.

DF52 / DF60 – Power Supply for Fieldbus

Description

These modules were specially designed to supply the Fieldbus networks. The only difference between them is the input voltage:

DF52 (90 ~ 264 Vac)
DF60 (20 ~ 30 Vdc)

The **DF52** power supply is a non-intrinsically safe equipment with an universal AC input (90 to 264 Vac, 47 to 63 Hz or 127 to 135 Vdc), and a 24 Vdc output, isolated, with short circuit and overcurrent protection, ripple and fault indication, proper to supply fieldbus elements.

The **DF60** power supply unit is a non-intrinsically safe equipment with a DC input (20 to 30 Vdc) and a 24 Vdc output, isolated, with short circuit and overcurrent protection, ripple and fault indication, proper to supply fieldbus elements.

The interconnection of Fieldbus elements to the **DF52/DF60** is indicated in figure bellow. There is no overshoot when it is switched on or off. The **DF52/DF60** can power up to 4 fully loaded fieldbus networks.

NOTE
The length of the cables that interconnect the DF52/DF60 to the DF49/DF53 modules must not exceed 3 meters.

If any abnormal condition occurs in the output, such as overloading or short circuit, the **DF52/DF60** internal switches are automatically switched off to protect its circuit. When the outputs return to normal operation conditions, the circuit is automatically switched on.

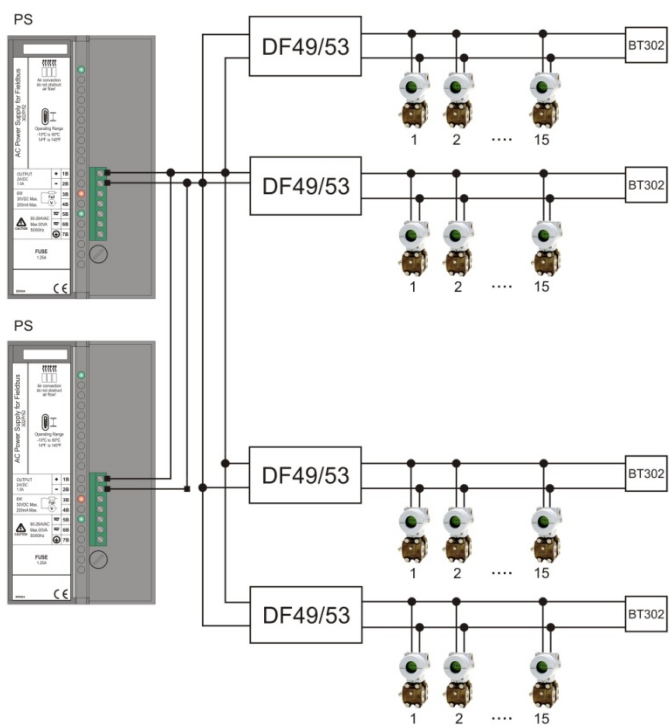


Figure 5.7- System powered by DF52

The **DF52/DF60** modules allow redundancy without any component connected to their outputs.

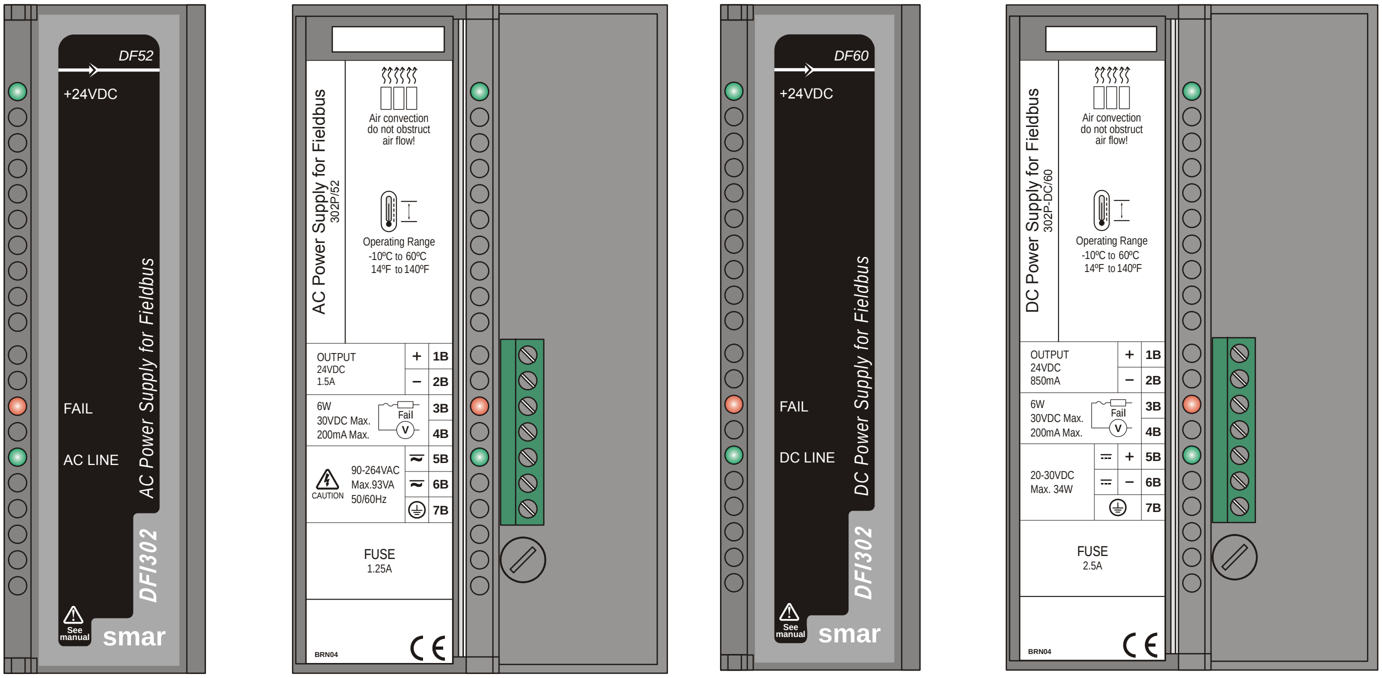


Figure 5.8 - Power Supply Module for Fieldbus: DF52/DF60

Technical Specifications

INPUTS DF52	
DC	127 to 135 Vdc
AC	90 to 264 Vac, 50/60 Hz (nominal), 47 to 63 Hz (range)
Maximum Inrush Current	< 30 A @ 220 Vac [ΔT < 640 us]
Maximum Consumption	93 VA
Indicator	AC LINE (Green LED)

INPUTS DF60	
DC	20 to 30 Vdc
Maximum Inrush Current	< 24 A @ 30 Vdc [ΔT < 400 us]
Maximum Consumption	34 W
Indicator	DC LINE (Green LED)

OUTPUTS		
Output	24 Vdc ± 1%	
Current	**DF52**	**DF60**
	1.5 A Maximum	850 mA Maximum
Ripple	20 mVpp Maximum	
Indicators	+24 Vdc (Green LED)	
	FAIL (Red LED)	

ISOLATION		
Input signal, internal outputs and the external output are isolated among them	**DF52**	**DF60**
Among outputs and ground	1000 Vrms	500 Vrms
Between input and output	2500 Vrms	1500 Vrms

FAILURE RELAY	
Type of Output	Solid state relay, normally closed (NC), isolated
Limits	6 W, 30 Vdc Max, 200 mA Max
Maximum Initial Contact Resistance	<13Ω
Overload Protection	Should be provided externally
Operation Time	5 ms maximum

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	39.9 x 137.0 x 141.5 mm ; (1.57 x 5.39 x 5.57 in)
Weight	0.450 kg

TEMPERATURE	
Operation	-10 °C to 60 °C (14 ºF to 140 ºF)
Storage	-30 °C to 70 °C

NOTE
To meet the EMC standards requirements, the wires’ length to the failure relay must be less than 30 meters. The power supply of activated load by the failure relay must not be from external network.

DF49 / DF53 – Power Supply Impedance for Fieldbus

Description

These modules were specially designed to provide appropriate impedance for fieldbus networks. The only difference between them is the number of fieldbus ports supported:

DF49 (2 ports) – PSI302P-2
DF53 (4 ports) – PSI302P-4
DF53-FC (4 ports)

The purpose of this impedance is to implement an output circuit where the impedance is greater than 3 KΩ, and when assembling in parallel with two 100 Ω ±2% terminators, it results in a 50 Ω line impedance approximately. This impedance can be implemented in a passive mode (50 Ω resistance in series with a 100 mH inductance) or in an active mode, through an impedance control circuit.

The fieldbus power supply impedance is a non-isolated, active impedance control device, in compliance with IEC 61158-2 standard. This device provides an output impedance which, in parallel with the two bus terminators (a 100 Ω resistor in series with a 1 μF capacitor) required by the standard, results in a pure resistive line impedance for a broad frequency range. The **DF49/DF53** cannot be used in intrinsic safety areas.

The figure shows the device block diagram. The **DF49/DF53** can be used in redundancy, connecting its output (+ and -) in parallel. In this case, use an external bus terminator (**BT302**) to allow maintenances or replacing the **DF49/DF53** in case of failure without interrupting the fieldbus communication.

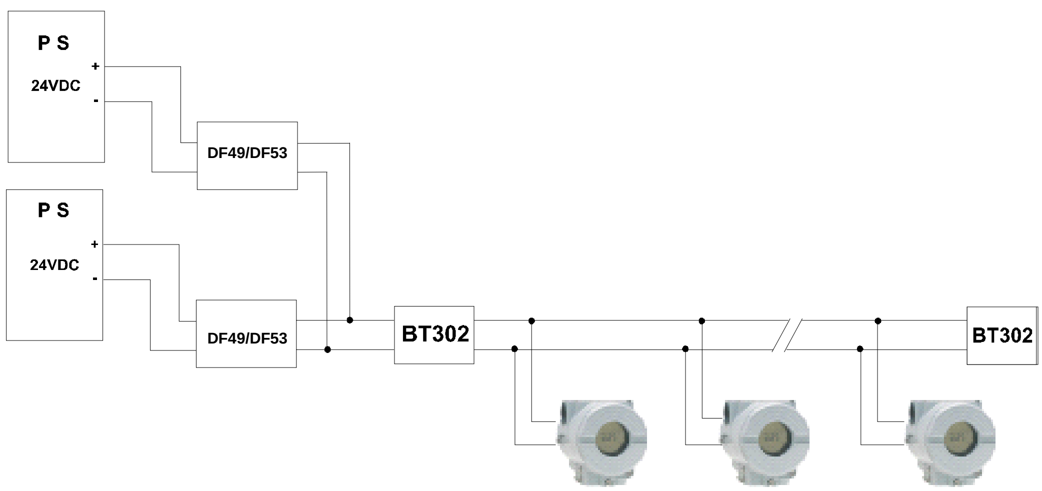


Figure 5.9 – System using the impedance DF49/DF53

The **DF49/DF53** modules have LEDs to indicate power supply and overcurrent. The input terminal block has two terminals (1A and 2A) that are connected to the external 24 Vdc. The power supply indication LED is green and it is energized while there is an external 24 Vdc power supply.

The overcurrent indication LED is red and it is energized only in case of an overcurrent caused by a short circuit in the plant or by an excessive number of devices connected. The following figure shows a **DF49/DF53** layout.

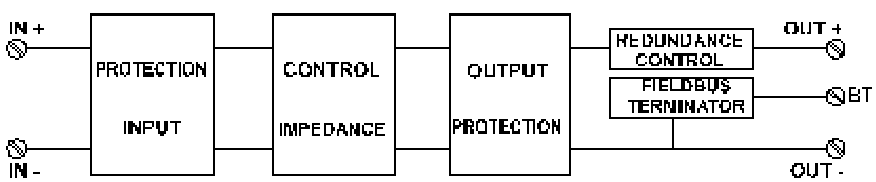


Figure 5.10 – System using the impedance DF49/DF53

DF49 (PSI302P-2): Four terminals (3A to 6A) implementing two independent Fieldbus ports, two DIP switches for activating the bus termination, one green LED for power status, and two red LEDs indicating overcurrent.

DF53 (PSI302P-4): Eight terminals (3A to 10A) implementing four independent Fieldbus ports, four DIP switches for activating the bus termination, one green LED for power status, and four red LEDs indicating overcurrent.

DF53-FC (PSI302P-4): It has the same characteristics of DF53 and meets the requirements for hardware tests of OIML R117-1 (Flow Measurement System of Liquids).

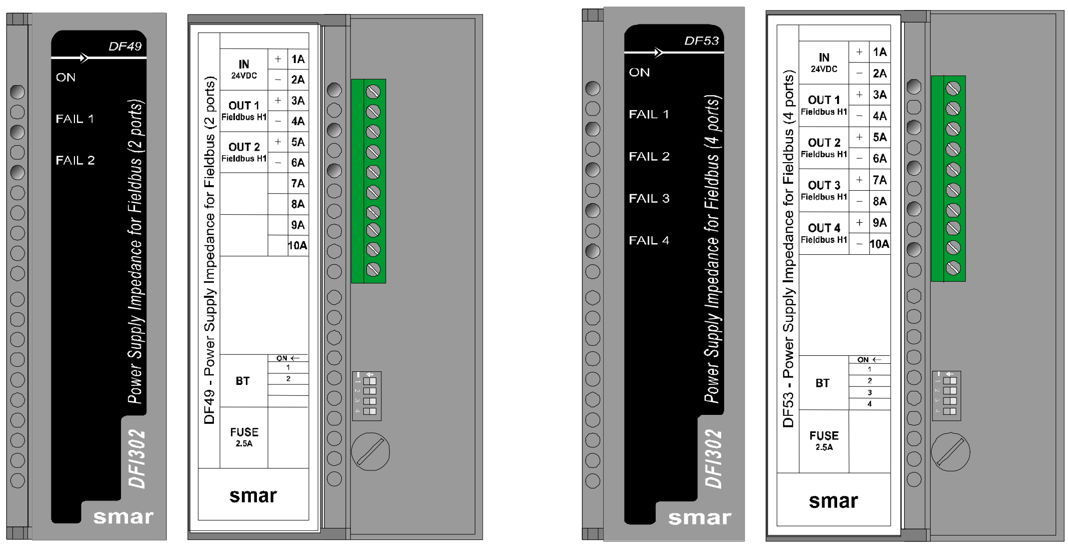


Figure 5.11 – Impedance for Fieldbus Modules: DF49/DF53

Technical Specifications

INPUT	
DC	24 to 32 Vdc +/- 10%

OUTPUT	
Current	340 mA per channel

INPUT FILTER	
Attenuation	10 dB in the input power ripple @60 Hz

DIMENSIONS AND WEIGHT	
Dimensions (W x H x D)	39.9 x 137.0 x 141.5 mm; (1.57 x 5.39 x 5.57 in)
Weight (without package)	DF49 = 220 g DF53 = 260 g

TEMPERATURE	
Operation	0 °C to 60 °C
Storage	-30 °C to 70 °C

SAFETY	
Output Overcurrent	450 mA
Input Fuse	2.5 A
Atmospheric Discharges	Input and output protected by transient suppressors
Intrinsic Safety	It cannot be applied directly

MAXIMUM LENGTH OF FIELDBUS WIRING		
DF49/DF53	No redundancy	1.900 m
	Redundant	1.900 m
DF53-FC	No redundancy	1.900 m
	Redundant	1.000 m

Installation

The **DF49/53** is a device specially designed for panel installation and it cannot be installed in unsheltered locations, as it cannot be exposed directly to the weather. The module can be connected to the panel directly on the DIN rail or using the auxiliary support provided with the module, fixed with screws. Refer to the "Hardware" section for further details about installation and dimensional drawings of the module.

Maintenance and troubleshooting

The **DF49/53** is a robust device which basically requires no preventive maintenance. It is simply recommended to protect it from excessive dust accumulation and humid environments which might affect its output impedance.

The two models have LEDs which inform their operation status – one green LED which informs that the module is properly powered, and one red LED for each channel, that will be lit if any abnormal condition occurs in the field wiring.

These LEDs detect most of the problems which may occur in a Fieldbus installation. However, they might not detect other problems, such as:

- Excessive noise caused by the external power supply;
- Impedance lower than 20Ω in the communication line (note that such impedance may not be pure resistive and, therefore not detectable by the overcurrent circuit).

Such abnormal conditions may be easily detected by measurement instruments.

Because the **DF49/53** is a simple and compact device, it is recommended to replace faulty modules instead of electronic components during repair services.

DF47-12 and DF47-17 – Intrinsic Safety Barrier for Fieldbus

Description

The Intrinsically Safe (I.S.) technology incorporated in the DF47-12 and DF47-17 totally isolates the control network on the hazardous side of the barrier. The I.S. values of the power supply are designed for fieldbus devices, which are in compliance with the FISCO model.

The incorporation of a fieldbus repeater in compliance with IEC 61158-2 (31.25 kbits/s) essentially filters and boosts the incoming communication signal transmitting it to hazardous environment. The networks of the hazardous and safe sides of the DF47-12 and DF47-17 are completely independent from one another.

In addition the bus termination for the hazardous network is incorporated into the DF47-12 and DF47-17, which means that only a single far terminator is required.

NOTES
1. If the terminator of the DF53 module is not being used, it is necessary to install another external terminator in the safe area. 2. The model DF47 was discontinued due to the new FISCO requirements. The replacement by DF47-12 or DF47-17 models should be evaluated according to the current limits. The model DF47-17 supports up to 7 Smar devices of the 302 series. If the replacement is using the DF47-12 model, it supports up to 5 Smar devices of the 302 series.

- H1 Isolated Barrier and IS Power Supply in compliance with the FISCO Model.
- H1 Fieldbus Signal Repeater.
- In compliance with the IEC 61158-2, 31.25 kbits/s standard for fieldbus. (FOUNDATION fieldbus and PROFIBUS PA).
- IEC, FM & CENELEC Intrinsic Safety standards certified.
- In compliance with IEC 60079-27, FISCO and FNICO Power Supply.
- Dual Marking in compliance with IEC 60079-11 and IEC 60079-27.
- Bus terminator on hazardous area.

Installation

The selection and installation of the barrier should always be accomplished by competent technical personnel. Please contact Smar or our local representative if further information is required.
According to the standards for hazardous areas the barrier DF47-12 or DF47-17 must be installed out of hazardous area. The input parameters for installation in hazardous area are in the Certificates for Hazardous Areas topic.

The barrier has to be installed on DF1A, DF93 or DF9 and fixed in a DIN rail. For further details see the Hardware section.

Installation Principles
1. Ensure that there is an appropriate separation of intrinsically safe and non-intrinsically safe circuits (more than 50 mm or 1.97 inches), so the ignition energy from non-intrinsically safe circuit does not intrude into the intrinsically safe circuit.
2. Ensure that the limiting parameters of system design, for example total inductance and capacitance, upon which system approval is based are not exceeded.
3. Ensure that power system faults and ground potential differences do not generate system ignition.

Location
The barrier is normally installed in a dust-free and moisture-free enclosure located in the non-hazardous area. The enclosure should be as close as possible to the hazardous area to reduce cable runs and increased capacitance. If the barrier is installed in a hazardous area, it must be in a proper enclosure suited for the intended area. The only intrinsically safe terminals are at the barrier output.

Wiring

Intrinsically safe circuits may be wired in the same manner as conventional circuits installed for hazardous areas with two exceptions summarized as separation and identification. The intrinsically safe conductors must be separated from all other cables by placing them in separate conduits or by a separation of more than 50 mm or 1.97 inches of air. The cables, cable trays, open wiring, and terminal boxes must be labeled "Intrinsically Safe Wiring" to prevent interference with other circuits.

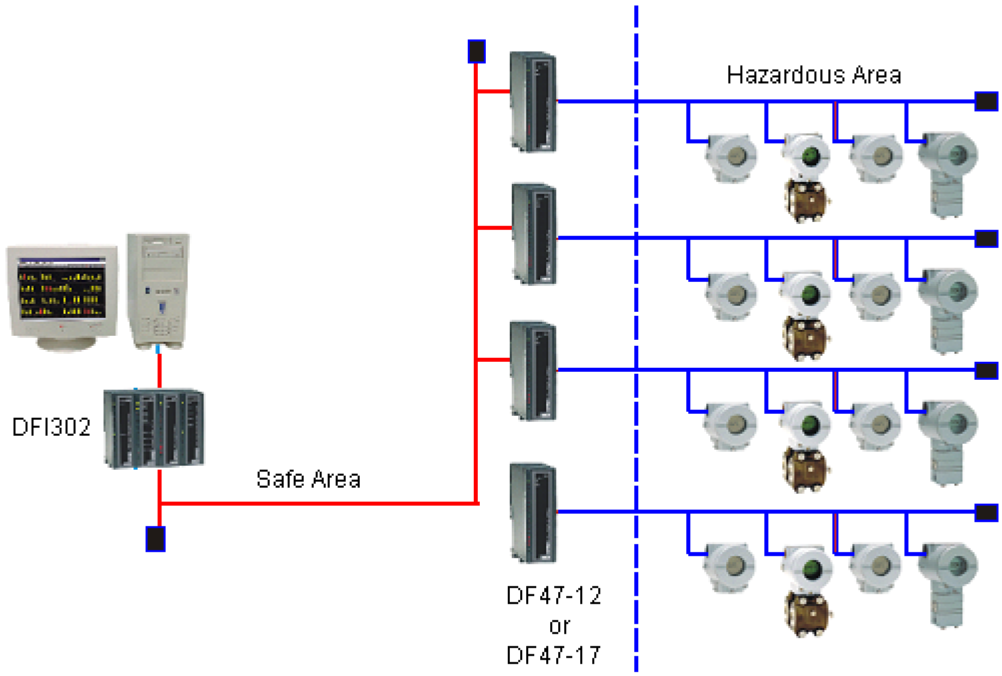


Figure 5.12 – DF47 installation

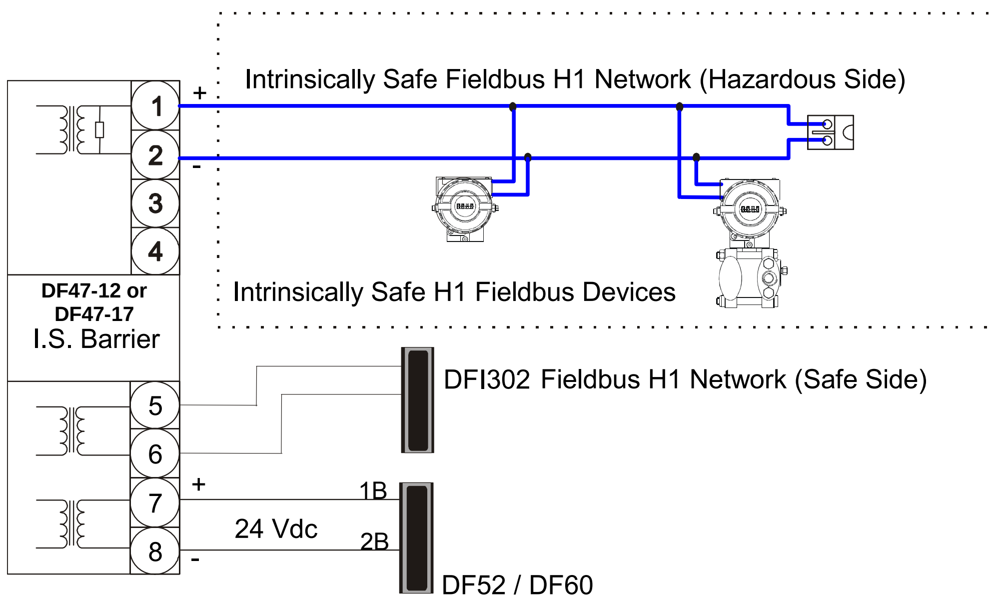


Figure 5.13 – DF47 installation

Technical Specifications

POWER	
Power Supply Input	Voltage: 24Vdc ± 5%
	Current (max.): 350mA @ 24Vdc

HAZARDOUS AREA	
Power Supply Output	Maximum voltage available at the barrier terminals: Us = 13.8 Vdc
	Maximum Current in typical operation (considering Us = 13.8 Vdc) DF47-12: Is = 65 mA DF47-17: Is = 90 mA
	Current limiting resistor (typical) DF47-12: Ri ≥ 247.5 Ω DF47-17: Ri ≥ 176.22 Ω
	Maximum output power DF47-12: Po = 1.2 W DF47-17: Po = 1.72W
Safety Parameters (Hazardous Area)	Refer to the item “Certificates for Hazardous Areas”
Internal Dissipation	3W maximum at 24Vdc input, nominal conditions (for non-intrinsically safe circuits)
Cable Length, Number of Devices	Maximum cables lengths are determined by IS requirements, and depend on both the number of devices attached and the maximum acceptable voltage drop along the cable. Use FISCO cable.
Digital Signal Transmission	Compatible with 31.25 kbps – Fieldbus systems.
Fuse	In order to guarantee the product safe, the internal fuse change must be executed only by the manufacturer.
Terminals	Accommodate conductors up to 2.5 mm^2 (22AWG).
Isolation	2500V galvanic isolation among input, output, and power supply terminals. Tested at 1500 Vrms minimum between hazardous and safe area terminals.

PHYSICAL	
Ambient Temperature	0 to +60 ºC (operation)
	-30 ºC to 70 ºC (storage)
Humidity	5% to 95% relative humidity

IMPORTANT
By using active junction boxes you must consider their current consumption to calculate the total consumption of segment.

European Directive Information

This product complies with following European Directives:

EMC Directive (89/336/EEC) – Electro Magnetic Compatibility
The EMC test was performed in compliance with IEC standard: IEC 61326:2002. See annex A (table A.1) and table 3 of the standard.

ATEX Directive (94/9/EC) –Equipment and protective systems intended for use in potentially explosive atmospheres.
This product is certified in compliance with the European Standards at EXAM.

Consult www.smar.com for the EC declarations of conformity for all applicable European directives and certificates.

Hazardous Locations Approvals

WARNING

Explosions can result in death or serious injury, besides financial damage.

Installation of this instrument in an explosive environment must be in compliance with the national standards and according to the local environmental protection method. Before proceeding with the installation match the certificate parameters from the barrier, cable and device according to the environmental classification.

NOTES

Maintenance and Repair

The module modification or replaced parts supplied by any other supplier than authorized representative of Smar Equipamentos Industriais Ltda is prohibited and will void the Certification.

Installation Details

- Connect to a proper intrinsically safe instrument.
- Check the intrinsically safe parameters involving the barrier, equipment including the cable and connections.
- The terminals from associated apparatus to be connected through the classified area shall be insulated from panels and mounting enclosures.
- Cable capacitance and inductance plus Ci* and Li* must be smaller than Co* and Lo* of the Associated Apparatus.
- The intrinsically safe conductors must be of blue colored, based in the IEC standards.
- If one component of the intrinsically safe system is not FISCO comply, it is necessary to match all safety parameters among cable, device and barrier.
- Designated for connection to a Fieldbus system in compliance FISCO Model with parameters as follows:

  - Intrinsically safe apparatus interconnected to the power supply circuit (Fieldbus) shall be passive current sink (not supplying) and effective internal inductance/capacitance shall be within the following maximum values:

    $Li \leq 10\ \mu H$
    $Ci \leq 5\ nF$

  - With regard to cable-length parameters of Fieldbus interconnection-cable shall be within the following ranges:

PARAMETER	VALUE
Resistance per unit length	15 Ω/km ≤ R' ≤ 150 Ω/km
Inductance per unit length	0.4 mH/km ≤ L' ≤ 1mH/km
Capacitance per unit length (including shield)	80 nF/km ≤ C' ≤ 200 nF/km

Where:
C'=C' wire/wire + 0.5 x C' wire/shield when Fieldbus-circuit insulated.
C'=C' wire/wire + C' wire/shield when shield is connected to the output of the Fieldbus power supply.

Maximum length of each spur cable: 60m in IIC/IIB.

  - A Fieldbus-data-signal terminator, providing a capacitance less than or equal to 1.1 μF connected in series with a resistor greater than or equal to 100 Ω, is integrated in the Barrier DF47-12 and DF47-17; similar terminator may be connected to the other end of the Fieldbus circuit.

  - When meeting the parameter mentioned above, maximum permissible Fieldbus-cable length including length of all spur cables for Group IIC is 1000 m.

  - When meeting the parameter mentioned above, maximum permissible Fieldbus-cable length including length of all spur cables for Group IIB and Group I is 5000 m.

*Ci : Input's capacitance, Li : Input's inductance, Co : Output's capacitance, Lo : Output's inductance

Certificates for Hazardous Areas

DF47-12 – Intrinsic Safety Barrier for Fieldbus

Non intrinsically safe circuits:

POWER SUPPLY	VALUE
Rated Input voltage (Un)	24 Vdc
Maximum applicable voltage in safety condition (Um)	250 Vac
Rated Input power (Pn)	3 W

FIELDBUS SIGNAL CIRCUITS	VALUE
Maximum applicable voltage in safety condition (Um)	250 Vac

RATED VALUE	VALUE
Voltage (Un)	14.0 Vdc
Supply current at 14 V (In)	75 mA
Power (Pn)	1200 mW

European Certifications
EXAM (BBG Prüf - und Zertifizier GmbH)

Protection Method:
Associated Intrinsic Safety (BVS 03ATEX E 411X)

Group II, Category (1) G, [Ex ia Ga], Groups IIB, IIC FISCO Power Supply
Group I, Category (M2) [Ex ia Mb] I

Intrinsically Safe Fieldbus Supply and Signal Circuit (FISCO-Model):

SAFETY PARAMETER	VALUE
Maximum output voltage (Uo)	15.0 Vdc
Short circuit current (Io)	140.12 mA
Maximum output power (Po)	1200 mW
Current limiting resistor (Ri)	$\geq$ 247.5 Ω
Characteristics	Trapezoidal

South American Certifications
CEPEL (Centro de Pesquisa de Energia Elétrica)

Protection Method:
Associated Intrinsic Safety (CEPEL-EX-1095/06X)

[BR Ex ia], Group IIB (in compliance with IEC60079-11)
FISCO Power Supply (in compliance with IEC60079-27)

[BR Ex ia], Groups IIC, IIB (in compliance with IEC60079-11)
FNICO Power Supply (in compliance with IEC60079-27)

Nominal Values of the Terminals Intrinsically Safe (FISCO-Model):

SAFETY PARAMETER	VALUE
Maximum applicable voltage in safety condition (Um)	250 Vac
Maximum output voltage (Uo)	15.0 Vdc
Short circuit current (Io)	140.12 mA
Maximum output power (Po)	1200 mW
Current limiting resistor (Ri)	$\geq$ 247.5 Ω

North American Certifications
FM Approvals (Factory Mutual)

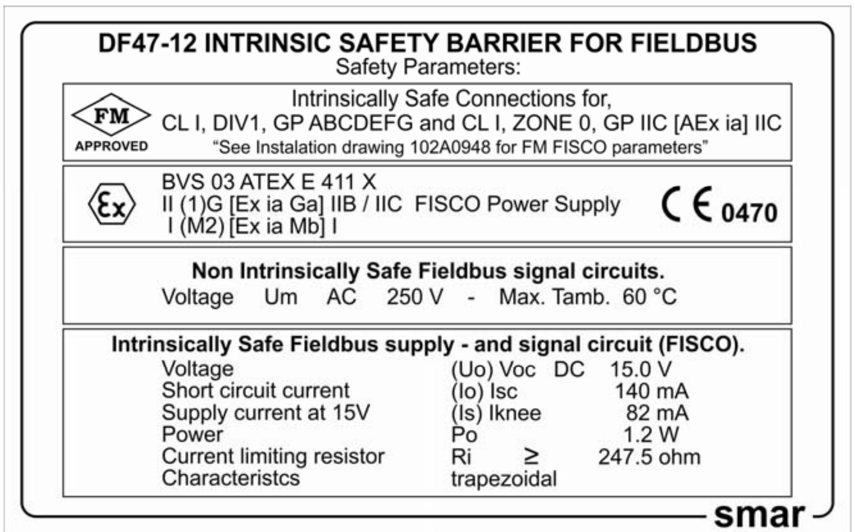
Protections Methods:
Associated Intrinsic Safety (FM 3017363)

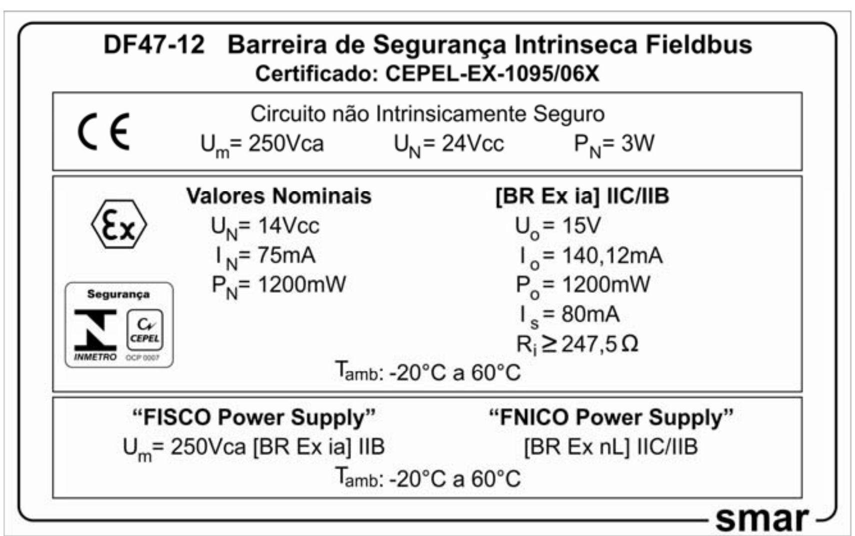
Class I, Division 1, Groups A, B, C and D
Class II, Division 1, Groups E, F and G
Class III, Division 1
Class I, Zone 0 [AEx ia], Group IIC

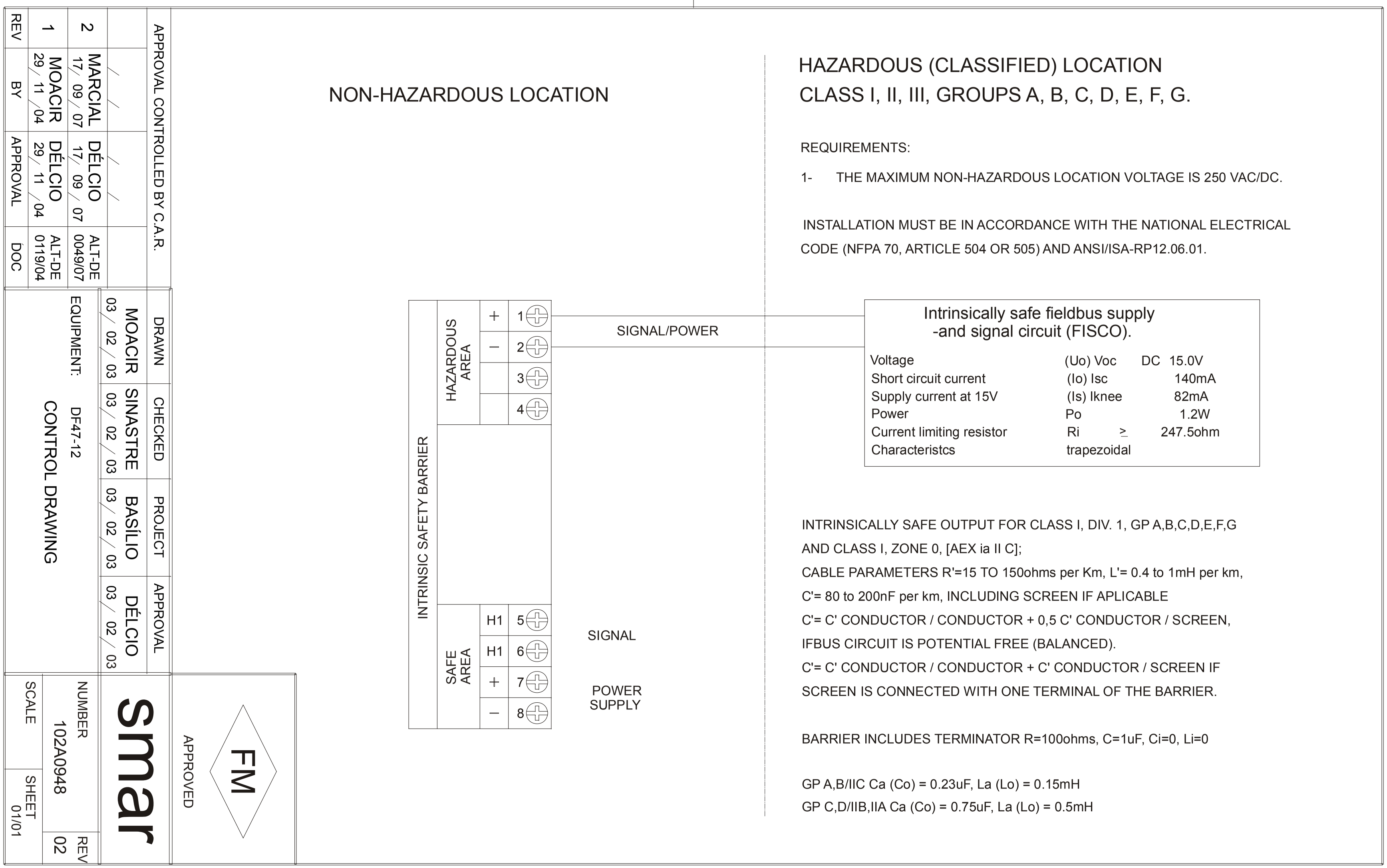
Special Conditions for Safe Use:

PARAMETERS (Trapezoidal characteristic)						
		Voc/Uo	Isc/Io	Po	Ca/Co	La/Lo
Terminals	Groups	(Vdc)	(mA)	(W)	(μF)	(mH)
1 and 2	A/B/IIC	15	140	1.2	0.23	0.15
1 and 2	C/IIB	15	140	1.2	0.75	0.5
Integral terminator: R= 100 Ω, C = 1.0 μF, Ci = 0, Li = 0						

Labels






NON-HAZARDOUS LOCATION
HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, II, III, GROUPS A, B, C, D, E, F, G.
REQUIREMENTS:
1- THE MAXIMUM NON-HAZARDOUS LOCATION VOLTAGE IS 250 VAC/DC.
INSTALLATION MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL
CODE (NFPA 70, ARTICLE 504 OR 505) AND ANSI/ISA-RP12.06.01.
Intrinsically safe fieldbus supply
-and signal circuit (FISCO).
Voltage (Uo) Voc DC 15.0V
Short circuit current (Io) Isc 140mA
Supply current at 15V (Is) Iknee 82mA
Power Po 1.2W
Current limiting resistor Ri ≥ 247.5ohm
Characteristcs trapezoidal
SIGNAL/POWER
INTRINSIC SAFETY BARRIER
HAZARDOUS AREA
SAFE AREA
+ 1
– 2
3
4
H1 5
H1 6
+ 7
– 8
SIGNAL
POWER SUPPLY
INTRINSICALLY SAFE OUTPUT FOR CLASS I, DIV. 1, GP A,B,C,D,E,F,G
AND CLASS I, ZONE 0, [AEX ia II C];
CABLE PARAMETERS R'=15 TO 150ohms per Km, L'= 0.4 to 1mH per km,
C'= 80 to 200nF per km, INCLUDING SCREEN IF APLICABLE
C'= C' CONDUCTOR / CONDUCTOR + 0,5 C' CONDUCTOR / SCREEN,
IFBUS CIRCUIT IS POTENTIAL FREE (BALANCED).
C'= C' CONDUCTOR / CONDUCTOR + C' CONDUCTOR / SCREEN IF
SCREEN IS CONNECTED WITH ONE TERMINAL OF THE BARRIER.
BARRIER INCLUDES TERMINATOR R=100ohms, C=1uF, Ci=0, Li=0
GP A,B/IIC Ca (Co) = 0.23uF, La (Lo) = 0.15mH
GP C,D/IIB,IIA Ca (Co) = 0.75uF, La (Lo) = 0.5mH
APPROVAL CONTROLLED BY C.A.R.
2 MARCIAL 17/09/07 DÉLCIO 17/09/07 ALT-DE 0049/07
1 MOACIR 29/11/04 DÉLCIO 29/11/04 ALT-DE 0119/04
REV BY APPROVAL DOC
DRAWN CHECKED PROJECT APPROVAL
MOACIR 03/02/03 SINASTRE 03/02/03 BASÍLIO 03/02/03 DÉLCIO 03/02/03
EQUIPMENT: DF47-12
CONTROL DRAWING
FM
APPROVED
smar
NUMBER 102A0948
REV 02
SCALE
SHEET 01/01

DF47-17 – Intrinsic Safety Barrier for Fieldbus

Non intrinsically safe circuits:

POWER SUPPLY	VALUE
Rated input voltage (Un)	24 Vdc
Maximum applicable voltage in safety condition (Um)	250 Vac
Rated input power (Pn)	3 W

FIELDBUS SIGNAL CIRCUITS	VALUE
Maximum applicable voltage in safety condition (Um)	250 Vac

RATED VALUE	VALUE
Voltage (Un)	14.0 Vdc
Supply current at 14 V (In)	110 mA
Power (Pn)	1700 mW

European Certifications
EXAM (BBG Prüf - und Zertifizier GmbH)

Protection Method:
Associated Intrinsic Safety (BVS 03ATEX E 411X)

Group II, Category (1) G, [Ex ia Ga], Groups IIB, IIC FISCO Power Supply
Group I, Category (M2) [Ex ia Mb] I

Intrinsically Safe Fieldbus Supply and Signal Circuit (FISCO-Model):

SAFETY PARAMETER	VALUE
Maximum output voltage (Uo)	15.0 Vdc
Short circuit current (Io)	197 mA
Maximum output power (Po)	1720 mW
Current limiting resistor (Ri)	≥ 176.22 Ω
Characteristics	Trapezoidal

South American Certifications
CEPEL (Centro de Pesquisa de Energia Elétrica)

Protection Method:
Associated Intrinsic Safety (CEPEL-EX-1095/06X)

[BR Ex ia], Group IIB (in compliance with IEC60079-11)
FISCO Power Supply (in compliance with IEC60079-27)

[BR Ex ia], Groups IIC, IIB (in compliance with IEC60079-11)
FNICO Power Supply (in compliance with IEC60079-27)

Nominal Values of the Terminals Intrinsically Safe (FISCO-Model):

SAFETY PARAMETER	VALUE
Maximum applicable voltage in safety condition (Um)	250 Vac
Maximum output voltage (Uo)	15.0 Vdc
Short circuit current (Io)	197 mA
Maximum output power (Po)	1720 mW
Current limiting resistor (Ri)	≥ 176.22 Ω

North American Certifications
FM Approvals (Factory Mutual)

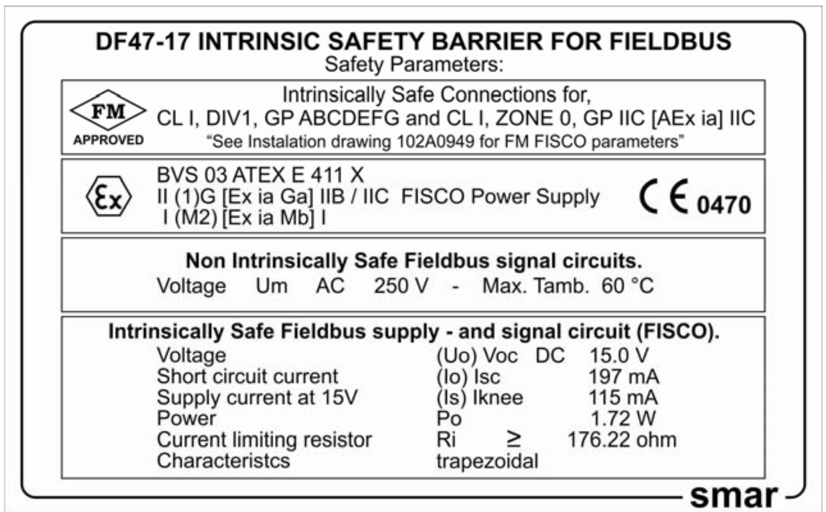
Protections Methods:
Associated Intrinsic Safety (FM 3017363)

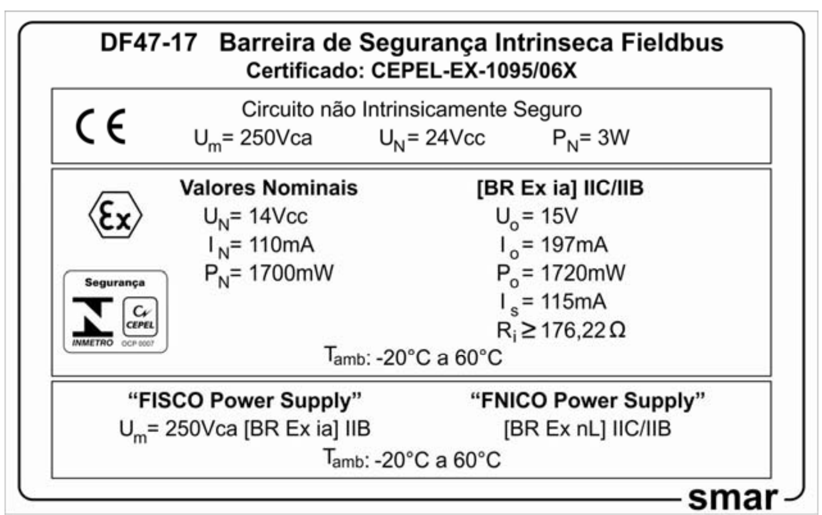
Class I, Division 1, Groups A, B, C and D
Class II, Division 1, Groups E, F and G
Class III, Division 1
Class I, Zone 0 [AEx ia], Group IIC

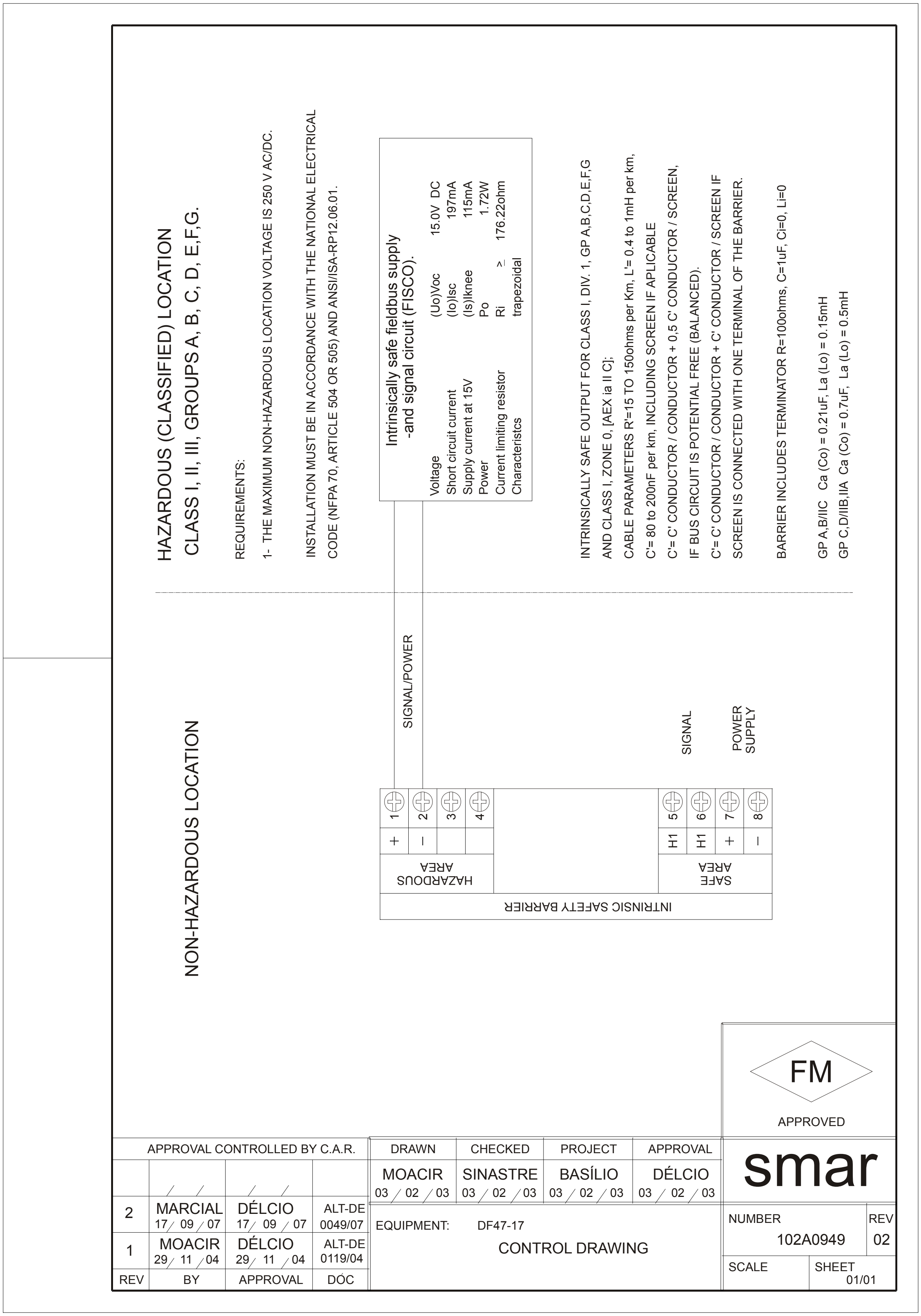
Special Conditions for Safe Use:

PARAMETERS (Trapezoidal characteristics)						
		Voc/Uo	Isc/Io	Po	Ca/Co	La/Lo
Terminals	Groups	(Vdc)	(mA)	(W)	(μF)	(mH)
1 and 2	A/B/IIC	15	197	1.72	0.21	0.15
1 and 2	C/IIB	15	197	1.72	0.7	0.5
Integral terminator: R= 100 Ω, C = 1.0 μF, Ci = 0, Li = 0						

Labels






HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, II, III, GROUPS A, B, C, D, E,F,G.
REQUIREMENTS:
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INSTALLATION MUST BE IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE (NFPA 70, ARTICLE 504 OR 505) AND ANSI/ISA-RP12.06.01.
Intrinsically safe fieldbus supply -and signal circuit (FISCO).
Voltage (Uo)Voc 15.0V DC
Short circuit current (Io)Isc 197mA
Supply current at 15V (Is)Iknee 115mA
Power Po 1.72W
Current limiting resistor Ri ≥ 176.22ohm
Characteristcs trapezoidal
INTRINSICALLY SAFE OUTPUT FOR CLASS I, DIV. 1, GP A,B,C,D,E,F,G
AND CLASS I, ZONE 0, [AEX ia II C];
CABLE PARAMETERS R'=15 TO 150ohms per Km, L'= 0.4 to 1mH per km,
C'= 80 to 200nF per km, INCLUDING SCREEN IF APLICABLE
C'= C' CONDUCTOR / CONDUCTOR + 0,5 C' CONDUCTOR / SCREEN,
IF BUS CIRCUIT IS POTENTIAL FREE (BALANCED).
C'= C' CONDUCTOR / CONDUCTOR + C' CONDUCTOR / SCREEN IF
SCREEN IS CONNECTED WITH ONE TERMINAL OF THE BARRIER.
BARRIER INCLUDES TERMINATOR R=100ohms, C=1uF, Ci=0, Li=0
GP A,B/IIC Ca (Co) = 0.21uF, La (Lo) = 0.15mH
GP C,D/IIB,IIA Ca (Co) = 0.7uF, La (Lo) = 0.5mH
NON-HAZARDOUS LOCATION
SIGNAL/POWER
SIGNAL
POWER SUPPLY
1 2 3 4
+ −
HAZARDOUS AREA
5 6 7 8
H1 H1 + −
SAFE AREA
INTRINSIC SAFETY BARRIER
FM
APPROVED
smar
APPROVAL CONTROLLED BY C.A.R.
DRAWN CHECKED PROJECT APPROVAL
MOACIR 03/02/03
SINASTRE 03/02/03
BASÍLIO 03/02/03
DÉLCIO 03/02/03
2 MARCIAL 17/09/07 DÉLCIO 17/09/07 ALT-DE 0049/07
1 MOACIR 29/11/04 DÉLCIO 29/11/04 ALT-DE 0119/04
REV BY APPROVAL DÓC
EQUIPMENT: DF47-17
CONTROL DRAWING
NUMBER 102A0949
REV 02
SCALE
SHEET 01/01

Chapter 6

ADDING INTERFACES

Introduction

There are several Interface modules available for the AuditFlow System, that provide a wide connectivity to different media used in the Automation and Process Control industry.

In applications that connect Modbus RTU to AuditFlow and other Modbus Devices are connected to the same Modbus network, it is necessary to use the RS232/RS485 module interface for multipoint communication.

It will also be necessary to use a RS232/RS485 module interface in applications that use only one Modbus device and the distance between the devices is over 15 meters.

Originally, the FC302 (Processor module) was designed as a 10 Mbps Ethernet port. Add the 10/100 Mbps Ethernet Switch module to connect the FC302 to the 100 Mbps Ethernet Local Network.

The following table shows the Interface modules available.

INTERFACE		
MODEL	**DESCRIPTION**	**I/O TYPE**
DF58	RS232/RS485 Interface	No I/O
DF61	Ethernet Switch 10/100 Mbps	No I/O

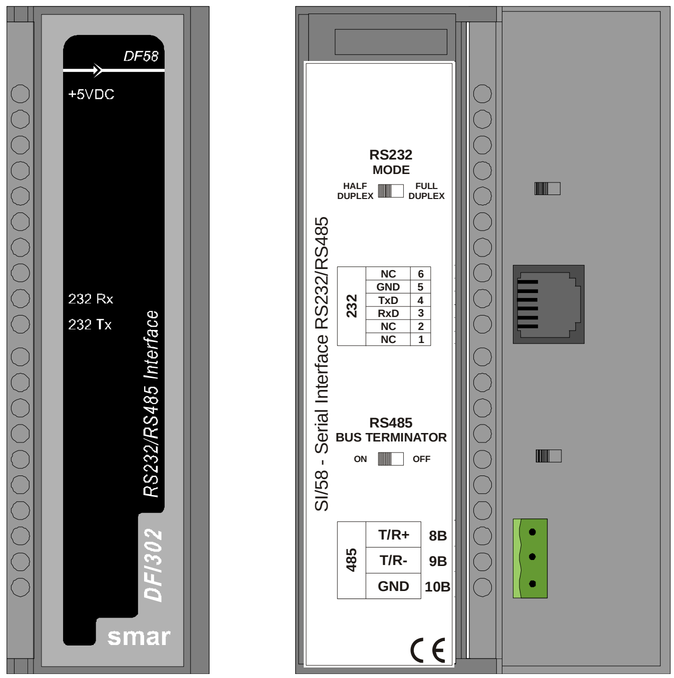
The following sections describe the specifications for each module.

DF58 – RS232/RS485 Interface

Description

This module converts the electrical characteristics of the communication signal from the EIA/RS232 specification to the EIA/RS485 specification. Because of the different purposes of RS232 and RS485 (RS232 is used for peer-to-peer applications), this module was implemented to work automatically. No signal is necessary to control the RS485 bus. Simply connect the transmission and reception lines to initialize the interface communication.

The converter circuit isolates the signal to guarantee a safe connection between two systems. This module was designed for the AuditFlow/DFI302/LC700 platform and therefore no power supply was included in the board. The module uses the +5Vdc voltage from the Rack to energize the circuit.



RS232/RS485 Interface: DF58

Interface Settings

The interface mode is selected on the front panel to adapt the interface to the application. There are two options: RS232 Mode and RS485 Bus Terminator.

RS232 Mode: Half-Duplex/Full-Duplex

The RS232 Mode adapts the RS232/RS485 Interface to the communication driver of the RS232. Normally, the interfaces that connect unidirectional buses to bi-directional buses will show Full-Duplex characteristics in the unidirectional bus caused by echoes of the message transmitted.

If the driver doesn't operate simultaneously receiving and transmitting the messages, because reception is disabled or reflected messages were discarded, it will be necessary to select the Half-Duplex option. If the reflected message doesn't disturb the applications, the user can select the Full-Duplex option.

RS485 Bus Terminator: On/Off

The RS485 is a Multi-Drop bus and the transmission driver has high impedance (Hi-Z) when there is no message to be transmitted. Therefore, the RS485 bus requires a bus terminator to avoid the noise during the idle time of the RS485.
Activate only one terminator per bus to obtain the correct line impedance. The other terminators must be deactivated.

Connectors

There are two connectors on the front panel to interconnect two communication systems. The first one is a RJ12 connector used in RS232 systems, and the other one is a terminal block connector used in RS485 systems.

RJ12 Pins

Pin Number	Description
1	Connected to pin 6.
2	Not used
3	RxD: RS232 input signal - reception
4	TxD: RS232 output signal – transmission
5	GND: RS232 grounding signal
6	Connected to pin 1.

Note
Pins 1 and 6 are interconnected to allow the communication of the modem signals requested by the drivers, such as Clear-To-Send (CTS) and Request-To-Send (RTS).

Block Terminal Pins

Pin Number	Description
1	+: RS485 Non-inverting Signal
2	-: RS485 Inverting Signal
3	GND: Reference for RS485 Communication Signal.

Note
The pin GND sets the voltage reference for all RS485 nodes. The RS485 side of the RS232/RS485 Interface is isolated and stays on floating state. To avoid undesirable voltage, it is recommended to set all RS485 nodes in the same voltage reference, connecting all pins GND and grounding in the same point

Cabling and Applications

There is a set of cables manufactured by Smar that is used according to the applications.

To connect the ***FC302 (Processor)*** to the ***DF58 (RS232/RS485 Interface)***, use a DF59 cable or assemble the cable according to the diagram below.

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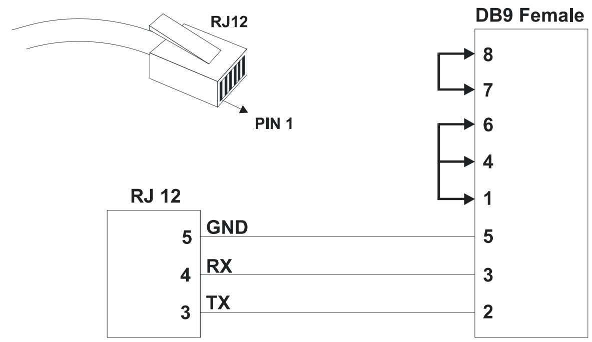
To assemble the serial cable between the FC302 (Processor) and the computer, observe the diagram below that describes the connection between the RJ12 (used in the FC302) and the DB9 Female:



It is recommended to use the jumpers on the DB9 side, but they are not necessary, depending on the application running on the PC.

Technical Specifications

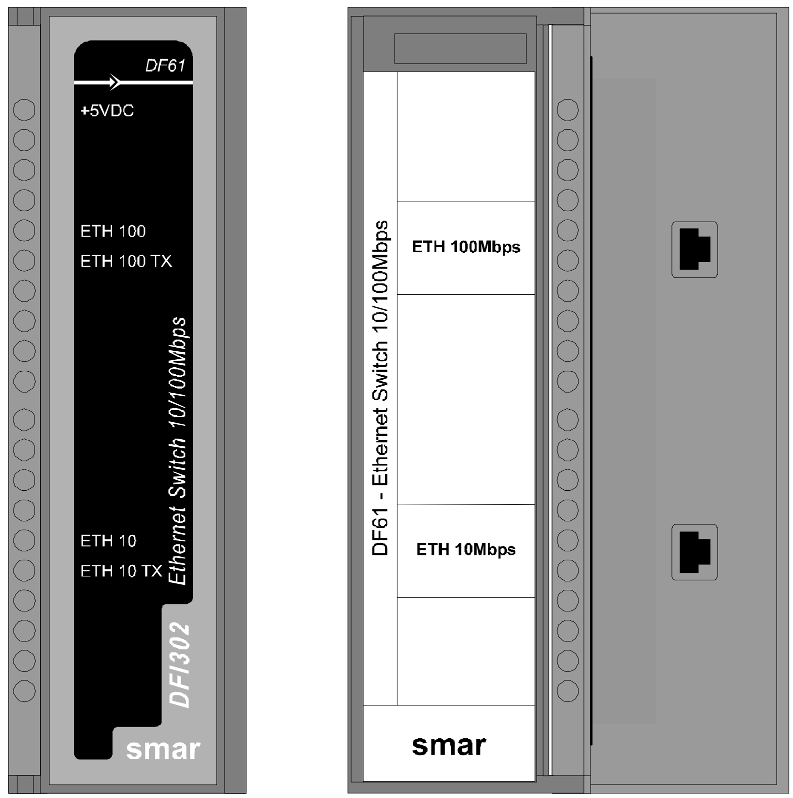
GENERAL FEATURES	
Number of Communication Channels	1
Data Communication Interface	RS-232 / RS-485
Data rate	Up to 200 Kbps
RS232 side	Enables RS-232 Half-Duplex or Full-Duplex mode
RS485 side	Enables the Bus Terminator
Isolation	1600 Vrms @ 1 minute, typical
Power Supply	Powered by the IMB bus, +5 Vdc @ 60 mA Typical

DF61 – Ethernet Switch 10/100 Mbps

Description

This module connects the FC302 processor directly to the 100 Mbps Ethernet Local Area Network (LAN). Install the DF61 in the Rack and using the DF54 cable, connect the 10 Mbps port to the 10 Mbps port of the FC302. The 100 Mbps port is ready to be connected to the LAN.

Make sure the Ethernet is communicating, check if the LEDs ETH10 and ETH100 are green (links connected) and LEDs ETH10TX and ETH100TX are blinking while the FC302 is sending data.



Chapter 7

ADDING I/O MODULES

Introduction

The AuditFlow was specifically, and primarily, designed to operate with Fieldbus instruments. All common field instrument types are available in Fieldbus versions. Therefore the amount of conventional I/O points required in a system is drastically reduced and will eventually be eliminated. However, since many applications require connection of old or new devices that do not have Fieldbus communication, the AuditFlow may also be fitted with conventional discrete and analogue I/O on an extended backplane. Each controller module can be fitted with an I/O-subsystem for up to 256 points.

There are many types of Modules available for the AuditFlow. Besides the presented list, many other modules are being developed to fit a broad range of applications in the Automation and Process Control industry.

The following tables show the available I/O module types.

DISCRETE INPUTS		
MODEL	**DESCRIPTION**	**I/O TYPE**
DF11	2 Groups of 8 24Vdc Inputs (Isolated)	16-discrete input
DF12	2 Groups of 8 48Vdc Inputs (Isolated)	16- discrete input
DF13	2 Groups of 8 60Vdc Inputs (Isolated)	16- discrete input
DF14	2 Groups of 8 125Vdc Inputs (Isolated)	16- discrete input
DF15	2 Groups of 8 24Vdc Inputs (Sink)(Isolated)	16- discrete input
DF16	2 Groups of 4 120Vac Inputs (Isolated)	8- discrete input
DF17	2 Groups of 4 240Vac Inputs (Isolated)	8- discrete input
DF18	2 Groups of 8 120Vac Inputs (Isolated)	16- discrete input
DF19	2 Groups of 8 240Vac Inputs (Isolated)	16- discrete input
DF20	1 Group of 8 On/Off Switches	8- discrete input

DISCRETE OUTPUTS		
MODEL	**DESCRIPTION**	**I/O TYPE**
DF21	1 Group of 16 Open Collector Outputs	16- discrete output
DF22	2 Group of 8 Transistor Outputs (source) (Isolated)	16- discrete output
DF23	2 Groups of 4 120/240Vac Outputs	8- discrete output
DF24	2 Groups of 8 120/240Vac Outputs	16- discrete output
DF25	2 Groups of 4 NO Relays Outputs	8- discrete output
DF26	2 Groups of 4 NC Relays Outputs	8- discrete output
DF27	1 Group of 4 NO and 4 NC Relay Outputs	8- discrete output
DF28	2 Groups of 8 NO Relays Outputs	16- discrete output
DF29	2 Groups of 4 NO Relays Outputs (W/o RC)	8- discrete output
DF30	2 Groups of 4 NC Relays Outputs (W/o RC)	8- discrete output
DF31	1 Group of 4 NO and 4 NC Relay Outputs (W/o RC)	8- discrete output
DF71	2 Groups of 4 NO Relays Outputs (W/o RC)	8-discrete output
DF72	2 Groups of 4 NC Relays Outputs (W/o RC)	8-discrete output
DF69	2 Groups of 8 NO Relays Outputs (RC)	16-discrete output

COMBINED DISCRETE INPUTS AND OUTPUTS		
MODEL	DESCRIPTION	I/O TYPE
DF32	1 Group of 8 24Vdc Inputs and 1 Group of 4 NO Relays	8- discrete input/4-discrete output
DF33	1 Group of 8 48Vdc Inputs and 1 Group of 4 NO Relays	8- discrete input/4-discrete output
DF34	1 Group of 8 60Vdc Inputs and 1 Group of 4 NO Relays	8- discrete input/4-discrete output
DF35	1 Group of 8 24Vdc Inputs and 1 Group of 4 NC Relays	8- discrete input/4-discrete output
DF36	1 Group of 8 48Vdc Inputs and 1 Group of 4 NC Relays	8- discrete input/4-discrete output
DF37	1 Group of 8 60Vdc Inputs and 1 Group of 4 NC Relays	8- discrete input/4-discrete output
DF38	1 Group of 8 24Vdc Inputs, 1 Group of 2 NO and 2 NC Relays	8- discrete input/4-discrete output
DF39	1 Group of 8 48Vdc Inputs, 1 Group of 2 NO and 2 NC Relays	8- discrete input/4-discrete output
DF40	1 Group of 8 60Vdc Inputs, 1 Group of 2 NO and 2 NC Relays	8- discrete input/4-discrete output

PULSE INPUTS		
MODEL	DESCRIPTION	I/O TYPE
DF41	2 Groups of 8 pulse inputs – low frequency	16-pulse input
DF42	2 Groups of 8 pulse inputs – high frequency	16-pulse input
DF67	2 Groups of 8 pulse inputs – high frequency (AC)	16-pulse input

ANALOG INPUTS		
MODEL	DESCRIPTION	I/O TYPE
DF44	1 Group of 8 analog inputs with shunt resistors	8-analog input
DF57	1 Group of 8 differential analog inputs with shunt resistors	8-analog input
DF45	1 Group of 8 temperature Inputs	8-temperature

ANALOG OUTPUTS		
MODEL	DESCRIPTION	I/O TYPE
DF46	1 Group of 4 analog outputs	4-analog output

ACCESSORIES		
MODEL	DESCRIPTION	I/O TYPE
DF0	Blind module to fill empty slots	No I/O
DF1A	Rack with 4 slots – support to shielded flat cable	No I/O
DF2	Terminator for last the rack – right side	No I/O
DF3, DF4A~DF7A	Flat cables to connect 2 racks	No I/O
DF9	Support for a single module	No I/O
DF54	Twisted pair cable 100 Base-TX	No I/O
DF55	Twisted pair cable 100 Base-TX – cross cable – length 2m	No I/O
DF59	Cable RJ12 used to connect controllers and DF58	No I/O
DF68	Cable to connect redundant CPUs	No I/O
DF76	Cable to connect co-processors	No I/O
DF78	Rack with 4 slots – It supports Hot Swap of CPUs and redundant I/O access	No I/O
DF82	Synchronism cable to connect redundant controllers – length 500 mm	No I/O
DF83	Synchronism cable to connect redundant controllers – length 1800 mm	No I/O
DF84	IMB Soft Starter	No I/O
DF90	IMB power cable	No I/O
DF91	Lateral adapter	No I/O
DF92	Rack with 4 slots for redundant CPUs, hot swap and diagnostic support	No I/O
DF93	Rack with 4 slots, with diagnostic	No I/O
DF96	Terminator for the last rack – left side	No I/O
DF101	Flat cable to connect racks by left side – length 70 cm	No I/O
DF102	Flat cable to connect racks by right side – length 65 cm	No I/O
DF103	Flat cable to connect racks by right side – length 81 cm	No I/O
DF104	Flat cable to connect racks by right side – length 98 cm	No I/O
DF105	Flat cable to connect racks by right side – length 115 cm	No I/O

Steps to Set up I/O Modules

The first steps to configure AuditFlow with I/O modules, need the knowledge on "How to Add a Function Block" using SYSCON (the configuration tool). See the Chapter "Adding Function Blocks", for further information

Add one Resource Block, one Hardware Configuration Transducer (HC) and one or more Temperature Transducers (when using Temperature Modules.

After the Resource and these transducers blocks, the user can add the other blocks (AI, MAI, AO, MAO, DI, MDI, DO, MDO).

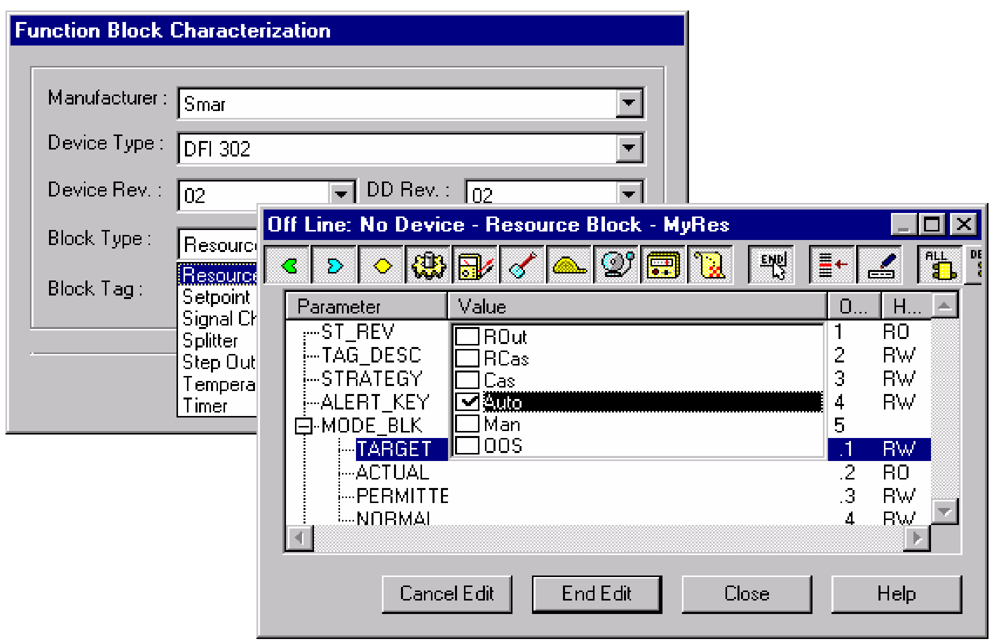
The order of the Resource, Transducers and block creation is very important because when SYSCON does the configuration download, a lot of consistency checks will be done inside AuditFlow.

For instance, an AI block will not accept a channel configuration if the desired pointed hardware was not declared before in the Hardware Configuration Transducer.

A complete documentation about Fieldbus Foundation blocks and its parameters could be found under Function Blocks Manual inside the System302 documentation folder. The following steps are more related with details about AuditFlow, and the complete description about blocks will not be found here.

RES – Resource Block

This function block has already been instantiated in the device. So, it is necessary set the MODE_BLK.TARGET parameter to AUTO.



HCT – Hardware Configuration Transducer

This transducer configures the module type for each slot in the AuditFlow. The execution method of this transducer block will write to all output modules and it will read all the input modules.

If any I/O module has failed in this scan, it will be indicated in BLOCK_ERR as well in the MODULE_STATUS_x. It makes easy to find the module or even the sensor in failure. This function block has already been instantiated in the device, so set the MODE_BLK parameter to AUTO and fill IO_TYPE_Rx parameters with its respective module that has been used.

PARAMETER	VALID RANGE/ OPTIONS	DEFAULT VALUE	DESCRIPTION
ST_REV		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1 to 255	0	
MODE_BLK		O/S	See Mode Parameter
BLOCK_ERR			
REMOTE_IO		Remote I/O Master	Reserved
IO_TYPE_R0		0	Select module type for the rack 0
IO_TYPE_R1		0	Select module type for the rack 1
IO_TYPE_R2		0	Select module type for the rack 2
IO_TYPE_R3		0	Select module type for the rack 3
IO_TYPE_R4		0	Select module type for the rack 4
IO_TYPE_R5		0	Select module type for the rack 5
IO_TYPE_R6		0	Select module type for the rack 6
IO_TYPE_R7		0	Select module type for the rack 7
IO_TYPE_R8		0	Select module type for the rack 8
IO_TYPE_R9		0	Select module type for the rack 9
IO_TYPE_R10		0	Select module type for the rack 10
IO_TYPE_R11		0	Select module type for the rack 11
IO_TYPE_R12		0	Select module type for the rack 12
IO_TYPE_R13		0	Select module type for the rack 13
IO_TYPE_R14		0	Select module type for the rack 14
MODULE_STATUS_R0_3			Status of modules in rack 0-3.
MODULE_STATUS_R4_7			Status of modules in rack 4-7.
MODULE_STATUS_R8_11			Status of modules in rack 8-11.
MODULE_STATUS_R12_14			Status of modules in rack 12-14.
UPDATE_EVT			This alert is generated by any change to the static data.
BLOCK_ALM			The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

TEMP – Temperature Transducer

This is the transducer block for the module DF45, an eight low signal input module for RTD, TC, Ohm.

When using this module, the TEMP Transducer is necessary and must be added to SYSCON Configuration, just before the Function Block, which will provide the interface with the I/O module. Therefore, create this block, set the MODE_BLK parameter to AUTO and fill parameters with range, sensor, etc, that will be used by the Temperature Module.

PARAMETER	VALID RANGE/ OPTIONS	DEFAULT VALUE	DESCRIPTION
ST_REV		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1 to 255	0	
MODE_BLK		O/S	See Mode Parameter
BLOCK_ERR			
CHANNEL			The rack and slot number of the associated DF-45 module coded as RRSXX.
TEMP_0			Temperature of point 0.
TEMP_1			Temperature of point 1.
TEMP_2			Temperature of point 2.
TEMP_3			Temperature of point 3.
TEMP_4			Temperature of point 4.
TEMP_5			Temperature of point 5.
TEMP_6			Temperature of point 6.
TEMP_7			Temperature of point 7.
VALUE_RANGE_0		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_0	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 0.
SENSOR_TYPE_0	See table below	Pt 100 IEC	Type of sensor 0.
VALUE_RANGE_1		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_1	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 1.
SENSOR_TYPE_1	See table below	Pt 100 IEC	Type of sensor 1.
VALUE_RANGE_2		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_2	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 2.
SENSOR_TYPE_2	See table below	Pt 100 IEC	Type of sensor 2.
VALUE_RANGE_3		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_3	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 3.
SENSOR_TYPE_3	See table below	Pt 100 IEC	Type of sensor 3.
VALUE_RANGE_4		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_4	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 4.

PARAMETER	VALID RANGE/ OPTIONS	DEFAULT VALUE	DESCRIPTION
SENSOR_TYPE_4	See table below	Pt 100 IEC	Type of sensor 4.
VALUE_RANGE_5		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_5	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 5.
SENSOR_TYPE_5	See table below	Pt 100 IEC	Type of sensor 5.
VALUE_RANGE_6		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_6	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 6.
SENSOR_TYPE_6	See table below	Pt 100 IEC	Type of sensor 6.
VALUE_RANGE_7		0-100%	If it is connected to AI block, it is a copy of XD_SCALE. Otherwise the user can write in this scaling parameter.
SENSOR_CONNECTION_7	1 : differential 2 : 2-wire 3 : 3-wire	3	Connection of the sensor 7.
SENSOR_TYPE_7	See table below	Pt 100 IEC	Type of sensor 7.
UPDATE_EVT			This alert is generated by any change to the static data.
BLOCK_ALM			The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

Function Block Creation

The AuditFlow and Fieldbus devices use function blocks to build strategies, such as PID, AI blocks, etc. This means that SYSCON can be used to set up every part of the system - transmitters, positioners and controller - in a same language. Once built the control strategy and chose the function blocks to be located in AuditFlow, set up the CHANNEL parameter for that function block, which makes the interface with I/O modules.

CHANNEL Configuration

Using AuditFlow, the user can configure the number of I/O modules as well the I/O type (input or output, discrete, analog, pulse etc). The AuditFlow is the only device classified as a configurable I/O device. All I/O modules have the I/O points arranged as follow:

Rack	0 ~ 14
Slot	0 ~ 3
Group	0 ~ 1
Point	0 ~ 7

The value in the CHANNEL parameter is composed by these elements in the **RRSGP** form.

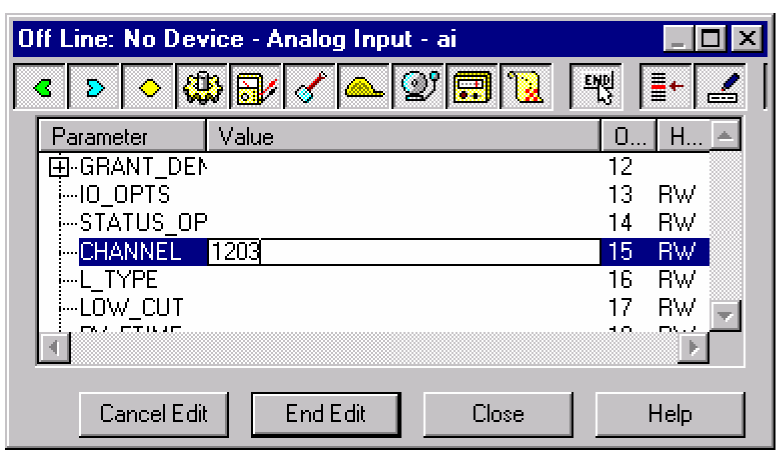
Rack (R): Each rack has four slots. The rack is numbered from 0 (first rack) till 14 (last rack). Therefore a single I/O point in the AuditFlow can be identified by specifying the rack (R), slot (S), group (G) and point (P). The CHANNEL parameter in the multiple I/O blocks (MIO) must specify the whole group (8 points), the point must be 9, that means the whole group.

Slot (S): One slot supports one I/O module, and it is numbered from 0 (first slot in the rack) till 3 (last slot in the rack).

Group (G): Ordinal number of group in the specified I/O module, it is numbered from 0 (first group) till number of groups minus 1.

Point (P): Ordinal number of I/O point in a group, it is numbered from 0 (first point) to 7(last point in the group), and 9 mean the whole group of points.

For example, a CHANNEL parameter equals to 1203, it means rack 1, slot 2, group 0 and point 3. If the CHANNEL parameter of a MAI block is 10119, it means rack 10, slot 1, group 1 and point 9 (whole group). Before setting the CHANNEL parameter, it is recommended to configure the hardware in the HC block. Because the write check will verify if the I/O type configured in the HC block is suitable for block type. Therefore setting the CHANNEL parameter of AI block to access an I/O type different of analog input will be rejected.



Module Specification Standard

The module specification is shown in a format similar to the example below. All of the Module specifications explain functionality, field connection, and electrical characteristics, and shows a simplified schematic of the interface circuit for better understanding.

DF11/DF12/DF13/DF14 - DC Input Modules

Module Name

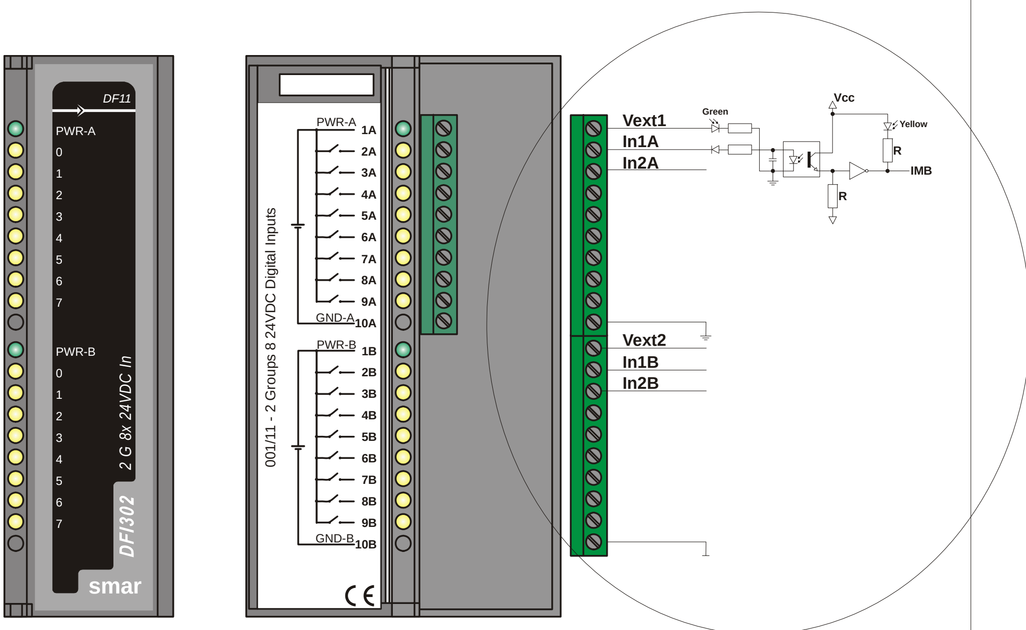
DF11 (2 groups of 8 24 Vdc inputs isolated)
DF12 (2 groups of 8 48 Vdc inputs isolated)
DF13 (2 groups of 8 60 Vdc inputs isolated)
DF14 (2 groups of 8 125 Vdc inputs isolated)

Part Number

Description

This module detects the DC input voltage and converts it in a TRUE (ON) or FALSE (OFF) logic signal . It has 2 groups isolated optically.

Brief Module Description



Simplified Internal Circuit Diagram

Technical Specifications

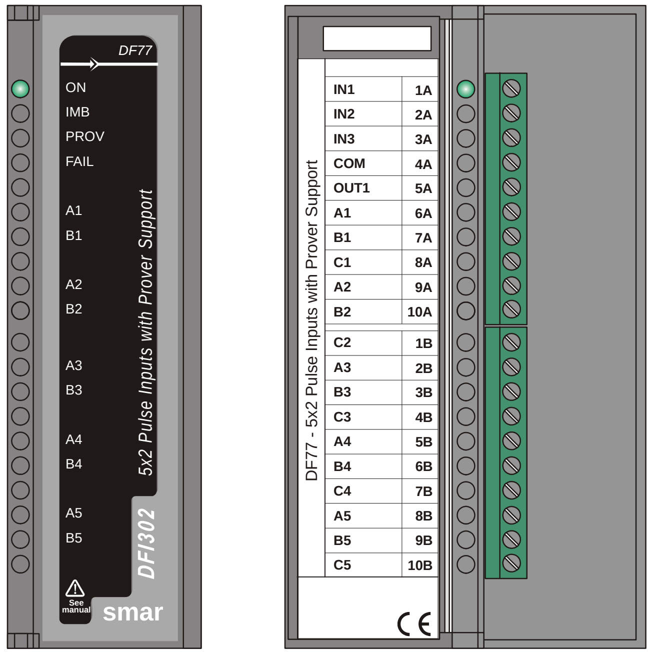
ARCHITECTURE	
Number of Inputs	16
Number of Groups	2
Number of Points per Group	8

Technical Specifications

DF77 – PULSE INPUTS MODULE WITH PROVER SUPPORT

Ordering Code

DF77 – 5 x 2 Pulse Input Module with Prover Support



Pulse Inputs Module with Prover Support: DF77

Overview

Standards Compliance

- ANP/INMETRO Regulation number 1 and number 64;
- API MPMS 4.6: Proving Systems - Pulse Interpolation;
- API MPMS 5.5: Metering - Fidelity and Security of Flow Measurement Pulsed-Data Transmission Systems;
- ISO 6551: Petroleum Liquids and Gases - Fidelity and security of dynamic measurement - Cabled transmission of electric and or electronic pulsed data;
- ISO 7278-3: Liquid hydrocarbons - Dynamic measurement - Proving systems for volumetric meters - Part 3: Pulse interpolation techniques.

Features

The DF77 is an “A level” pulse totalization module used with AuditFlow system (HFC302) in applications that transmit the mass or volume information by pulses, such as turbines or positive displacement meters. The DF77 allows the HFC302 to fulfill the international and Brazilian standards related to pulse transmission reliability and volumetric meter provings with pulsed output. It can be used with liquids and for gases.

For pulse totalization, this device provides the following features:

- Use of Advanced programmable logic technology to guarantee reliable and accurate operation, with specific hardware for critical functions;
- 10 independent 16 bit totalizers operating in single pulse mode or 5 independent totalizers operating in dual pulse mode;

- The totalizers reading is done simultaneously in each CPU cycle with the counters synchronized. This feature is important for Master Meter (MM) proving;
- All inputs have the following features:
  - o Configurable frequency range from 5Hz to 25 kHz.
  - o Pulse width digital filter, adjusted by the maximum limit of the frequency configured in the transducer block;
  - o Do not accept variable reluctance sensors, magnetic sensors or inductive sensors directly connected. A preamplifier must be used to provide the signal with the required amplitude;
  - o Schmitt-trigger comparator with 30/60DC/VAC tolerance and logic level ‘0’ below 1.2V and level ‘1’ above 3.5V;
  - o Active pull-up (5V) for open-collector/drain outputs, external resistors are not necessary;
  - o Average frequency measurement with 0.01% of accuracy;
  - o Fault indication using the transducer block parameter and front LEDs.

- On the dual pulse mode, the DF77 automatically detects and corrects the errors related to:
  - o Coincident pulses;
  - o Sequence error;
  - o Phase difference error;
  - o Missing pulses;
  - o Additional pulses;
  - o Coincident pulses, phase errors, sequence errors and additional pulses errors are automatically ignored in the totalization, being computed by counters that are individual for each type of error, which are available in the CPU transducer block;
  - o Detected missing pulses are automatically counted.
  - o If one of the signals is lost, the totalization will continue only with the remaining signal, without error detection and correction.

The prover support includes:

- Connection to any prover that detects the beginning and the end of the calibrated section (compact, U type, etc).
- Open-drain output controlled by the flow computer (FC302) to start proving;
- Dual chronometry implementation for pulse interpolation, using counters operating at a 50 MHz providing high resolution.
- Proving doesn't interfere in the totalization, because it is executed by independent, specific hardware.

The DF77 provides the following features related to the Master Meter proving:

- The reading of pulse totalizers is executed simultaneously to guarantee that the pulse totalization in the meter being proved is the same as in the Master Meter.
- Group 5 is assigned to the Master Meter by default. All diagnostics, error detection and error correction are also applied to this group.

This equipment has Electrostatic Discharge (ESD) sensitive components. Do not open the module while it is powered or without the appropriate ESD protection. Otherwise, the circuits can be damaged permanently.

NOTE
It is important to install and configure all measurement system components correctly. It is also important to check the installation to make sure there are no noise sources. The automatic error detection and correction implemented in the DF77 helps the flow computer to reduce the measurement uncertainness only in untypical conditions. This equipment does not guarantee the system functionality in precarious installation conditions, with noise or meter problems. Frequent maintenances are extremely important.

Installation

This equipment has Electrostatic Discharge (ESD) sensitive components. Do not open the module while it is powered or without the appropriate ESD protection. Otherwise, the circuits can be damaged permanently.

The DF77 was developed using the most recent technology and must be installed and operated carefully to obtain the best results.

Things the user should never do

- Start the installation before reading and understanding this manual;
- Expose or touch the electronic circuits when the module is powered;
- Touch any internal part without ESD protection (wrist trap, ionizers, etc) and appropriate grounding. This item also applies to the front terminal;
- Insert metallic objects inside the module when it is powered;
- Connect the shield loop of the signal cables to more than one point;
- Operate the system without appropriate grounding (< 20 Ohms);
- Operate the equipment in constant noise conditions, as in the AC network or in pulse signals.
- Install signal cables in the same conduit of the power cables;
- Use signal cables without the shield loop installed correctly;
- Start the system operation without validating the installation and the pulse totalization devices, according to the recommendations in this manual;
- Start the system operation without validating the installation and the proving devices, according to the recommendations in this manual.

Things the user should always do

- Read the manuals carefully before installing and operating the system. This step prevents damages and installation delays;
- Use quality grounding (< 20 Ohms) in the installation, connecting cables with appropriate measures and isolation;
- Use shielded twisted pair cables to connect the signals from the field to the panel;
- Connect the cable loop to one single point, preferentially on the base of the mounting panel, preserving the loop in the input of the front module if the cable segment internal to the panel is superior to 50 cm. Isolate the cable terminal with a heat shrink tubing to protect the loop.

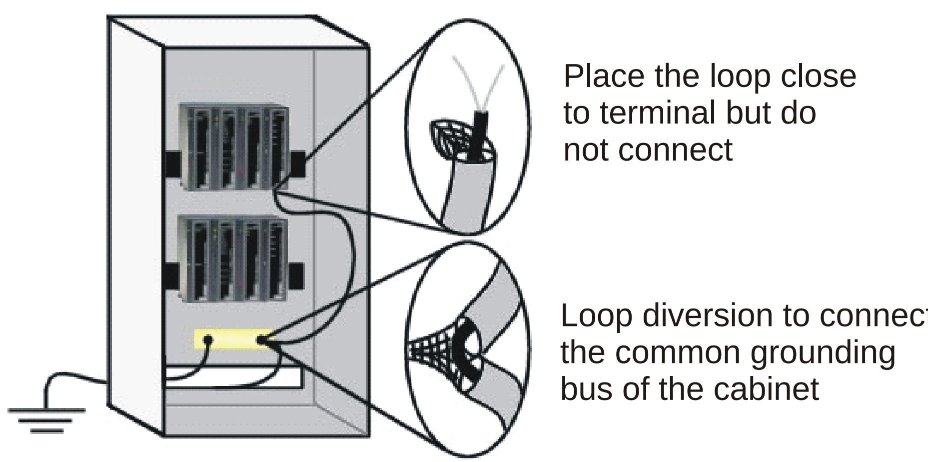


Figure 1** - **Example of control panel installation

Pulse transmitters connection

The DF77 module can be used with different meter types with pulsed output. The only condition is the generated pulses to observe the module operation limits for the amplitude, frequency and active cycle:

- **Frequency**: 5Hz to 25 kHz.
- **Amplitude**: $V_{0,max}$=1V and $V_{1,min}$=4,3V, where the transition levels are: **'0' < 1,2V** and **'1' > 3,5V**.
- **Duty cycle**: 15% to 85% of the FREQ_UPPER_RANGE configured in the transducer block.

Using preamplifiers

The DF77 pulse inputs are not developed for sensors with small amplitude, such as magnetic pick-ups, inductive sensors, variable reluctance, etc. If the flow meter uses this type of sensor, a proper preamplifier must be installed between the sensor and the module, according to the following figure:

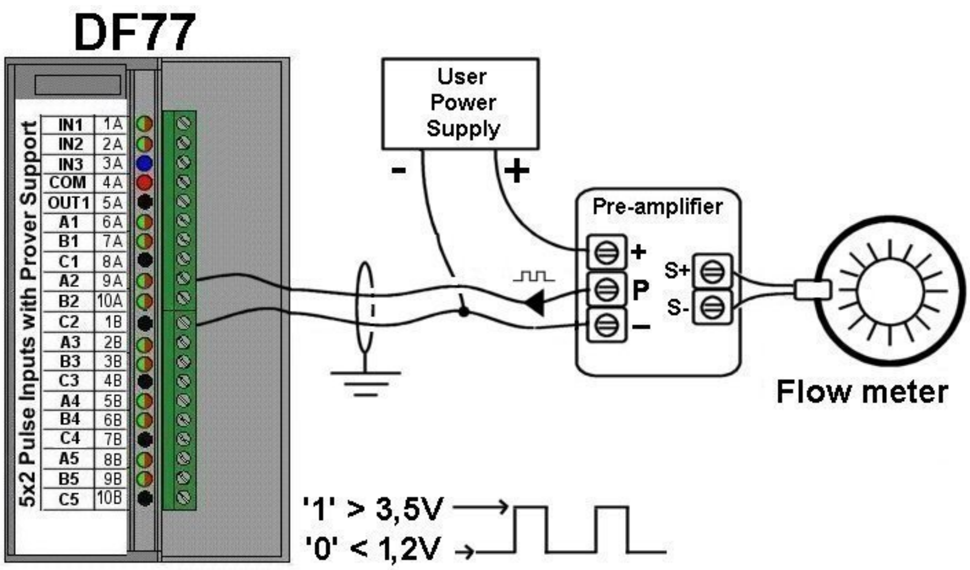


Figure 2 – Single signal connected to the A2 pulse input

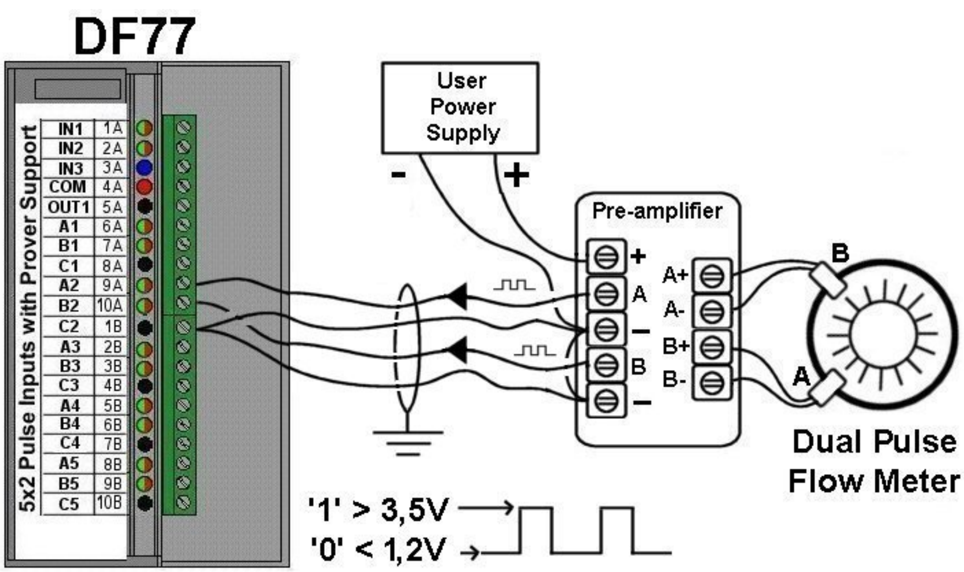


Figure 3 – Dual signal connected to group 2 (A2 and B2 inputs)

IMPORTANT
In dual pulse example above, it is extremely important to observe the pulse sequence A→B and configure the correct phase difference in the DF77 transducer block (usually 90º). The group should also be configured to operate in the dual signal check mode. If the phase difference between pulses changes, it is necessary to increase the tolerance in the phase difference in order to totalize correctly. Refer to the FC302 manual for further details.

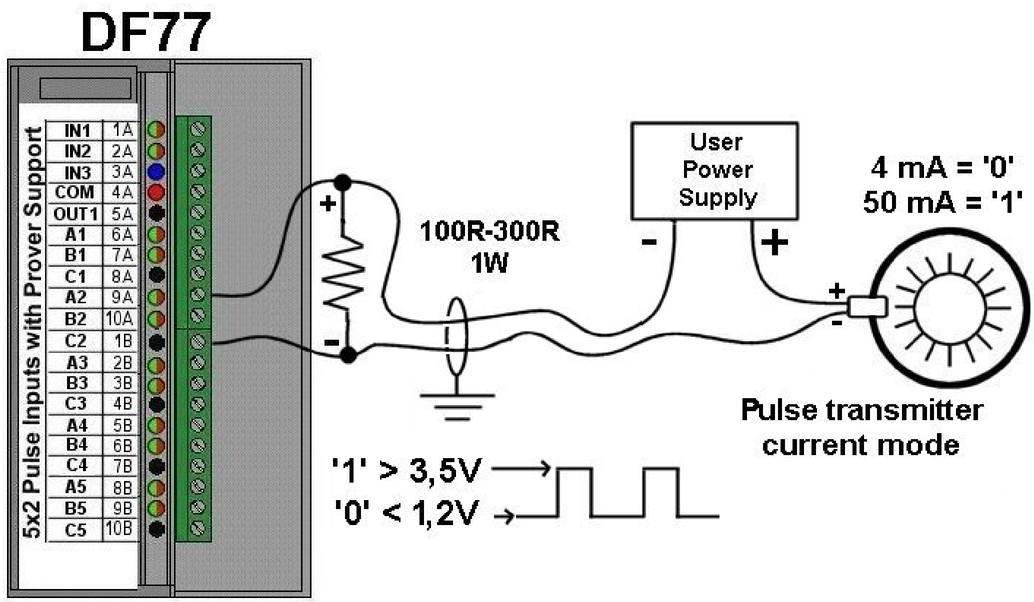


Figure 4 – Connecting the current pulse generator

Prover Connections

The DF77 allows the FC302 to operate with a large variety of provers, from conventional provers, such as the U-type, to compact provers. The following figures show how to connect the DF77 to the most common types of provers. It is important to observe that there are no standard for provers, and therefore this figures should only be used as a reference. It is recommended to consult the specific prover documentation before the installation.

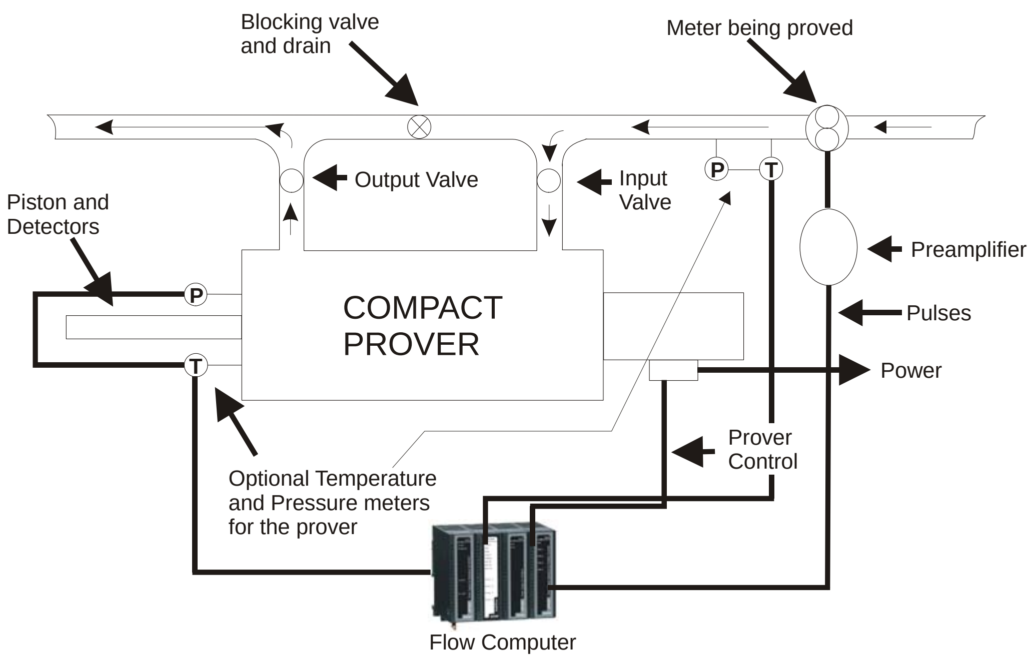


Figure 5 – Typical installation for Prover and flow computer

General connection for provers

The DF77 operates with compact provers or provers with a larger volume, such as the U-type. The figure below shows an example of a general connection. There are independent signal interfaces for each detector or a single signal for 2 detectors.

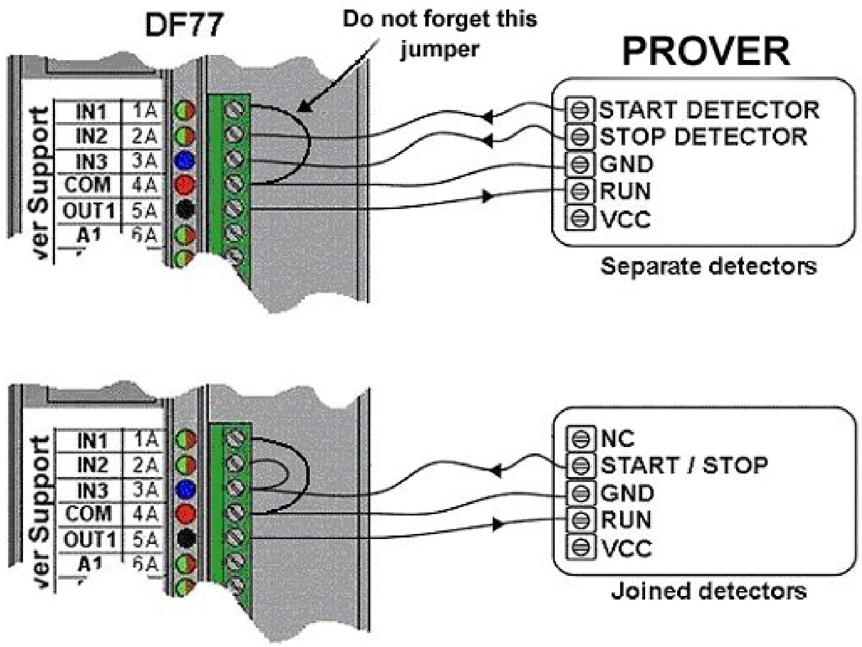


Figure 6 – General connection for provers

Connecting the Calibron Syncrotrak compact prover

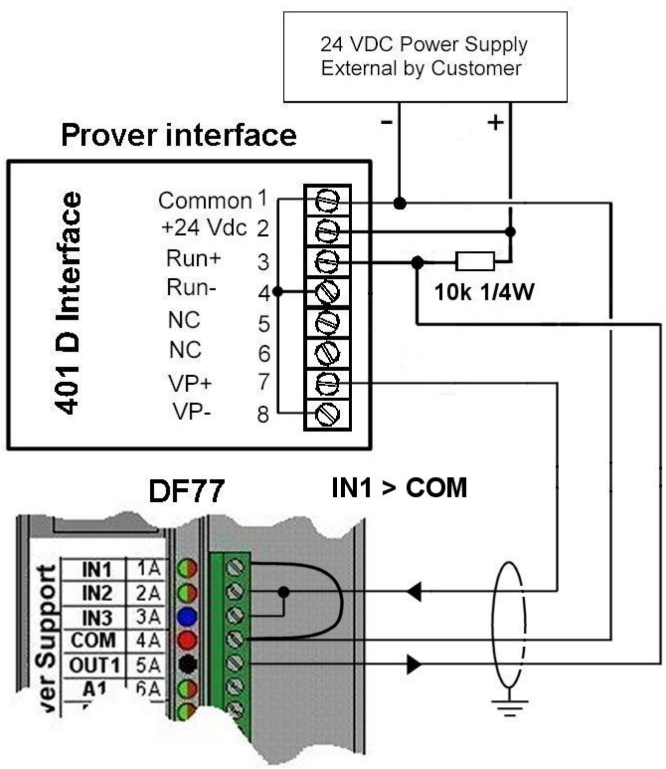
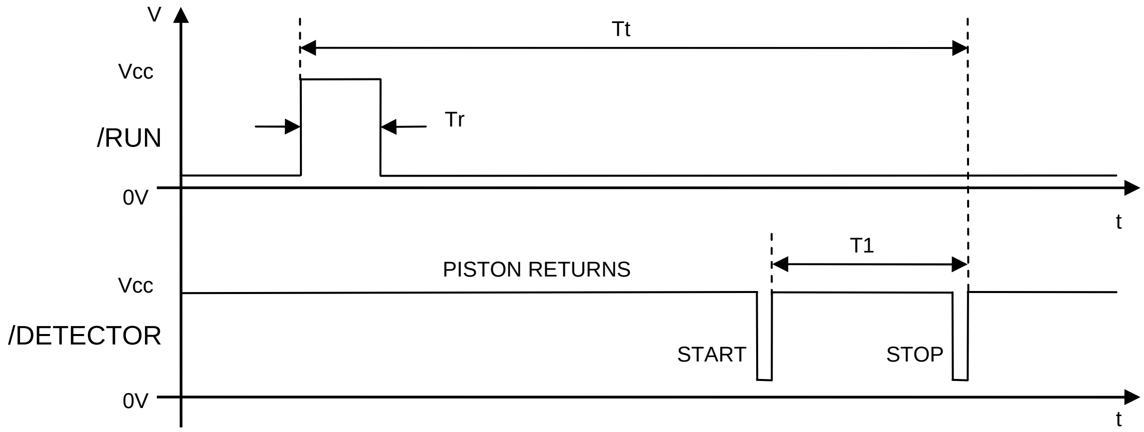


Figure 7 – Connecting the Calibron Syncrotrak compact prover

Wave form for Calibron prover (none /UPSTREAM signal):



- **Tr**: the pulse duration is configured in the OUT1_CONTROL parameter of the PIP block.
- **T1**: time used to calculate the pulses interpolation.
- **Tt**: proving total time.

Observation: The pulses of STOP and START during the piston return are not transmitted to flow computer.

Connecting the Brooks compact prover

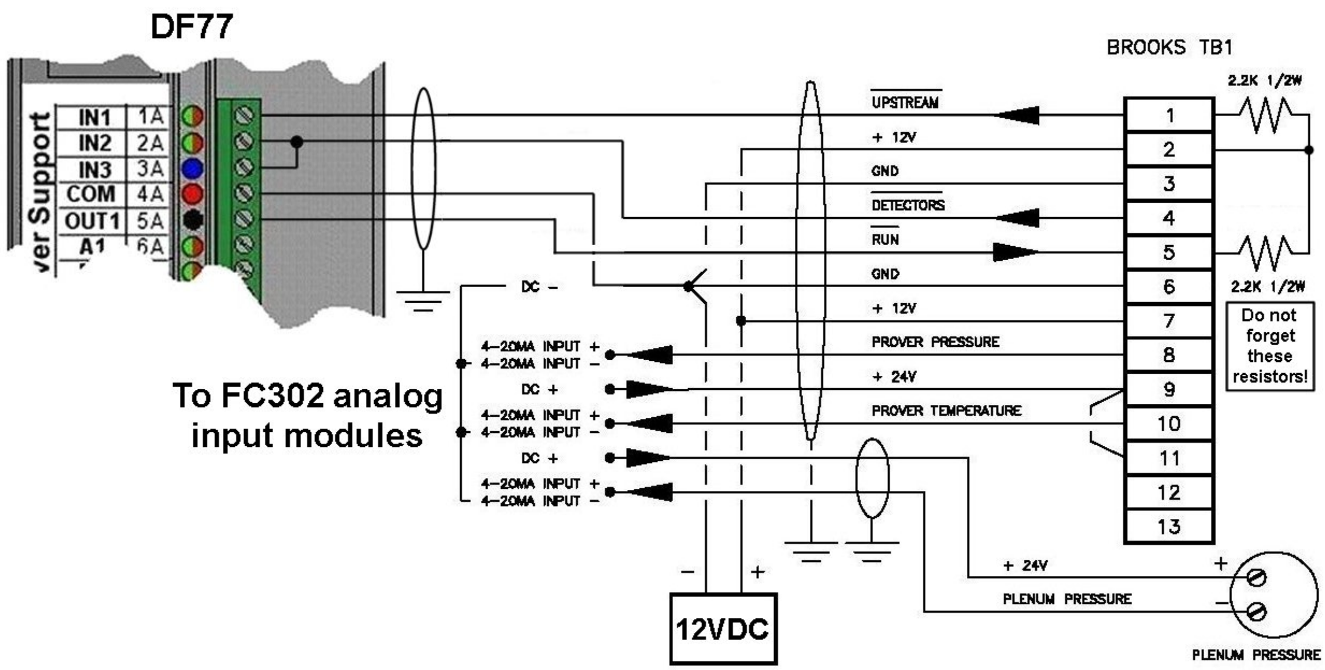
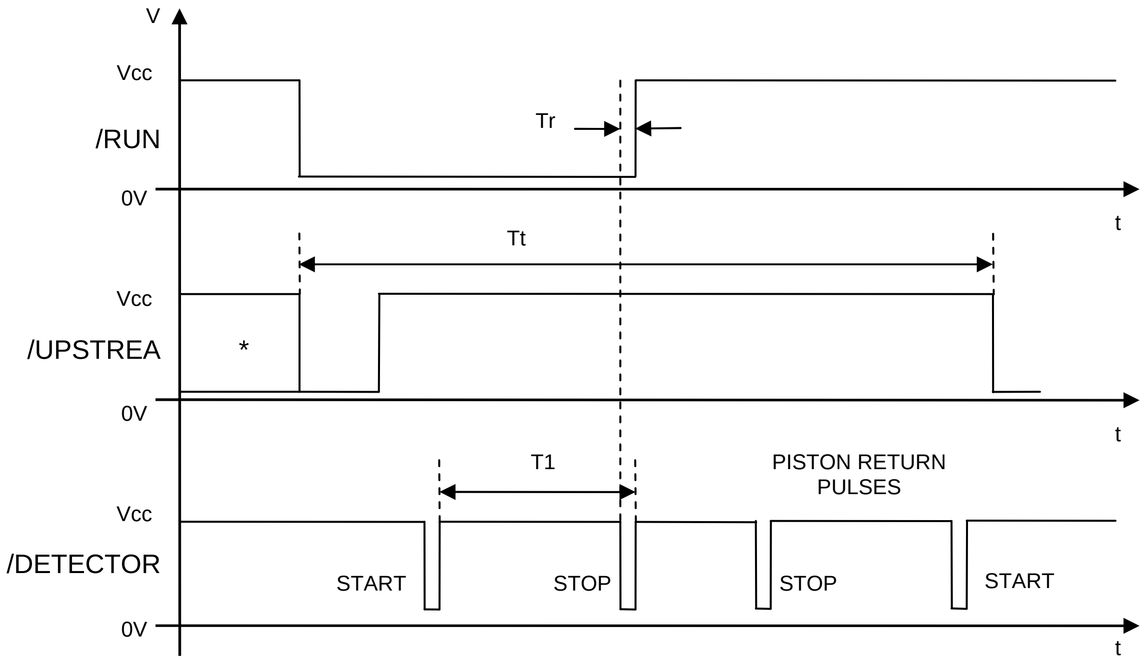


Figure 8 – Connecting the Brooks compact prover

Wave form for Brooks prover:



- *Initial level: ‘0’ if the prover is powered and ‘1’ if is no powered.
- **Tr**: time between the detector STOP descent and the DF77 to force the /RUN signal for logic level ‘1’, provoking the return of the piston.
- **T1**: time used to calculate the pulses interpolation.
- **Tt**: proving total time. The proving is initiate with /UPSTREAM signal in logic level ‘0’. After the /UPSTREAM signal return to ‘0’ a new proving can be initiate.

Connecting the Master Meter

The DF77 also supports the proving Master Meter (MM). The MM operation is the same of any other meter. This means that all filter mechanisms, error detection and correction are applied to the MM. It was defined that group 5 should be used for the MM connection. However, any input or group of inputs can be used once the FC302 blocks were configured correctly. The MM must be carefully installed, as the production meters.

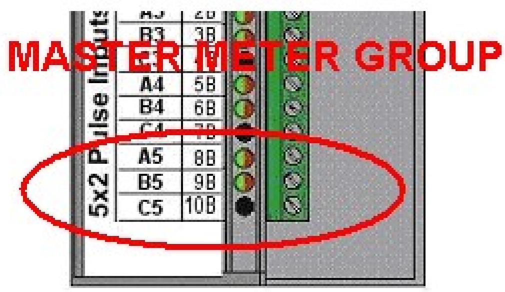


Figure 9 – Connecting the Master Meter

Installation in Hazardous Areas

The DF77 cannot be connected directly to the devices which are located in hazardous environment. One of the ways to do this kind of installation is to use intrinsic safety barriers.

Pulse signals installation

To the pulse inputs (A1, B1 ... A5, B5) should be used barriers type digital repeater. The barrier output should attend the DF77 input levels: "0" < 1.2V and "1" > 3.5V, and the barrier's response time should be sufficient to work in the operation frequency range of the pulse transmitter (for example, rising response time plus falling response time must be less than half of period, therefore 5ms, if frequency up to 100 Hz). See the following example which is using the SENSE KD-11/Ex barrier:

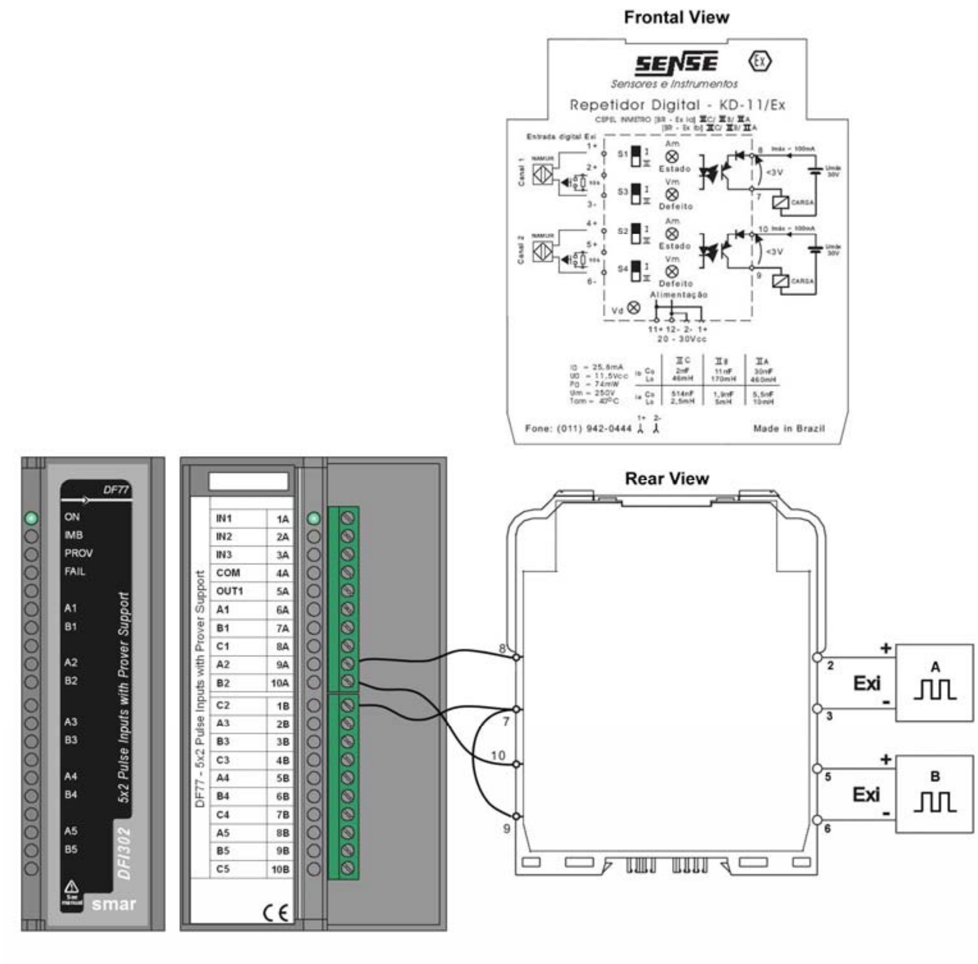


Figure 10 – Pulse input installation in Hazardous Areas

Interface with volumetric prover

To the discrete inputs (IN1, IN2, and IN3) should be used barriers type digital repeater with the same restrictions applied to the pulse inputs. To the OUT1 output should be used a barrier type digital drive. The OUT1 output is type OPEN DRAIN, which assures a voltage drop in the output less than 1V (100mA@100V maximum). To supply a barrier in 24VDC use a 10kΩ 1/4W resistor as pull-up. See the example, in the figure below, the SENSE KD-572T/Ex barrier:

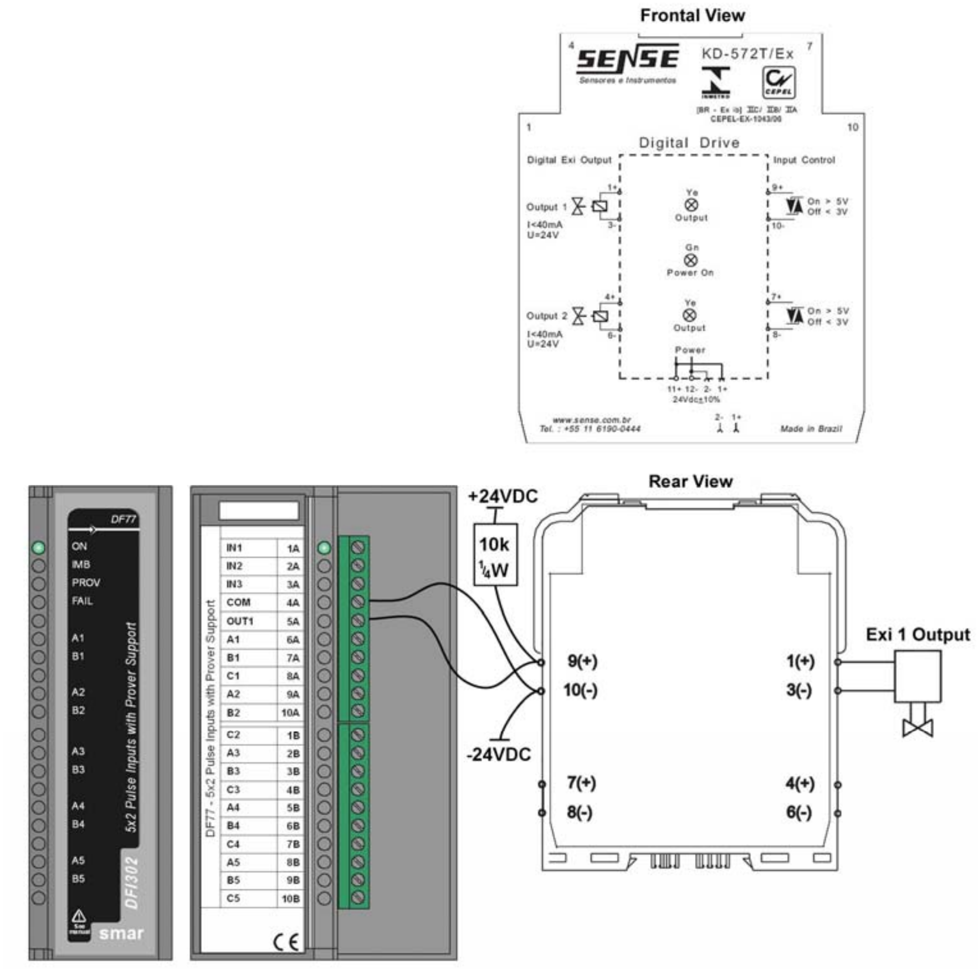


Figure 11 - Interface with Volumetric Prover in Hazardous Areas

Connection with Calibron Syncotrak prover with barriers

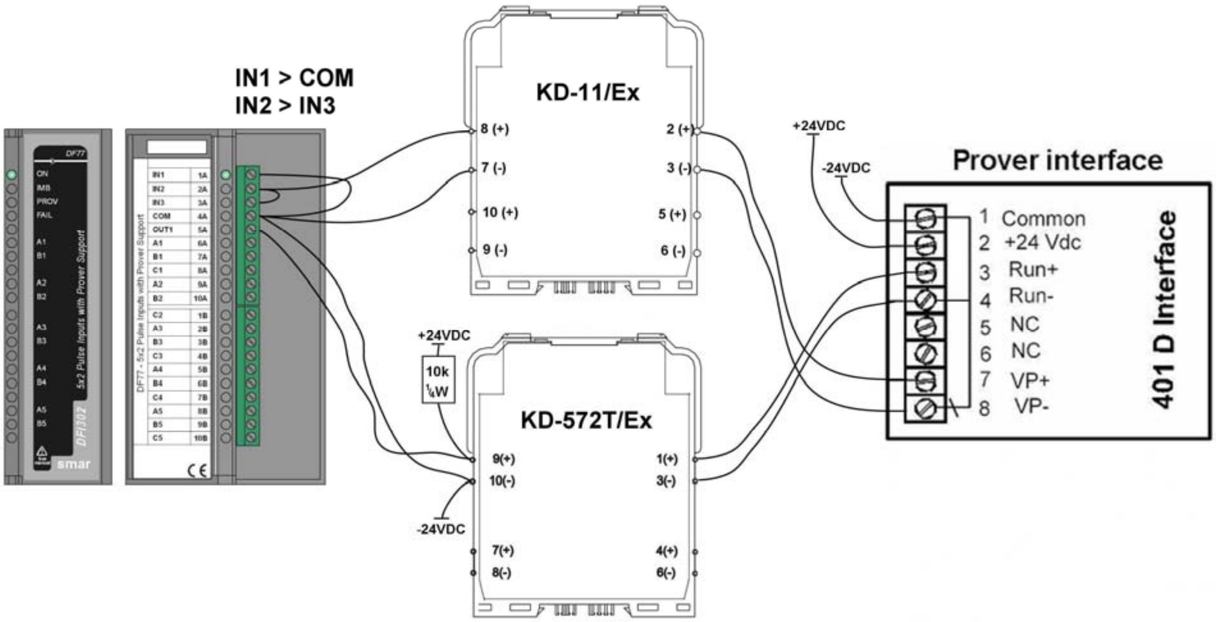


Figure 12 – Calibron Syncrotrak Prover in Hazardous Areas

IMPORTANT
The 24 VDC power supply which supplies the 401D interface have to be isolated from the barriers' power supply and from the power supply of the safe side (DF77).

DF77 Operation

Description of the Front Panel LEDs

LED	Status	Description
ON	Green ON	The module is powered; the HOT SWAP circuit is operating correctly and the FPGA initialization sequence was successful.
	Red ON	The module is powered via IMB (+5V), but the FPGA initialization sequence wasn't successful. The FPGA may not have been programmed yet, or there is an internal problem.
	OFF	There is no power on the IMB or the HOT SWAP circuit failed.
IMB	Green ON	The flow computer, FC302, is accessing the module in the correct periodicity.
	Red ON	The FC302 is not accessing the module.
PROV	Blue ON	Proving is being executed.
	OFF	There is no proving being executed.
FAIL	Red ON	Hardware failure, the FC302 and/or the power supply is indicating failure in the IMB (HC block missing, power failure).
	OFF	No hardware failure.
A1…A5 B1…B5	Green ON	Input is continuously receiving the pulse train with frequency and active cycle in the configured limits in the FREQ_LOWER_RANGE and FREQ_UPPER_RANGE parameters of the PIP block.
	Green blinking	The signal frequency is between the limits: 5Hz < f < FREQ_LOWER_RANGE or FREQ_UPPER_RANGE < f < 25 kHz
	Red ON	The measured frequency is out of the maximum limits of the equipment (5Hz-25kHz) or then the duty cycle is less than 15% of the period correspondent to the value configured in FREQ_UPPER_RANGE.
	OFF	The correspondent input is disabled by the configuration in the FC302 transducer block.

Table 1 – Front Panel LEDs

Hardware Specification

- The interface is composed by 6 isolated groups (500 Vrms), with individual grounds.
- It has 10 pulse inputs divided in groups 1 to 5. Each input can be used in the single signal mode or in the dual signal mode, when combined with other input in the same group.
- Group 6 has prover interface, composed by 3 discrete inputs and 1 discrete output:
  - The OUT1 discrete output is open drain with N channel DMOS transistor, 100mA @ 100VDC, protected by reset-able polymeric fuse.
- All inputs (groups 1 to 6) have:
  - Range frequency for pulse counting : 0Hz to 25 kHz
  - Range frequency for frequency reading: 5Hz to 25 kHz with range operation configuration.
  - Indication of average frequency in the transducer block, with 0.01 % accuracy.
  - Support for quadratic wave, pulses or sinusoidal:
    - V_0 : -30V to 1V (wave form inferior limit)
    - V_1 : 4,3V to 60V (wave form superior limit)
  - Minimum pulse width: 12.5% of period corresponding to PIP.FREQ_UPPER_RANGE.
  - 5k6 Ohm input impedance.
  - Polymeric resettable protection fuse.
  - ESD and surges protection.
  - Pull-up active resistor for +5VDC, eliminating the external resistor.
  - Electromagnetic interference filter (ferrite bead).
  - Green/red Front LED to indicate the input status.
  - Digital debouncing circuit to eliminate the installation of external capacitors.
  - 16 bits Totalizers.
- Common features for all groups:
  - Isolated ground using individual DC-DC converter.
  - Digital signal isolation using individual opt couplers.
  - 500 Vrms optical isolation.
- The module has Hot Swap circuit.
- It also has the MODULE_ID circuit, where the identifier is 77.
- Front LEDs indication:
  - **ON** indicates if the module is powered and if the internal FPGA is operating correctly.
  - **IMB** indicates if the FC302 is accessing the DF77 correctly.
  - **PROV** turns on if a proving is being executed.
  - **FAIL** indicates that a serious error occurred in the equipment.
- The DF77 uses components with the most advanced semiconductors technology to improve performance.
- Using a Flash memory, all device functionalities can be updated in the field.
- Internal overload and short-circuit protections for all regulators.
- The IMB interface is protected:
  - Internal failures in the equipment won't endanger the flow computer operation or any other module in the same bus.
  - Interferences from the IMB won't compromise the module operation that continues to totalize even if the flow computer no longer access the module.

I/O Circuits

The figure below shows the block diagram of the I/O circuits to facilitate the connection of the pulse transmitters, preamplifiers and external interfaces.

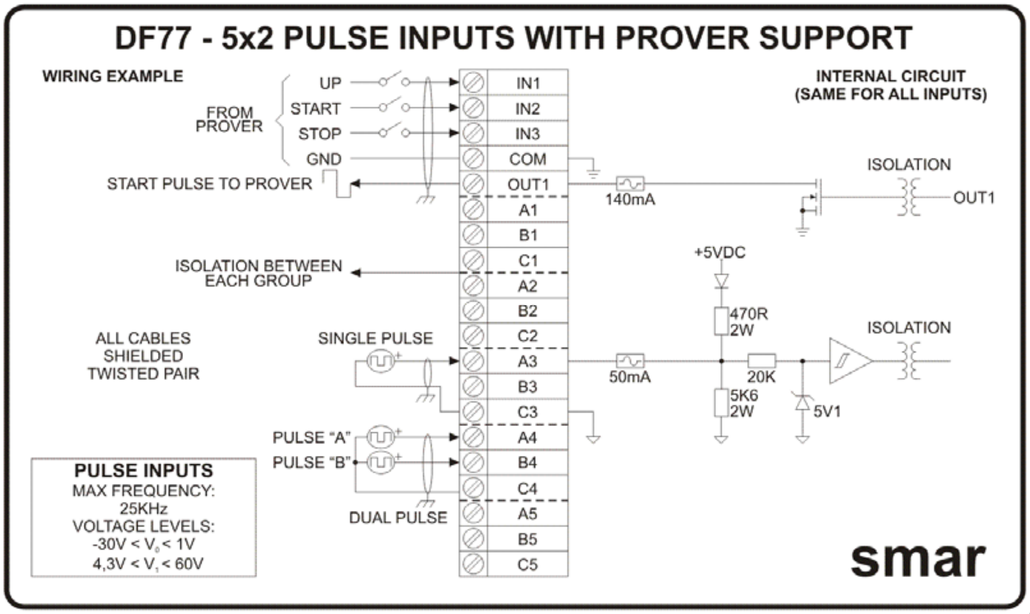


Figure 13 - I/O internal circuits

Checking the installation

The DF77 assists the FC302 flow computer to fulfill Brazilian and international standards related to the pulse totalization and volumetric proving. However, to get the most from the system, it is necessary to carefully check the installation before starting the measurement system operation. Some procedures are described in the standards and others originated from the experience of using this equipment. Even if the procedures described in this manual do not verify the installation, it is important to detect and correct the problems before initializing the system.

Checking the safety level for pulse totalization

Using a pulse generator with accuracy lower than 0.001% to simulate a pulse train, the installed set should have a **totalization error lower than 1 pulse for each 100.000**.

The test suggests generate 10^6 pulses in a frequency corresponding to twice the maximum flow frequency of the meter and half of the meter output amplitude. At the end of the counting, check if the totalized number differs from less than 10 pulses. Repeat this procedure using a frequency corresponding to half of the minimum working flow, with the same maximum error. In this case, the installation and the tested equipments fulfill and exceed the API MPMS 5.5 and ISO 6551 standards related to the pulse transmission and totalization. If this test is not successful, check the installation for noise sources, grounding problems, wrong connections, low quality cables, problems with the meter or the preamplifier, etc.

Note: Use the TEST_COUNTER parameter of the DF77 transducer block to check the pulse totalization.

Double chronometry proving

The following procedure checks the proving functionality available in the DF77, generating a simple pulse train and simulating the beginning and end detectors of the calibrated section.

The correct operation of the equipment that interpolates the pulses is extremely important for the proving accuracy, as for compact provers, as for reduced volume conventional provers (U type). A proving method for double chronometry is described below, according to the API MPMS 4.6 and

ISO 7278-3 standards. See the block diagram below with the equipments required to execute the test.

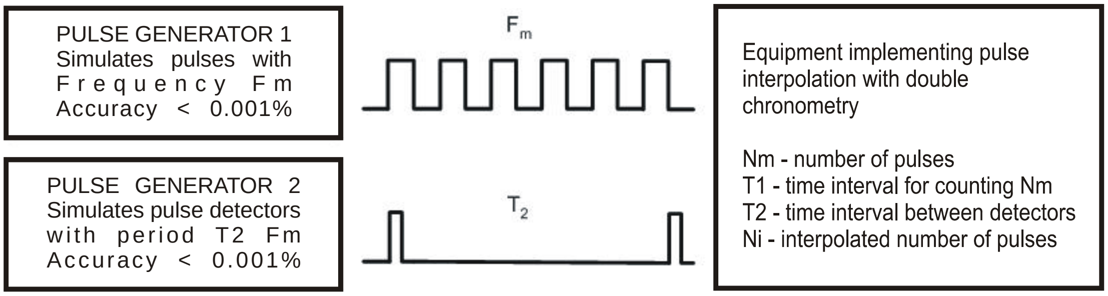


Figure 14 – Double chronometry verification

In the figure above, observe that a pulse generator is used to generate a pulse train simulating the meter output, where the frequency $\boldsymbol{F_m}$ must correspond to the maximum work flow of the meter/prover. The second signal generator simulates the beginning and end detectors of the prover calibrated section, simulating the time interval $\boldsymbol{T_2}$. The signal generators should have accuracy ≤ 0.001%. The $\boldsymbol{F_m}$ and $\boldsymbol{T_2}$ values must be set for the worst case, that is, the smaller number of pulses in the smallest proving time. Select the meter with the smallest ***K*** (pulses/volume), with the smallest work flow. It is extremely important that there are two conditions to guarantee a fragmented number of pulses during the test:

- Time interval $\boldsymbol{T_2}$ is not a multiple of the frequency $\boldsymbol{F_m}$ and,
- The signal of the detectors is not synchronized with the generated pulses.

The ideal number of interpolated pulses can be calculated as:

$$N_i^* = F_m \cdot T_2^*$$

The number of pulse calculated by the equipment being tested is:

$$N_i = N_m \cdot \frac{T_2}{T_1}$$

The difference between the calculated and measured values should not exceed ±0.01%, that is:

$$\left| \frac{N_i^* - N_i}{N_i^*} \right| < 0.0001$$

Note: Use the LMF block to simulate the proving and to check if the calculated number of interpolated pulses is acceptable. If the error is greater than the acceptable value, check again the adjustments made in the signal generators. Also, check the wiring, grounding and noise sources.

Operation Theory

Pulse Transmission Reliability

The purpose of using a pulse dual signal to guarantee the transmission and totalization reliability is to:

1. Provide an additional signal for comparison to eliminate false errors. The comparison between two pulse trains considers:
   a. Pulse sequences, according to A→B.
   b. Phase difference, calculated cycle by cycle to validate the pulses.
   c. Instant frequency, calculated cycle by cycle.
   d. Total pulse counting for A and B.

2. Provide a basic level of redundancy: if one signal fails, the flow computer will continue totalizing using the other pulse train.
   a. In this condition, there is no error detection or correction based on the comparison between two signals, and therefore more errors may occur.

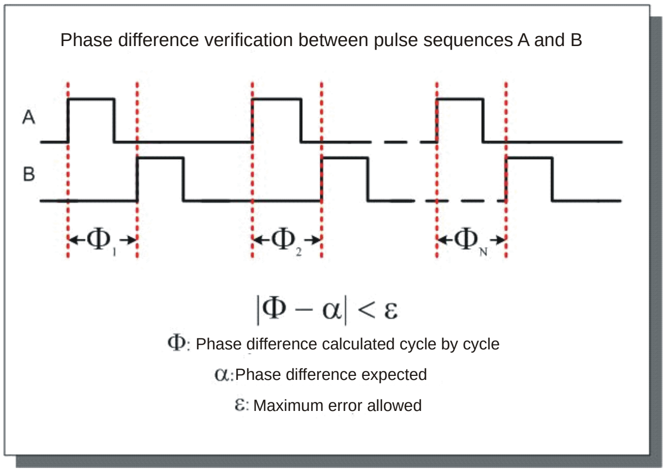


Figure 15 - Dual signal with phase difference according to the API 5.5 and ISO 6551 standards

Real-time diagnostic for the pulse train

The DF77 uses high speed dedicated hardware to analyze the pulse train and diagnose the errors, automatically correcting the totalization, when possible.

Sequence error

A sequence error occurs when a pulse arrives in B before a pulse in A, as indicated in the following figure:

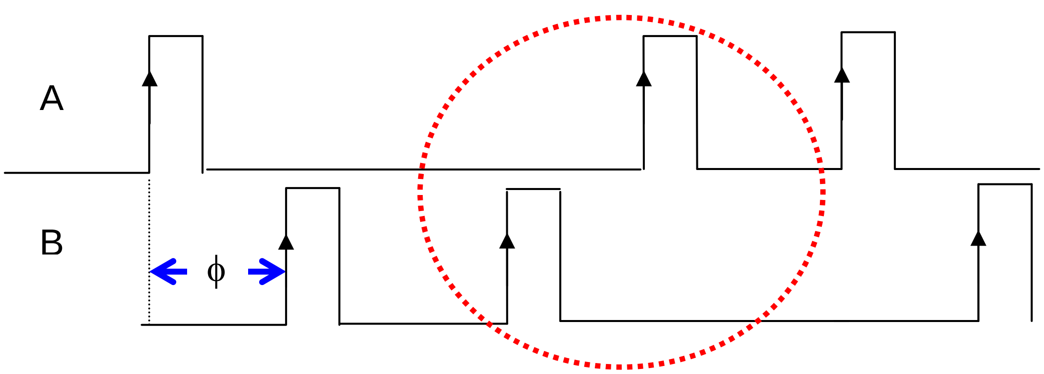


Figure 16 - Detecting a Sequence Error

In this case, these two pulses are ignored in the totalization and computed only in the sequence error counter of the PIP block, in the SEQUENCE_ERROR parameter.

Phase error and coincident pulses

These errors occur when the A→B phase difference is out of the configured range in the correspondent parameters of the PIP block (transducer).

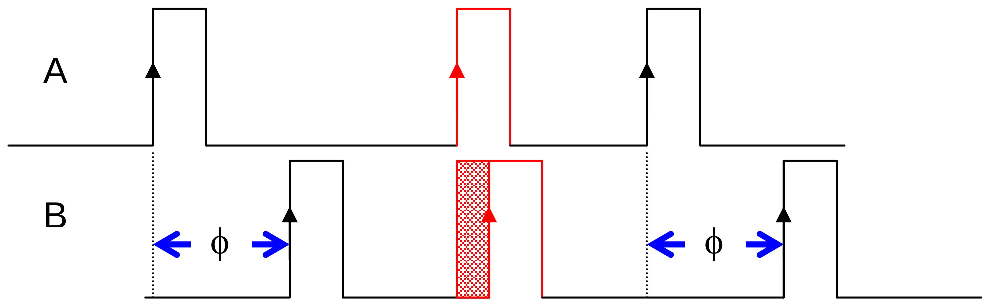


Figure 17 - Detecting Phase error and coincident pulses

The DF77 checks the following conditions in each cycle:

$$\begin{cases}(1)\phi \le 11{,}25^o \\ (2)11{,}25^o < \phi < (\theta - \varepsilon) \\ (3)(\theta - \varepsilon) \le \phi \le (\theta + \varepsilon) \\ (4)\phi > (\theta + \varepsilon)\end{cases}$$

Where:
ϕ is the instantaneous phase difference measured between pulse A and pulse B (positive edges).
θ is the phase difference configured in the PIP.Gx_PHASE_DIF parameter.
ε is the maximum deviation allowed, configured in the PIP.Gx_PHASE_DEV parameter.

Notes:

- The ideal operational condition, with no errors, is represented by the equation (3). Usually, the pulses are totalized by the FC302.
- The condition (1) represents an error of coincident pulses. The pulses are automatically rejected (they are not totalized) and the PIP.COINCIDENT_ERROR parameter is incremented, indicating the error.
- If the conditions (2) or (4) occur, that is, the error is not related to coincident pulses but to the deviation that is out of the configured limits, a phase error will be reported and the correspondent counter of the group PIP.PHASE_ERROR will be incremented. The pulses are not totalized by the flow computer.

Missing pulse error

This error indicates a missing pulse between 2 regular pulses. The error can occur with signal A or B, as indicated in the following figure:

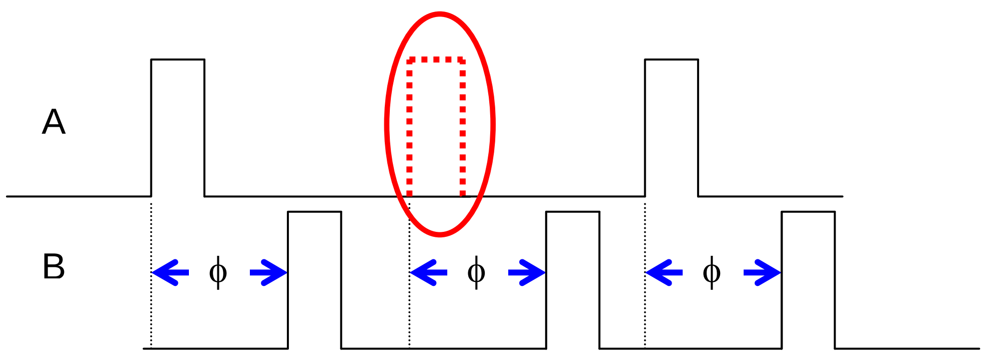


Figure 18 - Detecting missing pulses

In the example above, there is one missing pulse in signal A. The DF77 identifies the missing pulse, automatically totalizes the pulse for the flow computer and indicates this error using the PIP.MISSING_PULSES parameter.

Extra pulse error

Extra pulses conditions are extremely hard to be detected because they can be misinterpreted as an external noise. The DF77 checks if there is a false pulse between 2 regular pulses, that is, if the periods in A and in B are close to the previous periods. See the following figure:

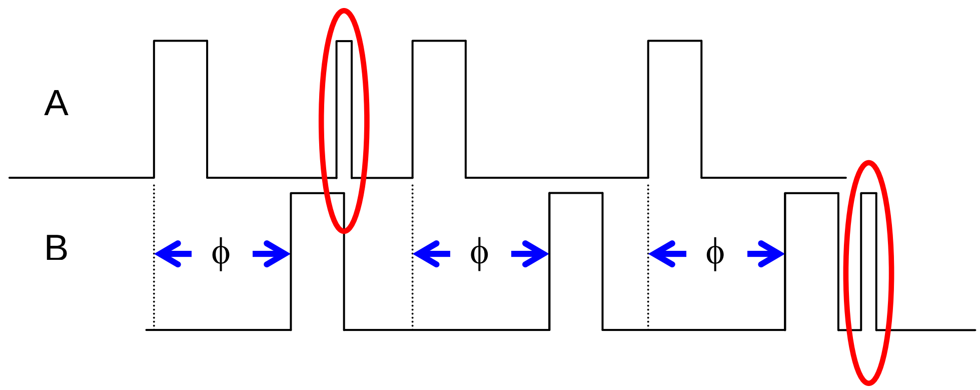


Figure 19 – Detecting extra pulses

In this example, observe an extra pulse identified in signal A and, after that, an extra pulse identified in signal B. In both events, the module automatically rejects the extra pulses, incrementing the correspondent error counters PIP.EXTRA_PULSES.

Pulse interpolation using double chronometry

The DF77 uses the double chronometry method to interpolate the pulses during the proving period. The purpose of the pulse interpolation is to calculate the fragmented part of a pulse that could not have been counted during the proving period. The result of this process, which is the interpolated number of pulses ***Ni***, is used to determine the ***MF*** with accuracy 1 in 10.000.

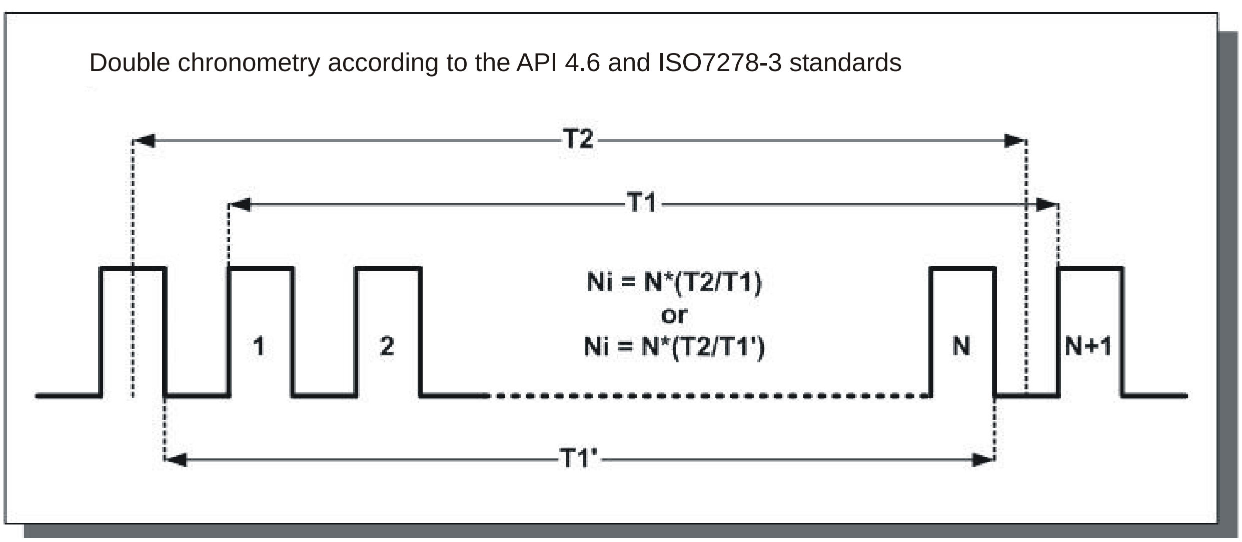


Figure 20 – Pulse interpolation according to the API 4.6 and ISO 7278-3 standards

Chapter 9

HARDWARE INSTALLATION

Purpose

This document provides general guidelines to install the AuditFlow, including I/O modules, interfaces and communication network.
Use this guideline as a tool to help to avoid Eletromagnetic Interference (EMI), that may cause malfunction or damage to the electronics.

Category of Conductors

Classify all cables following the table below and follow the recommendation to avoid coupling between cables. The basic idea is to separe noisy cables (category 1) from others (category 2) inside and outside of cabinet.

Category	Category Description	Examples	Recommendation
1	**Control e AC Power** Cable of high power, that are more tolerant to noise and interference than conductors of Category 2. They can generate noise in the other cables.	• AC power lines to power supply and I/O • Digital I/O lines with AC power — high power and high immunity to noise. • Digital I/O lines with DC power — high power and high immunity to noise. Typically for connection with dry contact switch, relay and solenoid valve.	• These conductors may be in the same conduit with power lines to machines up to 600Vac/100 Hp.

2	**Low level signal and Communication**
	Cables of low power, that are less tolerant to noise and interference than conductors of Category 1.
	They generate less noise to cause interference in other cables near to it.
		Analog I/O lines and DC power lines for analog devices.
		AC/DC I/O lines of low power.
		Digital I/O lines of low power with low constant time in order to detect pulses. Typically for connection with switches, opto sensors and encoders.
		Cables of communication — connection between CPUs or communication interface modules, local HMI, personal computers.
			• If these conductors have to cross conductors of category 1, it must be done in right angle.
			• Keep a distance of 1.5m , at least, from high voltage cabinet and RF/microwave sources.
			• If using a metallic conduit, certify that all segments have electric connections to guarantee continuity. It must connect to the grounding of cabinet too.
			• Use shielded cables where recommended.
			• If a metallic conduit, the minimum distance of conduits category 1 in the field :
			  • 0.08m : less than 20A;
			  • 0.15m : more than 20A, but up to 100 kVA;
			  • 0.3m : more than 100 kVA.
			• Apply the double of these minimum distances, if using a non-metallic conduit or without electric continuity.

3	**Inner to cabinet** Connection between components inside of cabinet.	• Cables of DC power with low voltage, cables of power to modules in the cabinet. • Communication cables to connect devices inside the cabinet, for example, flat cable for rack interconnection.	Route external conductors keeping separated the categories 1 and 2, observing also the minimum distance, if possible.

Mounting Racks in the Cabinet

See the instructions to mount the rack.

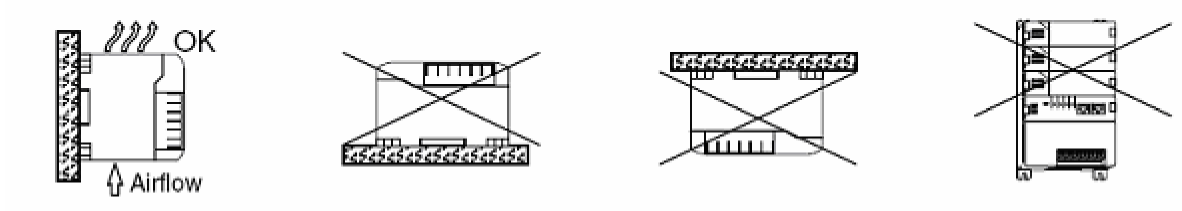


Figure 9.1 – Correct Position of Rack

Mount the racks in the vertical position in order to guarantee the airflow convection. Keep a minimum distance of modules to the wall of cabinet.

Mounting Devices and Grounding in the Cabinet

The grounding of devices chassis and shields of cable are performed to minimize electromagnetic interference (EMI) and ground noise.

Chassis Grounding Bus — Connect the chassis terminal of each device inside of cabinet to this bus, then it must be connected to the Ground Electrode System using a 8 AWG wire, at least.
The majority of AuditFlow modules does not have a chassis terminal to ground it, but they have their chassis connected to the DIN rail by a spring in the rear of module.
The DIN rail must be connected to the wall of cabinet using the fixing screws, observing a good electric connection removing the paint of cabinet if necessary.

List of points that must be connected to the Chassis Grounding Bus:

- o AuditFlow Power Supply Modules (DF50, DF52, DF56, DF60) : ground terminal
- o AuditFlow – Modules connected to DIN rail by spring : DIN rail
- o Third party devices - Painel View (HMI), fan, power supply and other : chassis ground

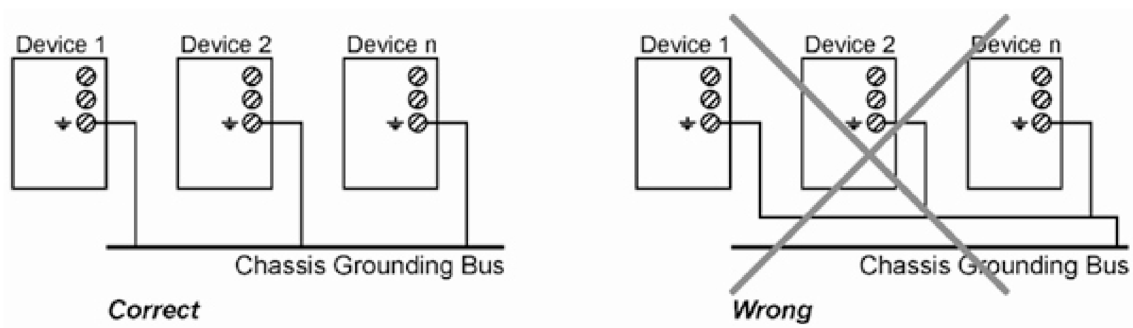


Figure 9.2 – Correct connection to Chassis Grounding Bus

Analog Grounding Bus - Some cables classified as category 2 have recommendation to use shielded cables. In this case, the shields of these cables must be connected to the Analog Grounding Bus. The negative terminal of third party power supply to I/O (4-20 mA transmitter and others) must also be connected to the Analog Grounding Bus, if the cable is classified as category 2. Then the Analog Grounding Bus must be connected to the Ground Electrode System using a 8 AWG wire, at least.

Shielded cables — It is recommended to use shielded cables for the following signals in order to minimize noise coupling:

- o Foundation Fieldbus – H1 bus
- o Pulse signal from turbine, coriolis, ultrassonic,... (flow meters)
- o 4-20 mA signals
- o EIA-485
- o Ethernet

Recommendations to the shields of these cables:

- o The shield of each cable must be connected to the ground only in one point and it is recommended to ground it to the Analog Grounding Bus at the cabinet. Connecting the shield to the ground in more than one point may cause current loop due to difference in the ground.
- o Connect each shield to Analog Grounding Bus directly, never in daisy chain, similarly as indicated in the figure 8.2.
- o Don't forget to connect the shields if the shielded cable goes through a junction box. And don't remove the shield more than it is necessary to connect them.
- o Don't mix different categories of cable in the same junction box.

Power Supply for flowmeters — It is recommended to use an exclusive power supply for the pulse signal flowmeter / pre-amplifier, therefore it must be separated from the other I/O signals.

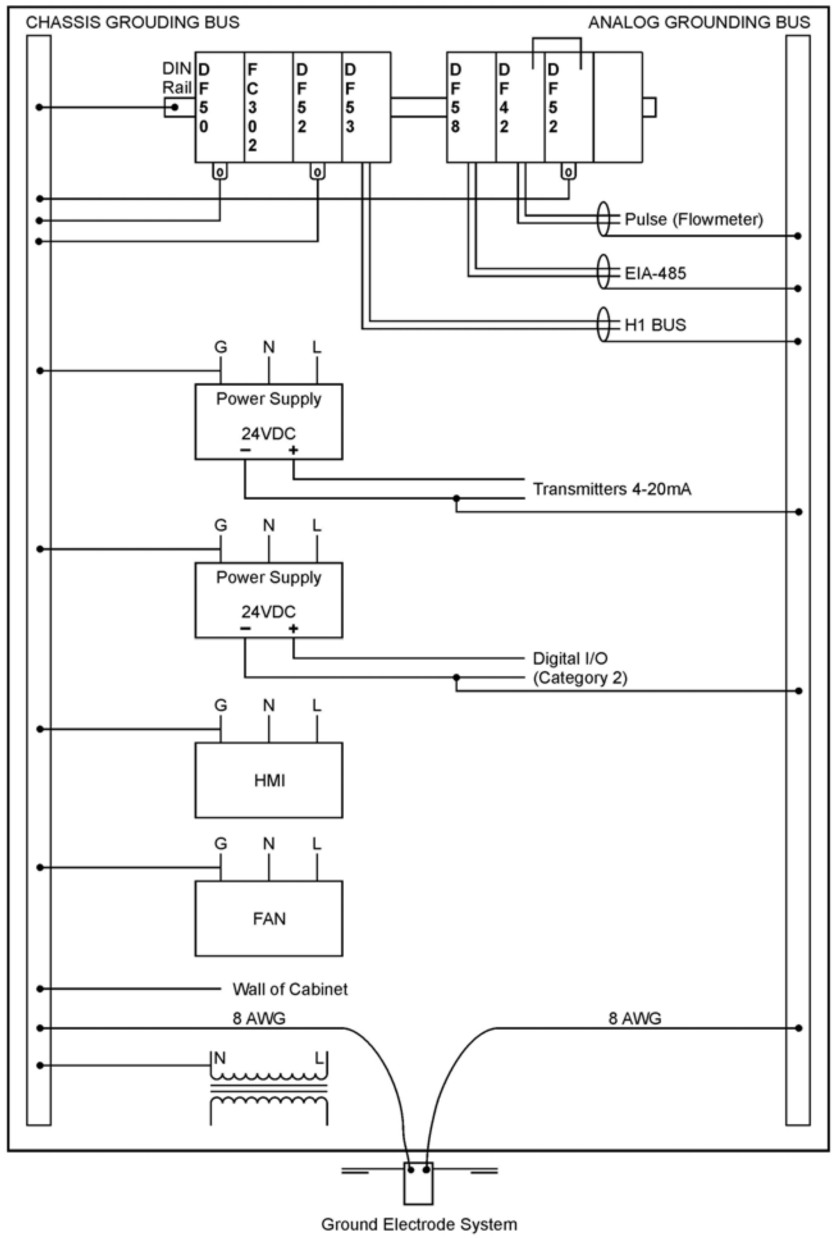


Figure 9.3 - Connection to Chassis Grounding Bus and Analog Grounding Bus

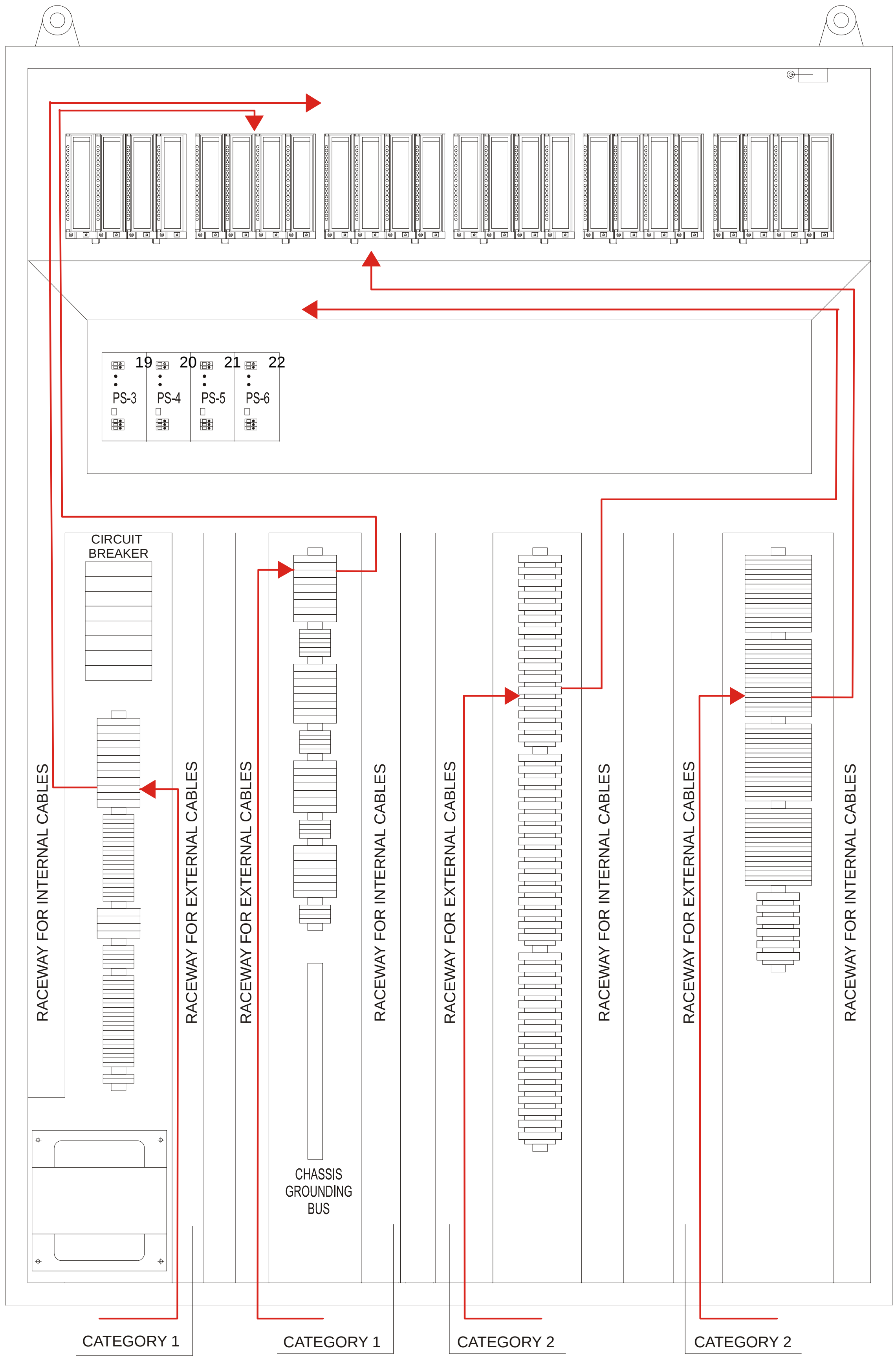


Figure 9.4 – Routing Cables of Category 1 and 2 in the Cabinet

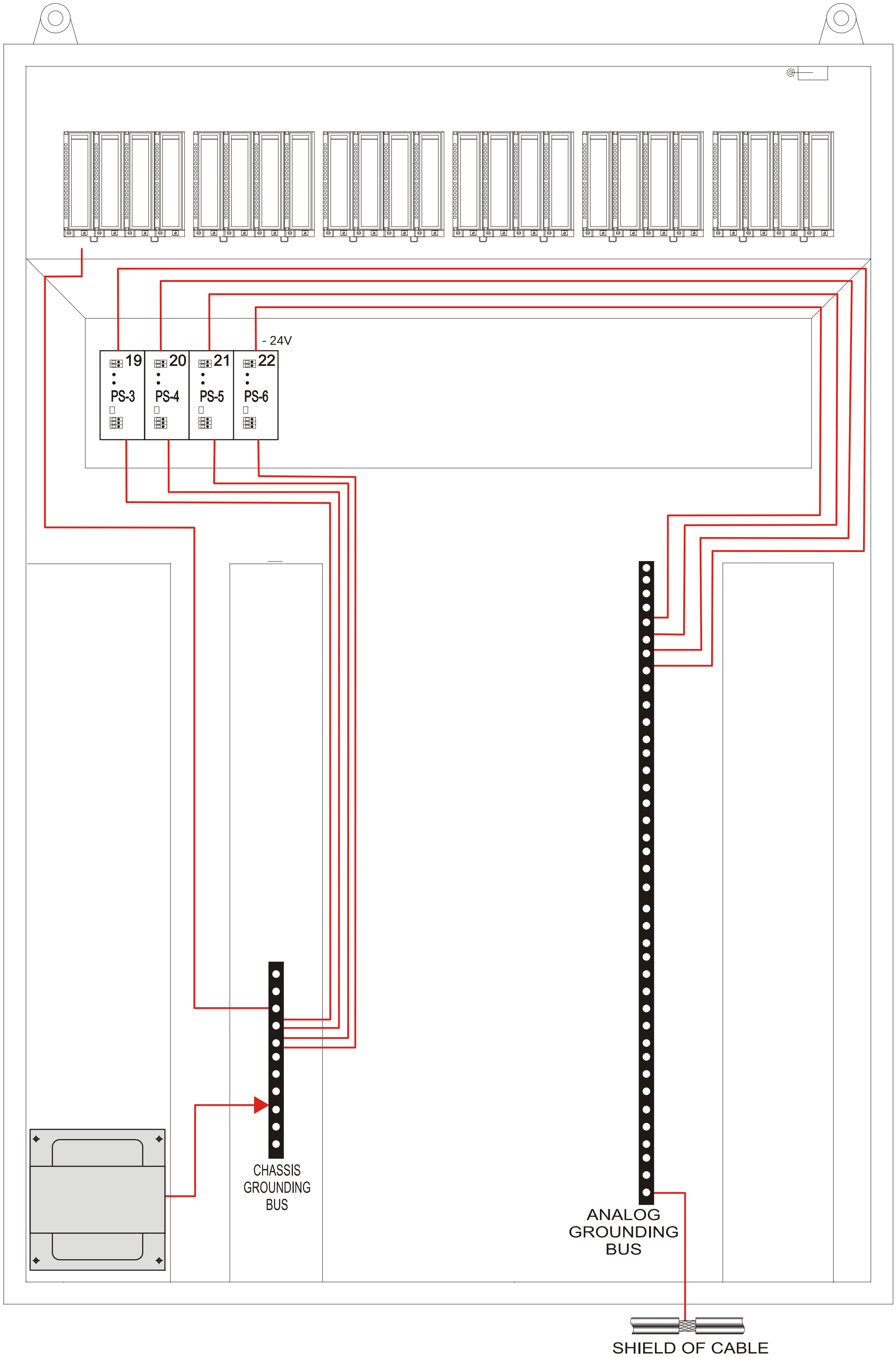


Figure 9.5 – Routing Cables of Third Party Power Supply for Category 2

Other Recommendations

It is also necessary to follow other recommendations regarding to:

1. Switching inductive load: see each I/O module specification of AuditFlow regarding the clamp diode and snubber circuit.
    - Inductive DC load: Despite of the AuditFlow digital output modules for DC load have a clamping diode, it is recommended to insert another clamping diode near to the inductive load. It will avoid the noise in the cable from the inductive load till the output module that may cause interference in other cables in the same conduit.

	Clamping diode specification
Forward current	Greater than current load
Reverse voltage	• Supply voltage 24 Vdc : 3-4 times greater than supply voltage (100Vdc) • Supply voltage 110Vdc : 8-10 times greater than supply voltage (1000 Vdc)

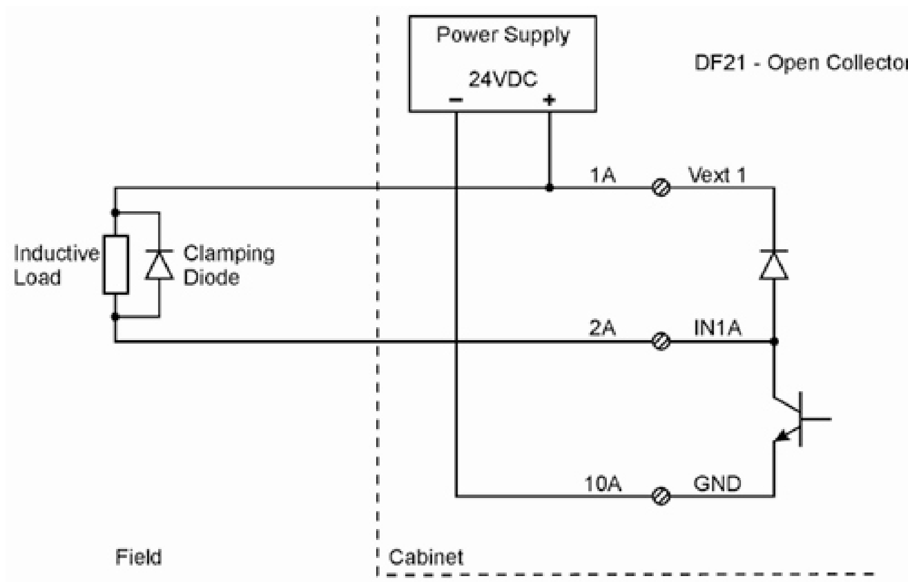


Figure 9.6 – Clamping Diode in Parallel to DC Load

- Inductive AC load: Despite of the AuditFlow digital output modules for AC load have a snubber circuit in series to the load, it is recommended to insert another snubber circuit in parallel to the load and near to i. It will avoid the noise in the cable from the inductive load till the output module that may cause interference in other cables in the same conduit.

	Snubber capacitor specification	
Load inductance	**Capacitance**	**Voltage**
25-70 milienries	0.50 microfarads	2-3 times greater than the supply voltage
70-180 milienries	0.250 microfarads	
180mH-10 Henries	0.10 microfarads	

	Snubber resistor specification	
Inductive load	**Resistance**	**Power**
Smaller than 100 Ω	1-3 Ω	2 W
Bigger than 100 Ω	47 Ω	½ W

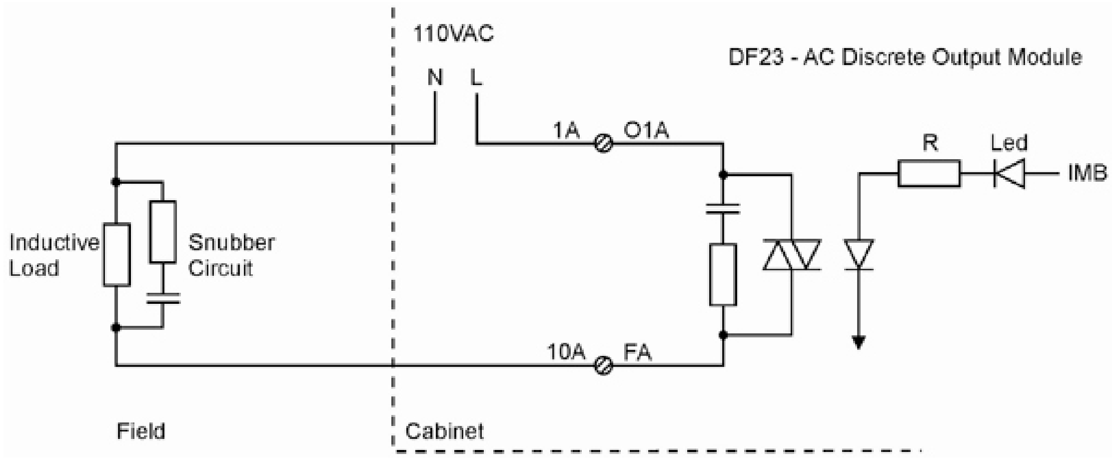


Figure 9.7 – Snubber Circuit in Parallel to AC Load

2. Network EIA-485: use a suitable cable for EIA-485 network and terminators at each end, whose specification is :
    - Resistor: resistance equal to the characteristic impedance of cable (Z_0), typically 100 – 120 Ω , ¼ W.

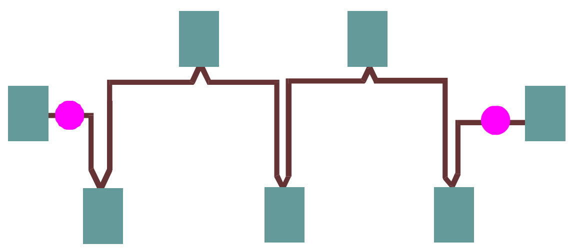


Figure 9.8 – Terminators of EIA-485 Bus

- The recommended topology is daisy chain, but backbone with stubs is acceptable.

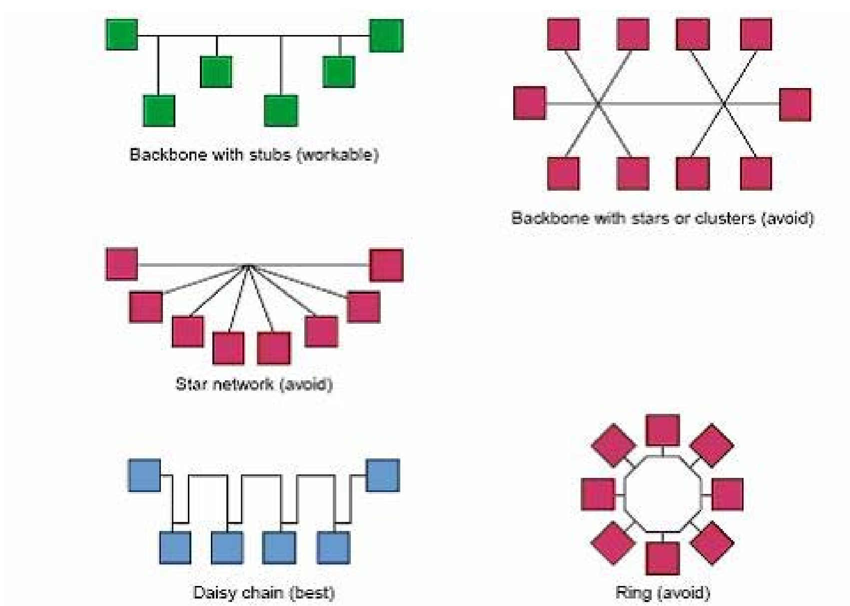


Figure 9.9 – Topology of EIA-485 Network

3. Recommendations to avoid damage due to Electrostatic Discharge (ESD) :
    - Ground yourself before touching the electronic circuit in maintenance in order to avoid electrostatic discharge that may damage the device.
    - Keep the module lid closed when operating.
    - Maintenance of the device, when it is energized, must be performed only by a trained technician.

Chapter 10

SOFTWARE INSTALLATION

Installing the Studio302

Install the programs that compose the Studio302 using the **SYSTEM302** installation DVD. For further details about installing the programs, refer to the **SYSTEM302** Installation Guide. The **Studio302** is the user-friendly, easy-to-use software tool that integrates all applications included in Smar's Enterprise Automation package.

Getting License for DFI OLE Server

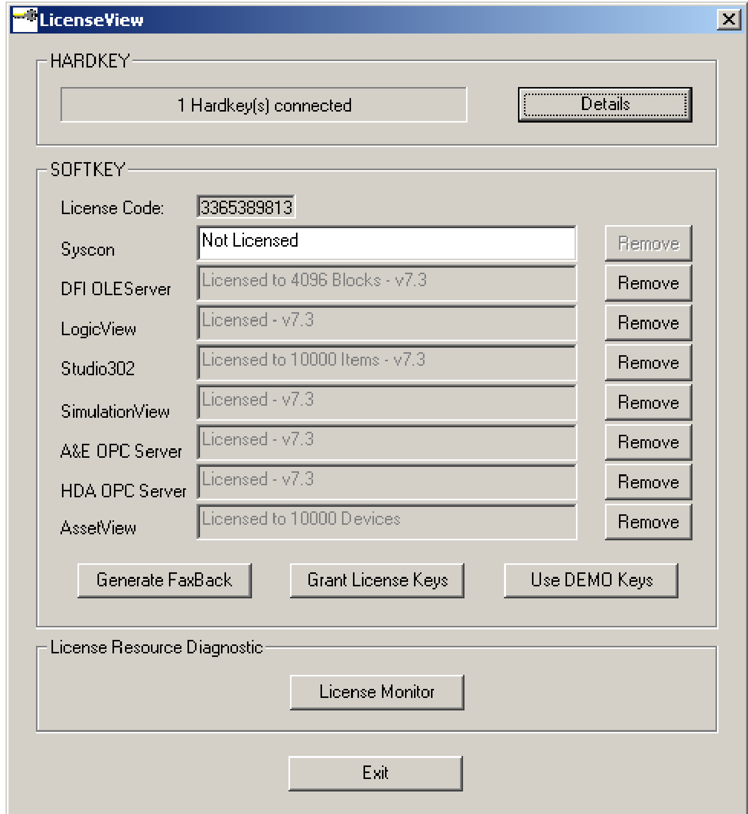
There are two ways to get the DFI OLEServer and HSE OLEServer license. One version is through Hard Lock protection (Hard Keys) and other through Software (Soft Key).

When using Hard Key, just connect it in the appropriated port in the computer (parallel or USB ports).

When using Soft Key, it is necessary to get a License Key through an SMAR contact. For this use the application **LicenseView**, found in the shortcut in the **Studio302** interface.

From the information generated by this application, fill in the form FaxBack.txt and send it to SMAR appropriate fax number.

NOTE
This license is valid for DFI OLEServer and HSE OLEServer.



Afterwards, SMAR will send the Licenses Keys. Type the codes in the blank fields (observe the previous figure).

Click the "Grant License Keys" button. If these codes were accepted, a message will be generated confirming the operation successful. At this moment, **Syscon**, **DFI OLEServer** and **HSE OLEServer** will be ready to be used.

Connecting the AuditFlow in the Subnet

AuditFlow working environment is composed of a network (subnet) where IP addresses will be necessary for each connected instrument.

The automatic solution for attribution of these addresses is called DHCP (Dynamic Host Configuration Protocol) Server.

Using DHCP Server these IP addresses are generated automatically preventing any IP conflict between two distinct devices.

ATTENTION
To connect more than one **AuditFlow**, the following steps must be fully executed for each **AuditFlow**.

1-Plug the Ethernet cable (DF54) of the FC302 module to its respective Subnet Switch (or hub).

NOTE
For point-to-point connection (the **AuditFlow** connected directly to the computer), uses the DF55 cross cable.

2-Turn on the FC302 module. Ensure that ETH10 and RUN LED indicators are on.
3-Keep tight pressed the left push-button (Factory Init / Reset) and press the right push-button for three times. The FORCE LED will blink three times consecutively.

NOTE
If the user loses the number of times that the right push-button was pressed, just see the number of times that the FORCE LED is blinking consecutively. It will turn to blink once after the fourth touch (it is a cyclic function).

4-Release the left push-button and the system will fulfill the RESET, and subsequently will start the firmware with standard values for IP address and the Subnet Mask

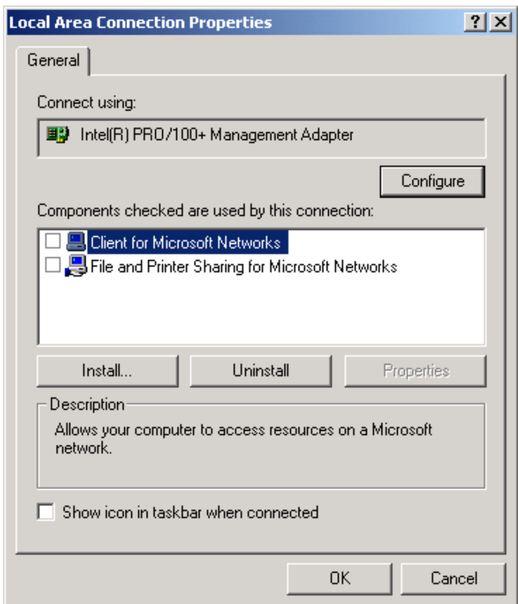
For Network without DHCP

5-If the network does not have a DHCP server, the AuditFlow will have the default IP address 192.168.164.100 and it will need to follow the next steps.

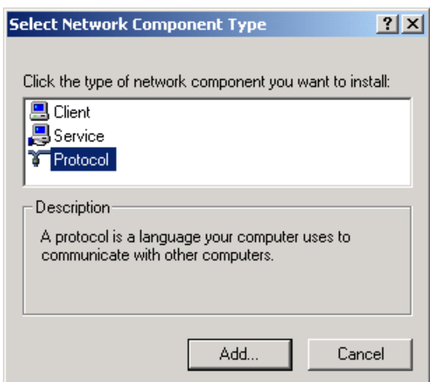
The IP address of the user's computer needs to change for a while (network management knowledge is required). The following procedures are based on Windows XP. Choose **Start →Control Panel**. Double-click **Network and Dial-Up Connections** option or similar.

NOTE
Right-click **Local Area Connection**, choose **Properties** from the pop-up menu. Whether in the component list has TCP/IP protocol, the user should skip to step 9 or proceed the installation using the **Install** button.

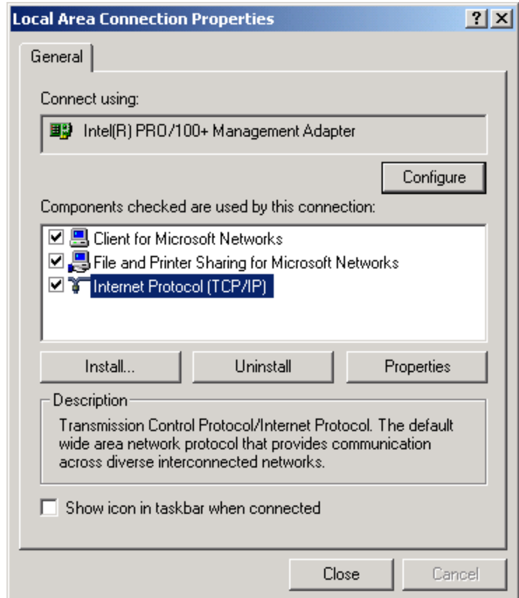
6-Click **Install**;



7-Select the network type **Protocol**, and click **Add**:



8-Select the **Internet Protocol** and click **OK**.



9-Select **Internet Protocol (TCP/IP)**, and click **Properties**;

10-Take a note of the original values of IP address and Subnet Mask of the computer to restore them when the operation ends.

NOTE
If the IP address is already something like: 192.168.164.XXX, skip to Step 14.

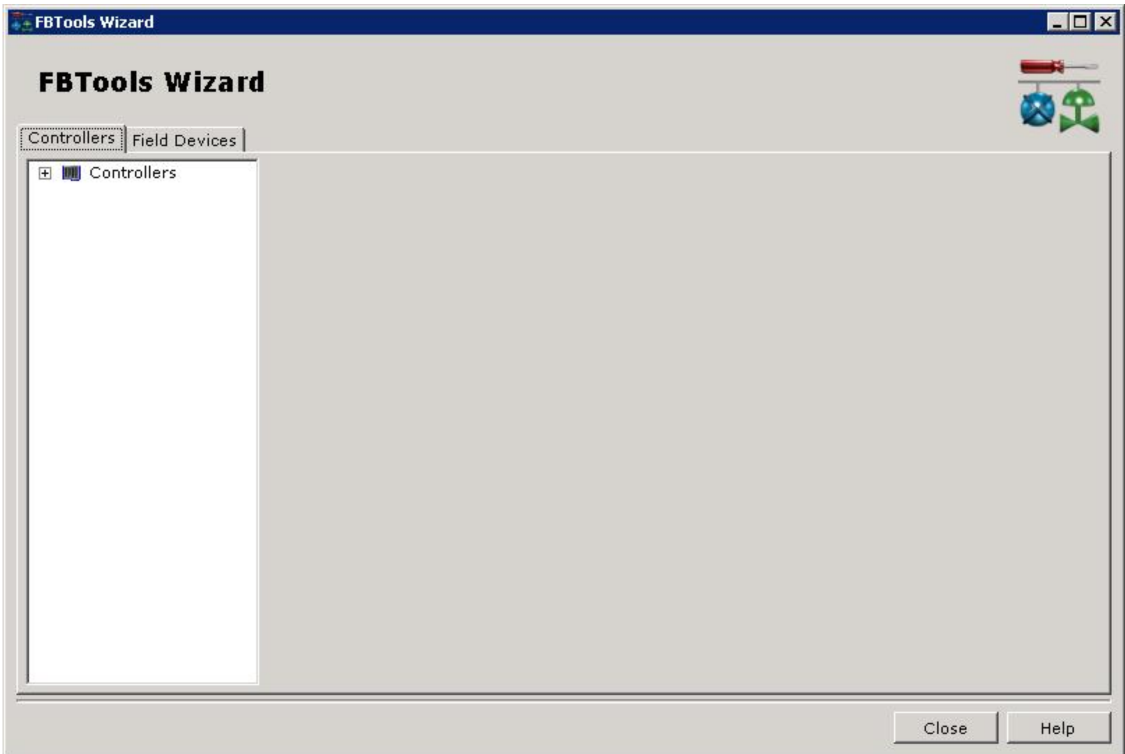
11-Change IP address and the Subnet Mask of the computer. It must select the same Subnet of **AuditFlow** (164). The Network Administrator must supply the IP address.

NOTE
The values will be something like: IP Address 192.168.164.XXX and network mask (Subnet Mask) 255.255.255.0. Keep the default gateway value.

ATTENTION
Do not use the IP Address 192.168.164.100. This is already FC302 default address

12-Click **Apply**.

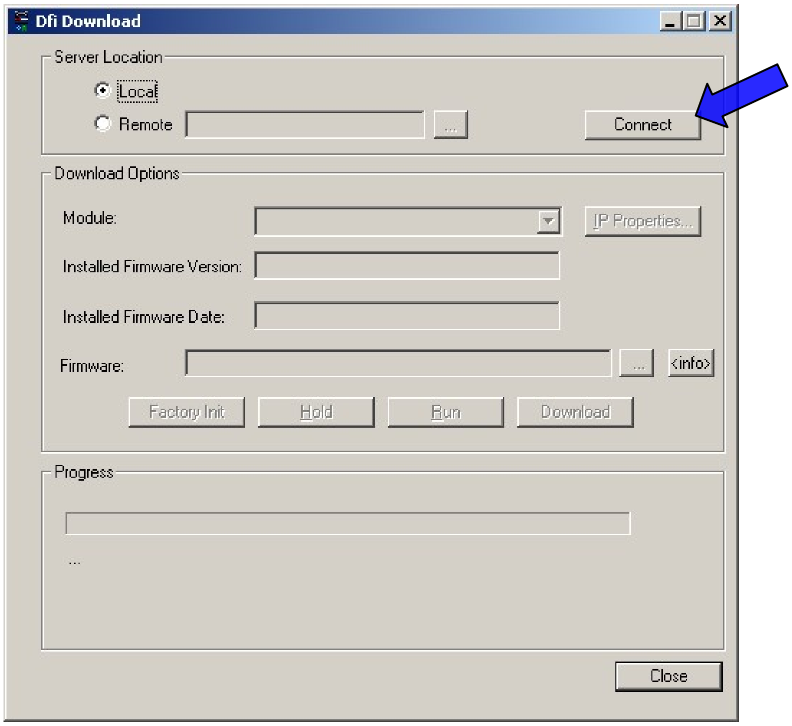
13-Run **FBTools** through **Studio302**, at the **Start menu → Programs → System302 → Studio302**.Make a login in the system. In the **Studio302** interface click the  icon in the main toolbar. The following window will appear.



14-In the **Controller** tab click the symbol ⊞ and the **DFI302** and **HI302** options will appear. Click again the symbol ⊞ in **DFI302** and select the **FC302**.

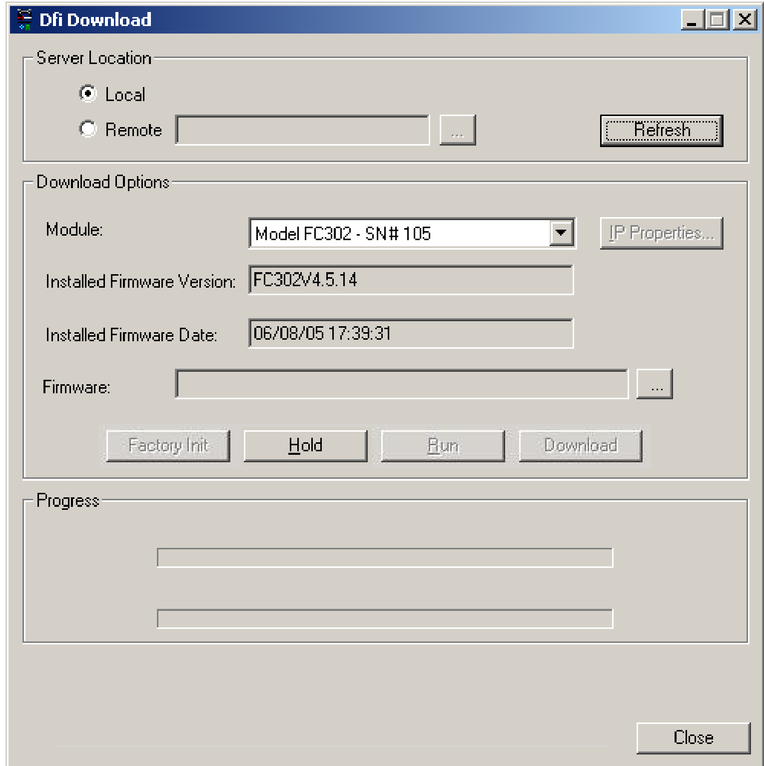
Right-clicking the FC302 the **Dfi Download Classic** and **Batch Download** options will appear. See the following figure.

Choose **DFi Download Classic.** The **Dfi Download** dialog box will open. Select the DFI OLEServer path to be used (Local is the default path), and click **Connect**.

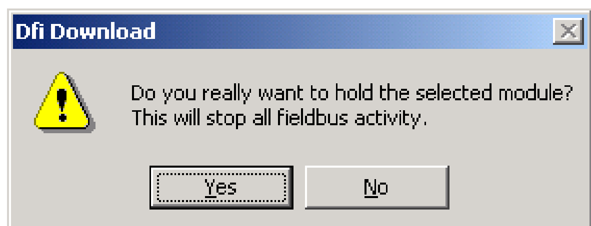


15-Select the FC302 in the **Module** box. Use the serial number as a reference that is in the external identification label

ATTENTION
The non-observance of this step may imply in serious consequence.



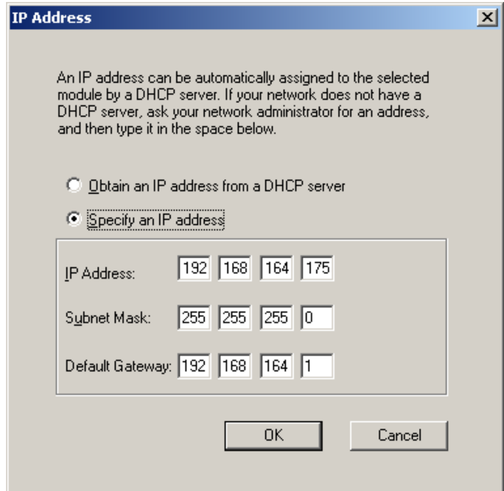
16-Click **Hold** to interrupt the firmware execution, thus the module will stop the firmware execution as well as all the activities in the Fieldbus line. Confirm the operation by clicking **Yes**



ATTENTION
This step will be necessary only if the **Hold** button is enabled; pointing out that the firmware is being fulfilled.

17-Check if HOLD LED is ON. Click **IP Properties** to configure the IP address of the module. The **IP Address** dialog box will open.

18-The default option is to obtain the **IP address from DHCP Server**. Select the option **Specify an IP address** to change to another IP address.



19-Type the IP address, the subnet mask and the default gateway. The subnet mask should be the same of the user's computer original default address (Step 11). So, the computer settings can be restored later, and the network will show **FC302** modules

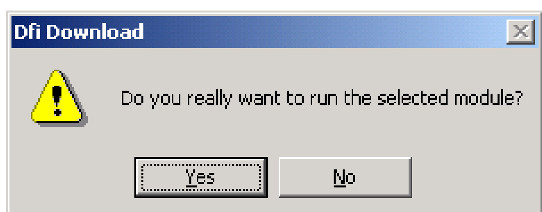
ATTENTION
Do not use the IP Address 192.168.164.100 (it is already being used by **FC302**).

HINT
Write down the IP addresses that will be specified and the serial number of each FC302 module. It will help in the identification and diagnostics of possible failures.

20-Click the **OK** button to end up this operation. Go back to the **Internet Protocols (TCP/IP)** properties of the computer and restore the original values of the IP address and the subnet mask.

21-Click the **Run** button to execute the **FC302** firmware again.

22-A dialog box will open to confirm the operation. Click the **Yes** button to continue.



23-The procedure to connect the **FC302** to the subnet is complete. Repeat these steps above for the other modules.

NOTE
In case of there is more than one AuditFlow to be set up, fulfill the following command to clear **ARP table**, before setting up the next AuditFlow. C:\>arp -d 192.168.164.100 < enter >

24-In the DOS prompt, type "C:\>arp –d 192.168.164.100 <enter>".

Visualizing and Updating the Firmware

1. Make sure that the **FC302** is ON and has been connected to the subnet, according to the procedures in "Connecting the AuditFlow in the Subnet".
2. To continue, it will be necessary to interrupt the firmware execution in the FC302 module forcing it for the **Hold** mode.

   Maintain firmly pressed the Push-Bottom (Factory Init/Reset) of the left and after, click twice in Push-Bottom of the right. The LED FORCE will blink twice consecutive. Liberate the Push-Bottom (Factory Init/Reset) of the left, this will force the **Hold** mode.

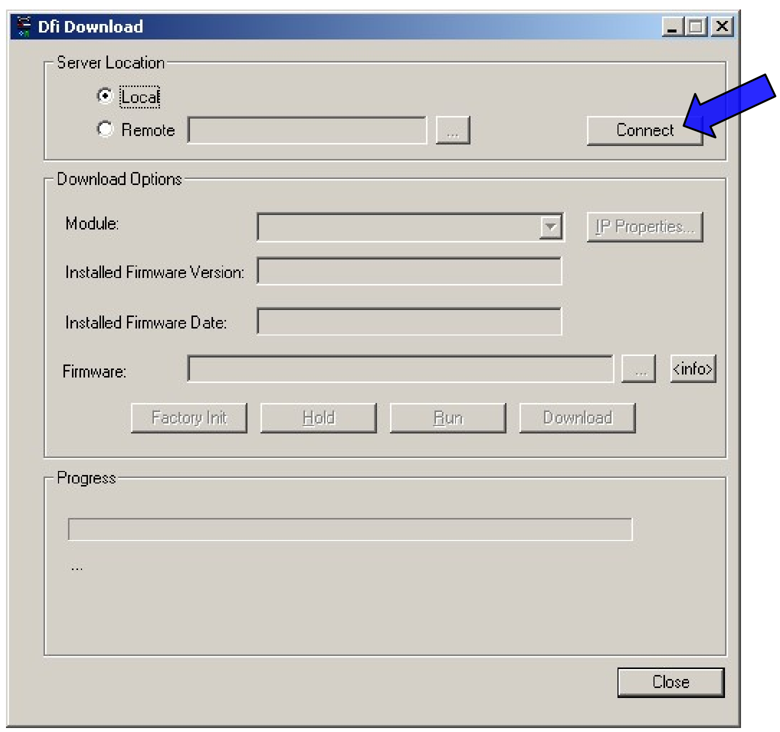
   For safety and audit trail, this is the only mode to force the **Hold** mode and then to start the firmware download process.
3. Be sure that LED HOLD is on.
4. Execute the FBTools Wizard as described at step 13 of previous topic.
5. Select the **FC302** module and right-click it. Choose **Dfi download Classic.**

The **Dfi Download Classic** option allows updating the firmware, changing the IPs of controllers and other devices.

The **Batch Download** option allows updating the firmware of up to 64 controllers simultaneously, but this option is not available for FC302.

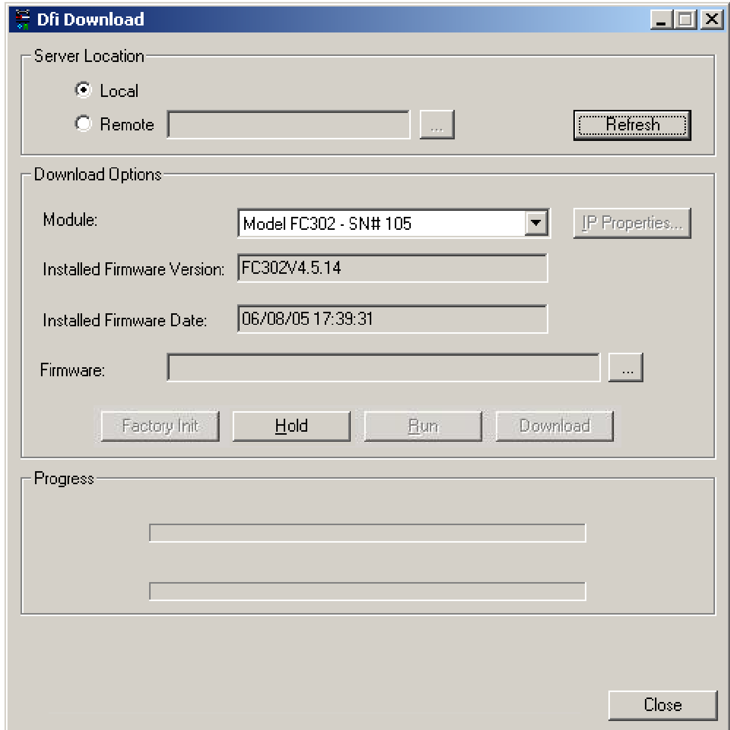
DFi Download Classic

1. By selecting **DFi Download Classic** the **Dfi Download** dialog box will open. Select the DFI OLEServer path to be used (Local is the default path), and click the **Connect** button.

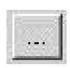


2. Select the FC302 module in the **Module** box. Use the serial number as a reference (see the external identification label).
3. After to select the FC302 module, the firmware installed will be shown. This is the procedure indicated to verify the firmware version.

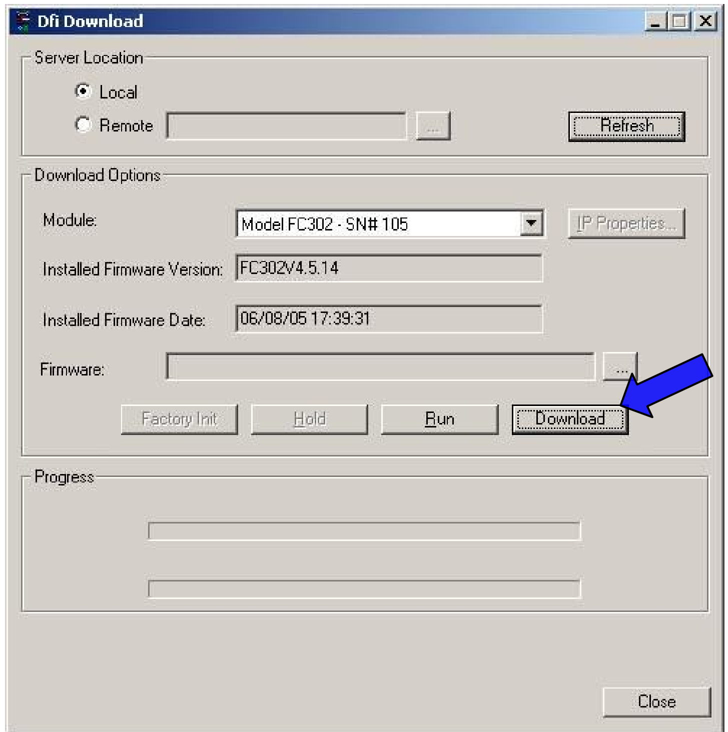
ATTENTION
The non-observance of this step can imply in serious damages. The module must be in Hold mode.



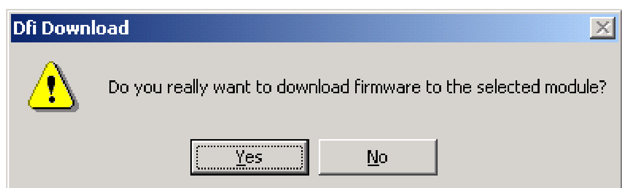
Note that the **DFI Download** dialog box shows the installed version and date of the current firmware loaded in the FC302 module.

4. Click the **Browse...** button  to select the firmware file to be downloaded (FC302*.ABS).

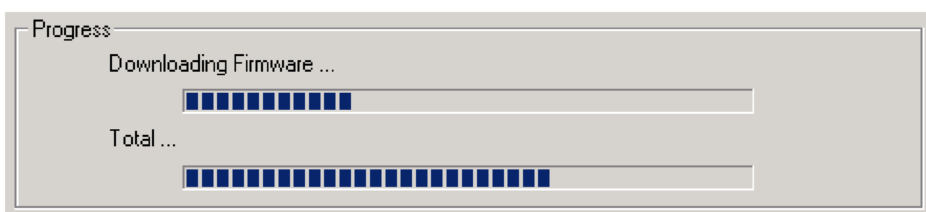
5. After selecting the firmware file, click the **Download** button to start the firmware download.



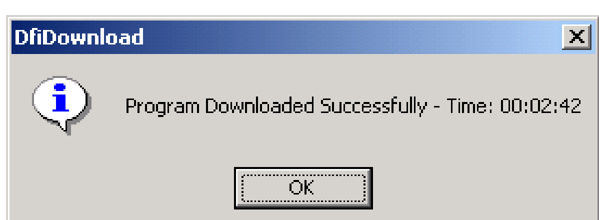
6. A message box will come up requesting a confirmation. Click **Yes** to continue.



7. The progress bar at the bottom of the dialog box will show the operation progress.



8. When the download is complete, a dialog box will appear confirming that the program was downloaded successfully. Click the **OK** button and wait a few minutes while the information is updated. The **FC302** will be in "Run Mode". (Check if the RUN LED is ON).



9. Click the **Close** button to exit from the **Dfi Download** dialog box.

Changing IP Address

Changing FC302 IP

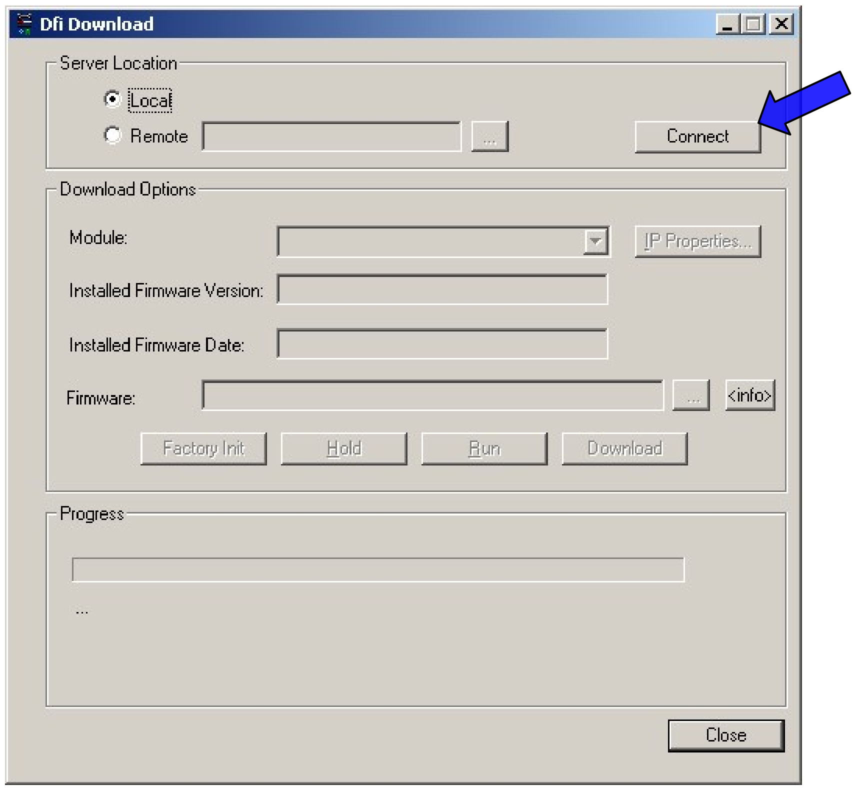
NOTE
To change the **FC302** subnet, see the procedures in "Connecting the AuditFlow in the Subnet" (described in this section). Follow these steps only to change the IP address.

1.Make sure that the FC302 is ON and has been connected to the subnet, according to the procedures in "Connecting the AuditFlow in the Subnet".

2.Run the FBTools Wizard, as shown in previous topics.

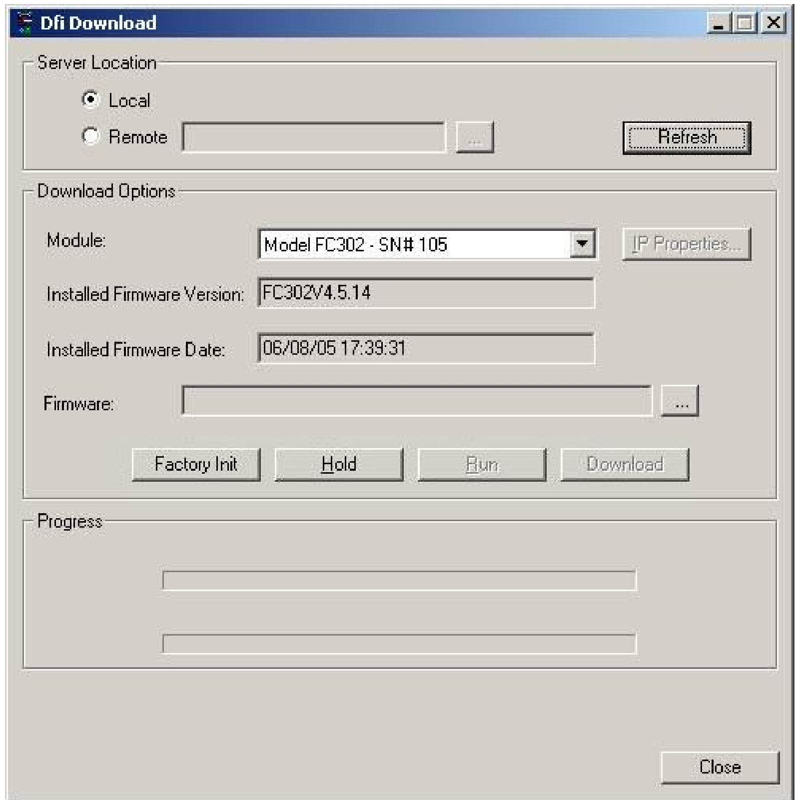
3.Select the **FC302** module and click **DFi Download Classic.**

4.The **DFI Download** dialog box will be open. Select the DFI OLE Server path to be used (Local is the default path) and click the **Connect** button.



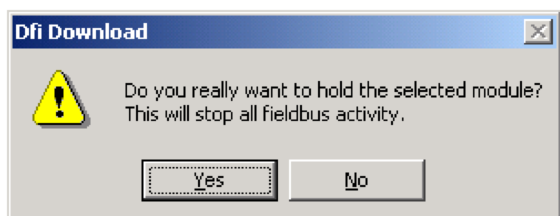
5.Select the FC302 module in the **Module** box. Use the serial number as a reference (see the external identification label).

ATTENTION
The non-observance of this step can imply in serious damages.



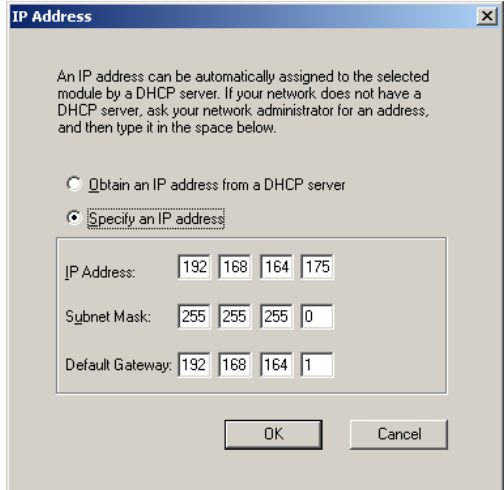
6.Click the **Hold** button to interrupt the firmware execution in the FC302.

7.Afterwards all activities in the Fieldbus network will be stopped. Confirm this operation by clicking **Yes**.



ATTENTION
This step will be necessary only if the **Hold** button is enabled, indicating that the firmware is being fulfilled.

8. Check if the HOLD LED is ON.
9. Click **IP Properties** button at the **DFI Download** dialog box. The **IP Address** dialog box will open.
10. The default option is **Obtain the IP Address from a DHCP Server**. Click the **Specify an IP address** option to change to another IP address.



11. Type the IP address, the Subnet mask and the default gateway (provided by the network administrator) to be associated to the **FC302.**

ATTENTION
Do not use the IP Address 192.168.164.100 (it is already being used by **FC302**). In addition, be sure that the chosen address is not in use.

HINT
Write down the IP addresses that will be specified and the serial number of each FC302 module. It will help in the identification and diagnostics of possible failures.

12. Click the **OK** button to conclude this operation.
13. After assigning a new IP address, the process will return to the **Dfi Download** dialog box.
14. Click the **Run** button to fulfill the **FC302** firmware again.
15. Click the **Close** button to exit from the **Dfi Download** dialog box.

Chapter 11

BLOCK LIBRARY

Block Types supported by FC302

It is recommended to read the Function Blocks Manual first, included in the System302 documentation, because it provides the information about the Foundation Fieldbus standard.

The FC302 supports several block types, also supported by other Smar devices, and they are classified as Generic Blocks.

The Flow Measurement Blocks were developed exclusively for this device and this is the main focus of this chapter.

The table below shows the blocks supported by FC302 and the correspondent description:

Mnemonic	Description
PIP	Pulse Input & Proving
LCF	Liquid Correction Factors
ATV	Audit Trail View
AEV	Audit Trail View
LMMF	Liquid Master Meter Factor
LMF	Liquid Meter Factor
LMFV	Liquid Master Factor View
GC	Gas Composition cromatógrafo
WT	Well Test
WTV	Well Test View
LST	Liquid Station Transaction
GST	Gas Station Transaction
FCT	Flow Computer Transducer
GKD	Gas Knowledge Database
LKD	Liquid Knowledge Database
GFC	Gas Flow Calculation
GT	Gas Transaction
LBT	Liquid Batch Transaction
LCT	Liquid Continuous Transaction
GTV	Gas Transaction View
LTV	Liquid Transaction View
RS	Resource
DIAG	Diagnostic Transducer
MBCF	Modbus Configuration
TEMP	Temperature Transducer DF-45
AI	Analog Input
DI	Discrete Input
ARTH	Arithmetic
AALM	Analog Alarm
TIME	Timer and Logic
CT	Constant
MBCS	Modbus Control Slave
MBSS	Modbus Supervision Slave
MBCM	Modbus Control Master
MBSM	Modbus Supervision Master
AO	Analog Output
MDO	Mulitple Discrete Outputs
HC	Hardware Configutration
TRD	IDShell Transducer

Generic Blocks

RESOURCE	DESCRIPTION
RS	**RESOURCE** – This block contains data specific to the hardware associated to the resource.

TRANSDUCER BLOCKS	DESCRIPTION
HC	**HARDWARE CONFIGURATION TRANSDUCER** – Configures the module type for each slot in the FC302.
DIAG	**DIAGNOSTICS TRANSDUCER** – Provides online measurement for the block execution time, check the links between blocks and other features.

INPUT TRANSUCER BLOCKS	DESCRIPTION
TEMP	**DF45 TEMPERATURE TRANSDUCER** – This is the transducer block for the module DF45, an 8-low signal input module for RTD, TC, mV, Ohm.
PIP	**PULSE INPUT & PROVING –** Transducer block of the DF77 module that has 5 groups of pulse inputs with fidelity level A in pulse transmission and proving capability.

INPUT FUNCTION BLOCKS	DESCRIPTION
AI	**ANALOG INPUT** – This block reads the analog input data from the analog input signal and send the data to other function blocks. It has scaling conversion, filtering, square root, low cut and alarm processing.
DI	**DISCRETE INPUT** – This block reads the discrete input data from the discrete input signal and send the data to other function blocks. It has filtering and alarm processing, and can invert the data.

CONTROL AND CALCULATION FUNCTION BLOCKS	DESCRIPTION
AALM	**ANALOG ALARM** – This alarm block has dynamic or static alarm limits, hysteresis, temporary expansion of alarm limits on step setpoint changes to avoid nundesired alarms, two levels of alarm limits and delay for alarm detection.
CT	**CONSTANT** – Provides analog and discrete output parameters with constant values.
ARTH	**ARITHMETIC** – This calculation block provides pre-defined equations to be used in applications such as flow compensation, HTG, ratio control and others.
TIME	**TIMER and Logic** – This block has four discrete inputs, that are processed by a combination logic. The selected timer processing type operates on the combined input signal to obtain measurement, delay, extension, pulse or debounce.

MODBUS FUNCTION BLOCKS	DESCRIPTION
MBCF	**MODBUS CONFIGURATION** – This transducer block configures general features related to the Modbus gateway.
MBCS	**MODBUS CONTROL SLAVE** – When the device is operating as a gateway between FOUNDATION Fieldbus and Modbus (slave device), this block can be used to exchange control data between both protocols.
MBSS	**MODBUS SUPERVISION SLAVE** – When the device is operating as a gateway between FOUNDATION Fieldbus and Modbus (slave device), this block can be used to convert Foundation Fieldbus parameters to Modbus variables. These variables will be available to the supervisory system with a Modbus driver.
MBCM	**MODBUS CONTROL MASTER** – When the device is operating as a gateway between FOUNDATION Fieldbus and Modbus (master device), this block can be used to exchange control data between both protocols.
MBSM	**MODBUS SUPERVISION MASTER** – When the device is operating as a gateway between FOUNDATION Fieldbus and Modbus (master device), this block can be used to convert Modbus variables to Foundation Fieldbus parameters. These parameters will be available to the supervisory system with a Foundation Fieldbus driver (OPC).

OUTPUT FUNCTION BLOCKS	DESCRIPTION
AO	**ANALOG OUTPUT** – The AO block receives an analog value and generates an analog output signal. It provides value and rate limiting, scaling conversion, fault state mechanism and other features.
MDO	**MULTIPLE DISCRETE OUTPUT OUTPUT** –This block can send 8 discrete variables to other modules.

Flow Measurement Blocks

Transducer Blocks

Transducer Block	Description
FCT	**Flow Computer Transducer** – It provides the elements to configure common parameters of the gas and liquid measurements, as well that ones related to the device. The main parameters refer to access restriction, passwords and correspondent access level configurations, logger initialization, Engeneering Unit Selection, real time clock.
GKD	**Gas Knowledge Database** – This block is specific for gas measurement and it has parameters to configure the base condition, the gas composition and the information about the flow meters.
LKD	**Liquid Knowledge Database** – This block is specific for liquid measurement and it has parameters to configure the base condition and the information about meters, provers and products.

Gas Measurement Blocks

Function Block	Description
GFC	**Gas Flow Calculation** – This block is specific for gas measurement and it has the parameters to configure the flow correction calculation. It receives the process variables and generates the calculated flow rates as outputs.
GT	**Gas Transaction** – This block calculates the weighed average of the input variables and the intermediate variables of the flow correction calculation. It also calculates the flow totalizations in flowing conditions, base conditions, totalizations in mass and energy. The totalizations are calculated for different periods and batch.
GST	**Gas Station Transaction –** The main purpose of this block is to sum and/or subtract the corrected flow rates, and it doesn't consider any references to auxiliary variables (temperature and static pressure) or calculate intermediate variables, correction factors or used sensors.
GC	**Gas Composition –** This block receives the gas composition, the heat value and the relative density as inputs. It checks the consistence and transfers the values to the correspondent product.

Liquid Measurement Blocks

Function Block	Description
LBT	**Liquid Batch Transaction** – It calculates the indicated volume flow rate, gross standard volume flow rate and net standard volume flow rate, and the correspondent totalizers and weighed averages for the batch. This block allows to configure batches of different products and how to end them.
LCT	**Liquid Continuous Transaction** – It calculates the indicated volume flow rate, gross standard volume flow rate and net standard volume flow rate, and the correspondent totalizers and weighed averages for continuous transaction, generating reports by periods: hour, day, week and month.
LST	**Liquid Station Transaction –** The main purpose of this block is to sum and/or subtract the corrected flow rates, and it doesn't consider any references to auxiliary variables (temperature and pressure) or calculate intermediate variables, correction factors or used sensors.
LMMF	**Liquid Master Meter Factor** – This block allows to configure the proving process using a master meter, as well to monitor it, including all measured and calculated variables (averages, correction factors, information about the meter, prover, product, etc.).
LMF	**Liquid Meter Factor** - The main purpose of this block is to provide support for proving using a prover, which can be: Ball Prover (conventional prover, U-type), Small Volume Prover (piston prover) and Tank Prover. This functionality is available only for the DF77 module, because this module was developed to attend standards related to the prover, as API-Chapter 4 and ISO7278.
WT	**Well Test –** This block is used in the well test process, that is executed in parallel to the custody transfer measurement or the allocation measurement. The objective is to obtain the factors (flow test / production potential / RGO) for the production allocation in shared measurement system.
LCF	**Liquid Correction Factors –** This block calculates the correction factors for temperature, pressure, BSW and shrinkage factor. It includes all the correction factors used in custody transfer and allocation measurements.

Report/Register Visualization Blocks

Function BLock	Description
GTV	**Gas Transaction Visualization** – This block allows to browse and to display the QTR report for gas, one report at a time, selected from the logger (FC302 NVRAM memory). This block provides the status of the logger, including warning and overflow (a not-stored report was lost).
LTV	**Liquid Transaction Visualization** – This block allows to browse and to display the QTR report for liquid, one report at a time, selected from the logger (FC302 NVRAM memory). This block provides the status of the logger, including warning and overflow (a not-stored report was lost).
LMFV	**Liquid Meter Factor Visualization** – This block allows to browse and to display the proving report for liquid, one report at a time, selected from the logger (FC302 NVRAM memory). This block provides the status of the logger, including warning and overflow (a not-stored report was lost).
WTV	**Well Test Visualization –** This block allows to browse and to display the well test report, one report at a time, selected from the logger (FC302 NVRAM memory). This block provides the status of the logger, including warning and overflow (a not-stored report was lost).
ATV	**Audit Trail View** – This block allows to browse and to display the configuration log, a group of 10 changes at a time, selected from the logger (FC302 NVRAM memory). This block provides the status of the logger, including warning and overflow (a not-stored register was lost).
AEV	**Alarm/Event View** – This block allows to browse and to display the process alarms and events, a group of 10 occurences at a time, selected from the logger (FC302 NVRAM memory). This block provides the status of the logger, including warning and overflow (a not-stored register was lost).

Classification of the FC302 specific blocks

Block Type	Class	Application	Maximum Number of Instances
FCT	TRD	Both	1
GKD	TRD	Gas	1
LKD	TRD	Liquid	1
PIP	TRD	Liquid and Gas	Number of supported flows
GFC, GT, GC	FB	Gas	Number of supported flow measurements
GST, GTV	FB	Gas	1
LBT, LCT, LMMF	FB	Liquid	Number of supported flow measurements
LMF	FB	Liquid	Number of supported flow measurements+1
LCF	FB	Liquid	100
LST, LTV, LMFV	FB	Liquid	1
ATV, AEV, WT,WTV	FB	Both	1

The table above shows the following information:

- Transducer and Visualization Blocks accept only one instance per FC302;
- For the other blocks, the maximum number of instances is the number of flow measurements (four);
- The mnemonic of specific Blocks for gas measurement starts with a “G”;
- The mnemonic of specific Blocks for liquid measurement starts with a “L”;
- The mnemonic of Visualization Blocks ends with a “V”.

Generic Blocks

RS – Resource Block

Description
This block contains data specific to the hardware associated to the resource. All data is modeled as Contained, so there are no links to this block. The data is not processed as a function block would process the data, so there is no function schema.

The parameters have the minimum requirements of a Function Block Application associated with the resource. Some parameters, such as calibration data and ambient temperature, are included in the respective transducer blocks.

The mode controls major states of the resource. The O/S mode stops all function block execution. The actual mode of the function blocks will be changed to O/S, but the target mode will not be changed. The Auto mode allows normal operation of the resource. The IMan mode indicates that the resource is initializing or receiving the software download.

The parameters MANUFAC_ID, DEV_TYPE, DEV_REV, DD_REV, and DD_RESOURCE are required to identify and locate the correct DD to be used with the resource, selected by the Device Description Services.

The parameter HARD_TYPES is a read-only bitstring parameter that indicates the type of the hardware available to this resource. If a configured I/O block requires a type of hardware that is not available, the result will be a block alarm indicating the configuration error.

The parameter RS_STATE indicates the operational status of the Function Block Application for the resource containing this resource block.

RESTART parameter
The parameter RESTART has different level for the initialization of the resource. They are:
1 - Run: passive state of the parameter.
2 - Restart resource: resets problems such as garbage collection.
3 - Restart with defaults: erases the configuration memory; it acts like a factory initialization.
4 - Restart processor: acts like the reset button on the processor associated to the resource.
This parameter does not appear in a view because it returns to 1 right after being written.

Non-volatile parameters
Smar devices do not support cyclic saving of non-volatile parameters to a non-volatile memory, therefore the parameter NV_CYCLE_T will always be zero, which means that it doesn't support the feature.

On the other hand, Smar devices have a mechanism to save non-volatile parameters to a non-volatile memory while shutting down, and to recover the parameters when turning on.

Timeout for remote cascade modes
SHED_RCAS and SHED_ROUT set the time limit when the communication with a remote device is lost. These constants are used by all function blocks that support a remote cascade mode. The effect of a timeout is described in Mode Calculation. Shedding from RCAS/ROUT should not occur when SHED_RCAS or SHED_ROUT is set to zero.

Alert Notification
The value of the parameter MAX_NOTIFY is the maximum number of alert reports that this resource can send without receiving a confirmation, corresponding to the amount of buffer space available for alert messages. The user can set a lower number to control the alert flow by adjusting the value of the parameter LIM_NOTIFY. If LIM_NOTIFY is set to zero, no alerts will be reported. The CONFIRM_TIME parameter is the time interval that the resource will wait for the confirmation that the report was sent before trying again. If the CONFIRM_TIME is zero, the device won't try again.

FEATURES / FEATURE_SEL parameters
The bit strings parameters FEATURES and FEATURE_SEL specify optional behaviors of the resource. The first parameter defines the available features, and it is read-only. The second parameter activates an available feature by configuration. If a bit is set in FEATURE_SEL and it is not set in FEATURES, the result will be a block alarm for a configuration error.
Smar devices support the following features: Reports, Fault State, Write-protect Software.

Fault state for the entire resource
If the user sets the SET_FSTATE parameter, the FAULT_STATE parameter will indicate active and **all output function blocks** in the resource will change, immediately, to the condition selected by the "Fault State Type" of the IO_OPTS parameter. It can be cleared by setting the CLR_FSTATE parameter. The parameters set and clear do not appear in a view because they are transitory.

Write-Protect Software
The WRITE_LOCK parameter, when configured, will prevent any external change to the static or non-volatile database in the Function Block Application of the resource. Block connections and calculation results will proceed normally, but the configuration will be locked. The parameter is configured and cleared by writing to the WRITE_LOCK parameter. Clearing WRITE_LOCK will generate the discrete alert WRITE_ALM, with the WRITE_PRI priority. Setting WRITE_LOCK will clear the alert, if it exists.
Before setting WRITE_LOCK parameter to *Locked*, it is necessary to select the “Soft Write lock supported” option in FEATURE_SEL.

Features being implemented
The parameter CYCLE_TYPE is a bitstring that defines the types of cycles that this resource canexecute. CYCLE_SEL allows the configurator to choose one of the types. If CYCLE_SEL contains more than one bit, or if the bit is not configured in CYCLE_TYPE, the result will be a block alarm for a configuration error. MIN_CYCLE_T is the minimum time specified by the manufacturer to execute a cycle. It sets a lower limit to the scheduling of the resource.

MEMORY_SIZE defines the size of the resource to configure thefunction blocks, in kilobytes.

The parameter FREE_SPACE shows the percentage of the configuration memory that is still available. FREE_TIME shows the approximate percentage of time available in the resource for processing new function blocks, should they be configured.

BLOCK_ERR
The BLOCK_ERR of the resource block will indicate the following causes:
- Device Fault State Set – When FAULT_STATE is active.
- Simulate Active – When the Simulate jumper is ON.
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S, IMAN and AUTO

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	RS_STATE	Unsigned8			E	D / RO	Status of the function block application state machine.
8	TEST_RW	DS-85			None	D	Read/write test parameter - used only for conformity testing.
9	DD_RESOURCE	VisibletString (32)		Spaces	Na	S / RO	String identifying the tag of the resource that contains the Device Description for this resource.
10	MANUFAC_ID	Unsigned32	Enumeration; controlled by FF	0x00000302	None	S / RO	Manufacturer's identification number - used by the interface device to locate the DD file for the resource.
11	DEV_TYPE	Unsigned16	Set by mfgr		None	S / RO	Manufacturer’s model number associated to the resource - used by the interface device to locate the DD file for the resource.
12	DEV_REV	Unsigned8	Set by mfgr		None	S / RO	Manufacturer's revision number associated to the resource - used by the interface device to locate the DD file for the resource.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
13	DD_REV	Unsigned8	Set by mfgr		None	S / RO	Revision of the DD associated to the resource - used by the interface device to locate the DD file for the resource.
14	GRANT_DENY	DS-70	See Block Options	0	Na	D	Options for controlling the access of the host computer and local control panels to the operation, tune and alarm parameters of the block.
15	HARD_TYPES	Bitstring(2)	Set by mfgr		Na	S / RO	The types of hardware available as channel numbers.
16	**RESTART**	Unsigned8	1: Run, 2: Restart resource, 3: Restart with defaults, 4: Restart processor		E	D	Allows manual initialization. Several initialization levels are possible.
17	FEATURES	Bitstring(2)	Set by mfgr		Na	S / RO	Display options supported by the resource block.
18	**FEATURE_SEL**	Bitstring(2)		0	Na	S	Select the options from the resource block.
19	CYCLE_TYPE	Bitstring(2)	Set by mfgr		Na	S / RO	Identifies the block execution methods available for this resource.
20	CYCLE_SEL	Bitstring(2)		0	Na	S	Select the block execution method for this resource.
21	MIN_CYCLE_T	Unsigned32	Set by mfgr		1/32 millisec	S / RO	Time interval of the shortest cycle that the resource can execute.
22	MEMORY_SIZE	Unsigned16	Set by mfgr		kbytes	S / RO	Configuration memory available in an empty resource. Should be checked before executing the download.
23	NV_CYCLE_T	Unsigned32			1/32 millisec	S / RO	Time interval between writing copies of the NV parameters to the non-volatile memory. Zero means that no copy will be written.
24	FREE_SPACE	Float	0 to 100 %		%	D / RO	Percent of the memory available for further configuration. The value will be zero in a pre-configured resource.
25	FREE_TIME	Float	0 to 100%		%	D / RO	Percent of the block processing time available to process additional blocks.
26	SHED_RCAS	Unsigned32		640000	1/32 millisec	S	Time interval to write to the computer in the positions Rcas of the function block.
27	SHED_ROUT	Unsigned32		640000	1/32 millisec	S	Time interval to write to the computer in the positions ROut of the function block.
28	FAULT_STATE	Unsigned8	1: Clear, 2: Active		E	D	Condition set when the communication with the output block fails, caused by the output block or a physical contact. When the Fault State condition is set, the output function blocks will execute the FSAFE procedures.
29	SET_FSTATE	Unsigned8	1: Off, 2: Set	1	E	D	Allows the fault state condition to be manually initiated when selecting "Set".
30	CLR_FSTATE	Unsigned8	1: Off, 2: Clear	1	E	D	Selecting "Clear" for this parameter will clear the device fault state if the field condition is cleared.
31	MAX_NOTIFY	Unsigned8	Set by mfgr		None	S / RO	Maximum number of alert messages unacknowledged.
32	LIM_NOTIFY	Unsigned8	0 to MAX_ NOTIFY	MAX_ NOTIFY	None	S	Maximum number of alert messages unacknowledged.
33	CONFIRM_TIME	Unsigned32		640000	1/32 millisec	S	The minimum time interval before trying to send an alert report again.
34	WRITE_LOCK	Unsigned8	1:Unlocked, 2:Locked	1	E	S	When configured, the user won't be able to write to the parameter, except to clear the WRITE_LOCK parameter. Block inputs will be updated.
35	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
36	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.
37	ALARM_SUM	DS-74			Na	S	The current alert status, unacknowledged status, unreported status, and disabled status of the alarms associated to the function block.
38	ACK_OPTION	Bitstring(2)	0: Auto ACK Disabled 1: Auto ACK Enabled	0	Na	S	Select the alarms associated to the block that will be automatically acknowledged.
39	WRITE_PRI	Unsigned8	0 to 15	0	None	S	Priority of the alarm generated by clearing the writelock.
40	WRITE_ALM	DS-72			None	D	This alert is generated if the writelock parameter is cleared.
41	ITK_VER	Unsigned16			Na	S/RO	This parameter indicates the ITK version of the device (only for certified devices).

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

HC – Hardware Configuration Transducer

Overview
This block configures the module type for each slot in the **FC302.**

Description
The following table shows the module types available.

Code	Description	I/O Type
	Available slot	No I/O
DF51	DFI302 Processor 1x10Mbps, 4xH1	No I/O
DF50	Power Supply 90-264VAC	No I/O
DF56	Power Supply for Backplane 20-30VDC	No I/O
DF52	Power Supply for Fieldbus	No I/O
DF49	2-channel Power Supply Impedance	No I/O
DF53	4-channel Power Supply Impedance	No I/O
DF11	2 Groups of 8 24VDC Inputs (Isolated)	16-discrete input
DF12	2 Groups of 8 48VDC Inputs (Isolated)	16-discrete input
DF13	2 Groups of 8 60VDC Inputs (Isolated)	16-discrete input
DF14	2 Groups of 8 125VDC Inputs (Isolated)	16-discrete input
DF15	2 Groups of 8 24VDC Inputs (Sink)(Isolated)	16-discrete input
DF16	2 Groups of 4 120VAC Inputs (Isolated)	8-discrete input
DF17	2 Groups of 4 240VAC Inputs (Isolated)	8-discrete input
DF18	2 Groups of 8 120VAC Inputs (Isolated)	16-discrete input
DF19	2 Groups of 8 240VAC Inputs (Isolated)	16-discrete input
DF20	1 Group of 8 On/Off Switches	8-discrete input
DF21	1 Group of 16 Open Collector Outputs	16-discrete output
DF22	2 Group of 8 Transistor Outputs (source) (Isolated)	16-discrete output
DF23	2 Groups of 4 120/240VAC Outputs	8-discrete output
DF24	2 Groups of 8 120/240VAC Outputs	16-discrete output
DF25	2 Groups of 4 NO Relays Outputs	8-discrete output
DF26	2 Groups of 4 NC Relays Outputs	8-discrete output
DF27	1 Group of 4 NO and 4 NC Relay Outputs	8-discrete output
DF28	2 Groups of 8 NO Relays Outputs	16-discrete output
DF29	2 Groups of 4 NO Relays Outputs (W/o RC)	8-discrete output
DF30	2 Groups of 4 NC Relays Outputs (W/o RC)	8-discrete output
DF31	1 Group of 4 NO and 4 NC Relay Outputs (W/o RC)	8-discrete output
DF32	1 Group of 8 24VDC Inputs and 1 Group of 4 NO Relays	8-discrete input/4-discrete output
DF33	1 Group of 8 48VDC Inputs and 1 Group of 4 NO Relays	8-discrete input/4-discrete output
DF34	1 Group of 8 60VDC Inputs and 1 Group of 4 NO Relays	8-discrete input/4-discrete output
DF35	1 Group of 8 24VDC Inputs and 1 Group of 4 NC Relays	8-discrete input/4-discrete output
DF36	1 Group of 8 48VDC Inputs and 1 Group of 4 NC Relays	8-discrete input/4-discrete output
DF37	1 Group of 8 60VDC Inputs and 1 Group of 4 NC Relays	8-discrete input/4-discrete output
DF38	1 Group of 8 24VDC Inputs,1 Group of 2 NO and 2 NC Relays	8-discrete input/4-discrete output
DF39	1 Group of 8 48VDC Inputs, 1 Group of 2 NO and 2 NC Relays	8-discrete input/4-discrete output
DF40	1 Group of 8 60VDC Inputs, 1 Group of 2 NO and 2 NC Relays	8-discrete input/4-discrete output
DF41	2 Groups of 8 pulse inputs – low frequency	16-pulse input
DF42	2 Groups of 8 pulse inputs – high frequency	16-pulse input

Code	Description	I/O Type
DF44	1 Group of 8 analog inputs with shunt resistors	8-analog input
DF57	1 Group of 8 differential analog inputs with shunt resistors	8-analog input
DF45	1 Group of 8 temperature inputs	8-temperature
DF46	1 Group of 4 analog output	4-analog output

The execution method of this transducer block will write to all output modules and read from all input modules. If any I/O module fails this scan, it will be indicated in BLOCK_ERR as well as in the MODULE_STATUS_x. It is easy to locate the module or the sensor that failed.
All I/O modules in the previous table can be accessed directly using Input/Output Function Blocks, without a transducer block, except for the DF-45 that requires the TEMP block.

BLOCK_ERR
The BLOCK_ERR of the HC block will indicate the following causes:

- Lost static data – Low battery voltage indication.
- Device needs maintenance now – High temperature in the CPU.
- Input Failure – a physical input point failed.
- Output Failure – a physical output point failed.
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S and AUTO.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	REMOTE_IO	Unsigned8	0 : Master 1 : Remote I/O Slave 1 2 : Remote I/O Slave 2 3 : Remote I/O Slave 3 4 : Remote I/O Slave 4 5 : Remote I/O Slave 5 6 : Remote I/O Slave 6	0	E	S / O/S	Identification of the master or slave remote I/O.
8	**IO_TYPE_R0**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 0
9	**IO_TYPE_R1**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 1
10	**IO_TYPE_R2**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 2
11	**IO_TYPE_R3**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 3
12	**IO_TYPE_R4**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 4
13	**IO_TYPE_R5**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 5
14	**IO_TYPE_R6**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 6
15	**IO_TYPE_R7**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 7
16	**IO_TYPE_R8**	4 Unsigned8		0	E	S / O/S	Select the module type for rack 8
17	IO_TYPE_R9	4 Unsigned8		0	E	S / O/S	Select the module type for rack 9
18	IO_TYPE_R10	4 Unsigned8		0	E	S / O/S	Select the module type for rack 10
19	IO_TYPE_R11	4 Unsigned8		0	E	S / O/S	Select the module type for rack 11
20	IO_TYPE_R12	4 Unsigned8		0	E	S / O/S	Select the module type for rack 12
21	IO_TYPE_R13	4 Unsigned8		0	E	S / O/S	Select the module type for rack 13

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
22	IO_TYPE_R14	4 Unsigned8		0	E	S / O/S	Select the module type for rack 14
23	**MODULE_STATUS_R0_3**	Bitstring(2)				D / RO	Status of the modules in rack 0-3.
24	**MODULE_STATUS_R4_7**	Bitstring(2)				D / RO	Status of the modules in rack 4-7.
25	**MODULE_STATUS_R8_11**	Bitstring(2)				D / RO	Status of the modules in rack 8-11.
26	**MODULE_STATUS_R12_14**	Bitstring(2)				D / RO	Status of the modules in rack 12-14.
27	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
28	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

DIAG – Diagnostics Transducer Block

Description
This transducer block provides the following features:

- Online measurement of the block execution time
- Hardware revision
- Firmware revision
- Serial number of the device
- Serial number of the main board

The parameter BEHAVIOR will define which initial values for the parameters will be used after a block is instantiated. The option *Adapted* selects a more suitable initial value set, avoiding invalid values for parameters. The initial values can also be defined by selecting the option *Spec*.

Supported modes
O/S and AUTO.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D	
7	**EXE_TIME_TAG**	Visible String (32)		spaces	Na	D	Tag of the block selected to measure the execution time.
8	MIN_EXE_TIME	Float		+INF	ms	D / RO	Minimum execution time of the selected block.
9	**CUR_EXE_TIME**	Float		0	ms	D / RO	Current execution time of the selected block.
10	MAX_EXE_TIME	Float		0	ms	D / RO	Maximum execution time of the selected block.
11	**HW_REV**	Visible String(5)				S / RO	Hardware revision.
12	**FIRMWARE_REV**	Visible String(5)				S / RO	Firmware revision.
13	**DEV_SN**	Unsigned32				S / RO	Device serial number.
14	MAIN_BOARD_SN	Unsigned32				S / RO	Main board serial number.
15	**BEHAVIOR**	Unsigned8	0:Adapted 1:Spec	0	E	S	Select the initial values for parameters. There are two options: Adapted and Spec.
16	PUB_SUB_STATUS	Unsigned8	0-good 1-bad		E	D / RO	Indicates if all external links are good or if at least one is bad.
17	LINK_SELECTION	Unsigned8	0-first 1-next 2-previous	0	E	D	Select an external link.
18	LINK_NUMBER	Unsigned16				D / RO	Number of the external link selected.
19	LINK_STATUS	Unsigned8				D / RO	Status of the external link selected (see the table below)
20	LINK_RECOVER	Unsigned8	0-no action 1-action	No action	E	D	Executes a recovery process to the external link selected.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
21	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.
22	SAVING_CONFIG	UNSIGNED 8	0 – NOT SAVING 1 - SAVING	0	E	D	Indicates if the device is saving the configuration in a non-volatile memory.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

Description of the values of the LINK_STATUS parameter

Link Status	General Status	Publisher/ Subscriber	Connection Status	Sending/Receiving	Block Update
0X00	Good	Publisher			
0X40	Good	Subscriber			
0X84	Bad	Publisher	Established	Sending/Receiving	Not updating
0X88	Bad	Publisher	Established	Not sending/receiving	Updating
0X8C	Bad	Publisher	Established	Not sending/receiving	Not updating
0X98	Bad	Publisher	Not established	Not sending/receiving	Updating
0X9C	Bad	Publisher	Not established	Not sending/receiving	Not updating
0XA8	Bad	Publisher	Pending	Not sending/receiving	Updating
0XAC	Bad	Publisher	Pending	Not sending/receiving	Not updating
0XBC	Bad	Publisher	Not configured	Not sending/receiving	Not updating
0XC4	Bad	Subscriber	Established	Sending/Receiving	Not updating
0XCC	Bad	Subscriber	Established	Not sending/receiving	Not updating
0XDC	Bad	Subscriber	Not established	Not sending/receiving	Not updating
0XEC	Bad	Subscriber	Pending	Not sending/receiving	Not updating
0XFC	Bad	Subscriber	Not configured	Not sending/receiving	Not updating

TEMP – DF45 Temperature Transducer

Overview
This is the transducer block for the module DF45, an 8-low signal input module for RTD, TC, mV, Ohm.

Description
This transducer block contains the parameters to configure the eight low signal inputs, as well as the individual status and the value in engineering units for each input. Therefore, the user can configure only the TEMP block, if the purpose is to monitor variables.

If the application is a control loop or a calculation, it is also necessary to configure an AI or MAI block to address these variables. One important difference for the TEMP block, when using an AI block to access an input: writing to the VALUE_RANGE_x parameter is disabled. The user must configure the scale in the XD_SCALE parameter of the AI block, and it will be copied to the corresponding VALUE_RANGE_x parameter.

BLOCK_ERR
The BLOCK_ERR will indicate the following causes:
- Block Configuration Error - When it is not compatible to the CHANNEL parameter and the HC configuration (DFI302);
- Input Failure – At least one input failed (DFI302);
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S and AUTO.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**CHANNEL**	Unsigned16			None	S / O/S	The rack and slot number of the associated DF-45 module, coded as RRSXX.
8	TEMP_0	DS-65				D	Temperature of point 0.
9	TEMP_1	DS-65				D	Temperature of point 1.
10	TEMP_2	DS-65				D	Temperature of point 2.
11	TEMP_3	DS-65				D	Temperature of point 3.
12	TEMP_4	DS-65				D	Temperature of point 4.
13	TEMP_5	DS-65				D	Temperature of point 5.
14	TEMP_6	DS-65				D	Temperature of point 6.
15	TEMP_7	DS-65				D	Temperature of point 7.
16	VALUE_RANGE_0	DS-68		0-100%	VR0	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
17	SENSOR_CONNECTION_0	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 0.
18	**SENSOR_TYPE_0**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 0.
19	VALUE_RANGE_1	DS-68		0-100%	VR1	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
20	SENSOR_CONNECTION_1	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 1.
21	**SENSOR_TYPE_1**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 1.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
22	VALUE_RANGE_2	DS-68		0-100%	VR2	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
23	SENSOR_CONNECTION_2	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 2.
24	**SENSOR_TYPE_2**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 2.
25	VALUE_RANGE_3	DS-68		0-100%	VR3	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
26	SENSOR_CONNECTION_3	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 3.
27	**SENSOR_TYPE_3**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 3.
28	VALUE_RANGE_4	DS-68		0-100%	VR4	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
29	SENSOR_CONNECTION_4	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 4.
30	**SENSOR_TYPE_4**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 4.
31	VALUE_RANGE_5	DS-68		0-100%	VR5	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
32	SENSOR_CONNECTION_5	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 5.
33	**SENSOR_TYPE_5**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 5.
34	VALUE_RANGE_6	DS-68		0-100%	VR6	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
35	SENSOR_CONNECTION_6	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 6.
36	**SENSOR_TYPE_6**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 6.
37	VALUE_RANGE_7	DS-68		0-100%	VR7	S / O/S	If it is connected to the AI block, it is a copy of XD_SCALE. Otherwise, the user can write to the scale of the parameter.
38	SENSOR_CONNECTION_7	Unsigned8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 7.
39	**SENSOR_TYPE_7**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 7.
40	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
41	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

Code	Sensor Type	Class	Sensor range – Differential (Celsius)	Sensor range – 2-wires (Celsius)	Sensor range – 3-wires (Celsius)
1	Cu 10 GE	RTD	-270 to 270	-20 to 250	-20 to 250
2	Ni 120 DIN		-320 to 320	-50 to 270	-50 to 270
3	Pt 50 IEC		-1050 to 1050	-200 to 850	-200 to 850
4	Pt 100 IEC		-1050 to 1050	-200 to 850	-200 to 850
5	Pt 500 IEC		-270 to 270	-200 to 450	-200 to 450
6	Pt 50 JIS		-850 to 850	-200 to 600	-200 to 600
7	Pt 100 JIS		-800 to 800	-200 to 600	-200 to 600
51	0 to 100	Ohm		0 to 100	0 to 100
52	0 to 400			0 to 400	0 to 400
53	0 to 2000			0 to 2000	0 to 2000
151	B NBS	TC	-1600 to 1600	100 to 1800	
152	E NBS		-1100 to 1100	-100 to 1000	
153	J NBS		-900 to 900	-150 to 750	
154	K NBS		-1550 to 1550	-200 to 1350	
155	N NBS		-1400 to 1400	-100 to 1300	
156	R NBS		-1750 to 1750	0 to 1750	
157	S NBS		-1750 to 1750	0 to 1750	
158	T NBS		-600 to 600	-200 to 400	
159	L DIN		-1100 to 1100	-200 to 900	
160	U DIN		-800 to 800	-200 to 600	
201	-6 to 22	MV		-6 to 22	
202	-10 to 100			-10 to 100	
203	-50 to 500			-50 to 500	

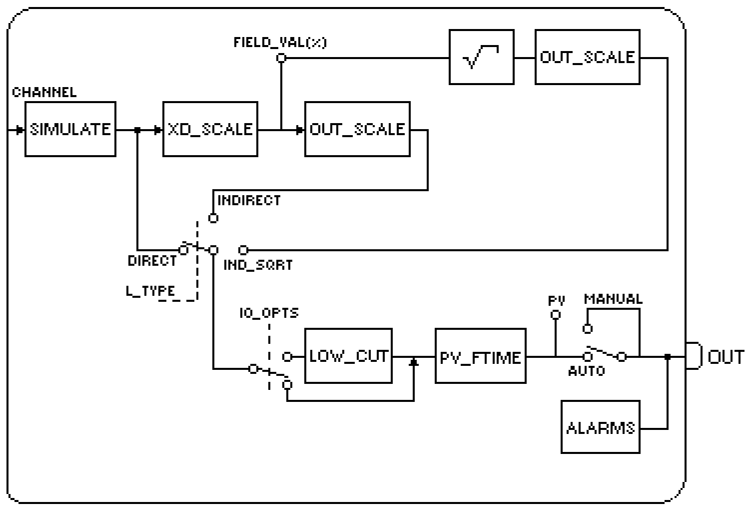
If the BEHAVIOR parameter is configured as "Adapted":
When the configuration of the sensor type has a different class, the connection is automatically changed to default (RTD and Ohm – 3-wires, TC and mV – 2-wires).

AI - Analog Input

Overview

The Analog Input block reads the input data from the Transducer block, selected by the channel number, and sends data to other function blocks.

Schematic



Description

The AI block is connected to the transducer block through the CHANNEL parameter, that must match the following parameter in the transducer block:

- SENSOR_TRANSDUCER_NUMBER parameter for the TT302
- TERMINAL_NUMBER parameter for the IF302

The CHANNEL parameter must be set to 1 (one) if the AI block is executing in the LD302, and no configuration is necessary in the transducer block to connect it to the AI block.

The scale of the Transducer (XD_SCALE) is applied to the value of the channel to produce the FIELD_VAL in percent. The XD_SCALE engineering units code and range should be proper to the sensor of the transducer block connected to the AI block, otherwise a block alarm indicating a configuration error will be generated.

The L_TYPE parameter determines how the values sent by the transducer block will be used by the block. The options are:

- Direct - the value from the transducer block is sent directly to the PV. OUT_SCALE will not be used.
- Indirect - the value of the PV is the value of FIELD_VAL converted to the OUT_SCALE.
- Indirect with Square Root - the value of the PV is the square root of the FIELD_VAL converted to the OUT_SCALE.

The scales of PV and OUT are always identical, based on OUT_SCALE.
The LOW_CUT parameter is an optional characteristic that can be used to eliminate noises near zero for a flow sensor. The LOW_CUT parameter has a corresponding “Low cutoff” option in the IO_OPTS bit string. If the bit is true, any output below the low cutoff value (LOW_CUT) will be changed to zero.

BLOCK_ERR

The parameter BLOCK_ERR of the AI block will indicate the following causes:

- Block Configuration Error – the configuration error is indicated when one or more of the following situations occur:
- When the parameter CHANNEL or L_TYPE has an invalid value;
- When the XD_SCALE doesn't have a engineering unit or range proper for the sensor of the transducer block.

- When the CHANNEL parameter and the HC configuration (FC302) are not compatible;
- Simulate Active – When the Simulate is active;
- Input Failure – I/O module failed (FC302);
- Out of Service – When the block is in O/S mode.

Supported Modes

O/S, MAN and AUTO.

Status

The AI block does not support cascade mode. The output status doesn't have a cascade sub-status.

When the OUT value exceeds the OUT_SCALE range and there isn't a bad condition configured in the block, the OUT status will be “uncertain, EU Range Violation”.

The STATUS_OPTS has the following options, where Limited refers to the sensor limits: (see the Function block options for details)

- Propagate Fault Forward
- Uncertain if Limited
- BAD if Limited
- Uncertain if Man mode

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**PV**	DS-65			PV	D / RO	Process the analog value that will be used to execute the function.
8	**OUT**	DS-65	OUT_SCALE +/- 10%		OUT	D / Man	The analog value is calculated as a result of the function execution.
9	SIMULATE	DS-82	1: Disable ; 2: Active These are the Enable/Disable options.	Disable		D	Allows the input value to be manually supplied when simulate is enabled. In this case, the simulate value and status will be the PV value.
10	XD_SCALE	DS-68		0-100%	XD	S / Man	The higher and lower scale values, for the transducer of a specified channel.
11	OUT_SCALE	DS-68		0-100%	OUT	S / Man	The higher and lower scale values for the OUT parameter.
12	GRANT_DENY	DS-70		0	na	D	
13	IO_OPTS	Bitstring(2)	See Block Options	0	na	S / O/S	See Block Options
14	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
15	**CHANNEL**	Unsigned16		0	None	S / O/S	The channel number of the logical hardware, for the transducer that is connected to this I/O block.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
16	**L_TYPE**	Unsigned8	1: Direct 2: Indirect 3: Indirect Square Root	0	E	S / Man	Define how the values sent by the transducer block can be used: Directly (Direct); as a percentage (Indirect) ; or as a percentage with square root (Ind Sqr Root).
17	LOW_CUT	Float	Non-Negative	0	OUT	S	A value equals to zero percent of the scale will be used to process the block, if the transducer value is lower than this limit, in % of the scale. This feature can be used to eliminate noises near zero for a flow sensor.
18	**PV_FTIME**	Float	Non-Negative	0	Sec	S	Time constant of a single exponential filter for the PV, in seconds.
19	FIELD_VAL	DS-65			%	D / RO	Raw value of the field device in percentage of the PV range, the status indicates the Transducer condition, before signal characterization (L_TYPE) or filtering (PV_FTIME).
20	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
21	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.
22	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged status, unreported status, and disabled status of the alarms associated to the function block.
23	ACK_OPTION	Bitstring(2)	0: Auto ACK Disabled 1: Auto ACK Enabled	0	Na	S	Select the alarms associated to the block that will be automatically acknowledged.
24	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. To clear the alarm, the PV should return a value within the alarm limits plus the hysteresis.
25	HI_HI_PRI	Unsigned8	0 to 15			S	Priority of the high high alarm.
26	HI_HI_LIM	Float	OUT_SCALE, +INF	+INF	OUT	S	The limit for the high high alarm, in engineering units.
27	HI_PRI	Unsigned8	0 to 15			S	Priority of the high alarm.
28	HI_LIM	Float	OUT_SCALE, +INF	+INF	OUT	S	The limit for the high alarm, in engineering units.
29	LO_PRI	Unsigned8	0 to 15			S	Priority of the low alarm.
30	LO_LIM	Float	OUT_SCALE, -INF	-INF	OUT	S	The limit for the low alarm, in engineering units.
31	LO_LO_PRI	Unsigned8	0 to 15			S	Priority of the low low alarm.
32	LO_LO_LIM	Float	OUT_SCALE, -INF	-INF	OUT	S	The limit for the low low alarm, in engineering units.
33	HI_HI_ALM	DS-71			OUT	D	The status of the high high alarm and the associated time stamp.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
34	HI_ALM	DS-71			OUT	D	The status of the high alarm and the associated time stamp.
35	LO_ALM	DS-71			OUT	D	The status of the low alarm and the associated time stamp.
36	LO_LO_ALM	DS-71			OUT	D	The status of the low low alarm and the associated time stamp.

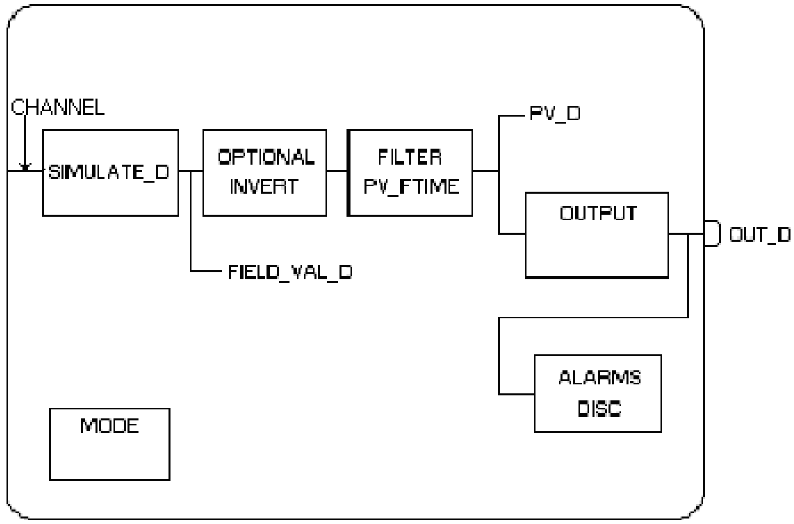
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

If the BEHAVIOR parameter is configured as "Adapted":
The default value of CHANNEL is the lowest number available.
The default value of L_TYPE is direct.
The required writing mode is the actual mode, regardless of the target mode: OUT.

DI - Discrete Input

Overview
The DI block reads the manufacturer's discrete input data, selected by the channel number, and sends data to other function blocks.

Schematic



Description
The FIELD_VAL_D shows the true on/off status of the hardware, using XD_STATE. The Invert I/O option can execute the Boolean function NOT between the field value and the output. A discrete value equals to zero (0) will be considered a logical zero (0) and a discrete value different from zero will be considered a logical one (1), i.e., if the bit "invert" is selected, the logical NOT of a value different from zero would result a discrete output equals to zero, and the logical NOT of zero would result a discrete output equals to one (1). PV_FTIME can be used to set the time that the hardware must be in a specific status before sending data to the PV_D. The PV_D is the value that the block will always have in OUT_D, if the mode is Auto. If the Man mode is allowed, a value can be written to OUT_D. The PV_D and the OUT_D Have the same scale defined by OUT_STATE.

BLOCK_ERR
The parameter BLOCK_ERR of the DI block will indicate the following causes:

- Block Configuration Error – the configuration error is indicated when one or more of the following situations occur:
- When the CHANNEL parameter has an invalid value;
- When the CHANNEL parameter and the HC configuration (FC302) are not compatible;
- Simulate Active – When the Simulate is active;
- Input Failure – I/O module failed (FC302);
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S, Man, and Auto.

Status
The DI block does not support cascade mode. The output status doesn't have a cascade sub-status. The STATUS_OPTS has the following options: Propagate Fault Forward.

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with the string different from spaces, this parameter will replace the block tag in the alarm and event reports.
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**PV_D**	DS-66			PV	D / RO	The primary discrete value being used to execute the function, or a process value associated to it.
8	**OUT_D**	DS-66	OUT_STATE		OUT	D / Man	The primary discrete value calculated as a result of the function execution.
9	SIMULATE_D	DS-83	1: Disable ; 2: Active These are the Enable/Disable options.	Disable		D	Provides the transducer discrete input or output manually when the simulation is enabled. When simulation is disabled, the value and status of the parameter will have the current value and status.
10	XD_STATE	Unsigned16		0	XD	S	Index of the text that describe the status of the discrete value obtained from the transducer.
11	OUT_STATE	Unsigned16		0	OUT	S	Index of the text that describe the status of a discrete output.
12	GRANT_DENY	DS-70		0	na	D	
13	IO_OPTS	Bitstring(2)	See Block Options	0	na	S / O/S	See Block Options
14	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
15	**CHANNEL**	Unsigned16		0	None	S / O/S	The channel number of the logical hardware for the transducer that is connected to this I/O block.
16	**PV_FTIME**	Float	Non-Negative	0	Sec	S	Time constant of a single exponential filter for the PV, in seconds.
17	FIELD_VAL_D	DS-66			On/Off	D / RO	Raw value of the field device discrete input, the status indicates the Transducer condition.
18	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
19	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.
20	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged status, unreported status, and disabled status of the alarms associated to the function block.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
21	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Select the alarms associated to the block that will be automatically acknowledged.
22	DISC_PRI	Unsigned8	0 to 15	0		S	Priority of the discrete alarm.
23	DISC_LIM	Unsigned8	PV_STATE	0	PV	S	Status of the discrete input that will generate an alarm.
24	DISC_ALM	DS-72			PV	D	The status and time stamp associated to the discrete alarm.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

AALM - Analog Alarm

Description

The Analog Alarm Block reportes an alarm condition to the analog output of any block. Alarm conditions include high, high-high, low and low-low alarms. These limits are based on gains and biases from a process setpoint input, providing a dynamic deviation alarm. It is possible to temporarily expand the alarm limits after changing the setpoint. Also, an alarm condition can be ignored for a specified period of time to prevent alarm reports caused by noises.

The input value, IN, is filtered according to the PV_FTIME time constant, to become the PV. PV is configured in auto mode.

Alarm limits can be dynamically calculated from the process setpoint (PSP). The operation limits (named as the parameter limits with the suffix “X”) are calculated based on specified gains and biases, as indicated below:

HI_HI_LIMX = PSP * HI_GAIN + HI_HI_BIAS + EXPAND_UP (or default for HI_HI_LIM if any parameter is undefined)

HI_LIMX = PSP * HI_GAIN + HI_BIAS + EXPAND_UP (or default for HI_LIM if any parameter is undefined)

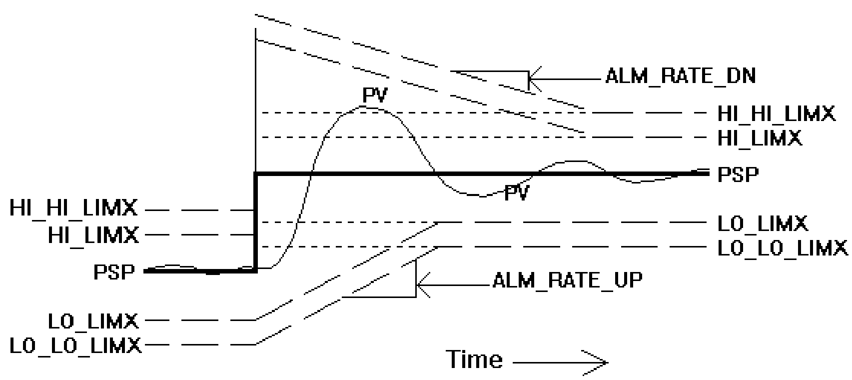
LO_LIMX = PSP * LO_GAIN - LO_BIAS - EXPAND_DN (or default for LO_LIM if any parameter is undefined)

LO_LO_LIMX = PSP * LO_GAIN - LO_LO_BIAS - EXPAND_DN (or default for LO_LO_LIM if any parameter is undefined)

Undefined means:

- HI_GAIN/HI_HI_BIAS = ± INF
- PSP_STATUS = BAD O/S

Expandind alarm limits
Effective alarm limits can be temporarily expanded by changing the setpoint to prevent undesired alarms. The high alarm limits are increased by a calculated term, EXPAND_UP. The low alarm limits are decreased by a calculated term, EXPAND_DN. See the example in the following chart:



Both level 1 (advisory) and level 2 (critical) of the effective alarm limits are expanded after changing the setpoint with the absolute value of the alteration for the PSP. The expansions will decrease to the base limits at a rate determined by the ALM_RATE_UP and ALM_RATE_DN parameters. This parameter permits responses to the normal process with over-damped to avoid alarms on the initial change and permits under-damped process responses to avoid alarms on overshooting or ringing. The following properties and rules apply:

- The four limits are expanded by the same value, according to the alteration of the setpoint.

The two high limits are always expanded by the same value, EXPAND_UP, and decreased by the same rate, ALM_RATE_DN (which may differ from the low limits).

- The two low limits are always expanded by the same value, EXPAND_DN, and decreased by the same rate, ALM_RATE_UP (which may differ from the high limits).
- The expansion feature may be suppressed when increasing by setting ALM_RATE_DN to zero.

The expansion feature may be suppressed when decreasing by setting ALM_RATE_UP to zero.
- Changing the setpoint before the previous expansion is complete will expand the alarm limits to both direction, to the maximum remaining value or the new expansion value.

IGNORE_TIME
The occurrence of a new alarm condition can be temporarily ignored by setting the IGNORE_TIME parameter to the time interval, in seconds, that the alarm will be ignored. The alarm indication and the PRE_OUT_ALM alterations will be ignored during this interval. This parameter does not delay the acknowledgement of the alarm when returning to normal operation. If the alarm condition does not persist after the IGNORE_TIME seconds, it will not be reported.

OUT_ALM Indication
OUT_ALM parameter will assume the PRE_OUT_ALM value when the block is in Auto mode.

PRE_OUT_ALM and OUT_ALM indicate the occurrence of one or more alarm conditions selected in the specification of the OUT_ALM_SUM parameter. The table below shows the options for the OUT_ALM_SUM parameter and the alarm conditions:

OUT_ALM_SUM	INCLUDED ALARM CONDITIONS			
	HI_HI_ALM	HI_ALM	LO_ALM	LO_LO_ALM
ANY	✓	✓	✓	✓
LOWs			✓	✓
HIGHs	✓	✓		
LEVEL1		✓	✓	
LEVEL2	✓			✓
LO_LO				✓
LO			✓	
HI		✓		
HI_HI	✓			
NONE				

For example, if LOWs is selected for OUT_ALM_SUM, and LO_ALM or LO_LO_ALM is *true*, OUT_ALM will be set to *true*. If LEVEL1 is selected for OUT_ALM_SUM, and LO_ALM or HI_ALM is *true*, OUT_ALM will be set to *true*.

The OUT_ALM parameter can be used to control a lock signal, for example, besides monitoring the alarm.

Simple alarm calculation: static alarm limits, with no expansion and no delay for detection

The alarm limits will be static (HI_HI_LIM, HI_LIM, LO_LIM and LO_LO_LIM are the effective operation alarm limits) if the corresponding gain or bias is +/- INF, or the input PSP is disconnected and configured with the status Bad – O/S.

The alarm limit expansion will be disabled by setting ALM_RATE_DN and ALM_RATE_UP to zero.

There will be no delay to detect an alarm by setting IGNORE_TIME to zero.

BLOCK_ERR
The BLOCK_ERR of the Analog Alarm block will indicate the following cause:
Out of Service – When the block is in O/S mode.

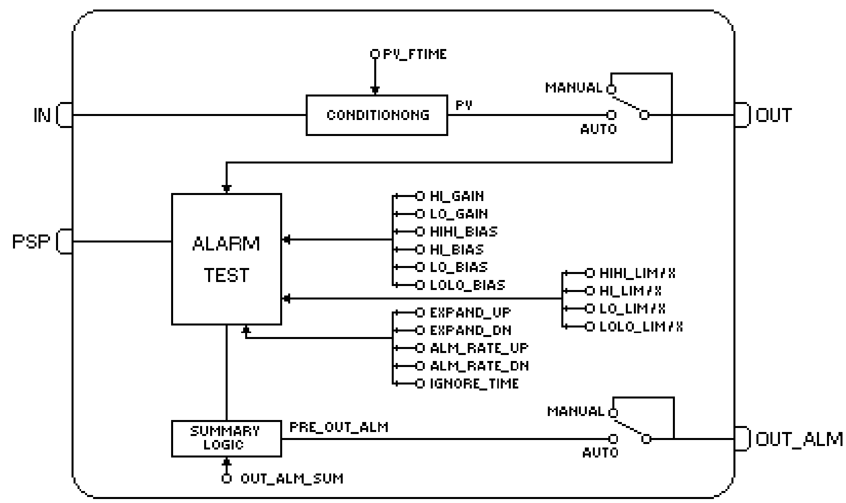
Supported Modes
O/S, MAN and AUTO.

Status
The block will not filter an IN value with a bad status or uncertain status (the option "Use Uncertain" in STATUS_OPTS is not configured), it will filter the last proper value of PV and indicate the improper status of IN instead. When the IN status returns to a proper value (good or uncertain, and the option "Use Uncertain" in STATUS_OPTS is configured), the PV value will be filtered again for the value of IN, with the IN status.
The OUT status is configured with the status of PV (and IN), when in auto mode.

If the worst status quality of PV and PSP is bad, or uncertain (and the option "Use Uncertain" in STATUS_OPTS is not configured), the alarm test will not be performed and the status of PRE_OUT_ALM will be set to bad (non-specific). Otherwise, the alarm test will be performed and the status quality of PRE_OUT_ALM will be set to the worst status quality of PV and PSP (good or uncertain). While the alarm condition is not being evaluated because of improper status, the existing alarms will not be cleared and new alarms will not be generated. Alarms from the previous conditions can be acknowledged.

In auto mode, the status of OUT_ALM will be configured with the status of PRE_OUT_ALM. In man mode, the limit status of OUT_ALM is set to double-limited.

Schematic



Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3(A2) (CL)	STRATEGY	Unsigned16		0	None	S	
4(A2) (CL)	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5(A2) (CL)	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	PV	DS-65			PV	D / RO	Process analog value. This is the IN value after passing through the PV filter.
8	**OUT**	DS-65	OUT_SCALE +/- 10%		OUT	N / Man	The output value resulting from the block calculation.
9	OUT_SCALE	DS-68		0-100%	OUT	S / Man	The high and low scale values for the OUT parameter.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
10	GRANT_DENY	DS-70		0	na	D	Options for controlling the access to the host computer and local control panels to the operation, tune and alarm parameters of the block.
11 (A2)	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
12 (A2)	PV_FTIME	Float	Non-Negative	0	Sec	S	Time constant of a single exponential filter for the PV, in seconds.
13	**IN**	DS-65			PV	D	The primary input value of the block, or PV value.
14	PSP	DS-65			OUT	D	This is the process setpoint, that can be used to determine the alarm limit.
15 (A2)	HI_GAIN	Float		1.1		S	This gain multiplies PSP before adding the bias to HI_LIM and HI_HI_LIM.
16 (A2)	LO_GAIN	Float		0.9	Na	S	This gain multiplies PSP before subtracting the bias from LO_LIM and LO_LO_LIM.
17 (A2)	HI_HI_BIAS	Float	Positive	1.0	Out	S	This bias is added to PSP*HI_GAIN to determine HI_HI_LIM.
18 (A2)	HI_BIAS	Float	Positive	0.0	Out	S	This bias is added to PSP*HI_GAIN to determine HI_LIM.
19 (A2)	LO_BIAS	Float	Positive	0.0	Out	S	This bias is subtracted from PSP*LO_GAIN to determine LO_LIM.
20 (A2)	LO_LO_BIAS	Float	Positive	1.0	Out	S	This bias is subtracted from PSP*LO_GAIN to determine LO_LO_LIM.
21	PRE_OUT_ALM	DS-66			E	D	This parameter is the alarm summary variable of the analog alarm block.
22 (A2)	**OUT_ALM**	DS-66			E	D	This parameter is the alarm summary variable of the analog alarm block when in *Auto* mode, and it is the value specified by the operator/engineer in *Man* mode.
23(A2) (CL)	**OUT_ALM_SUM**	Unsigned8	0:NONE 1:LO_LO 2:LO 3:LOWs 4:HI 6:LEVEL1 8:HI_HI 9:LEVEL2 12:HIGHs 15:ANY	0	E	S	Specifies the alarms conditions that must be *true* to configure OUT_ALM with *true*: ANY, LOWs, HIGHs, LEVEL1, LEVEL2, LO_LO, LO, HI, or HI_HI.
24 (A2)	ALM_RATE_UP	Float	Positive	0.0	OUT/sec	S	Decreasing rate (ascendent) after the alarm expansion for the lower limit caused by PSP changes . It is indicated in engineering units per second. The Lower Llimit Expansion feature will be disabled if this parameter is set to zero. (Positive)
25 (A2)	ALM_RATE_DN	Float	Positive	0.0	OUT/sec	S	Decreasing rate (descendent) after the alarm expansion for the upper limit caused by PSP changes. It is indicated in engineering units per second. The Upper Limit Expansion feature will be disabled if this parameter is set to zero. (Positive)
26	EXPAND_UP	Float			OUT	D	Value, in engineering units, to expand the HI and HI_HI limits after changing the setpoint. Dynamically calculated by the block. It is initially expanded by the value of a setpoint change and decreased by the rate of ALM_RATE_UP. (Positive)

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
27	EXPAND_DN	Float			OUT	D	Value, in engineering units, to expand the LO and LO_LO limits after changing the setpoint. Dynamically calculated by the block. It is initially expanded by the value of a setpoint change and decreased by the rate of ALM_RATE_DN. (Positive)
28 (A2)	IGNORE_TIME	Float	Positive	0.0	Sec	S	The time interval, in seconds, to ignore the existence of a new alarm condition. There is no delay to acknowledge the alarm and return to normal operation. If the alarm doesn't persist for IGNORE_TIME seconds, it will not be reported. It is not applied to self-clearing (transient) alarms.
29	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
30	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.
31 (A2)	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged status, unreported status, and disabled status of the alarms associated to the function block.
32	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Select the alarms associated to the block that will be automatically acknowledged.
33(A2) (CL)	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm, the value that the PV must return within the alarm limit plus the hysteresis.
34	HI_HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high high alarm.
35(A2) (CL)	**HI_HI_LIM**	Float	OUT_SCALE, +INF	+INF	PV	S	Settings for the high high alarm, in engineering units.
36	HI_HI_LIMX	Float	OUT_SCALE, +INF	+INF	PV	S	Setting for the high high alarm, in engineering units.
37	HI_PRI	Unsigned8	0 to 15	0		S	Priority of the high alarm.
38(A2) (CL)	**HI_LIM**	Float	OUT_SCALE, +INF	+INF	PV	S	Settings for the high alarm, in engineering units.
39	HI_LIMX	Float	OUT_SCALE, +INF	+INF	PV	S	Settings for the high alarm, in engineering units.
40	LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low alarm.
41(A2) (CL)	**LO_LIM**	Float	OUT_SCALE, -INF	-INF	PV	S	Settings for the low alarm, in engineering units.
42	LO_LIMX	Float	OUT_SCALE, -INF	-INF	PV	S	Settings for the low alarm, in engineering units.
43	LO_LO_PRI	Unsigned8	0 to 15	0		S	Priority of the low alarm.
44(A2) (CL)	**LO_LO_LIM**	Float	OUT_SCALE, -INF	-INF	PV	S	Settings for the low alarm, in engineering units.
45	LO_LO_LIMX	Float	OUT_SCALE, -INF	-INF	PV	S	Settings for the low alarm, in engineering units.
46	HI_HI_ALM	DS-71			PV	D	Status and associated time stamp for the high alarm.
47	HI_ALM	DS-71			PV	D	Status and associated time stamp for the high alarm.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
48	LO_ALM	DS-71			PV	D	Status and associated time stamp for the low alarm.
49	LO_LO_ALM	DS-71			PV	D	Status and associated time stamp for the low low alarm.

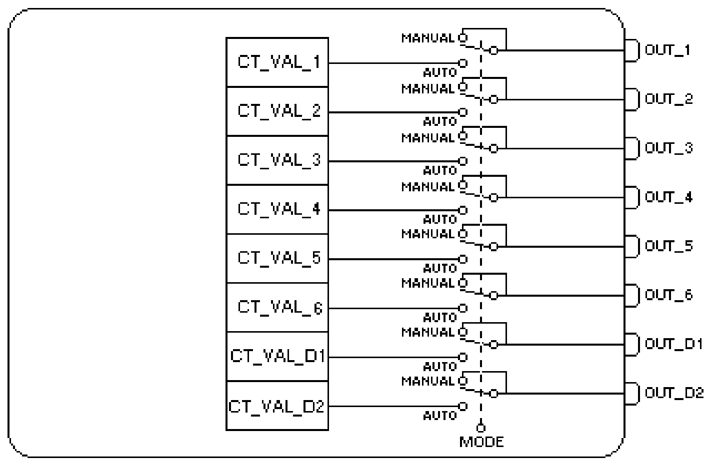
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4
Gray Background Line: Custom Parameters

If the BEHAVIOR parameter is configured as "Adapted":
The required mode for writing is the actual mode, regardless of the target mode : OUT

CT – Constant

Overview
The Constant function block generates constant values to be used by the inputs parameters of other blocks.

Schematic



Description
The Constant function block has 6 analog constants and 2 discrete constants to be connected to any other blocks.

If the mode is Man, all output values can be manually replaced. In Auto mode, the output values will be the respective constant values.

Supported modes
O/S, MAN, AUTO.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3 (A2)	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A2)	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D	
7 (A2)	OUT_1	DS-65				N / Man	Output 1.
8 (A2)	OUT_2	DS-65				D / Man	Output 2.
9 (A2)	OUT_3	DS-65				D / Man	Output 3.
10 (A2)	OUT_4	DS-65				D / Man	Output 4.
11 (A2)	OUT_5	DS-65				D / Man	Output 5.
12 (A2)	OUT_6	DS-65				D / Man	Output 6.
13 (A2)	OUT_D1	DS-66				N / Man	Discrete output 1.
14 (A2)	OUT_D2	DS-66				D / Man	Discrete output 2.
15 (A2)	**CT_VAL_1**	Float		0		S	Value of the Analog constant transferred to the output OUT_1.
16 (A2)	**CT_VAL_2**	Float		0		S	Value of the Analog constant transferred to the output OUT_2.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
17 (A2)	**CT_VAL_3**	Float		0		S	Value of the Analog constant transferred to the output OUT_3.
18 (A2)	**CT_VAL_4**	Float		0		S	Value of the Analog constant transferred to the output OUT_4.
19 (A2)	**CT_VAL_5**	Float		0		S	Value of the Analog constant transferred to the output OUT_5.
20 (A2)	**CT_VAL_6**	Float		0		S	Value of the Analog constant transferred to the output OUT_6.
21 (A2)	**CT_VAL_D1**	Unsigned8		0		S	Value of the Discrete constant transferred to the output OUT_D1.
22 (A2)	**CT_VAL_D2**	Unsigned8		0		S	Value of the Discrete constant transferred to the output OUT_D2.
23	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
24	BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

If the BEHAVIOR parameter is configured as “Adapted”:
The required mode for writing is the actual mode, regardless of the target mode: OUT_1, OUT_2, OUT_3, OUT_4, OUT_5, OUT_6, OUT_D1 and OUT_D2.

ARTH – Arithmetic

Description

The ARTH block was implemented to calculate measurements from combinations of the signals from the sensors. It is not to be used in the control, and for that reason it does not support the cascade mode or the back calculation mode. It doesn't convert values to percentage, or scales. It doesn't have process alarms.

The block has 5 inputs. The first two inputs are dedicated to a range extension function that results in a PV, with status reflecting the input being used. The other three inputs are combined with the PV to select four functions of terms that can be used is several measurements. The inputs that compose the PV must be read from the devices in the desired engineering units, so that the PV has the correct unit in the equation. Each one of the additional inputs has a constant bias and gain. The bias can be used to correct the absolute temperature or pressure. The gain can be used to normalize terms in the square root function. The output has also a constant gain and bias for any further required adjustment.

The function for the range extension function has a graduated transfer, controlled by two constants related to IN. An internal value, g, will be zero if the value of IN is lesser than RANGE_LO. It will be one if the value of IN is greater than RANGE_HI. It is interpolated from zero to one using the range of RANGE_LO to RANGE_HI.

The equation of the PV is:

$$PV = g * IN + (1 - g) * IN\_LO$$

if :

IN < RANGE_LO or

IN_LO < RANGE_HI and the status of IN is unusable and the status of IN_LO is usable:

g = 0

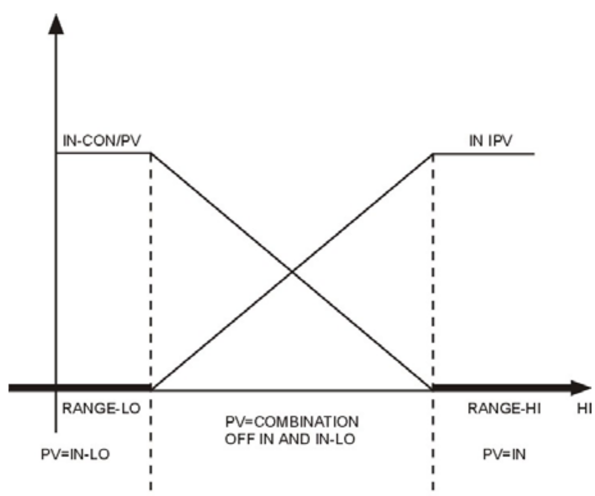
IN > RANGE_HI or

IN > RANGE_LO and the status of IN is usable and the status of IN_LO is unusable:

g = 1

RANGE_LO ≤ IN ≤ RANGE_HI:

$$g = \frac{IN - RANGE\_LO}{RANGE\_HI - RANGE\_LO}$$



If the status of IN_LO is unusable and IN is usable and greater than RANGE_LO, then g will be set to one (1). If the status of IN is unusable, and IN_LO is usable and lesser than RANGE_HI, then g will be set to zero (0). For each case, the PV will have the status Good until the condition is no longer valid. Otherwise, the status of IN_LO will be used for the PV, if g is lesser than 0.5, while IN is used when g is greater than or equal to 0.5.

Six constants are used for the three auxiliary inputs. Each constant has a BIAS_IN_i and a GAIN_IN_i. The output has a static constant BIAS and GAIN. For the inputs, the bias is added and the gain is applied to the sum. The result is an internal value called t_i in the equations.
t_i = (IN_i + BIAS_IN_i) ∗ GAIN_IN_i

The limits of the function for the flow compensation is the value of the compensation applied to the PV, to guarantee the degradation if an auxiliary input is unstable.

The following equations have a compensation factor limited by COMP_HI_LIM and COMP_LO_LIM:

- flow compensation, linear
- flow compensation, square root
- flow compensation, approximate
- BTU flow
- Traditional multiple division

Arithmetic exceptions :
a) Division by zero will result a value equals to OUT_HI_LIM or OUT_LO_LIM, depending on the sign of PV.
b) Roots of negative numbers will result the root of the absolute value, with the negative sign.

Although the output is not scaled, it has absolute high and low limits, to keep reasonable values.

Minimum Configuration
RANGE_HI and RANGE_LO: If the function for the range extension is not used, these two parameters must be set to INF. Therefore, the value of the PV will be a copy of IN.

If the ARITH_TYPE is one of the first five equations, the COMP_HI_LIM and COMP_LO_LIM parameters must be set properly. The default value of the COMP_HI_LIM parameter is zero.
Since the default value of the GAIN parameter is zero, it is necessary to set a proper value.

BLOCK_ERR
The BLOCK_ERR of the Arithmetic block will indicate the following causes:

- Block Configuration Error – the configuration error occurs when the ARITH_TYPE has an invalid value.
- Out of Service – When the block is in O/S mode.

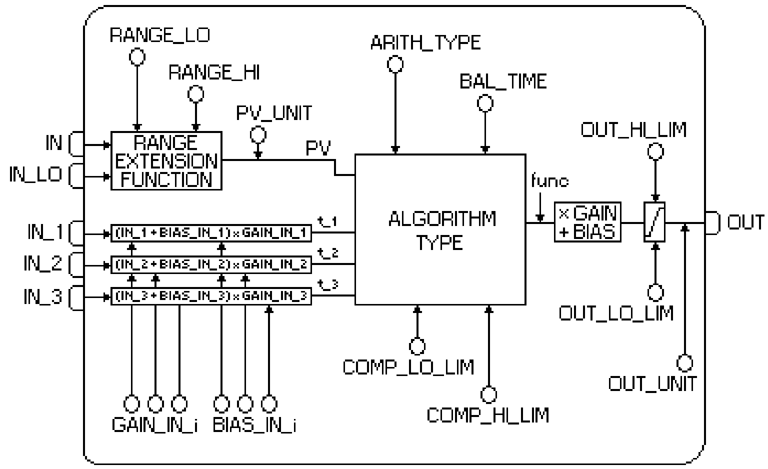
Supported Modes
O/S, MAN and AUTO.

Status
The status of PV depends on the factor “g”, if it is less than 0.5, then the status of IN_LO will be used; otherwise, the status of IN will be used.

The INPUT_OPTS parameter can use auxiliary inputs with status lower than good. The status of the unused inputs is ignored.

The status of the output will be the same from the PV, except when the status of the PV is good and the status of an used auxiliary input is not good, and INPUT_OPTS is not configured to use the PV. In this case, the status of OUT will be Uncertain.

Schematic



Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3 (A2)	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A2)	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**PV**	DS-65			PV	D / RO	Process analog value used when executing the function.
8 (A2)	**OUT**	DS-65	OUT_SCALE +/- 10%		OUT	D / Man	The analog value resulting from the function execution.
9	PRE_OUT	DS-65			OUT	D / RO	Displays the probable OUT value and status if the mode was Auto or lower.
10	PV_UNITS	Unsigned16		0	PV	S	The engineering units index for the display. See the Arithmetic block.
11	OUT_UNITS	Unsigned16		0	OUT	S	The engineering units of the output for the display.
12	GRANT_DENY	DS-70		0	na	D	Options for controlling the access to the host computer and local control panels to the operation, tune and alarm parameters of the block.
13 (A2)	INPUT_OPTS	Bitstring(2)		0	na	S / O/S	Bitstring option for handling the status of the auxiliary inputs.
14 (A2)	**IN**	DS-65			PV	D	The primary input of the block
15 (A2)	IN_LO	DS-65			PV	D	Input for the low range transmitter, in a range extension application.
16 (A2)	IN_1	DS-65			None	D	Input 1.
17 (A2)	IN_2	DS-65			None	D	Input 2.
18 (A2)	IN_3	DS-65			None	D	Input 3.
19 (A2)	**RANGE_HI**	Float		0	PV	S	Higher constant value that switches the range extension to the high range transmitter.
20 (A2)	**RANGE_LO**	Float		0	PV	S	Lower constant value that switches the range extension to the low range transmitter.
21 (A2)	BIAS_IN_1	Float		0	None	S	The constant added to IN_1.
22 (A2)	GAIN_IN_1	Float		0	None	S	The constant multiplied by (IN_1 + bias).
23 (A2)	BIAS_IN_2	Float		0	None	S	The constant added to IN_2.
24 (A2)	GAIN_IN_2	Float		0	None	S	The constant multiplied by (IN_2 + bias).
25 (A2)	BIAS_IN_3	Float			None	S	The constant added to IN_3.
26 (A2)	GAIN_IN_3	Float		0	None	S	The constant multiplied by (IN_3 + bias).
27 (A2)	COMP_HI_LIM	Float		0	None	S	The high limit imposed on the PV compensation term.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
28 (A2)	COMP_LO_LIM	Float		0	None	S	The low limit imposed on the PV compensation term.
29 (A2)	**ARITH_TYPE**	Unsigned8	1= Flow comp. linear 2= Flow comp. square root 3= Flow comp. approx. 4= BTU flow 5= Traditional mult. div. 6= Average 7= Traditional summing 8= 4th order polynomial 9= HTG comp. level	0	E	S	The identification number of the arithmetic algorithm.
30 (A2)	BAL_TIME	Float	Positive	0	Sec	S	This parameter specifies the time interval, in seconds, for the internal operation value of the bias or ratio to be returned for the operator to set the bias or ratio. In the PID block, it can be used to specify the time constant for the integral term to be moved, to obtain the balance when the output is limited and the mode is Auto, Cas, or RCas.
31 (A2)	BIAS	Float		0	OUT	S	The bias value used to compute the function block output, in engineering units.
32 (A2)	**GAIN**	Float		0	None	S	Undimensional value used by the block algorithm to calculate the block output.
33 (A2)	OUT_HI_LIM	Float		100	OUT	S	Limits the maximum output value.
34 (A2)	OUT_LO_LIM	Float		0	OUT	S	Limits the minimum output value.
35	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
36	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

If the BEHAVIOR parameter is configured as “Adapted”:
The default value of ARITH_TYPE is the Gas flow compensation for linear transmitters, equation type 1.
The required mode for writing is the actual mode, regardless of the target mode : OUT

Equation Types

ARITH_ TYPE	Equation
1 Flow comp. Linear	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\frac{T1}{T2}\right]$ is limited
2 Flow comp. Square root	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\sqrt{\frac{T1}{T2 * T3}}\right]$ is limited
3 Flow comp. Approx.	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\sqrt{T1 * T2 * T3^2}\right]$ is limited
4 BTU flow	$OUT = PV * f * GAIN + BIAS$ where $f = [T1 - T2]$ is limited
5 Traditional mult. div.	$OUT = PV * f * GAIN + BIAS$ where $f = \left[\frac{T1}{T2} + T3\right]$ is limited
6 Average	$OUT = \frac{PV + T1 + T2 + T3}{f} * GAIN + BIAS$ Where f is the number of inputs used in the calculation (unusable inputs are not used).
7 Traditional summing	$OUT = (PV + T1 + T2 + T3) * GAIN + BIAS$
8 4th order polynomial	$OUT = (PV + T1^2 + T2^3 + T3^4) * GAIN + BIAS$
9 HTG comp. Level	$OUT = \frac{PV - T1}{PV - T2} * GAIN + BIAS$

Examples

ARITH_ TYPE	Example	Example equation	Note
1	Gas flow compensation for linear transmitters (e.g. turbine)	$Q_b = Q_f * K * \frac{P}{T}$	
2	Gas flow compensation for DP transmitters.	$Q_b = Q_f * K * \sqrt{\frac{P}{T * Z}}$	Z may be a constant or an input from other block (AGA3)
3	Approx. liquid & steam flow comp.	$Q_b = Q_f * K * \sqrt{(K + K * T + K * T^2)}$ $Q_b = Q_f * K * \sqrt{(K + K * P)}$	Temperature connected to 3 and 4
4	BTU meter (heat flow)	$Q_{HEAT} = K * Q_{VOL} * (t_1 - t_2)$	
5	Simple “hard” (non-cascade) ratio	$Q_{SP} = Q_{WILD} * RATIO$	Output is the setpoint for the PID block
6	Average of four temperature measurements	$t_a = \frac{t_1 + t_2 + t_3 + t_4}{f}$	.
7	Pressure (or level) difference	$P_{bm} = P_b - P_m$	
9	Simple HTG compensated level	$h_{BT} = \frac{P_B - P_T}{P_B - P_M} * h_{BM}$	

NOTE: The square root of the third power can be calculated by selecting ARITH_TYPE = 3 and connecting the input to IN and IN_1. The square root of the fifth power can be calculated by connecting the input to IN, IN_1 and IN_3.

TIME – Timer and Logic

Description
The Timer and Logic function block provides logic combination and timing functions, including:

- Combined multiple inputs such as OR, AND, vote, or EXACT counter;
- Measuring the duration of the combined discrete input signal;
- Accumulating, until reset, the duration of the combined input signal;
- Counting the changes of the combined discrete input signal;
- Adjusting the discrete output, if the duration of the combined input signal exceeds a limit;
- Extend, Delay, Pulse, or Oscillate the combined input as an output;
- Providing outputs that indicate the elapsed time and the time remaining;
- Selectively invert any discrete input or output connected;
- Timer Reset.

Up to four inputs may be combined logically (AND, OR), voted (any 2 or more true inputs, any 3 or more true inputs), or counted (exactly 1 true input, exactly 2 true inputs, exactly 3 true inputs, odd count, or even count). The combined input value is specified by the list of combination types (COMB_TYPE). The options are indicated in the table below.

Connected inputs can be true, false, or undefined. Undefined connected inputs are interpreted as bad status (out-of-service). Unconnectedinputs can be true, false, or undefined. Undefined unconnected inputs (operator) are ignored.

COMB_TYPE	PV_D value
OR	true if one or more inputs are true
ANY2	true if two or more inputs are true
ANY3	true if three or more inputs are true
AND	true if all inputs are true
EXACTLY1	true if exactly 1 input is true
EXACTLY2	true if exactly 2 inputs are true
EXACTLY3	true if exactly 3 inputs are true
EVEN	true if exactly 0, 2 or 4 inputs are true
ODD	true if exactly 1 or 3 inputs are true

Timer Processing

The processing type of the timer is specified by TIMER_TYPE. It will result the measurement, delay, extension, pulse (non-retriggerable or retriggerable) orthe oscillation of the combined input signal.

TIMER_SP is the specification for the time interval of the delay, extension, pulse, oscillation filter or comparison limit. The parameter can be configured as a constant by the operator or connected as an input, determined by another block. In any case, the block will be checked on each execution to verify the interval of the current delay, extension, pulse, oscillation, or to compare the time exceeding the current TIMER_SP.

OUT_D parameter will assume the PRE_OUT_D value when the block is in Auto mode.

OUT_EXP indicates the time expired in the measurement, comparison, delay, extension, oscillation, or pulse. Refer to the TIMER_TYPE for details.

OUT_REM indicates the time remaining in the comparison, delay, extension, oscillation, or pulse. Refer to the TIMER_TYPE for details.

QUIES_OPT allows the configurator to select the behavior of OUT_EXP and OUT_REM when the timer is quiescent, that is, it is not temporized and it is not in a triggered condition. The following table shows the definition of the quiescent state for each TIMER_TYPE option:

Definition for the beginning and end of the quiescent state as a function of the TIMER_TYPE		
TIMER_TYPE	The Quiescence state **starts** when the combined input (PV_D):	The Quiescence state **ends** when the combined input (PV_D):
MEASURE	returns to false	changes from false to true
ACCUM	[QUIES_OPT does not apply]	[QUIES_OPT does not apply]
COMPARE	returns to false	changes from false to true
DELAY	returns to false	changes from false to true
EXTEND	returns to true	changes from true to false
DEBOUNCE	has changed and the timer has expired	changes
PULSE	has returned to false and the timer has expired	changes from false to true
RT_PULSE	has returned to false and the timer has expired	changes from false to true

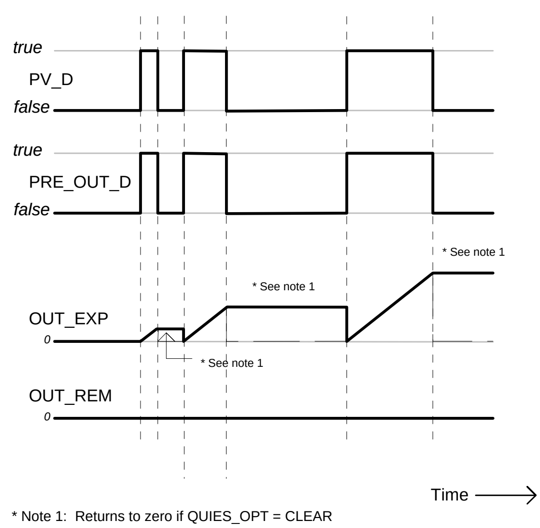
The option CLEAR of QUIES_OPT will cause both OUT_EXP and OUT_REM to be set to zero during quiescence. The option LAST of QUIES_OPT will cause both OUT_EXP and OUT_REM to keep their values when the block becomes quiescent. That is, the time expired and time remaining will be available until the quiescence ends when the next activation is started. Note that a false-to-true transition on RESET_IN will also reset OUT_EXP and OUT_REM.

N_START counts the number of false-to-true transitions of the combined input, PV_D, since the last false-to-true transition was indicated on RESET_IN.

The TIMER_TYPE, operating according to the combined input signal, can indicate:

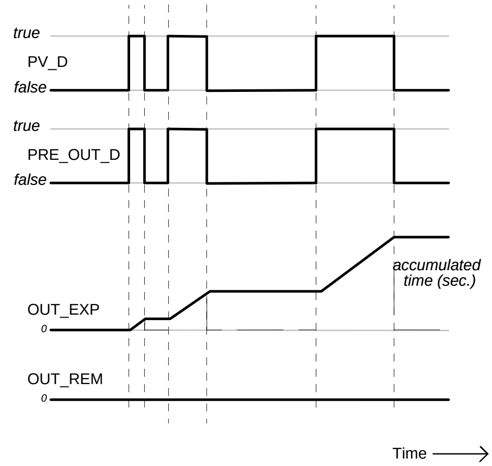
- MEASURE Indicates the duration of the most recent true signal
- ACCUM Accumulates the duration of a true signal
- COMPARE Compares the duration of a true signal with a specified duration
- DELAY Delays a false-to-true transition, eliminating it if it is short
- EXTEND Extends a true-to-false transition, eliminating it if it is short
- DEBOUNCE Delays any transition, eliminating it if it is short
- PULSE Generates a true pulse on a false-to-true transition, non-retriggerable
- RT_PULSE Generates a true pulse on a false-to-true transition, retriggerable

- If TIMER_TYPE is **MEASURE**, PRE_OUT_D will be the same as the combined input, PV_D. OUT_EXP indicates the time interval, in seconds, that the combined signal is true. OUT_REM is set to 0.



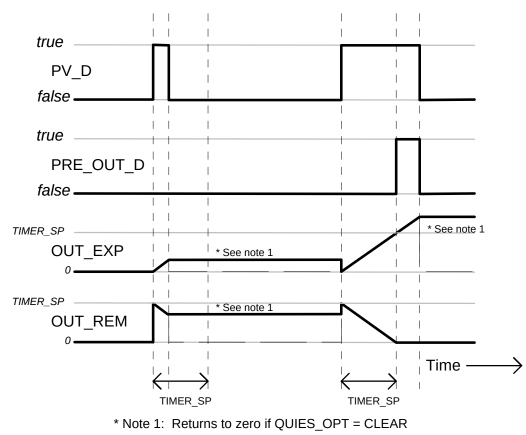
Timer Example when TIMER_TYPE = MEASURE

- If TIMER_TYPE is **ACCUM**, PRE_OUT_D will be the same as the combined input, PV_D. OUT_EXP indicates the accumulated time interval, in seconds, that the combined signal was true. Unlike TIMER_TYPE = MEAS, it will not be automatically reset by the occurrence of a false-to-true transition of PV_D. Instead, it will continue to accumulate the "on" time or "run" time until being reset to 0 by a false-to-true transition on RESET_IN. OUT_REM is unused (set to 0.0) for this type of timer.



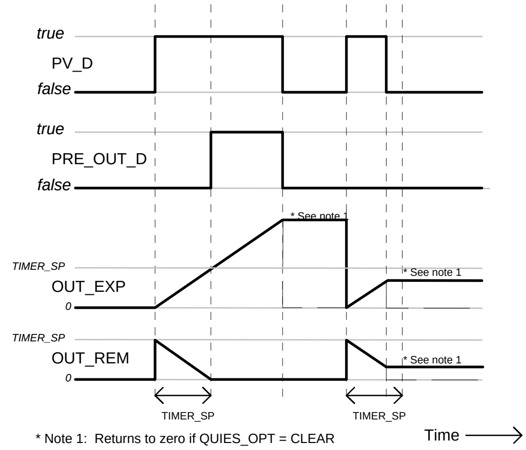
Timer Example when TIMER_TYPE = ACCUM

- If TIMER_TYPE is **COMPARE**, the block will measure the time since a false-to-true transition on the combined input, PV_D. The current duration will be indicated by OUT_EXP. OUT_REM will indicate the time remaining between the current expired duration, OUT_EXP, and the current limit, TIMER_SP. If OUT_EXP does not exceed TIMER_SP, PRE_OUT_D will be set to false. If OUT_EXP is equal to or exceeds TIMER_SP, PRE_OUT_D will be set to true and OUT_REM will be set to zero. When the combined input returns to false, whether exceeding the limits specified by TIMER_SP or not, OUT_D will be set to false. [Note that this type of behavior is the same as TIMER_TYPE = DELAY. The difference is only in the application perspective].



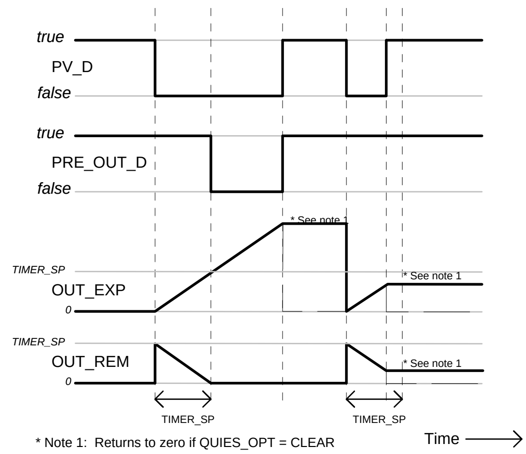
Timer Example when TIMER_TYPE = COMPARE

- If TIMER_TYPE is **DELAY**, a false-to-true transition on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the time interval specified by TIMER_SP expires. If the combined input returns to false before the time expires, the output will remain as false, hiding the input transitions. If the PRE_OUT_D output is set to true because the time has expired, a true-to-false transition in the combined input will be indicated in PRE_OUT_D immediately. [Note that this type of behavior is the same as TIMER_TYPE = COMPARE. The difference is only in the application perspective].



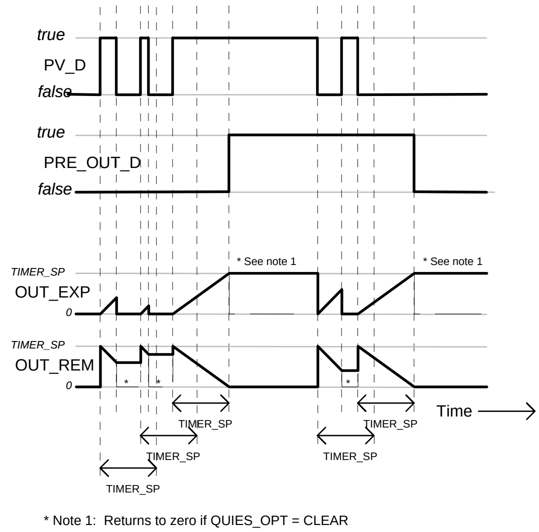
Timer Example when TIMER_TYPE = DELAY

- If TIMER_TYPE is **EXTEND**, a true-to-false transition on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the time interval specified by TIMER_SP expires. If the combined input returns to true before the time expires, the output will remain as true, hiding the input transitions. If the PRE_OUT_D output is set to false because the time has expired, a false-to-true transition in the combined input will be indicated in PRE_OUT_D immediately.



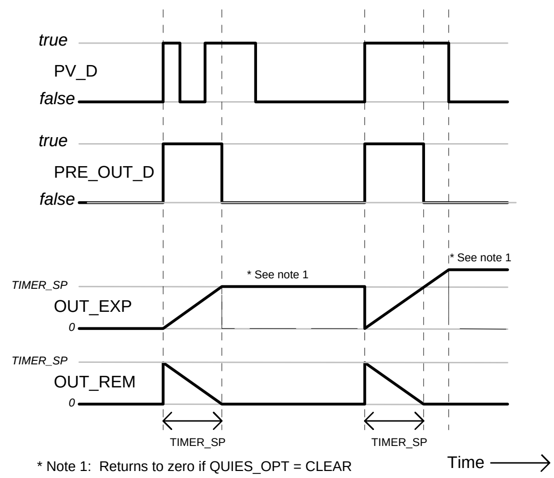
Timer Example when TIMER_TYPE = EXTEND

- If TIMER_TYPE is **DEBOUNCE**, and PRE_OUT_D is false, a false-to-true transition on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the time interval specified by TIMER_SP expires. If the combined input returns to false before the time expires, the output will remain as false, hiding the input transitions. If PRE_OUT_D is true, a true-to-false transition on the combined input, PV_D, will be delayed at the output, PRE_OUT_D, until the time interval specified by TIMER_SP expires. If the combined input returns to true before the time expires, the output will remain as true, hiding the input transitions. in these cases, the true initializations will be delayed and the true endings will be extended, acting as a filter for intermittent state changes.



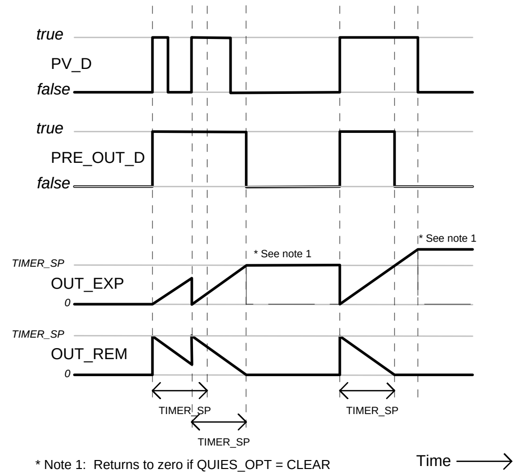
Timer Example when TIMER_TYPE = DEBOUNCE

- If TIMER_TYPE is **PULSE**, a false-to-true transition on the combined input, PV_D, will initiate a true pulse at PRE_OUT_D, and the duration is determined by the TIMER_SP value. At the end of the time interval, the output will return to false. Further false-to-true transitions of the combined input, while PRE_OUT_D is true, will be ignored.



Timer Example when TIMER_TYPE = PULSE

- If TIMER_TYPE is **RT_PULSE**, (Retriggerable pulse type) a false-to-true transition on the combined input, PV_D, will initiate a true pulse at PRE_OUT_D, and the duration is determined by the TIMER_SP value. At the end of this time interval, PRE_OUT_D will return to false. If the combined input returns to false and indicates a subsequent false-to-true transition while the timer is counted, the timer will be re-initialized and PRE_OUT_D will continue to be true.



Timer Example when TIMER_TYPE = RT_PULSE

RESET_IN is a discrete input that resets the timer on a false-to-true transition. OUT_EXP is set to 0.0, and then the timer executes the process described in "Initial Value Handling" for the values of PRE_OUT_D and OUT_REM. If RESET_IN is not connected, an operator/engineer can set it to true. In this case, the block logic will reset it to false on the next execution.

TIME_UNITS allows the user to specify the time units for the HMI where TIMER_SP, OUT_EXP and OUT_REM are displayed.
Each bit in INVERT_OPTS, when set, indicates that the corresponding input or output parameter with discrete status is inverted. That is, input values are inverted before being used by the block and outputs are inverted after the value is determined by the block.

BLOCK_ERR
The BLOCK_ERR of the TIME block will indicate the following causes:

- Block Configuration Error – the configuration error occurs when the TIME_UNITS or QUIES_OPT parameters have an invalid value;
- Out of Service –when the block is in O/S mode.

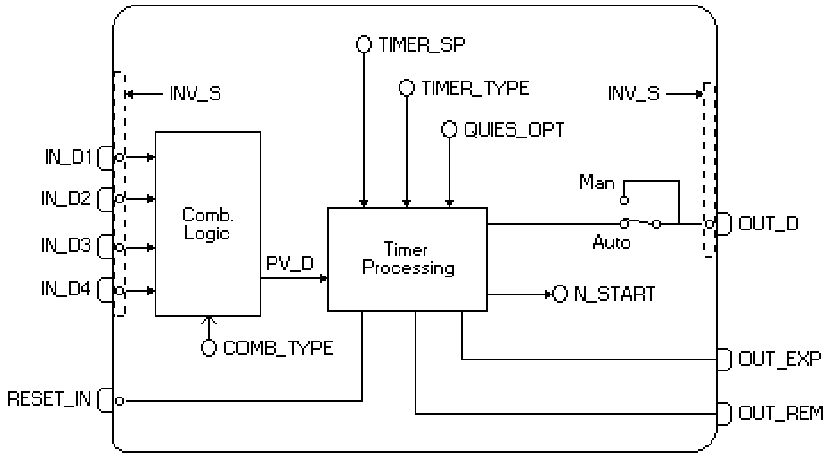
Inicialization
The following table summarizes the values of PRE_OUT_D, OUT_EXP and OUT_REM after the initial execution, as a function of TIMER_TYPE and the initial value of the combined input, PV_D:

TIMER_TYPE	PV_D	PRE_OUT_D	OUT_EXP	OUT_REM	Timer Status
MEASURE	False	False	0.0	0.0	Inactive
MEASURE	True	True	0.0	0.0	Inactive
ACCUM	False	False	0.0	0.0	Inactive
ACCUM	True	True	0.0	0.0	Inactive
COMPARE	False	False	TIMER_SP †	0.0	Inactive
COMPARE	True	False	0.0	TIMER_SP †	Active
DELAY	False	False	TIMER_SP †	0.0	Inactive
DELAY	True	False	0.0	TIMER_SP †	Active
EXTEND	False	True	0.0	TIMER_SP †	Active
EXTEND	True	True	TIMER_SP †	0.0	Inactive
DEBOUNCE	False	False	TIMER_SP †	0.0	Inactive
DEBOUNCE	True	True	TIMER_SP †	0.0	Inactive
PULSE	False	False	0.0	0.0	Inactive
PULSE	True	False	TIMER_SP †	0.0	Inactive
RT_PULSE	False	False	0.0	0.0	Inactive
RT_PULSE	True	False	TIMER_SP †	0.0	Inactive

† Initialize the TIMER_SP value if QUIES_OPT = LAST, initialize with 0.0 if QUIES_OPT = CLEAR.

Supported Modes
O/S, MAN and AUTO.

Schematic



Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D	This is the timer interval used by the timer block for delay, extension, oscillation, and pulse time-processing.
7	**PV_D**	DS-66				D	The primary discrete value being used to execute the function, or a process value associated to it.
8	**OUT_D**	DS-66				D	The primary discrete value calculated as a result of the function execution.
9	TIMER_SP	Float	Positive	0	Sec	S	
10	PV_STATE	Unsigned16		0		S	Index of the text that describe the status of a discrete PV.
11	OUT_STATE	Unsigned16		0		S	Index of the text that describe the status of a discrete output.
12	GRANT_DENY	DS-70		0	Na	D	Options for controlling the access of the host computer and local control panels tothe operation , tune and alarm parameters of the block.
13	**INVERT_OPTS**	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
14	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
15	**IN_D1**	DS-66				D	Discrete input 1.
16	**IN_D2**	DS-66				D	Discrete input 2.
17	**IN_D3**	DS-66				D	Discrete input 3.
18	**IN_D4**	DS-66				D	Discrete input 4.
19	**COMB_TYPE**	Unsigned8	0=AND 1=OR 2=ANY2 3=ANY3 21=EXACTLY1 22=EXACTLY2 23=EXACTLY3 40=EVEN 41=ODD	1	E	S	Determine how the multiple values of IN_D[i] are combined.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
20	**TIMER_TYPE**	Unsigned8	0=MEASURE 1=ACCUM 2=COMPARE 3=DELAY 4=EXTEND 5=DEBOUNCE 6=PULSE 7=RT_PULSE	0	E	S	Type of the time-processing applied to PV_D to determine the PRE_OUT_D.
21	PRE_OUT_D	DS-66				D	This parameter is the combined output and the time processed by the timer block.
22	N_START	Unsigned16			None	D	Counts *false*-to-*true* transitions in the combined input, PV_D. Reset by the *false*-to-*true* transition of RESET_IN.
23	OUT_EXP	DS-65			Sec	N / RO	This is the time expired. Stops when TIMER_SP is reached. Reset to zero (1) by RESET_IN, (2) in the next timer event if QUIES_OPT = LAST, or (3) when the block becomes quiescent if QUIES_OPT = CLEAR.
24	OUT_REM	DS-65			Sec	N / RO	This is the time remaining if the timer is active. Stops when event ends (block becomes quiescent). Reset to 0.0 if QUIES_OPT = CLEAR, and the timer is inactive.
25	RESET_IN	DS-66	0=Off 1=Reset				Resets the timer.
26	QUIES_OPT	Unsigned8	1=CLEAR 2=LAST	0	E	S / O/S	Mode of OUT_EXP and OUT_REM during quiescence. CLEAR resets the parameters to zero. LAST keeps the last values of the parameters.
27	TIME_UNITS	Unsigned8	1=seconds 2=minutes 3=hours 4=days 5=[day-[hr:[min[:sec]]]]	0	E	S	Displays the Time Units for TIMER_SP, OUT_EXP, and OUT_REM:
28	UPDATE_EVT	DS-73			na	D	This alert is generated by any changes to the static data.
29	BLOCK_ALM	DS-72			na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

If the BEHAVIOR parameter is configured as “Adapted”:
The default value of TIME_UNITS is “Seconds”.
The default value of QUIES_OPT is “CLEAR”.

MBCF – Modbus Configuration

Overview

This block configures the communication parameters of the Modbus protocol.

Description

This block configures the communication parameters between the FC302 and the Modbus slave devices through the Ethernet and serial ports (EIA-232). The user defines the data transference rate of the serial ports, the parity, timeout and the number of re-transmissions.

NOTE
Every time a MODBUS parameter is changed, it is necessary to set the ON_APPLY parameter of the MBCF block to “Apply”. Otherwise, these changes won't be applied.

The user must set ONLY one MBCF block for each device.

MODBUS Addresses

The user must attribute a Modbus address to the FC302. However, this address cannot be the same of any other device connected to the Modbus network through the serial or Ethernet ports. In this case, the user must set the parameter DEVICE_ADDRESS. The default value of this parameter is 247.

In applications where the FC302 operates as a master TCP/IP, the user should also inform the IP address of the devices in the parameter SLAVE_ADRESSES.

Parameters MASTER_SLAVE and MEDIA

These parameters set the mode and the communication of the FC302. The MASTER_SLAVE parameter defines if the FC302 will operate as a slave or master MODBUS device. The MEDIA parameter can be serial or TCP/IP. It is necessary that the DEVICE_ADDRESS is unique in the MODBUS network.

Transference Rate of the serial ports

It is possible to select the baud rate of the serial ports. The baud rate is configured by the parameter BAUD_RATE. The following values are available:

- 0:100 bps
- 1:300 bps
- 2:600 bps
- 3:1200 bps
- 4:2400 bps
- 5:4800 bps
- 6:9600 bps(default)
- 7:19200 bps
- 8:38400 bps
- 9:57600 bps
- 10:115200 bps

Parity

The PARITY parameter defines the type or the parity of the serial ports.

- 0: No parity
- 1: Even Parity
- 2: Odd parity

Timeout and number of re-transmissions

Timeout is the time interval that the controller will wait for an answer from a slave after a message is sent to the serial port or Ethernet. The default value is 1000 ms. This parameter is directly connected to the parameter NUMBER_RETRANSMISSIONS.

The number of re-transmissions is the number of times that the FC302 will retry to establish the communication with the slave device when a reply is not obtained. The time interval to wait for this answer is set by the TIME_OUT parameter. The number of re-transmissions is configured by the NUMBER OF RETRANSMISSIONS parameter. The user can select a value from 0 to 255 for this parameter. The default value is 1.

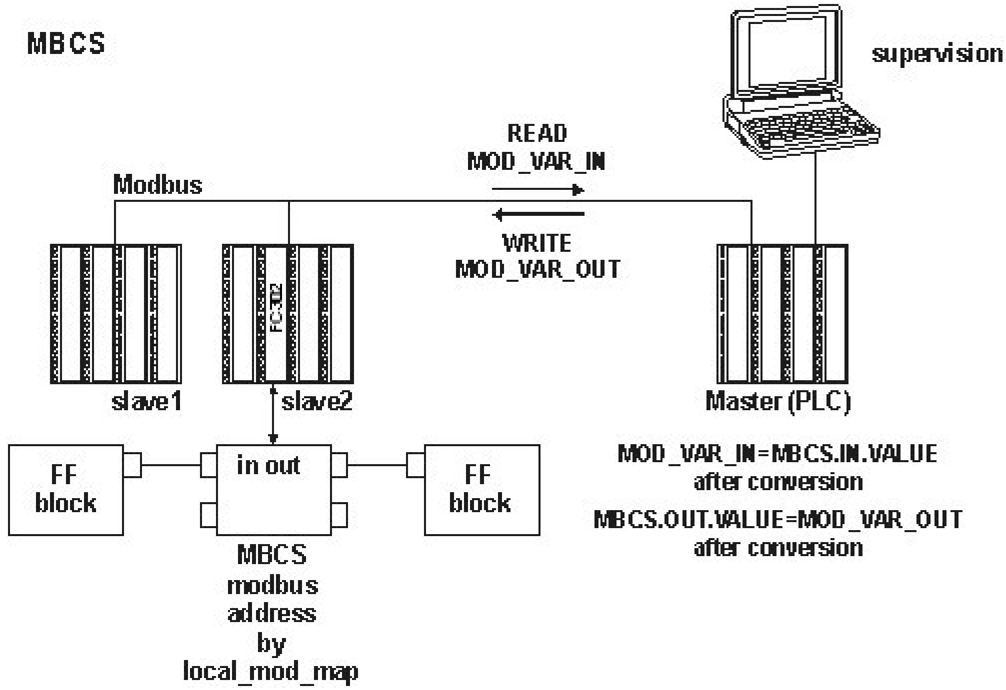
Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**MEDIA**	Unsigned8	0:Serial, 1:TCP/IP	Serial	E	S	Defines the type of the Modbus channel.
8	**MASTER_SLAVE**	Unsigned8	0:Master, 1:Slave	Slave	E	S	Defines if the FC302 is a master or slave.
9	**DEVICE_ADDRESS**	Unsigned8	1-247	1	E	S	Defines the FC302 Modbus address (only for the FC302 slave).
10	**BAUD_RATE**	Unsigned8	0:110, 1:300, 2:600, 3:1200, 4:2400, 5:4800, 6:9600, 7:19200, 8:38400, 9:57600, 10:115200	19200	E	S	Defines the baud rate (only for serial communication).
11	**STOP_BITS**	Unsigned8	0:1, 1:2	1	E	S	Defines the number of stop bits (only for serial communication).
12	**PARITY**	Unsigned8	0:None, 1:Even, 2:Odd.	Even	E	S	Defines the parity (only for serial communication).
13	**TIMEOUT**	Unsigned16	0-65535	1000	ms	S	Time interval that the FC302 master will wait for an answer from a slave or the time interval that the DFI302 slave will wait until the OUTs are updated.
14	NUMBER_RETRANSMISSIONS	Unsigned8	0-255	1		S	Number of re-transmissions if the FC302 doesn't receive an answer from the slave.
15	SLAVE_ADDRESSES	DS-263				S	IP number and modbus addresses of the slaves (only for FC302 master in the TCP/IP communication);
16	RESTART_MODBUS	Boolean		FALSE		S	Indicates if there will be a new transmission after the communication with the slave fails, after the time defined in TIME_TO_RESTART (only for FC302 master).
17	TIME_TO_RESTART	Unsigned16	1-65535	1	s	S	When the device is operating as a master, it is the time interval between the periodic scan of the commands.
18	RTS_CTS	Boolean	0=False 1=True	FALSE		S	Enables (True) or disables (False) the inversion of registers for variables such as Integer32 and Float types. This feature is applied to all blocks MBSS, MBSM.FVALUE and MBSM.IVALUE.
19	**ON_APPLY**	Unsigned16	0:None, 1: Apply	None	E	S	Apply the changes made in the modbus blocks.
20	CHECK_COMM_STANDBY	Unsigned8	0-255	0	Na	S/RW	This parameter is configured to Standby if the communcation test was performed between slave equipment in the TCP. 0: Disables the test. 1 – 255: Enables the test setting the time between each test. (s).

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

MBCS – Modbus Control Slave

Overview



Description
The MBCS block generates a communication strategy between a MODBUS master and a FOUNDATION FIELDBUS slave. In this case, the Smar's linking device FC302 operates as the slave of the MODBUS network. It allows MODBUS variables to be associated with FIELDBUS variables, and data will be exchanged between these two protocols through the FC302.

NOTE: Every time a MODBUS parameter is changed, it is necessary to set the ON_APPLY parameter of the MBCF block to "Apply". Otherwise, these changes won't be applied.

Inputs and Outputs
This block has 4 digital inputs, 4 analog inputs, 4 digital outputs and 4 analog outputs, that can be connected to other FIELDBUS function blocks or to the MODBUS protocol.

- IN1, IN2, IN3 and IN4 are analog inputs.
- IN_D1, IN_D2, IN_D3 and IN_D4 are digital inputs.
- OUT1, OUT2, OUT3 and OUT4 are analog outputs.
- OUT_D1, OUT_D2, OUT_D3 and OUT_D4 are digital outputs.

Digital outputs and inputs are DS-66 data type. Both inputs and outputs have a Status and a value (both Unsigned 8). The analog outputs and inputs are DS-65 data type, and also have status and value. The type of the values is Float. See "Chapter 14 – Adding Modbus" for further details.

Parameter LOCAL_MOD_MAP
This parameter defines the address range of the MODBUS addresses attributed to the input and output FIELDBUS variables of the MBCS block. Check the table below to configure this parameter properly:

LOCAL_ MOD_MAP (MBCS)		
PARAMETER	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_MOD_MAP =1
IN1-Value	40001+ OFFSET 40002+ OFFSET	40041 40042
IN2-Value	40003+ OFFSET 40004+ OFFSET	40043 40044
IN3-Value	40005+ OFFSET 40006+ OFFSET	40045 40046
IN4-Value	40007+ OFFSET 40008+ OFFSET	40047 40048
OUT1-Value	40009+ OFFSET 40010+ OFFSET	40049 40050
OUT2-Value	40011+ OFFSET 40012+ OFFSET	40051 40052
OUT3-Value	40013+ OFFSET 40014+ OFFSET	40053 40054
OUT4-Value	40015+ OFFSET 40016+ OFFSET	40055 40056
IN1-Status	40017+ OFFSET	40057
IN2-Status	40018+ OFFSET	40058
IN3-Status	40019+ OFFSET	40059
IN4-Status	40020+ OFFSET	40060
OUT1-Status	40021+ OFFSET	40061
OUT2-Status	40022+ OFFSET	40062
OUT3-Status	40023+ OFFSET	40063
OUT4-Status	40024+ OFFSET	40064
IN_D1-Status	40025+ OFFSET	40065
IN_D2-Status	40026+ OFFSET	40066
IN_D3-Status	40027+ OFFSET	40067
IN_D4-Status	40028+ OFFSET	40068
OUT_D1-Status	40029+ OFFSET	40069
OUT_D2-Status	40030+ OFFSET	40070
OUT_D3-Status	40031+ OFFSET	40071
OUT_D4-Status	40032+ OFFSET	40072
IN_D1-Value	1+ OFFSET	41
IN_D2-Value	2+ OFFSET	42
IN_D2-Value	3+ OFFSET	43
IN_D2-Value	4+ OFFSET	44
OUT_D1-Value	5+ OFFSET	45
OUT_D2-Value	6+ OFFSET	46
OUT_D3-Value	7+ OFFSET	47
OUT_D4-Value	8+ OFFSET	48

In this table, note that:

LOCAL_MOD_MAP= X
OFFSET = 40*X

The second column of the table above shows the values attributed to the Inputs and Outputs of the MBCS block, according to the value set to LOCAL_MOD_MAP. For example, if LOCAL_MOD_MAP is equal to 1, the MODBUS range of addresses will be the result showed in the third column. It is important to note that when this parameter isconfigured, a whole range is selected, not only a specific address.

INn and OUTn values use two MODBUS registers (for example IN1, 40041 and 40042) because the data type is float. IN_Dn and OUT_Dn values use one MODBUS register (for example IN_D1, 41). Status values also use only one register.

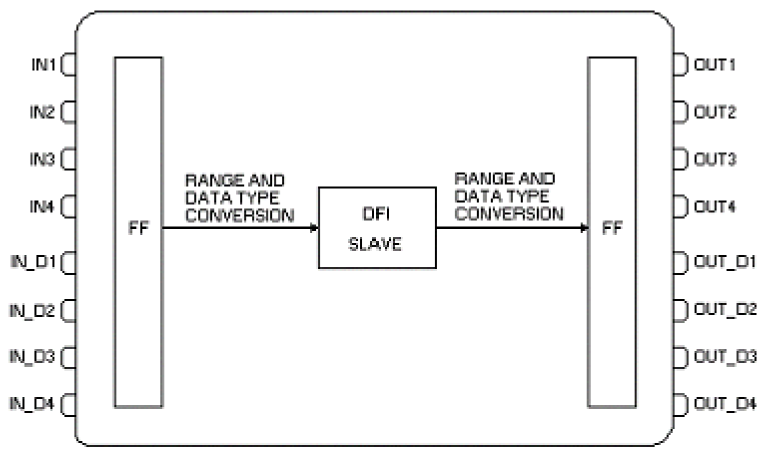
Once this MODBUS range is defined, it is possible to configure how the MODBUS master will read the data.

This block has Modbus Scale Conversion, to execute the conversion procedure, refer to the item "View 1 – MBCS" in the chapter 14 for further details.

Output Status

If the OUTs are not updated by the Modbus Master in a time interval specified by the user (parameter TIMEOUT in MBCF), a "bad status" will be generated. If TIMEOUT < Macrocycle, TIMEOUT = Macrocycle. Once all parameters are configured as mentioned above, it will be possible to use the parameters in the control strategy. The MODBUS master will be able to read all the MBCS inputs and outputs, connected by the user, reading the values from the DF I/O modules and sending to the MODBUS master, or configuring the values in the MODBUS master and sending them to the DF I/O modules. Each input and output are associated to the MODBUS addresses and the MODBUS master is able to read their values from the address DEVICE_ADDRESS (configured by the MBCF block) and from the specific MODBUS address (configured by this block).

Schematic



BLOCK_ERR

The BLOCK_ERR of the MBCS block will indicate the following causes:

- Other: occurs when the conversion from Y to DATA_TYPE_IN results in a value out of range for this data type;
- Out of Service: when the block is in O/S mode.

Parameters

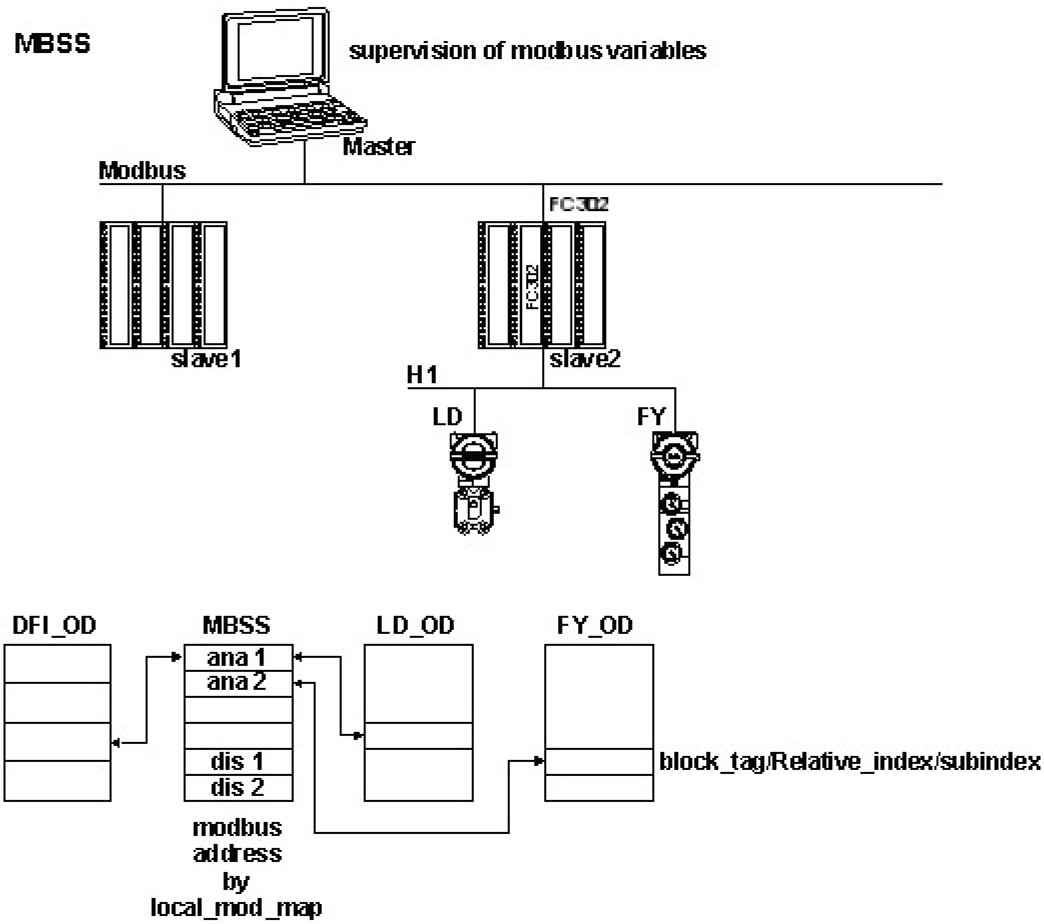
Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**LOCAL_MOD_MAP**	Unsigned8	0 to 15	0		S / O/S	Defines the modbus addresses.
8	**IN1**	DS-65				N	Analog input 1
9	SCALE_CONV_IN1	DS-256				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B.
10	**IN2**	DS-65				N	Analog input 2
11	SCALE_CONV_IN2	DS-256				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
12	**IN3**	DS-65				N	Analog input 3
13	SCALE_CONV_IN3	DS-256				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B.
14	**IN4**	DS-65				N	Analog input 4
15	SCALE_CONV_IN4	DS-256				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B.
16	**IN_D1**	DS-66				N	Discrete input 1
17	**IN_D2**	DS-66				N	Discrete input 2
18	**IN_D3**	DS-66				N	Discrete input 3
19	**IN_D4**	DS-66				N	Discrete input 4
20	**OUT1**	DS-65				N / Man	Analog output 1
21	SCALE_CONV_OUT1	DS-257				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B and the output status.
22	**OUT2**	DS-65				N / Man	Analog output 2
23	SCALE_CONV_OUT2	DS-257				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B and the output status.
24	**OUT3**	DS-65				N / Man	Analog output 3
25	SCALE_CONV_OUT3	DS-257				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B and the output status.
26	**OUT4**	DS-65				N / Man	Analog output 4
27	SCALE_CONV_OUT4	DS-257				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B and the output status.
28	**OUT_D1**	DS-66				N / Man	Discrete output 1
29	STATUS_OUT_D1	Unsigned8				S / O/S	Status of OUT_D1 if the master is not updated.
30	**OUT_D2**	DS-66				N / Man	Discrete output 2
31	STATUS_OUT_D2	Unsigned8				S / O/S	Status of OUT_D2 if the master is not updated.
32	**OUT_D3**	DS-66				N / Man	Discrete output 3
33	STATUS_OUT_D3	Unsigned8				S / O/S	Status of OUT_D3 if the masteris not updated.
34	**OUT_D4**	DS-66				N / Man	Discrete output 4
35	STATUS_OUT_D4	Unsigned8				S / O/S	Status of OUT_D4 if the master is not updated.
36	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
37	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

MBSS – Modbus Supervision Slave

Overview



Description

The MBSS block generates a communication strategy between a MODBUS master and a FOUNDATION FIELDBUS slave. In this case, the Smar's linking device FC302 operates as the slave of the MODBUS network. The MBSS block allows the FIELDBUS variables to be monitored. Unlike the MBCS block, the MBSS doesn't have inputs or outputs to be connected. In other words, links to other function blocks can not be created. This block only allows the MODBUS master to monitor specific configured variables. For example, suppose that there is a PID function block in a FIELDBUS control strategy and it is necessary to display this value in the MODBUS master. The MBSS block will monitor this value.

NOTE
Every time a MODBUS parameter is changed, it is necessary to set the ON_APPLY parameter of the MBCF block to "Apply". Otherwise, these changes won't be applied.

I_IDn, F_IDn, B_IDn parameters

I_IDn are integer variables, F_IDn are float variables and D_IBn refers to boolean variables.
These parameters are DS-262 data type. This data type has 3 elements:

√ Block Tag: Indicates the Tag of the block that contains the variable to be displayed. For example, if the user needs to monitor the gain of the PID block, include the Tag of the PID block containing the "gain" parameter to be displayed in the MODBUS master.

√ Relative Index: Every parameter of a function block has this index. The relative index is indicated in the first column of all parameter tables for function blocks. Include the number of the relative index in the parameter to be monitored. In the example above, the relative index to monitor the gain parameter of the PID function block is 23.

√ Sub Index: The sub index is used for parameters that have a structure. In this case, it is necessary to indicate which element of the structure is being referred.

LOCAL_MOD_MAP parameter

This parameter will attribute the MODBUS address to the variables to be monitored. See the table below:

LOCAL_MOD_MAP (MBSS)		
PARAMETER	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_MOD_MAP =1
FVALUE1	42601+ OFFSET 42602+ OFFSET	42641 42642
FVALUE2	42603+ OFFSET 42604+ OFFSET	42643 42644
FVALUE3	42605+ OFFSET 42606+ OFFSET	42645 42646
FVALUE4	42607+ OFFSET 42608+ OFFSET	42647 42648
FVALUE5	42609+ OFFSET 42610+ OFFSET	42649 42650
FVALUE6	42611+ OFFSET 42612+ OFFSET	42651 42652
FVALUE7	42613+ OFFSET 42614+ OFFSET	42653 42654
FVALUE8	42615+ OFFSET 42616+ OFFSET	42655 42656
IVALUE1	42617+ OFFSET 42618+ OFFSET	42657 42658
IVALUE2	42619+ OFFSET 42620+ OFFSET	42659 42660
IVALUE3	42621+ OFFSET 42622+ OFFSET	42661 42662
IVALUE4	42623+ OFFSET 42624+ OFFSET	42663 42664
BVALUE1	2601+ OFFSET	2641
BVALUE2	2602+ OFFSET	2642
BVALUE3	2603+ OFFSET	2643
BVALUE4	2604+ OFFSET	2644
BAD_STATUS	42625+OFFSET	42665

LOCAL_MOD_MAP= X
OFFSET = 40*X

Once the values for LOCAL_MOD_MAP are set, the MODBUS ADDRESSES are assigned to the variables that will be monitored. Each integer, float or boolean variable will have an associated MODBUS address.

For example, suppose that LOCAL_MOD_MAP = 1 and a float value will be monitored. Selecting F_ID1 and configuring the parameters, the user will have:

F_ID1.Tag = Tag of the float parameter to be monitored.
F_ID1.Index= Index of the first column of the parameter to be monitored.
F_ID1.subindex = The subindex is used by the parameters that have a structure. In this case, it is necessary to indicate which element of the structure is being referred.

See the table above. The MODBUS addresses assigned to this parameter (remember that float values use two MODBUS registers) are 42641 and 42642.

BAD_STATUS parameter

It indicates if the Fieldbus communication is OK. If the corresponding bit is in the logic level 1, so there was an errror during the reading/writing of the parameter. The table below shows the status values.

Relation between the BAD_STATUS bits and Modbus addresses

BIT	VARIABLE
0	FVALUE1
1	FVALUE2
2	FVALUE3
3	FVALUE4
4	FVALUE5
5	FVALUE6
6	FVALUE7
7	FVALUE8
8	IVALUE1
9	IVALUE2
10	IVALUE3
11	BVALUE4
12	BVALUE1
13	BVALUE2
14	BVALUE3
15	BVALUE4

BLOCK_ERR

The BLOCK_ERR of the MBSS block will indicate the following causes:

- Block Configuration Error: If the tag requested has a data type that is not permitted, or it is invalid, or the block tag was not found;
- Out of Service: when the block is in O/S mode.

Remarks

The BVALUEx parameters can address FF block parameters for the following data types: boolean, integer8 and unsigned8. These data types are automatically converted to a bit (0 or 1) and vice versa, for Modbus supervision and, also, they can be converted to a boolean parameter (BVALUEx).

The IVALUEx parameters can address FF block parameters for the following data types: Integer8, Integer16, Integer32, Unsigned8, Unsigned16 and Unsigned32.

Each analog parameter (IVALUEx) is mapped as two Modbus analog registers, that is, four bytes. When addressing a FF block parameter with one or two bytes, this parameter will change to Unsigned32 or Integer32.

If the Relative Index is 5 (MODE_BLK) e the Sub Index is 0, a writing will be execute in Sub Index 1 and a reading in Sub Index 2.

Parameters

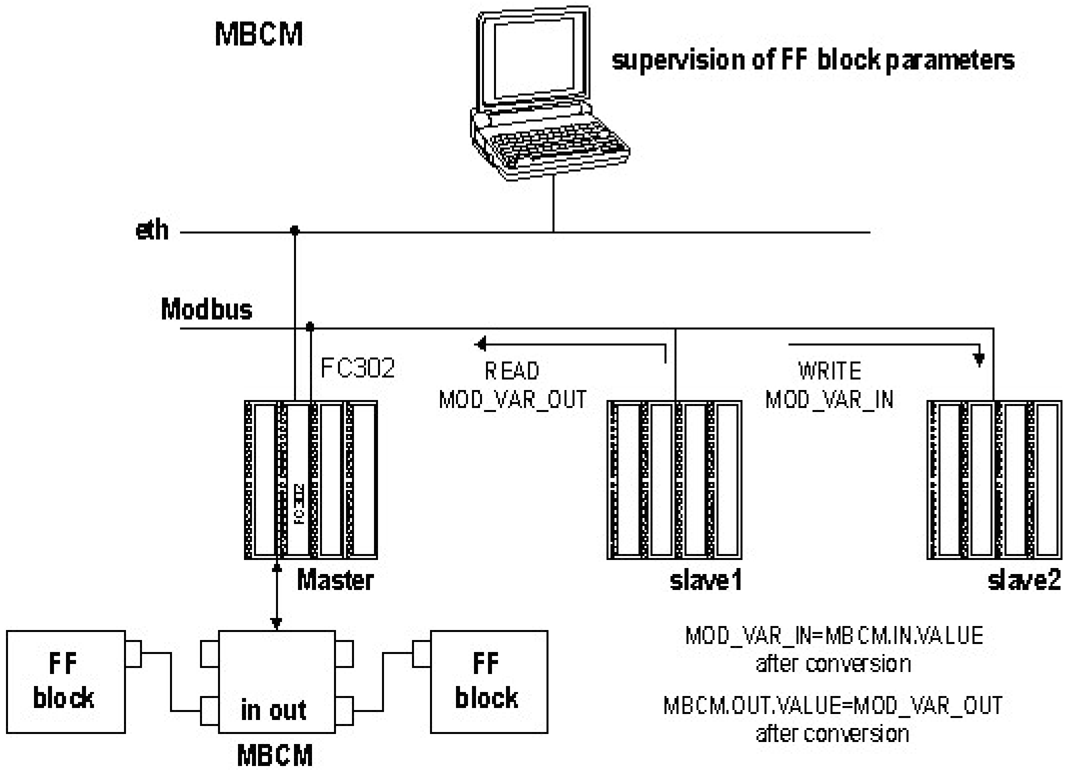
Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**LOCAL_MOD_MAP**	Unsigned8	0 to 15	0		S / O/S	Defines the modbus addresses.
8	F_ID1	DS-262				S / O/S	Information to locate the float parameter.
9	**FVALUE1**	Float		0		N	Value of the requested float parameter.
10	F_ID2	DS-262				S / O/S	Information to locate the float parameter.
11	**FVALUE2**	Float		0		N	Value of the requested float parameter.
12	F_ID3	DS-262				S / O/S	Information to locate the float parameter.
13	**FVALUE3**	Float		0		N	Value of the requested float parameter.
14	F_ID4	DS-262				S / O/S	Information to locate the float parameter.
15	**FVALUE4**	Float		0		N	Value of the requested float parameter.
16	F_ID5	DS-262				S / O/S	Information to locate the float parameter.
17	FVALUE5	Float		0		N	Value of the requested float parameter.
18	F_ID6	DS-262				S / O/S	Information to locate the float parameter.
19	FVALUE6	Float		0		N	Value of the requested float parameter.
20	F_ID7	DS-262				S / O/S	Information to locate the float parameter.
21	FVALUE7	Float		0		N	Value of the requested float parameter.
22	F_ID8	DS-262				S / O/S	Information to locate the float parameter.
23	FVALUE8	Float		0		N	Value of the requested float parameter.
24	I_ID1	DS-262				S / O/S	Information to locate the integer parameter.
25	**IVALUE1**	Integer32		0		N	Value of the requested integer parameter.
26	I_ID2	DS-262				S / O/S	Information to locate the integer parameter.
27	**IVALUE2**	Integer32		0		N	Value of the requested integer parameter.
38	I_ID3	DS-262				S / O/S	Information to locate the integer parameter.
29	**IVALUE3**	Integer32		0		N	Value of the requested integer parameter.
30	I_ID4	DS-262				S / O/S	Information to locate the integer parameter.
31	**IVALUE4**	Integer32		0		N	Value of the requested integer parameter.
32	B_ID1	DS-262				S / O/S	Information to locate the boolean parameter.
33	**BVALUE1**	Boolean		TRUE		N	Value of the requested boolean parameter.
34	B_ID2	DS-262				S / O/S	Information to locate the boolean parameter.
35	**BVALUE2**	Boolean		TRUE		N	Value of the requested boolean parameter.
36	B_ID3	DS-262				S / O/S	Information to locate the boolean parameter.
37	**BVALUE3**	Boolean		TRUE		N	Value of the requested boolean parameter.
38	B_ID4	DS-262				S / O/S	Information to locate the boolean parameter.
39	**BVALUE4**	Boolean		TRUE		N	Value of the requested boolean parameter.
40	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
41	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
42	BAD_STATUS	BitString			E	D/RO	This parameter indicates the status of the corresponding variable.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

MBCM – Modbus Control Master

Overview



Description
This block controls the communication in a strategy where the FC302 is a MODBUS master and the slaves can exchange data among them and with the FC302. With this block, it is not only possible to read the MODBUS variables, but also to write to the variables in the MODBUS protocol, exchange data and communicate with the FOUNDATION fieldbus control strategy.

NOTE: Every time a MODBUS parameter is changed, it is necessary to set the ON_APPLY parameter of the MBCF block to “Apply”. Otherwise, these changes won't be applied.

LOCAL_MOD_MAP parameter
All MBCM blocks added to the strategy must have different values in the LOCAL_MOD_MAP parameter. Otherwise, the block will not operate properly.

Inputs and Outputs
This block has 4 digital inputs, 4 digital outputs, 4 analog inputs and 4 analog outputs. These inputs and outputs can be connected to other FIELDBUS function blocks and then connected to the MODBUS I/O modules or registers.

- INn: Analog input. DS-65 Data type. Value and Status. In this parameter, the value of the parameter configured for this input and its status will be displayed.
- IN_Dn: Digital input. DS-66 Data type. Value and Status. In this parameter, the value of the parameter configured for this input and its status will be displayed.
- OUTn: Analog output. DS-65 Data type. Value and Status. In this parameter, the value of the parameter configured for this output and its status will be displayed.
- OUT_Dn: Digital output. DS-66 Data type. Value and Status.In this parameter, the value of the parameter configured for this output and its status will be displayed.

SCALE_LOC_INn and SCALE_LOC_OUTn
These parameters are DS-259 data type. They convert the value to Engineering Units and address the variable in the MODBUS network. The INn and OUTn inputs and outputs are associated to the SCALE_LOC_INn and SCALE_LOC_OUTn parameters. It is necessary to configure these parameters to monitor and exchange data properly.

Each of these parameters consist of the following elements:

√ From Eu 100 %
√ From Eu 0 %
√ To Eu 100 %
√ To Eu 0 %
√ Data Type:
√ Slave Address;
√ MODBUS Address Of Value;
√ Modbus Address of Status

This block allows Modbus scale conversion. To execute the conversion procedure, refer to the item “View 3 - MBCM” in the chapter 14 for further details.

The following table shows the input/output treatment:

Input/Ouput	Configured Status (Modbus_Address_Of_Status ≠ 0)	NON-Configured Status (Modbus_Address_Of_Status = 0)
Inputs (IN_n , IN_Dn)	The block sends to the device the status corresponding to the input of the Modbus slave. (The status follows the FF standard format)	No status information is sent to the slave device.
Outputs (OUT_n, OUT_Dn)	The block reads the corresponding status from the slave device. (The block assumes that the Modbus variable follows the same format of the FF Status)	- The block updates the status to “Good Non Cascade” when the communication with the Modbus slave device is ok. - The block updates the status to “Bad No Communication with last value” when the communication with the Modbus slave device is not ok.

Float values use two MODBUS registers, but it is necessary to inform only the first one.

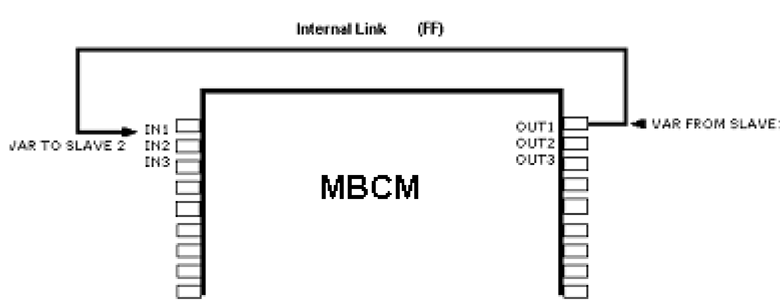
Setting the inputs and outputs of the MBCM block
To read a MODBUS variable, connect the variable to an output of the MBCM function block. To write to a MODBUS register connect the register to an input of the MBCM block.

Usually, MODBUS address are :
The Modbus protocol standards specifies the division of the address range for the variables.

- 00001 to 9999 => Digital Outputs
- 10001 to 19999 => Digital Inputs.
- 30001 to 39999 =>Analog Inputs.
- 40001 to 49999 => Analog Outputs

Once the variables that need to be mapped are defined and referenced in the MBCM block, the user can configure the strategy.

Connect the variables to other FIELDBUS function blocks (Connect the block output or input to other blocks in the strategy), to write to the MODBUS registers (Connect the MBCM block input to a MODBUS register). To exchange data between two slaves, configure the input of the MBCM block with the slave address and specify the MODBUS address where the value will be written; configure the output of the MBCM block with the slave address and the MODBUS address of the variable where the value will be read. See the application below:



BAD_STATUS Parameter

This parameter indicates if the communication between the slaves was established properly. If the corresponding bit is at logic level 1, it indicates that there was an error during the writing/reading of the respective parameter. The table below shows the values for these status.

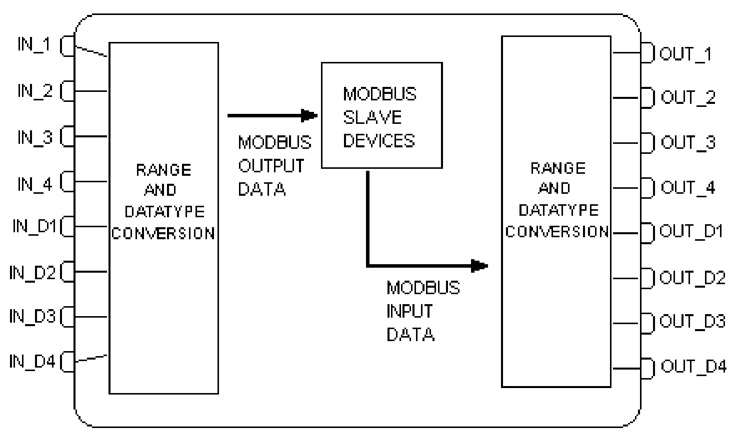
Relation between bits in BAD_STATUS and Modbus addresses

BIT	VARIABLE
0	N1
1	IN2
2	IN3
3	IN4
4	IN_D1
5	IN_D1
6	IN_D1
7	IN_D1
8	OUT1
9	OUT1
10	OUT1
11	OUT1
12	OUT_D1
13	OUT_D1
14	OUT_D1
15	OUT_D1

Notes

Each bit corresponds to an OR between the value and the status, indicating whether the communication with the slave is good or bad.
If only the value is used, the status will be considered zero.
If only the status is used, the value will be considered zero.

Schematic



BLOCK_ERR

The BLOCK_ERR of the MBCM block will indicate the following cause:

- Other: occurs when the conversion from Y to DATA_TYPE_IN results in a value out of range for this data type;
- Out of Service: occurs when the block is in O/S mode.

Parameters

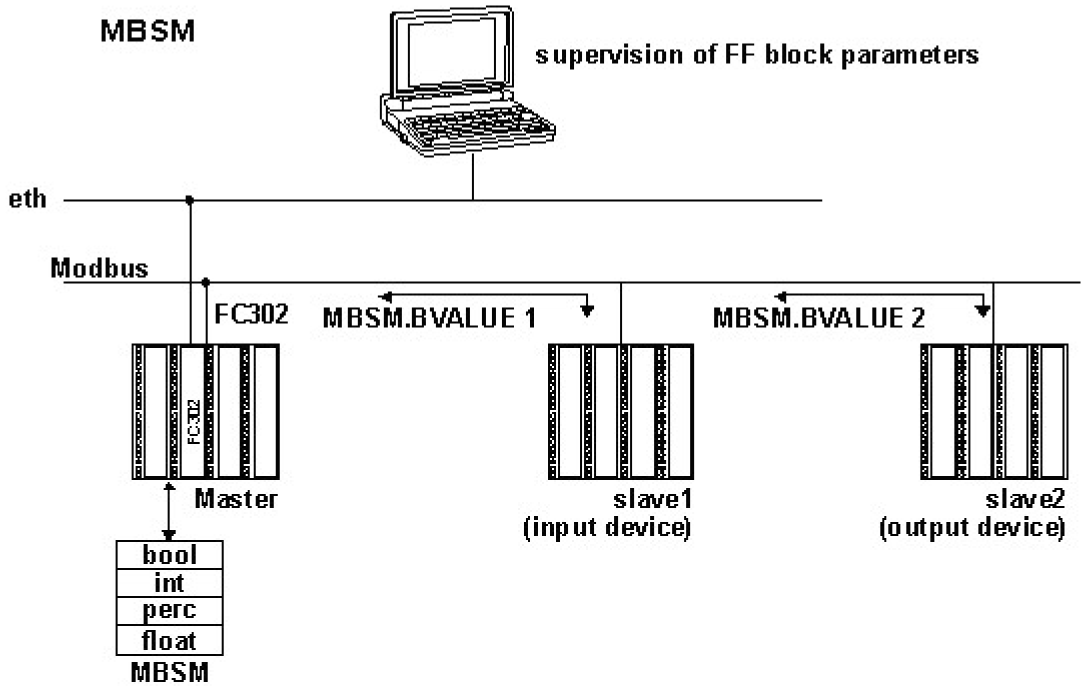
Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**LOCAL_MOD_MAP**	Unsigned8	0 to 15	0		S / O/S	Defines the modbus addresses.
8	**BAD_STATUS**	Bitstring(2)		0	E	D / RO	Indicates whether the communication with the slave is good or not (each bit corresponds to a Modbus variable).
9	**IN1**	DS-65				N	Analog input 1
10	**SCALE_LOC_IN1**	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
11	**IN2**	DS-65				N	Analog input 2
12	**SCALE_ LOC_IN2**	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
13	**IN3**	DS-65				N	Analog input 3
14	**SCALE_ LOC_IN3**	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
15	**IN4**	DS-65				N	Analog input 4
16	SCALE_ LOC_IN4	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
17	**IN_D1**	DS-66				N	Discrete input 1
18	**LOCATOR_IN_D1**	DS-261				S / O/S	Addresses in a slave device.
19	**IN_D2**	DS-66				N	Discrete input 2
20	**LOCATOR_IN_D2**	DS-261				S / O/S	Addresses in a slave device.
21	**IN_D3**	DS-66				N	Discrete input 3
22	LOCATOR_IN_D3	DS-261				S / O/S	Addresses in a slave device.
23	**IN_D4**	DS-66				N	Discrete input 4
24	LOCATOR_IN_D4	DS-261				S / O/S	Addresses in a slave device.
25	**OUT1**	DS-65				N / Man	Analog output 1
26	SCALE_ LOC_OUT1	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
27	**OUT2**	DS-65				N / Man	Analog output 2
28	SCALE_ LOC_OUT2	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
29	**OUT3**	DS-65				N / Man	Analog output 3

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
30	SCALE_ LOC_OUT3	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
31	**OUT4**	DS-65				N / Man	Analog output 4
32	SCALE_ LOC_OUT4	DS-259				S / M	Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
33	**OUT_D1**	DS-66				N / Man	Discrete output 1
34	LOCATOOUT_D1	DS-261				S / O/S	Addresses in a slave device.
35	**OUT2_D2**	DS-66				N / Man	Discrete output 2
36	LOCATOR_OUT_D2	DS-261				S / O/S	Addresses in a slave device.
37	**OUT_D3**	DS-66				N / Man	Discrete output 3
38	LOCATOR_OUT_D3	DS-261				S / O/S	Addresses in a slave device.
39	**OUT_D4**	DS-66				N / Man	Discrete output 4
40	LOCATOR_OUT_D4	DS-261				S / O/S	Addresses in a slave device.
41	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.
42	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

MBSM – Modbus Supervision Master

Overview



Description
This block enables the FC302 to monitor MODBUS variables. The FC302 is the master for the slaves that contain the MODBUS variables to be read. Unlike the MBCM block, this block does not have inputs and outputs that can be connected.

Nota
Every time a MODBUS parameter is changed, it is necessary to set the ON_APPLY parameter of the MBCF block to “Apply”. Otherwise, these changes won't be applied.

LOCAL_MOD_MAP
All MBCM blocks added to the strategy must have different values in the LOCAL_MOD_MAP parameter. Otherwise, the block will not operate properly.

Parameters FVALUEn, PVALUEn, IVALUEn and BVALUEn
These parameters are selected when needed. If the variable being monitored is float, a FVALUE parameter will be necessary. If the variable is in percentage, the PVALUEn parameter will be used. The IVALUE parameter refers to Integer values and the BVALUE parameter refers to boolean values.

For each one of these parameters, there are other parameters associated to address them in the MODBUS network so the MBSM block will know the location.

Parameter FLOCATORn
This parameter refers to the FVALUEn parameter.
This parameter is a DS-260 data type, so it is necessary to configure two elements for this parameter:

- Slave Address: Type the slave address where the variable being monitored is located. For example, if a LC700 has the Device Address equals to 1, the Slave Address should be equal to 1.
- Modbus Address OF Value: Type the MODBUS address of the variable being monitored in the MBSM block. Suppose that the user will monitor the variable in the MODBUS address 40001, located in the Slave I/O module with the Device Address equals to 1. The Modbus Address Of Value must be equal to 40001.

The FVALUEn parameters will display the values of the variables configured in FLOCATORn.
Float values use two MODBUS registers, but it is necessary to inform only the first one.

MODBUS Addresses

- 00001 to 9999 => Digital Outputs
- 10001 to 19999 => Digital Inputs.
- 30001 to 39999 =>Analog Inputs.
- 40001 to 49999 => Analog Outputs

Parameter PLOCATORn

This parameter refers to the PVALUEn parameter.
These parameters are DS-258 data type. They convert the value to Engineering Units and address the variable in the MODBUS network. It is necessary to configure these parameters to monitor the data properly.

Each parameter consists of the following elements:
- From Eu 100 %
- From Eu 0 %
- To Eu 100 %
- To Eu 0 %
- Data Type: It is necessary to inform the data type of the variable.
- Slave Address;
- MODBUS Address Of Value.

This block allows Modbus scale conversion. To execute the conversion procedure, refer to the item “View 4 - MBSM” in the chapter14 for further details.

Parameter ILOCATORn

This parameter refers to the IVALUEn parameter:

- Slave Address
- Modbus Address OF Value:

The IVALUEn parameters will display the values of the variables configured in the ILOCATORn parameter.

Parameter BLOCATORn

This parameter refers to the BVALUEn parameter.
This parameter is a DS-260 data type, so the user will have to configure two elements for this parameter:

- Slave Address
- Modbus Address OF Value

The BVALUEn parameters will display the values of the variables configured in BLOCATORn.

BAD_STATUS Parameter

This parameter indicates if the communication between the slaves was established properly. If the corresponding bit is at logic level 1, it indicates that there was an error during the writing/reading of the respective parameter. The table below shows the values for these status.

Relation between bits in COMM_STATUS and Modbus addresses

Bit	Variable
0	BAD COMM B1
1	BAD COMM B2
2	BAD COMM B3
3	BAD COMM B4
4	BAD COMM B5
5	BAD COMM B6
6	BAD COMM B7
7	BAD COMM B8
8	BAD COMM I1
9	BAD COMM I2
10	BAD COMM P1
11	BAD COMM P2
12	BAD COMM F1
13	BAD COMM F2

Parameters

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**LOCAL_MOD_MAP**	**Unsigned8**	0 to 15	0		S / O/S	Defines the modbus addresses.
8	**BAD_STATUS**	Bitstring(2)		0	E	D / RO	Indicates whether the communication with the slave is good or not (each bit corresponds to a Modbus variable).
9	FLOCATOR1	DS-260				S / O/S	Information to locate the float parameter
10	**FVALUE1**	Float		0		N	Value of the requested address.
11	FLOCATOR2	DS-260				S / O/S	Information to locate the float parameter
12	**FVALUE2**	Float		0		N	Value of the requested address.
13	PLOCATOR1	DS-258				S / O/S	Information to locate the percentage parameter
14	**PVALUE1**	Float		0		N	Value of the requested address.
15	PLOCATOR2	DS-258				S / O/S	Information to locate the percentage parameter
16	**PVALUE2**	Float		0		N	Value of the requested address.
17	ILOCATOR1	DS-260				S / O/S	Information to locate the integer parameter
18	ILENGTH1	Integer8	1,2,4	2		S / O/S	Data length.
19	**IVALUE1**	Interge32		0		N	Value of the requested address.
20	ILOCATOR2	DS-260				S / O/S	Information to locate the integer parameter
21	ILENGTH2	Integer8	1,2,4	2		S / O/S	Data length.
22	**IVALUE2**	Interge32		0		N	Value of the requested address.
23	BLOCATOR1	DS-260				S / O/S	Information to locate the boolean parameter
24	**BVALUE1**	Boolean		TRUE		N	Value of the requested addresses.
25	BLOCATOR2	DS-260				S / O/S	Information to locate the boolean parameter
26	**BVALUE2**	Boolean		TRUE		N	Value of the requested addresses.
27	BLOCATOR3	DS-260				S / O/S	Information to locate the boolean parameter
28	**BVALUE3**	Boolean		TRUE		N	Value of the requested addresses.
29	BLOCATOR4	DS-260				S / O/S	Information to locate the boolean parameter
30	**BVALUE4**	Boolean		TRUE		N	
31	BLOCATOR5	DS-260				S / O/S	Information to locate the boolean parameter
32	**BVALUE5**	Boolean		TRUE		N	Value of the requested addresses.
33	BLOCATOR6	DS-260				S / O/S	Information to locate the boolean parameter
34	**BVALUE6**	Boolean		TRUE		N	Value of the requested addresses.
35	BLOCATOR7	DS-260				S / O/S	Information to locate the boolean parameter
36	**BVALUE7**	Boolean		TRUE		N	Value of the requested addresses.
37	BLOCATOR8	DS-260				S / O/S	Information to locate the boolean parameter
38	**BVALUE8**	Boolean		TRUE		N	Value of the requested addresses.
39	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.

Idx	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
40	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

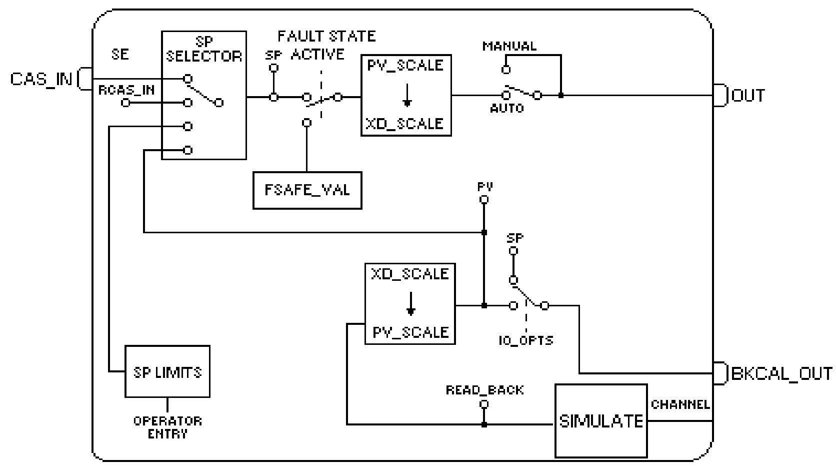
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

AO - Analog Output

Overview

The Analog Output Block is a function block used by the devices operating as an output element in a control loop, such as valves, actuators, positioners, etc. The AO block receives a signal from another function block and sends the results to an output transducer block through the internal reference channel.

Schematic



Description

The AO block is connected to the transducer block through the CHANNEL parameter that must match the following parameter in the transducer block:
TERMINAL_NUMBER parameter for the FI302.

The CHANNEL parameter must be set to 1 (one) if the AO block is running in the FY302 or FP302, and no configuration is necessary in the transducer block to connect it to the AO block.

Handling Input Values

The SP value can be automatically controlled through a cascade control, a remote cascade control or controlled manually by the operator. The PV_SCALE and XD_SCALE are used in the SP scale conversion.

Handling Output Values

The transducer scale parameter (XD_SCALE) converts span percentage to a number used by the transducer. The SP span can cause a full span movement for the output.

OUT = SP% * (EU_100% - EU_0%) + EU_0% [XD_SCALE]
The bit “Increase to Close” in the IO_OPTS parameter allows the output to be inverted according to the span of the input value. For example, if the SP is 100. (PV_SCALE=0-100%; XD_SCALE = 3-15Psi):
If the bit “Increase to Close” in IO_OPTS is zero, the SP converted to OUT_SCALE will be15 psi. Therefore, the actuator type will be “air to open”.

If the bit “Increase to Close” in IO_OPTS is true, the SP converted to OUT_SCALE will be 3 psi. Therefore, the actuator type will be “air to close”.

Simulate

The SIMULATE parameter is used for the diagnostics and checkout. When it is active, the transducer value and status will be overridden by the simulate value and status. The SIMULATE parameter can be disabled by the software in the SIMULATE parameter or the hardware, using a jumper.

The SIMULATE structure is composed by the following attributes:

- Simulate Value and Status
- Transducer Value and Status
- Simulate Enable/Disable

The Transducer Value/Status attributes of the SIMULATE parameter always show the value that the AO block receives from the corresponding transducer block.

There is a hardware jumper to disable the SIMULATE parameter. If this jumper is set to Off, the simulation will be disabled. In this case, the user cannot change the ENABLE/DISABLE attribute. This jumper avoid the simulation from being accidentally enabled during the plant operations. When the jumper is set to ON, the “Simulate Active” attribute in the BLOCK_ERR of Resource block will be true.

The simulation will be active if the following conditions exist:

- The jumper of the simulation hardware is not set to Off;
- The SIMULATE.ENABLE/DISABLE parameter is “Active”.

When simulation is active, the READBACK and PV parameters are calculated based on the attribute Simulate Value/Status of the SIMULATE parameter. Otherwise, they will be provided by the transducer block in the Transducer Value/Status attribute of the SIMULATE parameter.

Readback parameter
If the hardware supports a readback value, such as valve position, then the value will be read by the transducer block and will be sent to the corresponding AO block through the Transducer Value/Status attribute of the SIMULATE parameter. If the hardware does not support the readback value, the Transducer Value/Status attribute of the SIMULATE parameter will be generated from the AO.OUT by the transducer block.

The READBACK parameter is a copy from the Transducer Value/Status attribute of the SIMULATE parameter when the simulation is disabled; otherwise, it will be a copy of the Simulate Value/Status attribute of the SIMULATE parameter.

The PV is the READBACK parameter converted to the PV_SCALE, therefore the PV can be simulated through the SIMULATE parameter.

In addition, the block admits the safe condition as described previously in the fault state processing. The AO block supports the mode-shedding feature as described previously in the mode parameter.

BLOCK_ERR
The BLOCK_ERR of the AO block will indicate the following causes:

1. Block Configuration Error – the configuration error is indicated when one or more of the following situations occur:
   a. When the CHANNEL or SHED_OPT parameters have an invalid value;
   b. When the XD_SCALE doesn't have a engineering unit and/or a range proper for the respective transducer block;
   c. When the transducer block is in O/S mode;
   d. When it is not compatible to the CHANNEL parameter and the HC configuration (FC302).
2. Simulate Active – When the Simulate is active.
3. Local Override – When the block is in LO mode because the fault state is active.
4. Output Failure – I/O module failed (FC302).
5. Out of Service – When the block is in O/S mode.

Supported Modes
O/S, IMAN, LO, MAN, AUTO, CAS and RCAS.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D	
7	PV	DS-65			PV	D / RO	Process the analog value.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
8	SP	DS-65	PV_SCALE +/- 10%		PV	N / Auto	Analog setpoint. It can be configured manually, automatically through the device interface or by another field device.
9	OUT	DS-65	XD_SCALE		OUT	N / Man	The output value resulting from the transducer block.
10	SIMULATE	DS-82	1: Disable ; 2: Active These are the Enable/Disable options.	Disable		D	Allows the readback value to be manually supplied when simulate is enabled. In this case, the simulate value and status will be the PV value.
11	PV_SCALE	DS-68		0-100%	PV	S / Man	The higher and lower scale values for the SP parameter.
12	XD_SCALE	DS-68		0-100%	XD	S / Man	The higher and lower scale values for the transducer of a specific channel.
13	GRANT_DENY	DS-70		0	Na	D	
14	**IO_OPTS**	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
15	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
16	READBACK	DS-65			XD	D / RO	Indicate the readback of the current position of the transducer, in transducer units.
17	**CAS_IN**	DS-65				D	This parameter is the value of the remote setpoint, received from another Fieldbus block, or from a DCS block through a defined link.
18	SP_RATE_DN	Float	Positive	+INF	PV/Sec	S	Ramp rate to increase the setpoint, in PV units per second. It will be disabled if it is zero or +INF. Rate limiting will be applied in AUTO, CAS and RCAS modes.
19	SP_RATE_UP	Float	Positive	+INF	PV/Sec	S	Ramp rate to decrease the setpoint, in PV units per second. It will be disable if it is zero or +INF. Rate limiting will be applied in AUTO, CAS and RCAS modes.
20	SP_HI_LIM	Float	PV_SCALE +/- 10%	100	PV	S	The setpoint high limit is the highest executed setpoint that can be used for the block.
21	SP_LO_LIM	Float	PV_SCALE +/- 10%	0	PV	S	The setpoint low limit is the lowest executed setpoint that can be used for the block.
22	CHANNEL	Unsigned16		0	None	S / O/S	The channel number of the logical hardware, for the transducer that is connected to this I/O block.
23	FSTATE_TIME	Float	Positive	0	Sec	S	The time interval, in seconds, to ignore the existence of a new fault state condition. If the fault state condition doesn't persist during FSTATE_TIME seconds, and while this time interval doesn't expires, the block will execute in the last current mode.
24	FSTATE_VAL	Float	PV_SCALE +/- 10%	0	PV	S	The preset analog value of the SP to be used when a failure occurs. This value will be used if the I/O option of the fault state is selected.
25	BKCAL_OUT	DS-65			PV	D / RO	The value and status required by an block before BKCAL_IN. The previous block can prevent a final reset and provide bumpless transfer to end the control loop.
26	RCAS_IN	DS-65			PV	D	Target setpoint and status provided by a supervisory Host for an analog control or an output block.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
27	SHED_OPT	Unsigned8	1: NormalShed, NormalReturn 2: NormalShed, NoReturn 3: ShedToAuto, NormalReturn 4: ShedToAuto, NoReturn 5: ShedToMan, NormalReturn 6: ShedToMan, NoReturn 7: ShedToRetained Target, NormalReturn 8: ShedToRetained Target, NoReturn	0		S	Defines the action to be taken on a remote control device timeout.
28	RCAS_OUT	DS-65			PV	D / RO	Block setpoint and status after ramping – provided to a supervisory Host for back calculation and to allow define the action to be taken under limiting on limit conditions or mode changealterations.
29	UPDATE_EVT	DS-73			Na	D	
30	BLOCK_ALM	DS-72			Na	D	

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

If the BEHAVIOR parameter is configured as "Adapted":

The default value of CHANNEL is the lowest number available.
The default value of SHED_OPT is NormalShed/NormalReturn.
The required writing mode is the actual mode, regardless of the target mode: SP and OUT

MDO - Multiple Discrete Output

Description
The MDO block enables 8 input parameters, IN_D1 to IN_D8, to the I/O subsystem .

This function block has the same fault state characteristics of the DO block, including an option to store the last value or change to a preset value when the fault state is active, individually preset values for each point, and a delay time to before changing to the fault state.

The current mode will be LO because of the resource block, otherwise the bad status in the input parameter and the configuration of MO_STATUS_OPTS will not affect the mode calculation. However, the functionality of the fault state will be applied only for that input parameter.

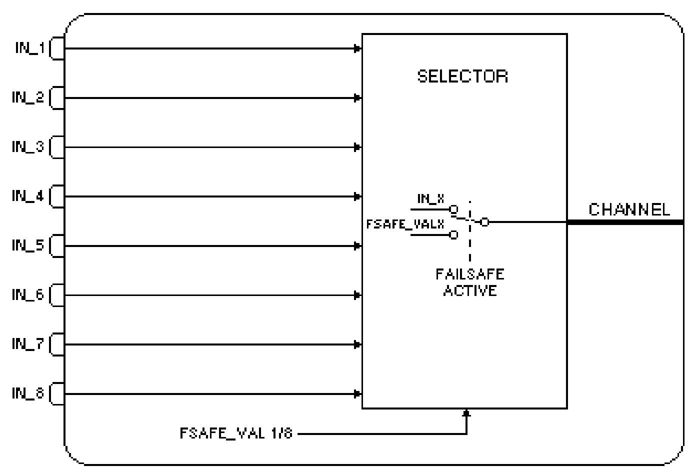
The parameter FSTATE_STATE shows for which points the fault state is active.

BLOCK_ERR
The BLOCK_ERR of the MDO block will indicate the following causes:

- Other – the number of the MDI, MDO, MAI and MAO blocks, or the device tag in FB700, differs from the LC700;
- Block Configuration Error – the configuration error is indicated when OCCURRENCE / CHANNEL has an invalid value;
- Output failure – the CPU of the LC700 stopped working;
- Power up – there is no LC700 CPU in the rack or the hardware configuration of the LC700 has an error;
- Out of Service – When the block is in O/S mode.

Supported Modes
O/S, LO and AUTO.

Schematic



Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	**BLOCK_ERR**	Bitstring(2)			E	D	
7	OCCURRENCE / CHANNEL	Unsigned16		0	None	S / O/S	The OCCURRENCE/CHANNEL number of the logical hardware connected to this multiple I/O block. It defines the transducer block . It addresses a group of eight points.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
8	**IN_D1**	DS-66				D	Discrete input 1.
9	**IN_D2**	DS-66				D	Discrete input 2.
10	**IN_D3**	DS-66				D	Discrete input 3.
11	**IN_D4**	DS-66				D	Discrete input 4.
12	**IN_D5**	DS-66				D	Discrete input 5.
13	**IN_D6**	DS-66				D	Discrete input 6.
14	**IN_D7**	DS-66				D	Discrete input 7.
15	**IN_D8**	DS-66				D	Discrete input 8.
16	MO_OPTS (different bit description in profile revision 1)	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
17	MO_STATUS_OPTS (not availabe in profile revision 1)	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options
18	FSTATE_TIME	Float	Positive	0	Sec	S	The time interval, in seconds, to ignore the existence of a new fault state condition. If the fault state condition doesn't persist during FSTATE_TIME seconds, and while this time interval doesn't expires, the block will execute in the last current mode.
19	FSTATE_VAL_D1	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D1. It will be ignored if “Fault state to value 1” in the MO_OPTS parameter is false.
20	FSTATE_VAL_D2	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D2. It will be ignored if “Fault state to value 2” in the MO_OPTS parameter is false.
21	FSTATE_VAL_D3	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D3. It will be ignored if “Fault state to value 3” in the MO_OPTS parameter is false.
22	FSTATE_VAL_D4	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D4. It will be ignored if “Fault state to value 4” in the MO_OPTS parameter is false.
23	FSTATE_VAL_D5	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D5. It will be ignored if “Fault state to value 5” in the MO_OPTS parameter is false.
24	FSTATE_VAL_D6	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D6. It will be ignored if “Fault state to value 6” in the MO_OPTS parameter is false.
25	FSTATE_VAL_D7	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D7. It will be ignored if “Fault state to value 7” in the MO_OPTS parameter is false.
26	FSTATE_VAL_D8	Unsigned8		0		S	The preset discrete value to be used when a failure occurs in IN_D8. It will be ignored if “Fault state to value 8” in the MO_OPTS parameter is false.
27	FSTATE_STATE	Unsigned8			None	D / RO	Shows for which points the fault state is active.
28	BLOCK_ALM	DS-72			Na	D	The block alarm is used for configuration failures, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has changed.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
29	UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

If the BEHAVIOR parameter is configured as “Adapted”:
The default value of OCCURRENCE is the number of MDO blocks instantiated in the profile revision 0.

Device type	Description
FB700	The block has the OCCURRENCE parameter.
DFI302 AND DC302	The block has the CHANNEL parameter. MO_OPTS has a different bit description MO_STATUS_OPTS is not availabe in profile revision 1. The relative index is shifted for the following parameters.

IDShell Transducer Block

Description
This transducer block provides the following features:
- Initial Settings Configuration of the System
- Device and Block Online Diagnostics and Configuration

This block is a tool to provide the interoperability of new devices in System302**.**

Supported modes
O/S and AUTO.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
1	ST_REV	unsigned int	0 to 2^{16}	0	None	RO	FF – 891
2	TAG_DESC	OctString(32)		Spaces	Na	RW	FF – 891
3	STRATEGY	unsigned int	0 to 2^{16}	0	None	RW	FF – 891
4	ALERT_KEY	unsigned char	1 to 255	1	None	RW	FF – 891
5	**MODE_BLK**	DS-69		O/S	Na		FF – 891
6	**BLOCK_ERR**	Bitstring(2)			E	RO	FF – 891
7	**UPDATE_EVT**	EventUpdate					FF – 891
8	**BLOCK_ALM**	AlarmDiscrete					FF – 891
9	TRANSDUCER_DIRECTORY	unsigned int	0 to 2^{16}			RO	A directory that specifies the number and the initial indexes of the transducers in the transducer block. (FF – 903)
10	TRANSDUCER_TYPE	unsigned int	0 to 2^{16}			RO	Identifies the transducer. (FF – 903)
11	XD_ERROR	unsigned char	1 to 255			RO	Defines one of the error codes. (FF – 903)
12	COLLECTION_DIRECTORY	unsigned long	0 to 2^{32}			RO	A directory that specifies the number, the initial indexes and DD Item IDs of the data for each transducer in the transducer block. (FF – 903)
13	**FUNCTION_IDS**	unsigned char	Passive Active Backup Active not link master	—		RW	IDShell application functionality.
14	**UPDATE_TIME**	unsigned long	0 to 2^{32}	1000		RW	Update time for the supervision.
15	ACTUAL_LINK_ADDRESS_1	unsigned int	0 to 2^{16}	0		RO	Actual link address for Port 1.
16	CONF_LINK_ADDRESS_1	unsigned int	0 to 2^{16}	0		RW	Configured link address for Port 1.
17	ACTUAL_LINK_ADDRESS_2	unsigned int	0 to 2^{16}	292		RO	Actual link address for Port 2.
18	CONF_LINK_ADDRESS_2	unsigned int	0 to 2^{16}	0		RW	Configured link address for Port 2.
19	ACTUAL_LINK_ADDRESS_3	unsigned int	0 to 2^{16}	293		RO	Actual link address for Port 3.
20	CONF_LINK_ADDRESS_3	unsigned int	0 to 2^{16}	0		RW	Configured link address for Port 3.
21	ACTUAL_LINK_ADDRESS_4	unsigned int	0 to 2^{16}	294		RO	Actual link address for Port 4.
22	**CONF_LINK_ADDRESS_4**	unsigned int	0 to 2^{16}	0		RW	Configured link address for Port 4.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
23	**SELECT_IDS**	unsigned char	0 to 256	0		RW	Extra functionality of the IDShell Application.
24	**SOFTWARE_NAME**	VisibleString		—		RO	Name of the software that executed the last download to the PCI card.
25	**SYSTEM_OPERATION**	unsigned char	Redundant Single	Single		RW	System Operation mode (single or redundant). It will impact the calculation of SUP_UPDATE_SUGGESTED.
26	**SUP_UPDATE_CONFIGURED_ms**	unsigned long	0 to 2^{32}	0		RW	Target update time, configured for the system. It can be achieved or not, depending on the traffic schedule, the number of MVCs, the number of Views and the bus parameters. Refer to the macrocycle equation (1).
27	**SUP_UPDATE_SUGGESTED_ms**	unsigned long	0 to 2^{32}	—		RO	Suggested update time based on the traffic programmed on the bus (traffic schedule, MVCs, Views, bus parameters, traffic maintenance). **Note: Not Available.**
28	**NO_DATA_CHANGE_TIMEOUT_ms**	unsigned long	0 to 2^{32}	2000		RW	Timeout to report the data even if a change is not acknowledged.
29	RESOURCE_FAULT	unsigned char	Ok Failure Recovered			RO	Indicates a resource failure in the card.
30	**MVC_ENABLE**	unsigned char	Disabled Enabled	Disabled		R/W	Enables the supervision using MVC broadcast configured by the IDSHELL. When disabled, the IDSHELL will use the normal procedures to update the requested list of TAGs.
31	**SCHEDULE_UPDATE**	unsigned char	Failed Update Req Updated Updating	—		R/W	Writing to this parameter will trigger the update of the LAS schedule, based on the information on the network.
32	T1_ms	unsigned long	0 to 2^{32}	8,000		R/W	T1 timer used to manage the SM for the timeout confirmation of the Assign Tag, Assign Address, or Enable SM Operation from the SM Agent. Refer to the equation (2).
33	T2_ms	unsigned long	0 to 2^{32}	60,000		R/W	T2 timer used by the SM Agent to interrupt the Assign Addressprocedure. Refer to the equation (2).
34	T3_ms	unsigned long	0 to 2^{32}	8,000		R/W	T3 timer used by SM to manage the timeout before sending the Enable SM Operation. Refer to the equation (2).
35	FIRST_UNPOLLED_ADDRESS	unsigned char	0 to 256	48		R/W	The PCI acting as the LAS will not poll the consecutive addresses N_UNPOLLED_ADDRESS, starting on FIRST_UNPOLLED_ADDRESS.
36	N_UNPOLLED_ADDRESS	unsigned char	0 to 256	184		R/W	The PCI acting as the LAS will not poll the consecutive addresses N_UNPOLLED_ADDRESS, starting on FIRST_UNPOLLED_ADDRESS.
37	SLOT_TIME_octet	unsigned int	0 to 2^{16}	10		R/W	The devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activities on the network.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
38	MAX_RESPONSE_DELAY_octet	unsigned int	0 to 2^{16}	8		R/W	The devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activities on the network.
39	MIN_INTER_PDU_DELAY_octet	unsigned char	0 to 256	12		R/W	Minimum time interval that there will be no communication in the network, allowing the device to be prepared to receive the next frame on the network.
40	TARGET_ROTATION_TIME_ms	unsigned long	0 to 2^{32}	—		R/W	Time interval for the target LAS to send the token to all devices in the network.
41	MAX_CONFIRM_DELAY_ON_DATA_ms	unsigned int	0 to 2^{16}	8260		R/W	Maximum timeout for data confirmation, configured on the client/server VCRs.
42	LOCAL_VCR_SELECT	unsigned char	First Next None Previous	—			Selects a local VCR in the device interface related to this transducer block.
43	L_VCR_ID	unsigned char		—		R/W	VCR selected.
44	L_VCR_TYPE_AND_ROLE	unsigned char	Bnu, Publisher Bnu, Subscriber Qub, Client Qub, Server Quu, Source Quu, Sink Undefined	—		RO	VCR type and role.
45	L_VCR_REMOTE_ADDRESS	octet string, 4		—		RO	VCR Remote address.
46	L_VCR_STATISTICS_RESET	unsigned char	Ok Reset	—		R/W	Resets the statistics of the selected VCR.
47	L_VCR_ST_N_ABORT	unsigned long	0 to 2^{32}	—		RO	Number of aborted actions on the selected VCR.
48	L_VCR_ST_N_DT_PDU_SENT	unsigned long	0 to 2^{32}	—		RO	Number of DT PDU sent by the selected VCR.
49	L_VCR_ST_N_DT_PDU_RCV	unsigned long	0 to 2^{32}	—		RO	Number of DT PDU received on the selected VCR.
50	L_VCR_ST_N_DT_TIMEOUT	unsigned long	0 to 2^{32}	—		RO	Number of DT failures caused by a timeout.
51	L_VCR_ST_REQ_REJECTED	unsigned int	0 to 2^{16}	—		RO	Number of requests that could not be queued on this VCR.
52	L_VCR_ST_W_REQ_REJECTED	unsigned int	0 to 2^{16}	—		RO	Number of write requests that could not be queued on this VCR.
53	NET_STATUS	bit string	Port 0 mismatch Port 1 mismatch Port 2 mismatch Port 3 mismatch Reserved			RO	It will indicate any mismatch occurrence between PORT_N_CONF_DEV and PORT_N_DEV_READY. **Note: Not Available.**
54	PORT_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the port to be analyzed or configured in the following parameters.
55	PORT_ID	unsigned char		0		R/W	Port selected. (1, 2, 3 or 4)
56	PORT_UPDATE_PROFILE	unsigned char	Ready Start Update Update Processing	—		R/W	Updates the database of all devices on the selected port.
57	PORT_MACROCYCLE_CONFIGURED_ms	unsigned long	0 to 2^{32}	0		R/W	Configured macrocycle.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
58	PORT_MACROCYCLE_SUGGESTED_ms	unsigned long	0 to 2^{32}	—		RO	Suggested macrocycle. **Note: Not Available.**
59	PORT_TOKEN_ROTATION_TIME_ms	unsigned long	0 to 2^{32}	—		RO	Current time interval for the LAS to pass the token to all devices in the network.
60	PORT_N_CONF_DEV	unsigned char	0 to 256	—		R/W	Number of stations expected on this network.
61	PORT_N_DEV	unsigned char	0 to 256	—		RO	Number of devices on the network.
62	PORT_N_DEV_READY	unsigned char	0 to 256	—		RO	Number of devices where the entire database was updated. **Note: Not Available.**
63	PORT_LIVE_LIST_STATUS_1	bit string , 8 bytes 256 bits	0 to 15	—		RO	Live list of the selected port.
64	PORT_LIVE_LIST_STATUS_2	bit string , 8 bytes 256 bits	16 to 31	—		RO	Live list of the selected port.
65	PORT_LIVE_LIST_STATUS_3	bit string , 8 bytes 256 bits	32 to 47	—		RO	Live list of the selected port.
66	PORT_LIVE_LIST_STATUS_4	bit string , 8 bytes 256 bits	48 to 63	—		RO	Live list of the selected port.
67	PORT_LIVE_LIST_STATUS_5	bit string , 8 bytes 256 bits	64 to 79	—		RO	Live list of the selected port.
68	PORT_LIVE_LIST_STATUS_6	bit string , 8 bytes 256 bits	80 to 95	—		RO	Live list of the selected port.
69	PORT_LIVE_LIST_STATUS_7	bit string , 8 bytes 256 bits	96 to 111	—		RO	Live list of the selected port.
70	PORT_LIVE_LIST_STATUS_8	bit string , 8 bytes 256 bits	112 to 127	—		RO	Live list of the selected port.
71	PORT_LIVE_LIST_STATUS_9	bit string , 8 bytes 256 bits	128 to 143	—		RO	Live list of the selected port.
72	PORT_LIVE_LIST_STATUS_10	bit string , 8 bytes 256 bits	144 to 159	—		RO	Live list of the selected port.
73	PORT_LIVE_LIST_STATUS_11	bit string , 8 bytes 256 bits	160 to 175	—		RO	Live list of the selected port.
74	PORT_LIVE_LIST_STATUS_12	bit string , 8 bytes 256 bits	176 to 191	—		RO	Live list of the selected port.
75	PORT_LIVE_LIST_STATUS_13	bit string , 8 bytes 256 bits	192 to 207	—		RO	Live list of the selected port.
76	PORT_LIVE_LIST_STATUS_14	bit string , 8 bytes 256 bits	208 to 223	—		RO	Live list of the selected port.
77	PORT_LIVE_LIST_STATUS_15	bit string , 8 bytes 256 bits	224 to 239	—		RO	Live list of the selected port.
78	PORT_LIVE_LIST_STATUS_16	bit string , 8 bytes 256 bits	240 to 254	—		RO	Live list of the selected port.
79	PORT_STATISTICS_RESET	unsigned char	Ok Reset	Ok		R/W	Resets port statistics.
80	PORT_ST_LIVE_LIST_REV	unsigned char	0 to 256	0		RO	Number of updates on the live list. It is incremented every time a device leaves or enters the live list.
81	PORT_ST_N_MACROCYCLE	unsigned long	0 to 2^{32}	0		RO	Number of macrocycles executed by the selected port.
82	PORT_ST_PDU_SENT	unsigned long	0 to 2^{32}	0		RO	Number of frames sent by the selected port.
83	PORT_ST_PDU_RECEIVED	unsigned long	0 to 2^{32}	0		RO	Number of frames received by the selected port.
84	PORT_ST_WRONG_FCS	unsigned long	0 to 2^{32}	0		RO	Number of frames with wrong FCS received by the selected port.
85	PORT_ST_CLAIM_LAS	unsigned long	0 to 2^{32}	0		RO	Number of Claim Las processes initialized by the selected port.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
86	PORT_ST_AP_DATA	unsigned long	0 to 2^{32}	0		RO	Percentage of application data on the bus.
87	PORT_ST_CON_MAINTENANCE	unsigned long	0 to 2^{32}	0		RO	Percentage of connection maintenance data on the bus, iIncluding residual activity and frame connection.
88	PORT_ST_MAINTENANCE_DATA	unsigned long	0 to 2^{32}	0		RO	Percentage of maintenance data on the bus.
89	DEVICE_CHANGE_PASSWORD	visible string, 32				R/W	Password protection from unexpected changes in the device address and device ID.
90	DEVICE_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the device to be analyzed or configured in the following parameters.
91	DEV_ADDRESS	unsigned char	0 to 256	—		R/W	Address of the selected device. Also used to select a device by the address.
92	DEV_ID	visible string		—		R/W	Device ID of the selected device.
93	DEV_TAG	visible string		—		RO	Device Tag.
94	DEV_STATUS	unsigned char	None Alive Complete DB	—		RO	Device database status in the interface device.
95	DEV_FORCE_OUT	unsigned char	Force Ok	Ok		R/W	Writing to this parameter triggers the interface device to force the selected device to leave the network. It will be polled later.
96	DEV_MANUFACTURER_ID	OctetString		—		RO	Device Manufacturer ID.
97	DEV_TYPE_2	OctetString		—		RO	Device Type.
98	DEV_FIRST_BLOCK_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first Function Block of the selected device.
99	DEV_FIRST_VCR_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first VCR of the selected device.
100	DEV_FIRST_OBJECT_LINK_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first Object Link of the selected device.
101	DEV_FIRST_FBSTART_INDEX	unsigned int	0 to 2^{16}	—		RO	Index of the first FB Start parameter of the selected device. The FB Start defines the Function Block schedule.
102	DEV_VFD_ID_SM	unsigned long	0 to 2^{32}	—		RO	VFD ID for system and network management.
103	DEV_VFD_ID_FBAP	unsigned char	0 to 256	—		RO	VFD ID for the function block application.
104	DEV_T1_ms	unsigned long	0 to 2^{32}	—		R/W	T1 timer used to manage the SM for the timeout confirmation of the Assign Tag, Assign Address, or Enable SM Operation from the SM Agent.
105	DEV_T2_ms	unsigned long	0 to 2^{32}	—		R/W	T2 timer used by the SM Agent to interrupt the Assign Address procedure.
106	DEV_T3_ms	unsigned long	0 to 2^{32}	—		R/W	T3 timer used by SM to manager the timeout before sending the Enable SM Operation.
107	DEV_SLOT_TIME_octet	unsigned int	0 to 2^{16}	—		R/W	The devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activities on the network.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
108	DEV_MAX_RESPONSE_DELAY_octet	unsigned int	0 to 2^{16}	—		R/W	The devices on the network will use SLOT TIME and MAX_RESPONSE_DELAY to set a timeout to control some activities on the network.
109	DEV_MIN_INTER_PDU_DELAY_octet	unsigned int	0 to 2^{16}	—		R/W	Minimum time interval that there will be no communication in the network, allowing the device to be prepared to receive the next frame on the network.
110	DEV_MACROCYCLE_ms	unsigned long	0 to 2^{32}	—		R/W	Macrocycle for the function block application.
111	DEV_BLOCK_SELECT	unsigned char	First Next None Previous			R/W	Selects the block to be analyzed or configured in the following parameters.
112	BLK_TYPE	unsigned char	No Selection Resource Transducer Function Block	—		RO	Block Type (Resource, Transducer, or Function Block).
113	BLK_INDEX	unsigned int	0 to 2^{16}	—		R/W	Block Index.
114	BLK_TAG	visible string		—		R/W	Block Tag.
115	BLK_DD_ITEM	octet string		—		RO	Block DD Item.
116	BLK_FIRST_VIEW_INDEX	unsigned int	0 to 2^{16}	—		RO	Block index of the first View.
117	DEV_VCR_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the device VCR to be analyzed or configured in the following parameters.
118	VCR_INDEX	unsigned char	0 to 256	—		R/W	Selected VCR.
119	VCR_TYPE_AND_ROLE	unsigned char	Bnu, Publisher Bnu, Subscriber Qub, Client Qub, Server Quu, Source Quu, Sink Undefined	—		R/W	VCR type and role.
120	VCR_LOCAL_ADDR	octet string ,4		—		R/W	VCR Local address.
121	VCR_REMOTE_ADDR	octet string, 4		—		R/W	VCR Remote address.
122	VCR_PRIOTIRY	unsigned char	Invalid Normal Time Available Urgent	—		R/W	VCR priority.
123	VCR_DELIVERY_FEATURES	unsigned char	Classical Disordered Invalid Ordered Unordered	—		R/W	VCR delivery features.
124	VCR_AUTHENTICATION	unsigned char	Invalid Maximal Short Source	—		R/W	VCR authentication.
125	VCR_MAX_DLSDU_SIZE	unsigned int	0 to 2^{16}	—		R/W	VCR DLS DU Maximum size.
126	VCR_VFD_ID	octstring, 4		—		R/W	VFD associated to the selected VCR.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
127	VCR_FEATURES_SUPPORTED_SEND	octstring, 4		—		R/W	VCR features supported when sending information.
128	VCR_FEATURES_SUPPORTED_RCV	octstring, 4		—		R/W	VCR features supported when receiving information.
129	VCR_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	—		R/W	Writing to this parameter will trigger the writing to the selected VCR with the changed values.
130	DEV_OBJECT_LINK_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the device object link to be analyzed or configured in the following parameters.
131	OBJECT_LINK_ID	unsigned char	0 to 256	—		R/W	Selects the object link.
132	LNK_LOCAL_INDEX	unsigned int	0 to 2^{16}	—		R/W	Local index.
133	LNK_VCR	unsigned int	0 to 2^{16}	—		R/W	Index of the VCR associated to the selected object link.
134	LNK_REMOTE_INDEX	unsigned int	0 to 2^{16}	—		R/W	Remote index.
135	LNK_SERVICE	unsigned char	Alert Local MVC Publisher Subscriber Trend Undefined	—		R/W	Service performed by the selected object link.
136	LNK_STALE_CNT	unsigned char	0 to 256	—		R/W	The maximum number of consecutive input values received before the status was set to BAD.
137	LNK_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	Ok		R/W	Writing to this parameter will trigger the writing to the selected object link with the changed values.
138	DEV_FBSTART_SELECT	unsigned char	First Next None Previous	—		R/W	Selects the device FB start parameter to be analyzed or configured in the following parameters.
139	FBSTART_ID	unsigned char	0 to 256	—		R/W	Selected FB Start.
140	FBSTART_OFFSET_ms	unsigned int	0 to 2^{16}	—		R/W	Offset time interval for the beginning of each macrocycle when the function block associated to this parameter is being executed.
141	FBSTART_FB_INDEX	unsigned int	0 to 2^{16}	—		R/W	Index of the function block associated to this parameter.
142	FBSTART_VFD_ID	unsigned long	0 to 2^{32}	—		R/W	VFD associated to this parameter.
143	FBSTART_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	Access Ok		R/W	Writing to this parameter will trigger the writing to the selected FB Start parameter with the changed values.
144	WR_PARAMETER_VFD	unsigned char	MIB FBAP	—		R/W	VFD where the read/written parameter belongs.
145	RW_PARAMETER_INDEX	unsigned int	0 to 2^{16}	—		R/W	Index of the parameter to be read/written.
146	RW_PARAMETER_LENGTH	unsigned char	0 to 256	—		R/W	Length of the parameter to be read/written.
147	RW_PARAMETER_DATA	octet string, 100				R/W	Data read or data to be written.
148	RW_READ_CMD	unsigned char	Access Ok Read Req Write Req	Access Ok		R/W	Writing to this parameter will trigger the reading of the selected parameter.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
149	RW_WRITE_CMD	unsigned char	Access Ok Read Req Write Req	Access Ok		R/W	Writing to this parameter will trigger the writing to the selected parameter with the changed values in RW_PARAMETER_DATA.
150	DEV_STATISTICS_RESET	unsigned char	Ok Reset	—		R/W	Resets the Device Statistics.
151	DEV_ST_N_LIVE_LIST_IN_OUT	unsigned int	0 to 2^{16}	—		RO	Number of times that the device requests the live list from the interface device.
152	DEV_ST_N_PT_RETRIES	unsigned int	0 to 2^{16}	—		RO	Number of pass token retries for this device.
153	DEV_ST_N_DT_RETRIES	unsigned int	0 to 2^{16}	—		RO	Number of data retries for this device.
154	DEV_ST_N_DLPDU_TRANSMITTED	unsigned long	0 to 2^{32}	—		RO	Device number of the transmitted DLPDU.
155	DEV_ST_N_GOOD_DLPDU_RCV	unsigned long	0 to 2^{32}	—		RO	Device number of the good DLPDU received.
156	DEV_ST_N_PARTIAL_RCV_PDU	unsigned long	0 to 2^{32}	—		RO	Device number of the partial DLPDU received.
157	DEV_ST_N_FCS_FAILURES	unsigned long	0 to 2^{32}	—		RO	Device number of the DLPDU received with the wrong FCS.
158	DOWNLOAD_CONF_STATUS	unsigned char	Ok No data Processing	No data		RO	Status of the maintenance procedure to download the configuration to a device based on a previously configuration saved on the interface device memory. **Note: Not Available. Replaced by a partial download.**
159	READ_CONF	unsigned char	Ok Run	Ok		R/W	Command to read the configuration and save it on interface device memory. **Note: Not Available. Replaced by a partial download.**
160	DOWNLOAD_CONF	unsigned char	Ok Run	Ok		R/W	Command to download the last saved configuration to a device or a set of devices. **Note: Not Available. Replaced by a partial download.**
161	BLK_EXECUTION_TIME	unsigned long	0 to 2^{32}	0		RO	Block Execution Time. This parameter belongs to the block section.
162	APPLICATION_TIME	timevalue		—		R/W	Adjusts the application time, in the interface device.
163	**FEATURES**	bitstring	SM Timers optimization Automatic set tag/address FB Link status monitoring Hot Swap IDShell				Enables the automatic procedures of the IDShell. Check notes (3). **Note: Not Available.**
164	**HOT_SWAP_STATE**	unsigned char	Disable Idle Verifying Configuring Rebuilding				Reports the status of the procedure when a device is replaced or re-configured. **Note: Not Available.**
165	**FB_LINK_STATUS**	unsigned char	Disable Ok Failure				Indicates the status of the strategy links. **Note: Not Available.**

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
166	**REBUILD**		DD Database Hot Swap Database MVC Configuration - Active Station MVC Configuration - Backup Station None				Triggers the special procedures of the IDShell Application. Check notes (4).
167	**DD_DATABASE_STATUS**	unsigned char	Disable Failure Building Idle				Indicates the status of the database maintained by the Interface Device that contains the information of the data types and function block objects.
168	**MVC_STATE**	unsigned char	Disable Configuring Idle				Reports the status of the machine that configures the MVC. **Note: Not Available.**

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Gray Background Line: Custom Parameters

Notes:
(1) Macrocycle Equation:
$T_M = (N_E * 30 + N_D * T_R) * 1.2$

where
T_M = macrocycle (ms)

N_E = number of external links

N_D = number of devices

T_R =
30 ms for single operation or

60 ms for redundant operation

(2) Equation:
T1 < T2 > T3
T3 > cycle to poll the valid addresses on the network.

(3) SM Timers Optimization - default: enabled.
IDShell will find the values of T1, T2, T3 suitable for the system.
Automatic Tag/Address Adjustment - default: enabled.
IDShell will automatically set a valid address and tag to the device added to the network. IDShell will solve any address and/or tag collisions.
FB Link Status Monitoring - default: disabled.
IDShell monitors all function block links and indicates the status through the FB_LINK_STATUS.
Hot Swap - default: disabled.
IDShell holds the information of the function block links for all 4 ports and automatically performs the configuration of the device if the Hot Swap function is enabled.

(4) DD Database – the current database is created and a new database with the data types and function block object is rebuild.
Hot Swap Database – IDShell builds the function block link database based on the information in the network.
MVC Configuration - Active Station/Backup Station – IDShell re-configures the MVC to optimize the performance of the communication in the network.

Transducer Blocks

FCT –Flow Computer Transducer

Description
This block contains general information about the FC302, that is, non specific to a measured stream, either related to gas or liquid measurements.

The main features of this block are related to access restriction, engineering units system selection, initialization of logger and date/hour.

COMPANY_NAME, LOCAL_NAME, RESPONSIBLE_NAME and MANAGER_NAME Parameters
These parameters are strings used for all report types to identify the company, local and the responsibles for the reports.

Configuration of the enabled users to modify the configuration
The FC302 supports up to 30 users, and the following parameters must be configured for each user: access level (LOGIN_LEVEL), user_name (USER_NAME_x, string used for user identification in the configuration log report), and configuration of the second password if double password is required.

The access level indicates the allowed modifications in configuration, according to the table below:

Access level (*)	Operations allowed
AA – Administrator	This level allows unrestricted access to the configuration, including the user and password configurations, for example.
A1 – Level 1	It allows configuration download and writing into all parameters.
A2 – Level 2	It allows writing into majority of parameters.

(*) The required access level for the configuration of each parameter is indicated in the Index column in the function block table.

The operations that have only access restriction by password are not registered in the configuration log, for example, the password configuration of each login/ user name.

The access restriction (only) is indicated in the function block table as follows:
- RA –Restriction requiring Administrator access level;
- R1 – Restriction requiring Level 1 or higher;
- R2 – Restriction requiring Level 2.

User Logon Process in the FC302
To change the configuration, the user needs to be registered in the FC302 that must have been configured previously as described above. So, the user needs to inform the login (LOGIN) or user name (USER_NAME), write the password (PASSWORD_CODE) and if the double password is configured, the other user must write the second password in the PASSWORD_CODE_2 parameter.

The double password is an important feature for applications, where the measurement system is shared by provider and client during the custody transfer. When there is an intervention in the configuration, it is necessary to enter with the two passwords.

When the double password is configured for a specific login/user name, the PASSWORD_CODE and PASSWORD_CODE_2 parameters inform if it is waiting the writing of the first or the second password. The sequence of writing the passwords is not considered; therefore it must be executed in a time interval less than the specified in the LOGON_TIMEOUT parameter.

Logoff Process
Once the logon process was accomplished successfully, the user will be able to change the configuration. The user have to write zero (logoff) in the PASSWORD_CODE or PASSWORD_CODE_2 parameter to logoff, At each change, the FC302 starts a timeout which is restarted at each new successful change in the configuration. However, if this timeout exceeds the value configured in LOGON_TIMEOUT, the FC302 automatically will logoff.

The logoff feature is useful, but it can be disabled writing zero in the LOGON_TIMEOUT parameter. It avoids that the user which has forgotten to logoff, has its login/user name used improperly.

FC302 real time clock

The FC302 real time clock can be monitored and set through the RTC parameter that has the DATE format (see the definition in the end of this chapter), or utilize the RTC_RD, RTC_WR and RTC_CMD parameters, when the man machine interface has problems in handling this data type.

The RTC_RD and RTC_WR parameters should be interpreted as follow:

Element	Description	Range / Intepretation
1	Second	0 - 59
2	Minute	0 - 59
3	Hour	0 - 23
4	Week day	1=Monday,.... 7=Sunday
5	Month day	1 - 31
6	Month	1=January,.... 12=December
7	Year	00 - 99

In order to synchronize the hours automatically, refer to the FCView chapter.

Initialization of registers and reports in the FC302 memory

The registers and reports in the FC302 memory are initialized in the following situations:

Event	Register / report type initialized
Writing into CLEAR_LOG	It is possible to initialize only a specific type or all types
Register/report diagnosis detects inconsistence	Only the inconsistent register/report type.
Writing into the GAS_QTR or LIQ_QTR parameter	Only the QTR reports.

The total quantity of QTR reports for gas and liquid is defined by the FC302 hardware, whose specification is in the “Register/ Reports Quantity supported by the FC302” item. So, configuring the GAS_QTR parameter, automatically, involves changing the LIQ_QTR parameter, keeping always the whole specification quantity of the FC302.

WARNING
When the initialization of register/report starts, it means they will be removed from the FC302 memory. Thus these operations must be accomplished only after assuring the reports were already stored in the database by FCView. As it is a critical operation, the access level required is the highest (AA – Administrator).

Storage of the registers/reports in only one database

The FCVIEW_VSN parameter must be configured with the volume serial number of the hard disk where the FCView designated to read the register/report of the FC302 is executing, only this computer will do this operation. This procedure avoids the registers and reports of one FC302 to be downloaded by different computers, which would cause a scattered database.

If the FCVIEW_VSN parameter is not configured, its default value is null. It means that any computer executing the FCView will be able to download the registers and reports.

Engineering Unit selection for each variable

There are two ways to select the Engineering Units:

a) Selection of the whole set of Engineering Units through the SYSTEM_UNITS parameter (metric or USA units);

b) Choosing the Engineering Unit for each kind of variable (custom).

The user can select the following Engineering Units for each kind of variable according to the table below: (these Engineering Units are classified as selectable engineering units)

The derived engineering units are selected by an indirect way, for example, the compressibility factor has the Engineering Unit as the inverse of the selected unit for pressure (P_UNITS).

FCT Parameter	Unit(*)	Description	Engineering Units for USA system	Engineering Unit for metric system
SELECTABLE UNITS				
T_UNITS	T	Temperature	°F	°C
P_UNITS	P	Pressure	psia	kPa
DP_UNITS	DP	Differential Pressure	psig	kPa
GD_UNITS	GD	Gas Density	lb/ft^3	kg/m^3
LD_UNITS (**)	LD	Liquid Density	°API	kg/m^3
GV_UNITS	GV	Gas Volume	MCF	m^3
LV_UNITS	LV	Liquid Volume	Bbl	m^3
M_UNITS	M	Mass	klb	ton
VISC_UNITS	Visc	Viscosity	cP	Pa.s
EN_UNITS	EN	Energy	MMBTU	GJ
HV_UNITS	HV	Heating Value	BTU/ft^3	MJ/m^3
L_UNITS	L	Length	inch	mm
DERIVED UNITS				
	F	Compressibility Factor - F	1/[P]	
	Elas	Elasticity Module - E	1/[P]	
	G	Coefficient of Thermal Expansion: Gl, Ga and Gc	1/[T]	
	TV	Volume Totalization	[V]	
	TM	Mass Totalization	[M]	
	QV	Volume Flow Rate	[V]/h	
	QM	Mass Flow Rate	[M]/h	
	K	K Factor	pulses/ [V] or pulses /[M]	
	ER	Energy Flow	[EN]/h	

(*) This column provides the engineering units symbology used for each parameter in the function block table.
(**) The selected Engineering Unit will also indicate the selection of standards to be used:

- SG -> API-11.1 tables 23 & 24 and API-11.2.1/API-11.2.2;
- API –> API-11.1 tables 5 & 6 and API-11.2.1/API-11.2.2;
- kg/ m^3 -> API-11.1 tables 53 & 54 (base temperature of 5°C) or tables 59 & 60 (base temperature of 20°C) and API-11.2.1.M/API-11.2.2.M

Some configuration parameters of function blocks are converted automatically, when the correspondent Engineering Unit is changed. The table below shows these parameters:

VALUE	BLOCK	PARAMETER
P_UNITS	GKD	BASE_PRESSURE ATMOSPHERE_PRESSURE
	LBT	OVERRIDE_PRESSURE
	LCT	OVERRIDE_PRESSURE
	GFC	OVERRIDE_PRESSURE
		GROSS_PGR
		GROSS_PD
DP_UNITS	GFC	OVERRIDE_DIFF_PRESSURE
		RANGE_HI_2
		RANGE_LO_2
		RANGE_HI_3
		RANGE_LO_3
T_UNITS	LKD	BASE_TEMPERATURE
	GKD	BASE_TEMPERATURE
	LBT	OVERRIDE_TEMPERATURE
	LCT	OVERRIDE_TEMPERATURE
	GFC	OVERRIDE_TEMPERATURE
		TEMP_DIAMETER
		ALPHA_1
		ALPHA_2
		GROSS_TGR
		GROSS_TD
		GROSS_TH
HV_UNITS	GKD	PRODUCT1.[24]
		PRODUCT2.[24]
		PRODUCT3.[24]
		PRODUCT4.[24]
		TEMPORARY_PRODUCT.[24]
LD_UNITS	LBT	OVERRIDE_DENSITY
	LCT	OVERRIDE_DENSITY
L_UNITS	GFC	ORIFICE_DIAMETER
		TUBE_DIAMETER
	GFC	ABS_VISCOSITY
GV_UNITS	GT	NO_GAS_FLOW
LV_UNITS	LBT	VOLUME_DELAY
		NO_LIQ_FLOW
	LCT	MAX_IV_PROVING
		NO_LQ_FLOW
LV_UNITS or M_UNITS	LKD	METER1_INFO.NOMINAL_K_FACTOR
		METER2_INFO.NOMINAL_K_FACTOR
		METER3_INFO.NOMINAL_K_FACTOR
		METER4_INFO.NOMINAL_K_FACTOR
		MASTER_METER_INFO.NOMINAL_K_FACTOR

Note

It is recommended to download the reports/registers from the FC302 before changing any Engineering Unit, because the Engineering Unit indicated in the reports is that one configured in the FC302 at the moment of download by FCView. Therefore this procedure addresses the information consistence contained in the reports.

Daylight-saving Time
The day and the month to start (DS_START_DAY and DS_START_MONTH parameters) and to stop (DS_END_DAY and DS_END_MONTH parameters) can be configured for the daylight-saving time. Thus, the FC302 changes automatically the date/hour of the real time clock according to the configuration. These events are registered in the FC302 memory (showed by the AEV block) and are also detected at the beginning or the ending when the daylight-saving time occurs when the FC302 is turned off.

In the table below, an example of QTR reports generated during the transition of the end of the daylight-saving time:

DS_END_DAY = 8
DS_END_MONTH = May
ENABLE_REPORT = Hourly & Daily

Item	QTR Type	Report period			Comment
		Date/hour to start	Date/hour to stop	Flow Time	
1	Hourly	May 7 - 23:00	May 8 -0:00	1 hour	Hourly report that antecedes the end of the daylight-saving time.
2	Dialy	May 7 - 0:00	May 8 - 0:00	1 day	Daily report that antecedes the end of the daylight-saving time.
3	Hourly	May 7 - 23:00	May 8 - 0:00	1 hour	Second hourly report from May 7 - 23:00 to May 8 – 0:00. This report will have the same beginning and closing date/time of the item 1, however the report number will be different.
4	Daily	May 7 - 23:00	May 8 -0:00	1 hour	Second daily report of the day May 7, however the flow time is just one hour and report number will be different

Start of period: day, week and month
The definition for accounting periods, regarding to QTR reports, can be different in comparison with the calendar when configuring the following parameters:

- START_HOUR: hour which starts the accounting day;
- START_DAY_WEEK: first day of the week;
- START_DAY_MONTH: first day of month.

-

Diagnosis and Troubleshooting
1. Failure in writing the LOGIN and USER_NAME parameters: verify if another user is already logon, thus the writing is allowed only in logoff;
2. Failure in writing the parameter USER_NAME_x: verify if another user has already the desired user name;
3. Failure in the logon process: verify if it the selected LOGIN/USER_NAME is correct and the correspondent restriction level configured in LOGIN_LEVEL parameter;
4. BLOCK_ERR. Out of Service : block in Out of service mode;
5. BLOCK_ERR. Block configuration: it indicates if there are blocks for gas measurement, however no one QTR was reserved for gas measurement, similarly for liquid measurement.

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	This parameter is used to identify the run number. This block has information related to all runs; therefore it is a read only parameter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode Parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (CL)	2	COMPANY_NAME	Visiblestring[32]		Blank		S	Company identification. It is used to generate reports.
8 (CL)	2	LOCAL_NAME	Visiblestring[32]		Blank		S	Identification of the place where the measurement is being done. It is used to generate reports.
9 (CL)	2	RESPONSIBLE_NAME	Visiblestring[32]		Blank		S	Identification of the responsible for the reports.
10 (A1) (CL)	2	SYSTEM_UNITS	Unsigned8	0=Metric 1=USA units 2=Custom	0	E	S / O/S	Metric system (cubic meter, meter, Celsius, kPa) American system (barrel, inche, Fahrenheit, psi) The Custom option indicates the free choosing of the Engineering Units for each kind of variable.
11	1	LOGIN	Unsigned8	1 to 30=Login 1 / 30	0	E	D	Login for configuration changes with access restriction.
12	1	PASSWORD_CODE	Unsigned16	Read : 0=Logoff 1=Logon 2=WaitingPW1 3=WaitingPW2 Write: 0=Logoff 4 to 65535, =password	0	Na	D	This parameter has double functionality. When it is in reading, the value 1 indicates Logon, and thus it is possible to change the configuration with access restriction. When writing value 0, it means the operator wants to logoff. When writing values between 4 and 65535, the user is trying to logon.
13 (RA)	4	LOGIN_LEVEL	Unsigned8[30]	0=Administrator 1=Level 1 2=Level 2 255=Not allowed	First=Administrator Others=Not allowed	E	S	It is possible to attribute a level access for each one of 30 Logins by writing into this parameter. It is necessary to logon with Administrator level to write into this parameter.
14(RA)		PASSWORD	Unsigned16 [30]	4 to 65535	4	Na	S	In order to configure the password for each Login, it is necessary to type in this parameter. The reading/writing in this parameter is allowed when the operator has Administrator level or was registered with correspondent Login. Only when the user was registered as Administrator, the password will return. Otherwise, it will indicate zero.
15 (A2)	1	RTC	Date				N	Date and time in real time.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
16 (AA) (CL)		GAS_QTR	Unsigned16	0 to 1000	-	Na	S	Number of QTR for gas. The difference between the maximum number associated to QTR supported by FC302 module and this parameter will be the number of QTR reserved for liquid. This procedure must be accomplished only after certifying that all information was saved by the FCView in database and the correspondent report was printed.
17 (AA) (CL)		LIQ_QTR	Unsigned16	0 to 1000	-	Na	S	Number of QTR for liquid. The difference between the maximum number associated to QTR supported by FC302 module and this parameter will be the number of QTR reserved for gas. This procedure must be accomplished only after certifying that all information was saved by FCView in database and the correspondent report was printed.
18(AA)		CLEAR_LOG	Unsigned8	0 = None 1 = Clear all loggers 2=ATV-config log 3=AEV-alarm and event 4=LMFV-proving 5=WTV-well test 6=GTV-gas 7=LTV-liquid	0	Na	D	Writing “Clear all loggers” in this parameter, all logger types will be removed (GTV, LTV, ATV, AEV, LMFV, WTV) from the FC302 memory. This procedure must be accomplished only after certifying that all information was saved by the FCView in database and the correspondent report was printed.
19 (AA)		FCVIEW_VSN	Visiblestring[9]		Blank		S	Serial number of the hard disk where the FCView is installed. Only the FCView executed in this computer will communicate with the FC302.
20 (A1) (CL)		LOGON_TIMEOUT	Unsigned16	0 = never expire	0	Min	S	The Logon ends automatically after this time interval, if there is no changing in any parameter under Audit Trail.
21		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
22		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported, without clearing the Active status, if the subcode has changed.
23 (CL)	2	MANAGER_NAME	Visiblestring[32]		Blank		S	Identification of the responsible manager for the reports.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
24	1	PASSWORD_CODE_2	Unsigned16	Read : 0=Logoff 1=Logon 2=WaitingPW1 3=WaitingPW2 Write: 0=Logoff 4 to 65535=password	0	Na	D	When working with double password, the second password must be written in this parameter. This parameter has double functionality. When in reading, the value 1 indicates Logon, and thus it is possible to change the configuration with access restriction. When writing value 0, it means the operator wants to logoff. When writing values between 4 and 65535, the user is trying to logon.
25 (RA)		PASSWORD_2	Unsigned16[30]	0 = double password disabled 4 to 65535	0	Na	S	It is possible to configure the password for each associated login writing in this parameter. The reading/writing in this parameter is allowed when the user has Administrator level or was registered with correspondent Login. The real value of the parameter is only read via communication when the user has Administrator level. Otherwise, it will indicate zero.
26 (A1) (CL)		T_UNITS	Unsigned16	1000=Kelvin 1001=Celsius 1002=Fahrenheit 1003=Rankine	Celsius	E	S	Engineering Unit for Temperature.
27 (A1) (CL)		P_UNITS	Unsigned16	1130=Pa 1132=Mpa 1133=kPa 1137=bar 1138=mbar 1139=torr 1140=atm 1141=psi 1144=g/cm^2 1145=kgf/cm^2 1147=inH2O 4°C 1148=inH2O 68 °F 1150=mmH2O 4°C 1151= mmH2O 68 °F 1154=ftH2O 68 °F	KPa	E	S	Engineering Unit for Static Pressure.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
28 (A1) (CL)		DP_UNITS	Unsigned16	1130=Pa 1132=Mpa 1133=kPa 1137=bar 1138=mbar 1139=torr 1140=atm 1141=psi 1144=g/cm^2 1145=kgf/cm^2 1147=inH2O 4°C 1148=inH2O 68 °F 1150=mmH2O 4°C 1151= mmH2O 68 °F 1154=ftH2O 68 °F	KPa	E	S	Engineering Unit for Differential Pressure.
29 (A1) (CL)		GD_UNITS	Unsigned16	1097= Kg/m^3 1107=lb/ft^3	Kg/m^3	E	S	Engineering Unit for Gas density.
30 (A1) (CL)		LD_UNITS	Unsigned16	1097= Kg/m^3 1113=API 1599 = relative density/SG	Kg/m^3	E	S	Engineering Unit for Liquid density. The selection of this unit indicates which table should be used for correction factor calculations. (CTL and CPL).
31 (A1) (CL)		GV_UNITS	Unsigned16	1034=cubic meter 1038=liter 1048=US gallon 1051=barrel 1600=MCF 1610=MMCF	m^3	E	S	Engineering Unit for gas volume.
32 (A1) (CL)		LV_UNITS	Unsigned16	1034=cubic meter 1038=liter 1048=US gallon 1051=barrel 1600=MCF	m^3	E	S	Engineering Unit for liquid volume.
33 (A1) (CL)		M_UNITS	Unsigned16	1088=kilogram 1092=ton 1094=pound 1601=kilo pound	ton	E	S	Engineering Unit for mass.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
34 (A1) (CL)		EN_UNITS	Unsigned16	1171=Gigajoules 1172=MJ 1602=MMBtu 1603=MBtu	GJ	E	S	Engineering Unit for energy.
35 (A1) (CL)		HV_UNITS	Unsigned16	1604=MJ/ m^3 1605=KJ/m^3 1606=KJ/dm^3 1607=Kcal/m^3 1608=BTU/in^3 1609=BTU/ft^3	MJ/m^3	E	S	Engineering Unit for heating value.
36 (A1) (CL)		VISC_UNITS	Unsigned16	1159=Pascal second 1162=centipoise	Pa.s	E	S	Engineering Unit for viscosity.
37 (A1) (CL)		L_UNITS	Unsigned16	1013=mm 1019=in	mm	E	S	Engineering Unit for lenght.
38 (A2) (CL)		DS_START_DAY	Unsigned8	0 to 31 0=disabled	0	NA	S	Starting day of the daylight-saving time.
39 (A2) (CL)		DS_START_MONTH	Unsigned8	0 to 12 0=disabled 1=January 2=February .. 12=December	0	E	S	Starting month of the daylight-saving time.
40 (A2) (CL)		DS_END_DAY	Unsigned8	0 to 31 0=disabled	0	NA	S	Ending day of the daylight-saving time.
41 (A2) (CL)		DS_END_MONTH	Unsigned8	0 to 12 0=disabled 1=January 2=February .. 12=December	0	E	S	Ending month of the daylight-saving time
42 (CL)		START_HOUR	Unsigned8	0 to 23	0	Hour	S	Hour that starts the counting period of the day.
43 (CL)		START_DAY_WEEK	Unsigned8	1=Monday to 7=Sunday	1	E	S	Day that starts the counting period of the week.
44 (CL)		START_DAY_MONTH	Unsigned8	1 to 28	1	Day of month	S	Day that starts the counting period of the month.
45		USER_NAME	Visiblestring[8]		Blank		D	Selection of the User name selection to change the configuration. Also identifies the user that is already registered to changes the configuration.
46 (A2)		USER_NAME_1	Visiblestring[8]		User 1		S	User name related to login 1.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
47 (A2)		USER_NAME_2	Visiblestring[8]		User 2		S	User name related to login 2.
48 (A2)		USER_NAME_3	Visiblestring[8]		User 3		S	User name related to login 3.
49 (A2)		USER_NAME_4	Visiblestring[8]		User 4		S	User name related to login 4.
50 (A2)		USER_NAME_5	Visiblestring[8]		User 5		S	User name related to login 5.
51 (A2)		USER_NAME_6	Visiblestring[8]		User 6		S	User name related to login 6.
52 (A2)		USER_NAME_7	Visiblestring[8]		User 7		S	User name related to login 7.
53 (A2)		USER_NAME_8	Visiblestring[8]		User 8		S	User name related to login 8.
54 (A2)		USER_NAME_9	Visiblestring[8]		User 9		S	User name related to login 9.
55 (A2)		USER_NAME_10	Visiblestring[8]		User 10		S	User name related to login 10.
56 (A2)		USER_NAME_11	Visiblestring[8]		User 11		S	User name related to login 11.
57 (A2)		USER_NAME_12	Visiblestring[8]		User 12		S	User name related to login 12.
58 (A2)		USER_NAME_13	Visiblestring[8]		User 13		S	User name related to login 13.
59 (A2)		USER_NAME_14	Visiblestring[8]		User 14		S	User name related to login 14.
60 (A2)		USER_NAME_15	Visiblestring[8]		User 15		S	User name related to login 15.
61 (A2)		USER_NAME_16	Visiblestring[8]		User 16		S	User name related to login 16.
62 (A2)		USER_NAME_17	Visiblestring[8]		User 17		S	User name related to login 17.
63 (A2)		USER_NAME_18	Visiblestring[8]		User 18		S	User name related to login 18.
64 (A2)		USER_NAME_19	Visiblestring[8]		User 19		S	User name related to login 19.
65 (A2)		USER_NAME_20	Visiblestring[8]		User 20		S	User name related to login 20.
66 (A2)		USER_NAME_21	Visiblestring[8]		User 21		S	User name related to login 21.
67 (A2)		USER_NAME_22	Visiblestring[8]		User 22		S	User name related to login 22.
68 (A2)		USER_NAME_23	Visiblestring[8]		User 23		S	User name related to login 23.
69 (A2)		USER_NAME_24	Visiblestring[8]		User 24		S	User name related to login 24.
70 (A2)		USER_NAME_25	Visiblestring[8]		User 25		S	User name related to login 25.
71 (A2)		USER_NAME_26	Visiblestring[8]		User 26		S	User name related to login 26.
72 (A2)		USER_NAME_27	Visiblestring[8]		User 27		S	User name related to login 27.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
73 (A2)		USER_NAME_28	Visiblestring[8]		User 28		S	User name related to login 28.
74 (A2)		USER_NAME_29	Visiblestring[8]		User 29		S	User name related to login 29.
75 (A2)		USER_NAME_30	Visiblestring[8]		User 30		S	User name related to login 30.
76		RTC_RD	Unsigned8[7]				D / RO	Date and hour, in numeric format, read from the FC302 in real time.
77		RTC_WR	Unsigned8[7]				D	Date and hour to be typed in the real time clock FC302 of the in numeric format.
78 (A2)		RTC_CMD	Unsigned8	0=None 1=Copy from FC302 to RTC_WR 2=Copy from RTC_WR to FC302 3=Failed	0	E	D	Command to read or write in the real time clock of the FC302.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

GKD – Gas Knowledge Database

Description
This is a specific transducer block for gas measurement; however it is not specific for a run number, the configuration of the base conditions for this block affect the calculation for all instances of the GFC block.

Base conditions for gas measurement
The temperature and base pressure definitions (BASE_TEMPERATURE and BASE_PRESSURE parameters, respectively) for gas measurement are used at flowing calculation in the base condition (Qb), related to the flow calculated at flowing conditions (Qv).

Composition and information for each product
The FC302 supports up to four products, it means different compositions, heating value, relative density, mode to get the composition (manual input or via chromatograph), identification string. The same product can be referred by more than one gas measurement in the same FC302. The typical application is using the chromatograph measuring the gas composition before splitting in two measurement stations using the same FC302.

There are the following parameters for each product:

- COMPOSITION_Px: it selects the mode to get the gas composition which can be through chromatograph or by the user (“user enter”) or typical compositions as referenced by international standards (Gulf Coast, Amarillo, Ekofisk, High N_2, High CO_2-N_2);

- HV_GR_CALC_Px: it selects if the FC302 must calculate the heating value (Hv) and/or relative density (Gr). For example, if this parameter is selected in order to the FC302 calculates only the heating value, the input manual for this variable will be ignored and the relative density must be provided. If the composition comes from a chromatograph, thus the GC_HV input will be ignored and the GC_REL_DENSITY input must be linked in the GC block.

- PRODUCTx: it indicates the composition, heating value and the relative density utilized in the flow calculation. There is a consistency check for these information, regardless of the selected way to obtain the composition, heating value and relative density.

- PRODUCTx_NAME: string to identify the product.

Gas composition provided by user
When the gas composition is provided by laboratory analysis, the user must write the composition into the TEMPORARY_PRODUCT parameter, and then requests the transfer for the desired product through the command (GKD_CMD). The available options for written in the GKD_CMD parameter are indicated in the parameter table in the column “Valid range” by the suffix “(Wr)”. These writing options are basically for transference of the temporary product to a specific product, or the inverse.

Before accomplishing the transference to the product, the FC302 checks the consistence of the data provided related to the range for each component and sum of the percents. If there is inconsistence it will be indicated with details in the GKD_CMD parameter.

The transference for the selected product will include the heating value and relative density values if the FC302 was not configured to calculate these variables.

The table below indicates the component associated to the element in the array for the gas composition (PRODUCTx and TEMPORARY_PRODUCT).

	Description
1	Mol % - Methane
2	Mol % - Nitrogen
3	Mol % - Carbon Dioxide
4	Mol % - Ethane
5	Mol % - Prophane
6	Mol % - Water
7	Mol % - Hydrogen Sulphide
8	Mol % - Hydrogen
9	Mol % - Carbon Monoxide

	Description
10	Mol % - Oxygen
11	Mol % - i-Butane
12	Mol % - n-Butane
13	Mol % - i-Pentane
14	Mol % - n-Pentane
15	Mol % - n-Hexane
16	Mol % - n-Heptane
17	Mol % - n-Octane
18	Mol % - n-Nonane
19	Mol % - n-Decane
20	Mol % - Helium
21	Mol % - Argon
22	Reserved
23	Reserved
24	Heating Value [HV]
25	Relative Density (specific gravity)
26	Reserved
27	Reserved
28	Reserved

Configuration log for the composition provided by user
Although the PRODUCTx parameters are read only, they are under Audit Trail, because they can be written indirectly through TEMPORARY_ PRODUCT and GKD_CMD parameters. In this case, a comparison between the last and the new values will be executed for each element and only when they are different, it will be registered as configuration change, so it is possible to optimize the register quantity.

Information about the pulse signal flow meter (METERx_INFO)
The NKF is the main feature for the meter and must be configured in the METERx_INFO parameter. This factor is used in the conversion from pulses to volume/mass. Other information are strings to identify the meter manufacturer, serial number, model, size and meter number.

These information about the meter are associated to the run number, for example, the METER1_INFO refers to the meter used for the run number 1 and the METER2_INFO refers to the meter used for the run number 2, and so on. It means the GFC/GT block will utilize the NKF of the METER3_INFO parameter, when it has the STRATEGY parameter equals to 3 and using a pulse signal flow sensor.

If the sensor selected for the flow measurement does not use a pulse signal, this parameter can be ignored.

Meter Factor history for each meter
The MFx_HISTORY parameters store the last eight meter factor for the meter, thus the user can write only in the first element of the structure, and this will shift the last seven changes of the meter factor and to enter the new value. The MF1_HISTORY parameter is associated to the run number 1 and the MF2_HISTORY parameter is associated to the run number 2, and so on.

Local Atmospheric Pressure
The local atmospheric pressure must be configured in the ATMOSPHERE_PRESSURE parameter where the measurement system is installed. This information will be used to convert the gauge pressure into absolute pressure (value used in the flow calculations), and must be configured in the GFC.PRESSURE_TYPE block for gauge pressure. Thus, for each flow calculation block (GFC), it has the configuration if the static pressure provided is absolute or gauge (and in this case, the sum will be with the local atmospheric pressure).

Diagnosis and Troubleshooting
1. BLOCK_ERR. Out of Service: the block is in the Out of service mode;
2. Failure during the transference of the composition from the TEMPORARY_PRODUCT to the desired product, according to the indication in the GKD_CMD parameter. It one of the substances was indicated, verify the range according to the following table:

Substance	Expanded Range
Relative Density	0.07 to 1.52
Heating Value	0 to 66 MJ/m^3
Mol % - Methane	0 to 100
Mol % -Nitrogen	0 to 100
Mol % - Carbon Dioxide	0 to 100
Mol % - Ethane	0 to 100
Mol % - Prophane	0 to 12
Mol % - Total of butanes	0 to 6
Mol % - Total pentanes	0 to 4
Mol % - Total hexanes +	0 to Dew Point
Mol % - Helium	0 to 3
Mol % - Hydrogen	0 to 100
Mol % - Carbon Monoxide	0 to 3
Mol % - Argon	0 to 1
Mol % - Oxygen	0 to 21
Mol % - Water	0 to Dew Point
Mol % - Hydrogen Sulphide	0 to 100

(*)If the extended range is selected (GKD_CMD= Transf to Ext. PRODUCTx(Wr)), the range of the molar percentages for all components is 0% to 100%.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	This parameter is used to identify the run number. This block has information related to all measured flows; therefore it is a read only parameter.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (A1) (CL)	4	BASE_PRESSURE	Float	> 0.0	101.325 kPa	P	S / OS	Base pressure for gas in the Engineering Unit selected in P_UNITS parameter in the FCT block.
8 (A1) (CL)	4	BASE_TEMPERATURE	Float		15.00 °C	T	S / OS	Base temperature for gas in the Engineering Unit selected in T_UNITS parameter in the FCT block.
9 (A2) (CL)	4	COMPOSITION_P1	Unsigned8	0 - User Enter 1 - Chromatograph 2 - Gulf Coast 3 - Amarillo 4 - Ekofisk 5 - High N_2 6 - High CO_2-N_2	3	E	S	It defines the source of the gas composition for the product 1. If the option "Chromatograph" was selected, it is not allowed manual input of the gas composition through the GKD_CMD parameter.
10 (A2) (CL)	4	HV_GR_CALC_P1	Unsigned8	0 - None 1 – HV 2 – Gr 3 – HV & Gr	3	E	S	It selects if the FC302 should calculate the heating value (HV) and/or relative density (Gr) for the PRODUCT1.
11 (A2) (CL)	4	COMPOSITION_P2	Unsigned8	0 - User Enter 1 - Chromatograph 2 - Gulf Coast 3 - Amarillo 4 - Ekofisk 5 - High N_2 6 - High CO_2-N_2	3	E	S	It defines the source of the gas composition for the product 2. If the option "Chromatograph" was selected, it does not allowed handle input in the gas composition through the GKD_CMD parameter

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
12 (A2) (CL)	4	HV_GR_CALC_P2	Unsigned8	0 - None 1 – HV 2 – Gr 3 – HV & Gr	3	E	S	It selects if the FC302 should calculate the heating value (HV) and/or relative density (Gr) for the PRODUCT2.
13 (A2) (CL)	4	COMPOSITION_P 3	Unsigned8	0 - User Enter 1 - Chromatograph 2 - Gulf Coast 3 - Amarillo 4 - Ekofisk 5 - High N_2 6 - High CO_2-N_2	3	E	S	It defines the source of the gas composition for the product 3. If the option “Chromatograph” was selected, it is not allowed manual input for the gas composition through the GKD_CMD parameter.
14 (A2) (CL)	4	HV_GR_CALC_P3	Unsigned8	0 - None 1 – HV 2 – Gr 3 – HV & Gr	3	E	S	It selects if the FC302 should calculate the heating value (HV) and/or relative density (Gr) for the PRODUCT3.
15 (A2) (CL)	4	COMPOSITION_P 4	Unsigned8	0 - User Enter 1 - Chromatograph 2 - Gulf Coast 3 - Amarillo 4 - Ekofisk 5 - High N_2 6 - High CO_2-N_2	3	E	S	It defines the source of the gas composition for the product 4. If the option “Chromatograph” was selected, it is not allowed manual input for the gas composition through the GKD_CMD parameter.
16(A2) (CL)	4	HV_GR_CALC_P4	Unsigned8	0 - None 1 – HV 2 – Gr 3 – HV & Gr	3	E	S	It selects if the FC302 should calculate the heating value (HV) and/or relative density (Gr) for the PRODUCT4.
17 (A2) (CL)		PRODUCT1	Float[28]				N / RO	Information about the product 1 (including gas composition, heating value, relative density).
18 (A2) (CL)		PRODUCT2	Float[28]				N / RO	Information about the product 2 (including gas composition, heating value, relative density).
19 (A2) (CL)		PRODUCT3	Float[28]				N / RO	Information about the product 3 (including gas composition, heating value, relative density).
20 (A2) (CL)		PRODUCT4	Float[28]				N / RO	Information about the product 4 (including gas composition, heating value, relative density).
21 (A2) (CL)	2	PRODUCT1_NAM E	Visiblestring [16]				S	Product name 1.
22 (A2) (CL)	2	PRODUCT2_NAM E	Visiblestring [16]				S	Product name 2.
23 (A2) (CL)	2	PRODUCT3_NAM E	Visiblestring [16]				S	Product name 3.
24 (A2) (CL)	2	PRODUCT4_NAM E	Visiblestring [16]				S	Product name 4.
25	4	NO_GAS_FLOW	Float	>= 0.0	0.0	M	S / RO	Parameter not used.
26		TEMPORARY_PR ODUCT	Float[28]			%	D	Gas temporary composition while is being edited, after that, it must be transferred to the PRODUCTx desired through the GKD_CMD parameter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
27 (R)		GKD_CMD	Unsigned8	0=None 1=Transfer to PRODUCT1(Wr) 2=Transfer to PRODUCT2(Wr) 3=Transfer to PRODUCT3(Wr) 4=Transfer to PRODUCT4(Wr) 5=Transf to Ext. PRODUCT1(Wr) 6=Transf to Ext. PRODUCT2(Wr) 7=Transf to Ext. PRODUCT3(Wr) 8=Transf to Ext. PRODUCT4(Wr) 11=Methane 12=Nitrogen 13=Carbon Dioxide 14=Ethane 15=Propane 16=Water 17=Hydrogen sulfide 18=Hydrogen 19=Carbon monoxide 20=Oxygen 21=I-Butane 22=n-Butane 23=I-Pentane 24=n-Pentane 25=n-Hexane 26=n-Heptane 27=n-Octane 28=n-Nonane 29=n-Decane 30=Helium 31=Argon 32=Total butanes 33=Total Pentanes 34=HV 35=Gr 101=Copy from PRODUCT1(Wr) 102=Copy from PRODUCT2(Wr) 103=Copy from PRODUCT3(Wr) 104=Copy from PRODUCT4(Wr) 201=Total greater than 100% 202=Total less than 100% 203=Inconsistent composition 253=Successful transfer, but in expanded range 254=Successful transfer, but in extended range 255=Successful transfer	0	Na	D	Basically, it is possible to execute two types of operation: to transfer the gas composition from the TEMPORARY_PRODUCT parameter to the desired product or to copy from the PRODUCTx to the TEMPORARY_ PRODUCT. The second type of operation is recommended when it intends to adjust just some components. After the command, it will return the result of the consistence check.
28		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
29		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported, without clearing the Active status, if the subcode has changed.
30 (A2) (CL)		METER1_INFO	DS-268				S / OS	Information for the meter 1 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 1.
31 (A2) (CL)		METER2_INFO	DS-268				S / OS	Information for the meter 2 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 2.
32 (A2) (CL)		METER3_INFO	DS-268				S / OS	Information for the meter 3 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 3.
33 (A2) (CL)		METER4_INFO	DS-268				S / OS	Information for the meter 4 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 4.
34 (A2)		MF1_HISTORY	DS-271	0.8 to 1.2	1.0000		S / OS	The last 8 meter factors and their correspondent date/hour for the meter 1. The first element of the array is the MF used and it is the only one that can be written by user.
35 (A2)		MF2_HISTORY	DS-271	0.8 to 1.2	1.0000		S / OS	The last 8 meter factors and their correspondent date/hour for the meter 2. The first element of the array is the MF used and it is the only one that can be written by user.
36 (A2)		MF3_HISTORY	DS-271	0.8 to 1.2	1.0000		S / OS	The last 8 meter factors and their correspondent date/hour for the meter 3. The first element of the array is the MF used and it is the only one that can be written by user.
37 (A2)		MF4_HISTORY	DS-271	0.8 to 1.2	1.0000		S / OS	The last 8 meter factors and their correspondent date/hour for the meter 4. The first element of the array is the MF used and it is the only one that can be written by user.
38 (A2) (CL)		ATMOSPHERE_PRESSURE	Float	> 0.0	101.325	P	S	Local Atmospheric Pressure. It is used when the gauge pressure is selected in the GFC.PRESSURE_TYPE block.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

LKD – Liquid Knowledge Database

Description
This is a specific transducer block for liquid measurement; therefore it is not specific for a run number. The configuration of the base conditions for this block affects the calculations for all instances of the blocks for liquid measurement, that calculate the flow corrector, except the LCF block which has self-configuration for base condition.

Base conditions for liquid measurement
The base temperature (BASE_TEMPERATURE) and equilibrium pressure define the base conditions for liquid measurement. They are used in the flow/totalization calculation at base conditions (GSV) related to the flow/totalization at flowing conditions (IV). For the products which have the equilibrium pressure equals or less than 101.325 Kpa (abs) / 14.696 psia, the equilibrium pressure used is this value.

Information about the signal flow meter in pulse (METERx_INFO)
The NKF is the main feature for the meter and must be configured in the METERx_INFO parameter, this factor is used in the conversion from pulses to volume.

Information as strings identifies the meter manufacturer, serial number, model, size and meter number.

These information about the meter are associated to the run number, for example, the METER1_INFO refers to the meter used for the run number 1 and the METER2_INFO refers to the meter used for the run number 2, and so on. It means the GFC/GT block, which has the STRATEGY parameter equals to 3 and is using a pulse signal flow sensor, will utilize the NKF of the METER3_INFO parameter.

If the sensor selected for the flow measurement does not use a pulse signal, this parameter can be ignored.

Linearization of the pulse meter (LINx_TYPE, METERx_FREQ and METERx_LIN)
Rules for the linearization curve related to the frequency for meters with pulse signal input:

- Crescent values of frequency in the METERx_FREQ parameter;
- The first value zero in the METERx_FREQ parameter indicates the end of the curve, except for the first element;
- The value of the factor for each one of the configured frequencies must be higher than zero;
- If there is inconsistence in the configuration of the linearization curve, it will be indicated as configuration error and the measurement block will execute in Out of Service mode.
- Curve with 12 points.

If the operation frequency is out of range of the linearization curve in any moment, the value of the factor related to the limit of the configured frequency (upper or lower) will be used. This linearization curve allows 3 different operation ways according to the LINx_TYPE parameter:

1. K-factor linearization (K-factor = NKF/MF): the calibration value is included in the curve and the MF value for the calculations will be obtained through the division of NKF factor by the average weighted of K-factor. The proving process consists of executing the proving for different flows, this must be impossible due to project (proving in different flows) or time.
2. NKF linearization: the linearization curve, in fact, indicates NKF related to the frequency, that is, the curve obtained in the laboratory, after the meter manufacturing, is kept unchanged. The proving process must be executed using the usual flow (frequency), where the MF must be unique for the whole operation range.
3. MF linearization: the linearization curve indicates MF related to the frequency. It is obtained in large time intervals, while the last proving (low periodicity) executed for the flow closest to the usual provides to the linearization curve an adjusting.

The indicated values for k-factor, NKF and MF in the QTR reports or proving, if they are result of linearization process, are obtained through weighted average calculations, according to the API-21.2 item 10.3.4 standard.

LINx_TYPE	METERx_INFO.NKF	MF_METER_PRODUCT. Meter factor(n) – last proving	Factor that changes according to the frequency/flow	Specific consistence check
K-factor	It must be configured by user	Ignored, calculates the $MF=NKF/KF_{lin}$	MF, it is included in the K-factor.	NKF divided by each one of the K-factor values, This result must be between the range from 0.8 to 1.2
NKF	Ignored	Used for the calculations	NKF	
MF	It must be configured by user	Used for adjusting the linearization curve of MF.	MF	MF value in the range from 0.8 to 1.2

Note: Each meter has only one linearization curve, it is obtained from a determined condition, and also includes the product type. The user must keep the consistence between:

- Linearization curve obtained for the product type;
- MF obtained for proving using the same product of the obtained curve (NKF or MF linearization);
- The measured product must be the same of the product used for the curve obtainment.

Special procedures when selecting the MF linearization:

- It configures the linearization curve between the established range from 0.8 to 1.2 for METERx_LIN;
- It accomplishes the proving with the new configuration, or writing the MF and also the flow that the proving was executed.

Information about provers

When the master meter for proving is used, the MASTER_METER_INFO parameter must be configured properly.

Observe that the Base Prover Volume, Outside diameter and Wall thickness parameters must be provided at base temperature defined for this block at base TEMPERATURE parameter.

The default prover configuration using SI Unit System is shown below:

PROVER1_INFO :

E	Element Name	Data Type
1	Prover type	Small volume prover, unidirectional
2	Base Prover Volume (not used if tank prover)	0.120350 m^3
3	Outside diameter	469.90 mm
4	Wall thickness	31.75 mm
5	Pipe Gl	0.0000112 1/Celsius
6	Modulus of elasticity [Elas]	206 800 000 1/KPa
7	Single-walled (0=No; 1=Yes)	Yes
8	External shaft – Gl (0.0=internal detectors)	0.0000014 1/Celsius
9	Serial number	9501-1754
10	Manufacturer name	SK Instruments

PROVER2_INFO :

E	Element Name	Data Type
1	Prover type	U type, unidirectional
2	Base Prover Volume (not used if tank prover)	0.905060 m^3
3	Outside diameter	396.88 mm
4	Wall thickness	9.53 mm
5	Pipe Gl	0.0000159 1/Celsius
6	Modulus of elasticity [Elas]	193 100 000 1/KPa

E	Element Name	Data Type
7	Single-walled (0=No; 1=Yes)	Yes
8	External shaft – Gl (0.0=internal detectors)	0 1/Celsius
9	Serial number	SPA-430
10	Manufacturer name	PP Industries

PROVER3_INFO :

E	Element Name	Data Type
1	Prover type	U type, bidirectional
2	Base Prover Volume (round trip if bidirectional prover)	1.81974 m^3
3	Outside diameter	396.88 mm
4	Wall thickness	9.53 mm
5	Pipe Gl	0.0000159 1/Celsius
6	Modulus of elasticity [Elas]	193 100 000 1/KPa
7	Single-walled (0=No; 1=Yes)	Yes
8	External shaft – Gl (0.0=internal detectors)	0 1/Celsius
9	Serial number	SPB-430
10	Manufacturer name	PP Industries

PROVER4_INFO :

E	Element Name	Data Type
1	Prover type	Tank prover
2	Base Prover Volume (not used if tank prover)	5.00000 m^3
3	Outside diameter	0 mm
4	Wall thickness	0 mm
5	Pipe Gl	0 1/Celsius
6	Modulus of elasticity [Elas]	0 1/KPa
7	Single-walled (0=No; 1=Yes)	No
8	External shaft – Gl (0.0=internal detectors)	0 1/Celsius
9	Serial number	023
10	Manufacturer name	BR 102/5255

Linear Thermal Expansion Coefficient and elasticity module obtained from API MPMS 12.2.3 – item 11.2. for International System:

Material Type	Gl(1/°C)	E (kPa)
Mild carbon	0.0000112	206 800 000
304 Stainless	0.0000173	193 100 000
316 Stainless	0.0000159	193 100 000
17-4PH Stainless	0.0000108	-
Invar Rod	0.0000014	-

Linear Thermal Expansion Coefficient and Elasticity Module obtained from API MPMS 12.2.3 – item 11.2. for American Unit System (US) :

Material Type	Gl(1/°F)	E (psi)
Mild carbon	0.00000620	30 000 000
304 Stainless	0.00000960	28 000 000
316 Stainless	0.00000883	28 000 000
17-4PH Stainless	0.00000600	-
Invar Rod	0.00000080	-

Information about measured products (PRODUCTx_INFO)

The products measured by FC302 are showed in the graphs below and also the correspondent valid ranges for density and temperature for calculation of the correction factors.

The selection of emulsion product type (mix of crude oil/light hydrocarbon and water) means an allocation measurement and the API-MPMS 20.1 Allocation Measurement Standard will be used for the correction factor calculations.

The allocation measurement (mix of crude oil/light hydrocarbon and water) has some restrictions when compared to the custody transfer measurement:

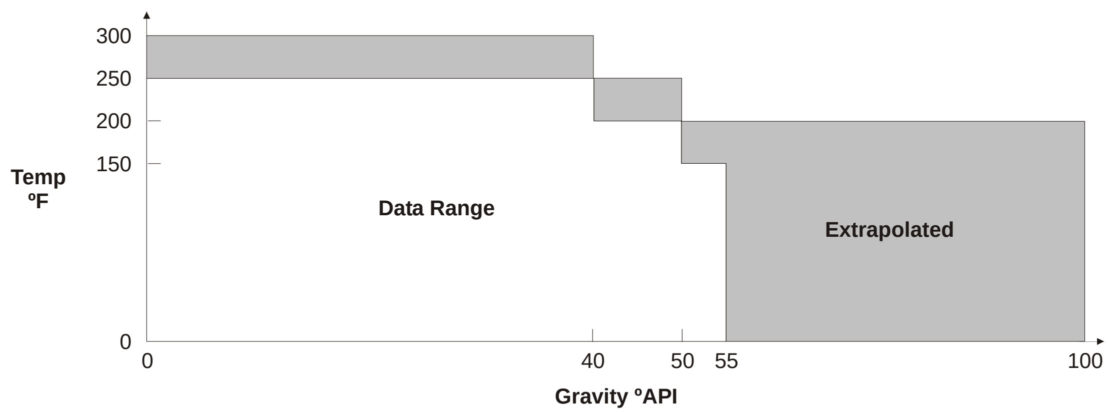
- Meter or master meter are not supported with pulse or analog signal IV*CTL.
- The density type for hydrocarbon (crude oil or light hydrocarbon) must be at base condition, resulting from laboratory analysis.
- Meter Proving in field using emulsion is only allowed on the following configurations:
    1. Volume meter of the IV pulse input and prover type (piston prover, ball prover and tank prover).
    2. Master meter: meter and master meter should be of the same type and one of the following types: IV pulse input, IV analog input, IM pulse input or IM analog input.

To calculate the temperature (CTL) and pressure (CPL) correction factors, if the density or temperature were out of the established range by the standard, these factors will assume the value 1. This event will be registered in the logger and accessed via AEV block, and also it will be showed in the summarized status of the QTR report for the correspondent period.

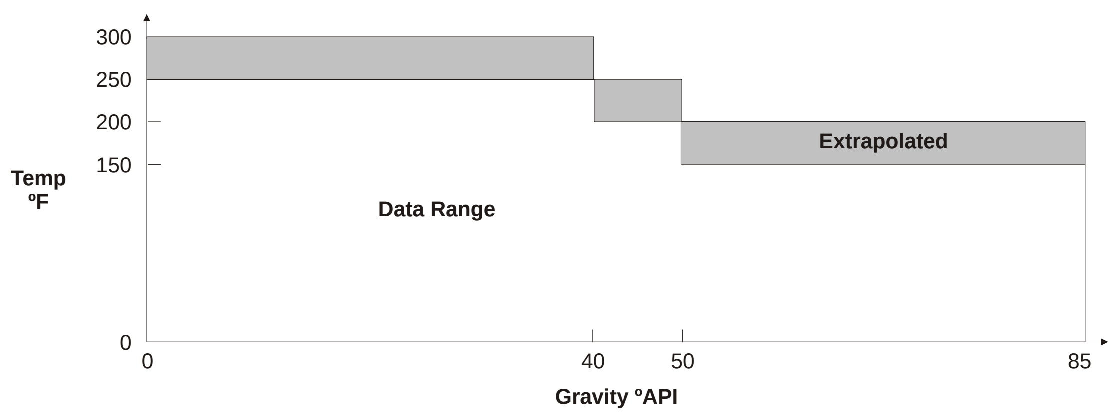
This rule is applied to average values (period of one batch, hour, day, week or month) or instantaneous values (used to calculate flow).

The variable ranges used in the correction factor calculations are presented below, which the density and temperature ranges indicated for the CTL calculation does not indicate a square area. This means even obeying the indicated range, it can have the “out-of-range” indication, therefore if the variable was out of the indicated range, certainly there will be the “out-of-range” indication.

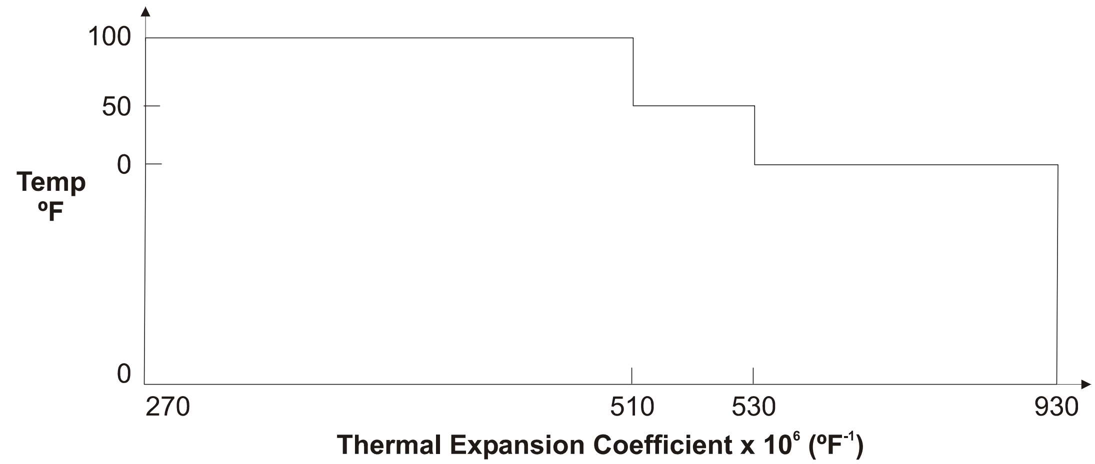
Tables used in the CTL calculation:



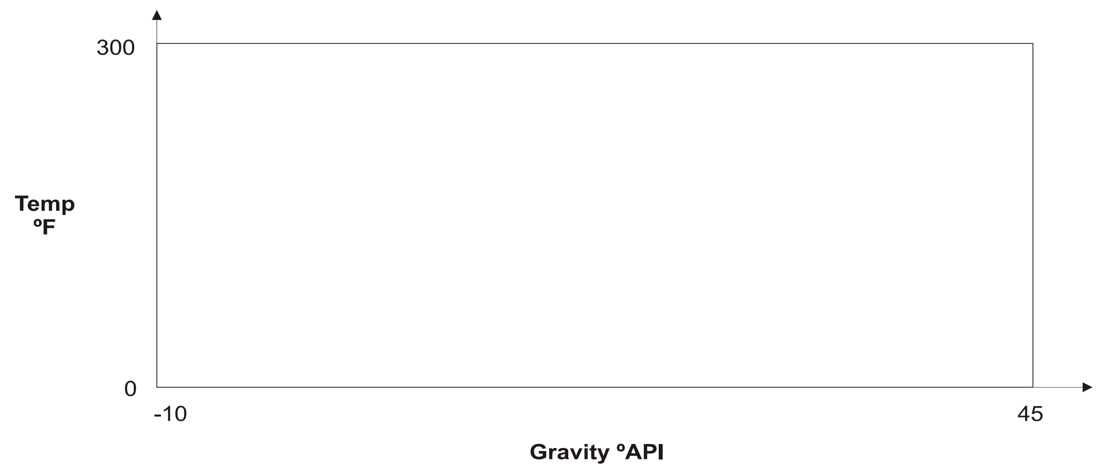
Graph for Tables 5A/6A – Crude Oil



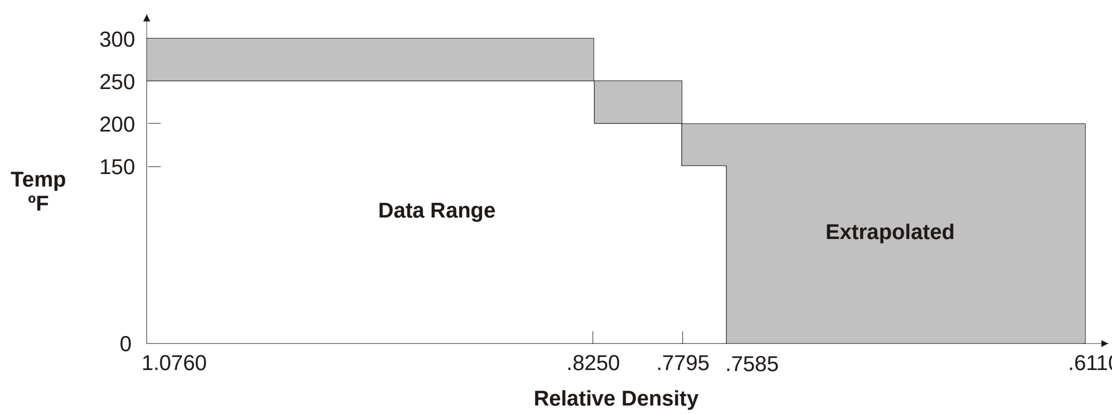
Graph for Tables 5B/6B – Generalized Products



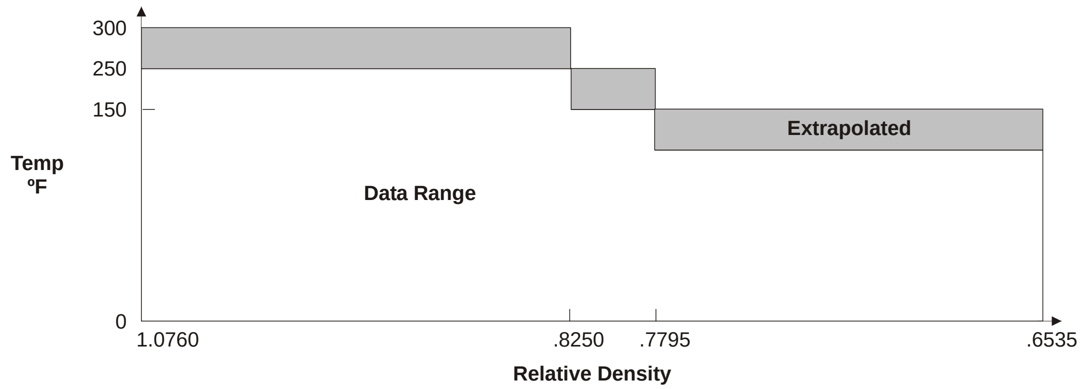
Graph for Table 6C - MTBE



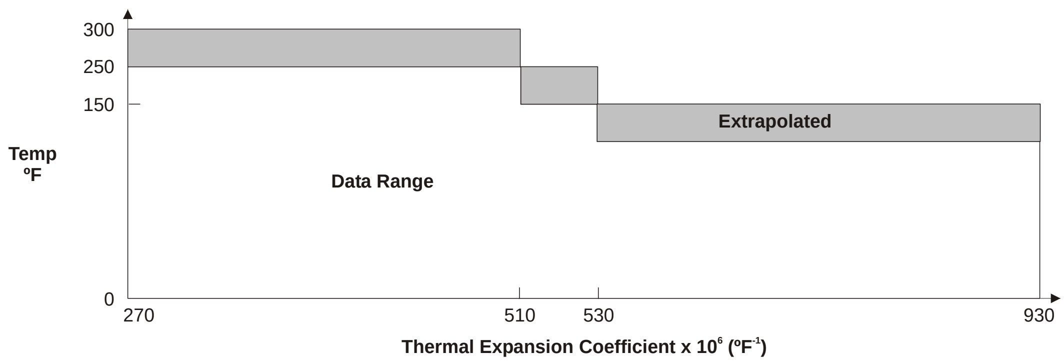
Graph for Table 5D – Lubrificant Oil



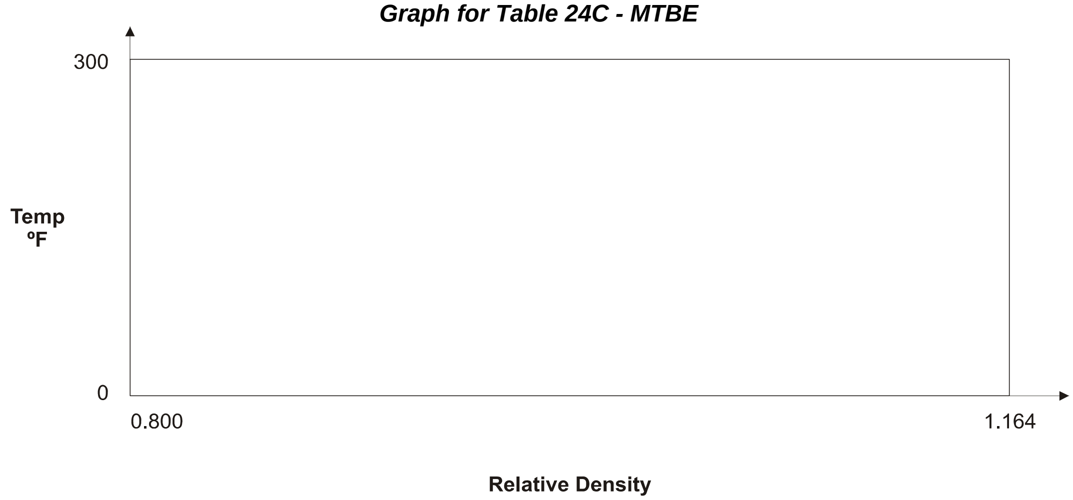
Graph for Tables 23A/24A –Crude Oil



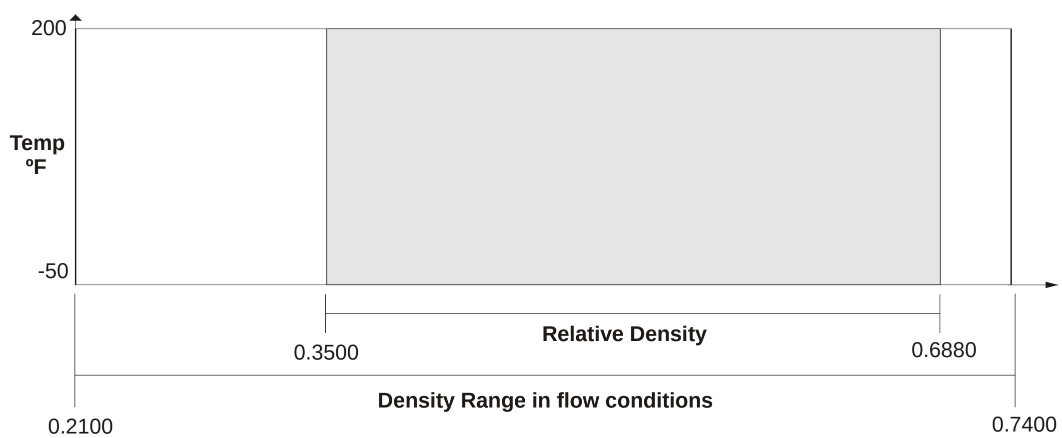
Graph for Tables 23B/24B – Generalized Products



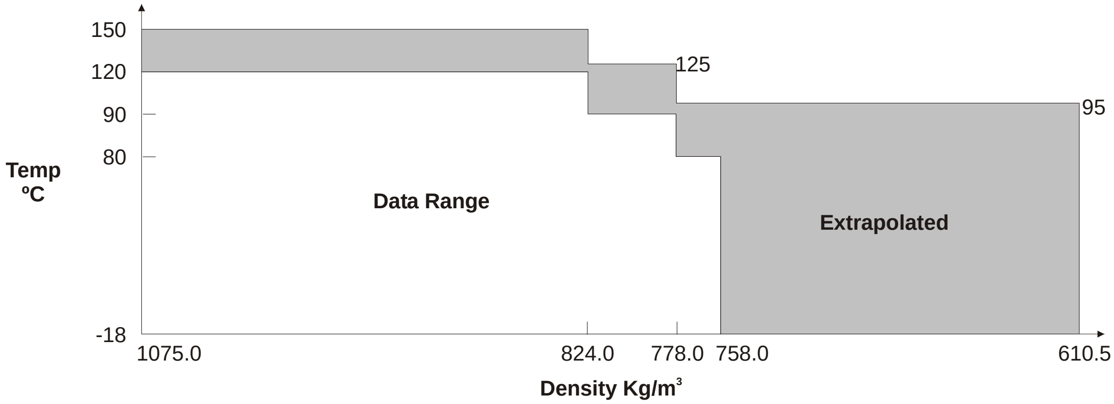
Graph for Table 24C - MTBE



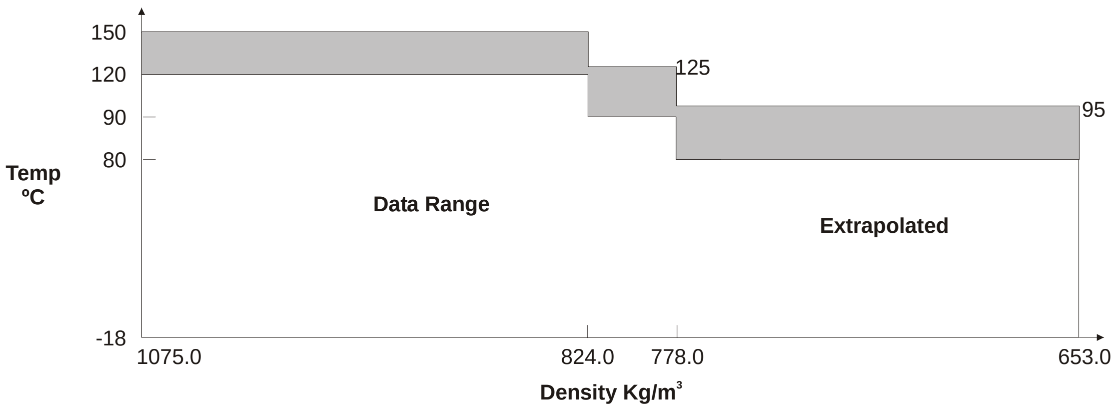
Graph for Tables 23D/24D – Lubricant Oil



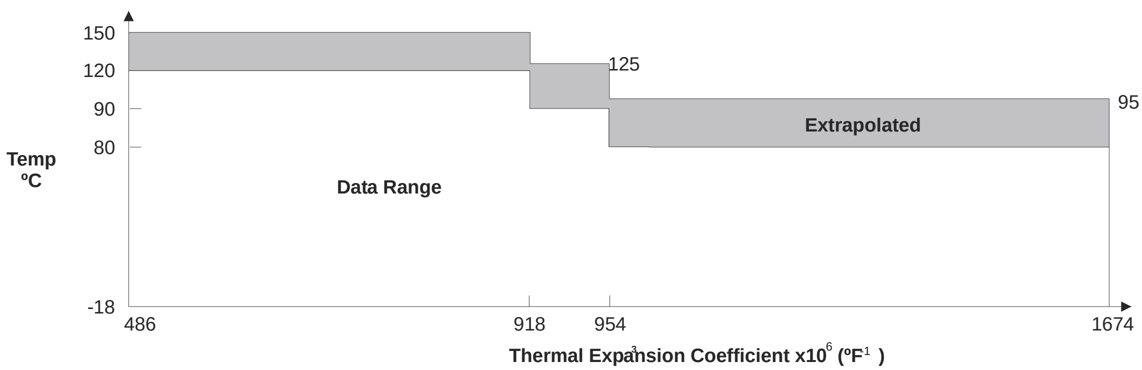
Graph for Tables 23E/24E – Light Hydrocarbon



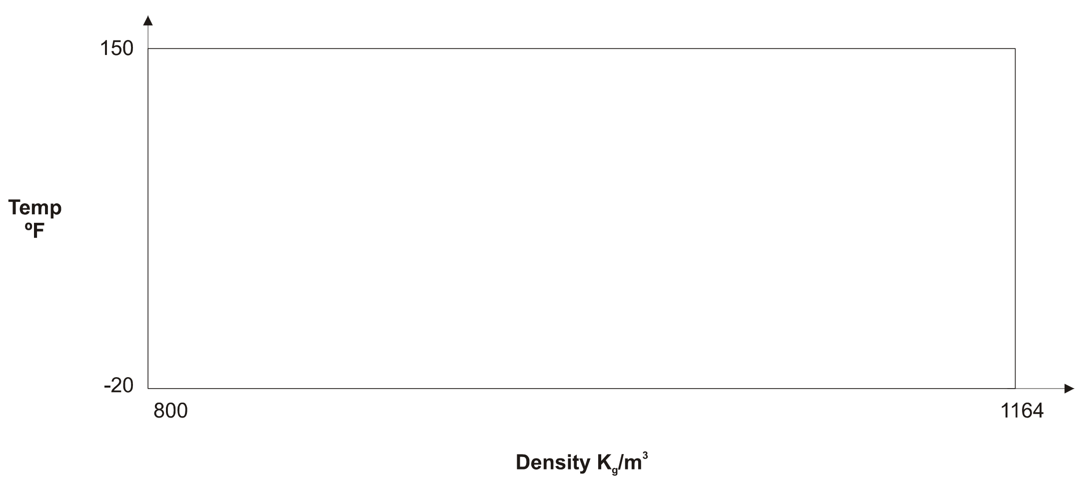
Graph for Tables 53A/54A/59A/60A – Crude Oil



Graph for Tables 53B/54B/59B/60B – Generalized Products



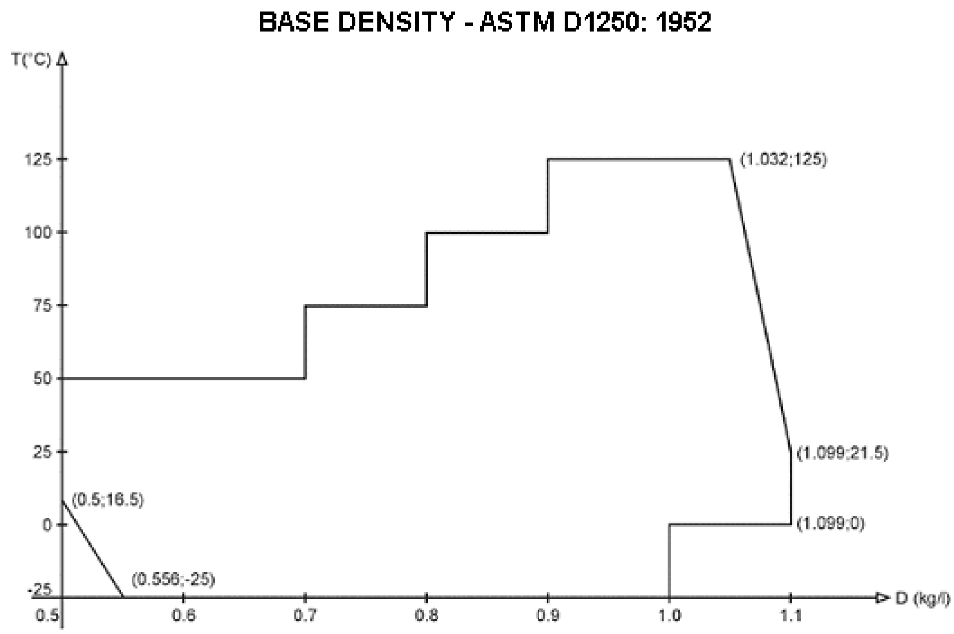
Graph for Tables 54C/59C - MTBE

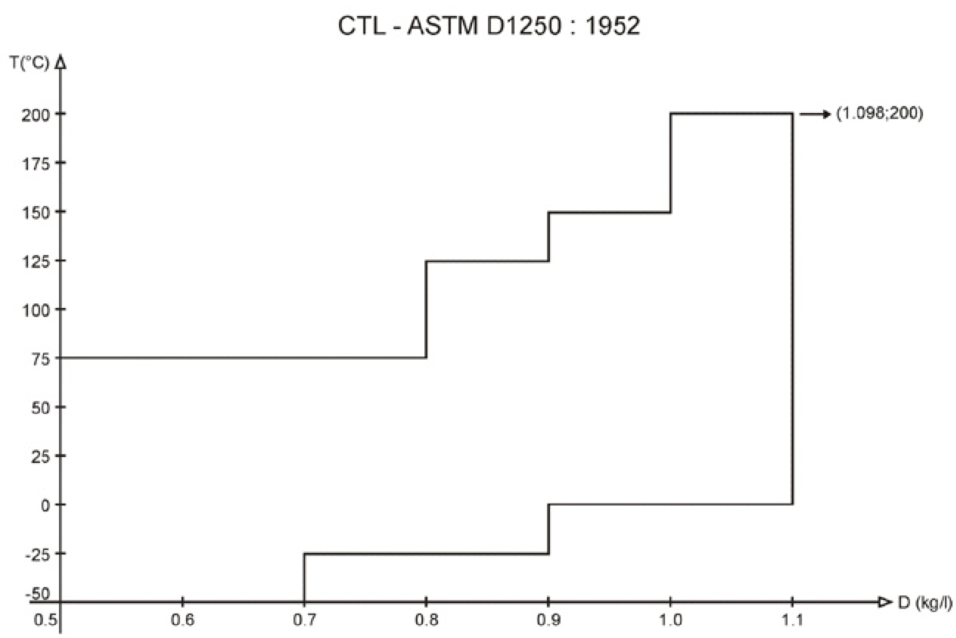


Graph for Tables 53D/54D/59D/60D – Lubrificant Oil

For the CTL calculation of the MTBE product (Methyl Tert-butyl Ether), it utilizes the coefficient of thermal expansion at base temperature instead of the density. This coefficient must be configured in the PRODUCTx_INFO parameter.
(*) Coefficient of thermal expansion at 60ºF
(**) Coefficient of thermal expansion at 15ºC

Calculation of base density and CTL by using ASTM D 1250:1952 (*)





(*) The product type is only available for non redundant version.

NOTE
The density value provided in the DENSITY_METER parameter of the LBT/LCT blocks is used for calculating the compressibility factor calculation for MTBE.

Standards used in the CPL calculation:

Standard	Base density range	Temperature range	Product Type
API-11.2.1	0-90 API @ 60 °F	-20 to 200 °F	Crude Oil Generalized Products MTBE Lubricant Oil Light Hydrocarbon Emulsion of Crude Oil and Water Emulsion of Light Hydrocarbon and Water ASTM D1250:1952
API-11.2.1.M	638-1074 Kg/m3 @15° C	-30 to 90 °C	Crude Oil Generalized Products MTBE Lubricant Oil Light Hydrocarbon Emulsion of Crude Oil and Water Emulsion of Light Hydrocarbon and Water ASTM D1250:1952
API-11.2.2 (*)	0.350-0.637 RD (60°F/60°F)	-50°F to 140°F	Light Hydrocarbon Emulsion of Light Hydrocarbon and Water
API-11.2.2.M (*)	350-637 Kg/m^3 @15° C	-46°C to 60°C	Light Hydrocarbon Emulsion of Light Hydrocarbon and Water

(*) The GPA TP 15 standard is used for calculating the equilibrium pressure.

Standard	Base Density Range(RD (60°F/60°F)	Temperature range (°F)
GPA-TP-15	0.490 to 0.676	-50°F a 140°F

The GPA TP 15 standard establishes two calculation formulas:

- New Correlation – Related to base density and temperature → mix of propane, mix of butane and NGL (mainly pentane and hexane).
- Modified Correlation – Related to base density, temperature and equilibrium absolute pressure at 100 °F = 37.8 °C → proper for NGL measurement that the variation of the equilibrium pressure at 100 °F is more significant for the same density

Besides five products mentioned (crude oil, generalized products, MTBE, lubrificant oil and LPG/NGL), there are another options to select water and emulsion of water and oil. For these two products, the water is compensated in temperature using the base density and flow temperature. The ranges for water base density and correction factor temperature are indicated in the table below:

Product	Base density range	Temperature range
water	999 to 1100	60°F/15°C to 280°F/138°C

The CPL calculation for water utilizes the following factors for compressibility, according to the ISO4267-2:

Temperature [°C]	F [1/Kpa]
T <= 7.5	4.9 E-7
7.5 < T <= 12.5	4.8 E-7
12.5 < T <= 17.5	4.7 E-7
17.5 < T <= 22.5	4.6 E-7
22.5 < T <= 32.5	4.5 E-7
T > 32.5	4.4 E-7

Light Hydrocarbon Measurement – NGL / LPG

The light hydrocarbon measurement shows a particularity, because there is no an international standard for temperature correction factor (CTL) for the base temperatures of 15°C or 20°C in the International System of Units.

The previous standards GPA TP16 and GPA TP 16M are discontinued. The GPA TP 16 M was applied to the International System of Units.

The new standard GPA TP 25, which defines the tables 23E and 24E, utilizes the relative density (SG) as input and the temperature in Fahrenheit to obtain the base density at 60°F and the CTL.

The following calculations are developed for FC302 in order to fill this standard table:

1. International System of Units and base temperature of 15°C

- The process density is converted from Kg/m^3 to SG
- The process temperature is converted from Celsius to Fahrenheit
- It calculates the relative density at the base temperature of 60°F using the table 23E
- The temperature correction factor is calculating following the equation below:

$$CTL_{T,15°C} = \frac{CTL_{T,60°F}}{CTL_{15°C,60°F}}$$

Where:
$CTL_{T,15°C}$: temperature correction factor of the process at 15°C
$CTL_{T,60°F}$: temperature correction factor of the process at 60°F using the table 24E.
$CTL_{15°C,60°F}$:correction factor from 15°C to 60°F using the table 24E.

- It calculates the equilibrium pressure using the GPA TP 15 standard providing the relative density in the base temperature of 60°F and the process temperature.
- It calculates the compressibility factor using the API-11.2.2 standard providing the relative density in the base temperature of 60°F, the process temperature and the pressure higher than the equilibrium pressure.

2. International System of Units and base temperature of 20°C

- The process density is converted from Kg/m^3 to SG
- The process temperature is converted from Celsius to Fahrenheit
- It calculates the relative density at base temperature of 60°F using the table 23E
- It calculates the temperature correction factor following the equation below:

$$CTL_{T,20°C} = \frac{CTL_{T,60°F}}{CTL_{20°C,60°F}}$$

Where:
$CTL_{T,20°C}$: temperature correction factor of the process for 20°C
$CTL_{T,60°F}$: temperature correction factor of the process for 60°F using the table 24E.
$CTL_{20°C,60°F}$: correction factor from 20°C to 60°F using the table 24E.

- It calculates the equilibrium pressure using the GPA TP 15 standard providing the relative density at base temperature at 60°F and the process temperature.

- It calculates the compressibility factor using the API-11.2.2.M standard, providing the relative density at base temperature at 60°F, process temperature and the pressure higher than the equilibrium pressure. The API-11.2.2.M standard determines the base temperature conversion at 15°C to the relative density at the base temperature of 60°F, thus it is not necessary to calculate the density in kg/m^3 at15°C.

The temperature and pressure correction factors are calculated using 3 standards: GPA TP 15, GPA TP 25 and API-11.2.2/API-11.2.2.M or API-11.2.1/API-11.2.1.M. Each standard has the density and temperature ranges proper, so the intersection among them provides the range which allows the whole calculation, as showed below:

Base density range (RD (60°F/60°F)	Temperature range
0.490 to 0. 676	- 46°C/-50°F to 60°C/140°F

Information for the proving historic

The historic of information about the last provings is stored in the FC302 memory and can be visualized after the meter selection and the measured product. The information are available in the MF_METER_PRODUCT and CONDITIONS_M_P parameters, and also be visualized through the combination between meter and product.

Each one of the configured products in PRODUCTx_INFO, measured by the operational and master meters has: historic (MF and date/hour) of the last provings in the MF_METER_PRODUCT parameter and the conditions which the last and the last but two provings were accomplished in the CONDITIONS_M_P parameter.

Meter factor changes (MF)
In some situations, it desired to change directly the MF, because the meter was calibrated by a prover with calculation capacity and MF determination or the meter was calibrated in laboratory, then the user must select the meter through the SELECT_METER and the product through the SELECT_PRODUCT, then:

1. Write the volume flow rate (IV) into the CONDITIONS_M_P.Current flowrate IV parameter. This information is very important if the meter factor linearization is selected.
2. Writing the new value for MF in the first element of the MF_METER_PRODUCT parameter in a time interval lower than 30 seconds after writing the flow rate. Writing it, FC302 will provide the correspondent date/time of change.

The CONDITIONS_M_P.Current flowrate IV parameter will return to the previous value if:

- The time interval of 30 seconds expired;
- The meter (SELECT_METER) or product (SELECT_PRODUCT) selection changed before completing the above procedure.

Therefore the writing into the flow rate is confirmed through the writing into the correspondent meter factor.

Diagnosis and Troubleshooting

1. BLOCK_ERR. Out of Service: the block is in the Out of service mode.
2. BLOCK_ERR. Block configuration : this indication can occur due to the following problem:
    a. There is an inconsistence in the linearization curve

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16		0	None	S / RO	This parameter is used to identify the run number. This block has information related to all measured flows; therefore it is a read only parameter.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	4	BASE_PRESSURE	Float SI-DD10 US-DD10 Bar-DD1	101.325 kPa or 14.696 psi	101.325 kPa	P	S / RO	Parameter not used.
8 (A1) (CL)	4	BASE_TEMPERATURE	Float SI-DD2 US-DD1	15.0 °C or 20.0 °C (Kg/m^3) or 60.0 °F (API or SG)	15.0 °C	T	S / OS	Base pressure for the fluid according to the SYSTEM_UNITS selected in the FCT block.

Idx	Type/View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
9 (A2) (CL)		METER1_INFO	DS-268				S / OS	Information for the meter 1 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 1.
10 (A2) (CL)		METER2_INFO	DS-268				S / OS	Information for the meter 1 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 2.
11 (A2) (CL)		METER3_INFO	DS-268				S / OS	Information for the meter 1 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 3.
12 (A2) (CL)		METER4_INFO	DS-268				S / OS	Information for the meter 1 provided by the manufacturer. This parameter should be configured when a pulse signal sensor is selected for the run number 4.
13 (A2) (CL)		MASTER_METER_INFO	DS-268				S / OS	Information for the Master meter information provided by the manufacturer.
14 (A2) (CL)		PROVER1_INFO	DS-269				S / OS	Information for Prover 1 provided by manufacturer.
15 (A2) (CL)		PROVER2_INFO	DS-269				S / OS	Information for Prover 2 provided by manufacturer.
16 (A2) (CL)		PROVER3_INFO	DS-269				S / OS	Information for Prover 3 provided by manufacturer.
17 (A2) (CL)		PROVER4_INFO	DS-269				S / OS	Information for Prover 4 provided by manufacturer.
18 (A2) (CL)		PRODUCT1_INFO	DS-270		Crude Oil		S / OS	Information for Product 1.
19 (A2) (CL)		PRODUCT2_INFO	DS-270		Generalized Products		S / OS	Information for Product 2
20 (A2) (CL)		PRODUCT3_INFO	DS-270		MTBE		S / OS	Information for Product 3.
21 (A2) (CL)		PRODUCT4_INFO	DS-270		Lubricating Oil		S / OS	Information for Product 4.
22 (A2) (CL)		PRODUCT5_INFO	DS-270		Light hydrocarbon		S / OS	Information for Product 5.
23 (A2) (CL)		PRODUCT6_INFO	DS-270		Emulsion Crude Oil and Water/ base density		S / OS	Information for Product 6.

Idx	Type/View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
24 (A2) (CL)		PRODUCT7_INFO	DS-270		Emulsion Light hydrocarbon and Water/base density		S / OS	Information for Product 7.
25 (A2) (CL)		PRODUCT8_INFO	DS-270		Crude Oil		S / OS	Information for Product 8.
26 (A2) (CL)		PRODUCT9_INFO	DS-270		Crude Oil		S / OS	Information for Product 9.
27 (A2) (CL)		PRODUCT10_INFO	DS-270		Crude Oil		S / OS	Information for Product 10.
28		SELECT_METER	Unsigned8	0=Master Meter 1=Meter 1 2=Meter 2 3=Meter 3 4=Meter 4	1	E	N	It selects the meter to visualize the factors and the proving conditions.
29		SELECT_PRODUCT	Unsigned8	1-10 = Product 1-10	1	E	N	Selection of one from among ten configured products to visualize the meter factors and the proving conditions.
30 (A2)		MF_METER_PRODUCT	DS-271	0.8 to 1.2	1.0000		S / OS	The last 8 meter factors and date/hour for the selected meter and product. The first element of the array is the actual and the only one can be written by user.
31		CONDITIONS_M_P	DS-272				S / OS	Previous conditions and the last session for the selected product and meter.
32		NO_LIQ_FLOW	Float	>= 0.0	0.0	V	S / RO	Parameter not used.
33		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
34		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute. When the Unreported status is cleared by the alert reporting task, another block alert can be reported, without clearing the Active status, if the subcode has changed.
35 (A2) (CL) (V4)		MM_TYPE	Unsigned8	0 = IV pulse input 1=IV*CTL pulse input 2=IM pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input 5=Flow IM analog input	0	E	S / O/S	When the option pulse input is selected, it is necessary to configure the CHANNEL_MM parameter to address the physical point of the pulse input. When the option analog input is selected, it is necessary to link the FLOW_MM input. IV: indicated volume without any correction IV*CTL: indicated volume corrected by temperature IM: indicated mass.

Idx	Type/View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
36 (A2) (CL)		METER1_FREQ	Float[12]	>= 0.0	0.0	Hz	S	Frequencies for the linearization curve of the NKF factor related to the frequency applied to the meter 1. If METER1_INFO.NKF is zero, the first element equals zero indicates the end of curve.
37 (A2) (CL)		METER1_NKF	Float[12]	>= 0.0	1.0	K	S	NKF's of the linearization curve for the K-factor/NKF/MF related to the frequency applied to the meter 1, if METER1_INFO.NKF is different from none.
38 (A2) (CL)		METER2_FREQ	Float[12]	>= 0.0	0.0	Hz	S	Frequencies for the linearization curve of the NKF factor related to the frequency applied to the meter 2. If METER2_INFO.NKF is zero, the first element equals zero indicates the end of curve.
39 (A2) (CL)		METER2_LIN	Float[12]	>= 0.0	0.0	K	S	NKF's of the linearization curve for the K-factor/NKF/MF related to the frequency applied to the meter 2, if METER2_INFO.NKF is different from none.
40 (A2) (CL)		METER3_FREQ	Float[12]	>= 0.0	0.0	Hz	S	Frequencies for the linearization curve of the NKF factor related to the frequency applied to the meter 3. If METER3_INFO.NKF is zero, the first element equals zero indicates the end of curve.
41 (A2) (CL)		METER3_LIN	Float[12]	>= 0.0	0.0	K	S	Factor of the linearization curve for the K-factor/NKF/MF related to the frequency applied to the meter 3, if LIN3_TYPE is different from none.
42 (A2) (CL)		METER4_FREQ	Float[12]	>= 0.0	0.0	Hz	S	Frequencies for the linearization curve of the NKF factor related to the frequency applied to the meter 4. If METER4_INFO.NKF is zero, the first element equals zero indicates the end of curve.
43 (A2) (CL)		METER4_LIN	Float[12]	>= 0.0	0.0	K	S	Factor of the linearization curve for the K-factor/NKF/MF related to the frequency applied to the meter 4, if LIN4_TYPE is different from none
44 (A2) (CL)		MASTER_METER_FREQ	Float[12]	>= 0.0	0.0	Hz	S	Frequencies for the linearization curve of the NKF factor related to the frequency applied to the master meter. If MASTER_METER_INFO.NKF is zero, the first element equals zero indicates the end of curve.
45 (A2) (CL)		MASTER_METER_LIN	Float[12]	>= 0.0	0.0	K	S	Factor of the linearization curve for the NKF factor related to the frequency applied to the master meter, if LIN_MASTER_TYPE is different from none
46 (A2) (CL)		LIN1_TYPE	Unisgned8	0=none 1=K-factor 2=NKF 3=MF				It indicates the linearization type to be used for the meter 1.
47 (A2) (CL)		LIN2_TYPE	Unsigned8	0=none 1=K-factor 2=NKF 3=MF	0	Na	S	It indicates the linearization type to be used for meter 2.
48 (A2) (CL)		LIN3_TYPE	Unsigned8	0=none 1=K-factor 2=NKF 3=MF	0	Na	S	It indicates the linearization type to be used for meter 3.

Idx	Type/View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
49 (A2) (CL)		LIN4_TYPE	Unsigned8	0=none 1=K-factor 2=NKF 3=MF	0	Na	S	It indicates the linearization type to be used for meter 4.
50 (A2) (CL)		LIN_MASTER_TYPE	Unsigned8	0=none 1=K-factor 2=NKF 3=MF	0	Na	S	It indicates the linearization type for the master meter.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4
Gray Background Line: Custom Parameters

PIP – Pulse Input & Proving

Description
This transducer block of the DF77 module allows whole configuration for the module, as well as the correct reading of the data and status related to pulse reading. For further details, refer to the specific chapter for this module (chapter 8).

Notice that, this block must always be associated to the DF77; and also it must be set previously in the HC transducer block (Hardware Configuration).

Identification for the measurement number – STRATEGY parameter
This parameter identifies the flow measurement number, which interpretation can be:
0 = Master meter → module used only for pulse reading of the master meter
1 to 4 = Measurement 1 to 4 → module used only for one single meter reading
255 = non specific → module used for pulse reading of different measurements

Monitoring of 5 groups of pulse input
The 5 groups of pulse inputs are composed, each one, by two pulse inputs, which can act as:

- single pulse: two independent pulse inputs
- dual pulse: two inputs related to only one meter that has two pulse inputs out of phase.

Each pulse input has: status monitoring, pulse quantity of the last macro cycle and the average frequency during the last macro cycle.

The table with the description of the input status is showed below:

Bit	Meaning	Description
0	Pulses have been lost	• Overflow of the input pulse counters (16 bits = 65 535)
1	Frequency out of range	• The frequency set in FREQ_UPPER_RANGE and FREQ_LOWER_RANGE is out of range.
2	Noise detected	• The occurred pulses have width larger than the value specified by the input filter (1/8 of the corresponding period of FREQ_UPPER_RANGE).
3	Pulse failure	• It is impossible to read the module: incorrect module ID or there is no module
4	Running proving	One proof is being done in this input.
5	Reserved5	Future use.
6	Dual pulse not active	• Totalization with Dual pulse is set in the GX_CONF parameter. If there is any error with the signs, they can be inverted (B/A), or with incorrect amplitude, or with frequency out of range, or with noise, or with incorrect phase deviation, or the flow is pulsing intense.
7	Pulse error	Occurrence of one of the following types of errors in dual-pulse: • Coincident pulses • Phase error • Sequence error
8…15	Reserved7…15	Future use

Detection, correction and indication of the error quantity during the pulse transmission
This block provides, through MISSING_PULSES and EXTRA_PULSES parameters, the monitoring of the error quantity due to missing or extra pulses, respectively, in single pulse or dual pulse modes.

The analysis is based on the instantaneous frequency does not change abruptly to a determined value and then returns to the previous condition, and also in the behavior of another phase if dual pulse.

When it is configured for dual pulse, it also has the following consistency checks between the pulses A and B that have the correspondent error counters:
1. COINCIDENT_ERROR: error counter which there is a coincidence on the active edges of the phases A and B, with tolerance.
2. SEQUENCE_ERROR: the waited behavior is the occurrence of the active edge of the signal A and then the active edge of the signal B, thus they should occur interpolated.

3. PHASE_ERROR: besides the waited sequence between the pulses A and B, the phase difference between them must be close to the configured in the Gx_PHASE_DIF parameter with a maximum deviation configured in the Gx_PHASE_DEV parameter.
4. COUNT_ERROR: indicates the difference in the counting of the pulses A and B.

The counters mentioned above are increased at each occurrence, it is possible to reset each one or together using the RESET_ERROR_COUNTER parameter.

Logic state of inputs and outputs - LOGIC_STATE_PINS parameter
The LOGIC_STATE_PINS parameters shows, at the moment of the reading, the logic state for each one of ten pulse inputs, for the three detector inputs (IN1, IN2 and IN3) and the OUT1 output.

Configuration for the CHANNEL parameter
The CHANNEL parameter indicates where placing the DF77 module associated to this block by rack number, slot, group and point.

The rules to configure the CHANNEL parameter for this block are a little different for the other blocks, so it is necessary to follow the steps below:

- The CHANNEL format is RRSGP, where RR indicates the rack number, S indicates the slot number, G indicates the group number and P indicates the point number.
- Point (P): ordinal number for the group input and numerated from 0 (first point) to 7 (last group point) and 9 (the whole group).
- Group (G): ordinal number for the module group and numerated from 0 (first group), 1 (second group) and 9 (all module groups). The DF77 module has 7 groups, the groups from 0 to 4 corresponds to pulse inputs, the group 5 refers to the detector inputs and the group 6 refers to output for prover.
- Slot (S): ordinal number of the slot for a determined rack and numerated from 0 (first slot) to 3 (last slot).
- Rack (R): Each rack has 4 slots and the racks are numerated from 0 (first rack) to 14 (last rack). The physical address of the racks is executed by a rotary key from 0 to F (located between the slots 2 and 3), where the last position (F) must not be used.

Example:
CHANNEL parameter is 1099: it means rack 1, slot 0, the whole group and all the points.
Before configuring the CHANNEL parameter, it recommends to configure previously the HC block that indicates the module types are being used and the positions (rack/slot). This is important when writing in the CHANNEL parameter, the PIP block will check the addressed module and also the availability (no other block is already using this block).

Pulse simulation – FREQ_SIMULATE parameter
This parameter can simulate the pulse signal in the pulse inputs. The frequency simulated is the value of this parameter given in hertz. The same simulation frequency will be used for all inputs and it ignores if the module is ok or no, and if there is one DF77 module in the rack and configured slot.

Pulse input configuration – Gx_CONF, Gx_PHASE_DIF and Gx_PHASE_DEV parameters
For each one of the 5 groups of pulse input, it has the following configuration:

- Gx_CONF Parameter:
  - Dual pulse check enable: indicates the pulses A and B are signals out of phase of the same meter, and then the consistency check is possible for pulse transmission related to: coincident pulses, sequence of the phases A and B, phase difference between A and B, and counting difference between A and B.
  - Falling edge Ax and Falling edge Bx: when this option was selected, indicates that the active edge is the falling edge.
  - Ax pulse filter disable and Bx pulse filter disable: the pulse signals going through the low pass filter before any consistency check. When this option is selected, the filter is disabled.
  - Input Ax disabled and Input Bx disabled: the signals A and B can be disabled when selecting these options.
- Gx_PHASE_DIF and Gx_PHASE_DEV parameters: these parameters are used when the dual pulse option is selected. In this situation, these parameters define the phase difference waited between the pulses A and B (Gx_PHASE_DIF), and also the maximum deviation between the measured and waited phase (Gx_PHASE_DEV).

Frequency range for the pulse inputs

The FREQ_UPPER_RANGE and FREQ_LOWER_RANGE parameters define the frequency operation range for ten pulse inputs. FREQ_UPPER_RANGE defines the cut frequency for the pass low filter applied to the pulse signals, before the consistency check processing. The pulse signals should have maximum width defined by 25% of the correspondent period configured in FREQ_UPPER_RANGE.

If the average frequency for the macro cycle is out of the determined range, the corresponding LED related to the pulse input, Green LED, will be blinking.

Output Control OUT1 – OUT1_CONTROL parameter

The configured value for this parameter defines the pulse width for the OUT1 output:
There are three different operation modes: temporized pulse, automatic control of the prover and control using discrete block:

1. Typing 0 or 255 indicates to the module that the OUT1 will be controlled by a MDO block.
2. Typing 1 the module will control the OUT1 according to the proving state machine. This option is recommended when using Brooks/Daniel prover.
3. Typing from 2 to 254, OUT1 will be controlled automatically bey the proving process, generating one pulse with width corresponding to the value of this parameter multiplied by 10ms to start the run. This option is recommended when using Calibron prover.

Maintenance and diagnosis for this module

- GENERAL_CONTROL parameter: allows forcing the manufacturer initialization, resetting the module and do the manufacturer auto test.
- TEST_COUNTER and TEST_COUNTER_CONTROL parameter: Enable/disable the pulse counting for the inputs without any processing, and it is indicated in TEST_COUNTER. This counting is accomplished in parallel to the usual module processing which the pulse are checked in order to attend the reliability level A.
- Direct access to the IMB bus:
  - ➢ IMB_REQUEST: defines the required operation type
  - ➢ IMB_START_ADDR: initial physical address
  - ➢ IMB_SIZE: quantity of bytes to be reading/writing
  - ➢ IMB_DATA: reading or writing data in the initial address specified in IMB_START_ADDR in the quantity of specified bytes in IMB_SIZE.

Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration: this indication can occur due to the following problems:
   - The CHANNEL parameter was not configured (value is zero);
   - When CHANNEL parameter addresses the module type on the block HC is incompatible with this transducer block
2. BLOCK_ERR.Input failure: any failure in inputs
3. BLOCK_ERR.Device needs maintenance now: input configured to dual pulse is failing
4. BLOCK_ERR. Simulate Active – all the pulse inputs are in simulation when the parameter FREQ_SIMULATE is different from zero.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	0 to 4, 255	255	None	S	This parameter is used to identify the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode Parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	1,3	GENERAL_STATUS	Bitstring(2)	See PULSE_MOD_STATUS		E	D / RO	Module status.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
8	1,3	PROVING_STATUS	Bitstring(2)	See PROV_STATUS		E	D / RO	Status indication related to proving.
9	1,3	A1_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input A1.
10	1,3	A1_PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input A1.
11		A1_FREQ	Float			Hz	D / RO	Average- frequency in the last macro cycle – pulse input A1.
12	1,3	B1_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input B1.
13	1,3	B1_PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input B1.
14		B1_FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input B1.
15	1,3	A2_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input A2.
16	1,3	A2_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input A2.
17		A2_ FREQ	Float			Hz	D / RO	Average frequency of the last macro cycle – pulse input A2.
18	1,3	B2_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input B2.
19	1,3	B2_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input B2.
20		B2_ FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input B2.
21	1,3	A3_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input A3.
22	1,3	A3_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input A3.
23		A3_ FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input A3.
24	1,3	B3_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input B3.
25	1,3	B3_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input B3.
26		B3_ FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input B3.
27	1,3	A4_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input A4.
28	1,3	A4_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input A4.
29		A4_ FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input A4.
30	1,3	B4_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input B4.
31	1,3	B4_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input B4.
32		B4_ FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input B4.
33	1,3	A5_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input A5.
34	1,3	A5_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input A5.
35		A5_ FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input A5.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
36	1,3	B5_STATUS	Bitstring(2)	See PULSE_STATUS		E	D / RO	Actual status of the pulse input B5.
37	1,3	B5_ PULSES	Unsigned32		0		D / RO	Number of pulses in the last macro cycle – pulse input B5.
38		B5_ FREQ	Float			Hz	D / RO	Average frequency in the last macro cycle – pulse input B5.
39		COINCIDENT_ERROR	Unsigned32[5]		0		D / RO	Array that contains the accumulated number of coincident pulses (common mode error) for each input.
40		SEQUENCE_ERROR	Unsigned32[5]		0		D / RO	Array that contains the accumulated number of sequence errors (A -> B) for each input.
41		PHASE_ERROR	Unsigned32[5]		0		D / RO	Array that contains the accumulated number of phase errors for each input.
42		COUNT_ERROR	Unsigned32[5]		0		D / RO	Array that contains the accumulated number of counting errors for each input, that is, the difference between the A and B inputs.
43		MISSING_PULSES	Unsigned32[10]		0		D / RO	Array that contains the accumulated number of missing pulses for each input. Only for diagnostics.
44		EXTRA_PULSES	Unsigned32[10]		0		D / RO	Array that contains the accumulated number of extra pulses (noise) for each input. Only for diagnostics.
45(A1)		RESET_ERROR_COUNTER	Bitstring(2)	Bit 0="Coincident Error" Bit 1="Sequence Error" Bit2="Phase Error" Bit3="Count Error" Bit 4= "Missing Pulses" Bit 5= "Extra Pulses" Bit 6..Bit 14 = "Reserved" Bit 15="All Error Counters"	All bits zero		D	Reset the error counters.
46	1,3	LOGIC_STATE_PINS	Bitstring(2)	See PINS_STATE		E	D / RO	Logic state of each pin in the last macrocycle.
47(A2) (CL)	4	CHANNEL	Unsigned16		0	Na	S / OS	Number for the hardware channel of the pulse input module.
48(A1) (CL)	4	FREQ_SIMULATE	Float	0=DISABLED 0 to 10000	0	Hz	S / OS	When this parameter is different from zero, the module acts in the simulation mode on the specified frequency for all inputs, regardless of the module status.
49(A2) (CL)	4	G1_CONF	Bitstring(2)	See Gx_CONF	All bits zero	E	S / OS	Configuration for the group 1.
50(A2) (CL)	4	G1_PHASE_DIF	Unsigned16	1: 180 degrees 2: 90 degrees 3: 45 degrees.	2	E	S / OS	Phase difference waited between A1 and B1, if the dual pulse option is configured.
51(A2) (CL)	4	G1_PHASE_DEV	Unsigned8	3: +-45 degrees 4: +-22.,5 5:+- 11.25 degrees 6: +- 5.625 degrees.	5	E	S / OS	Allowed deviation on the phase difference between A1 and B1 related to the waited value, if the dual pulse option is configured.
52(A2) (CL)	4	G2_CONF	Bitstring(2)	Veja Gx_CONF	All bits zero	E	S / OS	Configuration for the group 2.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
53(A2) (CL)	4	G2_PHASE_DIF	Unsigned16	1: 180 degrees 2: 90 degrees 3: 45 degrees.	2	E	S / OS	Phase difference waited between A2 and B2, if the dual pulse option is configured.
54(A2) (CL)	4	G2_PHASE_DEV	Unsigned8	3: +-45 degrees 4: +-22.5 5:+- 11.25 degrees 6: +- 5.625 degrees.	5	E	S / OS	Allowed deviation on the phase difference between A2 and B2 related to the waited value, if the dual pulse option is configured.
55(A2) (CL)	4	G3_CONF	Bitstring(2)	See Gx_CONF	All bits zero	E	S / OS	Configuration for the group 3.
56(A2) (CL)	4	G3_ PHASE_DIF	Unsigned16	1: 180 degrees 2: 90 degrees 3: 45 degrees.	2	E	S / OS	Phase difference waited between A3 and B3, if the dual pulse option is configured.
57(A2) (CL)	4	G3_ PHASE_DEV	Unsigned8	3: +-45 degrees 4: +-22.5 5:+- 11.25 degrees 6: +- 5.625 degrees.	5	E	S / OS	Allowed deviation on the phase difference between A3 and B3 related to the waited value, if the dual pulse option is configured.
58(A2) (CL)	4	G4_CONF	Bitstring(2)	See Gx_CONF	All bits zero	E	S / OS	Configuration for the group 4.
59(A2) (CL)	4	G4_ PHASE_DIF	Unsigned16	1: 180 degrees 2: 90 degrees 3: 45 degrees.	2	E	S / OS	Phase difference waited between A4 and B4, if the dual pulse option is configured.
60(A2) (CL)	4	G4_ PHASE_DEV	Unsigned8	3: +-45 degrees 4: +-22.5 5:+- 11.25 degrees 6: +- 5.625 degrees.	5	E	S / OS	Allowed deviation on the phase difference between A4 and B4 related to the waited value, if the dual pulse option is configured.
61(A2) (CL)	4	G5_CONF	Bitstring(2)	Veja Gx_CONF	All bits zero	E	S / OS	Configuration for the group 5.
62(A2) (CL)	4	G5_ PHASE_DIF	Unsigned16	1: 180 degrees 2: 90 degrees 3: 45 degrees.	2	E	S / OS	Phase difference waited between A5 and B5, if the dual pulse option is configured.
63(A2) (CL)	4	G5_ PHASE_DEV	Unsigned8	3: +-45 degrees 4: +-22.5 5:+- 11.25 degrees 6: +- 5.625 degrees.	5	E	S / OS	Allowed deviation on the phase difference between A5 and B5 related to the waited value, if the dual pulse option is configured.
64 (CL)	4	FREQ_UPPER_RANGE	Unsigned16[10]	5 to 25k	10k	Hz	S / OS	Upper limit of the frequency range used to check the pulse range and dynamic filter.
65 (CL)	4	FREQ_LOWER_RANGE	Unsigned16[10]	5 to 25k	50	Hz	S / OS	Lower limit of the frequency range used to check the pulse range and dynamic filter.
66(A2)		GENERAL_CONTROL	Bitstring(162)	See PULSE_MOD_CONTROL	0	E	D	Module control.
67(A2) (CL)		OUT1_CONTROL	Unsigned8	0 to 255	0		D	Discrete output control. Writing “0” or “255” in this parameter, the OUT1 output is controlled by the MDO block. And, writing values between 1 and 255, the control is executed automatically by the proving process, generating one pulse with width equals to the value typed and multiplied by 10ms, when the run begins. When the module is in manufacturer test mode is generated one standard for test.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
68		TEST_COUNTER	Unsigned32[10]		0		D / RO	Number of accumulated pulses for each input controlled by TEST_COUNTER_CONTROL parameter. This parameter is used only for test and maintenance.
69		TEST_COUNTER_CONTROL	Unsigned8	0= DISABLE 1=ENABLE	0	E	D	Enables/disables the pulse counting in the TEST_COUNTER parameter.
70		PULSE_INPUT_SEL	Unsigned8	0 to 10	0		D	Pulse input under analysis. Zero means disabled.
71		MAX_INTER_PULSE	Unsigned8	0 t o100	0	%	D / RO	Maximum space between pulses, in average percent.
72		IMB_REQUEST	Unsigned8	0:OK 1: WRITE 2: READ 3: ERROR	0	E	D	Requisition to reading/writing directly from/to the IMB.
73		IMB_START_ADDR	Unsigned16	0 to 511	0		D	Initial address for reading/writing
74		IMB_SIZE	Unsigned8	0 to 32	0		D	Size in bytes for reading/writing.
75		IMB_DATA	Octetstring(32)		0		D	Data to be writing or reading.
76		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
77		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

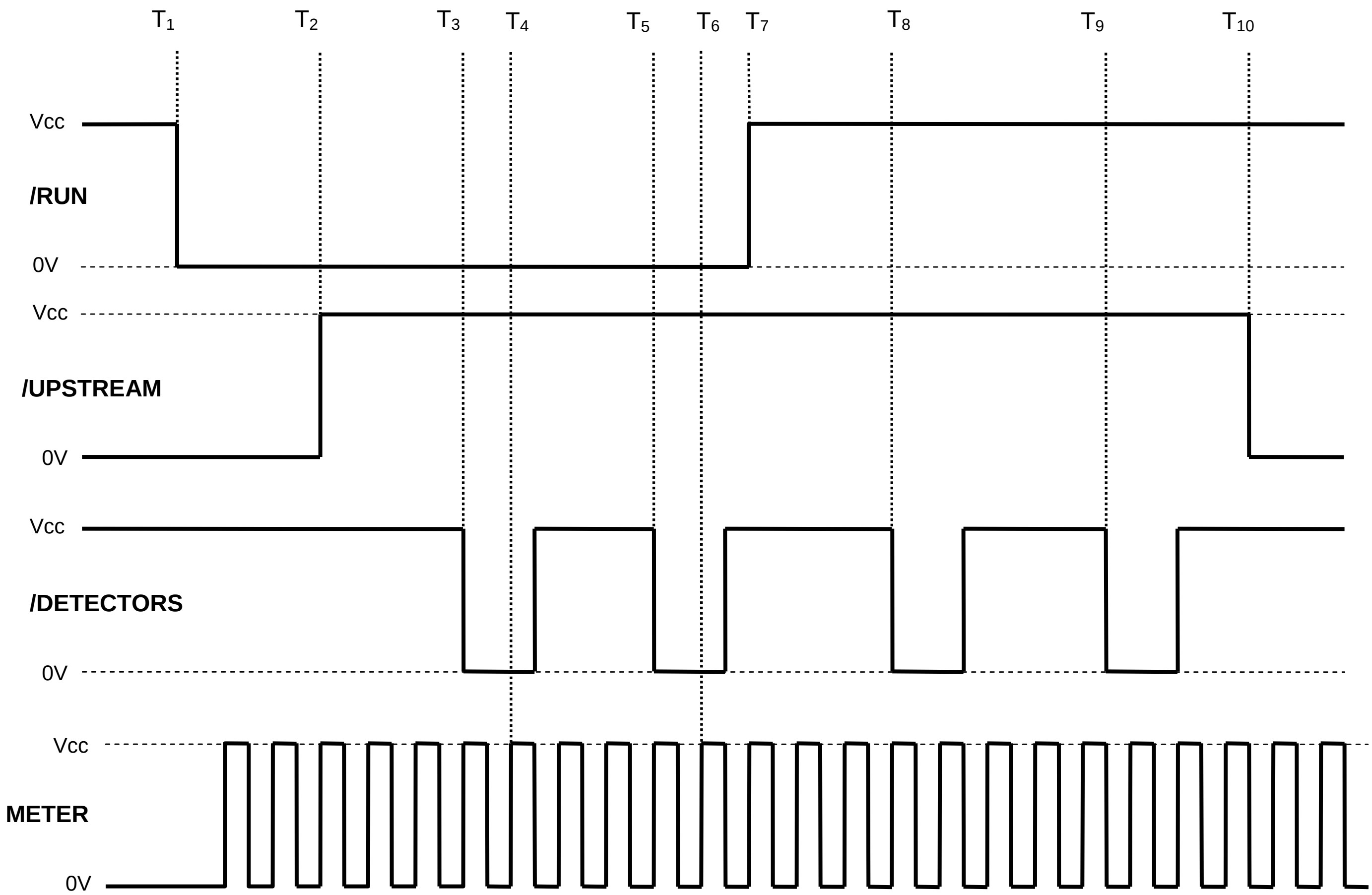
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4
Gray Background Line: Custom Parameters

Troubleshooting

Situation	Possible solutions
There is no pulse totalization	• Check if the CHANNEL parameter in the PIP block is set properly. Check if the CHANNEL parameter of the (LCT, GT etc.) block is set properly. • Check the electrical connections with the meter. • See the front LEDs of DF77 module: o Turned off: it indicates input disabled in the configuration. o Red: it indicates without proper signal. o Green blinking: it indicates that has signal, but it is out of the range set (FREQ_UPPER_RANGE and FREQ_LOWER_RANGE). o Green ON: it indicates that has signal without errors. • Check with an oscilloscope or frequencimeter if there is pulse signal in the DF77 input with proper amplitude and frequency. • If using DUAL_PULSE mode, check the corresponding status of the input (AX_STATUS, BX_STATUS) in the PIP block. If it is indicating “Dual pulse not active” check the coincident error, sequence and phase counters. If one or more counters are being increased, check if the signal A and signal B are not inverted. Check if the phase difference corresponds to the meter difference set (usually 90 degrees). Another check is to increase the allowed phase deviation in the GX_PHASE_DIF parameter.
It is not doing provings	• Check the electrical connections with the prover.

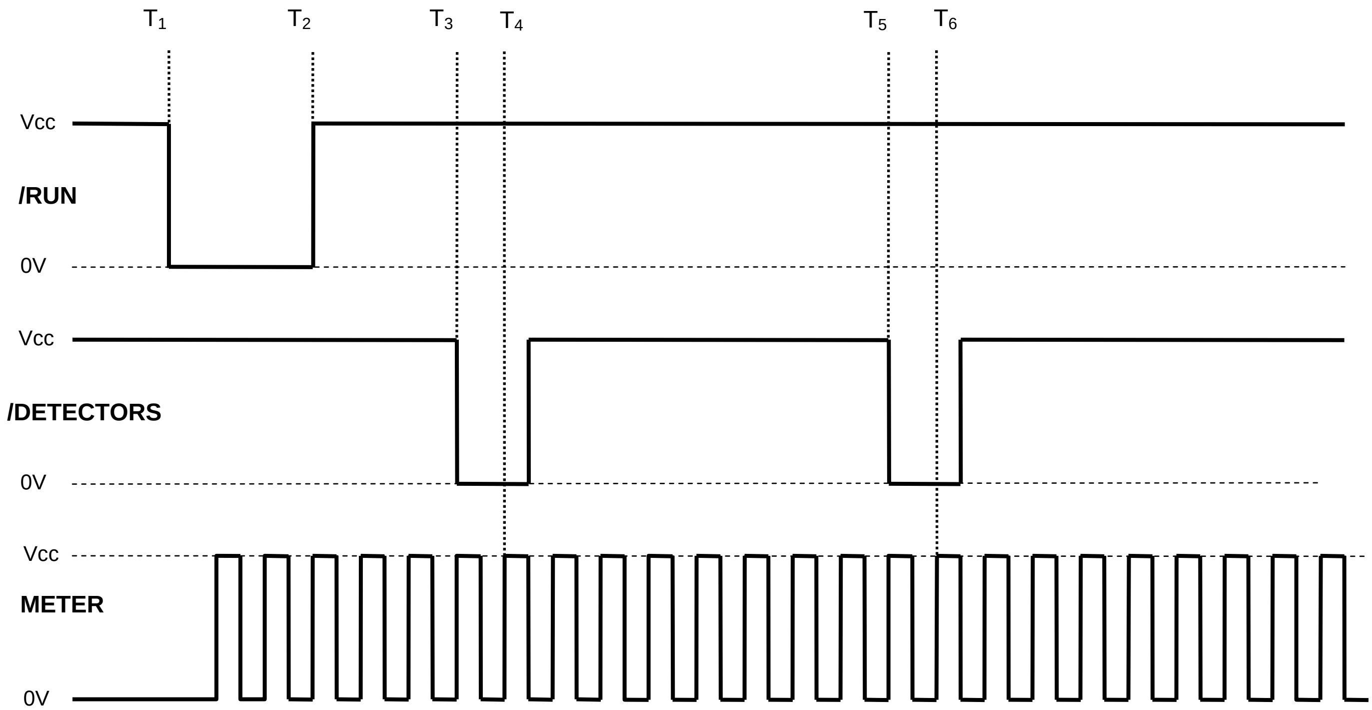
Situation	Possible solutions
	• Check if the OUT1_CONTROL parameter is set properly. • Check if the PROV_STATUS parameter in the PIP block shows any error. If the error is timeout, check the prover electrical connections and hardware.

Wave form of the proving with pulse interpolation using double chronometry (API 4.6 and ISO 7278-3) for Brooks/Daniel compact prover



T1: the flow computer transmits the command for the DF77 to start the proving. So, the DF77 forces the /RUN (OUT1) signal to the logic level ‘0’.
T2: the prover should indicate by the signal /UPSTREAM that it is in the standby position. When it receives the /RUN signal, prover starts the movement to execute the proving.
T3: when the prover shaft passes by the START detector, the prover transmits one pulse to the DF77 in the /DETECTORS (IN2,IN3)) input to start the timer T2 counting.
T4: as following, DF77 waits for the next rise edge of the pulse signal generated by the meter. This rise edge starts timer T1 counting.
T5: when the prover shaft passes by the STOP detector, DF77 receives another pulse, ending the timer T2 counting.
T6: the DF77 waits, for the next rise edge of the meter signal. When this rise edge is detected, the T1 counter stops. At this moment the proving ends.
T7: when the flow computer reads the proving result (T1, T2 and Nm), DF77 forces the /RUN (OUT1) output for the logic level ‘1’. It indicates to the prover to pull the piston for the standby position, so it will be ready for the next proving.
T8: during the return of the piston for the standby position (UPSTREAM), the shaft passes by the STOP detectot, transmiting one pulse that the DF77 ignores.
T9: during the return of the piston for the standby position (UPSTREAM), the shaft passes by the START detector, transmiting one pulse that the DF77 ignores.
T10: when reaching the standby position, the /UPSTREAM signal goes to the logic level ‘0’, indicating that the proving is ready for the next run.

Wave form of the proving with pulse interpolation using double chronometry (API 4.6 and ISO 7278-3) for Calibron Syncrotak compact prover

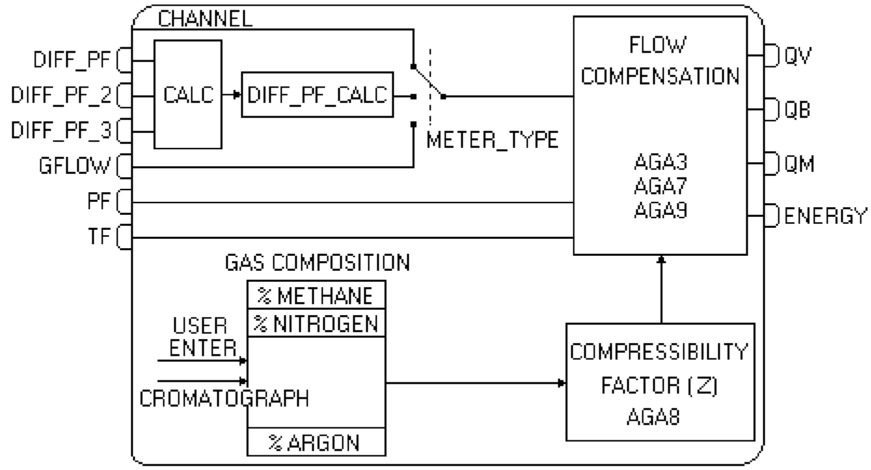


T1: the flow computer transmits the command for the DF77 to start the proving. So, the DF77 forces the /RUN (OUT1) signal to the logic level ‘0’ during the time set in the OUT1_CONTROL parameter of the PIP block. When receiving the /RUN = ‘0’, the prover starts the piston pulling for the upstream position.
T2: after the time set in the OUT1_CONTROL parameter of the PIP block, the /RUN (OUT1) signal returns to the logic level ‘1’.
T3: during the piston pulling, the shaft passes by the STOP and START detectors. However, the Syncrotak prover does not transmit these pulses for the DF77. When reaching the upstream position, the prover unfastens the piston that starts to move pushed by the flux. With the piston movement, the shaft passes by the start detector of the calibrated section (T2 START).
T4: as following, the DF77 waits for the next rise edge of the pulse signal generated by the meter. This rise edge starts the timer T1 counting.
T5: when the prover shaft passes by the STOP detector (end of the calibrated section), the DF77 receives other pulse, ending the timer T2 counting.
T6: the DF77 waits for the next rise edge of the meter signal. When this rise edge is detected, the T1 counter stops. At this moment the proving ends, the flow computer can read the DF77 results (T1, T2 and Nm) and execute a new proving if is necessary.

Blocks for Gas Measurement

GFC – Gas Flow Calculation

Schematic



Description

This block was developed to accomplish the flow compensation calculation in the natural gas measurement using orifice plate, turbine, ultra sonic or any other meter which provides volume measurement in pulse signal or analog signal.

The natural gas composition can be obtained by manual input or through the chromatograph communicating via Modbus or Foundation Fieldbus.

Run number identification – STRATEGY

The configuration for the STRATEGY parameter is mandatory, because it identifies the run number; if this parameter has the default value (zero), the block will execute in the O/S mode and indicate in the BLOCK_ERR.Block configuration parameter.

This parameter also associates the information of the operational meter in the GKD block (METERx_INFO - NKF and MFx_HISTORY – meter factor), if the meter type is “pulse input”.

Block inputs

The inputs of this block are used according to the configuration, as showed in the table below:

Input	When it is used	Description
PF	Always	Flowing static pressure
TF	Always	Flowing temperature
DIFF_PF	METER_TYPE = differential pressure	Flowing differential pressure
DIFF_PF_2	METER_TYPE = differential pressure	Flowing differential pressure
DIFF_PF_3	METER_TYPE = differential pressure	Flowing differential pressure
GFLOW	METER_TYPE = analog input	Volume flow rate input

Block outputs

The block outputs are flow rates resulting of the calculation and they are available to be connected to other blocks:
QV –volume flow rate at flowing conditions
QB – volume flow rate at base conditions
QM – mass flow rate
ENERGY – energy flow rate

Selection of the product to be measured – PRODUCT_SEL parameter

The PRODUCT_SEL parameter selects the product of the GKD block that is being used for the calculation. Thus, the same composition can be used in the calculations for different flow measurements. This situation can occur when the chromatograph is measuring before a splitting the stream.

Override handling for the inputs
There is an override handling for the temperature, static pressure or differential pressure inputs when it has bad status. There are the following options to choose the override value through the OVER_TEMP_USAGE / OVER_PRES_USAGE / OVER_DPRES_USAGE parameters:

- Override value when bad: when the input status is bad, it utilizes the value of the override parameter (OVERRIDE_TEMPERATURE, OVERRIDE_PRESSURE and OVERRIDE_DIFF_PRESSURE);
- Last good when bad: when the input status is bad, it utilizes the last good value of the input;
- Hourly average when bad : when the input status is bad, it utilizes the hourly weightweightted average;
- Force override value: it utilizes the value of the override parameter (OVER_TEMP_USAGE / OVER_PRES_USAGE / OVER_DPRES_USAGE) regarless of the input status. This option is useful to check the block calculation;
- Never use: when the input status is bad, it interrupts the flow calculation and considers null. In this situation, one event is registered ("Stop totalization – override never use").

The input and output transition events of the override use condition are registered as "Override temperature used" and "Override temperature cleared", for example, besides the indication in the summarized status of the correspondent period.

Input	Status	Override event	Description
PF	Bad or Uncertain	It is conditioned to the flow different of zero (*)	When the flow is different of zero there is an indication of override event
TF	Bad or Uncertain	It is conditioned to the flow different of zero (*)	When the flow is different of zero there is an indication of override event
DIFF_PF	Bad (**)	It is only based on status	When the pressure inputs are used in multiple ranges and the value used is related to the high range, the transmitter of low range can indicate Uncertain. So, the indication of override event is only related to the connected inputs with bad status (it does not include Uncertain status). For the secondary inputs handling, the indication of override event does not depend if the flow is different of zero.

(*) The check if the flow is not zero does not consider the cutoff handling through the NO_GAS_FLOW parameter of the GT block. However, the following situations are included:

- The status of the secondary variable (PF or TF) is Bad ou Uncertain and the override handling for the corresponding variable is set to "Never use".
- If the differential pressure input(s) used for the flow calculations (DIFF_PF_CALC) are higher or lower than zero.
- If all differential pressure inputs have bad status and the override handling implicates in differential pressure that was utilized in the calculations has its value equals to zero, for example, is set to "override value when bad" and the OVERRIDE_DIFF_PRESSURE parameter is equal to zero.
- The override value is forced to the differential pressure and the OVERRIDE_DIFF_PRESSURE parameter is equal to zero.

Observe that the cutoff through GT.NO_GAS_FLOW parameter is based on the flow. If it is necessary the cutoff related to the differential pressure, it recommends the AI block configuration.

(**) If the meter is (METER_TYPE) "Orifice plate", "Vcone" or "Wafer Cone" types, the considered status is that after the multiple range handling.

Configurations for the static pressure
There are two important parameters to be configured related to the static pressure:

- PRESSURE_DOWNSTREAM_SECTION: this parameter is configured if the measurement of the static pressure is upstream or downstream related to the orifice plate. This parameter is used only when the meter is differential pressure type (METER_TYPE = differential pressure, Vcone and Wafer Cone);

- PRESSURE_TYPE: this parameter is configured if the static pressure is "gauge" or "absolute". If it is using the gauge option, then the PF input value (or the resulting value of the override handling) will added to the local atmosphere pressure that is configured in the GKD.ATMOSPHERE_PRESSURE. The result of this sum is used in the flow calculations, as well as in the weightweightted average calculation.

Meter type selection (METER_TYPE parameter)
The METER_TYPE parameter allows selecting the flow meter type and this parameter has the following options:

- Orifice Plate: orifice plate;
- Pulse Input : tipically turbine, ultra sonic or coriolis;
- Analog Input: meter which provides volume or mass flow rate;
- V-Cone;
- Wafer-Cone.

Differential Pressure Meters

Specifications of orifice plate and piping section
The orifice plate and piping section manufacturers must provide the orifice plate bore diameter and the meter tube internal diameter at given temperature, respectively. The temperature for this measurement must be configured in the TEMP_DIAMETER parameter and the respective diameters in the ORIFICE_DIAMETER and TUBE_DIAMETER parameters.

There are two ways to provide the linear coefficient of thermal expansion of the material used for the orifice plate:

- The value of the linear coefficient of thermal expansion: ALPHA_1 parameter must be configured with the linear coefficient of thermal expansion for the orifice plate. The configuration of this parameter automatically changes the STEEL_TYPE1 parameter to the "custom" option;

- Selection of the material type: STEEL_TYPE1 parameter defines the type of the material used in the orifice plate and, consequentely, its linear coefficient of thermal expansion. When configuring this parameter, automatically the ALPHA_1 parameter is updated with the correspondent value to the selected material type.

Similarly, the configuration for the linear coefficient of thermal expansion of the meter tube (ALPHA_2) or the material selection (STEEL_TYPE2) must be accomplished.

Configuration of V-Cone and Wafer-Cone meters
The configuration of V-Cone and Wafer-Cone meters is different of the configuration of an orifice plate meter for the following reasons:

- V-Cone and Wafer-Cone meters require the configuration of the coefficient of discharge (CD) based on data of the device calibration, while in the orifice plate this calculation is computed by the FC302.
- The equation that determines the BETA parameter is different of the orifice plate, and usually the device calibration data only provides the beta and the diameter of the piping section, for that cases it must be use the following equation to calculate the value of the ORIFICE_DIAMETER (d) parameter:

$$\beta = \sqrt{1-(d\ \ /D\ \ )^2}$$

Differential pressure calculation
The flow calculations accomplished in the GFC block are according to the "flange tap" connection type, following the AGA 3:1992 description.

To improve the rangeability and maintaining the accuracy of the differential pressure, there is the option to configure up to three differential pressure transmitters in different ranges.

To utilize the multiple range feature (more than one differential pressure transmitter), it is necessary to connect the inputs DIFF_PF, DIFF_PF_2 and DIFF_PF_3, and also configure the following parameters obeying the rule: RANGE_LO_3 < RANGE_HI_3 < RANGE_LO_2 < RANGE_HI_2. The differential pressure used in the flow calculation will follow the rules below:

- Only the inputs with good status will be considered, the others will be ignored;

- When the multiple range option is used, there is a transition band (RANGE_LOx and RANGE_HIx) from an input (transmitter) to another;

- When the differential pressure is in the transition band, a weightweightted average is calculated between the lower and upper inputs (transmitters);

- The differential pressure is closer to the upper limit of the transition band, the weightweightted factor for the upper input is bigger (near to one), Consequently the weightweightted factor of the lower input will be the complement of 1.0. The equation for the transition between the inputs DIFF_PF_2 and DIFF_PF is showed below:

$$G = \frac{DIFF\_PF - RANGE\_LO\_2}{RANGE\_HI\_2 - RANGE\_LO\_2}$$

$$DIFF\_PF\_CALC = G * DIFF\_PF + (1 - G) * DIFF\_PF\_2$$

- Above the upper limit of this transition band (RANGE_HIx), it utilizes only the upper input value (transmitter);

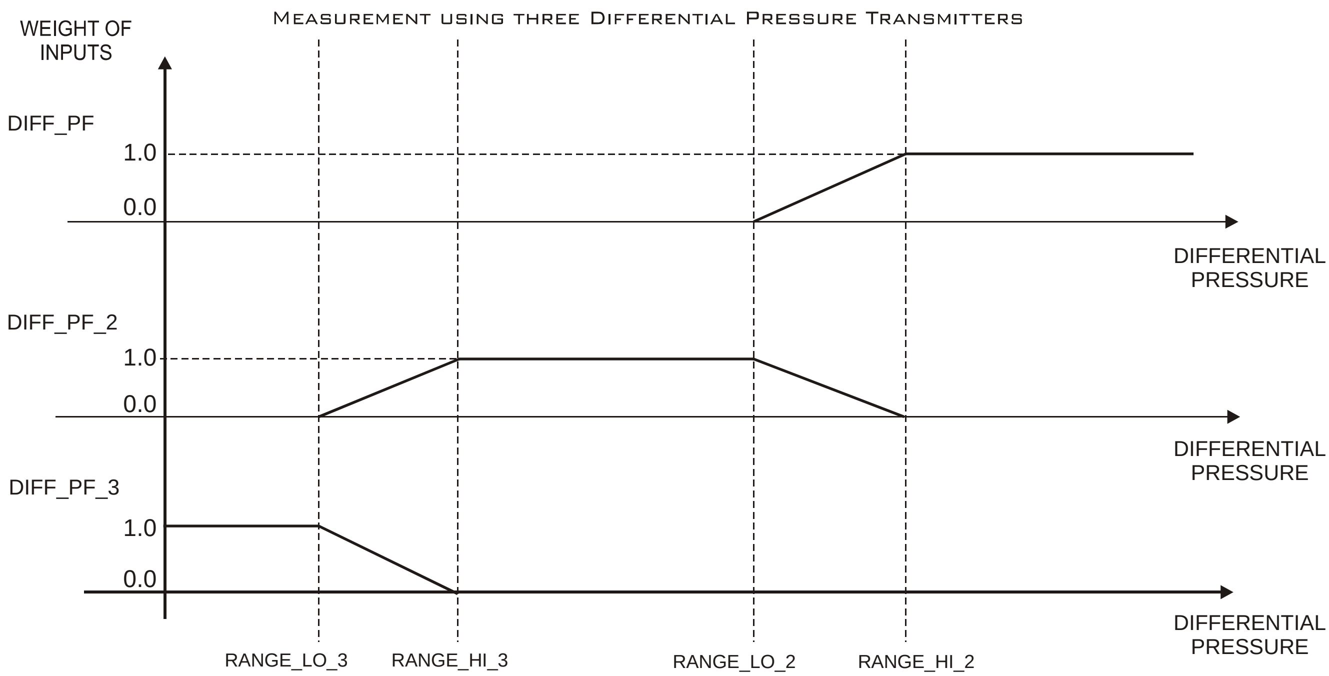
- Under the lower limit of this transition band (RANGE_LOx), it utilizes the lower input value (transmitter).

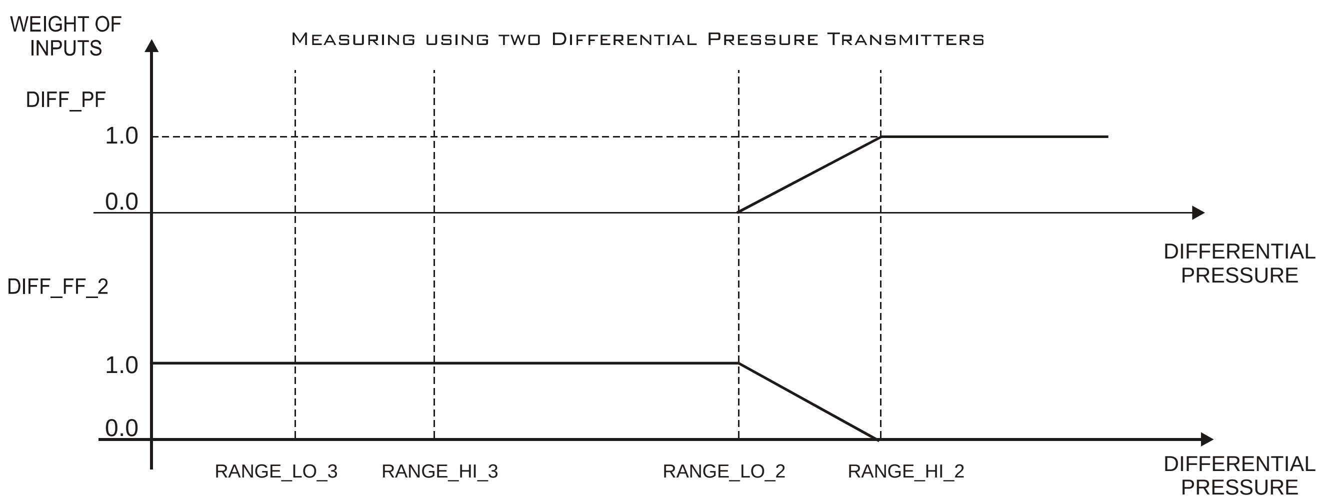
The next picture shows one situation that three inputs (transmitters) are used and two situations that two inputs (transmitters) are used. Observe the features below:

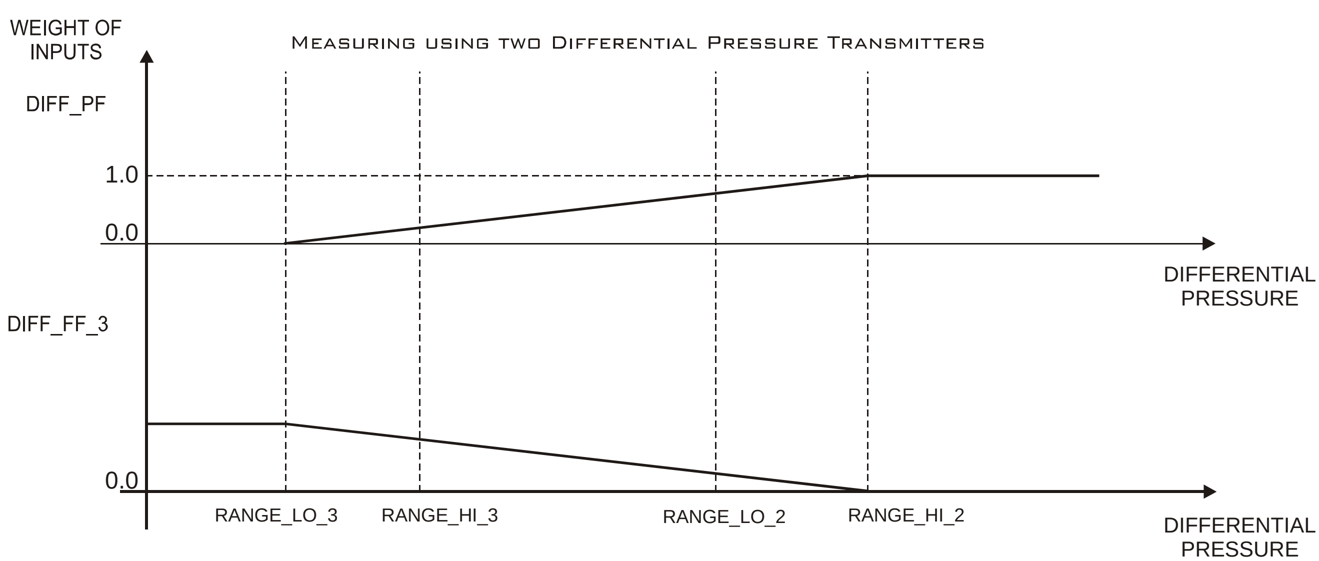
- The multiple range feature can be used as redundancy for the differential pressure transmitter, that is, if one of the transmitters fails, the GFC block uses automatically only the other transmitter which keeps working in good conditions;

- If one determined configuration utilizes three differential pressure transmitters, and there is necessity of maintenance in one of them, the GFC block considers only the other two transmitters, adjusting automatically for this situation. But there will be an indication in the BLOCK_ERR. Input failure parameter;

- The indication of the override value in the summarized status and the event register for differential pressure occurs only when the three inputs have bad status.


Measurement using three Differential Pressure Transmitters
WEIGHT OF INPUTS
DIFF_PF
1.0
0.0
DIFFERENTIAL PRESSURE
DIFF_PF_2
1.0
0.0
DIFFERENTIAL PRESSURE
DIFF_PF_3
1.0
0.0
DIFFERENTIAL PRESSURE
RANGE_LO_3
RANGE_HI_3
RANGE_LO_2
RANGE_HI_2


Measuring using two Differential Pressure Transmitters
WEIGHT OF INPUTS
DIFF_PF
1.0
0.0
DIFFERENTIAL PRESSURE
DIFF_FF_2
1.0
0.0
RANGE_LO_3
RANGE_HI_3
RANGE_LO_2
RANGE_HI_2
DIFFERENTIAL PRESSURE


Measuring using two Differential Pressure Transmitters
WEIGHT OF INPUTS
DIFF_PF
1.0
0.0
DIFFERENTIAL PRESSURE
DIFF_FF_3
0.0
RANGE_LO_3
RANGE_HI_3
RANGE_LO_2
RANGE_HI_2
DIFFERENTIAL PRESSURE

The differential pressure used in the flow calculations is indicated in the DIFF_PF_CALC parameter that is a result of the multiple ranges processing (if it is the case) and the override handling.

The differential pressure that detemines the input to be used (obtained through comparing RANGE_LO_X and RANGE_HI_X) is the highest., except when there are three inputs, so the DIFF_PF_2 input is used.

Intermediate variables for calculation
Some intermediate variables of the flow calculation at flowing conditions are indicated in the parameters:

- RE: Reynolds number
- BETA: Ratio between the diameters of the Orifice and the pipeline at flowing conditions
- CD: Coefficient of Discharge
- EV: Expansion speed factor
- Y: Expansion factor

Meters with Pulse Signal

Configuration for the CHANNEL parameter
The CHANNEL parameter associates to the pulse input via rack number, slot, group and point.

The rules to configure the CHANNEL parameter are the following:

- The format of the CHANNEL parameter is RRSGP, where RR indicates the rack number, S indicates the slot number, G indicates the group number and P indicates the point number;
- Point (P): ordinal number of point numbered from 0 (first point) to 7 (last point of the group). When accessing the DF77 module, point equals to 2 (P=2) means dual-pulse selection. In this case, the PIP.Gx_CONF parameter.Dual pulse check enable option must be enabled previoulsy;
- Group (G): ordinal number for the group numbered from 0 (first group) to 1 (second group);
- Slot (S): ordinal number for the slot numbered from 0 (first slot) to 3 (last slot);
- Rack (R): Each rack has 4 slots and the racks are numbered from 0 (first rack) to 14 (last rack). The physical address of the racks is configured through a rotary key from 0 to F (located between the slots 2 and 3). The last position (F) must not be used.

Example:
CHANNEL parameter equals 1203 means: rack 1, slot 2, group 0 and point 3.
Before configuring the CHANNEL parameter, it is recommended to configure previously the HC block that indicates which module types are being used and the positions (rack/slot). This is important when writing in the CHANNEL parameter, the GFC block will check the compatible type, pulse input and the availability of the addressed input (no other block may address it).

Meter factor (MF)
The meter factor used in the calculations is indicated in the MF parameter. It is a copy of the last meter factor in the MFx_HISTORY parameter of the GKD block. The value of the STRATEGY parameter indicates the run number and, consequently, indicates which MFx_HISTORY parameter is associated to.

QV/QM output calculation
The QV/QM output is calculated by multiplying the number of pulses by the correspondent meter factor, then dividing by the correspondent time and NKF. This procedure is applied to calculate QV, if METER_TYPE is configured to “Volume Pulse Input”. On the other hand, if METER_TYPE is configured to “Mass Pulse Input”, then it is calculated the output QM.

Flow Meters with Analog Signal

QV/QM output calculation
The QV/QM output is obtained from the multiplication of the GFLOW input, the volume flow rate provided in Engineering Unit at flowing conditions or the mass flow rate, by the meter factor.

QB, QM and ENERGY Outputs Calculation

Selection of the calculation method for the compressibility factor
The CALC_METH parameter selects the calculation algorithm for the compressibility factor which has the following options:

- Detailed: uses the whole gas composition for the calculation;
- Gross 1: uses only the Hv, Gr and CO_2 values;
- Gross 2: uses only the Gr, CO_2, N_2 values.

Calculation for QB, QM and ENERGY outputs
Using the gas universal equation and the compressibility factors at base and flowing conditions, it calculates the density at base and flowing conditions. Through these densities, it calculates the flow rate at base conditions (QB) and the mass flow rate (QM).

If any of the flow rates (QV, QB, QM and ENERGY) is higher than the rollover value (2000000000), it will be considered null and an event will be generated in order to indicate that the totalization stopped.

Diagnosis and Troubleshooting
1. BLOCK_ERR. Block configuration: this indication can occur due to the following problems:

- If the selected meter is “pulse input” type and the CHANNEL parameter is addressing a rack and slot where one module that does not read pulse is configured (in the HC block);
- STRATEGY parameter equals to zero. It is mandatory to configure this parameter, whose meaning is the run number;
- Inconsistency in the transition band that must consider the following rule: RANGE_LO_3 < RANGE_HI_3 < RANGE_LO_2 < RANGE_HI_2.
- Inconsistency in the linearization curve of the NKF factor versus frequency, if this option is selected.

2. BLOCK_ERR. Input failure : this indication occurs due to following problems:

- If the selected meter is “differential pressure” type and one of the differential pressure inputs is connected, but it has bad status;
- If the selected meter is “pulse input” type and the pulse reading is impossible for the addressed module using the CHANNEL parameter;
- If the selected module is “analog input” type and it has bad status in the GFLOW input.

3. BLOCK_ERR. Out of Service : the GFC block can continue in the Out of service mode although the target mode is Auto due to the following causes:

- STRATEGY parameter is not configured;
- the meter is “pulse input” type and the CHANNEL parameter is zero;
- Resource block is in O/S.

4. The consistence checks are executed and indicated as the table below, according to the meter type:

Condition	Status for the period	Registered event in the AEV	Action
Negative Differential Pressure			Set DP to zero.
Static Pressure out of the range: higher than zero and less than 40 000 psia (280 Mpa) Temperature out of range : -200ºF to 760ºF (-130ºC to 400ºC)	Out of range correction factor	"Flowing out range corr.fact. occ"	Set the pressure/temperature to the nearest limit
Upstream Static pressure and static pressure less than differential pressure	Inconsistent secondary variables	"Inconsistent 2nd Vars occurred"	Set flow to zero.
QM,QB,QV or ENERGY: invalid float point	Abnormal condition	"Abnormal condition of calc occ"	Set flow to zero.
QM,QB,QV or ENERGY : higher than the rollover value	Stop totalization	"Stop totalization – override never use occ"	It sets to zero the correspondent flow rate

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3 (A2) (CL)	4	STRATEGY	Unsigned16	1 to 4	0	None	S	This parameter identifies the number of the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A2) (CL)	1,3	MODE_BLK	DS-69	O/S, Man, Auto	O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (A2)	**I**,1,3	PF	DS_65			PRESSURE_TYPE: P (gauge) or P (abs)	N	Flowing static pressure.
8 (A2)	**I**,1,3	TF	DS_65			T	N	Flowing temperature.
9 (A2)	**I**,1,3	DIFF_PF	DS_65			DP	D	Differential pressure.
10	**O**,1,3	QM	DS-65			QM	N/RO	Mass flow rate.
11	**O**,1,3	QB	DS-65			QV	N/RO	Volume flow rate at base conditions (reference), Pb e Tb.
12	**O**,1,3	QV	DS-65			QV	N/RO	Volume flow rate at flowing conditions (Pf, Tf).
13	**O**,1,3	ENERGY	DS-65			ER	N/RO	Energy flow rate.
14 (A2) (CL)		PRODUCT_SEL	Unsigned8	1..4=Product 1 ..4	1	E	S/OS	Selection of the product from the list provided in the GKD block.
15 (A2) (CL)		OVERRIDE_PRESSURE	Float	> 0.0	101.325	PRESSURE_TYPE: P (gauge) or P (abs)	S	Override value for the pressure input when it has bad status.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
16 (A2) (CL)		OVERRIDE_TEMPERATURE	Float		15.0	T	S	Override value for the temperature input when it has bad status.
17 (A2) (CL)		OVERRIDE_DIFF_PRESSURE	Float	>= 0	1.0	DP	S	Override value for the differential pressure when it has bad status.
18 (A2)		RE	FLOAT		50000		N/RO	Reynolds Number.
19		BETA	FLOAT				D/RO	Ratio between the diameters of the Orifice and the pipeline at flowing conditions.
20		CD	FLOAT				D/RO	Coefficient of Discharge of the orifice plate. The writing is allowed only if METER_TYPE is V-Cone or Wafer-Cone.
21		EV	FLOAT				D/RO	Expansion speed factor.
22		Y	FLOAT				D/RO	Expansion factor.
23		DENSITY_FLUID_FLOWING	FLOAT			GD	D/RO	Density of the fluid at flowing conditions.
24		DENSITY_FLUID_BASE	FLOAT			GD	D/RO	Density of the fluid at base conditions.
25 (A2) (CL)		PRESS_DOWNSTREAM_SECTION	Boolean	FALSE and TRUE	TRUE		S/OS	It determines if the static pressure is upstream (TRUE) or downstream (FALSE).
26 (A2) (CL)		TEMP_DIAMETER	FLOAT			T	S/OS	Temperature for Diameter measurements.
27 (A2) (CL)		ORIFICE_ DIAMETER	FLOAT	> 0		L	S/OS	Orifice plate bore diameter at temperature TEMP_DIAMETER.
28 (A2) (CL)		TUBE_DIAMETER	FLOAT	> 0		L	S/OS	Meter tube internal diameter at temperature TEMP_DIAMETER.
29 (A2) (CL)		ALPHA_1	FLOAT	> 0		G	S/OS	Linear coefficient of thermal expansion for the material of the orifice plate.
30 (A2) (CL)		ALPHA_2	FLOAT	> 0		G	S/OS	Linear coefficient of thermal expansion for the material of the meter tube.
31 (A2) (CL)		K	FLOAT			Na	S/OS	Isentropic exponent.
32 (A2) (CL)		ABS_VISCOSITY	FLOAT			Visc	S/OS	Absolute viscosity of fluid.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
33 (A2) (CL)		CALC_METH	Unsigned8	0 to 2	0	Na	S	It determines the calculation method: 0 – Detailed method 1 – Gross 1 Method (HV, Gr, CO_2) 2 – Gross 2 Method (Gr, CO_2, N_2)
34 (A2) (CL)		GROSS_PGR	FLOAT			P	S/OS	Reference pressure for relative density.
35 (A2) (CL)		GROSS_TGR	FLOAT			T	S/OS	Reference temperature for relative density (specific gravity).
36 (A2) (CL)		GROSS_PD	FLOAT			P	S/OS	Reference pressure for molar density.
37 (A2) (CL)		GROSS_TD	FLOAT			T	S/OS	Reference temperature for molar density.
38 (A2) (CL)		GROSS_TH	FLOAT			T	S/OS	Reference temperature for heating value.
39		ZB	FLOAT			Na	D/RO	Compressibility factor at base conditions.
40		ZF	FLOAT			Na	D/RO	Compressibility factor at flowing conditions.
41		D	FLOAT			GD	D/RO	Molar density at PF and TF.
42		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
43		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
44 (A2)	**I**,1,3	DIFF_PF_2	DS_65			DP	N / RO	Differential pressure for low range.
45 (A2)	**I**,1,3	DIFF_PF_ 3	DS_65			DP	N / RO	Differential pressure for low low range.
46 (A2) (CL)		RANGE_HI_2	Float		0	DP	S	Upper limit of the transition band between DIFF_PF and DIFF_PF_1.
47 (A2) (CL)		RANGE_LO_2	Float		0	DP	S	Lower limit of the transition band between DIFF_PF and DIFF_PF_1.
48 (A2) (CL)		RANGE_HI_3	Float		0	DP	S	Upper limit of the transition band between DIFF_PF_1 and DIFF_PF_2.
49 (A2) (CL)		RANGE_LO_3	Float		0	DP	S	Lower limit of the transition band between DIFF_PF_1 and DIFF_PF_2.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
50 (A2) (CL)		STEEL_TYPE1	Unsigned8	0=custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless 5=Invar Rod	0	E	S/OS	Material type of orifice plate.
51 (A2) (CL)		STEEL_TYPE2	Unsigned8	0=custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless 5=Invar Rod	0	E	S/OS	Material type of pipeline.
52 (A2) (CL)		PRESSURE_TYPE	Unsigned8	0=gauge 1=absolute	0	E	S	It defines if the static pressure is gauge or absolute.
53 (A2) (CL)		OVER_TEMP_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	It specifies when and what value must be utilized as override value for the temperature.
54 (A2) (CL)		OVER_PRES_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	It specifies when and what value must be utilized as override value for the pressure.
55 (A2) (CL)		OVER_DPRES_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	It specifies when and what value must be utilized as override value for the differential pressure.
56		DIFF_PF_CALC	Float		0.0	DP	N / RO	Differential pressure resulting from the multiple range processing and the override handling.
57	I	GFLOW	DS-65			QV	N / RO	Volume flow rate input. This input is ignored if a different option of analog input is selected.

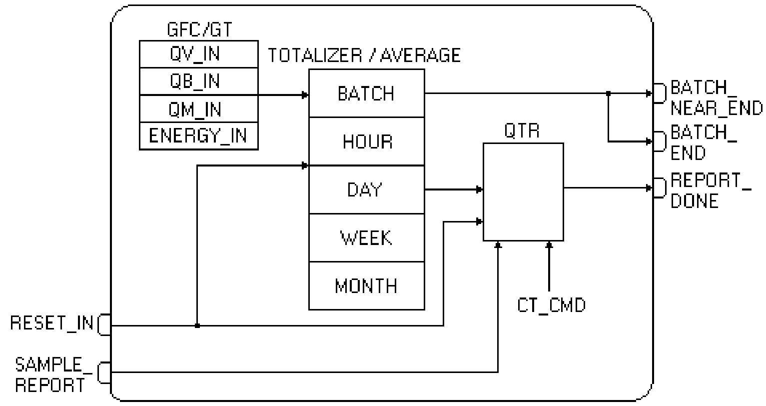
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
58 (A2) (CL)		METER_TYPE	Unsigned8	0=none (station) 1=Orifice Plate 2=Volume Pulse Input 3=Volume Analog Input 4=V-Cone 5=Wafer-Cone 6=Mass Pulse Input 7=Mass Analog Input	1	E	S / OS	Signal type to indicate flow.
59 (A2) (CL)		CHANNEL	Unsigned16		0	Na	S / O/S	The number for the logic hardware channel of the Pulse Input module. This parameter is ignored if a different option of Pulse Input is selected.
60 (CL)		MF	Float		1.0		N / RO	This is the MF parameter used according to the selected meter, which comes from the transducer block. It is used only in device with pulse signal.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

GT –Gas Transaction

Schematic



Description

This block performs the totalizations, weighted average calculations, status analysis and QTR report generation for the periods: batch, hour, day, week and month. Other features include the evaluation of the usual conditions; batch programming and indication of active process alarms and not acknowledged alarms related to the measurement.

Thus, this block must be always associated to the GFC block that is responsible for flow rate calculation.

Identification for the run number – STRATEGY

The configuration of the STRATEGY parameter is mandatory, because it identifies the run number. This parameter must be configured with the same value configured in the STRATEGY parameter of the GFC block to be associated. If the parameter has the default value (zero), the block will execute in the O/S mode and indicate in the BLOCK_ERR.Block configuration parameter.

Visualization of the flow rates and the input variables

The QV_IN, QB_IN, QM_IN and ENERGY_IN parameters indicate the flow rates of run number selected in the STRATEGY parameter and they were calculated by the associated GFC block.

The TF, PF e DIFF_PF parameters are also only for visualization and calculated by the associated GFC block. These parameters show the result after override processing and conversion of gauge static pressure into absolute static pressure by adding the local atmosphere pressure if necessary. The differential pressure, DIFF_PF parameter, includes the whole multiple range processing.

If the selected meter type is “analog input”, the GFLOW parameter reflects the value from the associated GFC block.

Parameters only for visualization – copy of other block parameters

The PRODUCT_SELECTION and METER_TYPE parameters reflect the configuration of the GFC block associated to the same run number (STRATEGY).

The MF parameter reflects the current value of this factor stored in the GKD.MFx_HISTORY block.
The START_HOUR, START_DAY_WEEK and START_DAY_MONTH parameters reflect the configuration of the FCT block.

QTR report generation
There are some events that generate QTR reports in the FC302 memory that are described below:

Event	Report type (GTV.QTR_TYPE)	Condition
Transition of the correspondent accounting period	"Continuous & period"	All the enable periods in ENABLE_REPORT
Reset of the totalizers through the RESET_IN input or by CT_CMD command	"Reset & period"	All the enable periods in ENABLE_REPORT and the batch
Configuration download : treatment similar to reset	"Reset & period"	All the enable periods in ENABLE_REPORT and the batch
Writing into the CT_CMD parameter requesting operational report.	"Operational & period"	Report of the request period
Rise edge in the SAMPLE_REPORT input	"Operational & period"	All the enable periods in ENABLE_REPORT
Command at the end of the batch through the CT_CMD	"Size & batch"	-

When the volume totalization at base conditions is null, the report generation in the FC302 memory will be disabled when configuring REPORT_NO_FLOW = no (default condition) parameter.

Batch programming
This block allows to program up to 10 batches. It must specify the size of each one in the BATCH_SIZE parameter, where the first element is the desired size for the current batch. If the desired size for the actual batch is zero, then the batch will finish only by the reset or batch end command.

It is necessary to specify if the configured size for the batches is volume at flowing or base conditions, or mass or energy, through the BATCH_TYPE parameter.

There is one indication when the current batch is near to the programmed size through the BATCH_NEAR_END output parameter. The NEAR_END parameter specifies the percentage of the programmed size for the batch to indicate in the BATCH_NEAR_END.

Evaluation of the usual conditions
The usual conditions refer to the weighted average value of the temperature, pressure and volume flow rate at base conditions for a determined period. The usual conditions also refer to the proving process, as well the well test, because it is desirable that these procedures were accomplished at conditions similar to the normal operation.

The START_USUAL_CONDITIONS parameter configures the variables that must be calculated by the FC302, thus there is also an option where user provides directly these usual values in the USUAL_TEMPERATURE, USUAL_PRESSURE and USUAL_FLOW parameters.

The GT block always monitors the deviation of the instantaneous values for the variables (temperature, pressure and volume flow at base conditions) comparing them to the usual conditions.

The maximum acceptable deviations are configured in the USUAL_TEMP_DEV, USUAL_PRESS_DEV and USUAL_FLOW_DEV parameters. Observe in the parameter table, the deviation for the temperature is in Engineering Unit. The deviations for pressure and flow rate are in percentage.

The GAS_WARN parameter indicates the deviation occurrence higher than the specified in the evaluation period of the usual conditions.

The OPEN_USUAL_CONDITIONS parameter register the date/hour of the beginning of the usual conditions evaluation and it may happen in the following situations:

- Writing into the START_USUAL_CONDITIONS parameter;
- When requested to start a new evaluation of usual conditions during a well test by writing into WT.TEST_STATE = Start usual conditions (Wr).

Calculations accomplished for period (batch, hour, day, week and month)

For each period, the flow totalizations are calculated for volume flow rate at flowing conditions (Qv), volume flow rate at base conditions (Qb), mass flow rate (Qm) and energy flow rate (energy).
If the volume flow rate at base condition (Qb) calculated by the GFC block is less than the specified in the NO_GAS_FLOW parameter, all the flow rates will be considered null for totalization, this will act as a cutoff.

The weighted average calculations for the input variables (temperature, pressure and differential pressure) and calculation of intermediate variables (Gr, Cd, Ev e Y1) are performed.
The following events are processed in the summarized status of the period:

- Override temperature used;
- Override pressure used;
- Block in O/S;
- Override differential pressure used;
- Bad status of chromatograph;
- Out of range correction factor;
- Process alarm;
- Bad status of flow input;
- Inconsistent secondary variables;
- Abnormal condition;
- Stop totalization.

This summarized status only provides one indication that in any moment of the considered period some important event occurred, and it does not indicate the current status (information provided by the STATUS_CURRENT parameter) or more details that must be obtained from the event register.

The Flow time calculation is the time counting which the flow occurred in the considered period.
If the QTR report was generated at end of period, it will have the number of the report indicated in the COUNTER_BATCH, COUNTER_HOUR, COUNTER_DAY, COUNTER_WEEK or COUNTER_MONTH parameter.

Monitoring and Batch ending

The current batch can be monitored if it is near to the programmed value through the BATCH_NEAR_END parameter or when it reached the programmed value through the BATCH_END output.

The batch ending can be accomplished by user command through the CT_CMD parameter or by automatic way when it gets the programmed value and linking the BATCH_END output and the RESET_IN input.

Nonresettable Totalizers

The TOT_ACC_QV, TOT_ACC_QB, TOT_ACC_QM and TOT_ACC_ENERGY totalizers does not reset through the RESET_IN input or command in the CT_CMD or start of a new account period. Only a configuration download resets these totalizers.

This nonresettable totalizer has a limit of 2,000,000,000, and then it returns to zero. This event to return to zero is registered as “Rollover accum. totalizer Qv” / “Rollover accum. totalizer Qb” / “Rollover accum. totalizer Qm” / “Rollover accum. totalizer energy”.

The rollover of these nonresettable totalizers is independent, thus TOT_ACC_QB may return to zero, but probably this will not occur simultaneously to the TOT_ACC_QV.

Previous Period Totalizers

The TOT_QV_YESTERDAY, TOT_QB_YESTERDAY, TOT_QM_YESTERDAY and TOT_ENERGY_YESTERDAY totalizers indicate the totalizations of the previous account period (yesterday). And the FTIME_YESTERDAY indicates the flow time. The selection and indication of the period visualized in the corresponding parameters are done through CT_CMD parameter.

These information about the previous day consider possible resets in the totalizations for this period, thus these totalizers and the flow time indicate the sum of totalizers/flow time if a reset occurred during the period.

The information of the previous day are consistent even if a power failure occurs. When the FC302 is energized, it checks if these totalizers are related to the previous account day.

Process alarm: active (ACTIVE_ALARM1 e ACTIVE_ALARM2) and unacknowledged (UNACK_ALARM1 e UNACK_ALARM2).

The process alarms (high, high high, low and low low) of variables related to the measurement such as temperature, static pressure, differential pressure, volume flow rate and mass flow rate are processed by the AALM block. In the GT block it has just one summarized indication of active and unacknowledged alarms. For further details, it is necessary to refer to the AALM block or the event register.

Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration : this indication can occur due to the following problems:

- STRATEGY parameter equals to zero. It is mandatory to configure this parameter, that is the run number;
- There is no GFC block associated to the run number configured in the GT.STRATEGY parameter.

2. BLOCK_ERR. Out of Service : GT block may be in the Out of service mode, although the target mode is Auto due to the following causes:

- The STRATEGY parameter is not configured;
- The Resource block is in O/S mode.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with the string different of spaces, then this parameter will substitute the block tag in the QTR report.
3 (A2) (CL)	4	STRATEGY	Unsigned16	0 to 4	0	None	S	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	1,3	QV_IN	DS-65			QV	N / RO	Volume flow rate at flowing conditions.
8	1,3	QB_IN	DS-65			QV	N / RO	Volume flow rate at base conditions.
9	1,3	QM_IN	DS-65			QM	N / RO	Mass flow Rate.
10	1,3	ENERGY_IN	DS-65			ER	N / RO	Energy flow Rate.
11	I,1,3	RESET_IN	DS-66				N / RO	This is a rising edge sensitive input parameter, causing reset in the totalizers, except in the nonresettable totalizer.
12	I,1,3	SAMPLE_REPORT	DS-66				N / RO	This is a positive transition sensitive input parameter which causes the operational report generation of the enabled periods.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
13	O,1,3	BATCH_NEAR_END	DS-66				N / RO	It indicates if the actual batch is near to end. This output will be TRUE until the batch ends.
14	O,1,3	BATCH_END	DS-66				N / RO	It indicates the batch ending for one micro cycle. After that, a new batch is initialized.
15	O,1,3	REPORT_DONE	DS-66				N / RO	It indicates for one macrocycle that a quantitative or operational transaction report was generated and registered.
16	4	PRODUCT_SELECTION_	Unsigned8	1-4 = Product 1-4	1	E	S / RO	Selection of one among four products configured in the GKD block.
17		START_HOUR	Unsigned8	0 to 23	0	Hour	S / RO	Start hour for the counting period of the day.
18		START_DAY_WEEK	Unsigned8	1=Monday to 7=Sunday	1	Day of week	S / RO	Start day for the counting period of the week.
19		START_DAY_MONTH	Unsigned8	1 to 28	1	Day of month	S / RO	Start day for the counting period of the month.
20 (A2) (CL)	4	ENABLE_REPORT	Bitstring[2]		Daily		S	It enables the report generation for hour, day, week or month periods.
21 (CL)	4	BATCH_TYPE	Unsigned8	0=Flowing volume 1=Volume at base 2=Mass 3=Energy	2	E	S	Totalization type to be configured and used for the batch end detection.
22 (CL)	2	BATCH_SIZE	Integer32[10]		0	V/V/M/EN	S	Batch programming through the size of each one. The first element is the actual batch and when finding one zero, the infinite batch starts until a reset or an end batch command occurs.
23 (A2) (CL)	4	NEAR_END	Float	50 to 100	95	%	S	It specifies a percentage of the batch size to be reached to active the BATCH_NEAR_END output.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
24 (A2)	1	CT_CMD	Unsigned8	0=None 1=Reset 2=Operational hour report 3=Operational day report 4=Operational week report 5=Operational month report 6=Batch End 7=Previous hour 8=Previous day 9=Previous week 10=Previous month	Previous day	E	N	Writing "Reset" in this parameter, it is as a positive transition in the RESET_IN parameter. Writing "Report" in this parameter, it is as a positive transition in the SAMPLE_REPORT parameter. Through this parameter is also possible to select the type of previous period to be visualized. After executing a request action, the value will return automatically to the state that shows the type of previous period visualized..
25		TOT_ACC_QV	Integer32		0	TV	N / RO	Nonresettable volume totalizer at flowing conditions.
26	1	TOT_ ACC_QB	Integer32		0	TV	N / RO	Nonresettable volume totalizer at base conditions.
27		TOT_ ACC_QM	Integer32		0	TM	N / RO	Nonresettable mass totalizer.
28		TOT_ ACC_ENERGY	Integer32		0	EN	N / RO	Nonresettable energy totalizer.
29		TOT_QV_BAT CH	Integer32		0	TV	N / RO	Volume totalizer at flowing conditions for the actual batch.
30	1	TOT_QB_ BATCH	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual batch.
31		TOT_QM_ BATCH	Integer32		0	TM	N / RO	Mass totalizer for the actual batch.
32		TOT_ENERGY _ BATCH	Integer32		0	EN	N / RO	Energy totalizer for the actual batch.
33		TWA_ BATCH	Float			T	N / RO	Temperature weighted average for the actual batch.
34		PWA_ BATCH	Float			P (abs)	N / RO	Absolute static pressure weighted average for the actual batch.
35		DPWA_ BATCH	Float			DP	N / RO	Differential pressure weighted average for the actual batch. Used only for differential pressure meter.
36		GRWA_BATC H	Float			Na	N / RO	Relative density weighted average for the actual batch. Used only for differential pressure meter.
37		CDWA_ BATCH	Float				N / RO	Discharge coefficient weighted average for the actual batch. Used only for differential pressure meter.
38		EVWA_ BATCH	Float				N / RO	Expansion speed factor weighted average for the actual batch. Used only for differential pressure meter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
39		Y1WA_ BATCH	Float				N / RO	Expansion factor weighted average for the actual batch. Used only for differential pressure meter.
40		FTIME_BATCH	Time difference				N / RO	Flow time for the actual batch.
41		STATUS_BATCH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual batch status. Similar to the BATCH_STATUS.
42		COUNTER_BATCH	Unsigned32		1	Na	N / RO	Batch report counter.
43		TOT_QV_HOUR	Integer32		0	TV	N / RO	Volume totalizer at flowing conditions for the actual hour.
44	1	TOT_QB_HOUR	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual hour.
45		TOT_QM_HOUR	Integer32		0	TM	N / RO	Mass totalizer for the actual hour.
46		TOT_ENERGY_HOUR	Integer32		0	EN	N / RO	Energy totalizer for the actual hour.
47		TWA_HOUR	Float			T	N / RO	Temperature weighted average for the actual hour.
48		PWA_HOUR	Float			P (abs)	N / RO	Absolute static pressure weighted average for the actual hour.
49		DPWA_HOUR	Float			DP	N / RO	Differential pressure weighted average for the actual hour. Used only for differential pressure meter.
50		GRWA_HOUR	Float			Na	N / RO	Relative density weighted average for the actual hour. Used only for differential pressure meter.
51		CDWA_HOUR	Float				N / RO	Discharge coefficient weighted average for actual hour. Used only for differential pressure meter.
52		EVWA_HOUR	Float				N / RO	Expansion speed factor weighted average for the actual hour. Used only for differential pressure meter.
53		Y1WA_HOUR	Float				N / RO	Expansion factor weighted average for the actual hour. Used only for differential pressure meter.
54		FTIME_HOUR	Time difference				N / RO	Flow time for the actual hour.
55		STATUS_HOUR	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual hour status. Similar to the BATCH_STATUS
56		COUNTER_HOUR	Unsigned32		1	Na	N / RO	Hourly report counter.
57		TOT_QV_DAY	Integer32		0	TV	N / RO	Volume totalizer at flowing conditions for the actual day
58	1	TOT_QB_ DAY	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual day.
59		TOT_QM_ DAY	Integer32		0	TM	N / RO	Mass totalizer for the actual day.
60		TOT_ENERGY_ DAY	Integer32		0	EN	N / RO	Energy totalizer for the actual day.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
61		TWA_ DAY	Float			T	N / RO	Temperature weighted average for the actual day.
62		PWA_ DAY	Float			P (abs)	N / RO	Static pressure weighted average for the actual day.
63		DPWA_ DAY	Float			DP	N / RO	Differential pressure weighted average for the actual day. Used only for differential pressure meter.
64		GRWA_DAY	Float			Na	N / RO	Relative density weighted average for the actual day. Used only for differential pressure meter.
65		CDWA_ DAY	Float				N / RO	Discharge coefficient weighted average for the actual day. Used only for differential pressure meter.
66		EVWA_ DAY	Float				N / RO	Expansion speed factor weighted average for the actual day.
67		Y1WA_ DAY	Float				N / RO	Expansion factor weighted average for the actual day. Used only for differential pressure meter.
68		FTIME_DAY	Time difference				N / RO	Flow time for the actual day.
69		STATUS_DAY	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual day status. Similar to the BATCH_STATUS.
70		COUNTER_DAY	Unsigned32		1	Na	N / RO	Daily report counter.
71		TOT_QV_WEEK	Integer32		0	TV	N / RO	Volume totalizer at flowing conditions for the actual week.
72	1	TOT_QB_ WEEK	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual week.
73		TOT_QM_ WEEK	Integer32		0	TM	N / RO	Mass totalizer for the actual week.
74		TOT_ENERGY_ WEEK	Integer32		0	EN	N / RO	Energy totalizer for the actual week.
75		TWA_ WEEK	Float			T	N / RO	Temperature weighted average for the actual week.
76		PWA_ WEEK	Float			P (abs)	N / RO	Absolute static pressure weighted average for the actual week.
77		DPWA_ WEEK	Float			DP	N / RO	Differential pressure weighted average for the actual week. Used only for differential pressure meter.
78		GRWA_WEEK	Float			Na	N / RO	Relative density weighted average for the actual week. Used only for differential pressure meter.
79		CDWA_ WEEK	Float				N / RO	Coefficient of discharge weighted average for the actual week. Used only for differential pressure meter.
80		EVWA_ WEEK	Float				N / RO	Approach speed factor weighted average for the actual week. Used only for differential pressure meter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
81		Y1WA_ WEEK	Float				N / RO	Expansion factor weighted average for the actual week. Used only for differential pressure meter.
82		FTIME_WEEK	Time difference				N / RO	Flow time for the actual week.
83		STATUS_ WEEK	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual week status. Similar to the BATCH_STATUS
84		COUNTER_ WEEK	Unsigned32		1	Na	N / RO	Weekly report counter.
85		TOT_QV_MON TH	Integer32		0	TV	N / RO	Volume totalizer at flowing conditions for the actual month.
86	1	TOT_QB_ MONTH	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual month.
87		TOT_QM_ MONTH	Integer32		0	TM	N / RO	Mass totalizer for the actual month.
88		TOT_ENERGY _ MONTH	Integer32		0	EN	N / RO	Energy totalizer for the actual month.
89		TWA_ MONTH	Float			T	N / RO	Temperature weighted average for the actual month.
90		PWA_ MONTH	Float			P (abs)	N / RO	Absolute static pressure weighted average for the actual month.
91		DPWA_ MONTH	Float			DP	N / RO	Differential pressure weighted average for the actual month. Used only for differential pressure meter.
92		GRWA_MONT H	Float			Na	N / RO	Relative density weighted average for the actual month. Used only for differential pressure meter.
93		CDWA_ MONTH	Float				N / RO	Discharge coefficient weighted average for the actual month. Used only for differential pressure meter.
94		EVWA_ MONTH	Float				N / RO	Expansion speed factor weighted average of the actual month. Used only for differential pressure meter.
95		Y1WA_ MONTH	Float				N / RO	Expansion factor weighted average for the actual month. Used only for differential pressure meter.
96		FTIME_MONT H	Time difference				N / RO	Flow time for the actual month.
97		STATUS_ MONTH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual month status. Similar to the BATCH_STATUS.
98		COUNTER_ MONTH	Unsigned32		1	Na	N / RO	Monthly report counter.
99		ACTIVE_ALAR M1	Bitstring[2]				N / RO	It indicates the active alarms related to this run number.
100		ACTIVE_ALAR M2	Bitstring[2]				N / RO	It indicates the active alarms related to this run number.
101		UNACK_ALAR M1	Bitstring[2]				N	It indicates the alarms related to this flow are not acknowledged by the operator.
102		UNACK_ALAR M2	Bitstring[2]				N	It indicates the alarms related to this flow are not acknowledged by the operator.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
103		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
104		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
105		TOT_QV_YESTERDAY	Integer32		0	TV	N / RO	Volume totalizer at flowing conditions for the previous period, selected in CT_CMD.
106		TOT_QB_ YESTERDAY	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the previous period, selected in CT_CMD.
107		TOT_QM_ YESTERDAY	Integer32		0	TM	N / RO	Mass totalizer for the previous period, selected in CT_CMD.
108		TOT_ENERGY_ YESTERDAY	Integer32		0	EN	N / RO	Energy totalizer for the previous period, selected in CT_CMD.
109		FTIME_ YESTERDAY	Time difference				N / RO	Flow time for the previous period, selected in CT_CMD.
110		USUAL_TEMP_DEV	Float	0.0=disabled 0.0 to 100.0	5	T	S	Maximum deviation for the temperature during the evaluation of the usual conditions and well test execution.
111		USUAL_PRESS_DEV	Float	0.0=disabled 0.0 to 100	10	%	S	Maximum deviation for the pressure during the evaluation of the usual conditions and well test execution.
112		USUAL_FLOW_DEV	Float	0.0=disabled 0.0 to 100	10	%	S	Maximum deviation for the volume flow at base conditions during the evaluation of the usual conditions and well tests.
113		START_USUAL_CONDITIONS	Bitstring[2]	See the specific description	0	E	S	A new evaluation of the usual conditions for the enabled variables in this parameter is initialized when one proving is accomplished successful or when it is requested during a well test or writing in this parameter.
114		OPEN_USUAL_CONDITIONS	Date				N / RO	Date/hour for the beginning of the usual conditions evaluation.
115		GAS_WARN	Bitstring[2]	See the specific description	0	E	N / RO	Warning events occurred during the usual conditions evaluation.
116 (A2)		USUAL_TEMPERATURE	Float		0	T	N	If the actual temperature is not configured to be calculated by the FC302 in the START_USUAL_CONTIONS parameter, the writing will be allowed in this parameter.

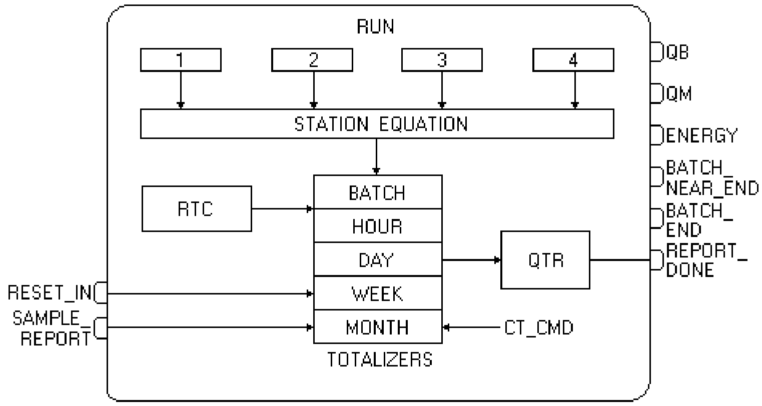
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
117 (A2)		USUAL_PRESSURE	Float	>= 0.0	0	P	N	If the actual temperature is not configured to be calculated by the FC302 in the START_USUAL_CONTIONS parameter, the writing will be allowed in this parameter.
118 (A2)		USUAL_FLOW	Float	>= 0.0	0	QV	N	If the actual volume flow at base conditions is not configured to be calculated by the FC302 in the START_USUAL_CONTIONS parameter, the writing will be allowed in this parameter.
119		MF	Float		0.0		N / RO	This parameter is the meter factor (MF) used according to the selected meter, and it is configured in the GKD transducer block. It is used only if the selected meter is “pulse input” type.
120		PF	DS_65			P (abs)	N / RO	Absolute static pressure at flowing conditions.
121		TF	DS_65			T	N / RO	Flow temperature.
122		DIFF_PF	DS_65			DP	N / RO	Differential pressure calculated after the multiple range and override process. Used only for differential pressure meters.
123		GFLOW	DS-65			QV	N / RO	Volume flow input at flowing conditions, and it is utilized if the selected meter is “analog input” type.
124		STATUS_CURRENT	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual status. Similar to the BATCH_STATUS.
125 (A2) (CL)		NO_GAS_FLOW	Float	>= 0.0 0.0=disabled	0.0	QV	S	Lower limit for the volume flow at base conditions, under this it considers null.
126 (A2) (CL)		REPORT_NO_FLOW	Unsigned8	0=No 1=Yes	0	E	S	QTR report is not generated if the QB totalizer was zero and this parameter is configured as “No”.
127		METER_TYPE	Unsigned8	0=none (station) 1=Orifice Plate 2=Pulse Input 3=Analog Input 4=V-Cone 5=Wafer-Cone	0	E	N / RO	Signal type for flow indication.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

GST – Gas Station Transaction

Schematic



Description

This block is used for gas measurement calculations, the corrected flows of the meters are combined (sum and/or subtract) according to the user configuration and one QTR report can be generated and visualized by the GTV block.

The main purpose of this block is to add/subtract the corrected flows, this block does not refer to secondary variables (temperature and pressure), intermediate variables for calculation, correction factors or sensors. And these flows may have been measured using different types of sensors.

Other features include batch programming and indication of active and unacknowledged process alarms related to the station.

Identification for the run number – STRATEGY parameter

As this block refers to many measurements, its default value is 253, it can be interpreted as “gas station”, and also it is a read only parameter.

Block inputs

The block inputs are used according to the configuration, as showed in the table below:

Input	Link Necessity	Description
RESET_IN	Depends on the application	This input can be utilized when it desires that an event was detected by other reset block, the totalizers. For example, the alignment ending for a determined meter which must initiate the measurement.
SAMPLE_REPORT	Depends on the application	When it desires to generate operational reports due to an event detected by other block, for example, the ending of the proving sucessful.

Block outputs

The block outputs are flows resulting of calculation and, they are available to be connected to other blocks:

- QB – corrected volume flow rate at base conditions
- QM – mass flow rate
- ENERGY – energy flow rate

The BATCH_NEAR_END output indicates the batch is near of the programmed value, that is, the totalized value represents a percentage of the configured value higher than the NEAR_END parameter.
The BATCH_END outputs indicate the totalized value is equal to or higher than the programmed and it will return to zero only when the batch ends.

The REPORT_DONE output indicates that a QTR report was generated and stored in the FC302 memory only for one macrocycle.

Configuration of the station equation – STATION_EQUATION parameter

The STATION_EQUATION parameter defines the operations to be accomplished between the streams, obeying the following rules:

- Allowed operations: sum (+) and subtract (-);
- Interspersed sequence of the run number with the arithmetic operator without spaces;
- If the first character is blank, no operation will be accomplished;
- There is a write check for the STATION_EQUATION parameter regarding to consistency: valid run number and operation;
- During the block execution, the equation consistence will be checked and any problem will be indicated in the BLOCK_ERR.Block Configuration Error parameter;
- Run number of a gas measurement;
- Configuration example:
  - 1+2+3-4
  - 2-1
  - 1+1-2

QTR report generation

There are several events that cause the QTR report generation in the FC302 memory for later reading and save it in database by the FCView.

The situations are showed below:

Event	Report Type (GTV.QTR_TYPE)	Condition
Transition of correspondent account period	"Continuous & period"	All the periods enabled in the ENABLE_REPORT
Reset of the totalizations through the RESET_IN input or by CT_CMD command	"Reset & period"	All the periods enabled in the ENABLE_REPORT and the period of the batch
Configuration download: treatment similar to reset	"Reset & period"	All the periods enabled in the ENABLE_REPORT and the period of the batch
Writing in the CT_CMD parameter requesting operational report.	"Operational & period"	Report of the requested period
Positive transition in the SAMPLE_REPORT input	"Operational & period"	All the periods enabled in the ENABLE_REPORT
Batch end command by the CT_CMD	"Size & batch"	-

When the volume totalizer at base conditions is null, the report generation in the FC302 memory will be disabled when configuring REPORT_NO_FLOW = no (default condition) parameter.

Batch programming

The block allows the programming up to 10 batches, and the size for each batch must be specified in the BATCH_SIZE parameter, whose first element should have the desired size for the current batch. If the desired size for the actual batch is zero, thus this will be finished only by a reset or batch end command.

Besides programming the batch size, it is necessary to specify the type of totalizer to be compared through the BATCH_TYPE parameter: volume flow rate at flowing and base conditions, mass flow rate or energy flow rate.

There is an indication that the actual batch is near of the programmed size, through the BATCH_NEAR_END output parameter. The NEAR_END parameter specifies the percentage of the programmed size for the batch from this will show the indication.

Calculations executed by period (batch, hour, day, week and month)

The flow calculations are calculated for volume at base conditions (Qb), mass (Qm) and energy (energy) for each period.

Indication of events in the summarized status of period:

- Override temperature used;
- Override pressure used;
- Block in O/S;
- Override differential pressure used;
- Bad status of chromatograph;
- Out of range correction factor;
- Process alarm;
- Bad status of flow input;
- Inconsistent secondary variables;
- Abnormal condition;
- Stop totalization.

This summarized status provides only indication that an important event occurred at one moment in any of the measured flows, which is in the station equation. And it does not indicate more details, which must be obtained from the event register.

The flow time calculation is the time counting when the flow rate is different of zero.

If the QTR report is generated, it will have the report number indicated in the COUNTER_BATCH, COUNTER_HOUR, COUNTER_DAY, COUNTER_WEEK or COUNTER_MONTH parameter.

Monitoring and batch ending
When the current batch is near to the programmed value, it is indicated through the BATCH_NEAR_END parameter or when it reaches the programmed value through the BATCH_END output.

The batch ending can be accomplished by user command through the CT_CMD parameter or automatically, when it reaches the programmed value and linking the BATCH_END output to the RESET_IN input.

Totalizers of the previous batch
The TOT_QB_PREV_BATCH, TOT_QM_ PREV_BATCH and TOT_ENERGY_ PREV_BATCH totalizers indicate the totalizations of the previous batch. Besides it, it is indicated the flow time in FTIME_ PREV_BATCH parameter.

Totalizers of the previous period
The TOT_QB_YESTERDAY, TOT_QM_YESTERDAY and TOT_ENERGY_YESTERDAY totalizers indicate the totalizations of the previous account period. Besides it, the flow time is indicated in FTIME_YESTERDAY parameter. The selection and indication of the period type visualized in the corresponding parameters are done through CT_CMD parameter.

This information of the previous day considers possible resets in the totalizations during this period, thus these totalizers and the flow time indicate a sum of totalizers/flow times if a reset occurred.

The information of the previous day is consistent even a power failure occurred, thus when energizing, the FC302 checks if the totalizers are related to the previous account day.

Process alarm: active (ACTIVE_ALARM1 and ACTIVE_ALARM2) and unacknowledged (UNACK_ALARM1 and UNACK_ALARM2).
The process alarms (high, high high, low e low low) of variables related to the measurement systems such as volume flow rate, mass flow rate, temperature and pressure, which are used in the station equation, are processed by the AALM block. In the GST block it has just one summarized status indication of active and unacknowledged alarms. For further details, refer to the AALM block or the event register.

Diagnosis and Troubleshooting
1. BLOCK_ERR. Block configuration: this indication occurs when there is any problem in the station equation, for example, any flow which participates in the equation is not measuring the gas;

2. BLOCK_ERR. Out of Service: the GST block can continue in the Out of service mode, although the target mode is Auto, because the Resource block is in O/S.

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with the string different of spaces, this parameter will replace the block tag in the QTR report.
3	4	STRATEGY	Unsigned16	253	253	None	S / RO	This parameter identifies the run number. It is used for more than one measured flows; therefore it is a read only parameter.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	O,1,3	QB	DS-65			QV	N / RO	Volume flow rate at base conditions.
8	O,1,3	QM	DS-65			QM	N / RO	Mass flow rate.
9	O,1,3	ENERGY	DS-65			ER	N / RO	Energy flow rate.
10	I,1,3	RESET_IN	DS-66				N / RO	This is a positive transition sensitive parameter; it causes reset in the totalizers.
11	I,1,3	SAMPLE_REPORT	DS-66				N / RO	This is a positive transition sensitive parameter; it causes the operation report generation for the enabled periods.
12	O,1,3	BATCH_NEAR_END	DS-66				N / RO	Indicate the actual batch is near of the end. This output will continue TRUE until the batch ends.
13	O,1,3	BATCH_END	DS-66				N / RO	Indicate the batch ending for one micro cycle. After this, a new batch is initialized.
14	O,1,3	REPORT_DONE	DS-66				N / RO	Indicate, for one macrocycle, the operational or quantitative transaction report was generated and registered.
15 (A2) (CL)		STATION_EQUATION	Visiblestring[16]		Blank		S	Station equation for gas. If the first is blank, it means no processing.
16 (A2) (CL)	4	ENABLE_REPORT	Bitstring[2]		Daily		S	This parameter enables the report generation for the periods: hour, day, week or month.
17 (CL)	4	BATCH_TYPE	Unsigned8	0=None 1=Volume at base 2=Mass 3=Energy	2	E	S	Totalization type to be configured and utilized for batch end detection.
18	2	BATCH_SIZE	Integer32[10]		0	V/V/M/EN	S	Batch programming through the size of each one. The first element is the actual batch and when finding one zero, the infinite batch starts until a reset or an end batch command occurs.
19 (A2) (CL)	4	NEAR_END	Float	50 to 100	95	%	S	Specify the percentage of the batch size to be reached to active the BATCH_NEAR_END output.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
20 (A2)	1	CT_CMD	Unsigned8	0=None 1=Reset 2=Operational hour report 3=Operational day report 4=Operational week report 5=Operational month report 6=Batch End 7=Previous hour 8=Previous day 9=Previous week 10=Previous month	Previous day	E	N	Writing "Reset" in this parameter, it means a positive transition in the RESET_IN parameter. Writing "Report" in this parameter, it means a positive transition in the SAMPLE_REPORT parameter. Through this parameter is also possible to select the type of previous period to be visualized. After executing a request action, the value will return automatically to the state that shows the type of previous period visualized.
21		TOT_QB_ YESTERDAY	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the previous period, selected in CT_CMD.
22		TOT_QM_ YESTERDAY	Integer32		0	TM	N / RO	Mass totalizer for the previous period, selected in CT_CMD.
23		TOT_ENERGY _ YESTERDAY	Integer32		0	EN	N / RO	Energy totalizer for the previous period, selected in CT_CMD.
24		FTIME_ YESTERDAY	Time difference				N / RO	Flow time for the previous period, selected in CT_CMD.
25		TOT_QB_ PREV_BATCH	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the previous batch.
26		TOT_QM_ PREV_BATCH	Integer32		0	TM	N / RO	Mass totalizer for the previous batch.
27		TOT_ENERGY _ PREV_BATCH	Integer32		0	EN	N / RO	Energy totalizer for the previous batch.
28		FTIME_ PREV_BATCH	Time difference				N / RO	Flow time for the previous batch.
29	1	TOT_QB_ BATCH	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual batch.
30		TOT_QM_ BATCH	Integer32		0	TM	N / RO	Mass totalizer for the actual batch.
31		TOT_ENERGY _ BATCH	Integer32		0	EN	N / RO	Energy totalizer for the actual batch.
32		FTIME_BATCH	Time difference				N / RO	Flow time for the actual batch.
33		STATUS_BATCH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual batch status. Similar to the BATCH_STATUS.
34		COUNTER_BATCH	Unsigned32		1	Na	N / RO	Batch report counter.
35	1	TOT_QB_HOUR	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual hour.
36		TOT_QM_HOUR	Integer32		0	TM	N / RO	Mass totalizer for the actual hour.
37		TOT_ENERGY _HOUR	Integer32		0	EN	N / RO	Energy totalizer for the actual hour.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
38		FTIME_HOUR	Time difference				N / RO	Flow time for actual hour.
39		STATUS_HOUR	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual hour status. Similar to the BATCH_STATUS
40		COUNTER_HOUR	Unsigned32		1	Na	N / RO	Hourly report counter.
41	1	TOT_QB_ DAY	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual day.
42		TOT_QM_ DAY	Integer32		0	TM	N / RO	Mass totalizer for the actual day.
43		TOT_ENERGY_ DAY	Integer32		0	EN	N / RO	Energy totalizer for the actual day.
44		FTIME_DAY	Time difference				N / RO	Flow time for the actual day.
45		STATUS_DAY	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual day status. Similar to the BATCH_STATUS.
46		COUNTER_DAY	Unsigned32		1	Na	N / RO	Daily report counter.
47	1	TOT_QB_ WEEK	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual week.
48		TOT_QM_ WEEK	Integer32		0	TM	N / RO	Mass totalizer for the actual week.
49		TOT_ENERGY_ WEEK	Integer32		0	EN	N / RO	Energy totalizer for the actual week.
50		FTIME_WEEK	Time difference				N / RO	Flow time for the actual week.
51		STATUS_ WEEK	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual week status. Similar to the BATCH_STATUS.
52		COUNTER_ WEEK	Unsigned32		1	Na	N / RO	Weekly report counter.
53	1	TOT_QB_ MONTH	Integer32		0	TV	N / RO	Volume totalizer at base conditions for the actual month.
54		TOT_QM_ MONTH	Integer32		0	TM	N / RO	Mass totalizer for the actual month.
55		TOT_ENERGY_ MONTH	Integer32		0	EN	N / RO	Energy totalizer for the actual month.
56		FTIME_MONTH	Time difference				N / RO	Flow time for the actual month.
57		STATUS_ MONTH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual month status. Similar to the BATCH_STATUS.
58		COUNTER_ MONTH	Unsigned32		1	Na	N / RO	Monthly report counter.
59		ACTIVE_ALARM1	Bitstring[2]				N / RO	Indicate the active alarms related to the station.
60		ACTIVE_ALARM2	Bitstring[2]				N / RO	Indicate the active alarms related to the station.
61		UNACK_ALARM1	Bitstring[2]				N	Indicate the alarms related to the station are unacknowledged by the operator.
62		UNACK_ALARM2	Bitstring[2]				N	Indicate the alarms related to the station are unacknowledged by the operator.
63 (A2) (CL)		REPORT_NO_ FLOW	Unsigned8	0=No 1=Yes	0	E	S	The QTR report will not be generated if the QB totalizer is zero and this parameter is configured as “No”.
64		UPDATE_EVT	DS-73			Na	D	This alert is generated by any changes to the static data.

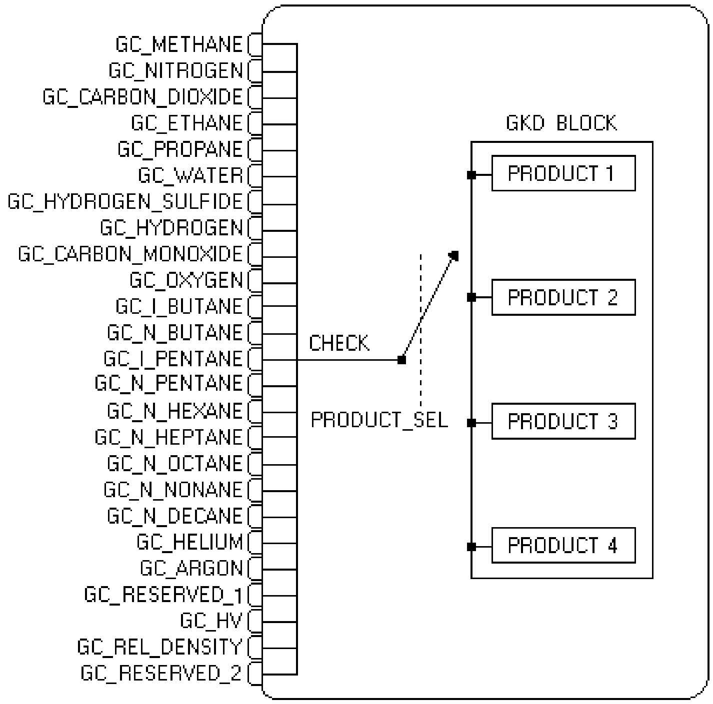
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
65		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

GC –Gas Composition

Schematic



Description

This block receives the gas composition from other blocks, which can be Modbus blocks (MBCM) or blocks from the chromatograph via Foundation Fieldbus.

Identification for the run number – STRATEGY parameter

The configuration of the STRATEGY parameter is mandatory, because it identifies the run number. The composition will be checked and transferred to a product in the GKD block. If this product is used in more than one stream, the STRATEGY parameter must be configured as 255 that means “Not specific”, it does not refer only to one measured flow.

Block inputs

The block inputs refer to 21 gas components plus viscosity, heating value, relative density and water content. Only the linked inputs will be analyzed considering consistency, and also they can be transferred to the GKD block in the specified product in the PRODUCT_SEL parameter.

Configuration of the PRODUCT_SEL parameter

This parameter indicates which product in the GKD block will receive the composition provided by the input parameters of this block, after the consistency check.

Block processing

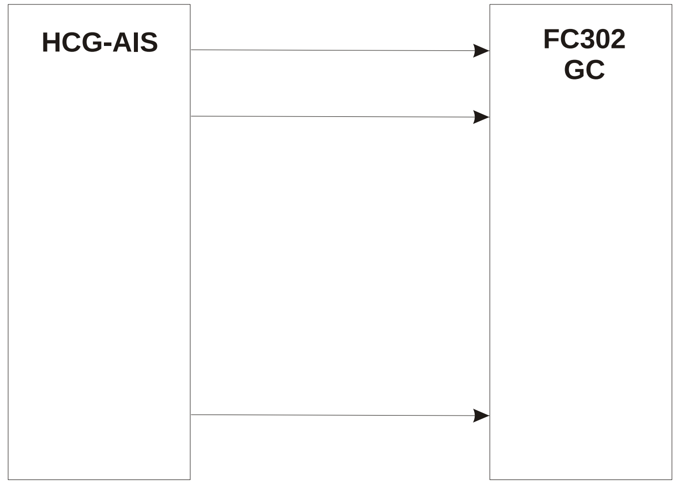
For each linked input, the status and the range will be analyzed (refer to the component range in the GKD block), if there is problem, the CHROMA_STATUS parameter will show it.
Besides this, the following analyses are accomplished:

- Total of the percentages equals to 100%;
- If the FC302 is not configured to calculate the heating value or relative density (GKD. HV_GR_CALC_Px), the correspondent inputs of this block must be linked with good status and within the range;
- The GKD.COMPOSITION_Px block must be configured to “chromatograph”.

The TIME_LAST_UPDATE parameter indicates the elapsed time since the last transference of the composition to the GKD block, if any value changed. Thus, after transferring the composition to the GKD block, if an inconsistency is detected or all linked inputs of this block remains unchanged, the TIME_LAST_UPDATE parameter will keep counting the time.

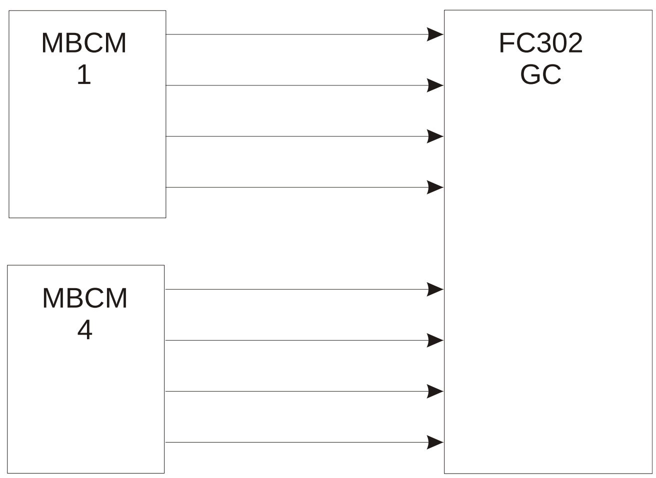
Application with Foundation Fieldbus chromatograph

The HGC-AIS block of the chromatograph provides the composition and they must be linked to the GC block in the FC302.



Application with Modbus chromatograph

The FC302 must be configured as Master Modbus and it can communicate with the chromatograph using Modbus RTU or Modbus TCP/IP. The MBCM block brings the gas composition from the chromatograph and its output parameters must be linked to the GC block.



Diagnosis and Troubleshooting

1. BLOCK_ERR. Out of Service: GC block may remain in the Out of service mode, although the target mode is Auto because the Resource block is in O/S;

2. The CHROMA_STATUS parameter shows problems occurred in consistency checks, as:

CHROMA_STATUS	Corrective action
Mode O/S	
Total greater than 100% Total less than 100%	Check the percentage sum for the 21 components
Inconsistent composition	
User enter	The GKD.COMPOSITION_Px parameter must be configured to “chromatograph”
Methane Nitrogen Carbon Dioxide Ethane Propane Water Hydrogen sulfide Hydrogen Carbon monoxide Oxygen I-Butane n-Butane I-Pentane n-Pentane n-Hexane n-Heptane n-Octane n-Nonane n-Decane Helium Argon Total butanes Total Pentanes	Check the linked input status, verify the component range (refer to the GKD block description)
HV Gr	Verify the GKD.HV_GR_CALC_Px block configuration. Check the range according to the table in the GKD block.

Supported Mode
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3 (CL)	4	STRATEGY	Unsigned16	1 to 4 255	255	None	S	This parameter identifies the meter run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode Parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	I	GC_METHANE	DS-65			%	N / RO	Methane percentage in the composition.
8	I	GC_NITROGEN	DS-65			%	N / RO	Nitrogen percentage in the composition.
9	I	GC_CARBON_DIOXIDE	DS-65			%	N / RO	Carbon dioxide percentage in the composition.
10	I	GC_ETHANE	DS-65			%	N / RO	Ethane percentage in the composition.
11	I	GC_PROPANE	DS-65			%	N / RO	Propane percentage in the composition.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
12	I	GC_WATER	DS-65			%	N / RO	Water percentage in the composition.
13	I	GC_HYDROGEN SULFIDE	DS-65			%	N / RO	Hydrogen sulfide percentage in the composition.
14	I	GC_HYDROGEN	DS-65			%	N / RO	Hydrogen percentage in the composition.
15	I	GC_CARBON_MON OXIDE	DS-65			%	N / RO	Carbon monoxide percentage in the composition.
16	I	GC_OXYGEN	DS-65			%	N / RO	Oxygen percentage in the composition.
17	I	GC_I_BUTANE	DS-65			%	N / RO	I-butane percentage in the composition.
18	I	GC_N_BUTANE	DS-65			%	N / RO	N-butane percentage in the composition.
19	I	GC_I_PENTANE	DS-65			%	N / RO	I-pentane percentage in the composition.
20	I	GC_N_PENTANE	DS-65			%	N / RO	N-pentane percentage in the composition.
21	I	GC_N_HEXANE	DS-65			%	N / RO	N-hexane percentage in the composition.
22	I	GC_N_HEPTANE	DS-65			%	N / RO	N-heptane percentage in the composition.
23	I	GC_N_OCTANE	DS-65			%	N / RO	N-octane percentage in the composition.
24	I	GC_N_NONANE	DS-65			%	N / RO	N-nonane percentage in the composition.
25	I	GC_N_DECANE	DS-65			%	N / RO	N-decane percentage in the composition.
26	I	GC_HELIUM	DS-65			%	N / RO	Helium percentage in the composition.
27	I	GC_ARGON	DS-65			%	N / RO	Argon percentage in the composition.
28	I	GC_VISCOSITY	DS-65			Na	N / RO	Composition Viscosity.
29	I	GC_HV	DS-65			HV	N / RO	Composition Heating value.
30	I	GC_REL_DENSITY	DS-65			Na	N / RO	Composition Relative density.
31	I	GC_RESERVED2	DS-65			Na	N / RO	Reserved2.
32 (A2) (CL)	4	CHROMA_TYPE	Unsigned8	0 - None 1 – Yamatake HGC303 FF 2 – Yamatake HGC303 Modbus	1	E	S	Chromatograph type selection for PRODUCT1.
33 (A2) (CL)	4	PRODUCT_SEL	Unsigned8	1-4 = Product 1-4	1	E	S / OS	Product selection of list provided in the GKD block.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
34		CHROMA_STATUS	Unsigned32	0=normal 1=Mode O/S 2=Total greater than 100% 3=Total less than 100% 4=Inconsistent composition 5=User enter 11=Methane 12=Nitrogen 13=Carbon Dioxide 14=Ethane 15=Propane 16=Water 17=Hydrogen sulfide 18=Hydrogen 19=Carbon monoxide 20=Oxygen 21=I-Butane 22=n-Butane 23=I-Pentane 24=n-Pentane 25=n-Hexane 26=n-Heptane 27=n-Octane 28=n-Nonane 29=n-Decane 30=Helium 31=Argon 32=Total butanes 33=Total Pentanes 34=HV 35=Gr		E	N / RO	Status information for the gas analyzer device.
35		TIME_LAST_UPDATE	Time difference				N / RO	Time elapsed since last composition update.
36		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
37		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.

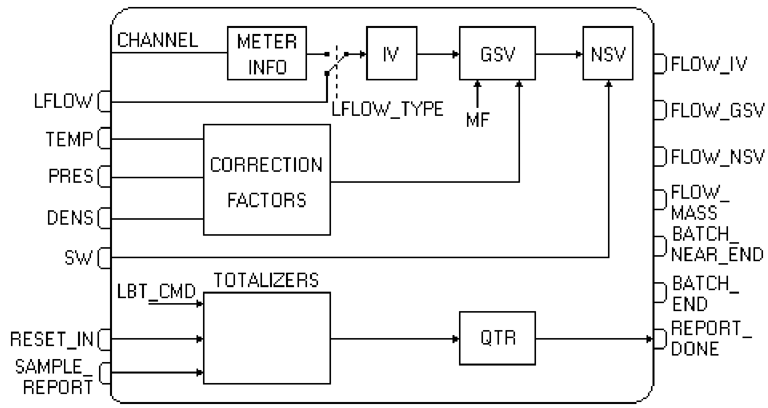
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

Blocks for liquid measurement

LBT –Liquid Batch Transaction

Schematic



Description

For batch operations, the QTR is related to the loading for the specified product (product batch), usually a pre determined quantity.
The manual mode to end the bath is through writing the Batch End into the LBT_CMD parameter.

Up to 10 batches can be programmed. The product type and quantity to be transferred should be specified. When a sequential transference of different product occurs, each batch can be finished automatically through the detection of change in the product density.

Identification for the run number – STRATEGY parameter

The configuration of the STRATEGY parameter is mandatory, because it identifies the run number. If the parameter is configured with default value (zero), the block will execute in the O/S mode and indicate in the BLOCK_ERR.Block configuration parameter. This parameter also associates the information of the operational meter in the LKD block (METERx_INFO - NKF and MF_METER_PRODUCT – meter factor), if the meter type is “pulse input”.

Block inputs

The block inputs are used according to the configuration, as showed below:

Input	Link necessity	Description
TEMPERATURE_METER	mandatory	Flowing temperature
PRESSURE_METER	If custody transfer measurment, this parameter is mandatory. If allocation measurement, this parameter is optional	Flowing gauge pressure
DENSITY_METER	mandatory	Density for the product measured at flowing or base conditions depending on the configuration of LKD.PRODUCTx_INFO.Density type parameter. If an online densitometer is measuring in temperature and pressure conditions (it requires instruments to read the variables) different from that found in the meter, it is recommended to use the LCF block to convert the density from flowing conditions to base conditions, and also it must be connected to the DENSITY_METER input. For water measurements, the density must be at base temperature. **If it was an appropriation measurement (PRODUCTx_INFO.Product type = Emulsion crude oil and water / Emulsion light hydrocarbon and water), this input will receive the dry oil density at base condition. So, it will be the result of laboratory analysis because any line density meter would measure a crude oil/light hydrocarbon and water mixture in a rate from 0 to 100%.**
SW_METER	mandatory	Percent of water and sand.
LFLOW	Mandatory, if meter is “analog input”	This input should indicate the flow rate type that is configured in LFLOW_TYPE parameter.

Input	Link necessity	Description
SW_METER	mandatory	Percent of water and sand.
LFLOW	Mandatory, if meter is “analog input”	This input should indicate the flow rate type that is configured in LFLOW_TYPE parameter.
RESET_IN	Depends on the application	This input can be used when an event detected by another block must reset the totalizers. For example, the alignment ending for a determined meter should start the measurement.
SAMPLE_REPORT	Depends on the application	When operational reports are generated due to an event detected by another block, for example, the proving ending successful.

Block outputs
The flows resulting of calculations are indicated in the outputs below (regardless of the selected meter type in LFLOW_TYPE), and also are available to be linked to other blocks:

- FLOW_IV – volume flow rate at flowing conditions;
- FLOW_GSV – volume flow rate at base conditions, it is not calculated in allocation measurement;
- FLOW_NSV – corrected volume flow rate at base conditions, discounting the percentage of water and sediments;
- FLOW_MASS – mass flow rate.

The REPORT_DONE output indicates for just one macrocycle that one QTR report, regardless of the type, was generated and stored in the FC302 memory.

The BATCH_NEAR_END output indicates that current batch is near to the programmed value, the totalized value represents a percentage higher than the configured value to the NEAR_END parameter.

The BATCH_END parameter indicates if the totalized value is equals to or higher than the programmed and it will return to zero at the batch ending.

Selection of the meter type (LFLOW_TYPE parameter)
In the LFLOW_TYPE parameter, the user can select the available types for flow meter. The options are indicated below:

LFLOW_TYPE	Volume / Mass	Corrected in temperature	Pulse input / Analog input
IV pulse input	volume	No	pulse input
IV*CTL pulse input	volume	Yes	pulse input
IM pulse input	mass	-	pulse input
Flow IV analog input	volume	No	analog input - LFLOW
Flow IV*CTL analog input	volume	Yes	analog input - LFLOW
Flow IM analog input	mass	-	analog input - LFLOW

Configuration of the CHANNEL parameter – pulse input
The CHANNEL parameter associates the pulse input via the rack, slot, group and point.
In order to configure the CHANNEL parameter, the rules below should be followed:

- The CHANNEL parameter format is the following RRSGP, which RR indicates the rack number, S indicates the slot number, G indicates the group number and P indicates the point number;
- Point (P): ordinal number of the input in the group and numerated from 0 (first point) to 7 (last point). When accessing the DF77 module, point 2 (P=2) means dual-pulse selection. The option to configure the PIP.Gx_CONF.Dual pulse check enable must be enabled previoulsy;
- Group (G): ordinal number of the group for the module and numerated from 0 (first group) to 1 (second group);
- Slot (S): ordinal number of the slot in the rack and numerated from 0 (first slot) to 3 (last slot);
- Rack (R): Each rack has 4 slots and the racks are numerated from 0 (first rack) to 14 (last rack). The rack physical addressing is accomplished through a rotary key from 0 to F (placed between the slots 2 and 3), the last position (F) must not be used.

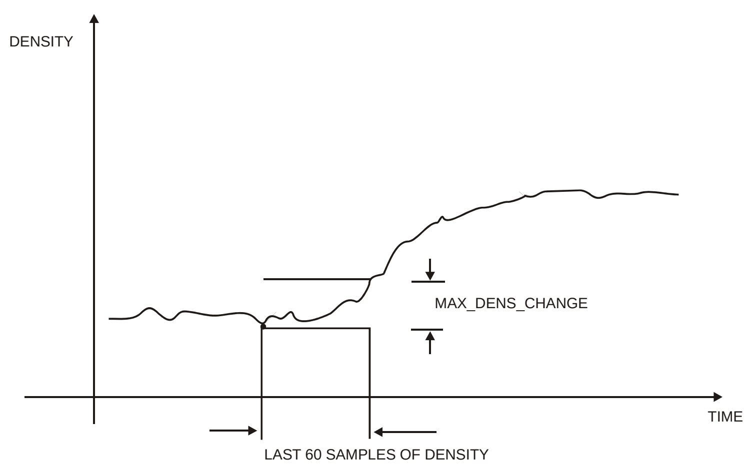
Example:
The CHANNEL parameter equals to 1203 means rack 1, slot 2, group 0 and point 3.
Before configuring the CHANNEL parameter, it is recommended to configure previously the HC block that indicates which module types are being used and the rack/slot. It is important because writing in the CHANNEL parameter, the LCT block will check the compatibility and the rangeability of the addressed module, that is, pulse input, (no other block is already using).

Batch programming
The block allows the programming up to 10 batches, it is necessary to specify the size of each one batch in the BATCH_SIZE parameter. The first element is the desired size for the current batch. If the size of the actual batch is equals to zero, thus the batch will be finished just with a reset or batch end command.

For each batch is also necessary to configure the product type in the BATCH_PRODUCT_ID parameter, because this block is used to transfer different products of different densities without interruption.
For each batch is possible to associate an identification string through the BATCH_ID1 to BATCH_ID10 parameters.

Batch ending
There are three options to finish the batch; it can be selected in the END_TYPE parameter:

- Manual: the user ends the batch by writing in the LBT_CMD = Batch end parameter;
- Batch size: the block automatically starts the next batch when the totalization reaches the programmed value;
- Change of product: the batch is automatically finished by the detection of the density change, when the change is larger than the specified in MAX_DENS_CHANGE parameter. There is also a way to specify the pipeline volume (VOLUME_DELAY parameter) between the density meter and the valve which cuts/separates the products, thus after the interface detection between the products with different densities, this volume is totalized and the batch is finished.



Override handling for the inputs
For the temperature, pressure, density and BSW inputs, there is a way to select which value must be used when it is with bad status; it may mean that the sensor failed, for example, an open thermocouple. There are the following options to select the override value through the OVER_TEMP_USAGE / OVER_PRES_USAGE / OVER_DENS_USAGE / OVER_SW_USAGE parameters:

- Override value when bad: when the input status is bad, utilizes the override parameter value (OVERRIDE_TEMPERATURE, OVERRIDE_PRESSURE, OVERRIDE_DENSITY and OVERRIDE_SW);
- Last good when bad: when the input status is bad, utilizes the last good value of input;
- Hourly average when bad: when the input status is bad, utilizes the hourly weighted average;
- Force override value: utilizes the override parameter value (OVER_TEMP_USAGE / OVER_PRES_USAGE / OVER_DENS_USAGE / OVER_SW_USAGE) regardless of the input status. This option is useful to check the block calculation;

- Never use: when the input status is bad, the flow calculation is interrupted and considered null. In this situation, an event is registered (“Stop totalization – override never use”).

The input and output transition events of the override use condition are registered as “Override temperature used” and “Override temperature cleared”, for example, besides the indication in the summarized status of the correspondent period of the totalization.

QTR report generation
There are several events which generate the QTR reports in the FC302 memory for later reading and save it in database by the FCView.

The situations are showed below:

Event	Report type (LTV.QTR_TYPE)	Condition
Reset of the totalization through the RESET_IN input or by command in the LBT_CMD parameter	“Reset & Batch”	
Configuration download: treatment similar to reset	“Reset & Batch”	
Writing in the LBT_CMD = batch end parameter	“Manual & Batch”	
The totalization reached the programmed value	“Size & Batch”	END_TYPE = Batch size
If the change detected in the density is larger than the MAX_DENS_CHANGE	“Change product & Batch”	END_TYPE = change of product
Writing in the LBT_CMD parameter requesting operational report.	“Operational & Batch”	
Positive transition in the SAMPLE_REPORT input	“Operational & Batch”	

Evaluation of the usual conditions
Usual conditions refer to weighted average value for the variables as temperature, pressure, density, BSW and volume flow rate at base conditions for a determined period. The usual conditions are used as reference in the proving process and well test, because it is desirable these procedures are accomplished in conditions near to the operation.

Through the START_USUAL_CONDITIONS parameter, configure the variables that the FC302 must calculate, because the user can also provides directly these usual values for the USUAL_TEMPERATURE, USUAL_PRESSURE, USUAL_DENSITY, USUAL_SW e USUAL_FLOW parameters.

The LCT block always monitors the instantaneous deviation of the variables (temperature, pressure, density, BSW and volume flow rate at base conditions) comparing them to their values at usual conditions, besides the calculation of the usual conditions.

The acceptable maximum deviation is configured in the USUAL_TEMP_DEV, USUAL_PRESS_DEV, USUAL_DENS_DEV, USUAL_SW_DEV and USUAL_FLOW_DEV parameters. In the parameter table, the deviation for the temperature is in Engineering Unit and the deviation for pressure, density, BSW and flow rate are in percentage.

The LIQ_WARN parameter accomplishes the indication of the occurrence of the deviation when it is larger than the specified in the evaluation period in this usual condition

The OPEN_USUAL_CONDITIONS parameters registers the date/time for the beginning of the usual condition evaluation and it can occur in the following situations:
- Writing in the parameter START_USUAL_CONDITIONS;
- When writing into the WT.TEST_STATE = Start usual conditions (Wr) parameter, requested during the well test.

Nonresettable totalizer - MR
The MR totalizer is not reset either by the RESET_IN input or command in the LBT_CMD parameter or batch end. This totalizer is only reset when a new configuration is downloaded.

This nonresettable totalizer has a maximum value that depends on the Engineering Unit selected for volume. The event of return to zero is registered as “Rollover Totalizer MR”.

Volume Unit (LV_UNITS)	Rollover Value(*)
Cubic meter (m^3)	2.000.000
Barrel (Bbl) and gallon (US gallon)	20.000.000
Liter (l) and millions of cubic foot (MCF)	2.000.000.000

(*) These values are used as upper limit for the maximum hour flow rate (FLOW_IV), if the flow rate is higher than this value, the flow rate will be considered null and an event will be generated in order to indicate that the totalization stopped.

Calculations executed for batch

At the beginning of a new batch, the date/time is sampled and stored in OPENING_DATE_TIME parameter and the value of the nonresettable totalizer MR is stored in the MRO parameter.

The weighted averages calculations for the input variables (temperature, pressure, density and BSW) use weight the volume at base conditions as weight factor.
The correspondent correction factors are indicated for each period:

- CTL: temperature correction factor based on average temperature, average density and the type of the measured product;
- CPL: pressure correction factor based on average temperature, average density, average pressure and the type of the measured product;
- MF: meter factor utilized, which is associated to the combination meter number/run number and product.

The flow totalizations are calculated: volume without any corrections (IV), volume at base conditions (GSV) and volume at base conditions discounting water and sediments (NSV).

If the volume flow at base conditions (FLOW_GSV) is lower than the specified in the NO_LIQ_FLOW parameter, all the flows will be considered null for totalization effect, acting as a cutoff.

Event indication in the summarized status for the period:

- Override temperature used;
- Override pressure used;
- Override density used;
- Override SW used;
- Bad status of pulse input;
- Block in O/S;
- Extrapolated correction factor;
- Out of range correction factor;
- Process alarm;
- Bad status of flow input;
- Stop totalization.

This summarized status only provides an indication that in any moment of the considered period an important event occurred. It does not indicate the current status (information provided by STATUS_CURRENT parameter) or more details, which must be obtained in the event register.

The flow time calculation is the time counting during the considered period if there is flow.

If the QTR report generation occurs; it will have the report number indicated in the COUNTER_BATCH parameter.

Information for the previous batch

The PREV_IV, PREV_GSV and PREV_NSV totalizers indicate the totalizations of the previous batch related to the current. And also the PREV_FTIME_BATCH parameter indicates the flow. The PREV_BATCH_ID parameter identifies the string for the previous batch.

Appropriation Measurement

To select the appropriation measurement, the parameter LKD.PRODUCTx_INFO.Product type = Emulsion crude oil and water Emulsion light hydrocarbon and water must be set. It shows simplified features related to equipment for oil treatment compared to custody transfer. They are described below:

- MF Variation: from 2% to 7% : set and reproved
  Higher than 7%: repaired and reproved

- Proving and Sample Frequency: semestral
- Well test Frequency : yearly
- Percentage of water between 0 and 100%

The shrinkage factor configuration can be executed in the SF parameter that must be configured with the value different from 1 only for emulsion of crude oil. If the block LCF is used with the CALC_BSW parameter set to “Lab analysis” option for BSW calculation, the shrinkage factor will be updated automatically in the LCF block, and vice-versa.

Calculation of the temperature correction factor for oil – CTL:
It uses the dry oil density that must be provided for the block using the DENSITY_METER input at base condition.

NSV Calculation:

$NSV = IV * MF * (1 – X_{w,m}) * CTL_{o,m} * CPL_{o,m} * SF$
$SWV = IV * MF * X_{w,m} * CTL_{w,m} * CPL_{w,m}$

Where:
NSV: net volume of oil in standard condition
SWV: volume of water in standard condition
$X_{w,m}$: percent of water in the emulsion in measuring condition
$CTL_{o,m}$: temperature correction factor for oil in measuring condition
$CPL_{o,m}$: pressure correction factor for oil in measuring condition. The standard does not consider this factor, and the way to do this is not linking the PRESSURE_METER input.
$CTL_{w,m}$: temperature correction factor for water in measuring condition
$CPL_{w,m}$: pressure correction factor for water in measuring condition

For the appropriation measurement, the weighted factor used for the average calculations is showed below:
$IV * [(1 – X_{w,m}) * CTL_{o,m} * CPL_{o,m} .+ X_{w,m} * CTL_{w,m} * CPL_{w,m}] * MF$

Process alarms: active (ACTIVE_ALARM1 and ACTIVE_ALARM2) and unacknowledged (UNACK_ALARM1 and UNACK_ALARM2).
The process alarms (high, high high, low and low low) of variables related to the measuring such as temperature, pressure, density, BSW, volume flow and mass flow are processed by the AALM block. In this block, there is only a summarized indication of the active and unacknowledged alarms. For further details, refer to the AALM block or the event register.

Note:
The IV, GSV, NSV, PREV_IV, PREV_GSV, PREV_NSV and MR totalizers can indicate difference in the fractional part of the values showed by the QTR reports, because the values showed in the reports also include the discrimination of values.

Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration: this indication can occurs due to the following problems:

- If the selected meter is “pulse input” type and the CHANNEL parameter is addressing a rack and slot, where the configured module does not read pulse input (HC block) or it is not addressing none block (equals to zero);
- STRATEGY parameter equals to zero. It is mandatory to configure this parameter. It means to associate it to a number for the flow measurement.
- Inconsistence in the meter linearization curve, if this option is selected.
- If the selected product is emulsion (allocation measurement) and the meter is IV*CTL pulse input or analog input type (LFLOW_TYPE).

2. BLOCK_ERR. Input failure: this indication can occur due to the following problems:

- If the selected meter is “pulse input” and it is impossible to read the pulses from the module addressed by the CHANNEL parameter;
- If the selected meter is “analog input” type and the LFLOW input has bad status.

3. BLOCK_ERR. Out of Service: the LCT block can continue in the Out of service mode, although the target mode is Auto due to the following causes:

- STRATEGY parameter equals to zero;
- CHANNEL parameter equals to zero and the meter type “pulse input”;
- Resource block is in O/S.

Supported Modes
O/S and AUTO.

Status
When the TEMPERATURE_METER, PRESSURE_METER, DENSITY_METER or SW_METER has bad status, the correspondent override value will be used. The BATCH_STATUS parameter will show it and it will registered as one event.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with string different of spaces, this parameter will replace the block tag in the QTR report.
3 (A2) (CL)	4	STRATEGY	Unsigned16	0 to 4	0	None	S	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (A2)	I	TEMPERATURE_METER	DS-65			T	N	Temperature used for calculating the correction factor for the liquid thermal expansion.
8 (A2)	I	PRESSURE_METER	DS-65			P	N	Pressure (gauge) used for calculating the correction factor for the liquid compressibility.
9 (A2)	I	DENSITY_METER	DS-65			LD	N	Density used for calculating the CPLm and CTLm factors.
10 (A2)	I	SW_METER	DS-65			%	N	Percentage of sand and water mixed in the oil.
11	I	RESET_IN	DS-66				N / RO	Positive sensitive transition input parameter which cause reset in the totalizers, except in the nonresettable totalizers. After one reset, this block will continue in the same batch until completing the specified size, detect change in the product or manual command.
12	I	SAMPLE_REPORT	DS-66				N / RO	This is a positive sensitive transition input parameter which causes one operational report, to be generated and registered.
13	O	BATCH_NEAR_END	DS-66				N / RO	Indicates if the actual batch is near of the end. This output will continue TRUE until the batch ends.
14	O	BATCH_END	DS-66				N / RO	Indicates the batch end for one micro cycle. After that, one new batch is initialized.
15	O	REPORT_DONE	DS-66				N / RO	Indicates for one macrocycle the quantitative transaction report was generated and registered.
16	O	FLOW_IV	DS-65		0	QV	N / RO	Volume flow rate at flowing conditions.
17	O	FLOW_GSV	DS-65		0	QV	N / RO	Volume flow rate corrected by CCF. It is not calculated for allocation measurement.
18	O	FLOW_NSV	DS-65		0	QV	N / RO	Volume flow rate corrected by CCF and discounted the SW percent.
19	O	FLOW_MASS	DS-65		0	QM	N / RO	Total mass flow rate (hydrocarbon and water).

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
20 (A2) (CL)	4	CHANNEL	Unsigned16		0	Na	S / O/S	Channel number of the logic hardware for the pulse input module.
21	2	BATCH_PRODUCT_ID	Unsigned8[10]	1 to 10	0	Na	S	Define the identification sequence of the product for each batch. The product ID identifies the product which the information is provided in the LKD block. It is allowed to change the first element only in O/S.
22	2	BATCH_SIZE	Integer32[10]		0	TV	S	Define the sequence of the size for each batch. The specified size in this parameter is compared to the NSV. The first element is the actual batch and when finding a zero, an infinite batch starts till a rising edge in the RESET_IN parameter.
23		BATCH_ID1	Visiblestring[8]				S	Actual batch description.
		….						
32		BATCH_ID10	Visiblestring[8]				S	Description for the 10ª batch.
33 (CL)	2	END_TYPE	Unsigned8	0 = Manual 1 = Batch size 2 = Change of product	0	E	S	Selecting the mode to end the batch.
34 (CL)	4	MAX_DENS_CHANGE	Float	> 0.0	10.0	LD	S	This parameter specifies the necessary density change to consider the batch end and the beginning of a new one.
35 (CL)	4	VOLUME_DELAY	Float	> 0.0	2.0	LV	S	Indicate the fluid volume in the pipeline between the density meter and the valve to cut/separate the products.
36 (A2) (CL)	4	NEAR_END	Float	50 to 100	95	%	S	Specify a percentage of the batch size to be reached to active the BATCH_NEAR_END output.
37 (A2) (CL)	4	OVERRIDE_TEMPERATURE	Float		15.0	T	S	Override value for the temperature input when it has bad status.
38 (A2) (CL)	4	OVERRIDE_PRESSURE	Float	> 0.0	101.325	P	S	Override value for the pressure input when it has bad status.
39 (CL) (A2)	4	OVERRIDE_DENSITY	Float	> 0.0	800.0	LD	S	Override value for the density input when it has bad status.
40 (A2) (CL)	4	OVERRIDE_SW	Float	0.0 to 100.0	0.0	%	S	Override value for the SW input when it has bad status.
41 (A2)	1	LBT_CMD	Unsigned8	0=None 1=Reset 2=Report 3=Batch End	0	E	N	Writing “Reset” in this parameter, it acts as a positive transition in the RESET_IN parameter. Writing “Report” in this parameter, it acts as a positive transition in the SAMPLE_REPORT parameter. Writing “BATCH END” in this parameter, it will be a batch manual end. After executing a request action, the value will return automatically to None
42		OPENING_DATE_TIME	Date				N / RO	Opening date/hour of the actual batch.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
43		MRO	Float		0	TV	N / RO	MR nonresettable totalizer value in the beginning of the actual batch.
44		TWA	Float			T	N / RO	Temperature weighted average for the actual batch.
45		PWA	Float			P	N / RO	Pressure weighted average for the actual batch.
46		DWA	Float			LD	N / RO	Density weighted average for the actual batch.
47		SWWA	Float			%	N / RO	SW weighted average for the actual batch.
48		MF	Float		1.0		N / RO	This is the MF used according to the selected meter and product from the LKD block.
49		CTL	Float		1.0		N / RO	Temperature correction factor based on the weighted average of the input parameters.
50		CPL	Float		.1.0		N / RO	Pressure correction factor based on the weighted average of the input parameters.
51	1	IV	Float			TV	N/ RO	Indicated volume for the batch.
52	1	GSV	Float			TV	N/ RO	Gross corrected volume for the batch.
53	1	NSV	Float			TV	N/ RO	Net corrected volume for the batch.
54	1	MR	Float		0	TV	N / RO	Nonresettable totalizer of indicated volume (without correction).
55	1	STATUS_BATCH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual batch status.
56		COUNTER_BATCH	Unsigned32		1	Na	N / RO	Batch counter. Number of the next QTR report to be generated.
57		PREV_BATCH_ID	Visiblestring[8]				N / RO	Description for the previous batch.
58		PREV_IV	Float			TV	N / RO	Volume indicated for the previous batch.
59		PREV_GSV	Float			TV	N / RO	Gross corrected volume for the previous batch.
60		PREV_NSV	Float			TV	N / RO	Net corrected volume for the previous batch.
61		ACTIVE_ALARM1	Bitstring[2]				N / RO	Indicate the active alarms related to the flow.
62		ACTIVE_ALARM2	Bitstring[2]				N / RO	Indicate the active alarms related to the flow are actives.
63		UNACK_ALARM1	Bitstring[2]				N	Indicate the alarms related to this flow are unacknowledged by the operator.
64		UNACK_ALARM2	Bitstring[2]				N	Indicate the alarms related to this flow are unacknowledged by the operator.
65		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
66		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
67	I,1,3	LFLOW	DS-65			QV or QM	N / RO	Mass or volume flow rate according to the selection in LFLOW_TYPE. This input is ignored if the option pulse input is selected.
68 (A2) (CL)	4	LFLOW_TYPE	Unsigned8	0 = IV pulse input 1=IV*CTL pulse input 2=IM pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input 5=Flow IM analog input	0	E	S / O/S	When the option pulse input is selected, it is necessary to configure the CHANNEL parameter to address the physical point of the pulse input. When the option analog input is selected, it is necessary to link the LFLOW input. IV: indicated volume without any correction IV*CTL : indicated volume corrected by the temperature IM: indicated mass.
69		USUAL_TEMP _DEV	Float	0.0=disabled 0.0 to 100.0	5	T	S	Maximum deviation allowed for the temperature during the evaluation of the usual conditions and well test execution.
70		USUAL_PRES S_DEV	Float	0.0=disabled > 0.0	10	%	S	Maximum deviation allowed for the pressure during the evaluation of the usual conditions and well test execution.
71		USUAL_DENS _DEV	Float	0.0=disabled 0.0 to 100	2	%	S	Maximum deviation allowed for the density during the evaluation of the usual conditions and well test execution.
72		USUAL_SW_D EV	Float	0.0=disabled 0.0 to 100	2	%	S	Maximum deviation allowed for the BSW during the evaluation of the usual conditions and well test execution.
73		USUAL_FLOW _DEV	Float	0.0=disabled > 0.0	10	%	S	Maximum deviation allowed for net volume flow rate at base condition during usual conditions evaluation and well tests.
74		START_USUA L_CONDITION S	Bitstring[2]	See the specific description	0	E	S	The new evaluation of the usual conditions for the enabled variables in this parameter is initialized when a proving is accomplished successfully or when requested during a well test or writing in this parameter.
75		OPEN_USUAL _CONDITIONS	Date				N / RO	Date/time for the beginning of the usual condition evaluation.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
76		LIQ_WARN	Bitstring[2]	See the specific description	0	E	N / RO	Warning events occurred.
77 (A2)		USUAL_TEMPERATURE	Float		0	T	N	If the FC302 is not configured to calculate the usual temperature in the START_USUAL_CONDITIONS parameter, the writing is allowed for this parameter.
78 (A2)		USUAL_PRESSURE	Float	>= 0.0	0	P	N	If the FC302 is not configured to calculate the usual pressure in the START_USUAL_CONDITIONS parameter, the writing is allowed for this parameter.
79 (A2)		USUAL_DENSITY	Float		0	LD	N	If the FC302 is not configured to calculate the usual density in the START_USUAL_CONDITIONS parameter, the writing is allowed for this parameter.
80 (A2)		USUAL_SW	Float	0.0 to 100	0	%	N	If the FC302 is not configured to calculate the usual BSW in the START_USUAL_CONDITIONS, in the writing is allowed for this parameter.
81 (A2)		USUAL_FLOW	Float	>= 0.0	0	QV	N	If the FC302 is not configured to calculate the usual net volume flow at base conditions the parameter START_USUAL_CONDITIONS, the writing is allowed for this parameter.
82		FTIME_BATCH	Time difference				N / RO	Flow time for the actual batch.
83		PREV_FTIME_BATCH	Time difference				N / RO	Flow time for the previous batch.
84		STATUS_CURRENT	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual status. Similar to the BATCH_STATUS.
85 (A2) (CL)		OVER_TEMP_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2=hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value is used as override value for the temperature.
86 (A2) (CL)		OVER_PRES_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value is used as override value for the pressure.
87 (A2) (CL)		OVER_DENS_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value is used as override value for the density.

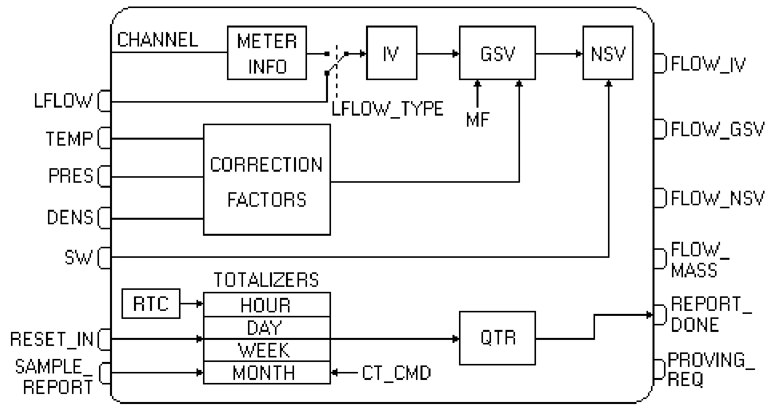
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
88 (A2) (CL)		OVER_SW_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value is used as override value for the BSW.
89 (A2) (CL)		NO_LIQ_FLOW	Float	>= 0.0 0.0=disabled	0.0	QV	S	Lower limit for the net volume flow rate at base conditions. If it is less than this value, it is considered null.
90 (A2) (CL) (V4)		SF	Float	1=disabled 0< SF <= 1	1	Na	S	Shrinkage factor obtained from laboratory analysis.
91		CTL_W	Float	0=Custody transfer >= 0.0 : Allocation measurement	0		N / RO	Correction factor of the temperature effect for water volume. This factor is calculated based on the water base density configured in PRODUCTxINFO parameter and flowing temperature.
92		CPL_W	Float	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in the volume of water that is calculated using the flowing pressure.
93		MASS	Float			TM	N / RO	Mass totalization for batch.
94		PREV_MASS	Float			TM	N / RO	Mass for the previous batch.
95		MMR	Float		0	TM	N / RO	Nonresettable totalizer of mass.
96		MMRO	Float		0	TM	N / RO	MMR nonresettable totalizer value in the beginning of the actual batch.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

LCT – Liquid Continuous Transaction

Schematic



Description

This block calculates the correction factors (CTL and CPL), the totalizations, weighted average, status analysis and QTR report generation for the periods: hour, day, week and month. Other features include the usual condition evaluation, indication of active and unacknowledged process alarms related to the measurement and check/indication of the proving necessity for the operational meter.

Identification for the run number – STRATEGY parameter

The configuration of the STRATEGY parameter is mandatory, because it identifies the run number. If the parameter has the default value (zero), the block will execute in the O/S mode and indicate in the BLOCK_ERR.Block configuration parameter. This block also associates the operational meter information in the LKD block (METERx_INFO - NKF and MF_METER_PRODUCT – meter factor), if the meter type is "pulse input".

Block inputs

The block inputs are used according to the configuration, as showed in the table below:

Input	Link necessity	Description
TEMPERATURE_METER	mandatory	Flowing temperature
PRESSURE_METER	This option is mandatory, if is custody transfer measurement. This option is optional if is allocation measurement	Flowing gauge pressure
DENSITY_METER	mandatory	Density of the measured product, which can be at flowing or base conditions depending on the configuration of LKD.PRODUCTx_INFO.Density type. If an online densitometer is measuring in temperature and pressure conditions (it requires instruments to read the variables) different from that found in the meter, it is recommended to use the LCF block to convert the density from flow conditions to base conditions, and also it must be connected to the DENSITY_METER input. For water measurement, the density must always be at base temperature. **If it was an appropriation measurement (PRODUCTx_INFO.Product type = Emulsion crude oil and water / Emulsion light hydrocarbon and water), this input will receive the dry oil density at base condition. So, it will be the result of laboratory analysis because any line density meter would measure a crude oil/light hydrocarbon and water mixture in a rate from 0 to 100%.**
SW_METER	mandatory	Percentage of water and sediments
LFLOW	Mandatory, if the meter type is "analog input"	This input must indicate the flow rate type configured in the LFLOW_TYPE parameter.

Input	Link necessity	Description
RESET_IN	Depends on the application	This input can be used when a event detected by another block must reset the totalizers. For example, the alignment ending for a determined meter which must initialize the measurement.
SAMPLE_REPORT	Depends on the application	When it is desired to generate an operational reports, when detected an event by other block, for example, the end of a sucessful proving.

Block outputs
The flow rates resulting from calculations are indicated in the outputs below (regardless of the meter type selected in LFLOW_TYPE), and thus they are available to be linked to other blocks:
1. FLOW_IV – volume flow rate at flowing conditions;
2. FLOW_GSV – corrected volume flow rate at base conditions, it is not calculated for allocation measurement;
3. FLOW_NSV – corrected volume flow rate at base conditions, discounting the percentage of water and sediments;
4. FLOW_MASS – mass flow rate.

The REPORT_DONE output indicates only for one macrocycle, that a QTR report, regardless of the type, was generated and stored in the FC302 memory.

The PROV_REQ output indicates the necessity of a new proving, due to the elapsed time or by measured volume since the last proving.

Selection of the meter type (LFLOW_TYPE parameter)
The LFLOW_TYPE selects the flow meter type, and it has the following options:

LFLOW_TYPE	Volume / Mass	Corrected in temperature	Pulse input / Analog input
IV pulse input	volume	Not	pulse input
IV*CTL pulse input	volume	Yes	pulse input
IM pulse input	mass	-	pulse input
Flow IV analog input	volume	Not	analog input - LFLOW
Flow IV*CTL analog input	volume	Yes	analog input - LFLOW
Flow IM analog input	mass	-	analog input - LFLOW

CHANNEL parameter configuration – pulse input
The CHANNEL parameter addresses the pulse input via the rack number, slot, group and point.

In order to configure the CHANNEL parameter, it is recommended to follow the rules below:

- The CHANNEL parameter format is RRSGP, where RR indicates the rack number, S indicates the slot number, G indicates the group number and P indicates the point number;
- Point (P): ordinal number of the point and numerated from 0 (first point) to 7 (last point of the group). When accessing the DF77 module, point equals to 2 means dual-pulse selection, in this case the configuration for the PIP.Gx_CONF.Dual pulse check enable must be enabled previously;
- Group (G): ordinal number of the group for the module and numerated from 0 (first group) to 1 (second group);
- Slot (S): ordinal number of the slot for a determined rack and numerated from 0 (first slot) to 3 (last slot);
- Rack (R): Each rack has 4 slots and the racks are numerated from 0 (first rack) to 14 (last rack). The rack physical addressing is accomplished through the rotary key from 0 to E (located between the slots 2 and 3). The last position (F) must not be used.

Example:
The CHANNEL parameter equals to 1203 means rack 1, slot 2, group 0 and point 3.
Before configuring the CHANNEL parameter, it recommends to configure previously the HC block, because it indicates which module types are being used and the places of them (rack/slot). This is important when writing in the CHANNEL parameter, the LCT block will check the compatibility and the rangeability of the addressed module, as well availability of pulse input (no other block is already using).

Selection of the product to be measured – PRODUCT_SELECTION parameter
The PRODUCT_SELECTION parameter selects which product of the LKD block is being used for the calculation.

Override handling for the inputs
For the temperature, pressure, density and BSW inputs there is an override processing when the input has bad status. When a sensor is bad, there are the following options to choose the override value through the OVER_TEMP_USAGE / OVER_PRES_USAGE / OVER_DENS_USAGE / OVER_SW_USAGE parameters:

- Override value when bad: when the input has bad status, it utilizes the value of the override parameter (OVERRIDE_TEMPERATURE, OVERRIDE_PRESSURE, OVERRIDE_DENSITY and OVERRIDE_SW);
- Last good when bad: when the input has bad status, it utilizes the last good value of input;
- Hourly average when bad: when the input has bad status, it utilizes the hourly weighted average;
- Force override value: it utilizes the value of the override parameter (OVER_TEMP_USAGE / OVER_PRES_USAGE / OVER_DENS_USAGE / OVER_SW_USAGE) regardless of the input status. This option is useful to verify the block calculation;
- Never use: when the input has bad status, the flow calculation is interrupted and considered null. An event is registered in this situation ("Stop totalization – override never use").

The events of the input and output transition of the override use condition are registered as "Override temperature used" and "Override temperature cleared", for example, besides the indication in the summarized status of the correspondent period.

Parameters only for visualization – reflect the configuration of other blocks
The START_HOUR, START_DAY_WEEK and START_DAY_MONTH parameters indicate the configuration on the FCT block.

QTR report generation
There are several events which cause the QTR report generation in the FC302 memory, for later reading and save it in database by the FCView.
The situations are described below:

Event	Report type (LTV.QTR_TYPE)	Condition
Transition of the correspondent counting period	"Continuous & period"	All the enabled periods in the ENABLE_REPORT
Reset of the totalizations through the RESET_IN input or by command in the CT_CMD parameter	"Reset & period"	All the enabled periods in the ENABLE_REPORT
Configuration Download: treatment similar to the reset	"Reset & period"	All the enabled periods in the ENABLE_REPORT
Writing in the CT_CMD parameter requesting an operational report.	"Operational & period"	Report of the requested period
Rising edge in the SAMPLE_REPORT input	"Operational & period"	All the enabled periods in the ENABLE_REPORT

When the net volume totalizer at base condition (NSV) is null, the report generation in the FC302 memory will be disabled when configuring the REPORT_NO_FLOW = no (default condition) report.

Indication for the proving necessity
The block can indicate the necessity of a new meter proving through the PROV_REQ output parameter, based on two rules:

- Volume measured at flowing conditions since the last proving: the MAX_IV_PROVING parameter specifies the maximum volume, from this the PROV_REQ parameter will indicate;
- Time elapsed since the last proving successful: there are two ways to specify the maximum time since the last proving, from this the PROV_REQ parameter will indicate. Writing a value between 1 and 12 in the MAX_TIME_PROVING parameter, the indication will occur in multiple number of months, always in the same day of the month. If the value is between 13 and 120, thus it means the number of days.

After a successful proving and the new meter factor is acknowledged by user (if it is configured), the PROV_REQ output automatically returns to zero.

Evaluation of the usual conditions
Usual conditions refer to the weighted average value of the temperature, pressure, density, BSW and volume flow rate at base conditions of a determined period. The usual conditions can be referred to the proving realization and well test, because it is desirable to perform these procedures at conditions near to the usual operation.

The START_USUAL_CONDITIONS parameter configures the variables to be calculated by the FC302, because the user can also provide these values directly in the USUAL_TEMPERATURE, USUAL_PRESSURE, USUAL_DENSITY, USUAL_SW and USUAL_FLOW parameters.

The LCT block always checks the deviation of instantaneous values of the variables (temperature, pressure, density, BSW and net volume flow at base conditions) comparing them to the calculated or manual input of values at usual conditions.

The maximum acceptable deviation is configured in the USUAL_TEMP_DEV, USUAL_PRESS_DEV, USUAL_DENS_DEV, USUAL_SW_DEV and USUAL_FLOW_DEV parameters. In the parameter table, the deviation for the temperature is represented in Engineering Unit and the deviation for pressure, density, BSW and flow rate are represented in percentage.

The LIQ_WARN parameter indicates the occurrence of deviation if it is larger than the specified in the period of usual condition evaluation.

The OPEN_USUAL_CONDITIONS registers the date/hour for the beginning of the usual condition evaluation, and it occurs in the following situations:

- Writing in the parameter START_USUAL_CONDITIONS;
- When requested by writing into the WT.TEST_STATE = Start usual conditions (Wr) parameter during a well test.

Nonresettable totalizer - MR
The MR totalizer is nonresettable either by the RESET_IN input or command in the CT_CMD parameter or change of the accounting period. Only configuration download resets this totalizer.

This nonresettable totalizer has a maximum value that depends on the Engineering Unit selected for volume, and then it returns to zero. The event of returning to zero is registered as “Rollover Totalizer MR”.

Volume Units (LV_UNITS)	Rollover value(*)
Cubic meter (m^3)	2.000.000
Barrel (Bbl) and gallon (US gallon)	20.000.000
Liter (l) and millions of cubic foot (MCF)	2.000.000.000

(*) These values are also used as upper limit for the maximum flow rate (FLOW_IV), if the flow rate is higher than this value, the flow rate will be considered null and an event will be generated in order to indicate that the totalization stopped.

Calculations performed by period (hour, day, week and month)
In the beginning of the new counting period, the MR nonresettable totalizer value is sampled and stored in the MRO_HOUR / MRO_DAY / MRO_WEEK / MRO_MONTH parameters.

The calculations for the weighted averages of the input variables (temperature, pressure, density and BSW) use as weight factor the volume at base conditions.

The correspondent correction factors are indicated for each period:

- CTL: temperature correction factor is calculated using average temperature, average density and product type;
- CPL: pressure correction factor is calculated using average temperature, average density, average pressure and product type;
- MF: meter factor utilized, which is associated to the combination between the meter number/run number and product number.

The totalizers of indicated volume flow rate (IV), gross volume flow rate at base condition (GSV) and net volume flow rate at base condition (NSV) are calculated for each period.

If the net volume flow rate at base condition (FLOW_NSV) is less than the specified in the parameter NO_LIQ_FLOW, all the flow rates will be considered null for the totalization and it works as cutoff.

Event indication in the summarized status of the period:

- Override temperature used;
- Override pressure used;
- Override density used;
- Override SW used;
- Bad status of pulse input;
- Block in O/S;
- Extrapolated correction factor;
- Out of range correction factor;
- Process alarm;
- Bad status of flow input;
- Stop totalization.

This summarized status provides only one indication at the moment of the considered period when an important event occurred. This does not indicate the current status (information provided by STATUS_CURRENT parameter) nor has more details, which must be obtained from the event register.

The flow time calculation is the time counting during the considered period that the flow occurred.

If the QTR report is generated at end of period, it will have the report number indicated in the COUNTER_HOUR, COUNTER_DAY, COUNTER_WEEK or COUNTER_MONTH parameter.

Totalizers of the previous period
The IV_YESTERDAY, GSV_YESTERDAY and NSV_YESTERDAY totalizers indicate the totalizations of the previous period and the FTIME_YESTERDAY parameter indicates the flow time. The selection and indication of the period visualized in the corresponding parameters are done through the CT_CMD parameter.

These information of the previous day consider possible resets in the totalizations in this period, thus these totalizers and flow time indicate a sum of totalizers/flow times if a reset occurred.

The information of the previous day are consistent even when a power failure occurs, thus, when energizing, the FC302 checks if the totalizers are pertinent to the previous day.

Appropriation Measurement
In order to select the appropriation measurement, the LKD.PRODUCTx_INFO.Product type = Emulsion crude oil and water/ Emulsion light hydrocarbon and water parameter must be configured, which shows simplified features related to equipment for oil treatment when compared to custody transfer. They are showed below:

- MF Variation: from 2% to 7%: set and reproved
- MF Variation: from 2% to 7%: set and reproved
- Higher than 7%: repaired and reproved
- Proving and Sample Frequency: semestral
- Well test frequency: yearly
- Percentage of water between 0 and 100%

The shrinkage factor is configured in the SF parameter and it must be different from 1 only for emulsion of crude oil. If the block LCF is used with the CALC_BSW parameter set to “Lab analysis” option for BSW calculation and the run number is configured properly, the shrinkage factor will be updated automatically in the LCF block, and vice-versa.

Calculation of the temperature correction factor for oil - CTL
It uses the dry oil density that should be provided to the block through DENSITY_METER input at base condition.

NSV calculation
$NSV = IV * MF * (1 – X_{w,m}) * CTL_{o,m} * CPL_{o,m} * SF$
$SWV = IV * MF * X_{w,m} * CTL_{w,m} * CPL_{w,m}$

Where:
NSV: net volume of oil at standard condition
SWV: volume of water t standard condition
$X_{w,m}$: percent of water in the emulsion at measuring condition
$CTL_{o,m}$: temperature correction factor for oil at measuring condition
$CPL_{o,m}$: pressure correction factor for oil at measuring condition. The standard does not consider this factor; this block will behave in this way not linking the PRESSURE_METER input.
$CTL_{w,m}$: temperature correction factor for water at measuring condition
$CPL_{w,m}$: pressure correction factor for water at measuring condition

Process alarms: active (ACTIVE_ALARM1 and ACTIVE_ALARM2) and unacknowledged (UNACK_ALARM1 and UNACK_ALARM2).
The process alarms (high, high high, low and low low) of the variables as temperature, pressure, density, BSW, volume flow rate and mass flow rate related to the measurement are processed by the AALM block. In this block, it has only a summarized indication of active and unacknowledged alarms, for further details, refer to the AALM block or the event register.

Note:
The MR, MRO_HOUR, IV_HOUR, GSV_HOUR, NSV_HOUR, MRO_DAY, IV_DAY, GSV_DAY, NSV_DAY, MRO_WEEK, IV_ WEEK, GSV_ WEEK, NSV_ WEEK, MRO_MONTH, IV_ MONTH, GSV_ MONTH, NSV_ MONTH, IV_YESTERDAY, GSV_ YESTERDAY and NSV_ YESTERDAY totalizers may indicate a difference in the fractional part of the values showed by the QTR reports, because the values showed in the reports also include the discrimination of values.

Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration: this indication may occur due to the following problems:

- If the selected meter is “pulse input” type and the CHANNEL parameter is addressing a rack and slot that has a module unable to read pulses (in the HC block), or it is addressing no module (equals to zero);
- STRATEGY parameter equals to zero. It is mandatory to configure this parameter; it is the run number.
- Inconsistence in the meter linearization curve, if this option was selected.
- If the selected product is emulsion (allocation measurement) and the meter is IV*CTL pulse input or analog input type (LFLOW_TYPE).

2. BLOCK_ERR. Input failure: this indication may occur due to the following problems:

- If the selected meter is “pulse input” type and it is impossible to read the pulses from the module addressed by the CHANNEL parameter;
- If the selected meter is “analog input” type and the LFLOW input has bad status.

3. BLOCK_ERR. Out of Service: the LCT block can continue in the Out of Service mode, although the target mode is Auto due to the following causes:

- STRATEGY parameter equals to zero;
- CHANNEL parameter equals to zero and meter is “pulse input” type;
- Resource block is in O/S.

Supported Modes
O/S and AUTO.

Status
When the TEMPERATURE_METER, PRESSURE_METER, DENSITY_METER or SW_METER parameter has bad status, the correspondent override value will be used. The BATCH_STATUS parameter will indicate and registered as one event.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with string different of spaces, this parameter will substitute the block tag in the QTR report.
3 (A2) (CL)	4	STRATEGY	Unsigned16	0 to 4	0	None	S	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (A2)	I,1,3	TEMPERATURE_ METER	DS-65			T	N	Temperature used for the correction factor calculation of the liquid thermal expansion.
8 (A2)	I,1,3	PRESSURE_MET ER	DS-65			P	N	Gauge pressure used for the correction factor calculation of the liquid compressibility.
9 (A2)	I,1,3	DENSITY_METER	DS-65			LD	N	Density used for the calculations of CPLm and CTLm factors.
10 (A2)	I,1,3	SW_METER	DS-65			%	N	Percentage of land and water mixed in the oil.
11	I,1,3	RESET_IN	DS-66				N / RO	Positive transition input parameter that causes reset in the totalizers, except in the nonresettable totalizers.
12	I,1,3	SAMPLE_REPOR T	DS-66				N / RO	Positive transition input parameter. It generates and registers operational reports, if enabled in the ENABLE_REPORT.
13	O,1,3	REPORT_DONE	DS-66				N / RO	Indicate for one macrocycle the quantitative transaction report was generated and registered.
14	O	FLOW_IV	DS-65		0	QV	N / RO	Volume flow rate at flowing conditions.
15	O	FLOW_GSV	DS-65		0	QV	N / RO	Volume flow rate corrected by CCF. It is not calculated for allocation measurement.
16	O	FLOW_NSV	DS-65		0	QV	N / RO	Volume flow rate corrected by CCF and percentage of SW.
17	O	FLOW_MASS	DS-65		0	QM	N / RO	Total mass flow rate (hydrocarbon and water).
18	O	PROVING_REQ	DS-66				N / RO	This output indicates the calculated volume indicated since the last proving is larger than the MAX_IV_PROVING or the elapsed time is higher than the MAX_TIME_PROVING.
19 (A2) (CL)	4	CHANNEL	Unsigned16		0	Na	S / O/S	Channel number of the logic hardware for the pulse input module.
20 (A2) (CL)	4	PRODUCT_SELE CTION	Unsigned8	1-10 = Product 1-10	1	E	S / O/S	Selection of one among ten products in the LKD block.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
21 (A2) (CL)	4	OVERRIDE_TEMPERATURE	Float		15.0	T	S	Override value for the temperature input, when it has bad status.
22 (A2) (CL)	4	OVERRIDE_PRESSURE	Float	> 0.0	101.325	P	S	Override value for the pressure input, when it has bad status.
23 (A2) (CL)	4	OVERRIDE_DENSITY	Float	> 0.0	800.0	LD	S	Override value for the density input, when it has bad status.
24 (A2) (CL)	4	OVERRIDE_SW	Float	0.0 to 100.0	0.0	%	S	Override value for the SW input, when it has bad status.
25		START_HOUR	Unsigned8	0 to 23	0	Hour	S / RO	Starting hour of the day for the counting period.
26		START_DAY_WEEK	Unsigned8	1=Monday to 7=Sunday	1	Day of week	S / RO	Starting day of the week for the counting period.
27		START_DAY_MONTH	Unsigned8	1 to 28	1	Day of month	S / RO	Starting day of the month for the counting period.
28 (A2) (CL)		ENABLE_REPORT	Bitstring[2]		Daily		S	It enables the report generation for the periods: hour, day, week or month.
29 (CL)		MAX_IV_PROVING	Integer32	0 = disabled	0	TV	S	IV maximum totalization since the last proving, from this it will be indicated in PROV_REQ.
30 (A2)	1	CT_CMD	Unsigned8	0=None 1=Reset 2=Operational hour report 3=Operational day report 4=Operational week report 5=Operational month report 7=Previous hour 8=Previous day 9=Previous week 10=Previous month	Previous day	E	N	Writing “Reset” in this parameter, it is as a positive transition in the RESET_IN parameter. Writing “Operational Report” in this parameter, the correspondent report type will be generated. Through this parameter is also possible to select the type of previous period to be visualized. After executing a request action, the value will return automatically to the state that shows the type of previous period visualized.
31		MR	Float		0	TV	N / RO	Meter reading. Counter for the indicated volume (without any correction).
32		MRO_HOUR	Float		0	TV	N / RO	Starting value for the actual hour of the nonresettable totalizer.
33		TWA_HOUR	Float			T	N / RO	Temperature weighted average for the actual hour.
34		PWA_HOUR	Float			P	N / RO	Pressure weighted average for the actual hour.
35		DWA_HOUR	Float			LD	N / RO	Density weighted average for the actual hour.
36		SWWA_HOUR	Float			%	N / RO	SW weighted average for the actual hour.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
37		MF_HOUR	Float		1.0		N / RO	This is the MF parameter used according to the selected product and meter, provided by the LKD block.
38		CTL_HOUR	Float		1.0		N / RO	Temperature correction factor based on the weighted average of the input parameters.
39		CPL_HOUR	Float		1.0		N / RO	Pressure correction factor based on the weighted average of the input parameters.
40	1	IV_HOUR	Float			TV	N/ RO	Indicated volume for the actual hour.
41	1	GSV_HOUR	Float			TV	N/ RO	Corrected gross volume for the actual hour.
42	1	NSV_HOUR	Float			TV	N/ RO	Corrected net volume for the actual hour.
43	1	STATUS_HOUR	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual hour status. Similar to the BATCH_STATUS.
44		COUNTER_HOUR	Unsigned32		1	Na	N / RO	Hourly report counter.
45		MRO_DAY	Float		0	TV	N / RO	Starting value for the actual day of the nonresettable totalizer.
46		TWA_DAY	Float			T	N / RO	Temperature weighted average for the actual day.
47		PWA_DAY	Float			P	N / RO	Pressure weighted average for the actual day.
48		DWA_DAY	Float			LD	N / RO	Density weighted average for the actual day.
49		SWWA_DAY	Float			%	N / RO	SW weighted average for the actual day.
50		MF_DAY	Float		1.0		N / RO	This is the MF parameter used according to the selected product and meter, from the LKD block.
51		CTL_DAY	Float		1.0		N / RO	Temperature correction factor based on the weighted average of the input parameters.
52		CPL_DAY	Float		1.0		N / RO	Pressure correction factor based on the weighted average of the input parameters.
53	1	IV_DAY	Float			TV	N/ RO	Indicated volume for the actual day.
54	1	GSV_DAY	Float			TV	N/ RO	Corrected gross volume for the actual day.
55	1	NSV_DAY	Float			TV	N/ RO	Corrected net volume for the actual day.
56	1	STATUS_DAY	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual day status. Similar to the BATCH_STATUS.
57		COUNTER_DAY	Unsigned32		1	Na	N / RO	Dialy report day.
58		MRO_WEEK	Float		0	TV	N / RO	Starting value for the actual week of the nonresettable totalizer.
59		TWA_WEEK	Float			T	N / RO	Temperature weighted average for the actual week.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
60		PWA_WEEK	Float			P	N / RO	Pressure weighted average for the actual week.
61		DWA_WEEK	Float			LD	N / RO	Density weighted average for the actual week.
62		SWWA_WEEK	Float			%	N / RO	SW weighted average for the actual week.
63		MF_WEEK	Float		1.0		N / RO	This is the MF parameter used according to the selected product and meter, provided by the LKD block.
64		CTL_WEEK	Float		1.0		N / RO	Temperature correction factor based on the weighted average of the input parameters.
65		CPL_WEEK	Float		1.0		N / RO	Pressure correction factor based on the weighted average of the input parameters.
66	1	IV_WEEK	Float			TV	N/ RO	Indicated volume for the actual week.
67	1	GSV_WEEK	Float			TV	N/ RO	Corrected gross volume for the actual week.
68	1	NSV_WEEK	Float			TV	N/ RO	Corrected net volume for the actual week.
69	1	STATUS_WEEK	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual week status. Similar to the BATCH_STATUS
70		COUNTER_WEEK	Unsigned32		1	Na	N / RO	Weekly report counter.
71		MRO_MONTH	Float		0	TV	N / RO	Starting value for the actual month of the nonresettable totalizer.
72		TWA_MONTH	Float			T	N / RO	Temperature weighted average for the actual month.
73		PWA_MONTH	Float			P	N / RO	Pressure weighted average for the actual month.
74		DWA_MONTH	Float			LD	N / RO	Density weighted average for the actual month.
75		SWWA_MONTH	Float			%	N / RO	SW weighted average for the actual month.
76		MF_MONTH	Float		1.0		N / RO	This is the MF parameter used according to the selected product and meter, provided by the LKD block.
77		CTL_MONTH	Float		1.0		N / RO	Temperature correction factor based on the weighted average of the input parameters.
78		CPL_MONTH	Float		1.0		N / RO	Pressure correction factor based on the weighted average of the input parameters.
79	1	IV_MONTH	Float			TV	N/ RO	Indicated volume for the actual month.
80	1	GSV_MONTH	Float			TV	N/ RO	Corrected gross volume for the actual month.
81	1	NSV_MONTH	Float			TV	N/ RO	Corrected net volume for the actual month.
82	1	STATUS_MONTH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual month status. Similar to the BATCH_STATUS

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
83		COUNTER_MONTH	Unsigned32		1	Na	N / RO	Monthly report counter.
84		ACTIVE_ALARM1	Bitstring[2]				N / RO	Indicate the alarms are active related to the flow.
85		ACTIVE_ALARM2	Bitstring[2]				N / RO	Indicate the alarms are active related to the flow.
86		UNACK_ALARM1	Bitstring[2]				N	Indicate the alarms related to this flow are unacknowledged by the operator.
87		UNACK_ALARM2	Bitstring[2]				N	Indicate the alarms related to this flow are unacknowledged by the operator.
88		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
89		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
90		IV_YESTERDAY	Float			TV	N/ RO	Indicated volume for the previous period, selected in CT_CMD.
91		GSV_ YESTERDAY	Float			TV	N/ RO	Corrected gross volume for the previous period, selected in CT_CMD.
92		NSV_ YESTERDAY	Float			TV	N/ RO	Corrected net volume for the previous period, selected in CT_CMD.
93		FTIME_ YESTERDAY	Time difference				N / RO	Flow time for the previous period, selected in CT_CMD.
94	I,1,3	LFLOW	DS-65			QV or QM	N / RO	Mass or volume flow according to the selection in LFLOW_TYPE. This input is unconsidered if the option pulse input is selected.
95 (A2) (CL)	4	LFLOW_TYPE	Unsigned8	0 = IV pulse input 1=IV*CTL pulse input 2=IM pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input 5=Flow IM analog input	0	E	S / O/S	When the option pulse input is selected, it is necessary to configure the CHANNEL parameter to address the physical point of the pulse input. When the option analog input is selected, it is necessary to link the LFLOW input. IV: indicated volume without any correction. IV*CTL: indicated volume corrected by the temperature. IM : indicated mass.
96		USUAL_TEMP_DEV	Float	0.0=disabled 0.0 to 100.0	5	T	S	Maximum deviation allowed for the temperature during the evaluation of the usual conditions and well test execution.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
97		USUAL_PRESS_DEV	Float	0.0=disabled 0.0 to 100	10	%	S	Maximum deviation allowed for the pressure during the evaluation of the usual conditions and well test execution.
98		USUAL_DENS_DEV	Float	0.0=disabled 0.0 to 100	2	%	S	Maximum deviation allowed for the density during the evaluation of the usual conditions and well test execution.
99		USUAL_SW_DEV	Float	0.0=disabled 0.0 to 100	2	%	S	Maximum deviation allowed for the BSW during the evaluation of the usual conditions and well test execution.
100		USUAL_FLOW_DEV	Float	0.0=disabled 0.0 to 100	10	%	S	Maximum deviation allowed for the net volume flow at base condition during the usual condition evaluation and well test execution.
101		START_USUAL_CONDITIONS	Bitstring[2]	See the specific description	0	E	S	When the proving is done successful, or it is requested during the well test or writing in this parameter, a new evaluation of the usual conditions for the enabled variables is initialized.
102		OPEN_USUAL_CONDITIONS	Date				N / RO	Date/hour of beginning of the usual condition evaluation.
103		LIQ_WARN	Bitstring[2]	See the specific description	0	E	N / RO	Warning events occurred.
104 (A2)		USUAL_TEMPERATURE	Float		0	T	N	If the FC302 is not configured to calculate the usual temperature in the START_USUAL_CONDITIONS parameter, then the writing is allowed in this parameter.
105 (A2)		USUAL_PRESSURE	Float	>= 0.0	0	P	N	If the FC302 is not configured to calculate the usual pressure in the START_USUAL_CONDITIONS parameter, then the writing is allowed in this parameter.
106 (A2)		USUAL_DENSITY	Float		0	LD	N	If the FC302 is not configured to calculate the usual density in the START_USUAL_CONDITIONS parameter, then the writing is allowed in this parameter.
107 (A2)		USUAL_SW	Float	0.0 to 100	0	%	N	If the FC302 is not configured to calculate the usual BSW in the START_USUAL_CONDITIONS parameter, then the writing is allowed in this parameter.
108 (A2)		USUAL_FLOW	Float	>= 0.0	0	QV	N	If the FC302 is not configured to calculate the usual net volume flow at base condition in the START_USUAL_CONDITIONS parameter, then the writing is allowed in this parameter.
109		FTIME_HOUR	Time difference				N / RO	Flow time for the actual hour.
110		FTIME_DAY	Time difference				N / RO	Flow time for the actual day.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
111		FTIME_WEEK	Time difference				N / RO	Flow time for the actual week.
112		FTIME_MONTH	Time difference				N / RO	Flow time of the actual month.
113 (CL)		MAX_TIME_PROVING	Unsigned16	0 = disabled 1 to 12 = number of months 13 to 120 = number of days	0	Months/Days	S	Maximum time elapsed since the last proving successful, from this it will be indicated in PROV_REQ parameter.
114		STATUS_CURRENT	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual status. Similar to the BATCH_STATUS.
115 (A2) (CL)		OVER_TEMP_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value utilizes as override value for the temperature.
116 (A2) (CL)		OVER_PRES_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value utilizes as override value for the pressure.
117 (A2) (CL)		OVER_DENS_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value utilizes as override value for the density.
118 (A2) (CL)		OVER_SW_USAGE	Unsigned8	0=override value when bad 1=last good when bad 2= hourly average when bad 3=force override value 4=never use	0	E	S	Specify when and which value utilizes as override value for the BSW.
119 (A2) (CL)		NO_LIQ_FLOW	Float	>= 0.0 0.0=disabled	0.0	QV	S	Lower limit for net volume flow at base condition. If this value is less than this limit, it is considered null.
120 (A2)		REPORT_NO_FLOW	Unsigned8	0=No 1=Yes	0	E	S	If the NSV totalizer is zero and is configured as “No”, the QTR report will not be generated.

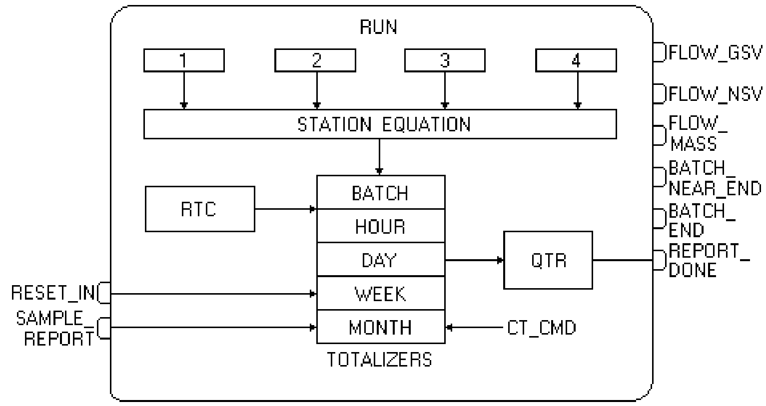
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
121 (A2) (CL) (V4)		SF	Float	1=disabled 0< SF <= 1	1	Na	S	Shrinkage factor obtained in laboratory analysis.
122		CTL_W	Float	0=Custody transfer >= 0.0 : Allocation measurement	0		N / RO	Temperature effect correction factor for water volume. It is calculated based on the water base density which should be configured in the PRODUCTxINFO parameter and flowing temperature.
123		CPL_W	Float	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in volume of water that is calculated using the flowing pressure.
124		MASS_HOUR	Float			TM	N / RO	Mass totalization for the actual hour.
125		MASS_DAY	Float			TM	N / RO	Mass totalization for the actual day.
126		MASS_WEEK	Float			TM	N / RO	Mass totalization for the actual week.
127		MASS_MONTH	Float			TM	N / RO	Mass totalization for the actual month.
128		MASS_YESTERDAY	Float			TM	N / RO	Mass of the previous period, selected in CT_CMD.
129		MMR	Float		0	TM	N / RO	Nonresettable totalizer of mass.
130		MMRO_HOUR	Float		0	TM	N / RO	Starting value for the actual hour of the nonresettable mass totalizer.
131		MMRO_DAY	Float		0	TM	N / RO	Starting value for the actual day of the nonresettable mass totalizer.
132		MMRO_WEEK	Float		0	TM	N / RO	Starting value for the actual week of the nonresettable mass totalizer.
133		MMRO_MONTH	Float		0	TM	N / RO	Starting value for the actual month of the nonresettable mass totalizer.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in the Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

LST – Liquid Station Transaction

Schematic



Description
This block is used in liquid measurements referred to the station. According to the user configuration, the corrected flows of the meters are combined (summed and/or subtracted) and a QTR report can be generated and visualized through the LTV block.

The main purpose of this block is adding/subtracting the corrected flows, so this block does not refer to secondary variables (temperature and pressure), intermediate variables for calculation, correction factors or utilized sensors. These streams may have been measured using different types of sensors.

Other features include batch programming and indication of active and unacknowledged process alarms related to the station.

Identification for the run number – STRATEGY parameter
As this block refers to many streams, its default value is 254. It can be interpreted as “liquid station”, and it is also a read only parameter.

Block Inputs
The block inputs are used according to the configuration, as showed below:

Input	Link Necessity	Description
RESET_IN	Depends on the application	This input may be used when an event detected by other block has to reset the totalizers. For example, the end of run switch must start the measurement.
SAMPLE_REPORT	Depends on the application	When an operational report has to be generated due to an event detected by other block, for example, the end of a successful proving.

Block outputs
The block outputs are flow rates resulting of calculations and they are available to be connected to other blocks:

- FLOW_GSV – gross volume flow rate at base conditions, it is not calculated for allocation measurement.
- FLOW_NSV – net volume flow rate at base conditions,
- FLOW_MASS – mass flow rate.

The BATCH_NEAR_END output indicates the batch is near to the programmed value, the totalized value represents a percentage of the programmed value higher than the NEAR_END parameter.

The BATCH_END outputs indicate the totalized value is equal to or higher than the programmed value and this output will return to zero only when the batch ends.

The REPORT_DONE output indicates, only for one macrocycle, that a QTR report was generated and stored in the FC302 memory.

Configuration for the Station Equation – STATION_EQUATION parameter

The STATION_EQUATION parameter defines the operations to be accomplished between the measured streams, obeying the following rules:

- Allowed operations: sum (+) and subtract (-).
- Interspersed sequence of run number with an arithmetic operator without spaces.
- If the first character is blank, no operation will be accomplished.
- There is a write check for writing the STATION_EQUATION parameter related to the consistency of valid run number and operation.
- During the block execution, the equation consistence will be checked and any problem will be indicated in the BLOCK_ERR.Block Configuration Error;
- Run number for the liquid measurement and all runs measuring the same product type or the combination of crude oil/light hydrocarbon and its correspondent emulsion:
- Configuration example:
  - 1+2+3-4
  - 2-1
  - 1+1-2

QTR report generation

There are several events that cause the QTR report generation in the FC302 memory for later reading and save it in database by the FCView.
The situations are showed below:

Event	Report type (LTV.QTR_TYPE)	Condition
Transition of the corresponding account period	“Continuous & period”	All the enabled periods in the ENABLE_REPORT
Reset of the totalizers through the RESET_IN input or by command in the CT_CMD	“Reset & period”	All the enabled periods in the ENABLE_REPORT and that of the batch
Configuration download: treatment similar to the reset	“Reset & period”	All the enabled periods in the ENABLE_REPORT and that of the batch
Writing into the CT_CMD parameter requesting operational report.	“Operational & period”	Report of the requested period
Rising edge in the SAMPLE_REPORT input	“Operational & period”	All the enabled periods in the ENABLE_REPORT
Batch end command in the CT_CMD	“Size & batch”	-

When the net volume totalizer at base conditions is null, the report generation in the FC302 memory will be disabled when configuring REPORT_NO_FLOW = no (default condition) parameter.
The product name and its viscosity indicated in the QTR report are related to that product measured in the first flow of the equation in the STATION_EQUATION parameter. If the operation involves emulsion (allocation) measurement, then the GSV totalizers will show zero.

Batch programming

The block allows the programming up to 10 batches, and the size for each batch must be specified in the BATCH_SIZE parameter for liquid volume at base conditions, where the first element refers to the current batch. If the desired size for the actual batch is zero, thus the batch will finish only by a reset or batch end command.

Each programmed batch can have an identification tag in the BATCH_IDx parameters.

There is an indication when the actual batch is near to the programmed size through the BATCH_NEAR_END output parameter. The NEAR_END parameter specifies the percentage of the programmed size for the batch to indicate that it is near to reach the programmed size.

The batch end can occur in two ways, depending on the configuration of the END_TYPE parameter.

- Manual: when the programmed value is reached, it is indicated in the BATCH_END output, but the batch end occurs only by user request (CT_CMD = Batch end parameter).
- Batch size: the batch automatically is finished when the programmed value is reached.

Calculations executed for each period (batch, hour, day, week and month)
The flow totalizers are calculated: gross volume at base conditions (FLOW_GSV), net volume at base conditions (FLOW_NSV) and mass (FLOW_MASS) for each period.

The following events are indicated in the summarized status of the period:

- Override temperature used;
- Override pressure used;
- Override density used;
- Override SW used;
- Bad status of pulse input;
- Block in O/S;
- Extrapolated correction factor;
- Out of range correction factor;
- Process alarm;
- Bad status of flow input;
- Stop totalization.

This summarized status provides only indication that an important event occurred at one moment in any of the measured streams participating in the station equation. And it does not indicate more details, which must be obtained from the event register.

The flow time calculation is the time counting during the considered period if the flow occurred.
If a QTR report is generated at end, it will have the report number indicated in the COUNTER_BATCH, COUNTER_HOUR, COUNTER_DAY, COUNTER_WEEK or COUNTER_MONTH parameter.

Monitoring and batch ending
The current batch can be monitored if it is near to the programmed value through the BATCH_NEAR_END parameter or even when it reaches the programmed value through the BATCH_END output.

The batch ending can be accomplished by user command, through the CT_CMD parameter or automatically, as showed below:

- Linking the BATCH_END output to the RESET_IN input.
- Configuring END_TYPE = Batch end.

Totalizers of the previous batch
The GSV_PREV_BATCH and NSV_ PREV_BATCH totalizers indicate the totalizations of the previous batch. Besides this, the FTIME_PREV_BATCH parameter indicates the flow time.

Totalizers of the previous period
1. The GSV_YESTERDAY and NSV_YESTERDAY totalizers indicate the totalizations of the previous account period. Besides this, the FTIME_YESTERDAY parameter indicates the flow time. The selection and indication of the period type visualized in the corresponding parameters are done through the CT_CMD parameter.

These information about the previous day consider possible resets in the totalizations during this period, thus these totalizers and flow time indicate a sum of totalizers/flow time if a reset occurred.

The information about the previous day are consistent, even when a power failure occurs, thus when the FC302 is powered up, it checks if the totalizers are pertinent to the previous account day.

Process alarms: active (ACTIVE_ALARM1 and ACTIVE_ALARM2) and unacknowledged (UNACK_ALARM1 and UNACK_ALARM2).
The process alarms (high, high high, low and low low) of the variables as volume flow rate, mass flow rate, temperature, pressure, density and SW related to the streams participating of the station equation are processed by the AALM block. The LST block has only a summarized indication of active and unacknowledged alarms. For further details, refer to the AALM block or the event register.

Note:
The GSV_ YESTERDAY, NSV_ YESTERDAY, GSV_PREV_BATCH, NSV_ PREV_BATCH, GSV_HOUR, NSV_HOUR, GSV_DAY, NSV_DAY, GSV_ WEEK, NSV_ WEEK, GSV_ MONTH and NSV_ MONTH totalizers can indicate difference in the fractional part of the values showed by the QTR reports; this is because the values showed in the reports also include a discrimination of values.

Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration: this indication occurs when there is any problem in the station equation, for example, any stream participating of the equation is not measuring liquid or it is not the same product. The operation between crude oil/light hydrocarbon and its correspondent emulsion is possible.

2. BLOCK_ERR. Out of Service: the LST block can continue in the Out of service mode, although the target mode is Auto because the Resource block is in O/S.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with string different of spaces, this parameter will substitute the block tag in the QTR report.
3	4	STRATEGY	Unsigned16	254	254	None	S / RO	This parameter is used to identify the run number. This block has information related to all runs; therefore it is a read only parameter.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	I,1,3	RESET_IN	DS-66				N / RO	This is a positive transition sensitive input parameter. It causes a reset in the totalizers.
8	I,1,3	SAMPLE_REPORT	DS-66				N / RO	This is a positive transition sensitive parameter; it causes the operation report generation for the enabled periods.
9	O	BATCH_NEAR_END	DS-66				N / RO	Indicate the actual batch is near of the end. This output will continue TRUE until the batch ending.
10	O	BATCH_END	DS-66				N / RO	Indicate the batch ending for one micro cycle. After this, a new batch is initialized.
11	O,1,3	REPORT_DONE	DS-66				N / RO	Indicate, for one macrocycle, that a quantitative transaction report or operational was generated and registered.
12	O	FLOW_GSV	DS-65		0	QV	N / RO	Volume flow rate corrected by the CCF. It is not calculated for allocation measurement.
13	O	FLOW_NSV	DS-65		0	QV	N / RO	Volume flow rate corrected by the CCF and discounting the SW percentage.
14	O	FLOW_MASS	DS-65		0	QM	N / RO	Mass flow rate.
15 (A2) (CL)		STATION_EQUATION	Visiblestring[16]		Blank		S	Station equation for liquid. If the first element is blank, it means no processing
16 (A2) (CL)		ENABLE_REPORT	Bitstring[2]		Daily		S	This parameter enables the report generation for the periods: hour, day, week or month.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
17		BATCH_SIZE	Integer32[10]		0	TV	S	Define the sequence of the batch size. The specified size is compared to the NSV. The first element is the actual batch and when it finds one zero, the batch is finished only when a reset or batch end command occurs.
18		BATCH_ID1	Visiblestring[8]				S	Description tag for the actual batch.
		….						
27		BATCH_ID10	Visiblestring[8]				S	Description tag for the decimal batch.
28 (CL)		END_TYPE	Unsigned8	0 = Manual 1 = Batch size	0	E	S	Selection of the mode to end the batch.
29 (A2) (CL)		NEAR_END	Float	50 to 100	95	%	S	Specify the percentage of the batch size to be reached in order to active the BATCH_NEAR_END output.
30 (A2)	1	CT_CMD	Unsigned8	0=None 1=Reset 2=Operational hour report 3=Operational day report 4=Operational week report 5=Operational month report 6=Batch End 7=Previous hour 8=Previous day 9=Previous week 10=Previous month	Previous day	E	N	Writing “Reset” in this parameter, it acts as a positive transition in the RESET_IN parameter. Writing “Operational Report” in this parameter, the correspondent report type will be generated. Through this parameter is also possible to select the type of previous period to be visualized. After executing a request action, the value will return automatically to the state that shows the type of previous period visualized.
31		GSV_YESTERDAY	Float			TV	N/ RO	Gross volume totalizer at base conditions for the previous period, selected in CT_CMD. It is not calculated for allocation measurement.
32		NSV_YESTERDAY	Float			TV	N/ RO	Net volume totalizer at base conditions for the previous period, selected in CT_CMD.
33		FTIME_YESTERDAY	Time difference				N / RO	Flow time for the previous period, selected in CT_CMD.
34		GSV_PREV_BATCH	Float			TV	N/ RO	Gross volume totalizer at base conditions for the previous batch. It is not calculated for allocation measurement.
35		NSV_ PREV_BATCH	Float			TV	N/ RO	Net volume totalizer at base conditions for the previous batch.
36		FTIME_ PREV_BATCH	Time difference				N / RO	Flow time for the previous batch.

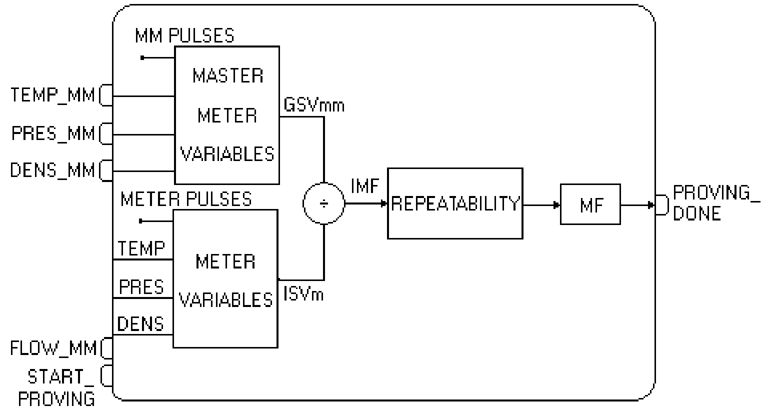
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
37		GSV_BATCH	Float			TV	N/ RO	Net volume totalizer at base conditions for the actual batch. It is not calculated for allocation measurement.
38		NSV_BATCH	Float			TV	N/ RO	Net volume totalizer at base conditions for the actual batch.
39		FTIME_BATCH	Time difference				N / RO	Flow time for the actual batch.
40		STATUS_BATCH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual batch status. Similar to the BATCH_STATUS.
41		COUNTER_BATCH	Unsigned32		1	Na	N / RO	Batch report counter.
42	1	GSV_HOUR	Float			TV	N/ RO	Gross volume totalizer at base conditions for the actual hour. It is not calculated for allocation measurement.
43	1	NSV_HOUR	Float			TV	N/ RO	Net volume totalizer at base conditions for the actual hour.
44		FTIME_HOUR	Time difference				N / RO	Flow time for the actual hour.
45	1	STATUS_HOUR	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual hour status. Similar to the BATCH_STATUS.
46		COUNTER_HOUR	Unsigned32		1	Na	N / RO	Hourly report counter.
47	1	GSV_DAY	Float			TV	N/ RO	Gross volume totalizer at base conditions for the actual day. It is not calculated for allocation measurement.
48	1	NSV_DAY	Float			TV	N/ RO	Net volume totalizer at base conditions for the actual day.
49		FTIME_DAY	Time difference				N / RO	Flow time for the actual day.
50	1	STATUS_DAY	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual day status. Similar to the BATCH_STATUS
51		COUNTER_DAY	Unsigned32		1	Na	N / RO	Daily report counter.
52	1	GSV_WEEK	Float			TV	N/ RO	Gross volume totalizer at base conditions for the actual week. It is not calculated for allocation measurement.
53	1	NSV_WEEK	Float			TV	N/ RO	Net volume totalizer at base conditions for the actual week.
54		FTIME_WEEK	Time difference				N / RO	Flow time for the actual week.
55	1	STATUS_WEEK	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual week status. Similar to the BATCH_STATUS.
56		COUNTER_WEEK	Unsigned32		1	Na	N / RO	Weekly report counter.
57	1	GSV_MONTH	Float			TV	N/ RO	Gross volume totalizer at base conditions for the actual month. It is not calculated for allocation measurement.
58	1	NSV_MONTH	Float			TV	N/ RO	Net volume totalizer at base conditions for the actual month.
59		FTIME_MONTH	Time difference				N / RO	Flow time for the actual month.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
60	1	STATUS_MONTH	Bitstring[2]	See Block Options	0	Na	N/ RO	Actual month status. Similar to the BATCH_STATUS.
61		COUNTER_MONTH	Unsigned32		1	Na	N / RO	Monthly report counter.
62		ACTIVE_ALARM1	Bitstring[2]				N / RO	Indicate the alarms related to the station are actives.
63		ACTIVE_ALARM2	Bitstring[2]				N / RO	Indicate the alarms related to the station are actives.
64		UNACK_ALARM1	Bitstring[2]				N	Indicate the alarms related to the station are unacknowledged by the operator.
65		UNACK_ALARM2	Bitstring[2]				N	Indicate the alarms related to the station are unacknowledged by the operator.
66 (A2)		REPORT_NO_FLOW	Unsigned8	0=No 1=Yes	0	E	S	If the NSV totalizer is zero and is configure as “No”, it will not generate the QTR report.
67		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
68		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
69		MASS_HOUR	Float			TM	N / RO	Mass totalization for the actual hour.
70		MASS_DAY	Float			TM	N / RO	Mass totalization for the actual day.
71		MASS_WEEK	Float			TM	N / RO	Mass totalization for the actual week.
72		MASS_MONTH	Float			TM	N / RO	Mass totalization for the actual month.
73		MASS_PREV_BATCH	Float			TM	N / RO	Mass totalizer for the previous batch.
74		MASS_YESTERDAY	Float			TM	N / RO	Mass totalizer for the previous period, selected in CT_CMD.
75		MASS_BATCH	Float			TM	N / RO	Mass totalizer for the actual batch.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in Configuration Log
Gray Background Line: Custom Parameters

LMMF – Liquid Master Meter Factor

Schematic



Description

The main purpose of this block is providing support for the proving using a master meter.

This block receives from field devices all the necessary variables: flow meter pulses, temperature, pressure and density, for the proving process related to the master meter and the meter in calibration.

Identification for the run number – STRATEGY parameter

The configuration of the STRATEGY parameter is mandatory, because it identifies the number of the flow measurement to be submitted to the proving. If the parameter is with default value (zero), the block will execute in the O/S mode and indicate in the BLOCK_ERR.Block configuration parameter. This parameter associates the information of the operational meter to the LKD block (METERx_INFO - NKF e MF_METER_PRODUCT – meter factor), if the meter is “pulse input” type.

Block Inputs

The block inputs are used according to the configuration, as showed in the table below:

Input	Link necessity	Description
TEMPERATURE_MM	mandatory	Master meter flowing temperature.
PRESSURE_MM	Mandatory if it is custody transfer measurement. This parameter is optional if it is allocation measurement	Master meter flowing gauge pressure.
DENSITY_MM	mandatory	Density of the measured product in the Master, which can be at flowing or base conditions depending on the configuration of LKD.PRODUCTx_INFO.Density type. Thus, the type of meter and master meter densities must be the same configured in the parameter.
LFLOW_MM	Mandatory if the meter is “analog input”	This input must indicate the master meter flow rate and it must be of the same type of that one configured for the operational meter in the LFLOW_TYPE parameter.
START_PROVING	Depends on the application	This input can be used when it desires that an event detected by other block initiates automatically the proving. For example, the alignment ending for the master meter must initialize the proving automatically or the necessity indication of the proving in the LCT.PROV_REQ block.

Block outputs

The PROVING_DONE output indicates, only for one macrocycle, that a proving was accomplished successfully and the repeatability is less than REQ_REPEATABILITY and the MF percentage variation is within the range (ALLOWED_DEV_MF) and it also was acknowledged/ accepted by the user, which generates the proving report.

Parameters only for visualization – reflect the configuration from other blocks

The STRATEGY parameter provides to this block a connection to all information about the operational meter regarding to configuration, measured and calculated variables. They are:

- CHANNEL parameter of the operational meter, if the meter type is “pulse input”.
- Measured product type (PRODUCT_SELECTION).
- TEMPERATURE_DEVIATION, PRESSURE_DEVIATION and DENSITY_DEVIATION: these parameters reflect the acceptable deviations between the variables of the operational meter and master meter related to the usual conditions evaluated by the LBT/LCT blocks. These parameters reflect the parameter values USUAL_TEMP_DEV, USUAL_PRESS_DEV and USUAL_DENS_DEV, respectively.
- Operational meter variables: TEMPERATURE_METER, PRESSURE_METER and DENSITY_METER.

Override handling for the master meter variables

The override handling for the TEMPERATURE_MM, PRESSURE_MM and DENSITY_MM inputs consists of utilizing the correspondent values to the operational meter (after the respective override treatment) when the master meter variable has bad status.

Specific configuration for meter with pulse signal

It is necessary to configure the CHANNEL_MM parameter to address the pulse physical input associated to the master meter if LKD.MM_TYPE is selecting a pulse signal master meter.

In order to read the pulses from the operational and master meter in the same time frame (synchronous pulse reading), the pulse input of both must be addressing the same rack, slot and group. For example, CHANNEL = 2100 and CHANNEL_MM = 2107, that is, both addressing the rack 2, slot 1 and group 0.

The PULSES_PROVING_RUN parameter specifies another configuration for meters of the pulse input type; this parameter sets the minimum quantity of pulses for the operational and master meter for each proving run. The specific standards for proving determine that the minimum pulse quantity is 10,000, which is the lower limit of configuration for the PULSES_PROVING_RUN parameter.

Specific configuration for meter with analog signal

If the master meter type is analog input, thus it is necessary to link the FLOW_MM input. It is important remember to set the meter type for the master meter in the LKD block through the MM_TYPE parameter (Flow IV analog input, Flow IV*CTL analog input or Flow IM analog input).

The criteria to end a proving run will be the indicated volume specified in the SIZE_PROVING_RUN parameter, thus when the operational and master meter measured a volume larger than this parameter, the proving run will be finished.

The proving process

The proving process using master meter consists of comparing the gross standard volume measured by master meter (GSVmm = IVmm***** CTLmm*CPLmm*MFmm) with the indicated volume corrected by the temperature and pressure (ISVm = IVm***** CTLm*CPLm) of the operational meter, in the same time interval. Using the volume measured by the master meter as reference, a multiplier factor for ISVm is calculated.

It follows the sequential steps of proving process:

- Before starting the first proving run, there is a stability check for temperature, pressure and density of the meter and master meter during the specified time in STABILITY_TIME parameter. The stability is analyzed comparing the instantaneous value of these variables to the values at the usual condition. This stability check proceeds for whole proving process and it is indicated in the status of each proving run.
- For each proving run, whose total number of runs depends on the RUN_CRITERIA parameter, it is started the calculation of the weighted average, correction factors, totalizers of the corrected flows and the intermediate meter factor (IMF);
- Each proving run ends when the number of pulses for the master meter and the meter are higher than the specified in PULSES_PROVING_RUN parameter for pulse signal meter or the volume measured by both are larger than the SIZE_PROVING_RUN parameter for the analog signal meter.
- When the required number of proving runs is executed, the final calculations are done, including the repeatability according to the configuration of the RUN_CRITERIA parameter. If the repeatability was attended, it verifies the configuration of the ALLOWED_DEV_MF parameter that specifies the maximum percentage variation of the meter factor obtained comparing to the current value.

o If the rules below were attended, it verifies the configuration of the REQ_ACK parameter, which allows two options: to use the MF obtained in the calibration process or wait for the user acknowledgement; if it does not occur, the proving process will be rejected.

o If the proving process was acknowledged (automatically or by user acknowledgement), there are still the following options:

  - o To use immediately the new MF, it means that the batches running start to use this new factor applying it retroactively since the beginning of batches.
  - o The new MF would be used only in the posterior batch to the actual.

o A proving report is generated.

Mass Meters

When the meter is of mass type, the proving process compares the measured mass by master meter (MMmm = Nmm * MFmm / NKFmm) with the mass indicated by meter that is IMm = Nm / NKFm.

In this case, it is MF = MMmm / IMm.

Observe that the output type of the operational meter determines if the comparison will be accomplished in volume or mass. The mass meter with volume output will be handled as a volume meter and also if the output type of the operational meter and master meter are different, the master volume will be converted to mass or vice-versa.

Operational meter and master meter combinations:

Operational Meter LFLOW_TYPE	Master meter LKD.MM_TYPE	Variable Compared in proving	Comments
0 = IV pulse input 1=IV*CTL pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input	0 = IV pulse input 1=IV*CTL pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input	Corrected volume for temperature and pressure	Any combination of volume meters.
2=IM pulse input 5=Flow IM analog input	2=IM pulse input 5=Flow IM analog input	Mass	Any combination of mass meters.
0 = IV pulse input 1=IV*CTL pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input	2=IM pulse input 5=Flow IM analog input	Corrected volume for temperature and pressure	Any combination of volume operational meter with mass master meter.
2=IM pulse input 5=Flow IM analog input	0 = IV pulse input 1=IV*CTL pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input	Mass	Any combination of mass operational meter and volume master meter.

Proving Configuration

Stability check at the beginning of the proving process– STABILITY_TIME parameter

The input variables stability analysis is performed during the time configured in this parameter, before starting the first proving run.

Rule to be used – RUN_CRITERIA parameter

The RUN_CRITERIA parameter defines the rule to be used for the repeatability calculation, whose options are:

- Any 5 of 6 consecutive: six proving runs must be processed in sequence and select the better five (any, they do not need to be in sequence) and, the repeatability is calculated using these five proving runs. The selection of the better five consists of rejecting the proving run whose IMF value is the furthest from the average of the six IMF’s.
- 5 consecutive of 10 consecutive: after processing ten proving runs in sequence, select any 5 proving runs, in sequence, which attend the repeatability.

- 3 sets of 5: 3 groups of 5 consecutive proving runs are executed, an average value of IMF is calculated for each group. The repeatability is calculated using these three averages of IMF
- 5 consecutive: it processes five proving runs in sequence and the repeatability of them is calculated.
- 3 consecutive: it processes 3 proving runs in sequence and the repeatability of them is calculated.
- 2 consecutive: it processes 2 proving runs in sequence and the repeatability of them is calculated.

Required repeatability - REQ_REPEATABILITY parameter
The calculated repeatability is compared to the maximum value allowed that is configured in REQ_REPEATABILITY parameter. The repeatability is calculated following the form:

$$\text{Repeatability (\%)} = \frac{\text{max IMF} - \text{min IMF}}{\text{Min IMF}}$$

The maximum and minimum values are determined between the intermediate values of meter factor (IMF's) of the proving runs selected after the application of the RUN_CRITERIA.

Maximum allowed percentage variation of the meter factor– ALLOWED_DEV_MF parameter
When the required repeatability is attended, the percentage variation of the meter factor obtained in the proving compared to the actual value is calculated. If the percentage variation calculated is larger than the specified in the ALLOWED_DEV_MF parameter, the proving is rejected.

Configuring the value in the ALLOWED_DEV_MF parameter to zero, it means that this verification is disabled

Acknowledgement by user before using the new meter factor – REQ_ACK parameter
The REQ_ACK parameter specifies the maximum time after the end of proving and the repeatability calculation, in order to the user acknowledges the new meter factor calculated and starts use it. If this does not occur, the PROVING_STATE parameter goes to "Acknowledgment timeout", this means that the proving is rejected.

The user acknowledges the new meter factor writing into PROVING_STATE = Using new MF (Wr). This parameter specifies the maximum time between the end of a proving run and the beginning of the next, when the proving is executed interactively (one by one proving run).

When using the new meter factor – APPLY_RETROACTIVELY parameter
The parameter allows defining two ways to use the new meter factor:

- "No": the totalizations in operation continue utilizing the previous meter factor and they start to use the new meter factor only in the beginning of a new accounting period.
- "Yes": the totalizations in operation start to use the new meter factor immediately, the new meter factor is applied to the indicated volume measured since the beginning of each period (hour, day, week and month).

Calculations accomplished during the Proving

During the execution of the proving run, the following calculations are accomplished:

- Pulse counting if it is pulse input or volume/mass totalization if it is analog input type.
- Calculation of the weighted averages of the variables associated to the operational and master meters.
- Status evaluation for the corresponding proving run (PROVING_RUNxx_STATUS);
- Determination of the duration in seconds for the proving run (TEST_TIME).

At the end of each proving run the following operations are accomplished:

- Correction factor calculations (CTL and CPL) associated to the operational and master meters.
- Calculation of gross standard volume for master meter (GSVmm) and indicated standard volume for operational meter(ISVm);
- Calculation of intermediate meter factor (IMF).

After finishing all required proving runs, according to the selected criteria, the following procedure is performed:

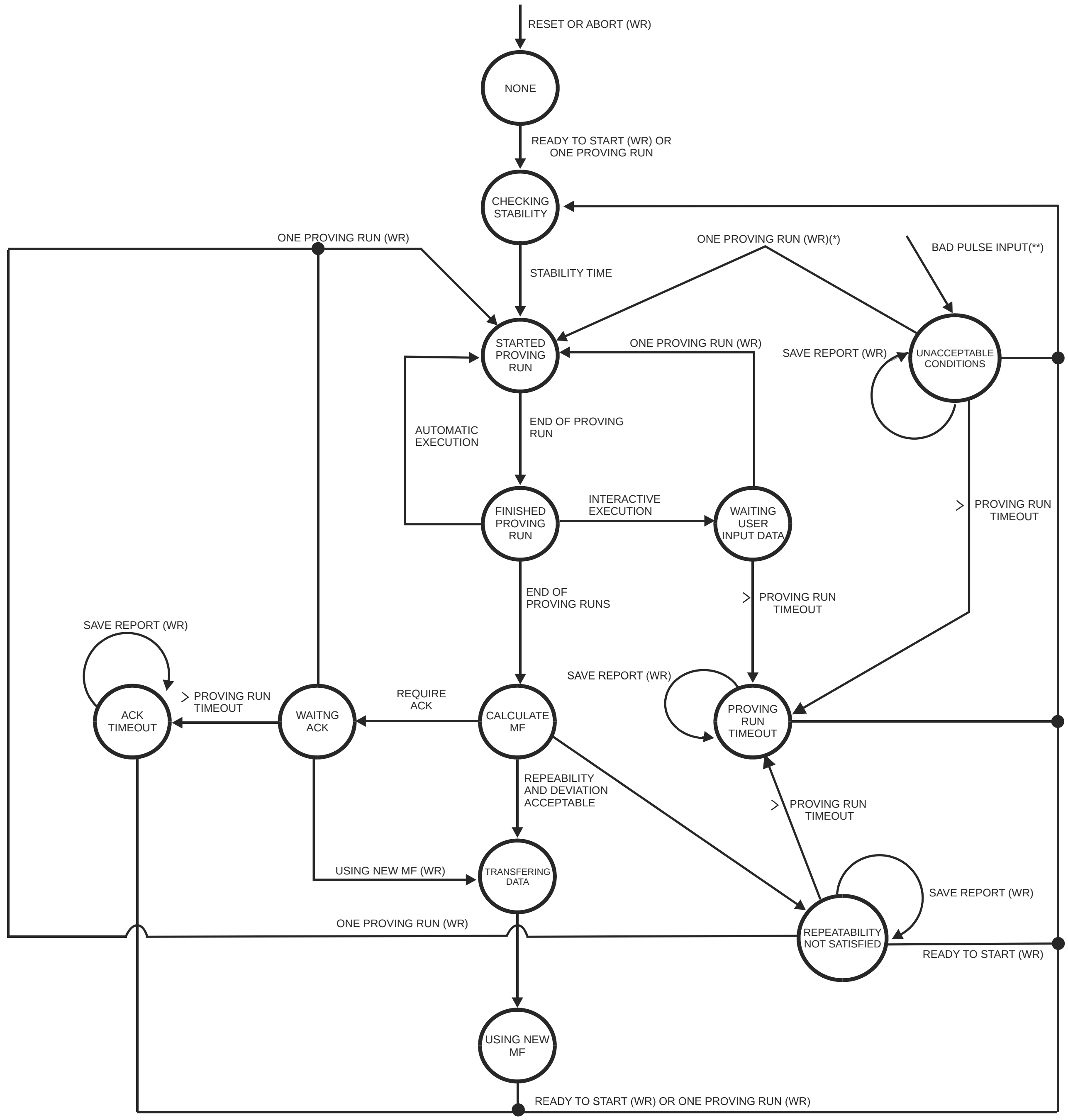
- Application of selected criteria (RUN_CRITERIA).
- Repeatability calculation.
- Calculation of the MF, CMF, MA, KF and CKF parameters.
- Repeatability check and percentage variation of the meter factor;
- If the specifications and user acknowledgement were attended (if required), the new meter factor is transferred to the LKD.MF_METER_PRODUCT block;
- A proving report is automatically generated when transferring the new meter factor to the LKD block. The user may request a report generation even when a proving failed by writing PROVING_STATE = Save report of failed proving (Wr);
- If one failure occurred during the proving, the cause is indicated in PROV_FAIL_CAUSE and the state in PROVING_STATE will be one of the following options:

  - Repeatability not satisfied – the calculated repeatability is greater than REQ_REPEATABILITY.
  - Acknowledgment timeout – the user did not acknowledge the new meter factor.
  - Unacceptable conditions – problems in the pulse reading or the pulse input module.
  - Proving run timeout – the time between proving runs exceeded the PROVING_RUN_TIMEOUT.

Operation during the proving process
The below state diagram shows two possible ways of execution:

- Automatic and sequential execution of the proving runs: all the proving runs are executed sequentially up to the required number to attend the selected criteria (RUN_CRITERIA).

- Interactive execution under user request for each proving run writing PROVINVG_STATE = One proving run: since the first proving run or after a failure, even when it occurred after an automatic and sequential execution of the proving runs.



(*) If PROV_FAIL_CAUSE equals to “Too Large Variation of MF” or “Abnormal Condition”.

Diagnosis and Troubleshooting

- BLOCK_ERR. Block configuration: this indication can occur due to the following problems:
  - If a “pulse input” meter type was selected and the CHANNEL or CHANNEL_MM parameter is addressed for a rack and slot, and there is a configured module (in the HC block) which does read pulse or not addressing any module (equals to zero).
  - CHANNEL_MM parameter equals to zero and “pulse input” type master meter.
  - CHANNEL and CHANNEL_MM parameters are not addressing the same rack, slot and group.
  - If the master meter is “pulse input” type and the FLOW_MM input is linked, because the master meter flow rate is calculated and indicated in the FLOW_MM input.
  - STRATEGY parameter equals to zero. It is mandatory to configure this parameter, because it identifies the run number.
  - There is no LBT/LCT block for the run number selected in the STRATEGY parameter.
  - The measured product is water.
  - Inconsistence in the linearization curve, if this option was selected for meter or master.

- BLOCK_ERR. Input failure: this indication may occur due to the following problems:
  - If the selected meter is "pulse input" type and it is not being possible to read the pulses from the module addressed by the CHANNEL or CHANNEL_MM parameter.
  - If the selected meter is "analog input" type and the LFLOW or FLOW_MM input has bad status.

- BLOCK_ERR. Out of Service: LCT block can continue in the Out of Service mode, although the target mode is Auto, due to the following causes:
  - STRATEGY parameter equals to zero.
  - CHANNEL_MM parameter equals to zero and meter is "pulse input" type.
  - There is no LBT/LCT block for the selected run number in the STRATEGY parameter.
  - The measured product is water.
  - The Resource block is in O/S.

- If a proving failure occurs due to repeatability not satisfied (PROVING_STATE = Repeatability not satisfied), the user can check the following options:
  - The obtained repeatability compared to the requested value.
  - Analyze possible differences in the pulse number between the operational and master meters.
  - Instability in the variables of the operational and master meters (temperature, pressure and density).

- If a proving failure occurs due to unacceptable conditions (PROVING_STATE =Unacceptable conditions), the options below should be checked:
  - Pulse reading failure: module with problem or pulse transmission from the meter to the module.
  - Verify if the variables (density and temperature) of the operational and master meters are in the calculation ranges of the correction factors. Refer to the tables in the LKD block description.
  - Percentage variation of the meter factor was larger than the specified in the ALLOWED_DEV_MF parameter.
  - Meter factor is out of the range 0.8 to 1.2.

- Write failure in writing configuration parameter: writing is allowed only if no proving is being performed.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3 (A2) (CL)	4	STRATEGY	Unsigned16	0 to 4	0	None	S	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (A2)	I,1,3	TEMPERATURE_MM	DS-65			T	N	Master meter temperature.
8 (A2)	I,1,3	PRESSURE_MM	DS-65			P	N	Master meter pressure.
9 (A2)	I,1,3	DENSITY_MM	DS-65			LD	N	Master meter density..
10	1,3	TEMPERATURE_METER	DS-65			T	N / RO	Temperature for the operational meter used for the correction factor calculation for the liquid thermal expansion.
11	1,3	PRESSURE_METER	DS-65			P	N / RO	Gauge pressure of the operational meter used for correction factor calculation of the liquid compressibility.
12	1,3	DENSITY_METER	DS-65			LD	N / RO	Density of the operational meter used for calculating the CPLm and CTLm factors.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
13	I,1,3	START_PROVING	DS-66				N / RO	When this input was TRUE, it will force one session of automatic proving.
14	O,1,3	PROVING_DONE	DS-66				N / RO	Proving session finished successfully and using the new MF. This output will be TRUE for one macrocycle.
15	4	CHANNEL	Unsigned16		0	Na	S / RO	Channel number of the logic hardware for the pulse input module.
16 (A2) (CL)		CHANNEL_MM	Unsigned16		0	Na	S / O/S	Channel number of the logic hardware for the pulse input module of the master meter. The master meter must be in the same group of the operational meter to be tested, in order to reach the desired accuracy of the proving process.
17(A2)	4	PRODUCT_SELECTIO N	Unsigned8	1-10 = Product 1-10	1	E	S / RO	It indicates the selected product related to the LBT/LCT block.
18 (A2) (CL)	4	PULSES_PROVING_R UN	Unsigned16	10000 to 65535	10000	Na	S	Minimum number of pulses for proving, when the master meter is used. And applied to the operational meter and also to the master meter. It is allowed to write since a proving is not occurring.
19 (CL)	4	STABILITY_TIME	Unsigned16	0 to 65535	60	Sec	S	Minimum time desired of stable temperature, pressure and density to start the proving. It is allowed to write since a proving is not occurring.
20	4	TEMPERATURE_DEVI ATION	Float	0.0=disabled 0.0 to 100.0	5	T	S / RO	Maximum deviation allowed for the temperature (operational and master meter) when it is compared to the usual temperature.
21	4	PRESSURE_DEVIATI ON	Float	0.0=disabled > 0.0	10	%	S / RO	Maximum deviation allowed for the pressure (operational and master meters) when it compared to the usual pressure.
22	4	DENSITY_DEVIATION	Float	0.0=disabled > 0.0	2	%	S / RO	Maximum deviation allowed for the density (operational and master meters) when it compared to the usual density.
23 (A2) (CL)	4	RUN_CRITERIA	Unsigned8	0=any 5 of 6 consecutive 1= 5 consecutive of 10 consecutive 2=3 sets of 5 3=5 consecutive 4=3 consecutive 5=2 consecutive	0	E	S	Rule used to analyze the repeatability. The writing is allowed since there is no executing a proving process
24 (A2) (CL)	4	REQ_ACK	Unsigned8	0=Use new MF 1=Ack to new MF	0	E	S	The MF calculated recently and that attends the repeatability, can be used immediately or need the operator acknowledge. It is allowed to write since a proving is not occurring.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
25 (A2) (CL)	4	APPLY_RETROACTIVELY	Unsigned8	0=No 1=Yes	0	E	S	This parameter allows the user applies the new MF to the totalizations in operation. It is allowed to write since a proving is not occurring.
26		REPORT_COUNTER	Unsigned32		1	Na	N / RO	Report counter for the report type and number of the measured flow.
27 (A2)	1	PROVING_STATE	Unsigned8	0=None 1=Ready to start(Wr) 2=Checking stability 3=Started proving run 4=Finished proving run 5=Waiting user input data 6=Calculate MF 7=Repeatability accepted and waiting acknowledgement 8=Transferring data 9=Using new MF(Wr) 10=Repeatability not satisfied 11=Acknowledgment timeout 12=Unacceptable conditions 13=Save report of failed proving(Wr) 14=Abort(Wr) 15=One proving run(Wr) 16=Proving run timeout 17=Finished forward pass 18=Started reverse pass 19 = Waiting BPV tank prover input 20 = Acknowledgment BPV tank prover input(Wr)	0	E	D	Indicate the proving situation. When the state was Waiting user input data, it means any data supplied by the user must be supplied to calculate the MF. If the REQ_ACK was configured to Ack to new MF and the state was “Repeatability accepted and waiting acknowledgement”, the operator must type Using new MF to initiate the use of the new MF. This acknowledgement must occur up to the timeout of 5 minutes. When the repeatability is not satisfied, the user has the option to execute a new proving run and reject the last. The option “One proving run” also can be used for executing the proving in an interactive form.
28	1	PROVING_RUN	Unsigned8		0	Na	D / RO	Show the proving run number in execution. For unidirectional provers indicate one running. For bidirectional provers indicate one whole running (start and back).
29		TWA_MM	Float[21]		0.0	T	D / RO	Temperature weighted average for the master meter.
30		PWA_MM	Float[21]	> 0.0	0.0	P	D / RO	Pressure weighted average for the master meter.
31		DWA_MM	Float[21]	> 0.0	0.0	LD	D / RO	Density weighted average for the master meter.
32		N_MM	Float[21]	> 0.0	0.0		D / RO	Pulse number of the master meter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
33		TWA_METER	Float[21]		0.0	T	D / RO	Temperature weighted average for the operational meter.
34		PWA_METER	Float[21]	> 0.0	0.0	P	D / RO	Pressure weighted average for the operational meter.
35		DWA_METER	Float[21]	> 0.0	0.0	LD	D / RO	Density weighted average for the operational meter.
36		N_METER	Float[21]	> 0.0	0.0		D / RO	Pulse number for the operational meter.
37		IVMM	Float[21]	> 0.0	0.0		D / RO	Indicated volume for the master meter.
38		CTLMM	Float[21]	> 0.0	0.00000		D / RO	Temperature correction factor for the master meter.
39		CPLMM	Float[21]	> 0.0	0.00000		D / RO	Compressibility correction factor for the master meter.
40	1	GSVMM	Float[21]	> 0.0	0.0	V	D / RO	Gross volume for the master meter. This parameter indicates the mass in the master meter if mass meter.
41		IVM	Float[21]	> 0.0	0.0		D / RO	Indicated volume for the operational meter. This parameter indicates the mass in the master meter if mass meter.
42		CTLM	Float[21]	> 0.0	0.00000		D / RO	Effect temperature correction of the liquid hydrocarbon for meter in proving conditions. When the “average data” is selected, only the first matrix element is used.
43		CPLM	Float[21]	> 0.0	0.00000		D / RO	Compressibility correction factor of the liquid hydrocarbon for meter in proving conditions. When the “average data” is selected, only the first matrix element is used.
44	1	ISVM	Float[21]	> 0.0	0.0	V	D / RO	Standard volume indicated for proving in volume operations. When the “average data” option is selected, only the first matrix element is used.
45		IMF	Float[21]	> 0.0	0.0		D / RO	Intermediate MF obtained in each run. When the METER_FACTOR_METHOD is selected for “average MF”, only the first element of the matrix is used.
46	1	MF	Float	0.8 to 1.2	1.0		D / RO	Meter factor. If the MF calculated is accepted, the proving basic information will be stored in the LKD block.
47		CMF	Float	> 0.0	0.0		D / RO	Composite meter factor (MF * CPL)
48		MA	Float	> 0.0	0.0		D / RO	Meter accuracy (1 / MF).
49		KF	Float	> 0.0	0.0	K	D / RO	K factor calculated, pulses by volume unit (NKF/MF).
50		CKF	Float	> 0.0	0.0	K	D / RO	Composite K factor, given in pulses by volume unit (KF/CPL).
51	1	REPEATABILITY	Float		0.0	%	D / RO	Repeatability of the proving session.
52		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the data static.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
53		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
54	I,1,3	FLOW_MM	DS-65			QV or QM	N / RO	If the MM_TYPE parameter defines master meter as "analog input", thus this input must be connected. Otherwise ("pulse input"), this input must not be connected and the net volume flow in base condition for master meter will be indicated.
55 (A2) (CL)		SIZE_PROVING_RUN	Float	> 0.0	100	LV	S	Minimum size of the proving run. Based on the indicated volume, always, regardless of the LFLOW_TYPE parameter.
56 (A2) (CL)		REQ_REPEATABILITY	Float	0.01 to 2.00	0.05	%	S	Repeatability necessity of the proving session to be accepted. Applied to the IMF parameter or N_INTERPOLATED, according to the selected method.
57 (A2) (CL)		ALLOWED_DEV_MF	Float	0.0=No restriction > 0.0	0.0	%	S	Define the maximum deviation allowed for the MF when it is compared to the actual value.
58		PROV_FAIL_CAUSE	Unsigned32	0= OK 1= bad flow sensor 2 = repeatability not achieved 3 = out-of-range correction factor 4=too large variation of MF 5= abnormal proving 6=proving run timeout 7= T2 start timeout 8= T1 start timeout 9= T2 stop timeout 10= T1 stop timeout 11= invalid pulse input selected 12= pulse input error	0	E	D / RO	Proving failure cause.
59		LIQ_WARN	Bitstring[2]	See the specific description	0	E	N / RO	Warning events occurred.
60		TEST_TIME	Float[21]			Sec	N / RO	Duration of each proving run.
61		PROVING_RUN1_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 1. See the WARN description.
62		PROVING_RUN2_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 2. . See the WARN description.

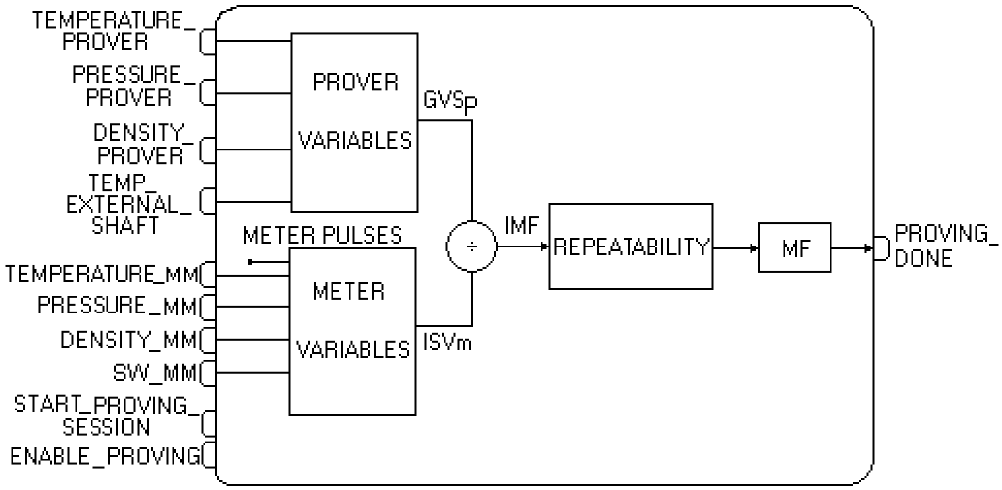
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
63		PROVING_RUN3_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 3... See the WARN description
64		PROVING_RUN4_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 4. See the WARN description
65		PROVING_RUN5_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 5. See the WARN description.
66		PROVING_RUN6_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 6. See the WARN description.
67		PROVING_RUN7_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 7. See the WARN description.
68		PROVING_RUN8_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 8. See the WARN description
69		PROVING_RUN9_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 9. See the WARN description
70		PROVING_RUN10_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 10. See the WARN description
71		PROVING_RUN11_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 11. See the WARN description
72		PROVING_RUN12_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 12. See the WARN description
73		PROVING_RUN13_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 13. See the WARN description
74		PROVING_RUN14_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 14. See the WARN description
75		PROVING_RUN15_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 15. See the WARN description
76		PROVING_RUN16_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 16. See the WARN description
77		PROVING_RUN17_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 17. See the WARN description
78		PROVING_RUN18_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 18. See the WARN description.
79		PROVING_RUN19_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 19. See the WARN description
80		PROVING_RUN20_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 20. See the WARN description
81		PROVING_RUN21_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status for the proving run 21. See the WARN description.
82 (CL)		PROVING_RUN_TIMEOUT	Unsigned8	0=disabled 1 to 255	5	Min	S	Maximum time between proving runs when executing the proving using interactive form. Maximum time for the acknowledgement of the new MF.
83		CTL_W_P	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Temperature correction factor in water volume for prover/master meter. This parameter is calculated based on the water base density that should be configured in the PRODUCTxINFO parameter.
84 (V4)		CTL_W_M	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Temperature correction factor in water volume for meter. It is calculated based on the water base density that must be configured in the PRODUCTxINFO parameter.
85		CPL_W_P	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in volume of water for prover/master that is calculated using the average pressure for each proving run.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
86		CPL_W_M	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in volume of water for meter that is calculated using the average pressure for each proving run

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in Configuration Log
V4 – Parameter added in version 4
Gray Background Line: Custom Parameters

LMF – Liquid Meter Factor

Schematic



Description

The main purpose of this block is to provide support for proving using a prover, which can be: Ball Prover (conventional prover, U-type), Small Volume Prover (piston prover) and Tank Prover. This functionality is available only for the DF77 module, because this module was developed to attend standards related to the prover, as API-Chapter 4 and ISO7278.

This block receives all the variables from the field equipment: pulses from the flow meter, temperature, pressure and density, that are required to the proving process related to prover and meter in calibration.

The sequence below shows the events that occur during a proving run:

- IN1: input of DF77 module. It indicates when the prover is ready to execute a proving run.
- IN2: input of DF77 module. It indicates the start of the calibrated section of the prover.
- IN3: input of DF77 module. It indicates the end of the calibrated section of the prover.
- OUT1: output of DF77 module. It indicates to prover when to start a proving run, which can mean a command to launch the ball of the Ball Prover or the piston of the Small Volume Prover.

- Ball Prover – Unidirectional: 1 proving run corresponds to 1 proving pass. Alignment (IN1), start run (OUT1), start pass, start detector (IN2), end detector (IN3), end pass, end run.

1. It checks if the sphere is in the correct position in order to start the run (IN1),
2. It starts the start run output (OUT1) discharging the sphere to go through the prover,
3. It waits the start detector (IN2),
4. It waits the end detector (IN3),
5. The sphere is deviated from the way that the fluid is, and the sphere is positioned for the next run.

- Ball Prover – Bidirectional: 1 proving run corresponds to 2 proving passes (forward and backward). Alignment (IN1), start run (OUT1), start pass, start detector (IN2), end detector (IN3), end pass, change of direction (IN1), start run (OUT1), start pass, end detector (IN3), start detector (IN2), end pass, end run.

1. It checks if the sphere is in the correct position in order to start the run (IN1),
2. It starts the start run output (OUT1) discharging the sphere to go through the prover,
3. It waits the start detector (IN2),
4. It waits the end detector (IN3),
5. The sphere is deviated from the way that the fluid is, and the sphere is positioned to do the inverse way.
6. It waits the direction changes and the sphere positioned (IN1),
7. The start run output (OUT1) is started,

8. It waits the end detector (IN3),
9. It waits the start detector (IN2),
10. The sphere is deviated from the way that the fluid is, and the sphere is positioned for the next run.

- Small Volume Prover – Unidirectional: 1 proving run corresponds to 1 proving pass. Check the piston on the wait position (IN1), start run (OUT1), start pass, start detector (IN2), end detector (IN3), piston returns (OUT1), wait position (IN1), end pass, end run.

1. It checks if the piston is in the ready position to start the run (IN1),
2. It starts the start run output (OUT1) in order to close the valve which causes the displacement of the embolus (Brooks) or the guard of the piston and closing the valve automatically which causes the embolus displacement (Calibron) ,
3. It waits the start detector (IN2),
4. It watis the end detector (IN3) and the prover opens the valve automatically allowing that the fluid flows.
5. The Brooks' Prover guards the piston, positioning it for the next run (upstream position), While the Calibron's Prover is kept in the downstream position.

The Brooks' Prover needs to control the Plenum pressure that actuates like a pneumatic spring to close the Poppet's valve that causes the embolus displacement. The Plenum pressure is controlled through the nitrogen injection or discharging it to the air. For further details about the control of this pressure as well as the setpoint and the maximum error allowed are described in the Prover maintenance and operation manual.

6. Tank Prover: User provides to the FC302 the starting and the ending of the proving run using the PROVING_STATE parameter.

Identification for the Run Number – STRATEGY parameter
The configuration of the STRATEGY parameter is mandatory, because it identifies the run number submitted to the proving, where value "zero" means Master meter proving. This parameter also associates the information of the operational or master meter information to the LKD block (METERx_INFO - NKF and MF_METER_PRODUCT – meter factor), if the meter type is "pulse input".

Block inputs
The block inputs are used according to its configuration, as showed below:

Input	Link Necessity	Description
TEMPERATURE_PROVER	mandatory	Prover flowing temperature.
PRESSURE_PROVER	Mandatory, if it is custody transfer measurement. This parameter is optional if it is allocation measurement	Prover flowing gauge pressure
DENSITY_PROVER	mandatory	Density of the measured product in the prover that can be at flowing or base conditions depending on the configuration of LKD.PRODUCTx_INFO.Density type. Thus the meter and prover density type must be the same type.
TEMP_EXTERNAL_SHAFT	Mandatory for Small Volume Prover	Shaft temperature where are the detectors of the calibrated section of prover.
TEMPERATURE_MM	Mandatory for Master Meter proving	Master meter flowing temperature.
PRESSURE_MM	Mandatory for Master Meter proving and optional for allocation measurement	Master meter flowing gauge pressure.
DENSITY_MM	Mandatory for Master Meter proving	Density of the measured product of the master meter that can be at flowing or base conditions depending on the configuration of LKD.PRODUCTx_INFO.Density type.
SW_MM	Mandatory for master meter proving if it is allocation	BSW for emulsion (crude oil/light hydrocarbon and water) used in master meter proving.

Input	Link Necessity	Description
	measurement	
START_PROVING_SESSION	Depends on the application	This input can be used when an event detected by another block starts automatically a proving session. For example, the alignment end for the prover or the indication of the necessity of proving on the LCT.PROV_REQ block should start a proving automatically.
ENABLE_PROVING	Depends on the application	If this input is linked, the status and the value must be proper, in order to start the proving. If the proving has already been started and status changes to bad or zero, the proving will be aborted.

Block output

The PROVING_DONE output shows only for one macro cycle if the proving was successful, it means that the desired repeatability and the MF percent change is within the maximum acceptable and it was acknowledged by user, that causes the proving report generation.

Handling for block input with bad status

If proving an operational meter, the handling is the same of the LMMF block. Thus, the override handling for the inputs TEMPERATURE_PROVER, PRESSURE_PROVER and DENSITY_PROVER uses the correspondent values to the operational meter (after the respective override handling) when the status is bad. For the input TEMP_EXTERNAL_SHAFT with bad status, it uses the input TEMPERATURE_PROVER or the correspondent override value.

If a master meter is submitted to the proving, thus all the input must be good status, because it is required a higher repeatability in this case(less than 0.02%). If any status is bad, the proving will be aborted.

Configuration for Master meter proving

- CHANNEL_MM parameter: addresses the physical pulse input associated to the master meter.
- Configure STRATEGY parameter to zero (master meter).
- Configuration on the LKD block related to master meter, as: MASTER_METER_INFO, MM_TYPE parameters,
- Create the links for the inputs TEMPERATURE_MM, PRESSURE_MM and DENSITY_MM.
- Set the parameter REQ_REPEATABILITY to 0.02%.

Proving process

The proving process for volume meters consists of a comparison between the Base Prover Volume corrected to the proving condition using properties of steel type and converted to the base condition using the fluid properties (GSVp = BPV * CTSp * CPSp * CTLp * CPLp), and the volume measured by the meter corrected by temperature and pressure (ISVm = IVm***** CTLm*CPLm) in the same time frame. Therefore the corrected prover volume (GSVp) is used as reference/true volume and a multiplier factor to be applied to the indicated standard volume (ISVm) is calculated.

$$MF = \frac{GSVp}{ISVm} = \frac{BPV * (CTSp * CPSp * CTLp * CPLp)}{(Ni/NKFm) * (CTLm * CPLm)}$$

If the tank prover is used, so CPSp = CPLp = 1 and BPV is the difference between the initial and end volume in the tank prover.

In general, the process steps are:

o Before starting the first proving run, stability checks for temperature, pressure and density of the meter and master meter are executed according to the specified time in STABILITY_TIME parameter. The stability is analyzed comparing the value of these instantaneous variables to the corresponding values at the usual condition. This stability check proceeds for whole proving process and it is indicated in the status of each proving run;

o For each proving run, which the total number depends on the RUN_CRITERIA parameter, the weighted average, correction factors and totalizations of the corrected flows are calculated. If the method is “Average MF”, the IMF is also calculated

o For all prover types, except for the Tank Prover, the sequence of events for each proving run is basically the following:

➢ It waits for the indication in the IN1 input of the DF77 if the prover is ready to execute the run.

- ➢ Under user command, the proving run is started, where the prover is informed via the output OUT1 of the DF77.
- ➢ The measurement of times T1 and T2, and also the pulse counting are started when the indication occurs on the IN2 input of the DF77 and stops when the indication occurs on the IN3 input.

o For the Tank Prover, the operation is manually, that is, the command to start the run, as well as the end indications, is provided by the user.

o When finishing the proving runs, the final calculations are accomplished, including the MF, the repeatability using the configured criteria in RUN_CRITERIA and the MF variation obtained compared to the actual value, whose maximum is the ALLOWED_DEV_MF parameter;

o If the above requirements are attended, it checks the configuration of the REQ_ACK parameter that allows two options: use the new MF automatically or wait for a user acknowledgement, which if it does not happen, the proving process will be discarded.

o If the acknowledgement of the proving process occurs (automatically or by user acknowledgement), there is also the following options:
- ❑ Use immediately the new MF, that is, the running batches start to use this new value.
- ❑ The new MF will be used only for new batches;
- ❑ A proving report is generated

Mass meters
For mass meters, the proving process consists on determine the liquid mass in the prover by converting the BPV (Base Prover Volume) to proving conditions related to temperature (CTSp) and pressure (CPSp), then multiplying by density at flowing condition. The mass indicated by mass meter (IMm) is obtained using the interpolated number of pulses divided by NKF (Nominal K-factor).

The division of mass indicated by prover by the mass indicated by meter provides the MF (meter factor).

The proving process method for mass meters with mass output (LFLOW_TYPE=IM Pulse input) used in the AuditFlow is the Inferred Mass Proving, according to the API-5.6 standard, item 9.1.7.2.

If it is mass meter with volume output, the proving process will be executed as volume meter.

$$MF = \frac{\text{Prover Mass}}{\text{IMm}} = \frac{BPV * CTSp * CPSp * \text{Dens f,p}}{Ni / NKFm}$$

Where:
BPV: prover volume at base condition
CTSp: BPV correction factor due to the temperature effect
CPSp: BPV correction factor due to the pressure effect
Dens f, p: density measured for prover at proving condition

Meter type and prover type combinations:

Operational or master meter	Prover Type	Variable compared in proving	Comments
0 = IV pulse input 1=IV*CTL pulse input	0 = tipo U, unidirectional 1 = tipo U, bi-directional 2 = Small volume prover, unidirectional 3 = Small volume prover, bi-directional 4 = Tank prover	Corrected volume in temperature and pressure	Any combination of pulse per volume meter and any prover type.
2=IM pulse input	0 = tipo U, unidirectional 1 = tipo U, bi-directional 2 = Small volume prover, unidirectional	Mass	Pulse per mass meter and any prover type.

Operational or master meter	Prover Type	Variable compared in proving	Comments
	3 = Small volume prover, bi-directional 4 = Tank prover		

Proving configuration

Stability check at the beginning of the proving process– STABILITY_TIME parameter
The input stability analysis is performed by the time configured in this parameter, before starting the first proving run.

Criteria to be used – RUN_CRITERIA parameter
The parameter RUN_CRITERIA defines the rules to be used for the repeatability calculation, whose options are:

- any 5 of 6 consecutive: six proving runs must be processed in sequence and select the better five (any, they are not in sequence) and using these, the repeatability is calculated. The selection of the better five consists of ignoring the proving run which obtained result for IMF is the most far from the arithmetic average of the six IMF's.
- 5 consecutive of 10 consecutive: after processing ten proving runs in sequence, select any 5 proving runs, in sequence, which the repeatability was attended.
- 3 sets of 5: for each group of 5 consecutive runs, it calculates the average of the weighted averages, IMF (if it was "Average MF" method) and the number of interpolated pulses. The repeatability is calculated related to these three averages.
- 5 consecutive: it processes 5 proving runs in sequence and the repeatability of them.
- 3 consecutive: it processes 3 proving runs in sequence and the repeatability of them.
- 2 consecutive: it processes 2 proving runs in sequence and the repeatability of them.

Required repeatability - REQ_REPEATABILITY parameter
The repeatability calculated is compared with the maximum value allowed that is configured in REQ_REPEATABILITY. The repeatability is calculated following the formula:

"Average MF" Method:

$$\text{Repeatability (\%)} = \frac{\text{max IMF} - \text{min IMF}}{\text{Min IMF}}$$

"Average Data" Method:

$$\text{Repeatability (\%)} = \frac{\text{max Ni} - \text{min Ni}}{\text{Mmin Ni}}$$

The maximum and minimum values are determined between the proving runs selected after the application of the RUN_CRITERIA parameter.

Maximum percent variation of the obtained meter factor – ALLOWED_DEV_MF parameter
When the repeatability is attended, the percent variation of the meter factor comparing to the actual value is calculated. If the percent variation calculated is higher than the specified in the ALLOWED_DEV_MF parameter, it is treated as a failed proving.
Setting the value of the ALLOWED_DEV_MF parameter as zero, it means to disable this check.

Acknowledgement by user before utilizing the new meter factor – REQ_ACK and PROVING_RUN_TIMEOUT parameters

When all rules for proving are attended, the meter factor (MF) obtained will be automatically acknowledged if the parameter REQ_ACK = Use new MF, otherwise (REQ_ACK = Ack to new MF) it waits for the user acknowledgement in order to accept the new meter factor.

The PROVING_RUN_TIMEOUT parameter specifies the maximum time after finishing proving calculation and the user acknowledgement. If it does not happen, the PROVING_STATE parameter goes to "Acknowledgment timeout"; it means that the whole proving process is discarded.

The user acknowledges the new meter factor by writing into PROVING_STATE = Using new MF (Wr). The PROVING_RUN_TIMEOUT parameter specifies the maximum time between the end of a proving run and the start of the next one, when the proving is accomplished by user interaction.

When using the new meter factor – APPLY_RETROACTIVELY parameter
The parameter allows defining two ways to use the new meter factor:

- "No": the totalizations continue using the previous meter factor and start to use the new MF only for new accounting periods.
- "Yes": the totalizations start to use the new meter factor, the new meter factor is applied to the totalizer of current period (hour, day, week and month).

Calculations executed during the proving

During the proving run are executed the following calculations:

- Measurement of the times T1 and T2 corresponding to each proving run.
- Counting of the interpolated pulses of the meter.
- Weighted average calculations for the associated variables to the meter (operational or master meter) and to the prover.
- Status evaluation for the correspondent proving run (PROVING_RUNxx_STATUS).

At the end of each proving run are executed the following operations:

- Correction factor calculations (CTLm and CPLm) associated to the meter.
- Correction factor calculations (CTSp, CPSp, CTLp and CPLp) associated to the prover.
- Calculations of the Gross standard volume of prover (GSVp) and the Indicated Standard volume at base conditions (ISVm).
- Calculations of the Intermediate Meter Factor (IMF), if the method is "Average MF".

After finishing all required proving runs, according to the selected criteria, it proceeds:

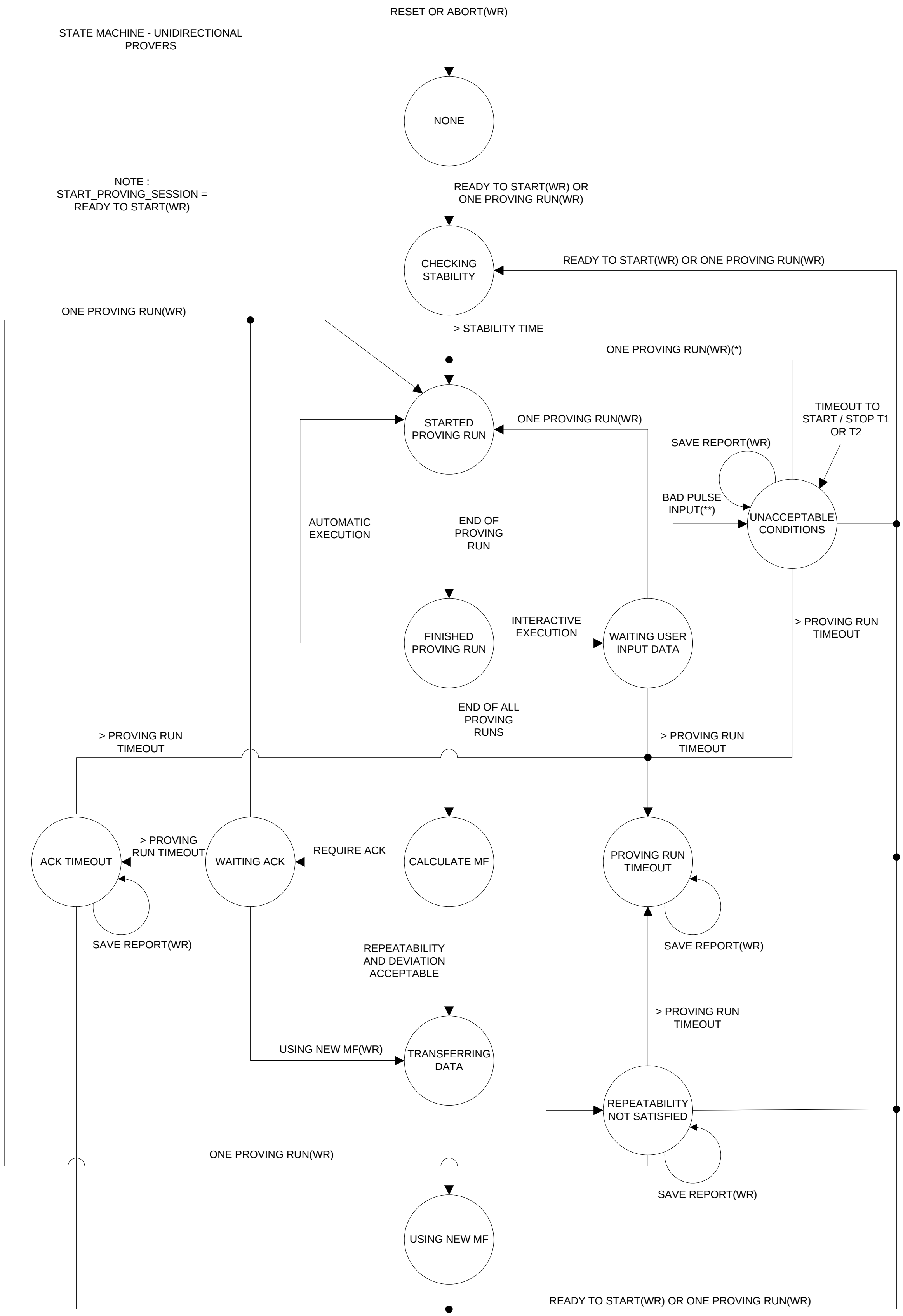
- the MF calculation using the average of the weighted averages and the interpolated pulses, if the selected method is "Average Data".
- Application of the selected criteria.
- Repeatability calculation.
- Calculation of the parameters MF, CMF, MA, KF and CKF.
- Repeatability and percent variation of the meter factor.
- When the specifications are attended and the user acknowledges (if necessary), the transfering of the new meter factor to the block LKD.MF_METER_PRODUCT occurs.
- The proving report generation is automatic when transferring the new MF to the LKD block. The user can request the report generation even when a failure occurs by writing PROVING_STATE = Save report of failed proving (Wr).
- If a failure occurs during the proving, the reason is showed in PROV_FAIL_CAUSE parameter and the state in PROVING_STATE parameter can be one of the following options:
  - Repeatability not satisfied – repeatability not attended.
  - Acknowledgement timeout – user did not acknowledge the new meter factor in the specified time.
  - Unacceptable conditions – problems with the pulse reading or in the pulse module.
  - Proving run timeout – the time between proving runs exceeded the PROVING_RUN_TIMEOUT parameter.

Proving process operation
There are two possible ways for the proving execution:

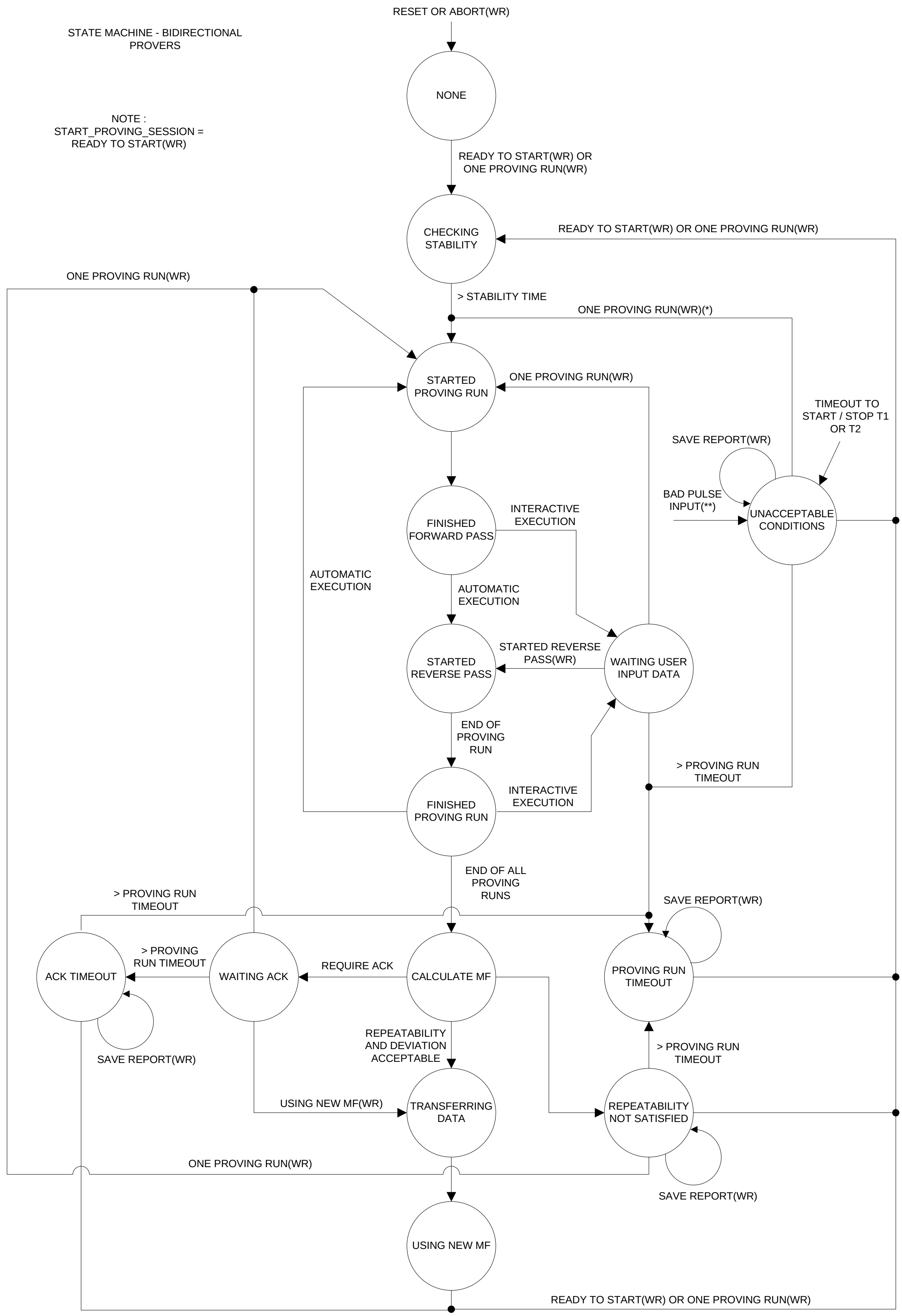
- Automatic and sequential execution of the proving runs: all the proving runs are executed in sequence up to the required number in order to attend the selected criteria (RUN_CRITERIA parameter).

- Interactive execution under user request for each proving run writingPROVINVG_STATE = One proving run: since the first proving run or after a failure, even when it occurred during an automatic and sequential execution of the proving runs.

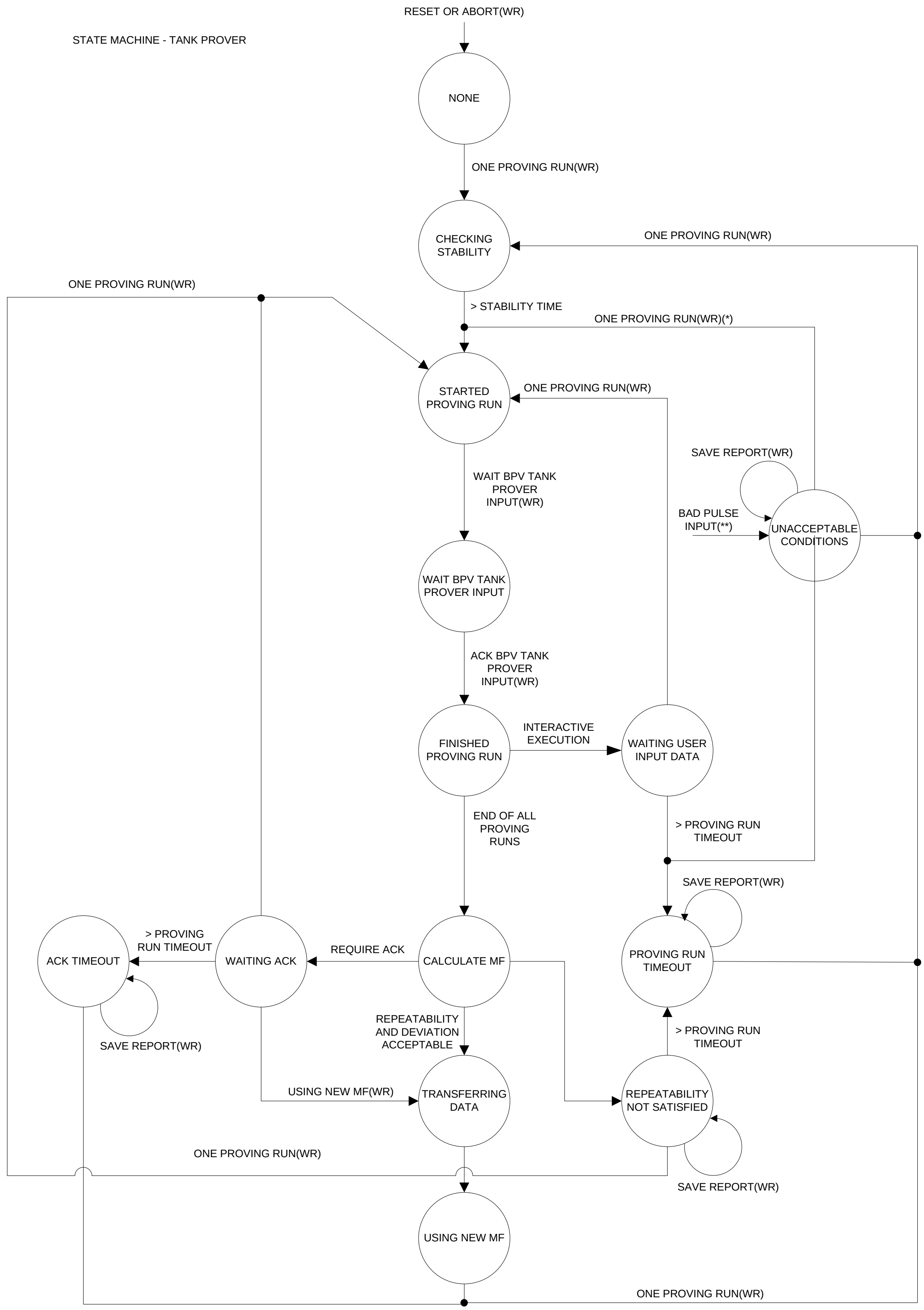
State Machine for Small Volume Prover and U type unidirectional



State Machine for U type bidirectional prover



State Machine for tank prover



Diagnosis and Troubleshooting

1. BLOCK_ERR.Block configuration: this indication can occur due to the following problems:
   - Configuration of the meter submitted to the proving: LKD.METERx_INFO.NKF or LKD.MASTER_METER_INFO.NKF equals to zero.
   - Prover configuration LKD.PROVERx_INFO (where, x = [1...4]) is not correct.
   - Product type is “Water”.
   - Signal type of meter different from “IV Pulse input” and “CTL*IV Pulse input” and “IM Pulse input”.
   - Operational meter proving: CHANNEL parameter is not configured correctly.
   - Master meter proving: parameter CHANNEL_MM is not configured correctly.
   - If the prover type is “Tank Prover” and the calculation method of the meter factor is different from “Average MF” type.
   - Inconsistence in the linearization curve of the meter, if this option is selected.
   - There is no operational meter associated to STRATEGY parameter.
   - Using a pulse input module different from DF77.
   - The meter submitted to the proving is different from “IV Pulse input” for allocation measurement.
   - Tank Prover option is selected and the product is “Light hydrocarbon” or “Emulsion light hydrocarbon and water”.

2. BLOCK_ERR. Input failure: this indication can occur due to the following problems:
   It is impossible to read the pulses from the addressed module of the operational meter (LCT. CHANNEL, LBT.CHANNEL) or master meter (LMF.CHANNEL_MM).

3. BLOCK_ERR. Out of Service: block LMF can continue in Out of service mode, although the target mode is Auto, due to the following reasons:
- If the parameter STRATEGY is zero, that is, master meter proving and parameter CHANNEL_MM is zero.
- If the parameter STRATEGY is different from zero, that is, operational meter proving and there is no block LBT/LCT for the run number.
- Resource block is in O/S.
- If there is any indication of BLOCK_ERR.Block configuration.

4. If a failure occurs in the proving due to repeatability not satisfied (PROVING_STATE = Repeatability not satisfied), check the following items:
- The obtained repeatability compared to the required (REQ_REPEATABILITY).
- Large change on the interpolated pulses between the proving runs.
- Instability of the variables of meter submitted to the proving (temperature, pressure and density).

5. If a failure occurs in unacceptable conditions (PROVING_STATE = Unacceptable conditions):
- Pulse reading failure: module with problem or pulse transmission from the meter to the module.
- Check if the variables (density and temperature) of the operational meter or master meter are in the calculation ranges of the correction factors. Refer to the tables on the LKD block.
- Percent variation of the meter factor higher than the specified in the parameter ALLOWED_DEV_MF.
- Meter factor is out of the range from 0.8 to 1.2.

6. Write of configuration parameter fails: The writing is allowed in these parameters only if it is not executing a proving.

7. Interpretation of the PROV_FAIL_CAUSE interpretation:
   a. Abnormal proving :

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3 (A2) (CL)	4	STRATEGY	Unsigned16	0 to 4	0	None	S	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A2) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	I,1,3	TEMPERATURE_PROVER	DS-65			T	N	Temperature of the prover product that is used for the calculations of the CTSp and CTLp factors.
8	I,1,3	PRESSURE_PROVER	DS-65			P	N	Pressure in the prover that is used for the calculations of the CPSp and CPLp factors.
9	I,1,3	DENSITY_PROVER	DS-65			LD	N	Density of the prover product that is used for calculating the CPLp and CTLp factors.
10 (A2)	I,1,3	TEMPERATURE_MM	DS-65			T	N	Temperature of the product in master meter.
11 (A2)	I,1,3	PRESSURE_MM	DS-65			P	N	Master meter pressure.
12 (A2)	I,1,3	DENSITY_MM	DS-65			LD	N	Master meter liquid density.
13	I,1,3	TEMP_EXTERNAL_SHAFT	DS-65			T	N	External shaft temperature that has the detectors of beginning and ending of the calibrated section.
14	I,1,3	START_PROVING	DS-66				N/RO	When this input is TRUE, it will force an automatic proving.
15	I,1,3	ENABLE_PROVING	DS-66				N /RO	This input must be TRUE during the whole proving. It will be ignored if it was not connected.
16	O,1,3	PROVING_DONE	DS-66				N / RO	Proving successful and using the new MF. This output will be TRUE by one macrocycle.
17 (A2) (CL)		CHANNEL_MM	Unsigned16		0	Na	S / O/S	The channel number of the logic hardware for the pulse input module of the master meter.
18 (A2) (CL)	4	PROVER_SELECTION	Unsigned8	1-4 = Prover 1-4	1	E	S	Prover selection between 4 configured in the LKD block. It is allowed to write since a proving is not occurring.
19 (A2) (CL)	4	PRODUCT_SELECTION	Unsigned8	1-10 = Product 1-10	1	E	S	Product selection between 10 products configured in the LKD block. It is allowed to write since a proving is not occurring. It is necessary to configure this parameter only if it is executing a master meter proving.
20 (A2) (CL)	4	METER_FACTOR_METHOD	Unsigned8	0 = Average MF 1 = Average data	0	E	S	Method used for MF calculation. It is allowed to write since a proving is not occurring.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
21 (CL)	4	STABILITY_TIME	Unsigned16	0 to 65535	60	Sec	S	Minimum time desired of stable temperature, pressure and density to start the proving. It is allowed to write since a proving is not occurring.
22 (A2) (CL)	4	RUN_CRITERIA	Unsigned8	0=any 5 of 6 consecutive 1= 5 consecutive of 10 consecutive 2=3 sets of 5 3=5 consecutive 4=3 consecutive 5=2 consecutives	0	E	S	Rule used for analyze the repeatability. It is allowed to write since a proving is not occurring.
23 (A2) (CL)	4	REQ_ACK	Unsigned8	0=Use new MF 1=Ack to new MF	0	E	S	MF calculated recently and that attends the repeatability, it can be used immediately or need the user acknowledgement. It is allowed to write since a proving is not occurring.
24 (A2) (CL)	4	APPLY_RETROACTIVELY	Unsigned8	0=No 1=Yes	0	E	S	This parameter allows to the user applies the new MF retroactively to the actual totalizations. It is allowed to write since a proving is not occurring.
25 (A2) (CL)	4	REQ_REPEATABILITY	Float	0.01 to 2.00	0.05	%	S	Needed repeatability of the proving to be acknowledged. Applied to the parameter IMF or N_INTERPOLATED according to the selected method.
26 (A2) (CL)	4	ALLOWED_DEV_MF	Float	0.0=No restriction > 0.0	0.0	%	S	It defines the maximum deviation allowed for the MF when comparing with the actual value.
27 (A2) (CL)	4	PROVING_RUN_TIMEOUT	Unsigned8	0=disabled 1 to 255	5	Min	S	Maximum interval between proving runs when executing proving automatically. Maximum time to acknowledge the new MF.
28		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Report counter for the report type and number of measured flow.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
29 (A2)	1	PROVING_STATE	Unsigned8	0=None 1=Ready to start(Wr) -> Not applicable for tank prover 2=Checking stability 3=Started proving run 4=Finished proving run 5=Waiting user input data 6=Calculate MF 7=Repeatability accepted and waiting acknowledgement 8=Transferring data 9=Using new MF(Wr) 10=Repeatability not satisfied 11=Acknowledgment timeout 12=Unacceptable conditions 13=Save report of failed proving(Wr) 14=Abort(Wr) 15=One proving run(Wr) 16=Proving run timeout 17=Finished forward pass 18=Started reverse pass 19 = Waiting BPV tank prover input(Wr) 20 = Ack BPV tank prover input(Wr)	0	E	D	This parameter indicates the proving state: When the state is "Waiting user input data", it means some data provided by user must be used to calculate the MF. If REQ_ACK was configured to "Ack to newMF" and the state is "Repeatability accepted and waiting acknowledgement", the operator must write "Using new MF" to start to use the new MF. This acknowledgment must occur before timeout. When the repeatability is not satisfied, the user has the option to execute a new proving run and ignore the last. The option "One proving run" can also be used to execute the proving interactively.
30	1	PROVING_RUN	Unsigned8		0	Na	D / RO	It shows the number of the actual proving run. For unidirectional provers, it indicates one pass. For bidirectional provers, it indicates one complete turn (starting and return).
31 (A2)		BPV_TANK_PROVER	Float[21]	> 0.0	0.0	LV	D	This parameter is used only when the selected prover is Tank Prover. The user must calculate the difference between the reading for the upper scale (Sru - volume before the run) and lower scale (Srl - volume at end of the run) and must be written when PROVING_STATE is "Waiting user input data".
32		LIQ_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events occurred.
33		T1	Float[20]			Sec	N / RO	T1 corresponds to each run.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
34		T2	Float[20]			Sec	N / RO	T2 corresponds to each run (time between detectors).
35		NM	Float[20]				N / RO	Integer number of pulses correspondent to each run.
36		N_INTERPOLATED	Float[21]	> 0.0	0.0		D / RO	Number of interpolated pulses correspondent to each run.
37		AVERAGE_FREQ	Float[20]				N / RO	Average frequency corresponding to each run.
38		TWA_PROVER	Float[21]		0.0	T	D / RO	Liquid weighted average temperature in the prover correspondent to each run.
39		PWA_PROVER	Float[21]	> 0.0	0.0	P	D / RO	Liquid weighted average pressure in the prover correspondent to each run.
40		DWA_PROVER	Float[21]	> 0.0	0.0	LD	D / RO	Liquid weighted average density in the prover correspondent to each run.
41		TWA_EXTERNAL_SHAFT	Float[21]		0.0	T	D / RO	Shaft weighted average temperature where the detectors are correspondent to each run.
42		TWA_METER	Float[21]		0.0	T	D / RO	Liquid weighted average temperature in the meter correspondent to each run.
43		PWA_METER	Float[21]	> 0.0	0.0	P	D / RO	Liquid weighted average pressure in the meter correspondent to each run.
44		DWA_METER	Float[21]	> 0.0	0.0	LD	D / RO	Liquid weighted average density in the meter correspondent to each run.
45		CTSP	Float[21]	> 0.0	0.00000		D / RO	Temperature effect correction in the prover steel. When selecting “average data” parameter, only the last element from the array is used.
46		CPSP	Float[21]	> 0.0	0.00000		D / RO	Pressure effect correction in the prover steel. When selecting “average data” parameter, only the last element from array is used.
47		CTLP	Float[21]	> 0.0	0.00000		D / RO	Temperature effect correction in liquid hydrocarbon for prover in proving conditions. When selecting “average data” parameter, only the last element from the array is used.
48		CPLP	Float[21]	> 0.0	0.00000		D / RO	Liquid compressibility correction in hydrocarbon for prover in proving conditions. When selecting “average data” parameter, only the last element from array is used.
49		GSVP	Float[21]	> 0.0	0.0	V	D / RO	Prover gross volume in the correspondent measurement. When selecting “average data” parameter, only the last element from array is used. It indicates the mass in prover if mass meter.
50		NKF_METER	Float[21]	> 0.0	0.0	QV	D / RO	NKF of meter for each proving run when it is linearization related to the frequency. When the “average data” option is selected, the last element of the matrix is the average.
51		IVM	Float[21]	> 0.0	0.0		D / RO	Volume showed in the meter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
52		CTLM	Float[21]	> 0.0	0.00000		D / RO	Temperature effect correction in liquid for the prover in proving conditions. When selecting “average data” parameter, only the last element from array is used.
53		CPLM	Float[21]	> 0.0	0.00000		D / RO	Correction factor due to compressibility in liquid for the meter in proving conditions. When selecting “average data” parameter, only the last element from array is used.
54	1	ISVM	Float[21]	> 0.0	0.0	V	D / RO	Standard volume for net proving operations. When selecting “average data” parameter, only the last element from array is used.
55		IMF	Float[21]	> 0.0	0.0		D / RO	Intermediate MF correspondent to each proving run, when the METER_FACTOR_METHOD parameter was “average MF”.
56	1	MF	Float	0.8 to 1.2	1.0		D / RO	Meter factor. If the calculated MF is acknowledged, the proving basic information will be stored in the LKD block.
57		CMF	Float	> 0.0	0.0		D / RO	Composed meter factor (MF * CPL)
58		MA	Float	> 0.0	0.0		D / RO	Meter accuracy (1 / MF).
59		KF	Float	> 0.0	0.0	K	D / RO	K factor calculated, given in pulses by volume unit or mass (NKF/MF).
60		CKF	Float	> 0.0	0.0	K	D / RO	K factor composed, given in pulses by volume unit or mass (KF/CPL).
61	1	REPEATABILITY	Float		0.0	%	D / RO	Repeatability of the proving session.
62		PROV_FAIL_CAUSE	Unsigned32	0= OK 1= bad flow sensor 2 = repeatability not achieved 3 = out-of-range correction factor 4=too large variation of MF 5= abnormal proving 6=proving run timeout 7= T2 start timeout 8= T1 start timeout 9= T2 stop timeout 10= T1 stop timeout 11= invalid pulse input selected 12= pulse input error	0	E	D / RO	Proving failure reasons.
63		PROVING_RUN1_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 1. See WARN description.
64		PROVING_RUN2_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 2. See WARN description.
65		PROVING_RUN3_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 3. See WARN description.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
66		PROVING_RUN4 _STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 4. See WARN description.
67		PROVING_RUN5 _STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 5. See WARN description.
68		PROVING_RUN6 _STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 6. See WARN description.
69		PROVING_RUN7 _STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 7. See WARN description.
70		PROVING_RUN8 _STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 8. See WARN description.
71		PROVING_RUN9 _STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 9. See WARN description.
72		PROVING_RUN1 0_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 10. See WARN description.
73		PROVING_RUN1 1_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 11. See WARN description.
74		PROVING_RUN1 2_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 12. See WARN description.
75		PROVING_RUN1 3_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 13. See WARN description.
76		PROVING_RUN1 4_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 14. See WARN description.
77		PROVING_RUN1 5_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 15. See WARN description.
78		PROVING_RUN1 6_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 16. See WARN description.
79		PROVING_RUN1 7_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 17. See WARN description.
80		PROVING_RUN1 8_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 18. See WARN description.
81		PROVING_RUN1 9_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 19. See WARN description.
82		PROVING_RUN2 0_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 20. See WARN description.
83		PROVING_RUN2 1_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of the proving run 21. See WARN description.
84		UPDATE_EVT	DS-73			Na	D	The alert associated to this parameter is generated by any change in static data.
85		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
86		CTL_W_P	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Temperature effect correction factor in water volume for prover/master meter. It is calculated based on the water base density which must be configured on PRODUCTxINFO parameter.

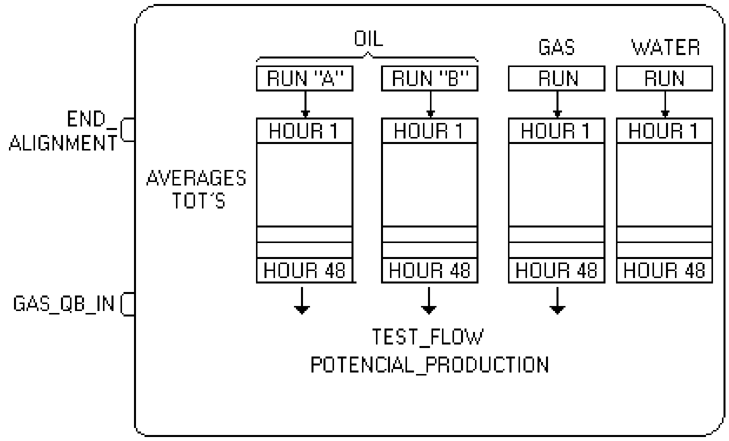
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
87		CTL_W_M	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Temperature effect correction factor in water volume for meter. It is calculated based on water base density which must be configured on PRODUCTxINFO parameter.
88	I	SW_MM	DS-65			%	N	BSW for the emulsion used in master meter proving. It is used only if the product is emulsion (allocation measurement).
89		CPL_W_P	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in volume of water for prover/master, which is calculated using the medium pressure for each proving run.
90		CPL_W_M	Float[21]	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in volume of water for meter, which is calculated using the medium pressure for each proving run.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

WT – Well Test

Schematic



Description
This block is used in the well test and it is executed in parallel to custody transfer or allocation measurement. The purpose is the evaluation of a well production by calculating the well test flow rate, potential of production and RGO (gas/oil ratio) for allocation of production to the wells in shared measurement system.

Through this block, the well test begins and ends, so it generates a well test report, whose final results are the well test flow rates corresponding to oil, gas and water.

If the duration of the well test is longer than 48 hours, only the last 48 hours will be registered and considered in the test flow rate calculations.

Identification for the run number – STRATEGY parameter
This block always refers to many measurements; and its default value is 255, meaning “Not specific”, and it is a read only parameter.

Block input
The block input is used according to the configuration, as showed below:

Input	Link necessity	Description
END_ALIGNMENT	Depends on the application	This input can inform that the well alignment process was concluded.

There are two ways to indicate the ending for the well alignment:

- Through the END_ALIGNMENT input or
- The user provides the date/time in the ALIGN_DATE_TIME parameter.

Field and well identifications
The field and well identifications are accomplished through the FIELD_NAME and WELL_ID parameters, these parameters are also used in the well test report generation.

Runs associated to the well test
OIL_STATION_EQUATION parameter: this block is prepared for up to two oil/emulsion measurements, the sum of runs associated to the well must be written in this parameter. Or simply, the run number.

The equation that defines the operation to be accomplished between the runs must obey the following rules:

- Allowed operations: sum (+) and subtract (-).
- Only one operation is allowed.
- If the first character is blank, no operation will be accomplished.

- The writing in the STATION_EQUATION parameter will be checked about consistency.
- Blank equation means disabled crude oil/light hydrocarbon/emulsion measurement in the well test.
  - Run number of liquid measurement.
  - The block used in the measurement must be the LCT;
  - The measured product in each run is a combination of:
    - Crude oil and/or emulsion of crude oil and water.
    - Light hydrocarbon and/or emulsion of light hydrocarbon and water.

- During the block execution also will be checked the equation consistency, and any problem will be indicated in BLOCK_ERR.Block Configuration Error;
- Example:
  - 1+2
  - 3 -1
  - 1+1

GAS_RUN_NUMBER parameter: indicates the run number of gas measurement. If this parameter has value 0, the gas measurement will be ignored in the well test.

WATER_RUN_NUMBER parameter: indicates the run number of water measurement. If this parameter has value 0, the water measurement will be ignored in the well test.

Open and close date/time of the well test

The date/time indication of the start and end of the well test is through the OPEN_DATE_TIME and CLOSE_DATE_TIME parameters. The NUM_HOURS parameter shows the duration in number of hours.

Crude oil/light hydrocarbon/emulsion measurement

The first oil/emulsion measurement indicated in the OIL_STATION_EQUATION parameter (the first number from left to right) will be processed and indicated in this block as OIL1. If there is the second oil/emulsion measurement, this will be indicated as OIL2.
For each one of the oil/emulsion measurement, the following calculations are accomplished:

- Temperature, pressure, density and BSW: instantaneous values when openning and closing the well test, weighted averages for each hour.
- If it is appropriation measurement (emulsion), so the corresponding shrinkage factor will be applied, set in the measurement block (LCT/LBT);
- Hourly totalizersof the indicated volume, gross standard volume and net standard volume.

At the end of well test, there are the totalizers in gross corrected volume (GSV) and net corrected volume (NSV) correspondent to the equation described in OIL_STATION_EQUATION parameter; it is the sum of the hourly totalizers for each stream and then the sum with the other stream, if it is the case.

During the well test is accomplished a status processing, as indicated below:
- LIQ_WARN parameter: status during the usual conditions evaluation, that is, indicates if any problem occurred in any moment during the usual conditions evaluation.
- LIQ_CURRENT_WARN parameter: current status of the crude oil measurements.
- LIQ_TEST_WARN parameter: status during the well test, it does not consider the phases of the well alignment, warm up period, usual conditions evaluation period.

This status word provides the following information:
- Override temperature meter;
- Override pressure meter;
- Override density meter;
- Bad temperature master meter;
- Bad pressure master meter;
- Bad density master meter;
- Unstable temperature meter;
- Unstable pressure meter;
- Unstable density meter;
- Unstable temperature master meter;
- Unstable pressure master meter;
- Unstable density master meter;
- Unstable SW;
- Unstable volume flow at base.

The standards applied to the crude oil measurement calculation are indicated in LIQ_SPEC_1 and LIQ_SPEC_2 parameters.

Gas measurement
For the gas measurement produced, the following calculations are accomplished:

- Temperature and absolute static pressure: instantaneous values at the beginning and ending of the well test, weighted averages for each hour.
- Hourly totalizers of the volume flow rate at flowing conditions (Qv), volume flow rate at base conditions (Qb) and mass flow rate (Qm).

At the end of the well test, there are volume totalizers at flowing conditions (TOT_QV) and at base conditions (TOT_QB), and also mass totalization (TOT_QM) correspondent to the measured flow indicated in GAS_RUN_NUMBER parameter; they are the sum of the hourly totalizers during the well test.
During the well test, a status processing is accomplished, as indicated below:

- GAS_WARN parameter: status during the usual conditions evaluation, that is, indicates if any problem occurred in any moment during the usual condition evaluation.
- GAS_CURRENT_WARN parameter: current status of the gas measurement.
- GAS_TEST_WARN parameter: status during the well test, it does not consider the well test alignment, warm up period, usual conditions evaluation phases.

The information contained in these status words are:

- Override temperature meter;
- Override pressure meter;
- Unstable temperature meter;
- Unstable pressure meter;
- Unstable volume flow at base;
- Bad GAS_QB_IN.

The gas composition produced used for the calculations is indicated in the GAS_PRODUCT parameter. The standards applied to the gas measurement are indicated in GAS_SPEC_1 parameter.

This block also offers the option to execute the operation with another gas measurement (before calculating the RGO, well test flow rate and potential of production) in the following situations:
  - GAS_OPERATION=None: this option is used when there is no necessity of subtracting or adding another gas flow;
  - GAS_OPERATION= Subtract GAS_QB_IN: the injected gas is subtracted from the produced gas,, calculating the net produced gas;
  - GAS_OPERATION= Add GAS_QB_IN: if another gas measurement is required due to the rangeability, it is possible to execute the sum with the volume flow rate at base condition indicated in GAS_QB_IN input.

The hourly totalizers of gas, after the operation indicated in GAS_OPERATION parameter, are showed in NET_QB_HOUR1 and NET_QB_HOUR2 parameters, as well as the total during the test (NET_TOT_QB). These values can be negative, when the “Subtract GAS_QB_IN” option is selected, so they indicate that the injected volume of gas is higher than the produced.

Water measurement
For water measurement, the hourly totalizers of the volume flow rate at base conditions are corrected in temperature and pressure

At the end of the well test, there is the totalizer in volume at base condition (WATER_GSV) correspondent to the measured flow indicated in WATER_RUN_NUMBER parameter; it is the sum of the hourly totalizers during the well test, added the water of the emulsion.
During the well test a status processing is accomplished, as showed below:

- WATER_WARN parameter: status during the usual conditions evaluation, that is, indicates if any problem occurred in any moment during the usual conditions evaluation.
- WATER_CURRENT_WARN parameter: current status of the water measurement.
- WATER_TEST_WARN parameter: status during the well test, it does not consider the phases of well alignment, warm up period, usual conditions evaluation period.

The information contained in these status words are:

- Override temperature meter;
- Override pressure meter;
- Override density meter;
- Unstable temperature meter;
- Unstable pressure meter;
- Unstable density meter;
- Unstable volume flow at base.

Duration the well test phases
The WELL_TEST_TIME parameter indicates the current phase of the well test:

- When WELL_STATE = Waiting start of usual conditions: indicates the warm up period, that is, after the well alignment and before the usual conditions evaluation.
- When WELL_STATE = Evaluating usual conditions: indicates the usual conditions evaluation period, that is, after the warm up and before the well test.
- When WELL_STATE = Calculating: indicates the well test period, that is, after the usual conditions evaluation.

The time computed during the "Calculating" phase, the duration of the well test, is used in the crude oil, gas and water test flow rate calculation.

Final results
The final results of well are:

- OIL_TEST_FLOW parameter: It is the net standard volume flow rate at base conditions (per hour), corresponds to the oil totalizer (NSV parameter) dividedby the well test duration in hours.
- GAS_ TEST_FLOW parameter: It is the standard volume flow rate at base conditions (per hour), it corresponds to the gas totalizer (NET_TOT_QB parameter) divided by the well test duration in hours.
- WATER_ TEST_FLOW parameter: It is the volume flow rate at base condition (per hour), it corresponds to the water totalizer (WATER_GSV parameter) divided by the well test duration in hours.

Other calculated variables are:

- OIL_POTENTIAL_PRODUCTION: It is the net standard volume flow rate at base conditions per day.
- GAS_POTENTIAL_PRODUCTION: It is the standard volume flow rate at base condition per day.
- RGO: It is the ratio between the gas volume at base conditions and the oil volume at base conditions during the test; it corresponds to the division of the TOT_QB parameter by NSV.

OILx_FACTOR1

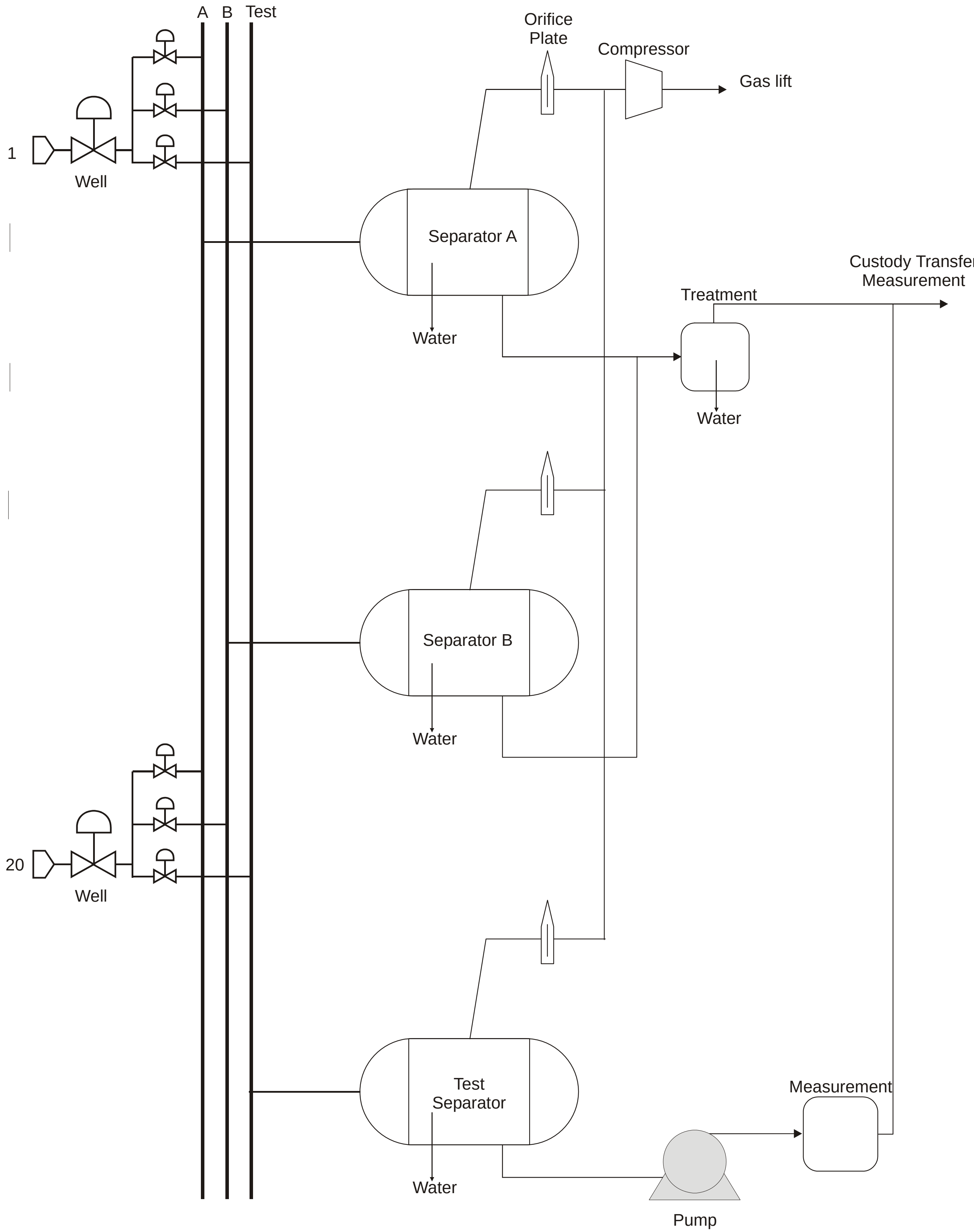
#	Symbol	Description	Discrimination
1	Twa	Temperature weighted average of the test	SI-DD25 US-DD1
2	Pwa	Pressure weighted average of the test	SI-DD10 US-DD10 Bar-DD1
3	Dwa	Density weighted average of the test	SI-DD1 US-DD1 SG-DD4
4	SWwa	BSW weighted average of the test	DD3
5	Visc	Viscosity	-
6	Db	Base density of the hydrocarbon	SI-DD1 US-DD1 SG-DD4
7	CTL	Temperature correction factor of the hydrocarbon	DD4
8	CPL	Pressure correction factor of the hydrocarbon	DD4

9	MF	Meter calibration factor	DD4
10	SF	Shrinking factor	DD4
11	Dbw	Water base density	SI-DD1 US-DD1 SG-DD4
12	CTLw	Water temperature correction factor	DD4
13	CPLw	Water pressure correction factor	DD4
14	IV	Gross volume accumulated during the test	SI-DD3 US-DD2 Liter-DD10 Gallon-DD2
15	GSV	Gross volume in base condition accumulated during the test	SI-DD3 US-DD2 Liter-DD10 Gallon-DD2
16	NSV	Net volume in base condition accumulated during the test	SI-DD3 US-DD2 Liter-DD10 Gallon-DD2
17	SWV	Corrected water volume	SI-DD3 US-DD2 Liter-DD10 Gallon-DD2

Block application

The below example shows a typical application of this block with the following features:

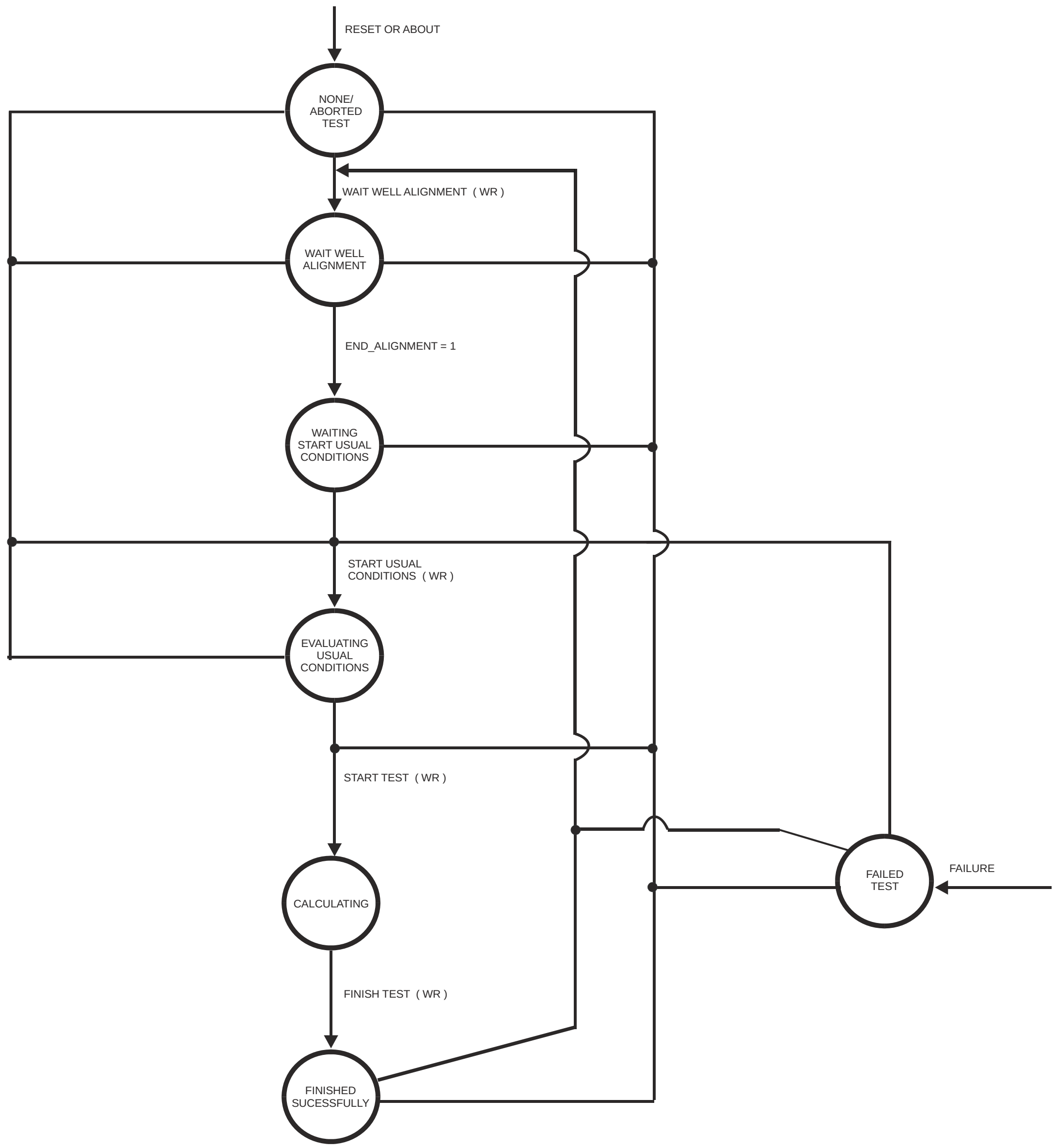
- Shared measurement: measurement system measuring oil/gas of different wells.
- Well test flow rate used as factor to allocate the production in shared measurement.
- Two production separators (A and B): it separates the water, oil and gas of the production (mixed of many wells).
- Test separator: It separates the water, oil and gas of the well which is aligned to the well test.



Operation during the Well Test

The well test state diagram shows the following features:

- The well test process is composed of the following sequential phases: well alignment, warm up, usual condition evaluation and well test.
- the beginning of the well test phase can occur at any moment, except if a well test isalready executing.
- The test begins when writing in the TEST_STATE parameter:
  - Start Test(Wr) : the beginning of hourly variables occurs at the beginning of each hour of the real time clock (RTC) ;
  - Start Test 60 minutes (Wr) : the hourly variables are related to the 60 minutes in sequence, therefore except for the last hour, the others have 60 minutes of duration.



Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration: this indication occurs when there are the following problems:

- A run number indicated in OIL_STATION_EQUATION parameter is not associated to the crude oil/light hydrocarbon /emulsion measurement by the LCT block.
- There is no gas measurement in the run number indicated by GAS_RUN_NUMBER parameter;
- The run number indicated in WATER_RUN_NUMBER parameter is not associated to the water measurement by the LCT block.

2. BLOCK_ERR. Out of Service: the LST block can continue in the Out of service mode, although the target mode is Auto because the Resource block is in O/S.

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	I	END_ALIGNMENT	DS-66				N	When it is TRUE, this input indicates the alignment ending for the well to be tested.
8 (CL)	2	FIELD_NAME	Visiblestring[32]		Blank		S	String to identify the field well. It is used in report generation.
9 (CL)	2	WELL_ID	Visiblestring[32]		Blank		S	String to identify the well that will be tested. It will be used in report generation.
10 (A2) (CL)		OIL_STATION_EQUATION	Visiblestring[16]		Blank		S	Liquid station equation. When it is initialized by a blank character, it will not accomplish any operation. It supports an equation with up to two flow measurements. The writing is allowed in this parameter since the well test is not in operation.
11 (A2) (CL)		GAS_RUN_NUMBER	Unsigned16	0 to 4	0	Na	S	Number of the gas flow. If it was zero, the gas measurement will be ignored in this well test. The writing is allowed since the well test is not in operation.
12 (A2) (CL)		WATER_RUN_NUMBER	Unsigned16	0 to 4	0	Na	S	Number of the water flow. I was zero; the water measurement will be ignored in this well test. The writing is allowed since the well test is not in operation.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
13		TEST_STATE	Unsigned8	0=none 1=Wait well alignment (Wr) 2=Waiting start of usual conditions 3=Start usual conditions (Wr) 4=Evaluating usual conditions 5=Start test (Wr) 6=Calculating 7=Finish test (Wr) 8=Finished successfully 9=Abort (Wr) 10=Aborted test 11=Failed test 12=Start test 60minutes (Wr)	0	E	D	This parameter is used to start and abort the well test, and also to indicate the test state or failure.
14		ALIGN_DATE_TIME	Date				N	Date/hour of the alignment for the well in test.
15		OPEN_DATE_TIME	Date				N / RO	Date/hour of the beginning of the actual test. After the warm up period.
16		CLOSE_DATE_TIME	Date				N / RO	Date/hour of the ending of the actual test.
17		NUM_HOURS	Unsigned16		0	Na	N / RO	Number of hourly periods of information collect.
18		LIQ_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events occurred during the usual condition evaluation.
19		LIQ_CURRENT_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events at the moment.
20		LIQ_TEST_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events occurred during the well test.
21		GAS_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events occurred during the usual condition evaluation.
22		GAS_CURRENT_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events at the moment.
23		GAS_TEST_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events occurred during the well test.
24		WATER_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events occurred during the usual condition evaluation.
25		WATER_CURRENT_ WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events at the moment.
26		WATER_TEST_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Events occurred during the well test.
27		OPEN_OIL1_TEMP	Float		0	T	N / RO	Temperature of the first oil flow at the beginning of the well test.
28		OIL1_TWA_HOUR1	Float[24]		0.0's	T	N / RO	Temperature weighted average of the first oil flow for each hour of test during the first day (the first 24 hours).
29		OIL1_TWA_HOUR25	Float[24]		0.0's	T	N / RO	Temperature weighted average of the first oil flow for each hour of test during the second day (the next 24 hours).

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
30		CLOSE_OIL1_TEMP	Float		0	T	N / RO	Temperature of the first oil flow at the end of the well test.
31		OPEN_OIL1_PRESS	Float		0	P	N / RO	Pressure of the first oil flow at the beginning of the well test.
32		OIL1_PWA_HOUR1	Float[24]		0.0's	P	N / RO	Pressure weighted average of the first oil flow for each hour of test during the first day (the first 24 hours).
33		OIL1_PWA_HOUR25	Float[24]		0.0's	P	N / RO	Pressure weighted average of the first oil flow for each hour of test during the second day (the next 24 hours).
34		CLOSE_OIL1_PRESS	Float		0	P	N / RO	Pressure of the first oil flow at the end of the well test.
35		OPEN_OIL1_DENS	Float		0	LD	N / RO	Density of the first oil flow at the beginning of the well test.
36		OIL1_DWA_HOUR1	Float[24]		0.0's	LD	N / RO	Density weighted average of the first oil flow for each hour of test during the first day (the first 24 hours).
37		OIL1_DWA_HOUR25	Float[24]		0.0's	LD	N / RO	Density weighted average of the first oil flow for each hour of test during the second day (the next 24 hours).
38		CLOSE_OIL1_DENS	Float		0	LD	N / RO	Density of the first oil flow at the ending of the well test.
39		OPEN_OIL1_SW	Float		0	%	N / RO	SW of the first oil flow at the beginning of the well test.
40		OIL1_SWWA_HOUR1	Float[24]		0.0's	%	N / RO	SW weighted average of the first oil flow for each hour of test during the first day (the first 24 hours).
41		OIL1_SWWA_HOUR25	Float[24]		0.0's	%	N / RO	SW weighted average of the first oil flow for each hour of test during the second day (the next 24 hours).
42		CLOSE_OIL1_SW	Float		0	%	N / RO	SW of the first oil flow at the ending of the well test.
43		OIL1_IV_HOUR1	Float[24]		0	TV	N / RO	IV of the first oil flow for each hour of test during the first day (the first 24 hours).
44		OIL1_IV_HOUR25	Float [24]		0	TV	N / RO	IV of the first oil flow for each hour of test during the second day (the next 24 hours).
45		OIL1_FACTOR1	Float[24]		0	TV	N / RO	Results of the oil 1 measurement.
46		OIL1_FACTOR25	Float [24]		0	TV	N / RO	Not used.
47		OIL1_NSV_HOUR1	Float[24]		0	TV	N / RO	Not used.
48		OIL1_NSV_HOUR25	Float [24]		0	TV	N / RO	Not used.
49		OPEN_OIL2_TEMP	Float		0	T	N / RO	Temperature of the second oil flow at the beginning of the well test.
50		OIL2_TWA_HOUR1	Float[24]		0.0's	T	N / RO	Temperature weighted average of the second oil flow for each hour of test during the first day (the first 24 hours).

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
51		OIL2_TWA_HOUR 25	Float[24]		0.0's	T	N / RO	Temperature weighted average of the second oil flow for each hour of test during the second day (the next 24 hours).
52		CLOSE_OIL2_TE MP	Float		0	T	N / RO	Temperature of the second oil flow at the ending of the well test.
53		OPEN_OIL2_PRE SS	Float		0	P	N / RO	Pressure of the second oil flow at the beginning of the well test.
54		OIL2_PWA_HOUR 1	Float[24]		0.0's	P	N / RO	Weighted average of the pressure of the second oil flow for each hour of test during the first day (the first 24 hours).
55		OIL2_PWA_HOUR 25	Float[24]		0.0's	P	N / RO	Pressure weighted average of the pressure of the second oil flow for each hour of test during the second day (the next 24 hours).
56		CLOSE_OIL2_ PRESS	Float		0	P	N / RO	Pressure of the second oil flow at the end of the well test.
57		OPEN_OIL2_DEN S	Float		0	LD	N / RO	Density of the second oil flow at the beginning of the well test.
58		OIL2_DWA_HOU R1	Float[24]		0.0's	LD	N / RO	Density weighted average of the density of the second oil flow for each hour of test during the first day (the first 24 hours).
59		OIL2_DWA_HOU R25	Float[24]		0.0's	LD	N / RO	Density weighted average of the density of the second oil flow for each hour of test during the second day (the next 24 hours).
60		CLOSE_OIL2_DE NS	Float		0	LD	N / RO	Density of the second oil flow at the ending of the well test.
61		OPEN_OIL2_SW	Float		0	%	N / RO	SW of the second oil flow at the beginning of the well test.
62		OIL2_SWWA_HO UR1	Float[24]		0.0's	%	N / RO	SW weighted average of the second oil flow for each hour of test during the first day (the first 24 hours).
63		OIL2_SWWA_HO UR25	Float[24]		0.0's	%	N / RO	SW weighted average of the second oil flow for each hour of test during the second day (the next 24 hours).
64		CLOSE_OIL2_SW	Float		0	%	N / RO	SW of the second oil flow at the ending of the well test.
65		OIL2_IV_HOUR1	Float [24]		0	TV	N / RO	IV of the second oil flow for each hour of test during the first day (the first 24 hours).
66		OIL2_IV_HOUR25	Float [24]		0	TV	N / RO	IV of the second oil flow for each hour of test during the second day (the next 24 hours).
67		OIL2_FACTOR1	Float [24]		0	TV	N / RO	Results of the oil 2 measurement.
68		OIL2_FACTOR25	Float [24]		0	TV	N / RO	Not used.
69		OIL2_NSV_HOUR 1	Float [24]		0	TV	N / RO	Not used.
70		OIL2_NSV_HOUR 25	Float [24]		0	TV	N / RO	Not used.
71		IV	Float			TV	N/ RO	Gross volume of this test.
72		NSV	Float			TV	N/ RO	Corrected net volume of this test.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
73		OPEN_GAS_TEMP	Float		0	T	N / RO	Gas temperature at the beginning of the well test.
74		GAS_TWA_HOUR1	Float[24]			T	N / RO	Gas temperature weighted average for each hour of test during the first day (the first 24 hours).
75		GAS_TWA_HOUR25	Float[24]			T	N / RO	Gas temperature weighted average for each hour of test during the second day (the next 24 hours).
76		CLOSE_GAS_TEMP	Float		0	T	N / RO	Gas temperature at the ending of the well test.
77		OPEN_GAS_PRESS	Float		0	P (abs)	N / RO	Gas absolute static pressure at the beginning of the well test.
78		GAS_PWA_HOUR1	Float[24]			P (abs)	N / RO	Gas absolute static pressure weighted average for each hour of test during the first day (the first 24 hours).
79		GAS_PWA_HOUR25	Float[24]			P (abs)	N / RO	Gas absolute static pressure weighted average for each hour of test.
80		CLOSE_GAS_PRESS	Float		0	P (abs)	N / RO	Gas absolute static pressure at the ending of the well test.
81		TOT_QV_HOUR1	Integer32[24]		0	TV	N / RO	Gas volume flow totalization in flowing conditions for each hour of test during the first day (the first 24 hours).
82		TOT_QV_HOUR25	Integer32[24]		0	TV	N / RO	Gas volume flow totalization in flowing conditions for each hour of test during the second day (the next 24 hours).
83		TOT_QB_HOUR1	Integer32[24]		0	TV	N / RO	Gas volume flow totalization in base conditions for each hour of test during the first day (the first 24 hours).
84		TOT_QB_HOUR25	Integer32[24]		0	TV	N / RO	Gas volume flow totalization in base conditions for each hour of test during the second day (the next 24 hours).
85		TOT_QM_HOUR1	Integer32[24]		0	TV	N / RO	Gas mass flow totalization for each hour of test during the first day (the first 24 hours).
86		TOT_QM_HOUR25	Integer32[24]		0	TV	N / RO	Gas mass volume totalization for each hour of test during the second day (the next 24 hours).
87		TOT_QV	Integer32		0	TV	N / RO	Gas volume flow totalization in flowing conditions.
88		TOT_QB	Integer32		0	TV	N / RO	Gas volume flow totalization in base conditions.
89		TOT_QM	Integer32		0	TV	N / RO	Gas mass flow totalization.
90		WATER_GSV_HOUR1	Float [24]		0	TV	N / RO	Water GSV for each hour of test during the first day (the first 24 hours), related to the flow indicated in WATER_RUN_NUMBER.
91		WATER _GSV_HOUR25	Float [24]		0	TV	N / RO	Water GSV for each hour of test during the second day (the next 24 hours), related to the flow indicated in WATER_RUN_NUMBER parameter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
92		WATER_GSV	Float			TV	N / RO	Water GSV during the test related to the flow indicated by WATER_RUN_NUMBER parameter summed to the water emulsioned to the oil.
93		WELL_TEST_TIME	Time difference				N / RO	Actual state time. When the state is "waiting start of usual conditions", this parameter indicates the warm up time. When in the state "evaluating usual conditions", this parameter indicates the usual condition evaluation. When in the state "calculating", this parameter indicates the well test time.
94		OIL_TEST_ FLOW	Float			QV	N / RO	Oil net volume flow in base condition during the well test.
95		GAS_TEST_ FLOW	Float			QV	N / RO	Gas volume flow in base condition during the well test.
96		WATER_TEST_ FLOW	Float			QV	N / RO	Water volume flow during the well test.
97		RGO	Float			Na	N / RO	Gas/oil ratio.
98		OIL_POTENTIAL_ PRODUCTION	Float		0.0	LV / day	N / RO	Oil daily production potential in liquid volume in base condition.
99		GAS_POTENTIAL _PRODUCTION	Float		0.0	GV / day	N / RO	Gas daily production potential in volume in base condition.
100		GAS_PRODUCT	Float[28]				N / RO	Information about gas (including composition, heat value, relative density).
101		VISCOSITY	Float		0.0	Visc	N / RO	Not used.
102		LIQ_SPEC_1	Bitstring[2]				N / RO	Show the standards used in the calculation.
103		LIQ_SPEC_2	Bitstring[2]				N / RO	Show the standards used in the calculation.
104		GAS_SPEC_1	Bitstring[2]				N / RO	Show the standards used in the calculation.
105		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
106		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware, connection failure or system problems in the block. The cause of the alert is entered in the subcode field. The first alert to become active will set the Active status in the Status attribute. As soon as the Unreported status is cleared by the alert reporting task, another block alert may be reported without clearing the Active status, if the subcode has changed.
107 (V4)	I	GAS_QB_IN	DS-65			QV	N / RO	Volume flow in base condition to be additioned or subtracted of the gas flow indicated in GAS_RUN_NUMBER parameter.

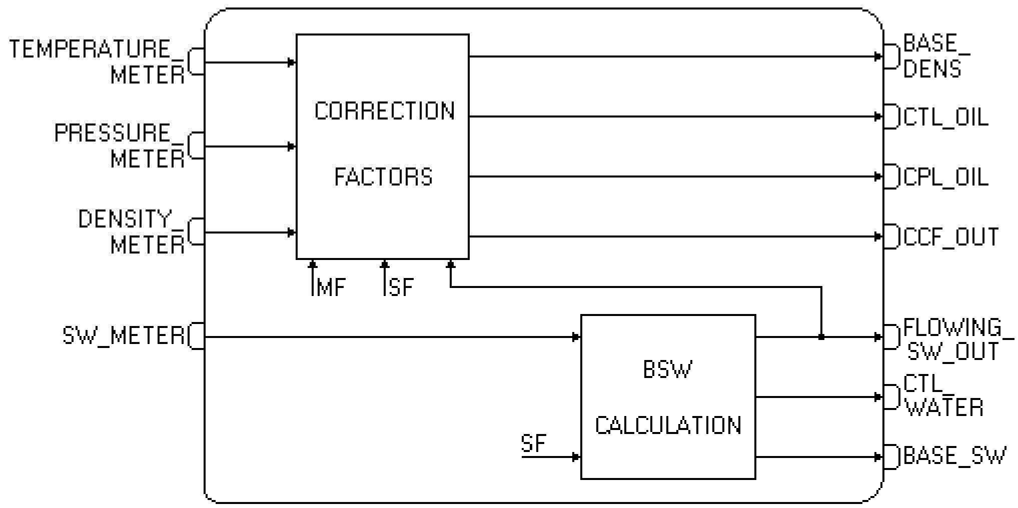
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
108 (A2) (CL)		GAS_OPERATIO N	Unsigned8	0=None 1=Subtract GAS_QB_IN 2=Add GAS_QB_IN	0	E	S	Indicates the operation to be performed between the measured gas (GAS_RUN_NUMBER) and the input GAS_QB_IN.
109		NET_QB_HOUR1	Integer32[2 4]		0	TV	N / RO	Totalization of the gas volume flow in base condition for each hour of test during the first day (the first 24 hours) after the operation indicated in m GAS_OPERATION.
110		NET_QB_HOUR2 5	Integer32[2 4]		0	TV	N / RO	Totalization of the gas volume flow in base condition for each hour of test during the second day (the next 24 hours), after the operation indicated in GAS_OPERATION.
111		NET_TOT_QB	Integer32		0	TV	N / RO	Totalization of volume flow in base condition for gas, after the operation indicated in GAS_OPERATION.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

LCF – Liquid Correction Factors

Schematic



Description
This block calculates the correction factors (CTL, CPL and BSW at flowing temperature) for the liquid measurement.

Identification for the run number – STRATEGY parameter
The configuration for the STRATEGY parameter is mandatory, because this identifies the run number.

The quantity of the block instances is **not** limited to the maximum number of streams.

Product Configuration
Using the PRODUCT_TYPE parameter is possible to select the product type to be used in the calculation. There is also the selection of the density type in the DENSITY_TYPE parameter, the application of the glass hydrometer correction (HYDROMETER_CORRECTION parameter) and the coefficient of thermal expansion at base temperature.

CCF Calculation

If the TEMPERATURE_METER and DENSITY_METER inputs are connected, the CTL_OIL factor will be calculated. And if the PRESSURE_METER input is also connected, the CPL_OIL factor will be calculated.

If the CALC_BSW parameter is configured to accomplish the BSW calculation, thus:
$CCF = CTL * CPL * MF * (1 - X_{w,m}) * SF$

Block Inputs

Input	Link Necessity	Description
TEMPERATURE_METER	Mandatory	Flowing temperature If the system has an online density meter, the temperature which the density measurement is being accomplished must be lower than the variation of the acceptable limits related to the flow temperature in the flow meter.
PRESSURE_METER	Optional	Flowing gauge pressure If this input is not connected, CPL = 1.
DENSITY_METER	Mandatory	Density of the measured product (emulsion), which can be at flowing conditions or base conditions, it depends on the DENSITY_TYPE configuration

Block Outputs
This block provides four outputs described below. In the applications which the CPL factor is not calculated and the PRESSURE_METER input is not connected, thus the CPL_OUT output will indicate 1.

Output	Description	Value in the exception condition (*)
BASE_DENS	Density at base conditions defined by DENSITY_TYPE and BASE_TEMPERATURE parameters.	DENSITY_METER
CTL_OIL	Temperature Correction Factor	1.0000
CPL_OIL	Pressure Correction Factor	1.0000
CCF_OUT	Combined Correction Factor	1.0000

(*) When it is impossible to calculate due to the input status or it is out of range specified by the standard.

TEMPERATURE_METER and DENSITY_METER	PRESSURE_METER	CALC_BSW	CCF
No connected	-	-	1
Connected	No connected	None	CTL * MF
Connected	Connected	None	CTL * CPL * MF
Connected	No connected	Dual range / Lab analysis	MF * (1 - $X_{w,m}$) * CTL * SF
Connected	Connected	Dual range / Lab analysis	MF * (1 - $X_{w,m}$) * CTL * CPL * SF

The CCF_OUT output is the result of three correction factors multiplication (CTL, CPL and MF), if the calculation of any factor is impossible, thus the value in the exception condition must be used.

Temperature Correction Factor for Liquid Hydrocarbon (CTL_OIL parameter)
The density used in the CTL calculation depends on the configuration, as indicated below:

Density used	Configuration	Comments
DENSITY_METER	There are two conditions: CALC_BSW set to Dual range and LO_SW is 100%. CALC_BSW set to None.	The density of dry oil at flowing or base conditions (configured in DENSITY_TYPE) indicated in DENSITY_METER input is used in the CTL_OIL calculation.
LAB_DENS_OIL	CALC_BSW set to Dual range and LO_SW is different of 100%.	The DENSITY_METER input is the emulsion density (not suitable for the CTL_OIL calculation), which is used for the BSW calculation at flowing condition
	CALC_BSW set to Lab analysis.	The DENSITY_METER input is not used and the density of dry oil must be provided for the BSW calculation (LAB_DENS_OIL).

For the measurement of crude oil, general products, MTBE and lubrificating oil is used the API-11.1 standard. For the measurement of light liquid hydrocarbon is used GPA-TP25 standard.

Compressibility Factor – F
The Compressibility Factor for the measured liquid is calculated using the base density and flow temperature. If it is impossible to calculate the compressibility factor, the F parameter will be zero.

The CPL factor is calculated using compressibility factor, flowing gauge pressure and equilibrium pressure.

If the selected product is water, the compressibility factor will be zero and the CPL factor is 1.

The standards used for the compressibility factor calculation are API-11.2.1 and API-11.2.1.M for crude oil, general products, MTBE and lubrificant oil. For the measurement of light hydrocarbon liquid are used API-11.2.2 and API-11.2.2.M and GPA TP 15 standards.

Meter factor – MF
If the meter is submitted to the proving, thus the meter factor value obtained must be written in the MF parameter. Otherwise, the default value of the MF parameter must be kept, that is 1.

BSW Calculation– Dual range

If the CALC_BSW parameter is set to “Dual range”, the FLOWING_SW_OUT parameter is the SW_METER input, if this input is lower than LO_SW. Otherwise, the BSW will be calculated using the result of laboratory analysis and emulsion density at flow condition.

If LO_SW = 0.0, thus BSW will be always calculated
If LO_SW = 100.0, thus the FLOW_SW_METER input will be always used.

Block Inputs
The inputs used are indicated below:

Input	Link Necessity	Description
TEMPERATURE_METER	Mandatory	Flowing temperature
DENSITY_METER	Mandatory	Density of the measured product which must be at flowing condition for the Dual range option.
SW_METER	Optional	If the measured online BSW is lower than the configured value in LO_SW parameter, this input will be used. Otherwise the calculated value of BSW will be used. If this input is not connected, it will be ignored, thus the BSW will be always calculated.

Output Blocks

Outputs	Description
FLOWING_SW_OUT	If the value of the SW_METER input is lower than the LO_SW parameter, this output will follow the FLOW_SW_IN input. Otherwise, it will be the calculated value.
CTL_WATER	Temperature correction factor for water.
BASE_SW	BSW calculated at base temperature condition

BSW Calculation– LAB_DENS_OIL and LAB_DENS_WATER
The BSW is calculated using the dry oil and water densities at laboratory analysis condition, the density at flowing condition and the flowing temperature. These last two variables measured are online.

These calculations suppose constant properties (base density) of the produced oil and water.

FLOWING_SW_OUT Calculation:

- It calculates : $DENS_{óleo,T} = f(DENS_{óleo,Tlab}, T)$

Where:
$DENS_{óleo,T}$: dry oil density at flowing temperature
$DENS_{óleo,Tlab}$ = LAB_DENS_OIL : dry oil density at laboratory analysis temperature
T : flowing temperature

- It calculates : $DENS_{água,T} = f(DENS_{água,Tlab}, T)$

Where:
$DENS_{água,T}$: water density at flow temperature
$DENS_{água,Tlab}$ = LAB_DENS_WATER: water density at laboratory analysis temperature
T : flowing temperature

- It calculates BSW_T (FLOWING_SW_OUT parameter).

Where:
BSW_T : BSW at flowing temperature

$$BSW_T = \frac{DENS_{emulsion,T} - DENS_{oil,T}}{DENS_{water,T} - DENS_{oil,T}}$$

BASE_SW Calculation:

- CTL_A = f($DENS_{água,15/60}$, T, Tb) is the CTL_WATER parameter, which converts the volume at flowing temperature to base temperature.
- CTL_o = f($DENS_{óleo,Tlab}$, T,Tb), which converts the volume at flowing temperature to base temperature
- It calculates BSW_{Tb} (BASE_SW parameter).

$$BSW_{Tb} = \frac{BSW_T * CTL_A}{BSW_T * CTL_A + (1 - BSW_T) * CTL_o}$$

BSW Calculation – Lab analysis

If the CALC_BSW parameter is set to "Lab analysis", the value of the FLOWING_SW_OUT output will be calculated using only the laboratory analysis results. It is supposed a stability/regularity of fluid properties as oil base density and BSW (correction factors are applied to the temperature and the difference of the water and oil coefficients of thermal expansion).

This equation is calculated as indicated in the API-201 standard. – Allocation measurement, located in the B Appendix

Block Inputs
The input is:

Input	Link Necessity	Description
TEMPERATURE_METER	Mandatory	Flowing temperature.

Block Outpus

Outputs	Description
FLOWING_SW_OUT	Value calculated for the BSW parameter at flowing condition.
CTL_WATER	Temperature correction factor for water.
BASE_SW	BSW calculated at base temperature

BSW – LAB_DENS_OIL, LAB_DENS_WATER and XWS Calculations
The BSW at flowing condition is calculated using the laboratory analysis results: dry oil density, water density and BSW at laboratory analysis temperature. These calculations assume constant properties (base density) for oil and water.

FLOWING_SW_OUT Calculation:
The following equation is used:

$$X_{w,m} = \frac{X_{w,lab} * (CTL_{w,lab} / CTL_{w,m})}{X_{w,lab} * (CTL_{w,lab} / CTL_{w,m}) + (1 - X_{w,lab}) * (CTL_{o,lab} / (CTL_{o,m} * SF))}$$

Where:
$X_{w,m}$: BSW at flowing condition
$X_{w,lab}$: BSW in laboratory analysis condition
$CTL_{w,lab}$: Temperature correction factor for water, from the temperature of the laboratory analysis to BASE_TEMPERATURE.
$CTL_{w,m}$: Temperature correction factor for water, from flowing temperature to BASE_TEMPERATURE.
$CTL_{o,lab}$: Temperature correction factor for oil, from the temperature of laboratory analysis to BASE_TEMPERATURE.

$CTL_{o,m}$: Temperature correction factor for oil, from flowing temperature to BASE_TEMPERATURE.
SF: oil shrinkage factor

Diagnosing and Troubleshooting

1. BLOCK_ERR. Block configuration: The Temperature or Density Inputs are not connected.
2. BLOCK_ERR. Out of Service: LCF block can continue in Out of service mode, although the target mode is Auto, because the Resource block is in O/S.

Special Indications for BATCH_STATUS

"Abnormal Conditions" – Problems in the BSW calculation.

- when input SW_METER is being used as flowing BSW and it is out of range;
- the calculated BSW is out of range.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	If this parameter is configured with a string other than blank spaces, then this parameter will replace the block tag in the QTR report.
3 (A2) (CL)	4	STRATEGY	Unsigned16	0 to 4	0	None	S	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1) (CL)	**1,3**	**MODE_BLK**	**DS-69**		**O/S**	**Na**	**S**	**Refer to the Mode parameter.**
6	**1,3**	**BLOCK_ERR**	**Bitstring(2)**			**E**	**D / RO**	
7 (A2)	I,1,3	TEMPERATURE_METER	DS-65			T_UNITS	N / RO	Temperature used for the correction factor calculation for the thermal expansion of a liquid.
8 (A2)	I,1,3	PRESSURE_METER	DS-65			P_UNITS	N / RO	Gauge pressure used for the correction factor calculation for the liquid compressibility.
9 (A2)	I,1,3	DENSITY_METER	DS-65			LD_UNITS	N / RO	Density used for the factors CPLm and CTLm calculations.
10 (A2)	I,1,3	SW_METER	DS-65			%	N / RO	Percentage of sand and water mixed in the oil.
11	O,1,3	BASE_DENS	DS-65			LD_UNITS	N / RO	Base density of the dry oil. This parameter is calculated.
12	**O,1,3**	**CTL_OIL**	**DS-65**				**N / RO**	**Temperature Correction Factor.**
13	**O,1,3**	**CPL_OIL**	**DS-65**				**N / RO**	**Pressure Correction Factor.**
14	**O,1,3**	**CCF_OUT**	**DS-65**				**N / RO**	**Combined Correction Factor.**
15	O,1,3	FLOWING_SW_OUT	DS-65			%	N / RO	Percentage calculated of sand and water mixed in the oil.
16	O,1,3	CTL_WATER	DS-65				N / RO	Temperature Correction Factor.
17	O,1,3	BASE_SW	DS-65			%	N / RO	Percentage of sand and water mixed in the oil calculated in base conditions.
18 (A1)	**4**	**BASE_PRESSURE**	**Float**	**101.325 kPa or 14.696 psi**	**101.325 kPa**	**P_UNITS**	**S**	**Base pressure for the fluid according to the selected unit in the P_UNITS parameter.**

Idx	Type/ View	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description
19 (A1) (CL)	**4**	**BASE_TEMPERATURE**	**Float**	**15.0 °C or 20.0 °C or 60.0 °F**	**15.0 °C**	**T_UNITS**	**S**	**Base temperature for the fluid according to the selected unit in the T_UNITS parameter.**
20 (A1) (CL)	4	T_UNITS	Unsigned16	1000=Kelvin 1001=Celsius 1002=Fahrenheit 1003=Rankine	Celsius	E	S	Engineering Unit for temperature.
21 (A1) (CL)	4	P_UNITS	Unsigned16	1130=Pa 1132=Mpa 1133=kPa 1137=bar 1138=mbar 1139=torr 1140=atm 1141=psi 1144=g/cm^2 1145=kgf/cm^2 1147=inH2O 4°C 1148=inH2O 68 °F 1150=mmH2O 4°C 1151= mmH2O 68 °F 1154=ftH2O 68 °F	KPa	E	S	Engineering Unit for static pressure
22 (A1) (CL)	4	LD_UNITS	Unsigned16	1097= Kg/m^3 1113=API 1599 = relative density/SG	Kg/m^3	E	S	Engineering Unit for liquid density. The selection of this unit indicates which table uses for the correction factor calculations (CTL and CPL).
23 (A2) (CL)	4	PRODUCT_TYPE	Unsigned8	0=Crude oil(Table suffix A) 1=Generalized products (Table suffix B) 2=MTBE (Table suffix C) 3=Lubricating oil (Table suffix D) 4=Water 5=Light hydrocarbon (NGL&LPG)	0	E	S	Product type.
24 (A2) (CL)	4	DENSITY_TYPE	Unsigned8	1=Density at base 2=Measured density	1	E	S	Density type.
25 (A2) (CL)	4	HYDROMETER_CORRECTION	Unsigned8	0=No correction 1=Correction is done	0	E	S	Hydrometer correction.
26 (A2) (CL)	4	COEF_OF_THERMAL_EXP	Float	>= 0.0	0.0		S	If the selected product is MTBE, the coefficient of thermal expansion at base temperature must be provided. If the selected product is Light hydrocarbon, the absolute equilibrium pressure is at 100 °F.

Idx	Type/ View	Parameter	Data Type	Valid Range / Options	Default Value	Units	Store/ Mode	Description
27 (A2) (CL)	**2**	**MF**	**Float**	**0.8 to 1.2**	**1.0**	**Na**	**S**	**MF used for the combined correction factor (CCF).**
28 (A2) (CL)	4	CALC_BSW	Unsigned8	0=None 1=Dual range 2=Lab analysis	0	Na	S	It selects one of possible modes to calculate the BSW.
29 (A2) (CL)	2	LO_SW	Float	0.0 to 100.0 0.0 = Always calculated 100.0 = Never calculated	0.0	%	S	Lower limit to calculate the BSW, if the “Dual range” option is selected in CALC_BSW.
30 (A2) (CL)	2	LAB_TEMP	Float		15	T_UNITS	S	Temperature of the laboratory analysis is accomplished to obtain the XWS.
31 (A2) (CL)	2	LAB_DENS_WATER	Float	>= 0.0	1000	LD_UNITS	S	Water density in laboratory analysis condition (LAB_TEMP).
32 (A2) (CL)	2	LAB_DENS_OIL	Float	>= 0.0	900	LD_UNITS	S	Oil density in laboratory analysis condition (LAB_TEMP).
33 (A2) (CL)	2	LAB_SW	Float	0 to 100	0	%	S	BSW value obtained in laboratory analysis condition (LAB_TEMP).
34 (A2) (CL)	2	SF	Float	1=disabled 0< SF <= 1	1	Na	S	Shrinkage factor obtained in laboratory analysis.
35	**3**	**F**	**Float**			**1/P_UNITS**	**N / RO**	**Compressibility factor**
36	3	STATUS_CURRENT	Bitstring[2]	See Block Options	0	Na	N/ RO	Current status. Similar to BATCH_STATUS.
37		PE_TF	Float			P_UNITS	N / RO	Equilibrium pressure in flow conditions.
38		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
39		BLOCK_ALM	DS-72			Na	D	The block alarm is used for all configuration, hardware and connection failure, or system problems in the block. The cause of the alert is indicated in the subcode field. The first active alert will set the Active status in the Status attribute. When the Unreported status is removed by the alert reporting task, another block alert can be reported without clearing the Active status, if the subcode has been changed.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
CL – Parameter stored in Configuration Log
V4 – Parameter added in version 4

Gray Background Line: Custom Parameters

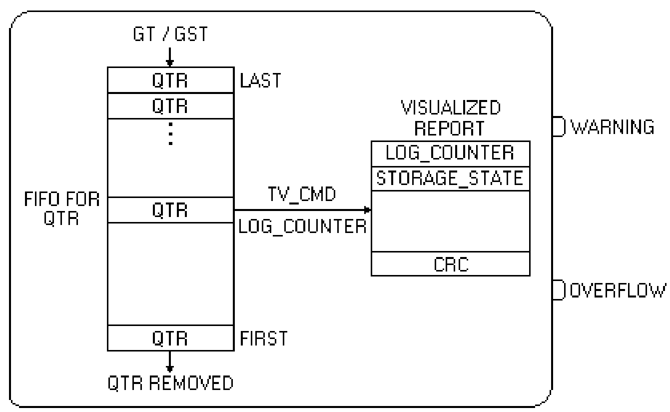
Report/Register Visualization Blocks

The report/register visualization function blocks in the FC302 memory has the following features:

- "V" suffix in the block mnemonic.
- All these blocks allow to search in the historical storage and visualizing the report data or the selected register group. Thus, the report data or the register group visualization occurs one by time.
- The FC302 supports an instantiation for each block type.
- The search for the reports/registers in the historical storage must be done exclusively by the FCView;
- When the report/register is generated by the FC302, it receives the status "not stored" and, after being read and stored in the data bank, it receives the status "stored".
- The report/register generation/save algorithm is of the FIFO type (first in first out), that is, the report generated superposes the oldest.
- WARNING Indication: when any of the five first (the oldest) reports/register is with status "not stored".
- OVERFLOW indication: when any report/register was superposed and this has the status "not stored".

GTV – Gas Transaction View

Schematic



Description
This block allows visualize all the registered reports referred to the Quantity Transaction Record (official) and the operational report for all measured gas flows, including the gas station.

Through the TV_CMD parameter, it is possible to select the registered reports; other option is selecting the desired report writing in the LOG_COUNTER parameter.

All the needed information to create the QTR report are provided in this block, except for:

- Flow computer tag (device tag);
- FCT block: company name, place, responsible names.

Diagnosis and Troubleshooting
BLOCK_ERR. Block configuration: this indication occurs when the report number for gas measurement is zero (FCT.GAS_QTR parameter).

BLOCK_ERR. Out of Service: the GTV block can continue in the Out of service mode, although the target mode is Auto because the Resource block is in O/S.

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	This parameter identifies the number of the measured flow. But, how this block is not specific to the flow, it is read only parameter.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	O,1,3	WARNING	DS-66				N / RO	This output will be TRUE when there was report in not-stored state between the first five reports (the oldest reports).
8	O,1,3	OVERFLOW	DS-66				N / RO	If the oldest report is superposed and the same was with not-stored status, thus it will be indicated in LOG_STATUS and OVERFLOW parameters. These parameters will cleared when the user acknowledgement occurs, through the LOG_STATUS parameter.
9	1	LOG_STATUS	Unsigned8	0=None 1=Warning level 2=Overflow unacknowledged 3=Overflow acknowledged	0	E	N	Indicate if overflow occurred in the log and if is acknowledge or not. The operator must type: “Overflow acknowledged” to acknowledge it.
10	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of reports with status “not stored”, that is, no stored in the FCView data bank.
11		FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Identifier (log counter) of the first QTR (oldest)
12	1	TV_CMD	Unsigned8	0=None 1=First 2=Next 3=Previous 4=Last	0	E	D	Selection of the gas report to be visualized. The first report is the oldest with STORAGE_STATE in not-stored, if there was only one report. The last report is the most recent with STORAGE_STATE in “Not-stored if there was only one. The next option means the next report more recent with STORAGE STATE in “Not-stored”, if there was only one The previous option means the next report oldest with STORAGE STATE in “Not-stored”, if there was only one
13		SET_STORED	Unsigned16	0=None 1 to 65000=Log counter to set as “Stored”	0	Na	D	Writing the report identifier (log counter) in this parameter, the state of the correspondent report will be changed to “Stored”.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
14		LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N	Report identifier in the FC302 memory. It is a rollover counter for stored reports. It is an identifier which shows the logging chronological sequence.
15	1	STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored	0	E	N / RO	Indicates the visualized report storage state. After reading this report and save in data bank, it will be changed to “Stored” by the FCView.
16	1	RUN_NUMBER	Unsigned8	1 to 4 255=Station	0	Na	N / RO	Number of measured flow of the visualized report.
17		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Report number for the report type and measured flow number. If it is operational report, it has the same number of the next transfer report of the same period type.
18		METER_NUMBER	Unsigned16		0	Na	N / RO	Meter number provided by the GKD block, METERx_INFO parameter. It did not use when gas station report.
19		QTR_TYPE	Unsigned8	0=None 1= Manual & Batch 2= Reset & Batch 3= Size & Batch 5= operational & Batch 6=Continuous & hour 7=Continuous & day 8=Continuous & week 9=Continuous & month 10=Operational & hour 11=Operational & day 12=Operational & week 13=Operational & month14= Reset & Hour15= Reset & Day 16= Reset & Week 17= Reset & Month	0	E	N / RO	QTR report type according to the report generation cause.
20		PERIOD_STATUS	Bitstring[2]	See Block Options	0	Na	N/ RO	Status during the report period. Similar to the BATCH_STATUS.
21		OPEN_DATE_TIME	Date				N / RO	Date and hour of opening of this report.
22		CLOSE_DATE_TIME	Date				N / RO	Date and hour of end of this report.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
23		PRODUCT_NAME	Visiblestring[16]				N / RO	Product name obtained from the GKD block.
24	1	TOT_QV	Integer32		0	TV	N / RO	Volume flow rate totalizer in flowing conditions.
25	1	TOT_QB	Integer32		0	TV	N / RO	Volume flow rate totalizer in base conditions.
26	1	TOT_QM	Integer32		0	TM	N / RO	Mass flow rate totalizer.
27	1	TOT_ENERGY	Integer32		0	EN	N / RO	Energy flow rate totalizer.
28		TOT_ACC_QV	Integer32		0	TV	N / RO	Volume flow non-reset totalizer in flowing conditions at the report ending.
29		TOT_ ACC_QB	Integer32		0	TV	N / RO	Volume flow non reset totalizer in base conditions at the report ending.
30		TOT_ ACC_QM	Integer32		0	TM	N / RO	Mass flow non reset totalizer at the report ending.
31		TOT_ ACC_ENERGY	Integer32		0	EN	N / RO	Energy flow non reset totalizer at the report ending.
32		TWA	Float			T	N / RO	Temperature weighted average in the period. It did not use when gas station report.
33		PWA	Float			P (abs)	N / RO	Absolute static pressure weighted average in the period. It did not use when gas station report.
34		DPWA	Float			DP	N / RO	Differential pressure weighted average in the period. It did not use when gas station report.
35		GRWA	Float			Na	N / RO	Relative density weighted average in the period. It did not use when gas station report.
36		CDWA	Float				N / RO	Discharge coefficient weighted average in the period. It did not use when gas station report.
37		EVWA	Float				N / RO	Approach speed factor weighted average in the period. It did not use when gas station report.
38		Y1WA	Float				N / RO	Expansion factor weighted average in the period. It did not use when gas station report.
39		FLOW_TIME	Time difference				N / RO	Flow time of the period.
40		CRC	Unsigned16		0	Na	N /RO	CRC of the input/selected group.
41		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Identifier (log counter) of the last report in the log (the most recent).
42		FLOW_TAG	Visiblestring[32]		Blank		N / RO	Block tag or TAG_DESC (GT, GST) of the block which generated the report.

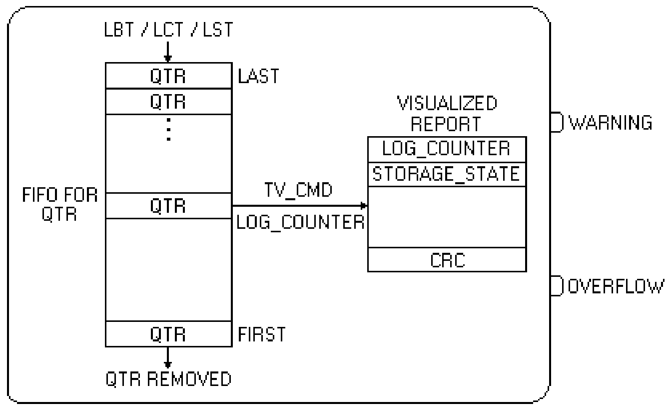
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
43		METER_TYPE	Unsigned8	0=none (station) 1=differential pressure 2=volume pulse input 3=volume analog input 4=V-Cone 5=Wafer-Cone 6=mass pulse input 7= mass analog input	0	E	N / RO	Flow indication signal type.
44		MF	Float				N / RO	Meter factor used in the calculations of this report. Used only when it was pulse input. It did not use when gas station report.
45		ORIFICE_ DIAMETER	FLOAT			L	N / RO	Orifice diameter at the measurement temperature.
46		TUBE_DIAMETER	FLOAT			L	N / RO	Tube internal diameter at the measurement temperature.
47		GAS_PRODUCT	Float[28]				N / RO	Gas composition (including gas composition, heat value, relative density)
48		GAS_SPEC_1	Bitstring[2]				N / RO	Show the standards applied to the flow calculation.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Size: 232bytes/report

Gray Background Line: Custom Parameters

LTV – Liquid Transaction View

Schematic



Description

This block allows visualize all registered reports referent to the Quantity Transaction Record (official) and operational report for all measured liquid flow and liquid stations.

Through the TV_CMD parameter, it is possible to select the registered reports; other option is selecting the desired report writing in the LOG_COUNTER parameter.

All the needed information to create the QTR report are provided in this block, except for:

- Flow computer tag (device tag).
- FCT block: company name, place, responsible names.

The QTR reports are always based on volume in base conditions, even though if using mass meter and also independently of the signal type used to transmit the flow information.

Diagnosis and Troubleshooting

- BLOCK_ERR. Block configuration: this indication occurs when the number of reports for liquid measurement is zero (FCT.LIQ_QTR parameter);

- BLOCK_ERR. Out of Service: LTV block can continue in Out of service mode, although the target mode is Auto because the Resource block is in O/S.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	This parameter identifies the number of the measured flow. But, how this block is not specific to the flow, it is read only parameter.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
7	O,1,3	WARNING	DS-66				N / RO	This output will be TRUE when there was report in not-stored state between the first five reports (the oldest reports).
8	O,1,3	OVERFLOW	DS-66				N / RO	If the oldest report is superposed and the same was with not-stored status, thus it will be indicated in LOG_STATUS and OVERFLOW parameters. These parameters will be cleared when the user acknowledgement occurs, through the LOG_STATUS parameter.
9	1	LOG_STATUS	Unsigned8	0=None 1=Warning level 2=Overflow unacknowledged 3=Overflow acknowledged	0	E	N	Indicates if overflow occurred in the log and if is acknowledged or not. The operator must type: “Overflow acknowledged” to acknowledge it
10	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of reports with status “not stored”, that is, no stored in the FCView data bank.
11		FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Identifier (log counter) of the first QTR (oldest)
12		TV_CMD	Unsigned8	0=None 1=First 2=Next 3=Previous 4=Last	0	E	D	Selection of the liquid report to be visualized. The first report is the oldest with STORAGE_STATE in not-stored, if there was only one report. The last report is the most recent with STORAGE_STATE in “Not-stored if there was only one. The next option means the next report more recent with STORAGE STATE in “Not-stored”, if there was only one The previous option means the next report oldest with STORAGE STATE in “Not-stored”, if there was only one
13		SET_STORED	Unsigned16	0=None 1 to 65000=Log counter to set as “Stored”	0	Na	D	Writing the report identifier (log counter) in this parameter, the state of the correspondent report will be changed to “Stored”.
14		LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N	Report identifier in the FC302 memory. It is a rollover counter for stored reports. It is an identifier which shows the logging chronologic sequence.
15		STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored	0	E	N / RO	Indicates the visualized report storage state. After reading this report and save in data bank, it will be changed to “Stored” by the FCView.
16	1	RUN_NUMBER	Unsigned8	1 to 4 255=Station	0	Na	N / RO	Number of measured flow of the visualized report.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
17		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Report number for the report type and measured flow number. If it is operational report, it has the same number of the next transfer report of the same period type.
18	1	METER_NUMBER	Unsigned16		0	Na	N / RO	Meter number provided by the LKD block, METERx_INFO parameter. It did not use when gas station report.
19		QTR_TYPE	Unsigned8	0=None 1= Manual & Batch 2= Reset & Batch 3= Size & Batch 4= Change product & Batch 5= operational & Batch 6=Continuous & hour 7=Continuous & day 8=Continuous & week 9=Continuous & month 10=Operational & hour 11=Operational & day 12=Operational & week 13=Operational & month 14= Reset & Hour 15= Reset & Day 16= Reset & Week 17= Reset & Month	0	E	N / RO	QTR report type according to the report generation cause.
20		PERIOD_STATUS	Bitstring[2]	See Block Options	0	Na	N/ RO	Status during the report period. Similar to the BATCH_STATUS.
21		OPEN_DATE_TIME	Date				N / RO	Date and hour of opening of this report.
22		CLOSE_DATE_TIME	Date				N / RO	Date and hour of ending of this report.
23		PRODUCT_NAME	Visiblestring[16]				N / RO	Product name obtained from the LKD block.
24		DWA	Float SI-DD1 US-DD1 SG-DD4			LD	N / RO	Density weighted average of the period. It did not use when liquid station report.
25		TWA	Float SI-DD25 US-DD1			T	N / RO	Temperature weighted average of the period. It did not use when liquid station report.
26		PWA	Float SI-DD10 US-DD10 Bar-DD1			P	N / RO	Gauge pressure weighted average of the period. It did not use when liquid station report

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
27		SWWA	Float DD3			%	N / RO	SW weighted average of the period. It did not use when liquid station report
28		PE_TWA	Float SI-DD10 US-DD10 Bar-DD1			P	N / RO	Equilibrium pressure of the temperature weighted average. It did not use when liquid station report
29		MRC	Integer32 SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N / RO	MR value at the report ending. It did not use when liquid station report. Value multiplied by the factor in order to attend the standard.
30		MRO	Integer32 SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N / RO	MR value at the report opening. It did not use when liquid station report. Value multiplied by the factor in order to attend the standard.
31		RHO_B	Float SI-DD1 US-DD1 SG-DD4			LD	N / RO	Density weighted average in base conditions used to report calculations. It did not use when liquid station report
32		MF	Float DD4				N / RO	MF used in report calculation. It did not use when liquid station report
33		CTL	Float DD4				N / RO	Temperature correction factor based on the input parameter weighted average It did not use when liquid station report.
34		F	Float SI-DD8 US-DD78 Bar-DD79			F	N / RO	Compressibility factor based on the input parameter weighted average. It did not use when liquid station report.
35		CPL	Float DD4				N / RO	Pressure correction factor based on the input parameter weighted average. It did not use when liquid station report.
36		CCF	Integer32 DD4				N / RO	Composite correction factor based on the input parameter weighted average. It did not use when liquid station report.
37	1	IV	Integer32 SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N/ RO	Indicated volume of the period. It did not use when liquid station report. Value multiplied by the factor in order to attend the standard.
38	1	GSV	Integer32 SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N/ RO	Gross volume in base condition of the period. Value multiplied by the factor in order to attend the standard.
39	1	NSV	Integer32 SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N/ RO	Net volume in base condition of the period. Value multiplied by the factor in order to attend the standard.
40	1	SW_VOLUME	Integer32 SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N/ RO	S&W volume of the period. Value multiplied by the factor in order to attend the standard.

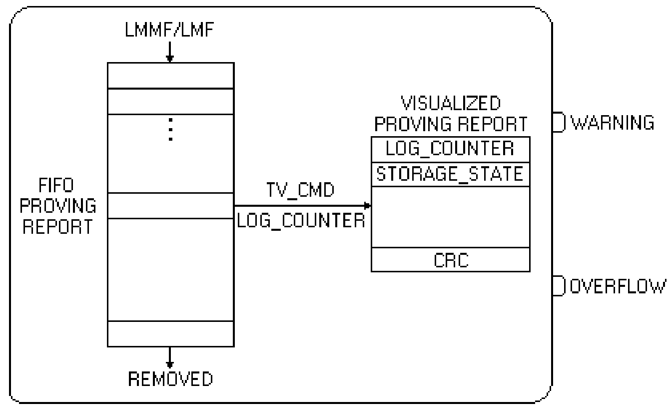
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
41		CRC	Unsigned16		0	Na	N / RO	CRC of the input/selected group.
42		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Identifier of the last report (log counter) in the log (the most recent).
43		FLOW_TAG	Visiblestring[32]		Blank		N / RO	Block tag or TAG_DESC (LCT, LBT, LST) of the block which generated the report.
44		FLOW_TIME	Time difference				N / RO	Flow time of the period.
45		LIQ_SPEC_1	Bitstring[2]				N / RO	Show the standards applied to the flow calculation.
46		LIQ_SPEC_2	Bitstring[2]				N / RO	Show the standards applied to the flow calculation.
47		VISCOSITY	Float		0.0	Visc	N / RO	Product viscosity.
48		NKF	Float			K	N / RO	Meter NKF. If the linearization related to the frequency is used, it indicates the average value.
49		SF	Float DD4	1=disabled 0< SF <= 1	1	Na	N / RO	Shrinkage factor obtained in laboratory analysis.
50		CTL_W	Float DD4	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of temperature effect in volume of water. It is calculated based to the water, which must be configured in PRODUCTxINFO.
51		CPL_W	Float DD4	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of pressure effect in volume of water, which is calculated using the weighted average pressure.
52		MASS	Integer32 SI-DD3 US-DD2 Kg-DD10 Lb-DD10			TM	N / RO	Mass totalization of the period.
53		MMRO	Integer32 SI-DD3 US-DD2 Kg-DD10 Lb-DD10			TM	N / RO	MMR value at the report opening. It did not use when liquid station report. Value multiplied by the factor in order to attend the standard.
54		MMRC	Integer32 SI-DD3 US-DD2 Kg-DD10 Lb-DD10			TM	N / RO	MMR value at the report ending. It did not use when liquid station report. Value multiplied by the factor in order to attend the standard.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Size: 199 bytes/report

Gray Background Line: Custom Parameters

LMFV – Liquid Master Factor View

Schematic



Description

This block allows the visualization of all logged blocks referred to the proving section.

Through the LMFV_CMD parameter, it is possible to select the logged reports.
All the needed information to create the proving report is provided in the block, except:

- Flow computer tag (device tag);
- FCT block: company name, place, responsible names.

According to the prover type specified in PROVER_INFO, a different report format will be used by the FCView, showing only the applicable parameters/variables.

When the data average method is used, the 21° matrix element means the average of the averages of proving batch.

Diagnosis and Troubleshooting

BLOCK_ERR. Out of Service: the LMFV block can continue in the Out of Service mode, although the target mode is Auto because the Resource block is in O/S.

Supported Mode

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	O,1,3	WARNING	DS-66				N / RO	This output will be TRUE when there was report in not-stored state between the first five reports (the oldest reports).
8	O,1,3	OVERFLOW	DS-66				N / RO	If the oldest report is superposed and it is with not-stored status, thus it will be indicated in LOG_STATUS and OVERFLOW parameters. These parameters will be cleared when the user acknowledgement occurs, through the LOG_STATUS parameter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
9	1	LOG_STATUS	Unsigned8	0=None 1=Warning level 2=Overflow unacknowledged 3=Overflow acknowledged	0	E	N	Indicates if overflow occurred in the log and if is acknowledge or not. The operator must type: “Overflow acknowledged” to acknowledge it
10	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of logged items for all flow measurements, but not stored in FCView data bank.
11		FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of the first report data (the oldest).
12	1	TV_CMD	Unsigned8	0=None 1=First 2=Next 3=Previous 4=Last	0	E	D	Selection of the liquid report to be visualized. The first report is the oldest and with STORAGE_STATE in “Not-stored”, if there was one. The last report will be the logged report most recent with the STORAGE_STATE in “Not-stored”, if there was one. The next option means the next report with STORAGE STATE in “Not-stored”, if there was one.
13		SET_STORED	Unsigned16	0=None 1 to 65000=Log counter to set as “Stored”	0	Na	D	Writing the log counter in this parameter, the correspondent state of the logged item will be “Stored”.
14		LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N	Number of the visualized or desired report when in writing. It is a counter for logged reports. Show the log chronological sequence.
15		STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored	0	E	N / RO	Indicate the visualized report storage state. After reading this report and save in data bank, it will be changed to “Stored” by the FCView.
16		RUN_NUMBER	Unsigned8	1 to 4=meter run 5=master meter	0	Na	N / RO	Number of the flow meter of this report.
17		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Report counter according to the report type and number of the flow meter.
18		METER_INFO	DS-268				N / RO	Meter information that was provided.
19		MASTER_METER_INFO	DS-268				N / RO	Information about the master meter that was used to prove the meter.
20		PRODUCT_INFO	DS-270				N / RO	Product information.
21		PROVER_INFO	DS-269				N / RO	Prover information supplied by the manufacturer.
22		PROVING_CONDITIONS	DS-272				N / RO	Conditions in the last and the previous proving sections.
23		METHOD	Unsigned8	0 = Average MF 1 = Average data	0	E	N / RO	Method used to calculate the MF.
24		CRITERIA	Unsigned8	0=any 5 of 6 consecutive 1= 5 consecutive of 10 consecutive 2=3 sets of 5 3=5 consecutive 4=3 consecutive 5=2 sets of 10	0	E	N / RO	Number in proving tests to be done for an acceptable proving.
25		REPEATABILITY	Float DD3		0.0	%	N / RO	Repeatability of the proving section.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
26		BPV_TANK_PROVER	Float[21] SI-SD67T US-SD67H Liter-SD6 Gallon-SD6	> 0.0	0.0	V	N / RO	This parameter is used only when the PROVER_SELECTION selected a prover from the LKD block, which corresponds to a tank prover. The operator must calculate the difference between Upper Scale Reading – Lower Scale Reading (Sru-SRl), and must be inserted into this parameter when PROVING_STATE is "Waiting user input data".
27		TWA_PROVER	Float[21] SI-DD25 US-DD1		0.0	T	N / RO	Temperature weighted average – the temperature average in the prover in the proving measurement.
28		PWA_PROVER	Float[21] SI-DD10 US-DD10 Bar-DD1	> 0.0	0.0	P	N / RO	Pressure weighted average – the pressure average in the prover in the proving batch.
29		DWA_PROVER	Float[21] SI-DD1 US-DD1 SG-DD4	> 0.0	0.0	LD	D / RO	Density weighted average – the density average in the prover in the proving batch.
30		N_MM	Float[21] DD10	> 0.0	0.0		N / RO	Number of pulses for master meter during the proving run.
31		TWA_METER	Float[21] SI-DD25 US-DD1		0.0	T	N / RO	Temperature weighted average – the temperature average in the meter in the proving batch.
32		PWA_METER	Float[21] SI-DD10 US-DD10 Bar-DD1	> 0.0	0.0	P	N / RO	Pressure weighted average – the pressure average in the meter in the proving batch.
33		DWA_METER	Float[21] SI-DD1 US-DD1 SG-DD4	> 0.0	0.0	LD	D / RO	Density weighted average – the density average in the meter in the proving batch.
34		N_METER	Float[21] DD10	> 0.0	0.0		N / RO	Number of pulses for meter during the proving run.
35		CTSP	Float[21] DD5	> 0.0	0.00000		N / RO	Temperature effect correction on the steel in the prover. When "average data" is selected, only the first matrix element is used.
36		CPSP	Float[21] DD5	> 0.0	0.00000		N / RO	Pressure effect correction on the steel in the prover. When "average data" is selected, only the first matrix element is used.
37		CTLP	Float[21] DD5	> 0.0	0.00000		N / RO	Temperature effect correction in the liquid hydrocarbon for prover in proving conditions. When "average data" is selected, only the first matrix element is used.
38		CPLP	Float[21] DD5	> 0.0	0.00000		N / RO	Liquid compressibility correction in hydrocarbon for prover in proving conditions. When the "average data" is selected, only the first matrix element is used.
39		GSVP	Float[21] SI-SD67T US-SD67H Kg,lb-SD65T Liter-SD6 Gallon-SD6	> 0.0	0.0	V	N / RO	Prover gross volume in correspondent measurement. When the "average data" is selected, only the first matrix element is used. Mass in Prover Mass in prover if mass meter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
40		IVMM	Float[21] SI-SD67T US-SD67H Kg,lb-SD65T Liter-SD6 Gallon-SD6	> 0.0	0.0		N / RO	Master meter indicated volume. Indicated mass (IMmm) in master meter if mass meter.
41		CTLMM	Float[21] DD5	> 0.0	0.00000		N / RO	Temperature effect correction in liquid hydrocarbon for master meter in proving conditions.
42		CPLMM	Float[21] DD5	> 0.0	0.00000		N / RO	Liquid compressibility correction in hydrocarbon for master meter in proving conditions.
43		GSVMM	Float[21] SI-SD67T US-SD67H Kg,lb-SD65T Liter-SD6 Gallon-SD6	> 0.0	0.0	V	N / RO	Master meter gross volume in the proving measurement. Measured Mass (MMmm) in master meter if mass meter.
44		IVM	Float[21] SI-SD67T US-SD67H Kg,lb-SD65T Liter-SD6 Gallon-SD6	> 0.0	0.0		N / RO	Meter indicated volume in test. Indicated mass (IMmm) in master meter if mass meter.
45		CTLM	Float[21] DD5	> 0.0	0.00000		N / RO	Temperature effect correction in liquid hydrocarbon for meter in proving conditions. When the “average data” is selected, only the first matrix element is used.
46		CPLM	Float[21] DD5	> 0.0	0.00000		N / RO	Liquid compressibility correction in hydrocarbon for meter in proving conditions. When the “average data” is selected, only the first matrix element is used.
47		ISVM	Float[21] SI-SD67T US-SD67H Liter-SD6 Gallon-SD6	> 0.0	0.0	V	N / RO	Indicated standard volume for net proving operations. When the “average data” is selected, only the first matrix element is used.
48		IMF	Float[21] DD5	> 0.0	0.0		N / RO	Intermediate MF in the proving correspondent measurement, when the METER_FACTOR_METHOD was “average MF”.
49		MF	Float DD4	0.8 to 1.2	1.0		N / RO	Meter Factor. If the MF calculated was accepted, the basic information of this proving will be stored in the LKD block.
50		CMF	Float DD4	> 0.0	0.0		N / RO	Meter composite factor (MF * CPL)
51		MA	Float DD4	> 0.0	0.0		N / RO	Meter accuracy (1 / MF).
52		KF	Float SD5	> 0.0	0.0	K	N / RO	K factor calculated, pulses by volume unit (NKF / MF).
53		CKF	Float SD5	> 0.0	0.0	K	N / RO	K factor calculated, pulses by unit volume (KF / CPL)
54		PROVING_CAUSE	Unsigned8	0=Auto 1 to 30 = Login1 to Login30			N / RO	Indicate the responsible for initializing the proving section.
55		OPEN_DATE_TIME	Date				N / RO	Date and hour of this report.
56		CRC	Unsigned16		0	Na	N / RO	CRC of the selected group.
57		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Identifier of the last report (log counter) in the log (the most recent).

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
58		LIQ_SPEC_1	Bitstring(2)				N / RO	It shows the used specification for the calculation.
59		LIQ_SPEC_2	Bitstring(2)				N / RO	It shows the used specification for the calculation.
60		PROV_FAIL_CAUSE	Unsigned32	0= OK 1= bad flow sensor 2 = repeatability not achieved 3 = out-of-range correction factor 4=too large variation of MF 5= abnormal proving 6=proving run timeout	0	E	N / RO	Cause of failed proving process.
61		LIQ_WARN	Bitstring[2]	See the specific description	0	E	N / RO	Warning events occurred.
62		PREVIOUS_DATE	Date				N / RO	Date of previous proving.
63		PREVIOUS_MF	Float			Na	N / RO	MF of previous proving.
64		TEST_TIME	Float[21]			Sec	N / RO	Duration of each proving run.
65		USED_PROV_RUN_1	Bitstring[2]	See the specific description			N / RO	Proving runs used to calculate MF.
66		USED_PROV_RUN_2	Bitstring[2]	See the specific description			N / RO	Proving runs used to calculate MF.
67		CLOSE_DATE_TIME	Date				N / RO	Closing date and time of this report
68		PROVING_RUN1_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 1. See the description of WARN.
69		PROVING_RUN2_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 2. See the description of WARN.
70		PROVING_RUN3_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 3. See the description of WARN.
71		PROVING_RUN4_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 4. See the description of WARN.
72		PROVING_RUN5_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 5. See the description of WARN.
73		PROVING_RUN6_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 6. See the description of WARN.
74		PROVING_RUN7_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 7. See the description of WARN.
75		PROVING_RUN8_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 8. See the description of WARN.
76		PROVING_RUN9_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 9. See the description of WARN.
77		PROVING_RUN10_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 10. See the description of WARN.
78		PROVING_RUN11_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 11. See the description of WARN.
79		PROVING_RUN12_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 12. See the description of WARN.
80		PROVING_RUN13_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 13. See the description of WARN.
81		PROVING_RUN14_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 14. See the description of WARN.
82		PROVING_RUN15_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 15. See the description of WARN.
83		PROVING_RUN16_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 16. See the description of WARN.
84		PROVING_RUN17_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 17. See the description of WARN.
85		PROVING_RUN18_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 18. See the description of WARN.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
86		PROVING_RUN19_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 19. See the description of WARN.
87		PROVING_RUN20_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 20. See the description of WARN.
88		PROVING_RUN21_STATUS	Bitstring[2]	See WARN description		E	N / RO	Status of proving run 21. See the description of WARN.
89		LFLOW_TYPE	Unsigned8	0 = IV pulse input 1=IV*CTL pulse input 2=IM pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input 5=Flow IM analog input	0	E	N / RO	IV: indicated volume without any correction factor. IV*CTL : indicated volume with temperature correction factor at base IM : indicated mass
90		T1	Float[20]			Sec	N / RO	T1 of each proving run.
91		T2	Float[20]			Sec	N / RO	T2 of each proving run.
92		LIN_ NKF_MM	Float[21]	>= 0.0	0.0	K	N / RO	NKF of the master meter for each proving run if the linearization related to the frequency was utilized. When the option “average data” is selected, the last element of the matrix is the average.
93		N_INTERPOLATED	Float[21] 1-20 : DD3 17,18,19,21:DD4	> 0.0	0.0		N / RO	Number of interpolated pulses during the corresponding proving run.
94		NKF_METER	Float[21]	>= 0.0	0.0	K	N / RO	NKF of the meter for each proving run if the linearization related to the frequency is utilized. When the option “average data” is selected, the last element of the matrix is the average.
95		TWA_EXTERNAL_SHAFT	Float[21] SI-DD25 US-DD1		0.0	T	D / RO	Temperature weighted average – the average temperature of the detector mounted at an external shaft for each proving run.
96		EQUILIBRIUM_PRESS	Float SI-DD10 US-DD1 Bar-DD1			P	N / RO	Equilibrium steam pressure.
97		MM_TYPE	Unsigned8	0 = IV pulse input 1=IV*CTL pulse input 2=IM pulse input 3=Flow IV analog input 4=Flow IV*CTL analog input 5=Flow IM analog input	0	E	N / RO	Master meter type signal type. IV : Indicated Volume without any correction IV*CTL : Indicated Volume corrected by temperature IM : Indicated mass
98		MM_MF	Float DD4		0	Na	N / RO	MF of the master meter for the type of measured product.
99		CTL_W_P	Float[21] DD5	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Temperature effect correction factor in water volume for prover/master meter. It is calculated based on the water base density which must be configured on PRODUCTxINFO parameter.

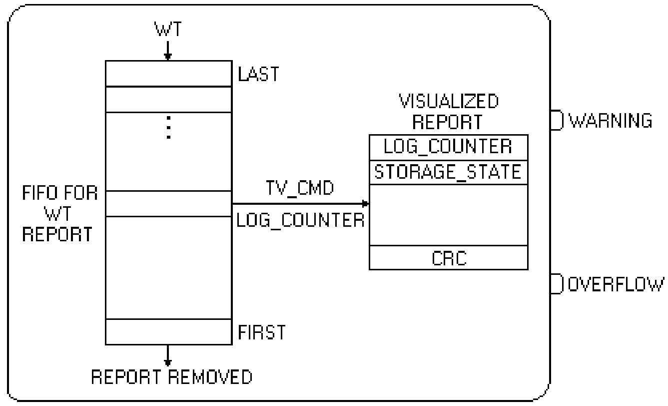
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
100		CTL_W_M	Float[21] DD5	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Temperature effect correction factor in water volume for meter. IT is calculated based on the water base density which must be configured on PRODUCTxINFO parameter.
101		SWWA_	Float[21] DD3			%	N / RO	BSW weighted average for meter – the BSW average for meter in proving batch.
102		CPL_W_P	Float[21] DD5	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in volume of water for the prover/master; it is calculated using the average pressure for each proving run.
103		CPL_W_M	Float[21] DD5	0=Custody transfer > 0.0 : Allocation measurement	0		N / RO	Correction factor of the pressure effect in volume of water for meter. It is calculated using the average pressure for each proving run.
104		LIN_MASTER_ TYPE	Unsigned8	0=none 1=K-factor 2=NKF 3=MF	0	Na	N / RO	It indicates the linearization type to be used for the master meter. The k-factor option utilizes MF=1, by default.
105		LIN_KF_MM	Float[21] SD5	>= 0.0	0.0	K	N / RO	K-factor of the master meter for each proving run if it is linearization related to the frequency.
106		LIN_MF_MM	Float[21] DD4	>= 0.0	0.0		N / RO	MF of the master meter for each proving run, if it is linearization related to the frequency.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Size: 3518 bytes/report

Gray Background Line: Custom Parameters

WTV – Well Test View

Schematic



Description

This block is used to visualize the well test report. Through the TV_CMD parameter, it is possible to select the logged reports.

All needed information to create the well test report is provided in the block, except for:

- Flow computer tag (device tag);
- FCT block: company name, place and responsible names.
- WT block: field name and well ID.

Diagnosis and Troubleshooting

BLOCK_ERR. Out of Service: the WTV block can continue in the Out of Service mode, although the target mode is Auto because the Resource block is in O/S.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	This parameter identifies the meter run number. But as this block is not specific to one meter run, it is a read-only parameter.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode Parameter
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	O,1,3	WARNING	DS-66				N / RO	This output is TRUE, when there is report in not-stored state between the first five reports to be shifted out (oldest entries).
8	O,1,3	OVERFLOW	DS-66				N / RO	If the oldest report is shifted out and it is a not-stored report, then it will be indicated in the LOG_STATUS and OVERFLOW parameters. They will be cleared only when it is acknowledged through LOG_STATUS parameter.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
9	1	LOG_STATUS	Unsigned8	0=None 1=Warning level 2=Overflow unacknowledged 3=Overflow acknowledged	0	E	N	It indicates if the overflow occurred in the log and if it is acknowledged or not. The operator must write "Overflow acknowledged" in order to acknowledge it.
10	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of logged items for all meter runs, but not stored in the dabase of FCView.
11		FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of first report in the QTR log (the oldest one).
12		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of last report in the QTR log (the newest one).
13		TV_CMD	Unsigned8	0=None 1=First 2=Next 3=Previous 4=Last	0	E	D	Selection of report for liquid to be visualized. The first report is the oldest logged report with STORAGE_STATE in "Not-stored", if there is one, at least. The last report is the newest logged report with STORAGE_STATE in "Not-stored", if there is one at least. The option next means the next newer report with STORAGE STATE in "Not-stored", if there is one at least. The option previous means the next older report with STORAGE STATE in "Not-stored", if there is one at least.
14		SET_STORED	Unsigned16	0=None 1 to 65000=Log counter to set as "Stored"	0	Na	D	Writing the log counter into this parameter, the corresponding state of the logged item will be set to "Stored".
15		LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N	Number of visualized report or the desired report to be visualized when writing. It is a rollover counter for logged reports. It is a counter showing the chronological sequence of logging.
16		STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored	0	E	N / RO	It indicates the storage state of report. After reading this report and saving in the database, it must be set to "Stored" by FCView itself.
17		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Rollover report counter
18		FIELD_NAME	Visiblestring[32]		Blank		N / RO	String to identify the field of well. It will be used to generate reports.
19		WELL_ID	Visiblestring[32]		Blank		N / RO	String to identify the well that is being tested. It will be used to generate reports.
20		ALIGN_DATE_TIME	Date				N / RO	Date and time of alignment to the well to be tested.
21		OPEN_DATE_TIME	Date				N / RO	Opening date and time of current test. After waiting for the initial stability time.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
22		CLOSE_DATE_TIME	Date				N / RO	Closing date and time of this report
23		NUM_HOURS	Unsigned16		0	Na	N / RO	Number of hours collecting weighted averages.
24		LIQ_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events happened during the usual conditions evaluation.
25		LIQ_CURRENT_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events at the moment
26		LIQ_TEST_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events happened during the well test.
27		GAS_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events happened during the usual conditions evaluation.
28		GAS_CURRENT_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events at the moment
29		GAS_TEST_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events happened during the well test.
30		WATER_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events happened during the usual conditions evaluation.
31		WATER_CURRENT_ WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events at the moment
32		WATER_TEST_WARN	Bitstring[2]	See WARN description	0	E	N / RO	Warning events happened during the well test.
33		OPEN_OIL1_TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Temperature of first oil run number at beginning of well test.
34		OIL1_TWA_HOUR1	Float[24] SI-DD25 US-DD1		0.0’s	T	N / RO	Weighted average temperature of first oil run number for each hour of test during the first day (the first 24 hours).
35		OIL1_TWA_HOUR25	Float[24] SI-DD25 US-DD1		0.0’s	T	N / RO	Weighted average temperature of first oil run number for each hour of test during the second day (the next 24 hours).
36		CLOSE_OIL1_TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Temperature of first oil run number at end of well test.
37		OPEN_OIL1_PRESS	Float SI-DD10 US-DD10 Bar-DD1		0	P	N / RO	Pressure of first oil run number at beginning of well test.
38		OIL1_PWA_HOUR1	Float[24] SI-DD10 US-DD10 Bar-DD1		0.0’s	P	N / RO	Weighted average pressure of first oil run number for each hour of test during the first day (the first 24 hours).
39		OIL1_PWA_HOUR25	Float[24] SI-DD10 US-DD10 Bar-DD1		0.0’s	P	N / RO	Weighted average pressure of first oil run number for each hour of test during the second day (the next 24 hours).

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
40		CLOSE_OIL1_ PRESS	Float SI-DD10 US-DD10 Bar-DD1		0	P	N / RO	Pressure of first oil run number at the ending of well test.
41		OPEN_OIL1_DE NS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N / RO	Density of first oil run number at beginning of well test.
42		OIL1_DWA_HOU R1	Float[24] SI-DD1 US-DD1 SG-DD4		0.0’s	LD	N / RO	Weighted average density of first oil run number for each hour of test during the first day (the first 24 hours).
43		OIL1_DWA_HOU R25	Float[24] SI-DD1 US-DD1 SG-DD4		0.0’s	LD	N / RO	Weighted average density of first oil run number for each hour of test during the second day (the next 24 hours).
44		CLOSE_OIL1_DE NS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N / RO	Density of first oil run number at the ending of well test.
45		OPEN_OIL1_SW	Float DD3		0	%	N / RO	SW of first oil run number at beginning of well test.
46		OIL1_SWWA_HO UR1	Float[24] DD3		0.0’s	%	N / RO	Weighted average SW of first oil run number for each hour of test during the first day (the first 24 hours).
47		OIL1_SWWA_HO UR25	Float[24] DD3		0.0’s	%	N / RO	Weighted average SW of first oil run number for each hour of test during the second day (the next 24 hours).
48		CLOSE_OIL1_S W	Float DD3		0	%	N / RO	SW of first oil run number at the ending of well test.
49		OIL1_IV_HOUR1	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	IV of first oil run number for each hour of test during the first day (the first 24 hours).
50		OIL1_IV_HOUR2 5	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	IV of first oil run number for each hour of test during the second day (the next 24 hours).
51		OIL1_FACTOR1	Float [24]		0	TV	N / RO	Results of the oil 1 measurement.
52		OIL1_FACTOR25	Float [24]		0	TV	N / RO	Not used.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
53		OIL1_NSV_HOUR1	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	Not used.
54		OIL1_NSV_HOUR25	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	Not used.
55		OPEN_OIL2_TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Temperature of second oil run number at beginning of well test.
56		OIL2_TWA_HOUR1	Float[24] SI-DD25 US-DD1		0.0’s	T	N / RO	Weighted average temperature of second oil run number for each hour of test during the first day (the first 24 hours).
57		OIL2_TWA_HOUR25	Float[24] SI-DD25 US-DD1		0.0’s	T	N / RO	Weighted average temperature of second oil run number for each hour of test during the second day (the next 24 hours).
58		CLOSE_OIL2_TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Temperature of second oil run number at end of well test.
59		OPEN_OIL2_PRESS	Float SI-DD10 US-DD10 Bar-DD1		0	P	N / RO	Pressure of second oil run number at beginning of well test.
60		OIL2_PWA_HOUR1	Float[24] SI-DD10 US-DD10 Bar-DD1		0.0’s	P	N / RO	Weighted average pressure of second oil run number for each hour of test during the first day (the first 24 hours).
61		OIL2_PWA_HOUR25	Float[24] SI-DD10 US-DD10 Bar-DD1		0.0’s	P	N / RO	Weighted average pressure of second oil run number for each hour of test during the second day (the next 24 hours).
62		CLOSE_OIL2_PRESS	Float SI-DD10 US-DD10 Bar-DD1		0	P	N / RO	Pressure of second oil run number at the ending of well test.
63		OPEN_OIL2_DENS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N / RO	Density of second oil run number at beginning of well test.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
64		OIL2_DWA_HOUR1	Float[24] SI-DD1 US-DD1 SG-DD4		0.0’s	LD	N / RO	Weighted average density of second oil run number for each hour of test during the first day (the first 24 hours).
65		OIL2_DWA_HOUR25	Float[24] SI-DD1 US-DD1 SG-DD4		0.0’s	LD	N / RO	Weighted average density of second oil run number for each hour of test during the second day (the next 24 hours).
66		CLOSE_OIL2_DENS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N / RO	Density of second oil run number at the ending of well test.
67		OPEN_OIL2_SW	Float DD3		0	%	N / RO	SW of second oil run number at beginning of well test.
68		OIL2_SWWA_HOUR1	Float[24] DD3		0.0’s	%	N / RO	Weighted average SW of second oil run number for each hour of test during the first day (the first 24 hours).
69		OIL2_SWWA_HOUR25	Float[24] DD3		0.0’s	%	N / RO	Weighted average SW of second oil run number for each hour of test during the second day (the next 24 hours).
70		CLOSE_OIL2_SW	Float DD3		0	%	N / RO	SW of second oil run number at the ending of well test.
71		OIL2_IV_HOUR1	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	IV of second oil run number for each hour of test during the first day (the first 24 hours).
72		OIL2_IV_HOUR25	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	IV of second oil run number for each hour of test during the second day (the next 24 hours).
73		OIL2_FACTOR1	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	Results of the oil 2 measurement.
74		OIL2_FACTOR25	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	Not used.

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
75		OIL2_NSV_HOUR1	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	Not used.
76		OIL2_NSV_HOUR25	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	Not used.
77		IV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N/ RO	Gross volume of this test.
78		NSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N/ RO	Net standard volume of this test.
79		OPEN_GAS_TEMP	Float		0	T	N / RO	Temperature of gas at beginning of well test.
80		GAS_TWA_HOUR1	Float[24]			T	N / RO	Weighted average temperature of gas for each hour of test during the first day (the first 24 hours).
81		GAS_TWA_HOUR25	Float[24]			T	N / RO	Weighted average temperature of gas for each hour of test during the second day (the next 24 hours).
82		CLOSE_GAS_TEMP	Float		0	T	N / RO	Temperature of gas at the ending of well test.
83		OPEN_GAS_PRESS	Float		0	P (abs)	N / RO	Absolute static pressure of gas at the beginning of well test.
84		GAS_PWA_HOUR1	Float[24]			P (abs)	N / RO	Weighted average absolute static pressure of gas for each hour of test during the first day (the first 24 hours).
85		GAS_PWA_HOUR25	Float[24]			P (abs)	N / RO	Weighted average absolute static pressure of gas for each hour of test.
86		CLOSE_GAS_PRESS	Float		0	P (abs)	N / RO	Absolute static pressure of gas at the ending of well test.
87		TOT_QV_HOUR1	Integer32[24]		0	TV	N / RO	Totalizer of volume flow rate at flowing conditions of gas for each hour of test during the first day (the first 24 hours).
88		TOT_QV_HOUR25	Integer32[24]		0	TV	N / RO	Totalizer of volume flow rate at base conditions of gas for each hour of test during the second day (the next 24 hours).

Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
89		TOT_QB_HOUR1	Integer32[24]		0	TV	N / RO	Totalizer of volume flow rate at base conditions of gas for each hour of test during the first day (the first 24 hours).
90		TOT_QB_HOUR25	Integer32[24]		0	TV	N / RO	Totalizer of mass flow rate of gas for each hour of test during the second day (the next 24 hours).
91		TOT_QM_HOUR1	Integer32[24]		0	TV	N / RO	Totalizer of mass flow rate of gas for each hour of test during the first day (the first 24 hours).
92		TOT_QM_HOUR25	Integer32[24]		0	TV	N / RO	Totalizer of volume flow rate at flowing conditions of gas for each hour of test during the second day (the next 24 hours).
93		TOT_QV	Integer32		0	TV	N / RO	Totalizer of volume flow rate at flowing conditions for gas.
94		TOT_QB	Integer32		0	TV	N / RO	Totalizer of volume flow rate at base conditions for gas.
95		TOT_QM	Integer32		0	TV	N / RO	Totalizer of mass flow rate for gas.
96		WATER_GSV_HOUR1	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	GSV of water for each hour of test during the first day (the first 24 hours), related to the flow indicated in WATER_RUN_NUMBER.
97		WATER _GSV_HOUR25	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	GSV of water for each hour of test during the second day (the next 24 hours), related to the flow indicated in WATER_RUN_NUMBER.
98		WATER_GSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			TV	N / RO	GSV of water during the test, related to the flow indicated in WATER_RUN_NUMBER summed to the water emulsioned to the oil.
99		WELL_TEST_TIME	Time difference				N / RO	Well test time.
100		OIL_TEST_FLOW	Float			QV	N / RO	Net volume flow for oil in base conditions during the well test.
101		GAS_TEST_FLOW	Float			QV	N / RO	Volume flow for gas in base conditions during the well test.
102		WATER_TEST_FLOW	Float			QV	N / RO	Water volume flow during the well test.
103		RGO	Float			Na	N / RO	Gas/oil ratio
104		OIL_POTENTIAL_PRODUCTION	Float		0.0	LV / day	N / RO	Potential production liquid volume of oil in base conditions
105		GAS_POTENTIAL_PRODUCTION	Float		0.0	GV / day	N / RO	Potential production volume of gas in base conditions

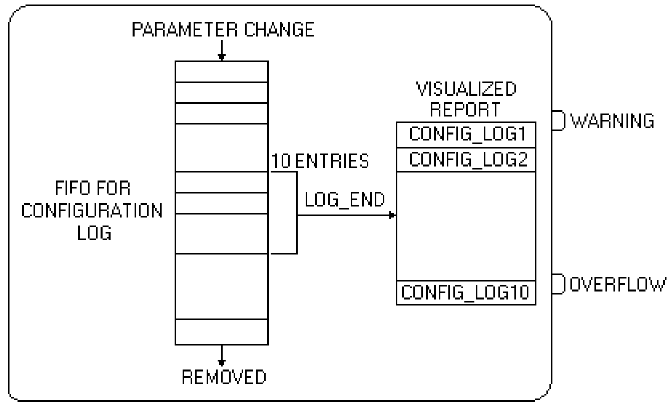
Idx	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
106		GAS_PRODUCT	Float[28]				N / RO	Information about product (including gas composition, heating value, water content). The elements 26 and 27 indicate, respectively, the shrinkage factor of OIL1 and OIL2, if appropriation measurement.
107		VISCOSITY	Float		0.0	Visc	N / RO	Not used.
108		LIQ_SPEC_1	Bitstring[2]				N / RO	It shows the used specification to calculate.
109		LIQ_SPEC_2	Bitstring[2]				N / RO	It shows the used specification to calculate.
110		GAS_SPEC_1	Bitstring[2]				N / RO	It shows the used specification to calculate.
111		CRC	Unsigned16		0	Na	N /RO	CRC of selected entry/group.
112		NET_QB_HOUR1	Integer32[24]		0	TV	N / RO	Totalization of the volume flow for gas in base condition for each hour of test during the first day (the first 24 hours) after the operation indicated in GAS_OPERATION.
113		NET_QB_HOUR25	Integer32[24]		0	TV	N / RO	Totalization of the volume flow for gas in base condition for each hour of test during the second day (the next 24 hours) after the operation indicated in GAS_OPERATION.
114		NET_TOT_QB	Integer32		0	TV	N / RO	Totalization of the volume flow in base condition for gas, after the operation indicated in GAS_OPERATION.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Size: 4014 bytes/report

Gray Background Line: Custom Parameters

ATV –Audit Trail View

Schematic



Description

This block allows the visualization of all changes in the configuration associated to the measurements.

The logged information about each configuration change will be grouped in 50-entry. Selecting the group through the LOG_CMD parameter, it is possible to visualize these configuration changes as block parameters.

The configuration log is organized in chronologic format. The FCView – Report and Management Tool will read the block parameters and one report will be generated according to the measured flow, and thus, by chronological format.

How different type parameters can be changed, the values found and kept, are stored as a string and the FCView Software Tool will print the Configuration Change Report, in order to interpret the information according to the correspondent data type.

All the needed information to create the configuration change report is provided by this block, except:

- FCT block: company name, responsible names and place.
- Flow computer tag (device tag);
- Date and hour of print

Diagnosis and Troubleshooting

BLOCK_ERR. Out of Service: the ATV block can continue in the Out of service mode, although the target mode is Auto, because the Resource block is in O/S.

Supported Modes

O/S and AUTO.

Parameters

Index	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	

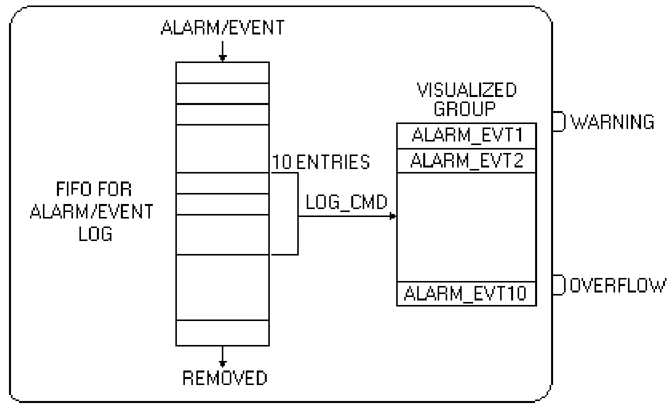
Index	Type/ View	Parameter	DataType (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
7	O,1,3	WARNING	DS-66				N / RO	This output will be TRUE when there was report in not-stored state, between the five first reports (the oldest reports).
8	O,1,3	OVERFLOW	DS-66				N / RO	If the oldest report is superposed and it was with not-stored status, thus it will be indicated in the parameter LOG_STATUS and OVERFLOW. This parameter only will be cleaned when the user acknowledgement occurs, through the LOG_STATUS parameter.
9	1	LOG_STATUS	Unsigned8	0=None 1=Warning Level 2=Overflow unacknowledged 3=Overflow acknowledged	0	E	N	Indicates if the overflow in the log occurred and if was acknowledged or not. The operator must type "Overflow acknowledged" for the acknowledgement.
10	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of logged items for all flow measurements, but not stored in FCView data bank.
11	1	LOG_CMD	Unsigned8	0=None 1=First Group 2=Next 3=Previous 4=Last 5=First not stored	0	E	D	Group number selection. The first group is the logged group for log time. The "First not stored" option means the groups posses the oldest data not stored in data bank. The last group is the group which posses the most recent data.
12		SET_STORED	Unsigned16	0=None 1 to 65000=Log counter to set as "Stored"	0	Na	D	Writing the log counter in this parameter, the correspondent state of the logged item will be "Stored".
13		GROUP_NUMBER	Unsigned8	1 to 20	1		D	The group number is visualized in the parameters below.
14		CONFIG_LOG 1	DS-273				N / RO	Logged configuration change, whose group number is the GROUP_NUMBER parameter.
		….						
23		CONFIG_LOG 10	DS-273				N / RO	Logged configuration change, whose group number is the GROUP_NUMBER parameter.
24		CRC	Unsigned16		0	Na	N / RO	CRC of the selected group/data.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Size: 822 bytes/group

Gray Background Line: Custom Parameters

AEV – Alarm/Event View

Schematic



Description
This block allows the visualization of all variable alarms occurred, as well events.

The logged information about alarms and events will be organized in groups of 10. Selecting the group through the LOG_CMD parameter, it will be possible to visualize these alarms/events as block parameters.

The log is organized in chronologic format. The FCView – Report and Management Tool will read the block parameters and one report will be generated, organized by flow measurements and events for whole flow computer and, thus, chronological format.

All the needed information to create the alarms/events report is provided by this block, except:

- FCT block: responsible and places names.
- Flow computer tag (device tag);
- Print date and hour.

Diagnosis and Troubleshooting
BLOCK_ERR. Out of Service: the AEV block can continue in the Out of service mode, although the target mode is Auto because the Resource block is in O/S.

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type (lenght)	Valid Range / Options	Default Value	Unit	Store/ Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		O/S	Na	S	Refer to the Mode Parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	O,1,3	WARNING	DS-66				N / RO	This output will be TRUE when there is a report in not-stored state between the five first reports (the oldest reports).

Idx	Type/ View	Parameter	Data Type (lenght)	Valid Range / Options	Default Value	Unit	Store/ Mode	Description
8	O,1,3	OVERFLOW	DS-66				N / RO	The oldest report is superposed and it was with not-stored status, thus it will be indicated in the parameter LOG_STATUS and OVERFLOW. This parameter only will be cleared when the user acknowledgement occurs, through the LOG_STATUS parameter.
9	1	LOG_STATUS	Unsigned8	0=None 1=Warning Level 2=Overflow unacknowledged 3=Overflow acknowledged	0	E	N	Indicates if the overflow in the log occurred and if was acknowledged or not. The operator must type "Overflow acknowledged" for the acknowledgement.
10	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of logged items for all flow measurements, but not stored in FCView database.
11	1	LOG_CMD	Unsigned8	0=None 1=First Group 2=Next 3=Previous 4=Last 5=First not stored	0	E	D	Group number selection. The first group is the logged group for log time. The "First not stored" option means the groups posses the oldest data not stored in data bank. The last group is the group which posses the most recent data.
12		SET_STORED	Unsigned16	0=None 1 to 65000=Log counter to set as "Stored"	0	Na	D	Writing the log counter in this parameter, the correspondent state of the logged item will be "Stored".
13		GROUP_NUMBER	Unsigned8	1 to 20	1		D	The group number is visualized in the parameters below.
14		ALARM_EVT1	DS-274				N / RO	Logged configuration change, whose group number is the GROUP_NUMBER parameter.
		….						
23		ALARM_EVT10	DS-274				N / RO	Logged configuration change, whose group number is the GROUP_NUMBER parameter.
24		CRC	Unsigned16		0	Na	N / RO	CRC of the selected group/data.

Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2
Size: 512 bytes/group

Gray Background Line: Custom Parameters

Data Discrimination and Format

Class	Format	Comments	Ref.
1-DD1	XX.X	One place decimal	API 12.2.3 – Tab. 3 – pag. 15
2-DD2	X.XX	Two places decimal	API 12.2.3 – Tab. 9 – pag. 18
3-DD3	X.XXX	Three places decimal	API 12.2.3 – Tab. 9 – pag. 18
4-DD4	X.XXXX	Four places decimal	API 12.2.3 – Tab. 8 – pag. 17
5-DD5	X.XXXXX	Five places decimal	API 12.2.3 – Tab. 8 – pag. 17
7-DD7	0.00000XX 0.0000XXX 0.000XXXX 0.00XXXXX	Seven decimal places	API 12.2.3 – Tab. 5 – pag. 16
8-DD8	0.000000XX 0.00000XXX 0.0000XXXX 0.000XXXXX	Eight decimal places	API 12.2.3 – Tab. 5 – pag. 16
9-DD9	0.000000XXX 0.00000XXXX 0.0000XXXXX	Nine decimal places	API 12.2.3 – Tab. 5 – pag. 16
10-DD10	XX.0	One decimal place equals zero	API 12.2.3 – Tab. 4 – pag. 16
11-DD78	0.00000XXX 0.0000XXX 0.000XXXX	Seven or eight decimal places	API 12.2.2 – Tab. 5 – pag.8
12-DD79	0.00000XXXX 0.0000XXX	Seven or nine decimal places	API 12.2.2 – Tab. 5 – pag.8
15-DD15	XXXX.5	One decimal place equals 0 or 5	API 12.2.2 – Tab. 2 – pag. 6
25-DD25	XX.X5	Two decimal places, the last is always 0 or 5	API 12.2.3 – Tab. 3 – pag. 15
45-DD45	X.XXX5	Four decimal places, the last is always 0 or 5	API 12.2.2 – Tab. 2 – pag. 6
50-SD5	A.XXXX AB.XXX ABC.XX ABCD.X ABCDE.0	Five significative digits	API 12.2.3 – Tab. 8 – pag. 17
60-SD6	A.XXXXX AB.XXXX ABC.XXX ABCD.XX ABCDE.X	Six significative digits	API 12.2.3 – Tab. 9– pag. 18
65-SD65T	ABCDE.X ABCD.XX ABC.XXX AB.XXX	Six or five (ten) significative digits	API-5.6 – Appendix E.3 –pag. 43
67-SD67T	AB.XXXXX A.XXXXX 0.XXXXXX 0.0XXXXXX	Six or seven (ten) significative digits	API 12.2.3 – Tab. 9 – pag. 18
68-SD67H	ABC.XXXX AB.XXXX A.XXXXX 0.XXXXXX	Six or seven (hundred) significative digits	API 12.2.3 – Tab. 9 – pag. 18
102-ISD2	AB,CDE,FGH	Integer32 with 2 significative digits	API 12.2.3 – Tab. 7 – pag. 17
104-ISD4	ABC,DEF,GHI	Integer32 with 4 significative digits	API 12.2.3 – Tab. 7 – pag. 17

Special Data Structure

Date

E	Element Name	Data Type	Size	Range
1	Milli-seconds	Unsigned16	2	0…59999
2	Minutes	Unsigned8	1	0…59
3	Hours	Unsigned8	1	0…23
4	Day of week (bit 5-7)& Day of month (bits 0-4)	Unsigned8	1	1…7 1…31
5	Month	Unsigned8	1	1…12
6	Year	Unsigned8	1	0…99

Time Difference

E	Element Name	Data Type	Size	Range
1	Number of milli-seconds	Unsigned32	4	0…134,217,727
2	Number of days	Unsigned16	2	0…65535

Value & Status –Float Structure– DS-65

This structure data consists of the values and status parameters of the float parameters which are Inputs or Outputs.

E	Element Name	Data Type	Size
1	Status	Unsigned8	1
2	Value	Float	4

Value & Status – Discrete Structure – DS-66

This structure consists of parameter value and status of discrete values.

E	Element Name	Data Type	Size
1	Status	Unsigned8	1
2	Value	Unsigned8	1

Scale Conversion Structure - DS-256

This data structure consists in data used to generate the A and B constants in the equation Y= A*X + B.

E	Element Name	Data Type	Size
1	From EU 100%	Float	4
2	From EU 0%	Float	4
3	To EU 100%	Float	4
4	To EU 0%	Float	4
5	Data Type	Unsigned8	1

Scale Conversion Structure with Status - DS-257

This data structure consists in data used to generate the A and B constants in the equation Y= A*X + B, plus the output status.

E	Element Name	Data Type	Size
1	From EU 100%	Float	4
2	From EU 0%	Float	4
3	To EU 100%	Float	4
4	To EU 0%	Float	4
5	Data Type	Unsigned8	1
6	Output Status	Unsigned8	1

Locator Scale Structure - DS-258

This data structure consists in data used to generate the A and B constants in the equation Y= A*X plus the slave device addresses.

E	Element Name	Data Type	Size
1	From EU 100%	Float	4
2	From EU 0%	Float	4
3	To EU 100%	Float	4
4	To EU 0%	Float	4
5	Data Type	Unsigned8	1
6	Slave Address	Unsigned8	1
7	Modbus Address of Value	Unsigned16	2

Locator and Status Scale Structure - DS-259

This data structure consists in data used to generate the A and B constants in the equation Y= A*X + B, plus the slave device address.

E	Element Name	Data Type	Size
1	From EU 100%	Float	4
2	From EU 0%	Float	4
3	To EU 100%	Float	4
4	To EU 0%	Float	4
5	Data Type	Unsigned8	1
6	Slave Address	Unsigned8	1
7	Modbus Address of Value	Unsigned16	2
8	Modbus Address of Status	Unsigned16	2

Modbus Variable Locator Structure - DS-260

This structure consists in data which indicate the slave device addresses.

E	Element Name	Data Type	Size
1	Slave Address	Unsigned8	1
2	Modbus Address of Value	Unsigned16	2

Modbus Variable Locator Structure with Status- DS-261

This data structure consists of data indicating the addresses in a slave device.

E	Element Name	Data Type	Size
1	Slave Address	Unsigned8	1
2	Modbus Address of Value	Unsigned16	2
3	Modbus Address of Status	Unsigned16	2

FF Parameter ID Structure - DS-262

This structure consists in data which inform the requested FF parameter position.

E	Element Name	Data Type	Size
1	Block Tag	Visiblestring(32)	32
2	Relative Index	Unsigned16	2
3	Sub Index	Unsigned8	1

Slave Address Structure - DS-263

This data structure consists in data which inform the Slave IP and Modbus Addresses.

E	Element Name	Data Type	Size
1	IP Slave1	Visiblestring(16)	16
2	IP Slave2	Visiblestring(16)	16
3	IP Slave3	Visiblestring(16)	16
4	IP Slave4	Visiblestring(16)	16
5	IP Slave5	Visiblestring(16)	16
6	IP Slave6	Visiblestring(16)	16
7	IP Slave7	Visiblestring(16)	16
8	IP Slave8	Visiblestring(16)	16
9	Slave Address1	Unsigned8	1
10	Slave Address2	Unsigned8	1
11	Slave Address3	Unsigned8	1
12	Slave Address4	Unsigned8	1
13	Slave Address5	Unsigned8	1
14	Slave Address6	Unsigned8	1
15	Slave Address7	Unsigned8	1
16	Slave Address8	Unsigned8	1

Meter Information Data Structure - DS-268

E	Element Name	Data Type	Size
1	Factor type (0=MF; 1=CMF)	Unsigned8	1
2	Reserved	Unsigned8	1
3	Nominal K factor [K]	Float	4
4	Meter num	Unsigned16	2
5	Manufacturer name	Visiblestring[16]	16
6	Size [L]	Visiblestring[16]	16
7	Serial number	Visiblestring[16]	16
8	Model number	Visiblestring[16]	16

Prover Information Data Structure - DS-269

E	Element Name	Data Type	Size
1	Prover type	Unsigned8	1
2	Base Prover Volume (not used if tank prover) [V]	Float SI-SD67T US-SD67H Liter-SD6 Gallon-SD6	4
3	Outside diameter [L]	Float SI-DD2 US-DD3	4
4	Wall thickness [L]	Float SI-DD2 US-DD3	4
5	Pipe Gl [G]	Float SI-DD7 US-DD8	4
6	Modulus of elasticity [Elas]	Float SI- ISD4 US-ISD2 Bar-ISD4	4
7	Single-walled (0=No; 1=Yes)	Unsigned8	1
8	External shaft – Gl (0.0=internal detectors)	Float SI-DD7 US-DD8	4
9	Serial number	Visiblestring[16]	16
10	Manufacturer name	Visiblestring[16]	16

Prover type:
0 = U type, unidirectional;
1 = U type, bi-directional;
2 = Small volume prover, unidirectional;
3 = Small volume prover, bi- directional;
4 = Tank prover;
5 = Master meter.

Product Information Data Structure - DS-270

E	Element Name	Data Type	1. Size
1	Product	Visiblestring[16]	16
2	Viscosity	Float	4
3	Product type	Unsigned8	1
4	Density type	Unsigned8	1
5	Coefficient of thermal expansion at base temperature (MTBE)	Float	4
6	Hydrometer correction	Unsigned8	1
7	Absolute equilibrium pressure @ 100 °F	Float SI-DD10 US-DD10 Bar-DD1	4
8	Base density of water	Float SI-DD1 US-DD1 SG-DD4	4

Product Type:
0=Crude Oil (Table Suffix A);
1=Generalized Products (Table Suffix B);
2=MTBE (Table Suffix C);
3=Lubrificating Oil (Table Suffix D);
4=Water
5=Light hydrocarbon (Table Suffix E)
6= Crude oil and water emulsion
7= Emulsion of light hydrocarbon and water
8=ASTM D1250:1952 (*)
(*) Product type only available for non redundant version.

Inputs and basis:
- API -> 60 °F (tables 5 & 6);
- Rel.Dens -> 60 °F (tables 23 & 24);
- Dens + 15 °C -> (tables 53 & 54);
- Dens + 20 °C -> (tables 59 & 60).

Note:
The LD_UNITS, in the FCT blocks and BASE_TEMPERATURE, in the LKD block, it is sufficient to select the correct table.

Density type:
1= base temperature density (this density type is mandatory for water measurement).
2= flowing temperature density.

Thermic expansion coefficient in base temperature
In order to calculate the CTL factor for MTBE measurement it is necessary to provide the thermic expansion coefficient in bas temperature.

Correction for glass density meter:
0 = Without Correction (default);
1 = Correction must be accomplished;
2 = Without Correction – expanded range CPL;
3 = Correction must be accomplished – expanded range CPL.

Equilibrium pressure at 100°F:
If the measured meter is Light Hydrocarbon (NGL&LPG), the equilibrium pressure is calculating according to the GPA TP 15 standard that shows two possible ways to calculate it. One is using the equilibrium pressure at 100°F. Thus, this structure element is important only for the referred product.

Water base density:
Water density measured in the temperature LKD.BASE_TEMPERATURE with maximum salinity degree of 14%, if the product is emulsion type; otherwise, this parameter is ignored. In allocation measurement applications for crude oil/light hydrocarbon, the base density of water is used for calculating the BSW conversion from base condition to flow condition, if it is static sample, as well as the water volume compensated in temperature.

Proving Information Data Structure - DS-271

E	Element Name	Data Type	Size
1	Meter factor (n) – last proving	Float DD4	4
2	Date and time of proving (n) – last proving	Date (11)	7
3	Meter factor (n-1)	Float DD4	4
4	Date and time of proving (n-1)	Date (11)	7
5	Meter factor (n-2)	Float DD4	4
6	Date and time of proving (n-2)	Date (11)	7
7	Meter factor (n-3)	Float DD4	4
8	Date and time of proving (n-3)	Date (11)	7
9	Meter factor (n-4)	Float DD4	4

E	Element Name	Data Type	Size
10	Date and time of proving (n-4)	Date (11)	7
11	Meter factor (n-5)	Float DD4	4
12	Date and time of proving (n-5)	Date (11)	7
13	Meter factor (n-6)	Float DD4	4
14	Date and time of proving (n-6)	Date (11)	7
15	Meter factor (n-7) – oldest proving	Float DD4	4
16	Date and time of proving (n-7) – oldest proving	Date (11)	7

If the user needs to record the MF, must be done in the first element. If the type was accepted, the list is changed and the oldest is removed. All the other elements of this data structure are read only.

Proving Conditions Data Structure - DS-272

E	Element Name	Data Type	Size
1	Current request type : 0=Auto; 1=Demand;	Unsigned8	1
2	Current flowrate IV [QV]	Float	4
3	Current MR [LV]	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2	4
4	Current density at base [LD]	Float SI-DD1 US-DD1 SG-DD4	4
5	Current viscosity [Visc]	Float	4
6	Current temperature of prover [T]	Float SI-DD25 US-DD1	4
7	Current repeatability (%)	Float	4
8	Previous request type : 0=Auto; 1=Demand; 2= User entry	Unsigned8	1
9	Previous flowrate IV [QV]	Float	4
10	Previous MR [LV]	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2	4
11	Previous density at base [LD]	Float SI-DD1 US-DD1 SG-DD4	4
12	Previous viscosity [Visc]	Float	4
13	Previous temperature of prover [T]	Float SI-DD25 US-DD1	4
14	Previous repeatability (%)	Float	4

Configuration Log Data Structure - DS-273

E	Element Name	Data Type	Size
1	Meter run (0=master meter; 1-4=meter run number, 253=Gas Station, 254=Liquid Station, 255=Not Specific)	Unsigned8	1
2	Block tag	Visiblestring[32]	32
3	Relative index	Unsigned16	2
4	Sub index	Unsigned16	2
5	Data type	Unsigned16	2
6	Login number (0 to 29)	Unsigned8	1

E	Element Name	Data Type	Size
7	Date and time	Date	7
8	As found	Octetstring[16]	16
9	As left	Octetstring[16]	16
10	Storage state	Unsigned8	1
11	Log counter (0 to 65000)	Unsigned16	2
12	Username	Visiblestring[8]	8

Note:
Structure total size: 90 bytes

Data Structure Alarm/Event of the Log Data Structure - DS-274

E	Element Name	Data Type	Size
1	Meter run (0=master meter or prover ; 1-4=meter run number, 253=Gas Station, 254=Liquid Station, 255=Not Specific)	Unsigned8	1
2	Block tag or Event description	Visiblestring[32]	32
3	Alert key	Unsigned8	1
4	Type	Unsigned16	2
5	Date and time	Date	7
6	Value (only for alarm)	Float	4
7	Priority	Unsigned8	1
8	Storage state	Unsigned8	1
9	Log counter (0 to 65000)	Unsigned16	2

Note:
- Structure total size: 51 bytes;
- The element meaning “Type” is the following:

1=Low (occurred);
2=High (occurred);
3=Low Low (occurred);
4=High high (occurred);
7=Discrete (occurred);
8=Alarm Block/Event (occurred).

30001=Low (cleared);
30002=High (cleared);
30003=Low Low (cleared);
30004=High high (cleared);
30007=Discrete (cleared);
30008= Alarm Block/Event (cleared).

- Priority:

0-7: non critical
8-15: critical.

- The correspondent Alert key element to the ALERT_KEY from the AALM block must be configured to identify the variable type:

0 = None.
1 = Temperature.
2 = Pressure.
3 = Differential Pressure.
4 = Density.
5 = SW.
6 = Flow in volume;
7 = Flow in mass.

Bit Enumeration Descriptions

BATCH_STATUS:

Bit	Meaning	LBT	LCT	GT
0	Override temperature used (LSB)	X	X	X
1	Override pressure used	X(*)	X(*)	X
2	Override density used	X	X	
3	Override SW used	X	X	
4	Bad status of pulse input	X	X	X
5	Block in O/S	X	X	X
6	Override differential pressure used			X
7	Bad chromatograph			X
8	Extrapolated CTL	X	X	
9	Out of range CTL / differential pressure	X	X	X
10	Process alarm	X	X	X
11	Bad flow input	X	X	X
12	Inconsistent secondary variables			X
13	IV rollover/ Abnormal condition	X	X	X
14	Stop totalization	X	X	X
15	Out of range CPL	X	X	

(*) The status is not indicated if allocation measurement and pressure input not connected. In this situation, neither the event is registered.

ACTIVE_ALARM1 and UNACK_ALARM1:

Bit	Meaning	LBT	LCT	GT
0	Temperature - lo (LSB)	X	X	X
1	Temperature - hi	X	X	X
2	Temperature – lo lo	X	X	X
3	Temperature – hi hi	X	X	X
4	Pressure - lo	X	X	X
5	Pressure - hi	X	X	X
6	Pressure – lo lo	X	X	X
7	Pressure – hi hi	X	X	X
8	Diff. Pressure - lo			X
9	Diff. Pressure - hi			X
10	Diff. Pressure – lo lo			X
11	Diff. Pressure – hi hi			X
12	Density - lo	X	X	
13	Density - hi	X	X	
14	Density – lo lo	X	X	
15	Density – hi hi	X	X	

ACTIVE_ALARM2 and UNACK_ALARM2:

Bit	Meaning	LBT	LCT	GT
0	SW - lo	X	X	
1	SW - hi	X	X	
2	SW – lo lo	X	X	
3	SW – hi hi	X	X	
4	Flow Volume - lo	X	X	X
5	Flow Volume - hi	X	X	X
6	Flow Volume – lo lo	X	X	X
7	Flow Volume – hi hi	X	X	X
8	Flow Mass - lo	X	X	X
9	Flow Mass - hi	X	X	X
10	Flow Mass – lo lo	X	X	X
11	Flow Mass – hi hi	X	X	X
12	Reserved			
13	Reserved			
14	Reserved			
15	Reserved			

ENABLE_REPORT:

Bit	Meaning	LCT	GT
0	Hourly report (LSB)	X	X
1	Daily report	X	X
2	Weekly report	X	X
3	Monthly report	X	X
4	Reserved		
5	Reserved		
6	Reserved		
7	Reserved		
8	Reserved		
9	Reserved		
10	Reserved		
11	Reserved		
12	Reserved		
13	Reserved		
14	Reserved		
15	Reserved		

LIQ_SPEC1:

Bit	Meaning
0	API-11.1-Tables 5A & 6A (LSB)
1	API-11.1-Tables 5B & 6B
2	API-11.1-Table 6C
3	API-11.1-Tables 5D & 6D
4	API-11.1-Tables 23A & 24A
5	API-11.1-Tables 23B & 24B
6	API-11.1-Table 24C
7	API-11.1-Tables 23D & 24D
8	API-11.1-Tables 53A & 54A
9	API-11.1-Tables 53B & 54B
10	API-11.1-Table 54C
11	API-11.1-Tables 53D & 54D
12	API-11.1-Tables 59A & 60A
13	API-11.1-Tables 59B & 60B
14	API-11.1-Table 60C
15	API-11.1-Tables 59D & 60D

LIQ_SPEC2:

Bit	Meaning
0	API-11.2.1 (LSB)
1	API-11.2.1 M
2	API-11.2.2
3	API-11.2.2 M
4	GPA-TP25-Tables 23E & 24E
5	GPA-TP15
6	API-201-Allocation measurement
7	ASTM D1250:1952
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	GPA-TP25-Tables 23E & 24E-15°C
15	GPA-TP25-Tables 23E & 24E-20°C

WARN:

Bit	Meaning
0	Override temperature meter (LSB)
1	Override pressure meter
2	Override density meter
3	Bad temperature master meter or prover
4	Bad pressure master meter or prover
5	Bad density master meter or prover
6	Unstable temperature meter
7	Unstable pressure meter
8	Unstable density meter
9	Unstable temperature master meter or prover
10	Unstable pressure master meter or prover
11	Unstable density master meter or prover
12	Unstable SW
13	Unstable volume flow at base
14	Bad temperature of external shaft / Bad GAS_QB_IN
15	Reserved 15

GAS_SPEC1:

Bit	Meaning
0	AGA3 (LSB)
1	AGA5
2	AGA7
3	AGA8 - Detailed
4	AGA9
5	AGA8 - Gross 1
6	AGA8 - Gross 2
7	Vcone
8	Wafer-Cone
9	AGA11
10	Reserved 10
11	Reserved 11
12	Reserved 12
13	Reserved 13
14	Reserved 14
15	Reserved 15

USED_PROV_RUN_1 and USED_PROV_RUN_2

Bit	Meaning
0	Proving run 1
1	Proving run 2
2	Proving run 3
3	Proving run 4
4	Proving run 5
5	Proving run 6
6	Proving run 7
7	Proving run 8
8	Proving run 9
9	Proving run 10
10	Proving run 11
11	Proving run 12
12	Proving run 13
13	Proving run 14
14	Proving run 15
15	Proving run 16

Bit	Meaning
0	Proving run 17
1	Proving run 18
2	Proving run 19
3	Proving run 20
4	Proving run 21
5	Reserved 5
6	Reserved 6
7	Reserved 7
8	Reserved 8
9	Reserved 9
10	Reserved 10
11	Reserved 11
12	Reserved 12
13	Reserved 13
14	Reserved 14
15	Reserved 15

START_USUAL_CONDITIONS

Bit	Meaning	LBT	LCT	GT
0	Temperature (LSB)	X	X	X
1	Pressure	X	X	X
2	Density	X	X	
3	SW	X	X	
4	Flow	X	X	
5	Reserved 5			
6	Reserved 6			
7	Reserved 7			
8	Reserved 8			
9	Reserved 9			
10	Reserved 10			
11	Reserved 11			
12	Reserved 12			
13	Reserved 13			
14	Reserved 14			
15	Reserved 15			

PULSE_STATUS

Bit	Meaning
0	Pulses have been lost
1	Frequency out of range
2	Noise detected
3	Pulse failure
4	Running proving
5	Reserved5
6	Dual pulse not active
7	Pulse error (*)
8	Reserved8
9	Reserved9
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

(*) It indicates that one of the following types of errors was detected: coincident error, phase error or sequence error. This indication is retained and it will be cleared only when writing into PIP.RESET_ERROR_COUNTER. Reset all Error Counters.

PULSE_MOD_STATUS

Bit	Meaning
0	Ready to scan
1	IMB failure
2	Saving configuration
3	Configuration saving error
4	General failure
5	Factory init jumper ON
6	Factory test running
7	Factory test 2 running
8	Reserved8
9	Reserved9
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

Gx_CONF

Bit	Meaning
0	Dual pulse check enable
1	Falling edge Ax
2	Ax pulse filter disable
3	Bx Falling edge
4	Bx pulse filter disable
5	Reserved5
6	Input Ax disabled
7	Input Bx disabled
8	Reserved8
9	Reserved9
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

PULSE_MOD_CONTROL

Bit	Meaning
0	Reserved1
1	Reserved2
2	Start factory test
3	Start factory test 2
4	Reserved4
5	Reserved5
6	Reserved6
7	Reserved7
8	Reserved8
9	Reserved9
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

PINS_STATE

Bit	Meaning
0	Input A1 active
1	Input B1 active
2	Input A2 active
3	Input B2 active
4	Input A3 active
5	Input B3 active
6	Input A4 active
7	Input B4 active
8	Input A5 active
9	Input B5 active
10	IN1 active
11	IN2 active
12	IN3 active
13	OUT1 active
14	Reserved14
15	Reserved15

PROV_STATUS

Bit	Meaning
0	Proving cycle is running
1	Time out to start T2 counter
2	Time out to start T1 counter
3	Time out to stop T2 counter
4	Time out to stop T1 counter
5	Selected input invalid or disabled
6	Pulse signal failure
7	Reverse flow direction
8	T2 started
9	Proving aborted
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

Chapter 12

ADDING BLOCKS

CHANNEL and STRATEGY Allocation (number of the measured flow)

CHANNEL Configuration

The CHANNEL parameter identifies the physical input or output point associated to the function block.

The AuditFlow system is classified as configurable hardware equipment, where the user configures the number of I/O modules and the type (input or output, discrete or analog, pulse, etc). The rules to configure the CHANNEL parameter in the AuditFlow system are listed below:

- Point (P): ordinal number of I/O points in a group, numbered from 0 (first point) to 7 (last point), where 9 indicates the whole group of points. The whole group can have 4 or 8 I/O points. When accessing the DF77 module, point 2 (P=2) means dual-pulse option for configuring the PIP.Gx_CONF parameter. The option Dual pulse check enable must be enabled previously;

- Group (G): Ordinal number of the group in the selected I/O module, numbered from 0 (first group) to the number of groups minus 1;

In the AuditFlow System, the input and output modules are classified according to the hierarchy.

- Slot (S): A slot supports the I/O module and it is numbered from 0 (first slot in the rack) to 3 (last slot in the rack);

- Rack (R): Each rack has four slots. The rack is numbered from 0 (first rack) to 14 (last rack). A single I/O point in the FC302 can be identified by the rack (R), slot (S), group (G) and point (P). Since the CHANNEL parameter for multiple I/O blocks (MIO) must specify the whole group (8 points), the point value will be 9.

The value of the CHANNEL parameter is represented by these elements in the format RRSGP.

For example, if the value of the CHANNEL parameter is 1203, the block will be in rack 1, slot 2, group 0 and point 3. If the CHANNEL parameter of the MAI block is 10119, the block will be in rack 10, slot 1, group 1 and point 9 (whole group).

Before setting the CHANNEL parameter, it is recommended to configure the hardware in the HC block. The FC302 checks if the I/O type configured in the HC block corresponds to the block type when writing the value to the block. If the CHANNEL parameter configures the AI block to access an I/O type that is not an analog input, the settings will be discarded.

CHANNEL Allocation:

Parameter	Check Type
LBT.CHANNEL LCT.CHANNEL GFC.CHANNEL	The consistence check should not allow two blocks to use the same CHANNEL.
LMMF.CHANNEL_MM	Checks if the addressed module is the pulse input, which indicates that more than one block may have the same CHANNEL.

STRATEGY Configuration

The STRATEGY parameter of some blocks in the FC302 identifies the run number, such as:

- Change in the configuration (AI, GFC, GT, LBT and LCT blocks) are registered to indicate the affected run number.
- Process alarms (AALM block) are registered to indicate which run number uses the variable that caused the alarm condition.

- QTR reports identify the run number using the STRATEGY parameter of the GFC, GT, LBT and LCT blocks;
- Proving reports use the LMMF.STRATEGY parameter to associate the run number submitted to the calibration process.

STRATEGY Allocation (run number):

The consistence check prevents two blocks of the types listed below from using the same STRATEGY (“run number”), considering each group of block types.

Group	Parameter
1	LBT. STRATEGY LCT. STRATEGY GFC.STRATEGY
2	LMMF. STRATEGY
3	GT. STRATEGY

Note:It is always allowed to set the CHANNEL or STRATEGY parameters to zero.

Value range to configure the STRATEGY parameter in the FC302 specific blocks:

STRATEGY	Block Types
255 (read only)	FCT, LKD, GKD, LTV, ATV, AEV, LMFV, GTV, WT, WTV
254 (read only)	LST
253 (read only)	GST
1-4, 255	GC
0-4	LMMF, LBT, LCT, GFC, GT

Recommendations to Configure the FC302

1. The Macrocycle must be lower or equal to 1, to fulfill the API-21.1 and API-21.2 standards. It is also recommended to set the macrocycle equal to or over 500 ms for proper execution of the function blocks and communication processing.

2. Adjust the macrocycle of all FC302 H1 channels with the same value.

3. Create the FC302 blocks in this order: RS, FCT, HC, etc.

4. After the firmware download or reset mode 1, the FC302 module will be in the logon mode with Administrator level and LOGON_TIMEOUT disabled (equal to zero):

a) The user will be able to perform any change in the configuration and it will be registered. It is recommended to keep these settings during the configuration, test and startup. When the measurement system starts operating, the user should logoff and write a proper value to the LOGON_TIMEOUT parameter.

b) Set the passwords and the correspondent access levels.

5. During the commissioning in the startup, the FCT.LOGON_TIMEOUT parameter can be set at zero, but during the operation, it is recommended to write a proper value (for example, between 5 and 10 minutes) to this paramenter, avoiding problems if the operator forgets to logoff.

6. To download the complete configuration of the FC302 and its H1 Foundation Fieldbus device, execute the download in the Fieldbus Networks (project window, right-click in the Fieldbus Networks icon and select the option Download).

7. It is recommended to update the Real Time clock in the FCT block when the device is first initialized, and then periodically.

8. Before starting the firmware download or the configuration download, interrupt the supervision through the DFI OPC Server or the Modbus protocol.

Note
When using Smar Field Devices, the Firmware version must be 3.46 or higher.

What Happens during Configuration Download

The configuration download has the following sequence :

1. Syscon starts to clear the whole configuration in the bridge (FC302), then it clears the configuration in the field devices (transmitters).
2. It starts to download the application (block instantiation, parameter write, function block schedule) in the FC302, then it downloads the transmitters.
3. Then it downloads the network schedule (external links between blocks).

What happens during configuration download:

1. As the configuration download starts by FC302, the flow calculation stops as soon as the download starts.
2. When FC302 receives a command to clear the whole configuration, before executing it, FC302 closes the current measurements, generating a QTR if necessary.
3. As the block execution in the FC302 starts before the external links are operating, the calculation of flow measurement executes using the override value for a while (till the download of network schedule).

If a message of failure is shown during the configuration download:

1. Check if all devices are in the live list, as well commissioned.
2. Check if you are logged on with Level 1, at least.
3. Repeat the configuration download
4. Read the Syscon – Installation and Operation Manual for more details.

Process Alarm Configuration

The date and time of entering or leaving the process alarm condition is registered in the alarm and event log, displayed by the AEV block.

The block developed to process the alarm of analog variables is the AALM block, which is described in the FF Function Blocks Manual. This block has several characteristics, such as:

- Dynamic alarm limits calculated according to the PSP input multiplyed by a gain, plus a bias or a static limits configured by the parameters HI_LIM, HI_HI_LIM, LO_LIM and LO_LO_LIM.
- Active alarm type selection (hihi, hi, lo, lolo) using the OUT_ALM_SUM parameter and indicated in the OUT_ALM output.
- Hysteresis: prevent frequent alarm condition indications caused by the process variable oscillating near the alarm limits.
- Temporization: the system enters the active alarm condition after a minimum configurable interval has elapsed.
- Alarm priority.

The AALM block has also tracking functionality, that is, the block registers the alterations when entering or leaving the alarm condition.

Configure the following parameters to make the necessary information available to generate alarm and events reports:

- STRATEGY: run number associated to the variable submitted to the alarm processing.

- TAG_DESC: if this parameter is different from spaces, this string is utilized for the event description in the report, instead of the AALM block tag;

- ALERT_KEY: identifies the type of the variable submitted to the alarm processing.

  1 = Temperature
  2 = Pressure
  3 = Differential pressure
  4 = Density
  5 = SW
  6 = Volume flow rate
  7 = Mass flow rate

- HI_HI_PRI, HI_PRI, LO_LO_PRI, LO_PRI: the alarm priority is a block standard feature;it is also used in the reports and as filter criteria in FCView.

The following characteristics will be available after configuring the system as indicated:

- Identification of run number affected by the alarm.
- Identification of the Variable type in the alarm condition.
- Status indication of the corresponding period in the transaction blocks (GT, GST, LCT, LBT and LST blocks) and indication in the alarm station through FCView.

Discrete Alarm Configuration (Electronic Seal)

The inlet and outlet of the discrete alarm condition are registered in the alarm and event log. The AEV block allows the visualization of this logger.

The DI block is developed for the alarm processing of discrete variables. For further details about this block, refer to the Foundation Fieldbus Function Blocks Manual. This block has the following available features:

- STRATEGY: run number associated to the variable submitted to the alarm process, and it will be also used for the report;
- TAG_DESC: configuring this parameter different from spaces, this string will be used in the event description for the report instead of the DI block tag;
- DISC_LIM parameter: condition of the discrete alarm which the alarm will be generated;
- DISC_PRI parameter: alarm priority.

Application

- The special feature regarding audit trail in theDI block is available only for physical discrete inputs.
- To detect and register events identified by description (TAG_DESC), and also the date and time of occurrence:
    - Opening/closing of cabinet and housing where the equipment for measurement station are stored (Electronic Seal).
    - Opening/closing valves that indicate the alignment of the operation or master meter.
    - Opening/closing the valves that indicate the start and the end of custody transfer
- The information above improve the system audit trail, allowing the comparison and/or association with other events, configuration changes, maintenance or operation procedures, etc.

Chapter 13

CREATING A FOUNDATION FIELDBUS CONFIGURATION

Introduction

This section will describe how to configure a Foundation Fieldbus strategy using a FC302 as a bridge. This example is a natural gas measurement application with one stream using orifice plate, where the differential pressure, static pressure and temperature are measured using Foundation Fieldbus transmitters.

FQI-100

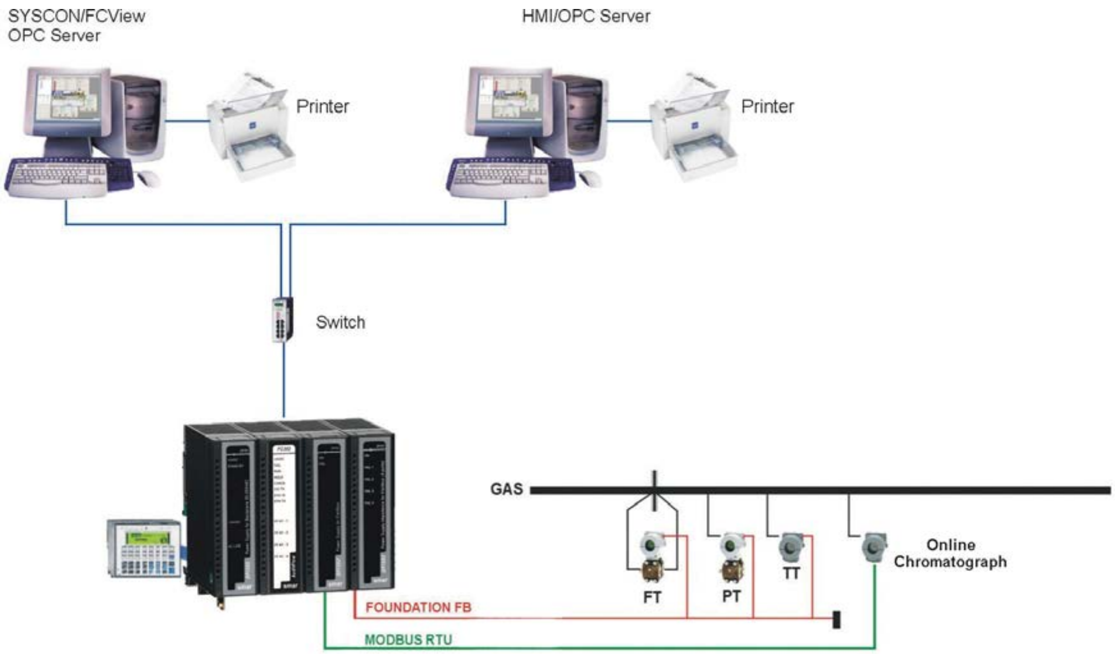
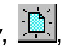


Figure 13.1 - Gas Measurement Application

Step by Step Configuration

Starting the Area

To create a new Area, go to the *File* menu on Syscon and click *New*. Or click *New*, , on the *General Operation* toolbar.

The *Document Type* dialog box will open. Select the option Area:

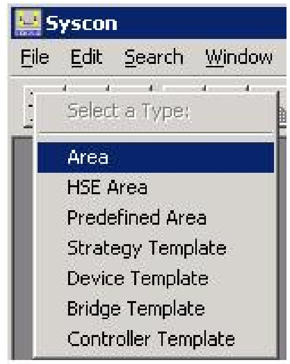


Figure 13.2 - Select the Area Type

After choosing the type of area, a window appears where the user must give a name to the new area .

Figure 13.3 – New area name

Type the name of the area on the *Area Name* box and click *Ok*. In this example, the name of the area will be **FQI-100**.

A new window will open. This window has the following icons:

- **Application** (Logical plant) - In this section, the control strategies are created.
- **Fieldbus Networks** (Physical plant) - In this section, the equipment and function blocks are added.

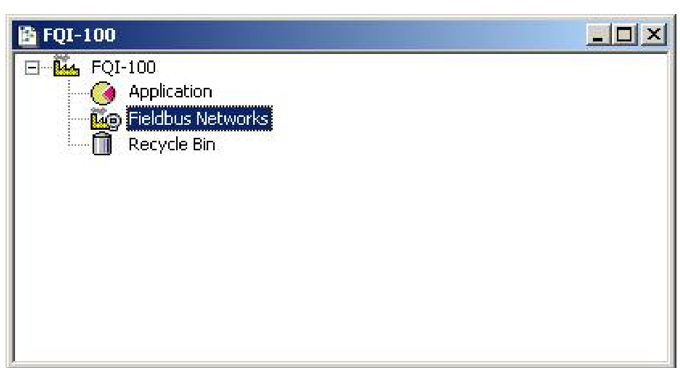


Figure 13.4 – Area divisions

Physical Plant

In the main window, named **FQI-100**, right-click the icon *Fieldbus Networks*, , and select the option *Communication Settings*. Or go to the *Communication* menu and click *Settings*. The dialog box will open to set the communication parameters.

Figure 13.5 - Selecting the Server

Select the option *Smar.DFIOLEServer.0* and click *OK*.

Creating a New Fieldbus

Right-click the *Fieldbus Networks* icon and click the item *New Fieldbus*. The *New Fieldbus* dialog box will open. Select the communication port for the fieldbus, type the tag *Fieldbus* 1 and click *Ok*.

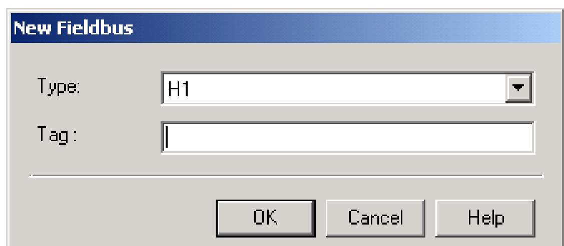


Figure 13.6 - Creating a New Fieldbus

Double-click the *Fieldbus 1* icon to open its window. To organize the screen view, go to the *Window* menu and click *Tile*.

Adding the Bridge

Now add the bridge FC302 in this area. Right click in the Fieldbus 1 and select Bridge.

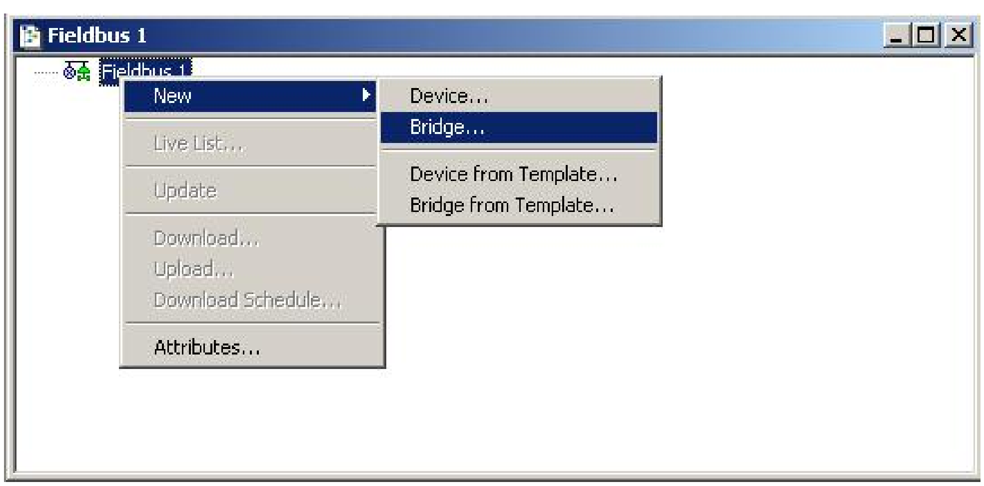


Figure 13.7 - Adding a New Bridge

The *New Bridge* dialog box will open.

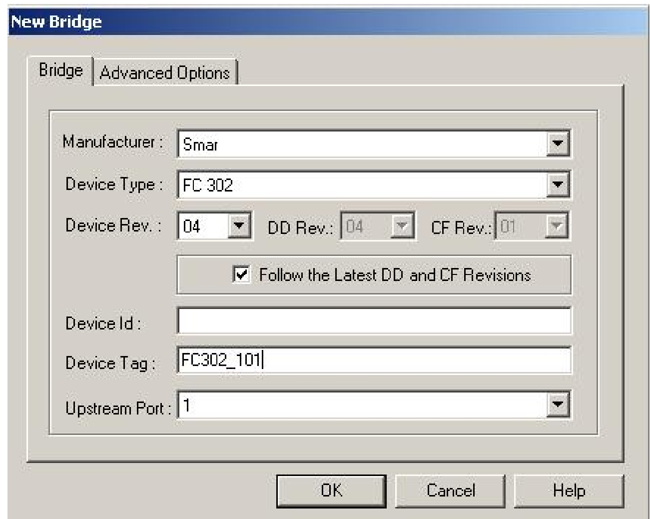


Figure 13.8 - Configuring the Bridge

On the *Manufacturer* box, select *SMAR* and from the drop down menu, select *FC302* as the *Device Type*. On the *Device Tag* box, type *FQI-100* or other related tag and click *OK*.

IMPORTANT

Remember that there are some characters that cannot be used in the tag.

The valid characters are:

```
A-Z a-z 0-9 # { } [ ] ( )+ -
```

The invalid characters are:

```
~ ` ! @ # $ % ^ & * = | : ; , . < > ? / ' " \
```

HINT

To better identify the equipments used in the area, it is recommended to use the equipment's serial number as the device tag. In this example, use *FC302_101*, where 101 is the serial number of the FC302 used. This hint also applies to field devices added to the area.

Adding Fieldbus Devices

Now add the devices that will be used in this area.

First, add the Smar *Temperature Transmitter – TT302*.

In the *Fieldbus 1* window, right-click the *Fieldbus1* icon. Click the item *New* > *Device*. The *Device* dialog box will open:

1. Select *Smar* in the *Device Manufacture* box.
2. Select the *TT302 Device* in the *Device Type* box.
3. Type the tag *Temperature* in the *Device Tag* box.
4. Click *OK*.

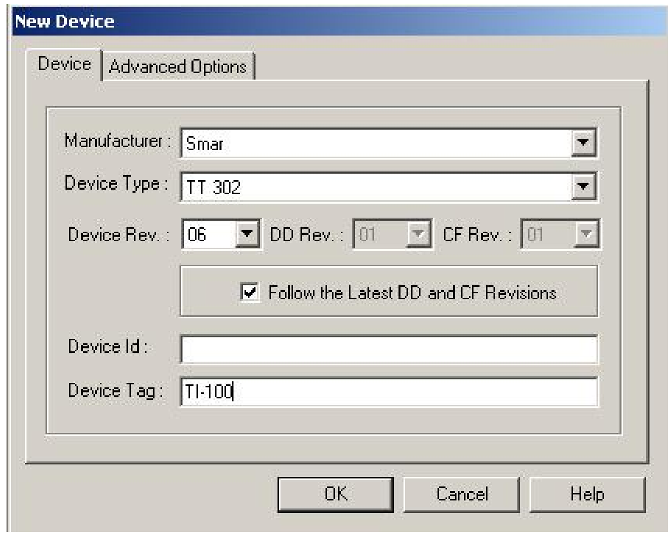


Figure 13.9 - Selecting the Transmitter

Follow the same procedure to add the Smar *Pressure Transmitter – LD302* with the tag *Differential Pressure*, and the Smar *Pressure Transmitter – LD302* with the tag *Static Pressure*.

After finishing this process, the *Fieldbus 1* window should look like the following figure:

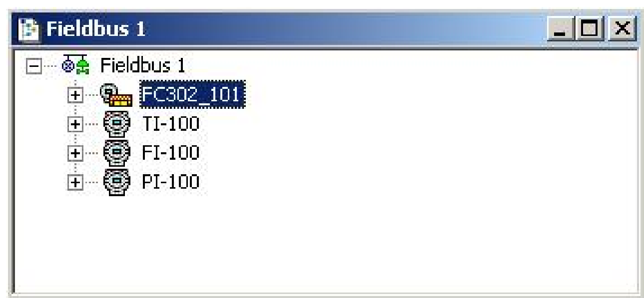


Figure 13.10 - Transmitters in the Fieldbus 1

Setting up the macrocycle of *Fieldbus 1*

Right click on the *Fieldbus 1*, select *Attributes*. Set up the Macrocycle to 1000 ms and click in the Override button as shown in the following figure.

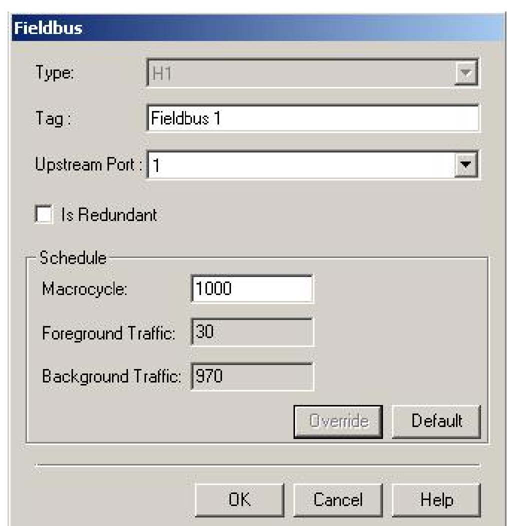


Figure 13.11 - Setting up Macrocycle of Fieldbus 1

Adding Function Blocks

Now the user can add the function blocks.

The *MIB* is responsible for data management.

Click the expansion sign ⊞ of the device icon, right-click the *FB VFD* icon (*Virtual Field Device*) and select the option *New Block*.

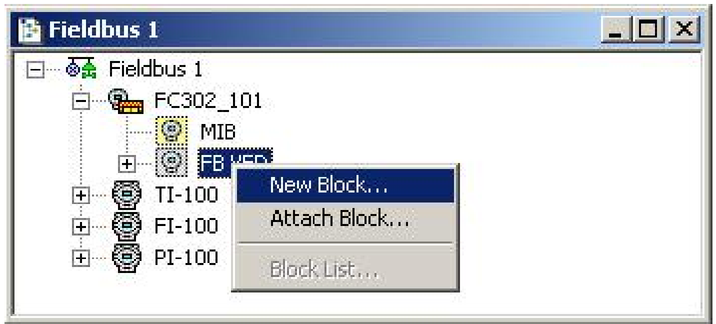


Figure 13.12 - Adding a New Block to FC302

The *New Block* dialog box will open. In the *Block Type* box, select the type of the block from the list of blocks available in the device. On the *Block Tag* box, type the tag for the new block. The figure below shows the *Gas Flow Calculation* block:

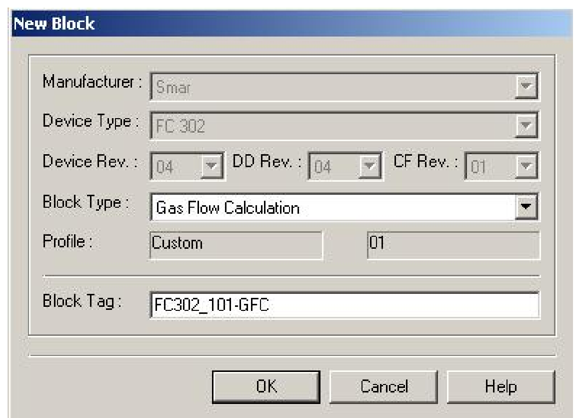


Figure 13.13 - Selecting a GFC Block

In this example, the blocks GFC, GT, GTV, ATV and AEV will be used to configure the application in the FC302.

Repeat the procedure from above to add the Analog Input blocks to the transmitters:

Device	*Block Type*	Block Tag
TI-100	Analog Input	TI-100-AI
FI-100	Analog Input	FI-100-AI
PI-100	Analog Input	PI-100-AI

NOTE
From SYSCON version 6.00 or higher, it is not necessary to configure the *Transducer Block* (TRD), the *Resource Block* (RES), *Diagnostics* (DIAG) and *Display* (DSP), because these blocks are already instantiated in the equipment.

The channel configuration with all devices and blocks is represented in the figure below. The *Transducer*, *Resource* and *Diagnostics* blocks have specific tags to better identify them.

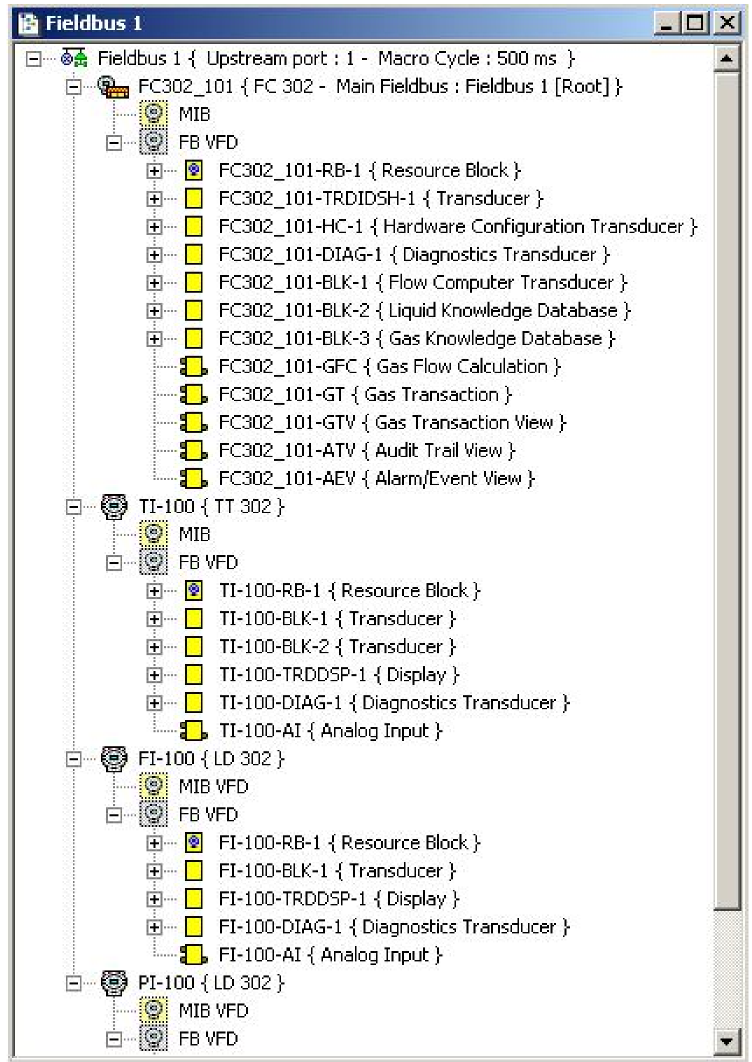


Figure 13.14 - Fieldbus Channel Configuration

Now, the user can create the strategy control. First, it is necessary to create a process cell.

Creating New Process Cells

The Logical plant can be divided in many process cells, according to the plant.

To create a new process cell, right-click the Application icon and select *New Process Cell.*

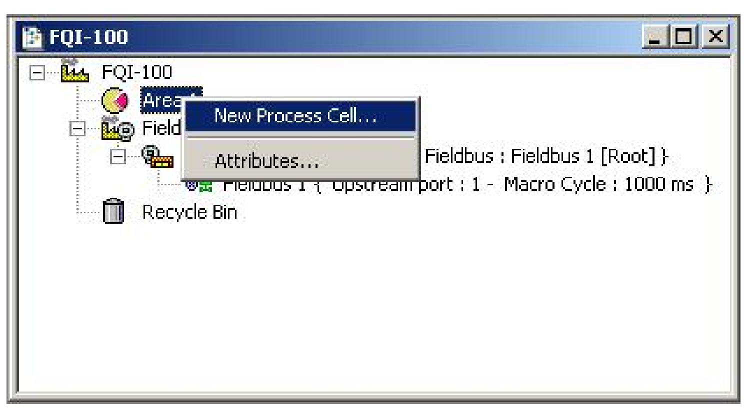


Figure 13.15 - Adding a Process Cell

The *Process Cell* dialog box will open:

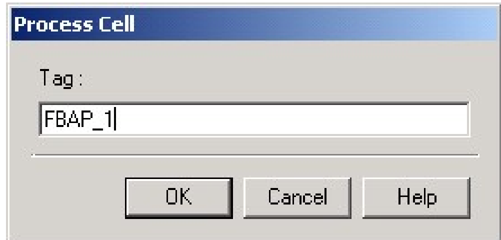


Figure 13.16 - Typing a tag for the Process Cell

Type the tag for the process cell and click *OK*. Repeat this procedure to create other process cells.

The area window will be similar to the following figure.

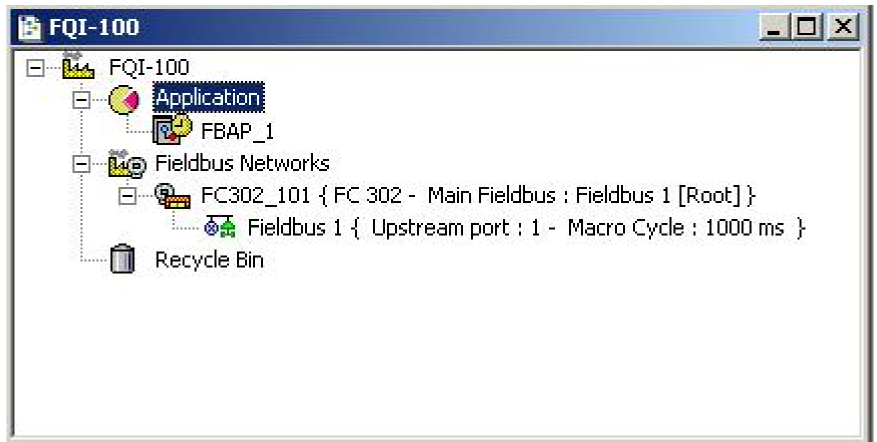


Figure 13.17 – Area Window

Creating a Control Module (FBApplication)

Proceeding with the project, now the user must create a *Function Block Application* in the *Application*.

Right-click the *FBAP_1* icon and select *Expand*.

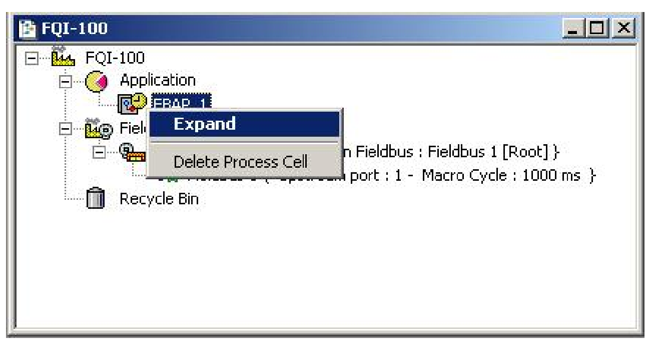


Figure 13.18 - Opening the Process Cell Window

To organize the windows in the screen, click the *FBAP*_01 window, go to the *Window* menu and select *Tile*.

On the *FBAP_01* window, right-click the *FBAP_01* icon and select *New Control Module*.

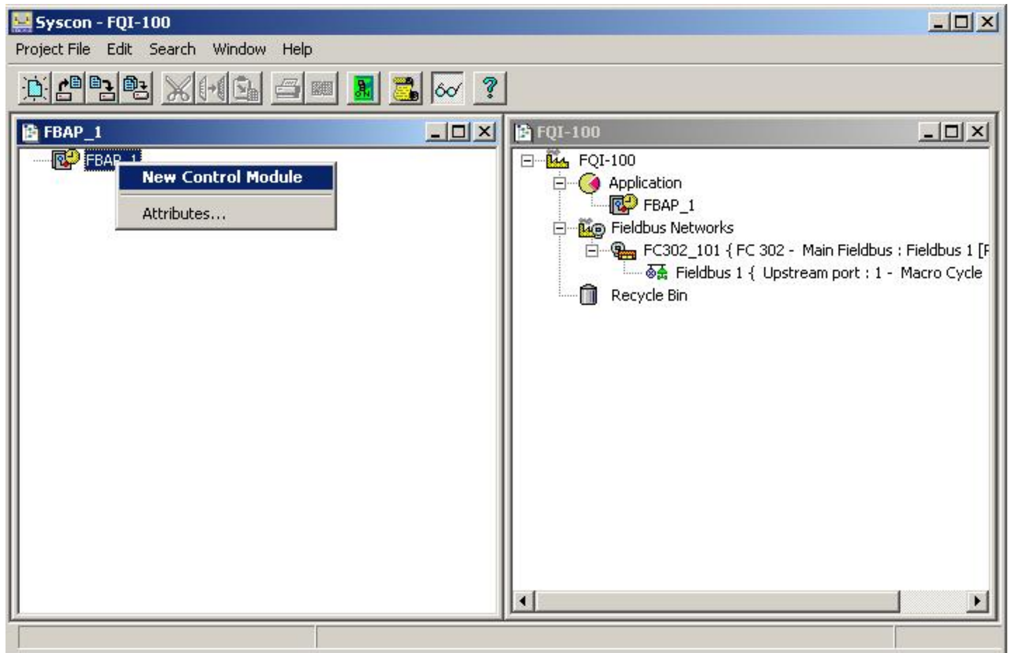


Figure 13.19 - Creating a Control Module

The *New Control Module* dialog box will open. Type the tag for the control module and click *OK*.

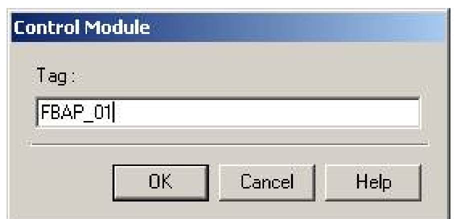


Figure 13.20 - Editing the tag of the Control Module

IMPORTANT
Remember that there are characters that cannot be used as in the tag.

Attaching the Blocks to the Control Module

Now you can attach the blocks from the devices to the control module. Right-click the *FBAP_01* icon and select the option *Attach Block*.

Figure 13.21 - Attaching Blocks to the Control Module

The *Attach Block* dialog box will open:

Figure 13.22 - Selecting Blocks

The blocks that can be attached to the control module are listed in this dialog box. Select also de AI block of TT302 and click *OK*. Repeat the procedure for both LD302.

The process cell window will be similar to the figure below:

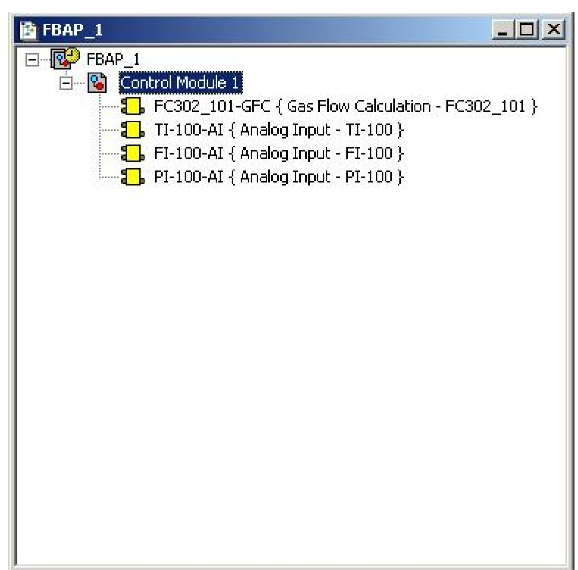


Figure 13.23 - Blocks Added to the Control Module

Another easy way to attach the blocks to the control module is to click the block icon in the fieldbus window and drag it to the process cell window.

Configuring the Control Strategy

Now the user is ready to develop the control strategy.

First, right-click the *Control Module 1* icon and select the option *Strategy*. The strategy window will open:

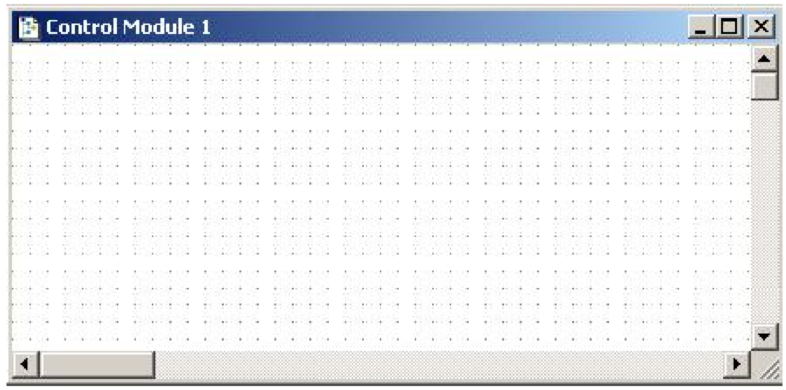


Figure 13.24 - Strategy Window

At this moment, there might be 3 or 4 windows opened in SYSCON. Minimize the *H1_1* window. Go to the *Window* menu and click the option *Tile*.

If the monitor is not bigger than 17", it is recommended to maximize the strategy window to visualize the entire area.

The strategy window offers several drawing tools. For details, refer to the SYSCON manual.

Adding Blocks to the Strategy Window

The blocks can be added to the strategy window *Control Module 1*.

Click the first block FC302_101-GFC, and drag it to the strategy window. The block will be created automatically. See the following figure:

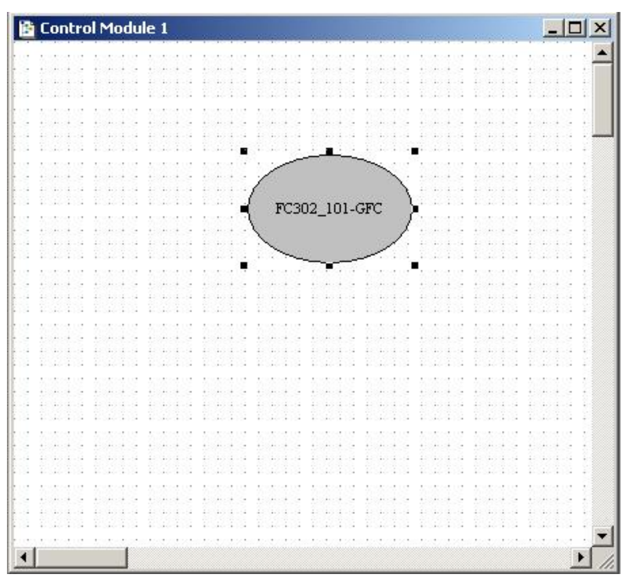


Figure 13.25 - Block Added to the Strategy Window

Repeat this procedure to drag the blocks *TI-100-AI*, *FI-100-AI2* and *PI-100-AI* to the strategy window.

Linking Blocks

Click the *Link* button, , in the *Strategy* toolbar, to connect the blocks.

Click the *Link* button and click the block *TI-100-AI*. A dialog box to select the output parameter will open. Select the parameter *Out* and click *OK*.

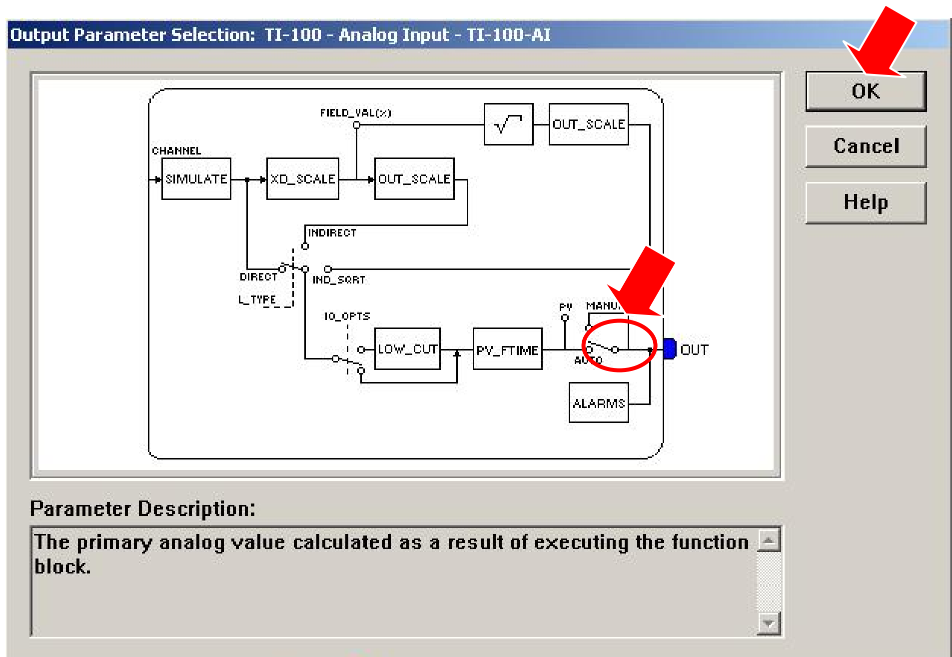


Figure 13.26 - Linking Blocks

Move the mouse cursor over the second block that will be linked to the first one (*FC302_101-GFC*), click on it, then click on the input of block (TF).

A faster way to create the link is right-clicking the *TI-100-AI* block, select OUTk right-clicking the *FC302_101-GFC block and select TF*.

Create the following links for this strategy:

- OUT(TI-100-AI) ➔ TF(*FC302_101-GFC*)
- OUT(FI-100-AI) ➔ DIFF_PF(*FC302_101-GFC*)
- OUT(PI-100-AI) ➔ PF(*FC302_101-GFC*)

The figure below shows the strategy window after connecting the parameters listed above.

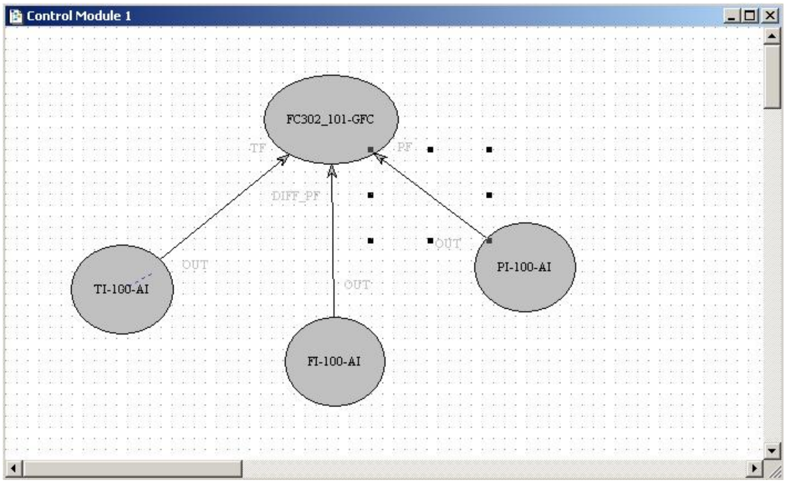


Figure 13.27 - Strategy Window

Block Characterization

The blocks added to the area must be parameterized according to the application.

The characterization can be performed in *offline* or *online* mode. In the *offline* mode, the parameters are configured before initializing the communication with the devices. In the *online* mode, the parameters are configured in the devices when the plant is already communicating with the system.

To configure the block parameters, follow these steps:

1. In the Strategy Window

Select the block to be configured. Right-click the block and select the option *Off Line Characterization,* or double-click the block. Observe the following figure:

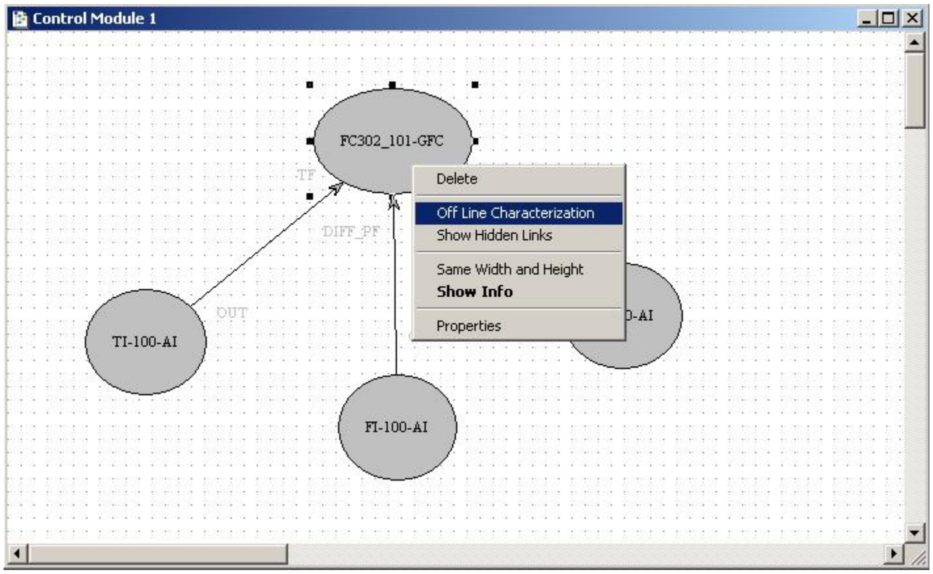


Figure 13.28 - Block Offline Characterization in the Strategy Window

2. In the H1_1 Window

Another way to parameterize the block is right-clicking the block in the fieldbus window and selecting the option *Off line Characterization*, as indicated below:

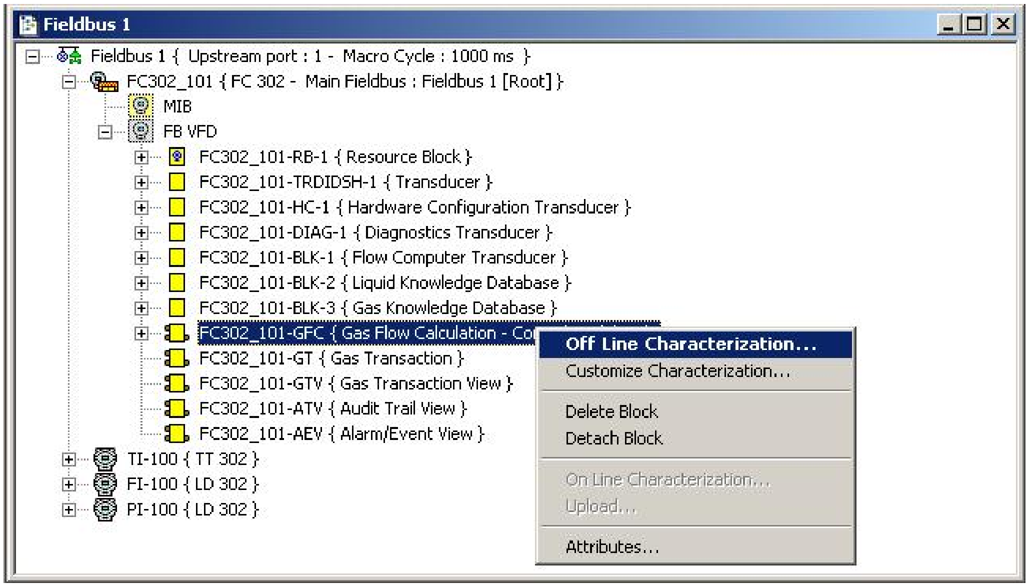


Figure 13.29 - Block Offline Characterization in the Fieldbus Window

In both cases, the *Block Characterization* dialog box will open:

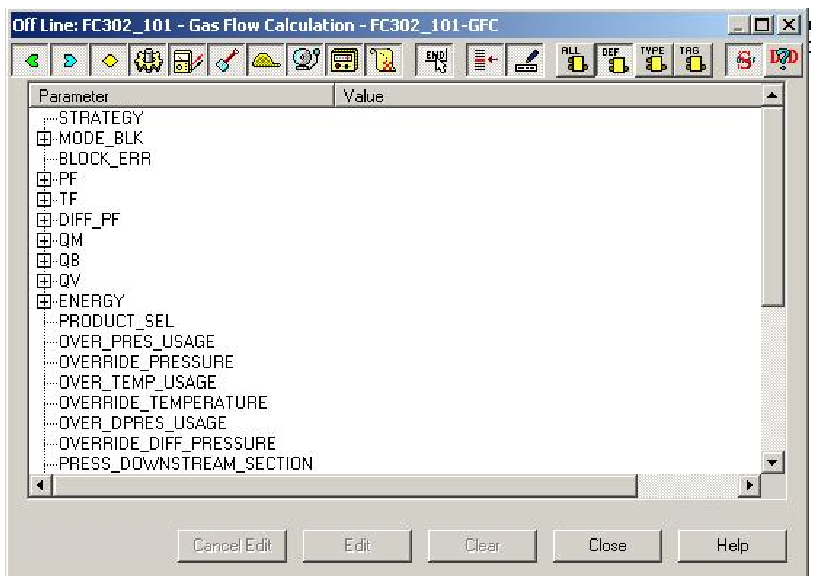


Figure 13.30 - Block Characterization Dialog Box

Double-click the *Value* column in front of the parameter that will be modified. Or click the parameter and click the button *Edit* to edit the parameter value. Click *End Edit* to conclude the alteration.

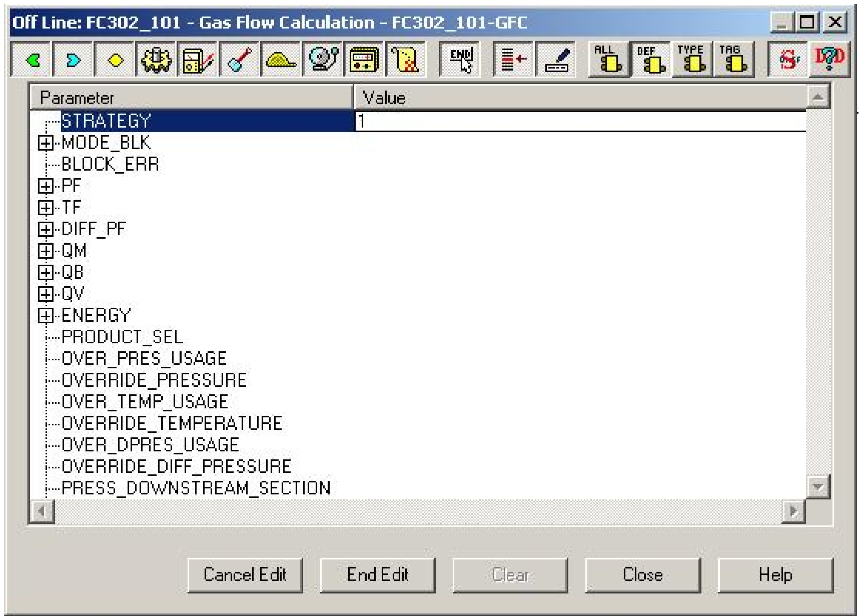


Figure 13.31 - Editing the Parameters

The list of the parameters to be configured in this area is described below:

DEVICE TAG	BLOCK TAG	PARAMETER
FC302_101	FC302_101-GFC	STRATEGY=1
		MODE_BLK.Target = AUTO
	FC302_101-GT	STRATEGY=1
		MODE_BLK.Target = AUTO

DEVICE TAG	BLOCK TAG	PARAMETER
TI-100	TI-100-AI	MODE_BLK.Target = AUTO

DEVICE TAG	BLOCK TAG	PARAMETER
FI-100	FI-100-AI	MODE_BLK.Target = AUTO

DEVICE TAG	BLOCK TAG	PARAMETER
PI-100	PI-100-AI	MODE_BLK.Target = AUTO

Initializing the Communication

Click the *Operation Mode* button, , on the *General Operation* toolbar, to initialize the communication.

The video clip below should appear for a couple of seconds. During this time, SYSCON will identify and attach any bridges installed in the computer and added to the configuration.

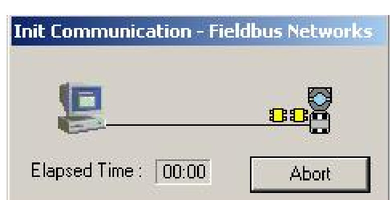


Figure 13.32 - Initializing the Communication

Commissioning the Bridge

Note that at this point, if all the procedures were completed successfully, a red symbol will be displayed in the top-left side of each device and bridge icon ( ). This means that the Device IDs were not commissioned yet.

On the fieldbus window, right-click the bridge icon and click the option *Attributes*.

The following dialog box will open:

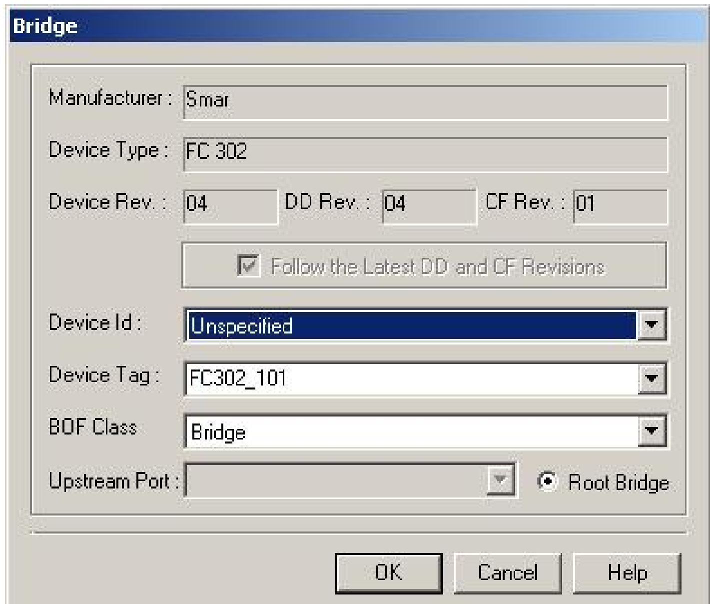


Figure 13.33 - Attributes Dialog Box

Select the device in the Device Id as shown below.

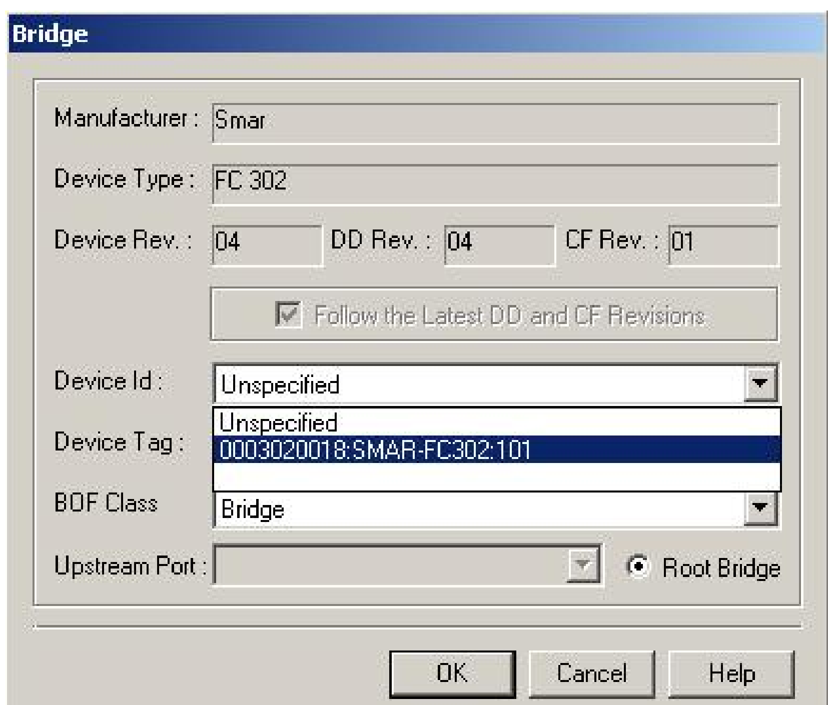


Figure 13.34 - Device Selection

Select the bridge and click *OK* The following dialog box will open while the device is being commissioned:

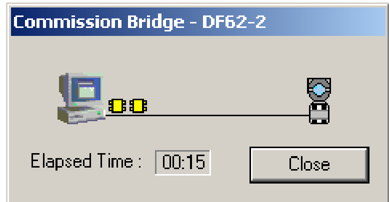


Figure 13.35 - Commissioning the Bridge

Now the red symbol in the bridge icon disappears:

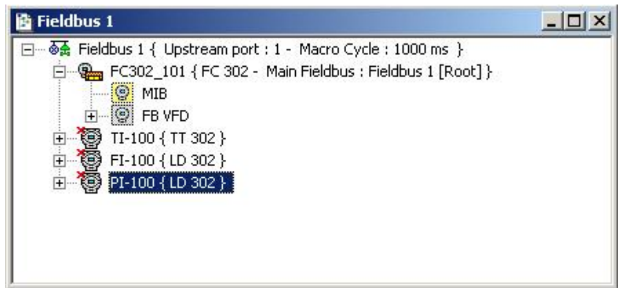


Figure 13.36 - H1 Channel after Commissioning the FC302

Clicking right in the bridge, select the Assign Tag.

Commissioning Devices

Each device must be commissioned using the procedure described for the bridge. Right-click the device icon, click the option *Attributes* and select the proper Device ID to each device.

IMPORTANT
If there are differences between the device configuration in the SYSCON file and the physical device, SYSCON will execute the *Exchange* procedure for the device, which means that the information in the configuration should be compatible to the information in the physical equipment.

Don't forget to save the area configuration by clicking Save Entire Configuration button.

Checking the Commissioning

For every channel (or segment), open the fieldbus window, right-click the fieldbus icon and select the option *Live List*:

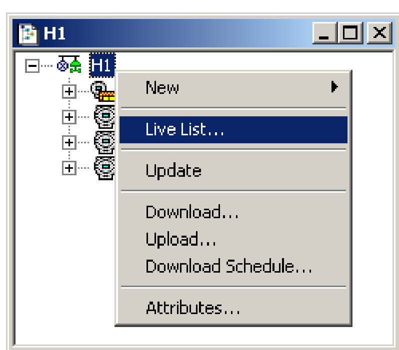


Figure 13.37 - Live List

Another window will list all devices connected to this segment, as in the example below:

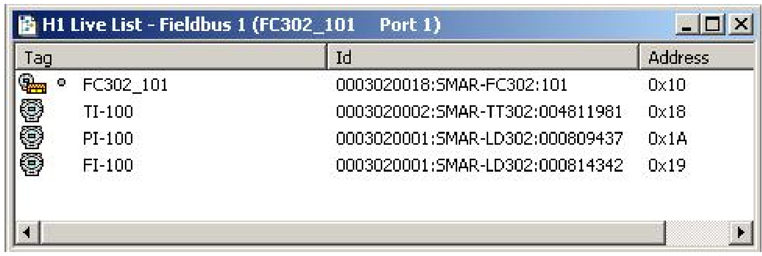


Figure 13.38 - Checking the Live List

Erasing the Error Log Registry

It is important to clear the *Error Log Registry* before downloading the configuration, because any eventual error that might occur during the download process will be easily detected as the *Error Log* window pops up automatically when the first error occurs.

Click the button , on the *General Operations* toolbar. The *Error Log* window will open. (If the button is not enabled, this step won't be necessary).

Right-click inside this window and select the option *Clear Log*, as indicated:

Figure 13.39 - Erasing the Error Log Registry

Plant Configuration Download

In the area window, click the Fieldbus Networks icon, go to the *Communication* menu and click the item *Download*. Or right-click the Fieldbus Networks icon and select the item *Download*.

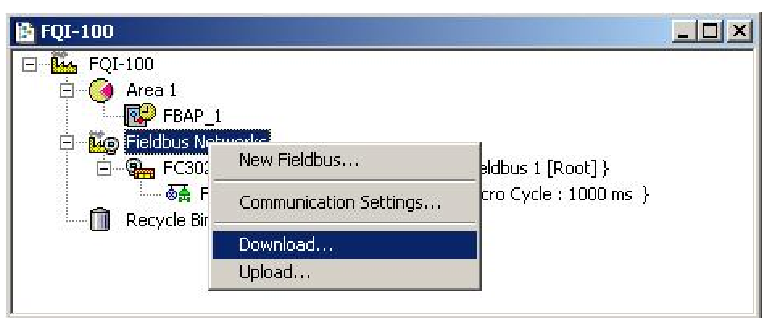


Figure 13.40 - Fieldbus Configuration Download

The *Download* dialog box will open. To download the entire configuration to the plant and click *Start*.

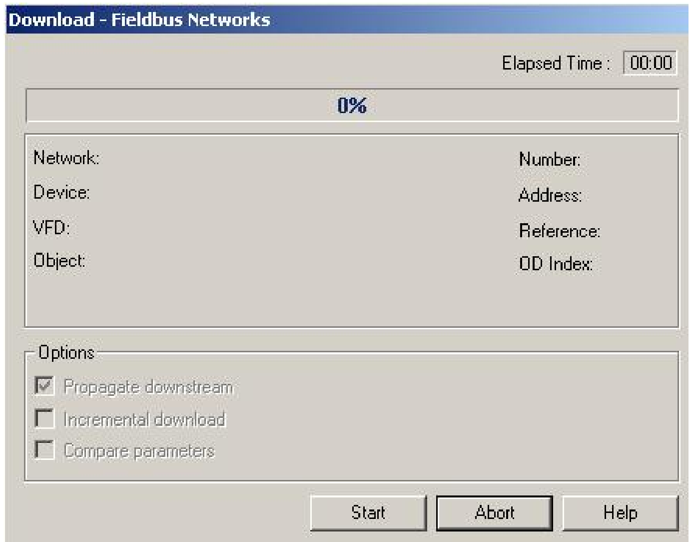


Figure 13.41 - Complete Download

Exporting Tags

Preferences

Before executing the *Export Tags* procedure, select the operation mode and the path to the *Taginfo.ini* file.

On the *File* menu, click *Preferences*. The *Preferences* window will open. Select the *Export Tag* tab.

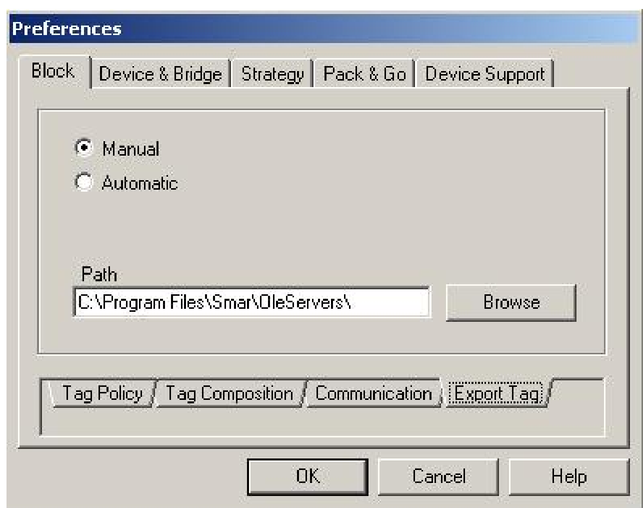


Figure 13.42 - Setting the Export Tag Preferences

Select the *Manual* or *Automatic* mode and type the path to the *Taginfo.ini* file. In this example, the path to the file is *C:\Program Files\ Smar\OleServers*.

Exporting Tags

In the area window, right-click the area icon and select *Export Tags*, as indicated below:

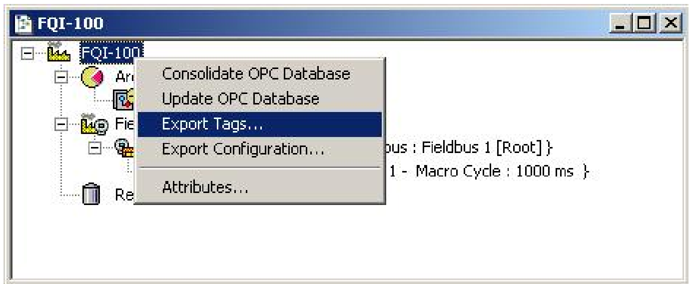


Figure 13.43 - Exporting Tags

The *Browse for Folder* dialog box will open.

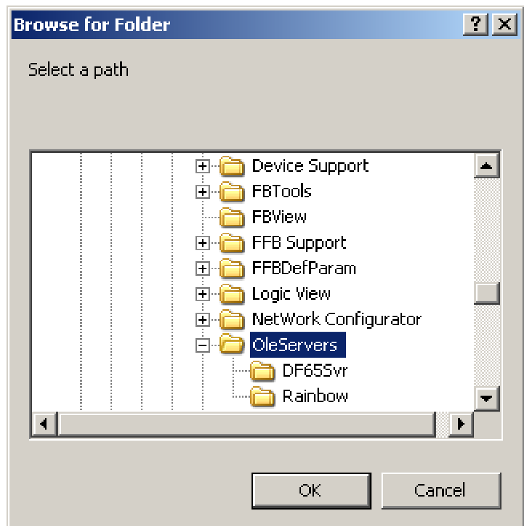


Figure 13.44 - Selecting the Folder to Export the tags

If the path to save the *Taginfo.ini* file was configured in the Preferences window, the dialog box will show the correct folder to this file. Otherwise, select the folder *C:\Program Files\Smar\OleServers* and click *OK*.

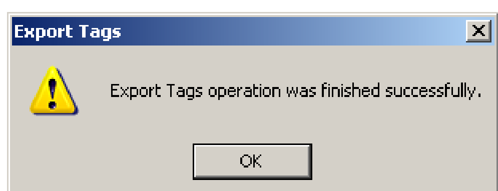


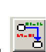
Figure 13.45 - Exporting the tags

Click *OK* to conclude.

NOTE
The *Export Tags* procedure must be executed only once, unless the tags in the area configuration are changed. In this case, execute again the procedure to update the file.

On-Line Supervision

It is possible to monitor the control strategy when SYSCON is operating in On-Line Mode.

Open the Strategy window, click the *On Line Monitoring* button, , in the *Strategy* toolbar. Click on the strategy window again. The figure below shows the process values being monitored.

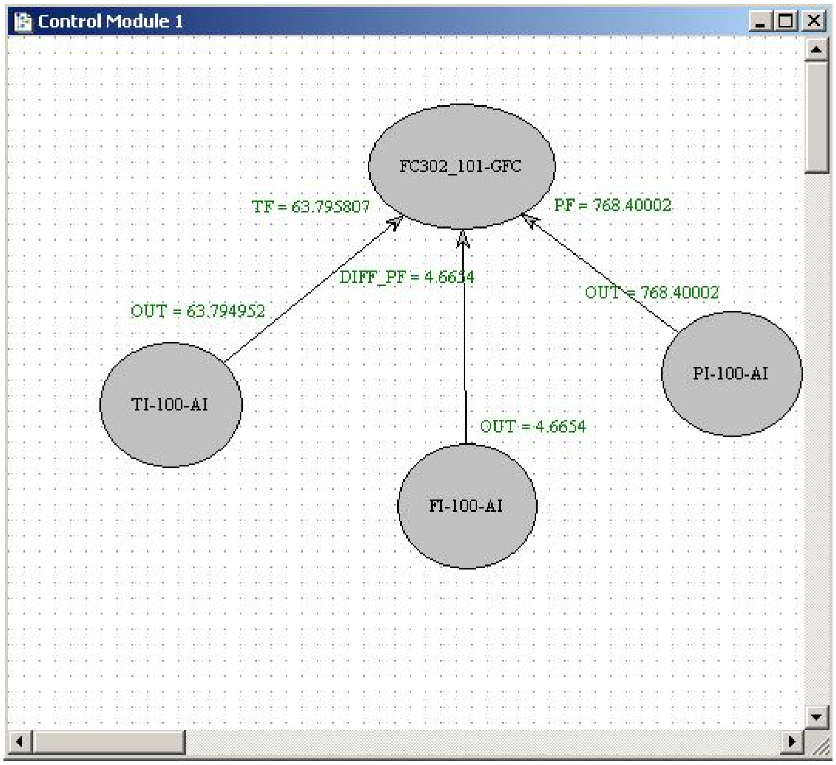


Figure 13.46 - On-Line Supervision

The green links indicate that there are no communication failures. When a failure occurs, the link color changes to red. See the example in the figure below that simulates a failure in the temperature sensor *PT100*.

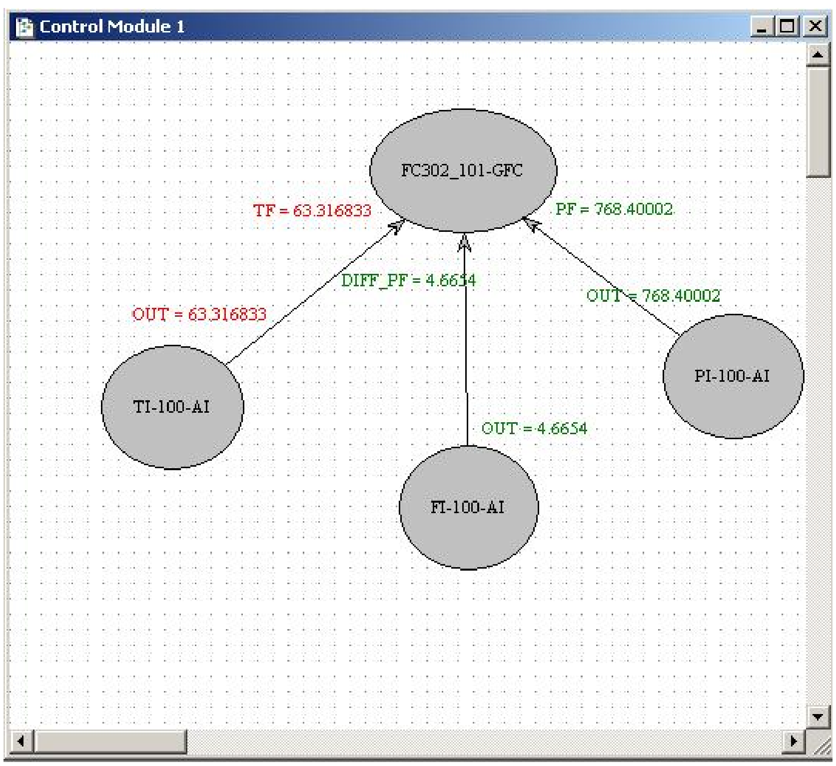


Figure 13.47 - Failure Simulation in the Strategy Window

On-Line Characterization

It is possible to monitor the block parameters when SYSCON is operating in On-Line Mode by right clicking in the block in the Fieldbus 1 window.

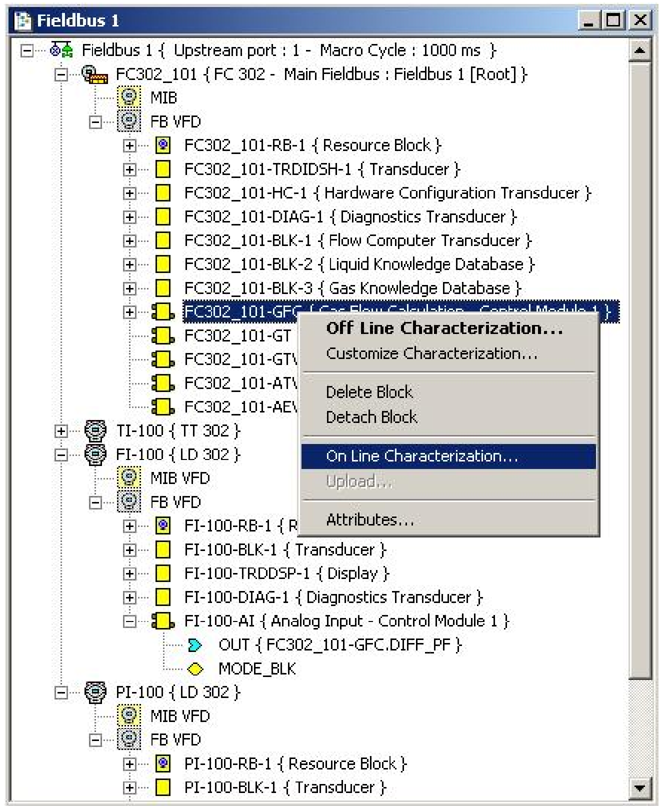


Figure 13.48 - Online Characterization

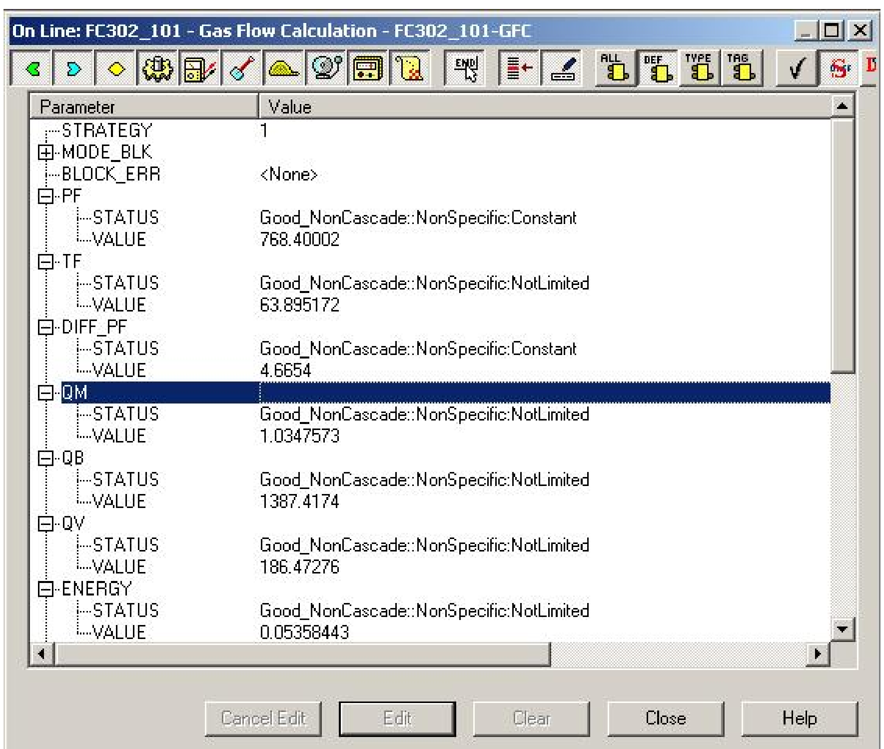


Figure 13.49 - Online Characterization

Chapter 14

AUDIT TRAIL AND ACCESS RESTRICTION

Access Restriction

The change in the configuration with audit trail and access restriction uses access level and Password in the FCT block, represented as:

- **Administrator Level (AA):** This level allows the user to have complete access to change the configuration, including password configuration, logger initialization and firmware download and configuration download.
- **Level 1 (A1):** It allows the download of the configuration and writing to all parameters, including critical ones.
- **Level 2 (A2):** It allows writing to regular parameters.

Some changes in the configuration have access restriction, but they are not trackable, such as the passwords and login configuration. These parameters are indicated by RA, R1 and R, according to the level required.

Before writing to the parameters being tracked, it is necessary to write to the parameter LOGIN or USER_NAME, and then to the parameter PASSWORD_CODE. If the Logon is executed with success, the user will have the time interval configured in the FCT.LOGON_TIMEOUT parameter to write to these parameters. Each time a parameter being tracked is written, this timeout is retriggered. After that, it will be necessary to write to the PASSWORD_CODE parameter again.

Password-Restricted Operations

The operator must be logged in the system to perform the following operations:

- Firmware Download: switching to hold mode (specific mode for this operation) through the FBTools requires an Administrator level.
- Configuration Download: requires an Administrator level logon.
- Writing to specified parameters with access restriction: in this case, the access level required is defined in the block description (chapter 9), at the Index column in the parameters table.

Communication Restriction

The user must logon to the system to change the AuditFlow configuration using:

- Syscon.
- FCView.
- Supervisory application through OPC Server, Modbus TCP/IP or Modbus RTU.
- Local Panel: Modbus TCP/IP or RTU.

The audit trail is warranted by any one of the applications listed above, because the AuditFlow system saves the configuration log in the device's NVRAM memory.

Logger Mechanism

The AuditFlow mechanism for audit trail has the following features:

- The FC302 module saves the information in the NVRAM memory to generate the reports in FCView, classified by the following types:

    - QTR: custody transfer reports (ticket);
    - Configuration log;
    - Process alarm and event reports;
    - Proving reports;
    - Well Test reports.

- The logger uses the FC302 NVRAM memory independent from the visualization blocks (GTV, LTV, ATV, AEV, LMFV and WTV), that is, the memory area is pre-allocated and has fixed size, independent from the configuration.

- The logger uses the FIFO logic (First In First Out). The reports are stored in a chronological sequence and the oldest report is discarded when a new report is generated in memory.

- When the new report is generated, it receives the "Not-stored" status. When FCView reads and saves it in the database, this status changes to "Stored". Therefore the status indicates if the report has alredy been copied from the FC302 memory to the database.

- FC302 can automatically print a report/register while saving in the database (this option is configured in FCView).

- Even after changing the report/register status to "Stored" in the logger (after saving to the database), the report/register continues in the FC302 memory until being replaced by the FIFO algorithm.Meanwhile, it is possible to force a new reading and storage in the database, if it hasn't been registered yet, through the Restore operation in FCView. Refer to the FCView chapter for further information.

- There are two alarm levels related to the status of each type of logger: warning and overflow.
    - Warning: there is a report/register in the logger that hasn't been stored in the database yet and there is a risk of being overlaid by a new one. The warning alarm indication of the logger occurs when one of the five oldest registers/reports has the "Not-stored" status.
    - Overflow: The overflow alarm indication occurs when a report/register overflows another report/register with the "Not-stored" status, and in this case the user must acknowledge the alarm, writing to the LOG_STATUS parameter.
    - These alarms are also indicated by the output parameters (WARNING and OVERFLOW) of each visualization block.

- The registers/reports of the logger have a CRC calculation to guarantee the consistence and the integrity of the data read from the FC302 memory.

- There is a mechanism that allows only one specific computer running FCView to transfer the reports/registers from the FC302 to the database. While FCView is storing the information from a specific FC302, the value of the parameter FCT.FCVIEW_VSN is confronted with the Volume Serial Number of the computer HDrunning FCView.

Report Persistence in the AuditFlow Memory

The persistence of the information in the logger follows the rules:

- When operating in normal condtions, a report/register of the logger is lost only when an overflow occurs, caused by a new report/register generation following the FIFO mechanism.

- Even after transferring the register/report from the NVRAM memory to the database using FCView, and consequently changing the status to Stored, the register/report remains in the NVRAM memory.

- The FC302 configuration download doesn't affect the registers/reports stored in the NVRAM memory.

- When downloading a compatible version of the firmware, regarding the logger, the registers/reports are preserved in the memory.

- In the "factory initialization" condition (after the firmware download or reset mode 1) or reset (when powering the equipment), the control variables of the logger, including the version of the logger, are checked and if any abnormality is detected, the variables will be initialized. This abnormality would imply in losing registers/reports in the memory.

- The FCT.CLEAR_LOG parameter allows the initialization of all logger.

- Writing to the parameters FCT.GAS_QTR or FCT.LIQ_QTR initializes the QTR's logger.

Report Type	Initialization
QTR (GTV,LTV)	• FCT.CLEAR_LOG • Configuring the QTR quantity for gas and liquid (FCT.GAS_QTR and FCT.LIQ_QTR). • Abnormality in the control variables of the logger
Configuration change (ATV) Alarms and Events (AEV) Proving Reports (LMFV) Well Test Reports (WTV)	• FCT.CLEAR_LOG • Abnormality in the control variables of the logger.

Configuration log of Foundation Fieldbus Transmitters

Observe the following items when configuring H1 Foundation Fieldbus devices to certify that the logger for configuration change will work properly:

- Use only RS, TRD, AI and DSP blocks in field devices, regarding the sensor data processing. Concentrate the calculation and processing in the FC302, ..

- Disable the local tuning, removing the jumper from the Smar transmitters.

- AuditFlow system provides restricted access and stores the configuration change of all Smar Foundation Fieldbus transmistters.

Events Registered by AuditFlow

The following events are registered in the logger:

- Power down;
- Power up;
- Override temperature used;
- Override temperature cleared;
- Override pressure used;
- Override pressure cleared;
- Override density used;
- Override density cleared;
- Override SW used;
- Override SW cleared;
- Override Diff. pressure used;
- Override Diff. pressure cleared;
- Bad pulse input occurred;
- Bad pulse input cleared;
- Flowing Out of range correction factor occurred;
- Flowing Out of range correction factor cleared;
- Hourly Out of range correction factor occurred (if enabled in ENABLE_REPORT);
- Hourly Out of range correction factor cleared (if enabled in ENABLE_REPORT);
- Daily Out of range correction factor occurred (if enabled in ENABLE_REPORT);
- Daily Out of range correction factor cleared (if enabled in ENABLE_REPORT);
- Weekly Out of range correction factor occurred (if enabled in ENABLE_REPORT);
- Weekly Out of range correction factor cleared (if enabled in ENABLE_REPORT);
- Monthly Out of range correction factor occurred (if enabled in ENABLE_REPORT);
- Monthly Out of range correction factor cleared (if enabled in ENABLE_REPORT);
- Batch Out of range correction factor occurred;
- Batch Out of range correction factor cleared;
- Configuration download;
- Rollover accum. Totalizer Qv;
- Rollover accum. Totalizer Qb;
- Rollover accum. Totalizer Qm;
- Rollover accum. Totalizer Energy;
- Rollover Totalizer MR;
- Initialization of loggers;
- Start of daylight saving;

- End of daylight saving;
- Switchover – Main is active;
- Switchover – Backup is active;
- Factory initialization;
- Bad analog input – flow;
- Stop totalization – override never use;
- Restore of loggers;
- FC302 - too high temperature – occurred;
- FC302 - too high temperature – cleared;
- FC302 - low voltage battery – occurred;
- FC302 - low voltage battery – cleared;
- GTV : Inconsistency fixed;
- LTV : Inconsistency fixed;
- LMFV : Inconsistency fixed;
- WTV : Inconsistency fixed;
- ATV : Inconsistency fixed;
- AEV : Inconsistency fixed;
- Rollover Hourly IV;
- Rollover Daily IV;
- Rollover Weekly IV;
- Rollover Monthly IV;
- Rollover Batch IV;
- Bad GAS_QB_IN.

Calculation Procedure for Rollover of IV Totalizer

The volume totalizer for liquid at flowing conditions (IV) for a specific period or batch has a maximum value that is the same to the specified value for rollover of Non-Resetable Totalizer (MR). See the LBT or LCT description in the Function Blocks chapter for further details.

If a Rollover IV occurs, it is recommended to select the suitable engineering unit for volume (FCT.LV_UNITS). However, if such situation occurs, it is also possible to calculate manually using data of the QTR reports following the procedure below:

- Select a calculator with 12 significative digits or more. One available option is using the Windows calculator.
- Check the number of rollovers occurred during the period, checking the alarm and event report (AEV).
- Multiply the number of occurrences by the rollover value that depends on the engineering unit selected for volume (LV_UNITS).
- Add with the IV value indicated in the QTR report.
- Calculate: GSV = IV * CCF, where CCF is the value showed in the QTR report.
- Calculate: NSV = GSV * CSW, where CSW = 1 – SWWA/100 and SWWA is the value indicated in the QTR report.

Procedure before the configuration download and/or firmware download

The reports in the FC302 memory are preserved during the configuration download, but it depends on the compatibility of logger version for firmware download.
It is recommended in both situations the following procedure before executing the download:

- Stop the product transferring;
- Finish the batches through reset command, it will cause report generation with the transferred quantities;
- Let FCView read all reports and store them in database;
- Execute the firmware and/or configuration download.

Blocks in Transmitters with configuration log

The parameter list of each block type below refers to the tracking, when running in a field device.

Parameter List

RS Block :

Rindex	Mnemonic
5	MODE_BLOCK

AI Block:

Rindex	Mnemonic
3	STRATEGY
5	MODE_BLOCK
8	OUT
9	SIMULATE
10	XD_SCALE
11	OUT_SCALE
13	IO_OPTS
14	STATUS_OPTS
15	CHANNEL
16	L_TYPE
17	LOW_CUT
18	PV_FTIME

TRD-LD:

Rindex	Mnemonic
3	STRATEGY
5	MODE_BLK
13	PRIMARY_VALUE_TYPE
16	CAL_POINT_HI
17	CAL_POINT_LO
22	SENSOR_SN
34	CUTOFF_FLAG
40	BACKUP_RESTORE
41	SENSOR_RANGE_CODE
42	COEFF_POL0
43	COEFF_POL1
44	COEFF_POL2
45	COEFF_POL3
46	COEFF_POL4
47	COEFF_POL5
48	COEFF_POL6
49	COEFF_POL7
50	COEFF_POL8
51	COEFF_POL9
52	COEFF_POL10
53	COEFF_POL11
54	POLYNOMIAL_VERSION
55	CHARACTERIZATION_TYPE
56	CURVE_BYPASS_LD
57	CURVE_LENGTH
58	CURVE_X
59	CURVE_Y
64	CAL_TEMPERATURE
69	ACTUAL_OFFSET
70	ACTUAL_SPAN

TRD-TT:

Rindex	Mnemonic
3	STRATEGY
5	MODE_BLK
13	PRIMARY_VALUE_TYPE
16	CAL_POINT_HI
17	CAL_POINT_LO
20	SENSOR_TYPE
27	SENSOR_CONNECTION
31	SECONDARY_VALUE_ACTION
32	BACKUP_RESTORE
38	TWO_WIRES_COMPENSATION
39	SENSOR_TRANSDUCER_NUMBER
41	FACTORY_GAIN_REFERENCE
42	FACTORY_BORNE_REFERENCE

TRD-DT:

Rindex	Mnemonic
3	STRATEGY
5	MODE_BLK
10	TRANSDUCER_TYPE
16	CAL_POINT_HI
17	CAL_POINT_LO
22	SENSOR_SN
34	DEAD_BAND_BYPASS
40	BACKUP_RESTORE
41	SENSOR_RANGE_CODE
42	COEFF_POL0
43	COEFF_POL1
44	COEFF_POL2
45	COEFF_POL3
46	COEFF_POL4
47	COEFF_POL5
48	COEFF_POL6
49	COEFF_POL7
50	COEFF_POL8
51	COEFF_POL9
52	COEFF_POL10
53	COEFF_POL11
54	POLYNOMIAL_VERSION
55	CHARACTERIZATION_TYPE
56	CURVE_BYPASS_LD
57	CURVE_LENGTH
58	CURVE_X
59	CURVE_Y
64	CAL_TEMPERATURE
69	ACTUAL_OFFSET
70	ACTUAL_SPAN
75	GRAVITY
76	HEIGHT
77	MEASURED_TYPE
78	LIN_DILATATION_COEF
79	PRESS_COEF
82	ZERO_ADJUST_TEMP
83	HEIGHT_MEAS_TEMP
84	AUTO_CAL_POINT_LO
85	AUTO_CAL_POINT_HI
86	SOLID_POL_COEFF_0
87	SOLID_POL_COEFF_1
88	SOLID_POL_COEFF_2
89	SOLID_POL_COEFF_3

Rindex	Mnemonic
90	SOLID_POL_COEFF_4
91	SOLID_POL_COEFF_5
92	SOLID_LIMIT_LO
93	SOLID_LIMIT_HI
95	SIMULATED_PRESS_ENABLE
96	SIMULATED_PRESS_VALUE
97	SIMULATED_DENSITY_VALUE
101	DT_RANGE_CODE

TRD-IF:

Rindex	Mnemonic
3	STRATEGY
5	MODE_BLK
16	CAL_POINT_HI
17	CAL_POINT_LO
25	TERMINAL_NUMBER
26	BACKUP_RESTORE
31	FACTORY_GAIN_REFERENCE

Data Structure Types with Configuration log

Besides the simple data types defined by Fieldbus Foundation (FF-890 item 5.3.1. data type from 1 to 14, and 21) for the function blocks, as well as the data type arrays, the following structures are also available for tracking:

DS-65: Value & Status – Floating Point Structure
DS-66: Value & Status – Discrete Structure
DS-68: Scaling Structure
DS-69: Mode Structure
DS-82: Simulate – Floating Point Structure
DS-83: Simulate – Discrete Structure

Note
All elements from the structures above appear as one single register in FC302 and, consequently, in the configuration change report printed by FCView.

Reports/Registers Provided by FC302

The FC302 NVRAM memory provides the following number of registers/reports:

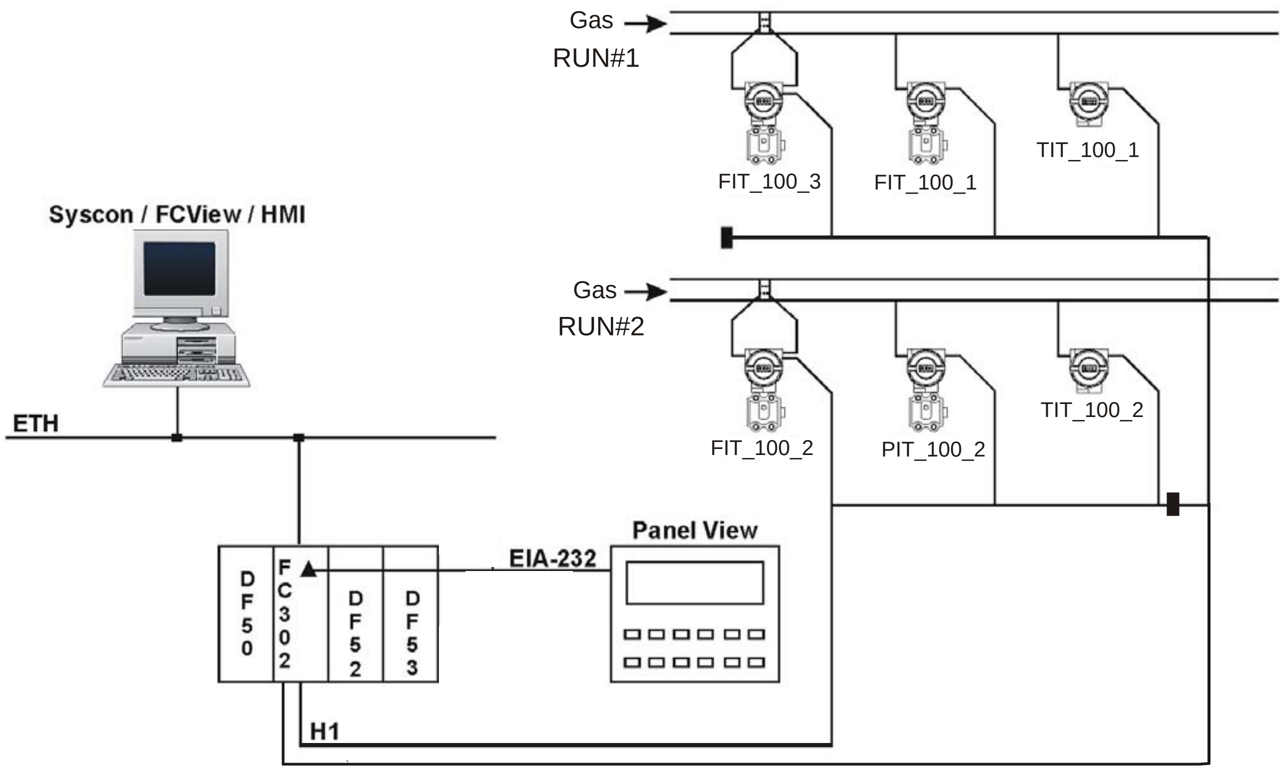
Type	Block	Quantity	
		2 Mbytes	4 MBytes
QTR (operational, hourly, daily, weekly, monthly) (*)	GTV, LTV	1000	4000
Alarms and Events	AEV	200	800
Configuration changes	ATV	200	400
Proving Report	LMFV	10	20
Well Test Report	WTV	2	8

There are two hardware options for the FC302 module: 2 Mbytes and 4 Mbytes.

(*) The quantity of reports specified for QTR is related to the total available for the module. The user configures the quantity used for liquid measurement (FCT.LIQ_QTR) and for gas measurement (FCT.GAS_QTR). So, the quantity specified for liquid measurement in FCT.LIQ_QTR parameter indicates the total quantity available for all liquid measurements, including station, for this FC302, and for all report types (batch, hourly, daily, weekly, monthly, operational and reset, except summary reports). Similarly, the rules for liquid measurements are applied to gas measurements.

GAS MEASUREMENT APPLICATIONS

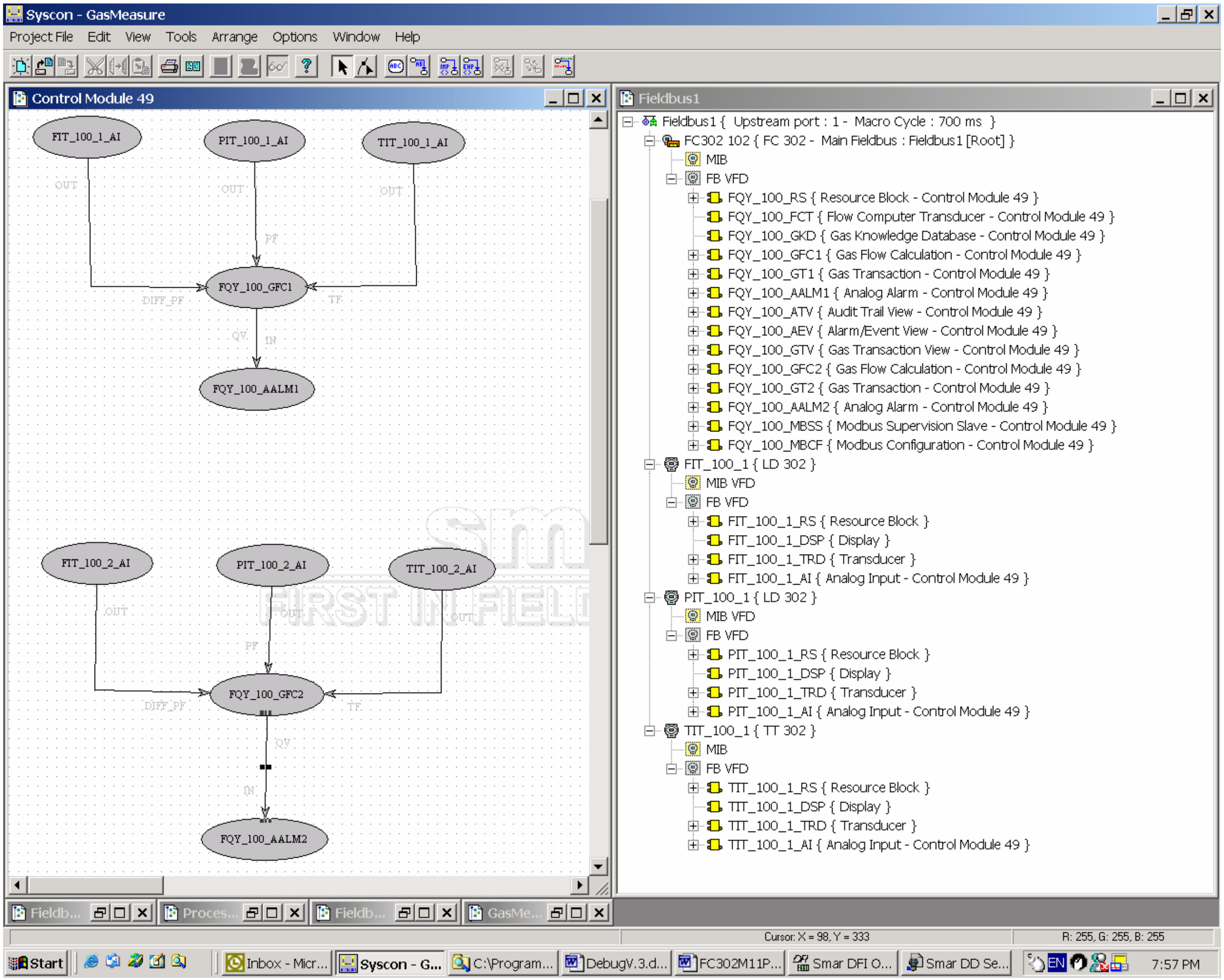
Gas Measurement Typical Application



Measurement Characteristics

- 2 measurements for natural gas flow.
- Sensor: orifice plate.
- Gas composition input: manual.
- 3 transmitters for each flow measurement: differential pressure, static pressure and temperature.
- Local Panel communicating via Modbus RTU + EIA-232.
- Syscon/FCView/Supervisory communicating via OPC Server+Ethernet.
- A copy of this configuration file is installed in the folder "\Smar\Syscon\Samples\FC302\GasMeasure".

Gas Measurement Configuration



Comments:

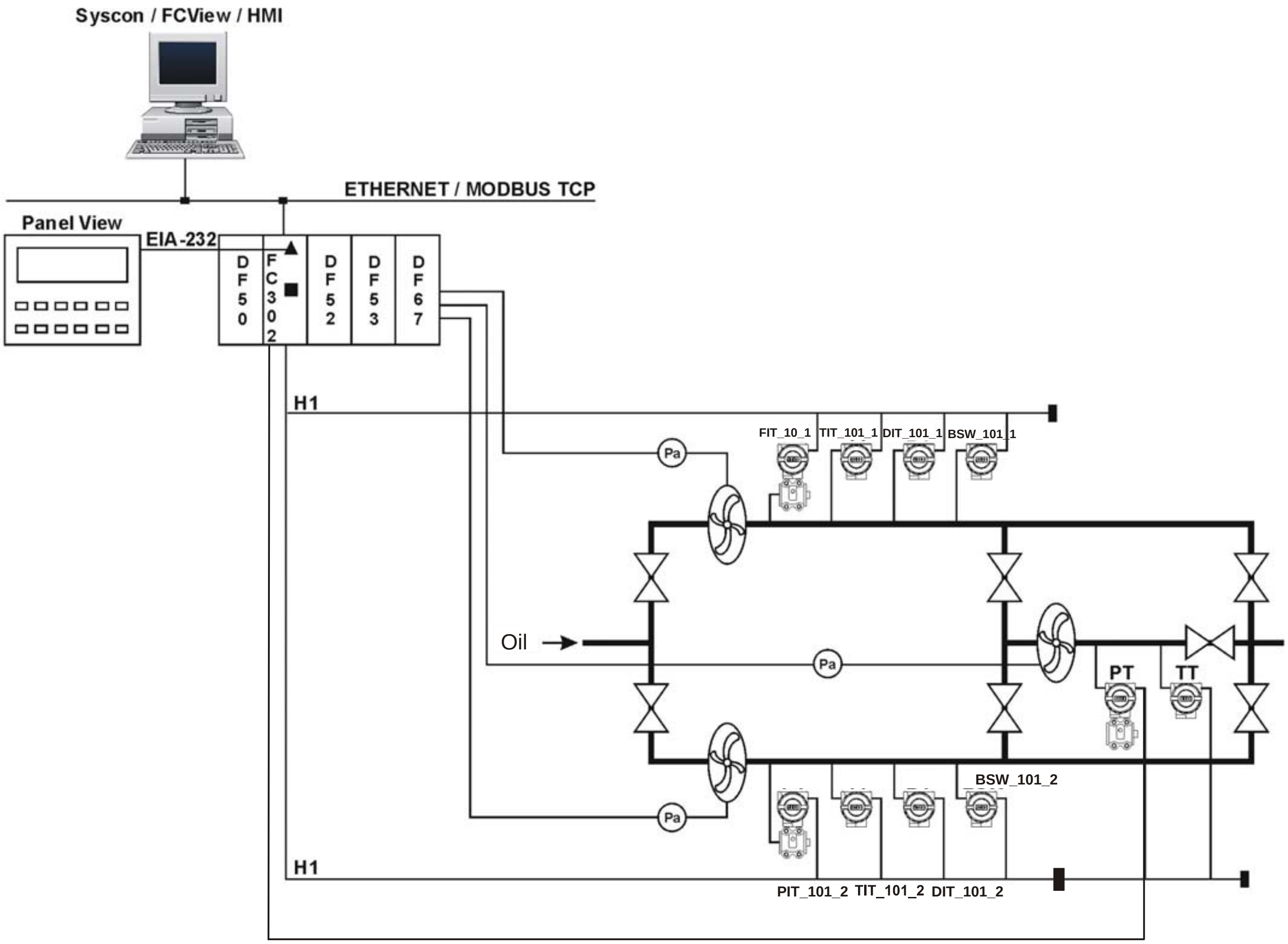
- The AI blocks from the differential pressure, static pressure and temperature transmitters transfer the measurements to the GFC block in the FC302, which uses the AGA3 and AGA8 standards to compensate the flow.
- GT blocks, associated to each one of the GFC blocks, calculate the totalization and weighed averages, and provide the information the QTR report.
- It is configured to generate QTR reports daily and monthly.
- GTV, ATV and AEV blocks provides the mechanism to transfer the information from the logger in the FC302 memory to the database.
- MBCF and MBSS blocks allow the FC302 to operate as a slave Modbus device, enabling monitoring in the local panel.
- AALM block calculates High and Low Alarms in the Qv flow rate, occurrences will be registered as event.
- Observe the STRATEGY parameter of blocks executing in transmitters and FC302 in order to classify according to the run number.
- Observe the following table, which indicates the variables monitored via Modbus RTU, where the FC302 is a slave device.

Parameter mapped in Modbus	MBSS corresponding parameter	Modbus Address
FQY_100_GT1.QV_IN.VALUE	F_ID1	42601
FQY_100_GT1.QB_IN.VALUE	F_ID2	42603
FQY_100_GT2.QV_IN.VALUE	F_ID3	42605
FQY_100_GT2.QB_IN.VALUE	F_ID4	42607
FQY_100_GT1.TOT_QV_DAY	I_ID1	42617
FQY_100_GT1.TOT_QB_DAY	I_ID2	42619
FQY_100_GT2.TOT_QV_DAY	I_ID3	42621
FQY_100_GT2.TOT_QB_DAY	I_ID4	42623

Chapter 16

LIQUID MEASUREMENT APPLICATIONS

Liquid Measurement Typical Application

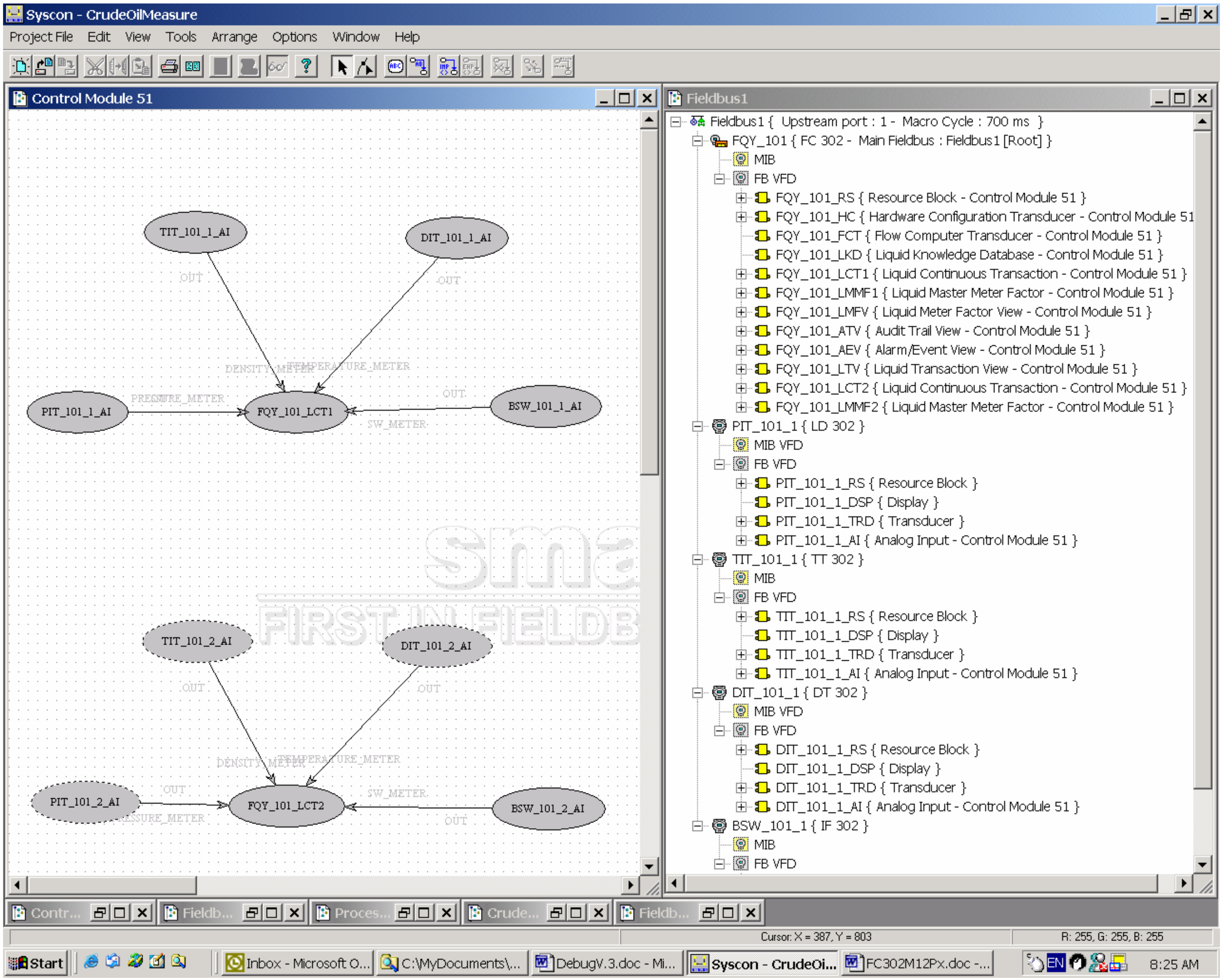


Measurement Characteristics

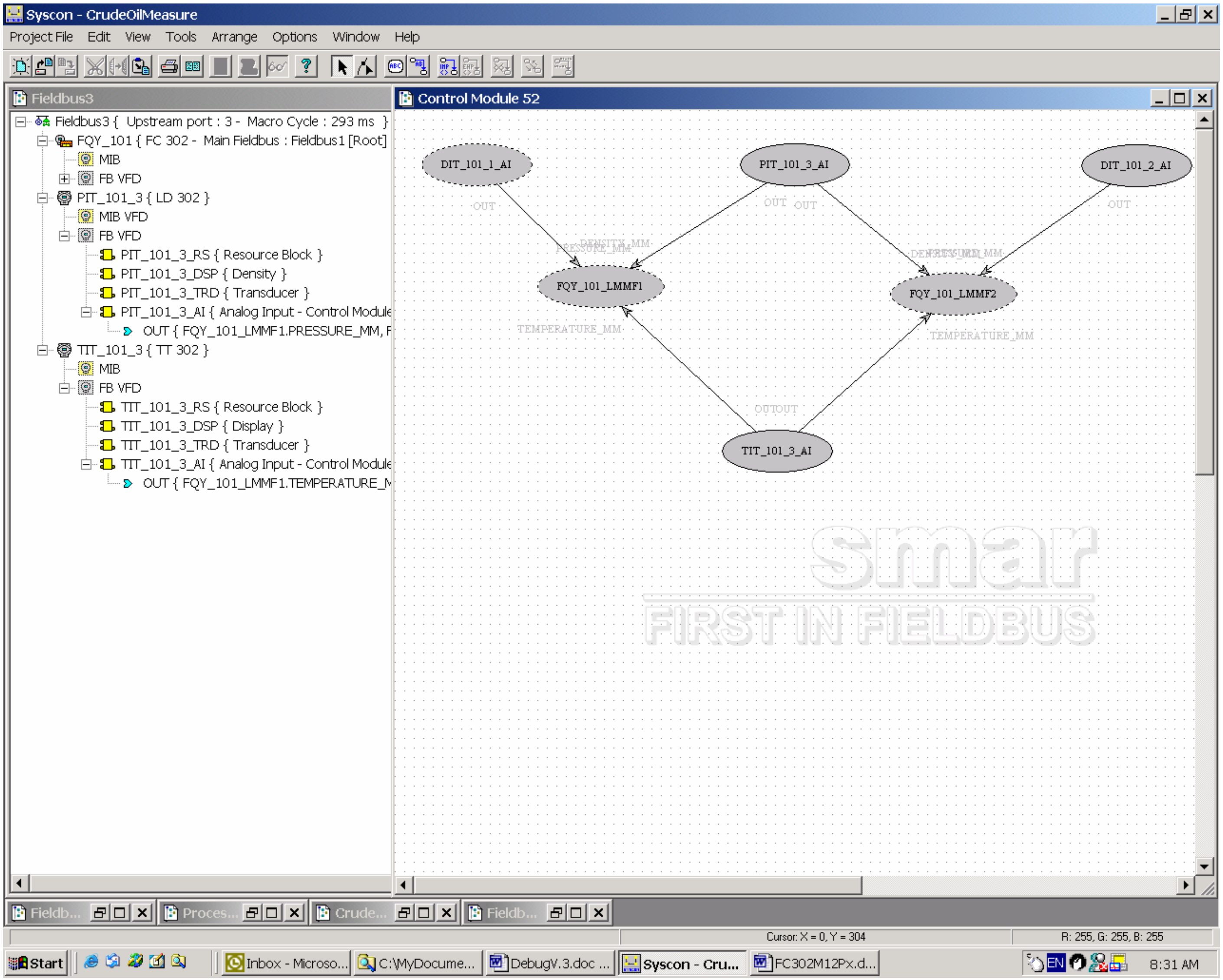
- Crude oil measurement system using a turbine or other type of sensor with pulse signal.
- The measurement system has two runs with specific instrumentation for each one.
- Proving using master meter.
- Two runs measuring crude oil in reduntant way for maintenance without interruption of production.
- Instruments for each run: pulse input, density, gauge pressure, temperature and BSW.
- H1 Bus: Channels 1 and 2 associate the devices of run 1 and 2, respectively, channel 3 connects the devices related to the master meter.
- Local panel communicating via Modbus RTU + EIA-232.
- Syscon/FCView/Supervisory communicating via OPC Server+Ethernet.
- A copy of this configuration file is installed in the folder: "\Smar\Syscon\Samples\FC302\CrudeOilMeasure".

Liquid Measurement Configuration

The configuration strategy in the figure below shows two crude oil measurements.



The configuration strategy in the figure below shows the proving of the operational meters using a master meter.



Comments:

- Configuration of I/O modules in the HC block, because this application has a pulse input module.
- Configuration about the meter, master meter and measured product in the LKD block
- The AI blocks from the density transmitters, gauge pressure transmitters, temperature transmitters and BSW transmitters transfer the measurements to the LCT blocks in the FC302, which compensates the flow by temperature (CTL) and pressure (CPL), calculates the totalization and weighed averages, and provides information for QTR report.
- LMMF blocks (one for each measurement) used in proving with the master meter.
- LTV, ATV, AEV and LMFV blocks provides the mechanism to transfer the information from the logger in the FC302 memory to the database.

Chapter 17

ADDING MODBUS

Introduction

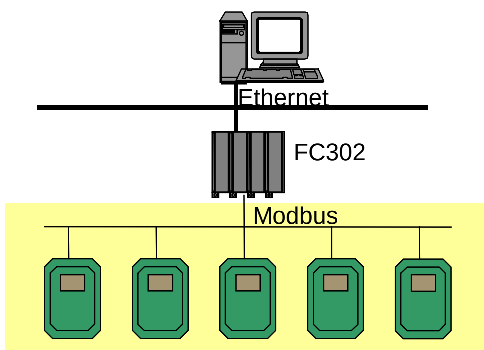
An existent plant can be commuted to the Fieldbus protocol using several features implemented in AuditFlow, not requiring large investments in instruments. The serial communication port is one of these features in the controller module that connects AuditFlow to a wide range of devices in a plant, using the Modbus protocol.

The Modbus protocol has become one of the most popular standard protocols used in the industry. Existent projects have many instruments and subsystems using this protocol.

The FC302 operates as a master or a slave, and can be connected through port 232 or the Ethernet port (using Modbus TCP/IP). The serial port 232 is integrated in the FC302 processor module, it is necessary to use a separated module (DF58) only when a port 485 is necessary.

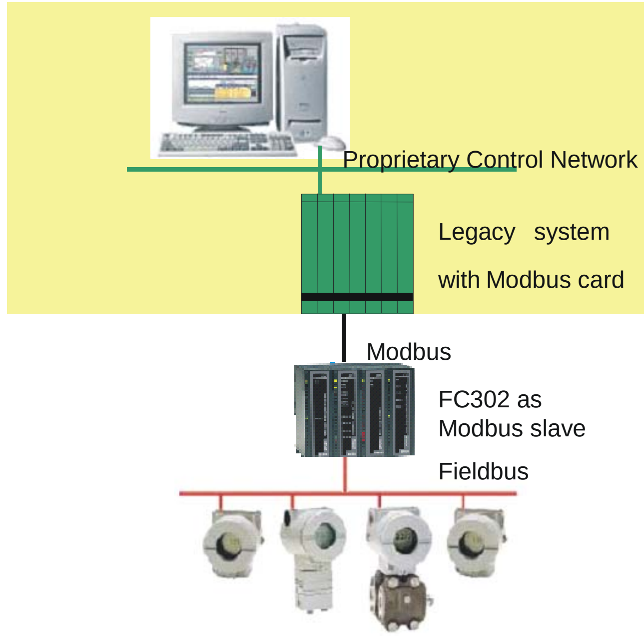
In Master mode, the FC302 can read and write data to the Modbus slaves.

The FC302 uses standard Modbus commands to read and write data providing the data from the devices to the control strategy, or to be displayed and saved in the operation workstation. The user can also operate the slave instruments and execute other supervisory functions. The inputs are available as normal parameters that can be used in the control strategy or for monitoring, alarm and history.



Most systems, such as DCS or PLC, have serial interface modules to support Modbus. These modules can supervise Fieldbus instruments using the FC302 as a gateway.

For the system connections, some extra interfaces can be necessary:
- For applications which the controller is connected via Modbus RTU protocol to the Modbus network with many Modbus devices, it is necessary the RS232/RS483 converter interface in order to provide the multi point communication functionality;
- For the point to point applications which the Modbus device is used, but the distance with the controller is larger than 15 meters, is also required a RS232/RS485 converter interface.



The FC302 data can be read or written by the Master, when the FC302 operates in Slave mode. Data can be accessed in binary format (functions 1, 2, 5 and 15) or through registers (functions 3, 4, 6 and 16).

Through the FC302, Fieldbus devices can be connected to an existent control system, providing specific characteristics of the Fieldbus devices to the system. Traditional process variables and controller gains can be mapped from the Fieldbus devices to the system database, but this system will not fully benefit from the Fieldbus technology. However, this solution can be applied during the transition to an open system.

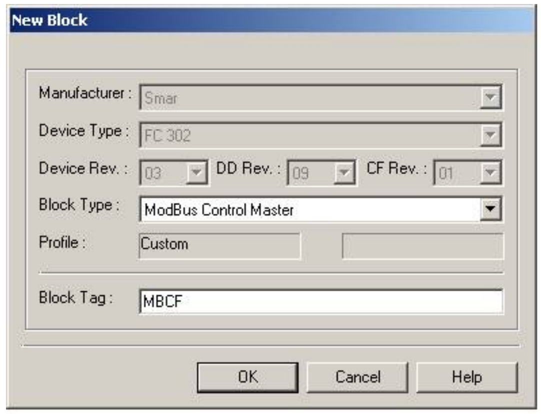
It is easy to use the Modbus port. No DIP switch has to be activated to configure the Modbus port. A status LED in the front panel indicates the communication is active.

Configuring the Modbus

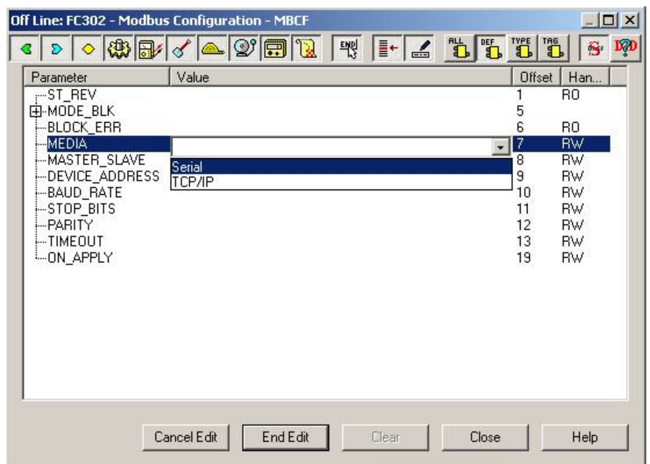
The FC302 uses Syscon to configure all the necessary functions, including Modbus.Refer to the chapter “Adding Blocks” for further information on how to add Function Blocks to the Syscon configuration. Remember that MODBUS function blocks are available in different DD Revisions.

1) To include the Modbus functions in the FC302, first of all, create a MBCF block (Modbus Configuration Block).

NOTE
Remember that, as for all Fieldbus devices, the Resource block must have been already created and configured as Auto.



2) Adjust the parameters according to the desired media, transmission rate, addresses, etc.

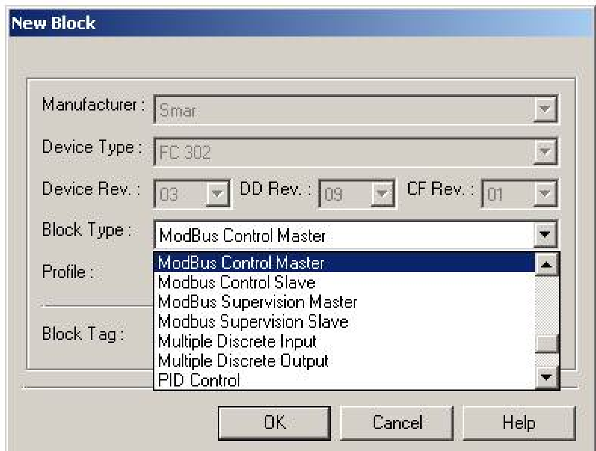


Parameter	Valid Range/ Options	Default Value	Description
ST_REV		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1to 255	0	
MODE_BLK		O/S	
BLOCK_ERR			
MEDIA	0:Serial, 1:TCP/IP	Serial	Define the Modbus channel type.
MASTER_SLAVE	0:Master, 1:Slave	Slave	Define if the FC302 is the master or slave.
DEVICE_ADDRESS	1-247	1	Define the FC302 Modbus address (only for a FC302 slave).
BAUD_RATE	0:110, 1:300, 2:600, 3:1200, 4:2400, 5:4800, 6:9600, 7:19200, 8:38400, 9:57600, 10:115200	19200	Define the transmission rate (only for serial channel).
STOP_BITS	0:1, 1:2	1	Define the number of stop bits (only for serial channel).
PARITY	0:None, 1:Even, 2:Odd.	Even	Define the parity (only for serial media).
TIMEOUT	0-65535	1000	Waiting time for a slave response (for a FC302 Master) or waiting time to update the outputs (for a FC302 Slave). It is disable when the value is 0.
NUMBER_RETRANSMISSIONS	0-255	1	Number of re-transmission, if the FC302 doesn't receive an answer from the slave.
SLAVE_ADDRESSES			IP Number and Modbus address of the slaves (only for a FC302 Master in TCP/IP channel).
RESTART_MODBUS		FALSE	Parameter not used.
TIME_TO_RESTART	1-65535	1	Time to restart the communication with the slave.
RTS_CTS		FALSE	Enable or disable handshaking.

Parameter	Valid Range/ Options	Default Value	Description
ON_APPLY	0:None, 1:Apply	None	Apply the changes from the Modbus blocks.
UPDATE_EVT			This alert is generated by any changes to the static data.
BLOCK_ALM			The block alarm is used for configuration fails, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute.

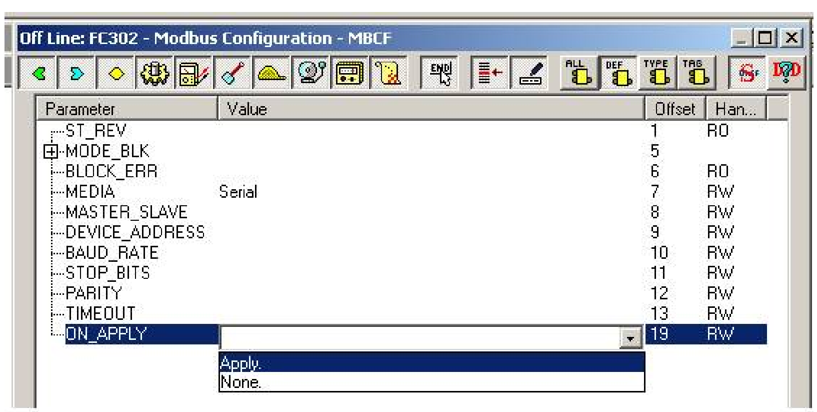
When using the RS-232, install the DF58 module (RS232/RS485 Interface Module) if it is necessary to communicate with more than one Modbus instrument, that is, in a Multipoint Network. Refer to chapter “Adding Interfaces”.

3) Now, create the necessary blocks. The blocks available are MBSS (Modbus Supervision Slave), MBSM (Modbus Supervision Master), MBCS (Modbus Control Slave), MBCM (Modbus Control Master).



To create these blocks, adjust the MODE_BLK.TARGET parameter to AUTO.

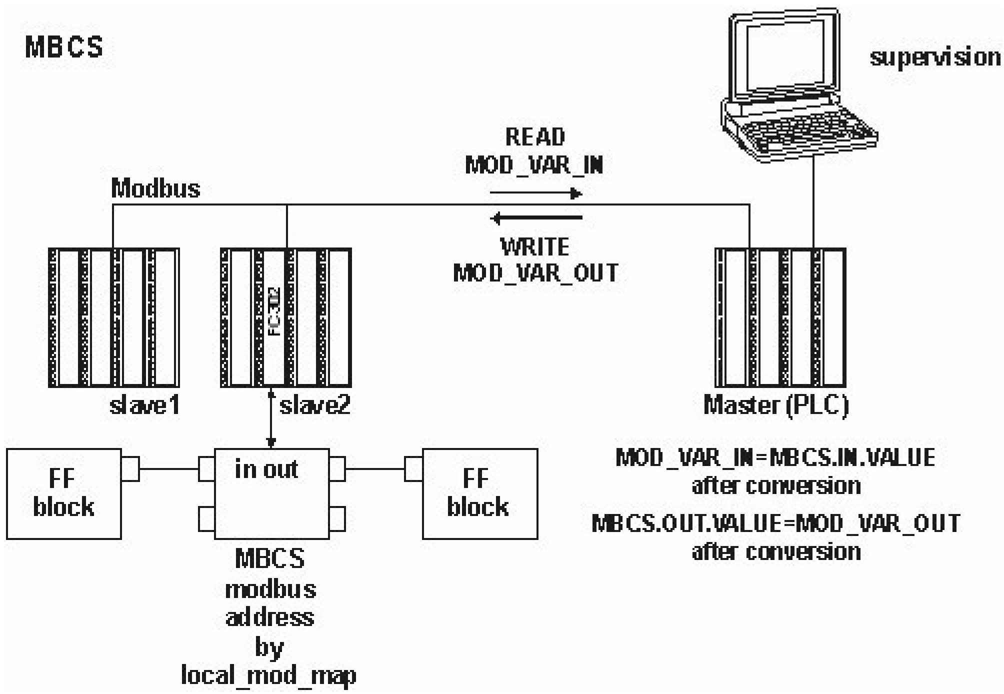
IMPORTANT
After downloading the configuration to the FC302, all Modbus blocks will set the MODE_BLK.ACTUAL parameter at Out of Service. This protection allows the user to create all the necessary blocks, adjusting the parameters even in the online mode. Only at the end of the configuration process the user changes all blocks to AUTO simultaneously, configuring the parameter ON_APPLY of the MBCF block. Other important parameter that should be defined for all blocks is LOCAL_MOD_MAP (0 ~ 15). Sixteen blocks are accepted for functionality and this variable identifies each function. For MBSS and MBCS blocks, the LOCAL_MOD_MAP parameter specifies the Modbus Slave address. A value 255 (default) does not permit the block runs.



The following views (1 to 4) summarize some of the applications that can be implemented using the FC302 Modbus Functions.

View 1 - MBCS

A Modbus Master Instrument wants to read and/or write to the Modbus registers of the FC302, mapped as Input and Output parameters in the Fieldbus network. Using Syscon, create a MBCF block and 1 to 16 MBCS blocks. In the Strategy window, link these blocks with FF blocks.



When creating these parameters, define the LOCAL_MOD_MAP (0 ~ 15) parameter, and the Input and Output parameters will indicate the Modbus pre-defined addresses. Refer to the sub-section LOCAL_MOD_MAP for further information.

Parameter Description

Refer to the FOUNDATION Fieldbus Function Blocks Manual for details.

Parameter	Valid Range/ Options	Default Value	Description
ST_REV		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1 to 255	0	
MODE_BLK		O/S	Refer to the Mode Parameter.
BLOCK_ERR			
LOCAL_MOD_MAP	0 to 15	0	Define the modbus addresses.
IN1			Analog Input 1.
SCALE_CONV_IN1			Information to generate the constants A and B in the equation Y=A*X+B.
IN2			Analog Input 2.
SCALE_CONV_IN2			Information to generate the constants A and B in the equation Y=A*X+B.
IN3			Analog Input 3.
SCALE_CONV_IN3			Information to generate the constants A and B in the equation Y=A*X+B.
IN4			Analog Input 4.
SCALE_CONV_IN4			Information to generate the constants A and B in the equation Y=A*X+B.
IN_D1			Discrete Input 1.
IN_D2			Discrete Input 2.
IN_D3			Discrete Input 3.

Parameter	Valid Range/ Options	Default Value	Description
IN_D4			Discrete Input 4.
OUT1			Analog Output 1.
SCALE_CONV_OUT1			Information to generate the constants A and B in the equation Y=A*X+B and the output status.
OUT2			Analog Output 2.
SCALE_CONV_OUT2			Information to generate the constants A and B in the equation Y=A*X+B and the output status.
OUT3			Analog Output 3.
SCALE_CONV_OUT3			Information to generate the constants A and B in the equation Y=A*X+B and the output status.
OUT4			Analog Output 4.
SCALE_CONV_OUT4			Information to generate the constants A and B in the equation Y=A*X+B and the output status.
OUT_D1			Discrete Output 1.
STATUS_OUT_D1			Status of OUT_D1 if the Master is not updated.
OUT_D2			Discrete Output 2.
STATUS_OUT_D2			Status of OUT_D2 if the Master is not updated.
OUT_D3			Discrete Output 3.
STATUS_OUT_D3			Status of OUT_D3 if the Master is not updated.
OUT_D4			Discrete Output 4.
STATUS_OUT_D4			Status of OUT_D4 if the Master is not updated.
UPDATE_EVT			This alert is generated by any changes to the static data.
BLOCK_ALM			The block alarm is used for configuration fails, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute

NOTE

The STATUS_OUT_Dx and STATUS_OUTPUT members, used in the output parameters, define the following rules for the OUTPUT STATUS parameters:

Once the user defines this member as “Set by master”, the output status will behave exactly as Fieldbus protocol works. In other words, the status will reflects the value, which the master is writing, but if after the TIMEOUT (defined in MBCF block) the status is not be updated, this status will be forced to BAD COMMUNICATION.

Once the user defines this member with anything different from “Set by master”, this value will be reflected in output status, while communication is good. Otherwise, status goes to BAD COMMUNICATION.

Inputs and Outputs

This block has 4 digital inputs, 4 analog inputs, 4 digital outputs and 4 analog outputs that can be connected to other FIELDBUS or MODBUS function blocks.

- IN1, IN2, IN3 and IN4 are analog inputs.
- IN_D1, IN_D2, IN_D3 and IN_D4 are digital inputs.
- OUT1, OUT2, OUT3 and OUT4 are analog outputs.
- OUT_D1, OUT_D2, OUT_D3 and OUT_D4 are digital outputs.

The digital outputs and inputs are DS-66, containing value and status (both Unsigned 8). The analog outputs and inputs are DS-65 and also contain status and value, in FLOAT type.

Scale Conversion Parameters

Each analog input and output has an extra parameter that should be adjusted using the SCALE_CONV_INn and SCALE_CONV_OUTn parameters, so the MBCS block executes properly. These parameters are represented by the data structures DS-256 and DS-257.

The DS-256 data structure has 5 elements to be configured:

- From EU 100 %
- From EU 0 %
- To EU 100 %
- To EU 0 %
- Data Type

The DS-257 data structure has 6 elements to be configured:

- From EU 100 %
- From EU 0 %
- To EU 100 %
- To EU 0 %
- Data Type
- Output Status

Data Type

It is necessary to configure the Data Type because MODBUS variables have different formats.

This parameter indicates only the number that refers to a specific format.

Data Type Number	Data Type Format
1	Float
2	Unsigned 8
3	Unsigned 16
4	Unsigned 32
5	Integer8
6	Integer16
7	Integer32
	Swapped Float
9	Swapped Unsigned 8
10	Swapped Unsigned 16
11	Swapped Unsigned 32
12	Swapped Integer 8
13	Swapped Integer 16
14	Swapped Integer 32

The swapped data types were created in order to support the communication between Modbus devices and Profibus devices. Normally, it has the following options:

4 Bytes (2 Registers – Word)

Normal Data type: Inside Register – Motorola
Between Registers – Intel
Swapped Data type: Inside Register – Motorola
Between Registers – Motorola

2 Bytes

Swapped Data type: Status information is in the Most Significant Byte (MSB)

1 Byte

Swapped Data type: Value (MSB) and Status (LSB) are in the same register.

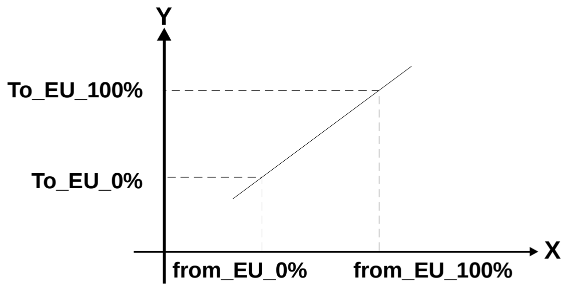
In case of the Swapped Integer 16 data type no change is done.

Procedure to convert FF parameter to MODBUS variable:

Load INn_ VALUE.
Calculate Y = A * Inn_VALUE + B.
Convert Y to DATA_TYPE_IN, generating MOD_VAR_IN.
Save MOD_VAR_IN.

Procedure to convert MODBUS variable to FF parameter:

Load MOD_VAR_OUT.
Convert MOD_VAR_OUT to float, generating Y.
Calculate OUTn_VALUE = (A*Y + B).
Save OUTn_VALUE.



A= (TO_EU_100% - TO_EU_0%) / (FROM_EU_100% - FROM_EU_0%)
B = TO_EU_0% - A* FROM_EU_0%

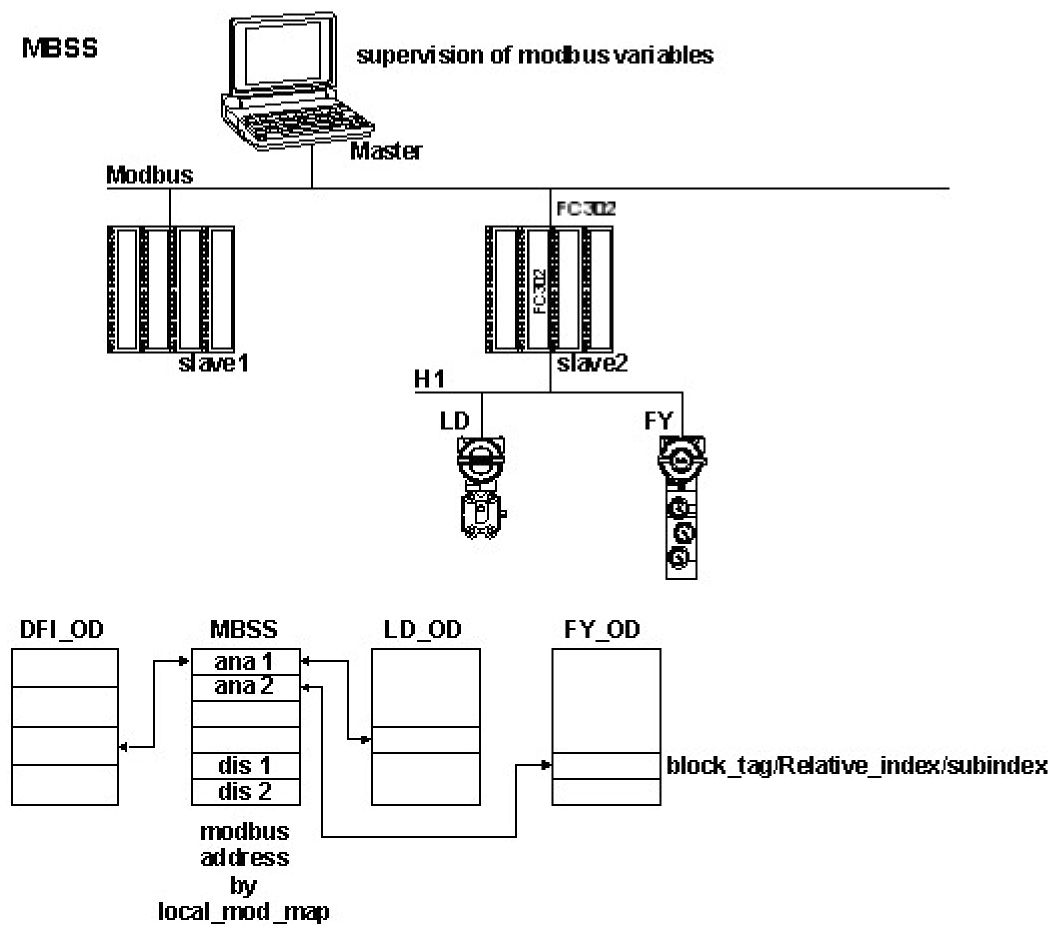
Inn_VALUE, OUTx_VALUE: FF parameters.
MOD_VAR_IN, MOD_VAR_OUT: MODBUS variable.
Y: auxiliary float variable

Output Status

If the outputs are not updated by the Modbus Master during the period of time specified by the user (parameter TIMEOUT in MBCF), a “BAD STATUS” will be generated. If TIMEOUT < Macrocycle, TIMEOUT = Macrocycle.

View 2 – MBSS

A Modbus Master Instrument wants to read and/or write to the Modbus registers of the FC302, mapped as Input and Output parameters in the Fieldbus network. Using Syscon, create a MBCF block and 1 to 16 MBSS blocks. In the characterization window, configure these blocks setting the parameters TAG, Relative Index and Sub-Index with the value of the parameters in the FF blocks.



To adjust these parameters, define the LOCAL_MOD_MAP (0 ~ 15) parameter, and the Input and Output parameters will indicate the Modbus pre-defined addresses. Refer to the sub-section LOCAL_MOD_MAP for further information.

Parameter Description

Refer to the FOUNDATION Fieldbus Function Blocks Manual for details

Parameter	Valid Range/ Options	Default Value	Description
ST_REV		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1to 255	0	
MODE_BLK		O/S	Refer to the Mode Parameter.
BLOCK_ERR			
LOCAL_MOD_MAP	0 to 15	0	Define the Modbus addresses.
F_ID1			Information to locate the float parameter.
FVALUE1		0	Value of the requested float parameter.

Parameter	Valid Range/ Options	Default Value	Description
F_ID2			Information to locate the float parameter.
FVALUE2		0	Value of the requested float parameter.
F_ID3			Information to locate the float parameter.
FVALUE3		0	Value of the requested float parameter.
F_ID4			Information to locate the float parameter.
FVALUE4		0	Value of the requested float parameter.
F_ID5			Information to locate the float parameter.
FVALUE5		0	Value of the requested float parameter.
F_ID6			Information to locate the float parameter.
FVALUE6		0	Value of the requested float parameter.
F_ID7			Information to locate the float parameter.
FVALUE7		0	Value of the requested float parameter.
F_ID8			Information to locate the float parameter.
FVALUE8		0	Value of the requested float parameter.
I_ID1			Information to locate the integer parameter.
IVALUE1		0	Value of the requested integer parameter.
I_ID2			Information to locate the integer parameter.
IVALUE2		0	Value of the requested integer parameter.
I_ID3			Information to locate the integer parameter.
IVALUE3		0	Value of the requested integer parameter.
I_ID4			Information to locate the integer parameter.
IVALUE4		0	Value of the requested integer parameter.
B_ID1			Information to locate the boolean parameter.
BVALUE1		TRUE	Value of the requested boolean parameter.
B_ID2			Information to locate the boolean parameter.
BVALUE2		TRUE	Value of the requested boolean parameter.
B_ID3			Information to locate the boolean parameter.
BVALUE3		TRUE	Value of the requested boolean parameter.
B_ID4			Information to locate the boolean parameter.
BVALUE4		TRUE	Value of the requested boolean parameter.
UPDATE_EVT			This alert is generated by any changes to the static data.
BLOCK_ALM			The block alarm is used for configuration fails, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute.
BAD_STATUS			This parameter indicates whether the status of the correspondent value is bad or no.

NOTE
Every time a MODBUS parameter changes, it is necessary to set the ON_APPLY parameter of the MBCF block at "Apply". Otherwise, these alterations will not be applied.

I_IDn, F_IDn, B_IDn Parameters

The I_IDn parameters are "integer" variables; F_IDn are "float" variables and B_IDn are "boolean" variables.

These parameters are DS-262. This data type has 3 elements.

- **Block Tag**: Indicates the Tag of the block that contains the variable to be displayed. For example, if the user needs to monitor the gain of the PID block, include the Tag of the PID block containing the "gain" parameter to be displayed in the MODBUS master.

- **Relative Index:** Every parameter of a function block has this index. The relative index is indicated in the first column of all parameter tables for function blocks. Include the number of the relative index in the parameter to be monitored. In the example above, the relative index to monitor the gain parameter of the PID functions 23.

- **Sub Index:** The sub index is used for parameters that have a structure. In this case, it is necessary to indicate which element of the structure is being referred.

BVALUEx and IVALUEx Parameters

The BVALUEx parameters can address the FF parameters for the following data types: boolean, integer8 and unsigned8. These data type are automatically converted to bit (0 or1), and vice versa, for MODBUS supervision and, also, they can be converted to a boolean parameter (BVALUEx).

The IVALUEx parameters can address FF parameters for the following data types: Integer8, Integer16, Integer 32, Unsigned 8, Unsigned 16 and Unsigned 32.

Each analog parameter (IVALUEx) is mapped as two MODBUS analog registers, that is, four bytes. When addressing a FF parameter with one or two bytes, this parameter will change to Unsigned 32 or Integer 32.

If the Relative Index is 5 (MODE_BLK) and the Sub Index is “zero”, a writing will be execute in Sub Index 1 and a reading in Sub Index 2.

BAD_STATUS Parameter

This parameter indicates if the communication with Master device is working properly. If the correspondent bit is in logic level 1 means that an error occurred during writing/reading in this respective parameter. The table below shows the values for this status parameter. If the communication with the specific parameter is good, there is no indication in BAD_STATUS. However, if the communication is bad, BAD_STATUS will indicate which parameter failed in the communication.

Relation between the bits in BAD_STATUS and Modbus addresses

BIT	VARIABLE
0	**FVALUE1**
1	**FVALUE2**
2	**FVALUE3**
3	**FVALUE4**
4	**FVALUE5**
5	**FVALUE6**
6	**FVALUE7**
7	**FVALUE8**
8	**IVALUE1**
9	**IVALUE2**
10	**IVALUE3**
11	**IVALUE4**
12	**BVALUE1**
13	**BVALUE2**
14	**BVALUE3**
15	**BVALUE4**

NOTE
Each bit corresponds to an OR function between the Value and Status, indicating if the communication with Master is good or bad.

Data Type and Supported Structures by MBSS

The Modbus supervision blocks (MBSS) used in the controllers configured as slave, have some restrictions about data types and structures that they support when supervising the block parameters tags. In such case, the next table shows the data types and structures which can be monitored by the MBSS block.

DATA TYPE *
Boolean
Float
Unsigned 8
Unsigned 16
Unsigned 32
Integer8
Integer16
Integer32

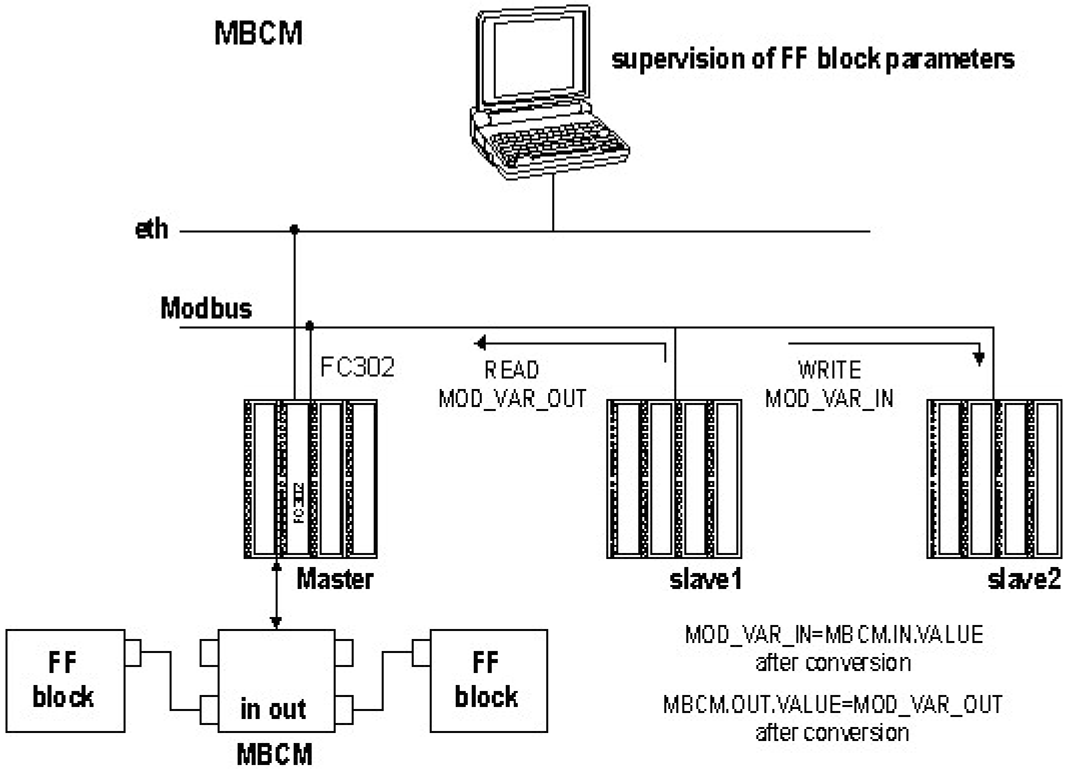
STRUCTURE TYPES
DS-65
DS-66
DS-68
DS-69
DS-71
DS-72
DS-74
DS-159 (DC302)
DS-160 (DC302)

*For the FC302 controller the data types Swapped Float and Swapped Integer can be obtained by setting the RTS_CTS parameter to TRUE value in the MBSS block.

For further information about the blocks parameters and their data and structures types, as mentioned in the previous table, please see the Function blocks manual and in the DataType field of each table presented in the manual.

View 3 – MBCM

A Modbus Slave Instrument needs to sent and/or receive Modbus registers from the FC302, mapped as Input and Output parameters in the Fieldbus network. Using Syscon, create a MBCF block and 1 to 16 MBCM blocks. In the Strategy window, link these blocks to FF blocks. This application is also useful for display instruments installed in the plant.



Adjust the option Master in the MASTER_SLAVE parameter, below the MBCF block.
Define the LOCAL_MOD_MAP (0 ~ 15) parameter.

Parameter Description

Refer to the FOUNDATION Fieldbus Function Blocks Manual for details

Parameter	ValidRange/ Options	Default Value	Description
ST_REV		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1to 255	0	
MODE_BLK		O/S	Refer to the Mode Parameter.
BLOCK_ERR			
BAD_STATUS		0	Indicate whether the communication with the slave is good or not (each bit corresponds to a Modbus variable).
IN1			Analog Input 1.
SCALE_LOC_IN1			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
IN2			Analog Input 2.
SCALE_ LOC_IN2			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
IN3			Analog Input 3.
SCALE_ LOC_IN3			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
IN4			Analog Input 4.

Parameter	ValidRange/ Options	Default Value	Description
SCALE_ LOC_IN4			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
IN_D1			Discrete Input 1.
LOCATOR_IN_D1			Addresses in a slave instrument.
IN_D2			Discrete Input 2.
LOCATOR_IN_D2			Addresses in a slave instrument.
IN_D3			Discrete Input 3.
LOCATOR_IN_D3			Addresses in a slave instrument.
IN_D4			Discrete Input 4.
LOCATOR_IN_D4			Addresses in a slave instrument.
OUT1			Analog Output 1.
SCALE_ LOC_OUT1			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
OUT2			Analog Output 2.
SCALE_ LOC_OUT2			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
OUT3			Analog Output 3.
SCALE_ LOC_OUT3			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
OUT4			Analog Output 4.
SCALE_ LOC_OUT4			Information to generate the constants A and B in the equation Y=A*X+B plus the addresses in the slave device.
OUT_D1			Discrete Output 1.
LOCATOR_OUT_D1			Addresses in a slave instrument.
OUT2_D2			Discrete Output 2.
LOCATOR_OUT_D2			Addresses in a slave instrument.
OUT_D3			Discrete Output 3.
LOCATOR_OUT_D3			Addresses in a slave instrument.
OUT_D4			Discrete Output 4.
LOCATOR_OUT_D4			Addresses in a slave instrument.
UPDATE_EVT			This alert is generated by any changes to the static data.
BLOCK_ALM			The block alarm is used for configuration fails, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute.

NOTES

The MODBUS_ADDRESS_OF_STATUS members define the following rules for the OUTPUT STATUS parameters:

- When the user defines this member with a value different from Zero, the output status will behave as an output protocol, that is, the status will reflect the value read by the master, but if the status is not updated after the TIMEOUT (defined in the MBCF block), it will be set as BAD COMMUNICATION;

- When the user defines this member with value equals to Zero, the output status will automatically display GOOD and accept the Syscon characterization (such as GOOD CASCADE, etc). But, if the communication with the Modbus Device is not Ok after the TIMEOUT (defined in the MBCF block), the status will be forced to BAD COMMUNICATION.

NOTE

Every time a MODBUS parameter is changed, it is necessary to set the ON_APPLY parameter of the MBCF block to “Apply”. Otherwise, these changes won't take effect.

LOCAL_MODE_MAP Parameter

All MBCM blocks added to the strategy must have different values in the LOCAL_MODE_MAP parameter. Otherwise, the block will not operate properly.

Outputs and Inputs

This block has 4 digital inputs and outputs and 4 analog inputs and outputs. These inputs and outputs can be connected to other FIELDBUS function blocks, connecting to MODBUS I/O modules or registers.

INn: Analog input. DS-65 Data type (Value and Status).. In this parameter, the value of the parameter configured for this input and its status will be displayed.

IN_Dn: Digital input. DS-66 Data type (Value and Status).. In this parameter, the value of the parameter configured for this input and its status will be displayed.

OUTn: Analog output. DS-65 Data type (Value and Status).. In this parameter, the value of the parameter configured for this output and its status will be displayed.

OUT_Dn: Digital output. DS-66 Data type (Value and Status).. In this parameter, the value of the parameter configured for this output and its status will be displayed.

SCALE_LOC_INn and SCALE_LOC_OUTn

These parameters are DS-259 data type. They convert the value to Engineering Units and address the variable in the MODBUS network. The INn and OUTn inputs and outputs are associated to the SCALE_LOC_INn and SCALE_LOC_OUTn parameters. It is necessary to configure these parameters to monitor and change data correctly.

Each parameter consists of the following elements:

- From Eu 100 %
- From Eu 0 %
- To Eu 100 %
- To Eu 0 %

To configure these elements:

Data Type: It is necessary to inform the data type of the variable. This parameter only displays the number that refers to a specific format.

Data Type Number	Data Type Format
1	Float
2	Unsigned 8
3	Unsigned 16
4	Unsigned 32
5	Integer8
6	Integer16
7	Integer32
8	Swapped Float
9	Swapped Unsigned 8
10	Swapped Unsigned 16
11	Swapped Unsigned 32
12	Swapped Integer 8
13	Swapped Integer 16
14	Swapped Integer 32

The swapped data types were created in order to support the communication of Modbus devices with Profibus devices. Normally we have the following cases:

4 Bytes (2 Registers – Word)

Normal Data type:	Inside Register – Motorola Between Register**s** – Intel
Swapped Data type:	Inside Register – Motorola Between Registers – Motorola

2 Bytes

Swapped Data type: Status information is in the Most Significant Byte (MSB)

1 Byte

Swapped Data type: Value (MSB) and Status (LSB) are in the same register.

In case of the Swapped Integer 16 data type no change is done.

Slave Address: Indicate the address of the slave required in the IN input. For example, suppose a LC700 has the Device Address equals to 3 and it is necessary to connect one of its inputs or outputs. The Slave Address should be equal to 3.

MODBUS Address of Value: Indicate the MODBUS address of the variable being referenced as the input or output. In the example of the previous element, suppose the MODBUS address is 40032. Therefore, this element should have the same address.

MODBUS Address of Status: In this parameter, the user indicates the Modbus address where the status will be read or written. Each input or output has a corresponding status. The interpretation of the status follows the FOUNDATION Fieldbus Standard.

The inputs and outputs are supervised as described in the table below:

Input/Output	CONFIGURED STATUS (Modbus_Address_Of_Status ≠ 0)	NON-CONFIGURED STATUS (Modbus_Address_Of_Status = 0)
(IN_n , IN_Dn)	The block sends to the device the status corresponding to the input of the modbus slave.(The status follows the FF standard format)	No status information is sent to the slave device.
Output (OUT_n, OUT_Dn)	The block reads the corresponding status from the slave device. (The block assumes that the Modbus variable follows the format of the FF Status).	- The block updates the status to “Good Non Cascade” when the communication with the Modbus slave device is ok. - The block updates the status to “Bad No Communication with last value” when the communication with the Modbus slave device is not ok.

Float values use two MODBUS registers, but it is necessary to inform only the first one.

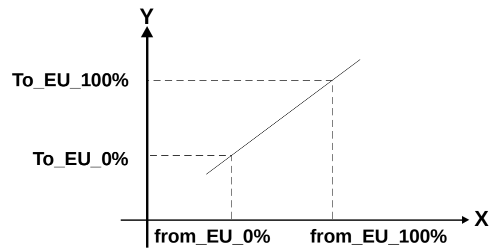
Procedure to convert FF parameter to MODBUS variable:

Load INx_VALUE
Calculate Y = (A * Inx_VALUE + B)
Convert Y to DATA_TYPE_IN, generating MOD_VAR_IN
Write MOD_VAR_IN

Procedure to convert MODBUS variable to FF parameter:

Read MOD_VAR_OUT
Convert MOD_VAR_OUT to float, generating Y
Calculate OUTx_VALUE = (A * Y + B)
Save OUTx_VALUE

A = (TO_EU_100% - TO_EU_0%) / (FROM_EU_100% - FROM_EU_O%)
B = TO_EU_0% - A * FROM_EU_0%;



IN_VALUE, OUT_VALUE: FF parameters
MOD_VAR_IN, MOD_VAR_OUT: MODBUS variables
Y = auxiliary float variable

Setting the inputs and outputs of the MBCM block

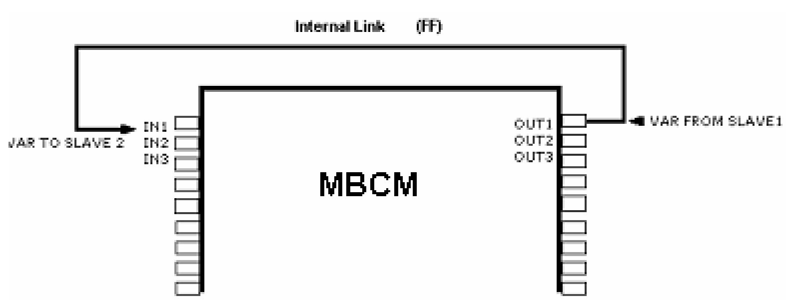
To read a MODBUS variable, connect the variable to an output of the MBCM function block. To write to a MODBUS register, connect the register to an input of the MBCM block.

Usually, MODBUS addresses are:

- 00001 to 9999 – Digital Outputs
- 10001 to 19999 – Digital Inputs
- 30001 to 39999 – Analog Inputs
- 40001 to 49999 – Analog Outputs

Once the variables that need to be mapped are defined and referenced in the MBCM block, the user can configure the strategy.

Connect the variables to other Fieldbus blocks (connect the block input or output to other blocks in the strategy) to write to the MODBUS registers (connect the MBCM block input to the MODBUS register). To exchange data between the slaves, configure the MBCM block input with the slave address, specify the MODBUS address where the value will be written, configure the MBCM block output with the slave address and the MODBUS variable where the value will be read. See the application below:



BAD_STATUS Parameter

This parameter indicates if the communication between the slaves was established properly. If the corresponding bit is at logic level 1, it indicates that there was an error during the reading/writing of the respective parameter. The table below shows the values for these status. If the communication with the specific parameter is god, there won't be any indication in BAD_STATUS. However, if the communication is bad, the BAD_STATUS parameter will indicate which parameter failed in the communication.

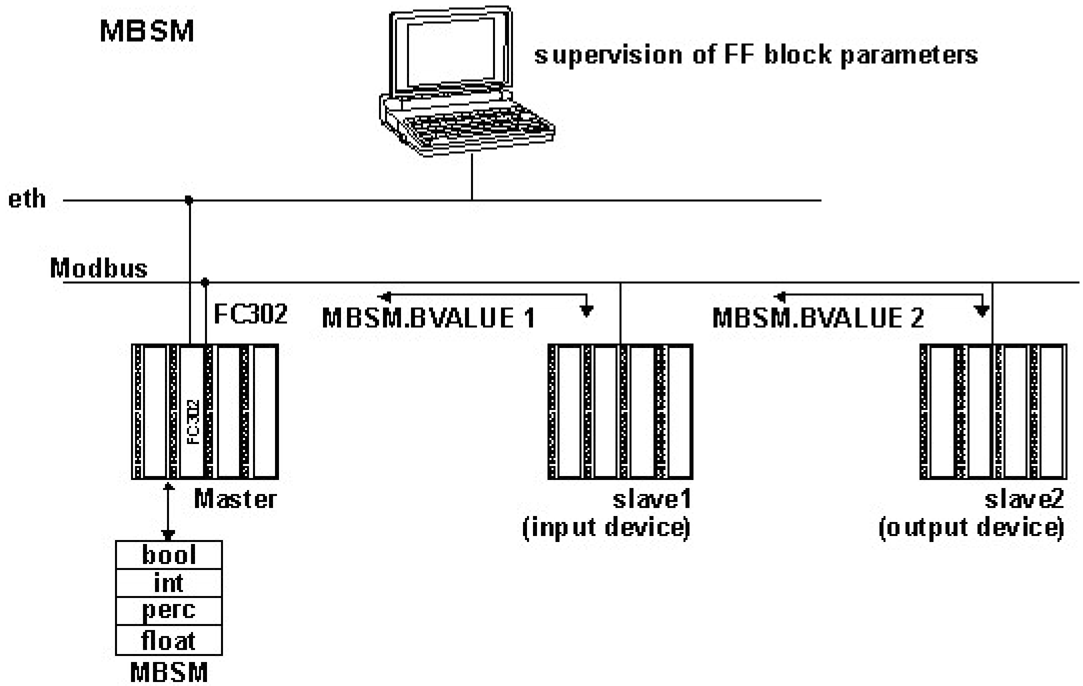
Relation between bits in BAD_STATUS and MODBUS addresses.

Bit	Variable
0	IN1
1	IN2
2	IN3
3	IN4
4	IN_D1
5	IN_D2
6	IN_D3
7	IN_D4
8	OUT1
9	OUT2
10	OUT3
11	OUT4
12	OUT_D1
13	OUT_D2
14	OUT_D3
15	OUT_D4

NOTE
Each bit corresponds to an OR between the value and the status, indicating whether the communication with the slave is good or bad. If only the value is used, the status is considered zero. If only the status is used, the value is considered zero.

View 4 – MBSM

A Supervisory System connected to the FC302, via OPC Server, needs to read and/or write some parameters, mapped as Modbus registers. Using Syscon, create a MBCF block and 1 to 16 MBSM blocks. In the Characterization window, configure these blocks setting the parameters with the Slave Address and Parameter Address.



Adjust the option Master in the MASTER_SLAVE parameter below the MBCF block.
Define the LOCAL_MOD_MAP (0 ~ 15) parameter.

Parameter Description

Refer to the FOUNDATION Fieldbus Function Blocks Manual for details.

Parameter	Valid Range/ Options	Default Value	Description
ST_REV		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1 to 255	0	
MODE_BLK		O/S	Refer to the Mode Parameter.
BLOCK_ERR			
LOC_MOD_MAP			
BAD_STATUS		0	Indicate whether the communication with the slave is good or not (each bit corresponds to a Modbus variable).
FLOCATOR1			Information to locate the float parameter.
FVALUE1		0	Value of the requested address.
			Information to locate the float parameter.
FVALUE2		0	Value of the requested address.
PLOCATOR1			Information to locate the percentage parameter
PVALUE1		0	Value of the requested address.
PLOCATOR2			Information to locate the percentage parameter
PVALUE2		0	Value of the requested address
ILOCATOR1			Information to locate the integer parameter.
ILENGTH1	1,2,4	2	Data length.

Parameter	Valid Range/ Options	Default Value	Description
IVALUE1		0	Value of the requested address.
ILOCATOR2			Information to locate the integer parameter.
ILENGTH2	1,2,4	2	Data length.
IVALUE2		0	Value of the requested address.
BLOCATOR1			Information to locate the boolean parameter.
BVALUE1		TRUE	Value of the requested address.
BLOCATOR2			Information to locate the boolean parameter.
BVALUE2		TRUE	Value of the requested address.
BLOCATOR3			Information to locate the boolean parameter.
BVALUE3		TRUE	Value of the requested address.
BLOCATOR4			Information to locate the boolean parameter.
BVALUE4		TRUE	
BLOCATOR5			Information to locate the boolean parameter.
BVALUE5		TRUE	Value of the requested address.
BLOCATOR6			Information to locate the boolean parameter.
BVALUE6		TRUE	Value of the requested address.
BLOCATOR7			Information to locate the boolean parameter.
BVALUE7		TRUE	Value of the requested address
BLOCATOR8			Information to locate the boolean parameter.
BVALUE8		TRUE	Value of the requested address.
UPDATE_EVT			This alert is generated by any changes to the static data.
BLOCK_ALM			The block alarm is used for configuration fails, hardware and connection failures or system problems. The cause of the alert is displayed in the subcode field. The first alert that becomes active will set the Active status in the Status attribute.

LOCAL_MODE_MAP

All MBCM blocks added to you're the strategy should have different values in the LOCAL_MODE_MAP parameter. Otherwise, the block will not operate properly.

FVALUEn, PVALUEn, IVALUEn and BVALUEn Parameters

These parameters are selected when needed. If the variable being monitored is “FLOAT”, a FVALUE parameter will be necessary. If the variable is in percentage, the PVALUE parameter will be used. The IVALUE parameter refers to “Integer” values and BVALUE parameter refers to boolean values.

For each one of these parameters, there are other parameters associated to address them in the MODBUS network, and the MBSM blocks will know the location.

FLOCATORn Parameter

This parameter refers to the FVALUE parameter. This parameter is a DS-260 data type, so it is necessary to configure two elements:

Slave Address: Type the slave address where the variable being monitored is located. For example, if a LC700 has the Device Address equals to 1, the Slave Address should be equal to 1.

MODBUS Address of Value: Type the MODBUS address of the variable being monitored in the MBSM block. Suppose the user will monitor the variable in the MODBUS address 40001, located in the slave I/O module with the Device Address equals to 1. The MODBUS Address of Value must be equal to 1.

The FVALUEn parameters will display the values of the variables configured in FLOCATORn. FLOAT values use two MODBUS registers, but it is necessary to inform only the first one.

MODBUS Addresses

00001 to 9999 – Digital Outputs
10001 to 19999 – Digital Inputs
30001 to 39999 – Analog Inputs
40001 to 49999 – Analog Outputs

PLOCATORn Parameter

This is a DS-258 data type parameter and refers to PVALUEn parameters. They convert the values to Engineering Units and address the variable in the MODBUS network.
It is necessary to configure these parameters to monitor that data properly. Each parameter consists of the following elements:

- From EU 100%
- From EU 0%
- To EU 100%
- To EU 0%

Data type: It is necessary to inform the data type of the variable. This parameter only displays the number that refers to a specific format.

Data Type Number	Data Type Format
1	Float
2	Unsigned 8
3	Unsigned 16
4	Unsigned 32
5	Integer8
6	Integer16
7	Integer32
8	Swapped Float
9	Swapped Unsigned 8
10	Swapped Unsigned 16
11	Swapped Unsigned 32
12	Swapped Integer 8
13	Swapped Integer 16
14	Swapped Integer 32

The swapped data types were created in order to support the communication of Modbus devices with Profibus devices. Normally, there are the following cases:

4 Bytes (2 Registers – Word)
Normal Data type: Inside Register – Motorola
Between Registers – Intel
Swapped Data type: Inside Register – Motorola
Between Registers – Motorola

2 Bytes
Swapped Data type: Status information is in the Most Significant Byte (MSB)

1 Byte
Swapped Data type: Value (MSB) and Status (LSB) are in the same register.

In case of the Swapped Integer 16 data type no change is done.

Slave Address: Indicate the slave address to the PVALUEn parameter. For example, suppose a LC700 has the Device Address equals to 3 and it is necessary to monitor a specific variable. The Slave Address should be equal to 3.

MODBUS Address of Value: Indicate the MODBUS address of the variable being monitored. In the example of the element above, suppose the MODBUS address is 40032. Therefore, this element should have the same address.

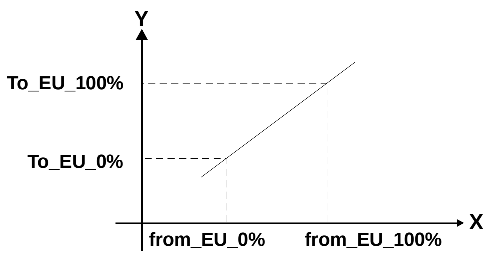
Procedure to convert FF parameter to MODBUS variable:

Load VALUEn
Calculate y = (A*VALUEn + B)
Convert Y to DATA_TYPE_IN, generating MOD_VAR_IN
Write MOD_VAR_IN

Procedure to convert MODBUS variable to FF parameter:

Read MOD_VAR_OUT
Convert MOD_VAR_OUT (from DATA TYPE) to Float, generating Y
Calculate PVALUE = (A*Y + B)
Save OUTx_VALUE

A = (TO_EU_100% - TO_EU_0%) / (FROM_EU_100% - FROM_EU_0%)
B = (TO_EU_0% - A*FROM_EU_0%);



PVALUEn: FF Parameter
MOD_VAR_IN, MOD_VAR_OUT: MODBUS Variables
Y: Auxiliary FLOAT Variable

ILOCATORn Parameter

Refer to the IVALUEn parameter.

Slave Address: Type the slave address where the variable being monitored is located. For example, if a LC700 has the Device Address equals to 1, the Slave Address should be equal to 1.

MODBUS Address of Value: Type the MODBUS address of the variable being monitored in the MBSM block. Suppose the user will monitor the variable in the MODBUS address 40001, located in the I/O module of the Slave with the Device Address equals to 1.The Modbus Address Of Value should be 40001.

The IVALUEn parameters will display the variable values configured in the ILOCATORn parameter.

BLOCATORn Parameter

Refer to the BVALUEn parameter.

This parameter is a DS-260 data type, the user will have to configure two elements for this parameter.

Slave Address: Type the slave address where the variable being monitored is located. For example, if a LC700 has the Device Address equals to 1, the Slave Address should be equal to 1.

MODBUS Address of Value: Type the MODBUS address of the variable being monitored in the MBSM block. Suppose the user will monitor the variable in the MODBUS address 40001, located in the Input/Output module with the Device Address equals to 1. The MODBUS Address of Value should be 40001.

The BVALUEn parameters will show the variable values configured in BLOCATORn.

BAD_STATUS Parameter

This parameter indicates if the communication between the slaves was established properly. If the corresponding bit is at logic level 1, it indicates that there was an error during the reading/writing of the respective parameter. The table below shows the values for these status:

Relation between bits in BAD_STATUS and MODBUS Addresses

Bit	Variable
0	B1
1	B2
2	B3
3	B4
4	B5
5	B6
6	B7
7	B8
8	I1
9	I2
10	P1
11	P2
12	F1
13	F2

Modbus Slave Addresses

MBCS		
PARAMETER	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_MOD_MAP =1
IN1-Value	40001+ OFFSET 40002+ OFFSET	40041 40042
IN2-Value	40003+ OFFSET 40004+ OFFSET	40043 40044
IN3-Value	40005+ OFFSET 40006+ OFFSET	40045 40046
IN4-Value	40007+ OFFSET 40008+ OFFSET	40047 40048
OUT1-Value	40009+ OFFSET 40010+ OFFSET	40049 40050
OUT2-Value	40011+ OFFSET 40012+ OFFSET	40051 40052
OUT3-Value	40013+ OFFSET 40014+ OFFSET	40053 40054
OUT4-Value	40015+ OFFSET 40016+ OFFSET	40055 40056
IN1-Status	40017+ OFFSET	40057
IN2-Status	40018+ OFFSET	40058
IN3-Status	40019+ OFFSET	40059
IN4-Status	40020+ OFFSET	40060
OUT1-Status	40021+ OFFSET	40061
OUT2-Status	40022+ OFFSET	40062
OUT3-Status	40023+ OFFSET	40063
OUT4-Status	40024+ OFFSET	40064
IN_D1-Status	40025+ OFFSET	40065
IN_D2-Status	40026+ OFFSET	40066
IN_D3-Status	40027+ OFFSET	40067
IN_D4-Status	40028+ OFFSET	40068
OUT_D1-Status	40029+ OFFSET	40069
OUT_D2-Status	40030+ OFFSET	40070
OUT_D3-Status	40031+ OFFSET	40071
OUT_D4-Status	40032+ OFFSET	40072
IN_D1-Value	1+ OFFSET	41
IN_D2-Value	2+ OFFSET	42
IN_D2-Value	3+ OFFSET	43
IN_D2-Value	4+ OFFSET	44
OUT_D1-Value	5+ OFFSET	45
OUT_D2-Value	6+ OFFSET	46
OUT_D3-Value	7+ OFFSET	47
OUT_D4-Value	8+ OFFSET	48

MBSS		
PARAMETER	LOCAL_MOD_MAP = x OFFSET = 40 * x x = 0 ~ 15	e.g. LOCAL_MOD_MAP =1
F_ID1	42601+ OFFSET 42602+ OFFSET	42641 42642
F_ID2	42603+ OFFSET 42604+ OFFSET	42643 42644
F_ID3	42605+ OFFSET 42606+ OFFSET	42645 42646
F_ID4	42607+ OFFSET 42608+ OFFSET	42647 42648
F_ID5	42609+ OFFSET 42610 + OFFSET	42649 42650
F_ID6	42611+ OFFSET 42612+ OFFSET	42651 42652
F_ID7	42613+ OFFSET 42614+ OFFSET	42653 42654
F_ID8	42615+ OFFSET 42616+ OFFSET	42655 42656
I_ID1	42617+ OFFSET 42618+ OFFSET	42657 42658
I_ID2	42619+ OFFSET 42620+ OFFSET	42659 42660
I_ID3	42621+ OFFSET 42622+ OFFSET	42661 42662
I_ID4	42623+ OFFSET 42624+ OFFSET	42663 42664
B_ID1	2601+ OFFSET	2641
B_ID2	2602+ OFFSET	2642
B_ID3	2603+ OFFSET	2643
B_ID4	2604+ OFFSET	2644
BAD_STATUS	42625+OFFSET	42665

NOTE
MBCS The second column in the table above shows the values applied to the inputs and outputs of the MBCS block, according to the value configured for the LOCAL_MODE_MAP. For example, if the LOCAL_MODE_MAP is equal to 1, the result of the MODBUS address range will be the values displayed in the third column. Observe that, when this parameter is configured, the entire range will be selected. The INn and OUTn values use two MODBUS registers (for example, IN1, 40041 and 40042) because the data type is float. The IN_Dn and OUT_Dn values use one MODBUS register (for example, IN_D1, 41). The values of the status also use only one register. Once the MODBUS range is defined, the user can configure the MODBUS master to read these values. **MBSS** When configuring the values for LOCAL_MODE_MAP, MODBUS addresses are applied to the variables to be monitored. Each variable - Integer, Float or Boolean - will have a MODBUS address. For example, suppose LOCAL_MODE_MAP = 1 and the float variable being monitored. Configuring the F_ID1 parameters, use: F_ID1.Tag = Tag of the float parameter being monitored. F_ID1.Index = Index of the first column of the parameter being monitored. F_ID1.Subindex = The sub index is used for parameters with a structure. In this case, it is necessary to indicate which element of the structure is being referenced. Refer to the table above. The MODBUS addresses applied to this parameter (Float values use two MODBUS registers) are 42641 and 42642.

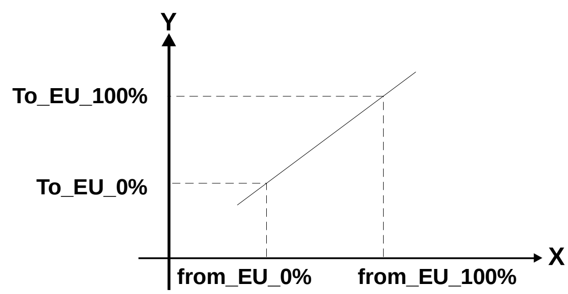
MODBUS Commands

When the FC302 is operating as a MASTER, that is, reading points, it uses commands 1 (addresses 1 to 9999), 2 (addresses 10001 to 19999), 3 (addresses 40001 to 49999) and 4 (addresses 30001 to 39999). When the FC302 is writing points, it uses commands 15 (addresses 0 to 9999) and 16 (addresses 40001 to 49999) for the MBCM block and commands 5 (addresses 0 to 9999) and 6 (addresses 40001 to 49999) for the MBSM block.

When operating as a SLAVE, the FC302 respond to any of the commands above.

Scale Conversion

This data structure consists of data used to generate the constants A and B in the equation Y= A*X+B



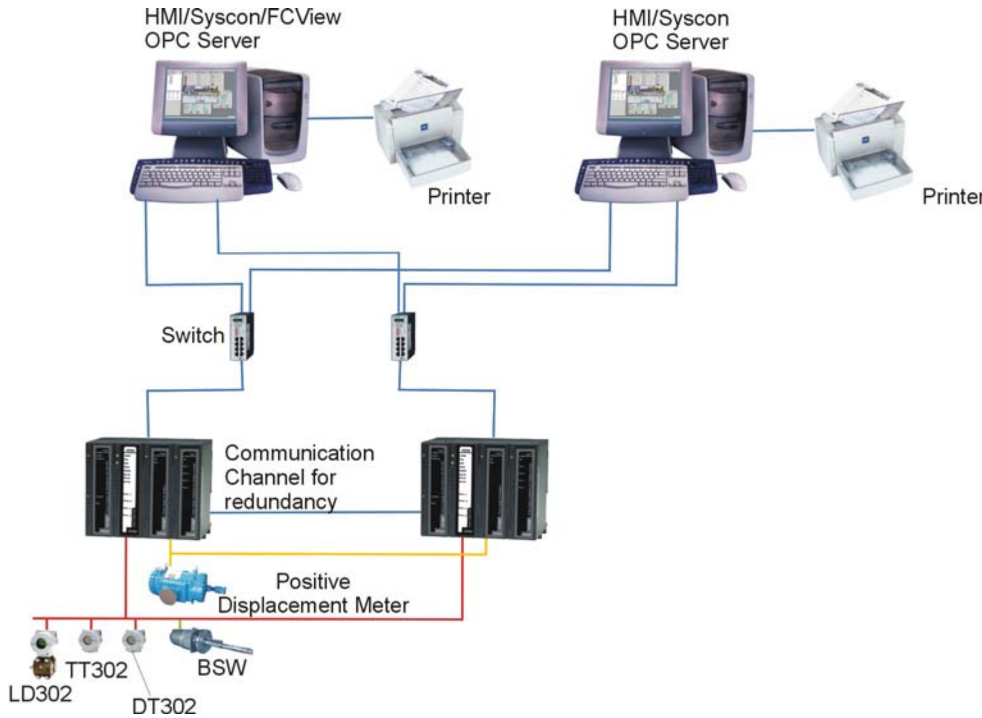
E	Element Name	Data Type	Size
1	From EU 100%	Float	4
2	From EU 0%	Float	4
3	To EU 100%	Float	4
4	To EU 0%	Float	4
5	Data Type (Use this parameter to convert Fieldbus to Modbus or Modbus to Fieldbus, where Modbus should be …) Float = 1 Unsigned8 = 2 Unsigned16 = 3 Unsigned32 = 4 Integer8 = 5 Integer16 = 6 Integer32 = 7 Swapped Float = 8 Swapped Unsigned8 = 9 Swapped Unsigned16 = 10 Swapped Unsigned32 = 11 Swapped Integer8 = 12 Swapped Integer16 = 13 Swapped Integer32 = 14	Unsigned8	1

Chapter 18

ADDING REDUNDANCY

Complete Redundant System Architecture

The redundant system below shows different functionalities with redundancy.



The functionalities with redundancy are:

- Supervisory Workstations: The application shows two supervisory workstations that can monitor variables/tags from the same FC302 module.
- Ethernet Network: Each supervisory station has two network boardsin different ethernet networks using different switches. If there is a problem with one network board, cabling or the switch of a supervisory workstation, this workstation will be able to continue the supervision, besides the other supervisory wokstation .
- Power supply and Backplane Redundacy: Each AuditFlow has its own power supply and backplane andit is possible to implement power supply redundancy for each AuditFlow, although not showing in the application above.
- Link Active Scheduler (LAS): The LAS is the network element responsible for organizing the communication in the H1 – Foundation Fieldbus network. Basically, the LAS controls when each device can publish/subscribe data to/from the network. The FC302 is a Link Master, which means it can operate as LAS. However, this functionality dependes on the conditions, that is, there can not be another active device. The application shows two FC302s in the same H1 network, one FC302 will be the LAS and the other will be in hot standby mode.
- FC302 Module Redundancy: Since the module is responsible for all flow calculations, compensation, totalizations and mainly log (reports / registers providing audit trail), the redundancy of this module guarantees the availability of the measurement system operation, as well as the availability of the information saved in the logger.

FC302 Module Redundancy

Terminology:

Role: User configuration that defines the module as Main or Backup.

State: The module state depends on the conditions of both FC302, and also on the Role configuration. Possible states are Active and Standby.

Active: This State indicates if the module is executing the function blocks, that is, calculating the flow, totalizations and generating reports.

Standby: This State indicates that the FC302 is monitoring the behaviour and the performance of the other module, in case that FC302 has to become Active. The FC302 is constantly updated with data processed by the Active module, through the redundant communication channel.

Main: Configured by the user, defines which module should be the preferential Active. Therefore, if both FC302s are operating in good conditions and executing the function blocks (including the Modbus communication), the module configured as Main will be the Active module.

Backup: Configured by the user, defines which module should transfer the control to the other, when in normal operation conditions. The Backup module will assume as the Active when the other FC302 module fails.

Hot Standby: Redundancy schema containing an active element and other element monitoring the condition of the active element constantly, being updated to assume the control from the last operation condition.

Local: It is the FC302 module communicating and supervising. Remember that the FC302 Standby module can be supervised, that is, the block parameters of the FC302 standby, that have the same value from the block parameters of the FC302 Active, can be monitored.

Remote: The database of the FC302 Active is transferred to the FC302 Standby, but not entirely. Some information is not transferred, such as the redundancy configuration (Role) and the State. Using the IdShell Transducer Block, the user can access the informationin the Local FC302 related to the Role and the State, and also the information in the other FC302 (Remote), because this information is exchanged in the redundant communication channel.

Redundant Communication Channel: Communication channel between the FC302 modules, used to to synchronize the information in the modules, that is, the configuration in both modules should always be the same and the dynamic process variables should be constantly transferred.

Switchover: Switch the control from one module to the other, that is, the FC302 in Standby will become the Active.

System Pre-requirements

The requirements listed here apply to both redundancy modes.

The version of firmware for redundant systems has the termination "R". It indicates a firmware suitable for redundant applications. With the redundant firmware, the module initializes by default in Hot Standby mode, in a safety state called “Sync_Idle”. The user as will be seen forth can change the redundancy mode later, if necessary.

The SYSCON configuration should be created as it is usually done for a non-redundant system. The unique difference (now that redundancy is involved) is that it is necessary to add a transducer function block to the bridge. This transducer will be used then to initialize the redundancy.

In the SYSCON configuration, the tag for the transducer block can be any, preferentially a meaningful tag concerned to the FC302 tag or to the plant. Be careful to not use tags already in use in the same plant.

Further information on SYSCON operation, can be found in its own manual.

For any of the redundancy modes it is necessary first of all to configure the network redundancy. The next section explains how to do it.

Configuring the Network Redundancy

In order all the OPC-Client tools be able to deal with network redundancy it is necessary configure the workstation and the DFI OLE Server.

Configuring the workstation

It is possible to have one or two workstation (redundancy of workstation). Here follows the steps for the configuration.

1 - Each workstation must have an HMI installed.

2 - Each workstation must have installed two NICs (Network Interface Card).

3 - Each NIC must be configured in a different subnet range (e.g. NIC1, IP=**192.168.164**.50 / Subnet Mask 255.255.255.0 and NIC2, IP=**192.168.163**.50 / Subnet Mask 255.255.255.0).

4 – Configure also the default gateway according to your specific needs.

5 - Install two HUBs or switches. Each NIC must be connected to one of them in such a way that two LAN are assembled isolated from each other.

6 - That way, each one of the FC302 modules can be connected to one of the HUBs obeying the subnet ranges predefined (e.g. First FC302, IP=**192.168.164**.51 / Subnet Mask 255.255.255.0 and Second FC302, IP=**192.168.163**.51 / Subnet Mask 255.255.255.0).

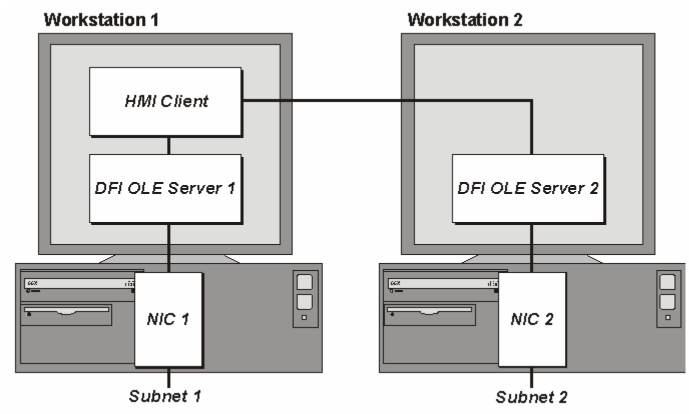
7 - To test the network configuration, a ping command to each one of the FC302 modules can confirm if everything is working fine.

Configuring the DFI OLE Server

There are two ways to configure the OLE Server for network redundancy: Here follows the steps for the configuration in each case.

The HMI Client chooses the DFI OLE Server (local and remote).

In this case, the local Server has a specific NIC adapter and the Client chooses what server will be used.



1 - Configure in the file SmarOleServer.ini, the NIC adapter that will be used on each workstation ports (e.g. First workstation, NIC=192.168.164.50 and Second workstation, NIC=192.168.163.50).

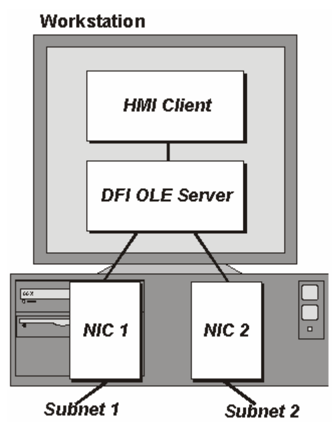
2 - Doing so, each DFI OLE Server will choose the specified NIC adapter.

3 - When configuring the HMI, configure each TAG to be monitored using two possible ways: First one, using Local DFI OLE Server, second option, using Remote DFI OLE Server (some HMI does not permit this kind of configuration and you will need to use an external software).

4 - To validate the Remote connection between Client and Server, make sure to configure DCOM and NT Security.

The DFI OLE Server is connected to both subnets where are located the redundant modules.

In this case, the client uses only one server that will choose which NIC adapter is to be used.



1 - Configure in the file SmarOleServer.ini the NIC adapters as intended. Example:
NIC = 192.168.164.50
NIC2 = 192.168.163.50
2 - Doing so, the DFI OLE Server will have information through both the NIC adapters.

The last updated good data will be chosen by the DFI OLE Server to be forwarded to the client. When the FC302 is in Hot Standby mode, the DFI OLE Server will preferably choose the data that came from the Active module, to be forwarded to the client.

Configuring Hot Standby Redundancy

In order to enable the Hot Standby redundancy and monitor its status, some parameters available in the FC302 transducer block should be used.

Most redundancy parameters have a suffix. The suffix “L” means Local, or that the parameter brings information of the module that is being monitored directly through the DFI OLE Server. The suffix “R” means Remote, or that the parameter brings information that the Local module knows about the other module through the synchronization path

Here is presented a functional description of these parameters in order to understand how the Hot Standby redundancy works. For further information on these parameters see also the transducer block description table (FF Blocks manual at section 2.4).

FUNCTION_IDS

This is the unique parameter to be configured. The user must assign one module to be the Main setting <u>Sync_Main</u>. After that, through the synchronism path the other one automatically will be set as Backup. This designates physically who should be, in other words, the Preferential and the Redundant processor module respectively. This way, Main and Backup can be understood simply as labels.

RED_ROLE_L / RED_ROLE_R

It reflects the configuration made at FUNCTION_IDS, identifying the Role of the module, <u>Sync_Main</u> or <u>Sync_Backup</u>.

RED_STATE_L / RED_STATE_R

<u>Active</u> - runs all the tasks and generates all the data.

<u>Standby</u> – does not run the tasks, but just receives all the data generated by the other one and stands ready to assume, if necessary.

<u>Not Ready</u> – redundancy not available.

The different failures that may occur in such system, lead it to a switch over, when the Standby bumplessly becomes Active and vice-versa. The possible reasons for a switch over, divided in two types, are as follows:

General Failures

When the whole processor module fails, this comprises:

- Hardware failure
- Power off
- Removal of the processor module from the back plane.

Bad Condition Failures

When one of the processor module interfaces fails:

- Modbus communication failure (hardware or cable; in the case of operating as master).
- FF H1 channel failure (hardware or cable).

The system is capable of checking which one has the best conditions, electing it as the Active.

It is certain the recovery of one failure at a time. That is, once a fail has occurred, a second fail will be recovered by redundancy just if the first fail has been fixed. While the failure is not fixed, the system has the redundancy not fully available (in case of Bad Condition Failures) or even not available (in case of General Failures).

For the case of General Failures, as soon as the failed module recovers a healthy state or is replaced, the modules automatically become a redundant pair again. That is, the system automatically recognizes a new inserted module.

RED_SYNC_STATUS_L / RED_SYNC_STATUS_R

This parameter reflects all the possible status of the synchronism between the modules.

SYNC STATUS	DESCRIPTION
Stand Alone	There is just one module operating. If the system has been synchronized at least once, and this value appears, it indicates that the other module had a General Failure.
Synchronizing	The modules are checking their configuration with each other in order to reach the Synchronized status. It can take up to 9 min. at maximum when the system waits for the module in “Not Ready” state get its live lists completed.
Updating Remote	Just after the download of the configuration, the module transfers the whole configuration to the other one through the synchronism path.
Maintenance	The module is being configured by the other module through the synchronism path or by the SYSCON. If it appears for both “L” and “R” parameters it indicates that none of the modules have been configured.
Synchronized	The modules are in perfect synchronism. The Active continuously updates the Standby databases.
Warning: Role Conflict	If a spare module is connected in the panel with the same Role of that one is already running, this warning is shown. The procedure to fix this conflict is to perform a Factory Init in the spare module.
Warning: Sync Cable Fail	If a failure occurs in the synchronism cable, this warning is shown. The system will not have the redundancy until the synchronism cable is fixed.
Warning: Updating Remote Fail	If a failure occurs in the transfer of configuration from the Active to the Standby, this warning is shown. The procedure is to perform a Factory Init in the module that is not Active and wait until the transfer is completed successfully.

RED_BAD_CONDITIONS_L / RED_BAD_CONDITIONS_R

It can present one or more value (concatenated) as follows:

<table>
<tr><th>BIT</th><th>BAD CONDITION</th><th>DESCRIPTION</th></tr>
<tr><td>0</td><td>Modbus</td><td>When working as master and if no Modbus slave device answers, it means that Modbus communication is in bad conditions. It can be caused by failures on the communication path or even a failure on the slave.</td></tr>
<tr><td>1</td><td>H1-1</td><td rowspan="3">Indicates failure on an H1 channel, specifying each channel had the failure.</td></tr>
<tr><td>2</td><td>H1-2</td></tr>
<tr><td>3</td><td>H1-3</td></tr>
<tr><td>4</td><td>LiveList</td><td>Indicates that the some Live List was not completed.</td></tr>
</table>

The desirable and most probable value is <none> for both modules (L and R), which assures good conditions for both, and therefore, redundancy fully available. This parameter can have two functions as follows:

A Bad Condition failure for the Active module lead the system to a switch over. In this case, this parameter acts as record of the reason of the last switch over.

When a Bad Condition failure occurs for the Standby module this parameter shows this condition as an alarm. Thus, warning the operator that the Standby presents a specific problem, it allows proactive maintenance in order to have redundancy fully available.

RED_MAIN_WDG / RED_BACKUP_WDG

These are watchdogs that indicate the communication status between the HMI and the processor modules. While their values are incrementing within 2 seconds the respective network connections (Main and Backup) are working fine.

As a simple rule, the redundancy is fully available, ONLY if the modules are Synchronized and have <none> in Bad Conditions parameters (L and R).

The following operations can be performed without process interruption: replacing a module with failure, fixing the system when the H1 cable breaks, firmware update, and adding redundancy to a system in operation.

NOTE
The most new FC302 modules have a LED labelled as “Standby” at the front to indicate the redundancy state of the module. When the LED is “on”, it means that the module is in Standby. When the LED is “off”, the module may be either in Active or Not Ready. If one of the modules is in Standby, the other is surely in Active.

Here follows the steps for the Hot Standby Redundancy configuration and maintenance. It is recommended that the steps are all read and understood before are executed.

First time configuration procedure

This is the procedure to configure the system with Hot Standby Redundancy for the first time, at the plant start-up.

1 - With the H1 connector disconnected, execute a Factory Init in both modules in order to grant the default state.

2 - Connect both modules together, through the FF H1 channels (1 to 4).

3 - Open the desired configuration in the SYSCON and put it in On-line mode. Right-click the bridge icon and with the option Attributes choose one of the modules listed in the field Device Id. The chosen module will be that one to be configured as Main.

4 - Even in the bridge icon, right-click the field FB VFD and then click Block List. A new window will be opened showing all the blocks pre-instantiated in the module. Then, in this window, right-click the transducer performing an Assign Tag with the tag that is predicted in the configuration. Close the Block List window.

5 - Right-click the transducer icon in the bridge and choose On Line Characterization. Set the parameter FUNCTION_IDS as Sync_Main. Through the synchronism path, the other module automatically will be initialized as Backup. After that, both the parameters RED_SYNC_STATUS (L and R) will indicate Maintenance, which means that neither of the modules was configured yet.

6 - If necessary, perform Assign Tag for all the field devices. Wait until the Live Lists of all the channels are complete. So, configure the system through the Active module executing all necessary downloads exactly the same way for a non-redundant FC302 system.

7 – As soon as downloads are completed successfully, the transducer will show the following phases:

- The Active will transfer the whole configuration to the other module (RED_SYNC_STATUS_L as Updating Remote and RED_SYNC_STATUS_R as Maintenance).
- After the configuration is successfully transferred, the modules can take some time to synchronize (parameters RED_SYNC_STATUS (L and R) as Synchronizing). This is the time necessary to the modules to check the configuration with each other.
- Finally, the modules will synchronize (parameters RED_SYNC_STATUS (L and R) as Synchronized and RED_STATE_R as Standby). Once the system is on these conditions, the Active will be constantly updating the Standby.

Changing the configuration

Just follow the steps 6 and 7 of the section “First time configuration procedure”.

Replacing a module with failure

1 - With the H1 connector disconnected, insert the new module in the backplane.

2 - Update the firmware in the new module, if necessary. Perform a Factory Init in the new module in order to grant the default state.

3 - Connect the H1 connector to the new module.

4 - The new module will be automatically recognized by the Active and both will stay in Synchronizing for some time. As soon the system get the Synchronized status and <none> in the parameters Bad Conditions, the redundancy will be fully available and failure simulations can be performed.

Fixing the system when the H1 cable breaks

If a fail occurs in a segment of H1 line such that it affects only one module, the redundancy will cover this fail. But, if the H1 cable is re-connected at once, the noise introduced in the line will cause communication problems for some time.

In order to avoid that problem, follow the procedure below.

1 - Put the module affected by H1 cable fail in Hold.

2 - Fix up the cable connection.

3 - Perform a Reset in the affected module in order it returns operating. The module will be automatically recognized by the Active and both will stay in Synchronizing for some time. As soon the system get the Synchronized status and <none> in the parameters Bad Conditions, the redundancy will be fully available and failure simulations can be performed.

Firmware update without process interruption

This procedure describes how to update the firmware of both the modules without process interruption.

1 – Be sure the system is in the Synchronized status and it has <none> in the parameters Bad Conditions. So, using FBTools update the firmware of the Active module. At this moment, the other module will take over.

2 - After the firmware update was finished, the modules will start to synchronize with each other, with the Active transferring all the configuration to the other one. Wait for the system get the Synchronized status and it has <none> in the parameters Bad Conditions.

3 - Using FBTools update the firmware of the Active module. At this moment, the other module will take over.

4 - After the firmware update was finished, the modules will start to synchronize with each other, with the Active transferring all the configuration to the other one. As soon the system get the Synchronized status and has <none> in the parameters Bad Conditions, the redundancy is fully available again and failure simulations can be performed.

Adding redundancy to a system in operation

If a non redundant system is intended to be redundant in the future, at the plant startup, the following conditions must be obeyed:

1 - The 4^{th} H1 port should be reserved as synchronization path. That is, this port should not have devices connected to it.

2 - Predict H1 channels cabling considering that a Backup module will be added in the future (the H1 channels of the Main module should be connected in parallel with the respective H1 channels of the Backup module).

3 - Predict that the LAN architecture can be expanded, in order to attend what is described in the Redundant System Architecture.

4 - The single module should use a redundant firmware (a version terminated in R). The parameter FUNCTION_IDS should be set as Sync_Main. This way the module will work in Stand Alone state and will be ready to recognize a new pair inserted at any time.

Configuring LAS Redundancy

Here follows the steps for the configuration and maintenance of this legacy mode. It is recommended that the steps are all read and understood before are executed.

First time configuration procedure

This is the procedure to configure the system with LAS Redundancy for the first time, at the plant start-up.

<u>Active Module</u>

1 - With the H1 connector disconnected, execute a Factory Init in both modules to grant the default state.

2 – Connect the H1 connector to the Active module. Keep the Backup module with the H1 connector disconnected for a while.

3 - Open the desired configuration in the SYSCON and put it in On-line mode. Right-click the bridge icon and with the option Attributes choose the module to be configured as Active in the field Device Id.

4 - Even in the bridge icon, right-click the field FB VFD and then click Block List. A new window will be opened showing all the blocks pre-instantiated in the module. Then, in this window, right-click the transducer performing an Assign Tag with the tag that is predicted for the Active in the configuration. Close the Block List window. In the main menu go to Export and click Tags.

5 - Right-click the transducer icon in the bridge and choose On Line Characterization. Set the parameter FUNCTION_IDS as Active.

6 - Even in the transducer, set the parameter SYSTEM_OPERATION as Redundant.

7 - If necessary, perform Assign Tag for all the field devices. Wait until the Live Lists of all the channels are complete. So, configure the system through the Active module executing all necessary downloads exactly the same way for a non-redundant DFI302 system.

<u>Backup module</u>

IMPORTANT – before connecting the H1 connector to the Backuo module, follow the steps below:

1 - Right-click the bridge icon and with the option Attributes choose the module to be configured as Backup in the field Device Id.

2 - In the configuration change temporarily the tag of the transducer (Backup must have it different from that one used for Active). In the main menu go to Export and click Tags.

3 - Even in the bridge icon, right-click the field FB VFD and then click Block List. A new window will be opened showing all the blocks pre-instantiated in the module. Then, in this window, right-click the transducer performing an Assign Tag with the tag that is predicted for the Backup in the configuration. Close the Block List window.

4 - Right-click the transducer icon in the bridge and choose On Line Characterization. Set the parameter FUNCTION_IDS as Passive.

5 – And then, connect the H1 connector to the new module, and after that set the parameter FUNCTION_IDS as Backup.

6 - Even in the transducer, set the parameter SYSTEM_OPERATION as Redundant. Wait until the Live Lists of all the channels are complete.

7 - For each one of the channels used in the configuration right-click the Fieldbus icon and choose the option Download Schedule.

NOTE
The parameter SCHEDULE_UPDATE in the transducer should not be used anymore. Instead of it use the option Download Schedule as described in the step above.

Replacing an Active module with failure

If the Active module fails, the Backup module takes over as LAS (Link Active Scheduler).

Here follows the procedure for the case the Active module must be replaced.

1 - With the H1 connector disconnected, insert the new module in the backplane.

2 - Update the firmware in the new module, if necessary. Perform a Factory Init in the new module in order to grant the default state.

3 - IMPORTANT- before connecting the H1 connector to the new module, the user must follow the steps below:

4 - Open the desired configuration in the SYSCON and put it in On-line mode. Right-click the bridge icon and with the option Attributes choose the module to be configured as Active in the field Device Id.

5 - Even in the bridge icon, right-click the field FB VFD and then click Block List. A new window will be opened showing all the blocks pre-instantiated in the module. Then, in this window, right-click the transducer performing an Assign Tag with the tag that is predicted for the Active in the configuration. Close the Block List window. In the main menu go to Export and click Tags.

6 – Right-click the transducer icon in the bridge and choose On Line Characterization. Configure the FUNCTION_IDS parameter as Passive.

7 – And then, connect the H1 connector to the new module, and after that set the FUNCTION_IDS parameter as Active Not Link Master.

8 – Even in the transducer, set the parameter SYSTEM_OPERATION as Redundant. Wait until the Live Lists of all channels are completed.

9 - For each one of the channels used in the configuration right-click the Fieldbus icon and choose the option Download Schedule.

10 – Change the parameter FUNCTION_IDS from Active Not Link Master to Active.

Replacing a Backup module with failure

If the Backup module fails the Active module remains as LAS (Link Active Scheduler).

The procedure for the case the Backup module must be replaced is the following:

1 - With the H1 connector disconnected, insert the new module in the backplane.

2 - Update the firmware in the new module, if necessary. Perform a Factory Init in the new module in order to grant the default state.

3 - IMPORTANT – before connecting the H1 connector, the user must follow the steps below:

4 – Right-click the bridge icon and with the option Attributes, choose the module to be configured as Backup in the Device Id option,

5 – In the configuration, change, for a while, the transducer tag (the Backup module must have a different tag in comparison with the Active). In the Syscon main menu, go to Export and click on Tags.

6 – Even in the bridge icon, right-click in FB VFD, and then click on Block List. A new window will be opened showing the pre instantiated blocks in the module. So, in this window, right-click in the transducer to do an Assign Tag with the tag that is the Backup in the configuration. Close the Block List window..

7 – Right-click in the bridge icon of the transducer and choose On Line Characterization. Configure the parameter FUNCTION_IDS as Passive.

8 – And then, connect the H1 connector to the new module, and after that set the parameter FUNCTION_IDS as Backup.

9 – Even in the transducer, configure the parameter SYSTEM_OPERATION as Redundant. Wait until the Live Lists of all channels are completed.

10 – For each one of the channels used for the configuration, right-click in the Fieldbus icon and choose the Download Schedule option.

Placing the system into operation after a general power outage

There is also a procedure to place the modules into operation after both have been turned off. If you turn them on at the same time, there will be many collisions on the H1 network because both modules (Active and Backup) will try to become the LAS at the same time. It will cause a delay for the perfect communication to be established. In order to avoid this problem, turn on first the Active module and wait until it is on line. Then, turn the Backup module on.

Fixing the system when the H1 cable breaks

If a fail occurs in a segment of H1 line such that it affects only one module, the redundancy will cover this fail. But, if the H1 cable is re-connected at once, the noise introduced in the line will cause communication problems for some time.

In order to avoid that problem, follow the procedure below.

1 - Put the module affected by H1 cable fail in Hold.

2 - Fix up the cable connection.

3 - Perform a Reset in the affected module in order it returns operating. The redundancy will be fully available and failure simulations can be performed.

Firmware update without process interruption

This procedure describes how to update the firmware of both the modules without process interruption.

1 - Using FBTools update the firmware of the Active module. At this moment, the other module will take over.

2 - After the firmware update had finished successfully, follow the steps 4 to 9 of “Replacing an Active module with failure”.

3 – Wait around one minute in order the Active module become the LAS again (the Active is always the preferential in this mode of redundancy).

4 - Using FBTools update the firmware of the Backup module.

5 – After the firmware update had finished successfully, follow the steps 1 to 6 of the section “Configuring the system for the first time- Backup Module”.

Chapter 19

FCVIEW

Overview

The FCView is the software tool used during the operational phase, that is, after the installation, configuration and start up of the measurement system using the Auditflow.
The main functionalities provided by FCView are:

• Monitoring and writing parameters of main blocks without any configuration for FCView : GT, GST, LBT, LCT and LST;
• Proving process management (LMMF) and well test (WT).
• Report: Transfer of the reports from the FC302 memory to the database, through task executed in background.
• Configuration Log generation: to keep the information of FCView configuration.
• Database navigation and directly from the FC302 memory for visualization and report print.
• Access restriction in the database to guarantee the inviolability.
• Web visualization and navigation in the database. The reports are generated using PDF.

Figure 1

Starting FCView

The FCView can be started from Start menu, because it is installed inside the Smar menu.

When starting the FCView at the first time, it is necessary to perform the device register. The register loads the CSV files in the corresponding database to the firmware version and DD. In this stage of preparing the database, it is necessary to provide data, which can be available in configuration file form or by upload.

The configuration file or upload define the topology which will be used by FCView. The database keeps the topology, so this procedure will not be necessary in the next time. The configuration files are used except for when there is a change in the plant, and it can distinguish the configuration and registers. So in the next system starting, the communication can starts without using the configuration files or upload.

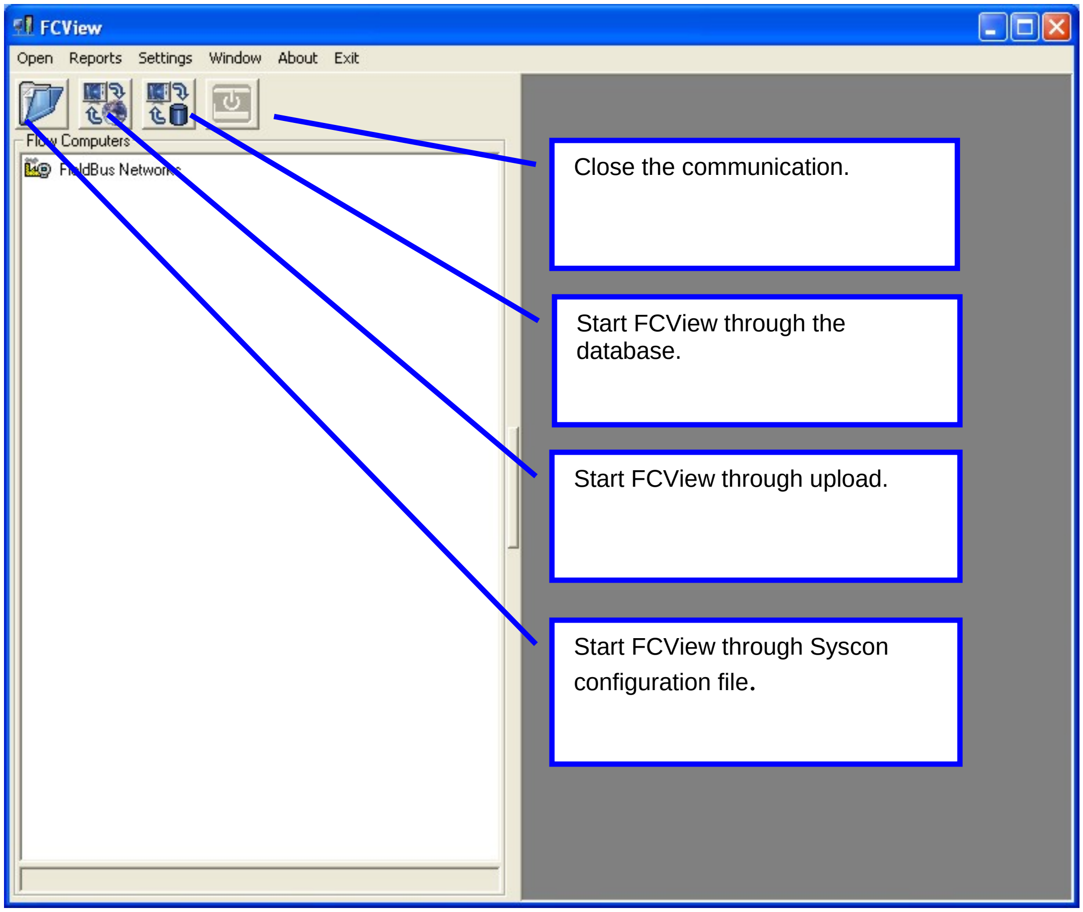


Figure 2

Register

The register process is the first procedure to be executed in the FCView after the installation. In this process, the FCView prepares the database to communicate with Auditflow. In the device, FCView checks the configuration to find the FC302s and attach them to its database, using values related to the version of the devices. These values are the units, lists, access level and filed description.

The register must be performed in the startup time of the measurement system and it will be done automatically when detected a configuration change.

The process is faster in the register by configuration file, because it does not depend on the communication with the equipment and the process can be done off line. While the register by upload does not require the configuration file created by Syscon and is guaranteed that real data are available.

After opening the FCView, in order to initiate the register process using the configuration file, click on **Open → from Configuration File** and select the desired file with “ffp” extension.

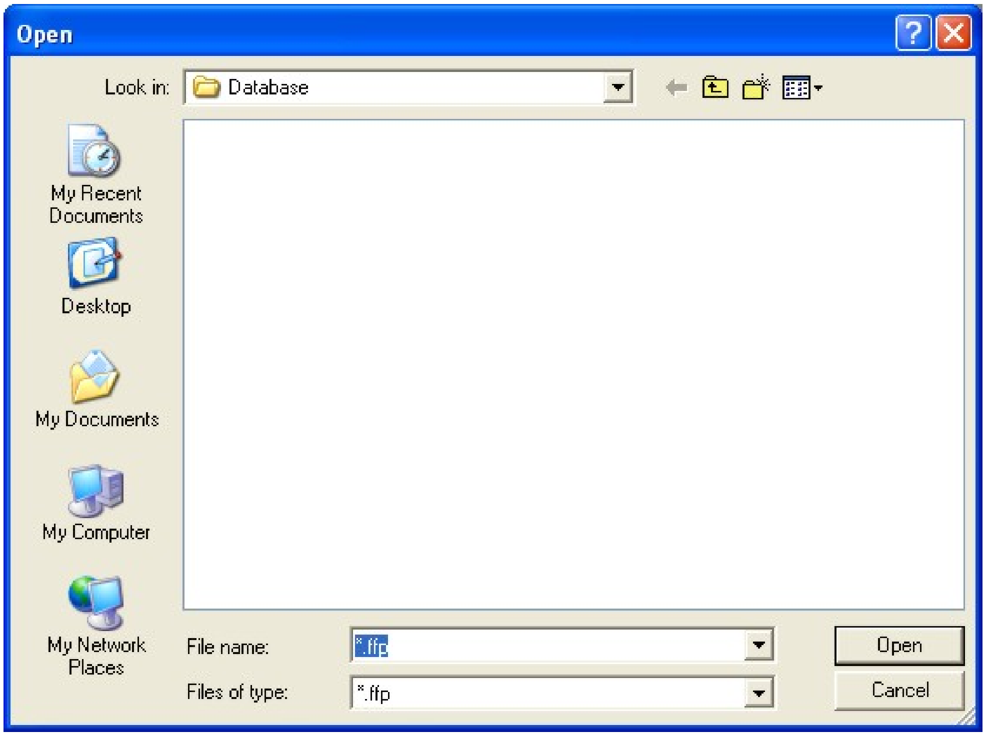


Figure 3

If the process was initiated by upload, click on **Open → from Upload**, the upload process begins and after the acknowledgment of all FC302's of the network, must select the bridges.

By default the upload option is not enabled, because devices from other manufacturers with corromped DDs can interfere in the upload process. To enable the upload option, go to the Options menu in the FCView.

Figure 4

When opening the configuration file or executing upload, FCView checks the topology and filtering all the devices, keeping only those which have the information about operation and reports.

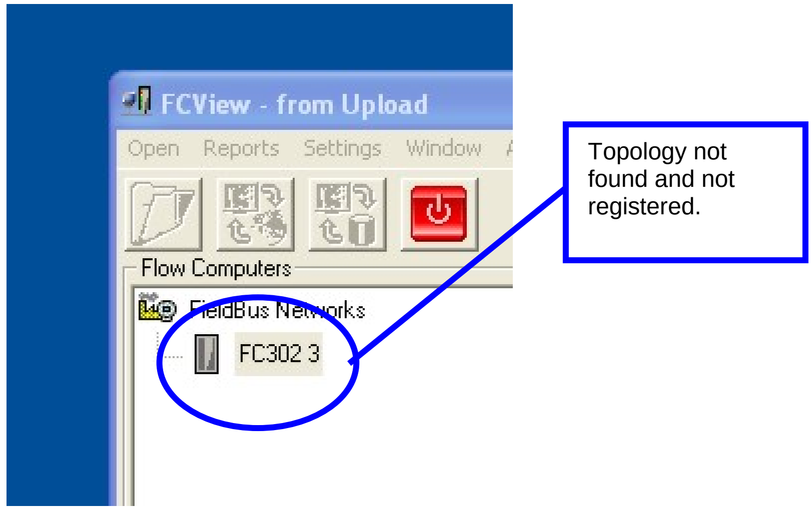


Figure 5

Once raised the topology, the devices founded in this and which are not registered in the FCView are represented for a grey icon. To verify the bridge attributes into the FCView and the actual status of this, click on **Information** through the menu popup.

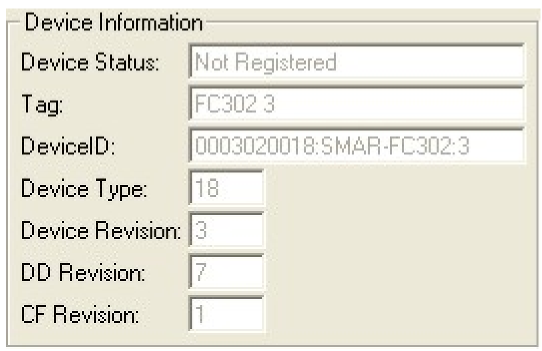


Figure 6

To register the device, select one FC302 and through the menu popup, select **Register Flow Computer**. The register process can take few minutes if the configuration was very complex.

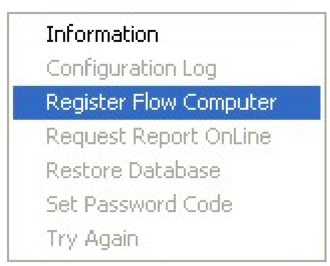


Figure 7

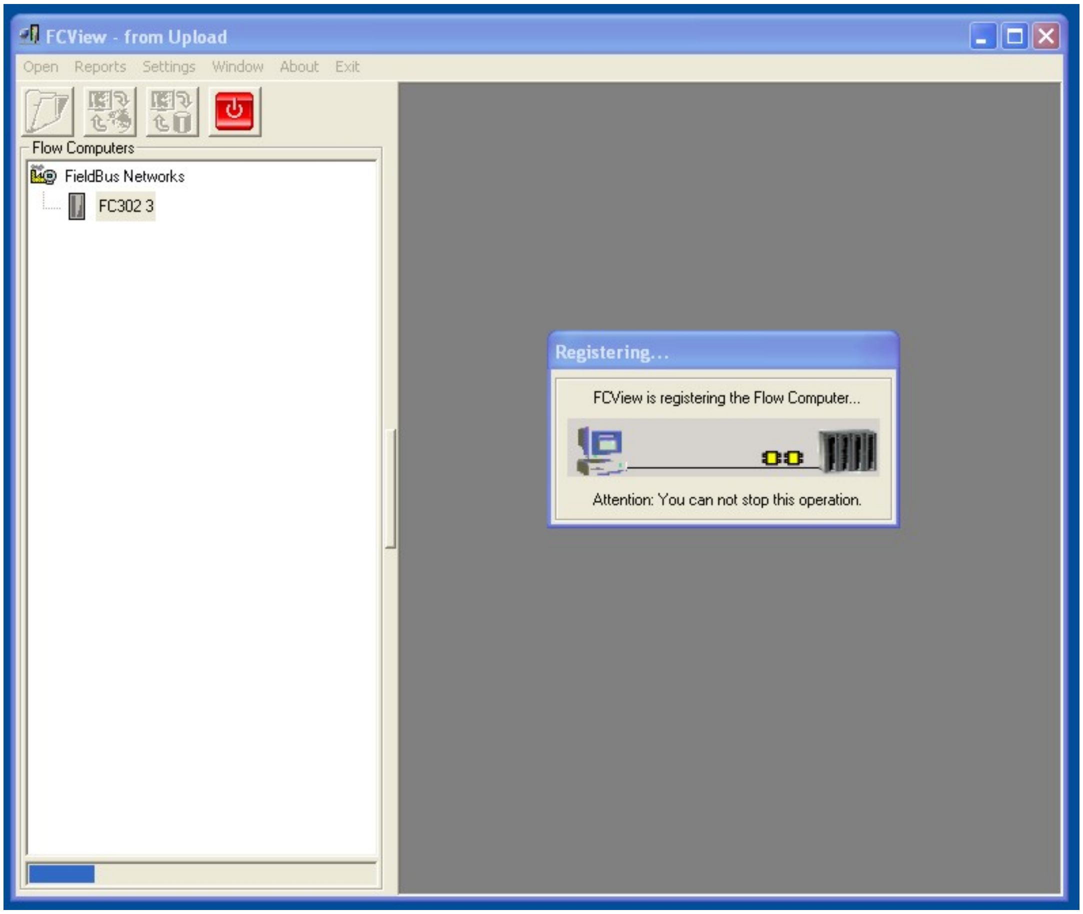


Figure 8

After the register process, the icon which represents the bridge changes of color becomes coloured and the actual status changes. The register process must be done for each FC302 individually. If any FC302 from the configuration must not be used, it does not do the register of it.

The register process can be accomplished in any moment, even so the FCView was communicating with other FC302.

Each time the process register is done, the FCView executes the diagnostic process for the registered FC302.

When there is, at least, one FC302 registered, it is possible to start the communication. Open the configuration from the database without using the configuration file and/or upload process.

Diagnostic

The diagnostic process claims to verify the FCView register consistence with the FC302, if the Syscon tags were exported correctly and the device communication. The data read on the diagnostic are:

- **units**: parameters for FCT block units
- **users**: usernames of the FCT block
- **strategies**: all the strategy parameters of each FC302 block are read to be linked with the needed screens. If all strategy parameters can be read, so FCView considers that the attached block is OK
- **security data**: parameters like the FCVIEW_VSN of the FCT block

This process is automatic and is executed always after a register is accomplished, or the FCView has been initialized.

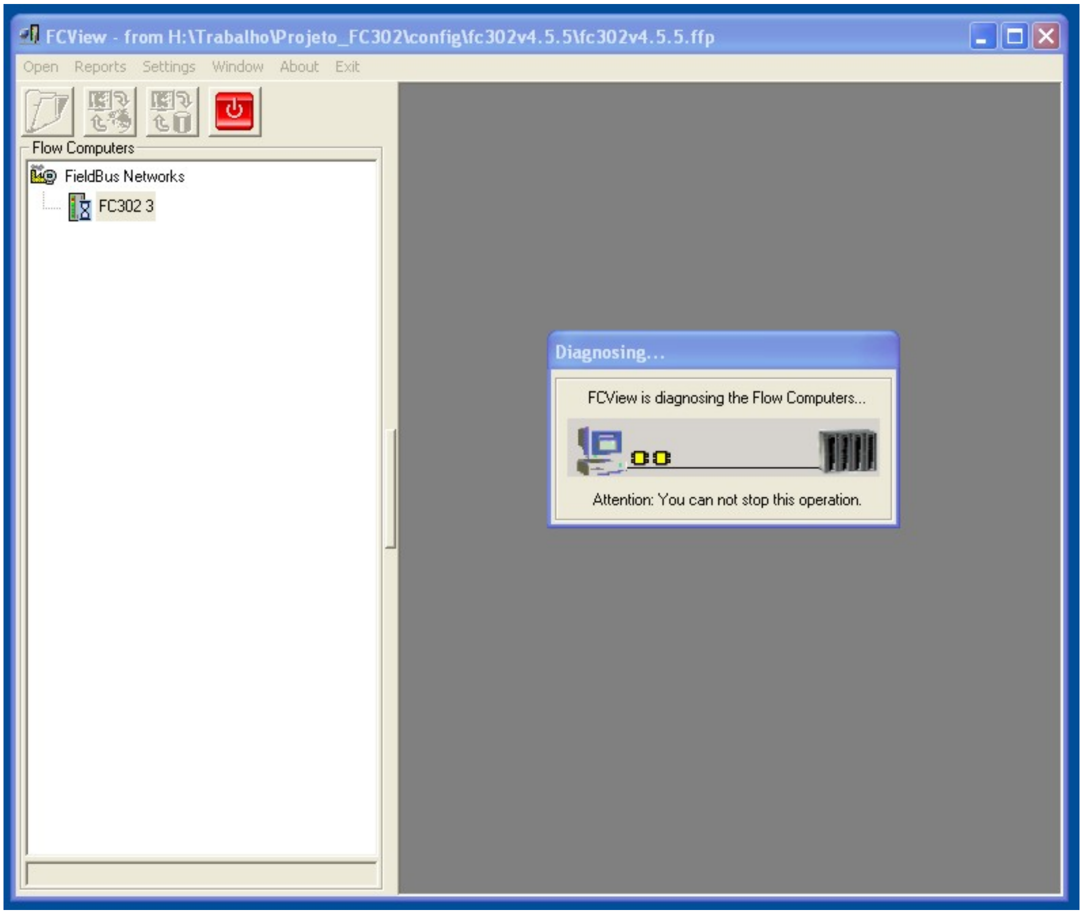


Figure 9

If any problem was found in the communication with FC302, the device will be disabled indicating problem in the menu popup **Information**.

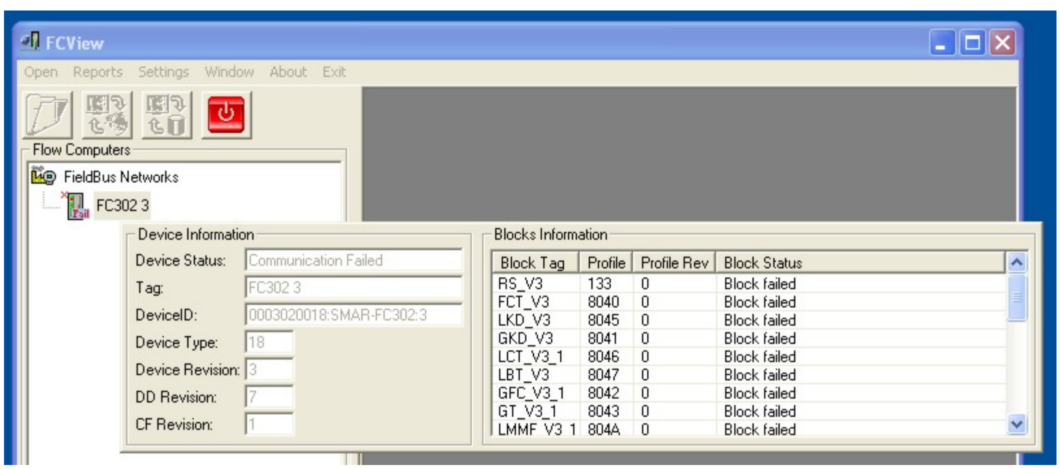


Figure 10

Once accomplished the diagnostic process, the FCView starts the report extraction process from the FC302 memory (Background Process), and allows the user to open the operation/supervision screens.

Reports

Report Extraction

The report extraction process is independent of the interaction with the user. Once begun the FCView and the diagnostic process finished successfully, the FCView is responsible for extract the reports automatically.

Even so the FCView was monitoring more than one FC302 at the same time the extraction is accomplished for one report for time, that is, for block.

The actual status of the reports is showed in the main screen:

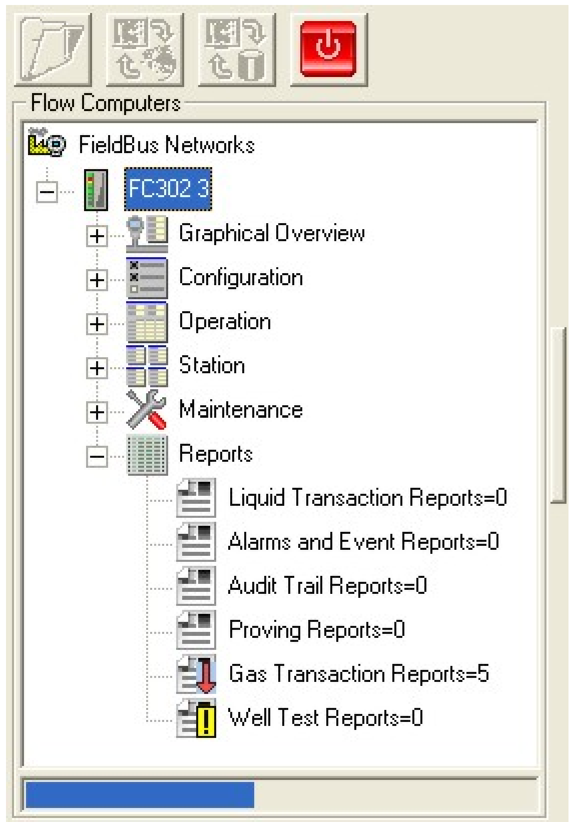


Figure 11

The report extraction process checks AEV, ATV, GTV, LMFV, LTV and WTV blocks. These blocks become available the reports which must be storage in FCView database. If any block has communication problems, the FCView detects the inconsistent block and ignores it, coming to check it, again, only after to extract the reports from the other blocks.

The FCView, for each extracted report, accomplishes one calculation of CRC to verify the data integrity. If there were problems, some errors can have occurred during the communication between the FC302 and the FCView. In this case, the FCView will try to extract the reports from other block for later tries this again.

Data as unit are read at each extracted report through the FCT block, to keep the reports updated.

To format date/hour field used in the reports, it is necessary to change the default format in the Windows. In the Control Panel verify:

- the format of the "Date/Time" field

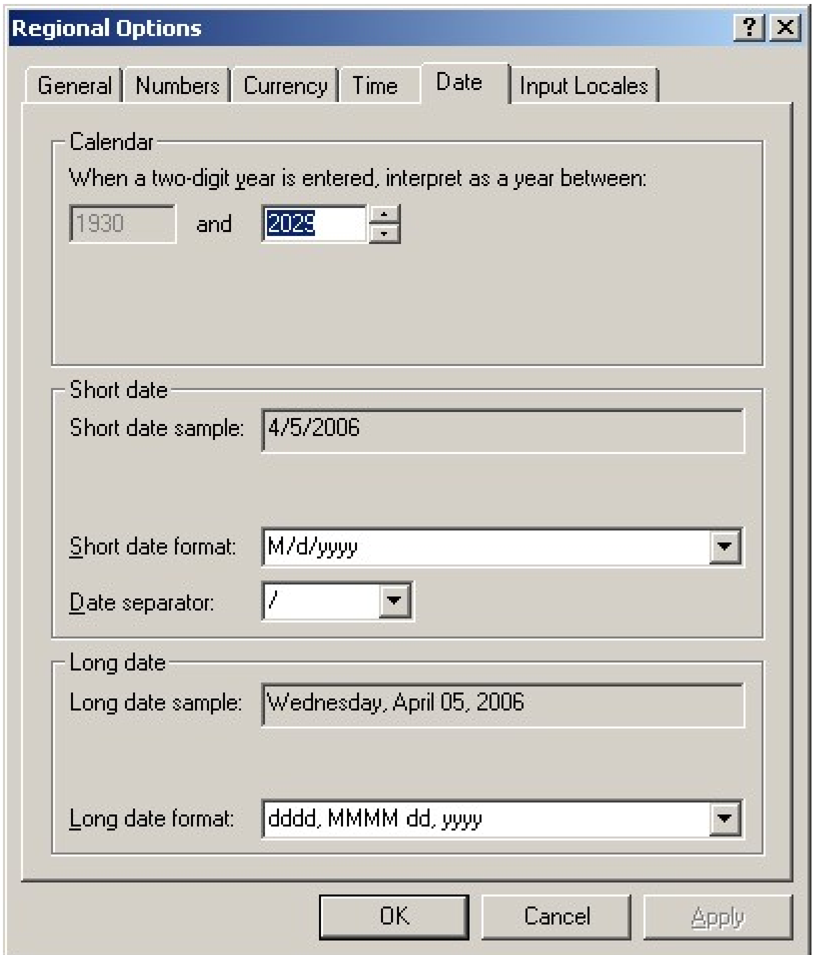


Figure 12

- the format of decimal symbol

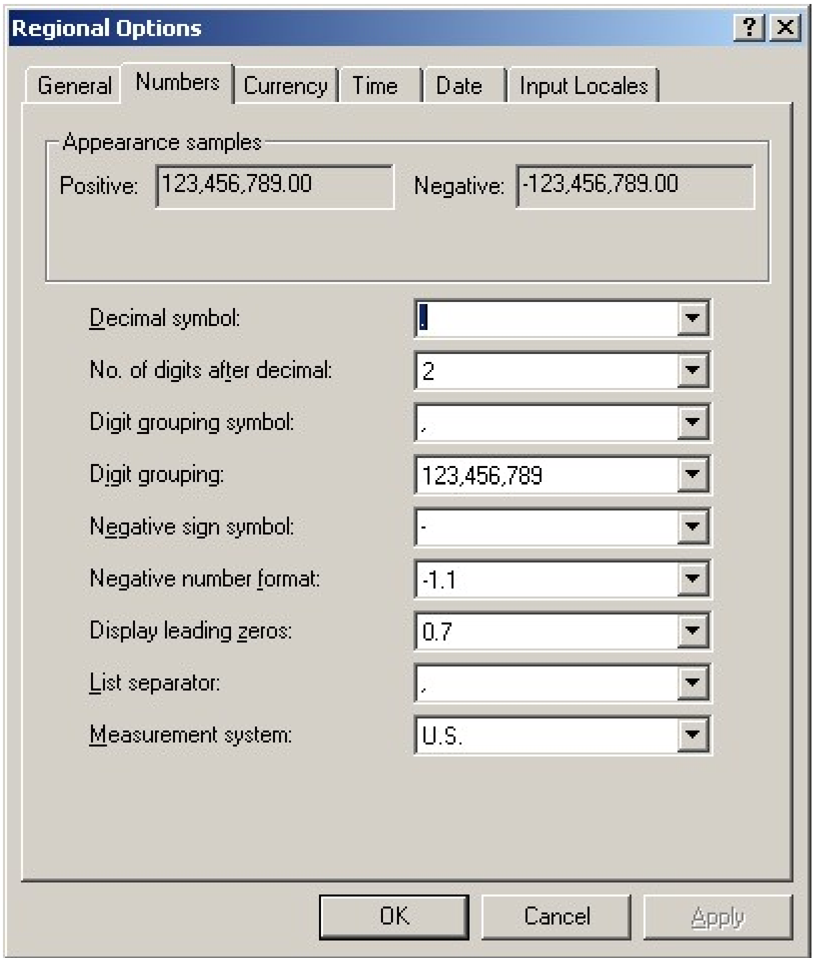


Figure 13

Report Visualization

The extracted reports from the FC302 memory can be visualized from FCView through a consultation interface. This interface can be opened in the menu **Report -> View**.

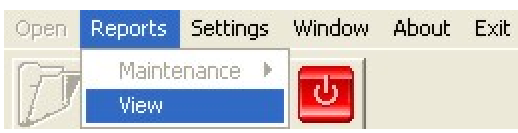


Figure 14

FCView becomes available report search from the actual database or from any external file (Backup), which this was generated by FCView.

It selects the report, clicking on this column

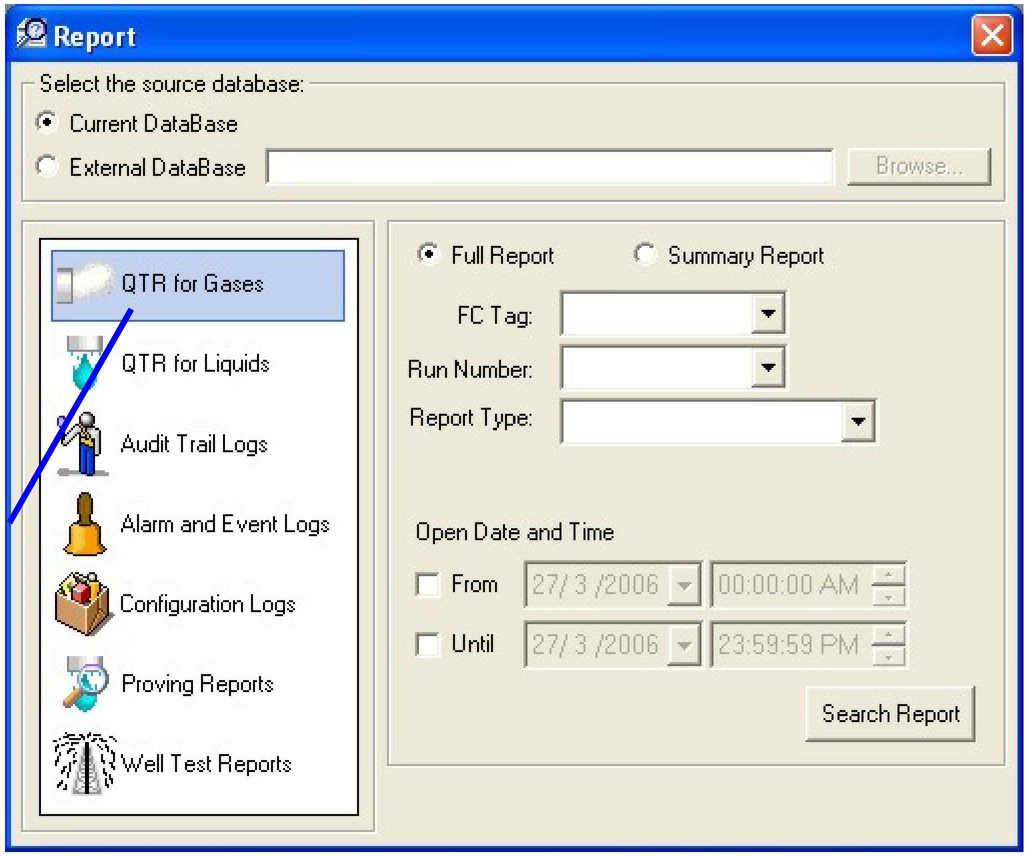


Figure 15

For this version, the following report types are available:

Reports for Gas Totalization

Reports for Liquid Totalization

Audit Trail Logs

Alarm and Event Logs

Proving Reports

Well Test Reports

The search is done for each report type and FC302 Tag. It can type data for filtering, but are optional. If there no are reports of the selected type in the database, the "FC Tag" field will not have any option to select. But when this field is blank, it will search in more than one FC302.

After supplying the data for the search, click on **Search Report** to open the report visualizator.

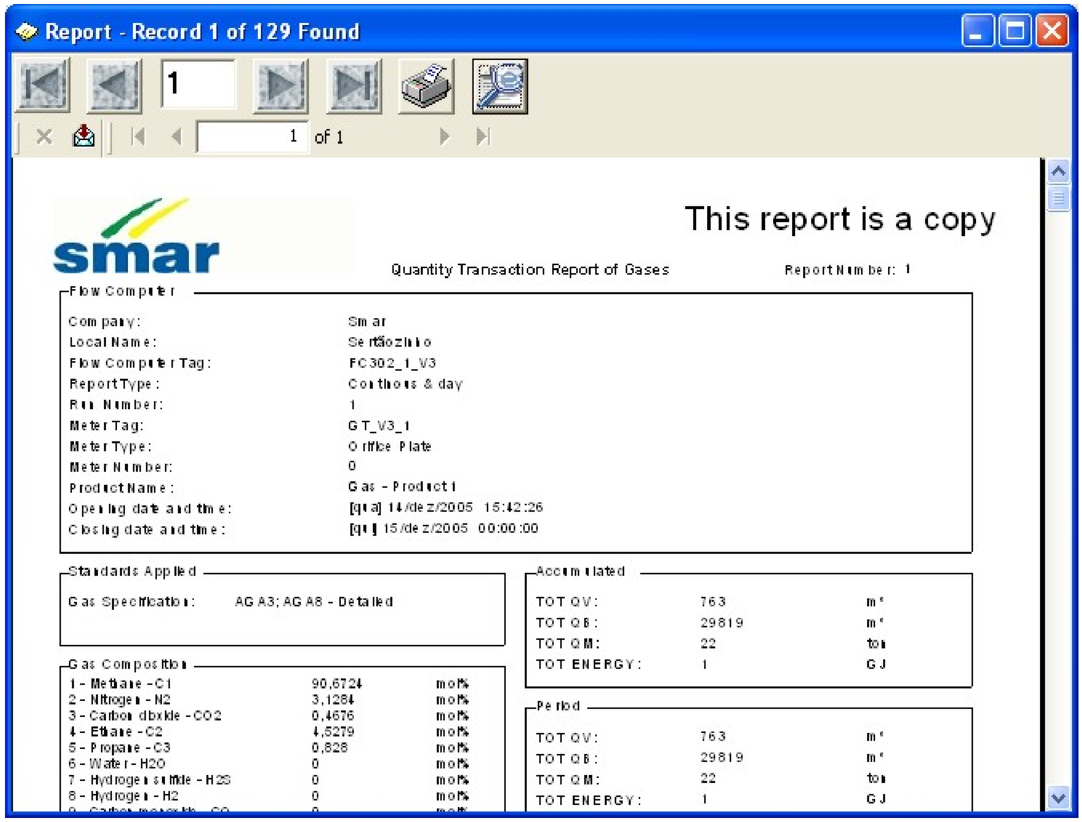


Figure 16

Register Navigation (Reports)

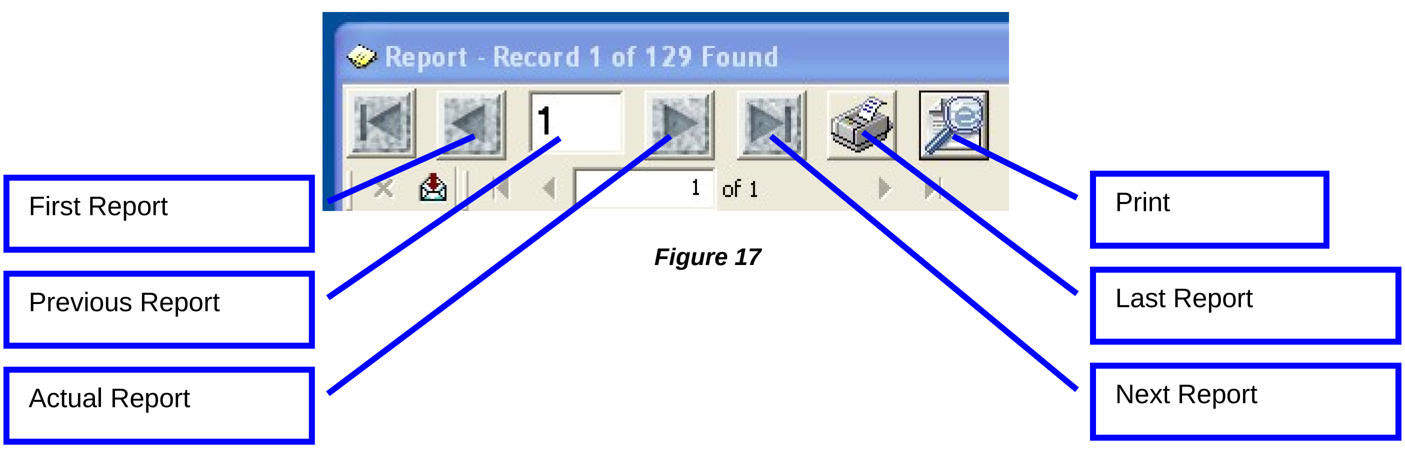


Figure 17

Page Register Navigation (Reports)

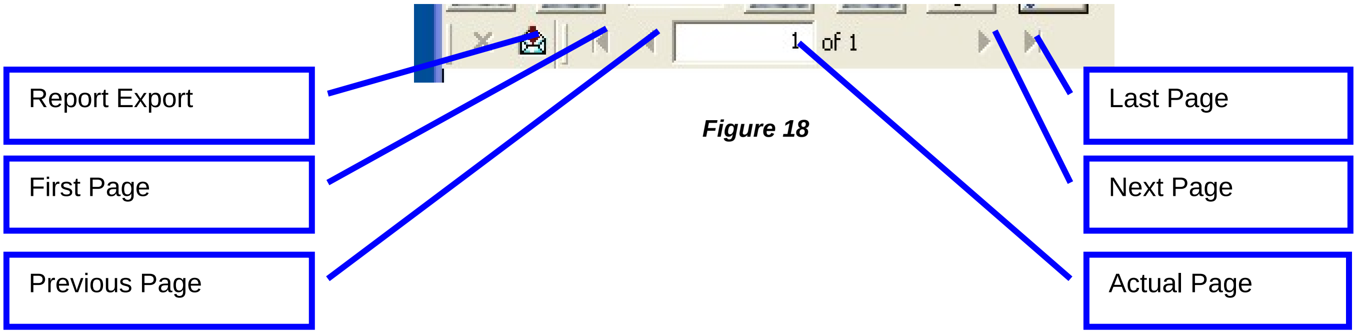


Figure 18

Note that all consulted reports in the FCView database have a label indication which is a copy. It indicates the data which are being consulted in database and can have been changed for anyone.

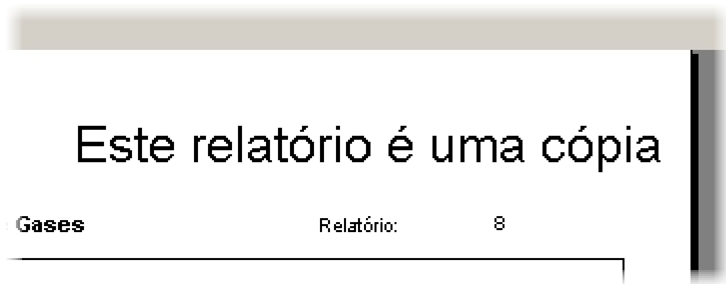


Figure 19

Printing Reports that had seen

The FCView allows the stored reports in the database were printed after consulting them, by clicking on the print menu.

Figure 20

From the search, the user can print all the reports, only the actual page or a range of reports. If was necessary, there still is the option to change the printer. But, must remember if was done any change using this option, the change only will be valid in this search.

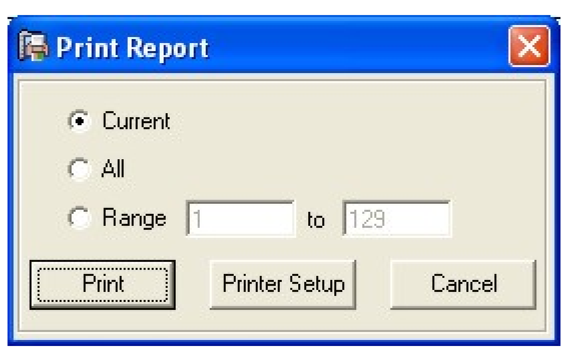


Figure 21

Automatic Print of reports extracted from the FCView memory

The report automatic print occurs when a report is extracted from the FC302 memory. This is optional and by default is disabled.

In the printed report through the automatic print, the label which indicates the relatory is a copy disappears, because this process collects data directly from the FC302 memory.

To configure the automatic print, refer to the section about FCVIew configuration.

Online Search of Reports from the Memory

An online consultation allows open a report directly from the FC302 memory. The report becomes authentic, dispensing the label which indicates copy. This consultation is not valid for "Alarm and Events" and "Audit Trail" reports.

To search, select through the menu popup "Request Report OnLine":

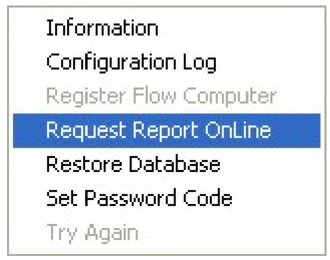


Figure 22

Select the flow computer, the report type and its "Log_Counter":

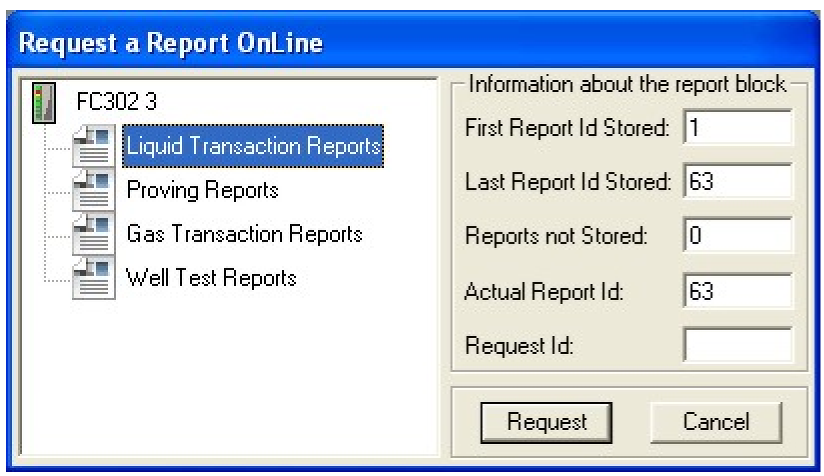


Figure 23

At supplying the Log_Counter, if the FCView was extracting one report at the moment, as soon as it finishes, it will begin to extract the required report; otherwise it begins at the same moment. After extracting the report, it will be showed on the screen.

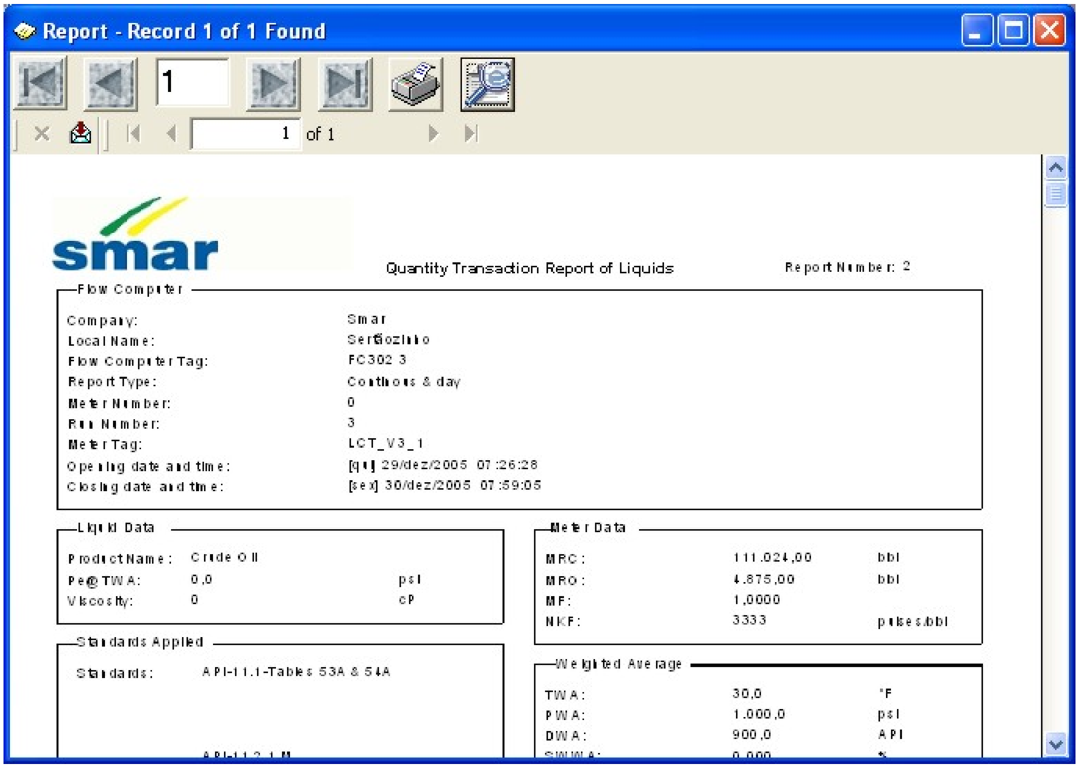


Figure 24

Configuration Log

The Configuration Log allows the user to read the main parameterization of the FC302 on the report format, and many reports can be generated along the time. So the operator can reconfigure the device if it is replaced or when the data is lost.

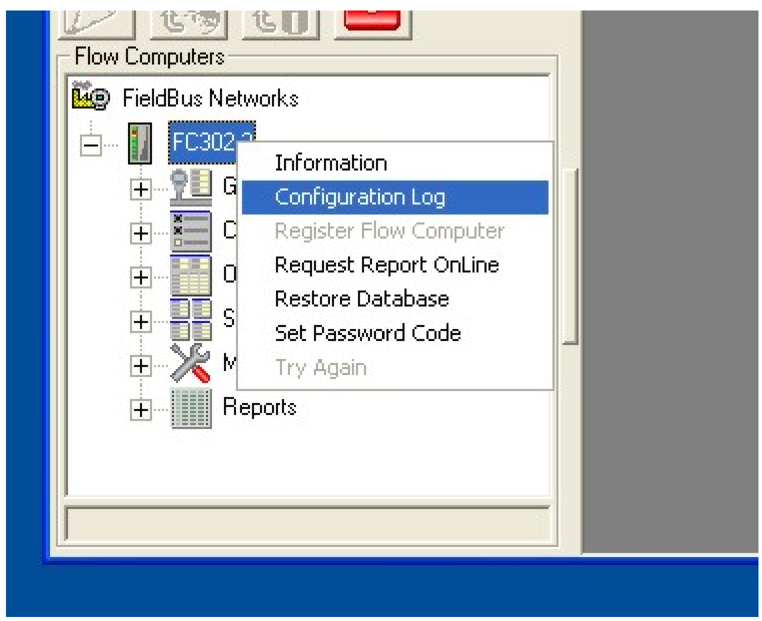


Figure 25

The Configuration Log is generated manually per FC302 unit by selecting the FCView popup menu. It is not a FCView feature. Once started the process, the FCView will get the FC302 information and save it in the database for searching through the report menu.

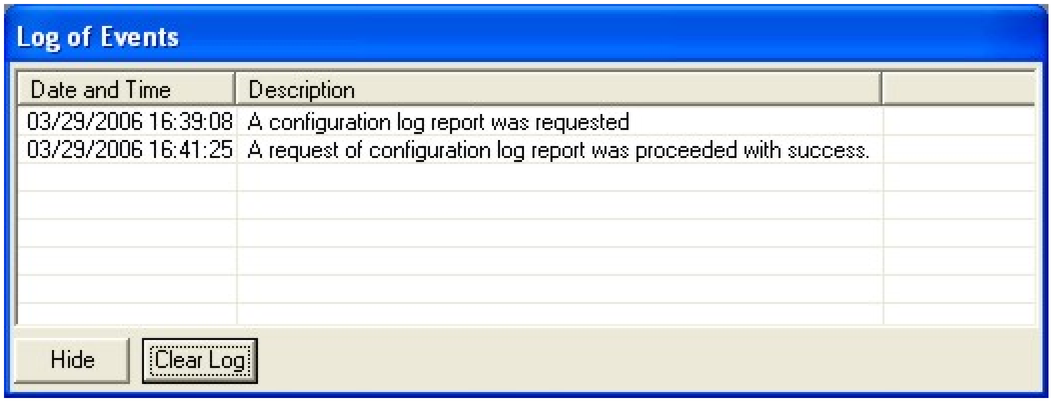


Figure 26

Report Search through the Web

FCView has an optional tool that allows the report visualization through the Web, allowing the report remote visualization without the local installation of FCView. This tool is optional and the installation depends on the available resources of the PC where it is desired to use as Server. The Appendix A shows how to install this tool.

Once this tool is configured, in order to do the search it can use Internet Explorer or similar similares, typing the web address as the example "http://endereço/fcview":

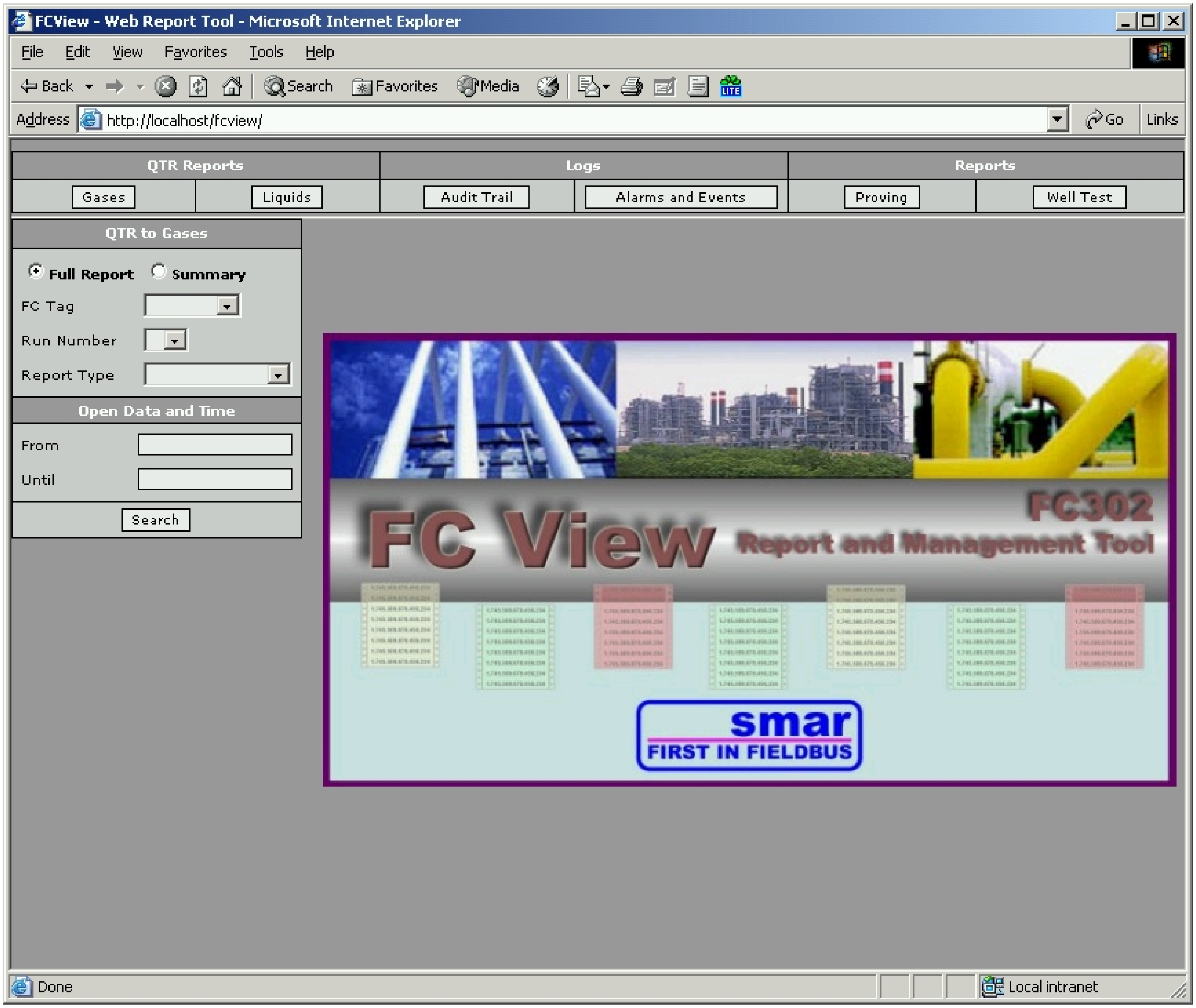


Figure 27

The procedure to search is the same of the used in the FCVIew. It selects the report type and goes to the search fields.

When the report is found, browser tries to interpret it opening the PDF visualizer. If the visualizer was Adobe Acrobat, the file can be seen into a dedicated window on the FCView page. Other types of visualizers can open the reports through other windows.

Operational Screens

The FCView operation mode is a form of supplying a visualization of the main measurement variables: measured inputs by the transmitters, weighed averages, correction factors, corrected flow (gross and net), simplified status from the period and resumed information about measured flow process alarm.

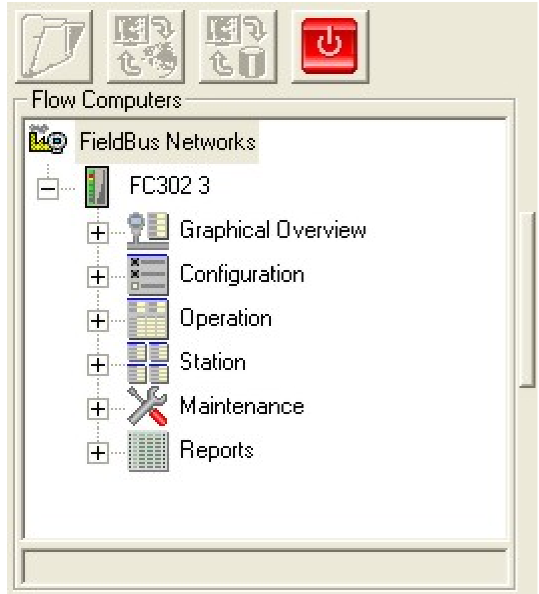


Figure 28

The screens are grouped in defined sections for each FC302 process:

- **Graphical Overview**: screen for graphical overview of the process. It includes the blocks LBT, LCT and GT
- **Configuration**: configuration or parameterization screens. It includes the blocks FCT, GKD, LKD, PIP and LCF.
- **Operation**: operational screens that operate with the process. It includes the blocks GT, LCT, LBT, GC, GFC and AALM
- **Station**: screens that concentrate information of more than one run at the same time. It includes the blocks LST, GST and AALM
- **Maintenance**: screens with well test and provinf functionalities. It includes the blocks LMMF, LMF and WT

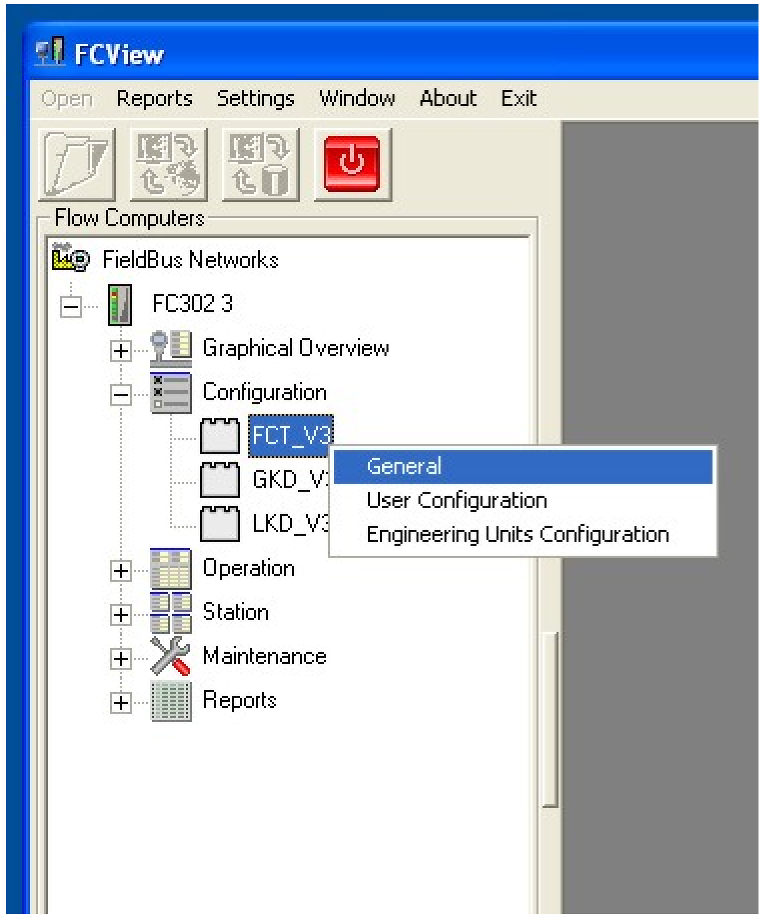


Figure 29

To access the screens, use the popup menu when selecting the node/element in the treeview.

By default the node/element description is the block name. But it is possible to change the block names setting the TAG_DESCRIPTION parameter. FCView uses this description to do more friendly the system operation for the operator.

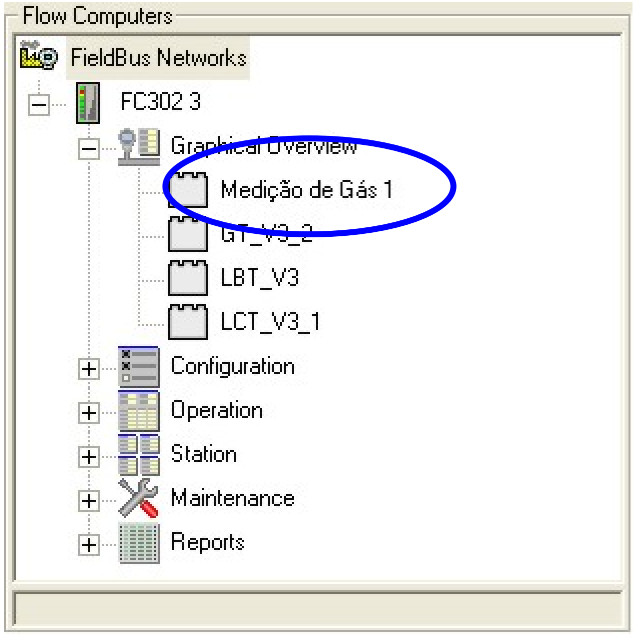


Figure 30

All the operational screens, if they are not maximized, are open and resized according to their contents to get the most utilization of the screen.

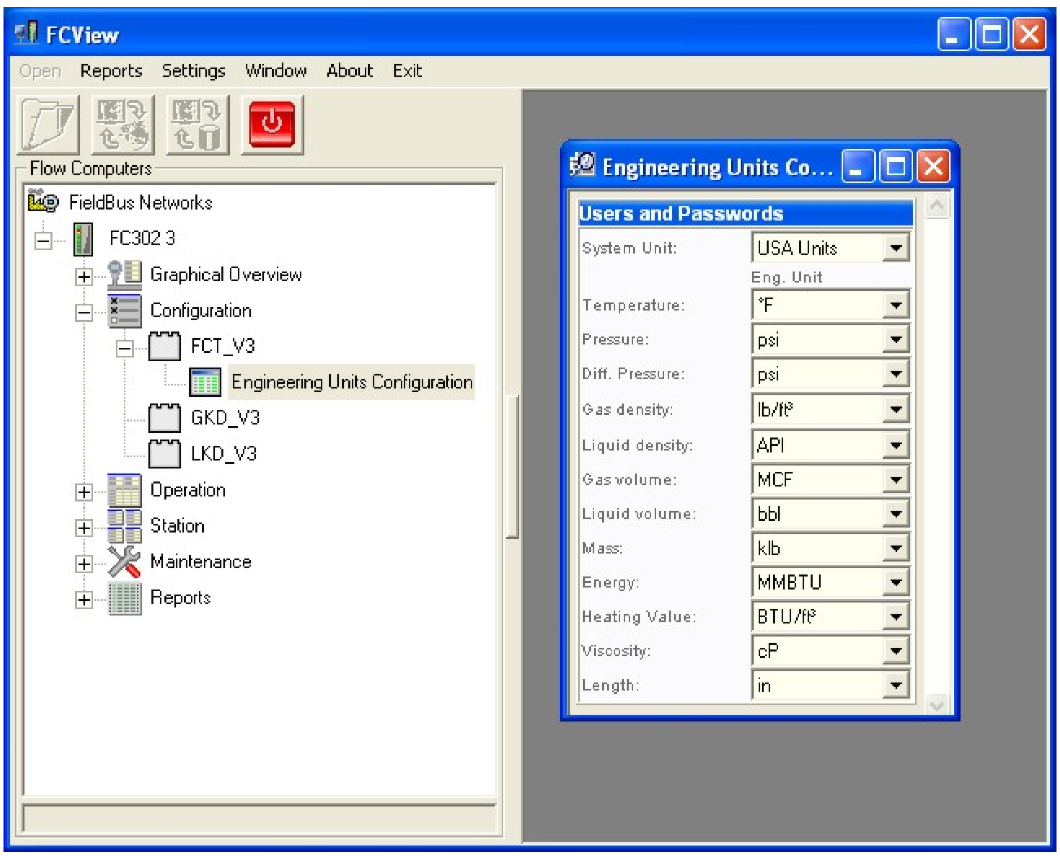


Figure 31

All the system variables are presented to be in accordance with discrimination standards and formatting for numerical data that are required by API-12.2.3, API-21.1 and API-21.2 standards, besides shows always the related engeneering unit, which depends on the set unit system in the LCT block.

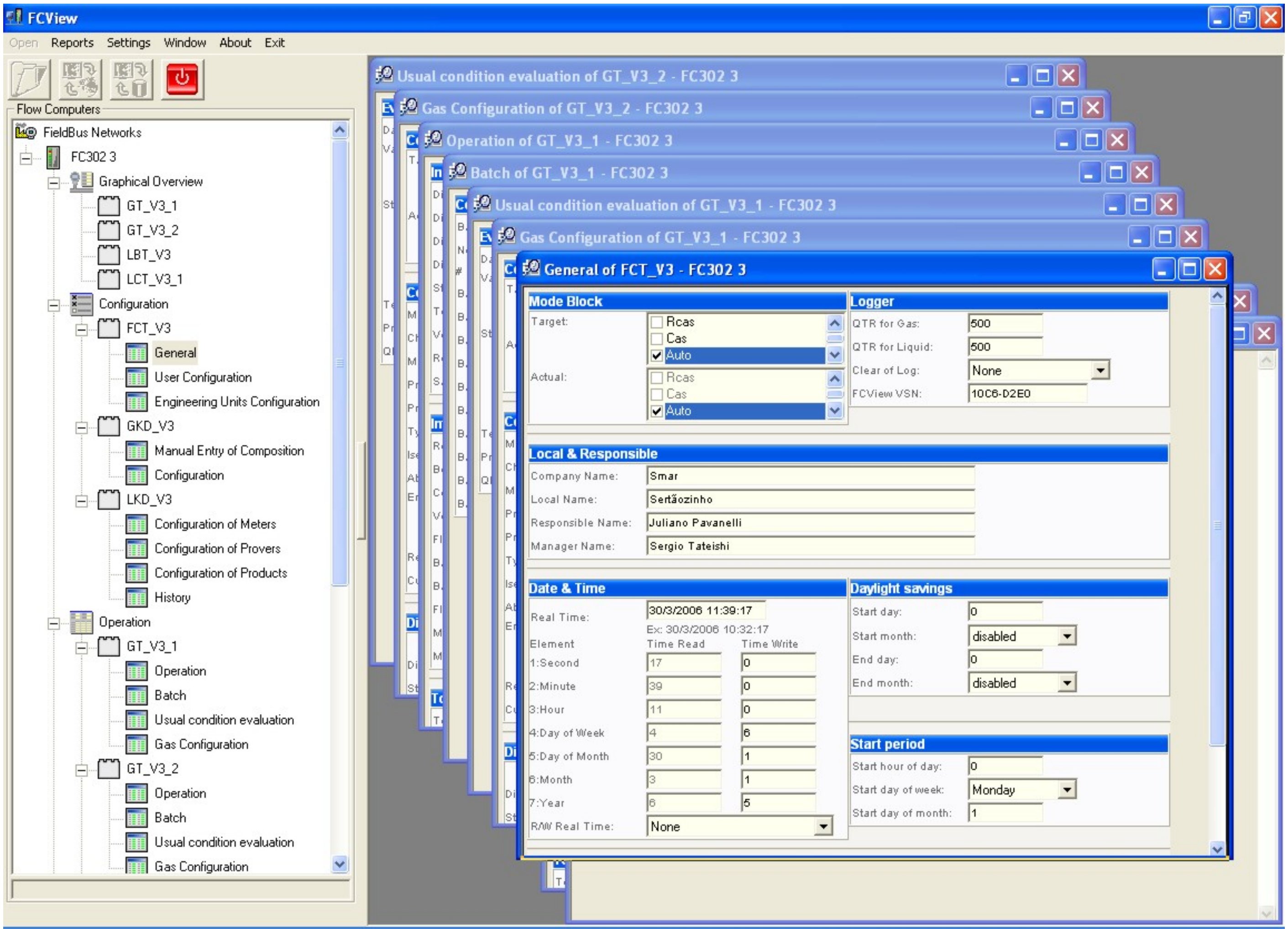


Figure 32

There is no limit for the maximum quantity of open screens. It depends on the maximum quantity of OPC point management and also the PC available memory.

Graphical Screens

The operation graphical screens are the friendliest representation of the system variables. Through them, it is possible to check all system runs only seeing the main variables.

The access to the screens is similar to other FCView screens, but it has a shortcut in the main menu that allows the screens to be open quickly and arranged automatically.

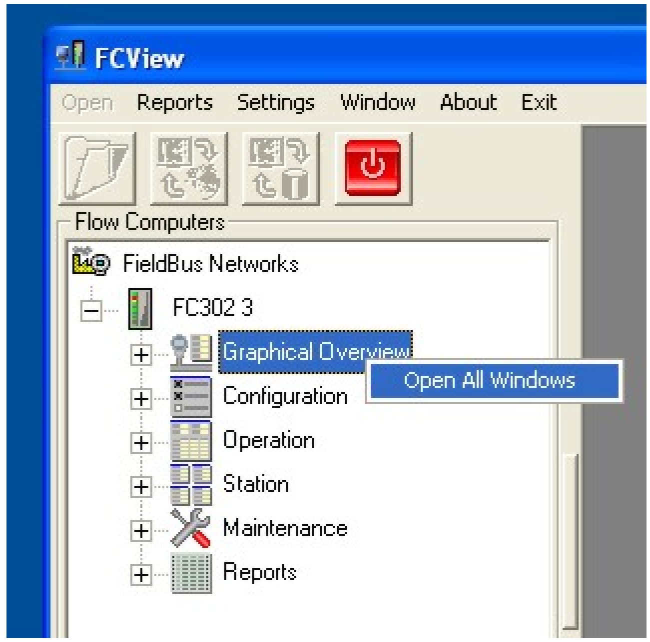


Figure 33

The quantity of graphical screens depends on the quantity of runs set in the process. The runs are identified by the blocks GT, LBT and LCT, with their respective strategies.

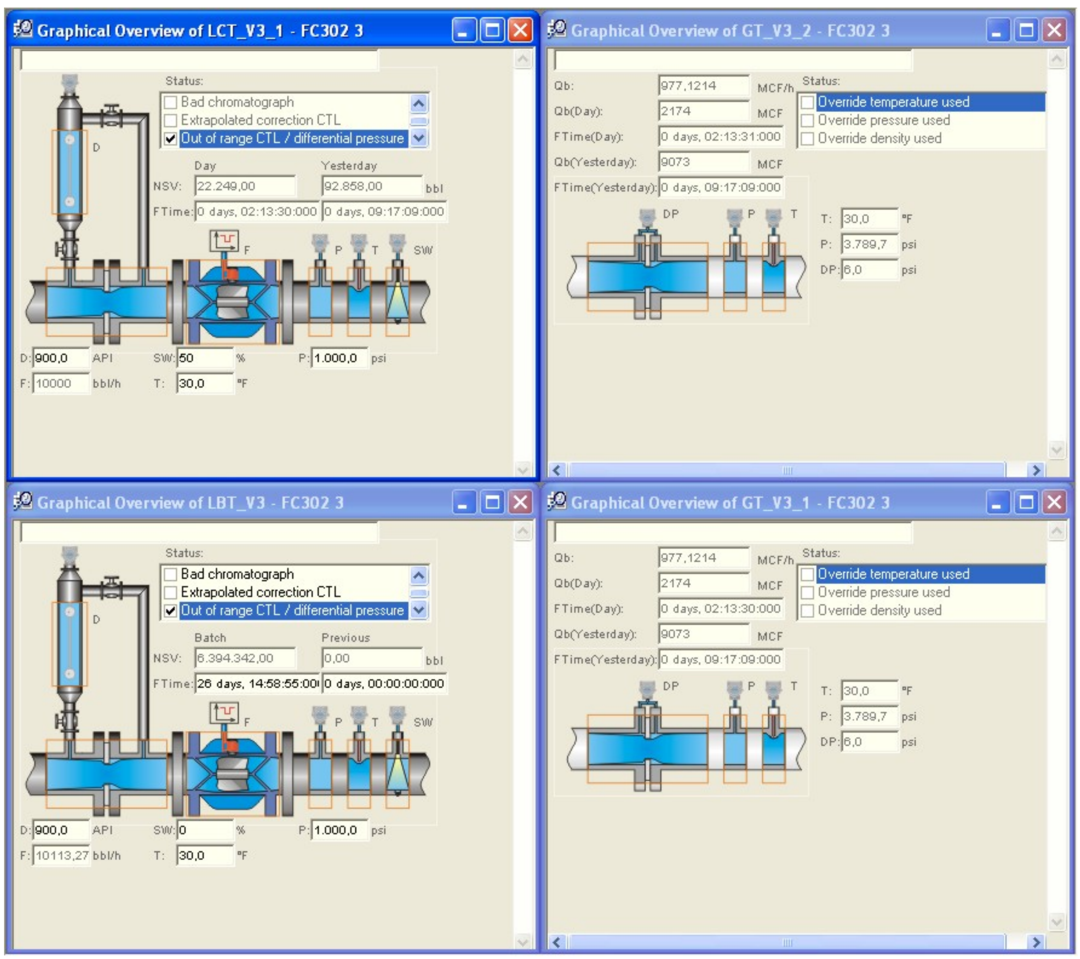


Figure 34

The pictures show the runs that depend on the meter types used and are changed when the runs are set.

Alarm screens

The alarms are blocks related to the runs through the strategies, that is, they are related to the blocks LBT, LCT, LST, GT and GST. To access the screens, use the popup menu of the corresponding blocks and will depend on the configuration to be available to access them.

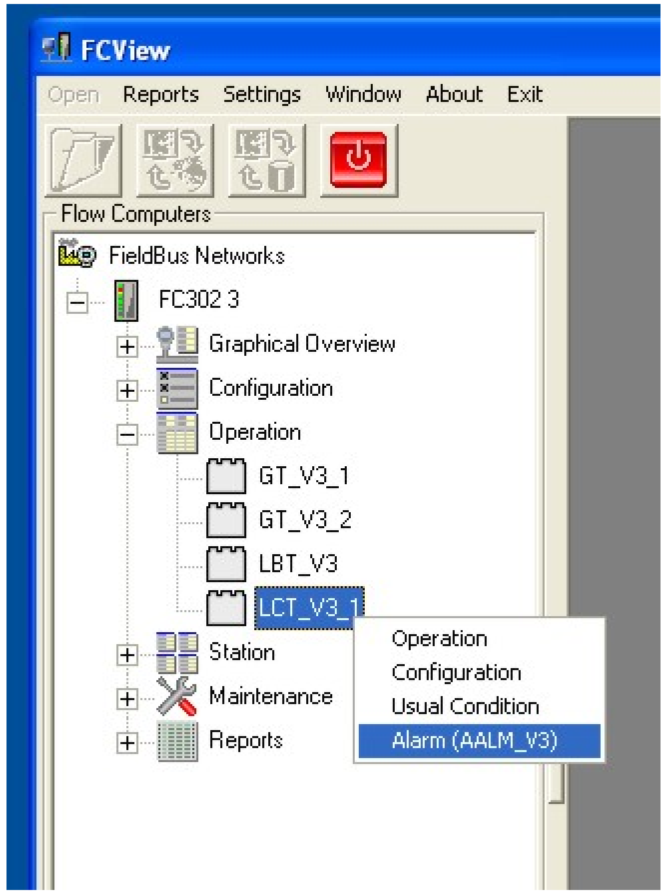


Figure 35

The alarm screen allows adjust the alarm limits, what alarms and variables are being checked.

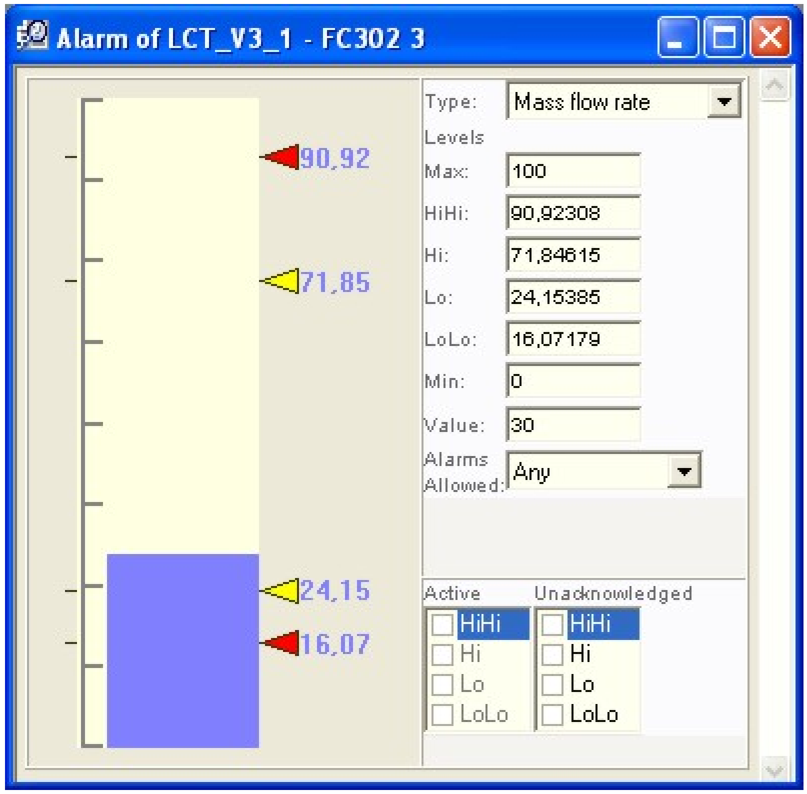


Figure 36

Protection by Password

Some screens have fields which allow the operator writes in some parameters. The parameters which have writing permission, the FCView allows that fields were editable. The writing operation occurs only with the confirmation pressing <ENTER> after the change. If the operator abandones the field without the confirmation, the data comes to the original value.

If the field was under "Audit Trail", the FCView requests the user login and password automatically. If the login was configured with double password, the user must be supplied both the passwords. The user must enter the password only once.

All the fiels under Audit Trail are logged in tge block ATV, and then extracted for the FCView database.

Figure 37

Maintenance

Export

The FCView allows export data handly. The export process creates one copy of the actual database.

Figure 38

The information to be exported depends on the export configurations. It is possible to export from the last export and to configure which report types will be exported.

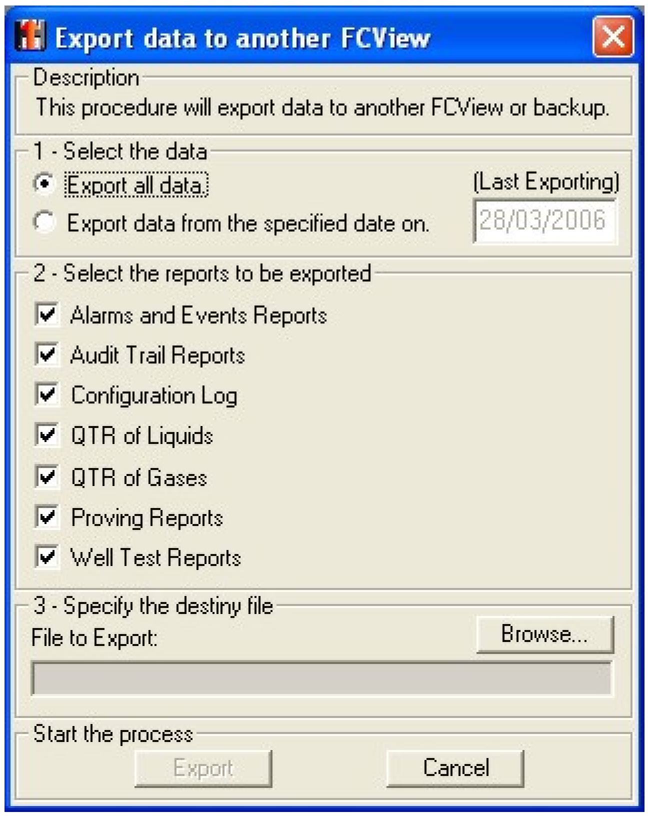


Figure 39

To export, execute the following sequence:

- Select if is desired to export all reports, all from the last export or from a specific date.
- Select which report types desire to export.
- Specify the file which will be salved the reports.
- Start the process.

The exported file format is MDB which can be copied to other media or directory. Even so this file had been copied to CD-ROM, the report visualization interface can open the information directly from the file.

Import

The FCView allows import data handly. The importation process creates one copy of the database in temporary directory to allow, even so the file was in CD-ROM, was open normally. The import does a merge operation with the actual base, but always checking if the registers are new or not, preventing duplicity.

Figure 40

The information to be imported depends on the import configurations. It is possible to import reports from the last import and to configre which report types will be imported.

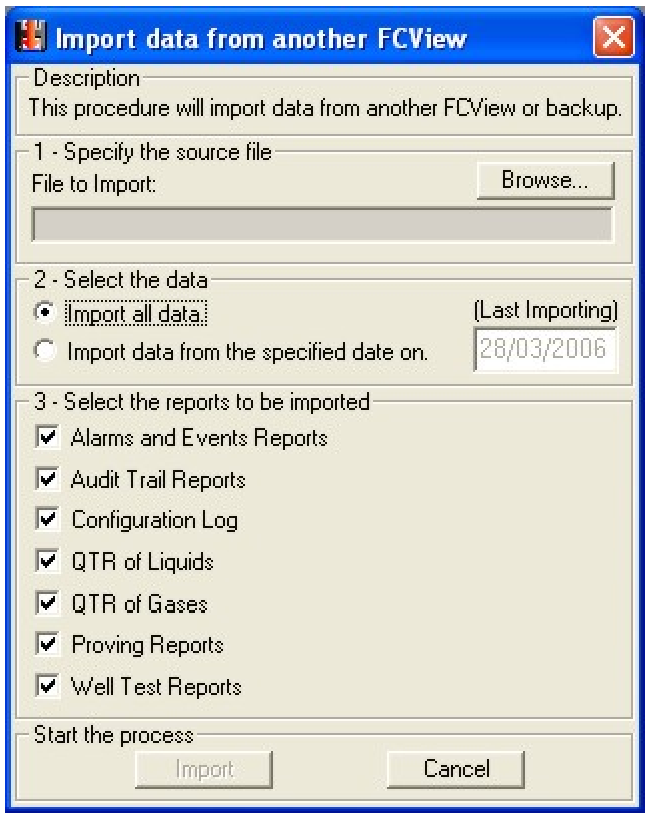


Figure 41

To import, execute the following sequence:

- Specify the file with the files to import.
- Select if is desired to import all the reports, all from the any date or from the last import.
- Start the process.

Backup

The FCView can accomplish backup process automatically using the "Task Scheduler" from Windows to execute this task, because it independs of the FCView to be executed or not.

The backup is configurable, from the FCView configuration menu, which is described in the chapter about configurations.

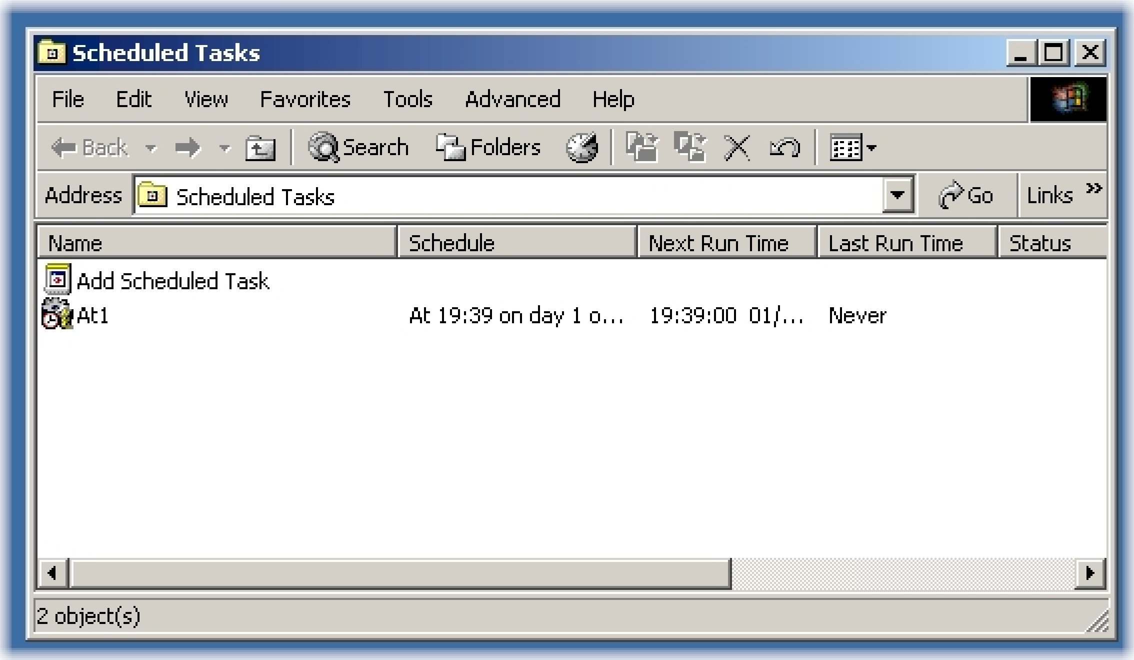


Figure 42

Once the task is created, the user can change the data handly, through the FCView or Windows.

Even the task is executed, it verifies if the FCView is working or not, if was, the communication with the FCView is stopped and the backup process is executed, copying the database to a specified directory. After the backup is done, the FCView comes to work again to allow the report extract.

Database Restore

The FCView allows recover the database from the FC302 memory. Once this recovery is requested, all the reports are checked to be extracted again.

The FCView verifies if the report which is being recovered already is in the database, thus preventing duplicity. To execute this recovery, click on Restore Database in the popup menu.

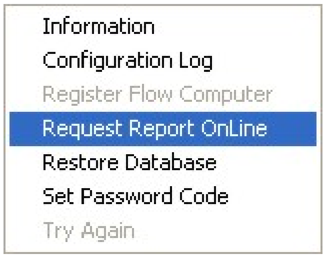


Figure 43

The FCView informs the operation will take few hours, because it depends on the report quantity in the FC302 memory.

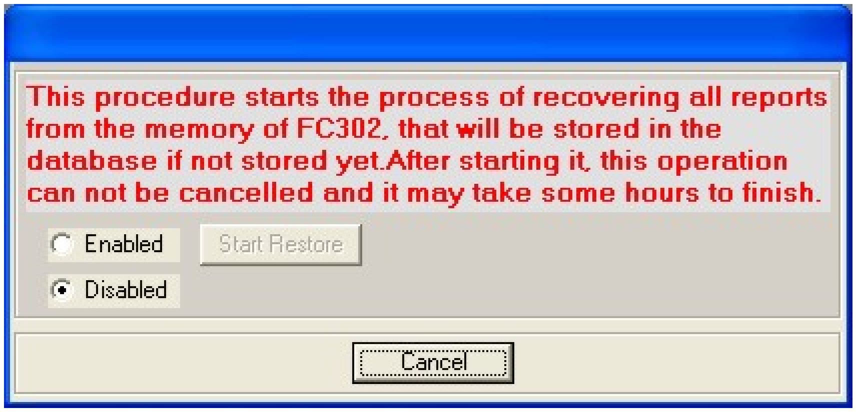


Figure 44

When clicking on "Start Restore", FCView confirms the action and asks the FC password, if the user was not logged.

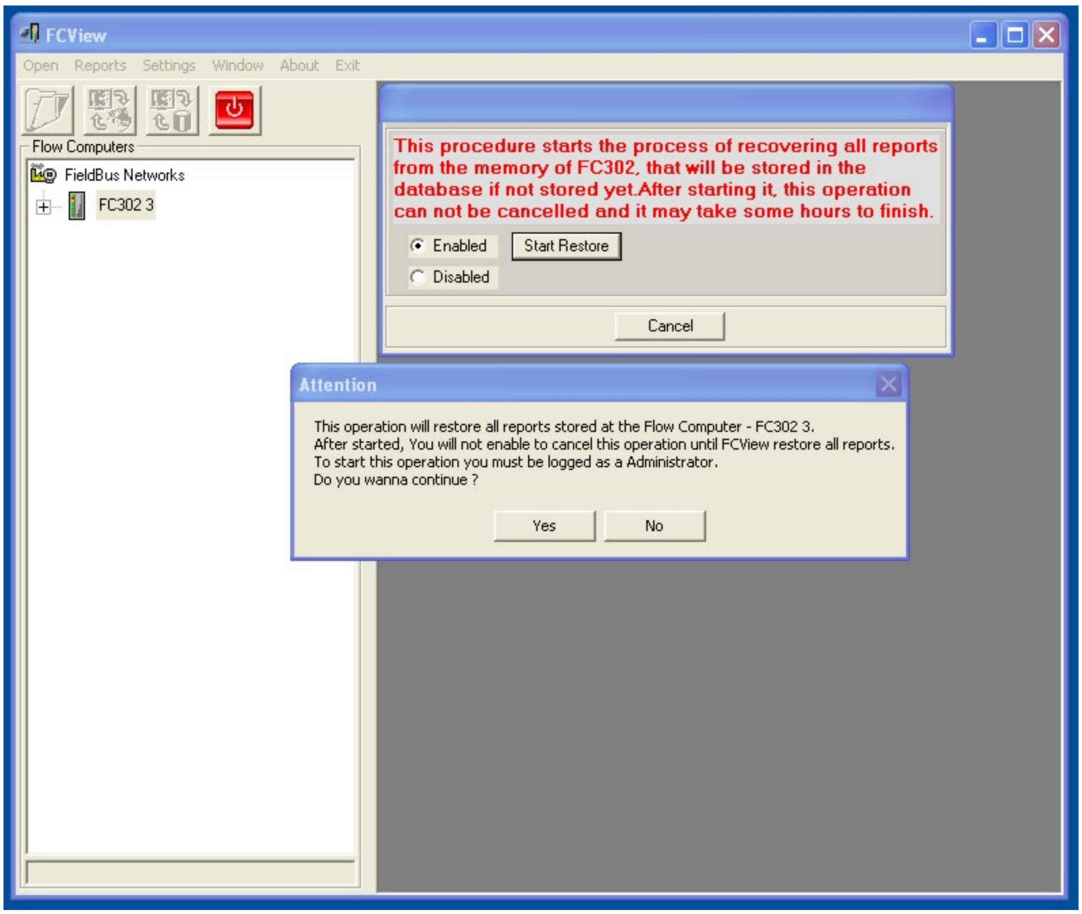


Figure 45

Removing FC302 Registers

To remove one FC302 from the register, always keeping the reports, click on **Settings → Flow Computer → Remove Flow Computer.**

Figure 46

Select the FC302s to remove and click **Delete**.

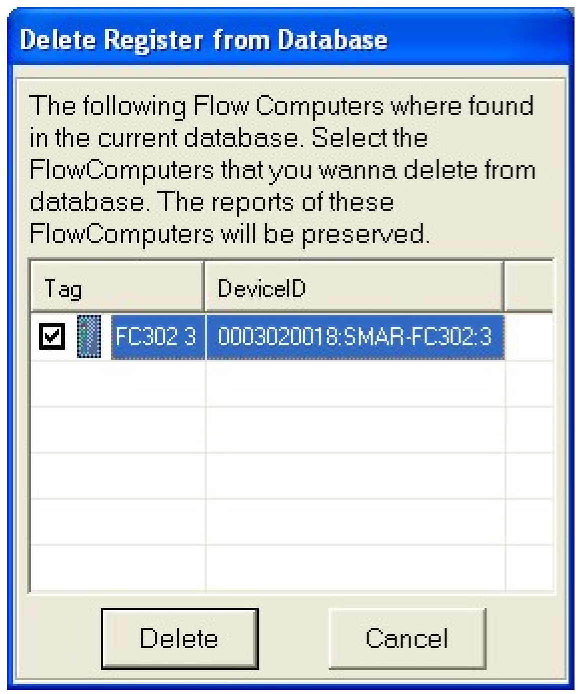


Figure 47

When removing the register, the equipment can not be monitored until it was registered again. In this case, it is necessary the configuration file or upload in order to register the equipment again.

Configuring the FCView

The FCView has some important configurations. To open the configuration screen, select **Settings → Options**.

Figure 48

The options are subdivided in:

General

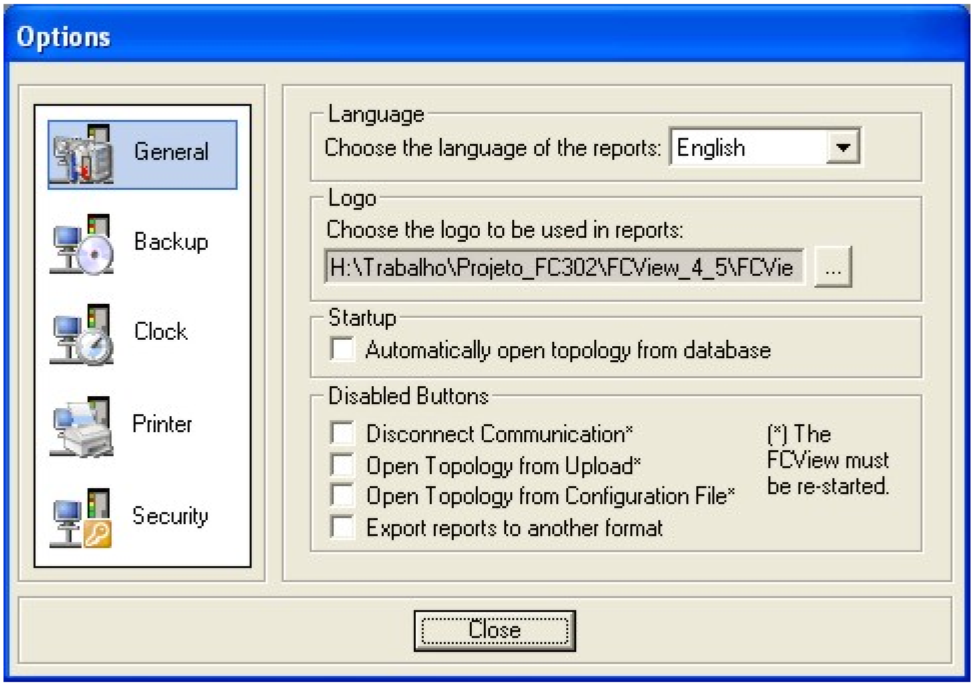


Figure 49

- **Language**: report language. The options presented are the only available. Therefore, if the user needs another languages, it will be necessary to have the Crystal Reports. In order to do insert another languages just insert the files in the folders correspondent to the desired language, and the FCView will recognize it automatically.

- **Logo**: logo used in the reports. By default, the Smar logo will be used.

- **Startup**: it defines if the FCView will start the communication just after has been started automatically, without the user starts it.

- **Disabled Buttons**: it disables some buttons that can be touched by accident by operator, causing damages in the download and reports.

Backup

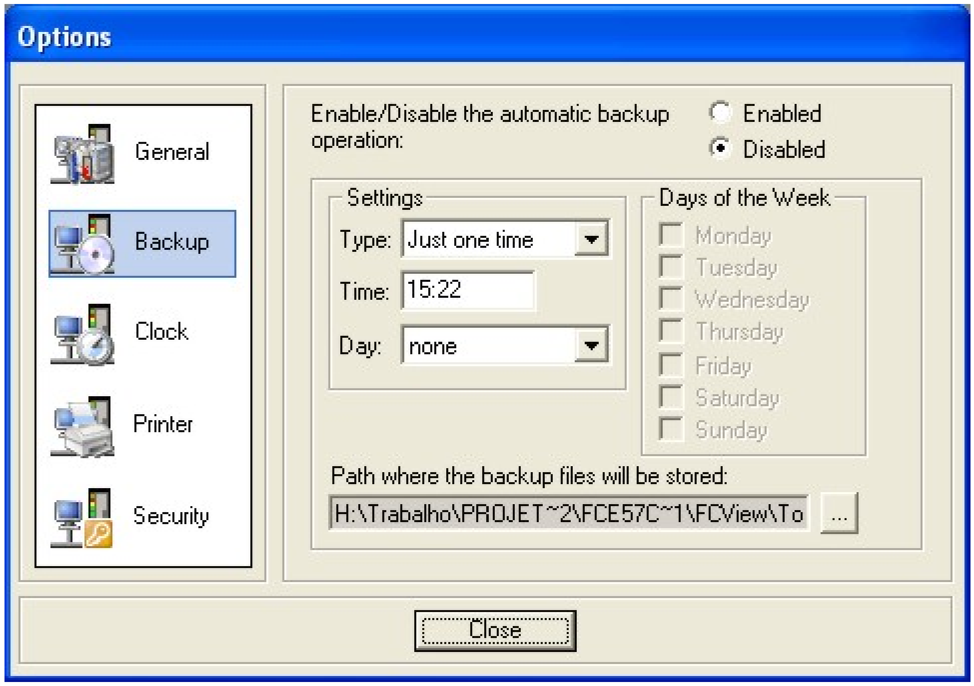


Figure 50

It enables the FCView to backup the files automatically, in order to do it, the user should add a backup task in the Task Scheduler of the Windows. This programmation can be only once, in one or more days of the week, or every day in the specified hour and /or date.

Clock

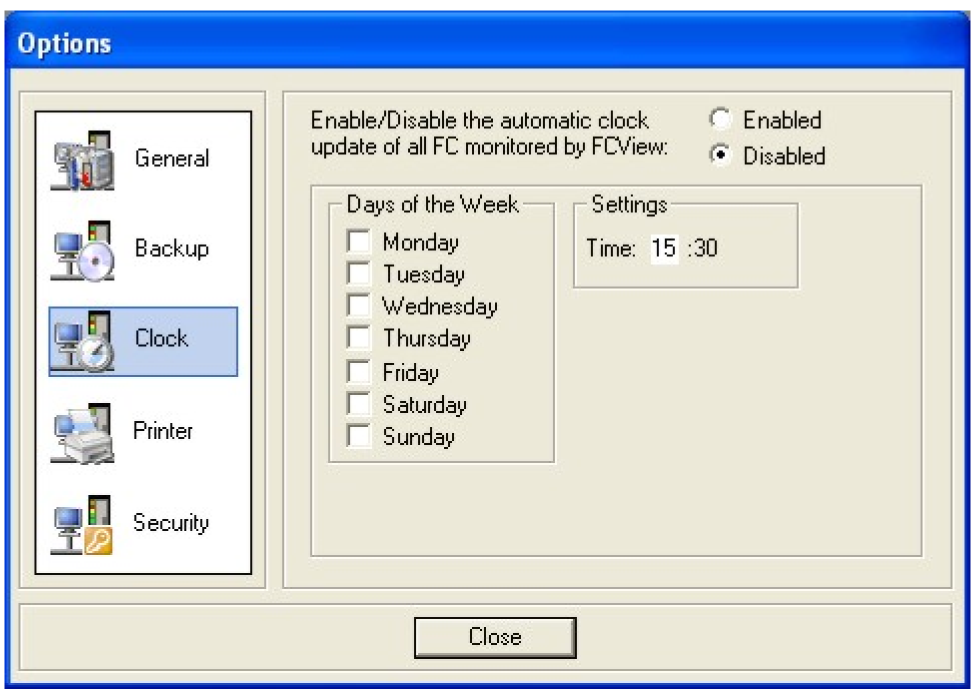


Figure 51

It enables setting the FC302 clock automatically. All the FC's that are communicating in the specified date and hour will be updated.

Printer

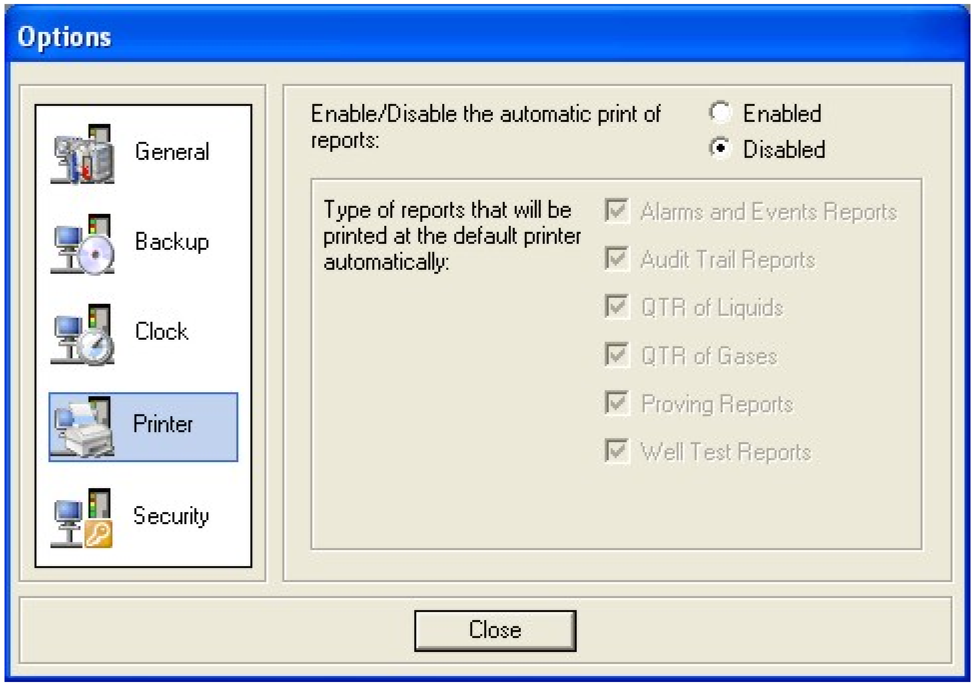


Figure 52

It enables the automatic printing of reports during the download. The reports to be printed can be selected in this window. The printer configurations are the same of the Windows system.

Security

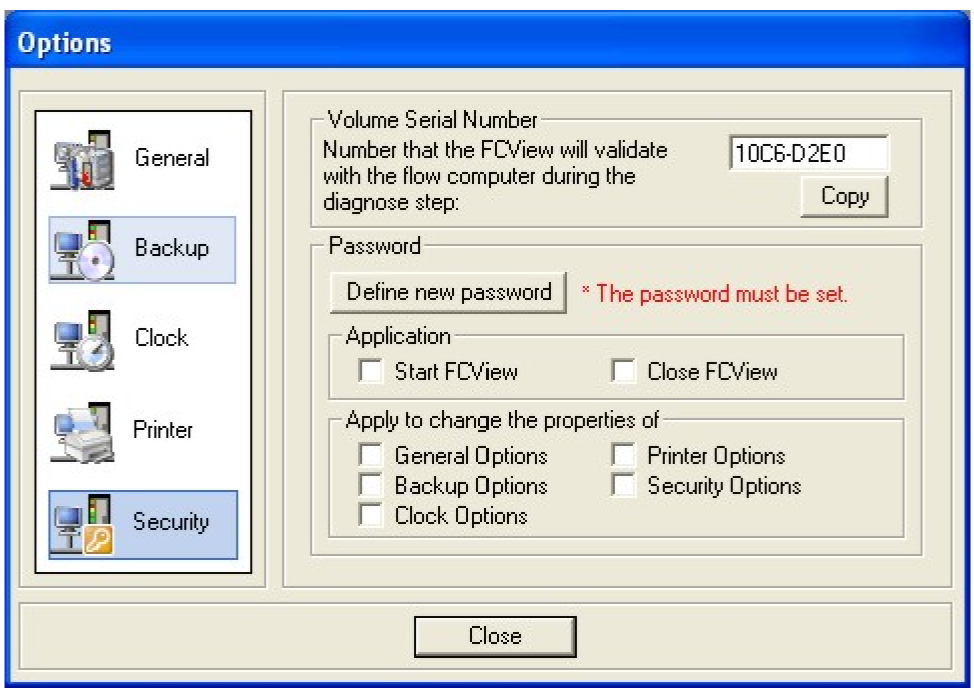


Figure 53

- **Volume Serial Number**: only for reference. It shows the Volume Serial Number of the HD that the FCView is installed, and this number must be written in the FCVIEW_VSN parameter of the LCT block from that the user needs to upload the reports.

- **Password**: the FCView can have an access password in order to avoid non authorized users change the application, guaranteeing security to the information obtained from FCs.

Visualizing System Logs

If eventually any error or warning occurs in the FCView, these information will be recorded in a log file in the FCView installation directory. However, the last messages can be visualized through the interface, clicking on **Settings → View Log** menu.

Figure 54

Data Security

It was created a mechanism to allow that only one machine, executing the FCView, can register the FC302 module, and, thus, only this machine to be able to register/report copy from the FC302 to database.

The FCT.FCVIEW_VSN parameter, which is dependent tracking and needs Adminstrator level, will must be type with the Volume Serial Number of the HD which will execute the FCView responsible for transfering the register/report to the database. The report download must be allowed only for the FC that corresponds to this number, if there is more than one FCView, the others only will monitor data through operation screens and do not have access to the reports.

The figure shows a FC with blocked access to the reports of the memory. Observe that there is an VSN icon in the equipment.

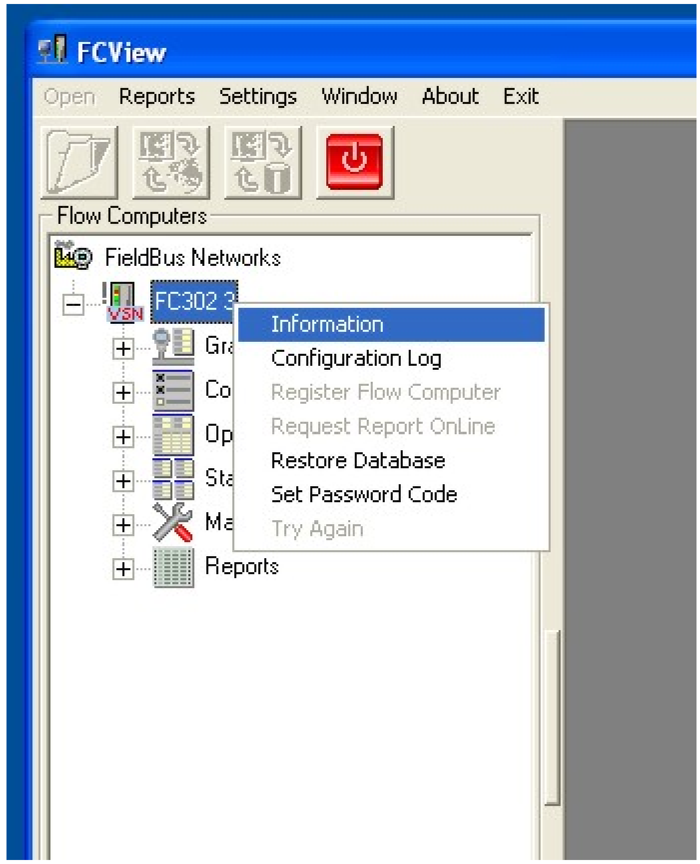


Figure 55

The FCT.FCVIEW_VSN parameter can also be set in the FCView. The value to be write in this parameter to extract the FC302 reports is available in the FCview options menu, in the security section.

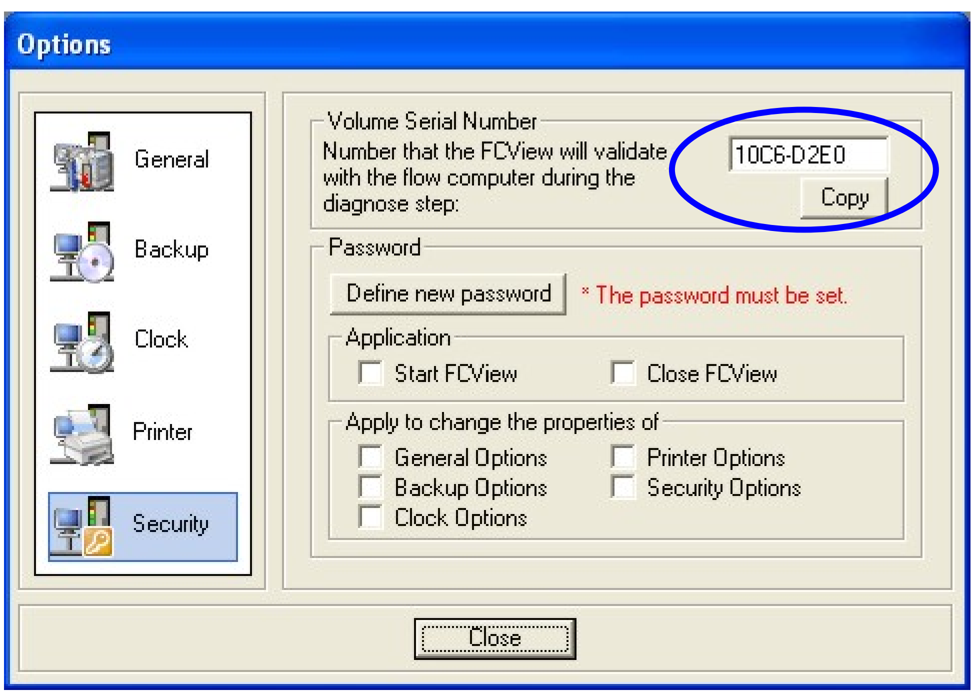


Figure 56

To write the value in the variable, use the configurator software or FCView, through the operation screen.

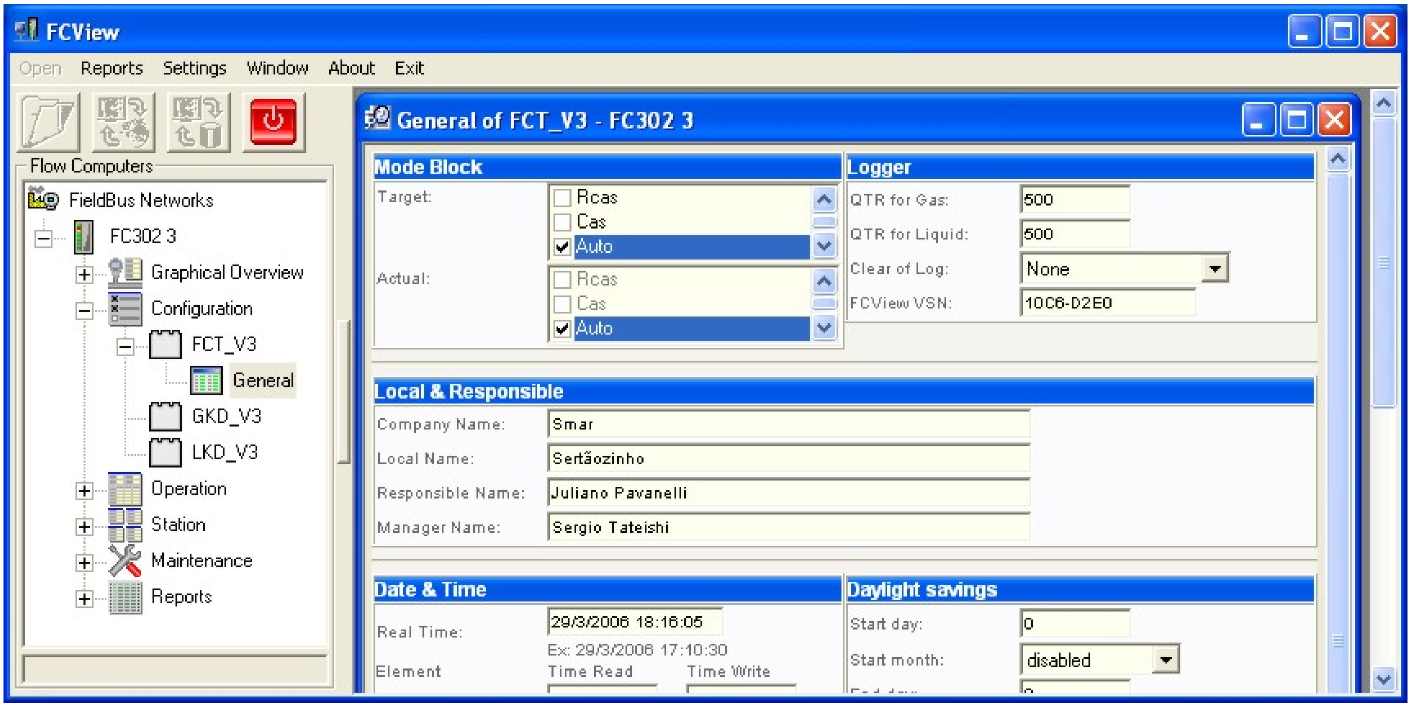


Figure 57

The database, which the registers/reports are stored, is protected by password, which is known only by the FCView project responsibles at Smar. So, it must nor be open neither changed by third part.

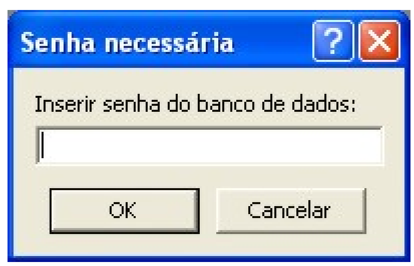


Figure 58

Even so the database password is not enough to guarantee the data reliability; the FCView distinguishs the printed reports from the memory and database through a message “THIS REPORT IS A COPY” or “ESTE RELATÓRIO É UMA CÓPIA”.. The reports/registers in the FC302 memory are not submitted to changes via communication by any medias or process available to the user.

To increase the confiability and consistence in the search and reading of the reports/registers in the FC302 memory through the OPC server, the CRC calculation was introduced for each report (QTR or proving) and register group (configuration changes or alarm/event). This CRC calculation is done in the FC302 and also in the FCView, but if the results are not the same, this report will be not considered and the FCView will discard it

Specifications

Operational System: Windows 2000 SP4 with IIS(*)
Internet Explorer: 6.0
Applicatives: Adobe Acrobat 5.XX (*)
Processor: Pentium III 700MHz
RAM: 128 Mbytes
Free space in Hard Disk: 30 Mbytes
Display: 1024 x 768 pixels
CD-ROM driver
Database format: MS Access 2000.

(*) – When using the search tool through the web.

Troubleshooting

1 – When it visualizes the reports through the FCView, the pages appears cut or missing parts from the borders during the visualization.
Solution: Be sure there is at least one print driver installed, the visualization program depends on the default printer configuration in the Windows. Check the margin limits.

2 - The FCView does not get to do any FC register.
Solution: Be sure the directory which the FCView was installed was read-only. Check the FC302 version is compatible with this FCView.

3 – Web page for search does not open anything.
Solution: check if the virtual directory was installed correctly using the application "CreateVirtualDirectory.exe" and the path of the database into the “connection.udl” file. Check the topic **How to configure the FCView to see reports on the web**.

4 - OPC Server stops to receiving events when the FCView opens with other supervisories.
Solution: probably problems with double instantiation of the OPC Server are occuring. Configure the DCOMCNFG in order to use the interactive user.

Compatibility

FCView 4.X is compatible with all previous versions from the version 3.X. And also, FCView 4.x is able to communicate with FC302 versions 3.X and 4.x., simultaneously.

How to configure the FCView to see reports on the web

FCView alows the reports are seen through the web page allocated in a Web Server.

The system is compatible with Internet Explorer and similars.

The visualization is done from a PDF file. Thus, it recommends the Adobe Acrobat as standard.

To become available the search on the Internet, it recommends to use a secure system, using Windows authentication. In this case, it is advisable the network administrator orientation to check how the structure was implemented to guarantee the better security.

For the system that the searches to the reports are done for more than 5 simultaneous connections, it recommends use Windows 2000 Server or higher, because the "professional" versions do not support many connections causing slowless and even so system break.

The system where the FCView will be installed must supply interpretation of ASP pages, requiring IIS module (Internet Information Service) that come with the operational system. In order to verify if this module exists in the operational system, just open the Task Manager and chech if the "inetinfo.exe" is enabled.

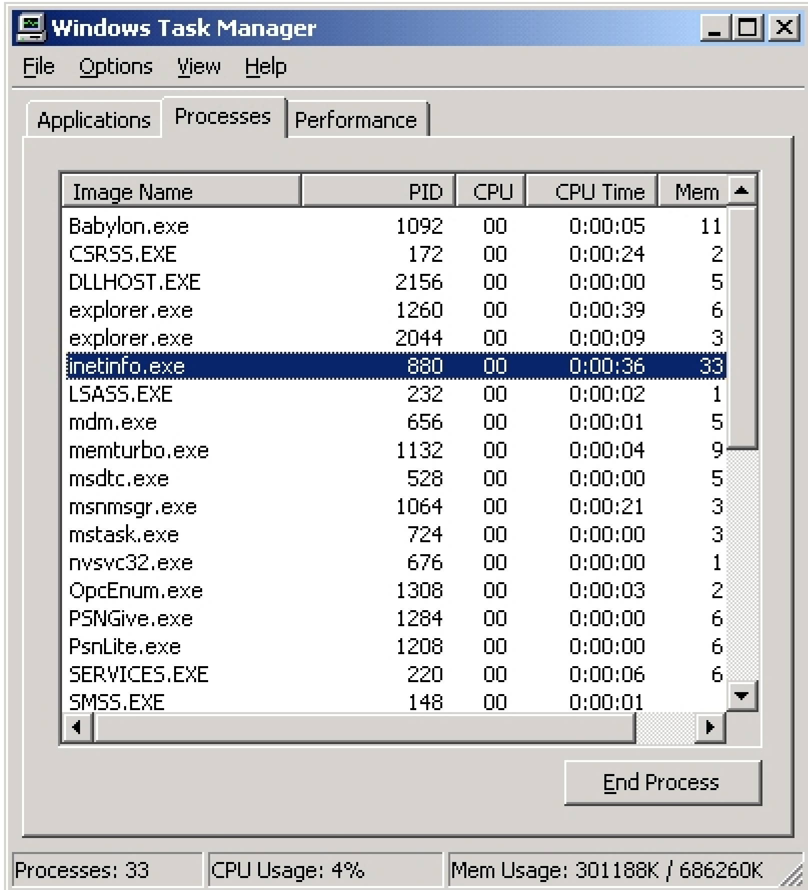


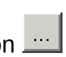
Figure 59

If it does not, it will be necessary to install using the Operational System Installation CD.

Other way to verify if the IIS module exists is typing in the browser "http://localhost". This procedure should open the default pages which are installed with the IIS.

Once this module is installed, it is possible to configure FCView to supply the Web.

Open the FCView installation folder through the "Explorer" and look for the " CreateVirtualDirectory.exe " file. Execute this application, it will configure the IIS to supply the Web pages on report searches.

Search the "connection.udl" file located in the FCView folder and execute it. Click on  and select the file from the database which is being indicated. This configuration will show to the Web page where is the file from the database. Confirm the changes up to close this configurator.

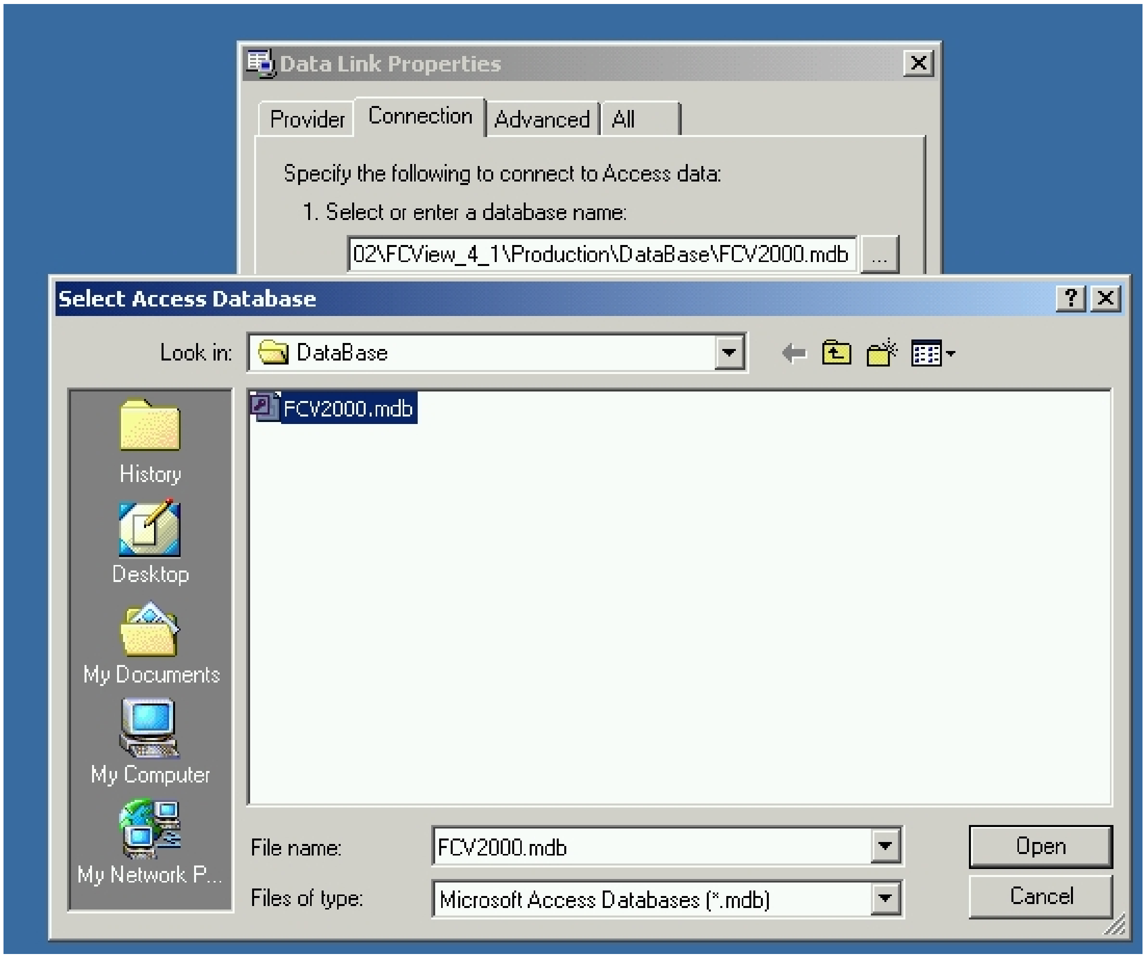


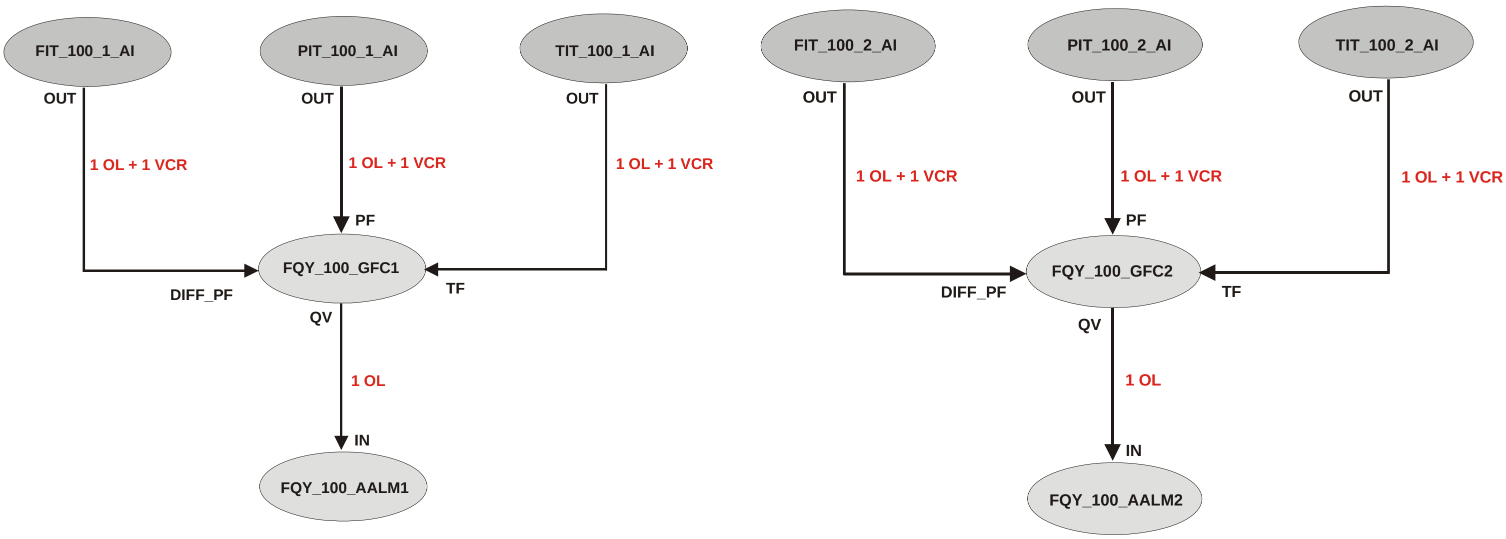
Figure 60

Once done these configurations, the report search will be already set and the user just need to type the Internet address that the FCView will do the task.

CONSIDERATIONS ABOUT LIMITS

For Fieldbus

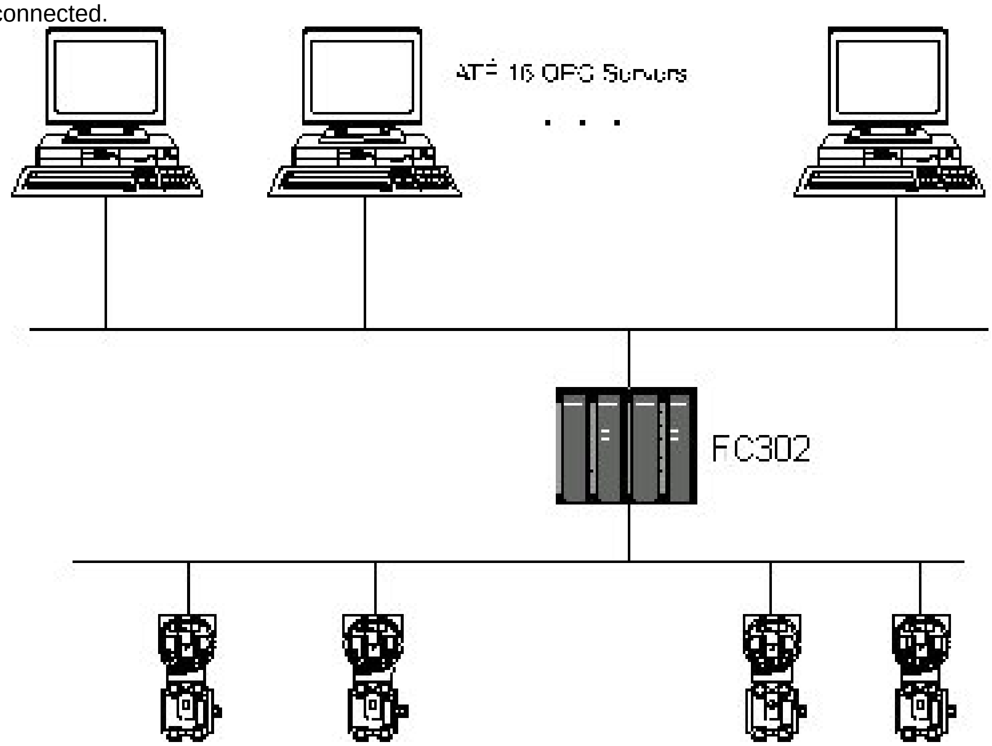
Foundation Fieldbus uses the Publisher/Subscriber model to communicate with the devices. When a link between two blocks is configured, the device that sends the data is called Publisher and the device that receives the data is called Subscriber. See the picture below:



Use only one Object Link (OL) for the internal links in the AuditFlow, and 1 OL + 1 VCR Publisher (for each block sending data) or 1 OL + 1VCR Subscriber (for each block receiving data), for the external links. It is necessary to consider the limits for the DFI302, such as 300 Ols (object links), 64 VCR publisher and 64 VCR subscriber supported by AuditFlow.

For Supervision

Each FC302 can supervise up to 400 Tags simultaneously and support up to 16 OPC Servers connected.



For Modbus

The FC302 supports up to 16 blocks of each type (MBSS, MBSM, MBCS and MBCM).

Chapter 21

ADDING LOGIC VIA COPROCESSOR

As described in the previous chapters, the AuditFlow system can instantiate several function blocks, that access all input and output modules. However, in some applications, the logic through these function blocks is not sufficient. Using the **DF65** (coprocessor module), it is possible to program the logic via ladder language and also interact with all the other modules in the AuditFlow system.

DF65 Configuration

The LogicView software configures the Smar's **DF65** Coprocessor.
Remember that in the communication between the Processor (FC302) and the Coprocessor (**DF65)**, the FC302 is a master device and the **DF65** is a slave. The physical connection between the modules uses the DF68, when using the 232 port. Another option is to use the DF58 module for a 485 connection.

To configure the **DF65** parameters, it is necessary to position and set the **DF65** coprocessor communication key in the default position, when the user loses the **DF65** configuration or it is the first test of the communication.

Serial Communication Configuration

In the **DF65**, there is a group with 4 keys between the communication ports. Using a screwdriver, make sure the bottom key is switched to the left. In this position, the coprocessor has the default parameters for the MODBUS communication that is the Device ID, also called Device Address, is equal to 1, the baud rate is equal to 9600 bps and it has even parity.

Later, these parameters can change using LogicView, but the changes will only take effect if the communication key is in the No Default position (key to the right).

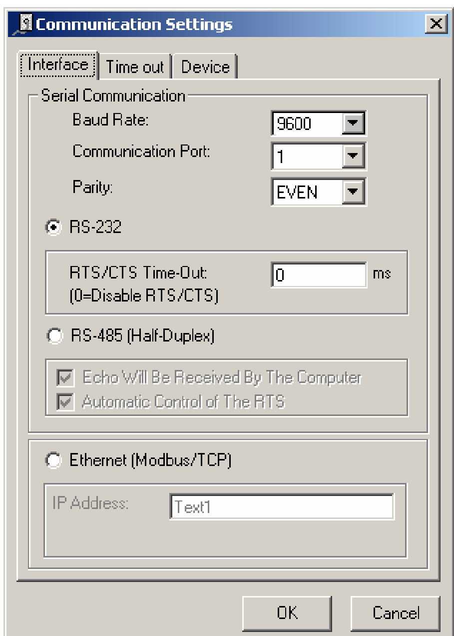
Physical Layer and Timeout

Set the configuration parameters in LogicView to enable the communication with the FC302.

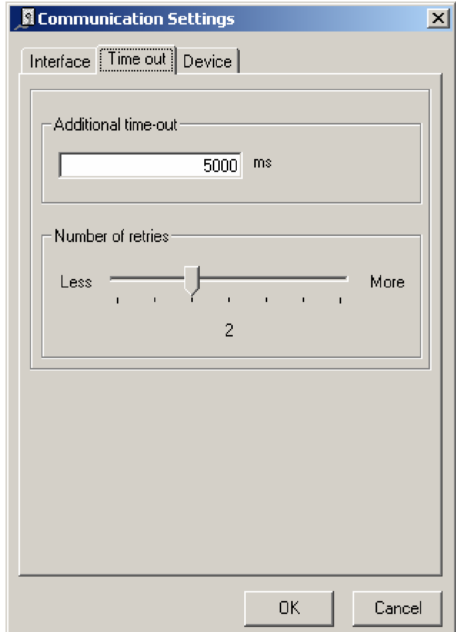
Using FBTools, check the IP Address of the FC302 that will be configured in LogicView. The configuration will be sent to the DF65 via FC302, that is, the FC302 will execute a Modbus bypass.

Remember the DF65 and FC302 baud rates must be the equals (9600 bps default).

In LogicView, go to the Tools menu and select Comm. Settings. Click the option Ethernet (Modbus/TCP). Type the IP Address of the FC302 that will communicate with LogicView. See the following picture.



Click the “Time Out” tab and select the number of times the computer should try to communicate when a failure occurs.



Now the user can create the ladder network configuration and download it to the DF65. Refer to the LogicView manual for details.

Changing the DF65 Communication Settings

Go to the Tools menu and select the option Online or click the button  to open the DF65 ONLINE dialog box.

LogicView will try to connect to the **DF65** once the online mode is active. If it does not detect the **DF65**, LogicView will change to the timeout state and wait until the user changes the parameters to configure the communication correctly.

If LogicView finds a CPU according to the configured parameters, it will add the Device, Version, Release, Configuration Name and Status.

The DF65 coprocessor has a communication key. It indicates if the default communication parameters are active. In this case, the address is 1, the baudrate is 9600 bps and the parity is even. The easiest way to set these conditions is selecting the option “Default” under “Communication Parameter”. In this condition, the user won't be able to change the serial port frame. Refer to the LogicView manual for details.

Logic Configuration Download

Make sure that all previous steps were executed correctly:

- Physical Connection (cables).
- Set the FC302 in the network using FBTools.
- Configure the serial communication between the DF65 and the FC302 (DF65 dip switches, baud rate, parity, serial communication channel, etc).
- Configure the communication between Logic View/DF65, using the FC302 as a bridge to bypass the Modbus data.

Create a new Ladder Logic configuration or open an existent strategy control. Download the configuration to the DF65.

Configuring the Modbus blocks in the FC302

It is necessary to add the Modbus blocks to control the communication between the coprocessor and the FC302, to monitor and exchange data between the DF65 and the FC302. The Modbus blocks are available in the AuditFlow system.

To add these Modbus blocks to the Syscon configuration, the user will need two DD versions. Select the Dev Rev= 02 and DD Rev = 01, and attach the blocks to the **Process Cell** right-clicking the FB VFB icon of the FC302 and selecting the option "Attach Block".

After adding the blocks to the device, drag them to the Process Cell window.

For further information, refer to chapter "Adding Modbus" in the FC302 manual.

The user should add a Resource block and a MBCF block (Modbus Configuration Block) before starting the configuration of the supervision (MBSM) and control (MBCM) block.

Supervising data from the DF65 Coprocessor using MBSM block

Once the MBSM block is instantiated, it is necessary to obtain the Modbus addresses of the input and output variables to monitor them.

Using LogicView, click the option Modbus Address and write the Modbus addresses.

Open the Process Cell window in the Syscon application, create a MBSM block and set the parameters using the Modbus addresses.

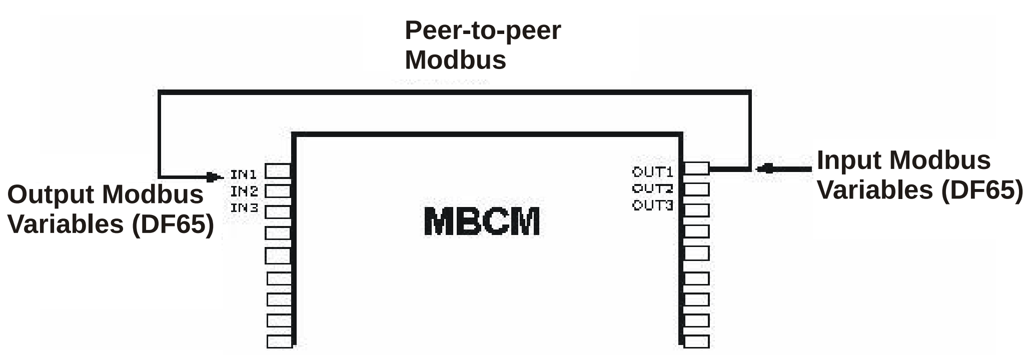
The user can monitor the Modbus variables using Syscon.

Exchanging data between the DF65 Coprocessor and the FC302 using the MBCM block

Add the MBCM block to the logic project. Set the Modbus addresses of the variables to control and monitor them.

The MBCM block can read Modbus variables and write them to the FC302, and read Fieldbus variables and write them to the DF65. This block allows the peer-to-peer communication between two Modbus slaves.

See the picture below:



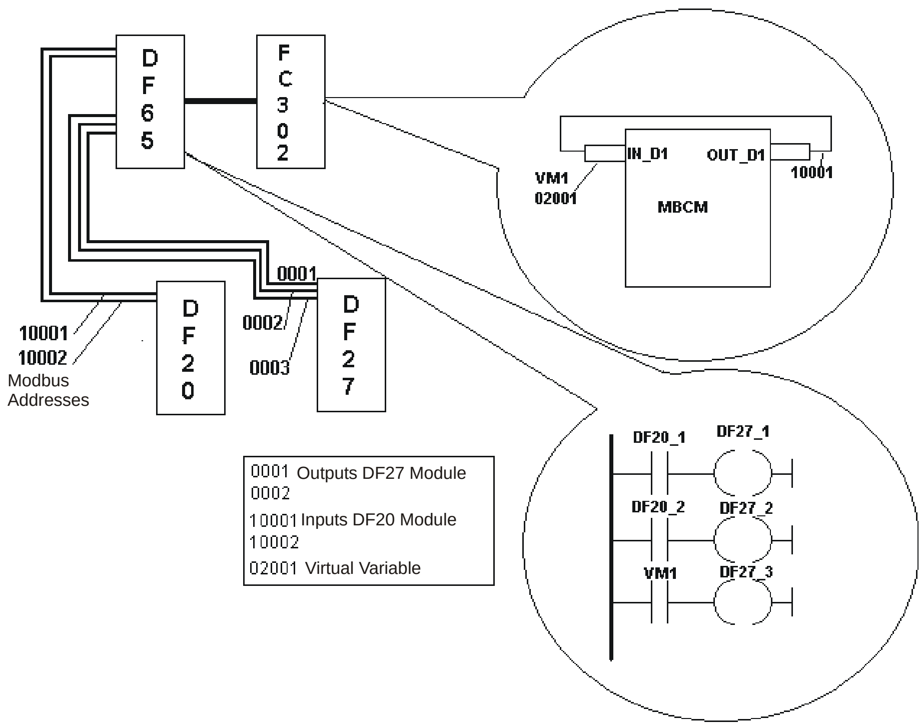
The picture above shows how to set the MBCM block parameters.

Modbus input variables: the data read from transmitters, discrete sensors, etc., are mapped to Fieldbus through the MBCM block. The user configures the Modbus address of the variables in the parameters of the MBCM block, checking that the address is configured in a block output parameter.

Modbus output variables: the data mapped to Modbus, such as an alarm signal, the temperature read in a Fieldbus device, etc., can be sent to the Logic Coprocessor using the MBCM block. The user should add the Modbus address where the variable value will be written, in the input parameter of the MBCM block.

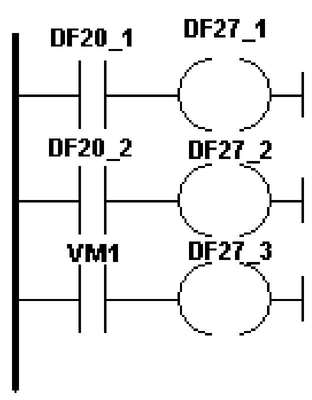
Peer-to-Peer: DF65 can read variables from modules connected to it, and the value can be written in other module using the MBCM block. The example below shows a simple application with these functionalities. This examples uses discrete input and output modules, but analog variables can also be used.

Example of Communication between the FC302 and the DF65 with ladder logic



There are two modules in the example: one DF20, digital input module with control pendants and one DF27, Relay Digital Output Module. Two configurations will be created to allow the communication, supervision and data exchange between the DF65 and the FC302.

In LogicView, create a new configuration. Add the modules DF20, DF27 and one virtual module. Create the following ladder logic.



The buttons 1 and 2 of the DF20 module are connected to the contacts, and the outputs of these contacts are connected to two coils, attached to the DF27 outputs. Similarly, a virtual variable is associated to the third contact. The Modbus addresses of these variables are:

- DF20_1 ➔ 10001
- DF20_2 ➔ 10002
- DF27_1 ➔ 1
- DF27_2 ➔ 2
- DF27_2 ➔ 3
- VM1 ➔ 02001

Using Syscon, create a new configuration. Add the Resource block, MBCF block, MBSM block and MBCM block. Remember that a Modbus input variable is always added to the output parameter of the MBCM block. Therefore, type the Modbus address 10001 in the LOCATOR_ OUT_D1.MODBUS_ADRESS_OF_VALUE parameter. Copy the Modbus variable of the DF20_1 input. Next, the LOCATOR_OUT_D1.MODBUS_ ADRESS_OF_ VALUE parameter should be equal to 02001. The value of the MBCM block input will be written in the address 02001, and in this case, it is the virtual variable associated to the contact. To conclude, open the strategy of the configuration in Syscon and link the IN_D1 input to the OUT_D1 output.

The current example used modules and discrete variables, but analog variables and input/output modules can also be used, as well as other Fieldbus modules connected to Modbus variables and modules. For example, the alarm block output can be associated to the module output connected to the DF65. The PID block output can be associated to the output of the analog output block connected to the DF65. The plant project control can be divided: the DF65 executes the discrete control, while the FC302 executes the process control.

Summary on how to configure the communication and the data exchange between the DF65 and the FC302

In Logic View:

✓ In LogicView, select **Tools→Comm Settings,** select “Ethernet Modbus” and type the IP address of the FC302 that will communicate with the DF65.

✓ Test the communication between LogicView and the DF65, performed via Ethernet and serial connection between the DF65 and the FC302, where the FC302 bypasses the Modbus information. If a failure occurs, check if the FC302 IP address is correct using FBTools. Check if the DF65 communication keys are correct. The fourth key on the bottom should be switched to the left. Verify if the cables are connected properly.

✓ In LogicView, create a new configuration or open an existent one. Download the configuration to the DF65.

In Syscon:

- Open Syscon. Select **Project File → New** and click “Project”. Syscon will open a dialog box to save the configuration.

- Right-click the Area1 icon and select “New Process Cell”. Type the new TAG and click Ok. Right-click the Process Cell icon and select "Expand". In the Process Cell window, right-click the Process Cell icon and select “New Control Module“, typing the new tag to the Control Module.

- Right-click the Control Module icon and select “New Block”. Add the Resource and MBCF blocks, configuring them according to the rules explained in this manual. Then add the MBSM and MBCM blocks, according to the requirements of the project. Right-click the Fieldbus Networks icon on the Project window and select “New Fieldbus”.

- Double-click the Fielbus icon to expand its window. Right-click the “Fieldbus” icon and select “New Bridge”. Select the Smar's FC302 device, and make sure the DD supports the Modbus blocks. Right-click the FB VD icon, selecting “Attach Block”. Attach all blocks created in the Control Module, and add other Modbus function blocks, if necessary.

- Double-click the Control Module icon to open the Strategy window. Drag and drop the blocks to configure the inputs. Remember the Resource block, MBCF block and MBSM block should not be included in the strategy.

- In the Project window, right-click the Project icon and select ”Export Tags”. Click Yes to save the “TagInfo.Ini” file.

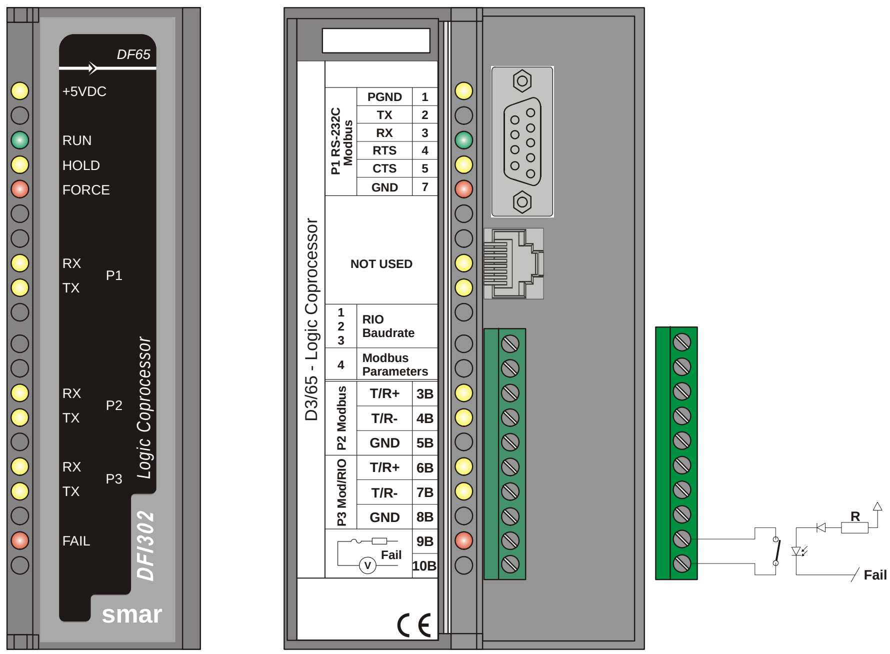
- Right-click the Fieldbus Networks icon and select “Comm. Settings”. Check if the Server ID is Smar.FC302OLEServer.0.

- Right-click the FC302 icon in the Project window and check if the Device ID is correct.

- Download the Configuration.

- In the MBCF block, select “ON LINE CHARACTERIZATION” and change the ON_APPLY parameter to “Apply”.

The user will be able to monitor the operation simultaneously, using LogicView and Syscon.



Technical Specifications

Configuration Memory	
Type	Non volatile memory
Available Size	30 Kbytes

Configuration	
Software Suite	System 302 and LogicView
Operation System	Windows NT or 2000

Communication Port	
Quantity	3

Communication Port	
Types	1-EIA-232-C (P1) 2-EIA-485 (multidrop, P2 and P3)
Connectors	Female DB9 for EIA-232-C (P1) Terminal block for EIA-485, remote I/O
Baud Rate/Address	P1: 9600-57600 Kbps P2/P3: 9600-115200 Kbps
Protocol	Modbus RTU
Slave Address	2 to 127, defined by the user (1 is the default address)
Maximum number of FC302 System per Network	31

Internal Power	
Provided by the IMB bus	5 Vdc @ 320 mA
Maximum Total Dissipation	1.6 W
Power Source Indicator	Green LED, +5Vdc

Failure Circuit	
Output Type	Solid State Relay, Normally Close (NC)
Contact Voltage Limits	20-115 Vac/Vdc
Maximum Contact Current for 115Vac	200 mA
Maximum Initial Contact Resistance	<13Ω
Status Indication	Red LED - Fail
Indication Logic	Light LED (close contact)
Overload Protection	Must be foreseen externally
Operation Time	Maximum 5ms
Discharge Time	Maximum 5ms
Optical Isolation	5000 Vac before the relay isolation

Other LEDs		
RUN		Green LED – shows the program is running
HOLD		Yellow LED - shows the program is on hold
FORCE		Red LED – shows these inputs and/or outputs are locked
Rx Tx	P 1	Yellow LED – shows the Modbus communication (EIA-232)
Rx Tx	P 2	Yellow LED - shows the Modbus communication (EIA-485)
Rx Tx	P 3	Yellow LED - shows the Modbus communication (EIA-485)
FAIL		Red LED – failure indication

Dimensions and Weight	
Dimensions (W x H x D)	39.9 x 137.0 x 141.5 mm (1.57 x 5.39 x 5.57 in)
Weight	0.286 kg

Cables	
One Wire	14 AWG (2 mm^2)
Two Wires	20 AWG (0.5 mm^2)

Note
To increase the life cycle of its contacts and protect the module from reverse voltage damage, connect one clamping diode externally in parallel with each DC inductive load or connect one snubber RC circuit in parallel with the AC inductive load.

Appendix A

TROUBLESHOOTING

1. The blocks are not being executed, because the current mode of the Resource block is O/S, while the target mode is Auto.

Suggestion: Check if the RS.DEV_TYPE parameter is with the value zero. If positive, the hardware is not the FC302.

2. The configuration download is failing completely.

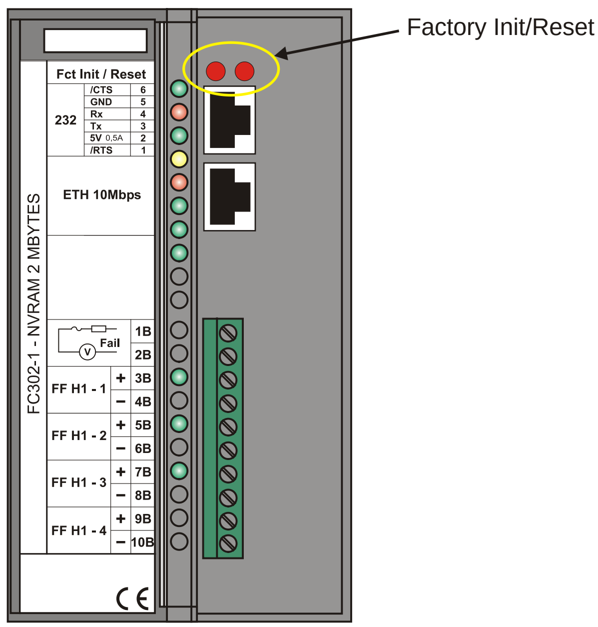
Suggestion: Check if the logon process is complete and the user has the Administrator access level.

The FC302 has initialization resources that solve some problems. These resources are explained in the following topics.

Warning: Any resource used will impact the system!

Reset

Press the *Push-Button* on the right (see the details in the following picture) and the system will perform the RESET. This operation might take a few seconds to initialize the system. According to the procedure executed by FBTools, a new IP address will be automatically attributed or the last IP address configured will be accepted. Make sure the RUN and ETH10 LEDs are lit.



Factory Init

Press the *Push-Button* on the left and, then, press the *Push-Button* on the right guaranteeing the LED FORCE is blinking one time per second. Release the *Push-Button* on the left and the system will execute the RESET, removing the previous configurations.

HOLD Mode

Press the *Push-Button* on the left and, then, press twice the *Push-Button* on the right, guaranteeing that the LED FORCE is blinking 2 times per second. Release the *Push-Button* on the left, the system will execute the RESET and go to the HOLD mode. Make sure the LEDs HOLD and ETH10 are lit.

In this mode, the FC302 can use the FBTools Wizard to update the firmware or change the IP address.

Use the RESET again to return to the execution mode (RUN).

TIP: Each of the modes (Factory Init and HOLD Mode) can be cancelled after started. Pressing the *Push-Button* on the right and releasing the button on the left first.

TIP: If the user misses the number of times the *Push-Button* on the right was pressed, just check the number of times the LED FORCE is blinking per second. It will blink one time per second again after pressing the button for the fourth time (the function is cyclic).

TIP: To press the *Push-Button* of the Factory Init/Reset, use any pointed instrument (such as a pen).

When to use the Factory Init/Reset procedures

1. How to reset the FC302 without turning it off?
Use the RESET procedure.

2. The LED HOLD is lit, what should I do?

If the LED HOLD is lit after turning off the FC302 (or resetting), the Firmware is probably corrupted. Download the firmware again.

To do so, follow the steps:

2.1- Make sure the FC302 is turned on and connected to the Subnet. Otherwise, follow the procedure "Connecting the FC302 to the Subnet". Check if the LED HOLD is lit.

2.2- Run the FBTools Wizard, (in the Start menu, at Smar installation folder).

2.3- In the main window (Choose device type), select the **FC302** and click the "**Next**" button.

2.4- Choose the path for the FC302 OLEServer (default: Local) and click "***Next***".

2.5- Select the FC302 module in the option "Module" using the serial number as a reference (check the label in the FC302 module).

2.6- Click the "**Browse…**" button to select the firmware file (*FC302**.ABS file).

2.7- After selecting the file, click "**Finish**" to start the firmware download;

2.8- During the download, the progress bar will show the status of the operation.

2.9- A message will open informing the download is complete. The FC302 will be in "Run Mode". Click "OK" (check if the LED RUN is lit).

2.10- Click "**Finish**" to finish.

3. The FBTools Wizard cannot set the FC302 in HOLD Mode, how should I proceed?
Use the HOLD Mode procedure. Set the FC302 in HOLD Mode, execute the firmware update procedure following the steps described in item 2.
If the problem persists, it could be related to the TCP/IP connection (check the cables and the LED ETH10).

4. The firmware starts the execution, but it locks after a while, how should I proceed?
It could be a problem with the configuration, use the Factory Init procedure and reconfigure the FC302.
It the problem persists, it will be necessary to download the firmware to the FC302 again.

5. The LED ETH10 does not lit, how should I proceed?
Check the cable connection, or if the cable is not broken. Remember the cable specification:
DF54 – Standard Cable. Used in networks between FC302 and Switch/HUB.
DF55 – Cross Cable. Used in point-to-point networks between PC and FC302.

6. The LED FORCE is blinking, how should I proceed?
Use the RESET procedure.

7. The FBTools doesn't show all FC302's connected to the SubNet, how should I proceed?
Probably, there is an IP Address conflict in this SubNet. To solve this problem, disconnect all FC302 modules from the SubNet and execute the procedure "Connecting the FC302 to the SubNet" for each module, checking if the address used is not associated to another device on the SubNet.

8. FBTools can't find the FC302.

- Check if the initial connection procedure was followed, that is, the Default IP was initially set using Reset 3 Mode and the IP of the computer is 192.168.164.101.
- The Ethernet cable should be the DF54 when using HUB or SWITCH. Use the DF55 cable to connect the computer with the FC302.
- Test the network board, executing the PING command for the IP address of the computer via DOS PROMPT.
- Test the Ethernet connection, executing the PING command for the FC302.

9. The FC302 was working correctly, then it was turned off and on again, and now the Reset doesn't work, the LED HOLD is lit and/or blinking.

In some versions of the FC302 hardware, before Revision 2 and Emission 1, the firmware and monitor areas are not written-protected. Some problems with the configuration and software bugs could corrupt the firmware and the monitor. In this case, it is necessary to use the Boot Flash.

10. Is it necessary to use the Boot Flash to load the Boot Program?

Use the factory procedure “Loading the Boot program in the FC302”.

11. During Syscon operation, in the Online Characterization of some blocks, it lose the connection with the FC302.

System 302 version 5.0 before the Service Pack 8 has a bug that could cause this problem. In this case, it is necessary to close Syscon and execute the software again and, sometimes, reset the FC302.

12. The Get license program does not accept the license.

Follow the steps below:

1. Try to register the DEMO license. In the Get License window, there is a “Use DEMO keys” button. If it accepts the DEMO license, then probably the key license was not typed correctly.

2. If it still doesn't work, search the SmarOlePath variable in the environment. Open “Start\Programs\Administrative Tools\Windows NT Diagnostics”, select the folder Environment and search for the SmarOlePath variable. If it doesn't exist, execute the program “Interface Setup” in the Smar installation directory.
P.S.: Use only numbers and dashes as characters “-“.DO NOT use spaces and symbols as characters “! @ # $ % ^ & * ( ) _ + ~ < > , . / ? \ | { } [ ] :;”

3. Register the servers again. In the Smar installation folder (Program Files\Smar\OleServers\), run the application Register.Bat.

4. If the steps above fail, generate the license file:
- Use a text editor (e.g notepad) because the file can not contain formatted characters. The name of each file and its content are showed below:

File: Syscon.dat
SMAR-MaxBlocks-**55873-03243-22123-04737-10406**

File: OleServer.dat
#PCI OLE Server
SMAR-OPC_NBLOCKS**8-23105-23216-11827-2196**

File: FC302OleServer.dat
#FC302 OLE Server
SMAR-FC302OPC_NBLOCKS**8-19137-32990-37787-24881-12787**

These keys are provided with the DEMO license.

13. The Modbus blocks cannot switch to “Auto”, even configuring the Mode Block target to “Auto”, the mode block actual is still “O/S”.

To switch the Modbus blocks to “auto”, it is necessary to switch the Mode Block of the FC302 Resource Block to “Auto”, and the Local Mod Map of each Modbus block should be different from 255.

14. A value different from 255 is defined for the LOCAL_MOD_MAP of the Modbus block, but it is still 255.

There can not be two blocks with the same LOCAL_MOD_MAP in the same Modbus block type (MBCM, MBCS, MBSS, MBSM), and the value should be between 0 and 15.

15. A static value of a Modbus block changes, but the value is not updated.
If a static value of a Modbus block is updated, the block will change to “O/S” after selecting "ON_Apply" in the MBCF block.

16. After changing a static value of the block and changing Mode Block target to “Auto”, the actual mode does not change to “Auto”.

If a static parameter of a Modbus block changes, the block will change to “Auto” after selecting “ON_Apply” in the MBCF block.

Specific problems in the measurement

1. Problem in the function block showed in the BLOCK_ERR parameter.
All the measurement blocks have a Troubleshoot section before the Parameters table, where some causes are listed.

2. General problems with audit trail and access restriction.
Read the section “Audit Trail and Data Security” on the Chapter 2.

3. Indications of “Override temperature/pressure/density/SW/differential pressure used” in the alarm/event reports.
The user must check:
- Configuration: the corresponding input is linked.
- If the device responsible to measure the secondary variable is turned on and set properly.
- If there is problem in the measurement block input (GFC, LCT or LBT) is related to the communication (Bad: No Communication), so try the partial download in the corresponding transmitter.
- If there is problem in the measurement block input (GFC, LCT or LBT), it can be diagnosis information detected by the transmitter. This problem can be related to: the sensor (for example: range or open sensor) or the configuration (for example: scale, physical connection, etc.).

4. Indications of “Flow Computer power down/up” in the alarm/event reports.
Check the following items:
- Voltage level and the quality of the voltage for the FC302 power supply.
- Load connected in the same power network: motor startup, inductive load switching.
- New firmware versions can correct reset problems in the CPU module.

5. Problems related to the FCView.
Check the section **Troubleshoot** in the chapter FCView.

6. Failure during the configuration download.
Check:
- If the logon was with Administrator access level.
- If during the configuration download occurred any event, such as: glitch in the powering network, reset in the device of the Foundation Fieldbus network, failure in the Etehrnet network communication.
- Repeat the download if any error appears.

7. Indications of “Bad pulse input occurred” in the alarm/event reports.
Check the following items:
- If the pulse input module is installed in the rack and the slot is addressed in the CHANNEL parameter.
- Check the module configuration related to rack number and slot. Also check the module status of the HC block through the parameters MODULE_STATUS_Rx_y.
- LED shows the Power supply status.
- If using the module DF77, check the status of the scan through the IMB LED, as well as the pulse input.

8. Problems related to the pulse transmission or proving.
Check the Troubleshooting section in the chapter of the DF77 module and the PIP block.

9. Indications of “FC302 – too high temperature occurred” / “FC302 – low voltage battery – occurred” in the alarm/event reports.
Run the FCView to read all reports of the FC302 memory and then replace the module.

Appendix B

TECHNICAL SPECIFICATIONS

FC302 Specifications

ENVIRONMENT CONDITIONS	
Operation	0-60 °C, 20-90% RH non condensing.
Storage	-20 to 80 °C, 20-90% RH non condensing. Exception FC302 module -20 to 25 °C, 20-90% (The battery would last ten years.).
Ingress Protection	IP55 (**) 5 – Solid entry: Protection against harmful dust 5 – Liquid entry: Protection against hose directed water
Power Supply	Refer to the specifications of the power supply module used. Car battery is not recommended to power the module.
Vibration	10 to 150 Hz 10 m/s^2

(**) Ingress protection of the standard panel of AudiFlow system.

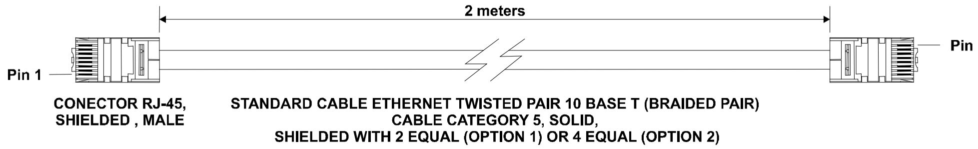
FC302		
Type	32-bit RISC	
Performance	50 MIPS	
Memory for Code	2MB, 32-bit Flash Memory (firmware can be upgraded)	
Memory for Data (Data and configuration retention)	2MB, 32-bit NVRAM	
	4MB, 32-bit NVRAM	
Fieldbus Interface	Number of Ports	4, independent with DMA
	Physical Layer Standard	ISA-S50.02-1992
	Baud Rate	31.25 Kbps (H1)
	MAU Type	Passive (no bus powered)
	Intrinsic Safety	Not Compliant
	Isolation	500 Vac (each channel)
Operation Voltage/Current	+5V ± 5% / 0.95A (typical)	
Connector Ethernet	RJ-45	
Connector EIA-232	RJ-12	

LED IDENTIFICATION	
+5VDC	Green
FAIL	Red
RUN	Green
HOLD	Yellow
FORCE	Red
232 TX	Green
ETH 10	Green
ETH TX	Green
FF-H1 – FF-H4	Green

Ethernet Cable Specifications

To connect a new Ethernet cable, these are the specifications of the twisted pair cable, according to the part number DF54 or DF55.

DF54 – Standard Cable. Used in a network between FC302 and Switch/HUB.
DF55 – Cross Cable (Cross). Used in a point-to-point network between PC and FC302.



DF54		
1	*Brown*	**1**
2	*White / Brown*	**2**
3	*Orange*	**3**
6	*White / Orange*	**6**

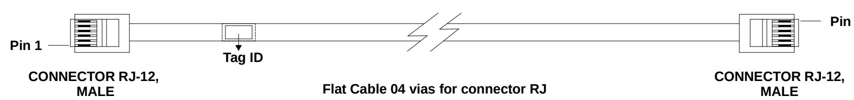
DF55		
1	*Brown*	**3**
2	*White / Brown*	**6**
3	*Orange*	**1**
6	*White / Orange*	**2**

Note: The colors schema is a suggestion, but it is important to use the pairs (color XXX and white/color XXX).

Serial Cable Specifications

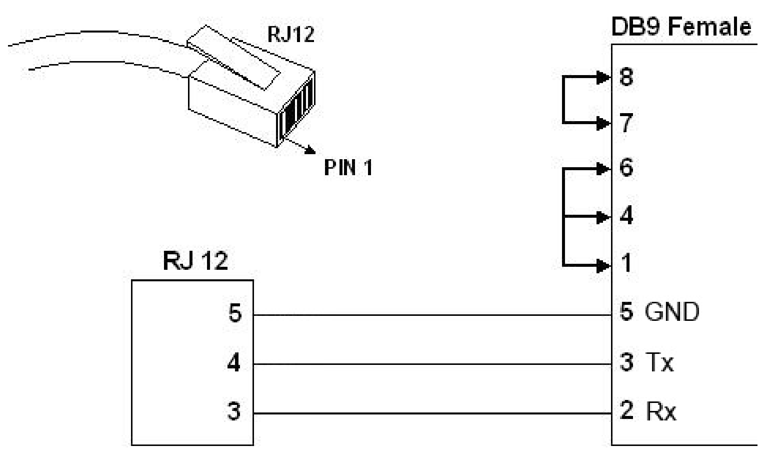
Connection Cable between FC302 and DF58

To connect the **FC302 (Processor) and DF58 (RS232/RS485 Interface)**, use a DF59 cable, according to the specifications.



DF59	
3	3
4	4
5	5

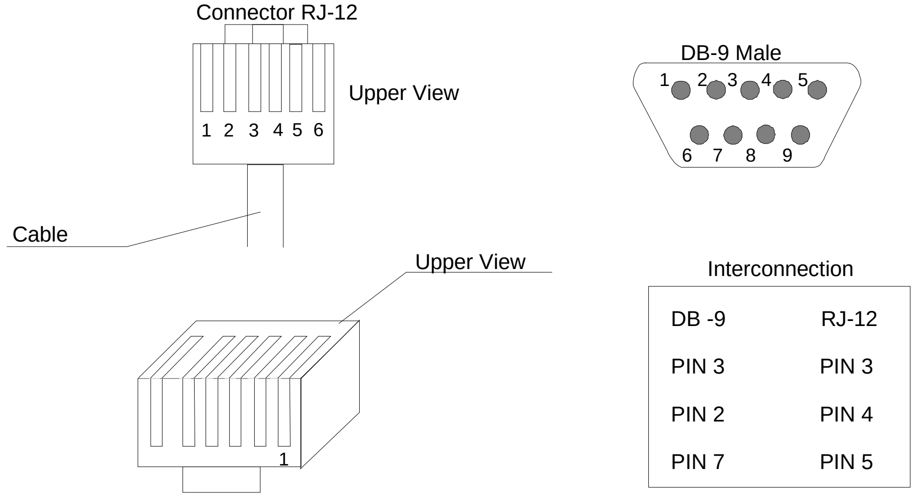
To assemble a serial cable between the ***FC302 (Processor module) and the PC computer***, follow these instructions of a connection between RJ12 (used in the FC302) and DB9 Female.



It recommends use the jumpers on the DB9 side, but it is not necessary. It depends on the application running on the PC.

Connection Cable between FC302 and LC700

To connect the **FC302 (Processor) to the LC700**, use a DF68 cable, according to the following figure.



DB -9	RJ-12
PIN 3	PIN 3
PIN 2	PIN 4
PIN 7	PIN 5

Cables for Racks Interconnection and Power Distribution

Depending on the rack model different types of cables are necessary to interconnect racks and for power distribution throughout the IMB bus. In the following table are the available cable types.

Code	Description
	System based on DF1A and DF78
DF3	AuditFlow flat cable to connect two racks – length 6.5 cm
DF4A	AuditFlow flat cable to connect two racks – length 65 cm
DF5A	AuditFlow flat cable to connect two racks – length 81.5 cm
DF6A	AuditFlow flat cable to connect two racks – length 98 cm
DF7A	AuditFlow flat cable to connect two racks – length 110 cm
	System based on DF92 and DF93
DF90	IMB power cable
DF101	Shielded flat cable to connect racks by left side – length 70 cm
DF102	Shielded flat cable to connect racks by right side – length 65 cm
DF103	Shielded flat cable to connect racks by right side – length 81 cm
DF104	Shielded flat cable to connect racks by right side – length 98 cm
DF105	Shielded flat cable to connect racks by right side – length 115 cm

For further details about the correct cable installation, please, refer to Hardware section.

Expansion flat cables for systems based on DF92 and DF93

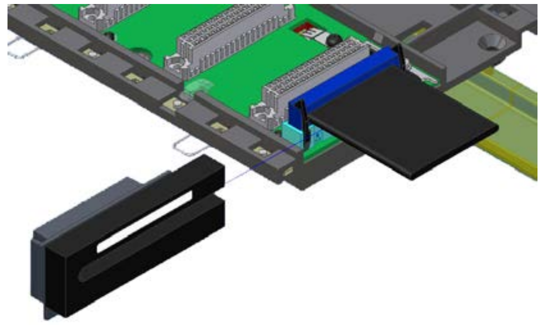
These flat cables are used when the Auditflow is expanded in more than one row of racks (DF92 or DF93), i.e., in different DIN rail segments, one below the other. To ground the flat cables' shield, use ground terminals next to the connections among flat cables and racks.

- **DF101 - Flat cable to connect racks by left side**
  The DF101 is installed on the rear connectors of the left extremity rack of each row of racks, interconnecting the rows 2-3, 4-5 and 6-7 (if they exist). The available terminal next to each DF91 can be used for grounding. See the Hardware section.

- **DF102, DF103, DF104 and DF105 - Flat cable to connect racks by right side**
  They are installed on the upper connectors of the right extremity rack of each row of racks, interconnecting the rows 1-2, 3-4 and 5-6 (if they exist). See the Hardware section.

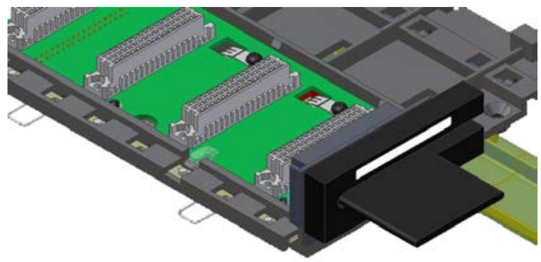
Flat cables protector (connector cap)

To meet the EMC requirements an ESD protector has to be installed on the flat cables connection, at right. In the following figure a flat cable protector is shown when it is being installed on the cable connector.



Installing the flat cables protector

The following figure shows the flat cable protector installed.



Flat cable protector installed

DF90 cable

The power expansion has to be used when the Auditflow is expanded in more than one row of racks, i.e., in different DIN rail segments, one below the other. The DF90 is the IMB power transmission cable. Its features provide low voltage drop and protection against electromagnetic interference.

The cable DF90 must be connected only through DF91. It cannot be directly installed in the racks, because it can damage the racks. For further details, see the Hardware section.

IMB power cable (DF90)

Appendix C

MAXIMUM FLOWS FOR THE TOTALIZATION

Liquid Measurement

The rollover value of the time totalizers (hour, day, week, month and batch) and the Non resetable totalizers (MR) for liquid measurements depends on the engineering unit selected for the volume (LV_UNITS), according to the table below:

Set the engineering unit for the volume (LV_UNITS) to avoid the rollover of the time totalizer. If the longest transferring time is 31 days, the maximum average measured flow will have the following values:

LV_UNITS	Rollover value	Maximum average flow (LV/h)	Instantaneous flow (LV/h) (*)
Cubic meter (m^3)	2 000 000	2 688 m^3/h	2 000 000
US gallon and Barrel	20 000 000	26 881 gal/h or Bbl/h	20 000 000
Liter and others	2 000 000 000	2 688 172 l/h	2 000 000 000

(*) If instantaneous flow is superior to the specified in the table above, the totalization will be interrupted and showed in the status as “Stop totalization”.

Gas Measurement

The rollover value of all totalizers (resettable or non-resettable, volume, mass or energy) is 2.000.000.000, regardless of the engineering unit.

If the longest transferring time is 31 days, the maximum average flow will be 2.688.172 [GV]/h or [M]/h or [EN]/h.

The instantaneous maximum flow is 2 000 000 000 [GV]/h or [M]/h or [EN]/h, superior to this value the totalization will be interrupted and showed in the status as “Stop totalization”.

Appendix D

smar

SRF – Service Request Form

AUDITFLOW

Proposal Nº:

COMPANY INFORMATION

Company: ____

Unit/Department: ____

Invoice: ____

COMMERCIAL CONTACT

Full Name: ____

Phone: _____ ___________ _____ ___________ **Fax:** ______________

Email: ____

TECHNICAL CONTACT

Full Name: ____

Phone: _____ ___________ _____ ___________ **Extension:** ______________

Email: ____

EQUIPMENT DATA

Model: ____

Serial Number: ____

PROCESS DATA

Process Type (E.g. boiler control)**:** ____

Operation Time: ____

Failure Date: ____

FAILURE DESCRIPTION

(Please, describe the observed behavior, if it is repetitive, how it reproduces, etc.)

____

____

____

____

OBSERVATIONS

____

____

____

USER INFORMATION

Company: ____

Contact: ____

Title: ____

Section: ____

Phone: _____ ___________ _____ ___________ **Extension:** ______________

E-mail: ____ **Date:** ______/ ______/ __________

For warranty or non-warranty repair, please contact your representative.
Further information about address and contacts can be found on **www.smar.com/contactus.asp**.

SMAR WARRANTY CERTIFICATE

1. SMAR guarantees its products for a period of 24 (twenty four) months, starting on the day of issuance of the invoice. The guarantee is valid regardless of the day that the product was installed.

2. SMAR products are guaranteed against any defect originating from manufacturing, mounting, whether of a material or manpower nature, provided that the technical analysis reveals the existence of a quality failure liable to be classified under the meaning of the word, duly verified by the technical team within the warranty terms.

3. Exceptions are proven cases of inappropriate use, wrong handling or lack of basic maintenance compliant to the equipment manual provisions. SMAR does not guarantee any defect or damage caused by an uncontrolled situation, including but not limited to negligence, user imprudence or negligence, natural forces, wars or civil unrest, accidents, inadequate transportation or packaging due to the user's responsibility, defects caused by fire, theft or stray shipment, improper electric voltage or power source connection, electric surges, violations, modifications not described on the instructions manual, and/or if the serial number was altered or removed, substitution of parts, adjustments or repairs carried out by non-authorized personnel; inappropriate product use and/or application that cause corrosion, risks or deformation on the product, damages on parts or components, inadequate cleaning with incompatible chemical products, solvent and abrasive products incompatible with construction materials, chemical or electrolytic influences, parts and components susceptible to decay from regular use, use of equipment beyond operational limits (temperature, humidity, etc.) according to the instructions manual. In addition, this Warranty Certificate excludes expenses with transportation, freight, insurance, all of which are the customer's responsibility.

4. For warranty or non-warranty repair, please contact your representative.

   Further information about address and contacts can be found on www.smar.com/contactus.asp

5. In cases needing technical assistance at the customer's facilities during the warranty period, the hours effectively worked will not be billed, although SMAR shall be reimbursed from the service technician's transportation, meals and lodging expenses, as well dismounting/mounting costs, if any.

6. The repair and/or substitution of defective parts do not extend, under any circumstance, the original warranty term, unless this extension is granted and communicated in writing by SMAR.

7. No Collaborator, Representative or any third party has the right, on SMAR's behalf, to grant warranty or assume some responsibility for SMAR products. If any warranty would be granted or assumed without SMAR's written consent, it will be declared void beforehand.

8. Cases of Extended Warranty acquisition must be negotiated with and documented by SMAR.

9. If necessary to return the equipment or product for repair or analysis, contact us.
   See item 4.

10. In cases of repair or analysis, the customer must fill out the Revision Requisition Form (FSR) included in the instructions manual, which contains details on the failure observed on the field, the circumstances it occurred, in addition to information on the installation site and process conditions. Equipments and products excluded from the warranty clauses must be approved by the client prior to the service execution.

11. In cases of repairs, the client shall be responsible for the proper product packaging and SMAR will not cover any damage occurred in shipment.

12. In cases of repairs under warranty, recall or outside warranty, the client is responsible for the correct packaging and packing and SMAR shall not cover any damage caused during transportation. Service expenses or any costs related to installing and uninstalling the product are the client´s sole responsibility and SMAR does not assume any accountability before the buyer.

13. It is the customer's responsibility to clean and decontaminate products and accessories prior to shipping them for repair, and SMAR and its dealer reserve themselves the right to refuse the service in cases not compliant to those conditions. It is the customer's responsibility to tell SMAR and its dealer when the product was utilized in applications that contaminate the equipment with harmful products during its handling and repair. Any other damages, consequences, indemnity claims, expenses and other costs caused by the lack of decontamination will be attributed to the client. Kindly, fill out the Declaration of Decontamination prior to shipping products to SMAR or its dealers, which can be accessed at www.smar.com/doc/declarationofcontamination.pdf and include in the packaging.

14. This warranty certificate is valid only when accompanying the purchase invoice.