USER'S MANUAL

AuditTank
Tank Measurement

AuditTank - smar First in Fieldbus

OCT / 12

AuditTank

Version 4

FOUNDATION

AUDI TTANME

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GLOSSARY

Access Restriction – To change the parameters that affect the calculation of the corrected volume, the user must enter with password.

ALG (Automatic Level Gauging) – Level measurement system in the tank.

Apparent Mass (in air) – Mass in vacuum subtracted the buoyant force from the air displacement volume. As the mass is indirectly measured by weight force or by the difference between this force and the buoyant, the apparent mass is the mass measured by these methods.

ATT (Automatic Tank Thermometer) – System of the liquid temperature measurement in the tank.

Audit Trail - Compilation and retention of information sufficient to verify the quantity in custody transfer. The QTR reports, configuration change, alarm/event and well test are included.

Base Conditions – Some variables refer to the base conditions, that is, at base temperature and pressure (reference) established by national regulation or international standard.

Base Density of Liquids – Measured density converted at base temperature and pressure conditions.

Base Temperature (reference) (Tb) – It is the reference temperature.

BSW (Base Sediment and Water) – Percentage of water and sediments that is emulsioned to the oil after the time of stabilization.

Course – Course of the tank shell, constituted of metal plates.

Dead Volume – Volume subtracted from the capacity of the tank due to insertion of equipments/piece in the tank, for example, moderated tube, temperature sensors to different levels.

Density Weighed Average (DWA) - The measured density is weighed by volume or mass.

$$DWA = \frac{\Sigma (Di * Vi)}{Vt}$$

Floating Roof – Type of tank where there is a floating roof (on the measured liquid) to avoid accumulation of gas.

Free Water – Water separate of the oil through decantation in tank.

Gross Observed Volume (GOV) – Product volume at process temperature subtracted the volume of free water and added the thermic dilation of the tank and floating top.

Gross Standard Volume (GSV) – Corrected volume at base conditions with low percentage of water and sediment mixed to the oil.

HTG (Hydrostatic Tank Gauge) – Measurement in tank with base in hydrostatic pressure measurement, where the density and level is obtained.

HTMS (Hybrid Tank Measurement System) – Tank measurement system with base in hydrostatic pressure and level where the density is obtained.

Hybrid System (HTMS – Hybrid Tank Measurement System) – Tank measurement system where have a combination of technology with base in hydrostatic pressure measurement and new technics of level measurement.

Level (innage) – Level of liquid relatively to measurement table.

Level (ullage/outage) – Distance between the sensor of level meter and the level of liquid, that is, the area available in tank. The liquid volume is obtained from difference with the reference height.

Mass in Vacuum – Mass obtained by conversion of the net standard volume (NSV) using the base density.

Measurement Table (dip-plate) – Plate used as reference to manual measurement of level. The position of the measurement table can't be affected by agitation of the tank's bottom or wall.

Net Standard Volume (NSV) – Corrected volume at base condition and subtracted the quantity of sediments and water mixed to the oil.

Process Conditions – Some volumetric variables refer to the process conditions, that is, volume at temperature and process pressure.

QTR (Quantity Transaction Report) – Report of quantity transaction, including all informations necessary to calculation of the corrected volume and mass of the correspondent period.

Reference Height – Distance between the sensor of the level meter and the measurement table.

Sampler – Equipment used in the collection of representative sample of the transferred volume.

Tank Table – Table of linearization points of the Volume x Level curve of a determined tank. According to ISO7507 standard, have a segment for each tank course added the number of segments necessary due to dead or additional volume in function of level.

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.

Total Observed Volume (TOV) – Volume obtained from level and tank table at base temperature. Therefore, before consider the thermic dilation of the tank at process temperature.

Weighed Average of the BSW (SWWA) - The BSW measured is weighed by volume or mass.

$$SWWA = \frac{\Sigma (SWi * Vi)}{Vt}$$

Well Test – Test accomplished to evaluate or monitor the production of an oil well.

Chapter 1

OVERVIEW

Introduction

The tank measurement system is a System302 application whose specific components are:

- **TM302 Module – Tank measurement:** module responsible for collect the informations of field device (level, temperature and density of liquid, free water interface, ambient temperature and BSW) and associated to configuration (for example, tank table) execute the calculation of the net volume at base condition, as well as the mass. This module also executes a significant role to guarantee the audit trail of the system.

- **TMView – Management and Report Tool:** It is the software component where the principal function is the management of reports. To do reading on the reports generate by TM302 from the NVRAM memory and storage in data base. It allow the view and print reports, monitoring and performance in all parameters of measurement and revision blocks / reports edition.

The TM302 and TMView Measurement System was designed for International Standards focusing applications like inventory control, custody transfer, weel test using tank and leak detection.

Based on AuditFlow – Flow Measurement System where the application is the fiscal measurement and custody transfer, the Smar innovate incorporating the characteristic of audit trail to Tank Measurement System, although there is no international standard applicable.

There is a special treatment for audit trail. It allows verify the calculations taken place in the TM302, access restriction to parameters which affect the flow calculation and configuration log, reports on occurence of process alarms and events, besides providing the QTR (Quantity Transaction Report) 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 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
- Smar OLE Server Manual
- Function Blocks Manual

System Architecture

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

The following figure shows a typical system using TM302. Due to hardware modular configuration, as well the Foundation Fieldbus, Modbus RTU and TCP/IP protocols as a builtin feature in the TM302 module, many options of architecture and connectivity are available 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 configuration is based on function block diagram language defined by IEC-61131-3 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 TMView is a software tool for operational phase of the system, it is used to monitoring the main measured and calculated variables and parameter configuration.

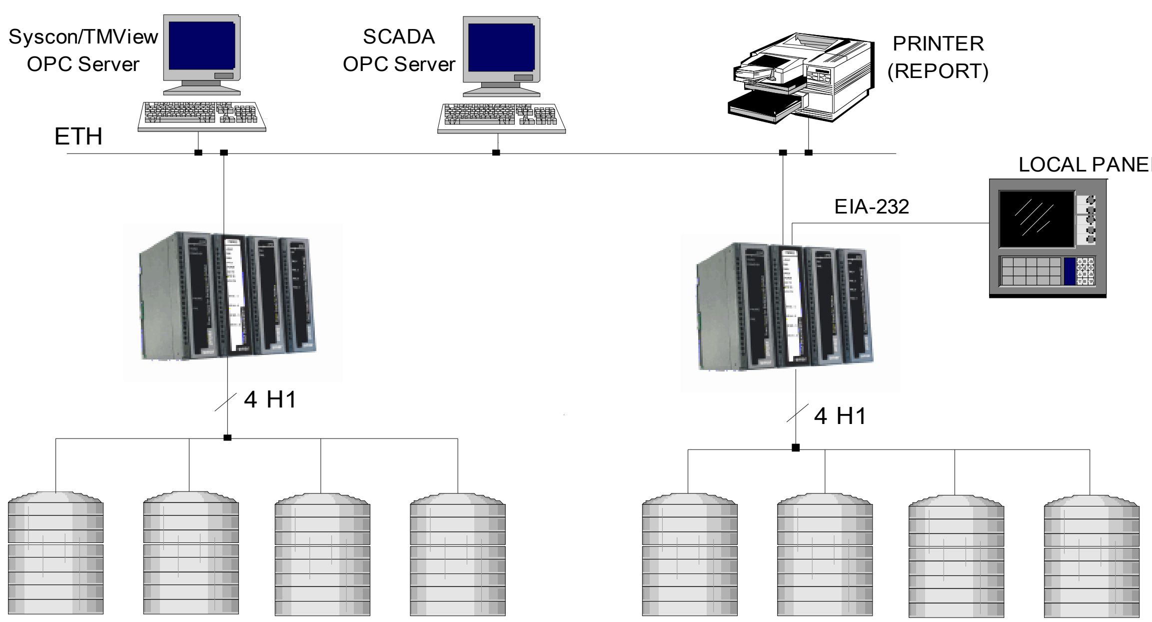
Through the TMView, all necessary informations to generate all report types and storage in the data base are obtained from AuditTank memory. Report views in data base and prints are also available in TMView.

The AuditTank (TM302 / TMView) has an OPC Server (DFI OLE Server), which allows communication with main supervisory softwares available in the market where the Syscon and TMView control and adjust function blocks parameters.

The interface between AuditTank and the field devices can be as follows:

- Communication through H1 Foundation Fieldbus protocol: Presents among other advantages, the digital transmission of the measured process variables (level, liquid temperature, ambient temperature, pressure, density, interface with free water and BSW) to avoid loss of accuracy in D/A and A/D conversions. Possibility of monitoring/performance in all parameters of equipment and, mainly, access to diagnostic informations allowing a preventive maintenance.
- I/O 4-20mA Modules and pulse inputs: The traditional access to measured variables by field devices is also available through 4-20mA to Foundation Fieldbus converter (IF302), 4-20mA analog input module (DF44 and DF57) and temperature module (DF45).
- Communication via Modbus RTU / TCP-IP protocol: TM302 has a set of function blocks which allows a suitable integration with Modbus devices. Through the EIA-232/485 or Ethernet+TCP/IP, the AuditTank can be a Master or Slave Modbus device. The Modbus communication implemented in TM302 allows the process variables to be reliably transferred, guaranteeing an adequate updating cycle to these variables, as established on the API-21.1 and API-21.1 standards, and also, the information on communication status and the use of an override value, in a failure situation.

Examples of applications: read level from radar, monitoring of variables through local HMI and reading on process variables of multivariable transmitter.



AuditTank - Typical Architecture

Chapter 2

THEORETICAL AND NORMATIVE DESCRIPTION

Standards used in Volume Correction and Measurement

API - American Petroleum Institute (USA)
API-11.1 – Temperature Correction Factor of Liquids Hydrocarbon
API-12.1.1 - Calculation of Quantity in Cylindric and Maritime Tanks
API-3.6 – Hybrid System in Tank
API-21.2 - Audit Trail and Data Security – Adapted to tank measurement

ISO - International Standard Organization
ISO4266-1 – Level Measurement in Atmospheric Tank
ISO4266-4 – Temperature Measurement in Atmospheric Tank
ISO7507 – Tank Calibration of Cylindric Shore Tank

OIML – International Organization of Legal Metrology
OIML R71 – Fixed Tanks – General Requeirement
OIML R85 – Automatic System of Level Measurement in Fixed Tank

Liquid Measurement

Tank Calibration – ISO7507-1 to ISO7507-6

The calibration process in cylindric tanks aims an average internal radius for each tank course and so a segment from tank table is obtained.

The ISO7507-1 refers to the tank process using tensioned tap for measurement of the external radius of each course. According to this standard is necessary:

- Load the tank, unless once, with work capacity and remain for 24 hours before calibration process.
- Measurement on three different levels for each course if the calibration is required by legal terms, and in two different levels if is internal procedure of work.
- If a tape is used to circle the tank, the zero should be a distance of vertical solders, at least a third of the plate length.
- Before reading a voltage should be applied in the tape.
- After reading the voltage should be reduced, and then, the reading should be repeated for same height. The standard establishes the tolerance between two consecutive readings for each tank size.
- The average between two consecutive readings according to tolerance established will be used as the course circumference for established height.
- Determination of "stepover" correction due to obstacle that cause a deviation from the measurement tape for a perfectly circular trajectory.
- Measurement on plate thickness and painting for each course.
- Measurement on course height for more than one point around of the tank. The average will be as course height. The sum of the course heights should be according to the total height which will be measured.
- Dead Volume: measurement on dead volume (if possible), as well as the height of the inferior and superior edge according to the reference point.
- For volume measurement on the tank bottom there are two methods:
    - Keep a nonvolatile liquid to a minimum level where the measurement table is totally submerged.
    - If is not possible use the previous method or the bottom of the tank has a regular format, then use physical inspection method.
- Measurement on tank inclination through plumb line of the tank top: measurement on a sufficient number of the points with the displacement maximum in the base of the tank.
- Measurement on apparent mass of the floating top, that is, to fill slowly the tank until the top is completely floating, that is, without depend on the support. The level measurement is realized as well as the measurement on density and temperature of the liquid.

- The tank recalibration should be realized always that there is a suspicion of tank deformation, agitations in the tank bottom, increase or decrease of dead volume or according to the periodicity established in national legislation.

Procedure to determine the tank table:

- Calculate the average circumference for each one of the three heights of a determined course;
- Correct this average circumference due to "stepover";
- The external average circumference of the course is obtained by arithmetic average between the average circumference corrected by "stepover" on three height of the course;
- Calculate the internal circumference of the course minus the plate thickness and the painting. The value that will be subtracted is 2 π t, where t is a plate thickness plus the painting;
- The value obtained for internal circumference is the temperature which was calibrated to tape;
- Calculate the correction volume factor due to tank inclination.

Level Measurement in Atmospheric Tank – ISO4266-1

Establish the requirements to level measurement in atmospheric tank, where custody transfer applications the intrinsic maximum error to level meter is +/- 1mm and the error of the level measurement system installed is +/- 3mm.

Liquid Temperature Measurement in Tank – ISO4266-4

Establish the requirements to temperature measurement:

- Intrinsic error to temperature measurement system: +/- 0.25°C.
- Two methods to measure the average temperature of the liquid in tank considering as gradient principal in the vertical direction due to insolation:
  - Multiple accurate sensors in different levels and the average of the submerged sensors is calculated;
  - The following table establishes the minimum number of accurate sensors depending on the tank height;

Minimum Number of Elements	Tank Height
4	< 9 m
5	9 to 15 m
6	> 15 m

  - Multiple sensors of different lengths and the sensor reading of bigger total length, totally submerged, is used.

Temperature Correction Factor (CTL) – API-11.1

The temperature correction factor (CTL) is calculated with base on the measured density at process conditions and process temperature. This correction factor is used to convert the volume of liquid hydrocarbon from process condition to base condition. Besides the density and temperature, there is necessity to specify the product type: A – crude oil; B – generalized products (gasoline, diesel,…); C – MTBE; D – lubricating oil.

Calculation of Quantity in Cylindric Tanks – API-12.1.1

This standard introduces the sequence of volume and mass calculation in shore and atmospheric cylindric tank, as well as oil tanks (not implemented int the TM302 – Version 1):

TOV → GOV → GSV → NSV → Mass

TOV = f(innage, tank table)
FWV = f(FW, tank table)

$$TSh = \frac{7 * T_{liq} + T_{amb}}{8}$$

$$CTSh = (1 + Gl * (TSh - Tb))^{2}$$

GOV = (TOV – FWV) * CTSh +/- FRA
GSV = [(TOV – FWV) * CTSh +/- FRA] * CTL
NSV = GSV * (1 – BSW)
M = NSV * WCF
Ma = M * (1 – Da / Dobs)

Where:
TOV: volume obtained from the level and tank table.
FW: level of free water.
FWV: free water volume from the water/oil interface and tank table.
T_{liq} : liquid temperature that will be measured.
T_{amb} : ambient temperature (near to tank).
TSh: tank temperature.
CTSh: Temperature correction factor for tank table obtained from the tank operation temperature, tank base temperature and coefficient of thermic expansion.
Gl: coefficient of linear thermic dilation of the tank material.
FRA: Adjustmente for tanks with floating top.
WCF: conversion factor of volume to mass obtained from the density.
Ma: apparent mass (in air).
M: mass in the vaccum.
Da: air density.
Dobs: liquid density in vacuum at operation condition.

Correction Factor for Ethanol

Using the NBR 5992-80 or OIML R22-75 standards, flowing density of the mixture and the flowing temperature, the base density and CTL factor are calculated.

There is an important difference between the standards above and the standards used for hydrocarbon, because such standards describe the behavior of the mixture etanol and water density with the temperature, while the standards for hydrocarbon treat of substances without water. This difference is necessary because the standards for the etanol treat of etanol and water mixtures in a proportion of the etanol in mass from 66% in NBR 5992-80 and 0% for OIML R22-75.

$$CTL = \frac{V_{m,b}}{V_{m,t}} = \frac{\rho_{m,t}}{\rho_{m,b}}$$

Where:
CTL : correction factor of the flowing temperature to base temperature
$V_{m,b}$: volume of the ethanol and water mixture at base condition
$V_{m,t}$: volume of the ethanol and water mixture at flowing condition
$\rho_{m,t}$: density of the ethanol and water mixture at flowing condition
$\rho_{m,b}$: density of the ethanol and water mixture at base condition

Another variable calculated from the flowing density and flowing temperature is the percentage in mass of the ethanol in the mixture (p%), that is also denominated INPM degree in Brazil.

$$p\% = INPM = \frac{m_e}{m_m}$$

Where:
p% : percentage in mass of ethanol in the mixture
m_e : ethanol mass
m_m : mass of ethanol and water mixture.

For this product the compressibility factor will be considered null, therefore CPL=1

The calculation of NSV presents a difference in relation to the liquid hydrocarbon, because when mixing ethanol and water happens a small shrink. Besides, BSW can be calculated by the following equantions.

$$NSV = V_{e,b} = \frac{m_e}{\rho_{e,b}} = \frac{m_m * p\%}{\rho_{e,b}} = \frac{GSV * \rho_{m,b} * p\%}{\rho_{e,b}} = GSV(1 - BSW_b)$$

Where:
$V_{e,b}$: volume of ethanol at base temperature

Then the BSW is calculated using the following equation:

$$BSW_b = 1 - \frac{\rho_{m,b} * p\%}{\rho_{e,b}}$$

Where :
$\rho_{m,b}$: mixture density at base temperature
$\rho_{e,b}$: ethanol density at base temperature

Temperature	Density of pure etanol
15 ºC	793.51 kg/m^3
60 ºF	793.1 kg/m^3
20 ºC	789.24 kg/m^3

BSW_b : percentage of water in volume at base condition and considering the volumetric expansion to remove the water.

All the tables of OIML R22 are based on Wagenbreth and Blake mathematical model, whose equation is:

$$\rho_{m,t} = A_1 + \sum_{k=2}^{12} A_k * p^{k-1} + \sum_{k=1}^{6} B_k * (t-20)^k + \sum_{i=1}^{n} \sum_{k=1}^{mi} C_{i,k} * p^k * (t-20)^i$$

Where :
t : temperature to calculate the density of the ethanol and water mixture in Celsius degree
p : percentage in mass of ethanol in the mixture
$\rho_{m,t}$: density of ethanol and water mixture in kg/m^3.

The coefficients are:

k	Ak	Bk	C1,k
1	9.982012300000000E+02	-2.061851300000000E-01	1.693443461530090E-01
2	-1.929769495000000E+02	-5.268254200000000E-03	-1.046914743455170E+01
3	3.891238958000000E+02	3.613001300000000E-05	7.196353469546520E+01
4	-1.668103923000000E+03	-3.895770200000000E-07	-7.047478054272790E+02
5	1.352215441000000E+04	7.169354000000000E-09	3.924090430035050E+03
6	-8.829278388000000E+04	-9.973923100000000E-11	-1.210164659068750E+04
7	3.062874042000000E+05		2.248646550400790E+04
8	-6.138381234000000E+05		-2.605562982188160E+04
9	7.470172998000000E+05		1.852373922069470E+04
10	-5.478461354000000E+05		-7.420201433430140E+03
11	2.234460334000000E+05		1.285617841998970E+03
12	-3.903285426000000E+04		

k	C2,k	C3,k	C4,k	C5,k
1	-1.193013005057010E-02	-6.802995733503800E-04	4.075376675622030E-06	-2.788074354782410E-08
2	2.517399633803460E-01	1.876837790289660E-02	-8.763058573471110E-06	1.345612883493350E-08
3	-2.170575700536990E+00	-2.002561813734160E-01	6.515031360099360E-06	
4	1.353034988843030E+01	1.022992966719220E+00	-1.515784836987210E-06	
5	-5.029988758547010E+01	-2.895696483903640E+00		
6	1.096355666577570E+02	4.810060584300680E+00		
7	-1.422753946421160E+02	-4.672147440794680E+00		
8	1.080435942856230E+02	2.458043105903460E+00		
9	-4.414153236817390E+01	-5.411227621436810E-01		
10	7.442971530188780E+00			

Algorithm for determination of the base density and percentage in mass of the etanol is:

- Input data: mixture density at flowing temperature and the flowing temperature
- Iterative method for determination of the percentage in mass of the ethanol using the Wagenbreth and Blake equation, flowing temperature and mixture density at flowing temperature.
- Calculation of the mixture density at base temperature using the Wagenbreth and Blake equation, percentage in mass of the ethanol in the mixture (defined in the previous item) and flowing temperature.

Hybrid System of Tank Measurement – API-3.6

In this standard is discussed the technique of measurement in tank denominated hybrid system, because arrange the traditional method through hydrostatic pressure (HTG) with the recent technology of level measurement of high accuracy.

The equation below is used to determine the liquid density and is based in the pressure balance.

$$D_{obs} = \frac{(P1 - P3) - g * (D_v - D_a) * H_t}{g * (L - Z)} + D_v$$

Where:
D_{obs}: Density at operation temperature in Kg/m^3
L: Liquid level in meters
Z: force center height of pressure sensor P1 (H1+H0) corrected in temperature, in meters
g: local gravity acceleration in m/s^2
H_t: distance between the force center of sensors P1 and P3 corrected in temperature, in meters
D_v : vapour density in tank in Kg/m3
D_a : air density in Kg/m^3
P1 and P3: gauge pressures in pascal
P3: Internal pressure in the tank (vapour column above of the pressure plug point)
Atmospheric Tank

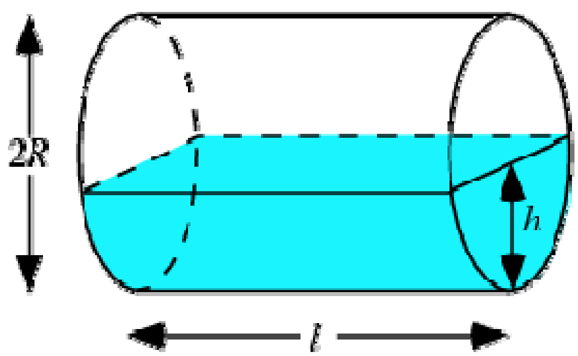
Pressurized Tanks

The measurement on pressurized tanks has some differences in the sequence of calculation, showed below:

TOV → GOV → GSV → NSV → Mass

TOV Calculation
1. Cylindric Tanks (API-2.2E/ISO 12917-1:2002, API-2551)

The cylindric area is calculated according to the equation:



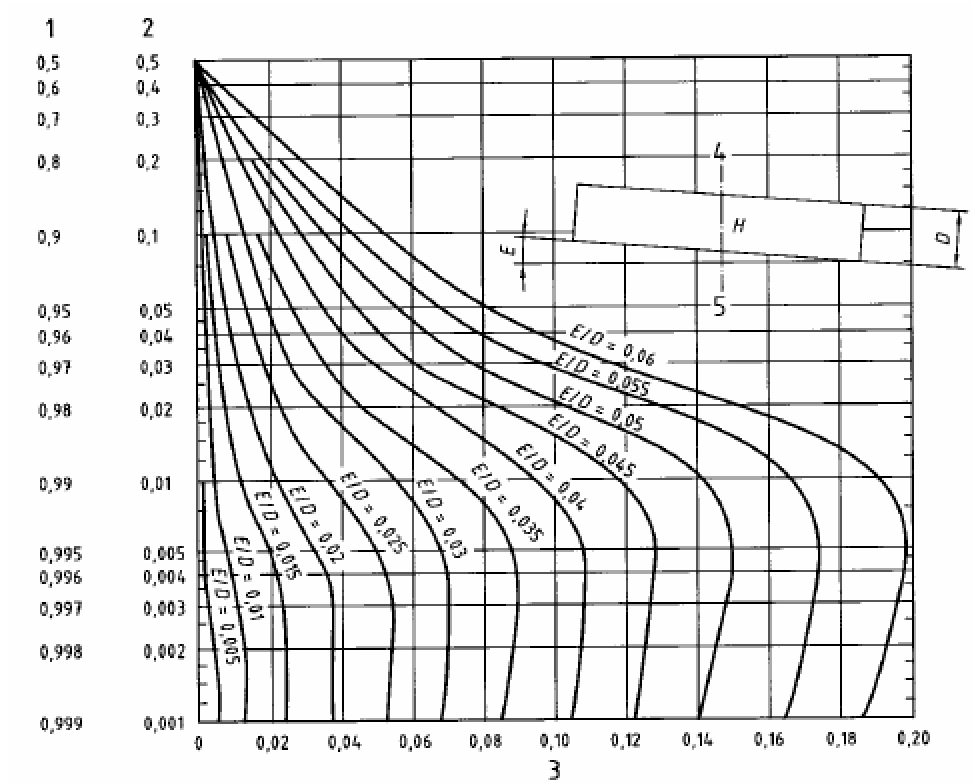
$$V_c = \frac{L}{2} R^2 \left(2 \arccos \frac{R-h}{R} - sen\left(2 \arccos \frac{R-h}{R} \right) \right)$$

If the tank will be inclined, then:

$$TOV_c = V_c * C_{tilt}$$

Where Ctilt is the correction factor for inclined horizontal cylindric tank calculated as API MPMS-2.2.E Figure A.1., which the correction factor is applied only to cylindric area, because the effect is negligible in the top (API MPMS-2.2.E Appendix A).

The conditions of inferior and superior wedge are ignored, that is, the tank is totally empty and totally full, respectively. This consideration is reasonable considering the maximum value of inclination of the graphic below, that is E/D = 0.06



Key

1 Value of *H/D* – subtract volume correction when tank is less than half full

2 Value of *H/D* – add volume correction when tank is less than half full

3 Volume correction, percentage of total tank capacity

4 Centre of tank

5 *D*, *E* and *H* may be measured vertically, if desired

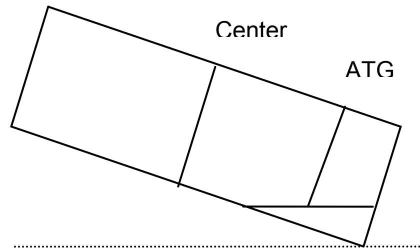
D Diameter of the tank, in metres

E Elevation (height) of the higher end of the tank above the lower end of the tank, in metres

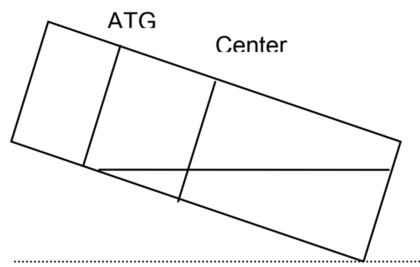
H Height of liquid in the tank, in metres

Notes:

1. If the level is so that the relation beteween level and diameter of the tank (H/D) is inferior to 0.001 or superior to 0.999, the Ctilt will be a value correspondent to these values.
2. In compliance with API MPMS-2.2.E appendix A, the correction factor is not considered due to inclination (Ctilt), if E/D is inferior to 0.012.

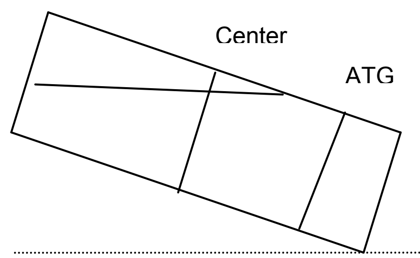


Case 1

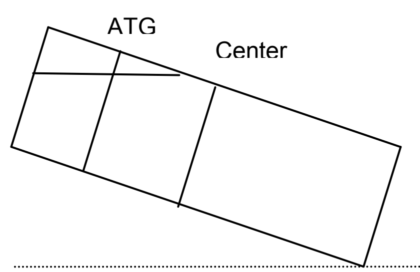


Case 2

TOV=0 in cases of inferior wedge, shown in the previous figures:



Case 3



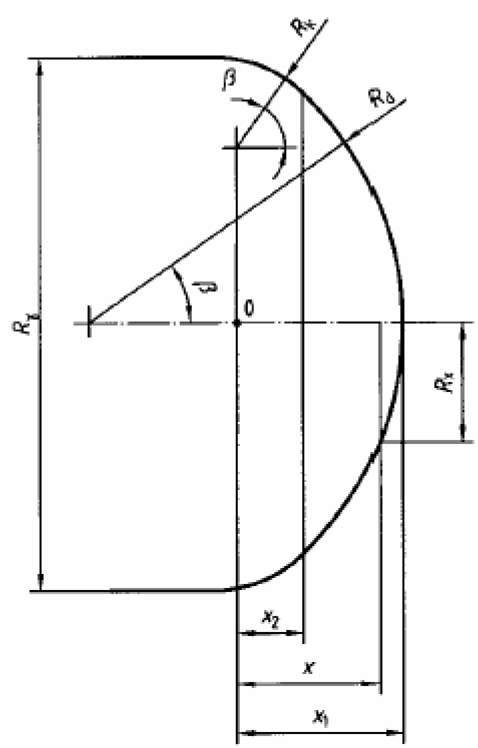
Case 4

In cases of superior wedge shown in the previous figures the TOV correspondent to full tank is considered.

Level in tank center	Type of wedge	Calculation	Description
Equal to zero	Inferior	TOV=0	TOV=0 in the following cases: - Level, different of zero, where the level meter is installed, but at central point of the tank, the level is zero (Case 1). - Level obtained from the level meter indicates zero, although there is level different of zero at central point (Case 2). In these cases the GSVvapour corresponds to total volume of the tank.
Greater than zero, but does not reach the superior head.	Inferior	TOV*Ctilt	Level obtained from the meter bigger than zero, as well as the value sent to central point of the tank. The graphic above is used to determine the Ctilt.
Less than diameter of main cylinder, but the inferior head is full.	Superior	TOV*Ctilt	Level obtained from the meter less than diameter of the tank, as well as the value sent to central point of the tank. The graphic above is used to determine the Ctilt.
Greater or equal to diameter of main cylinder.	Superior	TOV – full tank	TOV of the full tank is considered in the following cases: - Level obtained from the level meter indicates full tank, although the level at central point is inferior to diameter of the tank (Case 3). - Level where the level meter is installed is inferior to diameter of the main cylinder, but sending to central point of the tank, the level is equal to diameter of the tank (Case 4).

The edge of the horizontal cylindric tank ("heads") are calculated as geometry:

a) Knuckle-dish



Where:
Rk : knuckle radius
Rd : dish radius
R : cylinder radius

Observation: If the tank has different internal radius between the main cylinder and the flange, for equations below should be considered the flange radius on the contrary the cylinder radius (R).

From the three radius, calculates:

$$sen\beta = \frac{R - R_k}{R_d - R_k}$$

$$x_2 = R_k * \cos\beta$$

$$x_1 = R_d - (R_d - R_k) * \cos\beta$$

Calculation of Rx:

If 0<= x <= x2: $R_x = R - R_k + \sqrt{R_k{}^2 - x^2}$

If x2 <= x <= x1: $R_x = \sqrt{R_d{}^2 - [(R_d - R_k) * \cos\beta + x]^2}$

$$TOV_h = \int_0^{xh} R_x{}^2 * \left[\arccos\left(\frac{R-h}{R_x}\right) - 0.5 * sen\left(2 * \arccos\left(\frac{R-h}{R_x}\right)\right)\right] dx$$

Numeric integration using Simpson.

Where:
Xh: it is determinated with base in following restriction:

$$-1 \le \frac{R-h}{R_{xh}} \le 1$$

b) Elliptical

$$TOV_h = \frac{\pi * L1 * h^2}{2} * \left(1 - \frac{h}{3R}\right)$$

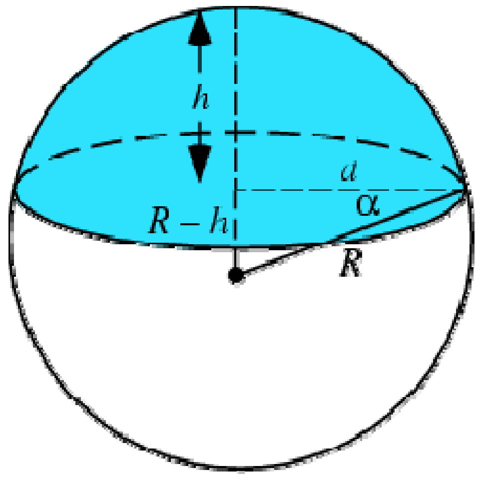
Where:
R: head radius
L1: head length
h: liquid level

c) Spherical
The calculation of spherical head is a particular case of the Knuckle dish which Rk=0.

The TOV of the horizontal cylindric tank is calculated by add the cylindric part with the heads, added or subtracted of the additional/dead volume:

$$TOV = TOV_c + 2 * TOV_h + V_{deadwood}$$

2. Spherical Tanks (API-2552)



The volume in the spherical cap added to volume on the tank bottom, added or subtracted of the additional/dead volume supply the TOV:

$$TOV(R,h) = \frac{1}{3}\pi h^2 (3R - h) + V_{bottom\_capacity} + V_{deadwood}$$

Calculation of GOV

1. Cylindric Tanks:

$$GOV = (TOV - FWV) * CTSh \left(\frac{TOV_c * C_{pvc}}{TOV_c + 2*TOV_h} + \frac{2*TOV_h * C_{pve}}{TOV_c + 2*TOV_h} \right)$$

$$C_{pvc} = 1 + \frac{P*R}{2*WT*E}(5 - 4*\sigma)$$

$$C_{pve} = 1 + \frac{3*P*R}{2*WT*E}(1 - \sigma)$$

Where:

C_{pvc}: correction factor due to pressure on the tank wall – cylindric part

C_{pve}: correction factor due to pressure on the wall of the tank head that, by approximation, will be calculated as a spherical cap. For heads knuckle-dish or spherical type will be used the spherical radius, while head of the elliptical type will use the radius of the tank cylindric part (internal radius of the flange).

2. Spherical Tanks:

GOV = (TOV – FWV) * CTSh * C_{pve}

CTSh = (1 + alpha * (TSh – Tb)) ^{2}

$$TSh = \frac{7*T_{liq} + T_{amb}}{8}$$

$$C_{pve} = 1 + \frac{3*P*R}{2*WT*E}(1 - \sigma)$$

Where:

P: gauge pressure

R: average radius of the sphere

WT: thickness of the tank plate

E: Young module (elasticity)

σ: Poisson coefficient

Calculation of GSV

$$GSV = GOV * CTL * CPL$$

Where:
CTL: temperature correction factor, converting the volume of liquid for base condition. Use the density and the average temperature of the liquid.
CPL: pressure correction factor, converting the volume of liquid for base condition. Use the density, average temperature of the liquid and the vapour pressure (P3).

Calculation of GSV_{vapour}
First the vapour volume in tank is calculated:

$$V_{vapour} = V_{\tan k\_capacity} - TOV$$

Where $V_{tank\_capacity}$ is total volume of the tank at base condition, including dead/additional volumes.
The vapour volume is converted for base condition using the equation of the ideal gas:

$$SV_{vapour} = \frac{V_{vapour} * P_f * T_b}{P_b * T_f}$$

The base temperatures and operation should be in Kelvin.
Then this vapour volume at base condition is converted in liquid at base condition using the factor depending on the type of measured substance (Rv,l);

$$GSV_{vapour} = \frac{SV_{vapour}}{R_{v,l}}$$

Product	$R_{v,l}$
Ethane	293.3
Propene	288.3
Propane	266.7
Butene-1	245.2
Cis-Butene-2	255.9
Trans-Butene-2	248.9
Iso-Butene	245.0
Iso-Butane	221.9
Butane	229.5
Iso-Pentane	193.7
Pentane	194.8

Calculation of NSV
NSV = (GSV+GSV_{vapour}) * (1 – BSW)

M = NSV * WCF
Ma = M * (1 – Da / Dobs)

Where:
TOV: volume obtained from the level and tank table.
FW: level of free water.
FWV: volume of free water obtained from the water/oil interface and tank table.
T_{liq}: temperatura do líquido a ser medido.
T_{amb}: ambient temperature (near to tank).
TSh: tank temperature.
CTSh: temperature correction factor for tank table, obtained from the operation temperature in tank, base temperature of the tank and coefficient of expansion thermic.
FRA: adjustment for floating roof tanks.
WCF: conversion factor of volume to mass, obtained from density.
Ma: apparent mass (in air).
M: mass in vacuum.
Da: air density.
Dobs: liquid density in vacuum at operation condition.

Equation for different configurations

The equations of calculation showed below consider different combinations:

- Density meter and BSW in tank and in line
- Fiscal measurement and appropriation
- Measurement in atmospheric and pressurized tanks

Dens In Tank **SW In Tank** CTLi, CTLf CPLi, CPLf SWi, SWf	Appropriation & T. Pressurized	GSVi/f = GOVi/f *((1 – SWi/f)*CTLo,i/f*CPLo,i/f + SWi/f*CTLw,i/f*CPLw,i/f)
		NSVi/f = [GOVi/f * CTLo,i/f * CPLo,i/f + GSVvapour] *((1 – SWi/f)
	Appropriation	GSVi/f = GOVi/f * ((1 – SWi/f) * CTLo,i + SWi/f * CTLw,i/f)
		NSVi/f = GOVi/f * (1 – SWi/f) * CTLo,i/f
	T. Pressurized	GSVi/f = GOVi/f * CTLo,i/f * CPLo,i/f
		NSVi/f = (GSVi/f + GSVvapour)* (1-SWi/f)
	-------------	GSVi/f = GOVi/f * CTLo,i/f
		NSVi/f = GSVi/f * (1-SWi/f)
Dens In Tank **SW In-line** CTLi, CTLf CPLi, CPLf SWv	Appropriation & T. Pressurized	Configuration Error
		Configuration Error
	Appropriation	Configuration Error
		Configuration Error
	T. Pressurized	GSVi/f = GOVi/f * CTLo,i/f * CPLo,i/f
		ΔNSV = (ΔGSV + ΔGSVvapour) * (1 – SWv)
	-------------	GSVi/f = GOVi/f * CTLo,i/f
		ΔNSV = ΔGSV * (1 – SWv)
Dens In-line **SW In-line** CTLv CPLv SWv	Appropriation & T. Pressurized	ΔGSV = ΔGOV * ((1 – SWv) * CTLo,v * CPLo,v + SWv * CTLw,v * CPLw,v)
		ΔNSV = (ΔGOV*CTLo,v*CPLo,v + ΔGSVvapour) * (1 – SWv)
	Appropriation	ΔGSV = ΔGOV * ((1 – SWv) * CTLo,v + SWv * CTLw,v)
		ΔNSV = ΔGOV * (1 – SWv) * CTLo,v
	T. Pressurized	ΔGSV = ΔGOV * CTLo,v * CPLo,v
		ΔNSV = (ΔGSV + ΔGSVvapour) * (1 – SWv)
	-------------	ΔGSV = ΔGOV * CTLo,v
		ΔNSV = ΔGSV * (1 – SWv)

Audit trail, Field Device Calibration and Data Security

These characteristics don't be required by international standard in the static measurement area in tank, conversely of that occurs in the flow measurement area (API-21.2), but was incorporated to this system, because are fundamentals for a measurement system in applications of custody transfer.

Audit trail must be warranted by storing the information related to the calculations, this 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, diagnostics and other.

The API-21.2 standard also establish the verification and calibration procedures for field devices. The verification procedure compares the values measured and transmitted to the device 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 storaged in the device memory that realizes the calculation, guarantee of authenticity and data transfer reliability 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 AuditTank 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.

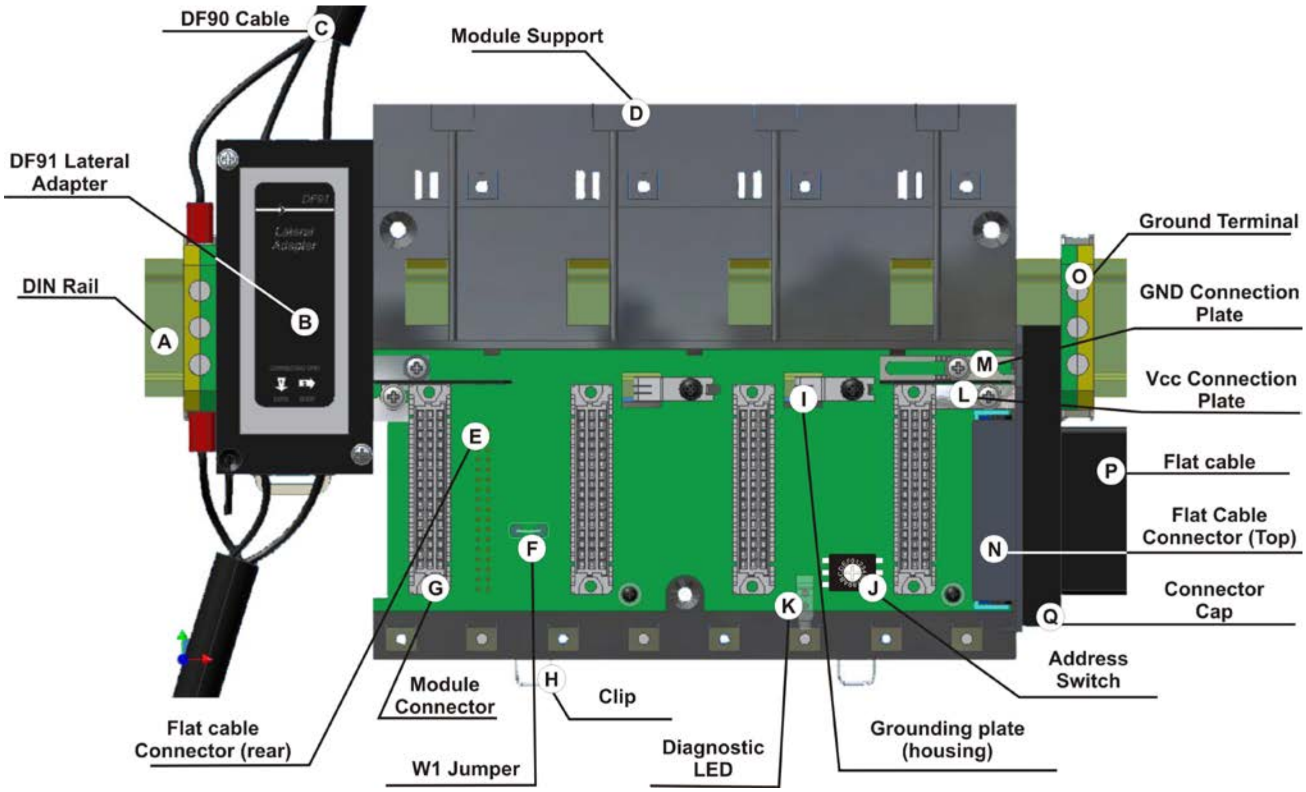


Figure 3. 1 - DF93 components

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.

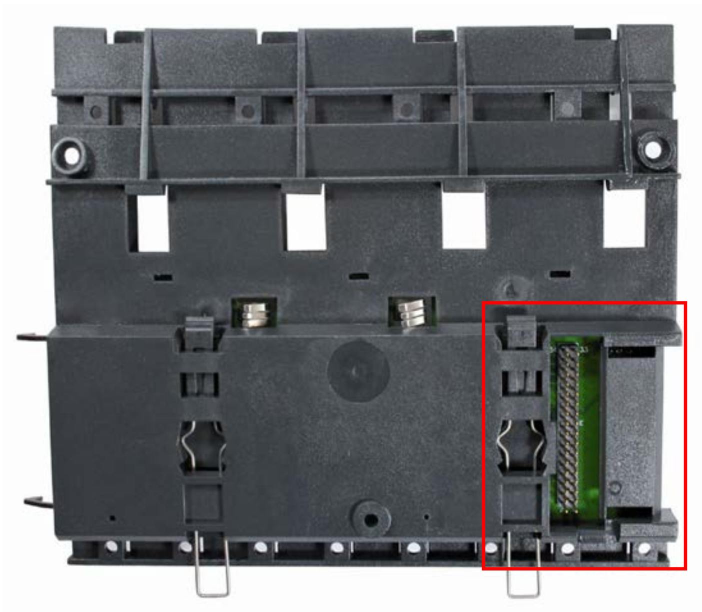


Figure 3. 2 - Rear connector of DF93 rack

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.

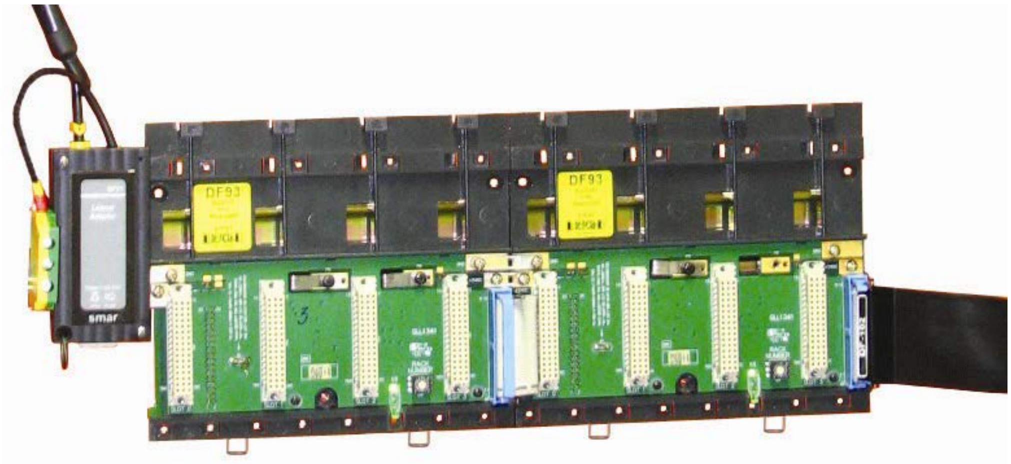


Figure 3. 3 - Connection between adjacent racks

Using the DF91

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

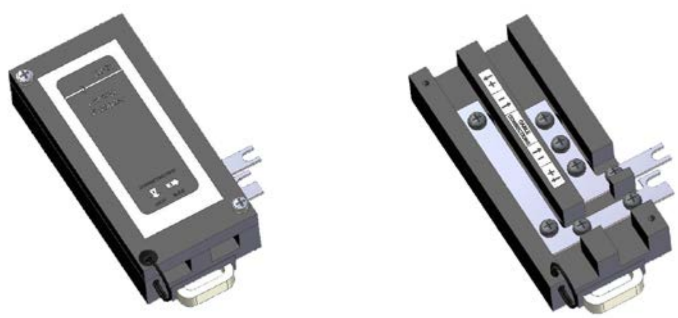


Figure 3. 4 - DF91 details

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 AuditTank 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).

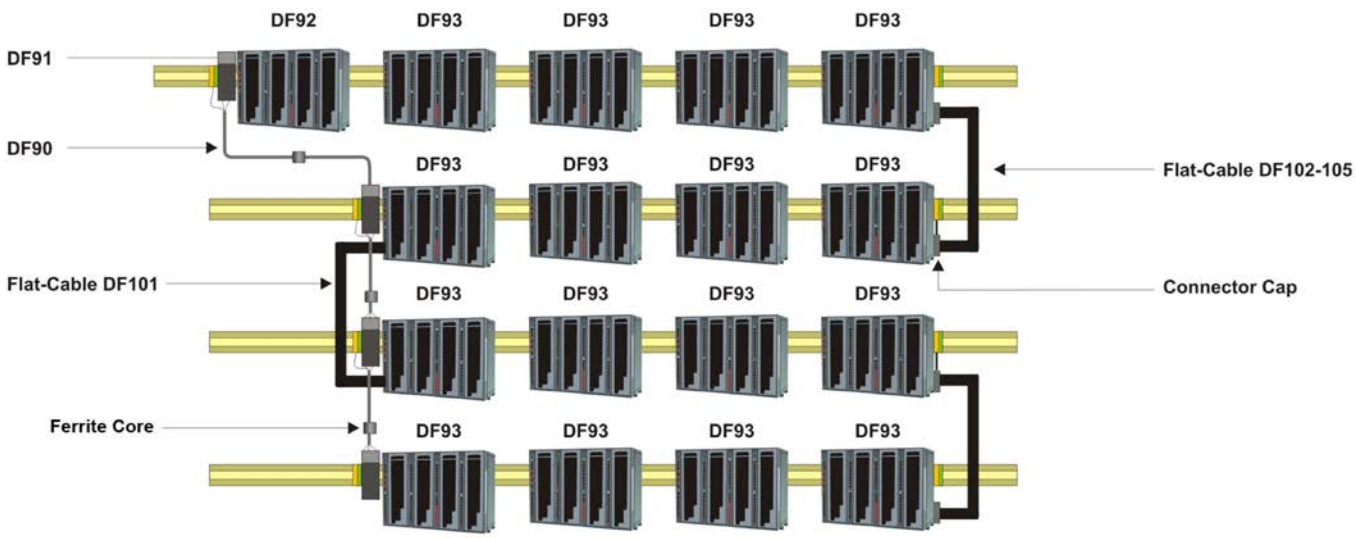


Figure 3. 6 - Illustration - DF101 and DF102-105 Flat cables

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

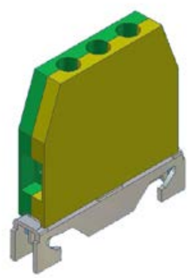


Figure 3. 7 - Ground terminal

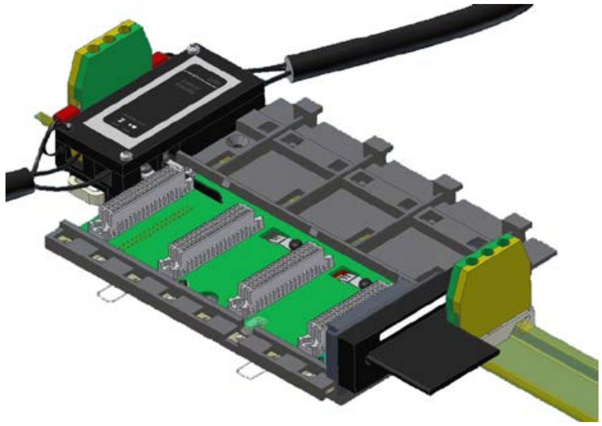


Figure 3. 8 - Ground terminal installed

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.

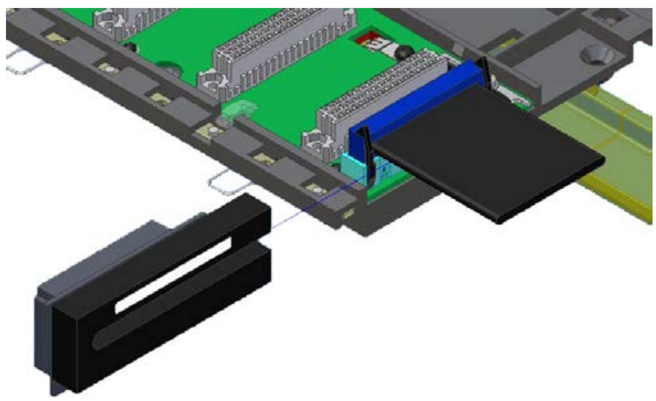


Figure 3. 9 - Installing the connector cap

In the following figure is shown a connector cap installed.

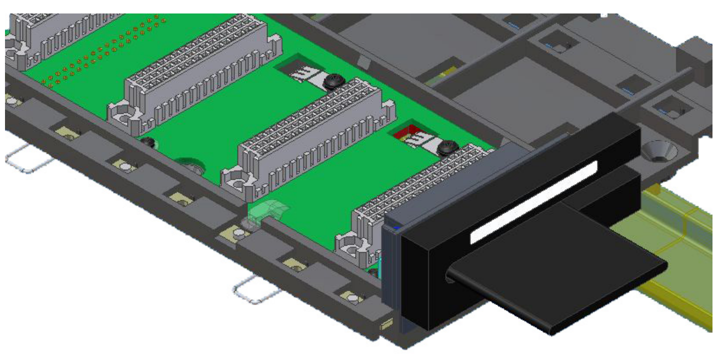


Figure 3. 10 - Connector cap installed

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.

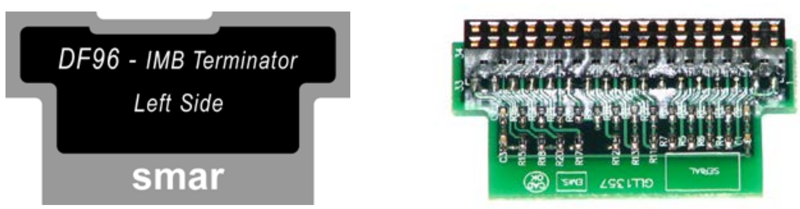


Figure 3. 12 - DF96 terminator

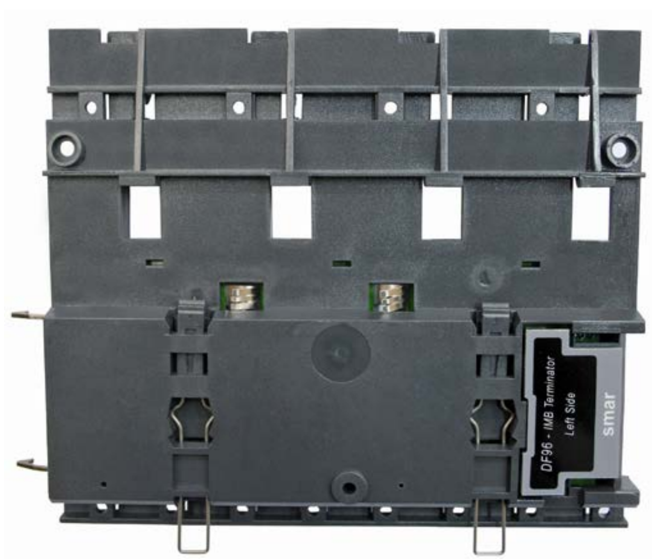


Figure 3. 13 - DF96 terminator installed in the DF93 rack

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 AuditTank is expanded in more than one row of racks, i.e., in different DIN rail segments, one below the other.

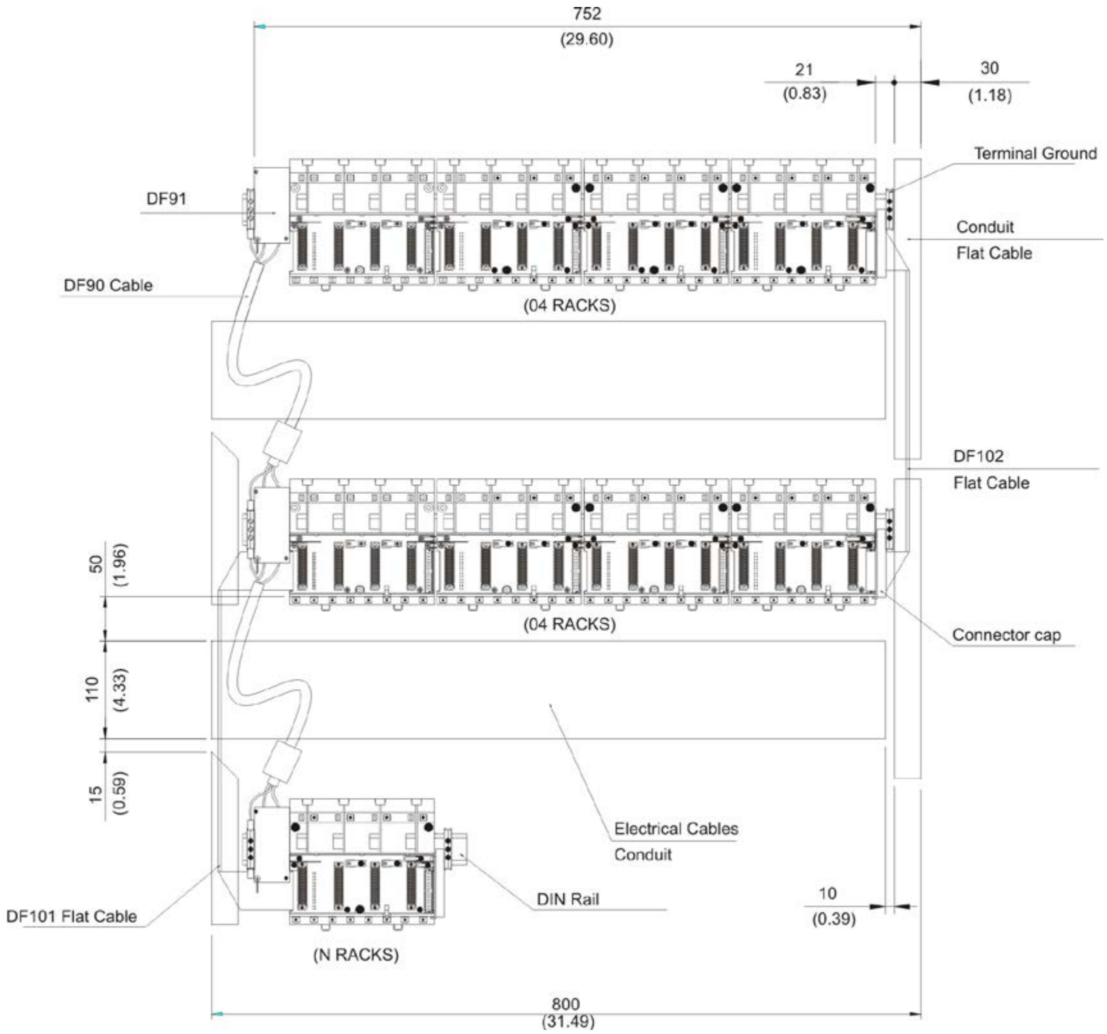


Figure 3. 14 - Example of expanded system

IMPORTANT
The DF91 must be installed at left side of each row of racks, to meet the requirements of EMC standards even if no expansion of power.

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.

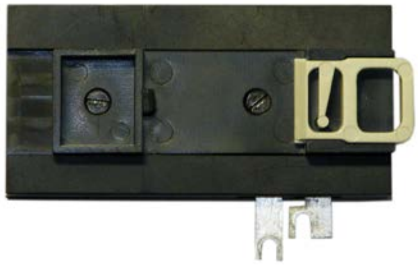


Figure 3. 15 - DF91 rear part

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.

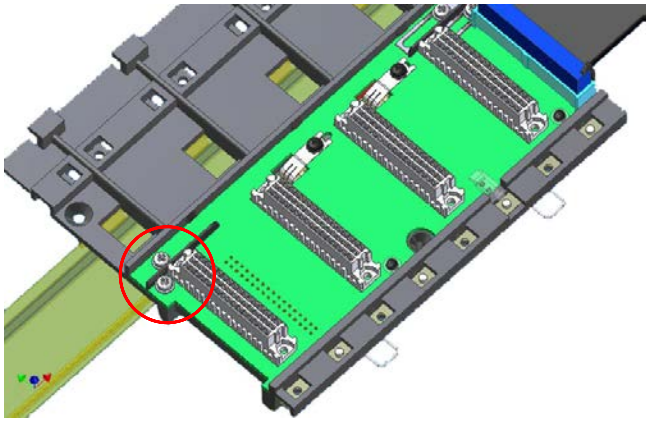


***Figure 3. 16 -* Details of screws of the rack's power connector**

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.

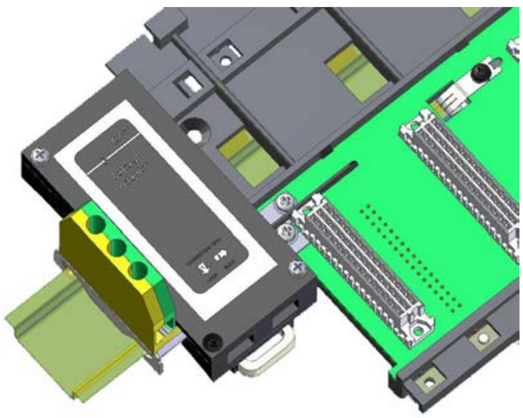


Figure 3. 17 - DF91 connected to rack

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 (-);

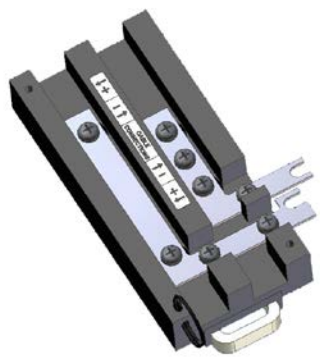


Figure 3. 19 - DF91 detail

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;

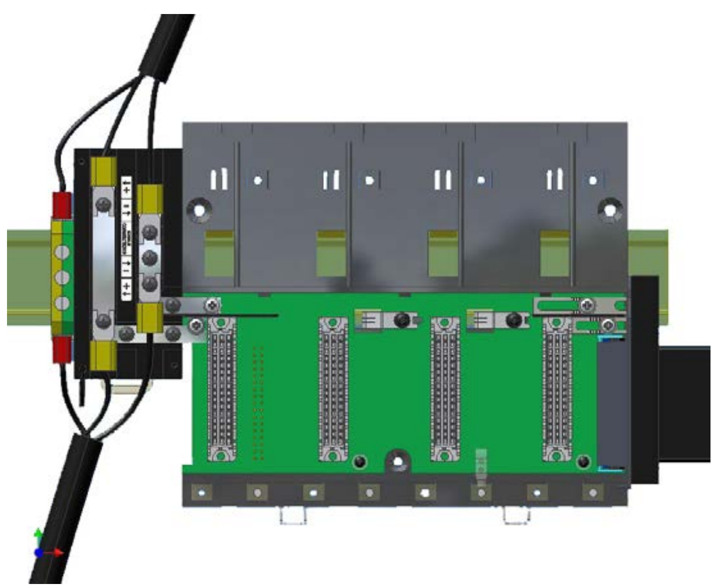


Figure 3. 20 - DF91 installed in the rack

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

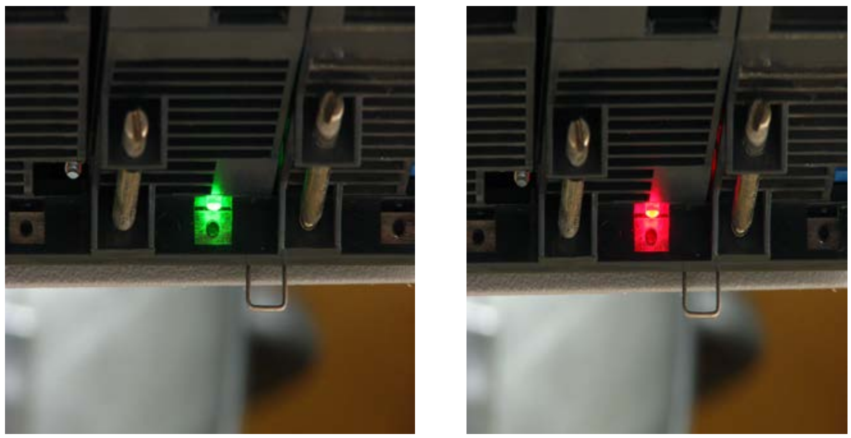


Figure 3. 21 - LEDs for diagnostic in the DF93 rack

Installing the system's base with DF1A and DF78

See below the figures and descriptions of module and rack:

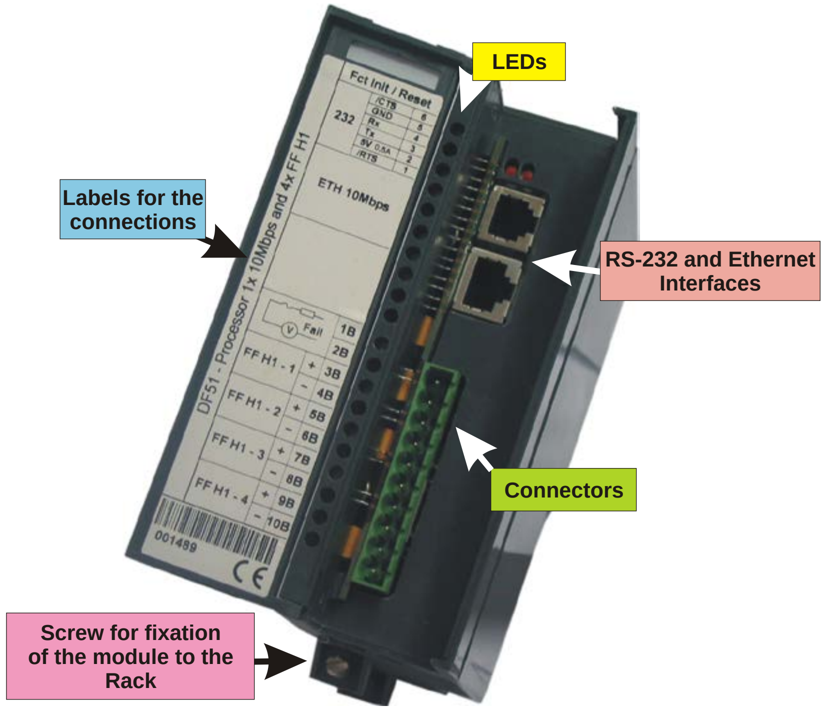


Figure 3. 22 - Module

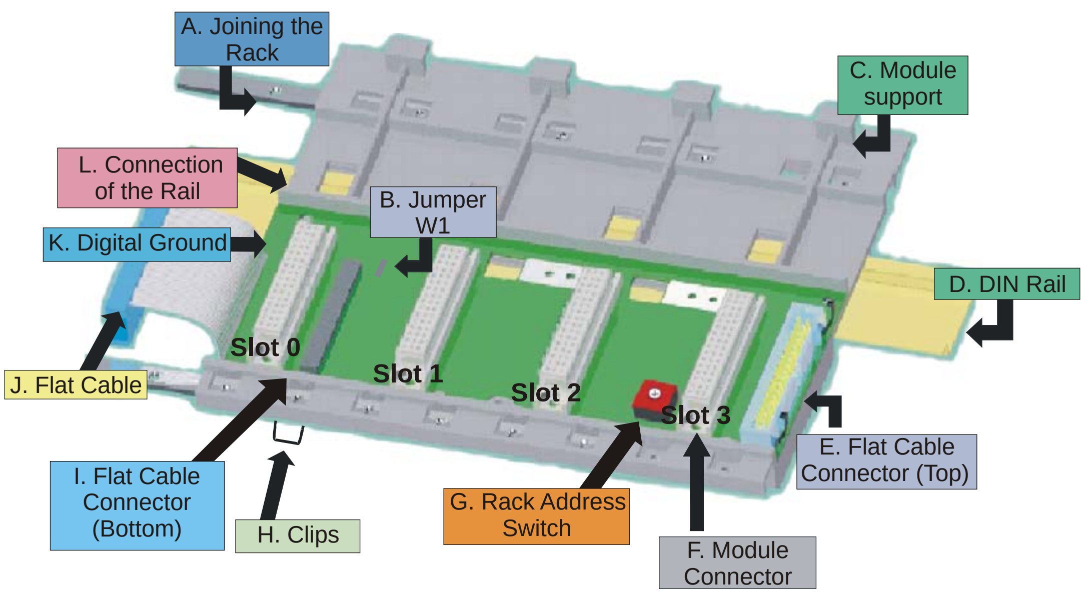


Figure 3. 23 - Rack – DF1A

- **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).

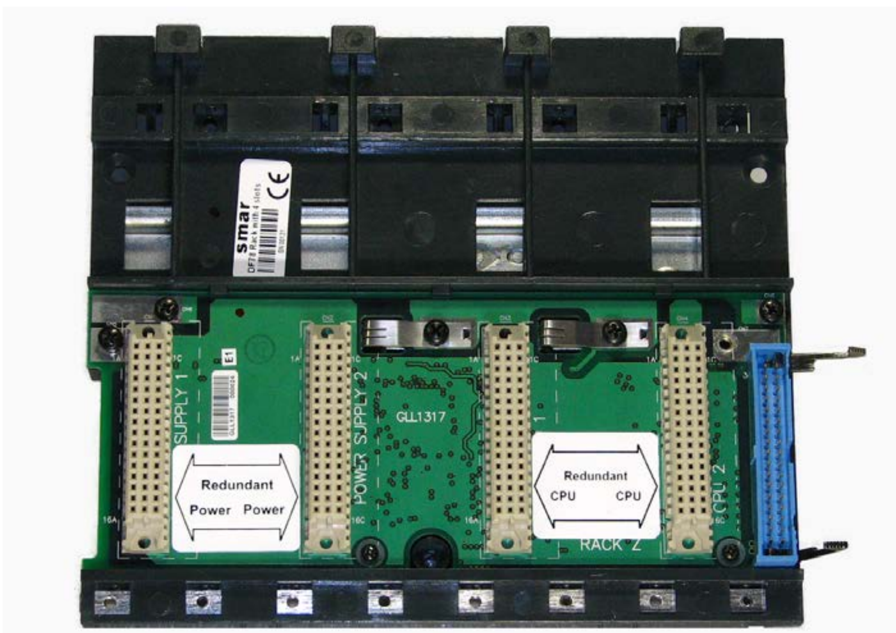


Figure 3. 24 - Rack – DF78

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 (TM302) 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

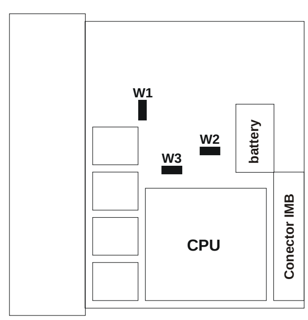
Terminals 1B and 2B of the TM302 can be used as Fault Indicators. These terminals are NC Relays. The NC Relay supports:

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

Usually the TM302 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 AuditTank (DF1A and DF78 Racks)

Although the rack 1A or DF78 of the **AuditTank** 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 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

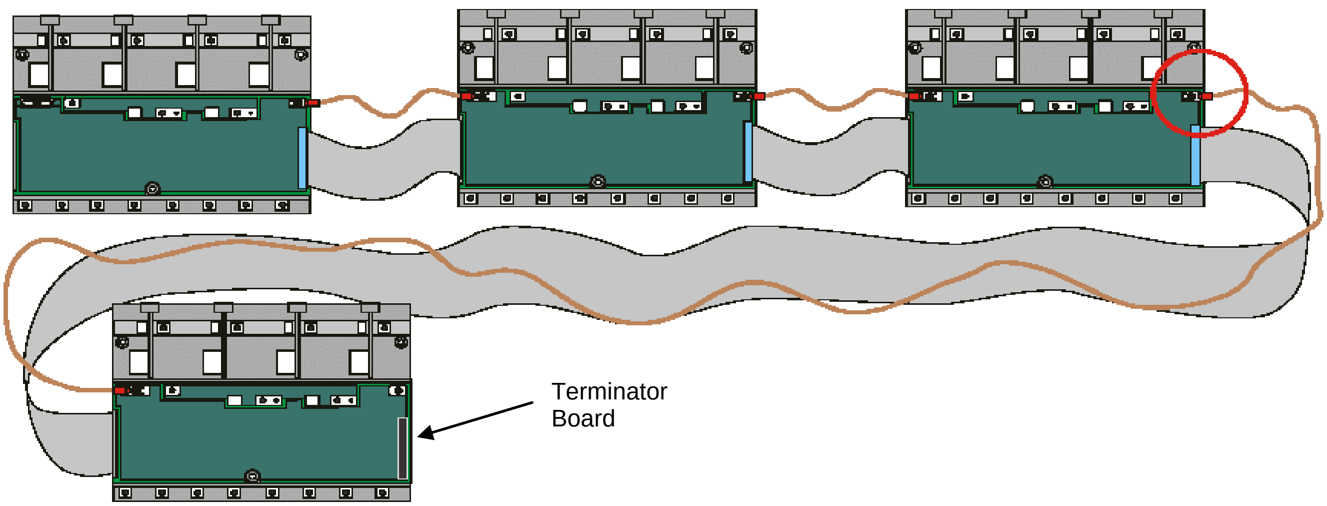


Figure 3. 25 – Improving the grounding signal

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

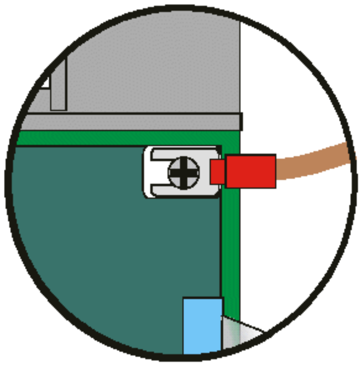


Figure 3. 26 - Connection Detail of the Grounding Signal Cable

Adjacent Racks

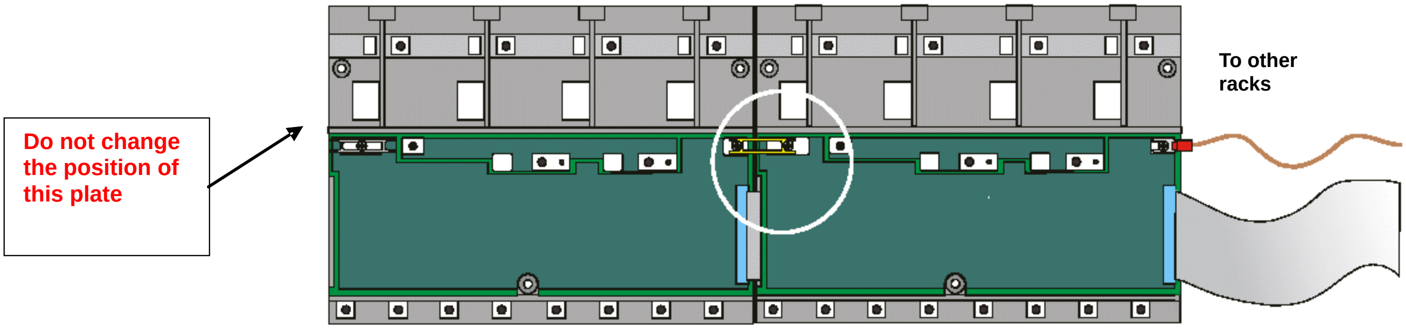
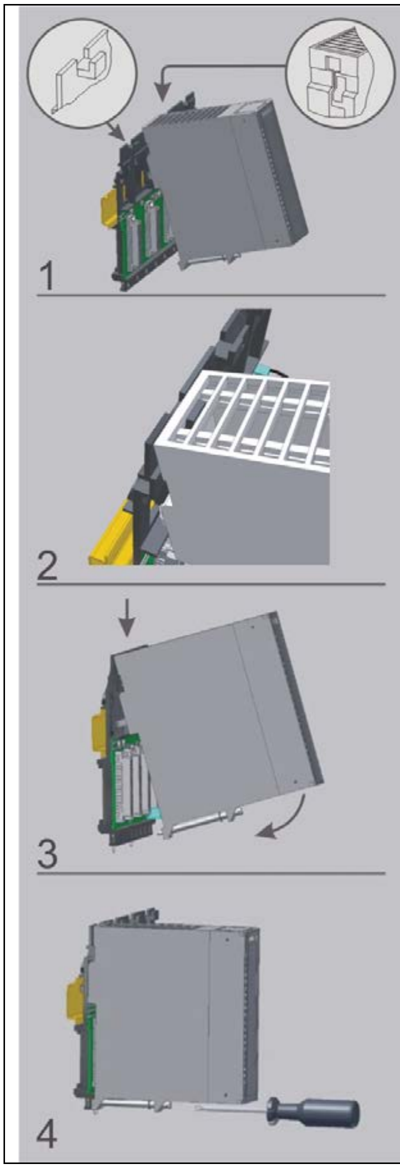


Figure 3. 27 - Connecting Adjacent Racks

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° inclination to the module support located on the upper part of the rack.
2	Mounting 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:

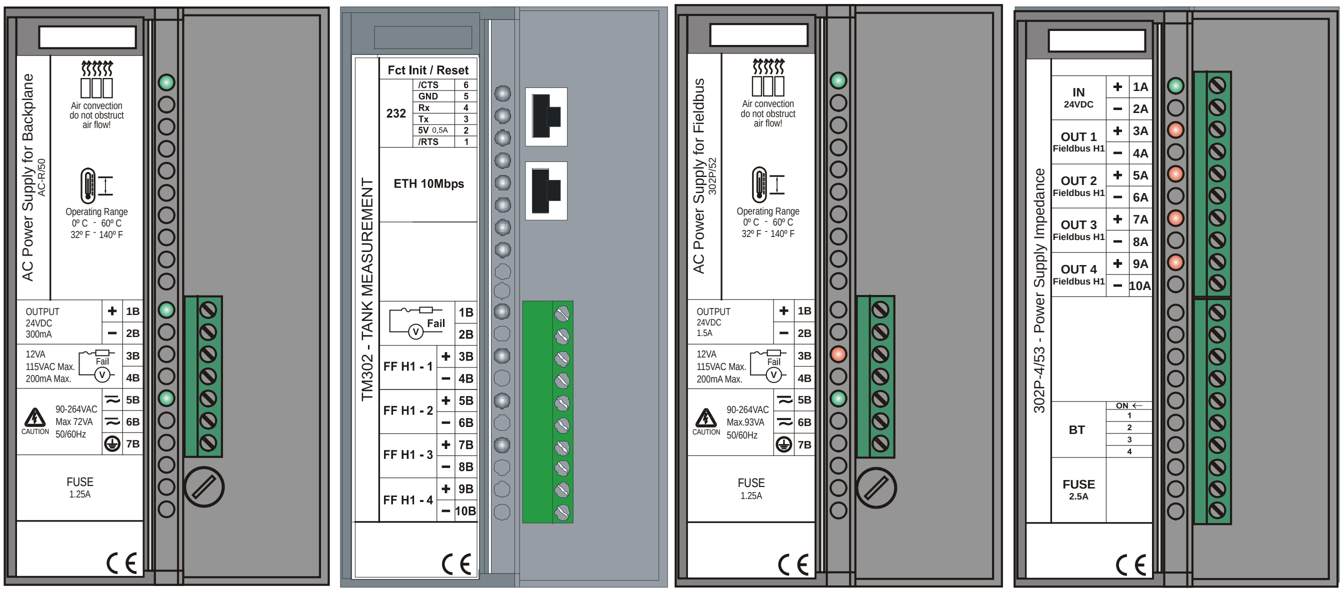


Figure 3. 29 - AuditTank Typical System (front view)

A shielded twisted-pair cable connects the TM302 to the hub. The TM302 uses RJ-45 connectors. The installation is simple and easy, and no specific tool or knowledge is required.

The LEDs of the TM302 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.

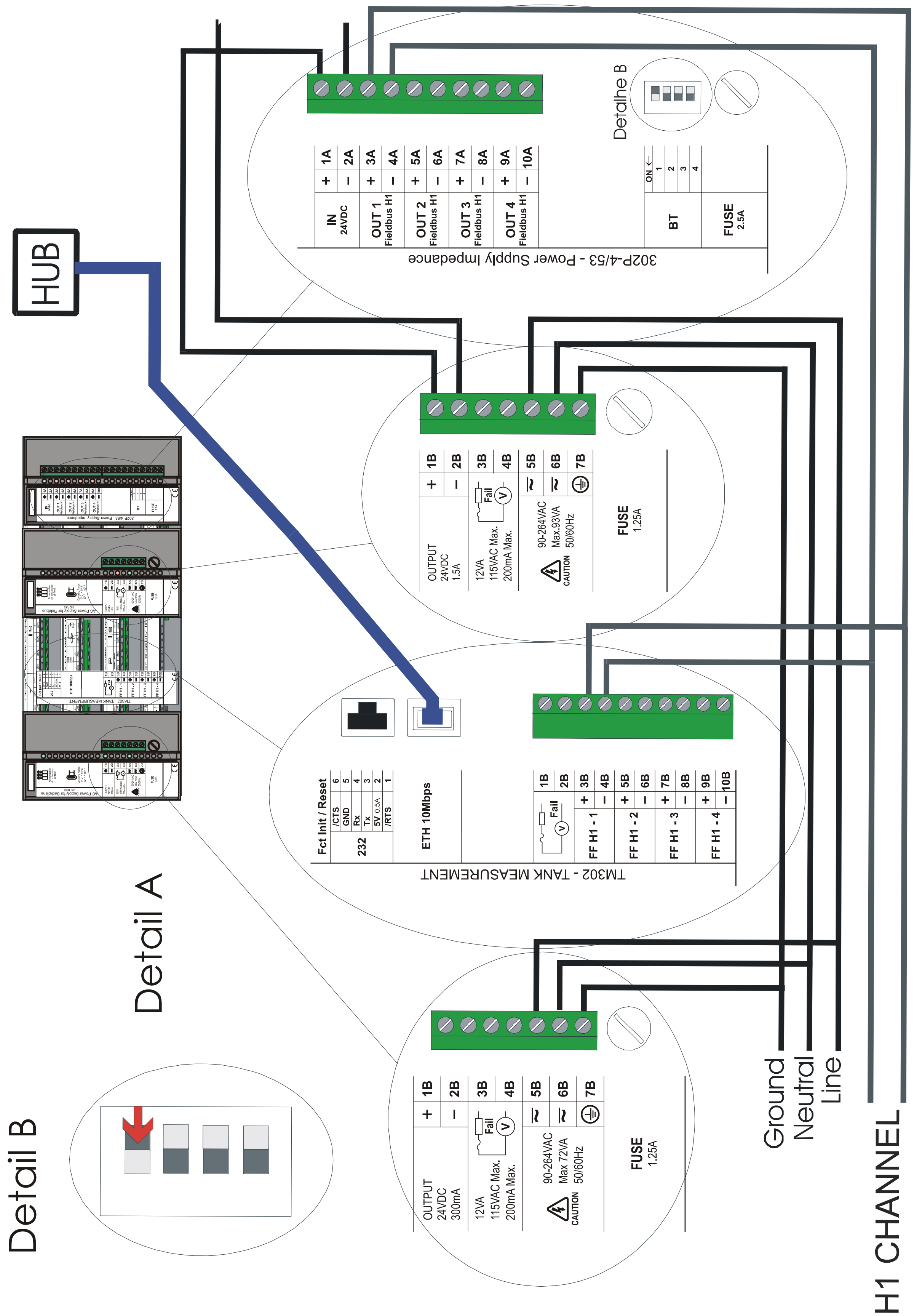
There are two types of connection cables: one for the TM302/HUB connection (DF54 cable) and other for the TM302/PC direct connection (DF55 cable). Refer to the Appendix of this Manual for further details.

The steps below describe the typical installation:

1. Connect the four modules (DF50, TM302, 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 theTM302 to the HUB;
5. Connect the Fieldbus H1 bus to the FF H1 ports of the TM302 and the DF53;
6. The TM302 automatically obtains the IP address from the DHCP Server, but if the server is not available, the TM302 will have an initial fixed IP address (this initial IP address can be configured using the FBTools application - see section Connecting the TM302 to the Subnet).

In the following figure, observe that:

- **Detail A** shows the electrical connections described above, without the rack view (Rack DF1A) and the terminator (DF2).
- **Detail B** shows the DIP switches that enable the internal terminator for each Fieldbus H1 channel. 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
302P-4/53 - Power Supply Impedance
TM302 - TANK MEASUREMENT
Fct Init / Reset
ETH 10Mbps
FUSE 2.5A
FUSE 1.25A
Ground
Neutral
Line
H1 CHANNEL

Dimensional Drawings of DF1A Rack and Modules

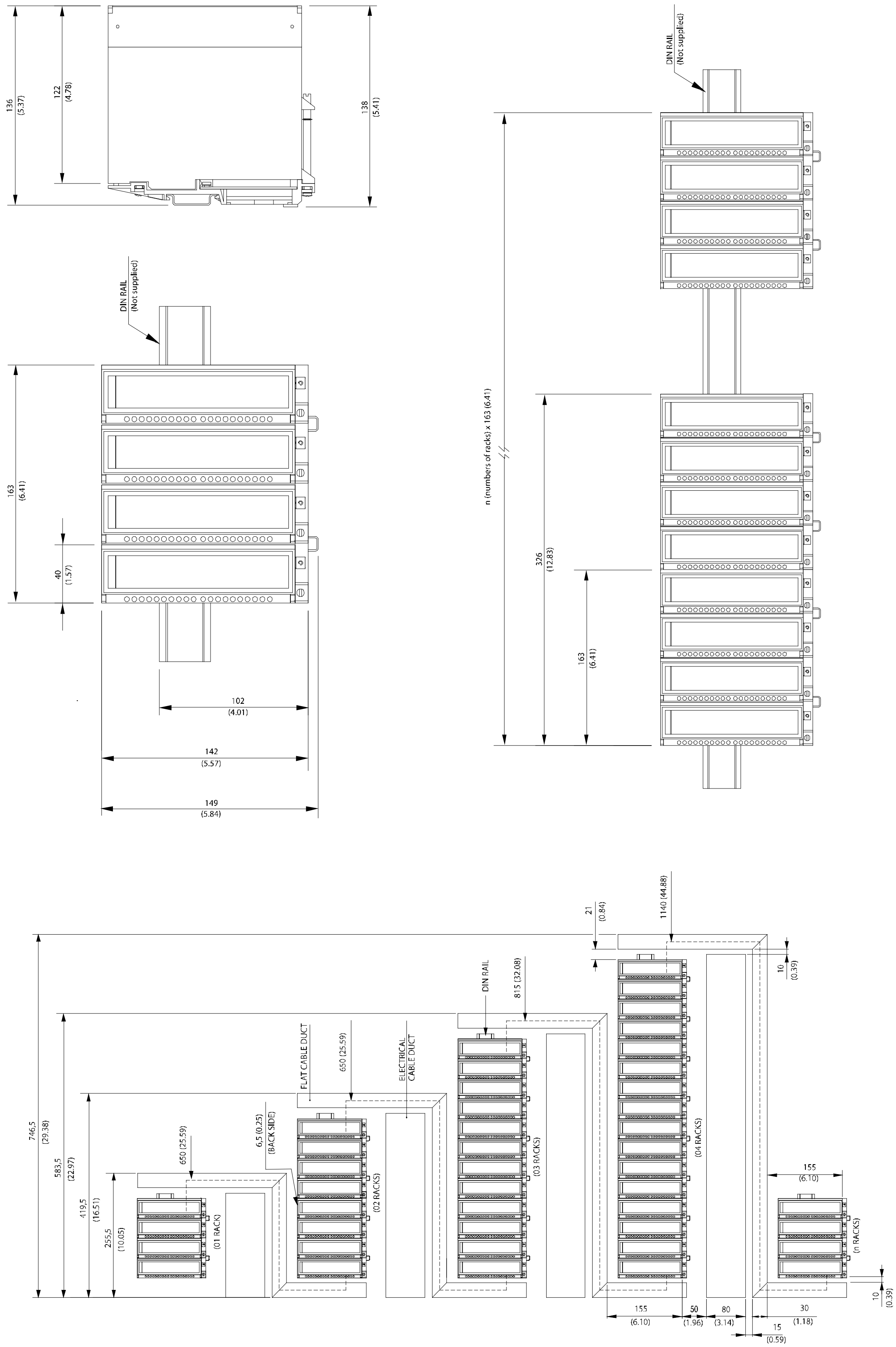
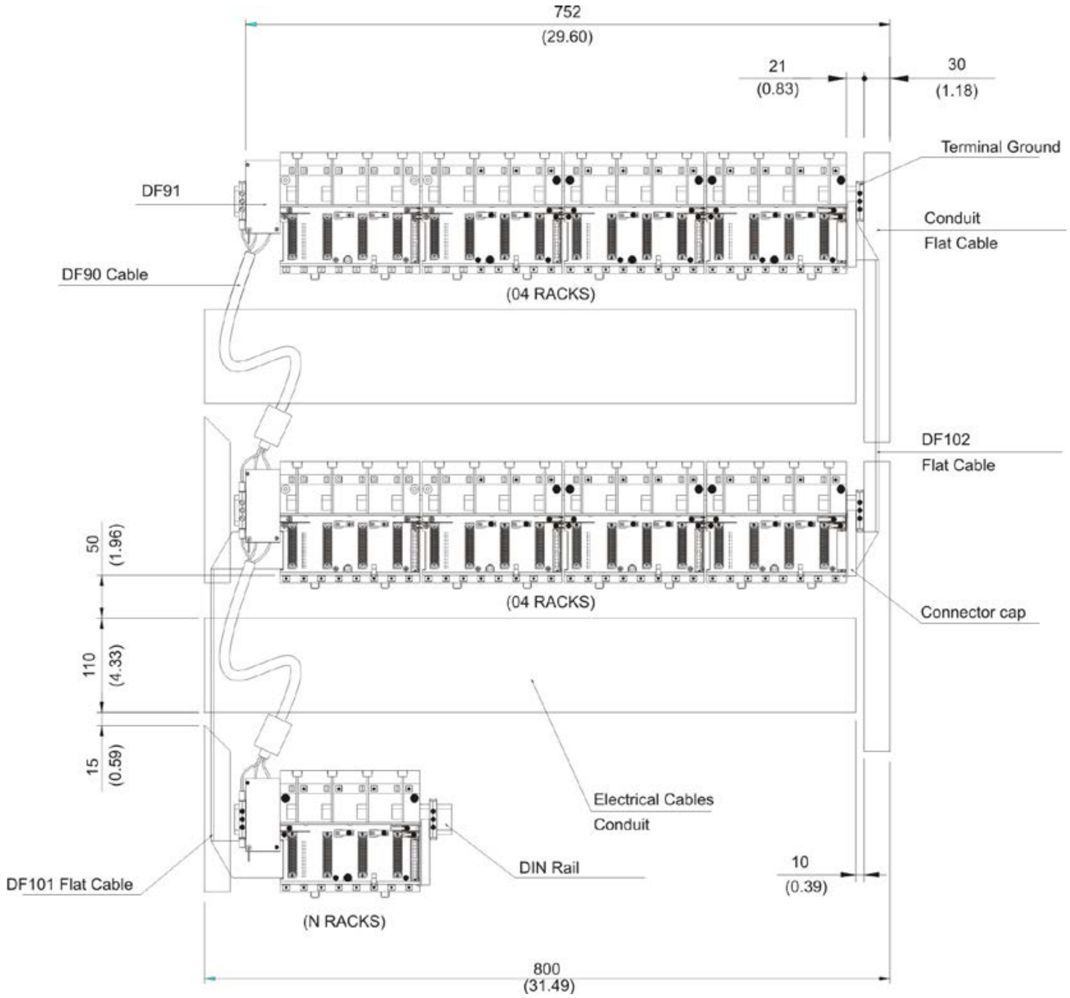
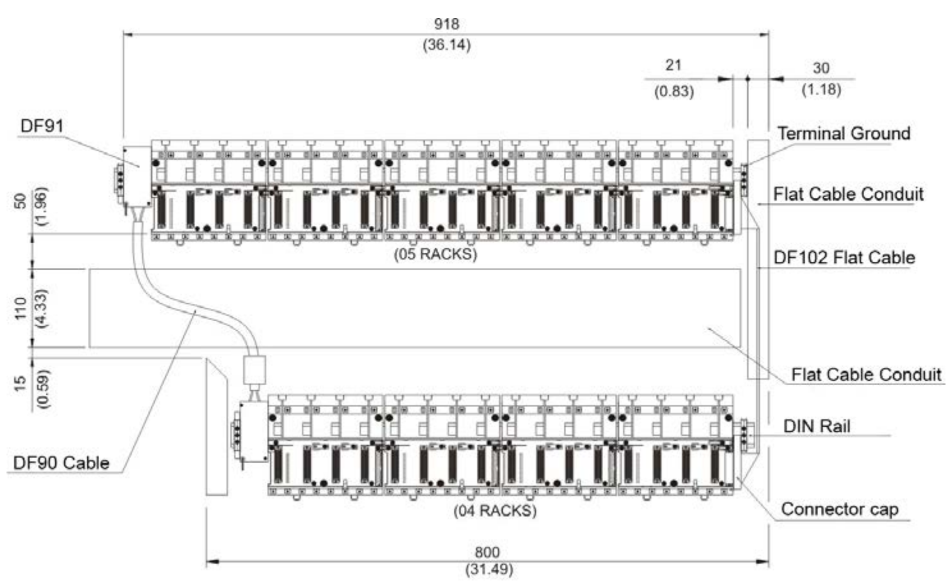


Figure 3. 30 – Dimensional Drawings

Dimensional Drawings of DF93 and Modules

The following figures show two possible combinations.





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 AuditTank 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.

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 (TM302) 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

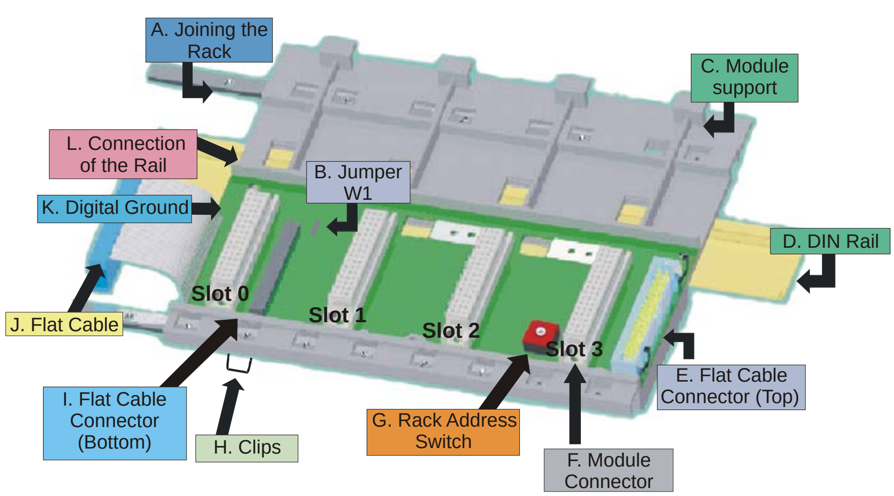


Figure 4. 1 – DF1A Rack

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 AuditTank 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.

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

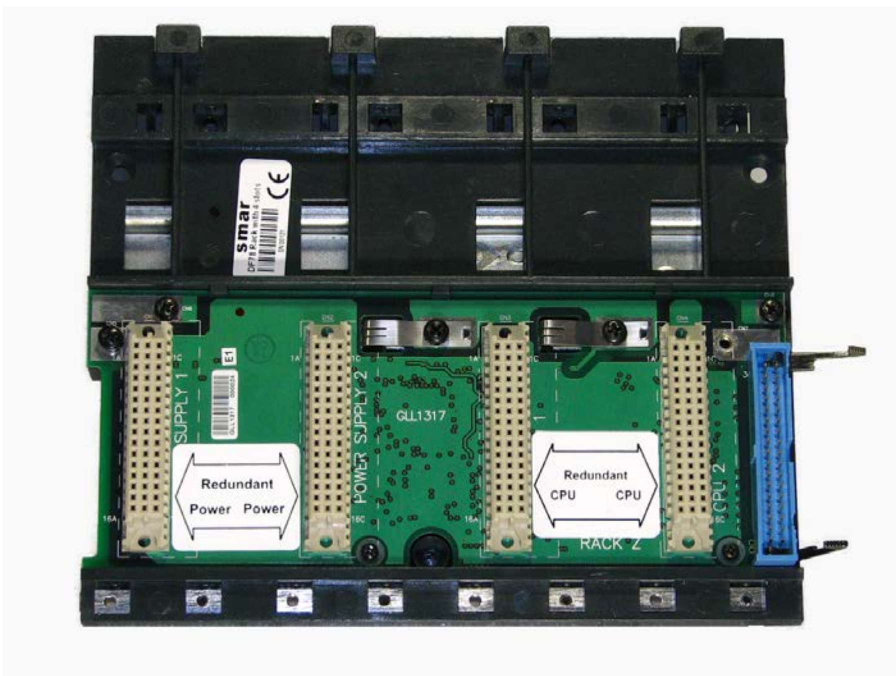


Figure 4. 2 – DF78 Rack

DF93 - Rack with 4 slots (with diagnostic)

Description

The DF93 rack is integral part of the new power system of AuditTank. 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 AuditTank 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 AuditTank 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.

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 (TM302) 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

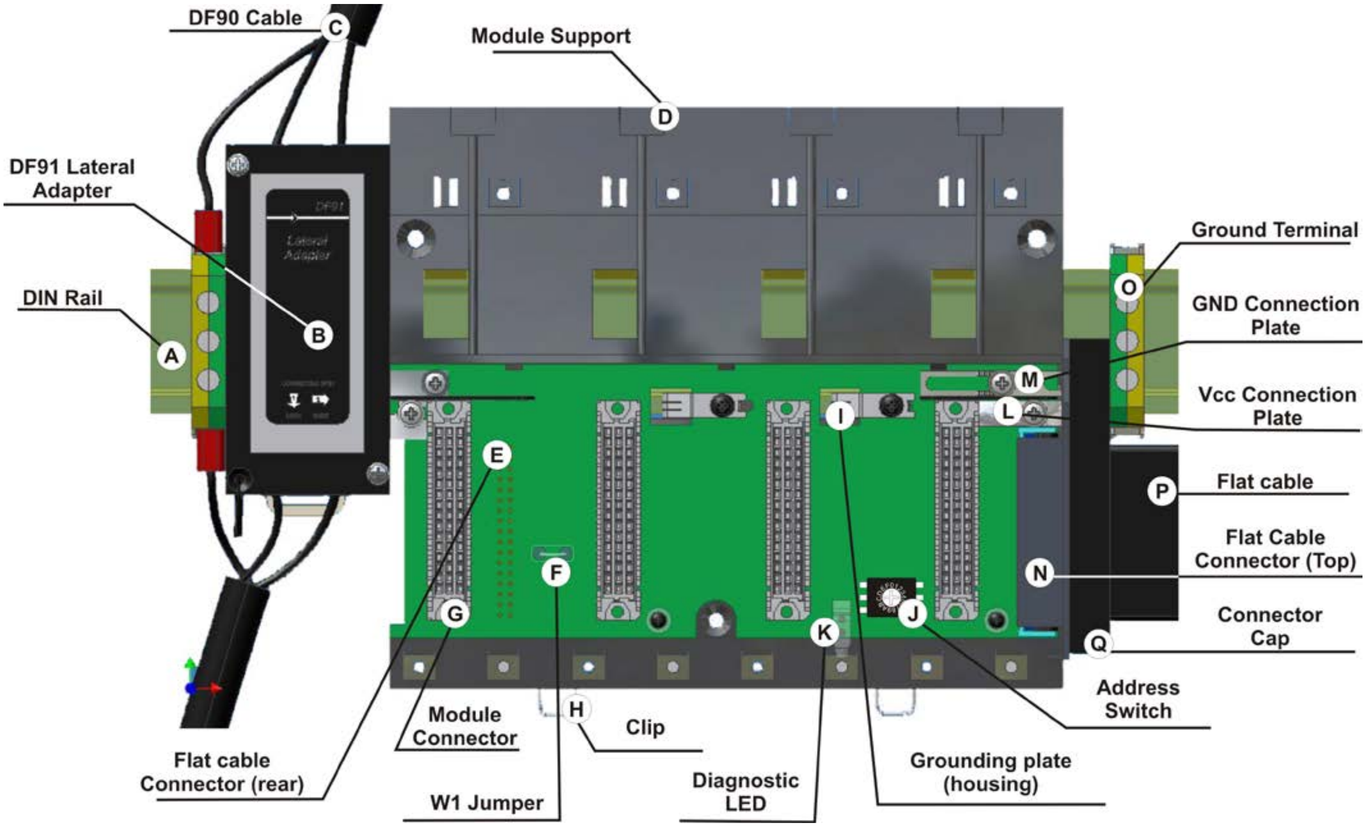


Figure 4. 3 – DF93 Rack

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 AuditTank 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.

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

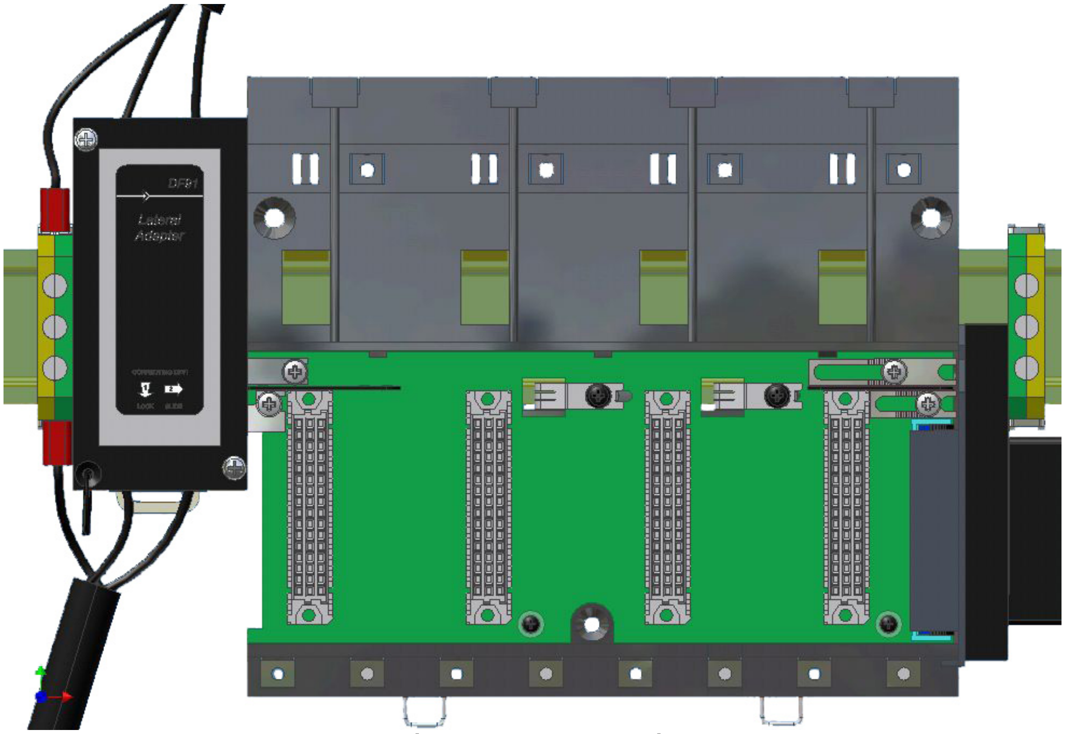


Figure 4. 4 – DF92 Rack

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 DF2 terminator.

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/O modules requires new calculations to the power supply.

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.

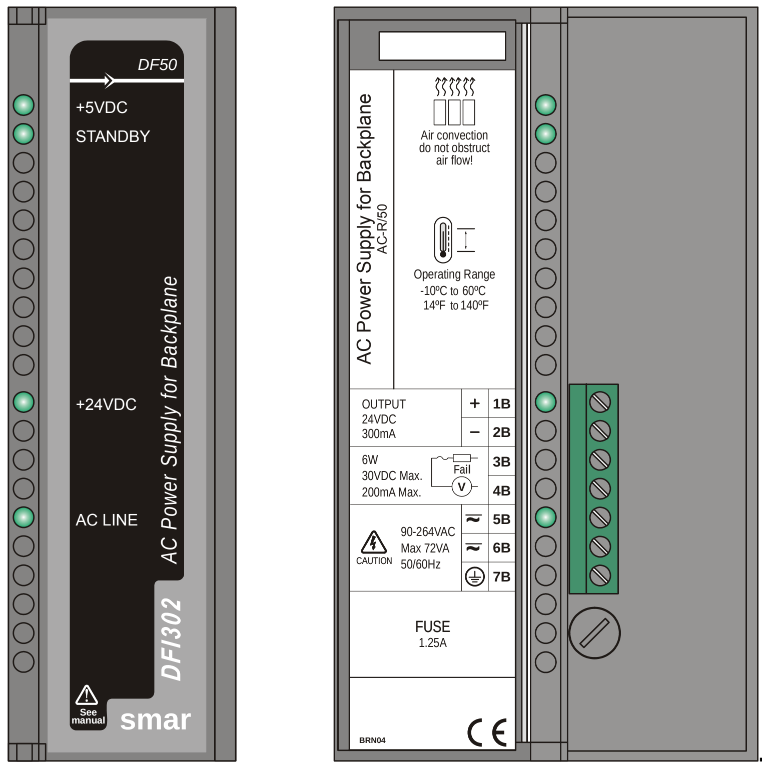


Figure 5. 1 - AC Power Supply Module: DF50

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 AuditTank 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”.

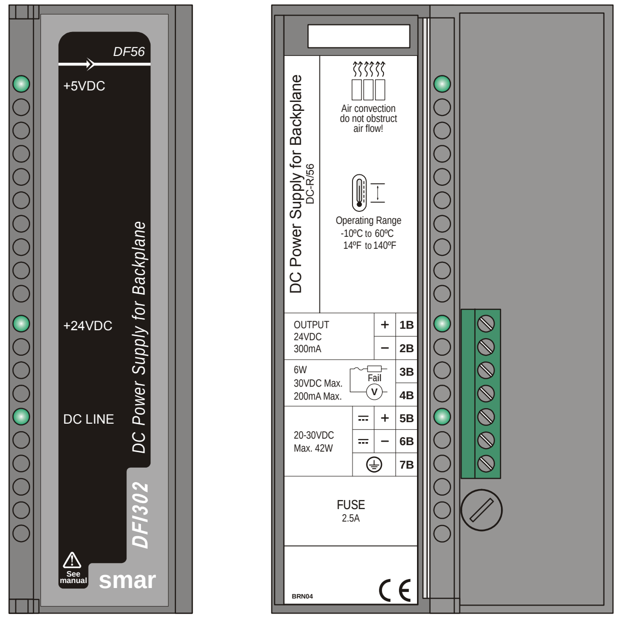


Figure 5.1 - DC Power Supply Module: DF56

Technical Specifications

INPUTS	
DC	20 to 30 Vdc
Inrush Current	< 20.6 A @ 30 Vdc [ΔT < 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 AuditTank 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 DFI302 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.

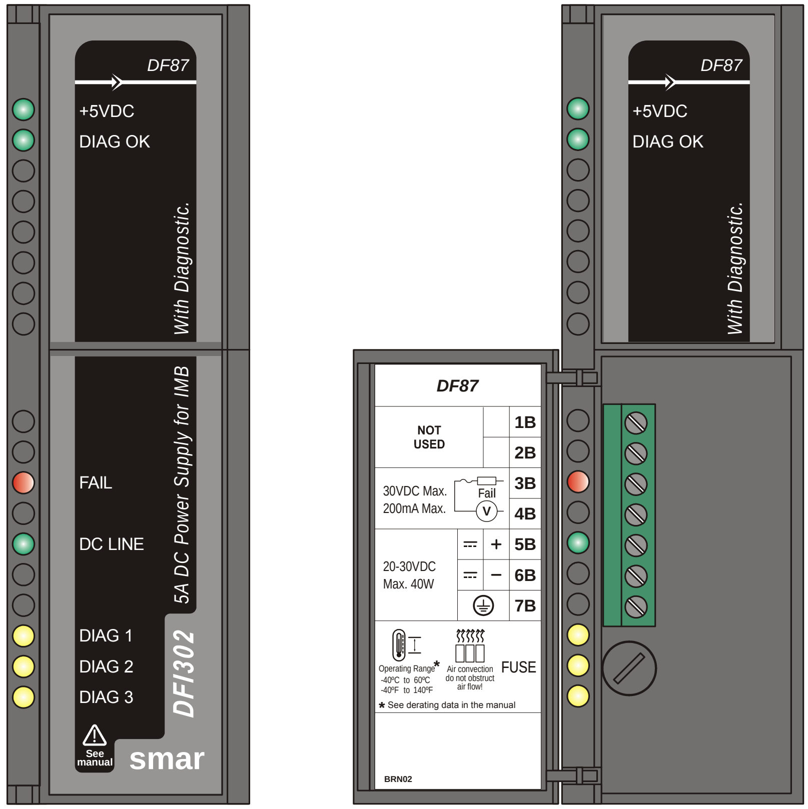


Figure 5.2 - DC Power Supply Module: DF87

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.

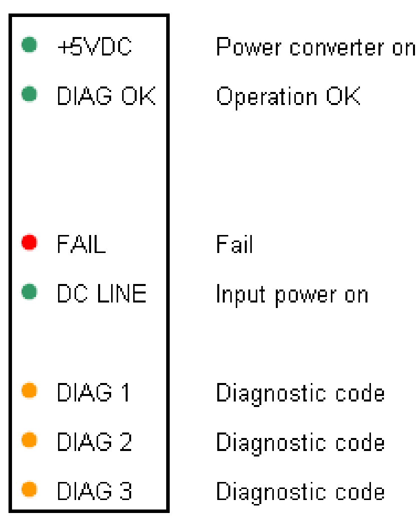


Figure 5.3 - DF87 frontal LEDs

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.

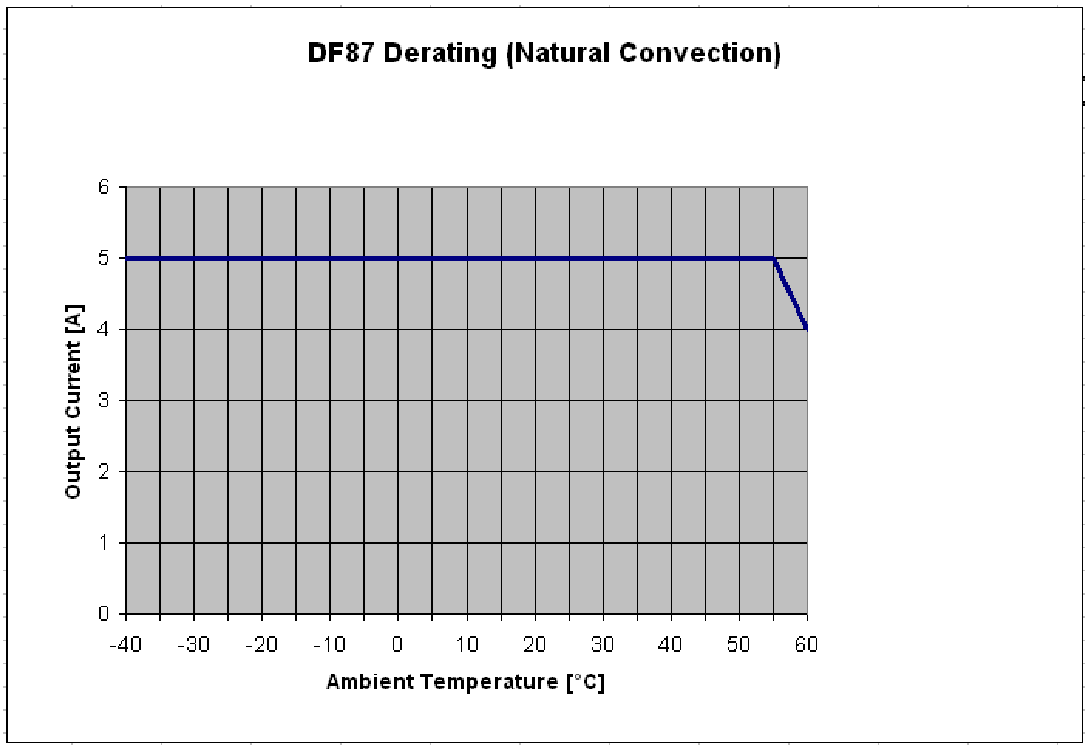


Figure 5.5 - Derating curve of the output current versus temperature, for environments without ventilation

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.

AuditTank 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**
TM302	Controller	1	0	950	0	950				
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.

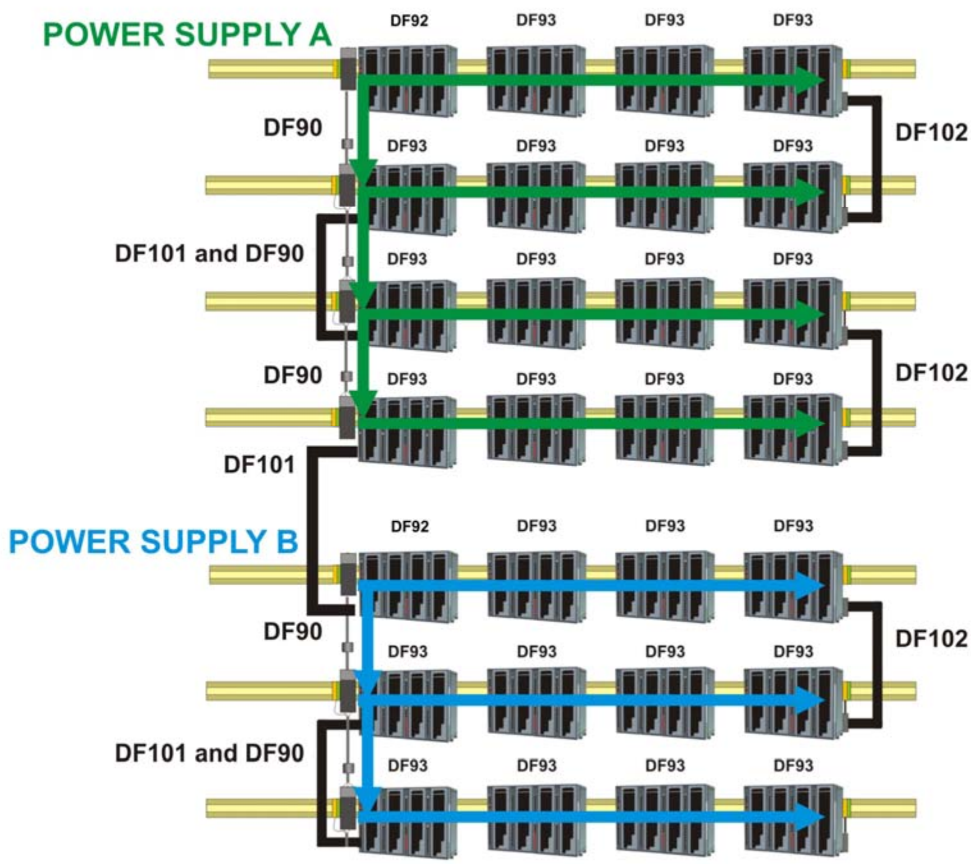


Figure 5.6 - System powered by two power supplies

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 **AuditTank** 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 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.

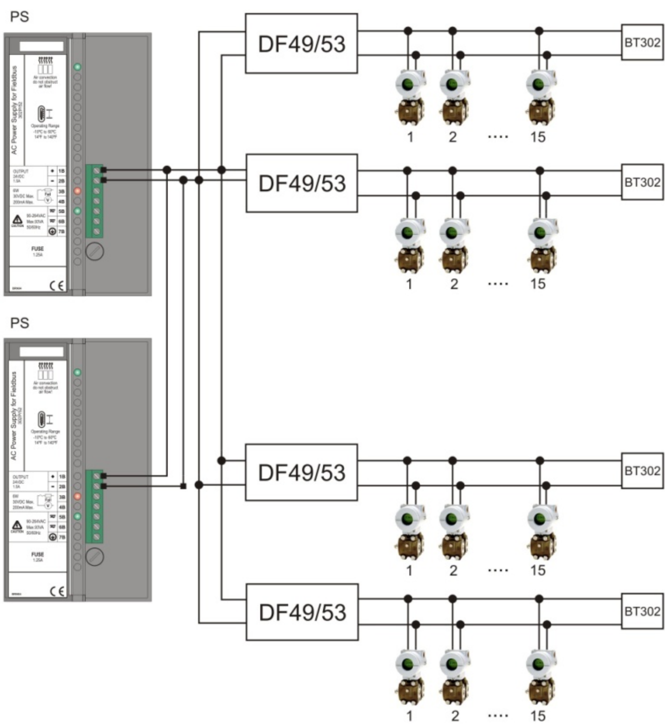


Figure 5.7- System powered by DF52

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

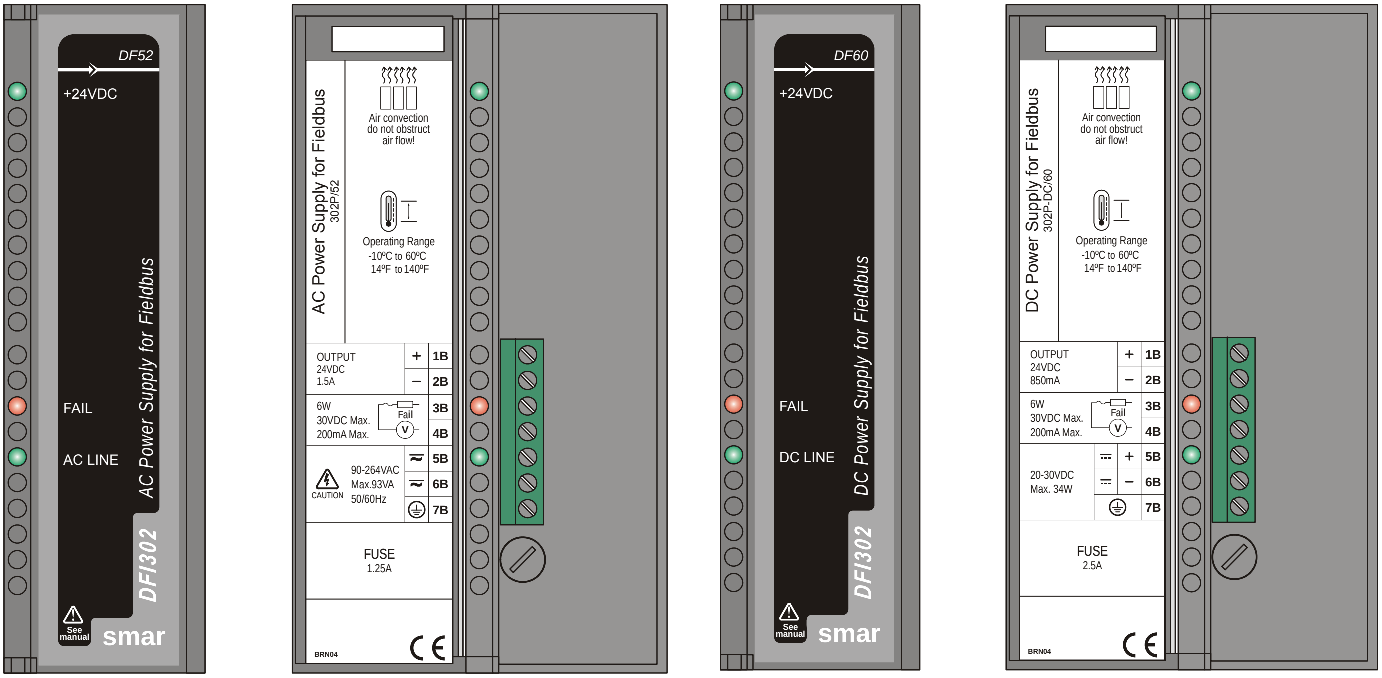


Figure 5.8 - Power Supply Module for Fieldbus: DF52/DF60

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 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.

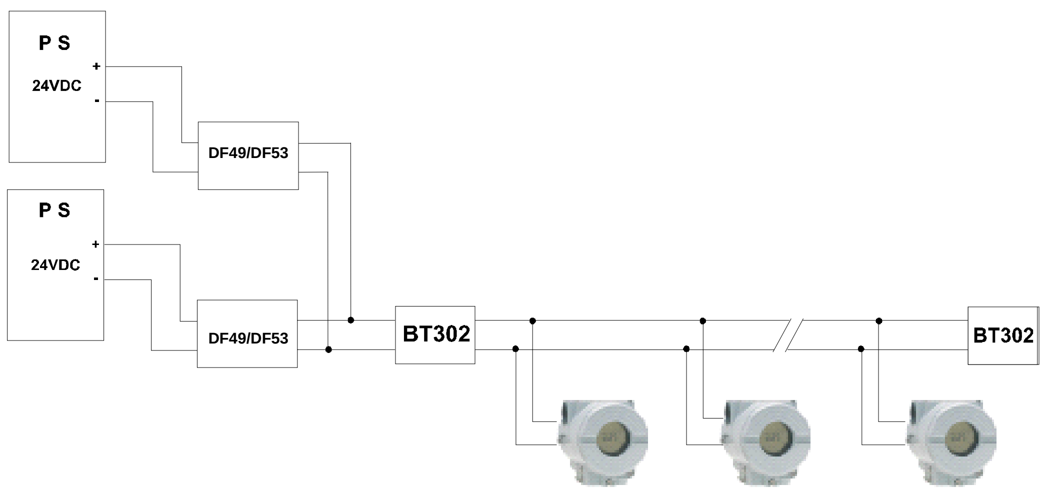


Figure 5.9 – System using the impedance DF49/DF53

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.

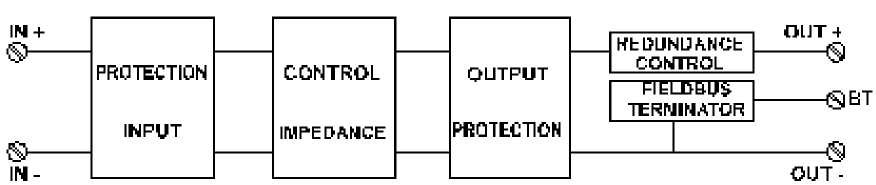


Figure 5.10 – System using the impedance DF49/DF53

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).

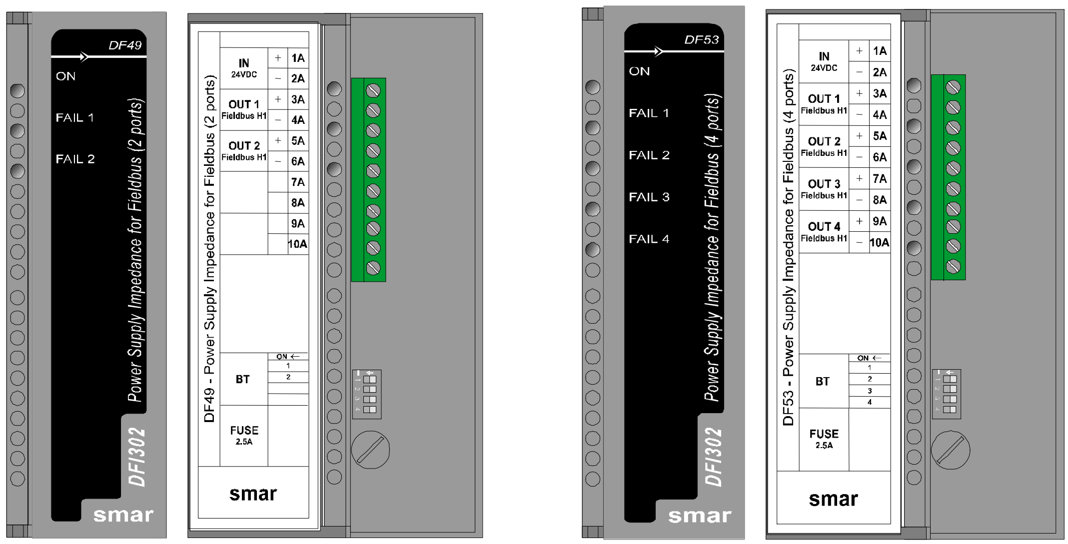


Figure 5.11 – Impedance for Fieldbus Modules: DF49/DF53

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.

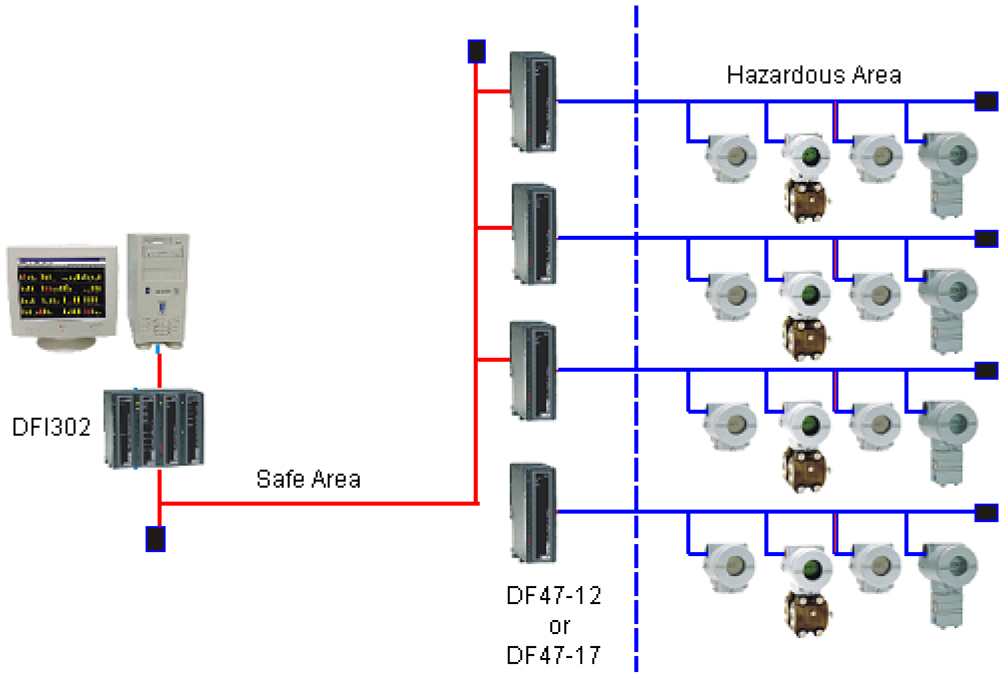


Figure 5.12 – DF47 installation

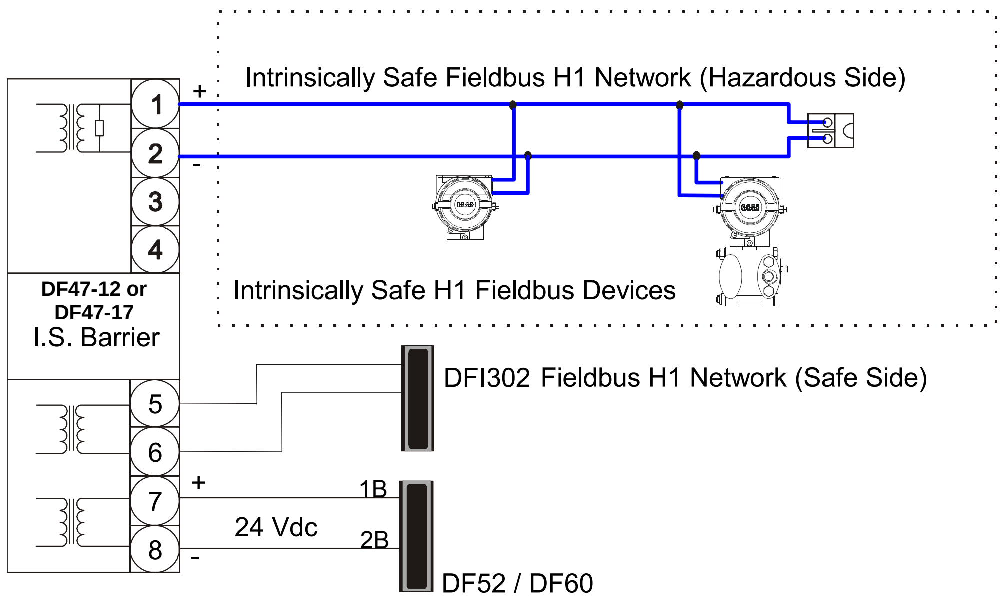


Figure 5.13 – DF47 installation

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 “Hazardous locations approvals”
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.

ENVIRONMENTAL CONDITIONS	
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.

Certification Information

Approved Manufacturing Locations
Smar Equipamentos Industriais Ltda – Sertãozinho, São Paulo, Brazil
Smar Research Corporation – Ronkonkoma, New York, USA

European Directive Information

This product complies with following European Directives:

EMC Directive (2004/108/EC) - Electromagnetic Compatibility
The equipment is in compliance with the directive and EMC test was performed according to IEC standards: IEC61326-1:2005 and IEC61326-2-3:2006. See table 2 from IEC61326-1:2005.
To comply with the EMC directive the installation must follow these special conditions:
- Use shielded, twisted-pair cable for powering the instrument and signal wiring.
- Keep the shield insulated at the instrument side, connecting the other one to the ground.

ATEX Directive (94/9/EC) - Electrical equipment and protective system intended for use in potential explosive atmospheres
The EC-Type Examination Certificate had been released by Nemko AS (CE0470) and/or DEKRA EXAM GmbH (CE0158), according to European Standards.
The certification body for Production Quality Assurance Notification (QAN) and IECEx Quality Assessment Report (QAR) is Nemko AS (CE0470).

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

Hazardous locations general information

Ex Standards:
IEC 60079-0 General Requirements
IEC 60079-11 Intrinsic Safety "i"
IEC 60079-27 Fieldbus intrinsically safe concept (FISCO)

Customer responsibility:
IEC 60079-10 Classification of Hazardous Areas
IEC 60079-14 Electrical installation design, selection and erection
IEC 60079-17 Electrical Installations, Inspections and Maintenance

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.

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

Marking Label
Once a device labeled with multiple approval types is installed, do not reinstall it using any other approval types. Scratch off or mark unused approval types on the approval label.

For Ex-i protection application
- Connect the instrument to a proper intrinsically safe barrier.
- Check the intrinsically safe parameters involving the barrier, equipment including the cable and connections.
- Associated apparatus ground bus shall be insulated from panels and mounting enclosures.
- When using shielded cable, isolate the not grounded cable end.
- Cable capacitance and inductance plus Ci and Li must be smaller than Co and Lo of the Associated Apparatus.

For FISCO System requirements (IEC 60079-27:2008)

FISCO Power Supplies

General
The power supply shall be resistive limited or have trapezoidal output characteristic. The maximum output voltage, Uo, shall be not greater than 17.5V nor less than 14V under the conditions specified in IEC60079-11 for the respective level of protection.

The maximum unprotected internal capacitance Ci and inductance Li shall be not greater than 5nF and 10µH, respectively.

The output of the power supply may be connected to earth.

No specification of the internal capacitance Ci and Li or the maximum external parameters Lo and Co is required on the certificate or label.

The determination of power supply output parameters shall into account the possible opening, shorting and grounding of field wiring connected to the field terminals of the apparatus.

Additional requirements of “ia” and “ib” FISCO power supplies
The maximum output current Io for any “ia” or “ib” FISCO power supply shall be determined in accordance with IEC60079-11 but shall not exceed 380 mA.

Table 1 – Assessment of maximum output current for use with “ia” and “ib” FISCO power supplies

Uo	Permissible current , for IIC (includes 1.5 safety factor)	Permissible current , for IIB (includes 1.5 safety factor)
14V	183 mA	380 mA
15V	133 mA	354 mA
16V	103 mA	288 mA
17V	81 mA	240 mA
17,5V	75 mA	213 mA
Note: The two largest current values for IIB are derived from 5.32W.		

Additional requirements of “ic” FISCO power supplies
The maximum output current Io for an “ic” FISCO power supply shall be determined in accordance with IEC60079-11.

Table 2 - Assessment of maximum output current for use with “ic” FISCO power supplies

Uo	Permissible current , for IIC (includes 1.5 safety factor)	Permissible current , for IIB (includes 1.5 safety factor)
14V	274 mA	570 mA
15V	199 mA	531 mA
16V	154 mA	432 mA
17V	121 mA	360 mA
17,5V	112 mA	319 mA

GENERAL NOTES

- 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:

    Resistance per unit length $15\ \Omega/km \leq R' \leq 150\ \Omega/km$
    Inductance per unit length $0.4\ mH/km \leq L' \leq 1 mH/km$
    Capacitance per unit length (including shield) $80\ nF/km \leq C' \leq 200\ nF/km$

    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

Hazardous Locations Approvals

FM Approvals (Factory Mutual)

DF47-12 FISCO Power Supply
Associated Intrinsic Safety (FM 3017363)
AIS Class I, Division 1, Groups A, B, C and D
AIS Class II, Division 1, Groups E, F and G
AIS Class III, Division 1
AIS Class I, Zone 0 [AEx ia], Group IIC

Special conditions for safe use:
Entity FISCO Trapezoidal Characteristic:
Terminals 1 and 2 Groups A/B IIC:
Voc (Uo)= 15.0 V, Isc (Io)= 140 mA, Iknee (Is)= 82 mA, Po= 1.2 W, Ca (Co)= 0.23 μF, La (Lo)= 0.15 mH
Terminals 1 and 2 Groups C IIB
Voc (Uo)= 15.0 V, Isc (Io)= 140 mA, Iknee (Is)= 82 mA, Po= 1.2 W, Ca (Co)= 0.75 μF, La (Lo)= 0.5 mH
Integral Terminator: R = 100 Ω, C = 1.0 μF, Ci = 0, Li= 0

Note: The Fieldbus Isolated Barrier shall be installed in compliance with the enclosure, mounting, spacing and segregation requirements of the ultimate application, including a tool removable cover.

Ambient Temperature: -20ºC ≤ Ta ≤ + 60ºC

DF47-17 FISCO Power Supply
Associated Intrinsic Safety (FM 3017363)
AIS Class I, Division 1, Groups A, B, C and D
AIS Class II, Division 1, Groups E, F and G
AIS Class III, Division 1
AIS Class I, Zone 0 [AEx ia], Group IIC

Special conditions for safe use:
Entity FISCO Trapezoidal Characteristic:
Terminals 1 and 2 Groups A/B IIC:
Voc (Uo)= 15.0 V, Isc (Io)= 197 mA, Iknee (Is)= 115 mA, Po= 1.72 W, Ca (Co)= 0.21 μF, La (Lo)= 0.15 mH
Terminals 1 and 2 Groups C IIB
Voc (Uo)= 15.0 V, Isc (Io)= 197 mA, Iknee (Is)= 115 mA, Po= 1.72 W, Ca (Co)= 0.7 μF, La (Lo)= 0.5 mH
Integral Terminator: R = 100 Ω, C = 1.0 μF, Ci = 0, Li= 0

Note: The Fieldbus Isolated Barrier shall be installed in compliance with the enclosure, mounting, spacing and segregation requirements of the ultimate application, including a tool removable cover.

Ambient Temperature: -20ºC ≤ Ta ≤ + 60ºC

EXAM (BBG Prüf - und Zertifizier GmbH)

Non Intrinsically safe circuits Parameters:
Power Supply Un = 24 Vdc, Um = 250 Vac, Pn = 3 W
Fieldbus signal circuits Um = 250 Vac

DF47-12 FISCO Power Supply
Associated Intrinsic Safety (BVS 03ATEX E 411X)
Group II, Category (1) G, [Ex ia, EPL Ga], Groups IIB/ IIC FISCO Power Supply
Group I, Category (M2) [Ex ia, EPL Mb], Group I

Intrinsically safe fieldbus supply and signal circuit (FISCO-Model):
Safety parameters:
Uo = 15.0 Vdc, Io = 140.12 mA, Is = 80 mA, Po = 1200 mW, Ri ≥ 247.5 Ω,
Characteristics trapezoidal

Special conditions for safe use
The Fieldbus-Isolated Barrier type DF47 -** shall be installed outside the hazardous area.
Wiring in the terminal box must satisfy the conditions of clause 6.3.11 and clause 7.6.e of EN60079-11:2007
Terminals or connectors for the intrinsically safe fieldbus supply and signal circuit circuits shall be arranged according to clause 6.21 or 6.2.2 of EN 60079-11:2007 respectively.

Local installation rules to determine Lo and Co are replaced by apparatus- and cable-parameters in clause 15.3.2.
For Group I application interconnection of fieldbus-apparatus to an intrinsically safe electrical system shall be assessed in a System Certificate, if required in local installation rules.
Ambient Temperature: -20ºC ≤ Ta ≤ + 60ºC

The Essential Health and Safety Requirements are assured by compliance with:

EN 60079-0:2009 General Requirements
EN 60079-11:2007 Intrinsic Safety "i"
EN 60079-26:2007 Equipment with equipment protection level (EPL) Ga
EN 60079-27:2008 Fieldbus intrinsically safe concept (FISCO)

DF47-17 FISCO Power Supply
Associated Intrinsic Safety (BVS 03ATEX E 411X)
Group II, Category (1) G, [Ex ia, EPL Ga], Groups IIB/ IIC FISCO Power Supply
Group I, Category (M2) [Ex ia, EPL Mb] Group I

Intrinsically safe fieldbus supply and signal circuit (FISCO-Model):
Safety parameters:
Uo = 15.0 Vdc, Io = 197 mA, Is = 115 mA, Po = 1720 mW, Ri ≥ 176.22 Ω,
Characteristics trapezoidal

Special conditions for safe use
The Fieldbus-Isolated Barrier type DF47 -** shall be installed outside the hazardous area.
Wiring in the terminal box must satisfy the conditions of clause 6.3.11 and clause 7.6.e of EN60079-11:2007
Terminals or connectors for the intrinsically safe fieldbus supply and signal circuit circuits shall be arranged according to clause 6.21 or 6.2.2 of EN 60079-11:2007 respectively.
Local installation rules to determine Lo and Co are replaced by apparatus- and cable-parameters in clause 15.3.2.
For Group I application interconnection of fieldbus-apparatus to an intrinsically safe electrical system shall be assessed in a System Certificate, if required in local installation rules.
Ambient Temperature: -20ºC ≤ Ta ≤ + 60ºC

The Essential Health and Safety Requirements are assured by compliance with:

EN 60079-0:2009 General Requirements
EN 60079-11:2007 Intrinsic Safety "i"
EN 60079-26:2007 Equipment with equipment protection level (EPL) Ga
EN 60079-27:2008 Fieldbus intrinsically safe concept (FISCO)

CEPEL (Centro de Pesquisa de Energia Elétrica)

Non Intrinsically safe circuits parameters:
Power Supply Un = 24 Vdc, Pn = 3 W

DF47-12 FISCO Power Supply
Associated Intrinsic Safety (CEPEL 06.1095 X)
[Ex ia, EPL Ga], Group IIB

Nominal values of the terminals Intrinsically safe (FISCO-Model):
Un = 14.0 V, In = 75 mA, Pn = 1200 mW

Safety parameters:
Um = 250 V, Uo = 15 V, Io = 140.12 mA, Is = 80 mA, Po = 1200 mW, Ri ≥ 247.5 Ω

Ambient Temperature: -20 to 60 ºC

Special conditions for safe use
The certificate number with "X" indicates that:
a) The equipment was projected to connect with a fieldbus system according to FISCO model, as IEC60079-27:2008. The Fieldbus intrinsic safety device connected to the fieldbus terminator must be current passive consumer (not generator) and must display Ci ≤ 5 nF and Li ≤ 10 µH;
b) Wiring in the terminal box must satisfy the conditions:

Resistance: 15 Ω/km ≤ Rc ≤ 1500/km
Capacitance (including loop): 45 nF/km ≤ Cc ≤ 200 nF/km
Inductance: 0,4 mH/km ≤ Lc ≤ 1mH/km

c) The maximum length allowed for Fieldbus cables is 1000 m for Group IIC and 5000m for Group IIB

The Essential Health and Safety Requirements are assured by compliance with:
ABNT NBR IEC 60079-0:2008 General Requirements
ABNT NBR IEC 60079-11:2009 Intrinsic Safety "i"
ABNT NBR IEC 60079-26:2008 Equipment with equipment protection level (EPL) Ga
IEC 60079-27:2008 Fieldbus intrinsically safe concept (FISCO)

DF47-17 FISCO Power Supply
Associated Intrinsic Safety (CEPEL 06.1095 X)
[Ex ia, EPL Ga], Group IIB

Nominal values of the terminals Intrinsically safe (FISCO-Model):
Un = 14.0 V, In = 110 mA, Pn = 1700 mW

Safety parameters:
Um = 250 V, Uo = 15 V, Io = 197 mA, Is = 115 mA, Po = 1720 mW, Ri ≥ 176,22 Ω

Ambient Temperature: -20 to 60 ºC

Special conditions for safe use
The certificate number with "X" indicates that:

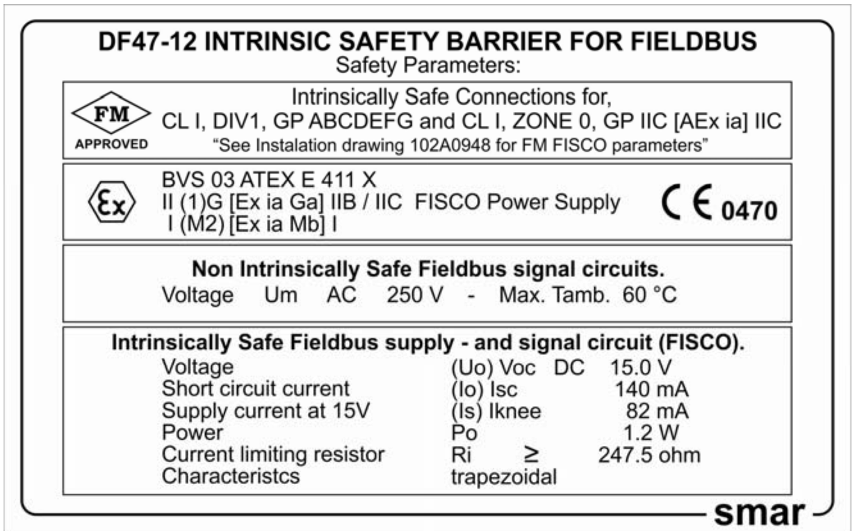
a) The equipment was projected to connect with a Fieldbus System according to FISCO model, as IEC60079-27:2008. The Fieldbus intrinsic safety device connected to the Fieldbus terminator must be current passive consumer (not generator) and must display Ci ≤ 5 nF and Li ≤ 10 μH;
b) Wiring in the terminal box must satisfy the conditions:
   Resistance: 15 Ω/km ≤ Rc ≤ 1500/km
   Capacitance (including loop): 45 nF/km ≤ Cc ≤ 200 nF/km
   Inductance: 0,4 mH/km ≤ Lc ≤ 1mH/km
c) The maximum length allowed for Fieldbus cables is 1000 m for Group IIC and 5000m for Group IIB

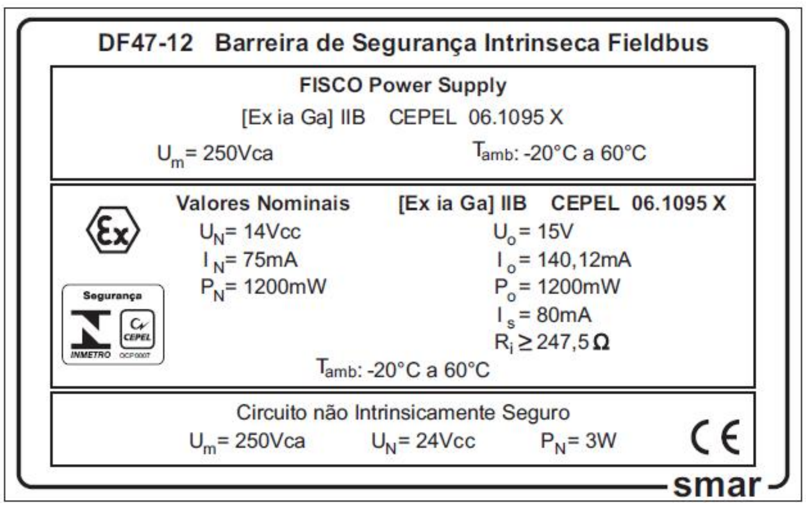
The Essential Health and Safety Requirements are assured by compliance with:
ABNT NBR IEC 60079-0:2008 General Requirements
ABNT NBR IEC 60079-11:2009 Intrinsic Safety "i"
ABNT NBR IEC 60079-26:2008 Equipment with equipment protection level (EPL) Ga
IEC 60079-27:2008 Fieldbus intrinsically safe concept (FISCO)

Identification labels and control drawings

DF47-12 – Intrinsic Safety Barrier for Fieldbus

Labels





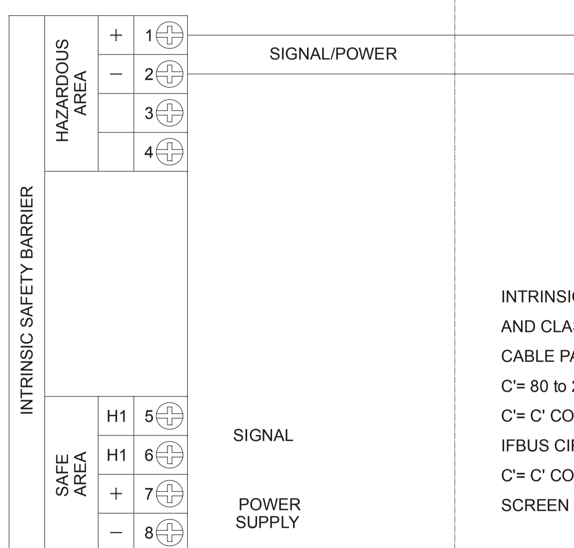
NON-HAZARDOUS LOCATION

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	

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.

REV	BY	APPROVAL	DOC
	/ /	/ /	
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

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

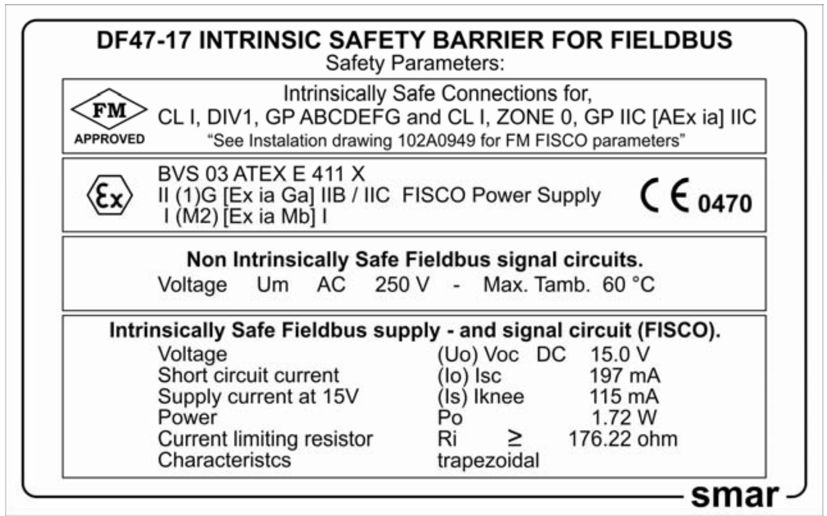
NUMBER 102A0948 REV 02

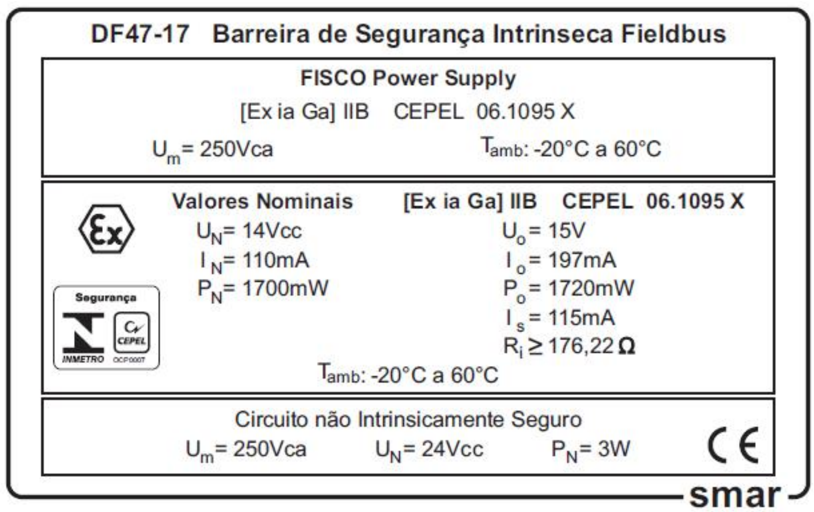
SCALE

SHEET 01/01

DF47-17 – Intrinsic Safety Barrier for Fieldbus

Labels





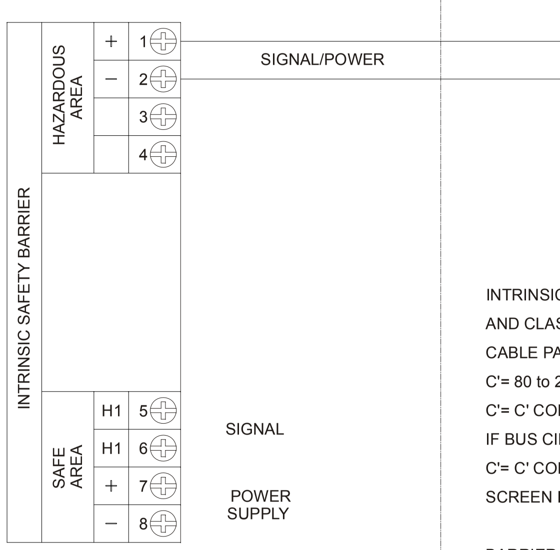
NON-HAZARDOUS LOCATION

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 V AC/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	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

APPROVAL CONTROLLED BY C.A.R.

REV	BY	APPROVAL	DOC
	/ /	/ /	
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

DRAWN	CHECKED	PROJECT	APPROVAL
MOACIR 03 / 02 / 03	SINASTRE 03 / 02 / 03	BASÍLIO 03 / 02 / 03	DÉLCIO 03 / 02 / 03

EQUIPMENT: DF47-17

CONTROL DRAWING

FM APPROVED

smar

NUMBER 102A0949 REV 02

SCALE

SHEET 01/01

Chapter 6

ADDING INTERFACES

Introduction

There are several interface modules available for **AuditTank** that provide a wide connectivity to different media used in the Automation and Process Control Industry.

In applications that connect Modbus RTU to **AuditTank**, and require more than one Modbus device in the same Modbus network, it is necessary the use of RS-232/RS-485 module interface to provide a multipoint communication.

In the cases where only one Modbus device is used, and the distance between both devices are longer than 15 meters, the RS-232/RS-485 module interface is also necessary.

Originally, the **TM302** (controller) were designed to be connected to the Ethernet 10 Mbps port. In order to connect it in an Ethernet 100 Mbps Local Area Network, add the Ethernet Switch 10/100 Mbps module.

The following table shows the available Interface module types.

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

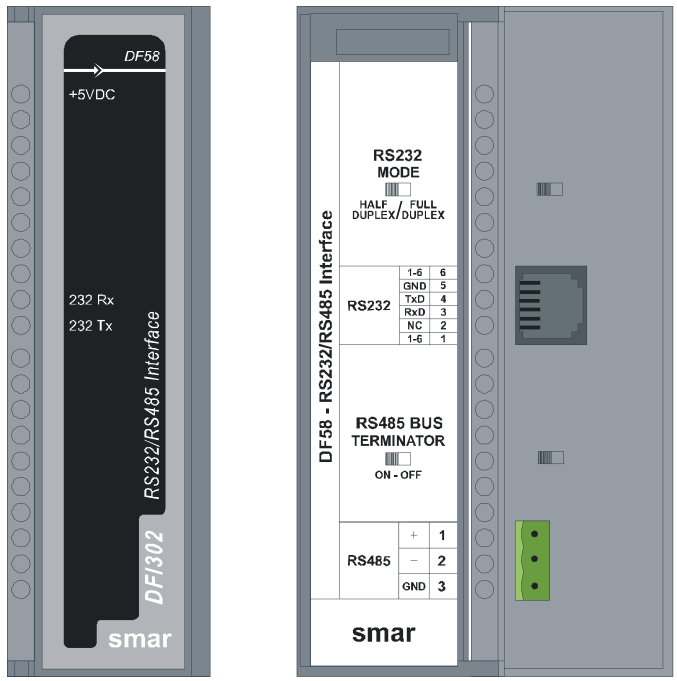
The specifications for each module are shown is the next pages.

DF58 –RS232/RS485 Interface

Description

This module converts the electrical characteristics of the communication signal from the RS-232 to RS-485 specifications. Due to the different purposes of use between RS-232 and RS-485, where the first one is proper to peer-to-peer applications, this module was implemented to work automatically.

No control signal is necessary to control the RS-485 bus. Simply connect the transmission and reception lines on the both sides to have the interface operational.



RS232/RS485 Interface Module: DF58

The converter circuit isolates the signal to guarantee a safe connection between both systems. This module was designed to be use with AuditTank /DFI302/LC700 platforms and, no power supply was embedded in the board. It uses the +5 Vdc voltage from the rack to energize the circuit.

Interface Settings
There are two interfaces settings located on the front panel to adapt the interface to the applications: RS-232 Mode and RS-485 Bus Terminator.

RS232 Mode: Half-Duplex/Full-Duplex
The RS-232 Mode setting adapts the use of RS-232/RS-485 Interface to the communication driver RS-232. Usually, these interfaces connect unidirectional buses with bidirectional buses. The unidirectional bus can contain Full-Duplex features caused by echoes of the transmitted message.

If the driver does not support the reception/transmission simultaneously, because the reception disables or discards the reflected message, select the **Half-Duplex** option. If the reflected message does not disturb the applications, select the **Full-Duplex** option.

RS485 Bus Terminator: On/Off
The RS-485 is a multidrop bus. The transmitter driver is set to high impedance (Hi-Z) state when there is no message to be transmitted. However, the RS-485 bus requires a bus terminator in order to avoid noise problems during the idle time of the RS-485. A perfect line impedance match is necessary to activate only one terminator by bus. The other terminators must be deactivated.

Connectors

Two connectors are available on the front panel to interconnect two communication systems: RJ-12 type connector, used in RS-232 systems; and a terminal block type connector, used in RS-485 systems.

RJ12 Pin Assignment

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 signal ground
6	Connected to pin 1

Note

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

Block Terminal Pin Assignment

PIN NUMBER	DESCRIPTION
1	+: RS485 Non-inverting signal
2	-: RS485 Inverting Signal
3	GND: Reference for RS-485 Communication Signal.

Note

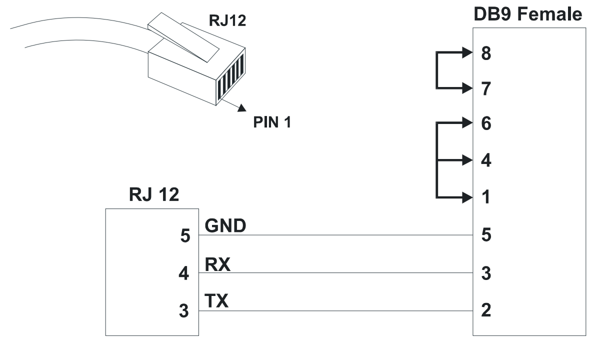
The pin GND sets the voltage reference for all RS-485 nodes. The RS-485 side of the RS-232/RS-485 Interface is isolated and left on floating state. To avoid undesirable high common mode voltage, it is recommended to set all RS-485 nodes to the same reference voltage by connecting all pins GND together and grounding at 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 ***TM302 (Processor)*** to the ***DF58 (RS232/RS485 Interface)***, use a DF59 cable or assemble the cable according to the diagram below.

To assemble the serial cable between the **TM302** (Processor) and the computer, observe the diagram below that describes the connection between the RJ12 (used in the **TM302**) 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

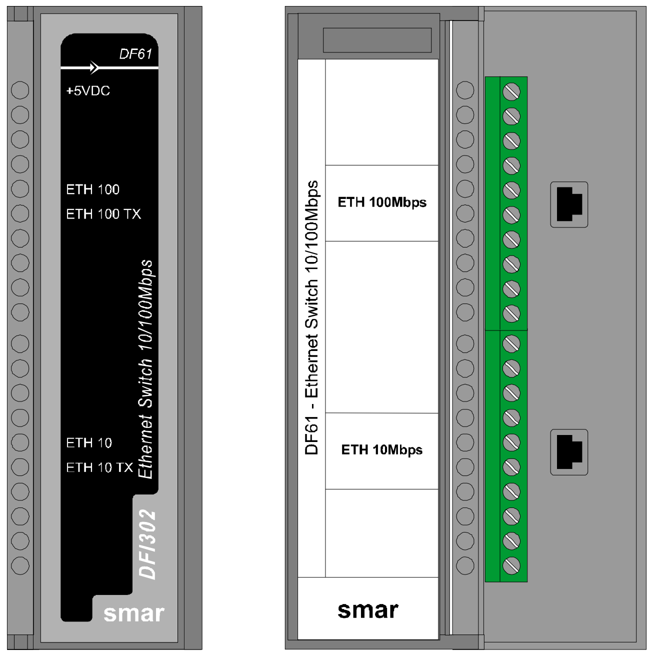
General Features	
Number of Communication Channels	1
Data Communication Interface	RS232 / RS485
Data rate	Up to 200 Kbps
RS232 side	Enables RS232 Half-Duplex or Full-Duplex mode
RS485 side	Enables the bus terminator
Isolation	1600 Vrms @1 minute, typical
Power Supply	Powered by the IMB bus, +5 Vdc, @ 60 mA typical

DF61 – Ethernet Switch 10/100 Mbps

Description

This module connects the TM302 directly to an Ethernet 100 Mbps Local Area Network (LAN).
The only procedures to follow are:
1 - Fix the DF61 in a rack, and
2 - Using DF54 cable, connect DF61 to the 10 Mbps port of the TM302. Afterwards, the 100 Mbps port will be ready to be connected to the LAN.

Make sure that the Ethernet is perfectly communicating, check if the ETH10 and ETH100 LED indicators are ON (link connected), and ETH10TX and ETH100TX are blinking in the same rate of TM302.



Ethernet Switch Module: DF61

Chapter 7

ADDING I/O MODULES

Introduction

The **AuditTank** 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 **AuditTank** 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 or 1024 depending on the controller specification. There are many types of modules available for the **AuditTank**, designed 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 inputs
DF12	2 Groups of 8 48Vdc Inputs (Isolated)	16 discrete inputs
DF13	2 Groups of 8 60Vdc Inputs (Isolated)	16 discrete inputs
DF14	2 Groups of 8 125Vdc Inputs (Isolated)	16 discrete inputs
DF15	2 Groups of 8 24Vdc Inputs (Sink)(Isolated)	16 discrete inputs
DF16	2 Groups of 4 120Vac Inputs (Isolated)	8 discrete inputs
DF17	2 Groups of 4 240Vac Inputs (Isolated)	8 discrete inputs
DF18	2 Groups of 8 120Vac Inputs (Isolated)	16 discrete inputs
DF19	2 Groups of 8 240Vac Inputs (Isolated)	16 discrete inputs
DF20	1 Group of 8 On/Off Switches	8 discrete inputs

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 24 Vdc Inputs and 1 Group of 4 NO Relay	8 discrete input/ 4 discrete output
DF33	1 Group of 8 48 Vdc Inputs and 1 Group of 4 NO Relay	8 discrete input / 4 discrete output
DF34	1 Group of 8 60 Vdc Inputs and 1 Group of 4 NO Relay	8 discrete input / 4 discrete output
DF35	1 Group of 8 24 Vdc Inputs and 1 Group of 4 NC Relay	8 discrete input / 4 discrete output
DF36	1 Group of 8 48 Vdc Inputs and 1 Group of 4 NC Relay	8 discrete input / 4 discrete output
DF37	1 Group of 8 60 Vdc Inputs and 1 Group of 4 NC Relay	8 discrete input / 4 discrete output
DF38	1 Group of 8 24 Vdc Inputs and 1 Group of 2 NO and 2 NC Relay	8 discrete input / 4 discrete output
DF39	1 Group of 8 48 Vdc Inputs and 1 Group of 2 NO and 2 NC Relay	8 discrete input / 4 discrete output
DF40	1 Group of 8 60 Vdc Inputs and 1 Group of 2 NO and 2 NC Relay	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 outputs

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 step to configure **TM302** with I/O modules, need the knowledge on “How to Add a Function Block” using Syscon (the configuration tool). See the section “Adding Function Blocks”, for further information.

Add one **Resource Block**, one **Hardware Configuration Transducer** (HCT) 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).

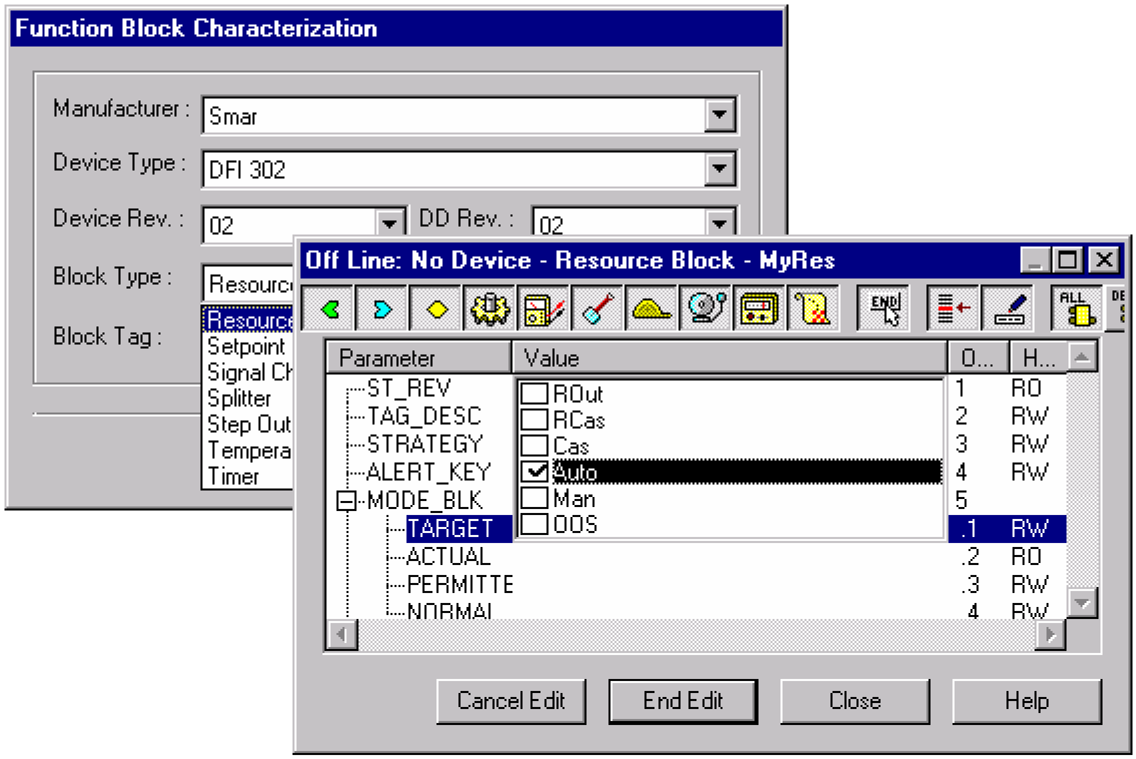
The order of the Resource, Transducers and block creation is very important because when Syscon does the configuration download, a lot of consistency checks will be done inside **TM302**.

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 Foundation fieldbus 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 **TM302**, 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 **TM302**.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, and 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 **TM302** 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 **TM302**, set up the CHANNEL parameter for that function block, which makes the interface with I/O modules.

CHANNEL Configuration

Using **TM302**, the user can configure the number of I/O modules as well the I/O type (input or output, discrete, analog, pulse etc). The **TM302** 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.

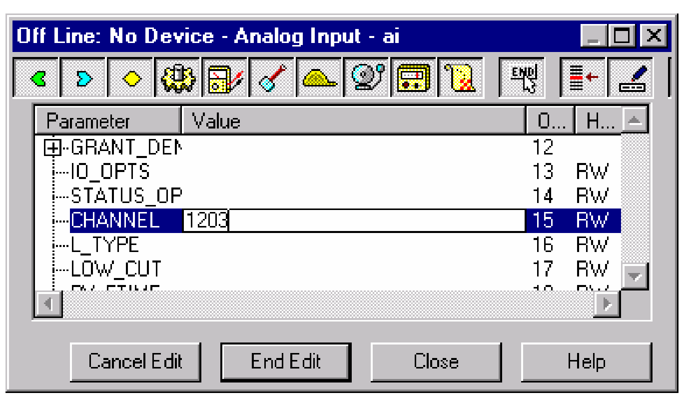
Rack (R): Each rack has four slots. The rack is numbered from 0 (first rack) till 14 (last rack). Therefore a single I/O point in the TM302 can be identified by specifying the rack (R), slot (S), group (G) and point (P). The CHANNEL parameter in the multiple I/O blocks (MIO) must specify the whole group (8 points), the point must be 9, which mean 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 HCT block. Because the write check will verify if the I/O type configured in the HCT 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

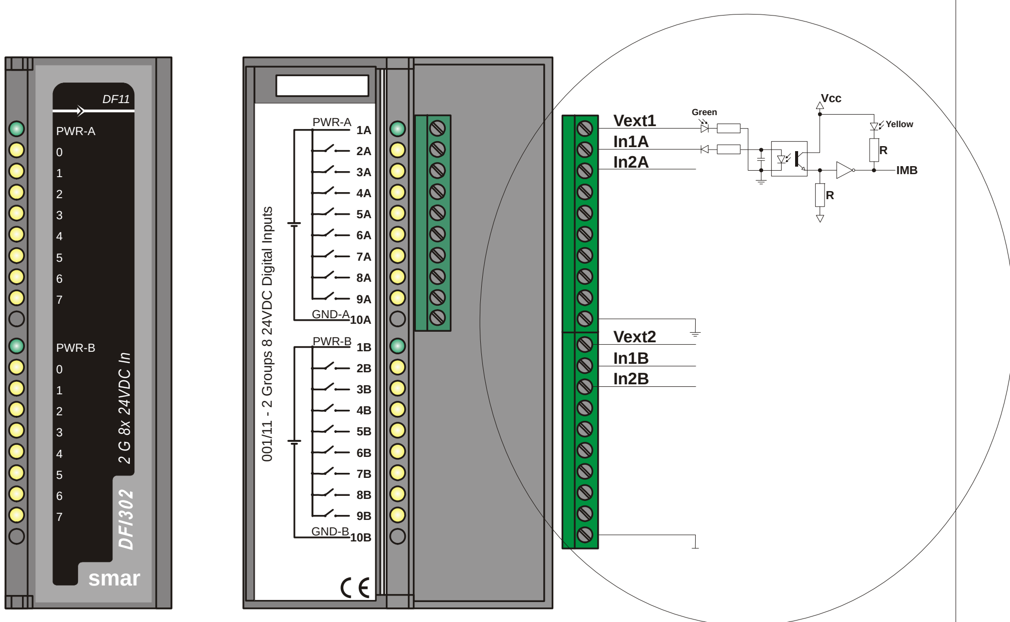
DF11 (2 groups of 8 24 Vdc inputs isolated)
DF12 (2 groups of 8 48 Vdc inputs isolated)
DF13 (2 groups of 8 60 Vdc inputs isolated)
DF14 (2 groups of 8 125 Vdc inputs isolated)

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

Chapter 8

SOFTWARE INSTALLATION

Installing the Studio302

Install the programs that compose the **SYSTEM302** using the 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.

Installing Studio302

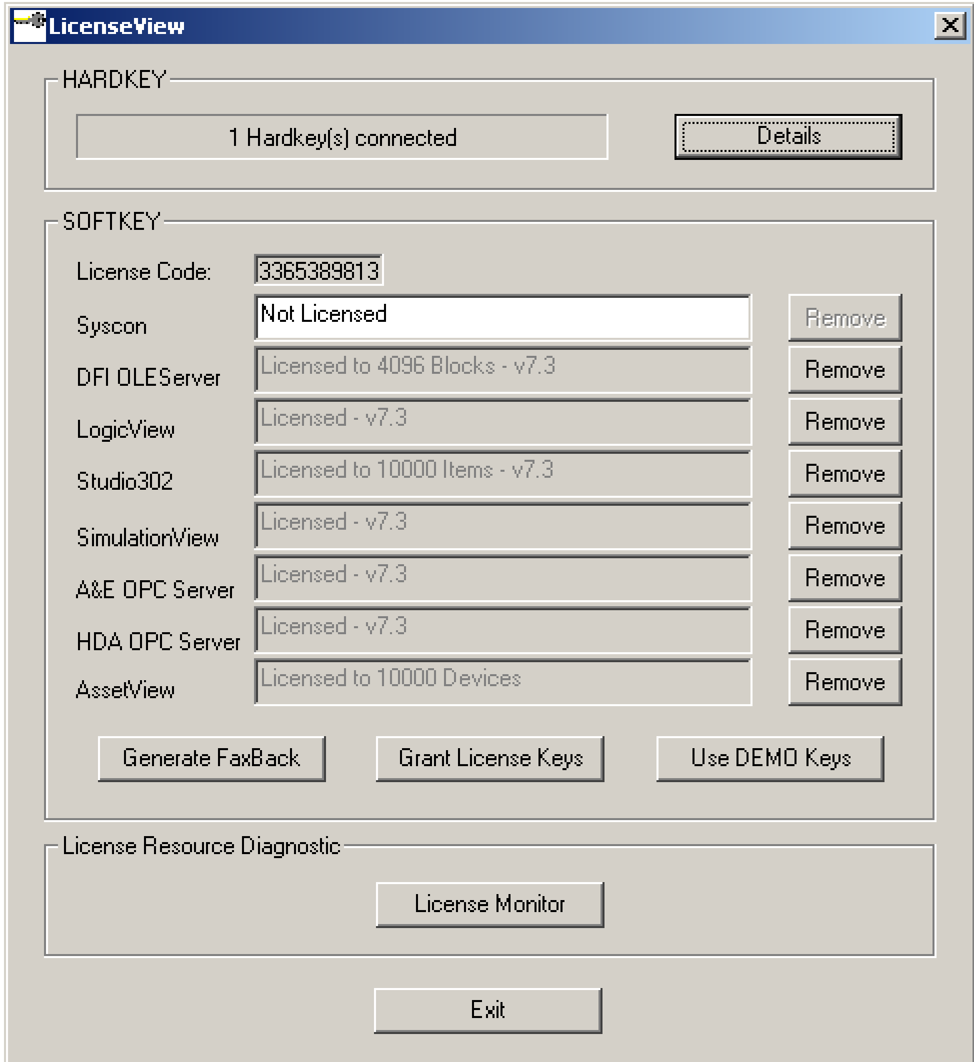
Getting the DFI OLE Server License

There are two options for the license of the DFI OLEServer: the Hard Lock license (HardKey) and the Software license (SoftKey).

The Hardkey version is ready to use, the user simply connect it to the parallel or USB port of the computer.

To use the software license, it is necessary to contact Smar and request a License Key. For this, use the application **LicenseView**, found 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.



Afterwards, SMAR will send the Licenses Keys. Type the codes in the blank fields (observe the previous figure) and click the **Grant License Keys** button.

If these codes were accepted, a message will be generated confirming the successful operation. At this moment, **Syscon** and **DFI OLEServer** will be ready to be used.

Connecting AuditTank to the Subnet

AuditTank operates in a network (Subnet) where each connected device has an IP address.

Use a DHCP ***(Dynamic Host Configuration Protocol)*** server to dynamically set the IP address to each device and prevent two different devices to have the same IP address.

ATTENTION
When connecting more than one **AuditTank**, the following steps must be executed for each **AuditTank** one after the other.

1- Connect the DF54 Ethernet cable of the **TM302** module to the Subnet Switch (or hub).

NOTE
In a peer-to-peer connection (**AuditTank** connected directly to the computer), use the DF55 cross cable.

2 – Turn on the **TM302** module. Check if the LED ETH10 and the LED RUN are lit.

3 - Press the Push-Button (Factory Init / Reset) on the left while pressing the Push-Button on the right three times, making sure that the LED FORCE blinks 3 times per second.

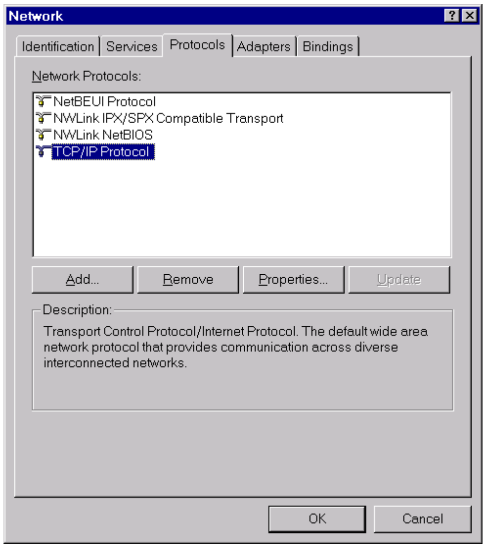
NOTE
If the user loses the number of times that the Push-Button on the right was pressed, simply check the number of times that the LED FORCE blinks per second. It will blink one time per second after pressing the button four times (the function is cyclic).

4 - Release the Push-Button on the left. The system will reset and then execute the firmware, using the standard values of the IP address and Subnet Mask.

5 - If the network has a DHCP server (consult the network administrator), **AuditTank** will be automatically connected to the Subnet. Otherwise, it will have the IP address 192.168.164.100 and the user will have to execute the following steps to configure the **AuditTank** system.

6 - Change the IP address of the computer (if the user is not familiar with this configuration, consult the network administrator). From the Windows Start menu, open the **Control Panel** and double-click the option **Network and Dial-up Connections**. Double-click the **Local Area Connection** icon and click the button **Properties**.

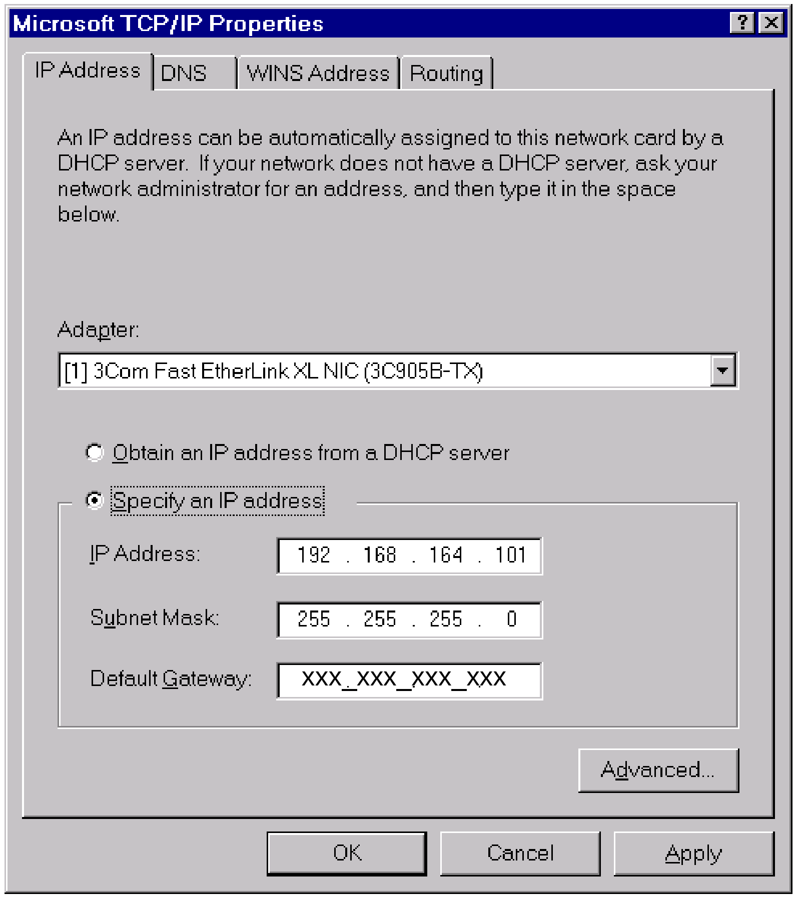
7 - Select the item **Internet Protocol (TCP/IP)** and click the **Properties**.



8 - Write the original values of the IP address and the Subnet Mask of the computer to restore these values at end of this procedure.

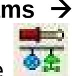
9 - Change the IP address and the Subnet Mask with the same Subnet addresses of **AuditTank**. The network administrator must provide the IP address.

NOTE
The values will be similar to: IP Address 192.168.164.XXX and Subnet Mask 255.255.255.0. Keep the default gateway value.



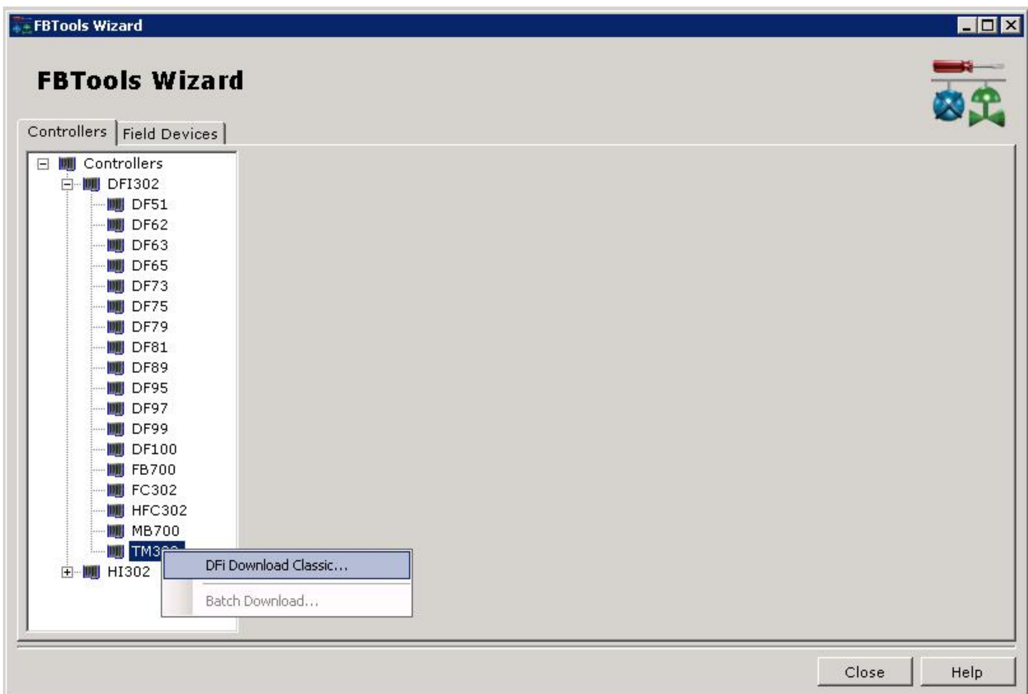
ATTENTION
Do not use the IP address 192.168.164.100. This is the default address used by the TM302. Make sure that the selected address is not being used.

10 - Click **Apply** to set the new IP address and conclude this configuration;

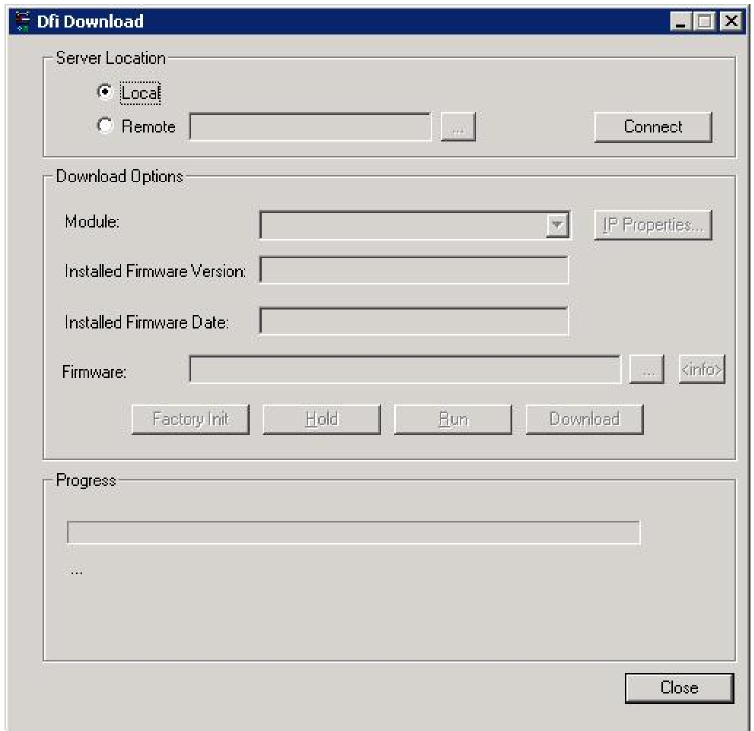
11 - Run **FBTools** through **Studio302**, at the **Start menu → Programs → System302 → Studio302**.Make a login in the system. In the **Studio302** interface click the  icon in the main toolbar. The following window will appear.

12 - In the **Controller** tab click the symbol ⊞ and the **DFI302** and **HI302** options will appear. Click again the symbol ⊞ in **DFI302** and select the **TM302**.

13 – Right-click the **TM302** and select **DFi Download Classic**. See the following figure.

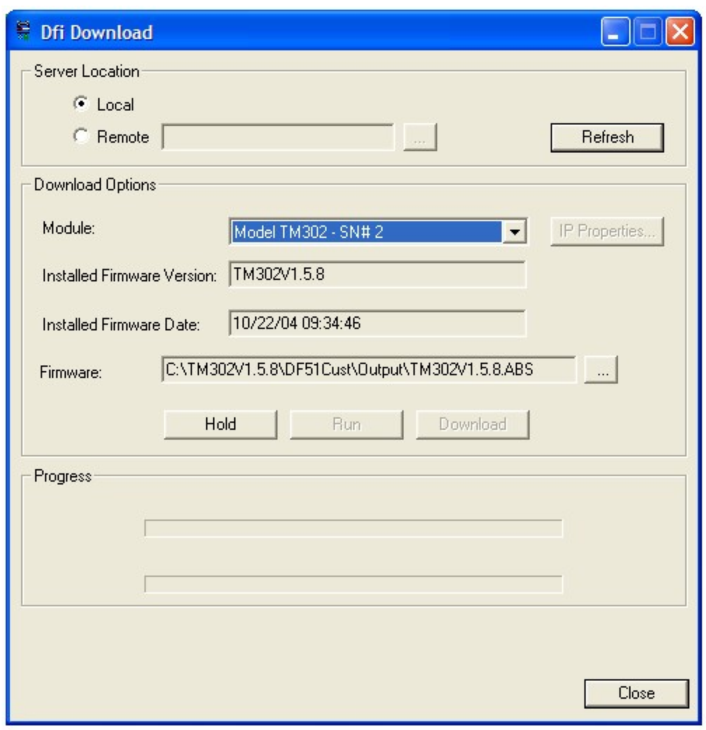


14 – The **DFi Download** window will appear. Select the path to the DFI OLEServer (Local is the default path) and click **Connect**.



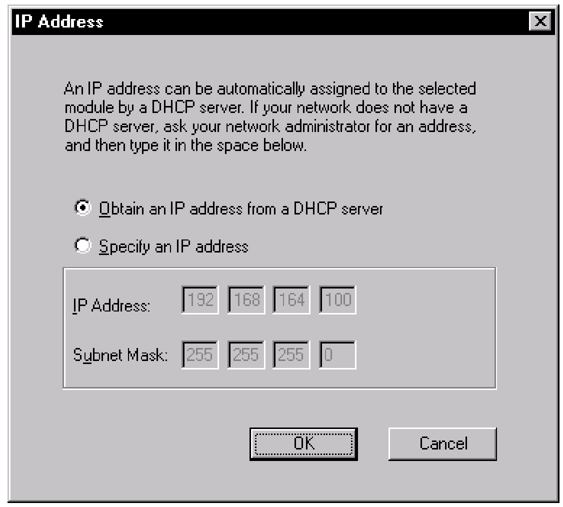
15 - Select the **TM302** module in the **Module** box. Use the serial number, located in the external identification label of the **TM302**, as a reference.

ATTENTION
It is mandatory to execute this step.



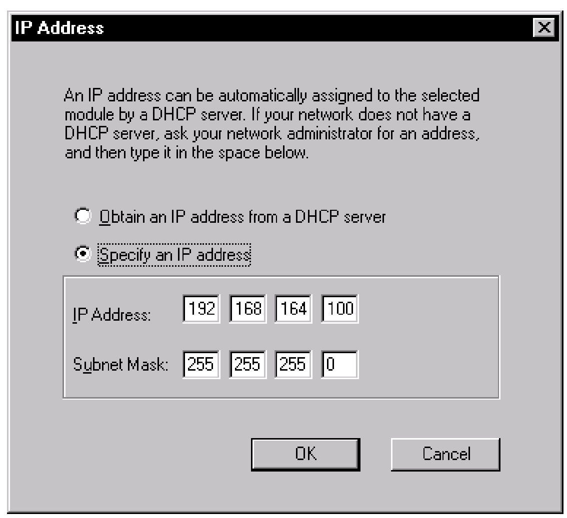
16 - Click **Hold** to interrupt the firmware being executed in the **TM302** module. The module will quit executing the Firmware and all activity in the Fieldbus line will stop. Confirm the operation clicking **Yes**.

17 - Check if LED HOLD is lit. After interrupting the firmware, the following dialog box will open. 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. Click the **Specify an IP address** option.

19- Type the IP Address and the Subnet Mask for the **TM302**;



ATTENTION
Do not use the address 192.168.164.100. This is the default IP address of the **TM302**.

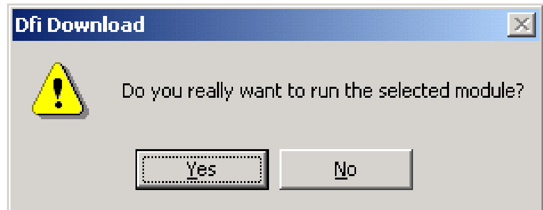
TIP
Write the configured IP addresses and relate them to the serial numbers of each **TM302** module. It will help to identify and diagnose possible faults.

11- Click **OK** to conclude.

12- Return to the TCP/IP Properties Dialog box of the computer and restore the original values of the IP address and the Subnet Mask.

13- After configuring the new IP address, the process will return to the **Dfi Download** window. Click **Run** and the firmware will execute again.

14 – A message will appear confirming the operation. Click **Yes** to continue.



15 - The procedure to connect the **TM302** to the subnet is complete. Repeat these steps above for the other modules.

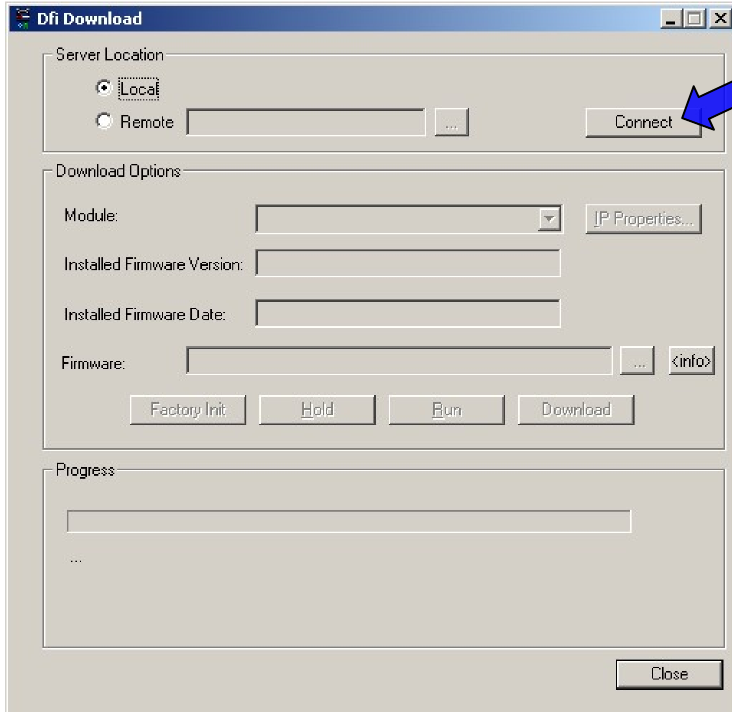
NOTE
In case of there is more than one AuditTank to be set up, fulfill the following command to clear **ARP table**, before setting up the next AuditTank. C:\>arp -d 192.168.164.100 < enter >

Visualizing and Updating the Firmware

1. Make sure that the **TM302** is ON and has been connected to the subnet, according to the procedures in "Connecting the AuditTank in the Subnet".
2. To continue, it will be necessary to interrupt the firmware execution in the TM302 module forcing it for the **Hold** mode.

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

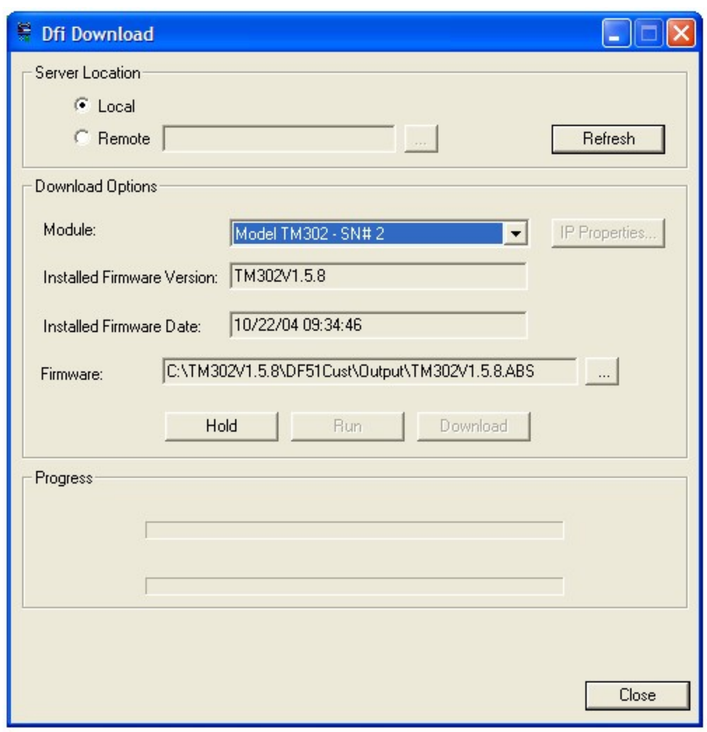
   For safety and audit trail, this is the only mode to force the **Hold** mode and then to start the firmware download process.
3. Be sure that LED HOLD is on.
4. Execute the **FBTools Wizard** as described at previous topic.
5. Select the **TM302** module and right-click it. Choose **Dfi download Classic.**
6. 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.



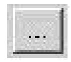
7. Select the **TM302** module in the **Module** box. Use the serial number as a reference (see the external identification label).

8. After to select the **TM302** 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.

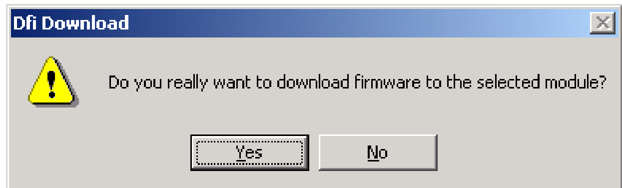


Note that the **DFI Download** dialog box shows the installed version and date of the current firmware loaded in the **TM302** module.

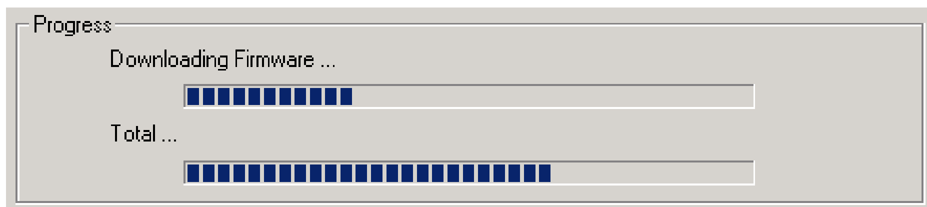
9. Click the button  to select the firmware file to be downloaded (TM302*.ABS).

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

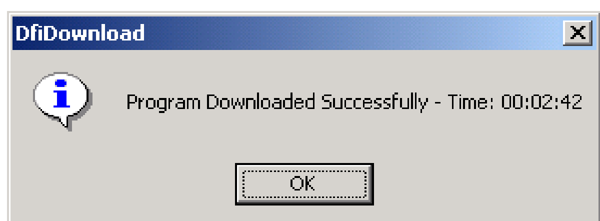
11. A message box will come up requesting a confirmation. Click **Yes** to continue.



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



13. When the download is complete, a dialog box will appear confirming that the program was downloaded successfully. Click **OK** and wait a few minutes while the information is updated. The TM**302** will be in "Run Mode". (Check if the RUN LED is ON).



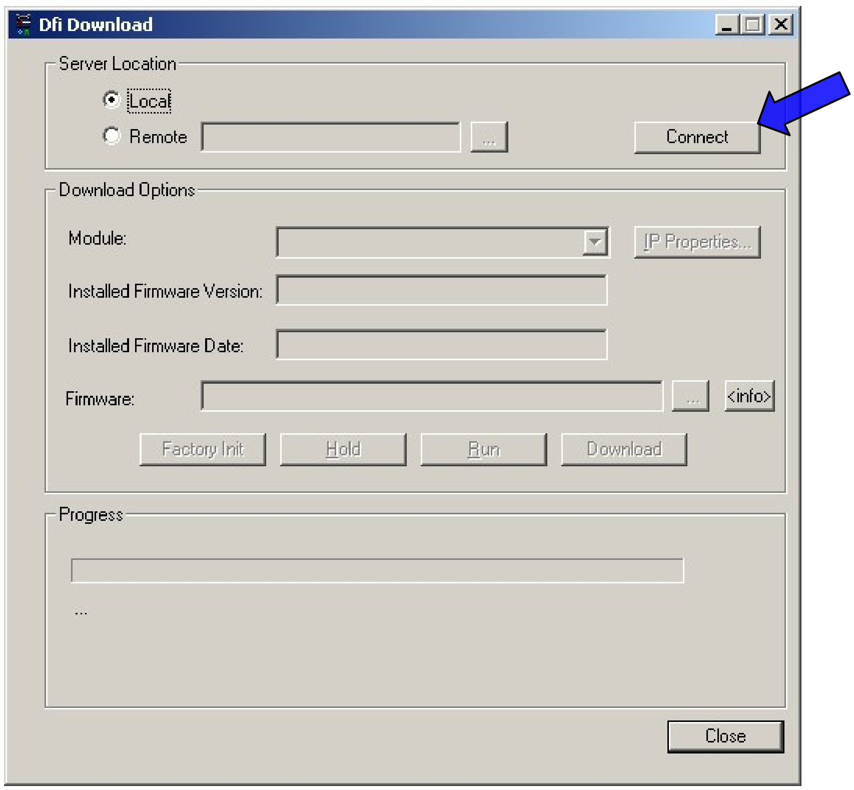
14. Click the **Close** button to exit from the **Dfi Download** window.

Changing IP Address

Changing TM302 IP

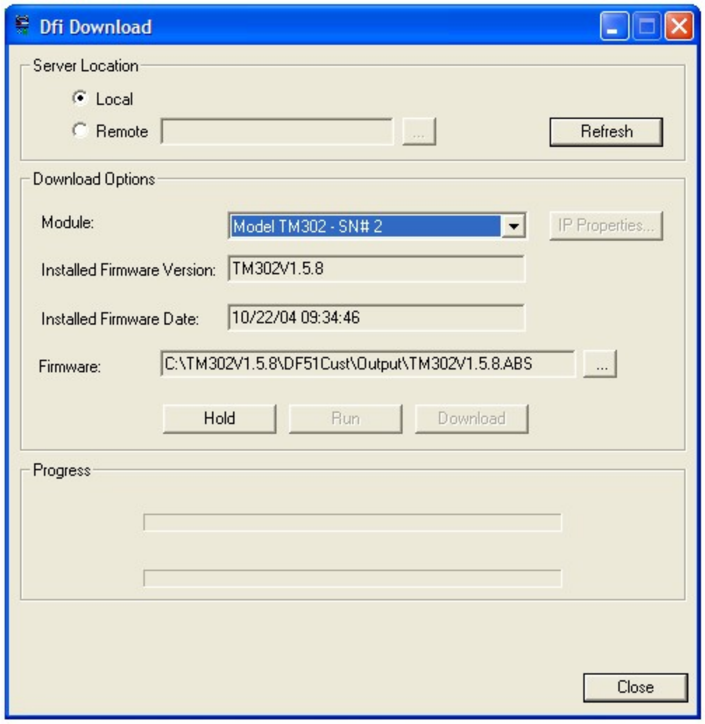
NOTE
To change the **TM302** subnet, see the procedures in "Connecting the AuditTank in the Subnet" (described in this section). Follow these steps only to change the IP address.

1. Make sure that the **TM302** is ON and has been connected to the subnet, according to the procedures in "Connecting the AuditTank in the Subnet".
2. Run the **FBTools Wizard**, as shown in previous topics.
3. Select the **TM302** 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.



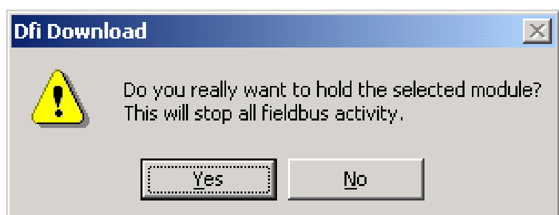
5. Select the **TM302** module in the **Module** box. Use the serial number as a reference (see the external identification label).

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



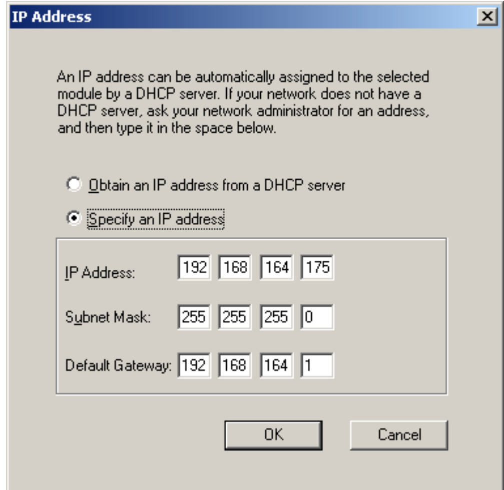
6. Click the **Hold** button to interrupt the firmware execution in the **TM302**.

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 **TM302.**

ATTENTION
Do not use the IP Address 192.168.164.100 (it is already being used by **TM302**). 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 **TM302** 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 **TM302** firmware again.
15. Click **Close** to exit from the **Dfi Download** dialog box.

Chapter 9

BLOCK LIBRARY

Block Types supported by TM302

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 TM302 supports several block types, also supported by other Smar devices, and they are classified as Generic Blocks.

The 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 TM302 and the correspondent DD revision:

DD Revision	Mnemonic	Profile number	Class	Maximum Number of Instances	Description
01	RS	0x0133	RS	1	Resource
	DIAG	0x8018	TRD	1	Diagnostic
	MBCF	0x802A	TRD	1	Modbus Configuration
	TEMP	0x8028	TRD	Not limited	DF-45 Temperature Transducer
	AI	0x0101	FB	Not limited	Analog Input
	DI	0x0103	FB	Not limited	Discrete Input
	MDI	0x8032	FB	Not limited	Multiple Discrete Input
	ARTH	0x8007	FB	Not limited	Arithmetic
	AALM	0x800B	FB	Not limited	Analog Alarm
	TIME	0x800E	FB	Not limited	Timer and Logic
	CT	0x801A	FB	Not limited	Constant
	MBCS	0x802B	FB	16	Modbus Control Slave
	MBSS	0x802C	FB	16	Modbus Supervision Slave
	MBCM	0x802D	FB	16	Modbus Control Master
	MBSM	0x802E	FB	16	Modbus Supervision Master
	AO	0x0102	FB	Not limited	Analog Output
	MDO	0x8030	FB	Not limited	Multiple Digital Output
	HC	0x8026	TRD	1	Hardware Configuration
	TRD	0x8029	TRD	1	Transducer IDShell
	SPG	0x800D	FB	Not limited	Setpoint Generator
02	TMT	0x8067	TRD	1	Tank Measurement Transducer
	STD	0x8068	TRD	1	Shore Tank Database
	TT	0x8069	FB	20	Tank Table
	ATT	0x806A	FB	Not limited	Automatic Thermometer Tank
	STG	0x806B	FB	4	Shore Tank Gauge
	STGR	0x8071	FB	1	Shore Tank Gauge Revision
	STGV	0x806D	FB	1	Shore Tank Gauge View
	ATV	0x804C	FB	1	Audit Trail View
	AEV	0x804D	FB	1	Alarm/Event View
03	TWT	0x806C	FB	1	Tank Well Test
	TWTR	0x8073	FB	1	Historic of Liquid Measurement
	TWTV	0x806E	FB	1	Tank Well Test View

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 DFI302.
DIAG	**DIAGNOSTICS TRANSDUCER** – Provides online measurement for the block execution time, check the links between blocks and other features.

INPUT TRANSDUCER BLOCKS	DESCRIPTION
TEMP	**DF-45 TEMPERATURE TRANSDUCER** – This is the transducer block for the module DF45, an 8-low signal input module for RTD, TC, mV, Ohm.

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.
MDI	**MULTIPLE DISCRETE INPUTS** – This block provides a mode to receive 8 discrete variables from other modules.

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.
PID	**PID CONTROL** – This standard block has several features, as: setpoint treatment (value and rate limitation), filter and PV alarm, feedforward, traced output 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.
SPG	**SETPOINT GENERATOR –** This block generates setpoint according to a curve in function of the time. Typical applications are temperature control, reactor in batch, etc.

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** – This block can send 8 discrete variables to other modules.

Measurement Blocks

Transducer Blocks

TRANSDUCER BLOCKS	DESCRIPTION
TMT	**TANK MEASUREMENT TRANSDUCER** – It provides the elements to configure parameters 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.
STD	**SHORE TANK DATABASE** – Configuration of tanks as: tags, tank table, type of the tank, type of the tank steel, temperature of tank, etc.
TT	**TANK TABLE** – Identification of the table and points of the tank table.

Measurement Blocks

FUNCTION BLOCKS	DESCRIPTION
ATT	**AUTOMATIC THERMOMETER TANK** – Calculates the average temperature of the liquid in tank, with base in the level and temperature in different heights.
STG	**SHORE TANK GAUGE** – The main function of this block is to calculate the volume and mass received or sent. Accomplishes also sampler control, emptying indication and overfill, aid in proration of raw oil production, etc.
STGR	**SHORE TANK GAUGE REVISION** – Through this block the user can to browse the reports from the TM302 memory and then supply laboratory analysis data or manual measurement. Besides, the user can edit a report, that is, the user supply all data relative to measurement, the TM302 calculates the volume and mass and then generate the transfer report.
TWT	**TANK WELL TEST** – This block is used in the well test process using tank for measurement. The function is to get factors (test flow / production potential) for proration of the production in shared measurement and monitoring of the well production capacity.
TWTR	**TANK WELL TEST REVISION** – Through this block the user can to browse the reports from the TM302 memory and then supply laboratory analysis data or manual measurement. Besides, the user can edit a report of well test, that is, the user supply all data relative to measurement, the TM302 calculates the volume, mass, test flow and production potential, then generate the well test report.

Report/Register Visualization Blocks

FUNCTION BLOCKS	DESCRIPTION
STGV	**SHORE TANK GAUGE VISUALIZATION** – This block allows to browse and to display the transfer reports, one report at a time, selected from the logger (TM302 NVRAM memory). This block provides the status of the logger, including warning and overflow.
TWTV	**TANK WELL TEST REPORT VISUALIZATION -** This block allows to browse and to display the well test reports in tank, one report at a time, selected from the logger (TM302 NVRAM memory). This block provides the status of the logger, including warning and overflow.
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 (TM302 NVRAM memory). This block provides the status of the logger, including warning and overflow.
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 (TM302 NVRAM memory). This block provides the status of the logger, including warning and overflow.

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 nonvolatile 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 can execute. 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 the function 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	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
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 (A2)	**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.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
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.
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.
19	**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	Data Type (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 Desabled 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

HC – Hardware Configuration Transducer

Overview

This block configures the module type for each slot in the **DFI302.**

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 Groups 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 Groups of 4 NO and 4 NC Relays 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 Relays 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
DF43	1 Group of 8 Analog Inputs	8-analog input
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

Code	Description	I/O Type
DF45	1 Group of 8 Temperature Inputs	8-temperature
DF46	1 Group of 4 Analog Outputs	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 date – 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	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
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(A2)	**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(A2)	IO_TYPE_R0	4 Unsigned8		0	E	S / O/S	Select the module type for rack 0
9(A2)	IO_TYPE_R1	4 Unsigned8		0	E	S / O/S	Select the module type for rack 1
10(A2)	IO_TYPE_R2	4 Unsigned8		0	E	S / O/S	Select the module type for rack 2
11(A2)	IO_TYPE_R3	4 Unsigned8		0	E	S / O/S	Select the module type for rack 3
12(A2)	IO_TYPE_R4	4 Unsigned8		0	E	S / O/S	Select the module type for rack 4
13(A2)	IO_TYPE_R5	4 Unsigned8		0	E	S / O/S	Select the module type for rack 5
14(A2)	IO_TYPE_R6	4 Unsigned8		0	E	S / O/S	Select the module type for rack 6
15(A2)	IO_TYPE_R7	4 Unsigned8		0	E	S / O/S	Select the module type for rack 7
16(A2)	IO_TYPE_R8	4 Unsigned8		0	E	S / O/S	Select the module type for rack 8
17(A2)	IO_TYPE_R9	4 Unsigned8		0	E	S / O/S	Select the module type for rack 9

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
18(A2)	IO_TYPE_R10	4 Unsigned8		0	E	S / O/S	Select the module type for rack 10
19(A2)	IO_TYPE_R11	4 Unsigned8		0	E	S / O/S	Select the module type for rack 11
20(A2)	IO_TYPE_R12	4 Unsigned8		0	E	S / O/S	Select the module type for rack 12
21(A2)	IO_TYPE_R13	4 Unsigned8		0	E	S / O/S	Select the module type for rack 13
22(A2)	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

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/RO	
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**	VisibletString(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**	VisibletString (5)				S / RO	Hardware Revision
12	**FIRMWARE_REV**	VisibletString (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	Unsigned8	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

Description of the values of the LINK_STATUS parameter

Status do Link	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 Confgured	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:
- 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	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	Oct String(32)		Spaces	Na	S	
3	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	Bit String(2)			E	D / RO	
7(A2)	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(A2)	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(A2)	SENSOR_CONNECTION _0	Unsigned8	1 : differential 2 : 2-wires 3 : 3- wires	3	E	S / O/S	Connection of the sensor 0.
18(A2)	**SENSOR_TYPE_0**	Unsigned 8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 0.
19(A2)	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(A2)	SENSOR_CONNECTION _1	Unsigned 8	1 : differential 2 : 2- wires 3 : 3- wires	3	E	S / O/S	Connection of the sensor 1.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
21(A2)	**SENSOR_TYPE_1**	Unsigned 8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 1.
22(A2)	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(A2)	SENSOR_CONNECTION_2	Unsigned 8	1 : differential 2 : 2- wires 3 : 3- wires	3	E	S / O/S	Connection of the sensor 2.
24(A2)	**SENSOR_TYPE_2**	Unsigned 8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 2.
25(A2)	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(A2)	SENSOR_CONNECTION_3	Unsigned 8	1 : differential 2 : 2- wires 3 : 3- wires	3	E	S / O/S	Connection of the sensor 3.
27(A2)	**SENSOR_TYPE_3**	Unsigned 8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 3.
28(A2)	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(A2)	SENSOR_CONNECTION_4	Unsigned 8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 4.
30(A2)	**SENSOR_TYPE_4**	Unsigned 8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 4.
31(A2)	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(A2)	SENSOR_CONNECTION_5	Unsigned 8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 5.
33(A2)	**SENSOR_TYPE_5**	Unsigned8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 5.
34(A2)	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(A2)	SENSOR_CONNECTION_6	Unsigned 8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 6.
36(A2)	**SENSOR_TYPE_6**	Unsigned 8	See table below	Pt 100 IEC	E	S / O/S	Type of sensor 6.
37(A2)	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(A2)	SENSOR_CONNECTION_7	Unsigned 8	1 : differential 2 : 2-wires 3 : 3-wires	3	E	S / O/S	Connection of the sensor 7.
39(A2)	**SENSOR_TYPE_7**	Unsigned 8	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.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
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

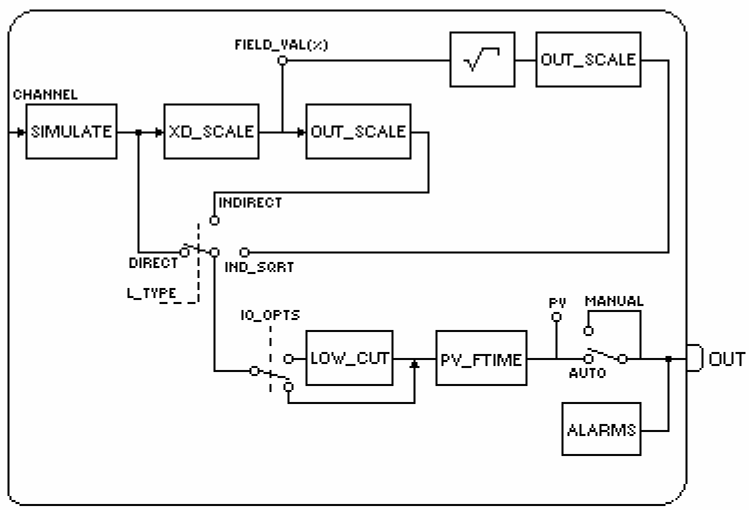
Code	Sensor Type	Class	Sensor Range – Differential (Celsius)	Sensor Range – 2-wires (Celsius)	Sensor Range – 3-wires (Celsius)
1	Cu 10 GE	RTD	-270 to 270	-20 to 250	-20 to 250
2	Ni 120 DIN		-320 to 320	-50 to 270	-50 to 270
3	Pt 50 IEC		-1050 to 1050	-200 to 850	-200 to 850
4	Pt 100 IEC		-1050 to 1050	-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 an engineering unit or range proper for the sensor of the transducer block.
  - When the CHANNEL parameter and the HC configuration (DFI302) are not compatible;

- Simulate Active – When the Simulate is active;
- Input Failure – I/O module failed (DFI302);
- 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 substatus.

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	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned6		0	None	S/RO	
2	TAG_DESC	Oct String(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**	Bit String(2)			E	D / RO	
7	**PV**	DS-65			PV	D / RO	Process the analog value that will be used to execute the function.
8(A2)	**OUT**	DS-65	OUT_SCALE +/- 10%		OUT	D / Man	The analog value is calculated as a result of the function execution.
9(A2)	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(A2)	XD_SCALE	DS-68	Depend on the device type. See manual for more details.	Depend on the device type. See the item Description for more details.	XD	S / Man	The higher and lower scale values, for the transducer of a specified channel. The default value for each Smar device is: LD292/302: 0 to 5080 [mmH_2O] IF302: 4 to 20 {mA] TT302: -200 to 850 [ºC] TP302: 0 to 100 [%] DT302: 1000 to 2500 (kg/m^3] DFI302: 100,0,1342 0 to 100 [%]
11(A2)	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(A2)	IO_OPTS	Bit String(2)	See Block Options	0	na	S / O/S	See Block Options.
14(A2)	STATUS_OPTS	Bit String (2)	See Block Options	0	Na	S / O/S	See Block Options.
15(A2)	**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	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
16(A2)	**L_TYPE**	Unsigned 8	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(A2)	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(A2)	**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	Bit String(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.
34	HI_ALM	DS-71			OUT	D	The status of the high alarm and the associated time stamp.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
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.

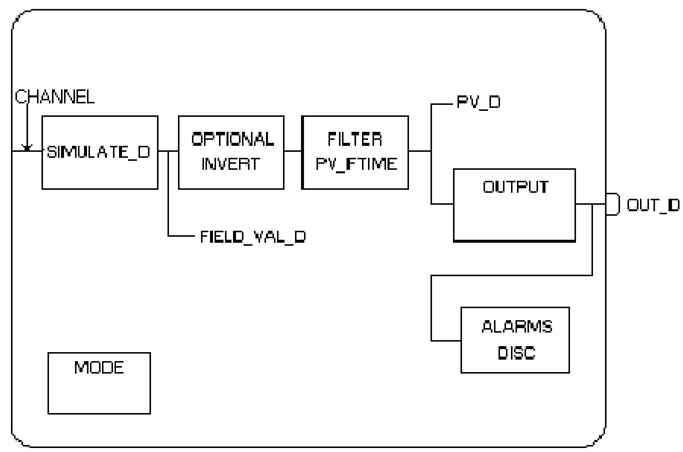
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2

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 (DFI302) are not compatible.
- Simulate Active – When the Simulate is active;
- Input Failure – I/O module failed (DFI302);
- 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 substatus. The STATUS_OPTS has the following options: Propagate Fault Forward.

Parameters

Idx	Parameter	Data Type (length)	Valid Range Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	Oct String(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(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	Bit String(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(A2)	OUT_D	DS-66	OUT_STATE		OUT	D / Man	The primary discrete value calculated as a result of the function execution.
9(A2)	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(A2)	IO_OPTS	Bit String(2)	See Block Options	0	na	S / O/S	See Block Options.
14(A2)	STATUS_OPTS	Bit String(2)	See Block Options	0	Na	S / O/S	See Block Options.
15(A2)	**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(A2)	**PV_FTIME**	Flutuante	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(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.
21	ACK_OPTION	Bit String(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(A2)	DISC_LIM	Unsigned8	PV_STATE	0	PV	S	Status of the discrete input that will generate an alarm.

Idx	Parameter	Data Type (length)	Valid Range Options	Default Value	Units	Store/ Mode	Description
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

MDI – Multiple Discrete Input

Description

The MDI block makes available for the FF network eight discrete variables of the I/O subsystem through its eight output parameters OUT_D1 through OUT_D8. Status indication in the output parameters OUT_Dx depends on the I/O subsystem and the transducer block, that is manufacturer specific. For example, if there is individual detection of sensor failure, it will be indicated in the status of related OUT_Dx parameter. Problem in the interface to the I/O subsystem will be indicated in the status of all OUT_Dx as BAD – Device Failure.

BLOCK_ERR

The BLOCK_ERR of the MDI block will reflect the following causes:

- Other – the number of MDI, MDO, MAI and MAO blocks or the device tag in FB700 is different from LC700;
- Block Configuration Error – the configuration error occurs when the OCCURRENCE has an invalid value (FB700) or it is not compatible the CHANNEL parameter and HC configuration (DFI302);
- Input Failure – the CPU of LC700 stopped working (FB700) or I/O module failure (DFI302);
- Power Up – there is no CPU of LC700 in the rack or the hardware configuration of LC700 has an error;
- Out of Service – When the block is in O/S mode.

Status

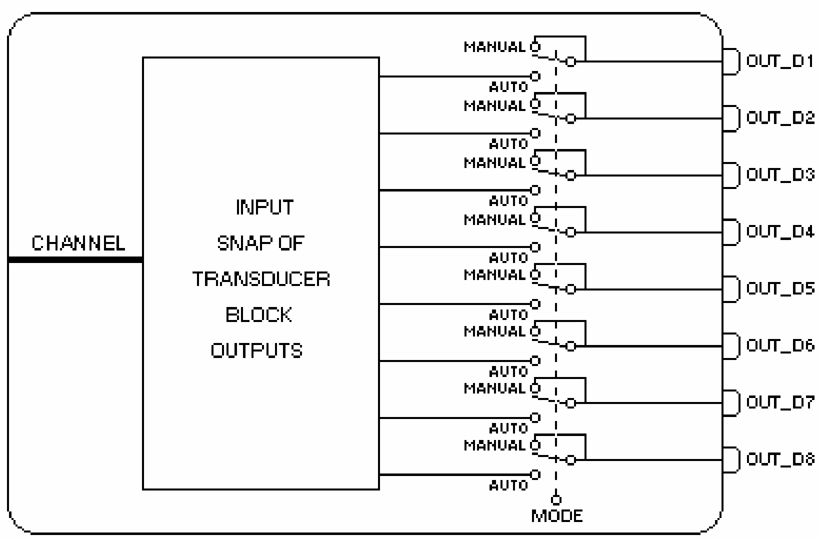
The status of OUT_Dx will be the following if the BLOCK_ERR indicates:

- Other – Bad: Configuration Error;
- Input failure – Bad: Device Failure;
- Power up – Bad: Device Failure.

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/RO	
2	TAG_DESC	Oct String(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	See Mode Parameter.
6	**BLOCK_ERR**	Bit String2)			E	D / RO	
7	**OCCURRENCE / CHANNEL**	Unsigned16		0	None	S / O/S	It defines the transducer to be used going to or from the physical world. It addresses a group of eight points.
8	**OUT_D1**	DS-66				D / Man	Numbered discrete input 1.
9	**OUT_D2**	DS-66				D / Man	Numbered discrete input 2.
10	**OUT_D3**	DS-66				D / Man	Numbered discrete input 3.
11	**OUT_D4**	DS-66				D / Man	Numbered discrete input 4.
12	**OUT_D5**	DS-66				D / Man	Numbered discrete input 5.
13	**OUT_D6**	DS-66				D / Man	Numbered discrete input 6.
14	**OUT_D7**	DS-66				D / Man	Numbered discrete input 7
15	**OUT_D8**	DS-66				D / Man	Numbered discrete input 8.
16	BLOCK_ALM	DS-72			Na	D	
17	UPDATE_EVT	DS-73			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

If the BEHAVIOR parameter is “Adapted”:
The default value of OCCURRENCE is the number of MDI blocks instantiated for the FB-700**.**

Device Type	Description
FB700	Block has OCCURRENCE parameter
DFI302 and DC302	Block has CHANNEL parameter

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)

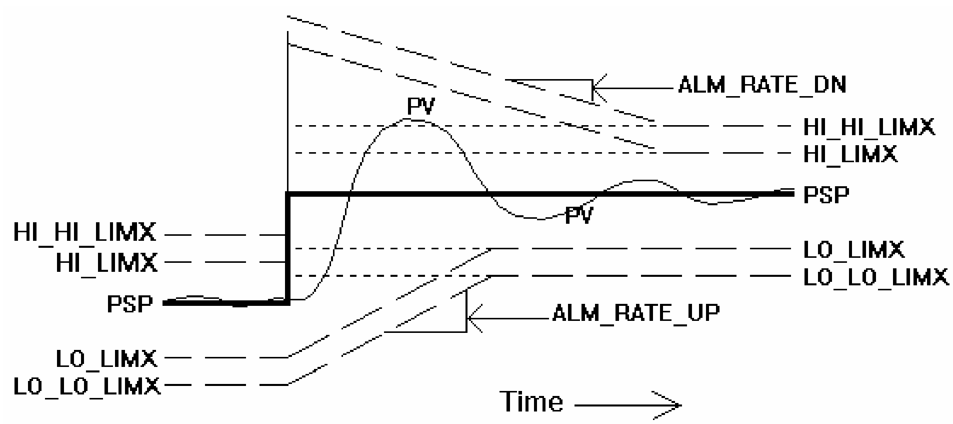
LO_LIMX = PSP * LO_GAIN - LO_BIAS - EXPAND_DN (or default for LO_LIM if any parameter is undefined)

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

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.

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.

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.

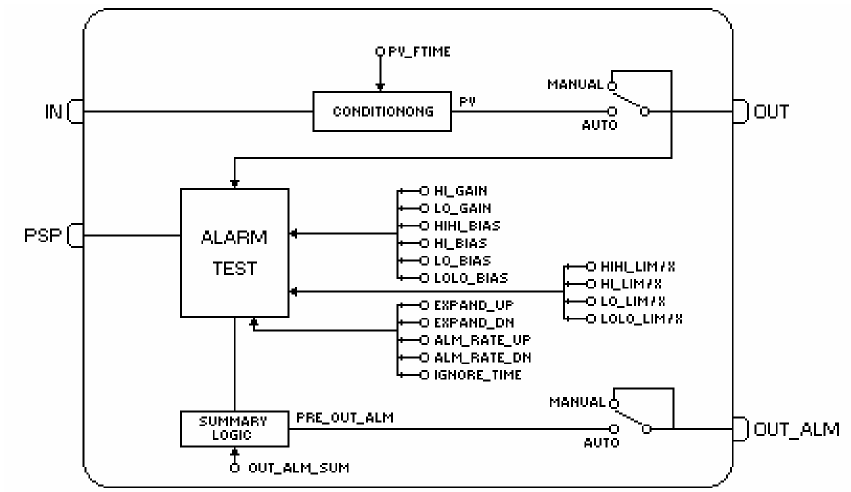
Status
The block will not filter an IN value with a bad status or uncertain status (the option "Use Uncertain" in STATUS_OPTS is not configured), it will filter the last proper value of PV and indicate the improper status of IN instead. When the IN status returns to a proper value (good or uncertain, 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.

Schematic



Parameters

Idx	Parameter	Data Type (Length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3(A2)	STRATEGY	Unsigned16		0	None	S	
4(A2)	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. 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.
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.

Idx	Parameter	Data Type (Length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
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)	**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).
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.

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.
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)	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)	**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	Settings for the high high alarm, in engineering units.
37	HI_PRI	Unsigned8	0 a 15	0		S	Priority of the high alarm.
38(A2)	**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)	**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	**LO_LO_LIM**	Float	OUT_SCALE, -INF	-INF	PV	S	Settings for the low low alarm, in engineering units.
45	LO_LO_LIMX	Float	OUT_SCALE, -INF	-INF	PV	S	Settings for the low low alarm, in engineering units.
46	HI_HI_ALM	DS-71			PV	D	Status and associated time stamp for the high high alarm.
47	HI_ALM	DS-71			PV	D	Status and associated time stamp for the high alarm.
48(A2)	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.

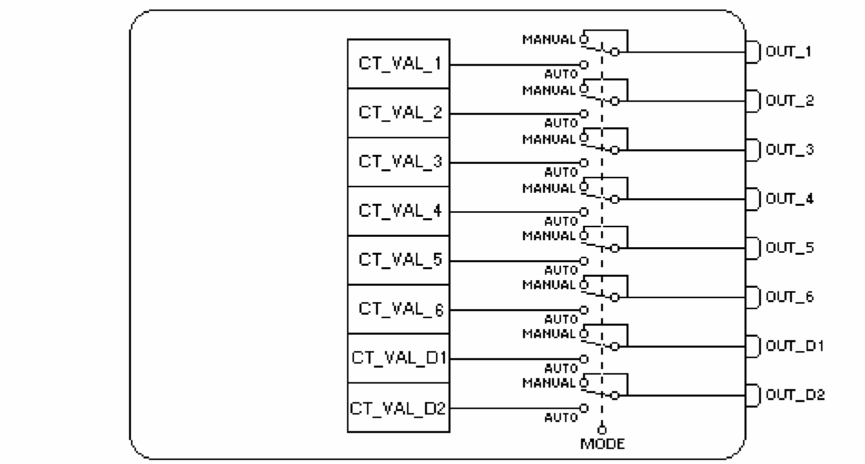
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2

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 and AUTO

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
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(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.
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.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
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

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.

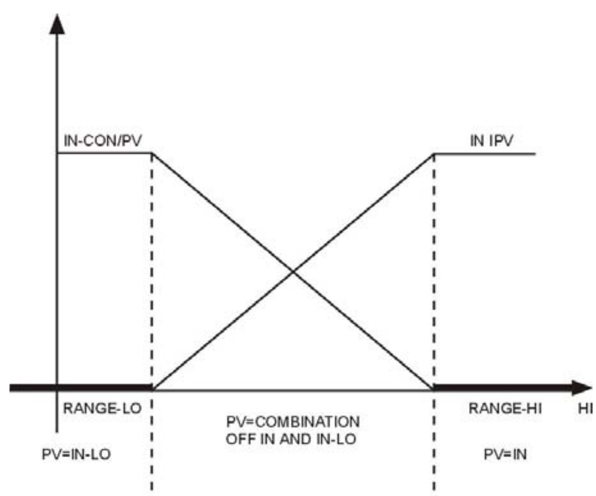
The block has 5 inputs. The first two inputs are dedicated to a range extension function that results in a PV, with status reflecting the input being used. The other three inputs are combined with the PV to select four functions of terms that can be used is several measurements. The inputs that compose 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 (Status of IN is Unusable) and (Status of IN_LO is Usable)) then
g = 0
if ((IN > RANGE_HI) or (IN > RANGE_LO) and (Status of IN is Usable) and (Status of IN_LO is Unusable)) then
g = 1
if ((RANGE_LO ≤ IN) and (IN < RANGE_HI)) then

$$g \quad \frac{IN \quad RANGE\_LO}{RANGE\_HI \quad RANGE\_LO}$$



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.

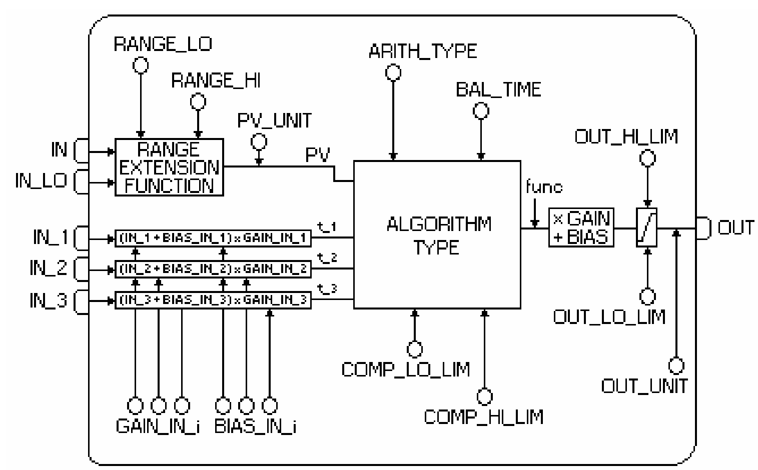
Supported Modes
O/S, MAN and AUTO.

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	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	Oct String(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**	Bit String(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	Bit String(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.
28(A2)	COMP_LO_LIM	Float		0	None	S	The low limit imposed on the PV compensation term.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
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 summer 8= Fourth 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	Dimensionless 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

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

TIPO ARITH_	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" (noncascade) 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). Unconnected inputs 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

The processing type of the timer is specified by TIMER_TYPE. It will result the measurement, delay, extension, pulse (non-retriggerable or retriggerable) or the 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_EXP indicates the time expired in the measurement, 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 false to true
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

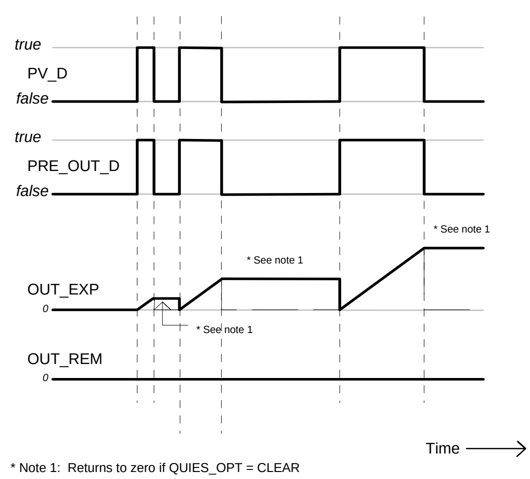
The option CLEAR of QUIES_OPT will cause both OUT_EXP and OUT_REM to be set to zero during quiescence. The option LAST of QUIES_OPT will cause both OUT_EXP and OUT_REM to keep their values when the block becomes quiescent. That is, the time expired and time remaining will be available until the quiescence 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:

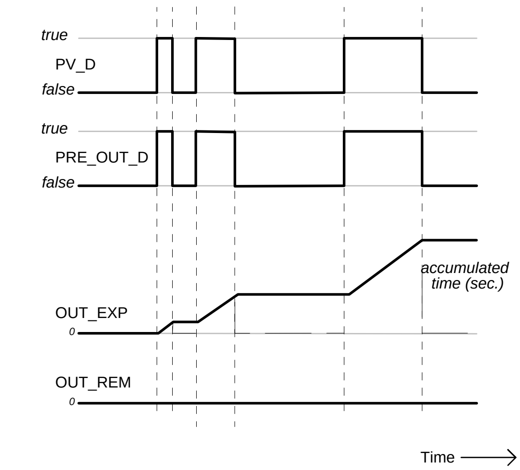
- MEASURE Indicates the duration of the most recent true signal
- ACCUM Accumulates the duration of a true signal
- COMPARE Compares the duration of a true signal with a specified duration
- DELAY Delays a false-to-true transition, eliminating it if it is short
- EXTEND Extends a true-to-false transition, 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.



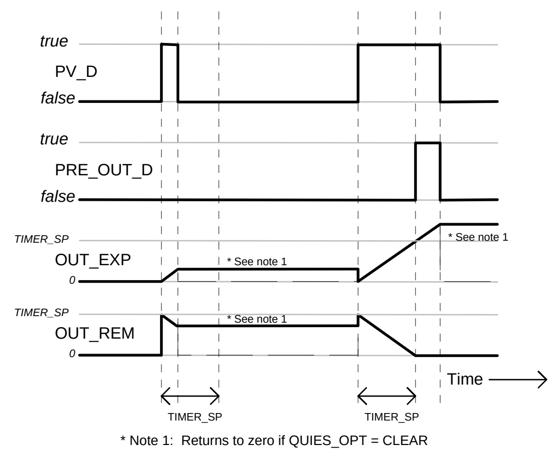
Timer Example when TIMER_TYPE = MEASURE

- 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.



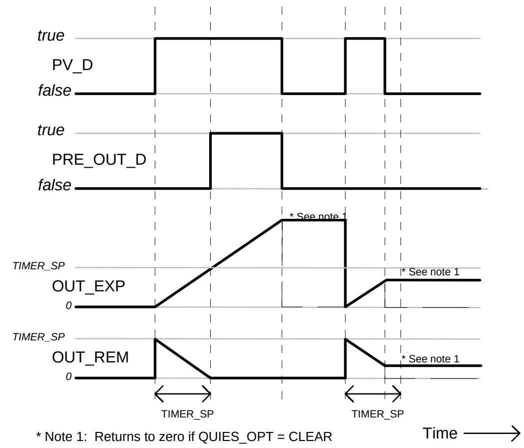
Timer Example when TIMER_TYPE = ACCUM

- 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].



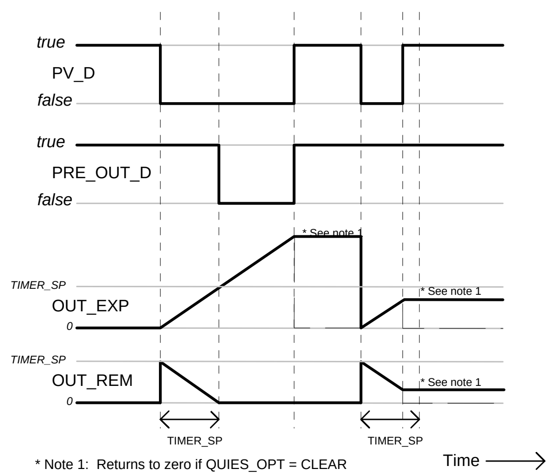
Timer Example when TIMER_TYPE = COMPARE

- 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 output 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].



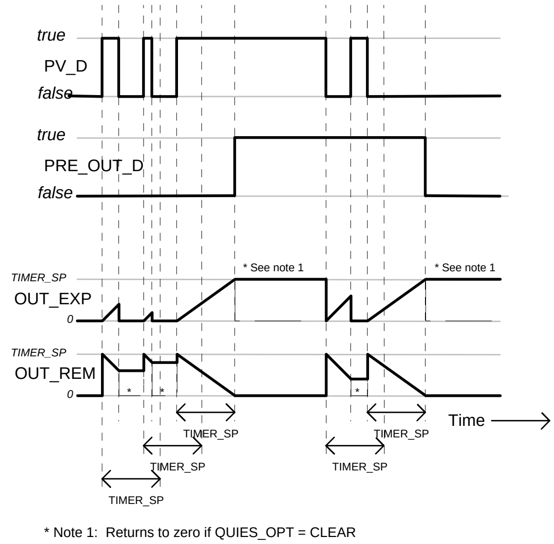
Timer Example when TIMER_TYPE = DELAY

- 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.



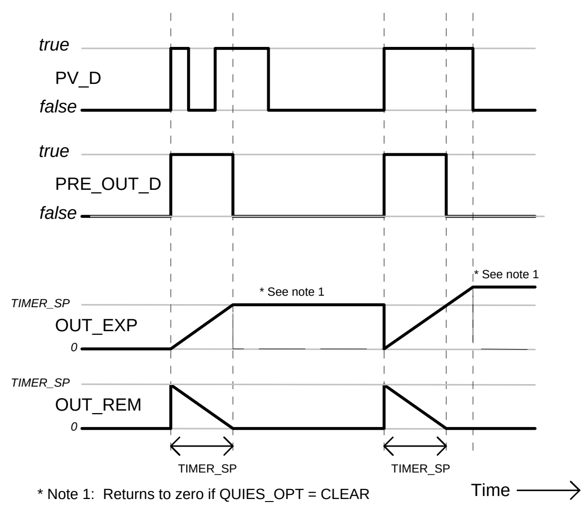
Timer Example when TIMER_TYPE = EXTEND

- 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-tofalse 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.



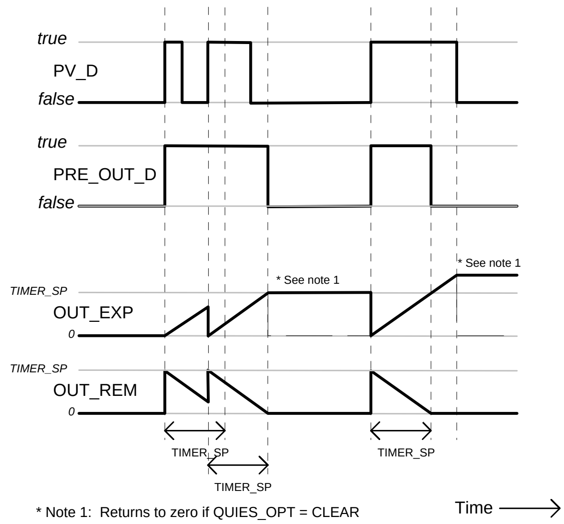
Timer Example when TIMER_TYPE = DEBOUNCE

- 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.

Initialization

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.

BLOCK_ERR

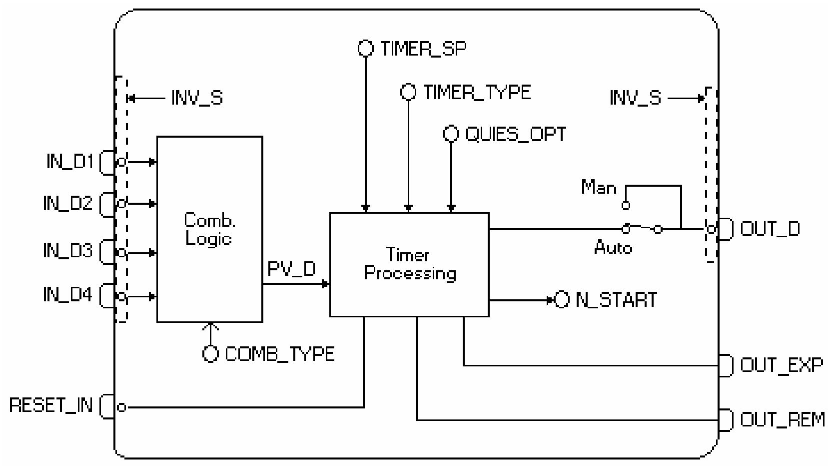
The BLOCK_ERR of the TIME block will indicate the following causes:

- 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.

Modos Suportados

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/RO	
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	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 to the 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.

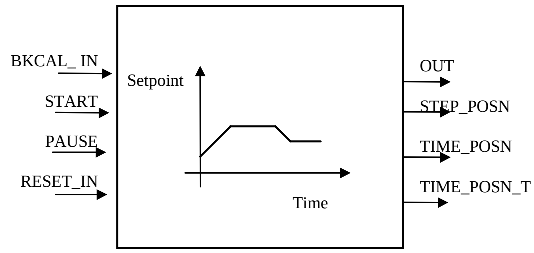
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2

If the BEHAVIOR parameter is configured as "Adapted":
The default value of TIME_UNITS is "Seconds".
The default value of QUIES_OPT is "CLEAR".

SPG – Setpoint Ramp Generator

Description

The Setpoint generator block is normally used to generate a Setpoint to a PID block in applications like temperature control, batch reactors, etc. In those applications, the Setpoint shall follow a certain profile in function of the time.



The block algorithm shall comply with the following:

1) The profile is determined by up to ten segments or steps. Each segment is defined by a starting value [START_VAL] and a time duration [DURATION].The starting value of the next segment determines if the previous segment ramps up, down or remains constant. The profile is given by two parallel arrays and a parameter for the time unit:

START_VAL (Starting value) - Eleven floating point values defining the initial value of each step, in engineering units.

DURATION (Time duration) - Ten floating point values defining the duration, in seconds, of each step. A null value defines the last step.

TIME_UNITS **-** A contained unsigned-eight parameter used to specify the time units used for display.

2) The two arrays define the Setpoint value (y-axis) in function of the time (t-axis). Between two given points, the Setpoint is calculated by interpolation. As each segment is defined by $[START\_VAL]_i$, $[DURATION]_i$ and $[START\_VAL]_{i+1}$, a profile with "**n**" segments will need **n+1** starting values and **n** time durations. As example, the two following arrays define the profile shown on Fig. 1:

	1	2	3	4	5	6
START_VAL	25	50	50	100	100	25
DURATION	60	60	120	60	60	0

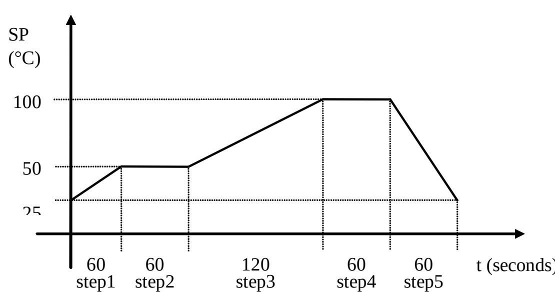


Fig.1 – Setpoint Profile

3) The timer is started by a transition from false to true at input START.

4) The timer may be interrupted at any time by changing the discrete signal PAUSE from false to true. It will resume running when PAUSE is set to false. The PAUSE will not force manual mode.

5) The timer is also interrupted by a PAUSE caused by the deviation between BKCAL_IN and the generated Setpoint. If the deviation exceeds DV_HI_LIM or DV_LO_LIM, an alarm is indicated in DV_HI_ALM or DV_LO_ALM, respectively. Both alarms stop the timer and resume normal operation when the deviation is within the prescribed limits.

6) The Setpoint is in the "y" axis, while the time is in the "t" axis. The Setpoint value is available at output OUT. It is also available in PRE_OUT even when the block is in Man mode. For display purpose, the engineering unit of OUT is given by OUT_SCALE.

7) Three outputs inform the current point of the profile:

STEP_POSN – Informs the current segment or step.

TIME_POSN – Informs the time elapsed since the beginning of the current step.

TIME_POSN_T - Informs the time elapsed since the beginning of the profile.

8) With the block in manual, the operator can write on the outputs STEP_POSN, TIME_POSN and TIME_POSN_T in order to select a particular point of the profile. When the block is switched back to auto, the profile will start from that point. The timer is restarted by activating the input START.

9) With the block in manual, the operator can also modify OUT. As the adjusted value may correspond to more than one point on the profile or to none, if the operator adjusts a value beyond the profile limits, the OUT value goes from the last adjusted value to the point before mode switching following a ramp defined by BAL_TIME.

10) Another operation that can be done with the block in manual, is to advance or return the time through the following operator commands (OP_CMD_SPG):

ADVANCE – sets the time to the beginning of the next step.

REPEAT – sets the time to the beginning of the current step.

11) The outputs can only be modified with the block is in manual mode.

12) The operator can give a RESET command using OP_CMD_SPG with the block in any mode. The timer is set to zero, i.e., to the beginning of the profile. In this case the operator must give a new start, by switching the input START from false to true. Therefore the block may be started even though the OP_CMD_SPG remains with RESET value.

13) The input RESET_IN allows a discrete signal coming from another block to set the timer to zero. While this input parameter has value TRUE, the block will remain in reset, therefore it will be able to start only after this input parameter goes to FALSE.

14) When the time reaches the last point of the profile, it will automatically return to zero (RESET) and restart (START) automatically, if the parameter AUTO_CYCLE is set to true.

15) The operation status is given by the parameter SPG_STATE

READY – When the profile is at the beginning, waiting for the starting signal.
ACTIVE – When the timer is "on".
PAUSE – When the PAUSE signal stopped the timer.
AT_END – When the time reaches the last point of the profile.

16) The parameter PAUSE_CAUSE enumerates the cause of the PAUSE state:

1 = Operator Pause
2 = Logic Pause
3 = Operator & Logic
4 = Deviation pause
5 = Operator & Deviation
6 = Logic & Deviation
7 = Operator & Logic & Deviation

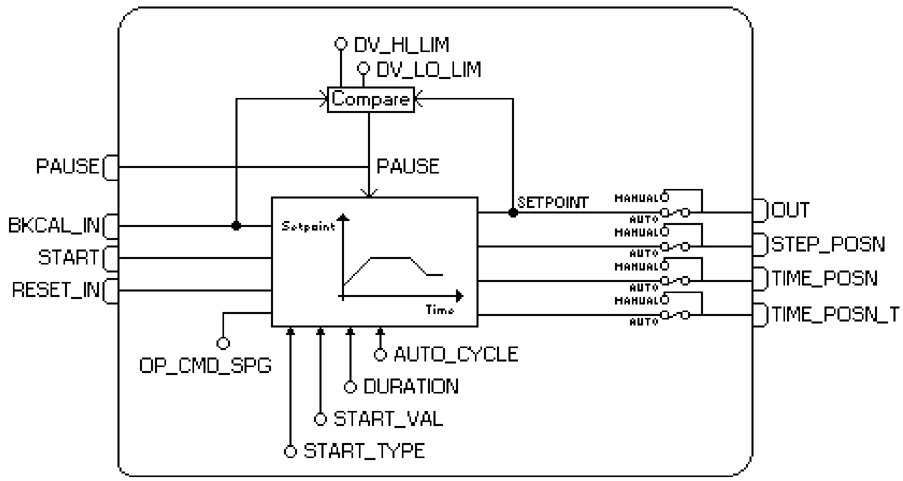
Logic Pause happens when the deviation limits are exceeded or the PID block is not in Cascade mode.

17) Sometimes there is a large deviation between the controlled variable (available in BKCAL_IN) and the profile initial value. In this situation, the timer may not be started or the control will start with a large upset. In order to avoid these problems, the parameter START_TYPE offers the following options:

a - USE_CURVE - The curve starts as specified by START_VAL and DURATION.
b - USE_DUR - The curve starts at BKCAL_IN value and use the duration specified.
c - USE_RATE - The curve starts at BKCAL_IN value and use the rate specified by the first two START_VAL values and the first DURATION value.

18) The input BKCAL_IN can be connected to the output of an Analog Input block or to the BKCAL_OUT of a PID control block. If a PID is connected, the CONTROL_OPTS of the PID should be configured to use PV for BKCAL_OUT. If the PID is not in Cas mode when the operation status is READY (see 15), initialization will occur as described in 17. If the operation status is ACTIVE, the block will go to IMan mode and behave as described in 9 to make the value of OUT equal the value of BKCAL_IN.

Schematic



BLOCK_ERR
The BLOCK_ERR of the SPG block will reflect the following causes:

- Block Configuration Error – the configuration error occurs when the START_TYPE parameter has an invalid value;
- Out of Service – it occurs when the block is in O/S mode.

Supported Modes
O/S, IMAN, MAN and AUTO.

Status
If the status of BKCAL_IN is bad and the option Use uncertain of STATUS_OPTS is set to true, the deviation alarms are not considered. If the status of any used input becomes bad or uncertain and the respective option Use bad or Use uncertain of STATUS_OPTS is not set, the block actual mode will be forced to manual.

Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
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	See Mode Parameter.
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**OUT**	DS-65	OUT_SCALE +/- 10%		OUT	N / Man	The analog value calculated as a result of executing the function.
8	OUT_SCALE	DS-68		0-100%	OUT	S / Man	The high and low scale values to the OUT parameter.
9	GRANT_DENY	DS-70		0	na	D	Options for controlling access of host computer and local control panels to operating, tuning and alarm parameters of the block.
10	STATUS_OPTS	Bitstring(2)	See Block Options	0	Na	S / O/S	See Block Options.
11	**START_VAL**	11 Floats					An array of up to eleven points defines the starting point of each segment of the Setpoint profile, in engineering units.
12	**DURATION**	10 Floats		0's	Sec	S	An array of up to ten points defines the duration of each segment of the Setpoint profile, in seconds.
13	TIME_UNITS	Unsigned8	1=seconds 2=minutes 3=hours 4=days 5=[day-[hr:[min[:sec]]]]	0		E	Display Time Units for TIME_POSN and TIME_POSN_T.
14	**BKCAL_IN**	DS-65			OUT	N	The value and status from a lower block's BKCAL_OUT that is used to prevent reset windup and to initialize the control loop.
15	**START**	DS-66			On/Off	D	A transition from false to true starts the timer.
16	**START_TYPE**	Unsigned8	1=Use Curve 2=Use Duration 3=Use Rate	0	E	S	This parameter selects the starting point option.
17	**PAUSE**	DS-66				D	Stops the timer when set to true. Resume time running when set back to false.
18	**PAUSE_CAUSE**	Unsigned8	0=Not paused 1=Operator Pause 2=Logic Pause 4=Deviation Pause 3=Operator & Logic 5=Operator & Deviation 6=Logic & Deviation 7=Operator & Logic & Deviation			E	This parameter enumerates the causes of PAUSE.
19	AUTO_CYCLE	Unsigned8	1:Auto cycle	0	E	S	When set to *true*, automatically resets the time to the beginning of the first step and restarts the timer.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
20	**STEP_POSN**	DS-66	0=none 1=step1 2=step 2 n=step n	0	E	D / Man	Determine the current step or segment of the profile in auto mode. Direct the timer to the step specified by the operator when in manual mode.
21	**TIME_POSN**	DS-65			Sec	D / Man	Determine the time elapsed since the beginning of the step in auto mode. The operator can set the time since the beginning of the current step when operating in manual.
22	TIME_POSN_T	DS-65			Sec	N / Man	Determine the time elapsed since the beginning of the curve in auto mode. The operator can set the time since the beginning of the curve when operating in manual.
23	**OP_CMD_SPG**	Unsigned8	0=UNDEFINED 1=RESET_IN 2=ADVANCE 3=REPEAT	0	E	D	Enable the positioning in the profile. Enumerations are:, RESET, ADVANCE*, REPEAT*. (*only valid with the block in manual).
24	**SPG_STATE**	Unsigned8	0=UNDEFINED 1=READY 2=ACTIVE 3=PAUSE 4=AT_END		E	N	Define the operating state of the block. Enumerations are: READY, ACTIVE, PAUSE and AT_END.
25	PRE_OUT	DS-65				D	Displays what would be the OUT value and status if the mode was Auto or lower.
26	**RESET_IN**	DS-66	0:Off 1:Reset		E	D	Resets the timer.
27	BAL_TIME	Float	Positive	0	sec	S	This specifies the time for the internal working value of bias or ratio to return to the operator set bias or ratio, in seconds.
28	OUTAGE_LIM	Float	Positive	0	Sec	S	The maximum tolerated duration for power failure. This feature is not supported.
29	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
30	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.
31	ALARM_SUM	DS-74	See Block Options		Na	S	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
32	ACK_OPTION	Bitstring(2)	0: Auto ACK Disable 1: Auto ACK Enable	0	Na	S	Selection of whether alarms associated with the block will be automatically acknowledged.
33	ALARM_HYS	Float	0 to 50 %	0.5%	%	S	Alarm hysteresis parameter. In order to clear the alarm the amount the PV must return within the alarm limit plus hysteresis.
34	DV_HI_PRI	Unsigned8	0 to 15			S	Priority of the high deviation alarm.
35	DV_HI_LIM	Float	+(OUT_SCALE) OU +(INF)	+INF	OUT	S	The setting for high deviation alarm in engineering units.
36	DV_LO_PRI	Unsigned8	0 to 15			S	Priority of the low deviation alarm.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
37	DV_LO_LIM	Float	-(OUT_SCALE) OU -(INF)	-INF	OUT	S	The setting for low deviation alarm in engineering units.
38	DV_HI_ALM	DS-71			OUT	D	The status for high deviation alarm and its associated time stamp.
39	DV_LO_ALM	DS-71			OUT	D	The status for low deviation alarm and its 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

If BEHAVIOR parameter is "Adapted":
The default value of START_TYPE is "Use Curve".
The required mode for writing is the actual mode, regardless the target mode: OUT, TIME_POSN, TIME_POSN_T and STEP_POSN

MBCF – ModBus Configuration

Overview

This block configures the communication parameters of the Modbus protocol.

Description

This block configures the communication parameters between the DFI302 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 DFI302. 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 DFI302 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 DFI302. The MASTER_SLAVE parameter defines if the DFI302 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 Port

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 (Default)
- 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 DFI302 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.

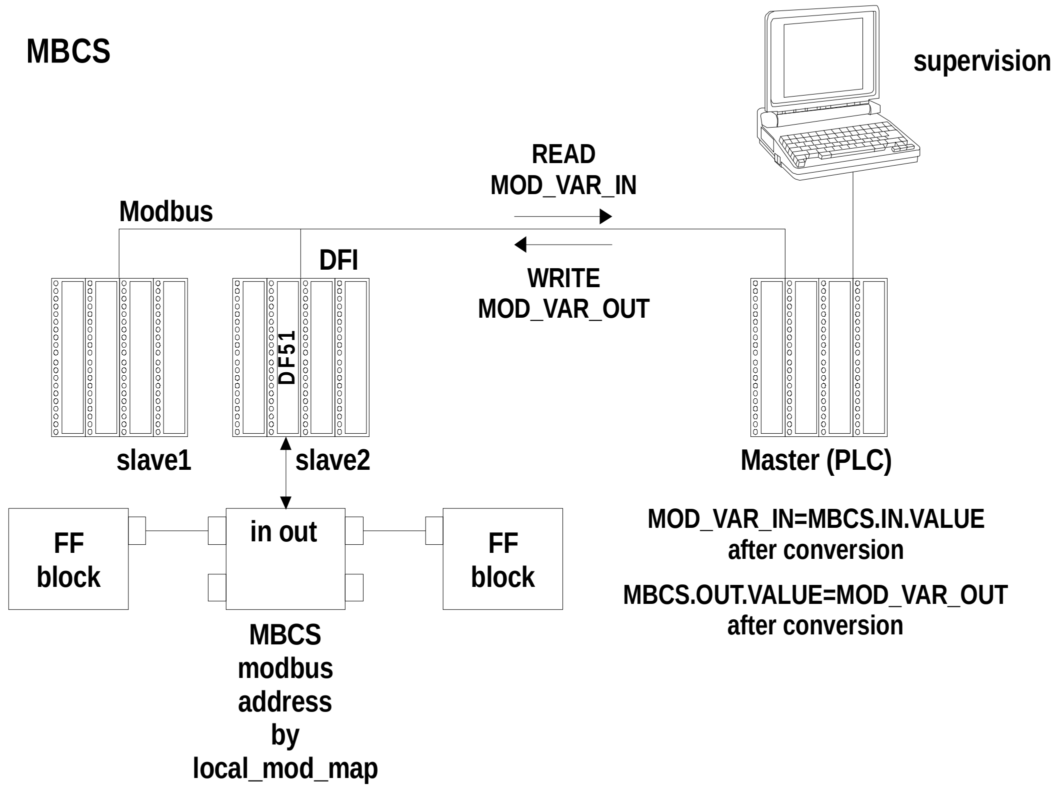
Parameters

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
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 DFI302 is a master or slave.
9	**DEVICE_ADDRESS**	Unsigned8	1-247	1	E	S	Defines the DFI302 Modbus address (only for the DFI302 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 DFI302 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 DFI302 doesn't receive an answer from the slave.
15	SLAVE_ADDRESSES	DS-263				S	IP number and modbus addresses of the slaves (only for DFI 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 DFI 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	UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
21	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

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 DFI302 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 DFI302.

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.

Parameter LOCAL_MODE_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_MODE_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 is configured, a whole range is selected, not only a specific address.

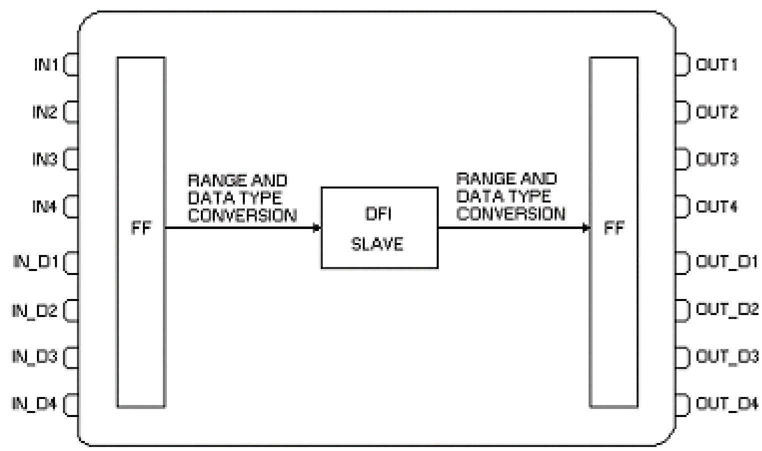
INn and OUTn values use two MODBUS registers (for example IN1, 40041 and 40042) because the data type is float. IN_Dn and OUT_Dn values use one MODBUS register (for example IN_D1, 41). Status values also use only one register.

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 12 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

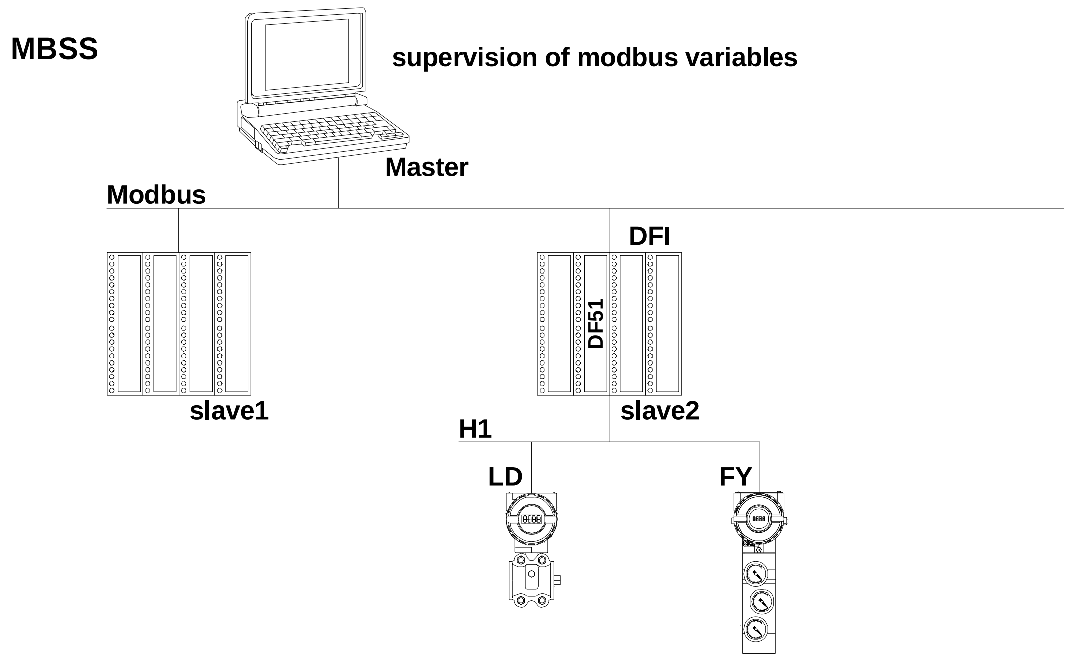
Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter.
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**LOCAL_MODE_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.

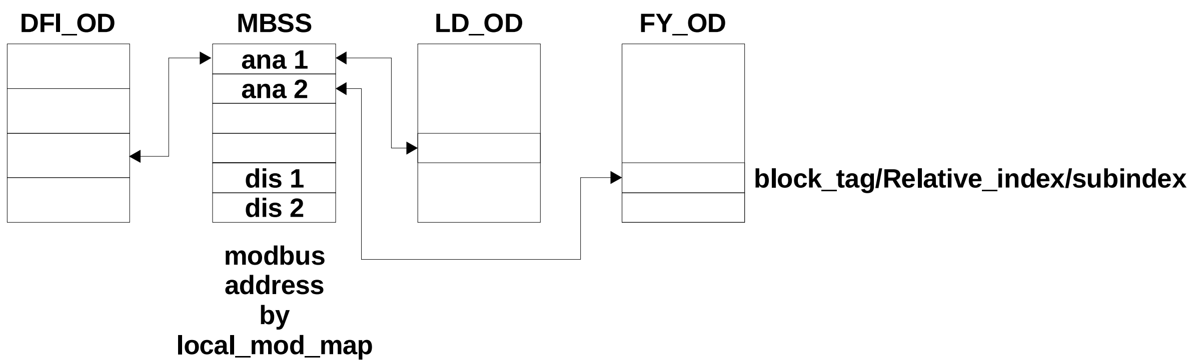
Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
12	IN3	DS-65				N	Analog input 3.
13	SCALE_CONV_IN3	DS-256				S / O/S	Information to generate the constants A and B in the equation Y=A*X+B.
14	IN4	DS-65				N	Analog input 4.
15	SCALE_CONV_IN4	DS-256				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 master is 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

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 DFI302 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.

LOCAL_MODE_MAP Parameter

This parameter will attribute the MODBUS address to the variables to be monitored. See the table below:

LOCAL_MODE_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_MODE_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:

- 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

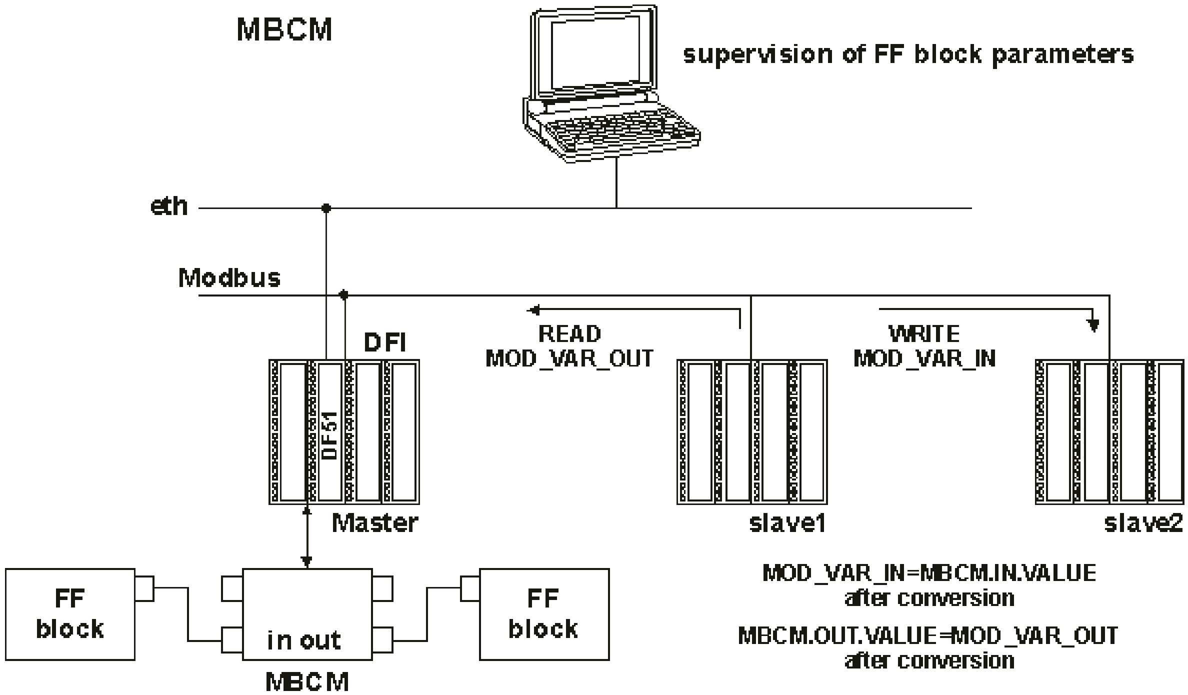
Idx	Parameter	Data Type (Length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter.
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**LOCAL_MODE_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 (FVALUE1).
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 (FVALUE2).
11	**FVALUE2**	Float		0		N	Value of the requested float parameter.

Idx	Parameter	Data Type (Length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
12	F_ID3	DS-262				S / O/S	Information to locate the float parameter (FVALUE3).
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 (FVALUE4).
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 (FVALUE5).
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 (FVALUE6).
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 (FVALUE7).
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 (FVALUE8).
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 (IVALUE1).
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 (IVALUE2).
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 (IVALUE3).
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 (IVALUE4).
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 (BVALUE1).
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 (BVALUE2).
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 (BVALUE3).
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 (BVALUE4).
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.
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

MBCM – ModBus Control Master

Overview



Description
This block controls the communication in a strategy where the DFI302 is a MODBUS master and the slaves can exchange data among them and with the DFI302. 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_MODE_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 consists 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 12 for further details.

The following table shows the input/output treatment:

Input/Output	Configured Status (MODBUS_A.DDRESS_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.

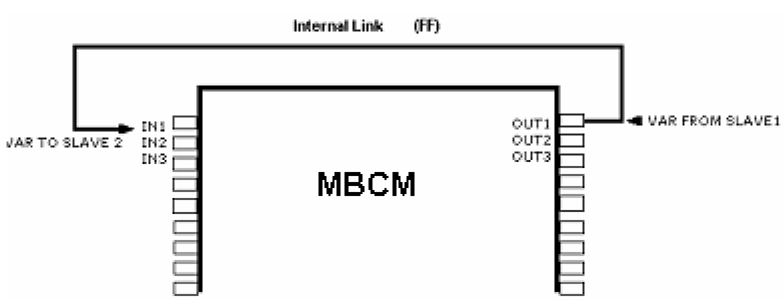
Usually the MODBUS addresses are:

The Modbus protocol standard specifies the division of the address range for the variables.

- 0001 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.

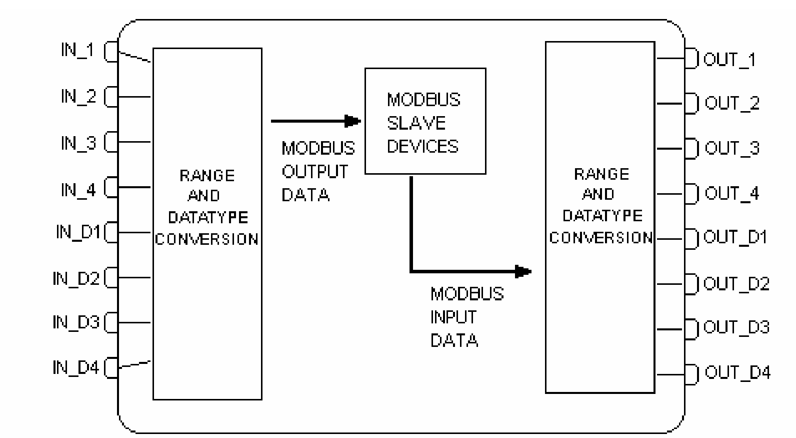
Relation between bits in BAD_STATUS and Modbus addresses

BIT	VARIABLE
0	N1
1	IN2
2	IN3
3	IN4
4	IN_D1
5	IN_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

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

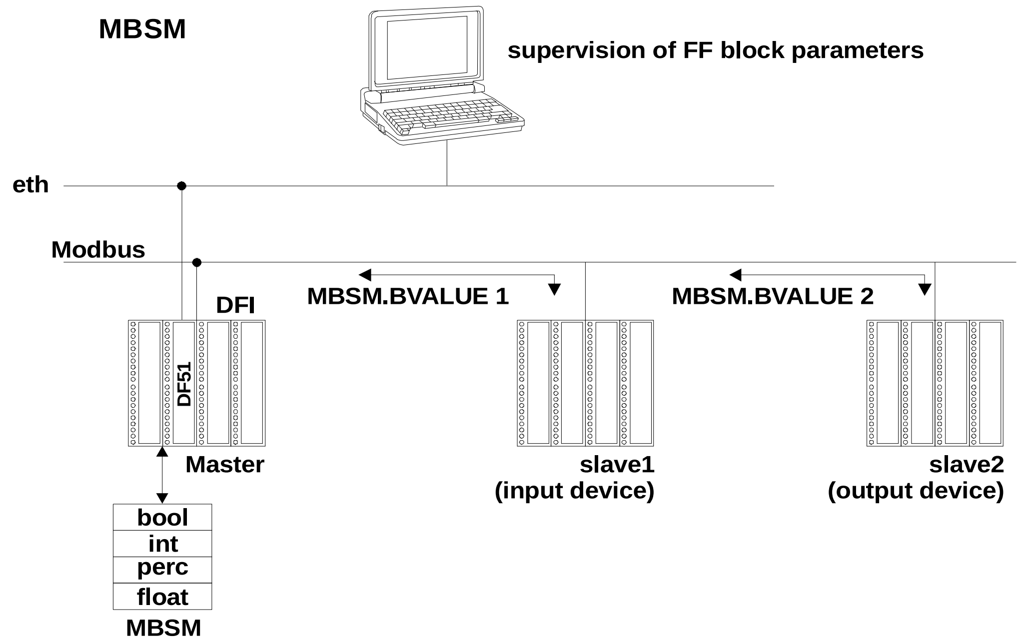
Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
2	TAG_DESC	OctString(32)		Spaces	Na	S	
3	STRATEGY	Unsigned16		0	None	S	
4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	**MODE_BLK**	DS-69		O/S	Na	S	Refer to the Mode Parameter.
6	**BLOCK_ERR**	Bitstring(2)			E	D / RO	
7	**LOCAL_MODE_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	**LOCATOIN_D1**	DS-261				S / O/S	Addresses in a slave device.
19	**IN_D2**	DS-66				N	Discrete input 2.
20	**LOCATOIN_D2**	DS-261				S / O/S	Addresses in a slave device.
21	**IN_D3**	DS-66				N	Discrete input 3.
22	LOCATOIN_D3	DS-261				S / O/S	Addresses in a slave device.
23	**IN_D4**	DS-66				N	Discrete input 4.
24	LOCATOIN_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
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.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
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	LOCATOOUT_D2	DS-261				S / O/S	Addresses in a slave device.
37	**OUT_D3**	DS-66				N / Man	Discrete output 3
38	LOCATOOUT_D3	DS-261				S / O/S	Addresses in a slave device.
39	**OUT_D4**	DS-66				N / Man	Discrete output 4
40	LOCATOOUT_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

MBSM – ModBus Supervision Master

Overview



Description

This block enables the DFI302 to monitor MODBUS variables. The DFI302 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.

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_MODE_MAP

All MBSM 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.
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

- 0001 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. Each parameter consists of the following elements:

- From EU 100%;
- From EU 0%;
- To EU 100%;
- To EU 0%;
- Data Type;
- 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 chapter12 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.

Parameter BAD_STATUS
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	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
1	ST_REV	Unsigned16		0	None	S/RO	
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_MODE_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 (FVALUE1).
10	**FVALUE1**	Float		0		N	Value of the requested address.
11	FLOCATOR2	DS-260				S / O/S	Information to locate the float parameter (FVALUE2).
12	**FVALUE2**	Float		0		N	Value of the requested address.
13	PLOCATOR1	DS-258				S / O/S	Information to locate the percentage parameter (PVALUE1).
14	**PVALUE1**	Float		0		N	Value of the requested address.
15	PLOCATOR2	DS-258				S / O/S	Information to locate the percentage parameter (PVALUE2).
16	**PVALUE2**	Float		0		N	Value of the requested address.
17	ILOCATOR1	DS-260				S / O/S	Information to locate the integer parameter (IVALUE1).
18	ILENGTH1	Integer8	1,2,4	2		S / O/S	Data length.
19	**IVALUE1**	Integer32		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**	Integer32		0		N	Value of the requested address.
23	BLOCATOR1	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE1).
24	**BVALUE1**	Boolean		TRUE		N	Value of the requested addresses.
25	BLOCATOR2	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE2).
26	**BVALUE2**	Boolean		TRUE		N	Value of the requested addresses.
27	BLOCATOR3	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE3).
28	**BVALUE3**	Boolean		TRUE		N	Value of the requested addresses.
29	BLOCATOR4	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE4).
30	**BVALUE4**	Boolean		TRUE		N	Value of the requested addresses.
31	BLOCATOR5	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE5).
32	**BVALUE5**	Boolean		TRUE		N	Value of the requested addresses.
33	BLOCATOR6	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE6).
34	**BVALUE6**	Boolean		TRUE		N	Value of the requested addresses.
35	BLOCATOR7	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE7).
36	**BVALUE7**	Boolean		TRUE		N	Value of the requested addresses.
37	BLOCATOR8	DS-260				S / O/S	Information to locate the boolean parameter (BVALUE8).
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	Data Type (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.

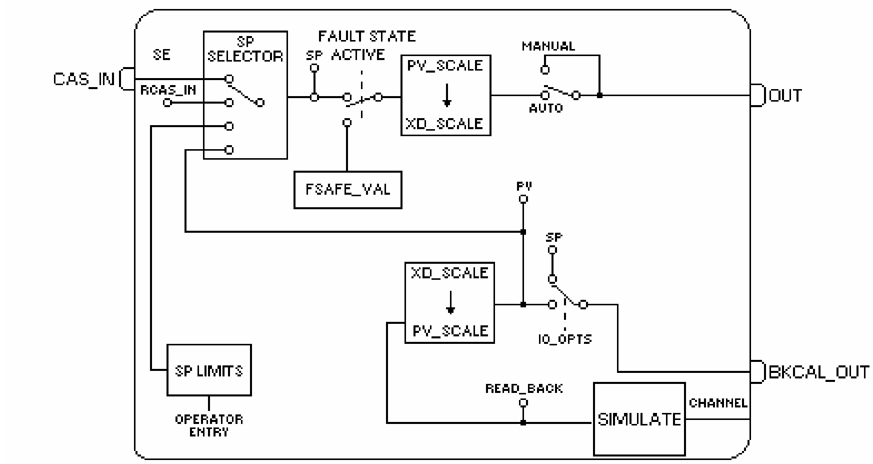
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non-volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2

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:

- Block Configuration Error – the configuration error is indicated when one or more of the following situations occur:
    - When the CHANNEL or SHED_OPT parameters have an invalid value;
    - When the XD_SCALE doesn't have a engineering unit and/or a range proper for the respective transducer block;
    - When the transducer block is in O/S mode;
    - When it is not compatible to the CHANNEL parameter and the HC configuration (DFI302).
- Simulate Active – When the Simulate is active.
- Local Override – When the block is in LO mode because the fault state is active.
- Output Failure – I/O module failed (DFI302).
- 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/RO	
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.
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	Depends on the device type. See the correspondent manual for more details.	Depends on the device type. See the description item for more details.	XD	S / Man	The higher and lower scale values for the transducer of a specific channel. The default value of each Smar device is below: FY302: 0 to 100 [%] FP302: 3 to 15 [psi] FI302: 4 to 20 [mA] DFI302: 0 to 100 [%]
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.

Idx	Parameter	Data Type (length)	Valid Range Options	Default Value	Units	Store / Mode	Description
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 PV 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.
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 change.
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

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 Outputs

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

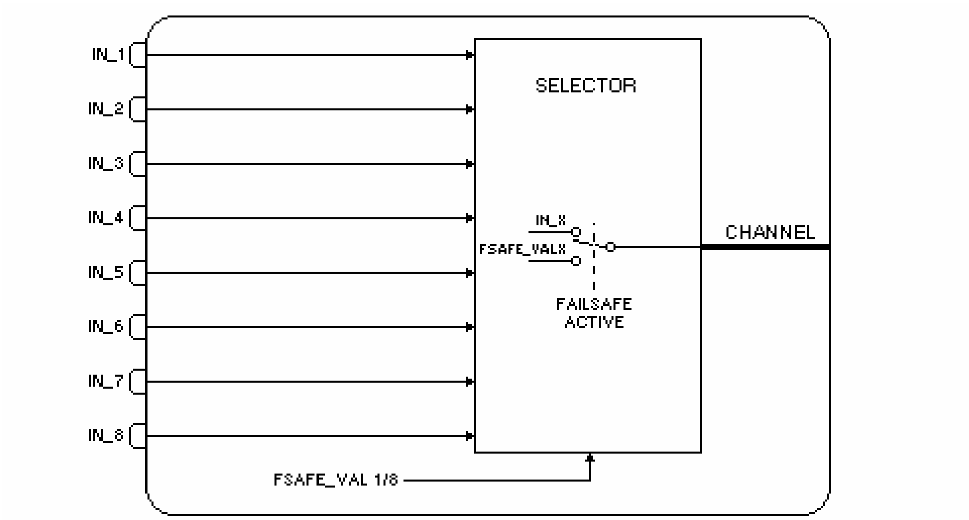
The BLOCK_ERR of the MDO block will indicate the following causes:

- 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/RO	
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	**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.
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 available 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.

Idx	Parameter	Data Type (length)	Valid Range Options	Default Value	Units	Store/ Mode	Description
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.
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

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.

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	ATUAL_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	ATUAL_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	ATUAL_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	ATUAL_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.
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.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
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 Address procedure. 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 transducerblock.
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	OctString, 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	BitString	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).

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
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.
58	PORT_MACROCYCLE_SUGGESTED_ms	Unsigned long	0 to 2^{32}	—		RO	Suggested macrocycle. **Nota: 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	BitString, 8 bytes 256 bits	0 to 15	—		RO	Live list of the selected port.
64	PORT_LIVE_LIST_STATUS_2	BitString, 8 bytes 256 bits	16 to 31	—		RO	Live list of the selected port.
65	PORT_LIVE_LIST_STATUS_3	BitString, 8 bytes 256 bits	32 to 47	—		RO	Live list of the selected port.
66	PORT_LIVE_LIST_STATUS_4	BitString, 8 bytes 256 bits	48 to 63	—		RO	Live list of the selected port.
67	PORT_LIVE_LIST_STATUS_5	BitString, 8 bytes 256 bits	64 to 79	—		RO	Live list of the selected port.
68	PORT_LIVE_LIST_STATUS_6	BitString	80 to 95	—		RO	Live list of the selected port.
69	PORT_LIVE_LIST_STATUS_7	BitString, 8 bytes 256 bits	96 to 111	—		RO	Live list of the selected port.
70	PORT_LIVE_LIST_STATUS_8	BitString, 8 bytes 256 bits	112 to 127	—		RO	Live list of the selected port.
71	PORT_LIVE_LIST_STATUS_9	BitString, 8 bytes 256 bits	128 to 143	—		RO	Live list of the selected port.
72	PORT_LIVE_LIST_STATUS_10	BitString, 8 bytes 256 bits	144 to 159	—		RO	Live list of the selected port.
73	PORT_LIVE_LIST_STATUS_11	BitString, 8 bytes 256 bits	160 to 175	—		RO	Live list of the selected port.
74	PORT_LIVE_LIST_STATUS_12	BitString, 8 bytes 256 bits	176 to 191	—		RO	Live list of the selected port.
75	PORT_LIVE_LIST_STATUS_13	BitString, 8 bytes 256 bits	192 to 207	—		RO	Live list of the selected port.
76	PORT_LIVE_LIST_STATUS_14	BitString, 8 bytes 256 bits	208 to 223	—		RO	Live list of the selected port.
77	PORT_LIVE_LIST_STATUS_15	BitString, 8 bytes 256 bits	224 to 239	—		RO	Live list of the selected port.
78	PORT_LIVE_LIST_STATUS_16	BitString, 8 bytes 256 bits	240 to 254	—		RO	Live list of the selected port.
79	PORT_STATISTICS_RESET	BitString 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 a 2^{32}	0		RO	Number of frames received by the selected port.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
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.
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, including 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	VisibletString, 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	VisibletString		—		R/W	Device ID of the selected device.
93	DEV_TAG	VisibletString		—		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	OctString		—		RO	Device Manufacturer ID.
97	DEV_TYPE_2	OctString		—		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.

Idx	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Handling	Description
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.
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	VisibletString		—		R/W	Block tag.
115	BLK_DD_ITEM	OctString		—		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	OctString ,4		—		R/W	VCR local address.
121	VCR_REMOTE_ADDR	OctString, 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 Maximum Short Source	—		R/W	VCR authentication.
125	VCR_MAX_DLSDU_SIZE	Unsigned int	0 to 2^{16}	—		R/W	VCR Dlsdu 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	oct 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**	Bit String	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 reconfigured. **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

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

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

TMT – Tank Measurement Transducer

Description
This block contains general information about the TM302, that is, non specific to a measured stream, either related to 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 TM302 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), password (PASSWORD – only writing, no view) and configuration of the second password if double password is required (PASSWORD_2 – only writing, no view).

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 access restriction by password are registered in the configuration log. However, there are cases that have only access restriction, that is, are not registered in the TM302 memory, 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;
R2 – Restriction requiring Level 2.

User Logon Process in the TM302
To change the configuration, the user needs to be registered in the TM302 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 TM302 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 TM302 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.

TM302 real time clock
The TM302 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 / Interpretation
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 TMView chapter.

Initialization of registers and reports in the TM302 memory
The registers and reports in the TM302 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	Only the QTR reports.

WARNING
When the initialization of register/report starts, it means they will be removed from the TM302 memory. Thus these operations must be accomplished only after assuring the reports were already stored in the database by TMView. 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 TMVIEW_VSN parameter must be configured with the volume serial number of the hard disk where the TMView designated to read the register/report of the TM302 is executing, only this computer will do this operation. This procedure avoids the registers and reports of one TM302 to be downloaded by different computers, which would cause a scattered database.

If the TMVIEW_VSN parameter is not configured, its default value is null. It means that any computer executing the TMView 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 (SI or USA units);
b) Choosing the Engineering Unit for each kind of variable (custom).

The user can select in the TMT block the following Engineering Units 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).

TMT Parameter	Unit(*)	Description	Engineering Units for USA system	Engineering Units for SI system
SELECTABLE UNITS				
T_UNITS	T	Temperature	°F	°C
P_UNITS	P	Pressure	psia	kPa
LD_UNITS (**)	LD	Liquid Density	°API	kg/m^3
LV_UNITS	LV	Liquid Volume	Bbl	m^3
M_UNITS	M	Mass	klb	ton
VISC_UNITS	VISC	Viscosity	cp	Pa.s
L_UNITS	L	Length	inch	mm
DERIVED UNITS				
	F	Compressibility Factor - F	1/[P]	
	G	Coefficient of Thermal Expansion: Gl, Ga and Gc	1/[T]	
	QV	Volume Flow Rate	[V]/h	
	QM	Mass Flow Rate	[M]/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 –> API-11.1 tables 5 & 6 and API-11.2.1.;
- kg/ m^3 -> API-11.1 tables 53 & 54 (base temperature of 15°C) or tables 59 & 60 (base temperature of 20°C) and API-11.2.1.M

Note
It is recommended to download the reports/registers from the TM302 before changing any Engineering Unit, because the Engineering Unit indicated in the reports is that one configured in the TM302 at the moment of download by TMView. 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 TM302 changes automatically the date/hour of the real time clock according to the configuration. These events are registered in the TM302 memory (showed by the AEV block) and are also detected at the beginning or the ending when the daylight-saving time occurs when the TM302 is turned off.

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;

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type (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.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the Mode Parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7		COMPANY_NAME	Visiblestring[32]		Blank		S	Company identification. It is used to generate reports.
8		LOCAL_NAME	Visiblestring[32]		Blank		S	Identification of the place where the measurement is being done. It is used to generate reports.
9		RESPONSIBLE_NAME	Visiblestring[32]		Blank		S	Identification of the responsible for the reports.
10		MANAGER_NAME	Visiblestring[32]		Blank		S	Identification of the responsible manager for the reports.
11 (A1)	2	SYSTEM_UNITS	Unsigned8	0=SI 1=USA units 2=Custom	0	E	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.
12 (A1)		T_UNITS	Unsigned16	1000=Kelvin 1001=Celsius 1002=Fahrenheit 1003=Rankine	Celsius	E	S	Engineering Unit for Temperature.
13 (A1)		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.
14 (A1)		LD_UNITS	Unsigned16	1097= Kg/m^3 1113=API 1599 = relatve 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).
15 (A1)		LV_UNITS	Unsigned16	1034=cubic meter 1038=liter 1048=US gallon 1051=barrel 1600=MCF	m^3	E	S	Engineering Unit for liquid volume.
16 (A1)		M_UNITS	Unsigned16	1088=kilogram 1092=ton 1094=pound 1601=kilo pound	ton	E	S	Engineering Unit for mass.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
17 (A1)		VISC_UNITS	Unsigned16	1159=Pascal second 1162=centipoise	Pa.s	E	S	Engineering Unit for viscosity.
18 (A1)		L_UNITS	Unsigned16	1013=mm 1019=in	mm	E	S	Engineering Unit for lenght.
19 (A2)	2	LOCAL_GRAVITY	Float	> 0	9,815.0	L/s^2	S	Gravity acceleration in the measurement.
20 (A2)	2	AIR_DENSITY	Float	> 0	1.2E-3	M/LV	S	Air density in the measurement.
21		USER_NAME	Visiblestring[8]		Blank		D	Selection of the User name to change the configuration. Also identifies the user that is already registered to changes the configuration.
22	1	LOGIN	Unsigned8	1 to 30=Login 1 / 30	0	E	D	Login for configuration changes with access restriction.
23	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.
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)	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.
26 (RA)	2	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.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
27 (AA)	4	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.
28 (A1)	2	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.
29 (A2)		USER_NAME_1	Visiblestring[8]		User 1		S	User name related to login 1.
30 (A2)		USER_NAME_2	Visiblestring[8]		User 2		S	User name related to login 2.
31 (A2)		USER_NAME_3	Visiblestring[8]		User 3		S	User name related to login 3.
32 (A2)		USER_NAME_4	Visiblestring[8]		User 4		S	User name related to login 4.
33 (A2)		USER_NAME_5	Visiblestring[8]		User 5		S	User name related to login 5.
34 (A2)		USER_NAME_6	Visiblestring[8]		User 6		S	User name related to login 6.
35 (A2)		USER_NAME_7	Visiblestring[8]		User 7		S	User name related to login 7.
36 (A2)		USER_NAME_8	Visiblestring[8]		User 8		S	User name related to login 8.
37 (A2)		USER_NAME_9	Visiblestring[8]		User 9		S	User name related to login 9.
38 (A2)		USER_NAME_10	Visiblestring[8]		User 10		S	User name related to login 10.
39 (A2)		USER_NAME_11	Visiblestring[8]		User 11		S	User name related to login 11.
40 (A2)		USER_NAME_12	Visiblestring[8]		User 12		S	User name related to login 12.
41 (A2)		USER_NAME_13	Visiblestring[8]		User 13		S	User name related to login 13.
42 (A2)		USER_NAME_14	Visiblestring[8]		User 14		S	User name related to login 14.
43 (A2)		USER_NAME_15	Visiblestring[8]		User 15		S	User name related to login 15.
44 (A2)		USER_NAME_16	Visiblestring[8]		User 16		S	User name related to login 16.
45 (A2)		USER_NAME_17	Visiblestring[8]		User 17		S	User name related to login 17.
46 (A2)		USER_NAME_18	Visiblestring[8]		User 18		S	User name related to login 18.
47 (A2)		USER_NAME_19	Visiblestring[8]		User 19		S	User name related to login 19.
48 (A2)		USER_NAME_20	Visiblestring[8]		User 20		S	User name related to login 20.
49 (A2)		USER_NAME_21	Visiblestring[8]		User 21		S	User name related to login 21.
50 (A2)		USER_NAME_22	Visiblestring[8]		User 22		S	User name related to login 22.
51 (A2)		USER_NAME_23	Visiblestring[8]		User 23		S	User name related to login 23.
52 (A2)		USER_NAME_24	Visiblestring[8]		User 24		S	User name related to login 24.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
53 (A2)		USER_NAME_25	Visiblestring[8]		User 25		S	User name related to login 25.
54 (A2)		USER_NAME_26	Visiblestring[8]		User 26		S	User name related to login 26.
55 (A2)		USER_NAME_27	Visiblestring[8]		User 27		S	User name related to login 27.
56 (A2)		USER_NAME_28	Visiblestring[8]		User 28		S	User name related to login 28.
57 (A2)		USER_NAME_29	Visiblestring[8]		User 29		S	User name related to login 29.
58 (A2)		USER_NAME_30	Visiblestring[8]		User 30		S	User name related to login 30.
59 (A2)	1	RTC	Date				N	Date and hour in real time.
60	1	RTC_RD	Unsigned8[7]				D / RO	Date and hour, in numeric format, read from the TM302 in real time.
61	1	RTC_WR	Unsigned8[7]				D	Date and hour to be typed in the real time clock TM302 of the in numeric format.
62 (A2)	1	RTC_CMD	Unsigned8	0=None 1=Copy from TM302 to RTC_WR 2=Copy from RTC_WR to TM302 3=Failed	0	E	D	Command to read or write in the real time clock of the TM302.
63 (A2)	4	DS_START_DAY	Unsigned8	0 to 31 0=disabled	0	NA	S	Starting day of the daylight saving time.
64 (A2)	4	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.
65 (A2)	4	DS_END_DAY	Unsigned8	0 to 31 0=disabled	0	NA	S	Ending day of the daylight-saving time.
66 (A2)	4	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.
67	4	START_HOUR	Unsigned8	0 to 23	0	Hour	S	Hour that starts the counting period of the day.
68	4	START_DAY_WEEK	Unsigned8	1=Monday to 7=Sunday	1	E	S	Day that starts the counting period of the week.
69	4	START_DAY_MONTH	Unsigned8	1 to 28	1	Day of month	S	Day that starts the counting period of the month.
70 (AA)	1	CLEAR_LOG	Unsigned8	0 = None 1 = Clear all loggers 2=ATV-config log 3=AEV-alarm and event 4=STGV-tank measurement 5=TWTV-well test	0	Na	D	Writing “Clear all loggers” in this parameter, all logger types will be removed (STGV, ATV, AEV, TWTV) from the TM302 memory. This procedure must be accomplished only after certifying that all information was saved by the TMView in database and the correspondent report was printed.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
71 (AA)		TMVIEW_VSN	Visiblestring[9]		Blank		S	Serial number of the hard disk where the TMView is installed. Only the TMView executed in this computer will communicate with the TM302.
72		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
73		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.

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

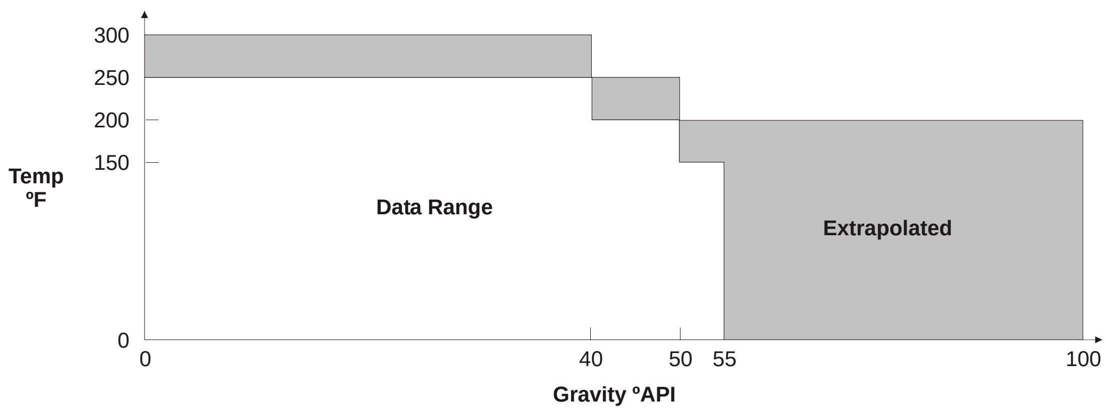
STD – Shore Tank Database

Information about measured products (PRODUCTx_INFO)
The products measured by TM302 are showed in the graphs below following the specifications of API-11.1 and also the correspondent valid ranges for density and temperature for calculation of the correction factors.

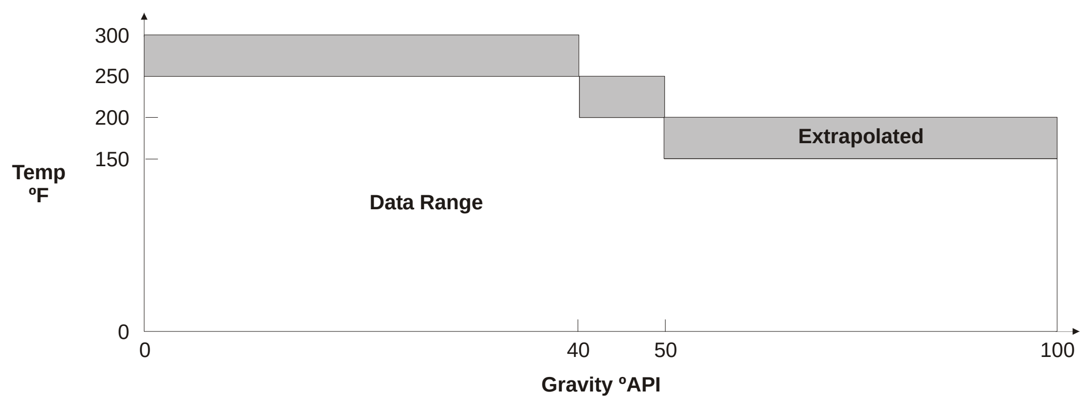
To calculate the temperature (CTL) and pressure (CPL) correction factors, if the density or temperature were out of the established range by the standard, these factors will assume the value 1. This event will be registered in the logger and accessed via AEV block, and also it will be showed in the summarized status of the QTR report for the correspondent period.

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.

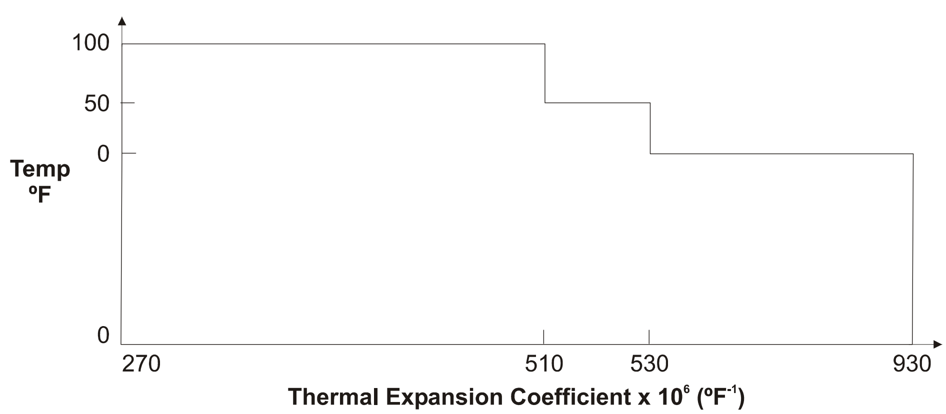
Tables used in the CTL calculation:



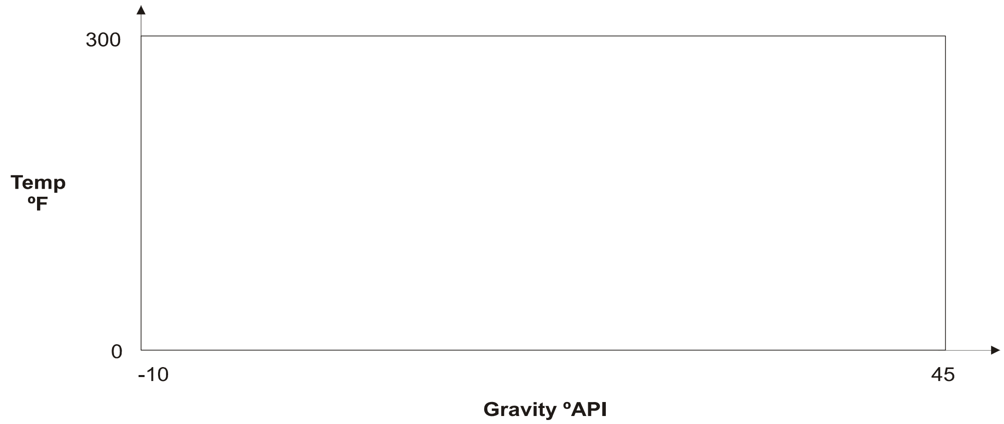
Graph for Tables 5A/6A – Crude Oil



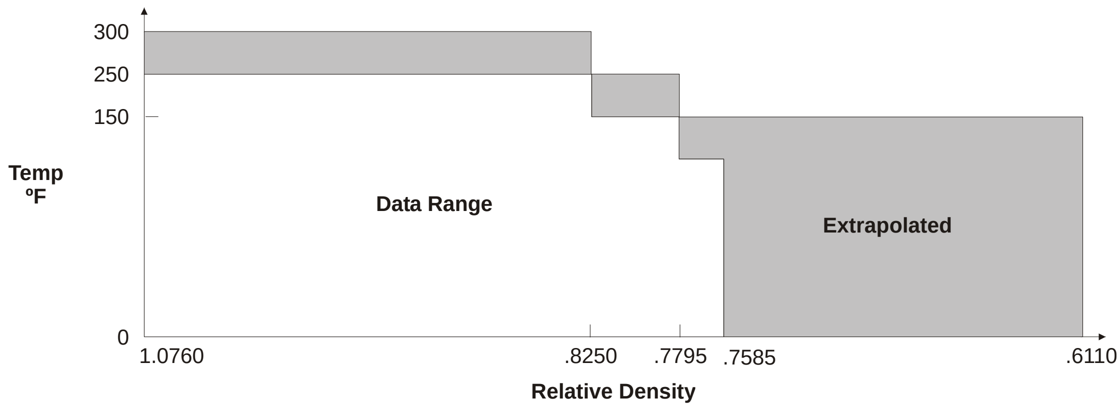
Graph for Tables 5B/6B – Generalized Products



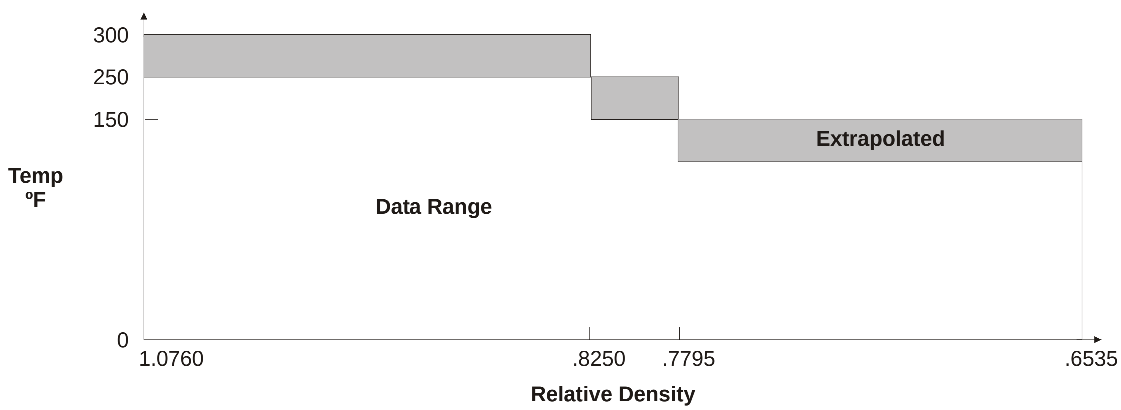
Graph for Table 6C – MTBE



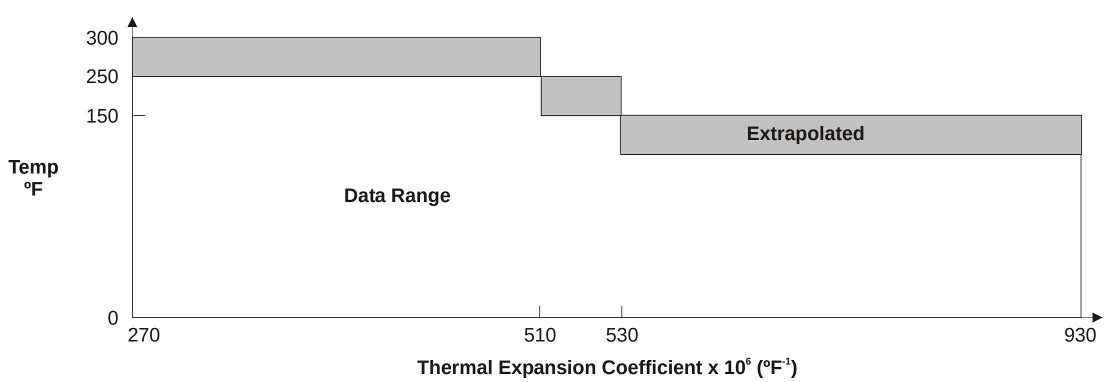
Graph for Tables 5D/6D – Lubricant Oil



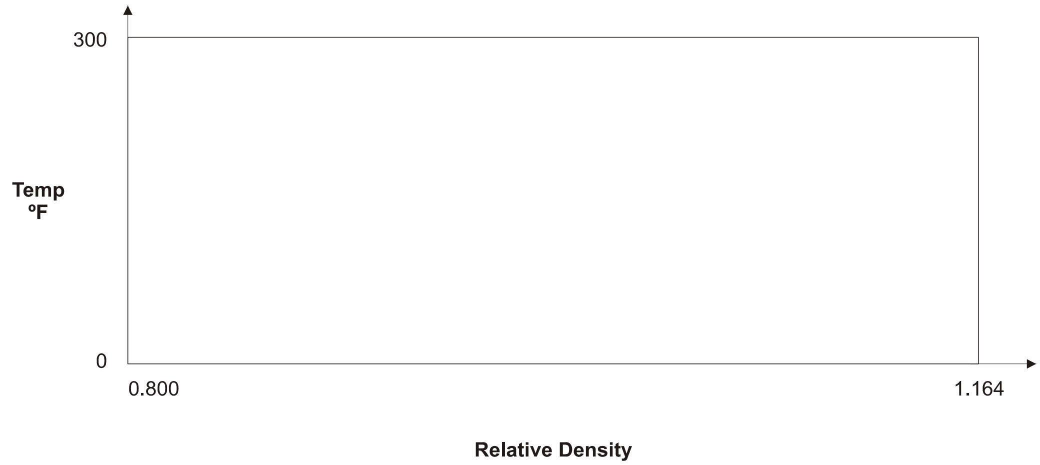
Graph for Tables 23A/24A – Crude Oil



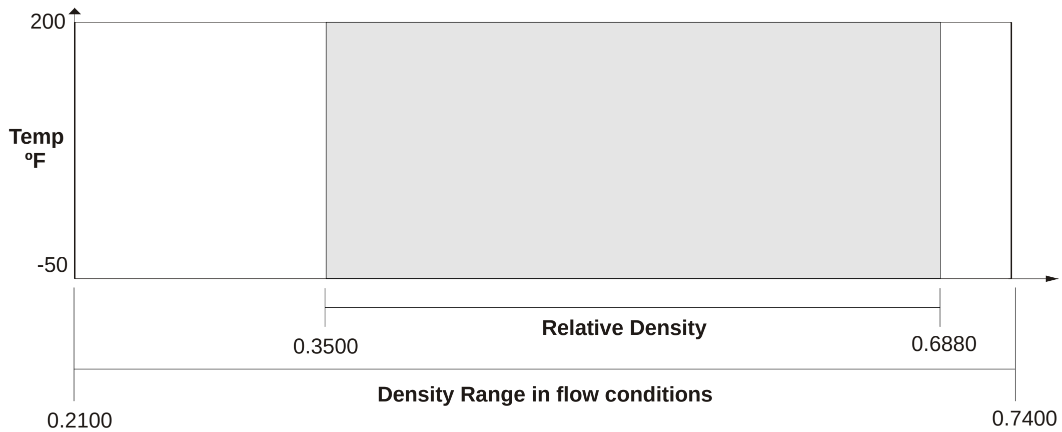
Graph for Tables 23B/24B – Generalized Products



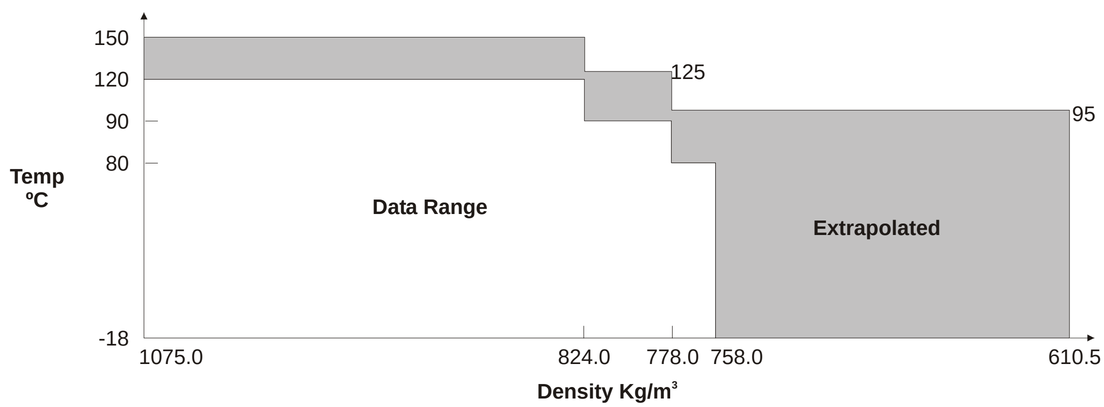
Graph for Table 24C - MTBE



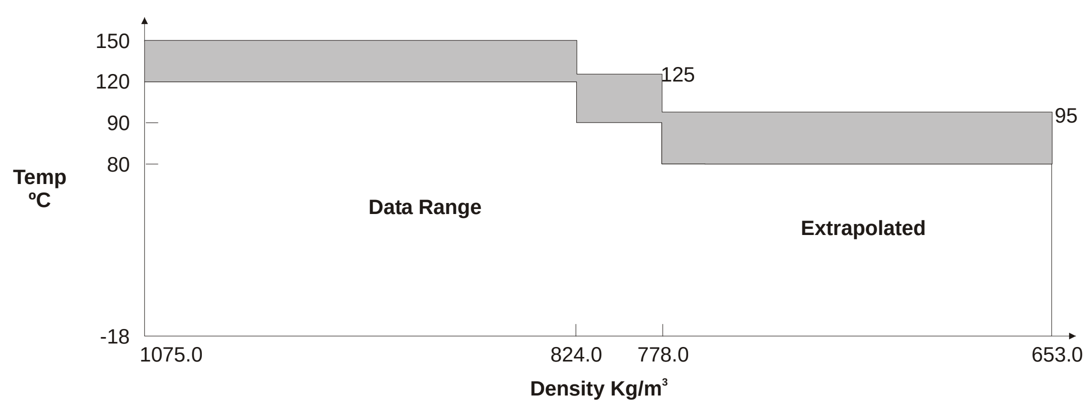
Graph for Tables 23D/24D – Lubricant Oil



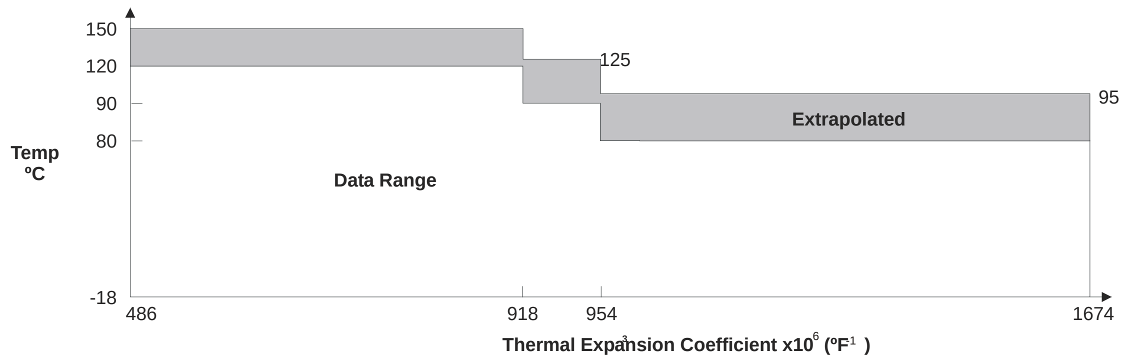
Graph for Tables 23E/24E – Light Hydrocarbon



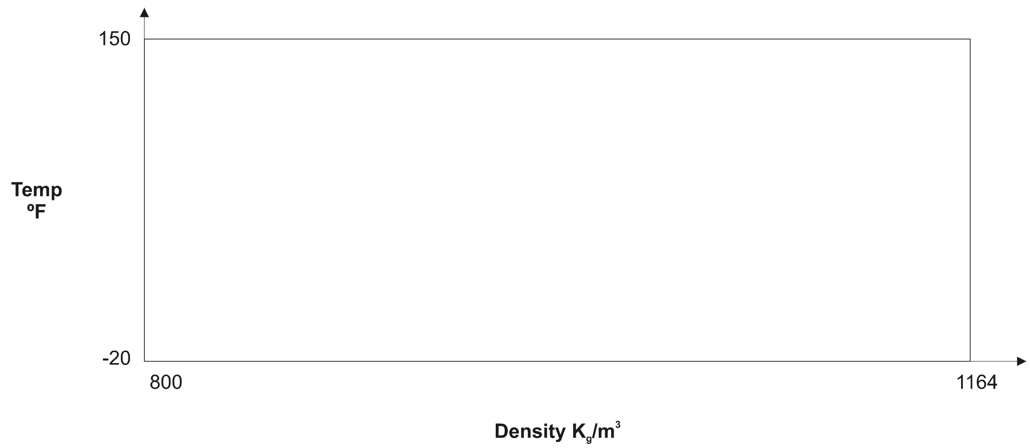
Graph for Tables 53A/ 54A/ 59A/ 60A – Crude Oil



Graph for Tables 53B/54B/59B/60B – Generalized Products



Graph for Tables 54C/59C – MTBE



Graph for Tables 53D/54D/59D/60D – Lubricant 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

Note
If is not possible to calculate the correction factor (CTL or CPL), for any reason, (for example, out of range of standard applicability) the used value will be 1 (one). In this situation will also be indicated in the status "Out of range correction factor".

Tables used in the CPL calculation:

Standard	Base Density Range	Temperature Range
API-11.2.1	0-90 API @ 60 °F	-20 to 200 °F
API-11.2.1.M	638-1074 Kg/m^3 @15° C	-30 to 90 °C
API-11.2.2 (*)	0.350-0.637 RD (60°F/60°F)	-50°F to 140°F
API-11.2.2.M (*)	350-637 Kg/m^3 @15° C	-46°C to 60°C

(*) 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 to 140°F

The GPA TP 15 standard establishes two calculation formulas:

- New Correlation – Related to base density and temperature → mix of propane, mx of butane and NGL (mainly pentane and hexane). It must be configured in PRODUCTx_INFO.Absolute equilibrium pressure @100F = 0.
- 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, lubricant 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 kg/m^3	60°F/15°C to 280°F/138°C

The CPL calculation for water utilizes the following factors for compressibility, according to the API-12.2.3 appendix A4:

F	Engineering Unit
3.20E-6	Psi^{-1}
4.64E-7	kPa^{-1}

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 TM302 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 density 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

Ethanol Measurement – NBR 5992-80 or OIML R22-75

- Must necessarily be in liquid stage.
- It is a mix of water and ethanol.
- NBR 5992: alcoholic content (percentage in mass in mix) from 66% to 100%.
- OIML R22: alcoholic content (percentage in mass in mix) from 0% to 100%.

Table 1 - BASE DENSITY - NBR 5992

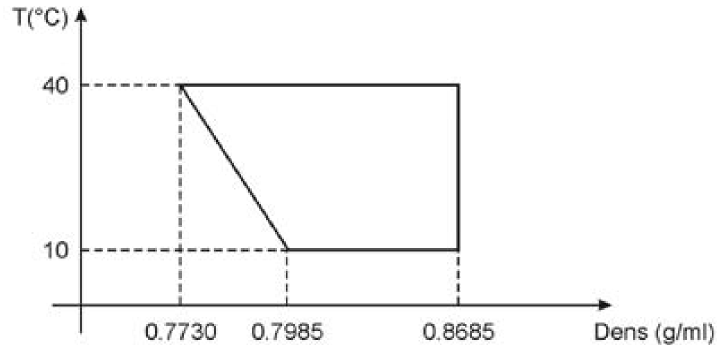
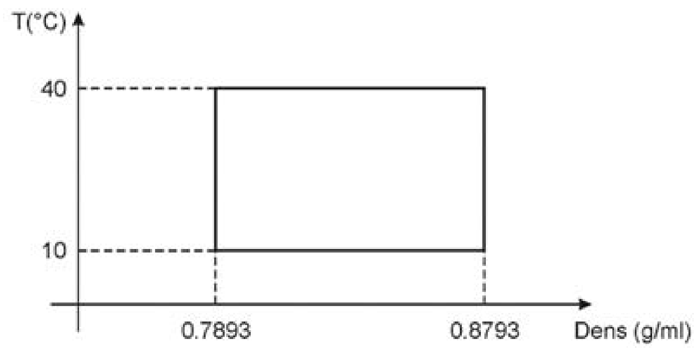
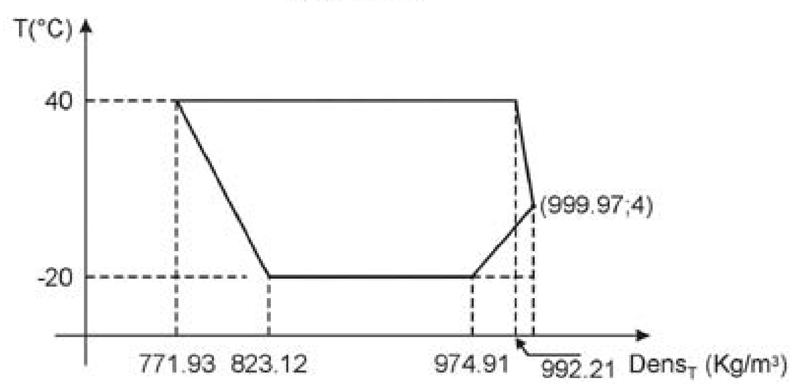


Table 2 - CTL - NBR 5992



OIML R22



Measurement Tanks Configuration

Tank ID	Tank Type	Application	Features
1-4	Real	Fiscal measurement: at least meter of automatic level, could be completely combined with analysis result in laboratory.	• Atmospheric cylindrical tanks no thermal isolation. • Fixed or floating roof • Calibration curve: 2 to 800 points • Can also be used for manual measurement, that is, it can work as simulate tank.
5-16	Simulate	Operational measurement and well test with manual input of the information.	• Atmospheric cylindrical tanks no thermal isolation. • Fixed roof • Calibration Curve: up to 40 points • Used exclusively for manual measurement.

Material type used in tanks

Material Type	Coefficient of lineal thermal dilation (GI)		Elasticity module (E)		Poisson Coefficient (σ)
	SI (°C^{-1})	USA (°F^{-1})	SI (Kpa)	USA (psi)	
Mild carbon	0.0000112	0.00000620	206 800 000	30 000 000	0.29
304 Stainless	0.0000173	0.00000960	193 100 000	28 000 000	0.29
316 Stainless	0.0000159	0.00000883	193 100 000	28 000 000	0.29
17-4PH Stainless	0.0000108	0.00000600	196 500 000	28 500 000	0.29

Tank of Floating Roof

There are two possible ways to do the correction due to the floating roof:

- Adjustment integrate to the tank table for a reference density (TANKx_ROOF_WEIGHT = 0):

If level > TANKx_LEVEL_FRA, then
FRA = (TANKx_DENS_FRA – Flowing Density) * TANKx_VOL_FRA

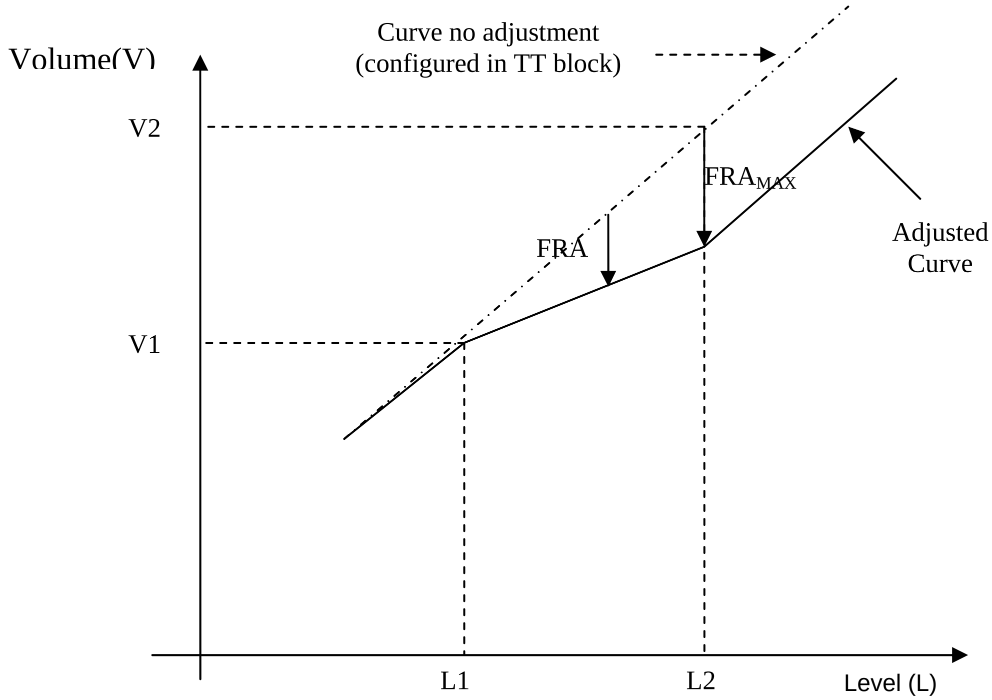
In this case the transition phase where the roof begins the floating state up to the phase where the roof is totally floating is in the tank table. The calculation above is applied when the roof is totally floating (level superior to TANKx_LEVEL_FRA). The transition phase is ignored.

- Tank table without any adjustment for floating roof (TANKx_ROOF_WEIGHT > 0):

If level > TANKx_START_FRA and level < TANKx_LEVEL_FRA, there is a transition where FRA is calculated by the following equation:

$$FRA = \frac{L - L1}{L2 - L1} * FRA\max$$

Where:
L1 : TANKx_START_FRA parameter
L2 : TANKx_LEVEL_FRA parameter
V1 : volume from the tank table – TOV(TANKx_START_FRA)
V2 : volume from the tank table – TOV(TANKx_LEVEL_FRA)
FRAmax : It is the adjustment when the roof is totally floating (TANKx_ROOF_WEIGHT/Flowing density).



If level > TANKx_LEVEL_FRA, then

$$FRA = -\frac{TANKx\_ROOF\_WEIGHT}{\text{Base density} * CTL} = -\frac{TANKx\_ROOF\_WEIGHT}{\text{Flowing Density}}$$

Inventory

The following parameters supply basic information for the inventory of the real tanks used in the measurement (STG) and well test (TWT) that are:

- INVENTORY_STATE: It indicates if the tank is receiving, sending, waiting the level stabilization, verifying leak or executing well test (TWT.TEST_STATE=Measuring or Stabilizing)
- INVENTORY_INNAGE: level in length unit
- INVENTORY_LEVEL: level in percentage of the maximum height of operation
- INVENTORY_GOV: gross volume at operation conditions
- INVENTORY_STATUS

It is also possible to configure a sum of the real tanks volumes through the parameter INVENTORY_EQ, that is indicated in INVENTORY_GOV[5].

Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration: this indication can occur due to: a) one curve is not monotonic; b) one of the tanks selected in INVENTORY_EQ is not in use as indicated in TANK_IN_USE; c) the selected tanks in the INVENTORY_EQ are not measuring the same product type; d) tanks of floating roof: TANKx_START_FRA must be smaller or equal to TANKx_LEVEL_FRA.
2. BLOC_ERR.Other: occur when one of the tanks does not have a table.

Parameters

Idx	Type/ View	Parameter	Data Type (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	255	0	None	S / RO	This parameter is used to identify the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (A1)	4	BASE_PRESSURE	Float SI-DD3 US-DD3 Bar-DD5	101.325 kPa or 14.696 psi	101.325 kPa	P	S / RO	Base pressure for the fluid according to the SYSTEM_UNITS selected in the TMT block.
8 (A1)	4	BASE_TEMPERATURE	Float SI-DD2 US-DD1	15.00 °C or 20.00 °C or 60.0 °F	20.0 °C	T	S	Base temperature for the fluid according to the SYSTEM_UNITS selected in the TMT block.
9	2	TANK1_TAG	Visiblestring[16]		Tank 1		S	Tag for tank 1.
10		TANK1_SITE_TAG	Visiblestring[16]		Site 1		S	Tag of the measurement site for tank 1.
11 (A2)	2	TANK1_TYPE	Unsigned8	0=Upright cylindrical – fixed roof 1=Upright cylindrical – floating roof 2=Horizontal cylindrical 3=Sphere	0	E	S	Type of tank 1.
12 (A2)	4	TANK1_FIRST_TABLE	Unsigned8	0 = None 1-20 = Table 1-20	0	E	S	Selection of the first capacity table for tank 1.
13 (A2)		TANK1_NUM_TABLE	Unsigned8	1-20	1	Na	S	Number of tables used for tank 1 curve.
14 (A2)	4	TANK1_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 1 table.
15 (A2)	4	TANK1_STEEL_TYPE	Unsigned8	1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 1.
16 (A2)	4	TANK1_ALPHA	Float	> 0	0.0000112	G	S / RO	Linear coefficient of thermal expansion for the material of the tank 1.
17 (A2)	4	TANK1_ROOF_WEIGHT	Float	>= 0.0 0.0=FRA in table	0.0	M	S	Tank 1 roof weigh. Used only in tanks of floating roof in that the tank table does not include adjustment for a reference density (TANK1_DENS_FRA).
18 (A2)	4	TANK1_LEVEL_FRA	Float	>= 0.0	0.0	L	S	Level which an adjustment on the correction factor of the floating roof for the tank 1 is requested.
19 (A2)		TANK1_DENS_FRA	Float			LD	S	Reference density for the adjustment of the floating roof integrated to tank 1 table.
20 (A2)	4	TANK1_VOL_FRA	Float	>= 0.0	0.0	LV/LD	S	Volumetric variation for liquid density unit at process condition referent to the correction factor of the tank 1 floating roof.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
21 (A2)		TANK1_PRODUCT	DS-270				S	Information of the measured product in tank 1.
22	2	TANK2_TAG	Visiblestring[16]		Tank 2		S	Tag for tank 2.
23		TANK2_SITE_TAG	Visiblestring[16]		Site 2		S	Tag of the measurement site for tank 2.
24 (A2)	2	TANK2_TYPE	Unsigned8	0=Upright cylindrical – fixed roof 1=Upright cylindrical – floating roof 2=Horizontal cylindrical 3=Sphere	0	E	S	Type of tank 2.
25 (A2)	4	TANK2_FIRST_TABLE	Unsigned8	0 = None 1-20 = Table 1-20	0	E	S	Selection of the first capacity table for tank 2.
26 (A2)		TANK2_NUM_TABLE	Unsigned8	1-20	1	Na	S	Number of tables used for tank 2 curve.
27 (A2)	4	TANK2_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 2 table.
28 (A2)	4	TANK2_STEEL_TYPE	Unsigned8	1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 2.
29 (A2)	4	TANK2_ALPHA	Float	> 0	0.0000112	G	S / RO	Linear coefficient of thermal expansion for the material of the tank 2.
30 (A2)	4	TANK2_ROOF_WEIGHT	Float	>= 0.0 0.0=FRA in table	0.0	M	S	Tank 2 roof weigh. Used only in tanks of floating roof in that the tank table does not include adjustment for a reference density (TANK2_DENS_FRA).
31 (A2)	4	TANK2_LEVEL_FRA	Float	>= 0.0	0.0	L	S	Level which an adjustment on the correction factor of the floating roof for the tank 2 is requested.
32 (A2)		TANK2_DENS_FRA	Float			LD	S	Reference density for the adjustment of the floating roof integrated to tank 2 table.
33 (A2)	4	TANK2_VOL_FRA	Float	>= 0.0	0.0	LV/LD	S	Volumetric variation for liquid density unit at process condition referent to the correction factor of the tank 2 floating roof.
34 (A2)		TANK2_PRODUCT	DS-270				S	Information of the measured product in tank 2.
35	2	TANK3_TAG	Visiblestring[16]		Tank 3		S	Tag for tank 3.
36		TANK3_SITE_TAG	Visiblestring[16]		Site 3		S	Tag of the measurement site for tank 3
37 (A2)	2	TANK3_TYPE	Unsigned8	0=Upright cylindrical – fixed roof 1=Upright cylindrical – floating roof 2=Horizontal cylindrical 3=Sphere	0	E	S	Type of tank 3.
38 (A2)	4	TANK3_FIRST_TABLE	Unsigned8	0 = None 1-20 = Table 1-20	0	E	S	Selection of the first capacity table for tank 3.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
39 (A2)		TANK3_NUM_TABLE	Unsigned8	1-20	1	Na	S	Number of tables used for tank 3 curve.
40 (A2)	4	TANK3_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 3 table.
41 (A2)	4	TANK3_STEEL_TYPE	Unsigned8	1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 3.
42 (A2)	4	TANK3_ALPHA	Float	> 0	0.0000112	G	S / RO	Linear coefficient of thermal expansion for the material of the tank 3.
43 (A2)	4	TANK3_ROOF_WEIGHT	Float	>= 0.0 0.0=FRA in table	0.0	M	S	Tank 3 roof weigh. Used only in tanks of floating roof in that the tank table does not include adjustment for a reference density (TANK3_DENS_FRA).
44 (A2)	4	TANK3_LEVEL_FRA	Float	>= 0.0	0.0	L	S	Level which an adjustment on the correction factor of the floating roof for the tank 3 is requested.
45 (A2)		TANK3_DENS_FRA	Float			LD	S	Reference density for the adjustment of the floating roof integrated to tank 3 table.
46 (A2)	4	TANK3_VOL_FRA	Float	>= 0.0	0.0	LV/LD	S	Volumetric variation for liquid density unit at process condition referent to the correction factor of the tank 3 floating roof.
47 (A2)		TANK3_PRODUCT	DS-270				S	Information of the measured product in tank 3.
48	2	TANK4_TAG	Visiblestring[16]		Tank 4		S	Tag for tank 4.
49		TANK4_SITE_TAG	Visiblestring[16]		Site 4		S	Tag of the measurement site for tank 4.
50 (A2)	2	TANK4_TYPE	Unsigned8	0=Upright cylindrical – fixed roof 1=Upright cylindrical – floating roof 2=Horizontal cylindrical 3=Sphere	0	E	S	Type of tank 4.
51 (A2)	4	TANK4_FIRST_TABLE	Unsigned8	0 = None 1-20 = Table 1-20	0	E	S	Selection of the first capacity table for tank 4.
52 (A2)		TANK4_NUM_TABLE	Unsigned8	1-20	1	Na	S	Number of tables used for tank 4 curve.
53 (A2)	4	TANK4_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 4 table.
54 (A2)	4	TANK4_STEEL_TYPE	Unsigned8	1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 4.
55 (A2)	4	TANK4_ALPHA	Float	> 0	0.0000112	G	S / RO	Linear coefficient of thermal expansion for the material of the tank 4.
56 (A2)	4	TANK4_ROOF_WEIGHT	Float	>= 0.0 0.0=FRA in table	0.0	M	S	Tank 4 roof weigh. Used only in tanks of floating roof in that the tank table does not include adjustment for a reference density (TANK1_DENS_FRA).

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
57 (A2)	4	TANK4_LEVEL_FRA	Float	>= 0.0	0.0	L	S	Level which an adjustment on the correction factor of the floating roof for the tank 4 is requested.
58 (A2)		TANK4_DENS_FRA	Float			LD	S	Reference density for the adjustment of the floating roof integrated to tank 4 table.
59 (A2)	4	TANK4_VOL_FRA	Float	>= 0.0	0.0	LV/LD	S	Volumetric variation for liquid density unit at process condition referent to the correction factor of the tank 4 floating roof.
60 (A2)		TANK4_PRODUCT	DS-270				S	Information of the measured product in tank 4.
61		TANK_IN_USE	Bitstring[2] See TANK_DATABASE definition			Na	N / RO	It indicates which Tank ID's are in use.
62	2	INVENTORY_EQ	Bitstring[2] See TANK_DATABASE definition			Na	S	This parameter defines which tanks will be added in the inventory.
63		INVENTORY_STATE	Unsigned8[4]	0=None 1=Start Rec (Wr) 2=Receiving 3=Stop (Wr) 4=Stabilizing 5=Checking leak 6=Start Del (Wr) 7=Delivering 8=Restart (Wr) 9=Running well test			N / RO	It indicates the state of each measurement tank.
64		INVENTORY_INNAGE	Float[4] SI-DD1 US-DD2			L	N / RO	Level in the measurement tanks.
65		INVENTORY_LEVEL	Float[5] DD1			%	N / RO	Level in percentage of MAX_HEIGHT. The fifth element is not used.
66	1,3	INVENTORY_GOV	Float[5] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	GOV (Gross volume at operation condition) of the measurement tanks, as well as the sum of the tanks selected in INVENTORY_EQ.
67	1,3	INVENTORY_NSV	Float[5]			LV	N / RO	Not used.
68	1,3	INVENTORY_MASS_VACUUM	Float[5]			M	N / RO	Not used.
69	1,3	INVENTORY_MASS_AIR	Float[5]			M	N / RO	Not used.
70		TANK5_TAG	Visiblestring[16]		Tank 5		S	Tag for tank 5.
71		TANK5_SITE_TAG	Visiblestring[16]		Site 5		S	Tag of the measurement site for tank 5.
72		TANK5_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 5.
73		TANK5_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 5 table.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
74		TANK5_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 5.
75		TANK5_PRODUCT	DS-270				S	Information of the measured product in tank 5.
76		TANK6_TAG	Visiblestring[16]		Tank 6		S	Tag for tank 6.
77		TANK6_SITE_TAG	Visiblestring[16]		Site 6		S	Tag of the measurement site for tank 6.
78		TANK6_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 6.
79		TANK6_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 6 table.
80		TANK6_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 6.
81		TANK6_PRODUCT	DS-270				S	Information of the measured product in tank 6.
82		TANK7_TAG	Visiblestring[16]		Tank 7		S	Tag for tank 7.
83		TANK7_SITE_TAG	Visiblestring[16]		Site 7		S	Tag of the measurement site for tank 7.
84		TANK7_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 7.
85		TANK7_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 7 table.
86		TANK7_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 7.
87		TANK7_PRODUCT	DS-270				S	Information of the measured product in tank 7.
88		TANK8_TAG	Visiblestring[16]		Tank 8		S	Tag for tank 8.
89		TANK8_SITE_TAG	Visiblestring[16]		Site 8		S	Tag of the measurement site for tank 8.
90		TANK8_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 8.
91		TANK8_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 8 table.
92		TANK8_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 8.
93		TANK8_PRODUCT	DS-270				S	Information of the measured product in tank 8.
94		TANK9_TAG	Visiblestring[16]		Tank 9		S	Tag for tank 9.
95		TANK9_SITE_TAG	Visiblestring[16]		Site 9		S	Tag of the measurement site for tank 9.
96		TANK9_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 9.
97		TANK9_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 9 table.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
98		TANK9_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 9.
99		TANK9_PRODUCT	DS-270				S	Information of the measured product in tank 9.
100		TANK10_TAG	Visiblestring[16]		Tank 10		S	Tag for tank 10.
101		TANK10_SITE_TAG	Visiblestring[16]		Site 10		S	Tag of the measurement site for tank 10.
102		TANK10_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 10.
103		TANK10_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 10 table.
104		TANK10_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 10.
105		TANK10_PRODUCT	DS-270				S	Information of the measured product in tank 10.
106		TANK11_TAG	Visiblestring[16]		Tank 11		S	Tag for tank 11.
107		TANK11_SITE_TAG	Visiblestring[16]		Site 11		S	Tag of the measurement site for tank 11.
108		TANK11_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 11.
109		TANK11_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 11 table.
110		TANK11_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 11.
111		TANK11_PRODUCT	DS-270				S	Information of the measured product in tank 11.
112		TANK12_TAG	Visiblestring[16]		Tank 12		S	Tag for tank 12.
113		TANK12_SITE_TAG	Visiblestring[16]		Site 12		S	Tag of the measurement site for tank 12.
114		TANK12_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 12.
115		TANK12_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 12 table.
116		TANK12_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 12.
117		TANK12_PRODUCT	DS-270				S	Information of the measured product in tank 12.
118		TANK13_TAG	Visiblestring[16]		Tank 13		S	Tag for tank 13.
119		TANK13_SITE_TAG	Visiblestring[16]		Site 13		S	Tag of the measurement site for tank 13.
120		TANK13_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 13.
121		TANK13_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 13 table.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
122		TANK13_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 13.
123		TANK13_PRODUCT	DS-270				S	Information of the measured product in tank 13.
124		TANK14_TAG	Visiblestring[16]		Tank 14		S	Tag for tank 14.
125		TANK14_SITE_TAG	Visiblestring[16]		Site 14		S	Tag of the measurement site for tank 14.
126		TANK14_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 14.
127		TANK14_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 14 table.
128		TANK14_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 14.
129		TANK14_PRODUCT	DS-270				S	Information of the measured product in tank 14.
130		TANK15_TAG	Visiblestring[16]		Tank 15		S	Tag for tank 15.
131		TANK15_SITE_TAG	Visiblestring[16]		Site 15		S	Tag of the measurement site for tank 15.
132		TANK15_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 15.
133		TANK15_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 15 table.
134		TANK15_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 15.
135		TANK15_PRODUCT	DS-270				S	Information of the measured product in tank 15.
136		TANK16_TAG	Visiblestring[16]		Tank 16		S	Tag for tank 16.
137		TANK16_SITE_TAG	Visiblestring[16]		Site 16		S	Tag of the measurement site for tank 16.
138		TANK16_TABLE	Unsigned8	1-20	0	Na	S	Selection of the capacity table for tank 16.
139		TANK16_BASE_TEMP	Float		20.0 °C	T	S	Base temperature for the tank 16 table.
140		TANK16_STEEL_TYPE	Unsigned8	0=Custom 1=Mild carbon 2=304 Stainless 3=316 Stainless 4=17-4PH Stainless	1	E	S	Material type of the tank 16.
141		TANK16_PRODUCT	DS-270				S	Information of the measured product in tank 16.
142		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
143		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.
144 (A2) (V3)		TANK1_START_FRA	Float	>= 0.0	0.0	L	S	Level which the roof starts to float, and it will be floating completely from the level indicated in TANKx_LEVEL_FRA. During this transition the indicated volume will stay in the last value.
145 (A2)		TANK2_START_FRA	Float	>= 0.0	0.0	L	S	Level which the roof starts to float, and it will be floating completely from the level indicated in TANKx_LEVEL_FRA. During this transition the indicated volume will stay in the last value.
146 (A2)		TANK3_START_FRA	Float	>= 0.0	0.0	L	S	Level which the roof starts to float, and it will be floating completely from the level indicated in TANKx_LEVEL_FRA. During this transition the indicated volume will stay in the last value.
147 (A2)		TANK4_START_FRA	Float	>= 0.0	0.0	L	S	Level which the roof starts to float, and it will be floating completely from the level indicated in TANKx_LEVEL_FRA. During this transition the indicated volume will stay in the last value.
148		INVENTORY_STATUS_1	Bitstring[2]	See Block Options	0	Na	N/ RO	Status of the tank 1 during the batch. See BATCH_STATUS.
149		INVENTORY_STATUS_2	Bitstring[2]	See Block Options	0	Na	N/ RO	Status of the tank 2 during the batch. See BATCH_STATUS.
150		INVENTORY_STATUS_3	Bitstring[2]	See Block Options	0	Na	N/ RO	Status of the tank 3 during the batch. See BATCH_STATUS.
151		INVENTORY_STATUS_4	Bitstring[2]	See Block Options	0	Na	N/ RO	Status of the tank 4 during the batch. See BATCH_STATUS.
152 (A2)		TANK1_CYL	DS-294				S	Configuration of the cylindrical tank.
153(A2)		TANK2_CYL	DS-294				S	Configuration of the cylindrical tank.
154(A2)		TANK3_CYL	DS-294				S	Configuration of the cylindrical tank.
155 (A2)		TANK4_CYL	DS-294				S	Configuration of the cylindrical tank.
156 (A2)		TANK1_SPHERE	DS-295				S	Configuration of the spherical tank.
157 (A2)		TANK2_SPHERE	DS-295				S	Configuration of the spherical tank.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store/ Mode	Description
158 (A2)		TANK3_SPHERE	DS-295				S	Configuration of the spherical tank.
159 (A2)		TANK4_SPHERE	DS-295				S	Configuration of the spherical tank.
160 (A2)		VAPOUR_LIQ1	Float	100 to 600	229.5	Na	S	Conversion factor of vapour to liquid.
161 (A2)		VAPOUR_LIQ2	Float	100 to 600	229.5	Na	S	Conversion factor of vapour to liquid.
162 (A2)		VAPOUR_LIQ3	Float	100 to 600	229.5	Na	S	Conversion factor of vapour to liquid.
163 (A2)		VAPOUR_LIQ4	Float	100 to 600	229.5	Na	S	Conversion factor of vapour to liquid.
164 (A2)		DEADWOOD_1	DS-296				S	Configuration of the dead or additional volume.
165 (A2)		DEADWOOD_2	DS-296				S	Configuration of the dead or additional volume.
166 (A2)		DEADWOOD_3	DS-296				S	Configuration of the dead or additional volume.
167 (A2)		DEADWOOD_4	DS-296				S	Configuration of the dead or additional volume.
168 (A2)		DEADWOOD_5	DS-296				S	Configuration of the dead or additional volume.
169 (A2)		DEADWOOD_6	DS-296				S	Configuration of the dead or additional volume.
170 (A2)		DEADWOOD_7	DS-296				S	Configuration of the dead or additional volume.
171 (A2)		DEADWOOD_8	DS-296				S	Configuration of the dead or additional volume.

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

TT – Tank Table

STRATEGY Parameter

The STRATEGY parameter is configured indirectly when selecting the table associated to the tank in the block STD.
Features of the tank table:

- It should be monotonic, mainly in situation where occur a transition of a table to other table (when selected more than a table for a same tank).
- When the height value is zero and the previous value is positive then is considered the end of the table.

Parameters

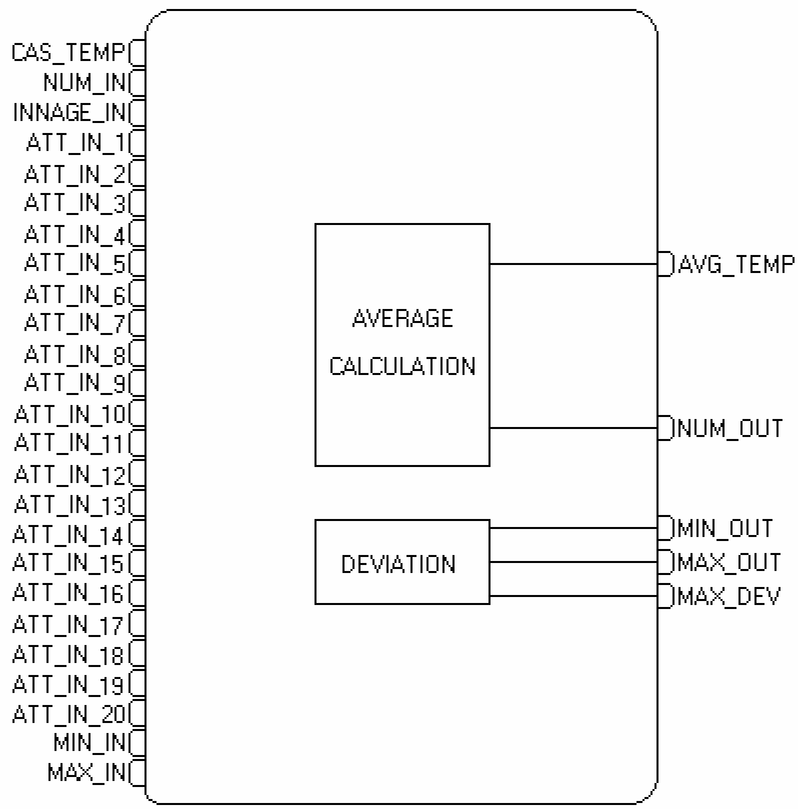
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Units	Store / Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	1 to 16	0	None	S / RO	This parameter is used to identify the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	2	TABLE_ID	Unsigned8	0-20	0	Na	S	Numeric identification of the tank table.
8 (A2)	2	HEIGHT_1	Float[20]		0.0	L	S	Abscissa of the tank table. Values in crescent order. If the value is zero, the other elements of the array are ignored.
9 (A2)		HEIGHT_2	Float[20]		0.0	L	S	Abscissa of the tank table. Values in crescent order. If the value is zero, the other elements of the array are ignored.
10 (A2)	4	VOLUME_1	Float[20]	>= 0	0.0	LV	S	Ordinate of the tank table. Values in crescent order. If the value is zero, the other elements of the array are ignored.
11 (A2)		VOLUME _2	Float[20]	>= 0	0.0	LV	S	Ordinate of the tank table. Values in crescent order. If the value is zero, the other elements of the array are ignored.
12		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
13		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.

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

Function Blocks

ATT –Automatic Tank Thermometer

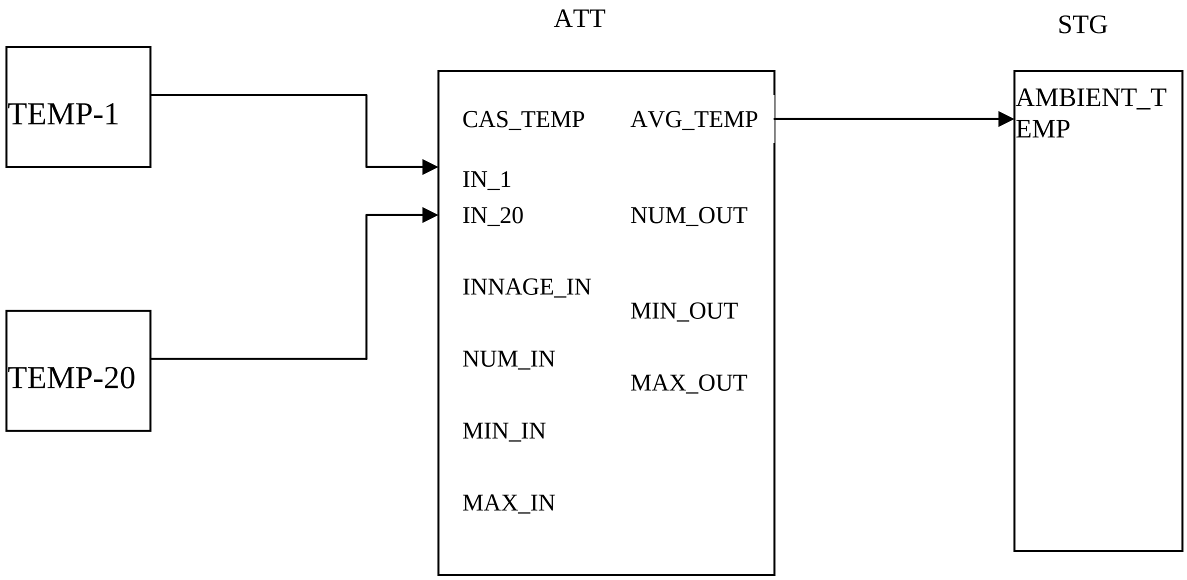
Schematic



Description
This block calculates the average temperature of the product using the following methods defined in AVERAGE_METHOD:

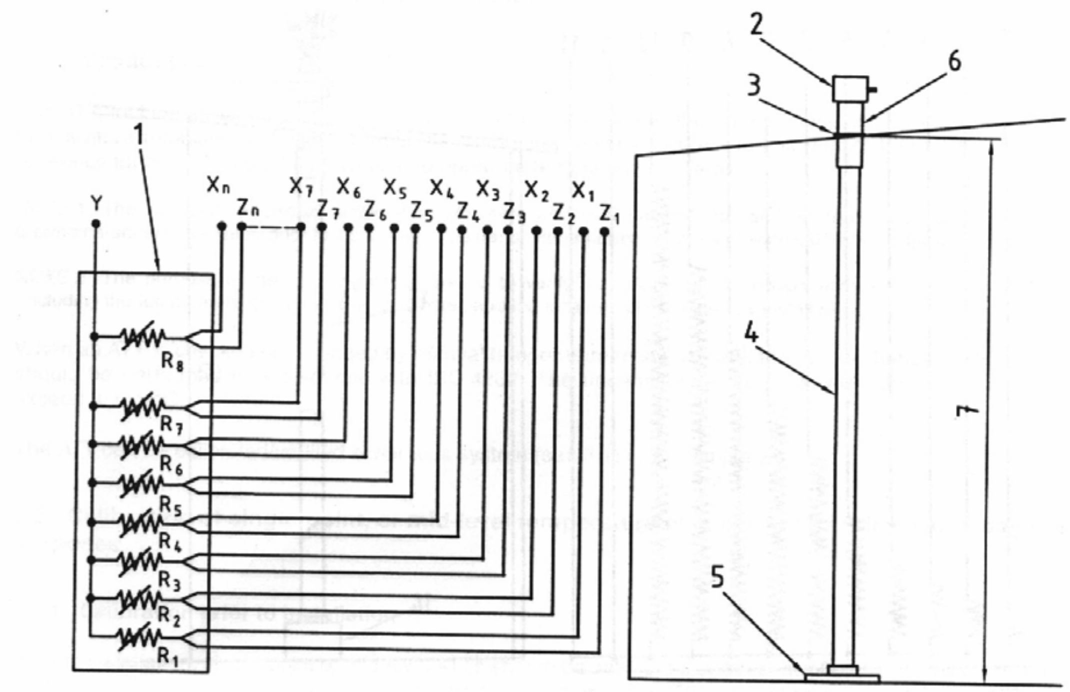
All elements: average of all inputs connected with status good.

Application: Ambient average temperature with temperature sensors in different points near to the tank.



Multiple-point: average arithmetic of the submerged sensors

Application: Temperature gradient in the vertical



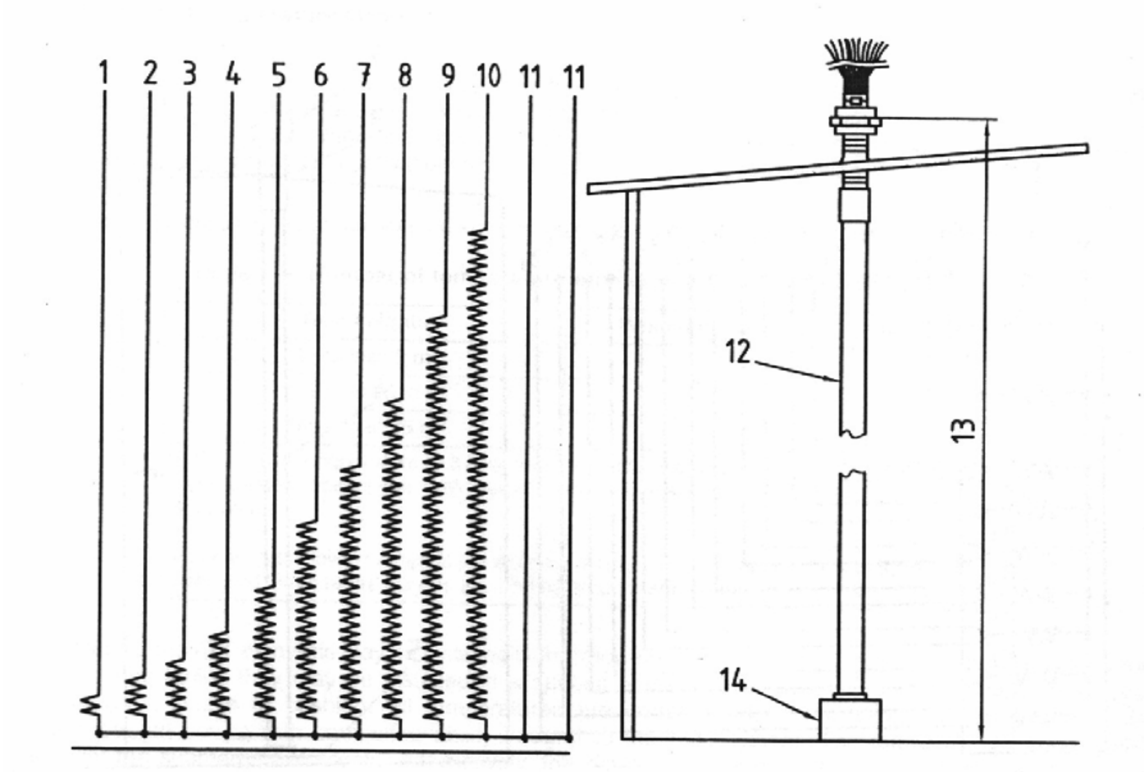
Key

1 Sensor housing
2 Junction box or temperature transmitter
3 Compression fitting (with or without flange)
4 Flexible element housing
5 Anchor weight
6 Extension fitting
7 Mounting height

Figure 1 — An example of a multiple-point temperature element installation

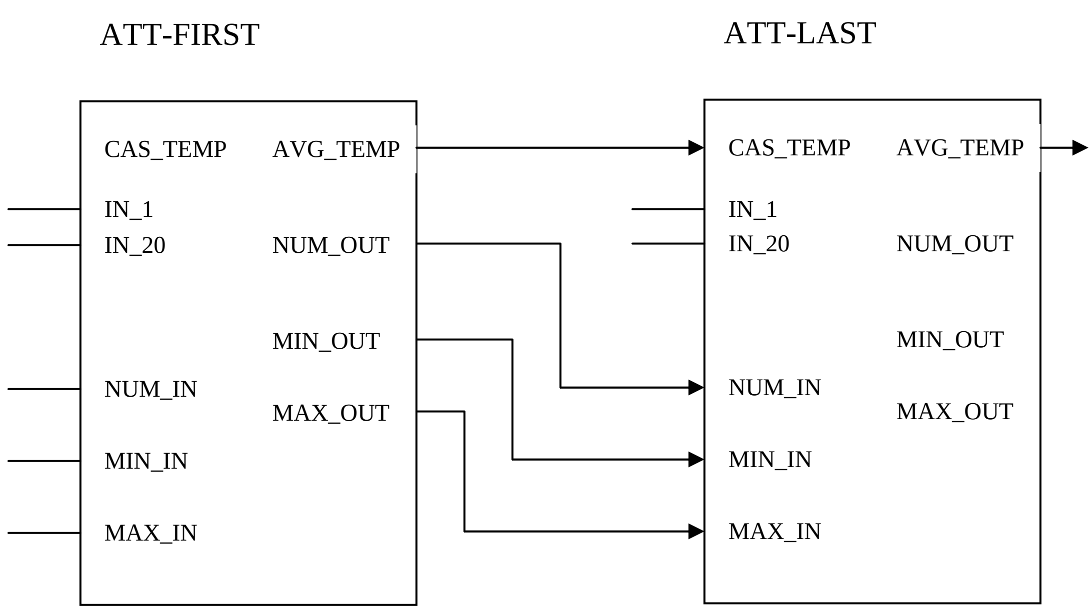
Variable-length: temperature from the sensor of larger length which is totally submerged.

Application: Temperature gradient in the vertical



Application: Temperature gradient in the vertical with measurement of temperature multi-point or variable length for up to 40 sensors

It is possible to configure the ATT blocks in cascade as shown below, and each ATT block supports up to 20 temperature inputs.



AVERAGE_METHOD=All Elements

CAS_ROLE	AVG_TEMP	NUM_OUT	MIN_OUT	MAX_OUT
No cascade or First of cascade	Average arithmetic of all inputs with status good	Number of inputs for average calculation	Value of the minor input used to calculate the average	Value of the major input used to calculate the average.
Last of cascade	Based on CAS_TEMP, NUM_IN inputs and inputs with status good, the arithmetic average is calculated	NUM_IN plus the inputs with status good	Verifies which the minor value among the linked inputs with status good (IN_1 to IN_20) and MIN_IN.	Verifies which the major value among the linked inputs with status good (IN_1 to IN_20) and MIN_IN.

AVERAGE_METHOD=Multiple-point

CAS_ROLE	AVG_TEMP	NUM_OUT	MIN_OUT	MAX_OUT
No cascade or First of cascade	Average arithmetic of all inputs with status good and submerged	Number of inputs for average calculation	Value of the minor input used to calculate the average	Value of the major input used to calculate the average.
Last of cascade	Based on CAS_TEMP, NUM_IN inputs and submerged inputs with status good, the arithmetic average is calculated	NUM_IN plus the submerged inputs with status good	Verifies which the minor value among the linked inputs with status good (IN_1 to IN_20) and MIN_IN.	Verifies which the major value among the linked inputs with status good (IN_1 to IN_20) and MIN_IN.

If the tank is pressurized, a weighed average of the temperature is calculated (as ISO 4266-6) whose weigh factor is the area of the circle where is the sensor.

AVERAGE_METHOD=Variable length

CAS_ROLE	AVG_TEMP	NUM_OUT	MIN_OUT	MAX_OUT
No cascade or First of cascade	Input value with thermo sensor of major length totally submerged and status good	Number of the selected input	Value of the minor input totally submerged	Value of the major input totally submerged
Last of cascade	Verifies if there is a thermo sensor totally submerged with status good. Otherwise, repeat the CAS_TEMP input.	Verifies if there is a thermo sensor totally submerged with status good. Otherwise, repeat the NUM_IN input.	Verifies if there is a thermo sensor totally submerged with status good and if the value is lesser than MIN_IN. Otherwise, repeat the MIN_IN input.	Verifies if there is a thermo sensor totally submerged with status good and if the value is bigger than MAX_IN. Otherwise, repeat the MAX _IN input.

Sensor Height

The configuration for the height of the timely sensors or superior extremities of the variable length sensors is executed by SENSOR_HEIGHT parameter. The reference to the sensor height is always the measurement table. For the spherical tanks is the STD.TANKx_CYL.Gauge zero shift.

Handling of Status

CAS_ROLE	Description
No cascade/First of cascade	If all inputs used to calculate the average or the input LEVEL (it is not applied to the All elements method) are in bad, then all outputs of the block will be in status bad.
Last of cascade	If it is not possible a temperature input with status good according to the tank level (it is not applied to the All elements method) and the input CAS_TEMP is also bad, then the output status is changed for bad. If all the temperature inputs are in bad and the CAS_TEMP is good, then the output receives the value from CAS_TEMP.

Handling when very low level:

The term-element input for lower level with status good will be selected. This situation where the level is inferior to the first term-element will be indicated in MATT_BAD_STATUS2 parameter.

Type	Description
Multiple point	None sensor submerged
Variable length	None sensor submerged totally

Diagnosis and Troubleshooting

1. BLOCK_ERR. Block configuration: this indication can occurs due to the following problems:
   - Parameter STRATEGY=0 , the mode block is O/S
   - AVERAGE_METHOD is multiple-point or variable length and the heights configured to sensors in SENSOR_HEIGHT are not in crescent order.
   - AVERAGE_METHOD is multiple-point and the tank is horizontal cylindrical or variable length and the tank is horizontal cylindrical or spherical.
   - If spherical tank:
     - SENSOR_HEIGHT – first element configured in zero level;
     - SENSOR_HEIGHT - level configured bigger or equal to the sphere diameter
     - Multiple-point and e cascade of ATT block

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	If this parameter is configured with string different of spaces, this parameter will replace the block tag in the QTR report.
3 (A2)	4	STRATEGY	Unsigned16	0 to 4 255	0	None	S	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1)	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7 (A2)	I,3	CAS_TEMP	DS-65			T	N	Input of average temperature calculated by other MATT block, when configured in cascade.
8 (A2)	I,3	NUM_IN	DS-66				N	If the MATT block is configured in cascade, this input indicates the number of inputs used to calculate the average or the number of the input (thermo-resistance of variable length).
9 (A2)	I,3	MIN_IN	DS-65			T	N	Minimum temperature of the MATT previous block, when configured in cascade.

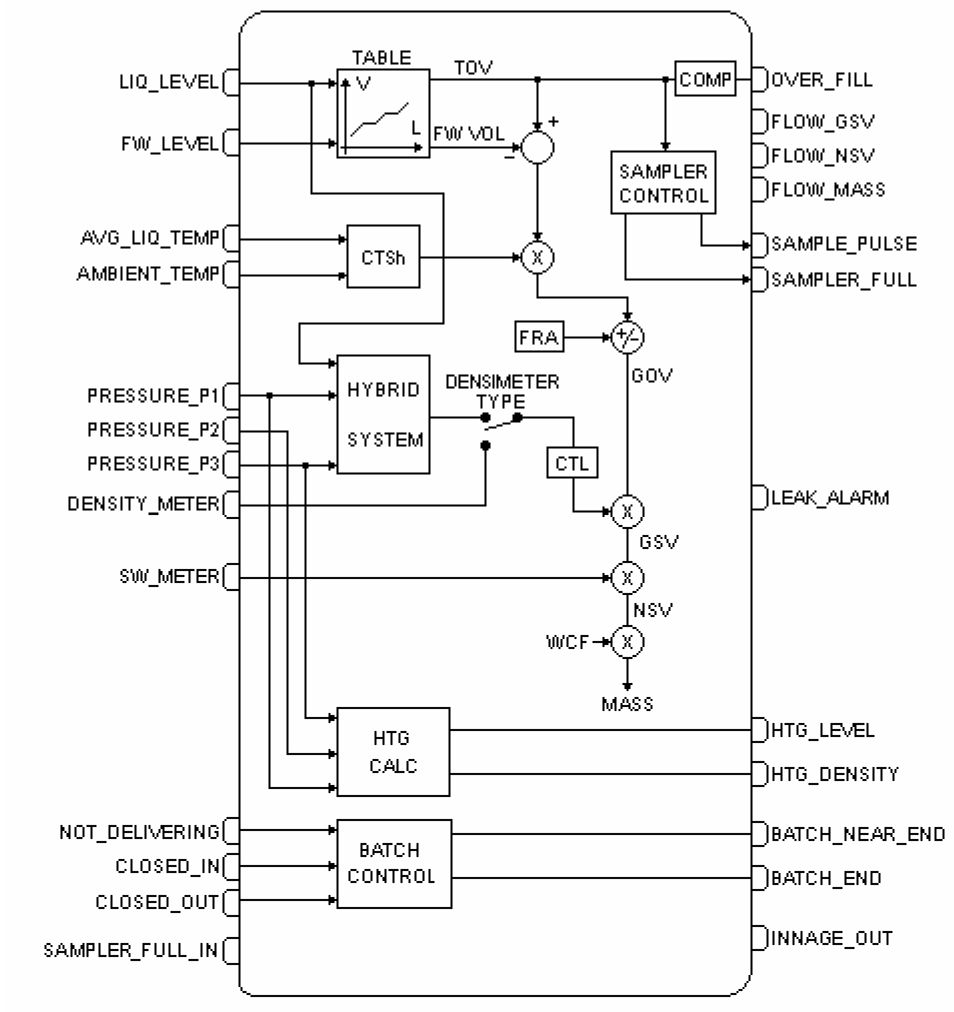
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
10 (A2)	I,3	MAX_IN	DS-65			T	N	Maximum temperature of the MATT previous block, when configured in cascade.
11	I,3	INNAGE_IN	DS-65			L	N / RO	Liquid level (innage) to be measured.
12 (A2)	I,1	ATT_IN_1	DS-65			T	N	Temperature 1 used to calculate the average temperature.
13 (A2)	I.1	ATT_IN_2	DS-65			T	N	Temperature 2 used to calculate the average temperature.
14 (A2)	I.1	ATT_IN_3	DS-65			T	N	Temperature 3 used to calculate the average temperature.
15 (A2)	I.1	ATT_IN_4	DS-65			T	N	Temperature 4 used to calculate the average temperature.
16 (A2)	I.1	ATT_IN_5	DS-65			T	N	Temperature 5 used to calculate the average temperature.
17 (A2)	I.1	ATT_IN_6	DS-65			T	N	Temperature 6 used to calculate the average temperature.
18 (A2)	I.1	ATT_IN_7	DS-65			T	N	Temperature 7 used to calculate the average temperature.
19 (A2)	I.1	ATT_IN_8	DS-65			T	N	Temperature 8 used to calculate the average temperature.
20 (A2)	I.1	ATT_IN_9	DS-65			T	N	Temperature 9 used to calculate the average temperature.
21 (A2)	I.1	ATT_IN_10	DS-65			T	N	Temperature 10 used to calculate the average temperature.
22 (A2)	I.1	ATT_IN_11	DS-65			T	N	Temperature 11 used to calculate the average temperature.
23 (A2)	I.1	ATT_IN_12	DS-65			T	N	Temperature 12 used to calculate the average temperature.
24 (A2)	I.1	ATT_IN_13	DS-65			T	N	Temperature 13 used to calculate the average temperature.
25 (A2)	I.1	ATT_IN_14	DS-65			T	N	Temperature 14 used to calculate the average temperature.
26 (A2)	I.1	ATT_IN_15	DS-65			T	N	Temperature 15 used to calculate the average temperature.
27 (A2)	I.1	ATT_IN_16	DS-65			T	N	Temperature 16 used to calculate the average temperature.
28 (A2)	I.1	ATT_IN_17	DS-65			T	N	Temperature 17 used to calculate the average temperature.
29 (A2)	I.1	ATT_IN_18	DS-65			T	N	Temperature 18 used to calculate the average temperature.
30 (A2)	I.1	ATT_IN_19	DS-65			T	N	Temperature 19 used to calculate the average temperature.
31 (A2)	I,1	ATT_IN_20	DS-65			T	N	Temperature 20 used to calculate the average temperature.
32	O,3	AVG_TEMP	DS-65			T	N / RO	Average temperature of the product.
33	O,3	NUM_OUT	DS-66	No cascade/First of cascade : 1 to 20 Last of cascade :1 to 40			N / RO	This output indicates the number of inputs used to calculate the average or the number of the input (thermo-resistance of variable length).
34	O,3	MIN_OUT	DS-65			T	N / RO	Minimum temperature between the temperatures considered to calculate the average, that is, totally submerged.
35	O,3	MAX_OUT	DS-65			T	N / RO	Maximum temperature between the temperatures considered to calculate the average, that is, totally submerged.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
36	O,3	MAX_DEV	Float		0.0	T	N / RO	It indicates the maximum deviation between the temperatures of the thermo-elements used to calculate the average (sensor totally submerged).
37	4	AVERAGE_METHOD	Unsigned8	0=All elements 1=Multiple-point 2=Variable-length	1	E	S	Method used to determine the average temperature. "All elements" use all inputs with status good. "Multiple-point" arithmetic average of the thermo-elements submerged. "Variable-length" the used temperature will be that of the maximum length thermo-element totally submerged.
38	4	CAS_ROLE	Unsigned8	0=No cascade 1=First of cascade 255=Last of cascade	0	E	S	Define if the block will work in cascade and its order in cascade mode.
39	4	SENSOR_HEIGHT	Float[20]		0.0	L	S	Heights (in relation to the measurement table) in which the thermo-elements are placed for the multi-point system. In the system of variable length, these heights refer the superior extremity. Values in crescent order. If the found value is zero, the other elements of the array are ignored.
40	4	MIN_SUBMERGENCE	Float	>=0.0	10	L	S	Minimum submergence level of the sensor to consider it in the average calculation for multi-point system.
41	3	MATT_BAD_STATUS 1	Bitstring(2)			E	D / RO	It indicates the status of the first 16 temperature inputs, if it is connected.
42	3	MATT_BAD_STATUS 2	Bitstring(2)			E	D / RO	It indicates the status of the last 4 temperature inputs, if it is connected.
43		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
44		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

STG – Shore Tank Gauging

Schematic



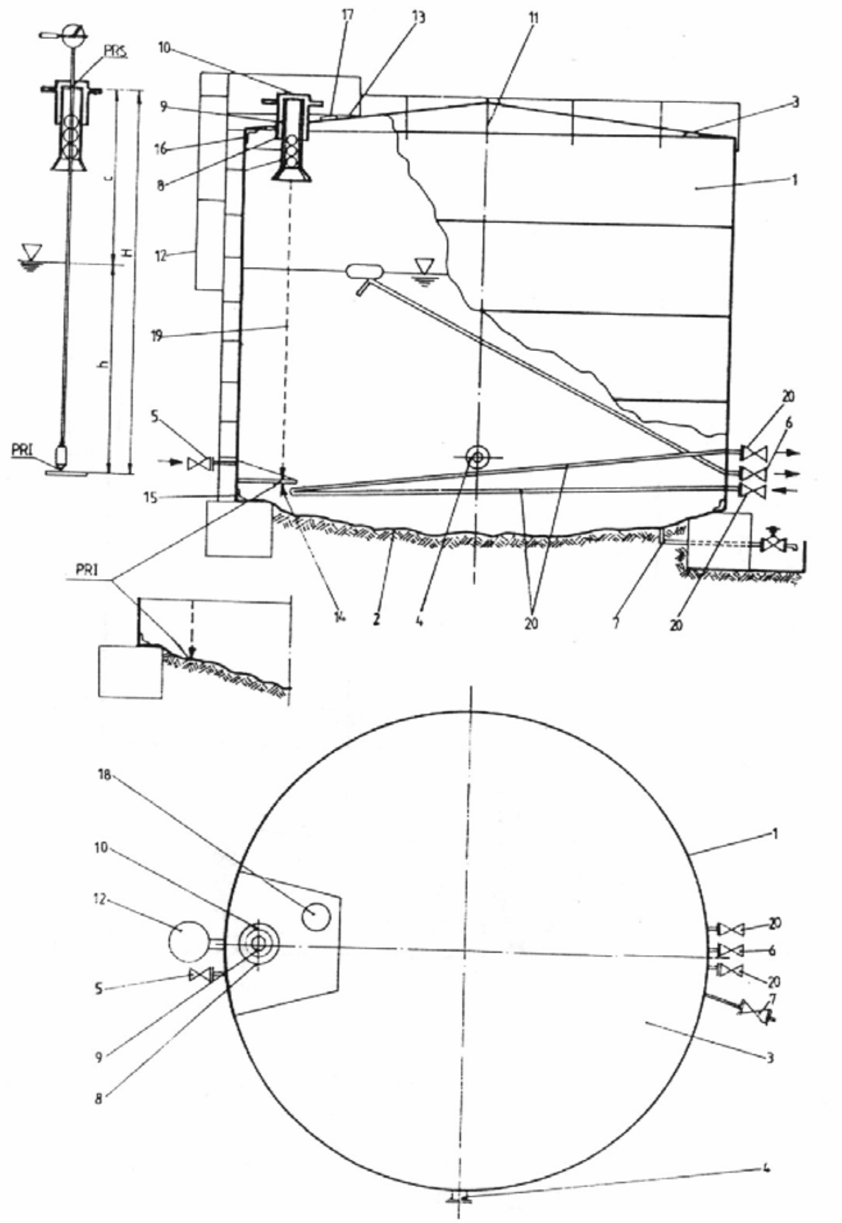


Figure 1. Diagram of a vertical cylindrical tank with fixed roof

Description

This block calculates the volume transferred in the tank measurement according to the API-12.1.1.

Calculation sequence:
TOV → GOV → GSV → NSV → Mass

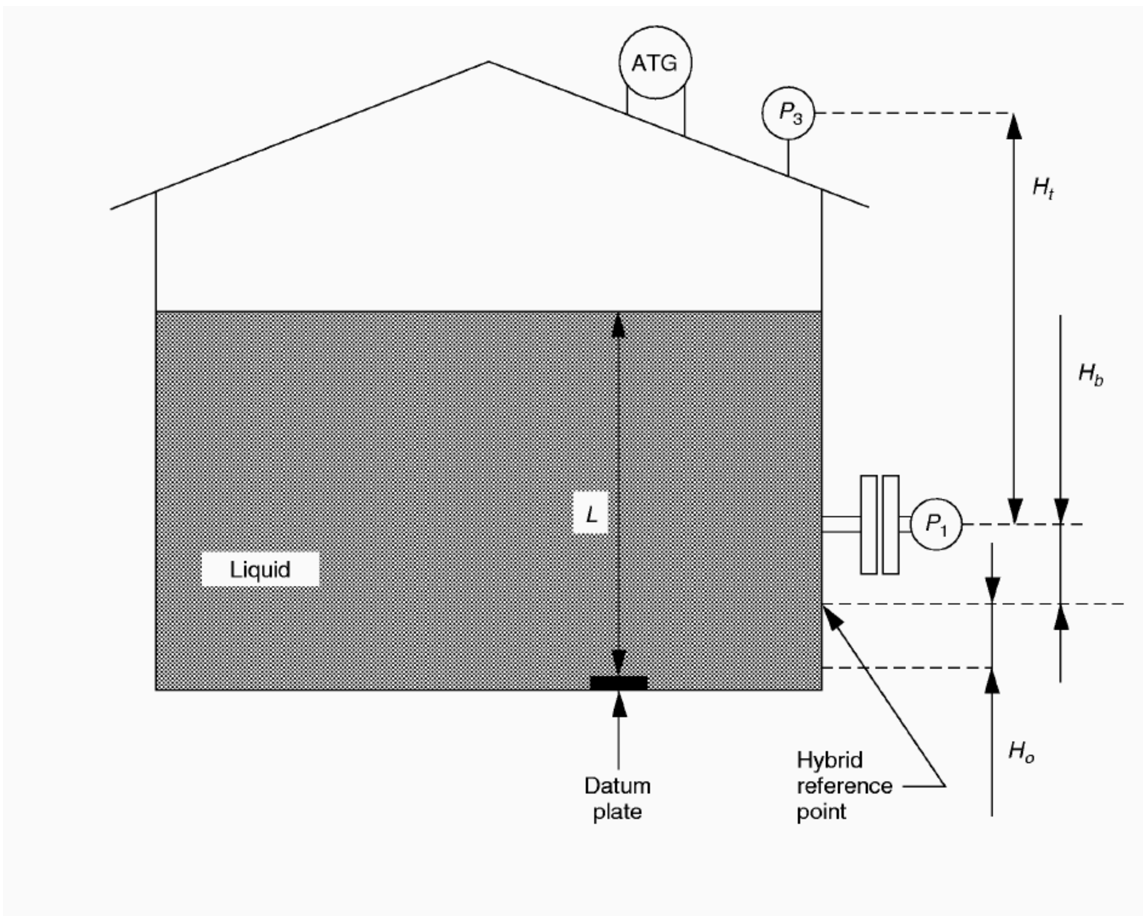
TOV = f(innage, tank table)
FWV = f(FW, tank table)

$$TSh = \frac{7 * T_{liq} + T_{amb}}{8}$$

$$CTSh = (1 + alpha * (TSh - Tb))^2$$

GOV = (TOV – FWV) * CTSh +/- FRA
GSV = [(TOV – FWV) * CTSh +/- FRA] * CTL
NSV = GSV * (1 – BSW)
M = NSV * WCF
Ma = M * (1 – Da / Dobs)

Where:
TOV: volume from the level and tank table
FW: free water level
FWV: free water volume from the water/oil interface and tank table
T_{liq}: temperature of the liquid to be measured
T_{amb}: ambient temperature (near to the tank)
TSh: tank temperature
CTSh: temperature correction factor for the tank table, from the tank operation temperature, tank base temperature and coefficient of thermal expansion.
FRA: adjust for tanks with floating roof
WCF: conversion factor of volume to mass from the density.
Ma: apparent mass (in air)
M: mass in vacuum
Da: air density
Dobs: liquid density in the vacuum at operation condition.



Determination of the level: ATG_TYPE

- Innage: level supplied directly by input LIQ_LEVEL.
- Outage: level obtained by difference REF_HEIGHT – LIQ_LEVEL
- Outage-corrected ref. Height: level obtained by difference between the REF_HEIGHT corrected for tank temperature at measurement condition and the input LIQ_LEVEL.

Density calculation: DENSIMETER_TYPE

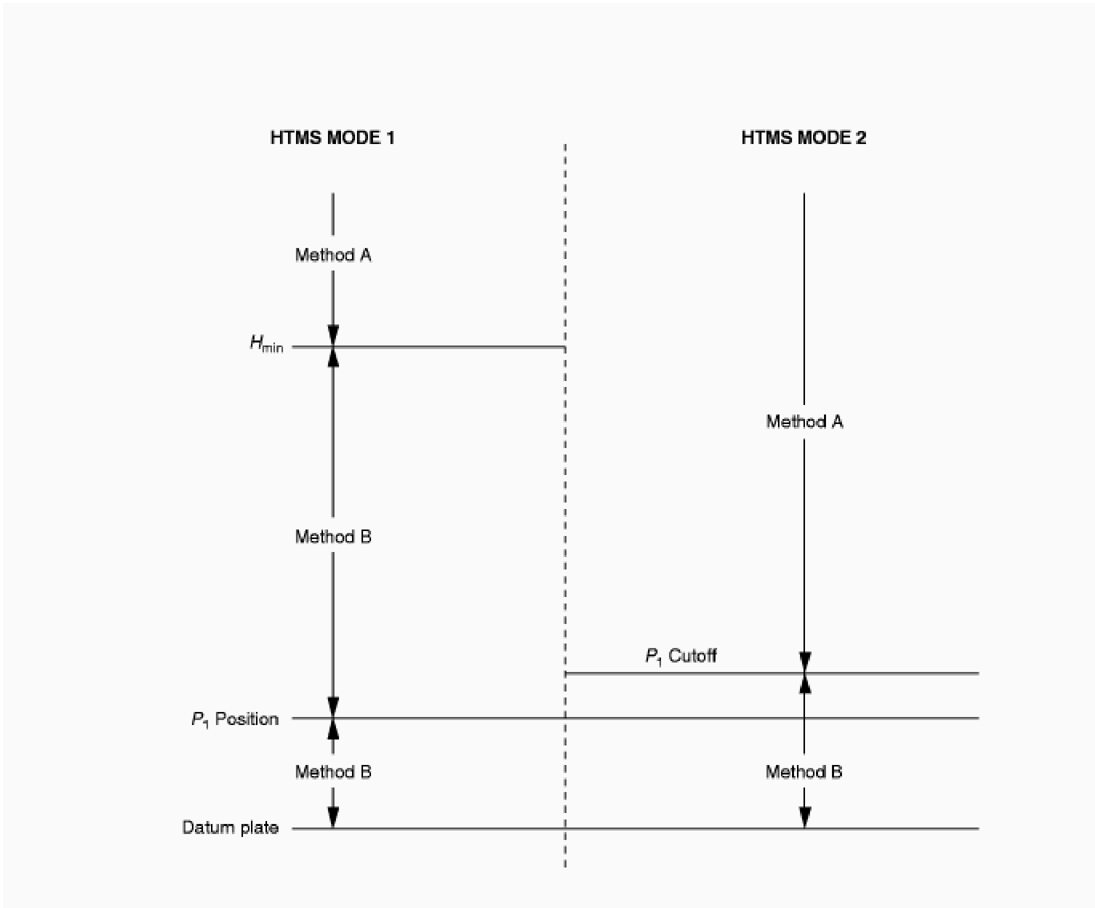
The parameter DENSIMETER_TYPE provides four forms of obtaining the liquid density to be measured, as presented below:

- In tank: This option is applied when the density meter instrument is installed in the tank, therefore there is the density at begin and end of the batch, that are the values used in the calculation of the transferred volume/mass.
- HTMS mode 1: For recommendation of API-3.6 item 8.1, this mode should be the selected mode when the measurement has as focus the volume at standard condition (instead of the mass) and the density is relatively uniform. This is an invalid option for appropriation measurement, because in this case the base density should be supplied based on laboratory analysis.
- HTMS mode 2: For recommendation of API-3.6 item 8.2, this mode should be the selected mode when the measurement has as focus the mass and the density is stratified. This is an invalid option for appropriation measurement, because in this case the base density should be supplied based on laboratory analysis.
- In-line delivering: This option should be used when there is a density meter in line in the tank output, then a weighted average density will be calculated during the tank unloading and the initial temperature will be used for CTL calculation. The override value of the density will be used when receiving product and the final temperature.
- In-line receiving: This option should be used when there is a density meter in line in the tank input, then a weighted average density will be calculated during the tank loading and using the final temperature (of loading). The final value of the weighted average during the last loading will be used when delivering product and the temperature used for CTL calculation is of the beginning of the delivery.

Configuration change of this parameter is allowed only in "None" and "Checking leak" states. This same restriction is applied to the parameter SW_TYPE.

Phase	Inline delivering	Inline receiving
Receiving	• Density: override • Temperature: final temperature of the receiving phase • The use of override value also occurs in: None and Checking leak states	• Density: calculates the weighted average using TOV • Temperature: final temperature of the receiving phase.
Delivering	• Density: calculates the weighted average • Temperature: initial temperature of the delivering phase	• Density: weighted average of the last loading • Temperature: initial temperature of the delivering phase.

Hybrid System: HTMS Mode 1 and HTMS Mode 2



	Mode 1	Mode 2
Transition level	HMIN – calculated from the uncertainties of the instruments and maximum uncertainty for the density acceptable by user	P1_CUTOFF – defined from the uncertainty of the P1 pressure measurement
Application	Uniform liquid	Stratified liquid

HTMS mode 1 and 2 use the pressure measurements (HTG) to calculate the observed density, in this case when the level is very low (and therefore the uncertainty of the observed calculated density increases), the last density obtained before the level is below at minimum level will be used, defined as method B.

This minimum level should be specified in HMIN for the HTMS mode1 or in P1_CUTOFF for HTMS mode 2.

When the level is superior to the minimum level, the density is calculated using the equation below (API-3.6. item A.3):

$$D_{obs} = \frac{(P1 - P3) - g * (D_v - D_a) * H_t}{g * (L - Z)} + D_v$$

Where:
D_{obs}: density at operation temperature in Kg/m^3
L: liquid level in meters
Z: height of the force center of the P1 pressure sensor (H1+H0) corrected in temperature, in meters
g: acceleration of the local gravity in m/s^2
H_t: distance between the force centers of the P1 and P3 sensors corrected in temperature, in meters
D_v: vapor density in the tank in Kg/m^3

D_a: air density in Kg/m^3
P1 and P3: gauge pressures in Pascal
P3: internal pressure in the tank (vapor column higher than the point of pressure tap)
Atmospheric tank

Note
The value calculated for the density observed by hybrid system is indicated in the parameter DENSITY_METER.

Examples:

Variables	SI	USA
P1	101.53712 KPa	14.72671 psi
P3	3.5 KPa	0.507632 psi
g	9.815.0 mm/s^2	386.417 in/s^2
Dv	1.25E-3 ton/m^3	4.38133E-4 Klb/Bbl
Da	1.2E-3 ton/m^3	4.20608E-4 Klb/Bbl
Ht	20.000.0 mm	787.4 in
L	10.000.0 mm	393.7 in
Z	0	0 in
Dens	1000.0 kg/m^3	9.86 API

Tolerance for the instruments in the hybrid system to custody transfer application based on volume:

Variable	Tolerance
ATG intrinsic accuracy – factory calibration	+/- 1mm
Accuracy of ATG installed –verification in field	+/- 4mm
P1 zero error	100 Pa
Linearity error in P1	0.1%
P3 zero error	40 Pa
Linearity error in P3	0.5%
ATT intrinsic accuracy	0.25 °C
Accuracy of ATT installed	0.5 °C
Comparison of the density calculated with representative sample in the tank	+/- 0.5%

The hybrid system has the following advantages:

- Constant monitoring of density;
- the density represents the content in the tank, considering the product higher than the P1 pressure measurement;
- it avoids problems of safety in the work due to collection of run sample

Note
If the density meter is In tank or HTMS and the SW meter is inline, then the factor WCF will be the average value of the initial and final values, obtained from the density in the beginning and end of the batch.

Calculation of BSW: SW_TYPE

Phase	Inline delivering	Inline receiving
Receiving	• SW: override • The use of the override value also occurs in the states: None and Checking leak	• SW: calculates the weighted average for TOV
Delivering	• SW: calculates the weighted average	• SW: weighted average of the last loading

If the measured product is ethanol, then BSW is calculated and indicated in SW_METER input and the SW_TYPE should be configured for "In tank".

Calculation HTG as backup for level and density in hybrid system

a) Liquid density (HTG_DENSITY), through pressure taps P1 and P2:

$$D = \frac{P1 \ - \ P2}{g^*(H_2 - H_1)}$$

Where H_2 = HEIGHT_P2 and H_1 = HEIGHT_P1.
D: density at operation temperature in Kg/m^3
g: local gravity acceleration in m/s^2
H2-H1: distance between the force centers of the sensors P2 and P1 corrected in temperature in meters
P1 and P2: gauge pressures in Pascal

b) Liquid level (HTG_LEVEL), through pressure taps P1 and P3 of the density D:

$$L = \frac{P1 - P3 - g^*H_T^*(D_V - D_A)}{g^*(D - D_V)} + H_0 + H_1$$

Where H_T = HEIGHT_HT, D_V = VAPOR_DENSITY and D_A = AIR_DENSITY.
L: liquid level in meters
D: density at operation temperature in Kg/m^3
Z: height of the force center of the pressure sensor P1 (H1+H0) corrected in temperature in meters
g: local gravity acceleration in m/s^2
H_t: distance between the force centers of the P1 and P3 sensors corrected in temperature in meters
D_v: vapor density in the tank in Kg/m^3
D_a: air density in Kg/m^3
P1 and P3: gauge pressures in Pascal

c) Parameters: HTG_LEVEL, HTG_DENSITY, HTG_ALARM, LEVEL_DEV and DENSITY_DEV.

The calculation of HTG is only realized when the density measurement is configured for HTMS Mode 1 or HTMS Mode 2. The P2 pressure input should be linked and the level shown in INNAGE should be superior to HEIGHT_P2. When in operation, the Density and the Level calculated in HTG are compared continually with the Density calculated in HTMS and the level shown in Innage. When the difference among those values is superior to maximum tolerance configured in LEVEL_DEV and DENSITY_DEV, this event will be accused in HTG_ALARM.

When the input LIQ_LEVEL of the block is with Status BAD and the parameter HTG_LEVEL is with Status GOOD, the block should use the level calculated in HTG.

When the pressure P3 is with Status BAD and the parameter HTG_DENSITY is with Status GOOD, the block should use the density calculated in HTG and CURRENT_STATUS should indicate Override_Density.

d) Interpretation of the HTG_ALARM status:

Event	Meaning	Consequence
Level deviation	Difference percentage of HTG_LEVEL relatively to the INNAGE superior to LEVEL_DEV.	
Density deviation	Difference percentage of HTG_DENSITY relatively to the LIQ_DENSITY superior to DENSITY_DEV.	
Bad status of P1		Status HTG_LEVEL → BAD Status HTG_DENSITY → BAD.
Bad status of P2		Status HTG_LEVEL → BAD Status HTG_DENSITY → BAD.
Bad status of P3		Status HTG_LEVEL → BAD. Status DENSITY_METER → BAD
Using HTG level as backup	Occurs when the input status LIQ_LEVEL is in BAD and the Status of HTG_LEVEL is in GOOD.	In this case, the block should use the level calculated in HTG.
Using HTG density as backup	Occurs when the input status PRESSURE_P3 in BAD (it is not possible to calculate the density in HTMS) and the Status of HTG_DENSITY is in GOOD.	In this case, the block should use the density calculated in HTG.
Inconsistent configuration	When HEIGHT_P2 < HEIGHT_P1.	Calculation of the HTG does not occur.
Below_HEIGHT_P2	When INNAGE < HEIGHT_P2.	The last Dens. Good is fixed.
Below_HEIGHT_P1	When INNAGE < HEIGHT_P1.	The last Dens. Good is fixed. Level is fixed in HEIGHT_P1

e) Backup mechanism (for level and density) and status indication:

Inputs Status				Values used in calculation		Outputs Status		Status Indication	
PRESSURE_P1	PRESSURE_P2	PRESSURE_P3	LIQ_LEVEL	INNAGE	LIQ_DENSITY	HTG_LEVEL	HTG_DENSITY	CURRENT_STATUS	HTG_ALARM
Good	Good	Good	Good	LIQ_LEVEL	HTMS	Good	Good	None	None
Good	Bad	Good	Good	LIQ_LEVEL	HTMS	Bad	Bad	None	P2 Bad
Good	Good	Bad	Good	LIQ_LEVEL	HTG_DENSITY	Bad	Good	OverrDens	P3 Bad, density used as backup
Bad	Good	Good	Good	LIQ_LEVEL	Override	Bad	Bad	OverrDens	P1 Bad
Any input in Bad		Bad	Good	LIQ_LEVEL	Override	Bad	Bad	OverrDens	Pressure inputs in Bad
Good	Good	Good	Bad	HTG_LEVEL	HTG_DENSITY	Good	Good	BadLevel,OverrDens	Level and density used as backup
Any input in Bad			Bad	Not calculate		Bad	Bad	BadLevel,OverrDens	Pressure input in Bad

f) Calculation example:
Considering the hybrid system below:

Variables	SI
g	9.815.0 mm/s^2
Dv	1.25E-3 ton/m^3
Da	1.2E-3 ton/m^3
Ht	20.000.0 mm
Z (H0+H1)	0
HEIGHT_P2	1000 mm

The results from the hybrid system (HTMS) and HTG are:

L (mm)	P1 (Kpa)	P2 (Kpa)	P3 (Kpa)	Results		
				HTG_DENSITY(kg/m^3)	HTG_LEVEL (mm)	HTMS density (kg/m^3)
10 000	101.5371	91.72	3.5	1000.039	9999.608	999.9997
10 000	101.5371	91.76	3.5	995.9642	10040.57	999.9997
5 000	50.8	41	3.5	998.2968	4832.425	964.8808

Calculation of the temperature in the tank: TANK_SHELL_TEMP
If the tank is thermally isolated, then to connect the ambient temperature in the AMBIENT_TEMP input, because in this case the tank temperature is the same to the liquid temperature (API-12.1.1.a item 9.1.3.2).

Allocation of the production for period: ALLOCATION_TYPE
Parameter no functionality in the current version.

Definition of the measurement period: TRANSFER_TYPE
TRANSFER_TYPE = receipt / delivery

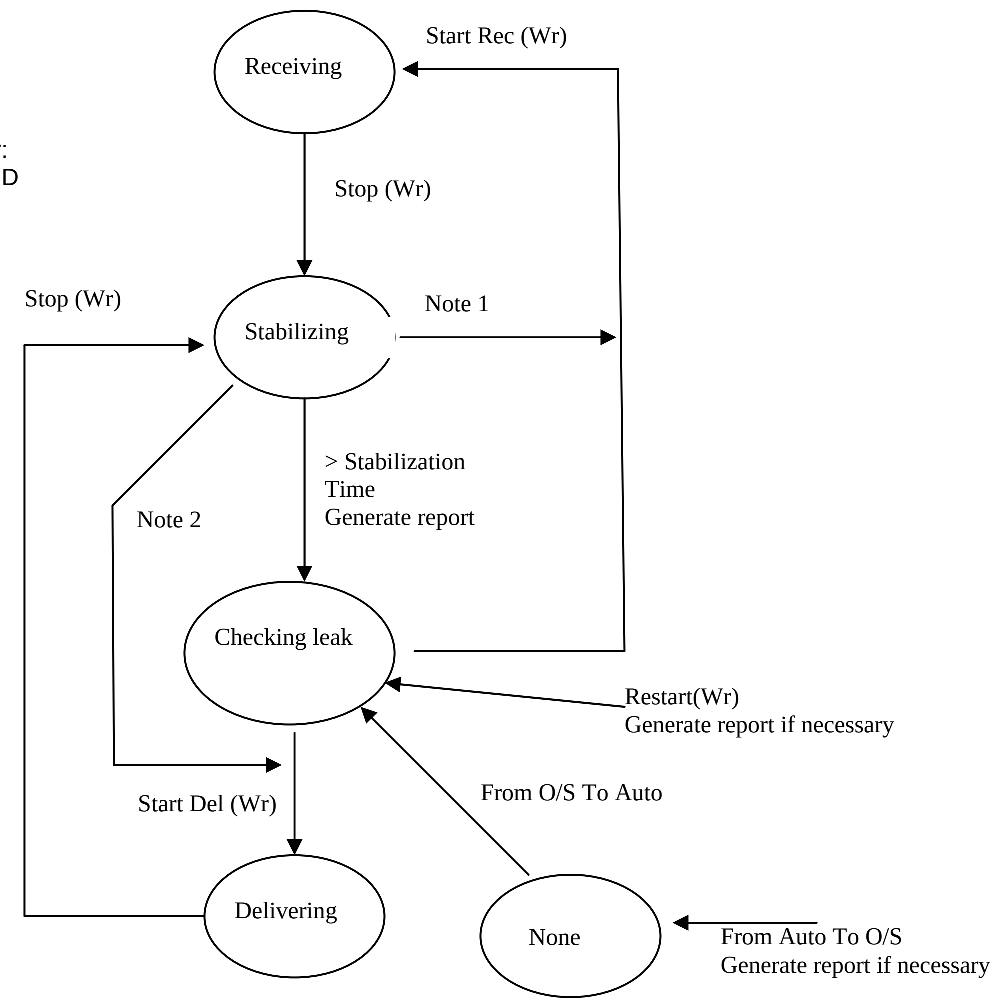
This parameter defines when the phase of custody transfer occurs legally, where the rigor applied to the calculations and procedures for measurement are more rigorous, as well as audit trail demand.

To the end of the transfer always occurs the report generation in the memory of TM302, and to the other phase (that is not the transfer) the report generation is conditioned to the configuration ENABLE_REPORT.Both phases.

State Machine: STG_STATE

Restrictions to OPERATING_MODE=User:
Note 1: If TRANSFER_TYPE=Delivery AND Stabilizing a reception

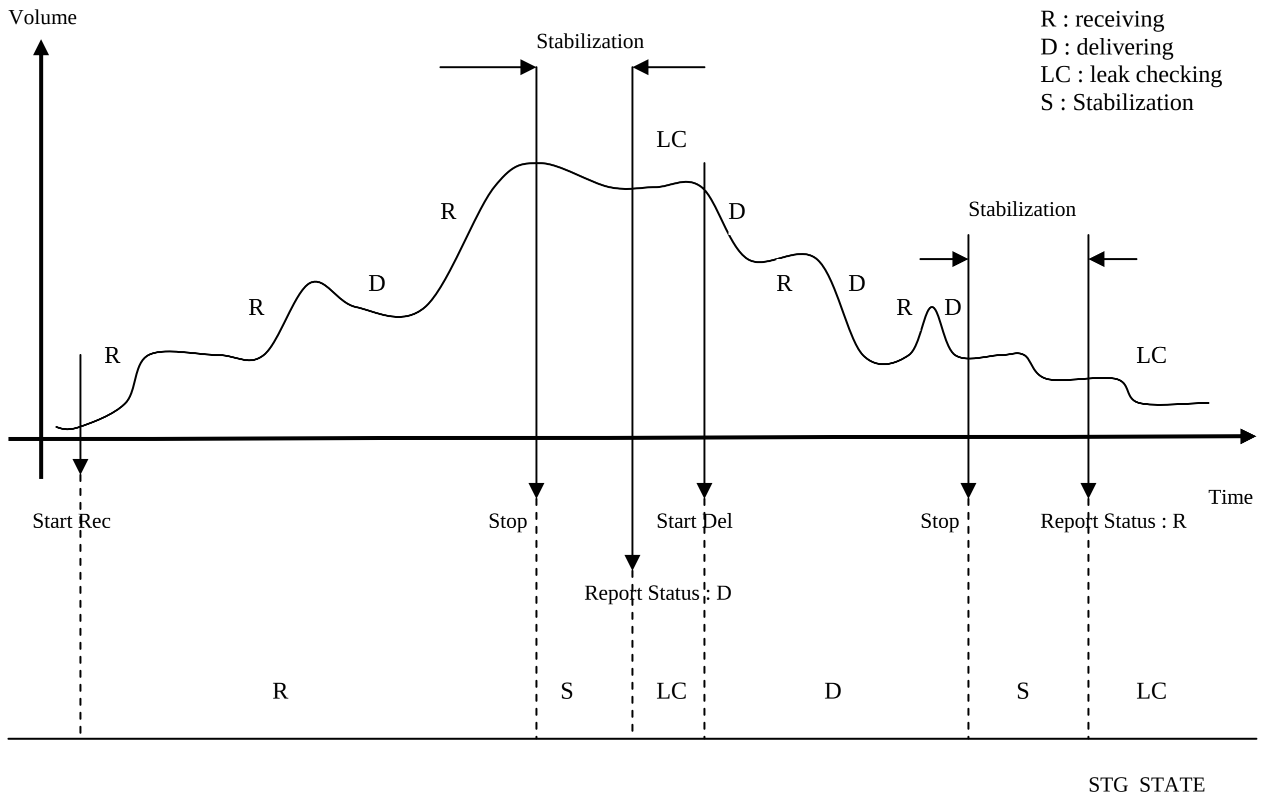
Note 2: If TRANSFER_TYPE = Receipt AND Stabilizing a delivery

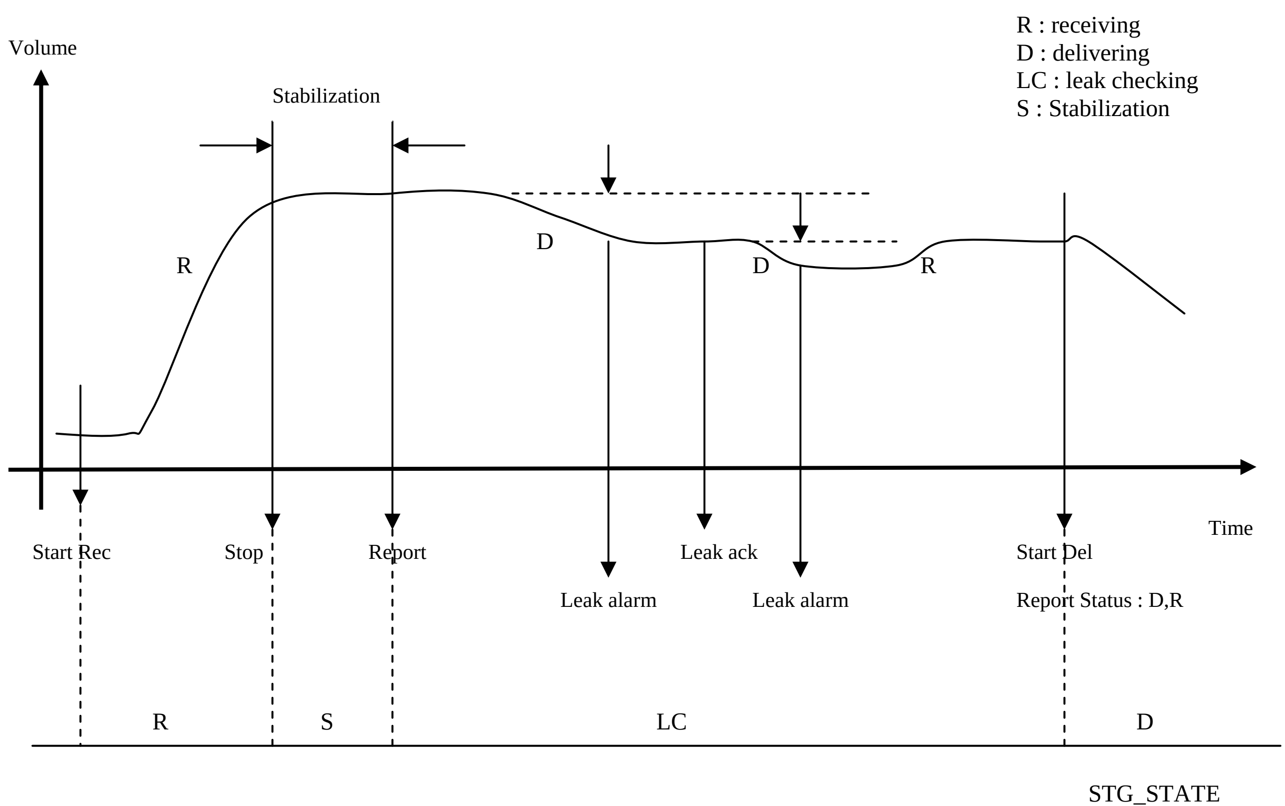


Observation: Report type to be generated is defined in the command Stop (Wr), while the generation of the report occurs: a) transition of Stabilizing to Checking leak; b) Start Rec (Wr) when in Stabilizing; c) Start Del (Wr) when in Stabilizing.

State	Possible Commands	Comments
None	-	None command is accepted
Stabilizing	Start Del(Wr)(*), Start Rec(Wr) (*), Restart(Wr)	Start Rec (Wr) :TRANSFER_TYPE=Delivery and stabilizing a reception Start Del (Wr) :TRANSFER_TYPE=Receipt and stabilizing a delivery
Checking leak	Start Del(Wr) (*), Start Rec(Wr) (*), Restart(Wr)	
Receiving	Stop(Wr) (*), Restart(Wr)	
Delivering	Stop(Wr) (*) Restart(Wr)	

(*) Commands accepted only if OPERATING_MODE=User


Volume
R : receiving
D : delivering
LC : leak checking
S : Stabilization
Stabilization
LC
R
D
R
D
R
D
R
D
Stabilization
R
LC
Time
Start Rec
Stop
Start Del
Stop
Report Status : R
Report Status : D
R
S
LC
D
S
LC
STG STATE


R : receiving
D : delivering
LC : leak checking
S : Stabilization
Volume
Stabilization
D
R
D
R
Time
Start Rec
Stop
Report
Leak ack
Start Del
Leak alarm
Leak alarm
Report Status : D,R
R
S
LC
D
STG_STATE

Operating mode (OPERATING_MODE)

There are two modes of operation:

- User: The state machine is the state previously indicated in the description of the parameter STG_STATE. The user indicates when begins and to finish the receiving and delivering of product. Anomalies occurred are indicated in the status.
- Automatic: The inputs CLOSED_IN and CLOSED_OUT are used to infer the transitions to begin and to finish the receiving and delivering of the product. The only accept command of written in STG_STATE is the Restart (Wr) that forces the state Checking leak. The interpretation of these inputs is presented below, no inversion in the interpretation (INVERT_LIMIT_SWITCHES):

CLOSED_IN	CLOSED_OUT	Transitions
1 -> 0	1	Start Rec (Wr)
0 -> 1	1	Stop (Wr)
1 -> 0 0 -> 1	0	Ignored
1	1 -> 0	Start Del (Wr)
1	0 -> 1	Stop (Wr)
0	1 -> 0 0 -> 1	Ignored

If power up, then:

CLOSED_IN	CLOSED_OUT	STG_STATE
0	0	Checking leak
0	1	Receiving
1	0	Delivering
1	1	Checking leak

Sampler Control

The sampler control will be executed if VOLUME_PULSE, SAMPLE_PULSE_WIDTH, SAMPLE_PULSE_VOL, SAMPLER_TVOL was configured for values different from zero and the process is in the phase of product transfer.

The output SAMPLE_PULSE can be used to request to the sampler the collection of a sample of the measured product and at the end of a period the collected volume would be sent for analysis in laboratory (proportional sampler).

This output will be activated every time that the totalization accumulate the volume specified in VOLUME_PULSE (variation of TOV is used for the control of the sampler) and during a time specified in SAMPLE_PULSE_WIDTH.

To calculate the configuration value of VOLUME_PULSE uses the following equation:

$$\text{VOLUME\_PULSE} = \frac{\text{Volume (MAX\_HEIGHT)} * \text{SAMPLE\_PULSE\_VOL}}{\text{SAMPLER\_TVOL}}$$

Where:
Volume (MAX_HEIGHT): volume corresponding to maximum height of work
SAMPLE_PULSE_VOL: volume collected to each sample
SAMPLER_TVOL: total volume to be collected by the sampler

Example: Tank with 300 m^3 and the sampler with capacity of 5 liters, where each sample of volume 4 cm^3.

Volume (MAX_HEIGHT) = 300 m^3

SAMPLE_PULSE_VOL = 4 cm^3 = 4 E-6 m^3
SAMPLER_TVOL = 5 litros = 5 E-3 m^3

$$\text{VOLUME\_PULSE} = \frac{300 * 4E\text{-}6}{5E\text{-}3} = 0.24\ m^3$$

Use of the block inputs

Input	Link	Description
LIQ_LEVEL AVG_LIQ_TEMP AMBIENT_TEMP PRESSURE_P3 (if pressurized tank)	Mandatory	If these inputs are not connected, the block will indicate BLOCK_ERR. Configuration error.
FW_LEVEL	Optional	If it is not linked, then the last good value of the free water level or zero value will be considered and a report will be generated with STORAGE_STATE pending. If the tank is spherical and this input is not linked, then will be considered the zero value, that is, no free water. This procedure avoids discontinuity for the volume calculation due to the TANKx_SPHERE.Bottom capacity.
DENSITY_METER PRESSURE_P1 PRESSURE_P2 PRESSURE_P3	Optional. If selected DENSIMETER_TYPE= HTMS, the P1 and P3 pressure inputs should be linked.	It will be generated report with STORAGE_STATE pending if: • configured to density meter in line (inline sampler when transferring or inline sampler when receiving) or "In Tank" and DENSITY_METER not linked • configured to HTMS and PRESSURE_P1 or PRESSURE_P3 is not linked.
SW_METER	Optional	If it is not linked, then will be generated report with STORAGE_STATE pending. If it is ethanol, this input is not used.

When the input NOT_DELIVERING is active with status good during the phase of Delivering, the transfer usually continues in Delivering state. The only change occurs in the transition of enable to disable, that implicates in a new Start Del.

Block outputs
The outputs related to batch (BATCH_NEAR_END and BATCH_END) and sampler control (SAMPLE_PULSE and SAMPLER_FULL) are activated according to its respective functionalities and disabled at the beginning of a Delivering or Receiving phase.

Flow calculation
The flow calculated for this block (FLOW_GSV, FLOW_NSV, FLOW_MASS) use a buffer with the last 60 samples of the volumes and mass calculated, where each sample is collected to every 10 seconds. Based on the oldest sample (10 minutes of phase difference) and on the current volume and mass, the flow is calculated.
This buffer is cleaned in Start Rec, Start Del and Stop.
With this algorithm it should be possible a better precision for values of calculated flow.

Note
The calculated flow values are only for supervision or approximate value, because it contains an uncertainty superior to the transferred volume/mass calculation. That is, the flow totalization will not be exactly the value obtained from the calculations above.

Flow signal	Meaning
Negative	Receiving or delivering unduly the product
Positive	Flow in the receiving or delivery of product as in the receiving and delivery phases, respectively

Batch Control
The output of BATCH_END is activated only in transfer phase when a batch was programmed and the programmed value was reached. This output is activated until that the report is generated (transition of Stabilizing to Checking leak).

Sequence of transferred volume/mass calculation
The variation values (third element in the array of the calculation sequence parameters) are final condition minus initial condition when receiving and the inverse when delivering, therefore such values should be positive, except when improper receipt or deliver.

Leak detection

The analysis of leak detection is based on minimum volume (MIN_LEAK_VOL) and minimum leak rate (MIN_LEAK_RATE), when both conditions are satisfied, then the output LEAK_ALARM will be activated. This output will be disabled only by user through the parameter LEAK_CMD.

When the user disable this output, a new analysis of leak detection is started (volume and flow).

The parameters LEAK_TIME_ACC, LEAK_GSV[1] and LEAK_AVG_RATE_GSV[1] refer to the analysis from the beginning of the Checking Leak phase, while the parameters LEAK_TIME, LEAK_GSV[2] and LEAK_AVG_RATE_GSV[2] refer to the analysis from the last user's identification.

The values of these leak analysis parameters remain with the last values, like when occurs the output of the Checking leak state, until that occurs a new beginning of the leak detection phase.

In the parameters CURRENT_STATUS and BATCH_STATUS are indicated two situations relative to leak detection, that occurs as described below:

- Shouldn't receive : occurs when:
    - Inputs CLOSED_IN and CLOSED_OUT are linked and the input CLOSED_IN indicates receiving of product in "Stabilizing" or "Checking leak" or "Delivering" state.
    - In "Delivering" state, occurs increase of the level (innage) superior to 10mm (0.4 in)
- Shouldn't deliver : occurs when:
    - Inputs CLOSED_IN and CLOSED_OUT are linked and the input CLOSED_OUT indicates delivering of product in "Stabilizing" or "Checking leak" or "Receiving" state.
    - In "Receiving" state, occurs decrease of the level (innage) superior to 10mm (0.4 in)

Subsidies to divide the production of crude oil to the corresponding days

For applications where the TM302 is used for measurement of crude oil production, this block has some parameters that can be used to aid the division of the production to the corresponding days.

This feature facilitates this operation, because on the contrary of the flow measurement, the production, measurement and transfer do not occur simultaneously.

The data are based exclusively on the receiving phases, even if the transfer occurs in the delivery (TRANSFER_TYPE=delivery) and it may be based on values calculated with the oil not stabilized.

Parameters	Receipt type	Calculation
START_PARTIAL_GOV START_PARTIAL_NSV START_PARTIAL_MASS	Not started, but ended on the previous day.	Values from the difference between the end of the receipt and the beginning of the previous day.
WHOLE_GOV WHOLE _NSV WHOLE _MASS	Started and ended on the previous day or started before the previous day and ended after the previous day.	Sum of the start and finished receipts on the previous day or not start and ended on the previous day.
END_PARTIAL_GOV END _PARTIAL_NSV END _PARTIAL_MASS	Started on the previous day, but ended in later day.	Values from the difference between the end of the previous day and the start of the receipt.

Numeration and report types

The reports have a sequential numeration for each tank (tank ID) and report type:

- Receiving batch: report of product receiving when the custody transfer occurs in the receiving phase (Receipt transfer & batch) or delivery (Receipt & batch);
- Delivery batch: report of product delivery when the custody transfer occurs in the delivery phase (Delivery transfer & batch) or receiving (Delivery & batch);
- Daily Inventory (Inventory & day): indicates the values of the input variables, correction factors, volumes and mass at the beginning and end of the day;
- Monthly Inventory (Inventory & month): indicates the values of the input variables, correction factors, volumes and mass at the beginning and end of the month;
- Leak (Leak): this report type is generated when is in "Checking Leak" state and there is variation of superior volume to NO_TRANSFER_VOL and to occur transition to the O/S mode, Receiving, Delivering or Restart (Wr).

The numeration of reports is restarted only when the correspondent type of logger in the TM302 memory is initialized.

Diagnosis and Troubleshooting

1 BLOCK_ERR. Block configuration: this indication can occurs due to the following problems:

- Input that should be obligatorily linked but it is not linked.
- If DENSIMETER_TYPE is in-line measurement and BSW_TYPE is not in-line measurement.
- If DENSIMETER_TYPE is in-tank measurement, BSW_TYPE is in-line measurement and appropriation measurement.
- If STRATEGY equal to zero.
- If DENSIMETER_TYPE select HTMS mode 1 or 2 and in STD block the configured product selected the base density or the input DENSITY_METER is linked.
- If the sampler is configured inadequately, that is, accumulation of 3 pulses or more for the output SAMPLE_PULSE and indication in CURRENT_STATUS and BATCH_STATUS. The same indication will occurs if the parameter SAMPLE_PULSE_WIDTH was configured with inferior value to the macrocycle.
- If MAX_HEIGHT is inconsistent in relation to the diameter of the main cylinder (horizontal cylindrical tank) or diameter of the sphere.
- If there is a dead volume configured bigger than the tank volume for a determined level, resulting in negative TOV.
- Inconsistence in the tank table configuration.
- If the measured product is ethanol and SW_TYPE is configured different of DENSIMETER_TYPE. That is, DENSIMETER_TYPE is configured to "In tank" or HTMS and SW_TYPE are configured to "In line delivering" or "In line receiving". Or DENSIMETER_TYPE is configured to "In line delivering" and the SW_TYPE is different. Or DENSIMETER_TYPE is configured to "In line receiving" and the SW_TYPE is different.

2 Writing failure in configuration parameter: The parameters that in Store/Mode column indicates NW, it only is written when STG_STATE indicates None or Checking leak.

3 The input value SW_METER is limited to the range from 0 to 100% (including the ends) before proceeding the volume and mass calculation.

4 The input value FW_LEVEL is limited in zero range to the INNAGE value before proceeding the volume and mass calculation. If the exceeded value is superior to 10mm (0.4 in), it will be indicated in BATCH_STATUS.Inconsistency.

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	If this parameter is configured with string different of spaces, this parameter will replace the block tag in the QTR report.
3 (A2)	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)	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	I,1	LIQ_LEVEL	DS-65			L	N / RO	Level of the liquid supplied by the level meter.
8 (A2)	I	FW_LEVEL	DS-65			L	N	Level of free water. Always in innage terms, independently of the TYPE_ATG configuration.
9 (A2)	I,1	AVG_LIQ_TEMP	DS-65			T	N / RO	Average liquid temperature.
10 (A2)	I,1	AMBIENT_TEMP	DS-65			T	N / RO	Average ambient temperature in tank not thermally isolated.
11 (A2)	I,1	DENSITY_METER	DS-65			LD	N	Liquid density at process temperature.
12 (A2)	I,1	PRESSURE_P1	DS-65			P	N	Pressure P1.
13 (A2)	I	PRESSURE_P2	DS-65			P	N	Pressure P2.
14 (A2)	I,1	PRESSURE_P3	DS-65			P	N	Vapor pressure in tank P3. Pressure input in pressurized tanks.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
15 (A2)	I	SW_METER	DS-65			%	N	Percentage of sand and water mixed in the oil, if the product is hydrocarbon. Percentage of ethanol in the mixture calculated, if the product is ethanol.
16	I,1	NOT_DELIVERING	DS-66				N / RO	It enables the transfer measurement.
17	I	CLOSED_IN	DS-66				N / RO	This input indicates if the input valve is totally closed.
18	I	CLOSED_OUT	DS-66				N / RO	This input indicates if the output valve is totally closed.
19	I	SAMPLER_FULL_IN	DS-66				N / RO	This input indicates if the sampler is full. It stops the pulse generation for the sampler (SAMPLE_PULSE).
20	O,1	BATCH_NEAR_END	DS-66				N / RO	Indicates if the current batch is near of the end. This output will continue TRUE until the batch ends.
21	O,1	BATCH_END	DS-66				N / RO	Indicates the batch end for one macro cycle. After that, a new batch is initialized.
22	O,1	FLOW_GSV	DS-65		0	QV	N / RO	Flow in gross standard volume form the level variation.
23	O,1	FLOW_NSV	DS-65		0	QV	N / RO	Flow in net standard volume form the level variation.
24	O,1	FLOW_MASS	DS-65		0	QM	N / RO	Flow in mass form the level variation.
25	O,1	LEAK_ALARM	DS-66		0	E	N / RO	Indicates if there is a leak for instantaneous flow (gross volume in standard condition) superior to MIN_LEAK._RATE and the accumulated volume LEAK_GSV is superior to MIN_LEAK_VOL. When the leak is detected, this output will be zero only by user's identification.
26	O,1	OVER_FILL	DS-66				N / RO	Indicates when the tank is full.
27	O	SAMPLE_PULSE	DS-66				N / RO	Output to activate the collection of a sample.
28	O	SAMPLER_FULL	DS-66				N / RO	Indicates that the total collected volume reached the value configured in SAMPLER_TVOL.
29 (A2)	2	TYPE_ATG	Unsigned8	0=Innage 1=Outage 2=Outage-corrected reference height	2	E	S / NW	Indicates if the input LIQ_LEVEL is supplying the level of liquid or the free length of the tank.
30 (A2)	2	REF_HEIGHT	Float	> 0.0	10000.0	L	S / NW	Tank reference height. Distance between the dip-plate and the level meter type outage measured in the temperature STD.TANKx_BASE_TEMP.
31	2	MAX_HEIGHT	Float	>=0.0 0.0 = Reference height	8000.0	L	S	Maximum height (for dip-plate) of the liquid. Above which will indicate over fill. This parameter should be defined considering factors as: minimum distance to guarantee the level reading accuracy and operation and sensor safety.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
32 (A2)	2	DENSIMETER_TYPE	Unsigned8	0=In tank 1=HTMS mode 1 2=HTMS mode 2 3=In-line delivering 4=In-line receiving	0	E	S / NW	Define if the density meter is measuring the liquid in the tank or measuring in the input/output of the tank. In this last case, a weighted average density will be calculated considering the volume obtained through the level variation.
33 (A2)		H0	Float	>= 0.0	0.0	L	S / NW	Distance between the hybrid reference point to the datum plate at temperature TANKx_BASE_TEMP.
34 (A2)	2	HEIGHT_P1	Float	>= 0.0	0.0	L	S / NW	Distance between the force center of the pressure sensor P1 and the hybrid reference point measured at temperature STD.TANKx_BASE_TEMP.
35 (A2)		HEIGHT_P2	Float	>= 0.0	0.0	L	S / NW	Distance between the force center of the pressure sensor P2 and the hybrid reference point measured at temperature STD.TANKx_BASE_TEMP.
36 (A2)	2	HEIGHT_HT	Float	>= 0.0	10000.0	L	S / NW	Distance between the force centers of the pressure sensors P1 and P3 measured at temperature STD.TANKx_BASE_TEMP.
37 (A2)		HMIN	Float	>= 0.0	0.0	L	S	Minimum level above the pressure tap P1 for use of the method A of calculation, when configured HTMS mode 1.
38 (A2)		P1_CUTOFF	Float	>= 0.0	0.0	L	S	Minimum level above the pressure tap P1 for use of the method A of calculation, when configured HTMS mode 2.
39 (A2)		SW_TYPE	Unsigned8	0=In tank 1=In-line delivering 2=In-line receiving	0	E	S / NW	Define if the BSW meter is measuring the liquid in the tank or measuring in the input/output of the tank. In this last case, a weighted average will be calculated considering the volume obtained through the level variation.
40 (A2)		VAPOR_DENSITY	Float	> 0.0	1.25 E-3	M/LV	S	Vapor density inside the tank.
41 (A2)		MIN_LEAK_RATE	Float	0.0=leak detection disabled >= 0.0	0.04	LV/min	S	Minimum gross volumetric flow at standard condition to consider a leak. Inferior flow to the specified in this parameter will be ignored.
42 (A2)		MIN_LEAK_VOL	Float	0.0=leak detection disabled >= 0.0	1	LV	S	Minimum gross volume at standard condition to consider a leak. Inferior volume to the specified in this parameter will be ignored.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
43 (A2)		STABILIZATION_TIME	Unsigned8	0 to 255	30	Min	S	Time for stabilization after the end of a transfer.
44 (A2)	2	TRANSFER_TYPE	Unsigned8	0=Receipt 1=Delivery	1	E	S / NW	Define if the transfer process occurs in the receiving or delivery of the product.
45	2	BATCH_SIZE	Float [10]		0	LV	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.
46		BATCH_ID1	Visiblestring[8]				S	Actual batch description.
		….						
55		BATCH_ID10	Visiblestring[8]				S	Description for the 10ªbatch.
56 (A2)	4	VOLUME_DELAY	Float	>= 0.0	2.0	LV	S	When configured to end automatically the batch for the volume, the output BATCH_END will be activated before the programmed value of the volume specified in this parameter.
57 (A2)	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.
58 (A2)	4	OVERRIDE__TEMP	Float		20.0	T	S	Override value for the temperature input when it has bad status and ambient temperature.
59 (A2)	4	OVERRIDE_DENSITY	Float	> 0.0	800.0	LD	S	Override value for the density input when it has bad status.
60 (A2)	4	OVERRIDE_SW	Float	0.0 to 100.0	0.0	%	S	Override value for the SW input when it has bad status.
61 (A2)	4	ENABLE_REPORT	Bitstring[2]	Daily/ Monthly/Both phases	Monthly		S	It enables the report generation for the periods: day or month. Both phases means that batch report will be generated when receiving and delivering, regardless how TRANSFER_TYPE is configured.
62 (A2)		NO_TRANSFER_VOL	Float	0= Always generated	1	LV	S	Liquid volume at standard condition below which no QTR report is generated.
63 (A2)		ALLOCATION_TYPE	Unsigned8	0=Production time 1=Level	0	E	S / NW	Criterion used in production allocation of proportional way. It is Based on the production time or level at the moment of period ending.
64 (A2)	1	LEAK_CMD	Unsigned8	0=None 1= Ack leak (Wr)	0	E	N	Writing "Ack leak (Wr)", a new analysis of leak detection is started, whose data are stored in LEAK_GSV and LEAK_AVG_RATE_GSV. The output LEAK_ALARM will be zero.
65		VOLUME_PULSE	Float	0.0=disabled > 0.0	0.0	LV	S / NW	Volume at flowing condition referent to one pulse to the sampler.
66		SAMPLE_PULSE_WIDTH	Unsigned8	0=disabled > 0	1	Sec	S / NW	Pulse width to the sampler.
67		SAMPLE_PULSE_VOL	Float	0.0=disabled > 0.0	0.0	LV	S / NW	Collected volume to each capture (grab).
68		SAMPLER_TVOL	Float	0.0=disabled > 0	0	LV	S / NW	Total volume to be collected by the sampler.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
69 (A2)		OPERATING_ MODE	Unsigned8	0=User 1=Automatic	0	E	S / NW	Selection of the operation mode. In the option controlled by the user, it is necessary the user indicates the desired operation writing in STG_STATE. The automatic option implicates in use of the inputs CLOSED_IN and CLOSED_OUT to detect the accomplished operation.
70 (A2)		INVERT_LIMIT _SWITCHES	Bitstring[2]				S / NW	Inverts the interpretation of the inputs CLOSED_IN and CLOSED_OUT.
71	1	STG_STATE	Unsigned8	0=None 1=Start Rec (Wr) 2=Receiving 3=Stop (Wr) 4=Stabilizing 5=Cheking leak 6=Start Del (Wr) 7=Delivering 8=Restart (Wr)	0	E	N	Indicates the state of the batch process.
72	3	PREV_BATCH _ID	Visiblestring[8]				N / RO	Description of the previous batch.
73	3	PREV_GSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Gross corrected volume of the previous transfer batch.
74	3	PREV_NSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Net corrected volume of the previous transfer batch.
75		PREV_MASS_ VACUUM	Float SI-DD3 US-DD3 Kg-DD10 Lb-DD10			M	N / RO	Mass (in vacuum) transferred in the previous transfer batch.
76		PREV_MASS_ AIR	Float SI-DD3 US-DD3 Kg-DD10 Lb-DD10			M	N / RO	Apparent mass (in air) transferred in the previous transfer batch.
77		PREV_FTIME_ BATCH	Time difference				N / RO	Flow time of the previous transfer batch.
78	3	CURRENT_ST ATUS	Bitstring[2]	See Block Options	0	Na	N/ RO	Current status. Similar to BATCH_STATUS.
79	3	BATCH_STAT US	Bitstring[2]	See Block Options	0	Na	N/ RO	Status during the batch. See BATCH_STATUS.
80		OPEN_DATE_ TIME	Date				N / RO	Open date/hour of the current batch.
81		CLOSE_DATE _TIME	Date				N / RO	Close date/hour of the current batch.
82	3	FTIME	Time difference				N / RO	Transfer time.
83		OUTAGE	Float[2]			L	N / RO	Free level at the beginning/end of the transfer.
84		CORRECTED_ REF_HEIGHT	Float[2]			L	N / RO	Tank reference height at the measurement condition for beginning/end of the transfer.
85	3	INNAGE	Float[3]			L	N / RO	Liquid level for beginning/end of the transfer and the difference.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
86	3	TOV	Float[3]			LV	N / RO	Total volume observed at the beginning/end of the transfer and the difference.
87		LIQ_FW_LEVEL	Float[2]			L	N / RO	Free water level at the beginning/end of the transfer.
88		FW_VOLUME	Float[3]			LV	N / RO	Free water volume at the beginning/end of the transfer and the difference.
89		LIQ_TEMP	Float[2]			T	N / RO	Liquid temperature at the beginning/end of the transfer.
90		AMB_TEMP	Float[2]			T	N / RO	Ambient temperature at the beginning/end of the transfer.
91		TANK_SHELL_TEMP	Float[2]			T	N / RO	Tank temperature at the beginning/end of the transfer.
92	3	CTSH	Float[2]			Na	N / RO	Correction factor of the tank table due to the temperature effect at the beginning/end of the transfer.
93		FRA	Float[2]			LV	N / RO	Correction factor of floating roof at the beginning/end of the transfer.
94	3	GOV	Float[3]			LV	N / RO	Gross observed volume at the beginning/end of the transfer and the difference.
95		LIQ_DENSITY	Float[3]			LD	N / RO	Liquid density at process condition for beginning/end of the transfer. If the product is ethanol, this is the density at process condition of the ethanol and water mixture.
96	3	BASE_DENSITY	Float[3]			LD	N / RO	Liquid base density for beginning/end of the transfer. If the product is ethanol, this is the base density of the ethanol and water mixture.
97	3	LIQ_CTL	Float[3]			Na	N / RO	Correction factor of the liquid temperature at the beginning/end of the transfer. If the product is ethanol, this is the CTL of the ethanol and water mixture.
98	3	LIQ_GSV	Float[3]			LV	N / RO	Gross volume at standard condition for beginning/end of the transfer and the difference.
99		LIQ_SW	Float[3]			%	N / RO	Liquid BSW at beginning/end of the transfer. If the product is ethanol, this is the water percentage in volume at base condition.
100		LIQ_NSV	Float[3]			LV	N / RO	Liquid volume at standard condition for beginning/end of the transfer and the difference.
101		WCF	Float[3]			M/LV	N / RO	Volume conversion factor for mass at beginning/end of the transfer. If the product is ethanol, the base density of the pure ethanol is used.
102	3	MASS_IN_VACUUM	Float[3]			M	N / RO	Mass (in vacuum) of the pure product (no water) at beginning/end of the transfer and the difference.
103		MASS_IN_AIR	Float[3]			M	N / RO	Apparent mass (in air) of the pure product (no water) at beginning/end of the transfer and the difference.
104		START_PARTIAL_GOV	Float			LV	N/ RO	Gross observed volume received in the previous day referent to receipt that not started in the previous day, but ended in the previous day.

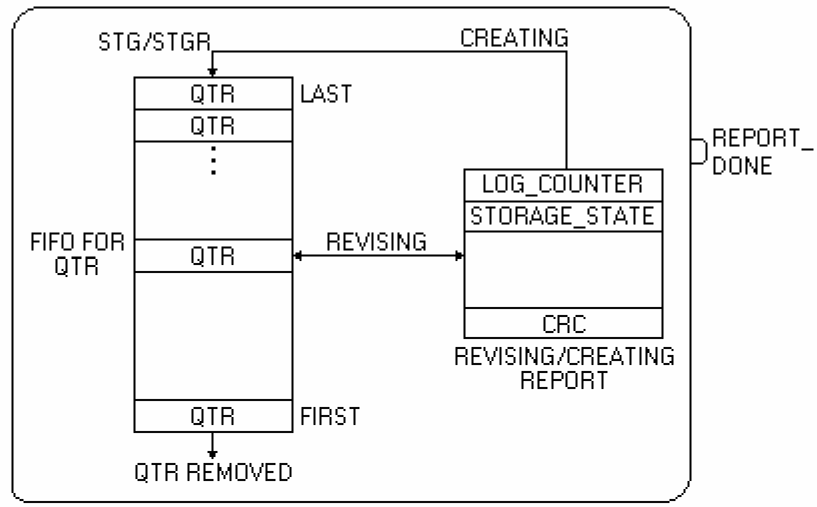
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
105		START_PARTIAL _NSV	Float			LV	N/ RO	Net corrected volume received in the previous day referent to receipt that not started in the previous day, but ended in the previous day.
106		START_PARTIAL _MASS	Float			M	N/ RO	Mass received in the previous day referent to receipt that not started in the previous day, but ended in the previous day.
107		WHOLE _GOV	Float			LV	N/ RO	Gross observed volume received in the previous day of receipts that started and ended in the previous day or that not started and ended in the previous day.
108		WHOLE _NSV	Float			LV	N/ RO	Net corrected volume received in the previous day of receipts that started and ended in the previous day or that not started and ended in the previous day.
109		WHOLE_MASS	Float			M	N/ RO	Mass received in the previous day of receipts that started and ended in the previous day or that not started and ended in the previous day.
110		END_PARTIAL _GOV	Float			LV	N/ RO	Gross observed volume received in the previous day referent to receipt started in the previous day and continued until the current day.
111		END_PARTIAL _NSV	Float			LV	N/ RO	Net corrected volume received in the previous day referent to receipt started in the previous day and continued until the current day.
112		END_PARTIAL MASS	Float			M	N/ RO	Mass received in the previous day referent to receipt started in the previous day and continued until the current day.
113		LEAK_TIME_ACC	Time difference				N / RO	Time elapsed from the last transition to the Checking leak state.
114		LEAK_TIME	Time difference				N / RO	Time elapsed from the last acknowledge for leak.
115		LEAK_GSV	Float[2]			LV	N / RO	Gross volume at standard condition accumulated during the Checking leak state and from the last acknowledge.
116		LEAK_AVG_RATE_GSV	Float[2]			QV	N / RO	Average flow in gross volume at standard condition during the Checking leak state and from the last acknowledge.
117		LEVEL_DEV	Float	0.0=disable >=0.0	0.0	%	S	Maximum deviation acceptable between the level from the HTG relatively to the level in LIQ_LEVEL.
118		DENSITY_DEV	Float	0.0=disable >=0.0	0.0	%	S	Maximum deviation acceptable between the density from the HTG relatively to density in DENSITY_METER.
119	O	HTG_LEVEL	DS-65			L	N / RO	Level obtained by HTG calculation.
120	O	HTG_DENSITY	DS-65			LD	N / RO	Density obtained by HTG calculation.
121		HTG_ALARM	Bitstring[2]				N / RO	Indication of relative alarms to HTG.
122	O	INNAGE_OUT	DS-65			L	N / RO	Liquid level (innage) obtained from the LIQ_LEVEL and TYPE_ATG.
123		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
124		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.
125 (A2) (V3)	4	OVERRIDE_PRES	Float	>= 0	101.325	P	S	Override value for the P3 pressure input in pressurized tanks.
126 (A2)		LEVEL_BAND	Float	0 to 100 0=disabled	10	L	S	Tolerance in level variation contrary to the expected according to the current state.
127		CTILT	Float[2]			Na	N / RO	Correction factor of inclination in horizontal cylindrical tanks.
128		TOV_C	Float[3]			LV	N / RO	Total observed volume of the cylindrical part (main cylinder and flanges) at the beginning/end of the transfer and the difference, if the tank is horizontal cylindrical.
129		LIQ_PRES	Float[2]			P	N / RO	Liquid pressure at the beginning/end of the transfer.
130		CPVC	Float[2]			Na	N / RO	Correction factor of pressure for cylindrical tank geometry.
131		CPVE	Float[2]			Na	N / RO	Correction factor of pressure for heads geometry of the cylindrical or spherical tank.
132		LIQ_CPL	Float[3]			Na	N / RO	Pressure correction factor for volume of the measured liquid in pressurized tanks.
133		LIQ_GSV_VAPOUR	Float[3]			LV	N / RO	Liquid volume at base condition referent to quantity of vapor within the pressurized tank.
134		ACTIVE_ALARM1	Bitstring[2]				N / RO	It indicates which alarms referent to the tank are active.
135		ACTIVE_ALARM2	Bitstring[2]				N / RO	It indicates which alarms referent to the tank are active.
136		UNACK_ALARM1	Bitstring[2]				N	It indicates which alarms referent to this tank were unacknowledged by the operator.
137		UNACK_ALARM2	Bitstring[2]				N	It indicates which alarms referent to this tank were unacknowledged by the operator.
138		P_FLOWING	Float	0.0 to 100.0	0	%	D / RO	Current percentage in mass of the ethanol in the mixture.
139		PERC_MASS	Float[3]	0.0 to 100.0	0	%	N / RO	Percentage in mass of the ethanol in the mixture at the beginning/end of the transfer and transferred.

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
NW – Allowed writing if STG_STATE indicates None or Checking leak

STGR – Shore Tank Gauging Revision

Schematic



Description

This block allows searching the reports stored in the TM302 memory and allows to the user the access to the laboratory analysis data or manual measurement (FW_LEVEL, LIQ_DENSITY, BASE_DENSITY and LIQ_SW). Then the user can request the calculation and to check the report. If the data are consistent, the report receives the status of "not stored".

Another function is the report generation totally based on information obtained manually and/or through laboratory analysis (simulate tank).

Searching the reports in the memory

There are the following search modes of reports from the TM302 memory.

Search mode	Features
LOG_COUNTER	It locates and shows the requested report. It is the chronological order of reports generated / stored in the TM302 memory.
REV_CMD	It allows the search (Next and Previous options) between the reports with STORAGE_STATE = pending if the filter is disabled or between the reports compatible with the configured filter independently of the STORAGE_STATE.
TANK_TAG_SEARCH SITE_TAG_SEARCH OPEN_DATE_REPORT	The writing in these parameters site and shows the oldest report pending with the tag/date of requested opening. From this moment the search through REV_CMD, for the Next and Previous options will be exclusively between the reports with the tag/date of requested opening. Writing blank in the parameters TANK_TAG_SEARCH or SITE_TAG_SEARCH or Jan 1, 2003 00:00:00:000 in the parameter OPEN_DATE_REPORT the search is done between all the pending reports.

The parameters OPEN_DATE_REPORT, TANK_TAG_SEARCH and SITE_TAG_SEARCH work as filter for the search through REV_CMD (Next and Previous options), where the last parameter writing is the active filter. Therefore there is not combination for the filter application.

The writing in the parameter REV_CMD with the options First pending or Last pending, implicates in the search and consequent visualization, if found, of the oldest report (first pending) or more recent (last pending) with STORAGE_STATE = pending. If filter is configured, then the search will be conditioned to the same.

Pending data
The numeric data susceptible to edition and that complement data collected by field devices are those indicated in the parameter MANUAL_DATA. This occur when the corresponding input is not linked or the value at the beginning or end of the transfer or weighed average presents some inconsistency.

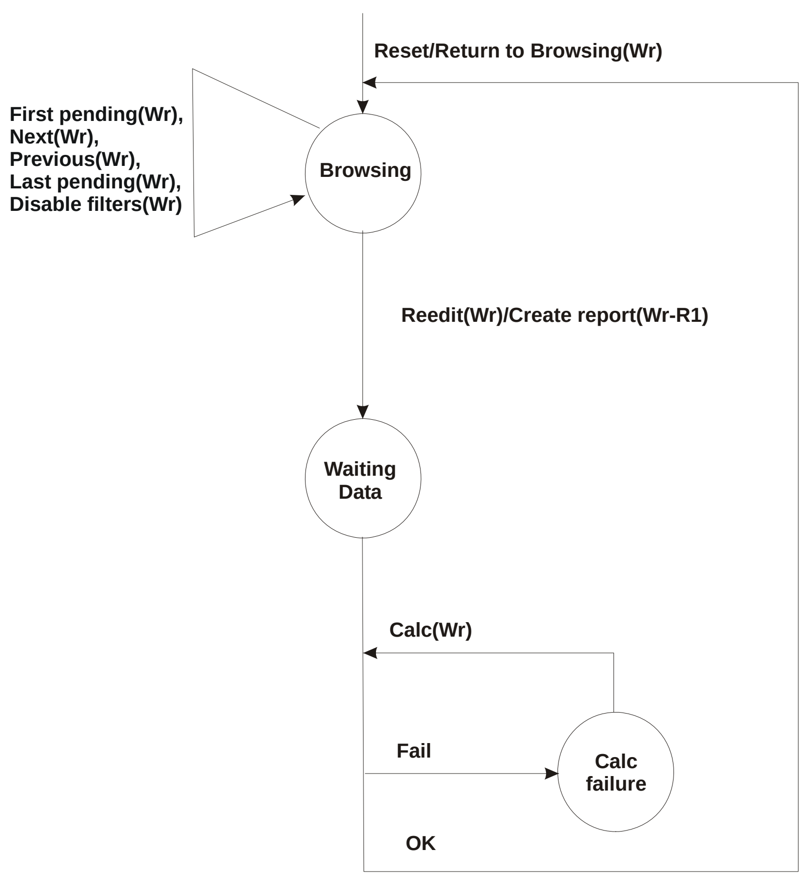
Reports review
The occurrence of problem listed below at the necessary moment to execute the calculation of the transferred volume/mass (beginning/end of the transfer or during the calculation of the weighed average) implicates to enable automatically the edition of the correspondent parameter:
- Out of range of CTL calculation enables the edition of the density and temperature;
- SW out of range of 0 to 100% at the beginning or end of the transfer when SW_TYPE is configured "In tank";
- Bad status in FW_LEVEL input;
- Negative variation of free water volume;
- Level of free water at the beginning or end of the transfer superior to the innage with tolerance of 10mm (0.4 inch).

All the reports whose data are supplied manually can be revised, independently of the status (not-stored, stored, pending). Where only the data supplied manually can be revised.

The report review (STGR/TWTR) with not-stored status read by the TMView through the block STGV/TWTV is momentarily disabled.

Complete review and edition of reports
These procedures should be executed and finished (calculation with success) of integral way by the same user (username). Otherwise, the supplied data will be discarded.

Only the following types of reports can be completely edited:
1= Receipt transfer & batch
2= Delivery transfer & batch



State	Possible Commands	CREATING_REPORT	Comments
Browsing	First pending(Wr), Next(Wr), Previous(Wr), Last pending(Wr), Reedit(Wr-R1), Disable filters(Wr), Create report (Wr-R1)	Revising	Only search commands, to start, reedition or to create report.
Waiting data	Calc(Wr-R1), Return to Browsing(Wr)	Creating or Revising	Awaiting user to provide information of laboratory analysis or manual measurement.
Calc failure	Calc(Wr-R1), Return to Browsing(Wr)	Creating or Revising	Awaiting user to correct the information of laboratory analysis or manual measurement.

Diagnosis and Troubleshooting:

1. Interpretation of problems indicated in CALC_ERROR parameter:

Indication	Description
0=No error	The supplied data are consistent, report was generated
2=Missing TANK_ID	• Tank ID not selected The Tank ID selected is being used in another measurement (STG or TWT): the selection is always accepted and the check is accomplished by user's solicitation (Calc (Wr)). • Type of tank different of vertical cylindrical in manual measurement.
3=Missing TMR_TYPE	To provide the type of report
4=Missing OPEN_DATE_TIME	To provide the date and hour of start
5=Missing CLOSE_DATE_TIME	• To provide the date and hour of close • Difference between date/hour of close and date/hour of start should be inferior to 24 hours.
6=Missing INNAGE	To provide the level
7=Missing FW_LEVEL	To provide the level of free water
8=Missing LIQ_TEMP	To provide the average temperature of the liquid
9=Missing AMB_TEMP	To provide the ambient temperature
10=Missing DENSITY	To provide the liquid density
11=Missing LIQ_SW	To provide the BSW
12= Reverse order date	The date/hour at the start is after the date/hour of close
13=Inconsistent innage	• Level increased in the delivery or decreased in the receiving
14=Inconsistent FW	• Level of free water increased in the delivery or decreased in the receiving • Level of free water superior to the liquid level
15=Out range-CTL	To verify the density range and temperature according to the product type.
16=Out range-Curve	Level out of range configured in the tank table.
17=Config error	Configuration error
18=General error	The edited or revised report was superposed or eliminated.

2. BLOCK_ERR. Out of Service: block STGR can remain in the Out of service mode in spite of the target mode is Auto because the block Resource is in O/S.
3. The writing in REV_CMD = Reedit(Wr) will be accepted if the visualized report was created with data manually edited.

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the mode parameter.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	O	REPORT_DONE	DS-66				N / RO	Indicate that one report was generated (manually edited) and stored in the TM302 memory.
8	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of reports with "not stored" status, that is, not stored in the database of TMView.
9		NUM_PENDING	Unsigned16		0	Na	N / RO	Number of reports with "pending" status, that is, awaiting data of laboratory analysis to finish calculations.
10	1	FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of first report in the QTR log (the oldest one).
11		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of last report in the QTR log (the newest one).
12		OPEN_DATE_SEARCH	Date				N	Opening date of period referent to the pending report to be search. It is possible to write in this parameter if REV_CMD=Browsing.
13		TANK_TAG_SEARCH	Visiblestring[16]		Blank		N	Reports search where the tank tag coincides with this parameter. It is possible to write in this parameter if REV_CMD=Browsing.
14		SITE_TAG_SEARCH	Visiblestring[16]		Blank		N	Reports search where the tag of measurement site coincides with this parameter. It is possible to write in this parameter if REV_CMD=Browsing.
15 (R1)	1	REV_CMD	Unsigned8	0=Browsing 1=First pending (Wr) 2=Next (Wr) 3=Previous (Wr) 4=Last pending (Wr) 5=Calc (Wr-R1) 6=Calculating 7=Calc OK 8=Calc failure 9=Create report (Wr-R1) 10=Waiting data 11=Reedit (Wr-R1) 12=Return to Browsing (Wr) 13=Disable filters(Wr)	0	E	D	Selection of report for gas to be visualized. The first report is the oldest logged report with STORAGE_STATE in “pending”, if there is one, at least. The last report is the newest logged report with STORAGE_STATE in “pending”, if there is one at least. The option next means the next newer report with STORAGE STATE in “pending”, if there is one at least and the filters are disabled. The option previous means the next older report with STORAGE STATE in “pending”, if there is one at least.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
16	1	LOG_COUNTER	Unsigned16	0=Creating report 1 to 65000	0	Na	N	Log counter in the TM302 memory. It is a rollover counter for logged reports. It is a counter showing the chronological sequence of logging. It is possible to write in this parameter if REV_CMD=Browsing.
17	1	STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored 2=Pending 3=Not-logged	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 TMView itself.
18		TANK_TAG	Visiblestring[16]		Blank		N / RO	Tank tag.
19 (R1)	1	TANK_ID	Unsigned16	1 to 16	0	Na	N / Yes	Identification of the tank used in the measurement.
20		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Report counter for the report type and tank ID. It is always zero for operational report.
21 (R1)	1	BATCH_ID	Visiblestring[8]				N / Yes	Batch description.
22 (R1)	1	TMR_TYPE	Unsigned8	0=None 1= Receipt transfer & batch 2= Delivery transfer & batch 3= Receipt & batch 4= Delivery & batch 5=Inventory & day 7= Inventory & month 8=Leak	0	E	N / Yes	Type of transfer report for tank measurement.
23	1	PRODUCT_NAME	Visiblestring[16]				N / RO	Product name from the LKD block.
24		CALC_DATE_TIME	Date				N / RO	Date/hour of the report revision.
25 (R1)	1	OPEN_DATE_TIME	Date				N / Yes	Open date/hour of the current batch.
26 (R1)	1	CLOSE_DATE_TIME	Date				N / Yes	Close date/hour of the current batch.
27	1	FTIME	Time difference				N / RO	Transfer time.
28	1	PERIOD_STATUS	Bitstring[2]	See Block Options	0	Na	N/ RO	Status during the period of report. Similar to the BATCH_STATUS.
29		OUTAGE	Float[2] SI-DD1 US-DD2			L	N / RO	Free level at beginning/end of the transfer.
30		CORRECTED_REF_HEIGHT	Float[2] SI-DD1 US-DD2			L	N / RO	Tank reference height at measurement condition for the beginning/end of the transfer.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
31 (R1)	1	INNAGE	Float[3] SI-DD1 US-DD2			L	N / Yes	Liquid level at beginning/end of the transfer and the difference.
32	1	TOV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Total observed volume at beginning/end of the transfer and the difference.
33 (R1)	3	LIQ_FW_LEVEL	Float[2] SI-DD1 US-DD2			L	N	Level of free water at beginning/end of the transfer.
34	3	FW_VOLUME	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Volume of free water at beginning/end of the transfer and the difference.
35 (R1)		LIQ_TEMP	Float[2] SI-DD25 US-DD1			T	N	Liquid temperature at beginning/end of the transfer.
36 (R1)		AMB_TEMP	Float[2] DD10			T	N / Yes	Ambient temperature at beginning/end of the transfer.
37		TANK_SHELL_TEMP	Float[2] DD10			T	N / RO	Tank temperature at beginning/end of the transfer.
38		CTSH	Float[2] DD5			Na	N / RO	Correction factor of the tank table due to temperature effect at beginning/end of the transfer.
39		FRA	Float[2] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Correction factor of floating roof at beginning/end of the transfer.
40	3	GOV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Gross observed volume at beginning/end of the transfer and the difference.
41 (R1)		LIQ_DENSITY	Float[3] SI-DD1 US-DD1 SG-DD4			LD	N	Liquid density at process condition for beginning/end of the transfer. If the product is ethanol this is the density at process condition of the ethanol and water mixture.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
42 (R1)		BASE_DENSITY	Float[3] SI-DD1 US-DD1 SG-DD4			LD	N	Base density of the liquid for beginning/end of the transfer. If the product is ethanol, this is the base density of the ethanol and water mixture.
43	3	LIQ_CTL	Float[3] DD5			Na	N / RO	Correction factor of the liquid temperature at beginning/end of the transfer. If the product is ethanol, this is the CTL of the ethanol and water mixture.
44	3	LIQ_GSV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Gross volume at standard condition for beginning/end of the transfer and the difference.
45 (R1)		LIQ_SW	Float[3] DD3			%	N	Liquid BSW at beginning/end of the transfer. If the product is ethanol, this is the percentage of water in volume at base condition.
46	3	LIQ_NSV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Liquid volume at standard condition for beginning/end of the transfer and the difference.
47		WCF	Float[3]			M/LV	N / RO	Conversion factor of volume to mass at beginning/end of the transfer. If the product is ethanol, the base density of pure ethanol is used.
48	3	MASS_IN_VACUUM	Float[3] SI-DD3 US-DD3 Kg-DD10 Lb-DD10			M	N / RO	Mass (in vacuum) of the pure product (no water) at beginning/end of the transfer and the difference.
49	3	MASS_IN_AIR	Float[3] SI-DD3 US-DD3 Kg-DD10 Lb-DD10			M	N / RO	Apparent mass (in air) of the pure product (no water) at beginning/end of the transfer and the difference.
50		MEASURE_TYPE	Unsigned8	0=Initial and end values 1=SW in-line 2=Density and SW in-line			N / RO	Indicate if the density meters and BSW are in line. For simulate tank will always be "Density and SW in-line".
51	3	FR_GSV	Float			QV	N / RO	Average flow during the transfer.
52		LIQ_SPEC_1	Bitstring[2]				N / RO	Show the standards applied in the calculation.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
53		LIQ_SPEC_2	Bitstring[2]				N / RO	Show the standards applied in the calculation.
54		TM_SPEC	Bitstring[2]				N / RO	Show the standards applied in the calculation.
55		SITE_TAG	Visiblestring[16]		Blank		N / RO	Tag of the measurement site.
56		MANUAL_DATA	Bitstring[2]				N / RO	Indicate which data are supplied manually by user.
57		EDITED_BY	Visiblestring[8]		Blank		N / RO	Indicate the responsible user to edit the data supplied manually by username.
58		REPORT_REV	Unsigned16		0		N / RO	Indicate the report review. Zero indicates the first version of the report.
59		CALC_ERROR	Unsigned16	0=No error 1=Not checked 2=Missing TANK_ID 3=Missing TMR_TYPE 4=Missing OPEN_DATE_TIME 5=Missing CLOSE_DATE_TIME 6=Missing INNAGE 7=Missing FW_LEVEL 8=Missing LIQ_TEMP 9=Missing AMB_TEMP 10=Missing DENSITY 11=Missing LIQ_SW 12= Reverse order date 13=Inconsistent innage 14=Inconsistent FW 15=Out of range-CTL 16=Out of range-Curve 17=Config error 18=General error	0	E	N / RO	Error code in the calculation.
60		CREATING_REPORT	Unsigned8	0=Revising 1=Creating	0	E	N / RO	Indicate if the visualized report is being completely revised or edited (field data supplied manually).

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
61 (V3)		TANK_TYPE	Unsigned8	0=Upright cylindrical – fixed roof 1=Upright cylindrical – floating roof 2=Horizontal cylindrical 3=Sphere	0	E	N / RO	Tank type.
62		PRODUCT_TYPE	Unsigned8	0=crude oil (A) 1=Generalized products(B) 2=MTBE (C) 3=Lubricating oil (D) 4=Water 5=Light hydrocarbon (E) 6=Emulsion of crude oil		E	N / RO	Type of measured product.
63		CTILT	Float[2] DD5			Na	N / RO	Correction factor of ramp in cylindrical horizontal tanks.
64		LIQ_PRES	Float[2] SI-DD10 US-DD10 Bar-DD1			P	N / RO	Liquid pressure at beginning/end of the transfer.
65		CPVC	Float[2] DD5			Na	N / RO	Pressure correction factor for geometry of cylindrical tank.
66		CPVE	Float[2] DD5			Na	N / RO	Pressure correction factor for geometry of the cylindrical or spherical tank heads.
67		LIQ_CPL	Float[3] DD5			Na	N / RO	Pressure correction factor in volume of the measured liquid in pressurized tank.
68		LIQ_GSV_VAPOUR	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			Na	N / RO	Liquid volume at base condition referent to quantity of vapor within the pressurized tank.

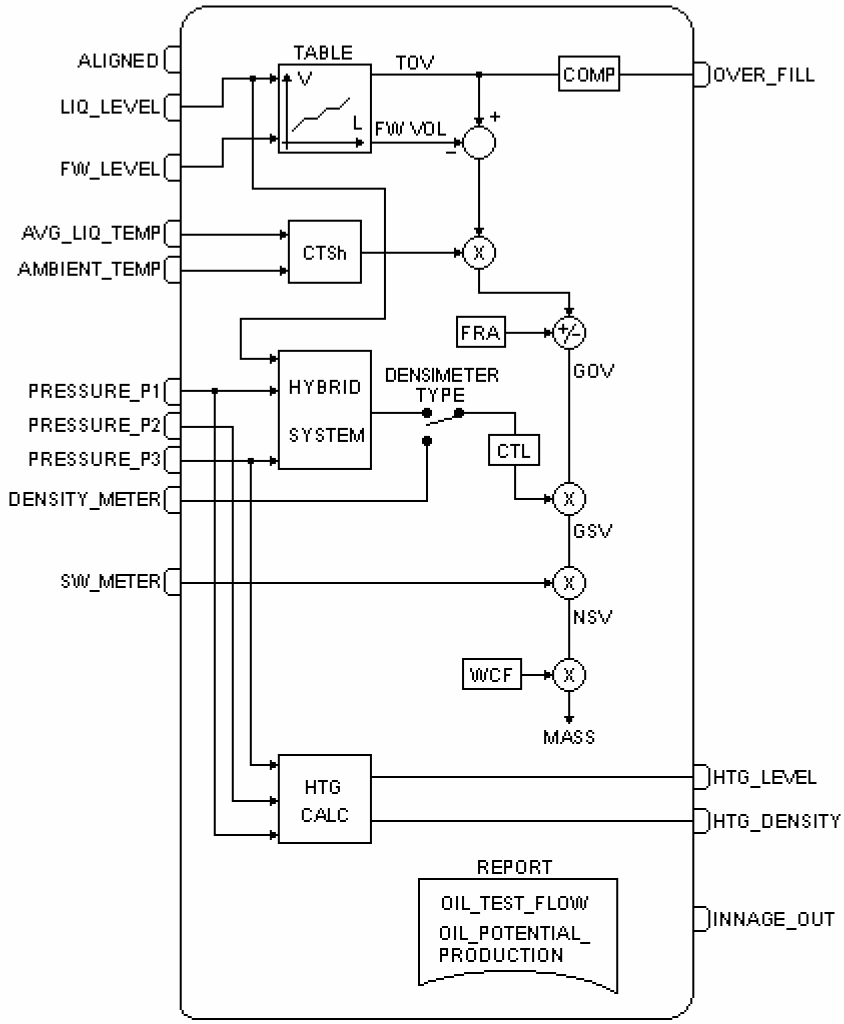
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
69 (R1)		STG_REVISION_ CAUSE	Unsigned8	0 = Blank 1 = Generic 2 = Report edition 3 = Providing manual measurements 4 = FW-manual measurement 5 = Density-manual measurement 6 = SW-manual measurement 7 = Providing corrections 8 = Tank ID-correction 9 = Batch ID-correction 10 = Type of transfer-correction 11 = Open date & time – correction 12 = Close date & time–correction 13 = Level–correction 14 = FW-correction 15 = Liquid temperature-correction 16 = Ambient temperature-correction 17 = Density-correction 18 = SW-correction		E	N	Indicate the cause of report revision.
70		PERC_MASS	Float[3]	0.0 to 100.0	0	%	N / RO	Percentage in mass of ethanol in the mixture for beginning/end of the transfer and the transferred.

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

Store/Mode Column:
- Yes means that the parameter can be written only when a report is being created (simulate tank).

TWT – Tank Well Test

Schematic



Description

This block is used in well test process. The objective is to obtain factors (flow test / production potential) to divide the production in shared measurement.

Through this block, the process of well test is started and ended, that implicates in the generation of a well test report, where the final result is the flow of well test corresponding to the oil and water.

If the time of well test is superior to 24 hours, the last 24 hours will be registered and the calculation of the flow test will be based on these last 24 hours.

Identification of measurement number – STRATEGY

As this block always refers to several measurements, this parameter has a default value 255, that is interpreted as "Not specific" and it can not be written by the user.

Block input

The ALIGNED input of this block is used according to the configuration, as shown in the table below.

Input	Link Necessity	Description
ALIGNED	Depends on the application	This input can be used to inform that the well is aligned.

There are two modes to indicate that the well is aligned.

- Through the input ALIGNED or
- The own user defines if there is need to inform the end of the alignment and, also, to supply the date / hour in the parameter ALIGN_DATE_TIME.

Use of the block inputs

Input	Link	Description
LIQ_LEVEL AVG_LIQ_TEMP AMBIENT_TEMP	Mandatory	If these inputs are not connected, the block will indicate BLOCK_ERR. Configuration error.
FW_LEVEL	Optional	If bad status, the last good value of the free water level or zero will be considered.
DENSITY_METER PRESSURE_P1 PRESSURE_P2 PRESSURE_P3	Optional If DENSIMETER_TYPE= HTMS is selected, the P1 and P3 pressure inputs should be linked.	The report will be generated with STORAGE_STATE pending if: • Configured for density meter in line (inline sampler when transferring or inline sampler when receiving) or "manual sample and DENSITY_METER not linked. • Configured for HTMS and PRESSURE_P1 or PRESSURE_P3 is not linked.
SW_METER	Optional	If it is not linked, then the report will be generated with STORAGE_STATE pending.
CLOSED_IN CLOSED_OUT	Mandatory for well test no free water.	If SW_TYPE=inline delivering, that is, well test no water, then this inputs should be linked to calculate the time of test and to calculate the test flow and potential production.

Field and Well Identification

The identifications of field and well are through the parameters FIELD_NAME and WELL_ID, these parameters are used also for generation of well test report.

Date/hour for begin and end of the well test

The indication of the date/hour for begin and end of well test is through the parameters OPEN_DATE_TIME and CLOSE_DATE_TIME. The time in number of hours is through the parameter NUM_HOURS.

Crude oil measurement

It is possible the use of up to two tanks in well test. For each one of the tanks has the following information:

- Reading of values: level, level of free water, temperature, density and BSW: instantaneous values at begin, at the end of each hour and the end of the well test
- Calculated values: totalization of GOV, GSV and NSV for each hour.

At the end of the well test, there are variations in gross corrected volume (GSV) and net corrected volume in relation to initial and final conditions of the well test. During the well test a status processing is accomplished as shown below:

- CURRENT_STATUS: current status of the measurements;
- TEST_STATUS: status during the well test.

The information in these status words is:

The standards applied in the calculation of the crude oil measurement are indicated in LIQ_SPEC_1 and LIQ_SPEC_2.

In the table below are indicated the conditions for Failed test and Inconsistent data state:

Bit	Meaning	TEST_STATE	
		Failed test	Inconsistent data
0	Bad level input (LSB)	x	
1	Override temperature used		
2	Override density used		
3	Override SW used		
4	Extrapolated correction factor - CTL		
5	Out of range correction factor - CTL		x
6	HTMS Method B		
7	Shouldn't receive	x	
8	Shouldn't deliver	x	
9	Not stabilized		
10	Out-of-range curve	x	x
11	Inconsistency	x	x
12	Configuration error	x	x
13			
14			
15			

Water measurement

At the end of well test have the totalization in volume at base condition (WATER_GSV) during the well test.

Time of the well test phases
The parameter WELL_TEST_TIME indicates the time of well test. The calculated time during the "Calculating" phase, that is the time of well test, is used for calculations of test flows of the crude oil and water.

Final results

The final objective of the well test is to obtain the test flows:

- OIL_TEST_FLOW: is the liquid volumetric flow at base condition per hour, corresponding to division of the oil totalization during the test (parameter NSV) by time of well test in hours;
- WATER_ TEST_FLOW: is the volumetric flow at base condition per hour, corresponding to division of the water totalization during the test (parameter WATER_GSV) by time of well test in hours.

Another calculated factor is the OIL_POTENTIAL_PRODUCTION, that is the gross volumetric flow at base condition per day.

Data Input: laboratory analysis and manual measurements
When the parameter TEST_STATE is "Wait for data (Wr)", then the user can to supply/change data referent to results of laboratory analysis or then manual measurements.
The values to be supplied refer to initial and/or final condition of the well test, that are the values used to obtain the test flows (final result). The intermediate values (at the end of each hour of test) are optional, therefore the corresponding volumes will be calculated only if the supplied inputs are consistent.

Density measurement

The parameters OPEN_DENS, DENS_HOUR and CLOSE_DENS are information related to density during the well test. Where such densities are of the type specified in the block STD.TANKx_PRODUCT.density type, that is, density at base or flowing condition.

For applications where the density is obtained from the laboratory analysis it is recommended to configure TANKx_PRODUCT.density type for base density.

Block application

The example below show a typical application of this block, that presents the following characteristics:

- Shared measurement: measurement station measuring oil/water of different wells;
- Well test to obtain the test flows, that are used for allocation of production in shared measurement;
- 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 process is composed of the following sequential phases: well alignment, warm up and well test. The parameters referent to close condition (CLOSE_LEVEL, CLOSE_FW, CLOSE_TEMP, CLOSE_DENS, CLOSE_SW, CLOSE_GOV, CLOSE_GSV, CLOSE_NSV, CLOSE_AMBIENT_TEMP) are updated in the Measuring, Stabilizing, Wait for data and Inconsistent data states and at the end of well test.
- In states of Wait for data and Inconsistent data all variables maintain the last value of the Measuring state and the user can supply the values referent to inputs not linked. When requested the calculation through the Calculate (Wr) command, the consistence check is accomplished and then the values are updated considering the data supplied by user.
- The instantaneous level and volume monitoring (GOV) independentently of the well test can be accomplished through the STD block in inventory parameters.

Well test with free water discarded

Unlike the other options, the well test with free water discarded is concluded in the delivery of the oil.

When the well test with free water discarded is selected (SW_TYPE=inline delivering), then the process consists of various cycles of filling and discard of free water until the oil volume in tank (GOV) is superior to MIN_VOL_OIL (oil volume transferred plus the resident oil, below the measurement table and in the pipe). In this condition the parameter DENSIMETER_TYPE will be fixed in “Inline delivering”, impeding the user to change the parameter, to maintain the consistence of the configuration.

The free water discard is requested by user, but the closing of the output valve will be controlled by OPEN_OUT output, when the BSW is below the value configured in MIN_SW_FW.

The initial and final conditions of the free water discards, as well as the weighed average of BSW are used to calculate the volumes of oil and water at standard condition, that are accumulated in various discards of free water accomplished. This accumulated values are used to calculate the test flow and potential production.

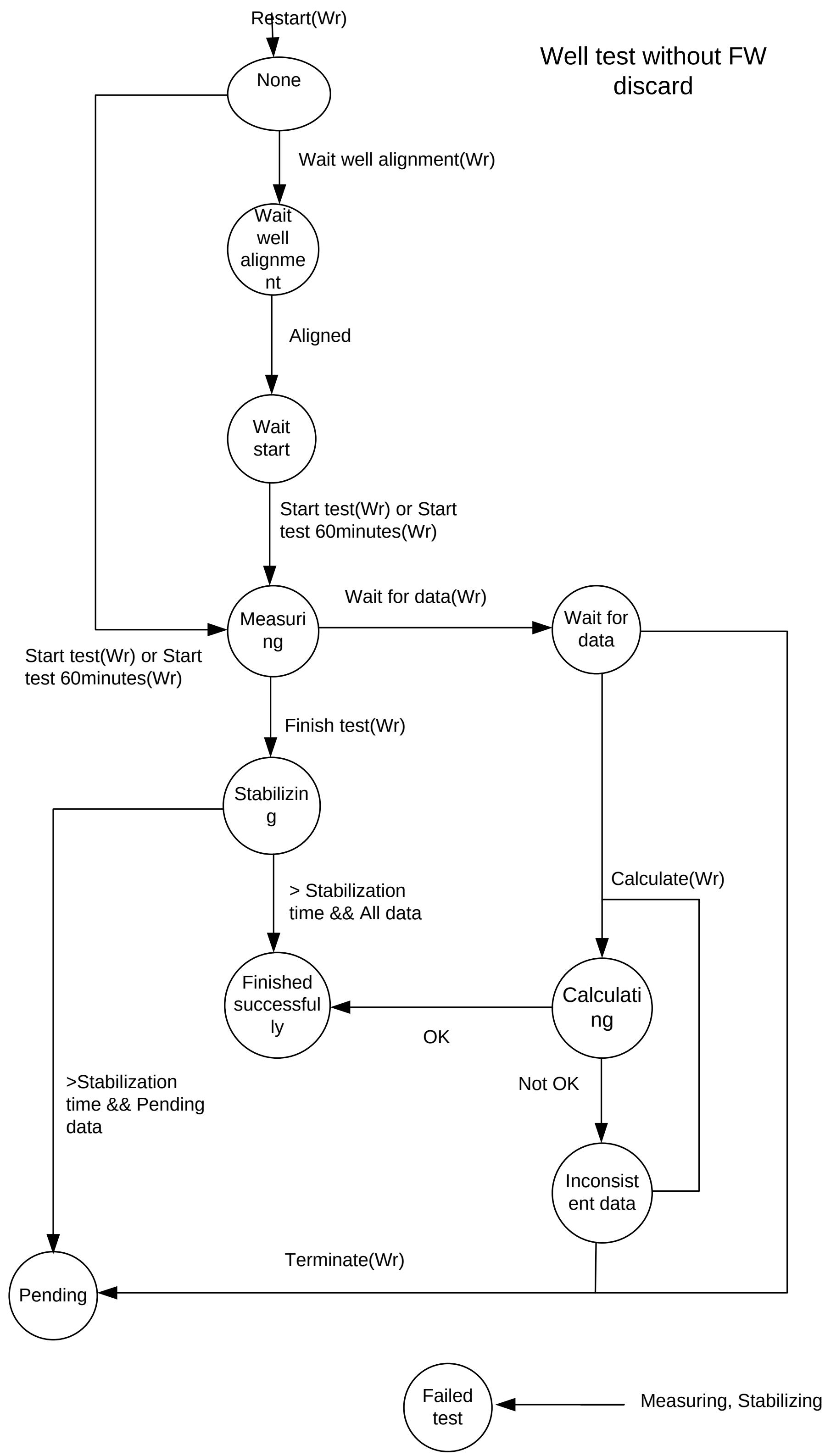
Only when the volume (GOV) after the discard of water is superior to MIN_VOL_OIL will be possible to start the delivery of oil (Start Del (Wr)). The closing of the oil delivery can occur in two modes: 1) user command (Stop(Wr)); 2) when the level is inferior to the specified in MIN_INNAGE.

The count of the test time is accomplished only in state Measuring and the inputs CLOSED_IN=0 and CLOSED_OUT=1.

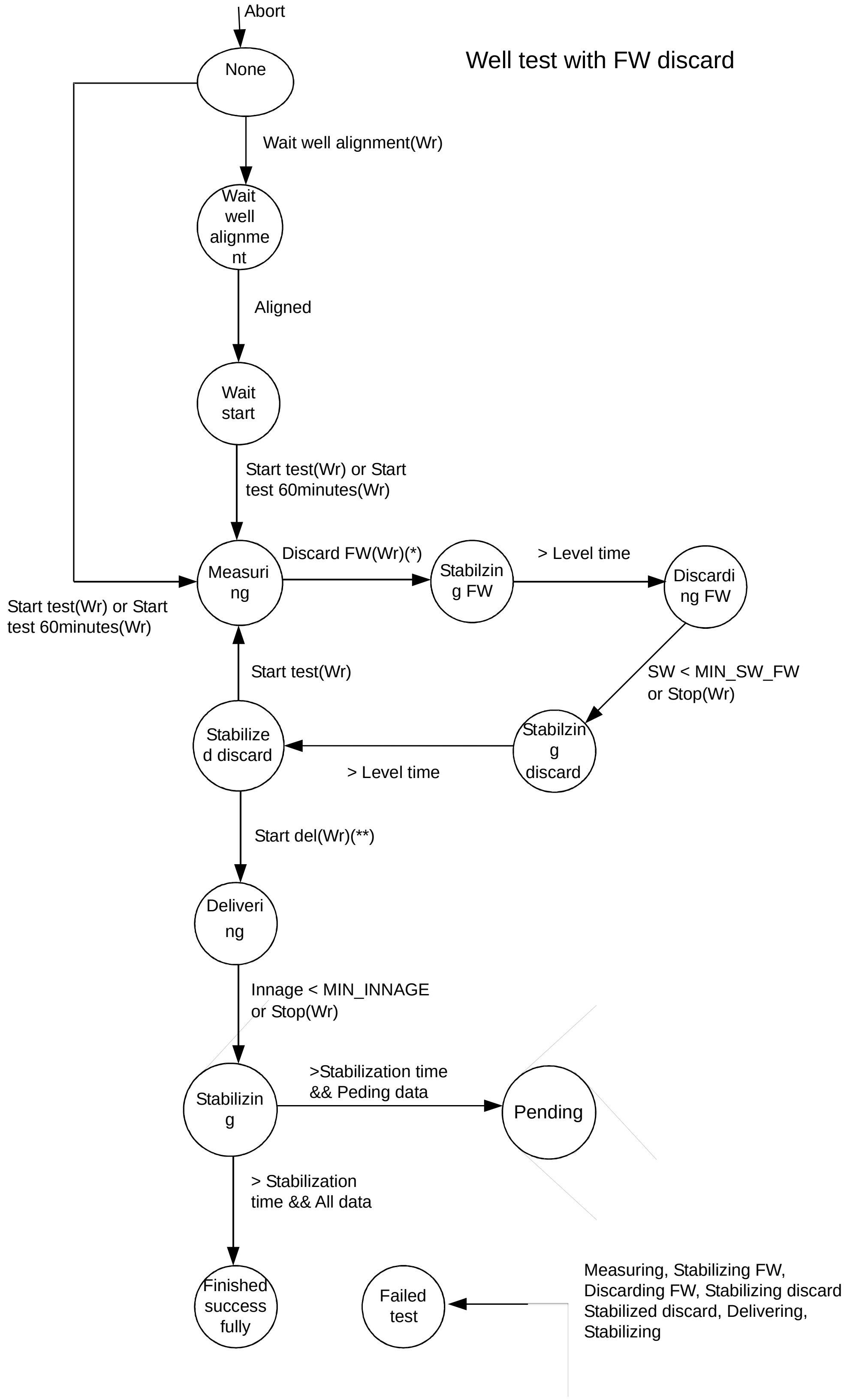
The parameters used in well test with discards of free water are:

State	Parameters	Description
Start of the test	OPEN_LEVEL OPEN_TEMP	Values captured in the transition due to Start test (Wr) or Start test 60 minutes (Wr).
Values to each discard of free water	SW_HOUR[1...22] GOV_HOUR[1...22] GSV_HOUR[1...22] NSV_HOUR[1....22]	Values referent to each discard of free water. To observe that the number of discards of free water is limited to 22 per well test.
Start of the delivery	LEVEL_HOUR[23] TEMP_HOUR[23] GOV_HOUR[23]	After the free water discard, according to pre-configured minimum conditions and the user's request, the delivery of the accumulated crude oil is started (no free water) in the several cycles of filling and free water discard. The listed parameters indicate the initial condition of the delivery of this accumulated crude oil.
End of the delivery	LEVEL_HOUR[24] TEMP_HOUR[24] GOV_HOUR[24]	The listed parameters indicate the final condition of delivery of this accumulated crude oil.
Delivery variation	CLOSE_DENS(depends on DENSIMETER_TYPE) CLOSE_SW CLOSE_GOV CLOSE_GSV CLOSE_NSV	The listed parameters indicate the variation in the delivery of the accumulated crude oil, therefore to obtain the total crude oil produced during the test the values of free water discards should be added.

Below is a state diagram that describes the well test if SW_TYPE is different from "in-line delivering":


Restart(Wr)
Well test without FW discard
None
Wait well alignment(Wr)
Wait well alignme nt
Aligned
Wait start
Start test(Wr) or Start test 60minutes(Wr)
Measuri ng
Wait for data(Wr)
Wait for data
Start test(Wr) or Start test 60minutes(Wr)
Finish test(Wr)
Stabilizin g
Calculate(Wr)
> Stabilization time && All data
Finished successful ly
Calculati ng
OK
>Stabilization time && Pending data
Not OK
Inconsist ent data
Terminate(Wr)
Pending
Failed test
Measuring, Stabilizing

State	Possible Commands	Comments
None	Wait well alignment(Wr), Start test(Wr), Start test 60minutes(Wr)	Start of the well test process
Wait well alignment	Restart (Wr)	Waiting alignment of the well.
Wait start	Start test(Wr), Start test 60minutes(Wr), Restart (Wr)	Waiting user command to start the well test.
Measuring	Finish test(Wr), Wait for data, Restart (Wr)	Collecting data referent to the well test.
Stabilizing	Restart (Wr)	Waiting the stabilization of the product and level measurement.
Finished successfully	Restart (Wr)	Test finished successfully and with all necessary information. Report of well test generated with not-stored status.
Pending	Restart (Wr)	Test finished, but still needs information obtained by laboratory analysis or manual measurement. Report of well test generated with pending status.
Failed test	Restart (Wr)	Failed test
Wait for data	Calculate(Wr), Terminate(Wr), Restart (Wr)	Waiting the user to supply information of laboratory analysis or manual measurement.
Inconsistent data	Calculate(Wr), Terminate(Wr), Restart (Wr)	Information of laboratory analysis or inconsistent manual measurement and waiting corrections.


Abort
None
Well test with FW discard
Wait well alignment(Wr)
Wait well alignment
Aligned
Wait start
Start test(Wr) or Start test 60minutes(Wr)
Measuring
Discard FW(Wr)(*)
Stabilzing FW
> Level time
Discarding FW
Start test(Wr) or Start test 60minutes(Wr)
Start test(Wr)
SW < MIN_SW_FW or Stop(Wr)
Stabilized discard
Stabilzing discard
> Level time
Start del(Wr)(**)
Delivering
Innage < MIN_INNAGE or Stop(Wr)
>Stabilization time && Peding data
Stabilizing
Pending
> Stabilization time && All data
Finished successfully
Failed test
Measuring, Stabilizing FW, Discarding FW, Stabilizing discard Stabilized discard, Delivering, Stabilizing

State	Possible Commands	Comments
None	Wait well alignment(Wr), Start test(Wr)	Start of the well test process.
Wait well alignment	Restart (Wr)	Waiting well alignment.
Wait start	Start test(Wr), Restart (Wr)	Waiting user's command to start the well test.
Measuring	Discard FW(Wr), Restart (Wr)	Collecting data referent to the well test, referent the filling phase of filling cycle and discard of free water.
Stabilizing FW	Restart(Wr)	Waiting the reading stabilization of the level to start the discard of free water.
Discarding FW	Restart(Wr)	Discarding free water while the BSW measured is superior to MIN_SW_FW.
Stabilizing discard	Restart(Wr)	Waiting reading stabilization of the level after the discard of free water.
Stabilized discard	Restart(Wr) Start Del(Wr) Start test(Wr)	Waiting a new cycle of filling and discard of free water or delivery of the oil accumulated in various cycles.
Delivering	Stop(Wr), Restart(Wr)	Delivering oil accumulated in various cycles of filling and discard of free water.
Stabilizing	Restart (Wr)	Waiting the stabilization of level measurement after the delivery of the crude oil accumulated.
Finished successfully	Restart (Wr)	Test finished successfully and with all necessary information. Report of well test generated with not-stored status.
Pending	Restart (Wr)	Test finished, but still needs information obtained by laboratory analysis or manual measurement. Report of well test generated with pending status.
Failed test	Restart (Wr)	Failed test.

Diagnosis and Troubleshooting

BLOCK_ERR. Block configuration: this indication occurs when there are the following problems:

- If DENSIMETER_TYPE is in-line measurement and BSW_TYPE is not in-line measurement.
- If DENSIMETER_TYPE is in-tank measurement, BSW_TYPE is in-line measurement and allocation measurement.
- If TANK_ID equal to zero.
- If the tank type indicated for TANK_ID is different of vertical cylindrical.
- If DENSIMETER_TYPE select HTMS mode 1 or 2 and in STD block the configured product selected base density.
- If configured for free water discard (SW_TYPE equal to "inline delivering") and MIN_VOL_OIL equal to zero.
- If configured for free water discard (SW_TYPE equal to "inline delivering") and one of the inputs CLOSED_IN or CLOSED_OUT is not linked.
- If there is dead volume configured superior to the own volume of the tank for a certain level resulting in negative TOV.
- Inconsistency in the configuration of the tank calibration table.

BLOCK_ERR. Out of Service: block TWT can remain in Out of service mode in spite of the target mode is Auto because the Resource block is in O/S or TANK_ID=0

Writing TEST_STATE = Wait for Data (Wr) is allowed if the current state is Measuring and one of the inputs FW_LEVEL, DENSITY_METER or SW_METER is not connected.

Writing fail in configuration parameter: The parameters that in the column Store/Mode indicate NW, mean that it can be written only when TEST_STATE indicate None, Pending or Finished Successfully.

Writing fail in the parameter DENSIMETER_TYPE: If SW_TYPE= inline delivering is configured, that is, well test with discard of free water, then the writing to the DENSIMETER_TYPE will be rejected.

Supported Modes

O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5 (A1)	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	I	ALIGNED	DS-66				N	Indicate if the well is aligned.
8	I,1	LIQ_LEVEL	DS-65			L	N / RO	Liquid level supplied by level meter.
9 (A2)	I	FW_LEVEL	DS-65			L	N	Level of free water. Always in innage independent of the TYPE_ATG configuration.
10 (A2)	I,1	AVG_LIQ_TEMP	DS-65			T	N / RO	Average liquid temperature.
11 (A2)	I,1	AMBIENT_TEMP	DS-65			T	N / RO	Average ambient temperature in tank not isolated thermally.
12 (A2)	I,1	DENSITY_METER	DS-65			LD	N	Liquid density at process temperature.
13 (A2)	I,1	PRESSURE_P1	DS-65			T	N	Pressure P1.
14 (A2)	I	PRESSURE_P2	DS-65			T	N	Pressure P2.
15 (A2)	I,1	PRESSURE_P3	DS-65			T	N	Vapor pressure in tank P3.
16 (A2)	I	SW_METER	DS-65			%	N	Percentage of sand and water mixed in the oil.
17	O	OVER_FILL	DS-66				N / RO	Indicate when the tank is fill.
18 (A2)	2	TYPE_ATG	Unsigned8	0=Innage 1=Outage 2=Outage-corrected reference height 3=HTG	2	E	S / NW	Indicate if the input LIQ_LEVEL is supplying the liquid level or the free length of the tank.
19 (A2)	2	REF_HEIGHT	Float	> 0.0	10000.0	L	S / NW	Tank reference height. Distance between the dip-plate and the level meter type outage measured at temperature STD.TANKx_BASE_TEMP.
20 (A2)	2	MAX_HEIGHT	Float	>=0.0 0.0 = Reference height	8000.0	L	S	Maximum height (relatively to the dip-plate) of the liquid. Superior to this height will indicate over fill. This parameter should be defined considering factors as: minimum distance to guarantee the precision of the level reading and operation and sensor safety.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
21 (A2)	2	DENSIMETER_TYPE	Unsigned8	0=In tank 1=HTMS mode 1 2=HTMS mode 2 3=In-line delivering 4=In-line receiving	0	E	S / NW	Define if the density meter is measuring the liquid in the tank or in the input/output of the tank. In the last case, a weighted average density will be calculated considering the volume obtained from the level variation. "In-line delivering" is the only valid option if the well test is selected with discard of free water.
22 (A2)	2	H0	Float	>= 0.0	0.0	L	S / NW	Distance between the hybrid reference point to the datum plate at temperature TANK1_BASE_TEMP for the tank 1.
23 (A2)	2	HEIGHT_P1	Float	>= 0.0	0.0	L	S / NW	Distance between the force center of the P1 pressure sensor and the hybrid reference point measured at temperature STD.TANKx_BASE_TEMP.
24 (A2)	2	HEIGHT_P2	Float	>= 0.0	0.0	L	S / NW	Distance between the force center of the P2 pressure sensor and the hybrid reference point measured at temperature STD.TANKx_BASE_TEMP.
25 (A2)	2	HEIGHT_HT	Float	>= 0.0	10000.0	L	S / NW	Distance between the force centers of the P1 and P3 pressure sensors measured at temperature STD.TANKx_BASE_TEMP.
26 (A2)	2	HMIN	Float	>= 0.0	0.0	L	S	Minimum level higher than the P1 pressure tap to use the method A of calculation, when configured HTMS mode 1 for the tank 1.
27 (A2)	2	P1_CUTOFF	Float	>= 0.0	0.0	L	S	Minimum level higher than the P1 pressure tap to use the method A of calculation, when configured HTMS mode 2 for the tank 1.
28 (A2)	2	SW_TYPE	Unsigned8	0=In tank 1=In-line delivering2=In-line receiving	0	E	S / NW	Define if the BSW meter is measuring the liquid in tank or measuring in the input/output of the tank. In the last case, a weighed average will be calculated considering the volume obtained form the level variation.
29 (A2)	2	VAPOR_DENSITY	Float	>= 0.0	1.25E-3	M/LV	S	Vapor density inside the tank.
30 (A2)	2	OVERRIDE_TEMP	Float		20.0	T	S	Override value for the temperature input of the liquid when it has bad status and ambient temperature.
31 (A2)	2	OVERRIDE_DENSITY	Float	> 0.0	800.0	LD	S	Override value for the density input when it has bad status.
32 (A2)	2	OVERRIDE_SW	Float	0.0 to 100.0	0.0	%	S	Override value for the SW input when it has bad status.
33	2	FIELD_NAME	Visiblestring [32]		Blank		S	String to identify the field of well.
34	2	WELL_ID	Visiblestring [32]		Blank		S	String to identify the well that is being tested.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
35	4	WELL_ID_SEL	Unsigned8	0=Direct entry 1-45=Well 1-45	0	E	S / NW	Selection of WELL_ID.
36		WELL_ID1	Visiblestring [32]		Blank		S	String to identify the well 1.
80		WELL_ID45	Visiblestring [32]		Blank		S	String to identify the well 45.
81	4	TANK_ID	Unsigned16	0 to 4	0	Na	S	String to identify the tank that is being used in the well test.
82 (A2)	4	STABILIZATION _TIME	Unsigned8	0 to 255 0=disabled 1 to 24 = hours 25 to 255 = minutes	30	Min	S	Necessary time for stabilization after the end of a transfer.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
83	1	TEST_STATE	Unsigned8	0=none 1=Wait well alignment (Wr) 2=Start test (Wr) 3=Measuring 4=Finish test (Wr) 5=Stabilizing 6=Wait for data (Wr) 7=Calculate (Wr) 8=Calculating 9=Finished successfully 10=Pending Data 11=Insconsistent data 12=Terminate (Wr) 13=Restart (Wr) 14=Failed test 15=Start test 60 minutes(Wr) 16=Wait Start 17=Discard FW(Wr) 18=Stabilizing FW 19=Discarding FW 20=Stabilizing discard 21=Stabilized discard 22=Start Del(Wr) 23=Delivering 24=Stop(Wr)	0	E	D	This parameter is used to start and abort the well test, and also to indicate the test state or failure.
84	3	ALIGN_DATE_TIME	Date				N	Date/hour of the alignment for the well in test.
85	3	OPEN_DATE_TIME	Date				N / RO	Date/hour of the beginning of the actual test. After the warm up period.
86	3	CLOSE_DATE_TIME	Date				N / RO	Date/hour of the ending of the actual test.
87		NUM_HOURS	Unsigned16		0	Na	N / RO	Number of hourly periods of information collect.
88		CURRENT_STATUS	Bitstring[2]	See Block BATCH_STATUS	0	Na	N/ RO	Current status. Similar to the BATCH_STATUS.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
89		TEST_STATUS	Bitstring[2]	See Block BATCH_STATUS	0	Na	N/ RO	Status during the well test. Similar to the BATCH_STATUS.
90	3	OPEN_ LEVEL	Float		0	L	N / RO	Oil level at beginning of the test.
91		LEVEL_HOUR	Float[24]		0.0's	L	N / RO	Instantaneous level at the end of each hour.
92	3	CLOSE_ LEVEL	Float		0	L	N / RO	Oil level at ending of the test.
93 (A2)	3	OPEN_ FW	Float		0	T	N / WD	Free water level at beginning of the test.
94		FW _HOUR	Float[24]		0.0's	T	N / WD	Level of instantaneous free water at ending of each hour.
95 (A2)	3	CLOSE_ FW	Float		0	T	N / WD	Level of free water at ending of the test.
96	3	OPEN_ TEMP	Float		0	T	N / RO	Oil temperature at beginning of the test.
97		TEMP _HOUR	Float[24]		0.0's	T	N / RO	Instantaneous temperature at ending of each hour.
98	3	CLOSE_ TEMP	Float		0	T	N / RO	Oil temperature at ending of the test.
99 (A2)	3	OPEN_ DENS	Float		0	LD	N / WD	Oil density at beginning of the test.
100		DENS_HOUR	Float[24]		0.0's	LD	N / WD	Instantaneous density or weighted average at ending of each hour.
101 (A2)	3	CLOSE_ DENS	Float		0	LD	N / WD	Oil density at ending of the test.
102 (A2)	3	OPEN_ SW	Float		0	%	N / WD	Oil SW at beginning of the test.
103		SW _HOUR	Float[24]		0.0's	%	N / WD	Instantaneous SW or weighted average at ending of each hour.
104 (A2)	3	CLOSE_ SW	Float		0	%	N / WD	Oil SW at ending of the test.
105		OPEN_GOV	Float		0	LV	N / RO	GOV at beginning of the test.
106		GOV_HOUR	Float [24]		0	LV	N / RO	GOV at ending of each hour.
107		CLOSE_GOV	Float		0	LV	N / RO	GOV at ending of the test.
108		OPEN_GSV	Float		0	LV	N / RO	If density meter in line, then it will be zero. Otherwise, indicate the GSV at beginning of the test.
109		GSV_HOUR	Float [24]		0	LV	N / RO	If density meter in line, then indicate the GSV variation at ending of each hour comparing to the beginning of the test. Otherwise, indicate the GSV at ending of each hour.
110		CLOSE_GSV	Float		0	LV	N / RO	If density meter in line, then indicate the GSV variation at ending of the test comparing to the begin. Otherwise indicate the GSV at ending of the test.
111		OPEN_NSV	Float		0	LV	N / RO	If BSW meter in line, then it will be zero. Otherwise indicate the NSV at beginning of the test.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
112		NSV_HOUR	Float [24]		0	LV	N / RO	If BSW meter in line, then indicate the NSV variation at ending of each hour comparing to the beginning of the test.
113		CLOSE_NSV	Float		0	LV	N / RO	If BSW meter in line, then indicate the NSV variation at ending of the test comparing to the begin. Otherwise indicate the NSV at ending of the test.
114	3	OPEN_AMBIENT_TEMP	Float		0	T	N / RO	Ambient temperature at beginning of the test.
115	3	CLOSE_AMBIENT_TEMP	Float		0	T	N / RO	Ambient temperature at ending of the test.
116		VOL_CLOSE	Float			LV	N / RO	GOV/GSV/NSV (depends on the density meter and BSW) at ending of the test tank loading, before the stabilization.
117		VOL_STABILIZED	Float			LV	N / RO	GOV/GSV/NSV (depends on the density meter and BSW) at ending of the test tank loading, after the stabilization.
118		SF	Float	0 to 1	0	Na	N / RO	Shrink factor after stabilization according to the GOV/GSV/NSV at ending of the test tank loading and after stabilization.
119	1	GSV	Float			LV	N/ RO	GSV received during the well test after stabilized.
120	1	NSV	Float			LV	N/ RO	NSV received during the well test after stabilized.
121	1	WATER_GSV	Float			LV	N / RO	Water GSV received during the well test.
122	1	WELL_TEST_TIME	Time difference				N / RO	Indication of the well test time. It does not include the stabilization time.
123	1	OIL_TEST_FLOW	Float			QV	N / RO	Volume liquid flow at standard condition of oil during the test.
124		WATER_TEST_FLOW	Float			QV	N / RO	Volume gross flow at standard condition of water during the test.
125	1	OIL_POTENTIAL_PRODUCTION	Float		0.0	LV/day	N / RO	Oil potential production in NSV.
126		VISCOSITY	Float		0.0	Visc	N / RO	Oil viscosity.
127		LIQ_SPEC_1	Bitstring[2]				N / RO	Standards used for calculations.
128		LIQ_SPEC_2	Bitstring[2]				N / RO	Standards used for calculations.
129		TM_SPEC	Bitstring[2]				N / RO	Show the standards used for calculations.
130		LEVEL_DEV	Float	0.0=disable >=0.0	0.0	L	S	Maximum acceptable deviation between the level from HTG and the level in LIQ_LEVEL.
131		DENSITY_DEV	Float	0.0=disable >=0.0	0.0	LD	S	Maximum acceptable deviation between the density from HTG and the density in DENSITY_METER.
132	O	HTG_LEVEL	DS-65			L	N / RO	Level obtained from the HTG calculation.

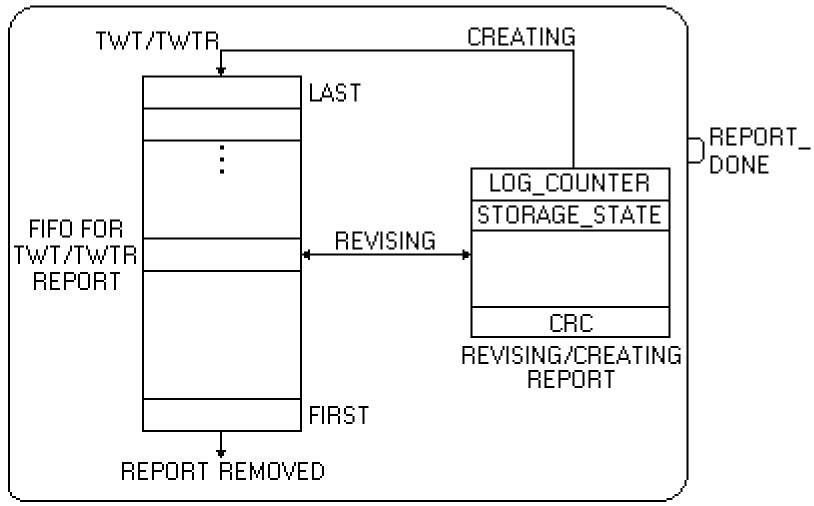
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
133	O	HTG_DENSITY	DS-65			LD	N / RO	Density obtained from the HTG calculation.
134		HTG_ALARM	Bitstring[2]				N / RO	Indication of alarms referent to the HTG.
135	O	INNAGE_OUT	DS-65			L	N / RO	Liquid level (innage) from the LIQ_LEVEL and TYPE_ATG.
136		UPDATE_EVT	DS-73			Na	D	This alert is generated by any change to the static data.
137		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.
138	I	CLOSED_IN	DS-66				N / RO	This input indicates if the input valve is totally closed.
139	I	CLOSED_OUT	DS-66				N / RO	This input indicates if the output valve is totally closed.
140	O	OPEN_OUT	DS-66			Na	D / RO	This output should be used to control the On/Off valve in the output of the tank. If the state is Discarding FW or Delivering then this output will be activated.
141 (A2)		LEVEL_BAND	Float	0 to 100 0=disabled	10	L	S	Tolerance in the level variation contrary to the expected according to the current state.
142 (A2)		MIN_SW_FW	Float	1 to 100	95	%	S	Minimum BSW to consider free water, which should be previously transferred.
143 (A2)		MIN_VOL_OIL	Float	>= 0 0=disabled	0	LV	S	Minimum volume of oil to end the well test under this it will be necessary at least one more filling cycle.
144 (A2)		MIN_INNAGE	Float	>= 0	0	LV	S	Level under the specified in this parameter causes the end of the oil delivery and therefore the closing of the well test with discards of free water.
145 (A2)		LEVEL_TIME	Unsigned8	0 to 255	0	Min	S	Stabilization time of the level reading before and after discarding the free water.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
146		CALC_ERROR	Unsigned16	0=No error 1=Not checked 2=Missing TANK_ID 3=Missing TMR_TYPE 4=Missing OPEN_DATE_TIME 5=Missing CLOSE_DATE_TIME 6=Missing INNAGE 7=Missing FW_LEVEL 8=Missing LIQ_TEMP 9=Missing AMB_TEMP 10=Missing DENSITY 11=Missing LIQ_SW 12= Reverse order date 13=Inconsistent innage 14=Inconsistent FW 15=Out of range-CTL 16=Out of range-Curve 17=Config error 18=General error 19…42=Inconsistent hour 1…24	0	E	N / RO	Error code for calculation.
147		ACTIVE_ALARM1	Bitstring[2]				N / RO	Indicate which alarms of the tank are active.
148		ACTIVE_ALARM2	Bitstring[2]				N / RO	Indicate which alarms of the tank are active.
149		UNACK_ALARM1	Bitstring[2]				N	Indicate which alarms of the tank are unacknowledged by operator.
150		UNACK_ALARM2	Bitstring[2]				N	Indicate which alarms of the tank are unacknowledged by operator.

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
WD = Writing if TEST_STATE=Wait for data

TWTR – Tank Well Test Revision

Schematic



Description

This block allows searching the reports stored in the TM302 memory and allows to the user the access to the laboratory analysis data or manual measurement (FW_LEVEL, LIQ_DENSITY, BASE_DENSITY and LIQ_SW). Then the user can request the calculation and to check the report. If the data are consistent, the report receives the status of "not stored".

Another function is the report generation totally based on information obtained manually and/or through laboratory analysis (simulate tank).

Searching the reports in the memory

There are the following search modes of reports from the TM302 memory.

Search mode	Features
LOG_COUNTER	It locates and shows the requested report. It is the chronological order of reports generated / stored in the TM302 memory.
REV_CMD	It allows the search (Next and Previous options) between the reports with STORAGE_STATE = pending if the filter is disabled or between the reports compatible with the configured filter independently of the STORAGE_STATE.
TANK_TAG_SEARCH SITE_TAG_SEARCH OPEN_DATE_REPORT	The writing in these parameters site and show the oldest report pending with the tag/date of requested opening. From this moment the search through REV_CMD, for the Next and Previous options will be exclusively between the reports with the tag/date of requested opening. Writing blank in the parameters TANK_TAG_SEARCH or SITE_TAG_SEARCH or Jan 1, 2003 00:00:00:000 in the parameter OPEN_DATE_REPORT the search is done between all the pending reports.

The parameters OPEN_DATE_REPORT, TANK_TAG_SEARCH and SITE_TAG_SEARCH work as filter for the search through REV_CMD (Next and Previous options), where the last parameter writing is the active filter. Therefore there is not combination for the filter application.

The writing in the parameter REV_CMD with the options First pending or Last pending, implicates in the search and consequent visualization, if found, of the oldest report (first pending) or more recent (last pending) with STORAGE_STATE = pending. If filter is configured, then the search will be conditioned to the same.

Pending data

The numeric data susceptible to edition and that complement data collected by field devices are those indicated in the parameter MANUAL_DATA. This occur when the corresponding input is not linked or the value at the beginning or end of the transfer or weighed average presents some inconsistency.

Reports review

The occurrence of problem listed below at the necessary moment to execute the calculation of the transferred volume/mass (beginning/end of the transfer or during the calculation of the weighed average) implicates to enable automatically the edition of the correspondent parameter:
- Out of range of CTL calculation enables the edition of the density and temperature;
- SW out of range of 0 to 100% at the beginning or end of the transfer when SW_TYPE is configured "In tank";
- Bad status in FW_LEVEL input;
- Negative variation of free water volume;
- Level of free water at the beginning or end of the transfer superior to the innage with tolerance of 10mm (0.4 inch).

All the reports whose data are supplied manually can be revised, independently of the status (not-stored, stored, pending). Where only the data supplied manually can be revised.

The report review (STGR/TWTR) with not-stored status read by the TMView through the block STGV/TWTV is momentarily disabled.

Complete review and edition of reports

These procedures should be executed and finished (calculation with success) of integral way by the same user (username). Otherwise, the supplied data will be discarded.

Complete edition of reports –intermediate results

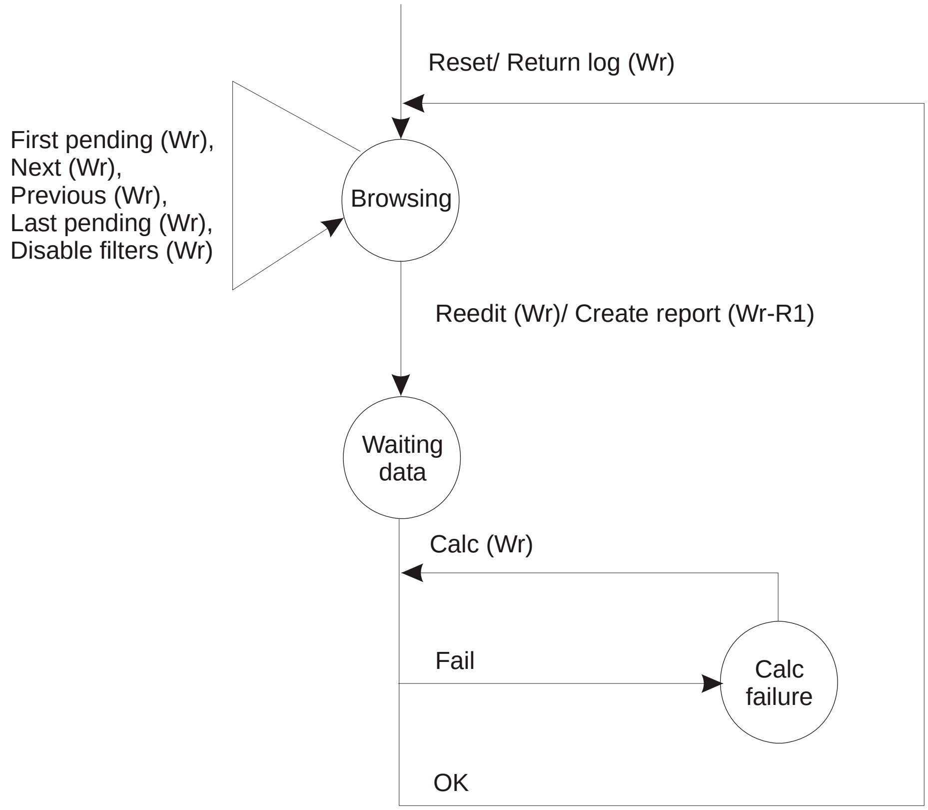
Hourly intermediate results of the well test will be calculated if supplied. If there is data of a certain hour that are inconsistent or data not supplied by the user, then the calculations of the subsequent hours are interrupted.

Inconsistency of these intermediate data does not impede the report generation, since the opening and closing data are consistent.

Density measurement

The parameters OPEN_DENS, DENS_HOUR and CLOSE_DENS are information referent to the density during the well test. Where such densities are the type specified in the block STD.TANKx_PRODUCT.density type, that is, density at base or flowing condition.

For applications where the density is obtained from laboratory analysis it is recommended to configure TANKx_PRODUCT.density type for base density.



State	Possible Commands	CREATING_REPORT	Comments
Browsing	First pending(Wr), Next(Wr), Previous(Wr), Last pending(Wr), Reedit(Wr-R1), Disable filters(Wr), Create report (Wr-R1)	Revising	Only search commands, to start reedition or to create report.
Waiting data	Calc(Wr-R1), Return to Browsing(Wr)	Creating ou Revising	Awaiting user to provide information of laboratory analysis or manual measurement.
Calc failure	Calc(Wr-R1), Return to Browsing(Wr)	Creating ou Revising	Awaiting user to correct the information of laboratory analysis or manual measurement.

Diagnosis and Troubleshooting:

1. BLOCK_ERR. Out of Service: block TWTR can remain in mode Out of service in spite of the target mode is Auto because the block Resource is in O/S.

2. The writing in REV_CMD = Reedit(Wr) will be accepted if the visualized report was created with data manually edited.

Indication	Description
0=No error	The supplied data are consistent, report was generated
2=Missing TANK_ID	• Tank ID not selected The Tank ID selected is being used in another measurement (STG or TWT): the selection is always accepted and the check is accomplished by user's solicitation (Calc (Wr)). • Tank type different of vertical cylindrical
3=Missing TMR_TYPE	To provide the type of report
4=Missing OPEN_DATE_TIME	To provide the date and hour of start
5=Missing CLOSE_DATE_TIME	• To provide the date and hour of close Difference between date/hour of close and date/hour of start should be inferior to 24 hours.

Indication	Description
6=Missing INNAGE	To provide the level
7=Missing FW_LEVEL	To provide the level of free water
8=Missing LIQ_TEMP	To provide the average temperature of the liquid
9=Missing AMB_TEMP	To provide the ambient temperature
10=Missing DENSITY	To provide the liquid density
11=Missing LIQ_SW	To provide the BSW
12= Reverse order date	The date/hour at the start is after the date/hour of close
13=Inconsistent innage	Level decrease in the receiving
14=Inconsistent FW	• Level of free water decrease in the receiving • Level of free water superior to the liquid level
15=Out range-CTL	To verify the density range and temperature according to the product type.
16=Out range-Curve	Level out of range configured in the tank table.
17=Config error	Configuration error
18=General error	• Shrink factor out of range of 0 to 1.01 in manual measurement. The edited or revised report was superposed or eliminated.
19…42=Inconsistent hour 1…24	Inconsistency in the data of the hour 1 ...24 (decreasing values of the levels, level of free water superior at the level, range of CTL calculation, out of range of the tank table)

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	This parameter identifies the run number.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	
7	O	REPORT_DONE	DS-66				N / RO	Indicate that one report was generated and stored in the TM302 memory.
8	1	NUM_NOT_STORED	Unsigned16		0	Na	N / RO	Number of reports with "not stored" status, that is, not stored in the database of TMView.
9		NUM_PENDING	Unsigned16		0	Na	N / RO	Number of reports with "pending" status, that is, awaiting data of laboratory analysis to finish calculations.
10		FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of first report in the QTR log (the oldest one).
11		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of last report in the QTR log (the newest one).
12		OPEN_DATE_SEARCH	Date				N	Opening date of period referent to the pending report to be search. It is possible to write in this parameter if REV_CMD=Browsing.
13		TANK_TAG_SEARCH	Visiblestring [16]		Blank		N	Reports search where the tank tag coincides with this parameter. It is possible to write in this parameter if REV_CMD=Browsing.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
14		SITE_TAG_SEARCH	Visiblestring [16]		Blank		N	Reports search where the tag of measurement site coincides with this parameter. It is possible to write in this parameter if REV_CMD=Browsing.
15 (R1)		REV_CMD	Unsigned8	0=Browsing 1=First pending (Wr) 2=Next pending (Wr) 3=Previous pending (Wr) 4=Last pending (Wr) 5=Calc (Wr-R1) 6=Calculating 7=Calc OK 8=Calc failure 9=Create report (Wr-R1) 10=Waiting data 11=Reedit (Wr-R1) 12=Return to Browsing (Wr) 13=Disable filters (Wr)	0	E	D	Selection of report for gas to be visualized. The first report is the oldest logged report with STORAGE_STATE in "pending", if there is one, at least. The last report is the newest logged report with STORAGE_STATE in "pending", if there is one at least. The option next means the next newer report with STORAGE STATE in "pending", if there is one at least. The option previous means the next older report with STORAGE STATE in "pending", if there is one at least.
16		LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N	Log counter in the TM302 memory. It is a rollover counter for logged reports. It is a counter showing the chronological sequence of logging. It is possible to write in this parameter if REV_CMD=Browsing.
17		STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored 2=Pending 3=Not-logged	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 TMView itself.
18		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Rollover counter of reports
19 (R1)		FIELD_NAME	Visiblestring [32]		Blank		N / Yes	String to identify the field of well.
20 (R1)		WELL_ID	Visiblestring [32]		Blank		N / Yes	String to identify the well that is being tested.
21		TANK_TAG	Visiblestring [16]		Blank		N / RO	Tank tag.
22 (R1)		TANK_ID	Unsigned16	1 to 16	0	Na	N / Yes	Identification of the tank used in the measurement.
23	3	ALIGN_DATE_TIME	Date				N / RO	Date and time of alignment to the well to be tested.
24 (R1)	3	OPEN_DATE_TIME	Date				N / Yes	Opening date and time of current test. After waiting for the initial stability time.
25 (R1)	3	CLOSE_DATE_TIME	Date				N / Yes	Closing date and time of this report.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
26		NUM_HOURS	Unsigned16		0	Na	N / RO	Number of hours collecting weighted averages.
27		TEST_STATUS	Bitstring[2]	See Block Options	0	Na	N/ RO	Status during the well test. Similar to the BATCH_STATUS.
28 (R1)	3	OPEN_ LEVEL	Float SI-DD1 US-DD2		0	L	N / Yes	Oil level at beginning of the test.
29 (R1)		LEVEL _HOUR	Float[24] SI-DD1 US-DD2		0.0's	L	N / Yes	Instantaneous level at the end of each hour.
30 (R1)	3	CLOSE_ LEVEL	Float SI-DD1 US-DD2		0	L	N / Yes	Oil level at end of the test.
31 (R1)	3	OPEN_ FW	Float SI-DD1 US-DD2		0	L	N	Free water level at beginning of the test.
32 (R1)		FW _HOUR	Float[24] SI-DD1 US-DD2		0.0's	L	N	Instantaneous level of free water at the end of each hour.
33 (R1)	3	CLOSE_ FW	Float SI-DD1 US-DD2		0	L	N	Free water level at end of the test.
34 (R1)	3	OPEN_ TEMP	Float SI-DD25 US-DD1		0	T	N	Oil temperature at beginning of the test.
35(R1)		TEMP _HOUR	Float[24] SI-DD25 US-DD1		0.0's	T	N	Instantaneous temperature at the end of each hour.
36 (R1)	3	CLOSE_ TEMP	Float SI-DD25 US-DD1		0	T	N	Oil temperature at the end of the test.
37 (R1)	3	OPEN_ DENS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N	Oil density at beginning of the test.
38 (R1)		DENS_HOUR	Float[24] SI-DD1 US-DD1 SG-DD4		0.0's	LD	N	Instantaneous density or weighed average at the end of each hour.
39 (R1)	3	CLOSE_ DENS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N	Oil density at the end of the test.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
40 (R1)	3	OPEN_ SW	Float DD3		0	%	N	Oil SW at beginning of the test.
41 (R1)		SW _HOUR	Float[24] DD3		0.0's	%	N	Instantaneous SW or weighed average at the end of each hour.
42 (R1)	3	CLOSE_ SW	Float DD3		0	%	N	Oil SW at the end of the test.
43		OPEN_GOV	Float		0	LV	N / RO	GOV at beginning of the test.
44		GOV_HOUR	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	TV	N / RO	GOV at the end of each hour.
45		CLOSE_GOV	Float		0	LV	N / RO	GOV at the end of the test.
46		OPEN_GSV	Float		0	LV	N / RO	If density meter in line, then it will be zero. Otherwise, indicate the GSV at beginning of the test.
47		GSV_HOUR	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	LV	N / RO	If density meter in line, then indicate the GSV variation at the end of each hour related to beginning of the test. Otherwise, indicate the GSV at the end of each hour.
48		CLOSE_GSV	Float		0	LV	N / RO	If density meter in line, then it indicate the GSV variation at the end of the test related to the beginning. Otherwise, indicate the GSV at the end of the test.
49		OPEN_NSV	Float		0	LV	N / RO	If BSW meter in line, then it will be zero. Otherwise, indicate the NSV at beginning of the test.
50		NSV_HOUR	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	LV	N / RO	If density meter in line, then it indicate the NSV variation at the end of each hour related to beginning of the test. Otherwise, indicate the NSV at the end of the test.
51		CLOSE_NSV	Float		0	LV	N / RO	If BSW meter in line, then it indicate the NSV variation at the end of the test related to beginning. Otherwise, indicate the NSV at the end of the test.
52 (R1)	3	OPEN_AMBIENT _TEMP	Float SI-DD25 US-DD1		0	T	N / Yes	Oil temperature at the beginning of the test.
53 (R1)	3	CLOSE_AMBIEN T_TEMP	Float SI-DD25 US-DD1		0	T	N / Yes	Oil temperature at the end of the test.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
54		VOL_CLOSE	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	GOV/GSV/NSV (depends on the density meter and BSW) at the end of the test tank loading, before stabilization.
55		VOL_STABILIZED	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	GOV/GSV/NSV (depends on the density meter and BSW) at the end of the test tank loading, after stabilization.
56		SF	Float	0 to 1	0	Na	N / RO	Shrink factor after stabilization by the GOV/GSV/NSV at the end of the test tank loading and after stabilization.
57	1	GSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	GSV received during the well test after stabilized.
58	1	NSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	NSV received during the well test after stabilized.
59	1	WATER_GSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	GSV of the water received during the well test after stabilized.
60	1	WELL_TEST_TIME	Time difference				N / RO	Indication of the well test time. It does not include the time of stabilization.
61	1	OIL_TEST_FLOW	Float			QV	N / RO	Liquid volume flow at standard condition of oil during the test.
62		WATER_TEST_FLOW	Float			QV	N / RO	Gross volume flow at standard condition of water during the test.
63	1	OIL_POTENTIAL_PRODUCTION	Float		0.0	LV	N / RO	Oil potential production in NSV.
64		VISCOSITY	Float		0.0	Visc	N / RO	Viscosity of the oil.
65		LIQ_SPEC_1	Bitstring[2]				N / RO	Standards used for the calculations.
66		LIQ_SPEC_2	Bitstring[2]				N / RO	Standards used for the calculations.
67		TM_SPEC	Bitstring[2]				N / RO	It shows the applied standards for the calculation.
68		CALC_DATE	Date				N / RO	Calculation date of the report with data supplied by the user. This date coincides with CLOSE_DATE_TIME for well test totally automated.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
69		SITE_TAG	Visiblestring [16]		Blank		N / RO	Tag of the measurement site.
70		MANUAL_DATA	Bitstring[2]				N / RO	Indicate which data are supplied manually by the user.
71		EDITED_BY	Visiblestring [8]		Blank		N / RO	Indicate the responsible user for the edition of the data supplied manually through the username.
72		MEASURE_TYPE	Unsigned8	0=Initial and end values 1=SW in-line 2=Density and SW in-line 3= SW in-line delivering			N / RO	Indicate if the density meters and BSW are in line.
73		REPORT_REV	Unsigned16		0		N / RO	Indicate the report review. Zero indicates the first version of the report.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
74		CALC_ERROR	Unsigned16	0=No error 1=Not checked 2=Missing TANK_ID 3=Missing TMR_TYPE 4=Missing OPEN_DATE_TIME 5=Missing CLOSE_DATE_TIME 6=Missing INNAGE 7=Missing FW_LEVEL 8=Missing LIQ_TEMP 9=Missing AMB_TEMP 10=Missing DENSITY 11=Missing LIQ_SW 12= Reverse order date 13=Inconsistent innage 14=Inconsistent FW 15=Out of range-CTL 16=Out of range-Curve 17=Config error 18=General error 19…42=Inconsistent hour 1…24	0	E	N / RO	Error code for the calculation.
75		CREATING_REPORT	Unsigned8	0=Revising 1=Creating		E	N / RO	Indicate if the visualized report is being revised or edited completely (field data supplied manually).

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
76 (V3) (R1)		TWT_REVISION _CAUSE		0 = Blank 1 = Generic 2 = Report edition 3 = Providing manual measurements 4 = FW-manual measurement 5 = Density-manual measurement 6 = SW-manual measurement 7 = Providing corrections 8 = Field name-correction 9 = Well ID-correction 10 = Tank ID-correction 11 = Open date & time – correction 12 = Close date & time–correction 13 = Level–correction 14 = FW-correction 15 = Liquid temperature-correction 16 = Density-correction 17 = SW-correction 18 = Ambient temperature-correction		E	N	Indicate the cause of the report revision.

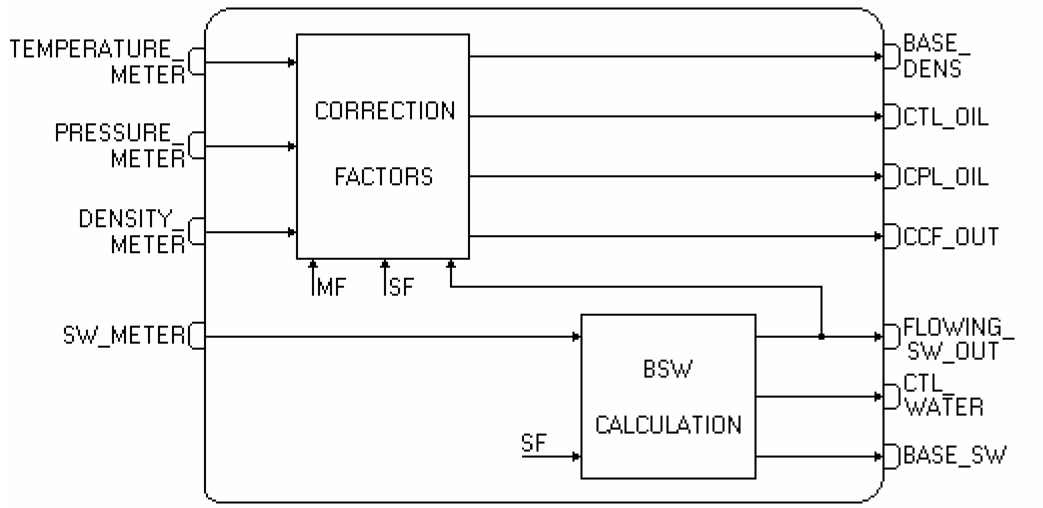
Legend: E – Enumerated Parameter; NA – Dimensionless Parameter; RO – Read Only; D – Dynamic; N – Non volatile;
S – Static; I – Input Parameter; O - Output Parameter
AA – Administrator Level; A1 – Level 1; A2 – Level 2
RA – Restriction to the Administration; R1 – Restriction Level 1; R – Restriction Level 2

Store/Mode Column:

- Yes means that the parameter will be written only if a report is being created (simulate tank).

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 condition defined by DENSITY_TYPE and BASE_TEMPERATURE .	DENSITY_METER
CTL_OUT	Temperature Correction Factor	1.0000
CPL_OUT	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 lubricant 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:

Inputs	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.

Block Outputs

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: $DENS_{oil,T} = f(DENS_{oil,Tlab}, T)$

Where:
$DENS_{oil,T}$: dry oil density at flowing temperature
$DENS_{oil,Tlab}$ = LAB_DENS_OIL: dry oil density at laboratory analysis temperature.
T : flowing temperature

- It calculates: $DENS_{water,T} = f(DENS_{water,15/60}, T)$

Where:
$DENS_{water,T}$: water density at flowing temperature
$DENS_{water,lab}$ = 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($DENS_{water,15/60}$, T, Tb) is the CTL_WATER parameter, which converts the volume at flowing temperature to base temperature.
- CTL_o = f($DENS_{oil,Tlab}$, Tlab,Tb), which converts the volume at laboratory analysis 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 outputs

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 Calculation – LAB_DENS_OIL, LAB_DENS_WATER and XWS

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:

It calculates:

$$X_{w,m} = \frac{X_{w,lab} * (CTL_{w,lab} / CTL_{w,m})}{X_{w,lab} * (CTL_{w,lab} / CTL_{w,m}) + (1 - X_{w,lab}) * (CTL_{o,lab} / (CTL_{o,m} * SF))}$$

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.
   - The selected product is MTBE and DENSITY_TYPE is “Measured density”.
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 STATUS_CURRENT
"Abnormal Conditions" – Problems in the BSW calculation. SW input values out of range 0-100 % (CALC_BSW ="Dual Range").

Supported Modes
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	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)	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)	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	4	BASE_PRESSURE	Float	101.325 kPa or 14.696 psi	101.325 kPa	P_UNITS	S / RO	Parameter not used.
19 (A1)	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)	4	T_UNITS	Unsigned16	1000=Kelvin 1001=Celsius 1002=Fahrenheit 1003=Rankine	Celsius	E	S	Engineering Unit for temperature.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
21 (A1)	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)	4	LD_UNITS	Unsigned16	1097= Kg/m^3 1113=API 1599 = relatve 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)	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)	4	DENSITY_TYPE	Unsigned8	1=Density at base 2=Measured density	1	E	S	Density type.
25 (A2)	4	HYDROMETER_CORRECTION	Unsigned8	0=No correction 1=Correction is done	0	E	S	Hydrometer correction.
26 (A2)	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.
27 (A2)	2	MF	Float	0.8 to 1.2	1.0	Na	S	MF used for the combined correction factor (CCF).
28 (A2)	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.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
29 (A2)	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)	2	LAB_TEMP	Float		15	T_UNITS	S	Temperature of the laboratory analysis is accomplished to obtain the XWS.
31 (A2)	2	LAB_DENS_WATER	Float	>= 0.0	1000	LD_UNITS	S	Water density in laboratory analysis condition (LAB_TEMP).
32 (A2)	2	LAB_DENS_OIL	Float	>= 0.0	900	LD_UNITS	S	Oil density in laboratory analysis condition (LAB_TEMP).
33 (A2)	2	LAB_SW	Float	0 to 100	0	%	S	BSW value obtained in laboratory analysis condition (LAB_TEMP).
34 (A2)	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 at flowing temperature.
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

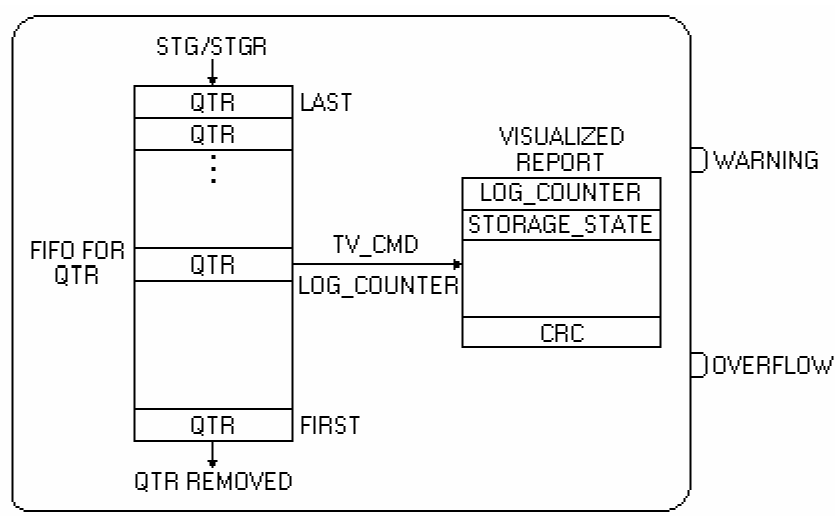
Report/Register Visualization Block

The report/register visualization function blocks in the TM302 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 TM302 supports an instantiation for each block type.
- The search for the reports/registers in the historical storage must be done exclusively by the TMView;
- When the report/register is generated by the TM302, 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".

STGV – Shore Tank Gauging Visualization

Schematic



Description
This block allows visualize all the registered reports referred to the transfer for tank measurement.

The reports are interpreted in the following way:

- Batch: The two first elements of the array represent the initial and final condition of the batch. The third element of the array is the difference between the initial and final condition. For totalizations, the third element means the transferred quantity of the product.
- Day/week/month: The two first elements of the array represent the initial and final condition of the corresponding period and the third element represents the quantity transferred during the period, which are not same the difference between final and initial condition. The instantaneous values will be considered at the beginning and end of period when they occur during the receipt or delivery of product.

Each report requests 337 bytes.

Phase	Variation
Receipt	End – Beginning
Delivery	Beginning – End

Report #	DENSIMETER_TYPE and report type
13	Transfer - Sample, HTMS mode 1 and HTMS mode 2
14	Transfer - In-line when transferring and In-line when receiving
15	Balance - Sample, HTMS mode 1 and HTMS mode 2

Sequence of transferred volume / mass calculation

The values referring to the variation (third element in the array) are final minus initial condition when receiving and the contrary when delivering, therefore such values usually should be positive, except in cases of improper receipt or delivery.

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	This parameter identifies the number of the measured flow.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	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 TMView data bank.
11		NUM_PENDING	Unsigned16		0	Na	N / RO	Number of reports with status "pending", that is, awaiting data of laboratory analysis to end the calculation.
12	1	FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Identifier (log counter) of the first QTR (oldest).
13		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Identifier (log counter) of the last QTR (newest).

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
14	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 "Notstored", if there was only one. The previous option means the next report oldest with STORAGE STATE in "Notstored", if there was only one.
15		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".
16	1	LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N	Report identifier in the TM302 memory. It is a rollover counter for stored reports. It is an identifier which shows the logging chronological sequence.
17	1	STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored 2=Pending	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 TMView.
18		TANK_TAG	Visiblestring[16]		Blank		N / RO	Tank tag.
19	1	TANK_ID	Unsigned16	1 to 16	0	Na	N / RO	Identifies the tank used in the measurement.
20		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Report number for the report type and measured flow number. If it is operational report, it always zero.
21	1	BATCH_ID	Visiblestring[8]				N / RO	Batch description.
22	1	TMR_TYPE	Unsigned8	0=None 1= Receipt transfer & batch 2= Delivery transfer & batch 3= Receipt & batch 4= Delivery & batch 5=Inventory & day 7= Inventory & month 8=Leak	0	E	N / RO	Transfer report type for tank measurement.
23	1	PRODUCT_NAME	Visiblestring[16]				N / RO	Product name obtained from LKD block.
24		CALC_DATE_TIME	Date				N / RO	Date/hour of the report revision.
25	1	OPEN_DATE_TIME	Date				N / RO	Opening date/hour of the current batch.
26	1	CLOSE_DATE_TIME	Date				N / RO	Closing date/hour of the current batch.
27	1	FTIME	Time difference				N / RO	Transfer time.
28	1	PERIOD_STATUS	Bitstring[2]	See Block Options	0	Na	N/ RO	Status during the report period. Similar to the BATCH_STATUS.
29		OUTAGE	Float[2] SI-DD1 US-DD2			L	N / RO	Free level at beginning/end of the transfer.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
30		CORRECTED_REF_HEIGHT	Float[2] SI-DD1 US-DD2			L	N / RO	Tank reference height at measurement condition for beginning/end of the transfer.
31	1	INNAGE	Float[3] SI-DD1 US-DD2			L	N / RO	Liquid level at beginning/end of the transfer and the difference.
32	1	TOV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Total observed volume at beginning/end of the transfer and the difference.
33	3	LIQ_FW_LEVEL	Float[2] SI-DD1 US-DD2			L	N / RO	Free water level at beginning/end of the transfer.
34	3	FW_VOLUME	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Free water volume at beginning/end of the transfer and the difference.
35		LIQ_TEMP	Float[2] SI-DD25 US-DD1			T	N / RO	Liquid temperature at beginning/end of the transfer.
36		AMB_TEMP	Float[2] DD10			T	N / RO	Ambient temperature at beginning/end of the transfer.
37		TANK_SHELL_TEMP	Float[2] DD10			T	N / RO	Tank temperature at beginning/end of the transfer.
38		CTSH	Float[2] DD5			Na	N / RO	Correction factor of the tank table due to temperature effect at beginning/end of the transfer.
39		FRA	Float[2] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Correction factor of floating roof at beginning/end of the transfer.
40	3	GOV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Gross observed volume at beginning/end of the transfer and the difference.
41		LIQ_DENSITY	Float[3] SI-DD1 US-DD1 SG-DD4			LD	N / RO	Liquid density at process condition for beginning/end of the transfer.
42		BASE_DENSITY	Float[3] SI-DD1 US-DD1 SG-DD4			LD	N / RO	Liquid base density at beginning/end of the transfer.
43	3	LIQ_CTL	Float[3] DD5			Na	N / RO	Temperature correction factor of the liquid at beginning/end of the transfer.
44	3	LIQ_GSV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Gross volume at standard condition at beginning/end of the transfer and the difference.
45		LIQ_SW	Float[3] DD3			%	N / RO	Liquid BSW at beginning/end of the transfer.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
46	3	LIQ_NSV	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	Liquid volume at standard condition for beginning/end of the transfer and the difference.
47		WCF	Float[3]			M/LV	N / RO	Conversion factor of volume to mass at beginning/end of the transfer.
48	3	MASS_IN_VACUUM	Float[3] SI-DD3 US-DD3 Kg-DD10 Lb-DD10			M	N / RO	Mass (in vacuum) at beginning/end of the transfer and the difference.
49	3	MASS_IN_AIR	Float[3] SI-DD3 US-DD3 Kg-DD10 Lb-DD10			M	N / RO	Apparent mass (in air) of the liquid at beginning/end of the transfer and the difference.
50		MEASURE_TYPE	Unsigned8	0=Initial and end values 1=SW in-line 2=Density and SW in-line			N / RO	Indicate if the density meters and BSW are in line.
51	3	FR_GSV	Float			QV	N / RO	Average flow during the transfer.
52		LIQ_SPEC_1	Bitstring[2]				N / RO	Show the standards applied in the calculation.
53		LIQ_SPEC_2	Bitstring[2]				N / RO	Show the standards applied in the calculation.
54		TM_SPEC	Bitstring[2]				N / RO	Show the standards applied in the calculation.
55		SITE_TAG	Visiblestring[16]		Blank		N / RO	Tag of the measurement site.
56		MANUAL_DATA	Bitstring[2]				N / RO	Indicate which data are supplied manually by the user.
57		EDITED_BY	Visiblestring[8]		Blank		N / RO	Indicate the responsible user for edition of the data supplied manually through the username.
58		REPORT_REV	Unsigned16		0		N / RO	Indicate the report revision. Zero indicates the first version of the report.
59		CRC	Unsigned16		0	Na	N /RO	CRC of the selected input/group.
60 (V3)		NUM_TO_READ	Unsigned16			Na	N / RO	Report number not-stored and pending.
61		TANK_TYPE	Unsigned8	0=Upright cylindrical – fixed roof 1=Upright cylindrical – floating roof 2=Horizontal cylindrical 3=Sphere	0	E	N / RO	Tank type.

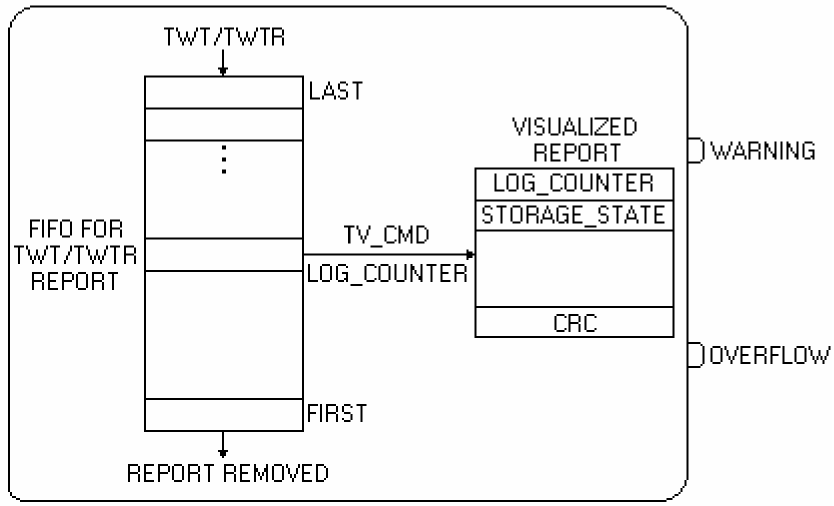
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
62		PRODUCT_TYPE	Unsigned8	0=crude oil (A) 1=Generalized products(B) 2=MTBE (C) 3=Lubricating oil (D) 4=Water 5=Light hydrocarbon (E) 6=Emulsion of crude oil 9=Ethanol-OIML R22 10=Ethanol-NBR 5992		E	N / RO	Measured product type.
63		CTILT	Float[2] DD5			Na	N / RO	Correction factor of ramp in horizontal cylindrical tanks.
64		LIQ_PRES	Float[2] SI-DD10 US-DD10 Bar-DD1			P	N / RO	Pressure for the liquid at beginning/end of the transfer.
65		CPVC	Float[2] DD5			Na	N / RO	Pressure correction factor for the geometry of the cylindrical tank.
66		CPVE	Float[2] DD5			Na	N / RO	Pressure correction factor for the geometry of the cylindrical tank heads or spherical tank.
67		LIQ_CPL	Float[3] DD5			Na	N / RO	Pressure correction factor at the volume of the measured liquid in pressurized tank.
68		LIQ_GSV_VAPOUR	Float[3] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			Na	N / RO	Liquid volume at base condition related to quantity of vapor inside the pressurized tank.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
69		STG_REVISION_CAUSE	Unsigned8	0 = Blank 1 = Generic 2 = Report edition 3 = Providing manual measurements 4 = FW-manual measurement 5 = Density-manual measurement 6 = SW-manual measurement 7 = Providing corrections 8 = Tank ID-correction 9 = Batch ID-correction 10 = Type of transfer-correction 11 = Open date & time – correction 12 = Close date & time–correction 13 = Level–correction 14 = FW-correction 15 = Liquid temperature-correction 16 = Ambient temperature-correction 17 = Density-correction 18 = SW-correction		E	N / RO	Indicate the cause of the report revision.
70		PERC_MASS	Float[3]	0.0 to 100.0	0	%	N / RO	Percentage in mass of the ethanol in the mixture at beginning/end of the transfer and the transferred.

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

TWTV – Tank Well Test Visualization

Schematic



Description

This block allows visualize the well test report.

Through the TV_CMD parameter, it is possible to select the logged reports.

All the needed information to create the well test report is provided in the block, except:
1. Flow computer tag (device tag);
2. TMT block: company name, place, responsible names;
3. 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 Mode
O/S and AUTO.

Parameters

Idx	Type/ View	Parameter	Data Type (length)	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	This parameter identifies the number of the measured flow.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	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).

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
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.
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 TMView data bank.
11		NUM_PENDING	Unsigned16		0	Na	N / RO	Number of reports with status "pending", that is, awaiting data of laboratory analysis to end the calculation.
12		FIRST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of the first report data (the oldest).
13		LAST_LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N / RO	Log counter of the last report data (the newest).
14		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 and with STORAGE_STATE in "Notstored", if there was one. The last report will be the logged report most recent with the STORAGE_STATE in "Notstored", if there was one. The next option means the next report with STORAGE STATE in "Not-stored", if there was one. The previous option means the next report oldest with STORAGE STATE in "Notstored", if there was only one.
15		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".
16		LOG_COUNTER	Unsigned16	1 to 65000	0	Na	N	Report identifier in the TM302 memory. It is a rollover counter for stored reports. It is an identifier which shows the logging chronological sequence.
17		STORAGE_STATE	Unsigned8	0=Not-stored 1=Stored 2=Pending	0	E	N / RO	Indicate the visualized report storage state. After reading this report and save in data base, it will be changed to "Stored" by the TMView.
18		REPORT_COUNTER	Unsigned32		0	Na	N / RO	Report rollover counter.
19		FIELD_NAME	Visiblestring [32]		Blank		N / RO	Identifies the field of the tested well.
20		WELL_ID	Visiblestring [32]		Blank		N / RO	Identifies the tested well.
21		TANK_TAG	Visiblestring [16]		Blank		N / RO	Tag of the first tank.
22		TANK_ID	Unsigned16	1 to 16	0	Na	N / RO	Identifies the tank used in the measurement.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
23	3	ALIGN_DATE_TIME	Date				N / RO	Date and hour of alignment of the well to be tested.
24	3	OPEN_DATE_TIME	Date				N / RO	Opening date and hour of the current test. After waiting the time of initial stabilization.
25	3	CLOSE_DATE_TIME	Date				N / RO	Closing date and hour of this report.
26		NUM_HOURS	Unsigned16		0	Na	N / RO	Number of hours of the collected weighed averages.
27		TEST_STATUS	Bitstring[2]	See Block Options	0	Na	N/ RO	Status during the well test. Similar to the BATCH_STATUS.
28	3	OPEN_ LEVEL	Float SI-DD1 US-DD2		0	L	N / RO	Oil level at beginning of the test.
29		LEVEL _HOUR	Float[24] SI-DD1 US-DD2		0.0's	L	N / RO	Instantaneous level at the end of each hour.
30	3	CLOSE_ LEVEL	Float SI-DD1 US-DD2		0	L	N / RO	Oil level at the end of the test.
31	3	OPEN_ FW	Float SI-DD1 US-DD2		0	L	N / RO	Level of free water at the beginning of the test.
32		FW _HOUR	Float[24] SI-DD1 US-DD2		0.0's	L	N / RO	Instantaneous level of free water at the end of each test.
33	3	CLOSE_ FW	Float SI-DD1 US-DD2		0	L	N / RO	Level of free water at the end of the test.
34	3	OPEN_ TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Oil temperature at the beginning of the test.
35		TEMP _HOUR	Float[24] SI-DD25 US-DD1		0.0's	T	N / RO	Instantaneous temperature at the end of each hour.
36	3	CLOSE_ TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Oil temperature at the end of the test.
37	3	OPEN_ DENS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N / RO	Oil density at beginning of the test.
38		DENS_HOUR	Float[24] SI-DD1 US-DD1 SG-DD4		0.0's	LD	N / RO	Instantaneous density or weighed average at the end of each hour.
39	3	CLOSE_ DENS	Float SI-DD1 US-DD1 SG-DD4		0	LD	N / RO	Oil density at the end of the test.
40	3	OPEN_ SW	Float DD3		0	%	N / RO	Oil SW at beginning of the test.
41		SW _HOUR	Float[24] DD3		0.0's	%	N / RO	Instantaneous SW or weighed average at the end of each hour.
42	3	CLOSE_ SW	Float DD3		0	%	N / RO	Oil SW at the end of the test.
43		OPEN_GOV	Float		0	LV	N / RO	GOV at beginning of the test.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
44		GOV_HOUR	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	LV	N / RO	GOV at the end of each hour.
45		CLOSE_GOV	Float		0	LV	N / RO	GOV at the end of the test.
46		OPEN_GSV	Float		0	LV	N / RO	If density meter in line, then it will be zero. Otherwise, indicate the GSV at beginning of the test.
47		GSV_HOUR	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	LV	N / RO	GSV variation at the end of each hour related to the beginning of the test.
48		CLOSE_GSV	Float		0	LV	N / RO	If density meter in line, then it indicates the GSV variation at the end of the test related to the beginning. Otherwise, it indicates the GSV at the end of the test.
49		OPEN_NSV	Float		0	LV	N / RO	If BSW meter in line, then it will be zero. Otherwise, it indicates the NSV at the beginning of the test.
50		NSV_HOUR	Float [24] SI-DD3 US-DD2 Liter-DD10 Gallon-DD2		0	LV	N / RO	NSV variation at the end of each hour related to the beginning of the test.
51		CLOSE_NSV	Float		0	LV	N / RO	If BSW meter in line, then indicate the NSV variation at the end of the test related to beginning. Otherwise, it indicates the NSV at the end of the test.
52	3	OPEN_AMBIENT_TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Oil temperature at beginning of the test.
53	3	CLOSE_AMBIENT_TEMP	Float SI-DD25 US-DD1		0	T	N / RO	Oil temperature at the end of the test.
54		VOL_CLOSE	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	GOV/GSV/NSV (depends on the density meter and BSW) at the end of the test tank loading, before the stabilization.
55		VOL_STABILIZED	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	GOV/GSV/NSV (depends on the density meter and BSW) at the end of the test tank loading, after the stabilization.
56		SF	Float	0 to 1	0	Na	N / RO	Shrink factor after stabilization by the GOV at the end of the test tank loading and after stabilization.
57	1	GSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	GSV received during the well test after stabilized.

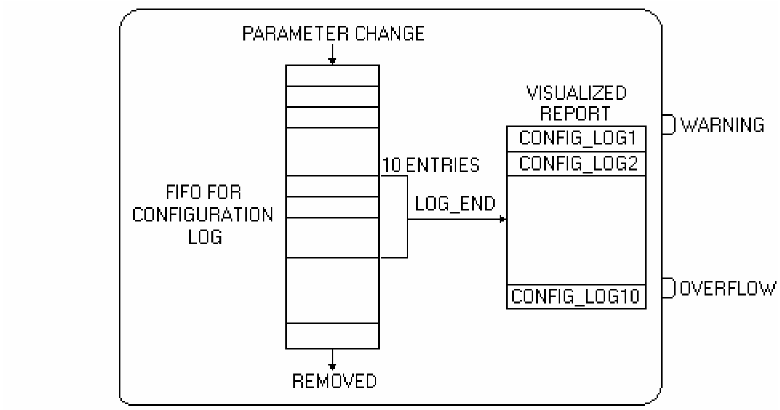
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
58	1	NSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N/ RO	NSV received during the well test after stabilized.
59	1	WATER_GSV	Float SI-DD3 US-DD2 Liter-DD10 Gallon-DD2			LV	N / RO	GSV of the water received during the well test after stabilized.
60	1	WELL_TEST_TIME	Time difference				N / RO	Indicate the well test time. It does not include the stabilization time.
61	1	OIL_TEST_ FLOW	Float			QV	N / RO	Liquid volume flow at standard condition of oil during the test.
62		WATER_TEST_ FLOW	Float			QV	N / RO	Gross volume flow at standard condition of water during the test.
63	1	OIL_POTENTIAL_P RODUCTION	Float		0.0	LV	N / RO	Oil potential production in NSV.
64		VISCOSITY	Float		0.0	Visc	N / RO	Oil viscosity.
65		LIQ_SPEC_1	Bitstring[2]				N / RO	Standards used in the calculations.
66		LIQ_SPEC_2	Bitstring[2]				N / RO	Standards used in the calculations.
67		TM_SPEC	Bitstring[2]				N / RO	Show the standards applied in the calculation.
68		CALC_DATE	Date				N / RO	Date of report calculation with data supplied by the user. This date coincides with CLOSE_DATE_TIME for well test totally automatized.
69		SITE_TAG	Visiblestring [16]		Blank		N / RO	Tag of the measurement site.
70		MANUAL_DATA	Bitstring[2]				N / RO	Indicate which data are supplied manually by user.
71		EDITED_BY	Visiblestring [8]		Blank		N / RO	Indicate the responsible user for the edition of the data supplied manually through the username.
72		MEASURE_TYPE	Unsigned8	0=Initial and end values 1=SW in-line 2=Density and SW in-line 3= SW in-line delivering			N / RO	Indicate if the density meters and BSW are in line.
73		REPORT_REV	Unsigned16		0		N / RO	Indicate the report revision. Zero indicates the first version of the report.
74		CRC	Unsigned16		0	Na	N /RO	CRC of the selected input/group.
75 (V3)		NUM_TO_READ	Unsigned16			Na	N / RO	Number of report not-stored and pending.

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
76		TWT_REVISION_CAUSE	Unsigned8	0 = Blank 1 = Generic 2 = Report edition 3 = Providing manual measurements 4 = FW-manual measurement 5 = Density-manual measurement 6 = SW-manual measurement 7 = Providing corrections 8 = Field name-correction 9 = Well ID-correction 10 = Tank ID-correction 11 = Open date & time – correction 12 = Close date & time– correction 13 = Level– correction 14 = FW-correction 15 = Liquid temperature-correction 16 = Density-correction 17 = SW-correction 18 = Ambient temperature-correction		E	N / RO	Indicate the cause of the report revision.

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

ATV – Audit Trail Visualization

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 TMView – 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 TMView 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:

• TMT 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

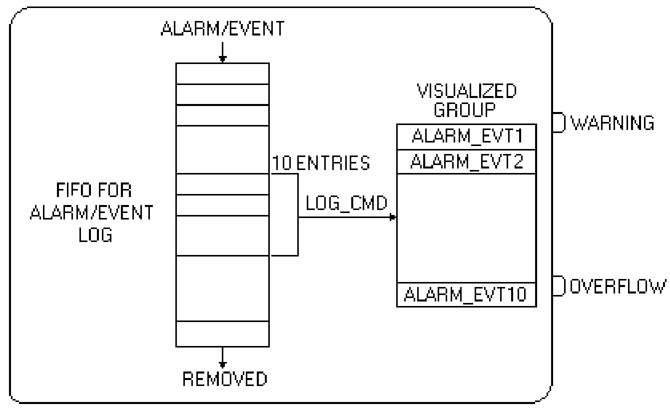
Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	Store/ Mode	Description
1	1,2,3,4	ST_REV	Unsigned16		0	None	S / RO	
2		TAG_DESC	OctString(32)		Spaces	Na	S	
3	4	STRATEGY	Unsigned16	255	255	None	S / RO	This parameter identifies the number of the measured flow.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	Na	S	Refer to the Mode parameter.
6	1,3	BLOCK_ERR	Bitstring(2)			E	D / RO	

Idx	Type/ View	Parameter	Data Type (length)	Valid Range/ Options	Default Value	Unit	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 parameters 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 TMView 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

AEV – Alarm and Event Visualization

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 TMView – 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:

1. TMT block: responsible and place names;
2. Flow compuer tag (device tag);
3. Print data 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 (length)	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	This parameter identifies the number of the measured flow.
4	4	ALERT_KEY	Unsigned8	1 to 255	0	None	S	
5	1,3	MODE_BLK	DS-69		Auto	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 (length)	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 TMView 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

Data Structure Type in Audit Trail

Besides "Simple Data Type" defined for Fieldbus Foundation (FF-890 item 5.3.1. data type of 1 to 14, and 21) for the function blocks, as well as arrays of "Simple Data Type", it has the following structures that can be in configuration log:

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

Notes
All the elements of the structures above are as an only registration in TM302 and consequently in the report of configuration log printed by TMView. The case of arrays should be treated of generic mode as possible, that is, for different data type and sizes, however in practice for the First Version of TM302/TMView, it has only an array of float with 5 elements.

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

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 + B, 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

- Slave Address: It informs the slave's address that is requested for reference to the parameter PVALUEn. For example, supposing that there is a LC700 with Address of Device equal to 3 and in this LC700 is requested to monitor a specific variable. Then, the Slave Address should be equal to 3.
- MODBUS Address Of Value: It informs the MODBUS address of the variable that will be monitored. In the example of the previous element, it is supposed that the MODBUS address of the monitored variable is 40032. Like this, this element should receive this address.

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

- Slave Address: It informs the slave's address that is requested for reference to the input IN. For example, supposing that there is a LC700 with Address of Device equal to 3 and in this LC700 is necessary to connect one or two inputs or outputs. Then, the Slave Address should be equal to 3.

- MODBUS Address Of Value: It informs the MODBUS address of the variable that will be referenced for input or output. In the example of the previous element, supposing the MODBUS address of the variable, it will be referenced as 40032. Like this, this element should receive this address.

- MODBUS Address of Status: In this parameter, the user informs the MODBUS address where the status will be reading or writing. Each input and output has a corresponding status. The interpretation of status follows the Fieldbus Foundation Default (See the item "Status of Parameters" for more details).

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

- Slave Address: Indicate the slave address where is the variable requested to be monitored. For example, if in an application a LC700 was configured to Device Address equal to 1. Slave Address should be equal to 1.
- Modbus Address Value: Write the MODBUS address of the variable that will be monitored in the block MBSM. Supposing that the user needs to monitor the variable with MODBUS address 40001 located in an I/O module of the Slave with Device Address equal to 1. Then, the MODBUS Address of Value should be equal to 40001.

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

√ Block Tag: Informs Tag of the block that contains the requested variable to visualize. For example, the user needs to monitor the gain value of PID block. Like this, it inserts the Tag of the PID block containing the gain parameter requested to be visualized in the MODBUS master;

√ Relative Index: It is the index of a functional block parameter which will be monitored (see the tables of the functional blocks parameters). Like this, the relative index is inserted to the required parameter to be monitored. In the case above, to monitor the gain parameter of the relative block ID, the relative index is 23;

√ Sub Index: The subIndex is used for parameters with a structure. In this case, it is necessary to indicate which element of the structure is being referred.

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

E	Element Name	Data Type	Size
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

Product Information Data Structure - DS-270

E	Element Name	Data Type	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	4
8	Base density of water	Float	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
9=Ethanol-OIML R22 (*)
10=Ethanol-NBR 5992 (*)
(*) Selecting this product type, the elements 4 to 8 of this structure don’t have function, that is, these elements are ignored, considering always the density at flowing temperature.

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 TMT 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 base temperature.

Correction for Hydrometer:
0 = without correction (default);
1= correction must be accomplished.

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, 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.

Configuration Log Data Structure - DS-273

E	Element Name	Data Type	Size
1	Tank ID (1-4=tank ID, 255=Not Specific)	Unsigned8	1
2	Block tag	Visiblestring[32]	32
3	Relative index	Unsigned16	2
4	Subindex	Unsigned16	2
5	Data type	Unsigned16	2
6	Login number (0 to 29)	Unsigned8	1
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

Notes:
Structure total size: 82bytes

Data Structure Alarm/Event of the Log Data Structure - DS-274

E	Element Name	Data Type	Size
1	Tank ID (1-4=tank ID, 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

Notes:

- 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 = Level;
4 = Density;
5 = SW;
6 = Flow in volume;
7 = Flow in mass.

Data Structure of Horizontal Tank - DS-294

E	Element Name	Data Type	Size	Range	Default
1	Average radius of cylinder [L]	Float	4	> 0	1500
2	Length of cylinder [L]	Float	4	> 0	6000
3	Plate thickness of cylinder [L]	Float	4	> 0	8
4	Average flange radius [L]	Float	4	> 0	1500
5	Average flange length [L]	Float	4	>= 0	6
6	Head type	Unsigned8	1	0 to 2	knuckle
7	Radius of knuckle (knuckle end) [L]	Float	4	>= 0	38
8	Radius of dish (knuckle or spherical end or elliptical) [L]	Float	4	> 0	3000
9	L1 (elliptical end) [L]	Float	4	> 0	435
10	Plate thickness of head [L]	Float	4	> 0	9.5
11	Gauge point from lower end [L]	Float	4	>= 0	3000
12	Tilt – elevation [L]	Float	4	>= 0	0

Head type:
0=Knuckle-dish;
1=Elliptical;
2=Spherical;

Gauge point from lower end – distance of the level measurement point in relation to the lowest extremity of the tank, as reference the main cylinder.

Data Structure of Spherical Tank - DS-295

E	Element Name	Data Type	Size	Range	Default
1	Average radius of sphere [L]	Float	4	> 0	5700
2	Plate thickness[L]	Float	4	> 0	17
3	Gauge zero shift [L] (*)	Float	4	>= 0	66
4	Bottom capacity [V]	Float	4	>= 0	0

(*) height of the measurement table

Data Structure of Dead Volume - DS-296

E	Element Name	Data Type	Size	Range	Default
1	Tank ID (0=not used, 1-4=tank ID)	Unsigned8	1	0 to 4	0
2	Deadwood type	Unsigned8	1	0 to 1	0
3	Object type	Unsigned8	4	0 to 1	0
4	Start level[L]	Float	4	>= 0	0
5	End level[L]	Float	4	>= 0	0
6	Cross section area [L*L]	Float	4	>= 0	0
7	Length of cylinder [L]	Float	4	>= 0	0

Deadwood type:
0=Deadwood;
1=Additional;

Object type:
0=Constant cross section area
1=Horizontal cylinder

Observation:

- If the object type is cylindrical horizontal, the diameter of the cylinder is defined from the difference between End level and Start level.
- Start level and End level are relative to the measurement table, that refers to "Gauge zero shift" in the spherical tank.
- It is not possible to configure additional or dead volume below the measurement table.

Bit Enumeration Descriptions

BATCH_STATUS

Bit	Meaning
0	Bad level input (LSB)
1	Override temperature used
2	Override density used
3	Override SW used
4	Extrapolated correction factor - CTL
5	Out of range correction factor - CTL
6	HTMS Method B
7	Shouldn’t receive
8	Shouldn’t deliver
9	Not stabilized
10	Out-of-range curve
11	Inconsistency
12	Configuration error
13	Configuration error of sampler
14	Out of range correction factor - CPL
15	Override pressure used

- Inconsistency: Volume of free water increases in the delivering or volume of free water decreases in the receiving. Level of free water superior to the level of the product with tolerance of 10mm. BSW out of range;
  Then:
  1) level of free water < level: calculates normally
  2) 0 <= level of free water - level <= 10mm: it not indicates inconsistency, however the level of free water is limited to the level (GOV=0)
  3) level of free water - level > 10mm: indicates inconsistency and limit the level of free water to the level (GOV=0)
- Configuration error: configuration error in the tank table of the used tank.
    - Table inexistence
    - Non monotonic
- Shouldn’t receive: This indication occurs in the following situations:
    - Inputs CLOSED_IN and CLOSED_OUT are linked and the input CLOSED_IN indicate receiving of product in “Stabilizing” or “Checking leak” or “Delivering” state.
    - In “Delivering” state, occurs increase of the level (innage) superior to the LEVEL_BAND parameter
- Shouldn’t deliver: This indication occurs in the following situations:

- o Inputs CLOSED_IN and CLOSED_OUT are linked and the input CLOSED_OUT indicate delivery of product in "Stabilizing" or "Checking leak" or "Receiving" state.
- o In "Receiving" state, occurs decrease of the level (innage) superior to the LEVEL_BAND parameter.

ENABLE_REPORT

Bit	Meaning	ATG
0	Reserved 0 (LSB)	
1	Daily report	X
2	Reserved	
3	Monthly report	X
4	Both phases	X
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-20.1 Allocation measurement
7	Reserved
8	Reserved
9	OIML R22
10	NBR 5992
11	Reserved
12	Reserved
13	Reserved
14	GPA-TP25-Tables 23E &24E-15˚C
15	GPA-TP25-Tables 23E &24E-20˚C

TM_SPEC

Bit	Meaning
0	API-12.1.1 (LSB)
1	API-3.6
2	API-2.2.E/API-2551
3	API-2552
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

TANK_DATABASE

Bit	Meaning
0	Tank 1
1	Tank 2
2	Tank 3
3	Tank 4
4	Reserved4
5	Reserved5
6	Reserved6
7	Reserved7
8	Reserved8
9	Reserved9
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

MANUAL_DATA

Bit	Meaning
0	All manual
1	FW level
2	Density
3	SW
4	Liquid Temperature
5	Reserved5
6	Reserved6
7	Reserved7
8	Reserved8
9	Reserved9
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

Note: If some variable among the FW level, Density, SW and Liquid temperature is inconsistent or out of calculation range at initial or final condition or relative to the transferred volume, then the corresponding bit will be set when generating the transfer report. Like this the user can revise the information although this information has been obtained from the instrument and therefore the report revision was not prevised.

INVERT_LIMIT_SWITCHES

Bit	Meaning
0	CLOSED_IN
1	CLOSED_OUT
2	Reserved2
3	Reserved3
4	Reserved4
5	Reserved5
6	Reserved6
7	Reserved7
8	Reserved8
9	Reserved9
10	Reserved10
11	Reserved11
12	Reserved12
13	Reserved13
14	Reserved14
15	Reserved15

MATT_BAD_STATUS_1

Bit	Meaning
0	Input 1
1	Input 2
2	Input 3
3	Input 4
4	Input 5
5	Input 6
6	Input 7
7	Input 8
8	Input 9
9	Input 10
10	Input 11
11	Input 12
12	Input 13
13	Input 14
14	Input 15
15	Input 16

MATT_BAD_STATUS_2

Bit	Meaning
0	Input 17
1	Input 18
2	Input 19
3	Input 20
4	Reserved 4
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	Low level-using first good

HTG_ALARM

Bit	Meaning
0	Level deviation
1	Density deviation
2	Bad status of P1
3	Bad status of P2
4	Bad status of P3
5	Using HTG level as backup
6	Inconsistent configuration
7	Below HEIGHT_P2
8	Below HEIGHT_P1
9	Using HTG density as backup
10	Reserved 10
11	Reserved 11
12	Reserved 12
13	Reserved 13
14	Reserved 14
15	Reserved 15

ACTIVE_ALARM1 and UNACK_ALARM1

Bit	Meaning
0	Temperature - lo (LSB)
1	Temperature - hi
2	Temperature – lo lo
3	Temperature – hi hi
4	Pressure - lo
5	Pressure - hi
6	Pressure – lo lo
7	Pressure – hi hi
8	Level - lo
9	Level - hi
10	Level – lo lo
11	Level – hi hi
12	Density - lo
13	Density - hi
14	Density – lo lo
15	Density – hi hi

ACTIVE_ALARM2 and UNACK_ALARM2

Bit	Meaning
0	SW - lo
1	SW - hi
2	SW – lo lo
3	SW – hi hi
4	Flow Volume - lo
5	Flow Volume - hi
6	Flow Volume – lo lo
7	Flow Volume – hi hi
8	Flow Mass - lo
9	Flow Mass - hi
10	Flow Mass – lo lo
11	Flow Mass – hi hi
12	Reserved
13	Reserved
14	Reserved
15	Reserved

LCF.STATUS_CURRENT

Bit	Meaning
0	Override temperature used (LSB)
1	Override pressure used
2	Override density used
3	Override SW used
4	Bad status of pulse input
5	Block in O/S
6	Reserved6
7	Reserved7
8	Extrapolated CTL
9	Out of range CTL
10	Process alarm
11	Bad flow input/ Pulse Error
12	Reserved12
13	IV rollover/ Abnormal condition
14	Stop totalization
15	Out of range CPL

Chapter 10

ADDING BLOCKS

CHANNEL and STRATEGY Allocation (Tank ID)

CHANNEL Configuration

The CHANNEL parameter identifies the physical input or output point associated to the function block.

The AuditTank 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 AuditTank 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;

- **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 AuditTank 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 TM302 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 TM302 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.

STRATEGY Configuration

The STRATEGY parameter of some blocks in the TM302 identifies the run number, such as:

- Change in the configuration (blocks AI, TT, ATT, STG,...) 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 (STGV) identify the run number using the STRATEGY parameter of the STG block;

STRATEGY Allocation

The consistence check prevents two blocks STG using the same STRATEGY (“run number”).

Note
It is always allowed to set the STRATEGY parameter to zero.

Value range to configure the STRATEGY parameter in the TM302 specific blocks:

STRATEGY	Block Types
255 (read only)	TMT, STD, STGR, TWTR, TWT, ATV, AEV, STGV, TWTV
0-16 (read only)	TT
0-4 and 255	ATT,
0-4	STG

Recommendations to Configure the TM302

1. Adjust the macrocycle of all TM302 H1 channels with the same value.

2. Remember that the download of TM302 only will be on the download of the "Main Fieldbus" channel ;

3. Create the TM302 blocks in this order: RS, TMT, HC, etc.

4. After the firmware download or reset mode 1, the TM302 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 TMT.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 TM302 and its H1 Foundation Fieldbus device, execute the download of each one H1 channels, starting for the Main Fieldbus

7. It is recommended to update the Real Time clock in the TM302 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.

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.

- ALERT_KEY: identifies the type of the variable submitted to the alarm processing.

  0 = None;
  1 = Temperature;
  2 = Pressure;
  3 = Level;
  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 TMView.

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.

Discrete Alarm Configuration (Electronic Seal)

The input and output 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: condition of the discrete alarm which the alarm will be generated;
- DISC_PRI: 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 11

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 TMT 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 TMT.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 at the Index column in the parameters table.

Communication Restriction

The user must logon to the system to change the AuditTank configuration using:
• Syscon.
• TMView.
• 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 AuditTank system saves the configuration log in the device's NVRAM memory.

Logger Mechanism

The AuditTank mechanism for audit trail has the following features:

- The TM302 module saves the information in the NVRAM memory to generate the reports in TMView, classified by the following types:

    - QTR: custody transfer reports (ticket);
    - Configuration log;
    - Process alarm and event reports;
    - Well Test reports.

- The logger uses the TM302 NVRAM memory independent from the visualization blocks (STGV, TWTV, ATV and AEV), 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 TMView 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 TM302 memory to the database.

- If when the transfer report is generated, TM302 still to need of values that depend on laboratory analysis or manual reading, then the report will be stored with status "Pending", that is, the user should complete this report with such information. At this time, the report will be calculated again for TM302 and if is consistent, then the report will have its status changed to "Not-stored";

- Reports that have been generated with data pending and be still in the memory of TM302, will be revised at any moment even if stored in database. In this case, the report will be calculated again for TM302, the status will be changed of "Stored" to "Not-stored" and then read for TMView. The two revisions of the same report will be stored in the database and they are distinguished among other information, for the parameter REPORT_REV;

- TM302 can automatically print a report/register while saving in the database (this option is configured in TMView).

- Even after changing the report/register status to "Stored" in the logger (after saving to the database), the report/register continues in the TM302 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 TMView. Refer to the TMView 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 TM302 memory.

- There is a mechanism that allows only one specific computer running TMView to transfer the reports/registers from the TM302 to the database. While TMView is storing the information from a specific TM302, the value of the parameter TMT.TMVIEW_VSN is confronted with the Volume Serial Number of the computer HDrunning TMView.

Report Persistence in the AuditTank 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 TMView, and consequently changing the status to Stored, the register/report remains in the NVRAM memory.

- The TM302 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 TMT.CLEAR_LOG parameter allows the initialization of all logger.

- The initialization of the logger occurs in two situations: 1) under the user's demand through the parameter TMT.CLEAR_LOG; 2) when detected an abnormality in the control variables of the logger or in the own report/register.

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 TM302;

- Disable the local tuning, removing the jumper from the Smar transmitters.

- AuditTank system provides restricted access and stores the configuration change of all Smar Foundation Fieldbus transmistters.

Events Registered

The following events are registered in the logger:

- TM302 power up
- TM302 power down
- Override temperature used
- Override temperature cleared
- Override density used
- Override density cleared
- Override SW used
- Override SW cleared
- Configuration download
- Initialization of loggers
- Start of daylight saving
- End of daylight saving
- Restore of loggers by TMView
- TM302 - too high temperature – occurred
- TM302 - too high temperature – cleared
- TM302 - low voltage battery – occurred
- TM302 - low voltage battery – cleared
- Bad level – occurred
- Bad level – cleared
- Inconsistent STGV
- Inconsistent TWTV
- Inconsistent ATV
- Inconsistent AEV

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 TM302 and, consequently, in the configuration change report printed by TMView.

Reports/Registers Provided by TM302

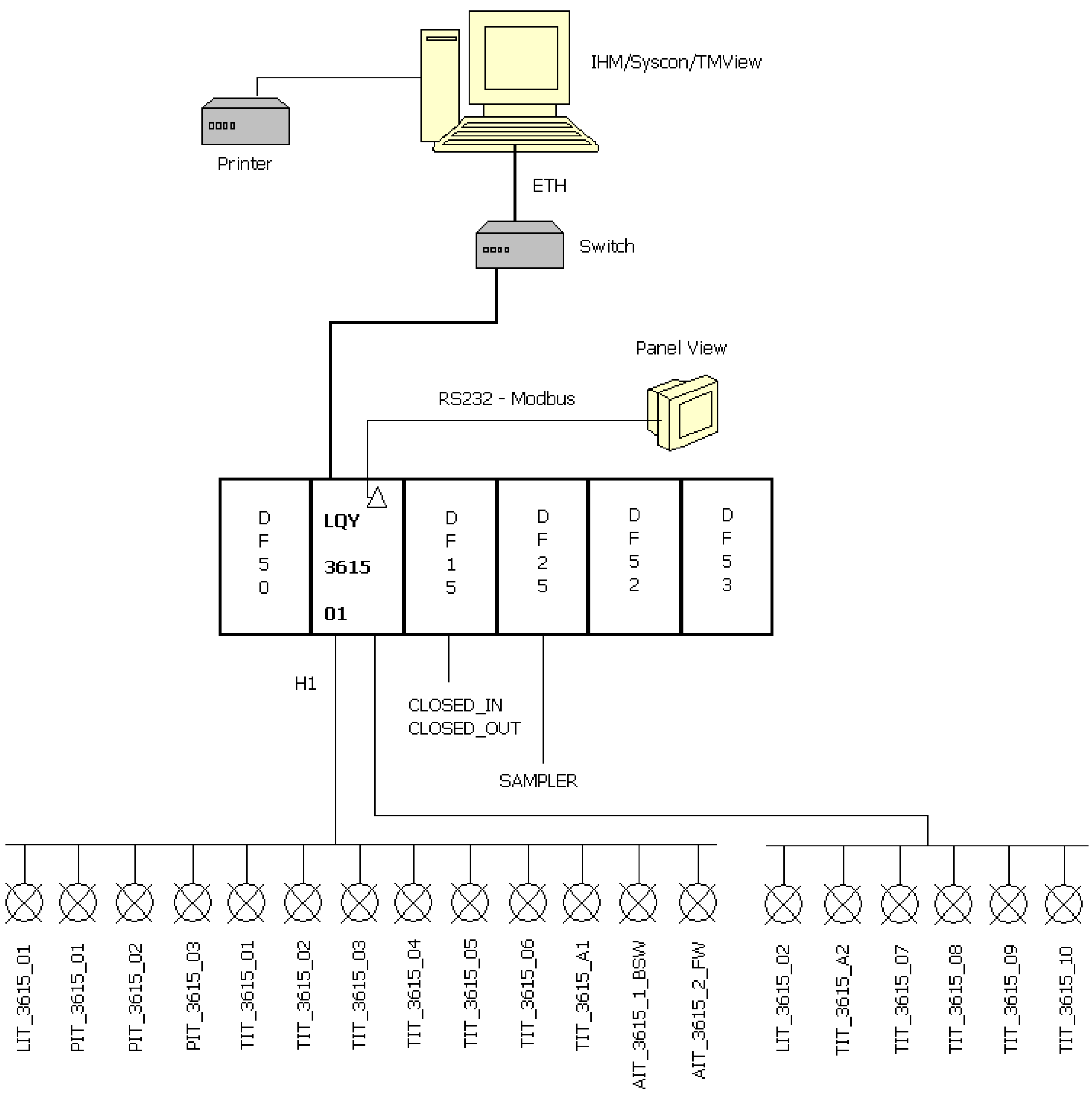
The TM302 NVRAM memory provides the following number of registers/reports:

Report Type	Quantity of Reports/Registers
STGV	600
TWTV	10
ATV	300
AEV	300

Chapter 12

TANK MEASUREMENT APPLICATIONS

Application 1: Custody Transfer Measurement of Crude Oil and Well Test

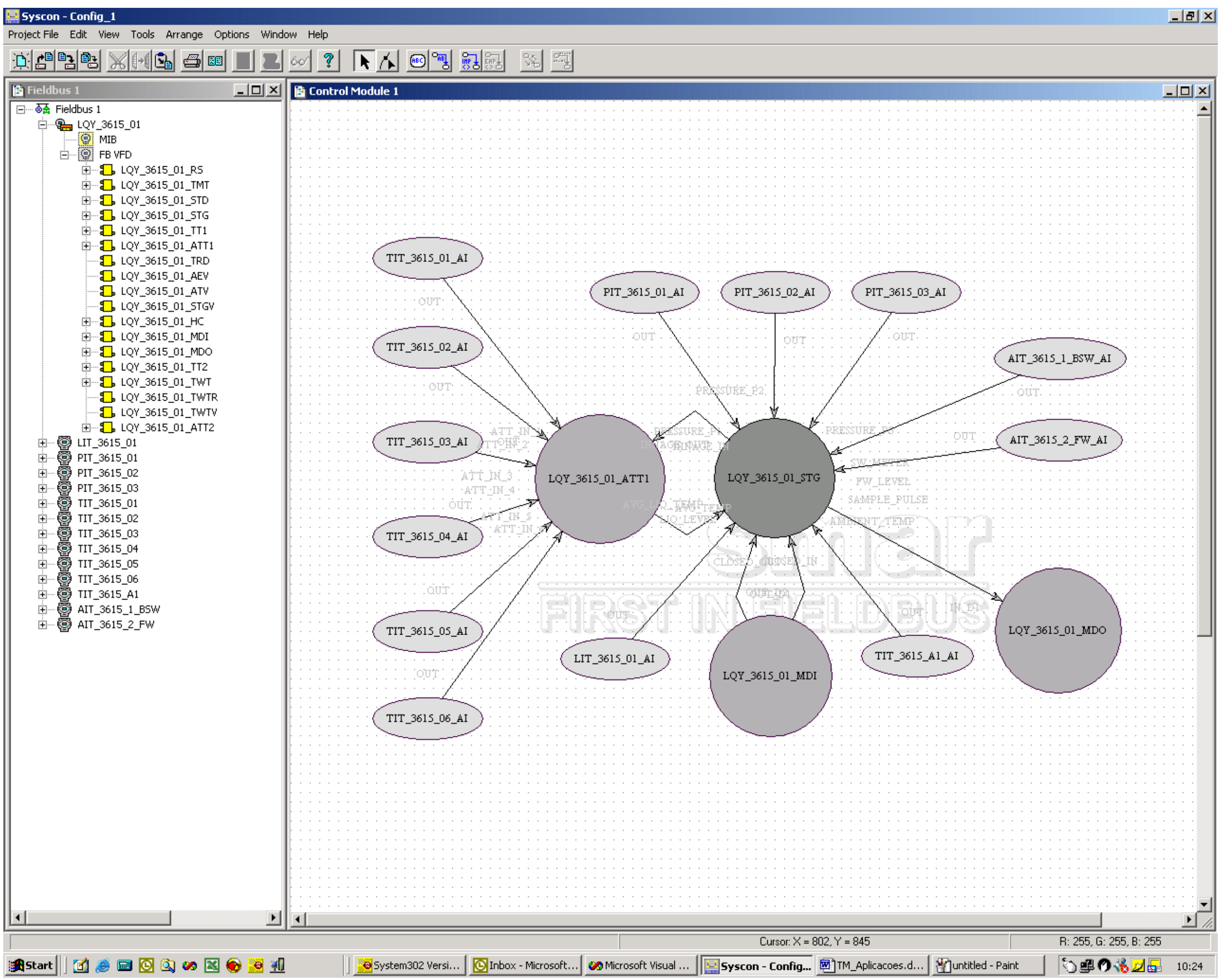


System of custody transfer measurement of crude oil (Tank TQ_3615_01) defined in the product delivery and well tests (Tank TQ_3615_02).
Syscon/TMView/Supervisory communicating via OPC Server + Ethernet.

Fieldbus 1 - Tank TQ_3615_01: Custody Transfer Measurement of Crude Oil

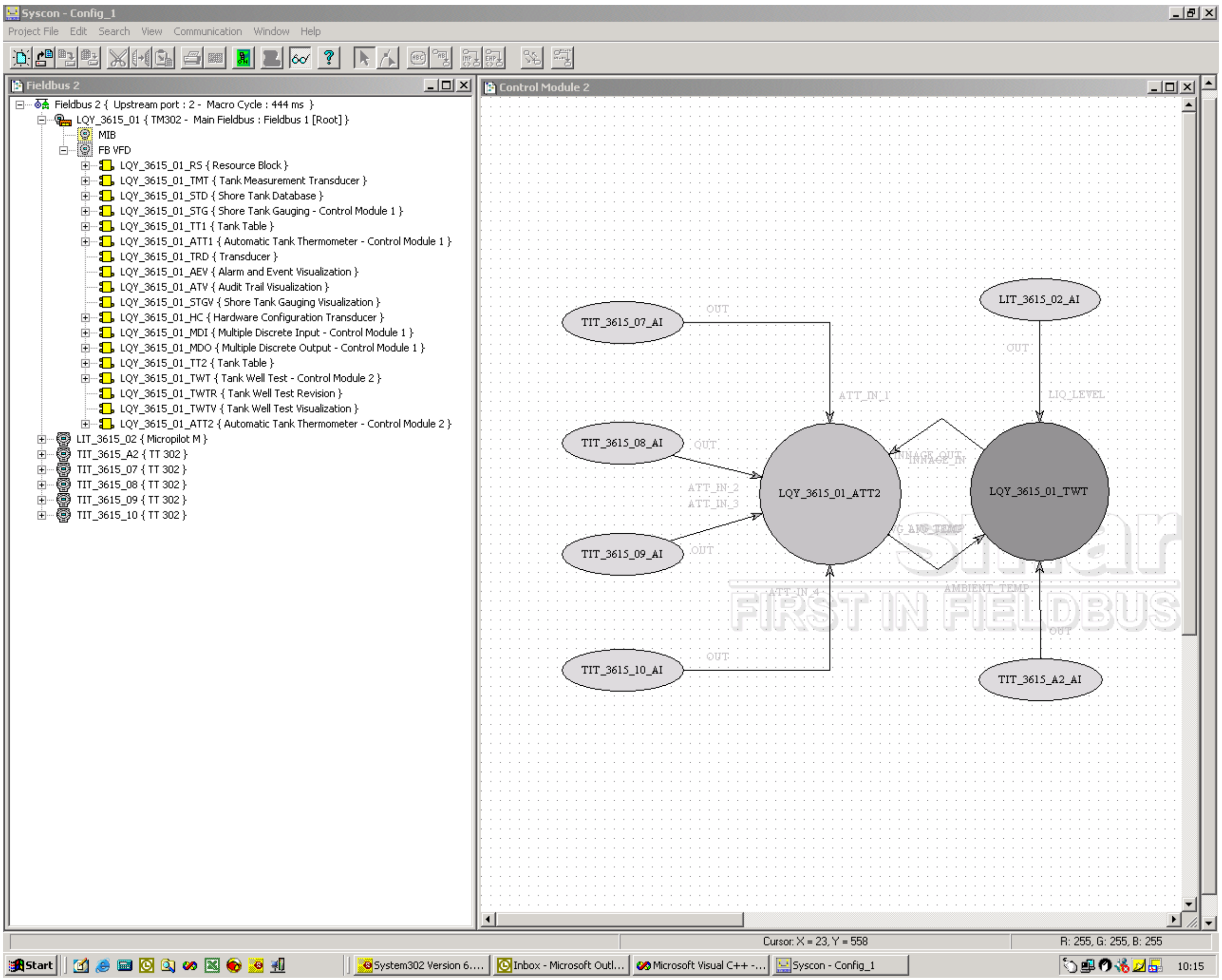
- Measurement system of liquid temperature composed of six thermo sensors internal to the tank and one measurement of ambient temperature external to the tank.
- Level measurement (outage) obtained from radar;
- Calculation of the liquid density in the tank via Hybrid System (HTMS 1) and HTG system as backup of the level input and of the calculated density. Like this, three measurements of gauge pressure are effectuated;
- Other transmitters: BSW measurement in line and measurement of the free water level (FW);
- Automatic operation mode: transitions of the receipt/delivery phases determined for the signals of the limit switch of the input and output valves of the tank;
- Sampler control;
- Syscon/TMView/Supervisory communicating via OPC Server + Ethernet.

Configuration



Fieldbus2 - Tank TQ_3615_02: Well Test

- All the inputs are manual, except for level (outage) and ambient and liquid temperatures.



Comments

Fieldbus 1 - Tank TQ_3615_01: Custody Transfer Measurement of Crude Oil

- The AI blocks from the BSW, free water level, liquid level and temperature transmitters transfer the measurements to the STG block in the TM302, which calculates the volume and the mass of the transferred liquid and it supplies the information referent to the situations of the tank at the beginning and end of the transfer.

- The MDI block receives the signals from the limit switch of the input and output valves of the tank and sends these to the CLOSED_IN and CLOSED_OUT parameters of the STG block for automatic operation of the receipt/delivery cycles;

- The SAMPLE_PULSE output of the STG block is sent to the module of digital output and it requests to the sampler a sample of the measured product;

- AEV, ATV and STGV blocks provides the mechanism to transfer the information from the logger in the TM302 memory to the database.

Fieldbus 2 - Tank TQ_3615_02: Well Test

- The AI blocks from the liquid level and temperature transmitters transfer the measurements to the TWT block in the TM302, which calculates the volume and the mass of the transferred liquid and it supplies the information referent to the situations of the tank at the beginning and end of each hour of the test.

- Through the writing in TEST_STATE parameter of the TWT block, the user controls the receipt/delivery cycles ;

- Through the TWTR block, the user can supply manually the density values, level of free water and BSW. However, it should find the respective pending report in the TWTR block and to write the "Reedit" option in the REV_CMD parameter.

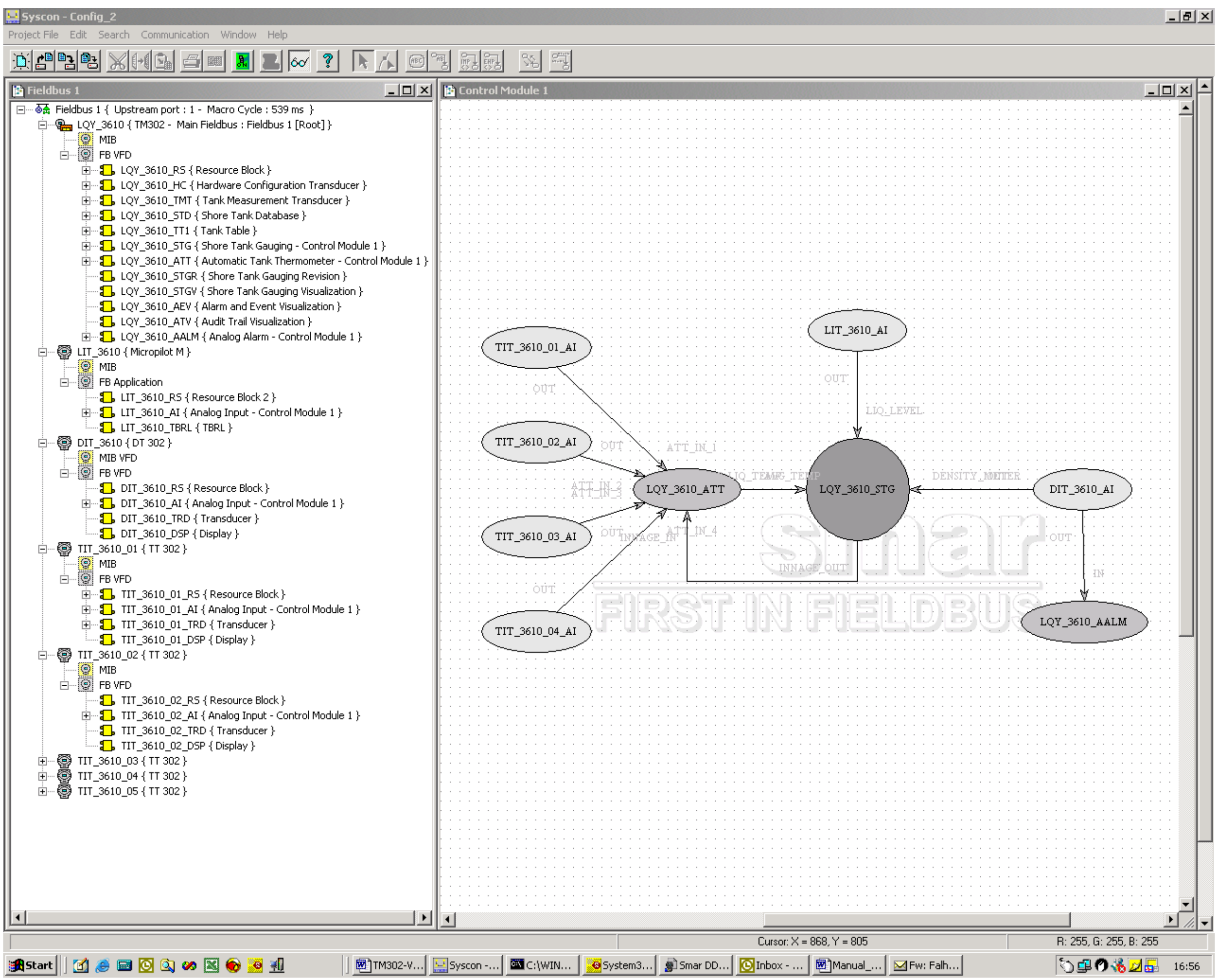
This configuration file is installed in the folder:
\Program Files\Smar\Syscon\Samples\TM302\Oil Production

Application 2: Measurement of Petroleum Derived

- Transfer measurement system of petroleum derived products defined in the product delivery.
- Measurement system of liquid temperature for four thermo sensors internal to the tank and a measurement of ambient temperature external to the tank.
- Level Measurement (outage) obtained from radar;
- Density measurements and BSW in line on the tank output; input of the free water level in manual mode. Operation mode: transitions of the receipt/delivery phases by the user.
- Alarm configured to indicate density of the product out of specified range.

Syscon/TMView/Supervisory communicating via OPC Server + Ethernet.

Configuration



Comments

- The AI blocks from the free water level, liquid level and temperature transmitters transfer the its measurements to the STG block in the TM302, which calculates the volume and the mass of the transferred liquid and it supplies the information referent to the situations of the tank at the beginning and end of the transfer;

- Through the writing in STG_STATE parameter of the STG block, the user controls the receipt/delivery cycles ;

- Through the STGR block, the user can supply manually the initial and final values of the free water level and BSW of the liquid in tank. However, it should find the respective pending report in the STGR block and to write the "Reedit" option in the REV_CMD parameter;

- AEV, ATV and STGV blocks provides the mechanism to transfer the information from the logger in the TM302 memory to the database.

This configuration file is installed in the folder:
\Program Files\Smar\Syscon\Samples\TM302\Refined Products

Application 3: Simulation of Crude Oil Transfer

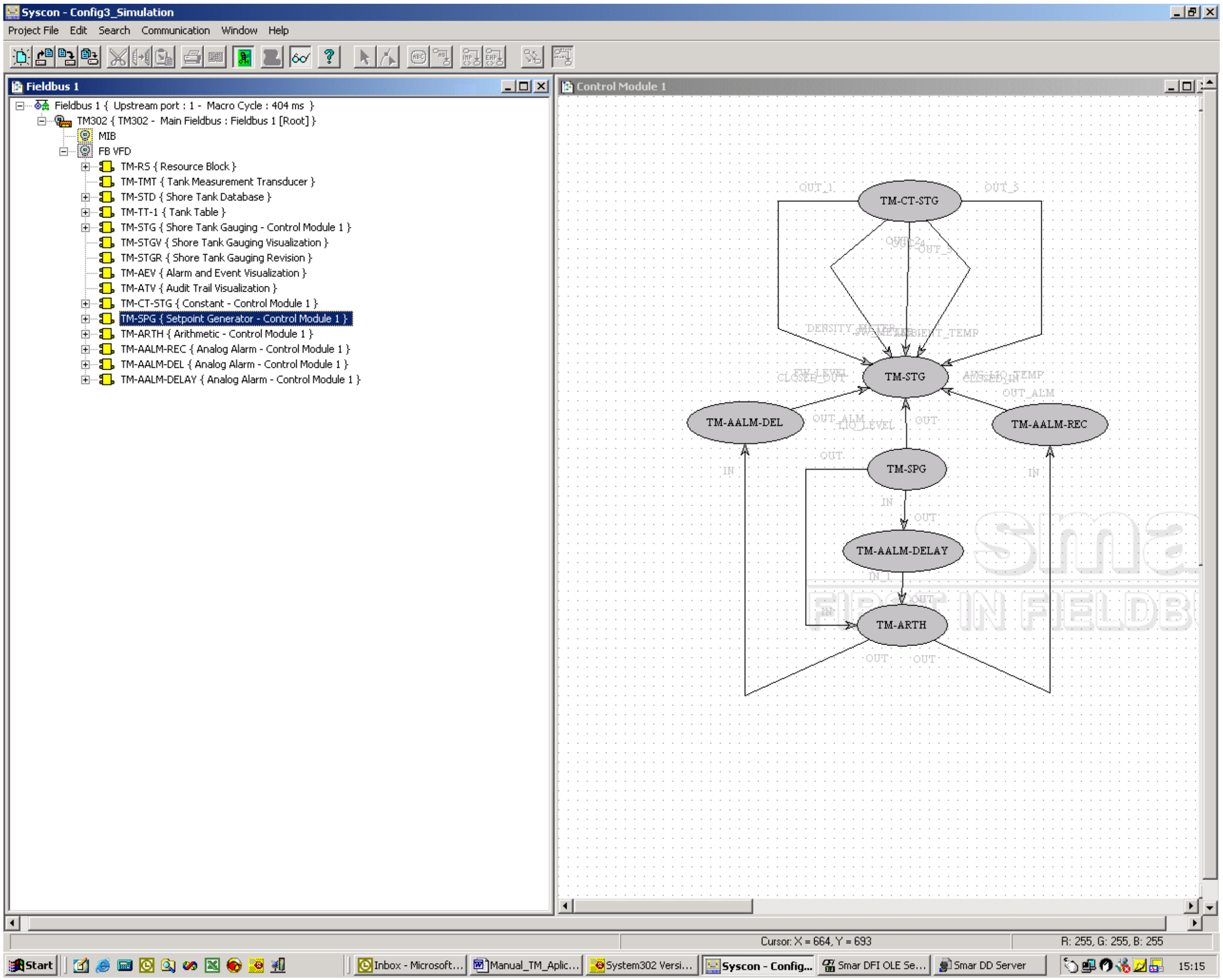
- Configuration to simulate the receipt and delivery cycles, where the level (outage) is generated for the SPG block. The control at beginning of the receipt and delivery cycles is in automatic mode in the STG block, where the CLOSED_IN and CLOSED_OUT inputs are controlled via logic that detect if the level is increasing or decreasing. To implement this logic, the ARTH and AALM blocks were used;

- To start the simulation, initially the block SPG (RESET_IN parameter) should be restarted, so that the SPG_STATE is in "Ready". Then, set the parameter START of the SPG in order to vary the simulate level;

- The temperature, level of free water, density and BSW inputs are simulate for the constant blocks (CT) linked to the STG block.

Syscon/TMView/Supervisory communicating via OPC Server + Ethernet.

Configuration



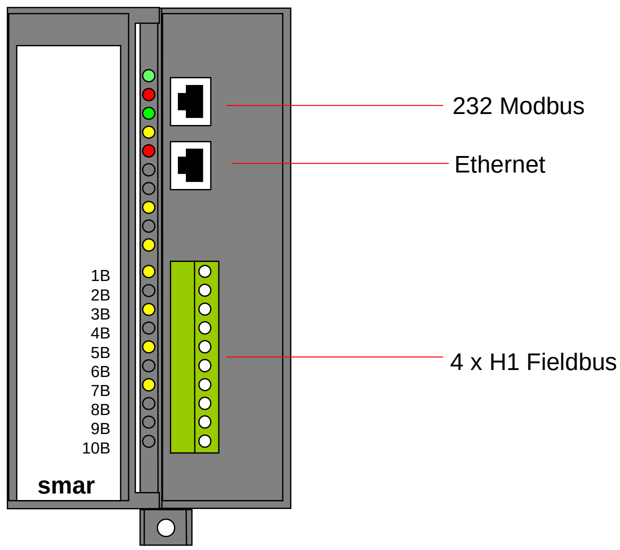
This configuration file is installed in the folder:
\Program Files\Smar\Syscon\Samples\TM302\Simulation

Chapter 13

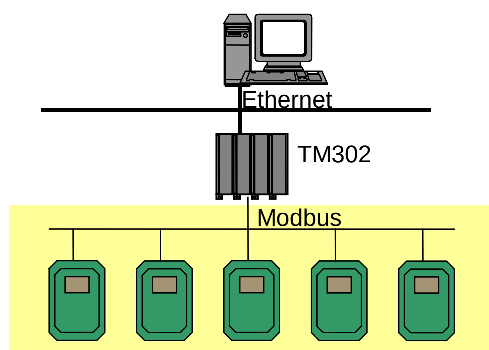
ADDING MODBUS

Introduction

An existent plant can be commuted to the Fieldbus protocol using several features implemented in **AuditTank**, not requiring large investments in instruments. The serial communication port is one of these features in the controller module that connects **AuditTank** 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 **TM302** 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 **TM302** processor module, it is necessary to use a separated module (DF58) only when a port 485 is necessary.



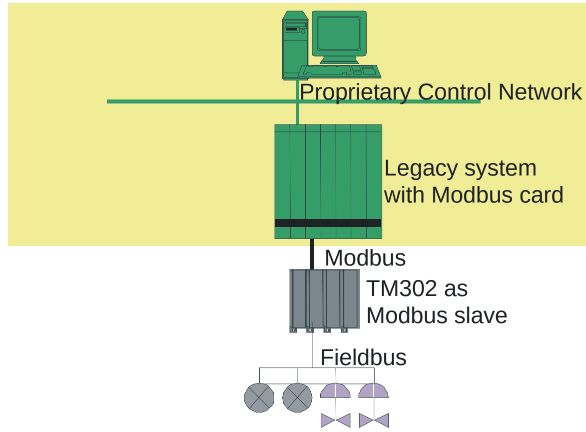
In Master mode, the **TM302** can read and write data to the Modbus slaves.



The **TM302** 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 **TM302** as a gateway.

The **TM302** data can be read or written by the Master, when the **TM302** 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 **TM302**, 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.

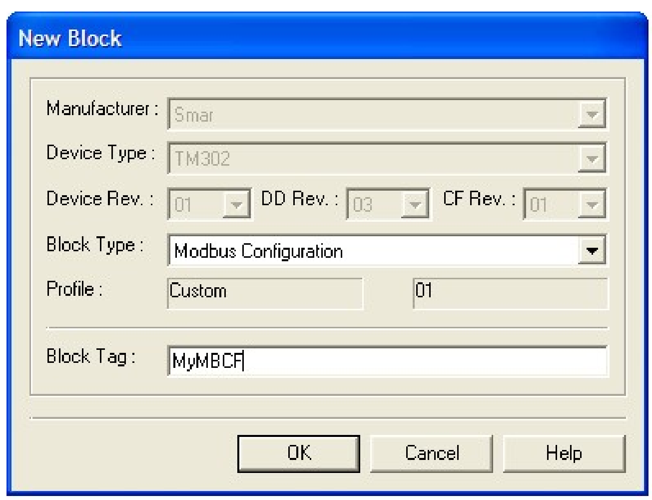
It is easy to use the Modbus port. No DIP switch has to be activated to configure the Modbus port. A status LED in the front panel indicates the communication is active.

Configuring the Modbus

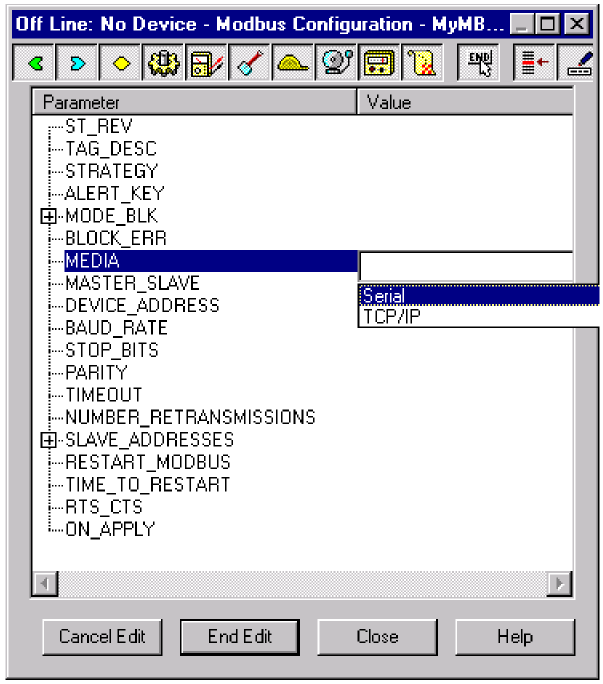
The **TM302** uses Syscon to configure all the necessary functions, including Modbus. Refer to the chapter "Adding Blocks" for further information on how to add Function Blocks to the Syscon configuration. Remember that Modbus function blocks are available in different DD Revisions.

1) To include the Modbus functions in the **TM302**, 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.

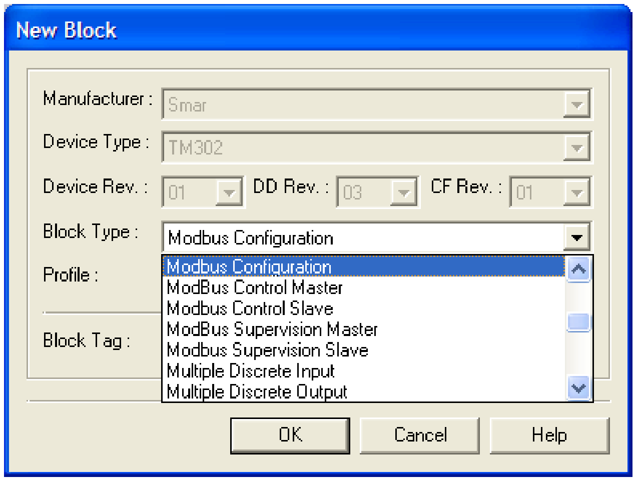


Parameter	Valid Range/ Options	Default Value	Description
ST_VER		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1to 255	0	
MODE_BLK		O/S	
BLOCK_ERR			
MEDIA	0:Serial, 1:TCP/IP	Serial	Define the Modbus channel type.
MASTER_SLAVE	0:Master, 1:Slave	Slave	Define if the TM302 is the master or slave.
DEVICE_ADDRESS	1-247	1	Define the TM302 Modbus address (only for a TM302 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 TM302 Master) or waiting time to update the outputs (for a TM302 Slave). It is disable when the value is 0.
NUMBER_RETRANSMISSIONS	0-255	1	Number of re-transmission, if the TM302 doesn't receive an answer from the slave.
SLAVE_ADDRESSES			IP Number and Modbus address of the slaves (only for a TM302 Master in TCP/IP channel).
RESTART_MODBUS		FALSE	Indicated if after occurs a communication failure with the slave, there will be a new transmission after the time defined in TIME_TO_RESTART (only for TM302 master).
TIME_TO_RESTART	1-65535	1	Time to restart the communication with the slave.
RTS_CTS		FALSE	Enable or disable handshaking.
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.

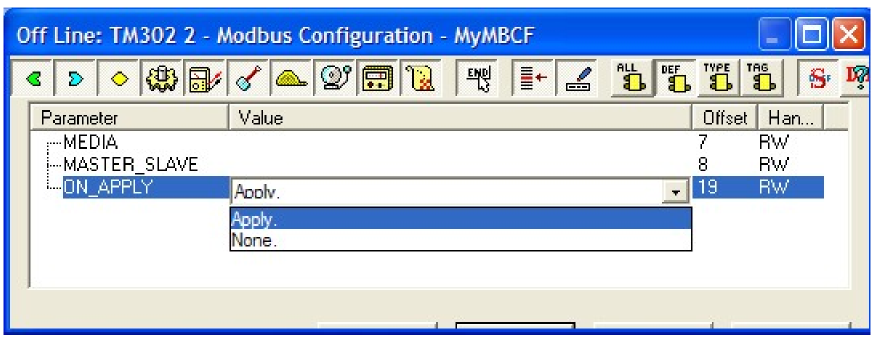
When using the RS-232, install the DF58 module (RS232/RS485 Interface Module) if it is necessary to communicate with more than one Modbus instrument, that is, in a Multipoint Network. Refer to chapter "Adding Interfaces".

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 **TM302**, 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.

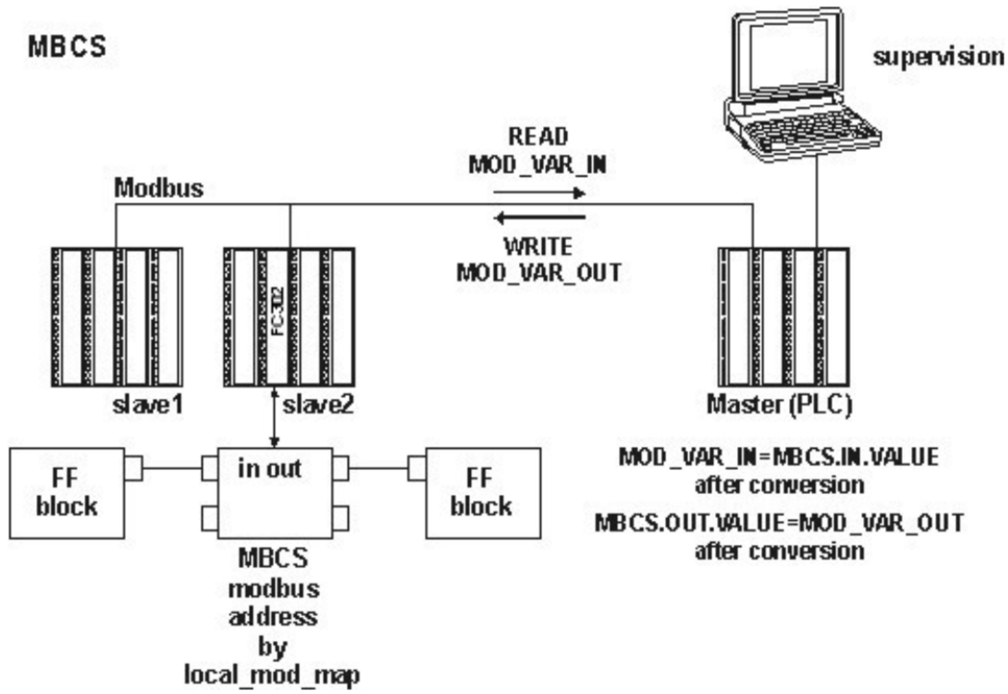


Other important parameter that should be defined for all blocks is LOCAL_MOD_MAP (0 ~ 15). Sixteen blocks are accepted for functionality and this variable identifies each function. For MBSS and MBCS blocks, the LOCAL_MOD_MAP parameter specifies the Modbus Slave address. A value 255 (default) does not permit the block runs.

The following views (1 to 4) summarize some of the applications that can be implemented using the **TM302** Modbus Functions.

View 1 - MBCS

A Modbus Master Instrument wants to read and/or write to the Modbus registers of the TM302, 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_VER		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1 to 255	0	
MODE_BLK		O/S	Refer to the Mode Parameter.
BLOCK_ERR			
LOCAL_MODE_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.
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 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 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 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 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 elements, used in the output parameters, define the following rules for the OUTPUT STATUS parameters:

- Once the user defines this element 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

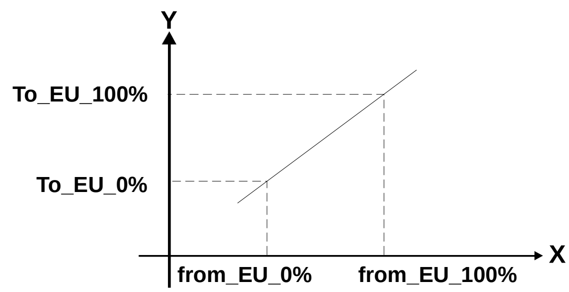
Data Type Number	Data Type Format
6	Integer16
7	Integer32

Procedure to convert FF parameter to Modbus variable:

Load IINn_ 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%

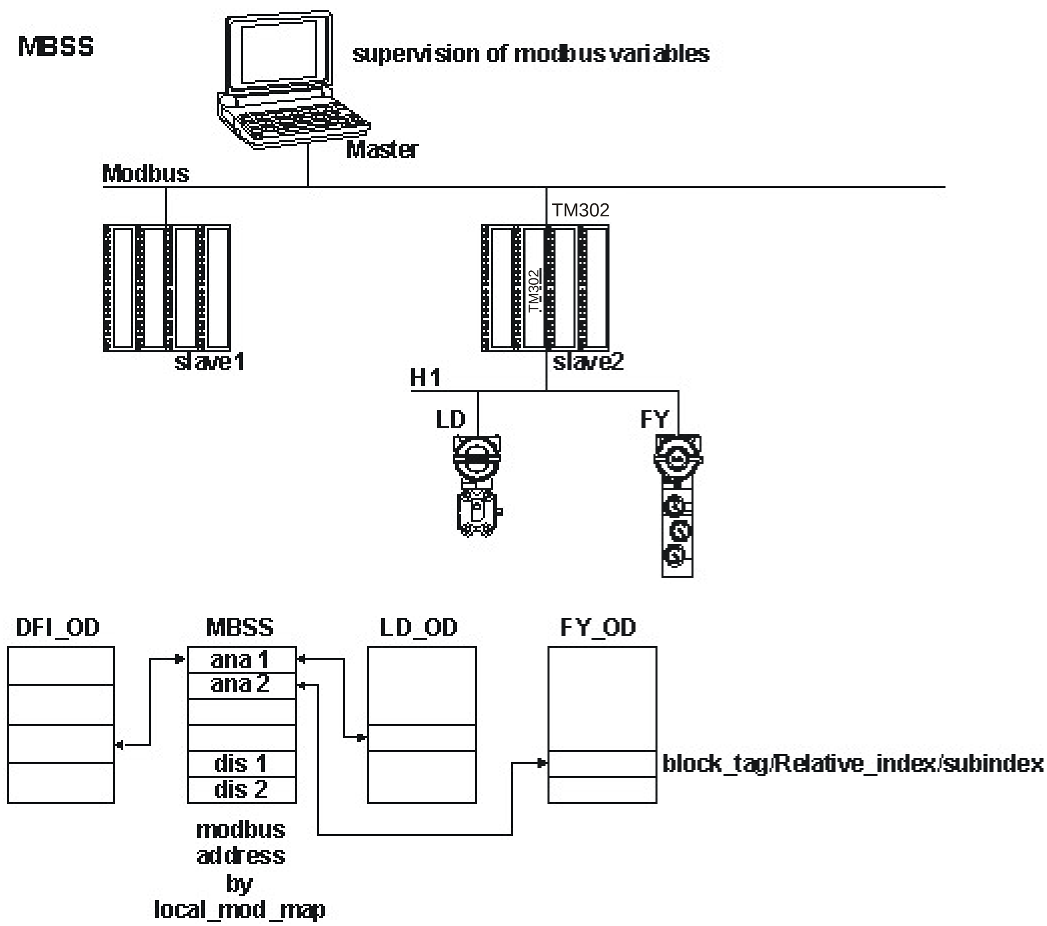
Inn_VALUE, OUTx_VALUE: FF parameter.
MOD_VAR_IN, MOD_VAR_OUT: MODBUS variable.
Y: auxiliary float variable

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 TM302, 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_VER		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.
F_ID1			Information to locate the float parameter.
FVALUE1		0	Value of the requested float parameter.
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.

Index Relativo: 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).

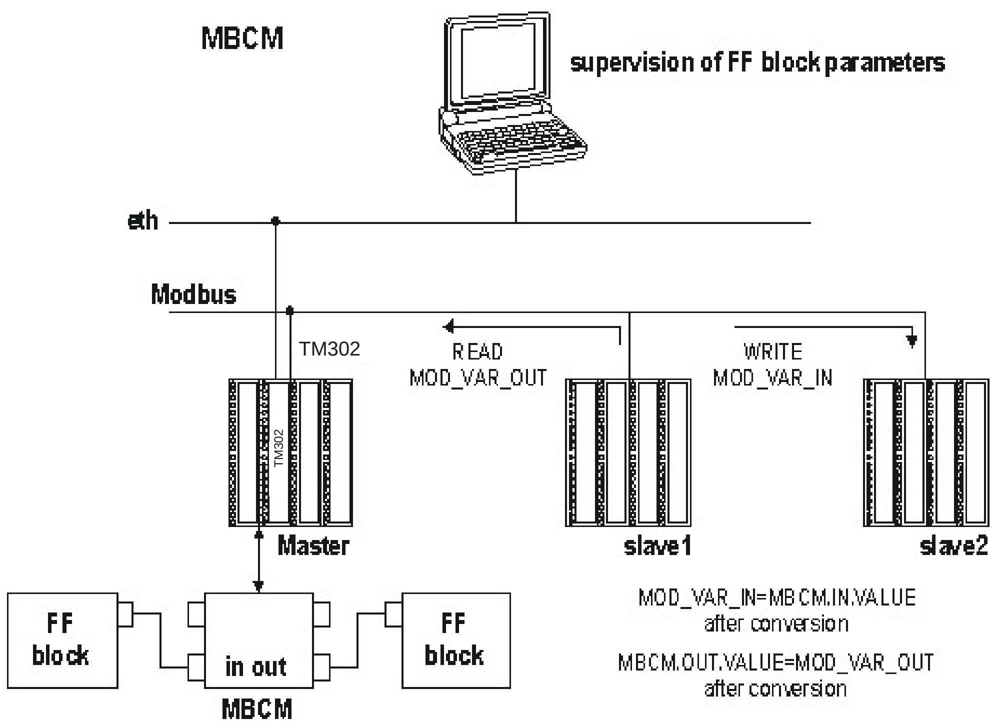
The IVALUEx parameters can address FF parameters for the following data types: Integer8, Integer16, Integer 32, Unsigned 8, Unsigned 16 and Unsigned 32.

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.

View 3 – MBCM

A Modbus Slave Instrument needs to sent and/or receive Modbus registers from the TM302, 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	Valid Range/ Options	Default Value	Description
ST_VER		0	
TAG_DESC		Spaces	
STRATEGY		0	
ALERT_KEY	1 to 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.
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.

Note

The MODBUS_ADDRESS_OF_STATUS elements define the following rules for the OUTPUT STATUS parameters:

- When the user defines this element 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 element 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.

Inputs and Outputs

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 Fromat
1	Float
2	Unsigned 8
3	Unsigned 16
4	Unsigned 32
5	Integer8
6	Integer16
7	Integer32

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)
Input (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.

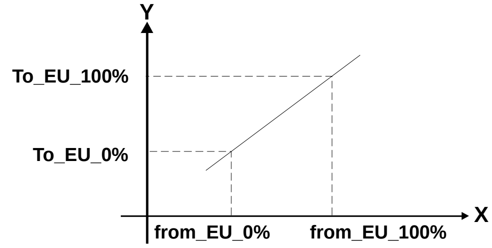
Procedure to convert FF parameter to Modbus variable:

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

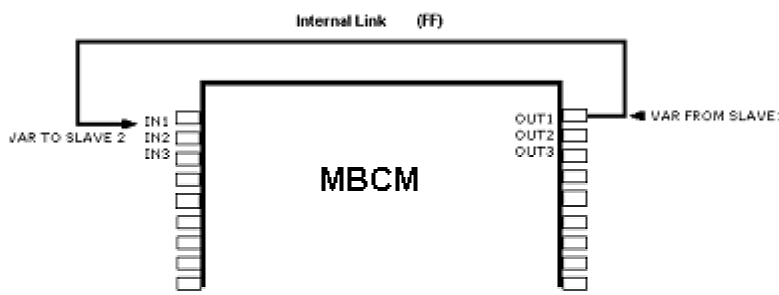
To read a Modbus variable, connect the variable to an output of the MBCM function block. To write to a Modbus register, connect the register to an input of the MBCM block.

Usually, Modbus addresses are:

0001 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 this status. If the communication with the specific parameter is good, 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

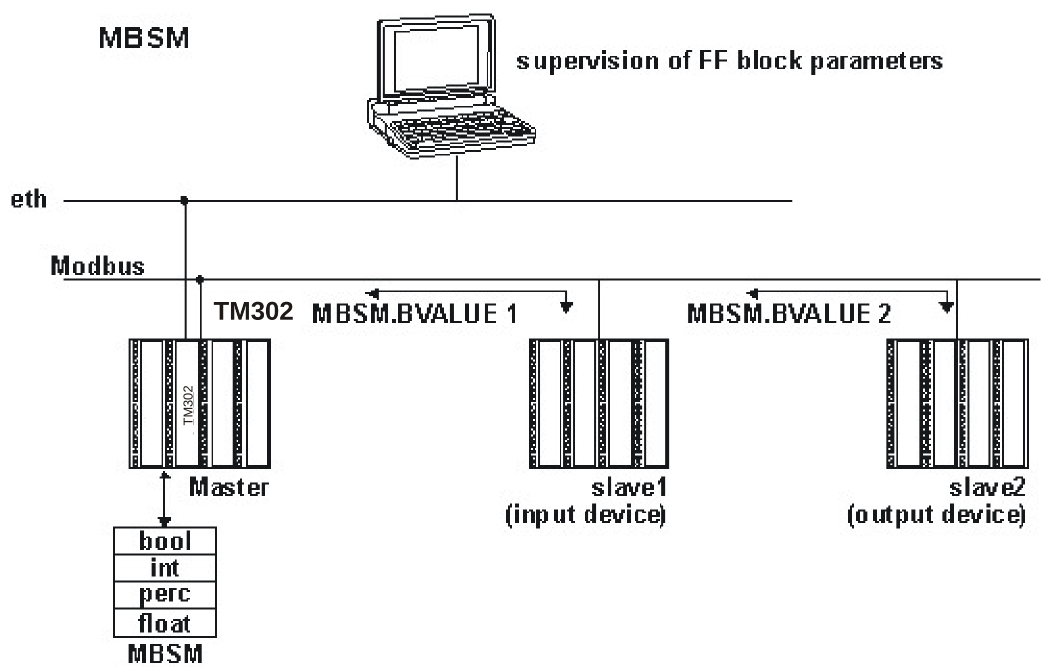
Bit	Variable
0	IN1
1	IN2
2	IN3

Bit	Variable
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 TM302, 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_VER		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.
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 boolean parameter.
BVALUE7		TRUE	Value of the requested address.
BLOCATOR8			Information to locate 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 MBSM 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

- 0001 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	Integer 8
6	Integer 16
7	Integer 32

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.

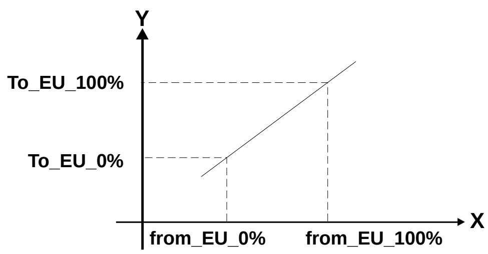
Procedure to convert FF parameter to Modbus variable:

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 (do 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 this 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

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

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

MBCS		
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		
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.

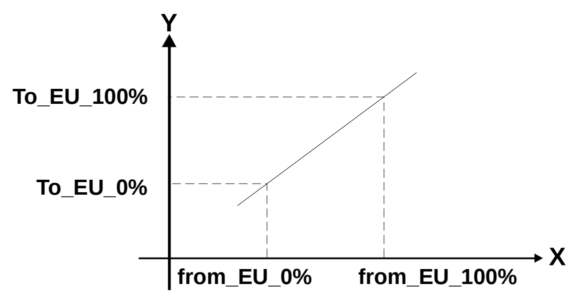
Modbus Commands

When the TM302 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 TM302 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 TM302 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	De EU 100%	Float	4
2	De EU 0%	Float	4
3	Para 100%	Float	4
4	Para EU 0%	Float	4
5	Tipo de Dado (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	Unsigned8	1

Chapter 14

TMVIEW

Overview

The TMView is the software tool used during the operational phase, that is, after the installation, configuration and start up of the tank measurement system.

The main functionalities provided by TMView are:

- Monitoring and writing parameters of main blocks without any configuration for TMView: ATT, TT, STD, STG, STGR, TMT, TWT and TWTR.
- Total parameterization of the TM302 configuration blocks.
- Report: Transfer of the reports from the TM302 memory to the database, through task executed in background.
- Database navigation and directly from the TM302 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 TMView

The TMView can be started from Start menu, because it is installed inside the Smar menu.

When starting the TMView 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 TMView. 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.

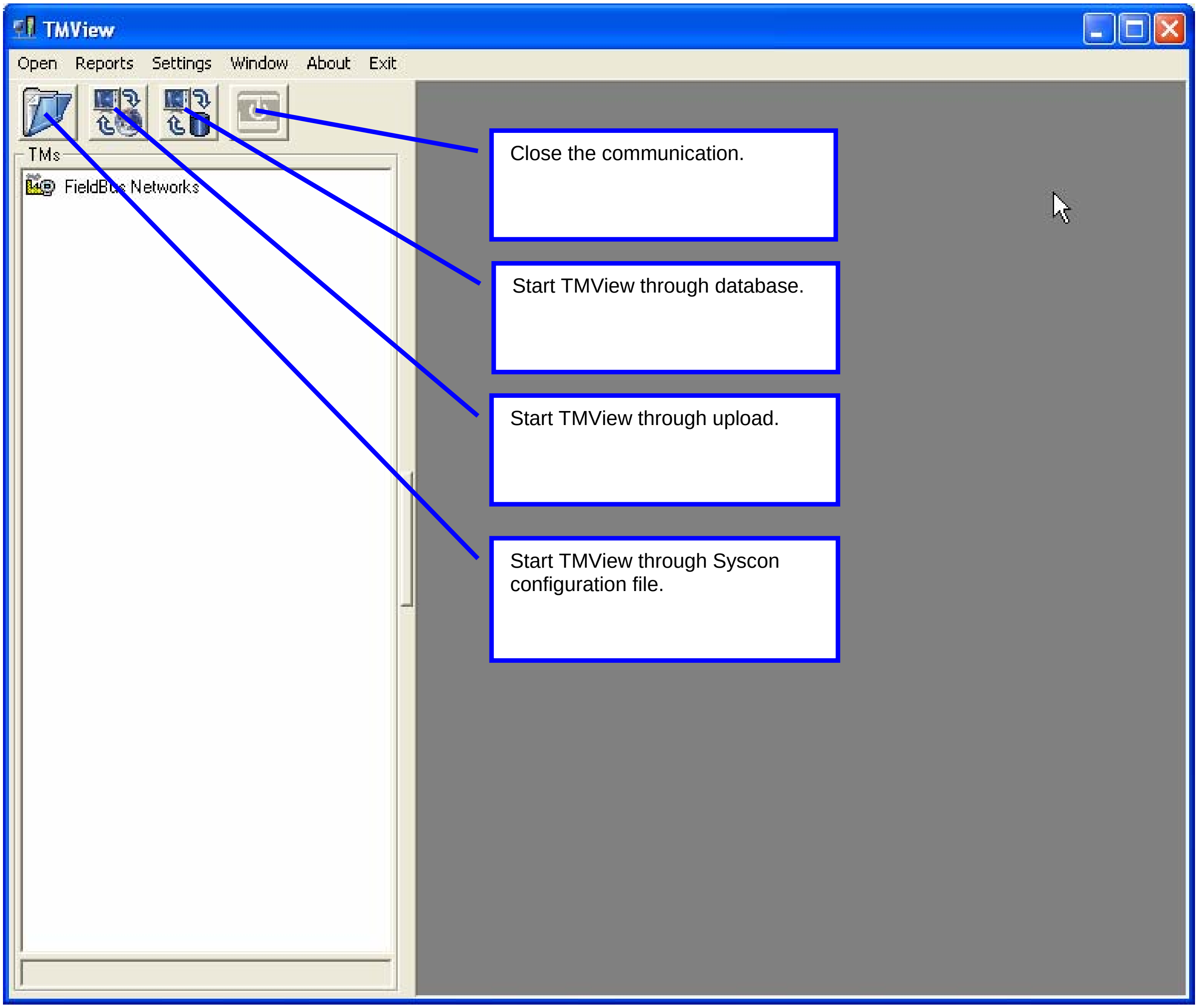


Figure 2

Register

The register process is the first procedure to be executed in the TMView after the installation. In this process, the TMView prepares the database to communicate with TM302. In the device, blocks and parameters of the TM302 and of the all devices on the bridge channels are registered which are essential to communicate with the device.

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 TMView, 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.

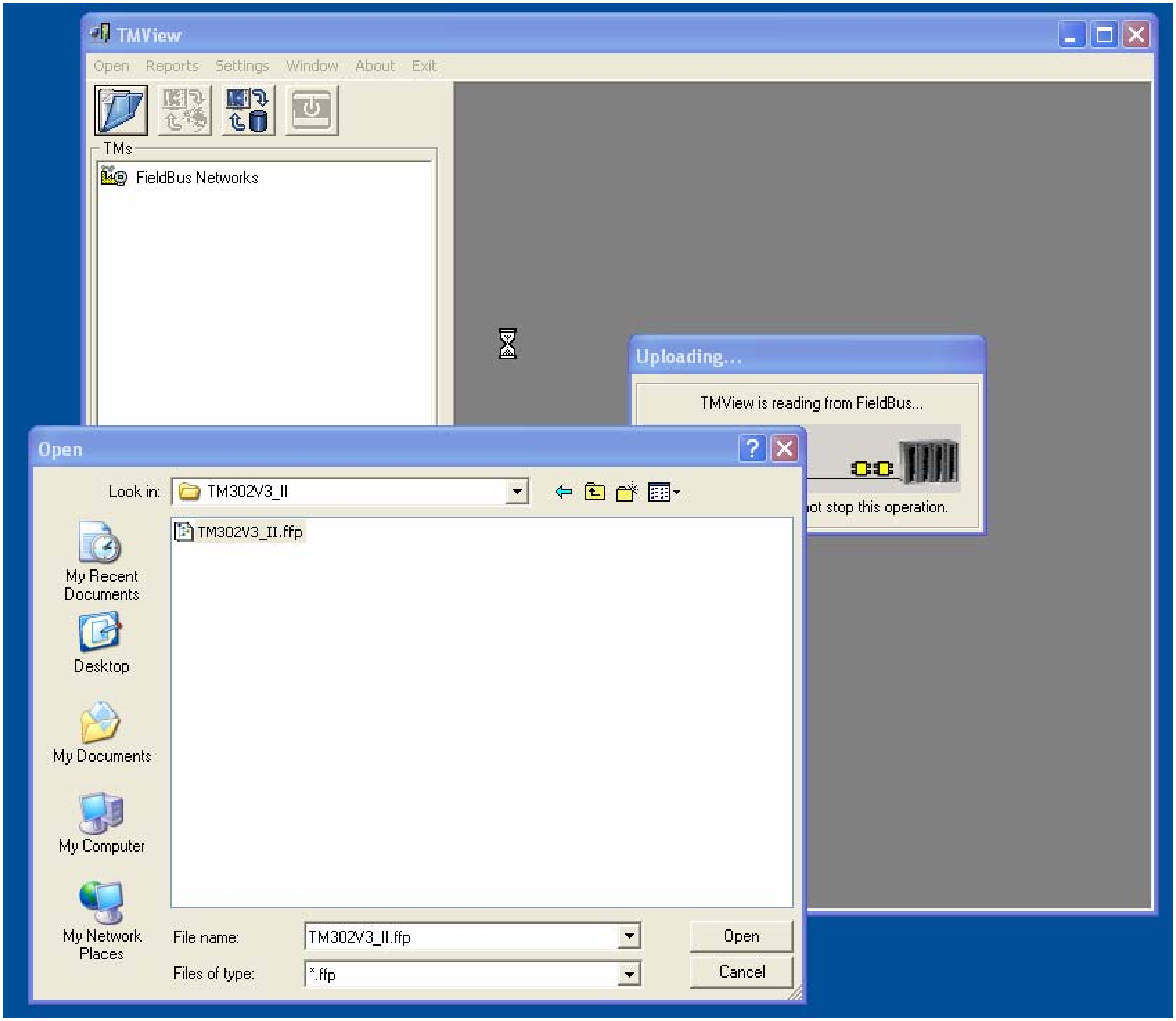


Figure 3

If the process was initiated by upload, click on **Open→ from Upload**, the upload process begins and after the acknowledgment of all TM302's of the network, must select the bridges.

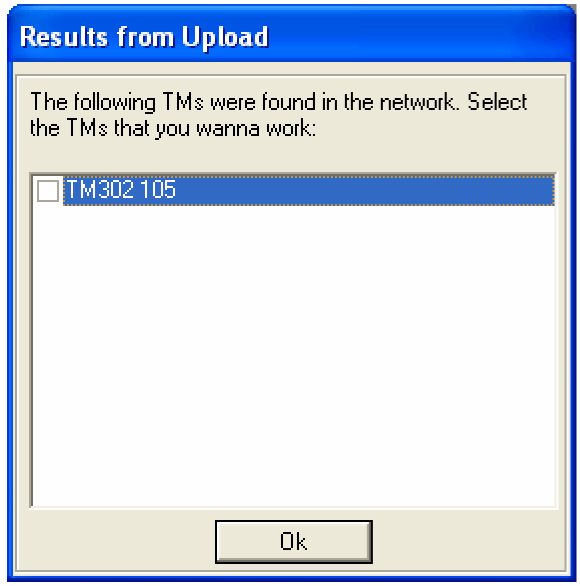


Figure 4

When opening the configuration file or executing upload, TMView checks the topology and filtering all the devices, keeping only those which have the information about operation and reports.

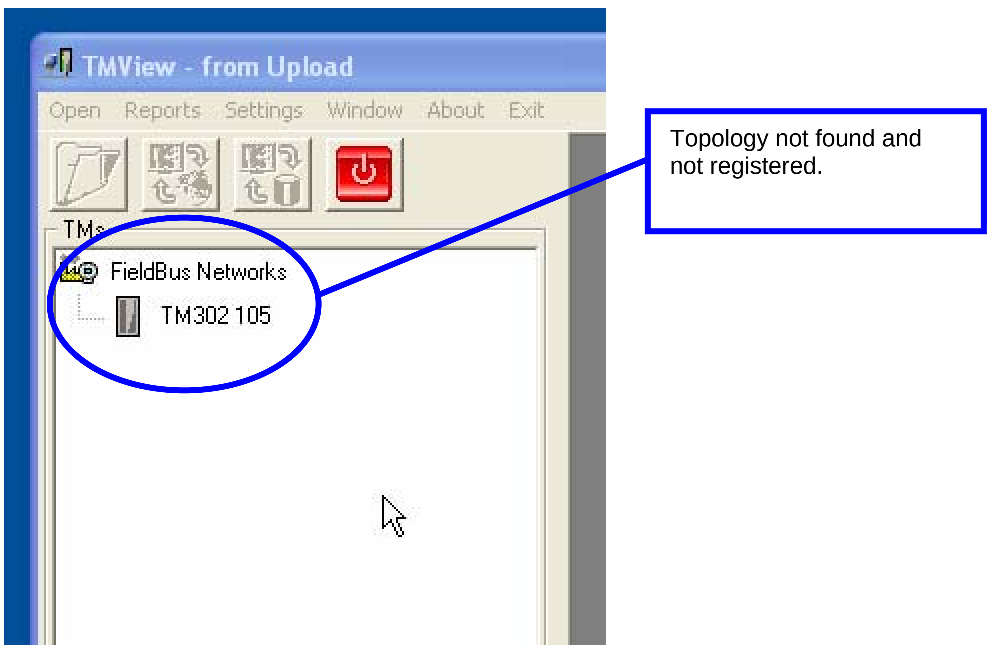


Figure 5

Once raised the topology, the devices founded in this and which are not registered in the TMView are represented for a grey icon. To verify the bridge attributes into the TMView and the actual status of this, click on **Information** through the menu popup.

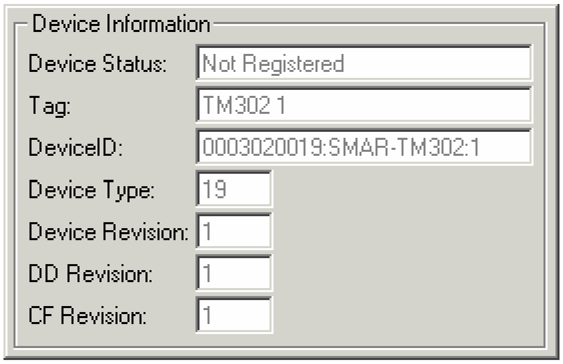


Figure 6

To register the device, select one TM302 and through the menu popup, select **Register TM**. The register process can take few minutes if the configuration was very complex.

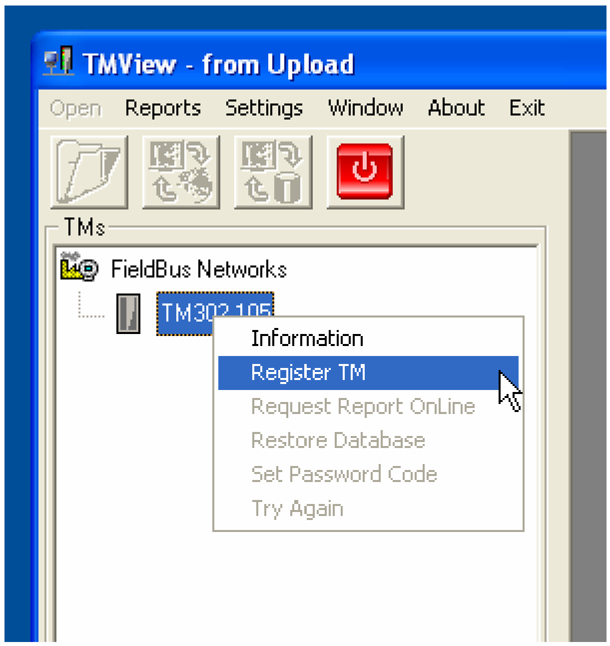


Figure 7

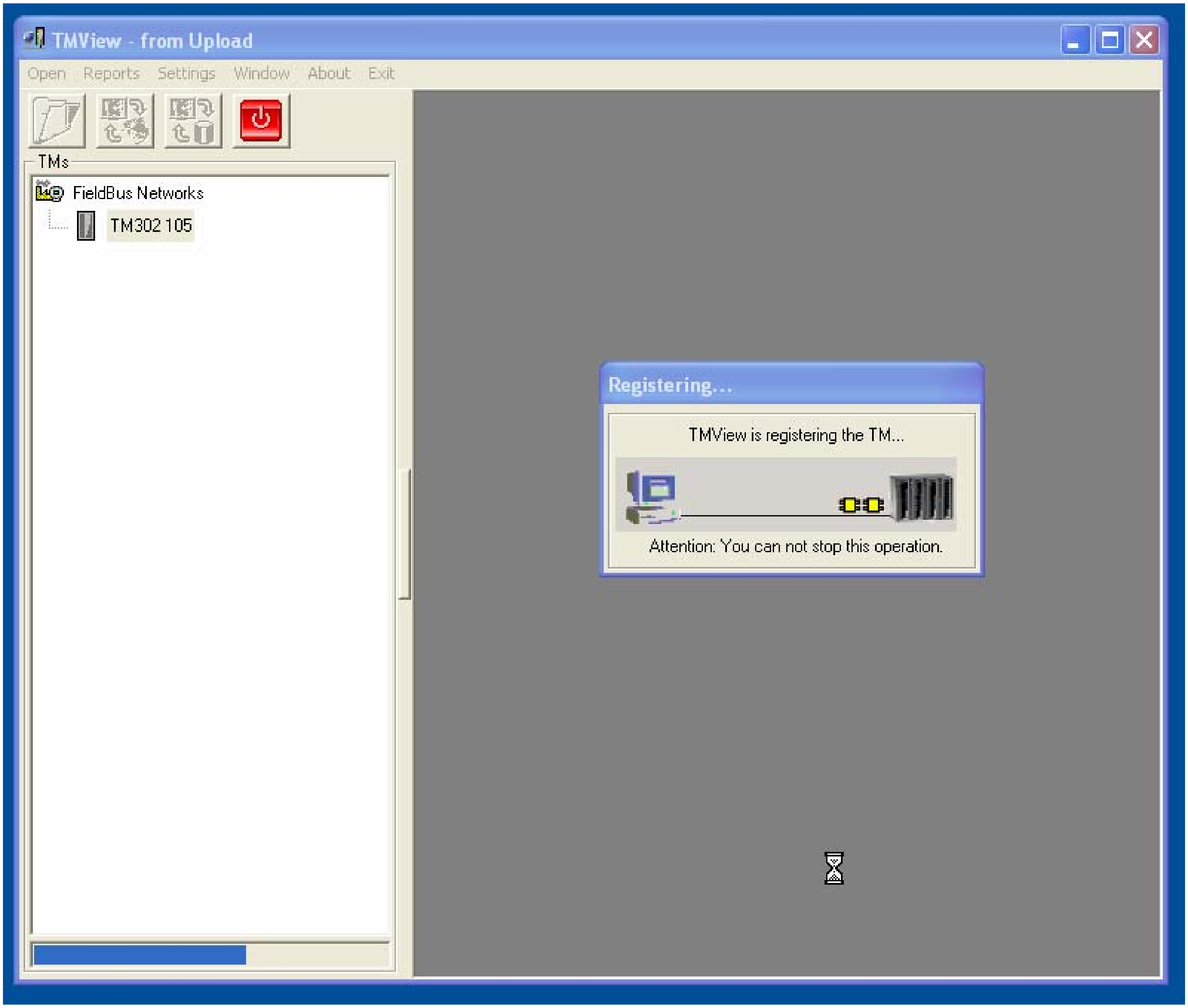


Figure 8

After the register process, the icon which represents the bridge changes of color becomes colored and the actual status changes. The register process must be done for each TM302 individually. If any TM302 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 TMView was communicating with other TM302.

When registered the devices, the communication can be directly starting from the database that is the most common mode, not using the configuration file or upload. However, if to use the configuration file or the upload, the TMView will work no problems, but a check will be made to verify if the database is synchronized with the configuration file or upload selected and will make the corrections in case of there is some change every time that is initiate.

In case of a new topology, but with a brigde of same Tag, TMView will try to update automatically the register. Before changing the topology, it is recommended to remove the register from the database.

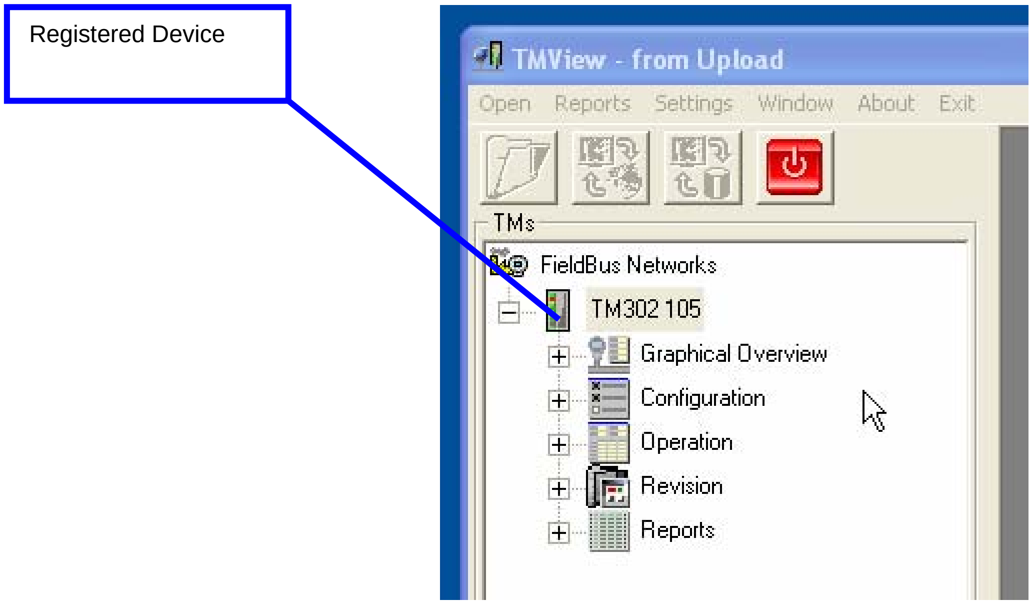


Figure 9

Diagnostic

The diagnostic process claims to verify the TMView register consistence with the TM302, if the Syscon tags were exported correctly.

It is executed whenever the communication begins with some equipment. In this stage the users are checked, blocks, strategies and units that are indispensable for the operation of TMView.

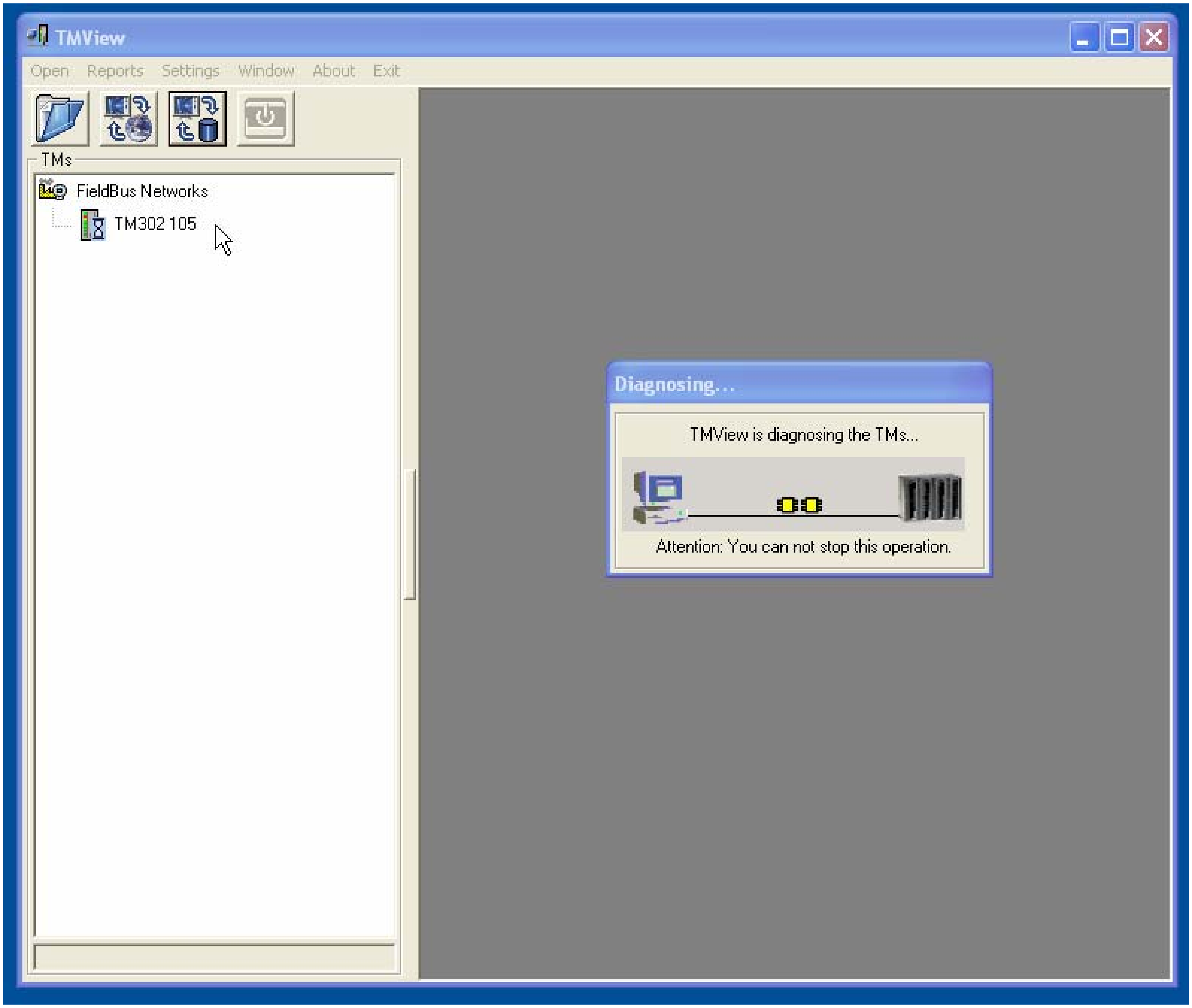


Figure 10

If any problem was found in the communication with TM302, the device will be disabled indicating problem in the menu popup **Information**.

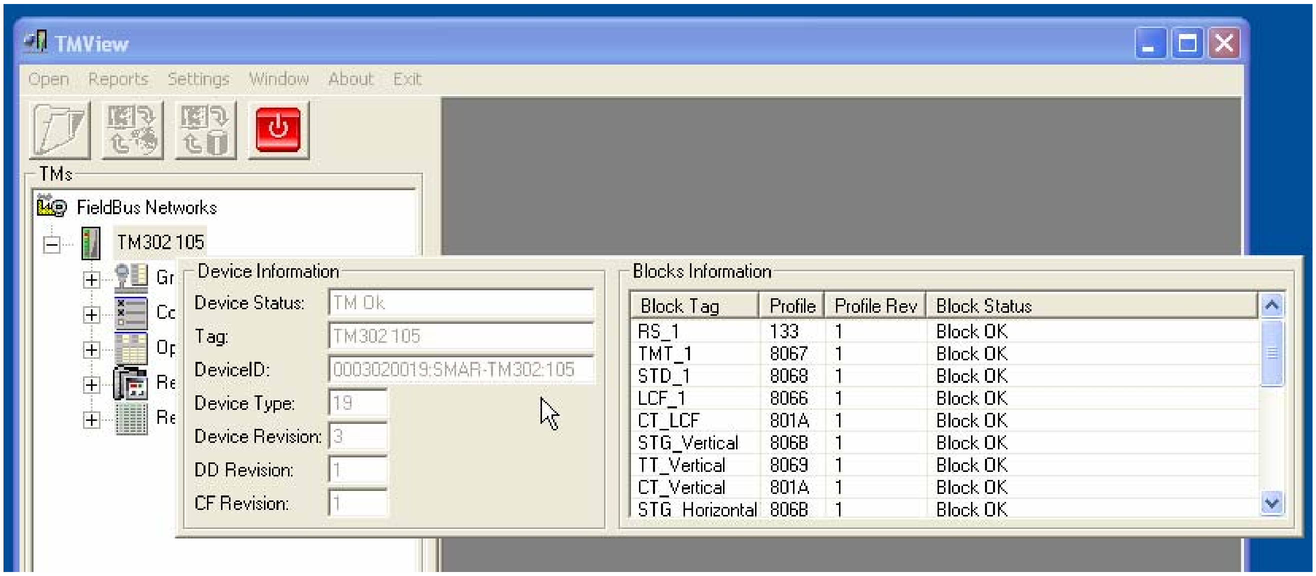


Figure 11

Through the "Information" screen it is possible to verify which block failed during the diagnosis phase and to analyze it later.

Once accomplished the diagnostic process, the TMView starts the report extraction process from the TM302 memory (Background Process).

Reports

Report Extraction

The report extraction process is independent of the interaction with the user. Once begun the TMView and the diagnostic process finished successfully, the TMView is responsible for extract the reports automatically.

Even so the TMView was monitoring more than one TM302 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:

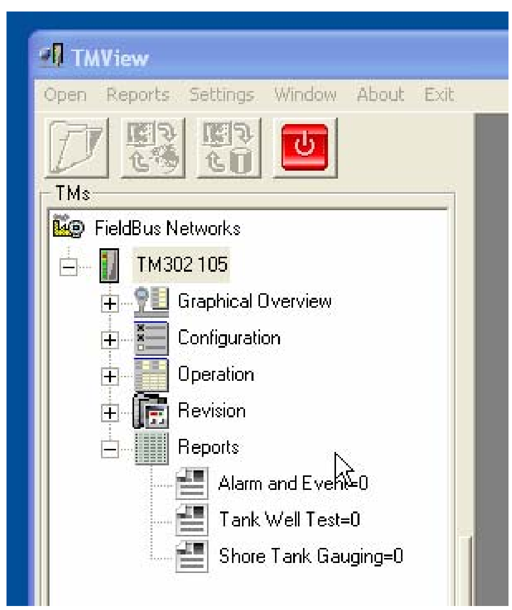


Figure 12

The report extraction process checks AEV, ATV, STGV and TWTV blocks. These blocks become available the reports which must be storage in TMView database. If any block has communication problems, the TMView detects the inconsistent block and ignores it, coming to check it, again, only after to extract the reports from the other blocks.

The TMView, 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 TM302 and the TMView. In this case, the TMView 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 TMT block, to keep the reports updated.

Report Visualization

The extracted reports from the TM302 memory can be visualized from TMView through a consultation interface. This interface can be opened in the menu **Report → View**.

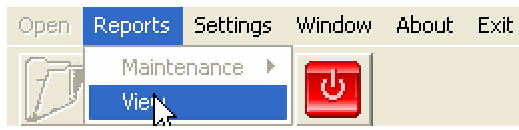


Figure 13

TMView becomes available report search from the actual database or from any external file (Backup), which this was generated by TMView.

It selects the report, clicking on this column

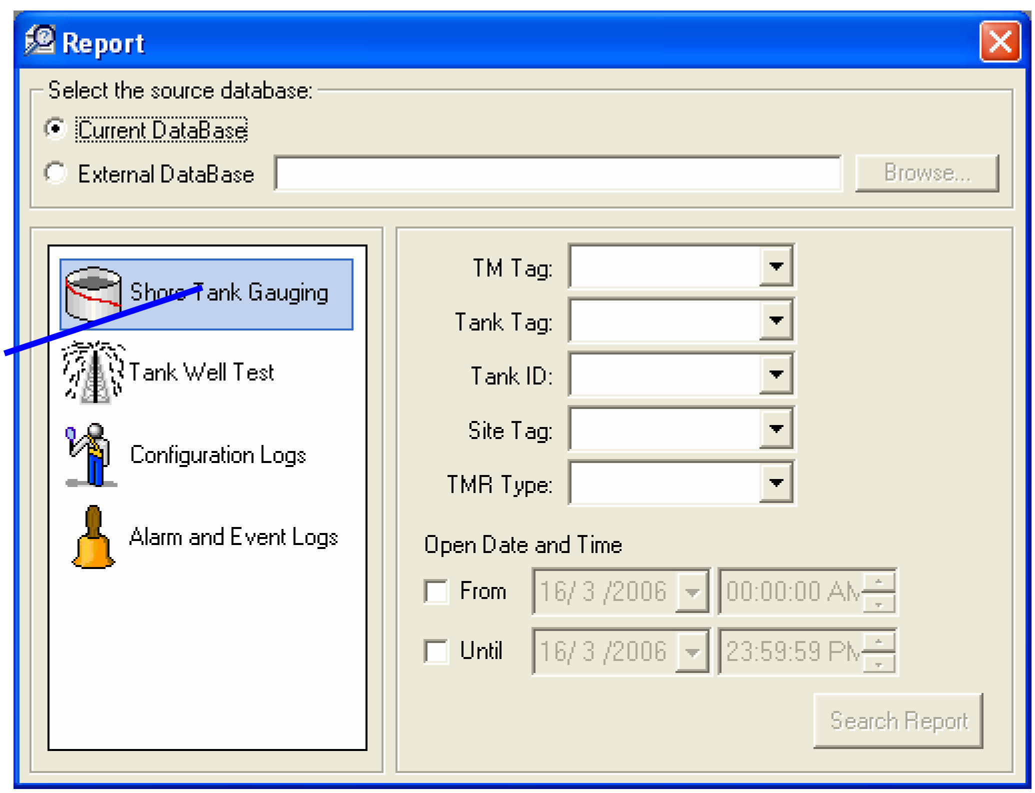


Figure 14

The search is done for each report type and TM302 Tag. It can type data for filtering, but are optional. If there no are reports of the selected type in the database, the "TM Tag" field will not have any option to select. But when this field is blank.

After supplying the data for the search, click on **Search Report** to open the report view.

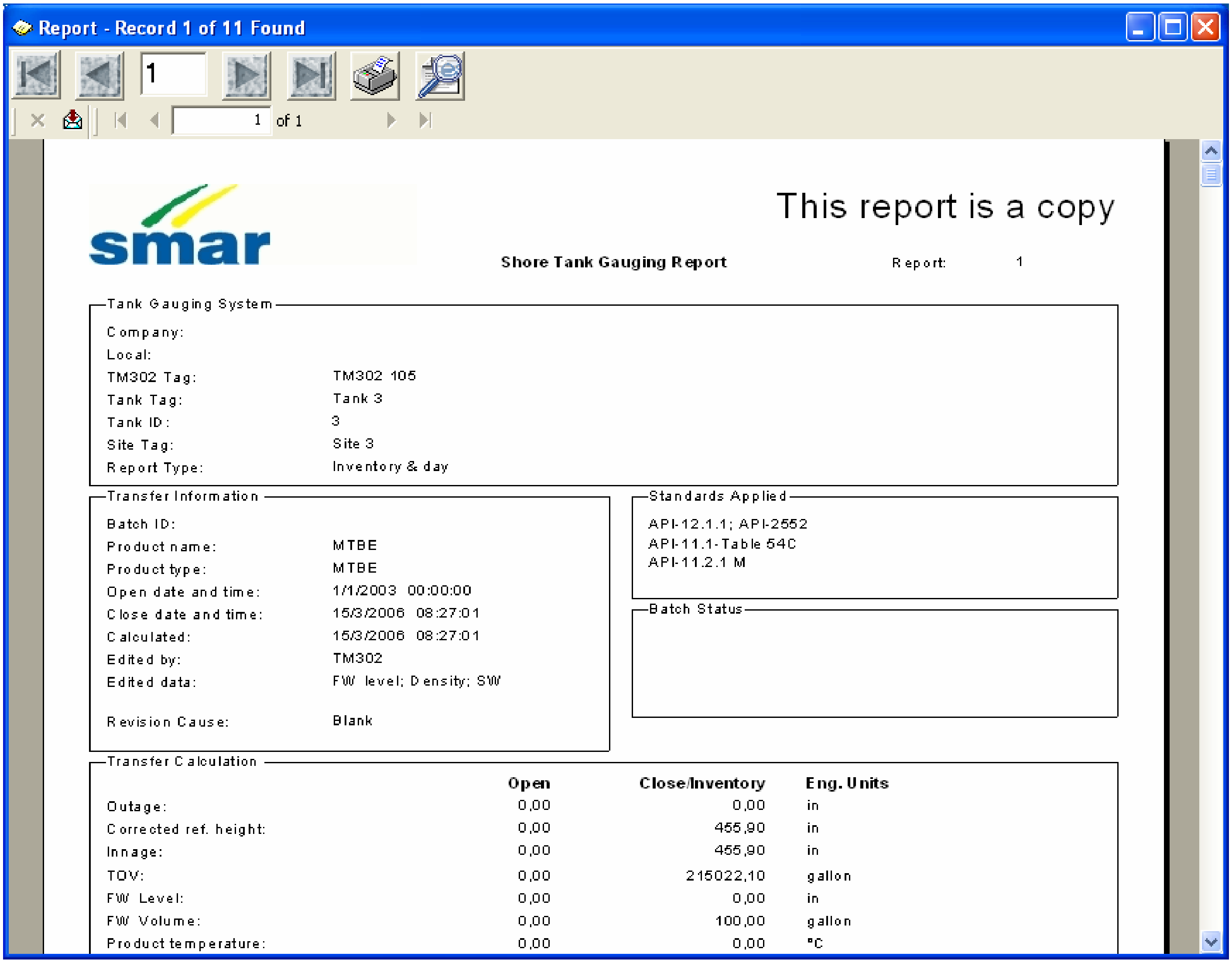


Figure 15

Register Navigation (Reports)

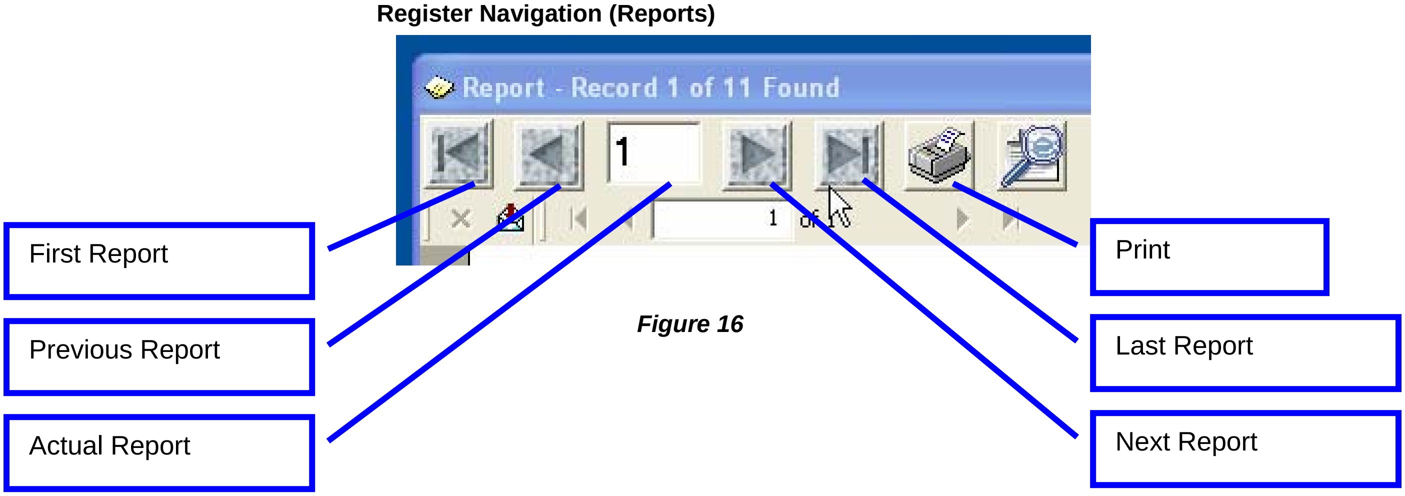


Figure 16

Page Register Navigation (Reports)

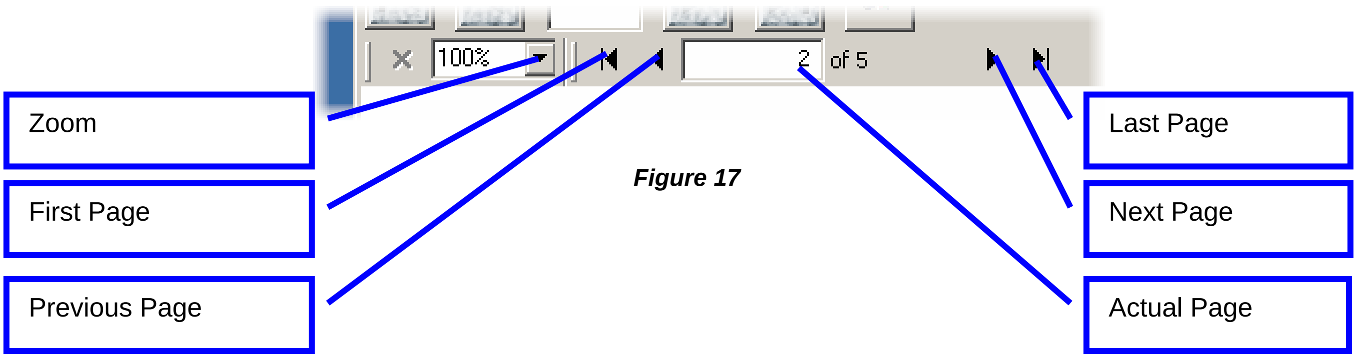


Figure 17

Note that all consulted reports in the TMView 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 18

Through the Zoom button, it is possible to do the correct framing of the report.

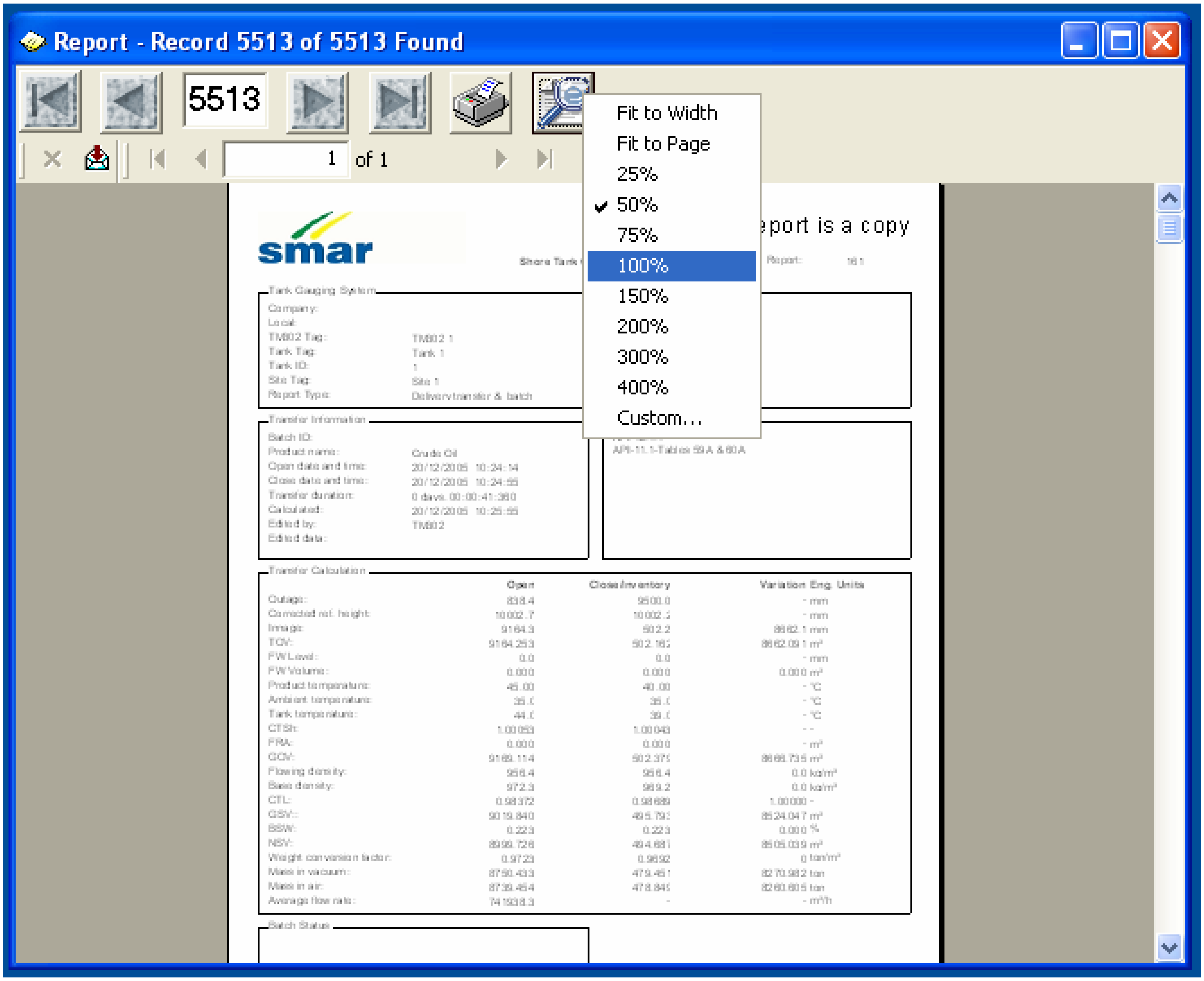
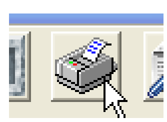


Figure 19

Printing Reports

The TMView allows the stored reports in the database were printed after consulting them, by clicking on the print menu.



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.

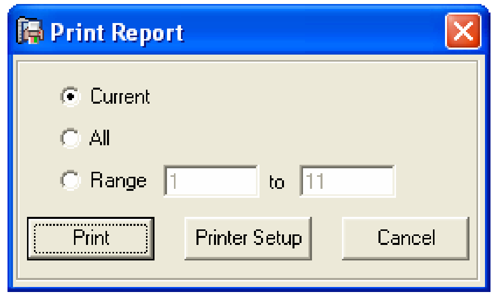


Figure 20

Automatic Print of reports

The report automatic print occurs when a report is extracted from the TM302 memory. This is optional and by default is disabled.

In the printed report through the automatic print, the label which indicates the report is a copy disappears, because this process collects data directly from the TM302 memory.

To configure the automatic print, refer to the section about TMView configuration.

On-Line Search

An online consultation allows open a report directly from the TM302 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":

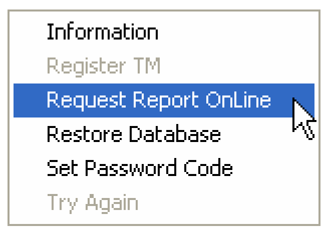


Figure 21

Select the TM, the report type and its "Log_Counter":

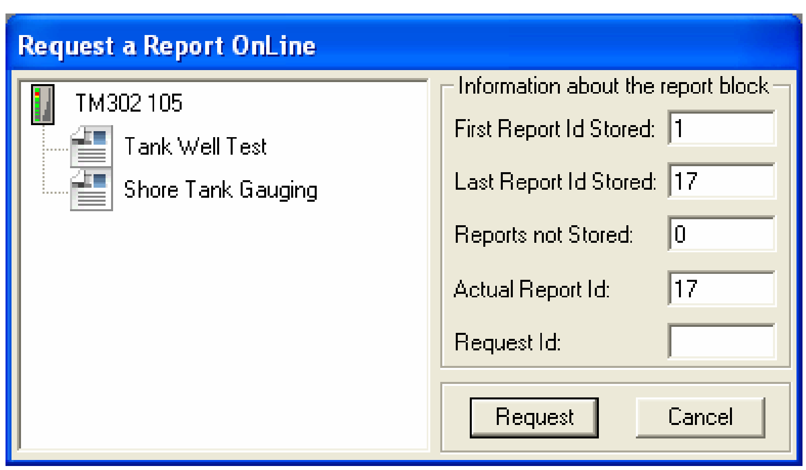


Figure 22

At supplying the Log_Counter, if the TMView 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.

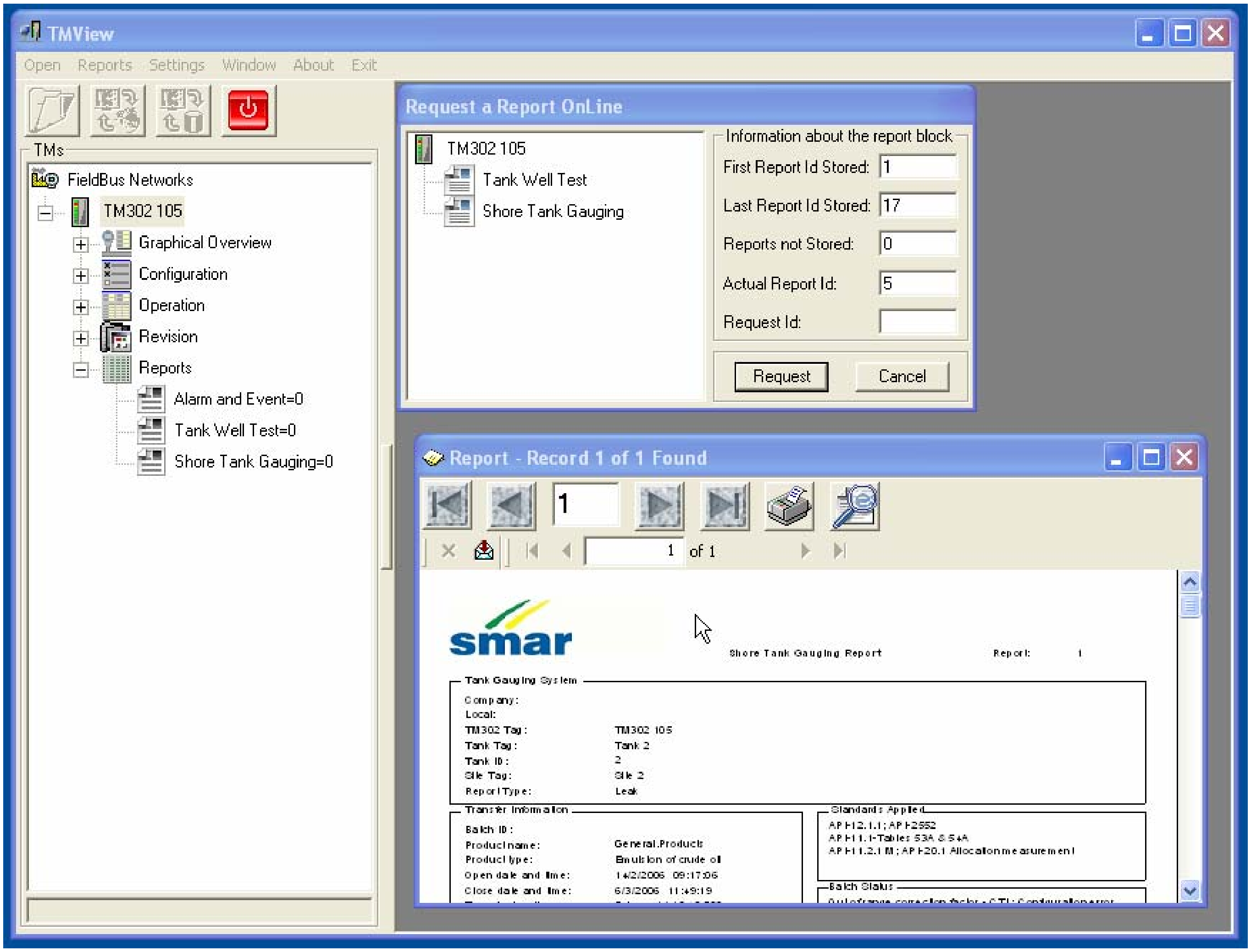


Figure 23

Report Revision

The reports generated from TM302 can have revisions, that is, when created and/or reedited through the blocks STGR and TWTR it can generate revisions creating reports with more than a version.

When there are reports with revisions, the TMView will indicate through a field, as show the example:

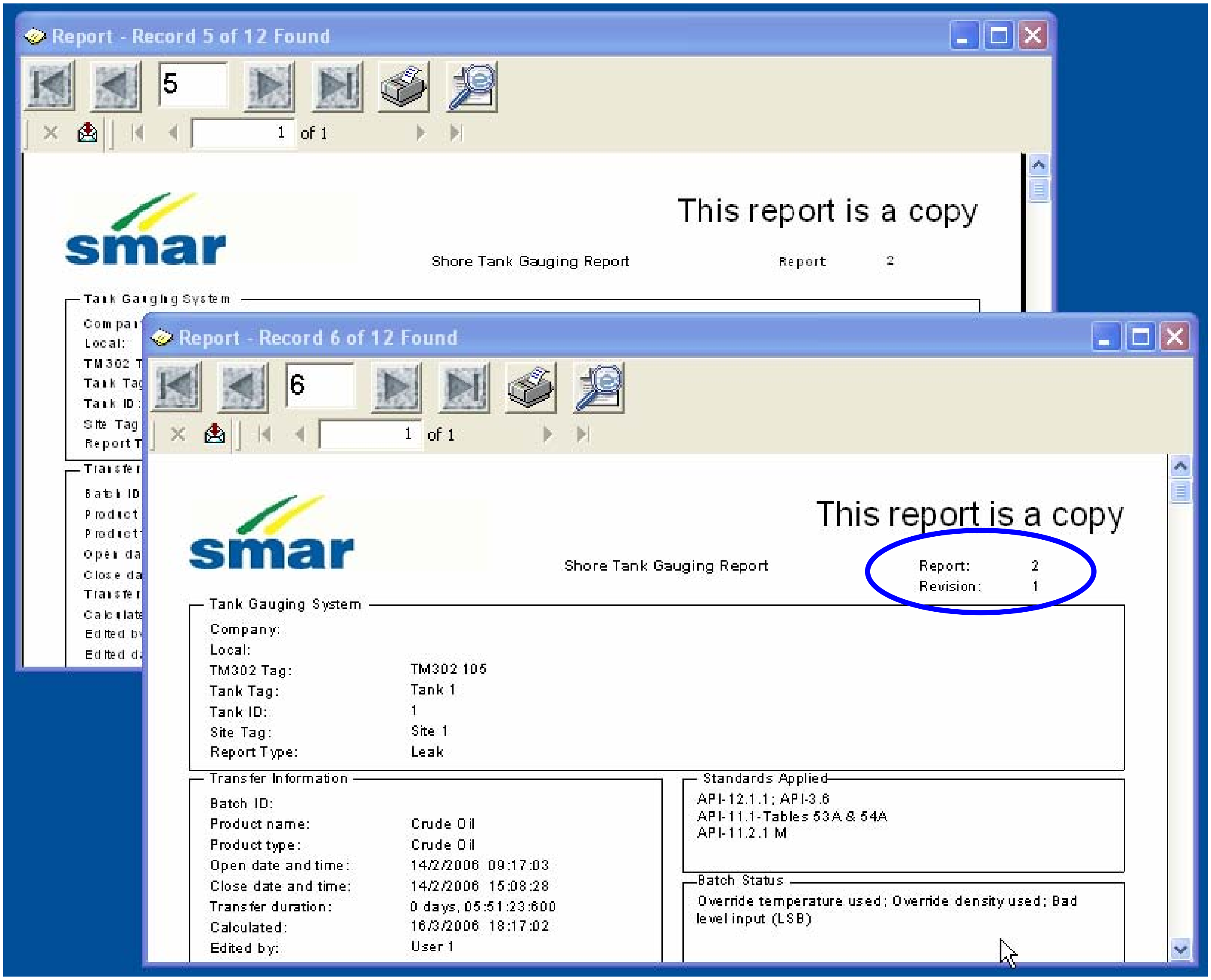


Figure 24

Creating / Editing reports

Through the STGR and TWTR blocks is possible to reedit (new revision) or to create a report. For both situations, the TM302 generates a new report and becomes it available to download and store on the TMView database.

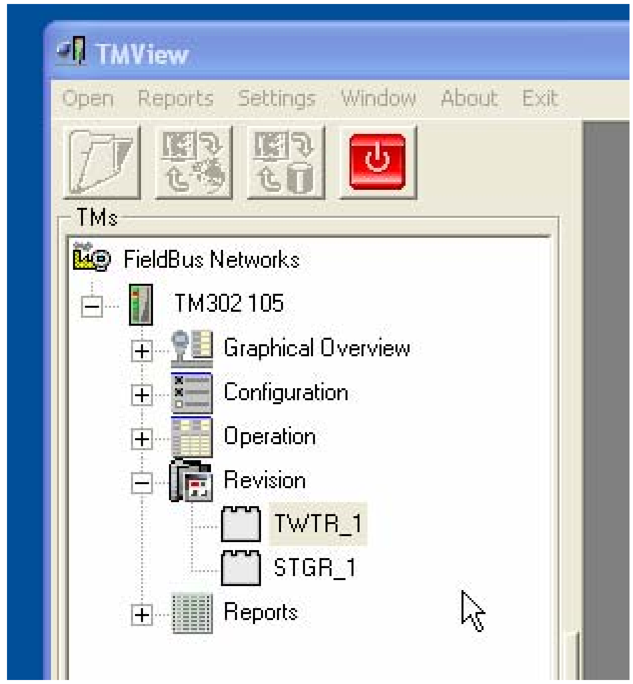


Figura 25

The report revision screens are accessible through the menu popup

When editing or creating a report, some variables can be disabled. That depends on the report type and if the operation is edition or creation. The available parameters for writing are identified through a demarcation in green color.

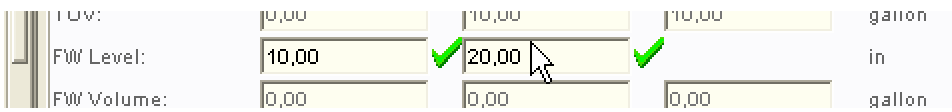


Figure 26

Report Search through the Web

TMView has an optional tool that allows the report visualization through the Web, allowing the report remote visualization without the local installation of TMView. 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, typing the web address as the example "http://endereço/tmview":

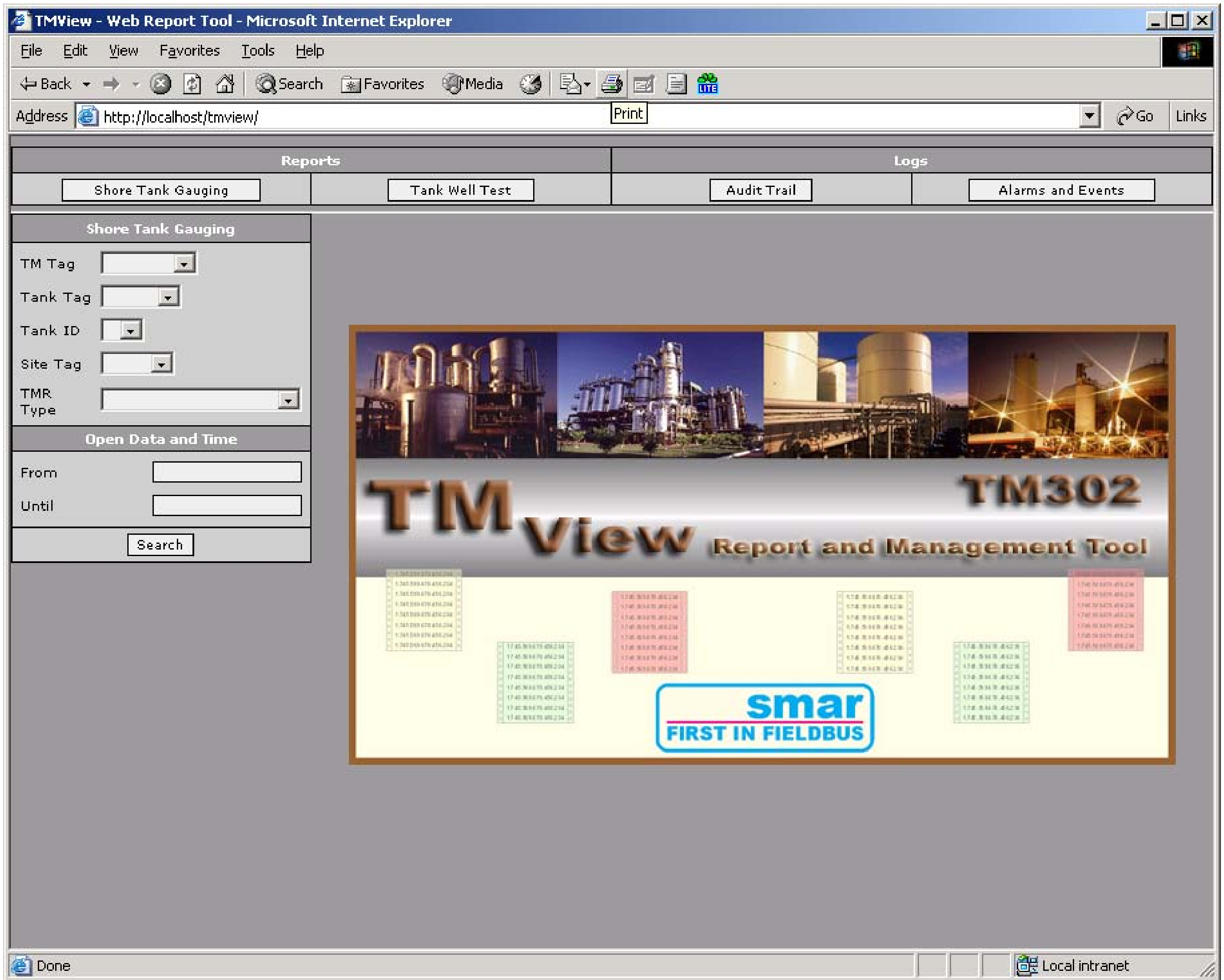


Figure 27

The procedure to search is the same of the used in the TMView. 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 TMView page. Other types of visualizers can open the reports through other windows.

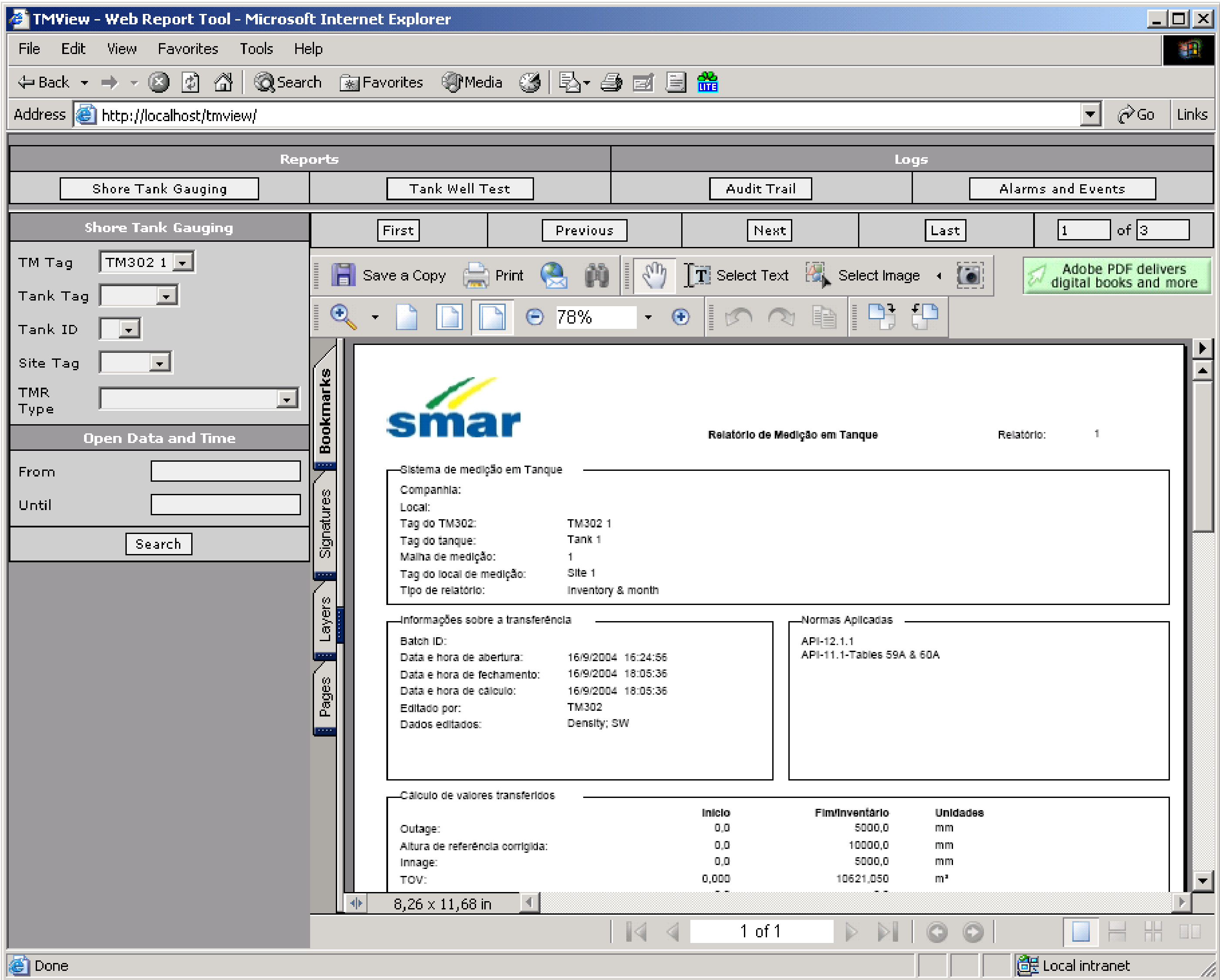


Figure 28

Operational Screens

The TMView operation mode is a form of supplying a visualization of the main measurement variables: measured inputs by the transmitters, weighed averages, correction factors, levels and parameters configuration.

The operation screens allow configuring any available block by TM302 to configure a tank or well measurement.

Therefore the operation mode of TMView is an adapted visualization and of easy interpretation of the information for these blocks types.

All the operation screens are organized through a "treeview" located in the left panel of TMView, and it can be open and/or selected through this.

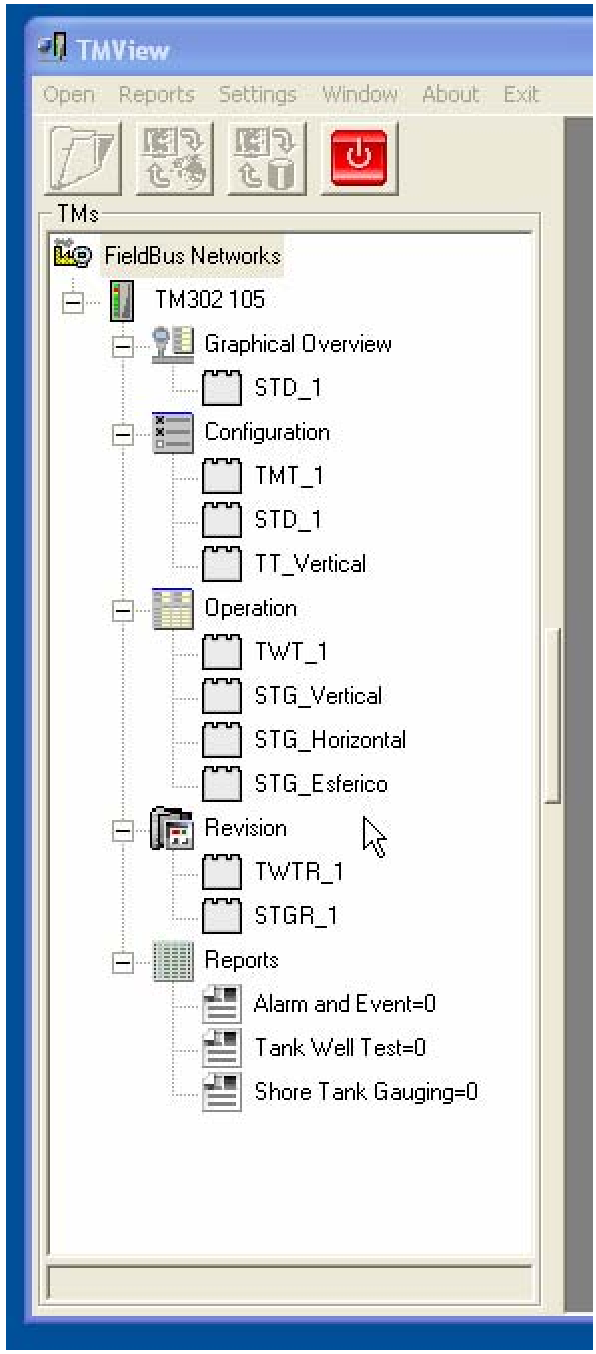


Figure 29

To open the operation screens is essential that TMView diagnosis phase has occurred and the communication is ok, otherwise the menus are not available for opening.

The "treeview" is organized separating the screens for operation type, which can be:

- Configuration: access to the configuration screens of the blocks STD, TMT and TT;
- Operation: access to the operation screens of the blocks ATT, STG and TWT;
- Revision: access to the report revision blocks. Through these screens it is possible to create and/or to edit reports already generated by STG and TWT blocks through the STGR and TWTR blocks, respectively.

Each block has a certain quantity of screens available for TMView, it depends on the type of selected block. To open the screens, select a block and on the right button it selects a screen type referent to the selected block.

Example:

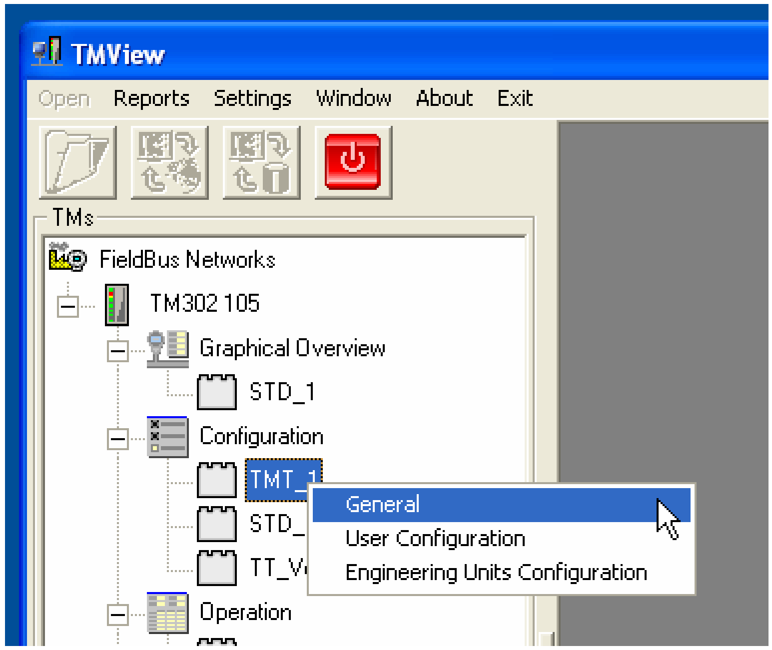


Figure 30

For a same item selected there is only an operation screen to open of every time, the TMView controls the quantity of open screens for a same item.

As the screens are open, the "treeview" opens a new node indicating the correspondent screens. When selecting this node, it focus this screen, allowing to the user to find a "lost" screen in case of there are many open screens at the same time.

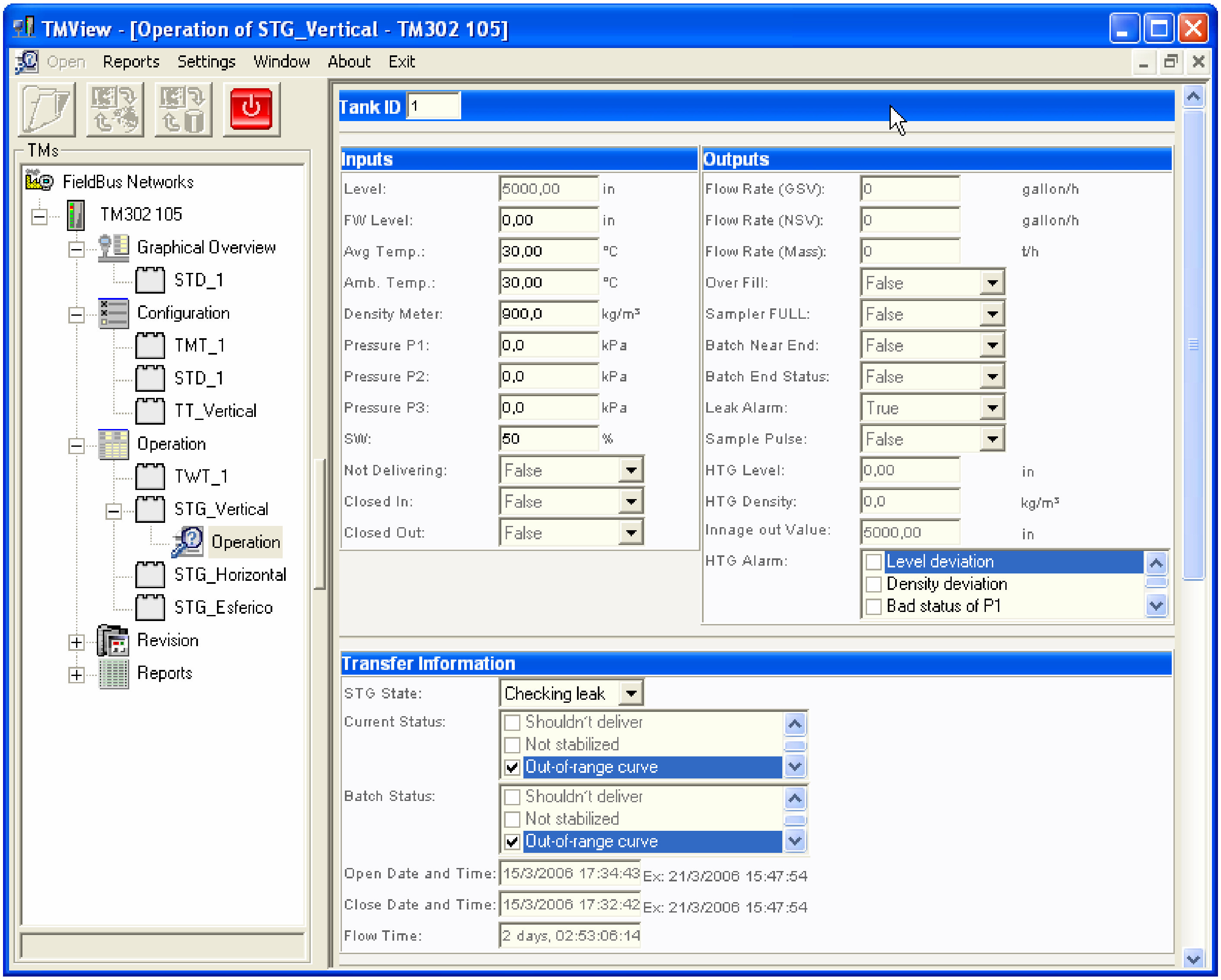


Figure 31

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. Those varied were in an only screen, where there are 4 possible options of tanks that TM302 supports.

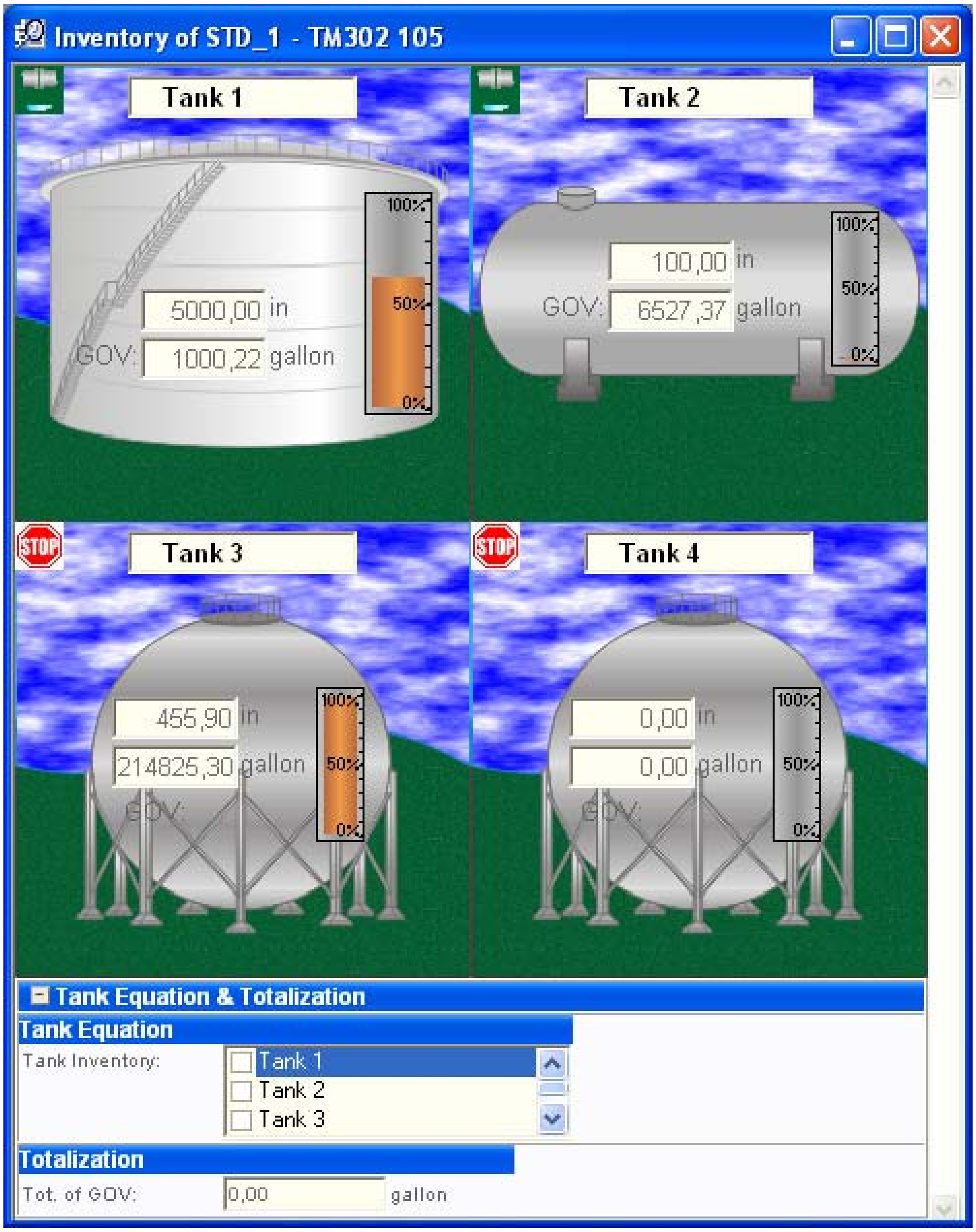
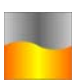


Figure 32

Through the graphic screens it is possible to monitor the status of each tank and its levels through graphic representation.

 Tank Stabilizing

 Tank Receiving

 Tank Sending

 Tank Verifying Leak

 Tank in Well Test operation

 Stopped Tank

Protection by Password

Some screens have fields which allow the operator writes in some parameters. The parameters which have writing permission, the TMView allows that fields were editable. The writing operation occurs only with the confirmation pressing <ENTER> after the change. If the operator abandons the field without the confirmation, the data comes to the original value.

If the field was under "Audit Trail", the TMView requests the user login and password automatically. If the login was configured with double password, the user must be supplied both the passwords.

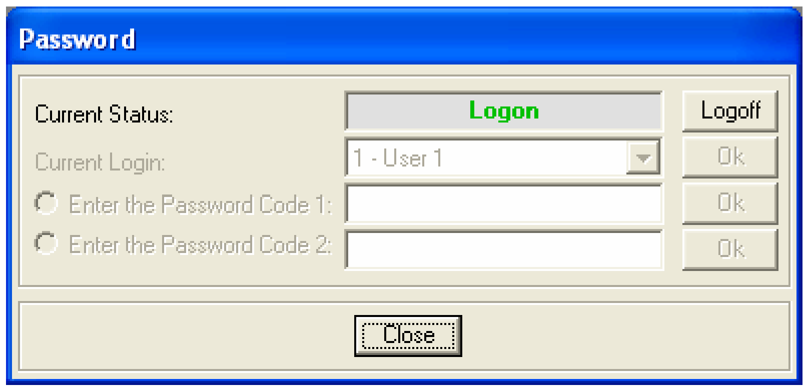


Figure 33

If the user wants to enter manually with the password, without TMView to request, click on the "Set Password Code" at menu Popup.

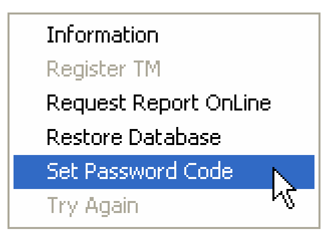


Figure 34

Maintenance

Export

The TMView allows export data manually. The export process creates one copy of the actual database.

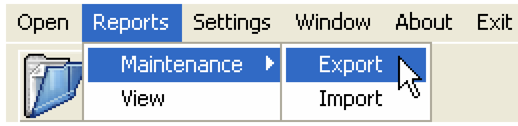


Figure 35

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.

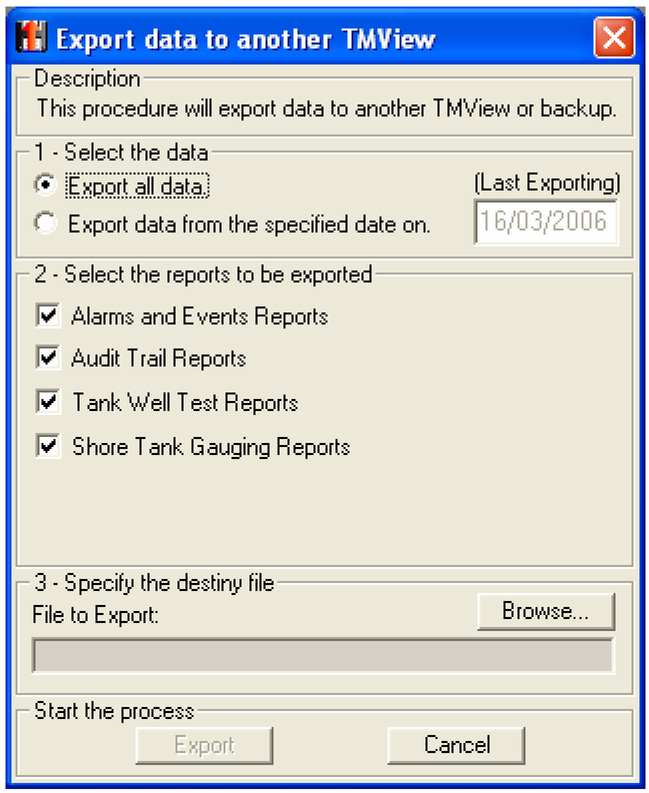


Figure 36

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 TMView allows import data manually. 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.

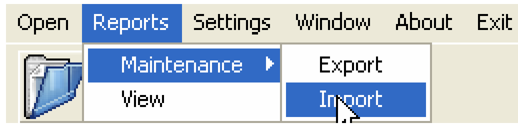


Figure 37

The information to be imported depends on the import configurations. It is possible to import reports from the last import and to configure which report types will be imported.

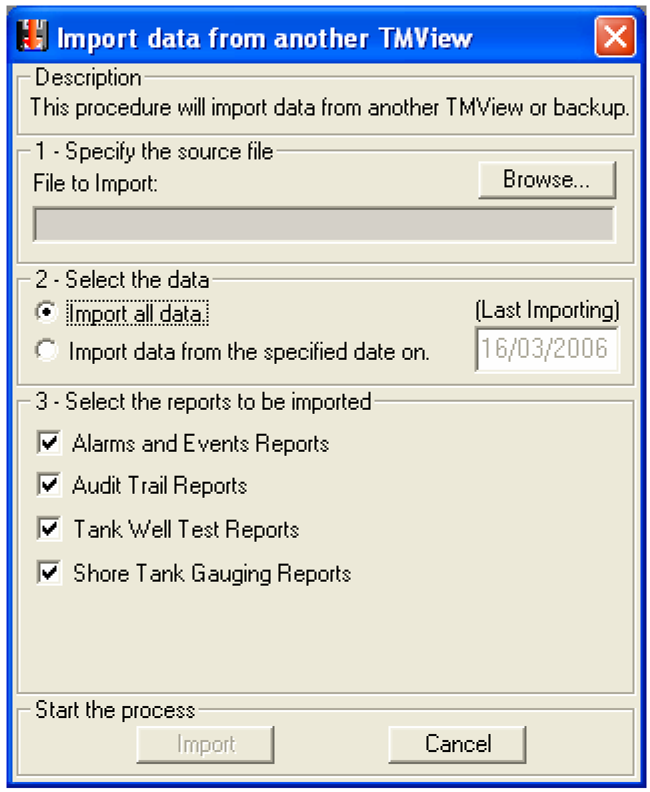


Figure 38

To import, execute the following sequence:

- Specify the file with the data 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 TMView can accomplish backup process automatically using the "Task Scheduler" from Windows to execute this task, because it independs of the TMView to be executed or not.

The backup is configurable, from the TMView configuration menu, which is described in the chapter about configurations.

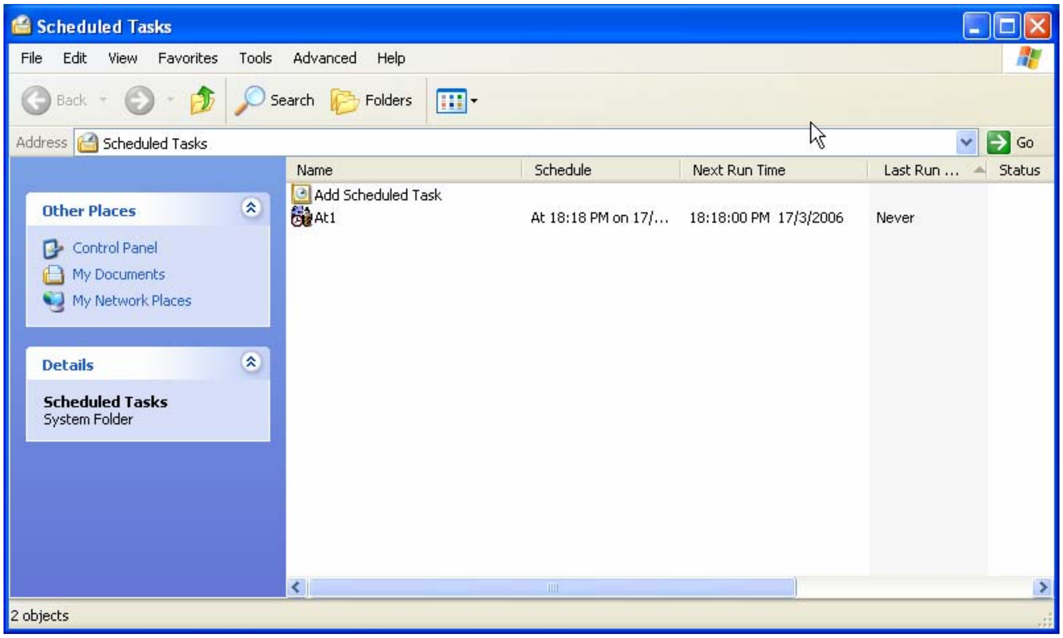


Figure 39

Once the task is created, the user can change the data manually, through the TMView or Windows.

Even the task is executed, it verifies if the TMView is working or not, if was, the communication with the TMView is stopped and the backup process is executed, copying the database to a specified directory. After the backup is done, the TMView comes to work again to allow the report extract.

Database Restore

The TMView allows recover the database from the TM302 memory. Once this recovery is requested, all the reports are checked to be extracted again.

The TMView 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.

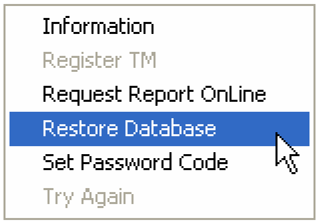


Figure 40

The TMView informs the operation will take few hours, because it depends on the report quantity in the TM302 memory.

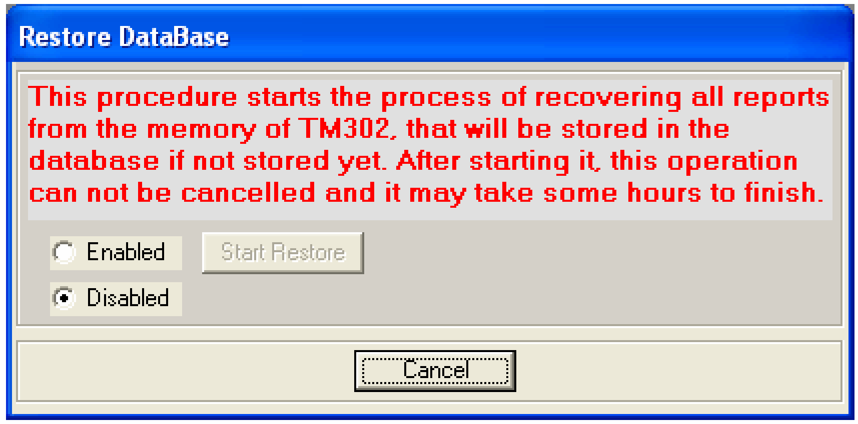


Figure 41

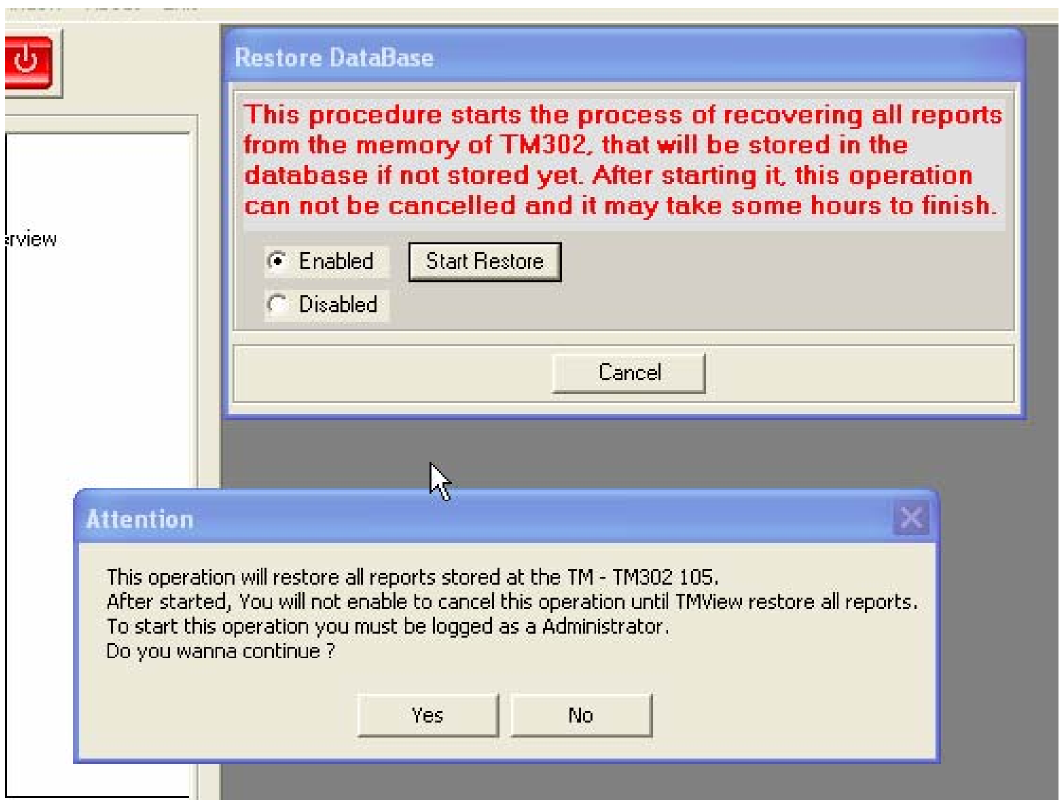


Figure 42

If the user of TM302 already is logged, when clicking "Yes", the restore process is started. Otherwise, the TMView requests the access password

Removing TM302's Registers

To remove one TM302 from the register, always keeping the reports, click on **Settings → Register → Remove TM**

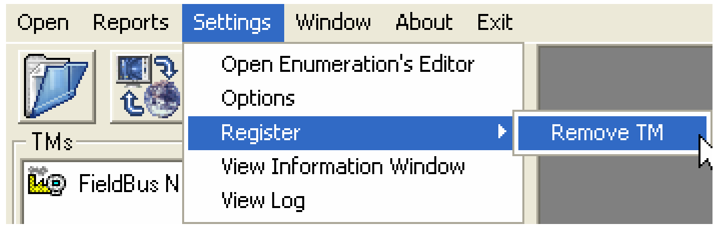


Figure 43

Select the TM302s to remove and click **Delete**.

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.

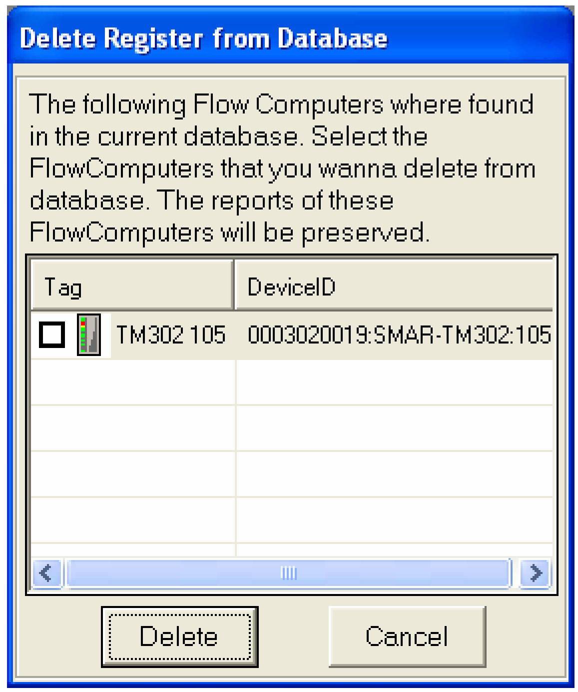


Figure 44

Configuring the TMView

The TMView has some important configurations. To open the configuration screen, select **Settings** → **Options**.

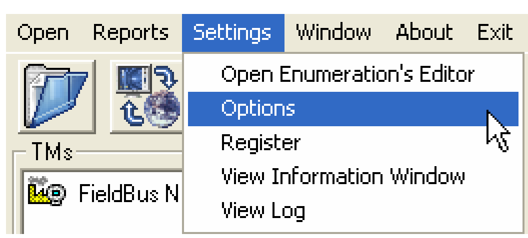


Figure 45

The options are subdivided in:

General

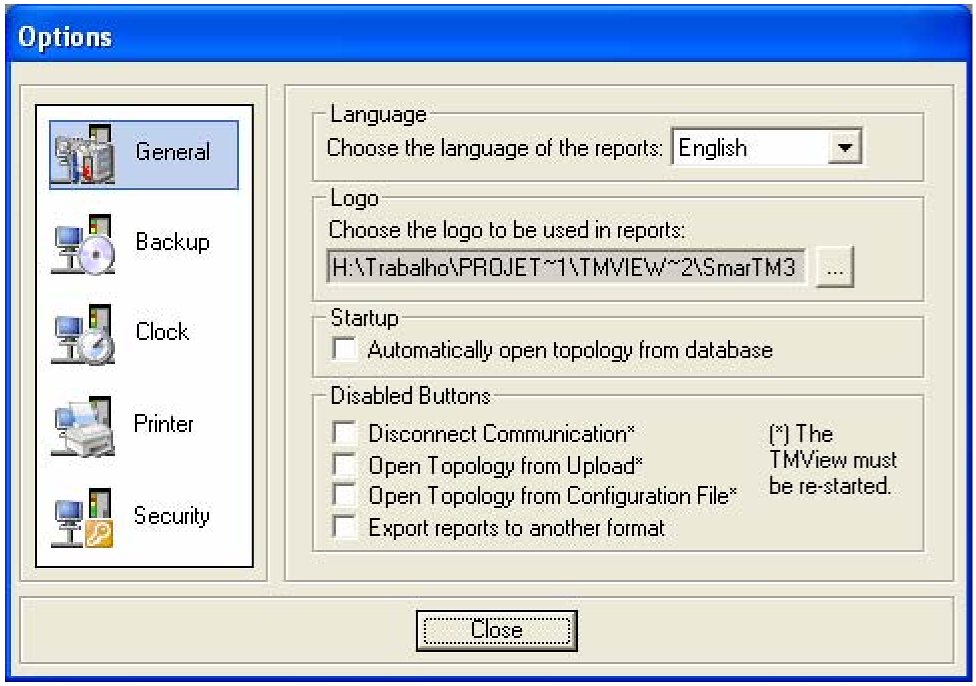


Figure 46

- **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 TMView will recognize it automatically.
- **Logo:** logo used in the reports. By default, the Smar logo will be used.
- **Startup:** it defines if the TMView 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

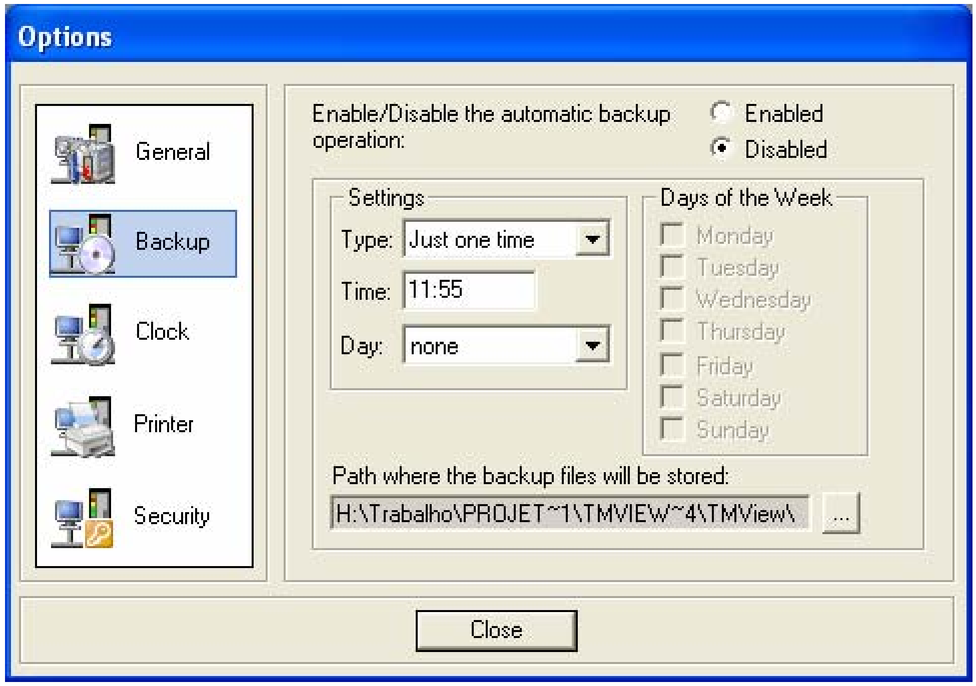


Figure 47

It enables the TMView 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

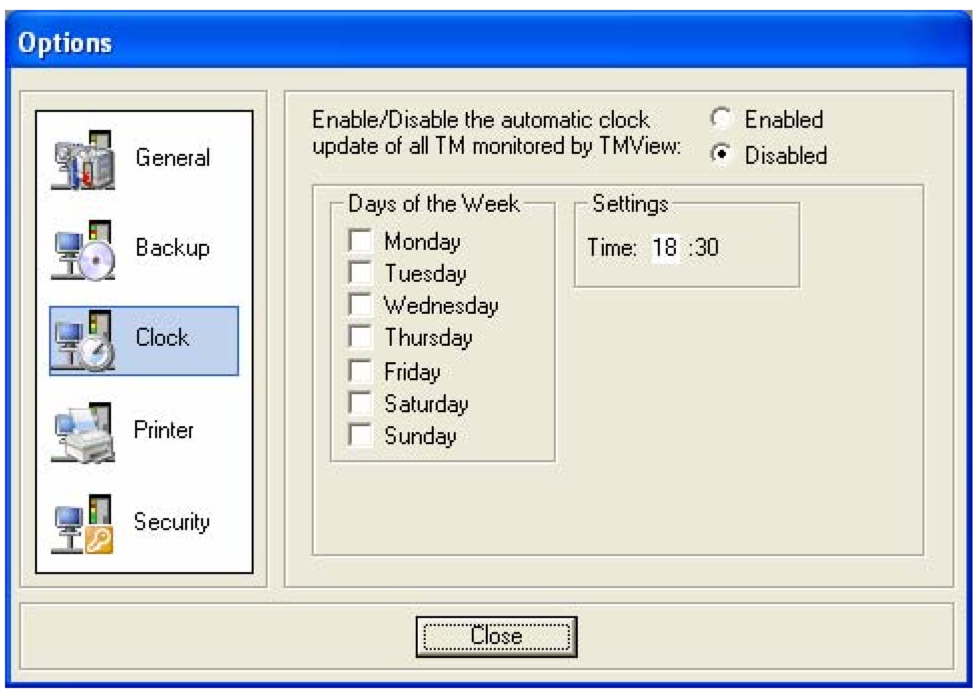


Figure 48

It enables setting the TM302 clock automatically. All the TM's that are communicating in the specified date and hour will be updated.

Printer

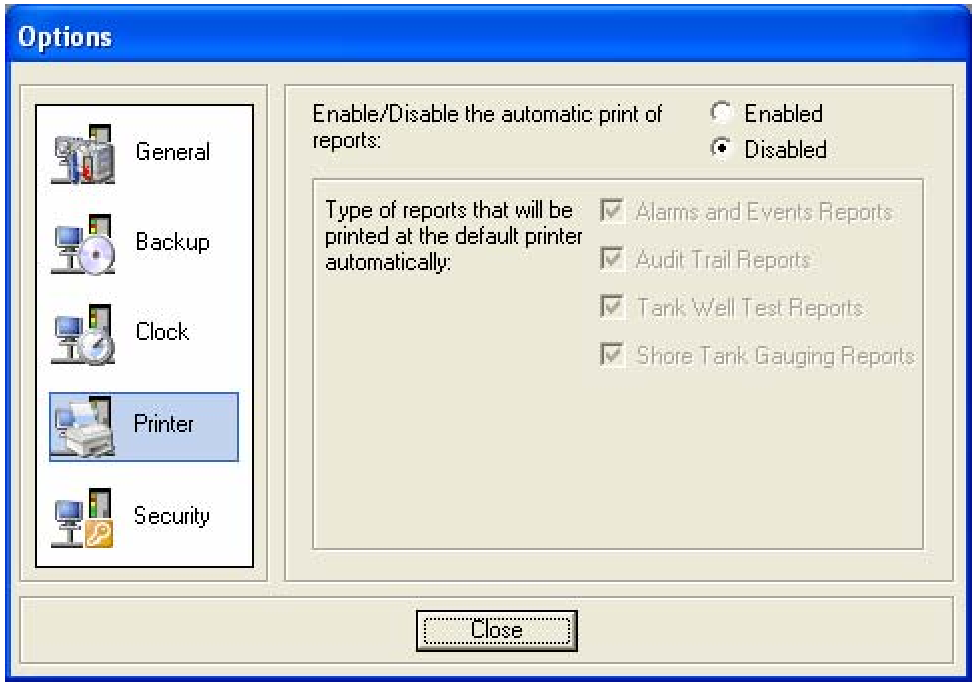


Figure 49

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

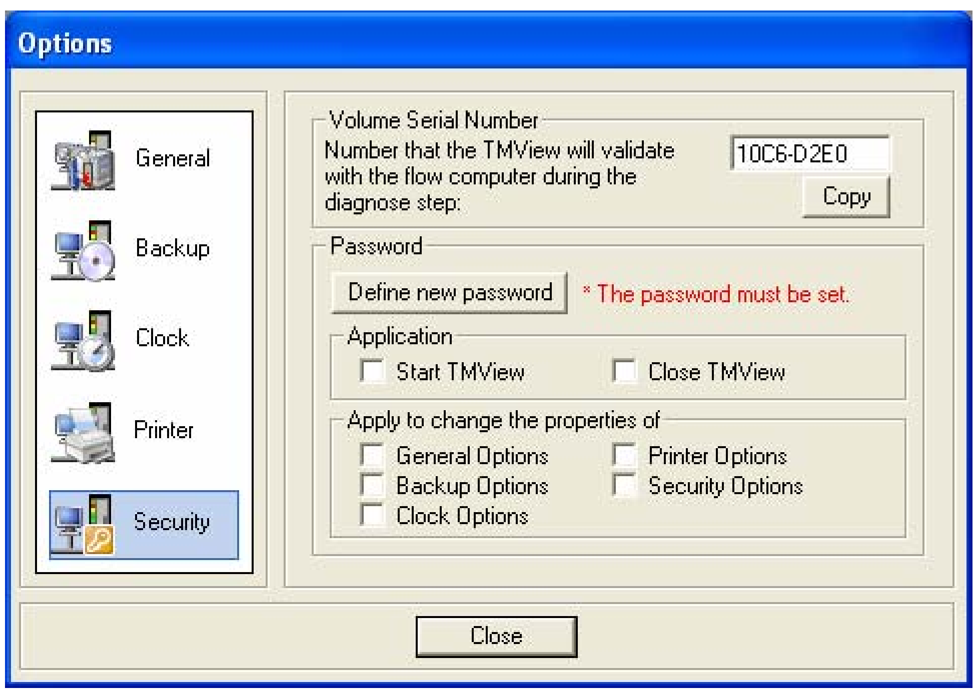


Figure 50

- **Volume Serial Number:** only for reference. It shows the Volume Serial Number of the HD that the TMView is installed, and this number must be written in the TMVIEW_VSN parameter of the TMT block from that the user needs to upload the reports.

- **Password:** the TMView can have an access password in order to avoid non authorized users change the application, guaranteeing security to the information obtained from TMs.

Enumerations

Some enumerations of TMView, as the justification in the report edition can be included or changed in the database through a window. To access this window, select **Settings → Open Enumeration Editor**.

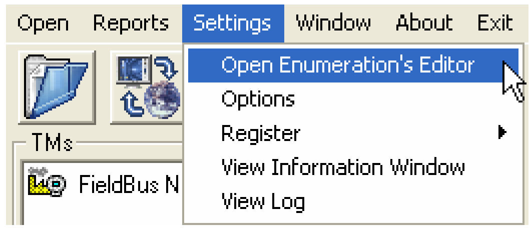


Figure 51

Only the enumerations from 100 to 255 are edited. The changes only will be used in the next time when to open the reports edition screen.

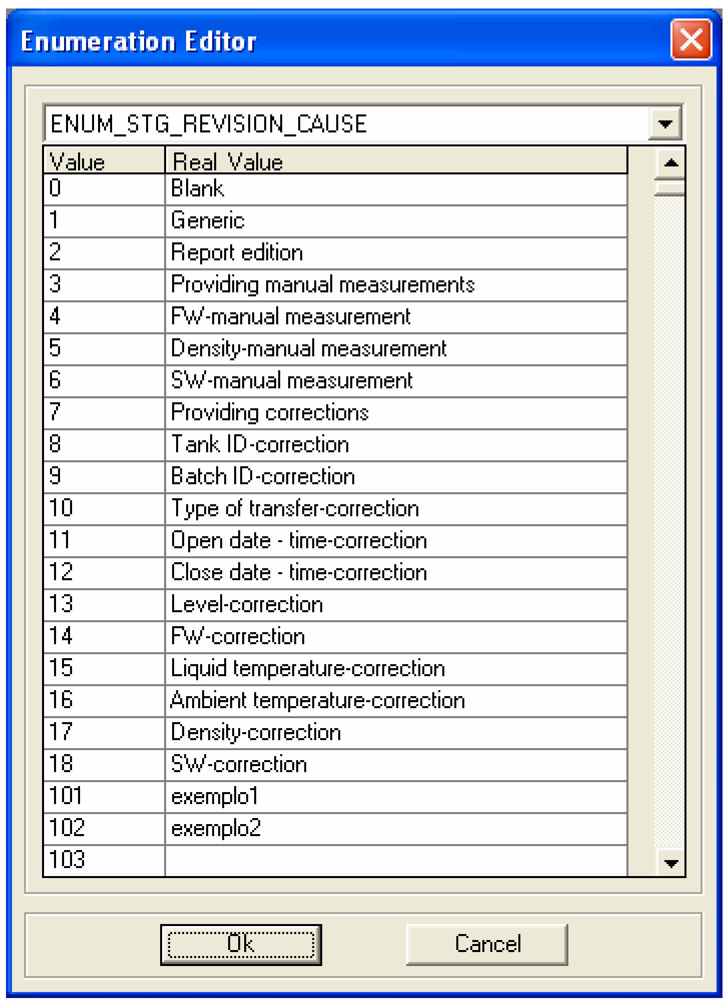


Figure 52

Every time that there is an enumeration change and the user to try edit other enumeration, the TMView will request the confirmation of the change, because it is not possible to change in different enumerations at the same time.

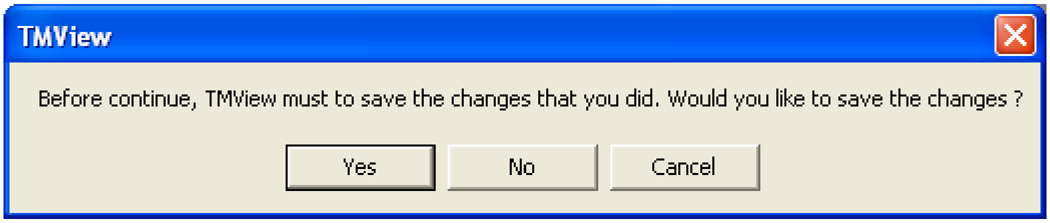


Figure 53

Visualizing System Logs

If eventually any error or warning occurs in the TMView, these information will be recorded in a log file in the TMView installation directory. However, the last messages can be visualized through the interface, clicking on **Settings** → **View Log** menu.

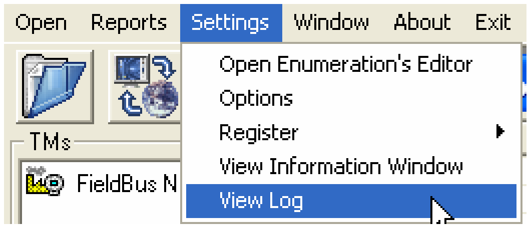


Figure 54

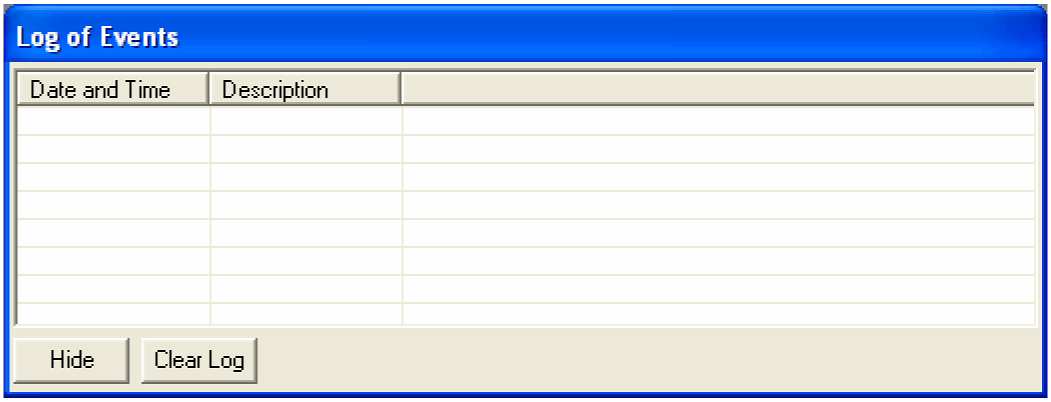


Figure 55

Data Security

The TMView tool has an own password, independent of the TM302's access restriction system.

It was created a mechanism to allow that only one machine, executing the TMView, can register the TM302 module, and, thus, only this machine to be able to register/report copy from the TM302 to database.

The TMT.TMVIEW_VSN parameter, which is dependent tracking and needs Administrator level, will must be type with the Volume Serial Number of the HD which will execute the TMView responsible for transferring the register/report to the database. The register process of a TM302 to TMView, will be accomplished only if there is equivalence between the parameter and the Volume Serial Number of the HD.

The database, which the registers/reports are stored, is protected by password, which is known only by the TMView project responsibles at Smar.

Even so the database password is not enough to guarantee the data reliability; the TMView 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 TM302 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 TM302 memory through the OPC server, the CRC calculation was introduced for each report (QTR or proving) and register group (configuration changes or alarm/event).

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
- Database Format: MS Access 2000.

(*) - When using the search tool through the web.

Troubleshooting

1 - When it visualizes the reports through the TMView, 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 TMView does not get to do any TM register.
Solution: Be sure the directory which the TMView was installed was read-only. Check the TM302 version is compatible with this TMView.

3 - Web page for search does not open anything.
Solution: check if the virtual directory was installed correctly using the application "CreateVirtualDirectory.exe". Check the Appendix A.

4 - OPC Server stops to receiving events when the TMView opens with other supervisories. Solution: probably problems with double instantiation of the OPC Server are occurring. Configure the DCOMCNFG in order to use the interactive user.

Appendix A - How to configure the TMView to see reports on the web

TMView 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 slowness and even so system break.

The system where the TMView 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 check if the "inetinfo.exe" is enabled.

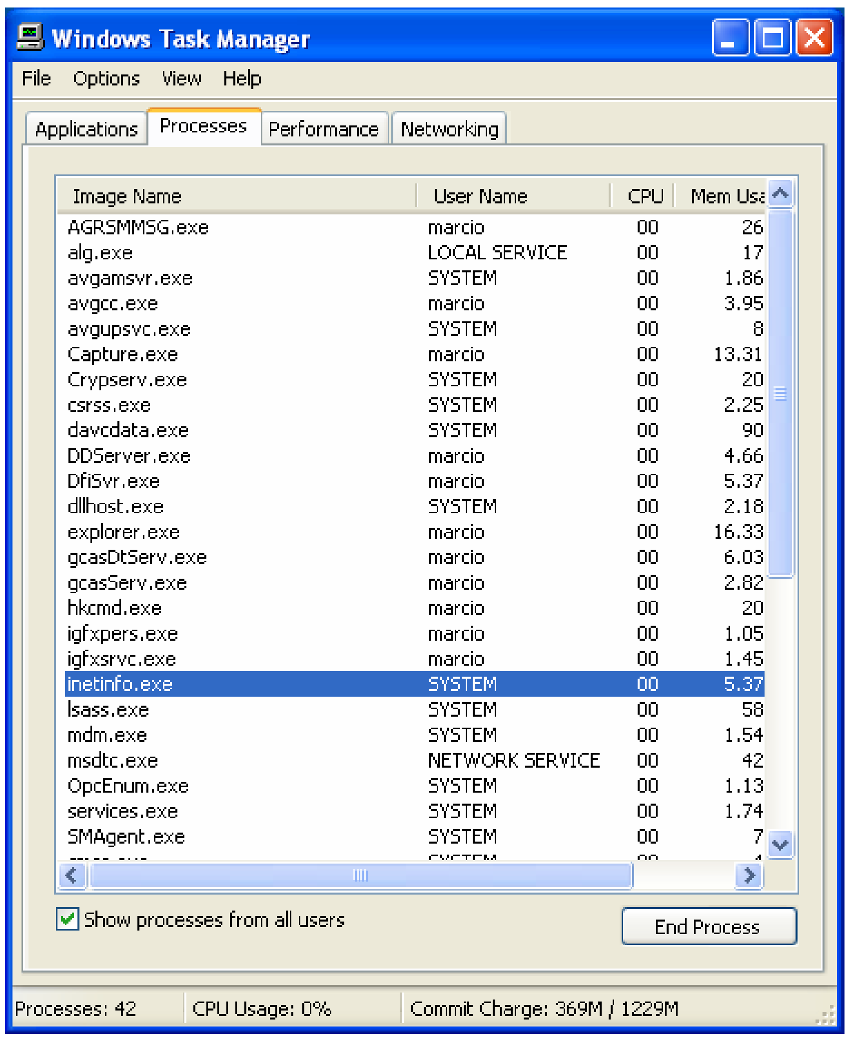


Figure 56

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 TMView to supply the Web.

Open the TMView 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 TMView 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.

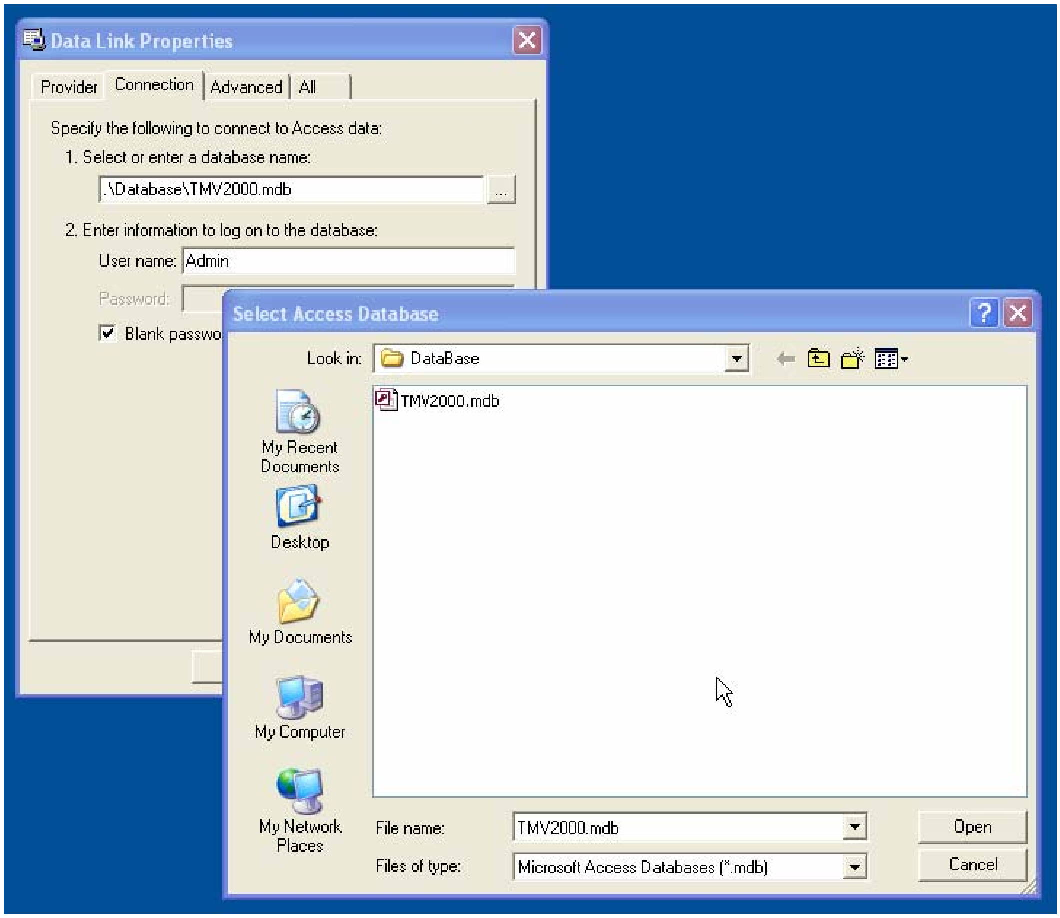


Figure 57

Once done these configurations, the report search will be already set and the user just need to type the Internet address that the TMView will do the task.

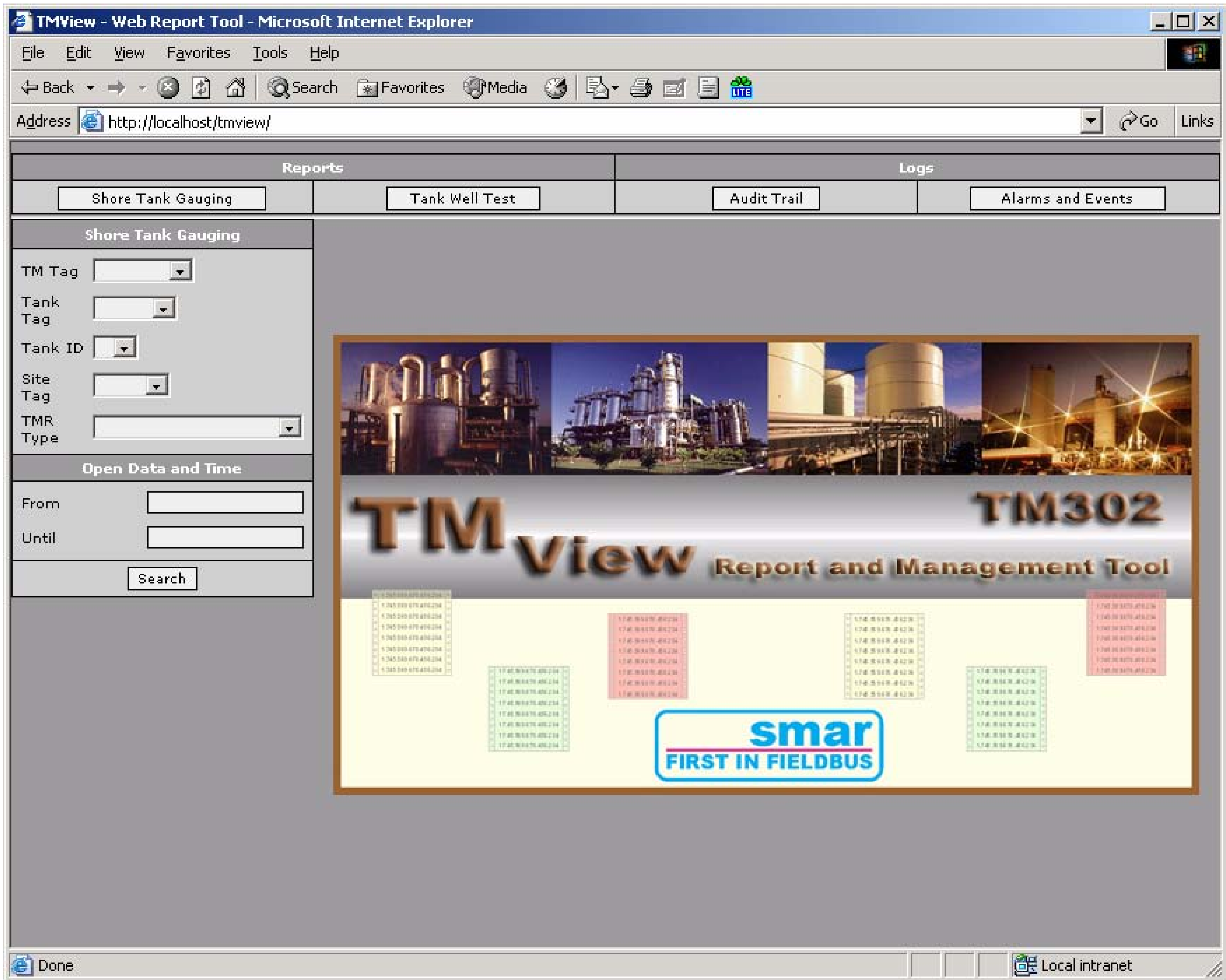

TMView - Web Report Tool - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://localhost/tmview/
Go Links
Reports
Logs
Shore Tank Gauging
Tank Well Test
Audit Trail
Alarms and Events
Shore Tank Gauging
TM Tag
Tank Tag
Tank ID
Site Tag
TMR Type
Open Data and Time
From
Until
Search
TM
View
TM302
Report and Management Tool
smar
FIRST IN FIELDBUS
Done
Local intranet

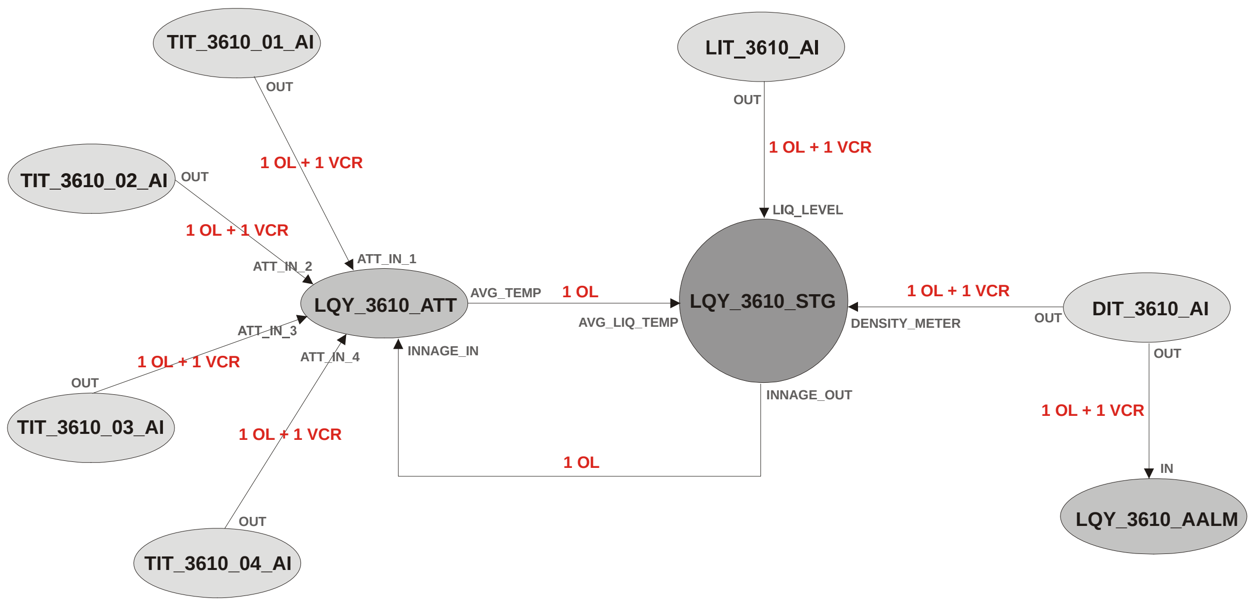
Figure 58

Chapter 15

CONSIDERATIONS ABOUT LIMITS

For Fieldbus

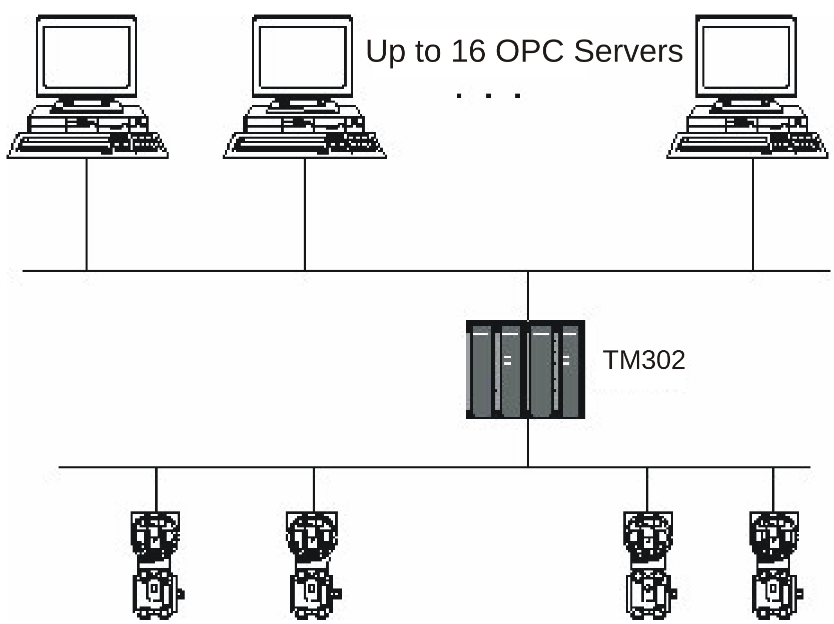
Foundation Fieldbus uses the Publisher/Subscriber model to communicate with the devices. When a link between two blocks is configured, the device that sends the data is called Publisher and the device that receives the data is called Subscriber. See the picture below:



Use only one Object Link (OL) for the internal links in the AuditTank, 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 AuditTank, such as 300 Ols (object links), 64 VCR publisher and 64 VCR subscriber supported by AuditTank.

For Supervision

Each TM302 can supervise up to 400 Tags simultaneously and support up to 16 OPC Servers connected.



For Modbus

The TM302 supports up to 16 blocks of each type (MBSS, MBSM, MBCS and MBCM).

Chapter 16

ADDING LOGIC VIA COPROCESSOR

As described in the previous chapters, the AuditTank 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 AuditTank system.

DF65 Configuration

The LogicView software configures the Smar's **DF65** Coprocessor. Remember that in the communication between the Processor (TM302) and the Coprocessor (**DF65)**, the TM302 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).

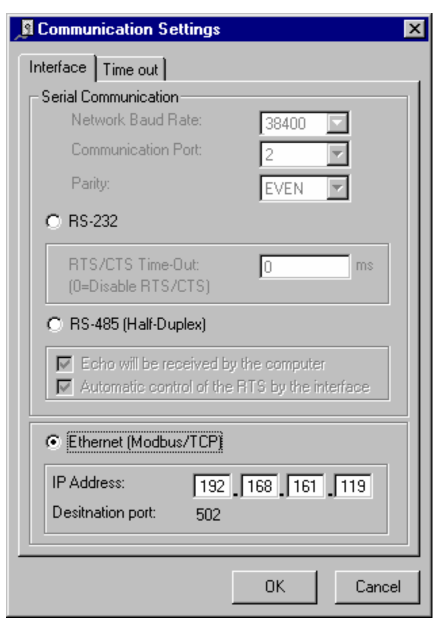
Physical Layer and Time Out

Set the configuration parameters in LogicView to enable the communication with the TM302.

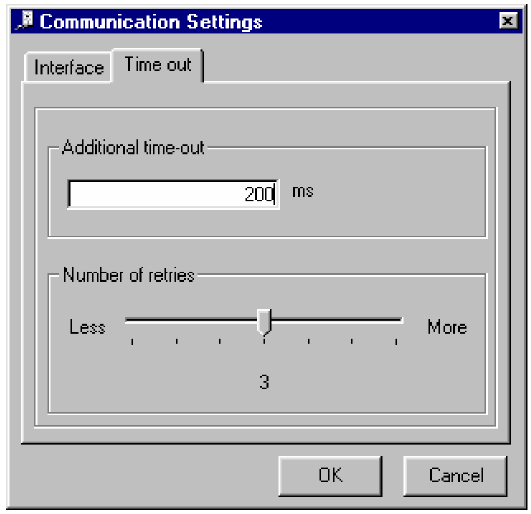
Using FBTools, check the IP Address of the TM302 that will be configured in LogicView. The configuration will be sent to the DF65 via TM302, that is, the TM302 will execute a Modbus bypass.

Remember the DF65 and TM302 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 TM302 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 TM302 in the network using Fbtools;
- Configure the serial communication between the DF65 and the TM302 (DF65 dip switches, baud rate, parity, serial communication channel, etc).
- Configure the communication between Logic View/DF65, using the TM302 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 TM302

It is necessary to add the Modbus blocks to control the communication between the coprocessor and the TM302, to monitor and exchange data between the DF65 and the TM302. The Modbus blocks are available in the AuditTank 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 TM302 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 TM302 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.

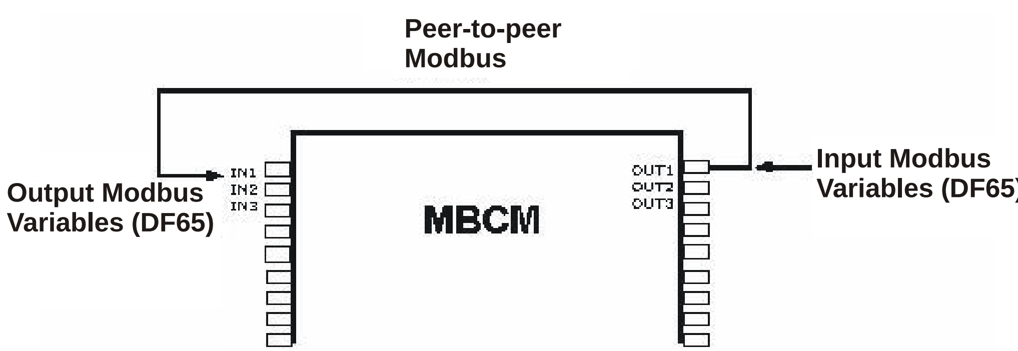
Using LogicView, click the option Modbus Address and write the Modbus addresses. Open the Process Cell window in the Syscon application, create a MBSM block and set the parameters using the Modbus addresses.

The user can monitor the Modbus variables using Syscon.

Exchanging data between the DF65 Coprocessor and the TM302 using the MBCM block

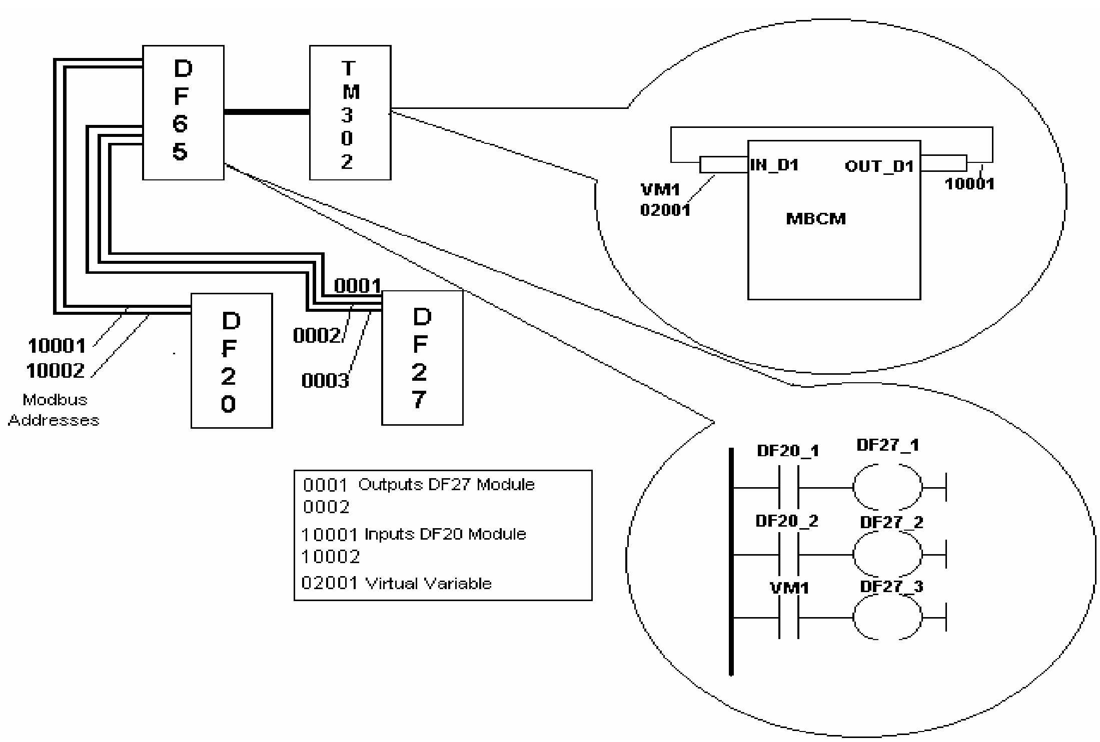
Add the MBCM block to the logic project. Set the Modbus addresses of the variables to control and monitor them.

The MBCM block can read Modbus variables and write them to the TM302, and read Fieldbus variables and write them to the DF65. This block allows the peer-to-peer communication between two Modbus slaves.



The picture above shows how to set the MBCM block parameters.

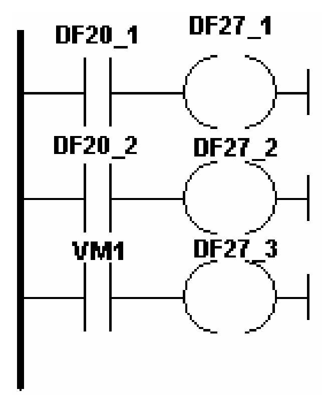
Modbus input variables: the data read from transmitters, discrete sensors, etc., are mapped to Fieldbus through the MBCM block. The user configures the Modbus address of the variables in the parameters of the MBCM block, checking that the address is configured in a block output parameter.
Modbus output 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 example uses discrete input and output modules, but analog variables can also be used.



Communication Example between TM302 and 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 TM302.

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 TM302 executes the process control.

Summary on how to configure the communication and the data exchange between the DF65 and the TM302

In Logic View

✓ In LogicView, select **Tools=>Comm Settings,** select “Ethernet Modbus” and type the IP address of the TM302 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 TM302, where the TM302 bypasses the Modbus information. If a failure occurs, check if the TM302 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 TM302 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.

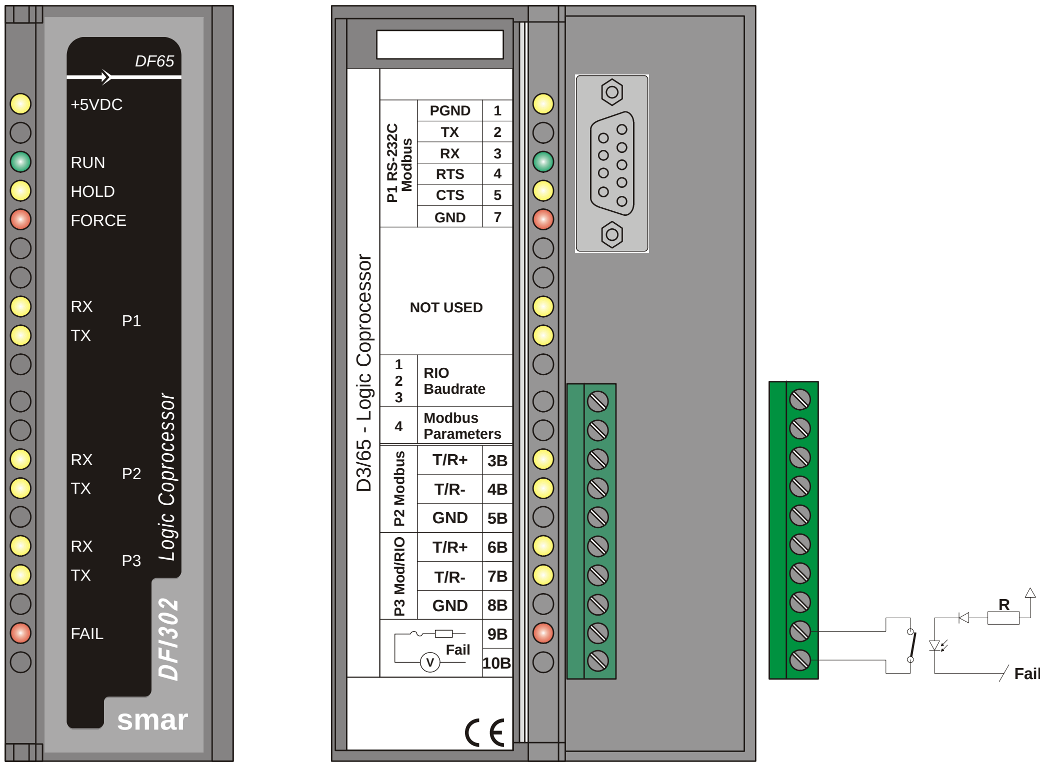
- Right-click the Fieldbus Networks icon and select “Comm. Settings”. Check if the Server ID is Smar.TM302OLEServer.0.

- Right-click the TM302 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	28 Kbytes

Configuration	
Software Suite	System 302 and LogicView
Operation System	Windows NT or 2000

Communication Port	
Quantity	3
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 TM302 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 Resistence	<13Ω
Status Indication	Red Led - Fail
Indication Logic	Light Led (close contact)
Overload Protection	Must be foreseen externally
Operation Time	Maximum 5 ms
Discharge Time	Maximum 5 ms
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 in 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 (L x P x A)	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 TM302.

2. The configuration download is failing completely.

Suggestion: Check if the logon process is complete and the user has the Administrator access level.

The TM302 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 TM302 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 TM302 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 TM302 (or resetting), the Firmware is probably corrupted. Download the firmware again. To do so, follow the steps:

2.1- Make sure the TM302 is turned on and connected to the Subnet. Otherwise, follow the procedure "Connecting the TM302 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 TM302 and click the "**Next**" button.
2.4- Choose the path for the TM302 OLEServer (default: Local) and click "**Next**".
2.5- Select the TM302 module in the option "Module" using the serial number as a reference (check the label in the TM302 module).
2.6- Click the "**Browse…**" button to select the firmware file (*TM302**.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 TM302 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 TM302 in HOLD Mode, how should I proceed?**
Use the HOLD Mode procedure. Set the TM302 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 TM302. It the problem persists, it will be necessary to download the firmware to the TM302 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 TM302 and Switch/HUB.
DF55 – Cross Cable. Used in point-to-point networks between PC and TM302.

6. The LED FORCE is blinking, how should I proceed?
Use the RESET procedure.

7. The FBTools doesn't show all TM302'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 TM302 modules from the SubNet and execute the procedure "Connecting the TM302 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 TM302.
- 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 TM302.
- 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 TM302.

9. The TM302 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 TM302 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 TM302".

11. During Syscon operation, in the Online Characterization of some blocks, it lose the connection with the TM302.

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 TM302.

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: TM302OleServer.dat
#TM302 OLE Server
SMAR-TM302OPC_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 TM302 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.

Appendix B

TECHNICAL SPECIFICATIONS

TM302 Specifications

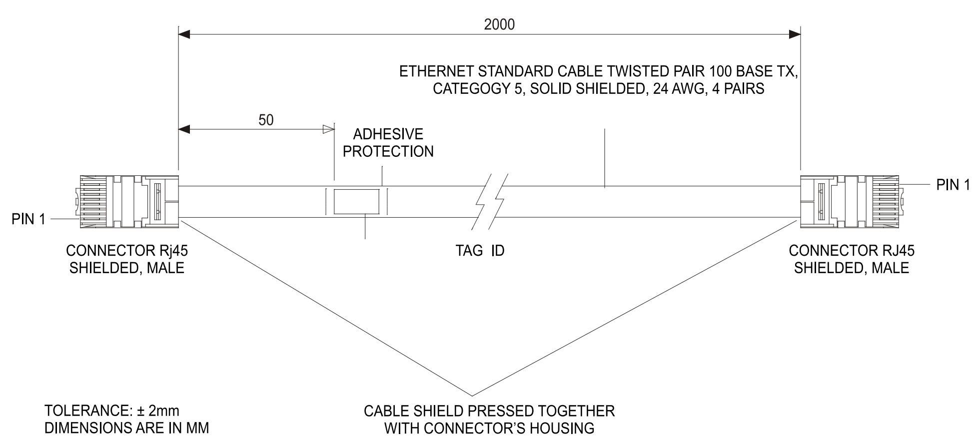
Environment Conditions	
Operation	0-60 °C, 20-90% RH non condensing.
Storage	-20 ± 80 °C, 20-90% RH non condensing. Exception DF51 module -20 ± 25 °C, 20-90% (The battery would last ten years).

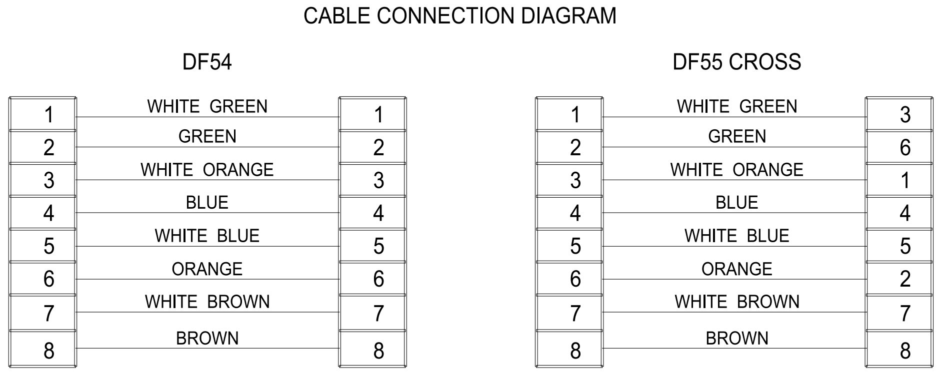
TM302		
Type	32-bit RISC.	
Performance	50 MIPS	
Memory for code	2MB, 32-bit Flash Memory (firmware can be upgraded).	
Memory for data	2MB, 32-bit NVRAM (Data and configuration retention).	
Fieldbus Interface	Number of Ports	4, independent with DMA
	Physical Layer Standard	ISA-S50.02-1992
	Baud Rate	31.25 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.	

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 TM302 and Switch/HUB.
DF55 – Cross Cable (Cross). Used in a point-to-point network between PC and TM302.





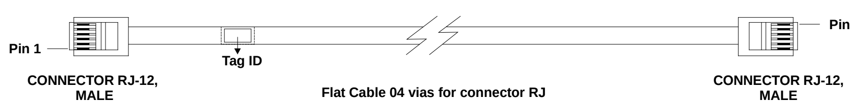
Note: The colors schema is a suggestion, but it is important to use the pairs (color XXX and white/color XXX).

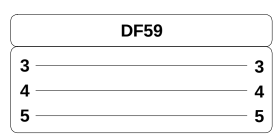
The DF54 cable has the following length options:

PRODUCT	CLASS	OPTION
DF54		**TWISTED PAIR CABLE 100 BASE TX**
1 – CABLE LENGTH	1	0.5 m
	2	2 m
	3	3 m
	4	5 m
	5	10 m

Serial Cable Specifications

To connect the TM302 (Processor) and DF58 (RS232/RS485 Interface), use a DF59 cable, according to the specifications





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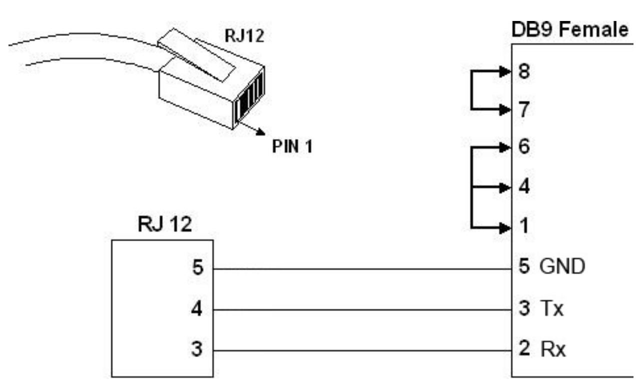
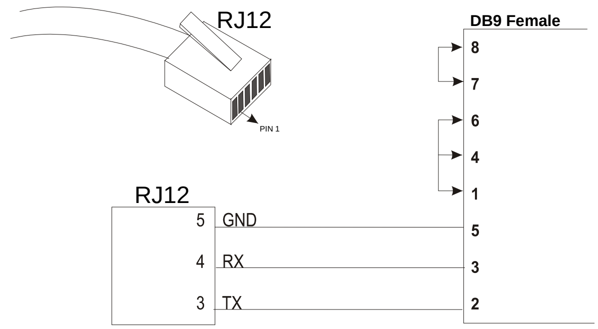
To assemble a serial cable between the TM302 (Processor module) and the PC computer, follow these instructions of a connection between RJ12 (used in the TM302) and DB9 Female.

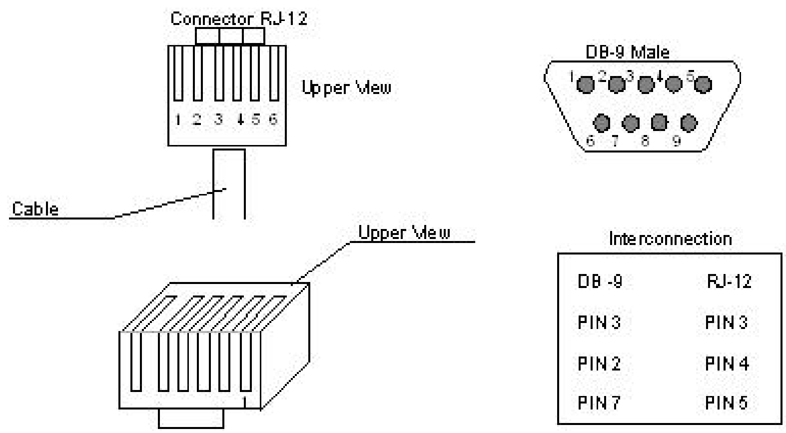


It recommends use the jumpers on the DB9 side, but it is not necessary. It depends on the application running on the PC.



Connection Cable between TM302 and LC700

To connect the TM302 (Processor) to the LC700, use a DF68 cable, according to the following figure.



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	AuditTank flat cable to connect two racks – length 6.5 cm
DF4A	AuditTank flat cable to connect two racks – length 65 cm
DF5A	AuditTank flat cable to connect two racks – length 81.5 cm
DF6A	AuditTank flat cable to connect two racks – length 98 cm
DF7A	AuditTank 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

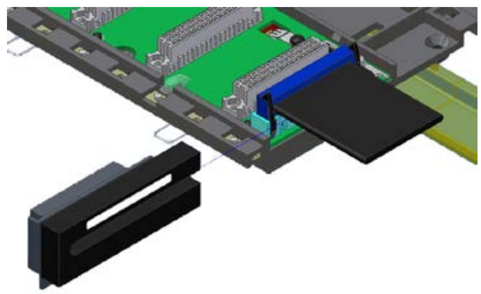
These flat cables are used when the AuditTank is expanded in more than one row of racks (DF92 or DF93), i.e., in different DIN rail segments, one below the other. To ground the flat cables' shield, use ground terminals next to the connections among flat cables and racks.

- **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.

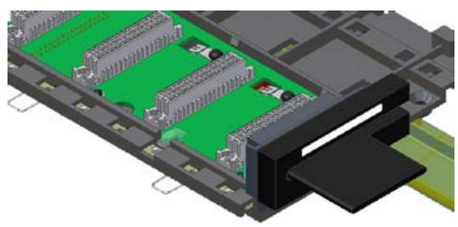
Flat cables protector (connector cap)

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 Audittank 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)

smar	SRF – Service Request Form	
	AUDITTANK	**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 failure. Can the error be reproduced? Is it repetitive?)

____

____

____

____

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**.