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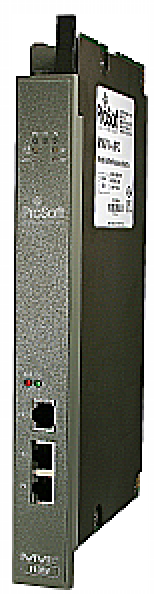

MVI71-AFC

PLC Platform

Gas and Liquid Flow Computer

User Manual

November 27, 2007

ProSoft TECHNOLOGY

Please Read This Notice

Successful application of this module requires a reasonable working knowledge of the Rockwell Automation hardware, the MVI71-AFC Module and the application in which the combination is to be used. For this reason, it is important that those responsible for implementation satisfy themselves that the combination will meet the needs of the application without exposing personnel or equipment to unsafe or inappropriate working conditions.

This manual is provided to assist the user. Every attempt has been made to ensure that the information provided is accurate and a true reflection of the product's installation requirements. In order to ensure a complete understanding of the operation of the product, the user should read all applicable Rockwell Automation documentation on the operation of the Rockwell Automation hardware.

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MVI71-AFC User Manual
November 27, 2007
PSFT.AFC.MVI71.UM.07.11.27

Contents

1 Introduction

In This Chapter

The MVI71-AFC Flow Computer module performs measurement of Hydrocarbon Gases and Liquids using currently accepted industry measurement standards. The module consists of a single-slot solution for Rockwell Automation chassis. To obtain its process inputs for calculations, the module uses the process data collected by analog and pulse I/O modules. The processor transfers this data to the AFC module, which then calculates flow rates, accumulated volumes, and accumulated mass. The results of the calculations are transferred back to the processor for use in the application ladder logic, or for transfer to a SCADA host.

The module has two communication ports for Modbus communication allowing easy access to a remote Modbus device. The module works as a Modbus slave or master device.

As discussed later in this manual, the internal Modbus database can be accessed by a Modbus Master device and by the processor (using the Modbus Gateway Function).

The AFC Manager software can be used for easy meter configuration and application monitoring. Refer to the *AFC Manager User Manual* for complete information about this tool.

The following section provides a sample application where input data is transferred from the transmitters to analog input cards on the Rockwell Automation rack and the values are transferred from the processor to the module (the module supports floating-point, scaled integer, or 4 to 20 mA format).

For Pulse meter applications, the pulse count and pulse frequency values are typically transmitted through high-speed counter modules in the rack.

The module performs the flow calculation based on the values transferred through the backplane. The calculation results can be read to the processor or polled from a remote Modbus master unit connected to one of the communication ports.

1.1 Update Notice

- ***If your module measures liquids, please read this notice before upgrading from version 2.04 (or earlier) to 2.05 (or later).***

For compliance with new measurement standards, the AFC version 2.05 has introduced several new liquid product groups. In particular, the two non-refined liquid product groups of version 2.04, which covered the entire density range of crudes and NGLs, have each been split into two separate product groups, one for the higher density range of crudes and the other for the lower density range of NGLs. If your module has meter channels configured for either "Crude, NGL" or "Oil-water emulsion", you should decide **before upgrading the firmware** the new product group (light or heavy) to which each such channel should be assigned. This assignment will be performed during the upgrade process and will preserve all other configuration and historical records including accumulator values and archives, in contrast to changing a product group after the upgrade which resets the meter configuration and erases all historical records. Meter channels configured for "Gas" or "Refined products" are not affected.

AFC Manager exhibits the same behavior when converting a project between versions 2.04 (or earlier) and 2.05 (or later).

The criterion for assigning the new product group depends on the density units and the Default Reference Density, as detailed in the following tables:

Density Units = kg/m3

Version 2.04 Product Group	Default Reference Density	Version 2.05 Product Group
Crude, NGL	= 0 OR ≥ 610.0	Crude oils, JP4
Crude, NGL	> 0 AND < 610.0	NGLs, LPGs
Oil Water Emulsion	= 0 OR ≥ 610.0	Oil-water emulsion (Crd)
Oil Water Emulsion	> 0 AND < 610.0	Oil-water emulsion (NGL)

Density Units = Rd/60

Version 2.04 Product Group	Default Reference Density	Version 2.05 Product Group
Crude, NGL	= 0 OR ≥ 0.6100	Crude oils, JP4
Crude, NGL	> 0 AND < 0.6100	NGLs, LPGs
Oil Water Emulsion	= 0 OR ≥ 0.6100	Oil-water emulsion (Crd)
Oil Water Emulsion	> 0 AND < 0.6100	Oil-water emulsion (NGL)

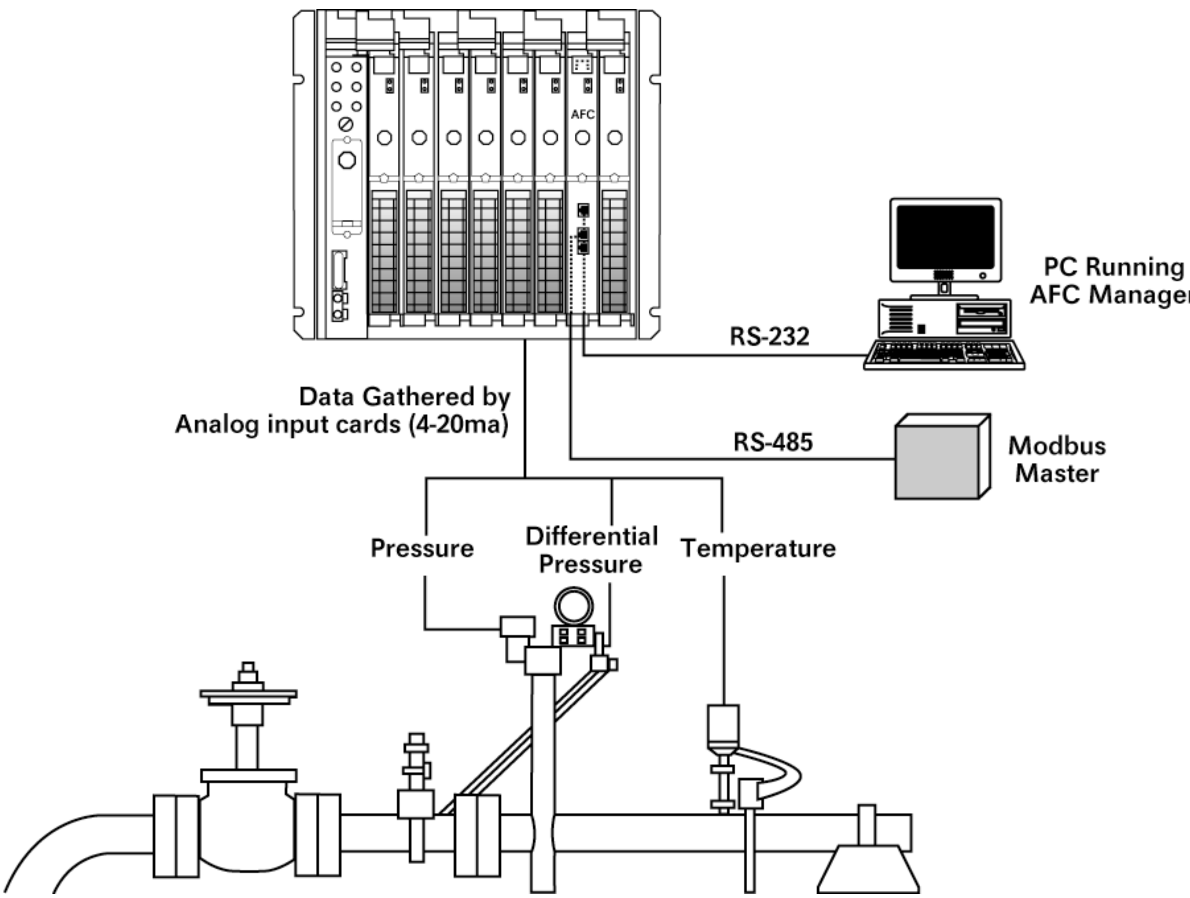
Due to roundoff error of numeric conversions, a Relative Density very close to the cutoff value of 0.6100 may cause the module to assign the new product group opposite to the one that was intended. Before upgrading, change the Default Reference Density to a number significantly different from 0.6100, such as 0.6110 (to target Crude) or 0.6090 (to target NGLs). You may change it back to the correct value after the upgrade

Density Units = API Gravity

Version 2.04 Product Group	Default Reference Density	Version 2.05 Product Group
Crude, NGL	= 0 OR ≤ 100.0	Crude oils, JP4
Crude, NGL	> 0 AND > 100.0	NGLs, LPGs
Oil Water Emulsion	= 0 OR ≤ 100.0	Oil-water emulsion (Crd)
Oil Water Emulsion	> 0 AND > 100.0	Oil-water emulsion (NGL)

1.2 MVI71-AFC Module

The following diagrams show examples of an application with an orifice meter and gas product:



2 Quick Start

In This Chapter

This section provides a general overview of the steps required to install and configure the module. You should read the *AFC Manager User Manual* to obtain a clear understanding of the steps outlined in this section.

2.1 Install AFC Manager

The AFC Manager application is included on the CD-ROM shipped with your module. Before you can use the application, you must install it on your computer.

2.1.1 System Requirements

The following system requirements are the recommended minimum specifications to successfully install and run AFC Manager:

- Microsoft Windows compatible PC
- Windows 2000 with Service Pack 2 or higher, or Windows XP Professional with Service Pack 2 or higher, or Windows 2003.
- 300 mHz Pentium processor (or equivalent)
- 128 megabytes of RAM
- 20 megabytes of free disk space
- Available serial port (COM port) or USB to Serial adapter cable with necessary drivers, required for communication between AFC Manager software and the AFC module.
- DB9 adapter cable (included with module), required for connection between PC serial port and AFC module (PTQ-AFC module does not require an adapter).

➢ ***To install the AFC Manager application:***

1. Insert the ProSoft Solutions CD in your CD-ROM drive. On most computers, a menu screen will open automatically. If you do not see a menu within a few seconds, follow these steps:
   a. Click the Start button, and then choose Run.
   b. In the Run dialog box, click the Browse button.
   c. In the Browse dialog box, click "My Computer". In the list of drives, choose the CD-ROM drive where you inserted the ProSoft Solutions CD.
   d. Select the file **prosoft.exe**, and then click Open.
   e. On the Run dialog box, click OK.
2. On the CD-ROM menu, click Documentation and Tools. This action opens a Windows Explorer dialog box.
3. Open the Utilities folder, and then open the AFCManager folder.
4. Double-click the file Setup.exe. If you are prompted to restart your computer so that files can be updated, close all open applications, and then click OK. When your computer has finished restarting, begin again at Step 1.
5. Click OK or Yes to dismiss any confirmation dialog boxes.
6. It may take a few seconds for the installation wizard to start. Click OK on the AFC Manager Setup dialog box to begin installing AFC Manager.
7. Follow the instructions on the installation wizard to install the program with its default location and settings.
8. When the installation finishes, you may be prompted to restart your computer if certain files were in use during installation. The updated files will be installed during the restart process.

2.2 Install the Module in the Rack

If you have not already installed and configured your processor and power supply, please do so before installing the AFC module. Refer to the processor documentation for installation instructions.

> **Warning:** You must follow all safety instructions when installing this or any other electronic devices. Failure to follow safety procedures could result in damage to hardware or data, or even serious injury or death to personnel. Refer to the documentation for each device you plan to connect to verify that suitable safety procedures are in place before installing or servicing the device.

After you have checked the placement of the jumpers, insert the AFC module into the rack. Use the same technique recommended by the processor manufacturer to remove and install AFC modules.

> **Warning:** When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Verify that power is removed or the area is non-hazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

Note: If you insert the module improperly, the system may stop working, or may behave unpredictably.

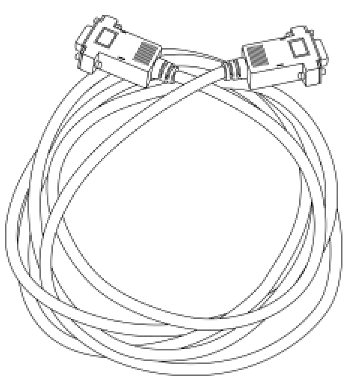
After you have installed the AFC module in the rack with the processor, you should then download the sample program to the processor.

1 Connect a null modem cable from the serial port on your computer to the serial port on the processor.
2 Start the configuration tool for your processor (RS Logix for MVI-AFC modules; Concept, Unity or ProWorx for PTQ-AFC) and establish communication with the processor.
3 Open the sample program in the configuration tool. Adjust the slot number and processor type, if necessary, to match the physical configuration of the processor and the position of the AFC module in the rack.
4 Download the program to the processor. The sample program is located on the CD-ROM in the box with your module. Refer to the User Manual for your module for specific instructions on downloading the sample program.

The next step is to connect your PC to the module to begin configuration with AFC Manager.

2.3 Connect the AFC Module to the AFC Manager

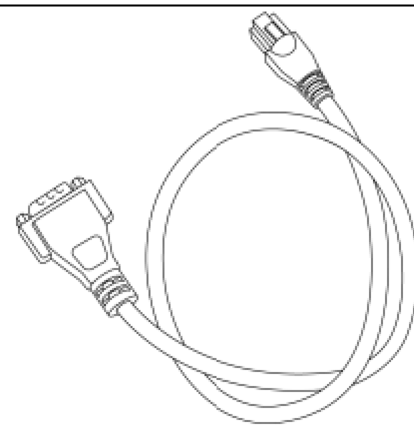
You will need the correct cables to connect the AFC module to the computer running AFC Manager. The null-modem cable as well as any required adapter cables are included in the box with the module.



Null-modem Cable

Included with all AFC modules

Connects directly to PTQ-AFC module configuration/debug port, all other AFC modules require an adapter cable (RJ45/DB9 adapter or 8 pin mini DIN/DB9 adapter, supplied with module as needed).



RJ45/DB-9 adapter

Included with MVI46, 56, 69 and 71 AFC modules

Connects Null-modem Cable to MVI46, 56, 69 and 71 AFC module configuration-debug port.

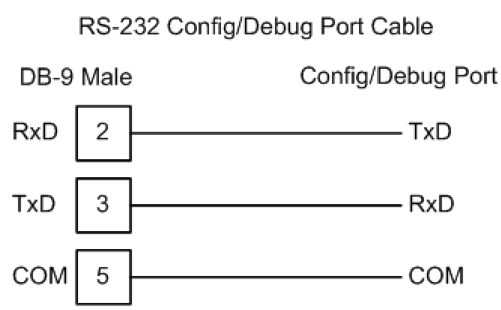
1 Connect the DB-9 adapter to the CFG (configuration/debug) port of the AFC module (refer to the port labels on the front of the module to find the correct port).

Note: The PTQ-AFC module connects directly to the null modem cable and does not require an adapter.

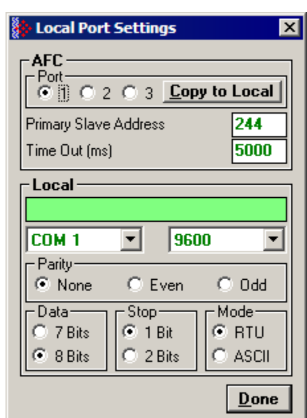
2 Connect the null-modem cable to the DB-9 adapter cable on the module, and to an available serial port on your computer.

Note: Some desktop and notebook computers are not equipped with a serial port. In this case, you may require a USB to Serial adapter cable, with drivers. Not all USB to Serial adapters will work correctly with this application. If you encounter problems, please contact ProSoft Technical Support for recommendations.

The null-modem cable that is supplied with the module uses the following cabling scheme:



3 Start AFC Manager, and then select the port settings at: **Communications / Local Port Settings**. The default communication settings are shown in the following illustration.



4 The AFC Manager will establish communication with the module. Open the Project menu and then select Site Configuration to open the Site Configuration dialog box.

5 On the Site Configuration dialog box, click the Read button. You should see the word "Success" in the Result area of the dialog box.

2.4 Starting AFC Manager

➢ ***To start AFC Manager:***

1 Click the Start button, and then choose Programs.
2 In the Programs menu, choose ProSoft Technology.
3 In the ProSoft Technology menu, choose AFC Manager.

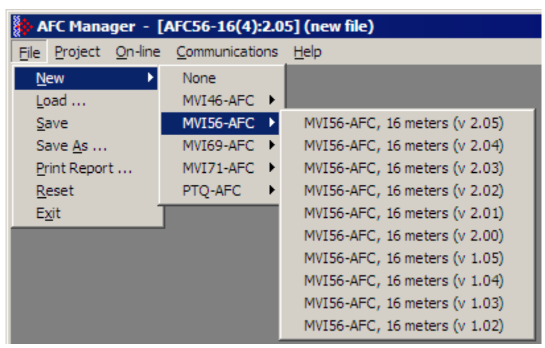
2.5 Using AFC Manager

The AFC module is configured with configuration files that you create using AFC Manager. A configuration file is called a Project.

2.5.1 Starting a New Project

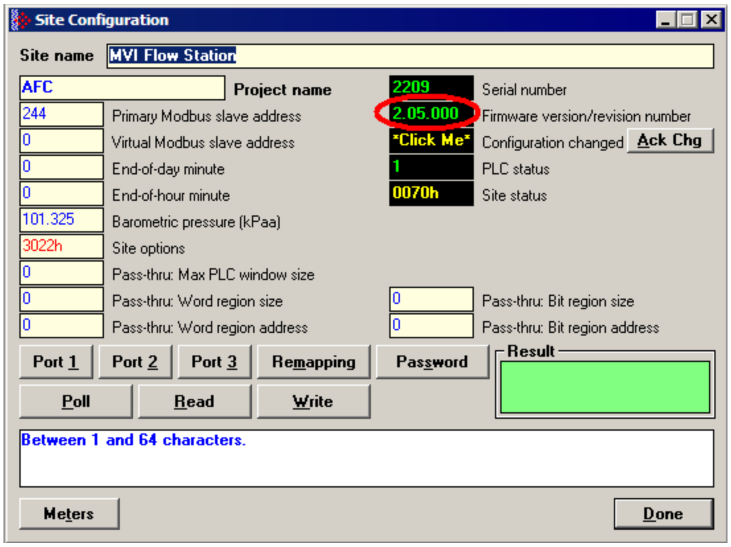
➢ ***To start a new project:***

1 Start AFC Manager, and then open the File Menu.
2 On the File Menu, choose New, and then select your module and firmware version number.



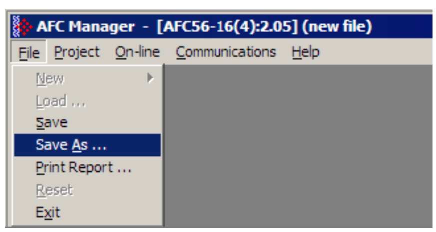
The version number refers to the firmware version of your module. If you do not know the firmware version number, follow these steps:

a) Open the Project menu.
b) Choose Site Configuration. This action opens the Site Configuration dialog box.
c) Click the Read button. The firmware version is listed below the serial number, in the upper right part of the dialog box.



> **Important:** You must be connected to the module and "online" to read data from the module.

3 Follow the steps in the remainder of this User Guide to configure your module and your AFC device.
4 Before closing the program, open the File menu and choose Save As, to save your project so you can open it again later.



2.5.2 *Loading an Existing project*

You can open and edit a project you have previously saved. Do this if you have started, but not completed, the configuration of your project, or if you need to modify the settings for a project that has already been downloaded to the module.

➢ ***To load an existing project:***

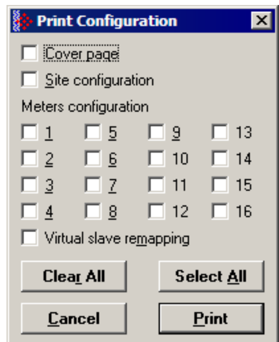
1 Start AFC Manager, and then open the File menu.
2 On the File menu, choose Load. This action opens a dialog box that shows a list of AFC Manager project files (AFC files) in the current folder.
3 Choose the project to load, and then click Open.

2.5.3 Printing the Configuration Report

You can print a report of your configuration for future reference, or for archival purposes.

➢ ***To print the configuration report:***

1 Open the File menu, and then select Print Report. This action opens the Print Configuration dialog box.



2 On the Print Configuration dialog box, select (check) the items to include in the printed report.
3 Click Print to send the report to your default printer.

> **Note:** The size of the report depends on items you choose to include, and may require 75 pages or more. Take this into account before printing.

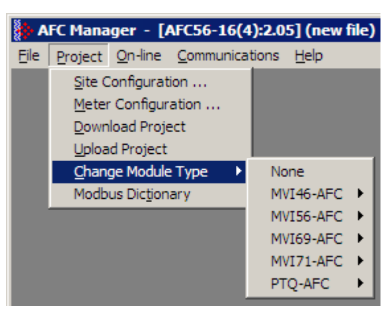
2.5.4 Converting a Project

You can convert an existing project (configuration file) to use it with a different module or firmware version. Do this if:

- You want to reuse an application created for a different AFC module, for example a project that was created for a PTQ-AFC that you want to use for an MVI69-AFC.
- You apply a firmware upgrade to a module.

➢ ***To convert a project:***

1 Open the File menu, and then choose Open.
2 Open the project (configuration file) to convert.
3 Open the Project menu, and then choose Change Module Type.



4 Choose the module type and firmware version from the menu.
5 Save your project.

Note: AFC Manager will save your updated configuration file with the same name as the file you loaded. If you need to keep your original configuration, change the file name of your updated configuration before saving.

2.5.5 Resetting Configuration Parameters

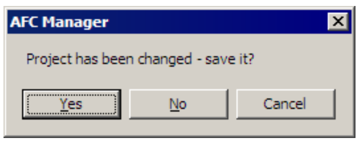
If you have modified your project (configuration file), or if you have loaded a configuration file from disk, but you want to start a new project, you can reset the configuration parameters back to their defaults without having to close and reopen the AFC Manager.

➢ ***To reset configuration parameters***

1 Close any dialog boxes that are open.
2 Save the configuration file you were working on, if you would like to load it again later.
3 On the File menu, choose Reset.

Note: This procedure has the same effect as choosing **File / New / None**.

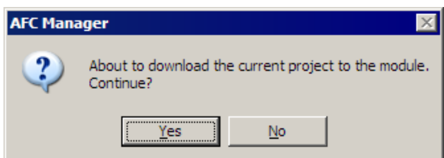
If you have made changes to the configuration that have not yet been saved, a confirmation dialog box will open.



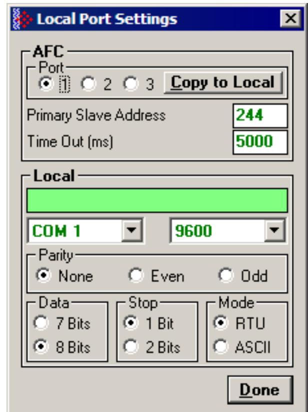
Answer Yes to save your changes, or No to discard your changes and begin working on a new configuration. Click Cancel to abandon the attempted action that caused this message.

2.5.6 Downloading the Project to the Module

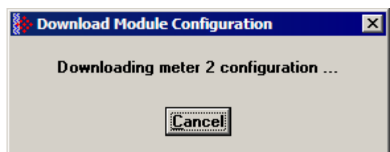
1 Click **Project / Download Project**.



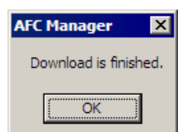
2 The following window is displayed the first time you attempt communication with the module. Enter the port parameters to use, and then click Done.



3 During the download operation, the following progress window is displayed:



4 When the file transfer is complete, the following window is displayed:



Note: The virtual slave remapping data (page 33) is not downloaded during the procedure because it requires a separate download operation.

Troubleshooting Tip: If the AFC Manager displays an "Illegal Data Value" message, it typically indicates an invalid meter type or product group configuration. The module does not accept a configuration file that attempts to change a meter type or product group for a meter that is currently enabled. Disable all meters, change the meter types and product groups, and then enable the meters again.

2.5.7 Verifying Correct Operation

When all of the configuration steps have been completed, the module should be ready to perform measurement calculations. To verify that the module is configured correctly, follow these steps:

1 Enable all meters that will be used, as any meter will only perform calculations if it is enabled. Any meter can be enabled either with ladder logic (MVI modules), function blocks (PTQ modules) or with AFC Manager.

2 Make sure that the wallclock is running, and that it has valid date and time information. After power-up, the wallclock will be stopped, therefore the module will not perform any time-scheduled operations, such as writing period-end archives, and will not timestamp records written to the event log until it receives a wallclock command from the ladder logic.

The sample ladder logic programs the wallclock update command upon detecting "power-up" status from the AFC. The date/time information used is the same as the processor, therefore you should use the configuration tool for your processor to verify that the processor has valid date/time data. If the processor wallclock is not valid (for example if the year = 1900), the module will not accept the command. You may easily determine if the wallclock is running by performing two consecutive read operations in the Meter Monitor.

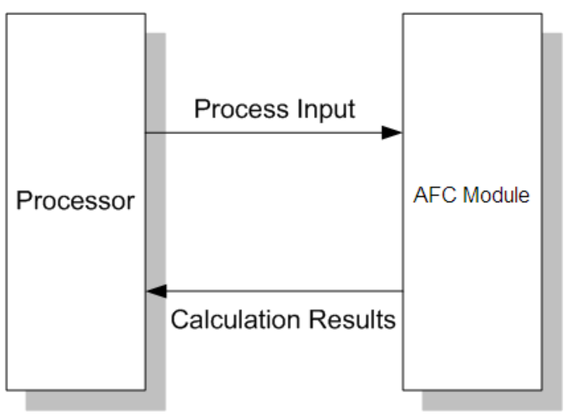
3 Make sure that the meter does not have any alarms. A meter alarm may affect flow calculation. Look at the Meter Monitor dialog box for alarms.

4 Make sure that the input parameters transferred from the processor are correct. You can look at these values in the Meter Monitor dialog box.

5 When using a pulse meter, make sure that the pulse input rollover parameter in Meter Configuration matches the actual input rollover value used in the high speed counter module.

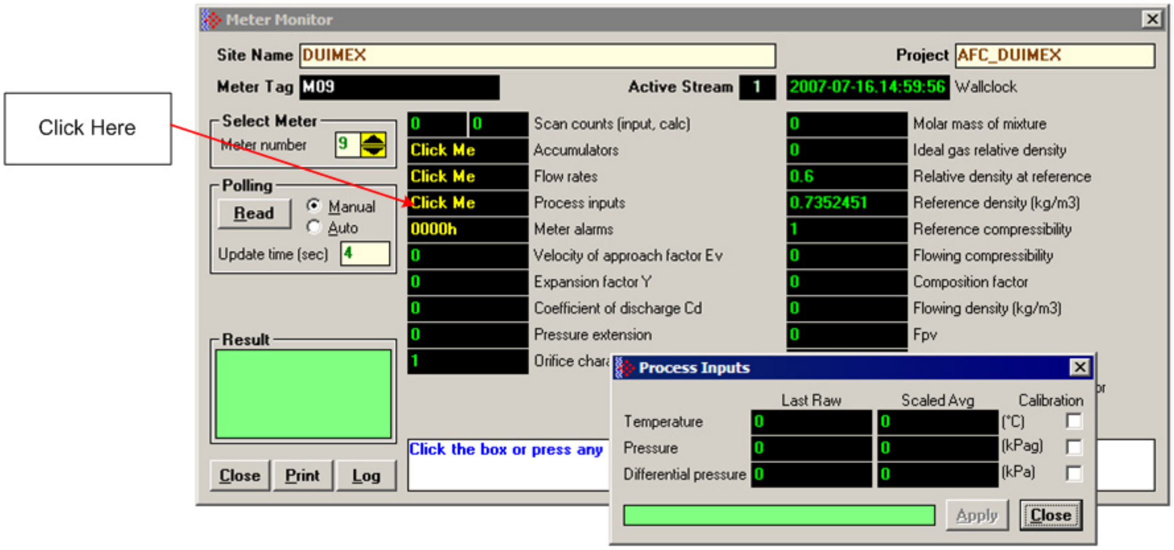
2.6 Ladder Logic Implementation

The sample ladder logic performs tasks that are covered in the Ladder Logic sections of this manual. The most important task is to continuously write meter process input variables from the processor to the module, and read calculation results from the module to the processor.

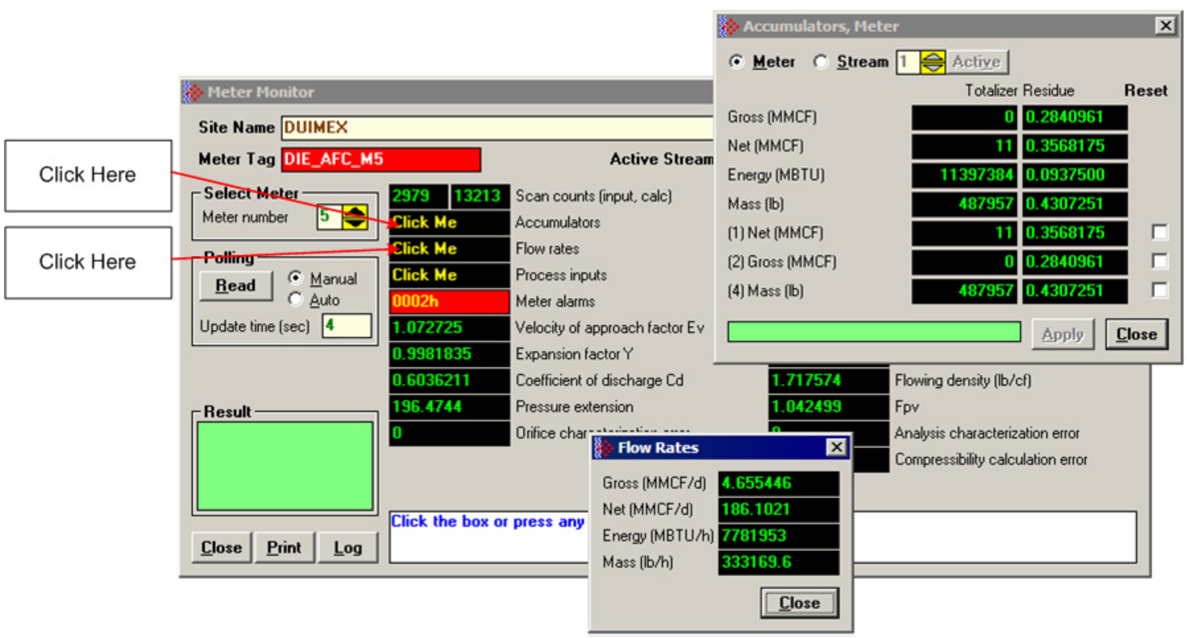


Refer to the Ladder Logic sections for instructions on how to transfer the meter process variables from the processor to the module. Ladder logic is required to move the process variables to the correct data file or controller tag in the processor.

The **Meter Monitor** window (*Process Inputs* field) displays the values that are transferred from the processor.



The values calculated by the module are continuously transferred to the processor. You can refer to the **Meter Monitor** window to verify results calculated by the module.



Refer to the Ladder Logic section for more information regarding the data files and controller tags that store the calculation results transferred from the module (for example, accumulator, flow rate, and so on).

2.7 Setting the Wallclock

After power-up, the module must receive valid wallclock data from the ladder logic to perform time-scheduled operations and to properly timestamp historical records. The sample ladder logic automatically writes the wallclock during the processor's first scan (using the processor's date and time information). You should ensure that the processor contains valid date and time information. If it does not, the module may not accept the wallclock block.

You can verify the wallclock information using the Meter Monitor section as shown in the following example:

Refer to the Sample Ladder Logic section for more information on this topic.

2.8 Module Initialization

When the module is powered up for the first time, both the **OK** and **ERR** BBRAM LEDs are illuminated. This indicates that the module is in the *Cold Start* state and is not yet ready to perform calculations. The following steps initialize the module:

- Enable at least one meter
- Set the processor to RUN mode

After these two steps are accomplished, the state is changed from *Cold Start* to *Released*. This indicates that that module is ready to perform flow calculations. When in the *Released* state, the **OK** LED is ON and the **ERR** LED is off.

When the module is ready, you will use AFC Manager to monitor meter operation, archives, and events. The *AFC Manager User Manual* contains detailed information on these tasks.

3 Meter Channel Functionality

In This Chapter

3.1 Meter Channels

The number of available meter channels depends on the platform as follows:

- MVI46-AFC = 8 meters
- MVI56-AFC = 16 meters
- MVI69-AFC = 8 meters
- MVI71-AFC = 8 meters
- PTQ-AFC = 16 meters

Each meter channel can be assigned as a linear meter (*pulse meter*) input or as a differential meter (*orifice meter*) input for flow measurement using either SI or US units. Selecting the differential meter causes the module to use the AGA 3 standards for flow calculation. Selecting the linear meter causes the module to use the AGA 7 standard for gas flow calculation.

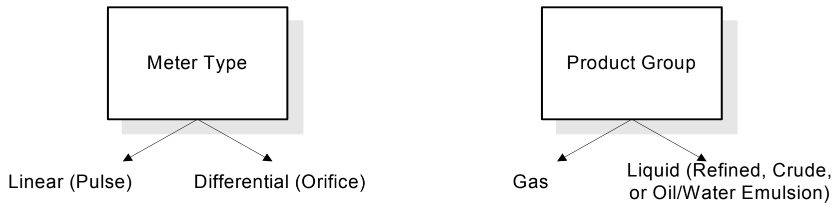
Each meter channel can be configured for gas or liquid (*crude* or *refined*) product. The Product Group essentially selects the API/AGA Standards to be used in calculating flow rates/increments.

Selecting "Gas" causes use of AGA8 and either AGA3 or AGA7 Standards.

Selecting any liquid group causes use of the API2540 Standards. "Crude/LPG" and "Oil-Water Emulsion" use the base, "A", and "E" tables 23/24/53/54, and "Refined Products" uses the "B" tables 23/24/53/54. "Crude/LPG" is used for propane, butane, NGLs (natural gas liquids), and crude oils which are relatively water-free (less than 5 per cent. "Oil-Water Emulsion" is used for crude and NGL/LPG that might have a high concentration of water for which API MPMS Chapter 20.1 is applicable. "Refined Products" is used for gasoline, jet fuels, and fuel oils.

The following table provides a brief overview of the standards used according to the Meter Type and Product Group:

Meter Type	Product Group	Standards
Differential	Gas	AGA8, AGA3
Differential	Liquid	API2540, AGA3
Linear	Gas	AGA8, AGA7
Linear	Liquid	API2540, MPMS ch12.2



Note: The meter channel must be disabled in order to change its meter type and product group.

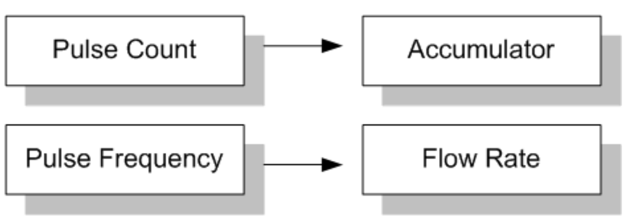
3.2 Linear (Pulse) Meter Overview

The module typically receives the pulse count and pulse frequency values from a high-speed counter module. The module uses these values to perform calculations.

You can configure the primary input to be used for volume calculation. You can configure it as Pulse Count or Pulse Frequency.

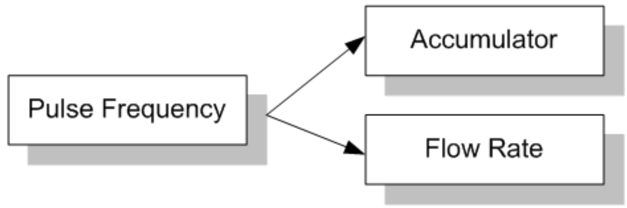
3.2.1 Primary Input = Pulse Count

If you select Pulse Count as the primary input, the module uses the pulse count value transferred through the backplane as the primary input for volume calculation. In this case, the pulse frequency will be used for flow rate calculation only.



3.2.2 Primary Input = Pulse Frequency

If you select Pulse Frequency as the primary input, the module uses the pulse frequency value transferred through the backplane as the primary input for both flow accumulation and flow rate calculation. The pulse count value is ignored by the module.



3.3 Differential (Orifice) Meter Overview

The static pressure of the gas stream can be measured either upstream of the meter (before the differential pressure drop), or downstream of the meter (after the pressure drop). Both AGA3 and AGA8 require the upstream static pressure for their calculations, where:

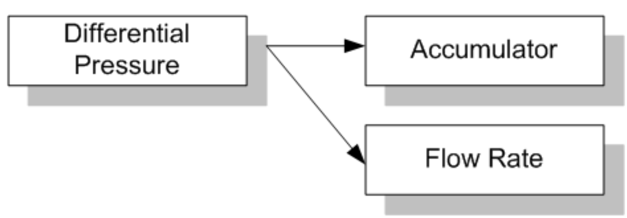
upstream pressure = downstream pressure + differential pressure

If the pressure is measured from a downstream tap (typical), the *Downstream Static Pressure* option should be set through the AFC Manager.

The module also supports the V-Cone device. You can configure V-Cone meters and downstream selections in AFC Manager, on the **Meter Configuration / Calculation Options** dialog box.

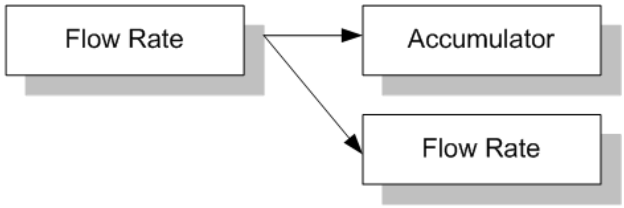
3.3.1 Primary Input = Differential Pressure

The primary input parameter configures the value used as source for the accumulator calculation. If the parameter is set to Differential Pressure, the module uses the differential pressure value transferred through the backplane for accumulator calculation.



3.3.2 Primary Input = Flow Rate

You can configure the primary input parameter as flow rate in order to use this value for the accumulator calculation.



Note: The flow rate can be converted to a different unit.

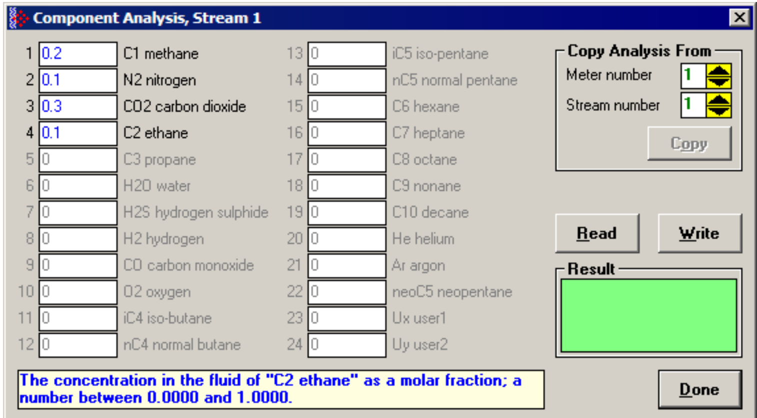
The AFC Manager software supports the following parameters:

- Orifice Plate and Meter Tube Measured Diameter
- Orifice Plate and Meter Tube Measurement Temperature
- Orifice Plate and Meter Tube, Coefficient of Thermal Expansion
- DP Flow Threshold (kPa)
- DP Alarm Threshold (kPa)

3.4 Gas Product Overview

The gas compressibility calculations are based on molar analysis concentrations of up to 21 components, using the Detail Characterization Method of AGA8 (1992). The module automatically generates alarms if the sum of the molar concentrations is not 100%

Supply the values using the AFC Manager (**Meter Configuration / Analysis**) as follows:



The module records events every time a molar concentration value changes. For applications that involve gas chromatograph devices, this feature might not be desirable because it is expected that the values should frequently change. You can disable this feature using AFC Manager (**Meter Configuration / Control Options** / **Treat Analysis as Process Input**).

3.5 Liquid Product Overview

The module supports applications involving crude or refined oil such as crude oil, oil/water emulsion, propane, butane, NGLs, LPGs, gasoline, jet fuels and lubricating oils.

When measuring liquids with density correction, density at flowing conditions is required. This value may be provided directly as a process input, or the module can calculate a density from the frequency provided by a densitometer device.

3.5.1 To use a densitometer

Follow the steps below to use a densitometer.

6 Configure it, entering all configuration parameters directly from the calibration data sheet supplied by the densitometer manufacturer.

7 Supply the frequency output from the densitometer in Hz as a floating-point value in the "Flowing density" process-input location over the backplane (refer to the Backplane Communication section for your platform to determine the correct location). The AFC then calculates a flowing density value, which is then validated by the range check mandated by the "Density" values of "Process Input Scaling" of the meter configuration. The "Scaling" sub-selection is not used against the frequency input, however; the frequency is always input as floating-point.

> **Note:** If using the Densitometer feature, select the Density Process Input Scaling for 4 to 20mA and enter the densitometer frequency as a floating-point value.

3.5.2 Density Units

The liquid density units can be expressed as:

- Density is in kg/m^3;
- Relative density 60ºF/60ºF;
- API gravity;

3.5.3 Measuring Water Diluent

For liquid measurement applications, the optional automatic calculation of Net Oil Volume and mass based on the Sediment and Water (S&W) percent input is supported. Only provide the S&W percent value in the specified controller register. The module puts the gross standard (or gross clean oil), net oil and water accumulations in separate accumulators. Refer to Net Accumulator Calculation (page 47).

3.6 General Features

3.6.1 Process Variable Interface

Process variables for each of the meter runs must be produced by the controller for consumption by the AFC module. A versatile architecture for backplane transfer of process variables and other data and signals allow you to easily implement the data transfer. The sample ladder logic automatically transfers the process variables to the module and reads the calculation results to the processor.

3.6.2 Meter Scan Time

For good measurement, the process I/O must be sampled, and the flow calculations completed quickly in order to avoid losing process information and measurement accuracy. The process I/O scan time for the module is under one second for all meter runs.

> **Note:** This is time-dependent on design of the ladder logic implemented to support the two-way data transfer between the AFC module and the controller. The meter calculation scan independent of the process I/O scan may take longer.

3.6.3 Multiple Meter Accumulators

Each meter channel supports the following set of full 32-bit accumulators that may be configured in binary or split decimal format with user-defined rollover values:

- Gross Volume
- Gross Standard Volume (liquid only)
- Net Volume

- Mass
- Water (liquid only)
- Energy (gas only)

Access to the above accumulators is available directly from the two Modbus Slave communications ports.

3.6.4 Product Batching

Any or all of the available meter runs may be configured for field installation that requires shipping and/or receiving product batches of predetermined size. The configuration utility option of selecting resettable accumulators provides a simple way to use the power of ladder logic to design product batching, monitoring, and control tailored to suit specific field requirements.

The Meter Signals feature can be used to create an archive or reset an accumulator after the batch is concluded. Refer to the Ladder Logic section for your platform for more information on using this feature.

3.6.5 Data Archiving

The module supports the archiving of data for each meter channel. Each time, one record consisting of all the associated data is date and time stamped and archived. This option allows for archiving each hour for 2 days (48 records per meter run) and every day for 35 days (35 daily records per meter run) for each meter channel. Each record consists of up to 40 process and other variables. Archives are mapped to the local Modbus Table. Refer to Archives (page 49) for more information about this topic.

3.6.6 Event Log Function

The module can log up to 1999 critical events in an Event Log File stored as a set of easily accessible Modbus registers in non-volatile RAM. Changing critical parameters, such as orifice plate size, Meter Base K factors, and Meter Correction Factors, are time stamped and logged. Refer to Events (page 65) for more information about this topic.

3.6.7 Measurement Units

This option is provided for each meter channel to be configured with SI or US units of measurement. Units for flow totalization (*volumetric* and *mass*) and flow rate monitoring are configurable for each meter channel separately if the default configuration is not applicable. Each meter channel may be configured to use any of the standard units from liters/gallons to thousand cubic meters/barrels. The flow rate period of each meter channel may be selected from flow rate per second, per minute, per hour, or per day.

3.6.8 Process Input Scaling

The module allows you to either pre-scale the process inputs via ladder logic for use in the measurement calculations, or provide unscaled values from the analog input modules directly. In the second case, the scaling is done internally. You can directly enter the zero-scale, the full-scale, and the default values for each of the process variable inputs through the configuration window.

Scaled Integer		
Variable	**Format**	**Example**
Temperature	Two decimal places implied	A value of 1342 would be equivalent to 13.42°C
Pressure	No decimal places implied for SI units (kPa) and one decimal place implied for U.S. units (psi).	A value of 200 would be equivalent to 200kPag
Differential Pressure	Two decimal places implied for inches of H2O and 3 places for kPa	A value of 35142 would be equivalent to 35.142kPa
Density (kg/m3)	One implied decimal place	A value of 5137 would be equivalent to 513.7 kg/m3
Density (Relative Density)	Four implied decimal places	A value of 10023 would be equivalent to 1.0023 60F/60F.
Density (API)	Two implied decimal places	A value of 8045 would be equivalent to 80.45 °API.

In the **Meter Monitor** window, the raw value is shown at the "Last Raw" column and the converted values are shown at the "Scaled Avg" column.

When selecting the 4 to 20mA process input scaling, the module uses the following ranges:

4 to 20mA			
Processor	**Module**	**0%**	**100%**
SLC	MVI46-AFC	3277	16384
ControlLogix	MVI56-AFC	13107	65535
CompactLogix	MVI69-AFC	6241	31206
PLC	MVI71-AFC	819	4095
Quantum/Unity	PTQ-AFC	4000	20000

The module uses the configured values for zero and full scale to interpret the process input scaling.

4 Modbus Database

In This Chapter

The module supports two individual Modbus slaves (Primary and Virtual) to optimize the polling of data from the remote SCADA system, or from the processor (through the backplane). Refer to the Modbus Dictionary dialog box in AFC Manager for information about Modbus addressing.

4.1 AFC Modbus Address Space

Addressable Modbus registers are divided into four banks as shown in the following figure:

MODBUS Address Space Allocation: Total MB Registers: 131,072			
Primary Slave Banks (131072 registers)		**Virtual Slave Banks (20,000 registers)**	
Holding Registers	**Input Registers**	**Holding Registers**	**Input Registers**
From: 0	From: 0	From: 0	From: 0
To: 65535	To: 65535	To: 9999	To: 9999

The first 100 registers of the virtual slave (registers 0 through 99) are predefined to map to the first 100 registers of the primary slave. This mapping cannot be changed. Also, the Virtual Slave Input Registers can be accessed as Virtual Slave Holding Registers by adding 10000 to the Modbus register address; for example, Input Register 2386 is the same as Holding Register 12386.

4.1.1 Primary Slave

The Primary Slave contains the main AFC database that consists of 131,072 Modbus registers. The Site and Meter configuration, as well as all live process data and ongoing calculations are kept in the Primary Slave address space. This address space is divided equally between the Input Register Bank (65,536 registers) and the Holding Register Bank (65,536).

The register addressing is shown in the Modbus Dictionary dialog box in AFC Manager.

Modbus Address References

In these documents (the AFC Manager User's Guide and the User's Guide for your platform) you will occasionally see Modbus address references like *Ph00018* or *Mh00162.* The first two characters of such references indicate how to convert the following number into an absolute Modbus address in the module.

This table shows the possible values for the first identification character:

Address Translation ID	Description
P	Absolute Modbus address, Primary Slave
M	Meter-relative Modbus address, Primary Slave
V	Absolute Modbus address, Virtual Slave

This table shows the possible values for the second identification character:

Register Bank ID	Description
h	Holding register
i	Input register

Modbus Address Examples

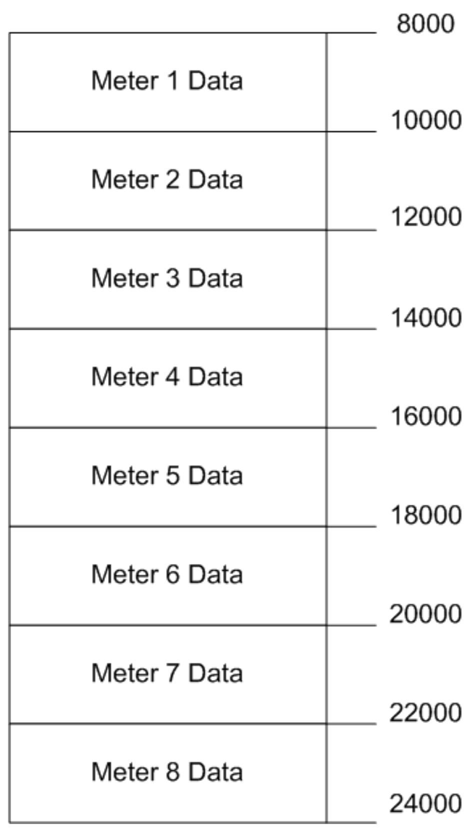
Ph02000 = holding register located at address 2000 in the primary slave

Pi02000 = input register located at address 2000 in the primary slave

Mh00100 = Meter-relative holding register located at offset 100 in the block of the primary slave that contains the data for the meter

Meter-relative Data

Meter-relative data starts at absolute holding register address 8000 and occupies 2000 words of data for each meter channel.



The meter-relative addresses are offsets within each meter data area. The correct absolute address is calculated by the following formula:

```
[absolute address] = [meter-relative address] + (8000)*[meter number-1]
```

In the Modbus Dictionary dialog box, addresses listed for the selected meter are absolute addresses, so you should subtract the appropriate multiple of 8000 to calculate the meter-relative address.

Example: Find the orifice diameter address for the first 5 meter channels.

The meter 1 orifice diameter registers are located at the holding register address 8162 and 8163 as follows:

8160	8161	Float	Parameter: orifice plate: measurement temperature
8162	8163	Float	Parameter: orifice plate: measured diameter
8164	8165	Float	Parameter: orifice plate: coef of thermal expansion
8166	8167	Float	Parameter: meter tube: measurement temperature
8168	8169	Float	Parameter: meter tube: measured diameter
8170	8171	Float	Parameter: meter tube: coef of thermal expansion
8172	8173	Float	Parameter: differential pressure flow threshold

The meter-relative addresses are Mh00162 and Mh00163

The addresses for meters 1 to 5 are listed on the following table:

Meter	Registers
1	8162 and 8163
2	10162 and 10163
3	12162 and 12163
4	14162 and 14163
5	16162 and 16163

Scratchpad

The Primary Modbus Slave contains a scratchpad area that can be used to store any data required by each application. This area is "empty" by default and contains 6000 words of data starting at holding register 2000 in the Primary Modbus Slave.

Virtual Slave

The module also provides a Virtual Address Space of 20,000 Modbus registers. This address space is divided equally between the Input Register Bank (10,000 registers) and the Holding Register Bank Holding Register Bank (10,000). This is where you can create a virtual re-map by cross-referencing any of the 130,072 Primary Slave Modbus registers to the 20,000 Modbus registers in the Virtual Slave Banks, thereby making it easy for a SCADA Master to poll only the necessary Modbus addresses in contiguous blocks. The virtual slave can also be used for data polling from the processor through the backplane.

Modbus access to the Virtual Modbus Slave is disabled by default since its Modbus address is originally set as 0. To use the Virtual Modbus Slave, you must initially configure a Modbus address greater than zero in order to enable it. Refer to Site Configuration for more information about enabling the Virtual Slave and using the remapping feature. The PLC may always access the Virtual Slave, whether or not it has a non-zero slave address and thus is available via Modbus.

A download operation will not transfer the Virtual Slave Remapping configuration. You must click on the **Write** button on the **Indirect Address Remapping** dialog box to transfer the data.

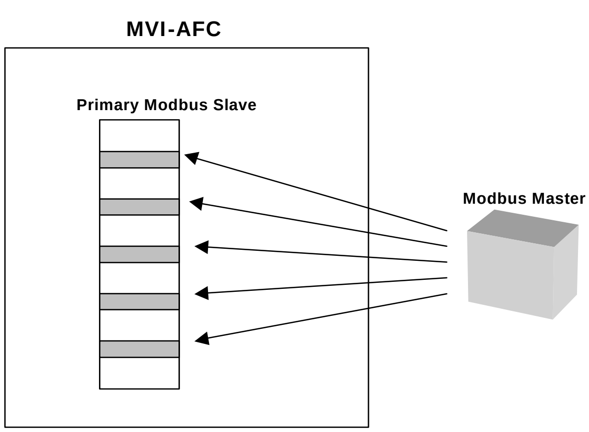
Note: The first 100 registers in the Virtual Slave Holding Register Bank have been pre-assigned and cannot be remapped. They map directly to the first 100 holding registers of the Primary Slave.

Virtual Slave Example Application

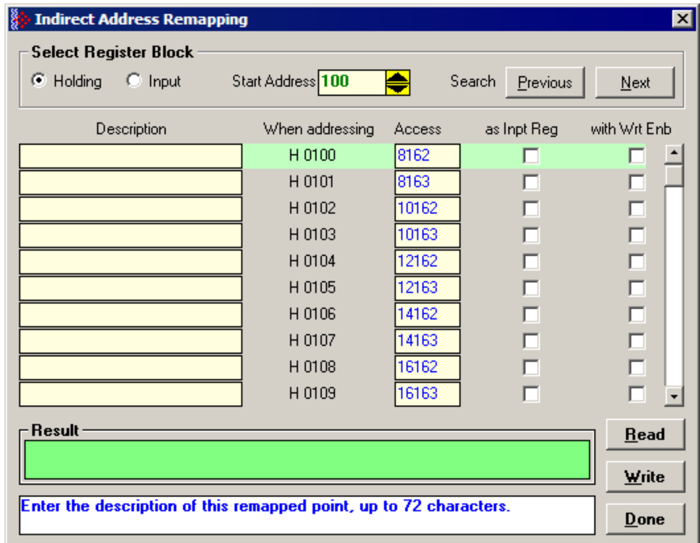
Assume that an application requires a remote Modbus master to poll the orifice diameters for the first 5 channels. Continuing the previous example, the holding register addresses are listed again the following table.

Meter	Registers
1	8162 and 8163
2	10162 and 10163
3	12162 and 12163
4	14162 and 14163
5	16162 and 16163

Because these addresses are not contiguous, the Modbus master would have to use five commands to poll all the data directly from the Primary Modbus Slave as follows:



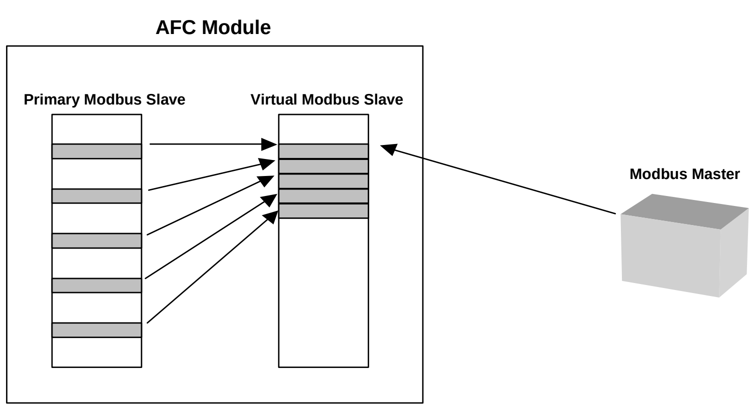
However, using the Virtual Modbus Slave optimizes the polling of data because the registers can be remapped in any order using the AFC Manager (Site Configuration window). The following illustration shows how the orifice diameter registers could be remapped to the Virtual Slave starting at address Vh00100:



The following table shows how the addresses would be remapped between both slaves:

Primary Modbus Slave Addresses	Virtual Modbus Slave Addresses
8162 and 8163	100 and 101
10162 and 10163	102 and 103
12162 and 12163	104 and 105
14162 and 14163	106 and 107
16162 and 16163	108 and 109

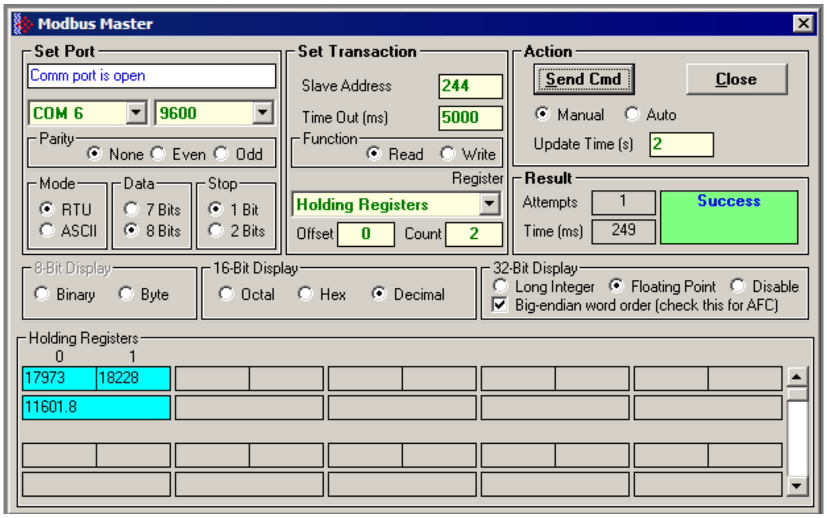
Therefore, instead of sending five Modbus commands (2 words each) to the Primary Modbus Slave, the Modbus master device can now send one single Modbus command (10 words) to the Virtual Modbus Slave in order to poll the same data from the module:



This example demonstrates the benefits of using the Virtual Slave instead of accessing the data directly from the Primary Modbus Slave. The same procedure can be used when polling data from the processor (through the backplane) because the Modbus Gateway block also requires the data to be listed in a contiguous order.

4.1.2 Accessing the Data

The AFC Manager provides an easy way to read and write data from both slaves through the Modbus Master Interface.



5 Modbus Communication

In This Chapter

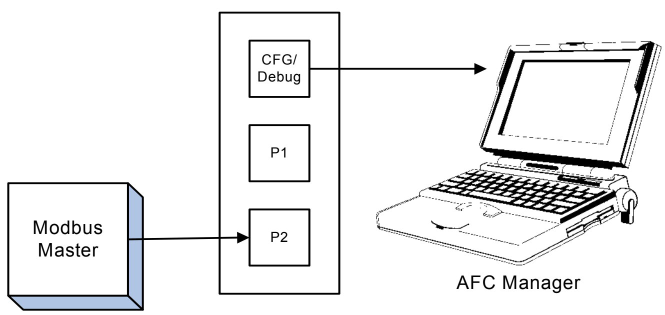
A remote Modbus master device can be connected to any one of the communication ports for data polling. The module accepts the following Modbus command functions according to the Modbus protocol specification:

Modbus Function Code	Description
3	Read Holding Registers
4	Read Input Registers
6	Preset Single Register
16	Preset Multiple Registers

Ports 2 and 3 support RS-232, RS-422, or RS-485 communications. The Configuration/Debug port (Port 1) supports RS-232 only.

Refer to Cable Connections for wiring instructions.

The Modbus master command can be sent to either the Primary or Virtual Modbus Slaves in the module. Each slave has individual Modbus addresses that you can configure (**Project / Site Configuration**). The Primary Slave address is configured as 244 by default.



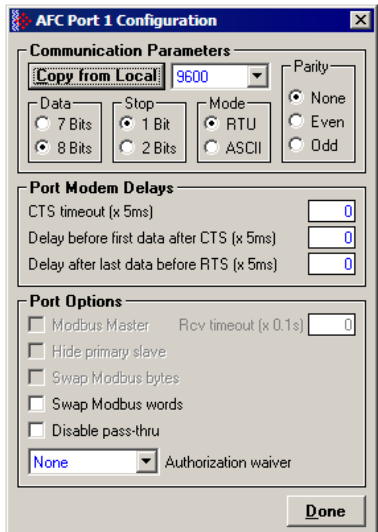
5.1 Communication Parameters

The module supports the following communication parameters for each communication port:

Parameter	Values
Baud Rate	300, 600, 1200, 2400, 4800, 9600 or 19200
Data Bits	7 or 8
Stop Bits	1 or 2 Bits
Mode	RTU or ASCII
Parity	None, Even or Odd

Note: Do not configure a port for both RTU mode and 7 data bits as this combination is not supported by the Modbus protocol.

You must configure the communication parameters for each communication port using the AFC Manager software (Site Configuration):



5.1.1 Port Options

The following options can be configured:

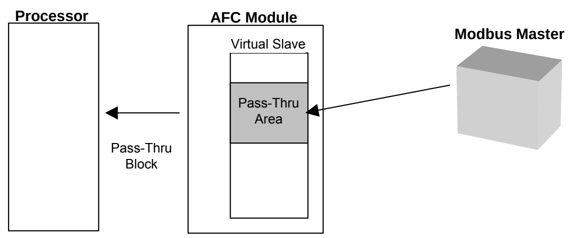
Port Options	Description
Hide Primary Slave	Protects the Primary Slave from any read or write operation from a remote master. Only the virtual slave is visible on this port.
Swap Modbus Bytes	Swap the Modbus bytes transferred through this port (Not implemented)
Swap Modbus Words	Swap the Modbus words transferred through this port. This parameter is only applicable to those data points that hold 32-bit quantities (long integers, floats, totalizers),
Disable Pass-Thru	Disables the pass-thru feature on this port
Modbus Master	Enables the Modbus master for the port (Port 3 only)

Not all options are available on every port:

- Port 1 is restricted, so that AFC Manager can always communicate with the Primary Slave using this port.
- Modbus Master option is available only on Port 3.

Modbus Pass-Thru

The Modbus pass-thru feature allows you to configure a Modbus pass-thru region in the Virtual Slave (**Project / Site Configuration**). After the module receives a holding register write command (Modbus functions 6 or 16) or a bit write command (Modbus functions 5 or 15) to this region, it will generate a pass-thru block to be sent to the processor containing the Modbus command data. You may define a word pass-thru region (for Modbus functions 6 and 16) and a bit pass-thru region (for Modbus functions 5 and 15).



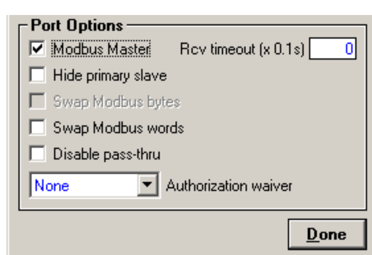
Important: You must enable the virtual slave by configuring a Modbus address greater than 0 (**Project / Site Configuration**).

You can control which communication ports will support the pass-thru (**Project / Site Configuration / Port X button**).

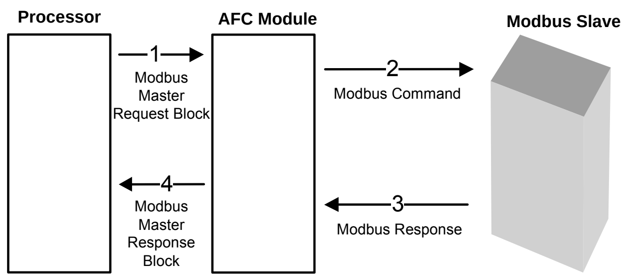
This feature requires ladder logic to read the pass-thru block from the module to the processor. Refer to the Ladder Logic section for more information about the pass-thru feature.

Modbus Master

Port 3 can be configured for Modbus master operation (**Project / Site Configuration / Port 3**).



The Modbus master command is generated from the processor using ladder logic (Modbus master block). After the Modbus master transaction is completed the module is ready to receive another Modbus master request from the ladder logic:



The following Modbus functions are supported for Modbus master operation:

Modbus Function Code	Description
1	Read Coil Status
2	Read Input Status
3	Read Holding Registers
4	Read Input Registers
15	Force Multiple Coils
16	Preset Multiple Registers

The module offers considerable flexibility for Modbus master operation, allowing the ladder logic to select one of the following data types:

- Bit (packed 16 to a word)
- Word (16-bit register)
- Long (32-bit items as register pairs)
- Long Remote (32-bit items as single registers)

Note: Long data type implements each data unit as one pair of 16-bit registers (words). Each register contains two bytes. Long remote data type implements each data unit as one 32-bit register. Each register contains four bytes. The proper choice depends on the remote slave's Modbus implementation.

Example

The following table shows how the data types are implemented if a **write** function is selected and the item count is configured with a value of 10 (decimal):

Data Type	Register Type	Modbus Function	Number of Coils	Number of Bytes	Number of Registers	Number of words (16-bits) transferred
Bit	Coil	15	10	2	-	1
Word	Holding	16	-	20	10	10
Long	Holding	16	-	40	20	20
Long Remote	Holding	16	-	40	10	20

Note: The number of coils, bytes, and registers are part of the Modbus request (functions 15 and 16) according to the Modbus specification.

The following table shows how the data types are implemented if a **read** function is selected and the item count is configured with a value of 10 (decimal):

Data Type	Register Type	Modbus Function	Number of Registers
Bit	Coil	1	10
Bit	Input	2	10
Word	Holding	3	10
Word	Input	4	10
Long	Holding	3	20
Long	Input	4	20
Long Remote	Holding	3	10
Long Remote	Input	4	10

Note: The number of registers is part of the Modbus request according to the Modbus specification.

Refer to the ladder logic section for your module for more information about the Modbus master block.

6 Accumulators

In This Chapter

The accumulators store the current amount of measured quantity for a meter channel. This section provides detailed information about the accumulators.

6.1 Accumulator Totalizer and Residue

The accumulators are expressed as the totalizer and residue parts. This implementation allows the accumulation of a wide range of increments, while keeping a high precision of fractional part with an approximately constant and small round off error.

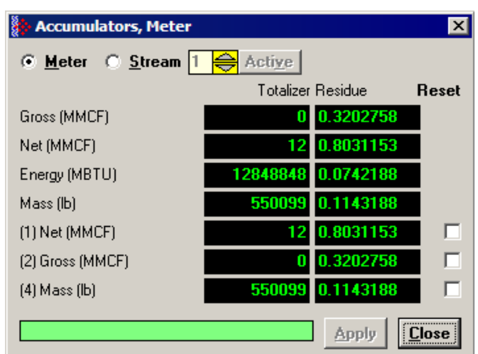
The totalizer stores the integral part of an accumulator as a 32-bit (or split) integer. The residue is the fractional part (always less than 1.0) expressed as a 32-bit IEEE floating point.

The Total Accumulator is given by the formula:

```
ACCUMULATOR = TOTALIZER + RESIDUE
```

6.1.1 Example

If the meter monitor window shows the following values for the accumulators:



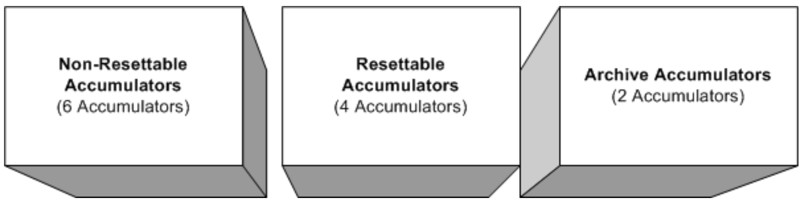
The total resettable accumulator 1 value (net) is 12.8031153.

The accumulator totalizer values can be configured to "split" with the low-order word rolling over from 9999 to 0000 at which time the high-order word is incremented. Refer to the AFC Manager (AFC Manager / Meter Configuration / Split Double Accumulators) to select this feature.

A 32-bit value is more suited to computation and has a greater range than a split value, whereas a split value is easier to read when it is represented as a pair of 16-bit numbers, as in a processor data file.

6.1.2 Accumulator Types

The module supports a total of 12 accumulators per meter channel divided into the following categories:



These 3 accumulator types are independent. For example, resetting a resettable accumulator does not affect the other accumulators.

For multiple-stream firmware (version 2.05 and later), each stream also has its own set of ten accumulators (six non-resettable and four resettable). Increments are applied both to the meter accumulators and to the accumulators for the active stream.

Non-Resettable Accumulators

The non-resettable accumulators are only reset when the accumulator rollover value is reached. The accumulator rollover value, and the accumulator unit must be configured using the AFC Manager. Refer to the AFC Manager User Manual for more information about this topic.

The module supports six non-resettable accumulators in order to show the measured quantity to be totalized:

- Non-resettable accumulator mass
- Non-resettable accumulator energy (Gas applications only)
- Non-resettable accumulator net
- Non-resettable accumulator gross
- Non-resettable accumulator gross standard (Liquid applications only). For Oil-Water Emulsion, this is non-resettable accumulator gross clean oil.
- Non-resettable accumulator water (Liquid applications only)

Refer to the Modbus Dictionary dialog box in AFC Manager for more information about the Modbus addresses for these registers.

Resettable Accumulators

The resettable accumulators are referred to as:

- Resettable Accumulator 1
- Resettable Accumulator 2
- Resettable Accumulator 3
- Resettable Accumulator 4

Configuring Resettable Accumulators

Resettable Accumulators are configured from the Resettable Accumulator Select dialog box. To open this dialog box, click the Resettable Accum button on the Meter Configuration dialog box.

Each Resettable Accumulator can be configured to represent a different quantity as follows:

Accumulator	Modbus address for accumulator select (Meter-relative)	Default Value
Resettable accumulator 1	136	Net (code 3)
Resettable accumulator 2	137	Gross (code 4)
Resettable accumulator 3	138	Gross Standard (code 5)
Resettable accumulator 4	139	Mass (code 1)

Valid Configuration Codes

The valid codes are:

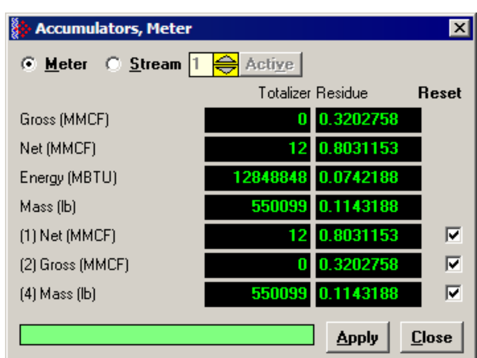
Code	Quantity
0	None
1	Mass
2	Energy (Gas Only)
3	Net
4	Gross
5	Gross Standard (Liquid Only)
6	Water (Liquid Applications Only).

For example, moving a value of 4 to holding register 8136 will configure Meter 1's resettable accumulator 1 as "Gross Volume". Moving "0" to holding register 10138 configures Meter 2's Resettable Accumulator 3 to accumulate nothing (takes it out of service).

The resettable accumulators are reset when one of the following situations occur.

Reset from AFC Manager

You may reset any of the resettable accumulators using the AFC Manager (Meter Monitor):

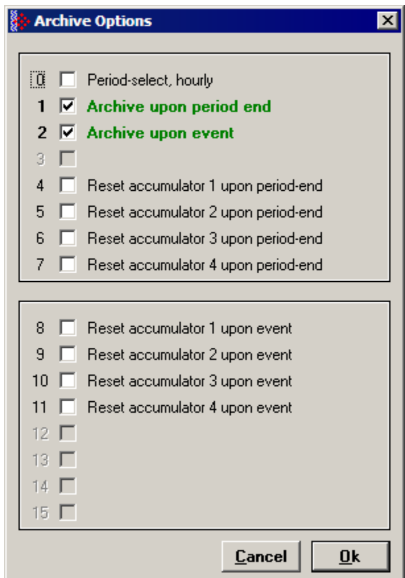


Reset from Ladder Logic

The ladder logic may send a meter signals block to command one or more resettable accumulators to be reset. This feature is especially important for applications involving field installations that require shipping and/or receiving product batches of predetermined size. Refer to the Ladder Logic section for your module type for more information.

Reset Upon Archive Period End or Reset Upon Event

Use AFC Manager to configure the resettable accumulator to be reset when the archive period ends or when an event occurs. Refer to **Event Log** in the *AFC Manager User Guide* for more information on configuring and monitoring events.



Refer to Archives (page 49) for more information.

Reset When the Accumulator Rollover Value is Reached

The resettable accumulator is reset when the accumulator rollover value is reached. You must configure the accumulator rollover value using the AFC Manager software (Meter Configuration). Refer to the AFC Manager User Manual for more information about this subject.

For multiple-stream firmware (version 2.05 or later), resetting a resettable accumulator resets that accumulator for both the meter and for all its streams.

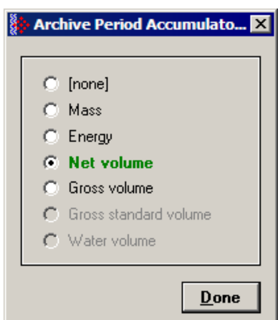
6.1.3 Archive Accumulators

The archive accumulators are part of the current archive (archive 0) data. These accumulators are automatically reset when a new archive is generated. The following Modbus holding registers are used:

	Daily Archive		Hourly Archive	
Meter	Accumulator: Totalizer	Accumulator: Residue	Accumulator: Totalizer	Accumulator: Residue
1	8890 to 8891	8892 to 8893	8894 to 8895	8896 to 8897
2	10890 to 10891	10892 to 10893	10894 to 10895	10896 to 10897
3	12890 to 12891	12892 to 12893	12894 to 12895	12896 to 12897
4	14890 to 14891	14892 to 14893	14894 to 14895	14896 to 14897
5	16890 to 16891	16892 to 16893	16894 to 16895	16896 to 16897
6	18890 to 18891	18892 to 18893	18894 to 18895	18896 to 18897
7	20890 to 20891	20892 to 20893	20894 to 20895	20896 to 20897
8	22890 to 22891	22892 to 22893	22894 to 22895	22896 to 22897

You can view the addresses, datum types and descriptions in the Modbus Dictionary dialog box.

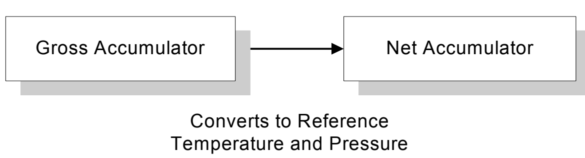
You may configure the accumulator quantity to be used for each archive accumulator using the AFC Manager (**Meter Configuration / Archive Config / Accumulator Select**):



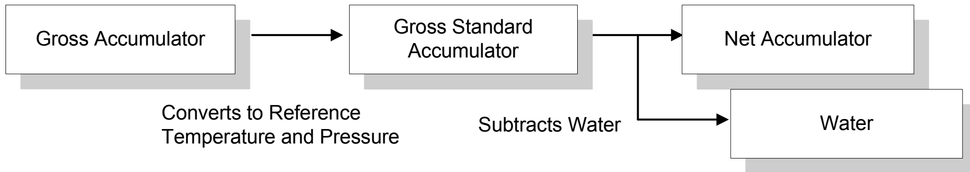
6.1.4 Net Accumulator Calculation

The Net Accumulator Calculation depends on the product group (gas or liquid).

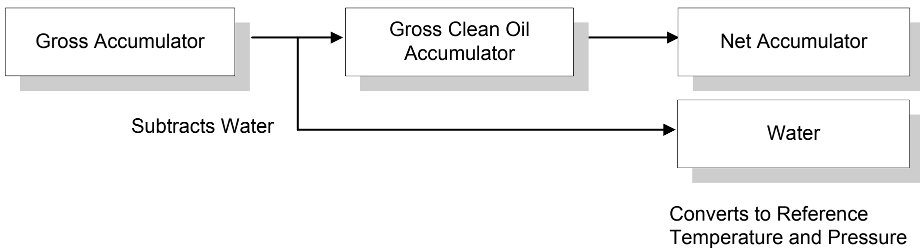
For gas applications, the Net Accumulator is calculated as follows:



For liquid applications (all except Emulsion), the Net Accumulator is calculated as follows:



For liquid applications (Oil-Water Emulsion), the net accumulator is calculated as follows, using API ch 20.1:



6.1.5 Frequently Asked Questions

I need the accumulators to be reset upon period end. Which accumulator should my application use? Resettable Accumulator or Archive Accumulator?

You can use either one. The Archive Accumulators are reset every time a new archive is created and you configure whether or not the archive should be created upon period end and/or upon events.

There are some applications that may require the archives to be generated upon period end and upon event while the accumulators should be reset only upon period end. For these applications, you should consider the Resettable Accumulator (configured to be reset upon period end only) because the Archive Accumulators will also be reset when an event occurs.

7 Archives

In This Chapter

7.1 Archive Overview

An archive is a set of data that records relevant process values that occurred during a certain period of time (per meter channel). The archives are automatically generated by the module and no further action is required. The process values can include:

- Net flow rate (average)
- Total accumulator
- Temperature (average)
- Alarms occurred during the period

The process values will depend on the meter type and product group as listed later in this section.

Each archive contains two values that informs the period of time about that archive:

- opening timestamp = starting date and time for archive
- closing timestamp = ending date and time for archive

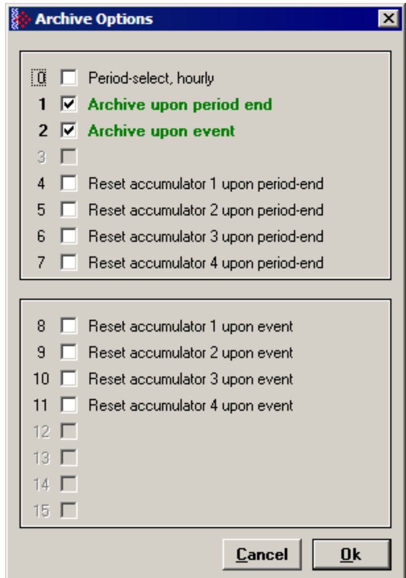
The example described in this chapter is of the default archive configuration as is present for a newly allocated meter. Version 2.01 of the firmware and AFC Manager allows the default configuration to be changed. Refer to Editing the Archive Structure.

7.1.1 Archive Generation

The archives can be generated during one of the following situations:

- Upon period end
- Upon event
- Upon processor command

You can configure if the archives should be generated upon period end and/or event using the AFC Manager (**Meter Configuration / Archive Config / Options**)



Refer to the AFC Manager User Manual for more information about this topic. By default the archives are generated upon period end and event.

If the archive is configured to be created upon period end, it will be periodically (daily or hourly) generated at the time configured by the End-of-day minute and End-of-hour minute parameters (**Project / Site Configuration**).

If the archive is configured to be created upon event, it will be generated every time an event occurs. For example, if an operator changes the orifice diameter for Meter 1, the module would automatically generate a new archive to save the relevant data to this point. Refer to this User Manual for the Events section for more information about events.

Note: Changing a meter type, product group, system of units, or primary input parameter will erase all archives for that meter.

7.1.2 Archive Types

The module supports two types of archives: hourly archives and daily archives:

Archive Type	Period	Period End	Number of 30-Word Archives Stored Locally
Hourly	60 minutes (1 hour)	Set by *End-of-Hour Minute* parameter	48
Daily	1440 minutes (1 day)	Set by *End-of-Day Minute* parameter	35

The Period End parameters must be set using the AFC Manager (Site Configuration). The default value is zero for both archive types which means that:

- Daily Archives are generated every day at midnight (00:00)
- Hourly Archives are generated every hour on the hour (1:00, 2:00, 3:00, 4:00)

For example, if the parameters are configured as follows:

End-of-day minute = 480

The daily archives would be created every day at 08:00.

End-of-hour minute = 30

The hourly archives would be created every hour at 1:30, 2:30, 3:30, 4:30, and so on.

7.1.3 Archive Order

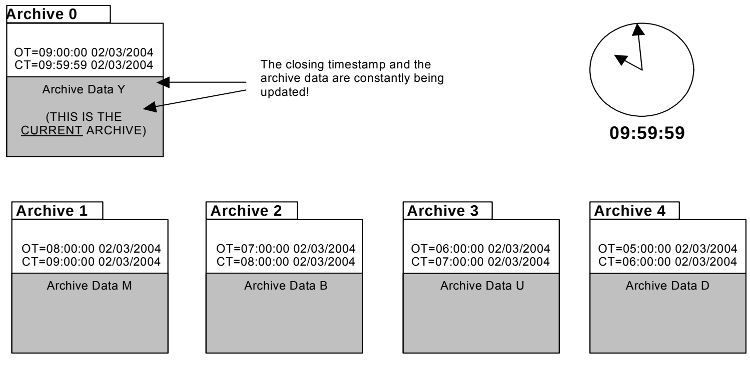
An important concept regarding this topic is the archive order. Understanding this simple concept is essential when reading archive data (through the backplane or Modbus master). Each archive has a number (its "age") that labels its position in the archive queue. The following table shows the archive numbering scheme (both daily and hourly archives):

Archive Age	Register Types	Description
0	Holding Register	Current archive.
1	Input Register	Most recent archive
2	Input Register	Second most recent archive
3	Input Register	Third most recent archive
4	Input Register	Fourth most recent archive
…	…	…

The archive 0 is the current archive. Because its period has not been concluded its closing timestamp and values (such as accumulator, average temperature, etc…) will be continuously updated. After the period is over (or an event occurs depending on the archive configuration) the data in archive 0 will be saved as the "new" archive 1. The data in the "old" archive 1 will be saved as the new archive 2 and so forth.

The current archive is stored in the primary slave's holding register bank. The past archives are stored in the primary slave's input register bank.

The following illustration shows an example for hourly archives:



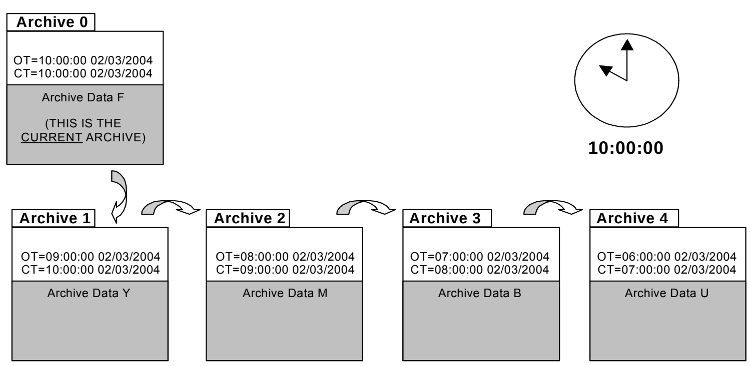
Where:

OT = Opening Time Stamp

CT = Closing Time Stamp

The previous figure shows an example where the hourly archives are configured to be generated upon period-end at the minute "0" (1:00, 2:00, 3:00, etc…). Therefore, at 09:59:59 the archive 0 (current archive) is just about to be saved as the "new" archive 1.

When the clock changes to 10:00:00 the following illustration shows how the latest four archives are modified:



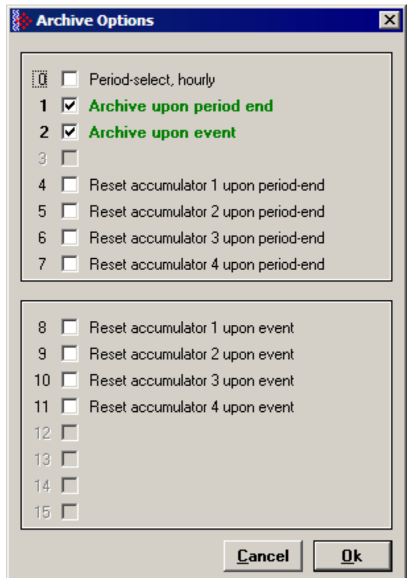
Where:

OT = Opening Time Stamp

CT = Closing Time Stamp

7.1.4 Archive Options

The module also allows you to configure whether or not the resettable accumulator should be reset upon period end and/or event. Most applications will require the resettable accumulators to be reset just after the archive is generated. The AFC Manager (version 2.01.000 or later) supports this feature through the archive options window as shown in the following example:



By default, the module is configured to generate archives upon period end and event. The module is not configured by default to reset the resettable accumulators upon period end.

7.1.5 Archive Locations

Click the Modbus Addresses button on the Archive Configuration dialog box to learn how to fetch an archive record of a specific age (procedure and Modbus location), and even the actual Modbus address of a specific file archived datum point (if you have highlighted the item in the archive record template).

The following table shows the current archive (Archive 0) location in the Primary Modbus Slave for each of the first 8 meters. These addresses refer to the holding register bank.

Archive 0 – Current Archives

Meter	Start Daily Archive	End Daily Archive	Start Hourly Archive	End Hourly Archive
1	9900	9939	9950	9989
2	11900	11939	11950	11989
3	13900	13939	13950	13989
4	15900	15939	15950	15989

Meter	Start Daily Archive	End Daily Archive	Start Hourly Archive	End Hourly Archive
5	17900	17939	17950	17989
6	19900	19939	19950	19989
7	21900	21939	21950	21989
8	23900	23939	23950	23989

Refer to the Modbus Dictionary dialog box for the current archive addressing.

The following table shows the past archives location in the Primary Modbus Slave for each of the first 8 meters. These addresses refer to the input register bank.

Archives 1 to n – Past Archives

Meter	Start Daily Archive	End Daily Archive	Start Hourly Archive	End Hourly Archive
1	0	1059	1060	2499
2	2500	3559	3560	4999
3	5000	6059	6060	7499
4	7500	8559	8560	9999
5	10000	11059	11060	12499
6	12500	13559	13560	14999
7	15000	16059	16060	17499
8	17500	18559	18560	19999

The default configuration sets 30 words per meter archive. For example, the Meter 1 daily archives are addressed as follows:

Daily Archive Number	Start Address	End Address
1	0	29
2	30	59
3	60	89
4	90	119
...	...	...
35	1020	1049

The Meter 1 hourly archives are addressed as follows:

Hourly Archive Number	Start Address	End Address
1	1060	1089
2	1090	1119
3	1120	1149
4	1150	1179
...	...	...
48	2470	2499

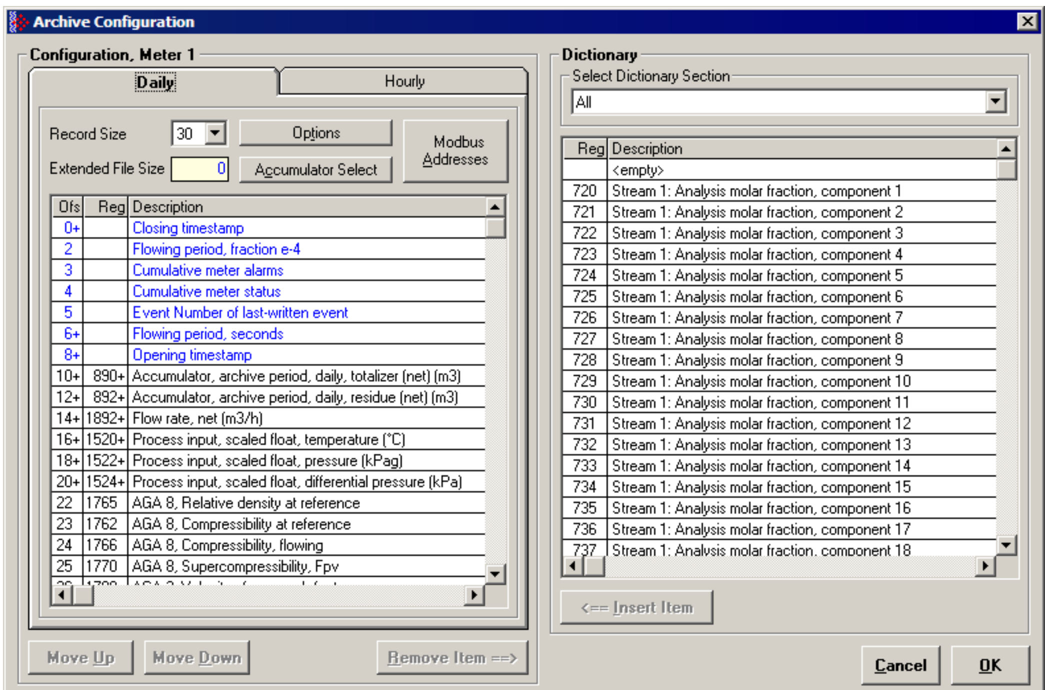
7.1.6 Editing the Archive Structure

Note: The features presented on this section are only available for AFC firmware version 2.01.000 or later. Please contact the tech support team for more information about the module upgrade.

For advanced applications, you can edit the archive contents, the record size, the order of the registers in the archive, and the archive accumulator quantity.

The Archive Configuration window (**Meter Configuration / Archive Config**) allows you to fully configure the meter archive (daily or hourly). The data to be inserted in the archive must be copied from the Dictionary Section on the right half of the window.

Refer to the AFC Manager User Manual for more information about this topic.



The module reserves 1060 words for daily archives and 1440 words for hourly archives. Because the default configuration sets the record size for 30 words, it means that the maximum (default) number of archives per meter channel is 35 daily archives and 48 hourly archives. However, because you can change the number of words per archive, the actual maximum number of archives per meter channel will depend on the configured number of words per archive as follows:

Number of Words per Archive	Number of Daily Archives	Number of Hourly Archives
10	106 daily archives	144 hourly archives
20	53 daily archives	72 hourly archives
30	35 daily archives	48 hourly archives
40	26 daily archives	36 hourly archives

You may also configure the accumulator type for each archive. You must configure one of the following options:

- Mass
- Energy (Gas product only)
- Net Volume
- Gross Volume
- Gross Standard
- Water Volume (Liquid product only)

The following topics show the default archive structure when you configure a new meter. You can edit this structure according to your own requirements.

7.1.7 Extended Archives

This feature is only supported on firmware versions 2.01.000 or newer, and requires a Compact Flash card to be installed.

The module supports the extended archive feature that allows you to configure more archives than the regular 35 daily archives and 48 hourly archives. The module supports the following number of extended archives:

	Daily Archives	Hourly Archives
Max Number of Archives	350 (version 2.04 and earlier) 1440 (version 2.05 and newer)	1260 (version 2.04 and earlier) 1440 (version 2.05 and newer)

Refer to Extended File Size entry on the **Archive Configuration** window for more information.

Note: The maximum number of extended archives is not dependent on the number of words per archive. Extended archives are stored on a Compact Flash card which must be installed for Extended Archive configuration to be effective.

Retrieving Extended Archives

The module implements an easy way to retrieve extended archives from the Modbus database. To learn how to retrieve extended archives, click Archive Config on the Meter Configuration dialog box, and then click Modbus Addresses.

For each archive file the module reserves a block of 50 Input registers to hold the "selected Archive", as listed in the following table.

Meter	Daily Archive Start (Input Register)	Daily Archive End (Input Register)	Hourly Archive Start (Input Register)	Hourly Archive End (Input Register)
1	60000	60049	60050	60099
2	60100	60149	60150	60199
3	60200	60249	60250	60299
4	60300	60349	60350	60399
5	60400	60449	60450	60499
6	60500	60549	60550	60599
7	60600	60649	60650	6069 9
8	60700	60749	60750	60799
9	60800	60849	60850	60899

Meter	Daily Archive Start (Input Register)	Daily Archive End (Input Register)	Hourly Archive Start (Input Register)	Hourly Archive End (Input Register)
10	60900	60949	60950	60999
11	61000	61049	61050	61099
12	61100	61149	61150	61199
13	61200	61249	61250	61299
14	61300	61349	61350	61399
15	61400	61449	61450	61499
16	61500	61549	61550	61599

Note: Meters 9 through 16 are only available for the PTQ-AFC and MVI56-AFC modules.

The Selected Archive start address can be calculated as:

Daily Archive Start Address = 60000 + (Meter Number –1) * 100
Hourly Archive Start Address = 60000 + (Meter Number –1) * 100 + 50

The Selected Archive is continuously maintained to be a copy of the archive record having the age given in the corresponding "Archive Select" holding register, as listed in the following table. This means that the Selected Archive changes whenever either (a) the age in the Open Archive Select register is changed or (b) when the posting of a new archive causes the ages of all archives to be increased by 1.

Meter	**Open Daily Archive Select Address**	**Open Hourly Archive Select Address**
1	8300	8301
2	10300	10301
3	12300	12301
4	14300	14301
5	16300	16301
6	18300	18301
7	20300	20301
8	22300	22301
9	24300	24301
10	26300	26301
11	28300	28301
12	30300	30301
13	32300	32301
14	34300	34301
15	36300	36301
16	38300	38301

Note: Meters 9 through 16 are only available for the PTQ-AFC and MVI56-AFC modules.

Use the following procedure to retrieve extended archives:

8 Copy the archive age to the correct Open Archive Select register.
9 Read the archive data from the 60000-range input addresses.

Example

To read Meter 2 Hourly Archive Number 277:

10 Write a value of 277 to Modbus Holding Register 10301.
11 Read the archive record data starting at input register 60150.

> **Note:** This procedure can also be used to retrieve regular archives.

7.1.8 Archive Reports

Use the Archive Monitor in AFC Manager to generate an archive report or print it to a local printer. You can also save the archive report in two formats:

- Text
- Comma Separated

A report saved in **text format** (.log) contains a complete archive description. The following illustration shows an example of a text format report.

```
AFC-56(16) [2.02] Daily Archive                                        Date: 4/15/2004 9:23:52 AM
Site Name: MVI Flow Station
Project: AFC
File: \\c$\AFC-56(16)
-----------------------------------------------------------------------------------------------

Meter 16:
    Tag                                                                     M01
    Archive                                                                 33

    Closing timestamp                                                       2004-04-17.01:49:42
    Flowing period, fraction e-4                                            1
    Cumulative meter alarms                                                 0000h
    Cumulative site status                                                  00h
    Event Number of last-written event                                      160
    Flowing period, seconds                                                 16
    Opening timestamp                                                       2004-04-17.01:49:26
    Accumulator, archive period, daily, totalizer (m3)                      0
    Accumulator, archive period, daily, residue (m3)                        0.4645103
    Flow rate, net (m3/h)                                                   101.4091
    Process input, scaled float, temperature (°C)                           20
    Process input, scaled float, pressure (kPag)                            50
    Process input, scaled float, dif prs / flow rate / freq (kPa)           70
    AGA 8, Relative density at reference                                    0.5548
    AGA 8, Compressibility at reference                                     0.998
    AGA 8, Compressibility, flowing                                         0.9959
    AGA 8, Supercompressibility, Fpv                                        1.001
    AGA 3, Velocity of approach factor                                      1
    AGA 3, Expansion factor                                                 0.9017
    AGA 3, Coefficient of discharge                                         0.5975
    <not used>                                                              0

    Alarm Bits
    bit  0  Temperature input out of range                                    -
    bit  1  Pressure input out of range                                       -
    bit  2  Differential pressure input out of range                          -
    bit  3  Flowing density input out of range                                -
    bit  4  Water content input out of range                                  -
    bit  5  Differential pressure low                                         -
    bit  7  Accumulator overflow                                              -
    bit  8  Orifice characterization error                                    -
    bit  9  Analysis total zero                                               -
    bit  10  Analysis total not normalized                                    -
    bit  11  Compressibility calculation error                                -
    bit  12  API calc error - density correction                              -
    bit  13  API calc error - Ctl                                             -
    bit  14  API calc error - vapour pressure                                 -
    bit  15  API calc error - Cpl                                             -

    Status Bits
    bit  11  Meter was enabled                                                -
    bit  12  Backplane communication fault                                    -
    bit  13  Measurement configuration changed                                -
    bit  14  Power up                                                         -
    bit  15  Cold start                                                       -
```

Saving the archive report in **comma-separated** (.csv) format allows it to be imported to an Excel® spreadsheet. The following example shows a portion of the .CSV report imported into Excel:

	A	B	C	D
1	AFC-71(8) [2.02] Daily Archive			
2	Date:	3/30/2004 11:21		
3	Site Name:	MVI Flow Station		
4	Project:	AFC		
5	Meter 2:			
6	Tag	M01		
7				
8	Archive	Current	1	2
9				
10	Closing timestamp	2004-03-30.08:36:54	2004-03-30.00:00:00	2004-03-29.00:00:00
11	Flowing period, fraction e-4	1	1	1
12	Cumulative meter alarms	0002h	0002h	0002h
13	Cumulative site status	00h	00h	00h
14	Event Number of last-written event	474	474	474
15	Flowing period, seconds	31014	86400	86400
16	Opening timestamp	2004-03-30.00:00:00	2004-03-29.00:00:00	2004-03-28.00:00:00
17	Accumulator, archive period, daily, totalizer (m3)	7	20	20
18	Accumulator, archive period, daily, residue (m3)	0.3965147	0.6051551	0.6052574
19	Flow rate, net (m3/h)	0.8572201	0.8571935	0.8571963
20	Process input, scaled float, temperature (°C)	49.99487	50.03679	50.03685
21	Process input, scaled float, pressure (kPag)	1	1	1
22	Process input, scaled float, dif prs / flow rate / freq (kPa)	11.00041	11.00247	11.00249
23	Process input, scaled float, flowing density (kg/m3)	700.3123	700.6372	700.6348
24	API 2540, Density at reference (kg/m3)	730.3	730.7	730.7
25	API 2540, Temperature correction factor, CTL	0.9592	0.9596	0.9596
26	API 2540, Pressure correction factor, CPL	0.9999	1.0001	1.0001
27	AGA 3, Velocity of approach factor	1	1.0003	1.0003
28	AGA 3, Expansion factor	0.9999	1.0001	1.0001
29	AGA 3, Coefficient of discharge	0.5964	0.5966	0.5966
30				

7.1.9 Archive Monitor

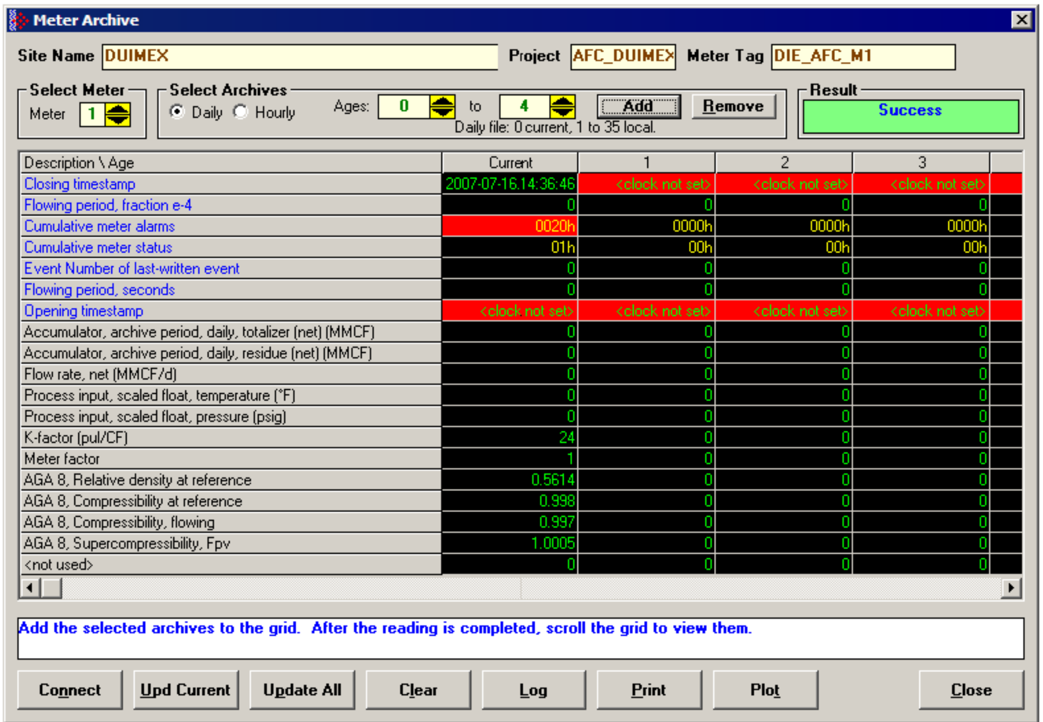
The Archive Monitor dialog box opens when you open the Monitor menu, and then choose Archive.

The module can archive data for each meter channel. The archives are periodically generated according to the period end defined in the Site Configuration.

There are hourly archives (48 archives) and daily archives (35 archives).

For example the daily archives will be stored as:

- Archive 0 = current archive
- Archive 1 = Archive created yesterday
- Archive 2 = Archive created 2 days ago
- Archive 3 = Archive created 3 days ago
  And so on.



Control	Description
Select Meter	Select the meter number
Select Archives	Select the archive type
Ages	Select the first archive to be added or removed
To	Select the last archive to be added or removed
Add	Add the selected archives to the grid, fetching as necessary
Remove	Remove the selected archives from the grid
Connect	Connect to the module, if necessary
Upd Current	Update the current archive
Update All	Update all archives in the grid
Clear	Clear the grid
Log	Create a log file containing the archived data
Print	Print the archives to the local printer
Plot	Display a plot of two datum points from archives in the grid

The following shows an example of an archive report generated by the AFC Manager:

```
AFC-56(16) Daily Archive                              Date: 16-09-2002 16:26:41
    Site Name: MVI Flow Station
    Project: AFC
    ___________________________________________________________________________

    Meter 1:
          Tag                                                M01
          Archive                                            0

          Closing timestamp of archive                       2002-04-27.23:59:08
          Opening timestamp of archive                       2002-04-27.00:00:02
          Status bitmap (details below)                      00h
          Alarms bitmap (details below)                      0000h
          Flowing period                                     86346
          Event counter                                      53
          Net accumulator (x f3)                             604
          Net accumulator residue (x f3)                     0,6703186
          Net flow rate (x f3/h)                             40247,93
          Temperature (°F)                                   14,99997
          Pressure (psig)                                    999,9995
          Differential pressure (hw)                         21,99997
          Relative density (60°F/60°F)                       0,7404
          Reference compressibility                          0,9989
          Flowing compressibility                            0,9051
          Fpv                                                1,0505
          Velocity of approach factor Ev                     1,0328
          Expansion factor Y                                 0,9997
          Discharge coefficient                              0,6043

          Alarm Bits
          bit  0  Temperature input out of range               -
          bit  1  Pressure input out of range                  -
          bit  2  Diff. pressure input out of range            -
          bit  3  Flowing density input out of range           -
          bit  4  Water content input out of range             -
          bit  5  Diff. pressure low                           -
          bit  8  Orifice characterization error               -
          bit  9  Analysis total zero                          -
          bit  10  Analysis total not normalized               -
          bit  11  AGA8 calculation error                      -
          bit  12  API calculation error, density correctio  -
          bit  13  API calculation error, Ctl                  -
          bit  14  API calculation error, vapor pressure       -
          bit  15  API calculation error, Cpl                  -

          Status Bits
          bit  11  Meter was enabled                           -
          bit  12  Backplane communication fault               -
          bit  13  Measurement configuration changed           -
          bit  14  Power up                                    -
          bit  15  Cold start                                  -
```

```
AFC-56(16) Daily Archive                         Date: 16-09-2002 16:26:41
Site Name: MVI Flow Station
Project: AFC
___________________________________________________________________________

Meter 1:
      Tag                                              M01
      Archive                                          1

      Closing timestamp of archive                     2002-04-27.00:00:02
      Opening timestamp of archive                     2002-04-26.23:59:42
      Status bitmap (details below)                    00h
      Alarms bitmap (details below)                    0000h
      Flowing period                                   20
      Event counter                                    53
      Net accumulator (x f3)                           234
      Net accumulator residue (x f3)                   0,1092186
      Net flow rate (x f3/h)                           40248,01
      Temperature (°F)                                 15
      Pressure (psig)                                  1000
      Differential pressure (hw)                       22
      Relative density (60°F/60°F)                     0,7404
      Reference compressibility                        0,9989
      Flowing compressibility                          0,9051
      Fpv                                              1,0505
      Velocity of approach factor Ev                   1,0328
      Expansion factor Y                               0,9997
      Discharge coefficient                            0,6043

      Alarm Bits
      bit  0  Temperature input out of range             -
      bit  1  Pressure input out of range                -
      bit  2  Diff. pressure input out of range          -
      bit  3  Flowing density input out of range         -
      bit  4  Water content input out of range           -
      bit  5  Diff. pressure low                         -
      bit  8  Orifice characterization error             -
      bit  9  Analysis total zero                        -
      bit  10  Analysis total not normalized             -
      bit  11  AGA8 calculation error                    -
      bit  12  API calculation error, density correctio  -
      bit  13  API calculation error, Ctl                -
      bit  14  API calculation error, vapor pressure     -
      bit  15  API calculation error, Cpl                -

      Status Bits
      bit  11  Meter was enabled                         -
      bit  12  Backplane communication fault             -
      bit  13  Measurement configuration changed         -
      bit  14  Power up                                  -
      bit  15  Cold start                                -
```

```
AFC-56(16) Daily Archive                          Date: 16-09-2002 16:26:44
Site Name: MVI Flow Station
Project: AFC
___________________________________________________________________________

Meter 1:
      Tag                                              M01
      Archive                                          2

      Closing timestamp of archive                     2002-04-26.23:59:42
      Opening timestamp of archive                     2002-04-26.06:16:34
      Status bitmap (details below)                    60h
      Alarms bitmap (details below)                    0000h
      Flowing period                                   1019877652
      Event counter                                    53
      Net accumulator (x f3)                           174811
      Net accumulator residue (x f3)                   0,9399567
      Net flow rate (x f3/h)                           40247,88
      Temperature (°F)                                 15,00736
      Pressure (psig)                                  1000,416
      Differential pressure (hw)                       22,00479
      Relative density (60°F/60°F)                     0,7404
      Reference compressibility                        0,9989
      Flowing compressibility                          0,9053
      Fpv                                              1,0506
      Velocity of approach factor Ev                   1,0331
      Expansion factor Y                               1,0001
      Discharge coefficient                            0,6045

      Alarm Bits
      bit  0  Temperature input out of range             -
      bit  1  Pressure input out of range                -
      bit  2  Diff. pressure input out of range          -
      bit  3  Flowing density input out of range         -
      bit  4  Water content input out of range           -
      bit  5  Diff. pressure low                         -
      bit  8  Orifice characterization error             -
      bit  9  Analysis total zero                        -
      bit  10  Analysis total not normalized             -
      bit  11  AGA8 calculation error                    -
      bit  12  API calculation error, density correctio  -
      bit  13  API calculation error, Ctl                -
      bit  14  API calculation error, vapor pressure     -
      bit  15  API calculation error, Cpl                -

      Status Bits
      bit  11  Meter was enabled                         -
      bit  12  Backplane communication fault             -
      bit  13  Measurement configuration changed         yes
      bit  14  Power up                                  yes
      bit  15  Cold start                                -
```

```
AFC-56(16) Daily Archive                          Date: 16-09-2002 16:26:51
Site Name: MVI Flow Station
Project: AFC
___________________________________________________________________________

Meter 1:
      Tag                                              M01
      Archive                                          3

      Closing timestamp of archive                     2002-04-26.06:16:34
      Opening timestamp of archive                     2002-04-26.06:14:08
      Status bitmap (details below)                    20h
      Alarms bitmap (details below)                    0000h
      Flowing period                                   146
      Event counter                                    50
      Net accumulator (x f3)                           1633
      Net accumulator residue (x f3)                   6,271362E-02
      Net flow rate (x f3/h)                           40248,02
      Temperature (°F)                                 14,99999
      Pressure (psig)                                  1000,002
      Differential pressure (hw)                       22,00003
      Relative density (60°F/60°F)                     0,7404
      Reference compressibility                        0,9989
      Flowing compressibility                          0,9051
      Fpv                                              1,0505
      Velocity of approach factor Ev                   1,0328
      Expansion factor Y                               0,9997
      Discharge coefficient                            0,6043

      Alarm Bits
      bit  0  Temperature input out of range             -
      bit  1  Pressure input out of range                -
      bit  2  Diff. pressure input out of range          -
      bit  3  Flowing density input out of range         -
      bit  4  Water content input out of range           -
      bit  5  Diff. pressure low                         -
      bit  8  Orifice characterization error             -
      bit  9  Analysis total zero                        -
      bit  10  Analysis total not normalized             -
      bit  11  AGA8 calculation error                    -
      bit  12  API calculation error, density correctio  -
      bit  13  API calculation error, Ctl                -
      bit  14  API calculation error, vapor pressure     -
      bit  15  API calculation error, Cpl                -

      Status Bits
      bit  11  Meter was enabled                         -
      bit  12  Backplane communication fault             -
      bit  13  Measurement configuration changed         yes
      bit  14  Power up                                  -
      bit  15  Cold start                                -
```

8 Events

In This Chapter

8.1 The Event Log

An "event" is any occurrence that may affect the manner in which, or whether, measurement is performed. Events include, for example:

- Any change to a sealable parameter.
- Power-up (product may have been lost during the power-down period).
- A change in PLC operating mode (programming changes may alter measurement).
- A download of the event log (for audit trail purposes).

The Event Log occupies a block of 16000 Input registers in the Modbus table starting at address 40000 and proceeding through address 55999. It consists of a 5-register "header" at address 40000 followed by 1999 8-register "event" records starting at address 40008. As they are Input registers (read with Modbus function code 4), no part of the Event Log can be written from outside the module, but it is maintained exclusively by the AFC firmware.

As events occur they are recorded in the Log, which acts as a circular file. Each new event record overwrites the oldest one, hence the log stores up to 1999 of the most recent events. As each record is written the values in the header are updated to reflect the new status of the log.

Auditors may require the Log to be "downloaded" from time to time; events are read from the module and stored in a more permanent database, and the events so copied and archived are marked in the module as "downloaded".

If all record positions contain events that have not yet been downloaded, the log is full. In this case, the handling of a new event depends on the value of the "Event log unlocked" site option:

- If the option is set, then the log-full condition is ignored and the new event overwrites the oldest one. Since the overwritten event was never downloaded, it is permanently lost.
- If the option is clear, then the Event Log is "locked", and the new event is rejected if possible and otherwise ignored. Controllable events, that is, changes to sealable parameters, are not allowed to occur; such datum points remain unchanged retaining their current values and a Modbus command that attempts such a change receives an "illegal data" exception response. Uncontrollable events, such as PLC mode change, are simply not recorded. The Log must be downloaded in order to unlock it for further events.

8.2 Event Log structures

The Event Log header contains housekeeping information for maintaining the Log. Its layout is:

Address	Description
40000	Number of records maximum (== 1999)
40001	Next new record position (0 thru maximum-1)
40002	Next new event number (0 thru 65535, wrapping to 0)
40003	Oldest event number on file
40004	Oldest event number on file not yet downloaded
40005-40007	[reserved]

Each event record is an 8-register quantity laid out as four 32-bit items (big-endian):

Registers	Contents
0 to 1	Event Id Tag (page 67)
2 to 3	Timestamp of event In our standard "packed bit-field" format.
4 to 5	Old item value For a Datum Point event, format depends on the "datum type" field of the Event Id Tag.
6 to 7	New item value For a Datum Point event, format depends on the "datum type" field of the Event Id Tag.

Each value is right-justified in its field and sign-extended if necessary.

8.3 Event Id Tag

This 32-bit field has the following structure:

<table>
<tr><th>Bits</th><th>N</th><th>Meaning</th></tr>
<tr><td>31</td><td>1</td><td>0 Special, 1 Datum Point (e.g. sealable parameter)

If this bit is clear, then bits 19-00 contain a value from the Special event tag list below; if the bit is set, then bits 19-00 have the interpretation given here.</td></tr>
<tr><td>30</td><td>1</td><td>PLC offline; timestamp may not be accurate

This bit may also be set for a Special event.</td></tr>
<tr><td>29</td><td>1</td><td>[reserved]</td></tr>
<tr><td>28 to 24</td><td>5</td><td>Meter number, or 0 for Site

This field may also be set for a Special event.</td></tr>
<tr><td>23 to 20</td><td>4</td><td>[Meter] Stream number or 0; [Site] 0

This field may also be set for a Special event.</td></tr>
<tr><td>19 to 16</td><td>4</td><td>Datum type:
<table>
<tr><th>Value</th><th>Mnemonic</th><th>Format</th></tr>
<tr><td>0</td><td>Ubyt</td><td>Unsigned byte</td></tr>
<tr><td>1</td><td>Usht</td><td>Unsigned short integer</td></tr>
<tr><td>2</td><td></td><td>[reserved]</td></tr>
<tr><td>3</td><td>Ulng</td><td>Unsigned long integer</td></tr>
<tr><td>4</td><td>Sbyt</td><td>Signed byte</td></tr>
<tr><td>5</td><td>Ssht</td><td>Signed short integer</td></tr>
<tr><td>6</td><td></td><td>[reserved]</td></tr>
<tr><td>7</td><td>Slng</td><td>Signed long integer</td></tr>
<tr><td>8</td><td>Bbyt</td><td>Bitmap (up to 8 bits)</td></tr>
<tr><td>9</td><td>Bsht</td><td>Bitmap (up to 16 bits)</td></tr>
<tr><td>10</td><td>Bm24</td><td>Bitmap (up to 24 bits)</td></tr>
<tr><td>11</td><td>Blng</td><td>Bitmap (up to 32 bits)</td></tr>
<tr><td>12</td><td>Bool</td><td>Boolean (value 0 or 1)</td></tr>
<tr><td>13</td><td>DiBy</td><td>Dibyte (both high and low)</td></tr>
<tr><td>14</td><td>B448</td><td>Bitfield nybble/nybble/byte</td></tr>
<tr><td>15</td><td>Flot</td><td>Floating point</td></tr>
</table></td></tr>
<tr><td>15 to 12</td><td>4</td><td>[reserved]</td></tr>
<tr><td>11 to 08</td><td>4</td><td>Group code

This value is one of the "measurement configuration changed" bit numbers.</td></tr>
<tr><td>07 to 04</td><td>4</td><td>Subgroup code

This value is the ordinal number (starting at 0) of the subgroup of parameters in the specified group.</td></tr>
<tr><td>03 to 00</td><td>4</td><td>Subgroup item code

Since a parameter subgroup may contain more than one item, this value identifies the particular item; items are numbered from 0.</td></tr>
</table>

8.4 Event-triggered archives and accumulator resets

Each archive file (two for each meter) contains an Archive Options bitmap whose configuration specifies the actions to be scheduled (write archive and/or reset resettable accumulator(s)) when an event occurs (daily or hourly period-end, or most loggable events). Archives and/or resets are scheduled only for enabled meters (with one important clarification; see "Rkv" notes (page 75)). The actions to be taken upon period-end and those to be taken upon loggable events are configured separately.

Several archive/reset-triggering events can occur simultaneously. In such cases the archive or reset occurs only once (an archive is written only when archivable data has been accumulated for at least one meter scan; additional resets of already-reset accumulators have no effect).

Scheduled accumulator resets are performed at the top of the meter scan. This permits their final values to be inspected/fetched/archived while the AFC rotates its scan among the other meters.

Scheduled archives are written at the top of the meter scan, at its bottom, or between successive scans, depending on the nature of the triggering event. Archives written at the top of the scan are written before any accumulator resets.

8.5 Period-end events

A "period-end" event is detected by the wallclock. There are two such:

a) "End-of-hour" occurs when the minute of the hour steps into the "End-of-hour minute" of Site Configuration.

b) "End-of-day" occurs when the minute of the day steps into the "End-of-day minute" of Site Configuration.

A wallclock change that skips forward over an end-of-period minute will cause that period-end to be missed, and a change that skips backward over that minute will cause that period-end to be repeated, so wallclock adjustments should be performed at times well-removed from either end-of-period minute.

Though a period-end event is not recorded in the event log, it does cause archives and resets to be scheduled for all enabled meters according to their configured "period-end" Archive Options. Archives and resets scheduled by period-end are delayed in their action until at least one meter scan has occurred after the event (the archive data accumulation that takes place at the end of the meter scan also records the latest timestamp, so the written archive then reflects the fact that the period-end has occurred).

8.6 Loggable events

The tables below give full details of all events that are recorded in the Event Log.

For the Special events (page 70), columns are:

Tag	**Numeric value that identifies the event.**
Rkv	Effect on archives and accumulator resets (see next).
Description	Lists: The event name, identifying its triggering condition. Contents and meaning of the old and new value fields. Relevant additional information.

For the Datum Point (page 71, page 71, page 73) events, columns are:

Grup	**Group code.**
Sbgp	Subgroup code.
Item	Item code.
Dtyp	Datum type code (mnemonic).
Rkv	Effect on archives and accumulator resets (see next).
Datum point	The corresponding writable Modbus point.

In these tables, the "Rkv" columns specify how archives and accumulator resets are scheduled upon occurrence of the corresponding loggable events.

Column values are:

Value	**Meaning**
*	Upon this event archives and resets are scheduled according to the configured "event" Archive Options, provided that the applicable meter(s) is(are) enabled. Applicable meters depend upon the event class: (a) Special (non-meter-specific) and Site Datum Point events: All meters. (b) Meter events (including meter-specific Specials): The addressed meter. (c) Stream events: The addressed meter, provided that the addressed stream is active. Scheduled archives are always written before completing any change to data or module state implied by the event; this ensures that the data contributing to an archive is limited to that which was available before the event.
-	This event has no effect on archives and resets.
(n)	Upon this event archives and resets are scheduled as for "*", modified by the conditions and actions given in "Note (n)" in "Rkv" notes (page 75).

8.7 Special events

Tag	Rkv	Description
0	-	Never Used Value: Always 0. Notes: This entry in the Event Log has never been written. The number of such entries starts at 1999 upon cold start and decreases as events are written until none remain, after which oldest events are overwritten with new ones.
1	-	Event Log Download Value: Number of last-downloaded event. Notes: Triggered by a purge of the Event Log, which marks older events as available to be overwritten by new ones.
2	-	Cold Start Value: Always 0. Notes: This event is obsolete and is never written.
3	(1)	Power-Up Value: "Old" value is the last-saved wallclock from the previous session; "new" value is always 0 (clock not yet set). Notes: The last event written upon restart of the application and before entering the meter scan. This event may be preceded by Checksum Alarm and/or PLC Mode Change events.
4	-	PLC Mode Change Value: PLC mode (0 on line, 1 off line). Notes: Logs changes to PLC connectivity as reported by the backplane procedures. Typically caused by switching the PLC between "run" and "program" modes.
5	-	Checksum Alarm Value: Checksum alarm word (datum type "Bsht"). Notes: Logs changes to the checksum alarm bitmaps. Includes site/meter identification (bits 28-24). Upon power-up: Written automatically upon power up when a checksum failure is detected. In this case the event is written even if the bitmap does not change, such as when an affected bit is already set from a previous failure that was never cleared. Upon Modbus write to the bitmap: Records changes to the bitmap only, typically when clearing bits, though setting bits is also permitted.
6	(2)	Wallclock Change Value: Wallclock (packed bitfields). Notes: Triggered when the wallclock is set for the first time, or when it is reset to a value that differs from its current value by five minutes or more. These two cases can be distinguished by the "old value" in the event entry: for the initial setting this value is zero ("clock not set").
7	*	Stream Select Value: Stream number. Notes: Triggered by a "select active stream" meter signal. Includes meter identification (bits 28-24).

8.8 Site Datum Point events

Grup	Sbgp	Item	DTyp	Rkv	Data point
0	0	0	Bsht	(3)	Site options
1					Site parameter value
	0	0	Flot	*	Barometric pressure
8	n	0	Usht	-	Arbitrary event-logged value "n" ("n" = 0 thru 9)
15					PLC image address (Quantum/Unity platform only)
	0	0	Usht	*	Supervisory, get
	1	0	Usht	*	Supervisory, put
	2	0	Usht	*	Wallclock, get & put
	3	0	Usht	*	Modbus gateway, get & put
	4	0	Usht	*	Modbus pass-thru, put
	5	0	Usht	*	Modbus master, get & put

8.9 Meter Datum Point events

Grup	Sbgp	Item	DTyp	Rkv	Data point
0	0				Process input calibration
		0	Flot	*	Temperature
		1	Flot	*	Pressure
		2	Flot	*	Primary input
		3	Flot	*	Flowing density
		4	Flot	*	Water content
0	1				Process input alarm
		0	Flot	-	Temperature range
		1	Flot	-	Pressure range
		2	Flot	-	Primary input range
		3	Flot	-	Flowing density range
		4	Flot	-	Water content range
1	0				Meter classification
		0	Bsht	*	Meter device and engineering units
		1	Usht	*	Product group
2					Reference conditions
	0	0	Flot	*	Temperature
	1	0	Flot	*	Pressure
3					Meter options
	0	0	Blng	*	Calculation options
	1	0	Blng	(4)	Control options
4					Input scaling
	0				Temperature
		0	Flot	*	Range low end
		1	Flot	*	Range high end

Grup	Sbgp	Item	DTyp	Rkv	Data point
		2	Flot	*	Default
		3	Sbyt	*	Module id code
	1				Pressure
		0	Flot	*	Range low end
		1	Flot	*	Range high end
		2	Flot	*	Default
		3	Sbyt	*	Module id code
	2				Primary input
		0	Flot	*	Range low end
		1	Flot	*	Range high end
		2	Flot	*	Default
		3	Sbyt	*	Module id code
	3				Flowing density
		0	Flot	*	Range low end
		1	Flot	*	Range high end
		2	Flot	*	Default
		3	Sbyt	*	Module id code
	4				Water content
		0	Flot	*	Range low end
		1	Flot	*	Range high end
		2	Flot	*	Default
		3	Sbyt	*	Module id code
5	0	0	Bm24	*	Analysis component selection map
6	0	0	Ulng	*	Pulse input rollover
7			Units		
	0	0	B448	*	Primary input (period, quantity, units)
	1	0	Ubyt	*	Mass flow rate period
	2	0	Ubyt	*	Mass flow rate units
	3	0	Ubyt	*	Mass accumulator units
	4	0	Ubyt	*	Energy flow rate period
	5	0	Ubyt	*	Energy flow rate units
	6	0	Ubyt	*	Energy accumulator units
	7	0	Ubyt	*	Volume flow rates period
	8	0	Ubyt	*	Volume flow rates units
	9	0	Ubyt	*	Volume accumulators units
8					Accumulator rollovers
	0	0	Ulng	*	Mass
	1	0	Ulng	*	Energy
	2	0	Ulng	*	Volumes
9					Meter parameter value
	0	0	Flot	*	Orifice plate measurement temperature

Grup	Sbgp	Item	DTyp	Rkv	Data point
	1	0	Flot	*	Orifice plate measured diameter
	2	0	Flot	*	Orifice plate coefficient of thermal expansion
	3	0	Flot	*	Meter tube measurement temperature
	4	0	Flot	*	Meter tube measured diameter
	5	0	Flot	*	Meter tube coefficient of thermal expansion
	6	0	Flot	*	Primary input flow threshold
	7	0	Flot	*	Primary input alarm threshold
	8	0	Flot	*	V-cone/Wedge coefficient of discharge
10					[reserved]
11	0				Densitometer
		0	Usht	*	Densitometer type
		1	Flot	*	Calibration temperature
		2	Flot	*	Calibration pressure
		3	Flot	*	Calibration constant K0
		4	Flot	*	Calibration constant K1
		5	Flot	*	Calibration constant K2
		6	Flot	*	Calibration constant 6
		7	Flot	*	Calibration constant 7
		8	Flot	*	Calibration constant 8
		9	Flot	*	Calibration constant 9
		10	Flot	*	Calibration constant 10
		11	Flot	*	Calibration constant 11
		12	Flot	*	Calibration constant 12
		13	Flot	*	Calibration constant 13
		14	Flot	*	Calibration constant 14
		15			PLC image address (Quantum/Unity platform only)
	0	0	Usht	*	Meter process input &c, get
	1	0	Usht	*	Meter results, put
	2	0	Usht	*	Meter archive fetch, put

8.10 Stream Datum Point events

Grup	Sbgp	Item	DTyp	Rkv	Data point
0	0	0	Bsht	*	Stream options
1					Stream parameter value
	0	0	Flot	*	Default relative density (gas) at reference
	1	0	Flot	*	Viscosity
	2	0	Flot	*	Isentropic exponent
	3	0	Flot	*	Default Fpv
	4	0	Flot	*	K/meter factor
	5	0	Flot	*	Default energy content

Grup	Sbgp	Item	DTyp	Rkv	Data point
	6	0	Flot	*	Default reference density (liquid)
	7	0	Flot	*	Default vapor pressure
	8	0	Flot	*	Water density at API reference
	9	0	Flot	*	Default Ctl
	10	0	Flot	*	Default Cpl
	11	0	Flot	*	Shrinkage factor
	12	0	Flot	*	Precalculated alpha
2	0				Meter factor curve
		0	Flot	*	Datum point 1, meter factor
		1	Flot	*	Datum point 1, flow rate
		2	Flot	*	Datum point 2, meter factor
		3	Flot	*	Datum point 2, flow rate
		4	Flot	*	Datum point 3, meter factor
		5	Flot	*	Datum point 3, flow rate
		6	Flot	*	Datum point 4, meter factor
		7	Flot	*	Datum point 4, flow rate
		8	Flot	*	Datum point 5, meter factor
		9	Flot	*	Datum point 5, flow rate
3	0				Analysis mole fraction
					** Because the item code extends into the subgroup field, this can be the only subgroup of group 3 ! (Pending any future reformat of the Event Id Tag.)
		0	Usht	(5)	Component 1, scaled molar fraction
		1	Usht	(5)	Component 2, scaled molar fraction
		2	Usht	(5)	Component 3, scaled molar fraction
		3	Usht	(5)	Component 4, scaled molar fraction
		4	Usht	(5)	Component 5, scaled molar fraction
		5	Usht	(5)	Component 6, scaled molar fraction
		6	Usht	(5)	Component 7, scaled molar fraction
		7	Usht	(5)	Component 8, scaled molar fraction
		8	Usht	(5)	Component 9, scaled molar fraction
		9	Usht	(5)	Component 10, scaled molar fraction
		10	Usht	(5)	Component 11, scaled molar fraction
		11	Usht	(5)	Component 12, scaled molar fraction
		12	Usht	(5)	Component 13, scaled molar fraction
		13	Usht	(5)	Component 14, scaled molar fraction
		14	Usht	(5)	Component 15, scaled molar fraction
		15	Usht	(5)	Component 16, scaled molar fraction
		16	Usht	(5)	Component 17, scaled molar fraction
		17	Usht	(5)	Component 18, scaled molar fraction
		18	Usht	(5)	Component 19, scaled molar fraction
		19	Usht	(5)	Component 20, scaled molar fraction

Grup	Sbgp	Item	DTyp	Rkv	Data point
		20	Usht	(5)	Component 21, scaled molar fraction
		21	Usht	(5)	Component 22, scaled molar fraction
		22	Usht	(5)	Component 23, scaled molar fraction
		23	Usht	(5)	Component 24, scaled molar fraction

8.11 "Rkv" notes

12 Archives (only, not resets) are forced regardless of configuration, capturing any unarchived data from the previous session.

13 Archives and resets are scheduled (immediately, without a "period-end" delay) only for the initial setting of the wallclock; a "five-minute" event causes no scheduling. This ensures capture of any flow that has occurred prior to the initial clock-set.

14 Event occurs only when one or more of the following bits are changed:

- Bit 2, "Barometric pressure units"
- Bit 5, "Process input out of range use last good"
- Bit 12, "Analysis is packed in module"
- Bit 13, "Analysis is packed over backplane" (1756 and 1769 platforms only)

15 A change to Meter Control Options bit 15, "Meter enable", imposes these adjustments to the normally-scheduled archives/resets:

- Upon meter enable, cancel any scheduled archives (no data yet to be archived), but leave in place any scheduled resets.
- Upon meter disable, cancel any resets (for inspection etc.; reset will be rescheduled upon subsequent enable), and force archiving of both files regardless of configuration (so that a disabled meter never has any pending unarchived data).

16 Events occur only if Meter Control Options bit 10, "Treat analysis as process input", is clear.

8.12 Event numbers and Event Log Download

For auditing purposes, each event has a "number" assigned sequentially, starting at 0 for the first event written and increasing up through 65535 then wrapping to 0 again.

An event record properly includes its event number along with the information listed in the preceding sections. To conserve space, and to make transmittal more efficient, the event number is not stored as part of the event record. Instead, the Event Log header contains sufficient information to calculate for any event its event number from the position of its record in the Log and vice versa.

The following procedures use these terms:

Term	Meaning
my_record	Known record position. Input to procedures (A) and (C)
event_number	Desired event number. Output from procedure (A).
Modbus_address	Desired Modbus address. Output from procedure (C).
my_event	Known event number. Input to procedure (B).
record_position	Desired record position. Output from procedure (B).
number_of_records	Maximum number of records. Contents of register 40000. In this version of the AFC "number_of_records" is 1999; however, to be compatible with future versions that may store a different number of events, an application should use the value from the header instead of a constant 1999.
next_record	Next new record position. Contents of register 40001.
next_event	Next new event number. Contents of register 40002.
oldest_event	Oldest event number on file. Contents of register 40003.
oldest_not_downloaded	Oldest event number not yet downloaded. Contents of register 40004.
events_on_file	Total number of events on file. Calculated. This value starts at 0 upon cold start, then, as events are logged, it rises to a maximum of "number_of_records" and stays there.
downloadable_event	Event number of event being downloaded. Calculated.
event_age	The age of the event in question. Calculated. The next event to be written (which of course is not yet on file) has age 0; the newest event already on file has age 1, the next older event has age 2, and so on up to age "number_of_records".

Also in these procedures:

A The expression "AND 0x0000FFFF" means "take the low-order 16 bits of the result, discarding all other higher-order bits"; it is equivalent to "(non-negative) remainder upon dividing by 65536". (A traditionally negative remainder that would result from dividing a negative dividend by 65536 must be made positive by subtracting its absolute value from 65536.)

B The operator ":=" means "assignment"; that is, "assign" the expression on the right to the object on the left by calculating the value of the expression on the right and making the object on the left assume that value. The operator "==" means "is equal to".

C Words in all caps and the other arithmetic operators have their expected meanings.

D Text enclosed in brackets ("[ ]") are comments only.

Procedure (A): Calculate event number from record position.

17 Calculate number of events on file.

```
events_on_file := ( next_event - oldest_event ) AND 0x0000FFFF
```

18 Determine whether desired record is on file.

```
IF ( my_record < 0 OR my_record ≥ events_on_file ) THEN
    [record is not on file]
    EXIT this procedure
```

19 Calculate age of desired record.

```
event_age := ( next_record - my_record )
IF ( event_age ≤ 0 ) THEN
    event_age := event_age + number_of_records
```

20 Calculate event number of desired record.

```
event_number := ( next_event - event_age ) AND 0x0000FFFF
```

Procedure (B): Calculate record position from event number.

21 Calculate number of events on file.

```
events_on_file := ( next_event - oldest_event ) AND 0x0000FFFF
```

22 Calculate age of desired event.

```
event_age := ( next_event - my_event ) AND 0x0000FFFF
```

23 Determine whether desired event is on file.

```
IF ( event_age == 0 OR event_age > events_on_file ) THEN
    [event is not on file]
    EXIT this procedure
```

24 Calculate record position of desired event.

```
record_position := ( next_position - event_age )
IF ( record_position < 0 ) THEN
    record_position := record_position + number_of_records
```

Procedure (C): Calculate Modbus address of record from record position.

25 Calculate number of events on file.

```
events_on_file := ( next_event - oldest_event ) AND 0x0000FFFF
```

26 Determine whether desired record is on file.

```
IF ( my_record < 0 OR my_record ≥ events_on_file ) THEN
    [record is not on file]
    EXIT this procedure
```

27 Calculate Modbus address.

```
Modbus_address := ( my_record * 8 ) + 40008
```

Procedure (D): Download all events not yet downloaded.

The downloading application should download the entire Log, starting at the oldest event not yet downloaded and extending through all newer events.

28 Fetch event number of oldest event not yet downloaded.

```
downloadable_event := oldest_not_downloaded
```

29 Determine whether any more events remain to be downloaded.

```
IF ( downloadable_event == next_event ) THEN
    [all events have been downloaded]
    EXIT this procedure
```

30 Download this event.

c) Calculate record number.

```
my_event := downloadable_event
record_position := { via Procedure (B) }
```

d) Calculate Modbus address.

```
my_record := record_position
Modbus_address := { via Procedure (C) }
```

e) Download the event with Modbus.

```
Set Modbus Function Code := 4, Read Input Registers
Set Modbus Number of Registers := 8
Set Modbus Register Address := Modbus_address
Execute
Copy the returned data to permanent storage
```

31 Step to next event and loop.

```
downloadable_event := ( downloadable_event + 1 ) AND 0x0000FFFF
GOTO step 2.
```

When the download is complete, and the downloaded events have been logged to disk, the AFC should be told of this fact by issuing the "download complete" Site Signal. This signal updates the header to show that all records have been downloaded, unlocking the Log for further events, and (if "Event log unlocked" is clear) posts a "download" event. A download may be performed at any time; it is not necessary to wait for the log-full condition in order to download.

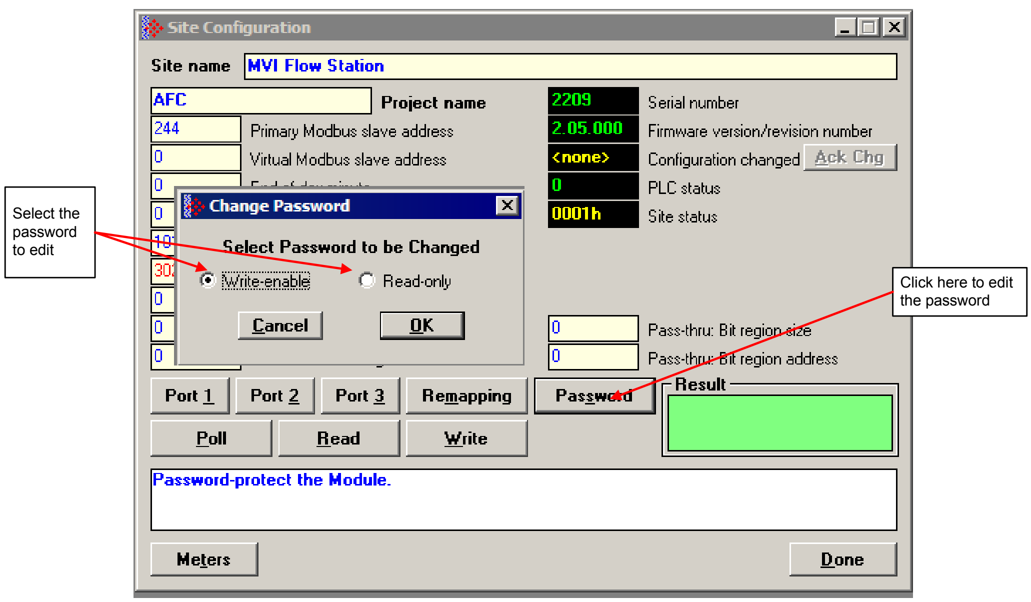
An application that downloads the event log should explicitly include the event number in any copy of the event that it stores in its own database.

9 Security (Passwords)

In This Chapter

The passwords are intended for interrogation by application software in order to verify an operator's authorization to make configuration changes and to view measurement results. The passwords are resident in the module so that different operators using different copies of the application software must use the same password. Passwords cannot be retrieved in "Hard Password" mode. The password protection is not used by default.

Passwords can be numbers between –32768 and 32767. For example, 1234. A password of 0 (zero) is interpreted as "No password present".



The module supports two passwords: Write-Enable and Read-Only. Each password is enabled when you write a non-zero value to the corresponding register.

Password	Holding Register Address	Description
Write-Enable	9	Protects the module from write operations from the AFC Manager
Read-Only	19	Protects the module from read or write operations from the AFC Manager

The following table shows how the passwords affect the AFC Manager operation depending on the values that you configure:

Protection Level	Read-Only Password	Write-Enable Password	Read Operation - Requires Authorization?	Write Operation - Requires Authorization?
No protection	Zero	Zero	No	No
Write Protection	Zero	Non-zero	No	Yes (Use Write-Enable password)
Read and Write Protection	Non-zero	Zero	Yes (Use Read-Only password)	Yes (Use Read Only password)
Read and Write Protection	Non-zero	Non-zero	Yes (Use Read-Only or Write-Enable password)	Yes (Use Write-Enable password)

Each port can be assigned to different password protection levels. Refer to the AFC Manager User Manual for more information about this topic.

9.1 Hard Password

The hard password feature offers further protection against unauthorized access to the module.

If the Hard Password option is cleared, these registers can be read either from an external Modbus device, from the processor or using the Modbus master interface in the AFC Manager. This operation mode is called "Soft Password" mode. It is then the responsibility of a compatible application (such as AFC Manager) to verify the password given by the operator against those fetched from the module in order to determine the access granted.

If the Hard Password option is selected, a read of a password register will return zero regardless of the password's actual value. In this case, read or write access is obtained by writing a candidate password to the Password Test register (register 18), the module itself verifies the password, and the access granted is determined by reading back that same register 18 (called the Accessed Port and Authorization register when read) and examining its contents. The access is granted to the port over which the request was made; other ports remain unaffected. If the port remains idle with no Modbus activity for two minutes, then the granted access is removed and can be regained only by writing a new password to the test register. For highest security, you can explicitly revoke your own password-obtained authorization before it times out by writing zero to the Password Test register.

Access granted by password, whether Soft or Hard, is to the module as a whole, including the password registers themselves. That is, in order to change a stored Hard password you must first obtain write access to the module by giving the correct Write-Enable password. However, some registers are exempt from authorization. There are a very few registers that are exempt from write authorization and are always writable; the Password Test register 18 is one such for the obvious reason. Similarly, some registers are exempt from read authorization and are always readable; they include most of the first 20 holding registers, including the Firmware Product and Group codes in registers 0 and 1 (so an application like AFC Manager can learn whether it is talking to an AFC without being trapped in a catch-22), the Site Status in register 6 (so the application can learn whether the password mode is Soft or Hard and verify the operator's password entry using the proper method), and the Accessed Port and Authorization register 18 (so the application can learn whether access was granted in Hard-password mode even if the wrong read password was entered).

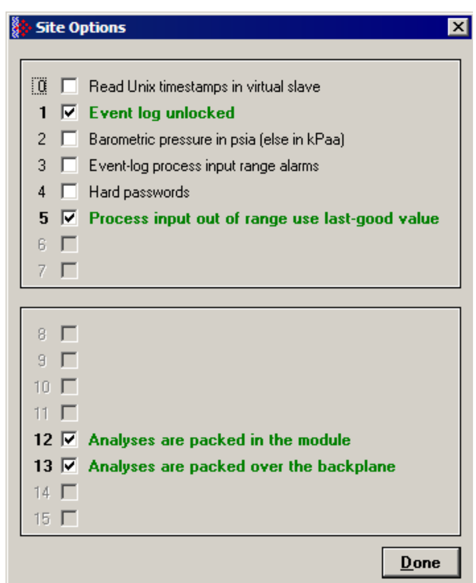
The Accessed Port and Authorization register is a bit-mapped word defined as follows:

Bits	Description
0 to 3	The number of the accessing port (0 for Modbus Gateway)
4	Read Authorization Waived
5	Write Authorization Waived
6	Read Access Granted
7	Write Access Granted
8 to 15	Reserved

A waived authorization means that password entry is not required for this action even if a non-zero password has been configured. Authorization waivers are configured separately for each port, so, for example, a SCADA system connected to port 2 can be allowed to read measurement results without having to supply a password while an operator connecting AFC Manager to port 1 still must enter the correct password. The backplane is always given both waivers, so the PLC never has to supply a password.

➢ ***To set a hard password in AFC Manager:***

32 Open the Site Configuration Dialog box
33 Click in the Site Options field. This action opens the Site Options dialog box
34 Select (check) option 4, Hard Passwords

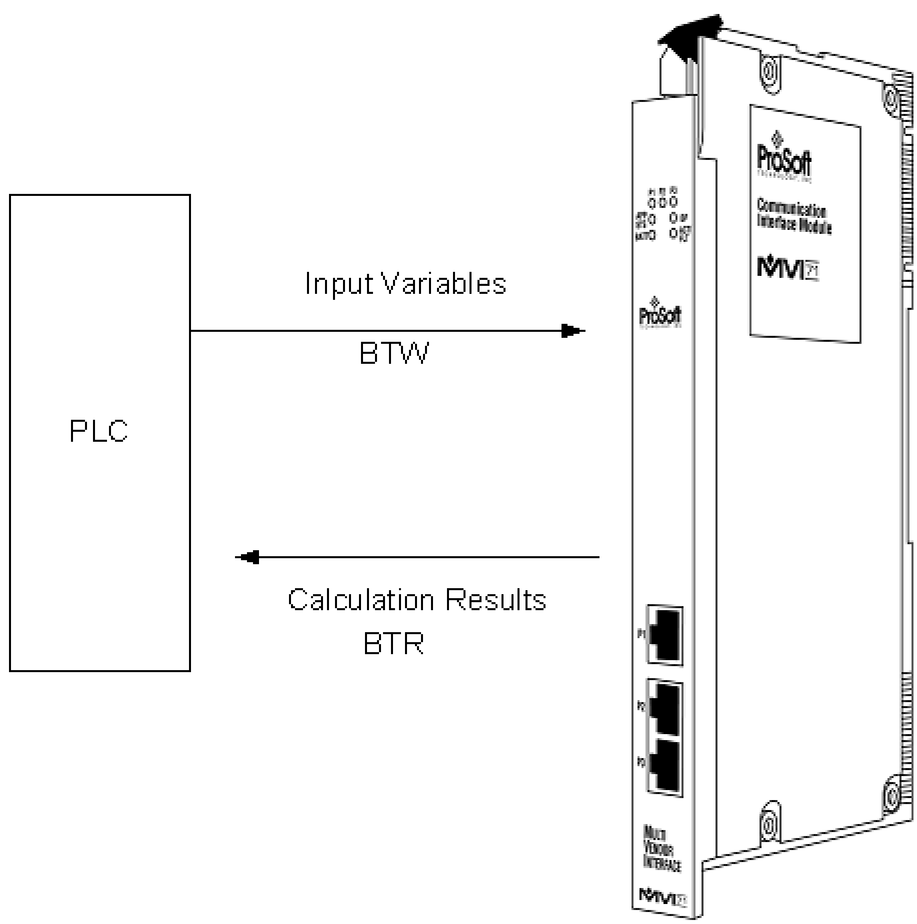


When this option is selected, any authorization granted using Hard Passwords times out after two minutes of inactivity, and the user will be required to re-enter the password to continue.

10 MVI71-AFC Backplane Communications

In This Chapter

The module periodically performs flow calculation using the input variables (temperature, pressure, etc.) transferred from the PLC through the chassis backplane. The calculation results (flow rate, accumulators, etc.) are periodically transferred from the module to the PLC processor.



The backplane communication is also used by the processor to request some tasks from the module (including Modbus master command, set wallclock, set molar analysis data).

The backplane communication between the MVI71-AFC and the processor is performed through Block Transfer instructions (up to 64 words of data). The BTW instruction (Block Transfer Write) writes data from the PLC to the module. The BTR instruction (Block Transfer Read) reads data from the module to the PLC:

10.1 MVI71-AFC Backplane Implementation

This section provides more information regarding how the output (BTW) and input (BTR) blocks are implemented.

10.1.1 Output Blocks (BTWs)

In order to implement block transfers, the MVI71-AFC uses the following structure for each BTW block (output block):

Word 0	Block Synchronization ID
Word 1	Function Block ID (Bitmapped)
Word 2	Output Data Word 0
...	...
...	...
Word 63	Output Data Word 61

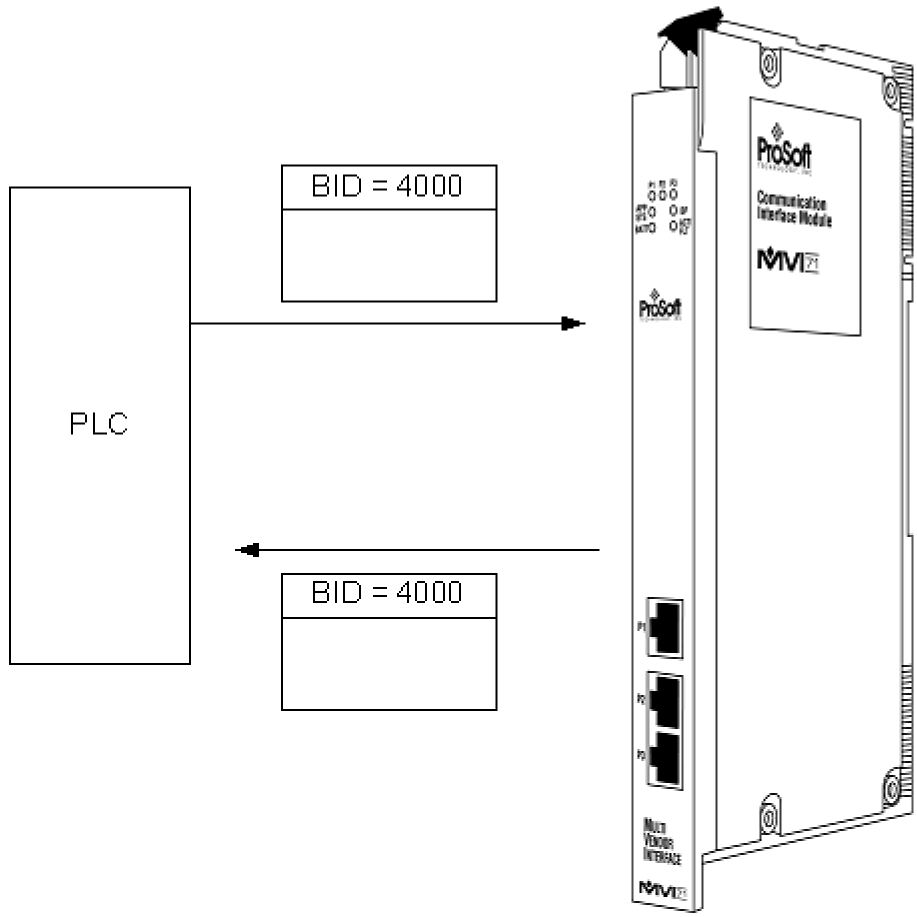
Block Synchronization ID

The Block Synchronization ID is an integer number (greater than 0) that identifies each output block.

The following section explains how the BTWs are divided into *Command Blocks* and *Calculation Blocks*.

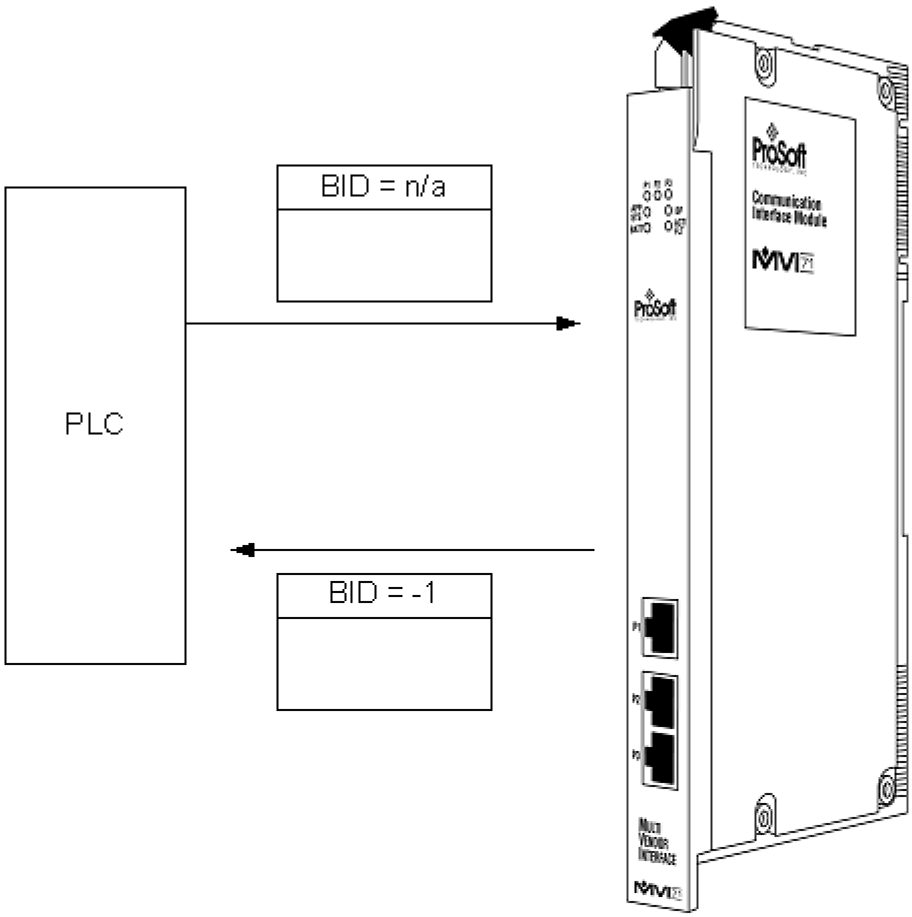
Command Block Operation

After the module receives a *Command Block* (BTW) request it will eventually generate a BTR response containing the same Block Synchronization ID sent by the module:



Calculation Block Operation

For *Calculation Blocks* the module will eventually generate a BTR response with a Block Synchronization ID of –1. The module may queue several blocks for the meter channel before sending a response block.



For more information about *Command Blocks* and *Calculation Blocks* refer to the following section.

Function Block ID (Bitmapped)

The Function Block ID contains the request identification for the output block. It basically informs the module of which task the PLC is requesting. This parameter is a bitmapped word which structure is defined as follows:

Bit Range	Description
0 to 7	Option Bits for selected function group
8 to 14	Function Group
15	Control Bit (1=Module will ignore this block and no BTR is issued, 0= module will process this block)

If the block contains an invalid Function Group or Option Bits, the BTW is ignored and the module will not generate any BTR response for this block.

The valid Function Groups and Option Bits are listed in the following topics.

10.1.2 Input Blocks (BTRs)

In order to implement block transfers, the MVI71-AFC uses the following structure for each BTR block (input block):

Word 0	Block Synchronization ID
Word 1	Block Status
Word 2	Site Status
Word 3	Meters in Alarm (Bitmapped)
Word 4	Input Data Word 1
...	
Word 63	Input Data Word 59

Where:

Block Synchronization ID

For Command Blocks: contains the echo of the BTW Block Synchronization ID

For Calculation Blocks: contains a value of –1

For Status Blocks: contains a value of –2

Block Status

The block status is defined as follows:

Bit Range	Description
0 to 14	Additional status depending on the function
15	Erroneous function parameters

Site Status

This register contains the site status information (Modbus address Ph00006) as follows:

Bit	Description
0	AFC-71(8) released
1	Checksum alarm
2	Reserved
3	Reserved
4	PLC Halted, offline, or missing
5	Measurement configuration changed
6	Power-up
7	Cold start
8	Hard Passwords
9	Reserved
10	Reserved

Bit	Description
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

Meters in Alarm

This is a bitmapped word where each bit informs if the meter has an alarm or not.

Bit	Description
0	Meter 1 Alarm (0=no alarm , 1 = alarm)
1	Meter 2 Alarm (0=no alarm , 1 = alarm)
2	Meter 3 Alarm (0=no alarm , 1 = alarm)
3	Meter 4 Alarm (0=no alarm , 1 = alarm)
4	Meter 5 Alarm (0=no alarm , 1 = alarm)
5	Meter 6 Alarm (0=no alarm , 1 = alarm)
6	Meter 7 Alarm (0=no alarm , 1 = alarm)
7	Meter 8 Alarm (0=no alarm , 1 = alarm)

The input data will depend on the function block associated with the BTR block.

10.2 Function Groups & Block Types

The following table shows the valid function groups supported by the MVI71-AFC module:

Base Value	Scaled Decimal	Scaled Hex	Group Type	Function Group
1	256	0100	Command	Wallclock and site signals
2	512	0200	Calculation	Single Meter I/O, signals, enab/disab
3	768	0300	Command	Meter Archive Fetch
4	1024	0400	Command	PLC Gateway
5	1280	0500	Command	Modbus Master
6	1536	0600	Command	Modbus Pass-Thru
8	2048	0800	Command	Arbitrary Modbus Fetch
17	4352	1100	Calculation	Quadruple Meter I/O
18	4608	1200	Calculation	Double Meter Analysis and signals

Each function block is discussed separately in the following topics.

The blocks are classified into command, calculation, or status blocks. The difference between calculation and command blocks has to do with how the module builds the response to a processor request.

Command Blocks – The module builds a BTR response to every BTW request received from the PLC processor. The BTR response will contain the same block synchronization ID sent on the BTW request. The ladder logic should handle the send/receive logics to check for the incoming block synchronization IDs.

The matching BTR response might not be returned immediately – several Calculation and/or Status BTR blocks might intervene. Also, if several Command BTWs are issued together, the matching BTWs might not be returned in the same order.

The extra space in command blocks Function 1 and 3 can be used to read specific Modbus registers from the module. The remainder of the BTW block may contain arbitrary Modbus addresses and the module will return the value of these registers in the BTR response.

Calculation Blocks – Each output block sends either meter input or molar analysis requests. The module will continuously repeat the following steps:

1 Add each received block to its internal queue
2 Calculate an average based on the received blocks
3 Send a BTR block to the processor containing the calculation results

The calculation block does not generate a response block for each individual request because the blocks are queued and an average calculation is performed. The module may receive a few calculation blocks before sending one response to the PLC processor. Each calculation response block contains data for only one meter. The module will only generate response blocks for the meters that are enabled.

The module always generates the same response block for all calculation blocks containing a block synchronization ID of –1. The response block is defined as follows:

Word Offset	Description		
0	Block Synchronization ID = –1		
1	Block Status		
	Word	**Bit**	**Description**
	0	0	Meter is in Alarm (0=no alarms, 1=alarm)
	0	1	Meter is enabled (0=disabled, 1=enabled)
	0	2 and 3	Not Used
	0	4	Meter Type (0=orifice/differential, 1=pulse/linear)
	0	5	Product Group (0=gas, 1=liquid)
	0	6	Primary Input (0=pulses/dp , 1=flow rate/frequency)
	0	7	Not Used
	0	8 to 11	Bitmap of enabled streams
	0	12 to 13	Active stream number (0 to 3)
	0	14 to 15	Not Used

Word Offset	Description
2	Site Status
3	Meters in Alarm
4	Meter Number
5 to 15	Process Input Backplane Return
16 to 63	Not Used

For a multiple-stream AFC (version 2.05 or later), non-zero stream information is returned. For a single-stream AFC (version 2.04 or earlier), that one stream is always enabled and active, rendering stream information redundant, and returned stream information is all zero.

The process input backplane sub-block will depend on the meter type and product group for the meter. The sub-block structure is shown in each calculation block discussion through the following topics.

Status Blocks (Block ID = –2) – The module periodically sends status blocks to the processor containing important information about each meter, whether the meter is enabled or not. The status block contains information about:

- *enable status*
- *if meter has alarms*
- *meter type*
- *product group*
- *primary input*
- *process input scan count*
- *calculation scan count*

The status block will be periodically sent after the module has sent calculation blocks for all enabled meters (Block ID=–1).

The status block is always sent with a block synchronization ID of –2. The block structure is defined as follows:

Word Offset	Description
0	Block Synchronization ID = –2
1	Block Status Bit / Description 0 / Clock not set
2	Site Status
3	Meters in Alarm
4	System Scan Count
5	Enabled Meters (bitmap)
6 to 7	Not Used
8	Modbus Master Status - bit 0 = Transaction Pending - bit 1 = Transaction Done
9	Modbus Master Done Transaction Error Code

<table>
<tr><th>Word Offset</th><th>Description</th></tr>
<tr><td>10</td><td>Pass-Thru status
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>0</td><td>Pending</td></tr>
<tr><td>1</td><td>Bit-write command</td></tr>
<tr><td>2</td><td>Overflow</td></tr>
</table></td></tr>
<tr><td>11</td><td>Pass-Thru Register Address</td></tr>
<tr><td>12</td><td>Pass-Thru Number of Registers</td></tr>
<tr><td>13 to 15</td><td>Not Used</td></tr>
<tr><td>16 to 18</td><td>Meter 1 Status</td></tr>
<tr><td>19 to 21</td><td>Meter 2 Status</td></tr>
<tr><td>22 to 24</td><td>Meter 3 Status</td></tr>
<tr><td>25 to 27</td><td>Meter 4 Status</td></tr>
<tr><td>28 to 30</td><td>Meter 5 Status</td></tr>
<tr><td>31 to 33</td><td>Meter 6 Status</td></tr>
<tr><td>34 to 36</td><td>Meter 7 Status</td></tr>
<tr><td>37 to 39</td><td>Meter 8 Status</td></tr>
<tr><td>40 to 63</td><td>Not Used</td></tr>
</table>

Each meter status block is defined as follows:

Word	Bit	Description
0	0	Meter is in Alarm (0=no alarms, 1=alarm)
0	1	Meter is enabled (0=disabled, 1=enabled)
0	2 and 3	Not Used
0	4	Meter Type (0=orifice/differential, 1=pulse/linear)
0	5	Product Group (0=gas, 1=liquid)
0	6	Primary Input (0=pulses/dp , 1=flow rate/frequency)
0	7	Not Used
0	8 to 11	Bitmap of enabled streams
0	12 to 13	Number of Active Stream (o-based; 0 thru 3)
0	14 to 15	Not Used
1	0 to 15	Process Input Count (number of times the meter has received an input block from the processor)
2	0 to 15	Calculation Count (number of times the meter has completed one calculation scan). The performance will depend on the meter configuration and the number of enabled meters.

For a multiple-stream AFC (version 2.05 or later), non-zero stream information is returned. For a single-stream AFC (version 2.04 or earlier), that one stream is always enabled and active, rendering stream information redundant, and returned stream information is all zero.

Each function block is defined in the following topics:

10.2.1 Wallclock and Site Signals (Function Group 1)

Function Group: 1 (Scaled Decimal 256)

Block Type: Command Block

This block can be used to set the wallclock, read the wallclock or set the site signals (Modbus address Ph00200).

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Option Bits)
2	Site Signals (Modbus Address Ph00200)
3	Not Used
4	WallClock - Year
5	WallClock - Month
6	WallClock - Day
7	WallClock - Hour
8	WallClock - Minute
9	WallClock - Second
10 to 63	Modbus Fetch of Input Registers (see Note) (Optional)

Note: This block performs the Modbus fetch operation from the Input Register bank, therefore these words may contain Modbus addresses. The module will copy the value of each Modbus register into the BTR response to the same word location used in the BTW request block. A Modbus address of 0 means "do not fetch"; to fetch register 0, use the address –1.

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Set Wallclock
1	Return Wallclock
2	Send Site Signals

The Site Signals register is defined as follows:

Bit	Description
0	Purge event log
1	Clear all checksum alarms
2 to 15	Not Used

Input Block

Word Offset	Description
0	Block Synchronization ID = –1
1	Block Status (contains Block Status Bits)
2	Site Status
3	Meters in Alarm
4	Wallclock Returned – Year
5	Wallclock Returned – Month
6	Wallclock Returned – Day
7	Wallclock Returned – Hour
8	Wallclock Returned – Minute
9	Wallclock Returned – Second
10 to 63	Modbus Fetch Return of Input Registers (Optional) This block contains the results of the Modbus fetch operation from the Input Register bank.

Input Block Status Bits

These bits are part of the Block Status word (word 1 / bits 0 to 7)

Bit	Description
0	Fail to Set the Clock
1	Clock not yet set

10.2.2 Single Meter I/O, Meter Signals, Meter Enable/Disable (Function Group 2)

Function Group: 2 (Scaled Decimal 512)

Block Type: Calculation Block

This block may be used to send the meter process input variables, molar analysis data, meter signals or request each meter to be enabled or disabled. Only one meter can be processed per block.

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (Contains Options Bits)
2	Meter Number (1 to 8) Bits 0 to 7: meter number (1 to 8); 0 = ignore Bits 1 to 15: stream number for analysis (1 to 4) or 0 (active stream) and signals
3	Meter Signals
4	Reserved
5 to 15	Process Input Variables

Word Offset	Description
16 to 39	Meter Analysis - Scaled e–4
40 to 63	Not Used

The meter signals bits are defined as follows:

Bit	Description
0	Select stream 1
1	Select stream 2
2	Select stream 3
3	Select stream 4
4	Reset Resettable Accumulator 1
5	Reset Resettable Accumulator 2
6	Reset Resettable Accumulator 3
7	Reset Resettable Accumulator 4
8	Write Daily Archive
9	Write Hourly Archive
10 to 15	Reserved

For a multiple-stream AFC (version 2.05 or later), non-zero stream information is returned. For a single-stream AFC (version 2.04 or earlier), that one stream is always enabled and active, rendering stream information redundant, and returned stream information is all zero.

The Process Input Variable Block depends on the meter type and product group configured for that meter. The possible combinations are listed as follows:

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Process input present
1	Analysis present
2	Send meter signals
3	Disable meter
4	Enable meter

Meter Signals

The meter signal bits are defined as follows:

Bit	Description
0	Select stream 1 (version 2.05 or later)
1	Select stream 2 (version 2.05 or later)
2	Select stream 3 (version 2.05 or later)
3	Select stream 4
4	Reset Resettable Accumulator 1
5	Reset Resettable Accumulator 2

Bit	Description
6	Reset Resettable Accumulator 3
7	Reset Resettable Accumulator 4
8	Write Daily Archive
9	Write Hourly Archive
10 to 15	Reserved

Process Inputs

The Process Input Variable Block depends on the meter type and product group configured for that meter. The possible combinations are listed as follows:

Differential (Orifice) meter with Gas product

Meter PV: Output Function Block	
Offset	**Attribute**
0	Reserved
1	Temperature MS (see Note)
2	Temperature LS
3	Pressure MS (see Note)
4	Pressure LS
5	Differential Pressure MS (see Note)
6	Differential Pressure LS
7	Reserved
8	Reserved
9	Reserved
10	Reserved

Linear (Pulse) meter with Gas product

Meter PV: Output Function Block	
Offset	**Attribute**
0	Reserved
1	Temperature MS (see Note)
2	Temperature LS
3	Pressure MS (see Note)
4	Pressure LS
5	Meter Pulses MS (double integer)
6	Meter Pulses LS
7	Reserved
8	Reserved
9	Meter Pulse Freq - Hz MS (see Note)
10	Meter Pulse Freq - Hz LS

Differential (Orifice) Meter with Liquid Product

Meter PV: Output Function Block

Offset	Attribute
0	Water %
1	Temperature MS (see Note)
2	Temperature LS
3	Pressure MS (see Note)
4	Pressure LS
5	Differential Pressure MS (see Note)
6	Differential Pressure LS
7	Density MS (see Note)
8	Density LS
9	Reserved
10	Reserved

Linear (Pulse) Meter with Liquid Product

Meter PV: Output Function Block

Offset	Attribute
0	Water%
1	Temperature MS (see Note)
2	Temperature LS
3	Pressure MS (see Note)
4	Pressure LS
5	Meter Pulses MS (double integer)
6	Meter Pulses LS
7	Density MS (see Note)
8	Density LS
9	Meter Pulse Freq - Hz MS (see Note)
10	Meter Pulse Freq - Hz LS

Flow Rate Integration with Gas Product

Meter PV: Output Function Block

Offset	Attribute
0	Reserved
1	Temperature MS (see Note)
2	Temperature LS
3	Pressure MS (see Note)
4	Pressure LS
5	Flow Rate MS (see Note)
6	Flow Rate LS
7	Reserved
8	Reserved

Meter PV: Output Function Block	
Offset	**Attribute**
9	Reserved
10	Reserved

Pulse Frequency Integration with Gas Product

Meter PV: Output Function Block	
Offset	**Attribute**
0	Reserved
1	Temperature MS (see Note)
2	Temperature LS
3	Pressure MS (see Note)
4	Pressure LS
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Meter Pulse Freq - Hz MS (see Note)
10	Meter Pulse Freq - Hz LS

Flow Rate Integration with Liquid Product

Meter PV: Output Function Block	
Offset	**Attribute**
0	Water %
1	Temperature MS (see Note)
2	Temperature LS
3	Pressure MS (see Note)
4	Pressure LS
5	Flow Rate MS (see Note)
6	Flow Rate LS
7	Density MS (see Note)
8	Density LS
9	Reserved
10	Reserved

Pulse Frequency Integration with Liquid Product

Meter PV: Output Function Block	
Offset	**Attribute**
0	Water %
1	Temperature MS (see Note)
2	Temperature LS
3	Flow Rate MS (see Note)

Meter PV: Output Function Block	
Offset	**Attribute**
4	Flow Rate LS
5	Reserved
6	Reserved
7	Density MS (see Note)
8	Density LS
9	Meter Pulse Freq - Hz MS (see Note)
10	Meter Pulse Freq - Hz LS

Note: For Process Inputs the following formats are supported:

- Floating-Point
- Scaled Integer
- 4 to 20 mA (raw A/D)

Note 1: For water % (liquids only) floating point is not available. As a Scaled Integer it must be copied to offset 0 with two decimal places implied. For example, water % value of 7.23 must be entered as 723. The module divides this value by 100.

Note 2: The floating point format takes up two elements (32 bits) for each process variable. For example, the Temperature must be copied from a floating point tag in the controller to offsets 1 and 2.

Note 3a: Temperature as a scaled integer must be copied to offset 2 with 2 decimal places implied (1/100th of a degree). For example, a temperature of 24.97° F must be copied as 2497. The element at offset 1 is ignored.

Note 3b: Flowing pressure as a scaled integer must be copied to offset 4 with no decimal places implied for the SI units (kPa) and one decimal place implied for the U.S. units (psi). For example, a pressure of 5000 kPag must be copied as 5000 and a pressure of 259.7 psi must be copied as 2597. The element at offset 3 is ignored.

Note 3c: Differential Pressure as a scaled integer must be copied to offset 6 with 2 decimal places implied for inches of H2O and 3 places for kPa (1/100th & 1/1000th of the selected unit). For example, a DP of 37.52 in H2O must be copied as 3752. The element at offset 5 is ignored.

Note 3d: Flow Rate as a scaled integer must be copied to offset 6 with zero decimal places implied. The element at offset 5 is ignored. To obtain a desired precision, choose an appropriate Flow Input Unit (Meter Configuration window, Primary Input Characteristics panel)

Note 3e: Pulse Frequency may be supplied in scaled integer or 4 to 20 mA formats only in version 2.05 or later; in version 2.04 or earlier only floating point format is available. As a scaled integer it must be copied to offset 10 as an INT in units of Hz with zero decimal places implied. For example, a frequency of 2574 Hz must be copied as 2574.

Note 4: Note that three options for the product density for liquid meters are available, and if the Scaled Integer option is selected then density must be copied as follows to offset 8 (the element at offset 7 is ignored):

- Kg/m3 - One implied decimal place. (513.7 kg/m3 must be entered as 5137)
- Relative Density - Four implied decimal places. (1.0023 60F/60F must be entered as 10023)

- API - Two implied decimal places. (80.45 API must be entered as 8045).

Note 5: For the 4 to 20 mA format, the raw A/D count from the analog input module must be copied as an INT to the even-numbered offset of the pair (or to offset 0 for Water %). The element at the odd-numbered offset is ignored.

Molar Analysis

The molar analysis block is defined as follows:

Offset	Attribute	Element	Attribute
0	Propane – C1		Reserved
1	Nitrogen – N2		Reserved
2	Carbon dioxide –CO2		Reserved
3	Methane – C2 **Note:** To enter mole fraction value of 0.8713 (that is, 87.13 mole %) for C2, enter 8713 in this location (AFC divides each entered component value by 10,000 internally).		Reserved
4	Propane – C3		Reserved
5	Water – H2O		Reserved
6	Hydrogen Sulfide – H2S		Reserved
7	Hydrogen – H2		Reserved
8	Carbon Monoxide – CO		Reserved
9	Oxygen – O2		Reserved
10	Iso Butane – IC4		Reserved
11	Butane – C4		Reserved
12	Iso Pentane – IC5		Reserved
13	Pentane – C5		Reserved
14	Hexane – C6		Reserved
15	Heptane – C7		Reserved
16	Octane – C8		Reserved
17	Nonane – C9		Reserved
18	Decane – C10		Reserved
19	Helium – He		Reserved
20	Argon – Ar		Reserved
21	Neo Pentane – C5		Reserved
22	Ux User 1		Reserved
23	Ux User 2		Reserved

Input Block

Word Offset	Description
0	Block Synchronization ID = –1
1	Block Status (contains Block Status Bits)

Word Offset	Description
2	Site Status
3	Meters in Alarm
4	Meter Number
5 to 15	Process Input Backplane Return
16 to 63	Not Used

Note 1: If the meter is currently disabled, the module will not generate the input block.

Note 2: The Input Block is not paired with the Output Block.

Process Input Backplane Return

The Process Input Backplane Return block depends on the configured meter type and product group. The possible combinations are shown below:

Gas product

Meter PV: Input Function Block	
Element	Attribute
1	Meter Alarms (Bitmap)
2	Net Accumulator MS
3	Net Accumulator LS
4	Net Flowrate MS (float)
5	Net Flowrate LS (float)
6	Gross Flowrate MS (float)
7	Gross Flowrate LS (float)
8	Fpv MS (float)
9	Fpv LS (float)
10	Cprime MS (float)
11	Cprime LS (float)

Liquid Product

Meter PV: Input Function Block	
Element	Attribute
1	Meter Alarms (Bitmap)
2	Net Accumulator MS
3	Net Accumulator LS
4	Net Flowrate MS (float)
5	Net Flowrate LS (float)
6	Gross Accumulator MS
7	Gross Accumulator LS
8	Gross Standard Accumulator MS
9	Gross Standard Accumulator LS
10	Mass Accumulator MS

Meter PV: Input Function Block	
11	Mass Accumulator LS

Input Block Status Bits

These bits are part of the Block Status word (Word 1)

Bit	Description
0	Meter is in Alarm
1	Meter is Enabled
2 and 3	Not Used
4	Meter Type (0=differential, 1= pulse)
5	Product Group (0= gas, 1=liquid)
6	Primary Input (0=pulses/dp, 1=freq/flow rate)
7	Not Used
8 to 11	Bitmap of Enabled Streams
12 to 13	Number of Active Stream (0-based; 0 thru 3)
14 to 15	Not used

Note: For a multiple-stream AFC (version 2.05 or later), non-zero stream information is returned. For a single-stream AFC (version 2.04 or earlier), that one stream is always enabled and active, rendering stream information redundant, and returned stream information is all zero.

Returned Alarm Codes for Meter Data

The following table provides Alarm codes for meter data:

Alarm Code	Bit
Input out of range: Temperature	Bit 0
Input out of range: Pressure	Bit 1
Input out of range: Differential Pressure (or Flow Rate, or Frequency)	Bit 2
Input out of range: Flowing Density	Bit 3
Input out of range: Water Content	Bit 4
Differential pressure low (or Flow Rate, or Frequency)	Bit 5
Orifice Pressure Exception	Bit 6
Accumulation Overflow Error	Bit 7
Orifice Characterization Error	Bit 8
Analysis Total Zero (version 2.04 or earlier) Reserved (version 2.05 or later)	Bit 9
Analysis Total Not Normalized (version 2.04 or earlier) Analysis Characterization Error (version 2.05 or later)	Bit 10
Compressibility Calculation Error (gas) High Water Error (liquids)	Bit 11
Reference Density Error	Bit 12
Temperature Correction Error	Bit 13

Alarm Code	Bit
Vapor Pressure Error	Bit 14
Pressure Correction Error	Bit 15

10.2.3 Meter Archive Fetch (Function Group 3)

Function Group: 3 (Scaled Decimal 768)

Block Type: Command Blocks

This block may be used to read an archive from the MVI71-AFC. The output block should select the meter number, archive type (hourly/daily) and the archive number (0 is the current). You may also read archives using the Modbus Gateway function group as described later in this User Manual; however, the Meter Archive Fetch function provides a more convenient way to read archive data to the PLC processor.

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Option Bits)
2	Meter Number (1 to 8)
3	Archive Age (0=current archive, 1=latest archive, etc…)
4 to 43	Not Used
44 to 63	Modbus Fetch of Holding Registers (see Note)

Note: This block performs the Modbus fetch operation from the Holding Register bank, therefore these words may contain Modbus addresses. The module will copy the value of each Modbus register into the BTR response to the same word location used in the BTW request block. A Modbus address of 0 means "do not fetch"; to fetch register 0, use the address -1.

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Archive File (0 = Daily , 1 = Hourly)
1 to 7	Not Used

Input Block

Word Offset	Description
0	Block Synchronization ID
1	Block Status (contains Block Status Bits)
2	Site Status
3	Meters in Alarm
4 to 43	Archive Record Data

Word Offset	Description
44 to 63	Modbus Fetch Return of Holding Registers This block contains the results of the Modbus fetch operation from the Holding Register bank.

Input Block Status Bits

These bits are part of the Block Status word (word 1 / bits 0 to 7)

Bit	Description
0	Meter is in Alarm
1	Meter is Enabled
2 to 3	Not used
4	Meter Type (0=differential, 1= pulse)
5	Product Group (0= gas, 1=liquid)
6	Primary Input (0=pulses/dp, 1=freq/flow rate)
7	Not used
8	Archive Age Out of Range

The archive structure will depend on the configured meter type and product group. The default archive structure contains 30 words (the first 10 words are the same for all meter types and product groups). The default archive structure is defined as follows:

Pre-defined Overhead

Start Offset	End Offset	Data Type	Description
00	01	Dt	Closing timestamp of archive
02		Wd	Flowing period
03		Bm	Cumulative meter alarms
04		Bm	Cumulative status
05		Wd	Event counter
06	07	Dw	Flowing period, seconds
08	09	Dt	Opening timestamp of archive

Refer to Archive Data Structure for a description of meter type and product group archive data structure.

10.2.4 Modbus Gateway (Function Group 4)

Function Group: 4 (Scaled Decimal 1024)

Block Type: Command Block

This block can be used to read or write registers from the Primary or Virtual Modbus Slaves. The block can be configured to access input or holding registers.

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Option Bits)
2	Register Address
3	Number of Registers (1 to 60)
4 to 63	Data to be written (if block is configured for write operation)

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Slave Type (0=Primary, 1=Virtual)
1	Register Type (0=holding, 1=input)
2	Function Type (0=read, 1=write)
3 to 7	Not Used

Input Block

Word Offset	Description
0	Block Synchronization ID
1	Block Status (contains Block Status Bits)
2	Site Status
3	Meters in Alarm
4 to 63	Data read (if block was configured for read operation)

Input Block Status Bits

These bits are part of the Block Status word (word 1 / bits 0 to 7)

Bit	Description
0	Illegal Function
1	Illegal Address
2	Illegal Data
3	Slave Fail (out of memory)
4 to 7	Reserved
8	Data Too Long

10.2.5 Modbus Master (Function Group 5)

Function Group: 5 (1280 scaled decimal)

Block Type: Command Block

This block can be used to send Modbus commands to remote Modbus slave devices. You must enable Port 3 for Modbus master operation (refer to the AFC Manager User Manual for more information about this subject). Each Modbus master command may transfer up to 58 words of data for read or write commands. The module supports Modbus functions 1, 2, 3, 4, 15 and 16.

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Option Bits)
2	Data Size
3	Slave Address
4	Register Address
5	Item Count
6 to 63	Data to be Written (for write command)

The Data Size may have one of the following values:

- 0 = Bit (packed 16 to a word)
- 1 = Word (16-bit register)
- 2 = Long (32-bit items as register pairs)
- 3 = Long Remote (32-bit items as single registers)
- For Byte Swap: add 10 (except type 0)
- For Word Swap: add 20 (except types 0 and 1)

The difference between the long and long remote data types is:

- Long data type implements each data unit as one pair of registers (words). Each register contains two bytes.
- Long Remote data type implements each data unit as one 32-bit register. Each register contains four bytes.

The following table shows how a Modbus poll is implemented if a write function is selected (refer to the Option Bits table below) and the Item Count is configured with a value of 10 (decimal):

Data Type	Register Type	Modbus Function	Number of Coils	Number of Bytes	Number of Registers	Number of words (16-bits) actually transferred
Bit	Coil	15	10	2	-	1
Word	Holding	16	-	20	10	10
Long	Holding	16	-	40	20	20
Long Remote	Holding	16	-	40	10	20

Note: The number of coils, bytes and registers are part of the Modbus request (functions 15 and 16) according to the Modbus specification.

The following table shows how a Modbus poll is implemented if a read function is selected (refer to the Option Bits table below) and the Item Count is configured with a value of 10 (decimal):

Data Type	Register Type	Modbus Function	Number of Registers	Number of 16-bit words actually transferred
Bit	Coil	1	10	1
Bit	Input	2	10	1
Word	Holding	3	10	10
Word	Input	4	10	10
Long	Holding	3	20	20
Long	Input	4	20	20
Long Remote	Holding	3	10	20
Long Remote	Input	4	10	20

Note: The number of registers is part of the Modbus request according to the Modbus specification. This table indicates how this value will be set in the Modbus message.

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Fetch Block Status Only
1	Register bank (holding/input registers) 0 = Holding or Coils 1 = Input
2	Function Type 0 = Read 1 = Write
3 to 7	Not Used

Input Block

Word Offset	Description
0	Block Synchronization ID
1	Block Status (contains Block Status Bits)
2	Site Status
3	Meters in Alarm
4	Error Code
5 to 63	Data Read (for read command)

The error code indicates whether a communication problem has occurred or a configuration error prevented the module from sending the Modbus command. A non-zero value indicates that an error has occurred.

Modbus exception codes are issued by the responding slave and listed in commonly available Modbus protocol manuals. These codes use values between 1 and 127 and include:

Code	Description
=0 -	**No Error**
>0	**Modbus Exception Code or Communication Error** Modbus Exception codes are issued by the responding slave and listed in commonly available Modbus protocol manuals; they lie between 1 and 127 and include: 1 - Illegal Function 2 - Illegal Address 3 - Illegal Data Value Communication Errors are issued by the AFC: 500 - CTS Timeout 501 - Receive Timeout 502 - Bad Framing 503 - Buffer Overrun 504 - Bad Checksum/CRC 505 - Wrong Slave 506 - Wrong Function Code 507 - Wrong Length
<0	**Configuration, Parameter, or Logic Error:** –1 - Master Port not configured –2 - Master Port never used –3 - Bad Slave Address –4 - Bad Direction/ Target –5 - Bad Datum Size / Swap Options –6 - Bad Number of Data Items

Input Block Status Bits - These bits are part of the Block Status word (word 1 / bits 0 to 7)

Bit	Description
0	Master Poll Pending
1 to 7	Not Used

10.2.6 Modbus Pass-Thru (Function Group 6)

Function Group: 6 (1536 scaled decimal)

Block Type: Command Block

This block fetches any pass-through Modbus write command sent by an external Modbus host to the pass-thru region in the Virtual Slave, which is returned to the Processor essentially verbatim. The AFC module buffers any such command until it is returned to the Processor via this input function block, at which time the buffer is made available for the next command. Up to 58 words of data are supported.

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Option Bits)
2 to 63	Not Used

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Swap Words of Pass-Thru
1	Acknowledge receipt
2	Flush buffer
3 to 7	Not Used

Input Block

Word Offset	Description
0	Block Synchronization ID
1	Block Status (contains Block Status Bits)
2	Site Status
3	Meters in Alarm
4	Register Address (bit 15 set upon overflow)
5	Number of Registers
6 to 63	Data Received

Input Block Status Bits

These bits are part of the Block Status word (word 1 / bits 0 to 7)

Bit	Description
0	Command was Pending (1=pending) so there is data in this block
1	Bit-Write (0=word, 1=bit)
2	Overflow, remains pending if not flushed (1=overflow)
3 to 7	Not Used

10.2.7 Arbitrary Modbus Fetch (Function Group 8)

Function Group: 8 (2048 scaled decimal)

Block Type: Command Block

This block provides a convenient way to read holding or input registers from the primary Modbus slave. Each register in the output block may contain a Modbus address. The values are returned at the same offset in the input block.

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Option Bits)
2	Not Used
3	Not Used
4 to 63	Arbitrary Modbus Addresses

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Register Type (0=holding register , 1 = input register)
1 to 7	Not Used

Input Block

Word Offset	Description
0	Block Synchronization ID
1	Block Status (contains Block Status Bits)
2	Site Status
3	Meters in Alarm
4 to 63	Modbus Values

Input Block Status Bits

These bits are part of the Block Status word (word 1 / bits 0 to 7)

Bit	Description
0 to 7	Not Used

A Modbus address of 0 means "do not fetch". To explicitly fetch register 0, use Modbus address of –1.

10.2.8 Quadruple Meter I/O (Function Group 17)

Function Group: 17 (4352 scaled decimal)

Block Type: Calculation Block

This block sends process input variables to four meters at the same time. The input block sends the calculation results back to the processor.

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Options Bits)
2	Not Used

Word Offset	Description
3	Not Used
4 to 15	Process Inputs for first meter
16 to 27	Process Inputs for second meter
28 to 39	Process Inputs for third meter
40 to 51	Process Inputs for fourth meter
52 to 63	Not Used

Each meter block has the following format:

Word Offset	Description
0	Meter and Stream Selection Bits 0 to 7: Meter Number (1 to 8); 0 = ignore Bits 1 to 15: Stream Number for analysis (1 to 4) or 0 (active stream)
1	Process Input

Refer to Function Group 2 Output Block (page 93) for a description of the output blocks.

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Process inputs for first meter present
1	Process inputs for second meter present
2	Process inputs for third meter present
3	Process inputs for fourth meter present
4 to 7	Not Used

Input Block

Refer to Function Group 2 Input Block (page 99) for a description of the input blocks.

10.2.9 Double Meter Analysis and Meter Signals (Function Group 18)

Function Group: 18 (4608 scaled decimal)

Block Type: Calculation Block

This block updates the molar analysis data for up to 2 meters at the same time. It can also be used to send meter signals, for example, to request one of the four resettable accumulators to be reset or to write an archive (hourly or daily).

Output Block

Word Offset	Description
0	Block Synchronization ID
1	Function Block ID (contains Options Bits)

Word Offset	Description
04 to 29	Analysis and signals for first meter
30 to 55	Analysis and signals for second meter
56 to 63	Not Used

Each meter block has the following format:

Word Offset	Description
0	Meter and Stream Selection Bits 0 to 7: Meter Number (1 to 8); 0 = ignore Bits 1 to 15: Stream Number for analysis (1 to 4) or 0 (active stream) and signals
1	Meter Signals (effective only when Stream Number is 0)
2 to 25	Meter Analysis, scaled e–4

Refer to Function Group 2 Output Block (page 93) for a description of the output blocks.

Option Bits

These bits must be set in the Function Block ID word (bits 0 to 7) at word 1

Bit	Description
0	Analysis for first meter present
1	Signals for first meter present
2	Analysis for second meter present
3	Signals for second meter present
4 to 7	Not Used

Input Block

Refer to Function Group 2 Input Block (page 99) for a description of the input blocks.

11 MVI71-AFC Sample Ladder Logic

In This Chapter

This section provides a general description about the sample ladder associated with the MVI71-AFC module. The sample ladder should be used in all flow measurement applications because it implements all MVI71-AFC features. You might have to perform some minor modifications on specific applications. The sample ladder supports the following features:

- Writes the input process variables to the module (all meter types and product groups)
- Reads the calculation results from the module (all meter types and product groups)
- Enable and disable meters
- Reset accumulators
- Write daily or hourly archives
- Monitors the meter status: alarms, enable status, meter type and product group
- Monitors the process input scan count for each meter
- Monitors the calculation scan count for each meter
- Sets and reads the module wallclock
- Writes the molar analysis data for each meter (for chromatograph applications)
- Allows read and write operations to the primary and virtual slaves databases
- Reads archives
- Generates Modbus master commands for remote slaves
- Handles Modbus pass-thru blocks

This section provides information on how to use the sample ladder. You should read this entire section before downloading the sample ladder to the PLC processor.

11.1 Sample Ladder Overview

The sample ladder handles the data transfer between the MVI71-AFC and the PLC processor. The data is continuously transferred through BTR and BTW block transfer operations.

After the sample ladder is downloaded to the PLC processor it will automatically perform the tasks that are discussed in the following section (Periodic Blocks).

11.1.1 Periodic Blocks

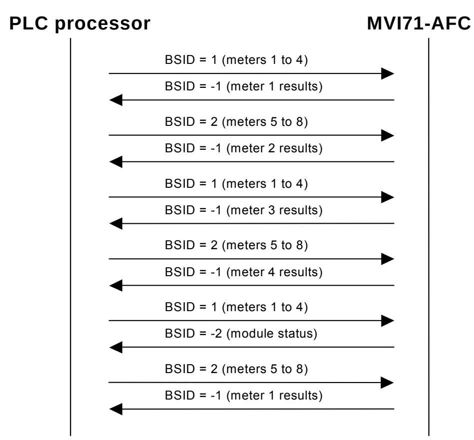
All applications will require the ladder logic to write input variables to the module and read calculation results to the PLC. The sample ladder logic was designed to continuously perform this task through function block 17 (Quadruple Meter I/O). This function block sends the meter process variable data for four meters at the same time, so the sample ladder logic will continuously send two blocks as follows:

Block Synch ID 1 = contains process input variables for meters 1, 2, 3 and 4.

Block Synch ID 2 = contains process input variables for meters 5, 6, 7 and 8.

The module will continuously add received blocks to its internal queue, calculate an average of all blocks, and finally send the calculation result for each meter. The calculation result is sent to the PLC with a block synchronization value of –1 (refer to the Backplane Communication overview).

The module will only generate response blocks for enabled meters. The following illustration shows a typical communication cycle example when meters 1 to 4 are enabled and meters 5 to 8 are disabled.



As the diagram shows, the module also periodically sends status blocks (Block Synchronization ID = –2) after every meter cycle.

Refer to the following registers to copy the meter process variable values:

Register	Description
N20	Meter 1 Process Data (integer format)
N21	Meter 2 Process Data (integer format)
N22	Meter 3 Process Data (integer format)
N23	Meter 4 Process Data (integer format)
N24	Meter 5 Process Data (integer format)
N25	Meter 6 Process Data (integer format)
N26	Meter 7 Process Data (integer format)
N27	Meter 8 Process Data (integer format)
F30	Meter 1 Process Data (floating point format)

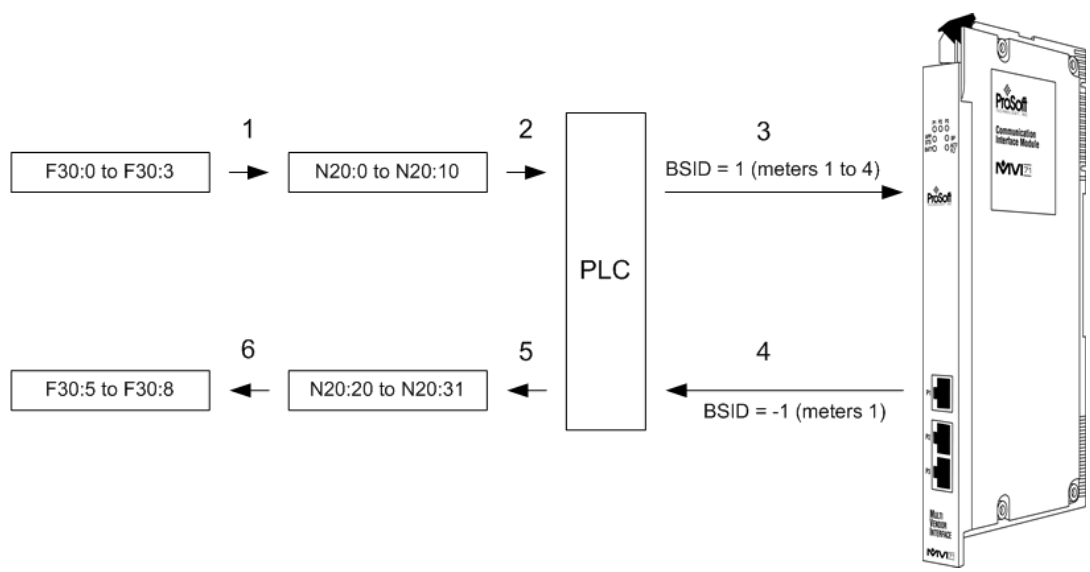
Register	Description
F31	Meter 2 Process Data (floating point format)
F32	Meter 3 Process Data (floating point format)
F33	Meter 4 Process Data (floating point format)
F34	Meter 5 Process Data (floating point format)
F35	Meter 6 Process Data (floating point format)
F36	Meter 7 Process Data (floating point format)
F37	Meter 8 Process Data (floating point format)

These data files store input variables and calculation results. The following table describes data file structure for meter 1:

Register Start	Register End	Description
N20:0	N20:10	Meter 1 process input variables
F30:0	F30:3	Meter 1 process input variables - floating point format
N20:20	N20:31	Meter 1 calculation results
F30:5	F30:8	Meter 1 calculation results - floating point format

Calculation Cycle

The calculation cycle is performed as follows (meter 1 as an example):



1 The ladder logic performs a copy operation to convert the input variables from floating point format to integer format.
2 The integer block is copied to the BTW instruction buffer to be sent to the MVI71-AFC module.
3 The BTW instruction is executed to write the process variables for meters 1 to 4
4 The BTR instruction is executed containing the meter calculation results for meter 1

5 The ladder logic copies the calculation results from the BTR buffer to the integer data file for meter 1

6 The ladder logic copies some variables to the appropriate data file in order to convert them from integer to floating point format.

The floating-point registers will be defined according to the meter type and product group configured for the meter channel. The following table shows the possible values for meter 1:

Register	Orifice Meter and Gas Product	Orifice Meter and Liquid Product	Pulse Meter and Gas Product	Pulse Meter and Liquid Product
F30:0	Temperature	Temperature	Temperature	Temperature
F30:1	Pressure	Pressure	Pressure	Pressure
F30:2	Differential Pressure	Differential Pressure	Pulse Frequency	Density
F30:3	Not Used	Density	Not Used	Pulse Frequency

Each integer file structure depends on the meter type and product group as follows (meter 1):

Register	Orifice Meter and Gas Product	Orifice Meter and Liquid Product	Pulse Meter and Gas Product	Pulse Meter and Liquid Product
N20:0	Not Used	Water %	Not Used	Water %
N20:1	Temperature (High Word)	Temperature (High Word)	Temperature (High Word)	Temperature (High Word)
N20:2	Temperature (Low Word)	Temperature (Low Word)	Temperature (Low Word)	Temperature (Low Word)
N20:3	Pressure (High Word)	Pressure (High Word)	Pressure (High Word)	Pressure (High Word)
N20:4	Pressure (Low Word)	Pressure (Low Word)	Pressure (Low Word)	Pressure (Low Word)
N20:5	Diff Pressure (High Word)	Diff Pressure (High Word)	Pulse Count (High Word)	Pulse Count (High Word)
N20:6	Diff Pressure (Low Word)	Diff Pressure (Low Word)	Pulse Count (Low Word)	Pulse Count (Low Word)
N20:7	Not Used	Density (High Word)	Not Used	Density (High Word)
N20:8	Not Used	Density (Low Word)	Not Used	Density (Low Word)
N20:9	Not Used	Not Used	Pulse Frequency (High Word)	Pulse Frequency (High Word)
N20:10	Not Used	Not Used	Pulse Frequency (Low Word)	Pulse Frequency (Low Word)

The other meters use the same structure shown in the table above.

The calculation result also depends on the meter type and product group as follows (meter 1):

Register	Orifice Meter and Gas Product	Orifice Meter and Liquid Product	Pulse Meter and Gas Product	Pulse Meter and Liquid Product
N20:20	Meter Status	Meter Status	Meter Status	Meter Status
N20:21	Meter Alarm	Meter Alarm	Meter Alarm	Meter Alarm
N20:22	Net Accumulator (High Word)	Net Accumulator (High Word)	Net Accumulator (High Word)	Net Accumulator (High Word)
N20:23	Net Accumulator (Low Word)	Net Accumulator (Low Word)	Net Accumulator (Low Word)	Net Accumulator (Low Word)
N20:24	Net Flow Rate (High Word)	Net Flow Rate (High Word)	Net Flow Rate (High Word)	Net Flow Rate (High Word)
N20:25	Net Flow Rate (Low Word)	Net Flow Rate (Low Word)	Net Flow Rate (Low Word)	Net Flow Rate (Low Word)
N20:26	Gross Flow Rate (High Word)	Gross Accumulator (High Word)	Gross Flow Rate (High Word)	Gross Accumulator (High Word)
N20:27	Gross Flow Rate (Low Word)	Gross Accumulator (Low Word)	Gross Flow Rate (Low Word)	Gross Accumulator (Low Word)
N20:28	Fpv (High Word)	Gross Standard Accumulator (High Word)	Fpv (High Word)	Gross Standard Accumulator (High Word)
N20:29	Fpv (Low Word)	Gross Standard Accumulator (Low Word)	Fpv (Low Word)	Gross Standard Accumulator (Low Word)
N20:30	Cprime (High Word)	Mass Accumulator (High Word)	Cprime (High Word)	Mass Accumulator (High Word)
N20:31	Cprime (Low Word)	Mass Accumulator (Low Word)	Cprime (Low Word)	Mass Accumulator (Low Word)

Status Word

The meter status word is a bitmapped word defined as follows:

Bit	Description
0	Meter is in Alarm
1	Meter is Enabled
2	Event Log is Full
3	Meter Type (0=differential, 1= pulse)
4	Product Group (0= gas, 1=liquid)
5	Primary Input (0=pulses/dp, 1=freq/flow rate)
6	Not Used
7	Ambiguous enable/disable signal

Alarm Code

The alarm code is a bitmapped word with the following structure:

Bit	Description
0	Input out of range: temperature
1	Input out of range: pressure
2	Input out of range: differential pressure
3	Input out of range: flowing density
4	Input out of range: water content
5	Differential Pressure Low
6	Orifice Pressure Exception
7	Accumulation overflow
8	Orifice characterization error
9	Analysis total zero
10	Analysis total not normalized
11	Compressibility calculation error
12	API calculation error: density correction
13	API calculation error: Ctl
14	API calculation error: vapor pressure
15	API calculation error: Cpl

The floating-point registers will be defined according to the meter type and product group configured for the meter channel. The following table shows the possible values for meter 1:

Register	Orifice Meter and Gas Product	Orifice Meter and Liquid Product	Pulse Meter and Gas Product	Pulse Meter and Liquid Product
F30:5	Net Flow Rate	Net Flow Rate	Net Flow Rate	Net Flow Rate
F30:6	Gross Flow Rate	Reserved	Gross Flow Rate	Reserved
F30:7	Fpv	Reserved	Fpv	Reserved
F30:8	Cprime	Reserved	Cprime	Reserved

11.2 Additional Features

The sample ladder logic may also perform additional tasks such as:

- Update molar analysis data
- Read archive data
- Enable or disable meters

In order to perform one of the command blocks the ladder logic has to move the correct block synchronization ID value to register N12:0. The LAD4 (BLK_SELECT) routine should be used to periodically (or upon event) move the correct BSID to register N12:0.

Important: The logic must only move a new BSID to data file N12:0 if its current value is 0.

The following table shows the valid block synchronization IDs implemented by the ladder logic:

Task	Block ID	Number of Blocks	Ladder Routine
Modbus Pass-Thru	3000	1	15
Modbus Master	4000	1	14
Arbitrary Modbus Fetch	5000	1	16
Meter Analysis & Meter Signals	6000	4	11
Meter Archive Fetch	7000	8	13
Modbus Gateway	8000	4	12
Meter Enable/Disable	9000	8	10
Read Wallclock	9800	1	9
Write Wallclock	9900	1	9

This implementation guarantees that most of the applications will not require any modifications to the sample ladder logic structure. It is required to add the logic that will periodically move the appropriate BSID to the register N12:0.

11.2.1 Example

In this example, an application requires the ladder logic to update the meter analysis for all 8 meters every 6 seconds. Follow the steps below:

Step 1: Add the logic to move the molar analysis data from the chromatograph device to the data files used by the sample ladder logic. The following data files are implemented:

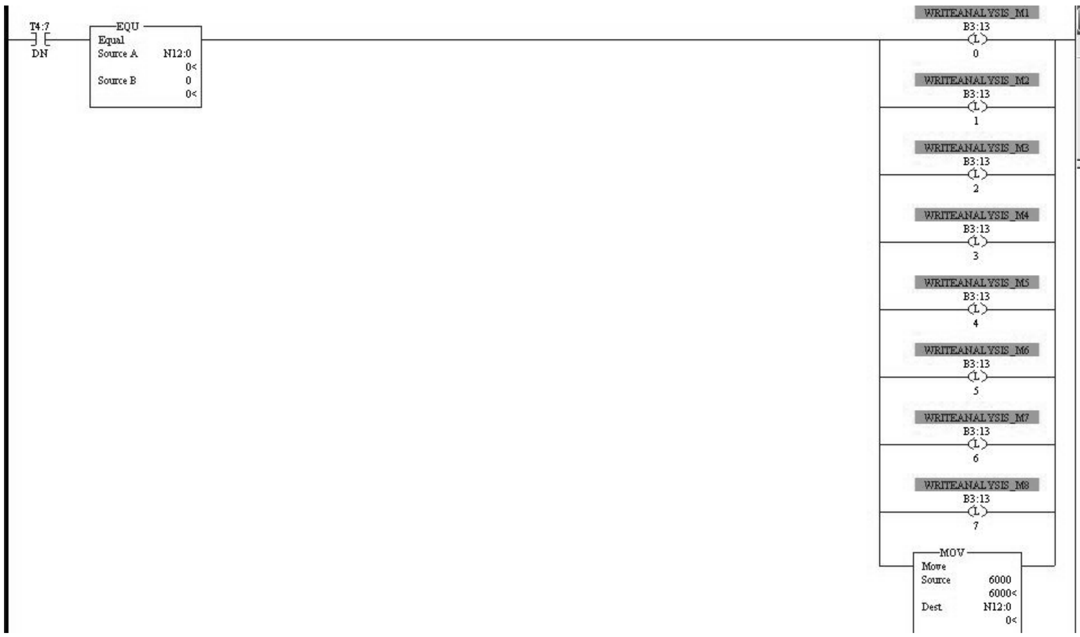
Meter	Data File
1	N40
2	N41
3	N42
4	N43
5	N44
6	N45
7	N46
8	N47

The module uses the scaled integer format where 10000 = 100%. For example, in order to update the molar concentrations for C1 and N2 with a value of 50% (meter 3) use the following registers:

N42:0 = 5000

N42:1 = 5000

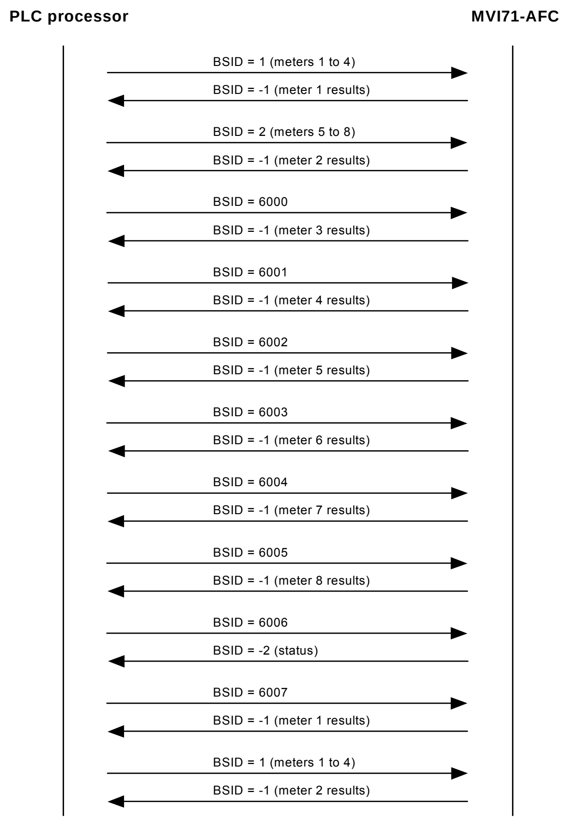
Step 2: Add the following logic to routine LAD 4 (BLK_SELECT):



The ladder logic will automatically generate blocks 6000 to 6007 to send the molar analysis data for all meter channels. Some minor modifications may be required depending on each application (for example if some of the meters do not use chromatograph data.

The register N12:0 will be automatically reset to 0 after all blocks are generated.

The following illustration shows an example of a typical backplane communication for this example. Note that the ladder logic still periodically sends the blocks 1 and 2:



11.2.2 Modbus Pass-Thru

Start Block Synchronization ID: 3000

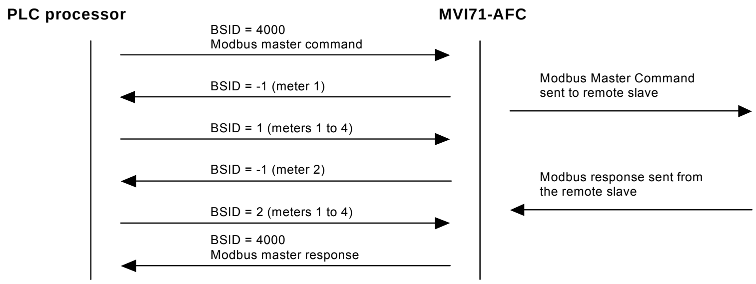
Ladder Routine: LAD 15

Function Block: 6

Overview

The module initially flags a "Modbus Pass-Thru Command Pending" flag once the module receives a Modbus write command (Modbus functions 15 or 16) having the destination address in the Virtual Slave Pass-Thru area. This flag is transferred to the PLC through a status block (BSID = –2).

The ladder logic will automatically send a Modbus Pass-Thru block to the module in order to request the data contained in the Modbus write command. The module will reply with a Modbus Pass-Thru response with the requested data.



Note: Several additional BTR/BTW cycles may occur between sending the BSID 3000 BTW and receiving the BSID BTR.

The ladder logic already implements the logic that sends the Modbus Pass-Thru request if the module has a pending Modbus Pass-Thru data as follows (LAD 4 routine):

Configuration

In order to use the Modbus Pass-Thru, you have to configure the Pass-Thru areas (word and bit) in the Virtual Slave using the AFC Manager software. Refer to the AFC Manager User Manual for further detail about the Pass-Thru configuration. You must also configure a non-zero value for the Virtual Slave address in order to enable the Virtual Slave.

In some applications it may be required to swap the bytes before the module sends the block to the PLC processor. In this case the ladder logic should set bit N80:0/0 to select the swap word mode.

Block Result

The Modbus Pass-Thru response updates the following bits:

Bit	Description
N80:10/1	0 = word write command (Modbus function 16)
	1 = bit write command (Modbus function 15)
N80:10/2	0 = no overflow
	1 = overflow (number of words greater than 58)

The Modbus Pass-Thru data will be transferred to data file N81.

11.2.3 Modbus Master

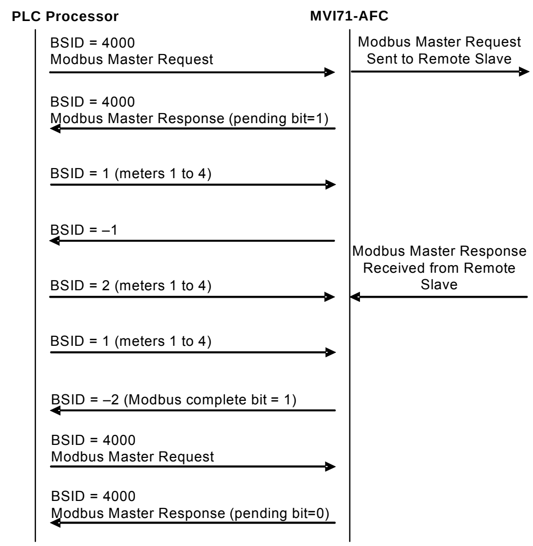
Start Block Synchronization ID: 4000

Ladder Routine: LAD 14

Function Block: 5

Overview

The ladder logic may generate a Modbus command to be sent to a remote slave connected to PORT 3. The module supports Modbus functions 1, 2, 3, 4, 15 and 16. The following is an example of typical backplane communication with the Modbus master function:



The previous diagram shows a typical backplane communication between the processor and the module. The processor initially requests the Modbus master transaction from the module. The module places the request in its internal queue and eventually sends a Modbus master response to the processor with pending bit = TRUE. The module eventually sends the Modbus command to the remote slave. After it receives the response it will inform the processor by setting the Modbus Master Complete bit as TRUE in the status block (ID = –2). The ladder logic should then send the Modbus master request one more time to actually read the Modbus response result from the module. The module responds with the Modbus master response block (same block ID as the request) where pending bit = FALSE. Therefore, the ladder should use this information (pending bit = TRUE or FALSE) to decide when it should read the actual response data from the block.

Note: This diagram is only a simplified version of the actual communication. In reality, the slave could take more than one scan to return the module response.

Configuration

You must configure the PORT3 for Modbus master operation using the AFC Manager. Refer to the FAC Manager User Manual for more information about this topic.

You must refer to data file N70 to configure the Modbus master command. The following registers must be configured:

Register	Description	Values
N70:0/0	Register Type	0 = Holding Register 1 = Input Register
N70:0/1	Modbus Function Type	0 = Read 1 = Write
N70:0/2	Data Item Size = Bit	0 = Bit size not selected 1 = Bit size selected
N70:0/3	Data Item Size = Word	0 = Word size not selected 1 = Word size selected
N70:0/4	Data Item Size = Long	0 = Long size not selected 1 = Long size selected
N70:0/5	Data Item Size = Long Remote	0 = Long Remote size not selected 1 = Long Remote selected
N70:0/6	Byte Swap	0 = Byte swap not selected 1 = Byte swap selected
N70:0/7	Word Swap	0 = Word swap not selected 1 = Word swap selected
N70:1	Slave address	1 to 247
N70:2	Register address	1 to 65535
N70:3	Register count	1 to 58 words of data

Block Result

The module response will contain the following information:

Register	Description
N70:5	Error Code

The ladder logic should monitor this address to troubleshoot possible communication problems.

11.2.4 Arbitrary Modbus Fetch

Start Block Synchronization ID: 5000

Ladder Routine: LAD 16

Function Block: 8

Overview

This function block allows the PLC processor to read registers from the Primary Modbus Slave database.

Configuration

The ladder logic must set the register type to be used in the block through the following register:

Register	**Description**
N56:0	Register Type 0 = Holding Register 1 = Input Register

Enter the addresses of the registers that will be returned by the module using the following registers:

Register	**Description**
N55:0	Register 1 Address
N55:1	Register 2 Address
N55:2	Register 3 Address
...	....
...	...
...	...
N55:59	Register 60 Address

Block Result

The module response will contain the following information:

Register	**Description**
N55:60	Register 1 Value
N55:61	Register 2 Value
N55:62	Register 3 Value
...	....
...	...
...	...
N55:119	Register 60 Value

Note: A register address of 0 causes no access to the Modbus table and 0 is returned. To explicitly fetch the contents of register 0, use a value of -0.

11.2.5 Double Meter Analysis & Signals

Starting Block Synchronization ID: 6000

Ladder Routine: LAD 11

Function Block: 18

Overview

This block is used on two situations:

1 To dynamically update the meter molar analysis data for applications that involve chromatograph devices.
2 To send meter signals (reset accumulators or write meter archives).

Configuration

For molar analysis applications:

Using the AFC Manager you should set the "selected" bits as checked for all molar elements. Refer to the AFC Manager User Manual for more information about this topic.

Create logic that latches the bits below every time the command block is requested (same rung where N12:10 receives a value of 6000):

Bit	Description
B3:13/0	Write molar analysis for meter 1
B3:13/1	Write molar analysis for meter 2
B3:13/2	Write molar analysis for meter 3
B3:13/3	Write molar analysis for meter 4
B3:13/4	Write molar analysis for meter 5
B3:13/5	Write molar analysis for meter 6
B3:13/6	Write molar analysis for meter 7
B3:13/7	Write molar analysis for meter 8

These bits are cleared after the block has been processed.

For version 2.05.000 or later, you can also select for which stream the molar analysis data will be copied to through the following registers:

Note: set a value of 0 also while sending meter signals. The meter signals will not works while the stream number selection for analysis has a value different than 0.

Files	Description
N40:30	Stream number (1 to 4) for molar analysis data for meter 1 (select 0 for active stream)
N41:30	Stream number (1 to 4) for molar analysis data for meter 2 (select 0 for active stream)

Files	Description
N42:30	Stream number (1 to 4) for molar analysis data for meter 3 (select 0 for active stream)
N43:30	Stream number (1 to 4) for molar analysis data for meter 4 (select 0 for active stream)
N44:30	Stream number (1 to 4) for molar analysis data for meter 5 (select 0 for active stream)
N45:30	Stream number (1 to 4) for molar analysis data for meter 6 (select 0 for active stream)
N46:30	Stream number (1 to 4) for molar analysis data for meter 7 (select 0 for active stream)
N47:30	Stream number (1 to 4) for molar analysis data for meter 8 (select 0 for active stream)

The molar analysis data should be copied starting at the following addresses (24 registers):

Bit	Description
N40:0	Molar analysis data for meter 1
N41:0	Molar analysis data for meter 2
N42:0	Molar analysis data for meter 3
N43:0	Molar analysis data for meter 4
N44:0	Molar analysis data for meter 5
N45:0	Molar analysis data for meter 6
N46:0	Molar analysis data for meter 7
N47:0	Molar analysis data for meter 8

For example, the meter 1 analysis data should be copied as follows:

Register	Molar Element
N40:0	C1
N40:1	N2
N40:2	CO2
N40:3	C2
N40:4	C3
N40:5	H2O
N40:6	H2S
N40:7	H2
N40:8	CO
N40:9	O2
N40:10	IC4
N40:11	C4
N40:12	IC5
N40:13	C5
N40:14	C6
N40:15	C7
N40:16	C8
N40:17	C9
N40:18	C10
N40:19	He
N40:20	Ar
N40:21	C5 (neo-Pentane)

Register	Molar Element
N40:22	Ux
N40:23	Uy

The values should be entered using scaled integer format where 10000 = 100%. For example: 8713 = 87.13%.

For meter signal applications the following data files are used:

Register	Description
B3:20	Meter 1 Signal Bits
B3:21	Meter 2 Signal Bits
B3:22	Meter 3 Signal Bits
B3:23	Meter 4 Signal Bits
B3:24	Meter 5 Signal Bits
B3:25	Meter 6 Signal Bits
B3:26	Meter 7 Signal Bits
B3:27	Meter 8 Signal Bits

The following table shows the structure for meter 1 (B3:20). The same structure is also used for the remainder meters:

Bit	Description
B3:20/0	Select Stream 1 (see Note)
B3:20/1	Select Stream 2 (see Note)
B3:20/2	Select Stream 3 (see Note)
B3:20/3	Select Stream 4 (see Note)
B3:20/4	Reset Accumulator 1
B3:20/5	Reset Accumulator 2
B3:20/6	Reset Accumulator 3
B3:20/7	Reset Accumulator 4
B3:20/8	Write Daily Archive
B3:20/9	Write Hourly Archive
B3:20/10	Reserved
B3:20/11	Reserved
B3:20/12	Reserved
B3:20/13	Reserved
B3:20/14	Reserved
B3:20/15	Reserved

Note: The Select Stream feature is only available for firmware 2.05 or later.

So ladder logic must be added to set the appropriate bits after this block is requested.

Important: The module continuously scans the transition from 0 to 1 for the signal bits. So the sample ladder logic sends a second block (after the request) in order to reset these bits back to 0. Otherwise the next request would be ignored by the module.

Block Result

There is no block response for this block request.

11.2.6 Meter Archive Fetch

Starting Block Synchronization ID: 7000

Ladder Routine: LAD 13

Function Block: 3

Overview

This block retrieves any archive (daily or hourly) from the module. The sample ladder logic automatically generates blocks (7000 to 7007) to read the archive contents for all meters.

Configuration

Configure the following data files:

Register	Description
N68:0	Archive Period 0 = Daily 1 = Hourly
N68:1	Archive Age 0 = current 1 = latest ....

Block Result

The meter archive data will be copied to the following data files:

Data File	Description
N60	Meter 1 Archive
N61	Meter 2 Archive
N62	Meter 3 Archive
N63	Meter 4 Archive
N64	Meter 5 Archive
N65	Meter 6 Archive
N66	Meter 7 Archive
N67	Meter 8 Archive

The default archive structure is discussed on the Backplane Communications section. The archive data structure will depend on the meter type and product group.

Note: The opening and closing timestamps for each archive uses a highly compressed format in order to represent the time and date information with only two words. The sample ladder logic contains extra-logic for meter 1 in order to extract the date and time information from the archives. The following registers are used:

Register	Description
N60:40	Opening Timestamp – Year
N60:41	Opening Timestamp – Month
N60:42	Opening Timestamp – Day
N60:43	Opening Timestamp – Hour
N60:44	Opening Timestamp – Minute
N60:45	Opening Timestamp – Second
N60:50	Closing Timestamp – Year
N60:51	Closing Timestamp – Month
N60:52	Closing Timestamp – Day
N60:53	Closing Timestamp – Hour
N60:54	Closing Timestamp – Minute
N60:55	Closing Timestamp – Second

If necessary you may easily extend the same logic to the other meter channels.

11.2.7 Modbus Gateway

Starting Block Synchronization ID: 8000

Ladder Routine: LAD 12

Function Block: 4

Overview

This block performs read or write operations to one of the Modbus slaves' databases. Up to 60 words of data can be transferred at each time. The sample ladder logic automatically sends five Modbus gateway requests to the module (BSIDs 8000 to 8004).

Configuration

The Modbus gateway requests define a starting register and the number of registers to be read or written, so the registers must be allotted in a contiguous order. For this reason, it is typically easiest to remap the registers from the Primary to the Virtual slave (through AFC Manager) in order to use this function block, because during the remap procedure you can configure the most convenient order. Refer to the AFC Manager User Manual for more information about this topic.

The following registers are used for each Modbus gateway block:

Modbus Gateway Block	BSID	Registers
1	8000	N50:0 to N50:4
2	8001	N50:5 to N50:9
3	8002	N50:10 to N50:14
4	8003	N50:15 to N50:19
5	8004	N50:20 to N50:24

The first 3 words for each Modbus gateway block are used for configuration purposes for Modbus Gateway Block 1 as follows:

Register	Description	Values
N50:0/0	Slave Type	0 = Primary Slave 1 = Virtual Slave
N50:0/1	Register Type	0 = Holding Register 1 = Input Register
N50:0/2	Function	0 = Read 1 = Write
N50:0/3	Enable Modbus gateway block	0 = Disable 1 = Enable
N50:1	Register Address	Starting address
N50:2	Register Count	Number of words to be transferred (1 to 60)

The fourth word is reserved and the fifth word is used for status information (refer to the following section):

For write functions the logic should copy the values to be written to the following ranges of addresses:

Start Register	End Register	Description
N51:0	N51:59	Data to be written for Modbus gateway block 1
N51:60	N51:119	Data to be written for Modbus gateway block 2
N51:120	N51:179	Data to be written for Modbus gateway block 3
N51:180	N51:239	Data to be written for Modbus gateway block 4
N51:240	N51:299	Data to be written for Modbus gateway block 5

Block Result

The status code for the Modbus gateway transaction will be copied to the following registers:

Start Register	Description
N50:4	Code transaction for Modbus gateway block 1
N50:9	Code transaction for Modbus gateway block 2
N50:14	Code transaction for Modbus gateway block 3
N50:19	Code transaction for Modbus gateway block 4
N50:24	Code transaction for Modbus gateway block 5

The following table shows the structure for block 1 status word. The same structure is used for the other blocks:

Start Register	Description
N50:4/0	Illegal Function
N50:4/1	Illegal Address
N50:4/2	Illegal Data
N50:4/3	Slave Fail (out of memory)
N50:4/4 to N50:4/7	Reserved
N50:4/8	Data Too Long

If the block is configured for a read operation the following blocks will be used:

Start Register	End Register	Description
N51:0	N51:59	Data to be read from Modbus gateway block 1
N51:60	N51:119	Data to be read from Modbus gateway block 2
N51:120	N51:179	Data to be read from Modbus gateway block 3
N51:180	N51:239	Data to be read from Modbus gateway block 4
N51:240	N51:299	Data to be read from Modbus gateway block 5

11.2.8 Enable/Disable Meters

Starting Block Synchronization ID: 9000

Ladder Routine: LAD 10

Function Block: 2

Overview

These blocks send enable or disable requests for all meter channels. The sample ladder logic automatically generates blocks 9000 to 9007 in order to send the requests for all meter channels. The meters should normally be enabled or disabled through AFC Manager

Configuration

The following bits must be toggled to command the enable/disable operations:

Bit Address	Description
B3:11/0	Enable Meter 1
B3:11/1	Enable Meter 2
B3:11/2	Enable Meter 3
B3:11/3	Enable Meter 4
B3:11/4	Enable Meter 5
B3:11/5	Enable Meter 6
B3:11/6	Enable Meter 7
B3:11/7	Enable Meter 8
B3:12/0	Disable Meter 1

Bit Address	Description
B3:12/1	Disable Meter 2
B3:12/2	Disable Meter 3
B3:12/3	Disable Meter 4
B3:12/4	Disable Meter 5
B3:12/5	Disable Meter 6
B3:12/6	Disable Meter 7
B3:12/7	Disable Meter 8

Note: Do not create logic to latch these bits. After the PLC receives the confirmation that the meters were in fact enabled or disabled, the logic will automatically reset the command bits.

Block Result

The module does not generate any response for this request block. The module will update the command bits based on the meter status information periodically received in the status block (BSID=–2)

11.2.9 Read Wallclock

Starting Block Synchronization ID: 9800

Ladder Routine: LAD 10

Function Block: 2

Overview

This block reads the current wallclock data from the module (date and time).

Configuration

There are no configuration procedures required for this request.

Block Result

The wallclock information read from the module is copied to the following registers:

Register	Description
N10:10	Year
N10:11	Month
N10:12	Day
N10:13	Hour
N10:14	Minute
N10:15	Seconds

11.2.10 Write Wallclock

Starting Block Synchronization ID: 9900

Ladder Routine: LAD 10

Function Block: 2

Overview

This block writes the wallclock information (date and time) from the PLC processor to the module. The ladder logic uses the PLC processor clock (starting at S:18) as the clock source.

Configuration

The wallclock information is copied from the PLC processor status area (S:18) to the following registers:

Register	Description
N10:0	Year
N10:1	Month
N10:2	Day
N10:3	Hour
N10:4	Minute
N10:5	Seconds

11.3 Status Blocks

The PLC periodically receives status blocks from the MVI71-AFC with a Block Synchronization ID of –2. If all meters are enabled the block status will be sent once every eight BTR transactions.

The sample ladder logic automatically updates several registers based on the information received from the status blocks. These registers are listed as follows:

11.3.1 Meter Enable Status

The status of each meter (enabled or disabled) is available in the following bits:

Bit Address	Description
B3:0/0	Meter 1 Status 0 = Disabled 1 = Enabled
B3:0/1	Meter 2 Status 0 = Disabled 1 = Enabled

Bit Address	Description
B3:0/2	Meter 3 Status 0 = Disabled 1 = Enabled
B3:0/3	Meter 4 Status 0 = Disabled 1 = Enabled
B3:0/4	Meter 5 Status 0 = Disabled 1 = Enabled
B3:0/5	Meter 6 Status 0 = Disabled 1 = Enabled
B3:0/6	Meter 7 Status 0 = Disabled 1 = Enabled
B3:0/7	Meter 8 Status 0 = Disabled 1 = Enabled

11.3.2 Meter Alarms

The following bits determine if each meter channel has an alarm:

Bit Address	Description
B3:1/0	Meter 1 Alarms (0 = No alarms , 1 = Meter has alarms)
B3:1/1	Meter 2 Alarms (0 = No alarms , 1 = Meter has alarms)
B3:1/2	Meter 3 Alarms (0 = No alarms , 1 = Meter has alarms)
B3:1/3	Meter 4 Alarms (0 = No alarms , 1 = Meter has alarms)
B3:1/4	Meter 5 Alarms (0 = No alarms , 1 = Meter has alarms)
B3:1/5	Meter 6 Alarms (0 = No alarms , 1 = Meter has alarms)
B3:1/6	Meter 7 Alarms (0 = No alarms , 1 = Meter has alarms)
B3:1/7	Meter 8 Alarms (0 = No alarms , 1 = Meter has alarms)

If the meter has an alarm, you may refer to the following addresses for the alarm code:

Register Address	Description
N20:21	Meter 1 alarm code
N21:21	Meter 2 alarm code
N22:21	Meter 3 alarm code
N23:21	Meter 4 alarm code
N24:21	Meter 5 alarm code
N25:21	Meter 6 alarm code
N26:21	Meter 7 alarm code

Register Address	Description
N27:21	Meter 8 alarm code

The alarm code is a bitmapped word with the following structure:

Bit	Description
0	Input out of range: temperature
1	Input out of range: pressure
2	Input out of range: differential pressure
3	Input out of range: flowing density
4	Input out of range: water content
5	Differential Pressure Low
6	Reserved
7	Accumulation overflow
8	Orifice characterization error
9	Analysis total zero
10	Analysis total not normalized
11	Compressibility calculation error
12	API calculation error: density correction
13	API calculation error: Ctl
14	API calculation error: vapor pressure
15	API calculation error: Cpl

11.3.3 Meter Type

The following bits indicate the configured meter type for the meter channel. The meter type has to be configured through AFC Manager. This information is important to the ladder logic because the meter process variables will depend on the meter type and product group.

Bit Address	Description
B3:2/0	Meter 1 type (0 = orifice or differential , 1 = pulse or linear)
B3:2/1	Meter 2 type (0 = orifice or differential , 1 = pulse or linear)
B3:2/2	Meter 3 type (0 = orifice or differential , 1 = pulse or linear)
B3:2/3	Meter 4 type (0 = orifice or differential , 1 = pulse or linear)
B3:2/4	Meter 5 type (0 = orifice or differential , 1 = pulse or linear)
B3:2/5	Meter 6 type (0 = orifice or differential , 1 = pulse or linear)
B3:2/6	Meter 7 type (0 = orifice or differential , 1 = pulse or linear)
B3:2/7	Meter 8 type (0 = orifice or differential , 1 = pulse or linear)

11.3.4 Meter Product

The following bits indicate the configured product group for the meter channel. The product group has to be configured through AFC Manager. This information is important to the ladder logic because the meter process variables will depend on the meter type and product group.

Bit Address	Description
B3:3/0	Meter 1 product (0 = gas , 1 = liquid)
B3:3/1	Meter 2 product (0 = gas , 1 = liquid)
B3:3/2	Meter 3 product (0 = gas , 1 = liquid)
B3:3/3	Meter 4 product (0 = gas , 1 = liquid)
B3:3/4	Meter 5 product (0 = gas , 1 = liquid)
B3:3/5	Meter 6 product (0 = gas , 1 = liquid)
B3:3/6	Meter 7 product (0 = gas , 1 = liquid)
B3:3/7	Meter 8 product (0 = gas , 1 = liquid)

11.3.5 Stream Settings

Note: This functionality is only available for MVI71-AFC firmware version 2.05.000 or later.

The following registers store the current active stream (1 to 4)

Bit Address	Description
N20:40	Meter 1 Active Stream (1 to 4)
N21:40	Meter 2 Active Stream (1 to 4)
N22:40	Meter 3 Active Stream (1 to 4)
N23:40	Meter 4 Active Stream (1 to 4)
N24:40	Meter 5 Active Stream (1 to 4)
N25:40	Meter 6 Active Stream (1 to 4)
N26:40	Meter 7 Active Stream (1 to 4)
N27:40	Meter 8 Active Stream (1 to 4)

The following bitmap registers informs if each stream is enabled.

Bit Address	Description
N20:41	Meter 1 Enabled Streams
N21:41	Meter 2 Enabled Streams
N22:41	Meter 3 Enabled Streams
N23:41	Meter 4 Enabled Streams
N24:41	Meter 5 Enabled Streams
N25:41	Meter 6 Enabled Streams
N26:41	Meter 7 Enabled Streams
N27:41	Meter 8 Enabled Streams

12 Troubleshooting

In This Chapter

MVI71-AFC modules have the following communication connections on the module:

- Two RS-232/422/485 Application ports
- One RS-232 Configuration/Debug port

This section provides information that will assist you during the module operation on troubleshooting issues. This section describes the following topics:

- LEDs
- Meter Alarms
- Events
- Audit Scan

12.1 User LEDs

There are two "user" LEDs used to indicate overall module status; App Status and BP Act (with P1, P2, or P3).

12.1.1 App Status LED

State	Description
Rapid Blinking	The processor is offline (probably in program mode).
Steady On	Some meter is indicating an alarm or no meters are enabled.
Off	The module is functioning properly.

12.1.2 BP Act and P1, P2, or P3

These LEDs indicate current Modbus traffic on any port.

State	Description
On	A Modbus command for the module is recognized. On Port 3, this LED may also indicate that a Modbus Master command was sent.
Off	No Activity

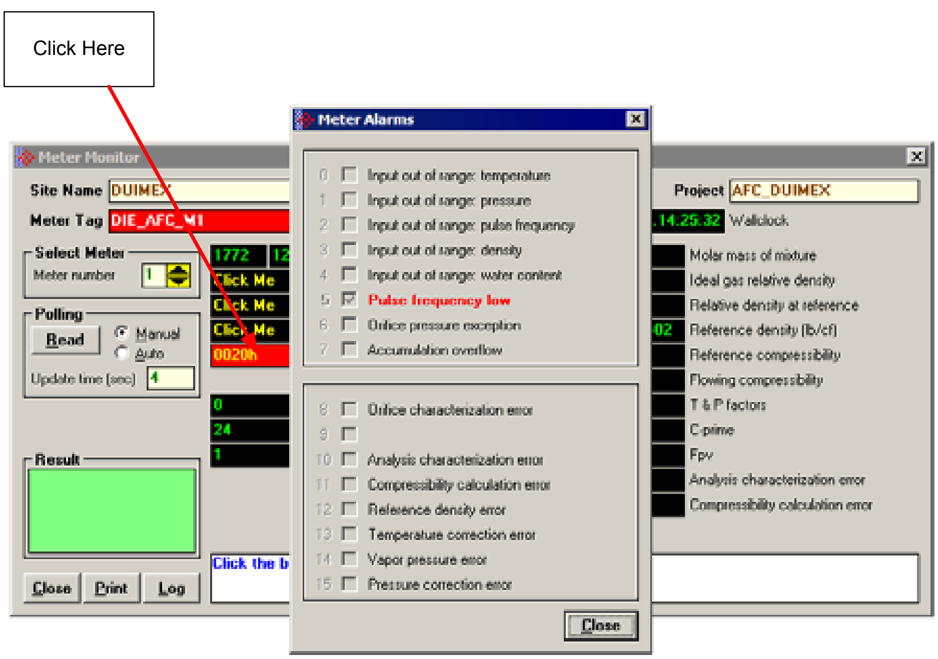
12.2 BBRAM LEDs

The BBRAM (Battery Backed RAM) LEDs inform you about the condition of the BBRAM hardware used for data storage. The following table lists the possible situations that might occur during normal operation.

OK (Green)	ERR (Red)	Description
ON	ON	The module is in a Cold Start condition that typically occurs when you power up the module for the first time. After at least one meter is enabled and the processor is in RUN mode the module starts operating.
ON	OFF	Normal Operation
Blinking	OFF	This condition is warning that a checksum flag was raised after a power cycle. If this alarm issue occurs, refer to the AFC Manager (On-line Monitor / Checksum Alarms) in order to determine the data section in which the alarm issue has occurred. After verifying that the checksum error has not affected the referred memory area you may clear the checksum alarm using the same AFC Manager interface. After the alarm is cleared the OK LED will be ON

12.3 Meter Alarms

If the module is generating unexpected data, you should verify if the meter has any alarms. Some alarms may be caused by an issue that could potentially affect the calculation results. Each archive also keeps track of the alarms that have occurred during the period (refer to the Archive section). The Meter Monitor dialog box allows you to monitor the meter alarms.



The above image shows the Meter Alarms bitmap, which gives you a quick overview of active alarms. Associated with many of these bits are Alarm Code registers which supply specific reasons for the alarms, most of which appear in the lower right corner of the main Meter Monitor window. For complete information, including which Code registers are associated with which alarm bits, use the Modbus Dictionary feature of AFC Manager.

The possible alarms are listed in the following table. Of the Alarm Codes listed, the values that can actually appear depend on both the selected Product Group and the firmware version.

Alarm Message	Description	Solution
Accumulation Overflow	The module ignores an accumulator increment of less than zero or greater than 1.000.000.000 occurring in a single meter scan.	Check your meter configuration to verify if your project is generating reasonable values.
Analysis Total Not Normalized (v ≤ 2.04)	Absolute difference between analysis total and 1.0000 (100%) is greater than the error tolerance	Make sure that the sum of all molar concentrations is within the error tolerance of 1.0000 (100%).
Analysis Total Zero (v ≤ 2.04)	The molar concentration sum is zero.	Make sure that the sum of all molar concentrations is within the error tolerance of 1.0000 (100%).
Analysis Characterization error (v ≥ 2.05)	Absolute difference between analysis total and 1.0000 (100%) is greater than the error tolerance, OR the molar concentration sum is zero.	Make sure that the sum of all molar concentrations is within the error tolerance of 1.0000 (100%). Alarm Code values: 0 = No alarm 1 = Analysis total not normalized 2 = Analysis total zero
Compressibility calculation error	The compressibility calculation resulted in error based on the input values and configuration parameters used.	Check the input values and meter configuration parameters. Alarm Code values: 0 = No alarm 1 = Density exceeded reasonable maximum (warning only) 2 = Pressure maximum found 3 = Non-convergence of procedure "braket" 4 = Non-convergence of procedure "ddetail"
Differential Pressure Low	The differential pressure value transferred to the module is below the DP Alarm Threshold parameter configured in the Meter Configuration.	Check the input differential pressure value transferred to the module. If the value is correct, change the DP Alarm Threshold parameter for your project.
Flow Rate Low	The flow rate value transferred to the module is below the FR Alarm Threshold parameter configured in the Meter Configuration.	Check the input flow rate value transferred to the module. If the value is correct, change the FR Alarm Threshold parameter for your project.

Alarm Message	Description	Solution
Pulse Frequency Low	The pulse frequency value transferred to the module is below the Frequency Alarm Threshold parameter configured in the Meter Configuration.	Check the input pulse frequency value transferred to the module. If the value is correct, change the Frequency Alarm Threshold parameter for your project.
High Water error	Set if input water content is greater than 99% (less than 1% oil). For this condition, the emulsion is deemed to be all water. Both volume and mass fractions are set to zero. The module does not perform any density correction calculation, so the "default standard density" value is assumed. This alarm is applied for emulsion liquids only.	Check that the value of process input "Water %" is reasonable Alarm Code values: 0 = No alarm 1 = Emulsion is more than 99% water
Input Out of Range	The input value is not within the range specified in the meter configuration window. Applies to temperature, pressure, differential pressure, flowing density, water content, pulse frequency (v ≥ 2.05).	Check that the input variable's ranges (**Meter Configuration / Process Input** button) and the process input itself have reasonable values.
Orifice Characterization error	The orifice parameters (**Meter Configuration / Orifice** button) are invalid.	Check the orifice and meter parameters. The following conditions should be true: ▪ Orifice diameter > 0 ▪ Tube diameter > 0 ▪ Orifice diameter < Tube diameter The beta ratio between the orifice and tube diameters should follow the AGA Standard. Alarm Code values: ▪ 0 = No alarm ▪ 1 = Orifice diameter non-positive ▪ 2 = Orifice not narrower than pipe ▪ 3 = Beta ratio less than 0.10 (adjusted by tolerance) ▪ 4 = Beta ratio greater than 0.75 (adjusted by tolerance) ▪ 5 = Pipe diameter less than 2.0 inches (adjusted by tolerance) ▪ 6 = Orifice diameter less than 0.45 inches (adjusted by tolerance) The "tolerance", fixed by the AFC firmware, allows the AGA limits to be exceeded by up to 75% towards the physical limit. For example, while AGA restricts pipe diameter to 2.0 inches or greater, the AFC allows it to be as small as 0.5 inch.

Alarm Message	Description	Solution
Orifice Pressure Exception	Configuration and process input for an Orifice Meter are such that the effective downstream pressure is less than vacuum. For calculation, upstream pressure is raised by the amount necessary to raise absolute downstream pressure to zero.	Check the process inputs for Gauge Pressure and Differential Pressure, and the configured Barometric Pressure and Static Pressure Tap Location. Also check any performed vapor pressure calculations to ensure that all are reasonable.
Pressure correction error	The pressure correction calculation resulted in an error according to the standard.	Alarm Code values: 0 = No alarm 1 = Density outside range of API Chapter 11.2 2 = Temperature above near critical limit 3 = Temperature outside range of API Chapter 11.2.1 4 = Temperature outside range of API Chapter 11.2.2 5 = Non-convergence of Cpl-density iteration
Reference density error	The density correction calculation resulted in an error according to the standard.	Alarm Code values:: 0 = No alarm 1 = Low density (NGLs), input outside API range 2 = High density (crudes & refined), input outside API range 3 = Non-convergence 4 = Zero VCF 5 = Temperature above critical point 6 = Input density outside reference fluid adjusted range 7 = Corrected density out of range 8 = Standard density input outside API range 9 = Alpha input outside API range Also check the input values and calculation parameters for your project.
Temperature Correction error	The temperature correction calculation OR the water temperature correction calculation resulted in an error according to the standard.	Alarm Code values: 0 = No alarm 1 = Low density (NGLs), input outside API range 2 = High density (crudes & refined), input outside API range 5 = Temperature above critical point 9 = Alpha input outside API range Also see the Alarm Code for Water Temperature Correction error.

Alarm Message	Description	Solution
Vapor pressure error	The vapor pressure calculation resulted in an error according to the standard.	Alarm Code values: 0 = No alarm 1 = Expected vapor pressure above range of TP-15 (stream's "Default Vapor Pressure" is substituted) 2 = Vapor pressure > measured static absolute pressure (vapor pressure assumed to equal static pressure) 3 = Both 1 and 2
Water Temperature error (Alarm Code only)	The water temperature correction calculation resulted in an error according to the standard. This Alarm Code sets the "Temperature Correction error" alarm bit.	Alarm Code values: 0 = No alarm 1 = Temperature < 0°C (32°F) or > 138°C (280°F)

12.4 Checksum alarms

A checksum alarm indicates a checksum verification failure during power-up. Non-volatile information is kept in battery-backed RAM. It is partitioned into several blocks, each of which contains a checksum, and when the information is changed the checksum is updated also. During power-up, the checksum is verified, and upon failure the alarm bit is latched and the checksum corrected.

The alarm bit remains latched, even through subsequent power cycles, until it is explicitly cleared from an external source such as the AFC Manager. Refer to the AFC Manager User Manual for more information about this feature.

12.5 Events

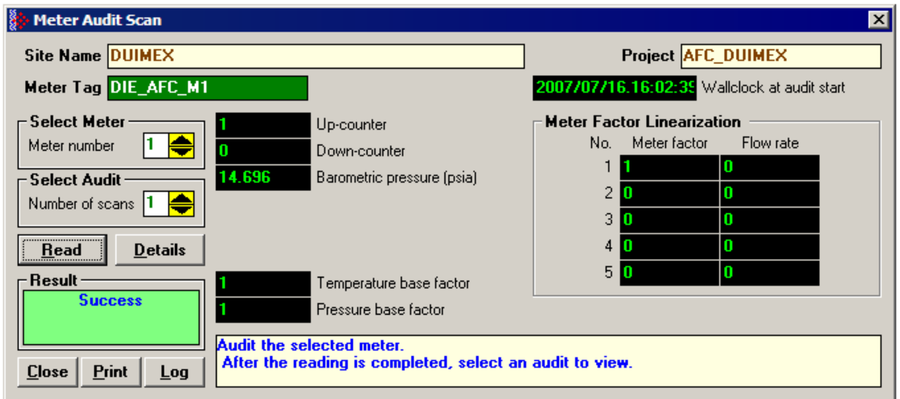
The module records up to 1999 events that have occurred during the module operation.

Important Note: Events are occurrences that may affect the results calculated by the module. This is an essential tool for troubleshooting the module.

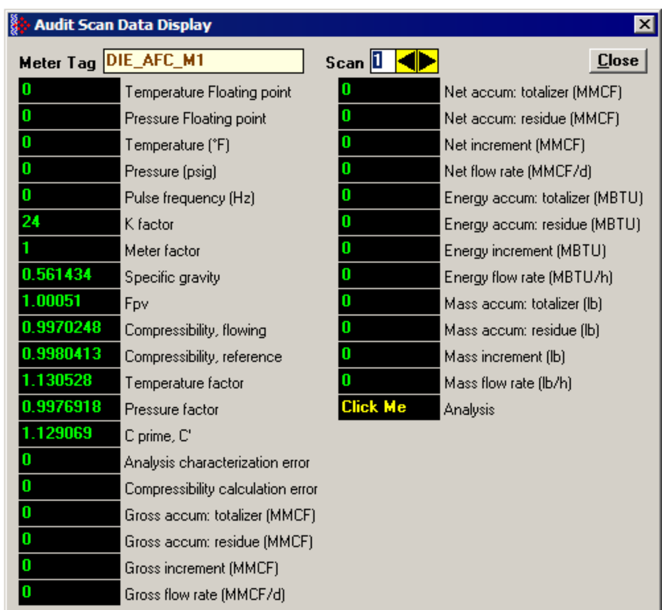
Refer to the Events section for more information about event monitor.

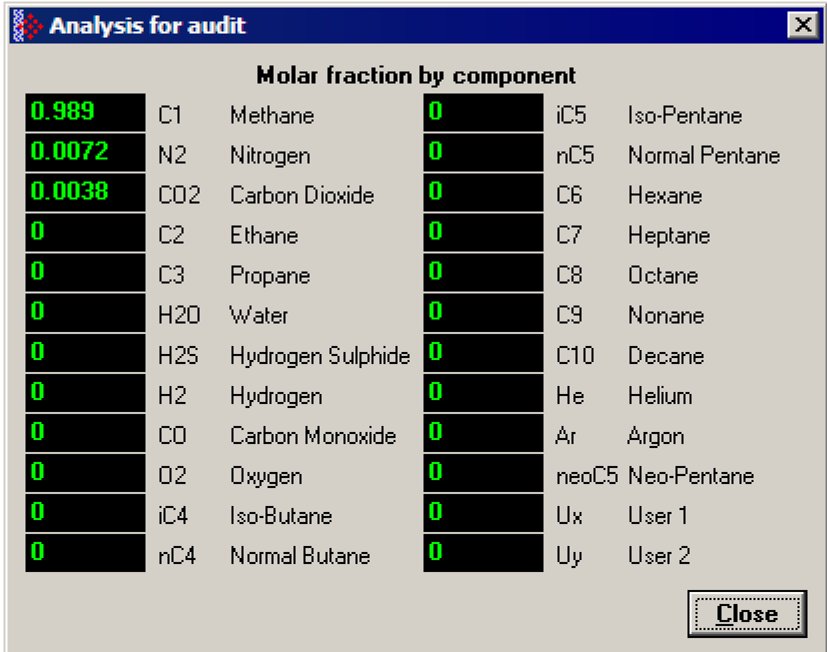
12.6 Audit Scan

An Audit Scan captures a "snapshot" of input values, intermediate calculated values, and output results for each of a short series of calculation scans for a single meter. This allows an auditor to rigorously verify the calculations performed by the AFC on live in-service production meters. The module supports eight consecutive audit scans at a time.



1 Select the Meter Number for the audit
2 Select the number of scans for the audit
3 Click the Read Button to begin the audit
4 Look at the operation result. Success = audit has been successfully completed
5 When the Audit Scan is complete, click the Details Button to view the calculation and the input variables.





The following shows an example of an audit scan file report generated by the AFC Manager for 2 scans:

```
AFC-56(16) Audit                                 Date: 16-09-2002 16:18:07
  Site Name: MVI Flow Station
  Project: AFC
______________________________________________________________________

  Meter 1:
   Tag                                             M01
   Wallclock                                       0000/00/00.00:00:00
   Barometric pressurekPaa                         101,325
   Viscosity                                       0,010268
   Orifice/pipe geometric parameters
                       Orifice plate               Meter tube
   Temperature         68                          68
   Diameter            1                           2
   Coefficient         9,25E-06                    0,0000062
______________________________________________________________________
  Scan                                            1
  Temperature (Floating point)                    15
  Pressure (Floating point)                       1000
  Dif. pressure (Floating point)                  22
  Temperature (°F)                                15
  Pressure (psig)                                 1000
  Dif. pressure (hw)                              22
  Scan period (second)                            0,48
  Specific gravity                                0,7404104
  Fpv                                             0
  Compressibility flowing                         0,9051347
  Compressibility reference                       0,9989105
  Diameter at T tube                              1,999343
  Diameter at T orifice                           0,9995098
```

Velocity of approach factor ev	1,032773
Pressure extension xt	149,4683
Coefficient of discharge cd	0,6042569
Expansion factor y	0,9997441
Composition factor	0,2728558
Mass flow Qh	2280,571
Orifice characterization error	0
Analysis characterization error	0
AGA8 calculation error	0
Gross accu.- totalizer (x f3)	3408
Gross accu. - residue (x f3)	0,2047686
Gross increment (x f3)	6,442598E-02
Gross flow rate (x f3/h)	483,1948
Net accu. - totalizer (x f3)	390113
Net accu. - residue (x f3)	0,8464546
Net increment (x f3)	5,3664
Net flow rate (x f3/h)	40248
Mass accu. - totalizer (x lb)	22094
Mass accu. - residue (x lb)	0,5677222
Mass increment (x lb)	0,3040761
Mass flow rate (x lb/h)	2280,571
Analysis components	
C1 methane	0,55
N2 nitrogen	0,45
CO2 carbon dioxide	0
C2 ethane	0
C3 propane	0
H2O water	0
H2S hydrogen sulphide	0
H2 hydrogen	0
CO carbon monoxide	0
O2 oxygen	0
iC4 iso-butane	0
nC4 normal butane	0
iC5 iso-pentane	0
nC5 normal pentane	0
C6 hexane	0
C7 heptane	0
C8 octane	0
C9 nonane	0
C10 decane	0
He helium	0
Ar argon	0
neoC5 neopentane	0
Ux user1	0
Uy user2	0

AFC-56(16) Audit Date: 16-09–2002 16:18:08
Site Name: MVI Flow Station
Project: AFC

Meter 1:

Tag	M01
Wallclock	0000/00/00.00:00:00
Barometric pressurekPaa	101,325

```
  Viscosity                                         0,010268
  Orifice/pipe geometric parameters
                      Orifice plate                 Meter tube
  Temperature         68                            68
  Diameter            1                             2
  Coefficient         9,25E-06                      0,0000062
________________________________________________________________________
  Scan                                              2
  Temperature (Floating point)                      15
  Pressure (Floating point)                         1000
  Dif. pressure (Floating point)                    22
  Temperature (°F)                                  15
  Pressure (psig)                                   1000
  Dif. pressure (hw)                                22
  Scan period (second)                              0,495
  Specific gravity                                  0,7404104
  Fpv                                               0
  Compressibility flowing                           0,9051347
  Compressibility reference                         0,9989105
  Diameter at T tube                                1,999343
  Diameter at T orifice                             0,9995098
  Velocity of approach factor ev                    1,032773
  Pressure extension xt                             149,4683
  Coefficient of discharge cd                       0,6042569
  Expansion factor y                                0,9997441
  Composition factor                                0,2728558
  Mass flow Qh                                      2280,571
  Orifice characterization error                    0
  Analysis characterization error                   0
  AGA8 calculation errore                           0
  Gross accu.- totalizer (x f3)                     3408
  Gross accu. - residue (x f3)                      0,2712079
  Gross increment (x f3)                            6,643929E-02
  Gross flow rate (x f3/h)                          483,1948
  Net accu. - totalizer (x f3)                      390119
  Net accu. - residue (x f3)                        0,3805552
  Net increment (x f3)                              5,534101
  Net flow rate (x f3/h)                            40248
  Mass accu. - totalizer (x lb)                     22094
  Mass accu. - residue (x lb)                       0,8813007
  Mass increment (x lb)                             0,3135785
  Mass flow rate (x lb/h)                           2280,571
Analysis components
  C1 methane                                        0
  N2 nitrogen                                       0
  CO2 carbon dioxide                                0
  C2 ethane                                         0
  C3 propane                                        0
  H2O water                                         0
  H2S hydrogen sulphide                             0
  H2 hydrogen                                       0
  CO carbon monoxide                                0
  O2 oxygen                                         0
  iC4 iso-butane                                    0
  nC4 normal butane                                 0
  iC5 iso-pentane                                   0
  nC5 normal pentane                                0
```

```
C6 hexane                                         0
C7 heptane                                        0
C8 octane                                         0
C9 nonane                                         0
C10 decane                                        0
He helium                                         0
Ar argon                                          0
neoC5 neopentane                                  0
Ux user1                                          0
Uy user2                                          0
```

13 Reference

In This Chapter

13.1 General Specifications

- Process I/O: analog inputs (pressure, temperature, differential pressure density) from analog modules and pulse inputs from pulse/frequency input modules in rack
- Number of meter channels: 8 meters: differential (AGA3 or ISO5167) or linear (AGA7) Gas; (MPMS Ch 12.2) Liquid.

Calculation Methods

- AGA3 (1992)
- AGA7
- AGA8 (1992) Detail Characterization Method
- API MPMS Ch 21.1, 21.2
- API Tables (API MPMS Ch 11.1) 23/53 and 24/54 for Hydrocarbon Liquids
- GPA TP-25 for Hydrocarbon Liquids (Tables 23E/24E)
- API MPMS Ch 11.2
- GPA TP-15 for Vapor Pressure Correlation
- Energy (heating value) for gases according to AGA 8 Appendix C-4
- API MPMS Ch 20.1
- ISO 5167

Supports energy measurement for gas applications

Meter I/O Scan Time: Less than one second for all channels.

Product Measurement: Hydrocarbon gases and liquids including refined products

Process I/O Calibration Mode: Allows the calibration of transmitters without interfering with the process update for the module or impacting measurement.

Data Archiving

- Hourly for 2 days for each meter run (48 records per channel)
- Daily for 35 days

Note: The number of archives depends on the archive size you have configured. The default values for a 30 word archive are 48 hourly archives and 35 daily archives.

- Extended Archive feature supports up to 1440 daily archives and 1440 hourly archives stored on Compact Flash
- Each record consists of nearly 20 process and other variables. All archived data is available in the onboard Modbus memory map.
- User may configure when archives are generated
- User may configure archive content (from pre-defined list)
- Archives can be exported to an Excel spreadsheet or printed to a local printer.

Other Features

- Event Log with 1999-event buffer and timestamp.
- Virtual Slave with 20,000 re-mappable Modbus registers for contiguous SCADA polling.
- Password protection

13.1.1 On-line Communication & Configuration

The module is designed for online configuration via the configuration port. A user-friendly Windows 95/98/2000/NT/XP-based Module Configuration and Reporting/Monitoring Manager allows easy access to all configuration data for editing and saving on your computer.

Project configurations may be uploaded, downloaded, and saved to disk under user-selectable filenames. The module takes just minutes to configure using the MS Windows-based AFC Manager.

13.1.2 Reports

- **Event Log Report:** All security-sensitive configuration data (for example, orifice diameter) is date and time stamped and mapped to the local Modbus memory map. This data can be imported into any spreadsheet program and saved to disk or printed to a local printer.
- **Hourly and Daily Archive Reports:** Mapped to local Modbus memory. This data can be imported into any spreadsheet program and saved to disk, or printed as hard copy.
- **System Configuration:** May be transferred to or from the module. The configuration file can also be printed for hard reference or archiving.
- **Audit Scan:** A report can be saved to disk or printed to the local printer.

13.1.3 Modbus Interface

The two Modbus Slave ports allow the unit to be used as a SCADA interface and to broaden access to the AFC module's data table.

- Ports 2 and 3 support RS-232, RS-422 and RS-485 modes
- Supports baud rates of up to 19200 baud
- All ports may be configured for RTU or ASCII Modbus mode.
- All Modbus Slave ports provide access to all configuration and measurement data mapped to the Modbus table.
- Module contains two internal slaves (Primary and Virtual)
- Over 130,000 Modbus registers of the Primary Slave table may be re-mapped to up to 20,000 Modbus registers of the Virtual Slave for contiguous polling from a SCADA master.
- Port 3 can be configured as a Modbus master node
- Supports Modbus functions 3, 4, 5, 6, 15 and 16 as a slave (5 and 15 only on pass-thru operation)
- Supports Modbus functions 1,2,3,4,15 and 16 as a master
- Scratch Pad Modbus block of 6000 words for transfer of arbitrary data between the processor and the SCADA host via the module.

13.1.4 Configurable Options

Configurable options include:

- Gas analysis concentrations for up to 21 components
- Accumulator Rollover
- Reference temperature and pressure for both gases and liquids
- Orifice and pipe diameters, selection of type of taps, and tap locations, and so on.
- Meter K Factor and Meter Factors with 5-point linearization curve
- Temperature, Pressure, and Density Correction for liquids
- Local Atmospheric (barometric) pressure
- Default process and operating parameters such as DP Threshold for flow cutoff, and so on.
- Metric or US units
- User-selectable units for totalizers and flow rates on a per channel basis
- Resettable and non-resettable totalizers for every meter channel.

13.1.5 Supported Meters

The following meter types have been used with the MVI71-AFC module. Because of the broad range of meters available in today's market, refer to the meter's specifications and the contents of this manual to evaluate the use of the AFC modules (even if the meter is listed here). If you have questions, please contact ProSoft Technology Technical Support Group.

Meter Type	Configured As (Differential or Linear)
Turbine	Linear
Orifice	Differential

Meter Type	Configured As (Differential or Linear)
V-Cone	Differential. You must configure the meter as V-Cone type in the AFC Manager (**Meter Configuration / Calculation Options**)
Wedge	Differential. Refer to Wedge Meter Applications (page 160) for information about using the wedge meters.
Vortex	Linear or Differential
Ultrasonic	Linear or Differential
Coriolis	Linear or Differential

Note: For Vortex, Ultrasonic or Coriolis meters, the selection depends on the output generated by the meter.

If the meter provides a pulse train representing the volume increment, the AFC meter should be configured as Linear with Primary Input selected as Pulse Count.

If the meter provides the instantaneous flow rate, then the AFC meter should be configured as Differential with Primary Input selected as Flow Rate.

Note: The module does not support applications to measure water, because the implemented standards are applicable to hydrocarbon fluids only.

13.1.6 Hardware Specifications

These modules are designed by ProSoft Technology and incorporate licensed technology from Schneider Electric (Modbus technology) and from Rockwell Automation (backplane technology).

	MVI71-AFC
Current Loads	800 mA @ 5.1 VDC (from backplane)
Operating Temperature	0 to 60°C 32 to 140°F
Storage Temperature	–40 to 85°C –40 to 185°F
Relative Humidity	5 to 95 % (non-condensing)
Modbus Port Connector	Three RJ45 connectors (RJ45 to DB-9 cable shipped with unit), two of which support RS-232, RS-422, and RS-485 interfaces.

13.2 Measurement Standards

The module supports the following hydrocarbon (gases and liquids) measurement standards currently employed in the oil and gas measurement industry:

American Petroleum Institute (API) Manual of Petroleum Measurement Standards (MPMS)	
a.	Density Correction to Reference Temperature Chapter 11.1.53, 11.1.23 Equations, Tables 53, 23 - Generalized Crude Oils, Refined Products, Lubricating Oils, Special Applications
b.	Correction of Volume to Reference Temperature and Thermal Expansion: Ctl. Chapter 11.1.54, 11.1.24 Equations, Tables 54, 24 - Generalized Crude Oils, Refined Products, Lubricating Oils, Special Applications
c.	Compressibility Factors for Hydrocarbons: Cpl. Chapter 11.2.1/Chapter 11.2.2 (Chapter 11.2.1M and 11.2.2M for SI units.
d.	Orifice Metering of NGLs & Crude Oils Chapter 14.3 (AGA3)
e.	Calculation of Liquid Petroleum Quantities Measured by Turbine or Displacement Meters Chapter 12.2
f.	Allocation Measurement Chapter 20.1 (high-water-content calculations used for emulsions)
g.	Flow Measurement Using Electronic Metering Systems Chapter 21.1, 21.2

American Gas Association (AGA)	
a.	Orifice Metering of Natural Gas & Other Hydrocarbon Fluids AGA Report No. 3 (1992) (MPMS Ch 14.3)
b.	Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases AGA Report No. 8 (1992) - Detail Characterization Method

International Standards Organization (ISO)	
a.	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – Part 2: Orifice plates ISO 5167-2 (2003)

Gas Processors Association (GPA)	
a.	Temperature Correction for the Volume of Light Hydrocarbons - TP-25
b.	A Simplified Vapor Pressure Completion for Commercial NGLs GPA Document TP-15

13.2.1 Basic Metering According to Meter type

Orifice (Include V-cone): Uses AGA3 1992 / ISO 5167.

A V-cone meter is like an orifice meter, except that the V-cone is an obstruction in the center of the pipe while an orifice is an aperture. V-cone calculation differs from orifice calculation in the following respects:

6 The orifice Beta ratio is actually the square root of the ratio of aperture cross-section to pipe cross-section hence for the V-cone it is calculated differently from the two diameters.

7 The V-cone Coefficient of Discharge is entered as configuration and not calculated. Expansion Factor (Y) is calculated differently.

Output of the calculation is mass flow rate, which is divided by density to get volume and then integrated over time for accumulation.

Pulse - Both Gas and Liquid

Gross Volume is (pulses) / (K-factor) * (meter factor), according to API MPMS Ch 12 sec 2 1981 and 1995. Output of the standard calculation is volume flow increment, which is then multiplied by density to get mass increment. Flow rate is calculated in parallel to flow increment by applying to (pulse frequency) process input the same calculation as is applied to (pulses); this technique is employed instead of flow increment differentiation because the pulse frequency available from the counter card in the processor is not subject to variations of timing caused by scheduling delays in processor backplane transfer and in the firmware of the module, thus yielding a smoother flow rate.

Correction Factors According to Product Phase

Gas

Compressibility is calculated according to the Detail Characterization Method of AGA8 (1992). Gas density is a byproduct of this calculation. Essential input for this calculation is molar analysis. The compressibility Z is a factor in the gas equation PV=ZNRT, which is the rule by which gas volumes are corrected to reference conditions.

Liquid

Temperature and pressure correction factors are calculated according to API MPMS Ch 11 and applied according to the rules given in MPMS Ch 12. Essential input for this calculation is Liquid Density (page 27) at either standard or flowing conditions.

Gas Pulse Measurement

The standard applied is AGA7, which is merely a combination of the gross volume calculation (page 156) and the gas law (PV=ZNRT) which includes compressibility. It also specifies calculation of some intermediate factors, which are now idiosyncratic and vestigial, having been imported from an earlier AGA3 (1985 and before) which used the "factor" method to calculate gas flow and which has been superseded by the completely overhauled 1990/1992 AGA3.

Water Content of Liquids

The handling of water content in crude and NGL products depends upon whether an "emulsion" Product Group is chosen.

For emulsions, water content is removed from the mixture according to the calculations of API MPMS Chapter 20.1 before calculating and applying correction factors. In this case the volumetric quantity intermediate between "Gross" and "Net" is "Gross Clean Oil", which is the hydrocarbon component of the mixture at flowing conditions. This method is recommended for mixtures containing more than 5% water.

For non-emulsions, water content is removed from the mixture according to the rules of API MPMS Chapter 12.2 after calculating and applying correction factors, In this case the volumetric quantity intermediate between "Gross" and "Net" is "Gross Standard", which is the entire mixture including its water content corrected to standard conditions under the assumption that it is pure hydrocarbon. Because the presence of water skews the correction calculations, this method should be used only when the water content is very low.

Non-Standard Reference Conditions

For both liquids and gases, the AFC permits a range of reference conditions for volume measurement which may vary from the API/AGA standard of 15°C/101.325kPaa (SI) or 60°F/14.696psia (US) (US pressure base for gases is 14.73psia). The allowed ranges for SI units are temperature between 0°C and 25°C and pressure between 50kPaa and 110kPaa, with the allowed ranges for US units approximately equivalent.

For gases, this flexibility of reference conditions is handled automatically by the implementation of the AGA 8 (1992) standard for compressibility Z together with the "real" gas law PV=ZNRT.

For liquids, correction factors for non-standard reference conditions are calculated differently depending on the firmware version. For version 2.05 and later, correction factors and corrected density are calculated according to the 2004 edition of API MPMS Chapter 11.1, except for the "NGL" product groups for which the CTL and density calculations of GPA TP-25 are extended with the CPL calculations of (old) MPMS Chapter 11.2 in a manner analogous to that of the 2004 Chapter 11.1. For version 2.04 and earlier, correction factors and corrected density are calculated as described in the following paragraphs, using the calculations of the 1980 edition of MPMS Chapter 11.1. In all cases, the density input to the calculations is the density at standard API base conditions.

Temperature Correction Factor, CTL

First, the "standard" factor, CTL(Flowing / ApiBase), is calculated, except that the final rounding step is not performed. Then, CTL(UserBase / ApiBase) is calculated, also unrounded. The CTL(Flowing / UserBase) is then calculated as (CTL(Flowing / ApiBase) / CTL(UserBase / ApiBase)), to which result is applied the final rounding step of the standard CTL calculation.

Pressure Correction Factor, CPL

The CPL(Flowing / UserBase) is calculated according to the method given in MPMS Ch 12.2 1995. In order to correct "density at reference" to User Base conditions, and also when iteratively calculating corrected density for the effect of elevated pressure, the CPL(Flowing / ApiBase) (unrounded) is also calculated according to the same method.

Density Correction

The density at API Base is determined according to relevant standards, which density is used as input to the CTL and CPL calculations. The density at User Base is determined by multiplying den(ApiBase) by the term (CTL(UserBase / ApiBase) * CPL(Flowing / ApiBase) / CPL(Flowing / UserBase)), all unrounded factors; this density is reported only and is not used in any calculations. When density correction is not selected, or an alarm causes a default to be assumed, any default "density at reference conditions" is deemed to be at User Base, and is also corrected to API Base for input to the CTL and CPL calculations.

Archiving and Event Log

A Accumulation and data recording for gas-phase archives conform to the requirements of API MPMS Ch 21 sec 1, 1993. Liquid-phase archives conform to API MPMS Ch 21 sec 2.

B Event-logging conforms to the requirements given in the Industry Canada Weights and Measures Board Draft Specification "Metrological Audit Trails" of 1995-03-01

13.2.2 Liquid Correction Factor Details

For firmware version 2.05 and later, correction factors for most liquids are calculated according to the 2004 edition of API MPMS Chapter 11.1, enhanced with additional CPL calculations if required in order to allow selection of a non-standard base (reference) pressure. For lighter liquids (NGLs and LPGs), to which the 2004 Chapter 11.1 does not apply, the CTL and density correction calculations of GPA TP-25 are enhanced with the incorporation of the CPL calculations of MPMS Chapters 11.2.1 and 11.2.2 in a manner analogous to the method of the 2004 Chapter 11.1, to permit density correction to account for the effect of pressure and to yield the combined correction factor CTPL. For all liquids the option is available to use the vapor pressure correlation of GPA TP-15 June 1988.

For firmware version 2.04 and earlier, correction factors are calculated as described in the following paragraphs.

Temperature Correction Factor CTL

(According to Several "Tables" of MPMS Ch 11.1 (1980, except E Tables 1998 = GPA TP-25) and Other Standards)

Calculation of CTL (= VCF, Volume Correction Factor) from flowing temperature and density at standard temperature depends on the measurement system (SI or US), the product type (crude or refined), and the density range (high or low).

SI units:

D ≥ 610 kg/m3 Table 54A (Crude&NGL) or 54B (Refined Products)

500 ≤ D < 610 (LPG) ASTM-IP-API Petroleum Measurement Tables for Light Hydrocarbon Liquids 500-653 kg/m3 1986 ISBN 0 471 90961 0

US units:

D ≥ 0.610 RD60 Table 24A (Crude&NGL) or 24B (Refined Products),

0.350 ≤ D < 0.610 (LPG) Table 24E - TP25

The low density range of 0.350 RD60 in US units is considerably lower than the 500 kg/m3 in SI units, because the E Tables are available only for US units.

Correction of density from flowing temperature to standard temperature is a converging iteration which includes the calculation of the VCF (Volume Correction Factor). Standards applied are those listed above except that Tables n3x are used instead of Tables n4x.

An option is available to iteratively correct the density calculation for elevated flowing pressure according to the condition given in bold type in MPMS Ch12.2 1995 Part 1 Appendix B Section B.1 (page 21).

Compressibility Factor F

(According to MPMS Ch 11.2 (US) or11.2M (SI) 1986.)

- Vapor pressure correlation according to GPA TP-15 June 1988.
- Pressure Correction Factor (CPL) is calculated from F and pressure above equilibrium according to MPMS ch12.2 1995, where "atmospheric pressure" is read as "base pressure" and "gage pressure" is read as "pressure above base". The module considers:

Pressure process input + barometric pressure = absolute pressure

13.3 Wedge Meter Applications

For Wedge Meter applications you must convert some parameters from the meter manufacturer's data sheet before entering these values to the AFC Manager. The following spreadsheets can be used to calculate the AFC Manager parameters according to the meter manufacturer as follows:

Filename	Application
WEDGE_ABB.xls	ABB Wedge Meter
WEDGE_PRESO.xls	PRESO Wedge Meter

You must initially configure the meter as a differential type. Then you must configure it as a V-Cone Device (**Meter Configuration / Calculation Options**).

Refer to the spreadsheet for instructions on how to enter the correct values into AFC Manager.

13.4 Configurable Archive Registers

The following table shows the possible registers that can be included in the archive definition. Use the Insert and Remove buttons on the Archive Configuration dialog box to customize the list of registers for each meter archive.

Description	Meter-Relative Address	Length
Analysis molar fraction, component 1	720	1 word
Analysis molar fraction, component 2	721	1 word
Analysis molar fraction, component 3	722	1 word
Analysis molar fraction, component 4	723	1 word
Analysis molar fraction, component 5	724	1 word
Analysis molar fraction, component 6	725	1 word
Analysis molar fraction, component 7	726	1 word
Analysis molar fraction, component 8	727	1 word
Analysis molar fraction, component 9	728	1 word
Analysis molar fraction, component 10	729	1 word
Analysis molar fraction, component 11	730	1 word
Analysis molar fraction, component 12	731	1 word
Analysis molar fraction, component 13	732	1 word
Analysis molar fraction, component 14	733	1 word
Analysis molar fraction, component 15	734	1 word
Analysis molar fraction, component 16	735	1 word
Analysis molar fraction, component 17	736	1 word
Analysis molar fraction, component 18	737	1 word
Analysis molar fraction, component 19	738	1 word
Analysis molar fraction, component 20	739	1 word
Analysis molar fraction, component 21	740	1 word
Analysis molar fraction, component 22	741	1 word
Analysis molar fraction, component 23	742	1 word

Description	Meter-Relative Address	Length
Analysis molar fraction, component 24	743	1 word
Input pulse count, archive reset, daily	840	2 words
Input pulse count, archive reset, hourly	842	2 words
Previous input pulse count	846	2 words
Current master pulse count	848	2 words
Non-resettable accumulator, mass, totalizer	850	2 words
Non-resettable accumulator, mass, residue	852	2 words
Non-resettable accumulator, energy, totalizer	854	2 words
Non-resettable accumulator, energy, residue	856	2 words
Non-resettable accumulator, net, totalizer	858	2 words
Non-resettable accumulator, net, residue	860	2 words
Non-resettable accumulator, gross, totalizer	862	2 words
Non-resettable accumulator, gross, residue	864	2 words
Non-resettable accumulator, gross standard, totalizer	866	2 words
Non-resettable accumulator, gross standard, residue	868	2 words
Non-resettable accumulator, water, totalizer	870	2 words
Non-resettable accumulator, water, residue	872	2 words
Resettable accumulator 1, totalizer	874	2 words
Resettable accumulator 1, residue	876	2 words
Resettable accumulator 2, totalizer	878	2 words
Resettable accumulator 2, residue	880	2 words
Resettable accumulator 3, totalizer	882	2 words
Resettable accumulator 3, residue	884	2 words
Resettable accumulator 4, totalizer	886	2 words
Resettable accumulator 4, residue	888	2 words
Accumulator, archive period, daily, totalizer	890	2 words
Accumulator, archive period, daily, residue	892	2 words
Accumulator, archive period, hourly, totalizer	894	2 words
Accumulator, archive period, hourly, residue	896	2 words
Process input, scaled float, temperature	1520	2 words
Process input, scaled float, pressure	1522	2 words
Process input, scaled float, dif prs / flow rate / freq	1524	2 words
Process input, scaled float, flowing density	1526	2 words
Process input, scaled float, water and sediment	1528	2 words
Process input, scaled integer, temperature	1540	1 word
Process input, scaled integer, pressure	1541	1 word
Process input, scaled integer, dif prs / flow rate / freq	1542	1 word
Process input, scaled integer, flowing density	1543	1 word
Process input, scaled integer, water and sediment	1544	1 word
Temperature, absolute	1570	2 words
Upstream pressure, absolute	1572	2 words

Description	Meter-Relative Address	Length
Densitometer frequency	1574	2 words
AGA 7 temperature base factor, Ftb	1594	2 words
AGA 7 pressure base factor, Fpb	1596	2 words
Meter alarms	1601	1 word
Orifice characterization error	1602	1 word
Analysis characterization error	1603	1 word
AGA 8 calculation error	1604	1 word
Density correction error	1605	1 word
Temperature correction error	1606	1 word
Vapor pressure error	1607	1 word
Pressure correction error	1608	1 word
Scan count, process input	1618	1 word
Scan count, calculation	1619	1 word
AGA 8, Molar mass of mixture	1620	2 words
AGA 8, Ideal gas relative density	1622	2 words
AGA 8, Compressibility at reference	1624	2 words
AGA 8, Molar density at reference	1626	2 words
AGA 8, Density at reference	1628	2 words
AGA 8, Relative density at reference	1630	2 words
AGA 8, Compressibility, flowing	1632	2 words
AGA 8, Molar density, flowing	1634	2 words
AGA 8, Density, flowing	1636	2 words
AGA 8, Supercompressibility, Fpv	1640	2 words
Previous timer tick count	1661	1 word
Scan period (seconds)	1662	2 words
AGA 3, Pressure extension	1664	2 words
AGA 3, Differential pressure in static pressure units	1666	2 words
AGA 3, Orifice bore diameter at temperature	1668	2 words
AGA 3, Meter tube internal diameter at temperature	1670	2 words
Reserved	1672	2 words
AGA 3, Density, flowing	1674	2 words
AGA 3, Mass flow rate, Qm	1678	2 words
AGA 3, Velocity of approach factor, Ev	1680	2 words
AGA 3, Expansion factor, Y	1682	2 words
AGA 3, Coefficient of discharge, Cd	1684	2 words
AGA 3, Composition factor	1686	2 words
AGA 7, Temperature factor, Ftm	1694	2 words
AGA 7, Pressure factor, Fpm	1696	2 words
AGA 7, C-prime	1698	2 words
Molar heating value, MJ/kmol	1700	2 words
Mass heating value	1702	2 words

Description	Meter-Relative Address	Length
Volumetric heating value	1704	2 words
API 2540, Density at API base temperature	1738	2 words
API 2540, Hydrometer correction factor	1740	2 words
API 2540, Density at reference	1742	2 words
API 2540, Vapor pressure	1744	2 words
API 2540, CPL low density factor A	1746	2 words
API 2540, CPL low density factor B	1748	2 words
API 2540, CPL factor F	1750	2 words
API 2540, Temperature correction factor, CTL	1752	2 words
API 2540, Pressure correction factor, CPL	1754	2 words
API 2540, Sediment and water correction factor, CSW	1756	2 words
Density calculation select	1759	1 word
AGA 8, Ideal gas relative density – scaled integer	1761	1 word
AGA 8, Compressibility at reference – scaled integer	1762	1 word
AGA 8, Relative density at reference – scaled integer	1765	1 word
AGA 8, Compressibility, flowing – scaled integer	1766	1 word
AGA 8, Supercompressibility, Fpv – scaled integer	1770	1 word
Reserved	1786	1 word
AGA 3, Velocity of approach factor – scaled integer	1790	1 word
AGA 3, Expansion factor – scaled integer	1791	1 word
AGA 3, Coefficient of discharge – scaled integer	1792	1 word
API 2540, Density at reference	1821	1 word
API 2540, Vapor pressure	1822	1 word
API 2540, Temperature correction factor, CTL	1826	1 word
API 2540, Pressure correction factor, CPL	1827	1 word
API 2540, Sediment and water correction factor, CSW	1828	1 word
Startup input pulse count	1840	2 words
Current input pulse count	1842	2 words
Pulse increment	1844	2 words
Pulse frequency	1846	2 words
Interpolated/static K-factor	1848	2 words
Interpolated/static meter factor	1850	2 words
Multiplier, mass flow rate	1864	2 words
Multiplier, energy flow rate	1866	2 words
Multiplier, volume flow rate	1868	2 words
Multiplier, mass accumulator	1870	2 words
Multiplier, energy accumulator	1872	2 words
Multiplier, volume accumulator	1874	2 words
Accumulator increment, mass	1876	2 words
Accumulator increment, energy	1878	2 words
Accumulator increment, net	1880	2 words

Description	Meter-Relative Address	Length
Accumulator increment, gross	1882	2 words
Accumulator increment, gross standard	1884	2 words
Accumulator increment, water	1886	2 words
Flow rate, mass	1888	2 words
Flow rate, energy	1890	2 words
Flow rate, net	1892	2 words
Flow rate, gross	1894	2 words
Flow rate, gross standard	1896	2 words
Flow rate, water	1898	2 words

13.5 Archive Data Format

There are 3 columns associated with each archive data:

Column	Description
Ofs	Shows the offset location of the data in each archive. The maximum offset value will depend on the *Record Size* value you configured. If the value has a "+" value (for example 0+) it means that the data occupies 2 words of data.
Reg	Shows the Primary Modbus Slave Address of the data. This is a meter-relative address. For example: a Reg value of 890+ for meter 1 would be equivalent to Modbus addresses 8890 and 8891.
Description	Data Description.

13.5.1 Pre-defined Header

These archive areas are included in the default archive data, and cannot be reconfigured by the user.

Start Offset	End Offset	Data Format	Type	Description
0	1	Timestamp	Snapshot	Closing timestamp of archive
2		Word	Calculated	Flowing period
3		Bitmap	Calculated	Cumulative meter alarms
4		Bitmap	Calculated	Cumulative status
5		Word	Snapshot	Event counter
6	7	Double word	Calculated	Flowing period, seconds
8	9	Timestamp	snapshot	Opening timestamp of archive

Additional areas are also included in the default archive data, according to the meter type and product group associated with the meter.

The cumulative meter alarms are defined as follows:

Offset	Description
0	Current archive, daily, cumulative meter alarm: Input out of range, temperature
1	Current archive, daily, cumulative meter alarm: Input out of range: pressure

Offset	Description
2	Current archive, daily, cumulative meter alarm: Input out of range: differential pressure
3	Current archive, daily, cumulative meter alarm: Input out of range: flowing density
4	Current archive, daily, cumulative meter alarm: Input out of range: water content
5	Current archive, daily, cumulative meter alarm: Differential Pressure Low
6	Current archive, daily, cumulative meter alarm: Orifice Pressure Exception
7	Current archive, daily, cumulative meter alarm: Accumulation overflow
8	Current archive, daily, cumulative meter alarm: Orifice characterization error
9	Not Used
10	Current archive, daily, cumulative meter alarm: Current archive, daily, cumulative meter alarm: Analysis characterization error
11	Current archive, daily, cumulative meter alarm: Compressibility calculation error
12	Current archive, daily, cumulative meter alarm: Reference density error
13	Current archive, daily, cumulative meter alarm: Temperature correction error
14	Current archive, daily, cumulative meter alarm: Vapor pressure error
15	Current archive, daily, cumulative meter alarm: Pressure correction error

The cumulative status bits are defined as follows:

Offset	End Offset
00	Stream 1 active
01	Stream 2 active
02	Stream 3 active
03	Stream 4 active
11	Meter enabled
12	Backplane Communication Fault
13	Measurement Configuration Changed
14	Power up
15	Cold Start

The following 20 words (default configuration) will depend on the meter type and product group as follows:

13.5.2 Orifice (Differential) Meter with Gas Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	Differential pressure
22		Word	Flow weighted average	Relative density, e–4
23		Word	Flow weighted average	Compressibility, reference, e–4

Start Offset	End Offset	Data Format	Type	Description
24		Word	Flow weighted average	Compressibility, flowing, e–4
25		Word	Flow weighted average	Supercompressibility, e–4
26		Word	Flow weighted average	Velocity of approach factor, Ev, e–4
27		Word	Flow weighted average	Expansion factor, Y, e–4
28		Word	Flow weighted average	Coefficient of discharge, Cd, e–4
29		Word		(available)

13.5.3 Pulse (Linear) Meter with Gas Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	K-Factor
22	23	Floating point	Flow weighted average	Meter Factor
24		Word	Flow weighted average	Relative density, e–4
25		Word	Flow weighted average	Compressibility, reference, e–4
26		Word	Flow weighted average	Compressibility, flowing, e–4
27		Word	Flow weighted average	Supercompressibility, e–4
28	29	Double Word	Snapshot	Pulse Count

13.5.4 Orifice (Differential) Meter with Liquid Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	Differential pressure
22	23	Floating point	Flow weighted average	Density input
24		Word	Flow weighted average	Corrected density (scaled integer)
25		Word	Flow weighted average	CTL e–4
26		Word	Flow weighted average	CPL e–4
27		Word	Flow weighted average	Velocity of approach factor, Ev, e–4
28		Word	Flow weighted average	Expansion factor, Y, e–4
29		Word	Flow weighted average	Coefficient of discharge, Cd, e–4

13.5.5 Pulse (Linear) Meter with Liquid Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	K-Factor
22	23	Floating point	Flow weighted average	Meter Factor
24	25	Floating point	Flow weighted average	Density Input
26		Word	Flow weighted average	Water content, % e–2
27		Word	Flow weighted average	Corrected density (scaled integer)
28		Word	Flow weighted average	CTL e–4
29		Word	Flow weighted average	CPL e–4

13.5.6 Flow Rate Integration with Gas Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	Flow Rate Input
22		Word	Flow weighted average	Relative density, e–4
23		Word	Flow weighted average	Compressibility, reference, e–4
24		Word	Flow weighted average	Compressibility, flowing, e–4
25		Word	Flow weighted average	Supercompressibility, e–4
26		Word		(available)
27		Word		(available)
28		Word		(available)
29		Word		(available)

13.5.7 Pulse Frequency Integration with Gas Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	K-Factor
22	23	Floating point	Flow weighted average	Meter Factor
24		Word	Flow weighted average	Relative density e–4
25		Word	Flow weighted average	Compressibility, reference, e–4
26		Word	Flow weighted average	Compressibility, flowing, e–4
27		Word	Flow weighted average	Supercompressibility, e–4
28	29	Floating point	Flow weighted average	Pulse Frequency

13.5.8 Flow Rate Integration with Liquid Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	Flow Rate Input
22	23	Floating point	Flow weighted average	Density Input
24		Word	Flow weighted average	Corrected density (scaled integer)
25		Word	Flow weighted average	CTL e–4
26		Word	Flow weighted average	CPL e–4
27		Word		(available)
28		Word		(available)
29		Word		(available)

13.5.9 Pulse Frequency Integration with Liquid Product

Start Offset	End Offset	Data Format	Type	Description
10	11	Accumulator	Snapshot	Accumulator totalizer, net
12	13	Floating point	Snapshot	Accumulator residue, net
14	15	Floating point	Flow weighted average	Flow rate, net
16	17	Floating point	Flow weighted average	Temperature
18	19	Floating point	Flow weighted average	Pressure
20	21	Floating point	Flow weighted average	K-Factor
22	23	Floating point	Flow weighted average	Meter Factor

Start Offset	End Offset	Data Format	Type	Description
24	25	Floating point	Flow weighted average	Density Input
26		Word	Flow weighted average	Water content, % e–2
27		Word	Flow weighted average	Corrected density (scaled integer)
28	29	Floating point	Flow weighted average	Pulse Frequency

Example 1

Find the Net Accumulator addresses at archive 1 (latest daily archive) for the first 4 meters.

Primary Modbus Slave *Input* Register Address	**Description**
10 and 11	Net Accumulator Totalizer from archive 1 – Meter 1
2510 and 2511	Net Accumulator Totalizer from archive 1 – Meter 2
5010 and 5011	Net Accumulator Totalizer from archive 1 – Meter 3
7510 and 7511	Net Accumulator Totalizer from archive 1 – Meter 4

Example 2

Find the Net Accumulator addresses at archive 0 (current daily archive) for the first 4 meters.

Primary Modbus Slave *Holding* Register Address	**Description**
9910 and 9911	Net Accumulator Totalizer from archive 0 – Meter 1
11910 and 11911	Net Accumulator Totalizer from archive 0 – Meter 2
13910 and 13911	Net Accumulator Totalizer from archive 0 – Meter 3
15910 and 15911	Net Accumulator Totalizer from archive 0 – Meter 4

13.6 Modbus Addressing Common to Both Primary and Virtual Slaves

Address	Type	Description
Ch00000	Char	Firmware product code, group Low byte: platform High byte: application class
Ch00001	Char	Firmware product code, item Low byte: number of streams High byte: number of meters
Ch00002	Int	Firmware version number Low byte: minor version number High byte: major version number
Ch00003	Int	Firmware revision number
Ch00004 to Ch00005	Int	Serial number

Address	Type	Description
Ch00006	Bm	Site status bit 0 - AFC released Latched when both bit 15 (cold start) and bit 12 (Processor offline) first become clear, remaining so until any subsequent cold start. While this bit remains clear events are not logged, allowing an initial configuration to be fully completed without filling up the event log. bit 1 - Checksum alarm Set when any bit in the "Checksum Alarms" registers, for site and each meter, is set; clear when all such bits are clear. bit 2 - [reserved] bit 3 - [reserved] bit 4 - Processor halted, offline, or missing Set while backplane communication is faulty, which typically occurs when the Processor is switched to program mode. While set, measurement continues using the latest process input values obtained from the processor. Upon resumption of backplane communication, the AFC compensates for the downtime by computing an accumulator increment in a manner that depends on the meter type. For differential (orifice) meters, the first measurement scan acquires a scan period equal to the period of downtime as computed from the system timer, hence periods of processor downtime shorter than the rollover period of the system timer cause no loss of product. For linear (pulse) meters, the first measurement scan acquires a pulse increment equal to the difference between the processor-supplied pulse count of the current scan and that of the last scan before communication loss, hence periods of processor downtime shorter than the rollover period of the counter module cause no loss of product. bit 5 - Measurement configuration changed Set when any bit in the "Measurement Configuration Changed" registers is set; clear when all such bits are clear. bit 6 - Power up Set upon power-up, and cleared upon setting the wallclock for the first time.. bit 7 - Cold start Upon power-up, AFC's non-volatile storage is checked for validity, by verifying a checksum and confirming that certain known values are present in their proper locations. If the storage is invalid, then it is initialized with a default configuration, and this bit is set. The bit remains set, even through subsequent power cycles, until at least one meter is enabled at which time the bit is cleared. bit 8 – A copy of the "Hard Passwords" site option, made available here so that an external application such as AFC Manager can learn all it needs to know in order to connect to the module by reading the first 20 holding registers from the Modbus table. bit 9 - [reserved] bit 10 - [reserved] bit 11 - [reserved] bit 12 - [reserved] bit 13 - [reserved] bit 14 - [reserved] bit 15 - [reserved]
Ch00007	By	Processor offline code: 0 online, 1 offline

Address	Type	Description
Ch00008	By	Zero / primary slave address This value distinguishes the two slaves. When read from the primary slave this value is zero; when read from the virtual slave this value is the primary slave address.
Ch00009	Wd	Password, write-enable
Ch00010 to Ch00015	Wd	Wallclock (Y,M,D,h,m,s) The wallclock has a resolution of 1 second.
Ch00016 to Ch00017	Bm	Wallclock (packed) The packed wallclock has a resolution of 2 seconds.
Ch00018	Bm	accessed port and authorization bits 0- 3 - Accessed port; 0 = gateway bit 4 - Password authorization waived for read bit 5 - Password authorization waived for write bit 6 - Password authorization granted for read bit 7 - Password authorization granted for write
Ch00019	Wd	Password, read-enable
Ch00020 to Ch00089	--	[reserved] Reserved for use by diagnostic and similar procedures.
Ch00090 to Ch00099	Wd	Arbitrary event-logged registers. A Modbus master (such as the processor using Modbus Gateway) can use these to record in the Event Log changes to values unrelated to flow measurement.

13.6.1 Modbus Dictionary Entries

The entries listed in this section are available in AFC Manager via **Project / Modbus Dictionary**. The Dictionary will show you only those points that are relevant to your firmware version and project configuration.

Firmware product code, group

This value identifies the application class and the platform upon which it runs. It may be interrogated by external software (such as the AFC Manager) in order to tailor its communication.

Firmware product code, group: platform

This ASCII character identifies the application platform.

Firmware product code, group: application class.

This ASCII character identifies the application class. It is always "F" (hexadecimal 46) for the AFC.

Firmware product code, item

This value identifies additional characteristics of the application build, and may be interrogated by external software as for the Firmware Product Group code.

Firmware product code, item: number of streams

This ASCII character reports the number of streams per meter available in this build of the AFC.

Firmware product code, item: number of meters

This ASCII character reports the number of meters available in this build of the AFC.

Firmware version number

The byte-coded version number of this build of the AFC.

Firmware version number: minor version number

The minor version number of this build of the AFC.

Firmware version number: major version number

The major version number of this build of the AFC.

Firmware revision number

The revision number of this build of the AFC.

Serial number

The serial number of the AFC module. To compare it with the label on the hardware, interpret it in hexadecimal.

Site status (basic)

View bit-level detail for more information.

AFC released

Latched when both bit 7 (Cold Start) and bit 4 (PLC Offline) both become clear, remaining so until any subsequent Cold Start. While this bit remains clear events are not logged, allowing an initial configuration to be fully completed without filling up the event log.

Checksum alarm

Set when any bit in the "Checksum alarms" registers, for site and each meter, is set; clear when all such bits are clear. Checksums are verified upon power-up, and failure raises an alarm.

PLC halted, offline, or missing

Set while backplane communication is faulty, which typically occurs when the PLC is switched to program mode. The behavior of the AFC under this condition depends upon the meter type.

- For linear meters receiving a pulse count primary input:
  While this bit is set no new pulses or process inputs are arriving from the PLC, hence measurement does not occur and all outputs are "frozen" at their latest values; upon resumption of backplane communication the first measurement scan acquires a pulse increment equal to the difference between the pulse count of the current scan and that of the last scan before communication loss, hence periods of PLC downtime shorter than the rollover period of the counter module cause no measurement loss.
- For all other meters, including flowrate or frequency integration and traditional orifices:
  While this bit is set measurement continues using the latest values of the process inputs before communication loss; upon resumption of backplane communication arrival of new process inputs resumes with consequent recalculation of outputs, hence no measurement loss occurs.

Measurement configuration changed

Set when any bit in the "Measurement configuration changed" registers is set; clear when all such bits are clear.

Power up

Set upon power-up and cleared upon setting the wallclock for the first time.

Cold start

Upon power-up the AFC's non-volatile storage is checked for validity, by verifying checksums and confirming that certain known values are present in their expected locations. If the storage is invalid, then it is initialized with a default configuration and this bit is set. The bit remains set, even through subsequent power cycles, until at least one meter is enabled at which time the bit is cleared. A checksum failure does not by itself cause a cold start; instead, a checksum alarm is raised and the module continues to operate with its existing memory.

Extended site status

View bit-level detail for more information.

Hard passwords

A copy of the "Hard passwords" site option. It is made available here to allow an external application (such as the AFC Manager) to determine whether hard password entry is required even when Modbus reads are password-protected, as the site status is always readable.

PLC offline

Values:

PLC is on-line
PLC is off-line

Zero (primary slave); Primary slave address (virtual slave)

Allows an external application to determine whether it is interrogating the primary slave or the virtual slave. When read from the primary slave this value is zero, while when read from the virtual slave this value is the address of the primary slave.

Password, write-enable

When non-zero, this value is the password required in order to enable Modbus writes. When zero, it is deemed to have the value of the read-enable password (register 19); if that value is also zero then Modbus writes are unprotected. If the module has hard passwords then the write-enable password is hidden and a read of this register always returns zero; hard passwords may only be written and cannot be read.

Wallclock, year

Continuously maintained.

Wallclock, month

Continuously maintained.

Wallclock, day

Continuously maintained.

Wallclock, hour

Continuously maintained.

Wallclock, minute

Continuously maintained.

Wallclock, second

Continuously maintained.

Wallclock (packed)

The wallclock as a 32-bit quantity, continuously maintained. If the site option "Return Unix-style timestamps via virtual slave" (register 119 bit 0) is set and this value is read from the virtual slave, then it appears as seconds since 1970 (Unix style) and its bit-field encoding is not relevant. Otherwise the timestamp is packed into bit fields with a resolution of 2 seconds; view bit-level detail for more information.

Wallclock (packed), bisecond

The wallclock second of the minute divided by 2; value 0 thru 29.

Wallclock (packed), minute

The wallclock minute of the hour; value 0 thru 59.

Wallclock (packed), hour

The wallclock hour of the day, using the 24-hour clock; value 0 thru 23.

Wallclock (packed), day

The wallclock day of the month less 1; value 0 thru (days in month) - 1.

Wallclock (packed), month

The wallclock month of the year less 1; value 0 thru 11.

Wallclock (packed), year

The wallclock year less 1996; value 0 thru 103 (through year 2099).

Accessed port and authorization (read); Password test (write)

When read, reports the serial port over which the read is performed and the read-write access granted; view bit-level detail for more information. In hard-password mode the master gains access by writing a candidate password to this register; a subsequent read reports the access granted.

Accessed port

The serial port over which the read is performed. If the read is over the Modbus gateway from the PLC, this value is zero.

Password authorization waived for read

This port is configured to allow all Modbus reads with no password required.

Password authorization granted for read

This port has been granted Modbus read access, by one of these conditions:

- Authorization is waived (this register, bit 4).
- The password is zero therefore not required.
- The correct password has been provided.

Password, read-enable

When non-zero, this value is the password required in order to enable Modbus reads. When zero, Modbus reads are unprotected. If the module has hard passwords then the read-enable password is hidden and a read of this register always returns zero; hard passwords may only be written and cannot be read.

Arbitrary event-logged registers #1 through #10

A change to any of these registers is recorded in the event log. This allows a master to record in the event log changes to values unrelated to flow measurement.

Modbus slave address, primary

Through this slave, all configuration, process, and historical data for the site and all meters are available. Regardless of the module's configuration, this slave is always accessible through Port 1. Value must lie between 1 and 247. A written value of 0 is ignored (without error) and does not change the currently configured value. A non-zero value changes the slave address to the new value; subsequent Modbus commands must address the module using the new slave address. Default value is 244.

Modbus slave address, virtual

This is the address of the 20,000-register "virtual" slave defined by its indirect address table in the primary slave. Value must lie between 0 and 247. A value of 0 disables the virtual slave via the serial ports; all data is then accessible only through the primary slave. If this address is the same as that of the primary slave then it is hidden by the primary slave at serial ports that enable access to the primary slave. Regardless of the value of this point, the PLC can always access either slave over the backplane using Modbus Gateway transfers. Default value is 0.

Port #, UART parameters and Modbus mode

View bit-level detail for more information.

Port #, Baud code

Values:

- 300 baud
- 600 baud
- 1200 baud
- 2400 baud
- 4800 baud
- 9600 baud
- 19200 baud

Writing 0 to this field causes the entire port reconfiguration to be ignored and the existing configuration remains unchanged.

Port #, Parity code

Values:

No parity
Odd parity
Even parity
Reserved (currently treated as "no parity")

Port #, Data bits

Values:

8 data bits
7 data bits

Port #, Stop bits

Values:

1 stop bit
2 stop bits

Port #, Modbus mode

Values:

RTU mode
ASCII mode

Port #, Swap mask

Values:

No swap
Swap bytes
Swap words (32-bit items only)
Swap both words and bytes (full reversal)

Port #, Disable pass-thru

Values:

Pass-thru enabled
Pass-thru disabled

Port #, CTS timeout

In units of 5 ms, with valid values from 0 to 255 (1.275 seconds). In a Modbus transmission, after RTS is raised CTS must appear within this time in order to continue the transmission; except if the timeout is zero then CTS is not expected but is immediately assumed to be present.

Port #, Delay before data

In units of 5 ms, with valid values from 0 to 255 (1.275 seconds). In a Modbus transmission, this delay is imposed between the actual or assumed appearance of CTS and the start of data transmission.

Port #, Password authorization waiver

Waive password requirement for Modbus reads and/or writes via this port. View bit-level detail for more information.

Port #, Authorization waiver, read

If set, Modbus reads through this port are always authorized; no password is required.

Port #, Authorization waiver, write

If set, Modbus writes through this port are always authorized; no password is required.

Port #, Delay after data

In units of 5 ms, with valid values from 0 to 255 (1.275 seconds). In a Modbus transmission, this delay is imposed between the end of data transmission and the dropping of RTS.

Site options

View bit-level detail for more information.

Return Unix-style timestamps via virtual slave

Return packed (32-bit) timestamps as seconds since 1970 (Unix style) when reading from the virtual slave. Packed timestamps read from the primary slave are always bit-field encoded.

Event log unlocked

If set, then event-log records may be overwritten before being downloaded first.

Barometric pressure in US units

If set, then barometric pressure for the site is expressed in US units (psia); if clear, then barometric pressure is expressed in SI units (kPaa).

Record process input range alarms as events

If set, then out-of-range alarms on process inputs are deemed to be events and are recorded in the event log.

Hard passwords

Enables secure password-controlled access to the AFC. Passwords are stored in the AFC by writing them to the password registers 9 and 19, but in hard-password mode reading those registers always returns zero. Read and/or write access to the AFC is granted by writing a candidate password to the password-test register (register 18) and the access granted is determined by reading back that register and examining its contents. The access is granted to the port over which the request was made; other ports remain unaffected. If the port remains idle with no Modbus activity for two minutes, then the granted access is removed and can be regained only by writing a new password to the test register. Refer to the description of registers 9, 19, and 18 for more information.

End-of-day minute

The minute of the day at which daily archive records are written. Value must lie between 0 and 1439.

End-of-hour minute

The minute of the hour at which hourly archive records are written, expressed as minutes since midnight. Value must lie between 0 and 59.

Barometric pressure

The normal atmospheric pressure for the site. It is added to the value from a pressure transmitter that supplies gauge units (above atmospheric) to arrive at absolute units for use in measurement calculations. It may be expressed in either SI units (kPaa) or US units (psia) according to the setting of site option "Barometric pressure in US units" (register 119 bit 2).

Modbus pass-thru: Maximum PLC window size

These five registers specify the pass-thru capability of the virtual slave, in which Modbus write commands issued by an external master are passed through directly to the PLC for interpretation, bypassing the AFC's Modbus table. Pass-thru is enabled by entering a non-zero PLC window size (this register) that specifies the maximum width (in 16-bit words) of the data portion of a Modbus command to be passed to the PLC, together with Modbus address regions (registers 142 and 143 for word-write, registers 144 and 145 for bit-write) that specify which incoming Modbus commands are to be treated as pass-thru. The window size may range from zero (pass-thru disabled) up through a maximum of 125 (the maximum length of the data portion of a Modbus command) or a smaller number depending on the backplane characteristics of the platform. Pass-thru is enabled or disabled for individual serial ports according to the setting of a port option bit. Pass-thru is effective only for Modbus write commands to the virtual slave arriving via an enabled serial port and only for the pass-thru register region specified; any other Modbus access, including reads, writes to registers outside the specified region, access via disabled ports, backplane gateway access, and primary slave access, is unaffected. A write to the virtual slave through an enabled port must reside either wholly within the pass-thru region (and is passed thru) or wholly without it (and is a normal virtual slave write); no region-spanning is permitted.

Modbus pass-thru: Word region address

This register and the next specify the region of the virtual slave Modbus address space to which incoming Modbus word-write commands (functions 6 and 16) are to be passed-thru directly to the PLC. This region may be taken from anywhere in the 65536-register Modbus holding-register address space, even from outside the defined range of the virtual slave, with the exception of the first 100 registers addressed 0 through 99. A region size of zero disables word-write pass-thru. Refer to the description of register 141 for more information.

Modbus pass-thru: Word region size

This register and the previous specify the region of the virtual slave Modbus address space to which incoming Modbus word-write commands (functions 6 and 16) are to be passed-thru directly to the PLC. This region may be taken from anywhere in the 65536-register Modbus holding-register address space, even from outside the defined range of the virtual slave, with the exception of the first 100 registers addressed 0 through 99. A region size of zero disables word-write pass-thru. Refer to the description of register 141 for more information.

Modbus pass-thru: Bit region address

This register and the next specify the region of the virtual slave Modbus address space to which incoming Modbus bit-write commands (functions 5 and 15) are to be passed-thru directly to the PLC. This region may be taken from anywhere in the 65536-register Modbus coil address space. As the AFC does not itself define any bit-registers, pass-thru bit-writes are the only bit-access Modbus commands that the AFC will recognize. A region size of zero disables bit-write pass-thru. Refer to the description of register 141 for more information.

Modbus pass-thru: Bit region size

This register and the previous specify the region of the virtual slave Modbus address space to which incoming Modbus bit-write commands (functions 5 and 15) are to be passed-thru directly to the PLC. This region may be taken from anywhere in the 65536-register Modbus coil address space. As the AFC does not itself define any bit-registers, pass-thru bit-writes are the only bit-access Modbus commands that the AFC will recognize. A region size of zero disables bit-write pass-thru. Refer to the description of register 141 for more information.

Project name

Identifies this AFC configuration. During project download the project name of the new configuration is compared to that already in the module and a warning is issued if they do not match. Also available for printing on reports.

Site name

Identifies the site, for printing on reports.

PLC address: Supervisory, get

The address in the PLC of the block of 52 registers through which the PLC issues system controls and signals to the AFC, including meter-enable signals. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465485 (stored in the module as a value between 1 and 65485) and is the starting address in the 4x register bank of the block. For proper operation of the AFC, this block is required. For more information, refer to the documentation of your platform's backplane.

PLC address: Supervisory, put

The address in the PLC of the block of 50 registers through which the AFC returns to the PLC system status and results of some system signals. Status includes the gross characterization or enable status of each meter. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465487 (stored in the module as a value between 1 and 65487) and is the starting address in the 4x register bank of the block. For more information, refer to the documentation of your platform's backplane.

PLC address: Wallclock, get & put

The address in the PLC of the block of 6 registers that transfers the wallclock between the PLC and the AFC. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465531 (stored in the module as a value between 1 and 65531) and is the starting address in the 4x register bank of the block. For proper operation of the AFC, this block is required. For more information, refer to the documentation of your platform's backplane.

PLC address: Modbus gateway, get & put

The address in the PLC of the block of 129 registers that transfers the addressing, data, and status of Modbus gateway transactions issued by the PLC to the AFC. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465408 (stored in the module as a value between 1 and 65408) and is the starting address in the 4x register bank of the block. For more information, refer to the documentation of your platform's backplane.

PLC address: Modbus pass-thru, put

The address in the PLC of the block of 130 registers through which the AFC transfers to the PLC the status of the Modbus pass-thru feature and any pass-thru data written by an external host. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465407 (stored in the module as a value between 1 and 65407) and is the starting address in the 4x register bank of the block. For more information, refer to the documentation of your platform's backplane.

PLC address: Modbus master, get & put

The address in the PLC of the block of 130 registers that transfers the addressing, data, and status of Modbus master transactions issued by the PLC through the AFC to an external slave. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465407 (stored in the module as a value between 1 and 65407) and is the starting address in the 4x register bank of the block. For more information, refer to the documentation of your platform's backplane.

Site signals

A signal instructs the AFC to immediately perform a particular function once. A signal bit is latched by the process issuing the signal (e.g. the PLC) and is unlatched by the AFC when the function has been performed. As site signals are discharged immediately upon receipt, a read of this word always returns zero. View bit-level detail for more information.

Event log download complete

Issued by an application (e.g. AFC Manager) after downloading all events, this signal causes the AFC to mark all events as "downloaded" so that they may be overwritten by new events.

Clear all checksum alarms

A checksum alarm indicates a checksum verification failure during power-up. Non-volatile information is kept in battery-backed RAM. It is partitioned into several blocks, each of which contains a checksum, and when the information is changed the checksum is updated also. During power-up the checksum is verified, and upon failure the alarm bit is latched and the checksum corrected. The alarm bit remains latched, even through subsequent power cycles, until it is explicitly cleared from outside, which may be performed by issuing this signal (to clear all alarms) or by writing a "1" to an individual alarm bit (to clear that alarm only). There is one checksum alarm word for the site as a whole and one checksum alarm word for each meter.

Checksum alarms, site

Checksum alarms detected for the site as a whole. For more information, view bit-level detail and refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Site identification and configuration

During power-up the checksum for the non-volatile memory containing the site identification and configuration did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Virtual slave indirect address table

During power-up the checksum for the non-volatile memory containing the virtual slave indirect address table did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Event log

During power-up the checksum for the non-volatile memory containing the event log did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Measurement configuration changed, site

Whenever a change is made to a configuration item that may affect the results of measurement calculations, a bit in one of these registers is set. These bits may also be set or cleared by writing directly to these registers. The contents of these registers determines the value of the "Measurement configuration changed" status bit (register 6 bit 5).

Measurement configuration changed, site: Options

Changes have been made to the site's options since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, site: Parameter value

Changes have been made to the site's parameter values since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, site: Arbitrary event-logged value

Changes have been made to arbitrary event-logged values since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter # base

Whenever a change is made to a configuration item that may affect the results of measurement calculations, a bit in one of these registers is set. These bits may also be set or cleared by writing directly to these registers. The contents of these registers determines the value of the "Measurement configuration changed" status bit (register 6 bit 5).

Measurement configuration changed, meter #: Process input calibration / alarm

Changes have been made to the calibration status of the meter's process inputs, or (if configured by site option "Record process input range alarms as events", register 119 bit 3) process input alarms have occurred for the meter, since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Meter classification

Changes have been made to the meter classification since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Reference conditions

Changes have been made to the meter's reference conditions since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Meter options

Changes have been made to the meter's options since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Process input scaling

Changes have been made to the ranging or scaling of the meter's process inputs since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Analysis component selection

Changes have been made to the list of recognized components of molar analyses for the meter since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Pulse input rollover

Changes have been made to the meter's pulse input rollover since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Units

Changes have been made to the meter's units for accumulator output, flow rate output, flow rate input, and/or K-factor since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Accumulator rollovers

Changes have been made to the meter's accumulator rollovers since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Parameter value

Changes have been made to the meter's parameter values since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter #: Densitometer

Changes have been made to the meter's densitometer configuration since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter # stream #

Whenever a change is made to a configuration item that may affect the results of measurement calculations, a bit in one of these registers is set. These bits may also be set or cleared by writing directly to these registers. The contents of these registers determines the value of the "Measurement configuration changed" status bit (register 6 bit 5).

Measurement configuration changed, meter # stream #: Options

Changes have been made to the stream's options since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter # stream #: Parameter value

Changes have been made to the stream's parameter values since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter # stream #: Meter/K factor curve

Changes have been made to the stream's K-factors or meter factors since the last time this bit was clear, and associated events have been written to the event log.

Measurement configuration changed, meter # stream #: Analysis mole fraction

Changes have been made to the stream's molar analysis since the last time this bit was clear, and associated events have been written to the event log.

Scan count

A free-running 16-bit counter, incremented once for each execution of the AFC's main scan loop.

Meters in alarm

Bitmap identifying meters that are currently in alarm.

Meter 1 in alarm

Set whenever any bit in meter 1's "Meter alarms" register (register 9601) is set.

Meter 2 in alarm

Set whenever any bit in meter 2's "Meter alarms" register (register 11601) is set.

Meter 3 in alarm

Set whenever any bit in meter 3's "Meter alarms" register (register 13601) is set.

Meter 4 in alarm

Set whenever any bit in meter 4's "Meter alarms" register (register 15601) is set.

Meter 5 in alarm

Set whenever any bit in meter 5's "Meter alarms" register (register 17601) is set.

Meter 6 in alarm

Set whenever any bit in meter 6's "Meter alarms" register (register 19601) is set.

Meter 7 in alarm

Set whenever any bit in meter 7's "Meter alarms" register (register 21601) is set.

Meter 8 in alarm

Set whenever any bit in meter 8's "Meter alarms" register (register 23601) is set.

Meter 9 in alarm

Set whenever any bit in meter 9's "Meter alarms" register (register 25601) is set.

Meter 10 in alarm

Set whenever any bit in meter 10's "Meter alarms" register (register 27601) is set.

Meter 11 in alarm

Set whenever any bit in meter 11's "Meter alarms" register (register 29601) is set.

Meter 12 in alarm

Set whenever any bit in meter 12's "Meter alarms" register (register 31601) is set.

Meter 13 in alarm

Set whenever any bit in meter 13's "Meter alarms" register (register 33601) is set.

Meter 14 in alarm

Set whenever any bit in meter 14's "Meter alarms" register (register 35601) is set.

Meter 15 in alarm

Set whenever any bit in meter 15's "Meter alarms" register (register 37601) is set.

Meter 16 in alarm

Set whenever any bit in meter 16's "Meter alarms" register (register 39601) is set.

Number of backplane transfers received by module

Free-running 16-bit counter. For diagnostic purposes only.

Number of backplane transfers sent by module

Free-running 16-bit counter. For diagnostic purposes only.

Backplane transfer state

State of the backplane transfer process. For diagnostic purposes only.

Number of backplane queue entries allocated

A number that varies, but that should not exceed a few dozen. For diagnostic purposes only.

Number of backplane queue allocation failures

Should always be zero. For diagnostic purposes only.

Audit in progress

Values:

Audit not in progress
Audit in progress
These dozen registers manage a meter audit, which is the capture of the meter's process input, intermediate calculated values, and output results for a short series of consecutive calculation scans, and which can be used by an auditor to verify compliance with applicable Standards. To perform an audit, write the meter number before the down-counter or write them both with the same transaction. Upon a transition of the down-counter from zero to non-zero, the meter number is latched, the wallclock is recorded, and the audit area is cleared and reinitialized. After each scan, the down-counter is decremented, the up-counter is incremented, and the corresponding detail area is completed with values. During an audit, the down-counter may be changed to add or remove scheduled scans, but any attempt to respecify the meter number is ignored. The audit ends when the down-counter becomes zero or the up-counter becomes 8; in the latter case the down-counter is forced to zero regardless of its previous value.

Audit meter number, request

To initiate an audit, write here the number of the meter to be audited, then write the down-counter. Refer to the description of register 381 for more information.

Audit scan down-counter

To initiate an audit, write the down-counter here, after writing the number of the meter to be audited. Refer to the description of register 381 for more information.

Wallclock at audit start, year

Captured at the start of the audit. Refer to the description of register 381 for more information.

Wallclock at audit start, month

Captured at the start of the audit. Refer to the description of register 381 for more information.

Wallclock at audit start, day

Captured at the start of the audit. Refer to the description of register 381 for more information.

Wallclock at audit start, hour

Captured at the start of the audit. Refer to the description of register 381 for more information.

Wallclock at audit start, minute

Captured at the start of the audit. Refer to the description of register 381 for more information.

Wallclock at audit start, second

Captured at the start of the audit. Refer to the description of register 381 for more information.

Audit meter number, latched

Copied from the requested-meter register at the start of the audit. Refer to the description of register 381 for more information.

Audit scan up-counter

The number of audit scans completed. Refer to the description of register 381 for more information.

Meter number (1-based)

This value is always 1.

Meter status

Bitmap of selected meter status accumulated since the last archive record was written. The bitmap is cleared to zero upon writing a record to either archive file. View bit-level detail for more information.

Meter status: Meter enabled, not yet archived

The state of the meter has been switched from disabled to enabled since the last archive record was written.

Meter status: Backplane communications fault since last archive

Loss of communication with the PLC has been detected since the last archive record was written. This is usually due to a switch of the PLC to program mode.

Meter status: Measurement configuration changed since last archive

Configured items that might affect measurement calculations have been changed since the last archive record was written.

Meter status: Power up since last archive

The module lost power and has been rebooted since the last archive record was written.

Meter status: Cold start, not yet archived

A cold start (complete reinitialization) has occurred and an archive record has not yet been written.

Active stream number (0-based)

The number of the currently active stream less 1.

Map of enabled streams

This bitmap reports the streams that are currently enabled and to which the active stream can be switched. As the meter must always have an active stream, the bitmap is never all zero.

Stream # enabled

Meter signals and stream-select

A signal instructs the AFC to immediately perform a particular function once. A signal bit is latched by the process issuing the signal (e.g. the PLC) and is unlatched by the AFC when the function has been performed. Meter signals are discharged upon the next calculation scan, before which several Modbus transactions may be completed, hence a read of this word may show pending undischarged signals. View bit-level detail for more information.

Select stream 1

Issued by an external process (almost always the PLC, as it is typically accompanied by the swinging of valves) to switch measurement to stream 1 and make it active. Measurement continues using stream 1's parameters and stream 1's accumulators. Stream 1 must be enabled; if it is disabled then the signal is cancelled immediately with no action.

Select stream 2

Issued by an external process (almost always the PLC, as it is typically accompanied by the swinging of valves) to switch measurement to stream 2 and make it active. Measurement continues using stream 2's parameters and stream 2's accumulators. Stream 2 must be enabled; if it is disabled then the signal is cancelled immediately with no action.

Select stream 3

Issued by an external process (almost always the PLC, as it is typically accompanied by the swinging of valves) to switch measurement to stream 3 and make it active. Measurement continues using stream 3's parameters and stream 3's accumulators. Stream 3 must be enabled; if it is disabled then the signal is cancelled immediately with no action.

Select stream 4

Issued by an external process (almost always the PLC, as it is typically accompanied by the swinging of valves) to switch measurement to stream 4 and make it active. Measurement continues using stream 4's parameters and stream 4's accumulators. Stream 4 must be enabled; if it is disabled then the signal is cancelled immediately with no action.

Reset resettable accumulator 1

Issued by an external process (e.g. the PLC), or automatically according to archive configuration options (registers 8341 and 8421), to reset resettable accumulator 1. For a multiple-stream AFC, resettable accumulator 1 for the meter and all its streams are simultaneously reset.

Reset resettable accumulator 2

Issued by an external process (e.g. the PLC), or automatically according to archive configuration options (registers 8341 and 8421), to reset resettable accumulator 2. For a multiple-stream AFC, resettable accumulator 2 for the meter and all its streams are simultaneously reset.

Reset resettable accumulator 3

Issued by an external process (e.g. the PLC), or automatically according to archive configuration options (registers 8341 and 8421), to reset resettable accumulator 3. For a multiple-stream AFC, resettable accumulator 3 for the meter and all its streams are simultaneously reset.

Reset resettable accumulator 4

Issued by an external process (e.g. the PLC), or automatically according to archive configuration options (registers 8341 and 8421), to reset resettable accumulator 4. For a multiple-stream AFC, resettable accumulator 4 for the meter and all its streams are simultaneously reset.

Write daily archive

Issued by an external process, or automatically according to archive configuration options (registers 8341 and 8421), to cause the current-period daily archive to be closed and written to the daily archive file and to restart the daily archive period.

Write hourly archive

Issued by an external process, or automatically according to archive configuration options (registers 8341 and 8421), to cause the current-period hourly archive to be closed and written to the hourly archive file and to restart the hourly archive period.

Process input calibration

Toggling these bits switches process inputs into and out of calibration mode. While a process input is in calibration mode its latest live value is stored in the point "Input scaling, input frozen during calibration" and used for all calculations, which allows the transmitter to be calibrated without the consequent changes in output affecting measurement. When the process input is switched out of calibration mode normal operation is resumed. Changes to calibration mode bits are written as events to the event log.

Process input calibration, temperature

The temperature process input is in calibration mode.

Process input calibration, pressure

The pressure process input is in calibration mode.

Process input calibration, differential pressure

The differential pressure process input is in calibration mode.

Process input calibration, flow rate

The flow rate process input is in calibration mode.

Process input calibration, density

The density process input is in calibration mode.

Process input calibration, water content

The water content process input is in calibration mode.

Meter tag

Identifies the meter, for printing on reports.

Gross meter characterization

Specifies gross characteristics of the meter, including meter type. Changes to this point are permitted only while the meter is disabled and cause a complete reinitialization of the meter configuration and zeroing of all accumulators.

Meter type

Basic meter type; also may select applicable measurement Standards. Values:

Differential meter (orifice/V-cone/wedge, or flow rate integration)
Linear meter (pulse input, or pulse frequency integration)

Measurement system

Fundamental system of engineering units; also may select applicable measurement Standards. Values:

SI (metric) units (temperature in °C, pressure in kPa, differential pressure in kPa)
US (English) units (temperature in °F, pressure in psi, differential pressure in hW@60)

Density units

Engineering units for the input and expression of density values. Values:

Density as kilograms per cubic meter (kg/m3)
Density as density relative to water at 60°F (Rd60)
Density as API gravity (°API)

Primary input

Specifies the input that directly represents the measured quantity; also may select applicable measurement Standards. Values:

Standard (differential pressure, pulse count)
Rate integration (quantity flow rate, frequency)

Product group

Specifies the overall class of substance measured by this meter, and selects applicable measurement Standards. Values are:

Gas
Densities and compressibilities required for volume correction are calculated from the gas molar analysis by the Detail Characterization Method of the AGA 8 (1992) Standard.
Liquid (crudes, NGLs, LPGs)
Standards are API MPMS Chapters 11.1 and 11.2 (API 2540), Tables "A" and "E".
Liquid (refined products: gasolines, jet fuels, etc.)
Standards are API MPMS Chapters 11.1 and 11.2 (API 2540), Tables "B".
Liquid (oil-water emulsion)
Standards are API MPMS Chapters 11.1 and 11.2 (API 2540), Tables "A", together with the high-water-content algorithms of API MPMS Chapter 20.1.
Changes to this point are permitted only while the meter is disabled and cause a complete reinitialization of the meter configuration and zeroing of all accumulators.

Reference (contract) temperature

The reference (or "base", or "standard") temperature to which measured volumes are to be corrected. When this value is downloaded to the Module, the AFC firmware rounds it to the nearest 0.05°C or 0.10°F; the rounded value is used in all subsequent calculations. The rounding is silent (unannounced) and the value stored in the AFC project file does not change until the project (or meter) configuration is re-uploaded and the project file re-saved.

Reference (contract) pressure

The reference (or "base", or "standard") pressure to which measured volumes are to be corrected.

Meter calculation options

Several options affecting details of the measurement calculations. View bit-level detail for more information.

Downstream static pressure

Specifies whether the static pressure transmitter is downstream or upstream of the flow constriction that causes the differential pressure. Measurement Standards require that the static pressure supplied to the calculations be determined upstream of the constriction; if this option is set, then the differential pressure is added to the downstream static pressure to yield the upstream static pressure supplied to the calculations. If the meter is an integral type (such as a V-cone or wedge) that includes its own pressure transmitter, do not set this option.

Corner taps

Applicable only to traditional orifice meters, this option specifies a differential pressure tapping that is alternate to the more common flange tapping.

Radius taps

Applicable only to traditional orifice meters, this option specifies a differential pressure tapping that is alternate to the more common flange tapping.

V-cone/Wedge device

Most of the AGA 3 and ISO 5167 Standards specify the calculation of the coefficient of discharge of a traditional orifice meter. When a V-cone or Wedge meter is used instead, the Standard calculation is not applicable and the discharge coefficient must be entered directly from the manufacturer's data sheet into the point "V-cone/Wedge coefficient of discharge". For these devices, also, the effective diameter of the flow obstruction (not the aperture, as it is for traditional orifice meters) must be entered into the point "Orifice plate: measured diameter"; that value is calculated by a spreadsheet which is primed with data from the manufacturer's data sheet.

ISO 5167 (2003)

Applicable only to traditional orifice meters, this option selects the measurement Standard to be used for the calculation of the orifice discharge coefficient.
Values:

AGA 3 (1992)
ISO 5167 (2003)

Ignore default flowing density

If a process input is out of range, normal behavior is to substitute a default value (refer to the "Input scaling" points for information) and proceed with the calculations that use the input. In the case of density input at flowing conditions (liquid meter with meter calculation option "Density correction", bit 8, set) this behavior might be less than ideal, as this default value would still undergo correction to reference conditions causing the corrected density to vary depending on temperature and pressure. Setting this option causes the AFC to ignore the process input default and instead assume a corrected density from the stream parameter point "Default density at reference" and to skip the density correction calculation.

Density correction

This option enables the Standard calculation for correcting the density process input from flowing to reference conditions. The Standards applied are those in API MPMS Chapter 11.1 ("API 2540")

- SI units: Tables 53xx. The input density is converted to the units required by the Standard (kg/m3) before applying the calculation.
- US units: Tables 23xx. The input density is converted to the units required by the Standard (Rd60) before applying the calculation.

If this option is clear then the input density is deemed to be corrected already to reference conditions.

Hydrometer correction

When the density process input has been measured at flowing conditions with a glass hydrometer, this option enables an adjustment of the density correction calculation that further corrects for the effect of temperature on the volume of the hydrometer.

Temperature correction

This option enables the Standard calculation for CTL, the factor that corrects measured liquid volume from flowing to reference conditions for the effect of temperature, and which requires as input the corrected density. The Standards applied are those in API MPMS Chapter 11.1 ("API 2540").

- SI units: Tables 54xx. The corrected density is converted to the units required by the Standard (kg/m3) before applying the calculation.
- US units: Tables 24xx. The corrected density is converted to the units required by the Standard (Rd60) before applying the calculation.

If this option is clear, or if the calculation fails, then the CTL used to correct liquid volume is that given in the stream parameter point "Default CTL".

Pressure correction

This option enables the Standard calculation for CPL, the factor that corrects measured liquid volume from flowing to reference conditions for the effect of pressure, and which requires as input the corrected density. The Standards applied are those in API MPMS Chapter 11.2, and the particular calculation that is used depends on both the measurement system for the meter (SI or US units) and the density range (low or high). The corrected density is converted to the units required by the Standard before applying the calculation. If this option is clear, or if the calculation fails, then the CPL used to correct liquid volume is that given in the stream parameter point "Default CPL".

Vapor pressure via TP-15

With this option set, liquid vapor pressure is calculated according to the correlation given in the Gas Processors Association Technical Publication #15. Vapor pressure is significant only if it can rise above reference pressure at either reference or operating temperature and only if pressure correction is enabled (bit 11). If this option is clear, then the vapor pressure given in the stream parameter point "Default vapor pressure" is assumed.

Density correction for pressure

The API 2540 (1980) procedure for correcting density from operating to reference conditions considers only the effect of temperature. For lighter fluids flowing under elevated pressure the effect of pressure can be significant and should not be ignored. This option, effective only when density correction is performed, enables an iteration which applies CPL to the input observed density and recalculates corrected density and CPL, repeating until two successive densities differ by no more than 0.005 kg/m3 (SI Units) or 0.00005 Rd60.

Calculate net energy

With this option clear, calculated energy content of the stream is the gross heating value, in which produced water is deemed to be condensed to the liquid state and the latent heat released is included in the energy content. Setting this option causes calculation of net heating value, in which produced water is deemed to remain in the vapor state and does not contribute its latent heat of condensation to the energy content.

Meter control options

Several options affecting the handling and representation of data, and whether certain calculations are performed. View bit-level detail for more information.

Split-double pulse input

If set, the input from the pulse counter module is deemed to arrive as a split-double value, in which the actual value is (MSW * 10,000 + LSW). If clear, the pulse input is interpreted as a full 32-bit integer.

Split-double accumulators

If set, then accumulator totalizers are stored and presented as split-double quantities, in which the actual value is (MSW * 10,000 + LSW). If clear, then accumulator totalizers are stored and presented as full 32-bit integers. This option also affects the maximum meaningful value of the accumulator rollovers (three long integers at register 8150).

Treat analysis as process input

If this option is clear, the molar analysis is treated as a sealable parameter and changes to it are recorded in the event log. If this option is set, then changes to the analysis can occur freely, just like any other process input.

Meter enable

While disabled, a meter ignores all process input and signals and performs no measurement or archiving. Generally, an in-service meter is always enabled.

Input scaling, temperature, range low end

This is the lowest value allowed for temperature input, and for "raw" input corresponds to the D/A zero-scale value. An input less than this causes an out-of-range alarm. This and the two following points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, temperature, range high end

This is the highest value allowed for temperature input, and for "raw" input corresponds to the D/A full-scale value. An input greater than this causes an out-of-range alarm. This and the two surrounding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, temperature, default

This is the default value for temperature input, assumed when the actual input is out of range. This and the two preceding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, temperature, module id code

The "module id code" specifies the processing of the PLC-supplied value that is required in order to obtain the process input value in engineering units. Permitted values are:

–1 The PLC supplies temperature directly as a floating-point value.

0 The PLC supplies temperature directly as a fixed-point value, scaled to 2 decimal places.

>0 The PLC supplies the "raw" D/A value from an analog input module; this code selects from a predefined list of modules whose pertinent characteristics are its D/A zero-scale and full-scale values; the AFC scales the raw input so that the valid D/A range scales to the configured temperature range.

Input scaling, temperature, input frozen during calibration

This point holds the scaled temperature input present at the time that the input was switched to calibration mode. This value is used for all calculations while in calibration, until the input is switched out of calibration mode at which time normal operation is resumed.

Input scaling, pressure, range low end

This is the lowest value allowed for pressure input, and for "raw" input corresponds to the D/A zero-scale value. An input less than this causes an out-of-range alarm. This and the two following points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, pressure, range high end

This is the highest value allowed for pressure input, and for "raw" input corresponds to the D/A full-scale value. An input greater than this causes an out-of-range alarm. This and the two surrounding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, pressure, default

This is the default value for pressure input, assumed when the actual input is out of range. This and the two preceding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, pressure, module id code

The "module id code" specifies the processing of the PLC-supplied value that is required in order to obtain the process input value in engineering units. Permitted values are:

–1 The PLC supplies pressure directly as a floating-point value.

0 The PLC supplies pressure directly as a fixed-point value, scaled to 0 decimal places.

>0 The PLC supplies the "raw" D/A value from an analog input module; this code selects from a predefined list of modules whose pertinent characteristics are its D/A zero-scale and full-scale values; the AFC scales the raw input so that the valid D/A range scales to the configured pressure range.

Input scaling, pressure, input frozen during calibration

This point holds the scaled pressure input present at the time that the input was switched to calibration mode. This value is used for all calculations while in calibration, until the input is switched out of calibration mode at which time normal operation is resumed.

Input scaling, differential pressure, range low end

This is the lowest value allowed for differential pressure input, and for "raw" input corresponds to the D/A zero-scale value. An input less than this causes an out-of-range alarm. This and the two following points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, differential pressure, range high end

This is the highest value allowed for differential pressure input, and for "raw" input corresponds to the D/A full-scale value. An input greater than this causes an out-of-range alarm. This and the two surrounding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, differential pressure, default

This is the default value for differential pressure input, assumed when the actual input is out of range. This and the two preceding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, differential pressure, module id code

The "module id code" specifies the processing of the PLC-supplied value that is required in order to obtain the process input value in engineering units. Permitted values are:

–1 The PLC supplies differential pressure directly as a floating-point value.

0 The PLC supplies differential pressure directly as a fixed-point value, scaled to 3 decimal places.

>0 The PLC supplies the "raw" D/A value from an analog input module; this code selects from a predefined list of modules whose pertinent characteristics are its D/A zero-scale and full-scale values; the AFC scales the raw input so that the valid D/A range scales to the configured differential pressure range.

Input scaling, differential pressure, input frozen during calibration

This point holds the scaled differential pressure input present at the time that the input was switched to calibration mode. This value is used for all calculations while in calibration, until the input is switched out of calibration mode at which time normal operation is resumed.

Input scaling, flow rate, range low end

This is the lowest value allowed for flow rate input, and for "raw" input corresponds to the D/A zero-scale value. An input less than this causes an out-of-range alarm. This and the two following points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, flow rate, range high end

This is the highest value allowed for flow rate input, and for "raw" input corresponds to the D/A full-scale value. An input greater than this causes an out-of-range alarm. This and the two surrounding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, flow rate, default

This is the default value for flow rate input, assumed when the actual input is out of range. This and the two preceding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, flow rate, module id code

The "module id code" specifies the processing of the PLC-supplied value that is required in order to obtain the process input value in engineering units. Permitted values are:

–1 The PLC supplies flow rate directly as a floating-point value.

0 The PLC supplies flow rate directly as a fixed-point value, scaled to 0 decimal places.

>0 The PLC supplies the "raw" D/A value from an analog input module; this code selects from a predefined list of modules whose pertinent characteristics are its D/A zero-scale and full-scale values; the AFC scales the raw input so that the valid D/A range scales to the configured flow rate range.

Input scaling, flow rate, input frozen during calibration

This point holds the scaled flow rate input present at the time that the input was switched to calibration mode. This value is used for all calculations while in calibration, until the input is switched out of calibration mode at which time normal operation is resumed.

Input scaling, density, range low end

This is the lowest value allowed for density input, and for "raw" input corresponds to the D/A zero-scale value. An input less than this causes an out-of-range alarm. This and the two following points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

If a densitometer is configured and its calculation enabled (see "module id code"), then the PLC supplies a frequency to the densitometer calculation and this point applies to the calculated density.

Input scaling, density, range high end

This is the highest value allowed for density input, and for "raw" input corresponds to the D/A full-scale value. An input greater than this causes an out-of-range alarm. This and the two surrounding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

If a densitometer is configured and its calculation enabled (see "module id code"), then the PLC supplies a frequency to the densitometer calculation and this point applies to the calculated density.

Input scaling, density, default

This is the default value for density input, assumed when the actual input is out of range. This and the two preceding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

If a densitometer is configured and its calculation enabled (see "module id code"), then the PLC supplies a frequency to the densitometer calculation and this point applies to the calculated density.

Input scaling, density, module id code

The "module id code" specifies the processing of the PLC-supplied value that is required in order to obtain the process input value in engineering units. Permitted values are:

–1 The PLC supplies density directly as a floating-point value. Any densitometer configuration is ignored.

0 The PLC supplies density directly as a fixed-point value, scaled to 1 decimal place. Any densitometer configuration is ignored.

>0 If a densitometer is not configured then the PLC supplies the "raw" D/A value from an analog input module; this code selects from a predefined list of modules whose pertinent characteristics are its D/A zero-scale and full-scale values; the AFC scales the raw input so that the valid D/A range scales to the configured density range. If a densitometer is configured then any positive value for this point enables the densitometer calculation; in this case, the PLC supplies the densitometer frequency in Hz as a floating-point value and the calculated density is then subjected to the range check.

Input scaling, density, input frozen during calibration

This point holds the scaled density input present at the time that the input was switched to calibration mode. This value is used for all calculations while in calibration, until the input is switched out of calibration mode at which time normal operation is resumed. If a densitometer is configured and its calculation enabled (see "module id code"), then the PLC supplies a frequency to the densitometer calculation and while in calibration mode this point holds the latest calculated density.

Input scaling, water content, range low end

This is the lowest value allowed for water content input, and for "raw" input corresponds to the D/A zero-scale value. An input less than this causes an out-of-range alarm. This and the two following points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, water content, range high end

This is the highest value allowed for water content input, and for "raw" input corresponds to the D/A full-scale value. An input greater than this causes an out-of-range alarm. This and the two surrounding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, water content, default

This is the default value for water content input, assumed when the actual input is out of range. This and the two preceding points must satisfy the relationship:

(low range) ≤ (default) ≤ (high range)

Input scaling, water content, module id code

The "module id code" specifies the processing of the PLC-supplied value that is required in order to obtain the process input value in engineering units. Permitted values are:

–1 The PLC supplies water content directly as a floating-point value.

0 The PLC supplies water content directly as a fixed-point value, scaled to 2 decimal places.

>0 The PLC supplies the "raw" D/A value from an analog input module; this code selects from a predefined list of modules whose pertinent characteristics are its D/A zero-scale and full-scale values; the AFC scales the raw input so that the valid D/A range scales to the configured water content range.

Input scaling, water content, input frozen during calibration

This point holds the scaled water content input present at the time that the input was switched to calibration mode. This value is used for all calculations while in calibration, until the input is switched out of calibration mode at which time normal operation is resumed.

Analysis component map

Specifies which pure chemical substances contribute to molar analyses.

Selected component 1, C1

If set, then molar concentrations for component 1, C1, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 1, C1, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 2, N2

If set, then molar concentrations for component 2, N2, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 2, N2, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 3, CO2

If set, then molar concentrations for component 3, CO2, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 3, CO2, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 4, C2

If set, then molar concentrations for component 4, C2, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 4, C2, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 5,

If set, then molar concentrations for component 5, C3, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 5, C3, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 6, H2O

If set, then molar concentrations for component 6, H2O, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 6, H2O, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 7, H2S

If set, then molar concentrations for component 7, H2S, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 7, H2S, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 8, H2

If set, then molar concentrations for component 8, H2, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 8, H2, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 9, CO

If set, then molar concentrations for component 9, CO, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 9, CO, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 10, O2

If set, then molar concentrations for component 10, O2, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 10, O2, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 11, IC4

If set, then molar concentrations for component 11, IC4, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 11, IC4, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 12, NC4

If set, then molar concentrations for component 12, NC4, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 12, NC4, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 13, IC5

If set, then molar concentrations for component 13, IC5, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 13, IC5, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 14, NC5

If set, then molar concentrations for component 14, NC5, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 14, NC5, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 15, C6

If set, then molar concentrations for component 15, C6, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 15, C6, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 16, C7

If set, then molar concentrations for component 16, C7, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 16, C7, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 17, C8

If set, then molar concentrations for component 17, C8, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 17, C8, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 18, C9

If set, then molar concentrations for component 18, C9, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 18, C9, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 19, C10

If set, then molar concentrations for component 19, C10, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 19, C10, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 20, He

If set, then molar concentrations for component 20, He, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 20, He, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 21, Ar

If set, then molar concentrations for component 21, Ar, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 21, Ar, are ignored (assumed to be zero) even if supplied as non-zero.

Selected component 22, neoC5

If set, then molar concentrations for component 22, neoC5, are expected in molar analyses and enter into the calculations. If clear, then molar concentrations for component 22, neoC5, are ignored (assumed to be zero) even if supplied as non-zero.

Number of components

Total number of selected components. This value cannot be written by an external process (any value written is ignored) but is recalculated whenever the component map is changed by counting the selected components.

Analysis normalization total error tolerance

The number of parts per ten thousand by which the sum of all molar concentrations in a component analysis may differ from 1.0000 without raising the alarm "Analysis total not normalized" (register 9601 bit 10). Each analysis, whether alarmed or not, is always normalized (concentrations scaled so that they sum to 1.0000) before entering into any further calculations. This value is intended to allow for small deviations from normality due to such causes as unavoidable imprecision in the output of a gas chromatograph and roundoff error when converting an analysis to the form required by the AFC.

Pulse input rollover

The value at which the pulse count in the counter module is reset to zero, which is 1 greater than the highest value that the counter can have.

Resettable accumulator # select

The measured quantity that is to be accumulated in resettable accumulator #. Values depend on the product group.

None (no accumulation)
Mass
Energy (heating value)
Net (corrected) volume
Gross volume

Units: Primary input characteristics

This point characterizes the measured quantity, engineering units, and scaling of the primary input, which is the process input that represents the quantity of fluid being measured. Depending on the meter type, some of these characteristics are available for configuration while others are fixed and cannot be changed. See byte- and bit-level detail for more information.

Units: Primary input units

This value specifies the engineering units base and scaling of the measured quantity selected for the primary input. For some meter types (notably a traditional orifice) this value is fixed and cannot be changed. For a linear (pulse) meter it specifies K-factor characteristics. See accompanying documentation for a complete list of values.

Units: Primary input measured quantity and flow rate period

This value selects the measured quantity that the primary input represents, and the time base to which the primary input flow rate is referenced. For some meter types (notably a traditional orifice) this value is fixed and cannot be changed. For a linear (pulse) meter it characterizes the K-factor. View bit-level detail for more information.

Units: Primary input measured quantity

This value specifies the physical property of the fluid that is measured directly or indirectly by the primary input. Values are:

Mass
Energy (heating value)
Gross volume (volume at operating conditions)
For some meter types (notably a traditional orifice) this value is fixed and cannot be changed. For a linear (pulse) meter it characterizes the K-factor. For a traditional pulse meter such as a turbine, this quantity is "Gross volume".

Units: Primary input flow rate period

This value specifies the time period to which the primary input flow rate is referenced. Values are:

Second
Minute
Hour
Day
For all meter types except flow rate integration this value is fixed and cannot be changed.

Units: Mass flow rate period

This value specifies the time period to which the calculated mass flow rate is referenced. Values are:

Second
Minute
Hour
Day

Units: Mass flow rate units

This value specifies the engineering units and scaling of the calculated mass flow rate. See accompanying documentation for a complete list of values.

Units: Mass accumulator units

This value specifies the engineering units and scaling of the calculated mass accumulation. See accompanying documentation for a complete list of values.

Units: Energy flow rate period

This value specifies the time period to which the calculated energy flow rate is referenced. Values are:

Second
Minute
Hour
Day

Units: Energy flow rate units

This value specifies the engineering units and scaling of the calculated energy flow rate. See accompanying documentation for a complete list of values.

Units: Energy accumulator units

This value specifies the engineering units and scaling of the calculated energy accumulation. See accompanying documentation for a complete list of values.

Units: Volume flow rate period

This value specifies the time period to which calculated volume flow rates are referenced. Values are:

Second
Minute
Hour
Day

Units: Volume flow rate units

This value specifies the engineering units and scaling of calculated volume flow rates. See accompanying documentation for a complete list of values.

Units: Volume accumulator units

This value specifies the engineering units and scaling of calculated volume accumulations. See accompanying documentation for a complete list of values.

Accumulator rollover, mass

This is the value at which mass accumulators are reset to zero, and is 1 greater than the highest value that the accumulator may hold. For example, a value of 1000000 (6 zeros) specifies a 6-digit accumulator, which rolls over to 0 from 999999. Any unsigned 32-bit value may be given. A value of zero indicates a free-running accumulator, which rolls over to 0 from 655359999 (split-double) or 4294967295 (32-bit). For a split-double accumulator, a value greater than 655360000 is deemed to be 655360000, i.e. free-running. Default value is 100000000 (8 zeros).

Accumulator rollover, energy

This is the value at which energy accumulators are reset to zero, and is 1 greater than the highest value that the accumulator may hold. For example, a value of 1000000 (6 zeros) specifies a 6-digit accumulator, which rolls over to 0 from 999999. Any unsigned 32-bit value may be given. A value of zero indicates a free-running accumulator, which rolls over to 0 from 655359999 (split-double) or 4294967295 (32-bit). For a split-double accumulator, a value greater than 655360000 is deemed to be 655360000, i.e. free-running. Default value is 100000000 (8 zeros).

Accumulator rollover, volume

This is the value at which volume accumulators are reset to zero, and is 1 greater than the highest value that the accumulator may hold. For example, a value of 1000000 (6 zeros) specifies a 6-digit accumulator, which rolls over to 0 from 999999. Any unsigned 32-bit value may be given. A value of zero indicates a free-running accumulator, which rolls over to 0 from 655359999 (split-double) or 4294967295 (32-bit). For a split-double accumulator, a value greater than 655360000 is deemed to be 655360000, i.e. free-running. Default value is 100000000 (8 zeros).

Orifice plate: measurement temperature

The temperature at which the orifice diameter was measured. For a V-cone or Wedge device, this is the temperature at which the documented Beta ratio was determined.

Orifice plate: measured diameter

The measured inside diameter of the orifice. For a V-cone or Wedge device, this is instead the effective diameter of the flow obstruction, calculated by spreadsheet.

Orifice plate: coefficient of thermal expansion

The coefficient of thermal expansion of the material of the orifice plate. For an integral device such as a V-cone or Wedge, this is the expansion coefficient of the material of the device.

Meter tube: measurement temperature

The temperature at which the meter tube diameter was measured. For an integral device such as a V-cone or Wedge, which includes its own section of pipe, this is the temperature at which the documented Beta ratio was determined, and should be the same value as that of "Orifice plate: measurement temperature".

Meter tube: measured diameter

The measured inside diameter of the meter tube. For an integral device such as a V-cone or Wedge, which includes its own section of pipe, this is the inside diameter of that section.

Meter tube: coefficient of thermal expansion

The coefficient of thermal expansion of the material of the meter tube. For an integral device such as a V-cone or Wedge, which includes its own section of pipe, this is the expansion coefficient of the material of the device, and should be the same value as that of "Orifice plate: coefficient of thermal expansion".

Differential pressure flow threshold

An input differential pressure smaller than this is deemed to be zero.

Flow rate flow threshold

An input flow rate smaller than this is deemed to be zero.

Pulse frequency flow threshold

An input pulse frequency smaller than this is deemed to be zero.

Differential pressure alarm threshold

An input differential pressure smaller than this raises the alarm "Differential pressure low" (register 9601 bit 5).

Flow rate alarm threshold

An input flow rate smaller than this raises the alarm "Flow rate low" (register 9601 bit 5).

Pulse frequency alarm threshold

An input pulse frequency smaller than this raises the alarm "Pulse frequency low" (register 9601 bit 5).

V-cone/Wedge coefficient of discharge

Used only with meter calculation option "V-cone/wedge device" (bit 4), this is the coefficient of discharge from the manufacturer's data sheet or calculated via spreadsheet.

PLC address: Meter process input etc., get

The address in the PLC of the block of 56 registers that supplies process input for the meter calculations. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465481 (stored in the module as a value between 1 and 65481) and is the starting address in the 4x register bank of the block. For proper measurement of an enabled meter, this block is required. If the meter is disabled, this block is not accessed. For more information, refer to the documentation of your platform's backplane.

PLC address: Meter results, put

The address in the PLC of the block of 38 registers that returns calculated results to the PLC. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465499 (stored in the module as a value between 1 and 65499) and is the starting address in the 4x register bank of the block. If the meter is disabled, this block is not accessed. For more information, refer to the documentation of your platform's backplane.

PLC address: Meter archive fetch, put

The address in the PLC of the block of 42 registers that returns requested archive records to the PLC. If this value is 0 then the block does not exist and is not accessed. Otherwise, this value must lie between 400001 and 465495 (stored in the module as a value between 1 and 65495) and is the starting address in the 4x register bank of the block. If the meter is disabled, this block is not accessed. For more information, refer to the documentation of your platform's backplane.

Densitometer type code

Selects the algorithm which calculates density at operating conditions from a frequency input. Values are:

None (densitometer not configured)
Solartron 78xx series (also used by many other manufacturers)
Solartron 1762 series
UGC series
The densitometer calculation is performed when both

(1) this value is non-zero,

and

(2) the density "Input scaling: module id code" is a positive value selecting "raw" input,

and when it is performed it expects its input frequency (Hz) in floating point (regardless of the "module id code" setting) and the calculated output is taken as the density process input. In all other cases the value supplied by the PLC is the density process input.

Densitometer calibration parameter 1 (CalT)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 2 (CalP)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 3 (K0)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 4 (K1)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 5 (K2)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 6 (K18/PF1)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 7 (K19/PF2)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 8 (K20a/TCF)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 9 (K20b)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 10 (K21a)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 11 (K21b)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 12

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 13

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 14

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Open archive record select (age), daily

Enter the age of the desired daily archive record (1 through oldest) into this point and immediately read the selected record from the associated window. Click the "Addresses" button in the "Archive Configuration" window for more information.

Open archive record select (age), hourly

Enter the age of the desired hourly archive record (1 through oldest) into this point and immediately read the selected record from the associated window. Click the "Addresses" button in the "Archive Configuration" window for more information.

Checksum alarms

Checksum alarms detected for this meter. For more information, view bit-level detail and refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Meter configuration

During power-up the checksum for the non-volatile memory containing the meter configuration did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Meter component analysis

During power-up the checksum for the non-volatile memory containing the meter component analysis did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Meter accumulators

During power-up the checksum for the non-volatile memory containing the meter accumulators did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Meter archive status

During power-up the checksum for the non-volatile memory containing the meter archive status did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Meter archive detail, daily

During power-up the checksum for the non-volatile memory containing the meter archive detail, daily, did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Checksum alarm: Meter archive detail, hourly

During power-up the checksum for the non-volatile memory containing the meter archive detail, hourly, did not verify. For more information, refer to the site signal "Clear all checksum alarms" (register 200 bit 1).

Backplane return select, analysis, offset #

Specifies the meter data point, if any, whose value is to be returned over the backplane to the PLC in the word at offset # of the "analysis backplane return" block, and some details of its handling. For more information about this value, view bit-level detail (AFC Manager and stored AFC project files hide this detail). For more information about backplane return, refer to the documentation of your platform's backplane.

Backplane return select, analysis, offset #: Address

The meter-relative Modbus holding register address of the register to be returned at offset #. For registers that are part of register pairs (longs and floats) this address is little-endian, i.e. (address+0) addresses the LSR and (address+1) the MSR.

Backplane return select, analysis, offset #: Invert bit 0

This bit is not used by the firmware but is recorded for use by external software to enable proper handling of individual halves of Modbus register pairs.

Backplane return select, analysis, offset #: Swap words

This bit, present only for pairs of entries that refer to Modbus register pairs (longs and floats), enables those register pairs to be swapped or not according to platform, so that the long or float appears in the PLC in its native orientation.

Backplane return select, analysis, offset #: Defined

If set, then this entry is defined; if clear, then this entry is ignored and the PLC receives zero at offset #.

Backplane return select, process input, offset #

Specifies the meter data point, if any, whose value is to be returned over the backplane to the PLC in the word at offset # of the "process input backplane return" block. and some details of its handling. For more information about this value, view bit-level detail (AFC Manager and stored AFC project files hide this detail). For more information about backplane return, see backplane documentation for your platform.

Backplane return select, process input, offset #: Address

The meter-relative Modbus holding register address of the register to be returned at offset #. For registers that are part of register pairs (longs and floats) this address is little-endian, i.e. (address+0) addresses the LSR and (address+1) the MSR.

Backplane return select, process input, offset #: Invert bit 0

This bit is not used by the firmware but is recorded for use by external software to enable proper handling of individual halves of Modbus register pairs.

Backplane return select, process input, offset #: Swap words

This bit, present only for pairs of entries that refer to Modbus register pairs (longs and floats), enables those register pairs to be swapped or not according to platform, so that the long or float appears in the PLC in its native orientation.

Backplane return select, process input, offset #: Defined

If set, then this entry is defined; if clear, then this entry is ignored and the PLC receives zero at offset 0.

Archive configuration, daily, archive record template type

This code selects the size and basic layout of the daily archive record. Values are:

10 words (2 predefined)
20 words (6 predefined)
30 words (10 predefined)
40 words (10 predefined)

Archive configuration, daily, filename character

This ASCII character, which intrinsically distinguishes the two archive files, is incorporated into codes in the project file (.AFC) and the names of extended archive files on compact flash. It is always "D" for the daily archive file.

Archive configuration, daily, options

Settings that determine the conditions under which daily archive records are automatically written and resettable accumulators are automatically reset. View bit-level detail for more information.

Archive option, daily: Period-select, hourly

Selects which of the two period-ends determine the automatic writing of daily archive records and the automatic resetting of accumulators. Values are:

Daily period
Period-end is the minute of the day selected by the point "End-of-day minute" (register 120).
Hourly period
Period-end is the minute of the hour selected by the point "End-of-hour minute" (register 121).

By default, this bit is clear for the daily archive file, but it can be toggled to select the other period-end regardless of the designation of the archive file as "daily". Refer to the descriptions of other archive options for more information.

Archive option, daily: Archive upon period-end

Upon the end of the period selected by "Archive option, daily: Period-select, hourly" (bit 0), this option causes the meter signal "Write daily archive" (bit 8) to be issued automatically. Refer to the description of that signal for more information.

Archive option, daily: Archive upon event

When an event occurs that records a change that might affect the results of measurement calculations, such as a change to a sealable parameter, this option causes the meter signal "Write daily archive" (bit 8) to be issued automatically. Refer to the description of that signal for more information.

Archive option, daily: Reset accumulator # upon period-end

Upon the end of the period selected by "Archive option, daily: Period-select, hourly" (bit 0), this option causes the meter signal "Reset resettable accumulator #" (bit 4) to be issued automatically. The reset occurs regardless of whether an archive record is written at the same time. Refer to the description of that signal for more information.

Archive option, daily: Reset accumulator # upon event

When an event occurs that records a change that might affect the results of measurement calculations, such as a change to a sealable parameter, this option causes the meter signal "Reset resettable accumulator #" (bit 4) to be issued automatically. The reset occurs regardless of whether an archive record is written at the same time. Refer to the description of that signal for more information.

Archive configuration, daily, period accumulator select

The measured quantity that is to be accumulated in the daily archive period accumulator, which is reset automatically each time the daily archive is written. Values depend on the selected product group.

Archive configuration, daily, extended file size

The number of older daily archives to be stored on compact flash. A compact flash card MUST be installed in the module for this setting to have effect. Recent archives are stored locally in the Modbus Input Register bank; when a new archive is written the oldest local one is copied to the extended file freeing up its space to receive the new one. Refer to **Open archive record select (age), daily** for information about how to retrieve these archives. The maximum number of extended daily archives depends on the firmware version.

Archive configuration, daily, item # flags

Archive configuration, daily, item # address

Archive configuration, hourly, archive record template type

This code selects the size and basic layout of the hourly archive record. Values are:

10 words (2 predefined)
20 words (6 predefined)
30 words (10 predefined)
40 words (10 predefined)

Archive configuration, hourly, filename character

This ASCII character, which intrinsically distinguishes the two archive files, is incorporated into codes in the project file (.AFC) and the names of extended archive files on compact flash. It is always "H" for the hourly archive file.

Archive configuration, hourly, options

Settings that determine the conditions under which hourly archive records are automatically written and resettable accumulators are automatically reset. View bit-level detail for more information.

Archive option, hourly: Period-select, hourly

Selects which of the two period-ends determine the automatic writing of hourly archive records and the automatic resetting of accumulators. Values are:

Daily period
Period-end is the minute of the day selected by the point "End-of-day minute" (register 120).
Hourly period
Period-end is the minute of the hour selected by the point "End-of-hour minute" (register 121).
By default, this bit is set for the hourly archive file, but it can be toggled to select the other period-end regardless of the designation of the archive file as "hourly". Refer to the descriptions of other archive options for more information.

Archive option, hourly: Archive upon period-end

Upon the end of the period selected by "Archive option, hourly: Period-select, hourly" (bit 0), this option causes the meter signal "Write hourly archive" (bit 9) to be issued automatically. Refer to the description of that signal for more information.

Archive option, hourly: Archive upon event

When an event occurs that records a change that might affect the results of measurement calculations, such as a change to a sealable parameter, this option causes the meter signal "Write hourly archive" (bit 9) to be issued automatically. Refer to the description of that signal for more information.

Archive option, hourly: Reset accumulator # upon period-end

Upon the end of the period selected by "Archive option, hourly: Period-select, hourly" (bit 0), this option causes the meter signal "Reset resettable accumulator #" (bit 4) to be issued automatically. The reset occurs regardless of whether an archive record is written at the same time. Refer to the description of that signal for more information.

Archive option, hourly: Reset accumulator # upon event

When an event occurs that records a change that might affect the results of measurement calculations, such as a change to a sealable parameter, this option causes the meter signal "Reset resettable accumulator #" (bit 4) to be issued automatically. The reset occurs regardless of whether an archive record is written at the same time. Refer to the description of that signal for more information.

Archive configuration, hourly, period accumulator select

The measured quantity that is to be accumulated in the hourly archive period accumulator, which is reset automatically each time the hourly archive is written. Values depend on the product group.

Archive configuration, hourly, extended file size

The number of older hourly archives to be stored on compact flash. A compact flash card MUST be installed in the module for this setting to have effect. Recent archives are stored locally in the Modbus Input Register bank; when a new archive is written the oldest local one is copied to the extended file freeing up its space to receive the new one. Refer to **Open archive record select (age), hourly** for information about how to retrieve these archives. The maximum number of extended hourly archives depends on the firmware version.

Archive configuration, hourly, item # flags

Archive configuration, hourly, item # address

Stream options

Several options specifying how stream-specific information is handled. View bit-level detail for more information.

Use meter factor to full precision

The API Standard requires that meter factors used in calculations be rounded to 4 decimal places. This option allows that requirement to be vacated. Rounding applies only to the meter factor; the K-factor is always used to its full precision.

Interpolate K-factor

The primary measured quantity (usually gross volume) is calculated as (pulse count) divided by (K-factor) and multiplied by (meter factor). The common practice is to combine a static K-factor (from the meter manufacturer's data sheet) with a meter factor derived from one or more proves and optionally interpolated over flow rate; the K-factor is entered into the single stream parameter "K-factor" (register 8512) and the one or more proven meter factors and their associated flow rates are entered into the meter factor linearization table beginning at register 8530. Setting this option enables the less common practice of combining a static meter factor (usually always 1.0000) with a K-factor determined from proves and interpolation; the roles of K-factor and meter factor are swapped, with the meter factor entered into the single stream parameter "Meter factor" (register 8512) and the one or more proven K-factors and their associated flow rates entered into the K-factor linearization table beginning at register 8530.

Stream enable

If set, stream 1 is enabled and may be made active by issuing the corresponding meter signal. The meter must always have an active stream, hence the currently active stream may not be disabled and there is always at least one enabled stream.

Stream component accumulator select

The measured quantity to be accumulated in the per-component accumulators for stream #. Values:

None (no accumulation)
Mass
Energy (heating value)
Net (corrected) volume
Net (absolute) volume

Default relative density at reference

Normally, the AFC uses the "Detail Characterization Method" of the AGA 8 Standard to calculate the density of the gas from its composition as given by the molar analysis, which density is used in all subsequent calculations. When AGA 8 cannot be applied because no analysis is available (no components selected, or analysis is all zero), then this value supplies the density at reference conditions (relative to the density of air at reference) to be substituted for the output of AGA 8.

Viscosity (cP)

The viscosity of the fluid, used only in the calculation of the meter's coefficient of discharge.

Isentropic exponent

The ratio of (specific heat at constant pressure) to (specific heat at constant volume).

Default Fpv

Normally, the AFC uses the "Detail Characterization Method" of the AGA 8 Standard to calculate the compressibilities of the gas from its composition as given by the molar analysis, which compressibilities are used in all subsequent calculations. When AGA 8 cannot be applied because no analysis is available (no components selected, or analysis is all zero), then this value supplies the supercompressibility (which combines the effects of the compressibilities at both reference and operating conditions) to be substituted for the output of AGA 8.

K/Meter factor

The primary measured quantity (usually gross volume) is calculated as (pulse count) divided by (K-factor) and multiplied by (meter factor). One of those factors (usually the K-factor) is static and is entered here; the other factor (usually the meter factor) is calculated by interpolating from the table that begins at register 8530, which table in turn acquires its values from one or more meter provings at different flow rates. For more information, see stream option "Interpolate K-factor" (register 8500 bit 8).

Default energy content

Normally, the AFC uses the "Detail Characterization Method" of the AGA 8 Standard to calculate the heating value of the gas from its composition as given by the molar analysis, which heating value is used in all subsequent calculations. When AGA 8 cannot be applied because no analysis is available (no components selected, or analysis is all zero), then this value supplies the mass heating value to be substituted for the output of AGA 8.

Default density at reference

The density at reference conditions ("corrected density") to be substituted for use in measurement calculations when it is otherwise unavailable because either

(a) density process input is out of range, and both meter calculation options "Density correction" and "Ignore default flowing density" (register 8025 bits 8 and 7) are set,

or

(b) the density correction calculation fails (for example, if an input to the calculation is outside the range allowed by the Standard).

Default vapor pressure

The vapor pressure (gauge units) of the liquid. This value is used only when pressure correction is enabled (meter calculation option "Pressure correction", register 8025 bit 11) and either

(a) vapor pressure calculation is not enabled (meter calculation option "Vapor pressure via TP-15", register 8025 bit 12)

or

(b) the vapor pressure calculation fails.

Water density at API reference (kg/m3)

The density of the water contained in the emulsion, which value may vary depending on the salt content. Value is always expressed as kg/m3, and is limited to the range 900 through 1200 kg/m3.

Default CTL

CTL is the factor that corrects for the effect of temperature on liquid volume when correcting the volume to reference conditions, This value is used only when either

(a) temperature correction is not enabled (meter calculation option "Temperature correction", register 8025 bit 10)

or

(b) the temperature correction calculation fails.

Default CPL

CPL is the factor that corrects for the effect of pressure on liquid volume when correcting the volume to reference conditions, This value is used only when either

(a) pressure correction is not enabled (meter calculation option "Pressure correction", register 8025 bit 11)

or

(b) the pressure correction calculation fails.

Shrinkage factor

An adjustment to the computed net volume, applied to account for losses sustained during processing (after measurement but before billing or payment) such as evaporation of lighter fractions. This value is the fraction of the measured net volume that remains after processing, and is a number between 0.0000 (total loss) and 1.0000 (no loss).

Meter/K-factor linearization, point #, factor

The factor (meter factor or K-factor, depending on the setting of stream option "Interpolate K-factor", register 8500 bit 8) determined by a meter prove at the flow rate for linearization point #. This table may define up to 5 linearization points; a point is defined if its factor is non-zero and undefined if its factor is zero; at least one point must be defined. The factor used in subsequent calculations is determined by interpolating the flow rate over all defined points. These linearization points may be entered in any order and in any position; the AFC sorts them internally into an order suitable for the interpolation logic.

Meter/K-factor linearization, point #, flow rate

The flow rate of the primary input measured quantity at which the meter was proved when determining the factor for linearization point #. The primary input measured quantity is configured in the point "Units: Primary input characteristics" (register 8140), bitfield "Units: Primary input measured quantity" (bits 8 thru 11), which for a traditional pulse meter (such as a turbine) is "Gross volume". For defined linearization points (factor non-zero), all flow rates must be different; for undefined points (factor zero), flow rate must also be zero.

Analysis molar fraction, component 1

The concentration of the 1st component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 1 then this table entry #1 contains the concentration of the component identified by the 1st "1"-bit in the component map, and if the number of components is less than 1 then this table entry #1 is zero.

Analysis molar fraction, component 2

The concentration of the 2nd component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 2 then this table entry #2 contains the concentration of the component identified by the 2nd "1"-bit in the component map, and if the number of components is less than 2 then this table entry #2 is zero.

Analysis molar fraction, component 3

The concentration of the 3rd component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 3 then this table entry #3 contains the concentration of the component identified by the 3rd "1"-bit in the component map, and if the number of components is less than 3 then this table entry #3 is zero.

Analysis molar fraction, component 4

The concentration of the 4th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 4 then this table entry #4 contains the concentration of the component identified by the 4th "1"-bit in the component map, and if the number of components is less than 4 then this table entry #4 is zero.

Analysis molar fraction, component 5

The concentration of the 5th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 5 then this table entry #5 contains the concentration of the component identified by the 5th "1"-bit in the component map, and if the number of components is less than 5 then this table entry #5 is zero.

Analysis molar fraction, component 6

The concentration of the 6th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 6 then this table entry #6 contains the concentration of the component identified by the 6th "1"-bit in the component map, and if the number of components is less than 6 then this table entry #6 is zero.

Analysis molar fraction, component 7

The concentration of the 7th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 7 then this table entry #7 contains the concentration of the component identified by the 7th "1"-bit in the component map, and if the number of components is less than 7 then this table entry #7 is zero.

Analysis molar fraction, component 8

The concentration of the 8th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 8 then this table entry #8 contains the concentration of the component identified by the 8th "1"-bit in the component map, and if the number of components is less than 8 then this table entry #8 is zero.

Analysis molar fraction, component 9

The concentration of the 9th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 9 then this table entry #9 contains the concentration of the component identified by the 9th "1"-bit in the component map, and if the number of components is less than 9 then this table entry #9 is zero.

Analysis molar fraction, component 10

The concentration of the 10th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 10 then this table entry #10 contains the concentration of the component identified by the 10th "1"-bit in the component map, and if the number of components is less than 10 then this table entry #10 is zero.

Analysis molar fraction, component 11

The concentration of the 11th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 11 then this table entry #11 contains the concentration of the component identified by the 11th "1"-bit in the component map, and if the number of components is less than 11 then this table entry #11 is zero.

Analysis molar fraction, component 12

The concentration of the 12th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 12 then this table entry #12 contains the concentration of the component identified by the 12th "1"-bit in the component map, and if the number of components is less than 12 then this table entry #12 is zero.

Analysis molar fraction, component 13

The concentration of the 13th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 13 then this table entry #13 contains the concentration of the component identified by the 13th "1"-bit in the component map, and if the number of components is less than 13 then this table entry #13 is zero.

Analysis molar fraction, component 14

The concentration of the 14th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 14 then this table entry #14 contains the concentration of the component identified by the 14th "1"-bit in the component map, and if the number of components is less than 14 then this table entry #14 is zero.

Analysis molar fraction, component 15

The concentration of the 15th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 15 then this table entry #15 contains the concentration of the component identified by the 15th "1"-bit in the component map, and if the number of components is less than 15 then this table entry #15 is zero.

Analysis molar fraction, component 16

The concentration of the 16th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 16 then this table entry #16 contains the concentration of the component identified by the 16th "1"-bit in the component map, and if the number of components is less than 16 then this table entry #16 is zero.

Analysis molar fraction, component 17

The concentration of the 17th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 17 then this table entry #17 contains the concentration of the component identified by the 17th "1"-bit in the component map, and if the number of components is less than 17 then this table entry #17 is zero.

Analysis molar fraction, component 18

The concentration of the 18th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 18 then this table entry #18 contains the concentration of the component identified by the 18th "1"-bit in the component map, and if the number of components is less than 18 then this table entry #18 is zero.

Analysis molar fraction, component 19

The concentration of the 19th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 19 then this table entry #19 contains the concentration of the component identified by the 19th "1"-bit in the component map, and if the number of components is less than 19 then this table entry #19 is zero.

Analysis molar fraction, component 20

The concentration of the 20th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 20 then this table entry #20 contains the concentration of the component identified by the 20th "1"-bit in the component map, and if the number of components is less than 20 then this table entry #20 is zero.

Analysis molar fraction, component 21

The concentration of the 21st component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 21 then this table entry #21 contains the concentration of the component identified by the 21st "1"-bit in the component map, and if the number of components is less than 21 then this table entry #21 is zero.

Analysis molar fraction, component 22

The concentration of the 22nd component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 22 then this table entry #22 contains the concentration of the component identified by the 22nd "1"-bit in the component map, and if the number of components is less than 22 then this table entry #22 is zero.

Analysis molar fraction, component 23

The concentration of the 23rd component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 23 then this table entry #23 contains the concentration of the component identified by the 23rd "1"-bit in the component map, and if the number of components is less than 23 then this table entry #23 is zero.

Analysis molar fraction, component 24

The concentration of the 24th component selected in the "Analysis component map" at register 8130, represented as an integer scaled by 10000. The value is as input via configuration or over the backplane from the PLC, before normalization. Concentrations are packed towards the beginning of this table; if the number of components (in register 8130 bits 8 thru 15) is not less than 24 then this table entry #24 contains the concentration of the component identified by the 24th "1"-bit in the component map, and if the number of components is less than 24 then this table entry #24 is zero.

Input pulse count, archive reset, daily

This unsigned 32-bit integer holds the total pulses accumulated during the current daily archive period. When the daily archive is written this point is zeroed. No rollover is applied, as it is assumed that daily archives will be written frequently enough that this 32-bit quantity never overflows.

Input pulse count, archive reset, hourly

This unsigned 32-bit integer holds the total pulses accumulated during the current hourly archive period. When the hourly archive is written this point is zeroed. No rollover is applied, as it is assumed that hourly archives will be written frequently enough that this 32-bit quantity never overflows.

Previous input pulse count

At the end of the meter calculation scan the pulse count received from the PLC is copied to this non-volatile point. At the next scan this value is subtracted from the new pulse input to yield the pulse increment required for the calculations.

Current master pulse count

Pulses received from the PLC are accumulated here with a fixed rollover value of 100000000 (8 zeros). This allows an external monitoring application to track pulse input accurately even if its polling period is longer than the rollover period of the pulse input module.

Non-resettable accumulator, mass, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, mass, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, energy, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, energy, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, net, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, net, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, gross, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, gross, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, gross standard, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, gross standard, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, gross clean oil, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, gross clean oil, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, water, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Non-resettable accumulator, water, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Resettable accumulator #, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Resettable accumulator #, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Accumulator, archive period, daily, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Accumulator, archive period, daily, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Accumulator, archive period, hourly, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Accumulator, archive period, hourly, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Component non-resettable accumulator, component #, totalizer

The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Component non-resettable accumulator, component #, residue

The total accumulation is maintained in two parts; the previous point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer or split-double value, and this point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Process input, scaled float, temperature

This point holds the temperature input received from the PLC as a floating-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary. For more information, refer to the "Input scaling, temperature" points.

Process input, scaled float, pressure

This point holds the pressure input received from the PLC as a floating-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary. For more information, refer to the "Input scaling, pressure" points.

Process input, scaled float, differential pressure

This point holds the differential pressure input received from the PLC as a floating-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary. For more information, refer to the "Input scaling, differential pressure" points.

Process input, scaled float, flow rate

This point holds the flow rate input received from the PLC as a floating-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary. For more information, refer to the "Input scaling, flow rate" points.

Process input, scaled float, density

This point holds the density input received from the PLC as a floating-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary. If a densitometer is configured and its calculation enabled, then the PLC supplies a frequency to the densitometer calculation and this point holds the calculated density. For more information, refer to the "Input scaling, density" points.

Process input, scaled float, water content

This point holds the water content input received from the PLC as a floating-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary. For more information, refer to the "Input scaling, water content" points.

Process input, scaled integer, temperature

This point holds the temperature input received from the PLC as a fixed-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary, scaled to 2 decimal places. For more information, refer to the "Input scaling, temperature" points.

Process input, scaled integer, pressure

This point holds the pressure input received from the PLC as a fixed-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary, scaled to 0 decimal places. For more information, refer to the "Input scaling, pressure" points.

Process input, scaled integer, differential pressure

This point holds the differential pressure input received from the PLC as a fixed-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary, scaled to 3 decimal places. For more information, refer to the "Input scaling, differential pressure" points.

Process input, scaled integer, flow rate

This point holds the flow rate input received from the PLC as a fixed-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary, scaled to 0 decimal places. For more information, refer to the "Input scaling, flow rate" points.

Process input, scaled integer, density

This point holds the density input received from the PLC as a fixed-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary, scaled to 1 decimal place. If a densitometer is configured and its calculation enabled, then the PLC supplies a frequency to the densitometer calculation and this point holds the calculated density. For more information, refer to the "Input scaling, density" points.

Process input, scaled integer, water content

This point holds the water content input received from the PLC as a fixed-point value after conversion and scaling according to the "module id code" configured for the input and after its range is checked and the default substituted if necessary, scaled to 2 decimal places. For more information, refer to the "Input scaling, water content" points.

Temperature, absolute

The process input temperature in units relative to absolute zero; required for some calculations.

Upstream pressure, absolute

The process input pressure in absolute units, upstream of the differential meter flow constriction; required for some calculations. This value is calculated as (gauge pressure) + (barometric pressure) + (differential pressure).

Pressure, absolute

The process input pressure in absolute units; required for some calculations. This value is calculated as (gauge pressure) + (barometric pressure).

Densitometer frequency

Holds the process input densitometer frequency when a densitometer is configured and its calculation enabled. For more information, refer to the "Input scaling, density" points.

AGA 7, Temperature base factor, Ftb

This value is the ratio of the reference temperature to the traditional US gas-measurement "base" temperature of 519.67°R (60°F), where both temperatures are in consistent absolute units. It is a factor in the calculation of C-prime.

AGA 7, Pressure base factor, Fpb

This value is the ratio of the traditional US gas-measurement "base" pressure of 14.73 psia to the reference pressure, where both pressures are in consistent absolute units. It is a factor in the calculation of C-prime.

Meter alarms

Bitmap that announces exceptional conditions about measurement of meter 1. Bit 0 of "Meters in alarm" (register 301) is set whenever this point is non-zero. These alarms are transient and any one might persist only for a single scan, so they might be missed when viewing this register directly. However, alarms are also accumulated into the archive, so alarms that have occurred during any archive period may be viewed by inspecting the relevant archive; click the "Addresses" button in the "Archive Configuration" window for relevant Modbus addresses. See bit-level detail for more information.

Meter alarm: input out of range, temperature

The temperature process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, temperature" points.

Meter alarm: input out of range, pressure

The pressure process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, pressure" points.

Meter alarm: input out of range, differential pressure

The differential pressure process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, differential pressure" points.

Meter alarm: input out of range, flow rate

The flow rate process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, flow rate" points.

Meter alarm: input out of range, density

The density process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. If a densitometer is configured and its calculation enabled, then the PLC supplies a frequency to the densitometer calculation and this alarm applies to the calculated density. For more information, refer to the "Input scaling, density" points.

Meter alarm: input out of range, water content

The water content process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, water content" points.

Meter alarm: Differential pressure low

The differential pressure process input is smaller than the "Differential pressure alarm threshold".

Meter alarm: Flow rate low

The flow rate process input is smaller than the "Flow rate alarm threshold".

Meter alarm: Pulse frequency low

The pulse frequency process input is smaller than the "Pulse frequency alarm threshold".

Meter alarm: Orifice pressure exception

The combination of gauge pressure process input, differential pressure process input, barometric pressure (register 138), and the setting of meter calculation option "Downstream static pressure" (register 8025 bit 0) results in an effective downstream static pressure of less than vacuum, a physical impossibility. Upstream pressure is raised by the amount necessary to raise absolute downstream pressure to zero, and calculation continues.

Meter alarm: Accumulation overflow

An accumulator increment in a single scan that is unreasonable, i.e. less than 0 or greater than 1,000,000,000 (9 zeros), is ignored and this alarm is raised.

Meter alarm: Orifice characterization error

Orifice meter parameters are such that measurement cannot occur. The specific reason for this alarm is available in the point "Orifice characterization error" (register 9602).

Meter alarm: Analysis total zero

The input molar analysis is zero, therefore it cannot be normalized and cannot be input to AGA 8 for calculation of compressibilities and densities. Calculation proceeds as if no components were selected. The point "Analysis characterization error" (register 9603) contains the value 2.

Meter alarm: Analysis total not normalized

The input molar analysis sums to a total that is outside the tolerance allowed by the value of the point "Analysis normalization total error tolerance". The analysis is normalized anyway and is input to AGA 8 for calculation of compressibilities and densities. The point "Analysis characterization error" (register 9603) contains the value 1.

Meter alarm: Analysis characterization error

The characterization of the input analysis has encountered a problem. The specific reason for this alarm is available in the point "Analysis characterization error" (register 9603)

Meter alarm: Compressibility calculation error

The AGA 8 calculation has reported an error. The specific reason for this alarm is available in the point "Compressibility calculation error" (register 9604)

Meter alarm: High water error

The water content of the emulsion is too large. The specific reason for this alarm is available in the point "High water error" (register 9604)

Meter alarm: Reference density error

The density correction calculation has reported an error. The specific reason for this alarm is available in the point "Reference density error" (register 9605)

Meter alarm: Temperature correction error

The temperature correction calculation has reported an error. The specific reason for this alarm is available in the point "Temperature correction error" (register 9606)

Meter alarm: Vapor pressure error

The vapor pressure correlation calculation has reported an error. The specific reason for this alarm is available in the point "Vapor pressure error" (register 9607)

Meter alarm: Pressure correction error

The pressure correction calculation has reported an error. The specific reason for this alarm is available in the point "Pressure correction error" (register 9608)

Orifice characterization error

The error code reported by the orifice characterization procedure, which is run whenever orifice parameters are changed. A non-zero value sets the alarm "Meter alarm: Orifice characterization error" (register 9601 bit 8) and measurement does not occur. Values are:

No alarm
Orifice diameter not positive
Orifice not narrower than pipe
Beta ratio < 0.10 (0.025)
Beta ratio > 0.75 (0.9375)
Pipe diameter < 2.0 (0.5) inches
Orifice diameter < 0.45 (0.1125) inches
In the above table, the non-parenthesized numbers are the limits specified by the AGA 3 Standard, and the parenthesized numbers are the limits enforced by the AFC; the AFC relaxes the AGA limits to 25% of their Standard values.

Analysis characterization error

The error code reported by the analysis characterization procedure, which is run whenever a new analysis is input. Values are:

No alarm
Analysis total not normalized
The input molar analysis sums to a total that is outside the tolerance allowed by the value of the point "Analysis normalization total error tolerance". The analysis is normalized anyway and is input to AGA 8 for calculation of compressibilities and densities. The alarm "Meter alarm: Analysis normalization error" (register 9601 bit 10) is set.
Analysis total is zero
The input molar analysis is zero, therefore it cannot be normalized and cannot be input to AGA 8 for calculation of compressibilities and densities. Calculation proceeds as if no components were selected. The alarm "Meter alarm: Analysis total zero" (register 9601 bit 9) is set.

Compressibility calculation error

The error code reported by the AGA 8 calculation, which is run each calculation scan. If non-zero, the compressibility and density available at the point that the error occurred are assumed for use in subsequent calculations, but their values might not be reliable. A non-zero value sets the alarm "Meter alarm: Compressibility calculation error" (register 9601 bit 11). Values are:

No alarm
Density exceeded reasonable maximum
This is a warning only and does not terminate the calculation.
Pressure maximum found
Too many iterations (braket)
Too many iterations (ddetail)
A full understanding of these error codes requires familiarity with the mathematics of the AGA 8 procedure.

High water error

The error code reported by the initial stages of the API MPMS Chapter 20.1 calculation, which is run each calculation scan. A non-zero value sets the alarm "Meter alarm: High water error" (register 9601 bit 11). Values are:

No alarm
Emulsion is more than 99% water
The calculation of the density of the clean oil component of the emulsion becomes highly sensitive to errors in the density and water content process inputs when the clean oil concentration is very low, and is impossible to perform when the clean oil concentration is zero. In such cases the water content is assumed to be 100% and the clean oil content to be zero; clean oil accumulations and flow rates therefore are zero, and clean oil density is not calculated.

Reference density error

The error code reported by the density correction calculation, which is run each calculation scan. A non-zero value sets the alarm "Meter alarm: Reference density error" (register 9601 bit 12), and the stream parameter "Default corrected density" supplies the corrected density to be used in subsequent calculations. Values are:

No alarm
Low density range, input value outside allowable range of Table
High density range, input value outside allowable range of Table
Non-convergence of density correction iteration
Zero VCF
Temperature above critical point
Input density outside reference fluid adjusted range
Corrected density out of range
Standard density input outside API range

Temperature correction error

The error code reported by the temperature correction calculation, which is run each calculation scan. A non-zero value sets the alarm "Meter alarm: Temperature correction error" (register 9601 bit 13), and the stream parameter "Default CTL" supplies the temperature correction factor to be used in subsequent calculations. Values are:

No alarm
Low density range, input value outside allowable range of Table
High density range, input value outside allowable range of Table
Temperature above critical point

Vapor pressure error

The error code reported by the vapor pressure correlation calculation of GPA TP-15, which is run each calculation scan. A non-zero value sets the alarm "Meter alarm: Vapor pressure error" (register 9601 bit 14). Values are:

No alarm
Expected vapor pressure above range of TP-15
The stream parameter "Default vapor pressure" supplies the vapor pressure to be used in subsequent calculations.
Vapor pressure greater than measured static pressure
The vapor pressure above equilibrium is assumed to be zero.

Pressure correction error

The error code reported by the pressure correction calculation, which is run each calculation scan. A non-zero value sets the alarm "Meter alarm: Pressure correction error" (register 9601 bit 15), and the stream parameter "Default CPL" supplies the pressure correction factor to be used in subsequent calculations. Values are:

No alarm
Density outside allowable range of Chapter 11.2
Temperature above near critical limit
Temperature outside allowable range of Chapter 11.2.1
Temperature outside allowable range of Chapter 11.2.2
Non-convergence of CPL-density iteration

Water temperature error

The error code reported by the calculation of CTW, the factor that corrects water density for temperature, which is run each calculation scan. A non-zero value sets the alarm "Meter alarm: Temperature correction error" (register 9601 bit 13), and CTW is assumed to be 1.0000 for subsequent calculations. Values are:

No alarm
Temperature < 0°C or > 138°C or Temperature < 32°F or > 280°F

Scan count, process input

A free-running 16-bit counter, incremented once for each set of the meter's process input received from the PLC.

Scan count, calculation

A free-running 16-bit counter, incremented once for each execution of the meter's measurement calculations.

Molar mass of mixture

The average of the molar masses of the pure components of the fluid, weighted by their concentrations as given by the input analysis. This value is calculated by the analysis characterization procedure, which is run whenever the input analysis changes.

AGA 8, Ideal gas relative density

The ratio of the density of the ideal gas at reference conditions to that of air at reference conditions. This value is calculated by the analysis characterization procedure, which is run whenever the input analysis changes.

AGA 8, Compressibility at reference

The compressibility of the gas at reference conditions. This value is calculated by the analysis characterization procedure, which is run whenever the input analysis changes.

AGA 8, Molar density at reference

The density of the real gas at reference conditions in units of kmol/m3. This value is calculated by the analysis characterization procedure, which is run whenever the input analysis changes.

AGA 8, Density at reference

The density of the real gas at reference conditions. This value is calculated by the analysis characterization procedure, which is run whenever the input analysis changes.

AGA 8, Relative density at reference

The ratio of the density of the real gas at reference conditions to that of air at reference conditions. This value is calculated by the analysis characterization procedure, which is run whenever the input analysis changes.

AGA 8, Compressibility, flowing

The compressibility of the gas at operating conditions.

AGA 8, Molar density, flowing

The density of the real gas at operating conditions in units of kmol/m3.

AGA 8, Density, flowing

The density of the real gas at operating conditions.

AGA 8, Supercompressibility, Fpv

The square root of the ratio of (reference compressibility) to (flowing compressibility).

Previous timer tick count

Remembers the value of the system timer between calculation scans. For all meter types except traditional linear (pulse) meters, flow accumulation is calculated by integrating the flow rate over time. The system timer supplies this time, the increment of which is multiplied by the flow rate to yield the accumulation at each calculation scan.

Scan period (seconds)

The time elapsed between this calculation scan and the previous, which is the difference between the current system timer value and the previous value (point "Previous timer tick count" scaled by the timer tick rate. For all meter types except traditional linear (pulse) meters, flow accumulation is calculated by integrating the flow rate over time. The system timer supplies this time, the increment of which is multiplied by the flow rate to yield the accumulation at each calculation scan.

AGA 3, Pressure extension

The square root of the product of (differential pressure) and (static pressure); one of the factors in the Bernoulli equation for measurement of gas flow using differential pressure.

AGA 3, Density extension

The square root of the product of (differential pressure) and (flowing density); one of the factors in the Bernoulli equation for measurement of liquid flow using differential pressure.

AGA 3, Differential pressure in static pressure units

The differential pressure converted to the units of static pressure.

AGA 3, Orifice bore diameter at temperature

The configured diameter of the orifice (or, for a V-cone or Wedge meter, the effective diameter of the flow constriction) corrected for the effect of temperature.

AGA 3, Meter tube inside diameter at temperature

The configured inside diameter of the meter tube corrected for the effect of temperature.

AGA 3, Beta ratio

The ratio at operating temperature of the orifice bore diameter to the diameter of the meter tube (or, for a V-cone or Wedge meter, the square root of the ratio of the apertures).

Density, flowing

The density of the gas at operating conditions.

AGA 3, Mass flow rate, Qm

The flow rate calculated from the Bernoulli equation.

AGA 3, Velocity of approach factor, Ev

The square root of (1 minus the reciprocal of Beta to the 4th power), one of the factors in the Bernoulli equation for measurement of fluid flow using differential pressure.

AGA 3, Expansion factor, Y

One of the factors in the Bernoulli equation for measurement of fluid flow using differential pressure. This factor represents the effect of the expansion of the fluid due to the differential pressure drop across the flow constriction; it is always 1.0 for liquids, which are deemed to be incompressible.

AGA 3, Coefficient of discharge, Cd

The coefficient of discharge for the meter, one of the factors in the Bernoulli equation for measurement of fluid flow using differential pressure. For a traditional orifice meter, this value is calculated by the procedure given in the AGA 3 (1992) Standard or the ISO 5167 (2003) Standard, depending on the setting of meter calculation option "ISO 5167 (2003)" (register 8025 bit 5). For a V-cone or Wedge meter, selected by the setting of meter calculation option "V-cone/Wedge device" (register 8025 bit 4), this value is copied from the point "V-cone/Wedge coefficient of discharge" which in turn receives its value from a spreadsheet primed with data from the manufacturer's data sheet.

Composition factor

This factor multiplied by the pressure extension is the density extension required by the AGA 3 / ISO 5167 Standard. It is the product of supercompressibility and the square root of (air factor times relative density at reference divided by absolute flowing temperature). The air factor depends only on the reference conditions and is the molar mass of air divided by (gas constant times compressibility of air at reference).

AGA 7, Temperature factor, Ftm

This value is the ratio of the traditional US gas-measurement "base" temperature of 519.67°R (60°F) to the operating temperature, where both temperatures are in consistent absolute units. It is a factor in the calculation of C-prime.

AGA 7, Pressure factor, Fpm

This value is the ratio of the operating pressure to the traditional US gas-measurement "base" pressure of 14.73 psia, where both pressures are in consistent absolute units. It is a factor in the calculation of C-prime.

C-prime

This value is the product of:

- the square of "AGA 8, Supercompressibility, Fpv"
- "AGA 7, Temperature factor, Ftb"
- "AGA 7, Temperature base factor, Ftb"
- "AGA 7, Pressure factor, Fpb"
- "AGA 7, Pressure base factor, Fpb"

It is the factor, according to the Gas Law, that converts gross volume (measured at operating conditions) to net volume (corrected to reference conditions).

C-prime

This value is the quotient of "AGA 8, Density, flowing" divided by "AGA 8, Density at reference". It is the factor, according to the Gas Law, that converts gross volume (measured at operating conditions) to net volume (corrected to reference conditions).

Molar heating value, MJ/kmol

This value depends only on the molar analysis and the setting of "Meter calculation options" bit 14, "Calculate net energy".

Mass heating value

This value depends only on the molar analysis and the setting of "Meter calculation options" bit 14, "Calculate net energy".

Volumetric heating value

This value depends only on the molar analysis, the reference conditions, and the setting of "Meter calculation options" bit 14, "Calculate net energy".

Clean oil mass fraction

The fraction of the total mass of the liquid that represents the clean oil component (water removed). For this product group, this value is the same as "API 2540, Water content correction factor, CSW".

MPMS Ch 20.1, Density of produced water, flowing

The density of the water component of the emulsion determined at operating conditions.

MPMS Ch 20.1, Water temperature correction to user base

The factor that corrects for the effect of temperature the volume of the water component of the emulsion to the reference conditions configured by the user.

MPMS Ch 20.1, Water temperature correction to API base

The factor that corrects for the effect of temperature the volume of the water component of the emulsion to the reference conditions of the API Standard.

MPMS Ch 20.1, Water salinity percent by mass

A measure of the salt content of the water component of the emulsion, determined from the density of pure water and stream parameter "Water density at API reference (kg/m3)".

API 2540, Vapor pressure, absolute

The absolute vapor pressure of the liquid, calculated by GPA TP-15 or assumed upon vapor pressure error. This value is meaningful only when both meter calculation options "Pressure correction" (bit 11) and "Vapor pressure via TP-15" (bit 12) are set.

API 2540, Density at API base

The density of the fluid corrected to the reference conditions of the API Standard.

API 2540, Hydrometer correction factor

The factor that corrects for the effect of temperature the volume of a glass hydrometer that is used to hold a sample of the fluid for the measurement of density at operating conditions. This value is calculated only when meter calculation option "Density correction" (bit 8) is set, and is 1.0000 unless meter calculation option "Hydrometer correction" (bit 9) is set.

API 2540, Density at reference

The density of the fluid corrected to the reference conditions configured by the user.

API 2540, Vapor pressure, gauge

The excess of the absolute vapor pressure of the liquid above the reference pressure configured by the user. If the absolute vapor pressure is less than reference, this value is zero. This value is meaningful only when both meter calculation options "Pressure correction" (bit 11) and "Vapor pressure via TP-15" (bit 12) are set.

API 2540, CPL low density factor A

The "A" factor calculated by API MPMS Chapter 11.2.2, for the correction for the effect of pressure of the volume of low-density hydrocarbons to the reference conditions configured by the user. This value is calculated only when meter calculation option "Pressure correction" (bit 11) is set.

API 2540, CPL low density factor B

The "B" factor calculated by API MPMS Chapter 11.2.2, for the correction for the effect of pressure of the volume of low-density hydrocarbons to the reference conditions configured by the user. This value is calculated only when meter calculation option "Pressure correction" (bit 11) is set.

API 2540, CPL factor F

The compressibility factor calculated by API MPMS Chapter 11.2, for the correction for the effect of pressure of volume to the reference conditions configured by the user. This value is calculated only when meter calculation option "Pressure correction" (bit 11) is set.

API 2540, Temperature correction factor, CTL

The factor that corrects volume for the effect of temperature to the reference conditions configured by the user.

API 2540, Pressure correction factor, CPL

The factor that corrects volume for the effect of pressure to the reference conditions configured by the user.

Density calculation select

Flags that select Standard calculations according to attributes of density.

Low density range for CPL calculation

Selects the procedure that calculates the compressibility factor for correcting volume for the effect of pressure to reference conditions. This value is meaningful only when meter calculation option "Pressure correction" (bit 11) is set. Values are:

High density range
Use API MPMS Chapter 11.2.1
Low density range
Use API MPMS Chapter 11.2.2

Input density is at reference

States whether the density supplied by the PLC or assumed from a default value, according to the settings of meter calculation options "Density correction" (bit 8) and "Ignore default flowing density" (bit 7), is at operating conditions or is already corrected to the reference conditions configured by the user. Values are:

Input density is at operating conditions
Input density is already corrected to reference conditions; no density correction need be performed

Input density is net oil at reference

States whether the density supplied by the PLC or assumed from a default value, according to the settings of meter calculation options "Density correction" (bit 8) and "Ignore default flowing density" (bit 7), is that of the emulsion at operating conditions or is that of the clean oil already corrected to the reference conditions configured by the user. Values are:

Input density is at operating conditions
Input density is already corrected to reference conditions; no density correction need be performed and water content has been removed

AGA 3, Beta ratio

The ratio at operating temperature of the orifice bore diameter to the diameter of the meter tube (or, for a V-cone or Wedge meter, the square root of the ratio of the apertures), represented as an integer scaled to 4 decimal places.

AGA 3, Velocity of approach factor

The square root of (1 minus the reciprocal of Beta to the 4th power), one of the factors in the Bernoulli equation for measurement of fluid flow using differential pressure, represented as an integer scaled to 4 decimal places.

AGA 3, Expansion factor

One of the factors in the Bernoulli equation for measurement of fluid flow using differential pressure, represented as an integer scaled to 4 decimal places. This factor represents the effect of the expansion of the fluid due to the differential pressure drop across the flow constriction; it is always 1.0 (i.e. 10000, here) for liquids, which are deemed to be incompressible.

AGA 3, Coefficient of discharge

The coefficient of discharge for the meter, one of the factors in the Bernoulli equation for measurement of fluid flow using differential pressure, represented as an integer scaled to 4 decimal places. For a traditional orifice meter, this value is calculated by the procedure given in the AGA 3 (1992) Standard or the ISO 5167 (2003) Standard, depending on the setting of meter calculation option "ISO 5167 (2003)" (register 8025 bit 5). For a V-cone or Wedge meter, selected by the setting of meter calculation option "V-cone/Wedge device" (register 8025 bit 4), this value is copied from the point "V-cone/Wedge coefficient of discharge" which in turn receives its value from a spreadsheet primed with data from the manufacturer's data sheet.

API 2540, Water content correction factor, CSW

The fraction of the total volume of the emulsion at operating conditions that represents the clean oil component, represented as an integer scaled to 4 decimal places.

Startup input pulse count

Upon power up the point "Previous input pulse count" is copied to this point and the "Previous input pulse count" is zeroed. Under the more likely scenario in which the pulse input module has also lost power and been restarted with its pulse counter zeroed, this results in an accurate pulse increment being computed for the first meter scan after power-up. In the less likely scenario in which the pulse input card has retained the value of its pulse counter, this point contains the information required in order to adjust for the spurious but possibly large pulse increment computed for the first meter scan.

Current input pulse count

The pulse count as received from the PLC.

Pulse increment

The number of pulses counted during this calculation scan, which is the difference (adjusted for rollover) between "Previous input pulse count" and "Current input pulse count". It is the raw measure of the flow increment to be accumulated for this scan.

Pulse frequency

The latest pulse frequency as received from the PLC.

K-factor

The K-factor actually used in the calculation of the primary input measured quantity from pulse count. It is either a copy of stream parameter "K-factor" or determined by interpolation over flow rate of the stream table "K-factor linearization", depending on the setting of stream option "Interpolate K-factor".

Meter factor

The meter factor actually used in the calculation of the primary input measured quantity from pulse count. It is either a copy of stream parameter "Meter factor" or determined by interpolation over flow rate of the stream table "Meter factor linearization", depending on the setting of stream option "Interpolate K-factor".

Multiplier, K-factor flow rate

The factor that when applied to the primary input flow rate scaled to the configured K-factor units ("Primary input units", yields the primary input flow rate scaled to the configured flow rate units for the "Primary input measured quantity" bits 8 thru 11). This value, which is the same as one of the three flow rate multipliers (selected according to the measured quantity), is combined with input pulse frequency, K-factor, and meter factor to yield the flow rate to be used in interpolating the factor linearization table for the stream.

Multiplier, mass flow rate

The factor that when applied to the mass flow rate scaled to the configured primary input units yields the mass flow rate scaled to the configured flow rate units.

Multiplier, energy flow rate

The factor that when applied to the energy flow rate scaled to the configured primary input units yields the energy flow rate scaled to the configured flow rate units.

Multiplier, volume flow rate

The factor that when applied to the volume flow rate scaled to the configured primary input units yields the volume flow rate scaled to the configured flow rate units.

Multiplier, mass accumulator

The factor that when applied to the mass flow increment scaled to the configured primary input units yields the mass flow increment scaled to the configured accumulator units.

Multiplier, energy accumulator

The factor that when applied to the energy flow increment scaled to the configured primary input units yields the energy flow increment scaled to the configured accumulator units.

Multiplier, volume accumulator

The factor that when applied to the volume flow increment scaled to the configured primary input units yields the volume flow increment scaled to the configured accumulator units.

Accumulator increment, mass

The flow increment added to the mass accumulator during this scan.

Accumulator increment, energy

The flow increment added to the energy accumulator during this scan.

Accumulator increment, net

The flow increment added to the net accumulator during this scan.

Accumulator increment, gross

The flow increment added to the gross accumulator during this scan.

Accumulator increment, gross standard

The flow increment added to the gross standard accumulator during this scan.

Accumulator increment, gross clean oil

The flow increment added to the gross clean oil accumulator during this scan.

Accumulator increment, water

The flow increment added to the water accumulator during this scan.

Flow rate, mass

The mass flow rate calculated during this scan.

Flow rate, energy

The energy flow rate calculated during this scan.

Flow rate, net

The net flow rate calculated during this scan.

Flow rate, gross

The gross flow rate calculated during this scan.

Flow rate, gross standard

The gross standard flow rate calculated during this scan.

Flow rate, gross clean oil

The gross clean oil flow rate calculated during this scan.

Flow rate, water

The water flow rate calculated during this scan.

Current archive, daily, closing timestamp (packed)

The closing timestamp of the archive, which for the current (on-going) archive is the timestamp of its latest update. If the site option "Return Unix-style timestamps via virtual slave" (register 119 bit 0) is set and this value is read from the virtual slave, then it appears as seconds since 1970 (Unix style) and its bit-field encoding is not relevant. Otherwise the timestamp is packed into bit fields with a resolution of 2 seconds; view bit-level detail for more information.

Current archive, daily, closing timestamp (packed), bisecond

The archive's closing timestamp second of the minute divided by 2; value 0 thru 29.

Current archive, daily, closing timestamp (packed), minute

The archive's closing timestamp minute of the hour; value 0 thru 59.

Current archive, daily, closing timestamp (packed), hour

The archive's closing timestamp hour of the day, using the 24-hour clock; value 0 thru 23.

Current archive, daily, closing timestamp (packed), day

The archive's closing timestamp day of the month less 1; value 0 thru (days in month) – 1.

Current archive, daily, closing timestamp (packed), month

The archive's closing timestamp month of the year less 1; value 0 thru 11.

Current archive, daily, closing timestamp (packed), year

The archive's closing timestamp year less 1996; value 0 thru 103 (through year 2099).

Current archive, daily, flowing period fraction

The fraction of the archive period during which flow occurred. This is calculated as

(number of scans with flow) / (total number of scans)

and is expressed as an integer scaled to 4 decimal places (so that "10000" means 1.0000, i.e. continuous flow). The period covered is the period that contributes to this record, i.e. the period between the opening timestamp and the closing timestamp.

Current archive, daily, cumulative meter alarms

Bitmap of all meter alarms occurring during the archive period, calculated by OR-ing into this point at the end of each calculation scan the contents of "Meter alarms", register 9601. See bit-level detail for more information.

Current archive, daily, cumulative meter alarm: input out of range, temperature

The temperature process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, temperature" points.

Current archive, daily, cumulative meter alarm: input out of range, pressure

The pressure process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, pressure" points.

Current archive, daily, cumulative meter alarm: input out of range, differential pressure

The differential pressure process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, differential pressure" points.

Current archive, daily, cumulative meter alarm: input out of range, flow rate

The flow rate process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, flow rate" points.

Current archive, daily, cumulative meter alarm: input out of range, density

The density process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. If a densitometer is configured and its calculation enabled, then the PLC supplies a frequency to the densitometer calculation and this alarm applies to the calculated density. For more information, refer to the "Input scaling, density" points.

Current archive, daily, cumulative meter alarm: input out of range, water content

The water content process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, water content" points.

Current archive, daily, cumulative meter alarm: Differential pressure low

The differential pressure process input is smaller than the "Differential pressure alarm threshold".

Current archive, daily, cumulative meter alarm: Flow rate low

The flow rate process input is smaller than the "Flow rate alarm threshold".

Current archive, daily, cumulative meter alarm: Pulse frequency low

The pulse frequency process input is smaller than the "Pulse frequency alarm threshold".

Current archive, daily, cumulative meter alarm: Orifice pressure exception

The combination of gauge pressure process input, differential pressure process input, barometric pressure (register 138), and the setting of meter calculation option "Downstream static pressure" (register 8025 bit 0) results in an effective downstream static pressure of less than vacuum, a physical impossibility. Upstream pressure is raised by the amount necessary to raise absolute downstream pressure to zero, and calculation continues.

Current archive, daily, cumulative meter alarm: Accumulation overflow

An accumulator increment in a single scan that is unreasonable, i.e. less than 0 or greater than 1,000,000,000 (9 zeros), is ignored and this alarm is raised.

Current archive, daily, cumulative meter alarm: Orifice characterization error

Orifice meter parameters are such that measurement cannot occur. While the original meter alarm is active, the specific reason for this alarm is available in the point "Orifice characterization error" (register 9602).

Current archive, daily, cumulative meter alarm: Analysis total zero

The input molar analysis is zero, therefore it cannot be normalized and cannot be input to AGA 8 for calculation of compressibilities and densities. Calculation proceeds as if no components were selected. The point "Analysis characterization error" (register 9603) contains the value 2.

Current archive, daily, cumulative meter alarm: Analysis total not normalized

The input molar analysis sums to a total that is outside the tolerance allowed by the value of the point "Analysis normalization total error tolerance". The analysis is normalized anyway and is input to AGA 8 for calculation of compressibilities and densities. The point "Analysis characterization error" (register 9603) contains the value 1.

Current archive, daily, cumulative meter alarm: Analysis characterization error

The characterization of the input analysis has encountered a problem. While the original meter alarm is active, the specific reason for this alarm is available in the point "Analysis characterization error" (register 9603)

Current archive, daily, cumulative meter alarm: Compressibility calculation error

The AGA 8 calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Compressibility calculation error" (register 9604)

Current archive, daily, cumulative meter alarm: High water error

The water content of the emulsion is too large. While the original meter alarm is active, the specific reason for this alarm is available in the point "High water error" (register 9604)

Current archive, daily, cumulative meter alarm: Reference density error

The density correction calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Reference density error" (register 9605)

Current archive, daily, cumulative meter alarm: Temperature correction error

The temperature correction calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the points "Temperature correction error" and/or "Water temperature error".

Current archive, daily, cumulative meter alarm: Vapor pressure error

The vapor pressure correlation calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Vapor pressure error" (register 9607)

Current archive, daily, cumulative meter alarm: Pressure correction error

The pressure correction calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Pressure correction error" (register 9608)

Current archive, daily, meter number (1-based)

This value is always 1.

Current archive, daily, cumulative meter status

Bitmap of selected meter status accumulated during the archive period, calculated by OR-ing into this point at the end of each calculation scan the contents of "Meter status". View bit-level detail for more information.

Current archive, daily, cumulative meter status: Meter enabled

The state of the meter has been switched from disabled to enabled during the archive period.

Current archive, daily, cumulative meter status: Backplane communications fault

Loss of communication with the PLC has been detected during the archive period. This is usually due to a switch of the PLC to program mode.

Current archive, daily, cumulative meter status: Measurement configuration changed

Configured items that might affect measurement calculations have been changed during the archive period.

Current archive, daily, cumulative meter status: Power up

The module lost power and has been rebooted during the archive period.

Current archive, daily, cumulative meter status: Cold start

A cold start (complete reinitialization) has occurred during the archive period.

Current archive, daily, event count

The number of the last event recorded during the archive period. This value is 1 less than the value of "Next event number" at register 40002 of the Input Register bank.

Current archive, daily, flowing period (seconds)

The number of seconds during which flow was detected during the archive period.

Current archive, daily, opening timestamp (packed)

The opening timestamp of the archive. If the site option "Return Unix-style timestamps via virtual slave" (register 119 bit 0) is set and this value is read from the virtual slave, then it appears as seconds since 1970 (Unix style) and its bit-field encoding is not relevant. Otherwise the timestamp is packed into bit fields with a resolution of 2 seconds; view bit-level detail for more information.

Current archive, daily, opening timestamp (packed), bisecond

The archive's opening timestamp second of the minute divided by 2; value 0 thru 29.

Current archive, daily, opening timestamp (packed), minute

The archive's opening timestamp minute of the hour; value 0 thru 59.

Current archive, daily, opening timestamp (packed), hour

The archive's opening timestamp hour of the day, using the 24-hour clock; value 0 thru 23.

Current archive, daily, opening timestamp (packed), day

The archive's opening timestamp day of the month less 1; value 0 thru (days in month) – 1.

Current archive, daily, opening timestamp (packed), month

The archive's opening timestamp month of the year less 1; value 0 thru 11.

Current archive, daily, opening timestamp (packed), year

The archive's opening timestamp year less 1996; value 0 thru 103 (through year 2099).

Current archive, daily, item #

Archive file header, daily: Archive record template type

This code selects the size and basic layout of the daily archive record. Values are:

10 words (2 predefined)
20 words (6 predefined)
30 words (10 predefined)
40 words (10 predefined)
This value is a copy of the corresponding configuration item at register 12340.L.

Archive file header, daily: Archive detail record size

The size of each daily archive record in words. This value is determined by the value of "Archive file header, daily: Archive record template type", register 12340.L.

Archive file header, daily: Number of records, local

The number of daily archive records stored locally and available by direct access to the Modbus Input Register bank. This value depends on the archive record size and is the total number of archive records that will fit into 1060 words. Click the "Addresses" button in the "Archive Configuration" window for more information.

Archive file header, daily: Number of records, extended

The actual number of records in the extended daily archive file. If a Compact Flash card is installed, this value is the same as that of "Archive configuration, daily, extended file size", register 12343; if a Compact Flash card is not installed, this value is zero.

Archive file header, daily: Index of last write, local

This number is maintained by the AFC to keep track of the physical location in the AFC's memory where the newest (age 1) local daily archive record has been stored. Outside the AFC it provides no useful information.

Archive file header, daily: Index of last write, extended

This number is maintained by the AFC to keep track of the physical location on the Compact Flash card where the newest extended daily archive record has been stored. Outside the AFC it provides no useful information.

Archive file header, daily: Modbus holding register address, header

This is the address in the Modbus Holding Register bank of the file header of the daily archive file. For this archive file it is always 13940.

Archive file header, daily: Modbus input register address, detail

This is the address in the Modbus Input Register bank of the local daily archive file. For this archive file it is always 5000. Click the "Addresses" button in the "Archive Configuration" window for more information.

Archive file header, daily: Modbus holding register address, summary

This is the address in the Modbus Holding Register bank of the current-period (ongoing) daily archive record. For this archive file it is always 13900. Click the "Addresses" button in the "Archive Configuration" window for more information.

Current archive, hourly, closing timestamp (packed)

The closing timestamp of the archive, which for the current (on-going) archive is the timestamp of its latest update. If the site option "Return Unix-style timestamps via virtual slave" (register 119 bit 0) is set and this value is read from the virtual slave, then it appears as seconds since 1970 (Unix style) and its bit-field encoding is not relevant. Otherwise the timestamp is packed into bit fields with a resolution of 2 seconds; view bit-level detail for more information.

Current archive, hourly, closing timestamp (packed), bisecond

The archive's closing timestamp second of the minute divided by 2; value 0 thru 29.

Current archive, hourly, closing timestamp (packed), minute

The archive's closing timestamp minute of the hour; value 0 thru 59.

Current archive, hourly, closing timestamp (packed), hour

The archive's closing timestamp hour of the day, using the 24-hour clock; value 0 thru 23.

Current archive, hourly, closing timestamp (packed), day

The archive's closing timestamp day of the month less 1; value 0 thru (days in month) –1.

Current archive, hourly, closing timestamp (packed), month

The archive's closing timestamp month of the year less 1; value 0 thru 11.

Current archive, hourly, closing timestamp (packed), year

The archive's closing timestamp year less 1996; value 0 thru 103 (through year 2099).

Current archive, hourly, flowing period fraction

The fraction of the archive period during which flow occurred. This is calculated as

(number of scans with flow) / (total number of scans)

and is expressed as an integer scaled to 4 decimal places (so that "10000" means 1.0000, i.e. continuous flow). The period covered is the period that contributes to this record, i.e. the period between the opening timestamp and the closing timestamp.

Current archive, hourly, cumulative meter alarms

Bitmap of all meter alarms occurring during the archive period, calculated by OR-ing into this point at the end of each calculation scan the contents of "Meter alarms", register 9601. See bit-level detail for more information.

Current archive, hourly, cumulative meter alarm: input out of range, temperature

The temperature process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, temperature" points.

Current archive, hourly, cumulative meter alarm: input out of range, pressure

The pressure process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, pressure" points.

Current archive, hourly, cumulative meter alarm: input out of range, differential pressure

The differential pressure process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, differential pressure" points.

Current archive, hourly, cumulative meter alarm: input out of range, flow rate

The flow rate process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, flow rate" points.

Current archive, hourly, cumulative meter alarm: input out of range, density

The density process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. If a densitometer is configured and its calculation enabled, then the PLC supplies a frequency to the densitometer calculation and this alarm applies to the calculated density. For more information, refer to the "Input scaling, density" points.

Current archive, hourly, cumulative meter alarm: input out of range, water content

The water content process input, after conversion and scaling according to the "module id code" configured for the input, was outside its configured allowable range and the default has been substituted. For more information, refer to the "Input scaling, water content" points.

Current archive, hourly, cumulative meter alarm: Differential pressure low

The differential pressure process input is smaller than the "Differential pressure alarm threshold".

Current archive, hourly, cumulative meter alarm: Flow rate low

The flow rate process input is smaller than the "Flow rate alarm threshold".

Current archive, hourly, cumulative meter alarm: Pulse frequency low

The pulse frequency process input is smaller than the "Pulse frequency alarm threshold".

Current archive, hourly, cumulative meter alarm: Orifice pressure exception

The combination of gauge pressure process input, differential pressure process input, barometric pressure, and the setting of meter calculation option "Downstream static pressure" (bit 0) results in an effective downstream static pressure of less than vacuum, a physical impossibility. Upstream pressure is raised by the amount necessary to raise absolute downstream pressure to zero, and calculation continues.

Current archive, hourly, cumulative meter alarm: Accumulation overflow

An accumulator increment in a single scan that is unreasonable, i.e. less than 0 or greater than 1,000,000,000 (9 zeros), is ignored and this alarm is raised.

Current archive, hourly, cumulative meter alarm: Orifice characterization error

Orifice meter parameters are such that measurement cannot occur. While the original meter alarm is active, the specific reason for this alarm is available in the point "Orifice characterization error" (register 9602).

Current archive, hourly, cumulative meter alarm: Analysis total zero

The input molar analysis is zero, therefore it cannot be normalized and cannot be input to AGA 8 for calculation of compressibilities and densities. Calculation proceeds as if no components were selected. The point "Analysis characterization error" (register 9603) contains the value 2.

Current archive, hourly, cumulative meter alarm: Analysis total not normalized

The input molar analysis sums to a total that is outside the tolerance allowed by the value of the point "Analysis normalization total error tolerance". The analysis is normalized anyway and is input to AGA 8 for calculation of compressibilities and densities. The point "Analysis characterization error" (register 9603) contains the value 1.

Current archive, hourly, cumulative meter alarm: Analysis characterization error

The characterization of the input analysis has encountered a problem. While the original meter alarm is active, the specific reason for this alarm is available in the point "Analysis characterization error" (register 9603)

Current archive, hourly, cumulative meter alarm: Compressibility calculation error

The AGA 8 calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Compressibility calculation error" (register 9604)

Current archive, hourly, cumulative meter alarm: High water error

The water content of the emulsion is too large. While the original meter alarm is active, the specific reason for this alarm is available in the point "High water error" (register 9604)

Current archive, hourly, cumulative meter alarm: Reference density error

The density correction calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Reference density error" (register 9605)

Current archive, hourly, cumulative meter alarm: Temperature correction error

The temperature correction calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Temperature correction error".

Current archive, hourly, cumulative meter alarm: Vapor pressure error

The vapor pressure correlation calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Vapor pressure error" (register 9607)

Current archive, hourly, cumulative meter alarm: Pressure correction error

The pressure correction calculation has reported an error. While the original meter alarm is active, the specific reason for this alarm is available in the point "Pressure correction error" (register 9608)

Current archive, hourly, meter number (1-based)

This value is always 1.

Current archive, hourly, cumulative meter status

Bitmap of selected meter status accumulated during the archive period, calculated by OR-ing into this point at the end of each calculation scan the contents of "Meter status", register 8800.H. View bit-level detail for more information.

Current archive, hourly, cumulative meter status: Meter enabled

The state of the meter has been switched from disabled to enabled during the archive period.

Current archive, hourly, cumulative meter status: Backplane communications fault

Loss of communication with the PLC has been detected during the archive period. This is usually due to a switch of the PLC to program mode.

Current archive, hourly, cumulative meter status: Measurement configuration changed

Configured items that might affect measurement calculations have been changed during the archive period.

Current archive, hourly, cumulative meter status: Power up

The module lost power and has been rebooted during the archive period.

Current archive, hourly, cumulative meter status: Cold start

A cold start (complete reinitialization) has occurred during the archive period.

Current archive, hourly, event count

The number of the last event recorded during the archive period. This value is 1 less than the value of "Next event number" at register 40002 of the Input Register bank.

Current archive, hourly, flowing period (seconds)

The number of seconds during which flow was detected during the archive period.

Current archive, hourly, opening timestamp (packed)

The opening timestamp of the archive. If the site option "Return Unix-style timestamps via virtual slave" (register 119 bit 0) is set and this value is read from the virtual slave, then it appears as seconds since 1970 (Unix style) and its bit-field encoding is not relevant. Otherwise the timestamp is packed into bit fields with a resolution of 2 seconds; view bit-level detail for more information.

Current archive, hourly, opening timestamp (packed), bisecond

The archive's opening timestamp second of the minute divided by 2; value 0 thru 29.

Current archive, hourly, opening timestamp (packed), minute

The archive's opening timestamp minute of the hour; value 0 thru 59.

Current archive, hourly, opening timestamp (packed), hour

The archive's opening timestamp hour of the day, using the 24-hour clock; value 0 thru 23.

Current archive, hourly, opening timestamp (packed), day

The archive's opening timestamp day of the month less 1; value 0 thru (days in month) – 1.

Current archive, hourly, opening timestamp (packed), month

The archive's opening timestamp month of the year less 1; value 0 thru 11.

Current archive, hourly, opening timestamp (packed), year

The archive's opening timestamp year less 1996; value 0 thru 103 (through year 2099).

Current archive, hourly, items 9 through 38

Archive file header, hourly: Archive record template type

This code selects the size and basic layout of the hourly archive record. Values are:

10 words (2 predefined)
20 words (6 predefined)
30 words (10 predefined)
40 words (10 predefined)
This value is a copy of the corresponding configuration item at register 8240.L.

Archive file header, hourly: Archive detail record size

The size of each hourly archive record in words. This value is determined by the value of "Archive file header, hourly: Archive record template type", register 9990.L.

Archive file header, hourly: Number of records, local

The number of hourly archive records stored locally and available by direct access to the Modbus Input Register bank. This value depends on the archive record size and is the total number of archive records that will fit into 1440 words. Click the "Addresses" button in the "Archive Configuration" window for more information.

Archive file header, hourly: Number of records, extended

The actual number of records in the extended hourly archive file. If a Compact Flash card is installed, this value is the same as that of "Archive configuration, hourly, extended file size", register 8243; if a Compact Flash card is not installed, this value is zero.

Archive file header, hourly: Index of last write, local

This number is maintained by the AFC to keep track of the physical location in the AFC's memory where the newest (age 1) local hourly archive record has been stored. Outside the AFC it provides no useful information.

Archive file header, hourly: Index of last write, extended

This number is maintained by the AFC to keep track of the physical location on the Compact Flash card where the newest extended hourly archive record has been stored. Outside the AFC it provides no useful information.

Archive file header, hourly: Modbus holding register address, header

This is the address in the Modbus Holding Register bank of the file header of the hourly archive file. For this archive file it is always 9990.

Archive file header, hourly: Modbus input register address, detail

This is the address in the Modbus Input Register bank of the local hourly archive file. For this archive file it is always 1060. Click the "Addresses" button in the "Archive Configuration" window for more information.

Archive file header, hourly: Modbus holding register address, summary

This is the address in the Modbus Holding Register bank of the current-period (ongoing) hourly archive record. For this archive file it is always 9950. Click the "Addresses" button in the "Archive Configuration" window for more information.

13.7 Modbus Port configuration

Configuration of the serial ports is stored in these blocks of the Modbus table:

Address	Type	Description
Ph00102 to Ph00105	Bm	Port 1 configuration
Ph00106 to Ph00109	Bm	Port 2 configuration
Ph00110 to Ph00113	Bm	Port 3 configuration

Each group of registers specifies configuration of the corresponding serial port. The four registers of each block are interpreted as follows:

Ofs	Type	Tag	Contents
+0	Bm	Uart	UART parameters and port options
+1.L	By	TmoC	LSB: Timeout for CTS
+1.H	By	TmoR	MSB: Master mode receive timeout
+2	By	Dly1	Delay before first data after CTS
+3	By	Dly0	Delay after last data before ~RTS

The CTS timeout and both delays are in units of 5ms (200Hz system clock), with valid values from 0 thru 255, and are significant only for transmission of outgoing Modbus messages. The receive timeout is in units of 0.1 second, with valid values from 0 thru 255 (where 0 implies the default of 5, that is, one-half second), and is significant only for the last port when configured as a Modbus master. The UART parameters and port options word is a bitmap:

Bit	Parameter	Value
bits 0 to 2	Baud	000 - none; see below 001 - 300 baud 010 - 600 baud 011 - 1200 baud 100 - 2400 baud 101 - 4800 baud 110 - 9600 baud 111 - 19200 baud
bits 3 to 4	Parity	00 - no parity 01 - odd parity 10 - even parity 11 - no parity (should not be used)
bit 5	Data bits	0 - 8 data bits 1 - 7 data bits
bit 6	Stop bits	0 - 1 stop bit 1 - 2 stop bits
bit 7	Modbus mode	0 - RTU mode 1 - ASCII mode
bit 8	Modbus orientation	0 - slave 1 - master (permitted only for last port)
bit 9	Primary slave accessibility (not meaningful for master port)	0 - primary slave accessible through this port 1 - primary slave not accessible (not permitted for Port 1)
bit 10		Swap Modbus bytes
bit 11		Swap Modbus words
bit 12		Disable pass-thru (not meaningful for master port)
bits 13 to 15		[reserved]

A change in configuration takes effect after transmission of the response to the Modbus command that causes the change; the response is sent using the old configuration, but subsequent Modbus commands to the reconfigured port must use the new one. Writing a baud code of 0 means that the current configuration is not to be changed, and all other items are ignored. Default values are 6 for the bitmap (9600,N,8,1,RTU,slave,primary,noswap,passthru) and 0 for the timeout and both delays. The message transmission procedure is:

- Raise RTS.
- If TmoC is zero ignore CTS, else wait up to TmoC clock ticks for CTS.
- Delay for Dly1 clock ticks.
- Transmit message.
- Delay for Dly0 clock ticks.
- Drop RTS.

13.8 Startup Basics and Frequently Asked Questions

The Automatic Flow Computer (AFC) is a powerful rack flow computer solution for PLC platforms. The design intent of the module is to simplify the setup and maintenance of a meter installation. With this in mind, the sample ladder logic was created to accomplish the following:

- Pass meter run variables to the module.
- Return meter results to the processor.
- Allow individual meters to be enabled or disabled.
- Allow resets of individual meter runs.
- Allow transfer of a new gas analysis to an individual meter run.

Actual meter setup includes units of measure setup, range checking for input variables, and the type of meter being used. This setup is handled by the AFC Manager software. The intended design is to have the processor only handle the variables of an actual process and the AFC Manager handle the setup and configuration of necessary meter variables.

The sample ladder logic included with the system is intended to fulfill this requirement and works for many applications. Should you feel that your application requires more than this, then a very intimate knowledge of the operations of the module are required to be successful in the implementation of the application. It is highly recommended that the sample be used as a starting point for any application.

13.8.1 How does the module work?

Ignoring the fundamentals of a meter run, the module's operation is very simply divided into two operations, those being the transfer of data from the Processor to the module (variables as a rule) and the second being the transfer of data from the module to the Processor (results).

Refer to the Backplane section of the AFC User Manual for your module for more information on backplane operation.

13.8.2 Why should I use the AFC Manager?

The AFC Manager should be used to configure the module project parameters (Site Configuration) and each meter (Meter Configuration).

Once your project is up and running, you can also use the AFC Manager to monitor each meter run (Meter Monitor), archives, and events.

13.8.3 Why can't the AFC Manager connect to the module?

Check the cable used in your project: a null-modem cable should be used to connect the module with the local PC serial port. Make sure that the baud rate, data bits, mode, parity and primary slave address are the same (both in PC and module).

If you change the primary slave address and later forget the new address, the module will not establish communications. You must read the primary slave address value (address 100) over the backplane using the Modbus Gateway Transaction Block.

13.8.4 Why do I have to enable or disable a meter?

A meter channel will only perform flow calculation if it is enabled. For performance reasons you should disable all meter channels that are not being used. You cannot change a meter type and/or product group for a meter channel that is currently enabled.

13.8.5 Why does the card not calculate results, or why did it stop calculating results?

This could be caused by a couple of things.

8 The first thing to check is that the module actually received a clock. If the card does not get a clock it will not be able to schedule storage of historical records.

9 The next possibility is that the meter is not enabled or some parameter for the run is not correct. Check to see if the run is enabled and that no errors exist in configuration or data for the run in question. Check for alarms arising from the calculations. The AFC Manager software can be a great help with this as it will highlight problem areas.

13.8.6 What is the Virtual Modbus Slave?

The AFC Modbus database can be accessed using the Primary Modbus Slave address. More than 100.000 registers may be accessed using this slave.

You may want to use certain values from the Modbus database in a different order than the one presented in the Primary Modbus Slave. One example is if you want to poll certain values from the Modbus database using a Modbus master device in the field. Instead of using several commands to poll from different locations in the Modbus database, it is better to remap these values to other locations in order to optimize the master polling.

This is the reason the AFC module offers a second slave: the Virtual Modbus Slave. Using the AFC Manager software, you can remap up to 20.000 registers from the Primary Modbus Slave in any order. The Virtual Modbus Slave Address must be configured using the AFC Manager software (Site Config dialog box).

The Virtual Modbus Slave is also used when using the Modbus Pass-Thru function block.

13.8.7 How does the AFC Manager transfer the configuration to the module?

You can configure the site and meter parameters at the local PC saving the project as a .AFC file. You may then download the configuration by clicking on **Project / Download Configuration**. In this case, all configuration will be downloaded from the local PC to the module, except for the Virtual Slave Re-mapping (must be written separately).

Once you download the entire configuration, you may perform smaller adjustments (Site Configuration and Meter Configuration) by clicking on the Write button.

13.8.8 What is the password used for?

The password protects the module from any changes to "sealable" parameters. Sealable parameters directly affect measurement calculations (for example, orifice diameter, or K-factor).

The password is stored in the module so different computers should always use the same password.

13.8.9 Why do I receive an "Illegal Data Value" warning when I try to write a meter configuration or download the entire configuration to the module?

Follow these steps:

- Ensure that any parameters you had changed (from the default configuration) are acceptable according to applicable standards. The white rectangle (Site Configuration and Meter Configuration) shows the correct range of values for each parameter.
- The module will not accept a downloaded configuration that changes the meter type and/or the product group of a meter that is currently enabled. Disable the meter first, then proceed with the meter download.
- Look at the number of events currently stored in the module. You can check this using **Monitor / Event Log** and then click on the Read button. If the "number of events not yet downloaded" is 1999 it means that the event log is full. In this case, if the project also has the "event log unlocked" option clear, the module will not accept any further configuration downloads generating the "Illegal Data Value" at any attempt. Delete all events from the module event buffer (refer to the Event Log section). You may want to select (check) the "Event Log Unlocked" check box. This setting allows the module to overwrite the oldest event from the buffer when the buffer is full.

13.8.10 Why is the Molar Analysis button disabled?

In order to transfer the molar analysis values between the module and the local computer, it is required that the module's configuration and the configuration at the local computer should match. In order to accomplish this, you can perform either a **Meter Configuration / Read** or a **Meter Configuration / Write** operation.

13.8.11 Why does the AFC Manager show a "Communication Timeout" warning?

The communication parameters for the AFC Manager and the module should match. Look at the communication parameters and cables (RS-232 null-modem). Also ensure that the setup jumper on the module is OFF.

13.8.12 What is the difference between Net Accumulator and Gross Accumulator?

The module initially calculates the Gross Accumulator value. It then uses the Gross Accumulator value and corrects it for pressure and temperature before calculating the Gross Standard Accumulator value.

For Gases, Gross Standard Accumulator = Net Accumulator

For Liquids, Gross Standard Accumulator - Water = Net Accumulator

13.8.13 What are the accumulator's totalizer and residue values?

The totalizer is the integer part and the residue is the fractional part. The accumulator will be calculated by:

Accumulator = Totalizer + Residue

13.8.14 Do I have to enter all molar concentrations for the gas product?

Yes, the module uses the Detail Characterization Method that requires all molar concentration values.

13.8.15 Can I update the molar concentration values dynamically?

Yes, if the values are generated from a gas chromatograph you can update these values from the processor to the module (via backplane). Refer to the module's user manual for more information about this subject.

13.8.16 Why do the accumulator values not update?

Follow these steps:

10 Check if the Wallclock is running. The Wallclock should be set every time the module powers up by ladder logic. If the Wallclock is not running, some very early versions of the AFC will not perform the applicable calculation.
11 Determine if the meter has an alarm using the Meter Monitor dialog box. If the alarm field is red, it indicates that the meter has at least one alarm.
12 Determine if the meter is enabled. If the meter is not enabled, it will not perform the applicable calculation.
13 Look at the input variables in the AFC Manager. Make sure the values that are being copied from the processor match the input variables displayed at the AFC Manager Meter Monitor dialog box.

13.8.17 What is the Wallclock?

The Wallclock is the internal module clock that is used by the module to perform the applicable calculation. Typically, the Wallclock will be copied from the processor at every power up operation, otherwise the module will not perform time-of-day-dependent calculations.

13.8.18 Can I read the Primary (or Virtual) Slave values using the AFC Manager?

Yes, the Modbus Master interface (**Communications / Modbus Master**) allows you to easily read (or write) to any register in both slaves.

13.8.19 When are the archives generated?

There are two types of archives: the *daily* archives (which are generated once a day) and the *hourly* archives (which are generated once a hour). The Site Configuration dialog box has two parameters that allow you to configure when the archives will be generated:

- End-of-Day minute = the minute of the day when the daily archives will be written
- End-of-Hour minute = the minute of the hour when the hourly archives will be written

14 Support, Service & Warranty

In This Chapter

Be sure and read the full Warranty that can be found on our web site at www.prosoft-technology.com for details and other terms and conditions. The content in this summary is subject to change without notice. The content is current at date of publication.

ProSoft Technology, Inc. strives to provide meaningful support to its customers. Should any questions or problems arise, please feel free to contact us at:

Internet	Web Site: http://www.prosoft-technology.com/support
	E-mail address: support@prosoft-technology.com

Those of us at ProSoft Technology, Inc. want to provide the best and quickest support possible, so before calling please have the following information available. You may wish to fax this information to us prior to calling.

1. Product Version Number
2. System architecture
3. Network details

In the case of hardware, we will also need the following information:

1. Module configuration and contents of file
2. Module Operation
3. Configuration/Debug status information
4. LED patterns
5. Information about the processor and user data files as viewed through the development software and LED patterns on the processor
6. Details about the networked devices interfaced, if any

For technical support calls within the United States, an after-hours answering system allows pager access to one of our qualified technical and/or application support engineers at any time to answer your questions.

14.1 How to Contact Us: Sales and Support

All ProSoft Technology Products are backed with full technical support. Contact our worldwide Technical Support team and Customer Service representatives directly by phone or email:

USA / Latin America (excluding Brasil) (Office in California)

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Vila Mariana - São Paulo
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+55-11-5084-5178, eduardo@prosoft-technology.com
Languages spoken include: Portuguese, English

14.2 Return Material Authorization (RMA) Policies and Conditions

The following RMA Policies and Conditions apply to any returned product. These RMA Policies are subject to change by ProSoft without notice. For warranty information, see Section C below entitled "Limited Warranty". In the event of any inconsistency between the RMA Policies and the Warranty, the Warranty shall govern.

14.2.1 All Product Returns

1 In order to return a Product for repair, exchange or otherwise, the Customer must obtain a Returned Material Authorization (RMA) number from ProSoft and comply with ProSoft shipping instructions.
2 In the event that the Customer experiences a problem with the Product for any reason, Customer should contact ProSoft Technical Support at one of the telephone numbers listed above in Section A. A Technical Support Engineer will request several tests in an attempt to isolate the problem. If after these tests are completed, the Product is found to be the source of the problem, ProSoft will issue an RMA.
3 All returned Products must be shipped freight prepaid, in the original shipping container or equivalent, to the location specified by ProSoft, and be accompanied by proof of purchase. The RMA number is to be prominently marked on the outside of the shipping box. Customer agrees to insure the Product or assume the risk of loss or damage in transit. Products shipped to ProSoft without an RMA number will be returned to the Customer, freight collect. Contact ProSoft Technical Support for further information.
4 Out of warranty returns are not allowed on RadioLinx accessories such as antennas, cables, and brackets.

The following policy applies for Non-Warranty Credit Returns:

A 10% Restocking Fee if Factory Seal is *not* broken
B 20% Restocking Fee if Factory Seal is broken

ProSoft retains the right, in its absolute and sole discretion, to reject any non-warranty returns for credit if the return is not requested within three (3) months after shipment of the Product to Customer, if the Customer fails to comply with ProSoft's shipping instructions, or if the Customer fails to return the Product to ProSoft within six (6) months after Product was originally shipped.

14.3 Procedures for Return of Units Under Warranty

1 A Technical Support Engineer must pre-approve all product returns.
2 Module is repaired or replaced after a Return Material Authorization Number is entered and a replacement order is generated.
3 Credit for the warranted item is issued within 10 business days after receipt of product and evaluation of the defect has been performed by ProSoft. The credit will only be issued provided the product is returned with a valid Return Material Authorization Number and in accordance with ProSoft's shipping instructions.

a) If no defect is found, a credit is issued.
b) If a defect is found and is determined to be customer generated or if the defect is otherwise not covered by ProSoft's Warranty, or if the module is not repairable, a credit is not issued and payment of the replacement module is due.

14.4 Procedures for Return of Units Out of Warranty

1 Customer sends unit in for evaluation.
2 If no defect is found, Customer will be charged the equivalent of US $100 plus shipping, duties and taxes that may apply. A new Purchase Order will be required for this evaluation fee.

If the unit is repaired the charge to the Customer will be 30%* of the list price plus any shipping, duties and taxes that may apply. A new Purchase Order will be required for a product repair.

3 For an immediate exchange, a new module may be purchased and sent to Customer while repair work is being performed. Credit for purchase of the new module will be issued when the new module is returned in accordance with ProSoft's shipping instructions and subject to ProSoft's policy on non-warranty returns. This is in addition to charges for repair of the old module and any associated charges to Customer.
4 If, upon contacting ProSoft Customer Service, the Customer is informed that unit is believed to be unrepairable, the Customer may choose to send unit in for evaluation to determine if the repair can be made. Customer will pay shipping, duties and taxes that may apply. If unit cannot be repaired, the Customer may purchase a new unit.

14.4.1 Un-repairable Units

- 3150-All
- 3750
- 3600-All
- 3700
- 3170-All
- 3250
- 1560 can be repaired, if defect is the power supply
- 1550 can be repaired, if defect is the power supply
- 3350
- 3300
- 1500-All

*** 30% of list price is an estimated repair cost only. The actual cost of repairs will be determined when the module is received by ProSoft and evaluated for needed repairs.**

14.4.2 Purchasing Warranty Extension

As detailed below in ProSoft's Warranty, the standard Warranty Period is one year (or in the case of RadioLinx modules, three years) from the date of delivery. The Warranty Period may be extended for an additional charge, as follows:

- Additional 1 year = 10% of list price
- Additional 2 years = 20% of list price
- Additional 3 years = 30% of list price

14.5 LIMITED WARRANTY

This Limited Warranty ("Warranty") governs all sales of hardware, software and other products (collectively, "Product") manufactured and/or offered for sale by ProSoft, and all related services provided by ProSoft, including maintenance, repair, warranty exchange, and service programs (collectively, "Services"). By purchasing or using the Product or Services, the individual or entity purchasing or using the Product or Services ("Customer") agrees to all of the terms and provisions (collectively, the "Terms") of this Limited Warranty. All sales of software or other intellectual property are, in addition, subject to any license agreement accompanying such software or other intellectual property.

14.5.1 What Is Covered By This Warranty

A *Warranty On New Products*: ProSoft warrants, to the original purchaser only, that the Product that is the subject of the sale will (1) conform to and perform in accordance with published specifications prepared, approved, and issued by ProSoft, and (2) will be free from defects in material or workmanship; provided these warranties only cover Product that is sold as new. This Warranty expires one year (or in the case of RadioLinx modules, three years) from the date of shipment (the "Warranty Period"). If the Customer discovers within the Warranty Period a failure of the Product to conform to specifications, or a defect in material or workmanship of the Product, the Customer must promptly notify ProSoft by fax, email or telephone. In no event may that notification be received by ProSoft later than 15 months (or in the case of RadioLinx modules, 39 months) from the date of delivery. Within a reasonable time after notification, ProSoft will correct any failure of the Product to conform to specifications or any defect in material or workmanship of the Product, with either new or used replacement parts. Such repair, including both parts and labor, will be performed at ProSoft's expense. All warranty service will be performed at service centers designated by ProSoft. If ProSoft is unable to repair the Product to conform to this Warranty after a reasonable number of attempts, ProSoft will provide, at its option, one of the following: a replacement product, a full refund of the purchase price or a credit in the amount of the purchase price. All replaced product and parts become the property of ProSoft. These remedies are the Customer's only remedies for breach of warranty.

B *Warranty On Services*: Material and labor used by ProSoft to repair a verified malfunction or defect are warranted on the terms specified above for new Product, provided said warranty will be for the period remaining on the original new equipment warranty or, if the original warranty is no longer in effect, for a period of 90 days from the date of repair.

C The Warranty Period for RadioLinx accessories (such as antennas, cables, brackets, etc.) are the same as for RadioLinx modules, that is, three years from the date of shipment.

14.5.2 What Is Not Covered By This Warranty

A ProSoft makes no representation or warranty, expressed or implied, that the operation of software purchased from ProSoft will be uninterrupted or error free or that the functions contained in the software will meet or satisfy the purchaser's intended use or requirements; the Customer assumes complete responsibility for decisions made or actions taken based on information obtained using ProSoft software.

B With the exception of RadioLinx accessories referenced in paragraph 1(c) this Warranty does not cover any product, components, or parts not manufactured by ProSoft.

C This Warranty also does not cover the failure of the Product to perform specified functions, or any other non-conformance, defects, losses or damages caused by or attributable to any of the following: (i) shipping; (ii) improper installation or other failure of Customer to adhere to ProSoft's specifications or instructions; (iii) unauthorized repair or maintenance; (iv) attachments, equipment, options, parts, software, or user-created programming (including, but not limited to, programs developed with any IEC 61131-3 programming languages, or "C") not furnished by ProSoft; (v) use of the Product for purposes other than those for which it was designed; (vi) any other abuse, misapplication, neglect or misuse by the Customer; (vii) accident, improper testing or causes external to the Product such as, but not limited to, exposure to extremes of temperature or humidity, power failure or power surges outside of the limits indicated on the product specifications; or (viii) disasters such as fire, flood, earthquake, wind or lightning.

D The information in this Agreement is subject to change without notice. ProSoft shall not be liable for technical or editorial errors or omissions made herein; nor for incidental or consequential damages resulting from the furnishing, performance or use of this material. The user guides included with your original product purchased by you from ProSoft, contains information protected by copyright. No part of the guide may be duplicated or reproduced in any form without prior written consent from ProSoft.

14.5.3 DISCLAIMER REGARDING HIGH RISK ACTIVITIES

PRODUCT MANUFACTURED OR SUPPLIED BY PROSOFT IS NOT FAULT TOLERANT AND IS NOT DESIGNED, MANUFACTURED OR INTENDED FOR USE IN HAZARDOUS ENVIRONMENTS REQUIRING FAIL-SAFE PERFORMANCE (INCLUDING, WITHOUT LIMITATION, THE OPERATION OF NUCLEAR FACILITIES, AIRCRAFT NAVIGATION OF COMMUNICATION SYSTEMS, AIR TRAFFIC CONTROL, DIRECT LIFE SUPPORT MACHINES OR WEAPONS SYSTEMS), IN WHICH THE FAILURE OF THE PRODUCT COULD LEAD DIRECTLY OR INDIRECTLY TO DEATH, PERSONAL INJURY, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE (COLLECTIVELY, "HIGH RISK ACTIVITIES"). PROSOFT SPECIFICALLY DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR HIGH RISK ACTIVITIES.

14.5.4 DISCLAIMER OF ALL OTHER WARRANTIES

THE WARRANTIES SET FORTH IN PARAGRAPH 1 ABOVE ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

*14.5.5 LIMITATION OF REMEDIES***

IN NO EVENT WILL PROSOFT (OR ITS DEALER) BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES BASED ON BREACH OF WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, STRICT TORT, OR ANY OTHER LEGAL THEORY. DAMAGES THAT PROSOFT AND ITS DEALER WILL NOT BE RESPONSIBLE FOR INCLUDE, BUT ARE NOT LIMITED TO: LOSS OF PROFITS; LOSS OF SAVINGS OR REVENUE; LOSS OF USE OF THE PRODUCT OR ANY ASSOCIATED EQUIPMENT; LOSS OF DATA; COST OF CAPITAL; COST OF ANY SUBSTITUTE EQUIPMENT, FACILITIES, OR SERVICES; DOWNTIME; THE CLAIMS OF THIRD PARTIES, INCLUDING CUSTOMERS OF THE PURCHASER; AND INJURY TO PROPERTY.

** Some areas do not allow time limitations on an implied warranty, or allow the exclusion or limitation of incidental or consequential damages. In such areas the above limitations may not apply. This Warranty gives you specific legal rights, and you may also have other rights which vary from place to place.

14.5.6 Time Limit for Bringing Suit

Any action for breach of warranty must be commenced within 15 months (or in the case of RadioLinx modules, 39 months) following shipment of the Product.

14.5.7 No Other Warranties

Unless modified in writing and signed by both parties, this Warranty is understood to be the complete and exclusive agreement between the parties, suspending all oral or written prior agreements and all other communications between the parties relating to the subject matter of this Warranty, including statements made by salesperson. No employee of ProSoft or any other party is authorized to make any warranty in addition to those made in this Warranty. The Customer is warned, therefore, to check this Warranty carefully to see that it correctly reflects those terms that are important to the Customer.

14.5.8 Intellectual Property

A Any documentation included with Product purchased from ProSoft is protected by copyright and may not be photocopied or reproduced in any form without prior written consent from ProSoft.

B ProSoft's technical specifications and documentation that are included with the Product are subject to editing and modification without notice.

C Transfer of title shall not operate to convey to Customer any right to make, or have made, any Product supplied by ProSoft.

D Customer is granted no right or license to use any software or other intellectual property in any manner or for any purpose not expressly permitted by any license agreement accompanying such software or other intellectual property.

E Customer agrees that it shall not, and shall not authorize others to, copy software provided by ProSoft (except as expressly permitted in any license agreement accompanying such software); transfer software to a third party separately from the Product; modify, alter, translate, decode, decompile, disassemble, reverse-engineer or otherwise attempt to derive the source code of the software or create derivative works based on the software; export the software or underlying technology in contravention of applicable US and international export laws and regulations; or use the software other than as authorized in connection with use of Product.

14.5.9 Additional Restrictions Relating To Software And Other Intellectual Property

In addition to complying with the Terms of this Warranty, Customers purchasing software or other intellectual property shall comply with any license agreement accompanying such software or other intellectual property. Failure to do so may void this Warranty with respect to such software and/or other intellectual property.

14.5.10 Allocation of risks

This Warranty allocates the risk of product failure between ProSoft and the Customer. This allocation is recognized by both parties and is reflected in the price of the goods. The Customer acknowledges that it has read this Warranty, understands it, and is bound by its Terms.

14.5.11 Controlling Law and Severability

This Warranty shall be governed by and construed in accordance with the laws of the United States and the domestic laws of the State of California, without reference to its conflicts of law provisions. If for any reason a court of competent jurisdiction finds any provisions of this Warranty, or a portion thereof, to be unenforceable, that provision shall be enforced to the maximum extent permissible and the remainder of this Warranty shall remain in full force and effect. Any cause of action with respect to the Product or Services must be instituted in a court of competent jurisdiction in the State of California.

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