Introduction

Welcome to the exciting world of SpiritIT Flow-X!

This manual is the operation and configuration manual for the SpiritIT Flow-X Gas Metric application.

There are three reference manuals:

- Volume I – This Installation manual, with the installation instructions.
- Volume II – The Operation and Configuration manual. This manual consists of a general part and one of the following application-specific parts:
  - IIA - Operation and configuration
  - IIB - Gas Metric application
  - IIC - Liquid Metric application
  - IID - Gas US customary units application
  - IIE - Liquid US customary units application
- Volume III - The manuals for solutions that exceed our standard applications. This volume consists of 1 part:
  - IIIB - Function reference

For more information

All publications of SpiritIT Flow-X are available for free download from:

<table>
<thead>
<tr>
<th>Manual Type</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpiritIT Flow-X instruction manual</td>
<td>IM/FlowX-EN</td>
</tr>
<tr>
<td>SpiritIT Flow-X configuration manual</td>
<td>CM/FlowX-EN</td>
</tr>
<tr>
<td>SpiritIT Flow-X gas metric application manual</td>
<td>CM/FlowX/GM-EN</td>
</tr>
<tr>
<td>SpiritIT Flow-X liquid metric application manual</td>
<td>CM/FlowX/LM-EN</td>
</tr>
<tr>
<td>SpiritIT Flow-X gas USC application manual</td>
<td>CM/FlowX/GU-EN</td>
</tr>
<tr>
<td>SpiritIT Flow-X liquid USC application manual</td>
<td>CM/FlowX/LU-EN</td>
</tr>
<tr>
<td>SpiritIT Flow-X function reference manual</td>
<td>CM/FlowX/RF-EN</td>
</tr>
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1 Manual introduction

Purpose of this manual
This Flow-X reference manual is written for a variety of readers:

- The application developer, who is interested in all details required to develop a complete flow measurement solution with a Flow-X product.
- The Instrumentation engineer, who selects the appropriate flow computer model, assigns inputs and outputs and designs transmitter loops and flow computer functionality.
- A more generally interested reader, who investigates whether the capabilities and features of Flow-X will satisfy his/her project requirements.

This manual expects the reader to be commonly acquainted with flow measurement principles, such as turbine, orifice and ultrasonic measurements. This manual is not an introduction to these techniques.

Overview
This manual works in conjunction with manual IIA 'Operation and Configuration' that covers the common operation and configuration aspects of the Flow-X flow computer.

The Flow-X flow computer family comes with the following 4 standard software applications:

- Gas Metric
- Liquid Metric
- Gas US Customary (USC)
- Liquid US Customary (USC)

Each application can be used for a single meter run or for a meter station consisting of multiple meter runs.

This application manual describes the specific functions and capabilities of the Gas Metric Application.

Document conventions
When the book symbol as displayed at the left appears in the text in this manual, a reference is made to another section of the manual. At the referred section, more detailed, or other relevant information is given.

When in this manual a symbol as displayed at the left appears in the text, certain specific operating instructions are given to the user. In such as case, the user is assumed to perform some action, such as the selection of a certain object, worksheet, or typing on the keyboard.

A symbol as displayed at the left indicates that the user may read further on the subject in one of the sample workbooks as installed on your machine.

When an important remark is made in the manual requiring special attention, the symbol as displayed to the left appears in the text.
# Abbreviations

Throughout this document the following abbreviations are used:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>Analog to Digital converter</td>
</tr>
<tr>
<td>AI</td>
<td>Analog Input</td>
</tr>
<tr>
<td>AO</td>
<td>Analog Output</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange. A set of standard numerical values for printable, control, and special characters used by PCs and most other computers. Other commonly used codes for character sets are ANSI (used by Windows 3.1+), Unicode (used by Windows 95 and Windows NT), and EBCDIC (Extended Binary-Coded Decimal Interchange Code, used by IBM for mainframe computers).</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>DAC</td>
<td>Digital to Analog Converter</td>
</tr>
<tr>
<td>DCS</td>
<td>Distributed Control System</td>
</tr>
<tr>
<td>DDE</td>
<td>Dynamic Data Exchange</td>
</tr>
<tr>
<td>DI</td>
<td>Digital Input</td>
</tr>
<tr>
<td>DO</td>
<td>Digital Output</td>
</tr>
<tr>
<td>EGU</td>
<td>Engineering Units</td>
</tr>
<tr>
<td>EIA</td>
<td>Electrical Industries Association</td>
</tr>
<tr>
<td>FET</td>
<td>Field Effect Transistor</td>
</tr>
<tr>
<td>GC</td>
<td>Gas Chromatograph</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>HART</td>
<td>Highway Addressable Remote Transducer. A protocol defined by the HART Communication Foundation to exchange information between process control devices such as transmitters and computers using a two-wire 4-20mA signal on which a digital signal is superimposed using Frequency Shift Keying at 1200 bps.</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface. Also referred to as a GUI or MMI. This is a process that displays graphics and allows people to interface with the control system in graphic form. It may contain trends, alarm summaries, pictures, and animations.</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute for Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organization</td>
</tr>
<tr>
<td>MMI</td>
<td>Man Machine Interface (see HMI)</td>
</tr>
<tr>
<td>MIC</td>
<td>Machine Identification Code. License code of Flow-X which uniquely identifies you computer.</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed Circuit Board</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller. A specialized device used to provide high-speed, low-level control of a process. It is programmed using Ladder Logic, or some form of structured language, so that engineers can program it. PLC hardware may have good redundancy and fail-over capabilities.</td>
</tr>
<tr>
<td>RS232</td>
<td>EIA standard for point to point serial communications in computer equipment</td>
</tr>
<tr>
<td>RS422</td>
<td>EIA standard for two- and four-wire differential unidirectional multi-drop serial</td>
</tr>
<tr>
<td>RS485</td>
<td>EIA standard for two-wire differential bidirectional multi-drop serial communications in computer equipment</td>
</tr>
<tr>
<td>RTU</td>
<td>Remote Terminal Unit</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>SQL</td>
<td>Standard Query Language</td>
</tr>
<tr>
<td>SVC</td>
<td>Supervisory Computer</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol/Internet Protocol. Transmission Control Protocol/Internet Protocol. The control mechanism used by programs that want to speak over the Internet. It was established in 1968 to help remote tasks communicate over the original ARPANET.</td>
</tr>
<tr>
<td>TTL</td>
<td>Transistor-Transistor Logic</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver &amp; Transmitter</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language. A specification for Web documents that allows developers to create custom tags that enable the definition, transmission, validation and interpretation of data contained therein.</td>
</tr>
</tbody>
</table>
## Terms and definitions

Throughout this manual the following additional terms and definitions are used:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asynchronous</td>
<td>A type of message passing where the sending task does not wait for a reply before continuing processing. If the receiving task cannot take the message immediately, the message often waits on a queue until it can be received.</td>
</tr>
<tr>
<td>Client/server</td>
<td>A network architecture in which each computer or process on the network is either a client or a server. Clients rely on servers for resources, such as files, devices, and even processing power. Another type of network architecture is known as a peer-to-peer architecture. Both client/server and peer-to-peer architectures are widely used, and each has unique advantages and disadvantages. Client/server architectures are sometimes called two-tier architectures.</td>
</tr>
<tr>
<td>Device driver</td>
<td>A program that sends and receives data to and from the outside world. Typically a device driver will communicate with a hardware interface card that receives field device messages and maps their content into a region of memory on the card. The device driver then reads this memory and delivers the contents to the spreadsheet.</td>
</tr>
<tr>
<td>Engineering units</td>
<td>Engineering units as used throughout this manual refers in general to the units of a tag, for example ‘bar’, or ‘°C’, and not to a type of unit, as with ‘metric’ units, or ‘imperial’ units.</td>
</tr>
<tr>
<td>Ethernet</td>
<td>A LAN protocol developed by Xerox in cooperation with DEC and Intel in 1976. Standard Ethernet supports data transfer rates of 10 Mbps. The Ethernet specification served as the basis for the IEEE 802.3 standard, which specifies physical and lower software layers. A newer version, called 100-Baset-T or Fast Ethernet supports data transfer rates of 100 Mbps, while the newest version, Gigabit Ethernet supports rates of 1 gigabit (1000 megabits) per second.</td>
</tr>
<tr>
<td>Event</td>
<td>Anything that happens that is significant to a program, such as a mouse click, a change in a data point value, or a command from a user.</td>
</tr>
<tr>
<td>Exception</td>
<td>Any condition, such as a hardware interrupt or software error-handler, that changes a program’s flow of control.</td>
</tr>
<tr>
<td>Fieldbus</td>
<td>A set of communication protocols that various hardware manufacturers use to make their field devices talk to other field devices. Fieldbus protocols are often supported by manufacturers of sensor hardware. There are debates as to which of the different fieldbus protocols is the best. Popular types of fieldbus protocol include Modbus, Hart, Profibus, DeviceNet, InterBus, and CANopen.</td>
</tr>
<tr>
<td>Gross volume</td>
<td>The corrected actual volume; as indicated by the flow meter and corrected for the flow meter calibration curve (if applicable), the meter factor, the meter body expansion and the viscosity influence (for helical turbine and PD meters).</td>
</tr>
<tr>
<td>Indicated volume</td>
<td>The uncorrected actual volume; as indicated by the flow meter without any correction being applied.</td>
</tr>
<tr>
<td>Kernel</td>
<td>The core of Flow-X that handles basic functions, such as hardware and/or software interfaces, or resource allocation.</td>
</tr>
<tr>
<td>Peer-to-peer</td>
<td>A type of network in which each workstation has equivalent capabilities and responsibilities. This differs from client/server architectures, in which some computers are dedicated to serving the others. Peer-to-peer networks are generally simpler, but they usually do not offer the same performance under heavy loads. Peer-to-peer is sometimes shortened to the term P2P.</td>
</tr>
<tr>
<td>Polling</td>
<td>A method of updating data in a system, where one task sends a message to a second task on a regular basis, to check if a data point has changed. If so, the change in data is sent to the first task. This method is most effective when there are few data points in the system. Otherwise, exception handling is generally faster.</td>
</tr>
<tr>
<td>Process visualization software</td>
<td>A system for monitoring and controlling for production processes, and managing related data. Typically such a system is connected to external devices, which are in turn connected to sensors and production machinery. The term ‘process visualization software’ in this document is generally used for software with which SCADA software, HMI software, or supervisory computer software applications can be built. In this document, although strictly not correct, the terms ‘SCADA’, ‘HMI’, ‘supervisory’, and ‘process visualization’ are alternately used, and refer to the computer software applications that can be realized with Spirit/ eXLerate, a PC-based supervisory software.</td>
</tr>
<tr>
<td>Protocol</td>
<td>An agreed-up format for transmitting data between two devices. In this context, a protocol mostly references to the Data Link Layer in the OSI 7-Layer Communication Model.</td>
</tr>
<tr>
<td>Query</td>
<td>In SCADA/HMI terms a message from a computer to a client in a master/client configuration utilizing the message protocol with the purpose to request for information. Usually, more than 1 data-point is transmitted in a single query.</td>
</tr>
<tr>
<td>Real-time</td>
<td>The characteristic of determinism applied to computer hardware and/or software. A real-time process must perform a task in a determined length of time. The phrase “real-time” does not directly relate to how fast the program responds, even though many people believe that real-time means real-fast.</td>
</tr>
<tr>
<td>Resource</td>
<td>Any component of a computing machine that can be utilized by software. Examples include: RAM, disk space, CPU time, real-world time, serial devices, network devices, and other hardware, as well as O/S objects such as semaphores, timers, file descriptors, files, etc.</td>
</tr>
<tr>
<td>Synchronous</td>
<td>A type of message passing where the sending task waits for a reply before continuing processing.</td>
</tr>
<tr>
<td>Tag</td>
<td>A ‘tag’ as used within this document refers to a data point existing in the tag database, with a number of properties, such as its assigned I/O address, current value, engineering units, description, alias name, and many others.</td>
</tr>
<tr>
<td>Web Server</td>
<td>A computer that has server software installed on it and is used to deliver web pages to an intranet/internet.</td>
</tr>
</tbody>
</table>
2 Application overview

This chapter lists the features of the Gas Metric application and shows some typical meter run configurations that are covered by it.

Capabilities

The Gas Metric application has the following capabilities:

- Supports both single meter runs and meter stations consisting of several meter runs.
- Support of turbine, PD, ultrasonic, Coriolis, orifice, venturi, V-cone and nozzle flow meters.
- Supports any type of flow meters outputting a flow rate through an analog, HART or Modbus signal.
- Analog, HART and Modbus options for live inputs.
- Last good, keypad and fallback options for failing input signals.
- Automatic switching from HART to analog signal in case of HART failure.
- Automatic use of backup signal for smart meters with an additional pulse output.
- Data valid input (in combination with a pulse input).
- One, two and three DP cells.
- Wet gas correction according to De Leeuw / Reader-Harris.
- One or two densitometers on stream and station level.
- One or two specific gravity transducers on stream and station level.
- One or two gas chromatographs on stream and station level.
- Meter body correction for pressure and temperature.
- Process inputs for density, base density and specific gravity.
- Selectable meter factor / meter K-factor interpolation curves (12 points).
- Hourly and daily totals and averages.
- Additional 2 freely definable periods for totals and averages.
- Several compressibility algorithms for line and base conditions: AGA-8, ISO-6976, SGERG, NX-19, GPA-2172, GERG, MR113.
- Built-in support for Alotosonic, Caldon, Sick, FMC, GE, Instromet and other ultrasonic flow meters.
- Built-in support for Micro Motion and Endress+Hauser Coriolis flow meters.
- Built-in support for ABB, Siemens, Instromet, Yamatake, Daniel and other chromatographs.
- User-definable HART and Modbus interface to any other type of flow meter and gas chromatograph.
- AGA-10 for velocity of sound verification.
- Cross-module I/O sharing.
- Indication of total rollover on reports.
- Indication of input override / failure on reports.
- Diagnostic displays for smart meters.
- Station functionality.
- Forward and reverse totalizers and averages.
- Maintenance totalizers.
- Accountable / non-accountable totalizers.
- Valve control.
- Flow / pressure (PID) control.
- Sampler control.
- Remote station functionality.
- Master meter proving.
- Daily, hourly, period A and period B reports (run/station).
- Daily events and alarm reports.
- Snapshot reports (run/station).
- Proving reports.
- Daily, hourly, period A and period B historical data archives.
- Complete Modbus tag list (32 bits registers).
- Abbreviated Modbus tag list (16 bits registers).
- Omni compatible tag list (v27).

Typical meter run configurations

The application has been designed for gas flow metering stations consisting of one or more parallel meter runs with all values and flow computations in metric units.

The application supports continuous operation with hourly and daily custody transfer data.

For meter stations the meter runs may run independently or with a common density or gas composition input.

The following typical meter stations are supported:

- Single meter run.
- Two 100 % meter runs (redundant runs) with an optional cross-over valve for master meter proving.
- Meter station with independent meter runs that run different products with one or two densitometers installed on each run.
- Meter station with multiple meter runs that run one common product with one or two common densitometers on the header.

Metering stations of maximum 4 meter runs can be controlled by a Flow-XP. For each meter run the Flow-XP must be equipped with a Flow-XM module. All station functionality is executed by the Flow-XP panel. In this case the application has to be configured as a multi-stream application, which is sent to the Flow-XP as a whole.

It is also possible to control a meter station using a number of separate Flow-X/M modules in Flow-X/S and / or Flow-X/R enclosures. In this case each Flow-X/M is running its own single stream application. For station functionality an extra Flow-X/M can be used, which communicates to up to 8 remote run Flow-X/M modules. Alternatively, station functionality can be enabled on the first run module. This will then be a combined station / run module with one local run (run 1) and up to 7 remote runs (runs 2 to 8).
Table 2-1: Flow meter inputs

<table>
<thead>
<tr>
<th>Input type</th>
<th>Meant for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse input</td>
<td>Any flow meter that provides a single or dual pulse output that represents the volumetric or mass quantity. Typically used for: Turbine meters, PD meters, Ultrasonic flow meters, Coriolis flow meters.</td>
</tr>
<tr>
<td>Smart input</td>
<td>Any flow meter that provides a Modbus, HART or analog output that represents the volumetric or mass quantity or flow rate. Typically used for: Ultrasonic flow meters, Coriolis flow meters.</td>
</tr>
<tr>
<td>Smart / pulse input</td>
<td>Typically used for ultrasonic and coriolis flow meters that provide both a ‘smart’ output and a pulse output. Either output signal may be selected as the primary signal. The secondary signal is used in case the primary signal fails.</td>
</tr>
<tr>
<td>Orifice</td>
<td>Orifice plates according to ISO-5167 / AGA-3</td>
</tr>
<tr>
<td>Venturi</td>
<td>Venturi tubes according to ISO-5167</td>
</tr>
<tr>
<td>V-cone</td>
<td>Metriometer V-cone and wafer cone meters</td>
</tr>
<tr>
<td>Venturi nozzle</td>
<td>Venturi nozzles according to ISO-5167</td>
</tr>
<tr>
<td>Long radius nozzle</td>
<td>Long radius nozzles according to ISO-5167</td>
</tr>
<tr>
<td>ISA 1932 nozzle</td>
<td>ISA 1932 nozzles according to ISO-5167</td>
</tr>
</tbody>
</table>

**Process inputs**

A process input is a live signal that is a qualitative measurement of the fluid.

A process input can be any of the following types:
- Analog input (0-20 mA, 4-20 mA, 0-5 Vdc, 1-5 Vdc)
- PT100 input (only for temperature measurement)
- HART input
- Modbus input
- Fixed value

The following process inputs are supported:

<table>
<thead>
<tr>
<th>Process input</th>
<th>Meant for</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter temperature</td>
<td>Temperature at the flow meter. Either one single or two redundant temperature transmitters are supported. For differential pressure type of flow meters (orifice, venturi, V-cone, nozzle) either the temperature at the upstream or downstream tapping or the temperature at the downstream location, where the pressure has fully recovered, may be used.</td>
</tr>
<tr>
<td>Density temperature</td>
<td>Temperature at the point where the density measurement is taken. This can be at the meter run or at the header. This input is only used if there is a live density measurement, based on a densitometer or observed density process input.</td>
</tr>
<tr>
<td>Density pressure</td>
<td>Pressure at the point where the density measurement is taken. This can be at the meter run or at the header. This input is only used if there is a live density measurement, based on a densitometer or observed density process input.</td>
</tr>
<tr>
<td>Observed density</td>
<td>The measured density. This can be taken at the meter run or at the header. Instead of a measured density the application can also determine the meter density from a gas composition or a base density or specific gravity input.</td>
</tr>
<tr>
<td>Base density</td>
<td>Density at base temperature and pressure. Also called standard density. Either taken at the meter run or header, or calculated.</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>Specific gravity at base conditions. Either taken at the meter run or header, or calculated. Sometimes called relative density, although there is a difference between the ideal and real value. In the Flow-X specific gravity represents the ideal value (uncorrected for compressibility influences).</td>
</tr>
<tr>
<td>Relative density</td>
<td>Relative density at base conditions. Either taken at the meter run or header, or calculated. In the Flow-X relative density represents the real value (corrected for compressibility influences).</td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon dioxide content. Only used if the SGERG / AGA8 gross or NX19 calculation is enabled. Either taken at the meter run or at the header.</td>
</tr>
<tr>
<td>N2</td>
<td>Nitrogen content. Only used if the SGERG / AGA8 gross or NX19 calculation is enabled. Either taken at the meter run or at the header.</td>
</tr>
<tr>
<td>H2</td>
<td>Hydrogen content. Only used if the SGERG / AGA8 gross or NX19 calculation is enabled. Either taken at the meter run or at the header.</td>
</tr>
</tbody>
</table>
The application supports one or two gas chromatographs for each meter run, or one or two gas chromatographs at the header. In case of two gas chromatographs the application uses the time period signal of the primary gas chromatograph and switches to the backup gas chromatograph in case the primary gas chromatograph should fail.

Densitometers
The application supports one or two gas densitometers for each meter run, or one or two densitometers at the header. In case of two densitometers the application uses the time period signal of the primary densitometer and switches to the backup densitometer in case the primary densitometer should fail.

Specific gravity transducers
The application supports one or two gas specific gravity transducers for each meter run, or one or two specific gravity transducers at the header. In case of two transducers the application uses the time period signal of the primary transducer and switches to the backup transducer in case the primary transducer should fail.

Output signals
The application supports the following outputs:
- Analog outputs
- Status outputs
- Pulse outputs

Analog outputs
Each flow module provides 4 analog outputs. Each output may be configured to output any process variable (e.g. the volume flow rate or the meter temperature) or a PID control output.

The application supports flow / pressure control for each individual meter run, or for the station as a whole. One analog output per PID loop is used for controlling the corresponding flow control / pressure control valve.

Digital status and command outputs
The application supports the following digital outputs:

<table>
<thead>
<tr>
<th>Status output</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve commands</td>
<td>Valve open / close or forward / reverse commands.</td>
</tr>
<tr>
<td>Sampler pulse command</td>
<td>Command to the sampler to grab one sample</td>
</tr>
<tr>
<td>Prove start command</td>
<td>Command to simultaneously start / stop pulse counting on the master meter module and the module of the meter on prove.</td>
</tr>
<tr>
<td>Can selection output</td>
<td>Selects a sample can</td>
</tr>
<tr>
<td>Flow direction output</td>
<td>Indicates that the reverse totals are active</td>
</tr>
<tr>
<td>FC duty status output</td>
<td>Only applicable in case of a pair of redundant flow computers. Indicates that the flow computer is on duty.</td>
</tr>
</tbody>
</table>

Additional status and command outputs may be used for user-defined functionality.

Gas chromatographs
The application supports one or two gas chromatographs for each meter run, or one or two gas chromatographs at the header. In case of two gas chromatographs the application uses the gas composition of the primary gas chromatograph (GC) and switches to the backup GC in case the primary GC should fail.

Besides of the gas composition being provided by a gas chromatograph there is the option for a gas composition that is communicated by an external device (e.g. a supervisory computer).

Alternatively a fixed gas composition can be used.

Densitometers
The application supports one or two gas densitometers for each meter run, or one or two densitometers at the header. In case of two densitometers the application uses the time period signal of the primary densitometer and switches to the backup densitometer in case the primary densitometer should fail.

Densitometers of make Solartron, Sarasota and UGC are supported.

Specific gravity transducers
The application supports one or two gas specific gravity transducers for each meter run, or one or two specific gravity transducers at the header. In case of two transducers the application uses the time period signal of the primary transducer and switches to the backup transducer in case the primary transducer should fail.

Output signals
The application supports the following outputs:
- Analog outputs
- Status outputs
- Pulse outputs

Analog outputs
Each flow module provides 4 analog outputs. Each output may be configured to output any process variable (e.g. the volume flow rate or the meter temperature) or a PID control output.

The application supports flow / pressure control for each individual meter run, or for the station as a whole. One analog output per PID loop is used for controlling the corresponding flow control / pressure control valve.

Digital status and command outputs
The application supports the following digital outputs:

<table>
<thead>
<tr>
<th>Status output</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve commands</td>
<td>Valve open / close or forward / reverse commands.</td>
</tr>
<tr>
<td>Sampler pulse command</td>
<td>Command to the sampler to grab one sample</td>
</tr>
<tr>
<td>Prove start command</td>
<td>Command to simultaneously start / stop pulse counting on the master meter module and the module of the meter on prove.</td>
</tr>
<tr>
<td>Can selection output</td>
<td>Selects a sample can</td>
</tr>
<tr>
<td>Flow direction output</td>
<td>Indicates that the reverse totals are active</td>
</tr>
<tr>
<td>FC duty status output</td>
<td>Only applicable in case of a pair of redundant flow computers. Indicates that the flow computer is on duty.</td>
</tr>
</tbody>
</table>

Additional status and command outputs may be used for user-defined functionality.
Pulse outputs
The application supports the configuration of up to 4 pulse outputs per flow module to drive electro-mechanical counters. Alternatively the pulse outputs can be used for sampling control.

Proving functionality
The application supports master meter proving.

Master meter proving can be executed based on pulse counting or on totalizer latching. In the first case the meter on prove and master meter volumes are calculated from the pulse counts of both meters. In the second case the totalizers are calculated from the latched cumulative totalizers at the start and end of the prove.

The number of required successful prove runs and the passes per run can be set, as well as the repeatability limit. A repeatability check is performed either on the calculated meter factor or on the number of counted pulses. Either a fixed or a dynamic repeatability limit can be applied to determine when the required number of successful runs has been reached. The dynamic limit is in accordance with the method described in API 4.8 appendix A.

Control features
Sample control
The application supports control of a sampler. Single and twin can samplers are supported. Several algorithms can be used for determining the time or metered volume between grabs.

Valve control
The application provides control of run inlet and outlet valves and crossover valves. This includes logic to manually open or close the valves, detailed status info and the generation of valve failure and travel timeout alarms.

Additional valve sequencing logic can be defined using the Flow-Xpress configuration software through additional Calculations. Examples are to be found in the application file 'Calculation Examples.xls'.

Flow / pressure control
The application supports PID control for Flow / Pressure Control Valves. PID control can be configured either on run level (separate control valves for individual meter runs) or at station level (one control valve for the whole station consisting of multiple runs). Furthermore a separate prover control valve can be controlled.

PID control can be configured as flow control, pressure control, or flow control with pressure monitoring.
3 Operation

This chapter describes the operational features of the flow computer that are specific for the Flow-X Gas Metric application.

General operational functions such as report printing, alarm acknowledgement, as well as descriptions of the LCD display, the touchscreen (Flow-X/P) and the web interface are described in manual IIA 'Operation and Configuration'.

Most of the displays described below are only visible after logging in with a username and password of security level 'operator (500)' or higher.

If no user has logged on, only a limited number of displays are visible, showing a short summary of process values, flow rates, cumulative totalizers and in-use gas composition.

In-use values

This display gives an overview of the actual process values, such as temperature, pressure and density, as well as the main calculation results, such as heating value and compressibility.

Display → In-use values

Flow rates

This display shows the actual flow rates.

Display → Flow rates

The following operational settings are available for the flow rates:

Process alarm limits

The limits in this section are used to monitor the flow rate. The flow computer generates an alarm if the flow rate passes any of these limits.

| Hi hi limit  | 500 | Limit for the flow rate high high alarm [unit/hr]* |
| Hi limit     | 500 | Limit for the flow rate high alarm [unit/hr]*     |
| Lo limit     | 500 | Limit for the flow rate low low alarm [unit/hr]*   |
| Lo lo limit  | 500 | Limit for the flow rate low low alarm [unit/hr]*   |
| Rate of change limit | 500 | Limit for the flow rate rate of change alarm [unit/hr/sec]* |

*Limits are based on the primary flow rate from the flow meter. Therefore, units are either [m³/hr] or [kg/hr], depending on the meter type.

Temperature

A separate operator display is available for every temperature input.

Display → Temperature

Depending on the actual configuration, displays are available for the following temperature inputs:

- <Run>, Meter temperature
- <Run>, Density temperature
- Station, Density temperature
- Auxiliary temperature 1/2

The following operational settings are available for each applicable temperature input:

Override

These settings can be used to switch between the (live) process value and a user definable fixed override value. The flow computer generates an alarm if the override value is in use.

During normal operation the use of override values should be avoided. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Override</th>
<th>500</th>
<th>Temperature override selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The live input value is used for the calculations</td>
<td></td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The override value is used for the calculations</td>
<td></td>
</tr>
</tbody>
</table>

Process alarm limits

The limits in this section are used to monitor the temperature. The flow computer generates an alarm if the temperature passes any of these limits.

| Hi hi limit | 500 | Limit for the temperature high high alarm [°C] |
| Hi limit    | 500 | Limit for the temperature high alarm [°C]     |
| Lo limit    | 500 | Limit for the temperature low alarm [°C]     |
| Lo lo limit | 500 | Limit for the temperature low low alarm [°C] |
| Rate of change limit | 500 | Limit for the temperature rate of change alarm [°C/sec] |

Transmitter A/B

Only applicable to the meter temperature. If the meter run is equipped with two (redundant) meter temperature transmitters, then each individual transmitter can be put out of service. If one transmitter is out of service the flow computer generates an alarm and uses the (live) value from the other transmitter.

If both transmitters are out of service (a situation that should be avoided during normal operation) the flow computer switches
over to the last good, fallback or override value (depending on the configuration). On MID compliant systems this means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Meter temperature A/B out of service</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The transmitter value is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The transmitter value is not used for the calculations</td>
</tr>
</tbody>
</table>

### Pressure

A separate operator display is available for every pressure input.

Display → Pressure

Depending on the actual configuration, displays are available for the following pressure inputs:

- <Run>, Meter pressure
- <Run>, Density pressure
- Station, Density pressure
- Auxiliary pressure 1/2

The following operational settings are available for each applicable pressure input:

<table>
<thead>
<tr>
<th>Input units</th>
<th>Pressure units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>1: Absolute</td>
</tr>
<tr>
<td></td>
<td>The input value is an absolute pressure [bara]</td>
</tr>
<tr>
<td></td>
<td>2: Gauge</td>
</tr>
<tr>
<td></td>
<td>The input value is a gauge pressure [barg] (i.e. relative to the atmospheric pressure)</td>
</tr>
</tbody>
</table>

### Override

These settings can be used to switch between the (live) process value and a user definable fixed override value. The flow computer generates an alarm if the override value is in use.

During normal operation the use of override values should be avoided. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Override</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The live input value is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The override value is used for the calculations</td>
</tr>
</tbody>
</table>

### Process alarm limits

The limits in this section are used to monitor the pressure. The flow computer generates an alarm if the pressure passes any of these limits.

<table>
<thead>
<tr>
<th>Hi hi limit</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi limit</td>
<td>500</td>
</tr>
<tr>
<td>Lo limit</td>
<td>500</td>
</tr>
<tr>
<td>Lo lo limit</td>
<td>500</td>
</tr>
<tr>
<td>Rate of change limit</td>
<td>500</td>
</tr>
</tbody>
</table>

*Either [bar(a)] or [bar(g)], depending on the selected **input units**

### Transmitter A/B

Only applicable to the meter pressure. If the meter run is equipped with two (redundant) meter pressure transmitters, then each individual transmitter can be put out of service. If one transmitter is out of service the flow computer generates an alarm and uses the (live) value from the other transmitter.

If both transmitters are out of service (a situation that should be avoided during normal operation) the flow computer switches over to the last good, fallback or override value (depending on the configuration). On MID compliant systems this means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Meter pressure A/B out of service</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The transmitter value is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The transmitter value is not used for the calculations</td>
</tr>
</tbody>
</table>
Density

Depending on the configuration the following density displays may be available:
- Observed density
- Base density
- Specific gravity
- Relative density
- Meter density
- Densitometer
- Densitometer selection
- Specific gravity transducer
- Specific gravity transducer selection

Display → Density

Observed density, base density, specific gravity and relative density

The flow computer has separate operator displays for observed density, base density, specific gravity and relative density. The observed density display is only visible in case of a live density input, e.g. a densitometer. The specific gravity display is only visible in case of a live specific gravity input, e.g. a specific gravity transducer. The relative density display is only visible in case of a live relative density input, e.g. if the relative density is read from a Gas Chromatograph.

For observed density, base density, specific gravity and relative density the following operational settings are available:

Override

These settings can be used to switch between the (live) process value and a user definable fixed override value. The flow computer generates an alarm if the override value is in use.

During normal operation the use of override values should be avoided. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Override</th>
<th>Density / gravity override selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The live / calculated value is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The override value is used for the calculations</td>
</tr>
</tbody>
</table>

During normal operation the use of override values should be avoided. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Override</th>
<th>Density/gravity override value (*)</th>
</tr>
</thead>
</table>

Densitometers

Depending on the density configuration the following densitometer displays may be available:
- Run: one or two densitometers (A / B)
- Station: one or two densitometers (A / B)

For each densitometer the following settings are available:

Override

The time period inputs of the densitometers can be manually overridden. This feature is meant for test purposes only. It requires security level 1000 ('Engineer'). During normal operation the use of override values should be avoided.

The flow computer generates an alarm if the override value is in use. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Override</th>
<th>Time period input override selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The live input value is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The override value is used for the calculations</td>
</tr>
</tbody>
</table>

| Override | Time period input override value [microseconds] |

*Units are [kg/m3] for the observed density, [kg/sm3] for the base density and [-] (dimensionless) for the specific gravity and relative density.

Meter density

Depending on the density configuration, the meter density (density at meter temperature and pressure) is calculated from the observed density or from the base density.

For the meter density the following operational settings are available:

Override

These settings can be used to switch between the calculated meter density value and a user definable fixed meter density value. The flow computer generates an alarm if the override value is in use.

During normal operation the use of override values should be avoided. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

<table>
<thead>
<tr>
<th>Meter density override</th>
<th>Meter density selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The calculated value is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The override value is used for the calculations</td>
</tr>
</tbody>
</table>

| Meter density override | Meter density override value [kg/m3] |

Process alarm limits

The limits in this section are used to monitor the density / gravity. The flow computer generates an alarm if the density / gravity passes any of these limits.

| Hi hi limit | 500 | Limit for the density/gravity high high alarm (*) |
| Hi limit | 500 | Limit for the density/gravity high alarm (*) |
| Lo limit | 500 | Limit for the density/gravity low alarm (*) |
| Lo lo limit | 500 | Limit for the density/gravity low low alarm (*) |
| Rate of change limit | 500 | Limit for the density/gravity rate of change alarm [(*)/sec] |
**Process alarm limits**
The limits in this section are used to monitor the densitometer time period signal. The flow computer generates an alarm if the time period passes any of these limits.

<table>
<thead>
<tr>
<th>Limit Type</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi hi limit</td>
<td>500</td>
<td>Limit for the time period input high high alarm</td>
</tr>
<tr>
<td>Hi limit</td>
<td>500</td>
<td>Limit for the time period input high alarm</td>
</tr>
<tr>
<td>Lo limit</td>
<td>500</td>
<td>Limit for the time period input low alarm</td>
</tr>
<tr>
<td>Lo lo limit</td>
<td>500</td>
<td>Limit for the time period input low low alarm</td>
</tr>
<tr>
<td>Rate of change</td>
<td>500</td>
<td>Limit for the time period input rate of change</td>
</tr>
</tbody>
</table>

**Densitometer selection**
If two (redundant) densitometers are available, then a separate ‘Densitometer selection’ display is available, which can be used to specify which densitometer value is used in the calculations.

<table>
<thead>
<tr>
<th>Densitometer select mode</th>
<th>Selection</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Auto-A</td>
<td>Densitometer B is only used if densitometer A fails and densitometer B is healthy. Densitometer A is used in all other cases.</td>
<td></td>
</tr>
<tr>
<td>2: Auto-B</td>
<td>Densitometer A is only used if densitometer B fails and densitometer A is healthy. Densitometer B is used in all other cases.</td>
<td></td>
</tr>
<tr>
<td>3: Manual-A</td>
<td>Always use densitometer A irrespective of its failure status</td>
<td></td>
</tr>
<tr>
<td>4: Manual-B</td>
<td>Always use densitometer B irrespective of its failure status</td>
<td></td>
</tr>
</tbody>
</table>

**Specific gravity transducers**
Depending on the density configuration the following specific gravity transducer displays may be available:

- Run: one or two specific gravity transducers (A / B)
- Station: one or two specific gravity transducers (A / B)

For each SG transducer the following settings are available:

**Override**
The time period inputs of the specific gravity transducers can be manually overridden. This feature is meant for test purposes only. It requires security level 1000 (‘Engineer’). During normal operation the use of override values should be avoided.

<table>
<thead>
<tr>
<th>Time period override</th>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td></td>
<td>The live input value is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td></td>
<td>The override value is used for the calculations</td>
</tr>
</tbody>
</table>

**Process alarm limits**
The limits in this section are used to monitor the time period signal from the specific gravity transducer. The flow computer generates an alarm if the time period passes any of these limits.

<table>
<thead>
<tr>
<th>Limit Type</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi hi limit</td>
<td>500</td>
<td>Limit for the time period input high high alarm</td>
</tr>
<tr>
<td>Hi limit</td>
<td>500</td>
<td>Limit for the time period input high alarm</td>
</tr>
<tr>
<td>Lo limit</td>
<td>500</td>
<td>Limit for the time period input low alarm</td>
</tr>
<tr>
<td>Lo lo limit</td>
<td>500</td>
<td>Limit for the time period input low low alarm</td>
</tr>
<tr>
<td>Rate of change</td>
<td>500</td>
<td>Limit for the time period input rate of change</td>
</tr>
</tbody>
</table>

**Specific gravity transducer selection**
If two (redundant) specific gravity transducers are available, then a separate ‘Specific gravity transducer selection’ display is available, which can be used to specify which specific gravity transducer value is used in the calculations.

<table>
<thead>
<tr>
<th>SG transducer select mode</th>
<th>Selection</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Auto-A</td>
<td>SG transducer B is only used if SG transducer A fails and SG transducer B is healthy. SG transducer A is used in all other cases.</td>
<td></td>
</tr>
<tr>
<td>2: Auto-B</td>
<td>SG transducer A is only used if SG transducer B fails and SG transducer A is healthy. SG transducer B is used in all other cases.</td>
<td></td>
</tr>
<tr>
<td>3: Manual-A</td>
<td>Always use SG transducer A irrespective of its failure status</td>
<td></td>
</tr>
<tr>
<td>4: Manual-B</td>
<td>Always use SG transducer B irrespective of its failure status</td>
<td></td>
</tr>
</tbody>
</table>
Gas Properties

The ‘Gas properties’ section contains the following displays:

- In-use composition
- Override composition
- GC selection
- Composition limits
- Heating value
- CO₂ input
- N₂ input
- H₂ input
- Velocity of sound
- Humidity

Display → Gas Properties

In-use composition

This display shows the actual gas composition that is used by the flow computer. It also shows other gas properties, like heating value, specific gravity and relative density, as these are read from a gas chromatograph (if available).

Override composition

This display can be used to specify a fixed override composition and to define whether the measured or override composition is to be used in the flow computer calculations.

The following settings are available:

<table>
<thead>
<tr>
<th>Composition override</th>
<th>Override selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>The live composition is used for the calculations</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>The override composition is used for the calculations</td>
</tr>
</tbody>
</table>

Gas composition

Component override 500

Override values for the following components:
- Methane (C₁)
- Nitrogen (N₂)
- Carbon Dioxide (CO₂)
- Ethane (C₂)
- Propane (C₃)
- Water (H₂O)
- Hydrogen Sulphide (H₂S)
- Hydrogen (H₂)
- Carbon Monoxide (CO)
- Oxygen (O₂)
- i-Butane (iC₄)
- n-Butane (nC₄)
- i-Pentane (iC₅)
- n-Pentane (nC₅)
- neo-Pentane (neoC₅)
- Hexane (C₆)*
- Heptane (C₇)*
- Octane (C₈)*
- Nonane (C₉)*
- Decane (C₁₀)
- Helium (He)
- Argon (Ar)

*If split coefficients are used for C₆+, C₇+, C₈+ or C₉+, then these components represent the corresponding Cₓ+ value. F.e. if a C₆+ split is used, which means that the C₆ – C₁₀ components are calculated from the C₆+ fraction and the C₆+ split coefficients, then the C₆ value represents the C₆+ fraction and the C₇ – C₁₀ values are not used.

The Cₓ+ split coefficients can be entered in the configuration menu: Configuration, Run <x> or Station, Gas properties, Composition

Composition limits

The limits on this display are used to monitor the gas composition that is read from a gas chromatograph or other device. The flow computer generates an alarm if any of the components passes its limits.

For each of the 22 components, the Cₓ+ fractions and the sum of components the following limits are available:

<table>
<thead>
<tr>
<th>Component</th>
<th>high limit</th>
<th>Limit for the component high alarm [%mole]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component</td>
<td>low limit</td>
<td>Limit for the component low alarm [%mole]</td>
</tr>
</tbody>
</table>

Depending on the configuration, a composition limit alarm optionally triggers a switch-over to the other gas chromatograph (if available), the override composition or to the last received good composition.

GC selection

This display is only available if two (redundant) gas chromatographs are available.

<table>
<thead>
<tr>
<th>GC selection mode</th>
<th>Controls the selection between the 2 GC’s. The gas composition of the selected GC is used for the calculations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Auto-A</td>
<td>GC B is only selected when it has no failure, while GC A has a failure. GC A is selected in all other cases.</td>
</tr>
<tr>
<td>2: Auto-B</td>
<td>GC A is only selected when it has no failure, while GC B has a failure. GC B is selected in all other cases.</td>
</tr>
<tr>
<td>3: Manual-A</td>
<td>GC A is always selected, independent of any failure</td>
</tr>
<tr>
<td>4: Manual-B</td>
<td>GC B is always selected, independent of any failure</td>
</tr>
</tbody>
</table>

Heating Value

The heating value display contains the following operator settings:

Override

These settings can be used to switch between the (live) process value and a user definable fixed override value. The flow computer generates an alarm if the override value is in use.

During normal operation the use of override values should be avoided. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.
Override  500  Override selection
0: Disabled
   The live / calculated value is used for the calculations
1: Enabled
   The override value is used for the calculations
Override  500  Override value (*)

Process alarm limits
The limits in this section are used to monitor the heating value. The flow computer generates an alarm if the heating value passes any of these limits.

Hi hi limit  500  Limit for the heating value high high alarm (*)
Hi limit  500  Limit for the heating value high alarm (*)
Lo limit  500  Limit for the heating value low alarm (*)
Lo lo limit  500  Limit for the heating value low low alarm (*)
Rate of change limit  500  Limit for the heating value rate of change alarm [MJ/sm3/sec]

*Units are [MJ/sm3] in case of a volume based heating value, [MJ/kg] in case of a mass based heating value.

CO2, H2 and N2
These displays are only available if SGERG / AGA8 gross or NX-19 is selected to calculate the compressibility and / or molar mass (see paragraph ‘Calculation Setup’).

For CO2, H2 and N2 the following operational settings are available:

Override
These settings can be used to switch between the (live) process value and a user definable fixed override value. The flow computer generates an alarm if the override value is in use.

During normal operation the use of override values should be avoided. On MID compliant systems, using an override value means that the accountable totalizers are stopped and the non-accountable totalizers are activated.

Override  500  Component override selection
0: Disabled
   The live value is used for the calculations
1: Enabled
   The override value is used for the calculations
Override  500  Component override value [%mole]

Process alarm limits
The limits in this section are used to monitor the component value. The flow computer generates an alarm if the component value passes any of these limits.

Hi hi limit  500  Limit for the component high high alarm [%mole]
Hi limit  500  Limit for the component high alarm [%mole]
Lo limit  500  Limit for the component low alarm [%mole]
Lo lo limit  500  Limit for the component low low alarm [%mole]
Rate of change limit  500  Limit for the component rate of change alarm [%mole/sec]

Velocity of sound
This display, which is only available in case of a smart meter, shows the measured and calculated velocity of sound.

Humidity
Only applicable if MR113 is used to calculate the compressibility and / or molar mass. The display shows an overview of the measured humidity, humidity temperature and humidity pressure, as well as the calculated water fraction and humidity values.
Master meter proving

The application supports master meter proving.

Displays to view the status of the current and previous prove sequence can be accessed through option "Proving" from the main menu.

The prove displays are only available if proving has been configured.

Proving operation

The proving operation display shows the actual prove status and contains commands to start or abort a prove sequence and to accept or reject the proved meter factor.

A prove can only be started if the prove permissive is ‘On’. The prove permissive is ‘Off’ if:

- Communication to the meter on prove is down (ultrasonic / Coriolis meter)
- Communication to the master meter is down (ultrasonic / Coriolis meter)
- A Custom permissive condition is not met (f.e. a valve must be opened or closed). This is no standard functionality, but it may have been added by the user.

If the prove permissive gets off during a prove sequence, then the sequence is aborted.

The resulting meter factor can be configured to be accepted automatically or manually. In the latter case, after finishing of the prove sequence the flow computer waits for the operator to accept or reject the meter factor.

The meter factor is accepted, provided that:

- A normal (no trial) prove sequence has been started
- The prove sequence has been completed successfully
- The new meter factor has passed all test criteria
- In case of manual acceptance: The operator issues the ‘accept meter factor’ command before the acceptance time-out period has elapsed

Display → Proving, Proving operation

The following settings / commands related to proving are available:

<table>
<thead>
<tr>
<th>Command</th>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start prove sequence</td>
<td>500</td>
<td>Command to start a prove sequence for the selected meter.</td>
</tr>
<tr>
<td>Accept meter</td>
<td>500</td>
<td>Command to accept the proved meter factor</td>
</tr>
</tbody>
</table>

Trial prove

<table>
<thead>
<tr>
<th>Command</th>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start trial prove</td>
<td>500</td>
<td>Command to start a trial prove sequence for the selected meter.</td>
</tr>
</tbody>
</table>

Operational settings

Display → Proving, Operational settings

These parameters are described in the paragraphs ‘Configuration, Master meter proving, Operational settings’ and ‘Configuration, Master meter proving, Meter factor tests’.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter to be proved</td>
<td>500 Number of the meter to be proved. Only applicable if multiple meters are involved. Depending on the flow computer configuration the selected meter may be a local run or a ‘remote run’.</td>
</tr>
<tr>
<td>Reject meter factor</td>
<td>500 Command to reject the proved meter factor</td>
</tr>
<tr>
<td>Abort prove sequence</td>
<td>500 Command to abort an active prove sequence</td>
</tr>
</tbody>
</table>
Valve control

The flow computer supports control of the following valves:

For each run:
- Run inlet valve
- Run outlet valve
- Crossover valve

For each valve a separate display is available. Only the displays of those valves that have been enabled are shown.

Display → Valve control

The following settings and commands are available for each valve:

<table>
<thead>
<tr>
<th>Manual control</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto/manual mode</td>
<td>500</td>
</tr>
<tr>
<td>Toggles the valve between automatic and manual mode of operation. The automatic mode of operation is meant for systems where valve sequencing is applied, either through the flow computer itself or by an external device (e.g. the DCS or the supervisory computer).</td>
<td></td>
</tr>
<tr>
<td>Manual open command</td>
<td>500</td>
</tr>
<tr>
<td>Issues the command to open the valve. Only accepted if the valve operates in manual mode and the valve open permissive is high.</td>
<td></td>
</tr>
<tr>
<td>Manual close command</td>
<td>500</td>
</tr>
<tr>
<td>Issues the command to close the valve. Only accepted if the valve operates in manual mode and the valve close permissive is high.</td>
<td></td>
</tr>
</tbody>
</table>
Flow / pressure control

The flow computer supports flow control, pressure control and flow control with pressure monitoring. Depending on the configuration the appropriate display is shown.

Display → Flow control, Station
Display → Pressure control, Station
With <x> the module number of the meter run

The following settings and commands are available for each flow control / pressure control valve:

Flow control
These settings are only available for flow control valves (with or without pressure monitoring).

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow control setpoint type 500</td>
<td>Toggles between the auto setpoint and the user setpoint. The auto setpoint is meant for systems where the flow rate setpoint is determined by the flow computer itself or by an external device (e.g. to implement a loading curve with several low / high flow rate stages).</td>
</tr>
<tr>
<td></td>
<td>1: Auto</td>
</tr>
<tr>
<td></td>
<td>2: User</td>
</tr>
<tr>
<td>Flow control - user setpoint 500</td>
<td>The control loop will try to achieve this setpoint value provided that the setpoint type is set to ‘User’ and Manual control mode is not enabled. The unit is the same as the controlled process value: [m³/hr] for volume flow meters and [kg/hr] for mass flow meters.</td>
</tr>
</tbody>
</table>

Pressure control
These settings are only available for pressure control valves.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure control - setpoint 500</td>
<td>The control loop will try to achieve this setpoint value provided that Manual control mode is not enabled. The unit is the same as the controlled process value [bar(g)] or [bar(a)], depending on the configured pressure control units.</td>
</tr>
</tbody>
</table>

Manual control

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual control mode 500</td>
<td>Enables or disables manual control.</td>
</tr>
<tr>
<td></td>
<td>0: Disabled</td>
</tr>
<tr>
<td></td>
<td>Manual control is disabled. The PID control algorithm is enabled. The valve position follows the manual output %.</td>
</tr>
<tr>
<td></td>
<td>1: Enabled</td>
</tr>
<tr>
<td></td>
<td>Manual control is enabled. The PID control algorithm is disabled. The valve position is controlled by the PID algorithm, which tries to achieve or maintain the flow rate or pressure setpoint.</td>
</tr>
<tr>
<td>Manual control output 500</td>
<td>The valve position will be set to this value [%] if Manual control mode is enabled</td>
</tr>
</tbody>
</table>
Sampler control

The following sampling modes are supported:

- Single can
- Twin can

The flow computer both supports flow-proportional and time-proportional sampling.

Flow-proportional sampling can be based on:

- A fixed volume between grabs
- An estimated total metered volume to be sampled until the can is full

Time-proportional sampling can be based on:

- A fixed time between grabs
- An estimated end time when the sample can should be full
- A time period during which the sample can should be filled

The can fill indication can be based on the actual grab count, a digital input (indicating the can full state) or an analog input. The sampler may be stopped automatically when the can is full. Automatic can switchover is also supported.

The sampling logic contains a virtual pulse reservoir which will be filled if the required sample rate is too high for the pulse output. The amount of grabs in the sampler reservoir is limited by a configurable limit. A ‘Grabs lost’ alarm is generated when the limit is reached. Another limit value (configurable) is used to generate an ‘Overspeed alarm’ when more pulses are generated than the sampler can handle.

Operator commands are available to start and stop sampling, to reset the whole sampler and to reset a specific can only.

Displays to control and monitor the sampler can be accessed through option "Sampling" from the main menu. The sampling displays are only visible if sampler control has been enabled.

### Test

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab test</td>
<td>Command for testing the sampler strobe. Issues one pulse (= one grab). Can only be used when sampling is inactive.</td>
</tr>
</tbody>
</table>

### Sample settings

| Display → Sampling, Sample settings |

The settings on this display can be used to define the frequency of the sample pulses.

#### Flow (fixed value)

Gives a sample pulse each time when a certain (fixed) volume has been metered.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume between grabs fixed value</td>
<td>500</td>
</tr>
</tbody>
</table>

#### Flow (estimated volume)

Calculates the volume between grabs based on an expected total metered volume, such that the can will be full when this volume has been metered.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected total volume</td>
<td>500</td>
</tr>
</tbody>
</table>

#### Time (fixed value)

Gives a sample pulse each time when a certain (fixed) time has passed.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time between grabs fixed value</td>
<td>500</td>
</tr>
</tbody>
</table>

#### Time (expected end time)

Calculates the time between pulses based on an expected end date and time, such that the can will be full at that moment.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected end time for sampling</td>
<td>500</td>
</tr>
</tbody>
</table>

#### Time (period)

Calculates the time between pulses based on a period [hours], such that the can will be full when this period has passed.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can fill period</td>
<td>500</td>
</tr>
</tbody>
</table>
4 Configuration

This chapter describes the configuration items of the flow computer that are specific for the Gas Metric application.

Introduction

The configuration procedure for any Flow-X flow computer is described in manual IIA- Operation and Configuration.

The procedure basically consists of the following steps:

- Setting up the flow computer device
- Configuring the HART and communications devices
- Defining the configuration settings
- Defining the reports and printers
- Defining the communication lists.

All the steps are described in manual IIA.

Manual IIA describes how to use the user interface to access the configuration settings. The actual settings however are dependent on the actual application. This chapter describes all the settings that are part the Gas Metric application in a sequence that is logical from a configuration point of view.
I/O setup

A logical first step in the configuration process is to define the physical I/O points that involve all the transmitters, controllers and devices that are or will be physically wired to the I/O terminals of the flow computer.

Each flow module has the following amount of I/O.

- 6 analog inputs
- 2 PT100 inputs
- 4 analog outputs
- 16 digital I/O

The total number of pulse inputs, time period inputs, status inputs, pulse outputs, frequency outputs and status outputs is 16.

Later on in the configuration procedure the I/O points can be assigned to the related meter run, station and proving variables and statuses.

**Analog Inputs**

Display → IO, <Module <x>, Configuration, Analog inputs, Analog input <y>

with <x> the number of the module to which the input is physically connected and <y> the relative input number

Each flow module has 6 analog inputs. For each analog input the following settings are available:

<table>
<thead>
<tr>
<th>Tag</th>
<th>600</th>
<th>Alphanumeric string representing the tag name of the transmitter, e.g. “PT-1001A”. Only used for display and reporting purposes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input type</td>
<td>1000</td>
<td>Type of input signal 1= 4-20 mA, 2= 0-20 mA, 3= 1-5 Vdc, 4= 0-5 Vdc</td>
</tr>
<tr>
<td>Averaging</td>
<td>1000</td>
<td>The method to average the individual samples within every calculation cycle. 15 samples per second are taken, so with a cycle time of 500 ms 7 to 8 samples are available per cycle. 1= Arithmetic mean 2= Root mean square Enter ‘2: Root Mean Square’ for differential pressure flow transmitters. Enter ‘1: Arithmetic Mean’ for other transmitters</td>
</tr>
<tr>
<td>Full scale</td>
<td>1000</td>
<td>The value in engineering units that corresponds with the full scale value. Uses the basic FC units: [°C] for temperature, [bara] or [barg] for pressure, [kg/m3] for density, [mbar] for differential pressure, [M3/sm3] or [M3/kg] for heating value, [m3/hr], [tonne/hr] or [GJ/hr] for flow rates. If a transmitter is used that uses different units, the range has to be converted into the basic FC unit. E.g. for a 4-20 mA temperature transmitter with a range of -30..+80 [°C] the value -30 [°C] must be entered. For a temperature transmitter with a range of 0-300 [°F] the value 148.889 [°C] must be entered.</td>
</tr>
</tbody>
</table>

**PT100 Inputs**

Display → IO, <Module <x>, Configuration, PT100 inputs, PT100 input <y>

with <x> the number of the module to which the input is physically connected and <y> the relative input number

Each flow module has 2 PT100 inputs that can be connected to a PT100 element. For each PT100 input the following settings are available:

<table>
<thead>
<tr>
<th>Tag</th>
<th>600</th>
<th>Alphanumeric string representing the tag name of the transmitter, e.g. “TT-1001A”. Only used for display and reporting purposes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input type</td>
<td>1000</td>
<td>Type of PT100 element 1: European (most commonly used) Alpha coefficient 0.00385 Ω/ Ω /°C As per DIN 43760, BS1905,IEC751 Range -200..+850 °C 2: American Alpha coefficient 0.00392 Ω/ Ω /°C Range -100..+457 °C</td>
</tr>
<tr>
<td>High fail limit</td>
<td>1000</td>
<td>The temperature in °C, at which a high fail alarm is given.</td>
</tr>
<tr>
<td>Low fail limit</td>
<td>1000</td>
<td>The temperature in °C, at which a low fail alarm is given.</td>
</tr>
</tbody>
</table>

**Digital I/O Assign**

Each flow module provides 16 multi-purpose digital channels that can be assigned to any type of input or output.

Display → IO, <Module <x>, Configuration, Digital I/O assign, Digital <y>

with <x> the number of the module to which the output is physically connected and <y> the output number

<table>
<thead>
<tr>
<th>Tag</th>
<th>600</th>
<th>Alphanumeric string representing the tag name of the transmitter, e.g. “MOV-34010”. Only used for display and reporting purposes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal type</td>
<td>1000</td>
<td>Assigns the digital signal to a specific purpose 0: Not used 1: Digital input</td>
</tr>
</tbody>
</table>
Digital IO settings

Display → IO, <Module <x>., Configuration, Digital IO settings, Digital <y>

with <x> the number of the module to which the output is physically connected and <y> the output number

| **Polarity** | 1000 | 1: Normal  
2: Inverted  
Refer to setting 'Input latch mode' for more details. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input threshold level</strong></td>
<td>1000</td>
<td>Each digital channel has 2 threshold levels, which are as follows (all relative to signal ground):</td>
</tr>
<tr>
<td>Channels 1 through 8:</td>
<td></td>
<td>1: + 1.25 Volts</td>
</tr>
<tr>
<td>Channels 9 through 16:</td>
<td></td>
<td>1: + 3.6 Volts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: + 12 Volts</td>
</tr>
<tr>
<td><strong>Input latch mode</strong></td>
<td>1000</td>
<td>Only applicable if signal type is 'Digital input'</td>
</tr>
</tbody>
</table>
| 1: Actual  
2: Latched |

If polarity = Inverted & input latch mode = Actual then:

- digital input is
  - 0: OFF when signal is currently above threshold
  - 1: ON when signal is currently below threshold

If polarity = Inverted & input latch mode = Latched then:

digital input is
  - 0: OFF when signal has not been below threshold
  - 1: ON when signal is or has been below threshold during the last calculation cycle

| **Output min. activation time** | 1000 | Only applicable if signal type is 'Digital output' |
| Minimum period of time that the signal will remain activated. |
| After the minimum activation time has elapsed the output signal will remain activated until the control value becomes 0. |

| **Output delay time** | 1000 | Only applicable if signal type is 'Digital output' |
| Period of time that the control signal must be high (> 0) without interruption before the output will be activated. |
| If the control signal becomes 0 before the time has elapsed, then the output signal will not be activated. |
| The value 0 disables the delay function |

Only digital channels 1-4 can be configured as time period inputs. For all other digital channels this option is not available.

Pulse inputs

Display → Configuration, <Module IO <x>., Pulse input with <x> the number of the module to which the input is physically connected

Each flow module supports either 1 single or 1 dual pulse input meant for a flow meter that provides a single or a dual pulse output signal.

A dual pulse signal is a set of two pulse signals (‘pulse trains’) A and B that originate from the same flow meter. The two pulse trains are similar but shifted in phase (typically 90°). The primary purpose of the dual signal is to allow for pulse integrity checking. Added or missing pulses on either pulse train are detected and corrected for and simultaneous noise pulses are rejected.

The function provides detailed information on the raw, corrected and bad pulses for both channels and for both the forward and reverse flow direction.

The phase shifted pulse train signal also allows for automatic detection of flow direction. Each A pulse is followed by a B pulse within a time period (Δt) in case the flow runs in the forward direction. In case the flow runs in the reverse direction, the opposite is the case, i.e. each B pulse is followed by an A pulse within the same time period Δt.
The Flow/X series of flow computers provides Level A and Level B pulse security as defined in ISO 6551. Level A means that bad pulses are not only detected but also corrected for. Level B means that bad pulses are detected but not corrected for.

Like any digital input signal a pulse input has a threshold level (Volts) that determines whether the actual signal is considered as on or off.

The actual threshold level is defined on display 'Digital IO settings'.

The following settings are available for the pulse input of each flow module.

**Pulse fidelity checking**

<table>
<thead>
<tr>
<th>Pulse fidelity level</th>
<th>1000</th>
<th>Pulse fidelity levels according to ISO6551</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: None</td>
<td></td>
<td>No pulse fidelity checking or correction</td>
</tr>
<tr>
<td>1: Level A</td>
<td></td>
<td>Pulse verification, alarming and correction</td>
</tr>
<tr>
<td>2: Level B</td>
<td></td>
<td>Pulse verification and alarming; no correction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If pulse fidelity level A is enabled, then the corrected pulses are used for flow totalization. If pulse fidelity level B is enabled or if pulse fidelity checking is disabled, then the uncorrected pulses of channel A are used or, in case channel A does not provide any pulses, the uncorrected pulses of channel B are used.</td>
</tr>
</tbody>
</table>

Fall back to secondary pulse

| 1000 | Only applicable to pulse fidelity level B. |
|      | 0: Enabled |
|      | pulse B will be used when pulse A fails. |
| 1: Disabled |  pulse B is solely used for pulse verification. |

Error pulses limit

| 1000 | Only applicable to dual pulse inputs. |
|      | If the total number of missing, added and simultaneous pulses for either channel becomes larger than this value, the FC will generate an 'error pulses limit alarm'. |
|      | The value 0 disables the error pulses limit check. |

Good pulses reset limit

| 1000 | Only applicable to dual pulse inputs. |
|      | If the number of good pulses since the last 'bad' pulse has reached this value, the bad pulse count and alarms will be reset automatically. |
|      | The value 0 disables this reset function. |

**Prover bus pulse outputs**

| Prover bus pulse output A | 1000 | Enables prover bus output A. Meant for systems using a common prover bus to a separate prover or master meter flow computer. |
| Prover bus pulse output B | 1000 | Enables prover bus output B. Meant for systems using a common prover bus to a separate prover or master meter flow computer. |

The flow module will output the raw pulse input signal A directly to the prover pulse out A channel. (This channel is assigned to a specific digital on display 'Digital IO assign')

In case of a multi-stream setup with a common prover or common master meter only the meter under prove should have its prover bus output enabled.

Automatically set by prover logic.

Time period inputs

Display → Configuration, <Module IO <x>, Time period inputs, Time period input <y>

with <x> the number of the module to which the input is physically connected and <y> the input number

Each flow module has 4 time period inputs, which can be used for densitometer and specific gravity transducer inputs.

For each time period input the following settings are available.

| Difference limit | 1000 | Maximum allowable difference in microseconds. |
|                 |      | When the time period between two consecutive pulses differs more than this limit from the previous time period, the reading is considered to be abnormal. |
|                 |      | Following an abnormal reading there must be 3 consecutive readings within the limit before the time period value is considered normal again. |
|                 |      | When no 3 consecutive readings within the limit are available in the last 5 readings then the input signal is considered to be invalid. |
|                 |      | Resolution of the limit value is 100 nanoseconds |

Like any digital input signal a time period input has a threshold level (Volts) that determines whether the
actual signal is considered as on or off.

The actual threshold level is defined on display 'Digital IO settings'.

**Analog outputs**

Display → IO, <Module <x>, Configuration, Analog outputs, Analog output <y>

with <x> the number of the module to which the output is physically connected and <y> the relative output number

Each flow module has 4 analog outputs. For each analog output the following settings are available.

<table>
<thead>
<tr>
<th>Tag</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alphanumeric string representing the tag name of the output signal, e.g. &quot;AO-045&quot;. Only used for display and reporting purposes.</td>
<td></td>
</tr>
</tbody>
</table>

Full scale 600

The value in engineering units that corresponds with the full scale (20mA) value.

Uses the original FC units: [m³/hr] for volume flow rate, [kg/hr] for mass flow rate, [GJ/hr] for energy flow rate, [°C] for temperature, [bar] for pressure, [kg/m³] for density, [MJ/sm³] or [MJ/kg] for heating value.

E.g. for a temperature with a range of -30..+80 [°C] the value 80 must be entered. For a temperature with a range of 0..300 [°F] the value 148.889 [°C] must be entered.

Zero scale 600

The value in engineering units that corresponds with the zero scale (4mA) value.

Uses the original FC units: [m³/hr] for volume flow rate, [kg/hr] for mass flow rate, [GJ/hr] for energy flow rate, [°C] for temperature, [bar] for pressure, [kg/m³] for density, [MJ/sm³] or [MJ/kg] for heating value.

E.g. for a temperature with a range of -30..+80 [°C] the value -30 must be entered. For a temperature with a range of 0..300 [°F] the value -16.778 [°C] must be entered.

Dampening factor 600

Dampening factor [0..8]. Can be used to obtain a smooth output signal. The value represents the number of calculation cycles * 8 that are required to get to the new setpoint.

0: No filtering
1: It takes 8 cycles to get to the new setpoint
2: It takes 16 cycles to get to the new setpoint etc.

For example: the following filtering is used when setpoint is set to 1.

Pulse outputs

Pulse outputs can be used to feed low frequency pulses to an electro-mechanical (E/M) counter or to control a sampling system.

Pulse outputs are connected to a totalizer: A pulse is given each time that the totalizer has incremented by a certain value.

A reservoir is used to accumulate the pulses. Pulses are taken from the reservoir and fed to the output at a rate that will not exceed the specified maximum output rate

Each flow module has 4 pulse outputs. For each pulse output the following settings are available.

<table>
<thead>
<tr>
<th>Tag</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum pulse frequency.</td>
<td></td>
</tr>
</tbody>
</table>

- When output pulses are generated at a frequency higher than the maximum output rate, the superfluous pulses will be accumulated in the pulse reservoir.
- The maximum output rate is not a restriction of the Flow-X flow computer, but may be a restriction of the connected device. E.g. a electro-mechanical counter may be able to generate pulses up to 10 Hz.

Pulse duration 600

The flow computer uses a fixed pulse duration to output the pulses. The 'Pulse duration' is the time in milliseconds that an output pulse remains active (high).

The actual pulse duration that will be used is the minimum of this setting and the time corresponding to 50% duty cycle at maximum frequency

E.g. if the pulse duration setting = 0.25 sec and the maximum frequency = 5 Hz, then the actual pulse duration equals 0.5 * 1/5 = 0.1 sec.

Reservoir limit 600

Alarm limit for the number of pulses in the reservoir buffer. When the number of pulses in the reservoir exceeds the limit, then an alarm will be raised and no further pulses will be accumulated.

Frequency outputs

Frequency outputs can be used to feed high frequency pulses to an electro-mechanical (E/M) counter or to control a sampling system.

Frequency outputs are connected to a process variable: The actual value of the process variable is translated into a pulse
frequency using linear interpolation. In principle any process value may be used (temperature, pressure, etc.), but flow rate and density are most common.

The use of frequency outputs is only supported by FPGA version 1422-21-2-2012 or later.

Display → IO, <Module <x>, Configuration, Frequency outputs, Frequency output <y>

with <x> the number of the module to which the output is physically connected and <y> the output number

Each flow module has 4 frequency outputs. For each frequency output the following settings are available.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full scale value</td>
<td>The value in engineering units that corresponds to the highest frequency.</td>
</tr>
<tr>
<td></td>
<td>Uses the original FC units: [m3/hr] for volume flow rate, [kg/hr] for mass flow rate, [GJ/hr] for energy flow rate.</td>
</tr>
<tr>
<td></td>
<td>E.g. for a flow rate with a range of 0-2000 [m3/hr] the value 2000 must be entered. For a flow rate with a range of 0-1000 [l/min] the value 60 [m3/hr] must be entered.</td>
</tr>
<tr>
<td>Zero scale value</td>
<td>The value in engineering units that corresponds with the lowest frequency.</td>
</tr>
<tr>
<td></td>
<td>Uses the original FC units: [m3/hr] for volume flow rate, [kg/hr] for mass flow rate, [GJ/hr] for energy flow rate.</td>
</tr>
<tr>
<td>Full scale frequency</td>
<td>Highest frequency</td>
</tr>
<tr>
<td>Zero scale frequency</td>
<td>Lowest frequency (&gt;=0)</td>
</tr>
</tbody>
</table>

**Forcing I/O**

For testing purposes all inputs and outputs can be forced to a defined value or state. This option is available at security level 1000 ‘engineer’ or higher.

Display → IO, Force IO

If an input is forced the flow computer will generate an alarm.
Overall setup

Flow computer concepts
The Flow-X supports 2 different flow computer concepts:

1. Independent flow computer
2. Station / prover flow computer with remote run flow computers

Independent flow computer
The flow computer does its job independent of other flow computers. It might be a single or multi-stream flow computer. If needed, station and / or proving functionality can be enabled, which is done by the flow computer itself. No other flow computer is needed for that. The flow computer runs one application, which takes care of everything.

Depending on the required functionality the flow computer has to be configured as one of the following FC types:

1: Run only
2: Station / run
3: Proving / run
4: Station / proving / run

Station / prover flow computer with remote run flow computers
In this concept a number of flow computers are working together. Usually several single-stream flow computers are involved. Station and / or proving functionality is done by a separate flow computer, which is communicating to the (remote) run flow computers to exchange the data that’s needed to fulfill its station / proving tasks. A prove is initiated on the station / prover flow computer. The station / proving flow computer and run flow computers are each running a separate application.

The run flow computers have to be configured as FC type:

1: Run only

Depending on the required functionality the station / proving flow computer can be configured as one of the following FC types:

6: Station only
7: Proving only
8: Station / proving

It’s also possible to enable run functionality on the station / proving flow computer, f.e. in case of master meter proving, where the proving flow computer can also control the master meter. In that case the station / proving flow computer has to be configured as one of the following FC types:

2: Station / run
3: Proving / run
4: Station / proving / run

A station may consist of a mixture of local runs (controlled by the module(s) in the station flow computer, max. 4 (X/P4)) and remote runs (remote run flow computers running their own application). The maximum number of runs in a station (local runs plus remote runs) is 8. Local runs are numbered 1-4. E.g. in case of a Flow-X/P with 2 local runs and 3 remote runs, the local runs are numbered 1 and 2 and the remote runs can be configured as 3, 4 and 5.

Common settings

Display → Configuration, Overall setup, Common settings

<table>
<thead>
<tr>
<th>Flow computer type</th>
<th>1000</th>
<th>Determines whether the flow computer contains meter run functionality and / or station functionality and / or proving functionality.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Run only</td>
<td></td>
<td>Only meter run functionality is activated on this flow computer. Station functionality and proving logic are de-activated. The flow computer is either a single run FC or a multiple run FC. In case of a single run FC the run may be part of a remote station.</td>
</tr>
<tr>
<td>2: Station / run</td>
<td></td>
<td>Both meter run and station functionality are activated on this flow computer. Proving logic is de-activated. The flow computer is a station FC with one or more local runs and may optionally be communicating to one or more remote runs FC’s. All local and remote runs are part of the station.</td>
</tr>
<tr>
<td>3: Proving / run</td>
<td></td>
<td>Both meter run functionality and proving logic are activated on this flow computer. Station functionality is de-activated. The flow computer is a prover FC with one or more local runs and may optionally be communicating to one or more remote runs FC’s. All local and remote runs are independent and are not part of a station, but they can all be proved by this FC.</td>
</tr>
<tr>
<td>4: Station / proving / run</td>
<td></td>
<td>Meter run and station functionality and proving logic are all activated on this flow computer. The flow computer is a station / prover FC with one or more local runs and may optionally be communicating to one or more remote runs FC’s. All local and remote runs are part of the station and can be proved by this FC.</td>
</tr>
<tr>
<td>6: Station only</td>
<td></td>
<td>Only station functionality is activated on this flow computer. Run functionality and proving logic are de-activated. The flow computer is a station FC without local runs and is communicating to one or more remote run FC’s. All remote runs are part of the station.</td>
</tr>
<tr>
<td>7: Proving only</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Only proving logic is activated on this flow computer. Run and station functionality are deactivated. The flow computer is a prover FC without local runs and is communicating to one or more remote run FC’s which can be proved by it.

B: Station / proving
Station functionality and proving logic are activated on this flow computer. Run functionality is disabled. The flow computer is a station / prover FC without local runs and is communicating to one or more remote runs FC’s. All remote runs are part of the station and can be proved by this FC.

Station product 1000
Defines whether one common product (density and gas composition) is used for all meter runs or each meter run uses its own product setup.

0: Disabled
Each meter run runs a separate product, i.e. has a separate density and gas composition

1: Enabled
A common product is used for all meter runs.

In case of a station FC with one or more remote run flow computers, station product has to be enabled both on the station FC and on the remote run flow computer(s).

In case of a proving flow computer without station functionality (FC type: proving/run or proving only), Station product has to be disabled both on the prove FC and on the remote run flow computer(s).

### Calculation settings

<table>
<thead>
<tr>
<th>Calculation settings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use net HV for energy</strong> 1000</td>
<td>Controls whether the net heating value is used for energy totals instead of the gross heating value.</td>
</tr>
<tr>
<td>0: Disabled</td>
<td>GHV (higher heating value) is used</td>
</tr>
<tr>
<td>1: Yes</td>
<td>NHV (lower heating value) is used</td>
</tr>
<tr>
<td><strong>Averaging method</strong> 1000</td>
<td>Determines the method used for calculating the period averages.</td>
</tr>
<tr>
<td>0: Time weighted</td>
<td>1: Flow weighted on gross volume</td>
</tr>
<tr>
<td>1: Flow weighted on mass</td>
<td>2: Flow weighted on mass</td>
</tr>
<tr>
<td>3: Flow weighted on base volume</td>
<td>In either case averaging is inactive if the meter is inactive (flow rate, dP or pulse frequency below the low flow cutoff).</td>
</tr>
</tbody>
</table>

### Totalizer settings

<table>
<thead>
<tr>
<th>Totalizer settings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disable totals if meter is inactive</strong> 1000</td>
<td>Controls if the totals are disabled when the meter is inactive (flow rate, dP or pulse frequency below the low flow cutoff).</td>
</tr>
<tr>
<td>0: No</td>
<td>1: Yes</td>
</tr>
<tr>
<td><strong>Set flowrate to 0 if meter is inactive</strong> 1000</td>
<td>Controls if the flow rates are set to 0 if the meter is inactive (flow rate, dP or pulse frequency below the low flow cutoff).</td>
</tr>
<tr>
<td>0: No</td>
<td>1: Yes</td>
</tr>
<tr>
<td><strong>Reset maint. totals on entering maint. mode</strong> 1000</td>
<td>This setting controls whether the maintenance totalizers start at 0 when entering maintenance mode or at the values from the last time that maintenance mode has been active.</td>
</tr>
<tr>
<td>0: No</td>
<td>1: Yes</td>
</tr>
<tr>
<td><strong>Reverse totals 1000</strong></td>
<td>Enables / disabled the reverse totals</td>
</tr>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
</tr>
<tr>
<td><strong>Allow manual overrides 1000</strong></td>
<td>Determines whether manual (operator) transmitter overrides are accepted or not.</td>
</tr>
<tr>
<td>0: No</td>
<td>1: Yes</td>
</tr>
</tbody>
</table>

### Station totals calculation method 1000
Defines the method for calculating the station totals. |

1: Station totals: Maintain separate station totals based on the sum of run increments.

### Alarm settings

<table>
<thead>
<tr>
<th>Alarm settings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable alarms if meter is inactive 1000</td>
<td>Controls if the limit alarms, calculation alarms and deviation alarms are suppressed when the meter is inactive (flow rate, dP or pulse frequency below the low flow cutoff).</td>
</tr>
<tr>
<td>0: No</td>
<td>1: Yes</td>
</tr>
<tr>
<td>Disable alarms in maintenance mode 1000</td>
<td>Controls if the limit alarms, calculation alarms and deviation alarms are suppressed when the meter is set in maintenance mode.</td>
</tr>
<tr>
<td>0: No</td>
<td>1: Yes</td>
</tr>
<tr>
<td>Calculation out of range alarms 1000</td>
<td>Controls if a calculation out of range alarm is generated when an input (e.g. temperature, pressure or gas composition) is out of range of the applicable standard to calculate the compressibility, molar mass or heating value.</td>
</tr>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
</tr>
<tr>
<td>Deviation alarm delay 1000</td>
<td>Delay time [s] on deviation alarms:</td>
</tr>
<tr>
<td>1: Enabled</td>
<td>Pressure deviation alarms (deviation between both pressure transmitter readings in case of dual transmitters)</td>
</tr>
<tr>
<td>0: Disabled</td>
<td>Temperature deviation alarms (deviation between both temperature transmitter readings in case of dual transmitters)</td>
</tr>
<tr>
<td><strong>Density deviation alarms</strong></td>
<td>Density deviation alarms (deviation between two density transmitters, deviation between two 5G transducers, deviation between observed density and AGA-8 calculated density).</td>
</tr>
<tr>
<td><strong>Flow deviation alarms</strong></td>
<td>Flow deviation alarms (deviation between pulse flow rate and smart meter flow rate).</td>
</tr>
<tr>
<td><strong>VOS deviation alarms</strong></td>
<td>VOS deviation alarms (deviation between meter VOS and FC calculated VOS).</td>
</tr>
<tr>
<td><strong>dP deviation alarms</strong></td>
<td>dP deviation alarms (deviation between two dP transmitter values if two transmitters of the same range are used).</td>
</tr>
</tbody>
</table>

### Metrological

<table>
<thead>
<tr>
<th>Metrological</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MID compliance 1000</td>
<td>Determines if compliance with the measuring instruments directive (MID, the European Metrology law) is required or not. Enables the accountable / non-accountable totalizers and alarms.</td>
</tr>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
</tr>
<tr>
<td><strong>Energy accountable alarm 1000</strong></td>
<td>Defines whether or not an accountable alarm is generated (accountable totals disabled, non-accountable totals enabled) in case of an energy / heating value alarm.</td>
</tr>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
</tr>
<tr>
<td><strong>Allow manual overrides</strong> 1000</td>
<td>Determines whether manual (operator) transmitter overrides are accepted or not.</td>
</tr>
<tr>
<td>0: No</td>
<td>1: Yes</td>
</tr>
</tbody>
</table>

### Date and time

<table>
<thead>
<tr>
<th>Date format 1000</th>
<th>Date format used on the flow computer screens and reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: dd/mm/yy</td>
<td>2: mm/dd/yy</td>
</tr>
</tbody>
</table>
The molar mass of air \[\text{kg/mol}\] is used to calculate the specific gravity. The local atmospheric pressure \[\text{bar(a)}\] is used to convert gauge pressure to absolute pressure and vice versa.

### FC Redundancy

<table>
<thead>
<tr>
<th>FC Redundancy</th>
<th>Value</th>
</tr>
</thead>
</table>
| **FC duty status**
| **DO** | 1000 |
| Defines if the flow computer duty status is sent to a digital output.
| 0: Disabled
| 1: Enabled Only applicable if flow computer redundancy is enabled. Please be aware that redundancy has to be enabled/configured in Flow-Xpress prior to writing the application to the flow computer. |
| **DO module** | 1000 |
| Number of the flow module to which the output signal is physically connected. |
| **DO channel** | 1000 |
| Number of the digital channel on the selected module to which the output signal is physically connected. |

### Constants

<table>
<thead>
<tr>
<th>Constants</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atmospheric pressure</strong></td>
<td>1000</td>
</tr>
<tr>
<td>The local atmospheric pressure [\text{bar(a)}] is used to convert gauge pressure to absolute pressure and vice versa.</td>
<td></td>
</tr>
<tr>
<td><strong>Molar mass of air</strong></td>
<td>1000</td>
</tr>
<tr>
<td>The molar mass of air [\text{kg/kmol}] is used to calculate the specific gravity. If the specific gravity is a live input (via a 5G transducer or as a process input) then this parameter is used to calculate the observed and base density and corresponding volumes. 28.9626 [\text{kg/mol}] according to ISO-6976:1995</td>
<td></td>
</tr>
</tbody>
</table>
and averages and generate the period reports and archives (if applicable).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Manual command to close the period</th>
</tr>
</thead>
<tbody>
<tr>
<td>End hourly period</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>End daily period</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>End period A</td>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>End period B</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

**Totalizer settings**

Display → Configuration, Overall setup, Totals

**Decimal resolution**

| Gross volume total  | 1000 | Decimal resolution at which the indicated and gross volume totals are maintained. |
| Base volume total   | 1000 | Decimal resolution at which the base volume totals are maintained.               |
| Mass total          | 1000 | Decimal resolution at which the mass totals are maintained.                      |
| Energy total        | 1000 | Decimal resolution at which the energy totals are maintained.                    |

**Rollover values**

| Gross volume total  | 1000 | The rollover value for the indicated volume and gross volume totalizers.        |
| Base volume total   | 1000 | The rollover value for the base (standard) volume totalizers.                    |
| Mass total rollover | 1000 | The rollover value for the mass totalizers.                                     |
| Energy total rollover| 1000 | The rollover value for the energy totalizers.                                   |

**Display levels**

When no user has logged in to the flow computer, only abbreviated versions of the following displays are shown:

- In-use values
- Flow rates
- Cumulative totals
- Gas composition

All other displays have a minimum security level that needs to be activated (by a log-in) before the displays are shown and therefore accessible.

The following settings define the minimum security level required to access the associated displays. A display is hidden when the active security level is below the setting.

For each type of displays a selection can be made from the following list:

**Always show**

Always shows the display(s), even if not logged in

**Operator (500)**

Only show the display(s) if logged in at security level 'operator' or higher

**Technician (750)**

Only show the display(s) if logged in at security level 'technician' or higher

**Engineer (1000)**

Only show the display(s) if logged in at security level 'engineer' or higher

**Administrator (2000)**

Only show the display(s) if logged in at security level 'administrator'

The display levels only define the security levels needed for viewing specific types of displays. They don't define the security levels needed for modifying the parameters that are shown on the displays. Each parameter has its own minimum security level, which is needed to modify it, as is indicated in this manual.

**System data**

Display → Configuration, Overall setup, System data

<table>
<thead>
<tr>
<th>Display level</th>
<th>Minimum security level for accessing the displays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas properties</td>
<td>2000</td>
</tr>
<tr>
<td>Sampler control</td>
<td>2000</td>
</tr>
<tr>
<td>Proving display</td>
<td>2000</td>
</tr>
<tr>
<td>Valve control</td>
<td>2000</td>
</tr>
<tr>
<td>Flow control</td>
<td>2000</td>
</tr>
<tr>
<td>Reports display</td>
<td>2000</td>
</tr>
<tr>
<td>Alarm overview</td>
<td>2000</td>
</tr>
<tr>
<td>IO calibration</td>
<td>2000</td>
</tr>
<tr>
<td>Metrological configuration</td>
<td>2000</td>
</tr>
<tr>
<td>Non-metrological configuration</td>
<td>2000</td>
</tr>
<tr>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Flow computer tag</td>
<td>600</td>
</tr>
<tr>
<td>Tag name of the flow computer, e.g. “FY-1001A”</td>
<td></td>
</tr>
<tr>
<td>System tag</td>
<td>600</td>
</tr>
<tr>
<td>Tag name for the meter station or in case of a single stream flow computer, the meter run, e.g. “YY-100”</td>
<td></td>
</tr>
<tr>
<td>System description</td>
<td>600</td>
</tr>
<tr>
<td>Description of the meter station or in case of a single stream flow computer, the meter run, e.g. “Export stream 2”</td>
<td></td>
</tr>
<tr>
<td>System company</td>
<td>600</td>
</tr>
<tr>
<td>Name of the company that owns the meter station or in case of a single stream flow computer, the meter run, e.g. “LiqTransco”</td>
<td></td>
</tr>
<tr>
<td>System location</td>
<td>600</td>
</tr>
<tr>
<td>Name of the location of the meter station or in case of a single stream flow computer, the meter run, e.g. “Green field, South section”</td>
<td></td>
</tr>
</tbody>
</table>
**Meter run setup**

The meter run configuration displays are only available for the following FC types:

- Run only
- station /run
- proving / run
- station / proving / run

**Run setup**

This display contains the general run settings. Depending on the selections made in this display, specific configuration displays for detailed configuration will be available further down the menu.

Display → Configuration, Run <x>, Run setup
with <x> the module number of the meter run

The settings in this paragraph that are marked with (*) are only available for the following FC types:

- run only
- proving / run

---

**Meter type**

<table>
<thead>
<tr>
<th>Meter type</th>
<th>1000</th>
<th>The following meter device types are supported:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Pulse</td>
<td>Any flow meter that provides a single or dual pulse signal representing the volumetric or mass flow. Typically used for turbine and PD (Positive displacement) flow meters.</td>
<td></td>
</tr>
<tr>
<td>2: Smart</td>
<td>Any flow meter that provides its flow rate and/or total value through an analog or HART signal or via a Modbus communications link. For a HART signal or a Modbus communications link the corresponding communications device needs to be defined using the Flow-Xpress software, prior to writing the application to the flow computer.</td>
<td></td>
</tr>
<tr>
<td>3: Smart / pulse</td>
<td>Any flow meter that provides its flow rate and/or total value through an analog or HART signal or via a Modbus communications link and also through a single or dual pulse signal. Either the smart or the pulse signal may be defined as the primary signal for totalization. Also a deviation check between the two signals is performed. Typically used for ultrasonic and coriolis flow meters.</td>
<td></td>
</tr>
<tr>
<td>4: Orifice</td>
<td>Orifice plate with up to 3 differential pressure transmitters.</td>
<td></td>
</tr>
<tr>
<td>5: Venturi</td>
<td>Classical venturi with up to 3 differential pressure transmitters.</td>
<td></td>
</tr>
<tr>
<td>6: V-cone</td>
<td>McCrometer V-Cone flow meter with up to 3 differential pressure transmitters.</td>
<td></td>
</tr>
<tr>
<td>7: Venturi nozzle</td>
<td>Venturi nozzle with up to 3 differential pressure transmitters.</td>
<td></td>
</tr>
<tr>
<td>8: Long radius nozzle</td>
<td>Long radius nozzle with up to 3 differential pressure transmitters.</td>
<td></td>
</tr>
<tr>
<td>9: ISA1932 nozzle</td>
<td>ISA1932 nozzle with up to 3 differential pressure transmitters.</td>
<td></td>
</tr>
</tbody>
</table>

**Meter temperature**

<table>
<thead>
<tr>
<th>Meter temperature</th>
<th>1000</th>
<th>Defines if one or two transmitters are used for indicating the meter temperature.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0: Single</td>
<td>One meter temperature transmitter</td>
</tr>
<tr>
<td></td>
<td>1: Dual</td>
<td>Two meter temperature transmitters</td>
</tr>
</tbody>
</table>

**Density**

The settings are replicated from the ‘Density setup’ display. See the paragraph ‘Density setup’ for a description of the individual settings.

- Observed density input type (*)
- Density temperature input type (*)
- Density pressure input type (*)
- Specific gravity input type (*)
- Relative density input type (*)
- Base density input type (*)

**Meter density calculation method**

If an impossible combination of settings is chosen, then a ‘Density configuration error’ alarm is shown.

---

**Gas composition**

Gas composition input type (*)

This setting is replicated from the ‘Gas composition’ configuration display. See the paragraph ‘Gas composition’ for a detailed description.

**Heating value**

Gross heating value input type (*)

---

**Run control setup**

From this display the run control functions, like valve control, flow control and sampler control can be enabled or disabled. Depending on the selections made in this display, specific configuration displays for detailed configuration will be available further down the menu.
Display → Configuration, Run <x>, Run control setup with <x> the module number of the meter run

**Valve control**

<table>
<thead>
<tr>
<th>Inlet valve control signals</th>
<th>600</th>
<th>With this setting control of the inlet valve can be enabled or disabled (none=disabled). For a thorough explanation of this setting refer to paragraph 'Valve control'.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outlet valve control signals</td>
<td>600</td>
<td>With this setting control of the outlet valve can be enabled or disabled (none=disabled). For a thorough explanation of this setting refer to paragraph 'Valve control'.</td>
</tr>
<tr>
<td>Run to prover valve control signals</td>
<td>600</td>
<td>With this setting control of the run to prover valve can be enabled or disabled (none=disabled). For a thorough explanation of this setting refer to paragraph 'Valve control'.</td>
</tr>
</tbody>
</table>

**Flow / pressure control**

| Flow / pressure control mode | 600 | With this setting flow / pressure control (PID control) can be enabled or disabled (none=disabled). For a thorough explanation of this setting refer to paragraph 'Flow / pressure control'. |

**Flow meter setup**

The type of flow meter is set up under Configuration, Run <x>, Run Setup. Depending on the selected meter type, specific display screens for configuration of the meter are available.

Display → Configuration, Run <x>, Flow meter, Meter data with <x> the module number of the meter run

**HF / LF pulses**

<table>
<thead>
<tr>
<th>HF / LF pulse type</th>
<th>1000</th>
<th>Enables or disables high frequency / low frequency pulses.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td></td>
<td>Pulse A and B are both high frequency pulses.</td>
</tr>
<tr>
<td>1: Enabled</td>
<td></td>
<td>Pulse A is a high frequency pulse. Pulse B is a low frequency pulse. The high frequency pulse (pulse A) is used for the flow calculations. The low frequency pulse is for indication only. The relation between the high frequency pulses and low frequency pulses is defined by the blade ratio.</td>
</tr>
<tr>
<td>2: Auto-adjust meter</td>
<td></td>
<td>Pulse A is the high frequency pulse of the main rotor of a Sensus Auto-adjust turbo meter. Pulse B is the low frequency pulse of the sense rotor.</td>
</tr>
<tr>
<td>HF / LF pulses blade ratio</td>
<td>1000</td>
<td>Defines the ratio between the high frequency pulses and low frequency pulses. E.g. a blade ratio of 4 means that there will be one LF pulse for every 4 HF pulses.</td>
</tr>
</tbody>
</table>

**Auto-adjust meter pulses**

The settings in this section are only applicable if HF / LF pulse type has been set to ‘Auto-adjust meter’.

A Sensus ‘Auto-adjust turbo meter’ contains two rotors: a high frequency main rotor and a low frequency sense rotor that’s running in the opposite direction. The aim of this design is to correct for inaccuracies due to drag, mechanical wear, non-uniform flow, swirl, pulsation and contamination.

The volume from this meter is calculated as:

\[
\text{Meter volume} = \text{main rotor volume} - \text{sense rotor volume}
\]

Main rotor volume = main rotor pulses / main rotor K-factor
Sense rotor volume = sense rotor pulses / sense rotor K-factor

The k-factors are chosen such that the sense rotor measures a certain share of the flow (defined by the ‘Factory calibration adjustment [%]’, f.e. 8%) and the main rotor measures 100% plus this amount (f.e. 108%).

For both rotors a separate cut-off frequency is applied. If the measured frequency is below the cut-off frequency, the rotor signal is considered to be inactive and is not taken into account in the calculations. If the main rotor signal is inactive (i.e. below the cut-off frequency) then the meter is set to inactive. If the sense rotor signal is inactive while the main rotor is active, then
the meter is set to active and the volume is calculated by the alternative formula:

\[
\text{Meter volume} = \text{main rotor pulses} / \text{mechanical k-factor}.
\]

**Custom pulse increment**

<table>
<thead>
<tr>
<th>Custom pulse increment</th>
<th>1000</th>
<th>If enabled, the totalizer increments are calculated from the value that is written to the 'Custom pulse increment' and the actual pulse input is not used.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0:</td>
<td>Disabled</td>
</tr>
<tr>
<td></td>
<td>1:</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

**Smart meter**

This display is only available if Meter device type is 'Smart' or 'Smart / Pulse'.

Display → Configuration, Run <x>, Flow meter, Smart meter

with <x> the module number of the meter run

**Analog input settings**

<table>
<thead>
<tr>
<th>Analog input quantity type</th>
<th>1000</th>
<th>Only applicable if smart meter input type = 2: Analog input' or input type is '1: HART / Modbus' with option 'HART to analog fallback' enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:</td>
<td>Volumetric</td>
</tr>
<tr>
<td></td>
<td>2:</td>
<td>Mass</td>
</tr>
</tbody>
</table>

For HART or Modbus inputs this setting is determined automatically from the communication tag list of the assigned communication device.

**HART / Modbus settings**

<table>
<thead>
<tr>
<th>HART to analog fallback</th>
<th>1000</th>
<th>Only applicable for a single HART transmitter in a loop, where the 4-20 mA signal is provided together with the HART signal.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0:</td>
<td>Disabled</td>
</tr>
<tr>
<td></td>
<td>1:</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

The 4-20 mA signal will not be used if the HART signal fails. Instead the value corresponding with the 'Fallback type' will be used.

**Meter active settings**

<table>
<thead>
<tr>
<th>Meter active threshold flow rate</th>
<th>1000</th>
<th>Low flow cutoff flow rate. The meter will be considered inactive when the flow rate is below this limit value. The value has the same units as the flow rate that is indicated by flow meter: [m³/hr] in case of a volume flow meter, [kg/hr] in case of a mass flow meter.</th>
</tr>
</thead>
</table>

Depending on the settings 'Disable totals when meter inactive' and 'Set flow rate to 0 when meter inactive' the totals are stopped and / or the flow rate is set to zero if the flow rate is below this threshold (refer to paragraph 'Overall setup').

**Enable meter inactive custom condition**

<table>
<thead>
<tr>
<th>Enable meter inactive custom condition</th>
<th>1000</th>
<th>If enabled, the 'meter inactive custom condition' of the meter run can be used to disable / enable the meter totals and / or set the flow rate to 0 through an internal 'calculation' or through communication. Should only be enabled if needed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0:</td>
<td>Disabled</td>
</tr>
<tr>
<td></td>
<td>1:</td>
<td>Enabled</td>
</tr>
</tbody>
</table>

**Communication settings**

<table>
<thead>
<tr>
<th>Pulse K-factor selection</th>
<th>1000</th>
<th>Defines if the K factor (pulses/unit) is read from the meter or set manually. Only applicable if meter type is 'Smart / pulse'.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:</td>
<td>User parameter</td>
</tr>
<tr>
<td></td>
<td>Use the K-factor that is configured in the flow computer</td>
<td></td>
</tr>
</tbody>
</table>
Flow meter total rollover

1000

Only applicable for a smart meter of which the ‘Flow total’ is used for flow accumulation.

Defines the value at which the total as received from the flow meter rolls-over to 0. When the current total value indicated by the flow meter is smaller than the previous value total, then the Flow-X calculates the increment assuming that a roll-over occurred. It then checks that the increment does not exceed the ‘Flow Meter Max. Change in Total’.

Unit is [m³] in case of a volume flow meter, [kg] in case of a mass flow meter.

Flow meter max. change in total

1000

Only applicable for a smart meter of which the ‘Flow total’ is used for flow accumulation.

Total increments beyond this limit will be ignored. This may i.e. happen in case the totalizer in the meter is reset or when the meter is replaced.

Unit is [m³] in case of a volume flow meter, [kg] in case of a mass flow meter.

Flow rate deviation check

Flow deviation limit smart / pulses

600

Only applicable if meter type is ‘Smart / pulse’. The flow rates as indicated by the smart and pulse inputs are compared and a ‘Smart / pulse flow deviation’ alarm is raised if the relative deviation between the two is larger than this Flow deviation limit [%].

Velocity of sound deviation check

AGA10 velocity of sound check

600

Only applies to ultrasonic flow meters. Enables or disables a check between the velocity of sound (VOS) from the meter and the velocity of sound calculated by the flow computer based on AGA10.

0: Disabled

1: Enabled

Velocity of sound deviation limit

600

Deviation limit [m/s] for the velocity of sound check. If the velocity of sound check is enabled and the deviation between the VOS from the meter and the VOS calculated by the flow computer exceeds this limit, then an alarm is generated.

Meter K-factor

Only available if Meter device type is 'Pulse input' or 'Smart / pulse'.

To convert meter pulses in metered volume a meter K-factor is used. The Meter K-factor value can be defined in two ways, either as a nominal meter K-factor value that is applied for all flow rates or as a calibration curve, where a number of calibrated K-factors is defined as a function of the actual pulse frequency.

Display → Configuration, Run <x>, Flow meter, Meter K-factor (K-factor setup)

With <x> the module number of the meter run

Nominal K-factor

Nominal K-factor (fwd/rev)

1000

The number of pulses per unit, with the unit being m³ for volumetric flow meters, or kg for mass flow meters. Separate nominal K-factors are maintained for forward and reverse flow directions.

Nominal K-factors are only used if K-factor curve interpolation is disabled. The reverse nominal K-factor is only used if reverse totalizers are enabled.

K-factor curve

K-factor curve 1000

Controls whether the nominal K-factor or the calibration curve is used.

0: Disabled

Nominal K-factor is used

1: Enabled

Calibration curve is used.

Curve extrapolation allowed

1000

Controls if extrapolation is allowed when the pulse frequency is outside the calibration curve

0: No

When the pulse frequency is below the first calibration point or above the last calibration point, then respectively the first or the last calibration K-factor will remain in use.

1: Yes

The interpolation is extrapolated when the pulse frequency is outside the calibrated range.

K-factor curve (forward / reverse)

Display → Configuration, Run <x>, Flow meter, Meter K-factor, K-factor curve (forward / reverse)

With <x> the module number of the meter run

K-factor curves are only visible if K-factor curve interpolation is enabled. The reverse K-factor curve is only visible if reverse totalizers are enabled.

Point x – Frequency

1000

Pulse frequency [Hz] of the calibration point

Point x – K-factor

1000

Meter K-factor [pls/unit] of the calibration point.

Remarks:

- Pulse frequency must be in ascending order
- Up to 12 points can be defined. For unused points, leave the pulse frequency to 0. E.g. if the curve has 6 points, the pulse frequency of points 7 through 12 must be set to 0.

Meter factor / error

To correct for a meter error that was determined at a meter calibration, the volume or mass as indicated by the meter can be corrected with either one nominal meter factor for all flow rates, or a calibration curve that defines the meter factor as a function of the flow rate.

Because meter calibration reports specify either the meter factor or the meter error as a function of the flow rate, the flow computer accommodates the entry of either value. The relationship between the meter error and the meter factor as follows:

\[
\text{Meter factor} = \frac{100}{(100 + \text{Meter error})}
\]

(with the meter error specified as a percentage).

By default a nominal meter factor of 1 is used, so effectively disabling the correction.
Separate nominal meter factors / errors and separate meter factor / error curves are used for forward and reverse flow.

Display → Configuration, Run <x>, Flow meter, Meter factor, Meter factor setup

With <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Type of input value</th>
<th>1000</th>
<th>Defines the meaning of the entered values. Applies for both the nominal value and the calibration curve values.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1: Meter factor [-]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Meter error [%]</td>
</tr>
</tbody>
</table>

**Nominal meter factor / error**

<table>
<thead>
<tr>
<th>Nominal meter factor / error</th>
<th>1000</th>
<th>The nominal meter factor [-] or error [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Separate nominal meter factor / error for forward and reverse flow</td>
</tr>
</tbody>
</table>

**Meter factor / error curve**

<table>
<thead>
<tr>
<th>Meter factor / error curve</th>
<th>1000</th>
<th>Controls whether the nominal meter factor / error or the calibration curve is used.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0: Disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Enabled</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Curve extrapolation allowed</th>
<th>1000</th>
<th>Controls if extrapolation is allowed when the flow rate is outside the calibration curve.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0: No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>When the flow rate is below the first calibration point or above the last calibration point, respectively the first or the last calibration error will remain in-use.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Interpolation is extrapolated when the pulse frequency is outside the calibrated range.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Curve flow rate corrected for MBF</th>
<th>1000</th>
<th>Only applicable if meter factor / error curve interpolation is enabled and meter body correction is enabled.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Determines whether or not the flow computer applies the MBF (Meter Body Correction Factor) to the flow rate before using it in meter factor interpolation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0: Disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Enabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uncorrected flow rate is used in meter factor / error curve interpolation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Corrected flow rate is used in meter factor / error curve interpolation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prove base flow rate (forward or reverse)</th>
<th>1000</th>
<th>Only applicable if meter factor / error curve interpolation is enabled.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Base flow rate at which the offset from the meter factor curve is calculated. [m3/hr] in case of a volume flow meter, [kg/hr] in case of a mass flow meter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The actual prove flow rate should not differ too much from this prove base flow rate.</td>
</tr>
</tbody>
</table>

**Meter factor offset**

| Meter factor offset (forward or reverse) | Only applicable if meter factor / error curve interpolation is enabled. Offset from the meter factor curve as determined from proving. Calculated by the flow computer based on the prove result. |

**Custom meter factor**

| Custom | 1000 | If enabled, the meter factor value that is written to the 'Custom meter factor' is used instead of the nominal or curve meter factor / error. |

**Meter factor / error curves**

The flow computer uses separate meter factor / error curves for forward and reverse flow. Meter factor / error curves are only visible if meter factor / error curve interpolation is enabled. The reverse meter factor / error curve is only visible if reverse totalizers are enabled.

Display → Configuration, Run <x>, Flow meter, Meter factor, Meter factors curve

With <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Point x – Flow rate</th>
<th>1000</th>
<th>Flow rate [unit/h] of the calibration point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point x – Meter factor / error</td>
<td>1000</td>
<td>Meter factor [-] or Meter error [%] of the calibration point, depending on the selected Type of input value.</td>
</tr>
</tbody>
</table>

**Remarks:**

- Flow rates must be in ascending order
- Up to 12 points can be defined. For unused points, leave the flow rate to 0. E.g. when the curve has 6 points, the flow rates of points 7 through 12 must be set to 0.

**Data valid input**

The Data valid input is an optional input that can be used to control the accountable totals (for MID compliance). It is usually only applicable for smart flow meters (e.g. ultrasonic or Coriolis) that provide a data valid output signal.

The Data Valid can also be used as a permissive for flow control.

Display → Configuration, Run <x>, Flow meter, Data valid input

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Data valid input type</th>
<th>1000</th>
<th>Selects the data valid input type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0: None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data valid check is disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Digital input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reads the data valid status from a digital input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Smart meter input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uses the data valid status from the flow meter Modbus communication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Custom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The value that is written to tag Data valid custom condition will be used. Use this option if the data application requires a custom condition.</td>
</tr>
</tbody>
</table>
Flow direction

Only available if Reverse totals are enabled (Display → Configuration, Overall setup, Common settings)

The flow direction is used to switch between the forward and reverse totals and averages.

Display → Configuration, Run <x>, Flow meter, Flow direction

with <x> the module number of the meter run

Flow direction input

<table>
<thead>
<tr>
<th>Flow direction input type</th>
<th>1000</th>
<th>Selects the flow direction input type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Meter pulse phase</td>
<td></td>
<td>Only applies to dual pulse meters. The flow direction is derived from the sequence of the dual pulses. See paragraph 'Pulse input' for more details.</td>
</tr>
<tr>
<td>2: Digital input</td>
<td></td>
<td>Reads the flow direction status from a digital input (0: Forward, 1: Reverse)</td>
</tr>
<tr>
<td>3: Smart meter Modbus</td>
<td></td>
<td>Uses the flow direction from the flow meter Modbus communication</td>
</tr>
<tr>
<td>4: Custom</td>
<td></td>
<td>The value that is written to tag Flow direction custom value will be used. Use this option if the flow direction value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the flow direction.</td>
</tr>
</tbody>
</table>

Flow direction digital input module 1000

Only applicable if Flow direction input type is 'Digital input'.
Number of the flow module to which the signal is physically connected.

Flow direction digital input channel 1000

Only applicable if Flow direction input type is 'Digital input'.
Number of the digital channel on the selected module to which the signal is physically connected.

Flow direction output

<table>
<thead>
<tr>
<th>Flow direction digital output</th>
<th>600</th>
<th>Enables / disables the flow direction digital output.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: Enabled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Flow direction digital output module 600

Number of the flow module to which the signal is physically connected.
-1: Local module means the module of the meter run itself

Flow direction digital output channel 600

Number of the digital channel on the selected module to which the signal is physically connected.

Meter body correction

Only available if Meter device type is 'Pulse', 'Smart' or 'Smart/Pulse'

The meter body correction facility is mainly meant for ultrasonic flow meters for which a correction of the expansion of the meter body may be required.

The meter body factor (MBF) accounts for the influence of temperature and pressure on the meter’s steel.

Refer to chapter Calculations for more details

Display → Configuration, Run <x>, Flow meter, Meter body correction

with <x> the module number of the meter run

If the flow rate value indicated by the smart flow meter already includes the correction for meter body expansion, then the Meter Body Correction in the flow computer must be disabled.

<table>
<thead>
<tr>
<th>Meter body correction type</th>
<th>1000</th>
<th>Controls how the meter body correction factor is calculated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Formula</td>
<td></td>
<td>Calculates the meter body correction factor using the formula: MBF = 1 + Temp coef * (T - Tref) + Pres coef * (P - Pref)</td>
</tr>
<tr>
<td>2: Custom</td>
<td></td>
<td>Uses the value [1] that is written to the Custom meter body correction factor. Use this option if you want to apply user-defined calculations to the meter body correction factor.</td>
</tr>
</tbody>
</table>

Calculation constants

<table>
<thead>
<tr>
<th>Body correction reference temperature</th>
<th>1000</th>
<th>Reference temperature for body correction [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body correction reference pressure</td>
<td>1000</td>
<td>Reference pressure for body correction [bar(g)]</td>
</tr>
<tr>
<td>Meter body coefficient selection</td>
<td>1000</td>
<td>1: Use parameter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Read from flow meter</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note that communication of the body expansion coefficients via Modbus is not supported by all smart meters.</td>
</tr>
</tbody>
</table>

User coefficients

<table>
<thead>
<tr>
<th>Cubical temperature</th>
<th>1000</th>
<th>Cubical temperature expansion coefficient [1/K] (same as 1/°C)</th>
</tr>
</thead>
</table>
Indicated totalizers
From this display the (forward and reverse) indicated totalizers can be adjusted.

```
Display → Configuration, Run <x>, Flow meter, Indicated totalizers
with <x> the module number of the meter run
```

This feature can be used to make the indicated totalizers on the flow computer run in line with the totalizers indicated on the meter. This is mainly applicable to ultrasonic meters and Coriolis meters that have a display showing an (indicated) volume or mass totalizer.

The unit of the indicated totalizer is either [m³] or [kg] depending on the meter quantity type.

Forward totalizer

```
Preset fwd indicated totalizer value 1000
Accept fwd totalizer 1000
```

Reverse totalizer

```
Preset rev indicated totalizer value 1000
Accept rev totalizer 1000
```

Serial mode

Only applicable for FC types:

Station/run
Station/proving/run
‘Run only’ with the run being part of a remote station

Serial mode avoids the totals of meters that are set in a serial configuration to be added together in a station total. If serial mode for a run is active, the totalizers of that run are not taken into account in the station totalizers.

```
Display → Configuration, Run <x>, Flow meter, Serial mode
with <x> the module number of the meter run
```

Serial mode can be activated by manual command, or from a digital input. The digital input may be connected to a status output of a ‘crossover valve’, by which 2 meters can be put into serial configuration. From this valve status the flow computer then can detect if the meters are in serial configuration or not.

```
Serial mode 1000 Enables or disables the serial mode logic for this meter.
0: Disabled
1: Enabled
```

Serial mode input type

```
Serial mode input type 1000 Enables or disables the serial mode logic for this meter.
0: None
1: Manual
The meter is set into / put out of serial mode by manual commands
2: Digital input
The meter is set into / put out of serial mode by reading a digital input.
3: Custom
Uses the status that is written to the Serial mode custom input value. Use this option if the serial mode status is received through a Modbus communications link, or if you want to apply user-defined logic to the serial mode status.
```

Serial mode digital input

```
Serial mode digital input module 1000 Only applicable if Serial mode input type is ‘Digital input’.
Number of the flow module to which the signal is physically connected.
-1: Local module means the module of the meter run itself
```

```
Serial mode digital input channel 1000 Only applicable if Serial mode input type is ‘Digital input’.
Number of the digital channel on the selected module to which the signal is physically connected.
```

```
Serial mode digital input polarity 1000 Only applicable if Serial mode input type is ‘Digital input’.
Polarity of the digital input to which the signal is physically connected.
1: Normal
2: Inverted
```

Serial mode switch permissive

```
Serial mode switch permissive 1000 Determines whether or not a serial mode switch permissive is taken into account. If enabled the run can only be manually put into / out of serial mode if the serial mode switch permissive (to be written through Modbus or using a ‘custom calculation’) is ON.
0: Disabled
1: Enabled
```

Orifice

For orifice plates in accordance with ISO-5167 or AGA-3.

Only available if Meter device type is ‘Orifice’

```
Display → Configuration, Run <x>, Flow meter, Orifice
with <x> the module number of the meter run
```

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```
### Calculation method

<table>
<thead>
<tr>
<th>Orifice calculation method</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defines the standard used for the calculations</td>
<td></td>
</tr>
<tr>
<td>1: ISO-5167</td>
<td></td>
</tr>
<tr>
<td>2: AGA-3 flange tappings</td>
<td></td>
</tr>
<tr>
<td>3: AGA-3 pipe tappings</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ISO5167 edition</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>The edition of the ISO-5167 standard to be used for the flow calculations.</td>
<td></td>
</tr>
<tr>
<td>1: 1991</td>
<td></td>
</tr>
<tr>
<td>2: 1998</td>
<td></td>
</tr>
<tr>
<td>3: 2003</td>
<td></td>
</tr>
</tbody>
</table>

Only applicable if Orifice calculation method is 'ISO-5167'.

### Pipe settings

<table>
<thead>
<tr>
<th>Pipe diameter</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal pipe diameter [mm]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe reference temperature</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference temperature for the specified pipe diameter [°C]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe expansion factor - type</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selects the pipe material. Used to set the pipe linear thermal expansion factor.</td>
<td></td>
</tr>
<tr>
<td>1: Carbon steel 1.12e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>2: Stainless steel 304 1.73e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>3: Stainless steel 316 1.59e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>4: Monel 1.43e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>5: User-defined (uses the 'Pipe expansion factor - user')</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe expansion factor - user</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>User-defined value for pipe linear thermal expansion factor [1/°C]</td>
<td></td>
</tr>
<tr>
<td>Only used when 'Pipe expansion factor - type' is set to 'User-defined'</td>
<td></td>
</tr>
</tbody>
</table>

### Device settings

<table>
<thead>
<tr>
<th>Device diameter</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orifice internal diameter [mm]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device reference temperature</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference temperature for the specified device diameter [°C]</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device expansion factor - type</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selects the orifice material. Used to set the device linear thermal expansion factor.</td>
<td></td>
</tr>
<tr>
<td>1: Carbon steel 1.12e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>2: Stainless steel 304 1.73e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>3: Stainless steel 316 1.59e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>4: Monel 1.43e-5 [1/°C]</td>
<td></td>
</tr>
<tr>
<td>5: User-defined (uses the Device expansion factor - user)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device expansion factor - user</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>User-defined value for device linear thermal expansion factor [1/°C]</td>
<td></td>
</tr>
<tr>
<td>Only used when 'Device expansion factor - type' is set to 'User-defined'</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Orifice configuration</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of the pressure tappings in accordance with the ISO5167</td>
<td></td>
</tr>
<tr>
<td>1: Corner tappings</td>
<td></td>
</tr>
<tr>
<td>2: D and D/2 tappings</td>
<td></td>
</tr>
</tbody>
</table>

### Pressure settings

<table>
<thead>
<tr>
<th>Pressure transmitter location</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of the pressure tap used for the static pressure relative to the orifice plate.</td>
<td></td>
</tr>
<tr>
<td>1: Upstream tapping</td>
<td></td>
</tr>
<tr>
<td>2: Downstream tapping</td>
<td></td>
</tr>
</tbody>
</table>

If 'Downstream tapping' is selected, a correction of the meter pressure to upstream conditions is applied. Refer to chapter Calculations for more details.

### Temperature settings

<table>
<thead>
<tr>
<th>Temperature transmitter location</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of the temperature element relative to the orifice plate.</td>
<td></td>
</tr>
<tr>
<td>1: Upstream tapping</td>
<td></td>
</tr>
<tr>
<td>2: Downstream tapping</td>
<td></td>
</tr>
<tr>
<td>3: Recovered pressure position</td>
<td></td>
</tr>
<tr>
<td>Downstream at the location where the pressure has fully recovered.</td>
<td></td>
</tr>
</tbody>
</table>

If 'Downstream tapping' or 'Recovered pressure position' is selected, a correction of the meter temperature to upstream conditions is applied. Refer to chapter Calculations for more details.

### Temperature correction

This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions.

<table>
<thead>
<tr>
<th>Temperature exponent</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only used when temperature has to be corrected to upstream conditions and type of temperature correction is either 'Temperature exponent' or 'Joule Thomson'.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Joule Thomson coefficient type</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only applicable if Temperature correction is set to 'Joule Thomson'. Defines how the Joule Thomson coefficient is defined.</td>
<td></td>
</tr>
<tr>
<td>1: Fixed value</td>
<td></td>
</tr>
<tr>
<td>Uses the temperature exponent as a fixed Joule Thomson coefficient.</td>
<td></td>
</tr>
<tr>
<td>2: Calculated</td>
<td></td>
</tr>
<tr>
<td>Calculated Joule Thomson coefficient calculation according to ISO/TR 9464. See section 'Calculations' for details.</td>
<td></td>
</tr>
</tbody>
</table>

### Density settings

<table>
<thead>
<tr>
<th>Density exponent</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>This parameter specifies how the density must be corrected from recovered to upstream conditions. Density correction is only applied if 'meter density correction method' is set to 'ISO5167 upstream density' (See 'Run setup').</td>
<td></td>
</tr>
</tbody>
</table>

If Density exponent = 0, then isentropic density correction is applied (using 1/isentropic exponent).
### AGA 3 settings

- **AGA3 Fpwl (gravitational correction factor)** 1000: Gravitational correction factor (Fpwl) for the AGA3 calculations. Only applicable if **Orifice calculation method** is 'AGA-3 flange tappings'.
- **AGA3 pipe tappings rounding** 1000: Enables / disables rounding of intermediate calculation values. Only applicable if **Orifice calculation method** is 'AGA-3 pipe tappings'.

### Product properties

- **Isentropic exponent**: Isentropic exponent of the gas at flowing conditions [dimensionless]. Also referred to as \( k \) (kappa). For an ideal gas this coefficient is equal to the ratio of the specific heat at constant pressure to the specific heat at constant volume.

### Venturi

For classical venturi tubes in accordance with ISO-5167.

Only available if Meter device type is 'Venturi'.
(temperature referral) and for wet gas correction calculation (if applicable). If pressure loss measurement is disabled, then the (fixed) pressure loss value is used for temperature referral.

0: Disabled
1: Enabled

Temperature settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature transmitter location</td>
<td>1000</td>
<td>Location of the temperature element relative to the venturi.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Upstream tapping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Downstream tapping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Recovered pressure position</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Downstream at the location where the pressure has fully recovered.</td>
</tr>
<tr>
<td>Temperature correction</td>
<td>1000</td>
<td>This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Isentropic exponent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isentropic expansion using (1+ν)/κ as the temperature referral exponent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Temperature exponent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isentropic expansion using the Temperature Exponent parameter value as the temperature referral exponent [-]. Please note that the Temperature Exponent must be &lt; 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Joule Thomson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isentropic expansion using the Temperature Exponent as the Joule Thomson coefficient [°C/bar]. This method is prescribed by ISO5167:2003.</td>
</tr>
<tr>
<td>Temperature exponent</td>
<td>1000</td>
<td>Only used when temperature has to be corrected to upstream conditions and type of temperature correction is either 'Temperature exponent' or 'Joule Thomson'.</td>
</tr>
<tr>
<td>Joule Thomson coefficient type</td>
<td>1000</td>
<td>Only applicable if Temperature correction is set to 'Joule Thomson'. Defines how the Joule Thomson coefficient is defined.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Fixed value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uses the temperature exponent as a fixed Joule Thomson coefficient.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Calculated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Joule Thomson coefficient calculation according to ISO/TR 9464. See section 'Calculations' for details.</td>
</tr>
</tbody>
</table>

Density settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density exponent</td>
<td>1000</td>
<td>This parameter specifies how the density must be corrected from recovered to upstream conditions. Density correction is only applied if meter density calculation method is set to 'ISO5167 upstream density' (See 'Run setup')</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If Density exponent = 0, then isentropic density correction is applied (using 1/Isentropic exponent)</td>
</tr>
</tbody>
</table>

Wet gas correction

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet gas correction type</td>
<td>1000</td>
<td>Enables or disables wet gas correction:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0: None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No wet gas correction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: De Leeuw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wet gas correction according to De Leeuw</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Reader-Harris</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wet gas correction according to Reader-Harris</td>
</tr>
</tbody>
</table>

Product properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
</table>

Isentropic exponent 1000 Isentropic exponent of the gas at flowing conditions [dimensionless]. Also referred to as κ (kappa). For an ideal gas this coefficient is equal to the ratio of the specific heat capacity at constant pressure to the specific heat at constant volume.

V-cone

Settings for McCrometer V-cone and wafer cone flow meters.

Only available if Meter device type is 'V-cone'

Display → Configuration, Run <x>, Flow meter, V-cone with <x> the module number of the meter run

Meter active settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low flow cutoff dP</td>
<td>1000</td>
<td>Meter active threshold dP. The meter will be considered inactive when the actual differential pressure [mbar] is below this limit value. Depending on the settings 'Disable totals when meter inactive' and 'Set flow rate to 0 when meter inactive' the totals are stopped and / or the flow rate is set to zero (refer to paragraph 'Overall setup').</td>
</tr>
<tr>
<td>Enable meter inactive custom condition</td>
<td>1000</td>
<td>If enabled, the 'meter inactive custom condition' of the meter run can be used to disable / enable the meter totals and / or set the flow rate to 0 through an internal 'calculation' or through communication. Should only be enabled if needed.</td>
</tr>
</tbody>
</table>

Pipe settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe diameter</td>
<td>1000</td>
<td>Internal pipe diameter [mm]</td>
</tr>
<tr>
<td>Pipe reference temperature</td>
<td>1000</td>
<td>Reference temperature for the specified pipe diameter [°C]</td>
</tr>
<tr>
<td>Pipe expansion factor - type</td>
<td>1000</td>
<td>Selects the pipe material. Used to set the pipe linear thermal expansion factor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Carbon steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.12e-5 [1/°C]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Stainless steel 304</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.73e-5 [1/°C]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Stainless steel 316</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.59e-5 [1/°C]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4: Monel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.43e-5 [1/°C]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5: User-defined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(uses the 'Pipe expansion factor - user')</td>
</tr>
<tr>
<td>Pipe expansion factor - user</td>
<td>1000</td>
<td>User-defined value for pipe linear thermal expansion factor [1/°C]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Only used if Pipe expansion factor - type is set to 'User-defined'</td>
</tr>
</tbody>
</table>

Device settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device diameter</td>
<td>1000</td>
<td>V-cone internal diameter [mm]</td>
</tr>
<tr>
<td>Device reference temperature</td>
<td>1000</td>
<td>Reference temperature for the specified device diameter [°C]</td>
</tr>
<tr>
<td>Device expansion factor - type</td>
<td>1000</td>
<td>Selects the V-cone material. Used to set the device linear thermal expansion factor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Carbon steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.12e-5 [1/°C]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Stainless steel 304</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.73e-5 [1/°C]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Stainless steel 316</td>
</tr>
</tbody>
</table>

Pipe expansion factor - user
### Density settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density exponent</td>
<td>1000</td>
</tr>
</tbody>
</table>

This parameter specifies how the density must be corrected from recovered to upstream conditions.

- **Density correction**: Only applied if ‘meter density calculation method’ is set to ‘ISO5167 upstream density’ (See ‘Run setup’).
- **Density exponent**: If Density exponent = 0, then isentropic density correction is applied (using 1/Isentropic exponent).

### Discharge coefficient

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge coefficient type</td>
<td>1000</td>
</tr>
</tbody>
</table>

Defines the way the discharge coefficient is determined.

- **Fixed value**: Uses the discharge coefficient fixed value.
- **Interpolated**: Discharge coefficient calculation using a discharge coefficient curve, in which the discharge coefficient as a function of the Reynolds number is given.

### Pressure settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure transmitter location</td>
<td>1000</td>
</tr>
</tbody>
</table>

Location of the pressure tap used for the static pressure relative to the v-cone.

- **Upstream tapping**
- **Downstream tapping**

### Temperature settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature element location</td>
<td>1000</td>
</tr>
</tbody>
</table>

Location of the temperature element relative to the v-cone.

- **Upstream tapping**
- **Downstream tapping**
- **Recovered pressure position**

- **Temperature correction**: This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions.
  - **Isentropic expansion**: Isentropic expansion using (1+α)/κ as the temperature referral exponent
  - **Temperature exponent**: Isentropic expansion using the Temperature Exponent parameter value as the temperature referral exponent [-]. Please note that the ‘Temperature Exponent’ must be < 0
  - **Joule Thomson**: Isenthalpic expansion using the Temperature Exponent as the Joule Thomson coefficient [°C/bar]. This method is prescribed by ISO5167-1:2003.

- **Temperature exponent**: Only used when temperature has to be corrected to upstream conditions and type of temperature correction is either ‘2: Temperature exponent’ or ‘3: Joule Thomson’.

- **Joule Thomson coefficient type**: Only applicable if Temperature correction is set to ‘Joule Thomson’. Defines how the Joule Thomson coefficient is defined.
  - **Fixed value**: Uses the temperature exponent as a fixed Joule Thomson coefficient.
  - **Calculated**: Joule Thomson coefficient calculation according to ISO/TR 9464. See section ‘Calculations’ for details.

## Product properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic viscosity</td>
<td>1000</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isentropic exponent</td>
<td>1000</td>
</tr>
</tbody>
</table>

Isentropic exponent of the gas at flowing conditions [dimensionless]. Also referred to as κ (kappa). For an ideal gas this coefficient is equal to the ratio of the specific heat capacity at constant pressure to the specific heat at constant volume.

### Venturi nozzle, long radius nozzle and ISA1932 nozzle

For venturi nozzles, long radius nozzles and ISA1932 nozzles in accordance with ISO-5167.

Only available if Meter device type is ‘Venturi nozzle’, ‘Long radius nozzle’ or ‘ISA1932 nozzle’

### Meter active settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low flow cutoff DP</td>
<td>1000</td>
</tr>
</tbody>
</table>

Meter active threshold DP. The meter will be considered inactive when the actual differential pressure [mbar] is below this limit value.

Depending on the settings ‘Disable totals when meter inactive’ and ‘Set flow rate to 0 when meter inactive’ the totals are stopped and / or the flow rate is set to zero (refer to paragraph ‘Overall setup’).

- **Enable meter inactive custom condition**: If enabled, the ‘meter inactive custom condition’ of the meter run can be used to disable / enable the meter totals and / or set the flow rate to 0 through an internal ‘calculation’ or through communication. Should only be enabled if...
### Calculation method

<table>
<thead>
<tr>
<th>ISO5167 edition</th>
<th>1000</th>
<th>The edition of the ISO-5167 standard to be used for the flow calculations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: 1991</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: 1998</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: 2003</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Only applicable to long radius nozzles and ISA1932 nozzles.

### Pipe settings

<table>
<thead>
<tr>
<th>Pipe diameter</th>
<th>1000</th>
<th>Internal pipe diameter [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe diameter</td>
<td>1000</td>
<td>Internal pipe diameter [mm]</td>
</tr>
<tr>
<td>Pipe reference temperature</td>
<td>1000</td>
<td>Reference temperature for the specified pipe diameter [°C]</td>
</tr>
<tr>
<td>Pipe expansion factor - type</td>
<td>1000</td>
<td>Selects the pipe material. Used to set the pipe linear thermal expansion factor.</td>
</tr>
<tr>
<td>1: Carbon steel 1.12e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Stainless steel 304 1.73e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Stainless steel 316 1.59e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: Monel 1.43e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: User-defined</td>
<td></td>
<td>(uses the 'Pipe expansion factor - user')</td>
</tr>
</tbody>
</table>

Only used when **Pipe expansion factor - type** is set to 'User-defined'.

### Device settings

<table>
<thead>
<tr>
<th>Device diameter</th>
<th>1000</th>
<th>Nozzle internal diameter [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device reference temperature</td>
<td>1000</td>
<td>Reference temperature for the specified device diameter [°C]</td>
</tr>
<tr>
<td>Device expansion factor - type</td>
<td>1000</td>
<td>Selects the nozzle material. Used to set the device linear thermal expansion factor.</td>
</tr>
<tr>
<td>1: Carbon steel 1.12e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Stainless steel 304 1.73e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Stainless steel 316 1.59e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: Monel 1.43e-5 [1/°C]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: User-defined</td>
<td></td>
<td>(uses the Device expansion factor - user)</td>
</tr>
</tbody>
</table>

Only used when **Device expansion factor - type** is set to 'User-defined'.

### Pressure settings

<table>
<thead>
<tr>
<th>Pressure transmitter location</th>
<th>1000</th>
<th>Location of the pressure tap used for the static pressure relative to the nozzle.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Upstream tapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Downstream tapping</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If 'Downstream tapping' is selected, a correction of the meter pressure to upstream conditions is applied. Refer to chapter Calculations for more details.

### Temperature settings

<table>
<thead>
<tr>
<th>Temperature transmitter location</th>
<th>1000</th>
<th>Location of the temperature element relative to the nozzle.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Upstream tapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Downstream tapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Recovered pressure position</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Downstream at the location where the pressure has fully recovered.

### Temperature correction

<table>
<thead>
<tr>
<th>Temperature correction</th>
<th>1000</th>
<th>This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Isentropic exponent</td>
<td></td>
<td>Isentropic expansion using (1+κ) as the temperature referral exponent.</td>
</tr>
<tr>
<td>2: Temperature exponent</td>
<td></td>
<td>Isentropic expansion using the 'Temperature Exponent' parameter value as the temperature referral exponent [-]. Please note that the 'Temperature Exponent' must be &gt; 0</td>
</tr>
<tr>
<td>3: Joule Thomson</td>
<td></td>
<td>Isenthalpic expansion using the 'Temperature Exponent' as the Joule Thomson coefficient [°C/bar]. This method is prescribed by ISO5167-1:2003.</td>
</tr>
</tbody>
</table>

### Dynamic properties

<table>
<thead>
<tr>
<th>Dynamic properties</th>
<th>1000</th>
<th>Dynamic viscosity of the gas at flowing conditions [Pa.s]. 1 [Pa.s] = 1000 [cP].</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isentropic exponent</td>
<td>1000</td>
<td>Isentropic expansion of the gas at flowing conditions [dimensionless]. Also referred to as κ (kappa). For an ideal gas this coefficient is equal to the ratio of the specific heat capacity at constant pressure to the specific heat at constant volume.</td>
</tr>
</tbody>
</table>

### Discharge coefficient curve

Only available if **Meter device type** is 'Venturi' or 'V-cone' AND **Venturi configuration** is set to 'User-defined' (only applicable to venturi) AND **Discharge coefficient calculation method** is 'Interpolated'.

Display → Configuration, Run «>>, Flow meter, Discharge coefficient curve with «>> the module number of the meter run.
Reynolds nr. must be in ascending order

Up to 12 points can be defined. For unused points, leave the Reynolds nr. at 0. E.g. when the curve has 6 points, the Reynolds nr. of points 7 through 12 must be set to 0.

dP inputs

Only available if Meter device type is 'Orifice', 'Venturi', 'V-cone', 'Venturi nozzle', 'Long radius nozzle' or 'ISA1932 nozzle'

Up to 3 differential pressure transmitters can be used for dP measurement, required for orifice, venturi, v-cone, venturi nozzle, long radius nozzle and ISA1932 nozzle flow meters.

The flow computer can handle the following type of cell range configurations:

- 1 cell, full range
- 2 cells, low range and high range
- 2 cells, full range
- 3 cells, low, mid and high range
- 3 cells, 1 low range and 2 high range
- 3 cells, full range

The flow computer selects between the configured input cells based on the actual measured value and the failure status of each cell.

The selection logic is described in chapter 'Calculations'.

dP selection

Display → Configuration, Run <x>, Flow meter, dP inputs, dP selection

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Point x – Reynolds</th>
<th>Reynolds nr. [-] of the curve point.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Point x – Discharge coefficient</th>
<th>Discharge coefficient [-] of the curve point.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Switch up percentage 1000

Switch-up value expressed as percentage of span of the lower range. Only used for 2 or 3 cells if more than one dP range is used. Refer to chapter 'Calculations' for more information on its usage.

The dP cell selection switches from low range to high range if the reading of the low range cell exceeds this percentage.

Switch down percentage 1000

Switch-down value expressed as percentage of span of the lower range. Only used for 2 or 3 cells if more than one dP range is used. Refer to chapter 'Calculations' for more information on its usage.

The dP cell selection switches from high range to low range if the reading of the low range cell gets below this percentage.

dP auto switchback 1000

Determines whether or not to switch back to a dP transmitter when it becomes healthy after a failure. Refer to chapter 'Calculations' for more information on its usage.

0: Disabled
1: Enabled

dP deviation limit 1000

Differential pressure deviation limit [mbar]. Only applicable if dP selection type is '2 cells full range', '3 cells low/high/high' or '3 cells full range'.

If the deviation between two dP cells of the same range exceeds this limit, then a dP deviation alarm is generated.

Fail fallback

Failback type 1000

Determines what to do if the selected dP transmitter fails and there is no other dP transmitter to switch to, or if all applicable dP transmitters fail.

1: Last good value
Keep on using the last value that was obtained when the input was still healthy.

2: Fallback value
Use the value as specified by parameter 'Fallback value'.

The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer.

3: Override value
Use the value as specified by parameter 'Override value'.

Failback value 1000

Only used if Failback type is 'Fallback value'.

Represents the differential pressure [mbar] that is used when the input fails.

dP input A, B, C, Pressure loss

Depending on the dP selection type, one, two or three dP inputs (measuring the differential pressure between the upstream and downstream positions) are available.

The pressure loss input (measuring the pressure loss between the upstream and recovered positions) is only available for venturi dP meters with pressure loss measurement enabled.
Display → Configuration, Run <x>, Flow meter, dP inputs, dP input A/B/C

Display → Configuration, Run <x>, Flow meter, dP inputs, Pressure loss

with <x> the module number of the meter run

### Input type

<table>
<thead>
<tr>
<th>Input type</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of input for dP cell</td>
<td></td>
</tr>
<tr>
<td>2: Analog input</td>
<td></td>
</tr>
<tr>
<td>4: HART</td>
<td></td>
</tr>
<tr>
<td>5: Custom</td>
<td></td>
</tr>
</tbody>
</table>

If option 5: Custom is selected then the value [mbar] that is written to tag ‘Differential pressure A/B/C custom value’ will be used. Use this option if the differential pressure value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the differential pressure.

### Analog input settings

These settings are only applicable if diff. pressure input type is ‘Analog input’, or if diff. pressure input type is ‘HART’ with option HART to analog fallback enabled

<table>
<thead>
<tr>
<th>Diff. pressure analog input module</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of the flow module to which the dP signal is physically connected.</td>
<td></td>
</tr>
<tr>
<td>1: Local module means the module of the meter run itself</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diff. pressure analog input channel</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of the analog input channel on the selected module to which the dP signal is physically connected.</td>
<td></td>
</tr>
</tbody>
</table>

### HART settings

These settings are only applicable if diff. pressure input type is ‘HART’

<table>
<thead>
<tr>
<th>Diff. pressure HART internal device nr.</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: ‘Ports &amp; Devices’)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diff. pressure HART variable value</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the dP value [mbar]. Usually this is the 1st (primary) variable.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diff. pressure HART full scale</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full scale [mbar] of the dP transmitter. Used to calculate the actual percentage of range, which is required for dP selection if multiple dP transmitters with different ranges are used.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diff. pressure HART zero scale</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero scale [mbar] of the dP transmitter. Used to calculate the actual percentage of range, which is required for dP selection if multiple dP transmitters with different ranges are used.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HART to analog fallback</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only applies for a HART transmitter, where the 4-20 mA signal is provided together with the HART signal.</td>
<td></td>
</tr>
</tbody>
</table>

| 0: Disabled |
| 1: Enabled |

The 4-20 mA signal will not be used when the HART signal fails. Instead the value corresponding to the ‘Fallback type’ will be used.

### Wet gas correction

For classical venturi tubes in accordance with ISO-5167.

Only available if Meter device type is ‘Venturi’ AND Wet gas correction type is set to ‘De Leeuw’ or ‘Reader-Harris’.

Display → Configuration, Run <x>, Flow meter, Wet gas correction

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Wet gas correction type</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables or disables wet gas correction:</td>
<td></td>
</tr>
<tr>
<td>0: None</td>
<td></td>
</tr>
<tr>
<td>1: De Leeuw</td>
<td></td>
</tr>
<tr>
<td>2: Reader-Harris</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure loss measurement</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables / disables pressure loss measurement using a dP cell. If enabled this measured value is used in the ISO5167 venturi calculations (temperature referral) and for wet gas correction calculation (if applicable). If pressure loss measurement is disabled, then the (fixed) pressure loss value is used for temperature referral.</td>
<td></td>
</tr>
</tbody>
</table>

| 0: Disabled |
| 1: Enabled |

<table>
<thead>
<tr>
<th>Lockhart-Martinelli calculation type</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determines how the Lockhart-Martinelli nr. is calculated (and therefore defines the basis for wet gas correction).</td>
<td></td>
</tr>
</tbody>
</table>

| 1: Manual |
| 2: Pressure loss |

| Lockhart-Martinelli nr. calculated from manually entered gas mass fraction. |
| Lockhart-Martinelli nr. calculated from measured pressure loss dp between upstream and recovered positions. |

<table>
<thead>
<tr>
<th>Manual gas mass fraction</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas mass fraction [-] defined as gas mass / (gas mass + liquid mass) used to calculate the Lockhart-Martinelli parameter.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liquid density</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density [kg/m³] of the liquid</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reader-Harris coefficient H</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient H [-]. For an explanation on the use of this coefficient see the ‘Calculations’ section.</td>
<td></td>
</tr>
</tbody>
</table>

| Typical values are 1.00 for hydrocarbon liquids and 1.35 for water at ambient temperature. |

<table>
<thead>
<tr>
<th>Pressure loss ratio calculation method</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defines how the pressure loss ratio is calculated:</td>
<td></td>
</tr>
<tr>
<td>1: Miller</td>
<td></td>
</tr>
<tr>
<td>2: ISO/DTR 11583</td>
<td></td>
</tr>
</tbody>
</table>

| Pressure loss ratio calculation according to Miller. |
ISO/DTR 11583.

3: Interpolated

Pressure loss ratio calculation using a pressure loss ratio curve, in which the pressure loss as a function of the Reynolds number is given.

<table>
<thead>
<tr>
<th>Pressure loss ratio</th>
<th>Coefficient A for pressure loss calculation according to Miller.</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Miller A</td>
<td>1000</td>
</tr>
<tr>
<td>Pressure loss ratio</td>
<td>Coefficient B for pressure loss calculation according to Miller.</td>
</tr>
<tr>
<td>– Miller B</td>
<td>1000</td>
</tr>
<tr>
<td>Pressure loss ratio</td>
<td>Coefficient C for pressure loss calculation according to Miller.</td>
</tr>
<tr>
<td>– Miller C</td>
<td>1000</td>
</tr>
</tbody>
</table>

**Pressure loss ratio curve**

Only available if **Meter device type** is 'Venturi' AND **Wet gas correction type** is set to 'De Leeuw' or 'Reader-Harris' AND **Pressure loss measurement** is enabled AND **Pressure loss ratio calculation method** is 'Interpolated'.

Display → Configuration, Run <x>, Flow meter, Wet gas correction, Pressure loss ratio curve

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Curve extrapolation</th>
<th>1000</th>
<th>Controls if extrapolation is allowed when the Reynolds nr. is outside the calibration curve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0: No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>When the Reynolds nr. is below the first calibration point or above the last calibration point, then respectively the first or the last calibration pressure loss ratio will remain in-use.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The interpolation is extrapolated when the Reynolds nr. is outside the calibrated range.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Point x – Reynolds</th>
<th>1000</th>
<th>Reynolds nr. [-] of the curve point.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point x – Pressure loss ratio</td>
<td>1000</td>
<td>Pressure loss ratio [-] of the curve point.</td>
</tr>
</tbody>
</table>

- Reynolds nr. must be in ascending order
- Up to 12 points can be defined. For unused points, leave the Reynolds nr. at 0. E.g. when the curve has 6 points, the Reynolds nr. of points 7 through 12 must be set to 0.
Station setup

A station consists of up to 8 runs, each of which can be a local or a remote run. Local runs are part of the station flow computer (and application; e.g. an X/P3 flow computer can contain 3 local runs), while remote runs are separate, single run flow computers, each running its own application, to which the station flow computer communicates through Modbus.

In order to be able to communicate to the remote run flow computer(s), the station flow computer must have a 'Connect to remote run' Modbus driver configured for every individual remote run (in Flow-Xpress 'Ports and Devices').

On the remote run flow computer(s) the 'Connect to remote station' Modbus driver has to be enabled (in Flow-Xpress 'Ports and Devices').

The station configuration displays are only available for the following FC types:
- Station /run
- Station /proving /run
- Station only
- Station /proving

Station setup

This display contains the general station settings. Depending on the selections made in this display, specific configuration displays for detailed configuration will be available further down the menu.

Display → Configuration, Station, Station setup

Station data

These data are only used for reporting.

<table>
<thead>
<tr>
<th>Station tag</th>
<th>600</th>
<th>Station tag (text)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station ID</td>
<td>600</td>
<td>Station ID (text)</td>
</tr>
</tbody>
</table>

Density

These settings are replicated from the 'Density setup' display. See the paragraph 'Density setup' for a description of the individual settings.

Observed density input type
Density temperature input type
Density pressure input type
Base density input type
Specific gravity input type
Relative density input type
Meter density calculation method

If an observed density input other than 'none' is selected, then also a density temperature input and a density pressure input have to be configured.

Gas composition

Gas composition input type
This setting is replicated from the 'Gas composition' configuration display. See the paragraph 'Gas composition' for a detailed description.

Heating value

Gross heating value input type

Station control setup

From this display the station control function flow / pressure control can be enabled or disabled.

Depending on the selections made in this display, specific configuration displays for detailed configuration will be available further down the menu.

Display → Configuration, Run <x>, Run control setup with <x> the module number of the meter run

Flow / pressure control

Flow / pressure control mode

With this setting flow / pressure control (PID control) can be enabled or disabled (none=disabled). For a thorough explanation of this setting refer to paragraph 'Flow / pressure control'.

Meter runs

This display page gives an overview of the meter runs that make up the station.

Display → Configuration, Station, Meter runs

Run <x>

Remote run device nr. 1000
Device nr. of the remote run flow computer as defined in Flow-Xpress 'Ports & devices'.
If a valid 'Remote run' device nr. is selected (i.e. if in Flow-Xpress this device nr. has been assigned to a remote run communication device), the run will be designated as 'Remote'.
If 'No Device' is selected, the run is either designated as 'Local' or as 'None', depending on the physical flow computer hardware.

Meter run <x> totalizer type 1000
Defines how the station totals and flow rates are calculated.
1: Positive
  The flow of this run is added to the station totals and rates. This is the default setting.
0: None
  The flow of this run is not taken into account in the station totals and rates.
-1: Negative
  The flow of this run is subtracted from the station totals and rates. This option can be used for return flows.
**System time deviation**

These settings are only applicable if the flow computer is communicating to one or more remote run flow computers.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote run max. system time deviation</td>
<td>1000</td>
<td>If the system time of a remote run module differs from the system time of the station module by more than this amount [s], then a 'System time out of sync alarm' is generated.</td>
</tr>
<tr>
<td>Delay for system time out of sync alarms</td>
<td>1000</td>
<td>System time out of sync alarms only become active after the deviation has been larger than the 'max. deviation' during the delay time [s].</td>
</tr>
</tbody>
</table>
Temperature setup

Temperature transmitters
The flow computer supports the following temperature transmitter inputs:

For each run:
- One or two meter temperature transmitters (A and B)
- One density temperature transmitter

For the station:
- One density temperature transmitter

Auxiliary inputs:
- Two auxiliary temperature transmitters (1 and 2)

Meter temperature transmitters
Either a single temperature transmitter or dual temperature transmitters can be used. In case of dual transmitters there are several schemes for determining the in-use meter temperature (duty / standby or average) and a deviation check is done between the two temperature values.

Density temperature transmitters
Density temperature transmitters are used in combination with an observed (live) density (e.g. a densitometer) and measure the temperature at the point where the density is measured.

In case of an observed (live) density on a run, a density temperature transmitter is obligatory. In case of an observed (live) density on a run, a density temperature transmitter is optional. If no density temperature transmitter is configured, the flow computer uses the meter temperature.

In case of a station observed (live) density, the use of a density temperature transmitter is obligatory.

Auxiliary temperature transmitters
Two auxiliary temperature transmitters can be defined (e.g. a station temperature). These are for informational purposes only, or can be used in custom calculations.

Display → Configuration, Run <x>, Temperature (, Meter temperature A/B)
Display → Configuration, Run <x>, Temperature, Density temperature
Display → Configuration, Station, Temperature
Display → Configuration, Auxiliary inputs, Auxiliary temperature 1/2
with <x> the module number of the meter run

For each temperature transmitter the following settings are available:

<table>
<thead>
<tr>
<th>Input type</th>
<th>1000</th>
<th>Type of input</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Analog / PT100 input settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>These settings are only applicable if the temperature input type is ‘Analog input’ or ‘PT100 input’, or if the temperature input type is ‘HART’ with HART to analog fallback enabled.</td>
</tr>
</tbody>
</table>

| Analog / PT100 input module | 1000 | Number of the flow module to which the signal is physically connected.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog / PT100 input channel</td>
<td>1000</td>
<td>Number of the analog / PT100 input channel on the selected module to which the signal is physically connected.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HART settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>These settings are only applicable if the temperature input type is ‘HART’.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HART internal device nr.</th>
<th>1000</th>
<th>Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: ‘Ports &amp; Devices’)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HART variable</td>
<td>1000</td>
<td>Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the temperature. Usually this is the 1st (primary) variable.</td>
</tr>
<tr>
<td>HART to analog fallback</td>
<td>1000</td>
<td>Only applies for a single HART transmitter, where the 4-20 mA signal is provided together with the HART signal.</td>
</tr>
</tbody>
</table>

| 0: Enabled |
| The 4-20 mA signal will be used when the HART signal fails. Instead the value corresponding with the Fallback type will be used. |
| 1: Enabled |
| The 4-20 mA signal will be used when the HART signal fails. If both the HART and the mA signal fail the value corresponding with the Fallback type will be used. |

If multiple HART transmitters are installed within a loop, then the HART to analog fallback option can't be used.

<table>
<thead>
<tr>
<th>Smart meter settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only applicable if the temperature input type is ‘Smart meter’.</td>
</tr>
</tbody>
</table>

| Smart meter internal device nr. | 1000 | Device nr. of the smart meter as assigned in the configuration software (Flow-Xpress, section ‘Ports & Devices’) |

<table>
<thead>
<tr>
<th>Fail fallback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determines what to do if the input fails.</td>
</tr>
</tbody>
</table>

| 1: Last good value |
| Keep on using the last value that was obtained when the input was still healthy. |
| 2: Fallback value |
| Use the value as specified by parameter |
The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer.

| Fallback value | 1000 | Only used if Fallback type is 'Fallback value'. Represents the temperature [°C] that is used when the input fails. |

Input frozen alarm

| Input frozen time | 1000 | Maximum time [s] which the input value is allowed to remain unchanged. If the input value hasn't changed during this time, an 'input frozen' alarm is given. Not applicable for Input type 'always use override'. Enter 0 to disable this functionality. |

Temperature transmitter selection

- Only applicable in case of dual meter temperature transmitters

Display → Configuration, Run <x>, Temperature, Meter temperature with <x> the module number of the meter run

Transmitter selection

<table>
<thead>
<tr>
<th>Dual transmitter mode</th>
<th>1000</th>
<th>Determines how the in-use meter temperature is calculated from both transmitter values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Auto transmitter A</td>
<td></td>
<td>Transmitter value A is used when it is healthy and not out of service. Transmitter value B is used when transmitter A fails, or is out of service, while transmitter B is healthy and not out of service. If both transmitters fail or are out of service, the value according to the Fallback type is used.</td>
</tr>
<tr>
<td>2: Auto transmitter B</td>
<td></td>
<td>Transmitter value B is used when it is healthy and not out of service. Transmitter value A is used when transmitter B fails, or is out of service, while transmitter A is healthy and not out of service. If both transmitters fail or are out of service, the value according to the Fallback type is used.</td>
</tr>
<tr>
<td>3: Average</td>
<td></td>
<td>If both transmitters are healthy and not out of service, the average of both values is used. If one transmitter fails or is out of service, while the other is healthy and not out of service, the other transmitter is used. If both transmitters fail or are out of service, the value according to the Fallback type is used.</td>
</tr>
</tbody>
</table>

Transmitter deviation

<table>
<thead>
<tr>
<th>Meter temperature deviation limit</th>
<th>1000</th>
<th>Temperature deviation limit [°C]. If the deviation between two temperature transmitters exceeds this limit, then a temperature deviation alarm is generated.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature deviation fallback mode</td>
<td>1000</td>
<td>Determines what happens in case of a temperature deviation alarm.</td>
</tr>
<tr>
<td>0: None</td>
<td></td>
<td>A deviation alarm is given, but the original input value remains in use.</td>
</tr>
<tr>
<td>1: Transmitter failure</td>
<td></td>
<td>The deviation alarm is treated as a transmitter failure: depending on the fallback type either the last good, fallback or override value is used.</td>
</tr>
<tr>
<td>2: Use transmitter A value</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pressure setup

Pressure transmitters
The flow computer supports the following pressure transmitter inputs:

For each run:
- One or two meter pressure transmitters (A and B)
- One density pressure transmitter

For the station:
- One density pressure transmitter

Auxiliary inputs:
- Two auxiliary pressure transmitters (1 and 2)

Meter pressure transmitters
Either a single pressure transmitter or dual pressure transmitters can be used. In case of dual transmitters there are several schemes for determining the in-use meter pressure (duty / standby or average) and a deviation check is done between the two pressure values.

Density pressure transmitters
Density pressure transmitters are used in combination with an observed (live) density (e.g. a densitometer) and measure the pressure at the point where the density is measured.

In case of an observed (live) density on a run, a density pressure transmitter is optional. If no density pressure transmitter is configured, the flow computer uses the meter pressure.

In case of a station observed (live) density, the use of a density pressure transmitter is obligatory.

Auxiliary pressure transmitters
Two auxiliary pressure transmitters can be defined (e.g. a station pressure). These are for informational purposes only, or can be used in custom calculations.

Display → Configuration, Run <x>, Pressure (, Meter pressure A/B)
Display → Configuration, Run <x>, Pressure, Density pressure
Display → Configuration, Station, Pressure
Display → Configuration, Proving (, Prover A/B), Pressure (, Prover inlet pressure)
Display → Configuration, Proving (, Prover A/B), Pressure (, Prover outlet pressure)
Display → Configuration, Proving (, Prover A/B), Pressure, Prover rod pressure
Display → Configuration, Proving (, Prover A/B), Pressure, Prover density pressure
Display → Configuration, Auxiliary inputs, Auxiliary pressure 1/2

with <x> the module number of the meter run

For each pressure transmitter the following settings are available:

<table>
<thead>
<tr>
<th>Input type</th>
<th>1000</th>
<th>Type of input</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1: Always use override</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Analog input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4: HART</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5: Custom input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6: Smart flow meter (meter pressure only)</td>
</tr>
</tbody>
</table>

If option 5: Custom is selected then the value ([bara] or [barg], depending on the selected pressure input units) that is written to the corresponding custom input tag (e.g. Meter pressure custom value) will be used. Use this option if the pressure value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the pressure.

| Input units | 1000 | 1: Absolute |
|            |      | The input value is an absolute pressure |
|            |      | 2: Gauge |
|            |      | The input value is a gauge pressure (i.e. relative to the atmospheric pressure) |

Analog input settings
These settings are only applicable if the pressure input type is ‘Analog input’, or if the pressure input type is ‘HART’ with HART to analog fallback enabled.

| Analog input module | 1000 | Number of the flow module to which the signal is physically connected |
|                     |      | 1: Local module means the module of the meter run itself |

Analog input channel | 1000 |
Number of the analog input channel on the selected module to which the signal is physically connected.

HART settings
These settings are only applicable if the pressure input type is ‘HART’.

<table>
<thead>
<tr>
<th>HART internal device nr.</th>
<th>1000</th>
<th>Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: ‘Ports &amp; Devices’)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HART variable</td>
<td>1000</td>
<td>Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the pressure. Usually this is the 1st (primary) variable.</td>
</tr>
</tbody>
</table>

| HART to analog fallback | 1000 | Only applies for a single HART transmitter, where the 4-20 mA signal is provided together with the HART signal. |
|                        |      | 0: Disabled |
|                        |      | The 4-20 mA signal will not be used when the HART signal fails. Instead the value corresponding with the ‘Fallback type’ will be used. |
|                        |      | 1: Enabled |
|                        |      | The 4-20 mA signal will be used when the HART signal fails. If both the HART and the mA signal fail the value corresponding with the ‘Fallback type’ will be used. |
|                        |      | If multiple HART transmitters are installed within a loop, then the HART to analog fallback option can’t be used. |

Smart meter settings
Only applicable if the pressure input type is ‘Smart meter’.
## Smart meter internal device nr.

**Device nr. of the smart meter as assigned in the configuration software (Flow-Xpress, section 'Ports & Devices')**

<table>
<thead>
<tr>
<th><strong>Fail fallback</strong></th>
<th><strong>1000</strong></th>
<th>Determines what to do if the input fails.</th>
</tr>
</thead>
</table>
| **Failback type** | **1000** | 1: Last good value  
Keep on using the last value that was obtained when the input was still healthy. |
|                    |          | 2: Failback value  
Use the value as specified by parameter 'Failback value'  
The failback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer. |
|                    |          | 3: Override value  
Use the value as specified by parameter 'Override value'  |
| **Failback value** | **1000** | Only used if **Failback type** is 'Failback value'.  
Represents the pressure ([bar(a)] or [bar(g)], depending on the selected input units) that is used when the input fails. |

<table>
<thead>
<tr>
<th><strong>Input frozen alarm</strong></th>
<th><strong>1000</strong></th>
<th>Maximum time [s] which the input value is allowed to remain unchanged.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input frozen time</strong></td>
<td><strong>1000</strong></td>
<td>If the input value hasn't changed during this time, an 'input frozen' alarm is given.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not applicable for <strong>Input type</strong> 'always use override'.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enter 0 to disable this functionality.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Pressure transmitter selection</strong></th>
<th><strong>Transmitter selection</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Only applicable in case of dual meter pressure transmitters</td>
<td>Determines how the in-use meter pressure is calculated from both transmitter values</td>
</tr>
</tbody>
</table>

| **Transmitter deviation** | **1000** | Pressure deviation limit [bar].  
If the deviation between two pressure transmitters exceeds this limit, then a pressure deviation alarm is generated. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressure deviation limit</strong></td>
<td><strong>1000</strong></td>
<td>Determines what happens in case of a pressure deviation alarm.</td>
</tr>
</tbody>
</table>
|                           |          | 0: None  
A deviation alarm is given, but the original input value remains in use. |
|                           |          | 1: Transmitter failure  
The deviation alarm is treated as a transmitter failure: depending on the fallback type either the last good, fallback or override value is used. |
|                           |          | 2: Use transmitter A value  |
|                           |          | 3: Use transmitter B value  |

<table>
<thead>
<tr>
<th><strong>Transmitter deviation fallback mode</strong></th>
<th><strong>1000</strong></th>
<th>Determines what happens in case of a pressure deviation alarm.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressure deviation fallback mode</strong></td>
<td><strong>1000</strong></td>
<td>Determines what happens in case of a pressure deviation alarm.</td>
</tr>
</tbody>
</table>
|                                       |          | 0: None  
A deviation alarm is given, but the original input value remains in use. |
|                                       |          | 1: Transmitter failure  
The deviation alarm is treated as a transmitter failure: depending on the fallback type either the last good, fallback or override value is used. |
|                                       |          | 2: Use transmitter A value  |
|                                       |          | 3: Use transmitter B value  |

<table>
<thead>
<tr>
<th><strong>Display</strong></th>
<th><strong>Configuration, Run &lt;x&gt;, Pressure, Meter pressure</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>with &lt;x&gt;</td>
<td>the module number of the meter run</td>
</tr>
</tbody>
</table>
Density setup

The flow computer supports the following density inputs:

For each run:
- One or two densitometers or one analog / HART / smart meter observed density input
- One or two specific gravity transducers or one analog / HART specific gravity input

For the station:
- One or two densitometers or one analog / HART observed density input
- One or two specific gravity transducers or one analog / HART specific gravity input

If the flow computer is used for 2 or more meter runs, the density input can be either a common input for all the meter runs or a separate input for each meter run. E.g. a densitometer can be installed in the header of the metering station in which case one and the same density measurement is used for all meter runs, or separate densitometers can be installed in each run.

Whether the density setup is on station or meter run level is controlled by parameter Station density, which is accessible through display Configuration, Overall setup, Common settings.

See paragraph ‘common settings’ for more details.

### Common settings

Display → Configuration, Run <x>, Density (, Density setup)

Display → Configuration, Station, Density (, Density setup) with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Observed density input type</th>
<th>1000</th>
<th>Defines how the observed density (density at densitometer conditions) is determined</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: None</td>
<td></td>
<td>There is no observed density input</td>
</tr>
<tr>
<td>1: Always use override</td>
<td></td>
<td>Use this option if a fixed value is used for the observed density</td>
</tr>
<tr>
<td>2: Analog input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: HART</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Custom input</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The value [kg/m³] that is written to tag Observed density custom value will be used as the observed density. Use this option if the observed density value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the observed density value.

6: One densitometer
The observed density is read from a single densitometer.

7: Two densitometers
The observed density is provided by two (redundant) densitometers. The observed density of the selected densitometer is used.

8: Smart flow meter
The observed density [kg/m³] is read from the smart (Coriolis) flow meter. Only applicable for run observed density input.

In case of a remote run with Station product enabled the observed density is read from the station flow computer.

If a station observed density input other than ‘none’ is selected, then also a station density temperature input and a density pressure input have to be configured.

In case of a run observed density input the use of separate density temperature and density pressure inputs are optional. See paragraphs ‘Temperature setup’ and ‘pressure setup’ for more information.

<table>
<thead>
<tr>
<th>Density temperature input type</th>
<th>1000</th>
<th>Type of input for the density temperature (temperature at the density meter).</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: Always use override</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Analog input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: PT100 input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: HART</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Custom input</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If this option is selected then the value [°C] that is written to tag Density temperature custom value is used. Use this option if the temperature value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the density temperature.

In case of a remote run FC with Station product enabled the density temperature is read from the flow station flow computer.

<table>
<thead>
<tr>
<th>Density pressure input type</th>
<th>1000</th>
<th>Type of input for the density pressure (pressure at the density meter).</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: Always use override</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Analog input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: HART</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Custom input</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If this option is selected then the value [bar] that is written to tag Density pressure custom value is used. Use this option if the pressure value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the density pressure.

In case of a remote run FC with Station product enabled the density pressure is read from the station flow computer.

<table>
<thead>
<tr>
<th>Base density input type</th>
<th>1000</th>
<th>Defines how the base density (density at reference conditions) is determined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Always use override</td>
<td></td>
<td>Use this option if a fixed value is used for the base density</td>
</tr>
<tr>
<td>2: Analog input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: HART</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Custom input</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The value [kg/sm³] that is written to tag Base density custom value will be used as the base density. Use this option if the base density value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the base density value.

6: Gas composition (molar mass)
The base density is calculated from the molar mass (which in turn is calculated from the gas composition using the molar mass calculation method).

Refer to chapter Calculations for more information about the actual calculations.

7: Observed density
The base density is calculated from the observed density value.
<table>
<thead>
<tr>
<th>Specific gravity</th>
<th>1000</th>
<th>Defines how the specific gravity (SG at reference conditions) is determined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input type</td>
<td></td>
<td>0: Calculated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is no specific gravity input. Specific gravity is calculated from base density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Always use override</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use this option if a fixed value is used for the specific gravity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Analog input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4: HART</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5: Custom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The value [(\text{kg/m}^3)] that is written to tag Relative density custom value will be used. Use this option if the specific relative density is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the relative density value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13: Gas chromatograph</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uses the relative density that is read from the gas chromatograph</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In case of a remote run FC with Station product enabled the relative density is read from the station flow computer.</td>
</tr>
<tr>
<td>Meter density calculation method</td>
<td>1000</td>
<td>Defines how the meter density (density at line conditions) is calculated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Base density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The meter density is calculated from the base density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Observed density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The meter density is calculated from the observed density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Down- to upstream correction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calculates the (upstream) meter density according to ISO5167. Only applicable to orifices, venturi and V-cone devices, venturi nozzles, long radius nozzles and ISA1932 nozzles with a density meter at the recovered pressure position.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4: Custom input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The value [(\text{kg/m}^3)] that is written to tag Meter density custom value will be used as the meter density. Use this option if the meter density value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the meter density value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5: Compressibility method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The base density is calculated by the same method that has been configured to calculate the compressibility.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This option is only valid in combination with one of the following compressibility methods:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AGA8 (detailed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO6976 – 1983</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO6976 – 1995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GPA2172</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GSSSD MR113 2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The compressibility method setting can be found on the display: Gas properties, Calculation setup.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relative density</th>
<th>1000</th>
<th>Defines how relative density (at reference conditions) is determined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input type</td>
<td></td>
<td>0: Calculated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is no relative density input. Relative density is calculated from base density</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Always use override</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use this option if a fixed value is used for the relative density</td>
</tr>
</tbody>
</table>

In case of a failure of the observed density source (e.g. densitometer) while a gas composition source is available, the flow computer switches over to base density input type ‘gas composition’ and meter density calculation method ‘base density’. This means the base density is calculated from the molar mass, which in turn is calculated from the gas composition using the selected molar mass calculation method.

If an impossible combination of settings is chosen, then a ‘Density configuration error’ alarm is shown.
**Observed density**
This display is only available if **Observed density input type** is set to Analog input', 'HART' or 'Smart flow meter'.

- **Display → Configuration, Run <x>, Density, Observed density**
- **Display → Configuration, Station, Density, Observed density with <x> the module number of the meter run**

**Analog input settings**
These settings are only applicable if the **observed density input type** is 'Analog input', or if the **observed density input type** is 'HART' with **HART to analog fallback** enabled.

- **Analog input module**
  - Number of the flow module to which the signal is physically connected.
  - **1**: Local module means the module of the meter run itself
  - Deviation limit [kg/m³] for the deviation check between the observed density and the density at the density meter conditions as calculated according to AGA-B.
  - If the deviation is larger than this limit, then an 'Observed / AGA-B density deviation limit exceeded' alarm is generated.

- **Analog input channel**
  - Number of the analog input channel on the selected module to which the signal is physically connected.

**HART settings**
These settings are only applicable if the **observed density input type** is 'HART'.

- **HART internal device nr.**
  - Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: 'Ports & Devices')
- **HART variable**
  - Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the **observed density**. Usually this is the 1st (primary) variable.
- **HART to analog fallback**
  - Only applies for a single HART transmitter, where the 4-20 mA signal is provided together with the HART signal.
  - **0**: Disabled
    - The 4-20 mA signal will not be used when the HART signal fails. Instead the value corresponding with the 'Fallback type' will be used.
  - **1**: Enabled
    - The 4-20 mA signal will be used when the HART signal fails. If both the HART and the mA signal fail the value corresponding with the **Fallback type** will be used.
    - If multiple HART transmitters are installed within a loop, then the HART to analog fallback option can't be used.

**Smart meter settings**
These settings are only applicable if the **observed density input type** is 'Smart meter'.

- **HART internal device nr.**
  - Internal device nr. of the smart meter as assigned in the configuration software (Flow-Xpress: 'Ports & Devices')

**Fail fallback**
If the observed density input fails while a gas composition is available, the in-use **base density** (which is normally calculated from the observed density) switches over to the base density value calculated from the gas composition and a 'Density fallback to calculated value' alarm is generated. If a gas composition is not available, the base density will use the value that is specified at the **Base density fallback type** (last good value, fallback value or override value). See paragraph 'Base density' for more details.

- **Input frozen alarm**
  - Input frozen time
  - Maximum time [s] which the input value is allowed to remain unchanged.
  - If the input value has't changed during this time, an 'input frozen' alarm is given.
  - Not applicable for **input type** 'always use override'.
  - Enter 0 to disable this functionality.

**Deviation limit**
These settings are only applicable if the **observed density input type** is unequal to 'None'.

- **Observed / AGA-B density deviation limit**
  - Deviation limit [kg/m³] for the deviation check between the observed density and the density at the density meter conditions as calculated according to AGA-B.
  - If the deviation is larger than this limit, then an 'Observed / AGA-B density deviation limit exceeded' alarm is generated.

**Densitometer setup**
This display is only available if **Observed density input type** is set to 'One densitometer' or 'Two densitometers'.

- **Display → Configuration, Run <x>, Density, Densitometer, Densitometer setup**
- **Display → Configuration, Station, Density, Densitometer, Densitometer setup with <x> the module number of the meter run**

- **Densitometer A/B type**
  - Densitometer A/B device type.
  - **1**: Solartron
  - **2**: Sarasota
  - **3**: UGC
- **Densitometer A/B units**
  - Densitometer A/B units.
  - **1**: kg/m³
  - **2**: g/cc
  - **3**: lb/ft³

**Time period A/B**
Time period settings of densitometer A /B. Time period B settings are only applicable if **Observed density input type** is set to 'Two densitometers'.

- **Input module**
  - Flow-X module to which the densitometer A/B signal is connected to.
- **Input number**
  - Defines the time period input of the Flow-X module for densitometer A/B.
Each module has a maximum of 4 time period inputs. A time period input can be connected to a physical digital channel on display: IO, Module <<x>>, Configuration, Digital IO assign. See paragraph ‘Digital IO assign’ for more details.

**Deviation limits**

| Observed / AGA-8 density deviation limit | 1000 | Deviation limit [kg/m3] for the deviation check between the observed density and the density at the density meter conditions as calculated according to AGA-8. If the deviation is larger than this limit, then an ‘Observed / AGA-8 density deviation limit exceeded’ alarm is generated. |

| Densitometer A/B deviation limit | 1000 | Only applicable if Observed density input type is set to ‘Two densitometers’. If the deviation between the density from both densitometers exceeds this limit [kg/m3], then a ‘Densitometer A/B deviation limit exceeded’ alarm is generated. |

**Density correction factor**

| Densitometer A/B nominal correction | 1000 | Nominal density correction factor (DCF) for densitometer A/B. The density as measured by densitometer A/B is multiplied by this factor. |

**Input frozen alarm**

| Input frozen time | 1000 | Maximum time [s] which the input value is allowed to remain unchanged. If the input value hasn’t changed during this time, an ‘input frozen’ alarm is given. Enter 0 to disable this functionality. |

**Spirit / Sarasota / UGC densitometer setup**

The densitometer constants are device-specific and can be defined on the following display.

- **Display → Configuration, Run <<x>>, Density, Densitometer, Densitometer A/ B constants**

  with <<x>> the module number of the meter run

  All densitometer constants are at security level 1000. Refer to section calculations for the meaning of these settings.

**Specific gravity**

The following settings apply if the Specific gravity input type is set to ‘Analog input’, ‘HART’ or ‘Custom input’.

- **Display → Configuration, Run <<x>>, Density, Specific gravity**

  with <<x>> the module number of the meter run

**Analog input settings**

These settings are only applicable if the Specific gravity input type is set to ‘Analog input’, or if the Specific gravity input type is ‘HART / Modbus’ with HART to analog fallback enabled.

| Analog input module | 1000 | Number of the flow module to which the signal is physically connected. |

| Analog input channel | 1000 | Number of the analog input channel on the selected module to which the signal is physically connected. |

**HART settings**

These settings are only applicable if the specific gravity input type is ‘HART’.

| HART internal device nr. | 1000 | Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: ‘Ports & Devices’) |

| HART variable | 1000 | Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the specific gravity. Usually this is the 1st (primary) variable. |

| HART to analog fallback | 1000 | Only applicable for a single HART transmitter, where the 4-20 mA signal is provided together with the HART signal. |

- **0:** Disabled
  - The 4-20 mA signal will not be used when the HART signal fails. Instead the value corresponding with the ‘Fallback type’ will be used.

- **1:** Enabled
  - The 4-20 mA signal will be used when the HART signal fails. When both the HART and the mA signal fail the value corresponding with the ‘Fallback type’ will be used.

  If multiple HART transmitters are installed within a loop, then the HART to analog fallback option can’t be used.

**Fail fallback**

| Failback type | 1000 | Determines what to do in case the input fails. |

| 1: Last good value | Keep on using the last value that was obtained when the input was still healthy. |

| 2: Failback value | Use the value as specified by parameter ‘Failback value’ The failback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer. |

| 3: Override value | Use the value as specified by parameter ‘Override value’ |

| Failback value | 1000 | Only used if Failback type is ‘Failback value’. Represents the specific gravity [-] to be used when the input fails. |

**Input frozen alarm**

| Input frozen time | 1000 | Maximum time [s] which the input value is allowed to remain unchanged. If the input value hasn’t changed during this time, an ‘input frozen’ alarm is given. |

| Only applicable in case of a life (not calculated) or custom input value. Not applicable for input type ‘always use override’. Enter 0 to disable this functionality. |
SG transducer setup
The following display is only available if Specific gravity input type is set to 'One SG transducer' or 'Two SG transducers'.

Display → Configuration, Run <x>, Density, SG transducer(s)
Display → Configuration, Station, Density, SG transducer(s) with <x> the module number of the meter run

| SG transducer select mode | 500 | Only applicable if Specific gravity input type is set to 'Two SG transducers'. SG transducer selection mode.
1: Auto-A
SG transducer B is only used when SG transducer A fails and SG transducer B is healthy. SG transducer A is used in all other cases.
2: Auto-B
SG transducer A is only used when SG transducer B fails and SG transducer A is healthy. SG transducer B is used in all other cases.
3: Manual-A
Always use SG transducer A irrespective of its failure status.
4: Manual-B
Always use SG transducer B irrespective of its failure status.

SG transducer A/B
SG transducer and time period settings of SG transducer A/B. B settings are only applicable if Specific gravity input type is set to 'Two SG transducers'.

| SG transducer A/B K0 | 1000 | SG transducer A/B constant K0
Refer to section calculations for more information on this setting.

| SG transducer A/B K2 | 1000 | SG transducer A/B constant K2
Refer to section calculations for more information on this setting.

| Time period A/B input module | 1000 | Flow-X module to which the SG transducer A/B signal is connected.

| Time period A/B input channel | 1000 | Defines the time period input of the selected Flow-X module for SG transducer A/B. Each module has a maximum of 4 time period inputs. A time period input can be connected to a physical digital channel on display: IO, Module <x>, Configuration, Digital IO assign. See paragraph 'Digital IO assign' for more details.

Fail fallback
Specific gravity fallback type

| Specific gravity fallback type | 1000 | Determines what to do if the SG transducer fails (in case of one SG transducer) or if both SG transducers fail (in case of two SG transducers).
1: Last good value
Keep on using the last value that was obtained when the input was still healthy.
2: Fallback value
Use the value as specified by parameter 'Specific gravity fallback value'. The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer.
3: Override value
Use the value as specified by parameter 'Specific gravity override value'.

| Specific gravity fallback value | 1000 | Only used if Fallback type is 'Fallback value'. Represents the specific gravity [-] to be used when the input fails.

Input frozen alarm

| Input frozen time | 1000 | Maximum time [s] which the input value is allowed to remain unchanged.
If the input value hasn't changed during this time, an 'input frozen' alarm is given.
Enter 0 to disable this functionality.

Deviation limit

| SG transducer A/B deviation limit | 1000 | Only applicable in case two SG transducers are configured.
If the deviation between the specific gravity from both SG transducers exceeds this limit [\(-\)], then a 'SG transducer A/B deviation limit exceeded' alarm is generated.

Relative density
The following settings apply if the Relative density input type is set to 'Custom input' or 'Gas chromatograph'.

Display → Configuration, Run <x>, Density, Relative density
Display → Configuration, Station, Density, Relative density with <x> the module number of the meter run

Fail fallback

| Fallback type | 1000 | Determines what to do in case the input fails.
1: Last good value
Keep on using the last value that was obtained when the input was still healthy.
2: Fallback value
Use the value as specified by parameter 'Fallback value'. The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer.
3: Override value
Use the value as specified by parameter 'Override value'.

| Fallback value | 1000 | Only used if Fallback type is 'Fallback value'. Represents the value to be used when the input fails.

Input frozen alarm

| Input frozen time | 1000 | Maximum time [s] which the input value is allowed to remain unchanged.
If the input value hasn't changed during this time, an 'input frozen' alarm is given.
Only applicable in case of a life (not calculated) or custom input value. Not applicable for input type 'always use override'. Enter 0 to disable this functionality.

Base density
The following settings are applicable if the Base density input type is set to 'Custom input' or 'Gas chromatograph' or in case of a 'remote run' flow computer with Station product enabled.

Display → Configuration, Run <x>, Density, Base density
Display → Configuration, Station, Density, Base density
with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Fail fallback</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallback type</td>
<td>1000</td>
<td>Determines what to do in case the input / communication to the ‘remote station’ flow computer fails.</td>
</tr>
</tbody>
</table>
|  |  | 1: Last good value  
| | | Keep on using the last value that was obtained when the input was still healthy. |
|  |  | 2: Fallback value  
| | | Use the value as specified by parameter ‘Fallback value’  
| | | The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer. |
|  |  | 3: Override value  
| | | Use the value as specified by parameter ‘Override value’ |
| Fallback value | 1000 | Only used if Fallback type is ‘Fallback value’. |
|  |  | Represents the value to be used when the input fails. |

<table>
<thead>
<tr>
<th>Input frozen alarm</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input frozen time</td>
<td>1000</td>
<td>Maximum time [s] which the input value is allowed to remain unchanged.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the input value hasn’t changed during this time, an ‘input frozen’ alarm is given.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Only applicable in case of a life (not calculated) or custom input value. Not applicable for input type ‘always use override’.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enter 0 to disable this functionality.</td>
</tr>
</tbody>
</table>
Gas properties

**Gas composition**
The flow computer supports the following Gas Composition inputs:

For each run:
- One or two Gas Chromatographs

For the station:
- One or two Gas Chromatographs

If the flow computer is used for 2 or more meter runs, the gas composition input can be either a common input for all the meter runs or a separate input for each meter run. E.g. a GC can be installed in the header of the metering station in which case one and the same gas composition is used for all meter runs, or separate GC’s can be installed in each run.

⚠️ Whether the gas composition configuration is on station or meter run level is controlled by parameter **Station product**, which is accessible through display Configuration, Overall setup, Common settings.

See paragraph ‘common settings’ for more details.

![Image](image_url)

Display → Configuration, Run <x>, Gas properties, Gas Composition

Display → Configuration, Station, Gas properties, Gas Composition

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Gas composition input type</th>
<th>1000</th>
<th>Defines how the gas composition is provided to the flow computer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0: None</td>
<td>No gas composition is being used</td>
</tr>
<tr>
<td></td>
<td>1: Always use override composition</td>
<td>Always uses the override gas composition, which is manually entered through the operator display</td>
</tr>
<tr>
<td></td>
<td>2: One gas chromatograph</td>
<td>The gas composition is provided by a single gas chromatograph (GC). The composition may be overruled by the override composition</td>
</tr>
<tr>
<td></td>
<td>3: Two gas chromatographs</td>
<td>The gas composition is provided by two (redundant) gas chromatographs. The composition of the selected GC will be used for the calculations. The composition may be overruled by the override composition</td>
</tr>
<tr>
<td></td>
<td>4: Custom composition</td>
<td>The component values that are written to the custom composition tags will be used. Use this option if the composition is sent to the flow computer over a Modbus communications link by an external system or if you want to apply user-defined calculations to set the component values.</td>
</tr>
</tbody>
</table>

⚠️ In case of a remote run FC with Station

<table>
<thead>
<tr>
<th>Composition fallback type</th>
<th>1000</th>
<th>Determines what to do when the (communication with the) GC is in failure (in case of one GC) or when the (communication with) both GC’s are in failure (in case of two GC’s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1: Use last received</td>
<td>Keep using the last received composition before the failure</td>
</tr>
<tr>
<td></td>
<td>3: Use override composition</td>
<td>Use the override composition</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composition fail on limit alarm</th>
<th>1000</th>
<th>Determines what to do when one or more components, or the sum of components, are out of limits.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0: Disabled</td>
<td>The live gas composition is used, even in case of a composition limit alarm.</td>
</tr>
<tr>
<td></td>
<td>1: Enabled</td>
<td>In case of a composition limit alarm, the flow computer switches to the other GC (if available). If a second GC is not available, or if the second GC also has an alarm, the flow computer switches to the last received good composition, or the override composition is used (depending on the fallback type).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composition normalization</th>
<th>1000</th>
<th>Determines whether or not the gas composition is normalized (scaled to 100%) if the sum of components doesn’t add up to 100%, which means that all component values are raised or lowered proportionally, so that the sum of components counts up to 100% if AGA8, ISO6976, GPA2172, GERP008 or GSSSD-MR113 is used for compressibility, molar mass or heating value calculation, then gas composition normalization is enabled automatically.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0: Disabled</td>
<td>The neo-Pentane component is not taken into account</td>
</tr>
<tr>
<td></td>
<td>1: Enabled</td>
<td>The neo-Pentane component is added to n-Pentane</td>
</tr>
</tbody>
</table>

**neo-Pentane mode**

<table>
<thead>
<tr>
<th>neo-Pentane mode</th>
<th>1000</th>
<th>Defines what has to happen to the neo-Pentane component. neo-C5 is not supported by AGA8 and GPA-2172, therefore it has to be added to i-C5 or n-C5, or it can be neglected.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1: Add to i-C5</td>
<td>The neo-Pentane component is added to i-Pentane</td>
</tr>
<tr>
<td></td>
<td>2: Add to n-C5</td>
<td>The neo-Pentane component is added to n-Pentane</td>
</tr>
<tr>
<td></td>
<td>3: Neglect</td>
<td>The neo-Pentane component is not taken into account</td>
</tr>
</tbody>
</table>

**Live composition split**

These settings apply to the live gas composition received from the gas chromatograph or the custom composition, not to the override composition.

<table>
<thead>
<tr>
<th>Live composition Cx+ split mode</th>
<th>1000</th>
<th>Controls the split up of the C6+, C7+, C8+ or C9+ component of the live composition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1: Not used</td>
<td>The values for C6, C7, C8, C9 and C10 will be used as received from the GC</td>
</tr>
<tr>
<td></td>
<td>2: C6+ split</td>
<td>The C6+ component is split into C6, C7, C8, C9 and C10 according to the defined split percentages. The values of C6, C7, C8, C9 and C10 as received from the GC are neglected.</td>
</tr>
</tbody>
</table>
|                                 | 3: C7+ split | The C7+ component is split into C7, C8, C9 and C10 according to the defined split percentages. The value of C6 is used as
Override composition split

These settings apply to the override composition, not to the live gas composition received from the gas chromatograph or the custom composition.

<table>
<thead>
<tr>
<th>Override composition Cx+ split mode</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls the split up of the C6+, C7+, C8+ or C9+ component from the override composition</td>
<td></td>
</tr>
</tbody>
</table>

- 1: Not used
- 2: C6+ split
  - The C6 component is split into C6, C7, C8, C9 and C10 according to the defined split percentages. The values of C7, C8, C9 and C10 from the override composition are neglected.
- 3: C7+ split
  - The C7 component is split into C7, C8, C9 and C10 according to the defined split percentages. The values of C6 and C9 from the override composition are neglected.
- 4: C8+ split
  - The C8 component is split into C8, C9 and C10 according to the defined split percentages. The values of C6 and C7 are used as specified in the override composition. The values of C9 and C10 from the override composition are neglected.
- 5: C9+ split
  - The C9 component is split into C9 and C10 according to the defined split percentages. The values of C6, C7 and C8 are used as specified in the override composition. The values of C10 from the override composition are neglected.

The split percentages must add up to 100%

Non-hydrocarbon components

For each of the non-hydrocarbon components: N2, CO2, H2O, H2S, H2, CO, O2, He and Ar, the following settings are available:

- GC analysis delayed alarm checking
- 1000 Enables or disables delay checking on the gas composition. Raises an alarm 'Gas composition analysis delay' if no new analysis is received within a configurable timeout time. In case of a delay alarm the flow computer switches over to the other GC (if available) or to the 'last received' or override composition (depending on the composition fallback type).
  0: Disabled
  1: Enabled
  Can also be used with a 'custom composition' that is written from a DCS or other system.

- GC analysis timeout time
  - 1000 Timeout time [min] for the gas composition delay alarm.

- <...> fraction input
  - 1000 Defines whether the fraction [mole %] is read as part of the gas composition, or from another source.
    0: Gas composition
    The component is read as part of the gas composition (GC or custom composition).
    1: Fixed value
    A fixed value is used for the component
    2: Custom input
    The value [mole %] that is written to component's custom value tag will be used.
    3: Auxiliary input 1
    The component value [mole %] is read through auxiliary input 1. This option can be used to read the component value from an analog or HART transmitter.
    4: Auxiliary input 2
    The component value [mole %] is read through auxiliary input 2. This option can be used to read the component value from an analog or HART transmitter.

- <...> fraction fixed value
  - 1000 Fixed component value [mole %]
    Only applicable if the fraction input type is set to 'Fixed value'.

The values of C6, C7, C8, C9 and C10 will be used as specified by the override composition.

<table>
<thead>
<tr>
<th>Override composition C6 split %</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>The C6 split percentage [%] for the live composition</td>
<td></td>
</tr>
<tr>
<td>Only applicable to split mode C6+</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Override composition C7 split %</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>The C7 split percentage [%] for the live composition</td>
<td></td>
</tr>
<tr>
<td>Only applicable to split modes C6+ and C7+</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Override composition C8 split %</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>The C8 split percentage [%] for the live composition</td>
<td></td>
</tr>
<tr>
<td>Only applicable to split modes C6+, C7+ and C8+</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Override composition C9 split %</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>The C9 split percentage [%] for the override composition</td>
<td></td>
</tr>
<tr>
<td>Only applicable to split modes C6+, C7+, C8+ and C9+</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Override composition C10 split %</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>The C10 split percentage [%] for the override composition</td>
<td></td>
</tr>
<tr>
<td>Applicable to all split modes</td>
<td></td>
</tr>
</tbody>
</table>

The split percentages must add up to 100%
**Gas chromatograph(s)**

Whether the gas chromatograph configuration is on station or meter run level is controlled by parameter *Station product*, which is accessible through display Configuration, Overall setup, Common settings.

The gas composition may be obtained from 1 or 2 gas chromatographs. The gas chromatograph(s) must be defined as a communications device in Flow-Xpress, section 'Ports & Devices'. Refer to manual II.A Operation and configuration for instructions on the definition of communication devices.

In the example above the GC has device nr. '5'.

The following display is only available if 'Gas composition input type' is set to 'One gas chromatograph' or 'Two gas chromatographs'.

**Display → Configuration, Run <x>, Gas properties, Gas chromatograph(s)**

**Display → Configuration, Station, Gas properties, Gas chromatograph(s)**

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>GC selection mode</th>
<th>500</th>
<th>Only applicable if 'Gas composition input type' is set to Two Gas Chromatographs</th>
</tr>
</thead>
</table>
|                   |     | Controls the selection between the 2 GC's. The gas composition of the selected GC is used for the calculations. The selection is based on a GC failure, which occurs when:
|                   |     | - a GC does not communicate (properly) to the flow computer
|                   |     | - a GC indicates a measurement problem
|                   |     | - a GC is not in normal operation, but e.g. in maintenance or in calibration
|                   |     | - a GC analysis is delayed
|                   |     | - a GC analysis causes a composition limit alarm

Note: The actual logic to determine a measurement problem or the operational mode of a GC may be different for each type of GC.

1: Auto-A
- GC B is only selected when it has no failure, while GC A has a failure. GC A is selected in all other cases.

2: Auto-B
- GC A is only selected when it has no failure, while GC B has a failure. GC B is selected in all other cases.

| GC analysis delay time | 1000 | Delay time [s] for reading data from the GC(s). This is to make sure that all data has been updated (composition, stream number, calibration flag) before the data is accepted.

**Gas Chromatograph A / B**

Settings of Gas Chromatograph A / B. Gas Chromatograph B settings are only available if *Gas composition input type* is set to 'Two gas chromatographs'.

| GC A/B internal device nr. | 1000 | Internal device nr. of the gas chromatograph as assigned in the configuration software (Flow-Xpress: 'Ports & Devices')
|---------------------------|------|------------------------------------------------|
| GC A/B multi-stream       | 1000 | Only applicable to GC’s that support multi-stream handling. If enabled, the gas composition is only accepted if the actual stream number from the GC equals the required stream number.
|                           | 0: Disabled | Requires a gas composition
|                           | 1: Enabled  | Stream number on the GC to be read.

**Calculation setup**

Whether the calculation setup is on station or meter run level is controlled by parameter *Station product*, which is accessible through display Configuration, Overall setup, Common settings.

See paragraph 'common settings' for more details.

**Display → Configuration, Run <x>, Gas properties, Calculation setup**

**Display → Configuration, Station, Gas properties, Calculation setup**

with <x> the module number of the meter run

| Compressibility calculation method | 1000 | Method to calculate the compressibility factor Z at the meter temperature and pressure and, in case of a live density measurement, also at the density temperature and pressure (Zdens).
|-----------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------|
|                                   | 1: Override value | Uses the meter compressibility and density compressibility override values
|                                   | 2: AGA8 (detailed) | Requires a gas composition
|                                   | 3: SGERG (AGA 8 gross) | Requires process inputs for hydrogen and at least 3 out of the 4 following inputs: nitrogen, carbon dioxide, relative density and gross heating value. (set by parameter SGERG input method).
|                                   | 4: AGA NX19 | Requires process inputs for nitrogen, carbon dioxide, specific gravity and gross heating value. |
**Calculation Method**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Override</td>
<td>Uses the base compressibility override value used when the compressibility calculation method is set to 'Override value'.</td>
</tr>
<tr>
<td>2: AGA8 (detailed)</td>
<td>Requires the gas composition and an absolute humidity input. Add-on programs version 1.0.0.1170 or higher is installed.</td>
</tr>
<tr>
<td>3: SGERG (AGA 8 gross)</td>
<td>Requires process inputs for hydrogen and at least 3 out relative density and gross heating value. (set by parameter SGERGInput method).</td>
</tr>
<tr>
<td>4: AGA NX19</td>
<td>Requires process inputs for nitrogen, carbon dioxide, specific gravity and gross heating value.</td>
</tr>
<tr>
<td>7: GPA2172</td>
<td>Requires a gas composition.</td>
</tr>
<tr>
<td>8: Custom</td>
<td>The value that is written to the tags Base compressibility custom value and Density compressibility custom value will be used. Use this option if the compressibility value(s) is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the compressibility.</td>
</tr>
<tr>
<td>9: Gas Chromatograph</td>
<td>Uses the base compressibility that is read from the gas chromatograph.</td>
</tr>
<tr>
<td>10: GERM 2008</td>
<td>Requires a gas composition. Can only be used if Add-on programs version 1.0.0.1170 or higher is installed (see display: System, Versions).</td>
</tr>
<tr>
<td>11: GSSSD MR113 2003</td>
<td>Requires a gas composition and an absolute humidity input. Add-on programs version 1.0.0.1170 or higher recommended.</td>
</tr>
<tr>
<td>12: GOST 30319 SGERG91</td>
<td>Requires process inputs for nitrogen, carbon dioxide and base density. The value that is written to the tags Base compressibility custom value and Density compressibility custom value will be used. Use this option if the compressibility value(s) is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the compressibility.</td>
</tr>
</tbody>
</table>

**Density compressibility override value**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Meter compressibility override value that is used when the compressibility calculation method is set to 'Override value'.</td>
</tr>
</tbody>
</table>

**Meter compressibility override value**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Meter compressibility override value that is used when the compressibility calculation method is set to 'Override value'.</td>
</tr>
</tbody>
</table>

**Base compressibility calculation method**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Override</td>
<td>Uses the base compressibility override value.</td>
</tr>
<tr>
<td>2: AGA8 (detailed)</td>
<td>Requires the gas composition.</td>
</tr>
<tr>
<td>3: SGERG (AGA 8 gross)</td>
<td>Requires process inputs for hydrogen and at least 3 out relative density and gross heating value. (set by parameter SGERGInput method).</td>
</tr>
<tr>
<td>4: AGA NX19</td>
<td>Requires process inputs for nitrogen, carbon dioxide, specific gravity and gross heating value.</td>
</tr>
<tr>
<td>7: GPA2172</td>
<td>Requires a gas composition.</td>
</tr>
<tr>
<td>8: Custom</td>
<td>The value that is written to the tags Base compressibility custom value and Density compressibility custom value will be used. Use this option if the compressibility value(s) is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the compressibility.</td>
</tr>
<tr>
<td>9: Gas Chromatograph</td>
<td>Uses the base compressibility that is read from the gas chromatograph.</td>
</tr>
<tr>
<td>10: GERM 2008</td>
<td>Requires a gas composition. Can only be used if Add-on programs version 1.0.0.1170 or higher is installed (see display: System, Versions).</td>
</tr>
<tr>
<td>11: GSSSD MR113 2003</td>
<td>Requires a gas composition and an absolute humidity input. Add-on programs version 1.0.0.1170 or higher recommended.</td>
</tr>
<tr>
<td>12: GOST 30319 SGERG91</td>
<td>Requires process inputs for nitrogen, carbon dioxide and base density. The value that is written to the tags Base compressibility custom value and Density compressibility custom value will be used. Use this option if the compressibility value(s) is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the compressibility.</td>
</tr>
</tbody>
</table>

**Molar mass**

The molar mass is used to calculate the base density if **base density input type** is set to 'Gas composition'.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Override</td>
<td>Uses the molar mass override value.</td>
</tr>
<tr>
<td>2: AGA8 (detailed)</td>
<td>Requires a gas composition.</td>
</tr>
<tr>
<td>3: SGERG (AGA 8 gross)</td>
<td>Requires process inputs for hydrogen and at least 3 out of the 4 following inputs: nitrogen, carbon dioxide, relative density and gross heating value. (set by parameter SGERGInput method).</td>
</tr>
<tr>
<td>6: GPA2172</td>
<td>Requires a gas composition.</td>
</tr>
<tr>
<td>7: Custom</td>
<td>The value [kg/kmol] that is written to the tag Molar mass custom value will be used. Use this option if the molar mass value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the molar mass.</td>
</tr>
<tr>
<td>8: GERM 2008</td>
<td>Requires a gas composition. Can only be used if Add-on programs version 1.0.0.1170 or higher is installed (see display: System, Versions).</td>
</tr>
<tr>
<td>9: GSSSD MR113 2003</td>
<td>Requires a gas composition and an absolute humidity input. Add-on programs version 1.0.0.1170 or higher recommended.</td>
</tr>
</tbody>
</table>

**Remote molar**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Only applicable if the base compressibility calculation method is set to 'Override value'.</td>
</tr>
</tbody>
</table>

**Molar mass calculation method**

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Override</td>
<td>Uses the molar mass override value.</td>
</tr>
<tr>
<td>2: AGA8 (detailed)</td>
<td>Requires a gas composition.</td>
</tr>
<tr>
<td>3: SGERG (AGA 8 gross)</td>
<td>Requires process inputs for hydrogen and at least 3 out of the 4 following inputs: nitrogen, carbon dioxide, relative density and gross heating value. (set by parameter SGERGInput method).</td>
</tr>
<tr>
<td>6: GPA2172</td>
<td>Requires a gas composition.</td>
</tr>
<tr>
<td>7: Custom</td>
<td>The value [kg/kmol] that is written to the tag Molar mass custom value will be used. Use this option if the molar mass value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the molar mass.</td>
</tr>
<tr>
<td>8: GERM 2008</td>
<td>Requires a gas composition. Can only be used if Add-on programs version 1.0.0.1170 or higher is installed (see display: System, Versions).</td>
</tr>
<tr>
<td>9: GSSSD MR113 2003</td>
<td>Requires a gas composition and an absolute humidity input. Add-on programs version 1.0.0.1170 or higher recommended.</td>
</tr>
</tbody>
</table>

**Base compressibility fallback type**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Only applicable if the base compressibility calculation method is set to 'Override value'. Represents the base compressibility that is used when the communication to the gas chromatograph/remote station flow computer fails.</td>
</tr>
</tbody>
</table>

**Remote molar**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Only applicable if the base compressibility calculation method is set to 'Override value'. Represents the base compressibility that is used when the communication to the gas chromatograph/remote station flow computer fails.</td>
</tr>
</tbody>
</table>
mass fallback type

- computer with **Station product** enabled.
  - Determines what to do in case the communication to the remote station flow computer fails.
  - 1: Last good value
    - Keep on using the last value that was obtained when the input was still healthy.
  - 2: Fallback value
    - Use the value as specified by parameter 'Fallback value'
    - The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer.
  - 3: Override value
    - Use the value as specified by parameter 'Override value'
    - Only used if Fallback value is 'Fallback value'. Represents the base molar mass [kg/kmol] to be used when the communication to the remote station flow computer fails.

Remote molar mass fallback value

- 1000

**Heating value**

- 1000

- **Heating value calculation method**
  - Controls how the heating value is determined
  - 1: HV process input
    - The heating value is provided as a process input (override value, analog input, HART input, GC value, custom value). See the paragraph 'Gross Heating value input'
  - 2: ISO6976-1995
    - Requires a gas composition
  - 3: ISO6976-1983
    - Requires a gas composition
  - 4: GPA-2172
    - Requires a gas composition
  - 5: AGA-5
    - Requires a gas composition and specific gravity
  - In case of a remote run FC with **Station product** enabled the heating value is read from the station flow computer.

**SGERG settings**

- Only applicable if SGERG (AGA8 gross) is selected to calculate the compressibility and / or the base compressibility

- **SGERG input method**
  - 1000
  - SGERG calculation method as specified in the standard:
  - 1: All inputs known
  - 2: Unknown N2
  - 3: Unknown CO2
  - 4: Unknown GHV
  - 5: Unknown RD (relative density)

- **SGERG reference conditions**
  - 1000
  - Reference conditions for the heating value and relative density values.
  - 1: GHV/RD 25/0 °C
  - 2: GHV/RD 0/0 °C
  - 3: GHV/RD 15/15 °C

**NX-19 settings**

- Only applicable if NX-19 is selected to calculate the compressibility and / or the base compressibility

- **NX19 G9 correction method**
  - 1000
  - 0: Disabled
  - 1: Enabled

**ISO-6976 settings**

- Only applicable if ISO6976:1995 is selected to calculate the base compressibility, molar mass and / or heating value.

- **ISO-6976-1995 reference conditions**
  - 1000
  - The reference temperatures for combustion / metering:
  - 1: 15°C / 15°C
  - 2: 0°C / 0°C
  - 3: 15°C / 0°C
  - 4: 25°C / 0°C
  - 5: 20°C / 20°C

- **ISO-6976-1995 molar mass calculation method**
  - 1000
  - Only applicable if ISO6976:1995 is selected to calculate the base compressibility, molar mass and / or heating value.
  - Defines how the molar mass is calculated from the gas composition.
  - 1: From atomic masses
    - Calculates the molar mass from the atomic masses as defined in the note of Table 1 of the standard
  - 2: Use table values
    - Uses the values from Table 1 of the standard

- **ISO-6976-1995 heating value calculation method**
  - 1000
  - Only applicable if ISO6976:1995 is selected to calculate the base compressibility, molar mass and / or heating value.
  - Defines how the calorific value is calculated from the gas composition.
  - 1: Definitive method
    - Calculates the mass based calorific value from the molar based calorific values from table 3 and from the calculated molar mass values.
    - Calculates the volume based calorific value by multiplying the molar based calorific values from table 3 by p2/R.T2
  - 2: Alternative method
    - Uses the values from tables 3, 4 and 5 as specified in the standard.
    - Refer to paragraph 6.1 and 7.1 of the ISO-6976:1995 standard for more information

- **ISO6976-1983 metering reference temp.**
  - 1000
  - Only applicable if ISO6976:1993 is selected to calculate the base compressibility, molar mass and / or heating value.
  - The temperature used for calculating the compressibility, the density and the real gas volume reference temperature
  - 1: 0°C
  - 2: 15 °C

- **ISO6976-1983 combustion ref. temp.**
  - 1000
  - Only applicable if ISO6976:1983 is selected to calculate the base compressibility, molar mass and / or heating value.
  - Temperatures used for calculating the calorific values. 1st value represents the combustion reference temperature and the 2nd value the gas volume reference temperature
  - 1: 25 °C / 0 °C
  - 2: 0 °C / 0 °C
  - 3: 15 °C / 0 °C
  - 4: 15 °C / 15 °C

**GPA-2172 settings**

- Only applicable if GPA2172 is selected to calculate the base compressibility, molar mass and / or heating value.

- **GPA2172 edition**
  - 1000
  - The GPA2172-96 standard uses the gas properties that are defined in the GPA-2145 standard. The latter standard is updated periodically.
  - Flow-X supports the following editions of the GPA-2145 standard:
  - 1: GPA2145-00
    - 2000 edition
  - 2: GPA2145-03
    - 2003 edition
  - Note: earlier versions of the GPA-2145 standard did not contain metric values.
Either the Gross Heating value (GHV, also called ‘Higher Heating value’ or ‘Higher calorific value’) or the Net Heating value (NHV, also called ‘Lower Heating value’ or ‘Lower calorific value’) can be used in the calculations. This can be configured by parameter ‘Use Net HV for energy’ on display Configuration, Overall setup, Common settings.

Furthermore, a volume based heating value [MJ/sm3] or mass based heating value [MJ/kg] can be selected. Preferably a volume based heating value is to be used in case of a volumetric flow meter and a mass based heating value in case of a mass flow meter.

In case of SGERG / AGA8 gross and NX-19 the volume based GHV is used as input to calculate the compressibility and / or molar mass (see paragraph ‘Calculation Setup’).

Display → Configuration, Run <x>, Gas properties, Heating value input

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Input type</th>
<th>1000</th>
<th>Type of input</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Calculated</td>
<td>Uses the heating value calculated according to ISO-6976:83, ISO-6976:95 or GPA2172 (see paragraph ‘Calculation Setup’)</td>
<td></td>
</tr>
<tr>
<td>1: Always use override</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Analog input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Density temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: HART</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Custom input</td>
<td>The value [MJ/sm3] or [MJ/kg] that is written to the tag Heating value custom value will be used. Use this option if the heating value value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the heating value.</td>
<td></td>
</tr>
<tr>
<td>6: Analog input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7: Gas chromatograph</td>
<td>Uses the heating value read from a gas chromatograph</td>
<td></td>
</tr>
<tr>
<td>8: Mass based</td>
<td>In case of a remote run FC with Station product enabled the heating value is read from the station flow computer.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heating value type</th>
<th>1000</th>
<th>Determines whether a volumetric or mass based heating value is used in the calculations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Volume based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Mass based</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analog input settings**

These settings are only applicable if the heating value input type is ‘Analogue input’, or if the heating value input type is ‘HART to analog fallback’ enabled.

<table>
<thead>
<tr>
<th>Analog input module</th>
<th>1000</th>
<th>Number of the flow module to which the signal is physically connected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Local module means the module of the meter run itself</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Analog input channel</th>
<th>1000</th>
<th>Number of the analog input channel on the selected module to which the signal is physically connected.</th>
</tr>
</thead>
</table>
HART settings
These settings are only applicable if the **heating value input type** is 'HART'.

### HART internal device nr.
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: ‘Ports &amp; Devices’).</td>
</tr>
</tbody>
</table>

### HART variable
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the Heating Value. Usually this is the 1st (primary) variable.</td>
</tr>
</tbody>
</table>

### HART to analog fallback
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1000  | Only applies for a single HART transmitter, where the 4-20 mA signal is provided together with the HART signal.  
0: Disabled  
The 4-20 mA signal will not be used when the HART signal fails.  
Instead the value corresponding with the 'Fallback type' will be used.  
1: Enabled  
The 4-20 mA signal will be used when the HART signal fails.  
When both the HART and the mA signal fail the value corresponding with the 'Fallback type' will be used.  
If multiple HART transmitters are installed within a loop, then the HART to analog fallback option can't be used. |

### Fail fallback
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1000  | Determines what to do in case the heating value input fails.  
1: Last good value  
Keep on using the last value that was obtained when the input was still healthy.  
2: Fallback value  
Use the value as specified by parameter 'Fallback value'  
The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer.  
3: Override value  
Use the value as specified by parameter 'Override value'  
If multiple HART transmitters are installed within a loop, then the HART to analog fallback option can't be used. |

### Input frozen alarm
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1000  | Maximum time [s] which the input value is allowed to remain unchanged.  
If the input value hasn't changed during this time, an 'input frozen' alarm is given.  
Only applicable in case of a life (not calculated) or custom input value. Not applicable for input type ‘always use override’.  
Enter '0' to disable this functionality. |

CO2, H2 and N2 inputs
If SGERG / AGA8 gross is chosen as method to calculate the compressibility, base compressibility and/or molar mass, process inputs for hydrogen (H2), nitrogen (N2; optional) and carbon dioxide (CO2; optional) are needed.

If AGA NX-19 is chosen as method to calculate the compressibility and/or base compressibility, process inputs for nitrogen (N2) and carbon dioxide (CO2) are needed.
HART settings
These settings are only applicable if the input type is ‘HART’.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HART internal device nr.</td>
<td>1000</td>
<td>Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: ‘Ports &amp; Devices’).</td>
</tr>
<tr>
<td>HART variable</td>
<td>1000</td>
<td>Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the CO2 / H2 / N2 value. Usually this is the 1st (primary) variable.</td>
</tr>
</tbody>
</table>

Fail fallback
Determines what to do in case the input fails.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallback type</td>
<td>1000</td>
<td>Determines what to do in case the input fails.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Last good value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Keep on using the last value that was obtained when the input was still healthy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Fallback value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use the value as specified by parameter ‘Fallback value’.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The fallback value is usually a fixed value and will generally never be changed during the lifetime of the flow computer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Override value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use the value as specified by parameter ‘Override value’.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fallback value</td>
<td>1000</td>
<td>Only used when Fallback type is ‘Fallback value’.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Represents the value [%mol/mol] to be used when the input fails.</td>
</tr>
</tbody>
</table>

Input frozen alarm
Maximum time [s] which the input value is allowed to remain unchanged.
If the input value hasn't changed during this time, an ‘input frozen’ alarm is given.
Not applicable for input type ‘always use override’.
Enter 0 to disable this functionality.
Analog outputs

Each flow module provides 4 analog outputs, which can be set up at meter run level for run process variables and at station level for station process variables.

Display → Configuration, Run <x>, Analog outputs, Analog output <y>

Display → Configuration, Station, Analog outputs, Analog output <y>

with <x> the module number of the meter run and <y> the analog output number (1-4)

<table>
<thead>
<tr>
<th>Analog output &lt;y&gt; module</th>
<th>600</th>
<th>Number of the flow module that is used for this output.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog output &lt;y&gt; channel</td>
<td>600</td>
<td>Analog output channel on the specified module that is used for this output.</td>
</tr>
</tbody>
</table>

The analog output scaling and dampening factors can be configured on the I/O configuration display: IO, Module <x>, Configuration, Analog outputs, Analog output <y>

<table>
<thead>
<tr>
<th>Analog output &lt;y&gt; Variable</th>
<th>600</th>
<th>The variable that is used for the analog output.</th>
</tr>
</thead>
<tbody>
<tr>
<td>For each run any of the following variables can be selected:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1 : Custom</td>
<td>0: Not assigned</td>
<td></td>
</tr>
<tr>
<td>1: Gross volume flow rate</td>
<td>2: Base volume flow rate</td>
<td></td>
</tr>
<tr>
<td>3: Mass flow rate</td>
<td>4: Energy flow rate</td>
<td></td>
</tr>
<tr>
<td>5: Specific gravity</td>
<td>6: Base density</td>
<td></td>
</tr>
<tr>
<td>7: Relative density</td>
<td>8: Heating value (volumetric)</td>
<td></td>
</tr>
<tr>
<td>9: Heating value (mass based)</td>
<td>10: Meter temperature</td>
<td></td>
</tr>
<tr>
<td>11: Meter pressure [bara]</td>
<td>12: Meter pressure [bar]</td>
<td></td>
</tr>
<tr>
<td>13: Meter density</td>
<td>14: Observed density</td>
<td></td>
</tr>
</tbody>
</table>

Selection 'Not assigned' disables the output.
If 'Custom' is selected then the value that is written (by a custom calculation) to the Analog output <y> custom value will be used. This option can be used to send any other variable to an analog output.
**Pulse outputs**

Each flow module provides a maximum of 4 pulse outputs.

Pulse outputs can be set up both at meter run level for **run totals** and at station level for **station totals**.

In order to be able to use a digital channel as a pulse output, the channel must be configured as **Pulse output (1-4)** (I/O, Module <y>, Configuration, Digital IO assign).

![Display → Configuration, Run <x>, Pulse outputs, Pulse output <y>](image)

Display → Configuration, Station, Pulse outputs, Pulse output <y>

with <x> the module number of the meter run

and <y> the pulse output number (1-4)

<table>
<thead>
<tr>
<th>Pulse output &lt;y&gt; totalizer</th>
<th>The totalizer that is used for the pulse output.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-1: Custom</td>
</tr>
<tr>
<td></td>
<td>0: Not assigned</td>
</tr>
<tr>
<td></td>
<td>1: Indicated (forward)*</td>
</tr>
<tr>
<td></td>
<td>2: Gross volume (forward)</td>
</tr>
<tr>
<td></td>
<td>3: Base volume (forward)</td>
</tr>
<tr>
<td></td>
<td>4: Mass (forward)</td>
</tr>
<tr>
<td></td>
<td>5: Energy (forward)</td>
</tr>
<tr>
<td></td>
<td>6: Good pulses (forward)*</td>
</tr>
<tr>
<td></td>
<td>7: Error pulses (forward)*</td>
</tr>
<tr>
<td></td>
<td>8: Indicated (reverse)*</td>
</tr>
<tr>
<td></td>
<td>9: Gross volume (reverse)</td>
</tr>
<tr>
<td></td>
<td>10: Base volume (reverse)</td>
</tr>
<tr>
<td></td>
<td>11: Mass (reverse)</td>
</tr>
<tr>
<td></td>
<td>12: Energy (reverse)</td>
</tr>
<tr>
<td></td>
<td>13: Good pulses (reverse)*</td>
</tr>
<tr>
<td></td>
<td>14: Error pulses (reverse)*</td>
</tr>
<tr>
<td></td>
<td>15: Indicated (forward/reverse)*</td>
</tr>
<tr>
<td></td>
<td>16: Gross volume (forward/reverse)</td>
</tr>
<tr>
<td></td>
<td>17: Base volume (forward/reverse)</td>
</tr>
<tr>
<td></td>
<td>18: Mass (forward/reverse)</td>
</tr>
<tr>
<td></td>
<td>19: Energy (forward/reverse)</td>
</tr>
<tr>
<td></td>
<td>20: Good pulses (forward/reverse)*</td>
</tr>
<tr>
<td></td>
<td>21: Error pulses (forward/reverse)*</td>
</tr>
</tbody>
</table>

*Only available on meter run level

Selection 'Not assigned' disables the output.

If 'Custom' is selected, then the value that is written to the tag **Pulse output <y> custom increment** will be used. Use this option if you want to apply user-defined calculations to the totalizers, e.g. converting them into different units.

<table>
<thead>
<tr>
<th>Pulse output &lt;y&gt; module</th>
<th>Number of the flow module to which the signal is physically connected.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-1: Local module means the module of the meter run itself</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulse output &lt;y&gt; index</th>
<th>Pulse output number on the specified module that is used for the signal.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1: Pulse output 1</td>
</tr>
<tr>
<td></td>
<td>2: Pulse output 2</td>
</tr>
<tr>
<td></td>
<td>3: Pulse output 3</td>
</tr>
<tr>
<td></td>
<td>4: Pulse output 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pulse output &lt;y&gt; Quantity per pulse</th>
<th>Factor that specifies the amount that corresponds to 1 pulse. The unit depends on the totalizer that has been selected: [m³/pls], [sm³/pls] or [kg/pls].</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E.g. a value of 100 means that 1 pulse is generated whenever 100 input units (m³, sm³ or kg) have been</td>
</tr>
</tbody>
</table>
**Frequency outputs**

Each flow module provides a maximum of 4 frequency outputs, each of which can be used to output a process variable (e.g. a flow rate) as a periodic signal with a frequency proportional to the process value.

Frequency outputs can be set up both at meter run level for run process variables and at station level for station process variables.

In order to be able to use a digital channel as a frequency output, the channel must be configured as Frequency output (1-4) (I/O, Module <y>, Configuration, Digital IO assign).

---

The use of frequency outputs is only supported by FPGA version 1422-21-2-2012 or later.

---

Display → Configuration, Run <x>, Frequency outputs, Frequency output <y>

Display → Configuration, Station, Frequency outputs, Frequency output <y>

with <x> the module number of the meter run

and <y> the frequency output number (1-4)

---

**Pulse output**

<table>
<thead>
<tr>
<th>&lt;y&gt; totalizer</th>
<th>600</th>
<th>The totalizer that is used for the frequency output.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Not assigned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: Indicated flow rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Gross volume flow rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Base volume flow rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: Mass flow rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5: Energy flow rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selection 'Not assigned' disables the output.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If 'Custom' is selected then the value that is written (by a custom calculation) to the Frequency output <y> custom value will be used. This option can be used to send any other variable to a frequency output.

<table>
<thead>
<tr>
<th>Frequency output &lt;y&gt; module</th>
<th>600</th>
<th>Number of the flow module to which the signal is physically connected.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1: Local module means the module of the meter run itself</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency output &lt;y&gt; index</th>
<th>600</th>
<th>Frequency output number on the specified module that is used for the signal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Frequency output 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: Frequency output 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3: Frequency output 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4: Frequency output 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

The frequency output scaling factors (zero and full scale values and frequencies) can be configured on the I/O configuration display: IO, Module <x>, Configuration, Frequency outputs, Frequency output <y>
**Snapshot report**

Display → Configuration, Run <x>, Snapshot report

Display → Configuration, Station, Snapshot report

with <x> the module number of the meter run

<table>
<thead>
<tr>
<th>Snapshot report</th>
<th>600</th>
<th>Defines whether or not snapshot reports can be generated.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 : Disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Enabled</td>
</tr>
</tbody>
</table>

Please be aware that a snapshot report has to be configured and enabled in Flow-Xpress prior to writing the application to the flow computer.

**Snapshot digital input**

Optionally a digital input can be used to issue a snapshot request command, in order to generate (and print) a snapshot report for a specific run or for the station.

<table>
<thead>
<tr>
<th>Print snapshot digital input module</th>
<th>600</th>
<th>Number of the flow module to which the input signal is physically connected.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>-1: Local module means the module of the meter run itself</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Print snapshot digital output channel</th>
<th>600</th>
<th>Number of the digital channel on the selected module to which the input signal is physically connected.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Enter '0' to un-assign the snapshot request digital input.</td>
</tr>
</tbody>
</table>
Valve control

The Flow-X application provides control of the following valves:

For each run:
- Run inlet valve
- Run outlet valve
- Crossover valve (Run to prover valve)

The control logic is based on 1 common or 2 separate output signals for the valve open and close commands, and 0, 1 or 2 input signals for the valve position (Open and Closed).

The valve position is determined as follows:

- If no inputs are available, then the position is determined from the latest issued valve command. No ‘traveling’ or ‘Fault’ positions can be derived.
- If one single input is available (for either the open or the closed position), then the valve is considered to be in the opposite position if the position signal is OFF. No ‘traveling’ or ‘Fault’ positions can be derived.
- If two inputs are available, then the position is derived as follows:

<table>
<thead>
<tr>
<th>Closed DI</th>
<th>Open DI</th>
<th>Valve position</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>OFF</td>
<td>Closed</td>
</tr>
<tr>
<td>OFF</td>
<td>ON</td>
<td>Open</td>
</tr>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>Traveling or Valve fault, depending on configured ‘traveling type’</td>
</tr>
<tr>
<td>ON</td>
<td>ON</td>
<td>Traveling or Valve fault, depending on configured ‘traveling type’</td>
</tr>
</tbody>
</table>

Separate open and close commands are available for manual and auto modes of operations. Manual mode is meant for direct control by the operator, automatic mode is meant for logic, which can be programmed through ‘User calculations’ in Flow-Xpress.

A time-out limit is applied to the valve travel time. A ‘valve travel timeout’ alarm is generated when the travel timer has reached the limit before the valve has reached its destination.

The valve may be equipped with a local / remote switch, which can be read into the flow computer through a digital input. If this input is ON, then a ‘valve local control’ alarm is generated and any open / close commands on the flow computer are rejected.

If the valve leaves the open or closed position while no command has been given from the flow computer (apparently because the valve is controlled locally), the travel timer is started and a ‘valve travel timeout’ alarm is generated when the valve remains too long in the ‘traveling’ state.

The valve may be equipped with a ‘valve fault’ digital output. This signal can be read into the flow computer through a digital input. A ‘valve fault’ alarm is generated when this input is ON.

Permissive flags are available to interlock the opening or closing of valves. The permissive flags are ON by default and can be set / reset through ‘User calculations’ in Flow-Xpress.

The crossover valve can be used in case of master meter proving with a so-called ‘z-configuration’, through which the two valves can alternatively be set in parallel or serial line-up. One of the valve position inputs can then be used to indicate to the flow computer that the valves are in serial configuration, so only one of the totals must be taken into account in the station total. See paragraph ‘Serial mode’ for more information.

Display → Configuration, Run <x>, Valve control
Display → Configuration, Prover A/B, Valve control

With <x> the module number of the meter run

The valve control configuration displays are only visible if valve control has been enabled on the Configuration, Run <x>, Run control display.

The following settings are available for each individual valve:

| Valve control signals | 600 | 0: None | Valve control is disabled
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1: Two pulsed outputs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two separate outputs for open and close commands. The outputs remain ON until the valve control pulse duration time has passed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Two maintained outputs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two separate outputs for open and close commands. The outputs remain ON until the valve has reached its target position, or until the travel timeout time has passed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Single output (open)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 output to open the valve (ON = open). After a valve open command the output stays ON until a close command is given.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4: Single output (close)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 output to close the valve (ON = close). After a valve close command the output stays ON until an open command is given.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valve control pulse duration</th>
<th>600</th>
<th>Only applicable if Valve control signals is set to ‘Two pulsed outputs’.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Defines the pulse duration [s] of the valve control output signals.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valve position signals</th>
<th>600</th>
<th>0: No inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No inputs for open and close positions. The valve position is solely derived from the latest valve command.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Two inputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two separate inputs for open and close positions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Single input (open)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Single input that is ON when the valve is in the open position, else OFF.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Single input (closed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>One input that is ON when the valve is in the closed position, else OFF.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valve traveling type</th>
<th>600</th>
<th>Only applicable in case of 2 position signals.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Determines how the ‘traveling’ and ‘Fault’ statuses are derived.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Both inputs inactive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The valve is in the ‘traveling’ state if both the open and close position inputs are OFF. The valve is in the ‘fault’ state if both the open and close position inputs are ON.</td>
</tr>
</tbody>
</table>
2: Both inputs active  
The valve is in the ‘traveling’ state if both the open  
and close position inputs are ON. The valve is in the  
‘fault’ state if both the open and close position  
inputs are OFF.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve travel timeout period</td>
<td>600</td>
<td>Maximum allowed time [s] for the valve to be traveling to the required position. The valve timeout alarm is raised when the valve does not reach the required position within this time.</td>
</tr>
</tbody>
</table>

**Position inputs**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open position DI module</td>
<td>600</td>
<td>Module to which the open position signal is physically connected.</td>
</tr>
<tr>
<td>Open position DI channel</td>
<td>600</td>
<td>Digital channel on the selected module to which the open position signal is physically connected.</td>
</tr>
<tr>
<td>Closed position DI module</td>
<td>600</td>
<td>Module to which the closed position signal is physically connected.</td>
</tr>
<tr>
<td>Closed position DI channel</td>
<td>600</td>
<td>Digital channel on the selected module to which the closed position signal is physically connected.</td>
</tr>
</tbody>
</table>

**Control outputs**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open control DO module</td>
<td>600</td>
<td>Module to which the open control output signal is physically connected.</td>
</tr>
<tr>
<td>Open control DO channel</td>
<td>600</td>
<td>Digital channel on the selected module to which the open control output signal is physically connected.</td>
</tr>
<tr>
<td>Close control DO module</td>
<td>600</td>
<td>Module to which the close control output signal is physically connected.</td>
</tr>
<tr>
<td>Close control DO channel</td>
<td>600</td>
<td>Digital channel on the selected module to which the close control output signal is physically connected.</td>
</tr>
</tbody>
</table>

**Local / remote input**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local / remote DI module</td>
<td>600</td>
<td>Module to which the local / remote signal is physically connected.</td>
</tr>
<tr>
<td>Local / remote DI channel</td>
<td>600</td>
<td>Digital channel on the selected module to which the local / remote signal is physically connected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enter 0 to disable the local / remote digital input.</td>
</tr>
</tbody>
</table>

**Valve fault input**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve fault DI module</td>
<td>600</td>
<td>Module to which the valve fault signal is physically connected.</td>
</tr>
<tr>
<td>Valve fault DI channel</td>
<td>600</td>
<td>Digital channel on the selected module to which the valve fault signal is physically connected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enter 0 to disable the valve fault digital input.</td>
</tr>
</tbody>
</table>

**Open / close permissives**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve open permissive</td>
<td>600</td>
<td>Determines whether or not a valve open permissive is taken into account. If enabled, the valve can only be opened if the valve open permissive (to be written through Modbus or using a 'custom calculation') is ON.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0: Disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Enabled</td>
</tr>
<tr>
<td>Valve close permissive</td>
<td>600</td>
<td>Determines whether or not a valve close permissive is taken into account. If enabled, the valve can only be closed if the valve close permissive (to be written through Modbus or using a 'custom calculation') is ON.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0: Disabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Enabled</td>
</tr>
</tbody>
</table>
Flow / pressure control

The application supports PID control for Flow / Pressure Control Valves. PID control can be configured either on run level (separate control valves for individual meter runs) or at station level (one control valve for the whole station consisting of multiple runs).

Three types of control are supported:

1. Flow control
   The flow computer controls a flow control valve (FCV) to maintain a flow rate that is defined by the flow rate setpoint.

2. Pressure control
   The flow computer controls a pressure control valve (PCV) to maintain a pressure that is defined by the pressure setpoint.

3. Flow / pressure control
   Primary control is on flow. The flow computer tries to maintain or reach the flow rate that is defined by the flow control setpoint. In the meantime it checks that the pressure doesn't pass a pressure limit, which is defined by the pressure setpoint / limit value. The limit may be a minimum value (to ensure a minimum delivery pressure) or a maximum value (to ensure a maximum back pressure).

   If the process pressure passes the limit, then the flow computer switches over to pressure control, such that the pressure is maintained at the pressure setpoint / limit value. This means that the flow will stabilize on a flow rate that differs from the original flow rate setpoint. Apparently the flow rate setpoint can't be reached without passing the pressure limit. Depending on the process properties (pressure rises or drops with increasing flow rate) and the type of pressure limit (minimum or maximum) the actual flow rate will be lower or higher than the flow rate setpoint.

   The flow computer remains in pressure control mode as long as the flow rate setpoint can't be reached without passing the pressure limit. As soon as the flow rate set point can be reached without passing the pressure limit (f.e. because a different flow rate setpoint is entered), then the flow computer switches back to flow control, controls the flow rate to the flow rate setpoint and maintains it at the flow rate setpoint value.

   An example. Let's consider a process for which the pressure increases with decreasing flow rate and for which a maximum pressure limit is configured at 30 bar. The actual flow rate is 2000 m3/h and the pressure is 25 bar. The operator enters a flow rate setpoint of 1000 m3/h, so the flow computer closes the FCV and the flow rate decreases. At the same time the pressure increases and at a flow rate of 1200 m3/h the pressure reaches the limit of 30 bar. Apparently the flow rate setpoint can't be reached without the pressure getting too high. The flow computer switches over to pressure control and maintains the pressure at 30 bar. The flow rate stabilizes around 1200 m3/h. Now the operator sets the flow rate setpoint at 1500 m3/h. Because this is higher than the actual flow rate, it is a flow rate that is reachable without passing the pressure limit, so the flow computer switches back to flow control and directs the flow rate to 1500 m3/h. (If the operator would have chosen a setpoint below the actual flow rate, f.e. 1100 m3/h, then the flow computer would have remained in pressure control mode and nothing would have happened).

   - Display → Configuration, Run <x>, Flow control
   - Display → Configuration, Station, Flow control
   - Display → Configuration, Proving, Flow control

   With <x> the module number of the meter run

   The flow control configuration displays are only visible if flow control has been enabled on any of the following displays:

   - Configuration, Run <x>, Run control
   - Configuration, Station, Station control

   The following configuration settings are available:

<table>
<thead>
<tr>
<th>Flow / pressure control mode</th>
<th>600</th>
<th>Process value that is used for PID Control.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: None</td>
<td></td>
<td>Flow / pressure control is disabled</td>
</tr>
<tr>
<td>1: Flow control</td>
<td></td>
<td>Controls the flow rate.</td>
</tr>
<tr>
<td>2: Pressure control</td>
<td></td>
<td>Controls the pressure</td>
</tr>
<tr>
<td>3: Flow / pressure control</td>
<td></td>
<td>Primarily controls the flow rate; switches over to pressure control if a configurable pressure limit is passed.</td>
</tr>
</tbody>
</table>

Flow control

These settings are applicable if the Flow / pressure control mode is set to ‘Flow control’ or ‘Flow / pressure control’.

   - Flow control - Input
     - Display → Configuration, Proving, Flow control
     - Display → Configuration, Station, Station control

   The following configuration settings are available:

<table>
<thead>
<tr>
<th>Flow control - Proportional Gain (P)</th>
<th>600</th>
<th>Proportional gain (P) factor for flow control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller output = Proportional gain * Actual error.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportional Gain = 100 / Proportional Band</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow control - Integral gain (I)</th>
<th>600</th>
<th>Integral gain (i) factor for flow control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integral gain = 1 / [Seconds per repeat], e.g. an integral gain of 0.02 means 1 repeat per 50 seconds.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   As a rule of thumb set this to the time [sec] it takes for the variable to react to the output.

<table>
<thead>
<tr>
<th>Flow control - Full scale value</th>
<th>600</th>
<th>Highest flow rate that can be achieved by controlling the valve. Units are the same as flow rate process value.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equals the flow rate process value that corresponds to 100% control output (20 mA) if Flow Control - Reverse</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   For more information on the configuration of the flow computer, see the section on 'Flow control' in the manual.
**Flow control**

These settings are applicable if the Flow / pressure control mode is set to 'Pressure control' or 'Flow / pressure control'.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Control - Input</td>
<td>600</td>
<td>Pressure process value used for pressure control.</td>
</tr>
<tr>
<td>Pressure Control - Units</td>
<td>600</td>
<td>Defines whether the pressure setpoint is absolute pressure [bar(a)] or gauge pressure [bar(g)] (i.e., relative to the atmospheric pressure).</td>
</tr>
<tr>
<td>Pressure Control Proportional Gain (P)</td>
<td>600</td>
<td>Proportional gain for pressure control. Controller output = Proportional Gain * Actual error. Proportional Gain a= 100 / Proportional Band</td>
</tr>
<tr>
<td>Pressure Control Integral gain (I)</td>
<td>600</td>
<td>Integral gain for pressure control. Integral gain = 1 / [Seconds per repeat], e.g., value of 0.02 means 1 repeat per 50 seconds.</td>
</tr>
<tr>
<td>Pressure Control Full scale value</td>
<td>600</td>
<td>Highest pressure that can be achieved by controlling the valve.</td>
</tr>
<tr>
<td>Pressure Control Zero scale value</td>
<td>600</td>
<td>Lowest pressure that can be achieved by controlling the valve.</td>
</tr>
</tbody>
</table>

**Pressure control**

**Mode is disabled, or 0% control output (4 mA) if Flow Control - Reverse mode is enabled.**

The unit is the same as the process value.

**Flow control - Zero scale value**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>Lowest flow rate that can be achieved by controlling the valve. Units are the same as flow rate process value.</td>
</tr>
</tbody>
</table>

**Flow control - Reverse mode**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>Enables or disables reverse control mode for flow control.</td>
</tr>
</tbody>
</table>

**Pressure control - Deadband**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>Deadband on flow control. Avoids that the control valve is constantly moving, even though the actual flow rate is very close to the setpoint. Flow control will be suspended if the flow rate is higher than the setpoint minus the deadband and lower than the setpoint plus the deadband. Same units as in-use process value.</td>
</tr>
</tbody>
</table>

**Pressure Control Setpoint**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>If Flow / Pressure control mode is 'Pressure control' this is the setpoint which the control loop will try to achieve, provided that Manual control is disabled. If Flow / Pressure control mode is 'Flow / Pressure control' this is the pressure limit value that is used to switch from flow control to pressure control. Units are [bar(a)] or [bar(g)] depending on the Pressure Control - Units.</td>
</tr>
</tbody>
</table>

**Pressure Limit Mode**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>Only applicable if Flow / Pressure control mode = 'Flow / pressure control'.</td>
</tr>
</tbody>
</table>

**Setpoint clamping**

**Flow control - Upward setpoint clamp rate (s)**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>The in-use flow setpoint will not be allowed to increase faster than this limit per second.</td>
</tr>
</tbody>
</table>

If a higher setpoint is entered, the actual setpoint for the PID controller will ramp up with the specified clamp rate until the setpoint value is reached. A value of 0 disables this function

**Flow control - Downward setpoint clamp rate (s)**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>The in-use flow setpoint will not be allowed to decrease faster than this limit per second.</td>
</tr>
</tbody>
</table>

If a lower setpoint is entered, the actual setpoint for the PID controller will ramp down with the specified clamp rate until the setpoint value is reached. A value of 0 disables this function

**Pressure control - Upward setpoint clamp rate (s)**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>The in-use pressure setpoint will not be allowed to increase faster than this limit per second.</td>
</tr>
</tbody>
</table>

If a higher setpoint is entered, the actual setpoint for the PID controller will ramp up with the specified clamp rate until the setpoint value is reached. A value of 0 disables this function

**Pressure control - Downward setpoint clamp rate (s)**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>The in-use pressure setpoint will not be allowed to decrease faster than this limit per second.</td>
</tr>
</tbody>
</table>

If a lower setpoint is entered, the actual setpoint for the PID controller will ramp down with the specified clamp rate until the setpoint value is reached. A value of 0 disables this function

**Control output settings**

**Bumpless transfer**

<table>
<thead>
<tr>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>Controls bumpless transfer from auto to manual mode by setting the initial manual output % equal to the current valve open %. When switching from auto to manual mode while bumpless transfer is enabled, the valve effectively freezes at its position at the moment of switching. This avoids unexpected valve movements when switching from auto to manual mode.</td>
</tr>
</tbody>
</table>

0: Disabled

1: Enabled
### Control output settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum limit</td>
<td>600</td>
<td>The control output % will not be allowed to go above this limit [%]</td>
</tr>
<tr>
<td>Minimum limit</td>
<td>600</td>
<td>The control output % will not be allowed to go below this limit [%]</td>
</tr>
<tr>
<td>Upward slew rate</td>
<td>600</td>
<td>The control output will not be allowed to increase faster than this limit [%/sec]. A value of 0 disables this function</td>
</tr>
<tr>
<td>Downward slew rate</td>
<td>600</td>
<td>The control output will not be allowed to decrease faster than this limit [%/sec]. A value of 0 disables this function</td>
</tr>
<tr>
<td>Idle output %</td>
<td></td>
<td>Value used for control output when the PID permissive flag is not set. This can f.e. be used to shut down the control valve if the permissive is withdrawn.</td>
</tr>
</tbody>
</table>

### Analog output settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td>600</td>
<td>Module to which the analog control output signal is connected. -1: Local module means the module of the meter run itself</td>
</tr>
<tr>
<td>Channel</td>
<td>600</td>
<td>Channel number for the analog control output signal.</td>
</tr>
</tbody>
</table>

### Permissive settings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Withdraw permissive on flow meter error</td>
<td>600</td>
<td>Only applicable if control mode is 'Flow control' or 'Flow / pressure control'. Withdraw PID permissive in case of a meter failure (comms fail, measurement fail, etc.) or data invalid status. The output is forced to the 'Idle output %'. 0: No 1: Yes</td>
</tr>
<tr>
<td>Withdraw permissive on pressure transmitter fail</td>
<td>600</td>
<td>Only applicable if control mode is 'Pressure control' or 'Flow / pressure control'. Withdraw PID permissive in case of a pressure transmitter failure. The output is forced to the 'Idle output %'. 0: No 1: Yes</td>
</tr>
<tr>
<td>Withdraw permissive if inlet valve not open</td>
<td>600</td>
<td>Withdraw PID permissive if the 'valve open' status from the inlet valve is not received. The output is forced to the 'Idle output %'. This avoids that flow control is fully opening the control valve while there's no flow because the inlet valve is not open. 0: No 1: Yes</td>
</tr>
<tr>
<td>Withdraw permissive if outlet valve not open</td>
<td>600</td>
<td>Withdraw PID permissive if the 'valve open' status from the outlet valve is not received. The output is forced to the 'Idle output %'. This avoids that flow control is fully opening the control valve while there's no flow because the outlet valve is not open. 0: No 1: Yes</td>
</tr>
<tr>
<td>Use custom PID permissive</td>
<td>600</td>
<td>Allows for creating custom PID permissive logic. If enabled the PID permissive will be withdrawn (and the output will be forced to the 'Idle output %') when a 0 is written to the 'Custom PID permissive'. 0: No 1: Yes</td>
</tr>
<tr>
<td>Custom PID permissive message</td>
<td>600</td>
<td>Message shown if custom permissive is Off.</td>
</tr>
<tr>
<td>Use PID active flag</td>
<td>600</td>
<td>Allows for creating custom logic to switch off PID control. If enabled the PID permissive will be withdrawn (and the output will be forced to the 'Idle output %') when a 0 is written to the 'PID active flag'. 0: No 1: Yes</td>
</tr>
</tbody>
</table>
**Sampler control**

The application supports control of a sampler.

Single can and twin can samplers are supported. Several algorithms can be used for determining the time or metered volume between grabs.

Display → Configuration, Sampler control

With <x> the module number of the meter run

The following configuration settings are available for each sampler:

<table>
<thead>
<tr>
<th>Sampler control</th>
<th>600</th>
<th>Determines whether the control of the sampler is enabled or not. Disabling control inhibits the output of grab commands (pulses) and hides the operator sampling displays.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
<td></td>
</tr>
</tbody>
</table>

- **Sampled flow**

  | 600 | Used for Flow proportional sampling methods only. Determines which flow value is used as a basis for sampling. |
|-----------------|-----|------------------------------------------------------------------------------------------------------------------|
| 0: Station | 1: Run 1 - 8 |

  - The sampler is installed on the station inlet or outlet header. The station gross volume totalizer is used as a basis for sampling.

  - 1-B: Run 1 - 8

    - The sampler is installed on a specific run (1-8). The run gross volume totalizer is used as a basis for sampling.

<table>
<thead>
<tr>
<th>Sampled flow direction</th>
<th>600</th>
<th>Only applicable to two-directional applications. (Reverse totals enabled on display Configuration, Overall setup, Common settings). Determines whether the sampler will be active for both flow directions, or only for one specific flow direction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Both directions</td>
<td>2: Forward only</td>
<td>3: Reverse only</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sampling method</th>
<th>600</th>
<th>The method to control the sample pulses, either flow- or time-proportional.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Flow (fixed value)</td>
<td>2: Flow (estimated volume)</td>
<td></td>
</tr>
</tbody>
</table>

  - Flow proportional method based on setting **Volume between grabs fixed value**. Gives a sample pulse each time this volume has been metered.

  - Flow proportional method where the required volume between grabs is calculated from the setting **Expected total volume**, the **can volume** and the **Grab size**. The can will be full to the target level when the estimated volume has been metered.

  - Time (fixed value)

    - Time proportional method based on setting **Time between grabs fixed value**. Gives a sample pulse each time this time has passed.

  - Time (estimated end time)

    - Time proportional method with the time between grabs calculated from setting **Expected end time for sampling**, the **can volume** and the **Grab size**. The can will be full to the target level at the expected end time.

  - Time (period)

    - Time proportional method with the time between grabs calculated from setting **Can fill period [hours]**, the **can volume** and the **Grab size**. The can will be full to the target level when the can fill period has passed.

**Grab size**

| Grab size | 600 | Volume of a sampler grab [cc]. |

**Can size**

<table>
<thead>
<tr>
<th>Can volume</th>
<th>600</th>
<th>Can storage capacity [cc]. This is the volume which corresponds to '100% full'.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can target fill percentage</td>
<td>600</td>
<td>The target level [%] to fill the can. Used to switch over to the other can if <strong>Auto-switch on can full</strong> and the can is empty. In all other cases a 'Sampler can &lt;x&gt; @ target level' alarm is raised, but sampling remains active until the <strong>can maximum fill percentage</strong> is reached.</td>
</tr>
<tr>
<td>Can maximum fill percentage</td>
<td>600</td>
<td>The maximum fill level [%] of the can. If this level is reached, a 'Sampler can &lt;x&gt; at maximum level' alarm is raised and sampling is stopped.</td>
</tr>
</tbody>
</table>

- **Can fill level indication method**

<table>
<thead>
<tr>
<th>600</th>
<th>The method to read or estimate the <strong>can fill level</strong>.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Number of grabs</td>
<td>The sampler provides no fill level indication. The flow computer accumulates the number of grabs and uses this to estimate the can fill level.</td>
</tr>
<tr>
<td>3: Analog input</td>
<td>The sampler provides an analog input that indicates the can fill level (0-100%).</td>
</tr>
<tr>
<td>8: Run 1 to the target level when the can fill period has passed.</td>
<td></td>
</tr>
</tbody>
</table>

**Sample options**

<table>
<thead>
<tr>
<th>Auto-switch can on can full</th>
<th>600</th>
<th>Only applicable to twin can samplers. Not available if <strong>Sampling method</strong> is 'Time (estimated end time)'</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
<td></td>
</tr>
</tbody>
</table>

  - When the target fill level is reached, sampling goes on until the maximum fill level is reached and then stops.

<table>
<thead>
<tr>
<th>Alarm settings</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Can at target level alarms</th>
<th>600</th>
<th>Enables or disables the can at target level alarms. If disabled, the target level is still used in the logic to switch to the other can (if applicable), but no alarm will be activated or logged.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Can at maximum level alarms</th>
<th>600</th>
<th>Enables or disables the can full alarms. If disabled, the can full status is still used in the logic to stop sampling, but no alarm will be activated or logged.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td>1: Enabled</td>
<td></td>
</tr>
</tbody>
</table>

| Sample pulse alarms | 600 | Enables or disables both the 'sampler overspeeding' alarm (indicating that more pulses are sent to the sampler than the sampler can handle) and the 'sample
grabs lost’ alarm (indicating that the pulse output reservoir is overflowing).

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: Enabled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pulse output settings**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample pulse output module</td>
<td>600</td>
<td>Module to which the sample strobe is physically connected.</td>
</tr>
<tr>
<td>Sample pulse output number</td>
<td>600</td>
<td>Pulse output number on the specified module that is used for the sample strobe.</td>
</tr>
<tr>
<td></td>
<td>1:</td>
<td>Pulse output 1</td>
</tr>
<tr>
<td></td>
<td>2:</td>
<td>Pulse output 2</td>
</tr>
<tr>
<td></td>
<td>3:</td>
<td>Pulse output 3</td>
</tr>
<tr>
<td></td>
<td>4:</td>
<td>Pulse output 4</td>
</tr>
<tr>
<td>Sample pulse output duration</td>
<td>600</td>
<td>The duration of the sample pulses [s]</td>
</tr>
<tr>
<td>Minimum time between grabs</td>
<td>600</td>
<td>Minimum time [s] between grabs. Used to determine the maximum pulse output frequency. If more pulses are requested than the maximum frequency allows for, then pulses are accumulated in the pulse reservoir.</td>
</tr>
<tr>
<td>Max. number of outstanding samples</td>
<td>600</td>
<td>The maximum number of pulses to be buffered in the pulse reservoir. Additional pulses will be lost (raises the ‘Grabs lost’ alarm).</td>
</tr>
<tr>
<td>Sampler overspeed alarm limit</td>
<td>600</td>
<td>If the number of pulses accumulated in the pulse reservoir reaches this limit, then the ‘Sampler overspeeding’ alarm is raised.</td>
</tr>
</tbody>
</table>

**Can settings**

These settings are applicable for both cans if Can fill level indication method is set to ‘analog input’ or if the Can full indication method is set to ‘digital input’ or ‘analog input’.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can fill indication module</td>
<td>600</td>
<td>The module to which the can fill level / can full indication signal is physically connected</td>
</tr>
<tr>
<td>Can fill indication channel</td>
<td>600</td>
<td>The channel number of the can fill level / can full indication signal. In case of a digital input this is the digital channel number (1-16). In case of an analog input this is the analog input channel (1-6).</td>
</tr>
</tbody>
</table>

**Can selection**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can selection digital output</td>
<td>600</td>
<td>Enables or disables a digital output for can selection.</td>
</tr>
<tr>
<td>Can selection digital output module</td>
<td>600</td>
<td>The module to which the can selection output is physically connected</td>
</tr>
<tr>
<td>Can selection digital output channel</td>
<td>600</td>
<td>The channel number on the selected module to which the can selection output is physically connected (1..16)</td>
</tr>
</tbody>
</table>
Proving

The Flow-X supports master meter proving.

The proving configuration displays are only available for the following FC types:
- Proving / run
- Station / proving / run
- Station / proving
- Proving only

Master meter proving

The Flow-X supports master meter proving, in which the readings of two meters that are set in serial configuration (the meter on prove and the master meter) are compared in order to calculate a correction factor (Meter Factor) for the meter on prove.

In the Flow-X the meter on prove and the master meter are regarded as two meters that are part of a station. Each meter is connected to its own module. The prove logic and calculations are running on the panel module (in case of a Flow-X/P), or by one of the run modules (meter on prove or master meter; FC type: ‘proving / run’), or by a third module (dedicated prove module of type ‘proving only’).

The proving flow computer can contain one or more local runs and / or one or more remote runs. It communicates to its remote run flow computers through Modbus to gather the process data that’s needed to do the proving calculations, to give the commands to start / stop the prove and to write the prove results.

In order to be able to communicate to the remote run flow computer(s), the proving flow computer must have a ‘Connect to remote run’ Modbus driver configured for every individual remote run flow computer (in Flow-Xpress ‘Ports and Devices’).

On the remote run flow computer(s) the ‘Connect to remote station’ Modbus driver has to be enabled (in Flow-Xpress ‘Ports and Devices’).

Additional station functionality (like station totals or a station gas chromatograph) may be enabled on the prover flow computer (FC types: ‘station / proving’ or ‘station / proving / run’).

Master meter proving based on totalizers

Master meter proving can be based on pulses or on totalizers. In case of master meter proving based on totalizers, communication between the modules is entirely by Modbus and no separate connections have to be made to pass through the meter pulses or to send a prove start / stop command.

Master meter proving based on pulses

In case of master meter proving based on pulses, a prove start command is used to start / stop pulse counting on the master meter module and meter module. On a multi-stream flow computer (X/P) the output has to be connected to a digital input on the module of each meter that can be proved and on the master meter module. This command ensures that the meter module and master meter module get the command to start / stop counting at exactly the same time. The command output digital channel has to be configured as ‘Digital output’, the inputs as ‘Prove (common) detector’ (display: IO, module <x>, Configuration, Digital IO assignment).

Additional station functionality (like station totals or a station gas chromatograph) may be enabled on the prover flow computer (FC types: ‘station / proving’ or ‘station / proving / run’).

X/P

Master meter totals

Figure 4: Master meter proving based on totalizers on a multi-stream flow computer (left) and a proving flow computer with remote runs (right).

Master meter proving based on pulses

In case of master meter proving based on pulses, a prove start command is used to start / stop pulse counting on the master meter module and meter module. On a multi-stream flow computer (X/P) the output has to be connected to a digital input on the module of each meter that can be proved and on the master meter module. This command ensures that the meter module and master meter module get the command to start / stop counting at exactly the same time. The command output digital channel has to be configured as ‘Digital output’, the inputs as ‘Prove (common) detector’ (display: IO, module <x>, Configuration, Digital IO assignment).

Figure 5: Master meter proving based on pulses on a multi-stream flow computer.
In case of **master meter proving based on pulses** with **single stream flow computers** using the ‘remote run’ functionality, the start / stop command output has to be connected to a digital input on the master meter flow computer only. In this case the master meter flow computer reads both the meter pulses and the master meter pulses. The command output digital channel has to be configured as ‘Digital output’, the input as ‘Prove common detector’ (display: IO, module <x>, Configuration, Digital IO assignment).

The figure below shows the connections for a combined ‘proving / run’ flow computer that holds the master meter (left; the master meter is a local run and the meter on prove is a remote run) and for a dedicated ‘proving only’ flow computer that holds no meter (right; both the master meter and the meter on prove are remote runs):

**Remote**

Master meter pulses

**Remote**

Master meter pulses

**Dedicated prover FC**

These settings are available if the **Prover type** is set to ‘Master meter proving’.

<table>
<thead>
<tr>
<th>Master meter proving type</th>
<th>Master meter number</th>
<th>Master meter proving type</th>
<th>Master meter proving type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>500</td>
<td></td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dedicated prover FC

**Prove size**

<table>
<thead>
<tr>
<th>Prove size</th>
<th>Prove size type</th>
<th>Master meter prove size type</th>
<th>Volume / mass per prove run</th>
<th>Master meter prove size type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td></td>
<td>1000</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Prove volume / mass</td>
<td>2: Volume / mass per prove run</td>
<td>2: Volume / mass per prove run</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the meter on prove is a volumetric meter, the prove size is specified as volume [m3]. If the meter on prove is a mass meter, the prove size is specified as mass [tonne].</td>
<td>Only applicable if Master meter prove size type is set to Prove volume / mass.</td>
<td>Only applicable if Master meter prove size type is set to Prove volume / mass.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2: Prove time</td>
<td>Time per prove run</td>
<td>Time per prove run</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The prove size is specified as time [min].</td>
<td>Only applicable if Master meter prove size type is set to Prove time.</td>
<td>Only applicable if Master meter prove size type is set to Prove time.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prove start command output**

If the master meter flow computer is a multi module flow computer (X/P), the following settings are used to specify by which module the pulses are read.

<table>
<thead>
<tr>
<th>Prove start command output</th>
<th>Prove start command output</th>
<th>Prove start command output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DO module</td>
<td>DO Channel</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Only applicable if Master meter proving type is set to Pulses.</td>
<td>Only applicable if Master meter proving type is set to Pulses.</td>
</tr>
</tbody>
</table>

**Remote meter pulses**

If the **Master meter proving type** is set to ‘Pulses’ and the meter on prove is on a remote module, the meter pulses have to be passed through from the meter module to the flow computer that runs the master meter prove logic. For that purpose on the meter module a digital channel has to be configured as ‘Prover
bus pulse out A’ and a second digital channel has to be configured as ‘Prover bus pulse out B’. This output duplicates the meter pulses.

### Operational settings

> Display → Configuration, Proving, Operational

The following settings are available for all types of proving (ball prover, compact prover, small volume prover, master meter proving).

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum nr of runs</td>
<td>500</td>
<td>The maximum number of prove runs allowed to achieve sufficient consecutive runs within the repeatability limit. If it is not possible to achieve sufficient consecutive runs within the remaining prove runs, the prove sequence may be aborted before the maximum nr. of runs is reached.</td>
</tr>
<tr>
<td>Passes per run</td>
<td>500</td>
<td>Only applicable to Brooks compact provers and Calibron / Flow MD small volume provers. Not applicable to master meter proving. The number of passes per run.</td>
</tr>
<tr>
<td>Required successful runs</td>
<td>500</td>
<td>Required number of consecutive runs within the repeatability limit before the prove sequence is completed successfully.</td>
</tr>
<tr>
<td>Double chronometry</td>
<td>500</td>
<td>Determines whether or not double-chronometry method of pulse interpolation is applied in accordance with API MPMS 4.6.</td>
</tr>
<tr>
<td>Repeatability mode</td>
<td>500</td>
<td>The method to check whether sufficient consecutive runs are within the required repeatability limit.</td>
</tr>
<tr>
<td>Run repeatability test method</td>
<td>500</td>
<td>Determines whether the repeatability calculation is based on pulse count or on the meter factor. Achieving repeatability based on meter factor might be more difficult to achieve, because the meter factor not only depends on the pulse count but also on the temperature, pressure, density etc.</td>
</tr>
<tr>
<td>Implement meter factor</td>
<td>500</td>
<td>Determines whether or not a new meter factor is implemented automatically at the end of a successful prove sequence, provided that the repeatability criteria are met and the meter factor tests have passed.</td>
</tr>
<tr>
<td>MF manual accept timeout</td>
<td>500</td>
<td>The maximum allowable time [s] to manually accept a new meter factor after the prove sequence has ended successfully, provided that the repeatability criteria are met and the meter factor tests have passed. If the operator does not accept the new meter factor within this time limit, then the new meter factor is rejected automatically.</td>
</tr>
<tr>
<td>Prove permissive</td>
<td></td>
<td>A prove can only be started if the prove permissive is ON. Furthermore, a prove is aborted if the permissive switches to OFF while the prove sequence is active. The prove permissive is ON if the following conditions are met:</td>
</tr>
<tr>
<td>Use proving permissive custom condition</td>
<td>1000</td>
<td>Determines whether or not the prove permissive custom condition is taken into account. If set to 'Yes' the prove permissive custom condition (to be written through Modbus or by a 'custom calculation') must be ON, otherwise the sequence can't be started or is aborted.</td>
</tr>
</tbody>
</table>
Prove integrity

A prove is aborted if the prove integrity switches to OFF while a prove is active.

The prove integrity is ON if the following condition is met:
- Custom prove integrity condition (optional)

Use prove integrity custom condition 1000 Determines whether or not the prove integrity custom condition is taken into account. If set to 'Yes' the prove integrity custom condition (to be written through Modbus or by a 'custom calculation') must be ON while proving, otherwise proving is aborted.
0: No
1: Yes

Stability check

Display → Configuration, Proving, Stability check

Initial stability check 1000 Determines whether or not the initial stability check is performed. If enabled, the prove sequence only starts if the initial stability check has passed successfully.

During the initial stability check the following process values are monitored:
- Prover inlet temperature
- Prover outlet temperature
- Meter temperature
- Prover inlet pressure
- Prover outlet pressure
- Meter pressure
- Flow rate

In case of master meter proving the following process values are monitored:
- Master meter temperature
- Master meter pressure
- Master meter pressure
- Flow rate

The initial stability check passes as soon as all the process values do not change more than their corresponding limit during the required stabilization sample time (default 5 seconds).

If the stability check has not passed during the max. stabilization time (default 30 sec.), then the prove sequence is aborted.

Prove sequence stability check 1000 Determines whether or not the deviation between:
Prover temperature (average) and meter temperature
Prover pressure (average) and meter pressure

Or in case of master meter proving:
Master meter temperature and meter temperature
Master meter pressure and meter pressure

is checked during proving.

The check is only performed when the sphere / piston is between the detectors (i.e. in the calibrated volume).

Max. stabilization time 1000 The maximum time [s] allowed for the initial stability check (default 30 seconds). If the stability check has not passed within this time, the prove sequence is aborted.

Stabilization 1000 The sample time [s] for the initial stability check. The

Sample time 1000 Initial stability check passes as soon as the process values do not change more than their corresponding limit during this time.

Temperature change limit 1000 The maximum allowable temperature fluctuation [°C] during the initial stability check
Pressure change limit 1000 The maximum allowable pressure fluctuation [bar] during the initial stability check
Flow rate change limit 1000 The maximum allowable relative flow rate fluctuation [%] during the initial stability check
Max. temperature deviation prover/meter 1000 The maximum allowable temperature deviation [°C] between the meter temperature and the prover temperature (average of inlet and outlet) c.q. master meter temperature
Max. pressure deviation prover/meter 1000 The maximum allowable deviation [bar] between the meter pressure and the prover pressure (average of inlet and outlet) c.q. master meter pressure

Meter factor tests

After completion of the last prove run, a number of tests is performed on the newly proved meter factor. The new factor is rejected automatically if one or more of these tests fail.

Display → Configuration, Proving, Meter factor tests

Meter factor limit test

<table>
<thead>
<tr>
<th>Meter factor limit test</th>
<th>500</th>
<th>Enables or disables the 'Meter factor limit test'.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td></td>
<td>The new meter factor is rejected if it is higher than the Meter factor high limit or lower than the Meter factor low limit, provided that the Meter factor limit test is enabled.</td>
</tr>
<tr>
<td>1: Enabled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Meter factor high limit</th>
<th>500</th>
<th>High limit [] for the meter factor limit test</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Meter factor low limit</th>
<th>500</th>
<th>Low limit [] for the meter factor limit test</th>
</tr>
</thead>
</table>

Previous meter factor test

<table>
<thead>
<tr>
<th>Previous MF test</th>
<th>500</th>
<th>Enables or disables the 'Previous meter factor test'.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td></td>
<td>The new meter factor is rejected if the deviation from the meter’s previous proved meter factor exceeds the Previous MF deviation limit, provided that the Previous MF test is enabled.</td>
</tr>
<tr>
<td>1: Enabled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Previous MF deviation limit</th>
<th>500</th>
<th>Deviation limit [%] for the previous MF test</th>
</tr>
</thead>
</table>

Historical meter factor test

<table>
<thead>
<tr>
<th>Historical avg MF test</th>
<th>500</th>
<th>Enables or disables the 'Historical average meter factor test'.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0: Disabled</td>
<td></td>
<td>The application keeps track of the last 10 proved meter factors for each flow meter. The new meter factor is rejected if the deviation from the average of the last Nr of historical MF meter factors exceeds the Historical avg MF deviation limit, provided that the Historical average MF test is enabled.</td>
</tr>
<tr>
<td>1: Enabled</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Historical avg MF deviation limit</th>
<th>500</th>
<th>Deviation limit [%] for the historical average MF test</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Nr of historical MF avg</th>
<th>500</th>
<th>Number of historical meter factors (1-10) to be used for the historical average MF test</th>
</tr>
</thead>
</table>
**Base curve meter factor test**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base curve MF test</td>
<td>500</td>
<td>This test is only applicable if meter factor curve interpolation is enabled for the meter on prove. The 'Base curve MF test' checks if the deviation between the proved meter factor and the 'meter factor determined from the meter factor curve at the proved flow rate' is not larger than the 'Base curve MF deviation limit'. The meter factor is rejected if the test fails.</td>
</tr>
<tr>
<td>Base curve MF deviation limit</td>
<td>500</td>
<td>Deviation limit [%] for the base curve MF test</td>
</tr>
</tbody>
</table>

**Prove report**

The 'Prove report' display contains the settings that define the number of decimal places for the meter factor and the intermediate correction factors. The display also contains settings that determine if the API truncating and rounding rules are applied for the calculation.

**Decimal resolution**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter factor decimal places proving</td>
<td>1000</td>
<td>Number of decimal places to which the (final) meter factor is rounded</td>
</tr>
<tr>
<td>Volume / mass total decimal places proving</td>
<td>1000</td>
<td>Number of decimal places to which the metered and proved volumes / masses are rounded.</td>
</tr>
<tr>
<td>CCF (CTPL) decimal places proving</td>
<td>1000</td>
<td>Number of decimal places to which the combined correction factors for the prover (CCFp) and the meter (CCFm) are rounded.</td>
</tr>
</tbody>
</table>

**Meter runs**

This display page gives an overview of the meter runs that are involved in proving.

**System time deviation**

These settings are only applicable if the flow computer is communicating to one or more remote run flow computers.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote run max. system time deviation</td>
<td>1000</td>
<td>If the system time of a remote run module differs from the system time of the station module by more than this amount [s], then a 'System time out of sync alarm' is generated.</td>
</tr>
</tbody>
</table>
Metrological settings

The Flow-X features accountable and non-accountable totalizers, in order to split the metered amount into an accountable amount (measured while there was no accountable alarm) and a non-accountable amount (measured while there was an accountable alarm).

This functionality is enabled by the setting MID compliance on the display: Configuration, Overall setup, Common settings.

If there is no accountable alarm then the accountable totalizers are active and the non-accountable totalizers are inactive. In case of an accountable alarm the non-accountable totalizers are active and the accountable totalizers are inactive. The normal totalizers are active regardless of the accountable alarm.

Display → Configuration, Metrological, Run <x>
with <x> the module number of the meter run

This display is only visible if MID compliance (Configuration, Overall setup, Common settings) is enabled.

### Flow rate

<table>
<thead>
<tr>
<th>Setting</th>
<th>Setting value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter minimum accountable flow rate</td>
<td>1000</td>
<td>Low range value (minimum allowable flow rate) of the flow rate. Unit [m³/hr] in case of a volume flow meter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the flow rate is below this value then the 'Flow range accountable alarm' is raised.</td>
</tr>
<tr>
<td>Meter maximum accountable flow rate</td>
<td>1000</td>
<td>High range value (maximum allowable flow rate) of the flow meter. Unit [m³/hr] in case of a volume flow meter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the flow rate is above this value then the 'Flow range accountable alarm' is raised.</td>
</tr>
</tbody>
</table>

### Temperature

<table>
<thead>
<tr>
<th>Setting</th>
<th>Setting value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum accountable temperature</td>
<td>1000</td>
<td>Minimum allowable temperature [°C]. If the temperature is below this value then the 'Temperature accountable alarm' is raised.</td>
</tr>
<tr>
<td>Maximum accountable temperature</td>
<td>1000</td>
<td>Maximum allowable temperature [°C]. If the temperature is above this value then the 'Temperature accountable alarm' is raised.</td>
</tr>
</tbody>
</table>

### Pressure

<table>
<thead>
<tr>
<th>Setting</th>
<th>Setting value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum accountable pressure</td>
<td>1000</td>
<td>Minimum allowable pressure [bar(a)]. If the pressure is below this value then the 'Pressure accountable alarm' is raised.</td>
</tr>
<tr>
<td>Maximum accountable pressure</td>
<td>1000</td>
<td>Maximum allowable pressure [bar(a)]. If the pressure is above this value then the 'Pressure accountable alarm' is raised.</td>
</tr>
</tbody>
</table>
5 Maintenance mode

Maintenance mode is a special mode of operation intended for testing the flow computer functionality, typically its calculations. Maintenance mode can be enabled and disabled for each meter run separately.

Maintenance mode is the same as normal operation mode except that in Maintenance Mode all the custody transfer totals are inhibited. Instead flow is accumulated in separate Maintenance totals. Optionally the maintenance totals automatically reset each time maintenance mode is enabled (setting Reset maint. totals on entering maint. mode on display: Configuration, Common settings).

A permissive flag is used to enter and exit maintenance mode. By default the flag is always 1, i.e. it is always permitted to enter/exit maintenance mode. However the permissive flag may be controlled by custom-made logic through ‘User Calculations’ in Flow-Xpress, e.g. to inhibit entering/exiting maintenance mode if the meter is active.

Optionally, process alarms and calculation alarms are disabled, when in maintenance mode (setting Disable alarms in maintenance mode on display: Configuration, Common settings).

Maintenance mode should be disabled for normal operation.

A ‘Maintenance mode enabled’ alarm is generated when the meter is in maintenance mode.

Display →Maintenance mode, Run <x>
with <x> the number of the flow module that controls the flow meter

<table>
<thead>
<tr>
<th>Enable maint mode</th>
<th>1000</th>
<th>Enter maintenance mode. Only allowed if Maint mode switch permissive is ON.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable maint mode</td>
<td>1000</td>
<td>Exit maintenance mode. Only allowed if Maint mode switch permissive is ON.</td>
</tr>
</tbody>
</table>
6 Calculations

This chapter specifies the main calculations performed by the Gas Metric application. The different parameters are accessible through the display menu.

Calculations in compliance with a measurement standard, such as ISO5167 and AGA-8, are not specified in this manual. Please refer to the standards for more details on these calculations.

Densitometer Calculations

The flow computer supports the following type of densitometers:
- Solartron
- Sarasota
- UGC

Solartron Densitometers

The flow computer provides the option to calculate the density from a frequency input signal provided by a Solartron 7810, 7811 or 7812 gas densitometer and to correct it for temperature and velocity of sound effects.

The calculations are in accordance with the following vendor documentation:

\[
\rho_i = K_0 + K_1 \cdot \tau + K_2 \cdot \tau^2
\]

Equation 6-1: Uncorrected density (Solartron)

\[
\rho_p = \rho_i \times \left[ 1 + \left( K_{20} \times P_f \right) \right] \times \left( K_{21} \times P_f \right)
\]

\[
K_{20} = K_{20A} + \left( K_{20B} \times P_f \right)
\]

\[
K_{21} = K_{21A} + \left( K_{21B} \times P_f \right)
\]

Equation 6-3: Density corrected for Pressure (Solartron)

\[
\rho_{VOS} = \rho_i \left[ 1 + \frac{K_3}{(\rho_i + K_4)} \cdot \left( \frac{G}{T + 273} \right) \right]
\]

\[
K_c = \frac{Cc}{T_c + 273}
\]

Equation 6-4: Density corrected for velocity of sound (Solartron)

Sarasota Densitometers

\[
\rho_c = d_0 \cdot \tau \cdot T_{C} \cdot \left( 2 + K \cdot \tau - \tau_{C} \right)
\]

\[
\tau_{C} = \tau_0 + T_{COEF} \cdot (T - T_{R}) + p_{COEF} \cdot (p - p_{R})
\]

Equation 6-5: Corrected density (Sarasota)
UGC densitometers

\[ \rho_i = K_0 + K_1 \tau + K_2 \tau^2 \]

Equation 6-6: Uncorrected density (UGC)

\[ \rho_c = \rho_i + \left[ (K_{p3} + K_{p5} \cdot \rho_i + K_{p7} \cdot \rho_i^2) \right] (P - P_0) + \left[ (K_{T1} + K_{T3} \cdot \rho_i + K_{T5} \cdot \rho_i^2) \right] (T - T_0) \]

Equation 6-7: Corrected density (UGC)

Specific gravity transducer

\[ SG = K_0 + K_2 \cdot \tau^2 \]

Equation 6-8: Specific gravity (Specific gravity transducer)

Density calculations

The density value depends on the type of fluid and the temperature and pressure conditions. The following density related properties are distinguished within the application:

- Observed density
  Density at the corresponding density input conditions
- Meter density
  Density at the flow meter conditions
- Base density
  Density at the reference conditions
- Specific gravity
  Ratio between the molar mass of the fluid and that of air
- Relative density
  Ratio between the base density of the fluid and that of air

Note: although the terms specific gravity and relative density are often used for the same properties, this context uses the ideal value for the term 'specific gravity' and the real value) for the term 'relative density'.

The actual calculations that are used to calculate these properties depend on the way the observed density is measured as defined through parameters ‘Observed density input type’, ‘Base density input type’ and ‘Meter density input type’. Refer to section ‘Configuration’, ‘Density’ for more information on these parameters.

Base density calculation

One of the following calculations applies depending on the base density input type:

\[ \rho_B = \frac{MM \times P_B}{T_R \times Z_B \times R / 100} \]

Equation 6-9: Base density calculation (based on molar mass)

\[ \rho_B = \rho_i \times \frac{P_B \times T_D \times Z_D}{P_D \times T_R \times Z_B} \]

Equation 6-10: Base density calculation (based on observed density)

\[ \rho_B = \frac{SG \times MM_{air} \times P_B}{T_R \times Z_B \times R / 100} \]

Equation 6-11: Base density calculation (based on specific gravity)

\[ \rho_B = RD \times \rho_{air} \]

Equation 6-12: Base density calculation (based on relative density)
**Meter density calculation**

One of the following calculations applies depending on the meter density input type:

\[ \rho = \rho_B \times \frac{P \times T_R \times Z_B}{P_R \times T \times Z} \]

Equation 6-13: Meter density calculation (based on base density)

- \( \rho \): Density at the (upstream) flow meter conditions, kg/m³
- \( \rho_B \): Base density, kg/sm³
- \( P \): Pressure at the flow meter, bar(a)
- \( T \): Temperature at the flow meter, K
- \( Z \): Compressibility at the (upstream) flow meter conditions
- \( P_R \): Reference pressure (parameter), bar(a)
- \( T_R \): Reference temperature (parameter), K
- \( Z_B \): Base compressibility (i.e. at reference conditions)

**Specific gravity calculation**

One of the following calculations applies depending on the specific gravity input type.

\[ SG = \frac{MM}{MM_{air}} \]

Equation 6-15: Specific gravity calculation (based on molar mass)

- \( SG \): Specific gravity
- \( MM \): Molar mass, kg/kmol
- \( MM_{air} \): Molar mass of air (parameter), kg/kmol

\[ SG = \frac{\rho_B \times T_R \times Z_B \times R/100}{P_R \times MM_{air}} \]

Equation 6-16: Specific gravity calculation (based on base density)

**Relative density calculation**

\[ RD = \frac{\rho_B}{\rho_{air}} \]

Equation 6-17: Relative density calculation

- \( RD \): Relative density
- \( \rho_B \): Base density (i.e. at reference conditions), kg/sm³
- \( \rho_{air} \): Base density of air (parameter), kg/kmol

**Flow rates for volumetric flow meters**

The following equations apply for any flow meter that provides a volumetric quantity as a pulse signal or as a smart signal (Modbus, HART or analog input)

It typically applies for the following type of meters:
- Turbine flow meter
- Positive displacement (PD) flow meter
- Ultrasonic flow meter

**Indicated flow rate**

For a flow meter that provides a pulse signal the meter K-factor is applied to obtain the indicated flow rate from the pulse frequency.

\[ Q_{iv} = \frac{f}{MKF} \times 3600 \]

Equation 6-18: Indicated volume flow rate

- \( Q_{iv} \): Indicated (volume) flow rate [m³/hr]
- \( MKF \): Meter K-factor [pulses/m³]
- \( f \): Pulse frequency [Hz]

For smart flow meters the indicated volume flow rate is obtained directly from the flow meter.

**Gross volume flow rate**

The gross volume flow rate (also called corrected flow rate) is derived from the indicated flow rate (or uncorrected flow rate) as following:

\[ Q_{gv} = Q_{iv} \times MF \times MBF \]

Equation 6-19: Gross volume flow rate (volumetric flow meters)

- \( Q_{gv} \): Gross volume flow rate [m³/hr]
- \( Q_{iv} \): Indicated volume flow rate [m³/hr]
- \( MBF \): Meter body correction factor [-]
- \( MF \): Meter factor [-]
The meter factor is calculated from the meter error by this formula:

\[
MF = \frac{100}{100 + ME}
\]

Equation 6-20: Meter factor from Meter error

However, when parameter 'MID compliance' is enabled, no correction is applied when either the pulse frequency is below 10 Hz or the volume flow rate is below parameter 'Qmin' (in accordance with the EN-12405 standard part of MID).

\[
Q_{GV} = Q_{M}
\]

Equation 6-21: Mass flow rate (volumetric flow meters)

\[
Q_M = Q_{GV} \times \rho
\]

Equation 6-22: Indicated mass flow rate (mass flow meters)

\[
Q_{BV} = Q_M \times \rho
\]

Equation 6-23: Mass flow rate (mass flow meters with pulse signal)

\[
Q_{GV} = Q_{M} / \rho
\]

Equation 6-24: Gross volume flow rate (mass flow meters)

\[
Q_{BV} = Q_{GV} / \rho_B
\]

Equation 6-25: Base volume flow rate (volumetric flow meters)

\[
Q_E = Q_{BV} \times HV / 1000
\]

Equation 6-26: Energy flow rate

\[
MBF = 1 + \varepsilon_T \times (T - T_R) + \varepsilon_p (P - P_R)
\]

Equation 6-28: Meter body correction factor

**Flow rates for mass flow meters**

The following equations apply for any flow meter that provides a mass quantity as a pulse signal or as a smart signal (communications, HART or analog input). It typically applies for Coriolis flow meters.

**Indicated flow rate**

If the flow meter provides a pulse signal, then the meter K-factor is applied to obtain the indicated mass flow rate from the pulse frequency.

\[
Q_{IM} = f / MKF \times 3600
\]

Equation 6-22: Indicated mass flow rate (mass flow meters)

For smart flow meters the indicated mass flow rate is obtained directly from the flow meter.

**Mass flow rate**

The mass flow rate (corrected flow rate) is derived from the indicated mass flow rate (uncorrected flow rate) using this formula:

\[
Q_M = Q_{IM} \times MF \times MBF
\]

Equation 6-23: Mass flow rate (mass flow meters with pulse signal)
Cubical expansion coefficient = Linear expansion coefficient x 3.

**Flow rate for differential pressure flow devices**


**Mass flow rate (ISO-5167)**

\[
q_M = \frac{C}{\sqrt{1 - \beta^4}} \times \frac{\pi}{4} \times d^2 \times \sqrt{2 \times \Delta P \times \rho_1}
\]

Equation 6-29: ISO-5167 mass flow rate

- \(q_m\): Mass flow rate [kg/sec]
- \(C\): Coefficient of Discharge [-]
- \(\epsilon\): Fluid expansion factor [-]
- \(\pi\): 3.14159
- \(d\): Orifice diameter at line temperature [m]
- \(\rho_1\): Flowing density at line conditions [kg/m3]
- \(\Delta P\): Differential pressure [Pa]

\[
Q_M = \frac{q_m \times 3600}{1000}
\]

Equation 6-30: Mass flow rate in practical working units (orifice plate)

**Device and pipe diameter (Corrected) at operating temperature**

\[
d = d_r \left[1 + \alpha_1(T_L - T_R)\right]
\]

Equation 6-31: Orifice Diameter correction

\[
D = D_r \left[1 + \alpha_1(T_L - T_R)\right]
\]

Equation 6-32: Pipe Diameter correction

**Diameter (Beta) Ratio**

\[
\beta = \frac{d}{D}
\]

Equation 6-33: Beta ratio calculation

**Reynolds Number**

\[
R_D = \frac{4 \times q_m}{\pi \times \mu \times D}
\]

Equation 6-34: Reynolds Number based on Pipe diameter

- \(R_D\): Reynolds Number [-]
- \(q_m\): Mass flow rate [kg/sec]
- \(\mu\): Fluid dynamic viscosity [Pa·sec]
- \(D\): Pipe diameter [m]

**Velocity of Approach (E_v)**

\[
E_v = \frac{1}{\sqrt{1 - \beta^4}}
\]

Equation 6-35: ISO-5167 Velocity of Approach calculation

**Fluid Expansion Factor \(\epsilon\)**

AGA-5167 defines the following equation for the Fluid Expansion Factor for orifices:

\[
\epsilon = 1 - \left(0.41 + 0.35 \times \beta^4\right) \times \frac{X_1}{\kappa}
\]

Equation 6-36: ISO-5167 Reynolds Expansion Factor (Gas)

- \(\epsilon\): Expansion Factor [-]
- \(\beta\): Beta ratio [-]
- \(X_1\): Ratio of differential pressure to absolute static pressure at the upstream tap [-]
- \(\kappa\): Isentropic exponent [-]

**Down- to upstream corrections**

The calculation of the mass flow rate from a differential pressure flow device (orifice, venturi and V-cone) requires the temperature, pressure and density values upstream of the flow device. For a variable that is measured downstream of the flow meter, a downstream to upstream correction is required.

Two downstream measurement locations are supported, namely at the downstream tap and at the location where the pressure has fully recovered from the pressure drop over the flow device.

**Pressure correction**

In most cases the static pressure is taken from the upstream tap, so no correction is required. When the pressure is measured downstream of the flow device then the following corrections are taken.

<table>
<thead>
<tr>
<th>MBF</th>
<th>Meter body correction factor [-]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\epsilon_r)</td>
<td>Cubical temperature expansion coefficient [m3/m3/°C]</td>
</tr>
<tr>
<td>(T)</td>
<td>Fluid temperature at the flow meter [°C]</td>
</tr>
<tr>
<td>(T_R)</td>
<td>Reference temperature for the expansion [°C]</td>
</tr>
<tr>
<td>(\epsilon_p)</td>
<td>Cubical pressure expansion coefficient [m3/m3/bar]</td>
</tr>
<tr>
<td>(P)</td>
<td>Fluid pressure at the flow meter [bar(a)]</td>
</tr>
<tr>
<td>(P_R)</td>
<td>Reference pressure for the expansion [bar(a)]</td>
</tr>
</tbody>
</table>
• The relation between the pressure at the upstream tapping \( p_1 \) and the pressure at the downstream tapping (\( p_2 \)) is as follows:

\[
P_1 = P_2 + \Delta P / 1000
\]

• The relation between the pressure at the upstream tapping and the fully recovered downstream tapping is as follows:

\[
P_1 = P_3 + P_{LOSS}
\]

The calculation of \( P_{LOSS} \) is as defined in the ISO-5167 standard.

| \( p_1 \) | Pressure at upstream tapping [bar(a)] |
| \( p_2 \) | Pressure at downstream tapping [bar(a)] |
| \( p_3 \) | Fully recovered downstream pressure [bar(a)] |
| \( \Delta P \) | Differential pressure [mbar] |
| \( P_{LOSS} \) | Pressure loss over the meter [bar] |

**Temperature correction**

The method used to correct the temperature from downstream to upstream conditions is user-definable. The following 3 methods are provided:

• **Method 1:** isentropic expansion based on the isentropic coefficient \( \kappa \).

\[
T_1 = \left( T_2 + 273.15 \right) \times \left( \frac{p_2}{p_1} \right)^{\frac{1}{\kappa}} - 273.15
\]

\[
T_2 = \left( T_3 + 273.15 \right) \times \left( \frac{p_3}{p_1} \right)^{\frac{1}{\kappa}} - 273.15
\]

• **Method 2:** isentropic expansion based on the separate user-definable parameter 'Temperature exponent' \( K_{TE} \):

\[
T_1 = \left( T_2 + 273.15 \right) \times \left( \frac{p_2}{p_1} \right)^{K_{TE}} - 273.15
\]

\[
T_2 = \left( T_3 + 273.15 \right) \times \left( \frac{p_3}{p_1} \right)^{K_{TE}} - 273.15
\]

• **Method 3:** isenthalpic expansion based on the linear Joule Thomson correction as defined in ISO5167-1:2003, taking parameter 'Temperature exponent' as the Joule Thomson coefficient \( \mu_{JT} \):

\[
T_1 = T_2 + \left( P_1 - P_2 \right) \cdot \mu_{JT}
\]

\[
T_2 = T_3 + \left( P_1 - P_3 \right) \cdot \mu_{JT}
\]

\[
T_3 \text{ Temperature at recovered pressure position } ^\circ C
\]

\[
T_1 \text{ Upstream temperature } ^\circ C
\]

\[
T_2 \text{ Downstream temperature } ^\circ C
\]

\[
\rho_{\text{liquid}} \text{ Manually entered liquid density } [kg/m^3]
\]

\[
\rho_{\text{gas}} \text{ Manually entered gas mass fraction, defined as gas mass / (gas mass + liquid mass) } [-]
\]

\[
\rho_{\text{lost}} \text{ Manually entered liquid mass/pressure loss } [kg/m^3]
\]

**Orifice correction for drain hole**

A drain hole may have been drilled into the bottom of the orifice plate to prevent condensate from interfering with measurement. The option is provided to define a drain hole diameter. When the drain hole diameter is larger than 0 then the following correction factor is applied on the orifice diameter according to the British standard 1042: Part 1: 1964.

\[
C_{DH} = 1 + 0.55 \times \left( \frac{d_{DH}}{d_0} \right)^2
\]

\[
C_{DH} \text{ Drain hole correction factor on orifice diameter } [-]
\]

\[
d_{DH} \text{ Drain hole diameter } [mm]
\]

\[
d_0 \text{ Orifice diameter at reference temperature } [mm]
\]

**Wet gas correction**

If differential pressure type flow meters are operated in the presence of free liquid, they will generally overestimate the dry gas flow rate. A number of algorithms have been used in order to account for the over-read. The correction algorithms by De Leeuw and Reader-Harris are supported. These operate in combination with a venturi dP meter.

Wet gas correction is either based on a manually entered gas mass fraction, or on a measured pressure loss between the upstream and recovered positions.

**Lockhart-Martineilli**

1.) In case of a manually entered gas mass fraction the Lockhart-Martineilli number is calculated by the following formula.

\[
X = \frac{1 - x_f}{x_f} \sqrt{\frac{\rho_{\text{gas}}}{\rho_{\text{liquid}}}}
\]

\[
X \text{ Lockhart-Martineilli nr. } [-]
\]

\[
x_f \text{ Manually entered gas mass fraction, defined as gas mass / (gas mass + liquid mass) } [-]
\]

\[
\rho_{\text{gas}} \text{ Upstream density } [kg/m^3]
\]

\[
\rho_{\text{liquid}} \text{ Manually entered liquid density } [kg/m^3]
\]
2.) In case of a measured pressure loss the following formulas are used.

The difference between the measured pressure loss ratio and the pressure loss ratio that is expected on dry gas is:

\[ Y = \xi - \xi_{\text{dry}} \]

- \( \xi \): Measured pressure loss ratio [-]
- \( \xi_{\text{dry}} \): Calculated pressure loss ratio for the dry gas [-]

The measured pressure loss ratio is calculated by:

\[ \xi = \frac{\Delta \omega}{\Delta p} \]

- \( \Delta \omega \): Measured pressure loss between upstream and recovered positions [mbar]
- \( \Delta p \): Measured differential pressure between upstream and downstream positions [mbar]

The calculated pressure loss ratio for the dry gas \( \xi_{\text{dry}} \) is derived by linear interpolation of a pressure loss ratio / Reynolds curve, or calculated by one of the following formulas:

- **Miller**
  \[ \xi_{\text{dry}} = A \beta^2 + B \beta + C \]

  - \( A, B, C \): Miller coefficients [-]
  - \( \beta \): Ratio of diameters [-]

- **ISO/DTR 11583**
  \[ \xi_{\text{dry}} = 0.0896 + 0.48 \beta^n \]

For a venturi with a divergent angle of 7° to 8° the limiting value of the difference in pressure loss is:

\[ Y_{\text{max}} = 0.61 \exp \left( -11 \frac{\rho_{\text{gas}}}{\rho_{\text{liquid}}} - 0.045 \frac{Fr_{\text{gas}}}{H} \right) \]

The Lockhart Martinelli number is calculated as follows:

\[ X = \left\{ \begin{array}{l} \sqrt[3]{-\ln \left( \frac{1 - \frac{Y}{Y_{\text{max}}}}{35 \exp \left( -0.28 \frac{Fr_{\text{gas}}}{H} \right)} \right)} \end{array} \right. \]

- \( Fr_{\text{gas}} \): Gas Froude nr. [-]

**Froude number**

\[ Fr_{\text{gas}} = \frac{4 q_{m,\text{gas}}}{\rho_{\text{gas}} \pi D^2 \sqrt{g D}} \sqrt{\frac{\rho_{\text{gas}}}{\rho_{\text{liquid}} - \rho_{\text{gas}}}} \]

**Density ratio exponent n**

De Leeuw:

\[ n = 0.606 \left( 1 - e^{-0.746 Fr_{\text{gas}}} \right) \quad \text{for} \quad Fr_{\text{gas}} \geq 1.5 \]

\[ n = 0.41 \quad \text{for} \quad 0.5 \leq Fr_{\text{gas}} \leq 1.5 \]

**Reader Harris**:

\[ n = \max \left( 0.583 - 0.18 \beta^2 - 0.578 e^{-0.8 Fr_{\text{gas}}/H}, 0.392 - 0.18 \beta^2 \right) \]

With:

\[ C_{Ch} = \left( \frac{\rho_{\text{liquid}}}{\rho_{\text{gas}}} \right)^n + \left( \frac{\rho_{\text{gas}}}{\rho_{\text{liquid}}} \right)^n \]

The corrected mass flow rate is calculated by the formula:

\[ q_{m,\text{gas}} = \frac{q_m}{\Phi} \]

**Discharge coefficient correction**

In case of wet gas correction according to Reader-Harris the discharge coefficient is corrected as follows:

\[ C = C_{\text{fully wet}} \]

\[ C = C_{\text{dry}} \left( C_{\text{dry}} - C_{\text{fully wet}} \right) \sqrt{\frac{X}{0.016}} \quad \text{for} \quad X < 0.016 \]

With:

\[ C_{\text{fully wet}} = 1 - 0.0463 e^{-0.05 Fr_{\text{gas}}} \]
\[ Fr_{gas,th} = \frac{Fr_{gas}}{\beta^{2.5}} \]

<table>
<thead>
<tr>
<th>C</th>
<th>Corrected discharge coefficient []</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C_{dry,wt} )</td>
<td>Fully wet discharge coefficient []</td>
</tr>
<tr>
<td>( C_{dry} )</td>
<td>Discharge coefficient for the dry gas []</td>
</tr>
<tr>
<td>( X )</td>
<td>Lockhart-Martinelli nr. []</td>
</tr>
<tr>
<td>( Fr_{gas} )</td>
<td>Froude nr. []</td>
</tr>
<tr>
<td>( Fr_{gas,th} )</td>
<td>Throat Froude nr. []</td>
</tr>
<tr>
<td>( \beta )</td>
<td>Ratio of diameters []</td>
</tr>
</tbody>
</table>

In case of wet gas correction according to De Leeuw, the discharge coefficient is not corrected:

\[ C = C_{dry} \]

**Gass mass fraction**

If the Lockhart-Martinelli number is calculated from the measured pressure loss, the gas mass fraction is calculated as follows:

\[ X_m = \frac{1}{1 + X \sqrt{\frac{\rho_{liquid}}{\rho_{1,gas}}}} \]

**Differential pressure cell selection**

When more than 1 differential pressure transmitters are applied on a differential pressure flow device, then one of the measurements will be used for the calculation of the mass flow rate. The flow computer provides several different selection methods meter runs using 2 or 3 differential pressure cells.

**2 cells, range type = ‘Lo Hi’**

When cell A is currently selected
- Select cell B when cell A value is above or equal to the switch-up percentage of its range and cell B is healthy.
- Select cell A when cell A fails while cell B is healthy

When cell B is currently selected
- Select cell A when cell A is healthy and ‘Auto switchback’ is enabled
- Select cell A when cell B fails and cell A is healthy

**2 cells, range type = ‘Hi Hi’**

When cell A is currently selected
- Select cell B when cell A value fails and cell B is healthy

When cell B is currently selected
- Select cell A when cell A is healthy and ‘Auto switchback’ is enabled
- Select cell A when cell B fails and cell A is healthy.

**3 cells, range type = ‘Lo Mid Hi’**

When cell A is currently selected
- Select cell B when cell A value is above or equal to the switch-up percentage of its range and cell B is healthy.

When cell B is currently selected
- Select cell A when cell A is healthy and ‘Auto switchback’ is enabled
- Select cell A when cell B fails and cell A is healthy
- Select cell C when cell B and A fail and cell C is healthy

When cell C is currently selected
- Select cell C when cell A fails while cell B is healthy
- Select cell C when cell A and cell B fail and cell C is healthy
- Select cell C when cell A and cell B fail and cell C is healthy

**3 cells, range type = ‘Hi Hi Hi’**

When cell A is currently selected
- Select cell B when cell A value fails and cell B is healthy
- Select cell C when cell A and cell B fail and cell C is healthy

When cell B is currently selected
- Select cell A when cell A is healthy and ‘Auto switchback’ is enabled
- Select cell A when cell B fails and cell A is healthy
- Select cell C when cell B and A fail and cell C is healthy

When cell C is currently selected
- Select cell A when cell A is healthy and ‘Auto switchback’ is enabled
- Select cell B when cell B is healthy and cell A fails and 'Auto switchback' is enabled
- Select cell A when cell C fails and cell A is healthy
- Select cell B when cell C and A fail and cell B is healthy

**Master meter proving**

Master meter proving is based on simultaneously measuring an amount of fluid by two meters that are installed in series. There are two different methods to calculate the volumes, by pulse counting or by totalizers latching.

**Pulse counting**

This method is only available if the flow computer reads pulses from both the meter on prove and the master meter.

The meter on prove and master meter prove totals (volume or mass totals, depending on meter quantity type) are calculated as follows:

\[
\begin{align*}
\text{Tot}_{\text{MM}} &= \frac{P_{\text{MM}}}{\text{MFK}_{\text{MM}}} \\
\text{Tot}_M &= \frac{P_M}{\text{MFK}_M}
\end{align*}
\]

Equation 6-37: Master meter proving total measurement using the pulse counting method.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{Tot}_{\text{MM}})</td>
<td>Master meter prove total</td>
<td>m3 or kg</td>
</tr>
<tr>
<td>(P_{\text{MM}})</td>
<td>Pulses between start and stop of the prove counted by the master meter</td>
<td>-</td>
</tr>
<tr>
<td>(\text{MFK}_{\text{MM}})</td>
<td>Actual K factor of the master meter (at the master meter frequency)</td>
<td>pls/m3 or pls/kg</td>
</tr>
<tr>
<td>(\text{Tot}_M)</td>
<td>Meter on prove prove total</td>
<td>m3 or kg</td>
</tr>
<tr>
<td>(P_M)</td>
<td>Pulses between start and stop of the prove counted by the meter on prove</td>
<td>-</td>
</tr>
<tr>
<td>(\text{MFK}_M)</td>
<td>Actual K factor of the meter on prove (at the meter frequency)</td>
<td>pls/m3 or pls/kg</td>
</tr>
</tbody>
</table>

**Totalizer latching**

This method is also available for smart meters and / or master meters from which the flow computer doesn’t read pulses.

The meter on prove and master meter prove totals (volume or mass totals, depending on meter quantity type) are calculated as follows:

\[
\begin{align*}
\text{Tot}_{\text{MM}} &= \text{Tot}_{\text{MM}}(\text{stop}) - \text{Tot}_{\text{MM}}(\text{start}) \\
\text{Tot}_M &= (\text{Tot}_M(\text{stop}) - \text{Tot}_M(\text{start})) \times \frac{t_{\text{MM}}}{t_M}
\end{align*}
\]

Equation 6-38: Master meter proving total measurement using the totalizer latching method.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{Tot}_{\text{MM}})</td>
<td>Master meter prove total</td>
<td>m3 or kg</td>
</tr>
<tr>
<td>(\text{Tot}_{\text{MM}}(\text{stop}))</td>
<td>Indicated totalizer of the master meter at prove end</td>
<td>m3 or kg</td>
</tr>
<tr>
<td>(\text{Tot}_{\text{MM}}(\text{start}))</td>
<td>Indicated totalizer of the master meter at prove start</td>
<td>m3 or kg</td>
</tr>
<tr>
<td>(\text{Tot}_M)</td>
<td>Meter on prove prove total</td>
<td>m3 or kg</td>
</tr>
</tbody>
</table>

The correction factor \(t_{\text{MM}} / t_M\) accounts for possible differences in prove time between the master meter flow module / computer and the meter on prove flow module / computer, caused by the fact that both modules have their own independent calculation cycle and possible delays in the start / stop signal.

**Meter factor calculation for master meter proving**

Both volumetric and mass meters are supported for both the meter on prove and the master meter. Therefore 4 different formulas are used for the 4 possible combinations.

\[
\begin{align*}
\text{MF}_P &= \frac{V_{\text{MM}} \times \text{MBF}_{\text{MM}} \times \text{MF}_{\text{MM}} \times \rho_{\text{MM}}}{\rho_B} \\
\text{MF}_P &= \frac{V_M \times \text{MBF}_M \times \rho_M}{\rho_B}
\end{align*}
\]

Equation 6-39: Prover Meter Factor for master meter proving of a volumetric meter using a volumetric master meter.

\[
\begin{align*}
\text{MF}_P &= \frac{M_{\text{MM}} \times \text{MBF}_{\text{MM}} \times \text{MF}_{\text{MM}} \times \frac{1}{\rho_B}}{M_M \times \text{MBF}_M} \\
\text{MF}_P &= \frac{V_{\text{MM}} \times \text{MBF}_{\text{MM}} \times \text{MF}_{\text{MM}} \times \rho_{\text{MM}}}{M_M \times \text{MBF}_M}
\end{align*}
\]

Equation 6-40: Prover Meter Factor for master meter proving of a mass meter using a volumetric master meter.

\[
\begin{align*}
\text{MF}_P &= \frac{M_{\text{MM}} \times \text{MBF}_{\text{MM}} \times \rho_{\text{MM}}}{M_M \times \text{MBF}_M}
\end{align*}
\]

Equation 6-41: Prover Meter Factor for master meter proving of a mass meter using a mass master meter.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Unit(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{MF}_P)</td>
<td>Meter factor calculated from proving</td>
<td>-</td>
</tr>
<tr>
<td>(V_{\text{MM}})</td>
<td>Master meter (uncorrected) volume</td>
<td>m3</td>
</tr>
<tr>
<td>(M_{\text{MM}})</td>
<td>Master meter (uncorrected) mass</td>
<td>kg</td>
</tr>
<tr>
<td>(\text{MFK}_{\text{MM}})</td>
<td>Meter factor of the master meter (at the proving flow rate)</td>
<td>-</td>
</tr>
<tr>
<td>(\text{MBF}_{\text{MM}})</td>
<td>Meter body correction factor of the master meter</td>
<td>-</td>
</tr>
<tr>
<td>(\text{MBF}_M)</td>
<td>Meter body correction factor of the meter on prove</td>
<td>-</td>
</tr>
<tr>
<td>(V_M)</td>
<td>Meter on prove (uncorrected) volume</td>
<td>m3</td>
</tr>
<tr>
<td>(M_M)</td>
<td>Meter on prove (uncorrected) mass</td>
<td>kg</td>
</tr>
<tr>
<td>Symbol</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>( \rho_{\text{mm}} )</td>
<td>Meter density of the master meter (density at the master meter conditions)</td>
<td></td>
</tr>
<tr>
<td>( \rho_{\text{m}} )</td>
<td>Meter density of the meter on prove (density at the meter conditions)</td>
<td></td>
</tr>
<tr>
<td>( \rho_b )</td>
<td>Base density (density at reference conditions)</td>
<td></td>
</tr>
</tbody>
</table>


7 Reports

Reports of the Flow-X flow computer are freely configurable. The layout of the standard reports can be modified and other user-defined reports may be added. Refer to manual IIA 'Operation and Configuration', chapter 'Reports' for further explanation. Reports are stored on the flow computer's flash disk, where they remain available for a configurable time. Reports can be read from the flow computer display or web browser and they can be retrieved from the flow computer by web requests (see the Flow-X webs services reference manual for details).

Standard reports

The Gas Metric application provides the following standard reports:

<table>
<thead>
<tr>
<th>Report name</th>
<th>Report description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run_Daily</td>
<td>Daily report for one run which is generated automatically at the end of each day. Shows forward values only.</td>
</tr>
<tr>
<td>Stn_Daily</td>
<td>Daily report for the station which is generated automatically at the end of each day. Shows the forward values for the station and up to 4 runs.</td>
</tr>
<tr>
<td>Run_Hourly</td>
<td>Hourly report for one run which is generated automatically at the end of each hour. Shows forward values only.</td>
</tr>
<tr>
<td>Stn_Hourly</td>
<td>Hourly report for the station which is generated automatically at the end of each hour. Shows the forward values for the station and up to 4 runs.</td>
</tr>
<tr>
<td>Run_PeriodA</td>
<td>Period A report for one run which is generated automatically at the end of each period A. Shows forward values for the station and up to 4 runs.</td>
</tr>
<tr>
<td>Stn_PeriodA</td>
<td>Period A report for the station which is generated automatically at the end of each period A. Shows the forward values for the station and up to 4 runs.</td>
</tr>
<tr>
<td>Run_PeriodB</td>
<td>Period B report for one run which is generated automatically at the end of each period B. Shows forward values only.</td>
</tr>
<tr>
<td>Stn_PeriodB</td>
<td>Period B report for the station which is generated automatically at the end of each period B. Shows the forward values for the station and up to 4 runs.</td>
</tr>
<tr>
<td>Run_Current</td>
<td>Shows a consistent snapshot of the actual input and calculated values of one run. All values are of the same calculation cycle. Printed on manual command. Shows forward values only.</td>
</tr>
<tr>
<td>Stn_Current</td>
<td>Shows a consistent snapshot of the actual input and calculated values of the station and up to 4 runs. Printed on manual command. Shows forward values only.</td>
</tr>
<tr>
<td>MasterMeter</td>
<td>Generated automatically at the end of a master meter proving sequence if the meter quantity type is 'volume'.</td>
</tr>
<tr>
<td>MasterMeterMass</td>
<td>Generated automatically at the end of a master meter proving sequence if the meter quantity type is 'mass'.</td>
</tr>
<tr>
<td>Events_Daily</td>
<td>Generated automatically at the end of the day. Shows all events (other than alarm transitions) during the day.</td>
</tr>
<tr>
<td>Alarms_Daily</td>
<td>Generated automatically at the end of the day. Shows all alarm transitions during the day.</td>
</tr>
</tbody>
</table>

Table 3: Standard reports

In flow-Xpress, generation of specific reports can be enabled or disabled. By default most reports have been disabled. They can be enabled in Flow-Xpress -> Reports, by right clicking on the report and selecting "Enabled".
8 Communication

The application contains a number of standard Modbus lists for communication to flow meters, DCS systems, HMI systems, etc. Furthermore a number of standard HART communication lists are available for communication to transmitters and flow meters that support the HART protocol.

To use any of these communication lists, you have to select it in Flow-Xpress 'Ports & Devices' and assign it to the appropriate communication port.

With Flow-Xpress Professional, communication lists can be freely added, modified, extended etc.

Refer to manual IIA 'Operation and Configuration', chapter 'Communication' for more details.

Standard Modbus communication lists

Modbus Tag List
The application provides an overall Modbus communication list that contains all variables and parameters of up to four meter runs, station and proving. This communication list can be used for serial and Ethernet communication.

This Modbus tag list uses a register size of 2 bytes (16 bits) for integer data, a register size of 4 bytes (32 bits) for single precision floating point data (f.e. process values and averages) and a register size of 8 bytes (64 bits) for double precision floating point data (totalizers).

This overall communication list can be used 'as is' or it can be modified if required.

Modbus Tag List 16 bits
This is an abbreviated Modbus tag list, which only includes the most important data, like process values and totalizers. It is mainly meant for communication to older (DCS) systems or PLC's that don't support data addresses larger than 16 bits.

This Modbus tag list uses a register size of 2 bytes (16 bits) for integer data, single precision floating point data (process values) and long integer data (totalizers).

Because with this tag list the totalizers are communicated as long integers, the totalizer rollover values should not be set higher than 1.E+09.

Except for the FC time, which can be written for time synchronization, this tag list only contains read data.

This communication list can be used 'as is' or it can be modified if required.

Connect to remote station
Generic Modbus list for communication between a station / proving flow computer and a remote run flow computer. Select this Modbus list on each remote run flow computer that has to communicate to a (remote) station / proving flow computer.

Refer to paragraphs Configuration, Overall setup, Flow computer concepts and Configuration, Proving, Proving setup for more details.

Connect to remote run
Generic Modbus list for communication between a station / proving flow computer and a remote run flow computer. Select this Modbus list on a station / proven flow computer that has to communicate to one or more remote run flow computers. For each remote run flow computer a separate 'Connect to remote run' Modbus list has to be selected.

A station / prove flow computer can communicate to up to 8 remote run flow computers.

Refer to paragraphs Configuration, Overall setup, Flow computer concepts and Configuration, Proving, Proving setup for more details.

Omni compatible communication list
The application contains the following Omni compatible Modbus list:

- Modbus tag list (Omni v27)
  - Compatible to Omni v27, max. 4 runs.

Custom data packets 1, 201 and 401 and historical data archives 701-710 are supported, but must be customized using Flow-Xpress Professional.

Modbus devices
The application by default supports the following Modbus devices:

Flow meters:
- Altosonic V12 ultrasonic flow meter
- Caldon LEFM 380Ci ultrasonic flow meter
- FlowSic 600 ultrasonic flow meter
- FMC MPU ultrasonic flow meter
- GE GF868 ultrasonic flow meter
- Micro Motion Coriolis flow meter
- Elster Q.sonic ultrasonic flow meter (uniform)
- Elster Q.sonic plus ultrasonic flow meter (Modbus)
- RMG USZ08 ultrasonic flow meter

Gas chromatographs:
- Siemens Maxum
- Siemens Sitrans
- Yamatake HGC
Additional Modbus devices can be configured using Flow-Xpress Professional.

**HART devices**

The application by default supports the following HART devices:

**Flow meters:**

- Flow meter HART

  Generic communication driver for flow meters that provide a flow rate through HART

  **Generic HART communication lists** for temperature, pressure, dP transmitters etc. that support the HART protocol:

  - **HART transmitter (1 var).** HART communication list that only reads the first HART variable. Because for most HART transmitters the first variable is the main process value, this can be used in most cases.

  - **HART transmitter (3 var).** HART communication list that reads all variables. Has to be selected if you want to use the 2nd or 3rd HART variable from a HART transmitter that supports 3 variables.

  - **HART transmitter (4 var).** HART communication list that reads all variables. Has to be selected if you want to use the 2nd, 3rd or 4th HART variable from a HART transmitter that supports 4 variables.

Additional HART devices can be configured using Flow-Xpress Professional.
9 Historical Data Archives

Historical Data Archives provide a convenient way to store, view and hand-off all relevant historical batch and period data.

Historical data archives are freely configurable using FlowXpress Professional. Existing archives may be modified and new archives may be added.

Historical data archives can be read from the flow computer display or web browser. They can be retrieved from the flow computer as XML files by web requests (see the Flow-X webs services reference manual for details) and they can be read using Modbus. The Flow-X supports the Omni Raw Data Archive RDA polling method (Omni archives 701-710).

Standard Data Archives

The application by default contains the following historical data archives:

- Daily_Run
  Contains the daily run data of the last 95 days (configurable)
- Daily_Station
  Contains the daily station data of the last 95 days (configurable)
- Hourly_Run
  Contains the hourly run data of the last 30 days (configurable)
- Hourly_Station
  Contains the hourly station data of the last 30 days (configurable)
- PeriodA_Run
  Contains the period A run data of the last 30 days (configurable)
- PeriodA_Station
  Contains the period A station data of the last 30 days (configurable)
- PeriodB_Run
  Contains the period B run data of the last 30 days (configurable)
- PeriodB_Station
  Contains the period B station data of the last 30 days (configurable)
10 MID Compliance

Accountable alarms
EN-12405, the metrological standard used by the MID (Measuring Instruments Directive) for gas flow computers requires that the base volume and mass totals are disabled when an accountable alarm occurs.

In the following situations the Flow-X raises an accountable alarm:
- Meter temperature transmitter fail, override value enabled, input forced or in calibration
- Meter pressure transmitter fail, override value enabled, input forced or in calibration
- Density transmitter failure, input forced or in calibration
- Density temperature transmitter fail, override value enabled, input forced or in calibration
- Density pressure transmitter fail, override value enabled, input forced or in calibration
- Differential pressure transmitter failure or ISO5167 / AGA3 calculation failure (dP meters)
- Pulse input failure or forced (pulse meters)
- Meter communication failure, measurement failure or flow rate forced (smart meter)
- Data invalid alarm
- Gas chromatograph communication fail, measurement fail, analysis delayed (optional), composition limit alarm (optional), override composition enabled
- Density calculation fail, base density transmitter fail, override value enabled, input forced or in calibration
- Meter density calculation fail
- Heating value calculation fail, transmitter fail, override value enabled, input forced or in calibration (optional)
- Flow rate out of accountable limits
- Meter temperature out of accountable limits
- Meter pressure out of accountable limits
- Custom accountable alarm, which can be used to add custom, user specific, accountable alarm conditions.

For this purpose the application provides an additional set of accountable and non-accountable totalizers. If there is no accountable alarm then the accountable totalizers are active and the non-accountable totalizers are inactive. In case of an accountable alarm the non-accountable totalizers are active and the accountable totalizers are inactive. The normal totalizers are active regardless of the accountable alarm.

If needed, the accountable alarm (Any accountable alarm) can also be used to stop the flow, by closing a valve or withdrawing the flow control PID permissive, using Flow-Xpress custom calculations.

Flow meter correction
EN-12405 requires that the flow meter signal correction (based on the meter factor / meter error calibration curve) is disabled under the following conditions:
- Pulse frequency < 10 Hz
- Flow rate < Qmin

When setting 'MID Compliance' is enabled then the flow meter correction will be disabled accordingly.
11 Revisions

Revision A
Date February 2009

Revision B
Date February 2015
• Complete review of the manual. Major update, describing new functionality of application version 1.2.2.
• Update to application version 1.2.3.
• Update to application version 1.3.2.
• Update to application version 1.4.0.
• Minor editorial changes

Revision C
Date December 2015
• Major review of the manual. Update to application version 2.1.0.

Revision C1
Date October 2017
• Update to ABB lay-out

Revision D
Date January 2018
• Update to application version 2.2.0.