PD3

smar

DIDACTIC PILOT PLANT

NOV / 13

PD3

PILOPLME

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INTRODUCTION

The objective of Smar pilot Plant is to demonstrate the operation of different control loops, using the same equipments and configuration tools (software) developed for industrial control applications. In a compact array, all components of this loop provide easy access, for the instructors and learners, being not only a structure to be observed, but manipulated too. The implementation of these loops contains the same characteristics and situations found by professionals of instrumentation through high technology resources available in the market. Besides the loops provided in default configuration, the operator can generate other loops using the same physical structures mounted without the necessity of mechanical modifications, only modifying the devices configuration. The Smar Pilot Plant is monitored and operated by one station which makes data acquisition and presents it through computer animations. It also allows actuation in registers, modifying internal values of devices and the operational modes of the loops.

This document is destined to guide Smar Pilot Plant users in the first steps using this Industrial Instrumentation and Control learning tool.

You will receive a CD-ROM called **Backup of Pilot Plant** when you get Smar Pilot Plant. With this CD, and having already previously installed the **System 302** in the computer, it is possible to load all the necessary configurations for the start of the Pilot Plant's operation.

NOTE
See the "Restoring Original Configuration Manual" for further detail.

GENERAL CHARACTERISTICS OF PILOT PLANTS

Smar Pilot Plants were created to allow easy transportation; therefore they have important characteristics that attend this requirement:

- ✓ They don't need any of their elements taken off or demounted for transportation in short or long distances;
- ✓ They have wheels for displacement;
- ✓ They are light-weighted, allowing them to be maneuvered with great facility by two people on a plain surface.

All tanks and piping are made of Stainless Steel which guarantees great longevity.

They have a mounting board instead of a panel, making electrical drive elements and command elements visible for learners. The acrylic frames contain plant identification, user's information and main control strategies related.

The "ProcessView" supervision systems installed in the PC is the software that allows monitoring and actuation in the on-line system mode and provides the user creation tools for synoptic screens, graphical registers, alarms treatment, reports, data base, information transference to other applicative, visualization in multiple monitors, among many others characteristics. The supervision station isn't attached to the plant, thus it can be operated remotely.

Section 3

EQUIPMENT

Below we have a brief description of the Pilot Plant 3 equipment.

3.1. Metallic Table

The metallic table is composed by supports, buttons, beepers, protectors, terminal blocks and tanks where the electrical and mechanical assemblies are made.

3.2. Pump with Motor

There are two hydraulic pumps in the pilot plant. They are responsible for water flow, mixture and hot water tanks fulfillment.

Pump with Motor

Characteristics

▪ **Model and Manufacturer:**
Model: P500
Manufacturer: KSB

▪ **Operational Data:**
Power: 220V / 0,5 HP
Repression: 1"
Suction: 1"
Max. Temperature: 80 C
Flow: 45 L/Min

▪ **Technical Specifications:**
Pump must be installed with the motor shaft in the horizontal position.

3.3. Control Valves

There are 2 control valves in the pilot plant that are responsible for water flow control.

Control Valve

Characteristics

▪ **Model and Manufacturer:**
Model: Masoneilan® 21000 Series Control Valve – (88-21125)
Manufacturer: Dresser Flow Control

▪ **Body:**
Type: Globe, Simple Seat.
Material: Carbon Steel, ASTM A 216 GR. WCB
Diameter: 0.5"
Leading/CV: Integral/6.000
Connection: RF Flanged
Connection Class: ANSI 150
Stud Bolt/ Nut: B7/2H

▪ **Tower:**
Type: Normal
Gasket: Teflon-Asbestos
Lube: No

- **Internal Parts:**
  Final Characteristic: Equal %
  Shutter Type: Profiled
  Shutter Material: AISI 316
  Seat Material: AISI 316
  Rod Material: AISI 316
  Guide Type: Top
  Guide Material: AISI 440 C
  Stanch Factor: Class IV ANSI B16.104

- **Actuator:**
  Type/Size: Multi-Spring and Diaphragm 6
  Action: Close/Open with 11/23 psi
  Flow: Open
  Air: Open
  Fault Position: Close
  Volant: No

- **Positioner:**
  Type/Model: Micro processed Fieldbus Positioner / FY-302

- **Accessories:**
  Regulator Filter 78-4 Model with Gage

3.4. Water Rotameter

The 2 rotameters in the pilot plant have the function of indicating if there is or there isn't flow in the piping.

These rotameters are basically constituted of a conic glass tube compressed between two connection terminals which are united by tie rods.
They can be optionally furnished with protection against hits/shocks.

Rotameter

Characteristics

- **Model and Manufacturer:**
  Model: 4T7BFR5A888NA with protection
  Manufacturer: OMEL

- **Technical data**
  Thread: NPT female
  Gauge: 1"

Packing: neoprene with esc - grave pipe
Contact material ASTM a744cf8m, no contact sae 1020
Float: aisi 316
-Conic pipe: 0m2450p4-c
X12 protection item code: 4t7bfr5a888na
Fluid to work with rotameter: water
Density: 1 g/cm3
Viscosity: 1 cp
Operational temperature: 21 oc
Operational pressure: 2 kgf/cm2
Scale: 0 - 2000 l/h
Input/output position: vertical

3.5. Level Switch

The level switch is responsible for low level detection in hot water tank. When the switch detects a low level, it will send a digital signal to the control panel to inhibit the current supplying the static converter. This procedure prevents that the electric resistances, which are responsible for water heating, are damaged by lack of water.

Level Switch

The level switch model LC-350, using the conductivity principle, is still one of the most used in all industrial segments. It can be furnished with an integral/local or electronic remote unit. It contains sensors made of stainless steel that permits the use of connecting rods with up to 100 meters and supports high temperatures. Because of these characteristics it is specially indicated for level boiler control and automatic control of electro-pumps, as much for low reservoirs level as superior reservoirs level. It can be furnished to actuate up to 4 different points.

Principle of Operation:
The electrodes (sensors) are disposed in heights where it is desired to control liquid level in the reservoir. The liquid, achieving the ground electrode and the actuation electrode, close the circuit by its own conductivity, activating an electric circuit that in turn commutes an output relay. The detector's sensibility is adjusted taking account the liquid conductivity controlled.

Characteristics

▪ **Model and Manufacturer:**
   Model: LC-350 Remote
   Manufacturer: Incontrol

▪ **Technical Specifications:**
   Power Supply: 220 V / 50 Hz

Output Signal: relay SPDT 10A, 110 Vac max.
Consumption: 3 VA
Operational Temperature: -30º to 350º C
Electronic Unit Temperature: 50º C
Operational Pressure: 10 kgf/cm^2 (under highest consult)
Hard Rod Length: 0.1 to 2 meters
Flexible Rod Length: 1 to 40 meters
Hard Rod Material: 304, 316 standard stainless steel
Process Connection: 1 1/2" NPT
Headstock: Melted Aluminum
Electric Connection: 2 x 1/2" NPT
Protection: IP-56, NEMA 4
Remote Electronic Unit

3.6. Level Sensor (Electrode)

These sensors are electrodes for the conductive level switch.

Characteristics

▪ **Technical Specifications:**
Level Sensor Type: Electrode, for conductive level switch
Process Connection: ¾" NPT
Process Connection Material: 304 Stainless Steel
Insulator: Teflon
Rod: ¼"
Rod Material: 304 Stainless Steel
Electrode Length: 150mm

▪ **Model and Manufacturer:**
Model: E-300/1
Manufacturer: Level Control

3.7. Static Converter

The static converter will be used to supply current for the electric resistances immersed in the tank.

Static Converter

Applications and Benefits:
In temperature control, specifically in environments heated by electric resistances, it is common to use contactor switching or transformers tap's commutation, but this configuration not always return good results, mainly when charge was variable and thermal demand oscillated in a short period of time. In this case the application of electric static converters is strongly recommended because of the following benefits: accuracy, limitation of demand factor, improvement in resistance lifetime, energy consumption reduction without outwearing mechanical mobile pieces and product quality improvement. A converter / rectifier can be used like battery loader, CC motor power supplier, etc.

Economic Factor:
In comparative studies between electrical static converter Tiristherm and magnetic contactors, it was proved in some processes an 80% energy consumption safety and a resistance increasing lifetime of 10%.

Assembly and Product Description:
The diode is a semiconductor crystal constituted of two layers called P and N, that is, a positively loaded layer and other layer with negative charge. The terminal connected to positive layer is defined ANODE, while the terminal connected to the negatively loaded layer is defined CATODE. Connecting a positive polarity voltage to ANODE, the diode will conduct. On the other hand, while negative voltage is applied to the ANODE, the diode will not conduct electric current to CATODE.

The thyristor (SCR= SILICON CONTROLLED RECTIFIER) is also a semiconductor crystal made by Si or Ge, however it is composed by 4 layers P-N-P-N. Besides ANODE and CATODE have a grade for electric current flow control, which is called trigger. The block commutation for electric current conduction in the thyristor is always done when a positive voltage is applied to the ANODE and through a trigger command current circulates to the CATODE. Once the ignition is done by the trigger, the thyristor will conduct while a positive voltage is kept in the ANODE, even if the ignition is turned off.

Trigger System:
The thyristor trigger system has anti-parallel connection through sequential pulses in the sine zero-crossing.

It is used in circuit equipped with metallic electric resistances or electric resistances which ohm value between the cold and hot state presents a variation lower than 50%. It is also used for high charges, because it doesn't pollute the electrical net with harmonics and doesn't let the power factor decrease when it is partially trigged.

Characteristics

▪ **Technical Characteristics:**
Maximum Power: 11 KW
Nominal Current: 50 A
Circuit Voltage: 220 V / 50 Hz
Command Signal: 4 – 20 mA
Discharge Command Model: TH 8925

Potentiometer for Current Limitation with 220 V / 50 Hz Power Supply
Refrigeration: Natural
With 1 Fuse Protection Extreme Fast, Single, Diazed Type, with Base
Circuit: Monophase – 01 Controlled Phase and 01 Direct Phase
Dimensions: Width: 215 mm x Height: 226 mm x Depth: 210 mm
It is a control unit in solid state, for the conduction of electric charge in controlled levels
Its control is done by electrical signals, sent to thyristor trigger through discharge command, which determine the current intensity to be discharged
Discharge System: Pulse Sequence – Control System that sends sinusoids packages to load through input signal, in intervals. The size of packages and intervals depend on charge necessity. The beginning and the end of packages are always in sine zero-crossing avoiding voltage peaks and disturbs in the electrical network.
Assembling: Assembling in aluminum thyristorised dissipater, shoot command, thermostats, fans brackets for panel fixing.
Cable Connection: Through bolts in Bus
Power Supply Connection and Signals: Through fast connection terminals

- **Model and Manufacturer:**
  Model: TH 8021 A / 50 – 12
  Manufacturer: Therma

3.8. Immersion Resistance

The 2 resistances stay immersed in the tank and provide the water heating.

Immersion Resistance

Applications:
Tanks, boilers, central heaters or water passing heaters, oil and other solutions.

Characteristics

- **Technical Specifications:**
  Immersion resistance: 1 1/2"
  Thread material: ni/cr
  Length: 180 mm
  2 stainless steel elements
  Power: 220 v / 4000 w

- **Model and Manufacturer:**
  Model: DA72I142
  Manufacturer: Resiluz

3.9. Thermostats

The thermostat is located in the hot water tank and it has the function of sending a contact to inhibit the static converter when temperature achieves a high limit.

Characteristics

- **Technical Specifications:**
  Thermostat: aluminium box & water proof
  Front cover - screw fixation
  Rubber seal
  Electrostatic painting: blue epoxy
  Face mounting
  Electrical connection: 1/2 npt female

Internal adjustment
No indication
Fixed differential
2 electrical contacts of the micro key spdt reversible
Length stainless steel sensor bulb: 3/8" x 100 mm
Process connection: 1/2" npt male
Range: 25 @ 95 C
Factory set point: 90 C

- **Model and Manufacturer:**
  Model: TP-T-AT-DN-40-HF - 25/95 oC - 1/2" NPT - 3/8" X 100 MM
  Manufacturer: ACROS
  Quantity: 01 piece

3.10. Temperature Sensor – Thermo resistance Type

The Pt-100 temperature sensor is the device that will measure temperature in hot water tank.
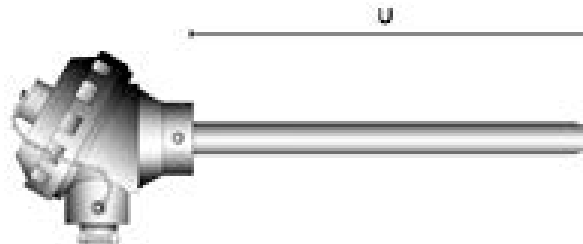
PT-100 Temperature Sensor

Functioning Principle:
The principle of temperature measurement, using thermo-resistances, is based on electric resistance variation of one metallic conductor, depending on the temperature changes. Approximately, but with good accuracy, electric resistance variation of the metal, which depends on the temperature, can be represented by the expression:

R (t) =Ro.(1+at)

Where:

R(t): Electric Resistance in the Temperature "t"
Ro: Electric Resistance in the 0 °Cs
a: Coefficient of electric resistance variation due to temperature, measured in (°Cs)$^{-1}$
t: Temperature, measured in °Cs

A deeper study shows that the coefficient "a" varies in function of the temperature, and this fact must be considered in resistance thermometers, mainly when these thermometers are used in measurements which ranges are higher than 100 °C. Amongst metals, those that showed better performance in Thermo-measurement are:

1- Alloy composed by Rh 99.5% x Fe 0.5%
It is used for temperature measurements in range from 0.5 K up to 25 K (-272.65 °C up to 248.15 °C)

2- Copper
It is used for temperature measurement in range from 193.15 K up to 533.15 K   (-80 °C up to 260 °C). It has linearity of 0.1 °C a temperature range of 200 °C. However, this material has low oxidation resistance which limits the useful temperature range.

3- Nickel
It is used for temperature measurement in range from 213.15 K up to 453.15 K   (-60 °C up to 180 °C). The main attractive in its utilization is its low cost and high sensibility. Its main disadvantage is low linearity.

4- Platinum
It is used for temperature measurement in range from 25 K up to 1235 K   (-248 °C up to 962 °C). This is the most used metal in the resistance thermometers construction, because of its ample useful range, good linearity and better oxidation resistance. Its characteristics will be presented with more details further.

Platinum Resistance Thermometer:
Beyond the characteristics mentioned above about the platinum, it also attends two very important aspects: it presents high chemical inertia and it is relatively easy to find it in the pure form. The resistance thermometers made of platinum present two basic configurations, as it follows: Standard Platinum Resistance Thermometer and Industrial Platinum Resistance Thermometer.

Standard Platinum Resistance Thermometer (SPRT):
This configuration is used in thermometers which are utilized as standard of interpolation in the International Temperature Scale of 1990 (ITS-90) in the temperature ranging from -248 °C up to 962 °C. The behavior of the resistance variation is function of the temperature and showed by the equation:

$$R(t) = R_0.(1 + At + Bt^2 + C(t - 100)t^3)$$

The typical values of the standard platinum thermometer constants are:

$$R_0 : 25.5 Ohms$$

$$A : 3.985 \times 10^{-3°} C^{-1}$$

$$B : -5.85 \times 10^{-7°} C^{-2} \quad \text{for t<0 °C and zero for t>0 °C}$$

$$C : 4.27 \times 10^{-12°} C^{-4}$$

The main construction characteristics are:

a) The sensor element is made of platinum with a pureness degree higher than 99.999%
b) The assembly is made in way that the platinum isn't submitted to tensions
c) In the production, materials with high pureness degree and chemical inertia, such as quartz in production of tubes and mica in the production of platinum sensor support, are utilized.

The justification for the use as a ITS-90 interpolation standard is the great stability of the thermometer and the accuracy in the measurement, with values from +-0.0006 °C up to 0.01 °C and +- 0.002 °C up to 420 °C.

Industrial Platinum Resistance Thermometer:
The different types of IPRT assembly configurations aim at adequacy to the utilization in an industrial plant, where undoubtedly it will be submitted to the worst aggressive conditions. Making an analogy to the SPRT, the behavior of the resistance variation in function of the temperature is shown by:

$$R(t) = R_0 (1 + At + Bt^2 + C(t-100)t^3)$$

The typical constant values of the industrial platinum resistance thermometer are:

$$R_0 : 100 Ohms$$

$$A : 3.908 \times 10^{-3°} C^{-1}$$

$$B : -5.80 \times 10^{-7°} C^{-2} \quad \text{for t<0 °C and zero for t>0 °C}$$

$$C : 4.27 \times 10^{-12°} C^{-4}$$

The difference between the IPRT constant values and SPRT is caused by the IPRT use of platinum with lesser pureness degree, approximately 99.99%, because of a previous contamination with the objective of reduction of further contamination during its utilization. However, its range is lower than the SPRT, having as highest operational limit 850 °C, because of the high level of contamination that the device starts to suffer. The main quality of the IPRT is its excellent accuracy, being available in models with accuracy of 0.1% and 0.5 % in its operational range. It's possible to achieve a +-0.015 °C accuracy, when it is calibrated and used with appropriate instruments and thermostatic environments, which guarantee its secondary temperature standard status.

Tolerance in Industrial Platinum Resistance Thermometer:
The IPRT tolerance is the maximum allowed deviation expressed in °Cs taking account temperature and nominal resistance relationship.

Tolerance Class	Tolerance °C
A	+-(0.15+0.002) [T]
B	+-(0.3+0.005) [T]
1/5*	+-(0.3+0.005) [T] / 5
1/10*	+-(0.3+0.005) [T] / 10

[T] Temperature module in °C (without signalization)
* Not Normalized

The following table presents values extracted from manufacturer's reference, where it is possible to do a comparison between the tolerances of the different accuracy classes of the bulbs:

Temperature	Class				Band				
	A	B	1/5	1/10	1	2	3	4	5
(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)
0	0,15	0,3	0,06	0,03	0,26	0,13	0,13	0,05	0,03
50	0,25	0,55	0,11	0,06	0,35	0,19	0,18	0,1	0,07
100	0,35	0,8	0,16	0,08	0,45	0,26	0,24	0,15	0,12

Temperature	Class				Band				
	A	B	1/5	1/10	1	2	3	4	5
(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)	(ºC)
150	0,45	1,05	0,21	0,11	0,55	0,33	0,29	0,2	0,16
200	0,55	1,3	0,26	0,13	0,65	0,4	0,35	0,25	0,21
250	0,65	1,55	0,31	0,16	0,76	0,47	0,42	0,31	0,27
300	0,75	1,8	0,36	0,18	0,87	0,55	0,48	0,37	0,32
350	0,85	2,05	0,41	0,21	0,99	0,64	0,55	0,44	0,38
400	0,95	2,3	0,46	0,23	1,11	0,72	0,63	0,51	0,45
450	1,05	2,55	0,51	0,26	1,23	0,81	0,7	0,58	0,51
500	1,15	2,8	0,56	0,28	1,36	0,91	0,78	0,65	0,58
550	1,25	3,05	0,61	0,31	1,49	1	0,86	0,73	0,65
600	1,35	3,3	0,66	0,33	1,63	1,1	0,95	0,81	0,73
650	1,45	3,55	0,71	0,36	1,77	1,21	1,03	0,89	0,8
700	1,55	3,8	0,76	0,38	1,91	1,31	1,12	0,97	0,88
750	1,65	4,05	0,81	0,41	2,06	1,42	1,22	1,06	0,97
800	1,75	4,3	0,86	0,43	2,21	1,54	1,31	1,15	1,05
850	1,85	4,55	0,91	0,46	2,37	1,66	1,41	1,25	1,14

Characteristics

▪ **Technical Information:**
Head: Aluminum, screwed cover, explosion proof
Electrical Connection: ½ NPT
Terminal Blocks: Simple
Nipple/Union: Without Nipple / Union
Nipple (or Bucim) Connection to Well (or process): ½ NPT
Sensor Element: Pt-100 – IEC
Sensor Characteristic: Simple Connection – 3 wires
Isolation: Mineral
Sheath: Material/ Diameter: 316 SST / 6 mm
Well: Construction: Without Well
Well Material: Without
Process Connection: Without Well
Special Features: Without Special Features

▪ **Model and Manufacturer:**
Model: Pt-100
Manufacturer: Consistec

3.11. Thermocouple

A temperature sensor of thermocouple type will measure the temperature in the mixture tank.
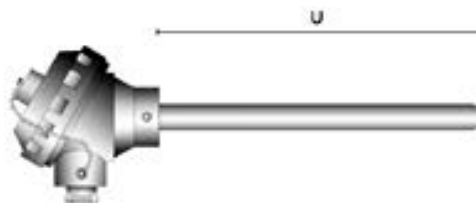
Thermocouple

Characteristics

- ▪ **Technical Specifications:**
  Thermocouple compensation cable
  Type: j
  Length: 1.5 m
  Section: 22 awg
  Isolation: pvc
  Shielding: mylar aluminium and drain wire

- ▪ **Model and Manufacturer:**
  Model: Type J Thermocouple
  Manufacturer: Consistec

3.12. OIT21-N1IT-I-0000-1

Integral orifice and straight pipe

3.13. DFI302 – Fieldbus Universal Bridge

The DFI302 is a multifunction hardware integrated into SYSTEM302.

It uses state-of-the-art hardware and software to manage, monitor, control and operate an industrial plant. Once installed, the DFI302 executes most of the functions required by the control system which results in a small number of additional devices.

Some DFI302 characteristics:
- Original part of SYSTEM302;
- Totally integrated unit with functions as interface, linking device, bridge, controller, gateway, Fieldbus supply font and distributed I/O subsystem;
- Interoperable with different manufactures instruments and software's since its based on open technology like OPC and FOUNDATION Fieldbus;
- Connects with existing devices using conventional I/O and Modbus communication via RS232 or Ethernet;
- Several levels Redundancy;
- Clean architecture based on devices technology;
- High capacity for data communication between plant floor and corporative network.

DFI302 – Fieldbus Universal Bridge

The DFI302 is complete modular. In the pilot plant we use the following standard configuration:

- **Hardware:**
    - Backplane DF1A – Rack with 4 Slots;
    - FieldBus Power Supply DF52 – Power Supply for Fieldbus;
    - Impedance DF53 – Power Supply Impedance for Fieldbus (4 ports);
    - IS400-P - Signal distributor
    - Power Supply DF50 - Power Supply for backplane 90-264VAC;
    - Processor Module DF62 – Processor with one 10/100 mbps port and four H1 FF channels
    - DF3 - Flat cable to connect two racks - length 65 mm
    - DF19 - Module DFI - 2 groups of 8 inputs 240 VAC (Isolated)
    - DF28 - module DFI - 2 groups of 8 no relays outputs
    - DF44 - Module DFI - 8 CH 0-20MA, 4-20MA, 0-5V, 1-5V, 0-10V, +/- 10V inp with shunt res.
    - DF46 - Module DFI - 4 channels 4-20MA, 0-5V, 1-5V, 0-10V, +/- 10V
    - Terminator DF2 – Last rack terminator;
    - SW-700 - Ethernet switch module
    - Standard Ethernet cable DF54 – Twisted-Pair (10 base T) Cable – 2 m length.

- **Software:**
    - DFI OLE Server;
    - System302.

- **Main Characteristics:**
    The DFI302 is the most flexible Fieldbus Foundation Controller and System Host. It is a key element in FCS (Field Control System) distributed architecture. It combines powerful direct I/O access communication characteristics and advanced control for discrete and analog applications. Its modular concept allows it to be placed inside panels on the control room or inside sealed boxes on the field.

DFI Inside View

It is recommended for small applications and/or large and complex plants since it is highly expansible. The DF302 is a multifunction modular device mounted on a backplane, attached on a DIN rail, where all the components are installed, including the Power Supply module (DF50), Processor module (DF51), Fieldbus Power Supply module (DF52) and Impedance module (DF53). The modules are fixed by industrial connectors and held safe by a metal screw.

A conventional I/O subsystem with modules for discrete and analogs I/O can be connected optionally. The modular architecture is the key to flexibility of the DF302 and as all the modules are in the same backplane we can still consider it as fully integrated.

The power supplies and the Fieldbus H1 channels connections are made using plug-in connectors allowing them to be easily and safe removed or inserted. These connectors can not be wrongly connected so any mistake is prevented. The power supply module has diagnose LEDs to indicate normal operation and fail conditions providing and easy way to identify problems and its solution, specially on a system with many units. The fuse is located in the front of the module allowing it to be quickly changed without the need to remove the module or disconnect any wire.

Notice that:
- One backplane supports 4 modules;
- One flat cable is needed between Backplanes sections;
- Each DFI302 requires a terminator;
- One Fieldbus Power Supply and one Processor Module is needed in each DFI302;
- Additional Fieldbus Power Supply may be needed;
- The DFI OLEServer License is available in different levels with different function blocks supervision capabilities.

- **Distributed Architecture:**
  The DIF302 open concept allows discrete and analog control strategy integration, exploring the Fieldbus Foundation protocol potential. It provides communication services for control, supervision with OPC, configuration and maintenance using OLE. The DFI302 modular concept allows the perfect match of the system components. All the configuration and maintenance can be done through him, with high efficiency and interoperability.
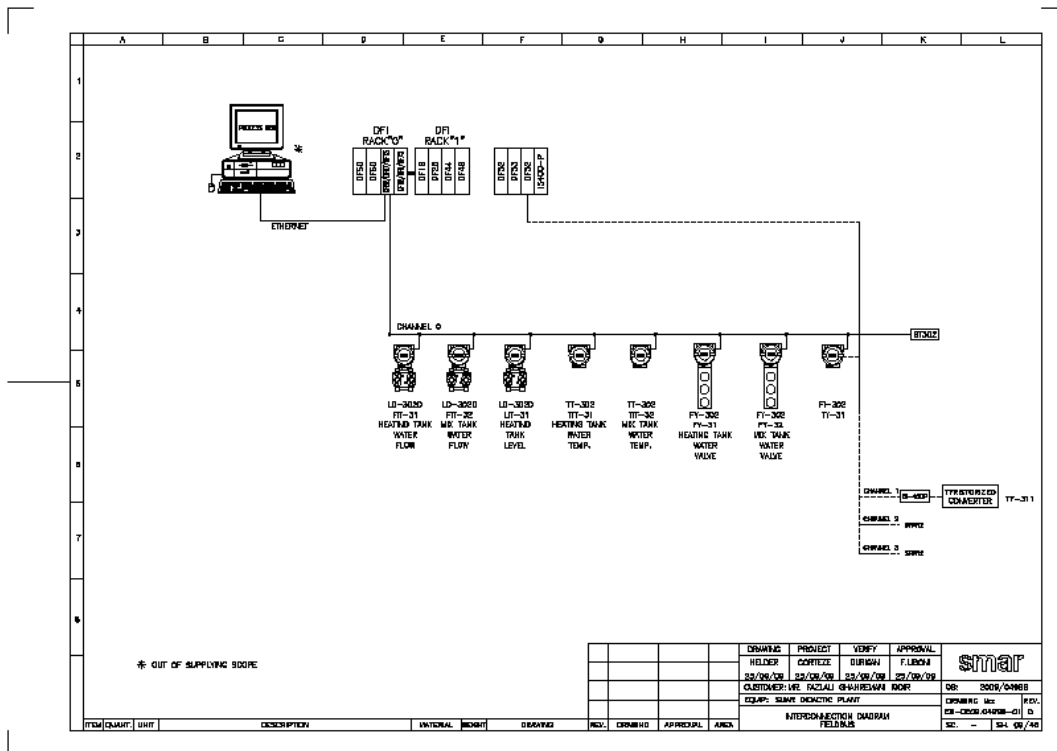
Didactic Plant Architecture

The distribution of the control tasks among the field devices and multiple DFI302 systems enhances the security and efficiency of the whole system.

System Integration:

DFI302 built-in advanced communication characteristics guarantees high system integration:

Fieldbus Bridge:
Transparent communication between Fieldbus ports:
- H1 (31,25kbps)

Redundancy:
DFI302 supports hot-standby redundancy in several levels:
- OLEServer;
- LAS(Link Activity Scheduler);
- Ethernet.

Expandable:
Each DFI302 can direct access 256 I/O nodes distributed among local I/O modules. Exploring Fieldbus characteristics like interoperability, Bridge and Ethernet, the DFI302 system become an unlimited solution for the Automation Industry.

▪ **DF1A - Rack with 4 slots**
   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.

▪ **DF3 – Flat cable**
   Flat cable to connect two racks - length 65 mm

▪ **DF0 - Box used in empty slots**
   Blind module to fill empty slots.

▪ **Fieldbus Power Supply – DF52:**
It is a non-intrinsic safety device that incorporates a universal AC input power supply (90 to 260 Vac, 47 a 440 Hz or DC equivalent), and an insulated 24Vdc output, short-circuit, overcurrent and ripple protected, fail indication, suitable for Fieldbus devices feed.

The module has an auxiliary output contact that indicates fail and may be used to activate a remote alarm or any independent protection.

It also has a fuse in the front that can be changed without removing the module or disconnecting any wire. The output is short-circuiting protected.

▪ **Impedance Module – DF49/DF53:**
   The Fieldbus Power Supply Impedance module – 2 ports (DF49) or 4 ports (DF53) – provides an impedance match in the Fieldbus network. The DF49/DF53 can not be used directly on hazardous areas that require intrinsic safety specifications.

   The fuse is in the module front making it easy to change without need to remove the module or disconnect any wire. The outputs are individually short-circuited protected. An internal LED indicates normal operation and fails condition to each channel.

   It also has and internal bus terminator to each Fieldbus channel that can be enable or disable using dip-switches.

▪ **IS400P – Signal distributor**
   The signal Isolator Distributor Module model IS400P is an auxiliary device projected to isolate galvanically a transmitted signal (current or voltage) of a receiver device, typically a register or controller. Besides, the power supply of the module is isolated from the input and output.

   The signal Isolator Distributor Module - IS400P - solves the problem of the distortion in the signal transfer due to potentials of different ground.
   It can also be used in the power supply of two-wire transmitters.

The Power Distributor and Isolator, model IS400P, can be used in two ways:
- Power supply for two-wire transmitters, providing isolation between input and outputs.
- Isolate at 4-20 mA or 1-5 Vdc signal between the input and outputs.

▪ **Power Supply Module – DF50:**
It is a high performance 24VDC standard power supply. A great number of characteristics make it the best choice of power supply in the market.

The module has diagnose functions and dedicated LEDs that indicates normal operation and fail conditions, making it easy to detect problems, specially on a system with several units.

The fuse is locates on the front of the module, making it easy to change, with no need to remove the module or disconnect any wire. The output is short-circuiting protected.

▪ **Processor Module – DF62:**
DF62 –HSE/ FOUNDATION fieldbus Controller with 1 Ethernet port and 4 H1 channels.

DF62 module is the second generation of Smar HSE Linking Devices. With four H1 channels (FOUNDATION fieldbus), one 10/100Mbits Ethernet port and capability of block execution. DF62 can work as a bridge H1-H1 or a linking device H1-HSE, allowing a wide communication between field devices and greater flexibility in the project of strategies of continuous control. Through the I/O cards, it is also possible to execute discrete control via relay diagram logic ("Ladder Diagram"), allowing a single and integrated system. The module DF62 also can act as Modbus gateway, allowing the interconnection of modules that are not fieldbus or HSE. DF62 also has redundant operation, giving higher security level for industrial process.

- Four H1 channels (FOUNDATION fieldbus).
- It recommends the use of up to 32 field devices (8 devices per H1 channel). However, more devices can be used (up to 16 per H1 channel) under evaluation of performance according each application.
- Limit of 128 linked parameters (16 VCRs publishers and 16 VCRs subscribers per H1 channel).
- Dynamic Block Instantiation.
- Maximum 100 function blocks.
- It supports Flexible Function Block with 242 parameters that can be connected by using interface between the discrete and analog control.
- LAS Function ("Link Active Scheduler").

▪ **DF19 – 2 groups of 8 inputs 240 VAC (Isolated)**

This module senses the AC input voltage and converts it to a True (ON) or False (OFF) logic signal. It has 2 optically isolated groups from each other and from IMB.
- Number of inputs: 16
- Number of groups: 2
- Number of inputs per group: 8
- Optical Isolation between Groups and IMB: 5000VAC
- Power supply: 240 VAC
- Typical Consumption per Point: 10mA

▪ **DF28 - module DFI - 2 groups of 8 no relays outputs**
This high density module is designed to switch pilot lamps, valves, as well as other relay coils up to 5 A per output. The relays can drive loads ranging up to 30 Vdc or 250 Vac. Each group of 8 relays has a common terminal and just one screw terminal is reserved for each relay output. The groups are optically isolated from each other and from IMB.
- Number of inputs: 16
- Number of groups: 2
- Number of inputs per group: 8
- Optical Isolation between Groups and IMB: 5000VAC
- Power supply: 20 – 30 VDC
- Typical Consumption per Point: 90 mA @ 24 Vdc
- Power Supply Indicator: Green Led

▪ **DF44 - Module DFI - 8 CH 0-20MA, 4-20MA**
These modules read 8 voltage or 8 current analog signals. The group is isolated from IMB. Only the module DF57 has differential inputs. The inputs are individually configured to read:

- 0 - 5 V, 1 - 5 V, 0 - 10 V, ± 10 V, with the internal shunt resistor in the position "V"
- 0 - 20 mA, 4 - 20 mA, with the internal shunt resistor in the position "I"
- Number of inputs: 8
- Number of groups: 1
- Number of inputs per group: 8
- Optical Isolation between Groups and IMB: Up to 1500 Vrms
- Internal Power:
  Provided by the IBM: 340 mA (maximum) @ 5 Vdc
  Total Maximum Dissipation: 1.7 W
- Power Supply Indicator: Green Led

▪ **DF46 - Module DFI - 4 channels 4-20MA, 0-5V, 1-5V, 0-10V, +/- 10V**
This module provides 4 pairs of analog outputs. Each pair is composed of one current output and one voltage output. When one output is selected, the corresponding pair is selected simultaneously. The current outputs can be configured individually on ranges 0 - 20 mA or 4 - 20 mA. For voltage outputs the range is 0 - 5 V, 1 - 5 V, ± 5 V, 0 - 10 V, 2 - 10 V or ± 10 V. The group is optically isolated from IMB.
- Dipswitch 1 - UP Side: Configure the Group of Ranges of Channel 0 (I0/V0);
- Dipswitch 2 - UP Side: Configure the Group of Ranges of Channel 1 (I1/V1);
- Dipswitch 1 - DOWN Side: Configure the Group of Ranges of Channel 2 (I2/V2);
- Dipswitch 2 - DOWN Side: Configure the Group of Ranges of Channel 3 (I3/V3).

▪ **DF78 - Rack with 4 slots for Redundant CPUs**
The DF78 rack allows 02 CPUs modules to access the same I/O. This possibility is used when redundancy is required and where is found 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)

▪ **Terminator DF2**
Last rack terminator

▪ **BT302- Foundation Fieldbus & Profibus PA Bus Terminator**
The BT302 is a fieldbus bus terminator specifically designed for industrial plant applications.

This device has been developed to comply with the requirements of IEC 61158-2 (ISA –S50.02-1992) and it can be used in safe or hazardous areas, in accordance with the intrinsic safety standards requirements.

Its concept is extremely simple, but efficient consisting of RC series circuit. Only highly accurate components with a low drift to temperature are used. The circuit is enclosed in housing for easy installation and totally enclosed, therefore protected from humidity and other environmental factors. The BT302 device can be mounted in panel or installed in distribution boxes.

▪ **JM1 - Junction Box for Foundation Fieldbus Fieldbus & Profibus PA**
The JM1 is a junction box especially designed for Fieldbus connections that makes wiring considerably easier. The IP67 rated enclosure combined with appropriate cable gland, protects the wire connections from dust, water and moisture. It may be used indoors or outside and can withstand the most severe environments.

The cover with internal threads permits an easy access to the terminals, without the use of tools. The terminals are twin type at both ends. They can be used as the input and output of the bus in one end and as device output in the other end, keeping apart the wires that should be disconnected in case of device maintenance. This arrangement makes possible the disconnection of a single device without disrupting the continuity of the whole segment.

Prevents short-circuiting the entire bus during maintenance;
Allows an easy and safe device connection to the Fieldbus;
Reduces the start-up time and simplifies electrical maintenance;
Permits disconnecting one device without disrupting the continuity of the bus;
The weather proof housing prevents water, oil and dust from reaching the connections;
Conduit connection according to several different international standards;
Heavy duty copper free cast aluminum construction;
Cover gasket allows the use in water-tight or wash-down applications;
Locking mechanism;
Do not require lugs.

- **ITF-D-12**
  Interface module

- **SW-700 - Ethernet switch module**
  Smar SW-700 module is a Fast Ethernet Switch that provides LAN networks with 10 Base-T/100 Base-TX high-speed auto-sensing connectivity. Five ports, where one is dedicated for the Uplink will provide access for many devices and will help to eliminate traffic congestions that can't be well treated by Network Hubs.
The SW-700 is also a great choice when connecting different speed networks as Ethernet and Fast Ethernet and will also optimize finding the right path for same type of Ethernet. LED indicators for link/activity, speed, full/half duplex and collision for each individual port and one for module power.
It can be powered by the Rack or by an external 24Vdc. Power supply redundancy circuit will automatically switch from the user preferred supply to the other one in case of failure.
Industrial design, no internal fans and low EMC makes it a great option for automation and process control applications.

- **Standard Ethernet cable DF54 – Twisted-Pair (10 base T) Cable – 2 m length.**
  To be used in network communication between controllers and Switch/HUB.

- **DF55 Ethernet Cable – Cross Cable**
  To be used in a point-to-point communication between PC and controller.

- **DF82 - DFI302 Hot Standby Sync Cable**
 DF82 cable interconnects redundant controllers. Length 500 mm

Open Protocols:
The DFI302 is a complete open solution to system integration compatible with many standard protocols. This means high integration with the Field Control System devices.

Fieldbus:
Supports the Fieldbus Foundation protocol, one of the most complete standard protocol available for the automation industry.

Ethernet, Fieldbus and
Modbus connections.

EIA 232 Modbus

Ethernet

4 x H1 Fieldbus
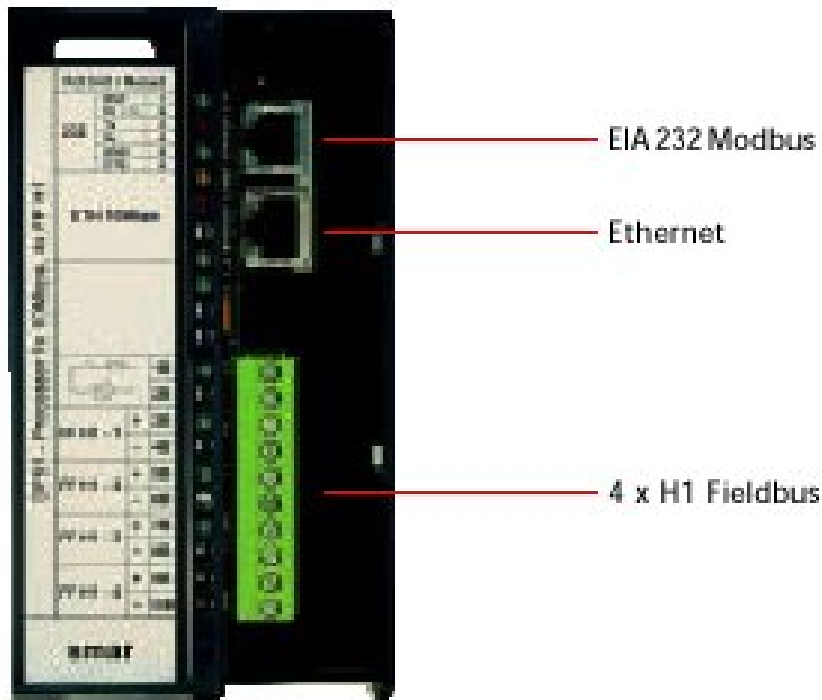
DFI Frontal View

Ethernet:
Implements the Smar Ethernet (SE) protocol based on TCP/IP and can coexist with other Ethernet protocols, allowing it to connect with other systems. Foundation Fieldbus High Speed Ethernet (FF-HSE) will be supported in upcoming versions.

EIA232:
With this additional port the Modbus protocol can connect the Fieldbus data to virtually any other device or system.

High Reliability:
The DFI302 built-in distributed architecture guarantees a high reliability even in hostile industrial environments: no hard disks, no moving mechanical parts. At software executing level, the internal tasks (communication, function blocks, supervision, etc) are controlled by a multi-task system to guarantee deterministic and real-time operation.

Configuration:

The DFI302 is complete configured using Function Blocks available in Fieldbus Foundation standard. This allows the system (DFI302 and field devices) to be complete configured by one applicative.

Process control, Interlocking logic, Recipes, Alarms, Calculus and Equations, everything can by configured in one environment.

Supervision:

The DFI302 is built with the most recent technologies. Some of these technologies like OPC (OLE for Process Control) make the DFI302 the most flexible Fieldbus Interface on the market.

The OPC server allows that the DFI302 connects to any supervision packet. The only requirement is a client OPC to the packet. You can connect the DFI302 to the best Supervision Interfaces available, customizing the SYSTEM302 to your needs.

3.14. LD302D – Fieldbus Foundation Differential Pressure Transmitter

The LD302 transmitter line incorporates the highly proof pressure measure with capacitive cell technique and the flexibility and accuracy guaranteed by the use of a microprocessor in its circuitry. It can be used to measure differential, absolute and barometric pressure and also level and flow.

The digital technology used in the LD302 allows the choice of several transfer function types, an easy interface between the field and the control room, better accuracy and stability. Special characteristics lower the installation, operation and maintenance costs.

The 302 series devices development takes in mind the need of Fieldbus implementation in both small and big systems. The LD302 can be locally configured using a magnetic tool or remotely using Syscon.

LD302 – Fieldbus Foundation Pressure Transmitter

Characteristics:

- **Output:**
  Digital Only. FOUNDATION Fieldbus on 31.25 kbit/s voltage mode according to IEC 61158-2.

- **Range:**
  0 to 40 MPa (5800 psi).

- **Rangeability:**
  Accepts calibration from URL to URL/40.

- **Accuracy:**
  ± 0.075% of calibrated span

- **Power Supply:**
  Bus powered: 9-32 Vdc

- **Power Consumption:**
  Quiescent 12 mA

- **Function Blocks:**
  Up to 20 Dynamically Instantiable Function Blocks. The Function Blocks available allow simple and complex control strategies to be placed inside the field device, making the field device an integral part of the control system. In order to fully benefit from the Function Blocks in the device a True Foundation Fieldbus system is recommended.

- ▪ **Indicator:**
  Optional 41/2-digit numerical and 5-character alphanumerical LCD indicator.

- ▪ **Temperature Limits:**
  Environment: -40 to 85 ºC (-40 to 185 ºF)
  Process:
  -40 to 100 ºC (-40 to 212 ºF) (Silicone Oil);
  0 to 85 ºC (-32 to 185 ºF) (Fluorolube Oil);
  -40 to 150 ºC (-40 to 302 ºF) for LD302L;
  -25 to 85 ºC (-13 to 185 ºF) (Viton O-Rings).

- ▪ **Environment Humidity Limits:**
  0 to 100% RH

- ▪ **Wetted Parts:**
  Plated carbon steel, 316L SST, Hastelloy C276, Monel or Tantalum.

- ▪ **Non-wetted Parts:**
  Injected aluminum with polyester painting or 316 SST

- ▪ **Hazardous Area Certification:**
  Explosion proof, weather proof and intrinsically safe

- ▪ **Weight:**
  3.15 kg (7 lb): all models, except level transmitters: 5.85-9 kg (13-20 lb)

3.15. TT302 – Fieldbus Foundation Temperature Transmitter

The TT302 is from the first generation of Fieldbus devices. It is a transmitter mainly intended for measurement of temperature using RTD's or thermocouples, but can also accept other sensors with resistance or mV output such as: pyrometers, load cells, resistance position indicators, etc.

The digital technology used in the TT302 enables a single model to accept several types of sensors, wide ranges, single-ended or different measurement and an easy interface between the field and the control room. Also, several interesting features reduce considerably the installation, operation and maintenance costs.

Configuration can be accomplished through the Syscon software.

TT302 – Fieldbus Foundation Temperature Transmitter

Characteristics:

- ▪ **Input:**
  Single unit accepts signal from:
  - Thermocouples, RTD's and Differential RTD's
  - mV signals from radiation pyrometers, load cells, etc
  - Ohm signals from position indicators, etc

- **Output:**
  Digital Only. FOUNDATION Fieldbus on 31.25 kbit/s voltage mode according to IEC 61158-2.

- **Accuracy:**
  ± 0.02% basic accuracy

- **Configuration:**
  Using local adjustment magnetic tool if device is fitted with LCD display. Complete configuration possible using PC software interface.

- **Power Supply:**
  Bus powered: 9-32 Vdc

- **Power Consumption:**
  Quiescent 12 mA

- **Function Blocks:**
  Up to 20 Dynamically Instantiable Function Blocks. The Function Blocks available allow simple and complex control strategies to be placed inside the field device, making the field device an integral part of the control system. In order to fully benefit from the Function Blocks in the device a True Foundation Fieldbus system is recommended.

- **Indicator:**
  Optional 4½-digit numerical and 5-character alphanumerical LCD indicator.

- **Temperature Limits:**
  Environment: -40 to 85 ⁰C (-40 to 185 ⁰F)

- **Environment Humidity Limits:**
  10 to 100% RH

- **Hazardous Area Certification:**
  Explosion proof, weather proof and intrinsically safe

- **Weight:**
  - ✓ Nominal: 0.80 kg;
  - ✓ Digital display adds: 0.13 kg;
  - ✓ Mounting bracket adds: 0.60 kg.

3.16. FY302 – Fieldbus Foundation Valve Positioner

The FY302 is from the first generation of Fieldbus devices. It is a control valve positioner for pneumatic valve in a Fieldbus system. The FY302 produces a pressure output as required to position a control valve according to an input received over the Fieldbus network or internal controller.

The Fieldbus technology used in the FY302 enables, an easy interface between the field and the control room and several interesting features that considerably reduce the installation, operation and maintenance costs.


FY302 – Fieldbus Foundation Valve Positioner

Characteristics:

- **Input:**
  Digital only, Foundation Fieldbus, 31.25 kbit/s voltage mode with bus power.

- **Output:**
  Output to actuator 0-100% supply air pressure. Single or double-action.

- **Output Capacity:**
  46.7 Nm³/h (28 SCFM) at 5.6 bar (80 psi) supply.

- **Power Supply:**
  Bus powered: 9-32 Vdc

- **Power Consumption:**
  Quiescent 12 mA

- **Accuracy:**
  ± 0.02% basic accuracy

- **Configuration:**
  Using local adjustment magnetic tool if device is fitted with LCD display. Complete configuration possible using PC software interface.

- **Pressure Supply:**
  1.4-7 bar (20-100 psi). Free of oil, dust and water.

- **Actual Position Sensor:**
  Magnet (Non-contact) via Hall Effect

- **Function Blocks:**
  Up to 20 Dynamically Instantiable Function Blocks. The Function Blocks available allow simple and complex control strategies to be placed inside the field device, making the field device an integral part of the control system. In order to fully benefit from the Function Blocks in the device a True Foundation Fieldbus system is recommended.

- **Indicator:**
  Optional 41/2-digit numerical and 5-character alphanumerical LCD indicator.

- **Material:**
  Injected low copper aluminum with polyester painting or 316 stainless steel housing.

- **Temperature Limits:**
  Environment: -40 to 85 ºC (-40 to 185 ºF)

- **Environment Humidity Limits:**
  0 to 100% RH

- **Hazardous Area Certification:**
  Explosion proof, weather proof and intrinsically safe

- **Weight:**
  - ✓ Nominal: 2.7 kg;
  - ✓ Digital display adds: 0.1 kg.

3.17. BFY Bracket for FY

BFY is a coupling device for the FY family of Smar positioners, designed for applications in several different models of final control elements.
The BFY is used with the FY301 / FY302 / FY303 / FY400 Smar positioners – presented in HART®/4-20 mA, Foundation fieldbus™ and PRoFiBuS PA communication protocol versions.

- Easy installation;
- Available in carbon and stainless steel;
- Diagnostics through the FY family positioner;
- Applications diversity.

3.18. FI302 – Fieldbus Foundation to Current Converter

The FI302 converts a FIELDBUS signal into a 4 to 20 mA signal. If the frequency converter does not have FIELDBUS capability, the bus signal can be converted into a conventional 4 to 20 mA by the FI302. The FIELDBUS signal can, for example, be a request from the bus to a frequency converter to set a conveyor speed to 3.4 ft/s.

This instrument has three independent channels, which means that three 4 to 20 mA outputs are available.

FI-302 – Fieldbus Foundation to Current Converter

Characteristics:

- **Input:**
  Digital only, Foundation Fieldbus, 31.25 kbit/s voltage mode with bus power.

- **Output:**
  Three 4 to 20 mA current links, external supply and common ground.

- **Output Load Capacity:**
  External Output Supply Voltage / 3-45 Vdc

- **Accuracy:**
  ± 0.1% basic accuracy

- **Power Supply:**
  Bus powered: 9-32 Vdc

- **Power Consumption:**
  Quiescent 12 mA

- **Function Blocks:**
  Up to 20 Dynamically Instantiable Function Blocks. The Function Blocks available allow simple and complex control strategies to be placed inside the field device, making the field device an integral part of the control system. In order to fully benefit from the Function Blocks in the device a True Foundation Fieldbus system is recommended.

- **Configuration:**
  Using local adjustment magnetic tool if device is fitted with LCD display. Complete configuration possible using PC software interface.

- **Indicator:**
  Optional 41/2-digit numerical and 5-character alphanumerical LCD indicator.

- **Material:**
  Injected low copper aluminum with polyester painting or 316 stainless steel housing.

- **Temperature Limits:**
  Process: -40 to 85 ºC (-40 to 185 ºF)

- **Environment Humidity Limits:**
  0 to 100% RH

- **Hazardous Area Certification:**
  Explosion proof, weather proof and intrinsically safe

- **Mounting:**
  Wall, panel, or 2" pipe with optional bracket

- **Weight:**
  - ✓ Nominal: 0.80 kg;
  - ✓ Digital display adds: 0.13 kg;
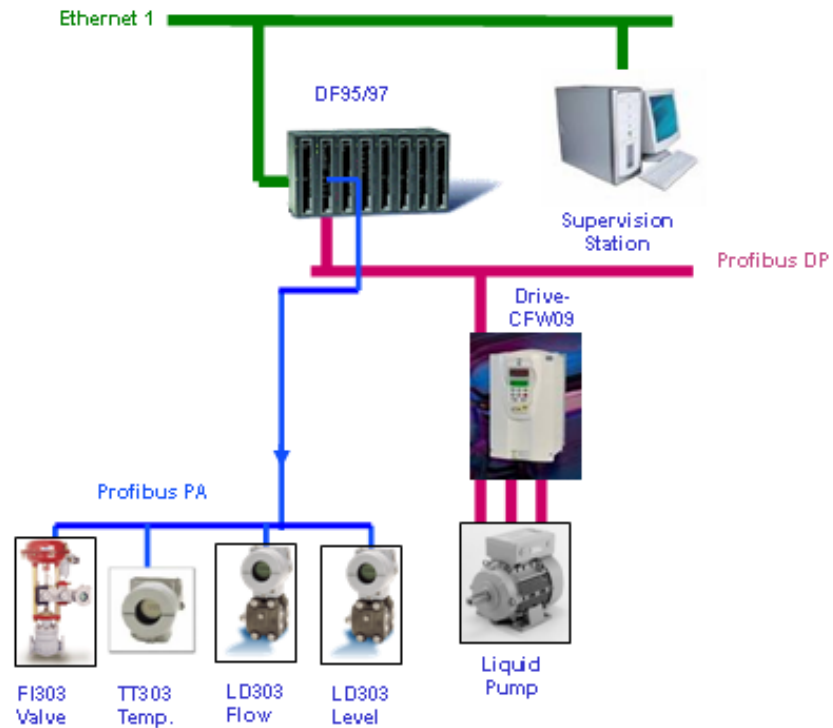 - ✓ Mounting bracket adds: 0.60 kg.

3.19. Profibus PA Protocol

PROFIBUS PA is the PROFIBUS solution for process automation. PROFIBUS PA connects automation systems and process control systems with field devices such as pressure, temperature and level transmitters. PROFIBUS PA can be used as a substitute for the analog 4 to 20 mA technology. PROFIBUS PA achieves cost savings of over 40% in planning, cabling, commissioning and maintenance and offers a significant increase in functionality and security. Some of the advantages of bi-directional digital communications are known: Higher accuracy, multivariable access, remote configuration and diagnostics, and multi-dropping of several devices on a single pair of wires. PROFIBUS PA requires decidedly less cabling. When using the conventional wiring method, each individual signal line must be connected to the I/O module of the process control system.
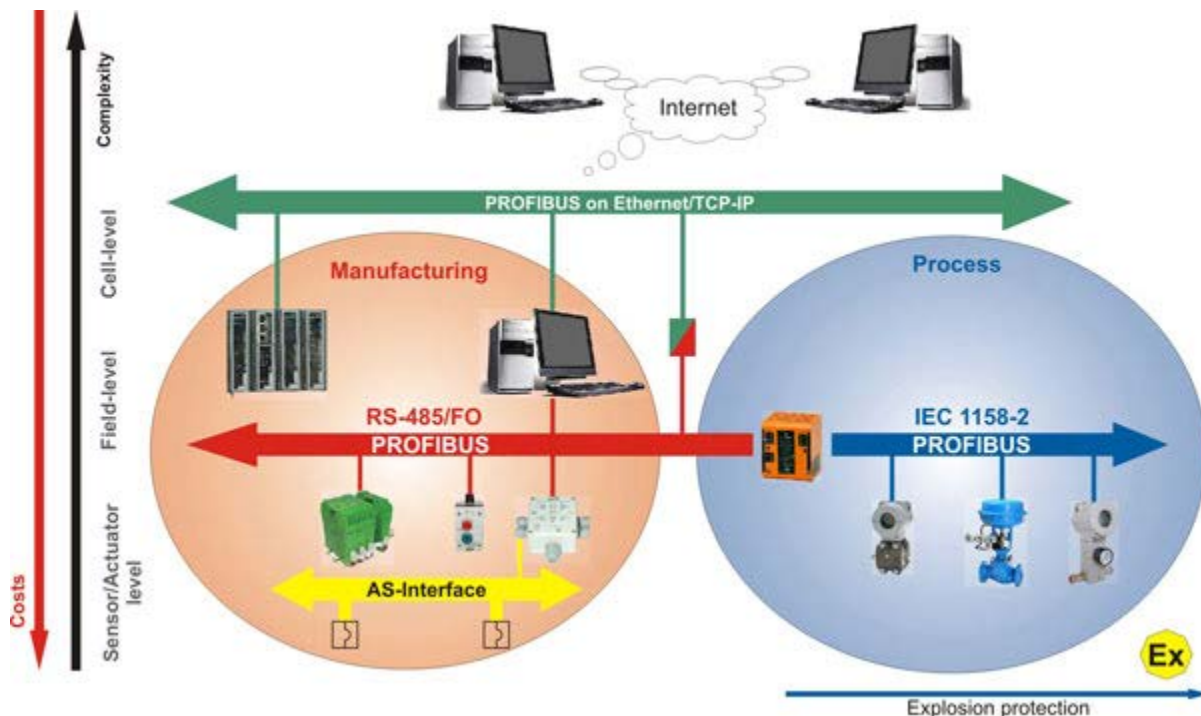
PROFIBUS PA has been developed in close cooperation with users in the Process Control Industry (NAMUR) and meets the special requirements of this application area:
- Unique application profiles for process automation and interoperability of field devices from different vendors.
- Addition and removal of bus stations even in intrinsically safe areas without influence to other stations.

- Transparent communication via segment couplers between the PROFIBUS PA bus segments in process automation and the PROFIBUS-DP bus segments in manufacturing automation.
- Remote powering and data transmission over the same two wires based on IEC 1158-2 technology.
- Use in potentially explosive areas with explosion protection type "intrinsically safe" or "not intrinsically safe".

Hardware
DF97- HSE Controller and Profibus Gateway W/ 2 Ethernet, 1DP (M12) AND 4 PA Ports.

Software:
DFI OLE Server;
System302.

▪ **Processor Module – DF97**
DF97 is a DP/4PA Profibus processor, which allows the DP Profibus communication with 04 PA ports.

DF97 module is the Smar solution for Profibus applications Its main feature is working as Profibus DP-HSE gateway to provide power to the connectivity and flexibility to the system application. It allows wide communication between the Profibus DP and PA field devices. Through the HSE network and other DFI302 modules, it is possible the communication between field devices and other industrial protocols, providing greater flexibility to the control strategy projects. Through the I/O cards, it is also possible to execute discrete control via relay diagram logic ("Ladder Diagram"), allowing a single and integrated system. The module DF97 also can act as Modbus gateway (slave), allowing the interconnection of modules that are not fieldbus or HSE.

Characteristics and Module Limits

✓ One Profibus DP channel supporting up to 12 Mbps;
✓ Four Profibus PA ports supporting up to 32 devices for channel;
✓ It supports up to 124 Profibus DP and PA field devices;
✓ It supports up to 3584 bytes of input and 3584 bytes of output during the data interchange process;
✓ Limit of 64 external links by the HSE network;
✓ Maximum of 250 function blocks per DF95;
✓ One (1) Flexible Function Block (counted into the 250 allowed blocks), with 242 linked parameter to interface between the discrete and continuous control.

Profibus PA Architecture

▪ **FDI-302 - Interface for FOUNDATION Fieldbus & PROFIBUS PA field devices**
The FDI302 is a serial communication interface which allows firmware update of Smar field devices - FOUNDATION Fieldbus and PROFIBUS PA.
The operation simple and direct of the FBTools application, running in a workstation, allows the user to keep his plant always updated.

Main Characteristics:

▪ **Serial Communication Port:** RS-232C (Female DB9 connector)

▪ **Baud Rate:** 115200 bps (max.)

▪ **Power Supply:** Powered by the computer, it does not need external power supply

▪ **Power Consumption:** 10 mA (max)

▪ **Firmware Download Time:** 2.5 min (average)

3.20. LD303 - Profibus PA Pressure Transmitter

The LD303 is from the first generation of Profibus-PA devices. It is a transmitter for differential, absolute and gauge pressure, level and flow measurements. It is based on a field-proven capacitive sensor that provides reliable operation and high performance. The digital technology used in the LD303 enables the choice of several types of transfer functions, an easy interface between the field and the control room and several interesting features that considerably reduce the installation, operation and maintenance costs.

The LD303, like the rest of the 303 family, has some Function Blocks built in, like Analog Input and Totalizer Block. The need for implementation of Fieldbus in small as well as large systems was considered when developing the entire 303 line of Profibus-PA devices. They have common features and can be configured locally using a magnetic tool, eliminating the need for a configurator or console in many basic applications.

The LD303, like its predecessor LD301, has some built-in blocks, eliminating the need for a separate control device. The communication requirement is considerably reduced, and that means less dead-time and tighter control is achieved, not to mention the reduction in cost. They allow flexibility in control strategy implementation.

Characteristics:

- **Output:**

- **Range:**

- **Rangeability:**

- **Accuracy:**

- **Power Supply:**

- **Power Consumption:**

- **Function Blocks:**

- **Indicator:**

- **Temperature Limits:**

- **Environment Humidity Limits:**

- **Wetted Parts:**

- **Non-wetted Parts:**

- **Hazardous Area Certification:**

- **Weight:**

3.21. TT303 Profibus PA Temperature Transmitter

The TT303 is from the first generation of Profibus PA devices. It is a transmitter mainly intended for measurement of temperature using RTDs or thermocouples, but can also accept other sensors with resistance or mV output such as: pyrometers, load cells, resistance position indicators, etc. The digital technology used in the TT303 enables a single model to accept several types of sensors, an easy interface between the field and the control room and several others features that considerably reduces the installation, operation and maintenance costs.

The digital technology used in the TT303 enables the choice of several types of transfer functions, an easy interface between the field and the control room and several interesting features that considerably reduce the installation, operation and maintenance costs.

The TT303 is part of Smar complete 303 line of Profibus-PA devices.

The system controls variable sampling, algorithm execution and communication so as to optimize the usage of the network, not loosing time. Thus, high closed loop performance is achieved. Using Profibus technology, with its capability to interconnect several devices, very large control schemes can be constructed. In order too be user friendly the function block concept was introduced

Characteristics:

- **Input:**

- **Output:**

- **Accuracy:**

- **Configuration:**

- **Power Supply:**

- **Power Consumption:**

- **Function Blocks:**

- **Indicator:**

- **Temperature Limits:**

- **Environment Humidity Limits:**

- **Hazardous Area Certification:**

- **Weight:**

3.22. FY303 Profibus PA Valve Positioner

The FY303 is a Profibus PA valve positioner for Single (spring return) or Double acting Linear motion type control valves e. g. Globe, Gate, Diaphragm, Pinch or Clamp and Rotary motion type control valves e. g. Ball, Butterfly or Plug with pneumatic type actuators e. g. Diaphragm, Piston, Vane, or Bellows. It is based on a field-proven piezo flapper and non-contacting Hall-effect position sensor that provides reliable operation and high performance. The digital technology used in the FY303 enabled the choice of several types of flow characterizations, an easy interface between the field and the control room and several interesting features that considerably reduce the installation, operating and maintenance costs.

Some of the advantages of bi-directional digital communications are known from existing smart transmitter protocols: Higher accuracy, multi-variable access, remote configuration and diagnostics, and multi-dropping of several devices on a single pair of wires.

The system controls variable sampling, algorithm execution and communication so as to optimize the usage of the network, not loosing time. Thus, high closed loop performance is achieved.

Characteristics:

- **Output:** Output to actuator 0-100% supply air pressure. Single or Double-action.

- **Output capacity:** 13.6 Nm³/h (8 SCFM) at 5.6 bar (80 psi) supply

- **Power Supply:** Bus powered: 9-32 Vdc.

- **Power Consumption:** Quiescent 12 mA

- **Pressure supply:** 1.4-7 bar (20-100 psi). Free of oil, dust and water

- **Indicator:** Optional LCD indicator

- **Material:** Injected low copper aluminium with polyester painting or 316 stainless steel housing

- **Process Temperature Limits:** -40 to 85°C (-40 to 185 °F)

- **Environment Humidity Limits:** 0 to 100 % RH

- **Hazardous Area Certification:** Explosion proof, weather proof and intrinsically safe

- **Weight:**
  ✓ Nominal: 2.7 kg;
  ✓ Digital display adds: 0.1 kg.

3.23. FI303 Triple Channel Profibus PA to current converter

The FI303 is from the first generation of Profibus PA devices. It is a converter mainly intended for interface of a Profibus PA system to control valve or other actuators. The FI303 produces a 4-20 mA output proportional to input received over the Profibus PA network. The digital technology used in the FI303 enables an easy interface between the field and the control room and several interesting features that reduce considerably the installation, operation and maintenance costs.

Profibus PA, is not only a replacement for 4-20 mA or intelligent/smart transmitter protocols, it contains much more.

The digital technology used in the FI303 enables the choice of several types of transfer functions, an easy interface between the field and the control room and several interesting features that considerably reduce the installation, operation and maintenance costs. Some of the advantages of bi-directional digital communications are known from existing smart transmitter protocols: Higher accuracy, multi-variable access, remote configuration and diagnostics, and multi-dropping of several devices on a single pair of wires.

Characteristics:

- **Output:** Three 4 to 20 mA current links, external supply and common ground

- **Output load limitation**: External Output Supply Voltage / 3-45 Vdc

- **Accuracy**: ±0.1%

- **Power Supply:** Bus powered: 9-32 Vdc

- **Power Consumption:** Quiescent 12 mA

- **Indicator:** Optional LCD indicator

- **Process Temperature Limits:** -40 to 85 ºC (-40 to 185 ºF)

- **Environment Humidity Limits:** 0 to 100% RH

- **Hazardous Area Certification:** Explosion proof, weather proof and intrinsically safe

- **Mounting:** Wall, panel, or 2" pipe with optional bracket

- **Weight:**
  - ✓ Nominal: 0.80 kg;
  - ✓ Digital display adds: 0.13 kg;
  - ✓ Mounting bracket adds: 0.60 kg

3.24. Hart + 4 - 20 Ma Protocol

HART® Field Communications Protocol is widely recognized as the industry standard for digitally enhanced 4-20 mA smart instrument communication. Use of the technology is growing rapidly and today virtually all major global instrumentation suppliers offer products with HART communication.

The HART protocol provides a uniquely backward compatible solution for smart instrument communication as both 4- 20 mA analog and digital communication signals are transmitted simultaneously on the same wiring. HART provides many benefits promised by fieldbus, while retaining the compatibility and familiarity of existing 4-20 mA systems.

This paper provides a brief overview of the HART protocol and the benefits achievable with this important technology. Per instrument cost savings benefits of $300-500 in initial installation/commissioning and $100-200 per year in ongoing maintenance/operations are commonly reported.

HART Technology

The HART protocol makes use of the Bell 202 Frequency Shift Keying (FSK) standard to superimpose digital communication signals at a low level on top of the 4-20 mA. Since the digital FSK signal is phase continuous, it does not interfere with the 4-20 mA signal. A logical "1" is represented by a frequency of 1200 Hz and a logical "0" is represented by a frequency of 2200 Hz as shown in Figures 1 and 2.

Analog + Digital Communication

For many years, the field communication standard used by process automation equipment has been a milliampere (mA) analog current signal. In most applications the milliampere signal varies within a range of 4-20 mA in proportion to the process variable being represented. Virtually all installed plant instrumentation systems use this international standard to communicate process variable information.

Simultaneous Analog + Digital Communication

| FSK freq: | 1200 Hz | 2200 Hz |
| Logical: | "1" | "0" |
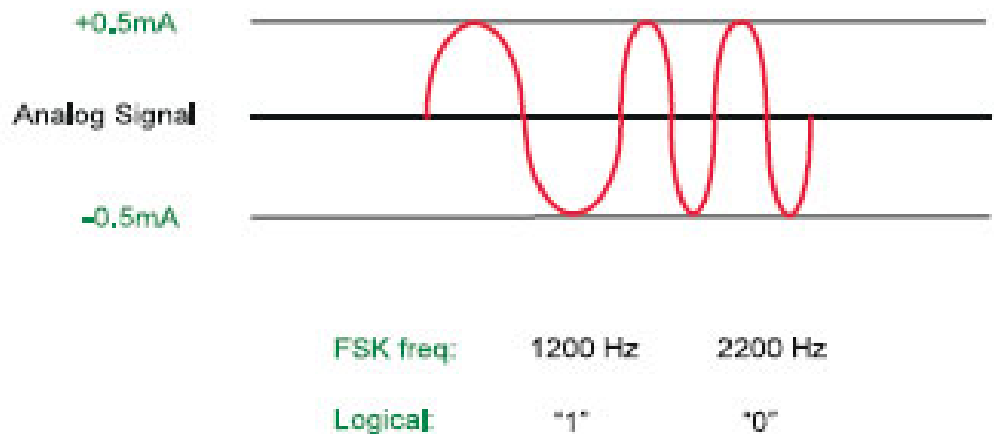
- **DF75 Processor Controller**

  DF75 module is the second generation of Smar Logic Controller including 2 Ethernet ports for HSE protocol and capability of FOUNDATION FieldbusTM block execution. DF75 is a HSE Field Device whose main purpose is the discrete control associated with continuous control through the use of FOUNDATION fieldbusTM Blocks.

  Through the I/O cards, it is possible to execute the discrete control via relay diagram logic (Ladder Diagram). Besides that DF75 has two Ethernet ports that guarantee high availability of control and supervision. DF75 also have redundant operation, giving higher availability security level for industrial process.

Software:
DFI Ole Server
Logic View

Main Characteristics
High Speed Ethernet controller;
Modbus gateway;
Access via internal bus for up to 64 conventional I/O modules;
Ethernet communication (FOUNDATION™ HSE and/or Modbus TCP);
EIA-232 serial communication (Modbus RTU and local diagnostic);
Instantiation capacity for up to 100 standard function blocks;
Supervision capacity for up to 2000 points per second;
Flexible function block instantiation capacity;
Discrete control through ladder language in compliance with IEC 61131;
Advanced control;
Redundant operation;
Support to SNMP, time stamp, and OPC communication;
Integrated web server for diagnostic and parameterization;
Modular structure for DIN rail;
Air cooling without fan.

▪ **HPC 401 - Universal HART® Communicator**

Main Characteristics

Turns the included Palm into a fast configuration and diagnostic platform for HART® instruments;
Provides full support for HART® instruments based upon the manufacturers device description files (DDL);
New device files can be downloaded and added from the Smar Research website
Faster and easier to use than other hand held alternatives;
Support Multidrop operation for all 15 nodes allowed by the HART® protocol;
Preinstalled software allows easy out-of-the-box operation;
Software upgradeable for future enhancements;

3.25. LD301 – Intelligent pressure transmitter with control capability

LD301 is a smart pressure transmitter for differential, absolute, gauge, level and flow measurements. It is based on a field-proven capacitive sensor that provides reliable operation and high performance. The digital technology used in LD301 enables the choice of several types of transfer functions, an easy interface between the field and the control room and several interesting features that considerably reduce installation, operation and maintenance costs.

Characteristics:

- **Input:**

- **Output:**

- **Accuracy:**

- **Configuration:**

- **Power Supply:**

- **Power Consumption:**

- **Function Blocks:**

- **Indicator:**

- **Temperature Limits:**

- **Environment Humidity Limits:**

- **Hazardous Area Certification:**

- **Weight:**

3.26. TT301 Intelligent Temperature Transmitter with Control Capability Optional

The TT301 is a transmitter mainly intended for measurement of temperature using RTDs or thermocouples, but can also accept other sensors with resistance or mV output such as: pyrometers, load cells, resistance position indicators, etc. The digital technology used in the TT301 enables the choice of several output functions, an easy interface between the field and the control room and several interesting features that reduce considerably the installation, operation and maintenance costs.

The TT301, besides the normal functions offered by other smart transmitters, offers the following functions:

Special sensor: the output follows a mV or Ohm input according to a 16-point linearization table.

PID output characterization: the PID output signal (MV) follows a curve determined by 16 points.

Backup sensor: the process measurement is realized by two sensors, but only one supplies the temperature. If it failure the other take its place.

Input selector: the selection between two sensors to obtain the measure is configured by user based in the conditions of maximum, minimum or average temperature of the sensor.

Controller: the process variable is compared to a setpoint. The deviation acts on the output signal according to a PID algorithm (Optional).

BATCH: setpoint generator allowing pre-programmed recipes of up to 2-week duration in 16 points.

Local adjust: allow setting lower and upper value, sensor type, operation mode, indication, setpoint, PID parameters without a configurator.

Password: three configurable levels for different functions.

Change counter: indicates the number of changes in each function.

Special-sensor-unit: allows the reading to be indicated by one of 100 standard engineering units or any special unit with up to 5 characters.

Characteristics:

- **Input:**

- **Output:**

- **Accuracy:**

- **Configuration:**

- **Power Supply:**

- **Power Consumption:**

- **Function Blocks:**

- **Indicator:**

- **Temperature Limits:**

- **Environment Humidity Limits:**

- **Hazardous Area Certification:**

- **Weight:**

3.27. FY301 – Smart Valve Positioner

The FY301 microprocessor based positioner provides fast and accurate positioning of diaphragm or cylinder actuators. The FY301 produces a pressure output as required to position a control valve according to a 4 to 20 mA input signal supplied by a controller. The FY301 is part of SMAR's complete 301 series of smart devices.

Compact and modular design;
Low air consumption;
Easy installation;
Direct non-contact position sensing;
Operate with rotary or linear motion, single or double acting pneumatic actuators;
Easy adjustment and parameter settings with remote HART® communication local adjustment and display;
Weather proof, explosion proof and intrinsically safe;
Flow Characteristics change with software cams.

Characteristics:

- **Input:** 2-wire, 4-20 mA

- **Output:** Output to actuator 0-100% supply air pressure. Single or double-action.

- **Output capacity:** 13.6 Nm³/h (8 SCFM) at 5.6 bar (80 psi) supply

- **Power Supply:** Supplied by the 4-20 mA current

- **Configuration:** Using local adjustment magnetic tool, remote configuration using HHT

- **Pressure Supply:** 1.4-7 bar (20-100 psi). Free of oil, dust and water

- **Actual Position Sensing:** Magnet (Non-contact) via Hall effect

- **Indicator:** Optional LCD indicator

- **Material:** Injected low copper aluminium with polyester painting or 316 stainless steel housing

- **Process Temperature Limits:** -40 to 85ºC (-40 to 185 ºF)

- **Environment Humidity Limits:** 0 to 100 % RH

- **Hazardous Area Certification:** Explosion proof, weather proof and intrinsically safe

- **Weight:**
  - ✓ Nominal: 2.7 kg;
  - ✓ Digital display adds: 0.1 kg.

SOFTWARE

Below we have a brief description of the software to be use.

4.1 SYSCON – Fieldbus Foundation System Configurator

SYSCON – System Configurator is a software tool developed specially to configure, maintain and operate Smar Fieldbus products using a PC with a Fieldbus Interface. With a friendly HMI (Human-Machine Interface) SYSCON provides a productive and efficient interaction with the user without need of previous software knowledge.
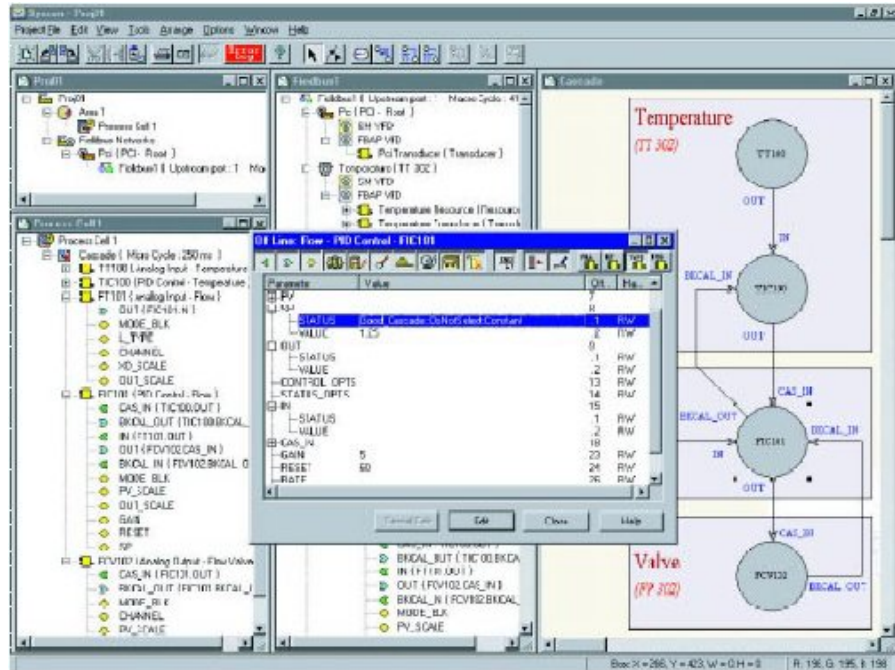
System and Device Configuration

This option allows communication with every device in the network, signal attribution, control strategy configuration, parameter adjustment and configuration download.
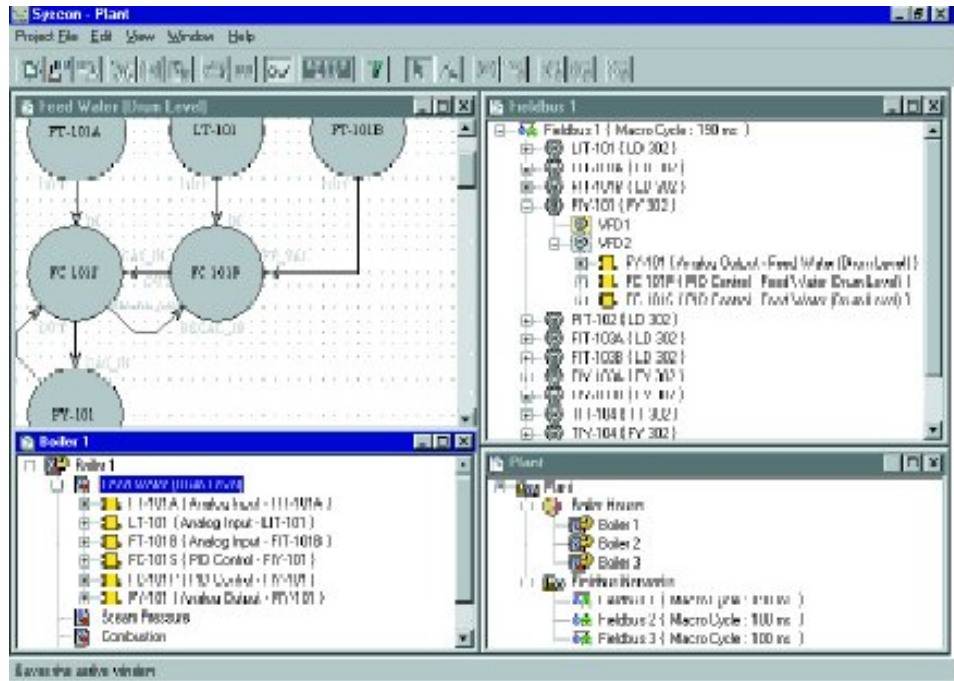
System Maintenance

This function allows communications with every field devices and collects information about device manufacturer, manufactured materials, scales, etc. It also allows the transducer calibration e controller adjustment. The on-line diagnostic report is a powerful tool to the plant reliability. The complete maintenance reports are emitted according to user configuration. The alarm and events reports are emitted on-line.
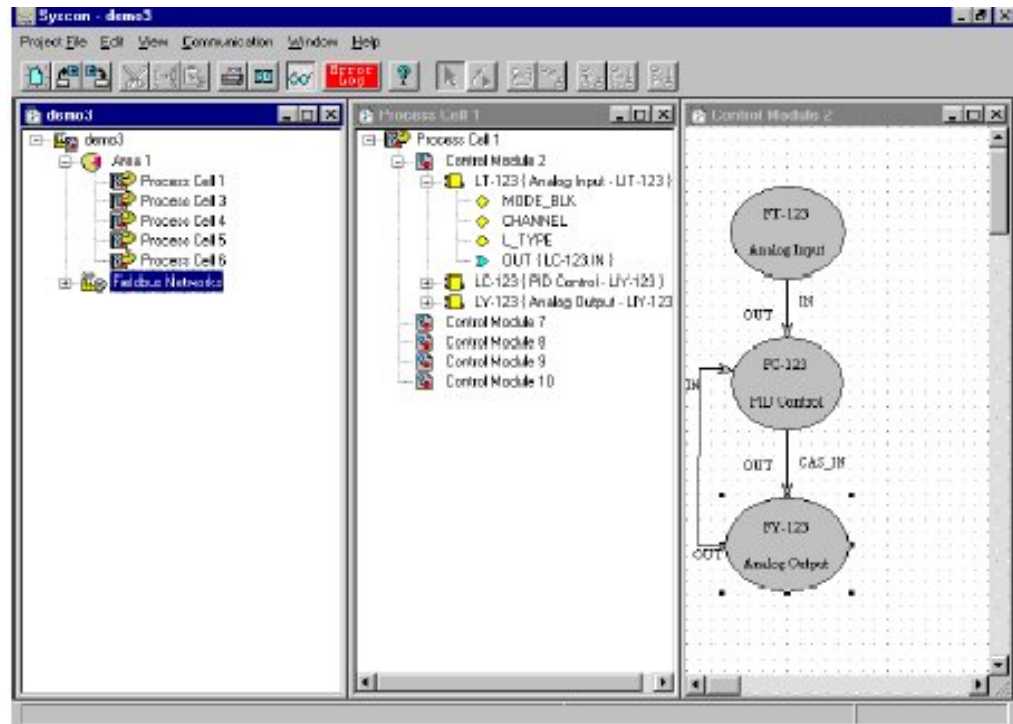
User Operation

The user can have indications of the variables, historical trends, alarm log, etc. He can also edit parameters and configurations or send commands. It is the ideal tool for plant preparation.
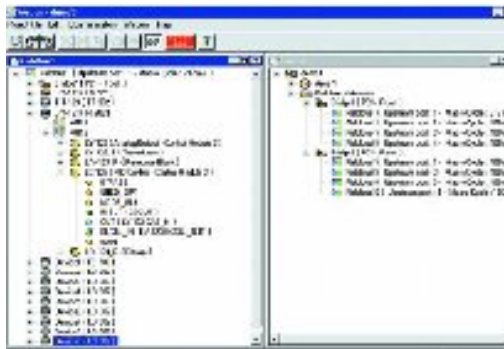
4.2. ProcessView – Process Visualization Interface

Smar' System 302 has a new component for process visualization, data collecting, alarm, trend analysis and much more.

Process View is the standard choice for the System 302 workstation operation packet. In a modular concept, the process offers 3 basic packets: GraphWorX32, AlarmworX32 and TrendworX32, responsible for visualization of the process, alarms and trends.
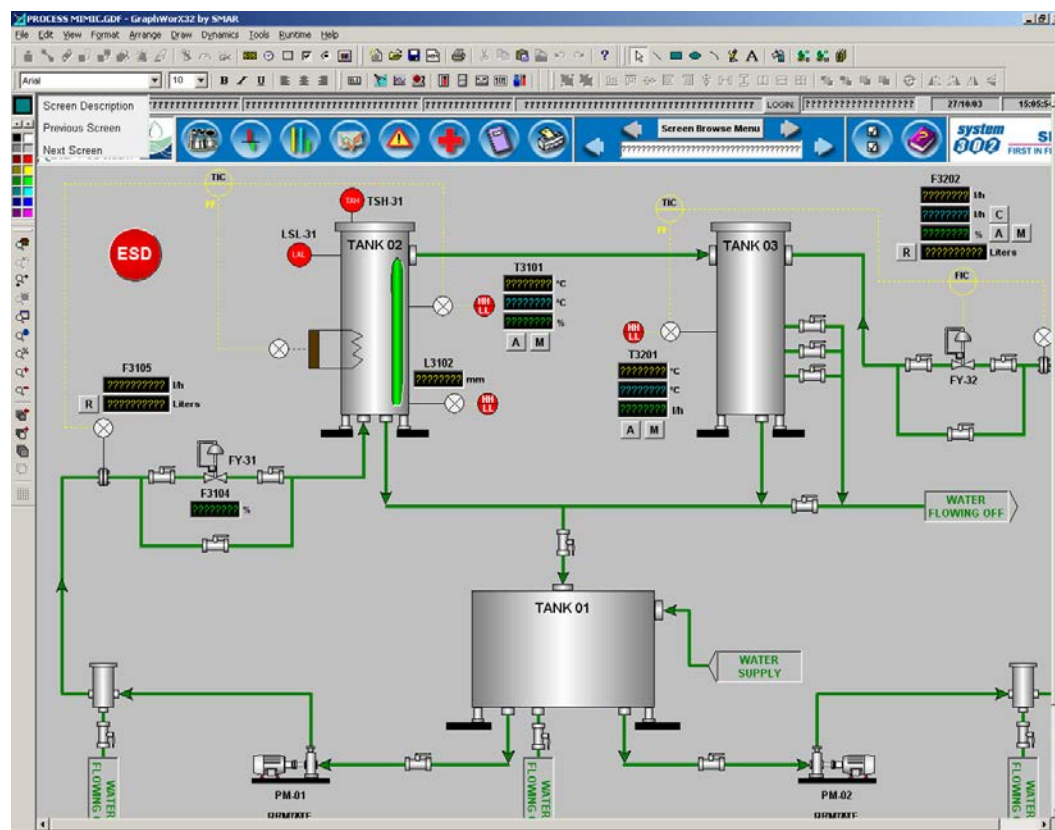
Process View offers writing versatility through Visual Basic for Applications (VBA), allowing the design of complex and flexible applications. The graphical versatility of Process View is a great add-on to this powerful tool, handling easily any type of graphic and image.

GraphWorX32 offers a complete drawing structure to make easy the sketch of the most innovative drawings, use of gradients, shadows and 3D perspective. The different degrees of animation allow animating balls and simple levels just as imported bitmaps. All these features help to create a more user-friendly environment so the operator can control the plant quicker and safer.
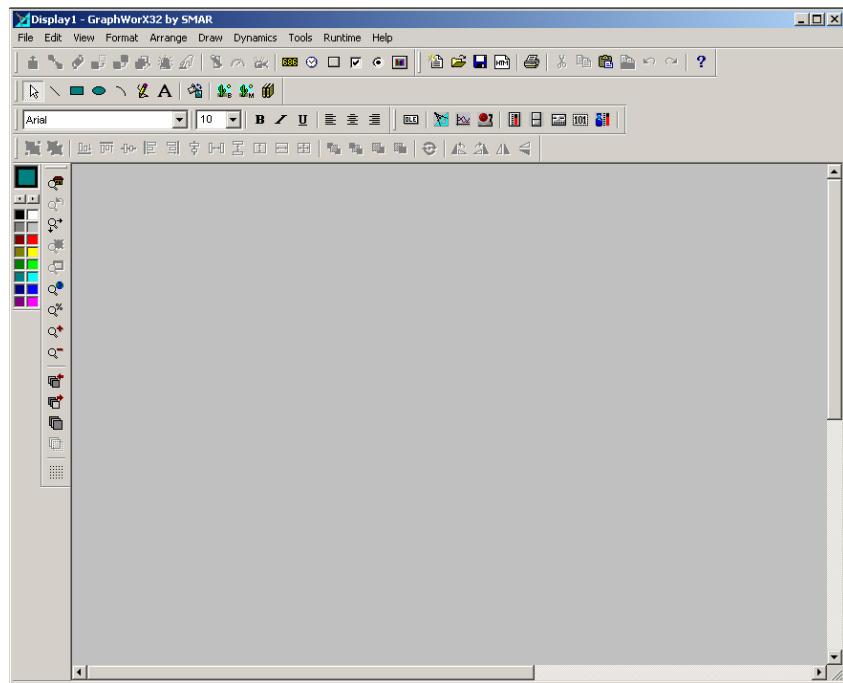
AlarmworX32 has a powerful alarm detection, sorting, filtering, visualization, logging, browser and data storage. TrendworX32 allows to determinate real-time trend besides historical trend, logging, thousands of point in different groups set by user. The operator has instantaneous access to any alarm or previous value with just a few clicks, allowing complete control e total perception of the actual and past historic of the plant.
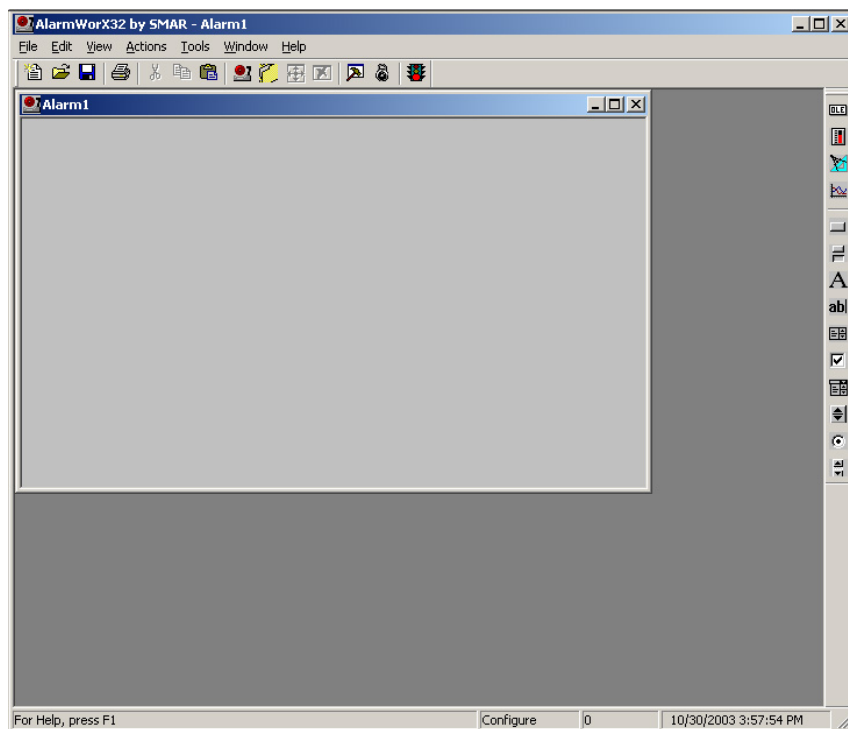
The ProcessView also has a wide enterprise alarm and an event management system, WEB visor, to remote system visualization and a totally reliable architecture with a redundant database and OPC server connection. ProcessView also runs in Windows CE devices like Compaq's iPAQ, providing an unimaginable option for wireless plant operation. The operator can control valves or tune a control loop right in the field, with the same information and graphics of the control room.

ProcessView is built with the OPC technology as its integration core besides graphics techniques and modern animation that makes it the most complete workstation operation packet in the market.
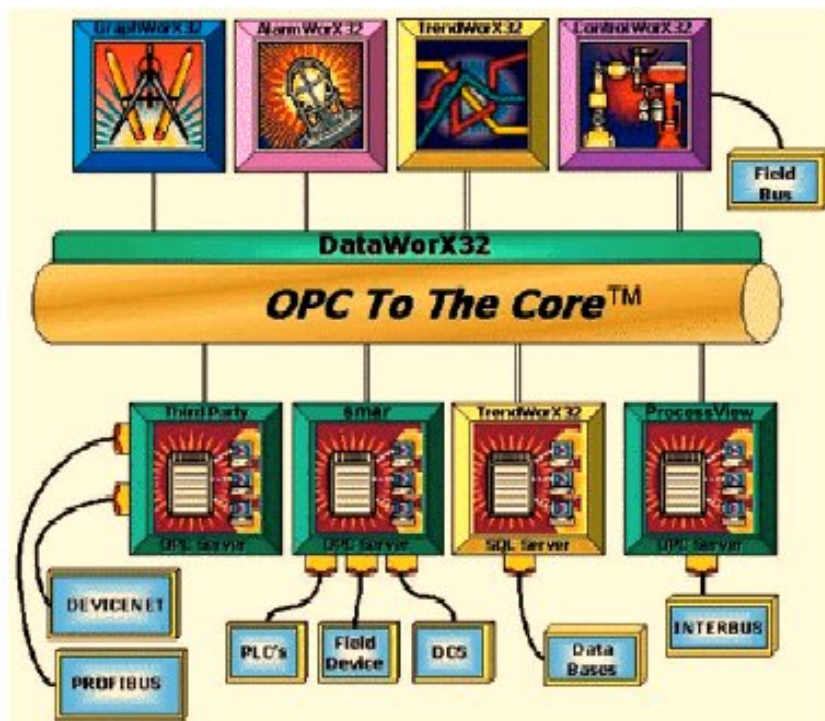
ProcessView is integrated with Smar OPC Server (DFI, PCI e LC700) and also with any other existing OPC Server, being the perfect integration packet for System302 with any third-party hardware that has an OPC Server.

The built-in OPC technology perfectly and transparently integrates to the System302 open architecture, providing a complete control system to your plant. With System302, Smar keep on the objective to supply the most sophisticated, opened, integrated and reliable solutions in the market.

UNDERSTANDING THE PROCESS

Before starting to use the pilot plant we need to understand the process. In this case we want to control the temperature in the mixed water tank by adjusting the flow of the hot and the cold water or we can adjust the temperature of the hot water tank.

Tank 1 is the water supply tank. Two pumps fill tanks 2 and 3 with water, in tank 2 the water is heated and then mixed with cold water in tank 3.

The process control begins by monitoring the mixed water tank temperature, after reading its value then the system decides what needs to be done by analyzing all the other variables.

In the hot water tank we have a lead control.

If the temperature is below the setpoint the cold water flow will decrease by sending a command to close the valve, on the other hand if the temperature is above the setpoint the valve will open and the flow of cold water will increase. Also the control will set the current applied to the resistance to do a better control of the water temperature.

In this plant there is a level switch to control the water level in the hot water. In case the level is below the permitted, the current applied to the resistance will be cut off and an alarm will be set.

Finally there is a temperature transmitter in the hot water tank to check if the temperature is too hot and prevent an overheating.

In the mixed water tank we have a cascade control. Here the control analyzes and compare the temperature of the water in the tank with the desired setpoint and adjust the flow of the cold water by controlling the valve to control the water temperature.

FRONT PANEL

The Pilot Plant's front panel has five lamps, 8 switches and 2 buttons. The lams are for High Temperature Alarm, Low Level Alarm, Power On, Pump 1 On and Pump 2 On.

The switches are for plant's power on/off, Local/Remote control, Pump 1 on/off, Pump 2 On/Off, Simulate High Temperature, Simulate Low Level, Simulate Pump 1 Safety Input, and Simulate Pump 2 Safety Input.

The buttons are one for lamp test and one Emergency Stop Button (ESD).

The ESD will turn both pumps.

The warming resistance and the compressor off.

Also remember that the switches, except the plant's on/off, Local/Remote control and Lamps Test will only work if the plant is in local control.

STARTING-UP THE SYSTEM FOR THE FIRST TIME

The Pilot Plant comes with two Standard control logics to familiarize the user with the system: Cascade logic and a Feedback logic, each one uses a typical and commonly found process control strategy.

DFI are already configured, you need only to establish the communication between the PC and the devices to be able to inform them which strategy will be used. To do so, follow the next steps:

NOTE
Make sure that the Local/Remote switch is in the Remote Position when using the supervisor program.

7.1. Connecting the PCs to the Plant

Check to see if the Ethernet cables are connected to both PCs and the plant. Each PC should have an Ethernet cable connecting to each switch. If there is no communication try exchanging the connections in the switches.

7.2. Starting the Supervisor System

The supervisor will automatically start after Windows 2000 has loaded. It will start in the Main screen and start all the necessary servers. If you wish you can minimize the Screen Manager window. If there is no communication problem you will see all the readings as soon as you enter the Process mimic Screen.

7.3. Manual Valve Check

Before using the plant check the position of all the manual valves and the water supply to guarantee a good and correct water flow. The manual valves are shown in the picture below:
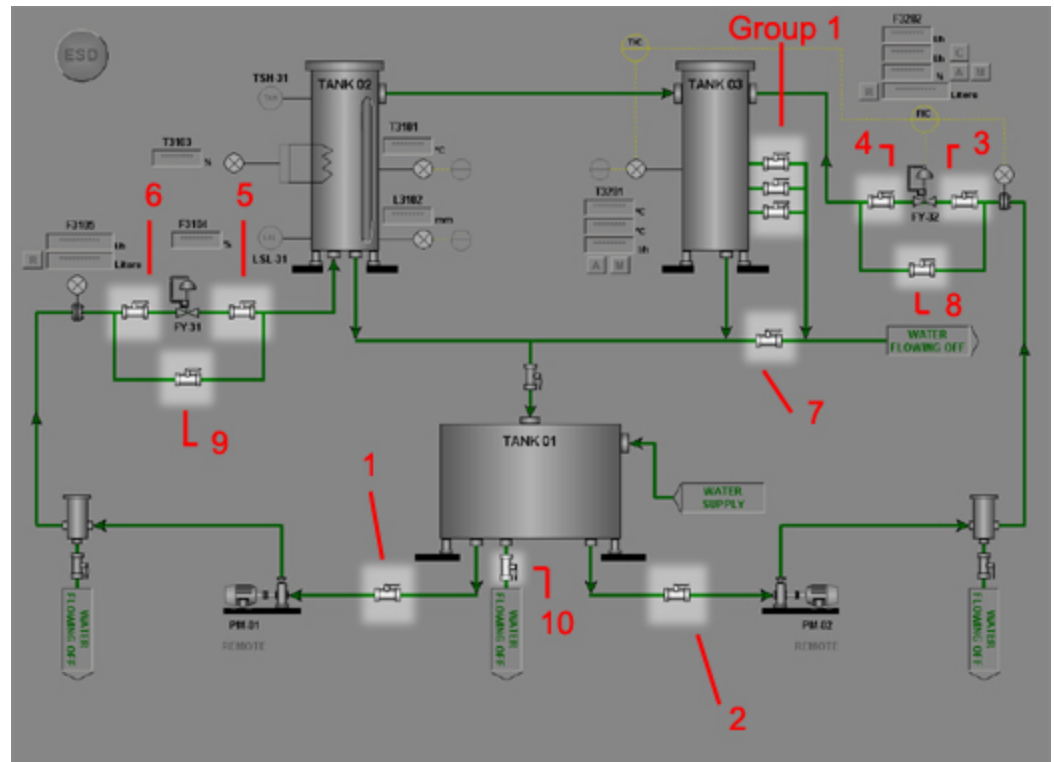
Valve Check

You can configure the valves in many ways, the standard configuration considering that the TANK 01 is full and that the water is cycling is:

Valves 1-6	OPEN
Valves 7-10	CLOSE

The Valve Group 1 is used to adjust the desired water level in the mixture tank.

7.4. Start the Plant

Check the power supply, if it is correct then turn on all the 4 breakers behind the plant's panel.

Finally turn the plant's power switch on to start the plant.

Section 8

OPERATING THE PLANT

8.1. Main Screen

Now the plant is ready to be used. You can browse to any screen using the Toolbar on the top of the page and execute any command within the supervisor software. Also there is an Alarm screen on the bottom of the screen.

Below is the Main screen:

Main Screen

8.2. Browse Toolbar

At the top of each page there is a browse toolbar, use it to browse between all the screens.

There are several buttons in the toolbar to help you get to each page. Place the cursor over them to see their description and click to go to the page.
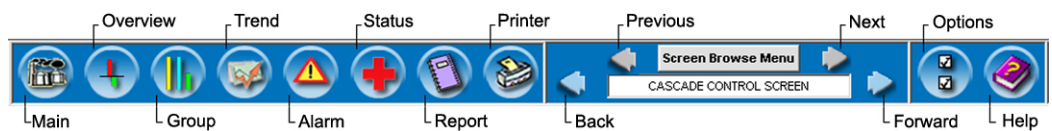
Browse Toolbar

8.3. Alarm Banner

At the screen bottom you will find the Alarm Banner, here you can see all the active alarms and acknowledge them. You can also turn the sound on/off.

Alarm Type	Time / Date	Description	Tag	Value	Priority	Type	Node
Alarm	10:53:08 AM 2/28/2003	Tank 2 High Limit Temperat	T3101		500	HI	
Alarm	10:53:08 AM 2/28/2003	Tank 2 Level Low Alarm	LAL-31		500	Digital	
Alarm	10:53:08 AM 2/28/2003	Tank 2 Low Limit Level Alar	L3102		500	LO	

Alarm Banner

8.4. Emergency Stop Button (ESD)

The Emergency Stop Button can be used to shutdown the plant if anything goes wrong. It will stop the pumps, the compressor, the current converter and the water flow.

8.5. Process mimic Screen

The process mimic screen is the most important screen on the system. Here you can execute all the control commands of the pilot plant like valve opening, pump action, adjust control variables, etc.

To open the process mimic screen, click the Pilot Plant Icon in the Main screen. See picture below:

Process Mimic Button

The process mimic screen will open:
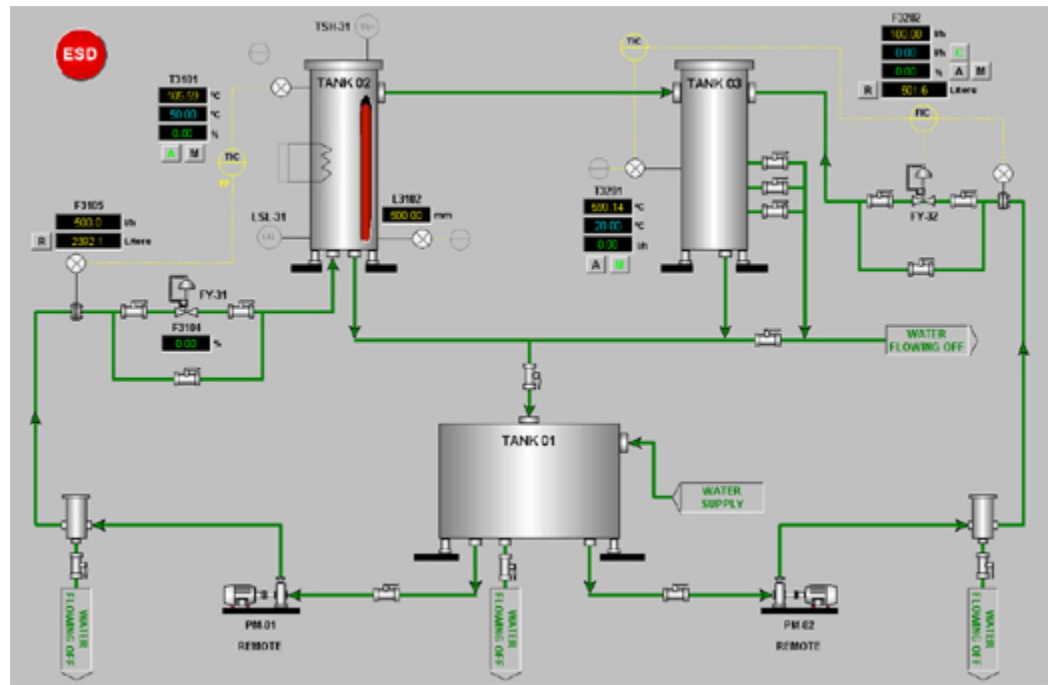
Process Mimic Screen

In this screen you can control the plant. Next we will describe each part of the screen and how to use them.

8.7. Pump Action

To turn on the pumps simply click on its icon.

A Pop up window will appear. Here you can Start or Stop the pumps.
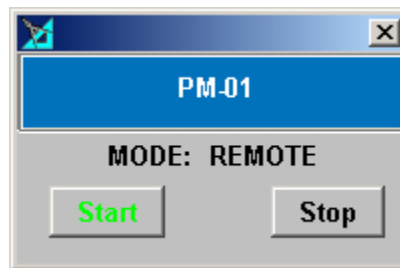
Pump Pop-up

Each pump has an animation to show whether it is on or off. The button will turn GREEN to show the actual pump status. Also the pump in the process mimic screen will be GREEN if it is on or GREY if it off.

NOTE
You will only be able to turn on/off the pumps with the supervisor if the Remote/Local switch is in the REMOTE position, otherwise the pumps can only be turned on/off with the panel keys.

8.8. Level Switch and Thermostat

The pilot plant has 3 tanks, a water supply tank (Tank 01), a hot water tank (Tank 02) and a mixed water tank (Tank 03). See next picture:
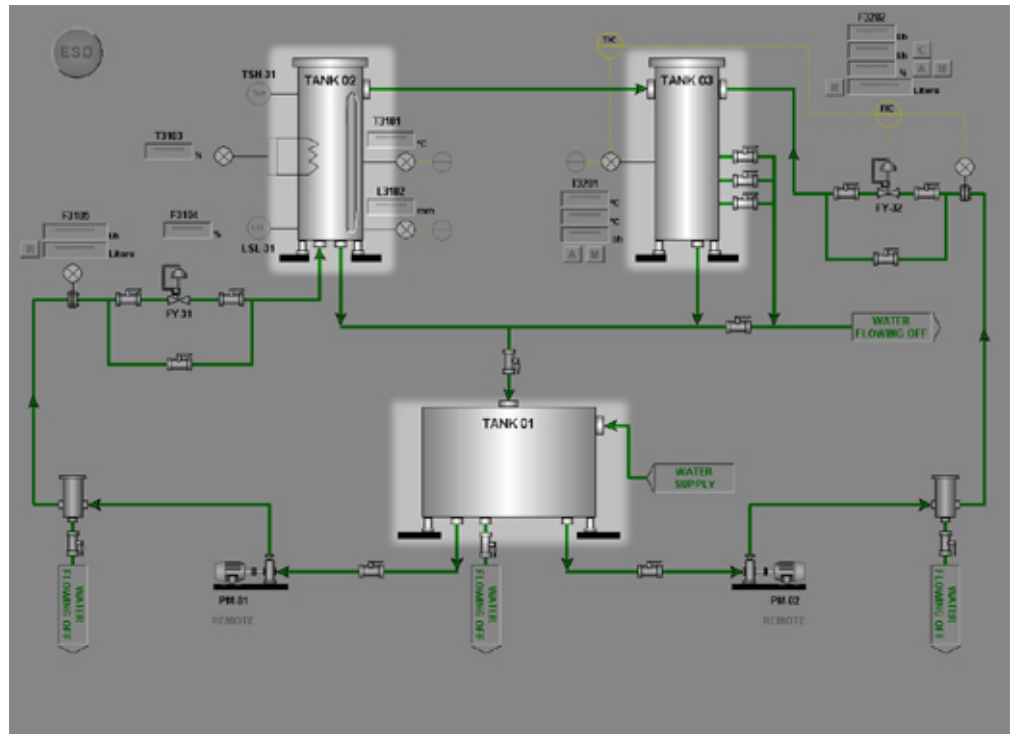
Pilot Plant's Tanks

The hot water tank has a level switch and a thermostat to control, respectively, its level and temperature.

The level switch will indicate a low water level when the tank is approximately 15% empty. When it is GREY the level is OK, if it is BLINKING RED the level is low. When the alarm is acknowledged it will become BLUE and stay BLUE if the alarm condition still exists, otherwise it will turn GREY.
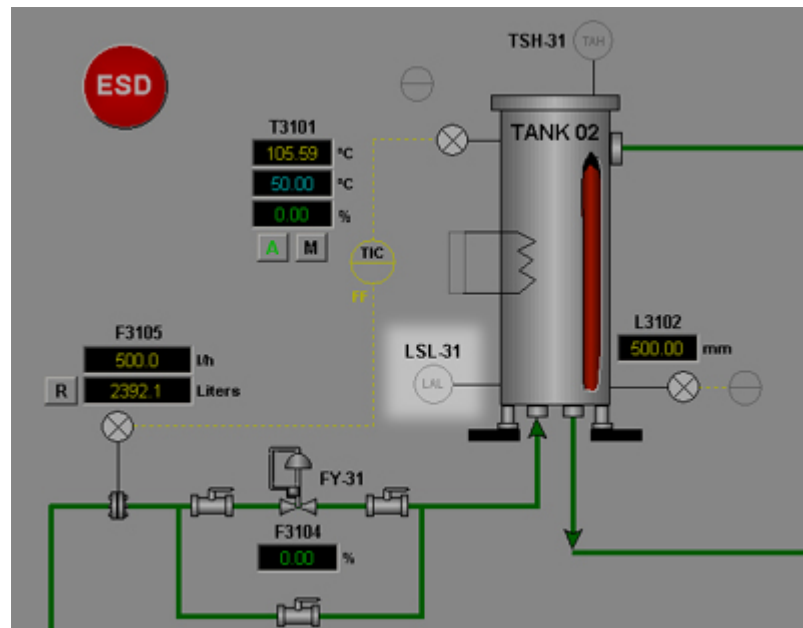
Tank 02 Level Switch Indicator

The thermostat will indicate a high tank temperature. When the temperature is high the animation will be BLINKING RED and when it is normal the animation will be GREY. When the alarm is

acknowledged it will become BLUE and stay BLUE if the alarm condition still exists, otherwise it will turn GREY.
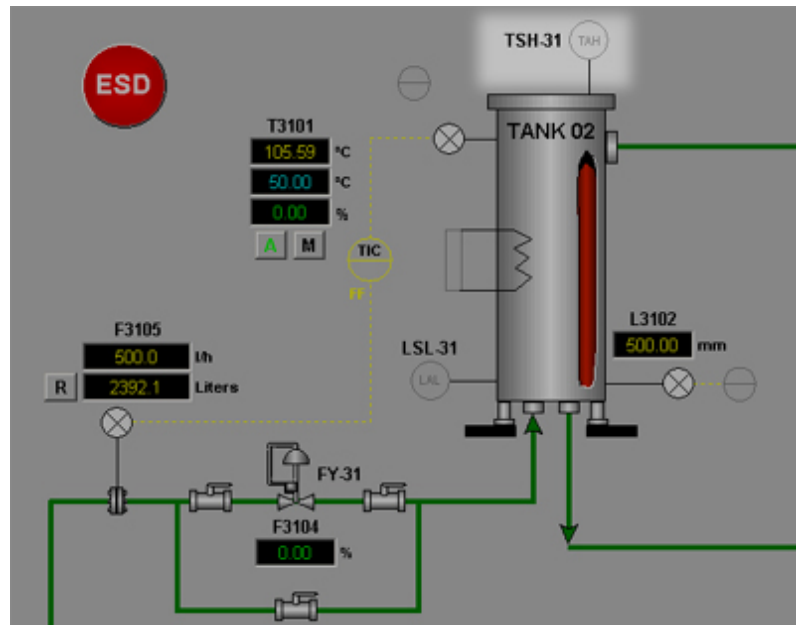
Tank 02 Thermostat Indicator

8.9. Flows

The pilot plant has 2 differentials LD302 Fieldbus transmitters coupled with integral holes and used to measure the instantaneous flow of the piping. In the process mimic screen you can read both the instantaneous flow and the flow totalizer. The "R" button is used to reset the totalizer.
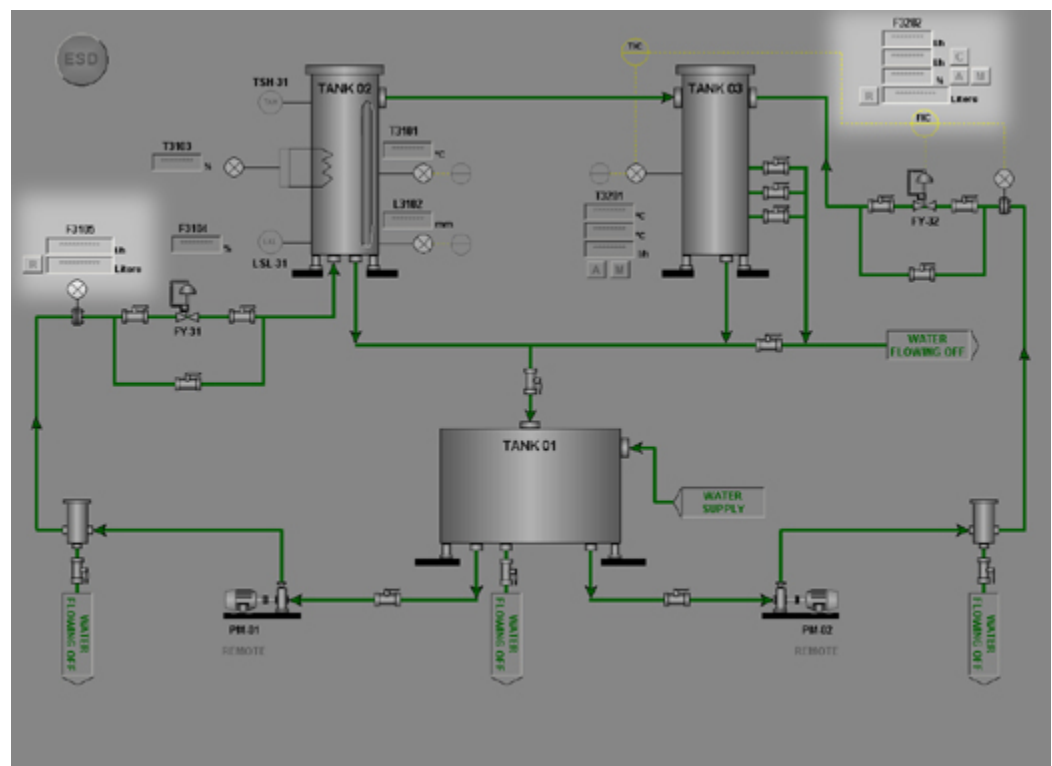
Flow Indicators

8.10. Hot Water Tank Level

A differential LD302 Fieldbus transmitter is responsible for measuring the hot water tank level. It has an alarm for a low level (blinking "L"). The measure can be read in the process mimic screen.
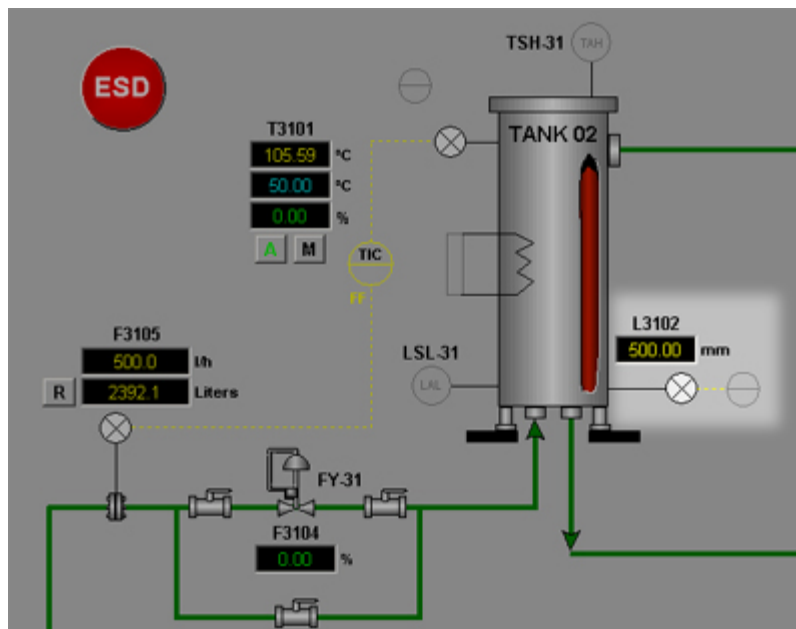
Tank 02 Level Measurement

8.11. Hot Water Tank Temperature

The hot water tank temperature is measured with a TT302 Fieldbus temperature transmitter that receives a signal from a PT-100 thermo resistance. It has an alarm for high temperatures (blinking "H"). Here you can also set the setpoint for the water tank temperature.
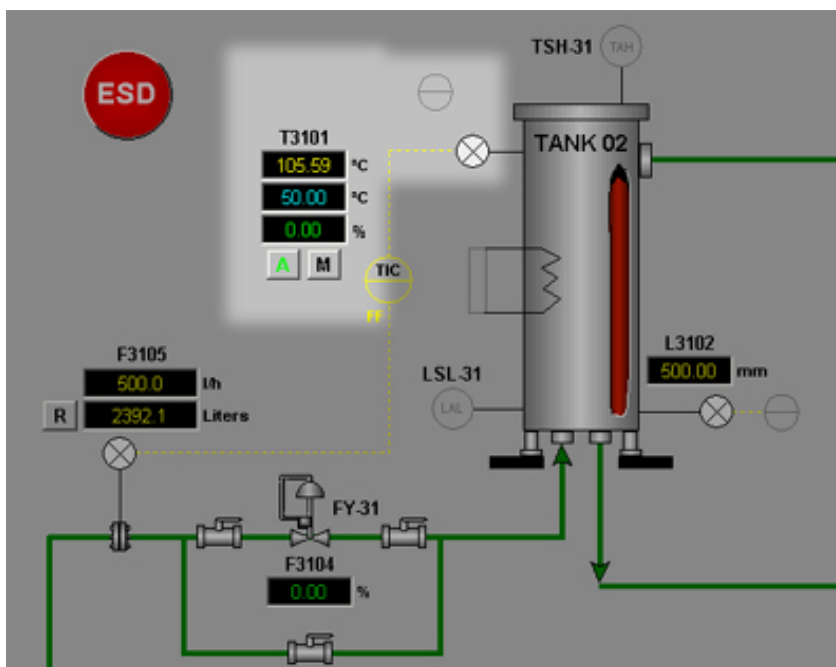
Tank 02 Temperature Measurement

8.12. Mixed Water Tank Temperature

The mixed water tank temperature is measured with a TT302 Fieldbus temperature transmitter that receives a signal from a type J thermocouple. Also you can set the setpoint for the temperature in this tank.
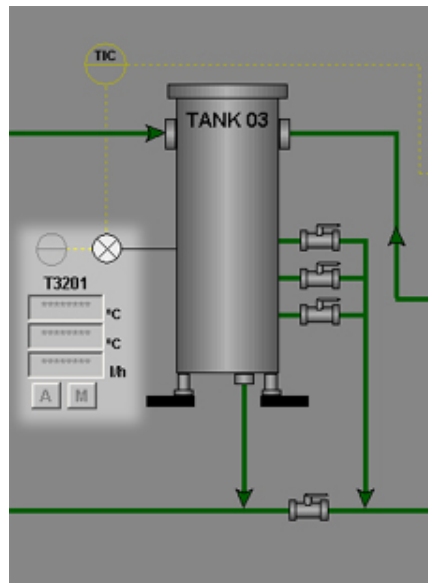
Tank 03 Temperature Measurement

8.13. Static Converter

The pilot plant has a resistive converter to convert current into electrical resistance. These resistances are inside the hot water tank and are used to heat the water. This plant uses a FI302 Fieldbus to 4-20 mA signal converter that sends the signal to the static converter. In the Auto position the current value will be set according to water flow, so the temperature is stable. If you want to set a fixed value, put the control in Manual and set the % value of the control. Remember that it is a 4-20 mA value.
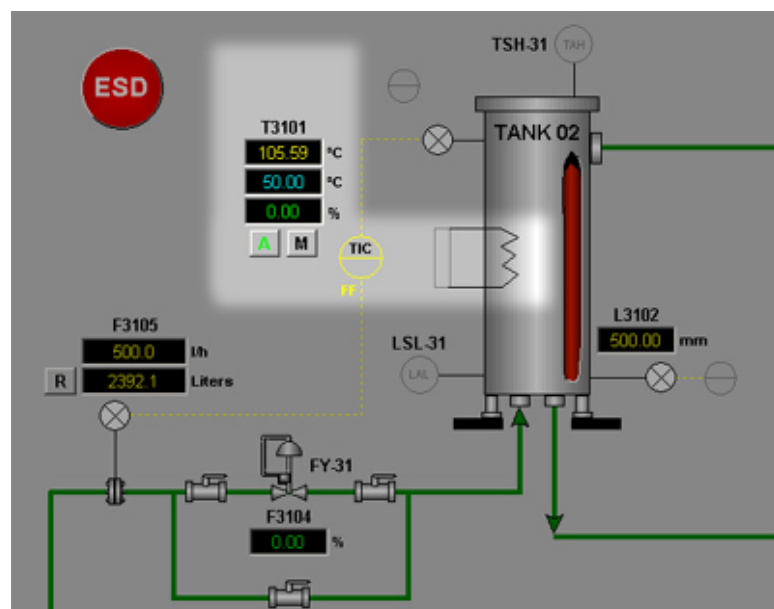
Static Converter Measurement

8.14. Hot Water Tank Intake Valve

The plant has a valve to control the water intake to the hot water tank. Although it can be automatically controlled, this valve will only have a manual control in the process mimic screen. There is a FY302 Fieldbus valve positioner that controls the valve opening. To adjust its value just click on its icon and type the new one.
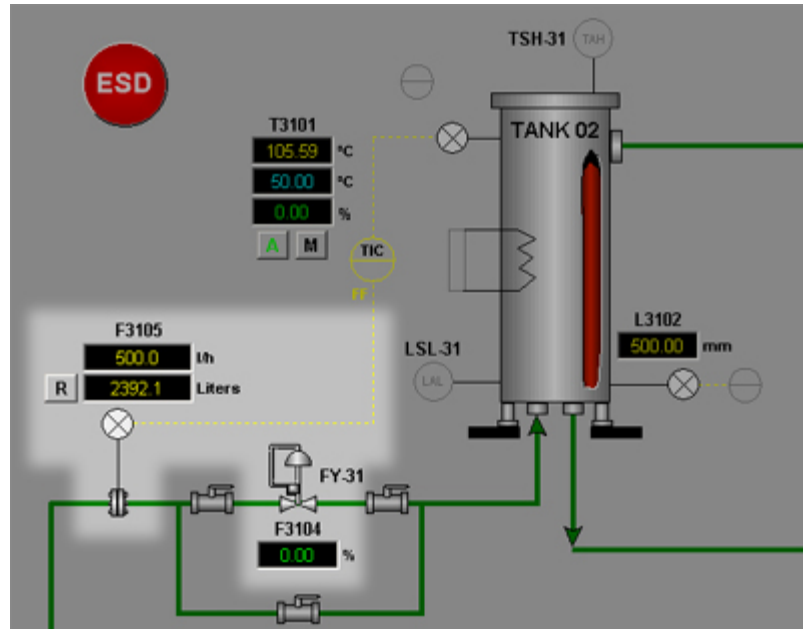
Tank 02 Intake Water Flow Measurement

8.15. Mixed Water Tank Intake Valve

The plant also has a valve to control the water intake to the mixed water tank. This valve is automatically controlled to keep the temperature in this tank equal to its setpoint. It can be set to manual control through the process mimic screen. This valve also has a FY302 Fieldbus valve positioner.
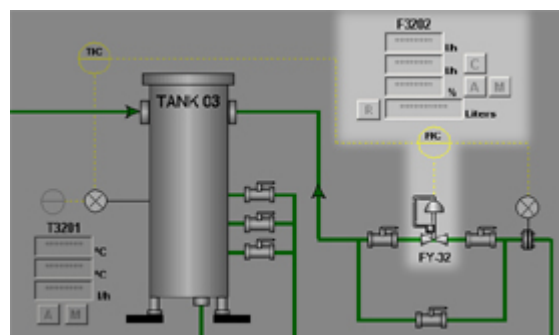
Tank 03 Intake Water Flow Measurement

8.16. Overview Screen

The overview screen shows all the areas and its units. In the pilot plant case there is only one area with just one unit. Click its icon to see all the faceplates. It has three selectable layers, deviation, analog measure and discrete measure. Click the respective layer icon to show or hide it. Click on the group line to open the group screen where you can see the faceplates configured for this unit.
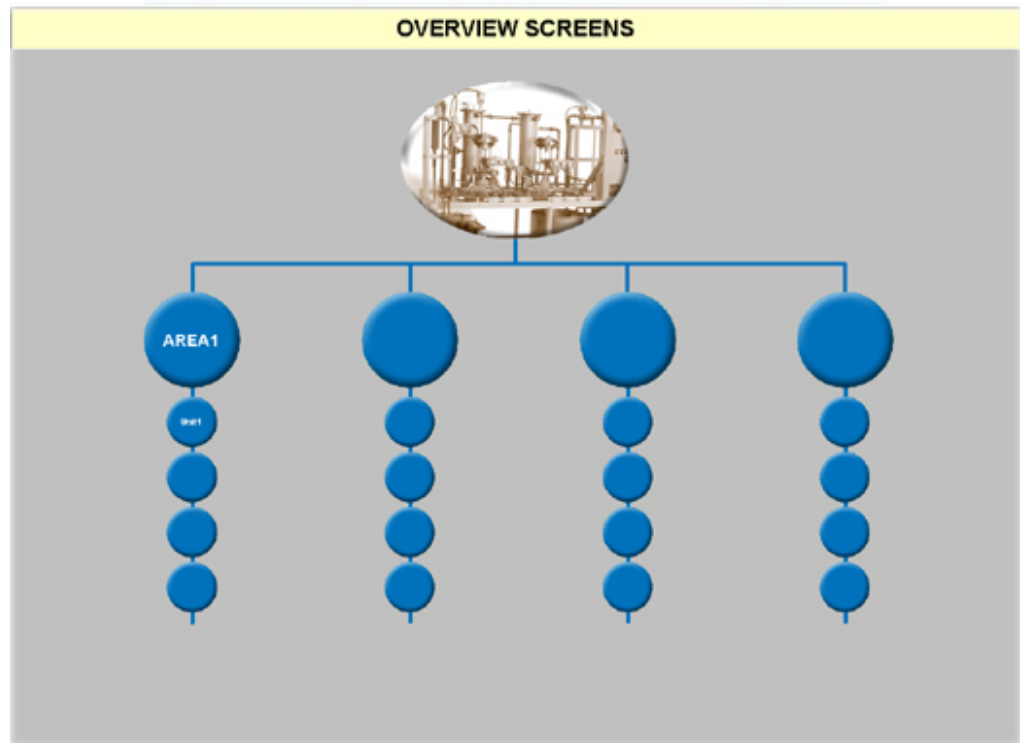
Overview Screen

The deviation measure may be RED or GREEN, RED indicates that de deviation of the PV from the SP is above the maximum allowed. If it is GREEN then it is below the maximum allowed.he discrete measure will be red if the alarm is active.

And if any measure has an orange border it means that the PID is stopped.

Group Overview Screen

Overview Screen Toolbar

8.17. Group Screen

In the group screen you have all the faceplates available. Here you can change and monitor all the values of all the variables of the process and check their status. You can see the PV, SP and MV of all the control loops. See the value of the analogs and discrete variables. Click on the TUNE button to go to the Tuning Screen where you can set the parameters for each control loop.
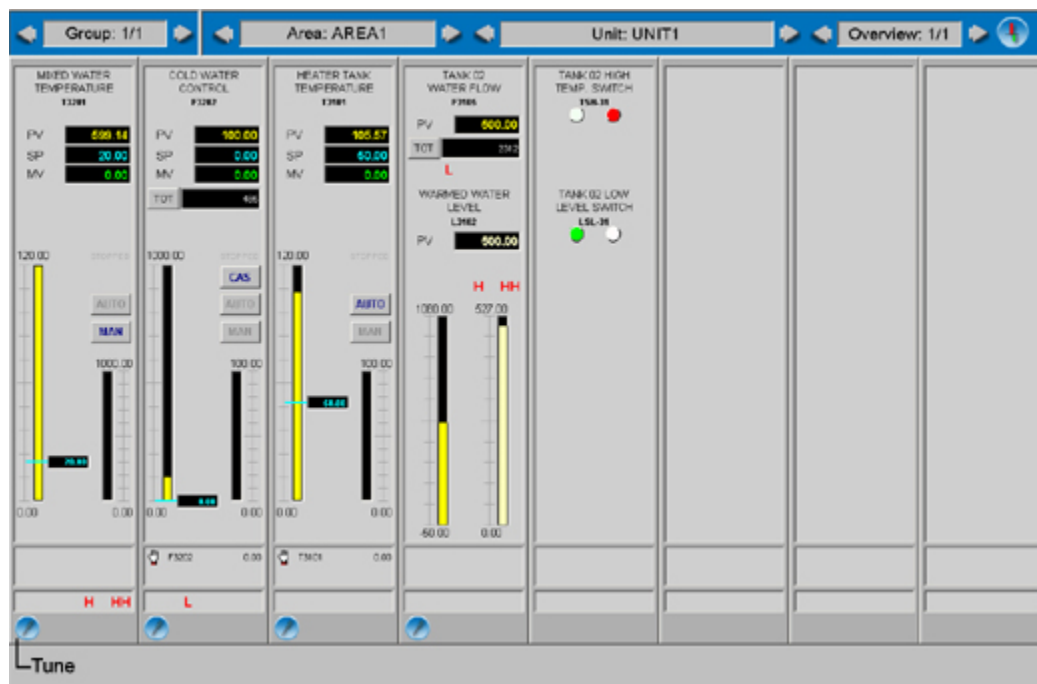
Group Screen

8.18. Tuning Screen

The tuning screen is used to tune the settings for each faceplate. You can change the alarms limits, SP, PV and MV of each one.

You can also change the parameters of the PID like KP, TR and TD to tune it.

The cursor will change to the text edit cursor when it is over an editable value. Just click on the value you want to change, enter the new value and press enter. Wait for the new value to show. In this screen the real-time trend graphic is also shown.

If the scale is not automatically updated, press the REFRESH SCALE button.
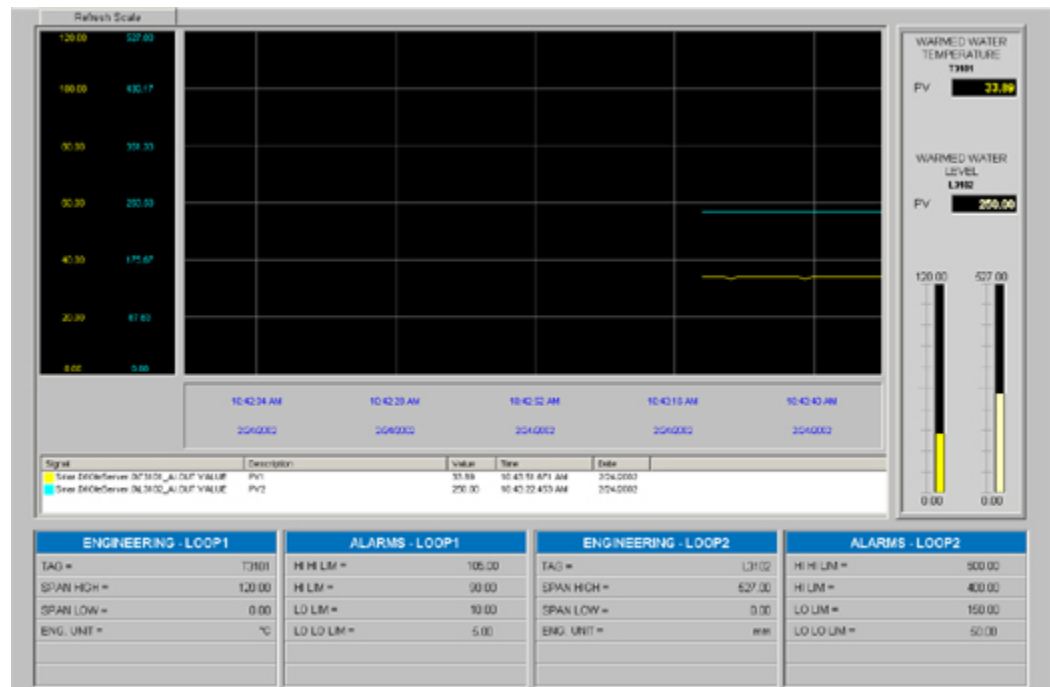
Tuning Screen

8.19. Trend Screen

The trend screen is used to show a historical graph of the measured and controlled variables of the process. Each screen shows the trend historical graph of a group of variables there is a caption to explicit the variable assigned to each graph.

Trend Selection Screen

In the Trend Screen you can navigate throughout the historic of the variables, and check their actual values. Double-click the graph area to open the trend viewer tool bar.
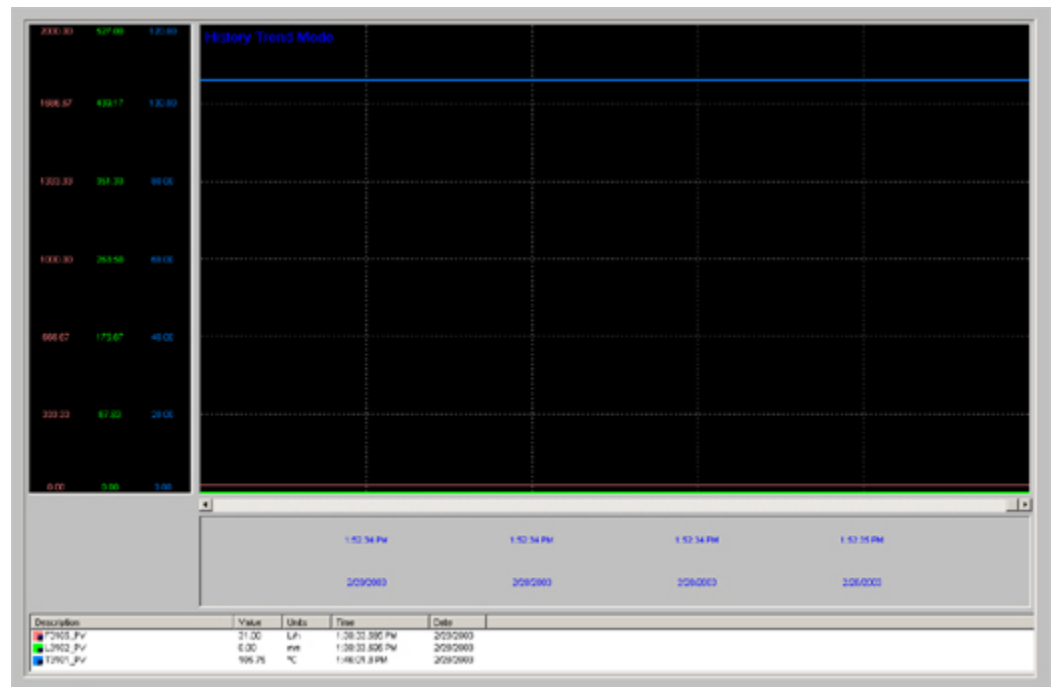
Trend Screen

8.20. Alarms Screen

The Alarms screen shows all the active alarms. There are 5 for this plant:

1. High temperature in the hot water tank (Discrete);
2. High temperature in the hot water tank (Analog);
3. Low level in the hot water tank (Discrete);
4. Low level in the hot water tank (Analog);
5. High temperature in the mixed water tank.

To acknowledge the alarms double-click its line.
To go to the Alarms Screen click the Alarms button in the Main screen.

8.21. Events Screen

The event screen shows a log of any event occurred during the process, like alarms that were activated or values changed.

8.22. Report Screen

The report screen is used to generate reports of the alarms, events and trends log.
All you have to do is selected which report you want to generate and click the report button.
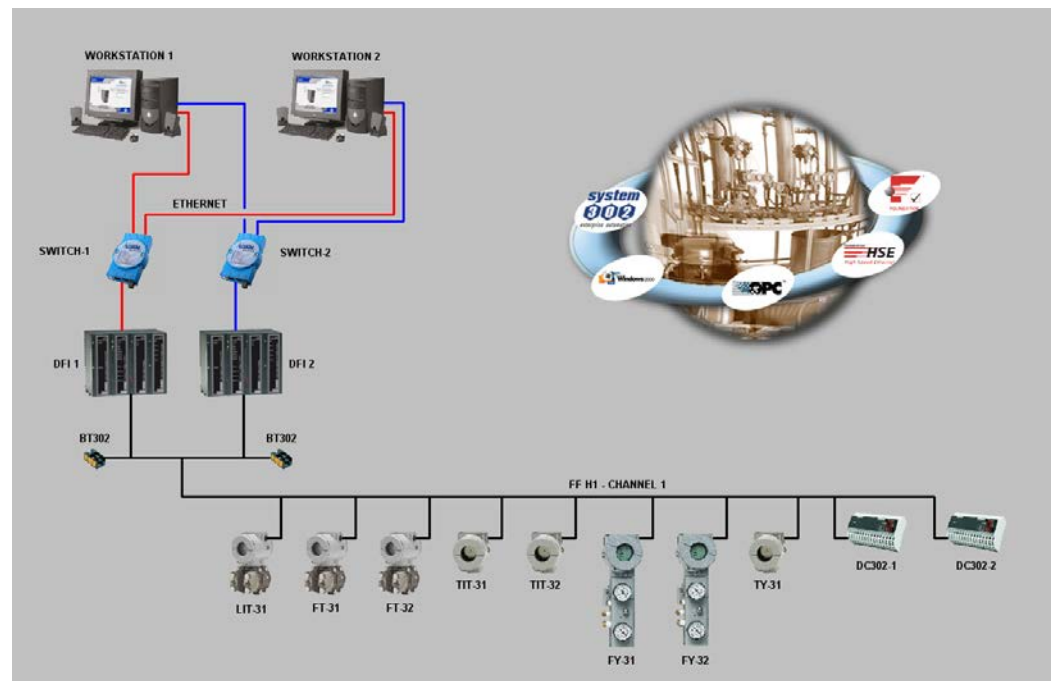
REPORT BROWSE SCREEN
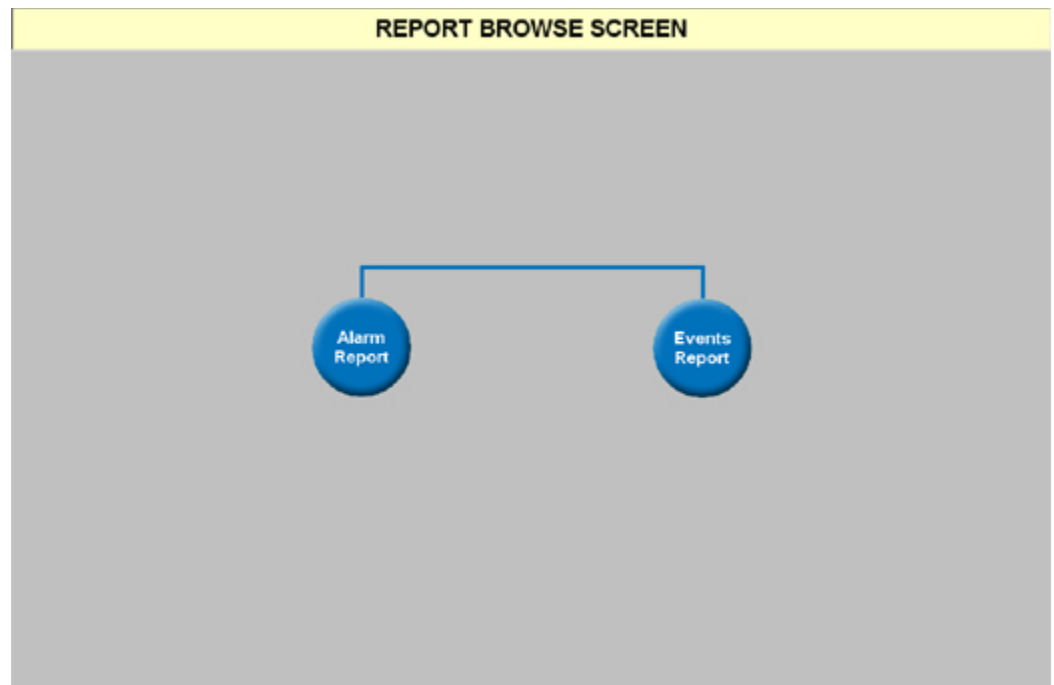
Report Screen

8.23. Status Screen

The status screen shows the status of the devices. A red cross indicates a communication problem and a blinking red device indicates a failure within the device.

Clicking on the DFI or any device will open the DFI Screen in Process View.


Status Screen

8.24. DFI Screen

The DFI screen shows the devices status in each communication channel. If the communication between the DFI and the devices is good the animated Tags will be GREEN, if not the device Tags will not show. Also if there is any failure with the device, the animated Tags will be RED.

To go to the DFI screen, click its icon or any device icon in the Status Screen.
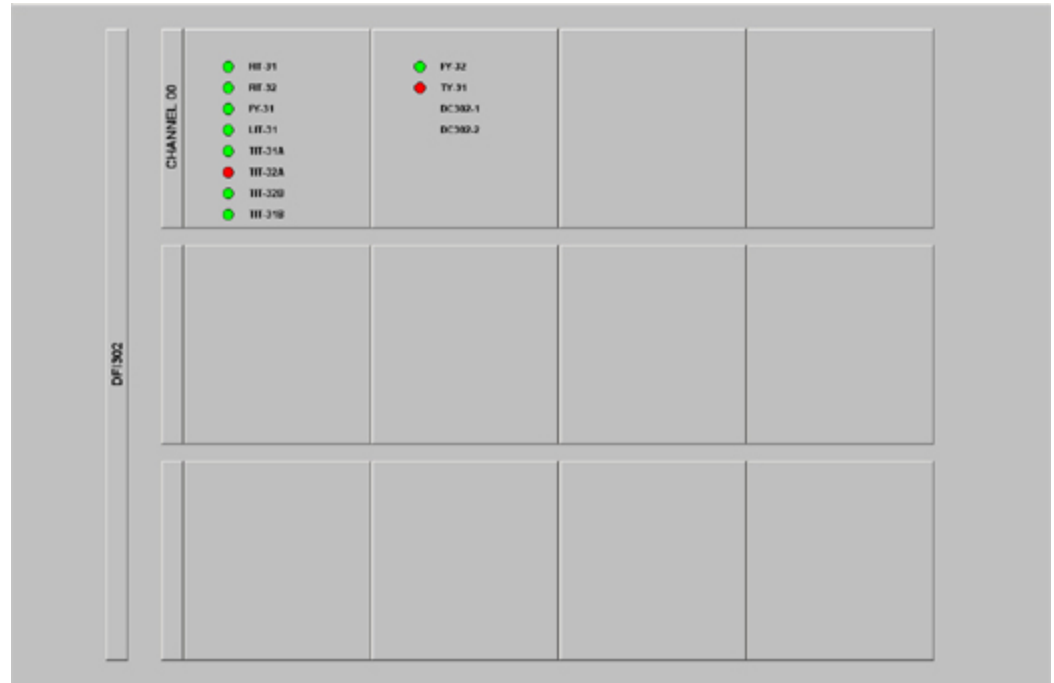
DFI Screen

Click on any device TAG to see its datasheet window. In the datasheet screen you can see the device diagnose and calibration. You can also adjust its calibration.
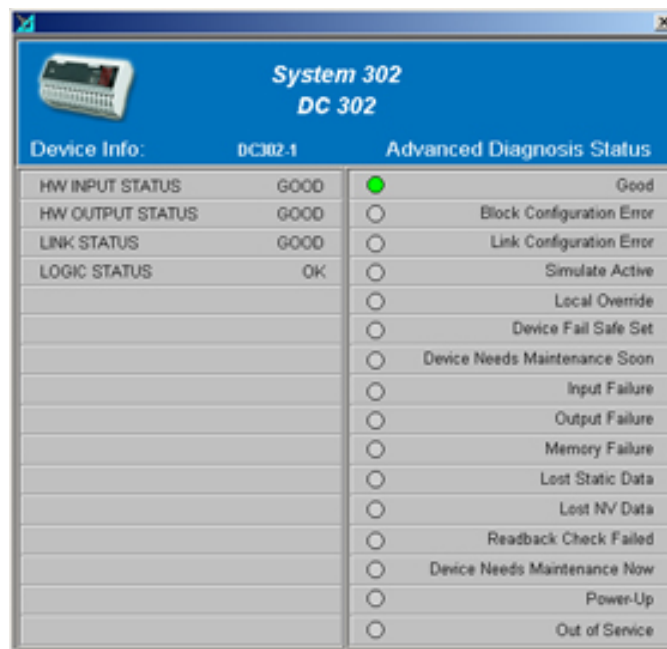
Datasheet Window

8.25. Options Screen

In the options screen you have a security button and an overview configurator button.

The Security button allows you to log in and out of the system.

The Overview configurator button will open an application where you can configure the overview screen. Here you can set what variables are to be shown and what type of faceplates you want.

8.26. Help Screen

The Help Button will open the Syscon Help Menu in Process View.

CONTROL LOOPS

The pilot plant has 2 different strategies.

9.1. Hot Water Tank Lead Control (Temperature and Cold Water Flow)

This control is intended to keep the hot water tank fixed. A power converter is the final control element. It is responsible to supply energy to a group of electric resistance that will heat the water. The temperature loop is the main. After the control is completed it receives a gain according to the water flow to increase or decrease the power needed to keep the temperature in the hot water tank constant. This strategy will provide quick responses to any variation of the hot water tank intake.

If you want to disable this control set it to manual and enter a current value for the static current converter.
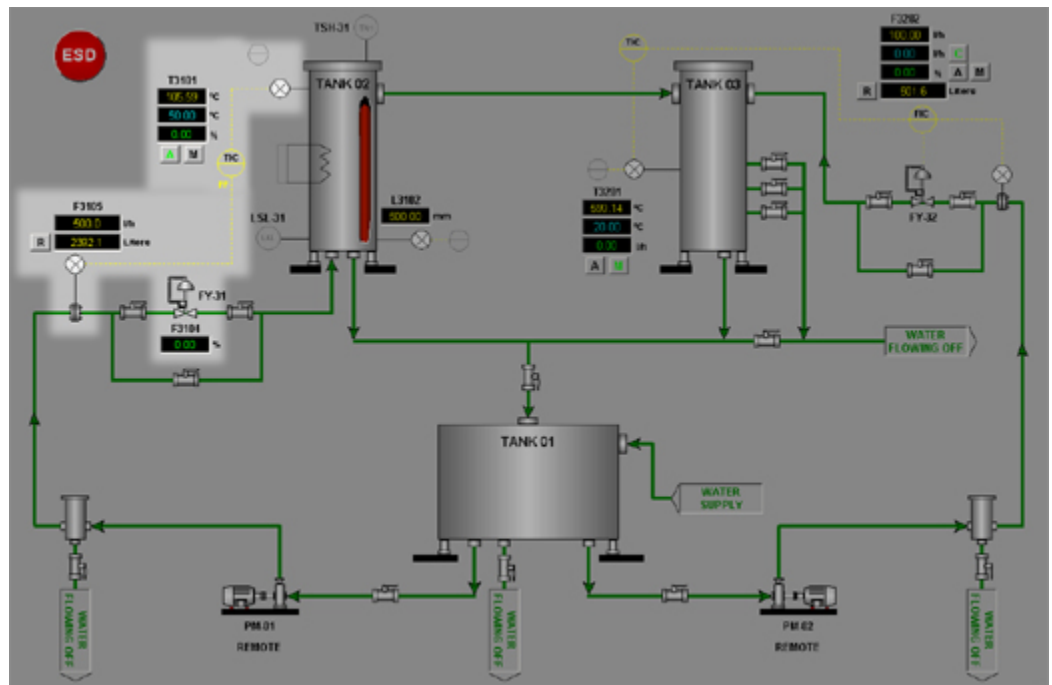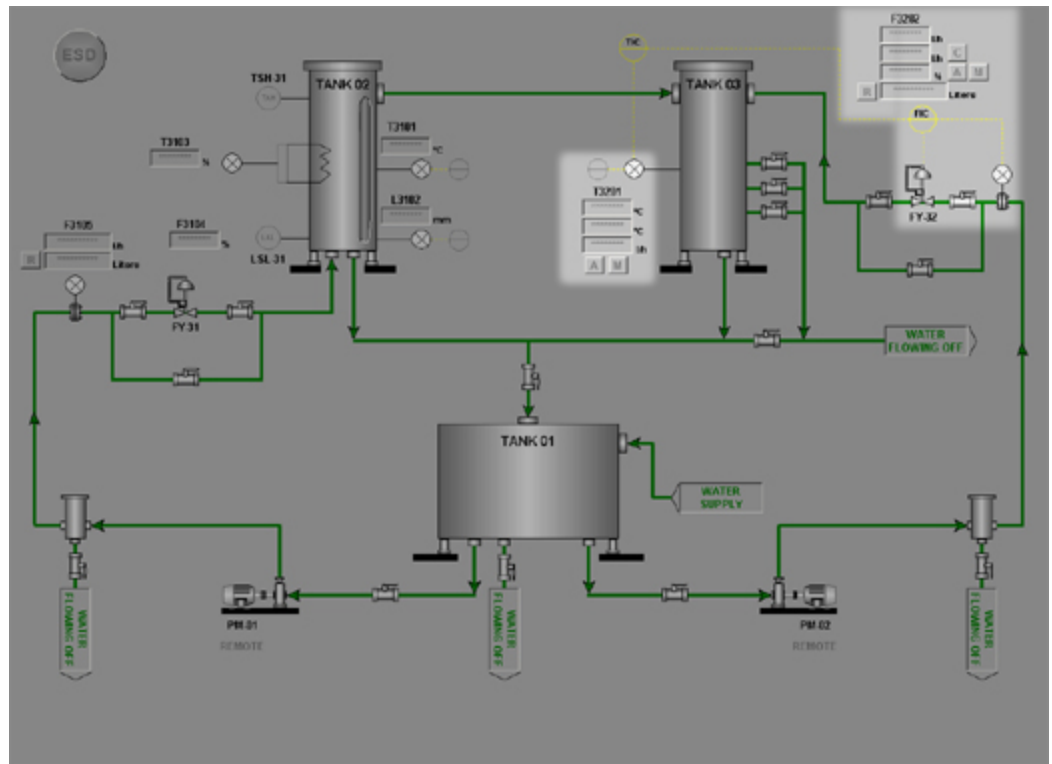

Lead Control Loop

9.2. Cascade Control (Temperature and cold water flow)

Hot water is mixed with cold water in the mixed water tank to heat the later. This control is intended to keep the mixed water tank temperature stable in case of variations to the hot water tank temperature. The cold water loop set its setpoint according to the mixed water tank temperature control output, acting on the cold water valve when the temperature read is different from the temperature wanted.

This control uses two control loops, the flow control loop F3202 and the temperature control loop T3202

Cascade Control Loop

9.2.1. Temperature Loop T3202

The temperature loop executes a PID control and its output will be used as the setpoint in the Flow loop. The users can only change the setpoint of this loop by double-clicking its display. It can be set to Auto (A) or Manual (M). For normal operation set it to Auto.
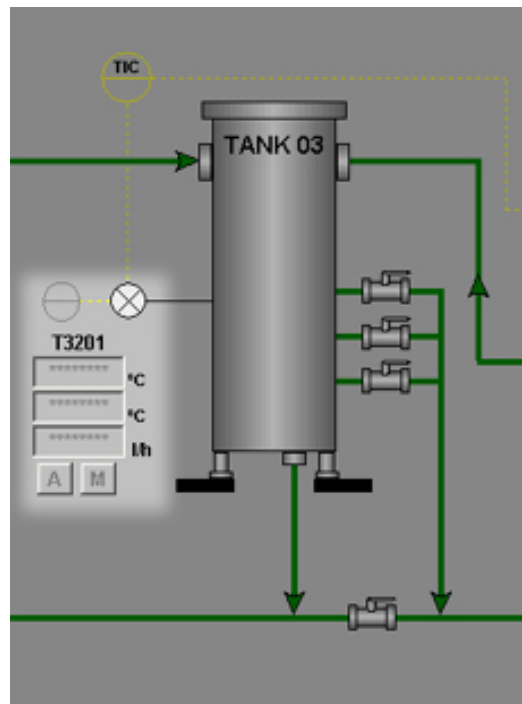
Temperature Control Loop

9.2.2. Cold Water Flow Loop F3202

This loop uses the temperature loop T3202 output as its setpoint, so its value can not be changed. This control loop also outputs the instantaneous flow and its totalizer. The user can set it so Cascade (C), Auto (A) or Manual (M). For normal operation set it to Cascade.
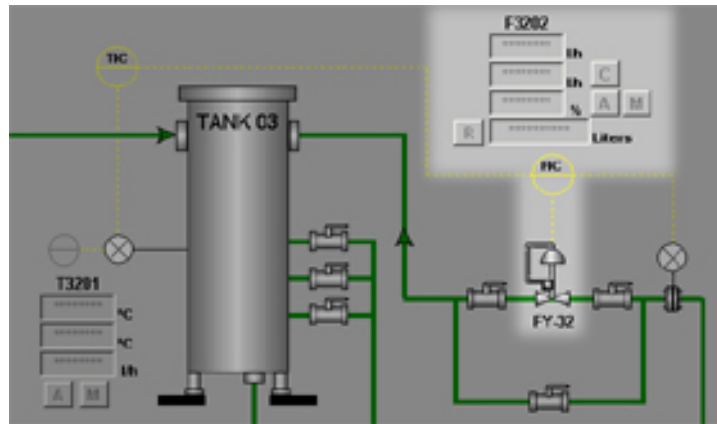
Cold Water Flow Control Loop

SHUTTING DOWN

To stop all operations simply turn off the plant's power switch and then disarm all the breakers behind the panel. After that shut down the computers.

APPENDIX

Appendix I - Specifications

1. Default Password:

Both computers need password to log on. The default password and log in is:
    LOGIN: Administrator
    PASSWORD: password

2. IP List:

3. Tag List:

4. Power Specifications:

Power Requirements: 220 Vac / 50 Hz
Maximum consumption: 16 A

Appendix II - PID

P&ID