

FLOW METERING SYSTEM SIGNAL SIMULATOR

TYPE: SIM 2.1.3.8

TECHNICAL DESCRIPTION



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TECHNICAL DESCRIPTION

1. SCOPE

Metrology controls or maintenance of flow computer needs volumes, temperature, pressure, density, viscosity... simulations for checking their acquisitions and calculation quality.

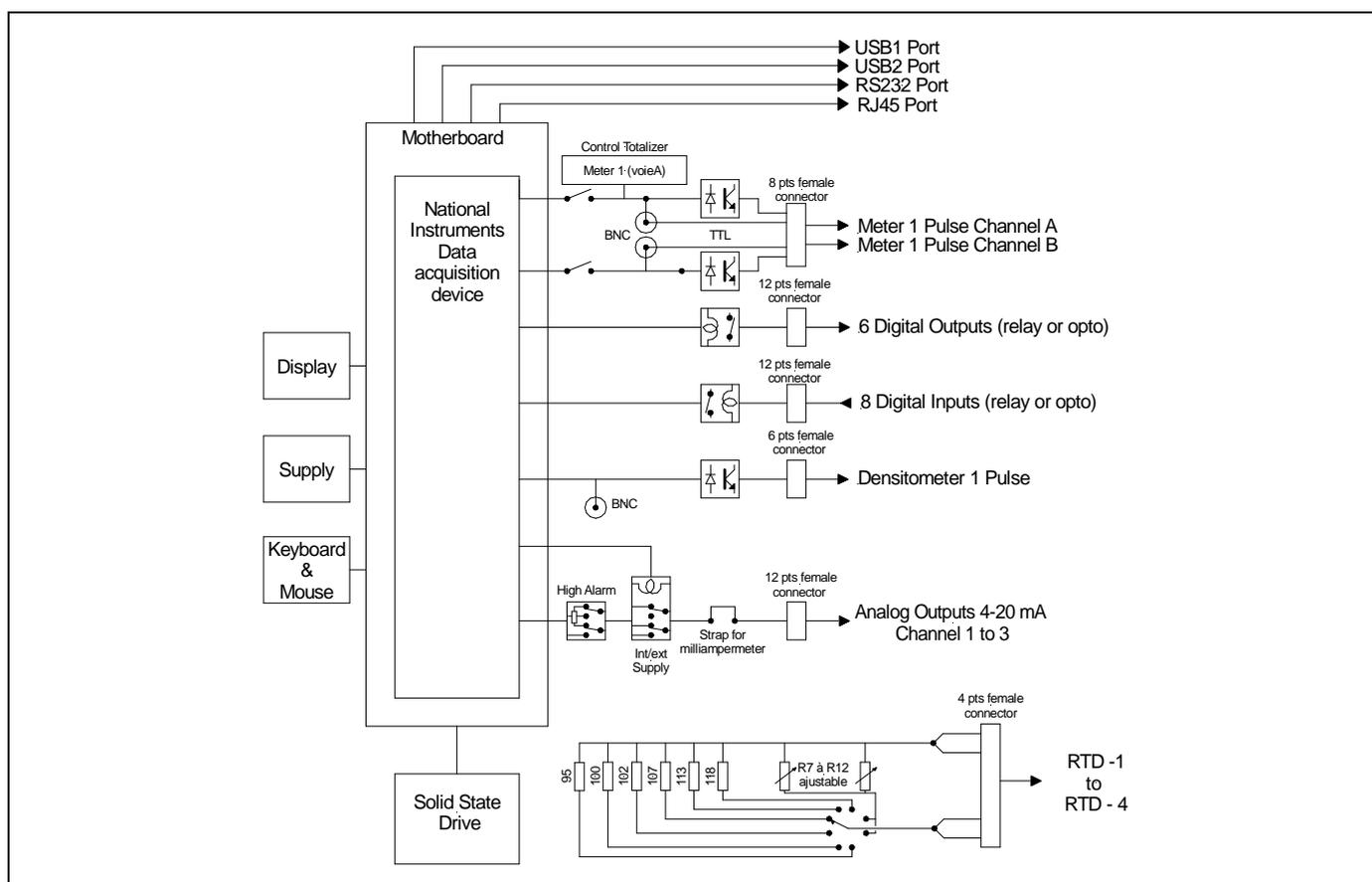
Flow signal simulator SIM 2.1.3.8 offer in the same instrument all the generators for initial or periodic flow computer conformity checking with standards, international recommendation or legal metrology rules in case of custody transfer application.

2. TECHNICAL DESCRIPTION

2.1. Principle of simulator

The concept of this simulator SIM 2.1.3.8 is to concentrate in the same instrument five industrial signal generators: pulse, current, voltage, resistor, contact.

The scheme of principle is:



This simulator comes as a suitcase integrating a laptop, equipped with signal generation/acquisition devices.

The suitcase front panel support connectors for electrical wiring and keyboard/touch pad for application control.

TECHNICAL DESCRIPTION

The screen takes place in the suitcase cover. Laptop motherboard and generators device are located inside the suitcase.

The simulator requires 220 – 230 VAC 50 - 60 Hz power supply.

2.2. Simulator main characteristics.

Meter pulses output:

- 1 output with 2 out of phase pulse trains (Channel A and B)
- Adjustable phase difference from 0 to 180°.
- Adjustable cyclic ratio from 0 to 100%.
- 0-5V TTL and photo coupler on open collector.
- Frequency: 0 to 5 kHz. Resolution 0.01 Hz. Stability 50 ppm.
- Permanent generator or preset generator
- Preset: 0 to 1 000 000 pulses.
- 1 external counter for control.
- Switch off of pulse train (A or B) for pulse fidelity alarm simulation
- BNC Plug for external scope.
- 1 low frequency output (0.01 to 15 Hz) on free voltage contact 62.5VA

Density transmitter pulse output:

- 1 pulse output.
- 0-5VTTL and photo coupler on open collector
- Period: 0 to 3000 μ s. Resolution: 0.1 μ s. Stability 50 ppm.
- Capacity for pressure and temperature correction.
- BNC Plug for external scope.

Analog outputs :

- 3 currents outputs 0 – 20 mA or 4 – 20 mA.
- Resolution: 0.01 mA. Accuracy: < 5 μ A. Stability 300 nA.
- Compatible with powered or not powered current loop (24Vdc).
- Capacity to insert milliamperemeter in the current loop.
- Generation of high current (22 to 25 mA) for out of scale alarm simulation.

Digital Input - Outputs

- 6 digital outputs.
- Output on free voltage contact (relay)
- Switching capacity: 60W, 62.5VA.
- Maximum switching current: 2A
- Maximum switching voltage: 220 Vdc or 230 Vac.
- 8 digital inputs
- Inputs on coil relay.

RTD simulator

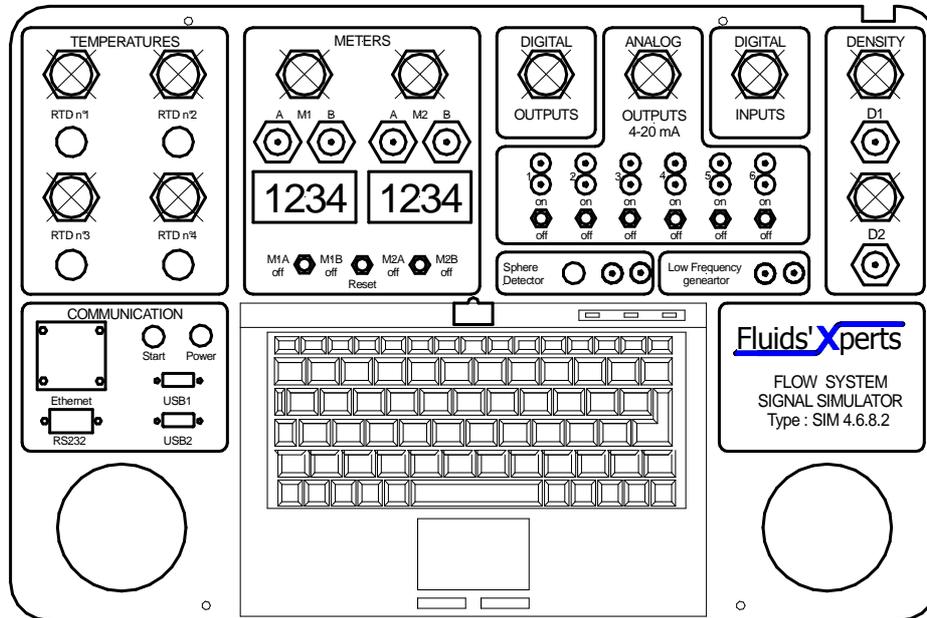
- Up to 4 RTD (100 ohm @ 0°C) – 4 wires.
- Accuracy : 0.1%.
- 12 ohmic values.

Communication

- RS232C port. Ethernet port.
- 2 USB ports.

TECHNICAL DESCRIPTION

2.3. Overview.



2.4. Device description

The simulator is built with following sub set:

- Suitcase.
 - Suitcase built in strong resin.
 - Size: 470 x 387 x 175 mm.
- Screen.
 - Type : color LCD, TFT active matrix.
 - Size : 13.3" (16:10).
 - Video signal type : NTSC, PAL, Computer.
 - Resolution : 1280 x 800.
- PC mother board
 - AT310NT-I – Format ITX
 - Memory: 1 GO DDR2 – SDRAM.
 - 1 slots PCI-e x16 for data acquisition devices plug in.
 - 1 COM port available on suitcase front panel.
 - 2 USB available on suitcase front panel.
 - 1 Ethernet port (RJ45) available on suitcase front panel.
- Hard disk
 - Type : Compact Flash SATA II
 - Capacity : 30 Go.
- Power supply.
 - Type : ITX 220/230 V 50/60Hz on CEE connector
 - Protection: over tension and short circuit. Integrated fuse
 - Power : 200 W

TECHNICAL DESCRIPTION

- Keyboard with touchpad.
 - Mini keyboard with integrated touchpad with page up/down functions.
 - Dimensions : 218 × 21 × 150 mm.
 - Silent stroke and tactile feedback due to high-quality X type membrane.
 - Appealing blue status LEDs for Caps, Num, and Scroll lock functions.
- Data acquisition device.
 - Manufacturer : National Instruments.
 - Type: 1 x PCI 6323 for pulse, current, period, digital I/O generators.
 - 3 Counter Timers 32 bits. Frequency max: 20 MHz – stability 50 ppm.
 - 4 analog outputs 0-10V – DAC resolution: 16 bits at 775 KS/s max.
 - 48 digital input/output
- Temperature RTD transducer:
 - 4 precision resistor network (0.1%) commutable by high quality rotary switch.
 - 6 to 12 ohmic values for each probe.
 - 4 wire output.
- Recopy meter pulse totalizer.
 - Manufacturer: Truometer.
 - Type: HED261B.
 - Mode: LCD rétro éclairé.
 - Capacity : 8 digits.

Nota: One totalizer with reset is connected on Meter 1 channel B output for checking number of pulse sent during simulation.

- Communication.
 - Serial port COM connector is available on suitcase front panel. This connection enables dialog with any instrument using serial link under RS232C or RS485 protocol.
 - Two USB 2.0 female connectors are available on suitcase front panel ports for memory key or printer devices.
 - Ethernet port (RJ45 connector) is available on suitcase front panel for network or flow computer dialog.

2.5. Software Description

Simulator is delivered with following software:

Operating system: Microsoft Windows 7™.

Data acquisition module driver: National Instruments NI-DAQmx™.

Application: Specific executable software for simulator management. This software is developed under National Instruments LabView 8™ language.

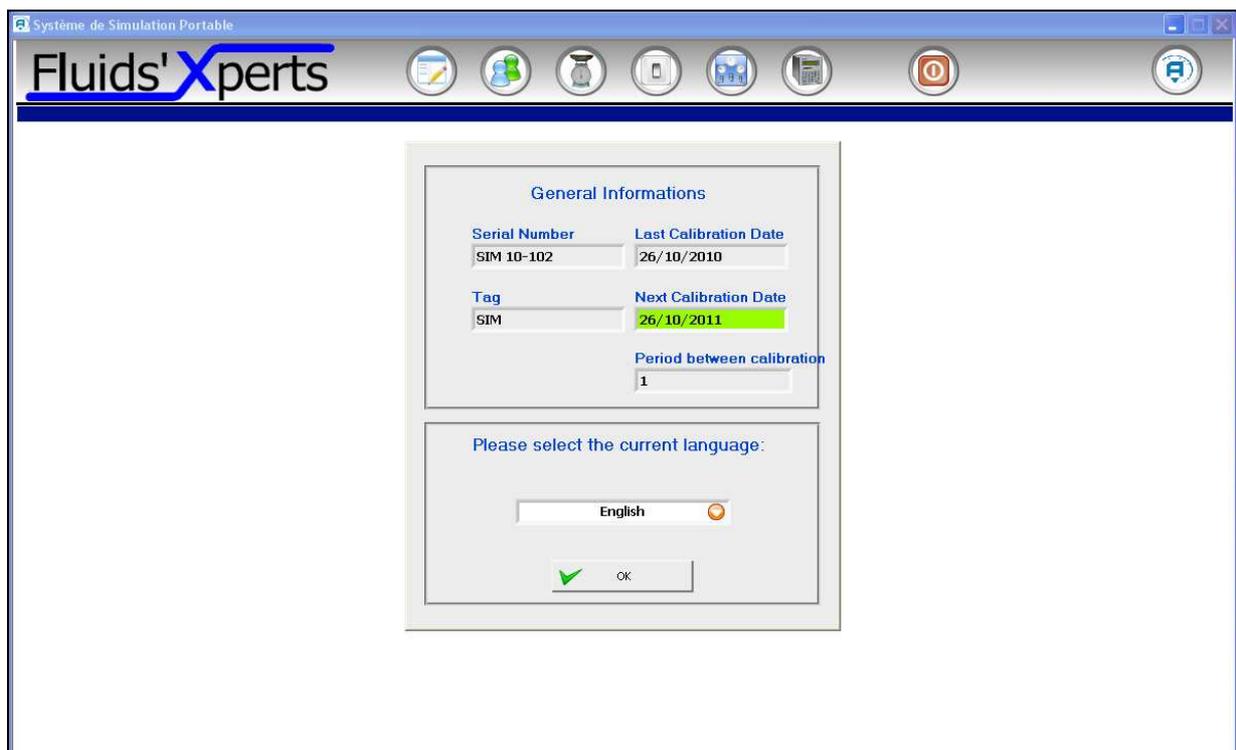
Specific executable software for simulator management with ergonomic visual interface allows to:

- Configure and start each simulation.
- Manage data acquisition device,
- Manage communication with flow computer under test.
- Calculate theoretical net volumes et simulation errors.
- Built and printed test reports.
- Choose application language (English or French)

2.5.1 Starting screen.

When simulator is power on the below screen appears. It shows general information about simulator and tool bar with different icons. These icons are used for choice simulator function:

	Icon for start flow meter simulator.
	Icon for start densitometer simulator.
	Icon for start analog outputs simulator.
	Icon for start digital input or output simulator and low frequency generator.
	Icon for start net volume calculator.
	Icon for launch metering skid library.
	Icon for stop simulator



TECHNICAL DESCRIPTION

Central panel give some general information about simulator.

Upper screen zone gives:

- Simulator serial number.
- Simulator Tag number.
- Date of previous calibration.
- Calibration periodicity in year.
- Date of next calibration. When the current date is two month before periodicity limit date, date of next calibration is displayed in orange colour to inform operator about next calibration proximity. If the calibration date is over, its display passes in red colour to inform operator about necessity of external calibration. Next calibration date and periodicity are user definable in specific file. (.txt).

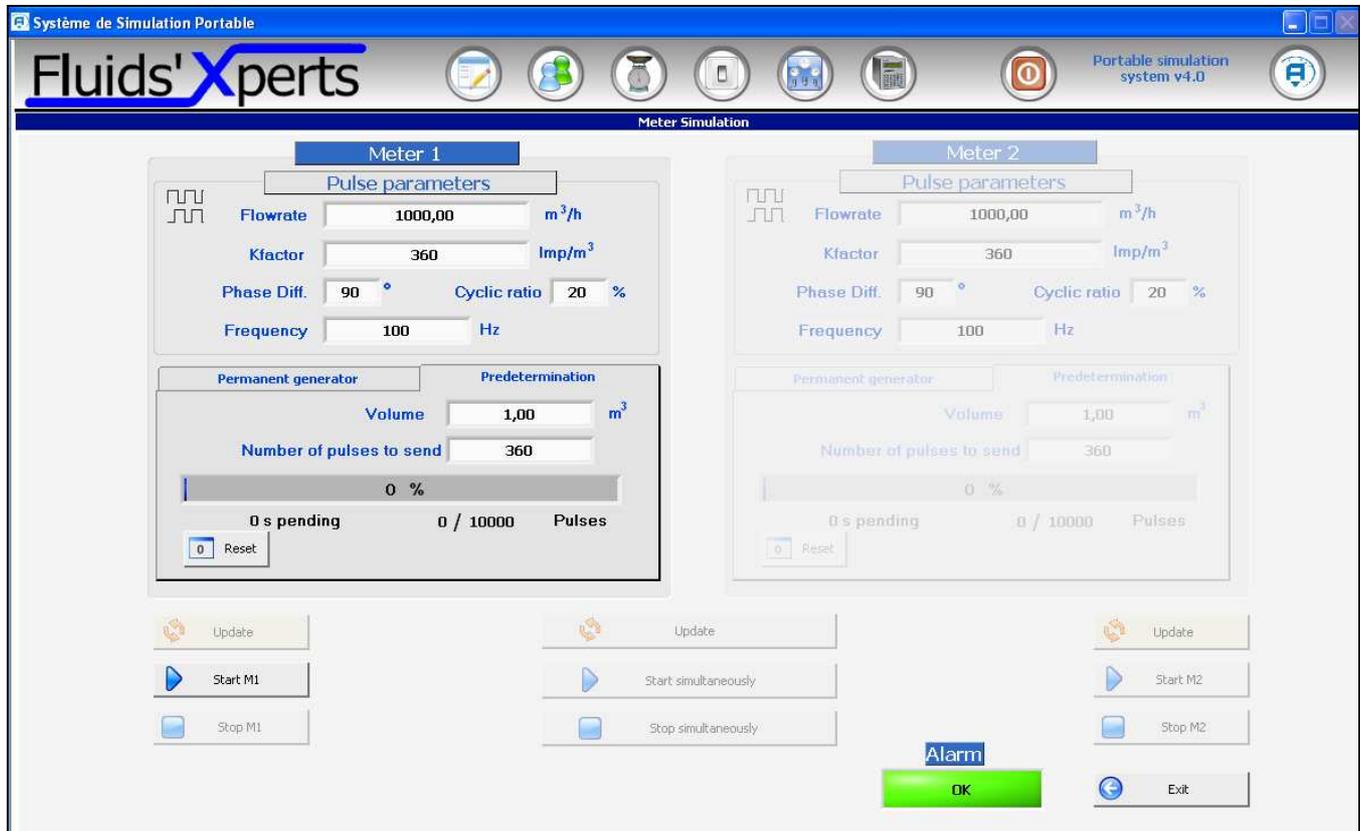
The screenshot displays a 'General Informations' window with the following data:

Serial Number	Last Calibration Date
SIM 10-102	26/10/2010
Tag	Next Calibration Date
SIM	26/10/2011
Period between calibration	
1	

Below the table, the text 'Please select the current language:' is followed by a dropdown menu showing 'English' and a green checkmark icon. An 'OK' button with a green checkmark is located at the bottom.

Lower screen zone is used for choice application language (French or English).

2.5.2 Flow meter simulators.



Volume or mass flow meters simulator is built around one pulse generators. This generator has two out of phase pulse outputs with frequency, electric phase, cyclic ratio and preset adjustable parameters.

Electric phase is adjustable from 0 to 180°. Cyclic ratio is adjustable from 0 to 100%. Typical values (90° for difference of phase and 20 for cyclic ratio) are factory adjusted.

Frequency signal is adjustable from 0 to 5 kHz. Frequency resolution is 0.01 Hz. Output square wave are available under open collector transistor and 5V TTL format.

Start and stop generator and reset commands are available. Update command enable parameter (frequency, Kf, flowrate...) setting during simulation.

It is possible to switch off channel A or B pulse train in order to simulate pulse fidelity calculator on test alarm.

TECHNICAL DESCRIPTION

Continuous generator mode.

For this mode, simulator is used like standard pulse generator. Pulses are generated on start stop order.

	<p>Used to adjust flowrate (in Bbl/h, USG/mn, m3/h).</p> <p>Used to adjust meter K factor (pulses/Bbl, pulses/USG).</p> <p>Used to adjust difference of phase between meter channel and cyclic ratio between pulse.</p> <p>Frequency is calculated in function of flow rate and meter Kfactor. Result could be force with other value</p> <p>Number of pulse sent since generator start command. This totalizer is stopped at stop command.</p> <p>Pulse totalizer reset.</p>
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We generally better know flowrate we want to simulate than relevant frequency.

To solve this point, it is possible to select the required flow rate (Q) and meter Kfactor. Meter frequency is automatically calculated like $F = Q \times kf / 3600$ where Q is in m3/h or Bbl/h, USG/mn and Kf in pulse per m³ or Barrel or USG. It remains possible to force frequency value.

'Update' button is available to change frequency, flowrate, Kf... without simulation interruption.

Preset generator mode.

In preset mode, it is easier to fixe required volume than relevant number of pulse. Simulator calculates preset pulse counter value in function of required volume and meter Kfactor. It remains possible to force preset counter value.

Preset selection range is from 0 to 1 000 000 pulses.

	<p>Used to adjust flowrate (in BBl/h, USG/mn, m3/h).</p> <p>Used to adjust meter K factor (pulses/Bbl, pulses/USG).</p> <p>Used to adjust difference of phase between meter channel and cyclic ratio between pulse.</p> <p>Frequency is calculated in function of flow rate and meter Kfactor. Result could be force with other value</p> <p>Preset volume.</p> <p>Preset number of pulse calculated (function of required volume and Kfactor). Result could be force with other value</p> <p>Bar graph display status of the preset counter.</p>
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2.5.3 Densitometer simulator.

Density :

Configuration of Densitometer simulator is performed through the following screen.



Densitometer simulator is built around one adjustable period pulse generator.

We generally better known density we want simulate than relevant densitometer period. Densitometer period τ is calculated in function of required density ρ and specific factors (K0, K1, K2) from densitometer calibration sheet.

It remains possible to force density calculation result.

Period range is from 0 to 3000 μs with 0.1 μs steps.

'Update' button is available to change period without simulation interruption.

TECHNICAL DESCRIPTION

	K0 <input type="text" value="-1,21776E+3"/> K1 <input type="text" value="-3,74124E-1"/> K2 <input type="text" value="1,34933E-3"/>	Calibration Densitometer coefficients. Must be fill by operator.
Period <input type="text" value="1369,323"/> µs	Calculated period in function of density and densitometer coefficients.	
Frequency <input type="text" value="730,29"/> Hz	Frequency in function of density (invert of period)	
Masse Vol. non corrigée <input type="text" value="800"/> kg/m³	Wanted density	

Pressure and temperature measurements can be affected to densitometer configuration for vibrating tube mechanical correction.

Densitometer 1

K18 <input type="text" value="-4,83311E-4"/>	K20A <input type="text" value="1,48357E-5"/>	Voie T. <input type="text"/>
K19 <input type="text" value="-5,73662E-1"/>	K20B <input type="text" value="-1,51498E-6"/>	T <input type="text" value="0"/> <input type="text"/>
	K21A <input type="text" value="1,20918E-1"/>	Voie P. <input type="text"/>
	K21B <input type="text" value="-2,32436E-3"/>	P <input type="text" value="0"/> <input type="text"/>

Masse Vol. corrigée en T
 kg/m³

Masse Vol. corrigée en P et T
 kg/m³

K18 and K19 correction factors are used for calculation and display of density at densitometer actual temperature.

K20A to K21B correction factors are used for calculation of density at densitometer actual pressure. Density at densitometer actual temperature and pressure is displayed.

Analog output affected to temperature and pressure densitometer is selected through a push down list of 4 -20 mA current channel.

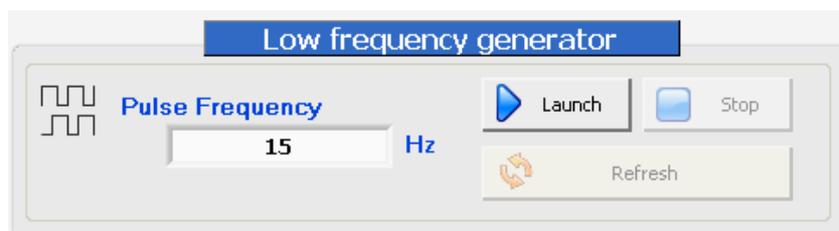
2.5.4 Digital inputs and Outputs – Low frequency generator.

Configuration of digital inputs or outputs and low flow generator is performed on the following screen.



Low frequency generator:

Low frequency generator is used to simulate PD meter equipped with ILS switch output. This generator command a relay at adjustable frequency from 0.01 to 15 Hz. Maximum switching capacity is 60 W. 62.5 VA



Start and stop low frequency generator commands are available. 'Update' button is available to change frequency without simulation interruption.

Digital inputs and Outputs:

8 colored buttons are available for digital outputs command. Button is green when the command is "on" and contact of relevant relay is closed. Button is red when the command is "off" and contact of relevant relay is opened. Maximum switching capacity is 60 W. 62.5 VA

TECHNICAL DESCRIPTION

Digital inputs are driven by the flow computer under test. Digital inputs status is displayed on coloured boxes.

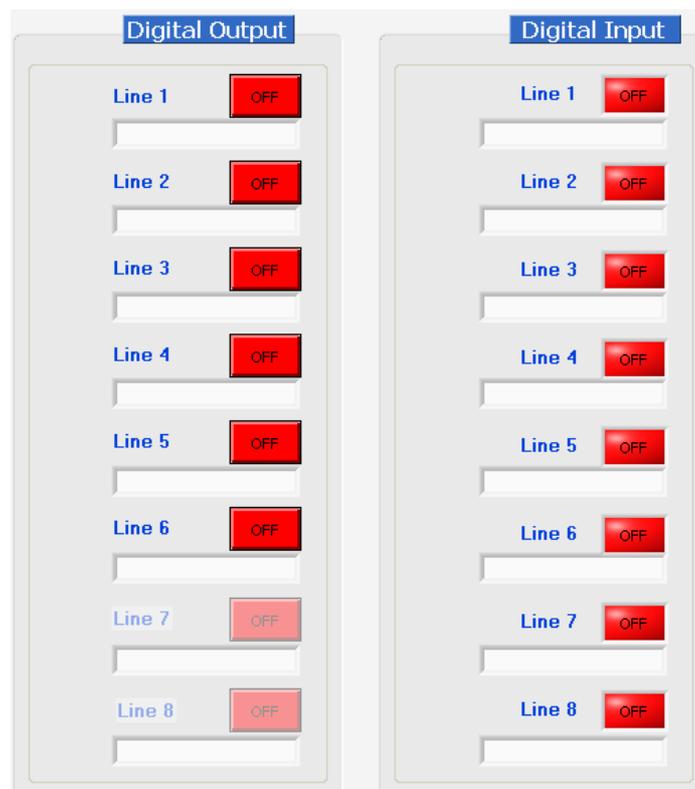
Green colour for level 1 – true status.

Red colour for level 0 – false status.

Result of exclusive OR off all digital inputs is display in "alarm" box placed on right bottom corner of each screen. For example, this display is used to alert operator of major alarm generated by flow computer.

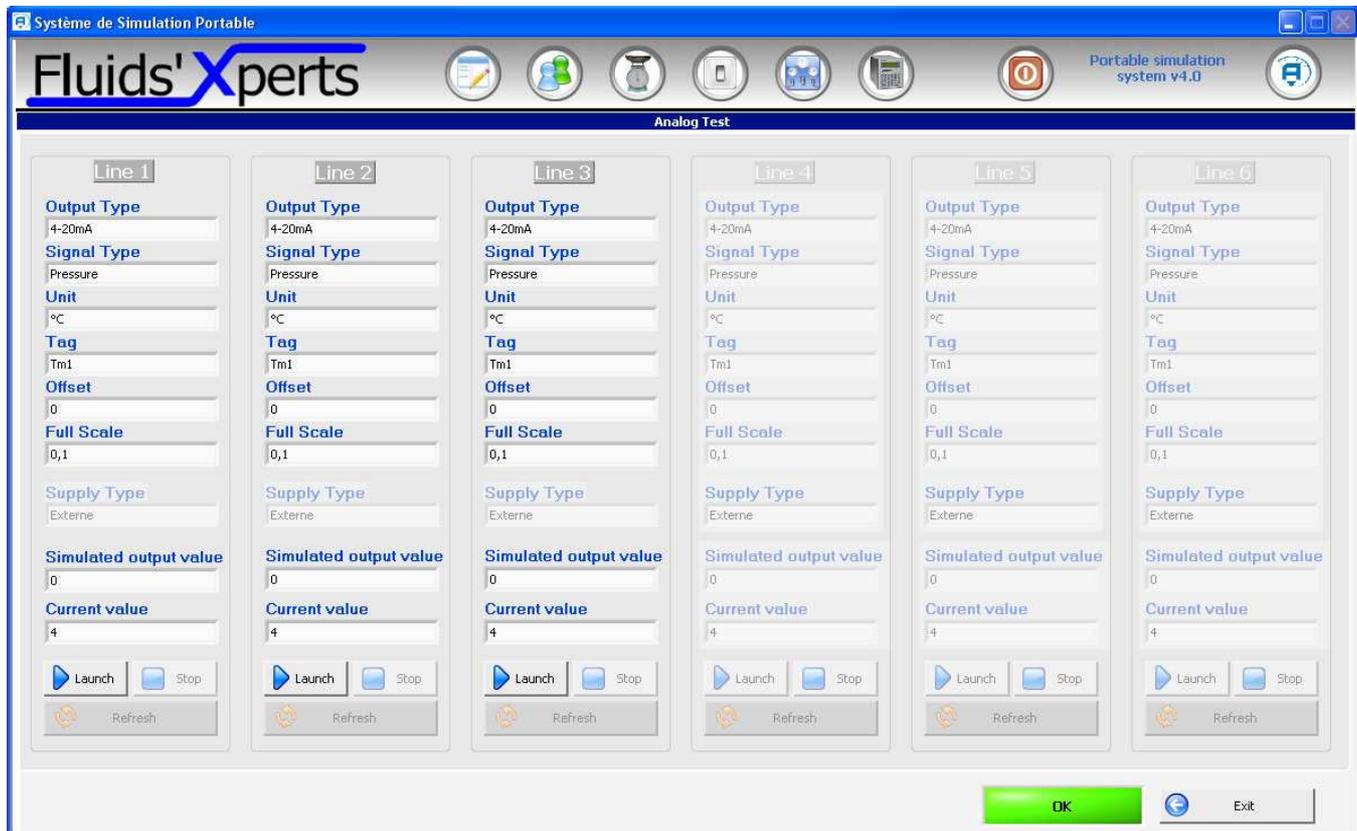
Input Relay is actuated by the flow computer under test. For each input, one extremity of coil relay can be connected to 24 VDC or Ground simulator power supply. During operation, flow computer output can be open collector or open emitter transistor.

Writable areas are located near each digital status for tag number or other comments.



2.5.5 Analog output generators

Configuration of analog outputs is performed through the following screen.



Analog outputs simulator integrates three similar and independent 0 or 4-20 mA generators.

We generally better known physical value (e.g. temperature, pressure...) we want to simulate than relevant current value.

During current generator configuration, operator must select the physical range of the simulated transducer (zero and full scale).

Calculation and generation of current are done according to selected physical values

It remain possible to force current calculation result.

Start and stop current generator commands are independent.

'Update'' button is available to change current without simulation interruption.

TECHNICAL DESCRIPTION

For each 0 or 4-20 mA current generator, the following parameters can be configured:

	<p>CONFIGURATION ZONE</p> <p>Current type= 4-20 mA or 0-20 mA ?</p> <p>Push down list with different type of physical measurement: Pressure, temperature, density...</p> <p>Push down list with different unit: °C, °F, kPa, bar, Psi, kg/m3</p> <p>Push down list with different tag: Tm1, Tm2, Tm3, Tm4, Tp1, Tp2, Ttmv, Pm1 ; Pm2, Pm3, Pm4, Pp1, Pp2, D1, D2.</p> <p>Physical value for the zero (0 or 4 mA) of the simulated transducer.</p> <p>Physical value for the full scale (20 mA) of the simulated transducer..</p> <p>Current loop power choice. Current loop could be active or not passive</p> <p>SIMULATION ZONE</p> <p>Required simulated physical value</p> <p>Current value calculated as a function of required physical value. Resolution: 0.01 mA</p> <p>Start and stop current generator commands.</p> <p>Update push button for update physical (or current) value without simulation interruption.</p>
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Current loop power supply: current loop could be active or passive.

If the current loop is passive, power is supply by the flow computer under test (general case). If the current loop is active, power is supply by the simulator.

On simulator switch on, current loop are in passive mode.

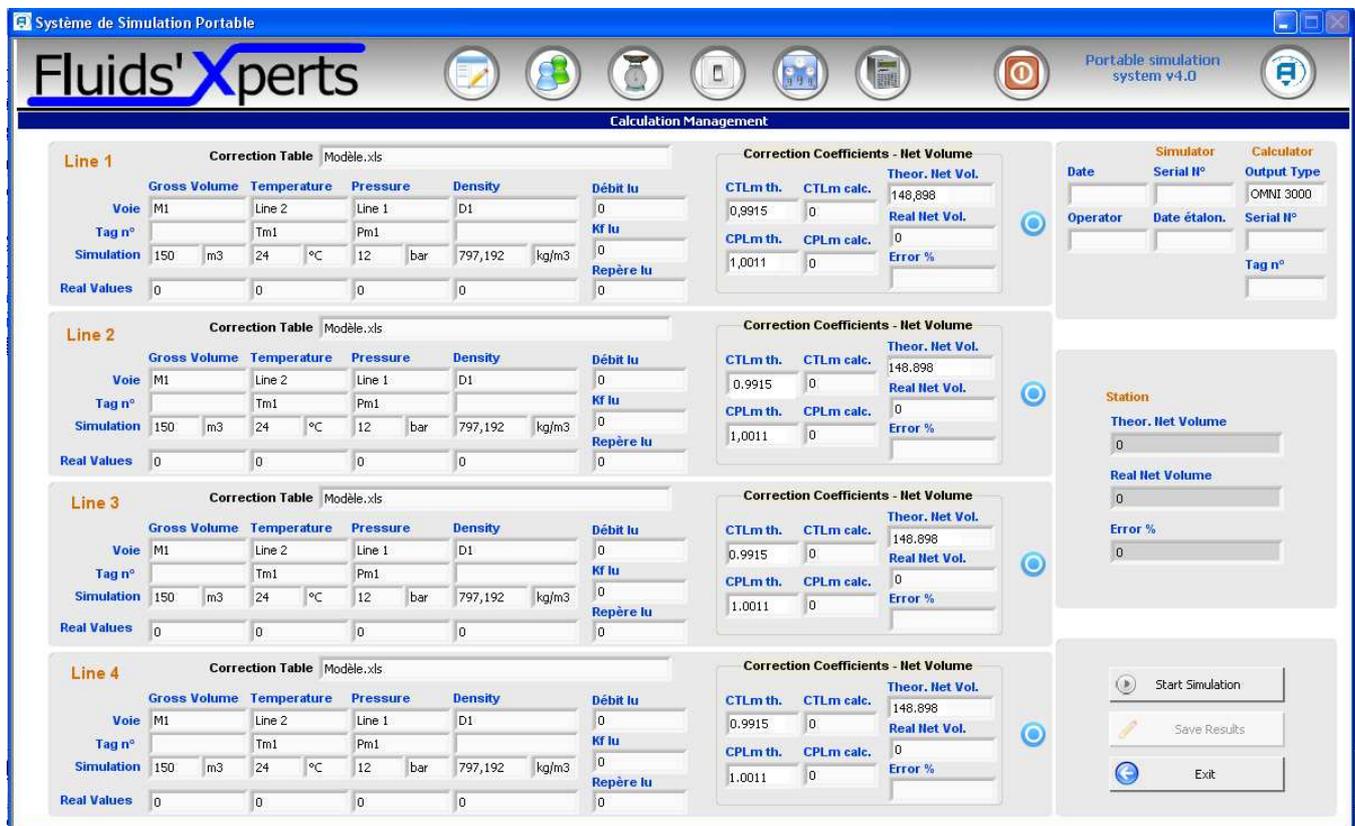
2.5.6 Volume Calculation

Simulator software allows calculating theoretical net volumes in function of simulation parameters (volume, pressure, temperature and density). Net volumes establish by flow computer could be compare with theoretical net volume. Error is calculate to define conformity of flow computer calculations.

Flow computer must be connected to simulator by serial link (RS232 or Ethernet) for memory register reading.

Serial link parameters and Modbus address registers are memorised in dedicated file.

Volume calculation screen is the following:



It shows four independents metering lines with volume, temperature, pressure and density measurement.

One simulator channel is dedicated at each measurement. Channel number, channel tag and simulated value are shown.

For each line, correction table can be choice for theoretical net volume calculation in function of type of product.

Theoretical net volumes are calculated with Excel in function of simulation parameters and correction table. Correction factors (CTLm and CPLm) and theoretical net volume are shown

Push button "Start simulation" launch the generators. Currents (P & T) and period (density) are firstly established, before preset volume generator starting.

TECHNICAL DESCRIPTION

During simulation, simulator read dedicated flow computer registers (Q, F, Kf, V, P, T, D) and refresh display.

Push down list for choice M1 or M2.

Push down list for choice analog output (channel 1 to 3).

Push down list for choice analog output (channel 1 to 3)..

Flowrate and Meter Kf read in flow computer

The screenshot shows a software interface for 'Line 1'. It is divided into two main sections. The left section, titled 'Correction Table', contains a grid of input fields for 'Gross Volume', 'Temperature', 'Pressure', and 'Density'. Below this grid are fields for 'Voie' (set to M1), 'Tag n°', 'Simulation' (150 m3, 24 °C, 12 bar, 797,192 kg/m3), and 'Real Values' (all 0). The right section, titled 'Correction Coefficients - Net Volume', contains fields for 'Débit lu', 'Kf lu', and 'Repère lu' (all 0). Below these are 'CTLm th.' (0,9915), 'CTLm calc.' (0), 'CPLm th.' (1,0011), and 'CPLm calc.' (0). On the far right, 'Theor. Net Vol.' is 148,898, 'Real Net Vol.' is 0, and 'Error %' is 0. Arrows from the text above point to various elements in the interface.

Volume, temperature, pressure and Density delivered by flow computer.

Simulated volume, temperature, pressure and density quantities and units.

Calculated by flow computer and theoretical correction factors.

Calculated by flow computer and theoretical net volume. Error display.

At the end of preset volume simulation, simulator read net volume and correction factors established by flow computer and calculate error with theoretical net volumes.

If there is no serial link with flow computer, established values can be write manually by operator.

Net volume of each line can be added or subtracted to obtain theoretical net volume see by the station. Error is also calculated in function of net volume establish by flow computer.

At the end of the test, one report can be memorise and print.

2.6. Wiring

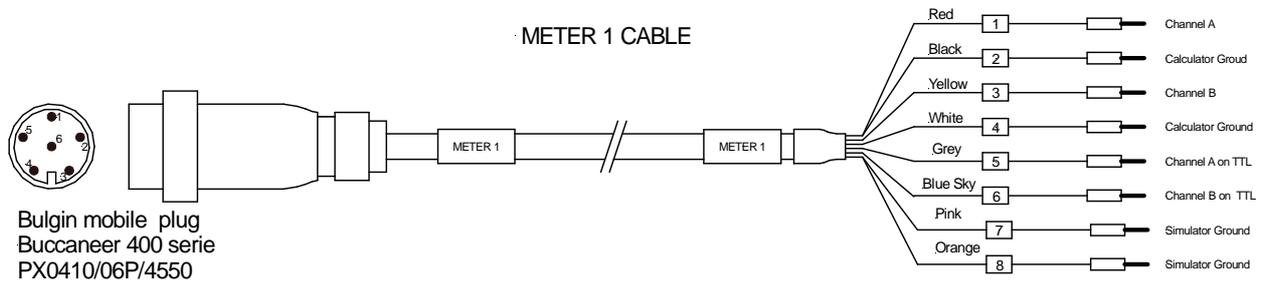
2.6.1 Flow Meter simulator

Meter channel A and B diphase pulse signals are available under TTL format or on open collector output.

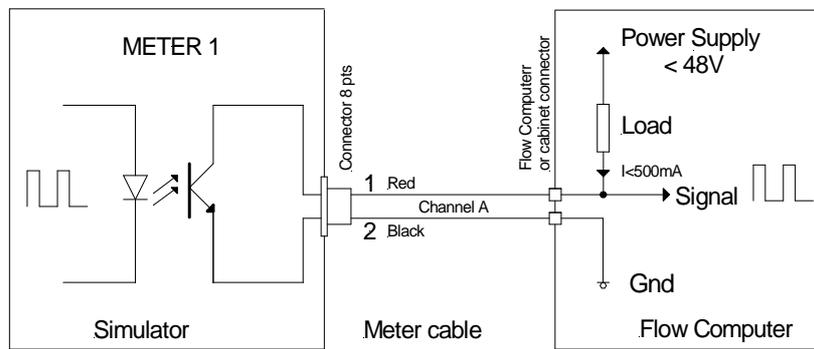
Pulses under TTL format signal are available on "M1A" and "M1B" tagged BNC connectors or on "Meter 1" tagged cylindrical connector.

Meter pulse on open collector are available on "Meter 1" tagged 4 points cylindrical connector.

TECHNICAL DESCRIPTION



Open collector wiring is the following:

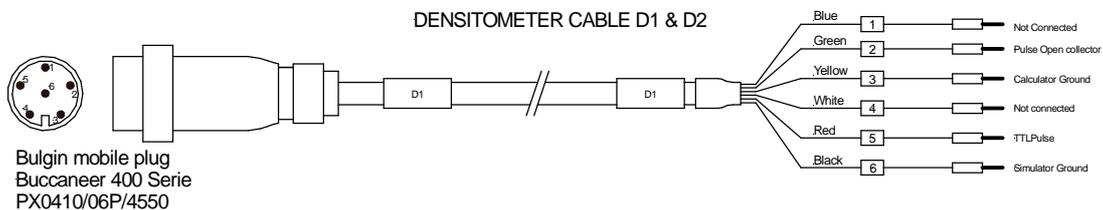


2.6.2 Densitometer simulator

Densitometer pulse signal is available under TTL format or on open collector output.

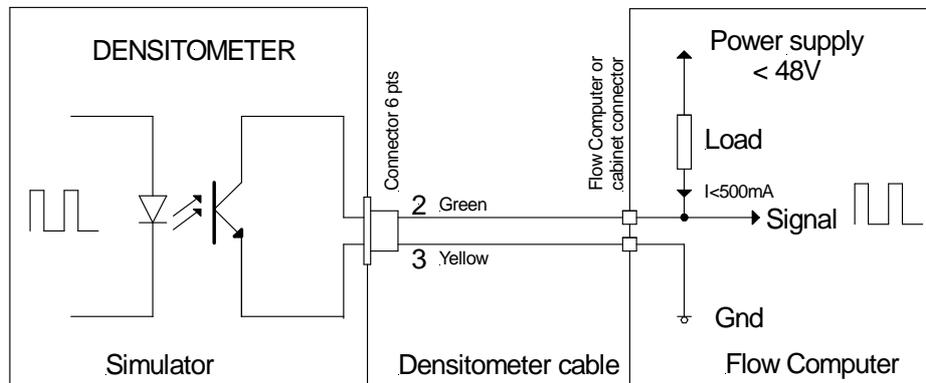
Pulse signal under TTL format signal is available on "D1" tagged BNC connector or on "Densitometer D1" tagged 6 points cylindrical connector.

Densitometer pulse signal on open collector is available on "Densitometer D1" tagged cylindrical connector.



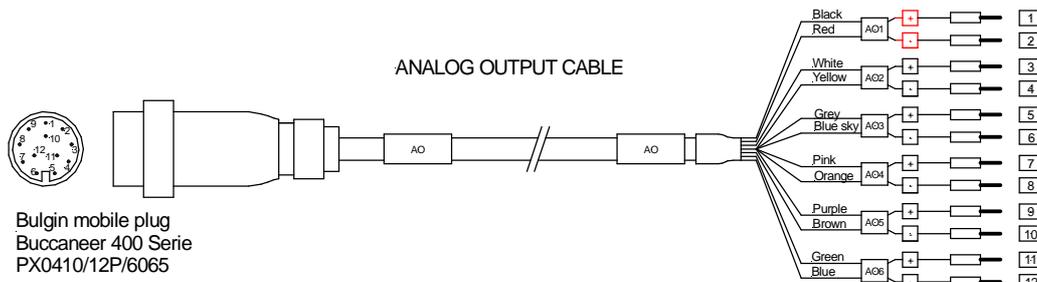
Open collector wiring is the following:

TECHNICAL DESCRIPTION



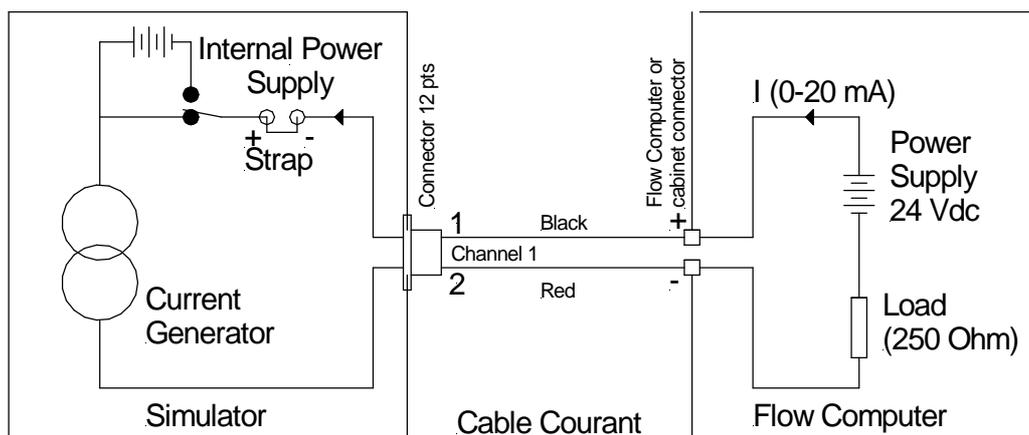
2.6.3 Analog outputs

3 analog outputs with 4-20 mA current are available on "Analog Output" tagged 12 points cylindrical connector.



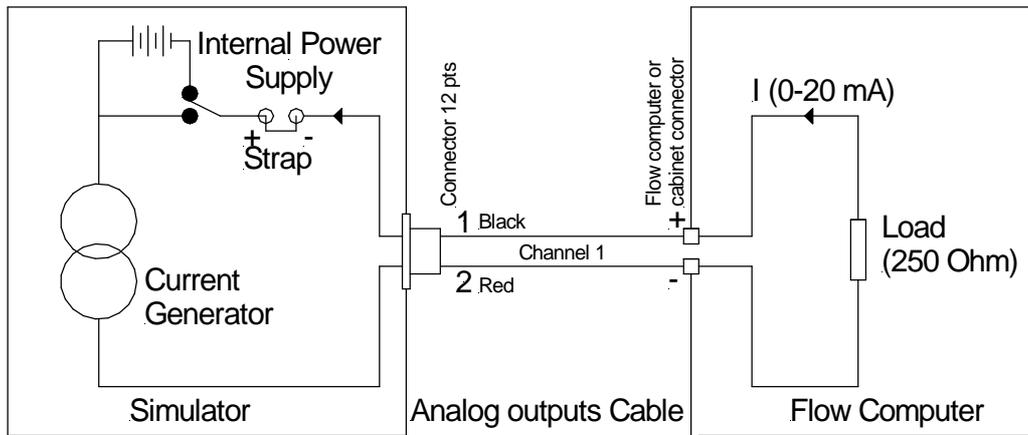
Current loop power supply can be done by simulator or flow computer.

In case of current loop power supply by flow computer, wiring is the following:



In case of current loop power supply by simulator, wiring is the following:

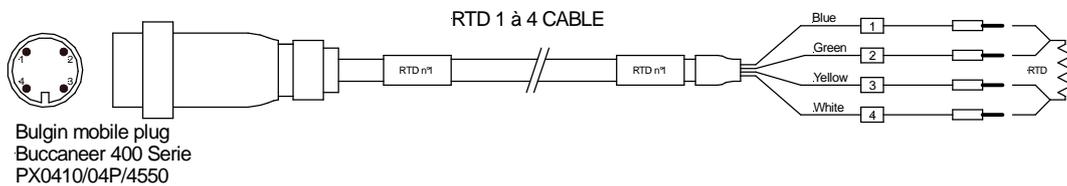
TECHNICAL DESCRIPTION



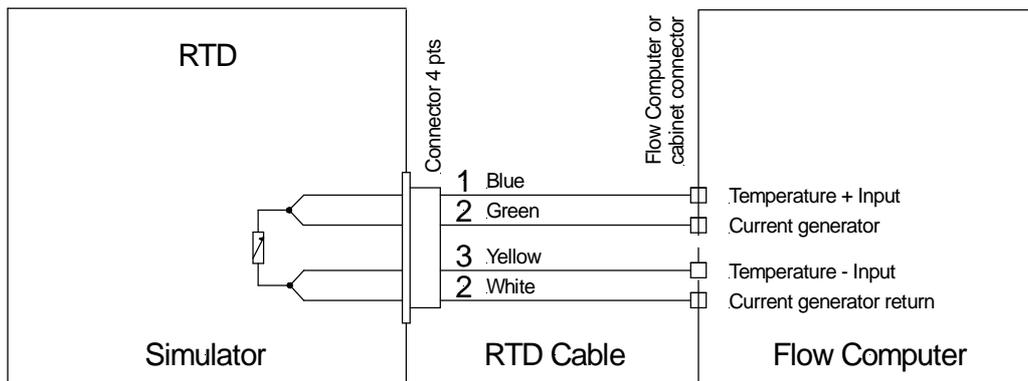
Before to choose this wiring, be sure than any voltage is delivered by flow computer on transmitter connection.

2.6.4 RDT Outputs

4 RTD outputs are available on "RTD 1 to 4" tagged 4 point cylindrical connector.



Wiring to flow computer is the following:



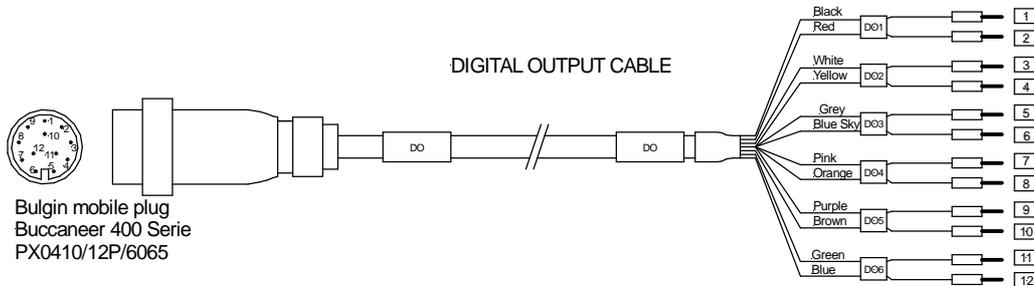
Simulated temperature is function of ohm resistor value. Resistors selected by rotary switches position 1 to 6 have following typical values: 95, 100, 102, 107, 113 et 118 Ohm.

Temperature values are obtained by using ISO 60751 standard ohm / °F or °C conversion.

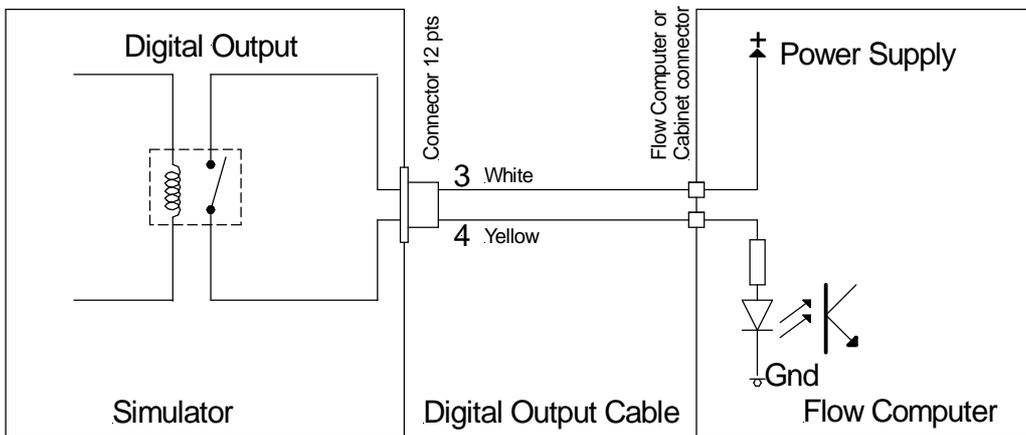
Resistors selected by rotary switches position 7 to 12 have on order factory adjustable values.

2.6.5 Digital output

8 digital outputs are available on "Digital output" tagged 12 point cylindrical connector.

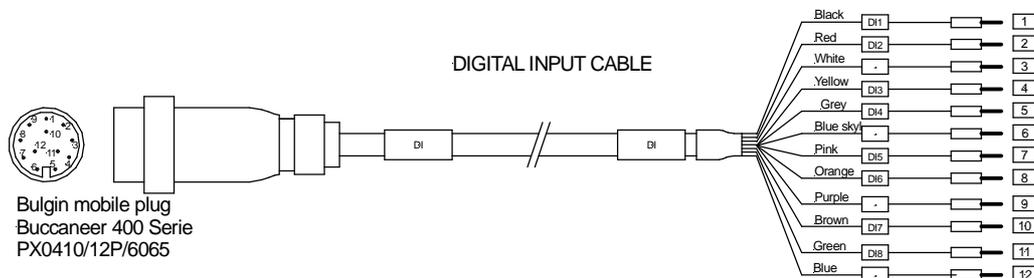


Wiring to flow computer is the following:



2.6.6 Digital input

6 digital inputs are available on "Digital input" tagged 12 point cylindrical connector.



Wiring to flow computer is the following:

TECHNICAL DESCRIPTION

