ABB MEASUREMENT & ANALYTICS | CONFIGURATION MANUAL

SpiritIT Flow-X

High accuracy flow computers

Operation and configuration – Gas USC

Measurement made easy

—
Flow-X/P with Flow-X/M module

Introduction

Welcome to the exciting world of SpiritIT Flow-X!

This manual is the operation and configuration manual for the SpiritIT Flow-X Gas USC 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 referencere

For more information

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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 USC** 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:

ADC	Analog to Digital converter
AI	Analog Input
AO	Analog Output
API	Application Programming Interface An interface that allows an application to interact with another application or operating system, in our case, Flow-X. Most of the Flow-X API is implemented through Excel worksheet functions.
ASCII	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).
CPU	Central Processing Unit
DAC	Digital to Analog Converter
DCS	Distributed Control System
DDE	Dynamic Data Exchange A relatively old mechanism for exchanging simple data among processes in MS-Windows.
DI	Digital Input
DO	Digital Output
EGU	Engineering Units
EIA	Electrical Industries Association
FET	Field Effect Transistor
GC	Gas Chromatograph
GUI	Graphical User Interface
HART	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.
HMI	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.
I/O	Input/Output
IEEE	Institute for Electrical and Electronics Engineers
ISO	International Standards Organization
MMI	Man Machine Interface (see HMI)
MIC	Machine Identification Code. License code of Flow-X which uniquely identifies you computer.
OEM	Original Equipment Manufacturer
P&ID	Piping and Instrumentation Diagram
PC	Personal Computer
PCB	Printed Circuit Board
PLC	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.
RS232	EIA standard for point to point serial communications in computer equipment
RS422	EIA standard for two- and four-wire differential unidirectional multi-drop serial
RS485	EIA standard for two-wire differential bidirectional multi-drop serial communications in computer equipment
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SQL	Standard Query Language
SVC	Supervisory Computer
TCP/IP	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.
TTL	Transistor-Transistor Logic
UART	Universal Asynchronous Receiver & Transmitter
URL	Uniform Resource Locator. The global address for documents and resources on the World Wide Web.
XML	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.

Terms and definitions

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

Asynchronous	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.
Client/server	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
Device driver	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.
Engineering units	Engineering units as used throughout this manual refers in general to the units of a tag, for example 'psi', or '°F', and not to a type of unit, as with 'metric' units, or 'imperial' units.
Ethernet	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-Base-T or Fast Ethernet supports data transfer rates of 100 Mbps, while the newest version, Gigabit Ethernet supports rates of 1 gigabit (900 megabits) per second.
Event	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.
Exception	Any condition, such as a hardware interrupt or software error-handler, that changes a program's flow of control.
Fieldbus	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.
Gross volume	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).
Indicated volume	The uncorrected actual volume; as indicated by the flow meter without any correction being applied.
Kernel	The core of Flow-X that handles basic functions, such as hardware and/or software interfaces, or resource allocation.
Peer-to-peer	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.
Polling	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.
Process visualization software	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 SpiritIT eXLerate, a PC-based supervisory software.
Protocol	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.
Query	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.
Real-time	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.
Resource	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.
Synchronous	A type of message passing where the sending task waits for a reply before continuing processing.
Tag	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.
Web Server	A computer that has server software installed on it and is used to deliver web pages to an intranet/Internet.

2 Application overview

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

Capabilities

The Gas USC 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
- 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
- Built-in support for 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
- Orifice, venturi, V-cone and nozzle standards: ISO-5167, AGA-3
- 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 (v23)

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 US Customary 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).

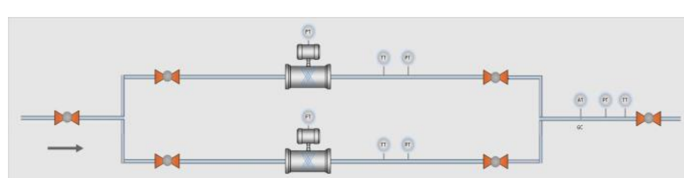


Figure 1: Meter station with 2 meter runs and common on-line analyzers

In order to enable the configurations above, the application can be configured either as:

- Independent single stream application
- Multiple stream Flow-X/P application (max. 4 streams)
- Single stream application that communicates to a station flow computer
- Station flow computer that communicates to a number of (max. 8) single stream flow computers
- Combined station / run flow computer that handles station functionality and one local run and that communicates to a number of (max. 7) single stream flow computers

Input signals

The application can process one or more gas meter runs. The following type of I/O can be configured:

- Flow meter input
- Process inputs
- Status inputs
- Gas Chromatograph inputs
- Densitometer inputs
- Specific gravity transducer inputs

Flow meter input

The application supports one flow meter input per meter run.

The following types of flow meter input are supported:

Input type	Meant for
Pulse input	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
Smart input	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
Smart / pulse input	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.
Orifice	Orifice plates according to ISO-5167 / AGA-3
Venturi	Venturi tubes according to ISO-5167
V-cone	McCrometer V-cone and wafer cone meters
Venturi nozzle	Venturi nozzles according to ISO-5167
Long radius nozzle	Long radius nozzles according to ISO-5167
ISA 1932 nozzle	ISA 1932 nozzles according to ISO-5167

Table 2-1: Flow meter inputs

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:

Process input	Meant for
Meter temperature	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.
Meter pressure	Pressure at the flow meter.
	Either one single or two redundant pressure transmitters are supported.
	For differential pressure type of flow meters (orifice, venturi, V-cone, nozzle) either the pressure upstream or downstream of the flow meter may be used.
Density temperature	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.
Density pressure	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.
Observed density	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.
Base density	Density at base temperature and pressure. Also called standard density
	Either taken at the meter run or header, or calculated.
Specific gravity	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).
Relative density	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)
CO2	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.
N2	Nitrogen content
	Only used if the SGERG / AGA8 gross or NX19 calculation is enabled
	Either taken at the meter run or at the header.
H2	Hydrogen content
	Only used if the SGERG / AGA8 gross or NX19 calculation is enabled Either taken at the meter run or at the header.
Heating value	The heating value. Also called calorific value.
	Either taken at the meter run or header, or calculated. May represent the higher heating value (superior calorific value) or lower heating value (inferior calorific value). Used for energy calculations and for SGERG / AGA8 gross or NX19 calculations.

Table 2-2: Process inputs

Furthermore, the application supports 2 auxiliary temperature inputs, 2 auxiliary pressure inputs and 2 generic auxiliary process inputs, which may be used to read any types of additional process values.

Digital status and command inputs

The application supports the following status and command inputs:

Status input	Purpose
Data validity input	Can be used in case the flow meter provides a status signal that indicates the validity of the flow meter signal. It is typically used by ultrasonic and coriolis flow meters in combination with a pulse signal. The input is used for alarming purposes and to control the accountable totals required for MID.
Flow direction input	Can be used to determine whether the forward or reverse totalizers must be activated.
Valve open input	Indicates if a valve is in the open position or not.
Valve closed input	Indicates if a valve is in the closed position or not.
Valve local / remote status input	Indicates whether a valve is controlled locally (on the valve itself) or remotely (from the flow computer)
Valve fault status input	Indicates whether a valve is in a valid or invalid position
Prove detector	Used in case of master meter proving based on pulses. Signal to simultaneously start / stop master proving on the master meter module and the module of the meter on prove. Has to be connected to the prove start command output of the flow computer that runs the proving logic.
Sampler can full indication	May be used to indicate that a sample can is full
Serial mode indication	Signal that indicates that two meters (usually master meter and meter on prove) are in serial configuration, so only one of the meter readings must be used in the station total. To be used on systems where the meters can be set in serial or parallel mode by means of a cross-over valve. The signal is to be connected to a position indication of the cross-over valve. The meters are in serial mode if the cross-over valve is not closed.
Print snapshot report command	Command to print a snapshot report

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

Gas chromatographs

The application supports one or two gas chromatographs. 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) to the flow computer.

Also a fixed gas composition can be applied.

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 Solartron specific gravity transducers. 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.

Analog output	Purpose
Flow and process values	To output the actual flow rate, density, pressure, temperature, etc.
PID control	For flow / pressure control

Digital status and command outputs

The application supports the following digital outputs:

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

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 USC 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 gives a flow rate alarm when the actual 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 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 [MCF/hr] or [klbm/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.

Override	500	Temperature override selection 0: Disabled The live input value is used for the calculations 1: Enabled The override value is used for the calculations
Override	500	Temperature override value [°F]

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 [°F]
Hi limit	500	Limit for the temperature high alarm [°F]
Lo limit	500	Limit for the temperature low alarm [°F]
Lo lo limit	500	Limit for the temperature low low alarm [°F]
Rate of change limit	500	Limit for the temperature rate of change alarm [°F/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.

Meter temperature A/B out of service	500	Temperature transmitter A / B out of service selection
		0: Disabled The transmitter value is used for the calculations
		1: Enabled The transmitter value is **not** used for the calculations

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:

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

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	Pressure override selection
		0: Disabled The live input value is used for the calculations
		1: Enabled The override value is used for the calculations
Override	500	Pressure override value [psi]*

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.

Hi hi limit	500	Limit for the pressure high high alarm [psi]*
Hi limit	500	Limit for the pressure high alarm [psi]*
Lo limit	500	Limit for the pressure low alarm [psi]*
Lo lo limit	500	Limit for the pressure low low alarm [psi]*
Rate of change limit	500	Limit for the pressure rate of change alarm [psi/sec]

*Either [psia] or [psig], 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.

Meter pressure A/B out of service	500	Pressure transmitter A / B out of service selection
		0: Disabled The transmitter value is used for the calculations
		1: Enabled The transmitter value is **not** used for the calculations

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, f.e. a densitometer. The specific gravity display is only visible in case of a live specific gravity input, f.e. a specific gravity transducer. The relative density display is only visible in case of a live relative density input, f.e. 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.

Override	500	Density / gravity 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	Density/gravity override value (*)

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]

*Units are [lb/cf] for the observed density, [lb/scf] 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.

Meter density override	500	Meter density selection 0: Disabled The calculated value is used for the calculations 1: Enabled The override value is used for the calculations
Meter density override	500	Meter density override value [kg/m3]

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.

Time period override	1000	Time period input override selection 0: Disabled The live input value is used for the calculations 1: Enabled The override value is used for the calculations
Time period override	1000	Time period input override value [microseconds]

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.

Hi hi limit	500	Limit for the time period input high high alarm [microseconds]
Hi limit	500	Limit for the time period input high alarm [microseconds]
Lo limit	500	Limit for the time period input low alarm [microseconds]
Lo lo limit	500	Limit for the time period input low low alarm [microseconds]
Rate of change limit	500	Limit for the time period input rate of change alarm [microseconds /sec]

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.

Densitometer select mode	500	Densitometer selection mode. 1: Auto-A Densitometer B is only used if densitometer A fails and densitometer B is healthy. Densitometer A is used in all other cases. 2: Auto-B Densitometer A is only used if densitometer B fails and densitometer A is healthy. Densitometer B is used in all other cases. 3: Manual-A Always use densitometer A irrespective of its failure status 4: Manual-B Always use densitometer B irrespective of its failure status

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.

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.

Time period override	1000	Time period input override selection 0: Disabled The live input value is used for the calculations 1: Enabled The override value is used for the calculations
Time period override	1000	Time period input override value [microseconds]

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.

Hi hi limit	500	Limit for the time period input high high alarm [microseconds]
Hi limit	500	Limit for the time period input high alarm [microseconds]
Lo limit	500	Limit for the time period input low alarm [microseconds]
Lo lo limit	500	Limit for the time period input low low alarm [microseconds]
Rate of change limit	500	Limit for the time period input rate of change alarm [microseconds /sec]

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.

SG transducer select mode	500	Specific gravity transducer selection mode. 1: Auto-A 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. 2: Auto-B 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. 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

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:

Composition override	500	Composition override selection 0: Disabled The live composition is used for the calculations 1: Enabled The override composition is used for the calculations

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 Sulphyde (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:

Component high limit	500	Limit for the component high alarm [%mole]
Component low limit	500	Limit for the component low alarm [%mole]

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.

GC selection mode	500	Controls the selection between the 2 GC's. The gas composition of the selected GC is used for the calculations.
		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.
		3: Manual-A GC A is always selected, independent of any failure
		4: Manual-B GC B is always selected, independent of any failure

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 [(*)/sec]

*Units are [BTU/scf] in case of a volume based heating value, [BTU/lbm] 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.

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:

Meter to be proved	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’.

Prove commands

Start prove sequence	500	Command to start a prove sequence for the selected meter.
Accept meter factor	500	Command to accept the proved meter factor
Reject meter factor	500	Command to reject the proved meter factor.
Abort prove sequence	500	Command to abort an active prove sequence

Trial prove

Start trial prove	500	Command to start a trial prove sequence for the selected meter. A trial prove is the same as a normal prove except that the new meter factor will not be accepted.

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’.

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:

Manual control

Auto/manual mode	500	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).
		1: Auto
		2: Manual
Manual open command	500	Issues the command to open the valve. Only accepted if the valve operates in manual mode and the valve open permissive is high.
Manual close command	500	Issues the command to close the valve. Only accepted if the valve operates in manual mode and the valve close permissive is high.

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 (, Run<x>)

Display → Flow control, Station

Display → Pressure control (, Run<x>)

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).

Flow control setpoint type	500	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).
		1: Auto
		2: User
Flow control - user setpoint	500	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: [MFC/hr] for volume flow meters and [klbm/hr] for mass flow meters.

Pressure control

These settings are only available for pressure control valves.

Pressure control - setpoint	500	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 [psig] or [psia], depending on the configured pressure control units.

Manual control

Manual control mode	500	Enables or disables manual control.
		0: Disabled Manual control is disabled. The PID control algorithm is enabled. The valve position follows the manual output %.
		1: Enabled 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.
Manual control output	500	The valve position will be set to this value [%] if Manual control mode is enabled

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.

Display → Sampling, Sampler control

Start sampler	500	Command to start the pulse output to the sampler and the accumulation of grabs in the grab counter.
Stop sampler	500	Command to stop the generation of pulses the accumulation of grabs in the grab counter.
Reset sampler	500	Resets the accumulated number of grabs of all available cans. Also implies a 'Stop sampler' command.
Selected can	500	Shows the can that is currently in use. Can be used to manually switch control to the other can. Alternatively, the can is automatically selected by the flow computer sampling logic.
Can 1 / 2	500	Enables / disables can 1 / can 2. A can that is disabled won't be used by the flow computer sampler logic.
Reset can 1 / 2	500	Command to reset the number of grabs in the can to 0. This effectively reports the can as 'empty'. Not applicable if Can fill indication method is 'Analog input'.

Test

Grab test	1000	Command for testing the sampler strobe. Issues one pulse (=one grab). Can only be used when sampling is inactive.

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.

Volume between grabs fixed value	500	Volume [MCF] that needs to be accumulated before the next grab command is issued.

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.

Expected total volume	500	Estimated total volume [MCF] to be metered in order to fill the can.

Time (fixed value)

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

Time between grabs fixed value	500	Interval at which grab commands (pulses) are issued [s].

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.

Expected end time for sampling	500	Date / time when the sample can has to be full to the target fill percentage.

Time (period)

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

Can fill period	500	Period of time [hr] in which the can has to be filled to the target fill percentage.

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:

Tag	600	Alphanumeric string representing the tag name of the transmitter, e.g. "PT-1001A". Only used for display and reporting purposes.
Input type	1000	Type of input signal 1= 4-20 mA 2= 0-20 mA 3= 1-5 Vdc 4= 0-5 Vdc
Averaging	1000	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
Full scale	1000	The value in engineering units that corresponds with the full scale value.
		Uses the basic FC units: [°F] for temperature, [psia] or [psig] for pressure, [lb/cf] for density, [mmH2O@60F] for differential pressure, [BTU/scf] or [BTU/lbm] for heating value, [bbl/hr], [klbm/hr] or [MMBTU/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 0-300 [°F] the value 300 [°F] must be entered. For a temperature transmitter with a range of -30..+80 [°C] the value 176 [°F] must be entered.
Zero scale	1000	The value in engineering units that corresponds with the zero scale value.
		Uses the basic FC units: [°F] for temperature, [psia] or [psig] for pressure, [lb/cf] for density, [mmH2O@60F] for differential pressure, [BTU/scf] or [BTU/lbm] for heating value, [bbl/hr], [klbm/hr] or [MMBTU/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 0-300 [°F] the value 0 [°F] must be entered. For a temperature transmitter with a range of -30..+80 [°C] the value -22 [°F] must be entered.
High fail limit	1000	The value as percentage of the total span, at which a high fail alarm is given.
		Should be between 100 and 112.5 % span. For a 4-20 mA transmitter this corresponds to 20 to 22 mA.
Low fail limit	1000	The value as percentage of the total span, at which a low fail alarm is given.
		Should be between -25 and 0 % span. For a 4-20 mA transmitter this corresponds to 0 to 4 mA.

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.

Tag	600	Alphanumeric string representing the tag name of the transmitter, e.g. "TT-1001A". Only used for display and reporting purposes.
Input type	1000	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
High fail limit	1000	The temperature in °F, at which a high fail alarm is given.
Low fail limit	1000	The temperature in °F, at which a low fail alarm is given.

Digital IO 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 IO assign, Digital <y>

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

Tag	600	Alphanumeric string representing the tag name of the transmitter, e.g. "MOV-3401O". Only used for display and reporting purposes.
Signal type	1000	Assigns the digital signal to a specific purpose
		0 : Not used
		1 : Digital input e.g. status input
		2 : Digital output e.g. status output, control output
		3 : Pulse input A meter or master meter pulse input single pulse / channel A of dual pulse
		4 : Pulse input B meter or master meter pulse input channel B of dual pulse
		5 : Time period input 1 for densitometers and SG transducers
		6 : Time period input 2
		7 : Time period input 3
		8 : Time period input 4
		9 : Pulse output 1 to drive an E/M counter or a sampler
		10 : Pulse output 2
		11 : Pulse output 3
		12 : Pulse output 4
		13: Prove detector master meter prove start / stop signal input
		17: Prover bus A meter pulse A output to prover FC
		18: Prover bus B meter pulse B output to prover FC
		23: Master meter 2nd pulse in A remote meter / master meter pulse input A for master meter proving
		24: Master meter 2nd pulse in B remote meter / master meter pulse input B for master meter proving
		25 : Frequency output 1 frequency outputs
		26 : Frequency output 2
		27 : Frequency output 3
		28 : Frequency output 4

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.
Input threshold level	1000	Each digital channel has 2 threshold levels, which are as follows (all relative to signal ground):
		Channels 1 through 8: 1: + 1.25 Volts 2: + 12 Volts
		Channels 9 through 16: 1: + 3.6 Volts 2: + 12 Volts
Input latch mode	1000	Only applicable if signal type is 'Digital input' 1: Actual 2: Latched
		If polarity = Normal & input latch mode = Actual **then** digital input is 0:OFF when signal is currently below threshold 1:ON when signal is currently above threshold
		If polarity = Normal & input latch mode = Latched **then** digital input is 0:OFF when signal has not been above threshold 1:ON when signal is or has been above thresholdn during the last calculation cycle
		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.

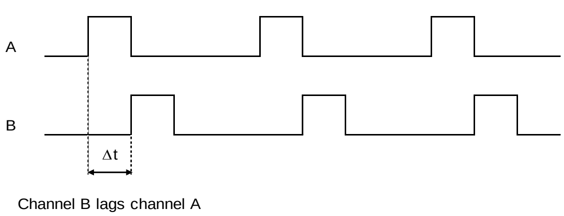


Figure 2: Flow direction from dual pulse signal

There is also the option to conditionally output the raw pulse ‘prover bus’ signal, which is useful in case a separate flow computer is used for proving purposes. The proving flow computer reads the ‘prover bus’ pulse output from the meter flow computer to perform prove measurements including double chronometry if required. The ‘prover bus’ output signal is generated at 10 MHz, the same frequency at which the raw pulse input signals are sampled.

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

Pulse fidelity level	1000	Pulse fidelity levels according to ISO6551 0: None No pulse fidelity checking or correction 1: Level A Pulse verification, alarming and correction 2: Level B Pulse verification and alarming; no correction 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.
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.
Error rate limit	1000	Only applicable to dual pulse inputs. If the difference in frequency between the two raw pulse trains is larger than this limit within the last calculation cycle, the FC will generate an 'Error pulse rate limit alarm'. The value 0 disables the error rate limit check.
Dual pulse fidelity threshold	1000	Dual pulse fidelity checking is only enabled when the actual pulse frequency is above this threshold limit [Hz]

Pulse frequency

Lowest discernable input frequency	1000	Lowest frequency that is discerned by the flow computer. Pulses coming in at a lower frequency are counted, but the frequency will be shown as 0 Hz.

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. The flow module will output the raw pulse input signal A directly to the prover bus 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.

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 B directly to the prover bus pulse out B 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.

Tag	600	Alphanumeric string representing the tag name of the output signal, e.g. "AO-045". Only used for display and reporting purposes.
Full scale	600	The value in engineering units that corresponds with the full scale (20mA) value.
		Uses the original FC units: [MCF/hr] for volume flow rate, [klbm/hr] for mass flow rate, [MMBtu/hr] for energy flow rate, [ºF] for temperature, [psi] for pressure, [lb/cf] for density, [BTU/scf] or [BTU/lbm] for heating value. E.g. for a temperature with a range of 0-300 [ºF] the value 300 [ºF] must be entered. For a temperature with a range of -30..+80 [ºC] the value 176 [ºF] must be entered.
Zero scale	600	The value in engineering units that corresponds with the zero scale (4mA) value.
		Uses the original FC units: [MCF/hr] for volume flow rate, [klbm/hr] for mass flow rate, [MMBtu/hr] for energy flow rate, [ºF] for temperature, [psi] for pressure, [lb/cf] for density, [BTU/scf] or [BTU/lbm] for heating value. E.g. for a temperature with a range of 0-300 [ºF] the value 0 [ºF] must be entered. For a temperature with a range of -30..+80 [ºC] the value -22 [ºF] 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.

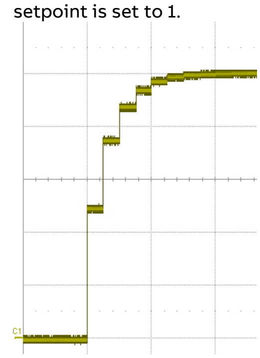


Figure 3: Analog output dampening factor

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

Display →IO, Configuration, <Module <x>, Pulse outputs, Pulse 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 pulse outputs. For each pulse output the following settings are available.

Max. frequency	600	Maximum pulse frequency.
		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.

Full scale value	600	The value in engineering units that corresponds to the highest frequency.
		Uses the original FC units: [MCF/hr] for volume flow rate, [klbm/hr] for mass flow rate, [MMBtu/hr] for energy flow rate. E.g. for a flow rate with a range of 0-2000 [MCF/hr] the value 2000 must be entered. For a flow rate with a range of 0-1000 [CF/min] the value 60 [MCF/hr] must be entered.
Zero scale value	600	The value in engineering units that corresponds with the lowest frequency.
		Uses the original FC units: [MCF/hr] for volume flow rate, [klbm/hr] for mass flow rate, [MMBtu/hr] for energy flow rate.
Full scale frequency	600	Highest frequency
Zero scale frequency	600	Lowest frequency (>=0)

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

In order to be able to communicate to the 'remote run' flow computer(s), the station / 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').

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

Flow computer type	1000	Determines whether the flow computer contains meter run functionality and / or station functionality and / or proving functionality.
		1: Run only 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.
		2: Station / run 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.
		3: Proving / run 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.
		4: Station / proving / run 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.
		6: Station only 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.
		7: Proving only Only proving logic is activated on this flow computer. Run and station functionality are de-activated. 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.
		8: 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

Use net HV for energy	1000	Controls whether the net heating value is used for energy totals instead of the gross heating value.	
		0: No	GHV (higher heating value) is used
		1: Yes	NHV (lower heating value) is used
Averaging method	1000	Determines the method used for calculating the period averages.	

		0: Time weighted
		1: Flow weighted on gross volume
		2: Flow weighted on mass
		3: Flow weighted on base volume
		In either case averaging is inactive if the meter is inactive (flow rate, dP or pulse frequency below the low flow cutoff).

Totalizer settings

Disable totals if meter is inactive	1000	Controls if the totals are disabled when the meter is inactive (flow rate, dP or pulse frequency below the low flow cutoff).
		0: No
		1: Yes
Set flowrate to 0 if meter is inactive	1000	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).
		0: No
		1: Yes
Reset maint. totals on entering maint. mode	1000	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.
		0: No
		1: Yes
Reverse totals	1000	Enables / disabled the reverse totals
		0: Disabled
		1: Enabled
		If enabled, the flow computer maintains forward AND reverse totalizers and averages. If disabled, the flow computer only maintains one set of (forward) totalizers and averages.
		Based on the flow direction input the forward or reverse totalizers are active. See paragraph ‘Flow direction input’ for an explanation how to configure the flow direction.
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.
		2: Sum of run totals Calculate station totals as the sum of run totals.

Alarm settings

Disable alarms if meter is inactive	1000	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).
		0: No
		1: Yes
Disable alarms in maintenance mode	1000	Controls if the limit alarms, calculation alarms and deviation alarms are suppressed when the meter is set in maintenance mode.
		0: No
		1: Yes
Calculation out of range alarms	1000	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.
		0: Disabled
		1: Enabled
Deviation alarm delay	1000	Delay time [s] on deviation alarms:
		Pressure deviation alarms (deviation between both pressure transmitter readings in case of dual transmitters) Temperature deviation alarms (deviation between both temperature transmitter readings in case of dual transmitters) Density deviation alarms (deviation between two densitometers, deviation between two SG transducers, deviation between observed density and AGA-8 calculated density) Flow deviation alarms (deviation between pulse flow rate and smart meter flow rate) VOS deviation alarms (deviation between meter VOS and FC calculated VOS) dP deviation alarms (deviation between two dP transmitter values if two transmitters of the same range are used)

Metrological

MID compliance	1000	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.
		0: Disabled
		1: Enabled
		If enabled, the accountable totalizers are active only if there’s no accountable alarm, while the non-accountable totalizers are active if there is an accountable alarm. If disabled, both the accountable and non-accountable totalizers are inactive.
		Refer to chapter 'MID Compliance' for more information.
		If enabled then metrological data is shown on display ‘Metrological’.
Energy accountable alarm	1000	Defines whether or not an accountable alarm is generated (accountable totals disabled, non-accountable totals enabled) in case of an energy / heating value alarm.
		0: Disabled
		1: Enabled
Allow manual overrides	1000	Determines whether manual (operator) transmitter overrides are accepted or not.
		0: No
		1: Yes

Date and time

Date format	1000	Date format used on the flow computer screens and reports
		1: dd/mm/yy
		2: mm/dd/yy
Time set inhibit time	1000	Number of seconds around the hour shift that any time shift request is inhibited. This is to avoid problems with the closing of period totals and the generation of reports on the hour / day shift. Typically 30 sec.

Historical data archives

Generate hourly archive data	1000	Defines if hourly archive data is generated and stored after each hour end.
		0: No
		1: yes
		Please be aware that the actual historical data archive content has to be configured in Flow-Xpress prior to writing the application to the flow computer.
Generate daily archive data	1000	Defines if daily archive data is generated and stored after each day end.
		0: No
		1: yes
		Please be aware that the actual historical data archive content has to be configured in Flow-Xpress prior to writing the application to the flow computer.
Generate period A archive data	1000	Defines if period A archive data is generated and stored after each period A end.
		0: No
		1: yes
		Please be aware that the actual historical data archive content has to be configured in Flow-Xpress prior to writing the application to the flow computer.
Generate period B	1000	Defines if period B archive data is generated and stored after each period B end.

archive data		0: No
		1: yes
		Please be aware that the actual historical data archive content has to be configured in Flow-Xpress prior to writing the application to the flow computer.
Generate prove archive data	1000	Defines if prove archive data is generated and stored when a prove is finished.
		0: No
		1: yes
		Please be aware that the actual historical data archive content has to be configured in Flow-Xpress prior to writing the application to the flow computer.

FC redundancy

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.
FC duty status DO module	1000	Number of the flow module to which the output signal is physically connected.
FC duty status DO channel	1000	Number of the digital channel on the selected module to which the output signal is physically connected.

Constants

Display → Configuration, Overall setup, Constants

Atmospheric pressure	1000	The local atmospheric pressure [bar(a)] is used to convert gauge pressure to absolute pressure and vice versa.
Molar mass of air	1000	The molar mass of air [lb/lbmol] is used to calculate the specific gravity.
		If the specific gravity is a live input (via a SG transducer or as a process input) then this parameter is used to calculate the observed and base density and corresponding volumes.
		28.9626 [lb/mol] according to ISO-6976 : 1995
Base density of air	1000	The base density of air [lb/CF] is used to calculate the relative density.
		Typical value: 0.076321 [lb/SCF] at 60 [CF]
Reference pressure	1000	The reference pressure [psi (a)] for the base density and base volume
Reference temperature	1000	The reference temperature [°F] for the base density and base volume
Universal gas constant	1000	Universal gas constant R [J/K/mol].
		8.314510 [J/K/mol] according to IS6976:1995
		Refer to section calculations to check when and how this parameter is used.
Local acceleration due to gravity	1000	Gravity constant g [m/s2].
		Used for wet gas correction.
		Default value 9.81.

Period settings

The application provides custody transfer data (totals and averages) for 4 different periods, the hourly period, the daily period and 2 freely definable periods A and B.

The start of the daily period is configurable. Periods A and B can be used for any period type and any period start, e.g. a 2 weekly period starting at Tuesday 06:00 or a 2^{nd} fiscal daily period starting at 08:00. The flow computer maintains similar totals and averages for the hourly, daily, period A and period B periods.

Display → Configuration, Overall setup, Periods

Daily period

Day start hour	600	Start of the daily period as offset in hours from midnight. E.g. for a day start at 6:00 AM this parameter should be set to 6.

Periods A / B

Period <X> label	600	Text to be shown on period displays and reports E.g. “Two weekly” or “Monthly”
Period <X> type	600	Type of period
		2: Minute
		3: Hour
		4: Day
		5: week
		6: Month
		7: Quarter
		8: Year
Period <X> duration	600	Period duration, i.e. number of period types. E.g. for a 2 weekly period, enter 2 (and set the period type at 5: week).
Period <x> offset days	600	Period offset from start of year ('January 1.') expressed in number of days, e.g. 10 means 'January 11.'
Period <x> offset hours	600	Period offset from midnight in number of hours. e.g. 6 means 6:AM
Period <x> offset minutes	600	Period offset from the whole hour in number of minutes, e.g. 30 means 30 minutes after the hour
Period <x> offset seconds	600	Period offset from the whole hour in number of seconds

Period end commands

Manual commands to end the periods for testing and special applications. The commands close the applicable period totals and averages and generate the period reports and archives (if applicable).

End hourly period	1000	Manual command to close the hourly period
End daily period	1000	Manual command to close the daily period
End period A	1000	Manual command to close the period A period
End period B	1000	Manual command to close the period B period

Totalizer settings

Display → Configuration, Overall setup, Totals

Decimal resolution

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

Rollover values

Gross volume total rollover val	1000	The rollover value for the indicated volume and gross volume totalizers.
Base volume total rollover val	1000	The rollover value for the base (standard) volume totalizers.

Mass total rollover val	1000	The rollover value for the mass totalizers.
Energy total rollover val	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.

Display → Configuration, Overall setup, Display levels

Detailed data display level	2000	Minimum security level for all displays that contain detailed information: • In-use values • Flow rates • Cumulative totals • Flow meter details • Temperature details • Pressure details • Density details • Gas properties details • Period data • Historical data • Event log • Metrological details (if applicable) • IO diagnostics • Communication diagnostics
Gas properties display level	2000	Minimum security level for the gas properties displays
Sampler control display level	2000	Minimum security level for sampler control displays
Proving display level	2000	Minimum security level for the proving displays
Valve control display level	2000	Minimum security level for displays for controlling the motor-operated valves
Flow control display level	2000	Minimum security level for flow control displays
Reports display level	2000	Minimum security level for viewing and printing reports
Alarm overview display level	2000	Minimum security level for accessing the alarm overview display
IO calibration display level	2000	Minimum security level for accessing the displays to calibrate the analog IO
Metrological configuration display level	2000	Minimum security level for accessing the metrological configuration displays (like run set, flow meter, pressure, temperature, pressure and density configuration displays)
Non-metrological configuration display level	2000	Minimum security level for accessing the non-metrological configuration displays (like valve control, flow control, analog outputs, pulse outputs)

System data

Display → Configuration, Overall setup, System data

Flow computer tag	600	Tag name of the flow computer, e.g. "FY-1001A"
System tag	600	Tag name for the meter station or in case of a single stream flow computer, the meter run, e.g. "YY-100"
System description	600	Description of the meter station or in case of a single stream flow computer, the meter run, e.g. "Export stream 2"
System company	600	Name of the company that owns the meter station or in case of a single stream flow computer, the meter run, e.g. "LiqTransco"
System location	600	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"

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 station configuration 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

Meter device type	1000	The following meter device types are supported:
		1:Pulse 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.
		2: Smart Any flow meter that provides its flow rate and / or total value through an analog or HART signal or via a Modbus communications link. Typically used for ultrasonic and coriolis flow meters. 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.
		3: Smart / pulse 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 that provide both a communications link and a pulse signal. 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.
		4: Orifice Orifice plate with up to 3 differential pressure transmitters.
		5: Venturi Classical venturi with up to 3 differential pressure transmitters.
		6: V-cone McCrometer V-Cone flow meter with up to 3 differential pressure transmitters.
		7: Venturi nozzle Venturi nozzle with up to 3 differential pressure transmitters.
		8: Long radius nozzle Long radius nozzle with up to 3 differential pressure transmitters.
		9: ISA1932 nozzle ISA1932 nozzle with up to 3 differential pressure transmitters.

Meter temperature

Meter temperature transmitter(s)	1000	Defines if one or two transmitters are used for indicating the meter temperature.
		0: Single One meter temperature transmitter
		1: Dual Two meter temperature transmitters

Meter pressure

Meter pressure transmitter(s)	1000	Defines if one or two transmitters are used for indicating the meter pressure.
		0: Single One meter pressure transmitter
		1: Dual Two meter pressure transmitters

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 (*)
Base density input type (*)
Specific gravity input type (*)
Relative 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 (*)	1000	See paragraph 'Heating value input'

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

Inlet valve control signals	600	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'.
Outlet valve control signals	600	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'.
Run to prover valve control signals	600	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'.

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

Meter tag	600	Flow meter tag, e.g. 'FT-1023AA'
Meter ID	600	Flow meter ID, e.g. 'Check meter gas export 2'
Meter serial number	600	Flow meter serial number, e.g. 'H1009245'
Meter manufacturer	600	Flow meter serial number, e.g. 'H1009245'
Meter model	600	Flow meter model, e.g. 'Promass 83'
Meter size	600	Flow meter size, e.g. '120 mm' or ' 11" '

Pulse input

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

Display → Configuration, Run <x>, Flow meter, Pulse input

with <x> the module number of the meter run

Pulse input quantity type	1000	Either 'Volumetric' for a volumetric flow meter (e.g. turbine, PD, ultrasonic) or 'Mass' for a mass flow meter (e.g. coriolis)
		1: Volume
		2: Mass

Meter active settings

Meter active threshold frequency	1000	Low flow cutoff frequency. When the actual frequency [Hz] is below this threshold value, the meter is considered to be inactive. 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	1000	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.
		0: Disabled
		1: Enabled

HF / LF pulses

HF / LF pulse type	1000	Enables or disables high frequency / low frequency pulses.
		0: Disabled Pulse A and B are both high frequency pulses.
		1: Blade ratio 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**.
		2: Auto-adjust meter 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.
HF / LF pulses blade ratio	1000	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.

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:

Meter volume = main rotor volume – 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:

Meter volume = main rotor pulses / mechanical k-factor.

Main rotor k-factor	1000	K-factor used to calculate the main rotor volume [pls/m3]
Sense rotor k-factor	1000	K-factor used to calculate the sense rotor volume [pls/m3]
Mechanical k-factor	1000	K-factor used to calculate the meter volume in case the sense rotor is inactive while the main rotor is active [pls/m3]
Main rotor cutoff frequency	1000	Cutoff frequency for the main rotor [Hz]
Sense rotor cutoff frequency	1000	Cutoff frequency for the sense rotor [Hz]
Factory	1000	Percentage that defines the share of flow that is

calibration adjustment		measured by the sense rotor [%]

Custom pulse increment

Custom pulse increment	1000	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.
		0: Disabled
		1: Enabled

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

Input type

Smart meter input type	1000	Type of input used for the 'smart' flow meter
		1: HART / Modbus (Serial, Ethernet or HART)
		2: Analog input
Use flowrate or total	1000	Only applicable if smart meter input type = 'HART / Modbus'.
		Determines whether the flow rate or the flow total value as provided by the flow meter is used for flow totalization.
		1: Flow rate
		2: Flow total
		In case of an analog input the input always represents a flow rate.
Pulse is primary	1000	Only applicable if meter type is 'Smart / pulse'.
		Controls whether the pulse input or the smart input is used as the primary source for flow totalization.
		0: No Smart input is primary
		1: Yes Pulse input is primary
Fall back to secondary flow signal	1000	Only applicable if meter type is 'Smart / pulse'.
		Defines what happens if the primary input fails.
		0: Disabled Don't use the secondary flow signal if the primary signal fails. The secondary signal is solely used for the deviation check.
		1: Enabled Use the secondary flow signal if the primary signal fails while the secondary signal is healty.

Analog input settings

Analog input quantity type	1000	Only applicable if smart meter input type = '2: Analog input' or input type is '1: HART / Modbus' with option 'HART to analog fallback' enabled
		1: Volumetric
		2: Mass
		For HART or Modbus inputs this setting is determined automatically from the communication tag list of the assigned communication device.
Analog input module	1000	Only applicable if smart meter input type = '2: Analog input' or input type is '1: HART / Modbus' with option 'HART to analog fallback' enabled
		Number of the flow module to which the analog signal is physically connected.
		-1: Local module means the module of the meter run itself
Analog input channel	1000	Only applicable if smart meter input type = '2: Analog input' or input type is '1: HART / Modbus' with option 'HART to analog fallback' enabled
		Number of the analog input channel on the selected module to which the analog signal is physically connected.

HART / Modbus settings

Smart meter internal device nr.	1000	Only applicable if smart meter input type = 'HART / Modbus'.
		Device nr. of the communication device as assigned in the configuration software (Flow-Xpress, section 'Ports & Devices')
HART to analog fallback	1000	Only applicable for a single HART transmitter in a loop, where the 4-20 mA signal is provided together with the HART signal.
		0: Disabled 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.
		1: Enabled The 4-20 mA signal will be used if the HART signal fails. When both the HART and the mA signal fail the value corresponding with the 'Fallback type' will be used.

Meter active settings

Meter active threshold flow rate	1000	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: [MCF/hr] in case of a volume flow meter, [klbm/hr] in case of a mass flow meter.
		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	1000	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.
		0: Disabled
		1: Enabled

Communication settings

Pulse K-factor selection	1000	Defines if the K factor (pulses/unit) is read from the meter or set manually. Only applicable if meter type is 'Smart / pulse'.
		1: User parameter Use the K-factor that is configured in the flow computer
		2: Read from flow meter Use the K-factor that is read from the smart meter
		Note that communication of the K-factor via Modbus is not supported by all smart meters.
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 [MCF] in case of a volume flow meter, [klbm] 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 f.e. happen in case the totalizer in the

		meter is reset or when the meter is replaced.
		Unit is [MCF] in case of a volume flow meter, [klbm] 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 [ft/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 MCF for volumetric flow meters, or klbm 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:

Meter factor = 100 / (100 + 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

Type of input value	1000	Defines the meaning of the entered values. Applies for both the nominal value and the calibration curve values.
		1: Meter factor [-]
		2: Meter error [%]

Nominal meter factor / error

Nominal meter factor / error	1000	The nominal meter factor [-] or error [%]
		Separate nominal meter factor / error for forward and reverse flow

Meter factor / error curve

Meter factor / error curve	1000	Controls whether the nominal meter factor / error or the calibration curve is used.
		0: Disabled Nominal value is used
		1: Enabled Calibration curve is used.
Curve extrapolation allowed	1000	Controls if extrapolation is allowed when the flow rate is outside the calibration curve
		0: No 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.
		1: Yes The interpolation is extrapolated when the pulse frequency is outside the calibrated range.
Curve flow rate corrected for MBF	1000	Only applicable if meter factor / error curve interpolation is enabled and meter body correction is enabled.
		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.
		0: Disabled Uncorrected flow rate is used in meter factor / error curve interpolation
		1: Enabled Corrected flow rate is used in meter factor / error curve interpolation
Prove base flow rate (forward or reverse)	1000	Only applicable if meter factor / error curve interpolation is enabled.
		Base flow rate at which the offset from the meter factor curve is calculated.
		[MCF/hr] in case of a volume flow meter, [klbm/hr] in case of a mass flow meter.
		The actual prove flow rate should not differ too much from this prove base flow rate.

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 meter factor	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.
		0: Disabled
		1: Enabled

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

Point x –Flow rate	1000	Flow rate [unit/h] of the calibration point
Point x – Meter factor / error	1000	Meter factor [-] or Meter error [%] of the calibration point, depending on the selected Type of input value.

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.

Meter factor offset

Meter factor offset	Offset from the meter factor curve as determined from proving.
	Calculated by the flow computer based on the prove result.

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

Data valid input type	1000	Selects the data valid input type
		0: None Data valid check is disabled
		1: Digital input Reads the data valid status from a digital input
		2: Smart meter input Uses the data valid status from the flow meter Modbus communication
		3: Custom The value that is written to tag Data valid custom condition will be used. Use this option if the data valid condition is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the data valid condition.
Data valid digital input module	1000	Only applicable if Data valid 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
Data valid digital input channel	1000	Only applicable if Data valid input type is 'Digital input'.
		Number of the digital channel on the selected module to which the signal is physically connected.

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

Flow direction input type	1000	Selects the flow direction input type
		1: Meter pulse phase 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.
		2: Digital input Reads the flow direction status from a digital input (0: Forward, 1: Reverse)
		3: Smart meter Modbus Uses the flow direction from the flow meter Modbus communication
		4: Custom 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.
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

Flow direction digital output	600	Enables / disables the flow direction digital output.
		0: Disabled
		1: Enabled
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.

Meter body correction	1000	Controls whether meter body correction is enabled or not
		0: Disabled
		1: Enabled
		-1: Local module means the module of the meter run itself
Meter body correction type	1000	Controls how the meter body correction factor is calculated
		1: Formula Calculated the meter body correction factor using the formula: MBF = 1 + Temp coef * (T - Tref) + Pres coef * (P - Pref)
		2: Custom Uses the value [-] 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.

Calculation constants

Body correction reference temperature	1000	Reference temperature for body correction [°F]
Body correction reference pressure	1000	Reference pressure for body correction [psi(g)]
Meter body coefficient selection	1000	1: Use parameter Uses the body expansion coefficients that are configured in the flow computer
		2: Read from flow meter Uses the body expansion coefficients that are read from the smart meter
		Note that communication of the body expansion coefficients via Modbus is not supported by all smart meters.

User coefficients

Cubical temperature expansion coefficient	1000	Cubical temperature expansion coefficient [1/°F)
		Equals linear temperature expansion coefficient multiplied by 3. Typical values are 2.29 E-5 for carbon steel and 2.91 E-5 for stainless steel.
Cubical pressure expansion coefficient	1000	Cubical pressure expansion coefficient [1/psi]
		Equals linear pressure expansion coefficient multiplied by 3. Typical value is 4 E-7 both for carbon steel and stainless steel.

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 [MCF] or [klbm] depending on the meter quantity type.

Forward totalizer

Preset fwd indicated totalizer value	1000	New value ([MCF] or [klbm]) for the forward indicated totalizer
Accept fwd totalizer	1000	Command to accept the new value for the forward indicated totalizer

Reverse totalizer

Preset rev indicated totalizer value	1000	New value ([CMF] or [klbm]) for the reverse indicated totalizer
Accept rev totalizer	1000	Command to accept the new value for the reverse indicated totalizer

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 Serial mode logic is disabled
		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

Meter active settings

Low flow cutoff dP	1000	Meter active threshold dP. The meter will be considered inactive when the actual differential pressure [inH2O@60°F] 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	1000	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.
		0: Disabled
		1: Enabled

Calculation method

Orifice calculation method	1000	Defines the standard used for the calculations
		1: ISO-5167
		2: AGA-3 flange tappings
		3: AGA-3 pipe tappings
ISO5167 edition	1000	The edition of the ISO-5167 standard to be used for the flow calculations.
		1: 1991
		2: 1998
		3: 2003
		Only applicable **if Orifice calculation method** is 'ISO-5167'

Pipe settings

Pipe diameter	1000	Internal pipe diameter [in]
Pipe reference temperature	1000	Reference temperature for the specified pipe diameter [°F]
Pipe expansion factor - type	1000	Selects the pipe material. Used to set the pipe linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°F]
		2: Stainless steel 304 9.6e-6 [1/°F]
		3: Stainless steel 316 8.83e-6 [1/°F]
		4: Monel 7.95e-6 [1/°F]
		5: User-defined (uses the 'Pipe expansion factor - user')
Pipe expansion factor - user	1000	User-defined value for pipe linear thermal expansion factor [1/°F]
		Only used when 'Pipe expansion factor - type' is set to 'User-defined'

Device settings

Device diameter	1000	Orifice internal diameter [in]
Device reference temperature	1000	Reference temperature for the specified device diameter [°F]
Device expansion factor - type	1000	Selects the orifice material. Used to set the device linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°K]
		2: Stainless steel 304 9.6e-6 [1/°K]
		3: Stainless steel 316 8.83e-6 [1/°K]
		4: Monel 7.95e-6 [1/°K]
		5: User-defined (uses the Device expansion factor - user)
Device expansion factor - user	1000	User-defined value for device linear thermal expansion factor [1/°F]
		Only used when 'Device expansion factor - type' is set to 'User-defined'
Orifice configuration	1000	Location of the pressure tappings in accordance with the ISO5167
		1: Corner tappings
		2: D and D/2 tappings
		3: Flange tappings
		Only applicable if **Orifice calculation method** is 'ISO-5167'
Drain hole diameter	1000	The drain hole size [mm]. When the value is > 0 then an additional correction on the orifice diameter will be applied to account for the effect the drain hole in accordance British standard 1042: Part 1: 1964.. Refer to chapter Calculations for more details

Pressure settings

Pressure transmitter location	1000	Location of the pressure tap used for the static pressure relative to the orifice plate.
		1: Upstream tapping
		2: Downstream tapping
		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

Temperature transmitter location	1000	Location of the temperature element relative to the orifice plate
		1: Upstream tapping
		2: Downstream tapping
		3: Recovered pressure position Downstream at the location where the pressure has fully recovered.
		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	1000	This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions
		1: Isentropic exponent Isentropic expansion using (1-κ)/κ as the temperature referral exponent
		2: Temperature exponent Isentropic expansion using the **Temperature Exponent** parameter value as the temperature referral exponent [-]. Please note that the 'Temperature Exponent' must be < 0
		3: Joule Thomson Isenthalpic expansion using the **Temperature Exponent** as the Joule Thomson coefficient [°F/psi]. This method is prescribed by ISO5167-1:2003 standard.
Temperature exponent	1000	Only used when temperature has to be corrected to upstream conditions and type of **temperature correction** is either 'Temperature exponent' or 'Joule Thomson'.
Joule Thomson coefficient type	1000	Only applicable if **Temperature correction** is set to 'Joule Thomson'. Defines how the Joule Thomson coefficient is defined.

Density settings

Density exponent	1000	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")
		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

Dynamic viscosity	Dynamic viscosity of the gas at flowing conditions [lbm/ft.s]. 1 [lbm/ft.s] = 1.488164 [Pa.s] = 1488.164 [cP].
Isentropic exponent	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

For classical venturi tubes in accordance with ISO-5167.

Only available if Meter device type is 'Venturi'

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

with <x> the module number of the meter run

Meter active settings

Low flow cutoff dP	1000	Meter active threshold dP. The meter will be considered inactive when the actual differential pressure [inH2O@60°F] 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	1000	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.
		0: Disabled
		1: Enabled

Pipe settings

Pipe diameter	1000	Internal pipe diameter [in]
Pipe reference temperature	1000	Reference temperature for the specified pipe diameter [°F]
Pipe expansion factor - type	1000	Selects the pipe material. Used to set the pipe linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°F]
		2: Stainless steel 304 9.6e-6 [1/°F]
		3: Stainless steel 316 8.83e-6 [1/°F]
		4: Monel 7.95e-6 [1/°F]
		5: User-defined (uses the 'Pipe expansion factor - user')
Pipe expansion factor - user	1000	User-defined value for pipe linear thermal expansion factor [1/°F]
		Only used when **Pipe expansion factor - type** is set to 'User-defined'

Device settings

Device diameter	1000	Venturi internal diameter [in]
Device reference temperature	1000	Reference temperature for the specified device diameter [°F]
Device expansion factor - type	1000	Selects the venturi material. Used to set the device linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°F]
		2: Stainless steel 304 9.6e-6 [1/°F]
		3: Stainless steel 316 8.83e-6 [1/°F]
		4: Monel 7.95e-6 [1/°F]
		5: User-defined (uses the Device expansion factor - user)
Device expansion factor - user	1000	User-defined value for device linear thermal expansion factor [1/°F]
		Only used when **Device expansion factor - type** is set to 'User-defined'
Venturi configuration	1000	ISO5167 specifies different discharge coefficients for the different fabrication methods. By selecting the right configuration, the appropriate discharge coefficient is used.
		1: As cast convergent section
		2: Rough welded
		3: Machined
		4: User-defined
		When 'User-defined' is selected then the parameter 'Discharge coefficient' will be used in the calculations. Note that he use of this option is not in accordance to the standard.

Discharge coefficient

Discharge coefficient	1000	The user-defined discharge coefficient.
		Only used if parameter Venturi configuration is set to 'User-defined'..

Pressure settings

Pressure transmitter location	1000	Location of the pressure tap used for the static pressure relative to the venturi.
		1: Upstream tapping
		2: Downstream tapping
		If 'Downstream tapping' is selected, a correction of the meter pressure to upstream conditions is applied. Refer to chapter Calculations for more details
Pressure loss mode	1000	The method for determining the pressure loss over the venturi tube
		1: Absolute value The pressure loss is taken as an absolute value (as set in parameter 'Pressure Loss Value')
		2: Percentage of dP The pressure loss value is taken as a percentage of the differential pressure. The percentage is as set in parameter 'Pressure Loss Value'.
Pressure loss value	1000	The pressure loss value either as an absolute value [inH2O@60°F] or as a percentage [%] of dP.

Temperature settings

Temperature transmitter location	1000	Location of the temperature element relative to the venturi
		1: Upstream tapping
		2: Downstream tapping
		3: Recovered pressure position Downstream at the location where the pressure has fully recovered.
		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	1000	This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions
		1: Isentropic exponent Isentropic expansion using (1-κ)/κ as the temperature referral exponent
		2: Temperature exponent Isentropic expansion using the **Temperature Exponent** parameter value as the temperature referral exponent [-]. Please note that the 'Temperature Exponent' must be < 0
		3: Joule Thomson Isenthalpic expansion using the **'Temperature Exponent'** as the Joule Thomson coefficient [°F/psi]. This method is prescribed by ISO5167-1:2003..
Temperature exponent	1000	Only used when temperature has to be corrected to upstream conditions and type of **temperature correction** is either 'Temperature exponent' or 'Joule Thomson'.

Density settings

Density exponent	1000	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")
		If Density exponent = 0, then isentropic density correction is applied (using 1/isentropic exponent)

Product properties

Dynamic viscosity	1000	Dynamic viscosity of the gas at flowing conditions [lbm/ft.s]. 1 [lbm/ft.s] = 1.488164 [Pa.s] = 1488.164 [cP].
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

Low flow cutoff dP	1000	Meter active threshold dP. The meter will be considered inactive when the actual differential pressure [inH2O@60°F] 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	1000	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.
		0: Disabled
		1: Enabled

Pipe settings

Pipe diameter	1000	Internal pipe diameter [in]
Pipe reference temperature	1000	Reference temperature for the specified pipe diameter [°F]
Pipe expansion factor - type	1000	Selects the pipe material. Used to set the pipe linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°F]
		2: Stainless steel 304 9.6e-6 [1/°F]
		3: Stainless steel 316 8.83e-6 [1/°F]
		4: Monel 7.95e-6 [1/°F]
		5: User-defined (uses the 'Pipe expansion factor - user')
Pipe expansion factor - user	1000	User-defined value for pipe linear thermal expansion factor [1/°F]
		Only used if **Pipe expansion factor - type is set** to 'User-defined'

Device settings

Device diameter	1000	V-cone internal diameter [in]
Device reference temperature	1000	Reference temperature for the specified device diameter [°F]
Device expansion factor - type	1000	Selects the V-cone material. Used to set the device linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°F]
		2: Stainless steel 304 9.6e-6 [1/°F]
		3: Stainless steel 316 8.83e-6 [1/°F]
		4: Monel 7.95e-6 [1/°F]
		5: User-defined (uses the Device expansion factor - user)
Device expansion factor - user	1000	User-defined value for device linear thermal expansion factor [1/°F]
		Only used if **Device expansion factor – type** is set to 'User defined'
V-cone configuration	1000	V-cone configuration:
		1: Standard V-cone
		2: Wafer cone

Pressure settings

Pressure transmitter location	1000	Location of the pressure tap used for the static pressure relative to the v-cone.
		1: Upstream tapping
		2: Downstream tapping
		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

Temperature transmitter location	1000	Location of the temperature element relative to the v-cone
		1: Upstream tapping
		2: Downstream tapping
		3: Recovered pressure position
		Downstream at the location where the pressure has fully recovered.
		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	1000	This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions
		1: Isentropic exponent Isentropic expansion using (1-κ)/κ as the temperature referral exponent
		2: Temperature exponent Isentropic expansion using the **Temperature Exponent** parameter value as the temperature referral exponent [-]. Please note that the 'Temperature Exponent' must be < 0
		3: Joule Thomson Isenthalpic expansion using the **'Temperature Exponent'** as the Joule Thomson coefficient [°F/psi]. This method is prescribed by ISO5167-1:2003.
Temperature exponent	1000	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'.

Density settings

Density exponent	1000	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”)
		If Density exponent = 0, then isentropic density correction is applied (using 1/isentropic exponent)

Discharge coefficient

Discharge coefficient	1000	The discharge coefficient of the cone.

Product properties

Dynamic viscosity	1000	Dynamic viscosity of the gas at flowing conditions [lbm/ft.s]. 1 [lbm/ft.s] = 1.488164 [Pa.s] = 1488.164 [cP].
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.

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’

Display → Configuration, Run <x>, Flow meter, Venturi nozzle

Display → Configuration, Run <x>, Flow meter, Long radius nozzle

Display → Configuration, Run <x>, Flow meter, ISA1932 nozzle

with <x> the module number of the meter run

Meter active settings

Low flow cutoff dP	1000	Meter active threshold dP. The meter will be considered inactive when the actual differential pressure [inH2O@60°F] 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	1000	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.
		0: Disabled
		1: Enabled

Calculation method

ISO5167 edition	1000	The edition of the ISO-5167 standard to be used for the flow calculations.
		1: 1991
		2: 1998
		3: 2003
		Only applicable to long radius nozzles and ISA1932 nozzles

Pipe settings

Pipe diameter	1000	Internal pipe diameter [mm]
Pipe diameter	1000	Internal pipe diameter [mm]
Pipe reference temperature	1000	Reference temperature for the specified pipe diameter [°F]
Pipe expansion factor -type	1000	Selects the pipe material. Used to set the pipe linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°F]
		2: Stainless steel 304 9.6e-6 [1/°F]
		3: Stainless steel 316 8.83e-6 [1/°F]
		4: Monel 7.95e-6 [1/°F]
		5: User-defined (uses the 'Pipe expansion factor - user')
Pipe expansion factor -user	1000	User-defined value for pipe linear thermal expansion factor [1/°F]
		Only used when **Pipe expansion factor - type** is set to 'User-defined'

Device settings

Device diameter	1000	Nozzle internal diameter [mm]
Device reference temperature	1000	Reference temperature for the specified device diameter [°F]
Device expansion factor - type	1000	Selects the nozzle material. Used to set the device linear thermal expansion factor.
		1: Carbon steel 6.2e-6 [1/°F]
		2: Stainless steel 304 9.6e-6 [1/°F]
		3: Stainless steel 316 8.83e-6 [1/°F]
		4: Monel 7.95e-6 [1/°F]
		5: User-defined (uses the Device expansion factor - user)
Device expansion factor - user	1000	User-defined value for venturi linear thermal expansion factor [1/°F]
		Only used when **Device expansion factor - type** is set to 'User-defined'

Pressure settings

Pressure transmitter location	1000	Location of the pressure tap used for the static pressure relative to the nozzle.
		1: Upstream tapping
		2: Downstream tapping
		If 'Downstream tapping' is selected, a correction of the meter pressure to upstream conditions is applied. Refer to chapter Calculations for more details
Pressure loss mode	1000	Only applicable to venturi nozzles.
		The method for determining the pressure loss over the nozzle
		1: Absolute value The pressure loss is taken as an absolute value (as set in parameter 'Pressure Loss Value')
		2: Percentage of dP The pressure loss value is taken as a percentage of the differential pressure. The percentage is as set in parameter 'Pressure Loss Value'.
Pressure loss value	1000	Only applicable to venturi nozzles.
		The pressure loss value either as an absolute value [inH2O@60°F] or as a percentage [%] of dP.

Temperature settings

Temperature transmitter location	1000	Location of the temperature element relative to the nozzle
		1: Upstream tapping
		2: Downstream tapping
		3: Recovered pressure position Downstream at the location where the pressure has fully recovered.
		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	1000	This parameter specifies how the temperature must be corrected from downstream / recovered to upstream conditions
		1: Isentropic exponent Isentropic expansion using (1-κ)/κ as the temperature referral exponent
		2: Temperature exponent Isentropic expansion using the 'Temperature Exponent' parameter value as the temperature referral exponent [-]. Please note that the 'Temperature Exponent' must be < 0
		3: Joule Thomson Isenthalpic expansion using the 'Temperature Exponent' as the Joule Thomson coefficient [°F/psi]. This method is prescribed by ISO5167-1:2003.
Temperature exponent	1000	Only used when temperature has to be corrected to upstream conditions and type of temperature correction is either 'Temperature exponent' or 'Joule Thomson'.

Product properties

Dynamic viscosity	1000	Dynamic viscosity of the gas at flowing conditions [lbm/ft.s]. 1 [lbm/ft.s] = 1.488164 [Pa.s] = 1488.164 [cP].
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.

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

dP selection type	1000	dP selection type
		1: 1 cell full range Cell A - full range
		2: 2 cells low / high range Cell A - low range Cell B - high range
		3: 2 cells full range Cell A - full range Cell B - full range
		4: 3 cells low / mid / high range Cell A - low range Cell B - mid range Cell C - high range
		5: 3 cells low / high / high range Cell A - low range Cell B - high range Cell C - high range
		6: 3 cells full range Cell A - full range Cell B - full range Cell C - full range
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 [inH2O@60F]. 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

Fallback 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'
Fallback value	1000	Only used if **Fallback type** is 'Fallback value'. Represents the differential pressure [inH2O@60F] that is used when the input fails.

dP input A, B and C

Display → Configuration, Run <x>, Flow meter, dP inputs, dP input A/B/C

with <x> the module number of the meter run

Input type

Input type	1000	Type of input for dP cell 2: Analog input 4: HART 5: Custom If option 5: Custom is selected then the value [inH2O@60F] 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

Diff. pressure analog input module	1000	Number of the flow module to which the dP signal is physically connected to. -1: Local module means the module of the meter run itself
Diff. pressure analog input channel	1000	Number of the analog input channel on the selected module to which the dP signal is physically connected.

HART settings

These settings are only applicable if **diff. pressure input type** is 'HART'

Diff. pressure HART internal device nr.	1000	Internal device nr. of the HART transmitter as assigned in the configuration software (Flow-Xpress: 'Ports & Devices')
Diff. pressure HART variable value	1000	Determines which of the 4 HART variables provided by the HART transmitter is used. Select the variable that represents the **dP value [inH2O@60F]**. Usually this is the 1st (primary) variable.
Diff. pressure HART full scale	1000	Full scale [inH2O@60F] 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.
Diff. pressure HART zero scale	1000	Zero scale [inH2O@60F] 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.
HART to analog fallback	1000	Only applies for a 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 to 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 to 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.

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; f.e. 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.

Station tag	600	Station tag (text)
Station ID	600	Station ID (text)

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.

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	1000	See paragraph 'Heating value input'

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	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'.

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.

Remote run max. system time deviation	1000	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.
Delay for system time out of sync alarms	1000	System time out of sync alarms only become active after the deviation has been larger than the 'max. deviation' during the delay time [s].

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

For each prover (A/B):
- One prover inlet temperature transmitter
- One prover outlet temperature transmitter
- One prover rod temperature transmitter (for Calibron / Flow MD small volume prover)
- One prover density 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 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.

In case of a prover observed (live) density, a density temperature transmitter is optional. If no prover density temperature transmitter is configured, the flow computer uses the prover temperature (which is the average of the prover inlet temperature and the prover outlet temperature).

Prover temperature transmitters
If both prover inlet and outlet temperatures are configured, the in-use prover temperature is calculated as the average of both. If only one of them is configured, the in-use prover temperature equals this one. If none is configured, the flow computer uses the meter temperature.

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, Proving (, Prover A/B), Temperature (, Prover inlet temperature)

Display → Configuration, Proving (, Prover A/B), Temperature (, Prover outlet temperature)

Display → Configuration, Proving (, Prover A/B), Temperature, Prover rod temperature

Display → Configuration, Proving (, Prover A/B), Temperature, Prover density 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:

Input type

Input type	1000	Type of input
		1: Always use override
		2: Analog input
		3: PT100 input
		4: HART
		5: Custom input
		6: Smart flow meter (meter temperature only)
		If option 5: Custom is selected then the value [°F] that is written to the corresponding custom input tag (e.g. **Meter temperature custom value**) will be 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 temperature.

Analog / PT100 input settings
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.

Analog / PT100 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 / PT100 input channel	1000	Number of the analog / PT100 input channel on the selected module to which the signal is physically connected.

HART settings
These settings are only applicable if the **temperature 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 **temperature**. Usually this is the 1st (primary) variable.
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 **temperature input type** is 'Smart meter'.

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

Fail fallback

Fallback type	1000	Determines what to do if 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 temperature [°F] that is used when the input fails.

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

Dual transmitter mode	1000	Determines how the in-use meter temperature is calculated from both transmitter values
		1: Auto transmitter A 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.
		2: Auto transmitter B 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.
		3: Average 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.

Transmitter deviation

Meter temperature deviation limit	1000	Temperature deviation limit [°F].
		If the deviation between two temperature transmitters exceeds this limit, then a temperature deviation alarm is generated.
Temperature deviation fallback mode	1000	Determines what happens in case of a temperature deviation alarm.
		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

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

For each prover (A/B):

- One prover inlet pressure transmitter
- One prover outlet pressure transmitter
- One prover plenum pressure transmitter (for Brooks compact prover)
- One prover density 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.

In case of a prover observed (live) density, a density pressure transmitter is optional. If no prover density pressure transmitter is configured, the flow computer uses the prover pressure (which is the average of the prover inlet pressure and the prover outlet pressure).

Prover pressure transmitters

If both prover inlet and outlet pressures are configured, the in-use prover pressure is calculated as the average of both. If only one of them is configured, the in-use prover pressure equals this one. If none is configured, the flow computer uses the meter pressure.

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, Auxiliary inputs, Auxiliary pressure 1/2

with <x> the module number of the meter run

For each pressure transmitter the following settings are available:

Input type

Input type	1000	Type of input
		1: Always use override
		2: Analog input
		4: HART
		5: Custom input
		6: Smart flow meter (meter pressure only)
		If option 5: Custom is selected then the value ([psia] or [psig], 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.

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’.

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 pressure. Usually this is the 1st (primary) variable.
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.	1000	Device nr. of the smart meter as assigned in the configuration software (Flow-Xpress, section 'Ports & Devices')

Fail fallback

Fallback type	1000	Determines what to do if 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 pressure ([psia] or [psig], depending on the selected input units) that is used when the input fails.

Pressure transmitter selection

Only applicable in case of dual meter pressure transmitters

Display → Configuration, Run <x>, Pressure, Meter pressure

with <x> the module number of the meter run

Transmitter selection

Dual transmitter mode	1000	Determines how the in-use meter pressure is calculated from both transmitter values
		1: Auto transmitter A 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.
		2: Auto transmitter B 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.
		3: Average 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.

Transmitter deviation

Meter pressure deviation limit	1000	Pressure deviation limit [psi].
		If the deviation between two pressure transmitters exceeds this limit, then a pressure deviation alarm is generated.
Pressure deviation fallback mode	1000	Determines what happens in case of a pressure deviation alarm.
		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

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.

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

Display → Configuration, Station, Density (, Density setup)

with <x> the module number of the meter run

Observed density input type	1000	Defines how the observed density (density at densitometer conditions) is determined
		0: None There is no observed density input
		1: Always use override Use this option if a fixed value is used for the observed density
		2: Analog input
		4: HART/Modbus
		5: Custom input
		The value [lb/cf] 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.
		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.
Density temperature input type	1000	Type of input for the density temperature (temperature at the density meter).
		0: None
		1: Always use override
		2: Analog input
		3: PT100 input
		4: HART
		5: Custom input If this option is selected then the value [°F] 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 station flow computer.
Density pressure input type	1000	Type of input for the density pressure (pressure at the density meter).
		0: None
		1: Always use override
		2: Analog input
		4: HART
		5: Custom input If this option is selected then the value [psi] 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.
Base density input type	1000	Defines how the base density (density at reference conditions) is determined
		1: Always use override Use this option if a fixed value is used for the base density
		5: Custom input The value [lb/scf] 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. Refer to chapter Calculations for more information about the actual calculations
		8: Specific gravity The base density is calculated from the specific gravity value Refer to chapter Calculations for more information about the actual calculations
		12: Gas chromatograph Uses the base density that is read from the gas chromatograph
		13: Relative density The base density is calculated from the relative density value Refer to chapter Calculations for more information about the actual calculations
		14: Base compressibility method The base density is calculated by the same method that has been configured to calculate the base compressibility. This option is only valid in combination with one of the following base compressibility methods: AGA8 (detailed) ISO6976 – 1983 ISO6976 – 1995 GPA2172 GERG 2008 GSSSD MR113 2003 The **base compressibility method** setting can be found on the display: Gas properties, Calculation setup.
		In case of a remote run FC with **Station product** enabled the base density is read from the station flow computer.
Specific gravity input type	1000	Defines how the specific gravity (SG at reference conditions) is determined
		0: Calculated There is no specific gravity input. Specific gravity is calculated from base density
		1: Always use override Use this option if a fixed value is used for the specific gravity
		2: Analog input
		4: HART
		5: Custom The value [-] that is written to tag **Specific gravity custom value** will be used as the specific gravity. Use this option if the specific gravity value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the specific gravity value.
		6: One SG transducer The specific gravity is read from a single SG transducer.
		7: Two SG transducers The specific gravity is provided by two (redundant) SG transducers. The specific gravity of the selected SG transducer is used.
		13: Gas chromatograph Uses the specific gravity that is read from the gas chromatograph
		In case of a remote run FC with **Station product** enabled the specific gravity is read from the station flow computer.
Relative density input type	1000	Defines how relative density (at reference conditions) is determined
		0: Calculated There is no relative density input. Relative density is calculated from base density
		1: Always use override Use this option if a fixed value is used for the relative density
		5: Custom The value [-] 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.
		13: Gas chromatograph Uses the relative density that is read from the gas chromatograph
		In case of a remote run FC with **Station product** enabled the relative density is read from the station flow computer.
Meter density calculation method	1000	Defines how the meter density (density at line conditions) is calculated
		1: Base density The meter density is calculated from the base density.
		2: Observed density The meter density is calculated from the observed density.
		3: Down- to upstream correction 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.
		4: Custom input The value [lb/cf] 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.
		5: Compressibility method The base density is calculated by the same method that has been configured to calculate the compressibility. This option is only valid in combination with one of the following compressibility methods: AGA8 (detailed) GERG 2008 The **compressibility method** setting can be found on the display: Gas properties, Calculation setup.

(!) 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 b**ase 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

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	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 **observed density 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 **observed density**. Usually this is the 1st (primary) variable.
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

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

HART internal device nr.	1000	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.

Deviation limit

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

Observed / AGA-8 density deviation limit	1000	Deviation limit [lb/cf] 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 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	1000	Densitometer A/B device type.
		1: Solartron
		2: Sarasota
		3: UGC
Densitometer A/B units	1000	Densitometer A/B units.
		1: kg/m3
		2: g/cc
		3: lb/CF
Densitometer select mode	500	Only applicable if **Observed density input type** is set to 'Two densitometers'.
		Densitometer selection mode.
		1: Auto-A Densitometer B only used when densitometer A fails and densitometer B is healthy. Densitometer A is used in all other cases.
		2: Auto-B Densitometer A is only used when densitometer B fails and densitometer A is healthy. Densitometer B is used in all other cases.
		3: Manual-A Always use densitometer A irrespective of its failure status
		4: Manual-B Always use densitometer B irrespective of its failure status

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'.

Time period Input module	1000	Flow-X module to which the densitometer A/B signal is connected to.
Input number	1000	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 [lb/cf] 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 [lb/cf], then a 'Densitometer A/B deviation limit exceeded' alarm is generated.

Density correction factor

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

Solartron / 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

Display → Configuration, Station, 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

Display → Configuration, Station, 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. -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 **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 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

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 specific gravity [-] to be used when the input fails.

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 to.
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	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.

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. 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

Fail fallback

Fallback type	1000	Determines what to do in case the input / 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'

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

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.

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

Display → Configuration, Station, Gas properties, Gas Composition

with <x> the module number of the meter run

Gas composition input type	1000	Defines how the gas composition is provided to the flow computer
		0: None No gas composition is being used
		1: Always use override composition Always uses the override gas composition, which is manually entered through the operator display
		2: One gas chromatograph The gas composition is provided by a single gas chromatograph (GC). The composition may be overruled by the override composition
		3: Two gas chromatographs 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
		4: Custom composition 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.
		In case of a remote run FC with Station product enabled the gas composition is read from the station flow computer.
Composition fallback type	1000	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)
		1: Use last received Keep using the last received composition before the failure
		3: Use override composition Use the override composition
Composition fail on limit alarm	1000	Determines what to do when one or more components, or the sum of components, are out of limits.
		0: Disabled The live gas composition is used, even in case of a composition limit alarm.
		1: Enabled 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).
Composition normalization	1000	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, GERG2008 or GSSSD-MR113 is used for compressibility, molar mass or heating value calculation, then gas composition normalization is enabled automatically.
		0: Disabled
		1: Enabled
neo-Pentane mode	1000	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.
		1: Add to i-C5 The neo-Pentane component is added to i-Pentane
		2: Add to n-C5 The neo-Pentane component is added to n-Pentane
		3: Neglect The neo-Pentane component is not taken into account

Live composition split

These settings apply to the live gas composition received from the **gas chromatograph** or the **custom composition**, <u>not</u> to the override composition.

Live composition Cx+ split mode	1000	Controls the split up of the C6+, C7+, C8+ or C9+ component of the live composition
		1: Not used The values for C6, C7, C8, C9 and C10 will be used as received from the GC
		2: C6+ split 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.
		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 received from the GC. The values of C7, C8, C9 and C10 as received from the GC 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 received from the GC. The values of C8, C9 and C10 as received from the GC 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 received from the GC. The values of C9 and C10 as received from the GC are neglected.
Live composition C6 split %	1000	The C6 split percentage [%] for the live composition
		Only applicable to split mode C6+
Live composition C7 split %	1000	The C7 split percentage [%] for the live composition
		Only applicable to split modes C6+ and C7+
Live composition C8 split %	1000	The C8 split percentage [%] for the live composition
		Only applicable to split modes C6+, C7+ and C8+
Live composition C9 split %	1000	The C9 split percentage [%] for the live composition
		Only applicable to split modes C6+, C7+, C8+ and C9+
Live composition C10 split %	1000	The C10 split percentage [%] for the live composition
		Applicable to all split modes

The split percentages must add up to 100%

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.

Override composition Cx+ split mode	1000	Controls the split up of the C6+, C7+, C8+ or C9+ component from the override composition
		1: Not used
		2: C6+ split The C6(+) component from the override composition 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 from the override composition is split into C7, C8, C9 and C10 according to the defined split percentages. The value of C6 is used as specified in the override composition. The values of C8, C9 and C10 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 value of C10 from the override composition is neglected.
		The values for C6, C7, C8, C9 and C10 will be used as specified by the override composition
Override composition C6 split %	1000	The C6 split percentage [%] for the override composition
		Only applicable to split mode C6+
Override composition C7 split %	1000	The C7 split percentage [%] for the override composition
		Only applicable to split modes C6+ and C7+
Override composition C8 split %	1000	The C8 split percentage [%] for the override composition
		Only applicable to split modes C6+, C7+ and C8+
Override composition C9 split %	1000	The C9 split percentage [%] for the override composition
		Only applicable to split modes C6+, C7+, C8+ and C9+
Override composition C10 split %	1000	The C10 split percentage [%] for the override composition
		Applicable to all split modes

The split percentages must add up to 100%

Analysis delayed alarm

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.

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:

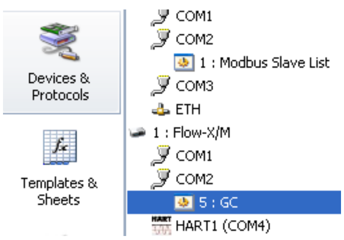
<…> fraction input	1000	Defines whether the fraction [mole %] is read as part of the gas composition, or from another source.
		0: Gas composition The component is read as part of the gas composition (GC or custom composition).
		1: Fixed value A fixed value is used for the component
		2: Custom input 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’.

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, Overall setup.

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

GC selection mode	500	Only applicable if 'Gas composition input type' is set to Two Gas Chromatographs'
		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.
		3: Manual-A GC A is always selected, independent of any failure
		4: Manual-B GC B is always selected, independent of any failure
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
		1: Enabled
GC A/B required stream number	1000	Only applicable if **multi-stream** is 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

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. 5: Custom The values that are written to the tags **Meter 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. 6: GERG 2008 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).
Meter compressibility override value	1000	Meter compressibility override value that is used when the compressibility calculation method is set to 'Override value'
Density compressibility override value	1000	Density compressibility override value that is used when the compressibility calculation method is set to 'Override value'
Base compressibility calculation method	1000	Method to calculate the compressibility factor at the reference conditions (Zbase). 1: Override Uses the base compressibility override value 2: AGA8 (detailed) Requires the gas composition 3: SGERG (AGA 8 gross) Requires process inputs for hydrogen and at least 3 out 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. 5: ISO6976-1983 Requires a gas composition 6: ISO6976-1995 Requires a gas composition 7: GPA2172 Requires a gas composition 8: Custom The value that is written to the tag **Base compressibility custom value** will be used. Use this option if the base compressibility value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the base compressibility. 9: Gas Chromatograph Uses the base compressibility that is read from the gas chromatograph. 10: GERG 2008 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). In case of a remote run FC with **Station product** enabled the base compressibility is read from the station flow computer.
Base compressibility override value	1000	Base compressibility override value that is used if the base compressibility calculation method is set to 'Override value'
(Remote) base compressibility fallback type	1000	Only applicable if the **base compressibility calculation method** is set to 'Gas Chromatograph', or in case of a 'remote run' flow computer with **Station product** enabled. Determines what to do in case the communication to the gas chromatograph / 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'
(Remote) base compressibility fallback value	1000	Only used if Fallback type is 'Fallback value'. Represents the base compressibility [-] to be used when the communication to the gas chromatograph / remote station flow computer fails.

Molar mass

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

Molar mass calculation method	1000	Method to calculate the molar mass 1: Override Uses the molar mass override value 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: ISO6976-1983 Requires a gas composition 5: ISO6976-1995 Requires a gas composition 6: GPA2172 Requires a gas composition 7: Custom The value [lb/lbmol] 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. 8: GERG 2008 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). In case of a remote run FC **with Station product** enabled the molar mass is read from the station flow computer.
Molar mass override value	1000	Molar mass override value [lb/lbmol] that is used when the molar mass calculation method is set to 'Override'
Remote molar mass fallback type	1000	Only applicable in case of a 'remote run' flow 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'
Remote molar mass fallback value	1000	Only used if Fallback type is 'Fallback value'.
		Represents the base molar mass [lb/lbmol] to be used when the communication to the remote station flow computer fails.

Heating value

Heating value calculation method	1000	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: GGHV/RD 60/60 °F, 14.73 psia
		2: GHV/RD 60/60 °F, 1.01592 bara

NX-19 settings

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

NX19 G9 correction method	1000	Controls whether the AGA-NX-19-mod / AGA-NX-19-mod.BR.KORR.3H is used instead of the AGA-NX-19-1962 standard calculation.
		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
		6: 25°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
IS06976-1983 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
		1: 0 °C 2: 15 °C
IS06976-1983 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: GPA2145-89 1989 edition
		2: GPA2145-00 2000 edition
		1: GPA2145-03 2003 edition
		2: GPA2145-09 2009 edition

Dynamic viscosity

Dynamic viscosity	1000	Dynamic viscosity of the gas at flowing conditions [Pa.s].
		1 [lbm/ft.s] = 1.488164 [Pa.s] = 1488.164 [cP]. Value is required for ISO-5167 / AGA-3 mass flow calculations..

Isentropic exponent

Isentropic	1000	Isentropic exponent of the gas at flowing

exponent	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. Value is required for ISO-5167 / AGA-3 mass flow calculations.

Heating Value input

The heating value is used to calculate the energy flow rates and totalizers.

The heating value is either calculated (see paragraph ‘Calculation Setup’) or read into the flow computer as a process value (analog, HART, Gas Chromatograph).

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 [BTU/scf] or mass based heating value [BTU/lbm] 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

Display → Configuration, Station, Gas properties, Heating value input

with <x> the module number of the meter run

Input type

Input type	1000	Type of input
		0: Calculated Uses the heating value calculated according to ISO-6976:83, ISO-6976:95 or GPA2172 (see paragraph ‘Calculation Setup’)
		1: Always use override
		2: Analog input
		4: HART
		5: Custom input The value [BTU/scf] or [BTU/lbm] 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.
		7: Gas chromatograph Uses the heating value read from a gas chromatograph
		In case of a remote run FC **with Station product** enabled the heating value is read from the station flow computer.
Heating value type	1000	Determines whether a volumetric or mass based heating value is used in the calculations.
		1: Volume based
		2: Mass based

Analog input settings

These settings are only applicable if the **heating value input type** is ‘Analog input’, or if the **heating value 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 **heating value 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 **Heating Value**. Usually this is the 1st (primary) variable.
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. 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

Fallback type	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'
Fallback value	1000	Only used if Fallback type is 'Fallback value'.
		Represents the heating value [BTU/scf] or [BTU/lbm] to be used when the input fails.

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 (H_2), nitrogen (N_2; optional) and carbon dioxide (CO_2; 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.

Display → Configuration, Run <x>, Gas properties, H2 input

Display → Configuration, Run <x>, Gas properties, N2 input

Display → Configuration, Run <x>, Gas properties, CO2 input

Display → Configuration, Station, Gas properties, H2 input

Display → Configuration, Station, Gas properties, N2 input

Display → Configuration, Station, Gas properties, CO2 input

with <x> the module number of the meter run

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

Input type

input type	1000	Type of input
		0: None The input is not used
		1: Always use override
		2: Analog input
		4: HART
		5: Custom input The value [% mol/mol] that is written to the **CO2 / H2 / N2 custom value** will be used. Use this option if the value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the CO2 / H2 / N2 content.
		7: Gas chromatograph value Uses the CO2 / H2 / N2 value read from a gas chromatograph
		In case of a remote run FC with **Station product** enabled the CO2 / H2 / N2 values are read from the station flow computer.

Analog input settings

These settings are only applicable if the **input type** is ‘Analog input’, or if the **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 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. 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.

HART settings

These settings are only applicable if the **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 **CO2 / H2 / N2 value**. Usually this is the 1st (primary) variable.

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 when Fallback type is 'Fallback value'.
		Represents the value [%mol/mol] to be used when the input fails.

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)

Analog output <y> Variable	600	The variable that is used for the analog output.
		For each run any of the following variables can be selected: -1 : Custom 0: Not assigned 1: Gross volume flow rate 2: Base volume flow rate 3: Mass flow rate 4: Energy flow rate 5: Specific gravity 6: Base density 7: Relative density 8: Heating value (volumetric) 9: Heating value (mass based) 10: Meter temperature 11: Meter pressure [psia] 12: Meter pressure [psig]

		13: Meter density 14: Observed density
		For the station the following variables can be selected: -1 : Custom 0: Not assigned 1: Gross volume flow rate 2: Base volume flow rate 3: Mass flow rate 4: Energy flow rate 5: Specific gravity 6: Base density 7: Relative density 8: Heating value (volumetric) 9: Heating value (mass based) 10: Observed density
		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.
Analog output <y> module	600	Number of the flow module that is used for this output. -1: Local module means the module of the meter run itself
Analog output <y> channel	600	Analog output channel on the specified module that is used for this output.

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>

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>

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)

Pulse output <y> totalizer	600	The totalizer that is used for the pulse output. --1: Custom 0: Not assigned 1: Indicated (forward)* 2: Gross volume (forward) 3: Base volume (forward) 4: Mass (forward) 5: Energy (forward) 6: Good pulses (forward)* 7: Error pulses (forward)* 8: Indicated (reverse)* 9: Gross volume (reverse) 10: Base volume (reverse) 11: Mass (reverse) 12: Energy (reverse) 13: Good pulses (reverse)* 14: Error pulses (reverse)* 15: Indicated (forward/reverse)* 16: Gross volume (forward/reverse) 17: Base volume (forward/reverse) 18: Mass (forward/reverse) 19: Energy (forward/reverse) 20: Good pulses (forward/reverse)* 21: Error pulses (forward/reverse)* *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, f.e. converting them into different units.
Pulse output <y> 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
Pulse output <y> index	600	Pulse output number on the specified module that is used for the signal. 1: Pulse output 1 2: Pulse output 2 3: Pulse output 3 4: Pulse output 4
Pulse output <y> Quantity per pulse	600	Factor that specifies the amount that corresponds to 1 pulse. The unit depends on the totalizer that has been selected: [MCF/pls], [MSCF/pls], [klbm/pls] or [MMBTU/pls]. E.g. a value of 100 means that 1 pulse is generated whenever 100 input units (MCF, MSCF, klbm or MMBTU) have been accumulated.

The pulse output settings like pulse duration and max. frequency can be configured on the I/O configuration display: IO, Module <x>, Configuration, Pulse outputs, Pulse output <y>

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 <y> totalizer	600	The totalizer that is used for the frequency output. --1: Custom 0: Not assigned 1: Indicated flow rate 2: Gross volume flow rate 3: Base volume flow rate 4: Mass flow rate 5: Energy flow rate
		Selection 'Not assigned' disables the output.
		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.
Frequency output <y> 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
Frequency output <y> index	600	Frequency output number on the specified module that is used for the signal.
		1: Frequency output 1
		2: Frequency output 2
		3: Frequency output 3 4: Frequency output 4

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

Snapshot report	600	Defines whether or not snapshot reports can be generated.
		0 : Disabled
		1: Enabled
		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.

Print snapshot digital input module	600	Number of the flow module to which the input signal is physically connected.
		-1: Local module means the module of the meter run itself
Print snapshot digital output channel	600	Number of the digital channel on the selected module to which the input signal is physically connected.
		Enter '0' to un-assign the snapshot request digital input.

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:

Closed DI	Open DI	Valve position
ON	OFF	Closed
OFF	ON	Open
OFF	OFF	Traveling or Valve fault, depending on configured 'traveling type'
ON	ON	Traveling or Valve fault, depending on configured 'traveling type'

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
		1: Two pulsed outputs Two separate outputs for open and close commands. The outputs remain ON until the **valve control pulse duration** time has passed.
		2: Two maintained outputs 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.
		3: Single output (open) 1 output to open the valve (ON = open). After a valve open command the output stays ON until a close command is given.
		4: Single output (close) 1 output to close the valve (ON = close). After a valve close command the output stays ON until an open command is given
Valve control pulse duration	600	Only applicable if Valve control signals is set to ‘Two pulsed outputs’.
		Defines the pulse duration [s] of the valve control output signals.
Valve position signals	600	0: No inputs No inputs for open and close positions. The valve position is solely derived from the latest valve command.
		1: Two inputs Two separate inputs for open and close positions.
		2: Single input (open) Single input that is ON when the valve is in the open position, else OFF.
		3: Single input (closed) One input that is ON when the valve is in the closed position, else OFF.
Valve traveling type	600	Only applicable in case of 2 position signals.
		Determines how the ‘traveling’ and ‘fault’ statuses are derived:
		1: Both inputs inactive 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.
		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.
Valve travel timeout period	600	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.

Position inputs

Open position DI module	600	Module to which the open position signal is physically connected.
		-1: Local module means the module of the meter run itself
Open position DI channel	600	Digital channel on the selected module to which the open position signal is physically connected
Closed position DI module	600	Module to which the closed position signal is physically connected.
		-1: Local module means the module of the meter run itself
Closed position DI channel	600	Digital channel on the selected module to which the closed position signal is physically connected

Control outputs

Open control DO module	600	Module to which the open control output signal is physically connected
		-1: Local module means the module of the meter run itself
Open control DO channel	600	Digital channel on the selected module to which the open control output signal is physically connected
Close control DO module	600	Module to which the close control output signal is physically connected
		-1: Local module means the module of the meter run itself
Close control DO channel	600	Digital channel on the selected module to which the close control output signal is physically connected

Local / remote input

Local / remote DI module	600	Module to which the local / remote signal is physically connected.
		-1: Local module means the module of the meter run itself
Local / remote DI channel	600	Digital channel on the selected module to which the local / remote signal is physically connected
		Enter 0 to disable the local / remote digital input.

Valve fault input

Valve fault DI module	600	Module to which the valve fault signal is physically connected.
		-1: Local module means the module of the meter run itself
Valve fault DI channel	600	Digital channel on the selected module to which the valve fault signal is physically connected.
		Enter 0 to disable the valve fault digital input.

Open / close permissives

Valve open permissive	600	Determines whether or not a **valve open permissiv**e 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.
		0: Disabled

		1: Enabled
Valve close permissive	600	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.
		0: Disabled
		1: Enabled

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 flowrate and for which a maximum pressure limit is configured at 100 psi. The actual flow rate is 2000 MCF/h and the pressure is 80 psi. The operator enters a flow rate setpoint of 1000 MCF/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 MCF/h the pressure reaches the limit of 100 psi. 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 100 psi. The flow rate stabilizes around 1200 MCF/h. Now the operator sets the flow rate setpoint at 1500 MCF/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 MCF/h. (If the operator would have chosen a setpoint below the actual flow rate, f.e. 1100 MCF/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:

Flow / pressure control mode	600	Process value that is used for PID Control.
		0: None Flow / pressure control is disabled
		1: Flow control Controls the flow rate.
		2: Pressure control Controls the pressure
		3: Flow / pressure control Primarily controls the flow rate; switches over to pressure control if a configurable pressure limit is passed.

Flow control
These settings are applicable if the **Flow / pressure control mode** is set to 'Flow control' or 'Flow / pressure control'.

Flow control - Input	600	Process value that is used for flow control.
		1: Gross volume Controls the gross volume flow rate [MCF/hr]
		2: Base volume Controls the base volume flow rate [MCF/hr]
		3: Mass Controls the mass flow rate [klbm/hr]
		4: Custom The value that is written to the tag **Flow control - Custom process value** will be used. Use this option if the flow rate value is sent to the flow computer over a Modbus communications link or if you want to apply user-defined calculations to the flow rate to be used for flow control.
Flow control - Proportional Gain (P)	600	Proportional gain (P) factor for flow control
		Controller output = Proportional gain * Actual error.
		Proportional Gain = 100 / Proportional Band
Flow control -	600	Integral gain (I) factor for flow control

Integral gain (I)		Integral gain = 1 / [Seconds per repeat], e.g. an integral gain of 0.02 means 1 repeat per 50 seconds.
		As a rule of thumb set this to the time [sec] it takes for the variable to react to the output.
Flow control –Full scale value	600	Highest flow rate that can be achieved by controlling the valve. Units are the same as flow rate process value.
		Equals the flow rate process value that corresponds to 100% control output (20 mA) if **Flow Control - Reverse 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	600	Lowest flow rate that can be achieved by controlling the valve. Units are the same as flow rate process value.
		Equals the flow rate process value that corresponds to 0% control output (4 mA) if **Flow Control - Reverse mode** is disabled, or 100% control output (20 mA) if **Flow Control - Reverse mode** is enabled.
		The unit is the same as the process value.
Flow control - Reverse mode	600	Enables or disables reverse control mode for flow control.
		0: Disabled Select 'Disabled' if the flow rate drops when the valve closes.
		1: Enabled Select 'Enabled' if the flow rate drops when the valve opens.
Flow control - Deadband	600	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.

Pressure control

These settings are applicable if the **Flow / pressure control mode** is set to ‘Pressure control’ or ‘Flow / pressure control’.

Pressure Control – Input	600	Pressure process value used for pressure control.
		1: Meter pressure Pressure control based on meter pressure (only applicable to run flow control)
		3: Auxiliary pressure 1 Pressure control based on auxiliary pressure 1
		4: Auxiliary pressure 2 Pressure control based on auxiliary pressure 2
		5: Custom The value that is written to the tag **Pressure control - Custom process value** [psi] 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 to be controlled.
Pressure Control - Units	600	Defines whether the pressure setpoint is absolute pressure [psi(a)] or gauge pressure [psi(g)] (i.e. relative to the atmospheric pressure).
		1: Absolute
		2: Gauge
Pressure Control Proportional Gain (P)	600	Proportional gain for pressure control
		Controller output = Proportional gain * Actual error.
		Proportional Gain a= 100 / Proportional Band
Pressure Control Integral gain (I)	600	Integral gain for pressure control
		Integral gain = 1 / [Seconds per repeat], e.g. value of 0.02 means 1 repeat per 50 seconds.
Pressure Control Full scale value	600	Highest pressure that can be achieved by controlling the valve.
		Equals the pressure process value that corresponds to 100% control output (20 mA) if **Pressure Control - Reverse mode** is disabled, or 0% control output (4 mA) if **Pressure Control - Reverse mode** is enabled.
		Units are [psi(a)] or [psi(g)] depending on the **Pressure Control - Units**.
Pressure Control Zero scale value	600	Lowest pressure that can be achieved by controlling the valve.
		Equals the pressure process value that corresponds to 0% control output (4 mA) if **Pressure Control - Reverse mode** is disabled, or 100% control output (20 mA) if **Pressure Control - Reverse mode** is enabled.
		Units are [bar(a)] or [bar(g)] depending on the **Pressure Control - Units**.
Pressure Control Reverse mode	600	Enables or disables reverse control mode for pressure control.
		0: Disabled Select 'Disabled' if the pressure drops when the valve closes.
		1: Enabled Select 'Enabled' if the pressure drops when the valve opens.
Pressure control Deadband	600	Deadband on pressure control. Avoids that the control valve is constantly moving, even though the actual pressure is very close to the setpoint.
		Pressure control will be suspended if the pressure is higher than the setpoint minus the deadband and lower than the setpoint plus the deadband.
		Units are [psi(a)] or [psi(g)] depending on the **Pressure Control - Units**.
Pressure Control Setpoint	600	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 [psi(a)] or [psi(g)] depending on the **Pressure Control - Units**.
Pressure Limit Mode	600	Only applicable if **Flow / pressure control mode** = 'Flow / pressure control'.
		1: Maximum The pressure control setpoint is regarded as maximum pressure: The flow computer switches from flow control to pressure control if the pressure rises above the setpoint / limit value.
		2: Minimum The pressure control setpoint is regarded as minimum pressure: The flow computer switches from flow control to pressure control if the pressure drops below the setpoint / limit value.

Setpoint clamping

Flow control - Upward setpoint clamp rate (/s)	600	The in-use flow setpoint will not be allowed to increase faster than this limit per second.
		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)	600	The in-use flow setpoint will not be allowed to decrease faster than this limit per second.
		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)	600	The in-use pressure setpoint will not be allowed to increase faster than this limit per second.
		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)	600	The in-use pressure setpoint will not be allowed to decrease faster than this limit per second.
		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	600	Controls bumpless transfer from auto to manual

transfer		mode by setting the initial manual ouput % 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.
		0: Disabled
		1: Enabled
Control output maximum limit	600	The control output % will not be allowed to go above this limit [%]
Control output minimum limit	600	The control output % will not be allowed to go below this limit [%]
Control output upward slew rate	600	The control output will not be allowed to increase faster than this limit [%/sec].
		A value of 0 disables this function
Control output downward slew rate	600	The control output will not be allowed to decrease faster than this limit [%/sec]..
		A value of 0 disables this function
Idle output %		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.

Analog output settings

Analog output module	600	Module to which the analog control output signal is connected.
		-1: Local module means the module of the meter run itself
Analog output channel	600	Channel number for the analog control output signal.

Permissive settings

Withdraw permissive on flow meter error	600	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
Withdraw permissive on pressure transmitter fail	600	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
Withdraw permissive if inlet valve not open	600	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
Withdraw permissive if outlet valve not open	600	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
Use custom PID permissive	600	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
Custom PID permissive message	600	Message shown if custom permissive is Off.

Use PID active flag	600	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

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:

Sampler control	600	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.
		0: Disabled
		1: Enabled
Sampled flow	600	Used for Flow proportional sampling methods only.
		Determines which flow value is used as a basis for sampling.
		0: Station The sampler is installed on the station inlet or outlet header. The station gross volume totalizer is used as a basis for sampling.
		1-8: 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.
Sampled flow direction	600	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.
		1: Both directions
		2: Forward only
		3: Reverse only
Sampling method	600	The method to control the sample pulses, either flow- or time-proportional.
		1: Flow (fixed value) Flow proportional method based on setting **Volume between grabs fixed value**. Gives a sample pulse each time this volume has been metered.
		2: Flow (estimated volume) 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.
		4: Time (fixed value) Time proportional method based on setting **Time between grabs fixed value**. Gives a sample pulse each time this time has passed.
		5: 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.
		6: 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

Can volume	600	Can storage capacity [cc]. This is the volume which corresponds to '100% full'.
Can target fill percentage	600	The target level [%] to fill the can. Used to switch over to the other can if **Auto-switch on can full** and the can is empty. In all other cases a 'Sampler can <x> at target level' alarm is raised, but sampling remains active until the **can maximum fill percentage** is reached.
Can maximum fill percentage	600	The maximum fill level [%] of the can. If this level is reached, a 'Sampler can <x> at maximum level' alarm is raised and sampling is stopped.
Can fill level indication method	600	The method to read or estimate the **can fill level**.
		1: Number of grabs The sampler provides no fill level indication. The flow computer accumulates the number of grabs and uses this to estimate the can fill level.
		3: Analog input The sampler provides an analog input that indicates the can fill level (0-100%). This fill level is also used to derive the 'can at target level' alarm.
Can full indication method	600	The method used to derive the can full status / 'can at maximum fill level' alarm.
		1: Number of grabs The flow computer only uses the accumulated number of grabs to derive the can full status.
		2: Digital input The sampler provides a 'can full' digital signal. The can is considered to be full and a 'can at maximum level' alarm is generated if the digital input is high or if the accumulated number of grabs indicates that maximum fill level has been reached.
		3: Analog input The sampler provides an analog input that indicates the can fill level (0-100%). The can is considered to be full and a 'can at maximum level' alarm is generated if the analog input or the accumulated number of grabs indicates that the maximum fill level has been reached.

Sample options

Auto-switch can on can full	600	Only applicable to twin can samplers.
		Not available if **Sampling method** is 'Time (estimated end time)'
		0: Disabled When the target fill level is reached, sampling goes on until the maximum fill level is reached and then stops.
		1: Enabled When the target fill level is reached, sampling switches over to the other can, provided that it is enabled and empty. If the can is disabled or not empty sampling goes on until the maximum fill level is reached and then stops.

Alarm settings

Can at target level alarms	600	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.
		0: Disabled
		1: Enabled
Can at maximum level alarms	600	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.
		0: Disabled
		1: Enabled
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).
		0: Disabled
		1: Enabled

Pulse output settings

Sample pulse output module	600	Module to which the sample strobe is physically connected.
Sample pulse output number	600	Pulse output number on the specified module that is used for the sample strobe.
		1: Pulse output 1
		2: Pulse output 2
		3: Pulse output 3
		4: Pulse output 4
Sample pulse output duration	600	The duration of the sample pulses [s]
Minimum time between grabs	600	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.
Max. number of outstanding samples	600	The maximum number of pulses to be buffered in the pulse reservoir. Additional pulses will be lost (raises the 'Grabs lost' alarm).
Sampler overspeed alarm limit	600	If the number of pulses accumulated in the pulse reservoir reaches this limit, then the 'Sampler overspeeding' alarm is raised.

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'.

Can fill indication module	600	The module to which the can fill level / can full indication signal is physically connected
Can fill indication channel	600	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).

Can selection

Can selection digital output	600	Disables or enables a digital output for can selection.
		0: Disabled No can selection output used/
		1: Enabled The can selection is sent to the sampler through a digital output: (output low=can 1, output high=can 2)
Can selection digital output module	600	The module to which the can selection output is physically connected
Can selection digital output channel	600	The channel number on the selected module to which the can selection output is physically connected (1..16)

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:

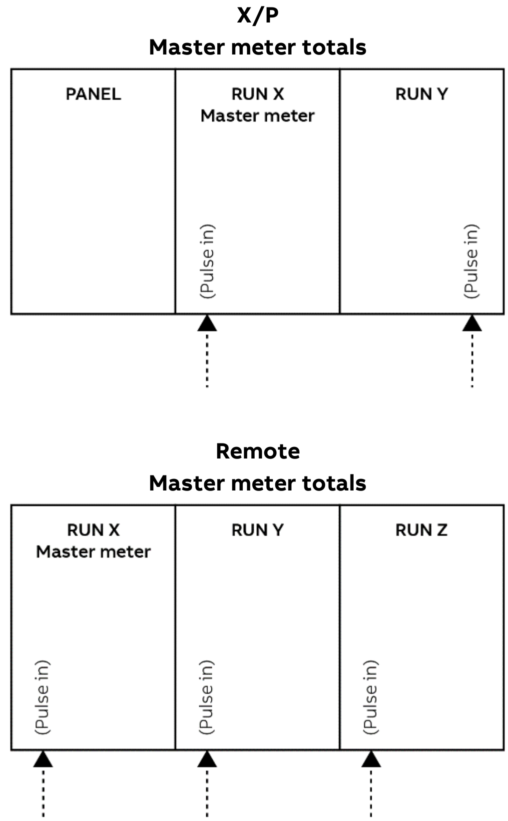


Figure 4: Master meter proving based on totalizers on a multi-stream flow computer (left) and a proving flow computer with remote runs (right).

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).

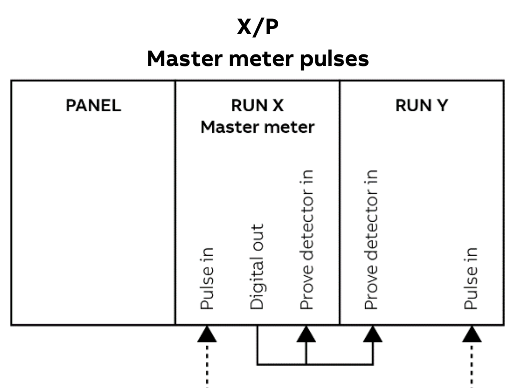
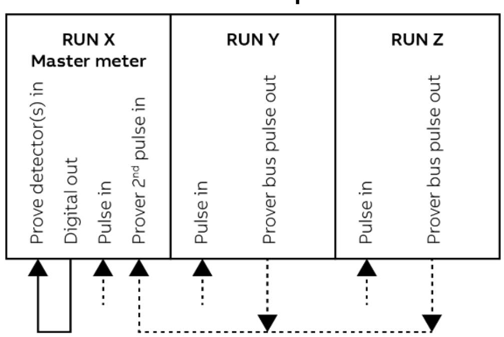


Figure 5: Master meter proving based on pulses on a multi-stream flow computer.

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

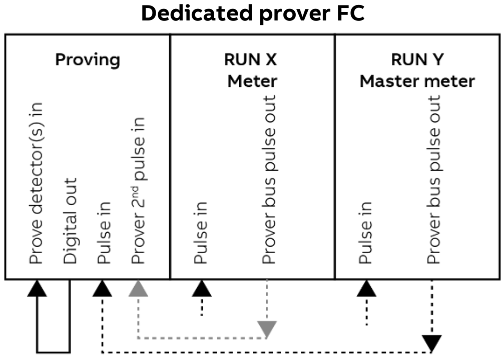


Figure 6: Master meter proving based on pulses on a prover flow computer with remote runs. Left: Master meter as local run on the prover flow computer; Right: Master meter on separate module.

The prover flow computer decides which meter flow computer has to forward its input pulses to the prover bus and enables the ‘prover bus pulse output’ of this flow computer accordingly.

Master meter proving setup

Display → Configuration, Proving, Master meter proving

These settings are available if the **Prover type** is set to ‘Master meter proving’.

Master meter number	500	Number of the meter (in the proving flow computer) that is used as master meter. In case of a Flow-X/P, the meter number corresponds to physical position of the related flow module in the proving flow computer. The selected master meter may be a local run or a remote run.
Master meter proving type	1000	Defines whether master meter proving is based pulses or on totalizers. 1: Pulses The pulses from both the meter on prove and the master meter are counted. The pulse counts are used to calculate the prove volumes, from which the meter factor is calculated. This option can only be used if both meters have a pulse output. 2: Totalizers The gross volume or mass totalizers from both the meter on prove and the master meter are simultaneously latched at the start of the prove and at end of the prove. From these totalizers prove volumes for the meter on prove and the master meter are calculated and from these the meter factor is calculated. This option is also available for meters without pulse output.

Prove size

Master meter prove size type	1000	Determines whether the prove size is specified as prove duration or as volume / mass. 1: Prove volume / mass If the meter on prove is a volumetric meter, the prove size is specified as volume [MCF]. If the meter on prove is a mass meter, the prove size is specified as mass [klbm]. 2: Prove time The prove size is specified as time [min].
Volume / mass per prove run	500	Only applicable if **Master meter prove size type** is set to 'Prove volume / mass'. Volume or mass to be proved. The prove run is completed when this volume or mass is reached. Unit [MCF] in case of a volume flow meter, [klbm] in case of a mass flow meter.
Time per prove run	500	Only applicable if **Master meter prove size type** is set to 'Prove time'. Duration of the prove. The prove run is completed when this time [minutes] has passed.

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.

Prove start DO module	1000	Only applicable if the **Master meter proving type** is set to ‘Pulses’ Number of the module to which the **Prove start** digital output signal in physically connected.
Prove start DO channel	1000	Only applicable if the **Master meter proving type** is set to ‘Pulses’ Channel number of the **Prove start** digital output signal.

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

Remote meter pulse input module	1000	Only applicable if the meter on prove is a remote meter while the **Master meter proving type** is set to ‘Pulses’.
		In case of master meter proving of a remote meter the pulses from the meter on prove have to be passed through from the meter flow computer to the proving flow computer. This setting defines on which module on the prove flow computer the remote meter pulses are coming in.
		On the specified module the digital channel though which the pulse is coming in must be configured as ‘Pulse input A’. Optionally also a ‘Pulse input B’ can be configured, which is used as a backup in case pulse input A fails.
Remote master meter pulse input module	1000	Only applicable if the master meter is a remote meter while the **Master meter proving type** is set to ‘Pulses’.
		In case of master meter proving with a remote master meter the pulses from the master meter have to be passed through from the master meter flow computer to the proving flow computer. This setting defines on which module on the proving flow computer the remote meter pulses are coming in.
		On the specified module the digital channel though which the master meter pulse is coming in must be configured as ‘Pulse input A’. Optionally also a ‘Pulse input B’ can be configured, which is used as a backup in case pulse input A fails.

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).

Maximum nr of runs	500	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.
Passes per run	500	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.
Required successful runs	500	Required number of consecutive runs within the repeatability limit before the prove sequence is completed successfully.
Double chronometry	500	Determines whether or not double-chronometry method of pulse interpolation is applied in accordance with API MPMS 4.6.
		0: Disabled
		1: Enabled
		API requires that pulse interpolation is performed when less than 5000 pulses are acquired within a single prove pass.
		This feature is typically enabled for compact provers and disabled for large volume pipe provers and master meter proving.

Run repeatability

Repeatability test method	500	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.
		Repeatability is calculated as (max - min) / min * 100%.
		1: Pulse count
		2: Meter factor
		Setting not available for master meter proving (Repeatability test method is automatically set to ‘Meter factor’).
Run repeatability mode	500	The method to check whether sufficient consecutive runs are within the required repeatability limit.
		1: Fixed The prove sequence is completed successfully when the **Required successful runs** have been performed consecutively within the 'Run repeatability fixed limit'.
		2. Dynamic (API 4.8 appendix A) The prove sequence is completed successfully when at least the **Required successful runs** have been performed consecutively within the repeatability limit that is in accordance with API 4.8 appendix A. API 4.8 app. A defines the repeatability limit as a function of the number or runs. Nr of runs — Repeatability limit [%] 3 — 0.02 4 — 0.03 5 — 0.05 6 — 0.06 7 — 0.08 8 — 0.09 9 — 0.10 10 — 0.12 Typically used for compact provers.
Repeatability fixed limit	500	The fixed repeatability limit [%] used if **Run repeatability mode** is set to 'Fixed'

Implement meter factor

Auto-implement new MF	500	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.
		0: No
		1: Yes
MF manual accept timeout	500	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 factors 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.

Prove permissive

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:

- Communication to meter flow computer OK (when proving a remote run)
- Communication to master meter flow computer OK (in case of a remote master meter)
- Custom prove permissive condition (optional)

Use proving permissive	1000	Determines whether or not the **prove permissive custom condition** is taken into account. If set to ‘Yes’ the **prove**

custom condition		**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.
		0: No
		1: Yes

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: • Meter temperature • Master meter temperature • 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 sample time	1000	The sample time [s] for the initial stability check. The 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 [°F] during the initial stability check
Pressure change limit	1000	The maximum allowable pressure fluctuation [psi] 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 deviation [°F] 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 [psi] 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

Meter factor limit test	500	Enables or disables the 'Meter factor limit test'.
		0: Disabled
		1: Enabled
		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.
Meter factor high limit	500	High limit [-] for the meter factor limit test
Meter factor low limit	500	Low limit [-] for the meter factor limit test

Previous meter factor test

Previous MF test	500	Enables or disables the 'Previous meter factor test'.
		0: Disabled
		1: Enabled
		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.
Previous MF deviation limit	500	Deviation limit [%] for the previous MF test

Historical meter factor test

Historical avg MF test	500	Enables or disables the 'Historical average meter factor test'.
		0: Disabled
		1: Enabled
		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.
Historical avg MF deviation limit	500	Deviation limit [%] for the historical average MF test

Nr of historical MF avg	500	Number of historical meter factors (1-10) to be used for the historical average MF test

Base curve meter factor test

Base curve MF test	500	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.
Base curve MF deviation limit	500	Deviation limit [%] for the base curve MF test

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.

Display → Configuration, Proving, Prove report

Print accepted runs only	1000	Determines whether the prove report contains the results of all runs, or only the results of the accepted runs.
		0: Disabled
		1: Enabled

Decimal places

Meter factor decimal places proving	1000	Number of decimal places to which the (final) meter factor is rounded
Volume / mass total decimal places proving	1000	Number of decimal places to which the metered and proved volumes / masses are rounded.
CCF (CTPL) decimal places proving	1000	Number of decimal places to which the combined correction factors for the prover (CCFp) and the meter (CCFm) are rounded.

Meter runs

This display page gives an overview of the meter runs that are involved in proving.

Display → Configuration, Proving, 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.

System time deviation

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

Remote run max. system time deviation	1000	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.
Delay for system time out of sync alarms	1000	System time out of sync alarms only become active after the deviation has been larger than the 'max. deviation' during the delay time [s].

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

Meter minimum accountable flow rate	1000	Low range value (minimum allowable flow rate) of the flow rate. Unit [MCF/hr] in case of a volume flow meter, [klbm/hr] in case of a mass flow meter.
		If the flow rate is below this value then the 'Flow range accountable alarm' is raised.
Meter maximum accountable flow rate	1000	High range value (maximum allowable flow rate) of the flow meter. Unit [MCF/hr] in case of a volume flow meter, [klbm/hr] in case of a mass flow meter.
		If the flow rate is above this value then the 'Flow range accountable alarm' is raised.

Temperature

Minimum accountable temperature	1000	Minimum allowable temperature [°F].
		If the temperature is below this value then the 'Temperature accountable alarm' is raised.
Maximum accountable temperature	1000	Maximum allowable temperature [°F].
		If the temperature is above this value then the 'Temperature accountable alarm' is raised.

Pressure

Minimum accountable pressure	1000	Minimum allowable pressure [psi(a)].
		If the pressure is below this value then the 'Pressure accountable alarm' is raised.
Maximum accountable pressure	1000	Maximum allowable pressure [psi(a)].
		If the pressure is above this value then the 'Pressure accountable alarm' is raised.

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

Enable maint mode	1000	Enter maintenance mode. Only allowed if **Maint mode switch permissive** is ON.
Disable maint mode	1000	Exit maintenance mode. Only allowed if **Maint mode switch permissive** is ON.

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.

Conversion metric <> US customary units

The following conversion factors are used:

Pressure:	1 psi = 0.0689476 bar
Differential pressure:	1 inH2O@60°F = 2.4884 mbar
Viscosity:	1 lbm/ft.sec = 1.488164 Pa.s
Temperature:	T [°F] = 1.8 x T [°C] + 32
Density:	1 lb/CF = 16.018463 kg/m3
Base density:	1 lb/SCF = 16.018463 kg/sm3
Heating value:	1 BTU/SCF = 0.0372589 MJ/sm3
Length:	1 inch = 25.4 mm
Mass:	1 klbm = 453.59237 kg
Volume:	1 MCF = 28.31685 m3
Base volume:	1 MSCF = 28.31685 sm3
Energy:	1 MMBTU = 1.055056 GJ
Velocity:	1 ft/sec = 0.3048 m/sec

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:

- 78125010 'Solartron 7812 Gas Density Transducer Manual', 2001.
- 78125040 Rev. C, 'Micro Motion 7812 Gas Density Meter', October 2007.

$$\rho_i = K_0 + K_1 \cdot \tau + K_2 \cdot \tau^2$$

Equation 6-1: Uncorrected density (Solartron)

ρ_i	Uncorrected density	lb/CF
K_0	Obtained from the calibration certificate	-
K_1	Obtained from the calibration certificate	-
K_2	Obtained from the calibration certificate	-
τ	The time period from densitometer	μs

$$\rho_t = \rho_i \cdot \left[1 + K_{18} \times (T - T_R)\right] + K_{19} \times (T - T_R)$$

Equation 6-2: Density corrected for temperature (Solartron)

ρ_t	Density corrected for temperature	lb/CF
K_{18}	Obtained from the calibration certificate	-
K_{19}	Obtained from the calibration certificate	-
T	Density temperature	°F
T_R	Densitometer reference temperature	°F

$$\rho_{pt} = \rho_t \times \left[1 + (K_{20} \times P_f)\right] + (K_{21} \times P_f)$$
$$K_{20} = K_{20A} + (K_{20B} \times P_f)$$
$$K_{21} = K_{21A} + (K_{21B} \times P_f)$$

Equation 6-3: Density corrected for Pressure (Solartron)

ρ_{pt}	Density corrected for pressure and temperature	lb/CF
ρ_t	Density corrected for temperature	lb/CF
K_{18}	Obtained from the calibration certificate	-
K_{19}	Obtained from the calibration certificate	-
K_{20A}	Obtained from the calibration certificate	-
K_{20B}	Obtained from the calibration certificate	-
K_{21A}	Obtained from the calibration certificate	-
K_{21B}	Obtained from the calibration certificate	-
P_f	Density pressure	psi(g)

$$\rho_{VOS} = \rho_t \left[1 + \frac{K_3}{(\rho_t + K_4)} \cdot \left(Kc - \frac{G}{T + 273}\right)\right]$$

$$Kc = \frac{Cc}{T_C + 273}$$

Equation 6-4: Density corrected for velocity of sound (Solartron)

ρ_{VOS}	Density corrected for temperature and VOS	lb/CF
K_3	Obtained from the calibration certificate	-
K_4	Obtained from the calibration certificate	-
Kc	Calibration gas constant from the calibration certificate	-
G	G value. Equals either parameter 'G value' or the ratio of the 'Specific gravity' and 'Ratio of specific heats', depending on parameter 'G value method'	-
T	Density temperature	°F
Cc	Specific Gravity/Ratio of specific heats of calibration gas	-
T_c	Calibration temperature	°F

Sarasota densitometers

$$\rho_C = d_0 \cdot \frac{\tau - \tau_C}{\tau_C} \cdot \left(2 + K \cdot \frac{\tau - \tau_C}{\tau_C}\right)$$

$$\tau_C = \tau_0 + T_{COEF} \cdot (T - T_R) + p_{COEF} \cdot (p - p_R)$$

Equation 6-5: Corrected density (Sarasota)

ρ_C	Corrected density	lb/CF
d_0	Obtained from the calibration certificate	lb/CF
τ_0	Obtained from the calibration certificate	µs
K	Obtained from the calibration certificate	-
d_0	Obtained from the calibration certificate	-
p_{COEF}	Obtained from the calibration certificate	µs/psi
T_{COEF}	Obtained from the calibration certificate	µs/°F
T	Density temperature	°F
T_R	Densitometer reference temperature	°F
p	Density pressure	psi(g)
p_R	Densitometer reference pressure	psi(g)
τ_C	Time periodic input corrected for temperature and pressure	µs
τ	Time period from densitometer	µs

UGC densitometers

$$\rho_i = K_0 + K_1 \cdot \tau + K_2 \cdot \tau^2$$

Equation 6-6: Uncorrected density (UGC)

ρ_i	Uncorrected density	lb/CF
K_0	Obtained from the calibration certificate	-
K_1	Obtained from the calibration certificate	-
K_2	Obtained from the calibration certificate	-
τ	Time period from densitometer	µs

$$\rho_t = \rho_i + \left[K_{P1} + K_{P2} \cdot \rho_i + K_{P3} \cdot \rho_i^2\right] \cdot (P - P_R) + \left[K_{T1} + K_{T2} \cdot \rho_i + K_{T3} \cdot \rho_i^2\right] \cdot (T - T_R)$$

Equation 6-7: Corrected density (UGC)

ρ_t	Density corrected for temperature and pressure	lb/CF
K_{P1}	Obtained from the calibration certificate	-
K_{P2}	Obtained from the calibration certificate	-
K_{P3}	Obtained from the calibration certificate	-
K_{T1}	Obtained from the calibration certificate	-
K_{T2}	Obtained from the calibration certificate	-
K_{T3}	Obtained from the calibration certificate	-
T	Density temperature	°F
T_R	Densitometer reference temperature	°F
P	Density pressure	psi(g)
P_R	Densitometer reference pressure	psi(g)

Specific gravity transducer

$$SG = K_0 + K_2 \cdot \tau^2$$

Equation 6-8: Specific gravity (Specific gravity transducer)

SG	Specific gravity	-
K_0	Obtained from the calibration certificate	-
K_2	Obtained from the calibration certificate	-
τ	Time period from SG transducer	µs

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**:

$$\rho_B = \frac{MM \times p_R}{T_R \times Z_B \times R / 100}$$

Equation 6-9: Base density calculation (based on molar mass)

ρ_B	Base density (i.e. at reference conditions)	kg/sm3
MM	Molar mass	kg/kmol
P_R	Reference pressure (parameter)	bar(a)
T_R	Reference temperature (parameter)	K
Z_B	Base compressibility (i.e. at reference conditions)	-
R	Universal gas constant (parameter)	J/K/mol

$$\rho_B = \rho_i \times \frac{P_R \times T_D \times Z_D}{P_D \times T_R \times Z_B}$$

Equation 6-10: Base density calculation (based on observed density)

ρ_B	Base density (i.e. at reference conditions)	lb/SCF
ρ_i	Observed density	lb/CF
P_R	Reference pressure (parameter)	psi(a)
P_D	Pressure corresponding with observed density	psi(a)
T_R	Reference temperature (parameter)	K
T_D	Temperature corresponding with observed density	K
Z_B	Base compressibility (i.e. at reference conditions)	-
Z_D	Compressibility at temperature and pressure corresponding with observed density	-

$$\rho_B = \frac{SG \times MM_{air} \times P_R}{T_R \times Z_B \times R/100}$$

Equation 6-11: Base density calculation (based on specific gravity)

ρ_B	Base density (i.e. at reference conditions)	kg/sm3
SG	Specific gravity	-
MM_{air}	Molar mass of air (parameter)	kg/kmol
P_R	Reference pressure (parameter)	bar(a)
T_R	Reference temperature (parameter)	K
Z_B	Base compressibility (i.e. at reference conditions)	-
R	Universal gas constant (parameter)	J/K/mol

$$\rho_B = RD \times \rho_{Bair}$$

Equation 6-12: Base density calculation (based on relative density)

ρ_B	Base density (i.e. at reference conditions)	lb/SCF
RD	Relative density	-
$\rho_{B\,air}$	Base density of air (parameter)	lb/SCF

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)

ρ	Density at the (upstream) flow meter conditions	lb/CF
P_B	Base density	lb/SCF
P	Pressure at the flow meter For differential pressure flow devices the upstream pressure is applied	psi(a)
P_R	Reference pressure (parameter)	psi(a)
T	Temperature at the flow meter For differential pressure flow devices the upstream	K
T_R	Reference temperature (parameter)	K
Z	Compressibility at the (upstream) flow meter conditions	-
Z_B	Base compressibility (i.e. at reference conditions	-

$$\rho = \rho_i \times \frac{P \times T_D \times Z_D}{P_D \times T \times Z}$$

Equation 6-14: Meter density calculation (based on observed density)

ρ	Density at the (upstream) flow meter conditions	lb/CF
ρ_i	Observed density	lb/CF
P	Pressure at the flow meter For differential pressure flow devices the upstream pressure is applied	psi(a)
P_D	Pressure corresponding with observed density	psi(a)
T	Temperature at the flow meter For differential pressure flow devices the upstream	K
T_D	Temperature corresponding with observed density	K
Z	Compressibility at the (upstream) flow meter conditions)	-
Z_D	Compressibility at temperature and pressure corresponding with observed density	-

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	lb/lbmol
MM_{air}	Molar mass of air (parameter)	lb/lbmol

$$SG = \frac{\rho_B \times T_R \times Z_B \times R/100}{P_R \times MM_{air}}$$

Equation 6-16: Specific gravity calculation (based on base density)

SG	Specific gravity	-
ρ_B	base density	kg/sm3
T_R	Reference temperature (parameter)	K
Z_B	Base compressibility (i.e. at reference conditions)	-
P_R	Pressure corresponding with observed density	bar(a)
R	Universal gas constant (parameter)	J/K/mol
MM_{air}	Molar mass of air (parameter)	kg/kmol

Relative density calculation

$$RD = \frac{\rho_B}{\rho_{Bair}}$$

Equation 6-17: Relative density calculation

RD	Relative density	-
ρ_B	Base density (i.e. at reference conditions)	lb/SCF
$\rho_{B\,air}$	Base density of air (parameter)	lb/SCF

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	[MCF/hr]
MKF	Meter K-factor	[pulses/MCF]
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	[MCFhr]
Q_{IV}	Indicated volume flow rate	[MCF/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

ME	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).

$$Q_{GV} = Q_{IV}$$

Equation 6-21: Mass volume flow rate (volumetric flow meters)

Mass flow rate

$$Q_M = Q_{GV} \times \rho$$

Q_M	Mass flow rate	[klbm/hr]
Q_{GV}	Gross volume flow rate	[MCF/hr]
ρ	Density at the flow meter conditions	[lb/CF]

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.

$$Q_{IM} = \frac{f}{MKF} \times 3600$$

Equation 6-22: Indicated mass flow rate (mass flow meters)

Q_{IM}	Indicated (mass) flow rate	[klbm/hr]
MKF	Meter K-factor	[pulses/klbm]
f	Pulse frequency	[Hz]

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)

Q_M	Mass flow rate	[klbm/hr]
Q_{IM}	Indicated (mass) flow rate	[klbm/hr]
MF	Meter factor	[-]
MBF	Meter body correction factor	[-]

Gross volume flow rate

$$Q_{GV} = \frac{Q_M}{\rho}$$

Equation 6-24: Gross volume flow rate (mass flow meters)

Q_{GV}	Gross volume flow rate	[MCF/hr]
Q_M	Mass flow rate	[klbm/hr]
ρ	Density at the flow meter conditions	[lb/CF]

Base volume flow rate

$$Q_{BV} = Q_{GV} \times \frac{\rho}{\rho_B}$$

Equation 6-25: Base volume flow rate (volumetric flow meters)

Q_{BV}	Base volume flow rate	[MSCF/hr]
Q_{GV}	Gross volume flow rate	[MCF/hr]
ρ	Density at the flow meter conditions	[lb/CF]
ρ_B	Density at the reference (base) conditions	[lb/SCF]

$$Q_{BV} = \frac{Q_M}{\rho_B}$$

Equation 6-26: Base volume flow rate (mass flow meters)

Q_{BV}	Base volume flow rate	[MSCF/hr]
Q_M	Mass flow rate	[klbm/hr]
ρ_B	Density at the reference (base) conditions	[lb/SCF]

Energy flow rate

$$Q_E = \frac{Q_{BV} \times HV}{1000}$$

Equation 6-27: Energy flow rate

Q_E	Energy flow rate	[IMMBTU/hr]
Q_{BV}	Base volume flow rate	[MSCF/hr]
HV	Heating value at reference (base conditions)	[BTU/SCF]

Depending on parameter **Use Net HV for energy** HV is either the

gross (higher) or the net (lower) heating value (calorific value).

Meter body correction

For ultrasonic flow meters a correction may be applied to compensate for the effect of the meter body expansion as a function of temperature and pressure of the fluid.

$$MBF = 1 + \varepsilon_T \times (T - T_R) + \varepsilon_p (P - P_R)$$

Equation 6-28: Meter body correction factor

MBF	Meter body correction factor	[-]
ε_T	**Cubical** temperature expansion coefficient	[1/°F]
T	Fluid temperature at the flow meter	[°F]
T_R	Reference temperature for the expansion	[°F]
ε_p	**Cubical** pressure expansion coefficient	[1/psi]
P	Fluid pressure at the flow meter	[psi(a)]
P_R	Reference pressure for the expansion	[psi(a)]

Cubical expansion coefficient = Linear expansion coefficient x 3.

Flow rate for differential pressure flow devices

The method uses the equations from the International Standard ISO 5167-1: ‘Measurement of Fluid Flow by means of pressure differential devices, Part 1: Orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits running full’.

Mass flow rate (ISO-5167)

$$q_M = \frac{C}{\sqrt{1-\beta^4}} \times \varepsilon \times \frac{\pi}{4} d^2 \times \sqrt{2 \times \Delta P \times \rho_1}$$

Equation 6-29: ISO-5167 mass flow rate

q_m	Mass flow rate	kg/sec
C	Coefficient of Discharge	-
ε	Fluid expansion factor	-
π	3.14159	
d	Orifice diameter at line temperature	m
ρ_1	Flowing density at line conditions	kg/m3
ΔP	Differential pressure	Pa

$$Q_M = \frac{q_M * 3600}{1000}$$

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

d	Orifice diameter at operating temperature	mm
d_r	Orifice diameter at reference temperature	mm
D	Pipe diameter at operating temperature	mm
D_r	Pipe diameter at reference temperature	mm
α_1	Coefficient of expansion of orifice and pipe material	mm/mm/°C
T_L	Fluid temperature at operating conditions	°C
T_R	Reference temperature of the Orifice/Pipe.	°C

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
π	3.14159	-
μ	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 ε

AGA-5167 defines the following equation for the Fluid Expansion Factor for orifices:

$$\varepsilon = 1 - \left(0.41 + 0.35 \times \beta^4\right) \times \frac{X_1}{\kappa}$$

Equation 6-36: ISO-5167 Reynolds Expansion Factor (Gas)

ε	Expansion Factor	-
β	Beta ratio	-
X_1	Ratio of differential pressure to absolute static pressure at the upstream tap	
κ	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.

- 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)]
ΔP	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 κ.

$$T_1 = (T_2 + 273.15) \times \left(\frac{P_2}{P_1}\right)^{\frac{1-\kappa}{\kappa}} - 273.15$$

$$T_1 = (T_3 + 273.15) \times \left(\frac{P_3}{P_1}\right)^{\frac{1-\kappa}{\kappa}} - 273.15$$

- Method 2: Isentropic expansion based on the separate user-definable parameter 'Temperature exponent' K_{TE}:

$$T_1 = (T_2 + 273.15) \times \left(\frac{P_2}{P_1}\right)^{K_{TE}} - 273.15$$

$$T_1 = (T_3 + 273.15) \times \left(\frac{P_3}{P_1}\right)^{K_{TE}} - 273.15$$

- 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 μ_{JT}:

$$T_1 = T_2 + (P_1 - P_2) \cdot \mu_{JT}$$

$$T_1 = T_3 + (P_1 - P_3) \cdot \mu_{JT}$$

T_1	Upstream temperature	°C
T_2	Downstream temperature	°C
T_3	Temperature at recovered pressure position	°C
P_1	Upstream pressure	bar(a)
P_2	Downstream pressure	bar(a)
P_3	Fully recovered downstream pressure	bar(a)
κ	Isentropic exponent	-
K_{TE}	Temperature exponent	-
μ_{JT}	Joule Thomson coefficient	°C/bar

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.

$$C_{DH} = 1 + 0.55 * \left(\frac{d_{DH}}{d_0}\right)^2$$

C_{DH}	Drain hole correction factor on orifice diameter	[-]
d_{DH}	Drain hole diameter	[mm]
d_0	Orifice diameter at reference temperature	[mm]

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 B when cell A fails while cell B is healthy

When cell B is currently selected

- Select cell A when cell A value is below or equal to the switch-down percentage of its range and cell A is healthy
- 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.
- Select cell B when cell A fails while 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 C when cell B value is above or equal to the switch-up percentage of its range and cell C is healthy
- Select cell A when cell A value is below or equal to the switch-down percentage of its range and cell A is healthy
- Select cell A when cell B fails while cell A is healthy
- Select cell C when cell B and cell A fail and cell C is healthy

When cell C is currently selected

- Select cell B when cell B value is below or equal to the switch-down percentage of its range and cell B is healthy
- Select cell B when cell C fails while cell B is healthy
- Select cell A when cell C and cell B fail and cell A is healthy

3 cells, range type = ‘Lo Hi 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 C when cell A value is above or equal to the switch-up percentage of its range and cell B fails and cell C is healthy.
- Select cell B when cell A fails while 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 value is below or equal to the switch-down percentage of its range and cell A is healthy
- Select cell C when cell B fails while cell C is healthy
- Select cell A when cell B and cell C fail and cell A is healthy

When cell C is currently selected

- Select cell A when cell A value is below or equal to the switch-down percentage of its range and cell A is healthy
- Select cell B when cell B is healthy and ‘Auto switchback’ is enabled
- Select cell A when cell C and cell B fail and cell A 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:

$$Tot_{MM} = \frac{P_{MM}}{MKF_{MM}}$$

$$Tot_{M} = \frac{P_{M}}{MKF_{M}}$$

Equation 6-37: Master meter proving total measurement using the pulse counting method.

Tot_{MM}	Master meter prove total	MCF or klbm
P_{MM}	Pulses between start and stop of the prove counted by the master meter	-
MKF_{MM}	Actual K factor of the master meter (at the master meter frequency)	pulses/MCF or pls/klbm
Tot_{M}	Meter on prove prove total	MCF or klbm
P_{M}	Pulses between start and stop of the prove	

	counted by the meter on prove	
MKF_M	Actual K factor of the meter on prove (at the meter frequency)	pulses/MCF or pls/klbm

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:

$$Tot_{MM} = Tot_{MM}(stop) - Tot_{MM}(start)$$

$$Tot_M = \left(Tot_M(stop) - Tot_M(start)\right) \times \frac{t_{MM}}{t_M}$$

Equation 6-38: Master meter proving total measurement using the totalizer latching method.

Tot_{MM}	Master meter prove total	MCF or klbm
$Tot_{MM}(stop)$	Indicated totalizer of the master meter at prove end	MCF or klbm
$Tot_{MM}(start)$	Indicated totalizer of the master meter at prove start	MCF or klbm
Tot_M	Meter on prove prove total	MCF or klbm
$Tot_M(stop)$	Indicated totalizer of the meter on prove at prove end	MCF or klbm
$Tot_M(start)$	Indicated totalizer of the meter on prove at prove start	MCF or klbm
t_{MM}	Time between start and stop from master meter module	sec
t_M	Time between start and stop from meter on prove module	sec

The correction factor t_{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.

$$MF_P = \frac{V_{MM} \times MF_{MM} \times \frac{\rho_{MM}}{\rho_B}}{V_M \times \frac{\rho_M}{\rho_B}}$$

Equation 6-39: Prover Meter Factor for master meter proving of a volumetric meter using a volumetric master meter.

$$MF_P = \frac{M_{MM} \times MF_{MM} \times \frac{1}{\rho_B}}{V_M \times \frac{\rho_M}{\rho_B}}$$

Equation 6-40: Prover Meter Factor for master meter proving of a volumetric meter using a mass master meter.

$$MF_P = \frac{V_{MM} \times MF_{MM} \times \rho_{MM}}{M_M}$$

Equation 6-41: Prover Meter Factor for master meter proving of a mass meter using a volumetric master meter.

$$MF_P = \frac{M_{MM} \times MF_{MM}}{M_M}$$

Equation 6-42: Prover Meter Factor for master meter proving of a mass meter using a mass master meter.

MF_P	Meter factor calculated from proving	-
V_{MM}	Master meter (uncorrected) volume	MCF
M_{MM}	Master meter (uncorrected) mass	klbm
MF_{MM}	Meter factor of the master meter (at the proving flow rate)	-
V_M	Meter on prove (uncorrected) volume	MCF
M_M	Meter on prove (uncorrected) mass	klbm
ρ_{MM}	Meter density of the master meter (density at the master meter conditions)	-
ρ_M	Meter density of the meter on prove (density at the meter conditions)	-
ρ_B	Base density (density at reference conditions)	-

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 Liquid Metric application provides the following standard reports:

Report name	Report description
Run_Daily	Daily report for one run which is generated automatically at the end of each day. Shows forward values only.
Stn_Daily	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.
Run_Hourly	Hourly report for one run which is generated automatically at the end of each hour. Shows forward values only.
Stn_Hourly	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.
Run_PeriodA	Period A report for one run which is generated automatically at the end of each period A. Shows forward values only.
Stn_PeriodA	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.
Run_PeriodB	Period B report for one run which is generated automatically at the end of each period B. Shows forward values only.
Stn_PeriodB	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.
Run_Current	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.
Stn_Current	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.
MasterMeter	Generated automatically at the end of a master meter proving sequence if the **meter quantity type** is 'volume'.
MasterMeterMass	Generated automatically at the end of a master meter proving sequence if the **meter quantity type** is 'mass'.
Events_Daily	Generated automatically at the end of the day. Shows all events (other than alarm transitions) during the day.
Alarms_Daily	Generated automatically at the end of the day. Shows all alarm transitions during the day.

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''.

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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 / prover 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 v23)
  Compatible to Omni v23, 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:
- 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)
- RMG USZ08 ultrasonic flow meter

Gas chromatographs:
- Siemens Maxum
- Siemens Sitrans
- Yamatake HGC
- ABB BTU 8100
- ABB NGC 8206

- Emerson Danalyzer
- Elster Encal 3000
- Angus Gas Quality Analyser

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 3th 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, 3th 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 Flow-Xpress 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 October 2010
Initial release of the Flow-X Manual Volume IID - Gas USC Application.

Revision B
Date February 2015
Minor editorial changes.

Revision C
Date January 2016
Major review of the manual. Update to application version 2.2.0

Revision C1
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- Update to ABB lay-out

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