SUMMIT 8800 Handbook

Flow Computer
Volume 2: Software

KROHNE

IMPORTANT INFORMATION

KROHNE Oil & Gas pursues a policy of continuous development and product improvement. The Information contained in this document is, therefore subject to change without notice. Some display descriptions and menus may not be exactly as described in this handbook. However, due the straight forward nature of the display this should not cause any problem in use.

To the best of our knowledge, the information contained in this document is deemed accurate at time of publication. KROHNE Oil & Gas cannot be held responsible for any errors, omissions, inaccuracies or any losses incurred as a result.

In the design and construction of this equipment and instructions contained in this handbook, due consideration has been given to safety requirements in respect of statutory industrial regulations.

Users are reminded that these regulations similarly apply to installation, operation and maintenance, safety being mainly dependent upon the skill of the operator and strict supervisory control.

1.1 Volumes

This is Volume 2 of 3 of the SUMMIT 8800 Handbook:

Volume 1
Volume 1 is targeted to the electrical, instrumentation and maintenance engineer
This is an introduction to the SUMMIT 8800 flow computer, explaining its architect and layout - providing the user with familiarity and the basic principles of build. The volume describes the Installation and hardware details, its connection to field devices and the calibration.
The manual describes the operation via its display, its web site and the configuration software. Also the operational functional of the Windows software tools are described, including the configurator, the Firmware wizard and the display monitor.

Volume 2
Volume 2 is targeted to the metering software configuration by a metering engineer.
The aim of this volume is to provide information on how to configure a stream and the associated hardware.
The handbook explains the configuration for the different metering technologies, including meters, provers, samplers, valves, redundancy etc.. A step by step handbook using the Configurator software, on the general and basic setup to successfully implement flow measurement based on all the applications and meters selections within the flow computer.

Volume 3
Volume 3 is targeted to the software configuration of the communication.
The manual covers all advance functionality of the SUMMIT 8800 including display configuration, reports, communication protocols, remote access and many more advance options.

1.2 Content Volume 1

Volume 1 concentrates on the daily use of the flow computer
- Chapter 2: Basic functions of the flow computer
- Chapter 3: General information on the flow computer
- Chapter 4: Installation and replacement of the flow computer
- Chapter 5: Hardware details on the computer, its components and boards
- Chapter 6: Connecting to Field Devices
- Chapter 7: Normal operation via the touch screen
- Chapter 8: How to calibration the unit
- Chapter 9: Operation via the optional web site
- Chapter 10: Operational functions of the configuration software, more details in volume 2
- Chapter 11: How to update the firmware
- Chapter 12: Display monitor software to replicate the SUMMIT 8800 screen on a PC and make screen shots

1.3 Content Volume 2

Volume 2 concentrates on the software for the flow computer.
- Chapter 2: General information on the software aspects of the flow computer
- Chapter 3: Details on metering principles
- Chapter 4: Basic functions of configurator
- Chapter 5: Configuration of the hardware of the boards
- Chapter 6: Stream configuration
- Chapter 7: Run switching
- Chapter 8: Watchdog

- Chapter 9: Configure a station
- Chapter 10: Configure a prover or master meter
- Chapter 11: Configure valves
- Chapter 12: Configure a sampler
- Chapter 13: Set-up batching
- Chapter 14: Set two flow computers in redundant configuration

1.4 Content Volume 3

Volume 3 concentrates on the configuration of the SUMMIT 8800
- Chapter 3; Configurator software
- Chapter 4: Date & Time
- Chapter 5: Data Logging
- Chapter 6: Display and web access
- Chapter 7: Reporting
- Chapter 8: Communication
- Chapter 9: General Information

1.5 Information in this handbook

The information in this handbook is intended for the integrator who is responsible to setup and configure the SUMMIT 8800 flow computer for Liquid and or Gas and or Steam application:

Integrators (hereafter designated user) with information of how to install, configure, operate and undertake more complicated service tasks.

This handbook does not cover any devices or peripheral components that are to be installed and connected to the SUMMIT 8800 it is assumed that such devices are installed in accordance with the operating instructions supplied with them.

Disclaimer
KROHNE Oil & Gas take no responsibility for any loss or damages and disclaims all liability for any instructions provided in this handbook. All installations including hazardous area installations are the responsibility of the user, or integrator for all field instrumentation connected to and from the SUMMIT 8800 Flow computer.

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Who should use this handbook?
This handbook is intended for the integrator or engineer who is required to configure the flow computer for a stream including devices connected to it.

Versions covered in this handbook
All Versions

2.1 Software versions used for this guide

This handbook is based on the software versions as mentioned in Appendix 1: software versions

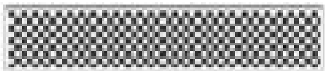
2.2 Terminology and Abbreviations

AGA	American Gas Association
API	American Petroleum Institute
Communication board	Single or dual Ethernet network board
Configurator	Windows software tool to configure and communicate to the SUMMIT 8800
CP	Control Panel
CPU	Central Processing Unit
CRC32	Cyclic Redundancy Check 32 bits. Checksum to ensure validity of information
FAT	Factory Acceptance Test
FDS	Functional Design Specification
HMI	Human-Machine Interface
HOV	Hand Operated Valve
I/O	Input / Output
ISO	International Standards Organization
KOG	KROHNE Oil and Gas
KVM	Keyboard / Video / Mouse
MOV	Motor Operated Valve
MSC	Metering Supervisory Computer
MUT	Meter Under Test
Navigator	360 optical rotary dial
PC	Personal Computer
PRT	Platinum Resistance Thermometers
PSU	Power Supply Unit
PT	Pressure Transmitter
Re-try	Method to repeat communication a number of times before giving an alarm
RTD:	Resistance Temperature Device
Run:	Stream/Meter Run
SAT	Site Acceptance Test
SUMMIT 8800	Flow computer
Timestamp	Time and date at which data is logged
Time-out	Count-down timer to generate an alarm if software stopped running
TT	Temperature Transmitter
UFC	Ultrasonic Flow Converter
UFM	Ultrasonic Flow Meter
UFP	Ultrasonic Flow Processor (KROHNE flow computer)
UFS	Ultrasonic Flow Sensor
VOS	Velocity of Sound
ZS	Ball detector switch
XS	Position 4-way valve
XV	Control 4-way valve

2.3 General Controls and Conventions

In the configurator software several conventions are being used:

Numeric Data Entry Box



Clear background, black text, used for entering Numeric Data, a value must be entered here
Optional: Coloured background, black text used for entering optional Numeric Data. If no value is entered then right click mouse key and select Invalidate, box will show and no number will be entered.

An invalid Number will be shown on the SUMMIT 8800 display as “---------“ and is read serially as 1E+38

Pull-Down Menu
Select a function or option from a list functions or options

Icon
Selects a function or a page.

Tabs
Allows an individual page, sub-page or function to be selected from a series of pages, sub-pages or functions.
Expanded item -
Fewer items shown.

Non Expanded item +
More items shown.

Option Buttons

 Red cross means OFF or No
 Green tick means ON or Yes

Data Tree
Items from the Data Tree can be either selected or can be “Dragged and dropped” from the Tree into a selection box; for example when setting up a logging system or a Modbus list, etc.
Yellow Data circle means Read Only. Red data circle means Read and Write.

Hover over
Hold the cursor arrow over any item, button or menu, etc. Do not click any mouse button, the item will be lightly highlighted and information relating to the selection will be illustrated.

Grey Text
Indicates that this item has no function or cannot be entered in this particular mode of the system. The data is shown for information purposes only.

Help Index
Display information that assists the user in configuration.

Naming convention of Variables
In the KROHNE SUMMIT 8800 there are variables used with specific naming.
This naming is chosen to identify a variable and relate it to the correct stream.

The most complex variable is explained below and this explanation can be used to interpret all the other variable names.

Example: + ph uVN . 1

+	Positive (+) or negative (-)
Ph	Previous (P) or Current (C) period Pqh – previous 15 minutes Ph – previous hour Pd – previous Day Pm – previous month Pq – previous quarter of a year Cqh – current 15 minutes Ch – current hour Cd – current Day Cm – current month Cq – current quarter of a year
u	Type of totals u – Unhaltable, counts always m – Maintenance, counts when maintenance is active (optional) n – Normal, fiscal counters during normal operation e – Error, fiscal counters with an accountable error t1 –> t4 – Tarif , fiscal counters based on fiscal thresholds
VN	Type of flow VPulses, pulses counted Vline, gross volume flow Vmon, monitored grass volume flow Vbc (p/t) pressure and temperature corrected gross volume flow Vbc, linearization corrected (Vbc(p/t))gross volume flow VN, Normalized volume flow VN(net), Nett normalized flow VM, Mass flow VE, Energy flow VCO2, carbon dioxide flow
1	Stream/ Run number

2.4 ID Data Tree

When selecting parameters and options in the Configurator software, the user will be presented with a tree structure for instance:

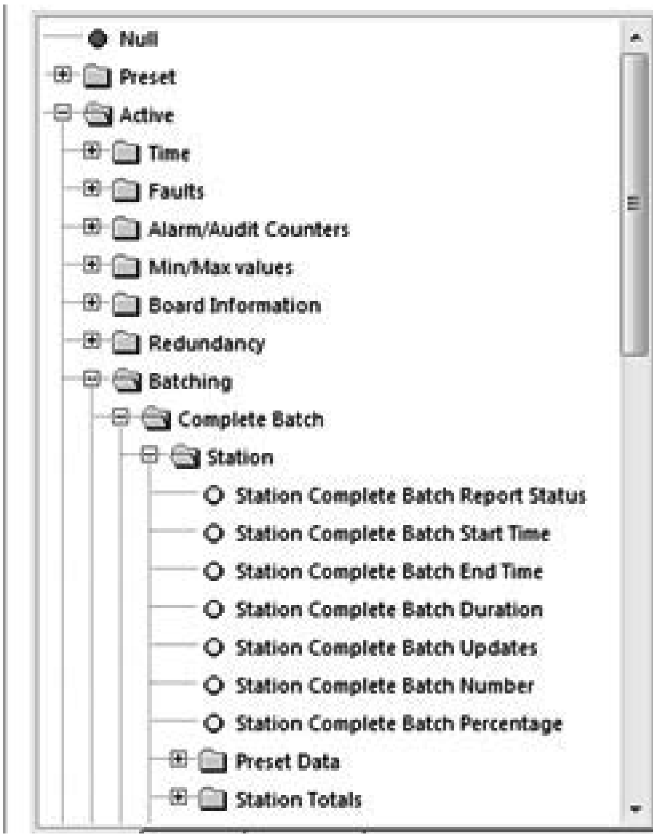


Figure 1 Example ID Tree

This is referred to as the ID tree which, depending on its context, includes folders and several parameters:

2.4.1 Type of data

The rest of this chapter will explain the folders available, the type of selection within the folder and any other corresponding data.

Preset Data
Essential to the configuration of the flow computer. Typical data would be keypad values, operating limits, equation selection, calibration data for Turbines and Densitometers and Orifice plates.
This data would be present in a configuration report, and enables you to see what the flow computer is configured to do.
Used for validation and will form the Data Checksum (visible on the System Information Page). E.g., if a data checksum changes, the setup of the flow computer has changed and potentially calculating different results to what is expected.
Typically configured and left alone, only updated after validation e.g. every 6 month / 1 year.

Active Data
These values cover inputs to the flow computer. E.g., from GC, pressure & temperature transmitters, meters etc..
Also Values calculated in the flow computer. E.g., Flow rates, Z, Averages, Density etc..

Local Data
Data that an operator can change locally to perform maintenance tasks. E.g., turn individual transmitters off without generating alarms. Setting Maintenance mode or Proving Mode.

Totals
Totals for the streams and station.
Contents of this folder are stored in the non-volatile RAM and are protected using the battery.

Custom
User defined variables.
Allows calculations, made in a LUA script, to be used in a configuration.
For details, see volume 3.

2.4.2 Colour codes

With each parameter and option, there are corresponding coloured dots that represent the access and status of the particular selection.

General ID tree

●	Red Dot	Data is Read/Write and can be changed over Modbus.
●	Yellow Dot	Data is Read-Only and cannot be changed over Modbus

Please note that it might be possible to change the values via the screen

90% of the data will be Read Only, but items such as Serial Gas Compositions, Time/Date, MF are commonly written over Modbus.

NOTE: Although the ID may be read/write, the security setting determines whether the ID indeed can be written.

Alarm Tree
The alarm tree is built of all the registers that hold alarm data. Alarm registers are 32-bit integers, where each bit represents a different alarm.

●	Red Dot	Represents an accountable alarm visible on the alarm list.
●	Dark Blue Dot	Represents a non-accountable alarm visible on the alarm list.
●	Orange Dot	Represents a warning visible on the alarm list.
●	Light Blue Dot	Represents a status alarm, not visible on the alarm list.
●	Black/Grey Dot	Represents a hard- or software fault alarm visible on the alarm list.

An example of typical usage would be the General Alarm Register. This is a 32 bit register that indicates up to 32 different alarms in the flow computer. This will contain Status Alarms, for example, 1 bit will indicate if there is a Pressure alarm or not. If the Pressure Status bit is set the user will know that there is a problem with the Pressure.
This should be sufficient information, however if it is not satisfactory, the user can look at the Pressure alarm, this contains 32 different alarms relating to the Pressure measurement, these would be Red Dots as they each can create an entry in the alarm list. By reading this register the user can view exactly what is wrong with the Pressure measurement.

The Light Blue Dots are generally an OR of several other dots. By reading the General register you can quickly see if the unit is healthy, more information can be provided by reading several more registers associated with that parameter.

2.5 Specific Requirements for Meters and Volume Convertors

2.5.1 Numbering formats

The number formats used internally in the unit are generally IEEE Double Precision floating point numbers of 64 bit resolution.
It is accepted that such numbers will yield a resolution of better than 14 significant digits.
In the case of Totalisation of Gas, Volumes, Mass and Energy such numbers are always shown to a resolution of 8 digits before the decimal point and 4 after, i.e. 12 significant digits.
Depending upon the required significance of the lowest digit, these values can be scaled by a further multiplier.

2.5.2 Alarms

Each of the various modules that comprise the total operating software, are continuously monitored for correct operation. Depending upon the configuration, the flow computer will complete its allocated tasks within the configured cycle time, 250mS, 500mS or 1 second. Failure to complete the tasks within the time will force the module to complete, and where appropriate, a substitute value issued together with an alarm indication.
For example, if a Calculation fails to complete correctly then a result of 1 or similar will be returned, which allows the unit to continue functioning whilst an accountable alarm is raised, indicating an internal problem.

2.5.3 Accountable alarm

When the value of any measurement item or communication to an associated device that is providing measurement item to the SUMMIT 8800 goes out of range, the flow computer will issue an Accountable Alarm.
When any calculation module or other item that in some way affects the ultimate calculation result goes outside its operating band, i.e. above Pressure Maximum or below Pressure minimum, then the SUMMIT 8800 will issue an Accountable Alarm.

When the SUMMIT 8800 issues an Accountable alarm a number of consequences will occur as follows:

Front panel accountable alarm will turn on and Flash.
Nature of accountable alarm will be shown on the top line of the alarm log.
Alarm log will wait for user acknowledgement of alarm.
During the period of the alarm, main totalisation will occur on the alarm counters.

2.5.4 Optional consequences

Depending upon the configuration of the SUMMIT 8800 the following optional Consequences will also occur:

An Entry will be made in the Audit Log, with Time and Date of occurrence.
The "Used" value of the Parameter in Alarm will be substituted by an alternative value, either from an alternative measurement source that is in range, or from a pre-set value.
A digital Alarm output will indicate an Alarm condition.

In this Chapter the different meter technologies supported by the SUMMIT 8800 and the need for correction and normalization is described. Each of these technologies has its own particularities which are important to know when configuring the flow computer.

3.1 Pulse based meters: e.g. turbine/ positive displacement / rotary meter

This method stems from the time when rotating meters where used, such as turbine meters and rotary (Positive displacement) meters.

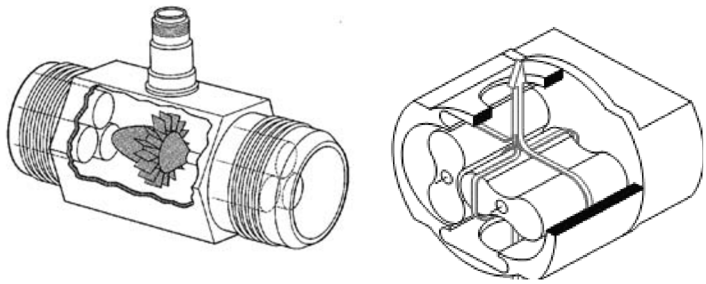


Figure 2 Turbine and rotary meter

A turbine meter is basically a fan in a tube. The gas makes the fan rotate and the rotations are recorded in an index on top of the meter. A positive displacement or rotary meter consists of two tighly coupled impellers which together create a moving chamber of gas. The rotation of the impellers drive an index.

A contact switch is operated by the rotating meter. The result is that the periodic closure of the switch is directly related to the amount of gas going through the meter. Depending on the location of the switch there are:

HF pulses or high frequency pulses
- The switch can be mounted just above the turbine blades. This switch is closing at the higher rate than the meter rotates (typically up to 5000 Hz). The ratio between the two is called "blade ratio".

MF pulses or medium frequency pulses
- The switch mounted on the primary axes, so this switch is closing every turn of the meter. This results in a medium frequency pulse (typically up to 500 Hz)

LF pulses or low frequency pulses
- For low cost meters the switch can be mounted in the index after a gear resulting in slow pulsing switches and in a low accuracy measurement (typically below 50 Hz)

A problem with this method is that the switches do not always close 100% reliable. This is particularly true for the HF pulses as non-contact switches are used. This means that we can have missing pulses. Also too many pulses can occur, e.g. when interference occurs with the high frequency wires or due to thunder storms. The solution is to have dual pulses and check the relation between the two.

It may also be that a turbine blade may break off resulting in the wrong measurement. There is therefore a need for diagnostics. Several solutions have been implemented:
- The dual pulse method with a 90° angle between the two. This allows for diagnostics and even corrections for missing pulses. An API classification level A to E is available (see below) for this.
- A second pulse from a turbine wheel with different blade angle.

- A second lower frequency pulse, so a combination of HF with MF or LF. Off course the frequency ratio or blade ratio between the two pulses must be given.

API has a classification on the quality actions taken on the pulses:

API level E is achieved solely by correctly applied transmission systems, criteria and recommended installed apparatus of good quality.	Basically a non-issue for flow computers
API level D system consists of manual error monitoring at methods of comparison, as used in Levels A through D.	This means: Only 1 pulse is needed on the flow computer.
API level C consists of automatic error monitoring for number, frequency, phase, and sequence and error indication at specified intervals.	This means: two pulses must be installed: the meter pulse and monitor pulse, which may be of different frequency (see frequency ratio)
API level B consists of continuous monitoring, with an error indication under all circumstances when impaired pulses occur.	This means two pulses of the same frequency must be installed: the meter and monitor pulse.
API level A: consists of continuous verification and correction given by the comparator.	The major issue here is; the flow computer has to correct when a wrong pulse occurs. This is quite advanced and is fully implemented in the SUMMIT.

Nowadays more and more electronics is incorporated into the meters, such as in ultrasonic and Coriolis meters. These meters normally emulate two high frequency pulses, to make them look the same as rotating meters from the installation standpoint. The flow is calculated and a special pulse output is driven by the processor. Although the need for a second output pulse is diminished, most meters still carry them. API Level A is not really required.

There are also meters with smart indexes. Here the indexes values itself can be read by the flow computer. The advantage is that the totals on the meters index are identical to the flow computer totals. Also, if the flow computer is replaced, the total will be automatically read. The communication is then digital and can be read via the serial port.

3.2 Ultrasonic meters

Ultrasonic meters are based on Transit Time Measurement of high frequency acoustic signals. These signals are transmitted and received along a diagonal measuring path.
A sound wave going downstream with the flow travels faster than a sound wave going upstream against the flow. The difference in transit time is directly proportional to the flow velocity of the liquid or gas. This can be compared with the speed a canoe travels upstream compared to downstream.

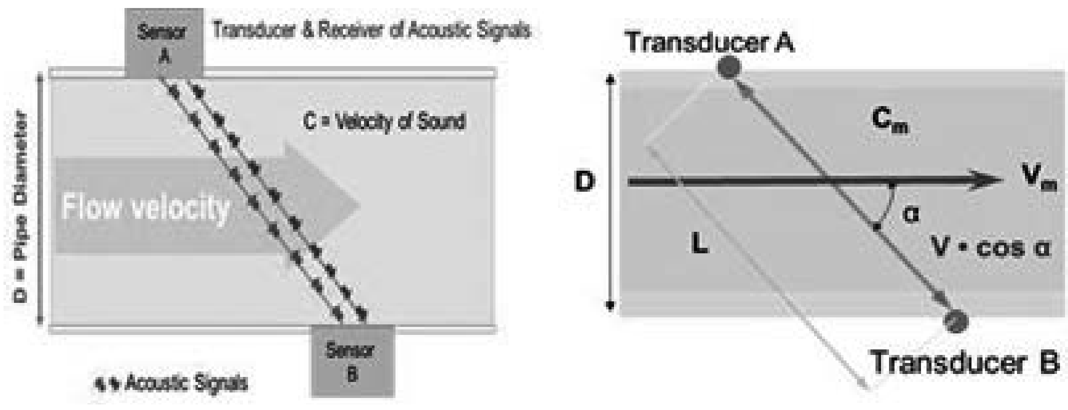


Figure 3 Ultrasonic measurement principle

Mathematically, the time to transmit from a to b and back depends on the distance (L) between the two transducers, the speeds of the medium (v) and sound (c) plus the angle of the path (α) as follows:

$$t_{ab} = \frac{L}{c+v*\cos\alpha} \quad \text{and} \quad t_{ba} = \frac{L}{c-v*\cos\alpha}$$

Resulting in

$$v = \frac{L}{2*\cos\alpha} * \frac{t_{ba}-t_{ab}}{t_{ba}*t_{ab}} \quad \text{and} \quad c = \frac{L}{2*\cos\alpha} * \frac{t_{ba}+t_{ab}}{t_{ba}*t_{ab}}$$

Equation 1 Ultrasonic measurement formulae

With the velocity of the gas and the area of the pipe, the volume flow rate can be calculated.

The problem is however that the oil or gas is not always equally distributed through the pipe. The flow normally is faster in the centre than in at the pipe and has a certain profile depending on turbulent or laminar flow. So you do need the proper average velocity over the complete pipe. With single beam meters, such as clamp-on meters, the accuracy is therefore very limited. That is why the medium must be measured at different locations in the pipe. The trick is to best estimate the profile/ the average flow. All manufacturers come up with different arrangements in multi-path meters.

The output of ultrasonic meters is normally a combination of a dual pulse and a serial link.
- The dual pulse is generated by the electronics to emulate a turbine meter but does not provide its diagnostics.
- The serial link has typically a modbus protocol specific to the manufacturer, but for Instromet there is also the proprietary "Instromet protocol". This serial protocol carries the flow rate, but also meter diagnostics. For that reason in many cases both links are used at the same time.

Each manufacturer has its own set of diagnostics. Typical diagnostics are:
- The amplification needed to send a signal between the transducers, both up- and downstream
- The signal to noise ratio at each transmitter
- The speed of sound measured by each path or ratio's between them
- An indication of the type of flow profile

For gas there is an interesting additional diagnostics which is the calculated against the measured speed of sound based on AGA 10. The meter calculates besides the speed of the gas also the speed of sound. AGA 10 gives the formula from which the speed of sound can be calculated from the composition, the temperature and the pressure. Off course the measured and calculated speed of sound should be equal. If not one of the variables (meter, chromatograph or P or T) must be wrong or badly calibrated. This is therefore a perfect over all metering system check.

3.3 Differential pressure (dP) meters: e.g. orifice, venturi and cone meter

Differential pressure flowmeters use the Bernoulli's rule to measure the volume flow of gas or liquid in a pipe. They use a restriction in a pipe to measure the volume as it creates a difference in pressure before and after the restriction. The pressure difference (Δp) increases as flow increases.

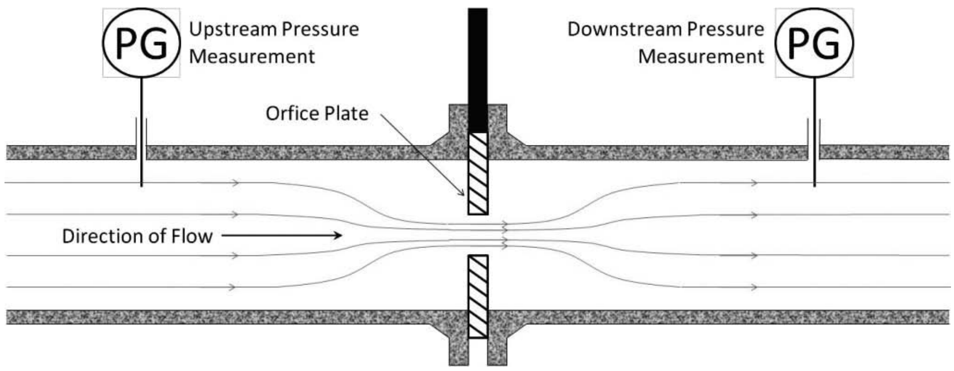


Figure 4 DP measurement principles

The shape of the restriction is determines the type of meter: orifice, V-cone venture or nozzle (see later paragraphs). For each type there are several parameters that will be required to successfully calculate the flow rate.

A single dP transmitter can used, but the problem is that a transmitter typically only has a 1:3 turndown ratio, so the accuracy for low flow is very limited. For that reason in custody transfer applications multiple dP transmitters with different ranges are used for one meter and the flow computer switches between them over depending on the flow.

The SUMMIT can handle 1 to 3 ranges:

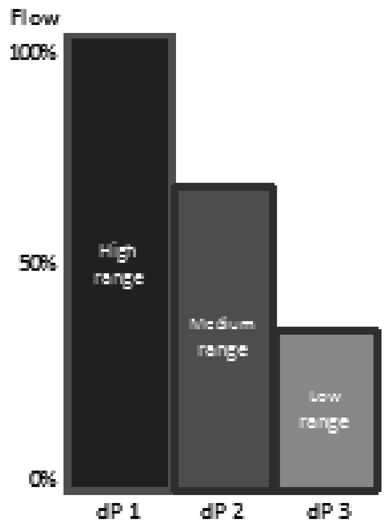


Figure 5 Up to 3 dP ranges

dP 1 will always measure the high range. In case of multiple ranges, an automatic switch-over to dP 2 will occur to medium range if the flow decreases to the dP measurement range, optimizing the accuracy. If 3 ranges are available, dP 3 will kick in when the flow gets within its measurement range.
In the SUMMIT the switch-up and switch-down values for the dP may be given. They will be normally be different to have some hysteresis to prevent continues switch-up and –down when at the threshold.

In high end applications, where the accuracy is crucial, multiple dP transmitters per range can be used for the following reasons:

- Accuracy: By averaging the transmitter values.
- Redundancy: If one transmitter fails, the other value may be used.
- Diagnostics: A warning can be given if there is a deviation between the transmitters.

For diagnostics 2 transmitters can be used, but it is not possible to determine which one is correct. For that reason 3 dP transmitters may be used.
The SUMMIT also can have 1 to 3 dP transmitters for 1 to 3 ranges, so 1 to 9 dP transmitters in total.

3.3.1 Orifice Plate

A flat circular plate with a hole, mounted inside the pipe that causes the fluid to push through a smaller diameter.

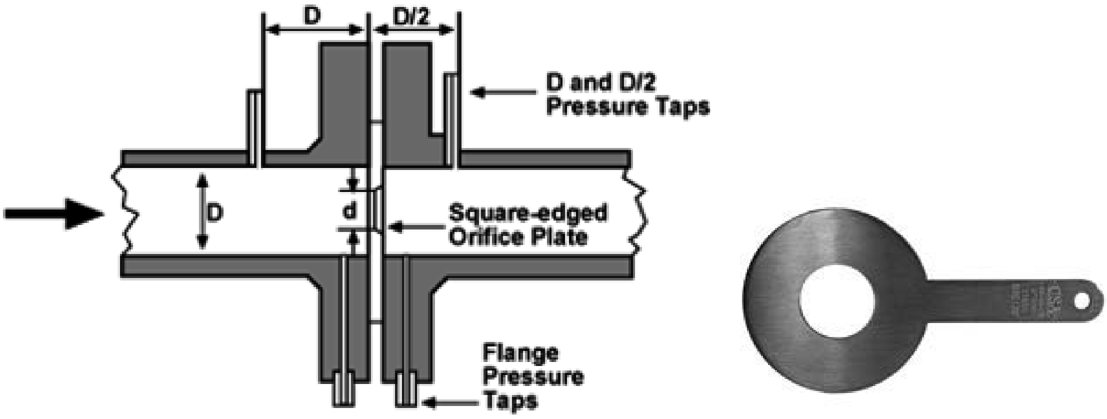


Figure 6 Orifice meter and plate

This is the most commonly used type of meter.

Classical venture or Herschel venturi
Consists of a tapering in the pipe.

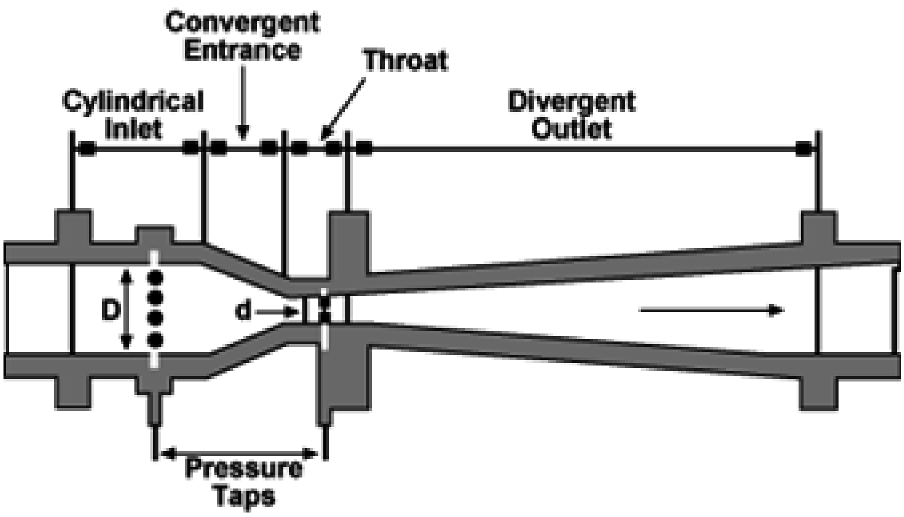


Figure 7 Venturi tube layout

3.3.2 Venturi nozzle

The venturi nozzle has a trumpet shape restriction ending up in the pipe..

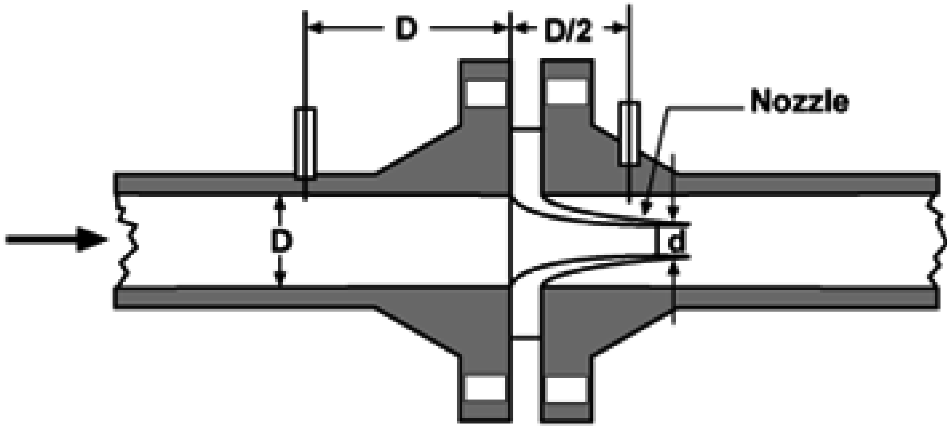


Figure 8 Venturi Nozzle

The main advantage of the venturi nozzle is pressure recovery.

ISA 1932 nozzle
Typically used for high velocity, set by ISO 5167 to determine the flow of fluid.

Long radius nozzle
A variation of the ISA 1932 nozzle, with a convergent section as the ISA 1932 nozzle and divergent section as a classical venturi

Cone or V-cone meter
The shape of the cone is to stable the flow profile in order to accurately measure the fluid regardless of flow properties.

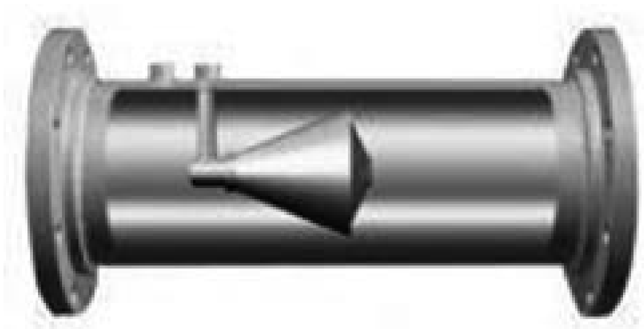


Figure 9 V-cone meter

3.4 Coriolis meters

The Coriolis effect is the deflection of a fluid by a rotating effect. If the rotation is clockwise, the deflection is to the left, if counter-clockwise, the deflection is to the right.
Coriolis meters use a vibrating meter tube to generate the rotating effect and measure the deflection to calculate the mass passing through the meter.

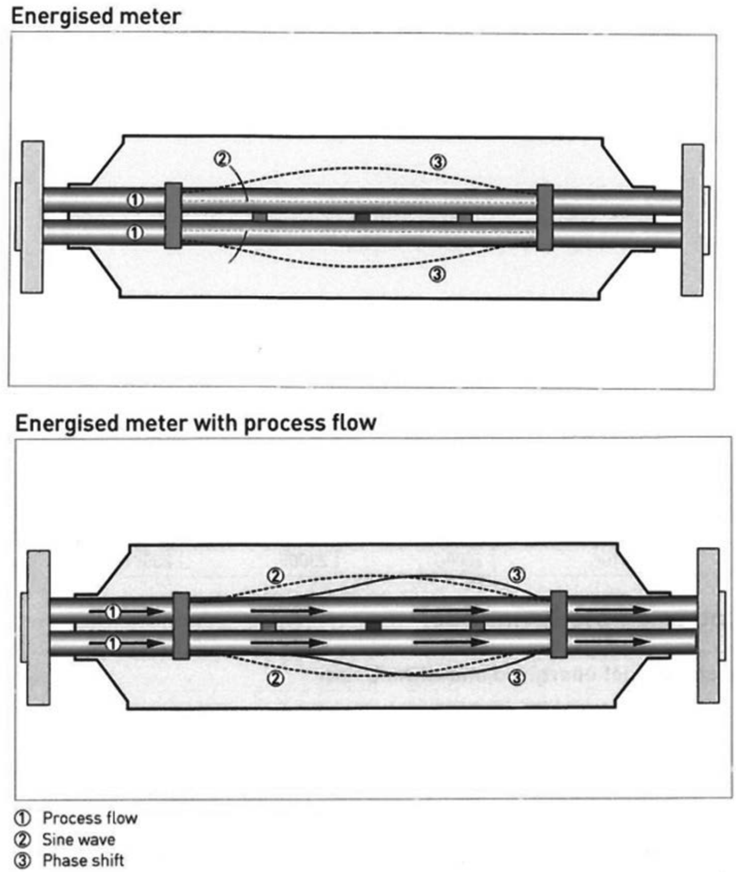


Figure 10 Coriolis meter flow principle

A tube with a fluid is brought into a sine waveform vibration. The eigen frequency with which this occurs is directly dependent on the density of the fluid. If the fluid is flowing, a phase shift of the vibration will occur between the inlet and outlet of the tube. This phase shift is a measure of the velocity with which the fluid passes through the pipe.

Traditional Coriolis meters have a bent tube to maximize the Coriolis effect. With more advanced electronics nowadays there is also straight tube Coriolis meters (see drawing).

Coriolis meters determine the mass flow, but can also determine the density. Most Coriolis meters will also calculate the volume flow using internal temperature and pressure, but it is recommended to use external measurements because of accuracy.

Coriolis meters typically have a dual pulse output mostly with the choice to have mass or volume flow rate, where mass flow rate is more accurate. Because of the fact that also density, pressure and temperature are available, most meters have also the option for a serial (modus) output, or a (multi-variable) Hart output.

3.5 Meter corrections

3.5.1 Gas & steam

The meter provides a number of pulses/s. We would like to know the Volume flow rate e.g. m3/s. For this need:

Pulse factor or impulse factor or meter factor
The factor provided by the manufacturer of the meter giving the number of pulses per volume of gas e.g. Pulses/m3. This assumes a linear meter. This is configured in the meter section.

Linearisation/ error Curve
The errors in % obtained during calibration of a meter which are the corrections needed to linearise the meter. So for each flow rate a different error is used. In between the given flow rates a linear interpolation is used. For flow outside the operating range, extrapolation is used, except when MID is chosen, then the error is fixed, and low and high flow is used.

Volume flow rate= Pulses per period*(1-Error)
Gross Volume= Pulses*(1-Error)

3.5.2 Liquid

The meter provides a number of pulses/s. We would like to know the Volume flow rate e.g. gallons/s. For this there are three important corrections for the meter possible:

K-factor
The factor provided by the manufacturer of the meter or as a result of proving which is the number of pulses per volume of fluid e.g. Pulses/gallon.
For a linear meter only one factor can be given.
In case that the meter is not linear then a K-factor curve can be used. In this These factors are obtained during calibration or prove of a meter which are the corrections needed to linearise the meter. This is expressed by a variation of the K-factor over the specified flow range. So for each flow rate a different K-factor is used. In between the given flow rates a linear interpolation is used. For flow above maximum extrapolation is used.

Meter factor
The factor determined during proving to correct a fluid flowmeter for the ambient conditions by shifting its curve. The factor is used to compensate for such conditions as liquid temperature change and pressure shrinkage and is meter and product dependent. The meter factor should be close to1.

$$\text{Volume flow rate} = Meter\ factor * \frac{Input\frac{pulses}{period}}{K-factor}$$

Equation 2 Volume calculation with MF

$$\text{Gross Volume} = Meter\ factor * \frac{Input\ pulses}{K-factor}$$

Equation 3 Gross volume calculation with MF

3.6 Liquid normalisation

As with gas also oil flow is measured by meters using a variety of different measurement principles, most based on volume flow, some based on mass flow. Examples are turbine meters, orifice meters, Coriolis meters and ultrasonic meters. In all cases the line flow is measured. The problem with this is that two measurements in the same pipe cannot be compared, due to difference in temperature, (to a lesser extend) pressure and possibly the type of product. This also means that billing of the oil will not be possible as no fixed tariff can be applied.

For this reason a flow computer is used to “normalize” the oil flow to standard (or base) conditions, such as:

Temperature	15 or 20 oC or 60 oF
Pressure	1.01325 bar or 14.73 psi

So from the input density, the standard density is calculated by correcting for pressure and density. Then, from the standard density, the meter density is calculated, by again correcting for pressure and density.

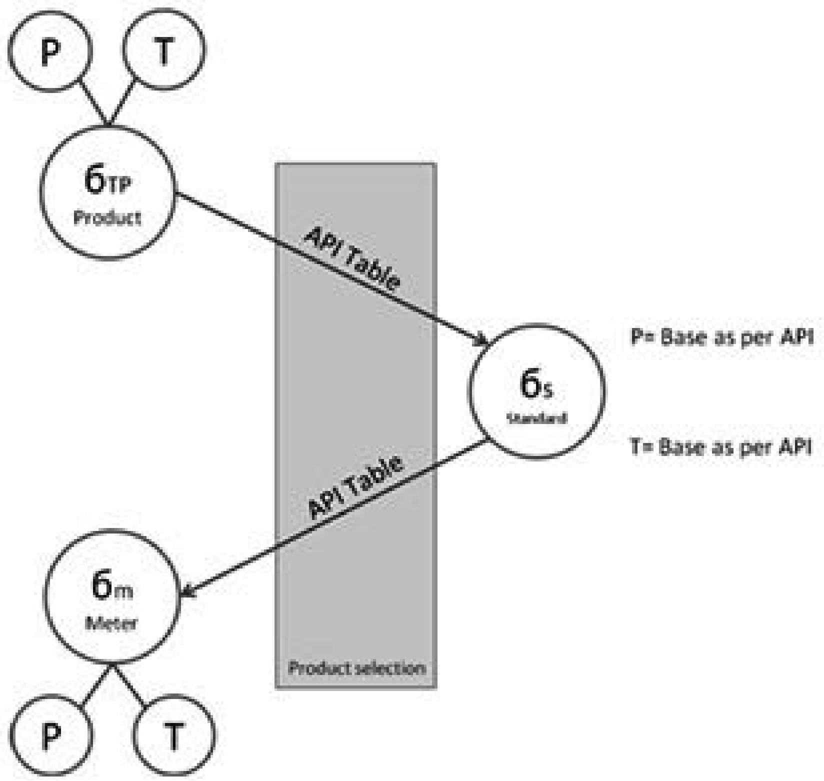


Figure 11 Density calculations for oil

The following formula applies:

$$\rho_s = \frac{\rho_{tp}}{CTL_\rho \ x \ CPL_\rho}$$

and

$$\rho_m = \frac{\rho_s}{CTL_m \ x \ CPL_m}$$

Where

ρm Line density of the liquid at metering conditions in kg/m3 or lbs/ft3
ρtp Line density of the liquid corrected for temperature and pressure in kg/m3 or lbs/ft3
ρs Standard Density of Liquid in kg/m3 or lbs/ft3
CTLρ : Temperature correction factor density at density test point
CPLρ : Pressure correction factor density at density test point
CTLm : Temperature correction factor at the meter
CPLm : Pressure correction factor at the meter

Several different calculations, depending on the type of product, are available to determine the correction factors.

3.6.1 Mass and energy

The mass and energy can be calculated from the volume (or the volume from the mass) using:

Mass flow rate: qm= qbc* ρm
Energy flow rate: qe= qn* Hs

Where Hs is the heating value. Two types can be used:

- The superior heating value, also known as higher heating value or higher calorific value or gross calorific value represents the heat released when a unit mass or volume of a material at 1 bar pressure and 25 °C is completely combusted and the combustion products are brought back to the starting pressure and temperature.
- The inferior heating value, also known as lower heating value or lower calorific value or net calorific value. This quantity assumes that the water produced by combustion remains in the vapour phase in the exhaust, and is lower than the gross calorific value by the latent heat of condensation joules/gram) of water at 25°C multiplied by the concentration of water in the material (expressed as grams/gram of fuel). For most common fuels, the net calorific value is about 10% less than the gross calorific value.

3.7 Gas normalisation

Gas is a compressible fluid, due to this fact the reference conditions (P base and T base) on which the volume is calculated has to be given, which are normally contractually agreed.

Gas flow is measured by meters using a variety of different measurement principles, most based on volume flow, some based on mass flow. Examples are turbine meters, orifice meters, Coriolis meters and ultrasonic meters. In all cases the line flow is measured. The problem with this is that two measurements in the same pipe cannot be compared, due to difference in temperature, pressure and possibly the composition of the product. This also means that billing of the gas will not be possible as no fixed tariff can be applied.

For this reason a flow computer is used to "normalize" the gas flow to standard (or base) conditions, such as:

Temperature 0, 15 or 20 °C or 60 °F
Pressure 1.01325 bar or 14.73 psi

We can calculate how much measurements may change to result in 1% change in normalized volume. Some typical numbers:
- The Volume changes 1% when the pressure changes 1% (e.g. 10 mBar at 1 bar)
- The Volume changes 1% when the temperature change of 3 °C
- The Volume changes 1% when the density change due to pressure or temperature:
- Pressure change of 4 bar or temperature change of 70 °C in a 5 bar pipeline
- Pressure change of 4 bar or temperature change of 4 °C in a 60 bar pipeline
- The Volume changes 1% when the density change due to composition:
- Either 3 % change of methane, 1% change of ethane or 0.5% change of pentane

This means that in gas:
- Correction for Pressure and Temperature is always needed.
- Correction for density is important for high pressure
- Correction for composition is only needed for high pressure
- A Gas chromatograph is only needed for changing composition

The SUMMIT 8800 flow computer calculates the gas volume at these expanded conditions based on the measured actual flow. For this the pressure and temperature at the location of the meter are used to calculate flow at "normalised" or "standardised" conditions.

Since most gases are non-ideal gasses, the gas compression needs to be corrected by means of the compressibility factor (z-equation). This compressibility factor must be calculated at normal conditions and on line conditions, the division of these defines the correction for a non-ideal gas. This correction factor can also be determined based on the density determined at base conditions and at line conditions.

Many different formula's have been developed in the last years to correct the liquid, gas and steam, depending on the type of product. Some based on a database of gasses, some based on physical properties, all off them with limited range of validity and associated accuracy. Therefore the configuration of a flow computer assumes the basic knowledge of formula's needed. Here the basics:

3.7.1 Equation of state

As gas, the influence can be calculated from "Equation of state"

$$P*V = n*Z*R*T \quad \text{or} \quad V = n*Z*R*T/P \qquad \text{where:}$$

P = Pressure
V = Volume
n = Number of moles= mass/molar mass or n=m/M
Z= Compressibility of the gas
R = Universal gas constant = 8.31451 J/mol K
T = Temperature

Z depends on the composition of the gas and is at very low pressure equal to 1.

From here it follows that: $V_b = V_m * (P_m*Z_b*T_b)/(P_b*Z_m*T_m)$

This is one of the ways to calculate the volume at base conditions. In this case the compressibility could be derived from the composition of the gas e.g. from a GC.

3.7.2 Line and base density

An alternative way is to rewrite the equation in terms of density as the density of gas is $\rho = m/V$

The result is therefore: $P = \rho * R/M * T$ or $P = \rho * R_{specific} * T$

Therefore $V_b = V_m * \rho_m / \rho_b$

This version can be used when the meter or line density is measured, e.g. when using a densitometer.
The base density will typically be calculated using the AGA 8 formula or via the relative density/ specific gravity.

3.7.3 Relative density/ specific gravity

The terminology specific gravity is mostly used in US related specifications. This is referred to as ratio between gas density and air density.

In the rest of the world this is called relative density, where specific gravity is the density ratio between a fluid and water. In this document it is further referred to relative density.

The base density can be derived from the relative density or specific gravity as follows:

The relative density or specific gravity is: $d_b = \rho_b / \rho_{air}$ or $\rho_b = d_b * \rho_{air}$

The relative density can be calculated from the composition, e.g. via a GC

3.7.4 Mass and energy

The mass and energy can be calculated from the volume (or the volume from the mass) using:

Mass flow rate: $q_m = q_{bc} * \rho_m$
Energy flow rate: $q_e = q_n * H_s$

Where Hs is the heating value. Two types can be used:
- The superior heating value, also known as higher heating value or higher calorific value or gross calorific value is referring to the energy produced when gas is burned and all flue gases/vapours are cooled down to ie 1 bar pressure and 25°C.
- The inferior heating value, also known as lower heating value or lower calorific value or net calorific value.indicates the energy produced considering the burning of the gas without cooling down the vapours.

3.7.5 Enthalpy

Enthalpy is a measure of the total energy of a thermodynamic system and is important for steam. It includes the internal energy, which is the energy required to create a system, and the amount of energy required to make room for it by displacing its environment and establishing its volume and pressure.

As enthalpy cannot be measured, the enthalpy difference is normally used. It deals with the vapour of gaseous phases of liquid and is the energy required to turn the liquid into gases.

In most cases, the IAPWS or International Association for the Properties of Water and Steam is followed.

3.8 Stream, station and batch totals

A total for flow is calculated by multiplying the flow rate by the time difference between the current and previous measurement. The SUMMIT 8800 keeps more than 25.000 different totals as a combination of:

Qty	Type total	Code used						
2	Metric							The totals in metric units
	USC							The totals in US customary units
2	Positive		+					Measured in positive direction
	Negative		-					Measured in negative direction
11	Running totals							Totals until now
	Current period 15 minutes			cqh.				Totals for the running15 minutes
	Current period Hourly			ch.				Totals for the running hour
	Current period Daily			cd.				Totals for the running day
	Current period Monthly			cm.				Totals for the running month
	Current period Quarterly			cq.				Totals for the running quarter
	Previous period 15 minutes			pqh.				Totals for the previous 15 minutes
	Previous period Hourly			ph.				Totals for the previous hour
	Previous period Daily			pd.				Totals for the previous day
	Previous period Monthly			pm.				Totals for the previous month
	Previous period Quarterly			pq.				Totals for the previous quarter
9	Unhaltable				U			All product measured
	Normal				N			Measured during normal conditions
	Error				E			Measured during error conditions
	Maintenance				M			Measured during maintenance
	Tariff level 1				t1			Measured when in tariff level 1
	Tariff level 2				t2			Measured when in tariff level 2
	Tariff level 3				t3			Measured when in tariff level 3
	Tariff level 4				t4			Measured when in tariff level 4
	Tariff level 5				t5			Measured when in tariff level 5
11	Pulse count					Pulses		The amount of pulses counted
	Line volume					VLine		Line volume for the main pulse
	Monitor volume					VMon		Line volume for the monitor pulse
	Volume before normalisation					Vbc		Volume after error curve
	Volume after P/T correction					Vbc		Volume after P and T correction
	Normalised volume					VN		Normalised volume
	Normalised volume net					VNnet		Net normalised volume (product only)

	Normalised volume saturated					VNsat		Normalised volume H2O saturated
	Energy					E		Energy flow
	Volume CO2					VCO2		CO2 flow
	Mass					M		Mass flow
7	Stream 1					.1	.1	The totals for stream 1
	Stream 2					.2	.2	The totals for stream 2
	Stream 3					.3	.3	The totals for stream 3
	Stream 4					.4	.4	The totals for stream 4
	Stream 5					.5	.5	The totals for stream 5
	Station A	SA						The totals for stream A
	Station B	SB						The totals for station B

The code for a running total of the positive unhaltable normalised volume of stream 1 is: +UVN.1
The code for a station A total of the current hourly period of the positive normal mass flow is: SA+ch.NM

3.9 Run switching

Run switching (also known as meter run staging or tube switching) is a function that allows the flow of fluid across multiple streams commonly used in stations and proving applications. The main purpose of this function is to maximize the station accuracy by trying to maximize the flow through individual meters without exceeding their maximum.

Meters have a limited flow range for which they work / work optimally. For minimum flow their accuracy is limited, for maximum flow there can be a chance for overspeeding, damaging the meter or limiting their accuracy. On the other hand stations have to deal with different flow regimes, e.g. low flow during summer, high flow during winter.
The solution is to have multiple meters with the total capacity for high flow, while limiting the number of meters used during low flow.

The run switch function in the SUMMIT is designed to do this automatically by switching valves to activate or deactivate streams within a station thus optimising the number of meters used for a certain flow.

3.10 Proving

Proving is a function to determine and verify the accuracy of a stream flow meter. With proving, the volume or mass flowing through a meter is compared with the same flow through the prover. As the prover is considered to be correct it is also referred to as the 'known traceable volume'. The result of proving is the generation of a meter factor (MF) which is retro-applied to the flow meter and which corrects the flow meter to give the same reading as the prover.

The SUMMIT 8800 flow computer can prove with the following prover systems:
- Unidirectional ball prover
- Bi-directional ball prover
- Piston small prover / compact prover
- Master meter

Historically provers are used in liquids while master meters are used for gasses. However nowadays, due to the complexity of provers, master metering is starting to get inroads into liquids too. In all cases, a prover / master meter is put in series with a meter under test to determine the accuracy of the meter.

Provers are based on a pipe with in it a ball or piston, moving with the medium. Detector switches are mounted at precise locations to detect the passing ball or piston. By very accurately determining the volume between detectors, the amount of volume moved from the prover to a meter can be determined and therefore the volume going through the meter. Since gas is compressible, this system is only working for liquids.

Master meters are meters with a higher accuracy that the meters to be tested. They are put in series with the meter under test. All the medium going through the master meter is also going through the meter under test.

Conventional ball provers typically generate enough flow to get 10,000 or more meter pulses from the meter under test to successfully complete a prove cycle. Small volume provers due to size do not generate 10,000 pulses during a run cycle and are subject to pulse interpolation (double chronometry). Both types of provers are available as bi-directional and unidirectional.

3.10.1 Unidirectional ball prover

An inlet and outlet are connected to the pipework. A unidirectional prover only has flow in one direction and the volume is based on the switching of the first detector switch followed by the second with a passing sphere (displacer) used as a trigger.

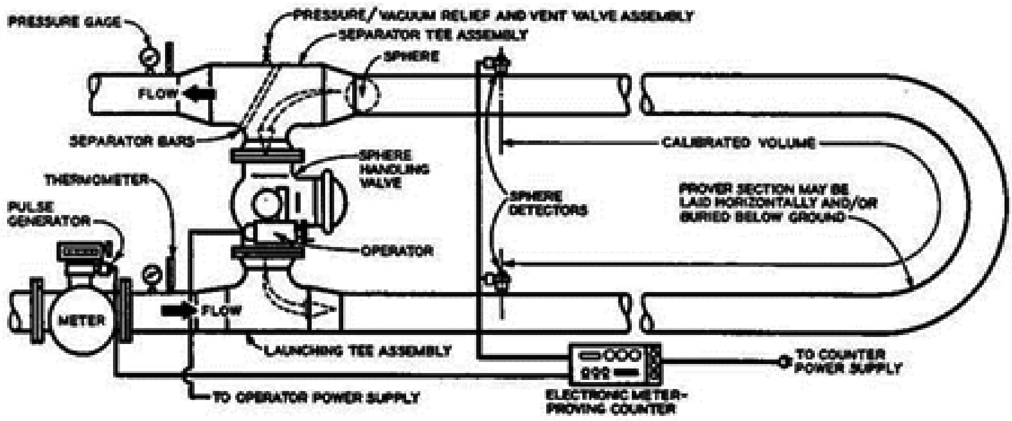


Figure 12 Uni-directional prover

3.10.2 Bi-directional pipe prover

In a bi-directional prover the flow can be reversed With the use of a four way diverter valve. The prove cycle is performed under operating stabilised conditions to maximize the accuracy.

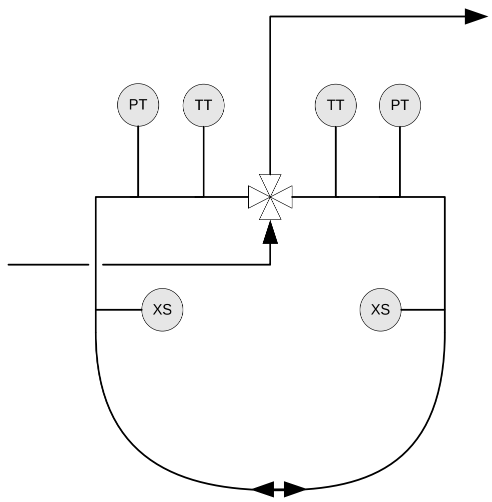


Figure 13 Bi-directional prover

Key
PT – Pressure transmitter in/outlet
TT – Temperature transmitter in/outlet
XS – Detector switches

3.10.3 Small volume / piston provers

Small volume provers are available as compact or conventional pipe provers which use displacement to measure the volume and pulse interpolation.

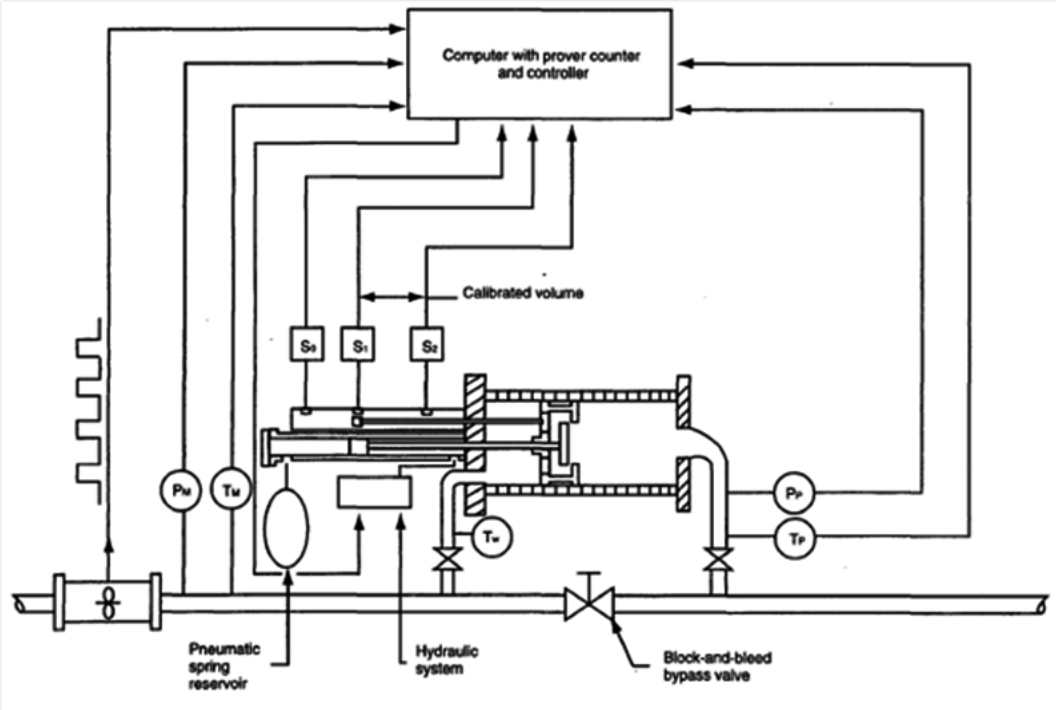


Figure 14 Small compact prover

3.10.4 Master meter

In master metering a high accuracy master is put in series with other flow meters to be tested while in production. This method of proving is predominately used for gas applications and is used in-line with the flow meter being proved.

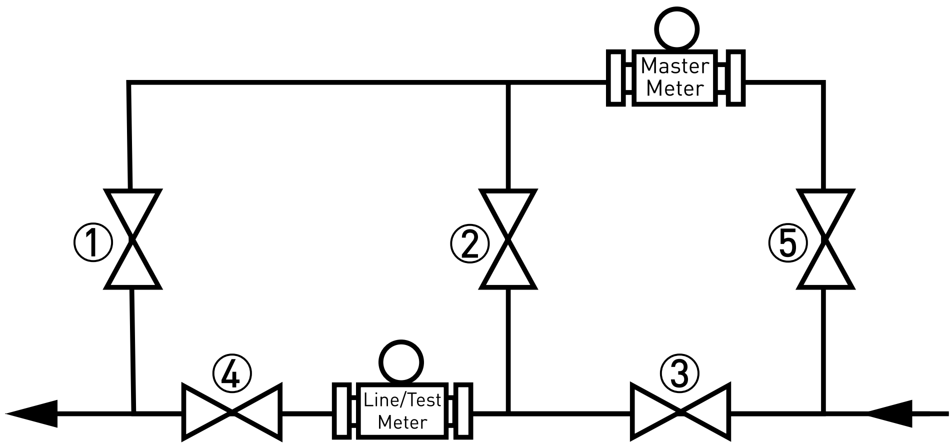


Figure 15 Master meter loop

3.10.5 Proving procedure

Proving is a complex but well defined procedure to control valves, take measurements and do calculations. As the quality of the result is depending very much on the tolerances, limits and stability of flow, temperature, pressure and density they are very well checked and controlled during the proving cycle as defined in many standards.

The following flow charts illustrate the necessary procedure to successfully prove and implement the result. As the procedure is quite extensive, it is necessary to be able to track exactly what is happening. For that reason, a checklist is added with the parameters to check.

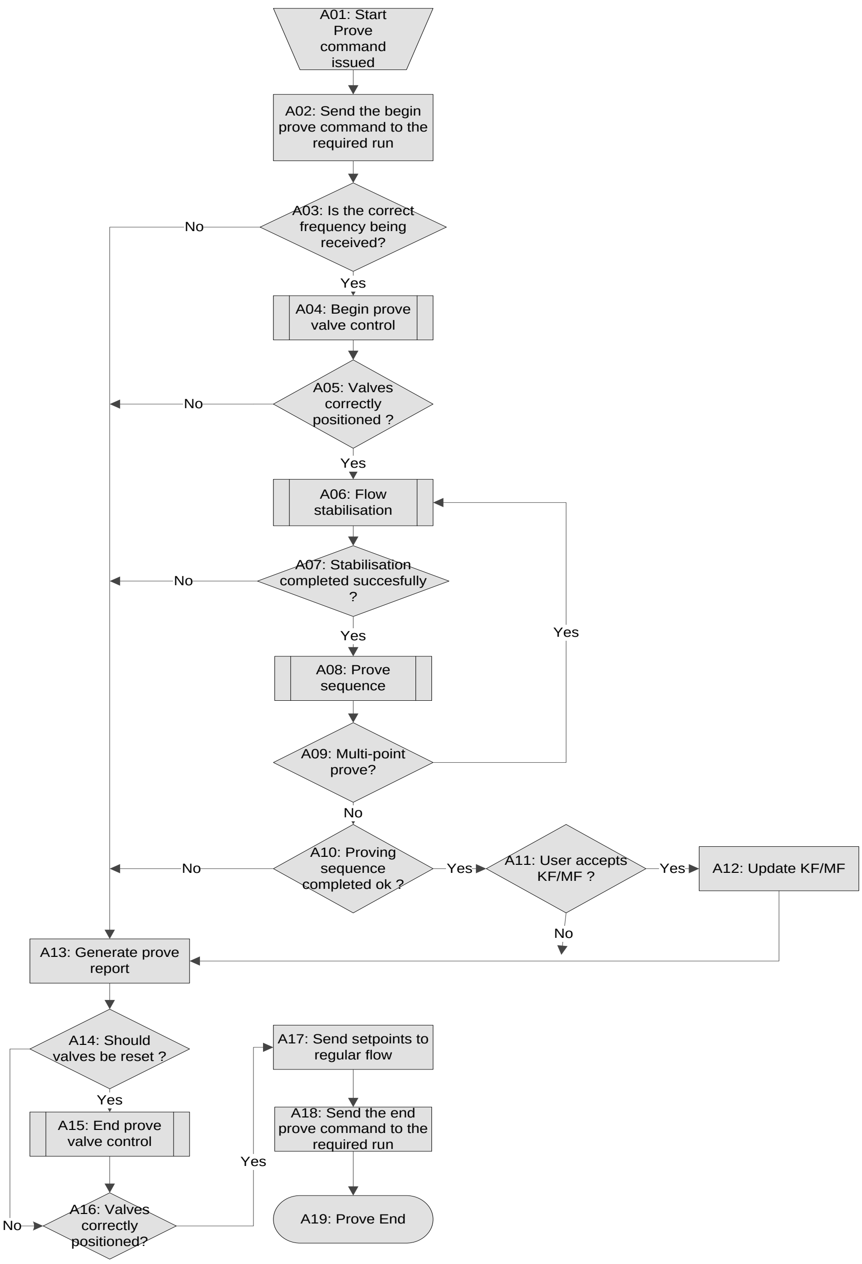


Figure 16 Proving flowchart

Proving description		
A01	Start proving	The proving request tag has been issued via display or Modbus - this initiates the prove request
		Tips: With the proving status tag, the result of the last prove can be monitored • N/A • OK • Manually aborted • Maximum runs reached • Not enough runs remain • Volume stability • Pressure stability • Temperature stability • Valve setup error • Valve return error • Communications error • Run error • Volume deviation • Pressure deviation • Temperature deviation • Density deviation • Pressure alarm • Temperature alarm • Density alarm • Frequency input • Validation rejected • Data update failed • Valve error • Turbine error • Setpoint error • USM error With the proving position tag the status of the prove can be monitored Idle • Beginning prove • Initialising report • Initialising communications • Configuring valves • Stabilising flow • Running • Resetting valves • Ending communications • Waiting for validation • Generating report The ball position tag does not indicate the actual ball position, but is a status indicator for the Proving run for ball provers. Instead of ball position monitor the status of the valve
A02	Send begin prove command to required run	The proving.1 tag of the required stream is set.
		The prover general alarm tag is set. These tags are displayed on the alarm page.
A03	Correct frequency?	Prover frequency tag is checked if pulses are being received, thus frequency cannot equal zero.
		Confirm that the pulse bus is configured correctly. Refer to section ‘prover I/O selection’ for configuration details.

A04	Begin prove valve control	All configured valve are set to proper position. If configured the following valves are set in the following sequence.
		1. Set run flow control; 2. Open required run outlet; 3. Open prover outlet; 4. Set prover flow control; 5. Close all run prover inlet; 6. Open required run prover inlet; 7. Close run outlet; 8. Set 4-way valve to reverse, only for ball provers; 9. Start flow control. Valve status tags can be found in the following location.
A05	Valves correctly positioned?	All configured valves are check if they are in the proper position with valve position tag. 1. Idle 2. Opening prover outlet valve 3. Opening prover flow control valve 4. Positioning fourway valve 5. Opening run prover inlet valve 6. Closing run prover inlet valve 7. Opening run flow control valve 8. Opening run outlet valve 9. Closing run outlet valve 10. Start regulating 11. Checking run outlet valves 12. Returning piston 13. Opening master run outlet 14. Closing master run outlet
A06	Flow stabilisation	Volume, temperature, and pressure are checked for deviations.
		• Minimum stability duration, this is the waiting time before stability check; • Maximum stability duration, after this time the conditions must be stable; • Stability limit, the maximum limit for the deviation.
A07	Stabilisation completed successfully?	Check is made if previous steps were successful.
		Important: If successful the conditions are recorded and monitored throughout the proving. For reference the standard deviation tag for flow, temperature and pressure can be found under the following location. There are a set of deviation alarm tags that are set is the standard deviation is greater than the limit set. Active>prover>alarms>live>prover pressure-temperature-flow
A08	Proving sequence	In this step sub routine proving sequence is initiated. The result of the sequence can be successful or failed
A09	Multi-point prove?	A check is made on how the prover is configured, single point or multi-point.
		If the prover is configured as multi-point proving, then the routine will go back to step A06 'flow stabilisation' and set the configured flow rate for each proving point. If the prover is configured as single point proving, then the routine will continue to the next step.

A10	Proving sequence completed?	A check is made if 'proving sequence' was completed successfully, the 'abort proving' tag can be monitored.
		• No • Manual abort • Valve failure • Communications failure • Run failure • Pressure failure • Temperature failure • Density failure • Volume failure • Deviation during prove • Turbine failure • USM failure
A11	User accepts KF/MF?	Verification made if user accepts new KF/MF.
		The new K-factor and meter factor must be accepted through the validate results tag via the display or Modbus.
A12	Update KF/MF	If the previous step was accepted, then the new KF/MF is updated. The tags are calculated K and calculated MF.
A13	Generate prove report	The proving status tag and other tags are updated.
A14	Reset valves?	If the prove is successful the valves will be reset.
		If the prove fails the valves will not be reset and will stay in the same position.
A15	End prove valve control	All configured valves are set to the position to finish the prove. If configured the following valves are set in the following sequence.
		1. Set 4-way valve to reverse, only for ball provers; 2. Set prover flow control; 3. Open prover outlet; 4. Open run flow control; 5. Open required run outlet; 6. Close prover inlet;
A16	Valves positioned correctly?	All configured valves are check if they are in correct position.
A17	Send setpoints to regulate flow	Send setpoints to regulate flow
A18	Send end prove command to required run	The proving.n tag of the required stream is reset.
A19	Prove end	The prover general alarm tag is reset.

3.10.6 Meter factor and K – factor

After every successful prove process, a flow meter will be assigned a new meter factor (MF) and K- factor.

K- factor, the number of signal pulses from a meter during a prove divided by the actual corrected prover volume.

K-factor = (meter pulse)/(correct prover volume)

Meter factor, the value obtained by the corrected prover volume divided by the actual liquid volume passed through the flow meter

MF = (correct prover volume)/(meter registered volume)

Equation 4 KF & MF prover calculation

3.10.7 Proving sequence

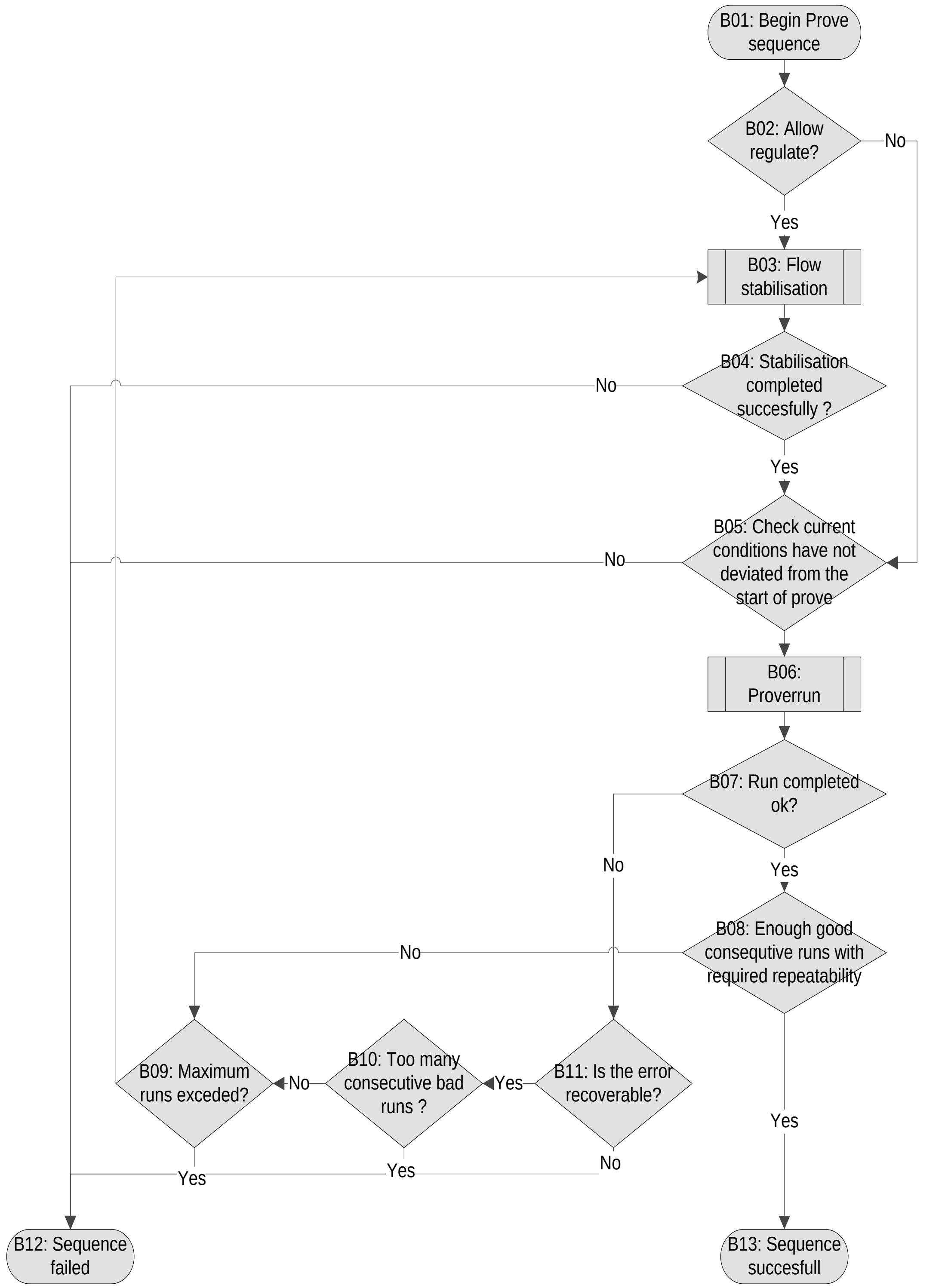


Figure 17 Proving sequence flowchart

Description		
B01	Start proving sequence	The proving sequence sub-routine is initiated by the main prove routine. The results of the individual run are stored in the status.run'n' tag. A general flag is set or reset, this done on the proving sequence tag.
B02	Regulate control valves?	Release PID between runs'. If yes, then the control valve will be released, and continue to the next step to stabilise flow again.
B03 Idem A06	Flow stabilisation	Volume, temperature and pressure are checked for deviations. Minimum stability duration, this is the waiting time before stability check; Maximum stability duration, after this time the conditions must be stable; Stability limit, the maximum limit for the deviation.
B04 Idem A07	Stabilisation completed successfully?	Check initiated if previous step was successful. Important: If successful the conditions are recorded and monitored throughout the proving process. For reference the standard deviation tag for flow, temperature and pressure can be found under the following location. There are a set of deviation alarm tags that are set is the standard deviation is greater than the limit set.
B05	Check deviation of conditions	Volume, temperature and pressure are checked for deviations from the start of the prove.
B06	Proving run	This step is depended on the type of prover configured. Depending on the selection, a sub-routine is started. Refer to prover>prover options>general>prover type Ball prover (tag: ball position) • Idle • Initialising switches • Waiting for initialisation • Forward rotate 4 way valve • Forward counting pulses • Forward waiting chamber • Initialising switches • Waiting for initialisation • Reverse rotate 4 way valve • Reverse counting pulses • Reverse waiting chamber • Generating report **Master meter (tag: run position)** 1. Idle 2. Initialising switches 3. Waiting for initialisation 4. Starting run 5. Counting Pulses 6. Ending run 7. Ending run 8. Generating report

		Small volume prover (tag: piston position) • Idle • Initialising piston • Initialising switches • Waiting for initialisation • Releasing piston • Counting pulses • Returning piston • Returning piston • Generating report
B07	Run completed ok?	Check if the run is completed successfully.
B08	Check consecutive run and repeatability	Check is done if enough consecutive runs required is completed successfully. Settings repeatability or uncertainty
B09	Maximum runs exceeded?	Check if maximum runs are exceeded.
B10	Too many consecutive bad runs?	Check if too many consecutive bad runs are performed
B11	Is error recoverable?	Is error recoverable? recoverable error are: Valve errors Accountable alarms
B12	Sequence failed	Sequence failed.
B13	Sequence successfully	Sequence successfully.

3.10.8 Proving run (ball position)

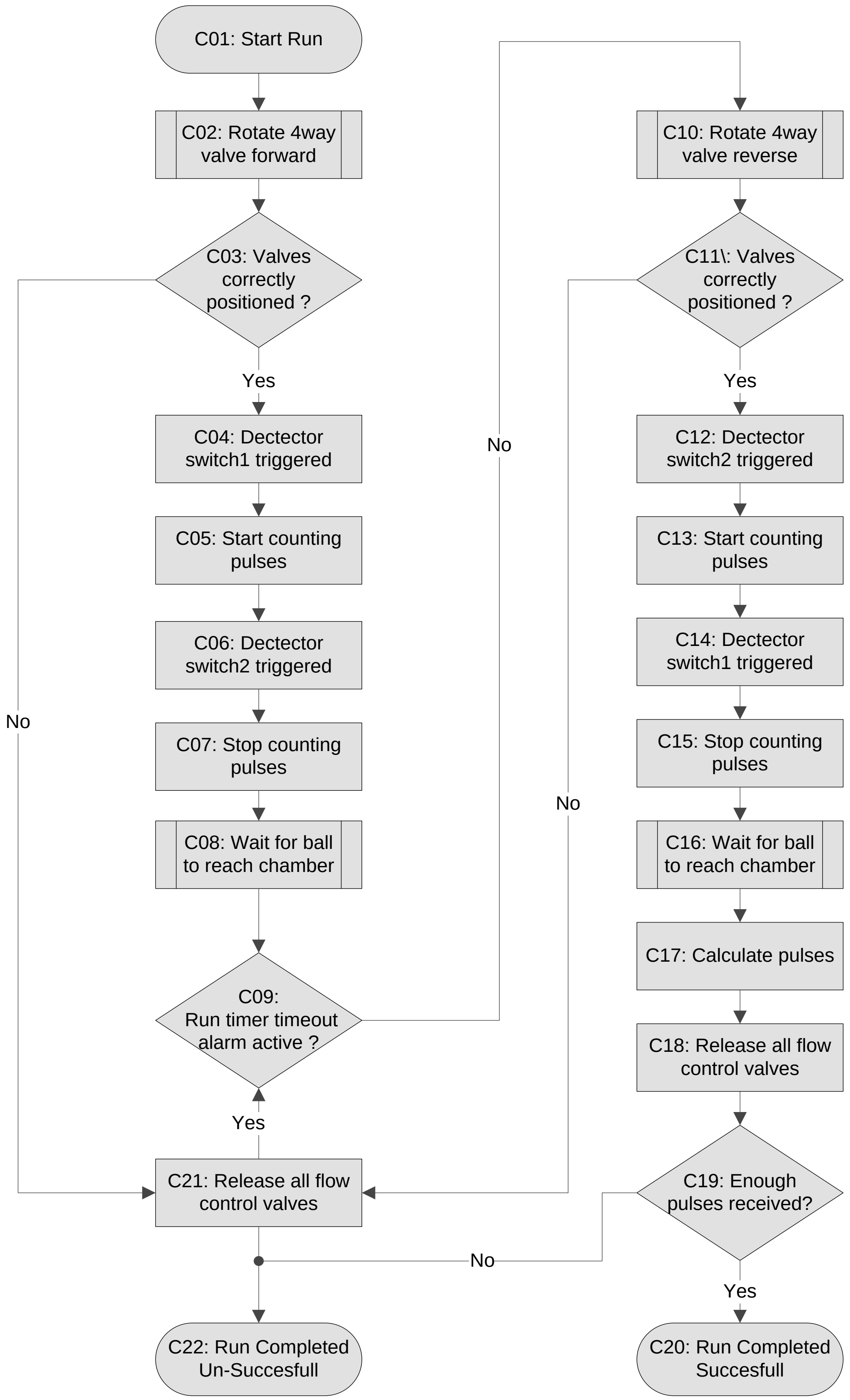


Figure 18 Proving run flowchart

Description		
C01	Start Run	
C02	Rotate 4 way valve forward	
C03	Are valves correctly positioned?	If not abort run (jump to C21)
C04	Detector switch 1 triggered	
C05	Start counting pulses	
C06	Detector switch 2 triggered	
C07	Stop counting pulses	
C08	Wait for ball to reach chamber	
C09	Run timer timeout activate?	If so abort run (jump to C21)
C10	Rotate 4 way valve reverse	
C11	Valves correctly positioned?	
C12	Detector switch 2 triggered	If not abort run (jump to C21)
C13	Start counting pulses	
C14	Detector switch 1 triggered	
C15	Stop counting pulses	
C16	Wait for ball to reach chamber	
C17	Calculate pulses	
C18	Release all flow control valves	
C19	Enough pulses received?	If not abort run (jump to C22)
C20	Run completed successfully	
C21	Release all flow control valves	
C22	Run completed un-successfully	

3.11 Sampling

Fixed time period	Activated during defined period with on and off timings
Duration	Actived for a fixed lenght of time
Batch	Quantity measurement based on parcel size
Continuous	Continuously running and obtaining samples

4.1 Applications

The SUMMIT 8800 is a multi-medium hydrocarbon flow computer which can handle 5 streams plus prover for liquid, gas, and steam applications simultaneously. It has been designed to accommodate multi-stream utilising various different types of flowmeter technology, and can be completely customised as per the user's requirements. This includes the operational units to be US Customary (USC) or Metric units, but also includes batching, sampling, valve switching etc..

Many other configurations features including data changing screen- and print layout but also graphical illustrations can be configured and will be described in detail in volume 3 of this manual set.

Application summary

The SUMMIT can be configured for the following metering types:
- Gas Master Meter
- Liquid Prover
- Gas Turbine/ Positive Displacement (PD)
- Gas Ultrasonic
- Gas Differential Pressure (DP)
- Gas Coriolis
- Liquid Turbine
- Liquid Ultrasonic
- Liquid Differential Pressure (DP)
- Liquid Coriolis
- Steam Ultrasonic

4.2 Measurement devices and signals

The SUMMIT 8800 is capable of receiving various signals from different technologies, and communicating with various field instruments including smart meters, and multi variable transmitters.
A simple summary of the types of commonly available signals from various meters, transmitters and transducers that can be used in conjunction with the SUMMIT 8800:
- HART, 1 or 2 masters or burst mode, up to 3 transmitters, 4 variables
- PRT/RTD/PT-100, 3 or 4 wire.
- 0-20mA/ 4-20mA
- Serial communication, several protocols
- Digital inputs
- Pulse inputs
- Status inputs

The following signals can also be used by the SUMMIT 8800 to communicate and send signals to various types of PLC, DCS, HMi, SCADA and other systems, including writing to field instrument registers
- 4-20mA output
- Serial communication, several protocols
- Digital outputs
- Pulse outputs

4.3 Create a new application

For initial installation and main menu functions of the software refer to Volume 1 of the handbook set.

This volume limits itself to the offline editing functions of the configurator, specifically to the configuration functions related to the meters and associated equipment.
The offline function allows the user to create a new application without actually being connected to the flow computer. It is also possible to load a previously created application from:

- a flow computer by using “Connect”
- a disk by using “Load Setup”.

The SUMMIT is continuously being improved with new functions and capabilities resulting in different versions of the configurator. The configurator is upwards compatible: a new configurator can handle all previous versions. Off course, only the highest version has all the latest capabilities, so it is recommended to always use the latest version.
The flow computer must support the configurator capabilities. Its firmware must therefore be compatible to the configurator version used, if not, the application cannot be loaded into the flow computer. It is possible to upgrade old applications to new versions via “Load setup” but check whether all functions are still supported.

To start the creation of a new application, start the configurator and select “Edit offline”:

Figure 19 Configurator main menu

And select the version to be used:

Figure 20 Configuration version

NOTE:
The version must match the firmware loaded in the SUMMIT 8800. See Appendix 1: software versions.

In the SUMMIT 8800 it is possible to define one to five different streams (or runs) plus a prover. Each of these streams is independent from the other. Each can be any metering medium (gas, liquid or steam) and any meter type: turbine, ultrasonic, Coriolis, orifice etc. (see next paragraphs for details). Also each stream can have a different engineering unit: Metric or USC (US Customary) or a mix of them.
The prover can be a master meter, but for liquid it can also be a small volume (or compact) prover and a uni- or bidirectional prover.

For a new application select the flow computer type (machine type). This will normally be "Standard", but if proving is required select gas prover or liquid prover. Then select per stream, the type of metering; in this case a gas turbine and a liquid Coriolis.

Figure 21 Configuration machine type

4.4 Main Screen

The main configuration page of the Configurator software provides all options available for the machine type selected. This means that certain menu options may not be available. For instance if only one meter and no prover is selected, only 1 stream will be shown and the prover and station tab will not be available.

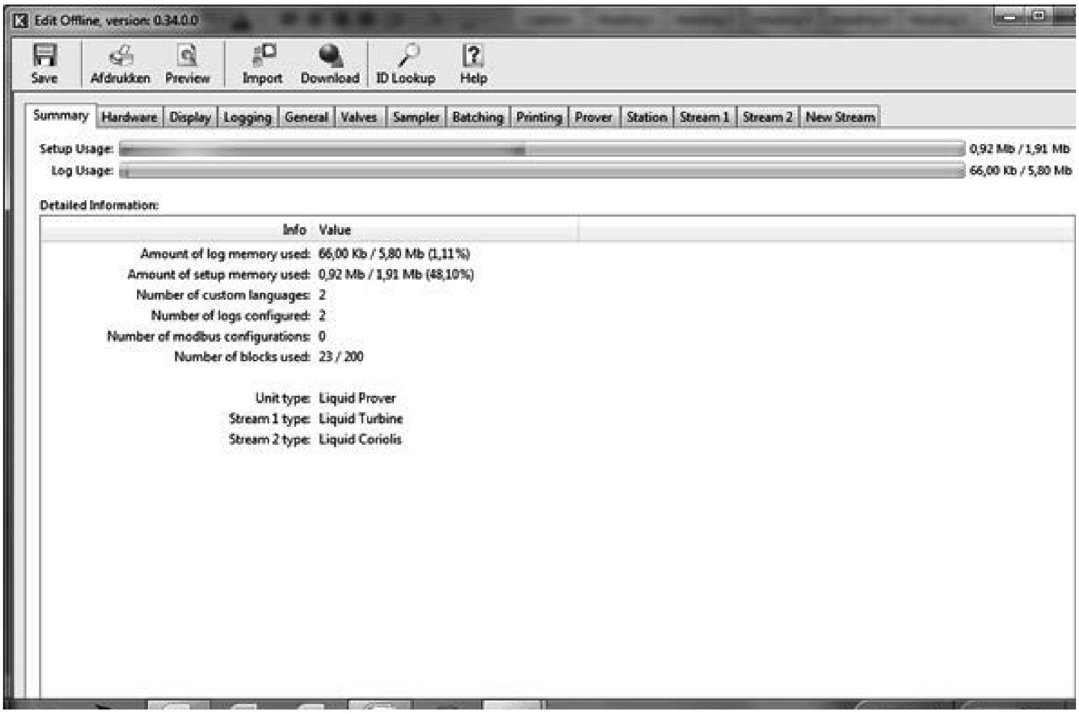


Figure 22 Main Configurator screen

The summary page shows the memory consumption for setup and log and details in the Information box.

For the main functions Save/ print/ preview/ import/ download and help, see volume 1

This volume describes all functions related to the meters and associated equipment: The manual follows the sequence most commonly used during configuration:

- Configure the hardware
- Configure the stream
- Configure the prover/ master meter if available
- Combine streams to a station if needed
- Optionally Configure valves, sampler and batching

In volume 3 the rest of the functions are described:
- Time and date
- Display
- Logging: Data, alarm and audit trail
- Reporting
- Communication
- Web access
- Miscellaneous functions

It is important to define first what boards will be used and what signals will be used on each board.

This paragraph provides instructions on how to configure the I/O boards for the types of signals to be utilised by the field instruments to the SUMMIT 8800. (For details on the boards, see volume 1)

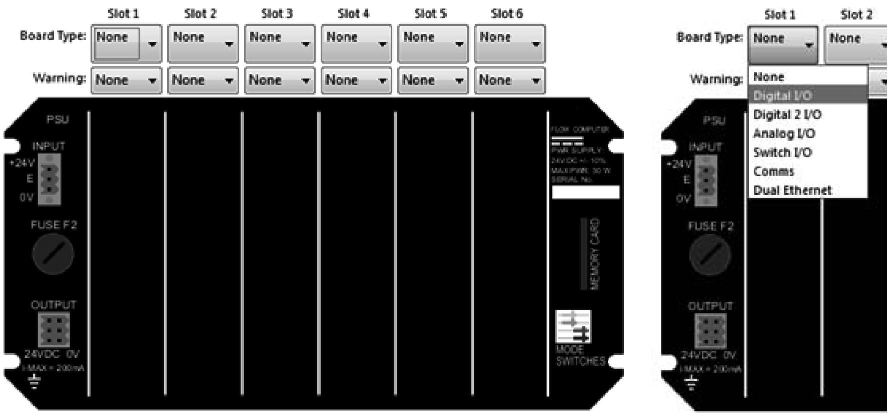


Figure 23 Configurator I/O board setup

The SUMMIT 8800, I/O and communication boards can be configured on-line or off-line.
When on-line, the slots will be populated as the current configuration information will be polled by the software.
When setting up in off-line mode, it is important to select the right I/O and communication board in the corresponding slot.

To configure a board, select the board type as per Figure 23, right hand side. This is done by clicking on the pull down menu and selecting the required/installed board in the relevant position.

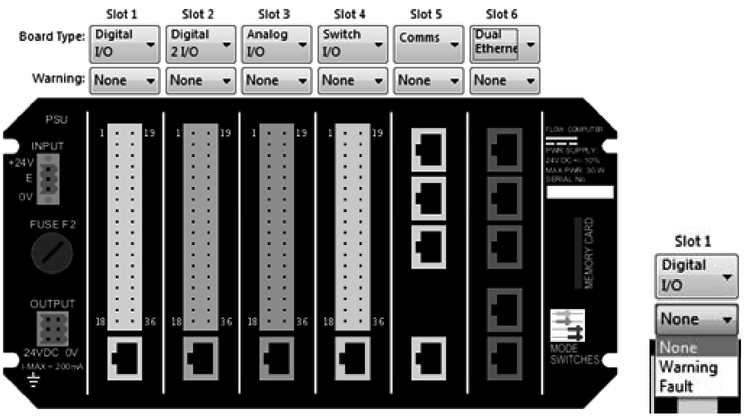


Figure 24 I/O and communication board selected

Figure 24 shows an example where each slot is occupied different boards.

Directly below the Board Type is a Warning tab. Here can be configured what action should be taken if, during normal operation, a wrong, missing or faulty board is found. This can be a warning, a fault or no action at all.

5.1 I/O board Configuration

To configure a board, click on the desired board as it appears in Figure 24. The board is divided into sections for the different in- and outputs, visible only when hovering over section. Depending on the section clicked, the specific in- or output is selected. As an example, when clicking on the analog board in slot 3 section digital in, the digital inputs are selected for configuration:

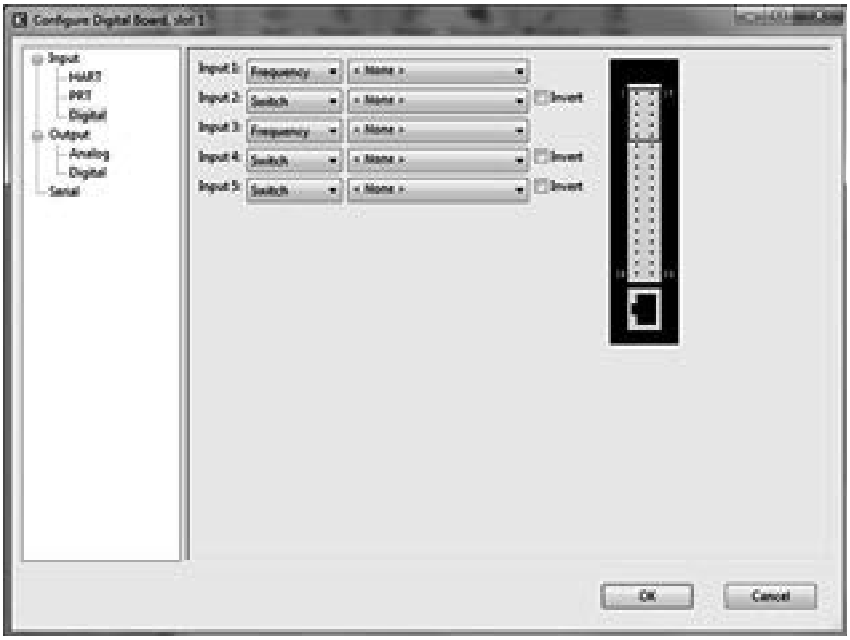


Figure 25 Board configuration window

The top of the configuration screen shows which board type and what slot position is choosen.

On the left side of the window there are different in- and outputs for configuration with the selected one highlighted. Of course any other selection can then be made by clicking on the section. The different selections will be described in the following paragraphs.

On the right the associated pin numbers on the connector are shown.

The button marked with "< None >" signifies what software variable is associated with the hardware signal connected. A software variable can be selected from an ID data tree. For each type of signal the tree will only be populated with appropriate variables to prevent mistakes. For instance in the case of a frequency input only the "active" and "custom" variables are available.

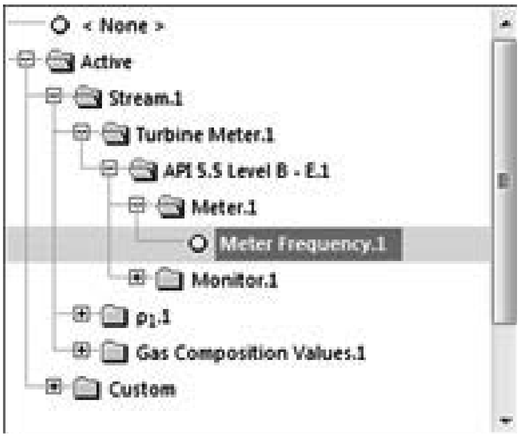


Figure 26 Signal selection from a tree

Of course the variable selected must match the hardware signal associated with it (see volume 1). Only one variable can be assigned to one signal.

Although it is possible to assign the same variable to two signals, an unpredictable behavior will be the result. For this reason an error will be given when this is the case. Make sure to correct this mistake.

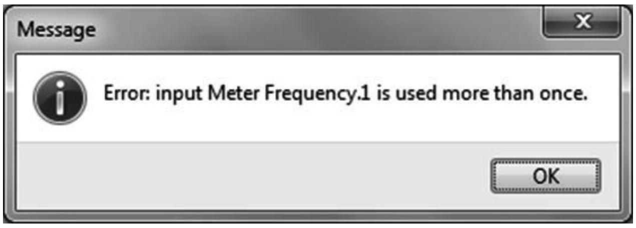


Figure 27 Error for a duplicated variable

5.1.1 HART Input

Most I/O boards have 1 or 2 Hart inputs (/loops), however the switch I/O board has none.

HART (Highway Addressable Remote Transducer) is a protocol, superimposed on the 4-20 mA signal, to connect smart transmitters to the flow computer. Hart has the following characteristics:

- A transmitter can send 1 to 4 values via HART, but only the primary measurement may also be transmitted via 4-20 mA.
- Hart transmitters can be in multi-drop or in burst mode.
- Multi-drop: each transmitter gets an address between 1 and 15 and a master reads one transmitter after the other.
- Burst mode: only one transmitter is connected and has no address (address 0). The transmitter is continuously transmitting its data and multiple devices may be listing.
- Hart accepts 2 masters, typically a flow computer and a field communicator (for calibration in the field). In redundancy mode two SUMMIT 8800 can communicate with one transmitter, but one has to be set as master 1, the other as master 2.
- One Hart loop can handle up to 15 devices in multi-drop. The SUMMIT 8800 limits this number to 3 to have an update time of less than 1 second.

The associated configuration screen is as follows:

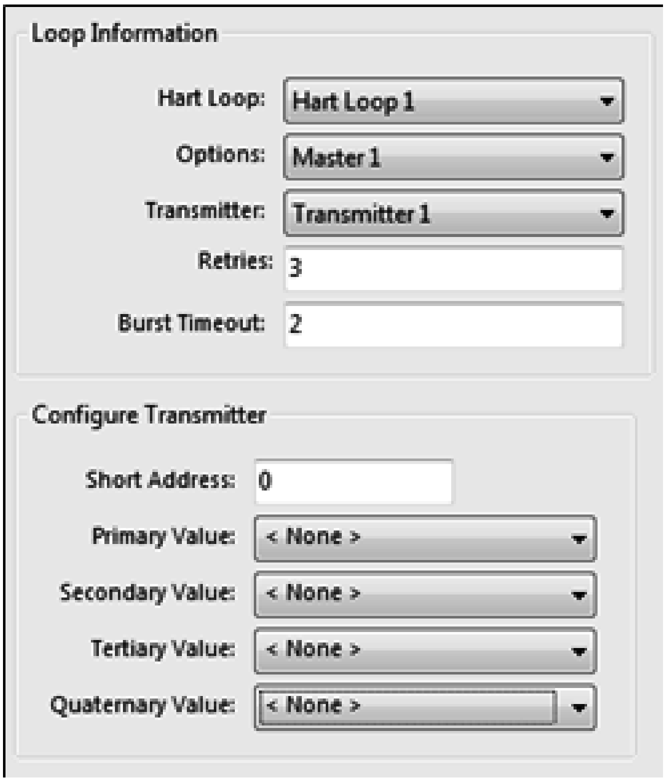


Figure 28 Configure HART inputs

Select the HART loop required as loop 1 or 2. In "options" select in Master 1 or 2 or Burst mode. Please note that in burst mode only 1 transmitter can be chosen, the other transmitters are greyed out..
Set the number of retries and the timeout (in seconds) before an error must be generated.

Then for each transmitter set under "Configure Transmitter":
- Assign a short id address: 0 when in burst mode, between 1 and 15 otherwise. Make sure the actual transmitters are programmed accordingly.
- Select the primary variable to be read from this transmitter from pull down tree.
- Select the other variables if the transmitter is a multi-variable type.

5.1.2 Analog Inputs

Only for the analog input board there are 4 analog inputs. For details, see volume 1.
Configure each sensor input as follows:

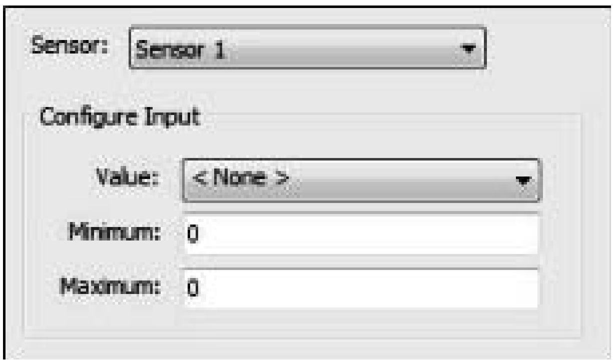


Figure 29 Configure analog input

- Select one of the four Analog sensor Inputs as connected in hardware.
- Select the Variable that will represent this sensor from the items listed in the pull-down tree.
- Set the Range extremes Maximum and Minimum values in the sensor units selected. It is recommended that these values are set approximately 20% above and below the Range Max and min values entered on the Stream set up pages.

Please be aware that the actual scaling of the inputs will be done in the configurator "Connect" menu under "Calibrate inputs and outputs". See volume 1.

5.1.3 PRT/ RTD/ PT-100 direct temperature input

Most I/O boards have 1 direct temperature input, however the switch I/O board has none. For details see volume 1.

The PRT (platinum resistive thermometer) also called RTD (resistive temperature device) is in the SUMMIT a direct 3 or 4 wire PT-100 input (platinum resistance 100 Ohm).

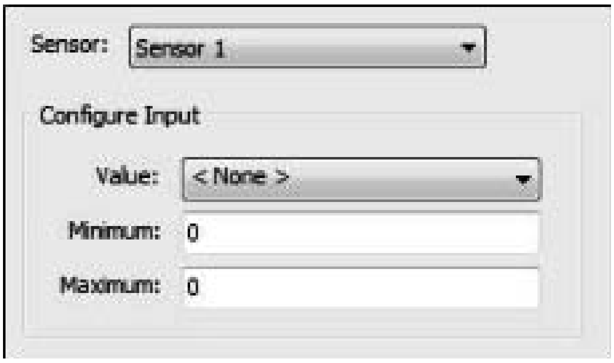


Figure 30 Configure PRT input

- Select the RTD sensor to be configured there is only one input on each I/O Board.
- Select the Variable that will represent this RTD input from the items listed in the pull down tree.
- Set the Range extremes Maximum and Minimum values in degrees C, it is recommended that these values are set approximately 20 degrees above and below the Range Max and min values entered on the Stream set up pages.

Please be aware that the actual scaling of the inputs will be done in the configurator "Connect" menu under "Calibrate inputs and outputs". See volume 1.

5.1.4 Digital Inputs

Most I/O boards have 5 digital inputs, however the digital 2 board has 4 and the switch I/O board has standard 6 digital inputs and optionally another 6 can be configured to be digital in- or outputs. For details see volume 1.

On every board, all digital inputs can be defined as switch (contact or status inputs). Inputs 1, 2 and 3 can also be defined as frequency, to measure frequency and count pulses. Input 1+2 can also be set as an API level A dual pulse for liquid meters. Please note that when Level A is selected for input 1, input 2 is also assigned.

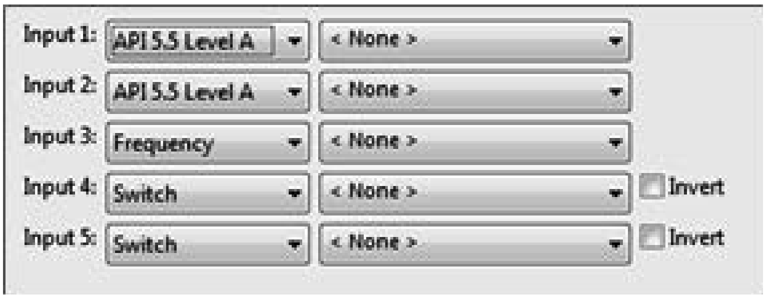


Figure 31 Configure digital inputs

For the Switch inputs, normally a signal of 0V will be interpreted as off and 5V as on. It is possible to reverse the logic of each input by enabling the Invert tick box.

Please note that for provers, a specific configuration is required. See paragraph 10 for details.

5.1.5 Analog Outputs

Most I/O boards have 2 to 4 analog outputs, however the switch I/O board has none. For details see volume 1.

Configure each output as follows:

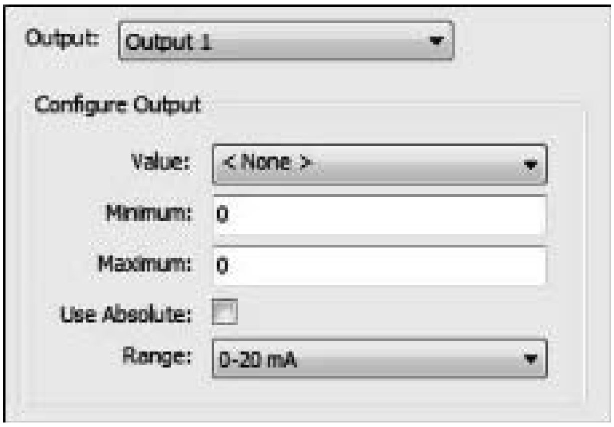


Figure 32 Configure analog output

- Select the desired output
- Select the value from the ID data tree
- Set the Output Range 4-20mA or 0-20mA.
- Set the Minimum value, this is the value represented by 0 or 4mA of the output.
- Set the Maximum value, this is the value represented by 20mA of the output.
- If the selected variable can be signed positive and negative, unclick the 'Use Absolute' tick box. If variable is only positive, then tick the box..

5.1.6 Digital Outputs

Most I/O boards have 4 to 6 digital outputs, however the switch I/O board has standard 6 digital outputs and optionally another 6 can be configured to be digital in- or outputs. For details see volume 1.

Configure each output as follows:

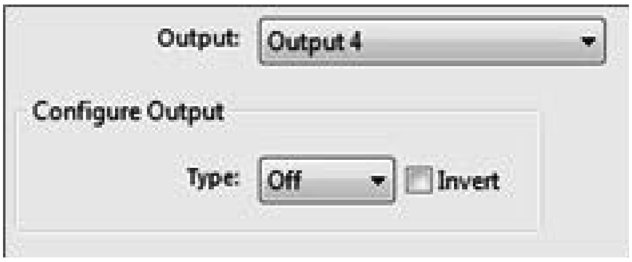


Figure 33 Configure digital output

Select the desired output	
Define the output type as follows	
Off	Not used
Pulse	Set to generate pulses to the output for e.g. telemetry
Alarm	Alarm indication to e.g. a alarm horn or a scada system
State	Output set to on or off state, e.g. valve operation
Corrected pulse	Used for proving, see paragraph 10. Only available on output 1.

5.1.6.1 Pulse output

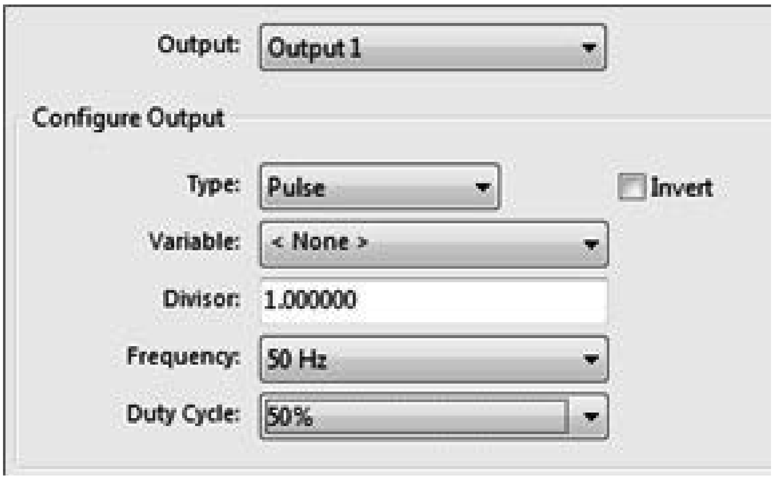


Figure 34 Configure pulse outputs

- Select the variable from the pull down ID data tree. This would normally be a counter increment value.
- The divisor is used to divide the counter increment. So use 10 to have an output of 50Hz for 500 increments per second.
- Select the maximum frequency of the output, from 50 to 2 Hz.
- Select the duty cycle from 25%, 50% or 75%. This means that e.g. 25% of the time the signal will be raised, the other 75% it will be low. Typically 50% will be chosen.
- It is possible to reverse the logic (invert high and low) of each output by enabling the Invert tick box.

5.1.6.2 Alarm output

An alarm output can be set to represent individual alarms or groups of alarms. From the Tree menu select the required alarm or alarms that the output will represent, the alarm is selected by enabling the tick box adjacent to each alarm or group of alarms.
Any alarms in the SUMMIT may be combined to one output. E.g. this might be any station or stream alarm, but it might also one specific alarm, such as a proving alarm.

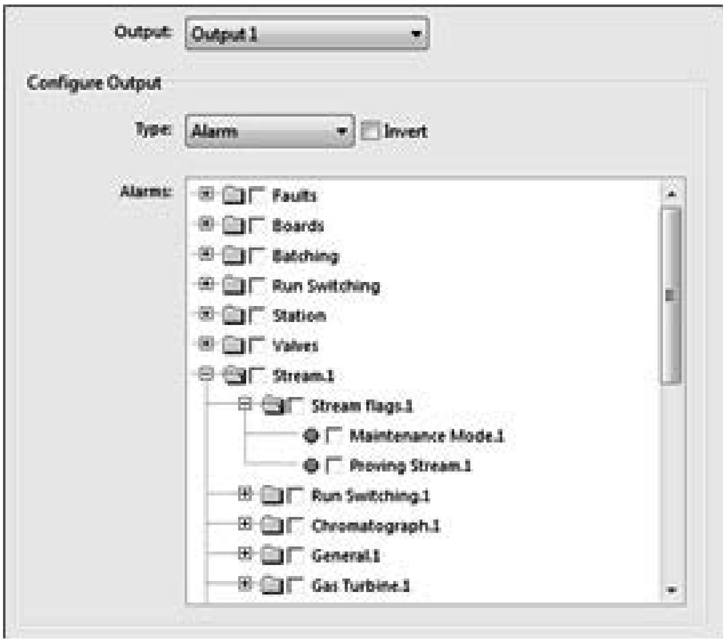


Figure 35 Configure alarm output

It is possible to reverse the logic (invert high and low) of each output by enabling the Invert tick box.

5.1.6.3 Status Output

A status output is set to follow a particular variable from the ID data tree.

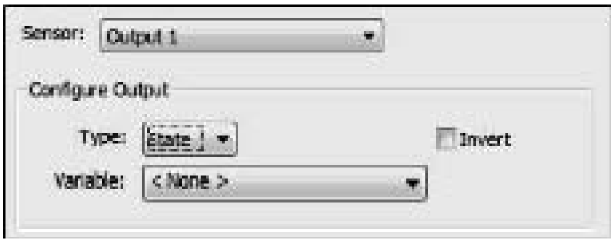


Figure 36 Configure State output

For valve operation select the Variable to be a manual Valve control value. The Output will then follow the logic State of the manual Valve Control. Further details on the valve configuration can be found in paragraph 11.

It is possible to reverse the logic (invert high and low) of each output by enabling the Invert tick box.

For testing, set the output to OFF. And use the invert tick box to turn the output to ON.

5.1.6.4 Corrected pulse output

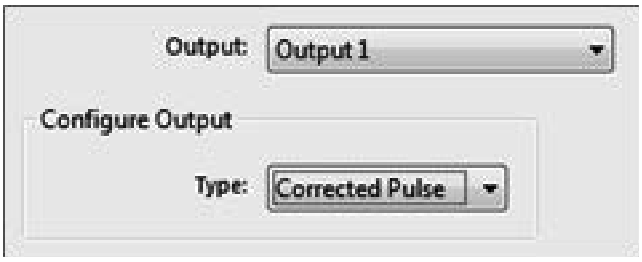


Figure 37 Configure corrected pulse output

On output 1 the corrected pulse output can be chosen. If used, the corrected pulse will be send to the pulse bus, as required in proving applications (see paragraph 10).

5.1.7 Serial Output

There is a single non-isolated serial output on all the I/O boards. There are 3 isolated serial outputs on both Communications boards.
A serial output can be configured to the following functions:

None	No function
Modbus Slave	Modbus slave for reading of Data
Modbus Master	For connection to slave devices, US meter, GC etc.
Printer	For Connection to a Serial Printer.
Encoder	For Turbine meters with smart electronics used for Totals
CTE	For communication protocol

In this volume only the modbus master will be discussed under the next paragraph. Further details on Serial configuration including printer and report setup can be found in Volume 3.

5.2 Stream hardware setup

When setting up a meter run, it is important to note, that there are a few basic parameters required to configure a simple run:

- Flowmeter
- Temperature
- Pressure
- Density/Specific gravity

This section will detail the hardware setup of a stream's basic parameters.

5.2.1 Flowmeters

For metering principle see chapter 3.

5.2.1.1 Pulse

Most meters have one or two pulse outputs (see paragraph 3.1), including:
- Turbine/Positive Displacement flowmeter sometimes also referred to as Rotary meters.
- Ultrasonic flowmeters.

- Coriolis meters.

In most cases they will be connected as API level B-E, thus pulse 1 as the meter frequency and possibly pulse 2 as a monitor frequency. See below for e.g. meter 1: turbine, meter 2: ultrasonic and meter 4: Coriolis.

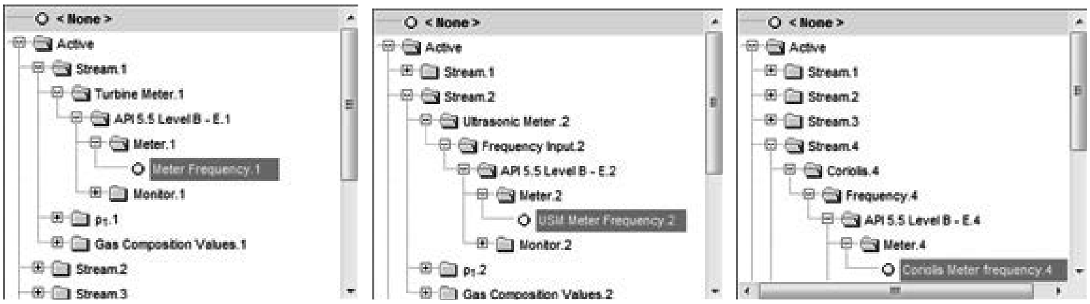


Figure 38 Setup of a meter pulse in Hardware selection

With digital input 2 of board 2, slot 3 used as the monitor frequency input for a turbine:

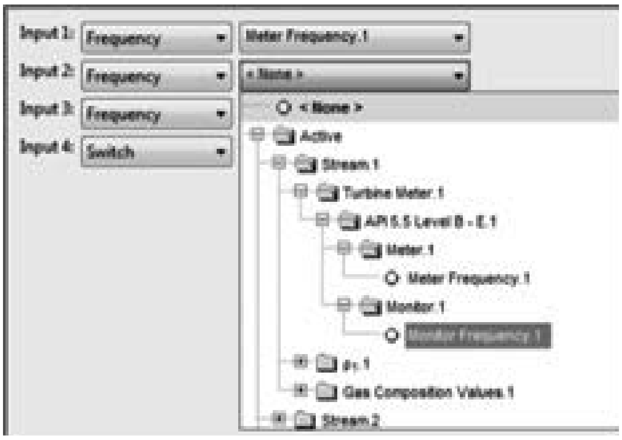


Figure 39 Setup of a monitor pulse in Hardware selection

Alternatively, a dual pulse might be connected as an API level A input. Select API 5.5 Level A for input 1. Input 2 will automatically be used, since they are hardware coupled for this function.

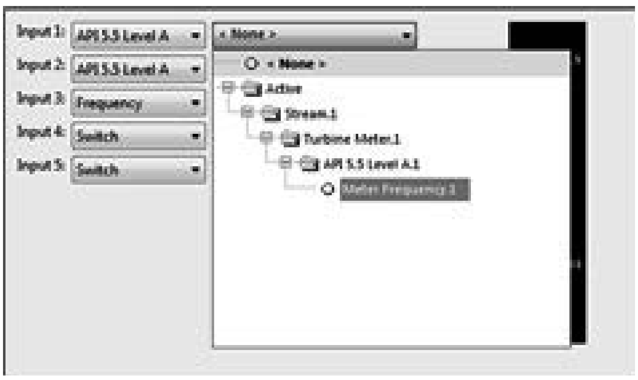


Figure 40 Setup of a Level A dual pulse in Hardware selection

5.2.1.2 Serial

Most modern flowmeters, like ultrasonic and Coriolis are smart and can communicate via a serial port. This will allow the SUMMIT 8800 to take not only the flow rate but also diagnostic information. This can often be used in parallel with pulses.

For such meters, often the modbus master protocol applies. Except for the standard serial settings (see volume 3), the master type must be chosen from gas or liquid ultrasonic or Coriolis. Also choose the way the meter is connected:

- Single: one meter is connected to the serial link
- Multiple: multiple meters are connected to in multi-drop on a RS485 link

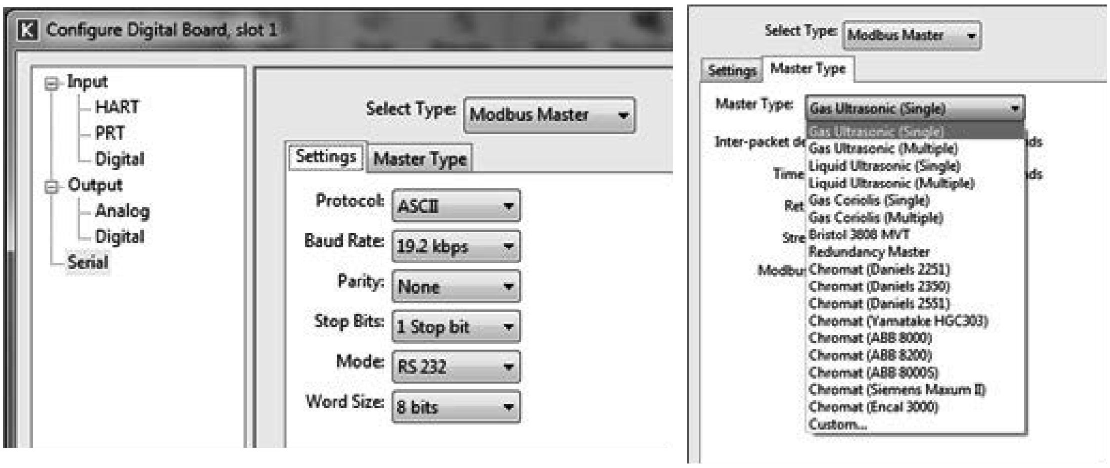


Figure 41 Setup of a serial meter in Hardware selection

All available parameters will automatically be retrieved.

For Instromet Qsonic meters a choice of "Instromet protocol" and modbus protocol is available. For the first select "Instromet ultrasonic" in the serial section as follows and match the other settings:

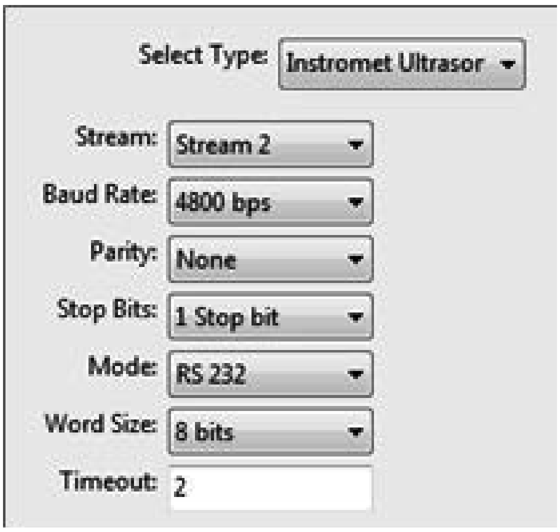


Figure 42 Setup of an Instromet ultrasonic meter in Hardware selection

For Elster turbine meters, there is the option to use an encoder.

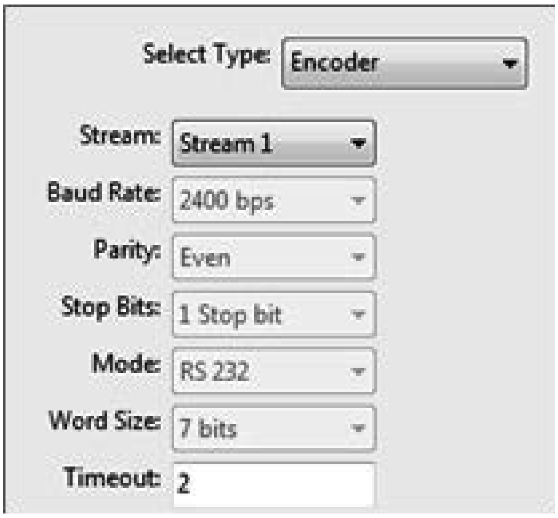


Figure 43 Setup of an Elster gas turbine encoder in Hardware selection

5.2.1.3 Analog

Some meters have an analog output, e.g. and ultrasonic meter:

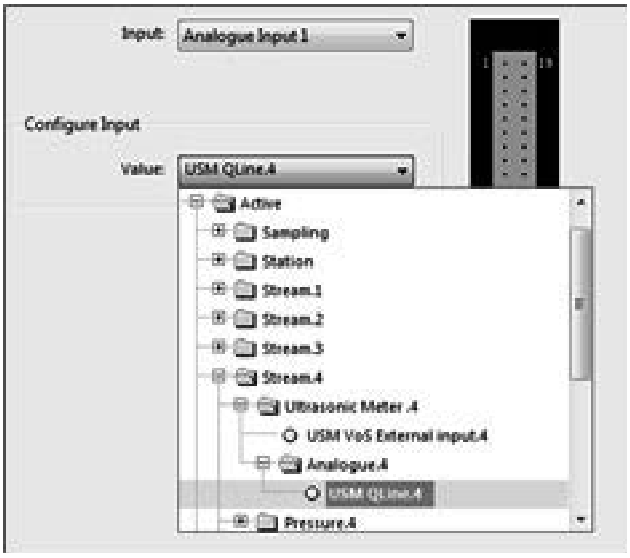


Figure 44 Setup of a analog meter in Hardware selection

5.2.1.4 HART

For a meter with HART output multiple variables may be available as in an ultrasonic meter UFM 3030:

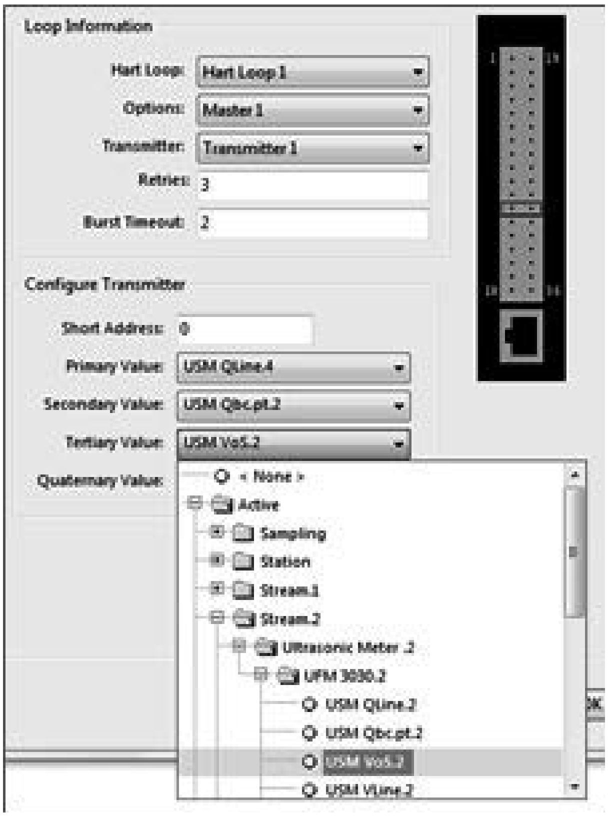


Figure 45 Setup of a meter with Hart in Hardware selection

In most case only one meter will be connected to one Hart loop, but up to 3 meters per loop could be connected. Please note that the update time might be more than 1 second with multiple meters as Hart is relatively slow.

5.2.1.5 Differential pressure

For Orifice plate, Venturi, Nozzle or Cone Meter differential pressure will be measured, see chapter 3.3.
Within the SUMMIT 8800, 1- 9 dP transmitters can be selected – 3x High, 3x Medium, and 3x Low range. At least 1 High range transmitter is needed.

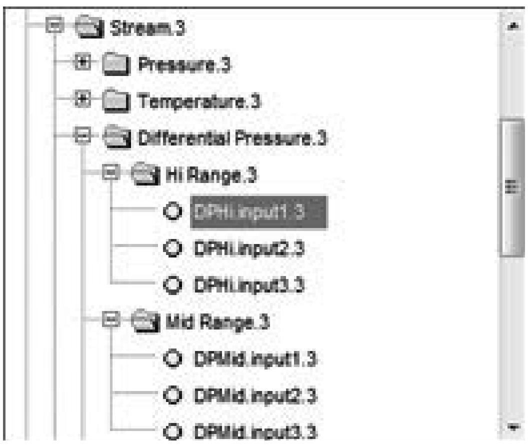


Figure 46 DP transmitter selection in Hardware input

The SUMMIT can handle Transmitters, which send out a Hart or analog (4-20mA) signal.

With Hart multiple transmitters can be used on one loop. Here for instance transmitter 2 is a dP medium on loop 1, address 2:

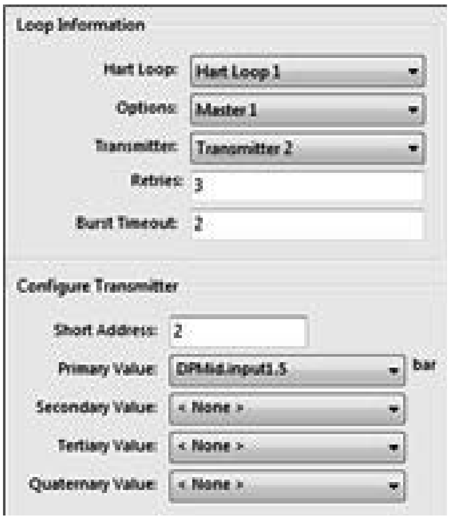


Figure 47 Hart DP transmitter selection in Hardware input

If multiple transmitters are used on 1 loop, it is a good practice to connect them such that there is still some dP information if a loop would fail.

The dP transmitters may also be connected via 4-20 mA:

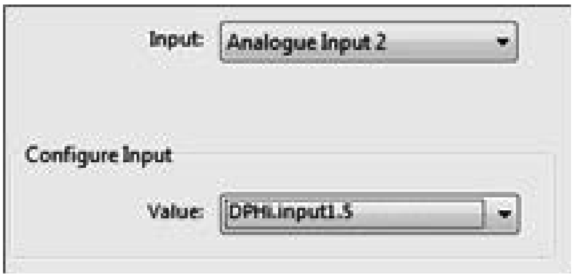


Figure 48 Analog DP transmitter selection in Hardware input

5.2.2 Temperature transmitter

An essential measurement for a flow computer is the temperature. This can be used for the correction (compensation) of flow, as well as density correction which is required according to certain standards.
The SUMMIT can handle 1 to 3 transmitters per stream:

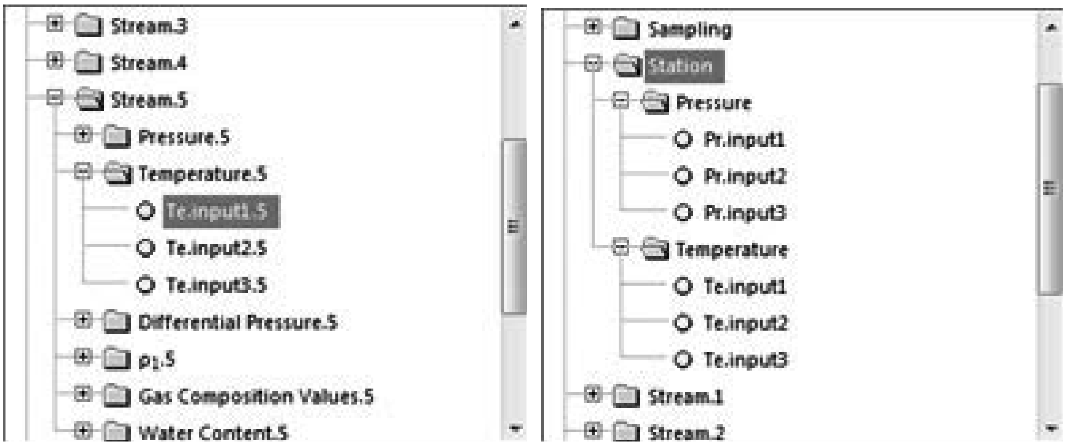


Figure 49 Stream and station temperature selection in Hardware input

The SUMMIT can receive these signals via:

- HART
- Analog (4-20mA)
- PRT/RTD
- Serial

For hardware signal details, see volume 1. See below configuration examples for Hart, Analog (4-20 mA) and PRT (PT-100):

Figure 50 Temperature input selection

A temperature can also be read serially via a modbus link. Normally this wil be the modbus slave link for instance from a SCADA system. See volume 3 for details how to configure a modbus slave.

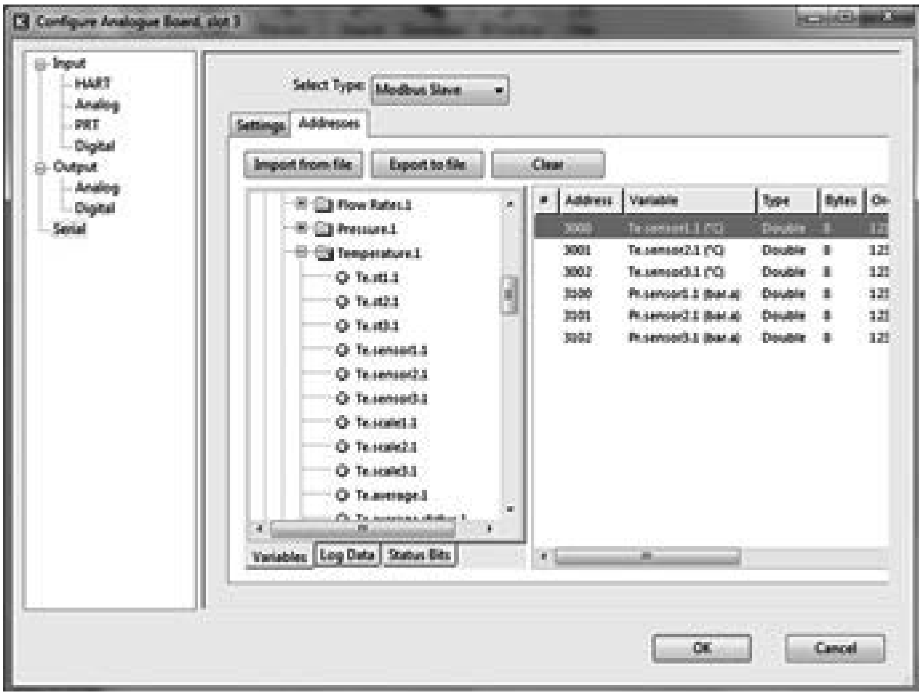


Figure 51 Temperature serial input selection

In certain meters, such as in the Coriolis meter, there is also the meter temperature. If this is included in the modbus master protocol of that meter, the same variable as for modbus slave is used. So although this is a fixed protocol which cannot be changed, the serial temperature can then still be used.

5.2.3 Pressure Transmitter

An important measurement for a flow computer is the pressure, specifically for gas. This can be used for the correction (compensation) of flow, as well as density correction which is required according to certain standards.
The SUMMIT can handle 1 to 3 transmitters per stream:

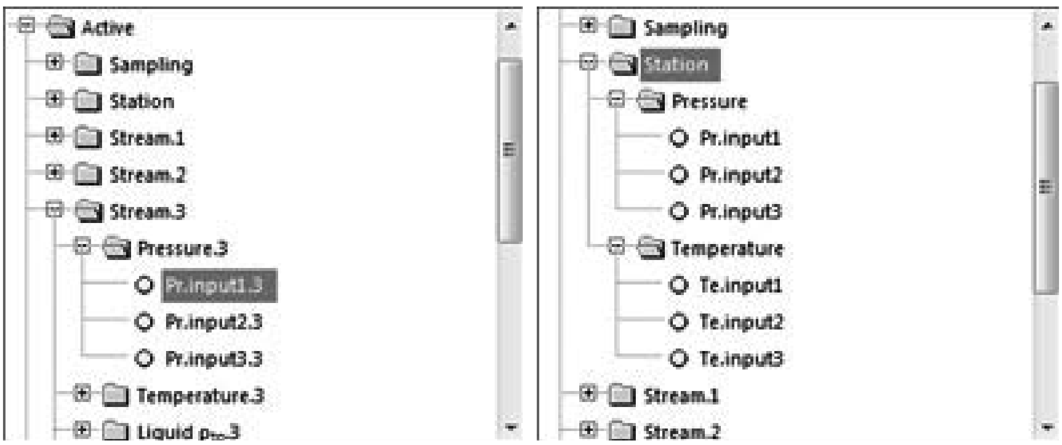


Figure 52 Stream and station pressure selection in Hardware input

The SUMMIT 8800 can receive 3 types of signals from these transmitters:

- HART
- Analog (4-20mA)
- Serial

For hardware signal details, see volume 1. See below configuration examples for Hart and Analog (4-20 mA):

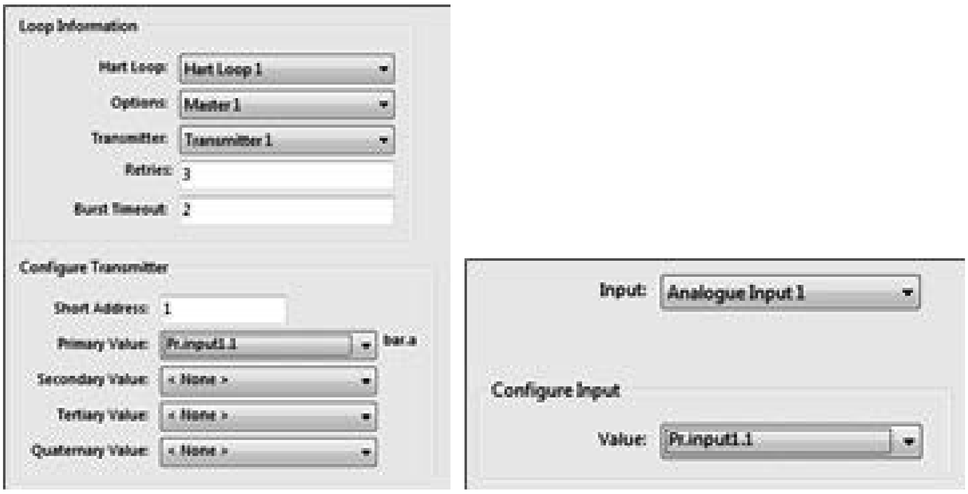


Figure 53 Pressure input selection

A pressure can also be read serially via a modbus slave link for instance from a SCADA system. See volume 3 for details how to configure a modbus slave.

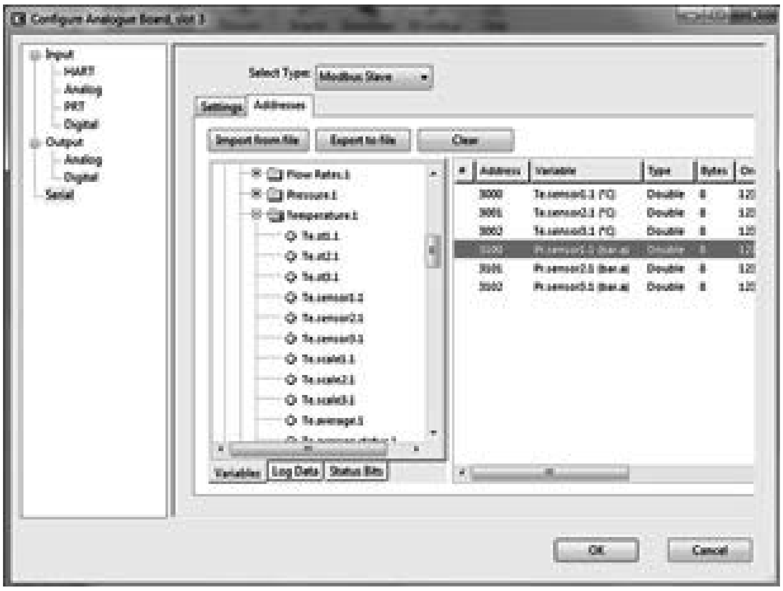


Figure 54 Pressure serial input selection

5.2.4 Density Transducer

A densitometer or density transducer is used to measure the density of the medium during flowing conditions. Reference source not found. for details. The density is used in calculations and corrected for temperature and/or pressure as required in many standards.

The type of density transducer and its selection within the stream measurement is made in the hardware section.

Densitometers can be connected to the SUMMIT 8800 via:

- Digital (Frequency)
- HART
- Analog (4-20mA)
- Serial (modbus)

In most of the cases a densitometer will be used. The SUMMIT supports models from Emerson/ Solartron 781x and Sarasota ID900 which have a frequency output. Up of two densitometers may be used per stream.

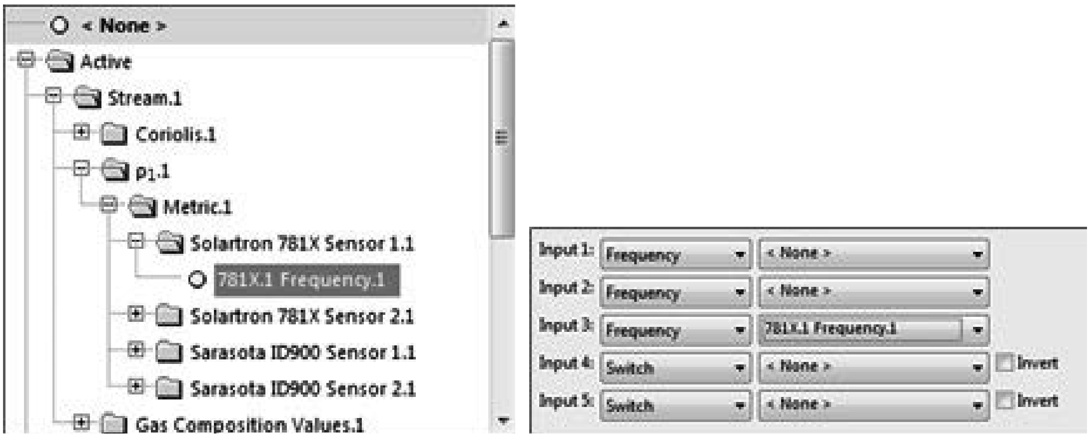


Figure 55 Densitometer input selection

Also a Hart or analog input may be used. In this case only one sensor can be used.

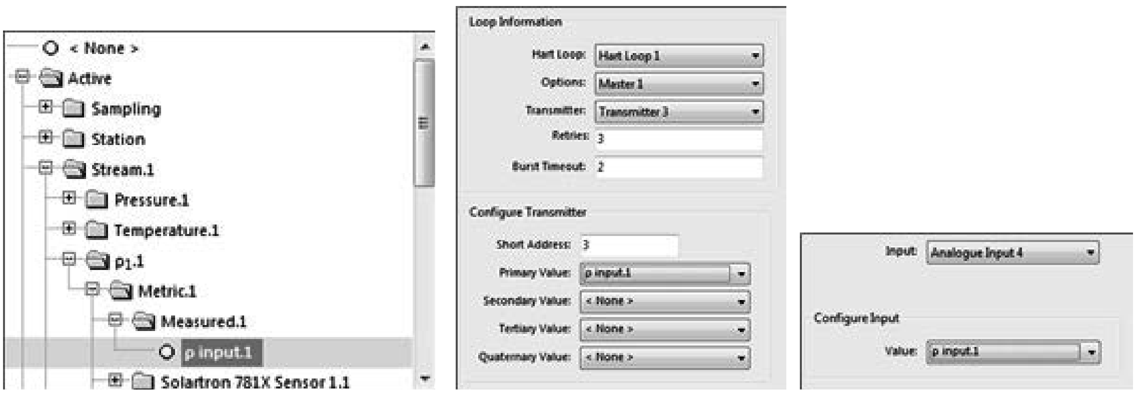


Figure 56 Density input selection

A density can also be read serially via a modbus slave link for instance from a SCADA system. See volume 3 for details how to configure a modbus slave.

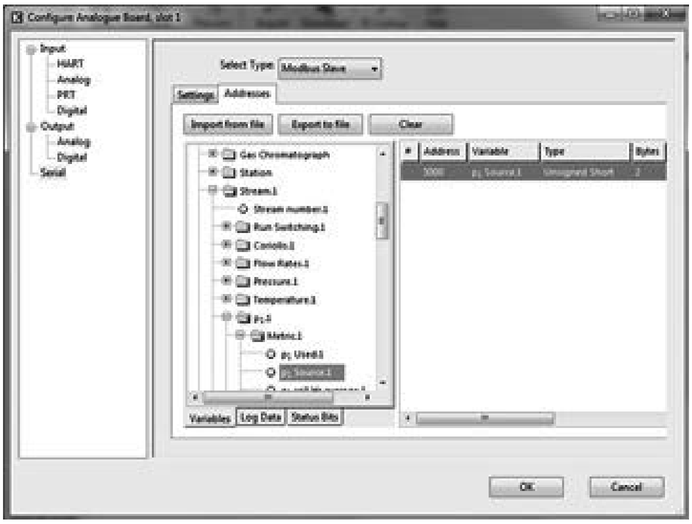


Figure 57 Density serial input selection

In certain meters, such as in the Coriolis meter, there is also the meter density. If this is included in the modbus master protocol of that meter, the same variable as for modbus slave is used. So although this is a fixed protocol which cannot be changed, the serial density can then still be used.

5.2.5 Density transmitter temperature and pressure

The density of both gases and liquids depends on the pressure and temperature of the fluid, and hence must be correct for base conditions.
The SUMMIT can use the same temperature and pressure as selected for the stream or specifically for the use of density effects only.
Solartron and Sarasota transducers have unique temperature and pressure points assigned to them. For each of them 2 different temperature and pressure inputs can be assigned for correction:

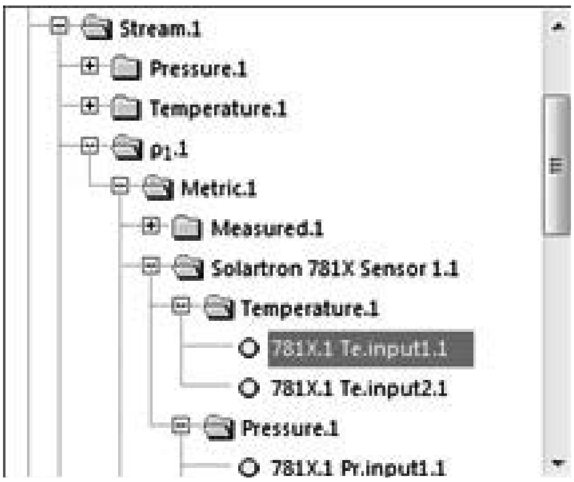


Figure 58 Density temperature and pressure input selection

The types of input signal available are as follows:
Temperature
- HART
- Analog (4-20mA)
- PRT
- Serial

Pressure
- HART
- Analog (4-20mA)
- Serial

Configuration is very similar to the normal temperature and pressure as per Figure 49 to Figure 53.

5.3 Flow and totals output

The SUMMIT can use the outputs for a wide variety of internal values, including stream and station flow and totals.

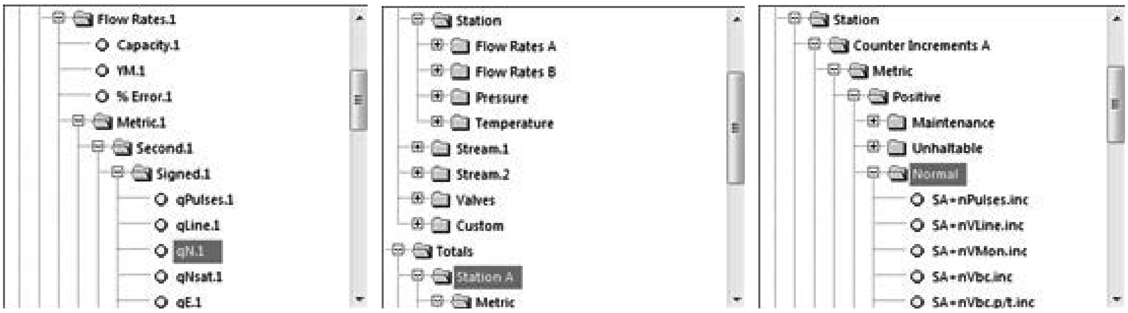


Figure 59 Stream and station ouput selection

The types of output signal available are as follows:
- Pulse
- Analog (4-20mA)
- Serial

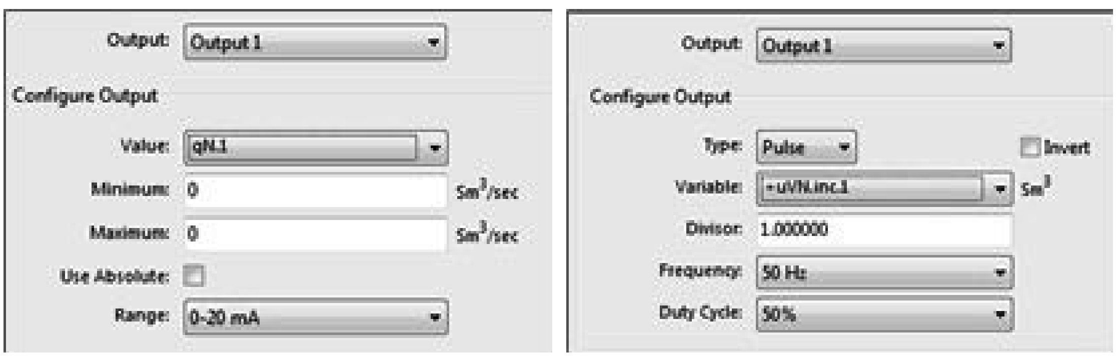


Figure 60 Analog and digital pulse output

The variables can also be written serially via a modbus slave link for instance to a SCADA system. See volume 3 for details how to configure a modbus slave.

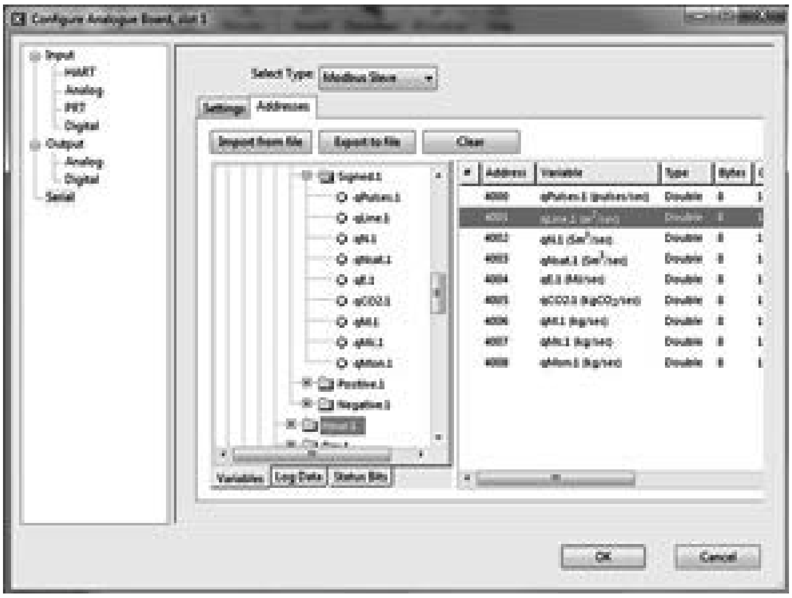


Figure 61 Density serial input selection

5.4 Alarm outputs

The SUMMIT 8800 has an extremely flexible alarm output mechanism. Any combination of alarms in the SUMMIT 8800 can be sent to a digital alarm output:

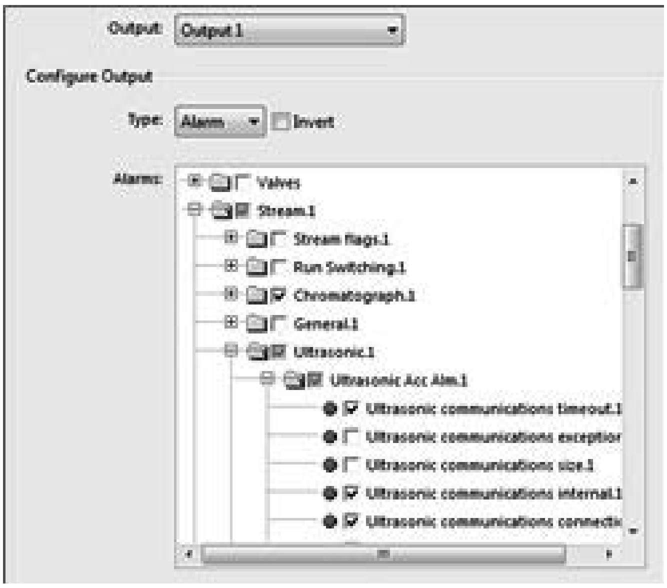


Figure 62 Alarm output

In this case any chromatograph alarm and some ultrasonic alarms generate one alarm on output 1.

This chapter will describe all the parameters necessary to configure a stream for flow measurement.
Generic information will be detailed and where necessary specific reference will be made to Liquid, Gas, and Steam related applications.

When selecting an application, it is important to remember, as the user configures the stream (meter run), that parameters may or may not be available depending on selected options.

All configuration is generic, unless indicated for specific applications – notification will be made for all liquid, gas, and steam specific parameters.

6.1 Units

	Liquid	Gas	Steam

The SUMMIT does all its calculations in both the metric and the US customary engineering units. The SUMMIT knows 4 sets of engineering units:

The default units	Set per user of the configurator (see volume 1)
The input units	Set under the general tab to define what units the transmitters are using.
Two output units	Set under the metric and USC tab to define what the output units will be.

The configurator will always start with the default units as set for the user of the configurator. This means that the template generated for the stream and displays will be in the default units, so a US customary user will see all units and displays in USC.

Under the general tab, the user can change the input units per type of input, e.g. the pressure, temperature, density and volume used by the associated transducers. So it might be that an ultrasonic meter could be in metric m3, although the user wants to output these data in USC bbl.

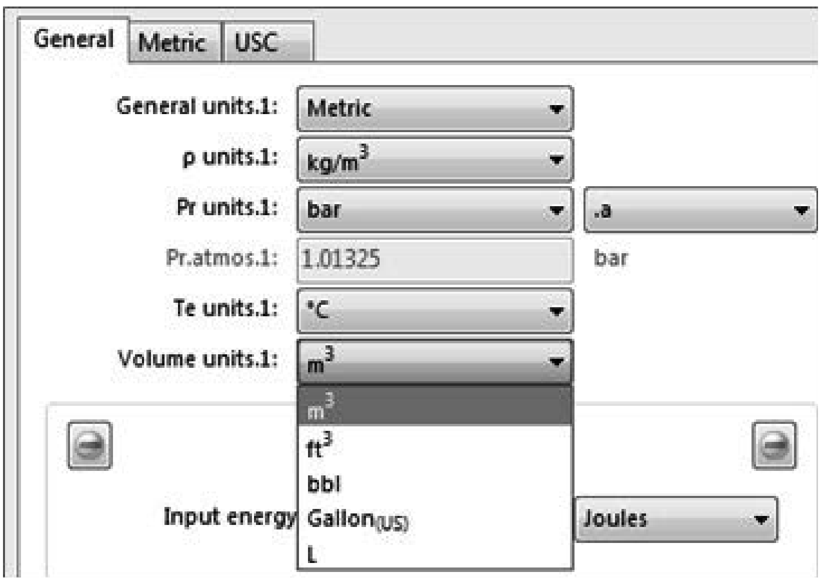


Figure 63 **Define input engineering units**

Independent of the previous, the user always has the choice to mix and match units, e.g. on a display page or report. For that reason, both the metric and the USC units can be set independently:

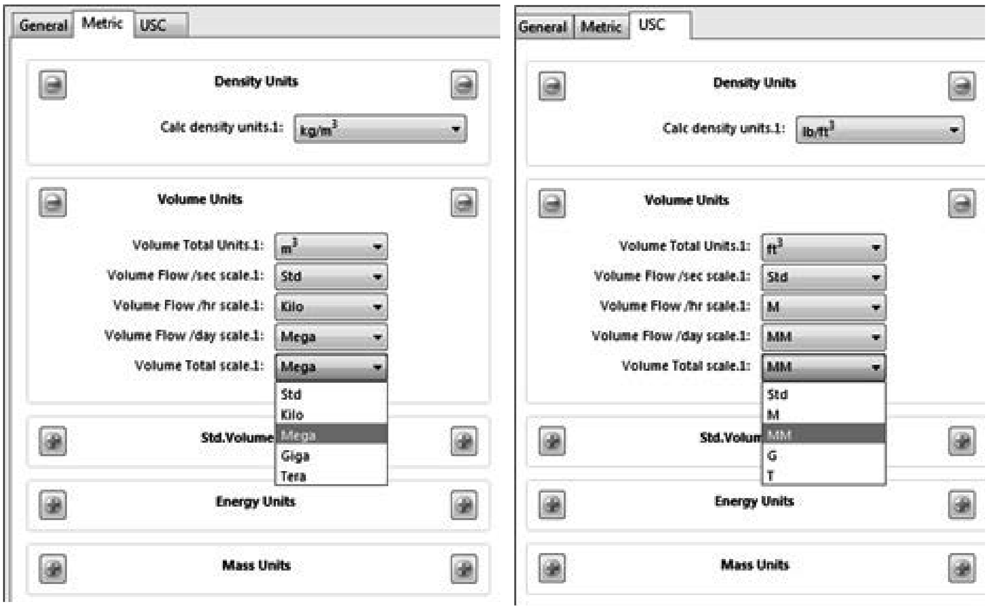


Figure 64 Define output engineering units

So the user can use a total volume in Mm3 and at the same time in MMft3.

The possible selections depend can vary, depending on the metering type selected.

6.2 Meter selection

6.2.1 Pulse based meters: Turbine / PD

	Liquid	Gas	Steam

This selection can be used for any meter with one or two pulse outputs.

For liquid the pulses can either be API 5.5 level A or level B to E, for gas API 5.5 Level B to E only.

- API 5.5 Level B to E : for single or dual pulse with the same of different frequencies and pulse monitoring.
- API 5.5 Level A: for dual pulse with pulse correction.

See also chapter 3.1.

6.2.1.1 Meter Input API 5.5 Level B to E

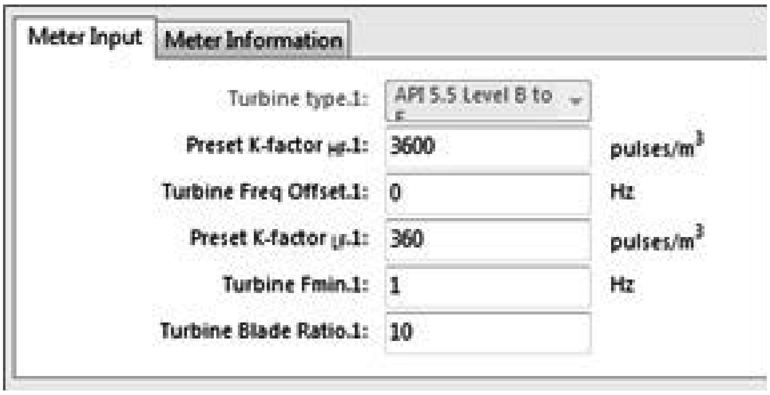


Figure 65 Define pulse based meter input API level B to E

Turbine type	API 5.5 Level B to E.
Turbine frequency offset	An offset to be added to the input frequency. Ideal for testing purpose: even when no input is available, a frequency can be set to simulate an input. Make sure that in normal mode the offset is 0.
K Factor	The total number of pulses corresponding to one unit of flow is the K-factor. A separate scaling K factor can be entered for both HF and LF inputs in pulses per volume.
Turbine minimum frequency	Low cut-off frequency. This is frequency below which the flow will be considered 0.
Blade ratio	Ratio between the two frequency inputs. For one input set to 0. For two identical frequency inputs set to 1

6.2.1.2 Meter Input API 5.5 Level A

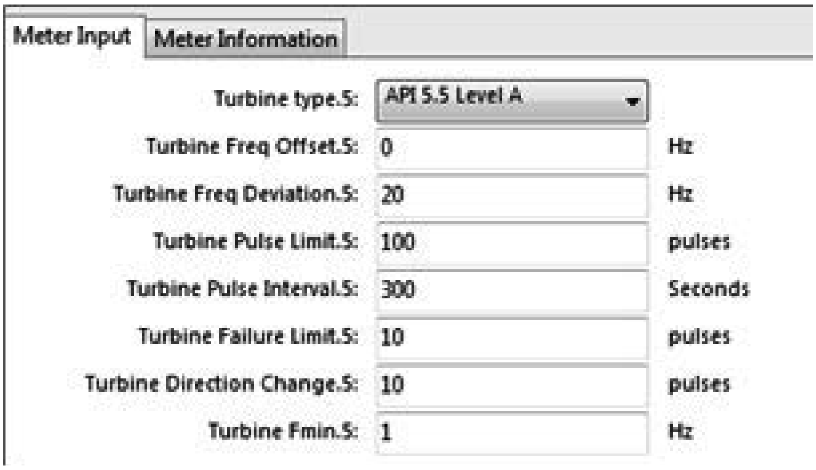


Figure 66 Figure 65 define pulse based meter input API level A

Turbine type	API 5.5 level A.
Turbine frequency offset	An offset to be added to the input frequency. Ideal for testing purpose: even when no input is available, a frequency can be set to simulate an input. Make sure that in normal mode the offset is 0.
Turbine frequency deviation	The threshold value (+/-) for the deviation of the two frequencies above which an alarm is raised.
Turbine pulse limit	Used to monitor pulse fidelity to alarm an added or missing pulse caused by electrical transients and electronic failures. This monitoring function allows the user to reduce the flowmeter uncertainty factors.
Turbine pulse interval	The time between pulses sequences. This is the maximum allowable time for pulse limits before an alarm is activated.
Turbine failure limit	Lack of continual pulses before the meter is deemed failed and raises an alarm
Turbine direction change	Number of pulses allowed in opposite flow to determine the direction of the medium flowing in the meter.
Turbine minimum frequency	Low cut-off frequency. This is frequency below which the flow will be considered 0.

6.2.1.3 Meter information

For each meter information to identify the meter can be enetered. This can be usefull as identifier text on the screen or to send to a supervisory system in a system.

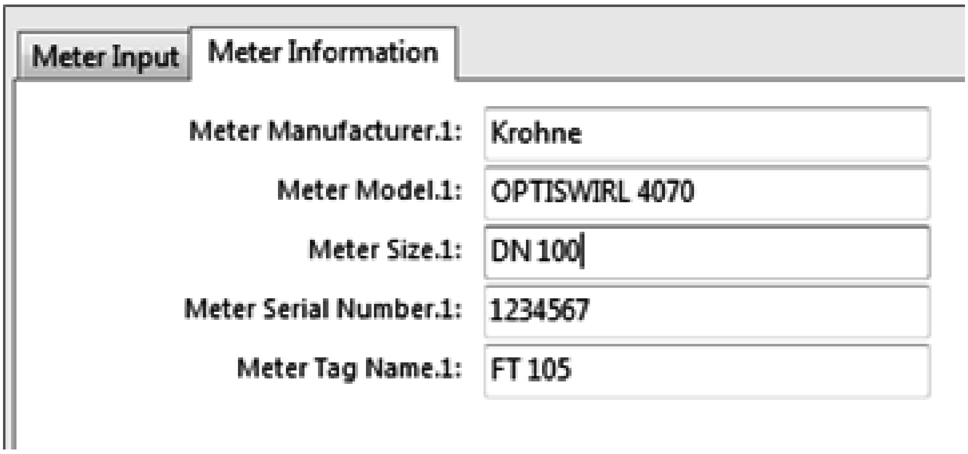


Figure 67 Define meter information

6.2.2 Ultrasonic

	Liquid	Gas	Steam

Please refer to chapter 4.2 for metering principles of ultrasonic meters.

Four setup sections available to configure an ultrasonic flowmeter:

Meter input	the meter connected and its basic settings
Pulse input	the preference for serial or pulse input and the pulse input setting if used
Meter correction	the correction for expansion of the meter body for pressure and temperature
Meter information	the identification of the meter

Most smart UFM have the option to send the flow data via a serial link and via pulses. In case pulses are used, then the API level has to be selected. For liquid the pulse input can either be API 5.5 level A or level B to E, for gas and steam API 5.5 Level B to E only.

API 5.5 Level B to E	for single or dual pulse with the same of different frequencies and pulse monitoring.
API 5.5 Level A	for dual pulse with pulse correction.

See also chapter 3.1.

6.2.2.1 Meter input

Define which meter type or manufacturer are applicable along with the associated parameters associated with the meter.

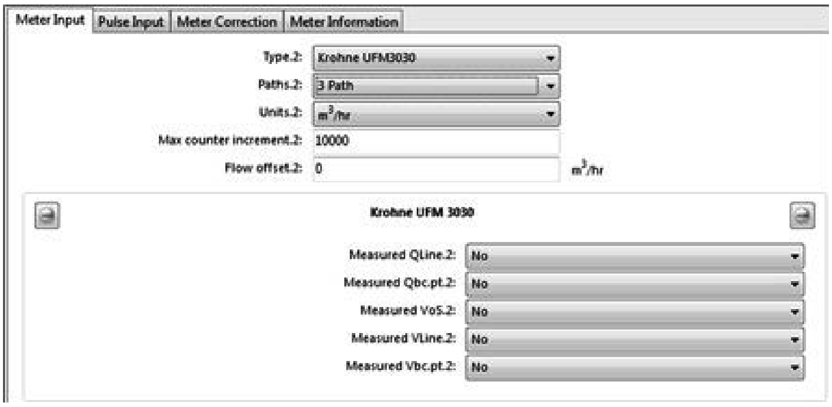


Figure 68 Example ultrasonic meter input section

Ultrasonic meter type	The specific meter to be used can be selected from a list. As meters are generally designed for liquid, gas or stream, the list varies depending on the medium. Also there is the option to use an analog input for flow.
Number of paths	The number of measurement paths (1 to 8) of the selected meter (see meter specifications for details). Used when the meter communicates serially. An alarm will be given if the meter is not configured for the same number of paths.
Meter units	The engineering units in which the meter is measuring flow.
Maximum Counter Increment	The maximum allowable increment for the flow data counter used for the calculated volume. Used when the meter communicates serially. This prevents a massive increment when, after a communication failure, the meter resumes normal communication.
Flow offset	This is used to simulate flow during testing when no meter is available. In theorie it could also be used to correct a fixed mis-match of the flow.
Meter specific data	For certain meters some parameters must be set. As these parameters are meter specific, please consult the meter manufacturer's operating instructions for further guidance. Parameters for the following meters are available:
- Flowsic 600	Use or ignore the security alarm, provided by Modbus or a digital output
- Senior Sonic	Dimensions and material of the meter and calculation of dynamic Viscosity
- Instromet QSonic	UFM efficiency settings used for reliability and diagnostic information.
- KROHNE UFM 3030	Select if the measured flow rate, velocity of sound and totals should be used.

6.2.2.2 Pulse Input API 5.5 level B to E

Define the preference for serial or pulse input and the pulse input setting for API 5.5 level B to E if used

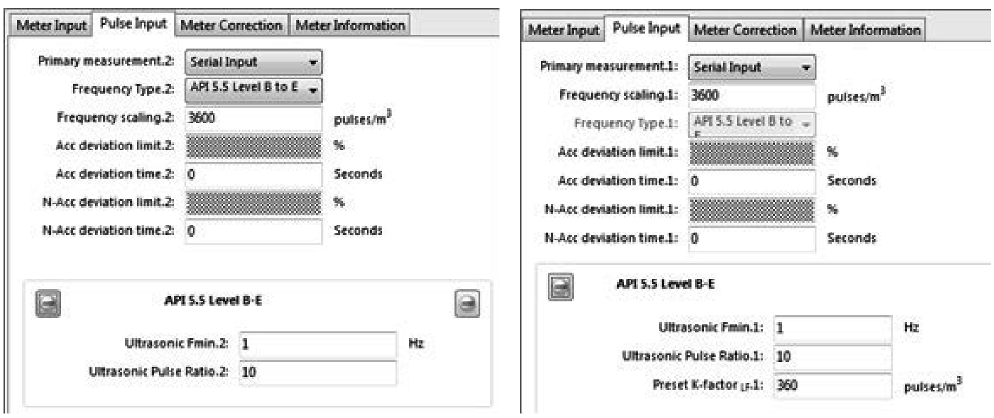


Figure 69 Ultrasonic pulse input section for liquid and gas API 5.5 Level B to E

Primary measurement	This option defines whether the serial link or the pulses will be used as a primary measurement. The other will be used when the primary fails. Off course only one of them can be used also: the other will not be connected..
Frequency type	API 5.5 level B to E.
Frequency scaling	The K-factor or impuls factor for the HF pulse. The total number of pulses corresponding to one unit of flow.
(N-)Acc deviation limit & time	A deviation alarm on the primary and secondary flow inputs from the UFM. This comparison can be used to set an accountable alarms or non-accountable warning if the difference exceeds a preset percentage during a given period of time.
Ultrasonic minimum frequency	Low cut-off frequency. This is frequency below which the flow will be considered 0.
Ultrasonic pulse ratio	Ratio between the two frequency inputs. For one input set to 0. For two identical frequency inputs set to 1
Preset K Factor LF	The K-factor or impuls factor for the LF pulse. The total number of pulses corresponding to one unit of flow. (Gas only).

6.2.2.3 Pulse Input API 5.5 Level A

Define the preference for serial or pulse input and the pulse input setting for API 5.5 level A if used

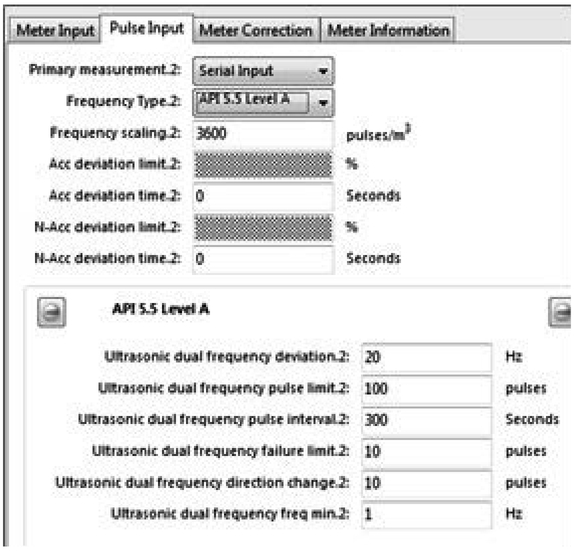


Figure 70 Ultrasonic pulse input section for liquid API 5.5 level A

Primary measurement	This option defines whether the serial link or the pulses will be used as a primary measurement. The other will be used when the primary fails. Off course only one of them can be used also: the other will not be connected..
Frequency type	API 5.5 level A.
Frequency scaling	The K-factor or impuls factor for the pulses. The total number of pulses corresponding to one unit of flow.
(N-)Acc deviation limit & time	A deviation alarm on the primary and secondary flow inputs from the UFM. This comparison can be used to set an accountable alarms or non-accountable warning if the difference exceeds a preset percentage during a given period of time.

Dual frequency deviation	The threshold value (+/-) for the deviation of the two frequencies above which an alarm is raised.
Dual frequency pulse limit	Used to monitor pulse fidelity to alarm an added or missing pulse caused by electrical transients and electronic failures. This monitoring function allows the user to reduce the flowmeter uncertainty factors.
Dual frequency pulse interval	The time between pulses sequences. This is the maximum allowable time for pulse limits before an alarm is activated.
Dual frequency failure limit	Lack of continual pulses before the meter is deemed failed and raises an alarm
Dual frequency direction change	Number of pulses allowed in opposite flow to determine the direction of the medium flowing in the meter.
Dual frequency min. frequency	Low cut-off frequency. This is frequency below which the flow will be considered 0.

6.2.2.4 Meter Correction

Define the correction for expansion of the meter body for pressure and temperature to maximize the ultrasonic meter accuracy as the properties of the UFM, and it's connection to the main stream pipe may change.

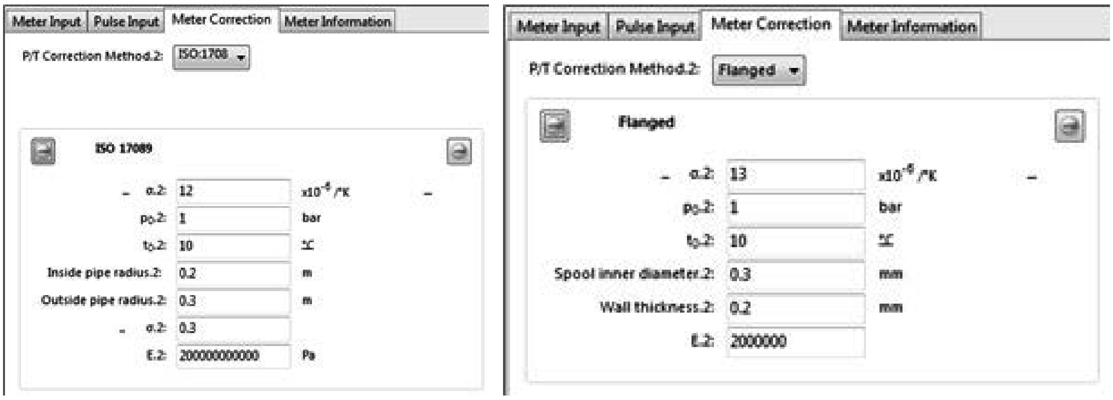


Figure 71 Examples ultrasonic meter correction section

Selection of any Pressure or Temperature expansion correction:

- None
- Correction for Flanged
- Correction for Welded
- Correction in accordance with ISO 17089
- Cryogenic

With as parameters:

Flanged & Welded	ISO 17089	Cryogenic
Thermal expansion, α	Thermal expansion, α	NIST constants A to E
Reference pressure, p0	Reference pressure, p0	
Reference temperature, t0	Reference temperature, t0	
Spool piece inner diameter	Inside pipe radius	
Wall thickness	Outside pipe radius	
Modulus of elasticity, E	UFM poison ratio, σ	
	Modulus of elasticity, E	

6.2.2.5 Meter information

For each meter information to identify the meter can be enetered. This can be usefull as identifier text on the screen or to send to a supervisory system in a system.

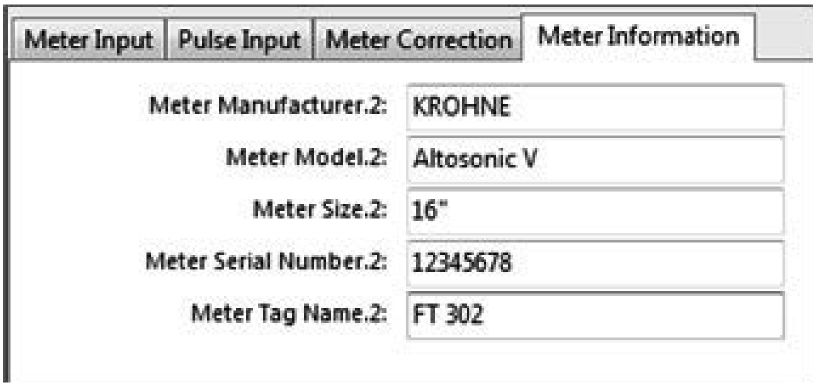
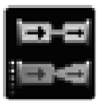


Figure 72 Define meter information

6.2.3 Differential Pressure

	Liquid	Gas	~~Steam~~

Please refer to chapter 3.3 for metering principles of differential pressure meters.

For liquid only orifice plate meters are available. For gas the following differential pressure meters can be chosen:

- Orifice plate
- Classic venture
- Venturi nozzle
- ISA 1932 nozzle
- Long radius nozzle
- Cone

6.2.3.1 General

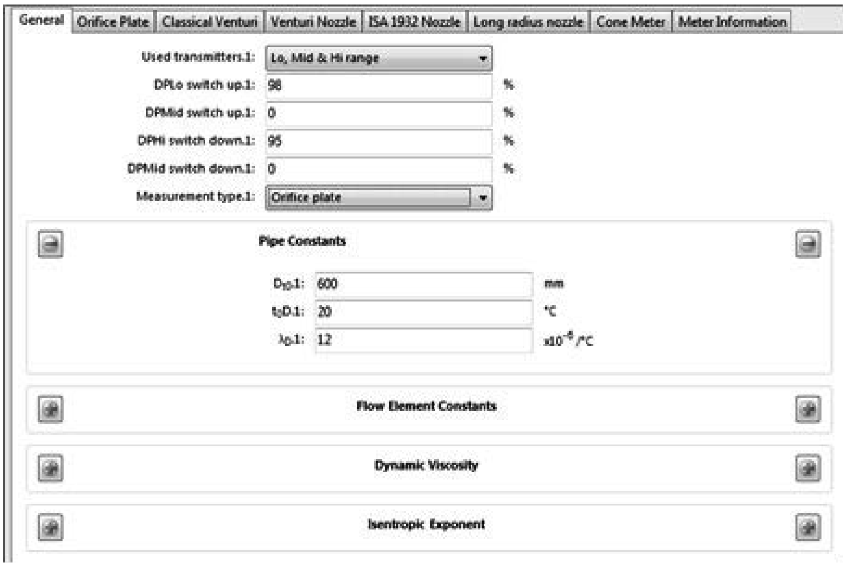


Figure 73 Differential pressure General section

Used Transmitters	This is the range of the transmitters to be used in the flow measurement. If only one DP transmitter is to be used select Hi Range. If two or three ranges are selected, the user will be prompted with switching values and new items appear in the list left: Mid (2 or 3 ranges) and Low (if 3 ranges are selected0.
Switch up & down	This selection is defined as a percentage of the transmitters range, and it's instructions to switch up or down to the next transmitter. Based on the percentage value of the range, the mid DP transmitter maybe required at a user entered value to switch up to the high range transmitter or switch down to the low range transmitter.
Measurement type	Select the restriction used in the pipe to create the differential pressure.
Pipe Constants	
Dt0	The measurement of the pipe diameter at the reference temperature
t0D	The pipe reference temperature of the device when measured
λD	Linear expansion coefficient of pipe based on material due to thermal changes
Flow Element Constants	
dt0	The diameter of the orifice plate at reference temperature
t0d	The reference temperature at the time of the orifice measurement
λd	Linear expansion coefficient of the orifice plate material due to thermal changes
Dynamic Viscosity Identify the source of viscosity measurement for the fluid. A choice of:	
Keypad	Fixed user defined value
Sutherland (pressure)	Deriving the dynamic viscosity of fluid as the result of flowing pressure
Polynomial	Defining viscosity formulation as a function of temperature
Sutherland	The dynamic viscosity as the function of temperature using Sutherlands's law
Keypad	The fixed keypad value
C	Sutherland constant
μ0	Viscosity at reference value of fluid
K11-K13	Viscosity constants

Isentropic Exponent Isentropic exponent of the fluid at flowing .Options available for source	
Keypad	Fixed user defined value
Method 1	From calculated Ratio specific heat γ0
AGA 10	Natural gas detailed density analysis based on speed of sound

6.2.3.1.1 Orifice Plate

The following parameters are available for this selection

Equation Orifice equation used for flow calculation	
Keypad	User defined fixed value for coefficient of discharge
ISO 5167	As per standards for 1991, 1997, and 2003 with the change of temperature to be used.
AGA3	Calculated independently from the type of fluid with a deadweight correction factor
Tappings Pressure taps for the orifice installed based on location where the reading is taken.	
Flange	Placed both sides of the orifice close to the face plate, usual an inch either side.
Corner	Pressure taps on both sides of the flange holding the orifice plate
D & D/2	Located in the pipe wall upstream and downstream of the face plate at half length.
Joule Thompson A pressure drop and temperature change based on a regulating process in conjunction with a steady flow across a restricted section.	
Keypad	A user defined fixed value for the Joule Thomson process
Reader-Harris	Simplified version of the Joule Thompson equation
ISO 5167:2003	Calculations to ISO 5167, based on temperature method.

6.2.3.1.2 Classical venturi

When selecting classical venturi as the measurement source the following parameters will need populating.

Pressure loss Pressure taps for the orifice installed based on location where the reading is taken.	
Calculated	....
Keypad	User defined fixed value
Coefficient of discharge A selection based on the tube installation, or defined values, as set by ISO5167 for the convergent section of the venturi.	
As cast	
Machined	
Rough weld	
CoD table	see paragraph 6.2.3.3
Keypad	
Constants	An alternative method to calculating the loss of pressure as defined the Beta calculation.

6.2.3.1.3 Venturi nozzle

Enter as a percentage the nozzle pressure loss.

ISA 193 2 nozzle	Typically used for high velocity, set by ISO 5167 to determine the flow of fluid. Enter as a percentage the nozzle pressure loss.
Long radius nozzle	A variation of the ISA 1932 nozzle, with a convergent section as the ISA 1932 nozzle and divergent section as a classical venture. Enter as a percentage the nozzle pressure loss.

6.2.3.1.4 Cone meter

Cone	Select the V-cone meter to be used.
	NUFLO
	McCrometer
	McCrometer wafer
Keypad CoD	A user defined value for the coefficient of discharge

6.2.3.2 Meter information

For each meter information to identify the meter can be enetered. This can be usefull as identifier text on the screen or to send to a supervisory system in a system.

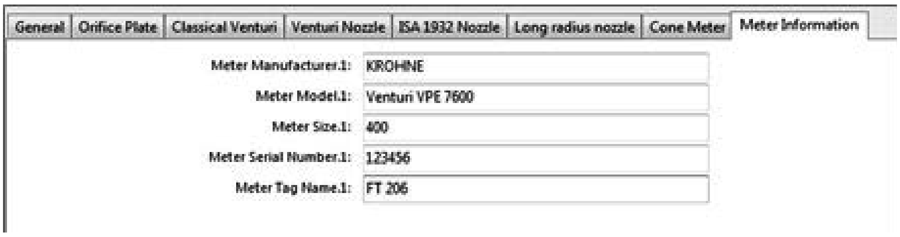
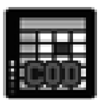


Figure 74 Define meter information

6.2.3.3 Coefficient of Discharge Table

	~~Liquid~~	Gas	~~Steam~~

This section applies to the classical venture only. Here is an option to select a CoD table. The ratio of the actual discharge to the theoretical discharge:

CoD = Actual discharge / Theoretical discharge.

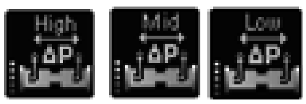
When selected, this page is used to set the values of CoD to be used in that table. The CoD can be given for 1 to 10 values of Pressure and Temperature. Linear interpolation is carried out between the table values.

Temperature Samples.1 [10 ▾] Pressure Samples.1 [10 ▾] [Import...]

	Temperature									
Pressure	0	10	20	30	40	50	60	70	80	90
0	0.5	0.525	0.55	0.575	0.6	0.625	0.65	0.675	0.7	0.7
1	0.525	0.55	0.575	0.6	0.625	0.65	0.675	0.7	0.725	0.7
2	0.55	0.575	0.6	0.625	0.65	0.675	0.7	0.725	0.75	0.7
3	0.575	0.6	0.625	0.65	0.675	0.7	0.725	0.75	0.775	0.8
4	0.6	0.625	0.65	0.675	0.7	0.725	0.75	0.775	0.8	0.8
5	0.625	0.65	0.675	0.7	0.725	0.75	0.775	0.8	0.825	0.8
6	0.65	0.675	0.7	0.725	0.75	0.775	0.8	0.825	0.85	0.8
7	0.675	0.7	0.725	0.75	0.775	0.8	0.825	0.85	0.875	0.9
8	0.7	0.725	0.75	0.775	0.8	0.825	0.85	0.875	0.9	0.8
9	0.725	0.75	0.775	0.8	0.825	0.85	0.875	0.9	0.925	0.9

The table can be manually entered but can also be imported by pressing the "Import" button and selecting the correct file .

6.2.3.4 DP high, mid, low: differential pressure transmitter selection

	Liquid	Gas	~~Steam~~

The differential measurement can be done with up to 9 transmitters: up to 3 ranges with up to 3 transmitters each.

The number of ranges has been selected under "General" by the parameter "Used Transmitters" with the selections: hi range, hi & lo range or hi, mid and lo range.Only the associated icons for the differential pressure transmitter selections DP high, mid and low will appear in the list. The purpose is to define how many transmitters are used and how the selection between them must be done to arrive at the used value for the range.

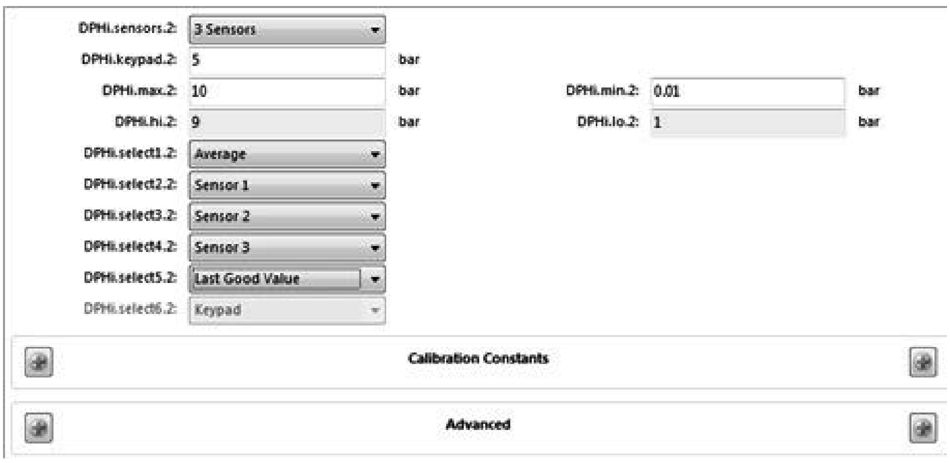


Figure 75 Define the differential pressure transmitter selection

DP Sensor	Select how many transmitters, configured in the hardware, will be used in the selection process for this range. The actual transmitters must be defined in the hardware section. Choosing zero means that there are no direct transmitters, but the value may come from a serial link (e.g. SCADA) or that a keypad value will be used.
DP Keypad	A user defined value that the SUMMIT 8800 will use in case the DP transmitter fails or is not available. The keypad value may later be changed via the SUMMIT display if security allows such.
DP max & min	Maximum and minimum alarm limits: generates an accounted alarm when exceeded.
DP high & low	High and low warning ranges: results in a warning when exceeded. These values should be within the DP max & min values.

6.2.3.4.1 DP select

This section defines the selection process to arrive to an "in use" value for the range. There are 6 options in order of priority with each 6 choices. The SUMMIT will start to check the first option. If the value is valid (not in alarm) then this option will be choosen. If not, then the second option will be checked etc. The last option is always the keypad value as defined earlier, even if all other choices are none.

The 6 choices provided for the DP selection are:

None	No functionality or transmitter selected, the option will be skipped.
Keypad	The user defined value for this range will be choosen.
Sensor 1-3	The transmitter value, as configure in hardware, will be used.
Average	Average value of all transmitters (selected in DP sensor) will be used.
Serial	Value as sent by Modbus e.g. from a PLC, or smart transmitter will be used.
Last good value	The last good value known before loss of signal will be used.

6.2.3.4.2 Calibration constants

The DP calibration range and offset which are the scaling factors for the transmitter, determined during the calibration of the transmitter. As this is a multiplier to the normal transmitter range and offset, this is not a mandatory setting, but a software calibration. This is used to correct the transmitter value without actually calibrating the transmitter itself. The advantage is that the changes will appear in the audit log.

This setting is also ideal for simulation purposes. With it, the transmitter can be set to any value without an actual transmitter connected.

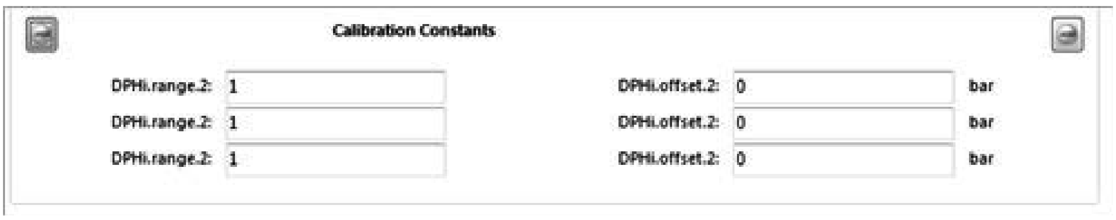


Figure 76 Define the differential pressure transmitter calibration constants

DP range	Default value is 1. This is a multiplier to the actual transmitter range.
DP offset	Default value is 0. This is an offset to the actual transmitter range.

6.2.3.4.3 Advanced

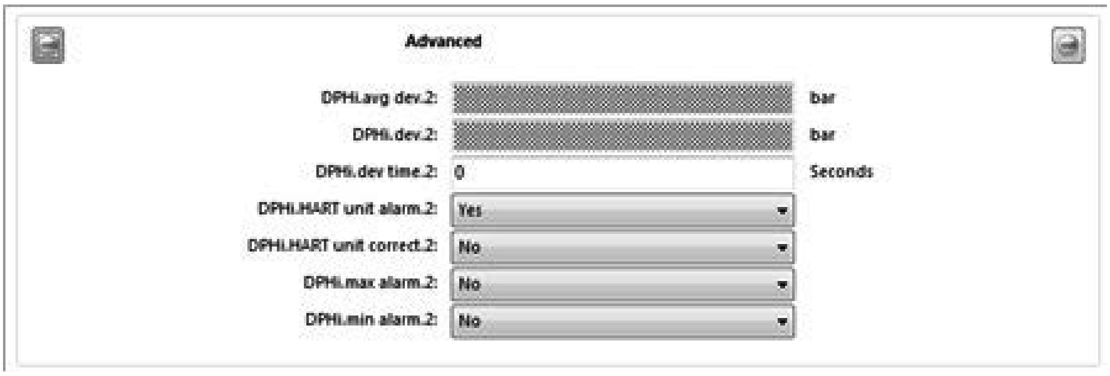


Figure 77 Define the differential pressure transmitter advanced settings

In case there is more than one transmitter in this range:

Average deviation	Deviation that one transmitter may have from the average of all transmitters in the range before an alarm is raised.
Deviation	The manimum deviation between the transmitters in the range before an alarm is raised.
Deviation time	The time during which the (previous) deviation exists before an alrm is raised.
When Hart transmitters are used, then a check on its units can be set	
HART unit alarm	Determines if an alarm should be raised when a DP HART transmitter reports another unit than defined for the transmitter
HART unit correct	Determines if the DP Hart units should be used instead of the configured units.

Determine what to do with the accountable alarms:

Maximum alarm	Raise an alarm when the transmitter range limits are exceeded or not
Minimum alarm	Raise an alarm when the transmitter range limits are exceeded or not

6.2.4 Coriolis

	Liquid	Gas	Steam

Please refer to chapter 3.4 for metering principles of Coriolis meters.

Four setup sections available to configure an Coriolis flowmeter:

Meter input	the meter connected and its basic settings
Pulse input	the preference for serial or pulse input and the pulse input setting if used

Meter correction	the correction for expansion of the meter body for pressure and temperature
Meter information	the identification of the meter

Most Coriolis meters have the option to send the flow data via a serial link and via pulses. In case pulses are used, then the API level has to be selected. For liquid the pulse input can either be API 5.5 level A or level B to E, for gas API 5.5 Level B to E only.

API 5.5 Level B to E	for single or dual pulse with the same of different frequencies and pulse monitoring.
API 5.5 Level A	for dual pulse with pulse correction.

See als chapter 3.1.

6.2.4.1 Meter Input

Define which meter type or manufacturer is applicable along with the associated parameters associated with the meter.

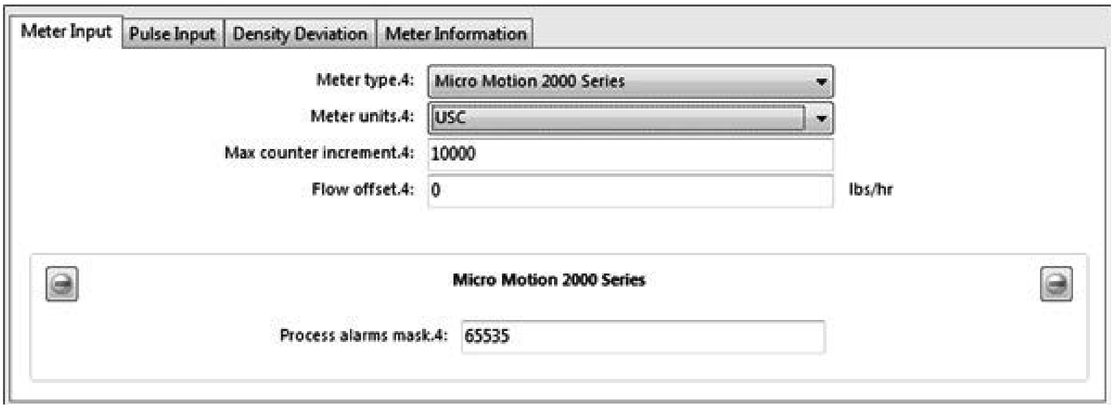


Figure 78 Example Coriolis meter input section

Meter type	The specific meter to be used can be selected from a list. As meters are generally designed for liquid, gas or stream, the list varies depending on the medium. Also there is the option to use an analog input for flow.
Meter units	The engineering units in which the meter is measuring flow.
Maximum Counter Increment	The maximum allowable increment for the flow data counter used for the calculated volume. Used when the meter communicates serially. This prevents a massive increment when, after a communication failure, the meter resumes normal communication.
Flow offset	This is used to simulate flow during testing when no meter is available. In theorie it could also be used to correct a fixed mis-match of the flow.
Meter specific data	For certain meters some parameters must be set. As these parameters are meter specific, please consult the meter manufacturer's operating instructions for further guidance. Parameters for the following meters are available: - KROHNE MFC010 (liquid) - Micro Motion 2000 Series (liquid) - Proline Promass 84 (gas)

6.2.4.2 Pulse Input API 5.5 level B to E

Define the preference for serial or pulse input and the pulse input setting for API 5.5 level B to E if used

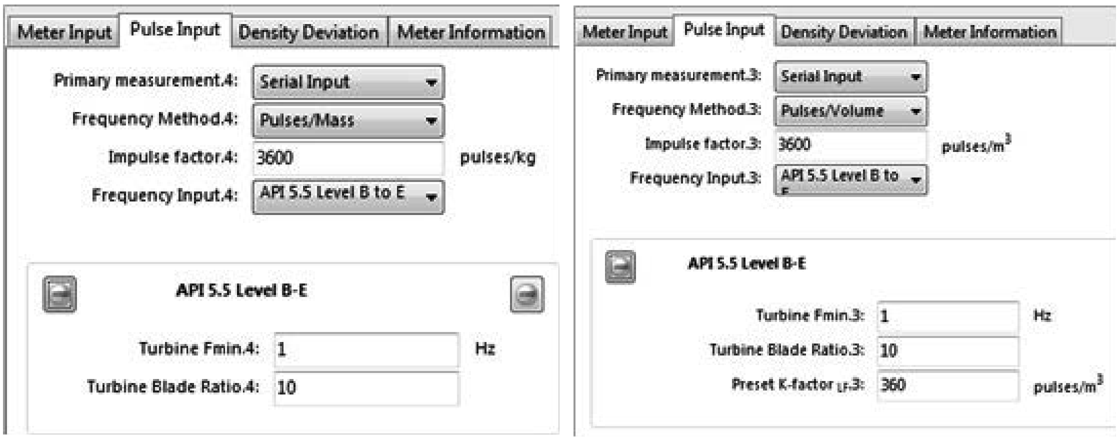


Figure 79 Coriolis pulse input section for liquid and gas API 5.5 Level B to E

Primary measurement	This option defines whether the serial link or the pulses will be used as a primary measurement. The other will be used when the primary fails. Off course only one of them can be used also: the other will not be connected..
Frequency method	Defines if the pulse corresponds with mass or volume. All Coriolis meters measure mass, they can also calculate the volume. Though less accurate, some users prefer this as their company standard
Impulse factor	The K-factor or impuls factor for the HF pulse. The total number of pulses corresponding to one unit of flow.
Frequency input	API 5.5 level B to E.
Turbine minimum frequency	Low cut-off frequency. This is frequency below which the flow will be considered 0.
Blade ratio	Ratio between the two frequency inputs. For one input set to 0. For two identical frequency inputs set to 1
Preset K Factor LF	The K-factor or impuls factor for the LF pulse. The total number of pulses corresponding to one unit of flow. (Gas only).

6.2.4.3 Pulse Input API 5.5 Level A

Define the preference for serial or pulse input and the pulse input setting for API 5.5 level A if used

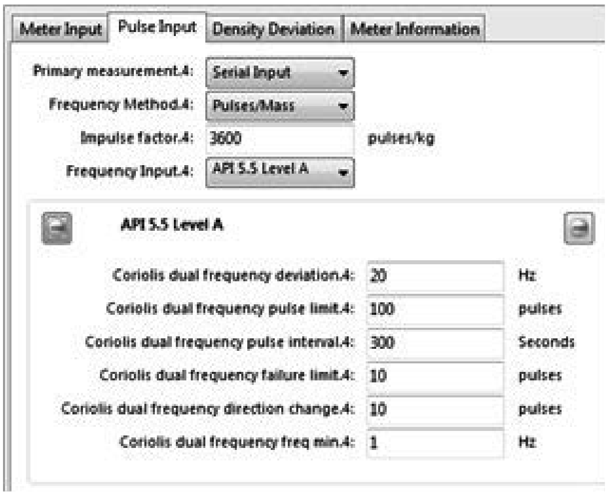


Figure 80 Coriolis pulse input section for API 5.5 level A

Primary measurement	This option defines whether the serial link or the pulses will be used as a primary measurement. The other will be used when the primary fails. Off course only one of them can be used also: the other will not be connected..
Frequency method	Defines if the pulse corresponds with mass or volume. Though all Coriolis meters measure mass, they can also calculate the volume. Though less accurate, some users prefer this as their company
Impulse factor	The K-factor or impulse factor for the HF pulse. The total number of pulses corresponding to one unit of flow.
Frequency input	API 5.5 level A.
Dual frequency deviation	The threshold value (+/-) for the deviation of the two frequencies above which an alarm is raised.
Dual frequency pulse limit	Used to monitor pulse fidelity to alarm an added or missing pulse caused by electrical transients and electronic failures. This monitoring function allows the user to reduce the flowmeter uncertainty factors.
Dual frequency pulse interval	The time between pulses sequences. This is the maximum allowable time for pulse limits before an alarm is activated.
Dual frequency failure limit	Lack of continual pulses before the meter is deemed failed and raises an alarm
Dual frequency direction change	Number of pulses allowed in opposite flow to determine the direction of the medium flowing in the meter.
Dual frequency min. frequency	Low cut-off frequency. This is frequency below which the flow will be considered 0.

6.2.4.4 Density deviation

The Coriolis meter can measure density. Often however, other density sources will be used to optimise the accuracy. The meter density is then an excellent way to verify the measured density. In the SUMMIT, this is done in the density deviation section. Here the difference between meter and measured/calculated densities set an accountable or non-accountable alarm if it exceeds a preset percentage and/or a given period of time.

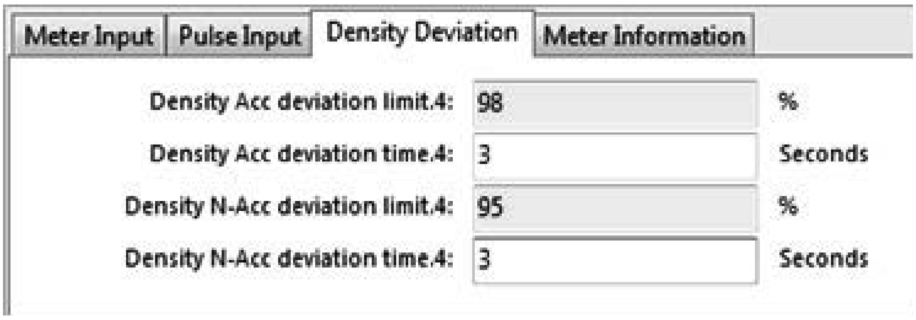


Figure 81 Coriolis density deviation

Density accountable deviation limit	Deviation in % to generate an alarm
Density accountable deviation time	The minimum period during which the deviation must exist to generate the alarm
Density non-accountable deviation limit	Deviation in % to generate an alarm
Density non-accountable deviation time	The minimum period during which the deviation must exist to generate the alarm

6.2.4.5 Meter information

For each meter, information to identify the meter can be entered. This can be useful as identifier text on the screen or to send to a supervisory system in a system.

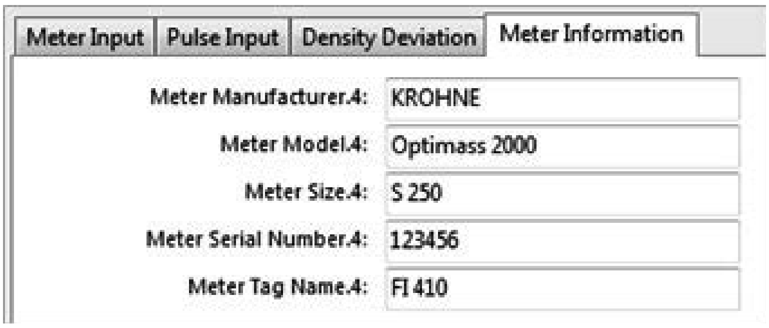
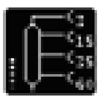


Figure 82 Define meter information

6.3 Product information

	Liquid	~~Gas~~	~~Steam~~

Product info can be found under the tab "General" and only applies to liquid.

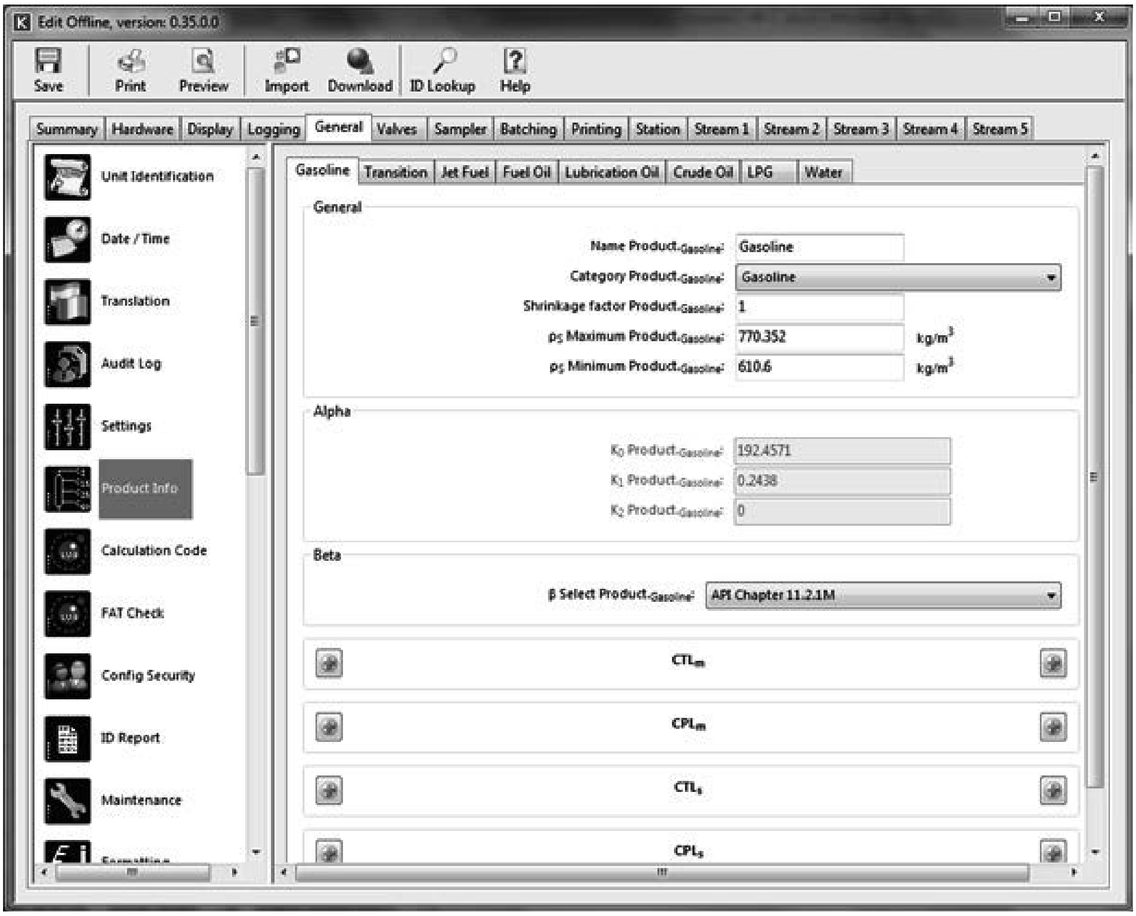


Figure 83 Product information

Up to 8 products can be defined, each with their own corrections. This may be done with one of the categories in the API MPMS, but can also be based on a custom setting.
Parameters such as the product shrinkage factor, category, temperature and pressure correction factors and density limits can be configured.

In each stream one of these products may be chosen. This can be done during configuration but may be changed at runtime via the display.

Name	A user defined name for the product. Any name may be choosen, but please make sure it matches the category.
Category	A selection from one of the categories in the API MMS can be made or Custom may be choosen.
Shrinkage factor	The shrinkage factor corrects the meter flow at operational conditions as per API bulletin 2509C. The default value is 1 or no shrinkage.
ρs maximum	The maximum standard density limit above which an alarm will be generated. This density is closely related to the product category so they normally should not be changed.
ρs minimum	The minimum standard density limit above which an alarm will be generated. This density is closely related to the product category so they normally should not be changed.
Alpha	The coefficient of thermal expansion, alpha, depends directly on the density of the product selected. Therefore the K0, K1 and K2 factors may only be changed when the category “custom” is selected.

Beta	The compressibility factor can be selected from the API 11.2.1M or 11.2.2M standard.
CTLm	Correction for temperature for the liquid at the meter. For selections, see below.
CPLm	Correction for pressure for the liquid at the meter. For selections, see below.
CTLs	Calculation of the liquid temperature at the density measurement point (CTLρ). For selections, see below.
CPLs	Calculation of the liquid pressure at the density measurement point (CTPρ). For selections, see below.

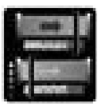
Correction factors for temperature may be selected from the following standards (Eqn CTLm and CTLs):

Keypad	
ASTM D1250 IP200 Table 54	Eqn 72 and 34
API Chp 12.2.5.3 Table 54A	Eqn 70 and 32
GPA TP-25	Eqn 80 and 40
GPA TP-27 API Ch11.2.4 Table 23E/24E Tb 60°F See Standard	
GPA TP-27 API Ch11.2.4 Table 53E/54E Tb 15°C See Standard	
GPA TP-27 API Ch11.2.4 Table 59E/60E Tb 20°C See Standard	

Correction factors for pressure may be selected from the following standards (Eqn CPLm and CPLs):

Keypad	
API Chp 12.2.5.3 Table 54A	Eqn 71 and 33

6.4 Flow rates and totals

	Liquid	Gas	Steam

This chapter describes the parameters related to flow rate:
- Its range and alarm limits
- Its display and print scaling factors
- The meter correction factors

As there are differences between oil, gas and steam corrections, we created two separate paragraphs for this.

6.4.1 Flow rate limits & scaling

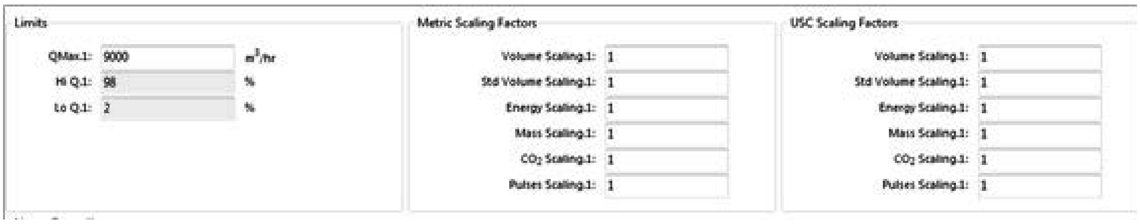


Figure 84 Flow rate limits & scaling

For the limits the following parameters are available:

Qmax	The maximum flow is for which the meter has been designed.
Hi Q	The maximum limit (in % of Qmax) above which an alarm must be generated
Lo Q	The minimum limit (in % of Qmax) below which an alarm must be generated

The scaling factors are used when displaying the flow on the SUMMIT screen. They are typically meant to be able to display a volume flow as Mm3 instead of m3 or as MMft3 instead of ft3, as the flow displayed is devided by the factor. Typical values are 1, 1000 and 1000000.
Separate factors are available for Metric and USC units.

The actual flow scaling factors available depend on the metering type at hand. A typical one would be:

USC volume setting	The scaling used when the volume is displayed in USC units on the SUMMIT screen

6.4.2 Liquid flow rate correction

Unlike gas and steam, meters for liquids are used for a wide variety of products. The product transported may also change during operation. Because the meter correction depends on the type of product a more elaborate correction scheme is available. Two correction methods are both performed in the SUMMIT 8800:

Meter factor	A correction per type of product
K-factor	A correction for the meter. A selection for a single point or multiple points can be selected. Single point will be used when the meter is considered to be linear and will often be used as the factor provided by the manufacturer. Multiple points will be used when the meter is calibrated or proved.

The meter factor and the K-factor may be changed by proving. See meter correctons for mor details.

6.4.2.1 Meter factor

For Liquid Meter correction an individual Meter Factor can be entered for up to 8 different liquid products. The default value is 1 (no correction)..

The factor will be determined during proving to correct a fluid flowmeter for the ambient conditions by shifting its curve. Normally, the meter factor should be close to 1.

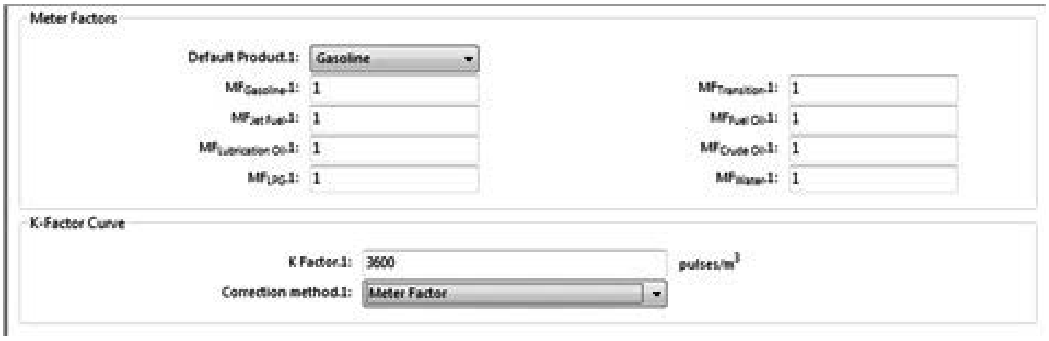
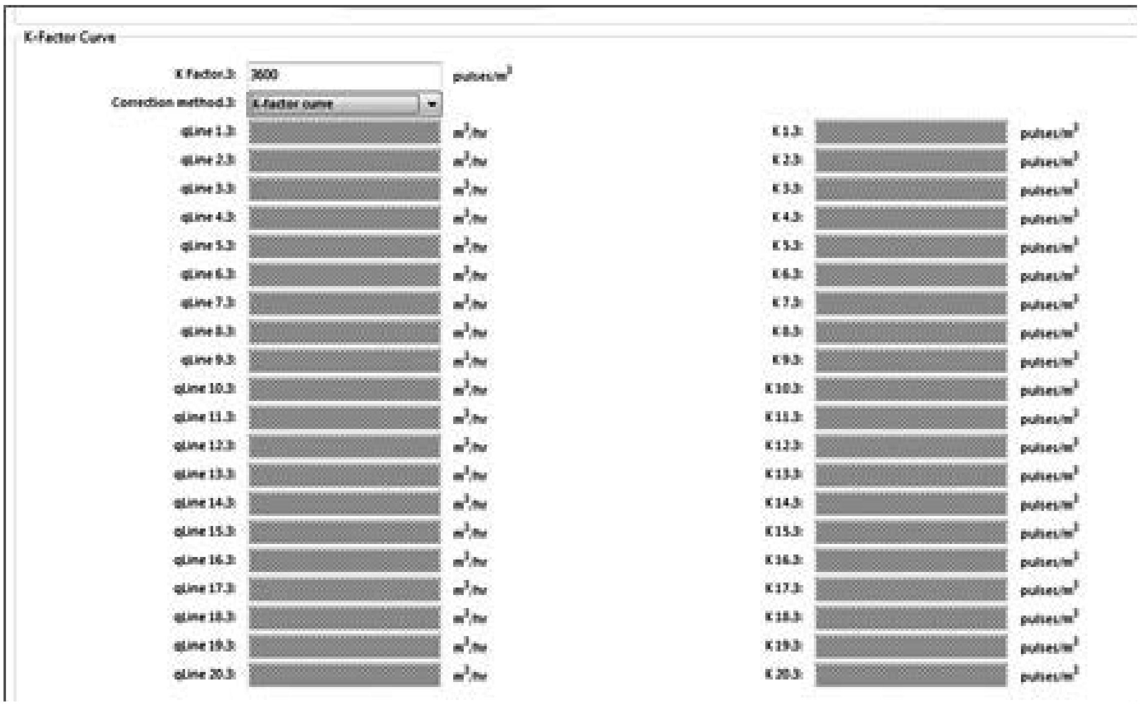


Figure 85 Liquid Meter and K-factor

6.4.2.2 K-factor

There are two choises for a K-factor: single point or K-factor curve. In case of a single K-factor, fill in the amount of pulses per volume (e.g. pulses/m3 or pulses/gallons) and leave the correction method on “meter factor”

In case of a K-factor curve, change the correction method to “K-factor curve”. The single K-factor will now not be used anymore and the page will change as follows:



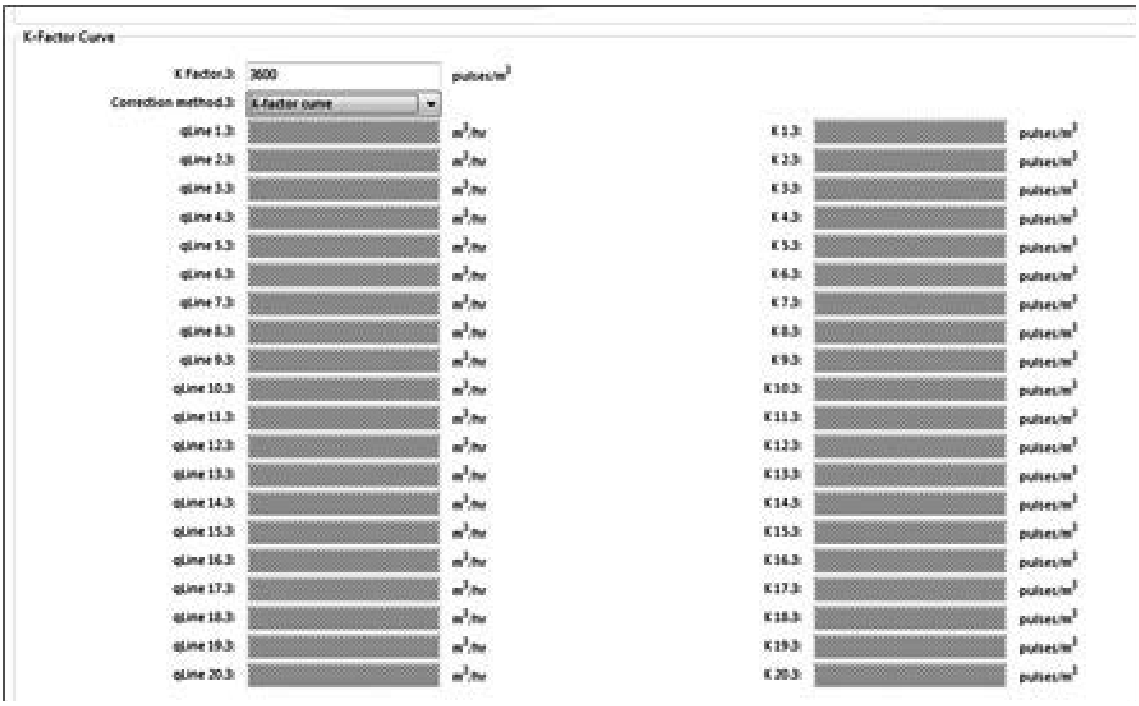


Figure 86 Liquid K-factor Curve

Up to 20 flow rates with a corresponding K factor can be entered. When less are needed, leave the others blank. Always start with the lowest flow rate and make sure the rest is entered in ascending order.

The factors obtained during calibration/proving of a meter which are the corrections needed to linearise the meter. This is expressed by a variation of the K-factor over the specified flow range. So for each flow rate a different K-factor is used. In between the given flow rates a linear interpolation is used. For flow above maximum extrapolation is used.

6.4.3 Gas and steam flow rate correction

For more details see section: Meter Corrections

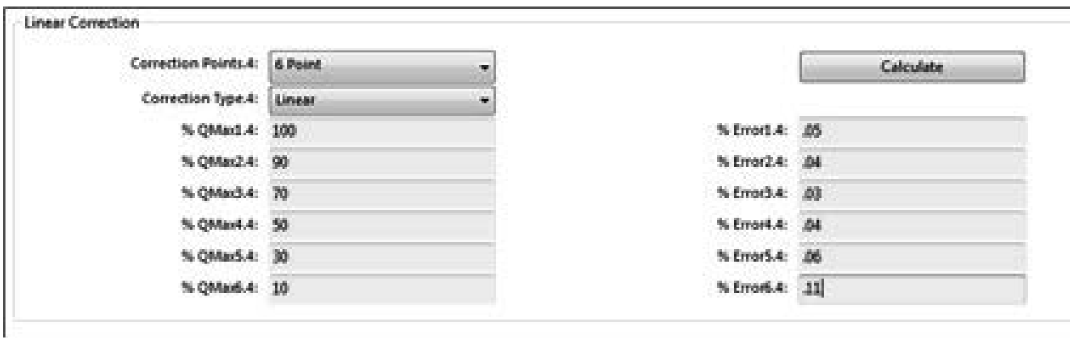


Figure 87 Gas or steam flow rate correction for a 6 point calibration

Meters may be calibrated on different flow rates to determine the deviation from a standard. The result is an error curve. For meter correction this curve can be entered as a table of data points of flow rate and corresponding error.

Correction points	The size of the table can be selected from 2 to 30 points or as none: no correction.
Correction type	Linear, where the correction is applied through the operating range by linear interpolation between the two nearest data points and linear extrapolation for low and high flow. MID, where the correction is limited under Low and high flow conditions as required by the MID approval. There is no extrapolation done for these conditions.
%Qmax-%Error	A data set of a flow rate (as a percentage of Qmax) and the associated error (%). The Qmax refers to the meter at hand not the reference meter. Always start with the lowest flow rate and each following must be higher than the previous. %Qmax is in % of maximum flow (Q max.) of the meter and can range from – Qmax to + Qmax to allow for different linearity in both flow direction %Er.rd is the % error of reading. If the output from the meter is less than the actual flow through the meter then the error is entered as a negative value.
Calculate	A calculation button allows the user to simply check the correction that would be applied at any flow rate entered. In case the flow for the reference meter is given, the Qmax for the meter at hand can be calculated and v.v.:

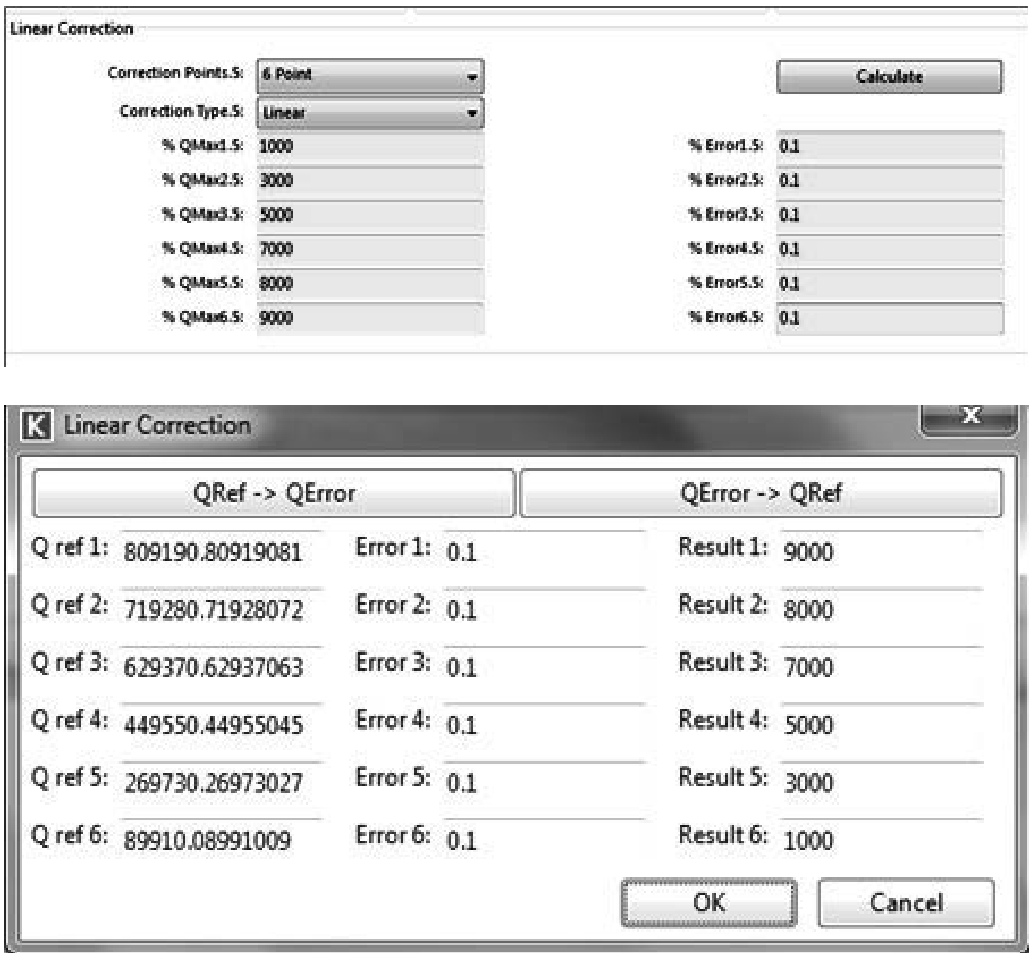


Figure 88 Gas or steam flow rate calculations

Linear correction is only applied if the meter produces at least 10 pulses per second at Qmin.

6.5 Tariff

	Liquid	Gas	Steam

Customers must often pay a different tariff depending on the flow rate. For instance a standard tariff will be charged up to a certain level, above that twice as much has to be paid until a second level after which 10 times as much must be paid. This is done by sellers to limit the total flow through a pipeline and therefore being able to use a smaller sided pipe than needed otherwise. A customer likes to have a clear overview of the totals within each regime and have an indication when a level is exceeded to be able to shut down parts of his plant..

The tariff option is designed for this and has a maximum of 4 levels.

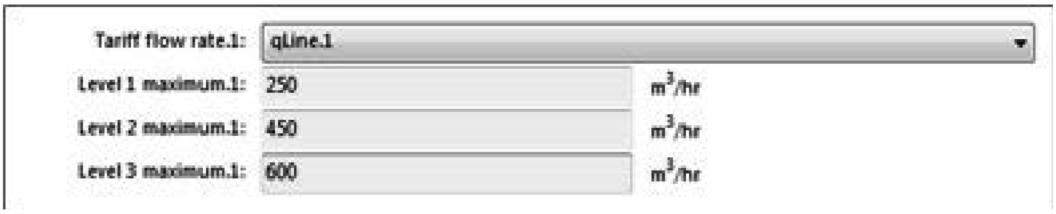


Figure 89 Tariff selection

The first option is to select what parameter which flow rate is used for the tariff. Mostly this will be volume, but it might also be mass, energy of CO2. The tariff system will always be based on hourly flow rate, but will react immediately.
Then for the first 3 levels their maximum flow can be set.

The tariff counters and increments will now be used depending of the tariff band it is in:

- Level 1 will always be counting but is limited to the Level 1 Max Value
- Level 2 will start counting the additional flow when the flow rate is above Level 1 Max Value with a maximum of Level 2 max minus Level 1 max.
- Level 3 will start counting the additional flow when the flow rate is above Level 2 Max Value with a maximum of Level 3 max minus Level 2 max.
- Level 4 will start counting the additional flow when the flow rate is above Level 3 Max Value.

The hardware pulse outputs can be configured to for the 4 level tariff flow rates:

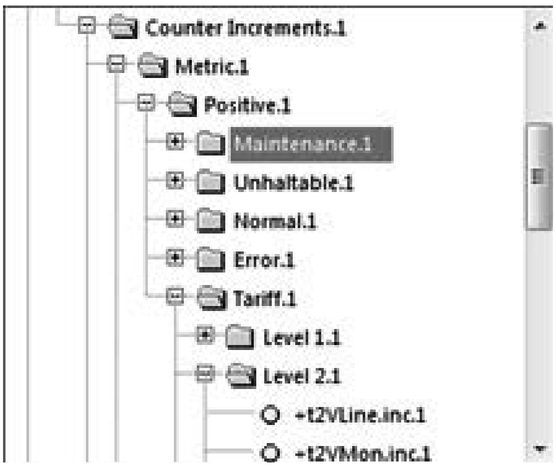
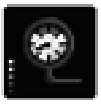


Figure 90 Tariff flow rate output

Also the tariff flow totals for all of the 4 levels of volume, mass, energy and CO2 are available for output to e.g. the printer and the display.

6.6 Pressure

	Liquid	Gas	Steam

For most corrections, the pressure of the fluid is needed. The SUMMIT has elaborate selection for multiple pressure sensors and includes error handling when one or more of these sensors has a problem.

Zero to three pressure sensors can be connected for each stream, with the option to use the average of these values. It is also possible to use the pressure send via a serial (modbus) link, e.g. from a SCADA system. In certain applications, there could be no pressure input for the streams, but only an input for the station. In that case the station pressure could be used by the streams.

This section defines the selection process to arrive to an "in use" value for the pressure. There are 6 selections in order of priority with each 7 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be chosen. If not, then the second selection will be checked etc. The last selection is always the keypad value as defined earlier, even if all other choices are none.

The 7 choices provided for the pressure selection are:

None	No functionality or transmitter selected, the option will be skipped.
Keypad	The user defined value for this range will be chosen.
Sensor 1-3	The transmitter value, as configure in hardware, will be used.
Average	Average value of all transmitters (selected in DP sensor) will be used.
Serial	Value as sent by Modbus e.g. from a PLC, or smart transmitter will be used.
Last good value	The last good value known before loss of signal will be used.
Station	A pressure as defined under the station/pressure tab

A selection could look like:

Figure 91 Stream pressure selection

Sensors	The number of sensors connected to the SUMMIT
Keypad	The default value which can be used in the selected
Max, Min	The alarm limits for the pressure. If only one of the two must be used, see advanced.
Hi, Lo	The warning limits for the pressure. If only one of the two must be used, see advanced.
Select	The 6 choices for selection of the pressure source

6.6.1 Sensor calibration constants

The calibration range and offset are the scaling factors for the transmitter, determined during the calibration of the transmitter. As this is a multiplier to the normal transmitter range and offset, this is not a mandatory setting, but a software calibration. This is used to correct the transmitter value without actually calibrating the transmitter itself. The advantage is that the changes will appear in the audit log.

This setting is also ideal for simulation purposes. With it, the transmitter can be set to any value without an actual transmitter connected.

Figure 92 Stream pressure calibration constants

Range	Default value is 1. This is a multiplier to the actual transmitter range.
Offset	Default value is 0. This is an offset to the actual transmitter range.

6.6.2 Advanced

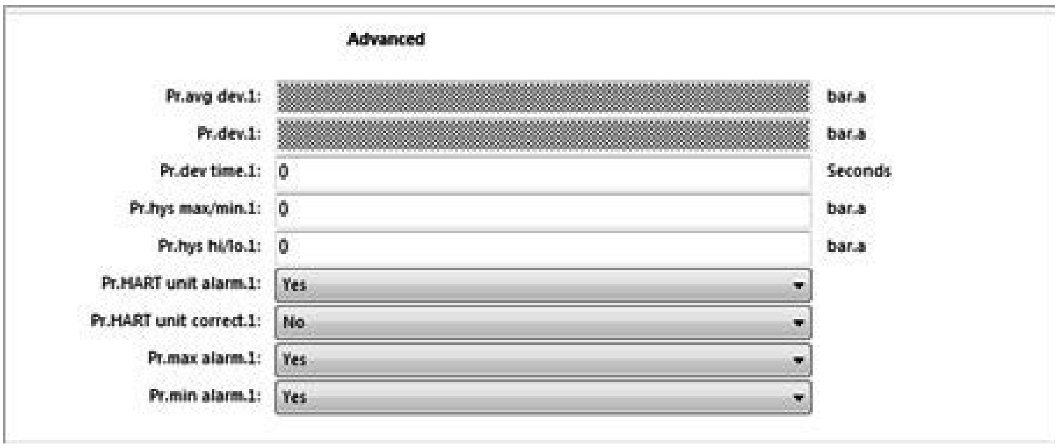
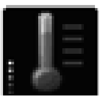


Figure 93 Stream pressure advanced options

Optional parameters in case there is more than one transmitter in this range:

Average deviation	Deviation that one transmitter may have from the average of all transmitters before an alarm is raised.
Deviation	The manimum deviation between the transmitters before an alarm is raised.
Deviation time	The time during which the (previous) deviation exists before an alrm is raised.
Hysteresis for alarms and warnings to prevent continuous switching:	
Hysteresis max/min	The value which must be exceeded to switch an alarm on or off.
Hysteresis hi/lo	The value which must be exceeded to switch an warning on or off.
When Hart transmitters are used, then a check on its units can be set	
HART unit alarm	Determines if an alarm should be raised when a pressure HART transmitter reports another unit than defined for the transmitter
HART unit correct	Determines if the pressure Hart units should be used instead of the configured units.
Determine what to do with the accountable alarms:	
Maximum alarm	Raise an alarm when the transmitter range limits are exceeded or not. Default: Yes.
Minimum alarm	Raise an alarm when the transmitter range limits are exceeded or not. Default: Yes.

6.7 Temperature

	Liquid	Gas	Steam

For most corrections, the temperature of the fluid is needed. The SUMMIT has elaborate selection for multiple temperature sensors and includes error handling when one or more of these sensors has a problem.

Zero to three temperature sensors can be connected for each stream, with the option to use the average of these values. It is also possible to use the temperature send via a serial (modbus) link, e.g. from a SCADA system. In certain applications, there could be no temperature input for the streams, but only an input for the station. In that case the station temperature could be used by the streams.

This section defines the selection process to arrive to an “in use” value for the temperature. There are 6 selections in order of priority with each 7 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be choosen. If not, then the second selection will be checked etc. The last selection is always the keypad value as defined earlier, even if all other choices are none.

The 7 choices provided for the temperature selection are:

None	No functionality or transmitter selected, the option will be skipped.
Keypad	The user defined value for this range will be chosen.
Sensor 1-3	The transmitter value, as configure in hardware, will be used.
Average	Average value of all transmitters (selected in DP sensor) will be used.
Serial	Value as sent by Modbus e.g. from a PLC, or smart transmitter will be used.
Last good value	The last good value known before loss of signal will be used.
Station	A temperature as defined under the station/temperature tab

A selection could look like:

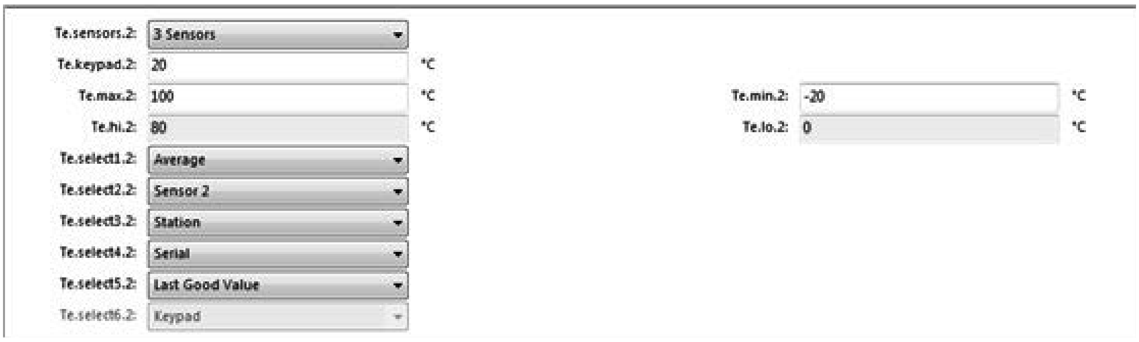


Figure 94 Stream temperature selection

Sensors	The number of sensors connected to the SUMMIT
Keypad	The default value which can be used in the selected
Max, Min	The alarm limits for the temperature. If only one of the two must be used, see advanced.
Hi, Lo	The warning limits for the temperature. If only one of the two must be used, see advanced.
Select	The 6 choices for selection of the temperature source

6.7.1 Sensor calibration constants

The calibration range and offset are the scaling factors for the transmitter, determined during the calibration of the transmitter. As this is a multiplier to the normal transmitter range and offset, this is not a mandatory setting, but a software calibration. This is used to correct the transmitter value without actually calibrating the transmitter itself. The advantage is that the changes will appear in the audit log.

This setting is also ideal for simulation purposes. With it, the transmitter can be set to any value without an actual transmitter connected.

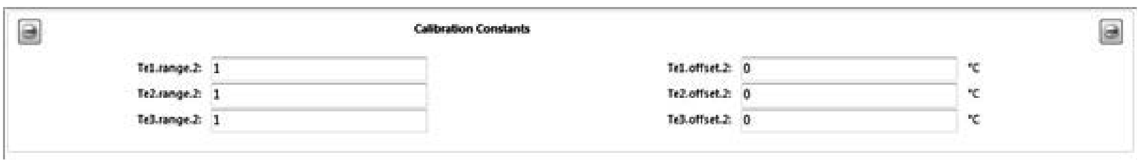


Figure 95 Stream temperature calibration constants

Range	Default value is 1. This is a multiplier to the actual transmitter range.
Offset	Default value is 0. This is an offset to the actual transmitter range.

6.7.2 Advanced

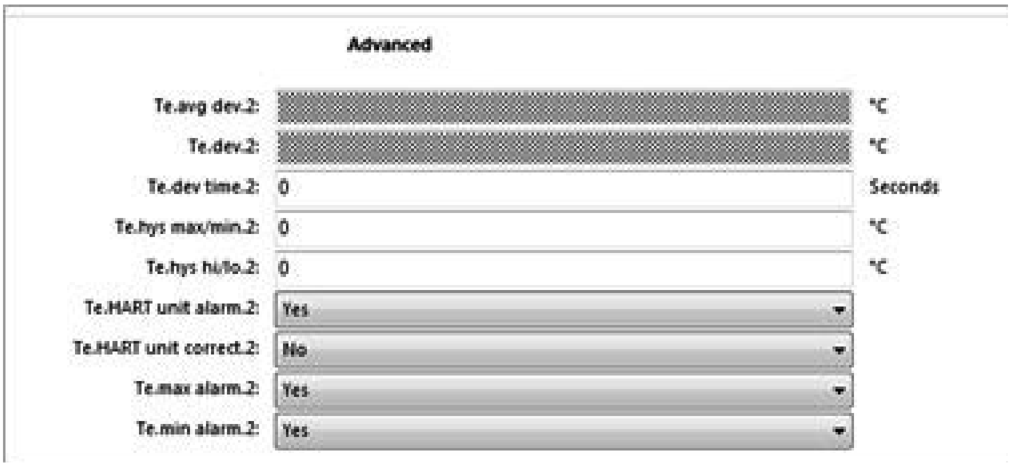
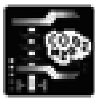


Figure 96 Stream temperature advanced options

Optional parameters in case there is more than one transmitter in this range:

Average deviation	Deviation that one transmitter may have from the average of all transmitters before an alarm is raised.
Deviation	The minimum deviation between the transmitters before an alarm is raised.
Deviation time	The time during which the (previous) deviation exists before an alarm is raised.
Hysteresis for alarms and warnings to prevent continuous switching:	
Hysteresis max/min	The value which must be exceeded to switch an alarm on or off.
Hysteresis hi/lo	The value which must be exceeded to switch an warning on or off.
When Hart transmitters are used, then a check on its units can be set	
HART unit alarm	Determines if an alarm should be raised when a temperature HART transmitter reports another unit than defined for the transmitter
HART unit correct	Determines if the temperature Hart units should be used instead of the configured units.
Determine what to do with the accountable alarms:	
Maximum alarm	Raise an alarm when the transmitter range limits are exceeded or not. Default: Yes.
Minimum alarm	Raise an alarm when the transmitter range limits are exceeded or not. Default: Yes.

6.8 Line density

	Liquid	~~Gas~~	~~Steam~~
	~~Liquid~~	Gas	~~Steam~~
	~~Liquid~~	~~Gas~~	Steam

For most corrections, the line density of the fluid is needed. The SUMMIT can an elaborate selection for the density source and includes error handling when one or more of these sources has a problem.

For liquid and gas, up to three density sensors can be connected for each stream: two Emerson/ Solartron or Sarasota pulse inputs and one (measured) analog or Hart input. For steam one sensor via analog or Hart input can be used.
It is also possible to use the density send via a serial (modbus) link, e.g. from a SCADA system. Furthermore a density table or a calculation can be used.

This section defines the selection process to arrive to an "in use" value for the density. There are 4 (6 for gas) selections in order of priority with each 7 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be choosen. If not, then the second selection will be checked etc. The last selection is always the keypad value as defined later, even if all other choices are none.

The 7 choices provided for the density selection are:

None	No functionality or transmitter selected, the option will be skipped.
Keypad	The user defined value for this range will be choosen.
Solartron & Sarasota 1/2	The transmitter value, as configure in the hardware pulse input, will be used.
Measured/ Sensor	The transmitters value as defined in the Hart or mA input, will be used.
Serial or modbus	A value from Modbus e.g. a meter, a PLC or smart transmitter will be used.
Table	A density table with varying pressure and temperature will be used
Calculated	A calculation (for LPG, LNG and gasses only). For steam this is IAPWS IF97.
Estimate (steam only)	An estimation based on the pressure and temperature.

A selection could look like:

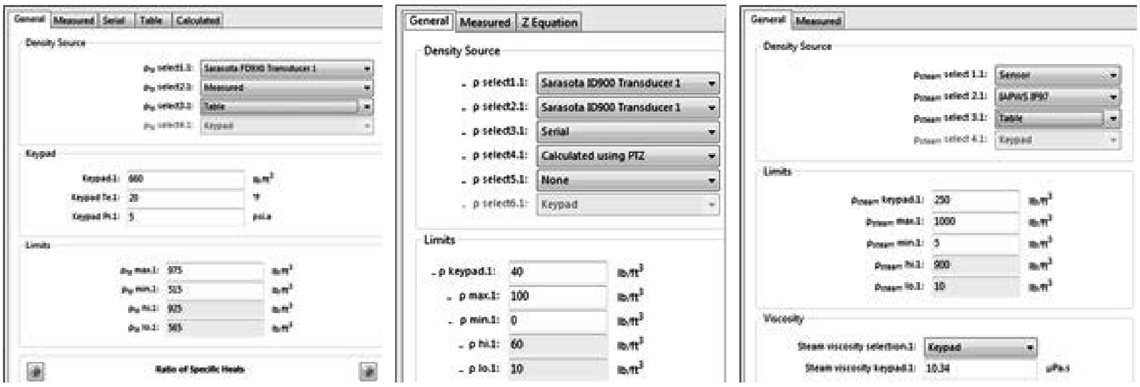


Figure 97 Stream Liquid, gas and steam line density selection

Keypad	The default value as used in the selection. This value may be changed by an operator. The keypad value is for line density, for liquids also for the temperature and density.
Limits	The alarm limits (max and min) and warning limits (hi and lo) for the line density.

6.8.1 Ratio of specific heats (liquid and gas)

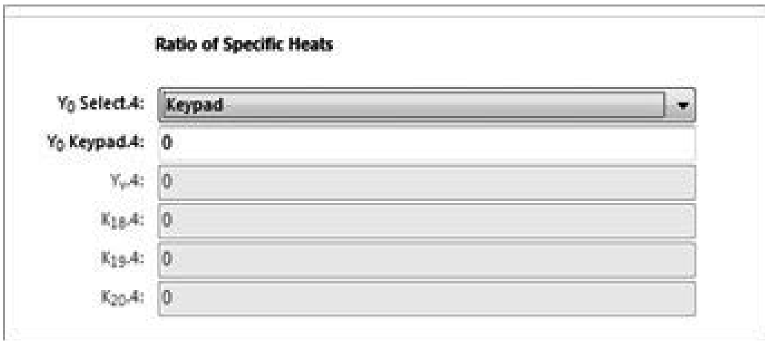


Figure 98 Stream ratio of specific heats

Optionally, the ratio of specific heat can be given as a keypad value or calculated using Method 1. In the following parameters must be specified:

Yv	Ratio of specific heat reference value
K18, K19, K20	Ratio of specific heat constants

Under the viscosity tab the source of viscosity is entered as either keypad or IAPWS IF97 together with the actual keypad value if required.

6.8.2 Viscosity (steam):

Three options are available for viscosity:

Keypad	The user defined value for this range will be choosen as given.
IAPWS IF97	The viscosity will be calculated to IAPWS IF97
Estimation	Estimation based on temperature and constants to be entered
	Viscosity= Visc1+ Visc2*t + Visc3* t2

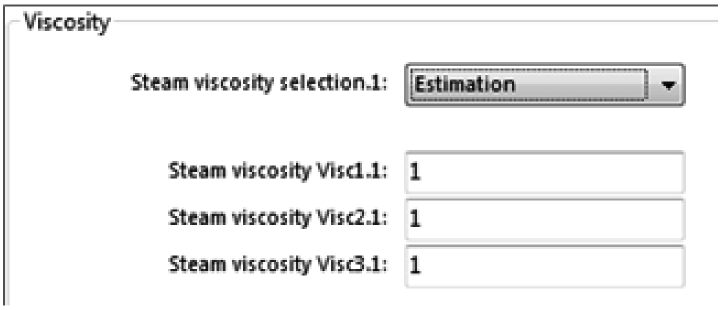


Figure 99 Viscosity

6.8.3 Solartron/Sarasota transmitter

For each Solartron/Sarasota transmitter selected, an additional icon "ρtp sensor" will appear in the left hand list:

	Liquid	Gas	Steam
	Liquid	Gas	Steam

The user will be required to enter the transducers calibration constants:

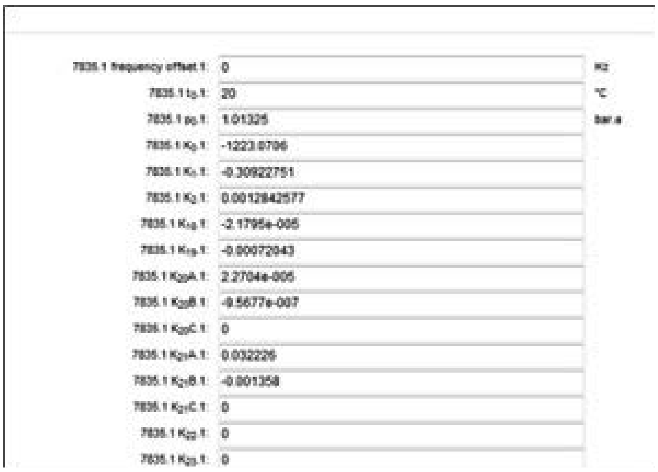


Figure 100 Density transducer parameters

For details on these parameters, please refer to the transducer calibration and instruction manual.

The pressure and temperature at the density point must be also specified. Their selection is almost identical to the stream pressure and temperature selection. Please note that in this case only 2 pressure and temperature sensors are possible but that also the pressure and temperature at the meter can be used.

6.8.4 TAB measured

If measured or sensor is selected, in the TAB "measured" will be asked what to do with the Hart units:

- Should an alarm given if there is a difference between the units specified and the units given via Hart?
- If there is a difference should the units given via Hart replace the specified units?

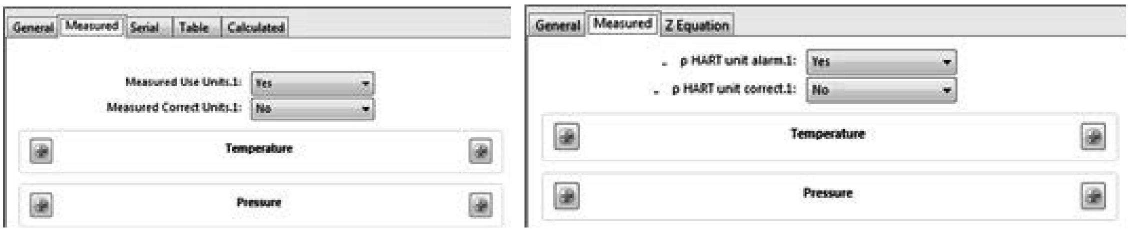


Figure 101 Liquid and gas measurement selection

Also the pressure and temperature at the density point must be specified. Their selection is almost identical to the stream pressure and temperature selection

6.8.5 TAB serial (liquid only)

If selected, the pressure and temperature at the density point must be specified in the TAB "measured"and/or "serial"; this is not needed for gas or steam.

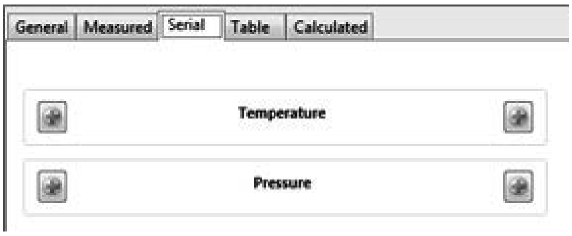
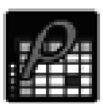
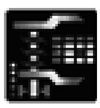


Figure 102 Liquid serial selection

Their selection is almost identical to the stream pressure and temperature selection. Please note that in this case only 2 pressure and temperature sensors are possible but that also the pressure and temperature at the meter can be used.

6.8.6 Line density table (includes TAB when liquid)

An additional icon for the line density table will appear in the left hand list:

	Liquid	~~Gas~~	Steam
	~~Liquid~~	Gas	~~Steam~~

This page is used to define the line density as a table of up to 10 pressures and 10 temperatures:

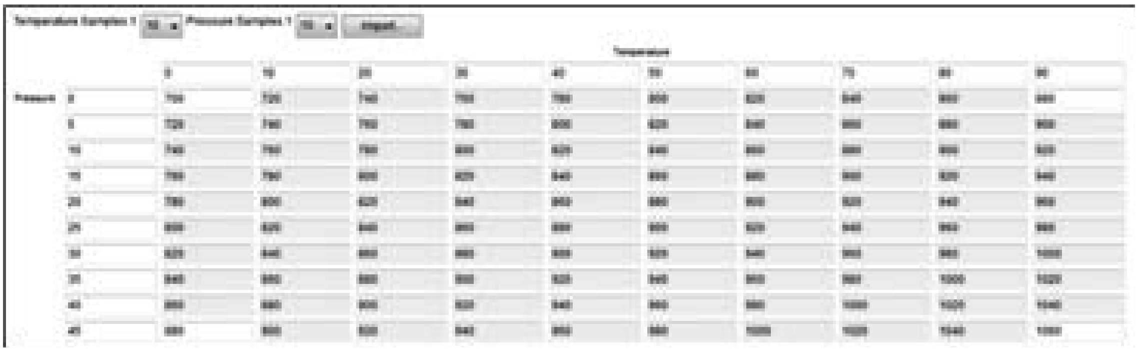


Figure 103 Line density table

The contents of the table can be imported from another configuration by clicking on the button “Import” and selecting the other configuration.

6.8.7 TAB calculated (liquid only)

If selected, the pressure and temperature at the density point must be specified in the TAB “calculated”. The SUMMIT 8800 uses the Klosek-McKinley equation to calculate density for LPG or LNG.

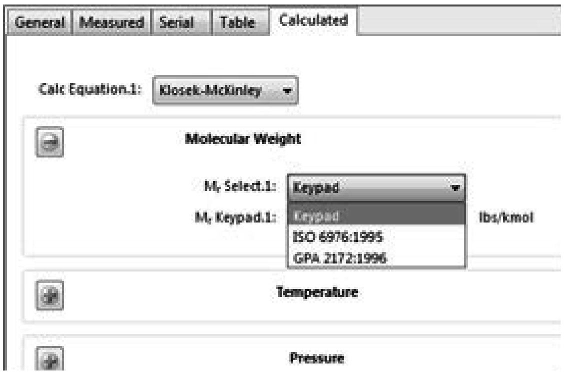


Figure 104 Liquid line density calculation method

This section requires the user to enter the molecular weight source. Three options are available:

Keypad	A fixed value to be entered
ISO 6976:1995	Using the ISO formula
GPA 2172:1996	Using the GPA formula

Furthermore the pressure and temperature at the density point must be specified. Their selection is almost identical to the stream pressure and temperature selection. Please note that in this case only 2 pressure and temperature sensors are possible but that also the pressure and temperature at the meter can be used.

6.8.8 TAB Z-equation (gas only)

If “calculated using AGA8 or PTZ” was selected, the equation for Z-factor compressibility used must be specified in the TAB “Z-equation”:

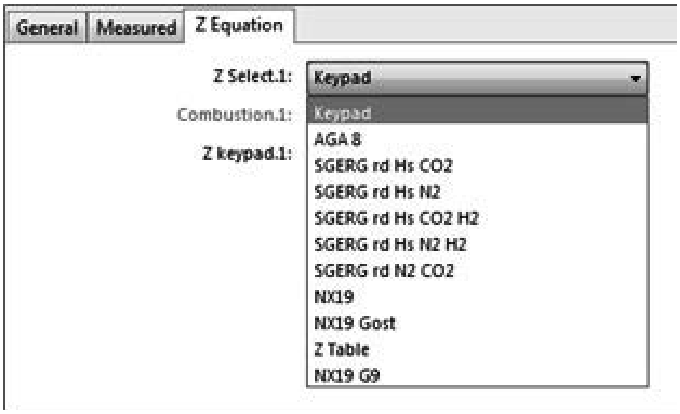


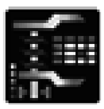
Figure 105 Gas Line density Z-equation method

The following formula's for compressibility can be selected:

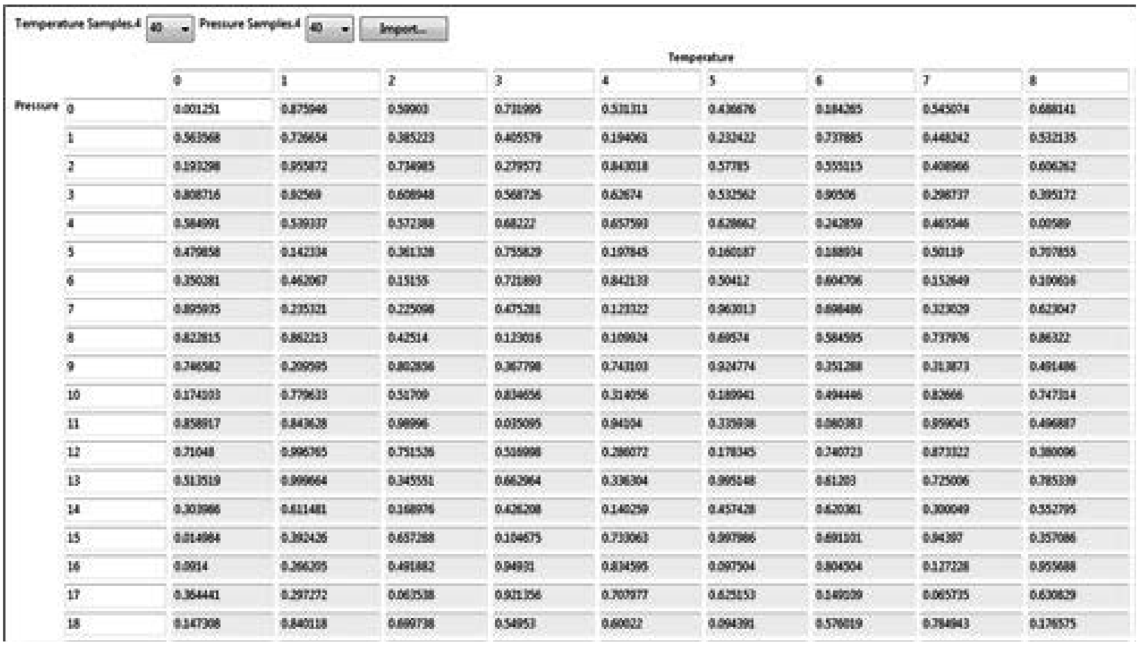
Keypad	A fixed user defined value to be entered
AGA8	Using the AGA8 calculation based on the gas data available
SGERG	Using the SGERG calculation based on relative density and combinations of gas data: rd-Hs-CO2 / rd-Hs-N2 / rd-Hs-CO2-H2 / rd-Hs-N2-H2 / rs-N2-CO2 Also the combustion temperature must be given.
NX19	Using the NX19 calculation based on the gas data available. 3 Versions are available: Standard / Gost / G9
Z Table	A table will appear to enter the compressibility against pressure and temperature.

6.8.8.1 Z-table

If a Z-table is selected for compressibility (under line density/ Z equation tab), an additional icon "Z-table" will appear in the left hand list:

	Liquid	Gas	Steam

This page is used to define the compressibility as a table of up to 50 pressures and 50 temperatures:



Temperature Samples.4: 40 Pressure Samples.4: 40 Import...

Pressure \ Temperature	0	1	2	3	4	5	6	7	8
0	0.001251	0.875946	0.59003	0.731995	0.531313	0.436676	0.184265	0.545074	0.688141
1	0.563568	0.726654	0.385223	0.405579	0.194061	0.232422	0.737885	0.448242	0.532135
2	0.193298	0.955872	0.734985	0.279572	0.843018	0.57785	0.555115	0.408966	0.606262
3	0.808716	0.82569	0.608948	0.568726	0.62674	0.532562	0.90506	0.298737	0.395172
4	0.584991	0.539337	0.572388	0.68222	0.657593	0.628662	0.242859	0.465546	0.00589
5	0.479858	0.142334	0.361328	0.755829	0.197845	0.160187	0.188934	0.50119	0.707855
6	0.350281	0.462067	0.15155	0.721893	0.842133	0.50412	0.604706	0.152649	0.100616
7	0.895935	0.235321	0.225098	0.475281	0.123322	0.963013	0.698486	0.323029	0.623047
8	0.822815	0.862213	0.42514	0.123016	0.109924	0.69574	0.584595	0.737976	0.86322
9	0.746582	0.209595	0.802856	0.367798	0.743103	0.924774	0.351288	0.313873	0.491486
10	0.174103	0.779633	0.51709	0.834656	0.314056	0.189941	0.494446	0.82666	0.747314
11	0.858917	0.843628	0.98996	0.035095	0.94104	0.335938	0.060383	0.859045	0.496887
12	0.71048	0.996765	0.751526	0.516998	0.286072	0.178345	0.740723	0.873322	0.380096
13	0.513519	0.999664	0.345551	0.662964	0.336304	0.995148	0.61203	0.725006	0.785339
14	0.303986	0.611481	0.168976	0.426208	0.140259	0.457428	0.620361	0.300049	0.552795
15	0.014984	0.392426	0.657288	0.104675	0.733063	0.997986	0.691101	0.94397	0.357086
16	0.0914	0.266205	0.491882	0.94931	0.834595	0.097504	0.804504	0.127228	0.955688
17	0.364441	0.297272	0.063538	0.921356	0.707977	0.625153	0.149109	0.065735	0.630829
18	0.147308	0.840118	0.699738	0.54953	0.60022	0.094391	0.576019	0.784943	0.176575

Figure 106 Z-table

The contents of the table can be imported from another configuration by clicking on the button "Import" and selecting the other configuration.

6.9 Liquid line density at the metering conditions

	Liquid	~~Gas~~	~~Steam~~

Typically the line density will be measured and from this the meter density will be calculated. This will be done in two steps: from line to base density and from base to meter density, both correcting for pressure and temperature.

For the calculation of the line density at metering conditions, there are three options for both pressure and temperature correction:

Keypad	The user defined value for this range will be choosen as given.
Norsok I-105 rev2	The Norsok calculation will be used
API chapter 12.2.5.1&2	The API calculation will be used

In case of keypad the user defined value has to be filled-in:

or

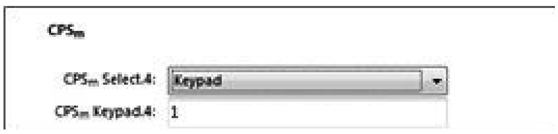
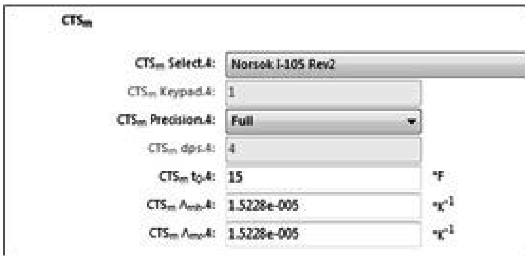


Figure 107 Meter line density, keypad

All other parameter are not needed and will be greyed-out

In case the Norsok or API formula will be used:



or

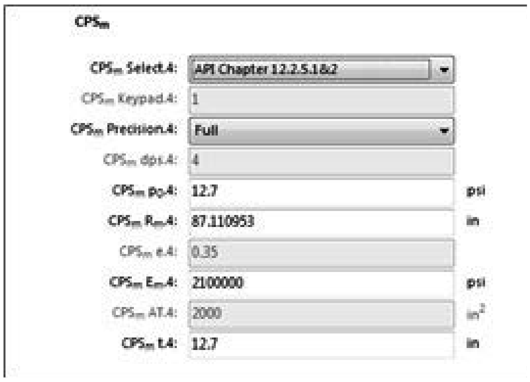
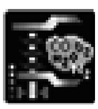


Figure 108 Meter line density, calculated

Precision	Full/ Rounded or truncated
dps	Precision decimal places
Only the parameters not greyed-out have to be filled for CTSm:	
t0	Meter reference temperature
λmh	Linear expansion coefficient of the meter housing
λmr	Linear expansion coefficient of the meter rotor
Only the parameters not grayed-out have to be filled for CPSm:	
p0	Meter reference pressure
Rm	Meter inner radius
e	Poisson ratio
Em	Modulus of elasticity
AT	Area of motor rotor
t	Wall thickness

6.10 Gas base density, relative density and specific gravity

6.10.1 Base density

	~~Liquid~~	Gas	~~Steam~~

This section defines the selection process to arrive to an “in use” value for the base density. There are 3 selections in order of priority with each 4 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be choosen. If not, then the second selection will bechecked etc. The last selection is always the keypad value as defined later, even if all other choices are none.

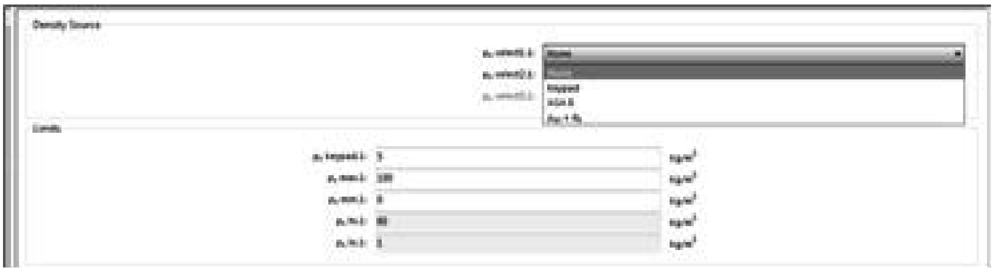


Figure 109 Base density selection

The 4 choices provided for the relative density selection are:

None	No relative density calculated
Keypad	A user can enter a fixed value for base density
AGA8	The value will be calculated via AGA8 calculations based on the gas data
Rho air x rd	The value will be calculated by multiplying relative density with base density of air.(see next page).

Also the keypad value can be entered together with the min, max alarm limits and high, low warning limits for base density.

Furthermore the compressibility setting can be given:

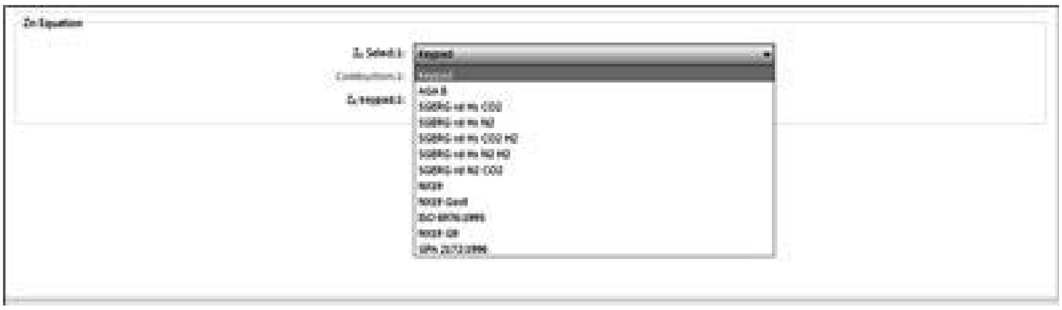
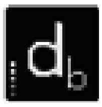


Figure 110 Compressibility options

The following choices for compressibility can be selected:

Keypad	A fixed user defined value to be entered
AGA8	Using the AGA8 calculation based on the gas data available
SGERG	Using the SGERG calculation based on relative density and combinations of gas data: rd-Hs-CO2 / rd-Hs-N2 / rd-Hs-CO2-H2 / rd-Hs-N2-H2 / rs-N2-CO2 Also the combustion temperature must be given.
NX19	Using the NX19 calculation based on the gas data available. 3 Versions are available: Standard / Gost / G9
ISO 6976	Using the ISO 6976 calculation based on the gas data available.
GPA 2172	Using the GPA 2172 calculation based on the gas data available.

6.10.2 Relative density / Specific gravity

	~~Liquid~~	Gas	~~Steam~~

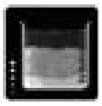
This section defines the selection process to arrive to an “in use” value for the relative density. There are 3 selections in order of priority with each 10 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be chosen. If not, then the second selection will be checked etc. The last selection is always the keypad value as defined later, even if all other choices are none.

Figure 111 Relative density options

The 10 choices provided for the relative density selection are:

Keypad	The fixed value entered will be used
Chromatograph A	The value from GC-A will be used
Chromatograph B	The value from GC-B will be used
Modbus	The value from a serial modbus interface will be used
Sensor	The value from the analog or Hart input will be used Extra inputs appear for the calibration constants of this sensor.
ISO 6976	The value is calculated using the ISO 6976 standard, from the gas data This requires an extra input of the reference temperature of the rd.
Last Good Value	The last good value before the selection went into error will be used
Last Hour Average	The value from the last hour will be used
Last Day Average	The value from the last day will be used
GPA2172	The value is calculated using the GPA2172 standard, from the gas data An extra page will appear for specific data related to the parameter.

6.10.3 Base sediment and water

	Liquid	~~Gas~~	~~Steam~~

When crude oil is extracted from an oil reservoir or well, it contains certain impurities such as water, and suspended solids. Sediment or mud is referred to the solid matter and water is the result of the oil field itself, and from water injection used to extract the oil from the ground.

This section defines the selection process to arrive to an "in use" value for BS&W. There are 3 selections in order of priority with each 4 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be chosen. If not, then the second selection will be checked etc.

This following page sets the options and parameters for the calculations used for the base sediment and water correction in accordance with API Ch 12.2.1:

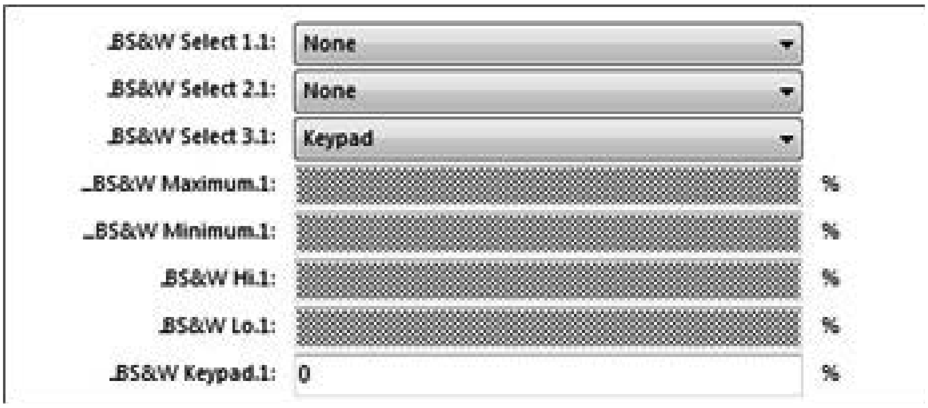


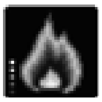
Figure 112 Basic sediment & water

The BS&W value can be sourced from:

None	No functionality or transmitter selected, the option will be skipped.
Keypad	The user defined value for this range will be chosen
Sensor	The transmitters value as defined in hardwaret, will be used.
Serial	Value as sent by Modbus e.g. from a PLC, or smart transmitter will be used.

Other parameters also include the minimum and maximum alarm limits, the high and low warning limits, as well as the fixed user defined keypad value.

6.11 Heating Value

	Liquid	Gas	~~Steam~~

This section defines the selection process to arrive to an “in use” value for the heating value. There are 3 selections in order of priority with each 10 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be choosen. If not, then the second selection will bechecked etc. The last selection is always the keypad value as defined later, even if all other choices are none.

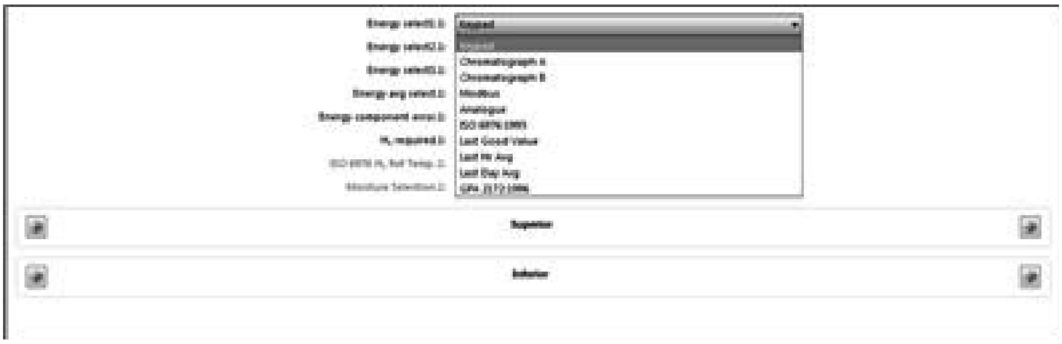
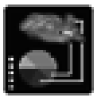


Figure 113 Heating value selection

The 10 choices provided for the heating value selection are:

Keypad	The fixed value entered will be used
Chromatograph A	The value from GC-A will be used
Chromatograph B	The value from GC-B will be used
Modbus	The value from a serial modbus interface will be used
Sensor	The value from the analog or Hart input will be used Extra inputs appear for the calibration constants of this sensor.
ISO 6976	The value is calculated using the ISO 6976 standard, from the gas data This requires an extra input of the reference temperature of the rd.
Last Good Value	The last good value before the selection went into error will be used
Last Hour Average	The value from the last hour will be used
Last Day Average	The value from the last day will be used
GPA2172	The value is calculated using the GPA2172 standard, from the gas data For gas an extra page will appear for specific data related to the parameter. For liquid this only applies to LNG and LPG.

6.11.1 GPA 2145

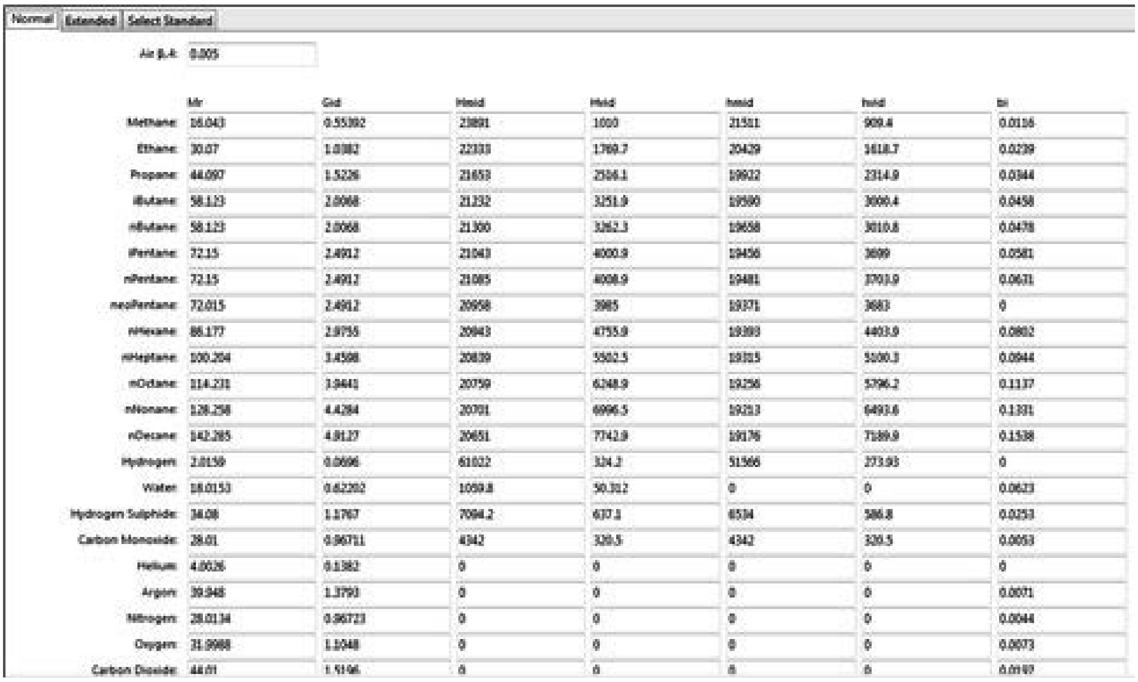
	Liquid	Gas	~~Steam~~

When GPA 2172:1996 is selected as the energy standard in Heating Valve or as Relative Density standard in relative density, this page will be made available.

6.11.2 TAB Normal and extended

The normal values refer to the 22 gas components normally used in calculations. The extended give the other 23 components that can be found in natural gas.

The following screen appears:



Normal | Extended | Select Standard

Air β-4: 0.005

	Mr	Gid	Hmid	Hvid	hmid	hvid	bi
Methane:	16.043	0.55392	23891	1000	21511	909.4	0.0116
Ethane:	30.07	1.0382	22333	1769.7	20429	1618.7	0.0239
Propane:	44.097	1.5226	21653	2516.1	19922	2314.9	0.0344
iButane:	58.123	2.0068	21232	3251.9	19590	3000.4	0.0458
nButane:	58.123	2.0068	21300	3262.3	19658	3010.8	0.0478
iPentane:	72.15	2.4912	21043	4000.9	19456	3699	0.0581
nPentane:	72.15	2.4912	21085	4008.9	19481	3703.9	0.0631
neoPentane:	72.015	2.4912	20958	3985	19371	3683	0
nHexane:	86.177	2.9755	20943	4755.9	19393	4403.9	0.0802
nHeptane:	100.204	3.4598	20839	5502.5	19315	5100.3	0.0944
nOctane:	114.231	3.9441	20759	6248.9	19256	5796.2	0.1137
nNonane:	128.258	4.4284	20701	6996.5	19213	6493.6	0.1331
nDecane:	142.285	4.9127	20651	7742.9	19176	7189.9	0.1538
Hydrogen:	2.0159	0.0696	61022	324.2	51566	273.93	0
Water:	18.0153	0.62202	1059.8	50.312	0	0	0.0623
Hydrogen Sulphide:	34.08	1.1767	7094.2	637.1	6534	586.8	0.0253
Carbon Monoxide:	28.01	0.96711	4342	320.5	4342	320.5	0.0053
Helium:	4.0026	0.1382	0	0	0	0	0
Argon:	39.948	1.3793	0	0	0	0	0.0071
Nitrogen:	28.0134	0.96723	0	0	0	0	0.0044
Oxygen:	31.9988	1.1048	0	0	0	0	0.0073
Carbon Dioxide:	44.01	1.5196	0	0	0	0	0.0197

Figure 114 GPA 2145 normal Gas data

Enter the GPA 2145 parameter per components used:

Mr	molar mass
Gid	molar mass ratio
Hmid	ideal gross heating value mass
Hvid	ideal gross heating value volume
hmid	ideal net heating value mass
hvid	Ideal net heating value volume
bi	summation factor

For complete information of these parameters and the values refer to the standards GPA 215 and GPA 2172.

NOTE: These standards are revised on a regular basis and as such care should be chosen to make sure the year of issue is appropriate to the desired use.

6.11.3 TAB Select standard

Select the year of the standard GPA 2145 to use from 1989 or 2003.

6.12 Enthalpy

H	~~Liquid~~	~~Gas~~	Steam

This section defines the selection process to arrive to an “in use” value for the enthalpy. There are 3 selections in order of priority with each 8 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be choosen. If not, then the second selection will bechecked etc. The last selection is always the keypad value as defined later, even if all other choices are none.

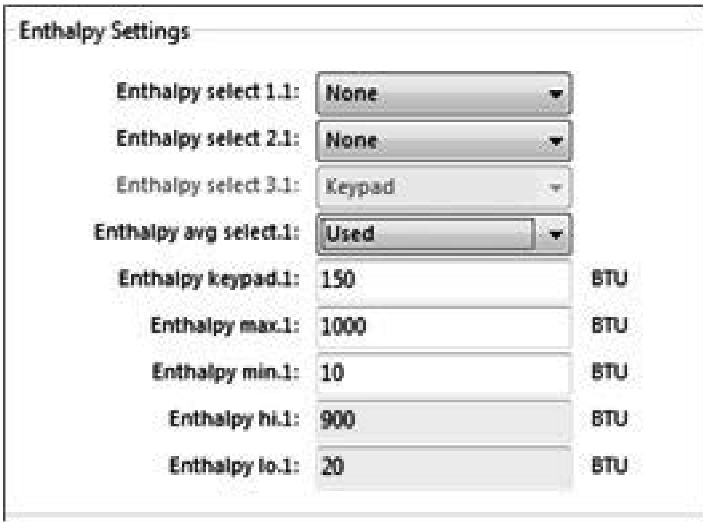


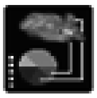
Figure 115 Enthalpy settings

The 10 choices provided for the enthalpy selection are:

None	
Keypad	The fixed value entered will be used
Modbus	The value from a serial modbus interface will be used
Analog	The value from the analog or Hart input will be used
Extra inputs appear for the calibration constants of this sensor.	
IAPWS IF97	The value is calculated using the IAPWS IF97standard.
Last Good Value	The last good value before the selection went into error will be used
Last Hour Average	The value from the last hour will be used
Last Day Average	The value from the last day will be used
The Source of the Average Enthalpy is also selected here from:	
Modbus	The value from a serial modbus interface will be used
Analog	The value from the analog or Hart input will be used
Extra inputs appear for the calibration constants of this sensor.	
IAPWS IF97	The value is calculated using the IAPWS IF97standard.
Used	The in-use value as determined from the earlier selection is used.

The keypad value the max and min alarm limits and hi and lo warning limits can also be entered here.

6.13 Gas Data

	Liquid	Gas	Steam

For liquids, gas data will only be needed if LNG or LPG is used, so if the line density is calculated.

This section defines the selection process to arrive to “in use” gas components. There are 4 selections in order of priority with each 9 choices. The SUMMIT will start to check the first selection. If the value is valid (not in alarm) then this selection will be choosen. If not, then the second selection will bechecked etc. The last selection is always the keypad value as defined earlier, even if all other choices are none.

The SUMMIT goes through the selection on a per component base. So if a GC would be the first choice and the GC only provides the data to C6+, then the other components will be taken from the next choices. This means that also the moisture can be added as a selection though a GC will not provide this.

The 9 choices provided for the gas data are:

Keypad	The fixed value enetered under TAB’s Normal and extended are used.
Chromatograph A	The data from GC-A will be used
Chromatograph B	The data from GC-B will be used
Modbus	The data from a serial modbus interface will be used
Analog Input	The data from the analog input(s) will be used
Last Good Value	The last good value before the selection went into error will be used
Last Hour Average	The value from the last hour will be used
Last Day Average	The value from the last day will be used
Calculated H2O value	The value for moisture will be used to calculate the total componenent

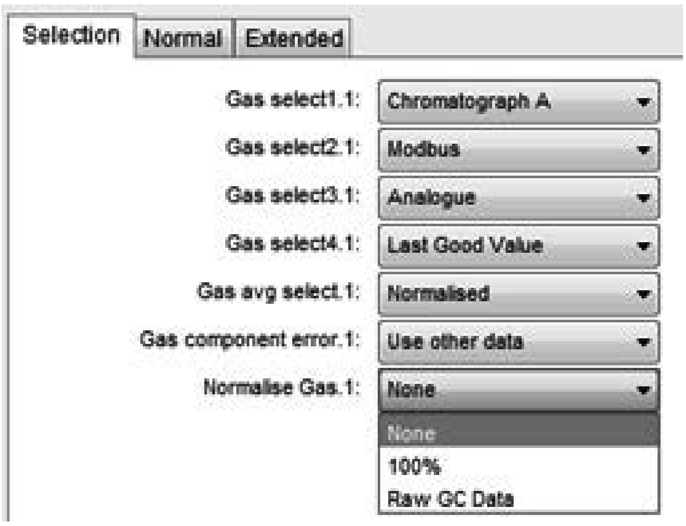


Figure 116 Gas data selection

A separate choice can be made to determine the source for the average gas composition:

Chromatograph A	The data from GC-A will be used
Chromatograph B	The data from GC-B will be used
Modbus	The data from a serial modbus interface will be used
Analog Input	The data from the analog input(s) will be used
Normalised	The value, as detemined by the selections, will be normalised
Used	The used value, as detemined by the selections, will be used

Gas component error determines how to handle the remaining components in case some of the gas components are in error (alarm state). A choice can be made to use the other components as they are or to use none of them.

As the gas components are in percentage of the total, all components together should be 100%. If this is not the case the gas can be normalised: multiplied by a factor to make the total 100%. The Normalization of Gas Data received can be selected from:

None	No normalisation needed: use the components as they are.
100%	Normalise all components to 100%
Raw GC Data	Normalise only the raw GC data and not the rest of the components

6.13.1 TAB Normal and extended

Sets Keypad and alarm values for gas components. The normal values refer to the 22 gas components normally used in calculations. The extended give the other 23 components that can be found in natural gas.

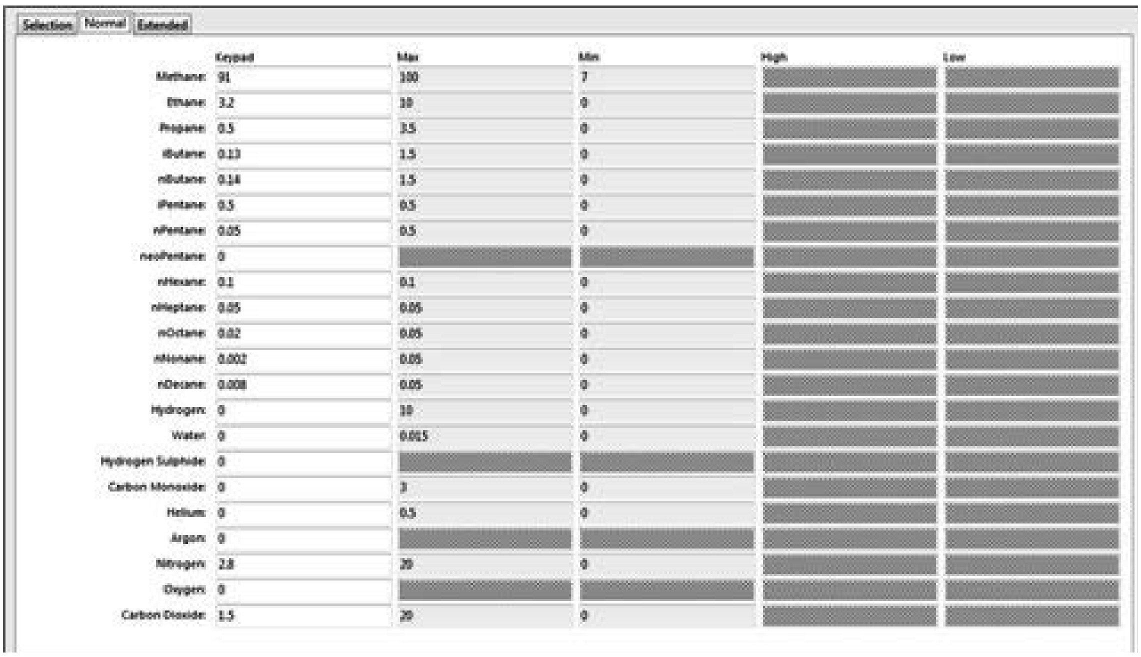
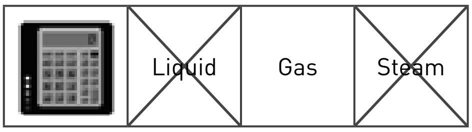


Figure 117 Normal Gas data

Per component enter the keypad value, the max and min alarm limits and the high and low warning limits in % of the gas. If there is no need for an alarm or warning value, please leave the associated field blank.

6.14 General Calculations



Selection and setup parameters associated with the calculation of Base Density of Air, Molecular Weight and CO2 Emissions Factor.

Selection Base density of air:

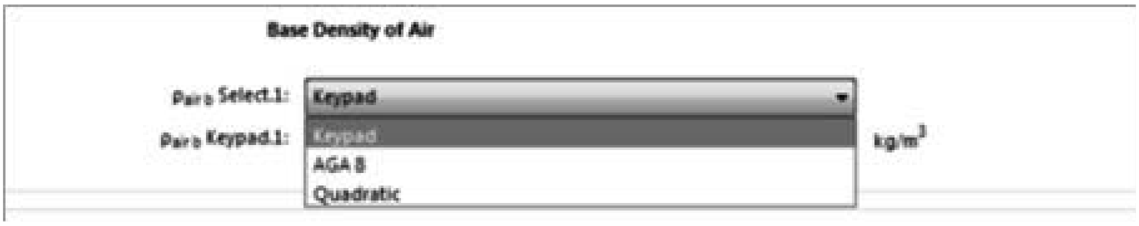


Figure 118 Base density of air

Keypad	A fixed value for density of air
AGA8	The density of air calculated via AGA8 calculations.
Quadratic	The density of air will be calculated by a temperature based formula: Density of air= 1.292923 – 4.732326666*tb + 1.543333*tb2

Selection molecular weight of the gas:

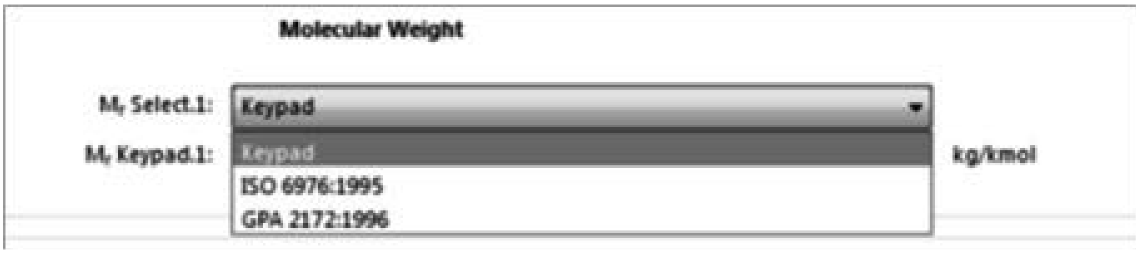


Figure 119 Molecular weight of gas

Keypad	A fixed value for molecular weight of the gas
ISO 6976	Molecular weight calculated using ISO 6976 standard (using gas data).
GPA2172	Molecular weight calculated using GPA2172 standard (using gas data).

Selection emission factors

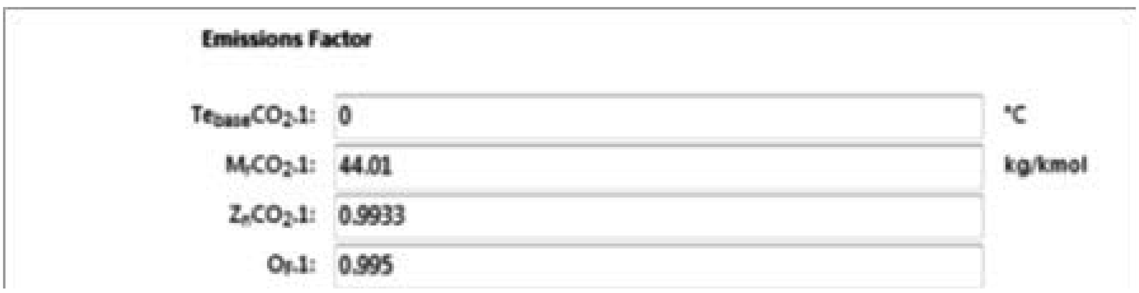


Figure 120 Emission factors

can be defined for the CO2 emission calculation.

TebaseCO2	Base temperature of CO2
MrCO2	Molecular mass CO2
ZnCO2	zn at base pressure and temperature
OF	CO2 oxidising factor

In case of gas ultrasonic meter, the selection for AGA10 speed of sound.

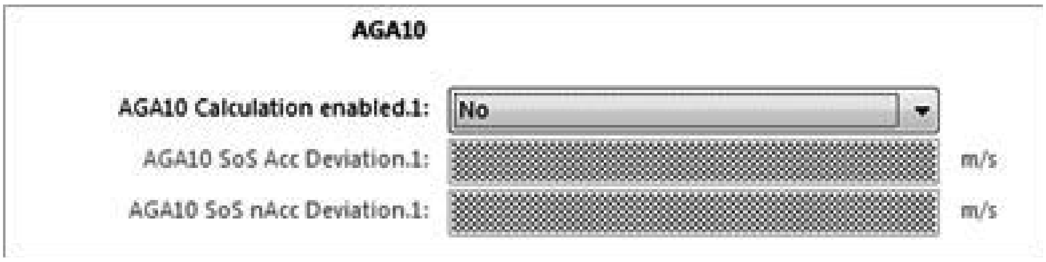
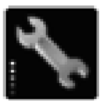


Figure 121 AGA 10 speed of sound

The AGA10 uses the composition, the temperature and the pressure to calculate the speed of sound for an ultrasonic meter, The selection allows the comparison between the measured and calculated speed of sound to verify the calibration of all components: meter, P, T and GC.

AGA10 calculation enabled	Calculation to be performed yes or no.
AGA10 SoS Acc deviation	Generates an accountable alarm when a deviation occurs
AGA10 SoS nAcc deviation	Generates an non-accountable alarm (warning) when a deviation occurs.

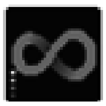
6.14.1 Pipe constants

	Liquid	Gas	Steam

All information related to the pipe details for steam application only:

- Pipe Data
- Saturation Pressure Constants
- Reynolds Constants
- Velocity of Sound Constants

6.15 Constants

	Liquid	Gas	Steam

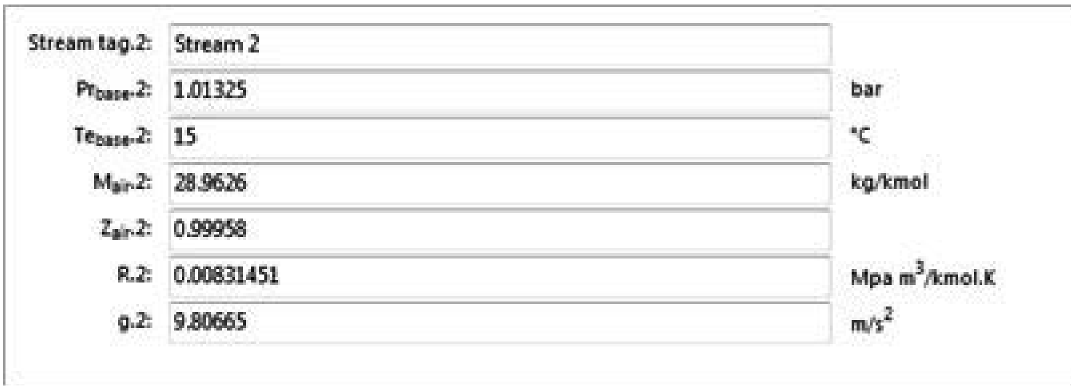


Figure 122 Constants

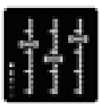
Several constants used throughout the SUMMIT:

Stream tag	A user defined name for this stream
Pbase	The base pressure
Tbase	The base temperature

For gas only:

Mair	Molar mass of air
Zair	Base compressibility of air
R	Molar gas constant R
g	Gravity g

6.16 Options

	Liquid	Gas	Steam

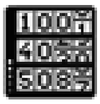
With the options, different settings depending on alarms are available by setting mode switches.

Figure 123 Stream options selection

List of mode switch options:

MS Inc nV in Acc	Increment normal totals when in accountable alarm
MS Inc eV in Acc	Increment error totals when in accountable alarm
MS count pulses during LoQ	Totals continue when in low-flow condition
MS zero flow during LoQ	Flow rate set to zero when in low-flow condition
MS use Nacc LED for LoQ	Indicate low-flow condition with non-accountable LED
MS use digital +ve counter	Use digital switch Input to enable +ve flow total
MS use digital -ve counter	Use digital switch input to enable –ve flow total
MS use digital invert flow	Use digital switch input to indicate flow direction
MS Indicate Acc alarms during loQ	Selects if accountable alarms should be indicated during low flow conditions.
MS Indicate Nacc alarms during loQ	Select if non accountable alarms should be indicated during low flow conditions.
MS Use Modbus timeout alarm	Select if the Modbus timeout alarm should be used for this stream.
MS Use PGC 9000	Select if this stream expects gas from a PGC 9000, and also the stream number that corresponds to the GC.

6.17 Preset counters

	Liquid	Gas	Steam

Normally the running totals of a stream or a station will be be always be kept alive by a back-up battery. So even when the power fails, these values will stay correct. However when this battery back-up is not available (initially or while replacing a battery) these totals will be reset to zero.

In several situations, it can be very helpful to to set the totals to the values before replacing the battery or replacing the unit. The following will be used for this:

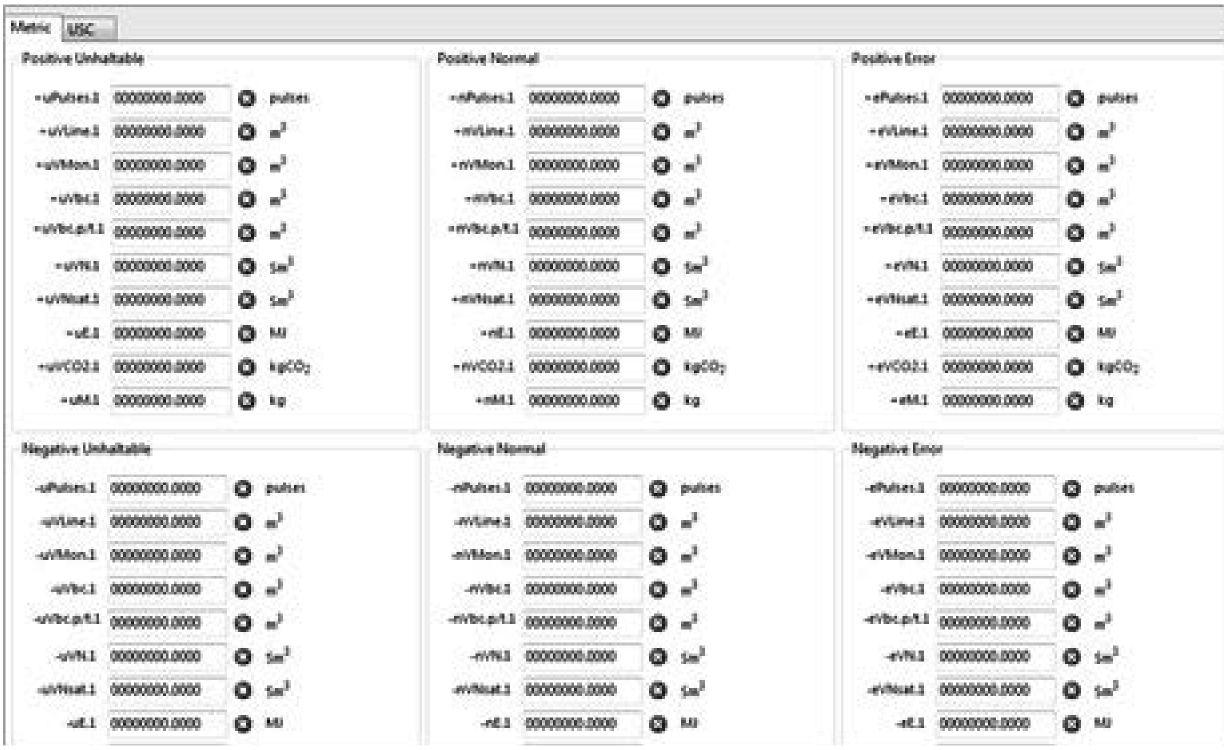
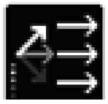


Figure 124 Preset counters

For each of the running totals, metric / USC, positive/ negative and unhaltable/ normal/ error/ maintenance, the preset values with which the totals must start counting, can be set.

	Liquid	Gas	Steam

7.1 Introduction

Run switching (also known as meter run staging or tube switching) is a function that controls the flow of fluid across multiple streams in a station. It normally is meant to optimize the accuracy, and can be used for normal operation or during proving.

To use run switching, it must be turned on first, under the general section.
The main run switching parameters must then be set per stream that will be used with the function.

7.2 General configuration

Under General, the run sitch function can be turned on:

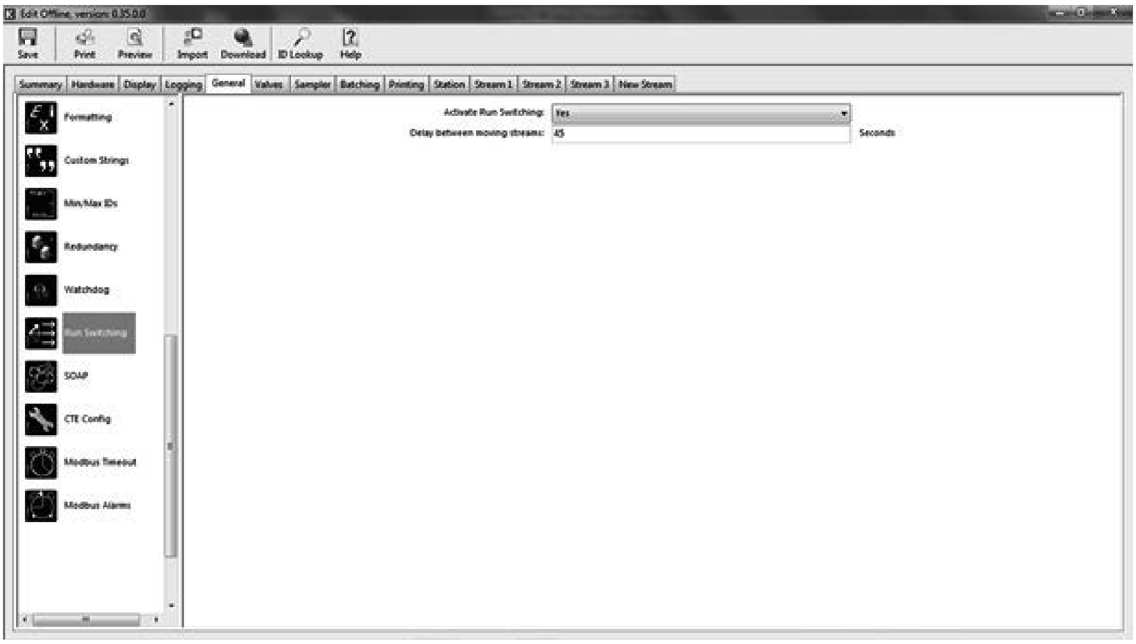


Figure 125 Turn run switching on

There are two parameters:

Activate run switching	Turns the run switching on or off
Delay between moving streams	To prevent continuous switching, a delay can be set after the conditions to switch are present and before the actual switch command will be given.

7.3 Stream configuration

For each stream that is involved with switching, the following configuration must be set:

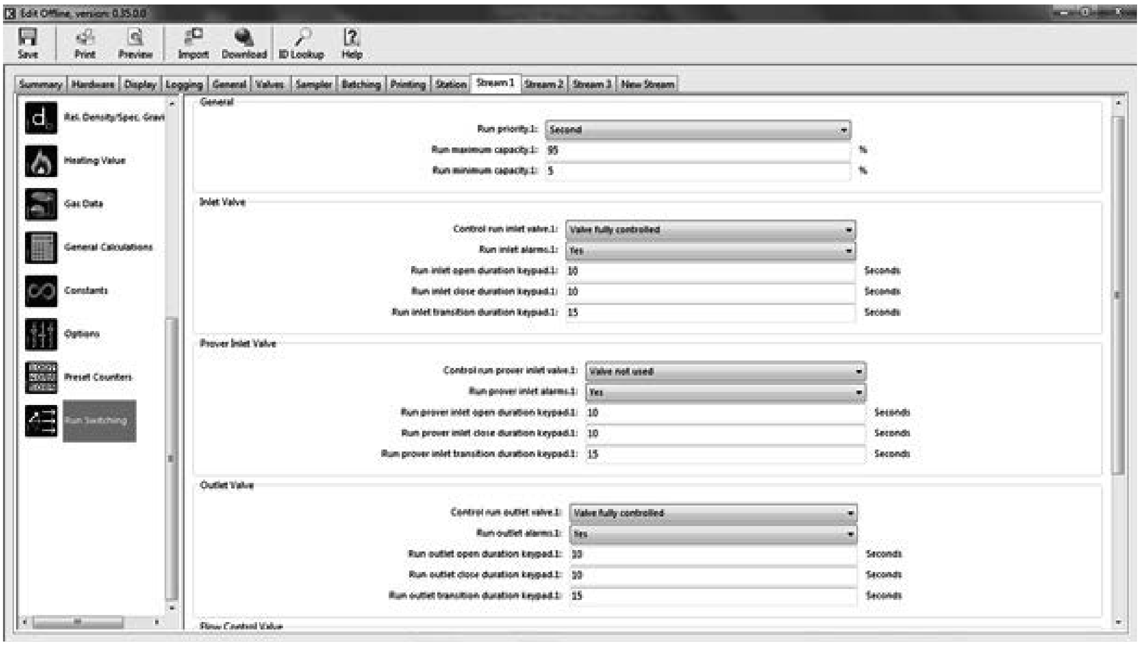


Figure 126 Stream configuration run switching

The configuration consists of 3 differen parts which will be describe in the following paragraphs:

General	Determines when to switch the stream
Valve control	Determines which valves must be controlled to switch
Flow control	Determines how to control the flow when through the stream

7.3.1 General

When run swiching needs to switch up (a new stream is added) it has to know which of the streams to take. Each stream can be given a priority, from 1 (or always used) to 5 (last stream to be added.
Also the flow switch point has to be given; add a new stream when above the maximum capacity of the stream and close a stream when below a minimum capacity:

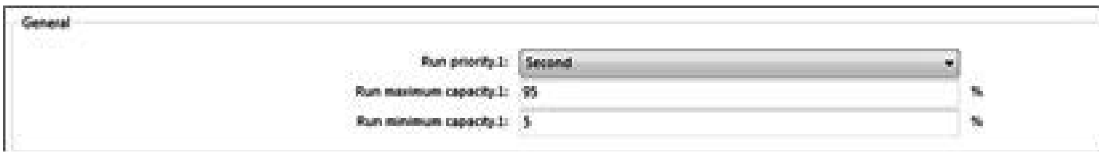


Figure 127 Stream run switching switch conditions

Run priority	Priority of this stream (1-5)
Max. capacity	Maximum capacity in % of the stream before opening a new stream
Min. capacity	Minimum capacity in % of the stream before closing a stream Please ensure that for streams 2..5 the minimum capacity is chosen such that it will be closed in time to arrive at a proper flow of the stream before, e.g. 45 %

The capacity limits are based on a percentage of the high and low flow as entered in the flow rates and totals page of the stream.

NOTE: Each stream must be assigned a different priority.

7.3.2 Valve control

Run switching can automatically open and close the following valves of a stream:

- Inlet valve
- Outlet valve
- Prover valve

Please note that these valves are specifically used for run switching and do not need to be configured anywhere else and that they are independent of any valve used under "Valves".

For each of them the following configuration is needed:

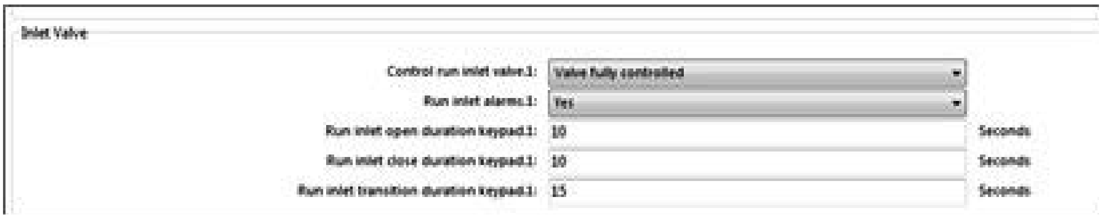


Figure 128 Stream run switching valve control

Control valve	Control setting for the stream valve	
	Not used	The valve will not be used by run switching
	Monitored	Run switching will only monitor, not control the valve.
	Fully controlled	Run switching will actively control the valve
Alarms		Select whether an alarm should be given when the valve cannot be switched. This is particularly important when control valve is monitored.
Open/ close duration keypad		Length of time the open and close the valve signal is sent
Transition duration keypad		The maximum time the valve may move before an alarm is raised

7.3.3 Flow control valve

A PID valve per stream to control the flow of the medium based on PID setpoints. Please note that this valve is specifically used for run switching and does not need to be configured anywhere else and that it is independent of any PID valve used under "Valves".

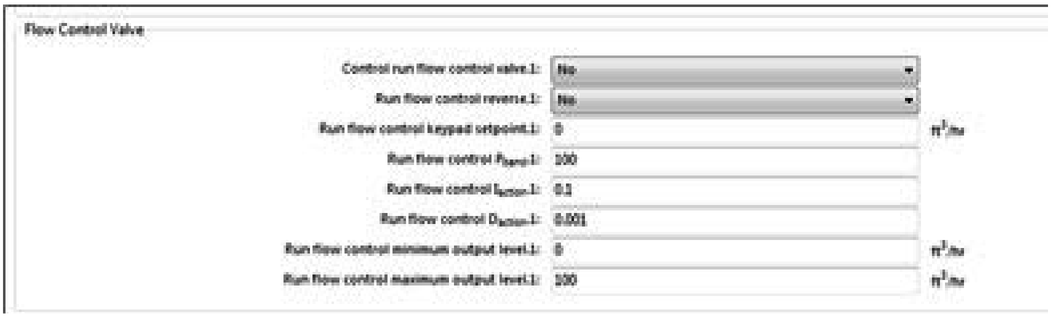


Figure 129 Stream run switching valve control

Control run flow valve	If the flow control valve is to be controlled – yes or no
Run flow control reverse	If the flow control valve is permitted to work with reverse flow
Run flow control keypad setpoint	User defined setpoint for flow
Run flow control Pband	Time based on present error
Run flow control Iaction	Accumulation of past errors
Run flow control Daction	Prediction of future errors
Run flow control minimum output level	Minimum flow output limit from valve
Run flow control maximum output level	Maximum flow output limit from valve

7.4 Run switching I/O selections

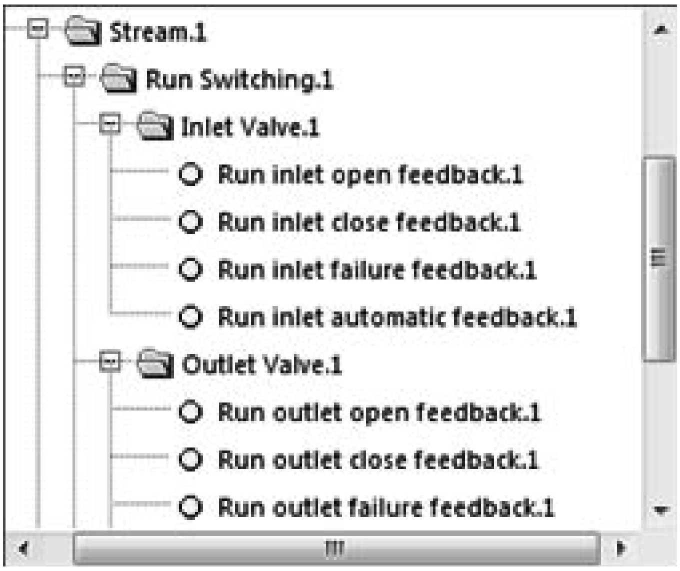


Figure 130 Run switching digital input selection

Inputs required
Local > stream n > run switching > inlet / outlet / prover inlet valve

Run inlet open feedback	Open status received from the valve.
Run inlet close feedback	Closed status received from the valve.
Run inlet failure feedback	Failure indication received from the valve
Run inlet automatic feedback	Mode selection received from the valve

Outputs required
Active > stream 'n' > run switching > inlet / outlet valve

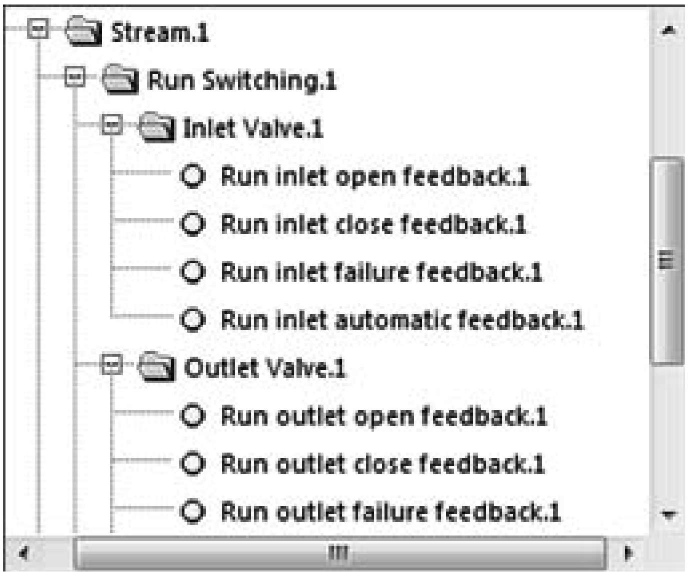


Figure 131 Run switch digital output selection

Run inlet open	Output signal from the flow computer to open the valve
Run inlet close	Output signal from the flow computer to close the valve
Run inlet failure feedback	Failure indication received from the valve
Run inlet automatic feedback	Mode selection received from the valve

The flow control valve selections are analogue outputs.

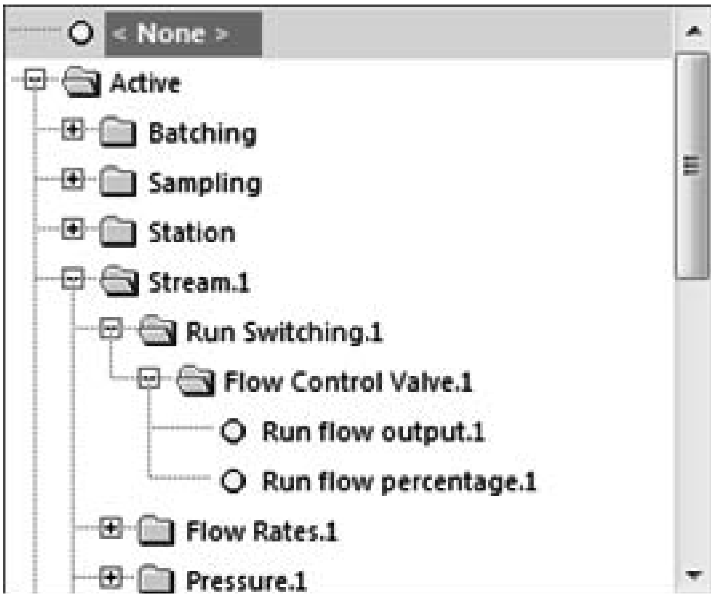


Figure 132 Flow control valve analogue output

Outputs Required
Active > Stream n > run switching > flow control valve

Run flow output	Indicates that there is flow through an open valve
Run flow percentage	Indicates the current open value of the flow control valve

Alarms
The inlet and outlet valves share the same alarm points.

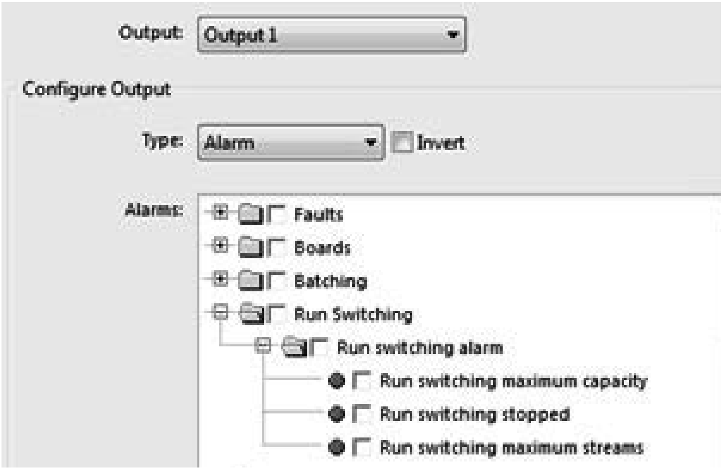


Figure 133 Run switching alarms

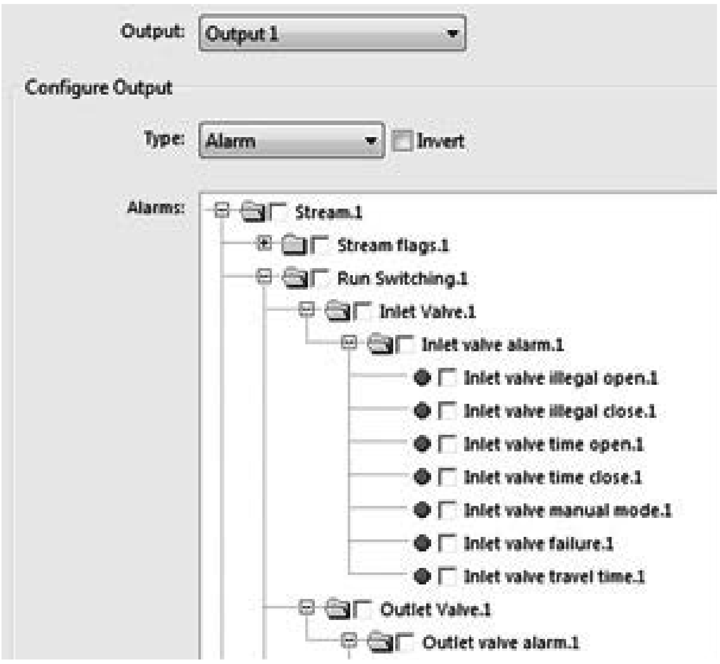
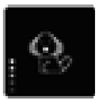


Figure 134 Stream run switching alarm selections

	Liquid	Gas	Steam

This function allows a system watchdog to be enabled which will perform a complete system reset after a defined watchdog time-out period has elapsed if any fault condition occurs.

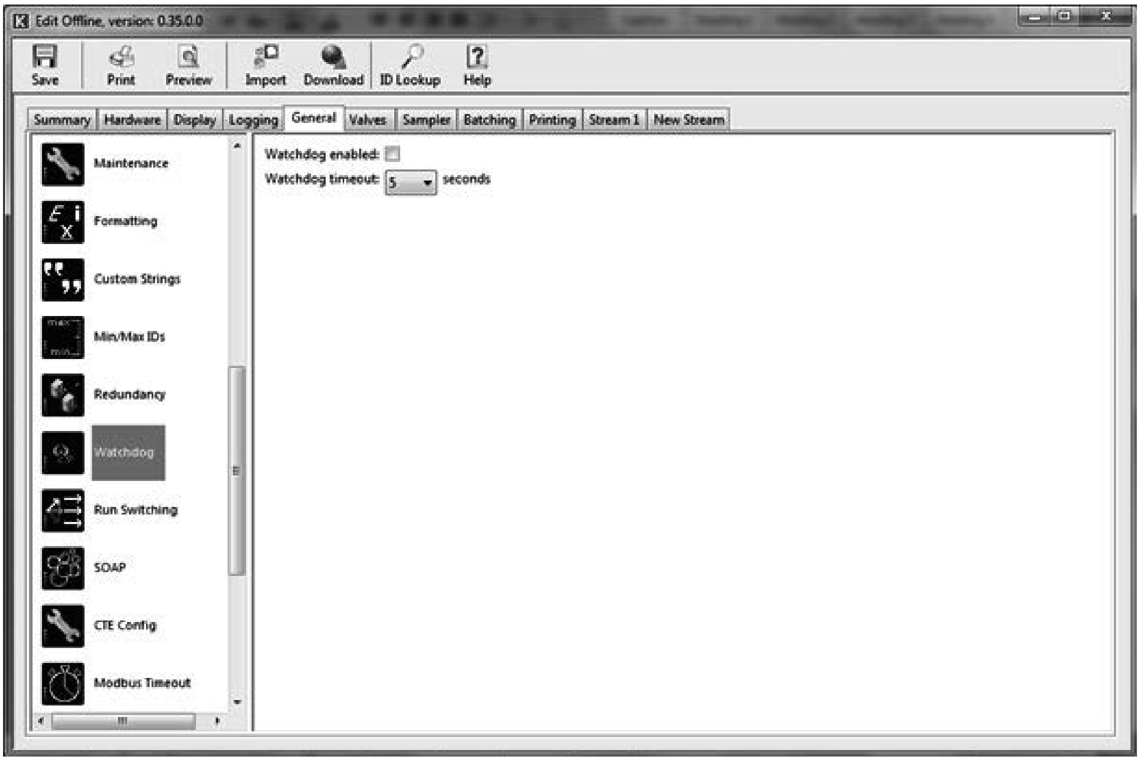
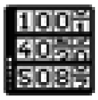


Figure 135 Watchdog settings

Enable	Check to enable the watchdog.
Timeout	The time-out period can be set from 5 to 60 seconds.

A metering station may consist of multiple incoming streams from suppliers and multiple out-going streams to customers. In this case it is is beneficial to be able to combine the flows from the different supplier or customers to one total.
For this purpose, in the SUMMIT two stations (station A and B) can be defined each with up to 5 streams. Each stream can be added to or subtracted from the station total. A recalculation to the station pressure and temperature will be done.

9.1 Station totals

	Liquid	Gas	Steam

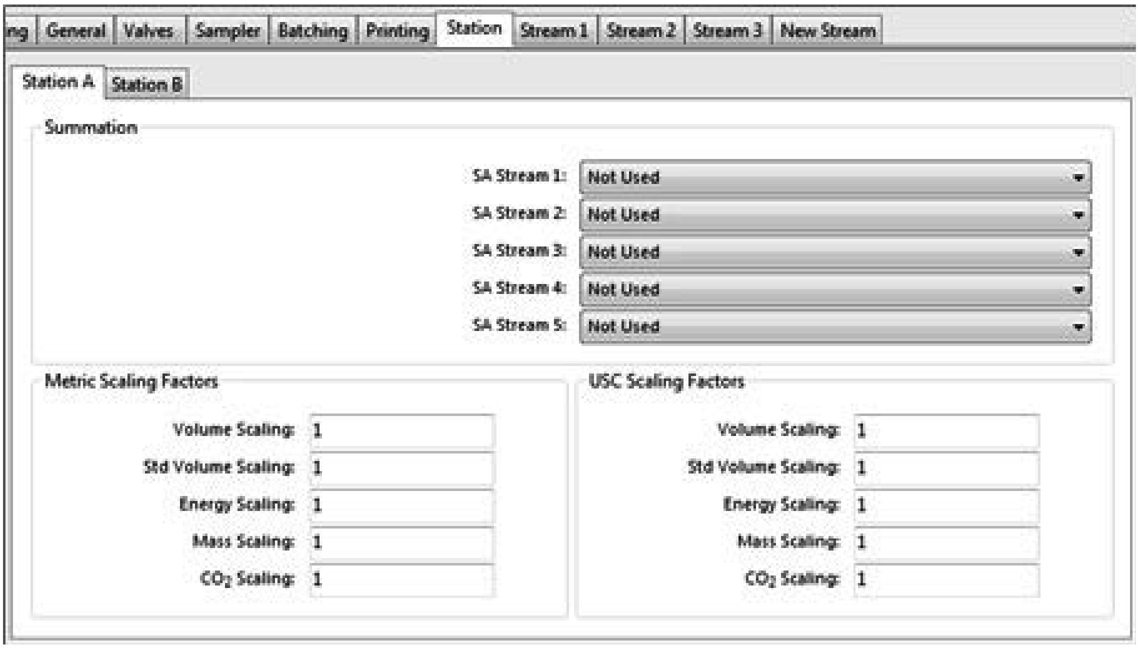


Figure 136 Define station totals

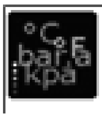
For each station (A and/or B), define which of the 5 streams have to be summed or subtracted to get a station total.

For example, selecting
- SA stream 1 sum,
- SA stream 2 sum
- SA stream 4 sum
- SA stream 5 subtract

translates as
Station total = stream 1 + stream 2 + stream 4 – stream 5.

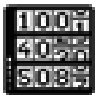
For both the metric and US customary units, for each of type of total a scaling factor for display of the totals can be given, similar to the stream totals. This multiplier will normally be 1, 1000 or 1000000.

9.2 Station units

	Liquid	Gas	Steam

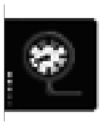
As for each stream also the engineering units for both the stations A and B can be defined.

9.3 Preset counters

	Liquid	Gas	Steam

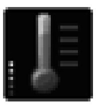
As for each stream, also the preset values for all the counters of station A and B can be set. Fo

9.4 Pressure

	Liquid	Gas	Steam

As for each stream, also a station pressure can be selected.

9.5 Temperature

	Liquid	Gas	Steam

As for each stream, also a station temperature can be selected. 7

Proving is a function to determine and verify the accuracy of a flow meter used within a stream. The methodology is to compare the volume or mass through the flow meter under test against the prover's known volume or mass (also referred to as 'known traceable volume').
The result of proving is the generation of a meter factor (MF) which is retro-applied to the flow meter which corrects the flow at ambient operating conditions to traceable standards.

The SUMMIT 8800 flow computer can prove with the following prover systems for liquid:

- Uni-directional ball prover
- Bi-directional ball prover
- Piston prover / small volume prover / compact prover
- Master meter

For gas only one option is available:

- Master meter

The SUMMIT can be configured to be

- a prover computer which included streams in the same computer
- a dedicated prover computer wich connects to stream flow computers via a serial RS485 modbus link.

In a master meter configuration one of the streams is assigned to be the master which can test production meters. The master meter itself can also be used as a production meter. In all cases, the master meter must also be configured as any other stream flow meter.

Configuring the prover's in- and outputs is done in the hardware section of the configuration software tool. See volume 1 for details.

10.1 Prover configuration

To be able to use the flow computer as a prover, the machine type must be defined as a gas or liquid prover:

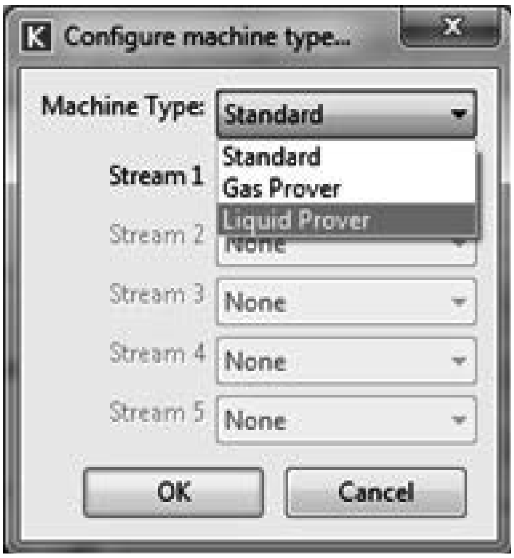


Figure 137 Flow computer machine type

A prover may be combined with other streams, if desired.

In the main menu, a prover section will appear which is slightly different for liquid and for gas: for gas the base- and line- density must also be configured.

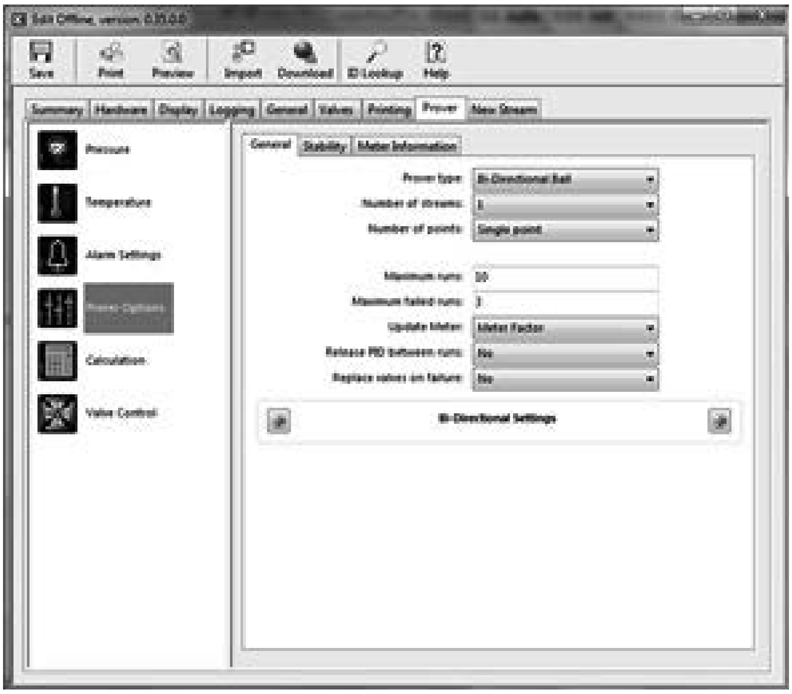
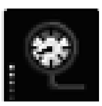


Figure 138 Prover section for liquid and gas

Under the prover section, the user will find the following pages that will be used to configure the prover functionality.

Pressure	define how inlet and outline pressure is measured
Temperature	define how inlet and outline temperature is measured
Alarm settings	define the different alarms levels that will be checked during proving
Prover options	define the type of prover and the parameters associated with it
Calculation	define the calculations to be done during proving
Valve control	define what valves should be controlled during proving
Line density (gas only)	define how the line density for the prover should be calculated
Base density (gas only)	define how the base density for the prover should be calculated

10.1.1 Prover pressure

	Liquid	Gas	Steam

Defines how the pressure is measured and in what units.

10.1.1.1 General

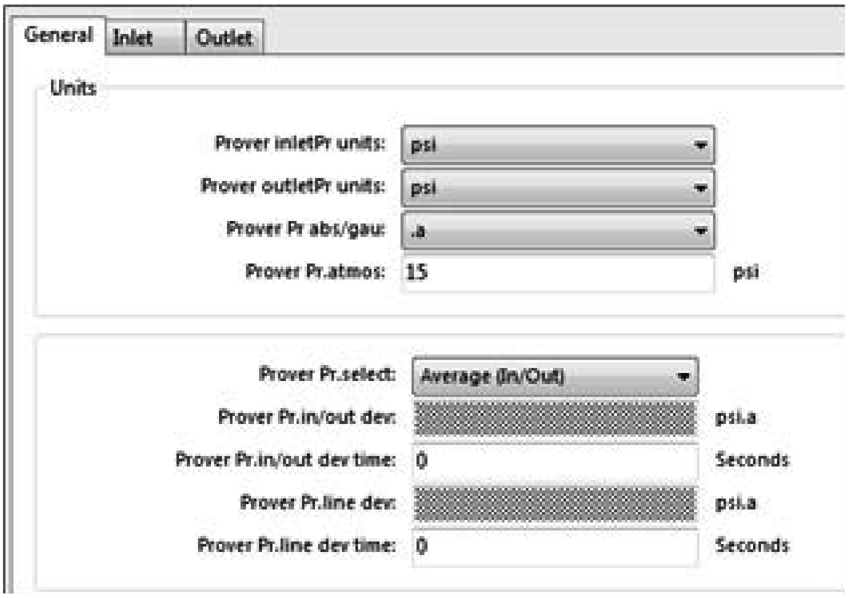


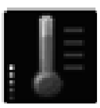
Figure 139 Prover pressure

Inlet unit	Pressure inlet units
Outlet unit	Pressure outlet units
Pressure absolute or gauge value	Calculated results as absolute or guage
Atomospheric pressure	Defined atmospheric pressure
Prover pressure selection	Prover pressure taken from input, output, average (I/O), or line
Inlet and outlet deviation	Pressure inlet and outlet deviation limit
Inlet and outlet deviation time	Inlet and outlet deviation timeout
Prover line deviation	Line pressure deviation limit
Pressure line deviation time	Line pressure deviation timeout

10.1.1.2 Inlet and outlet pressure

For details, see stream pressure.

10.1.2 Prover temperature

	Liquid	Gas	Steam

Defines how the temperature is measured and in what units.

10.1.2.1 General

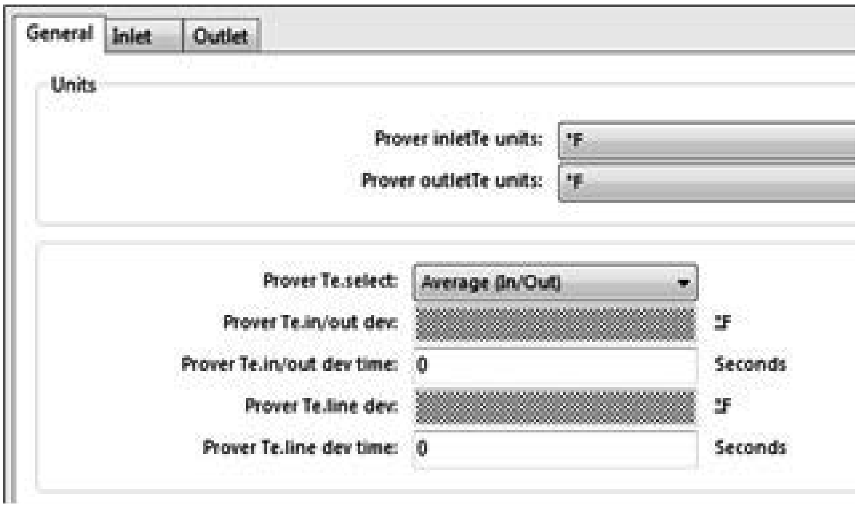


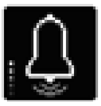
Figure 140 Prover temperature

Inlet unit	Temperature inlet units
Outlet unit	Temperature outlet units
Prover temperature selection	Prover temperature taken from input, output, average (I/O), or line
Inlet and outlet deviation	Temperature inlet and outlet deviation limit
Inlet and outlet deviation time	Inlet and outlet deviation timeout
Prover line deviation	Line temperature deviation limit
Temperature line deviation time	Line temperature deviation timeout

10.1.2.2 Inlet and outlet temperature

For details, see stream temperature.

10.1.3 Alarm settings

	Liquid	Gas	Steam

The re-prove cycle and the start of prove cycle work on the same principles. After the previous cycle and before a (re-)prove cycle is carried out, the flow computer checks the stability of the parameters to ensure that they are still within the define limits. Should any one of these limits be exceeded, the (re-)prove function will stop, and a report generated. A (re-)prove is also initiated should the parameters deviate during a prove cycle already in progress.

Here the absolute limits are configured:

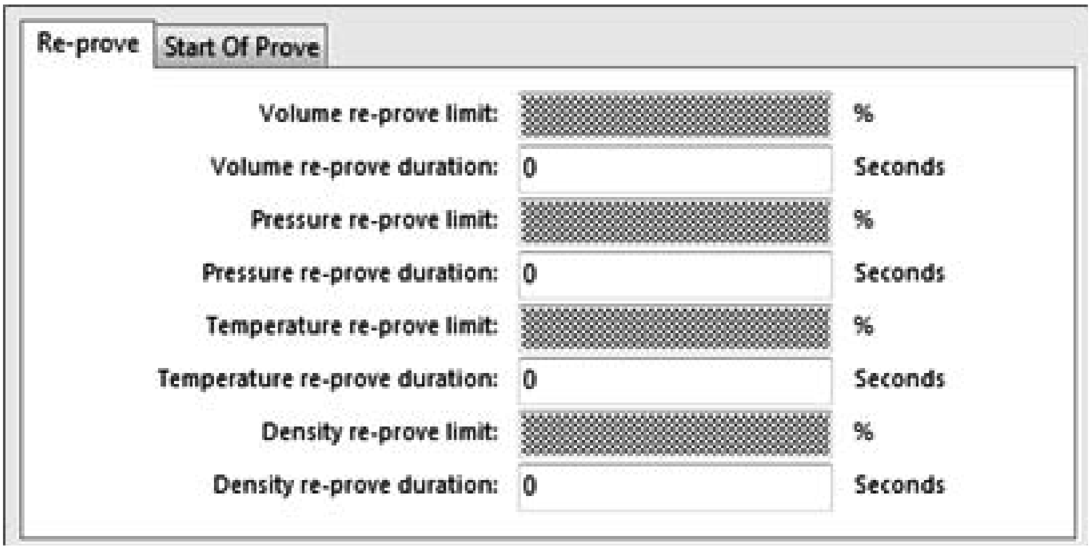


Figure 141 Prover alarm settings, re-prove

For both the re-prove and the start of prove the following parameters can be set for volume, pressure, temperature and density.

Limit	The % of the set value not to be exceeded for the prove to start
Duration	The time with which the limit must be reached

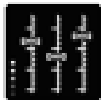
If these conditions are not met, the prove will not start, a report will be generated and the prove cycle will be reset to the start flag.

A deviation value in percentage for each parameter is calculated from the equation:

$$Deviation = \frac{currentcondition - referenceconditions}{referenceconditions} \times 100$$

Equation 5 Prove deviation calculation

10.1.4 Prover options

	Liquid	Gas	Steam

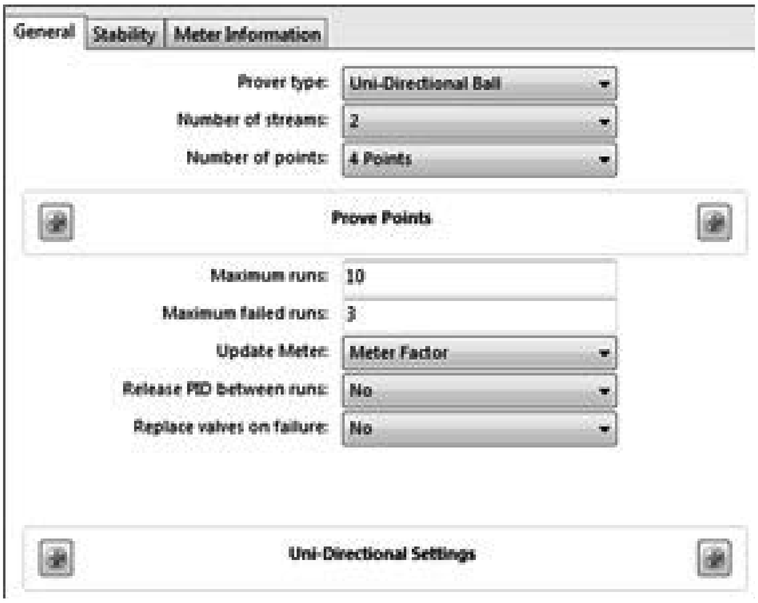


Figure 142 Prover options: general

This page deals with detailed prover parameters which are used to determine the following:

Prover type	Select prover used, for gas master meter only.
Number of streams	The number of streams connected to the prover application (1-5)
Number of points	Number of proving points (1-20), so at how many flow rates must be proved
Maximum runs	Maximum number of runs allowed during a proving
Maximum failed runs	Maximum number of failed runs allowed before the prove is aborted
Update meter	MF or K-factor update to meter
PID between runs	Release of PID valves between prover runs – yes or no
Valves on failure	Option to replace valves should the prove fail – yes or no

10.1.4.1 General

Proving points
If more than one proving point is selected the user will be displayed with an additional section to be able to enter at what flow rates must be proved:

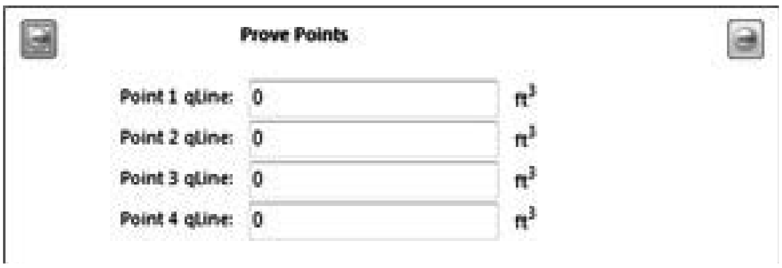


Figure 143 Prover options: general, proving points

Settings

Depending on the prover type, additional settings are needed as follows:

Figure 144 Prover options: general settings, uni-directional prover

Ball release time	Release command time to valve
Maximum loop time	Allowable time for sphere to travel a complete loop – chamber to chamber
Maximum chamber time	Time for sphere to travel past last detector switch to home chamber
Pump check delay time	Pump running signal check status wait delay

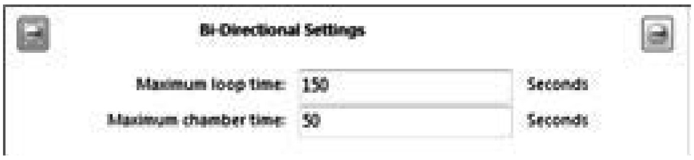


Figure 145 Prover options: general settings, bi-directional prover

Maximum loop time	Allowable time for sphere to travel a complete loop – chamber to chamber
Maximum chamber time	Time for sphere to travel past last detector switch to home chamber

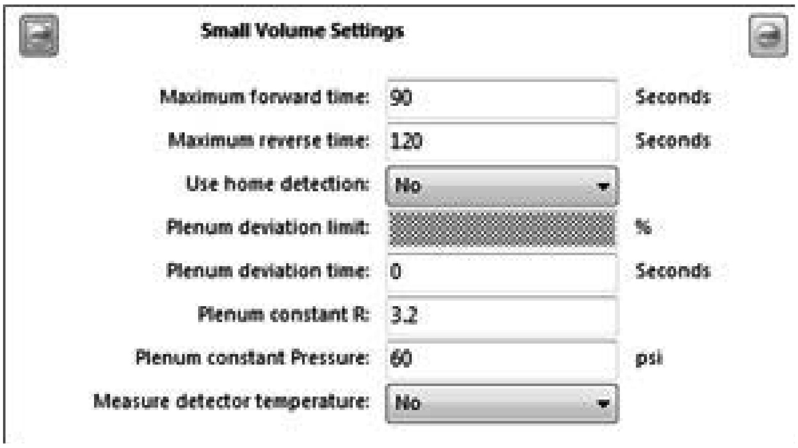


Figure 146 Prover options: general settings, small volume prover

Maximum forward time	Piston travel time from start to end position
Maximum reverse time	Piston start position recovery time
Home detection	The use of a home detector switch – yes or no
Plenum deviation limit	Maximum deviations between calculated and measure plenumm pressure
Plenum deviation time	Deviation time allowable for limit

Plenum constant R	Defined value for plenum R constant
Plenum constant pressure	Defined value for plenum pressure constant
Detector temperature	The use of detector to measure temperature – yes or no

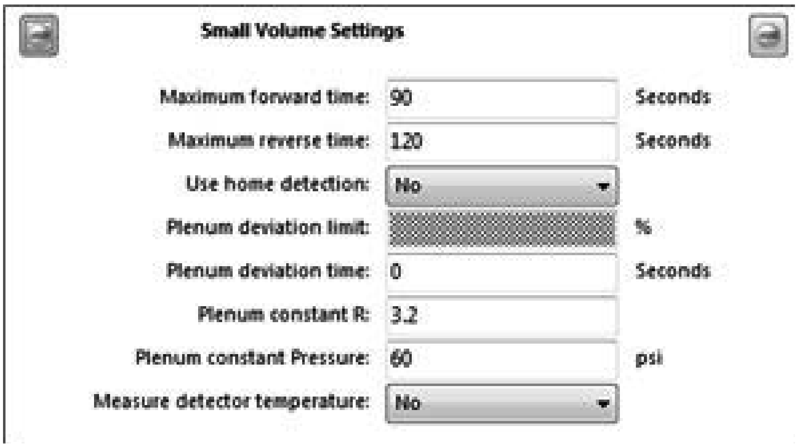


Figure 147 Prover options: general settings, master meter

Proving length section	Proving cycle - start to end based on time or number of pulses
Length of Proving run	Defined limit of pulses or time required for proving length
Meter correction	Correction data for the master meter – MF or K-factor
Meter preset KF	Master meter K-factor value

10.1.4.2 Stability

The prover can be configured to check the stability of volume, pressure and temperature before the proving sequence is initiated.

Once the proving sequence has been initiated, the prover will wait for the specified minimum stability duration time (in seconds) before adjusting the prover loop outlet valve, it will then wait up until a user selectable maximum stability duration time (in seconds) for the flow, pressure or temperature to stabilise. If the required stabilisation level is not met then the prove will be aborted.

The parameters for each of the volume, pressure and temperature are:

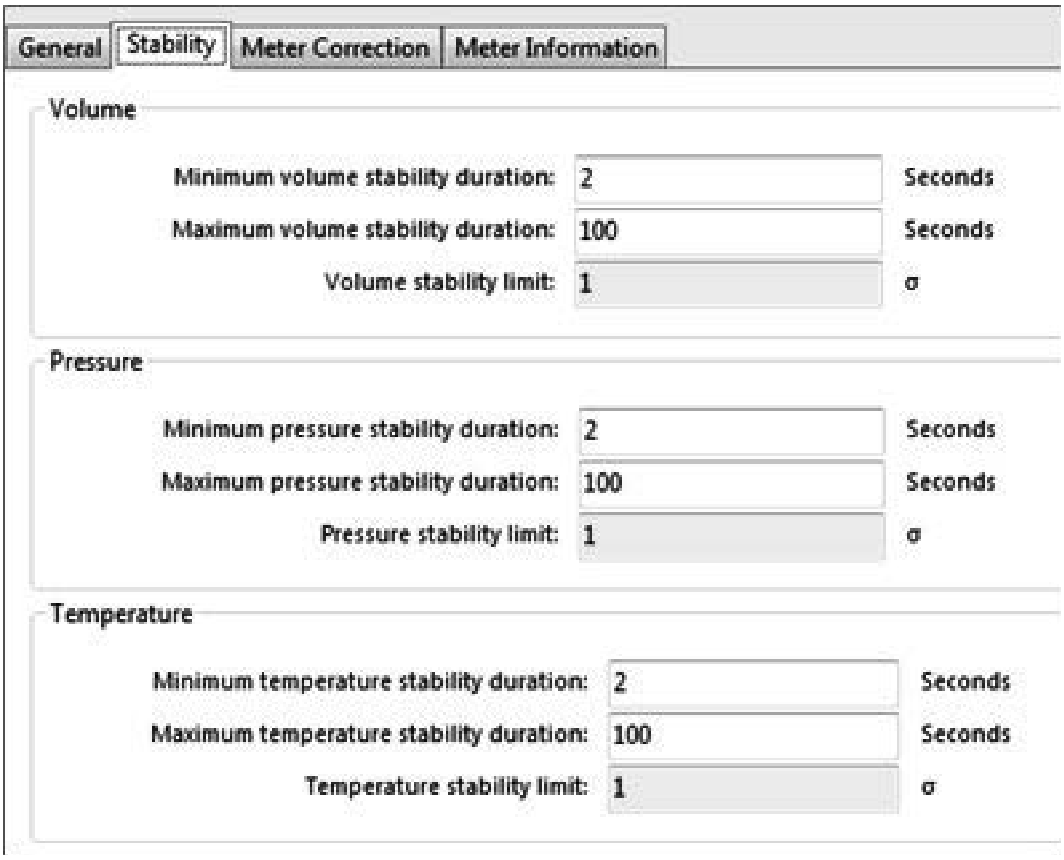


Figure 148 Prover options: stability

Minimum stability duration	time before adjusting the prover loop output valve starts
Maximum stability duration	time after which an alarm will be given when stability has not been reached
Stability limit	maximum standard deviations to be reached

10.1.4.3 Meter correction

This section is only available for master metering.

The correction of the pipe for the pressure and temperature based on how the master meter is connected to the pipe:

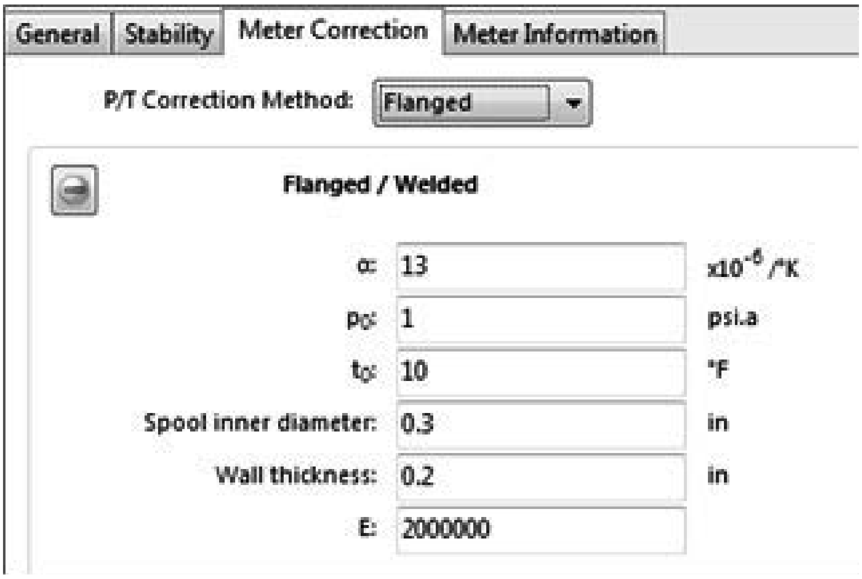


Figure 149 Prover options: meter correction

P/T Correction Method
Select the method for correction.
- None
- Flange/ Welded
- Welded
- ISO:17089
- Cryogenic

10.1.4.4 Meter information

General prover information to identify in a metering system:

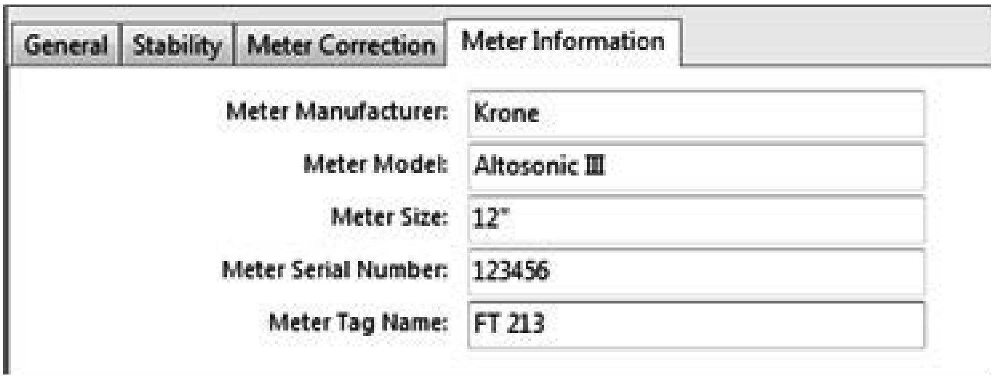
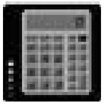


Figure 150 Prover options: meter information

10.1.5 Calculations

	Liquid	Gas	Steam

Here the parameters, associated with the prover calculations will be set.

10.1.5.1 K-factor

This page is for the calculation setup of the K-factor and pipe correction for liquid prover, where the user can determine what methods, and how the corrections are calculated.

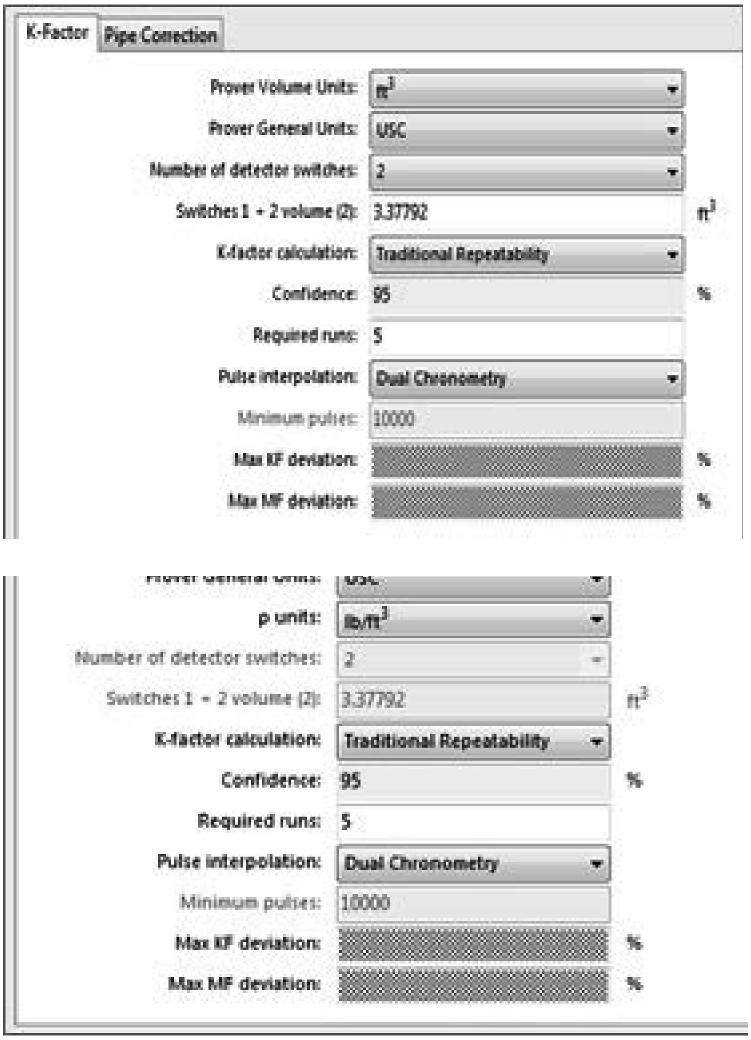


Figure 151 Prover calculations, k-factor for liquid and gas

Volume units	Specific selectable prover volume units
General units	Metric or USC
ρ units	Density units (gas only)
Number of detector switches	Detector switches used in the prove loop

Used switches	Sequence of switches used or the average of all detectors
Switches volume	Prover base volume at switch point
K-factor calculation	Method of K-factor calculation selectable
Confidence	User confidence level of calculation implemented
Required runs	Least amount of run required for a sucessful prove
Pulse interpolation	Method for pulse interpolation – non or double chronometry
Minimum pulses	Minimum allowable pulses for a prove, default 10,000
Max KF deviation	Maximum deviation limit for new K-factor compare to previous value
Max MF deviation	Maximum deviation limit for new MF compare to previous value

Please note that some parameters will not be needed, depending on previous choices.

The K-factor calculation method can be selected from

- Traditional repeatability
- Statistical repeatability
- Uncertainty calculations.

Provers are normally set to traditional repeatability. Uncertainty can also be selected but this requires a high repeatability and more runs than traditional repeatability.

Pipe correction
This section is for liquid provers only,

Here the user must enter the corrections for the liquid prover stream for CTSp (prover expansion due to temperature) and CPSp (prover metal expansion due to pressure)

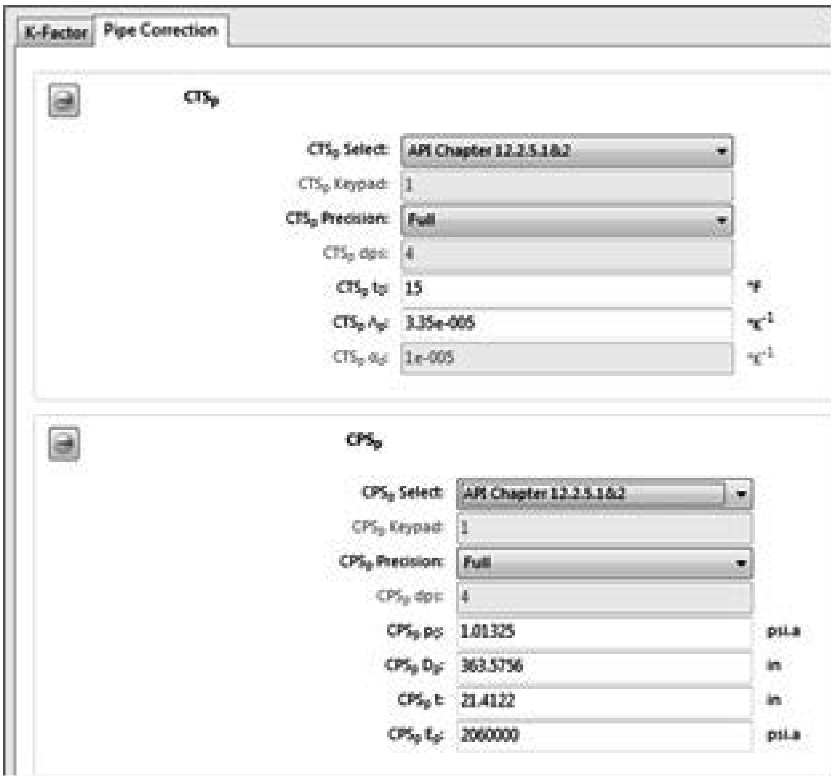
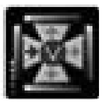


Figure 152 Prover calculations, pipe correction

CTSp select	Correction factor according to selectable API standard or keypad value
CTSp keypad	User defined keypad value
CTSp precision	Selectable precision – rounded, full, truncated
CTSp dps	Precision decimal place for reporting
CTSp t	Prover reference temperature
CTSp expansion	Prover cubical expansion coefficient
CTSp detector	Detector linear expansion
CPSp select	Correction factor according to selectable API standard or keypad value
CPSp keypad	User defined keypad value
CPSp precision	Selectable precision – rounded, full, truncated
CPSp dps	Precision decimal place for reporting
CPSp p	Prover reference pressure
CPSp D	Inner diameter of prover
CPSp t	Wall thickness of prover
CPSp E	Metal modulus of elasticity

10.1.6 Valve control

	Liquid	Gas	Steam

Several valves can be controlled automatically during proving and can be selected from the 18 valves. They work in conjuction with the prover valves as defined under run switching.

Depending on the prover type selected the following valves can be controlled:

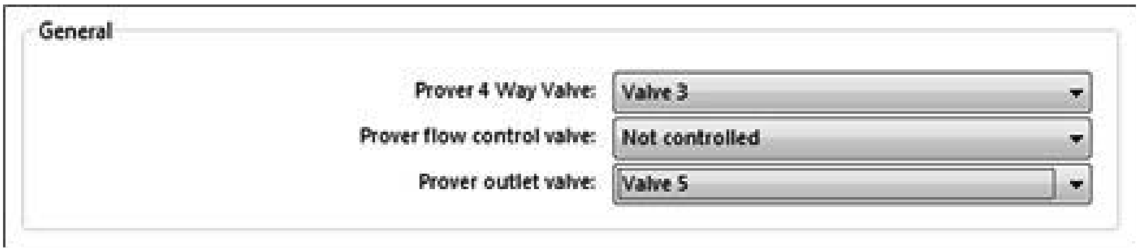


Figure 153 Prover valve control, bi-directional

Figure 154 Prover valve control, uni-directional or small volume

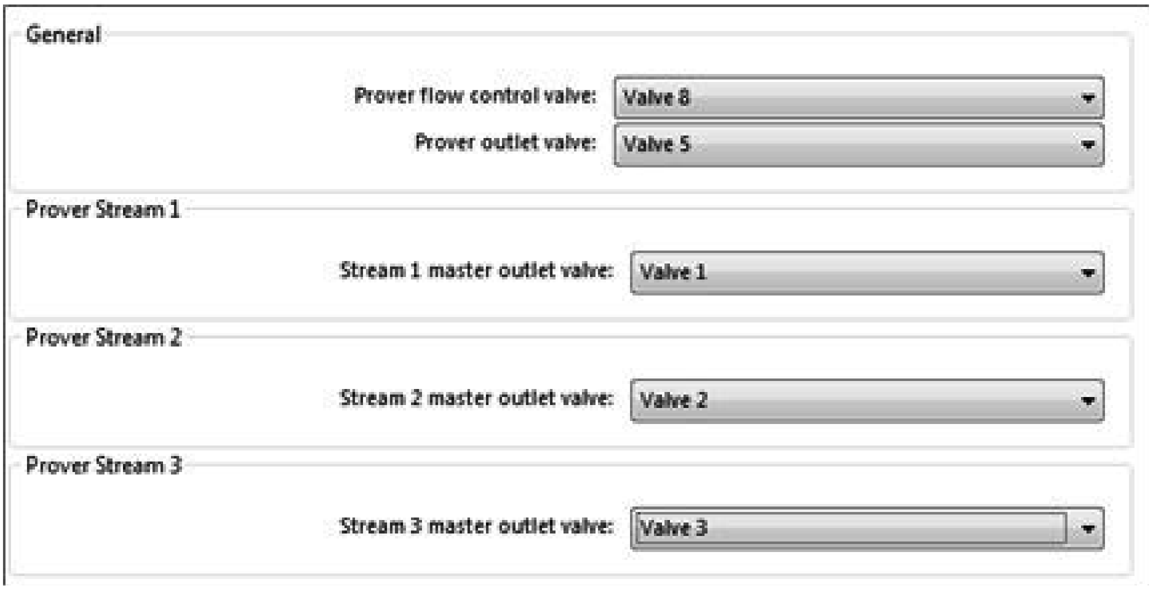
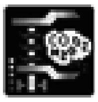
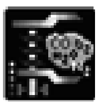


Figure 155 Prover valve control, master metering 3 streams

Prover 4 way valve	Select the valve to control the bi-directional 4 way valve
Prover flow control valve	Select the valve to control the flow of the prover
Prover outlet valve	Select the valve which will act as the prover flow outlet valve
Stream 'n' master outlet valve	Select the stream valve to control connection to the strea (master meter only)

Please remember to configure of the valves used under the valves tab.. Each of the valves used can be customised based on type, input, output, feedback, and alarms.

10.1.7 Line and base density

	Liquid	Gas	Steam
	Liquid	Gas	Steam

For gas prover applications, line density and base density pages are presented.

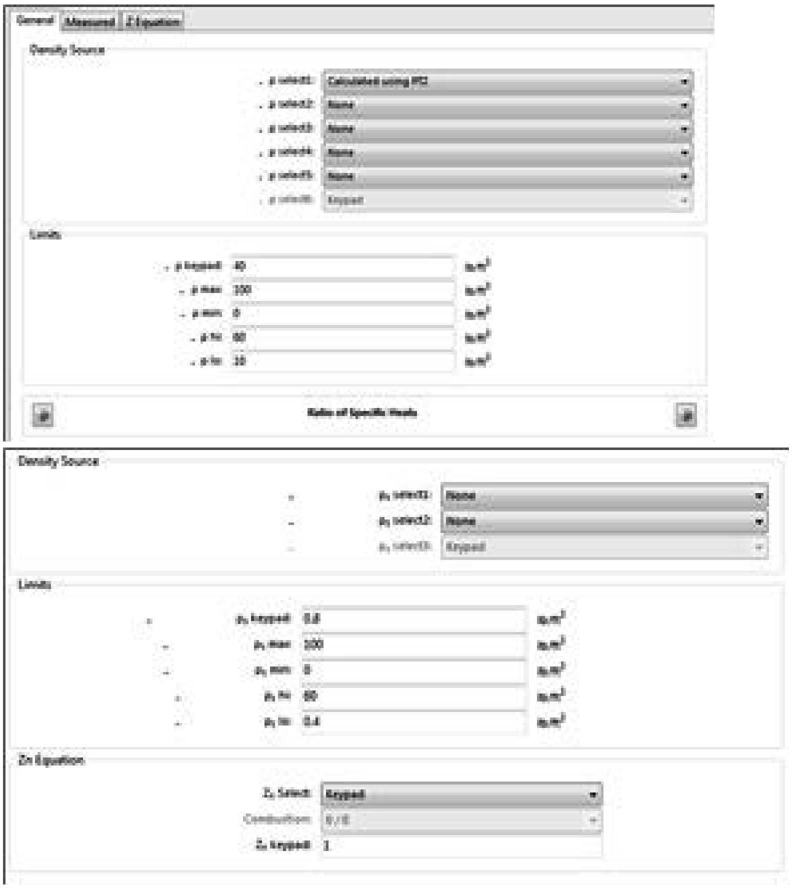


Figure 156 Prover line and base density

As they are identical to the stream density configuration.

10.2 Modbus link to stream flow computers

In case a dedicated prover computer is connected to multiple stream flow computers, then a pulse bus and an RS485 Modbus communications link needs to be setup, with the prover as the master and the stream flow computers as the slave. To setup a modbus master and slave, see volume 3.

There is a Modbus slave file included in the program files directory:

C:\Program Files (x86)\Krohne\SUMMIT 8800 Configuration\modbus

This file can be import to the Modbus slave configuration to automatically configure all necessary data for the steam flow computers.

Under modbus addresses, press import and select the correct file:

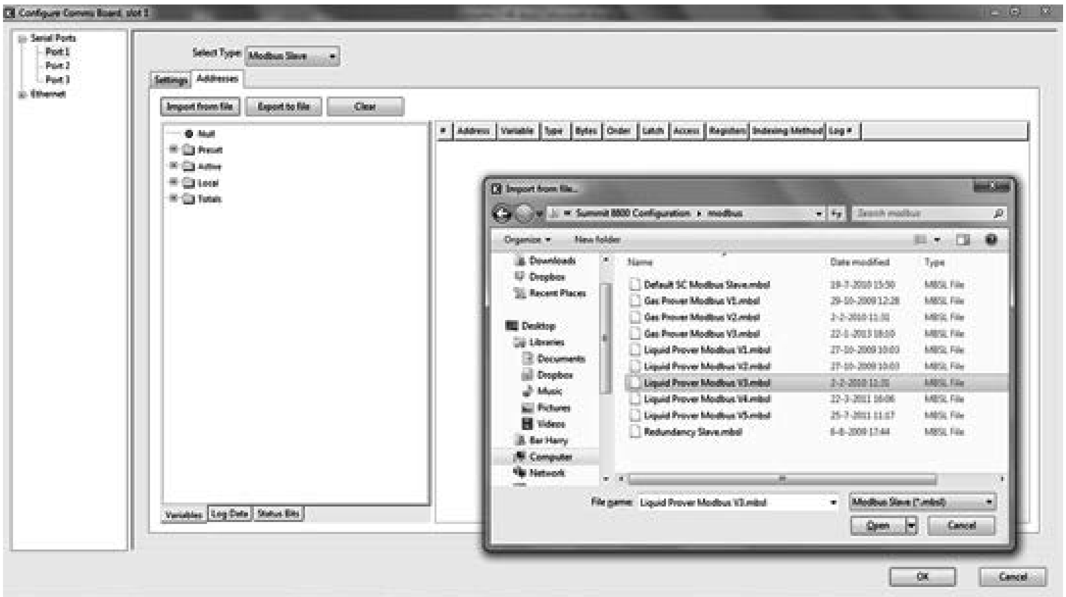


Figure 157 Prover modbus slave configuration

	Liquid	Gas	Steam

Valves are used in all metering applications from individual streams, to station and proving skids.
Up to 18 valves can be set by the flow computer for control purposes. Application can vary from simply opening and closing valves to controlling the valve position (e.g. for pressure or flow comtrol) or changing flow direction by a 4 way valve.
These valves are independent from the valves used for run switching and sampling, so the total number of valves can be far more than 18.

This page allows the user to configure the operation of each valve based on the type of valve connected to the SUMMIT 8800.
The following valve types are available for selection from the drop down menu:

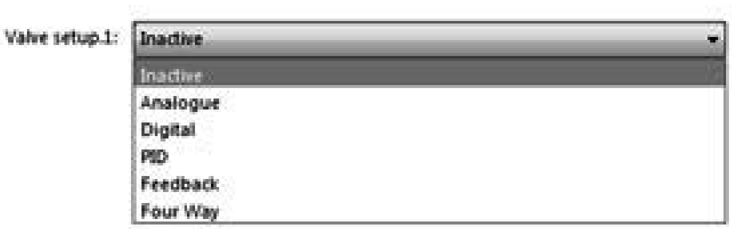


Figure 158 Valve options

Inactive	Not in use
Analogue	4-20mA signal operative set to a preset value and position
Digitial	Timed digital output with no feedback
PID	4-20mA signal used as a PID control output
Feedback	Digital switch output with open, close and transition time control coupled with digital status input to feedback valve position.
Four way	4 position valve control used in a liquid prover system.

NOTE: Valve output signals and in some cases input signals are configured in the hardware section under the relevant I/O board.
Valve alarm may occur.

11.1 Analog

A 4-20mA output will be used to control the valve. This value can be set either viamodbus or via the front panel of the flow computer.

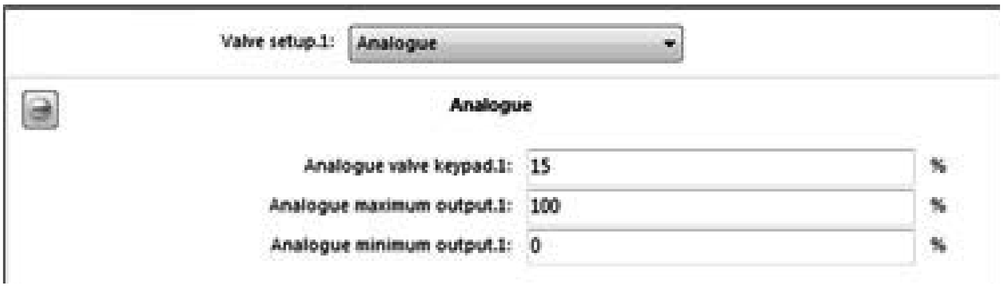


Figure 159 Analog valve

Keypad value	Value used if no set point is set.
Maximum output	The maximum valve opening percentage for 20 mA. Normally 100%: open.
Minimum output	The minimum valve opening percentage for 0 mA. Normally 0%: closed.

NOTE: Maximum and minimum values can be configured to prevent the output either fully opening or fully closing by setting the limits within the band set when configuring the output.

Please note that the actual hardware connection must be defined as an analog output in the hardware section (see volume 1).

The actual control of the valve must also be defined (see also volume 3):

- As a fixed keypad value, entered above
- In the modbus list to remotely control the value
- On display to locally control the valve

Select the control ID as follows:

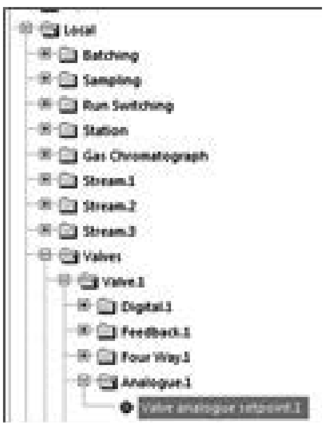


Figure 160 Analog valve setpoint

The valve output is configured as an analogue output.

Figure 161 Select the analog valve output ID

11.2 Digital

A digital output (status or pulse) will be used to control the valve. The valve can be controlled, viamodbus or via the front panel of the flow computer.

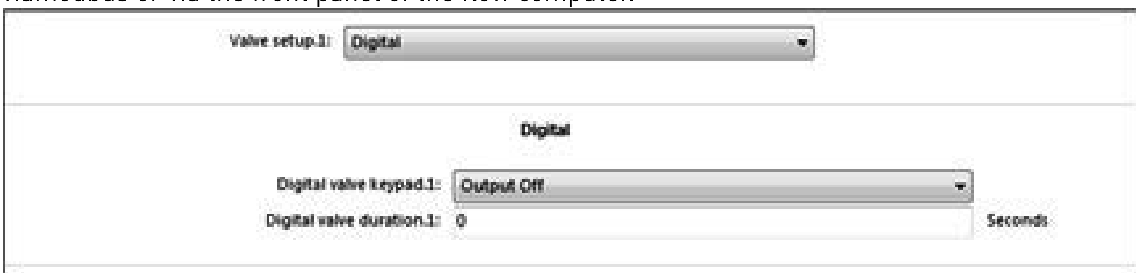


Figure 162 Digital valve

Keypad value	Value used if no set point is set.This can be on or off. Please take this into considuration that the hardware output can also be reversed.
Valve duration	Number of seconds the status output is active.

Please note that the actual hardware connection must be defined as a digital output in the hardware section (see volume 1). The type of output, status or frequency, depends on the valve duration (see earlier).
The actual control of the valve must also be defined (see also volume 3):

- As a fixed keypad value, entered above
- In the modbus list to remotely control the value
- On display to locally control the valve

In all cases select the ID as follows:

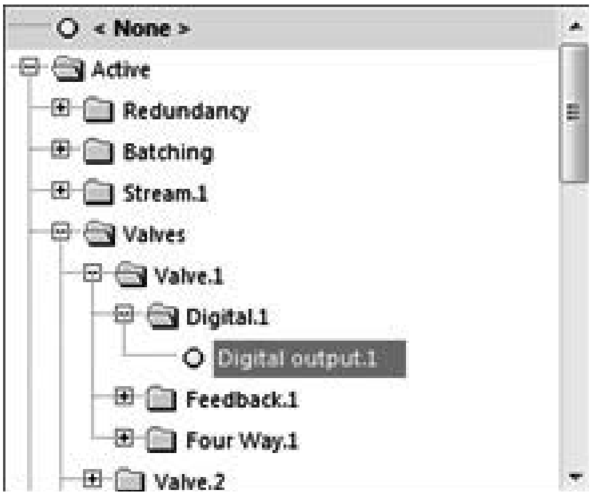


Figure 163 Select the digital valve ID

11.3 PID

A PID controller (proportional integral derivative) is a closed control loop to steer an output to a desired value (the setpoint). It uses a feedback system to calculate the difference between the output and the setpoint. The PID calculation tries to minimize this difference by adjusting the valve. Important is to set the correct PID parameters to optimize the error and speed.

An analog output will be used to control the valve, either as a direct output value of the PID algorithm or as a percentage of the maximum value of the PID output. The process value to be controlled can be any analog value, such as temperature, pressure or flow. The setpoint for the PID can be controlled viamodbus or via the front panel of the flow computer.

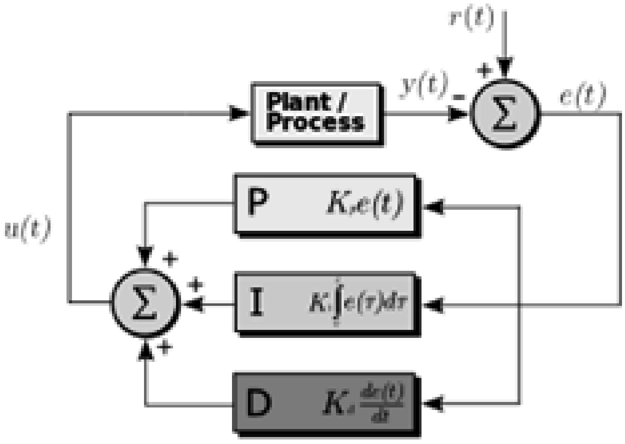


Figure 164 PID control loop

The PID valve has the following parameters:.

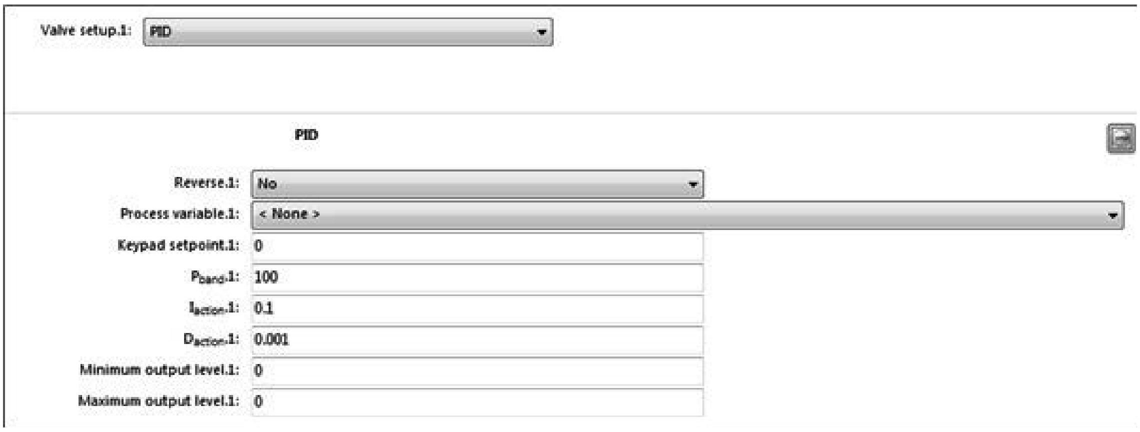


Figure 165 PID valve

Reverse	Flow reverse mode – yes or no
Process variable	Process value to be controlled
Keypad setpoint	Preset setpoint of the desired value
Proportional band	Time based on present error
Integral action	Accumlation of past errors
Deriviative action	Predicition of future errors
Minimum output level	Minimum valve output movement
Maximum output level	Maximum valve output movement

Please note that the actual hardware valve connection must be defined as an analog output in the hardware section (see volume 1).
The setpoint and the P, I and D values of the valve must also be defined (see also volume 3):

- As a fixed keypad value, entered above
- In the modbus list to remotely control the value
- On display to locally control the valve

Select the control ID as follows:

Figure 165 PID setpoint

The PID valve output is configured as an analogue output.

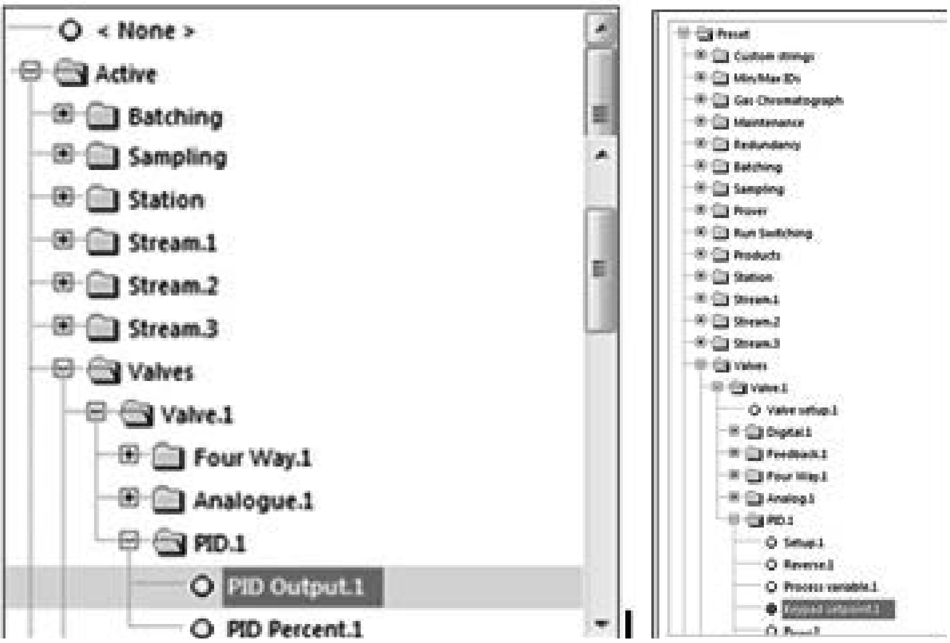


Figure 166 Select the PID valve ID and the Preset keypad setpoint ID

11.4 Feedback

For most vaves is is important to know if they realy opened or closed after a command has been given. Limit switches can be mounted or for electrical valves signals are generated in the cirquit to have two digital status feedback signals: one for open, one for closed.
Feedback valves can be opened and closed by two individual digital status outputs.
The SUMMIT will check if these signals are set within a specified period after a control signal is given.

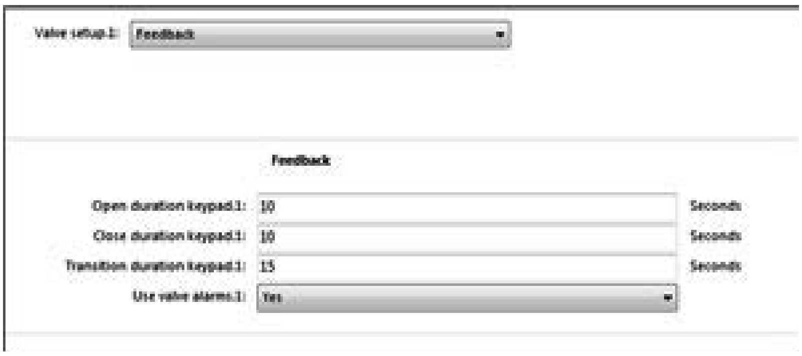


Figure 167 Feedback valve

Open and closed duration keypad	The length of time the corresponding command is sent.
Transition duration keypad	Maximum time allowed for the valve to move before a feedback signal should occur.
Use valve alarms	Select if an alarm must be generated if the transition time is exceeded.

Feedback valves are configured for digital switch input and pulse or state output.

The actual control of the valve must also be defined (see also volume 3):

- As a fixed keypad value, entered above
- In the modbus list to remotely control the value
- On display to locally control the valve

The valve control can be selected as follows:

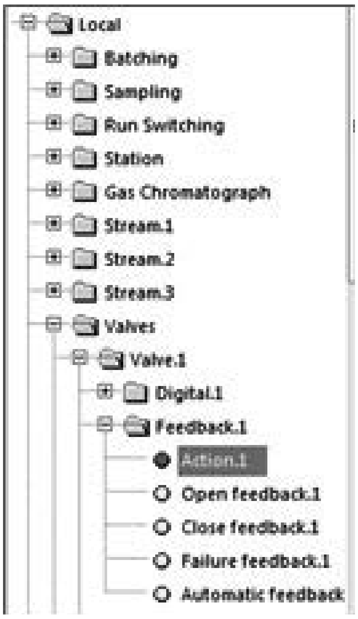


Figure 168 Open & close feedback action command

The feedback valve in- and outputs are configured as status signals:

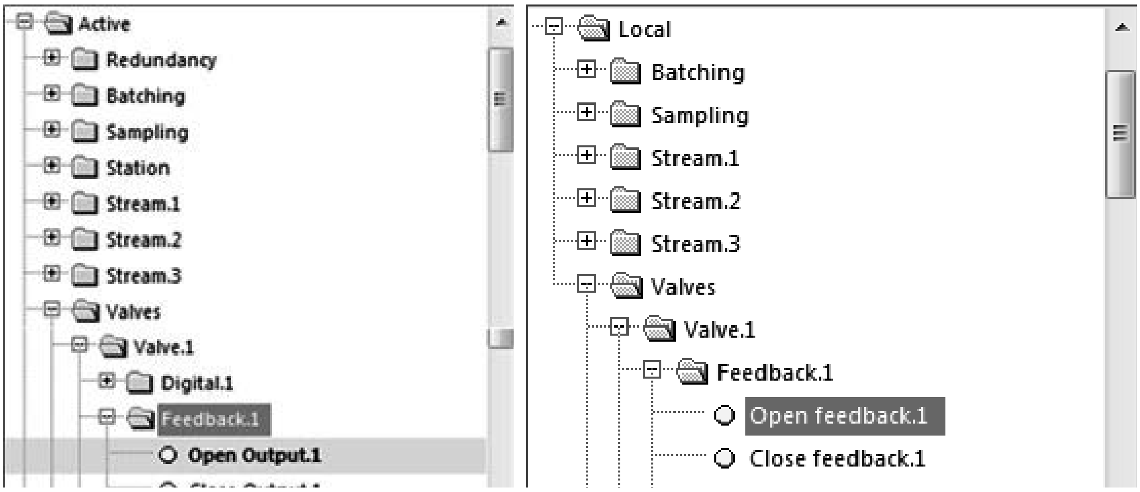


Figure 169 Open & close feedback valve signals: command and feedback

Feedback signals:	
Open and closed feedback	Status received from the valve
Failure feedback	Failure indicator received from the valve
Automatic feedback	Mode selection received from the valve

11.5 Four way

The four way valve, also known as a diverter valve, is often used to reverse a flow, but may be used for other purposes also. The valve opens and closes two different pipes, but only one will be opened and one will be closed at the same time.
Two signals are used to control the valve: forward and reverse which have digital status feed-back signals.

The parameters needed are:

Figure 170 Four way valve configuration for different leak sensors types

Parameters:	
Leak sensor	Source used to detect leaks:
- None	No leak sensor used
- Status	A digital status input is used to indicate if there is a leak
- Sensor	A analog or Hart input is used to connect a sensor to measure the leak size.
Leak detect	When to detect leaks
Open and close durations	Length of time the corresponding command is sent
Transition duration	Maximum time it should take for the valve tobmove. If time is exceeded then an alarm will occur.
In case a sensor is used:	
Leak sensor units	Units for the sensor
Sensor max and min	The Highest and lowest value the sensor can give
Use leak sensor units	In case of a Hart sensor: uses the sensor units instead of the earlier entered units
Correct leak sensor units	In case of a Hart sensor: uses the sensor units instead of the earlier entered units

The actual control of the valve must also be defined (see also volume 3):

- As a fixed keypad value, entered above
- In the modbus list to remotely control the value
- On display to locally control the valve

And can be selected as follows:

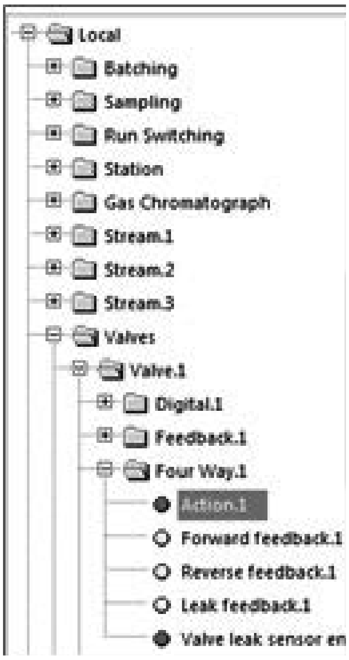


Figure 171 Four way valve action command

A four way valves are configured as two digital outputs, state or pulse:

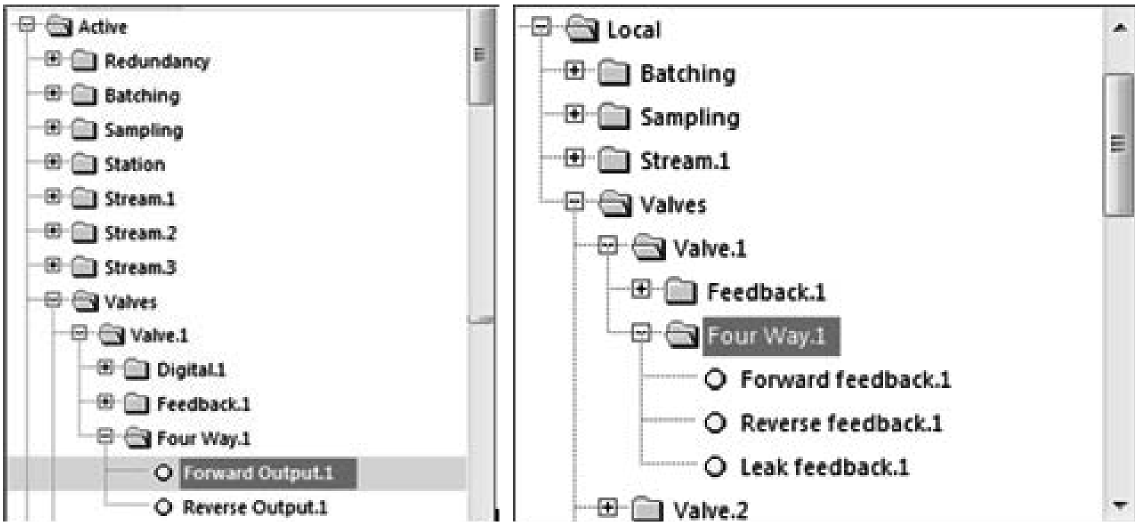


Figure 172 Four way valve digital output and input selection

If a digital status input is used to determine leak, see previous figure for the ID. A leak sensor can be selected as a HART or analogue input:

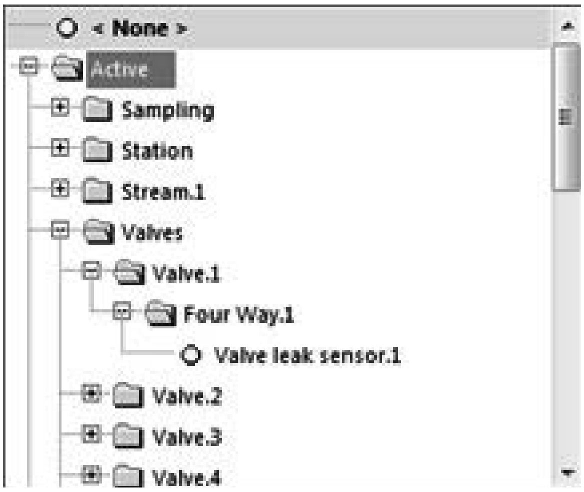


Figure 173 Four way valve leak sensor input

11.6 Digital valve alarm

A valve may have many different alarms. They can be used as individual alarms e.g. on screen and as outputs, but in many cases only one alarm per valve is required. Therefore the SUMMIT allows to group alarms based on valve status and monitoring conditions.
For instance one digital status output can user defined as a combination of valve 1 alarms:

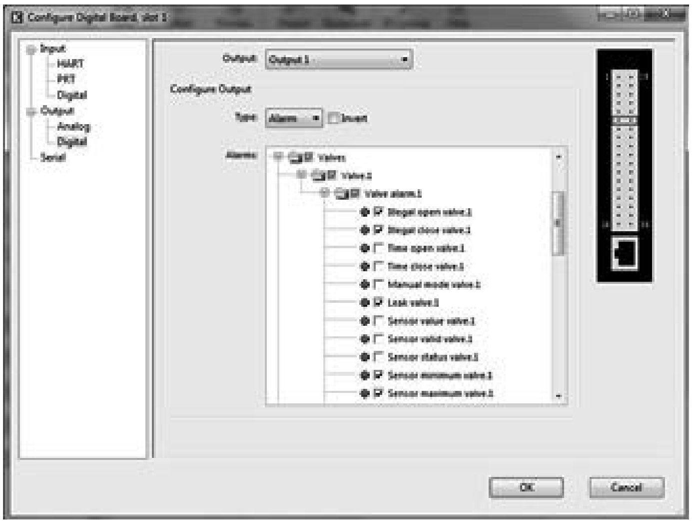
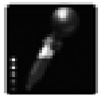


Figure 174 Digital alarm valve output

This is also possible for alarm logs.

	Liquid	Gas	Steam

For many applications it is necessary to monitor the quality or composition of the fluid going through the pipe. One of the ways to do so is to regularly collect a sample of fluid in a can or container and to take this to a laboratory analysis. The associated standards are the

ISO 3171, 1998, chapter 15	for the sample volume
API 8.2 appendix F	for the sample frequency, grab factor, performance factor etc.

In many cases only one sampler will be used for the station, but where multiple products are used multiple samplers might be needed. The SUMMIT can handle one sampler per stream.
In case of mass based sampling, the SUMMIT can handle two cans per sampler. The switching of cans has to be done manually, monitoring of the weight is done automatically, including tarring for bottle weight.
Many different methods are supported by the flow computer and have been devised to get the most relevant sample for an application. This varies on the sampler method (which period to take the sample) and the sampler frequency (how often to take a sample):

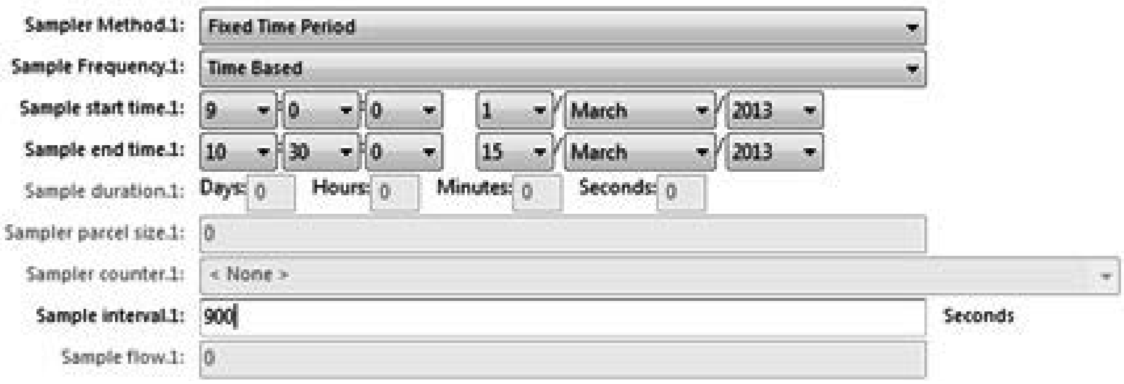


Figure 175 Sampler timed based configuration

12.1 Sampler method

Off	No sample is taken
Fixed time period	Sampling is activated from the start date/time to an end date/time
Duration	Sampling is actived for a fixed duration in days to seconds
Batch	Sampling is is based on the batch parcel size
Continuous	Sampling is always running

Sample frequency	
Time based	A sample will be taken periodically. The interval in seconds must be given
Flow based	A sample will be taken every time when a quantity of product has passed. In this case the ID must be selected from any of the available counter increments of volume, mass or energy (see below) and the quantity is defined as the flow passed.
Manual	A sample will be taken when manually triggered, or a request received via a modbus

Figure 176 Flow based sampler counter selection

Weighted sampler

Of course it is important to ensure that the sampler can is not overfilled. Here it is important to know if the check is done on volume or mass.
In case of mass, the weight of both the possible cans is checked. Please note that this is a check only against one or two analog inputs for the measured sampler can weight "can A and B input"

The parameters to check the cans are as follows:

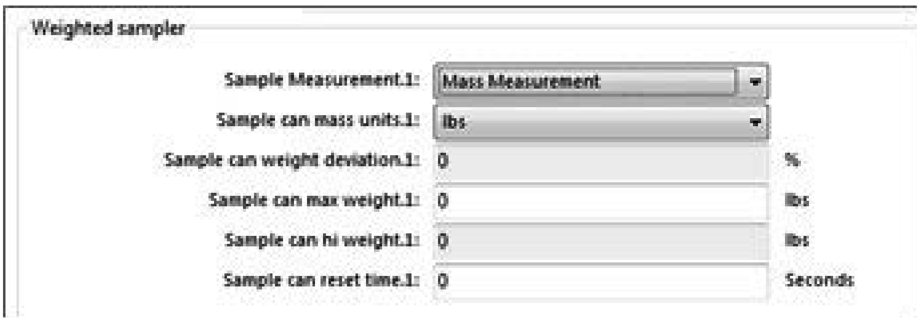


Figure 177 Sampler can weighing

Sample measurement	Measurement based on volume or mass
Sample can mass unit	Selectable units for mass measurement – ibs or kg
Sample can weight deviation	Maximum deviation allowed between sampling and the weight of can A and B
Same can maximum weight	Alarm limit for the weight of can A and B
Sample can high weight	Warning limit for the weight of can A and B
Sample can reset time	Change of can indication resetting all preset information (not implemented yet)

Flow limits

It is important to get a representative sample in the can. If the flow is very low this might not be the case. Simularly if the flow is too high, the flow to be counted in the error counters instead of the normal counters, so the sample would not reflect the normal count. For this reason, limits can be set outside which sampling may not occur:

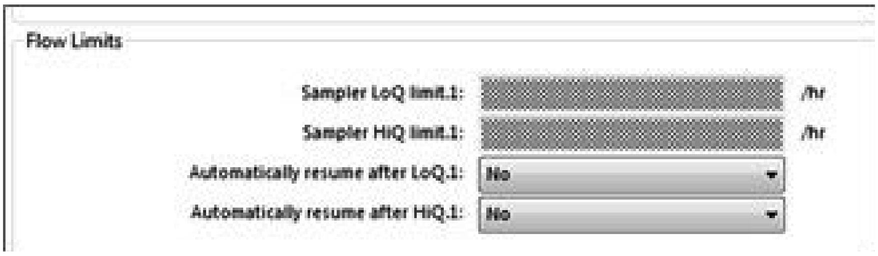


Figure 178 Sampler can flow limits

Sampler low and high flow limit	Low and high flow limits to stop sampling
Automatically resume after low and high flow	Restart sampling automatically after returning to normal

Sampler can

Also in case of volume measurement it is important to ensure that the sampler can is not overfilled. For this reason there is an analog input for the measured can level "can input" in volume % of full

This is compared to a can level calculated by the sampler, using the following parameters:

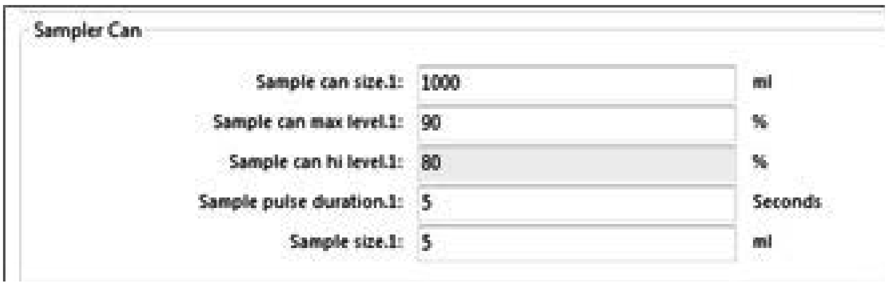


Figure 179 Sampler can calculated can level parameters

Sample can size	Can size in ml
Sample can maximum level	Alarm limit can level, in percentage of the ml
Sample can high level	Warning limit level, in percentage of the ml
Sample pulse duration	The time, in seconds, the output will be set to take one sample
Sample size	The quantity of product, in ml, of the sample being captured

Deviation alarms

It is important to verify the proper operation of the sampler. There could for instance be a faulty valve which would not open or which is leaking. For this reason, there is the option to check for deviation between the measured and calculated can level:

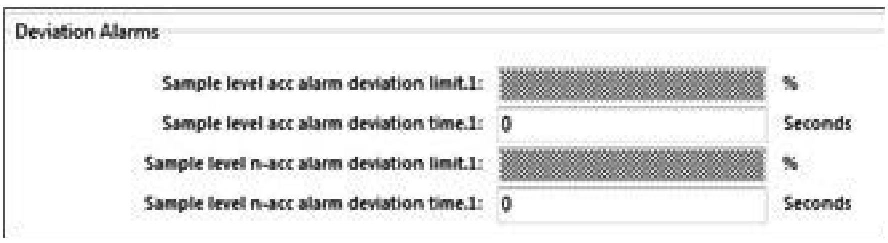


Figure 180 Sampler can calculated volume % full parameters

(non-)Accounteble alarm deviation limit	The % deviation between measured and calculated % full
(non-)accountable alarm deviation time	The time this deviation must be present before generating an alarm

Sampler ID's and hardware I/O selection

The sampler has many ID's associated to the operation. Furthermore, like any other equipment, must be configured in the hardware selection using the inputs and outputs as available and required. Here an overview of some of the important ID's:

Sampler status
The most important ID is the sampler status information, as can be found under active:

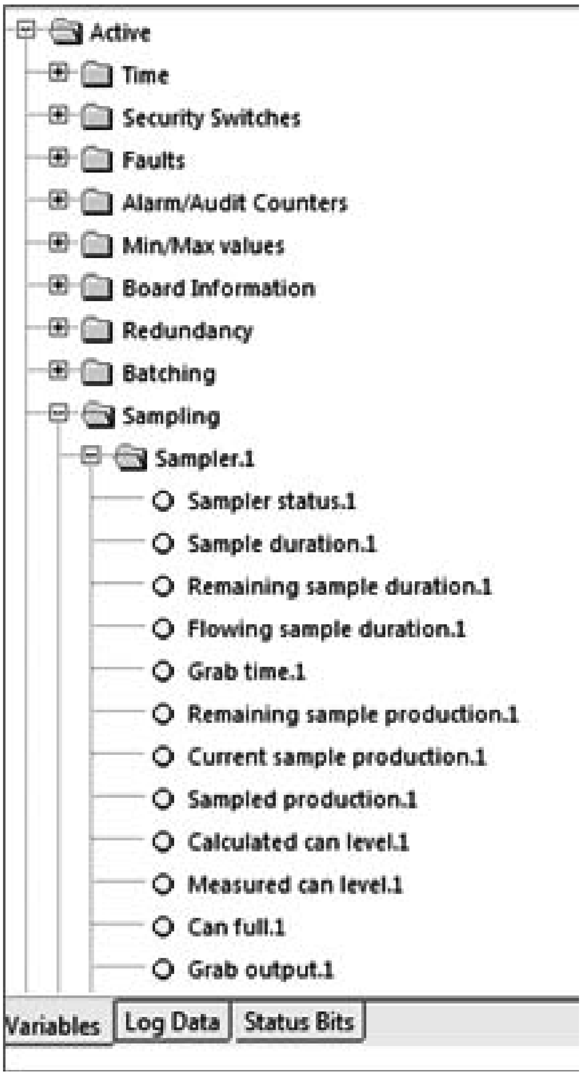


Figure 181 Sampler status information

This sampler status can be
- Idle
- Sampling
- Can Full
- Paused
- High Flow

- Low Flow
- Complete
- Waiting
- No Sample Can
- No Sample Tear

Digital grab output

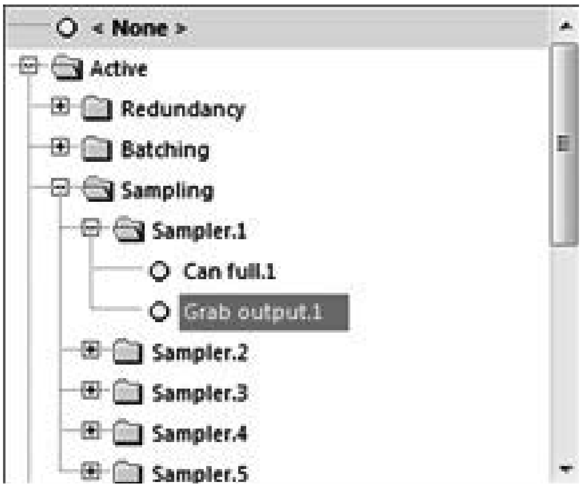


Figure 182 Sampler digital grab output

Measured can level

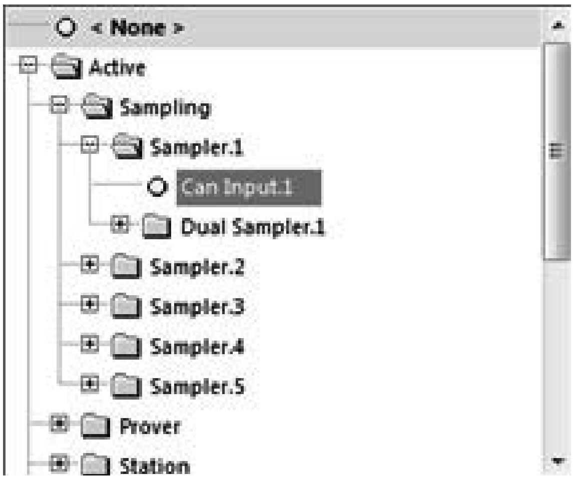


Figure 183 Sampler can measured can level

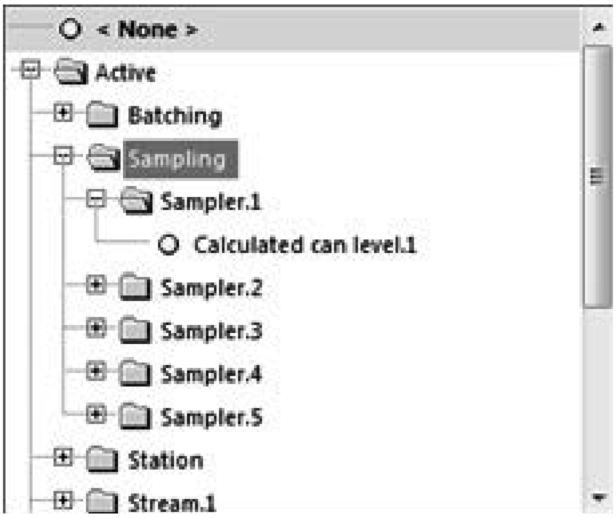


Figure 184 Sampler analogue output selection

Measured can A and B weight

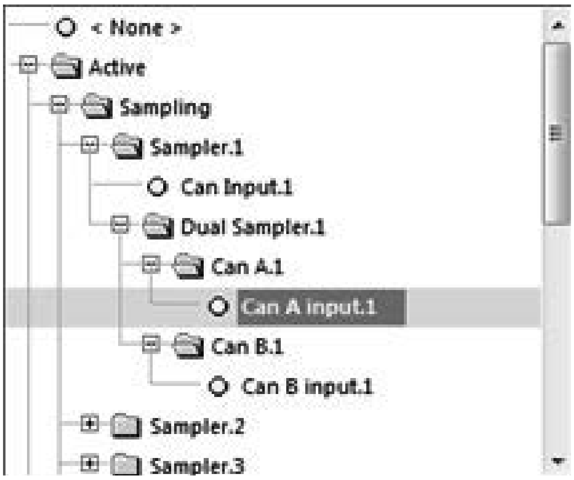
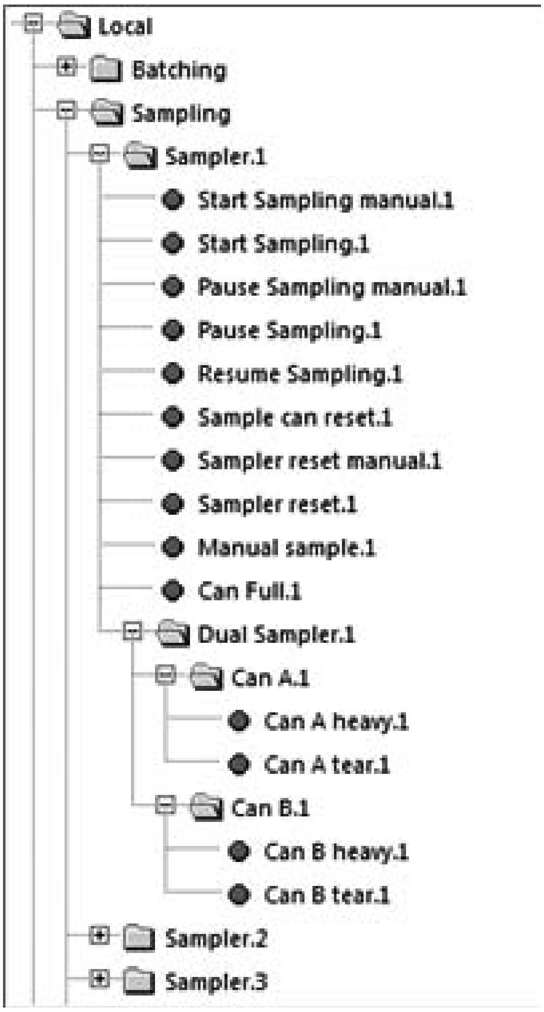


Figure 185 Sampler can weight inputs

Sampler control signals



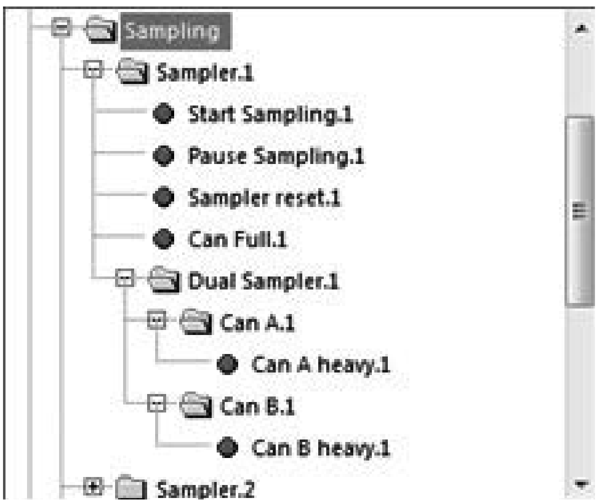


Figure 186 Sampler digital input selection

The sample may only be reset when sampling status is either full, paused or complete. Any reset requests received when the sampler is in another state will be ignored.

The entire sample mechanism may also be reset when the sampling status is in one of the three states. It is recommended that this reset is used when any preset data relating to the sampler is changed. Resetting this also resets the sample can information.

Sampler alarms

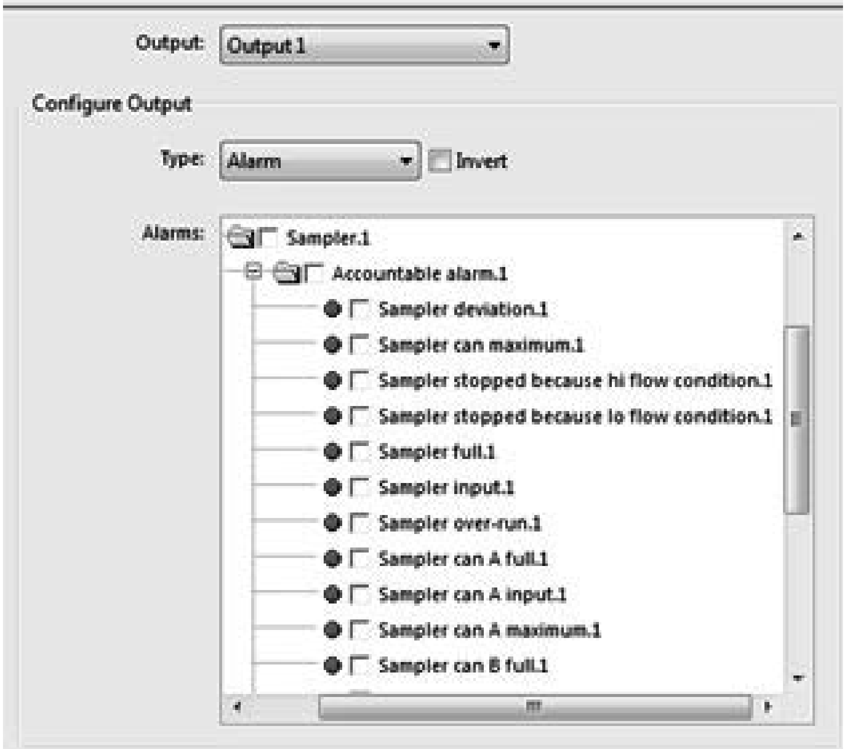
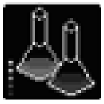


Figure 187 Sample accountable alarm selection

A digital status output may be a combination of any of above alarms.

.

	Liquid	Gas	Steam

In the oil industry one and the same pipes is often used to transport different products one after the other, or batch by batch. The process to do so is called batching and is used for:

- Pipeline transfer, e.g. to refineries
- Drum filling
- Truck, train and ship loading
- Mixing applications

The SUMMIT 8800 has 5 independent batching functions for each stream plus one station batching. Batching can be continuous, until an manual or automatic switch to a new batch occurs. Batching can also be based on transfer of a fixed volume or mass after which the batch stops, e.g. in filling applications.

For the configuration, see the next chapters.

13.1 General

Figure 188 Batching general selection

Preset batch type	The method used for batching:	Explanation
	None	No batching used
	Fixed	Batching based on fixed quantity to be transported
	Continuous	Continuous batching, flowing until an event occurs
Preset batch measurement	Volume or mass batch based measurements	
	Volume USC or Metric	
	Mass USC or metric	

Fixed batch information

For fixed batching it is often wise to slowly open and close the valve to prevent hammering, damaging the pipe or meter. For this a PID flow control valve is used to ramp up and down. On top of this often a preload is used to fill the pipe and an afterload is used to be able to stop the flow accurately. This gives a following diagram:

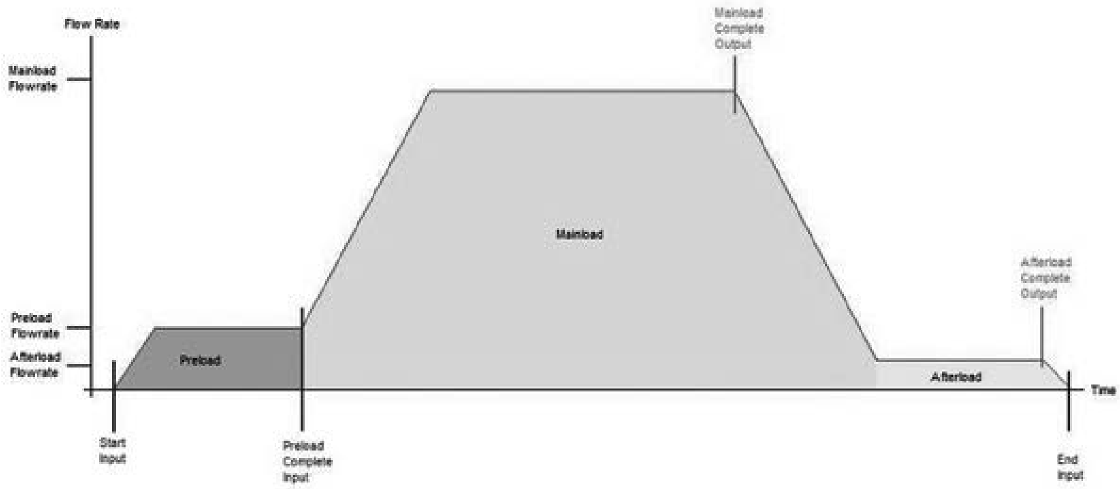


Figure 189 Fixed batching trigger

Please note the inputs (start, preload complete and end) and the output (afterload complete) in the diagram.
The parameters can be configured within this section.

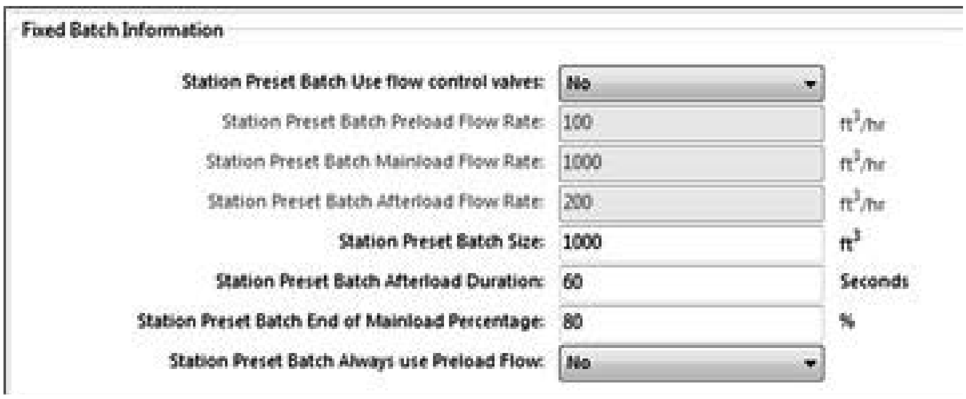


Figure 190 Batching fixed batching selection

Use flow control valves	Are flow control valves being used for batch control – yes or no
If yes:	
Preload flow rate	Required flow rate prior to start of batch
Main load flow rate	Required flow rate for main batch process
Afterload flow rate	Flow rate at the end of the batch process
Preset batch size	Product batch amount
Batch afterload duration	Time required at afterload flow rate
Main load percentage	Batch completion before afterload starts
Always use preload flow	The option to use the flow measured during preload– yes or no

Stream selection
For station batching only, the streams involved can be selected:

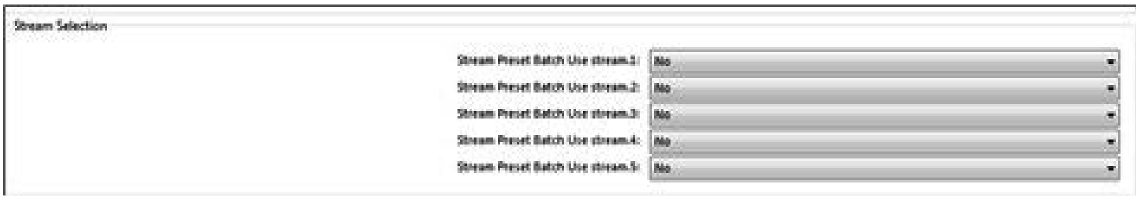


Figure 191 Station batching stream selection

Use stream 1..5 Select which stream used in the station batching process.

Batching information
Tags relating to the station stream being used.

Figure 192 Batching information

Batch information
Any text useful to identify a batch

Recalculation
In case a prove is done during the batching process, the results of the prove can be effective immediately after the prove or they can be considered to be valid over the complete batch. In the latter case the batch results before the prove is finished must be recalculated to match the prove results.

The recalculation tab allows the configuration of the variables that are to be used when the reports are created.

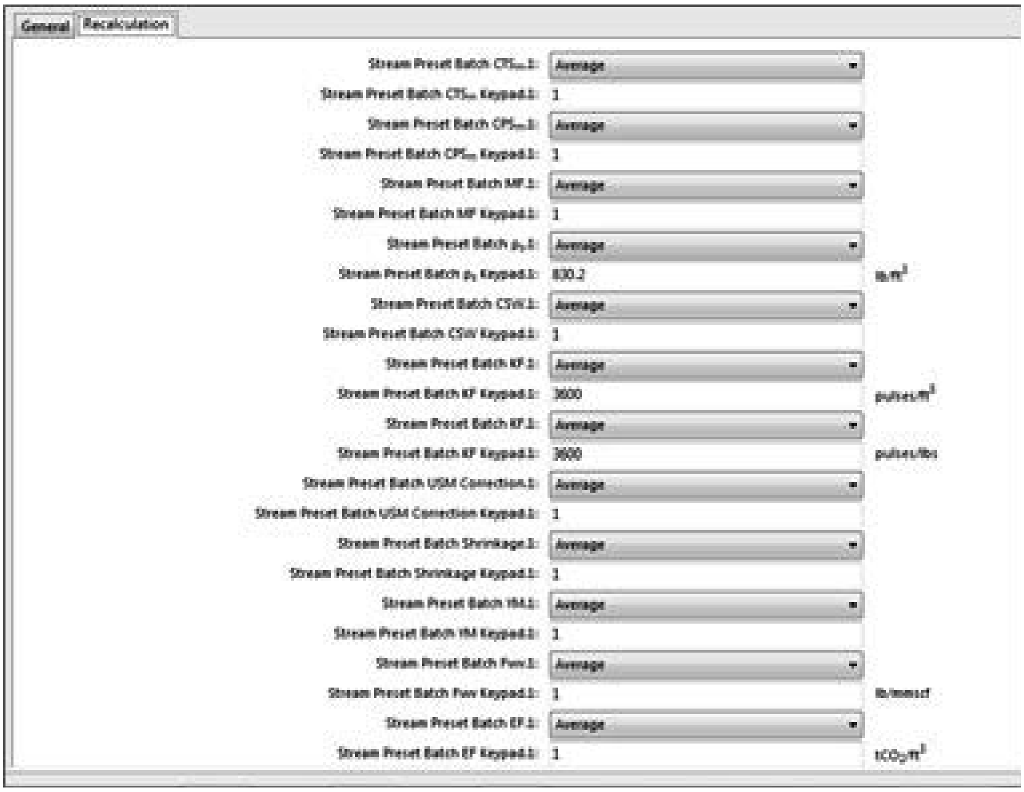


Figure 193 Batching parameters to be recalculated

For each listed parameter the user is present with a selection with the value used for the recalculation report:

Average	The average sum value for the given parameter
Keypad	A user defined fixed value
Start	The value determined at the start of the batch
End	The value determined at the end of the batch
Current	The current value being used at the time of report generation

This selection can be made including the keypad value for the following parameters:

CTSm	Meter expansion due to temperature
CPSm	Meter expansion due to pressure
MF	Meter factor
ρS	Standard density of the liquid
CSW	Correction sediment & water
KF	K-factor for volume (e.g. pulses/m3)
KF	K-factor for mass (e.g. pulses/kg)
USM correction	Corrections on the ultrasonic meter
Shrinkage	The shrinkage factor
YM	Linearisation curve of the meter
Fwv	Water Content Volume Factor
EF	Emission factor (CO2 calculation)
OF	Oxidation factor (CO2 calculation)
Hx	Heating value (inferior or superior)

Batching hardware configuration

Batch control

Triggers are based on digital inputs and outputs and analogue outputs for recalculations.
Alarms can also be selected from digital alarm status.

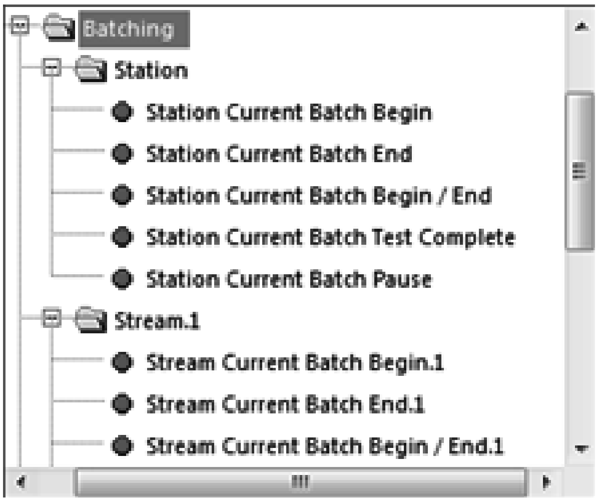


Figure 194 Batching digital input selection

Batch analog results

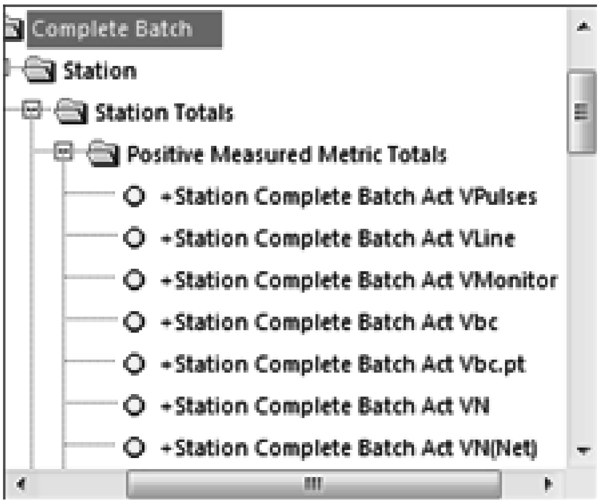


Figure 195 Batching analogue output selection

Continuous batch

Triggered based signals to start and end new and current batches – this trigger can be displayed on the main menu of the flow computer screen and/or received as a signal.

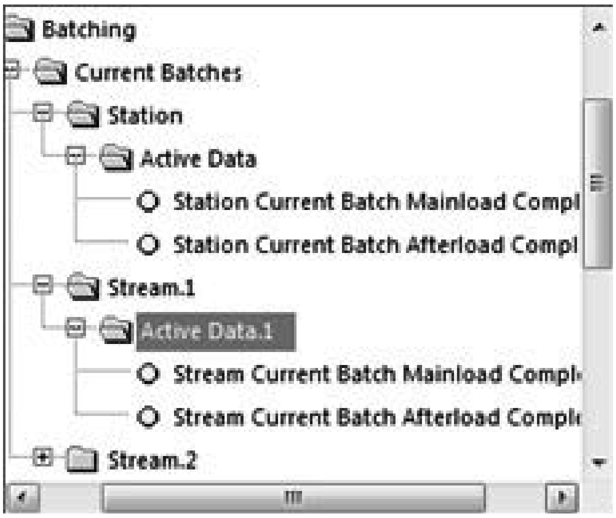


Figure 196 Batching digital output selection

Batch alarms

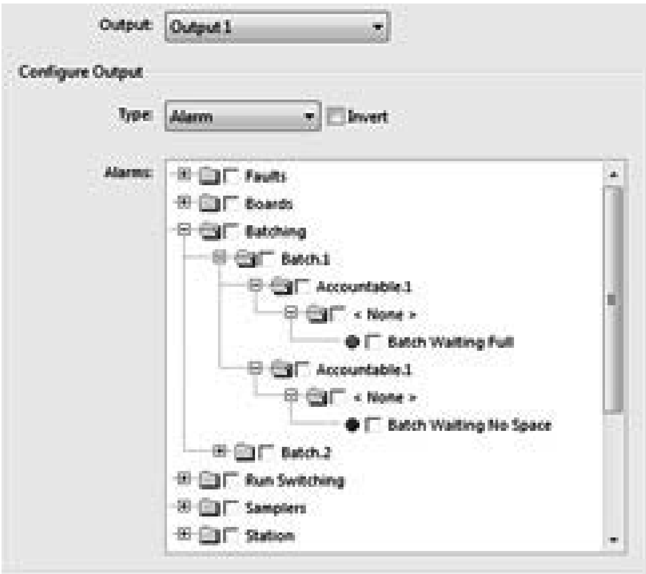
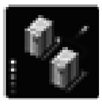


Figure 197 Batching alarm status

	Liquid	Gas	Steam

14.1 Introduction

The SUMMIT has a health based redundancy feature. Its primary objective is to prevent down time or failure that will affect the custody transfer of fluid.

Two SUMMIT flow computers can be put in redundancy mode, where both computers are running the same application in parallel with one assigned as the duty and one as the stand-by. Both computers check the correct running of the other by two modbus interfaces between them.

Modbus master	The main link to read the other computer's status and the "loop-back" of its own status.
Modbus slave:	The link to write its own status to the other flow computer and to "loop-back" the status read from the other flow computer.

If the information is not arriving a communication alarm will be given. At that moment the flow computer will use the other link to get the other flow computers status including its time. If the time deviates too much from the system time, than this is an indication that the other flow computer failed.
See also volume 1 for the hardware connections and volume 3 for modbus coinfiguration..

On top of this each computer monitors its health and compares it with the heath of the other flow computer. To determine the health, each alarm occurring in the flow computer or associated equipment can be associated with a penalty. An ideal running system is then 100% healty, with alarms the health will go down.

Once the health of duty machine is lower than that of the standby machine the duty and standby nominations will switch over. To prevent continuous switch-over score by a preset switch-over value and a switch-over time is introduced.

14.2 Global redundancy

Here the user enables the function and assigns the flow computer as either duty or standby. It is assumed that a system consists of a duty and a standby flow computer that are in communication with each other.

Found under the general tab, this section allows a system redundancy to be set-up:

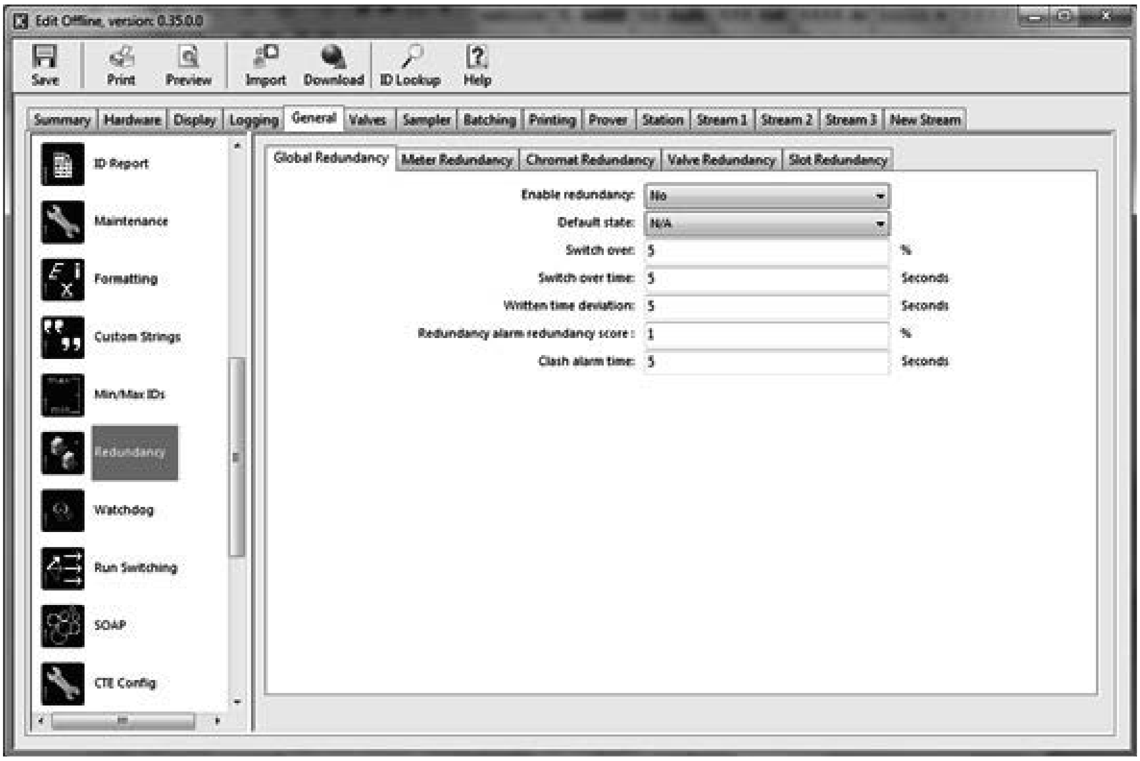


Figure 198 Global redundancy

Enable redundancy	Set Enable to "Yes" to use the redundancy feature
Default state	Set the initial state of this flow computer position as standby, duty or not used
Switch over	Set the value for the health difference between the flow computers to switch over
Switch over time	Set the time the difference must exist before switching over
Written time deviation	Maximum defined allowable time deviation between the other and the system time
Redundancy alarm score	The penalty for a redundancy alarm, e.g. a comms alarm.
Clash alarm time	Sets a time period allowed for switching of duty/ stand-by before an alarm is raised.

14.3 Redundancy Parameters

These pages deal with the essential flow measurement to determine the health of the system. Penalty points can be assigned to measurements that are failing. A complete healthy system is 100% healthy, any of the failures lower its health by the value entered with the measurement. The measurements are grouped in four area's:

Redundancy alarm	The penalty for a redundancy alarm (see global redundancy)
The meter.	All essential measurements to calculate the flow
The chromatograph	The penalty for a failing chromatograph
Valves	The penalty for failing valves
Slots	The penalty for alarms for the 6 slots, such as hardware failures or when an inserted board does not match the configured board

14.4 Redundancy ID's

Figure 199 Redundancy ID's

The following ID's are important:

My state	The state of this flow computer: N/A, duty or stand-by
Other state	The state of the associated flow computer
My health	The health of this flow computer in %
Other health	The health of the associated flow computer. • Normally this is the "Other state (R)" • If there is a comms alarm with no time deviation exceeded this is "Other state (W)" • If there is a comms alarm with time deviation exceeded this is "invalid"
Other state (R)	The state of other computer as received via modbus master (read from the other)
Other health (R)	The health of the other computer as received via modbus master (read from the other)
Other state (W)	The state of other computer as received via the modbus slave (written by the other)
Other health (W)	The health of the other computer as received via the modbus slave (written by the other)
Time (W)	The time of the other computer as received via the modbus slave (written by the other)
State output	Set when "my state" is duty

15.1 Versions/ Revisions

First Digit Major Revision that affects Compatibility of Software with Configuration data, most likely used when new software features are added or hardware features are added.
Second Digit Minor Revision that affects Compatibility of software with Configuration data, most likely used when major modifications are made to existing software or hardware features.
Third Digit Bug fix revision, compatibility with any existing configurations or set ups is not affected by such changes.
Forth Digit Bug fix revision to existing bug fix revision, again compatibility with any existing configuration or set up is not affected by this change type.

Example of coding: 0.34.2.1
Major revision 34, minor revision 2 whch includes minor bug fixes revision 1

15.2 Current versions

There are two sets of versions, the

- Latest version: includes all the features that are available in the SUMMIT 8800.
- Approved MID version: includes only the features that are tested by the certification for MID approval.

The latest version start with a main version revision 0, the MID versions with 1 and above.

15.2.1 Latest version 0.35.0.0

Type Board	Version	Date	Checksum
SUMMIT8800_Main	0.35.0.0	2013-03-01	0x14B3F2C1
SUMMIT8800_Boot	0.26.0.0	2011-07-25	0x01AAC8CC
AIOboard_Main	0.4.0.2	2010-11-24	0x004D9958
DIOboard_Main	0.4.0.2	2010-11-24	0x004D588F
DIO2board_Main	0.1.0.1	2010-11-24	0x004BFE39
SIOboard_Main	0.2.0.1	2010-11-24	0x0043DAE2
Commsboard_Main	0.9.0.0	2012-11-06	0x0137E837
DualEthernet_Main	0.5.0.1	2012-12-19	0x00F14370
BoardBoot	0.5.0.0	2011-02-17	0x000CC299
SUMMIT Configurator	0.35.0.0	2013-03-04	N.A.

15.2.2 Approved version MID2.4.0.0

Based on the following versions of firmware and configurator:
SUMMIT 8800 Configurator: 0.32.1.1
SUMMIT 8800 Firmware: 0.32.1.0

Type Board	Version	Date	Checksum
SUMMIT8800_Main	2.4.0.0	2012-07-27	0x13BE3F70

SUMMIT8800_Boot	0.26.0.0	2011-07-25	0x01AAC8CC
AIOboard_Main	2.4.0.0	2012-07-27	0x004C29FA
DIOboard_Main	2.4.0.0	2012-07-27	0x004C0DE0
DIO2board_Main	2.4.0.0	2012-07-27	0x004AC67A
SIOboard_Main	0.2.0.1	2010-11-24	0x0043DAE2
Commsboard_Main	0.8.0.0	2012-05-29	0x0137E837
DualEthernet_Main	0.4.0.0	2012-05-29	0x013DE995
BoardBoot	0.5.0.0	2011-02-17	0x000CC299
SUMMIT Configurator	2.4.0.0	2012-07-27	N.A.

16.1 Perform meter curve linearisation

For liquid meter correction an individual meter factor or K-factor curve of points can be entered. Up to 20 flow rates with a corresponding K-factor can be entered.

The correction of K-factor and/or frequency may be entered via the keypad under access control. A separate trigger point is provided to put all the new entered values into use at the same moment, which avoids any problems with temporary inconsistent data.

The flow computer searches the table to find an index 'I' so that fi < f < fi+1. If it succeeds in finding a suitable pair of points before reaching the end of the table, the exact K-factor is calculated by linear interpolation:

$$K_{f,lin} = K_{f,i} + (K_{f,i+1} - K_{f,i}) * \left[\frac{f - f_i}{f_{i+1} - f_i} \right]$$

Equation 6 Liquid K-factor calculation

f	Measured frequency [Hz]
fi	Nearest stored frequency in meter curve below f [Hz]
fi+1	Nearest stored frequency in meter curve above f [Hz]
Kf, i	Stored K-factor at fi [pulse/m³]
Kf, i+1	Stored K-factor at fi+1 [pulse/m³]
Kf, lin	Interpolated K-factor [pulse/m³]

If no pair of points can be found that bracket the actual frequency, the single frequency point closest to the measured value is selected. The corresponding K-factor is then applied without adjustment.

16.2 Linear corrected volume flow [m3/h]

The flow computer calculates actual volume flow rate as:

$$q_{line} = \frac{f}{K_{f,lin}} * MF * 3600$$

Equation 7 Actual volume flow rate

qline	Gross volume flow rate [m³/h]
f	Frequency [Hz]
Kf, lin	Linearised K-factor [pls/m³]
MF	Meter factor from proving [-]

The linearised K-factor is based on K-factor corrected with the meter curve linearisation

The meter factor is determined from proving. When the proving is completed the controller will calculate an average value for the new meter factor to be used by the duty meter. This meter factor has to be manually entered in both flow computers.

16.3 Perform meter body correction

The system corrects the volume flow for the impact of pressure and temperature on the geometry of the flanged meter body according to ISO standard 17089-1.
Simplified direct single-stage calculation is used which estimates the effect for pressure and temperature:

1) Body temperature effect

$$\left(\frac{Q_1}{Q_0}\right)_{bodytemperature} = 1 + \left(3 * \alpha * \Delta T\right)$$

Equation 8 Meter body temperature effect

Where:

Q1/Q0	flow correction factor for the meter output [-]
α	thermal expansion coefficient [K-1]
ΔT	temperature difference [K]

With:

$$\Delta T = T_{\varphi} - T_{cal}$$

Equation 9 Delta temperature

Where:

Top	Field operation temperature [K]
Tcal	Calibration temperature [K]

2) Body pressure expansion

$$\left(\frac{Q_1}{Q_0}\right)_{bodypressue\ \max} = 1 + \left(4 * \left(\frac{a^2 + R^2}{a^2 - R^2} + \sigma\right) * \frac{\Delta P}{E}\right)$$

Equation 10 Meter body pressure expansion

Where:

Q1/Q0	correction factor for the meter output [-]
R	inside pipe radius [m]
a	outside diameter of the meter body [m]
σ	Poison's ratio [-]
ΔP	pressure difference [Pa]
E	modulus of elasticity [Pa]

With:

$$\Delta P = P_{\varphi} - P_{cal}$$

Equation 11 Delta pressure

Where:

Pop	Field operation pressure [Pa]
Pcal	Calibration pressure [Pa]

3) For both directions the volume flow rate is corrected as follows:

$$q_{bt} = q_{line} * \left(\frac{Q_1}{Q_0}\right)_{bodytemperatur} * \left(\frac{Q_1}{Q_0}\right)_{bodypressue\ max}$$

Equation 12 Bi-directional volume flow rate

Where:

qbt	Corrected volume flow [m3/hr]
qline	Uncorrected volume flow [m3/hr]

16.4 Low flow cut-off control

The low flow cut-off, entered in m³/h, determines whether the stream status is on-line or off-line. As well as controlling the display status, this limit determines whether the stream can be considered 'non-flowing' to enter or leave maintenance mode. The default value is around the +/- 1%. Environment conditions may have an influence on this setting.

16.5 Retrieve base density

The flow computer receives the base density from a keypad value of 1050kg/m3 at base conditions.

16.6 Temperature correction factor to base

The temperature correction factor to standard temperature is calculated by inserting the duty stream temperature in:

$$\Delta T = (T - \mathrm{T}_{std})$$

Equation 13 Delta temperature base correction

Followed by:

$$\mathrm{C}_{tld} = \exp[-\alpha_b \Delta\mathrm{T}(1 + 0.8\alpha_b \Delta\mathrm{T})]$$

Equation 14 Liquid temperature correction

Ctld	Correction for liquid temperature at stream [-]
αb	Oil thermal expansion coefficient at standard temperature [1/°C]
ΔT	Temperature difference from standard temperature [°C]

For the first iteration, the line density is inserted for αb in the equation below. After this, the value of αb from the previous iteration is used:

$$\alpha_b = \frac{K_0}{\rho_b^2} + \frac{K_1}{\rho_b} + K_2$$

Equation 15 Liquid thermal expansion

αb	Oil thermal expansion coefficient at standard temperature [1/ C]
K0	API constant [-]

K1	API constant [-]
K2	API constant [-]
ρb	Base density [kg/m³]

NOTE:
API constants K0...K2 are set for refined product.

16.7 Pressure correction factor to base

The pressure correction factor Cpld is calculated by inserting the gauge version of the duty stream pressure in:

$$C_{pld} = \frac{1}{1 - b * P_g}$$

Equation 16 Liquid pressure correction

Where b is calculated by inserting the duty stream temperature in:

$$b = \exp\left[-1.6208 + 0.00021592 * T + \frac{0.87096 * 10^{6}}{\rho_b^2} + \frac{4.2092 * 10^{3} * T}{\rho_b^2}\right] * 10^{-4}$$

Equation 17 Liquid compressibility calculation

Cpld	Correction for liquid pressure at the duty stream [-]
Pg	Stream pressure [bar(g)]
b	Oil compressibility factor [1/bar]
T	Duty stream temperature [C]
ρb	Base density [kg/m³]

16.8 Line density

The flow computer calculates the line density, based on the base density in-use from GC, according to the API-2540 standard.
The Line density is then estimated according to:

$$\rho_l = C_{tld} * C_{pld} * \rho_b$$

Equation 18 API line density

ρb	Base density [kg/m³]
ρl	Fully-corrected line density [kg/m3]
Ctld	Correction for liquid temperature at stream [-]
Cpld	Correction for liquid pressure at the duty stream [-]

16.9 Mass flow [t/h]

$$q_m = \frac{q_v * \rho_l}{1000}$$

Equation 19 Gross mass flow

qm	Gross volume mass flow rate [t/h]
qv	Gross volume flow rate [m³/h]
ρl	Fully-corrected line density [kg/m3]

Standard volume flow [Sm3/h]

$$q_n = q_b \; * C_{tlm} * C_{plm}$$

Equation 20 Standard volume flow rate

qn	Standard volume flow rate [Sm³/h]
qbc	Corrected volume flow rate [m³/h]
Ctlm	Correction for liquid temperature at the meter [-]
Cplm	Correction for liquid pressure at the meter [-]

If the operating temperature and pressure is different from the conditions at high pressure calibration, the cross sectional area of the flow meter will change slightly. The following correction can be applied to the raw flow rate to compensate for this effect. The basic configuration has no meter body correction applied.

17.1 Perform meter body correction

If the operating temperature and pressure is different from the conditions at high pressure calibration, the cross sectional area of the flow meter will change slightly. The following correction can be applied to the raw flow rate to compensate for this. The basic configuration has no meter body correction applied.

Meter body correction calculations

The system corrects the volume flow for the impact of pressure and temperature on the geometry of the flanged meter body according to ISO standard 17089-1.
Simplified direct single-stage calculation is used which estimates the effect for pressure and temperature:

1) Body temperature effect

$$\left(\frac{Q_1}{Q_0}\right)_{bodytemperature} = 1 + \left(3 * \alpha * \Delta T\right)$$

Equation 21 Meter body temperature effect

Where:

Q1/Q0	Flow correction factor for the meter output [-]
α	Thermal expansion coefficient [K-1]
ΔT	Temperature difference [K]

With:

$$\Delta T = T_{\varphi} - T_{cal}$$

Equation 22 Delta meter body temperature

Where:

Top	Field operation temperature [K]
Tcal	Calibration temperature [K]

2) Body pressure expansion

$$\left(\frac{Q_1}{Q_0}\right)_{bodypressue\ \max} = 1 + \left(4 * \left(\frac{a^2 + R^2}{a^2 - R^2} + \sigma\right) * \frac{\Delta P}{E}\right)$$

Equation 23 Meter body expansion

Where:

Q1/Q0	Correction factor for the meter output [-]
R	Inside pipe radius [m]
α	Outside diameter of the meter body [m]
σ	Poison's ratio [-]
ΔP	Pressure difference [Pa]
E	Modulus of elasticity [Pa]

With:

$$\Delta P = P_{op} - P_{cal}$$

Equation 24 Delta meter body pressure

Where:

Pop	Field operation pressure [Pa]
Pcal	Calibration pressure [Pa]

3) For both directions the volume flow rate is corrected as follows:

$$q_{bc.p/t} = q_{line} * \left(\frac{Q_1}{Q_0} \right)_{bodytemperatur} * \left(\frac{Q_1}{Q_0} \right)_{bodypressure\ max}$$

Equation 25 Bi-directional volume flow rate

Where:

qbc p/t	meter body corrected volume flow [m3/hr]
qline	uncorrected volume flow [m3/hr]

17.2 Low flow cut-off control

The low flow cut-off entered in m³/h, determines whether the stream status is on-line or off-line. As well as controlling the display status, this limit determines whether the stream can be considered ´non-flowing, along with environment conditions which may influence the setting. For example expansion of gas due to increase of temperature may indicate a small flow. This value is normally around the accuracy of the meter applied. The default value is around the +/-1%.

17.3 Perform meter curve linearisation

The gas meter linearisation correction can be entered as a table of data points of flow rate and corresponding error. The size of the table can be selected from 2 to 20 points. The correction type is linear where the correction is applied through the operating range.

$$q_{bc} = q_{b\ .p/t} * \frac{100\%}{100\% + CallErr_{actual}}$$

Equation 26 Corrected volume flow rate

Where:

qbc	Corrected volume flow [m3/hr]
qbc.p/t	Corrected volume flow for pressure and temperature [m3/hr]
CallErractual	Meter error at actual flow rate [%]

17.4 Calculation for normal volume flow rate

The flow computer will calculate the flow rates for corrected volume qN, mass qM and energy qE according to the following equation:

$$q_N = q_b \times \frac{\rho_1}{\rho_s}$$

Equation 27 Normal volume flow rate

qn	Normal volume flow [Nm³/h]
qbc	Corrected line volume flow [m³/h]
ρ1	Line Density [kg/m3]
ρs	Base Density [kg/m3]

17.5 Calculate base and line density

The flow computer calculates the base compressibility, and base density based on the gas composition in-use according to the AGA-8 standard.

The line density is calculated according the AGA-8 standard based on the gas composition in-use.

17.6 Calculation for mass flow rate

$$q_m = \frac{q_b * \rho_1}{1000}$$

Equation 28 Mass flow rate

qm	Gross volume mass flow rate [t/h]
qbc	Corrected line volume flow [m³/h]
ρ1	Line density [kg/m3]

17.7 Calculation for energy flow rate

$$q_E = q_N \times cv$$

Equation 29 Energy flow rate

qE	Energy flow rate [MJ/h]
qn	Normal volume flow [Nm³/h]
cv	Caloric value of the gas [MJ/Nm3]

17.8 Calculate heating value

The flow computer calculates the calorific value according to the ISO-6976 standard, based on the gas composition in-use.

17.9 Integrate flow rates for totalisation

All rates of flow are integrated to form cumulative totals.

The following totalisers are configured:

Vbc	Corrected volume total at line conditions [m³]
VN	Volume total at normal conditions [Nm³]
VE	Energy total [MJ]
VM	Mass total [kg]

Based on these eternal totals, hourly and daily totals will be determined.