



AFC Manager
Configuration Tool
Automatic Flow Computer

User Manual

November 26, 2007



Please Read This Notice

The use and configuration of this software requires a reasonable working knowledge of the involved protocols and the application in which they are 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 assure that the information provided is accurate and a true reflection of the product's functionality. In order to assure a complete understanding of the operation of the product, the user should read all applicable ProSoft documentation on the operation of the module and protocol driver.

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AFC Manager User Manual
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1 Introduction

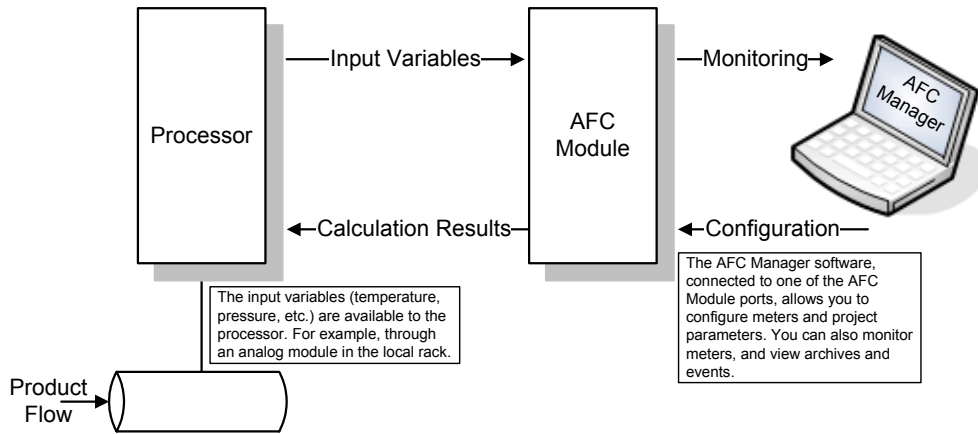
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The AFC Manager is a software application (computer program) for Microsoft Windows that allows you to perform the following tasks with your AFC module:

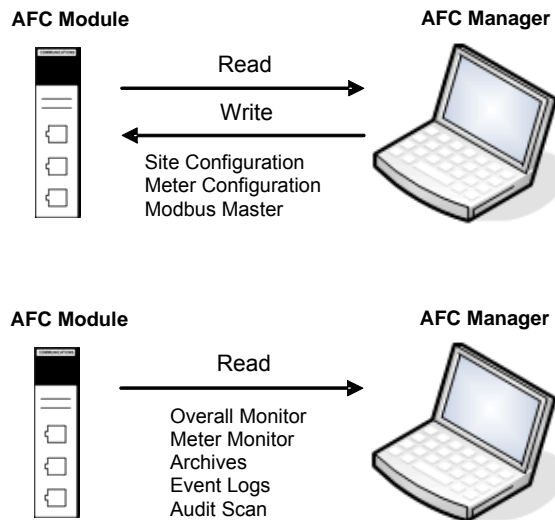
- Configure project parameters (site configuration)
- Configure the port communication parameters
- Remap registers from the primary slave to the virtual slave. Modbus master interface allows easy access to primary and virtual database.
- Configure meter channels
- Enable and disable the meter channels
- Set the module passwords
- Keep track of configuration changes
- Monitor the meter operation
- Perform an audit scan
- Configure the archives
- Monitor the archives
- Monitor the events

The following illustration shows a typical AFC Manager Software project:



You can configure each meter in the local computer (saving the configuration as a .AFC file) and then download the file to the module. Later, you can adjust specific meter configuration parameters without downloading the entire project; this is accomplished using the Write button in the Meter Configuration dialog box.

You can also transfer the current configuration from the module to the local computer by uploading the current configuration.



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 Quick Start

In this section, you will use these basic steps to configure the module using AFC Manager:

Step 1 - [Install the AFC Manager Software](#) (page 10)

Step 2 - Install the Module (Refer to the AFC User Guide for your module)

Step 3 - [Connect the AFC Module to the AFC Manager](#) (page 13)

Step 4 - [Start a New AFC project](#) (page 16)

Step 5 - [Configure the Project Parameters](#) (page 23)

Step 6 - [Configure Each Meter](#) (page 49)

Step 7 - [Save the Module Configuration to the Local Computer](#) (page 93)

Step 8 - [Download the Module Configuration to the Module](#) (page 93)

Step 9 - [Verify Correct Operation](#) (page 21)

1.3 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.

1.3.1 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.

1.3.2 Upgrading from a Previous Version of AFC Manager

This version of the AFC Manager User Manual discusses AFC Manager version 2.0.5, which supports AFC module firmware versions 2.0.5 and earlier.

➤ **To upgrade from an earlier version of AFC Manager**

- 1 Uninstall all previous versions of AFC Manager from your PC, using the **Settings/Control Panel/Add and Remove Programs** applet. Answer "Yes to all" when prompted to remove shared components.
- 2 Download the latest version of AFC Manager from <http://www.prosoft-technology.com>. Navigate to **Support / Downloads**, and then choose your AFC Module. From the download page, select AFC Manager. When the download is complete, choose "Open", and then run Setup.exe.

Note: Some parts of the user interface, particularly the Meter Configuration dialog box, have changed from previous versions of AFC Manager. These changes were necessary for the multiple stream support added in firmware version 2.0.5, and primarily involve a more logical arrangement of items on the meter configuration screen. These changes do not affect the functionality of the program, and all previous firmware versions are supported. For firmware upgrades, please contact ProSoft Technical Support.

1.4 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.

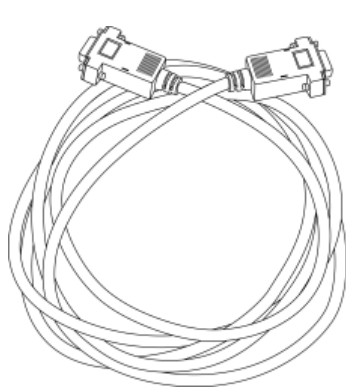
After you have installed the AFC module in the rack with the processor, you should then download the sample program to the processor.

- 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.

1.5 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

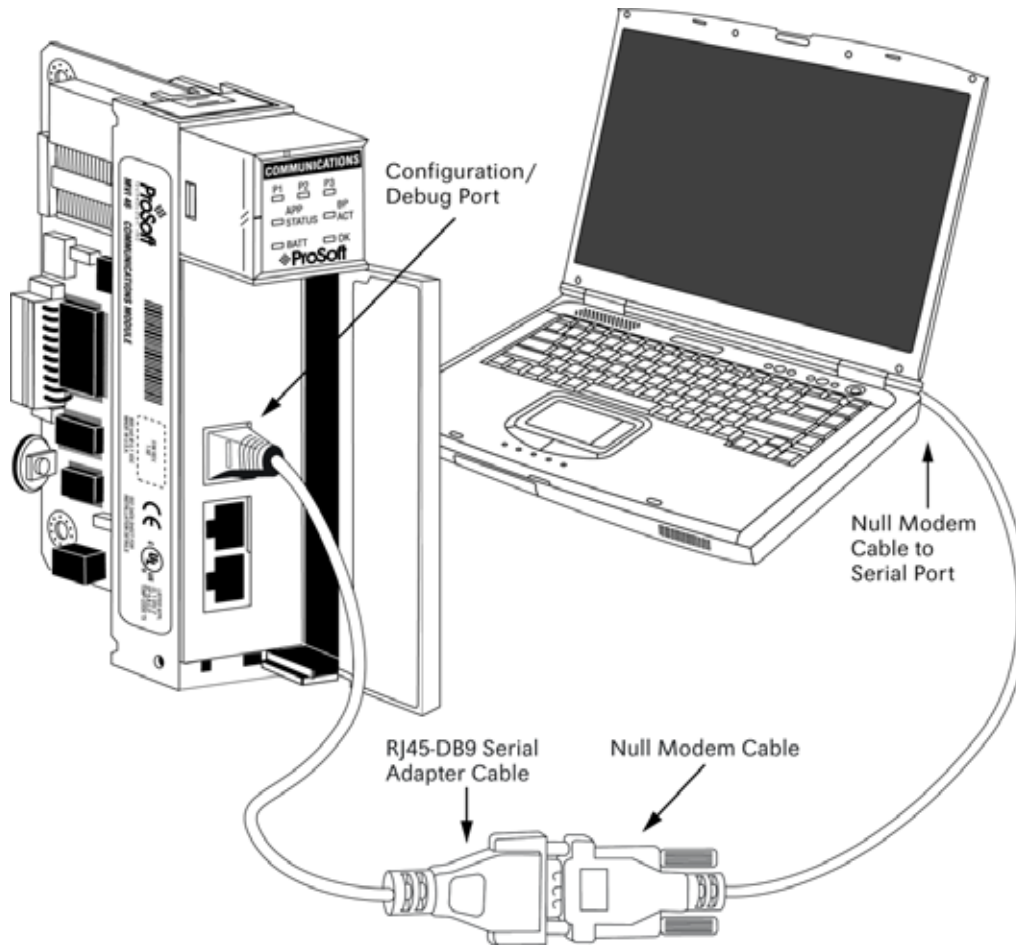
Connects Null-modem Cable to MVI46, 56, 69 and 71 AFC module configuration-debug port.

- 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.

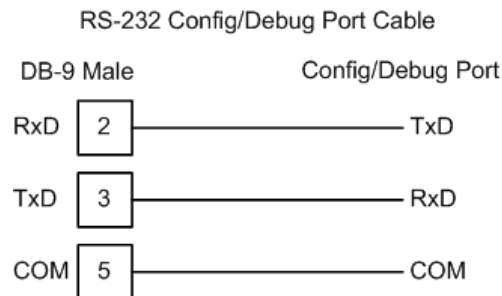
- 2 Connect the null-modem cable to the DB-9 adapter cable on the module, and to an available serial port on your computer.

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.

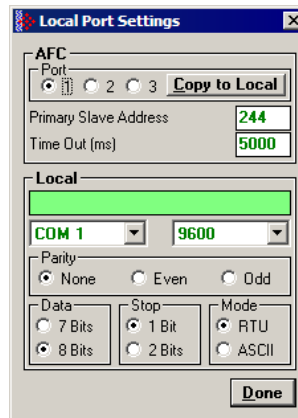


Note: The illustration above shows an MVI46-AFC. The connection process is similar for all MVI-AFC and PTQ-AFC models.

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.

1.5.1 Troubleshooting AFC Manager Connection Problems

If AFC Manager has trouble making a connection to the AFC's Primary Slave:

- 1 Check your cabling. You must connect a null-modem cable between the COM port on your PC and the serial port on the module.
- 2 Connect to the module's Configuration/Debug port if possible. If you try to connect to another of the module's ports, the AFC's configuration may have the Primary Slave hidden at that port. At the Configuration/Debug port the Primary Slave is always visible.
- 3 Double-check your communications settings via **Communications / Local Port Settings**. You must set up your COM port to match the settings of the AFC's port. By default the AFC sets up its Configuration/Debug port as: Slave address 244, 9600 baud, no parity, 8 data bits, 1 stop bit, RTU mode; so use those settings unless the AFC's default configuration has been changed. Be sure that you are selecting the correct COM port on your PC, especially if you are using a USB serial adapter as those adapters may be assigned to different COM ports at different times.
- 4 Ensure that the COM port on your PC is not in use by another application, such as HyperTerminal. If the port is held by another application, then AFC Manager will not be able to use it.

1.6 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.

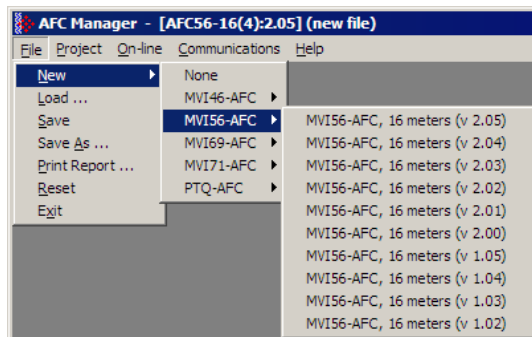
1.7 Using AFC Manager

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

1.7.1 Starting a New Project

➤ **To start a new project:**

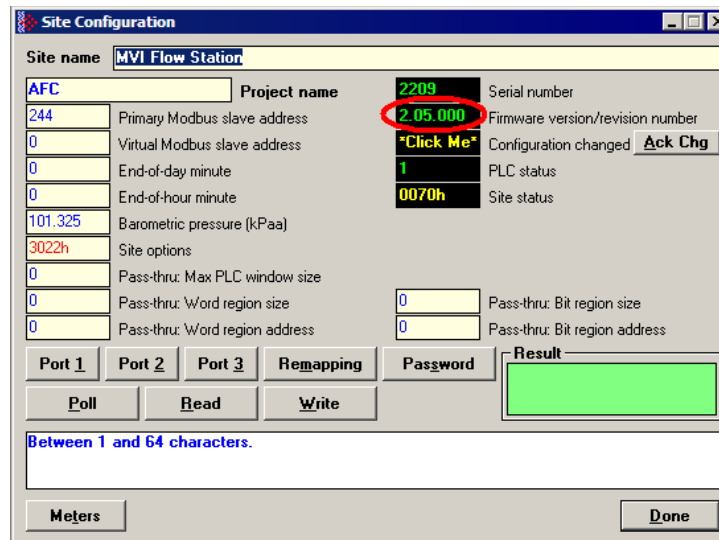
- 1 Start AFC Manager, and then open the File Menu.
- 2 On the File Menu, choose New, and then select your module and firmware version number.



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

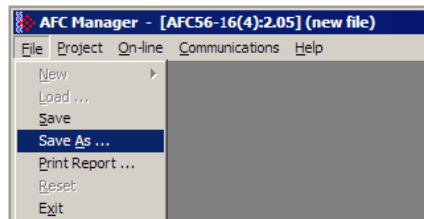
- a) Open the Project menu.
- b) Choose Site Configuration. This action opens the [Site Configuration dialog box](#) (page 24).

- c) Click the Read button (page 47). 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.

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



1.7.2 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:**

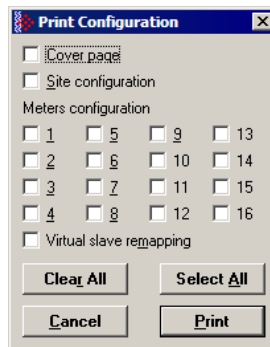
- Start AFC Manager, and then open the File menu.
- On the File menu, choose Load. This action opens a dialog box that shows a list of AFC Manager project files (AFC files) in the current folder.
- Choose the project to load, and then click Open.

1.7.3 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.

1.7.4 Converting a Project

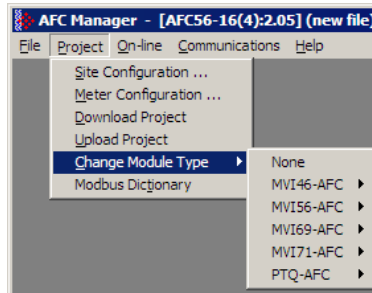
You can convert an existing project (configuration file) to use it with a different module or firmware version. Do this if:

- 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.

1.7.5 Resetting Configuration Parameters

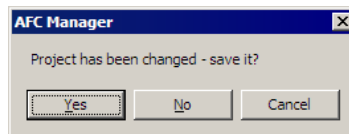
If you have modified your project (configuration file), or if you have loaded a configuration file from disk, but you want to start a new project, you can reset the configuration parameters back to their defaults without having to close and reopen the AFC Manager.

➤ **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**.

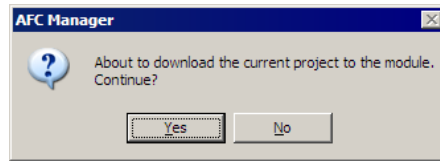
If you have made changes to the configuration that have not yet been saved, a confirmation dialog box will open.



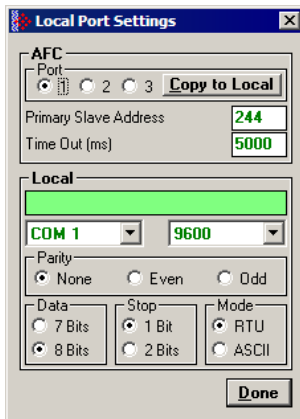
Answer Yes to save your changes, or No to discard your changes and begin working on a new configuration. Click Cancel to abandon the attempted action that caused this message.

1.7.6 Downloading the Project to the Module

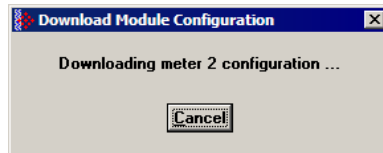
- 1 Click **Project / Download Project**.



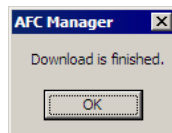
- 2 The following window is displayed the first time you attempt communication with the module. Enter the port parameters to use, and then click Done.



- 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 144) 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.

1.7.7 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 (page 99).

- 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 Site Configuration

In This Chapter

| | |
|---------------------------------------|----|
| ➤ Site Configuration Dialog Box | 24 |
| ➤ Site Information | 24 |
| ➤ Site Configuration Parameters | 29 |
| ➤ Site Configuration Buttons | 41 |

The first task in setting up a Project is to configure the overall settings for the site. The Site Configuration dialog box is where you assign the settings that apply to the entire project.

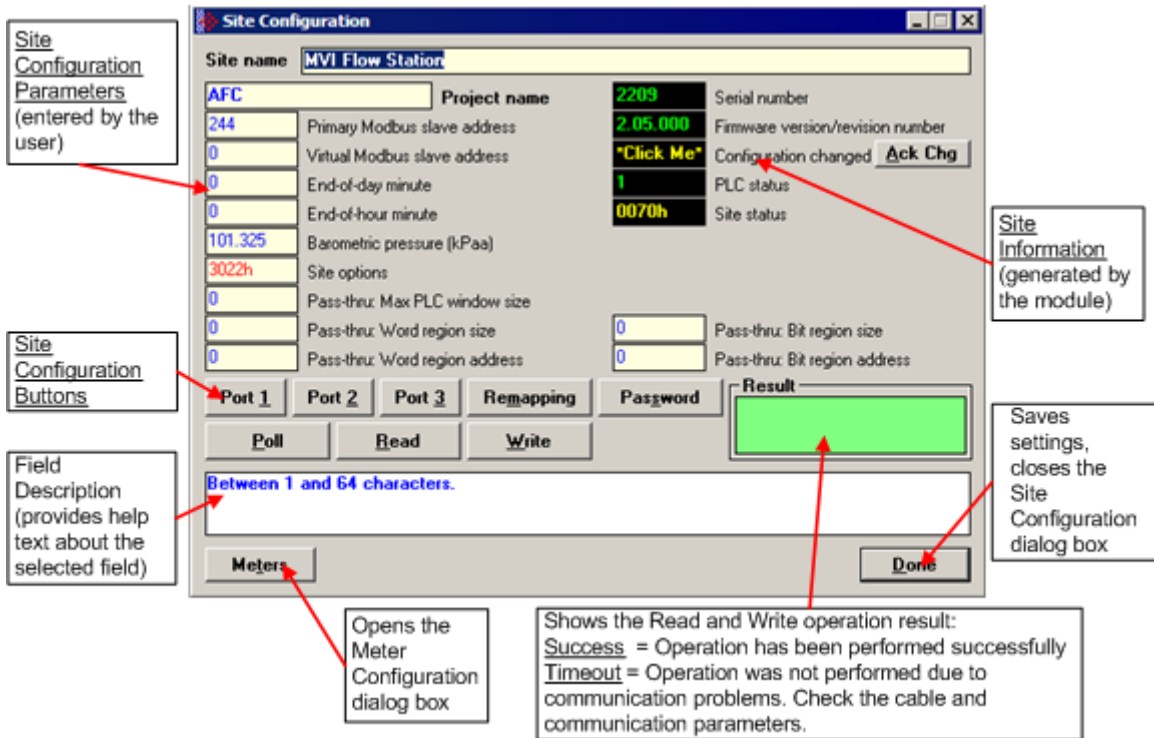
- Project name
- Modbus slave addresses
- Memory allocation
- Port configuration and mapping
- Site options and status.

➤ ***To begin configuring a site:***

- 1 Start AFC Manager.
- 2 On the File menu, choose New, and then select the module type, number of meters, and firmware version.
- 3 On the Project menu, choose Site Configuration. This action opens the Site Configuration dialog box.
- 4 Choose the settings to apply to the site.
- 5 When you are finished, click Done, and then open the File menu and choose Save As to save your project.

2.1 Site Configuration Dialog Box

The Site Configuration dialog box opens when you open the Project menu in AFC Manager, and then choose Site Configuration. Use this dialog box to define the settings that apply to the Project as a whole.



2.2 Site Information

This section of the Site Configuration dialog box contains a detailed explanation about the values that are generated by the module on the Site Configuration dialog box. These values can only be read from the module to the local computer.

2.2.1 Serial Number

This section of the Site Configuration dialog box shows the module serial number (hardware). AFC Manager must be connected and "online" to the module to display this value.

2.2.2 Firmware Version Number

This section of the Site Configuration dialog box shows the current module firmware version. For example, 2.05.000. The firmware version number corresponds with the module type and firmware version you selected from the File menu.

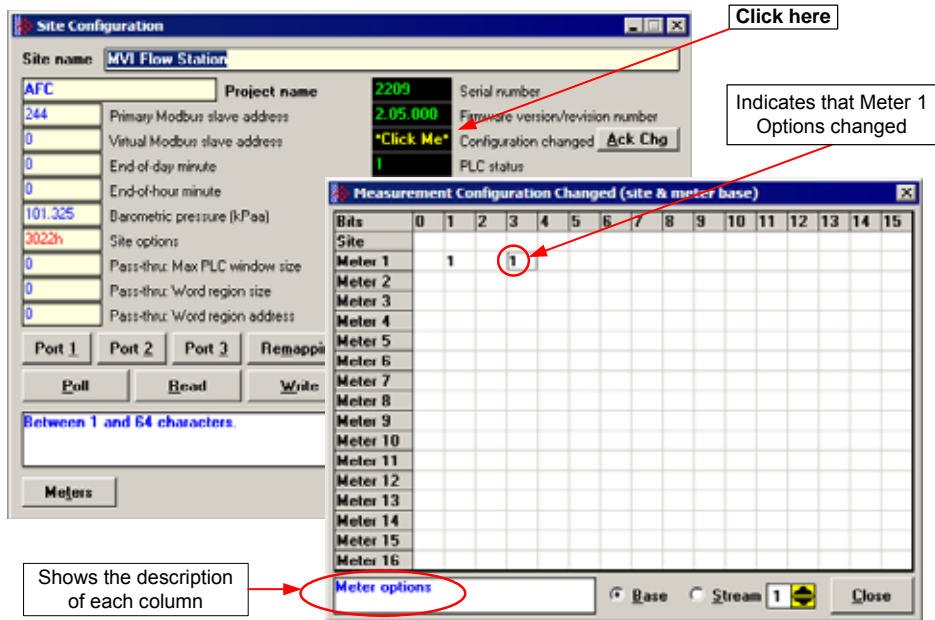
2.2.3 Configuration Changed

This value is set when any bit in the "measurement configuration changed" registers is set.

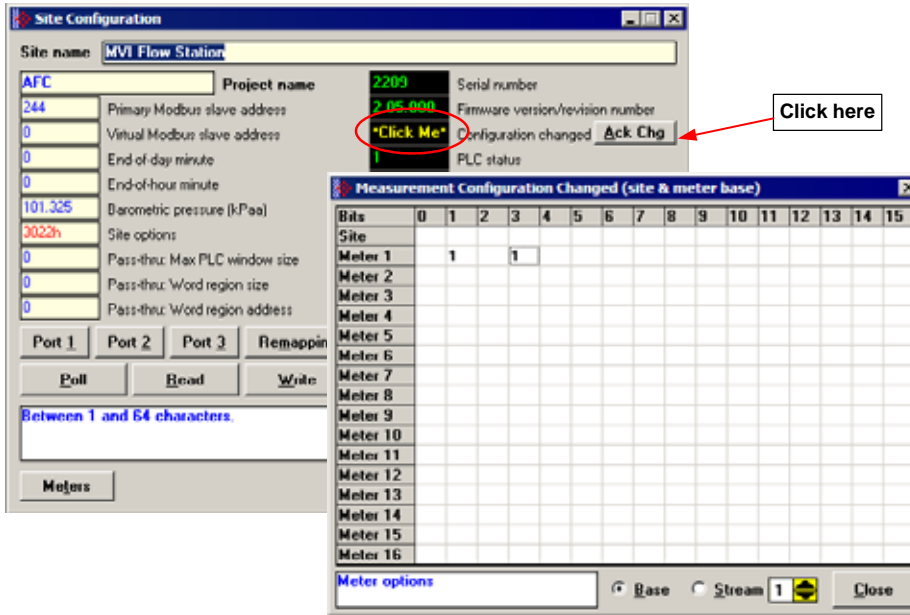
Measurement Configuration Changed dialog box

This dialog box opens when you click the Measurement Configuration Changed field on the Site Configuration dialog box.

The Measurement Configuration Changed dialog box contains detailed information about changes to the meter configuration. These changes are related to the "sealable parameters" that actually affect the module calculation. When a sealable parameter is changed, a new event is generated.



After you have verified the Measurement Configuration Changes, click the Ack Chg button on the Site Configuration dialog box to clear the bits in order to keep track of future changes.



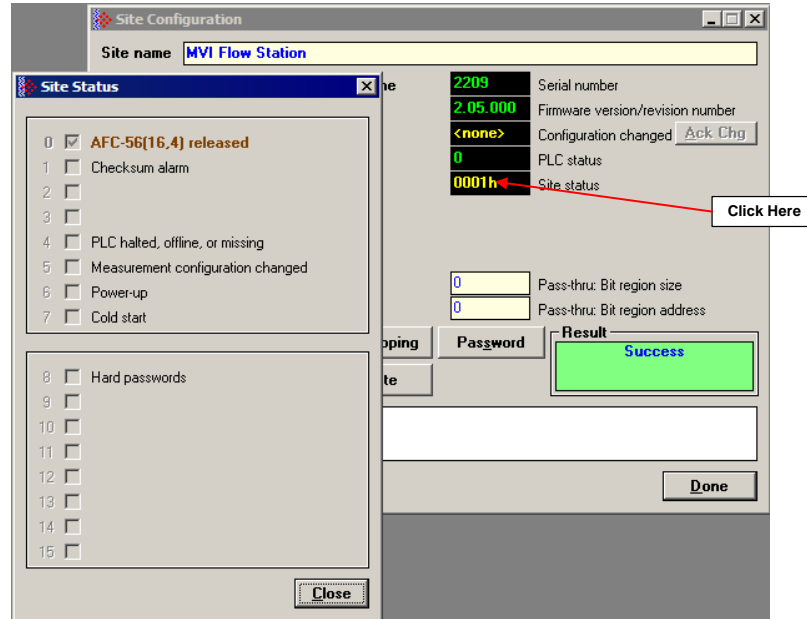
2.2.4 PLC Status

This section of the Site Configuration dialog box shows the current processor status. The possible values are:

- 0 = processor on-line
- 1 = processor off-line

2.2.5 Site Status

The Site Status dialog box opens when you click the Site Status field on the Site Configuration dialog box.



The Site Status dialog box provides information about the module's current status.

AFC Released

Latched when both **Cold Start** bit and **PLC Offline** bit first become clear simultaneously, 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

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. Refer to Checksum Alarms (page 147) to verify the source of the alarm, and then clear it.

The alarm bit remains latched, even through subsequent power cycles, until it is explicitly cleared from outside.

PLC Halted, Offline or Missing

Set while backplane communication is faulty, which typically occurs when the PLC is switched to program mode. While set, measurement does not occur. Upon resumption of backplane communication, the module compensates for the downtime by computing an accumulator increment in a manner that depends on the meter type.

For differential (orifice) meters, and meters configured for flow rate or pulse frequency integration, the first measurement scan acquires a scan period equal to the period of downtime as computed from the system timer, hence periods of PLC downtime shorter than the rollover period of the system timer causes no loss of product. For linear (pulse count) meters, the first measurement scan acquires a pulse increment equal to the difference between the PLC-supplied 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 loss of product.

Measurement Configuration Changed

Set when any bit in the measurement configuration changed registers is set.

Power-up

Set upon power-up, and cleared when the wallclock has been set.

Cold start

Upon power-up, the module's non-volatile memory is checked for validity, confirming that certain known values are present in their proper locations. If the contents of the memory are invalid, the memory is initialized with a default configuration and the 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.

If the module contains the BBRAM daughter card (supported on firmware versions 2.00.000 or newer), the cold start status is easily identified when both LEDs (OK and ERR) are illuminated.

Hard Password

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.

2.3 Site Configuration Parameters

The following topics describe the Site Configuration parameters you will enter.

2.3.1 Site Name

Identifies the site (1 to 64 characters). Default is "MVI Flow Station".

2.3.2 Project Name

The Project Name allows an external application such as AFC Manager to synchronize its database with the database resident in the module. Default is "AFC".

2.3.3 Primary & Virtual Modbus Slave Configuration

The configuration, process, and historical data for the site and all meters are stored in the Primary Modbus Slave (approximately 130,000 registers). In order to optimize the polling of data, the AFC module has a second Modbus slave; the Virtual Modbus Slave. These two Modbus slaves have distinct Modbus addresses that are configured in the Site Configuration dialog box.

Primary Modbus Slave Address

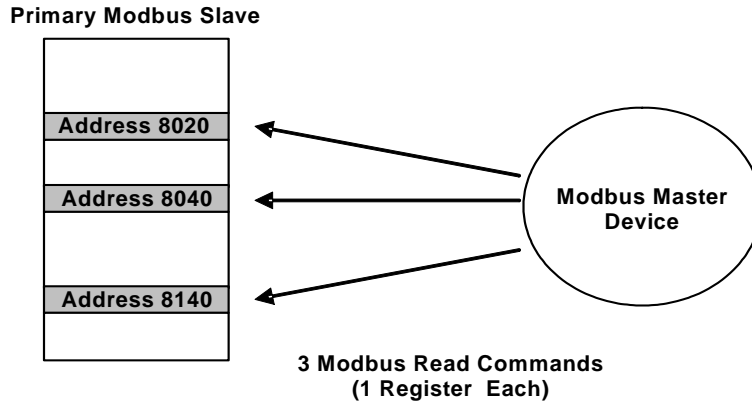
The primary Modbus slave address identifies the Primary Slave when another Modbus device is polling it. You can use the AFC Manager Modbus Interface to read and write Modbus registers from the Primary Modbus Slave. Except for the Modbus Master interface, every time the AFC Manager communicates with the module, it uses the Primary Modbus Slave. Valid address values are 1 to 247. The default address is 244.

Virtual Modbus Slave Address

The Virtual Modbus slave address identifies the Virtual Slave when another Modbus device is polling it. You can also use the AFC Manager Modbus Master Interface to read/write Modbus registers using the Virtual Modbus Slave. Any value greater than zero will activate the Virtual Modbus Slave and the module will use the remapping table to assign data to the correct memory locations. Valid address values are 0 (zero) to 247. A value of zero disables the Virtual Modbus Slave.

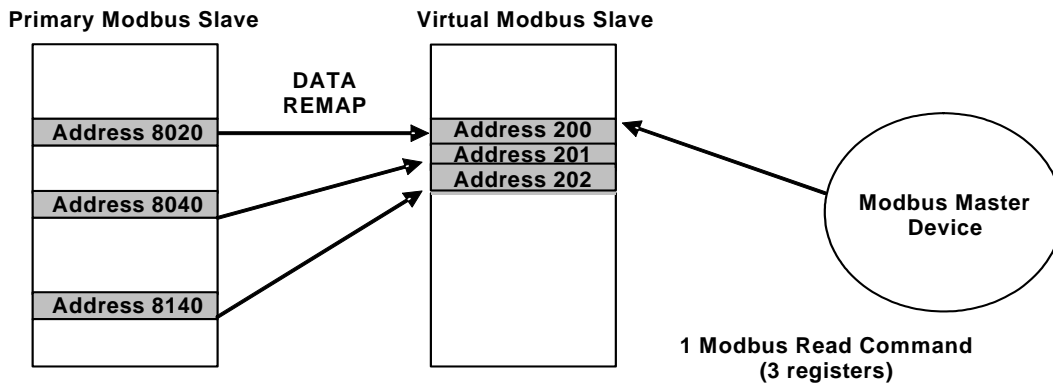
The following illustration shows the benefits of using the Virtual Modbus Slave when polling data from the module:

Data Polling Without Virtual Modbus Slave



For this application, the master reads three MODBUS registers: 8020, 8040 and 8140. As these registers are not contiguous, the master uses three Modbus commands to poll all the registers.

Data Polling With Virtual Modbus Slave



When the registers are remapped into a contiguous group in the Virtual Slave, the master can use a single Modbus command to poll the registers. This results in better system performance, because the number of commands is reduced.

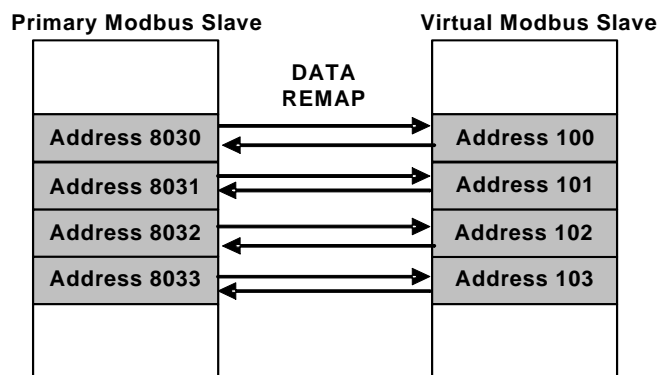
Note: You must configure a virtual Modbus address value greater than zero to enable the virtual slave.

Indirect Address Remapping dialog box

To configure the data remapping between the two slaves, click the Remapping button. This action opens the Indirect Address Remapping dialog box.

The screenshot shows the 'Indirect Address Remapping' dialog box. It features a table with columns for 'Description', 'When Addressing', 'Address', 'as Inpt Reg', and 'with Wrt Enb'. The 'Address' column contains values 8030, 8031, 8032, and 8033. A 'Result' field at the bottom is highlighted in green. Callouts include: 'Select Virtual Modbus Slave register bank' pointing to the 'Holding' radio button; 'Virtual Modbus Slave Address' pointing to the 'Start Address' field (value 100); 'Primary Modbus Slave Address' pointing to the 'Address' column; 'Quick access directly to the data that has been configured' pointing to the 'Remapping' button; 'Selects Primary Slave register bank: Check = input register, Clear = holding register' pointing to the radio buttons; 'Enable Write to Virtual Slave Address. When selected, every write performed to the Virtual Slave will be copied to the remapped Primary Slave register' pointing to the 'Write' checkbox; 'Reads the entire mapping configuration from the AFC module to the local computer' pointing to the 'Read' button; 'Writes the entire remapping configuration from the local computer to the AFC module' pointing to the 'Write' button; and 'CLICK HERE' pointing to the 'Remapping' button.

The values in the illustration above would configure the following indirect addressing remapping:



Because all registers in the example had the write enable bit set, all data copied to the Virtual Slave would also be written to the remapped Primary Slave. If a Modbus device writes a value to address 100 in the Virtual Slave, that value would also be written to address 8030 in the Primary Slave. If it reads the current value on the Virtual Slave address 102, it would be the same value in Primary Slave address 8032.

Important: Virtual Slave addresses must be equal to or greater than 100.

When the configuration procedure is complete, click the Write button to transfer the entire remapping configuration to the module. This process may take a few minutes. While the transfer is taking place, the Result field (green rectangle) shows the message "Writing indirect address definition block xx of yy", where xx = 1 to 249 and yy may be as large as 249. When the transfer is complete, the result field displays "Success".

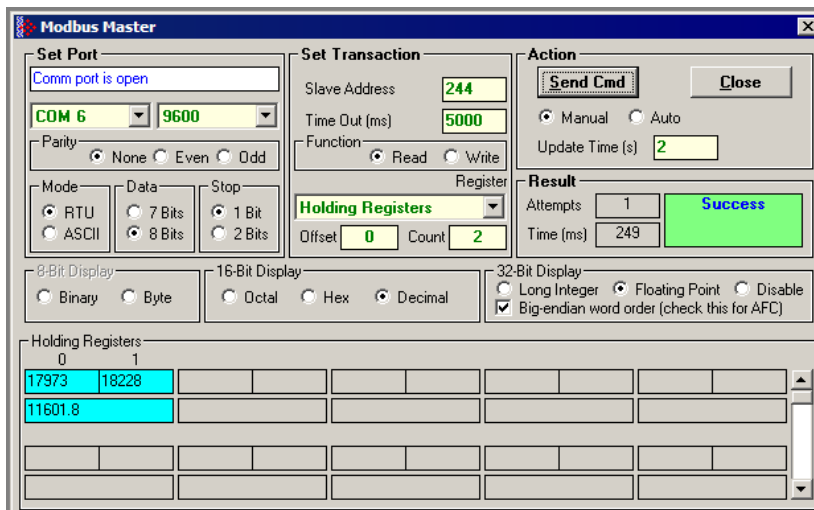
To read the current remapping configuration from the module to the local computer, click the Read button. This process may take a few minutes.

Important: The Download Configuration does not transfer the remapping configuration. Use the steps described in this topic to transfer the remapping configuration to the module.

Tip: Use the [Modbus Dictionary dialog box](#) (page 140) to view Modbus addresses in the module.

Accessing the Data

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



Modbus Communication

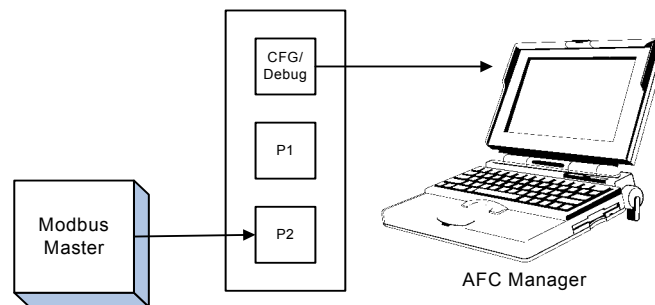
A remote Modbus master device can be connected to any one of the communication ports for data polling. The module accepts the following Modbus command functions according to the Modbus protocol specification:

| 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.

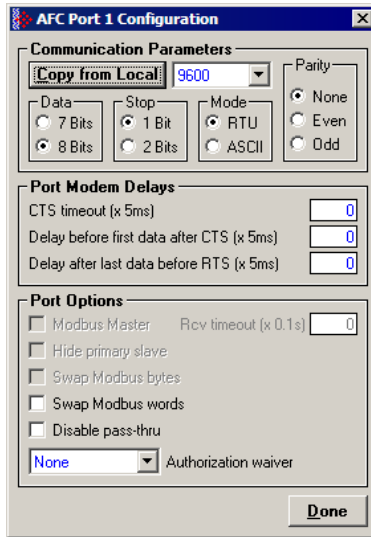
Communication Parameters

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):



Port Options

The following options can be configured:

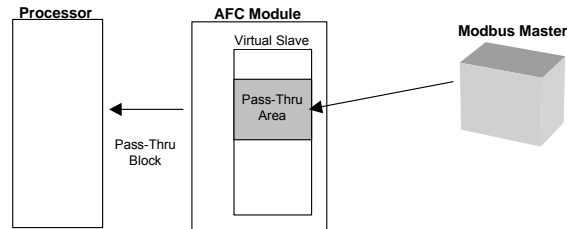
| Port Options | Description |
|--------------------|--|
| Hide Primary Slave | Protects the Primary Slave from any read or write operation from a remote master. Only the virtual slave is visible on this port. |
| Swap Modbus Bytes | Swap the Modbus bytes transferred through this port (Not implemented) |
| 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).



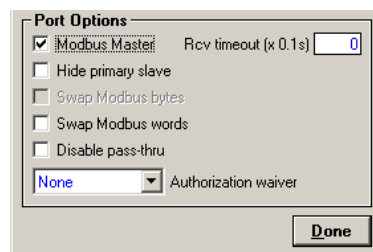
Important: You must enable the virtual slave by configuring a Modbus address greater than 0 (**Project / Site Configuration**).

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

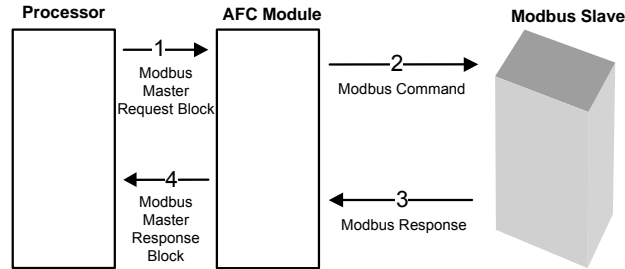
This feature requires ladder logic to read the pass-thru block from the module to the processor. Refer to the Ladder Logic section for more information about the pass-thru feature.

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.

2.3.4 End-of-Day Minute

This parameter sets the minute of the day when the daily archives are created. The default value of 0 (zero) creates the daily archive at midnight. Valid values are between 0 and 1439.

2.3.5 End-of-Hour Minute

This parameter sets the minute of the hour when the hourly archives are created. The default value of 0 (zero) creates hourly archives at the top of each hour. Valid values are between 0 and 59.

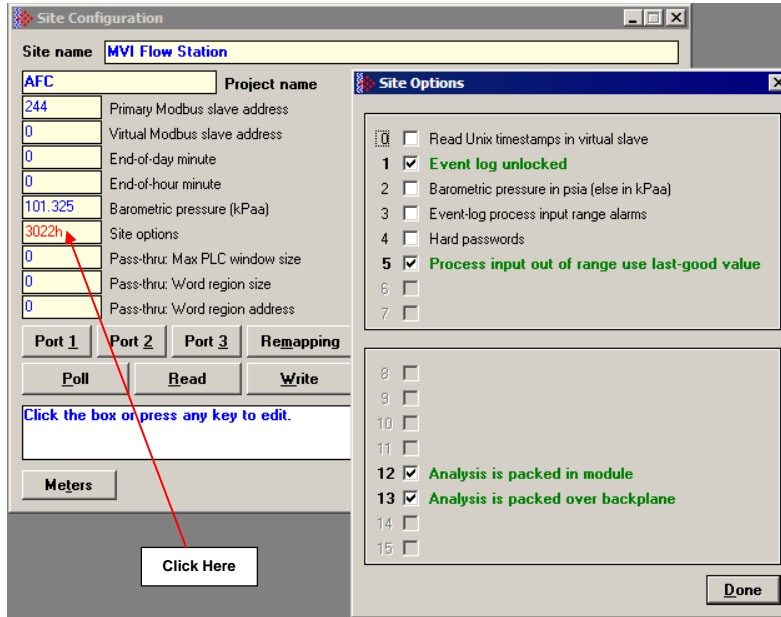
2.3.6 Barometric Pressure

This parameter sets the barometric pressure used on the module calculations. The module expects each meter's pressure input to be in gauge units. Because the AGA8, AGA3, and some API2540 calculations require the pressure of the fluid to be in absolute units, the module adds barometric pressure to the gauge pressure in order to obtain the absolute pressure.

The calculation assumes that all meters measured by a single AFC are located at the same site and have the same barometric pressure.

2.3.7 Site Options

The Site Options dialog box opens when you click the Site Options field in the Site Configuration dialog box.



Read UNIX Timestamps in Virtual Slave

When this option is set, and timestamps are remapped from the Primary to the Virtual Slave, their values will be expressed in UNIX format (the number of seconds since 1970). Timestamps viewed in the primary slave are always bit-field encoded.

Event Log Unlocked

The event log buffer can store up to 1999 events. When all record positions (1 through 1999) 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. As the overwritten event was never downloaded, it is permanently lost.
- If the option is clear, the event log is locked, and the new event is rejected if possible or otherwise ignored. In this case, controllable events (sealable parameters), are not allowed to occur. Such parameters 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 power-up, are not recorded. The log must be downloaded in order to unlock it for further events.

Barometric Pressure in psia (else in kPaa)

If set, the barometric pressure will be expressed in psia units, otherwise it will use kPaa.

Event-Log Process Input Range Alarms

This option determines how the event log should process input range alarms. If set, the process input out of range alarms are logged as events. Depending on the configuration and the stability of the site (meter transmitters), enabling this option may cause rapid fill up of event log and meter archives. If cleared, process input out of range alarms are not event-logged. (However, archives still record all alarms that occur during the archive period.)

Hard Password

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.

Process input out of range use last-good value

If set, then an out-of-range process input value is substituted by the latest detected in-range value. If clear, then the "default" value configured for the process input is substituted.

Analyses are packed in the module

If set, then molar concentrations of individual components are "packed" towards the front of the analysis for each stream of each meter by eliding the zeroes corresponding to components that are not selected in the component map for the meter. If clear, then molar concentrations of individual components appear always in the same locations regardless of whether the corresponding components are selected.

Changing this setting causes all stored analyses to be restructured consistently so that no analysis information is lost, and may require corresponding changes to polling systems such as SCADA. Default setting is "packed" to be consistent with earlier versions of the AFC, but this default will change in a future version.

Analyses are packed over the backplane

If set, then molar concentrations of individual components are "packed" towards the front of an analysis received over the backplane by eliding the zeroes corresponding to components that are not selected in the component map for the meter. If clear, then molar concentrations of individual components appear always in the same locations regardless of whether the corresponding components are selected.

Changing this setting may require corresponding changes to PLC programs that deliver the analyses. Default setting is "packed" to be consistent with earlier versions of the AFC, but this default will change in a future version.

This option is present only for MVI56-AFC and MVI69-AFC. For other platforms, where the option is not present, analyses transferred over the backplane are always "unpacked".

2.3.8 Pass-thru Configuration

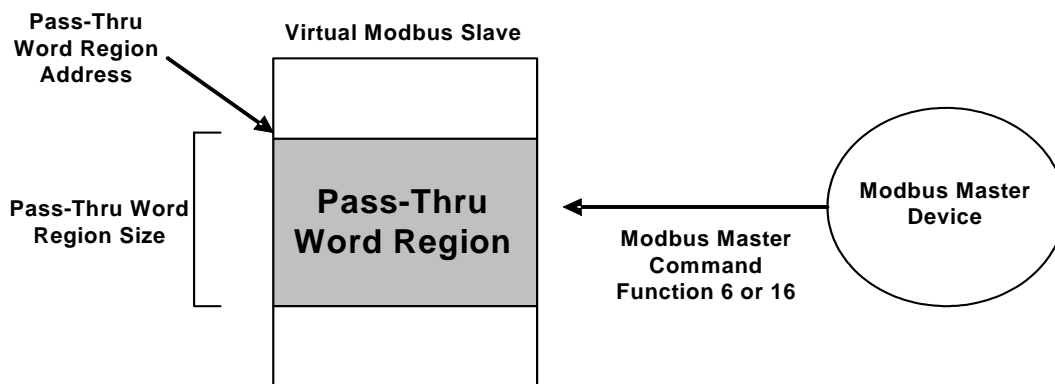
The module supports the Modbus Pass-Thru feature for write commands. When the pass-thru region in the virtual slave is properly configured, all Modbus write commands pointing inside that area will be handled by ladder logic using the Modbus Pass-Thru function block. Refer to the module's user manual for specific information on the pass-through backplane functionality.

Pass-Thru: Max Window Size

Defines the maximum pass-thru window size (expressed as 16-bit words) in the Virtual Modbus Slave. The maximum allowed value for this point depends on the platform. Refer to the user manual for your module for specific configuration information.

Pass-Thru: Word Region Address & Pass-Thru: Word Region Size

These two parameters define the Pass-Thru Word Region located in the Virtual Modbus Slave. The region starts at the address configured by the word region address parameter and its range is defined by the Pass-Thru Word Region Size parameter:

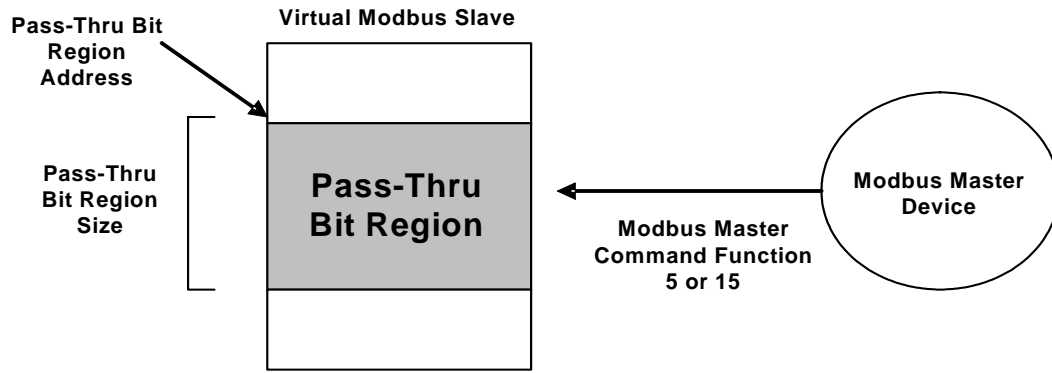


The first 100 words in the Virtual Slave are reserved. Therefore, the pass-thru region address value must begin no lower than word 100.

By configuring a Pass-Thru Word Region Address of 20,000 or greater, you may avoid any reduction of the remappable address space of the Virtual Slave.

Pass-Thru: Bit Region Address & Pass-Thru: Bit Region Size

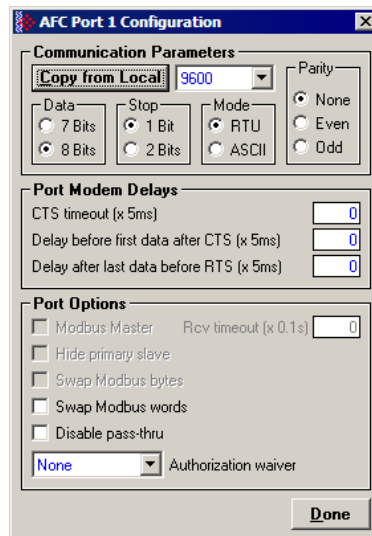
These two parameters define the Pass-Thru Bit Region located in the Virtual Modbus Slave. The region starts at the address configured by the Bit Region Address parameter and its range is defined by the Pass-Thru Bit Region Size parameter:



2.4 Site Configuration Buttons

2.4.1 Port 1, Port 2 and Port 3 Configuration

The Port Configuration dialog box opens when you click one of the port configuration buttons (Port 1, Port 2, and Port 3) on the Site Configuration dialog box. Use this dialog box to configure the communication parameters and Modbus access for each module port:



The Communication Parameters configure each port's communication settings. The default communication port configuration is 9600 baud rate, 8 data bits, 1 stop bit, RTU mode and no parity. Use these settings the first time you use AFC Manager on the port connected to the local PC.

The Port Modbus Options field configures the Modbus communication to a Modbus device.

Port Configuration Notes

The module has three Modbus ports, however Port 1 is intended mainly for configuration, and is only suitable for Modbus communication in the following circumstances.

- The top port (Configuration/Debug Port) is unbuffered, therefore it should not be used for other Modbus operations, such as SCADA.
- The Configuration/Debug Port is RS232 only, while Ports 2 and 3 support RS232, RS422 and RS485. Unless a device can only communicate using an RS232 port, use one of the other ports.
- Although you can set a maximum baud rate on the Configuration/Debug Port of 19200, this setting is not recommended for general use. Performance will be most satisfactory if you set the Configuration/Debug Port to 9600 baud or lower.

Modbus Master (Port 3 Only)

When checked, allows Port 3 to act as a Modbus Master device, sending Modbus master commands from ladder logic.

Hide Primary Slave

When checked, protects the Primary Modbus Slave from any read or write command from a Modbus master device. In this case, you could also remap the register from the Primary Slave to the Virtual Slave protecting each register from write commands (refer to the Primary & Virtual Modbus Slaves Configuration section).

Swap Modbus Bytes

If checked, the bytes transferred by a Modbus master device will be swapped.

Swap Modbus Words

If checked, the words transferred by a Modbus master device will be swapped. This setting only applies to double-register data items (floating point and long integer).

Disable Pass-Thru

Disables the pass-thru feature for this port.

Port Authorization Parameters

Each port can be individually configured to waive the authorization requirement. This feature allows each port to have a different access level as shown in the following table:

| Port Waiver Configuration | Read Operation - Requires Authorization? | Write Operation - Requires Authorization? |
|---------------------------|--|---|
| None | Yes | Yes |
| Read Only | No | Yes |
| Read-Write | No | No |

Note 1: The waiver is effective for both hard and soft passwords.

Note 2: The backplane (Modbus Gateway) always has a "read-write" waiver so that the processor has full unrestricted access regardless of any passwords or hard/soft configuration.

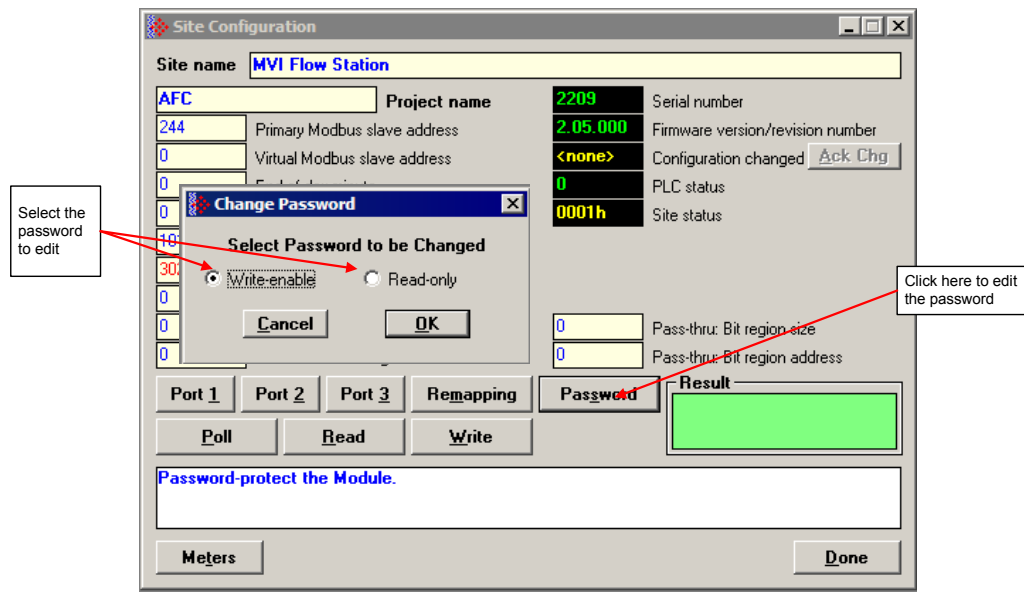
2.4.2 Remapping Button

Refer to the Primary & Virtual Modbus Slaves Configuration section.

2.4.3 Security (Passwords)

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.

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).

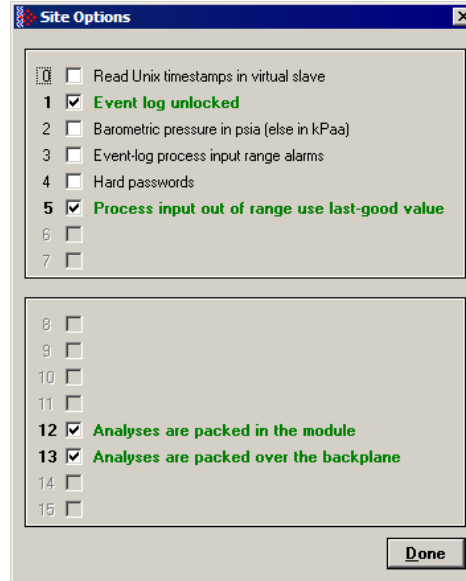
The Accessed Port and Authorization register is a bit-mapped word defined as follows:

| 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:**

- 1 Open the Site Configuration Dialog box
- 2 Click in the Site Options field. This action opens the Site Options dialog box
- 3 Select (check) option 4, Hard Passwords



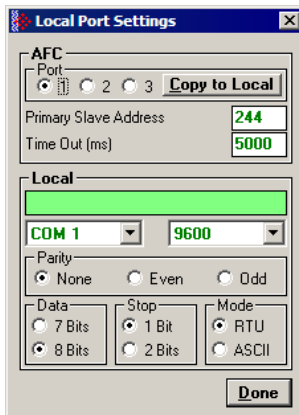
When this option is selected, any authorization granted using Hard Passwords times out after two minutes of inactivity, and the user will be required to re-enter the password to continue.

2.4.4 Poll Button

The function of the poll button is to update the display of site status (the black-background boxes in the upper right quadrant of Site Configuration).

Local Port Settings Dialog Box

This dialog box opens when you click the Read, Write or Poll buttons on the Site Configuration dialog box.



Adjust the communication settings if necessary, and then click Done to confirm your port settings and perform the requested task.

2.4.5 Read Button

The read button reads the current site configuration from the module to the local PC. Look at the result area (green rectangle) on the Site Configuration dialog box for the status of the read operation. When a "Success" indication shows in the result area, it indicates that the site configuration has been successfully read to the local PC.

2.4.6 Write Button

After you have completed the site configuration on the local PC AFC Manager software, click the Write button to transfer the configuration to the module. When the Result area shows "Success", the site configuration has been successfully written to the module.

Click the Read button to read the current module site configuration. The configuration should match the last write operation data.

If the result area shows "Time out", verify the serial port communication parameters and the communication cable (null modem).

2.4.7 PLC Image Button

This button is only visible when the module type is PTQ-AFC. Refer to the PTQ-AFC User Manual for detailed information about the Site PLC Images.

The PLC Image button opens the Site PLC Images dialog box, which shows the locations in the PLC of image files.

- 0 = not defined (file will not be scanned)
- else must be between 400001 and 465535.

| | Address | Size |
|------------------------------------|---------|------|
| Supervisory output from PLC to AFC | 0 | 52 |
| Supervisory input to PLC from AFC | 0 | 50 |
| Wallclock | 0 | 6 |
| Modbus gateway | 0 | 129 |
| Modbus pass-thru | 0 | 130 |
| Modbus master | 0 | 130 |

Zero, or a number between 400001 and 465485

Cancel Ok

2.4.8 Ack Chg Button

Refer to the Measurement Configuration Changed section.

2.4.9 Meters Button

This button opens the Meter Configuration dialog box (page 49).

2.4.10 Done Button

This button stores your settings temporarily and closes the Site Configuration dialog box. Note that you must also save your project before closing AFC Manager, otherwise your configuration will be discarded.

3 Meter Configuration

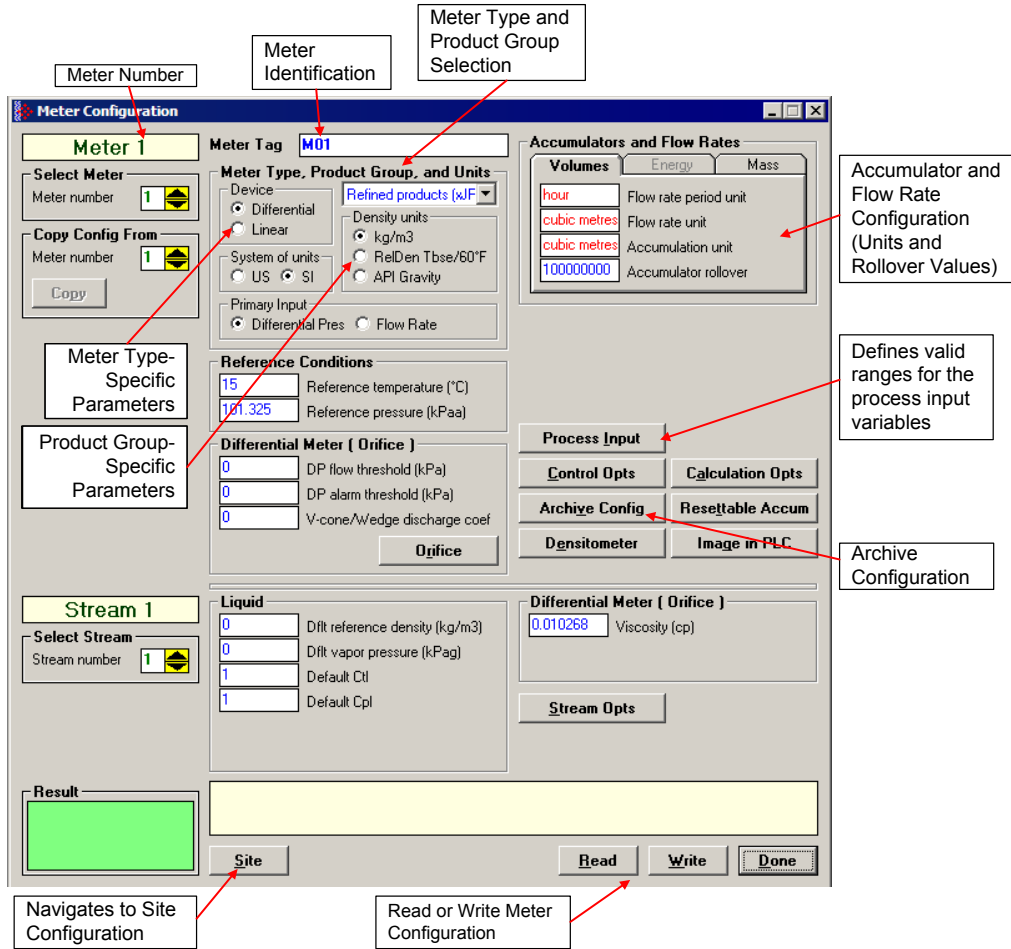
In This Chapter

- Meter Type and Product Group Configuration 50
- Reference Conditions..... 54
- Accumulators and Flow Rates..... 55
- Meter Control Options Dialog Box..... 56
- Archive Configuration 58
- Differential Meter Configuration..... 63
- Linear Meter Configuration..... 67
- Meter Factor Linearization 69
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- Process Input Scaling 75
- Stream Options 77
- Product Group Specific Parameters..... 78
- Densitometer Configuration 91
- Copying a Configuration From a Meter 92

After you have completed the Site Configuration tasks, the next step is to configure the Meters that will be associated with the module. The Meter Configuration dialog box is where you assign the settings for each meter.

➤ **To configure a meter:**

- 1 Start AFC Manager.
- 2 On the File menu, choose Load, and then open the project file.
- 3 On the Project menu, choose Meter Configuration. This action opens the Meter Configuration dialog box.
- 4 Choose the meter to be configured in the Select Meter panel.
- 5 To quickly set up a meter to be similar to another, you can use the Copy Config From panel.



Note: The items on this dialog box change according to the Meter Type and Product Group you select.

3.1 Meter Type and Product Group Configuration

Use the Meter Type and Product Group parameters to configure the type of meter and product to use for the calculation.

Specify the meter type (differential or linear) and the product group (gas, crude or refined liquids, or oil-water emulsion). Depending on the meter type and product group you select, additional settings may be visible.

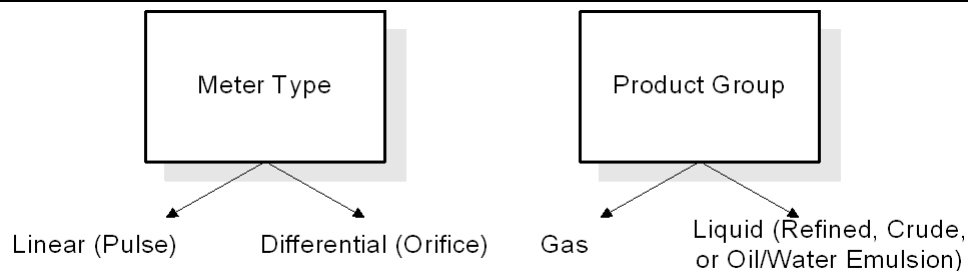
Each meter channel can be assigned as a linear meter (*pulse meter*) input or as a differential meter (*orifice meter*) input for flow measurement using either SI or US units.

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

| Product Group | Standard |
|--|------------------------------|
| Gas | AGA8 and either AGA3 or AGA7 |
| Liquid | API2540 |
| Crude oils, JP4 <ul style="list-style-type: none"> Use for crude oils that are relatively water-free (less than 5%), and for jet fuel JP4. | "A" tables 23/24/53/54 |
| NGLs, LPGs <ul style="list-style-type: none"> Use for propane, butane, NGLs (natural gas liquids), LPG (Liquefied Petroleum Gas, e.g. propane) | "E" tables 23/24/53/54 |
| Oil-Water Emulsions (Crd) <ul style="list-style-type: none"> Use for crude that might have a high concentration of water (more than 5%) for which the API Chapter 20.1 is applicable). Firmware version 2.03.000 or later is required to support this option. | "A" tables 23/24/53/54 |
| Oil-Water Emulsions (NGL) <ul style="list-style-type: none"> Use for NGL/LPG that might have a high concentration of water (more than 5%) for which the API Chapter 20.1 is applicable). Firmware version 2.03.000 or later is required to support this option. | "E" tables 23/24/53/54 |
| Refined Products <ul style="list-style-type: none"> Use for gasolines, jet fuels (except JP4), and fuel oils | "B" tables 23/24/53/54. |
| Lubricating Oils | "D" tables 23/24/53/54. |
| Special Applications <ul style="list-style-type: none"> For this product group the coefficient of thermal expansion is configured directly rather than being computed from density. | "C" tables 23/24/53/54. |

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.

3.1.1 API2540 Tables

Tables x3 calculate density at reference conditions from density measured at flowing conditions. Tables x4 calculate the CTL (temperature correction) factor. Tables 2x perform their calculations using US units (°F, psi, relative density 60/60), and tables 5x perform the calculations using SI units (°C, kPa, kg/m³).

The meter configuration dialog box will automatically display the correct configuration parameters for the meter type you selected.

Refer to Meter Type Specific Parameters and Product Group Specific Parameters (page 78) for more information.

3.1.2 Device = Differential or Linear

For Pulse Meters, select the Linear option. For Orifice meters, select the Differential option.

- When Differential is selected, the module will use the AGA 3 standards to perform the flow calculation.
- When Linear Meter (for Pulse meters) is selected, the module will use the AGA 7 report (for gases) to perform the flow calculation.

The meter configuration dialog box will automatically display the correct configuration parameters for the meter type you selected.

3.1.3 Product Group = Gas, Refined Product, Crude/NGL/LPG or Oil-Water Emulsion

The Product Group selects the API/AGA Standards to be used in calculating flow rates/increments.

- For "Gas", the calculation uses AGA8 and either AGA3 or AGA7 Standards.
- For liquids, the calculation uses the API2540 Standards.
 - "Crude, JP4" uses the "A" tables.
 - "NGLs, LPGs" uses the "E" tables (GPA TP-25). Choose this for lighter products such as propane, butane and natural gas liquids.
 - "Refined Products (xJP4)" uses the "B" tables. Choose this for gasolines, fuel oils and jet fuels (except JP4).
 - "Lubricating Oils" uses the "D" tables.
 - "Special Applications" uses the "C" tables. This selection requires explicit configuration of the coefficient of thermal expansion, and should be chosen when the other tables, which calculate that coefficient from density, are deemed to be unacceptable according to experimental results or contract.
 - "Oil-Wtr Emulsions (Crd)" is the same as "Crude, JP4", except that it also uses MPMS Ch 20.1 section 1.9.5 to calculate net clean oil. Choose "Oil-Water Emulsion" for crude oil that is emulsified with large amounts of water.
 - "Oil-Wtr Emulsions (NGL)" is the same as "NGLs, LPGs", except that it also uses MPMS Ch 20.1 section 1.9.5 to calculate net clean oil. Choose "Oil-Water Emulsion" for lighter products that are emulsified with large amounts of water.

3.1.4 Units = US or SI

Selects the units used in the flow measurement calculations (US or SI).

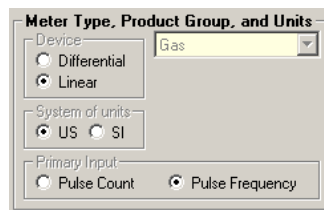
3.1.5 Primary Input

You can select the primary input for volume calculation. The available options depend on the configured meter type.

| Meter Type | Options |
|--------------|------------------------------------|
| Differential | Differential Pressure or Flow Rate |
| Linear | Pulse Count or Pulse Frequency |

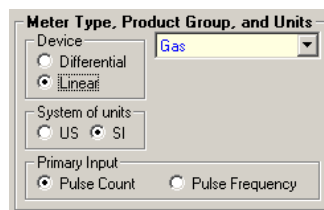
3.1.6 Changing the Meter Type, Product Group, or Unit

In order to perform a meter type and product group selection, the meter must be disabled temporarily, otherwise the fields would be locked for changes as shown below:



A meter can be enabled or disabled using ladder logic, however it is also possible to perform the same task using the AFC Manager. The following steps show this procedure:

- 1 Read the Current Configuration from the Module.** Click the Read button at the Meter Configuration dialog box to update the dialog box information.
- 2 Disable the Meter.** Click the **Control Opts** button, and clear the Meter Enable checkbox.
- 3 Write the Configuration to the Module.** Click the Write button at the Meter Configuration dialog box. When the result area shows that the operation has completed successfully it means that the meter should be now disabled. At this time, the Meter Type and Product Group Selection parameters should be enabled:



- 4 Enter the New Configuration.** Select the meter type, product group, and units.
- 5 Write the Configuration to the Module.** Click the Write button on the Meter Configuration dialog box.

- 6 Enable the Meter.** Click the **Control Opts** button, and select the Meter Enable checkbox. Click the Write button on the Meter Configuration dialog box to write the configuration to the module.

Important: If the meter is enabled, it is not allowed to download a configuration from the local computer to the module when the meter type or product group does not match the current meter configuration at the module. An "Illegal Data Value" warning will be generated at every configuration download attempt.

The only parameters that require the meter to be disabled for changing are Meter Type, Product Group, Units, and Primary Input. All other parameters can be changed at any time.

3.2 Reference Conditions

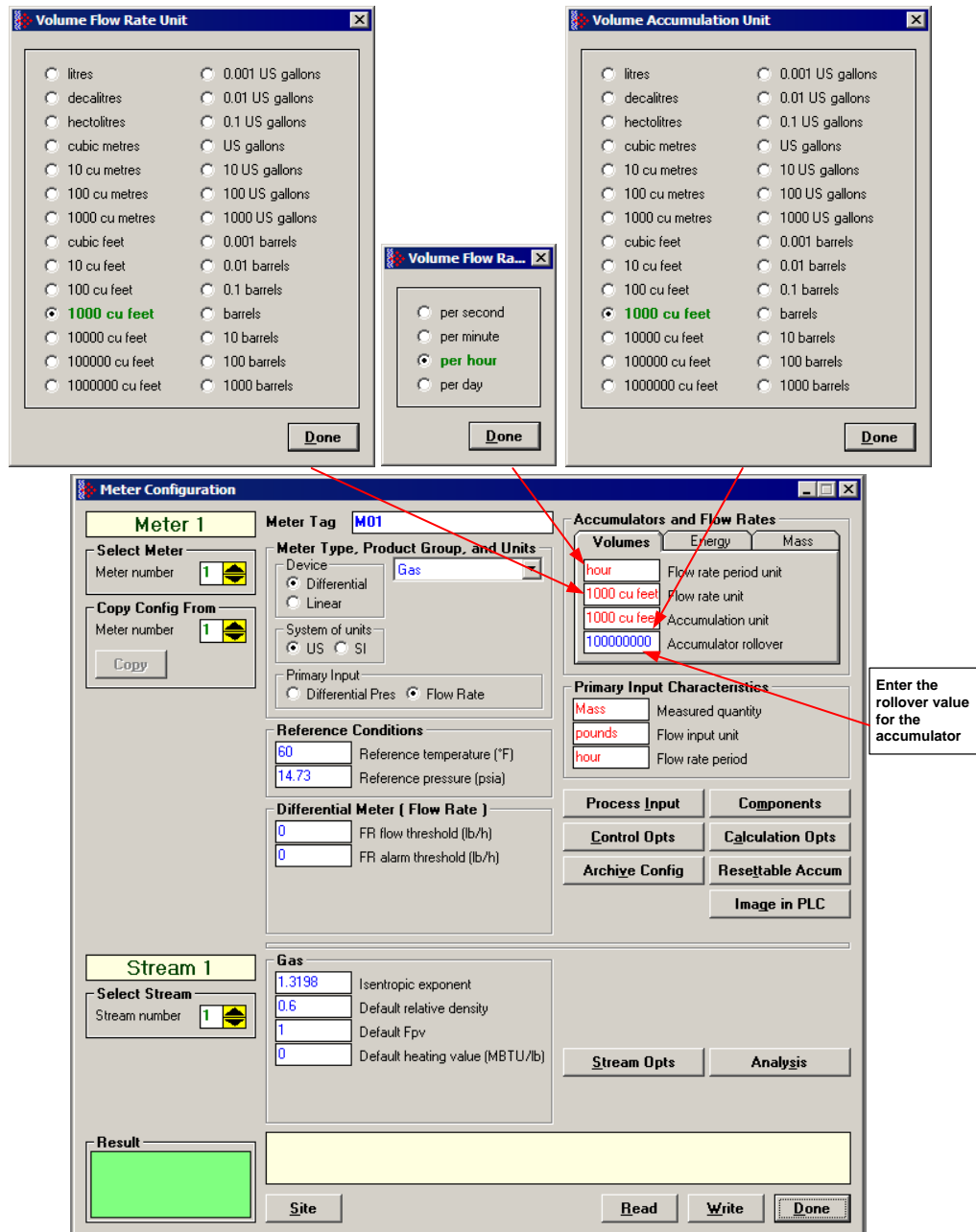
Measurements of gas and liquids are calculated based on their characteristics at a specific temperature and atmospheric pressure. Specify the reference conditions in this area. The default values are 15°C/101.325 kPaa (SI) and 60°F/14.696psia (US), which are the standard API 2540 base conditions. If configured reference conditions are different from API base, the API 2540 calculations are done twice as necessary to correct from flowing conditions to API base and then de-correct from API base to your selected reference.

The screenshot shows the 'Meter Configuration' dialog box for 'Meter 1'. The 'Reference Conditions' section is highlighted, showing input fields for 'Reference temperature (°C)' set to 15 and 'Reference pressure (kPaa)' set to 101.325. Two callout boxes on the left point to these fields with the text 'Enter the Reference Temperature to use' and 'Enter the Reference Pressure to use'. Other sections include 'Meter Type, Product Group, and Units', 'Accumulators and Flow Rates', 'Primary Input Characteristics', 'Differential Meter (Flow Rate)', and 'Liquid'.

3.3 Accumulators and Flow Rates

Use these parameters to configure the flow rate units, accumulator units, and the accumulator rollover values for Volume, Energy, and Mass.

The AFC Manager automatically displays the possible unit values to be selected as shown in the following illustration.

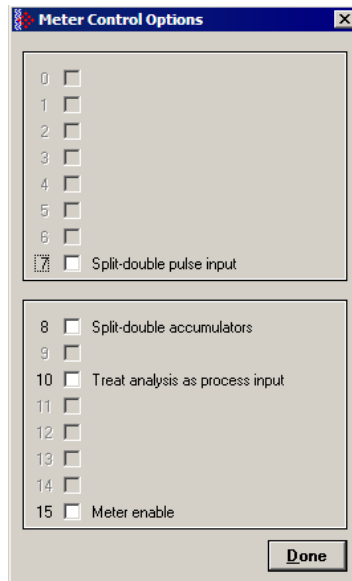


3.3.1 Accumulator Rollovers

An accumulator rollover value is the value at which the accumulator is 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 - refer to ctrl options button) or 4294967295 (32-bit). For a split accumulator, a value greater than 655360000 is deemed to be 655360000, that is, free-running. The rollover value for a free-running 24-bit accumulator is 16777216.

3.4 Meter Control Options Dialog Box

Click the Control Opts button to configure certain meter-specific parameters.



3.4.1 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.

3.4.2 Split-double Accumulator

If this option is clear, the accumulator totalizers are treated as unsigned 32-bit binary numbers, with any carry out of the low-order 16 bits being added into the high-order 16 bits.

If this option is set, then the totalizers are "split", with the low order half rolling over from 9999 to 0000 at which time the high-order half is incremented. 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 PLC data file.

3.4.3 Treat analysis as process input

When this option is selected, the module will treat the analysis as a process input, which means that the module will not generate events when the molar concentrations change.

If an analysis is manually entered, for example, once per month after receiving the results from a sample sent to a lab, then it makes sense to treat it as a "sealable parameter", logging the change to the event log. This arrangement would be appropriate for metering gas flowing from a well, whose composition would be expected to change only very slowly over time, if at all. In this case you would keep this option cleared.

On the other hand, an intermediate gas stream in an industrial process may undergo dramatic changes in composition over a short time. The analysis of such streams may be kept up to date by repeatedly sampling it with a Gas Chromatograph and sending the results to the AFC as they arrive, possibly as often as every 15 seconds. Logging analysis changes to the event log would drown out other events. It is appropriate in such cases to treat the analysis as process input like temperature or pressure, as that is indeed what it is. In this case you would keep this option checked.

3.4.4 Meter Enabled

When this option is selected, the meter will begin processing calculations. You must disable the meter by unchecking this box before you can change the meter type or product group. You should also disable any meter that is not being used, to allow for best possible module performance. After enabling or disabling the meter, click Done, and then click the Write button in the Meter Configuration area. To retrieve the status of a meter, click the Read button in the Meter Configuration area.

Note: The meter can also be enabled or disabled from ladder logic (refer to the module's User Manual).

Enable a Meter

- 1 Select (check) the Meter enable check box
- 2 Click the Meter Options Done button
- 3 Click on **Meter Configuration / Write** button.

Disable a Meter

- 1 Clear the Meter enable check box
- 2 Click the Meter Options Done button
- 3 Click on **Meter Configuration / Write** button.

Read the Current Status

- 1 Click on **Meter Configuration / Read** button.
- 2 Click on **Meter Configuration / Control Opts** button
- 3 If the check box is cleared, the meter is disabled, otherwise the meter is enabled.

Note: The meter can also be enabled or disabled from ladder logic (refer to the module's User Manual)

3.5 Archive Configuration

To configure archives for a meter, click the Archive Config button in the Meter Configuration dialog box. This action opens the Archive Configuration dialog box.

Firmware versions 2.01 and newer allow you to configure the calculation values that will be located in each archive. The default archive configuration depends on the meter type and the product groups.

Note: If the Archive Config button is not visible on the Meter Configuration dialog box, you are configuring a module with firmware earlier than version 2.01. Contact ProSoft Technical Support to update the firmware on your module if your project requires this functionality.

3.5.1 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.

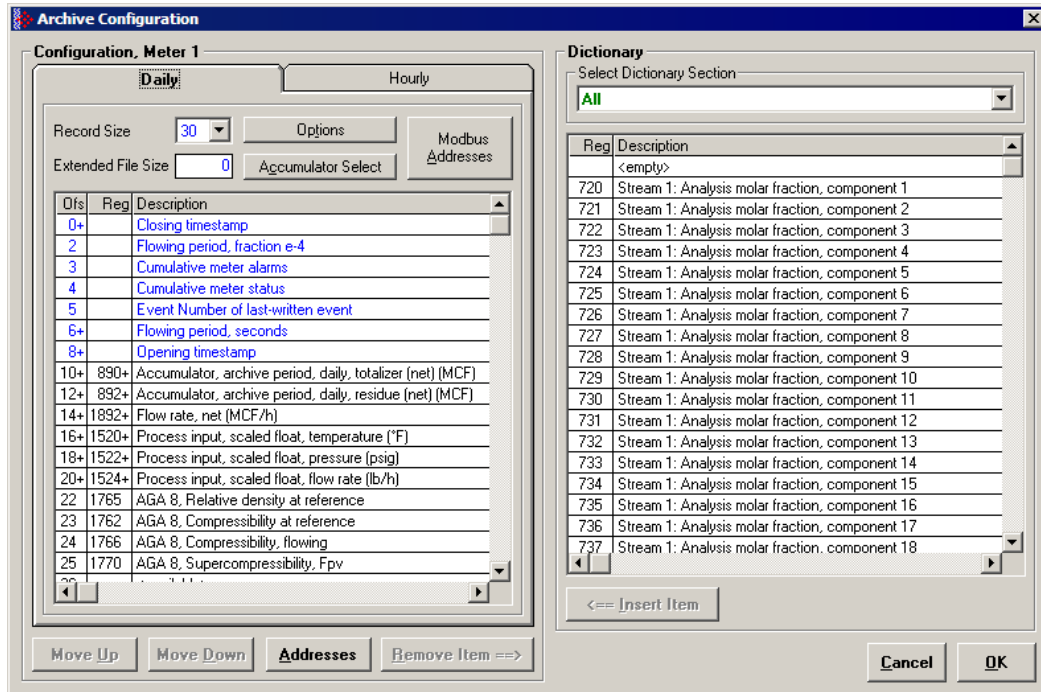
Each archive contains two values that informs the period of time about that archive:

- 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.

3.5.2 Archive Configuration Dialog Box

This dialog box opens when you click the Archive Config button on the Meter Configuration dialog box. Each meter has its own archive, which you can configure.



Daily and Hourly tabs: The Daily and Hourly tabs list the data elements that will be collected.

Record Size: The default configuration uses a 30 word record for each daily or hourly archive. Use the Record Size dropdown list to choose a different record size.

The module reserves a total of 1060 words for daily archives and 1440 words for hourly archives. Therefore, the total number of archives per meter run 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 |

Extended File Size: This feature is only available for firmware versions 2.02.001 and newer, as it requires the Compact Flash to be installed in the module. It should be used for projects that demand extra archives. You may define up to 1440 *extended* daily archives and 1440 *extended* hourly archives. The maximum number of extended archives does not depend on the number of words per archive.

Options: Opens the Archive Options dialog box.

Accumulator Select: Opens the Accumulator Select dialog box, where you can select the quantity to be accumulated in the *archive period accumulator* result.

Move Up and Move Down: Use these buttons to change the order of selected points in the list of elements to archive. Be aware that items occupying two words will be shifted by two word positions, so that they are always located at an even offset.

Addresses: Use this button to open the Archive Modbus Addresses window for the selected archive file, which you can use to learn how to retrieve specific archive records from the module, including the Modbus addresses where they reside.

Remove Item: Use this button to remove the selected point from the list of elements to archive.

Dictionary: The Dictionary dropdown list acts as a filter for the types of points to archive. The filtered results are listed in the right pane of the Archive Configuration dialog box. The default filter is "All". The other selections in the dropdown list depend on the Meter Type and Product Group you selected on the Meter Configuration dialog box.

Insert Item: Use this button to insert the selected point in the list of points to archive.

Archive Data Format

There are 3 columns associated with each archive data:

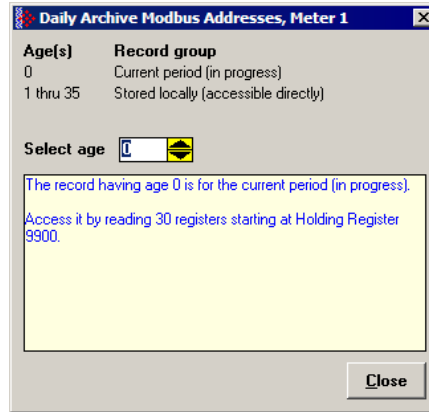
| Column | Description |
|-------------|---|
| Ofs | Shows the offset location of the data in each archive. The maximum offset value will depend on the <i>Record Size</i> value you configured. If the value has a "+" (for example "0+") it means that the data occupies 2 words of data. |
| Reg | Shows the Primary Modbus Slave Address of the source 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. |

The archive header is common for all meter types and product groups and cannot be edited. The archive header uses up to 10 words and is displayed with a blue text:

| Ofs | Reg | Description |
|-----|-----|------------------------------------|
| 0+ | | Closing timestamp |
| 2 | | Flowing period, fraction e-4 |
| 3 | | Cumulative meter alarms |
| 4 | | Cumulative meter status |
| 5 | | Event Number of last-written event |
| 6+ | | Flowing period, seconds |
| 8+ | | Opening timestamp |

3.5.3 Archive Modbus Addresses dialog box

This dialog box opens when you click the Addresses button on the Archive Configuration dialog box. Use it to learn how to retrieve specific archive records.



Select the age of the archive to be retrieved.

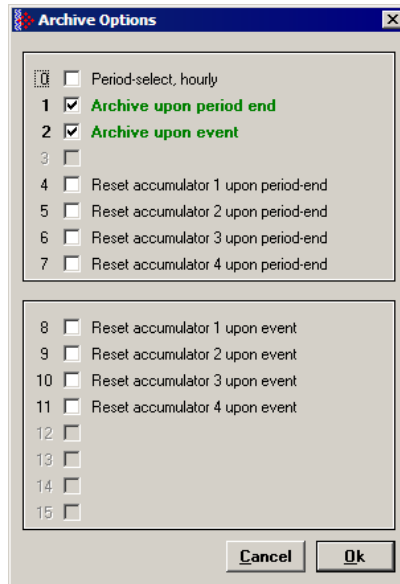
- Archive 0 is the current period (in progress).
- Archives 1 through 35 are recent records stored locally (for daily archives).
- Archives 1 through 48 are recent records stored locally (for hourly archives).
- Older archives are stored on Compact Flash, and are retrieved by copying them into a window in the Modbus table.
- The number of records stored locally depends on both the file selected (daily or hourly) and on the record size (numbers shown are for 30-word records).

The help text in this dialog box describes the procedure to fetch the contents of the archive you select.

3.5.4 Archive Options Dialog Box

This dialog box opens when you click the Options button on the Archive Configuration dialog box. On this dialog box, you can:

- Configure when the archives will be generated (upon period end and/or upon event)
- Specify when the accumulators will be reset (upon period end and/or upon event)

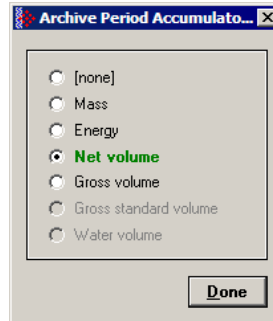


The following table explains each option:

| Parameter | Description |
|---------------------------------------|--|
| Period-select, hourly | This option should be clear for Daily Archive and set for Hourly Archive |
| Archive upon period end | If this option is set, the module will generate a new archive when the configured hourly or daily period ends. |
| Archive upon event | If this option is set, the module will generate a new archive every time an event occurs (for example: change the orifice diameter value) |
| Reset Accumulator X upon period-end | If this option is set, the Resettable Accumulator X will be reset once the archive period ends. Note: This is the actual meter accumulator value that is displayed in the Meter Monitor dialog box. |
| Reset Accumulator X upon period event | If this option is set, the Resettable Accumulator X will be reset every time an event occurs. Note: This is the actual meter accumulator value that is displayed in the Meter Monitor dialog box. |

3.5.5 Archive Period Accumulation Dialog Box

This dialog box opens when you click the Accumulator Select button on the Archive Configuration dialog box.



Select the quantity to be accumulated in the *archive period accumulator* result. The following types are available, according to the meter type and product group.

- None
- Mass
- Energy
- Net Volume
- Gross Volume
- Gross Standard Volume
- Water Volume.

3.6 Differential Meter Configuration

The Differential Meter parameters are displayed after you select Differential Meter in the Process Input area of the Meter Configuration dialog box.

Differential pressure configures the module to use the differential pressure value transferred through the backplane as the primary input for volume calculation. This is the normal setting for most projects.

Flow rate configures the module to use the flow rate value transferred through the backplane for volume calculation. In this situation, the flow rate value should be transferred through the backplane instead of the differential pressure. This means that the flow rate will use the same backplane location that the differential pressure would use.

3.6.1 Differential Meter, Differential Pressure (Orifice Meters)

After configuring the meter as a Differential meter (AGA 3), you might configure the following parameters:

The screenshot displays the 'Meter Configuration' window with several sub-windows open:

- Meter Calculation Options:** A window with a list of checkboxes for configuring AGA parameters. The 'Downstream static pressure' checkbox is checked. Other options include 'Taps: corner', 'Taps: radius', 'V-cone/Wedge device', 'ISO 5167 (2003) (else AGA 3 (1992))', 'Ignore default flowing density', 'Density correction', 'Hydrometer correction', 'Temperature correction', 'Pressure correction', 'Vapor pressure via TP-15', 'Density correction for pressure', and 'Calculate net heating value (else gross)'.
- Orifice and Tube Parameters:** A window with input fields for 'Temperature (°C)', 'Diameter (mm)', and 'Thermal expansion coefficient (/°C e-6)' for both 'Orifice' and 'Meter Tube'.
- Meter Configuration (Main):** The central window showing 'Meter 1' configuration. It includes sections for 'Select Meter', 'Copy Config From', 'Meter Type, Product Group, and Units', 'Reference Conditions', 'Differential Meter (Orifice)', 'Stream 1', and 'Result'. The 'Differential Meter (Orifice)' section has fields for 'DP flow threshold (kPa)', 'DP alarm threshold (kPa)', and 'V-cone/Wedge discharge coef'. The 'Stream 1' section has fields for 'Gas', 'Isentropic exponent', 'Default relative density', 'Default Fpv', and 'Default heating value (MJ/kg)'. The 'Result' section shows a message: 'The meter being edited, between 1 and 16.' Buttons for 'Site', 'Read', 'Write', and 'Done' are at the bottom.
- Process Input Scaling:** A window with a table for scaling input variables. The table has columns for 'Zero scale', 'Full scale', 'Default', and 'Raw input'. The 'Raw input' column has dropdown menus for 'Floating point'.

Annotations with red arrows point from text boxes to specific parts of the interface:

- 'Meter Calculation Options Allows you to configure certain AGA parameters' points to the 'Meter Calculation Options' window.
- 'Orifice and Tube Parameters' points to the 'Orifice and Tube Parameters' window.
- 'Process Input Scaling - Enter the value and format for the input variables' points to the 'Process Input Scaling' window.

DP Flow Threshold

If at any time the differential pressure input value is less than the DP Flow Threshold parameter, the module will treat the differential pressure as zero (no flow).

DP Alarm Threshold

If at any time the differential pressure input value is less than the DP Alarm Threshold parameter, the module will flag a Differential Pressure Low alarm. Note that this alarm is different than the one the module would flag if the differential pressure would be out of range (Input Out of Range: Differential pressure).

V-Cone Discharge Coefficient

For an Orifice meter, AGA3 dictates the calculation of the "Coefficient of Discharge", a multiplicative factor used in calculating the flow rate. For a V-cone meter, there is no corresponding calculation, so the Coefficient of Discharge must be entered from the manufacturer's data sheet. The "V-Cone Discharge Coefficient" has no meaning unless the "V-Cone Device" option is selected (see Calculation Options button).

Viscosity

Enter the viscosity value to be used in the calculation. The default value is 0.010268.

3.6.2 Orifice and Meter Tube Parameters dialog box

This dialog box opens when you click the Orifice button on the Meter Configuration dialog box.

| | Orifice | Meter Tube |
|--|---------|------------|
| Temperature (°C) | 20 | 20 |
| Diameter (mm) | 0 | 0 |
| Thermal expansion coefficient (1/°C e-6) | 16.7 | 11.2 |

Temperature

The temperatures at which the diameter measurements are made. Default value for each is 20°C (68°F).

Diameter

Each measured diameter should be positive, and orifice plate diameter should be less than meter tube diameter. Default values are zero, which will cause a measurement alarm. For a V-Cone device, enter the cone diameter instead of the orifice diameter.

Thermal Expansion Coefficient

For each, coefficient of thermal expansion ("alpha") is of the order of 10e-6 /°; the actual value is multiplied by 1000000 for display and the entered value is divided by 1000000 for storage and Modbus transmission.

Values for typical materials are:

| Material | Value |
|--------------|-------------------------|
| 304/316 SS | 16.7e-6 /°C, 9.2e-6 /°F |
| Monel | 14.3e-6 /°C, 7.9e-6 /°F |
| carbon steel | 11.2e-6 /°C, 6.2e-6 /°F |

Default values are 304/316 SS for orifice plate and carbon steel for meter tube.

3.6.3 Differential Pressure, Flow Rate Integration

Select Flow Rate as the primary input to configure the following parameters:

Choose Primary Input Characteristics according to the incoming flow rate delivered over the backplane.

FR Flow Threshold

If at any time the flow rate input value is less than the FR Flow Threshold parameter, the module will treat the flow rate as zero (no flow).

FR Alarm Threshold

If at any time the flow rate input value is less than the FR Alarm Threshold parameter, the module will flag a Flow Rate Low alarm. Note that this alarm is different than the one the module would flag if the flow rate would be out of range (Input Out of Range: Flow Rate).

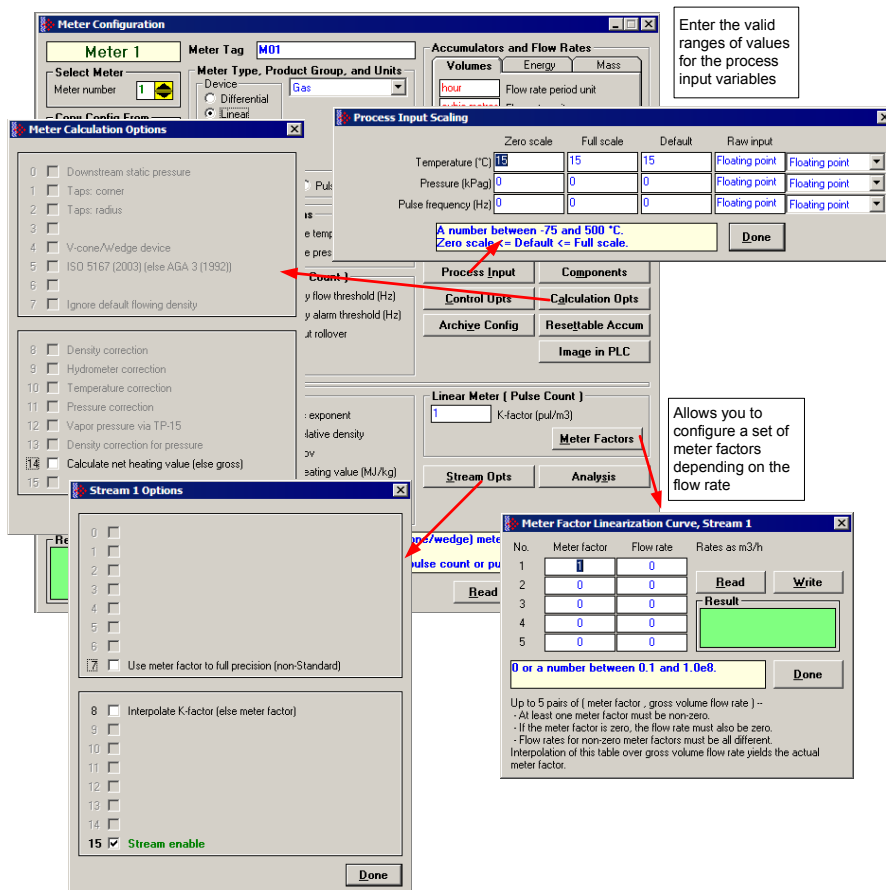
3.7 Linear Meter Configuration

The Linear Meter parameters are displayed after you select the Linear Meter.

Primary Input "Pulse Count" configures the meter to accept both pulse count and pulse frequency transferred over the backplane, and to calculate flow accumulations from the pulse count and flow rates from the pulse frequency.

Primary Input "Pulse Frequency" configures the meter to accept only pulse frequency input (pulse count is ignored), and to calculate both rates and accumulations from the frequency.

After configuring the Primary Input type for Pulse Count or Pulse Frequency, you will configure the following parameters:



3.7.1 Linear Meter (Pulse Count)

This area is visible when the meter type is set to Linear, and the Primary Input is set to Pulse Count. Enter the K-factor and pulse input rollover values for this meter. Click the Meter Factors button to enter values for Meter Factor at up to five different Flow Rates for this meter.

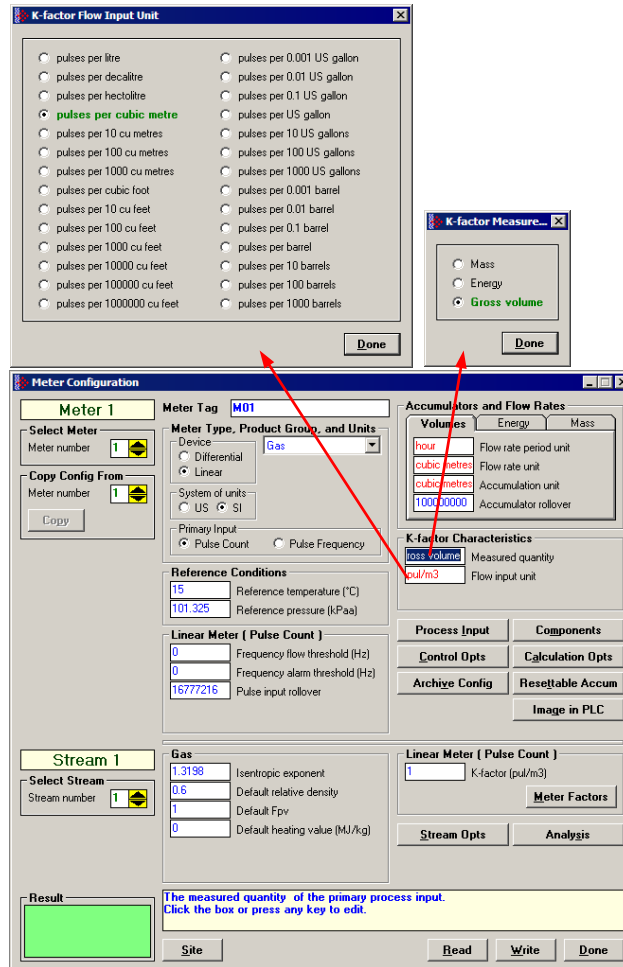
3.7.2 Linear Meter (Pulse Frequency)

This area is visible when the meter type is set to Linear, and the Primary Input is set to Pulse Frequency. Enter the K-factor, Frequency flow threshold and Frequency alarm threshold values. Click the Meter Factors button to enter values for Meter Factor at up to five different Flow Rates for this meter.

3.7.3 K-factor Characteristics

This area is visible when the meter type is Linear. Click the Measured quantity and Flow input unit fields to choose the quantity type and flow input unit for this meter.

The K-Factor itself is entered as a stream parameter; see below.



The K-factor units available for selection will depend on the selected measured quantity.

3.7.4 K-Factor

For a linear (pulse) meter:

$$\text{gross volume} = (\text{pulses}/\text{K-factor}) \times \text{meter factor}$$

The K-factor is a factor that converts raw pulse count (from the Pulse Meter) to a volume and is expressed as "pulses per unit volume", such as "1000 pulses per gallon" or "3578.224 pulses per cubic meter". This number, found on the manufacturer's data sheet for the meter, is determined at the factory for the specific unit before shipping. So, dividing "pulses" by "pulses per gallon" gives you "gallons". API calls the value "pulses / K-factor" as "indicated volume".

3.7.5 Pulse Input Rollover (Pulse Count meters)

When the meter is selected as a Pulse Meter, one of the input variables transferred from the programmable logic controller will be the Pulse Count value which is the number of pulses transferred from the Pulse Meter or the High Speed Counter Module. This parameter sets the value at which the pulse count will rollover to zero. It is essential that this value match the actual pulse rollover used in the field by the pulse meter or counter module, otherwise the flow calculation will generate unexpected values. Enter this value as (maximum value)+1.

3.7.6 Frequency Flow Threshold (Hz)

This is the threshold value for the pulse frequency. If the received value is less than the configured threshold it will be deemed to be zero.

3.7.7 Frequency Alarm Threshold (Hz)

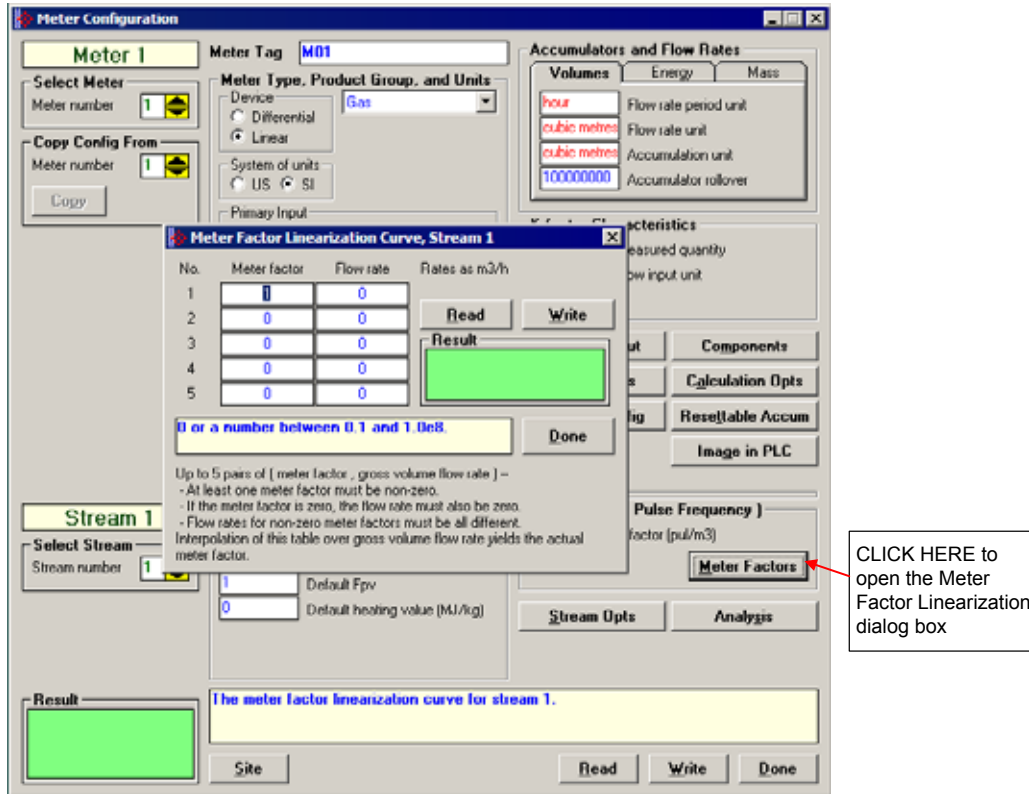
If the received pulse frequency is less than this value the "Pulse Frequency Low" alarm will be raised.

3.8 Meter Factor Linearization

Meters are mechanical instruments, so eventually they wear out. Over time, the actual measured volume (the "gross volume") will tend to drift from the nominal measured volume (the "indicated volume"). The factor that corrects "indicated" to "gross" is called the "meter factor", and is a number very close to 1. The procedure that is performed periodically to determine a (new) meter factor is called "proving". A pulse type meter is "proved" periodically to ensure that the meter performs as expected over a period of time.

A prover passes a known volume of product through the meter and compares the volume indicated by the meter against the fixed volume of the prover (measured with a high degree of precision). If the meter indicates the measured volume to be exactly the same as the known prover volume, the Meter Correction Factor is said to be equal to 1.00000 (*Meter Factor = Prover Volume/Metered Volume*).

Because meters are mechanical instruments, their behavior may differ depending on the rate of flow through the meter. That is, the meter factor may depend on the flow rate at which the measurement is performed. The AFC accommodates this by allowing you to enter up to 5 factor-flowrate pairs (the "Meter Factor Linearization" table); the AFC determines the meter factor to be used by linear interpolation on this table from flow rate at operating conditions. (Since flow rate depends on the meter factor according to API, but meter factor depends on flow rate according to the linearization table, the AFC performs a second iteration of the interpolation in order to obtain an accurate meter factor.)

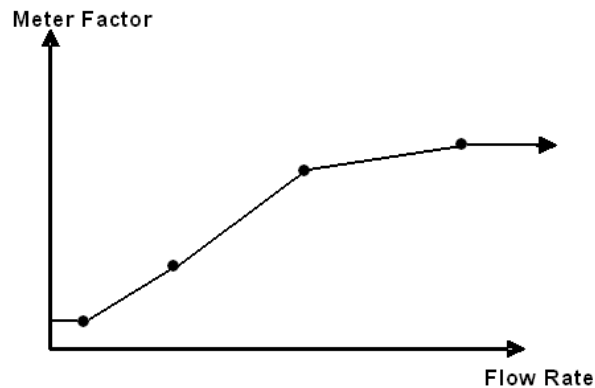


Click the Meter Factor Curve **Read** button to transfer the current Meter Factor Linearization configuration from the AFC module to the local PC

When the Meter Factor Linearization configuration is concluded, click the Meter Factor Curve **Write** button to transfer it to the AFC module

The module will use the values you entered in the Meter Factor Linearization dialog box and interpolate the values so it can use a specific meter factor depending on the current flow rate.

For example, if you enter four points (flow rate, meter factor) the module would interpolate the points as shown below:



In order for the module to accept the values you entered, the following conditions are required:

- All values are non-negative (≥ 0.0).
- At least one meter factor is non-zero.
- If a meter factor is zero, the corresponding flow rate is also zero.
- The flow rates corresponding to non-zero meter factors are all different.

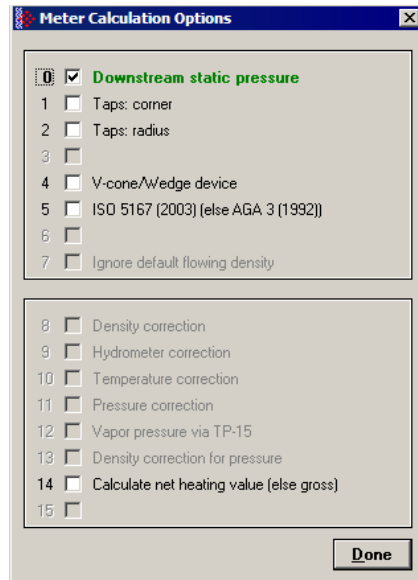
You do not need to enter factor-flowrate pairs in any particular order, or even enter them all as a contiguous group, but you may enter each factor-flowrate pair into any of the five table entries and the AFC will sort it all out.

If you do not want to enter meter factor linearization data, leave the first element as 1. This will set the meter factor as 1 for all flow rates.

3.9 Meter Calculation Options

The Meter Calculation Options dialog box opens when you click the **Calculation Opts** button. Use this dialog box to choose the required calculation parameters:

Note: Options that are not applicable to the meter type are not enabled and cannot be selected.



3.9.1 Downstream Static Pressure

The static pressure of the gas stream may 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:

$$\text{upstream pressure} = \text{downstream pressure} + \text{differential pressure}$$

If the pressure is measured from a downstream tap (typical), this parameter must be checked.

3.9.2 Taps: Corner & Taps: Radius

These options select the minor adjustments to the AGA3 calculations that depend on the precise geometry of the pressure taps.

There are 4 different kinds of taps; pipe, flange, corner, and radius. Pipe taps are obsolete; addressed in the 1985 AGA3, but absent in the 1992 version. Flange taps are used in the vast majority of orifice meter installations and are used as default for the module calculation. When using corner or radius taps, it is required that the corresponding option be selected.

3.9.3 V-Cone / Wedge Device

A differential meter is one that measures flow rate rather than flow increment. It does so by measuring a pressure drop ("differential pressure") across a constriction in the flow tube and calculating the mass flow from the DP, the geometry of the constriction, the temperature, etc., and a well-known flow equation.

One type of constriction is the "orifice", which blocks the flow around the periphery of the tube forcing the fluid to flow through a narrower aperture in the middle. The AGA3 standard specifies the calculations for this method of metering, including the calculation of the orifice "discharge coefficient".

Another type of constriction is the "V-cone", which blocks the flow in the center of the tube, forcing the fluid to flow around the blockage through the periphery of the tube; where the orifice blocks, the V-cone does not, and where the V-cone blocks, the orifice does not. Much of the AGA3 standard still applies (in particular, the well-known flow equation), except that there is no longer a calculation of the V-cone "discharge coefficient" which must then be entered into the AFC as a separate data point (refer to the previous discharge coefficient discussion).

A wedge meter is a device that constricts the flow towards one side of the flow tube. Here, also, a separate entry of the discharge coefficient must be made.

3.9.4 ISO 5167 (2003) (else AGA 3 (1992))

Available for firmware versions 2.04.000 or later. If cleared, the module will use the AGA3 standard for flow calculation. If checked, the module will use the ISO 5167 (2003) standard for flow calculation.

3.9.5 Ignore Default Flowing Density

For liquid measurement with an input of density at flowing conditions, if the density (either input over the backplane or output from a densitometer calculation) is out of range, the default is substituted, just as is done for the other process inputs of temperature and pressure. In some cases this might not be suitable, especially when the temperature of the fluid may vary, thus making it difficult to settle on an appropriate default value for density at flowing conditions. This option tells the AFC to ignore the flowing density default value, and to instead use the Default Standard Density while at the same time skipping any density correction that might be configured. (For liquid meters, the density at flowing conditions is combined with the temperature to calculate a density at standard conditions used in all further calculations.)

3.9.6 Density Correction, Hydrometer Correction, Temperature Correction & Pressure Correction

You should consider these options to select or unselect API2540 calculations for liquid measurement, depending on the requirements of the project.

For example, if flowing density is manually entered directly from the reading of a glass hydrometer containing a sample of the fluid, the Hydrometer Correction for the expansion of the glass due to temperature would be required. On the other hand, if the meter already provides a temperature-corrected pulse train, it would be an error to perform Temperature Correction a second time.

3.9.7 Vapor Pressure Via TP-15 ("Technical Paper #15")

API specifies that the pressure correction factor (CPL), which corrects the measured volume for the effect of pressure, must correct to "standard pressure or equilibrium pressure, whichever is higher".

In US units, "standard" pressure (for liquids) is 14.696 psia (one atmosphere at sea level) and "standard" temperature is 60°F. This works well for liquids such as gasoline and crudes, but lighter products (such as propane) are gaseous at these conditions.

The "equilibrium" pressure of the API standard is the pressure at which the liquid fluid and its vapor are in equilibrium. This is also called the "vapor pressure". GPA's TP-15 ("Technical Paper #15") is a correlation for calculating the equilibrium (vapor) pressure for typical hydrocarbon fluids (for example, propane) from density and temperature.

3.9.8 Density Correction for Pressure

This option, effective only when option "Density Correction" is selected, enables the effect of pressure to be included in the density correction calculation.

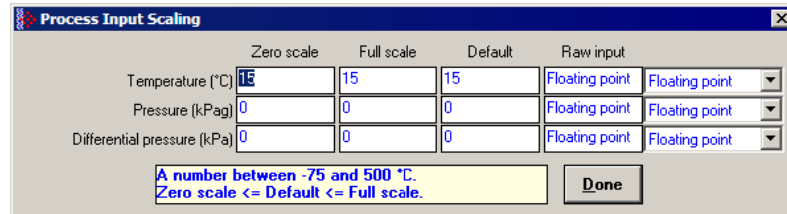
When cleared, only the effect of temperature is considered.

3.9.9 Calculate Net Heating Value (else gross)

This option selects whether the produced water is in vapor (net) or liquid (gross) state.

3.10 Process Input Scaling

Click the Input Data button to configure the valid input ranges. If an input data is not within the configured range, the AFC will flag an alarm on the Meter Monitor dialog box (refer to Meter Monitor section) and the alarm bit for the meter will be set.



The entries available on this dialog box depend on the selected product group, device, and primary input:

| Product Group | Input Variables |
|---------------|--|
| Gas | Temperature, Pressure, Flow Rate, Differential Pressure, Pulse Frequency |
| Liquid | Temperature, Pressure, Flow Rate, Differential Pressure, Pulse Frequency, Density, Water Content |

3.10.1 Zero Scale

This value is the minimum valid value for the input variable.

3.10.2 Full Scale

This value is the maximum valid value for the input variable.

3.10.3 Default

This parameter is used by the module as the input value when the input variable is out of range and site option "Process input out of range use last-good value" is clear. In this situation, the module will flag the alarm and use the default value instead of the value transferred by the module.

3.10.4 Raw Input

This parameter configures how the module will interpret the input variable within the given range. The possible selections are floating point, scaled integer, and 4 to 20 mA. The default is floating point, in which the raw input from the processor is a floating point value already converted to engineering units.

For scaled integer input, the module will expect the following data formats:

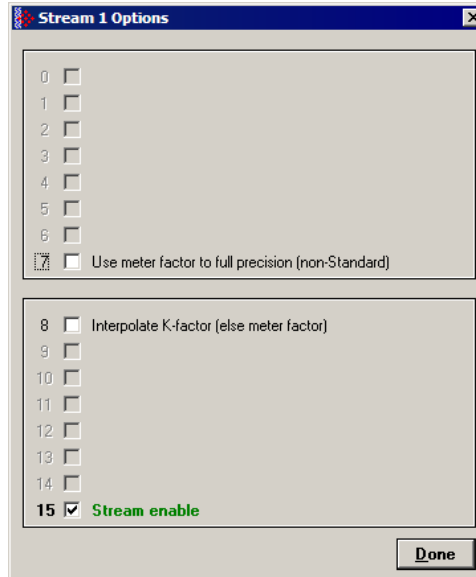
| Scaled Integer | | |
|------------------------------|--|--|
| Variable | Format | Example |
| Temperature | Two decimal places implied | A value of 1342 would be equivalent to 13.42°C |
| Pressure | Zero decimal places implied for the SI units (kPa) and one decimal place implied for the U.S. units (psi). | A value of 200 would be equivalent to 200 kPag |
| Differential Pressure | Two decimal places implied for inches of H ₂ O and three places for kPa | A value of 35142 would be equivalent to 35.142 kPa |
| Flow Rate | Zero decimal places implied; for desired precision, choose an appropriate input flow rate unit | A value of 6672, with input flow rate units configured as gal/hr, would be equivalent to 6672 gal/hr |
| Pulse Frequency | Zero decimal places implied | A value of 2276 would be equivalent to 2276 Hz |
| Density (kg/m ³) | One implied decimal place | A value of 5137 would be equivalent to 513.7 kg/m ³ |
| Density (Relative Density) | Four implied decimal places | A value of 10023 would be equivalent to 1.0023 60°F/60°F. |
| Density (API) | Two implied decimal places | A value of 8045 would be equivalent to 80.45 °API. |

For 4 to 20 mA input, the value received from the processor is the raw unscaled A/D count obtained from the analog input card. The module scales the raw count to engineering units using the configured values for zero scale and full scale assuming the following ranges:

| 4 to 20 mA A/D counts | | | |
|------------------------------|---------------|--------------------------|---------------------------|
| Processor | Module | Zero scale (4 mA) | Full scale (20 mA) |
| SLC | MVI46-AFC | 3277 | 16384 |
| ControlLogix | MVI56-AFC | 13107 | 65535 |
| CompactLogix | MVI69-AFC | 6241 | 31206 |
| PLC | MVI71-AFC | 819 | 4095 |
| Quantum | PTQ-AFC | 4000 | 20000 |

In the Meter Monitor dialog box, the raw value is shown in the "Last Raw" column and the converted values are shown in the "Scaled Avg" column.

3.11 Stream Options



Meters often are used for measurement of different products at different times. The reasons for doing so include cost and convenience (a pipeline may carry gasoline one day and fuel oil the next) and accounting (a plant may receive product from several different suppliers who must be fairly paid). Available for firmware versions 2.05 and later, the Multiple Stream feature of the AFC allows such a meter to be modeled with up to four different product streams, each of which has its own set of product-specific configuration parameters and accumulators.

A meter always has exactly one active stream, which corresponds to the particular product that flows through the meter at that moment. The active stream may be switched to any enabled stream via a meter signal; enabling a stream allows it to become active and disabling it prevents it from becoming active, and the currently active stream may not be disabled. As the physical switching of a product stream through a meter is almost always accompanied by additional actions such as the swinging of valves it is expected that the stream-switching signal will be issued by the processor, hence to reduce the likelihood of unfortunate errors the AFC Manager provides no specific method for issuing that signal. Issuing a stream-switch signal, however, is like issuing any other signal, which is by latching a bit in one of the AFC's Modbus registers, hence in exceptional circumstances it can be issued from anywhere, such as by a SCADA system connected to one of the Modbus ports or by the AFC Manager itself via the Modbus Master window.

Parameters whose values may depend on the properties of the product being measured are configured for each stream separately. Such parameters include both those that describe the product directly (e.g. density, viscosity, analysis) and those that describe indirect effects of the product (e.g. meter factor). Measurement calculations always use the parameters for the active stream.

The output of each stream consists of a complete set of accumulators laid out like those of the meter itself. Computed increments are accumulated simultaneously in both the meter accumulators and those of the active stream, so that each meter accumulator is always the sum of the corresponding accumulators for all four streams (modulo the rollover value).

3.11.1 Use meter factor to full precision (non-Standard)

If "Use meter factor to full precision" is clear, the Meter Factor is rounded to five decimal places (four decimal places for firmware versions 2.04 and earlier) before being used to calculate gross volume ($\text{gross} = \text{pulses} / \text{KF} * \text{MF}$). If the option is set, the MF is used as is without rounding. The API standard requires the meter factor to be rounded.

3.11.2 Interpolate K-factor

This option bit swaps the roles of K-factor and meter factor, so that when this option is selected, the "K-factor" entry becomes "Meter factor" and the "Meter Factor Linearization" table becomes "K-factor Linearization".

The calculations described up to this point are those recommended by API and performed by the vast majority of users of linear meters. Some users, however, may prefer to keep the meter factor at exactly 1.0000 and periodically adjust the K-factor with a meter prove; and then the K-factor may depend on the flow rate.

3.11.3 Stream Enable

Select (check) to enable the current stream. Unselect (uncheck) to disable the current stream. A disabled stream cannot be made active. When downloading the configuration to the module, this option is silently forced for the active stream.

3.12 Product Group Specific Parameters

After the meter type has been selected, and its specific parameters are set, it is time to configure the Product Group considered for the meter and its specific parameters.

The Product Group selects the measurement Standards to be used in calculating flow rates and accumulations. Select "Gas" to use AGA8 and either AGA3 or AGA7 Standards. Select a liquid group to use the API2540 Standards. For more detail on measurement standards, see the Measurement Standards subsection of the Reference chapter in this manual.

The following sections group products into two categories, Gas and Liquid., grouping all the liquid products together. The reason for this approach is because the configuration interfaces for all the liquid products are very similar while that for gas is significantly different.

3.12.1 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:

Component Selection Map

| | | | | | |
|---|--|----|---|----|---|
| 1 | <input checked="" type="checkbox"/> C1 methane | 9 | <input type="checkbox"/> CO carbon monoxide | 17 | <input type="checkbox"/> C8 octane |
| 2 | <input checked="" type="checkbox"/> N2 nitrogen | 10 | <input type="checkbox"/> O2 oxygen | 18 | <input type="checkbox"/> C9 nonane |
| 3 | <input checked="" type="checkbox"/> CO2 carbon dioxide | 11 | <input type="checkbox"/> iC4 iso-butane | 19 | <input type="checkbox"/> C10 decane |
| 4 | <input checked="" type="checkbox"/> C2 ethane | 12 | <input type="checkbox"/> nC4 normal butane | 20 | <input type="checkbox"/> He helium |
| 5 | <input type="checkbox"/> C3 propane | 13 | <input type="checkbox"/> iC5 iso-pentane | 21 | <input type="checkbox"/> Ar argon |
| 6 | <input type="checkbox"/> H2O water | 14 | <input type="checkbox"/> nC5 normal pentane | 22 | <input type="checkbox"/> neoC5 neopentane |
| 7 | <input type="checkbox"/> H2S hydrogen sulphide | 15 | <input type="checkbox"/> C6 hexane | 23 | <input type="checkbox"/> Ux user1 |
| 8 | <input type="checkbox"/> H2 hydrogen | 16 | <input type="checkbox"/> C7 heptane | 24 | <input type="checkbox"/> Uy user2 |

Normalization total error tolerance:

Check to include "C2 ethane" in the set of selected components.

Component Analysis, Stream 1

| | | | |
|----|--|----|---|
| 1 | <input type="text" value="0.2"/> C1 methane | 13 | <input type="text" value="0"/> iC5 iso-pentane |
| 2 | <input type="text" value="0.1"/> N2 nitrogen | 14 | <input type="text" value="0"/> nC5 normal pentane |
| 3 | <input type="text" value="0.3"/> CO2 carbon dioxide | 15 | <input type="text" value="0"/> C6 hexane |
| 4 | <input type="text" value="0.1"/> C2 ethane | 16 | <input type="text" value="0"/> C7 heptane |
| 5 | <input type="text" value="0"/> C3 propane | 17 | <input type="text" value="0"/> C8 octane |
| 6 | <input type="text" value="0"/> H2O water | 18 | <input type="text" value="0"/> C9 nonane |
| 7 | <input type="text" value="0"/> H2S hydrogen sulphide | 19 | <input type="text" value="0"/> C10 decane |
| 8 | <input type="text" value="0"/> H2 hydrogen | 20 | <input type="text" value="0"/> He helium |
| 9 | <input type="text" value="0"/> CO carbon monoxide | 21 | <input type="text" value="0"/> Ar argon |
| 10 | <input type="text" value="0"/> O2 oxygen | 22 | <input type="text" value="0"/> neoC5 neopentane |
| 11 | <input type="text" value="0"/> iC4 iso-butane | 23 | <input type="text" value="0"/> Ux user1 |
| 12 | <input type="text" value="0"/> nC4 normal butane | 24 | <input type="text" value="0"/> Uy user2 |

Copy Analysis From
Meter number:
Stream number:

Result

The concentration in the fluid of "C2 ethane" as a molar fraction; a number between 0.0000 and 1.0000.

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**).

3.12.2 Gas Specific Parameters and Component Analysis (Molar Analysis) Configuration

When gas is selected as the product group, the following parameters must be configured:

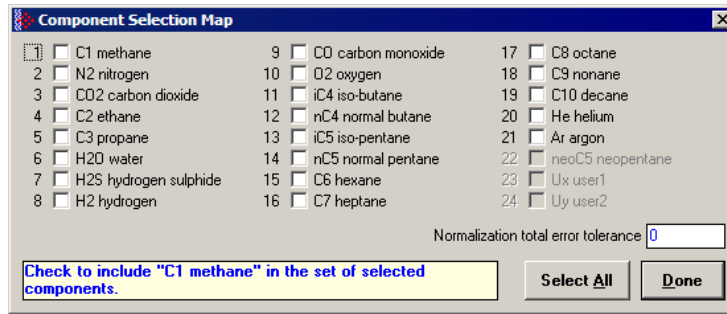
The following parameters are required for the calculations.

| Parameters | Low Limit | High Limit | Default |
|---|-------------------|-------------------|--------------------------|
| Isentropic Exponent | 1.01 | 5.0 | 1.3198 |
| Default Relative Density (Specific Gravity) | 0.04 | 5.0 | 0.6 |
| Default Fpv | 0.5 | 2.0 | 1 |
| Reference Temperature | 0°C (32°F) | 25°C (77°F) | 15°C (60°F) |
| Reference Pressure | 50kPaa (7.3 psia) | 110kPaa (16 psia) | 101.325kPaa (14.73 psia) |

Component Analysis (Molar Analysis) Dialog Box

Click Read to retrieve the Molar Analysis settings from the module, or click Write to send the Molar Analysis settings from the PC to the module. A dialog box will open to confirm your local port settings.

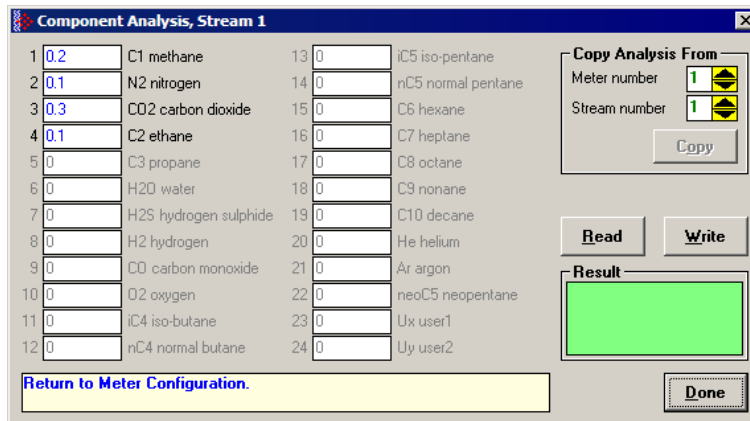
To enter gas molar concentrations, click the Components button on the Meter Configuration dialog box. This area of the Meter Configuration dialog box is visible when the product type is Gas.



Select (check) the components to be analyzed, enter the Normalization total error tolerance value, and then click Done.

The next step is to enter the molar concentration for each component. Click the Analysis button to open the Component Analysis dialog box.

Because the module uses the Detail Characterization Method, you must enter a complete molar analysis for the gas.



Enter the molar concentration for each component (up to 4 fractional digits).

For example, when you enter:

$$C1 \text{ Molar Fraction} = 0.8$$

It means that the methane (C1) component has a molar concentration of 80%.

Normalization Error Tolerance

Analyses are often obtained from an on-line gas chromatograph, which device should provide output consisting of a collection of numbers between 0 and 100 all adding up to exactly 100%. Real devices, however, usually produce a total slightly different than 100%, and sometimes may provide individual concentrations that go negative (for example, -1.08%) or super-positive (for example, 101.3%). When properly calibrated, most Gas Chromatographs produce individual concentrations that lie between 0 and 100% and a total that is very close to (but not always identical to) 100%.

The "Normalization Error Tolerance" is the amount by which an analysis total may differ from 10,000 (= 100%) without raising the "Analysis Total Not Normalized" alarm. It is intended to allow for deviation from the strict 100% total that arises either from the normal variation of the output from a properly calibrated Gas Chromatograph or from roundoff error when converting concentrations to the 4-digit integers required by the AFC.

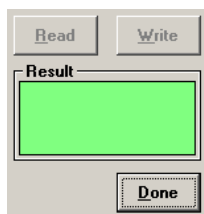
If the concentration total differs from 100% by more than the tolerance, the module raises the alarm.

In all cases, whether or not the alarm is raised, the module normalizes the analysis to 100% before continuing with the calculation.

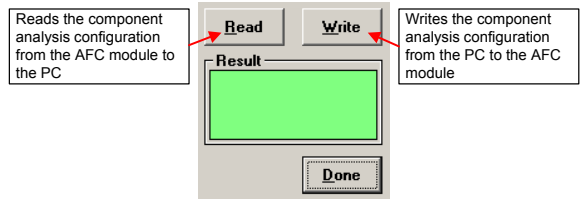
Transferring the Analysis

In order to transfer the Molar Analysis data between the local PC and the module, it is essential that the component selection in the local PC and the module match.

If the Molar Analysis Write and Read buttons are currently disabled, it indicates that the AFC Manager does not acknowledge that the current module meter configuration and the local PC component selection files are equal. In this case, the buttons are disabled, as shown in the following illustration.



In order to enable the Read and Write buttons, the component selection on the local PC and on the module must be the same. In order to accomplish this, you can perform a Read (Meter Configuration), then change your analysis and then Write it. After both component selections are identical, the Read/Write molar analysis buttons should be enabled:



After the molar analysis buttons are enabled, you can transfer the analysis between the module and the local PC.

The Result area contains the transfer process result:

| Message | Description |
|--------------------|---|
| Success | Transfer was successfully completed |
| Time out | Transfer was not completed. Verify the cables and the port communication parameters |
| Illegal Data Value | The values entered are not acceptable. Make sure the values have a valid format. |

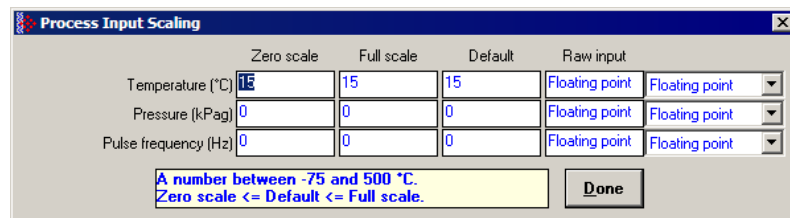
For applications involving chromatograph devices, the ladder logic can dynamically update the molar analysis data to the module. Refer to the Ladder Logic section of the user manual for your platform for more information about this subject.

Important: If the molar concentration values for your project are available from a gas chromatograph, it is possible to update these values dynamically from the programmable logic controller to the module using the Molar Analysis function block (requires ladder logic). In this case, the values entered in the AFC Manager Software will be overwritten by the function block values but you still need to select the components and enter the normalization error tolerance using the AFC Manager Software. Refer to the User Manual for your platform for more information about the Molar Analysis function block.

Process Input Scaling (Gas)

This parameter configures how the module will interpret the input variable within the given range. The possible values are floating point, scaled integer, and 4 to 20mA.

Click the Process Input button to configure the valid input ranges. If an input data is not within the configured range, AFC Manager will flag an alarm on the Meter Monitor dialog box and the alarm bit for the meter will be set.



The process input variables available for gas products depend on the meter type (differential or linear), and the primary input type.

For scaled integer process input scaling, the module requires the following data formats:

| 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 the SI units (kPa) and one decimal place implied for the U.S. units (psi). | A value of 200 would be equivalent to 200kPag |
| Differential Pressure | Two decimal places implied for inches of H ₂ O and three places for kPa | A value of 35142 would be equivalent to 35.142kPa |
| Flow rate | No decimal places implied for the SI units or US units. To obtain desired precision, choose appropriate Primary Input Characteristics | A value of 102 would be equivalent to 102 lb/hr |

3.12.3 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.

Density Units

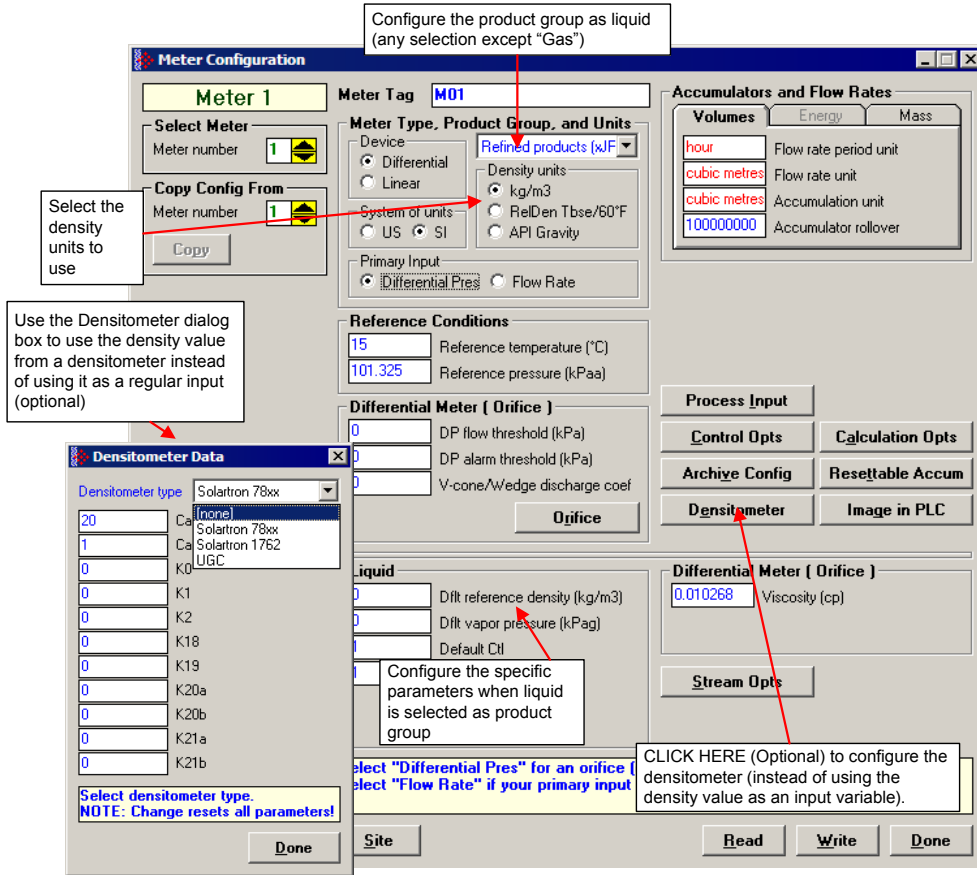
The liquid density units can be expressed as:

- Density is in kg/m³;
- Relative density 60°F/60°F;
- API gravity;

For NGL and crude oil 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, net oil and water accumulations in separate accumulators.

3.12.4 Liquid Specific Parameters and Densitometer Configuration

When liquid is selected as the product group, the following parameters must be configured:



This area is visible when the product group is set to a liquid group. Enter the values for Default Reference Density, Vapor Pressure, Default Ctl and Default Cpl. The following parameters are required for the calculations.

| Parameters | Low Limit | High Limit | Default |
|------------------------|---------------------|--------------------------|---------|
| Dflt Reference Density | 0 kg/m ³ | 2000 kg/m ³ | 0 |
| | 0 Rd60 | 2.0 Rd60 | |
| | -60.75°API | 320°API | |
| Default Vapor Pressure | 0 | 100,000 kPa (14,000 psi) | 0 |
| Default Ctl | 0.5 | 2.0 | 1 |
| Default Cpl | 0.5 | 2.0 | 1 |

Tip: To see the limits and defaults for each parameter, view the blue text in the "Note" box when you click in the entry text box.

For firmware version 2.03 and later, if you select an "Emulsion" group, the following parameters can be configured:

| Parameters | Low Limit | High Limit | Default |
|-----------------------|----------------|-------------|---------|
| Water density at 60°F | 900.0 | 1200.0 | 999.016 |
| Shrinkage Factor | 0 (total loss) | 1 (no loss) | 1 |

These parameters are covered by the standard specification API MPMS ch 20.1, First Edition, September 2003.

For firmware versions 2.05 and later, if you select "Special Applications" for the product group, the following parameter must be configured: "Thermal expansion coefficient".

Temperature Correction

If this option is selected, the module will calculate the temperature correction factor (CTL) as determined by the API standard. If this option is cleared, the module will not calculate the temperature correction factor. Instead, it will use the CTL value configured through the Default CTL parameter (meter configuration).

Default CTL

This value is used if the "Temperature Correction" option is unselected (Meter Calculation Options) or if the module cannot calculate the CTL factor. If the calculation fails, the module will set the Temperature Correction Alarm.

Pressure Correction

If this option is selected, the module will calculate the pressure correction factor (CPL) as determined by the API standard. If this option is cleared, the module will not calculate the pressure correction factor. Instead, it will use the CPL value configured through the Default CPL parameter (meter configuration).

Default CPL

This value is used if the "Pressure Correction" option is unselected (Meter Calculation Options) or if the module cannot calculate the CPL factor. If the calculation fails, the module will set the Pressure Correction Alarm.

Default Reference Density

This value is used if the flowing density transferred over the backplane is out of range (alarmed) and "Ignore Default Flowing Density" is selected on the Meter Calculation Options dialog box, or if the density correction calculation fails (also alarmed).

Default Vapor Pressure

If the vapor pressure via TP-15 option is not selected on the Meter Calculation Options dialog box, or the vapor pressure calculation results in error, this value is used as the vapor pressure.

Density Calculation

This section provides detailed explanations about the density correction logic used by the AFC module. It also explains the terminology that is implemented by the module.

Terminology

➤ *Conditions (Temperature & Pressure)*

▪ Reference Conditions

A fixed Temperature and a fixed Pressure at which a fluid's volume accumulation and volume flow rates are to be recorded. Also known as "Base" or "Standard" Conditions. Derives from sales contracts between parties that mandate transfer of fluids in volume units, such as "100,000 gallons of gasoline at 60°F and 1 atmosphere pressure". Typical Reference Conditions are:

- 60°F and 14.696 psia (US)
- 15°C and 101.325 kPa (Canada, Europe)
- 20°C and 101.325 kPa (Latin America)

▪ Flowing Conditions

The fluid's T&P in effect at the point the initial measurement is performed (DP measurement (differential meter), pulse counting (linear meter)). Almost always different from Reference Conditions, hence volume correction calculations are required, hence the flow computer.

➤ *Densities*

▪ Flowing Density

Density at Flowing Conditions. Calculations are applied to this to arrive at a Reference Density (next). In the AFC, "Flowing Density" is a process input (over the backplane from the Processor), though if the **Calculation Options / Density Correction** configuration is cleared, its value is deemed to be at Reference Conditions regardless of process Temperature and Pressure.

▪ Reference Density

Density at Reference Conditions. Also known as "Standard Density". This is a core parameter to the calculation of Volume Correction Factors (VCFs): CTL depends on Reference Density and Temperature; CPL depends on Reference Density, Temperature and Pressure.

The AFC's "Reference Density" is at user-specified Reference Conditions (User Base), while the Reference Density required for VCF calculations is at API-specified Reference Conditions (API Base); the AFC's calculations account for any difference between User Base and API Base. For MPMS Ch 11.1 (2004), API Reference Conditions are always 60°F and 14.696 psia.

- **Corrected Density**
Reference Density resulting from a calculation with inputs of Flowing Density, Temperature, and Pressure. It is the output of a calculation, as opposed to Default Reference Density which is a manual input. In some circumstances, the Corrected Density (output) is merely a copy of the Default Reference Density (input). In the AFC, it is the Corrected Density, not the Default Reference Density, that is used in subsequent VCF calculations.

Defaults

A "Default" value is one that is substituted for another when that other value is either unavailable or erroneous. In effect, it is a choice of last resort. For liquid measurement, the AFC provides two distinct Default Densities, "Default Flowing Density" and "Default Reference Density", both of which are manually entered as part of the meter configuration.

Calculations

The AFC calculates Corrected Density from process inputs (including Flowing Density) under control of its meter configuration that includes Process Input Scaling and two Calculation Options:

- "Ignore Default Flowing Density" (bit 7)
- "Density Correction" (bit 8)

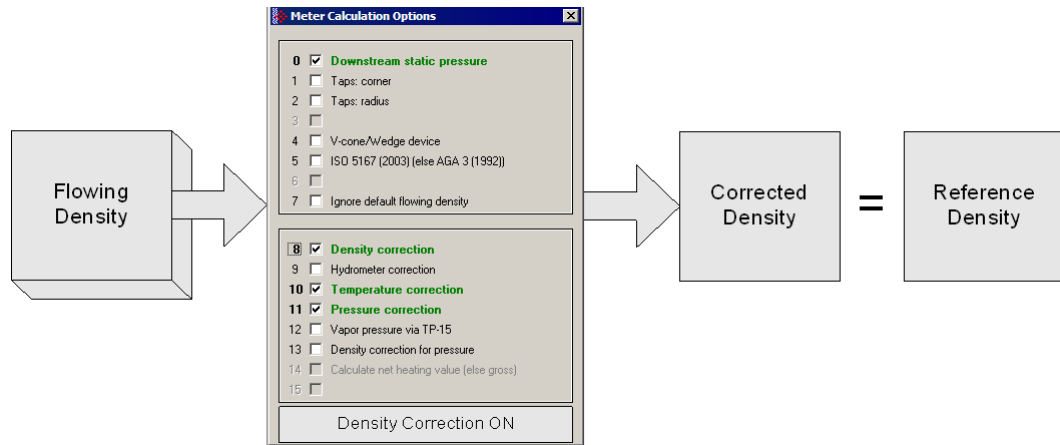
substituting one or both of the Default Densities under certain conditions.

The logic is:

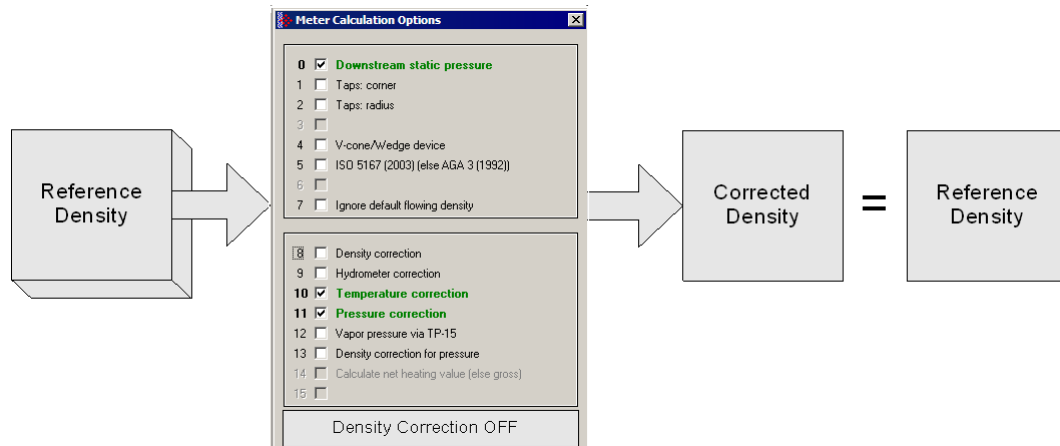
- 1** Flowing Density process input is marked "Unspecified" (we have not yet determined whether the process input is at Flowing or Reference Conditions).
- 2** Flowing Density process input is scaled, and if out of range it is substituted by:
 - a)** Default Flowing Density, if "Ignore Default Flowing Density" option is clear, or
 - b)** Default Reference Density, if "Ignore Default Flowing Density" option is set, and in this case the input is marked "Reference".
- 3** If "Density Correction" option is clear, then the input is marked "Reference", meaning that the process input over the backplane is at Reference Conditions regardless of its "Flowing" designation.
- 4** If the input is marked "Reference", then Corrected Density acquires this value.
- 5** If the input is still marked "Unspecified", it is assumed to be "Flowing", and the API density correction calculation is performed, which takes the Flowing Density as input, together with the (already scaled) Temperature and Pressure process inputs. Successful calculation yields Corrected Density as output; an error during the calculation, for example exceeding an API range limit, causes substitution of Default Reference Density for the Corrected Density output.
- 6** This Corrected Density is used for all subsequent VCF calculations.

The following diagram shows two possible density applications.

If input density is at flowing conditions:



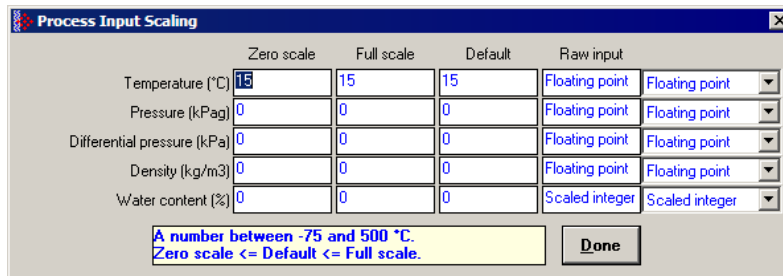
If input density is at reference conditions (already corrected)



Process Input Scaling (Liquid)

This parameter configures how the module will interpret the input variable within the given range. The possible values are floating point, scaled integer, and 4 to 20mA.

Click the Process Input button to configure the valid input ranges. If an input data is not within the configured range, AFC Manager will flag an alarm on the Meter Monitor dialog box and the alarm bit for the meter will be set.



The process input variables available for liquid products depend on the meter type (differential or linear), and the primary input type.

For scaled integer process input scaling, the module requires the following data formats:

Scaled Integer

| Variable | Format | Example |
|----------------------------|---|---|
| Temperature | Two implied decimal places | A value of 1342 would be equivalent to 13.42°C |
| Pressure | No decimal places implied for the SI units (kPa) and one decimal place implied for the US units (psi). | A value of 200 would be equivalent to 200kPag |
| Differential Pressure | Two decimal places implied for inches of H ₂ O and three places for kPa | A value of 35142 would be equivalent to 35.142kPa |
| Pulse Frequency (Hz) | No decimal places | A value of 200 would be equivalent to 200 Hz |
| 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 60°F/60°F. |
| Density (API) | Two implied decimal places | A value of 8045 would be equivalent to 80.45 °API. |
| Flow rate | No decimal places implied for the SI units or US units. To obtain desired precision, choose appropriate Primary Input Characteristics | A value of 102 would be equivalent to 102 lb/hr. |
| Water Content | Two implied decimal places | A value of 105 is interpreted as 1.05%. |

3.13 Densitometer Configuration

When measuring liquids with density correction, density at flowing conditions is required. This value may be either provided directly as a process input, or the AFC may calculate it from the frequency output of a densitometer.

➤ **To use a densitometer**

The module can calculate a density from the frequency provided by a densitometer device. Follow the steps below to use a densitometer.

- 1 Click the Densitometer button to select the densitometer type.
- 2 Configure it, entering all configuration parameters directly from the calibration data sheet supplied by the densitometer manufacturer.
- 3 In the Density entry of Process Input Scaling, select Raw Input as 4 to 20 mA.
- 4 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 Interface section for your platform in the AFC User Manual for 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 "Raw Input" sub-selection does not determine the format of the frequency input, however – the frequency is always input as floating-point.

Note: If you use the Densitometer feature, select the Density Process Input Scaling Raw Input for 4 to 20 mA and transmit the densitometer frequency over the backplane as a floating-point value.

3.13.1 Densitometer Data Dialog Box

This dialog box opens when you click the Densitometer button on the Meter Configuration dialog box. Choose the densitometer to use from the list of supported devices, and then fill in the calibration values from the calibration sheet of your densitometer.

Densitometer Data

Densitometer type: Solartron 78xx

Ca: 20

Ca: 1

K0: 0

K1: 0

K2: 0

K18: 0

K19: 0

K20a: 0

K20b: 0

K21a: 0

K21b: 0

Select densitometer type.
NOTE: Change resets all parameters!

Done

3.14 Copying a Configuration From a Meter

For projects where more than one meter uses the same or similar configurations, you can copy the configuration from one meter to another.

➤ **To copy a meter configuration:**

- 1 In the Select Meter panel of the Meter Configuration dialog box, select the number of the destination meter (the meter that has not yet been configured).
- 2 In the Copy Config From panel of the Meter Configuration dialog box, select the number of the source meter (the meter that has already been configured).
- 3 To copy the meter configuration and meter analysis, click Copy.

This action copies the entire meter configuration except:

- the Meter Tag
- the PLC Image assignments (PTQ-AFC only)

which retain their existing values.

You may then edit the copied configuration for any differences specific to the meter.

4 Saving the project

In This Chapter

- Configuration Download 93
- Configuration Upload 94

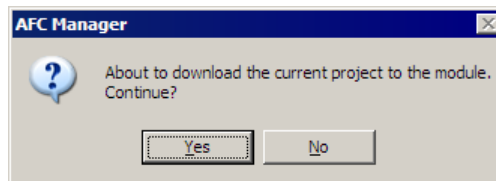
After you have finished working on your project, you should save your configuration so that you can open the project file later if you need to make changes.

To save your project, click the Done button to close any dialog boxes that are open, and then open the File menu and choose Save As to save your project.

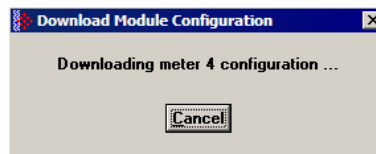
4.1 Configuration Download

A configuration download operation transfers the complete configuration (Meters & Site Configuration) from the local PC to the module. So, instead of writing each meter configuration to the module you can configure all meters at the local PC and then perform a configuration download operation.

After you click "**Project / Download Project**", you will be prompted to confirm the action.



After you confirm the download operation, the AFC Manager displays a download progress message:



Note: An "Illegal Data Value" warning indicates that the module has rejected one of the parameters. This error typically occurs when you try to download a meter configuration that has a different meter type, product group, units, density unit or primary input type than the configuration currently stored on the module. You cannot change a meter type when the meter is currently enabled. Disable the meter, perform the change, and then proceed with the download operation.

Another possible cause is that the event buffer is full and the module could be configured to lock any further events. To see the current number of events stored in the event buffer, click **On-Line / Event Log** and then click the Read button. If the "number of events not yet downloaded" is 1999, it indicates that the event log is full.

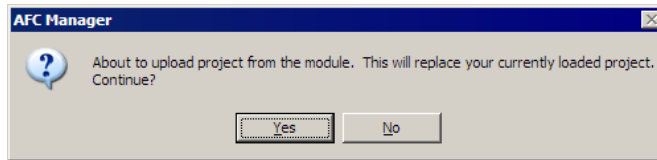
Finally, if "Event log unlocked" is unchecked on the Site Configuration dialog box, the module will not accept any further changes to configuration. Delete all events from the module event buffer, and then select (check) the "Event Log Unlocked" option so that the module can overwrite the oldest event from the buffer when the buffer is full.

Important: The download operation does not transfer the remapping configuration. The only way to transfer it to the module is by following the steps described in the Site Configuration section.

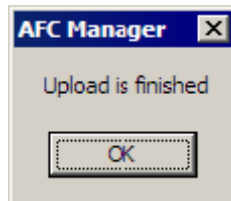
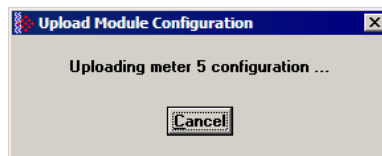
4.2 Configuration Upload

A configuration file upload transfers the complete configuration (Meters & Site Configuration) from the module to the local PC.

After you click "**Project / Upload Project**" you will be prompted to confirm the action.



After you confirm the upload operation, the AFC Manager indicates that the upload is in progress:



Important: The upload operation does not transfer the remapping configuration. The only way to transfer it from the module is by following the steps described in the Site Configuration section.

5 Overall Monitor

In This Chapter

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- Create the File Report (Log File)..... 97

The Overall Monitor provides a summary overview of all meters with less detail than the Meter Monitor. Use the Overall Monitor to get a summary of all meters. Use the Meter Monitor for more information about a specific meter.

The screenshot shows the 'Overall Monitor' window for site 'DUIMEX' and project 'AFC_DUIMEX'. It features a 'Select Meter' dropdown, 'Polling' mode selection (Manual/Auto), a 'Read' button, and a 'Result' display showing 'Success'. A table of meter data is shown with columns for 'Meter Tag & Active Strm' and numerical values. Callout boxes provide instructions: 'Select the first meter to be displayed on the left column at this window' points to the 'Select Meter' dropdown; 'Shows the current Wall Clock value' points to the 'Wallclock' field; 'If the meter has any alarms the meter tag will be red' points to the red 'DIE_AFC_M1' tag; 'Polling Mode selection Manual or Auto' points to the 'Manual' radio button; 'Shows the result of the Read operation' points to the 'Success' result; 'Prints an Overall Monitor Report' points to the 'Print' button; 'Creates a log file (text file) containing the Overall Monitor Data' points to the 'Log' button; and 'Overall Monitor Data contains general output and input data. For further information refer to the Meter Monitor section' points to the data table.

Overall Monitor Data Table:

| Meter Tag & Active Strm | Value | Unit |
|---------------------------------|-------|---------|
| DIE_AFC_M1 | 1 | MMCF |
| DIE_AFC_M2 | 1 | MMCF |
| Totalizer - Gross | 0 | MMCF |
| Totalizer - Grs std / clean oil | 0 | MMCF |
| Totalizer - Net | 0 | MMCF |
| Totalizer - Energy | 0 | MMBTU |
| Totalizer - Mass | 0 | lb |
| Flow rate - Gross | 0 | MMCF/d |
| Flow rate - Grs std / clean oil | 0 | MMCF/d |
| Flow rate - Net | 0 | MMCF/d |
| Flow rate - Energy | 0 | MMBTU/h |
| Flow rate - Mass | 0 | lb/h |
| Temperature | 0 | °F |
| Pressure | 0 | psig |
| Diff pres / Flow rate / Freq | 0 | Hz |
| Flowing density | | |
| Water content | | |

➤ **To read data from the module:**

- 1 Select the Meter Number** In the Select Meter panel, enter the meter number that will be displayed on the left. The dialog box shows two meters at once, so the consecutive meter will be displayed on the right.
- 2 Select the Polling Mode** The Polling Mode determines how frequently the data will be updated from the module.
 - **Manual:** the data will be read once.
 - **Auto:** the data will be updated periodically. Enter the number of seconds between each update operation in the Update Time (sec) field.
- 3 Click the Read Button** After selecting the Polling Mode, click the Read Button to read the current meter data from the module.
- 4 Look at the Result Area** for the read operation status.

| Status | Description |
|-------------|--|
| Transmitted | The read operation has commenced |
| Success | The read operation has completed |
| Timeout | The operation was not completed due to communication problems. Check the cable and communication parameters. It is essential that the communication parameters in the local PC are the same as the current module meter configuration. |

If the read operation has been successfully completed, but the output data calculated by the module does not seem to update correctly, follow these steps:

- Perform two consecutive Read operations to check if the Wall Clock is currently running. **If the Wall Clock is not running, the module may not correctly perform some time-scheduled operations.** The Wall Clock is set by the ladder logic (Wall Clock function). It should be set at least at every rack power up. Look at the ladder logic if the Wall Clock is not updating.
- Check to see if the meter has an alarm. If the Meter Tag background is red, it indicates that the meter has at least one alarm. The alarm typically indicates that an input is invalid or that there is some configuration error that would potentially affect the flow calculations. Refer to the Meter Monitor section in order to find out which alarm is currently set.
- Check to see if the meter is currently enabled. If the meter is disabled, the module will not perform the flow calculation for that meter. If you are currently on line to a disabled meter, the meter tag will be black. Refer to the Meter Configuration for more information about enabling and disabling a meter.
- Look at the process input variable (ex: temperature, pressure, etc.). Check to see if the variables values displayed on the Overall Monitor dialog box match the actual values transmitted by the processor. If the values do not match, look at the ladder logic in order to verify if the data is being transmitted correctly. Refer to the module's user manual for more information about the Process Variable function.

5.1 Print the Report

Click the Print Button to print the report to the local printer.

5.2 Create the File Report (Log File)

Click the Log Button to create a Log File that contains the last data read from the module. The following shows an example log file where only meter 1 is enabled:

```
AFC-56(16) Metering Data                               Date: 16-09-2002 11:53:51
Site Name: MVI Flow Station
Project: AFC
```

```
Meter 1:
  Tag                               M01
  Gross accum: totalizer (x f3)     1290
  Net accum: totalizer (x f3)       214197
  Mass accum: totalizer (x lb)      12173
  Gross flow rate (x f3/h)          564.0053
  Net flow rate (x f3/h)            42568.86
  Mass flow rate (x lb/h)           1954.654
  Temperature (°F)                  15
  Pressure (psig)                    1000
  Differential pressure (hw)         22
  Alarms                             0200h

Meter 2:
  Tag                               M02
  This meter channel is not enabled or used.

Meter 3:
  Tag                               M03
  This meter channel is not enabled or used.

Meter 4:
  Tag                               M04
  This meter channel is not enabled or used.

Meter 5:
  Tag                               M05
  This meter channel is not enabled or used.

Meter 6:
  Tag                               M06
  This meter channel is not enabled or used.

Meter 7:
  Tag                               M07
  This meter channel is not enabled or used.

Meter 8:
  Tag                               M08
  This meter channel is not enabled or used.

Meter 9:
  Tag                               M09
  This meter channel is not enabled or used.

Meter 10:
  Tag                               M10
```

This meter channel is not enabled or used.

Meter 11:
Tag M11
This meter channel is not enabled or used.

Meter 12:
Tag M12
This meter channel is not enabled or used.

Meter 13:
Tag M13
This meter channel is not enabled or used.

Meter 14:
Tag M14
This meter channel is not enabled or used.

Meter 15:
Tag M15
This meter channel is not enabled or used.

Meter 16:
Tag M16
This meter channel is not enabled or used.

6 Meter Monitor

In This Chapter

- Print the Report 101
- Creating a File Report (Log File) 102
- Accumulator Monitor 102
- Flow Rate Monitor 104
- Input Data Monitor 104
- Alarm Monitor 105

Use the Meter Monitor to monitor each meter run by reading the results calculated by the module, the current input values, and any meter alarms.

Note: For more information about the meaning of specific values calculated by the module, we suggest that you refer to applicable measurement standards. It is beyond the scope of this document to discuss flow measurement theory.

Click on *Monitor / Meter Monitor* in order to open the Meter Monitor dialog box:

The screenshot shows the Meter Monitor dialog box with the following components and callouts:

- Site Name:** DUIMEX
- Project:** AFC_DUIMEX
- Meter Tag:** DIE_AFC_M1
- Active Stream:** 1
- Wallclock:** 2007-07-16 14:21:06
- Select Meter:** Meter number 1 (Callout: "Selects the meter number")
- Process Input Count:** 1613 (Callout: "Process Input Count")
- Calculation Count:** 12946 (Callout: "Calculation Count")
- Scan counts (input, calc):** 16.23546 (Callout: "Shows the current Wall Clock value")
- Accumulators:** 0.5605673
- Flow rates:** 0.561434
- Process inputs:** 4.296604E-02
- Meter alarms:** 0.9980413
- Pulse frequency (Hz):** 0
- K-factor (pul/CF):** 24
- Meter factor:** 1
- Molar mass of mixture:** 16.23546
- Ideal gas relative density:** 0.5605673
- Relative density at reference:** 0.561434
- Reference density (lb/cf):** 4.296604E-02
- Reference compressibility:** 0.9980413
- Flowing compressibility:** 0.9970248
- T & P factors:** Click Me
- C-prime:** 1.129069
- Fpv:** 1.00051
- Analysis characterization error:** 0
- Compressibility calculation error:** 0
- Result:** Success (Callout: "Shows the result of the Read operation")
- Buttons:** Close, Print (Callout: "Prints the Meter Monitor Report"), Log (Callout: "Creates a log file (text file) containing the Meter Monitor Data")
- Text:** "Poll the selected meter."

➤ **To read data from the module:**

- 1 **Select the Meter Number** In the Select Meter panel, enter the meter number that will be displayed.
- 2 **Select the Polling Mode** The Polling Mode determines how frequently the data will be updated from the module.
 - **Manual:** The data will be read once.
 - **Auto:** The data will be updated periodically. Enter the number of seconds between each update operation in the Update Time (sec).
- 3 **Click the Read Button** After selecting the Polling Mode, Click the Read Button to read the current meter data from the module.
- 4 **Look at the Result Area** Look at the Result Area for the read operation status.

| Status | Description |
|-------------|--|
| Transmitted | The read operation has commenced. |
| Success | The read operation has completed |
| Timeout | The operation was not completed due to communication problems. Check the cable and communication parameters. It is essential that communication parameters on the local PC are the same as the current module meter configuration. |

If the read operation has been successfully completed, but the output data calculated by the module does not seem to update correctly, follow these steps:

- Perform two consecutive Read operations to determine if the Wall Clock is currently running. **If the Wall Clock is not running, the module may not correctly perform some time-scheduled operations.** The Wall Clock is set by the ladder logic (Wall Clock function) and should be set at least at every rack power up. Look at the ladder logic if the Wall Clock is not updating.
- Determine if the meter has an alarm. If the Meter Tag background is red, it indicates that the meter has at least one alarm. The alarm typically indicates that an input is invalid, or that there is some configuration error that would potentially affect the calculations. Refer to [Alarm Monitor](#) (page 105) to determine which alarm is currently set.
- Determine if the meter is currently enabled. If you are online to a disabled meter, the meter tag is black. If the meter is disabled, the module will not perform the calculation for that meter. Refer to Meter Configuration for more information about enabling and disabling a meter.
- Look at the process input variable (ex: temperature, pressure, etc.). Verify that the variable values displayed on the Process Inputs subwindow (subsection Input Data Monitor in this chapter) match the actual values transmitted by the processor. If the values do not match, look at the ladder logic in order to verify that the data is being transmitted correctly. Refer to the module's user manual for more information about the Process Variable function.

6.1 Print the Report

Click the Print button on any type of report to send a copy to your default printer.
The following example shows a typical report.

AFC-56(16) Metering Data Date: 16-09-2002 12:04:04
Site Name: MVI Flow Station
Project: AFC

```

Meter 1:
  Tag                                M01
  Gross accum: totalizer (x f3)      1383
  Gross accum: residue (x f3)        0.3344682
  Net accum: totalizer (x f3)        221451
  Net accum: residue (x f3)          7.455254E-02
  Mass accum: totalizer (x lb)       12537
  Mass accum: residue (x lb)         0.6372076
  Gross flow rate (x f3/h)           483.1948
  Net flow rate (x f3/h)             40248
  Mass flow rate (x lb/h)            2280.571
  Temperature input (Floating point) 15
  Temperature (°F)                   15
  Pressure input (Floating point)     1000
  Pressure (psig)                     1000
  Differential Pressure input (Floating point) 22
  Differential pressure (hw)           22
  Pressure extension                   149.4683
  Velocity of approach factor Ev      1.032773
  Expansion factor Y                   0.9997441
  Discharge coefficient Cd             0.6042569
  Orifice characterization error       0
  Molar mass of mixture                21.42973
  Ideal gas relative density           0.7399113
  Relative density (60°F/60°F)        0.7404104
  Reference density (kg/m3)           5.666295E-02
  Flowing density (kg/m3)             4.719774
  Fpv                                  1.050526
  Reference compressibility            0.9989105
  Flowing compressibility              0.9051347
  Composition factor                   0.2728558
  Analysis characterization error      0
  AGA8 calculation error              0
  Alarms (details below)              0000h

  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 correction -

```

```

bit 13  API calculation error, Ctl      -
bit 14  API calculation error, vapor pressure  -
bit 15  API calculation error, Cpl      -
    
```

6.2 Creating a File Report (Log File)

Click the Log Button to create a Log File containing the last data read from the module.

6.3 Accumulator Monitor

The accumulators display the total fluid quantities accumulated since the last time they rolled over or were reset.

The AFC calculates accumulations (and flow rates) for several different "measured quantities", depending on the Product Group. These are:

| Quantity | Products | Description |
|-----------------------|----------------------|--|
| Gross Volume | All | Volume at operating conditions (includes water content of liquids) |
| Net Volume | All | Volume corrected to reference (base) conditions (water content of liquids removed) |
| Mass | All | Mass (water content of liquids removed) |
| Energy | Gas | Energy content (heating value) |
| Gross Standard Volume | Non-emulsion liquids | Volume corrected to reference (base) conditions with water content included |
| Gross Clean Oil | Emulsion liquids | Volume at operating conditions with water content removed |
| Water | Liquids | Volume of the water content corrected to reference (base) conditions |

The AFC first calculates one of these quantities, the "primary" quantity, from process input depending on the meter type, then derives the other quantities by applying an appropriate combination of factors such as Temperature and Pressure Correction Factors, Density, characteristic Energy Content, and Water Content process input. These "primary" quantities are:

| Meter Type | Primary Quantity |
|------------------------|--|
| Differential Pressure | Mass |
| Differential Flow Rate | Configured Primary Input Measured Quantity |
| Linear | Configured K-factor Measured Quantity |

The accumulators are expressed as the Totalizer and Residue parts. In this way, it is possible to accumulate a wide range of increments, up to a very large rollover of the integral part, while keeping a high precision of fractional part with an approximately constant and small roundoff 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 residue is obtained using the following formula:

$$\text{Residue} = \text{Total Accumulator} - \text{Totalizer}$$

This technique ensures that the fractional part always has precision of between 7 and 8 decimal digits, and the round-off error of accumulation is always of the order of $2^{(-24)}$ of a totalizer unit, regardless of how large the totalizer itself is.

There are two types of accumulators: non-resettable and resettable accumulators.

6.3.1 Non-Resettable Accumulator

A non-resettable accumulator is only reset when the accumulator rollover value you configured (refer to the Meter Configuration section) is reached.

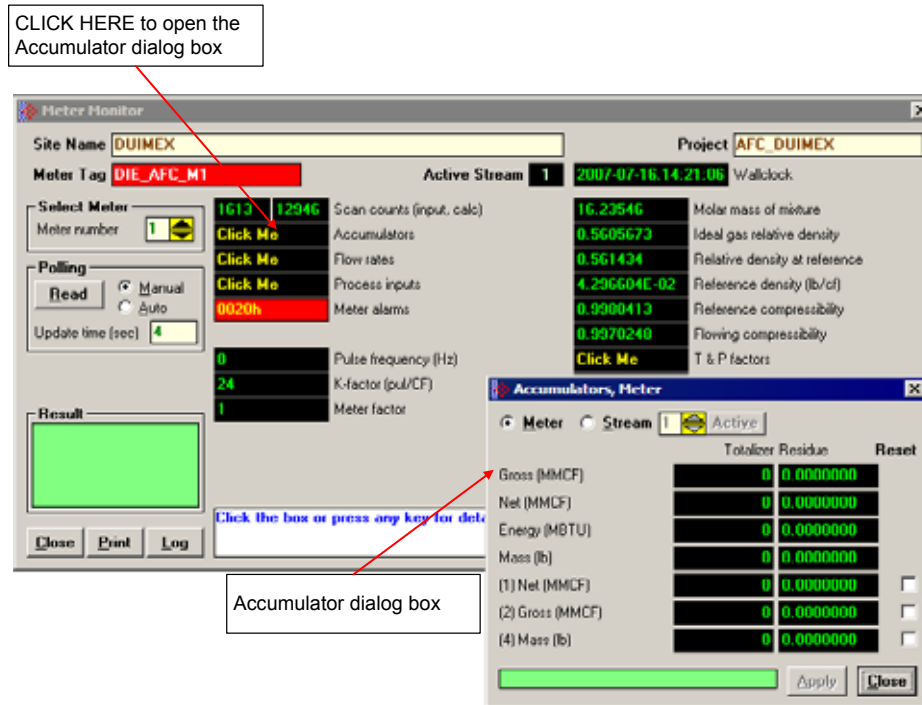
6.3.2 Resettable Accumulator

A Resettable Accumulator is reset automatically when the accumulator rollover value you configured (refer to the Meter Configuration section) is reached.

A Resettable Accumulator value may also be reset when the archive period end is reached. In this case the archive will be created and the resettable accumulator will be reset.

A resettable accumulator may also be reset by explicit signal, which may be issued by the PLC or SCADA, or by you manually.

To reset an accumulator manually, select the checkbox next to the accumulator to be reset, and then click Apply.

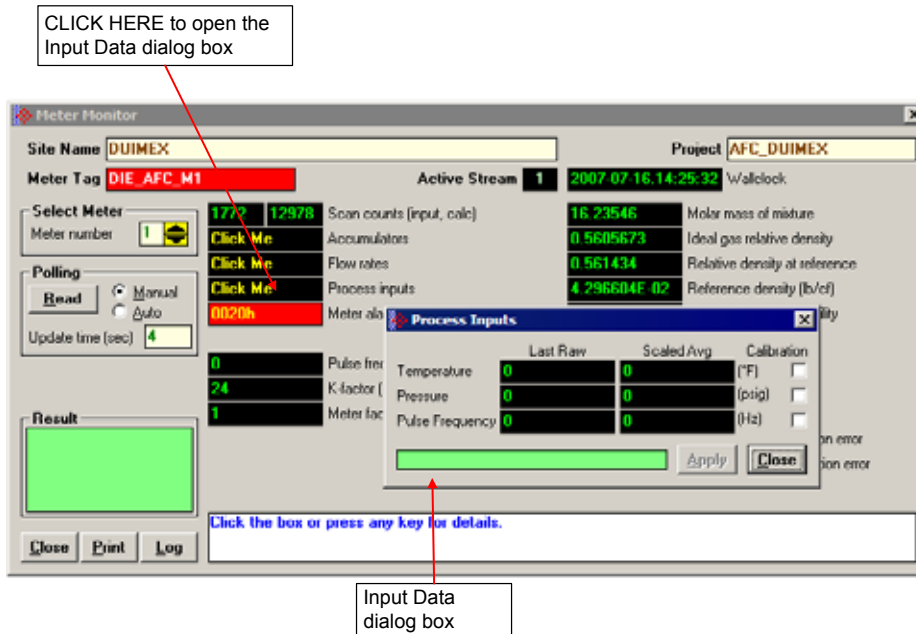


6.4 Flow Rate Monitor

You can monitor the flow rate values at any time. The flow rate units will be the ones you selected in the Meter Configuration dialog box.

6.5 Input Data Monitor

The processor constantly updates the input data values. You can verify these values as shown below:



Using these data is particularly important when troubleshooting the meter run, since you can verify if the values transferred from the processor are correctly being received at the module.

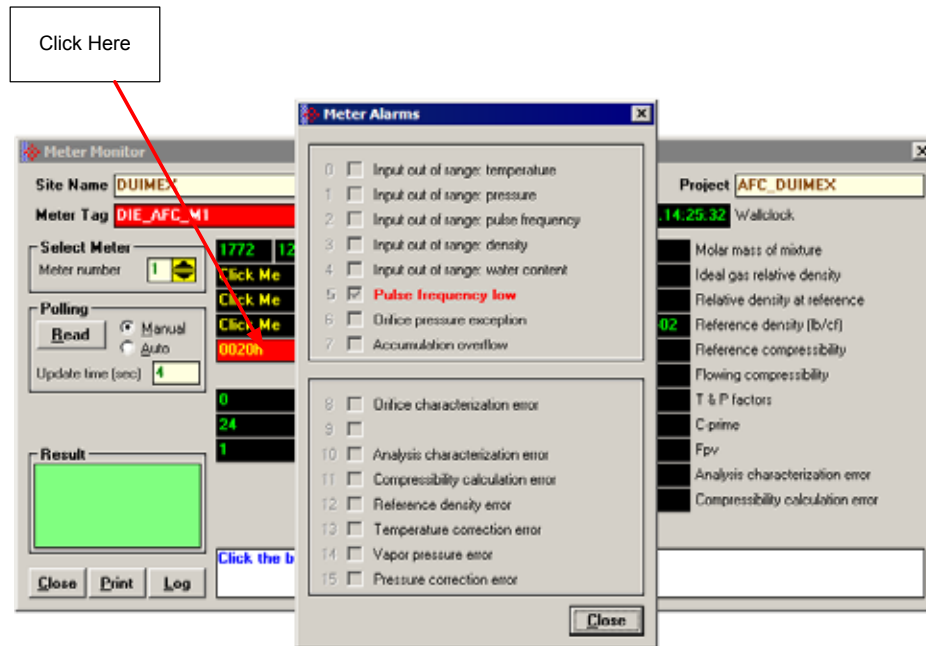
6.5.1 Calibration

The "Calibration" checkboxes force the AFC to "freeze" the input value for further calculations, until Calibration Mode is removed, at which time the AFC resumes taking the live value as the value of the input. Its purpose is to allow calibration of transmitters without shutting down or having to adjust measurement. During calibration, the transmitter's output may undergo significant changes that do not accurately reflect the value of the input. Calibration Mode makes the AFC ignore such changes, which assumes instead that the input value is constant throughout the period of calibration, holding the value of the input as it was at calibration start.

To switch an input into or out of Calibration Mode, toggle the checkbox and click Apply.

6.6 Alarm Monitor

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 ($v \leq 2.04$) | 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%). |

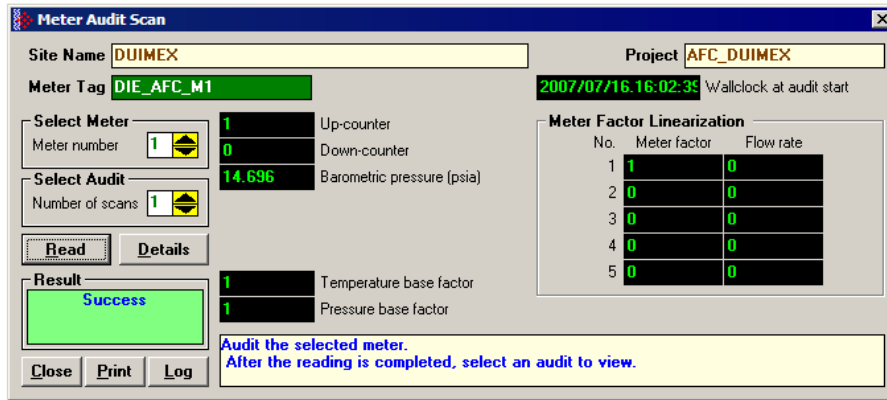
| Alarm Message | Description | Solution |
|--|---|---|
| Analysis Total Zero ($v \leq 2.04$) | The molar concentration sum is zero. | Make sure that the sum of all molar concentrations is within the error tolerance of 1.0000 (100%). |
| Analysis Characterization error ($v \geq 2.05$) | Absolute difference 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. |
| 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 ($v \geq 2.05$). | Check that the input variable's ranges (Meter Configuration / Process Input button) and the process input itself have reasonable values. |

| Alarm Message | Description | Solution |
|--------------------------------|---|--|
| Orifice Characterization error | The orifice parameters (Meter Configuration / Orifice button) are invalid. | <p>Check the orifice and meter parameters. The following conditions should be true:</p> <ul style="list-style-type: none"> ▪ Orifice diameter > 0 ▪ Tube diameter > 0 ▪ Orifice diameter < Tube diameter <p>The beta ratio between the orifice and tube diameters should follow the AGA Standard.</p> <p>Alarm Code values:</p> <ul style="list-style-type: none"> ▪ 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) <p>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.</p> |
| 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. | <p>Alarm Code values:</p> <ul style="list-style-type: none"> 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 |

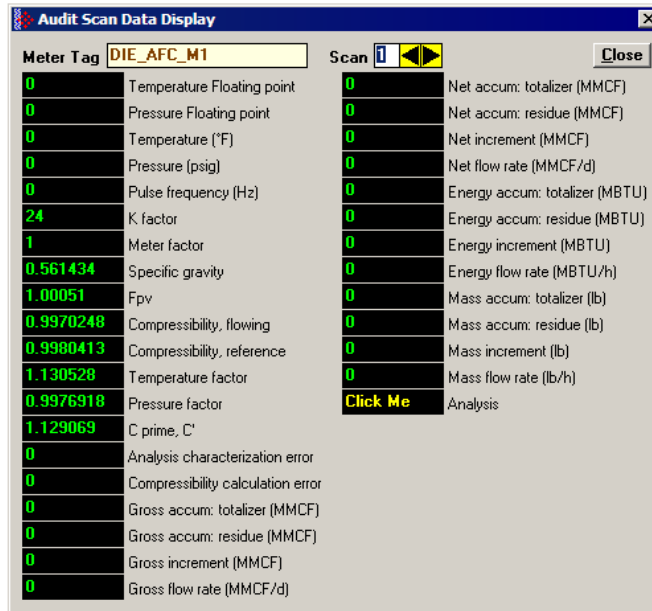
| Alarm Message | Description | Solution |
|---|---|--|
| Reference density error | The density correction calculation resulted in an error according to the standard. | <p>Alarm Code values::</p> <ul style="list-style-type: none"> 0 = No alarm 1 = Low density (NGLs), input outside API range 2 = High 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 <p>Also check the input values and calculation parameters for your project.</p> |
| Temperature Correction error | The temperature correction calculation OR the water temperature correction calculation resulted in an error according to the standard. | <p>Alarm Code values:</p> <ul style="list-style-type: none"> 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 <p>Also see the Alarm Code for Water Temperature Correction error.</p> |
| Vapor pressure error | The vapor pressure calculation resulted in an error according to the standard. | <p>Alarm Code values:</p> <ul style="list-style-type: none"> 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. | <p>Alarm Code values:</p> <ul style="list-style-type: none"> 0 = No alarm 1 = Temperature < 0°C (32°F) or > 138°C (280°F) |

7 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.



| Analysis for audit | | | | | |
|-----------------------------|-----|-------------------|---|-------|----------------|
| Molar fraction by component | | | | | |
| 0.989 | C1 | Methane | 0 | iC5 | Iso-Pentane |
| 0.0072 | N2 | Nitrogen | 0 | nC5 | Normal Pentane |
| 0.0038 | CO2 | Carbon Dioxide | 0 | C6 | Hexane |
| 0 | C2 | Ethane | 0 | C7 | Heptane |
| 0 | C3 | Propane | 0 | C8 | Octane |
| 0 | H2O | Water | 0 | C9 | Nonane |
| 0 | H2S | Hydrogen Sulphide | 0 | C10 | Decane |
| 0 | H2 | Hydrogen | 0 | He | Helium |
| 0 | CO | Carbon Monoxide | 0 | Ar | Argon |
| 0 | O2 | Oxygen | 0 | neoC5 | Neo-Pentane |
| 0 | iC4 | Iso-Butane | 0 | Ux | User 1 |
| 0 | nC4 | Normal Butane | 0 | Uy | User 2 |

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
Site Name: MVI Flow Station
Project: AFC

Date: 16-09-2002 16:18:08

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 |

8 Archive Monitor

In This Chapter

- Meter Archive Data Chart Dialog Box 120

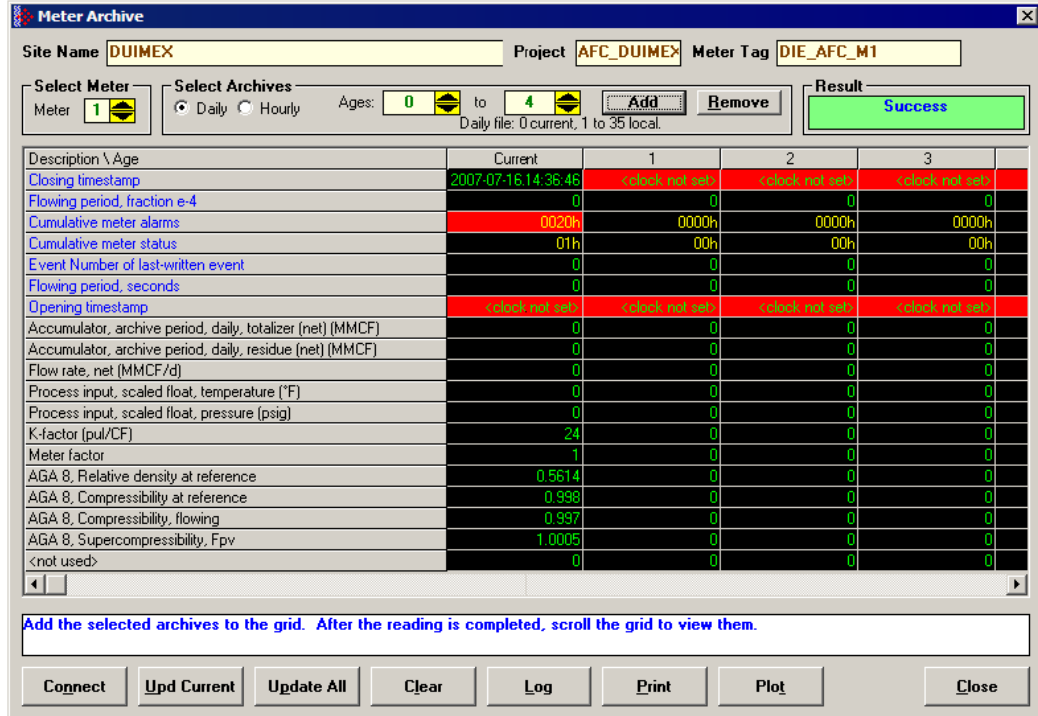
The Archive Monitor dialog box opens when you open the Monitor menu, and then choose Archive.

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
Site Name: MVI Flow Station
Project: AFC

Date: 16-09-2002 16:26:41

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
Site Name: MVI Flow Station
Project: AFC

Date: 16-09-2002 16:26:44

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
Site Name: MVI Flow Station
Project: AFC

Date: 16-09-2002 16:26:51

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 -
```

8.1 Meter Archive Data Chart Dialog Box

This dialog box opens when you click the Plot button on the Meter Archive dialog box. This dialog box shows a graphical plot of the data you select from the dropdown lists, and allows you to trend the different quantities simultaneously.



9 Events

In This Chapter

| | |
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9.1 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.

9.2 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 | <u>Event Id Tag</u> (page 123) |
| 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.

9.3 Event Id Tag

This 32-bit field has the following structure:

| Bits | N | Meaning | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------|----------|---|-------|----------|--------|---|------|---------------|---|------|------------------------|---|--|------------|---|------|-----------------------|---|------|-------------|---|------|----------------------|---|--|------------|---|------|---------------------|---|------|-----------------------|---|------|------------------------|----|------|------------------------|----|------|------------------------|----|------|------------------------|----|------|----------------------------|----|------|-----------------------------|----|------|----------------|
| 31 | 1 | 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. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30 | 1 | PLC offline; timestamp may not be accurate This bit may also be set for a Special event. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 29 | 1 | [reserved] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 to 24 | 5 | Meter number, or 0 for Site This field may also be set for a Special event. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 to 20 | 4 | [Meter] Stream number or 0; [Site] 0 This field may also be set for a Special event. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 to 16 | 4 | Datum type: <table border="1"> <thead> <tr> <th>Value</th> <th>Mnemonic</th> <th>Format</th> </tr> </thead> <tbody> <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> </tbody> </table> | Value | Mnemonic | Format | 0 | Ubyt | Unsigned byte | 1 | Usht | Unsigned short integer | 2 | | [reserved] | 3 | Ulng | Unsigned long integer | 4 | Sbyt | Signed byte | 5 | Ssht | Signed short integer | 6 | | [reserved] | 7 | Slng | Signed long integer | 8 | Bbyt | Bitmap (up to 8 bits) | 9 | Bsht | Bitmap (up to 16 bits) | 10 | Bm24 | Bitmap (up to 24 bits) | 11 | Blng | Bitmap (up to 32 bits) | 12 | Bool | Boolean (value 0 or 1) | 13 | DiBy | Dibyte (both high and low) | 14 | B448 | Bitfield nybble/nybble/byte | 15 | Flot | Floating point |
| Value | Mnemonic | Format | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | Ubyt | Unsigned byte | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Usht | Unsigned short integer | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | [reserved] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Ulng | Unsigned long integer | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Sbyt | Signed byte | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Ssht | Signed short integer | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | [reserved] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Slng | Signed long integer | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Bbyt | Bitmap (up to 8 bits) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Bsht | Bitmap (up to 16 bits) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Bm24 | Bitmap (up to 24 bits) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Blng | Bitmap (up to 32 bits) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Bool | Boolean (value 0 or 1) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | DiBy | Dibyte (both high and low) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | B448 | Bitfield nybble/nybble/byte | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Flot | Floating point | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 to 12 | 4 | [reserved] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 to 08 | 4 | Group code This value is one of the "measurement configuration changed" bit numbers. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 07 to 04 | 4 | Subgroup code This value is the ordinal number (starting at 0) of the subgroup of parameters in the specified group. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 03 to 00 | 4 | Subgroup item code Since a parameter subgroup may contain more than one item, this value identifies the particular item; items are numbered from 0. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

9.4 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 131)). 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.

9.5 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).

9.6 Loggable events

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

For the Special events (page 126), 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 127, page 127, page 130) 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 " <u>Rkv</u> " notes (page 131). |

9.7 Special events

| Tag | Rkv | Description |
|-----|-----|---|
| 0 | - | <p>Never Used Value: Always 0. Notes: This entry in the Event Log has never been written.</p> <p>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.</p> |
| 1 | - | <p>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.</p> |
| 2 | - | <p>Cold Start Value: Always 0. Notes: This event is obsolete and is never written.</p> |
| 3 | (1) | <p>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.</p> |
| 4 | - | <p>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.</p> |
| 5 | - | <p>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.</p> |
| 6 | (2) | <p>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").</p> |
| 7 | * | <p>Stream Select Value: Stream number. Notes: Triggered by a "select active stream" meter signal. Includes meter identification (bits 28-24).</p> |

9.8 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 |

9.9 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 |

| Grup | Sbgp | Item | DTyp | Rkv | Data point |
|------|------|------|------|-----|----------------------------------|
| | | 1 | Usht | * | Product group |
| 2 | | | | | Reference conditions |
| | 0 | 0 | Flot | * | Temperature |
| | 1 | 0 | Flot | * | Pressure |
| 3 | | | | | Meter options |
| | 0 | 0 | BIng | * | Calculation options |
| | 1 | 0 | BIng | (4) | Control options |
| 4 | | | | | Input scaling |
| | 0 | | | | Temperature |
| | | 0 | Flot | * | Range low end |
| | | 1 | Flot | * | Range high end |
| | | 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 | UIng | * | Pulse input rollover |

| Grup | Sbgp | Item | DTyp | Rkv | Data point |
|------|------|------|------|-----|--|
| 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 | UIng | * | Mass |
| | 1 | 0 | UIng | * | Energy |
| | 2 | 0 | UIng | * | Volumes |
| 9 | | | | | Meter parameter value |
| | 0 | 0 | Flot | * | Orifice plate measurement temperature |
| | 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 |

| Grup | Sbgp | Item | DTyp | Rkv | Data point |
|------|------|------|------|-----|---|
| | | 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 |

9.10 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 | * | Iisentropic exponent |
| | 3 | 0 | Flot | * | Default Fpv |
| | 4 | 0 | Flot | * | K/meter factor |
| | 5 | 0 | Flot | * | Default energy content |
| | 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 |

| Grup | Sbgp | Item | DTyp | Rkv | Data point |
|------|------|------|------|-----|--|
| | | 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 |
| | | 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 |

9.11 "Rkv" notes

- 1 Archives (only, not resets) are forced regardless of configuration, capturing any unarchived data from the previous session.
- 2 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.
- 3 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)
- 4 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).
- 5 Events occur only if Meter Control Options bit 10, "Treat analysis as process input", is clear.

9.12 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. |

| Term | Meaning |
|-----------------------|--|
| 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.

- 1 Calculate number of events on file.

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

- 2 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
```

- 3 Calculate age of desired record.

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

- 4 Calculate event number of desired record.

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

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

1 Calculate number of events on file.

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

2 Calculate age of desired event.

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

3 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
```

4 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.

1 Calculate number of events on file.

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

2 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
```

3 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.

1 Fetch event number of oldest event not yet downloaded.

```
downloadable_event := oldest_not_downloaded
```

2 Determine whether any more events remain to be downloaded.

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

3 Download this event.

a) Calculate record number.

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

b) Calculate Modbus address.

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

c) 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
```

4 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.

10 Modbus Master

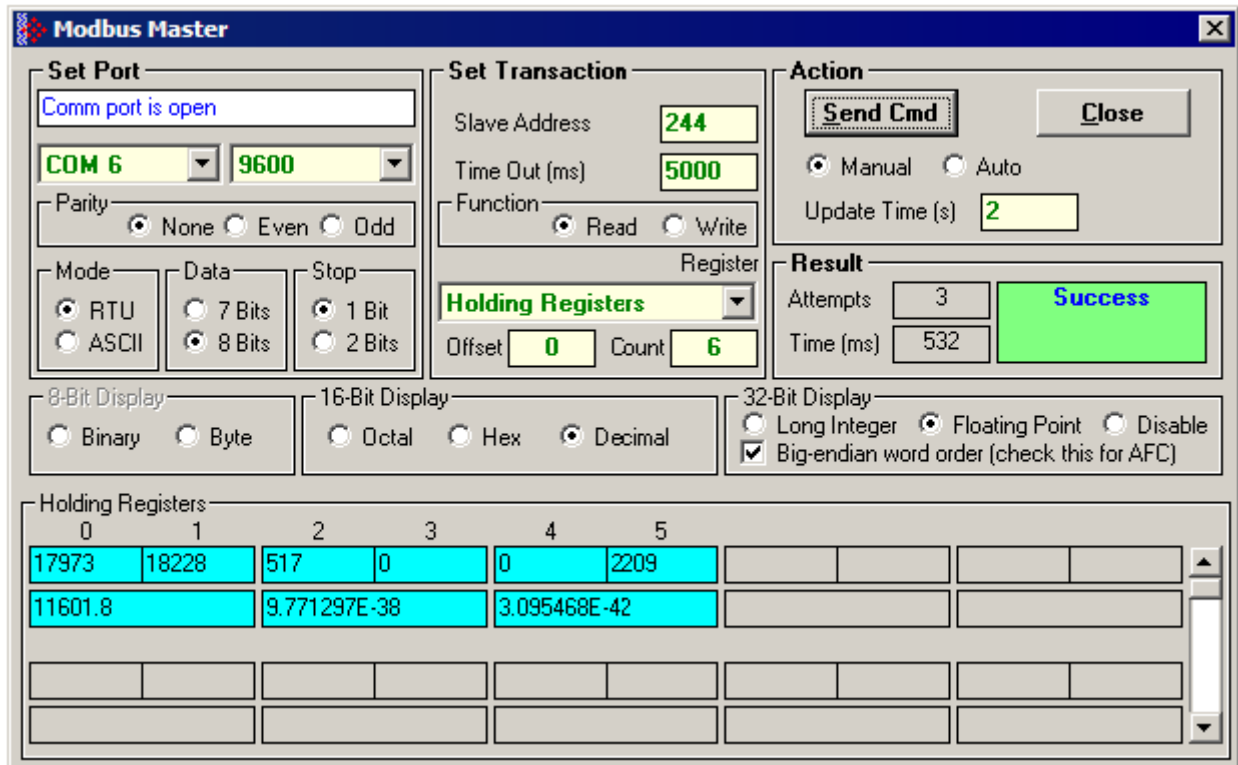
The Modbus Master dialog box opens when you open the Communications menu and then select Modbus Master. The Modbus Master allows you to read or write the registers in the Primary or Virtual Modbus Interface Slaves.

In order to access the Primary Slave, refer to the [Modbus Dictionary dialog box](#) (page 140), which contains the Primary Modbus Slave addressing. To access the registers defined in the Virtual Modbus Slave, remember that you must first re-map the registers from the Primary Modbus Slave. The Virtual Modbus Slave will only be active when its address is greater than 0. Refer to [Site Configuration](#) (page 23) for more information on configuring these options.

The following example describes the basic procedure to use the Modbus Master feature:

- 1 Configure the communication parameters.
- 2 Set the Primary or Virtual Modbus Slave Address configured in the Site Configuration section (>0).
- 3 Set the Time Out value. If the module does not respond within this period, it will time out.
- 4 Select the function type.
 - Read = reads from the module.
 - Write = writes to the module.
- 5 Select the register type: Holding Register or Input Register.
- 6 Enter the offset address in the Primary or Virtual Slave.
- 7 Enter the number of registers to transfer.
- 8 Choose the display format.
- 9 If writing, enter into the data panel the values that you want to write.
- 10 Click Send Cmd to execute the read or write operation.
- 11 If reading, the values read from the module are displayed in the data panel of the dialog box.

This example shows Holding Registers 0 (zero) and 1 containing the values 17973 and 18228 respectively; these values are fixed for the module type, and in this case the module has identified itself as a four stream, sixteen meter MVI56-AFC. Because the 32 bit Display parameter is configured as Floating Point, the 32-bit display shows the value in floating point format.



11 Modbus Database

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.

11.1 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.

11.1.1 Modbus Register Addressing

The original Modbus protocol specification partitions externally accessible registers into several blocks. These blocks include:

11.1.2 Input Registers

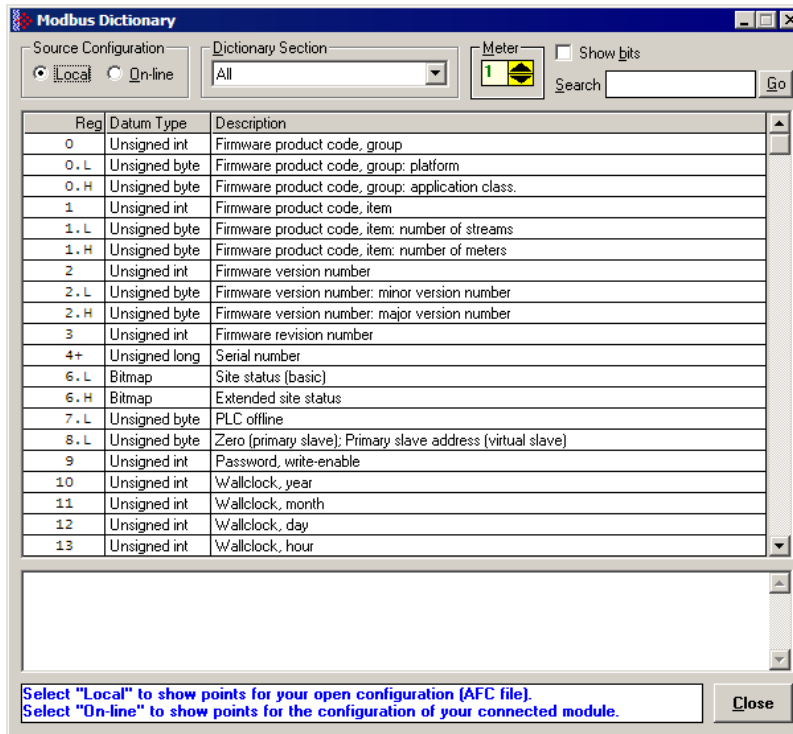
Intended for read-only values, these 16-bit integer registers are accessible via Modbus function 4 (Read Input Registers). The AFC module stores the archives and events as Input Registers.

11.1.3 Holding Registers

Intended for writable values such as setpoints, these 16-bit integer registers are accessible via Modbus function codes 3 (Read Holding Registers), 16 (Write Multiple Registers), and 6 (Write Single Register).

11.2 MODBUS Dictionary Dialog Box (MODBUS Map)

This dialog box opens when you open the Project menu and choose Modbus Dictionary. This dialog box shows a map of registers, addresses and data types for the Modbus database (holding register area only).



The information in this dialog box is "read-only", meaning that you cannot edit values here. To configure data remapping, refer to [Primary & Virtual Modbus Slave Configuration](#) (page 29).

Source Configuration selector - Select Local for current Modbus database configuration in AFC Manager. Select Online for current Modbus database configuration in the AFC module. The module must be connected to the PC and communicating with AFC Manager in order to view online configuration.

Note: The interpretation of specific Modbus addresses is determined by meter configuration. The configuration stored in the PC may be different from the one stored in the module.

Dictionary Section selector - Use the categories on this list to filter your view of the Modbus dictionary to locate specific sections of the database quickly. The following views are available:

- All (shows all registers)
- Site Identification (shows basic configuration information including firmware revision, serial number, and wallclock)
- Site Configuration (shows primary and virtual Modbus slave addresses, port parameters, project and site name, and configuration changed status)

- Site Operational (shows scan count, meter alarm status, and audit status)
- Meter Configuration (shows meter configuration details for the selected meter)
- Stream Configuration (shows stream options and calculation reference values)
- Stream Component Analysis (shows analysis molar fractions for each measured component)
- Meter Accumulators (shows gross and net values for non-resettable and resettable accumulators)
- Meter Calculations (shows meter calculation results)
- Meter Archive Status (shows current archive status for calculations).

Meter selector - Use the Up and Down arrows in the Meter selector to view settings for each configured meter.

Show bits check box - Select this check box to view individual bit values for bitmap registers such as Site Status and Meter Alarms.

Search window - You can search for specific text within the Description column. Type the search text in this window, then click the Search button or press **[Enter]**.

Search button - Use the Search button to select the next instance of the search text within the Description column.

Reg column - This column lists each Modbus register offset within the Modbus database (holding register area).

Datum Type column - This column lists the type of data stored in each register within the Modbus database, for example integer, byte, or bitmap.

Description column - This column describes the data stored in each register within the Modbus database.

Description window - If you select (highlight) a register, this window provides additional information about the selected register.

Help window - This window provides brief help information about the currently selected control (radio button, dropdown list, check box, edit window).

Close button - Use this button to close the dialog box.

11.2.1 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.

| | |
|--------------|-------|
| Meter 1 Data | 8000 |
| Meter 2 Data | 10000 |
| Meter 3 Data | 12000 |
| Meter 4 Data | 14000 |
| Meter 5 Data | 16000 |
| Meter 6 Data | 18000 |
| Meter 7 Data | 20000 |
| Meter 8 Data | 22000 |
| | 24000 |

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

$$[\text{absolute address}] = [\text{meter-relative address}] + (8000) * [\text{meter number} - 1]$$

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 (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](#) (page 23) 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.

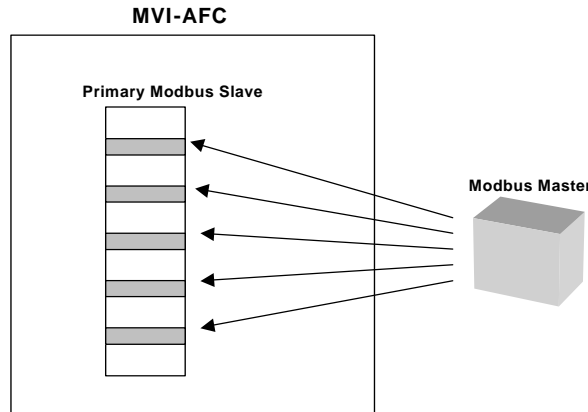
Note: The first 100 registers in the Virtual Slave Holding Register Bank have been pre-assigned and cannot be remapped. They map directly to the first 100 holding registers of the Primary Slave.

Virtual Slave Example Application

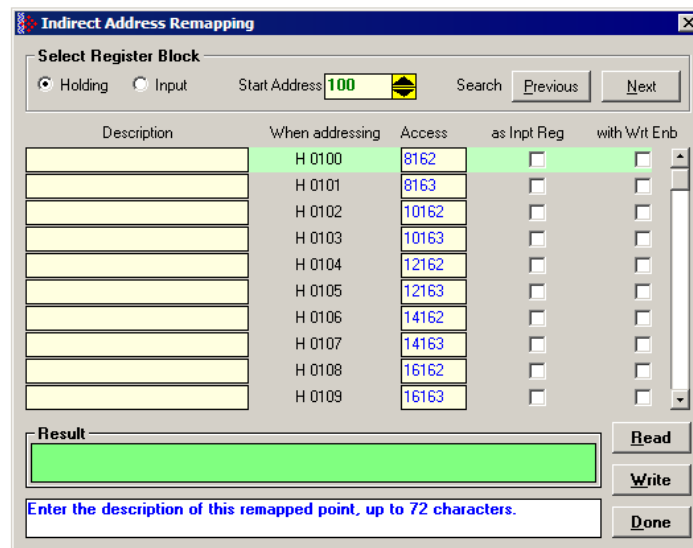
Assume that an application requires a remote Modbus master to poll the orifice diameters for the first 5 channels. Continuing the previous example, the holding register addresses are listed again the following table.

| 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:



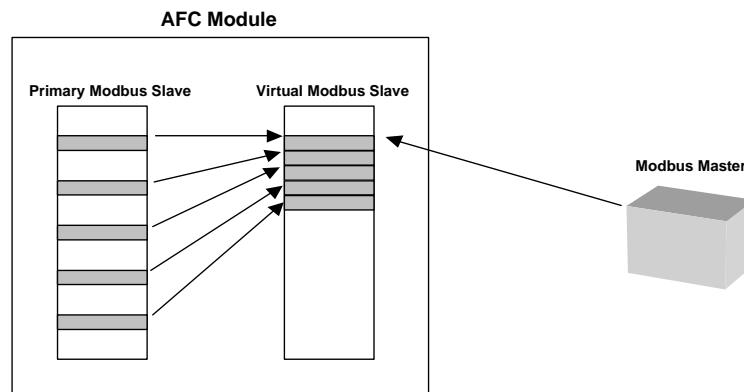
However, using the Virtual Modbus Slave optimizes the polling of data because the registers can be remapped in any order using the AFC Manager (Site Configuration window). The following illustration shows how the orifice diameter registers could be remapped to the Virtual Slave starting at address Vh00100:



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.

12 Checksum Alarms

Occasionally, the module may flag a checksum alarm condition after a power cycle.

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.

When this event occurs, the module will recalculate the checksum after the power cycle and restore the original value.

The module informs you that a checksum alarm has occurred by blinking the green LED on the module.

If a checksum alarm occurs, you should verify the associated data. Use the Checksum Alarm dialog box to identify which part of the data is related to the alarm. After you verify that the data is OK, click the Clear button to clear the alarm.

| Bits | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|----------|--------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| Site | <input type="checkbox"/> | | | | | | | | | | | | | | | |
| Meter 1 | | | | | | | | | | | | | | | | |
| Meter 2 | | | | | | | | | | | | | | | | |
| Meter 3 | | | | | | | | | | | | | | | | |
| Meter 4 | | | | | | | | | | | | | | | | |
| Meter 5 | | | | | | | | | | | | | | | | |
| Meter 6 | | | | | | | | | | | | | | | | |
| Meter 7 | | | | | | | | | | | | | | | | |
| Meter 8 | | | | | | | | | | | | | | | | |
| Meter 9 | | | | | | | | | | | | | | | | |
| Meter 10 | | | | | | | | | | | | | | | | |
| Meter 11 | | | | | | | | | | | | | | | | |
| Meter 12 | | | | | | | | | | | | | | | | |
| Meter 13 | | | | | | | | | | | | | | | | |
| Meter 14 | | | | | | | | | | | | | | | | |
| Meter 15 | | | | | | | | | | | | | | | | |
| Meter 16 | | | | | | | | | | | | | | | | |

Site configuration

13 Reference

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- Configurable Archive Registers 158
- Archive Data Format 162
- Modbus Addressing Common to Both Primary and Virtual Slaves 167
- Modbus Port configuration 262
- Startup Basics and Frequently Asked Questions 263

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 or 16 meters: differential (AGA3 or ISO5167) or linear (AGA7) Gas; (MPMS Ch 12.2) Liquid.

| | | | | |
|-----------|-----------|-----------|-----------|-----------|
| MVI46-AFC | MVI56-AFC | MVI69-AFC | MVI71-AFC | PTQ-AFC |
| 8 Meters | 16 Meters | 8 Meters | 8 Meters | 16 Meters |

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 AFC Manager 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 158) 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).

| | MVI46-AFC | MVI56-AFC | MVI69-AFC | MVI71-AFC | PTQ-AFC |
|-----------------------|---|---|---|---|---|
| Current Loads | 800mA @ 5.1 VDC (from backplane) | 800mA @ 5.1 VDC (from backplane) | 800 mA @ 5V (from backplane) Power supply distance rating of 2 | 800 mA @ 5.1 VDC (from backplane) | 800 mA @ 5V (from backplane) |
| Operating Temperature | 0 to 60°C 32 to 140°F | 0 to 60°C 32 to 140°F | 0 to 60°C 32 to 140°F | 0 to 60°C 32 to 140°F | 0 to 60°C 32 to 140°F |
| Storage Temperature | -40 to 85°C -40 to 185°F | -40 to 85°C -40 to 185°F | -40 to 85°C -40 to 185°F | -40 to 85°C -40 to 185°F | -40 to 85°C -40 to 185°F |
| Relative Humidity | 5% to 95% (non-condensing) | 5% to 95% (non-condensing) | 5% to 95% (non-condensing) | 5 to 95 % (non-condensing) | 5 to 95 % (non-condensing) |
| Modbus Port Connector | Three RJ45 connectors (RJ45 to DB-9 cable shipped with unit) supporting RS-232, RS-422, RS-485 interfaces | Three RJ45 connectors (RJ45 to DB-9 cable shipped with unit) supporting RS-232, RS-422, RS-485 interfaces | Two RJ45 connectors (RJ45 to DB-9 cable shipped with unit) (supporting RS-232, RS-422 and RS-485 interfaces (RJ45 to DB-9 cables shipped with unit. | Three RJ45 connectors (RJ45 to DB-9 cable shipped with unit), two of which support RS-232, RS-422, and RS-485 interfaces. | Three DB-9M connectors, 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:

- 1 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.
- 2 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 84) 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 154) 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, $CTL(\text{Flowing} / \text{ApiBase})$, is calculated, except that the final rounding step is not performed. Then, $CTL(\text{UserBase} / \text{ApiBase})$ is calculated, also unrounded. The $CTL(\text{Flowing} / \text{UserBase})$ is then calculated as $(CTL(\text{Flowing} / \text{ApiBase}) / CTL(\text{UserBase} / \text{ApiBase}))$, to which result is applied the final rounding step of the standard CTL calculation.

Pressure Correction Factor, CPL

The $CPL(\text{Flowing} / \text{UserBase})$ 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 $CPL(\text{Flowing} / \text{ApiBase})$ (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 $den(\text{ApiBase})$ by the term $(CTL(\text{UserBase} / \text{ApiBase}) * CPL(\text{Flowing} / \text{ApiBase}) / CPL(\text{Flowing} / \text{UserBase}))$, 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:

$D \geq 610 \text{ kg/m}^3$ Table 54A (Crude&NGL) or 54B (Refined Products)

$500 \leq D < 610$ (LPG) ASTM-IP-API Petroleum Measurement Tables for Light Hydrocarbon Liquids 500-653 kg/m³ 1986 ISBN 0 471 90961 0

US units:

$D \geq 0.610$ RD60 Table 24A (Crude&NGL) or 24B (Refined Products),

$0.350 \leq D < 0.610$ (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) or 11.2M (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 <i>Record Size</i> 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 |
| 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 |
| 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 |

| Start Offset | End Offset | Data Format | Type | Description |
|--------------|------------|-------------|-----------------------|---------------------------------|
| 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 |
| 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 |

| Address | Type | Description |
|--------------------|------|--|
| 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 |
| Ch00006 | Bm | <p>Site status</p> <p>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.</p> <p>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.</p> <p>bit 2 - [reserved]</p> <p>bit 3 - [reserved]</p> <p>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.</p> <p>bit 5 - Measurement configuration changed Set when any bit in the "Measurement Configuration Changed" registers is set; clear when all such bits are clear.</p> <p>bit 6 - Power up Set upon power-up, and cleared upon setting the wallclock for the first time..</p> <p>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.</p> <p>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.</p> <p>bit 9 - [reserved]</p> <p>bit 10 - [reserved]</p> <p>bit 11 - [reserved]</p> <p>bit 12 - [reserved]</p> <p>bit 13 - [reserved]</p> <p>bit 14 - [reserved]</p> <p>bit 15 - [reserved]</p> |
| Ch00007 | By | Processor offline code: 0 online, 1 offline |
| 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. |

| Address | Type | Description |
|--------------------|------|---|
| 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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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:

$$(\text{low range}) \leq (\text{default}) \leq (\text{high range})$$

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 (CaT)

The named parameter from the manufacturer's densitometer calibration sheet, where applicable to the selected densitometer type.

Densitometer calibration parameter 2 (CaP)

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, Q_m

The flow rate calculated from the Bernoulli equation.

AGA 3, Velocity of approach factor, E_v

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, C_d

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

$(\text{number of scans with flow}) / (\text{total number of scans})$

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 | Parameter | Value |
|---------------|--|---|
| 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.

- 1 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.
- 2 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:

- 1 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.
- 2 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.
- 3 Determine if the meter is enabled. If the meter is not enabled, it will not perform the applicable calculation.
- 4 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

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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)

+1(661) 716-5100
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Cep: 04101-300 – Brasil
+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.**

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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