FLOW METERING SYSTEM SIGNAL SIMULATOR

TYPE: SIM 2.1.2.0

TECHNICAL DESCRIPTION

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CONTENT

1. SCOPE

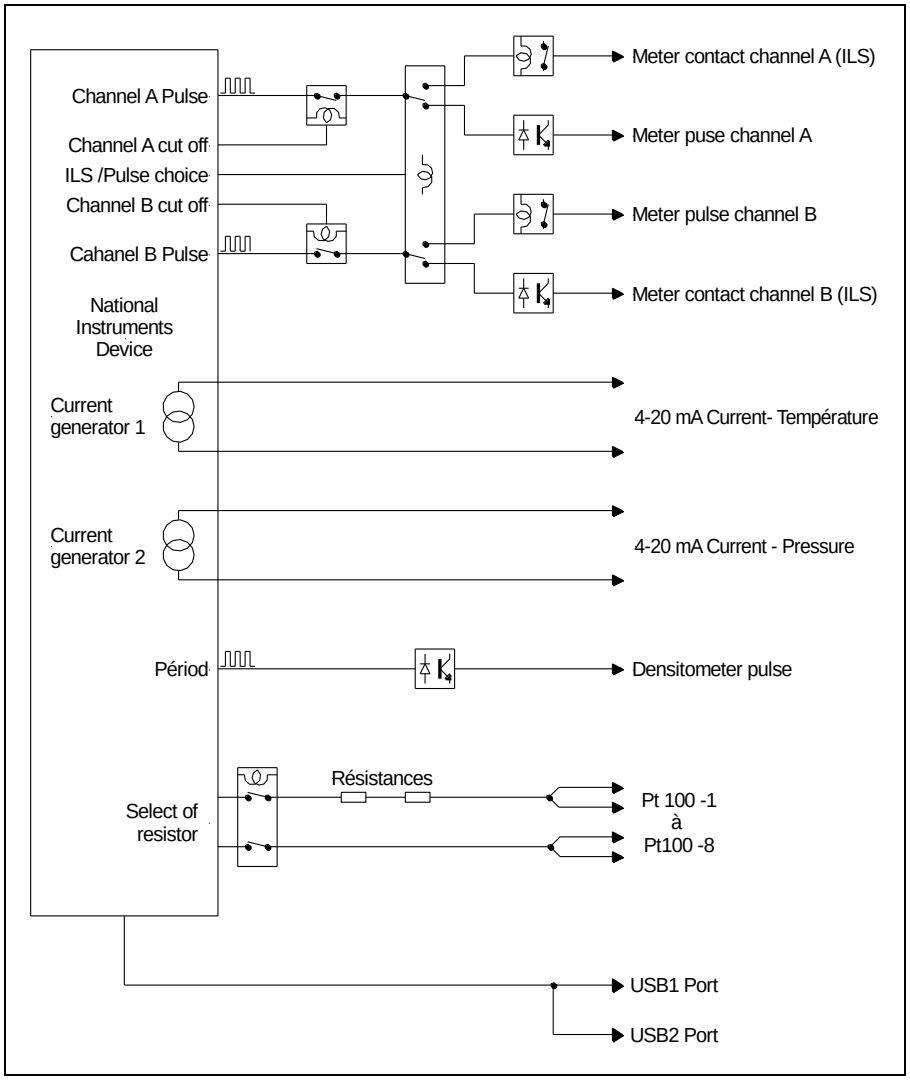
Metrology controls or maintenance of flow computer needs volumes, temperature, pressure, density, viscosity… simulations for checking their acquisitions and calculation quality.
Flow signal simulator SIM 2.1.2.0 offer in the same instrument all the generators for initial or periodic flow computer conformity checking with standards, international recommendation or legal metrology rules in case of custody transfer application.
SIM 2.1.2.0 is adapted for simulated standard flow metering mono line equipped with one flow meter, one temperature transducer, one pressure transducer and on densitometer.

2. TECHNICAL DESCRIPTION

Principle of simulator

The concept of this simulator SIM 2.1.2.0 is to concentrate in the same instrument four industrial signal generators: pulse, current, period and resistor.

The scheme of principle is:



Overview.

This simulator comes as a strong polycarbonate box for generator and interface module protection. The box front panel support male Sub D 37 pin connectors where all outputs are round up. USB B connector is also installing on box for wiring with personal computer (PC).

Simulator software must be installed on operator PC for generators configuration and management.

Device description

The simulator is built with following sub set:

- box.
  - Box built in strong polycarbonate resin.
  - Size: 200 x 120 x 75 mm.

- Data acquisition device.
  - Manufacter : National Instruments.
  - Type: USB 6316 for pulse, current, period I/O generators.
  - 2 Counter Timers 32 bits. Frequency max: 20 MHz – stability 50 ppm.
  - 2 analog outputs 0-10V – DAC resolution: 16 bits at 775 KS/s max.

- Interface device

This interface support amplifier, relays, optocoupler, for data acquisition device protection. Interface outputs are round up on sub D37 pin connector.
Wiring with flow computer on test is done with 2 m length specific cable delivered with flow simulator.

Simulator main characteristics.

Meter pulse outputs:

- 1 outputs with 2 out of phase pulse trains (Channel A and B)
- 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.
- Switch off of pulse train (A or B) for pulse fidelity alarm simulation
- BNC Plug for 0-5V TTL signal output.
- 1 low frequency output (0.01 to 15 Hz) on free voltage contact 62.5VA

Density transmitter pulse outputs:

- 1 pulse outputs.
- 0-5VTTL and photo coupler on open collector
- Period: 0 to 3000 µs. Resolution: 0.1µs. Stability 50 ppm.
- BNC Plug for 0-5V TTL signal output.

Analog outputs :

- 2 currents outputs 0 – 20 mA or 4 – 20 mA.
- Resolution: 0.01 mA. Accuracy: < 5 µA. Stability 300 nA.
- Compatible with 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.

RTD simulator

- 1 RTD (100 ohm @ 0°C) – 4 wires.
- Accuracy : 0.1%.
- 8 ohmic values. (values could be customised)

Connection

- 1 Sub D 37 pin connector for wiring with flow computer on test
- 3 BNC Plug for 0-5 V TTL signal for wiring with flow computer on test
- 1 USB connector for wiring with personal computer. One USB B to USBA cable is providing with simulator.

Software Description.

Simulator need following software:

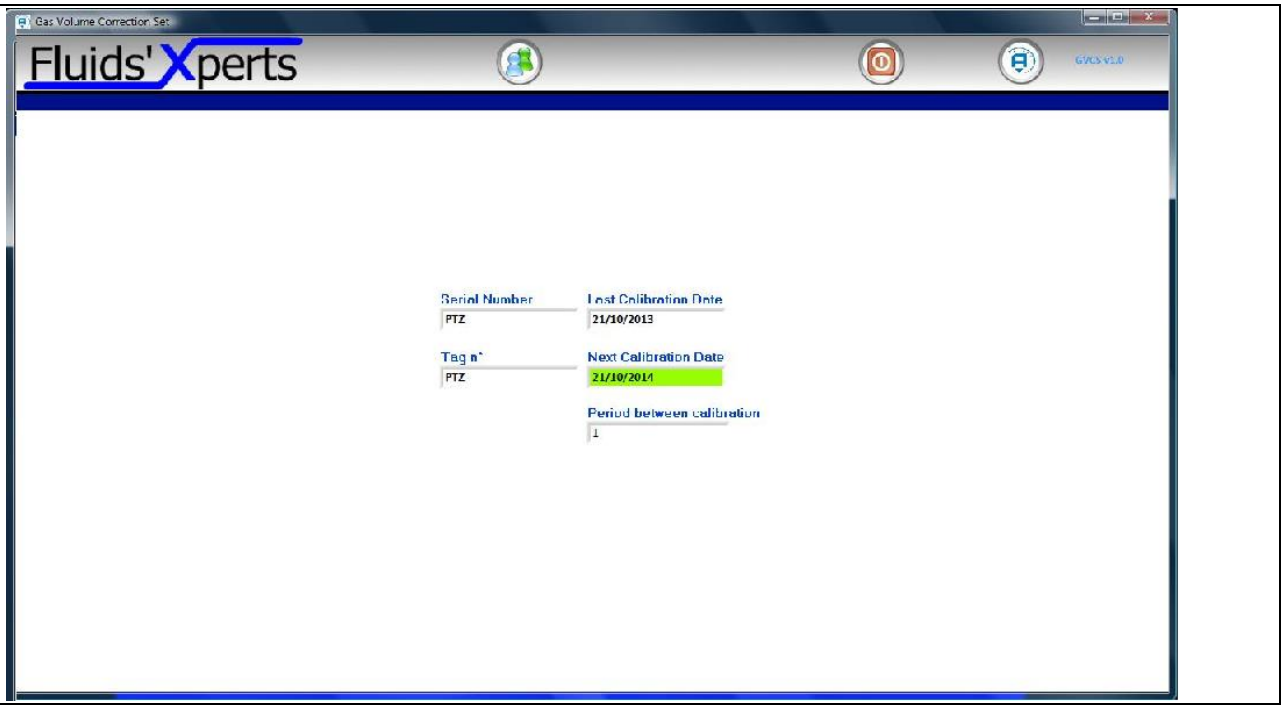
Operating system: Microsoft Windows 7 ™, Vista™ or XP™
Data acquisition module driver: National Instruments NI-DAQmx™.
Application: Specific executable software for simulator management. This software is developed under National Instruments LabView 9™ language.

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

- Manage data acquisition device.
- Configure and start each simulation.
- 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:

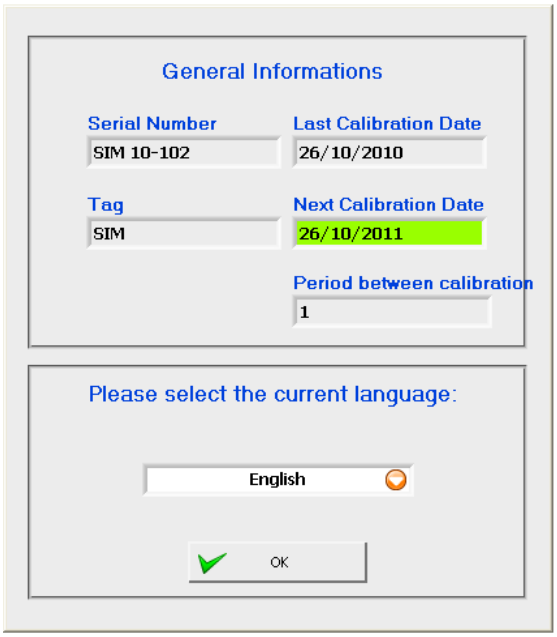
	Icon for opening simulator management display.
	Icon for simulator stop

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.

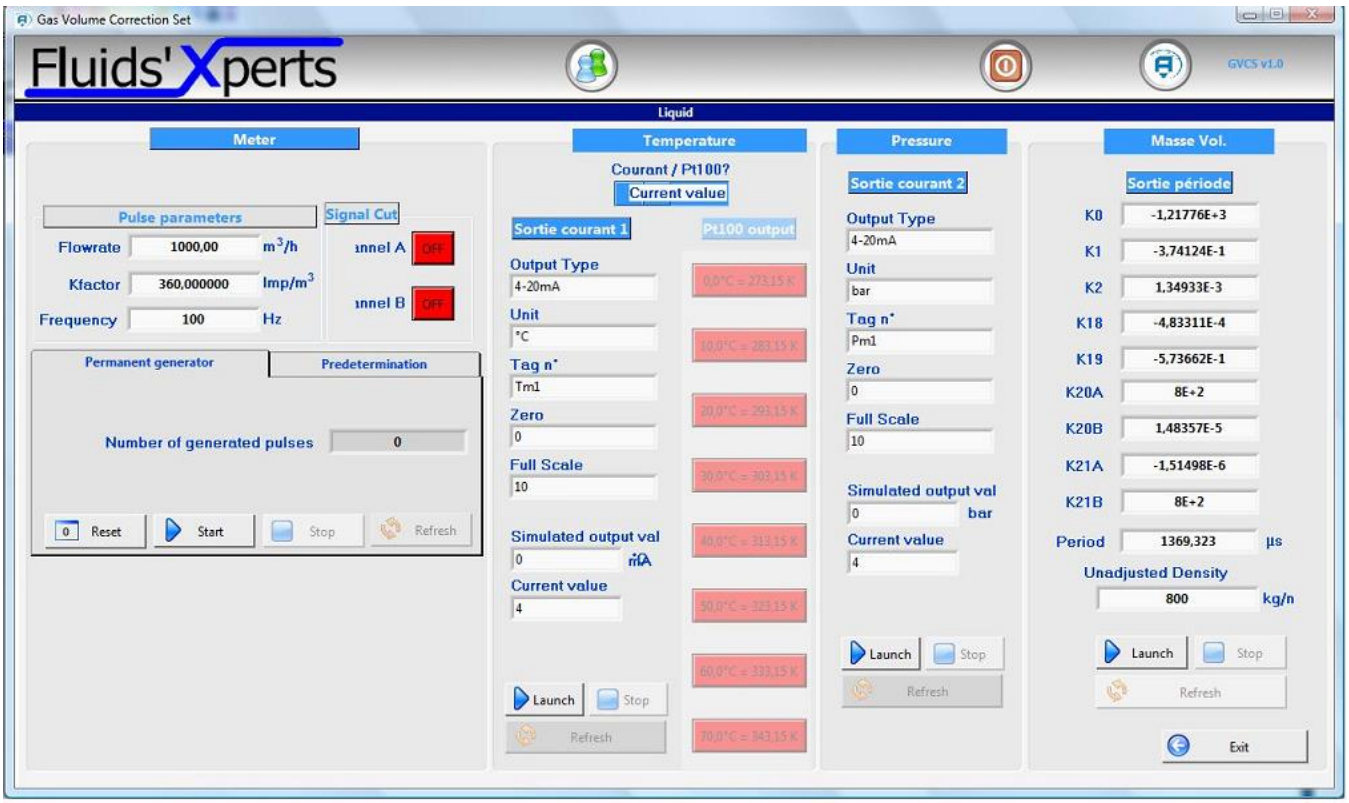
When the current date is two month before periodicity limit date, date of next calibration is displayed in orange colour to inform operator about next calibration proximity. If the calibration date is over, its display passes in red colour to inform operator about necessity of external calibration. Next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



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

2.5.2 Flow metering system simulator management screen.

By clicking on the following icon:  , simulator management screen is displayed:



This window accommodates all generator commands:

- Volume or mass flow meter (pulse).
- Temperature transducer (4-20 mA or Pt100).
- Pressure transducer (4-20 mA).
- Densitometer (period).

2.5.3 Flow (or mass) meter simulator.

Volume or mass flow meters simulator is built around two pulse generators. These generators have two out of phase pulse outputs with frequency and preset adjustable parameters.

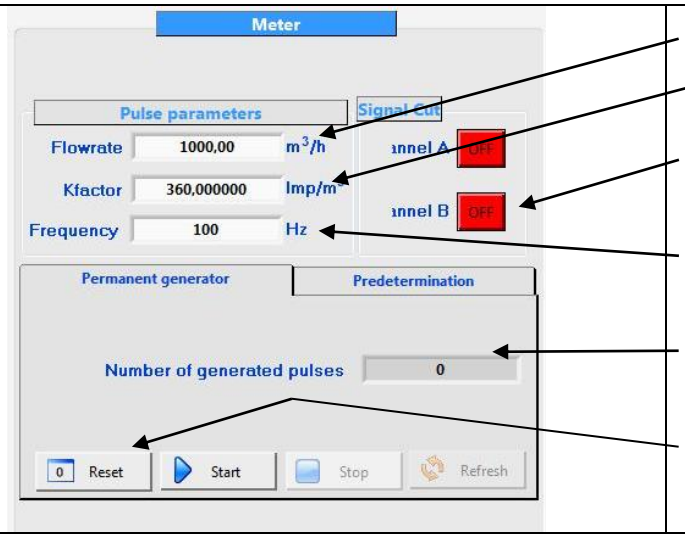
Frequency signal is adjustable from 0 to 5 kHz. Frequency resolution is 0.01 Hz. Output square wave are available under open collector transistor and 5V TTL format.

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

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

Continuous generator mode.

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



Used to adjust flow rate

Used to adjust meter K factor

Push button used for switch off channel A or B.
Pulse fidelity calculator function checking.

Frequency is calculated in function of flow rate and meter Kfactor. Result could be force with other value

Number of pulse sent since generator start command. This counter is stopped at stop command.

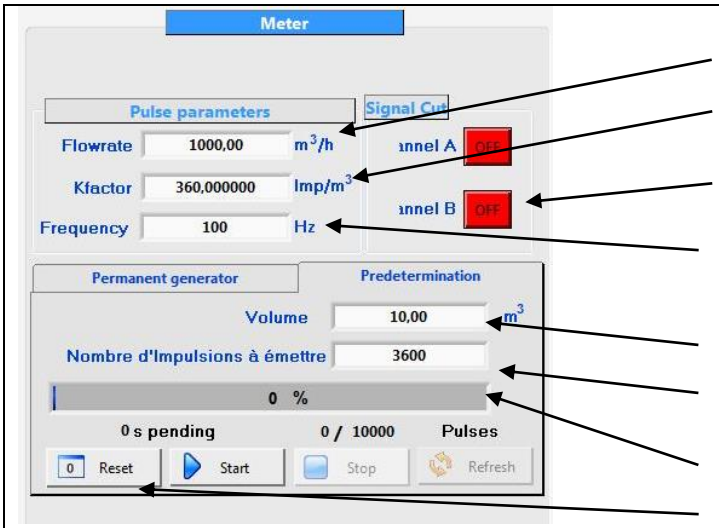
Pulse counter reset.

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 Kf. Meter frequency is automatically calculated like F= Q x Kf/3600 where Q is in m^3/h and Kf is in pulse per m^3 . It remains possible to force frequency value.

'Start' and 'stop' button are used for launch and stop pulse generator
'Reset' button is available to reset pulse counter.
'Refresh'' button is available to change frequency, flowrate, Kf… without simulation interruption.

Preset generator mode.

For this mode, volume or masse quantity is preset before pulse generator launching. Number of pulse is calculated in function of volume or mass preset and flow meter Kfactor (Kf).



Used to adjust flow rate.

Used to adjust meter K factor.

Push button used for switch off channel A or B.
Pulse fidelity calculator function checking.
Frequency is calculated in function of flow rate and meter Kfactor. Result could be force with other value

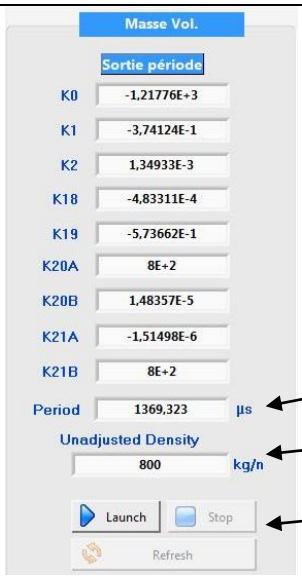
Preset volume.
Preset number of pulse calculated (function of required volume and Kfactor). Result could be force with other value
Bar graph display status of the preset counter.
Pulse counter reset.

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.

2.5.4 Densitometer simulator.

Densitometer simulator is built around one adjustable period pulse generator.
Configuration of densitometer simulator is performed through the following screen:



Calibration Densitometer coefficients. Must be fill by operator.

Calculated period in function of wanted density and densitometer coefficients

Wanted density

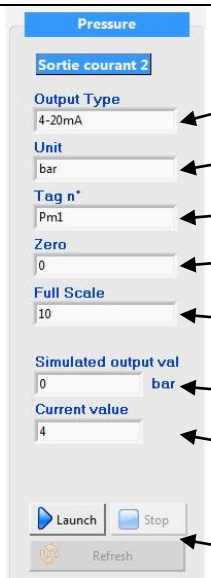
Generator command

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 period 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.

2.5.5 Pressure output generator

Configuration of analog pressure outputs is performed through the following screen.



Current type= 4-20 mA or 0-20 mA ?

Unit.

Tag number.

Physical value for the zero (0 or 4 mA) of the pressure transducer.

Physical value for the full scale (20 mA) of the pressure transducer.
Required simulated pressure value.

Current value calculated as a function of required physical value. Resolution: 0.01 mA.
Start and stop current generator commands.
Update push button for update physical (or current) value without simulation interruption.

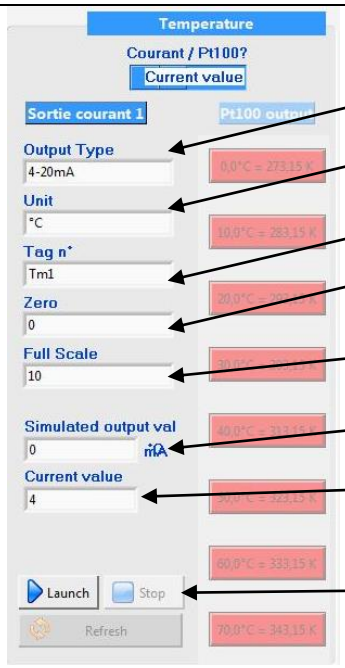
2.5.6 Temperature output generators

SIM 2.1.2.0 propose two temperature simulator solutions:

- One analog transducer simulator
- One RTD transducer simulator

Analog temperature transducer simulator

Configuration of analog temperature outputs is performed through the following screen.



Current type= 4-20 mA or 0-20 mA ?

Unit.

Tag number.

Physical value for the zero (0 or 4 mA) of the pressure transducer.

Physical value for the full scale (20 mA) of the pressure transducer.
Required simulated pressure value.

Current value calculated as a function of required physical value. Resolution: 0.01 mA.
Start and stop current generator commands.

Update push button for update physical (or current) value without simulation interruption.

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

During current generator configuration, operator must fixe the physical range of the simulated transducer (zero and full scale). Calculation and generation of current are done according to selected physical values

It remains possible to force current calculation result.

Start and stop current generator commands are independent.

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

RTD temperature transducer simulator

Eight (8) high accuracy resistors could be selected by software. Temperature values are done in Kelvin or in °Celsius.

When clicking on the right box, four wire RDT out put take value of relevant resistor.

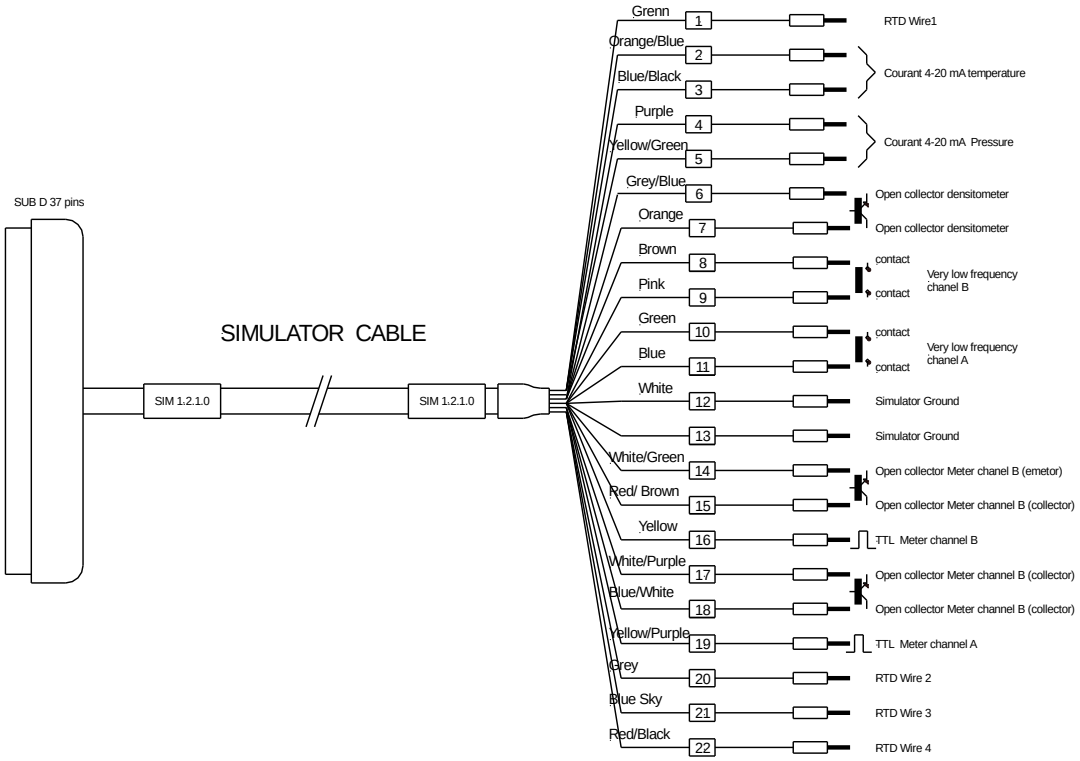
Resistor values could customised to be in relation with customer application.

Switch for RDT or analog temperature transducer

Click on a box, turn it on green colour, and output resistor value on four wire.
Temperature in °C or Kelvin are precise on the box

Wiring

All outputs are available on 37 pins Sub D connector. Wiring is the following:



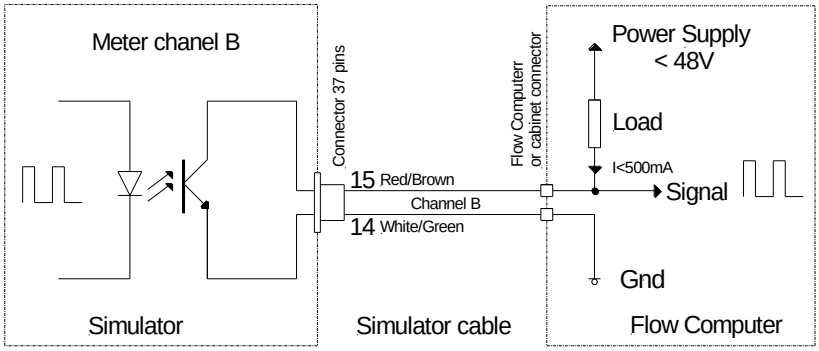
2.6.1 Flow Meter simulator

Meter channel A and B our of phase pulse signals are available under TTL format and on open collector output.

Pulses under TTL format signal are available on ‘’M1A” and ‘’M1B” tagged BNC connectors or on 37 pins Sub D connector.

Meter pulses on open collector are available on 37 pins Sub D connector.

Open collector wiring is the following:



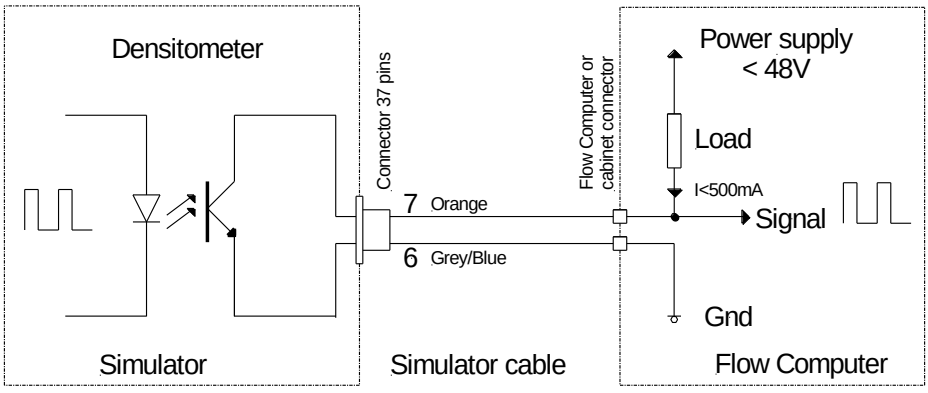
2.6.2 Densitometer simulator

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 and on 37 pins Sub D connector.

Densitometer pulse signal on open collector is available on 37 pins Sub D connector.

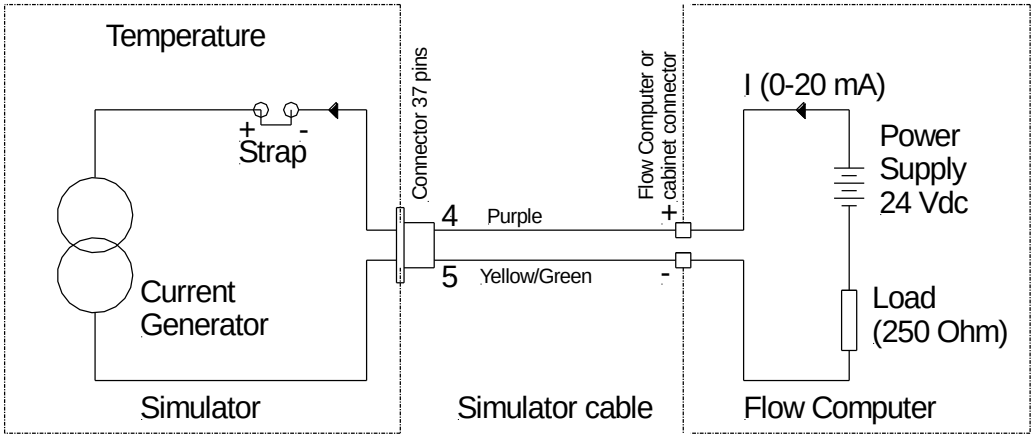
Open collector wiring is the following:



2.6.3 Analog outputs

2 analog outputs with 4-20 mA current are available for pressure and temperature.

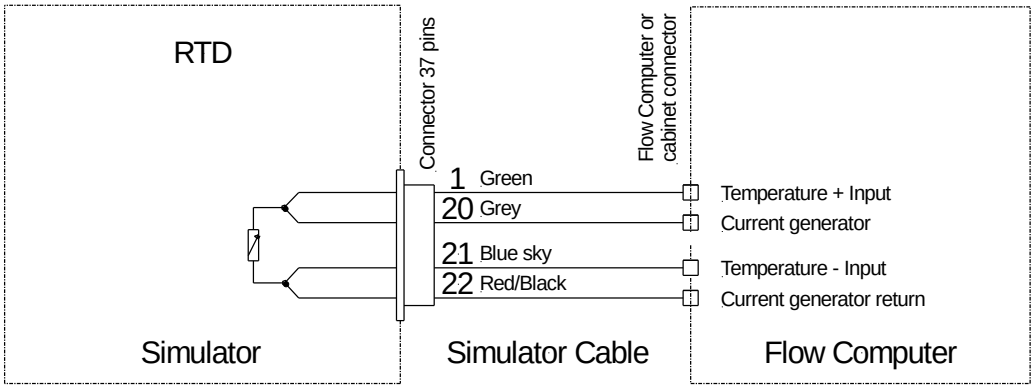
Current loop power supply is done by flow computer. Wring is the following:



2.6.4 RDT Outputs

1 RTD outputs is available on 37 pins Sub D connector.

Wiring to flow computer is the following:



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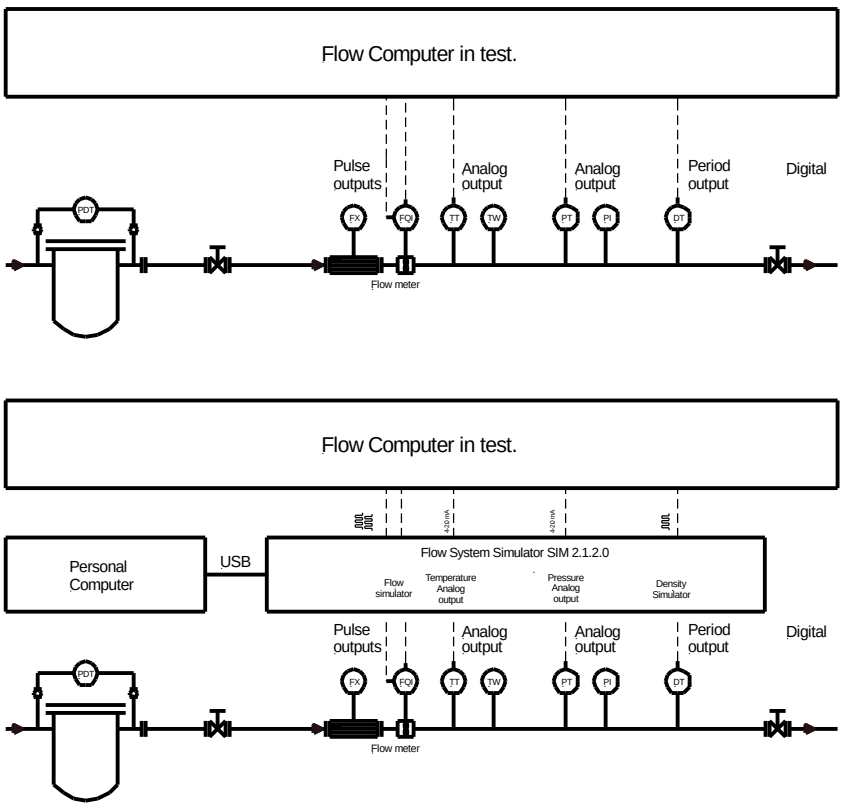
3 - Typical application

SIM 1.2.1.0 flow metering system simulator is adapted for initial or periodic flow computer verification. All flow metering line instrumentation could be simulated for checking if data are well acquired and computed by flow computer.
Theoretical gross and net volume could be calculated in function of volume, temperature, pressure and density simulated values. Gross and net volume determine by flow computer are compared with theoretical volume. Error is calculated for check if flow computer is in accordance with accuracy international rules.



Flow metering line instrumentation is disconnected from flow computer. Simulator outputs are connect in place of instrumentation and verification is launched.