



Where Automation Connects.



MVI56E-AFC / MVI69E-AFC
Enhanced Liquid and Gas Flow
Computer
ControlLogix® and CompactLogix™

June 8, 2023

REFERENCE GUIDE

Your Feedback Please

We always want you to feel that you made the right decision to use our products. If you have suggestions, comments, compliments or complaints about our products, documentation, or support, please write or call us.

ProSoft Technology, Inc.

+1 (661) 716-5100

+1 (661) 716-5101 (Fax)

www.prosoft-technology.com

support@prosoft-technology.com

MVlxxE-AFC Reference Guide
For Public Use.

June 8, 2023

ProSoft Technology®, is a registered copyright of ProSoft Technology, Inc. All other brand or product names are or may be trademarks of, and are used to identify products and services of, their respective owners.

Content Disclaimer

This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither ProSoft Technology nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. Information in this document including illustrations, specifications and dimensions may contain technical inaccuracies or typographical errors. ProSoft Technology makes no warranty or representation as to its accuracy and assumes no liability for and reserves the right to correct such inaccuracies or errors at any time without notice. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

No part of this document may be reproduced in any form or by any means, electronic or mechanical, including photocopying, without express written permission of ProSoft Technology. All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components. When devices are used for applications with technical safety requirements, the relevant instructions must be followed. Failure to use ProSoft Technology software or approved software with our hardware products may result in injury, harm, or improper operating results. Failure to observe this information can result in injury or equipment damage.

Copyright © 2023 ProSoft Technology, Inc. All Rights Reserved.



For professional users in the European Union

If you wish to discard electrical and electronic equipment (EEE), please contact your dealer or supplier for further information.



Warning – Cancer and Reproductive Harm – www.P65Warnings.ca.gov

Open Source Information

Open Source Software used in the product

The product contains, among other things, Open Source Software files, as defined below, developed by third parties and licensed under an Open Source Software license. These Open Source Software files are protected by copyright. Your right to use the Open Source Software is governed by the relevant applicable Open Source Software license conditions. Your compliance with those license conditions will entitle you to use the Open Source Software as foreseen in the relevant license. In the event of conflicts between other ProSoft Technology, Inc. license conditions applicable to the product and the Open Source Software license conditions, the Open Source Software conditions shall prevail. The Open Source Software is provided royalty-free (i.e. no fees are charged for exercising the licensed rights). Open Source Software contained in this product and the respective Open Source Software licenses are stated in the module webpage, in the link Open Source.

If Open Source Software contained in this product is licensed under GNU General Public License (GPL), GNU Lesser General Public License (LGPL), Mozilla Public License (MPL) or any other Open Source Software license, which requires that source code is to be made available and such source code is not already delivered together with the product, you can order the corresponding source code of the Open Source Software from ProSoft Technology, Inc. - against payment of the shipping and handling charges - for a period of at least 3 years since purchase of the product. Please send your specific request, within 3 years of the purchase date of this product, together with the name and serial number of the product found on the product label to:

ProSoft Technology, Inc.
Director of Engineering
9201 Camino Media, Suite 200
Bakersfield, CA 93311
USA

Warranty regarding further use of the Open Source Software

ProSoft Technology, Inc. provides no warranty for the Open Source Software contained in this product, if such Open Source Software is used in any manner other than intended by ProSoft Technology, Inc. The licenses listed below define the warranty, if any, from the authors or licensors of the Open Source Software. ProSoft Technology, Inc. specifically disclaims any warranty for defects caused by altering any Open Source Software or the product's configuration. Any warranty claims against ProSoft Technology, Inc. in the event that the Open Source Software contained in this product infringes the intellectual property rights of a third party are excluded. The following disclaimer applies to the GPL and LGPL components in relation to the rights holders:

"This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License and the GNU Lesser General Public License for more details."

For the remaining open source components, the liability exclusions of the rights holders in the respective license texts apply. Technical support, if any, will only be provided for unmodified software.

Important Installation Instructions

Power, Input, and Output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods, Article 501 to 4 (b) of the National Electrical Code, NFPA 70 for installation in the U.S., or as specified in Section 18-1J2 of the Canadian Electrical Code for installations in Canada, and in accordance with the authority having jurisdiction. The following warnings must be heeded:

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIV. 2;

WARNING - EXPLOSION HAZARD - WHEN IN HAZARDOUS LOCATIONS, TURN OFF POWER BEFORE REPLACING OR WIRING MODULES

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

Class 2 Power

MVI (Multi-Vendor Interface) Modules

WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.

AVERTISSEMENT - RISQUE D'EXPLOSION - AVANT DE DÉCONNECTER L'ÉQUIPEMENT, COUPER LE COURANT OU S'ASSURER QUE L'EMPLACEMENT EST DÉSIGNÉ NON DANGEREUX.

Warnings

North America Warnings

Power, Input, and Output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods, Article 501 to 4 (b) of the National Electrical Code, NFPA 70 for installation in the U.S., or as specified in Section 18-1J2 of the Canadian Electrical Code for installations in Canada, and in accordance with the authority having jurisdiction. The following warnings must be heeded:

- A** Warning - Explosion Hazard - Substitution of components may impair suitability for Class I, Division 2.
- B** Warning - Explosion Hazard - When in hazardous locations, turn off power before replacing or rewiring modules.
- C** Warning - Explosion Hazard - Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- D** Suitable for use in Class I, Division 2 Groups A, B, C and D Hazardous Locations or Non-Hazardous Locations.

ATEX Warnings and Conditions of Safe Usage

Power, Input, and Output (I/O) wiring must be in accordance with the authority having jurisdiction.

- A** Warning - Explosion Hazard - When in hazardous locations, turn off power before replacing or wiring modules.
- B** Warning - Explosion Hazard - Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- C** These products are intended to be mounted in an IP54 enclosure. The devices shall provide external means to prevent the rated voltage being exceeded by transient disturbances of more than 40%. This device must be used only with ATEX certified backplanes.
- D** DO NOT OPEN WHEN ENERGIZED.

Agency Approvals and Certifications

Please visit our website: www.prosoft-technology.com

Contents

Your Feedback Please	2
Content Disclaimer	2
Open Source Information	3
Important Installation Instructions.....	4
MVI (Multi-Vendor Interface) Modules.....	4
Warnings	4
1 Introduction	11
1.1 What you need to know about the AFC modules	11
1.2 EAFC Manager Software Requirements	12
2 Configuring an Operator Database	13
2.1 Operators Tab.....	14
2.2 Roles Tab.....	23
2.2.1 About Inherited roles.....	24
2.2.2 About Resolving Privileges	24
2.2.3 Adding a Role	24
2.2.4 Editing a Role Privilege.....	31
2.3 Authorization Defaults Tab	32
3 EAFC Manager Menus	34
3.1 File Menu	34
3.2 Project Menu.....	35
3.3 On-Line Menu	36
3.4 Communications Menu	40
4 Changing Passwords	41
5 Viewing Site Status Information	43
6 Viewing Events	48
6.1 Event Log	48
6.2 Event Log Structures	49
6.3 Event ID Tag.....	49
6.4 Event-triggered Archives and Accumulator Resets	51
6.5 Period End Events	51
6.6 Loggable Events	52
6.7 Event Class 0: Special Events.....	53
6.8 Event Class 1: Site Datum Point Events	55
6.9 Event Class 2: Meter Datum Point Events	56
6.10 Event Class 3: Stream Datum Point Events	59
6.11 Event Class 4: Prover Datum Point Events	61
6.12 Event Class 7: Transmitter Calibration and Verification	64
6.13 Subgroup coding and values, Group 0, Session action recorded:	64

6.14	Subgroup coding and values, Group 1, Session state change:	65
6.15	"Rkv" Notes	66
6.16	Event Priority and a "Locked" Log	67
6.17	Event Numbers and Event Log Download.....	68
6.18	Event Log Download.....	70
7	Creating Alarm Logs	73
8	Checking Meter Alarms on a PLC	75
9	Transmitter Calibration	77
9.1	Temperature Offset.....	77
9.2	Meter Verification	79
9.3	Meter Calibration	80
9.3.1	Performing Verification and Calibration	80
9.4	Temperature Offset.....	83
9.5	Multivariable Transmitters.....	84
9.5.1	Calibrating MVT Example	84
9.6	PLC Mediation	86
9.6.1	Setting Process Input Options for PLC Mediation	87
9.6.2	Using PLC Mediation	89
10	Meter Proving	90
10.1	Prover Configuration.....	90
10.1.1	Prover Type	92
10.1.2	Prover Options	96
10.1.3	Run Counts	96
10.1.4	Run Input Setup	96
10.1.5	Prover Characteristics	97
10.2	Meter Proving Process	100
10.2.1	Initial Requirements	102
10.2.2	Meter Proving Alarms	103
10.2.3	Prover Operation (Performing a Prove).....	105
10.3	Meter Proving Reports.....	110
10.4	Protected Meter Proving Data in the Input Register Bank.....	112
10.4.1	Prove Results.....	112
10.4.2	Meter Previous Prove Summary.....	113
10.4.3	Prover Temperature.....	113
10.5	Meter Factor Application Codes	114
11	Meter Monitor	115
11.1	Accessing the Meter Monitor Dialog.....	115
11.2	Accumulators	115
11.3	Flow Rates	116
11.4	Process Inputs	116
11.4.1	Viewing Process Inputs	116
11.4.2	Detail Alarms: Differential pressure	118
11.4.3	Detail Alarms: Temperature.....	119
11.4.4	Detail Alarms: Pressure	120

11.4.5	Viewing Meter Alarms	121
11.4.6	Meter Alarm Bits	122
12	Viewing Checksum Alarms	123
<hr/>		
13	Modbus Communication Reference	125
<hr/>		
13.1	Serial Port Communication Parameters	125
13.2	Port Options	126
13.3	Modbus Master	127
14	Primary and Virtual Slaves and Modbus Addressing	129
<hr/>		
14.1	Modbus Address Space	129
14.1.1	Accessing the Data	130
14.2	Primary Slave	131
14.2.1	Modbus Address References	131
14.2.2	Modbus Address Examples	131
14.2.3	Meter-relative Data	132
14.2.4	Scratchpad	133
14.3	Virtual Slave	133
14.3.1	Virtual Slave Example Application	133
14.4	Virtual Slave Addressing Collisions	137
14.5	Modbus Pass-Through	138
14.6	Disabling Pass-Through	140
15	ControlLogix Ladder Logic Details	141
<hr/>		
15.1	Enable Status	141
15.2	Enable/Disable Meter	142
15.3	Wallclock	142
15.4	Meter Profile	144
15.5	Meter Process Variables	145
15.5.1	Meter Type = Differential & Product Group = Gas	145
15.5.2	Meter Type = Differential & Product Group = Liquid	145
15.5.3	Meter Type = Linear & Product Group = Gas	146
15.5.4	Meter Type = Linear & Product Group = Liquid	146
16	CompactLogix Ladder Logic Details	147
<hr/>		
16.1	Enable Status	147
16.2	Enable/Disable Meter	148
16.3	Wallclock	149
16.4	Meter Profile	150
16.5	Meter Process Variables	151
16.5.1	Meter Type = Differential & Product Group = Gas	151
16.5.2	Meter Type = Differential & Product Group = Liquid	151
16.5.3	Meter Type = Linear & Product Group = Gas	152
16.5.4	Meter Type = Linear & Product Group = Liquid	152

17	Molar Analysis (For Gas Product Only)	153
<hr/>		
18	Site Status on PLC	157
18.1	Modbus Master	158
18.2	Modbus Pass-Through	162
18.3	Modbus Gateway	162
<hr/>		
19	Diagnostics and Troubleshooting	164
19.1	MVI56E-AFC LEDs and Alarm Information	164
19.2	MVI69E-AFC LEDs	165
19.3	NVRAM LEDs	165
19.4	Meter Alarms	166
19.5	Checksum Alarms	169
19.6	Events	169
19.7	Audit Scan	169
<hr/>		
20	Meter Extended Totalizers	174
20.1	Retrieving the Data	174
20.2	Viewing Data Values	176
20.2.1	Implementation	190
20.3	Accumulator Projection	191
20.3.1	Projection Periods	191
<hr/>		
21	Daily and Monthly Formula Calculations	193
<hr/>		
22	Configuration File Management Reference	194
22.1	Loading an Existing Project	194
22.2	Printing the Configuration Report	194
22.3	Resetting Configuration Parameters	195
22.4	Verifying Correct Operation	195
<hr/>		
23	Gas Component Analysis (Molar Analysis) Configuration	197
23.1	Entering Molar Concentrations	197
23.2	Normalization Error Tolerance	199
23.3	Transferring the Analysis	199
<hr/>		
24	Meter Calculation Options	201
<hr/>		
25	General Reference	206
25.1	General Specifications	206
25.1.1	Online Communication & Configuration	207
25.1.2	Reports	207
25.1.3	Modbus Interface	207
25.1.4	Configurable Options	208
25.1.5	Hardware Specifications (MVI56E-AFC)	208

25.1.6	Hardware Specifications (MVI69E-AFC)	209
25.2	Measurement Compliance Standards	210
26	Basic Metering According to Meter type	214
26.1	Orifice (Include V-cone): Uses AGA3 (2012) / ISO 5167	214
26.2	Pulse: Both Gas and Liquid	214
26.3	Correction Factors According to Product Phase	214
26.3.1	Gas	214
26.3.2	Liquid	214
26.4	Gas Pulse Measurement	215
26.5	Water Content of Liquids	215
26.6	Non-Standard Reference Conditions	215
26.7	Archiving and Event Log	215
26.8	Liquid Correction Factor Details	216
26.9	Compressibility Factor F	216
27	Configurable Archive Registers	217
27.1	Archive Data Format	217
27.2	Timestamp Date and Time Format	217
27.3	Pre-defined Header	217
28	Archive Configuration	218
28.1	Archive Overview	218
28.2	Archive Generation	219
28.3	Archive Types	219
28.4	Archive Order	219
28.5	Archive Options	221
28.6	Archive Locations	222
28.7	Editing the Archive Structure	223
28.7.1	User-Specified Archivables	224
28.7.2	MASC Default Archive Configuration	227
28.8	Retrieving Archives	228
28.9	Archive Reports	230
28.10	Meter Archive	233
28.11	Common Addressing Primary & Virtual Slaves	235
29	Mass Allocation Shrinkage Calculation (MASC)	238
29.1	Background	238
29.2	Configuring and Enabling Mass Allocation Shrinkage Calculations	238
29.3	Viewing MASC Results	248
29.4	Resetting Accumulators	249
29.5	MASC Alarms	252
29.5.1	Viewing Alarms	252
29.5.2	Clearing Latched Alarms	253
29.6	MASC Configuration Reference	254
29.6.1	MASC Enable and Meter Status	254
29.6.2	Volume Rates and Accumulations Tab	254
29.6.3	Mass Rates and Accumulations Tab	255
29.6.4	Configuration Tab	256
29.6.5	EOS Table Entries Tab	258

29.6.6	Intermediate Results Tab.....	259
29.6.7	Status Tab.....	262
29.6.8	Read and Write Commands	263
30	Meter Stream Configuration	265
<hr/>		
30.1	Overview	265
30.1.1	Overview of the Meter Stream Configuration Dialog	265
30.1.2	Default Configuration for Firmware Version 4.06	268
30.1.3	Default Configuration for Firmware Version 4.05 or Earlier	272
30.1.4	Default Configuration After Upgrading from 4.05 or earlier to 4.06	276
30.2	Configuring the Meter Stream Allocation	280
30.2.1	Rules and Limitations	280
30.2.2	Change the Meter Stream Configuration	281
31	Modbus Port Configuration	284
<hr/>		
32	Product Group Standards	286
<hr/>		
33	Important Information About Bogus IPs	288
<hr/>		
34	Cable Connections	289
<hr/>		
34.1	RS-232 Application Port(s)	289
34.1.1	RS-232: Modem Connection (Hardware Handshaking Required)	289
34.1.2	RS-232: Null Modem Connection (Hardware Handshaking)	290
34.1.3	RS-232: Null Modem Connection (No Hardware Handshaking)	290
34.2	RS-422 Application Port(s)	291
34.3	RS-485 Application Port(s)	291
34.4	DB9 to RJ45 Adaptor (Cable 14)	292
35	Support, Service & Warranty	293
<hr/>		
35.1	Contacting Technical Support.....	293
35.2	Warranty Information	293

1 Introduction

Note: This guide assumes you have already configured your module using the AFC Setup and Configuration Guide. This guide does not contain initial setup information.

1.1 What you need to know about the AFC modules

ProSoft Technology's MVIxxE-AFC in-chassis flow computer solution allows you to combine the power and scalability of a CompactLogix® or ControlLogix® automation system with the functionality typically only seen in standalone flow computers or dedicated measurement RTUs. This provides you with the industry standard calculations, archiving, and reporting needed for custody transfer and allocation-based measurement functions for oil and gas operations.

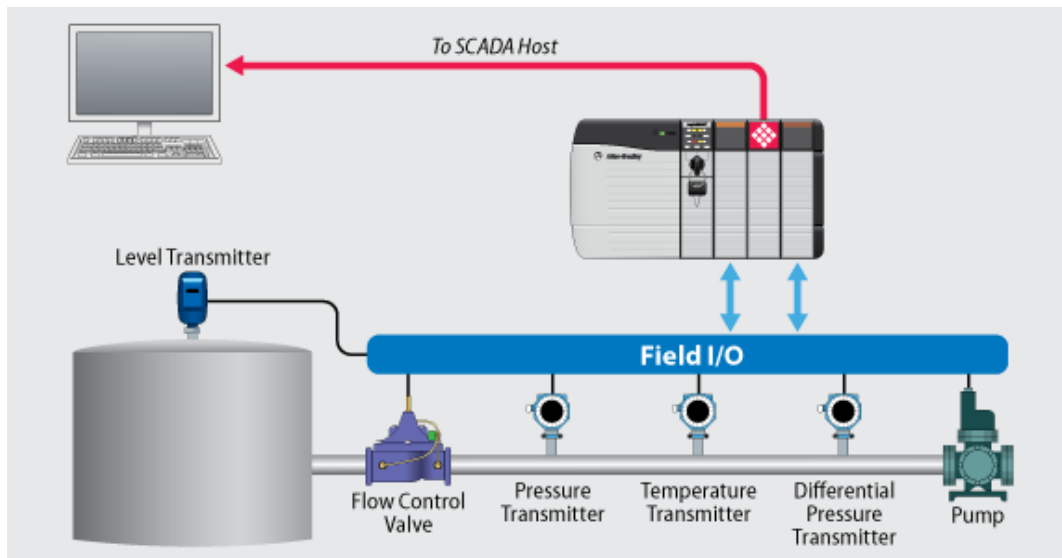
By combining automation and measurement functions into a single solution, this helps to reduce overall support and integration costs for Oil and Gas applications while also decreasing your overall capital spend. This simplified solution allows you to optimize your resources.

In addition, because our flow computer sits in a Logix system, you can take advantage of Rockwell Automation's distributed I/O capability, wide range of communications protocols, and ProSoft's wireless radios to greatly reduce wiring to your transmitters and I/O devices.

The AFC modules have two serial communication ports. One port can be used as a master to poll gas chromatographs (not for polling of instrumentation such as multivariable transmitters and Coriolis meters), and another serial port can be used as a Modbus serial slave. There is additionally one Ethernet port for Modbus TCP/IP communications, operating as a server device and allowing easy access by a remote Modbus Client device.

Since the module operates as a co-processor for measurement-related functions to the ControlLogix system, and as measurement requirements of the site grow, you can simply add an additional MVIxxE-AFC module to increase your measurement capabilities to an individual site. The MVIxxE-AFC is truly a scalable automation and measurement solution.

The following graphic provides a sample application where input data is transferred from the transmitters to analog input cards on the Rockwell Automation rack. The values are transferred from the processor to the module.



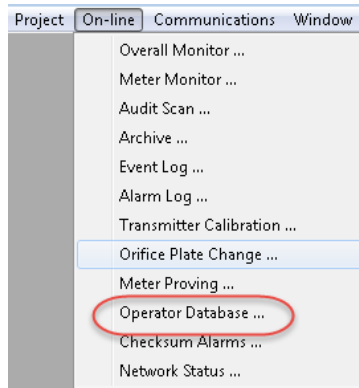
1.2 EAFC Manager Software Requirements

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

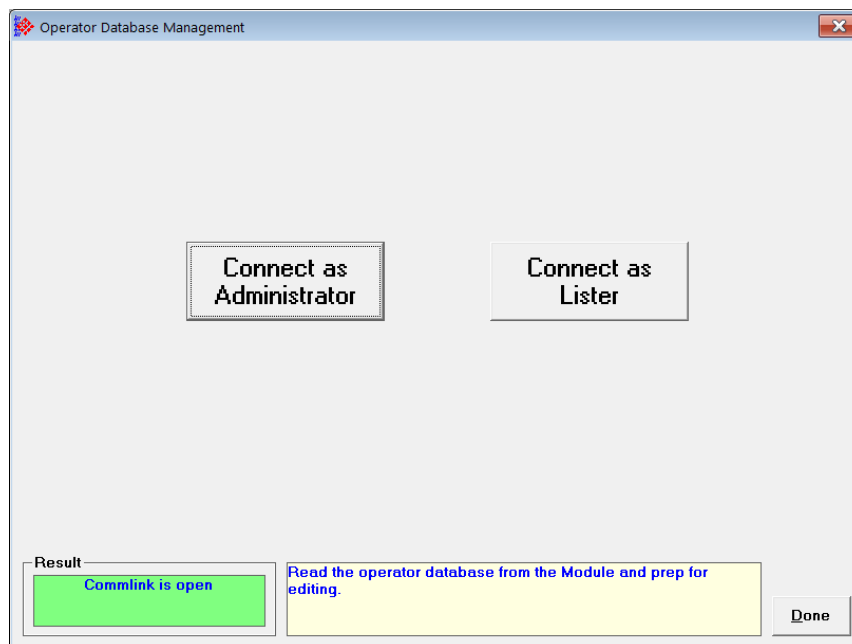
- 1 GHz or faster 32-bit (x86) or 64-bit (x64) processor
- 1 GB RAM (32-bit) or 2 GB RAM (64-bit)
- 16 GB available hard drive space (32-bit) or 20 GB (64-bit)
- Assigned IP address
- Available Ethernet port, Serial port (COM port) or USB to Serial adapter cable with necessary drivers, required for communication between EAFC Manager software and the AFC module.
- DB9 adapter cable (included with module), required for connection between PC serial port and AFC module.
- An Ethernet cable required for connections between a PC port and the Ethernet port of the AFC module.

2 Configuring an Operator Database

- 1 Navigate to **ON-LINE > OPERATOR DATABASE**.



- 2 The Operator Database Management page opens.

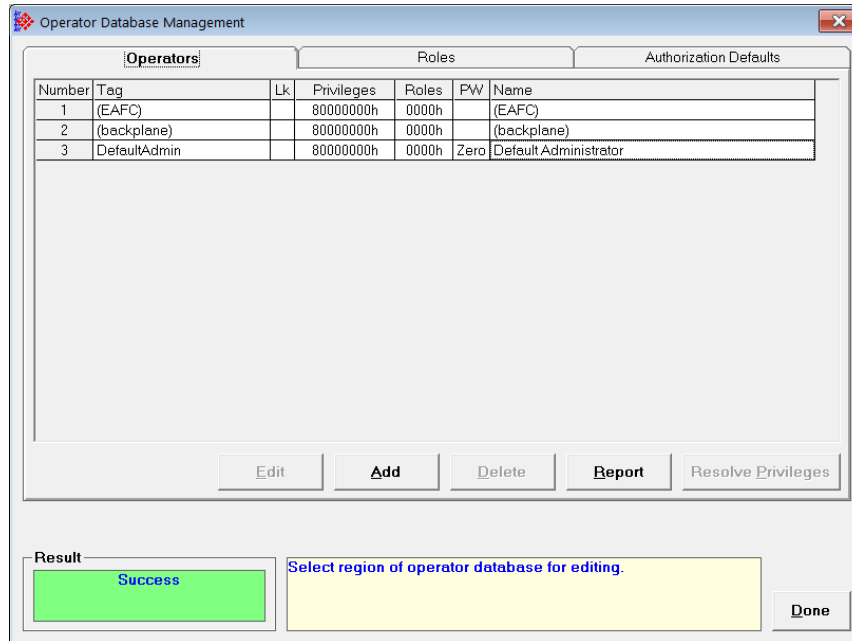


The initial page displays two buttons:

- **CONNECT AS ADMINISTRATOR** – Allows you to perform any system-wide function.
- **CONNECT AS LISTER** – A 'Lister' only performs read functions of the Operator Database.

- 3 Click **CONNECT AS ADMINISTRATOR**.
- 4 You must log into the module with "Administrator" privileges in order to accomplish this feature. The default Administrator Operator password is 0.

The Operator Database Management page opens.



This page contains three tabs:

- Operators
- Roles
- Authorization Defaults

2.1 Operators Tab



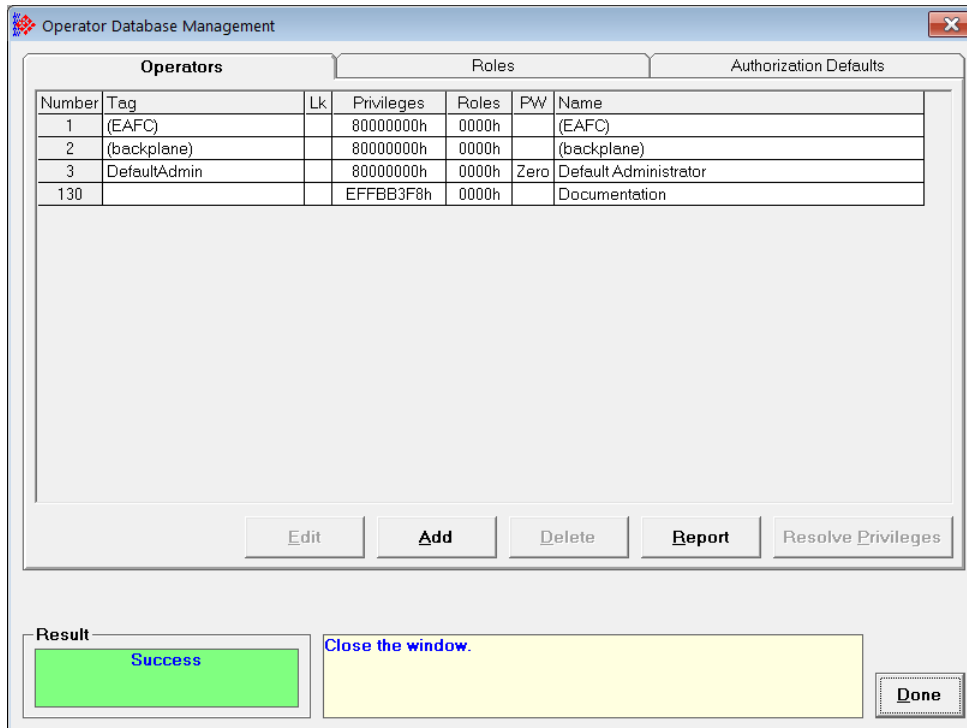
The *Operators* tab allows you to add operators, each with different roles and privileges. There are three special Operators defined in the system:

- **E AFC** – This represents the AFC module. This operator is always logged in and its record cannot be changed. Its purpose is to supply its number for inclusion in persistent records made as a consequence of actions initiated by the module’s firmware such as Event Log records. This operator cannot be logged in via an external communication channel.
- **(Backplane)** – The represents the backplane interface between the module and the PLC/PAC processor. This operator is always logged in and its record cannot be changed. Its purpose is to supply operator information for actions initiated by, or managed by the processor. For example, running a transmitter calibration session via the process from and HMI or supplying its operator number for Event Log records created as a result of Modbus gateway transactions. This operator cannot be logged in via an external communication channel.

- Default Administrator** – This record is available during cold start for logging into the module. This operator cannot be deleted, and editing is limited to its Lockout flag and its Password. The default administrator password is 0.

These records all have Administrator privilege, so actions initiated by the corresponding operator have full authority to exercise all EAFC Manager functionality.

Note: Be sure to either (a) change the default administrator operator default password to a value between 1 and 65535, or (b) setup an alternate operator with administrator privileges and lock out (disable) the Default Administrator Operator.



The following table describes each parameter.

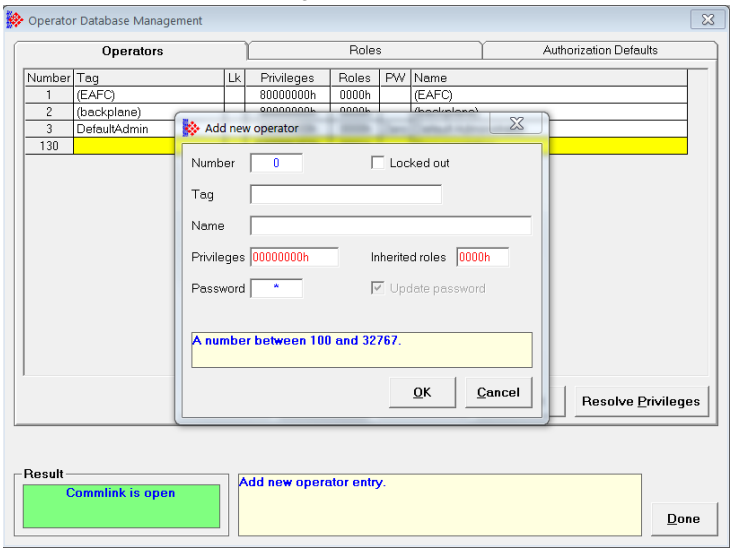
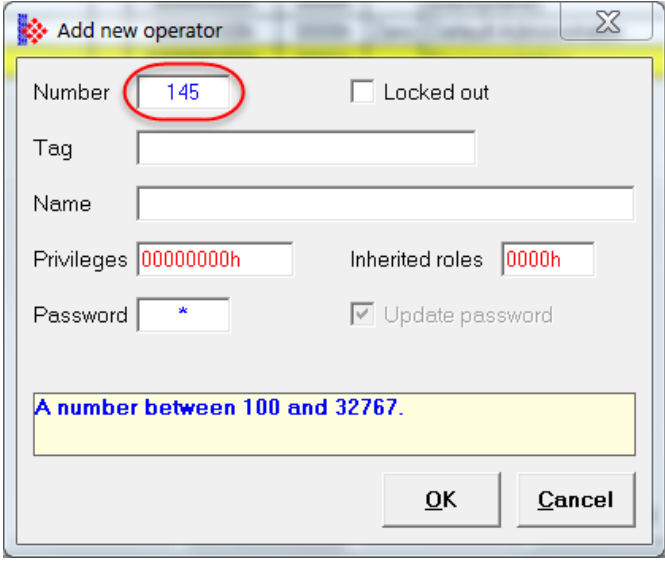
Parameter	Description
Number	This is the operator number. The operator number for the default administrator is always 3.
Tag	Tag assigned to this operator. May be used as a login name.
Lk	Lockout flag. If set, this operator cannot log into the module.
Privileges	Privileges assigned to this operator based on roles.
Roles	Inherited roles assigned to this operator.
PW	This is a password assigned to the operator. This column will only be blank or contain "zero". Zero acts as a wildcard and if set, a user can gain access using any password at all. This is used in exceptional cases and should be avoided unless absolutely necessary.
Name	This can be the name of the operator or the name of a an operation.

Adding an Operator

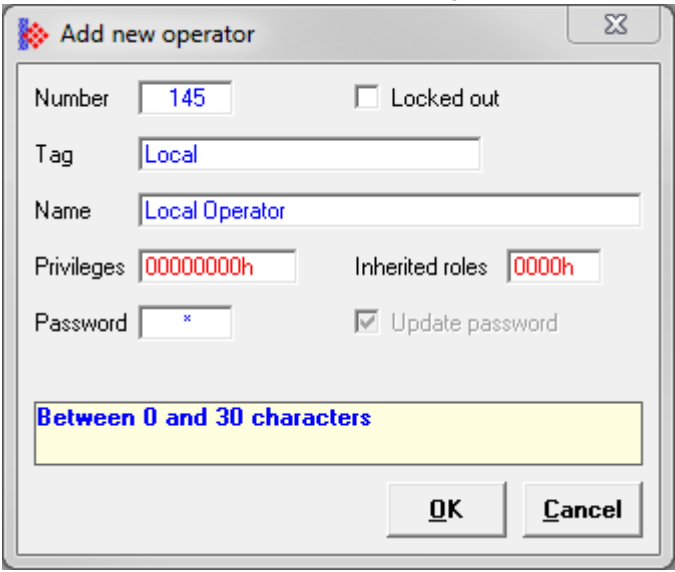
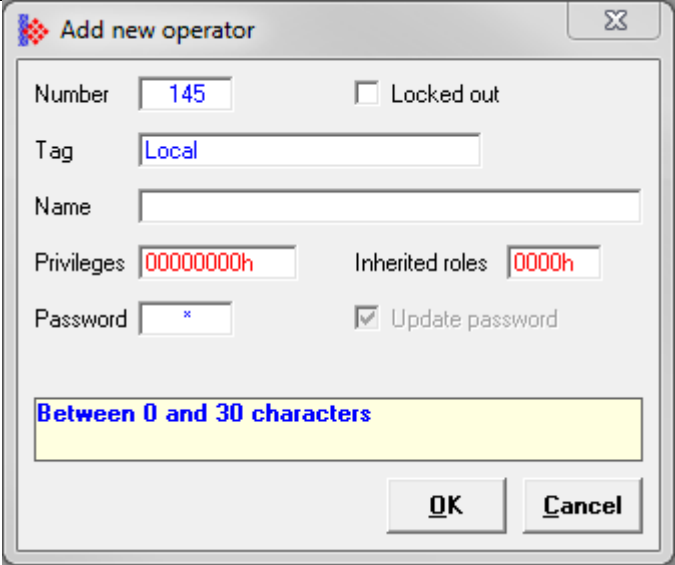


Make sure you are logged in as *Administrator*.

Note: These windows and functions are only available if logged in as Administrator. If logged in as “Lister”, similar windows are presented, but with much less detail and severely reduced functionality. If your login privileges don’t include Administrator or Lister, this interface is inaccessible to you.

Step	Task	Description
1	Click the Add button.	The <i>Add new operator</i> dialog opens: 
2	Add an operator number between 100 and 32767.	
3	Enter a <i>Tag</i> name.	This is an alternative means of locating a record in the database. It functions the same as a user ID.

Step	Task	Description
4	Enter a <i>Name</i> .	This identifies the operator, typically the name of the operator. It could also be a definition of a set of privileges.

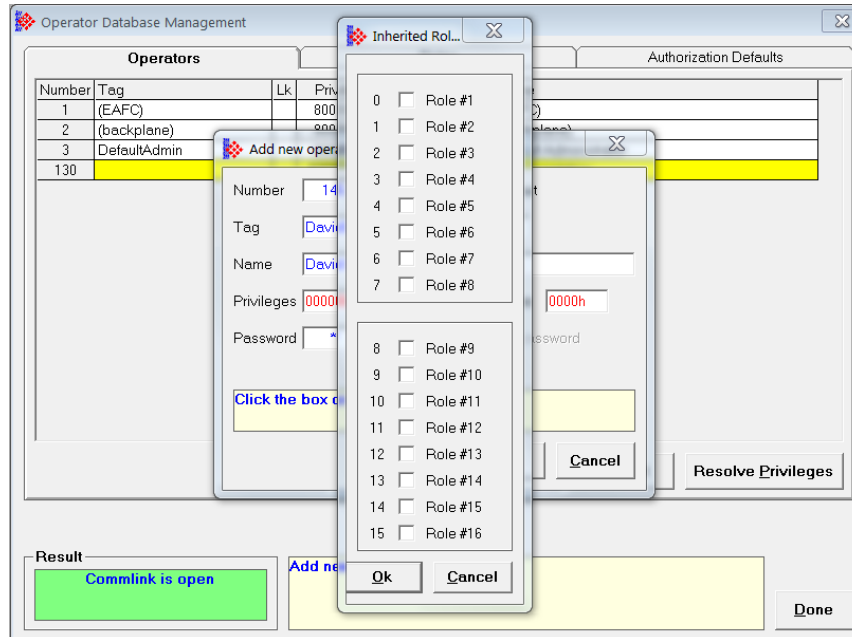


Step	Task	Description
5	Click within the <i>Privileges</i> field to open the <i>Privileges</i> dialog box.	
6	Select the privileges that you want to assign to this operator.	<p>In this example, we'll assign the Meter Proving privilege to this operator.</p>
7	Click OK to close the <i>Privileges</i> dialog.	
8	Add any inherited roles to the operator.	See <i>Adding Inherited Roles</i> below.
9	Add password	This is a password supplied by an administrator that logs in an operator under his or her ID. It is any number between 0 and 65535. Value 0 should be avoided except in exceptional cases.
	Update password	If the password is changed, check this box to write the updated password to the database.
10	Click OK .	This saves the Operator record.

Adding inherited roles

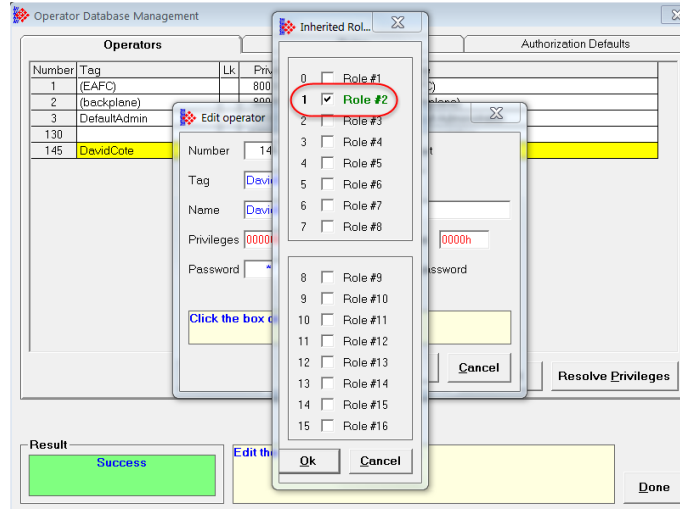


- 1 Click within the *Inherited Roles* field to open the *Inherited Roles* dialog box.



This dialog lists roles (containing associated privileges) that may be assigned to an operator. For example, Role #2 contains troubleshooting privileges. If you select this role, all privileges associated with this role are assigned to this operator.

Note: Privileges assigned to different roles are defined using the **Roles** tab functionality. For information on defining roles, see page 24.

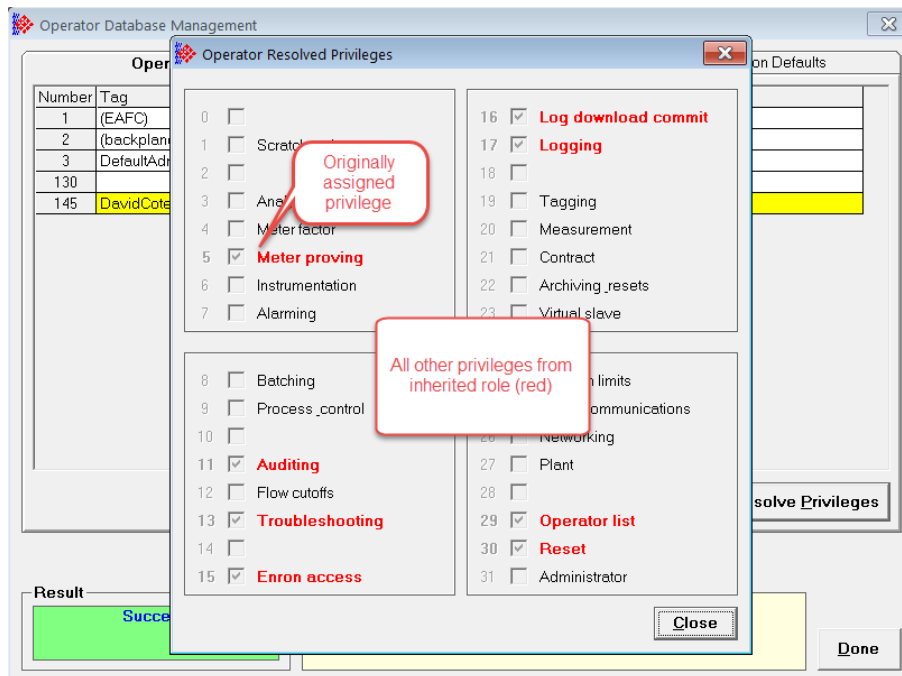


2 Select the inherited role and click **OK**.

Once complete, the operator has the privileges originally assigned, but also has any privileges connected to the selected role.

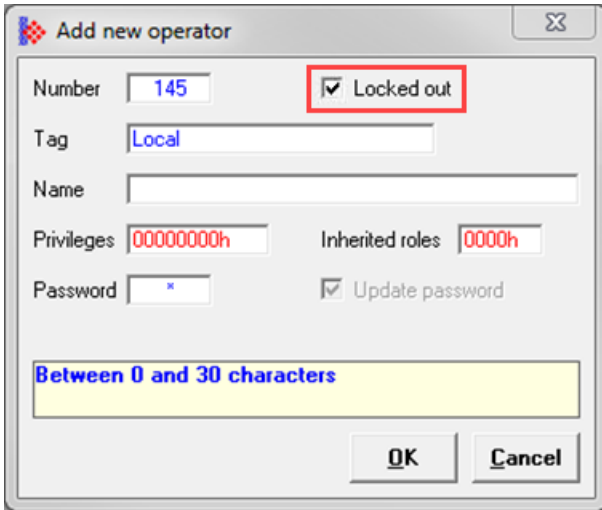
The following shows an example of the originally assigned privilege (meter proving), along with the other privileges that are a part of Role #2. You can view all current operator privileges by:

- Clicking on the *Privileges* field
- Clicking on the **RESOLVE PRIVILEGES** button.



Locking out an Operator

To lock out an operator, select the **LOCKED OUT** check box when adding or editing the operator.



Editing an Operator



From the Operator Database Management page....

- 1 Click the *Operator* tab.
- 2 Highlight the operator's record.
- 3 Click the **EDIT** button.
- 4 Make the appropriate changes or updates.
- 5 Click **OK** when done.

Deleting an Operator



From the Operator Database Management page....

- 1 Click on the *Operator* tab.
- 2 Highlight the operator's record.
- 3 Click the **DELETE** button.
- 4 Click **YES** at the confirmation prompt.

Generating an Operator Report

- 1 From within the Operator Database Management page...
- 2 Click on the **OPERATOR** tab.
- 3 Click on the **REPORT** button.
- 4 Name your file and specify a directory.
- 5 Click **OK**.

2.2 Roles Tab



Operator Database Management

Operators | **Roles** | Authorization Defaults

Number	Tag	Lk	Privileges	Roles	Name
80	Role #1		00000000h	0000h	
81	Role #2		00000000h	0000h	
82	Role #3		00000000h	0000h	
83	Role #4		00000000h	0000h	
84	Role #5		00000000h	0000h	
85	Role #6		00000000h	0000h	
86	Role #7		00000000h	0000h	
87	Role #8		00000000h	0000h	
88	Role #9		00000000h	0000h	
89	Role #10		00000000h	0000h	
90	Role #11		00000000h	0000h	
91	Role #12		00000000h	0000h	
92	Role #13		00000000h	0000h	
93	Role #14		00000000h	0000h	
94	Role #15		00000000h	0000h	
95	Role #16		00000000h	0000h	

Edit Resolve Privileges

Result: Success Select region of operator database for editing. Done

The *Roles* tab allows you to specify different role types. Roles provide a means of encapsulating groups of privileges. For example, perhaps you want to assign a role to an operator that deals with logging data. This operator might have a role of Full Log Retrieval. The *Full Log Retrieval* role may contain the following privileges: *Enron access*, *Log download commit*, *logging*, and *operator list*.

Parameter	Description
Number	Indicates the number of the role.
Tag	Specifies the role tag.
Lk	Specifies if this role is locked out. If Locked out is selected, privileges within this role are not inherited.
Privileges	Indicates privileges encompassed in the role.
Role	Specifies inherited roles.
Name	Specifies the name of the role.

2.2.1 About Inherited roles

Inherited roles contain additional privileges assigned to an operator. For example, when an administrator sets up an operator, they are assigned privileges which are assigned to roles.

Each role is defined by the privileges the role contains. If an operator’s basic role is logging, the privileges associated with logging are shown in the operator’s record. The administrator has the option of assigning additional inherited roles which he or she chooses to assign to the operator. All privileges that are part of these roles are now operator privileges.

2.2.2 About Resolving Privileges

The *Operators* tab contains a button labeled **RESOLVE PRIVILEGES**. When an operator is selected and this button is clicked, all privileges (including inherited role privileges) are shown as selected.

2.2.3 Adding a Role

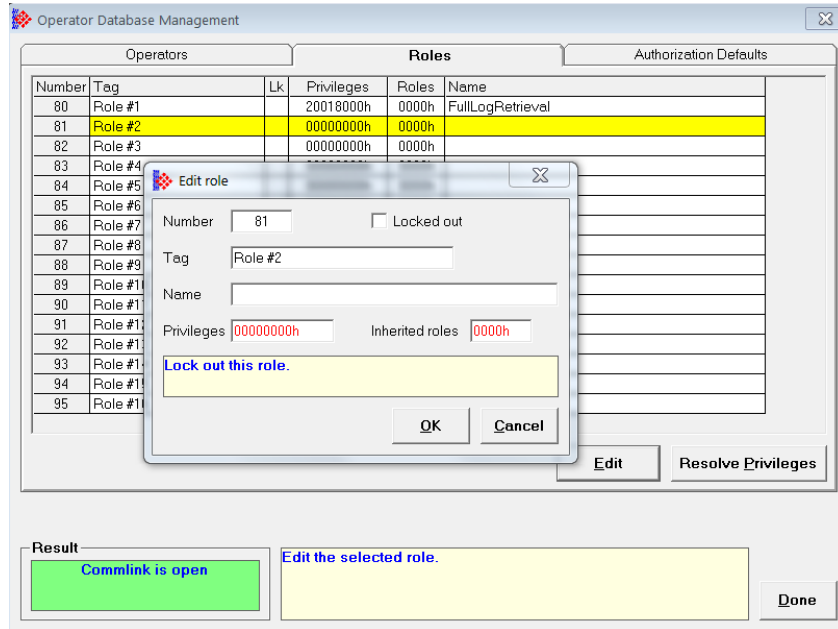


- 1 From within the *Operator Database Management* page, click on the **Roles** tab.

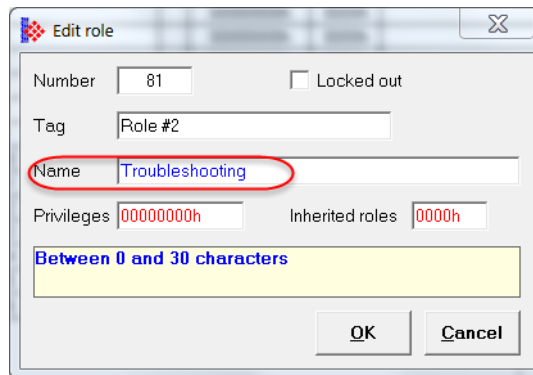
The screenshot shows the 'Operator Database Management' window with the 'Roles' tab selected. The window contains a table with columns for Number, Tag, Lk, Privileges, Roles, and Name. Row 81, 'Role #2', is highlighted in yellow. Below the table are 'Edit' and 'Resolve Privileges' buttons. At the bottom, a 'Result' box shows 'Commlink is open' and a text area contains 'Edit the selected role.' with a 'Done' button.

Number	Tag	Lk	Privileges	Roles	Name
80	Role #1		20018000h	0000h	FullLogRetrieval
81	Role #2		00000000h	0000h	
82	Role #3		00000000h	0000h	
83	Role #4		00000000h	0000h	
84	Role #5		00000000h	0000h	
85	Role #6		00000000h	0000h	
86	Role #7		00000000h	0000h	
87	Role #8		00000000h	0000h	
88	Role #9		00000000h	0000h	
89	Role #10		00000000h	0000h	
90	Role #11		00000000h	0000h	
91	Role #12		00000000h	0000h	
92	Role #13		00000000h	0000h	
93	Role #14		00000000h	0000h	
94	Role #15		00000000h	0000h	
95	Role #16		00000000h	0000h	

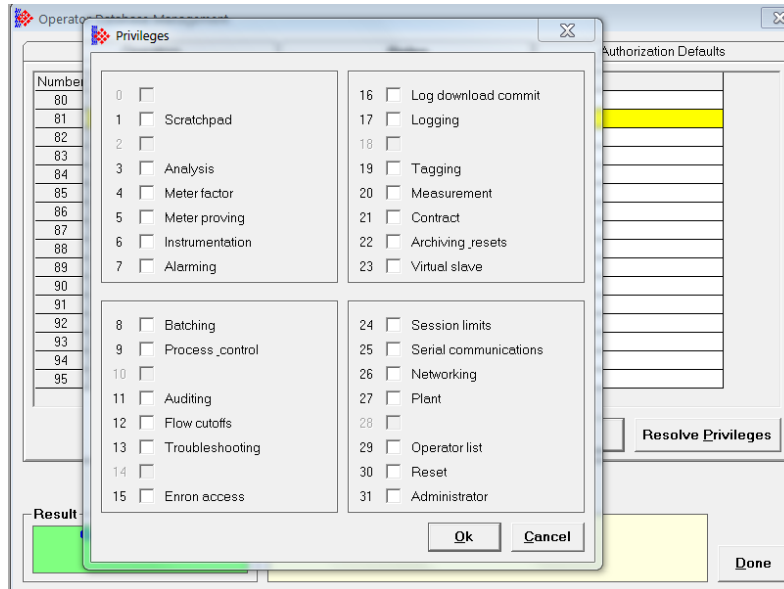
- Highlight an available role number and click the **EDIT** button. The *Edit Role* dialog opens.



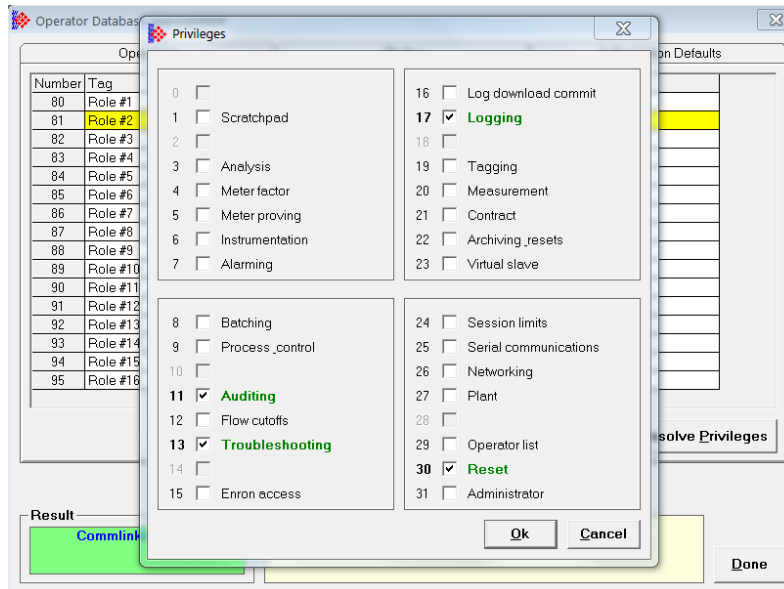
- Enter a *Name* for this role.



- Click inside the **PRIVILEGES** field to open the *Privileges* dialog.



- Select the privileges that are to be associated with this role by clicking each associated box. For example, privileges within this role might include troubleshooting, auditing, reset, or logging.



- Click **OK**.
- At the *Edit role* dialog, click **OK** again. The selected privileges are now associated with this role.

Privilege Definitions



Each privilege listed in the *Privileges* dialog provides access to a number of configuration points. For example, an operator must have the *Alarming* privilege in order to change values of the *alarm threshold hi*, *alarm threshold lo*, *enable alarm threshold lo*, and *enable alarm threshold lo* configuration points. The following table lists the available privileges and associated configuration points:

Privilege	Configuration points
Password not required	<ul style="list-style-type: none"> ▪ Session access attributes (for logging in) ▪ Open archive record select ▪ Operator Database (for changing your own password)
Scratch Pad	<ul style="list-style-type: none"> ▪ Scratch Pad
Analysis	<ul style="list-style-type: none"> ▪ Molar Fraction Analysis
Meter Factor	<ul style="list-style-type: none"> ▪ Meter/K Factor Curve
Meter Proving	<ul style="list-style-type: none"> ▪ Meter Number Requested ▪ Requested Interpolation point ▪ Auto-accept prove ▪ Auto-continue run ▪ Apply MF change to all streams ▪ Apply MF change to full curve ▪ Apply new meter factor ▪ Enable prove ▪ Accept prove ▪ Reject prove ▪ Run start ▪ Run complete ▪ Run cancel ▪ Run delete ▪ Pass complete ▪ Pause prove ▪ Select runs ▪ Abort prove
Instrumentation	<ul style="list-style-type: none"> ▪ Process input calibration mode ▪ Static pressure absolute ▪ Transmitter range, lo ▪ Transmitter range, hi ▪ Operating range, lo ▪ Operating range, hi ▪ MVT transmitter linkage ▪ Orifice plate measured temp ▪ Orifice plate measured diameter ▪ Orifice plate temp expansion coefficient ▪ Transmitter calibration
Alarming	<ul style="list-style-type: none"> ▪ Sample period limit ▪ Alarming: require manual acknowledge ▪ Alarming: disallow pre-acknowledge ▪ Alarming: acknowledge action sealable ▪ Alarming: acknowledge to resume normal operation ▪ Disable pulse-count sample rate alarm ▪ Alarm threshold, lo ▪ Alarm threshold, hi ▪ Enable alarm threshold, lo ▪ Enable alarm threshold, hi

Privilege	Configuration points
	<ul style="list-style-type: none"> ▪ Disable sample rate alarm
Batching	<ul style="list-style-type: none"> ▪ Reset resettable accumulators ▪ Post archives
Process & Control	<ul style="list-style-type: none"> ▪ Active stream select ▪ Analysis is process input ▪ Density input is densitometer frequency ▪ Calibration mediated by PLC ▪ Backplane return select, process input ▪ Backplane return select, analysis ▪ Max total runs before abort ▪ Max seconds per run
Auditing	<ul style="list-style-type: none"> ▪ Measurement configuration changed ▪ Audit meter number, requested ▪ Audit scan-down counter
Flow Cutoffs	<ul style="list-style-type: none"> ▪ Low pulse flow threshold ▪ Primary input flow threshold
Troubleshooting	<ul style="list-style-type: none"> ▪ Clear all checksum alarms ▪ Checksum alarms, site and prover ▪ Acknowledge meter alarms ▪ Acknowledge process input alarms ▪ Checksum alarms, stream
Enron access	<ul style="list-style-type: none"> ▪ Enron log file download, acknowledge, requires also "log download" privilege (next) ▪ Enron log file download, acknowledge ▪ Enron access
Log download	<ul style="list-style-type: none"> ▪ Enron log file download, acknowledge (acknowledge requires also "log download" privilege (next) ▪ Alarm log download ▪ Event log download
Logging	<ul style="list-style-type: none"> ▪ Event log lockable ▪ Flow average floats (user-specified) ▪ Arbitrary event-logged items
Tagging	<ul style="list-style-type: none"> ▪ Site name ▪ Project name ▪ Meter tag ▪ Prover tag
Measurement	<ul style="list-style-type: none"> ▪ Barometric pressure, US ▪ Barometric pressure ▪ US Units (else SI) ▪ Liquid density select ▪ Product group ▪ Units configuration ▪ Ignore default flowing density ▪ Density correction ▪ Hydrometer correction ▪ Temperature correction ▪ Pressure correction ▪ Vapor pressure (TP-15) ▪ Density correction for pressure ▪ Indicated volume (else gross) ▪ Strict MPMS 11.2M ▪ Net energy ▪ Resettable accumulator select ▪ Normalization total error tolerance ▪ Map of selected components ▪ Accumulator rollovers

Privilege	Configuration points
	<ul style="list-style-type: none"> ▪ Master pulse count rollover ▪ Reference conditions ▪ Physical device (algorithm changes within the same hardware) ▪ Meter factor full precision ▪ Interpolate K-factor ▪ Default relative density (gas) ▪ Viscosity ▪ Isentropic exponent ▪ Default Fpv ▪ K/meter factor ▪ Default energy content ▪ Default reference density (liquid) ▪ Default vapor pressure ▪ Water salinity ▪ Default CTL ▪ Default CPL ▪ Shrinkage factor ▪ Pre-calculated alpha ▪ Measurement system, Density units ▪ Average meter factor method ▪ Mass proving ▪ Full-precision calculations ▪ Runs per prove ▪ Passes per run ▪ Min pulses per run * 1000 ▪ Prover reference conditions ▪ Meter factor precision ▪ Variation limits ▪ MASC EOS table entries
Contract	<ul style="list-style-type: none"> ▪ End-of-period settings
Archiving and Resets	<ul style="list-style-type: none"> ▪ Resettable accumulator options ▪ Archive configuration
Virtual Slave	<ul style="list-style-type: none"> ▪ Pass-thru ▪ Virtual slave location ▪ Virtual slave mapping
Session Limits	<ul style="list-style-type: none"> ▪ Session timeout
Serial Communications	<ul style="list-style-type: none"> ▪ Modbus slave address, primary ▪ Modbus slave address, virtual ▪ Serial port descriptors
Networking	<ul style="list-style-type: none"> ▪ Network configuration
Plant	<ul style="list-style-type: none"> ▪ Linear meter (else differential) ▪ Flow rate integration (else standard) ▪ Downstream static pressure ▪ Taps ▪ Meter enable ▪ Densitometer configuration ▪ Pulse input rollover ▪ Physical device ▪ Meter tube measurement temperature ▪ Meter tube measured diameter ▪ Meter tube temp expansion coefficient ▪ V-Cone/Wedge discharge coefficient ▪ Device identification ▪ Nominal K-factor ▪ Stream enable ▪ Stream product description ▪ Prover type, Master meter number ▪ Dual transmitters, temperature

Privilege	Configuration points
	<ul style="list-style-type: none"> ▪ Dual transmitters, pressure ▪ Input meter density ▪ Input prover density ▪ Return leg count is round trip ▪ Prover is double-walled ▪ External switch bar ▪ Prover size characteristics ▪ Input format codes ▪ Pulse interpolation ratio ▪ Flow tube linear alpha ▪ Switch bar linear alpha ▪ Calibrated prover volume ▪ Flow tube inside diameter ▪ Flow tube wall thickness ▪ Flow tube modulus of elasticity ▪ Device identification
Operator List	<ul style="list-style-type: none"> ▪ Operator database (list only of some detail only)
Reset	<ul style="list-style-type: none"> ▪ FW product code, group (cold start) ▪ FW product code, item (restore default administrator access)
Administrator	<ul style="list-style-type: none"> ▪ Operator database (full access) ▪ Communications authorization defaults

2.2.4 Editing a Role Privilege



You can change role privileges, including the name of the role.

- 1 Ensure that you are connected to the module.
- 2 Navigate to On-line > Operator Database > Roles tab.
- 3 Click on the role that you want to edit and then click on the **EDIT** button.

Operator Database Management

Number	Tag	Lk	Privileges	Roles	Name
80	Role #1		20018000h	0000h	FullLogRetrieval
81	Role #2		40022800h	0001h	Troubleshooting
82	Role #3		00000000h	0000h	
83	Role #4		00000000h	0000h	
84	Role #5		00000000h	0000h	
85	Role #6		00000000h	0000h	
86	Role #7		00000000h	0000h	
87	Role #8		00000000h	0000h	
88	Role #9		00000000h	0000h	
89	Role #10		00000000h	0000h	
90	Role #11		00000000h	0000h	
91	Role #12		00000000h	0000h	
92	Role #13		00000000h	0000h	
93	Role #14		00000000h	0000h	
94	Role #15		00000000h	0000h	
95	Role #16		00000000h	0000h	

Buttons: Edit, Resolve Privileges

Result: Success

Select (highlight) any row to edit it. Click a bitmap to show details.

Select the role you want to edit and click here.

This opens the *Edit role* dialog.

Edit role

Number: 81 Locked out

Tag: Role #2

Name: Troubleshooting

Privileges: 40022800h Inherited roles: 0001h

Click the box or press any key to edit.

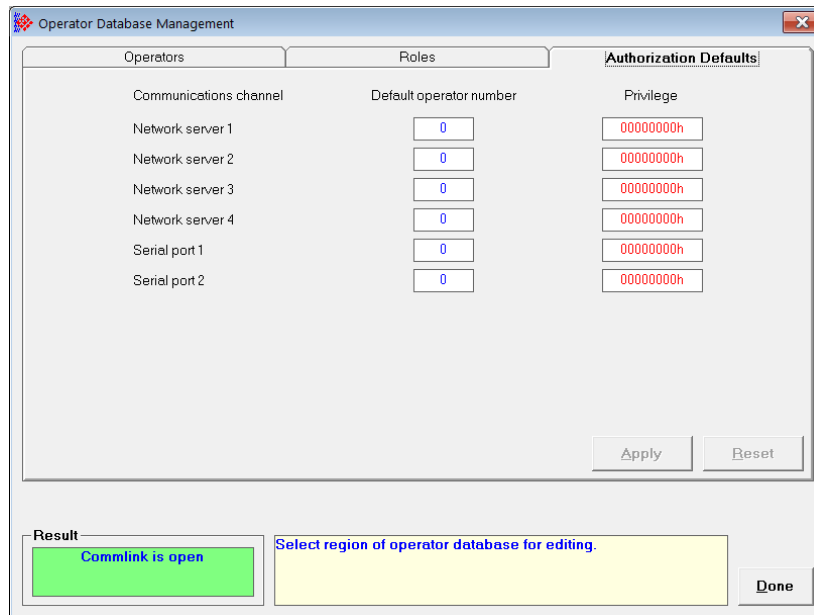
Buttons: OK, Cancel

- 4 Click in the appropriate fields to edit this role.
 - To exclude this role from being inherited, click the **LOCKED OUT** box.
 - To change the name of the role, click within the **NAME** field and make the required change
 - To change privileges associated with this role, click within the **PRIVILEGES** field to display privileges. Select or de-select privileges for this role and click **OK**.
 - To change inherited roles, click within the **INHERITED ROLES** field to display roles that should be inherited. Click **OK** when done.

- 5 When you are finished, click **OK** on the *Edit role* dialog.

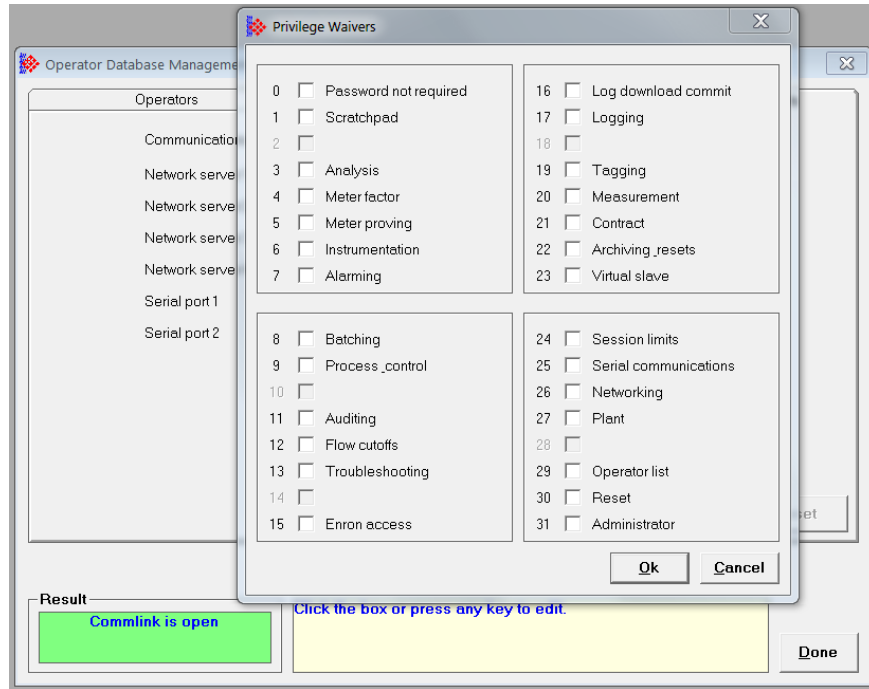
2.3 Authorization Defaults Tab

In order to achieve compatible operation with third-party device communication drivers such as Cygnet and Autosol, communication authorization defaults may be configured individually for each AFC module’s network server and serial port to allow or restrict data access without requiring a login. Authorization defaults allow to you specify default operator numbers and privilege waivers for each communication channel. In addition to selecting the privilege waiver, you should also select **PASSWORD NOT REQUIRED** for this connection.



Parameter	Description
Communications channel	The communications channel to specify a default operator number or privilege waivers.
Default operator number	The operator that is to be logged in automatically upon establishment of a new connection over the communications channel.
Privilege	Privileges specified for this user over the specified communications channel. “No password required” is to be set as for a privilege waiver.

- 1 Click within the **PRIVILEGE WAIVER** field to view Privilege waivers.



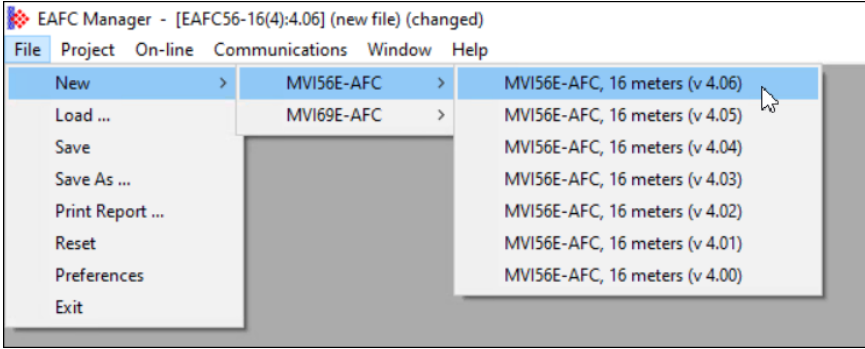
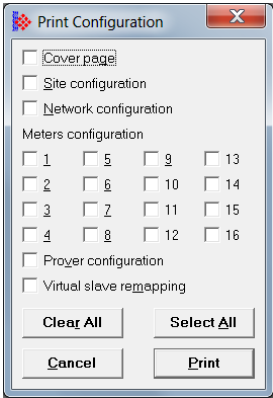
- 2 Select the privileges to be assigned to a user to a specified communications channel.
- 3 Click **OK**.
- 4 Click **DONE** from the main screen.

3 E AFC Manager Menus

This section provides an overview of the E AFC Manager menus.

Note: This guide applies to the MVI56E-AFC and the MVI69E-AFC modules. Configuration between the two modules is generally identical. However, this guide uses examples of configuration using both modules. The information is the same for both modules and differences are called out where applicable.

3.1 File Menu

Menu Item	Description
New	Creates a new project.
	
Load	Allows you to select an existing project for loading in order to edit or use the file.
Save	Saves a project file.
Save As	Names and saves a project file.
Print Report	Allows you to select print components and then print a report. Select the options (info) that you want to print and then click Print .
	
Reset	Resets the configuration file.
Preferences	Launches the Preferences page for editing.
Exit	Exits the <i>File</i> menu.

3.2 Project Menu

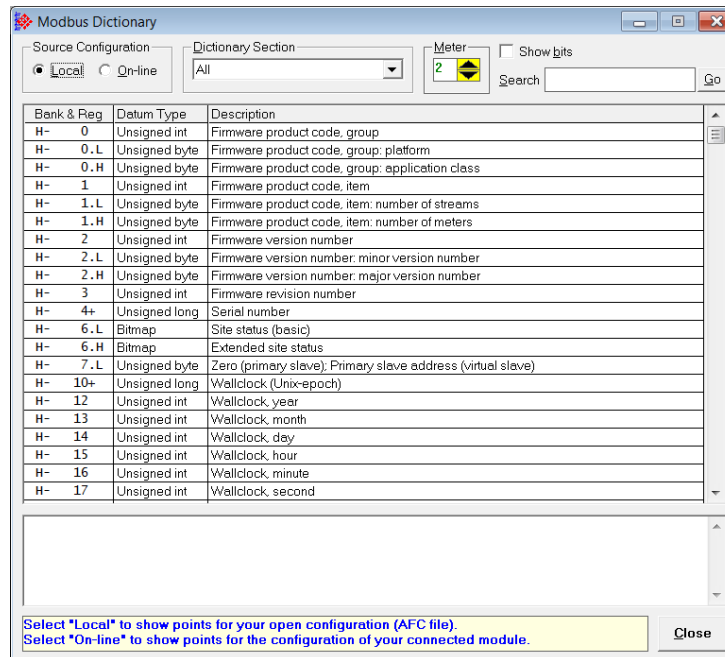
See the following table for descriptions of each menu item.

Menu Item	Description
Site Configuration	Launches the <i>Site Configuration</i> page for editing. See Configuring Site Parameters in the <i>MVI56E-AFC Setup & Configuration Guide</i> .
Meter Configuration	Launches the <i>Meter Configuration</i> page for editing. See Configuring Meter Parameters in the <i>MVI56E-AFC Setup & Configuration Guide</i> .
Prover Configuration	Launches the <i>Prover Configuration</i> page for editing. See page 90 in this manual for more details.
Download project	Allows you to download the current project.
Upload project	Allows you to upload an existing project. You can later use the project to load to your current module.
Change Module Type	Allows you to change the type of module. For example, use a different firmware version. You must close all windows of the current project before using this option.

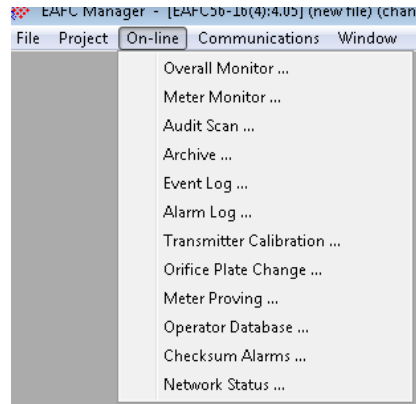
Modbus Dictionary

Opens the Modbus Dictionary.

Important: Although this manual is continuously maintained to bring you the latest information, the Modbus Dictionary contains the latest information on registers and dictionary sections. It is recommended that you use the Modbus Dictionary to locate bank and register values to ensure that you are looking at the latest information.

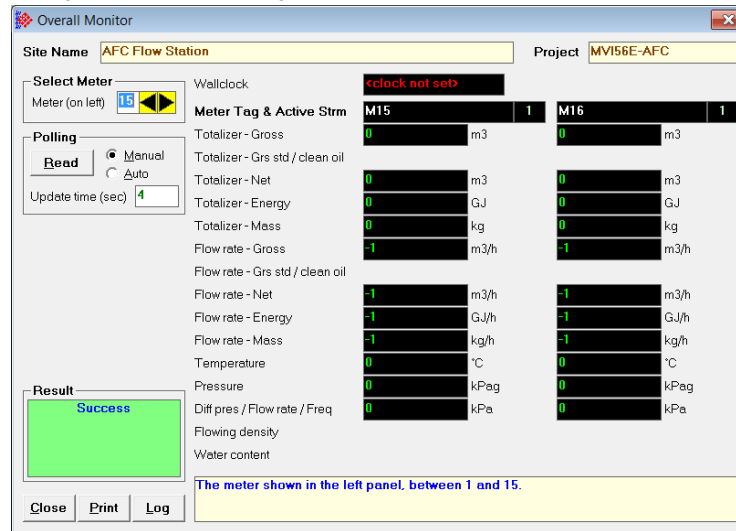


3.3 On-Line Menu

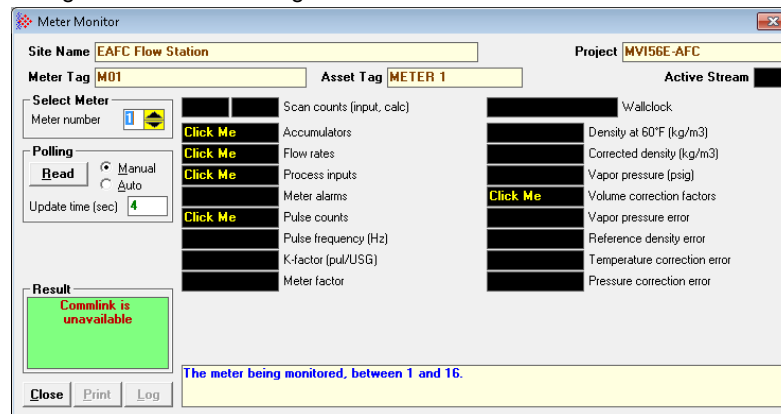


Menu Item	Description
-----------	-------------

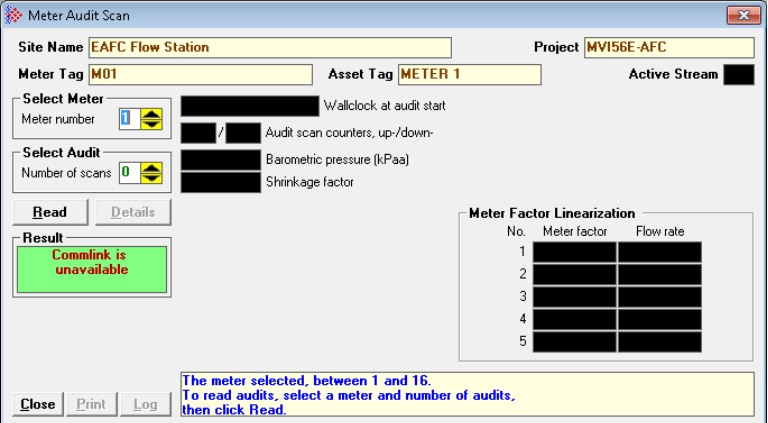
Overall Monitor	Displays the <i>Overall Monitor</i> page which provides you with overall monitor status and configuration. You can log and print this information.
-----------------	--



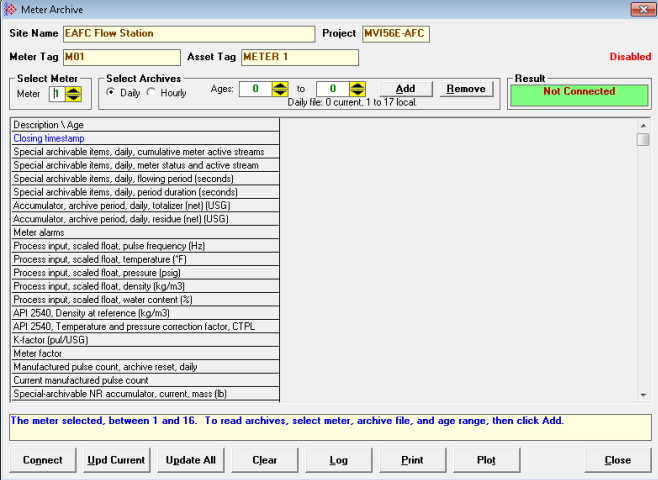
Meter Monitor	Displays the <i>Meter Monitor</i> page. This page allows you to select a meter and read configuration data as configured.
---------------	---



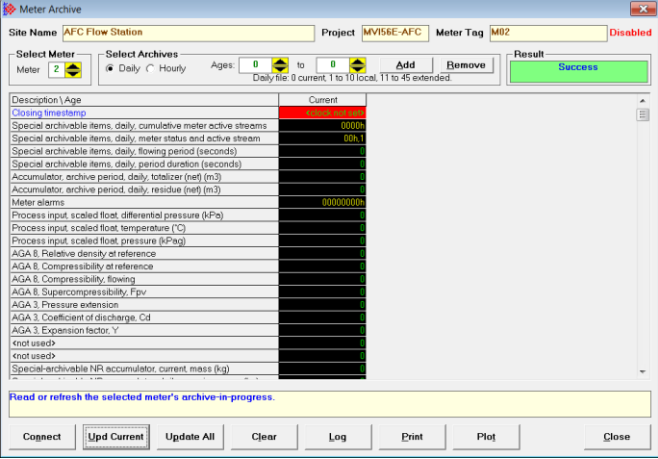
See page 115 for details.

Menu Item	Description
Audit Scan	

Meter Archive Opens the *Meter Archive* page. Select a meter, archive file, and age range. Click **Add**. See page 218 for details.



You can select an archive and click the **Upd Current** button to update the currently selected archive or click **Update All** to update all archives.



Event Log Click to display the event log.

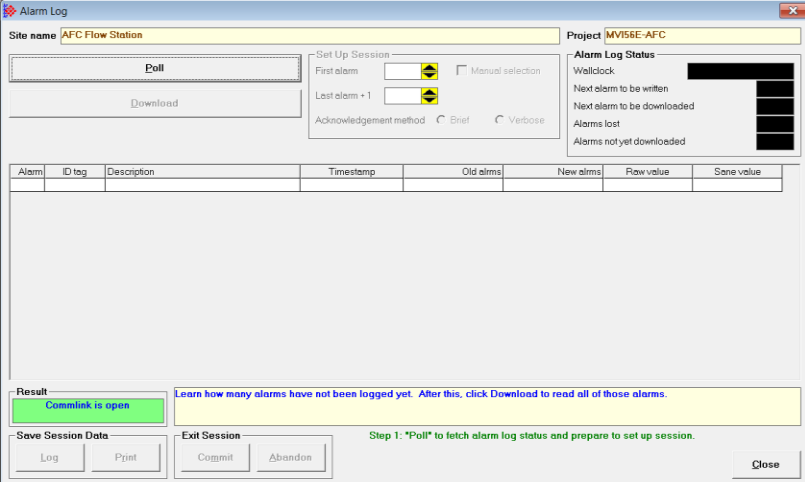
Menu Item	Description

Click **Poll**, then click **Download** to view events.

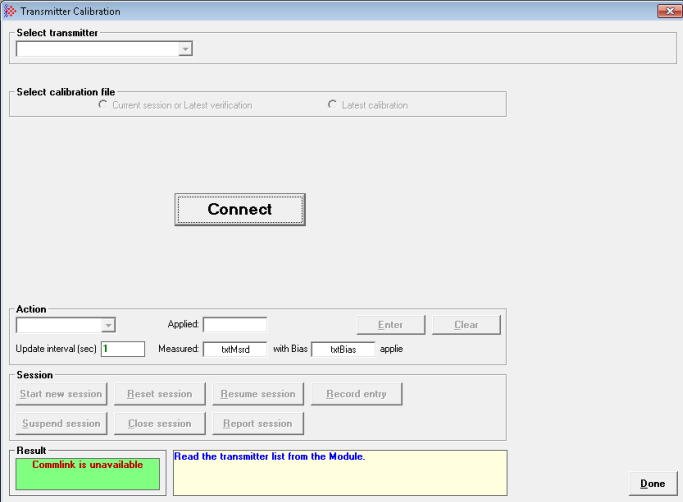
Event	ID tag	Description	Timestamp	Old value	New value	OpriD
0	00000001h	Firmware version change	<clock not set>	0.00.000	4.02.000	1
1	10000002h	Power-up	<clock not set>	<clock not set>		1
2	10000002h	Power-up	<clock not set>	<clock not set>		1

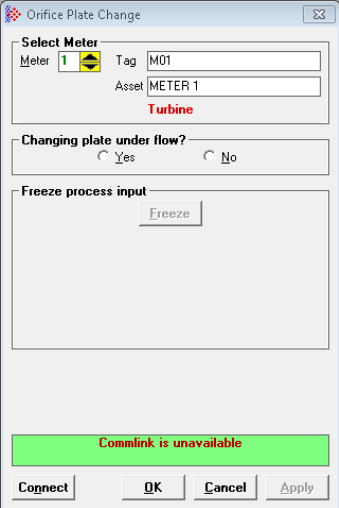
Click **Log** to log the file then click the **Commit** button. Then click **Print**. See page 48 for more details.

Alarm Log	Click to display the alarm log.
-----------	---------------------------------

Menu Item	Description
	

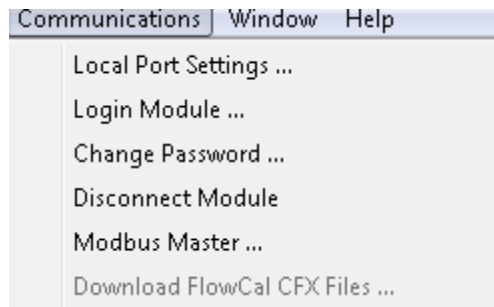
Click **Poll** and then click **Download** to view the alarm log.
 Click **Log** to save the file and then click **Commit**. See page 73 for more details.

Transmitter Calibration	<p>Click to view the transmitter calibration page. See page 77 in this manual for more details.</p> 
-------------------------	---

Orifice Plate Change	<p>Click to perform Orifice plate change.</p> 
----------------------	---

Menu Item	Description
Meter Proving	Click to view the Meter Proving page. See page 95 in this manual for more details.
Operator Database	Click to view the <i>Operator Database Management</i> page. See page 13 in this manual for more details.
Checksum Alarms	Click to view <i>Checksum Alarms</i> page. See page 123 in this manual for more details.
Network Status	Click to view the <i>Network Status</i> page. See <i>Network Status</i> in this manual for more details.

3.4 Communications Menu



These options allow you to make port settings, login, change passwords, and disconnect the module. Additionally, the *Modbus Master* option allows you to view holding register locations and if EAFC Export Utility is installed, the download FlowCal CFX files option will be available to launch the EAFC Export Utility software from within EAFC Manager..

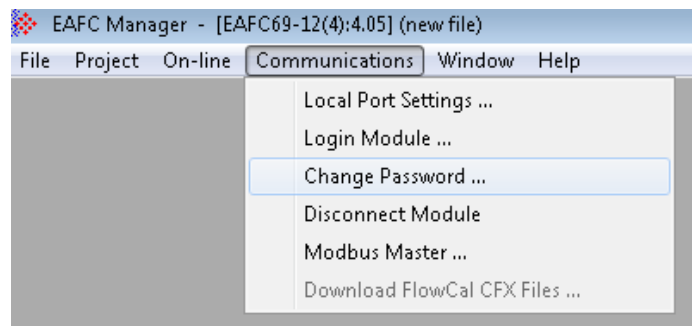
4 Changing Passwords



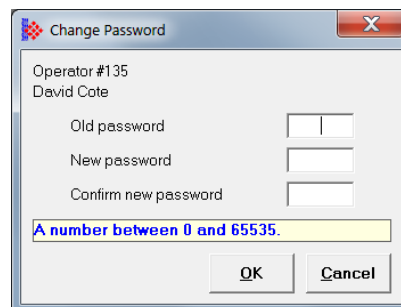
The administrator assigns an operator number and passwords during initial setup and configuration. However, you can change your operator password at any time. You must be logged in as an operator in order to change it.

To change your password, you must be logged in to perform the following steps:

- 1 Navigate to **COMMUNICATIONS > CHANGE PASSWORD**.



The *Change Password* dialog opens.



- 2 Enter the Old password.
- 3 Enter the New password.
- 4 Confirm the new password.
- 5 Click **OK**. The system displays a password changed message.
- 6 Click **OK** when complete.

Notes:

- An operator cannot change his or her password to zero “0”.
- If an operator is logged in as the “default operator” for the communication channel, the password cannot be changed.
- An operator is logged in as “default” only if he or she has not explicitly logged in as some operator. Explicitly logging in as an operator whose number happens to be the default is not considered a “default” login.

5 Viewing Site Status Information



Site configuration status information is located on the right-hand side of the *Site Configuration* page. This information allows you to view:

- Module serial number
- Firmware version
- Module configuration changes
- PLC status
- Site status
- Active special-window sessions
 - Event log download sessions
 - Alarm log download sessions
 - Operator database sessions
 - Transmitter calibration sessions
 - Enron access
 - MASC EOS table entries

Site Configuration

Site name: EAFC Flow Station

Project name: MVI56E-AFC

244 Primary Modbus slave address

0 Virtual Modbus slave address

0 : 0 End-of-day hour

0 End-of-hour minute

101.325 Barometric pressure (kPaa)

0000h Site options

0 Pass-thru: Max PLC window size

0 Pass-thru: Word region size

0 Pass-thru: Word region address

0 Pass-thru: Bit region size

0 Pass-thru: Bit region address

UDT tag prefix

Serial number: 00000000

Firmware version/revision number: 4.06.000

Configuration changed: <none> Ack Chg

PLC status: 0

Site status: 0000h

Active special-window sessions: <none>

Network Serial 1 Serial 2 Remapping

Poll Read Write Special wnd

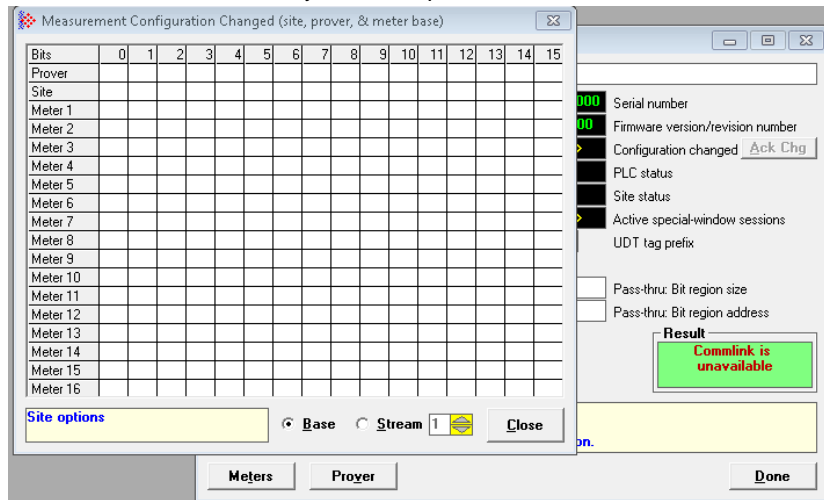
Result: Commlink is unavailable

Between 1 and 60 characters.

Meters Proyer Done

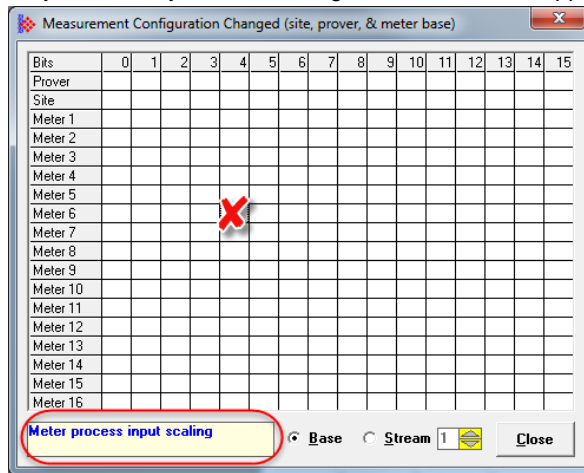
Parameter	Description
Serial number	Displays the serial number of the AFC module.
Firmware version/revision number	Displays the firmware version of the AFC module.
Configuration changed & Ack Chg button	Indicates that changes have been made to the measurement configuration. If no changes were made since the last acknowledgement, this field indicates <none>. If a code exists, click within the field to view changes.

Note: The MVI69E-AFC only handles up to 12 meters.



Changes are represented by an “X” in a box which indicates the change. For example, if box 4 is checked on the Meter 6 row, this indicates that the *Meter Process Input Ranges* configuration was changed for meter #6.

As you click any box, the configuration item name appears at the bottom.

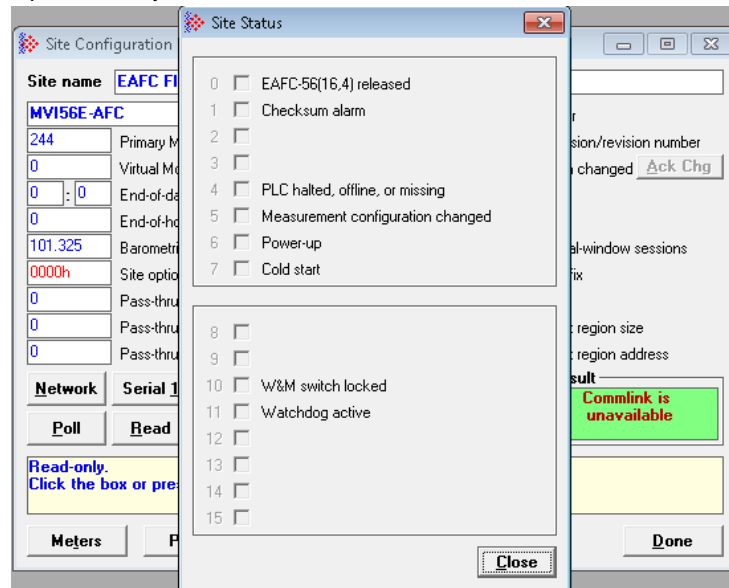


You can also select *Stream* and select a specific stream to view changes. Use the **Ack Chg** button to acknowledge the changes. The grid is cleared when this button is pressed.

PLC Status	This field displays the current status of the PLC. 0 = PLC online 1 = PLC offline
------------	---

Site Status

Opens when you click on the *Site Status* label.

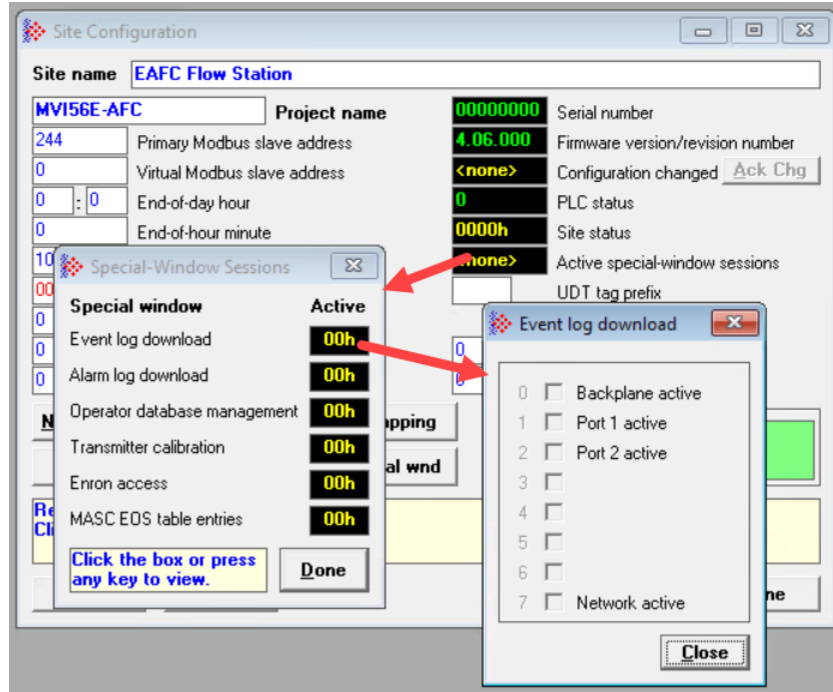


The *Site Status* dialog box provides information about the module status.

Indicator	Description
E AFC-56(16,4) 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 non-volatile 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 <i>Checksum Alarms</i> to verify the source of the alarm, and then clear it. The alarm bit remains latched, even though 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.

Parameter	Description
Measurement configuration changed	Set when any bit in the measurement configuration registers is set.
Power-up	Set upon power-up, and cleared when the wallclock has been set.
Cold start	<p>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 though subsequent power cycles, until at least one meter is enabled at which time the bit is cleared.</p> <p>The cold start status is easily identified when both NVRam-board LEDs (OK and ERR) are illuminated.</p>
W&M switch locked	Indicates whether the Weights & Measures Lock Switch is locked or unlocked. Configuring changes to the flow computer module are prevented by sliding the W&M Lock switch to the Locked position.
Watchdog active	If set, then the application of the module's firmware has resumed responsibly for regularly scratching the hardware watchdog. If the dog is not tickled frequently enough it will bark, startling the machine into resetting and rebooting. While online to the module, this bit should always be set.

Parameter	Description
Active special-window sessions	<p>This field contains session information for:</p> <ul style="list-style-type: none"> ▪ Event log download ▪ Alarm log download ▪ Operator database ▪ Transmitter calibration ▪ Enron access ▪ MASC database management <p>Click in the <i>Active special-window sessions</i> field to display the <i>Special-window Sessions</i> dialog.</p> <p>To view information on each session, click inside the appropriate field.</p>



6 Viewing Events



6.1 Event Log

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

- 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-logging system is comprised of three components:

- **The Event Log** – This area of non-volatile memory is used for storage of the AFC modules event history. Its contents are maintained by the AFC module. It is structured as an array of 2000 20-byte event records (40000 bytes). It is not Modbus-mapped, therefore, it cannot be directly accessed from outside of the AFC module.
- **The Event Log Header** – This block of non-volatile memory holds housekeeping information used for management and maintenance of the event log. Its contents are maintained by the AFC module. It is structured as an array of 10 Modbus input registers, so it is readable from outside the AFC module.
- **The Event Log Download Window and Access Protocol** – A client application retrieves logged events by using a specified communication protocol that addresses the Event Log Download window located at Modbus holding register Ph65400. As holding registers, this window is both readable and writable via Modbus, but the protocol strictly limits the addresses, size, contents, and sequencing of Modbus packets that access the window.

Events are recorded in the log as they occur. This log acts as a circular file. Each new event record overwrites the oldest one, hence the log stores up to 2000 of the most recent events. As each record is logged, the values in the header are updated to reflect the new status of the log.

Auditors may require that the log be downloaded from time to time. During download, events are read from the module and stored in a more permanent database. The events are copied and archived and are then marked in the module as "downloaded". If all positions contain events that have not yet been downloaded, the log is full.

6.2 Event Log Structures

The Event Log header contains status information for maintaining the Log:

Address	Description
Pi28800	Number of records maximum (2000)
Pi28801	Next new record position (0 thru maximum -1)
Pi28802	Next new event number (0 thru 65535, wrapping to 0)
Pi28803	Oldest event number on file
Pi28804	Oldest event number on file not yet downloaded
Pi28805	Number of lost events
Pi28806 to Pi28809	[Reserved]

Each event record is an 10-word quantity laid out as five 32-bit items (big-endian):

Registers	Contents
0 to 1	Event Id Tag (page 49)
2 to 3	Timestamp of event Seconds since the Unix epoch of 1970-01-01.00:00:00 UTC. The strict ISO form of this value is "1970-01-01T00:00:00Z", but our representation is a little easier to read. This is called Unix style.
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.
8 to 9	Additional information High-order word (word 8) Modbus address of relevant point Low-order word (word 9): ID of the operator causing the event to be logged.

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

6.3 Event ID Tag

This 32-bit field has the following structure:

Bits	N	Meaning
31 to 29	3	Event Class 0 = Special 1 = Site Datum Point 2 = Meter Datum Point 3 = Stream Datum Point 4 = Prover Datum Point 5 = [reserved] 6 = [reserved] 7 = Transmitter Calibration For event Class 0, Special, bits 15 to 00 contain a value from the Special Event tag list below. For event class 7, Transmitter Calibration, bits 22 – 00 have the interpretation given below. For other event classes and bit ranges, all bits have the interpretation given here.
28	1	PLC offline This bit may be set for any event class.

Bits	N	Meaning																																																			
27 to 23	5	<p>1 = based meter number (1 to 16)</p> <p>This field contains the meter number for these event classes: 2 = Meter Datum Point 3 = Stream Datum Point 7 = Transmitter Calibration (meter transmitters)</p> <p>This field is always 0 for these event classes: 1 = Site Datum Point = Prover Datum Point 7 = Transmitter Calibration</p> <p>This field may also be set for event Class 0, Special. See details below.</p>																																																			
22 to 16	7	<p>1 = based Stream number, per meter (1 to 16) or global (1 to 64).</p> <p>This field contains the per meter stream number for these Event Classes: 3 = Stream Datum Point</p> <p>This field is always 0 for these Event Classes: 1 = Site Datum Point 2 = Meter Datum Point 4 = Prover Datum Point</p> <p>This field may also be set for Even Class 0, Special. See details below.</p>																																																			
15 to 12	4	<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>B466</td><td>Bitfield 4/6/6</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	B466	Bitfield 4/6/6	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	B466	Bitfield 4/6/6																																																			
15	Flot	Floating point																																																			
11 to 8	4	<p>Group code</p> <p>This value is one of the "measurement configuration changed" bit numbers.</p>																																																			
7 to 4	4	<p>Subgroup code</p> <p>This value is the ordinal number (starting at 0) of the subgroup of parameters in the specified group.</p>																																																			

Bits	N	Meaning
3 to 0	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. Note: Some subgroups have item counts greater than 16, causing the item code to overflow into the subgroup code. In such cases, the affected group contains only a single subgroup (numbered 0). These cases include: <ul style="list-style-type: none"> ▪ Stream group 3, Analysis mole fraction ▪ Prover group 7, Prover variation limits

6.4 Event-triggered Archives and Accumulator Resets



Each archive file (two for each meter) contains an Archive Options bitmap, and each meter contains a Resettable Accumulator Options bitmap, whose configurations specify the action 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 resets are scheduled only for enabled meters. 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 or in quick succession. 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 module 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.

6.5 Period End Events



A period end event is detected by the wallclock. There are two such for each enabled meter”

End of Hour - Occurs when the minute of the hour steps into the *End of Hour* Minute of Meter Configuration if that point is enabled in the meter’s *Control Options*, or of Site Configuration otherwise.

End of Day - Occurs when the minute of the day steps into the *End of Day* minute of Meter Configuration if that point is enabled in the meter’s *Control Options*, or of Site Configuration otherwise.

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 minutes.

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).

6.6 Loggable Events



The tables below provide full details of all events that are recorded in the Event Log. For the Special Events (page 53):

Parameter	Description
Tag	Numeric value that identifies the event
Pr	Event priority: "Hi" or "lo"
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 55, page 59) events:

Parameter	Description
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.

For the Transmitter Calibration events, the columns are:

Parameter	Description
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.

Parameter	Description
-	This event has no effect on archives and resets.
*	<p>Upon this event archives and resets are scheduled according to the configured "event" Archive and Reset Options, provided that the applicable meter(s) is(are) enabled. Applicable meters depend upon the event class:</p> <p>(a) Special (non-meter-specific) and Site Datum Point events: All meters.</p> <p>(b) Meter Datum Point events (including meter-specific specials): The addressed meter.</p> <p>(c) Stream Datum Point events: The addressed meter, provided that the addressed stream is active.</p> <p>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.</p>
(n)	Upon this event archives and resets are scheduled as for "*", modified by the conditions and actions given in "Note (n)" in "Rkv" Notes (page 64).

6.7 Event Class 0: Special Events



Tag	Pr	Rkv	Description
0	--	-	<p>Never Used Value: Always 0.</p> <p>Notes: This entry in the Event Log has never been written. The number of such entries starts at 2000 upon cold start and decreases as events are written until none remain, after which oldest events are overwritten with new ones.</p>
1	Hi	-	<p>Firmware version change Value: Firmware version hex-coded as "MMmmRRRR"; for example version 4.01.022 is hex 04010016.</p> <p>Notes: Triggered when the firmware on startup detects a non-volatile database written by a different version. Either the new major/minor version is greater than the old (an "upgrade"), or the revision number is different (either up or down, a "sidegrade"). If the previous database has a higher major/minor version (a "downgrade") the module is cold-started: the database is erased and initialized with a default configuration. A cold start can also be caused by other conditions, such as a fatally corrupt database. This event is logged upon any change: upgrade, sidegrade, or cold start. The "old" value of this record for a cold-start event is all zero. When triggered, this is the first event logged upon startup. The timestamp of this event is 0 (clock not set).</p>

Tag	Pr	Rkv	Description
2	Hi	(1)	<p>Power-Up</p> <p>Value: "Old" value is the last-saved wallclock from the previous session; "new" value is always 0 (clock not yet set).</p> <p>Notes: The last event written upon restart of the application and before entering the meter scan. This event may be preceded by Firmware Version Change, Checksum Alarm, and/or PLC Mode Change Events. The timestamp of this event and any preceding events is 0 (clock not set).</p>
5	lo	-	<p>Checksum Alarm</p> <p>Value: Checksum alarm word (datum type "Bsht")</p> <p>Notes: Logs changes to the checksum alarm bitmaps. Includes object identification (bits 27 – 16):</p> <p>Site checksum alarm word: Both meter number (bits 27 – 23) and stream number (bits 22 – 16) are 0.</p> <p>Meter checksum alarm word: Meter number (bits 27 – 23) is non-zero and stream number (bits 22 – 16) is 0.</p> <p>Stream checksum alarm word: Meter number (bits 27 – 23) is 0 and stream number (bits 22 – 16) is non-zero; this is the <u>global</u> stream number which is not intrinsically related to any meter.</p> <p>Prover checksum alarms are included in the site alarms.</p> <p>Upon power-up: Written automatically upon power-up when a checksum failure is detected (the checksum is then corrected). In this case, the event is logged even if the bitmap does not change, which can occur when an affected bit is already set from a previous failure that was never cleared.</p> <p>Upon Modbus write to the bitmap: Records changes to the bitmap only; Modbus writes can clear bits only but cannot set them.</p> <p>Upon issuing site signal "clear all checksum alarms": Records changes to the bitmap only.</p>
10	Hi	-	<p>PLC Mode Change</p> <p>Value: PLC mode (0 on line, 1 off line).</p> <p>Notes: Logs changes to PLC connectivity as reported by the backplane procedures. Typically caused by switching the PLC between "run" and "program" modes.</p>
11	Hi	(2)	<p>Wallclock Change</p> <p>Value: Wallclock (Unix style).</p> <p>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>
12	Hi	-	<p>Weights & Measures Lock Switch Change</p> <p>Value: W&M lock switch status 90 unlocked, 1 locked)</p>

Tag	Pr	Rkv	Description
20	Hi	-	<p>Event Log Download</p> <p>Value: Contains two unsigned 16-bit values: a download pointer in the low-order half and a lost-event count in the high-order half. The “Old” value reports the state of the log just before this event is logged and the “new” value reports the state just after. The “old” count reports the number of events that have been permanently lost; the “new” pointer should always be the number of this event, and the new count should normally be 0.</p> <p>Notes: Triggered by a commit of an Event Log Download session which marks older events as available to be overwritten by new ones.</p>
21	Hi	-	<p>Alarm Log Download</p> <p>Value: Contains two unsigned 16-bit values: a download pointer in the low-order half and a lost-alarm count in the high-order half. The “Old” value reports the state of the log just before this alarm is logged and the “new” value reports the state just after. The “old” count reports the number of alarms that have been permanently lost; the “new” pointer should always be the number of this alarm, and the new count should normally be 0.</p> <p>Notes: Triggered by a commit of an Alarm Log Download session.</p>
100	Hi	*	<p>Stream Select</p> <p>Value: Per meter stream number (1-based).</p> <p>Notes: Triggered by a change to the meter’s Modbus database point “Active Stream Select”; normally performed by the PLC via the backplane function block available for this purpose. Includes meter identification (bits 27 – 23).</p>

6.8 Event Class 1: Site Datum Point Events



These events are high-priority. See [Event Priority and a “Locked” Log](#).

Group	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” , 16-bit word (“n” = 0 thru 9)
9	n	0	Ulng	-	Arbitrary event-logged value “n”, 32-bit word (“n” = 0 thru 4)
14					Site end-of-period settings
	0	0	Usht	(4)	end-of-day minute
	1	0	Usht	(4)	end-of-hour minute

6.9 Event Class 2: Meter Datum Point Events



These events are “high-priority”. See section [Event Priority and a “Locked” Log](#)

Group	Sbgp	Item	DTyp	Rkv	Data point
0	0				Process input calibration These events are “high-priority”; see section 0.
		0	Flot	*	Primary Input
		1	Flot	*	Temperature
		2	Flot	*	Pressure
		3	Flot	*	Flowing density
		4	Flot	*	Water content
1	0				Meter classification
		0	Bsht	*	Meter device and engineering units
		1	Usht	*	Product group
2					Meter Reference conditions
	0	0	Flot	*	Temperature
	1	0	Flot	*	Pressure
3					Meter options
	0	0	Blng	*	Calculation options
	1	0	Blng	(5)	Control options
4					Meter Process Input Ranges
	0				Primary Input
		0	Flot	*	Transmitter range low end
		1	Flot	*	Transmitter range high end
		2	Flot	*	Operating Range low end
		3	Flot	*	Operating range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
	1				Temperature
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating range low end
		3	Flot	*	Operating range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
	2				Pressure
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end

Group	Sbgp	Item	DTyp	Rkv	Data point
		2	Flot	*	Operating range low end
		3	Flot	*	Operating range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
	3				Flowing density
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating Range low end
		3	Flot	*	Operating Range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
	4				Water content
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating Range low end
		3	Flot	*	Operating Range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
5	0	0	BIng	*	Analysis component selection map
7					Units
	0	0	B466	*	Primary input (period, quantity, units)
	1	0	B466	*	Mass (accumulator units, flow rate units, period)
	2	0	B466	*	Energy (accumulator units, flow rate units, period)
	3	0	B466	*	Volumes (accumulator units, flow rate units, period)
8					Rollovers, pulse threshold
	0	0	UIng	*	Accumulator Rollover, Mass
	1	0	UIng	*	Accumulator Rollover, Energy
	2	0	UIng	*	Accumulator Rollover, Volumes
	3	0	UIng	*	Pulse input rollover
	4	0	UIng	*	Master pulse-count rollover
	5				Low pulse flow threshold
		0	Usht	*	Count
		1	Usht	*	Time
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

Group	Sbgp	Item	DTyp	Rkv	Data point
	5	0	Flot	*	Meter tube coefficient of thermal expansion
	6	0	Flot	*	Primary input flow threshold
	7	0	Flot	*	V-cone/Wedge coefficient of discharge
	8	0	Flot	*	Temperature process-input bias
	9	0	Flot	*	Pressure process-input bias
	10	0	Flot	*	MASC separate gas flowrate error limit (fraction)
10	0	0	Usht	*	MASC misc parameters
		1	Bsht	*	MASC reset accumulators
		-	-	*	MASC resets the current hour accumulators
		-	-	*	MASC resets the previous hour accumulators
		-	-	*	MASC resets the current day accumulators
		-	-	*	MASC resets the previous day accumulators
		-	-	*	MASC resets the current month accumulators
		-	-	*	MASC resets the previous month accumulators
11	0				Densitometer
		0	Usht	*	Densitometer type
		1	Flot	*	Calibration temperature
		2	Flot	*	Calibration pressure
		3	Flot	*	Calibration constant K0
		4	Flot	*	Calibration constant K1
		5	Flot	*	Calibration constant K2
		6	Flot	*	Calibration constant 6
		7	Flot	*	Calibration constant 7
		8	Flot	*	Calibration constant 8
		9	Flot	*	Calibration constant 9
		10	Flot	*	Calibration constant 10
		11	Flot	*	Calibration constant 11
		12	Flot	*	Calibration constant 12
		13	Flot	*	Calibration constant 13
		14	Flot	*	Densitometer correction factor
14					Meter end-of-period settings
	0	0	Usht	(4)	End-of-day minute
	1	0	Usht	(4)	End-of-hour minute
15					Miscellaneous
	0	0	Dbyt	*	Sample period limit
	1	0	Dbyt	*	Physical device

6.10 Event Class 3: Stream Datum Point Events



Group	Sbgp	Item	DTyp	Rkv	Data point
0	0	0	Bsht	*	Stream options
1					Stream parameter value
	0	0	Flot	*	Default relative density (gas) at reference
	1	0	Flot	*	Viscosity
	2	0	Flot	*	Isentropic exponent
	3	0	Flot	*	Default Fpv
	4	0	Flot	*	K/meter factor
	5	0	Flot	*	Default energy content
	6	0	Flot	*	Default reference density (liquid)
	7	0	Flot	*	Default vapor pressure
	8	0	Flot	*	Water salinity
	9	0	Flot	*	Default Ctl MASC oil density, sample
	10	0	Flot	*	Default Cpl MASC oil density, lab flash
	11	0	Flot	*	Shrinkage factor
	12	0	Flot	*	Precalculated alpha
2	0				Meter factor curve
		0	Flot	*	Datum point 1, meter factor
		1	Flot	*	Datum point 1, flow rate
		2	Flot	*	Datum point 2, meter factor
		3	Flot	*	Datum point 2, flow rate
		4	Flot	*	Datum point 3, meter factor
		5	Flot	*	Datum point 3, flow rate
		6	Flot	*	Datum point 4, meter factor
		7	Flot	*	Datum point 4, flow rate
		8	Flot	*	Datum point 5, meter factor
		9	Flot	*	Datum point 5, flow rate
3	0				Analysis mole fraction
					** Because the item code extends into the subgroup field, this can be the only subgroup of group 3 ! (Pending any future reformat of the Event Id Tag)
		0	Flot	(6)	Component 1, molar fraction
		1	Flot	(6)	Component 2, molar fraction
		2	Flot	(6)	Component 3, molar fraction
		3	Flot	(6)	Component 4, molar fraction
		4	Flot	(6)	Component 5, molar fraction
		5	Flot	(6)	Component 6, molar fraction

Group	Sbgp	Item	DTyp	Rkv	Data point
		6	Flot	(6)	Component 7, molar fraction
		7	Flot	(6)	Component 8, molar fraction
		8	Flot	(6)	Component 9, molar fraction
		9	Flot	(6)	Component 10, molar fraction
		10	Flot	(6)	Component 11, molar fraction
		11	Flot	(6)	Component 12, molar fraction
		12	Flot	(6)	Component 13, molar fraction
		13	Flot	(6)	Component 14, molar fraction
		14	Flot	(6)	Component 15, molar fraction
		15	Flot	(6)	Component 16, molar fraction
		16	Flot	(6)	Component 17, molar fraction
		17	Flot	(6)	Component 18, molar fraction
		18	Flot	(6)	Component 19, molar fraction
		19	Flot	(6)	Component 20, molar fraction
		20	Flot	(6)	Component 21, molar fraction
		21	Flot	(6)	Component 22, molar fraction
		22	Flot	(6)	Component 23, molar fraction
		23	Flot	(6)	Component 24, molar fraction
		24	Flot	(6)	Component 25, molar fraction
		25	Flot	(6)	Component 26, molar fraction
		26	Flot	(6)	Component 27, molar fraction
		27	Flot	(6)	Component 28, molar fraction
		28	Flot	(6)	Component 29, molar fraction
		29	Flot	(6)	Component 30, molar fraction
		30	Flot	(6)	Component 31, molar fraction
		31	Flot	(6)	Component 32, molar fraction

6.11 Event Class 4: Prover Datum Point Events



Group	Sbgp	Item	DTyp	Rkv	Datum point
0	0				Process input calibration (not implemented)
		0	Flot	-	(Inlet) temperature
		1	Flot	-	Outlet temperature
		2	Flot	-	Switch bar temperature
		3	Flot	-	(Inlet) pressure
		4	Flot	-	Outlet pressure
		5	Flot	-	Density
1	0				Prover classification
		0	Diby	-	Prover type, master meter number
		1	Diby	-	Measurement system, density selection
2	0	0	Bsht	-	Prover options
3	0				Prover run counts
		0	Usht	-	Runs per prove, total
		1	Usht	-	Runs per prove, selected
		2	Usht	-	Max total runs before abort
		3	Usht	-	Passes per run (short prover)
		4	Usht	-	Min pulses per run * 1000
		5	Usht	-	Max seconds per run
4					Prover input format codes
	0	0	Usht	-	Pulse count for run/pass
	1	0	Usht	-	Master meter pulse count
5	0	0	DiBy	-	Prover size units
6					Prover reference conditions
	0	0	Flot	*	Temperature
	1	0	Flot	*	Pressure
7					Prover parameter value
	0	0	Flot	-	Meter factor precision
	1	0	Flot	-	Pulse interpolation ratio
	2	0	Flot	-	Flow tube linear thermal expansion coefficient
	3	0	Flot	-	Switch bar linear thermal expansion coefficient
	4	0	Flot	-	Calibrated prover volume
	5	0	Flot	-	Flow tube inside diameter
	6	0	Flot	-	Flow tube wall thickness
	7	0	Flot	-	Flow tube modulus of elasticity
8	0				Prover variation limits
		0	Flot	-	Meter temperature

Group	Sbgp	Item	DTyp	Rkv	Datum point
		1	Flot	-	Prover inlet temperature
		2	Flot	-	Prover outlet temperature
		3	Flot	-	Prover inlet-outlet temperature
		4	Flot	-	Prover temperature
		5	Flot	-	Prover-Meter temperature
		6	Flot	-	Switch bar temperature
		7	Flot	-	Meter pressure
		8	Flot	-	Prover inlet pressure
		9	Flot	-	Prover outlet pressure
		10	Flot	-	Prover inlet-outlet pressure
		11	Flot	-	Prover pressure
		12	Flot	-	Prover-meter pressure
		13	Flot	-	Density
		14	Flot	-	Water content
		15	Flot	-	Meter flow rate
		16	Flot	-	Prover flow rate
		17	Flot	-	Pulses over runs
		18	Flot	-	Pulses over passes
		19	Flot	-	Repeatability
		20	Flot	-	Change in factor
9					Prover process input scaling
	0				(Inlet) temperature
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating Range low end
		3	Flot	*	Operating Range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
	1				Outlet temperature
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating Range low end
		3	Flot	*	Operating Range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
	2				Switch bar temperature
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating Range low end
		3	Flot	*	Operating Range high end

Group	Sbgp	Item	DTyp	Rkv	Datum point
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
3					(Inlet) pressure
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating range low end
		3	Flot	*	Operating range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
4					Outlet pressure
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating range low end
		3	Flot	*	Operating range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Bbyt	*	Options
5					Density
		0	Flot	*	Transmitter Range low end
		1	Flot	*	Transmitter Range high end
		2	Flot	*	Operating range low end
		3	Flot	*	Operating range high end
		4	Flot	*	Alarm low end
		5	Flot	*	Alarm high end
		6	Flot	*	Options

6.12 Event Class 7: Transmitter Calibration and Verification

Bits	N	Meaning
22-20	3	Transmitter Input Scaling Code: For a meter transmitter (bits 27 – 23 non-zero), one of: 0 Primary Input 1 Temperature 2 Pressure 3 Flowing density 4 Water content For a prover transmitter (bits 27 – 23 zero), one of: 0 (Inlet) temperature 1 Outlet temperature 4 Outlet pressure 5 Density
19-16	4	Transmitter Calibration Event Group; one of: 0 Session action recorded 1 Session State Change
15-00	16	Transmitter Calibration Event Subgroup; see Group Detail next

6.13 Subgroup coding and values, Group 0, Session action recorded:

Subgroup code has this layout:

Bits	N	Meaning
15-08	8	Index of action entry in calibration file, range 0 through 58
	7	1 Trailing verification entry marked “as left”: This event is written upon “closing” the calibration file. It repeats in every detail including timestamp the same event that recorded the original verification without “as left”, except for “as left” itself. As a verification action can be “as left” when it is known not to be followed by any calibration actions (which could adjust the transmitter to “leave” it delivering a different “measured” value for the verification), only when the calibration session has been closed (preventing the recording of any new actions) is it known that all (and only) trailing verification actions are not followed by calibration actions and are therefore “as left”.
	6	Leading verification entry marked “as found”. Verification actions performed at the start of a calibration session, before any true calibration (non-verification) actions are automatically flagged “as found”.
15-00	6	Calibration entry action, one of: Standard Group: 00: [unused; should never appear in the Event Log] 01: Verify 02: Set Zero 03: Set Span 04: Zero Shift 05: Set Mid 50 (50%) 06: Set Mid Lo (e.g., 25%)

Bits	N	Meaning
		10: PLC mediated group 0 ACK
		11: PLC mediated group 0 NAK 1
		12: PLC mediated group 0 NAK 2
		13: PLC mediated group 0 NAK 3
		14: PLC mediated group 0 NAK 4
		For future expansion:
		15-49: reserved for PLC mediated groups 1 to 7
		The two event-logged values are the two floating-point numbers recorded in the calibration entry:
		“Old” value is the “Applied” value
		“New” value is the “Measured” value.

6.14 Subgroup coding and values, Group 1, Session state change:

Subgroup code always 0.

Values are the “old” and “new” values having this format:

Bits	N	Meaning
15-08	15	Active calibration suspended upon boot. Upon boot, the EAFC discovered that this session was in “active” state and has automatically suspended it. This can occur, for example, when the EAFC experience an abrupt power loss while a transmitter calibration is active.
	14	File – object CRC fail. The calibration file maintained in auxiliary storage includes a CRC recorded within the file. When the file is read back from that storage upon boot, the CRC is verified. A verification failure sets this bit, which persists until the file is overwritten by a new calibration session
	6	Leading verification entry marked “as found”. Verification actions performed at the start of a calibration session, before any true calibration (non-verification) actions are automatically flagged “as found”.
13-09		Reserved
	8	Calibration session (else verification only). A “calibration” session is one that has recorded at least one non-verification action, indicating that some adjustment was made to the transmitter. An active session file for the transmitter does not exist because either the previous session was properly closed and reported or a session has never been performed. A new session can be started.
	01:	Reported. The session has been finalized and reported to off-module permanent storage (database, file, or printed report). A new session can be started.
	02:	Closed. This session has been finalized but not yet reported. The session cannot be resumed but neither can a new session be started.
	03:	Suspended. The session was started and partially performed but was suspended from the active state before being finalized. Such a session can be resumed to active. This session must be finalized and reported before a new one can be started.
	04	Active: The session has been and is currently underway having recorded at least one entry. The session must be finalized and reported before a new can be started.

All events in this Event Class 7:

- Are “high priority”
- Have no effect upon archives or accumulator resets

6.15 "Rkv" Notes

These notes are referenced by parenthesized numbers in the Rkv column of the tables above.

(1) Archives only, not resets, are forced regardless of configuration, capturing any unarchived data from the previous run 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 1, Event Log Lockable – Though this setting does not directly affect measurement calculations, it does affect the behavior of the Event Log itself, specifically that of the lost event counter and of the Download event. The Event Log may be used by external systems for auditing the measurement.

Bit 2, Barometric pressure units

(4) For now, these events are treated just like others as if the Rkv not references in the above tables were “*”.

(5) 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 and so on during the downtime; 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).

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

6.16 Event Priority and a “Locked” Log



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 Lockable” site option.

If the option is clear, 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 set, then the Event Log is “locked” and the new event is handled as follows:

- If the event is “high priority”, then the log-full condition is ignored and the new event overwrites the oldest one which is then permanently lost. High-priority events are those that record uncontrollable and critical changes to the MVI56E-AFC’s environment; they include most of the **Special Events** (see table 6.7) and the **Meter Datum Point events** “*Process Input Calibration*” (see table in section 6.9).
- Otherwise, if the event is controllable, that is, it is triggered by a change to a datum point, then the change is 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. Controllable events comprise almost all of those listed (see tables in sections 6.8, 6.9, 6.10, 6.11).
- Otherwise, the event is discarded and is permanently lost. At this time, the only such events are the “Checksum Alarm” Special events that are logged during startup (“Checksum Alarm” events triggered at other times are controllable).

A “locked” log must be downloaded in order to unlock it for normal behavior.

6.17 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 event log is downloaded using a strictly validated communication protocol that addresses a specific region of the Modbus database. This protocol is built upon standard Modbus, so it can be implemented in a client application that has access to only a standard Modbus Master communications driver; no special protocol-specific driver is required. The following illustrates the four phases of the download session:

- **Poll** – A poll merely fetches the Event Log header, whose information includes the ranges of event numbers that are on file and those that have never been downloaded. The client uses this information in deciding whether to proceed with the download session, and if so, the range of events to be downloaded.
- **Open** – This phase starts a download session; the main parameter to this action is the number of the first event to be downloaded in the session. This starting number has no limitation; it need not be that of the earliest never-downloaded event (although that is the usual case), and it need not even be the number of an event on file. A "session context" is created that tracks the progress of the download; its information includes:
 - The "next-fetch" point, which is the number of the next event to be retrieved in the session and is used by the "Download" phase. It is initialized from the parameter to "Open".
 - The "download" point, which is the number of the earliest event that has never been downloaded and is used by the "Download" and "Close" phases. It is initialized from the Event Log Header.

The session context is created local to the communication channel being used (serial port or network connection), allowing multiple independent sessions to be run simultaneously on different channels.

- **Download** – This phase comprises a sequence of packet pairs, first a "fetch" (read) that retrieves a group of event records, then an "acknowledge" (write) that informs the AFC module of successful receipt. The only parameter to "fetch" (encoded within the "number of registers" field of the Modbus command) is the count of event records to be fetched, which may lie between 0 (permitted) and the maximum count of event records that fit into a Modbus read-response (currently 11).

The response consists of a packet header that reports details of the current session state and of the packet itself, followed by a sequence of event records up to the count requested; the number of the first such record is the next "fetch" point from the session context. A successful "acknowledge" causes the AFC module to update the session context, including advancement of:

- The “next-fetch” point, to address the event that follows the last one in the acknowledged packet, ready for the next fetch.
- The “download” point if the acknowledged packet contained any events that have never been downloaded.

The client may leave this phase at any time and proceed to “Close”, even if he has retrieved no events; he need not continue until the latest logged event has been retrieved (though that would be the usual case).

- **Close** – There are two methods to close a session:
 - **Abandon** – This method merely discards the session. Even though the client’s session may have retrieved many events, including possibly many never downloaded ones, the Event Log itself is not affected and remains the same as if the session had never occurred.
 - **Commit** – This method informs the AFC module of a completed Event Log Download session. The Event Log header is updated to reflect the results of the download: if the “download” point in the session context has changed from the value in the header, then the header’s download point and lost-event count are updated and a Download event is posted that logs those changes. This event record is not appended to the events that were retrieved during the session being closed, but it will be present for retrieval in a subsequent session. For proper auditability, the client should ensure that the event records retrieved during the session are transferred to persistent storage before issuing a “Commit”. The session context is then destroyed.

A download may be performed at any time; it is not necessary to wait for the log-full condition in order to download (and waiting for that condition would be bad practice, risking lost events).

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

6.18 Event Log Download



The following is an example of the Event Log Download.

After opening the *Event log sessions* window from the **ON-LINE/EVENT LOG** menu, you will see instructions in green in the lower right area of the window.

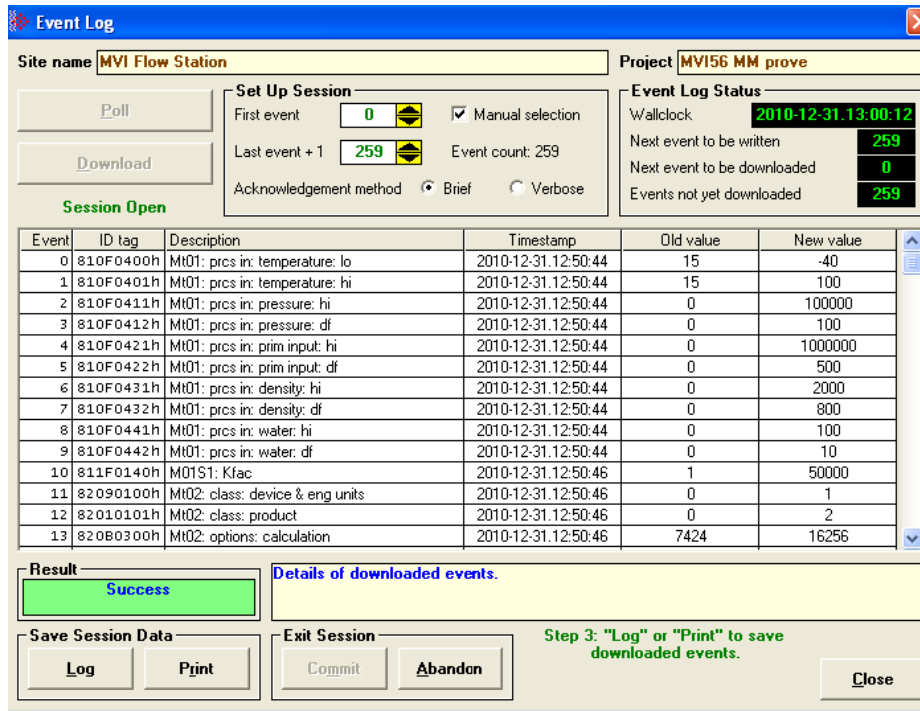
- 1 Click **POLL** to get the status and to prepare the session:

The screenshot shows the 'Event Log' window with the following details:

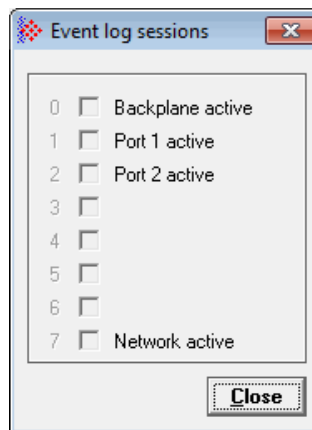
- Site name:** EAFC Flow Station
- Project:** MVI56E-AFC
- Buttons:** Poll, Download
- Set Up Session:** First event (dropdown), Last event + 1 (dropdown), Manual selection (checkbox), Acknowledgement method (Brief/Verbose radio buttons)
- Event Log Status:** Wallclock, Next event to be written, Next event to be downloaded, Events lost, Events not yet downloaded (all with black bars)
- Table:** Columns: Event, ID tag, Description, Timestamp, Old value, New value, OprID
- Result:** Commlink is unavailable
- Instructions:** Learn how many events have not been logged yet. After this, click Download to read all of those events.
- Buttons:** Save Session Data (Log, Print), Exit Session (Commit, Abandon), Close
- Green Text:** Step 1: "Poll" to fetch event log status and prepare to set up session.

- 2 After polling, you are prompted to download.
- 3 Before downloading you might want to modify the parameters of your download. Reasons for modification include such things as a need to re-fetch recent events that were already downloaded and committed in a previous session, or to limit the amount of download.
- 4 To change the download parameters, check the box **MANUAL SELECTION** in the *Event Log* window, and make any desired changes.
- 5 After the parameters are set to the chosen values click **DOWNLOAD**.

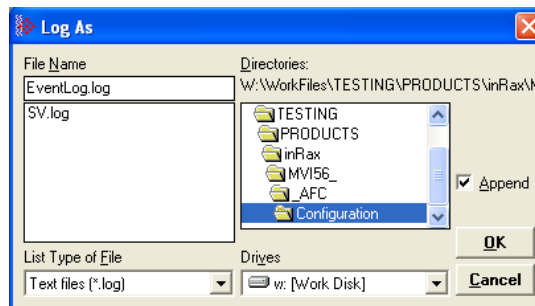
- The requested events are fetched and displayed in the scrollable grid. The events displayed in this screenshot are of changes to configuration (*sealable parameters*):



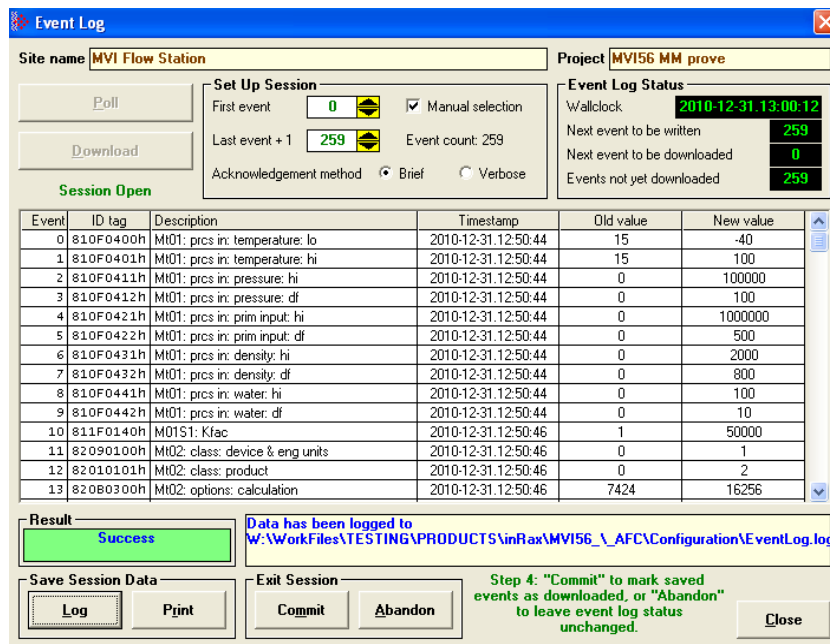
- The *Download* action opens a session context (invisible), which will be closed only when either (a) it is *Committed*, or (b) it is *Abandoned*, or (c) it times out due to no activity. The existence of this context can be seen by viewing again the *Event log download sessions* information from *Site Configuration* window (you will have to re-*Poll* the site information to see the update):



- 8 *Committing* a download tells the AFC module to purge the downloaded events, that is, to move its download pointer past the downloaded events and allow those events to be overwritten. Event log management standards mandate that downloaded events must be saved to more permanent storage before they can be purged from the module. In the earlier screenshot you can see that the **COMMIT** button is grayed out because the saving action has not yet been accomplished. EAFC Manager considers the events to have been saved when they have been either logged to a file or printed.
- 9 Click the **LOG** or **PRINT** button and save the downloaded events to a text file of type ".log":



- 10 The **COMMIT** button is now enabled.



- 11 Click **COMMIT**, and the AFC module then moves its download pointer (*Next event to be downloaded* in the *Event Log Status* panel):
- 12 To download again, click **POLL**. This will prompt you to start the next download starting from the new download pointer (*First event* in the *Set Up Session* panel). Once downloading all outstanding events is completed, there will be no more events to be downloaded as shown here by a 0 in the *Events not yet downloaded* field.

7 Creating Alarm Logs

Note: The Alarm Log feature works like the Event Log feature described in the previous chapter. This chapter provides information on usage only.



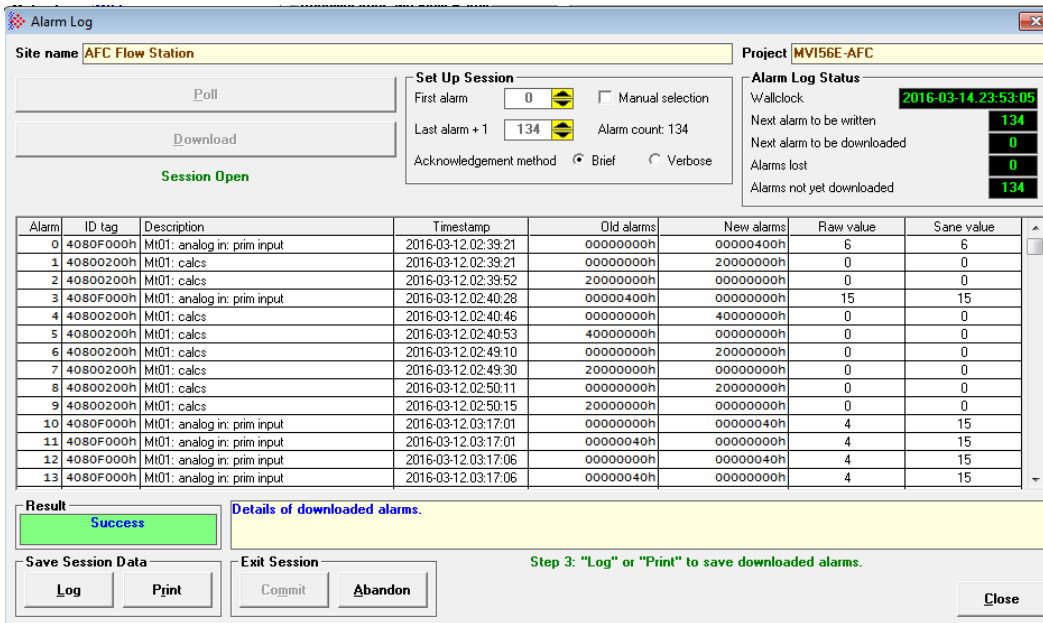
The alarm provides two alarm levels:

- **Severe:** Stops calculations
- **Warning:** Calculations proceed but alarm is generated

The screenshot shows the 'Alarm Log' window. At the top, there are fields for 'Site name' (AFC Flow Station) and 'Project'. Below these are buttons for 'Poll' and 'Download'. A 'Set Up Session' section includes 'First alarm' and 'Last alarm + 1' dropdowns, a 'Manual selection' checkbox, and 'Acknowledgement method' radio buttons for 'Brief' and 'Verbose'. On the right, the 'Alarm Log Status' section shows a grid for 'Wallclock', 'Next alarm to be written', 'Next alarm to be downloaded', 'Alarms lost', and 'Alarms not yet downloaded'. A table with columns 'Alarm', 'ID tag', 'Description', 'Timestamp', 'Old alarms', 'New alarms', 'Raw value', and 'Same value' is present. At the bottom, a 'Result' box shows 'Commlink is unavailable' in red. A yellow message box says 'Learn how many alarms have not been logged yet. After this, click Download to read all of those alarms.' Below that are 'Save Session Data' (Log, Print) and 'Exit Session' (Commit, Abandon) buttons, along with a 'Close' button. A status bar at the bottom reads 'Step 1: "Poll" to fetch alarm log status and prepare to set up session.'

- 1 From EAFC Manager, navigate to **ON-LINE > ALARM LOG**.

- Click the **POLL** button and then click the **DOWNLOAD** button to download results to the grid.



- The *Set Up* session shows the first alarm and the last alarm. In this case, there were 134 alarms. Let's assume that a period of time passes and during that time, 5 alarms were generated. If you *Poll* and *Download* again, the First alarm will indicate 135 and the Last Alarm will indicate 139. This represents the new alarms since the first poll (5). You can also manually change the First Alarm to any number you want and do the same for the Last Alarm to isolate a range of alarms that took place.
- To save session data, click the **LOG** button to log the session data that has been downloaded or the **PRINT** button to print the downloaded alarm information.
- Click the **COMMIT** to commit the data for this report so it can be logged, or click **ABANDON** to end the session without saving any data.
- Click **CLOSE** to close the *Alarm* window.

8 Checking Meter Alarms on a PLC



The logic continuously informs if a meter has an alarm or not. Refer to the following controller tags for the meter alarm status:

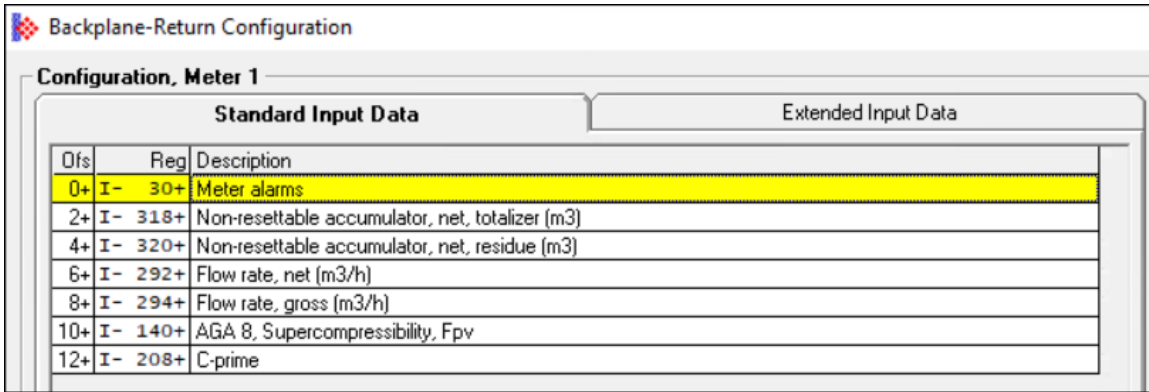
Information	Controller Tag	Values
Meter 1 Alarm Status	AFC.MeterAlarms.Meter1	0 = Meter 1 does not have alarm 1 = Meter 1 has alarm
Meter 2 Alarm Status	AFC.MeterAlarms.Meter2	0 = Meter 2 does not have alarm 1 = Meter 2 has alarm
Meter 3 Alarm Status	AFC.MeterAlarms.Meter3	0 = Meter 3 does not have alarm 1 = Meter 3 has alarm
Meter 4 Alarm Status	AFC.MeterAlarms.Meter4	0 = Meter 4 does not have alarm 1 = Meter 4 has alarm
...
Meter 16 Alarm Status	AFC.MeterAlarms.Meter16	0 = Meter 16 does not have alarm 1 = Meter 16 has alarm

For each meter, the logic also indicates which alarm was generated. Refer to the following controller tags for meter alarm information:

Information	Controller Tag*	Values
Meter 1 Alarm	AFCMeter01xxxx.BackPlaneReturn.Default.Meter_Alarms	Please see following table
Meter 2 Alarm	AFCMeter01xxxx.BackPlaneReturn.Default.Meter_Alarms	Please see following table
Meter 3 Alarm	AFCMeter01xxxx.BackPlaneReturn.Default.Meter_Alarms	Please see following table
Meter 4 Alarm	AFCMeter01xxxx.BackPlaneReturn.Default.Meter_Alarms	Please see following table
...	AFCMeter01xxxx.BackPlaneReturn.Default.Meter_Alarms	...
Meter 16 Alarm	AFCMeter01xxxx.BackPlaneReturn.Default.Meter_Alarms	Please see following table

* The “xxxx” in the Controller Tag name could refer to any of the following: “DifferentialGas”, “LinearGas”, “DifferentialLiquid”, or “LinearLiquid”.

Meter alarm information is mapped by default using the “Meter alarms” mapping shown here:

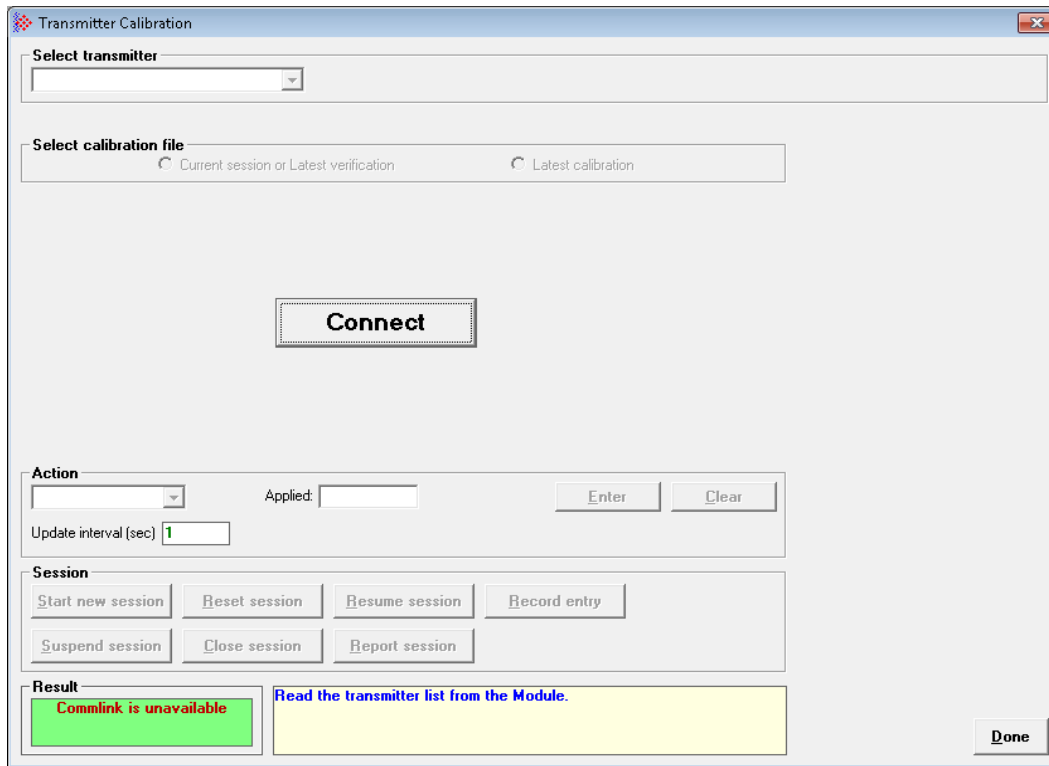


The following example shows how each alarm bit is interpreted. This is dependent on meter type.

Bit Number	Description
0	Differential Pressure General Failure
1	Differential Pressure Out Of Range
2	Differential Pressure Beyond Threshold
3	Temperature General Failure
4	Temperature Out Of Range
5	Temperature Beyond Threshold
6	Pressure General Failure
7	Pressure Out Of Range
8	Pressure Beyond Threshold
-	-
24	Compressibility Calculation Error
25	Accumulation Overflow
26	Orifice Pressure Exception
-	-
29	Analysis Characterization Error
30	Orifice Characterization Error

9 Transmitter Calibration

The Transmitter Calibration feature allows an engineer to verify and calibrate the transmitters. For example, a technician can connect to the module to run the verification and calibration feature on E AFC Manager. The technician receives real-time readings from the module which the technician can then direct another technician at an input device on how to calibrate the device.



This function places any input variable into calibration mode and uses the last known good value for measurement.

9.1 Temperature Offset

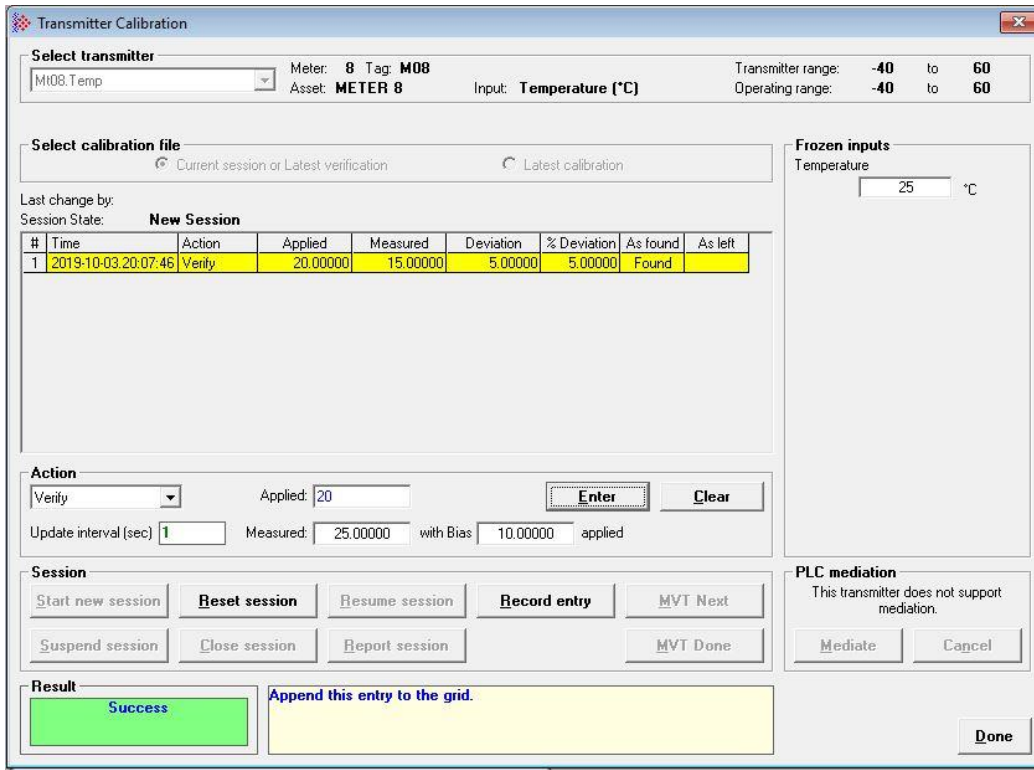
A meter configuration item will be added for temperature bias (offset). A change in the meter configuration temperature bias (offset) generates an event log record.

The temperature bias (offset) value is reflected in the meter results (MrsI) dictionary section. This value may be included in the meter archive configuration. It will be added to the process input temperature value prior to alarm threshold comparison in the calculation engine.

In the transmitter calibration display, it will indicate whether the temperature bias (offset) is applied and the temperature bias (offset) value.

Transmitter calibration entry actions where a value is applied does not account for the temperature bias (offset).

Here is an example of a transmitter calibration display showing temperature offset being applied.



Process inputs go to calibration automatically.



This allows calculations to continue (using the scaled avg) while the calibration is done. If transmitter calibration is suspended or the communication to the PLC is lost the calibration mode will switch to manual. Once in manual mode the user will need to come to this window to remove manual mode so the calculations will be based on last raw and scaled avg.



For the new orifice plate change feature, the process inputs go to calibration manually. This also allows calculations to continue similar to transmitter calibration. If EAFC Manager exits abruptly (e.g. PC crash) after the freeze selection occurs, the process inputs will stay in calibration manual mode, and you will need to return to the above window to return to normal calculation operation.



9.2 Meter Verification



Verification is typically done onsite to verify the accuracy of field devices. The verification includes the value of a process variable, the actual value, and the deviation between a measured value from instrumentation and actual value as delivered by precision calibration equipment.

9.3 Meter Calibration



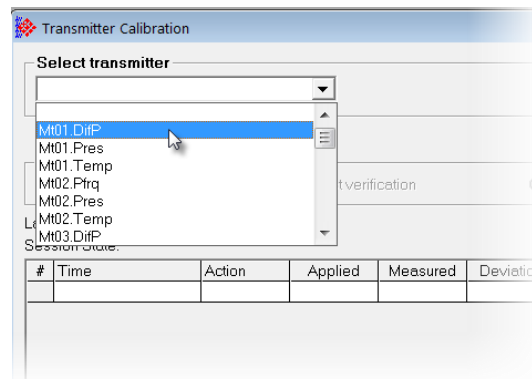
Meter calibration uses the same data as meter verification. The difference between meter calibration and meter verification is that the transmitter is actually calibrated based on being out of the desired specification while meter verification does not actually change the calibration of field devices.

9.3.1 Performing Verification and Calibration

The meter must be enabled for this function to work.

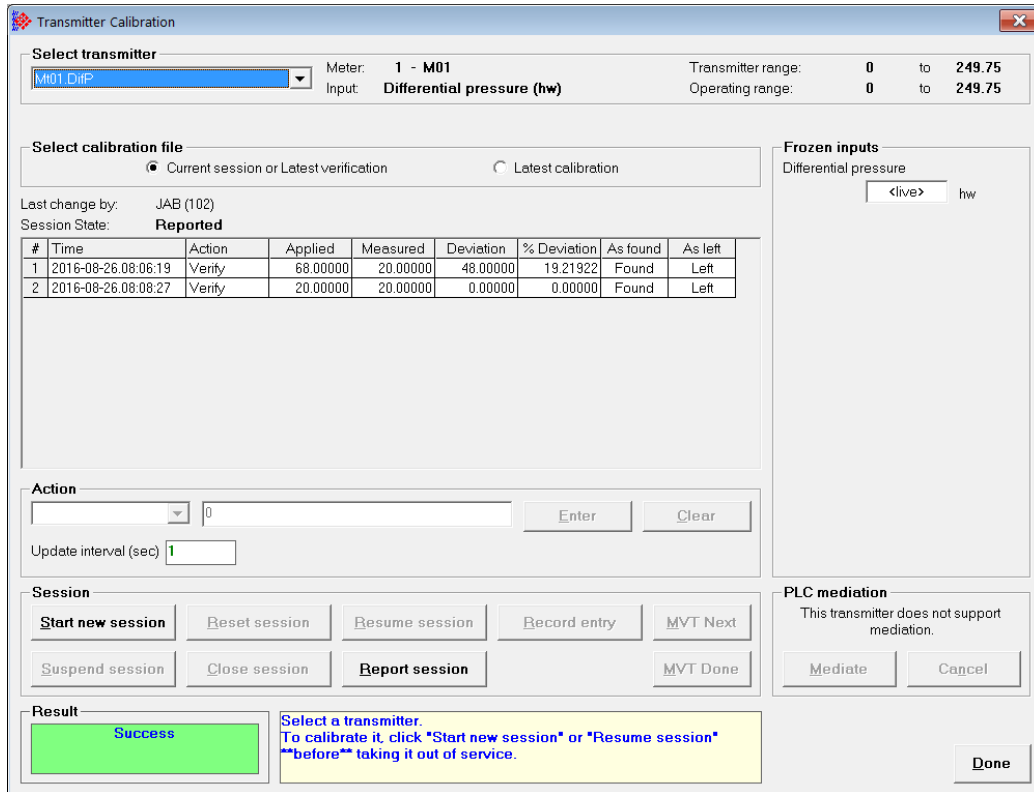
- 1 From within EAFC Manager, navigate to **ON-LINE > TRANSMITTER CALIBRATION**. The *Transmitter Calibration* page opens.
- 2 Click the **CONNECT** button.
- 3 Select the transmitter that pertains to the verification.

For example, Mt01.DifP (Differential Pressure), MT08.Pres (Pressure), and Mt08.Temp (Temperature). This information is read from the AFC module.



- 4 Select the transmitter from the *Transmitter* drop-down list box as shown above. For example, Mt01.DifP (Differential Pressure), MT08.Pres (Pressure), and Mt08.Temp (Temperature).

The page populates with the following information:



- 5 Click the **START NEW SESSION** button.
- 6 The calibration process allows up to five points of calibration (*Set Zero, Set Span, and Set Mid 1 through 3*). Select the *Action* (in this example, *Verify*) and enter the expected *Applied* value.

Action	Description
Verify	This action sets an expected or an <i>Applied</i> value. If the applied and measured values are not in an acceptable range, the transmitter must be calibrated.
Zero Shift	This can be used to move the zero point of the transmitter and apply a zero-bias on devices that support this.
Set Zero	Verifies that the transmitter is set to zero to begin calibration.
Set Span	If a range is 0 to 100, the span is 100 and the zero value = 0 If a range is -100 to 100, the span is 200 and the zero value = -100
Set Mid 1	Allows you to specify a value to check against based on your own specifications.
Set Mid 2	Set Mid 1 along with Set Zero and Set Span for 3 point calibration or add Set Mid 2 and 3 for five point.
Set Mid 3	Set Mid 1 default is 25% Set Mid 2 default is 50% Set Mid 3 default is 75%.

7 Set the *Update Interval*, the data update interval in seconds.

8 Click **ENTER**. The applied and measured values are compared and the deviation is calculated and displayed.

#	Time	Action	Applied	Measured	Deviation	% Deviation	As found	As left
1		Verify	68.00000	20.00000	48.00000	19.21922		

- The *Applied* value is the value that you delivered to the transmitter using precision calibration equipment.
- The *Measured* value is the actual value returned by the transmitter.
- The *Deviation* value is the absolute difference between the two values
- The *% Deviation* value is the deviation between the two values shown as a percentage of span.

You can enter a different value and click **ENTER** again in order to see if Measured values have changed.

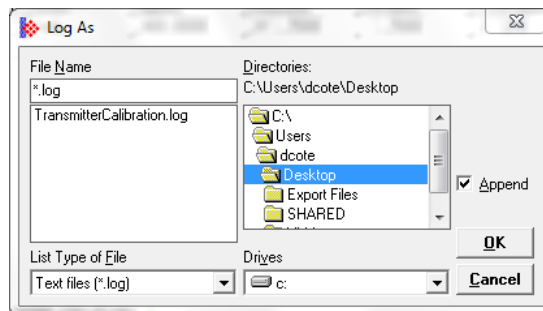
Click **RECORD ENTRY** to record the pending entry. Click **YES** at the warning dialog.

You can change action and expected values and perform the same procedure to get additional measurement readings or you can get updated readings using the same values to re-check values during the calibration process. For example, check again to see if calibration fixes brought the values closer indicated by a more acceptable deviation between the expected value and the measured value.

- 9 Click on the **REPORT SESSION** button to save the session data. The *Log As* dialog box opens.

Note: The session must be closed before it can be [Reported](#). A Closed session is finalized and cannot be altered.

Reporting a session makes a logged or printed output of the session detail, which action is deemed to transfer that detail to permanent external storage. Session must be Reported before that transmitter can undergo another verification/calibration. This ensures that each session file enters the audit trail in permanent storage. This requirement is similar to the Event Log's requirement of downloaded data being logged/printed before the download can be Committed.



- 10 The data is saved as a .log or .csv file.

The other buttons may be used to reset, suspend, resume, and close the session.

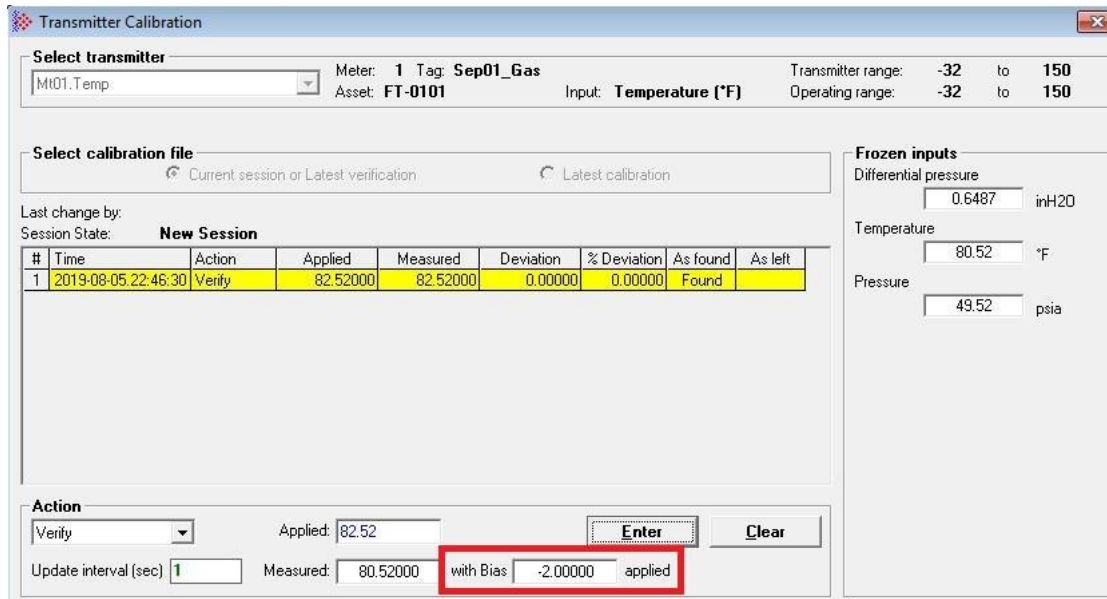
9.4 Temperature Offset

A configuration item is added for temperature bias (offset). A change in the meter configuration temperature bias (offset) generates a log record.

The temperature bias (offset) value is reflected in the Meter Results (MrsI) dictionary section. The temperature bias (offset) value is included in the meter archive configuration.

The temperature bias value will be added to the process input temperature value prior to alarm threshold comparison in the calculation engine. The Transmitter Calibration Display indicates whether the temperature bias (offset) is applied. Transmitter calibration entry actions where a value is applied does not account for the temperature bias (offset).

The following example shows the calibration display showing the temperature offset being applied.



9.5 Multivariable Transmitters

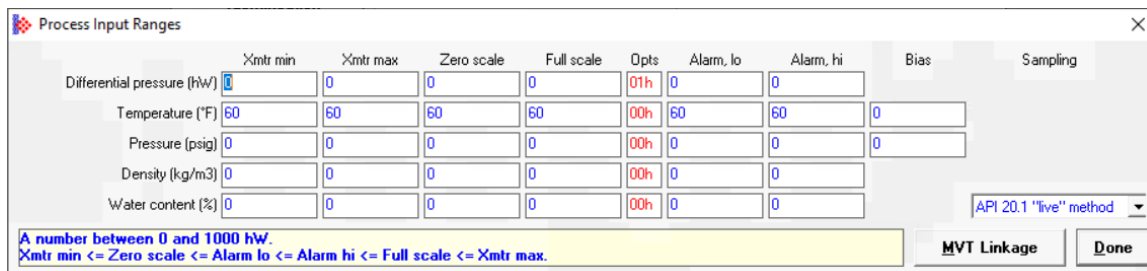
Some transmitters have the capability to send multiple outputs from the same device. These are called “multivariable transmitters”, or MVTs. For example, temperature and pressure at the same time.

Running verification on an MVT is possible. However, you must first configure the outputs of that transmitter to be *MVT-linked* (see below).

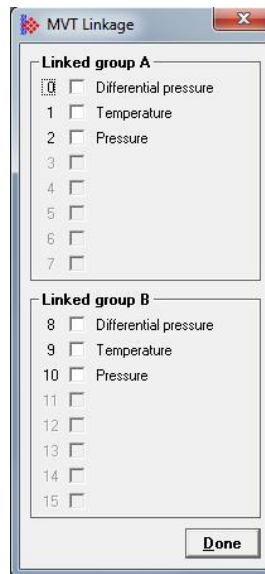
If you are calibrating an output of MVT, the **MVT NEXT** button allows you to step to the next output of the MVT for calibration. When you are finished with the MVT, and the transmitter has been put back online, click the **MVT DONE** button to release calibration mode on the MVT.

9.5.1 Calibrating MVT Example

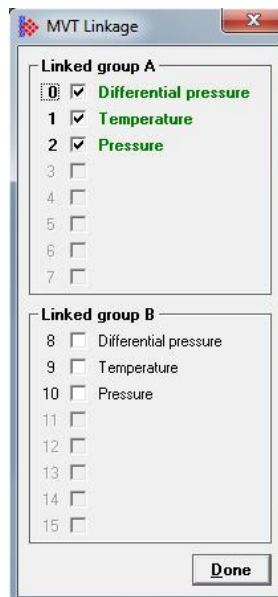
For example, if you want measurements for Temperature and Pressure you must first select the inputs. To do this, click on the **PROCESS INPUT** button on the *Meter Configuration* page to display the *Process Input Ranges* dialog.



- 1 Click on the **MVT LINKAGE** button. The *MVT Transmitter Linkage* dialog opens.



- 2 Select the outputs that the MVT delivers. For example, under *Linked group A*, click on the **TEMPERATURE** and **PRESSURE** checkboxes.



- 3 Click **DONE**.

The two “Linked Groups” are present for supporting up to two independent instrumentation groups on the same meter run. There is no difference between the two groups; each group is treated exactly the same as the other and the two groups are completely interchangeable. The only constraint is that any input can be MVT-linked in at most one group (EAFC Manager enforces this; selecting an input into one group deselects it from the other). An input that is not MVT-linked has its own, separate transmitter. A group that contains only one selected input is treated as if it were empty; that is, the input is stand-alone and not MVT-linked.

9.6 PLC Mediation

PLC mediation only pertains to transmitters having the *Calibration mediated by PLC* option set. When the option is clear, transmitter calibration does not make use of any mediation via the PLC and adjustments must be performed by other means such as manual adjustments of traditional transmitters.

When the operator determines that calibration is necessary, he or she records a sequence of calibration actions, together with their applied and measured values. The AFC module collects the latest instances of each of these recorded actions for delivery to the PLC.

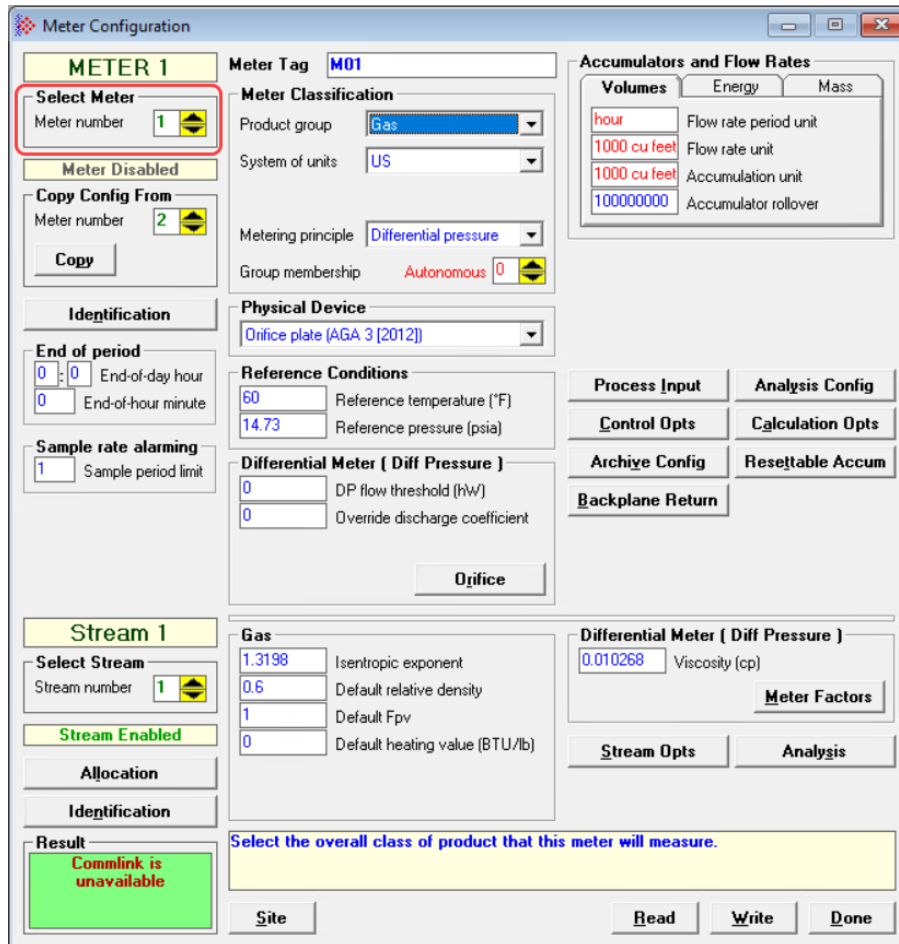
When the operator has recorded a suitable set of calibration actions, he or she issues a PLC calibration action that requests PLC mediation. The PLC uses the information in the mediation request to calibrate the “smart” transmitter (such as writing to it via Modbus) and informs the AFC module of its results. **This requires supporting ladder in the PLC code.**

The AFC module records the PLC calibration action in the calibration file. If there are no other mediation requests queued, input is dropped.

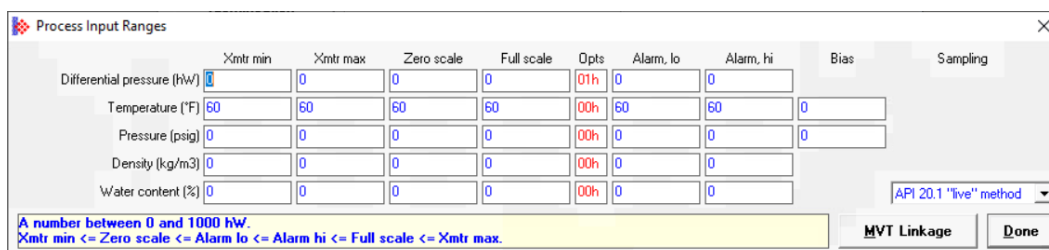
9.6.1 Setting Process Input Options for PLC Mediation

Meters must have process input options set in order to use PLC mediation.

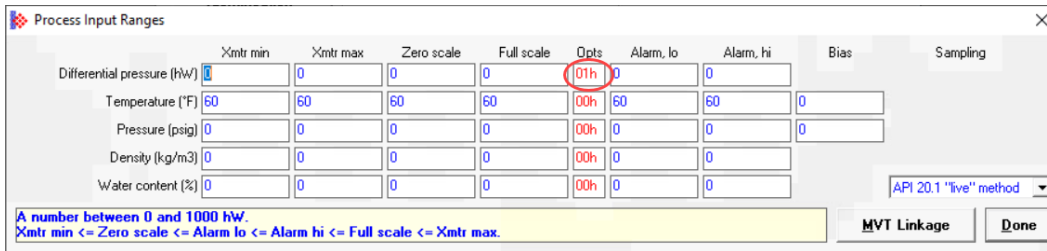
- 1 From the *Meter Configuration* dialog in EAFC Manager, select the appropriate meter number.



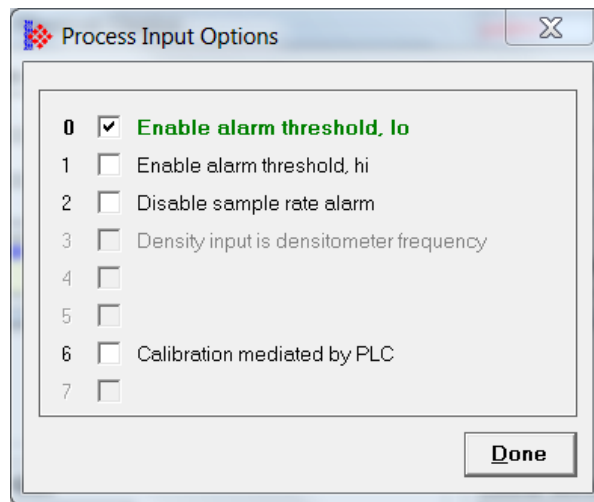
- 2 Click on the **PROCESS INPUT** button. This action opens the *Process Input Ranges* dialog.



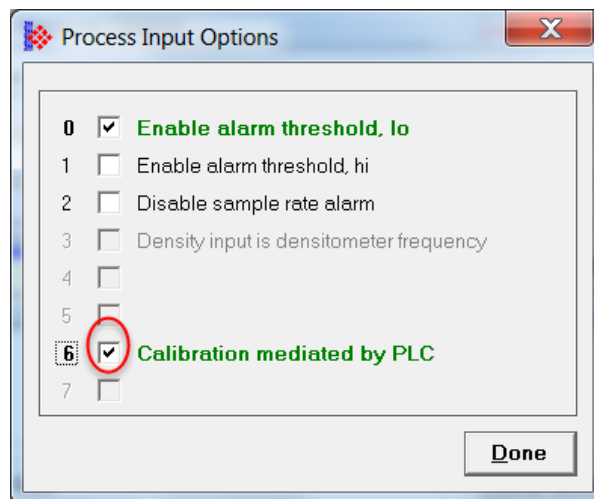
- If Differential Pressure calibration requires mediation by the PLC, click the *Opts* field on the Differential Pressure row.



This opens the *Process Input Options* dialog.



- Click the **CALIBRATION MEDIATED BY PLC** box and click **DONE** to close the *Process Input Options* dialog.

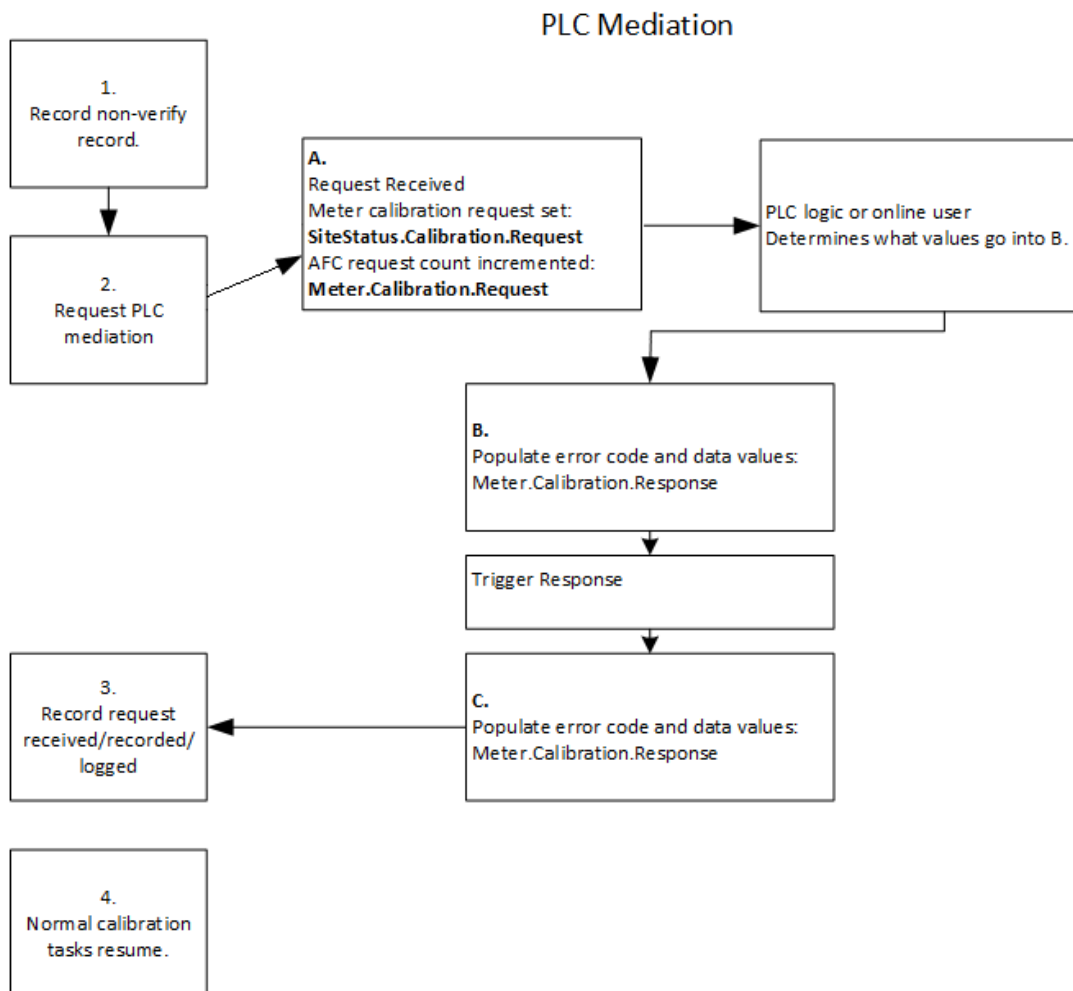


- Click **DONE** on the *Process Input Ranges* dialog.
- Click **WRITE** on the *Meter Configuration* page.

9.6.2 Using PLC Mediation

From the *Transmitter Calibration* window:

- 1 Login and select a transmitter.
 - a) The meter must be enabled.
 - b) The transmitter must be configured for calibration mediated by PLC as described in the previous section.
 - c) Start a new session.
- 2 Perform any action other than *Verify*.
- 3 Record the result.
- 4 Click the **MEDIATE** button to start PLC mediation. The following diagram illustrates what happens next.



10 Meter Proving



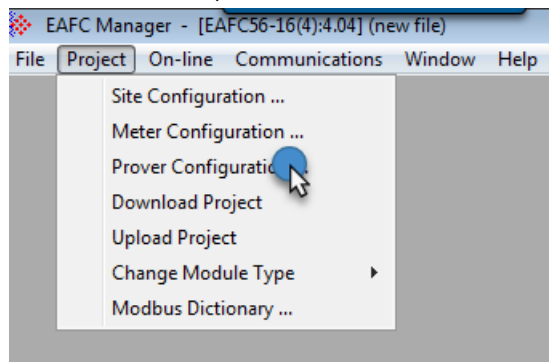
As meters continue to be used over time, the meter’s measurement accuracy deteriorates. Many things can cause the flow sensor bearings to wear down beyond specified limits so that meters are measuring lower volume levels causing producers to pump more oil than the consumer is buying. Meter Provers have a “Known Traceable Volume” which allows using actual flowing and operating conditions to establish a meter correction factor to restore measurement accuracy.

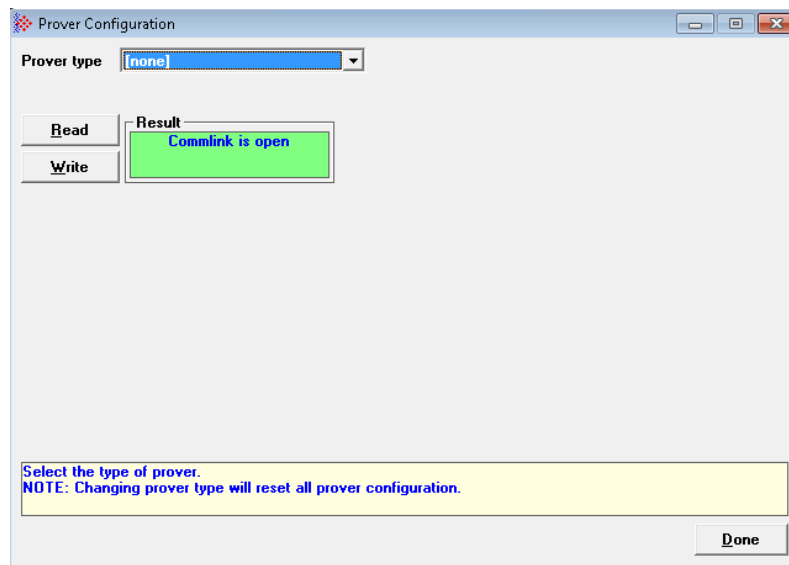
There are 4 types of provers. This chapter will give a basic overview for each type, its options, and configuration.

- Unidirectional Pipe Prover
- Bidirectional Pipe Prover
- Compact Prover (I/O platform required for this does not exist at this time)
- Master Meter

10.1 Prover Configuration

Provers are configured on the *Prover Configuration* dialog (**PROJECT > PROVER CONFIGURATION**)





The parameters displayed in this dialog depend on the value you select from the *Prover type* list. *Prover type* is a parameter that identifies the basic type of the prover. Its values are:

- **NO PROVER CONFIGURED**
- **UNIDIRECTIONAL PIPE PROVER** (You may also choose this selection for an atmospheric tank prover.)
- **BIDIRECTIONAL PIPE PROVER**
- **COMPACT (SHORT, SMALL VOLUME) PROVER**
- **MASTER METER**

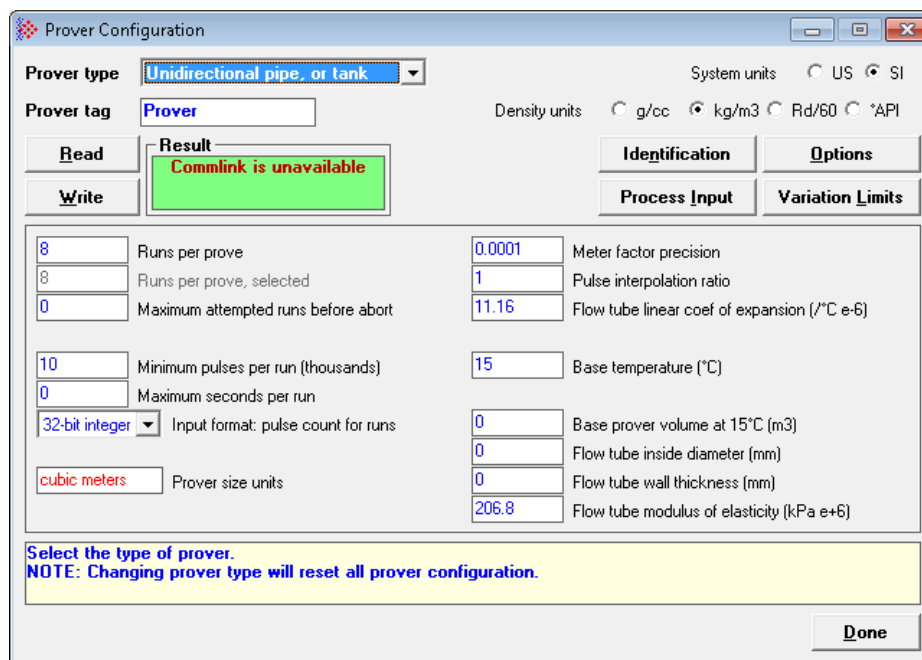
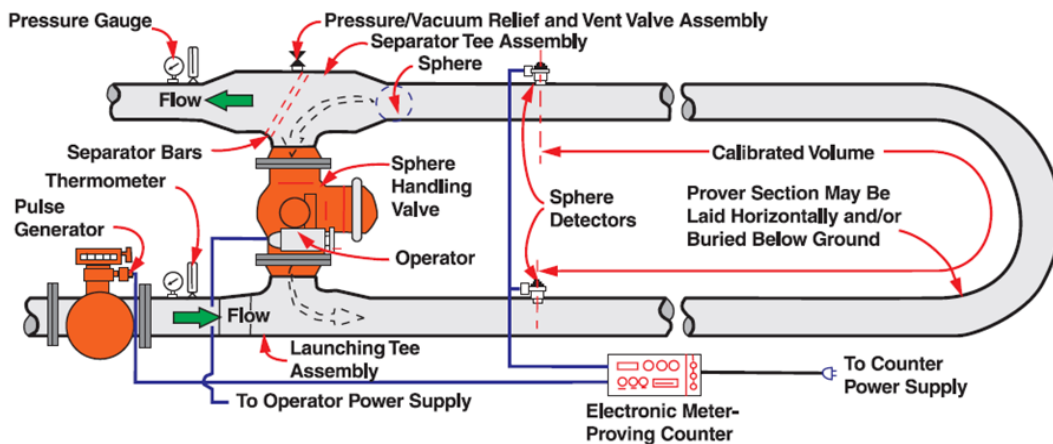
10.1.1 Prover Type

Prover characteristics and configurations will vary based on the type of prover and options you select. The following topics describe each type of prover.

Unidirectional Pipe Prover

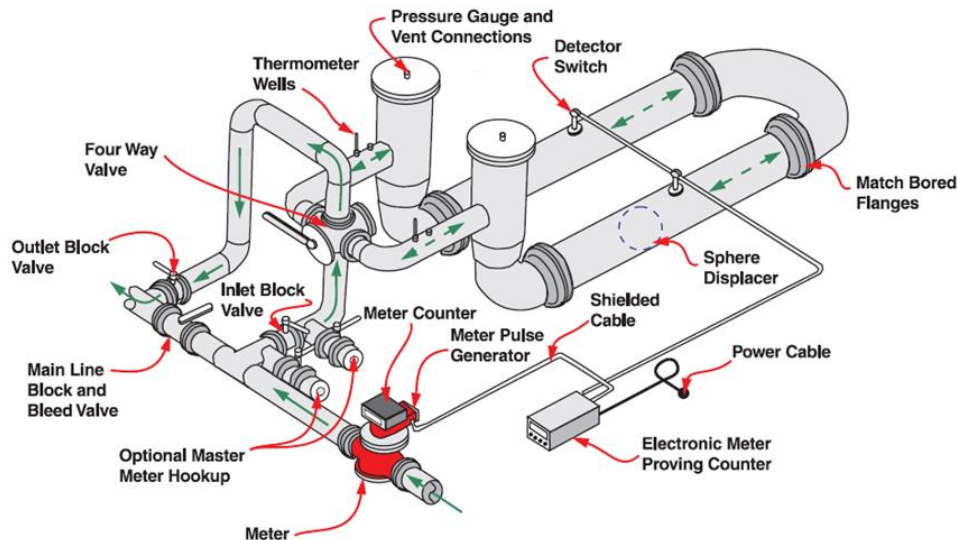
This is a long pipe, with a ball, piston, or displacer that fills the pipe and moves with the fluid flow. At each end of the pipe is a switch that is tripped when the ball passes it. A proving run counts the pulses occurring between the switch trips. A run is prepared by positioning the ball in a *cul-de-sac* upstream of the first switch, ready to be injected into the stream. At the end of the run, the ball is extracted from the stream and returned via another path to the upstream end.

In order to calculate a meter factor with sufficient precision, the prover volume must be large enough to count sufficient pulses. Therefore, unidirectional provers can be quite large.



Bidirectional Pipe Prover

This is similar to a unidirectional prover, except that use is made of the *deadhead* transfer of the ball back to its starting point. Instead of returning the ball via a separate path, valves are swung to reverse the direction of flow in the prover and the ball is returned along its original path to trip the switches a second time in the opposite order. The first pass of the ball is called the *forward leg* and the second is called the *backward* or *return leg*. The pulse count for the run is then the sum of the counts for the two legs. Because the run's pulse count arises from two passes between the switches, a bidirectional prover need be only half the volume of its unidirectional counterpart and can be correspondingly smaller.



Prover Configuration

Prover type: **Bidirectional pipe** System units: US SI

Prover tag: **Prover** Density units: g/cc kg/m3 Rd/60 °API

Read **Result** **Commlink is unavailable** Identification Options

Write **Commlink is unavailable** Process Input Variation Limits

8	Runs per prove	0.0001	Meter factor precision
8	Runs per prove, selected	1	Pulse interpolation ratio
0	Maximum attempted runs before abort	11.16	Flow tube linear coef of expansion (1/°C e-6)
10	Minimum pulses per run (thousands)	15	Base temperature (°C)
0	Maximum seconds per run	0	Base prover volume at 15°C (m3)
32-bit integer	Input format: pulse count for runs	0	Flow tube inside diameter (mm)
cubic meters	Prover size units	0	Flow tube wall thickness (mm)
		206.8	Flow tube modulus of elasticity (kPa e+6)

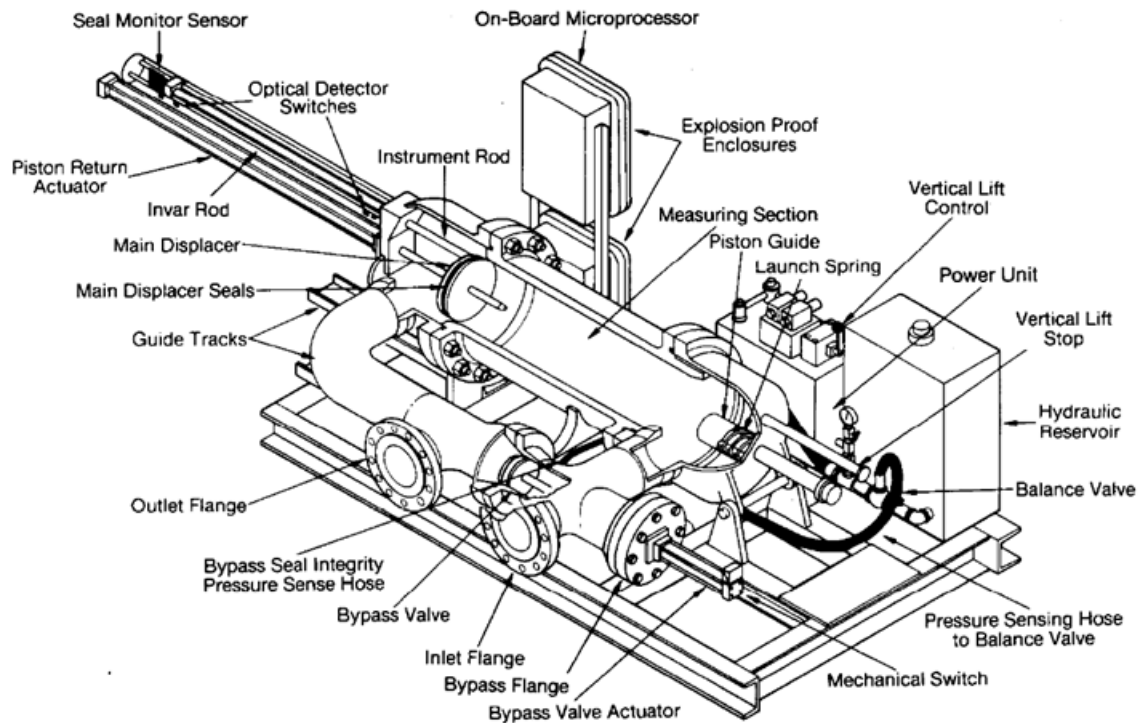
Select the type of prover.
 NOTE: Changing prover type will reset all prover configuration.

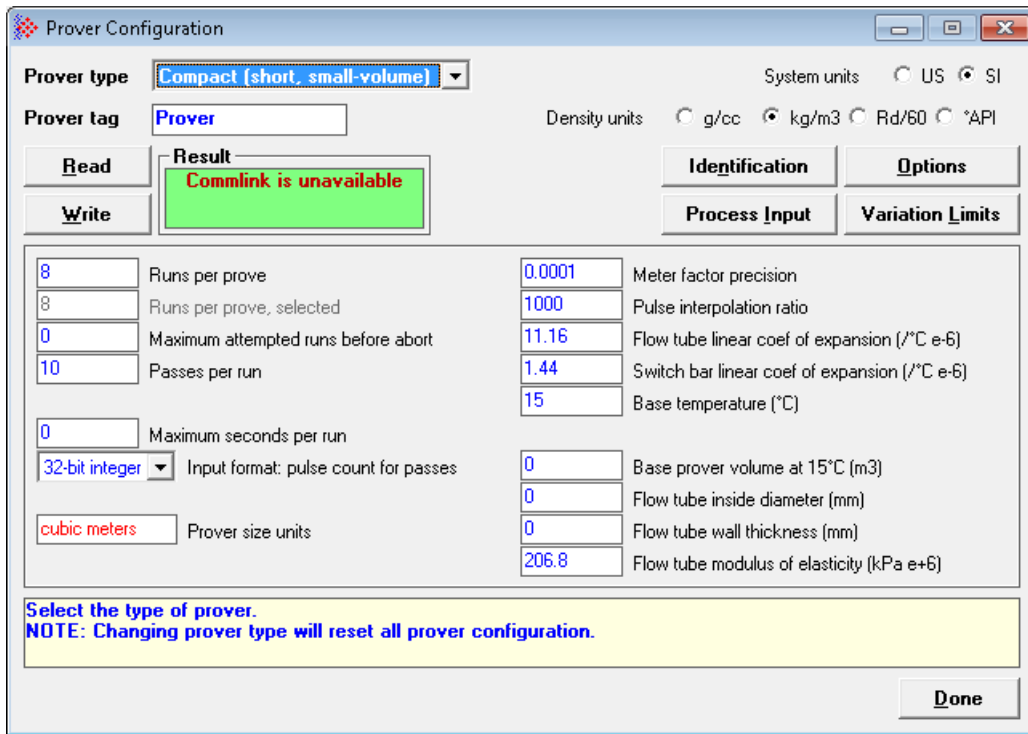
Done

Compact (short, small volume) Prover

Note: While the MVI56E-AFC or MVI69E-AFC modules have support for this type of prover, as of the print of this guide, the Rockwell I/O platform does not support double chronometry pulse input required for accurate prove using this type of prover. Small volume provers can still be used with the MVI56E-AFC or MVI69E-AFC systems, however you will need to run the prove cycle in a third party software package that also provides a high speed counter interface that supports double chronometry pulse input signals. The third party interface will provide you with a new meter factor that can be used on the measurement run.

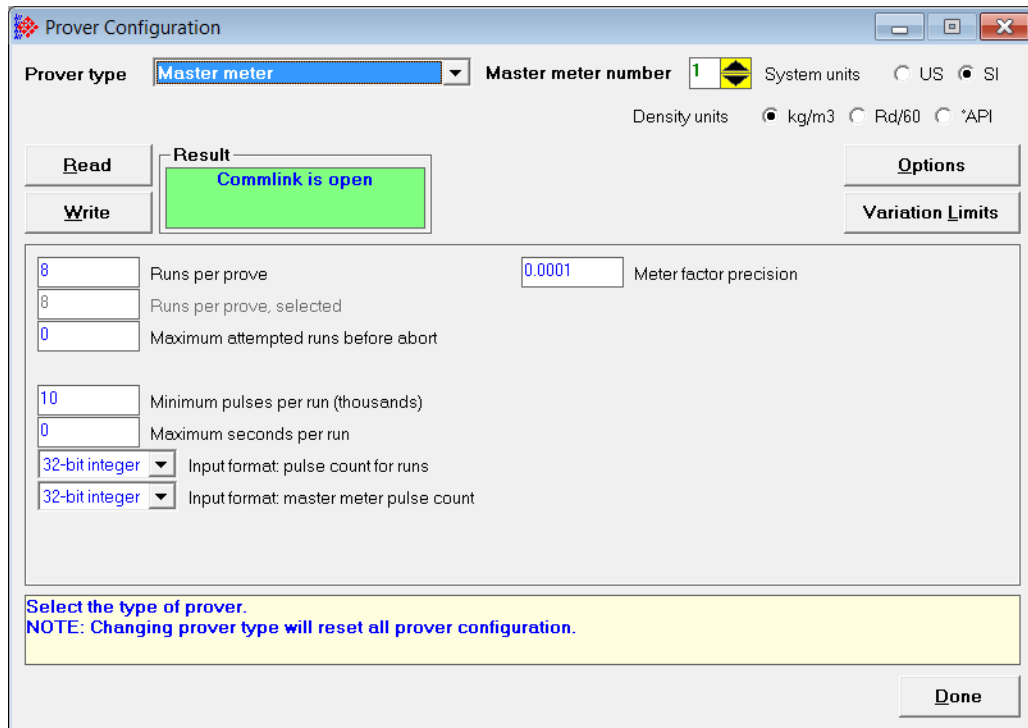
A compact prover, or small volume prover (SVP), has a short barrel or tube with a piston (also called a “displacer”) that travels the length of the tube. The piston has a valve that is opened to allow it to return to its starting point without stopping the flow in the tube. Most SVPs do not mount the switches to be tripped inside the tube. They mount the switches externally on a bar that moves with the piston outside the tube and the switches trip when they move past a fixed point. Each forth and back passage is called a pass. SVPs can be much less expensive than large volume providers (LVPs), so they are often preferred. Due to their small size they can collect at most a few hundred pulses during a pass. The number of pulses in a single pass is a number too small for calculating a meter factor with sufficient precision. The technique of double chronometry is then used to determine a fractional pulse count of sufficient precision. Even though a single pass in a SVP with double chronometry can yield a pulse count similar in precision to that from a single run of a LVP, it is often the practice to accumulate several passes into a single run so that the pulses totaled for all passes of the run yield a number large enough for calculating the required meter factor with sufficiently high precision.





Master Meter

This proving technique proves a meter by comparing its behavior to that of another *master* meter whose behavior is deemed to be accurate. A master meter itself must be proved to a high precision by using a conventional prover.



10.1.2 Prover Options



There are several options affecting the handling and representation of data, as well as affecting the relevance and availability of some configuration items. Not all options are available for all prover types. If an option does not apply to a particular prover type, it cannot be selected. For a description of each option listed below see the corresponding Modbus dictionary address.

- Dual transmitters, temperature
- Dual transmitters, pressure
- Input meter density
- Return leg pulse count is round-trip count
- Prover is double-walled
- External switch bar
- Calculation method: Average Meter Factor (else Average Data)

10.1.3 Run Counts

Runs per prove

The total number of completed runs that constitute a single prove. This value must be at least 2 and must not exceed 8. If *Maximum attempted runs before abort* is non-zero, this value must not exceed that value.

Runs per prove, selected

The total number of completed runs to be selected for contribution to the prove calculations. This value must be at least 2 and not exceed *Runs per prove*. This value is automatically updated when you edit the *Runs per prove* field.

Maximum attempted runs before abort

The total number of runs to be attempted before abandoning a prove as incomplete, which permits an automatic proving sequence to automatically terminate itself under exceptionally variable conditions. If this value is zero, no limit is imposed. Otherwise, the value must be at least as large as *Runs per prove* and must not exceed 65535.

10.1.4 Run Input Setup

Minimum pulses per run (thousands)

The minimum number of pulses required for a run to be considered for contribution to the prove, represented in thousands. This value must lie between 10 (representing 10,000 pulses) and 1000 (representing 1,000,000 pulses). Runs counting 10,000 pulses or more have sufficient precision to enable calculation of 4-digit meter factors. For all prover types except compact SVPs, the AFC module rejects any LVP run that does not meet this condition. Since SVPs can deliver fractional pulse counts that provide sufficient precision with only a small number of pulses, the AFC module does not impose this limitation on prover calculation using SVPs.

Maximum seconds per run

This parameter is a timeout for the duration of a run. A timer is started when the run is started, and if the timer value equals or exceeds this value before the run is completed, then the AFC module automatically cancels the run. This allows an automatic prove to recover from conditions that put the AFC module and the proving hardware out of step, such as a missed switch signal. This value must lie between 0 and 10000, where zero means that no timeout is imposed.

Input format: line meter pulse count

This parameter is a code that specifies the format in which pulse counts for the line meter are delivered to the MVI56xxE-AFC at the ends of runs or passes. These values are:

Value	Format	Description
0	None	No pulse counts are delivered. Used only when no prover is configured
1	32-bit	Pulse counts are delivered as 32-bit (double) integers
2	Floating point	Pulse counts are delivered as IEEE 32-bit floating point values

When a prover is configured, the default setting is 1 (32-bit), except for compact provers, for which it is 3 (floating point).

Input format: master meter pulse count

This parameter is a code that specifies the format in which pulse counts for the master meter are delivered to the AFC modules at the ends of runs or passes. These values are:

Value	Format	Description
0	None	No pulse counts are delivered. Used when the prover is not a master meter.
1	32-bit	Pulse counts are delivered as 32-bit (double) integers.
2	Floating point	Pulse counts are delivered as IEEE 32-bit floating point values.

When a master meter is configured, the default setting is 1 (32-bit). This parameter is meaningful only when using master meter provers.

10.1.5 Prover Characteristics

Prover Characteristics vary based on the type of prover and options you select. The following topics describe each field and its operating range.

Prover size units

This parameter sets the units in which the prover's base volume is represented. This parameter is not meaningful for master meter provers.

Meter factor precision

This parameter is a number between 0.00000001 and 0.0001. The default setting is 0.0001.

EAFC Manager uses the value of *Meter factor precision* to calculate the rounded value of the *Meter factor* parameter. This calculation is performed as follows:

1 *Meter factor rounding scale factor* = floor(1/*Meter factor precision* + 0.5)

2 Rounded *Meter factor* value = floor(*Meter factor* * *Meter factor rounding scale factor* + 0.05) / *Meter factor rounding scale factor*

Note: The *floor* function returns the greatest integer value less than or equal to the input value.

Examples are as follows:

- If *Meter factor* has a value of 1.00005, then the rounded *Meter factor* value at a *Meter factor* precision of 0.0001 would be 1.0001.
- If *Meter factor* has a value of 1.0000499, then the rounded *Meter factor* value at a *Meter factor* precision of 0.0001 would be 1.0000.

Pulse interpolation ratio

Meter-proving pulse counts delivered to the MVI56E-AFC may be fractional, such as when double chronometry is used with a SVP. This value is the number of delivered counts that constitute a single actual pulse, so that the actual pulse count is determined by dividing the delivered count by this. The default value is 1000.0 for compact provers and 1.0 for other types. This parameter is meaningful only for non-master meter provers.

Flow tube linear coefficient of thermal expansion

Holds the coefficient of thermal expansion of the prover barrel material, meaningful only for non-master-meter provers. Here are some typical materials and their expansion coefficients.

- | | | |
|------------------------------|-----------|------------|
| • Stainless steel 304 or 316 | 9.3e-6/°F | 16.7e-6/°C |
| • Monel | 7.9e-6/°F | 14.3e-6/°C |
| • Carbon steel | 6.2e-6/°F | 11.2e-6/°C |
| • Invar | .8e-6/°F | 1.4e-6/°C |

Switch bar linear coefficient of thermal expansion

Holds the coefficient of thermal expansion of the external switch bar material, meaningful only for non-master-meter provers with option *External switch bar* (register 65011 bit 6) set. Here are some typical materials and their expansion coefficients.

- | | | |
|------------------------------|-----------|------------|
| • Stainless steel 304 or 316 | 9.3e-6/°F | 16.7e-6/°C |
| • Monel | 7.9e-6/°F | 14.3e-6/°C |
| • Carbon steel | 6.2e-6/°F | 11.2e-6/°C |
| • Invar | .8e-6/°F | 1.4e-6/°C |

Base prover volume

Holds the base volume of the prover barrel as determined by the water-draw method, in the units specified by *Prover size units*. This parameter is meaningful only for non-master meter provers.

The accepted standards mandate that the base volume of a bidirectional prover be that registered by a round trip of the displacer.

Flow tube inside diameter (mm)

This parameter is the measured inside diameter of the prover barrel at standard (base) conditions and is meaningful only for non-master meter provers with the option *Prover is double-walled clear*.

Flow tube wall thickness (mm)

This parameter is the measured thickness of the prover barrel wall, and is meaningful only for non-master meter provers with the option *Prover is double-walled* clear.

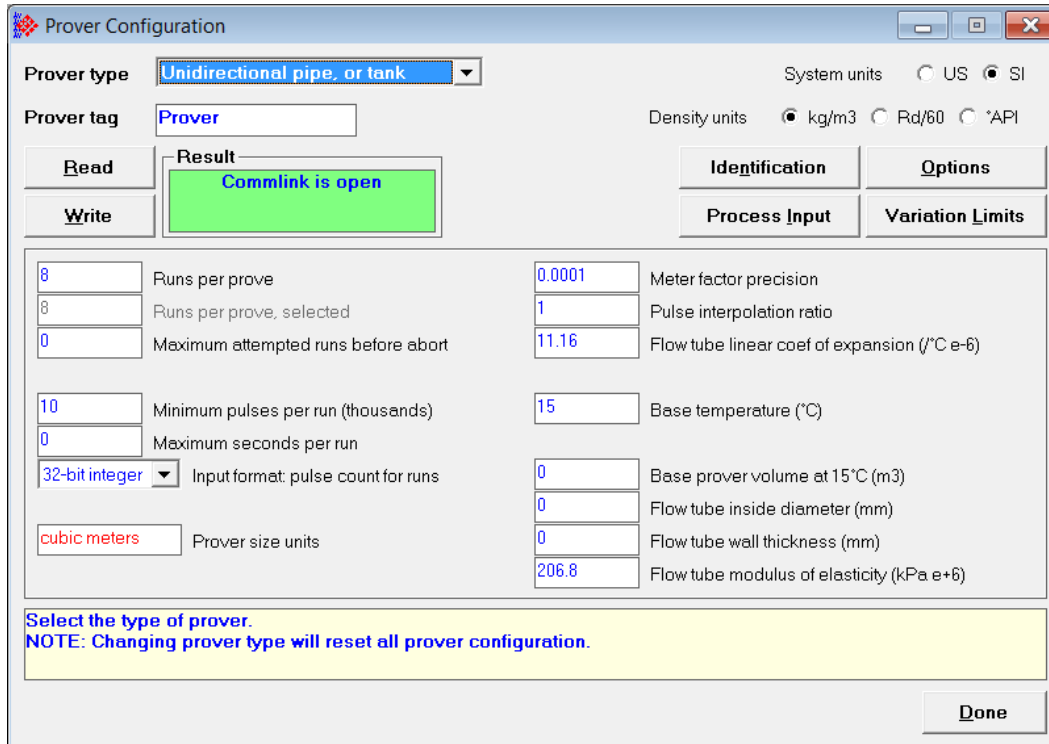
Flow tube modulus of elasticity

This parameter is the prover barrel material modulus of elasticity, and is meaningful only for non-master meter provers with the option *Prover is double-walled* clear. The default value is that of carbon steel, 206.8e+6 kPa.

10.2 Meter Proving Process

First, configure the parameters in the *Prover Configuration* dialog box. A Bidirectional Pipe Prover is shown in this example.

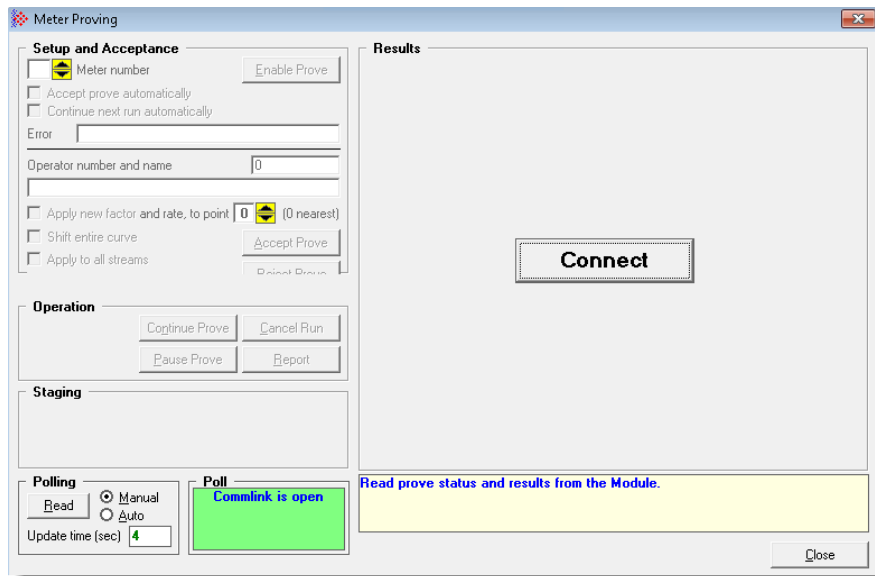
Note: Changing prover type will reset all prover configuration.



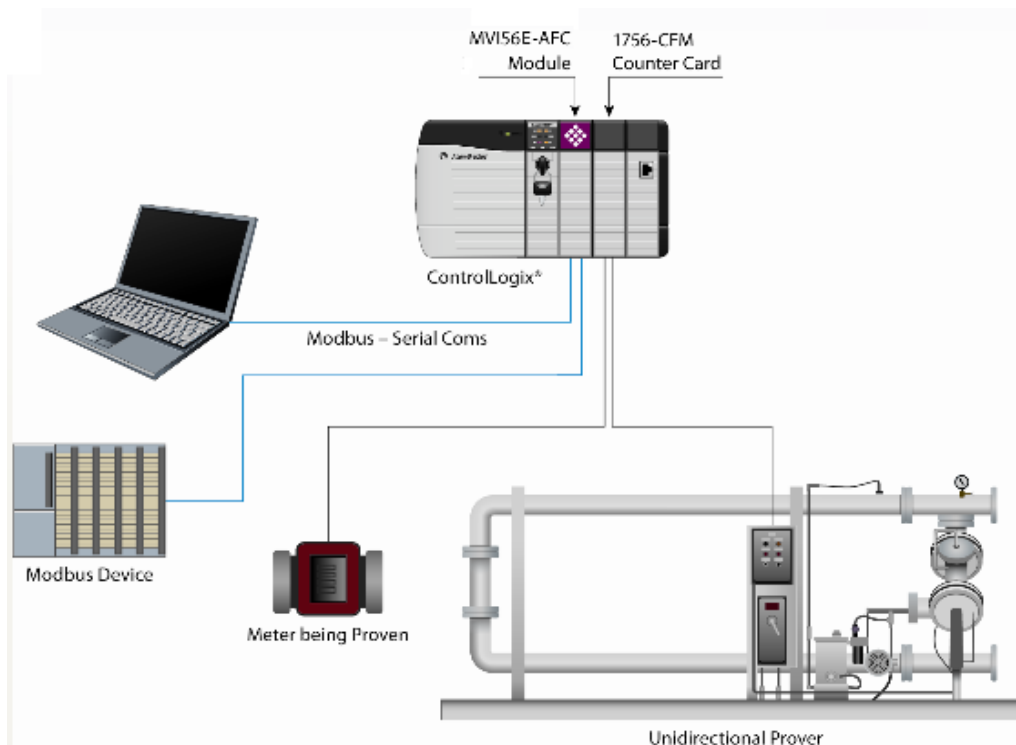
Please note that the bottom portion of the window provides help and suggestions.

Meter Proving dialog box

This window is used to connect to the module to manage the prove and/or monitor prove status and results from the Modbus database.

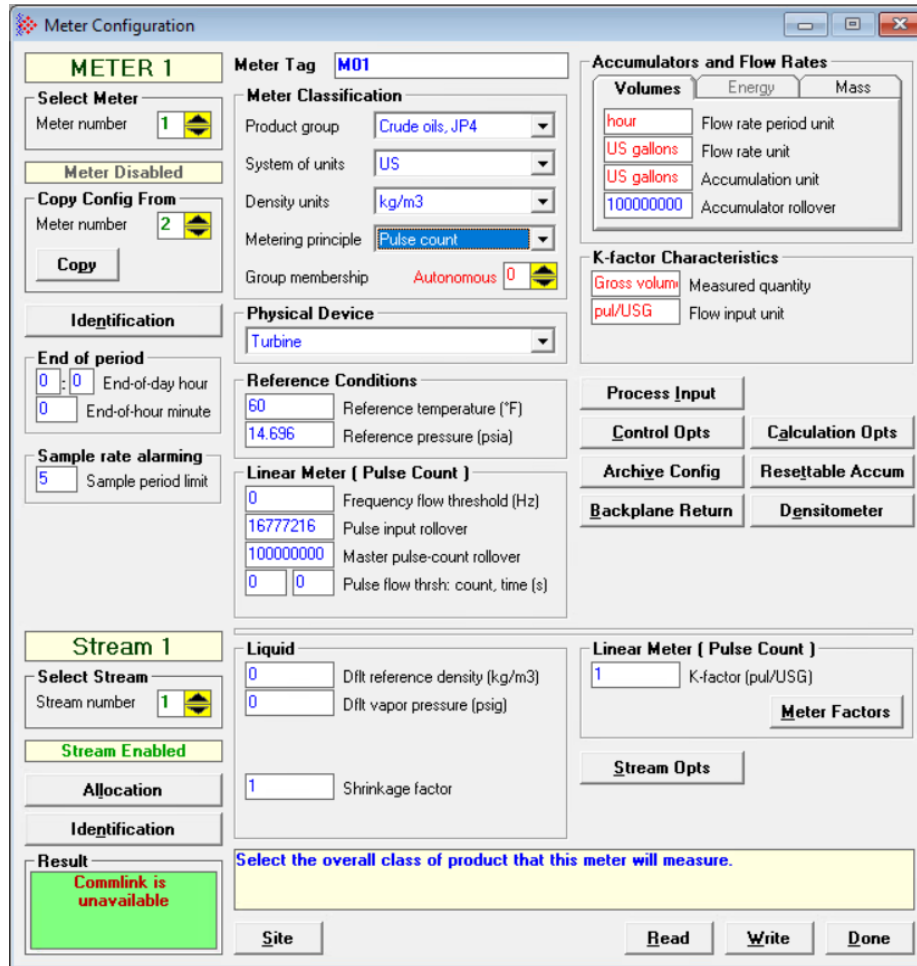


This is a typical configuration for a meter proving setup. Your application may vary from the example shown.

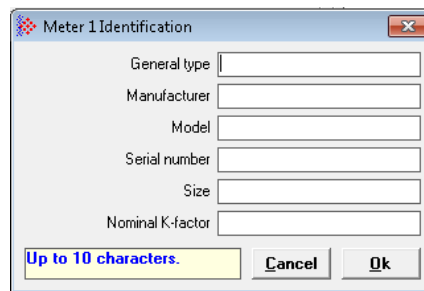


10.2.1 Initial Requirements

In its current version, the AFC module proving of only liquid products, measured with linear devices that use pulse counts as the primary input variable, where each pulse represents a quantity of liquid volume.



In the *Meter Configuration* dialog box above, Meter 1 is used in this example as the meter selected to be proved. It can be proved using any one of the four provers that the AFC modules support. These provers are described in the *Prover Configuration* section. There is an Identification button which opens an editable options window, shown below. Text entered here appears on the proving report.



10.2.2 Meter Proving Alarms

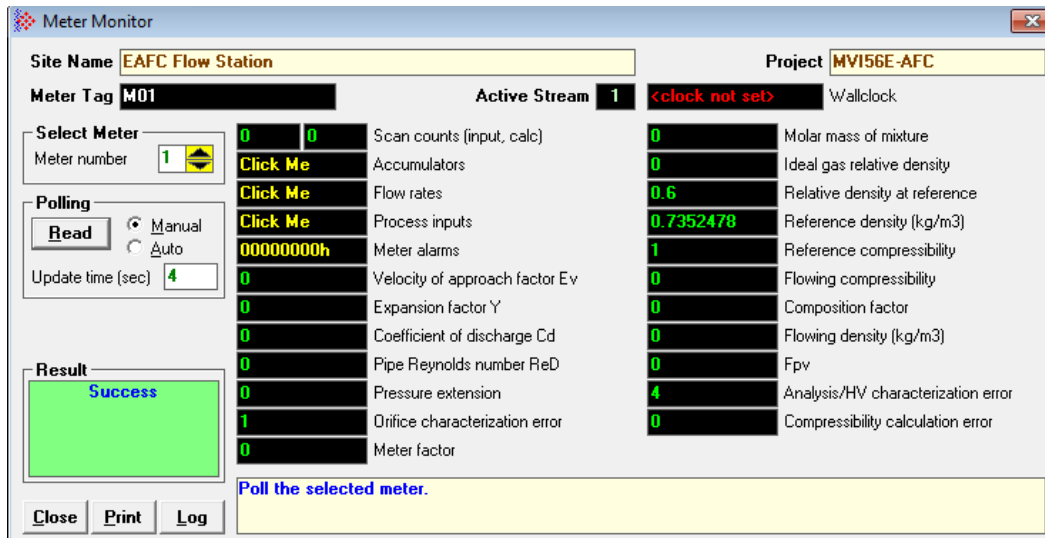


These alarms are transient and any one might exist only for a single scan, so they might be missed when viewing this register directly. However, alarms are also accumulated into the results database, so alarms that have occurred during any run may be viewed by inspecting that database.

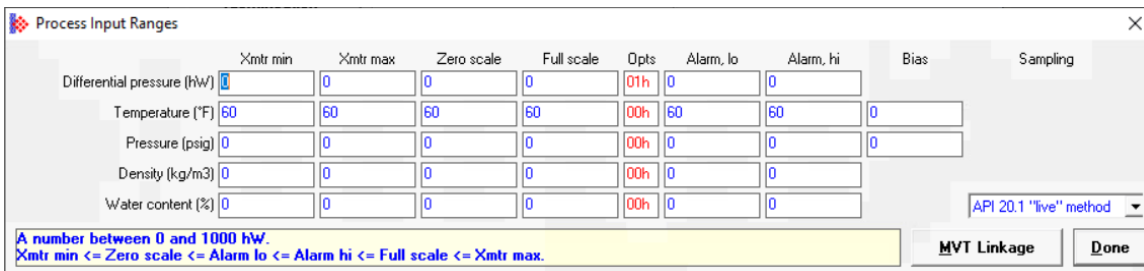
To Check for Alarms

- 1 Activate *Meter Monitor* dialog.
- 2 Select *Meter* to be proved.
- 3 Click on the **READ** button.

Note: Verify that the meter is not generating any alarms. Meter proving cannot proceed while any alarm is displayed.



This is accomplished by providing process parameter values that are within the ranges defined in the *Process Input Ranges* dialog box.



There are two sources of *alarms*:

- From the meter, which occur whether or not a prove is in progress. These are illustrated above.
- From the prove, and there are 2 types:
 - a) Variation Limit Alarms
 - b) Prove Calculation Alarms

Note: An alarm will make a run unselectable.

Variation Limit Alarms

These alarms are due to variation outside the configured limits:

Bit/Byte	Description
01	Prover inlet temperature
02	Prover outlet temperature
03	Prover inlet-outlet temperature
04	Prover temperature
05	Prover-meter temperature
06	Switch bar temperature
07	Meter pressure
08	Prover inlet pressure
09	Prover outlet pressure
10	Prover inlet-outlet pressure
11	Prover pressure
12	Prover-meter pressure
13	Meter density
14	Prover density
15	Prover-meter density
16	Water content
17	Meter flow rate
18	Prover flow rate
19	Pulses over runs
20	Pulses over passes
21	Not enough pulses in run
22 to 31	[Reserved]

Prove Calculation Alarms

These alarms arise from prove calculations (e.g. outside API limits):

Bit/Byte	Description
00	[Reserved]
01	CTS prover
02	CPS prover
03	[Reserved]
04	High water

Bit/Byte	Description
05	CTW
06	CPW
07	Density correction
08	CTL prover
09	CPL prover
10	CSW prover
11	Vapor pressure prover
12	CTL meter
13	CPL meter
14	CSW meter
15	Vapor pressure meter
16	Repeatability
17	Change in factor
18 to 22	[Reserved]
23	Divide by zero
24 to 31	[Reserved]

10.2.3 Prover Operation (Performing a Prove)

You must first configure a prover, and configure the channel of a Configurable Flow Meter (CFM) or High Speed Counter (HSC) module for proving.

Note: CFM modules are available for the 1756 platform from Rockwell Automation,. Any HSC card will work for the other modules, but if you use an HSC, you will need extra ladder logic in the PLC to implement proving.

Once the parameters for the proving session have been configured, (pipe diameter, water-draw volume, wall thickness, tolerances and limits on the variation of temperature, flow rate, and other process variables), and the prove setup has been completed, the entire proving session can be completely automated within the PLC ladder logic.

Steps for proving a meter:

- 1 Enter the prover parameter and variation limits (configuration).
- 2 Enter the number of meters to be proved (setup).
- 3 Set the **ENABLE PROVE** signal bit. This function verifies that the selected meter is provable (a liquid pulse meter), and clears the proving results for a new proving session.

- 4 Enable the counter card channel for proving, and launch the ball. When the first switch is tripped, set the **RUN START** signal bit. During the run, continuously copy the prover temperature, pressure, density, etc. to the AFC module, so that it may monitor their variation and accumulate them for final averaging. For the same purpose, the module itself retrieves meter process variables directly from the meter input from the PLC without PLC intervention.
- 5 When the second switch is tripped, copy the final pulse count from the counter card channel to the proper location and set the **RUN STOP** signal bit. This function computes results for the completed run (averages of process variables, variation limit alarms, etc.), and also computes results for the entire prove over all completed runs (averages of run averages, variation limit alarms, API calculations and calculation alarms, final meter factor and change in meter factor, and number of completed runs). Upon a *Run Start* or *Accept Prove* signal, any bad runs are deleted from the prove before continuing with the remainder of the signaled function.
- 6 When a sufficient number of runs have been completed, set either the *Accept Prove* or the *Reject Prove* signal, which function marks the data in the prover results accordingly.

Missed Switch

It is possible that the tripping of the second switch to end a run is not seen by the PLC (due to a broken wire or poorly lubricated switch), leaving the AFC module and the physical prover in inconsistent states. You may recover from this condition with the *Run Cancel* signal, which clears any active run and resets the AFC module to be ready to start a new run. Data from any bad run will also be deleted by the *Run Cancel*.

Proving Controls

These bits supply parameter information to the *Enable prove* and *Accept prove* signals. Control bits 0 through 7 parameterize the *Enable* and bits 8 through 15 parameterize the *Accept*. Controls are latched into the results database upon receipt of a signal. Changes thereafter have no effect on the state of these control bits.

Proving Signals

A prover signal instructs the AFC module to immediately perform a particular function once. A signal bit is latched by the process issuing the signal (for example, the PLC) and is unlatched by the module when the function has been performed. Prover signals are discharged upon the next proving scan, before which several Modbus transactions may be completed, hence, a read of the signal word may show pending undischarged signals.

Prover Sequencing

This parameter reports the state of the proving hardware, making it available to the prove-management software for display of prove status and possible control of the prove. The prove-management feature of uses it only for display. This value usually comes from the proving hardware integrated into the PLC platform, therefore it is normally supplied by the PLC.

Prover Phase

These bits report the state of the run as known by the proving hardware. These values are chosen specifically for compatibility with several kinds of proving hardware, so that the work necessary for the PLC to translate hardware register values into these values required by the AFC module is minimized and in many cases can be reduced to a simple mask-and-copy. There are 8 values ranging from 0 to 7.

These values are:

Value	Name	Description
0	Prover not selected (not ready)	This is the normal value when no proving run is in progress.
1	Prover active, not yet counting	The counter card has been initialized for a proving run, but the ball or piston has not yet passed the first switch. Counting of the pulses for the run has not yet begun.
2	Prover active, past first switch and counting	The ball or piston has passed the first switch but not yet passed the second switch, and the run counter is counting pulses. For bidirectional provers, this is the forward leg.
3	Prover active, past second switch	This state is for bidirectional provers only. The ball or piston has passed the second switch of the forward leg, the run counter has been stopped, and the intermediate count for the forward leg is available. During this state, the proving hardware should be swinging valves to reverse the stream's direction of flow through the prover, preparing it for the return leg.
4	Prover active, past first switch return leg	This state is for bidirectional provers only. The ball or piston has passed the first switch on the return leg but not yet passed the second switch, and the run counter is counting pulses.
5	Run Complete	The ball or piston has passed the second switch (for bidirectional provers, the second switch of the return leg), the run counter has been stopped, and the count for the run is available. For a bidirectional prover, this count may be either the count for only the return leg or the count for the entire run; use prover option "Return leg pulse count is round-trip count" (register 65011 bit 4) to specify which.
6	Prover not selected (not ready)	Some kinds of proving hardware report this value for a counting mode unrelated to proving. The MVI56E-AFC treats this value the same as value 0.
7	Prover not selected (not ready)	Some kinds of proving hardware report this value for a counting mode unrelated to proving. The MVI56E-AFC treats this value the same as value 0.

Prover Position: Ready for Launch

The prover's displacer is ready for launching into the stream. For a bidirectional prover, this is the launch of the forward leg.

Prover Position: Ready for Return

For bidirectional provers only, the prover's displacer is ready for launching into the stream for the return leg.

Prover Position: Valve Sealed Behind Ball

The prover's displacer has been launched into the stream and the sealing valve has been closed behind it. For a bidirectional prover, this is the start of the forward leg.

Prover Position: Valve Sealed Behind Ball, Return Leg

For bidirectional provers only, the prover's displacer has been launched into the stream for the return leg and the sealing valve has been closed behind it.

Proving Process Inputs

Absolute

This value is the process input pressure of the prover (traditional or master meter) in absolute units. This value is calculated as (gauge pressure) + (barometric pressure). This value is meaningful only while a prove is active.

Gauge

This value is the process input pressure of the prover (traditional or master meter) in gauge units. For a traditional prover with dual transmitters, this is the average of the two inputs. This value is meaningful only while a prove is active. This information is found in the Modbus dictionary.

Prove-enable Error Code

This code reports the result of the most recent attempt to enable a prove. If the code is zero, the prove was successfully enabled; a non-zero code reports the reason for failure. The values are:

Value	Name	Description
0	The new prove has been enabled	The new prove has been enabled.
21	Requested meter number	The Requested meter number (register 65300) is out of range, or, for a master meter prover, is the same as that of the master meter (an attempt to self-prove the master meter).
22	Line meter not liquid pulse	At the present time, the meter to be proved may only be a liquid pulse meter.
23	Incompatible measurement standard	At the present time, the configuration of both the prover and the line meter to be proved must specify the same system of measurement units (US, SI) and the same liquid density units selection (kg/m3, Rd/60, °API).
24	Unimplemented product group	<p>Because of the nature of the proving calculations at the present time, not all product groups are provable. Meters configured for these product groups are provable:</p> <ul style="list-style-type: none"> ▪ Liquid (crude oils and JP4) ▪ Liquid (refined products: gasolines, jet fuels, fuel oils, except JP4) ▪ Liquid (NGLs and LPGs) ▪ Liquid (lubricating oils) ▪ Liquid (special applications) <p>Meters configured for these product groups are not provable:</p> <ul style="list-style-type: none"> ▪ Gas ▪ Liquid (oil-water emulsion of crudes) ▪ Liquid (oil-water emulsion of NGLs)
25	Unimplemented measured quantity	At the present time, only pulse meters whose pulse train represents gross volume can be proved.
28	Line meter in calibration	The meter to be proved has at least one process input in calibration mode. Ensure that all process inputs are <i>live</i> before attempting to prove the meter.
29	Line meter not enabled	The meter to be proved is not enabled.

32	Master meter not liquid pulse	At the present time, a master meter prover must be a liquid pulse meter.
33	Master meter incompatible configuration	For a master meter prover, both the line meter and the master meter must be compatibly configured, including identical settings of: <ul style="list-style-type: none"> ▪ System of measurement units (US, SI) ▪ Liquid density units (kg/m³, Rd/60, °API) ▪ Product group ▪ Measured quantity (gross volume pulses) ▪ Reference conditions (base temperature and pressure) ▪ API calculation options (selection of density, temperature, and pressure corrections) ▪ For product group 8, <i>Special applications</i>, the coefficient of thermal expansion <i>Alpha</i>
38	Master meter in calibration	The master meter has at least one process input in calibration mode. Ensure that all process inputs are <i>live</i> before attempting to use the master meter for proving.
39	Master meter not enabled	The master meter is not enabled.
51	Invalid prover parameter	For a traditional (non-master-meter) prover, the base prover volume (register 65036) must be greater than zero, and, if the prover is single-walled, the inside diameter, wall thickness, and modulus of elasticity (registers 65038, 65040, and 65042) must all be greater than zero.
52	Invalid prover controls	Some undefined bits in the <i>at-enable</i> controls (register 65306 bits 0 through 7) have been set.

10.3 Meter Proving Reports

The **REPORT** button generates a report with information such as:

- Manufacturer
- Model Number
- Serial Number
- Material Type
- Prover Tag

Results of the prove appear in this report, along with the static data entered in the text window during startup.

The screenshot shows a software window titled "Meter Proving Report" with a close button in the top right corner. The window displays the following information:

1/13/2017 4:17:43 PM

General

Operator	0
Location	AFC Flow Station
Product	
Date & time	<rejected>
Report number	1

Meter Data

General Type		Meter number	11
Manufacturer		Stream number	1
Model		Nominal K-factor	
Serial number		Flow rate (m3/h)	3600
Size		Temperature-compensated	No

Prover Data

General Type		Inside diameter (mm)	25
Manufacturer		Wall thickness (mm)	50
Model		Calibrated volume at 15°C (m3)	1
Serial number			
Material			

At the bottom of the window, there are five buttons: "Meter Pulses" (highlighted with a dashed border), "Process Input", "Calculations", "Close", and "Print".

This window provides prover information in a report format. To print as a report, click the **PRINT** button.

Setup and Acceptance

12 Meter number

Accept prove automatically.
 Continue next run automatically

Error: _____

Operator: _____

Apply new factor and rate, to point 0 (0 nearest)
 Shift entire curve
 Apply to all streams

Operation

Staging

Meter flow rate, Gross (MCF/h) **2.1708**

Run 2 Ready Running Complete

Polling

Manual Auto
 Update time (sec) 4

Poll

Results

Meter 12 Stream 1 MMstrm 1 Runs: 2 completed 2 selected 2 attempted
 Begun 1998-01-02.23:06 Updated 1998-01-02.23:08 Accepted
 Prove Enabled Factor application by stream ...

1: Not applied 2: Not applied 3: Not applied 4: Not applied
 5: Not applied 6: Not applied 7: Not applied 8: Not applied
 9: Not applied 10: Not applied 11: Not applied 12: Not applied
 13: Not applied 14: Not applied 15: Not applied 16: Not applied

	Prove	Run 1	Run 2
Readings			
Number of samples	136	68	68
Process input alarms	00000000h	00000000h	00000000h
Readings alarms	00000000h	00000000h	00000000h
Meter temperature (°F)	60.5	60.4	60.5
Prover temperature (°F)	60.5	60.5	60.6
Meter pressure (psi)	45	45	45
Prover pressure (psi)	45	45	45
Meter density (kg/m3)	820.1	819.6	820.6
Water content (%)	0.04	0.04	0.04
Meter flow rate (MCF/h)	2.10352	2.103674	2.103366
Prover flow rate (MCF/h)	2.103406	2.102204	2.104608
Pulse counts			

The *Meter Proving* window above shows the system during a prove using a Master Meter. Notice the differences in the example of the information that is available before and after connecting to the module.

10.4 Protected Meter Proving Data in the Input Register Bank

The data concerned with Meter Proving is maintained in the AFC module's Input Register Bank, protected from change from outside. There are two areas described in the Modbus Dictionary under these selections:

- Prove Results (Input registers 62400 to 63737)
- Meter Previous Prove Summary:
 - a) Meter 1 (Input registers 540 to 599, 60 registers)
 - b) Meter 2 (Input registers 1540 to 1599, 60 registers)
 - c) Meter 3 (Input registers 2540 to 2599, 60 registers)
 - d) Meter 4 through 16...

10.4.1 Prove Results

This area contains the details of the latest prove that has been enabled:

- Prove setup
- Prover and proved-meter configuration summary
- Prove state
- Prove-level calculations
- Run-level input and calculations for each run of the prove

This area supplies most of the information presented on the proving report (the remaining info comes from the proved meter's *Previous Prove Summary*; see next). The contents of this area persist until a new prove is enabled, so a proving report may be regenerated at any time after the prove has been completed and before the next one is started. There is only one such area for all meters on the AFC module; therefore enabling a new prove for any meter resets the Prove Results from the last completed prove, regardless of which meters were involved.

The *Latest Prove Results* is a block of 1310 registers, starting at input register 62400 and proceeding through register 63709.

Name	Module Memory Address	Description
Prove Status	62400 to 62409	Occupies 10 registers
Prove Setup	62410 to 62553	Occupies 140 registers and protects meter configuration and prove setup information for use by proving calculations and report generation; this information remains unchanged from the moment of enable, regardless of how the original source information might be altered during or after the prove
Prove Acceptance	62554 to 62579	Occupies 22 registers and records timestamps associated with the prove, accumulator totalizer values, and details of the disposition of the new meter factor upon acceptance of the prove.
Prover Configuration	62580 to 62661	Occupies 80 registers and has the same purpose as Prove Setup, to protect the prover configuration against subsequent changes so that proving can proceed under reliably constant parameters, and so that the proving report can be generated and regenerated according to the original conditions of the prove.
Prove Only Calculations	62662 to 62675	Occupies 10 registers and contains a few calculated values that are applicable only for the prove as a whole.

Name	Module Memory Address	Description
Reading and Calculations for Prove	62676 to 62793	Occupies 116 registers and the "readings" part contains the averages of the corresponding readings for all runs of the prove. The "calculations" part contains calculations performed upon the prove-level readings if calculation method "average data" was chosen.
Reading and Calculations for Runs	62794 to 63737	Occupies 166 registers for each of up to 8 runs of the prove. The layout of each block of 116 registers is identical to that of the Readings and Calculations for Prove block. The "readings" part contains the weighted averages or snapshots of all process input and counter card input for the duration of the run. The "calculations" part contains calculations performed upon the run-level readings if calculation method "average meter factor" was chosen.

The *Latest Prove Results* area has a fixed layout so that any point can always be found at the same location regardless of setup, and with a collection of points intended to be sufficient for a variety of setups. Consequently, many points will be irrelevant for a given combination of prover configuration, meter configuration, and prove setup. Those irrelevant points will have zero values in the *Results* area and can be ignored. 's *Meter Proving* window does not show irrelevant points.

10.4.2 Meter Previous Prove Summary

Found in the Modbus Dictionary, this area contains summary data for the previous prove of each of the AFC's meter runs. Each time a new prove is enabled and before the *Prove Results* area is reset, summary prove information for the meter previously proved (if any) is copied to the meter's *Previous Prove Summary* block, overwriting the old information. This area supplies a small amount of the information presented in the proving report.

The *Previous Prove Summary* block for each meter occupies 60 registers. Meter #1's block begins at input register 540, Meter #2's block is at 1540, and so on, with an offset of 1000 registers per meter.

10.4.3 Prover Temperature

Absolute

This value is the process input temperature of the prover (traditional or master meter) in units relative to absolute zero, and is required for some calculations. This value is meaningful only while a prove is active.

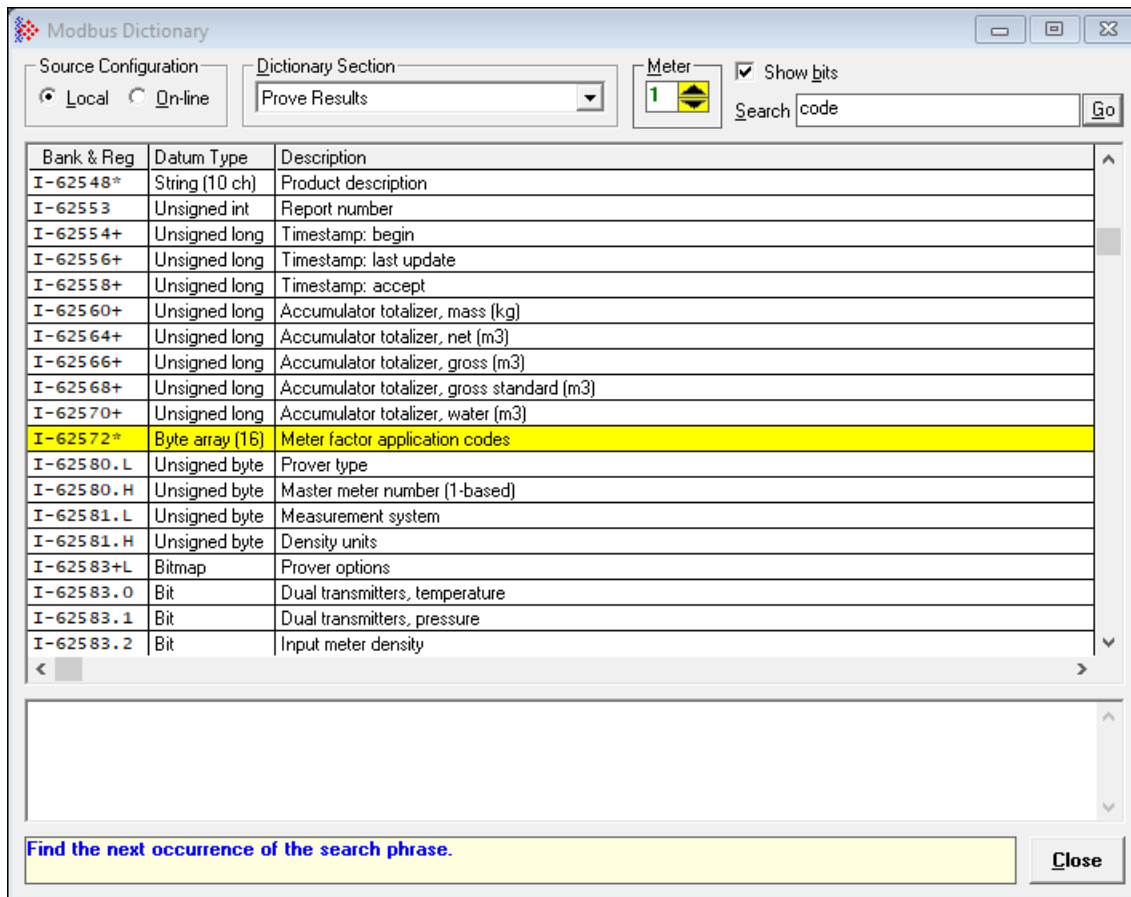
Conventional

This value is the process input temperature of the prover (traditional or master meter) in conventional units. For a traditional prover with dual transmitters, this is the average of the two inputs. This value is meaningful only while a prove is active.

This information is found in the Modbus Dictionary.

10.5 Meter Factor Application Codes

The *Meter factor application codes* data point is a byte array that indicates how the meter factor was applied for each meter.



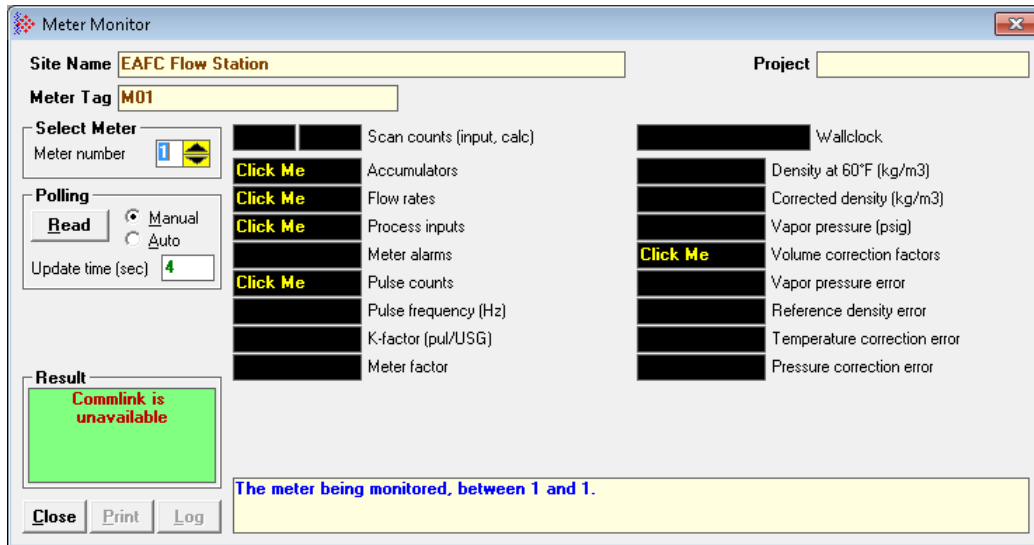
The following table explains the possible values for the *Meter factor application codes* data point.

Value	Description
Greater than 0	Applied (with flow rate) to this interpolation point
-1	Applied to all interpolation points
-2	Applied to static factor (intpl KF)
128	Event log full; not applied
0	Application not performed

11 Meter Monitor

11.1 Accessing the Meter Monitor Dialog

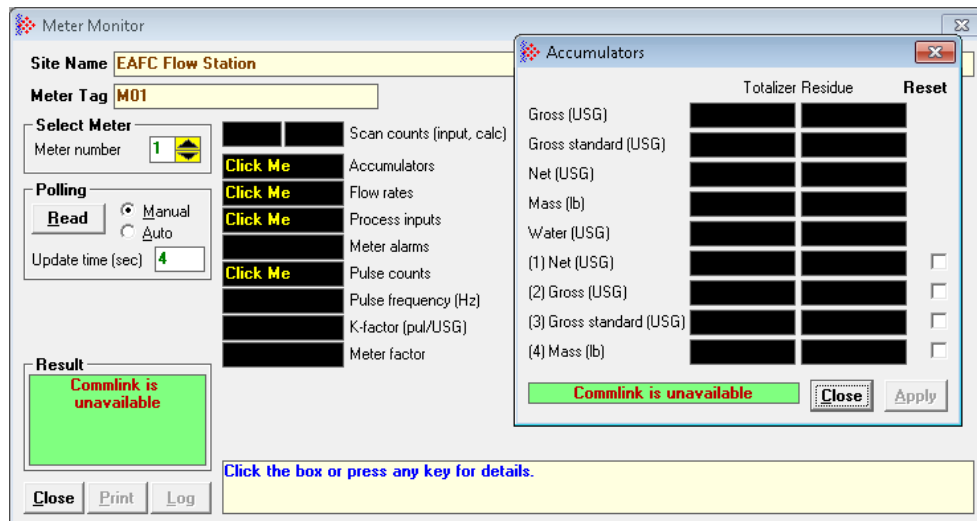
- 1 Within EAFC Manager, navigate to **ON-LINE > METER MONITOR**.



- 2 The *Meter Monitor* dialog provides you with information on a particular monitor. Select the *Meter Number* from the drop-down and click the **READ** button to poll the meter.
- 3 Click the fields with the word **CLICK ME** to obtain additional information on Accumulators, Flow rates, and Process Inputs.

11.2 Accumulators

- 1 Click the **ACCUMULATORS** field to display the *Meter Accumulators* dialog.

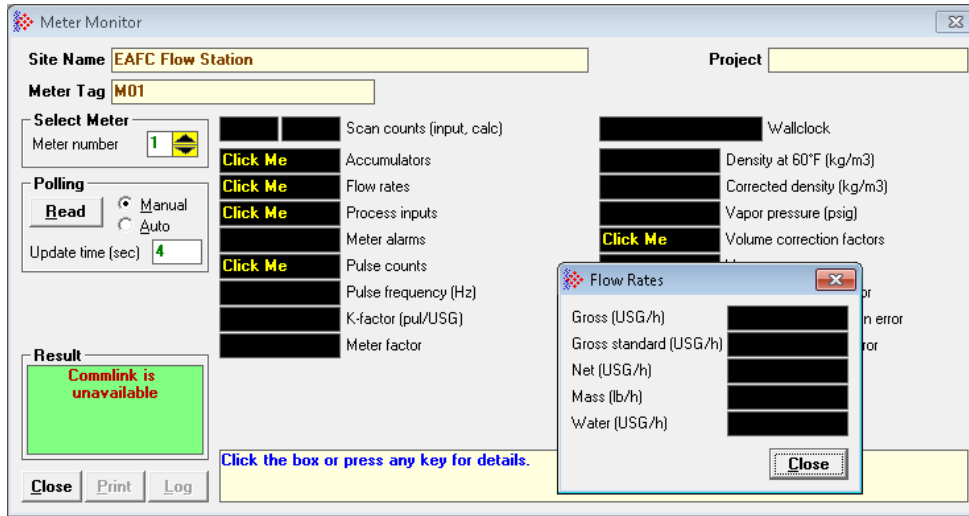


- 2 To reset an accumulator, click the checkbox to the right of the appropriate field and then click **APPLY**.

Note: Only resettable accumulators will be cleared after this action.

11.3 Flow Rates

- 1 Click on the Flow rates field to display flow rates for the selected meter.

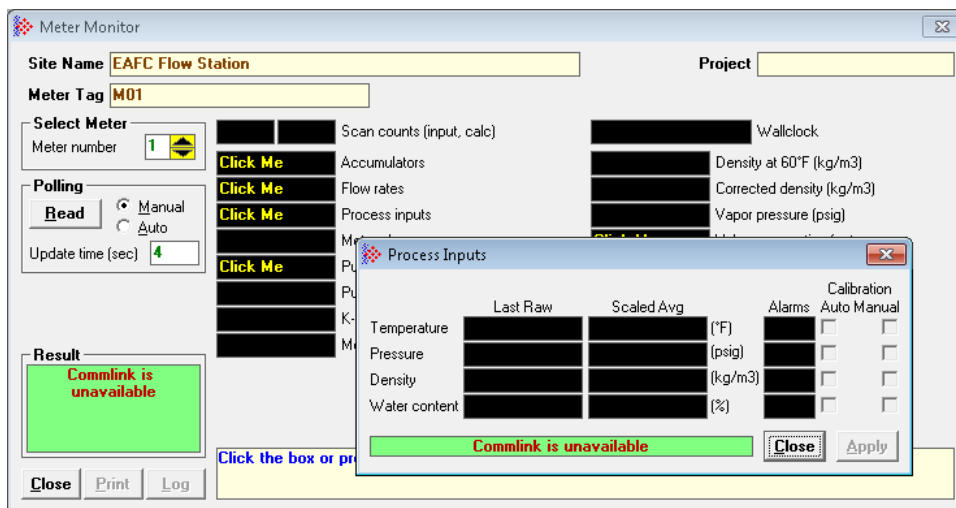


- 2 Click **CLOSE** to close the dialog.

11.4 Process Inputs

11.4.1 Viewing Process Inputs

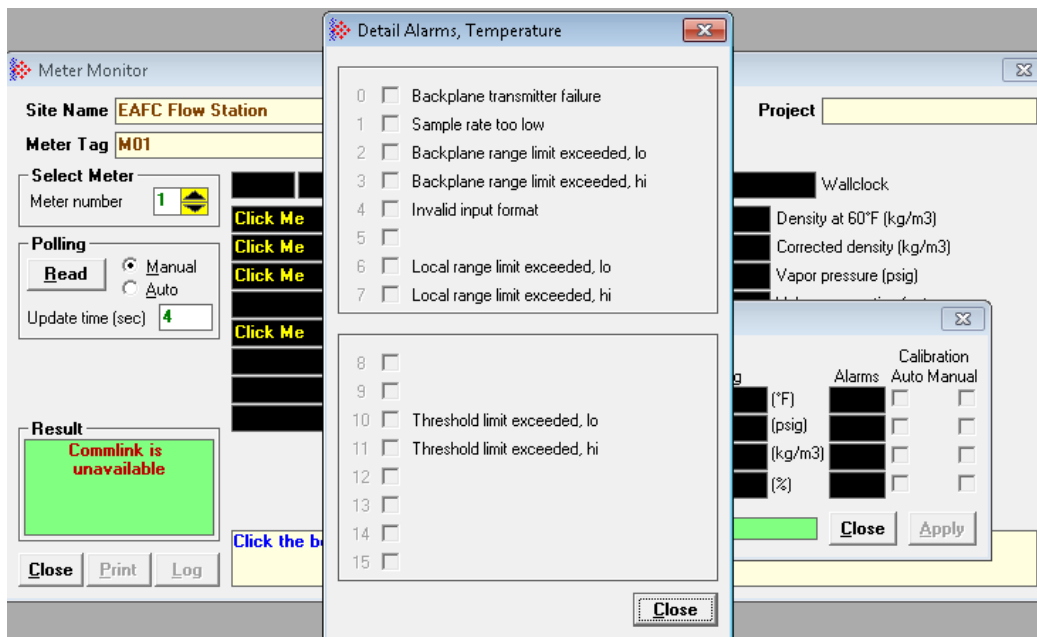
- 1 Click on the **PROCESS INPUTS** field to display the *Process Inputs* dialog.



- 2 The current value for the Process Inputs is displayed for each process input
- 3 The Process Inputs Calibration parameters are set to *Auto* when a Transmitter Calibration action is set through the **ONLINE > TRANSMITTER CALIBRATION** window.

All process inputs go into calibration auto while performing a transmitter calibration function. This allows calculations to continue (using the scaled average) while the calibration is done. If the transmitter calibration is suspended or the communication to the PLX is lost, the calibration will switch to manual. Once in manual mode, the user needs to access this window to remove manual mode to allow calculations to be based on the current value received from the PLC code.

- 4 The *Alarms* field displays any process input alarms. Click in the *Alarms* field to view alarm information in the *Detail Alarms* dialog.



An alarm is active if the **ALM** checkbox is checked. A checkmark within the **RQD** checkbox indicates that the alarm must be acknowledged. If an acknowledgment is required, check the **ACK** checkbox.

- 5 Once you make changes, click **APPLY** and then **OK**.

11.4.2 Detail Alarms: Differential pressure

Failure	Description
Backplane Transmitter Failure	The PLC has reported a failure of the differential of the differential pressure process input transmitter, and a known-good value has been substituted.
Sample rate too low	The module determined that the differential pressure process input is being delivered from the PLC at is unacceptably slow rate. No value substitution has been made.
Backplane range limit exceeded, lo	The PLC has reported that the differential pressure process input is below its configured lower range limit, and a known-good value has been substituted.
Backplane range limit exceeded, hi	The PLC has reported that the differential pressure process input is above its configured upper range limit, and a known-good value has been substituted.
Invalid input format	The module has determined that the differential pressure process input is not a valid floating-point value (a NAN or INF), and a known-good value has been substituted.
Local range limit exceeded, lo	The module has determined that the differential pressure process input is below its configured lower range limit, and a known-good value has been substituted. For more information, see the Input scaling, differential pressure points beginning at register H-8044.
Local range limit exceeded, hi	The module has determined that the different pressure process input is above its configured upper range limit, and a known-good value has been substituted. For more information, see the Input scaling, differential pressure points beginning at register H-8044.
Threshold limit exceeded, lo	The module has determined that the differential pressure process input is below its configured lower level alarm threshold; no value substitution has been made. For more information, see Input scaling, differential pressure points beginning at register H-8044.
Threshold limit exceeded, hi	The module has determined that the differential pressure process input is above its configured upper alarm threshold; no value substitution has been made. For more information, see the Input scaling, differential pressure points beginning at register H-8044.

11.4.3 Detail Alarms: Temperature

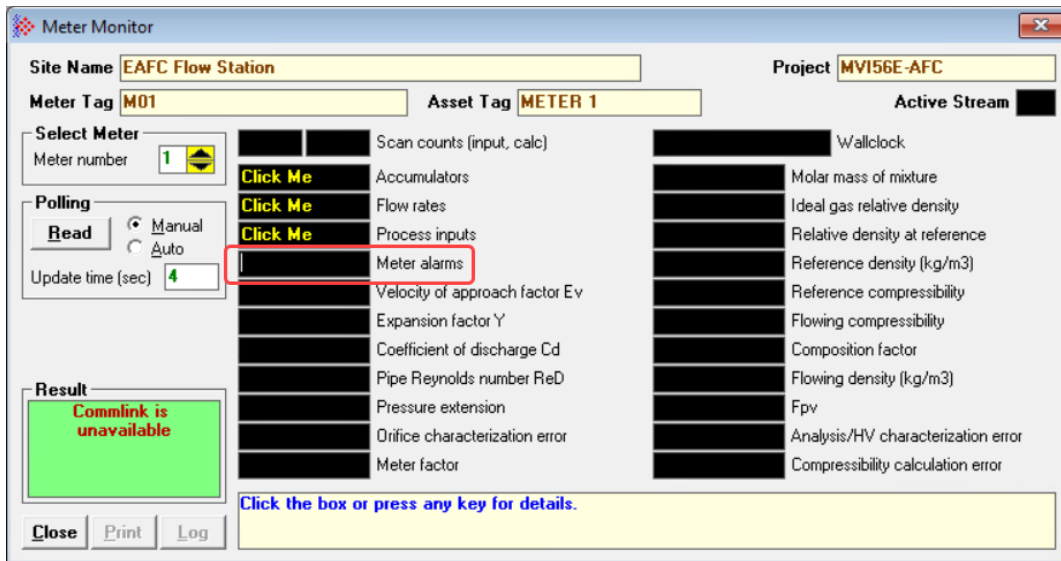
Failure	Description
Backplane Transmitter Failure	The PLC has reported a failure of the temperature process input transmitter, and a known-good value has been substituted.
Sample rate too low	EAFM Manager determined that the temperature process input is being delivered from the PLC at an unacceptably slow rate. No value substitution has been made.
Backplane range limit exceeded, lo	The PLC has reported that the temperature process input is below its configured lower range limit, and a known-good value has been substituted.
Backplane range limit exceeded, hi	The PLC has reported that the temperature process input is above its configured upper range limit, and a known-good value has been substituted.
Invalid input format	The module has determined that the temperature process input is not a valid floating-point value (a NAN or INF), and a known-good value has been substituted.
Local range limit exceeded, lo	The module has determined that the temperature process input is below its configured lower range limit, and a known-good value has been substituted. For more information, see the Input scaling, temperature points beginning at register H-8060.
Local range limit exceeded, hi	The module has determined that the temperature process input is above its configured upper range limit, and a known-good value has been substituted. For more information, see the Input scaling, temperature points beginning at register H-8060.
Threshold limit exceeded, lo	The module has determined that the temperature process input is below its configured lower level alarm threshold; no value substitution has been made. For more information, see Input scaling, temperature points beginning at register H-8060.
Threshold limit exceeded, hi	The module has determined that the temperature process input is above its configured upper alarm threshold; no value substitution has been made. For more information, see the Input scaling, temperature points beginning at register H-8060.

11.4.4 Detail Alarms: Pressure

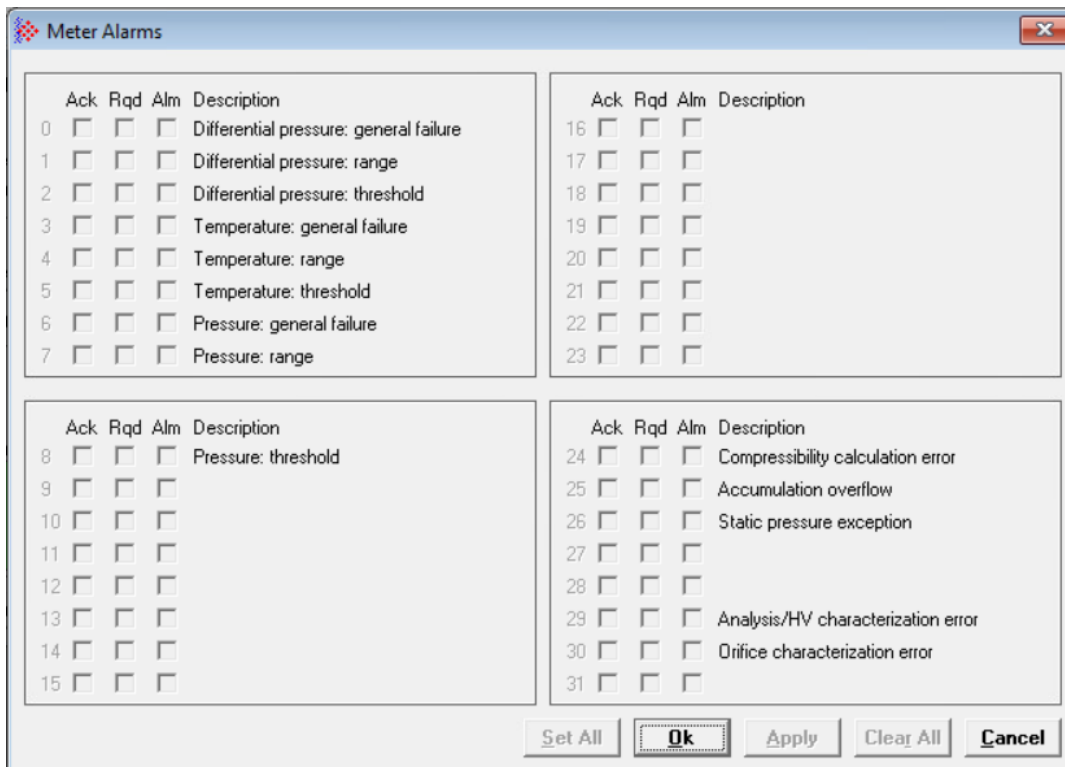
Failure	Description
Backplane Transmitter Failure	The PLC has reported a failure of the pressure process input transmitter, and a known-good value has been substituted.
Sample rate too low	The module determined that the pressure process input is being delivered from the PLC at is unacceptably slow rate. No value substitution has been made.
Backplane range limit exceeded, lo	The PLC has reported that the pressure process input is below its configured lower range limit, and a known-good value has been substituted.
Backplane range limit exceeded, hi	The PLC has reported that the pressure process input is above its configured upper range limit, and a known-good value has been substituted.
Invalid input format	The module has determined that the pressure process input is not a valid floating-point value (a NAN or INF), and a known-good value has been substituted.
Local range limit exceeded, lo	The module has determined that the pressure process input is below its configured lower range limit, and a known-good value has been substituted. For more information, see the Input scaling, pressure points beginning at register H-8076.
Local range limit exceeded, hi	The module has determined that the pressure process input is above its configured upper range limit, and a known-good value has been substituted. For more information, see the Input scaling, pressure points beginning at register H-8076.
Threshold limit exceeded, lo	The module has determined that the pressure process input is below its configured lower level alarm threshold; no value substitution has been made. For more information, see Input scaling, pressure points beginning at register H-8076.
Threshold limit exceeded, hi	The module has determined that the pressure process input is above its configured upper alarm threshold; no value substitution has been made. For more information, see the Input scaling, pressure points beginning at register H-8044.

11.4.5 Viewing Meter Alarms

- 1 From the *Meter Monitor* dialog, click within the **Meter Alarms** display box.



This opens the *Meter Alarms* dialog:



This dialog displays alarms. In addition, the window displays checkboxes that indicate an alarm, an acknowledgement request and required acknowledgement indicator.

- If the **Alm** checkbox is checked, but the **Rqd** checkbox is not, you do not have to acknowledge the alarm.
- If the **Alm** checkbox and the **Rqd** checkbox are checked, you must acknowledge the alarm by checking the **Ack** checkbox.

Note: This behavior is based on a user preference for alarming set in the **METER CONFIGURATION > CONTROL OPTS.**

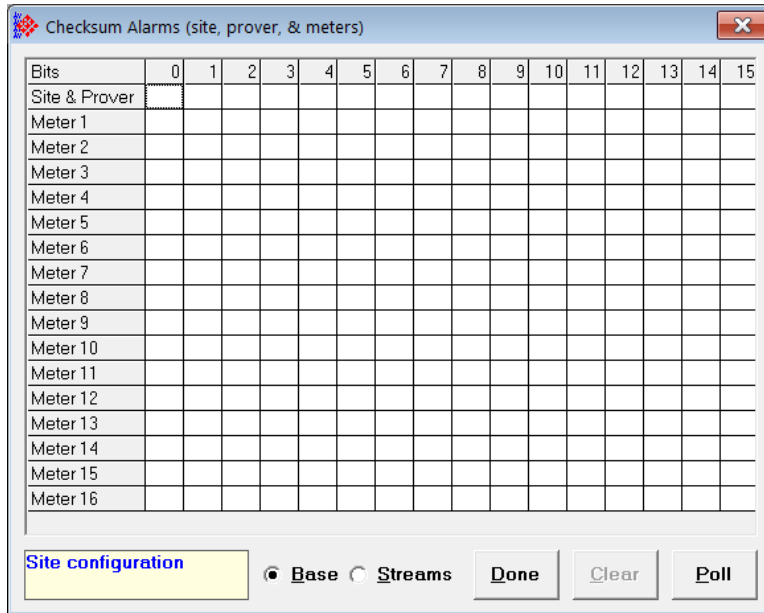
2 Click **APPLY** and then click **OK**.

11.4.6 Meter Alarm Bits

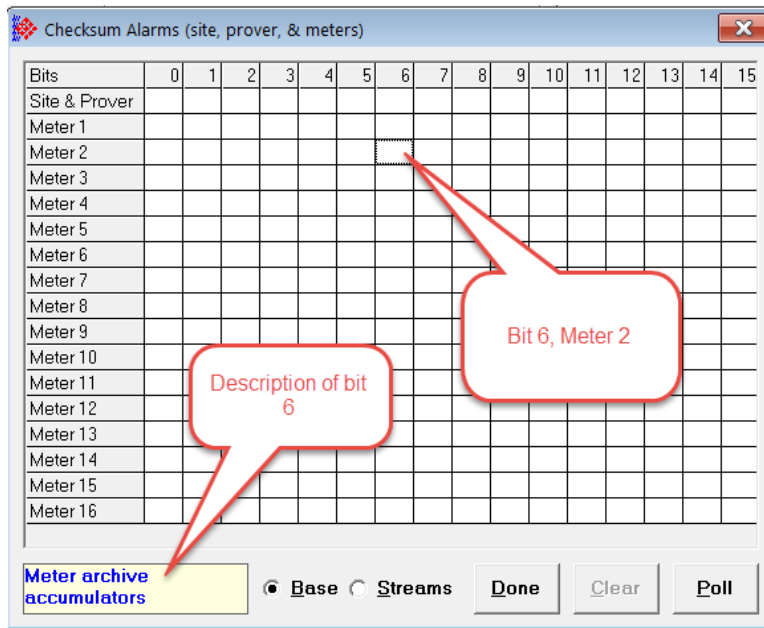
Alarm	Parameter	Description
0	Differential pressure: general failure	The differential pressure process input encountered a failure and an alarm must be acknowledged.
1	Differential pressure: range	The differential pressure process input is outside its configured allowable range and a known-good value has been substituted.
2	Differential pressure: threshold	The differential pressure process input has exceeded a configured threshold limit; no value substitution has been made.
3	Temperature: general failure	The temperature process encountered a failure and the alarm must be acknowledged.
4	Temperature: range	The temperature process input is outside of its configured allowable range and a known-good value has been substituted.
5	Temperature: threshold	The temperature process input has exceeded a configured threshold limit; no value substitution has been made.
6	Pressure: general failure	The pressure process input encountered a failure and the alarm must be acknowledged.
7	Pressure: range	The pressure process input is outside its configured allowable range and a known-good value has been substituted.
8	Pressure: threshold	The pressure process input has exceeded a configured threshold limit; no value substitution has been made.
24	Compressibility calculation error	The AGA 8 calculation has reported an error.
25	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 the alarm is raised.
26	Static pressure exception	Absolute static pressure is unreasonably low and has been adjusted.
29	Analysis/HV characterization error	The characterization of the input analysis and/or heating value configuration has encountered a problem.
30	Orifice characterization error	Orifice meter parameters are such that measurement cannot occur.

12 Viewing Checksum Alarms

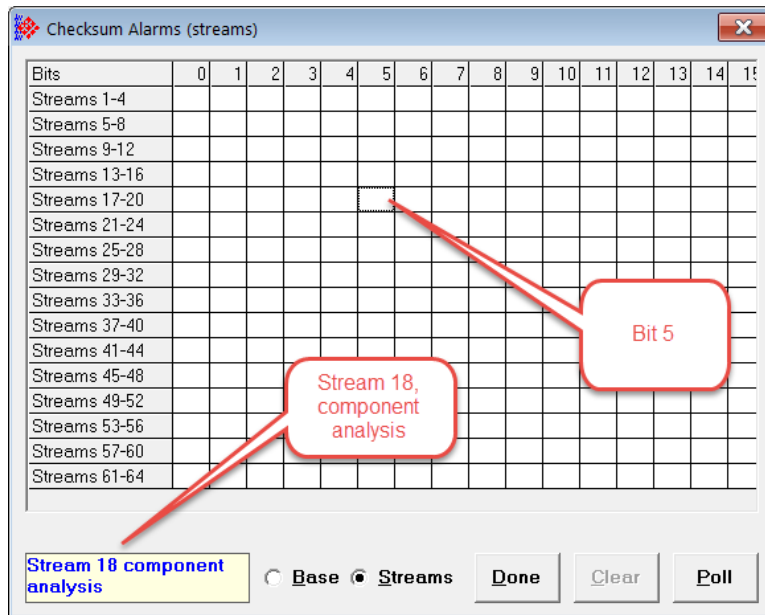
This grid displays existing checksum alarms (error detection).
 In EAFC Manager, navigate to **ON-LINE > CHECKSUM ALARMS**.



The grid represents bits and meters. Each bit is identified in the lower-left information window. For example, bit 6 for meter 2 represents Meter archive accumulators.



Display is per Base (per meter shown above) or Streams (Streams defined per meter).
 There may be 4 streams per meter. If detected by stream, the specific stream and checksum are displayed in the information window.



The **POLL** button allows you to poll all streams or meter in order to check for errors.

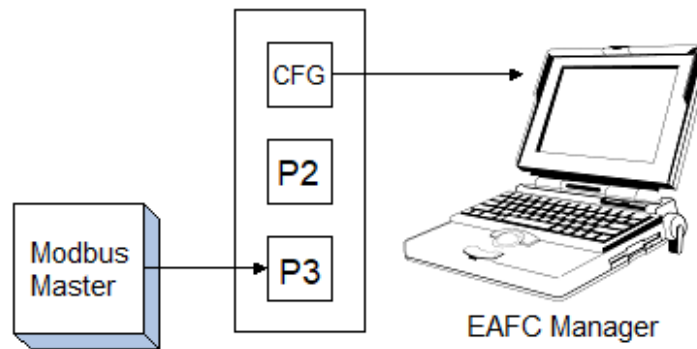
13 Modbus Communication Reference

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 (Write) Single Register
16	Preset (Write) Multiple Registers

Refer to *Cable Connections* (page 286) 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.



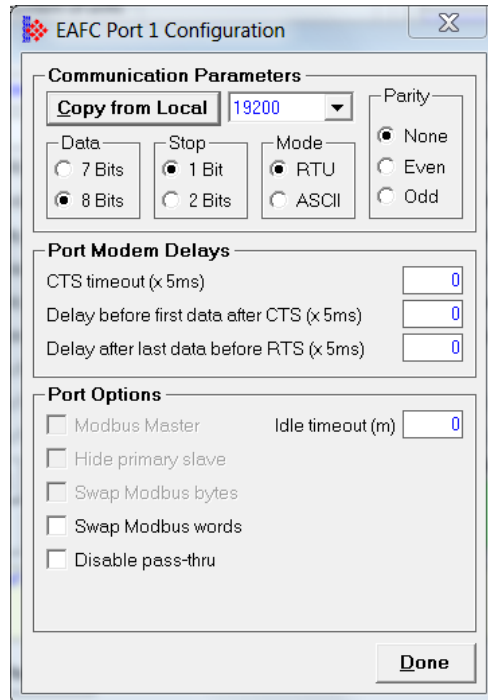
13.1 Serial Port Communication Parameters

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

Parameter	Values
Baud Rate	9600 through 230400. Default is 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 E AFC Manager (*Site Configuration*):



13.2 Port Options

The following options can be configured:

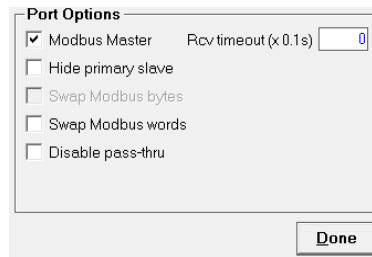
Parameter	Description
Modbus Master	Enables the Modbus Master for the port (Serial 2 only). Note: This port cannot be used to poll instrumentation, but it can be used to poll devices that do not require time-sensitive updates such as an online gas chromatograph.
Hide Primary Slave	Protects the Primary Slave from any read or write operations from a remote master. Only the Virtual Slave is visible on the port.
Swap Modbus Bytes	Swaps the Modbus bytes transferred through this port.
Swap Modbus Words	Swaps the Modbus words transferred through this port. The 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.

Not all options are available on every port:

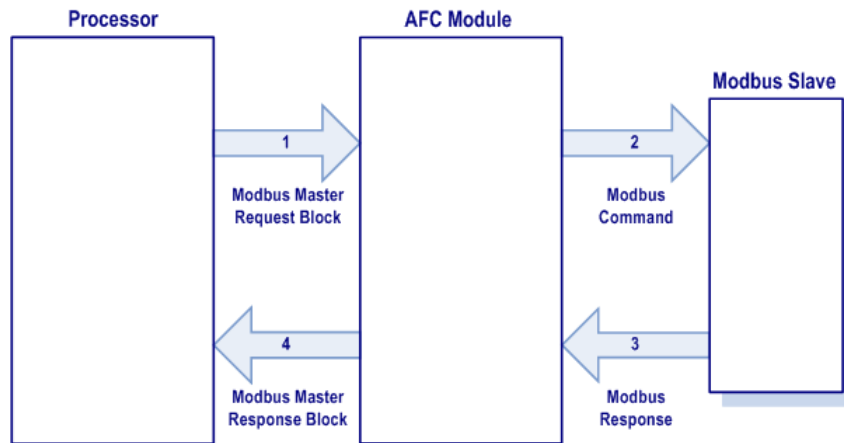
- Port 1 is restricted, so that can always communicate with the Primary Slave using this port.
- Modbus Master option is available only on Serial 2.

13.3 Modbus Master

Serial 2 can be configured for Modbus Master operation (**PROJECT > SITE CONFIGURATION > SERIAL 2**).



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 (approximately one command can be sent every second as Modbus master polling is a secondary process to the module).



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 (Write) Multiple Coils
16	Preset (Write) Multiple 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.

14 Primary and Virtual Slaves and Modbus Addressing

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 in for information about Modbus addressing.

14.1 Modbus Address Space

Addressable Modbus registers are divided into four banks as shown in the following table.

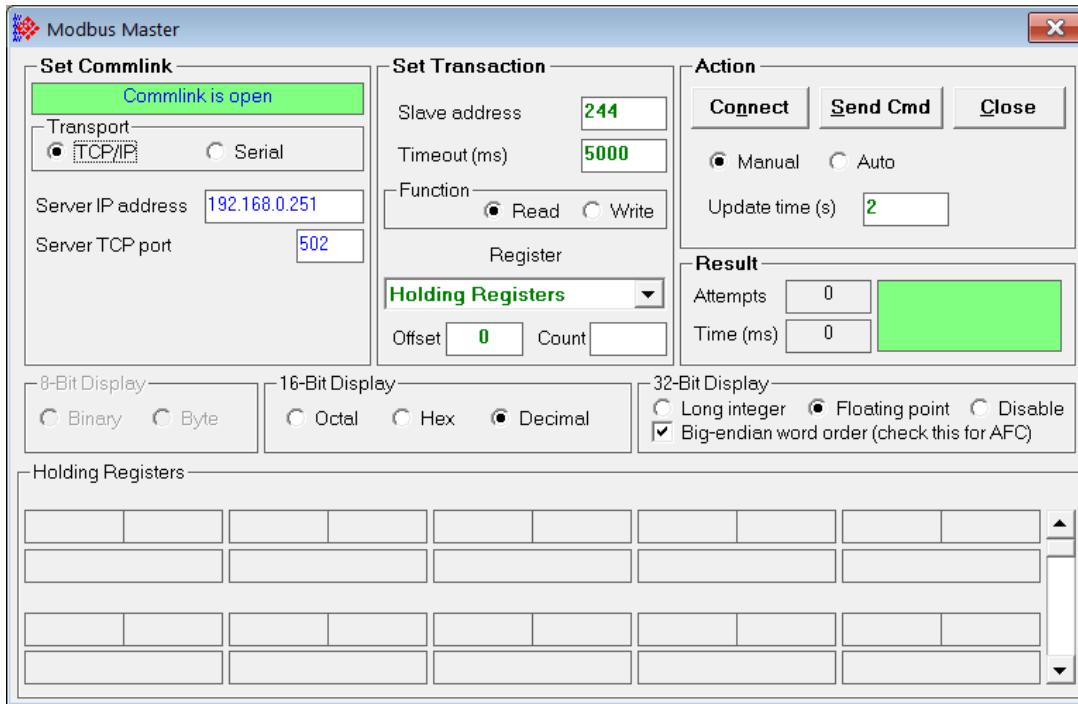
Modbus Address Space Allocation

Total Modbus 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.

14.1.1 Accessing the Data

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



Access the Modbus Master interface by navigating to **COMMUNICATIONS > MODBUS MASTER**. All register addressing is shown in the Modbus Dictionary.

14.2 Primary Slave

The Primary Slave contains the main EAFC 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 registers).

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

14.2.1 Modbus Address References

In some documents, you may 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.

The following 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

14.2.2 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.

14.2.3 Meter-relative Data

Meter-relative holding register starts at absolute holding register 8000 and occupies 1000 words of data for each meter channel.

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

The meter-relative addresses are offsets within each meter data area. The correct absolute address is calculated by the following formula (assumes meters are numbered starting with 1):

$$(\text{absolute address}) = (1000 * (\text{meter number}-1)) + 8000 + (\text{meter relative address})$$

In the Modbus Dictionary dialog box, addresses listed for the selected meter are absolute addresses, so you should subtract the appropriate multiple of 1000 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 8216 and 8217 as follows:

8214	8215	Float	Parameter: orifice plate: measurement temperature
8216	8217	Float	Parameter: orifice plate: measured diameter
8218	8219	Float	Parameter: orifice plate: coef of thermal expansion
8220	8221	Float	Parameter: meter tube: measurement temperature
8222	8223	Float	Parameter: meter tube: measured diameter
8224	8225	Float	Parameter: meter tube: coef of thermal expansion
8226	8227	Float	Parameter: differential pressure flow threshold

The meter-relative addresses are Mh00216 and Mh00217

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

Meter	Registers
1	8216 and 8217
2	9216 and 9217
3	10216 and 10217
4	11216 and 11217
5	12216 and 12217

14.2.4 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.

14.3 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 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.

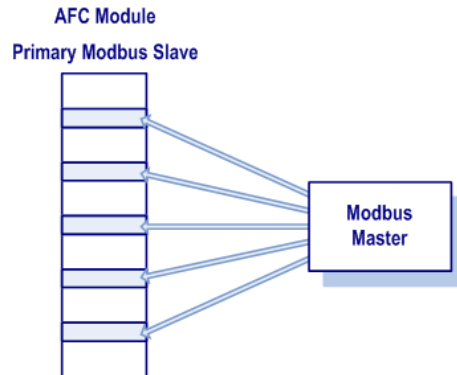
Note: The first 100 registers in the Virtual Slave Holding Register Bank have been pre-assigned and cannot be remapped. They map directly to the first 100 holding registers of the Primary Slave.

14.3.1 Virtual Slave Example Application

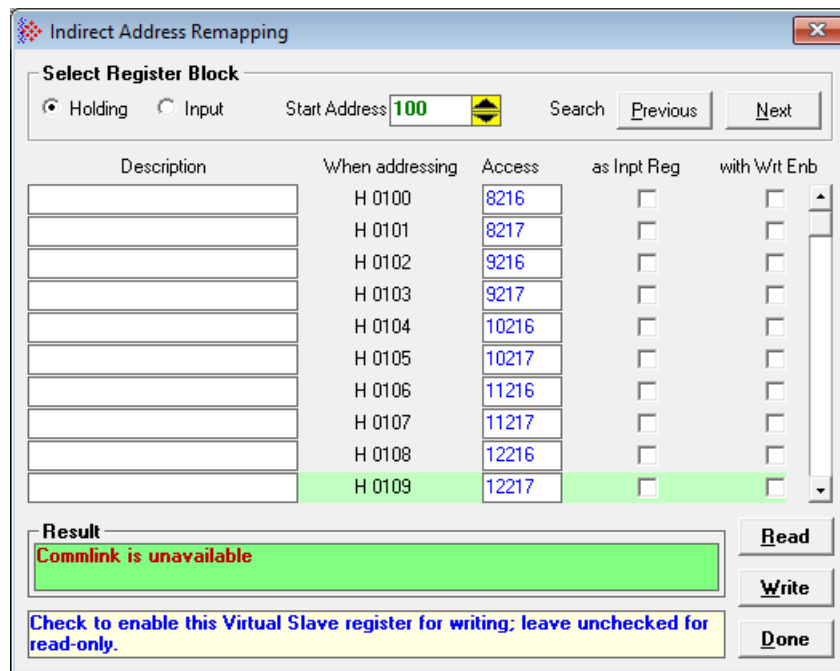
Assume that an application requires a remote Modbus Master to poll the orifice diameters for the first 5 channels. Continuing the previous example, the holding register addresses are listed again the following table:

Meter	Registers
1	8216 and 8217
2	9216 and 9217
3	10216 and 10217
4	11216 and 11217
5	12216 and 12217

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:



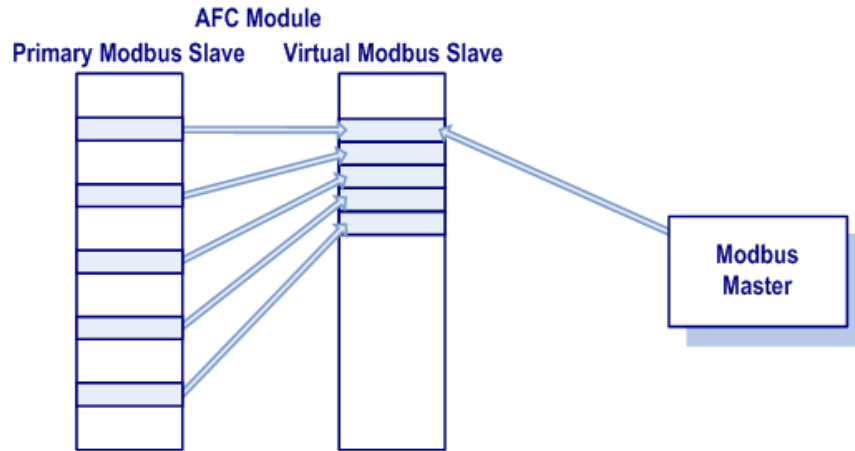
However, using the Virtual Modbus Slave optimizes the polling of data because the registers can be remapped in any order using the (Site Configuration window). The following illustration shows how the orifice diameter registers could be remapped to the Virtual Slave starting at address Vh00100:



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

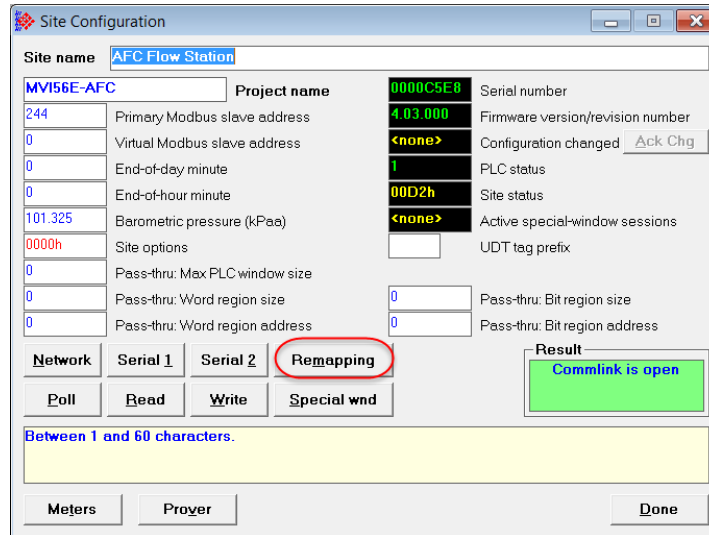
Primary Modbus Slave Addresses	Virtual Modbus Slave Addresses
8216 and 8217	100 and 101
9216 and 9217	102 and 103
10216 and 10217	104 and 105
11216 and 11217	106 and 107
12216 and 12217	108 and 109

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:

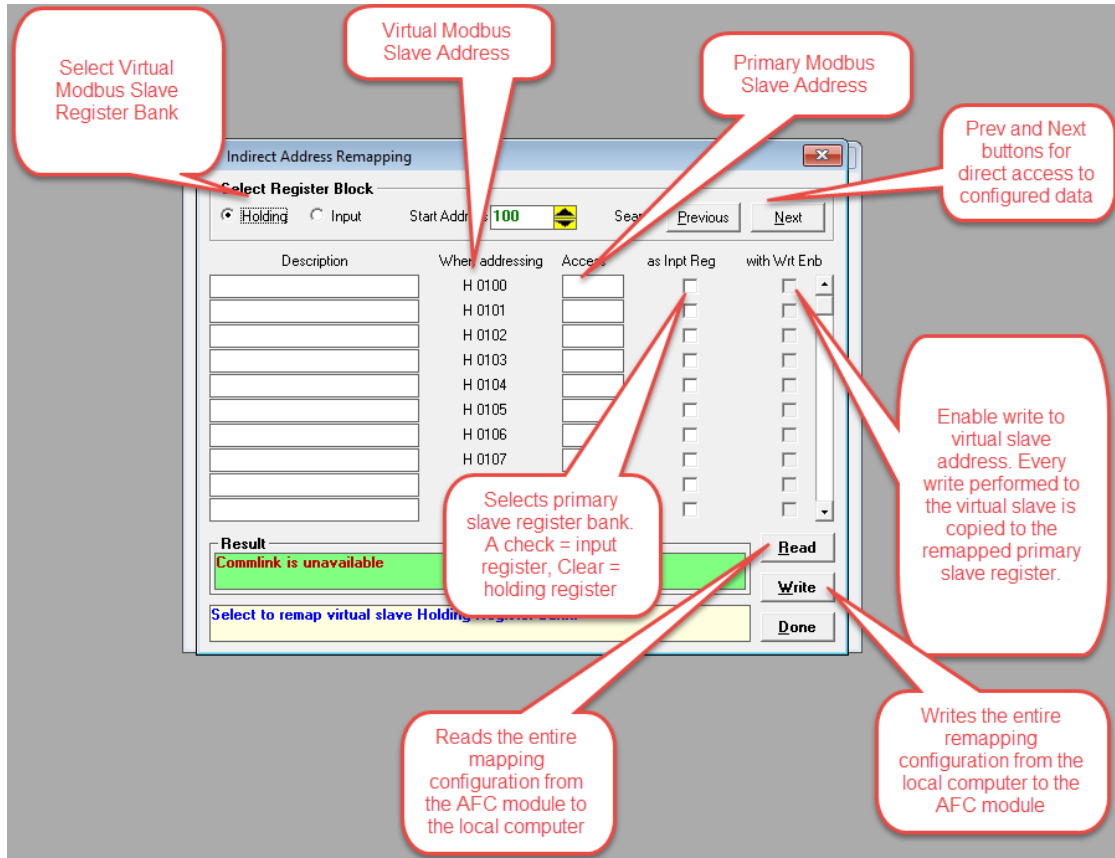


This example demonstrates the benefits of using the Virtual Slave instead of accessing the data directly from the Primary Modbus Slave. The same procedure can be used when polling data from the processor (through the backplane) because the Modbus Gateway block also requires the data to be listed in a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

To configure the data remapping between the two slaves, click the **REMAPPING** button.



This action opens the *Indirect Address Remapping* dialog.



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 up to a minute if using a serial connection. 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 up to a minute if using a serial connection.

14.4 Virtual Slave Addressing Collisions

Addressing conflicts (collisions) can arise among three distinct regions of the Virtual Slave holding register bank. These regions are:

- The defined range of 19900 registers to which Primary Slave registers may be mapped (where the Virtual Slave input register bank is seen as an extension of its holding register bank starting at address 10000).
- The word region of the pass-thru configuration, significant for Modbus write commands only.
- A Special Window, when mapped to the Virtual Slave by specifying its “Virtual Slave Location”.

An addressing collision arises when the address of a holding register falls within more than one region. The AFC module resolves such collisions by deeming the address to fall into the first region from the following list that matches.

- The pass-thru word region (Modbus write commands only)
- A mapped Special Window, in the sequence given by the Special Windows Configuration dialog.
- The 19900-register re-mappable range, address 100 to 19999.

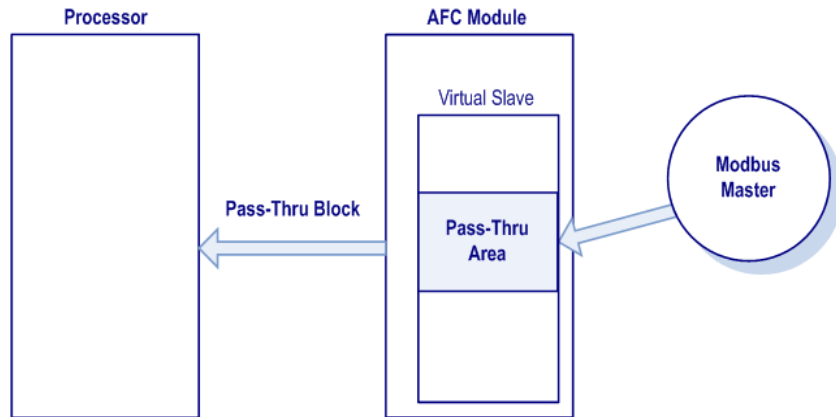
To avoid complexities of addressing collisions, it is recommended that all regions mapped to the virtual slave be mapped to disjoint (non-overlapping) portions of the Virtual Slave holding register bank, bearing in mind both the starting address and the region size. In particular, this means that every mapped region should have a virtual slave starting address of 20000 or greater, to place it outside the re-mappable range.

All Virtual Slave registers addressed by a single Modbus transaction must reside in the same region; no region-spanning is permitted. A region spanning transaction is rejected with Modbus exception code 2, Illegal Address.

Tip: Use the Modbus Dictionary dialog box to view Modbus addresses in the module.

14.5 Modbus Pass-Through

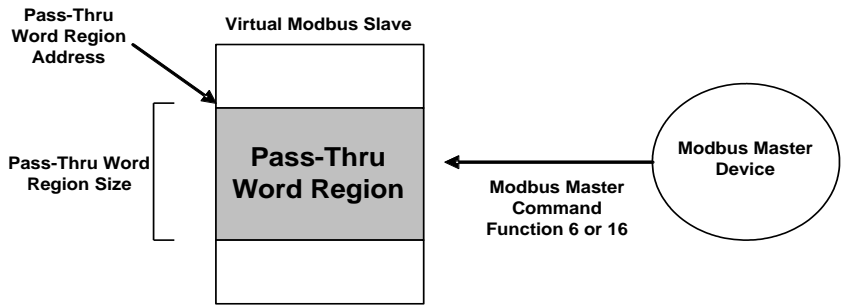
The Modbus pass-through feature allows you to configure a Modbus pass-through region in the Virtual Slave (**PROJECT > SITE CONFIGURATION**). After the module receives a holding register write command (Modbus functions 6 or 16) or a bit write command (Modbus functions 5 or 15) to this region, it will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

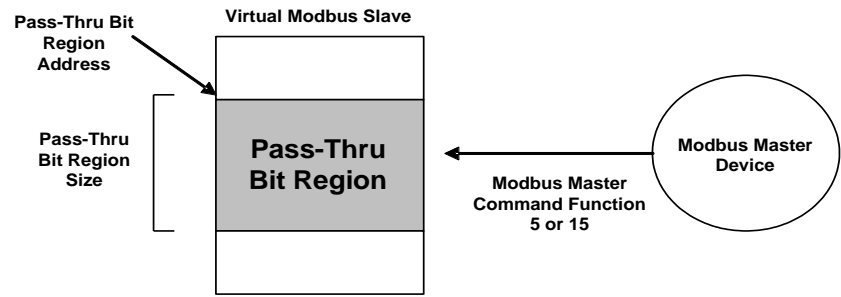


Important: You must enable the virtual slave by configuring a Modbus address greater than 0 (**PROJECT > SITE CONFIGURATION**).

You can control which communication ports will support the pass-through (**PROJECT > SITE CONFIGURATION > PORT X BUTTON**).

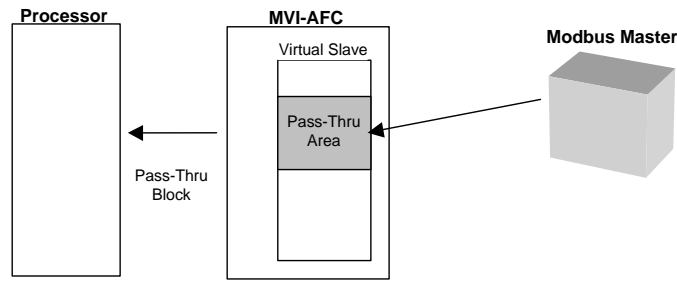
This feature requires ladder logic to read the pass-through block from the module to the processor. Refer to the Ladder Logic section for more information about the pass-through feature.

Feature	Description
Pass-thru: Max PLC window size	This defines the maximum window size (expressed as 16-bit words) in the Virtual Modbus Slave. The maximum allowed value for this point depends of the platform.
Pass-thru: Word region size and Word Region address	<p>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 <i>Pass-thru Word Region Size</i> parameter.</p>  <p>The diagram shows a vertical rectangle representing the 'Virtual Modbus Slave'. A shaded rectangular area in the middle is labeled 'Pass-Thru Word Region'. An arrow points from the label 'Pass-Thru Word Region Address' to the top-left corner of this shaded area. A bracket to the left of the shaded area is labeled 'Pass-Thru Word Region Size'. To the right of the rectangle, a circle represents a 'Modbus Master Device'. An arrow points from the circle to the shaded area, labeled 'Modbus Master Command Function 6 or 16'.</p> <p>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 <i>Pass-thru Word Region Address</i> of 20000 or greater, you may avoid any reduction of the re-mappable address space of the Virtual Slave.</p>

Pass-thru: Bit Region Address and Pass-Thru: Bit Region Size	<p>These two parameters define the <i>Pass-thru Bit Region</i> located in the Virtual Modbus Slave. The region starts at the address configured by the <i>Bit Region Address</i> parameter and its range is defined by the <i>Pass-thru Bit Region Size</i> parameter.</p>  <p>The diagram shows a vertical rectangle representing the 'Virtual Modbus Slave'. A shaded rectangular area in the middle is labeled 'Pass-Thru Bit Region'. An arrow points from the label 'Pass-Thru Bit Region Address' to the top-left corner of this shaded area. A bracket to the left of the shaded area is labeled 'Pass-Thru Bit Region Size'. To the right of the rectangle, a circle represents a 'Modbus Master Device'. An arrow points from the circle to the shaded area, labeled 'Modbus Master Command Function 5 or 15'.</p> <p>Note: The AFC modules allow configuration through an Ethernet port and also provides Modbus TCP/IP support. The <i>Site Configuration</i> dialog box looks slightly different in that the <i>Site Configuration</i> buttons are changed to allow for Ethernet connections. There is no Port 3.</p>
--	--

14.6 Disabling Pass-Through

The Modbus pass-through feature allows you to configure a Modbus pass-through 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-through block to be sent to the processor containing the Modbus command data. You may define a word pass-through region (for Modbus functions 6 and 16) and a bit pass-through 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-through (**PROJECT > SITE CONFIGURATION > NETWORK SERIAL 1** or **SERIAL 2** buttons).

Disable Pass-Thru: Disables the pass-thru feature for this port.

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

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

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

15 ControlLogix Ladder Logic Details

This section shows how you can extract important information from the sample logic without requiring you to know the details of how the sample logic actually works. For most applications it will be enough to refer only to the controller tags in order to perform the tasks.

Note: The tag name shown below is an example meter name and can be one of many different references based on Meter number, Meter Type, or personal preference for how you would like to name the individual meter runs. For example if using our sample ladder logic, some Meter names are AFCMeter01DifferentialGas, AFCMeter02DifferentialLiquid, AFCMeter03LinearGas, and AFCMeter04LinearLiquid.

15.1 Enable Status

Each meter run will only perform flow calculation while it is enabled. However, you cannot change a meter type, product group or units while the meter is enabled.

Warning: Changing meter types, product groups or units while the meter is enable will reset the entire meter configuration to default (depending on the new selections), including erasure/deletion of all historical records (archives) and accumulator values of the previously configured meter run. This is the case whether the reconfiguration is performed from the PLC or external Modbus client.

In order to accomplish this, you have to disable the meter, change meter type, product or units and then enable the meter again. The meters can be enabled or disabled from logic or EAFC Manager.

The logic constantly reads each meter enable/disable status from the MVI56E-AFC. Refer to *AFCMeterX.Status.Enabled* data structure for each meter status. Each variable should be interpreted as:

AFCMeterX.Status.Enabled = 0 => Meter x is Disabled

AFCMeterX.Status.Enabled = 1 => Meter x is Enabled

[-] AFCMeter01	{ ... }
[+] AFCMeter01.Control	{ ... }
[-] AFCMeter01.Status	{ ... }
[-] AFCMeter01.Status.Meter	{ ... }
AFCMeter01.Status.Meter.Enabled	1
AFCMeter01.Status.Meter.EnableAlarm	0

15.2 Enable/Disable Meter

Each meter can be enabled or disabled through logic. Refer to the *AFCMeterX.Control.Meter* data structure. Toggle *AFCMeterX.Control.Meter.Enable* controller tag in order to command the meter to be enabled.

The logic will continuously analyze the meter enabled status. After the logic determines that a specific meter is enabled (*AFCMeterX.Status.Enabled = 1*) the command bit (*AFCMeterX.Control.Meter.Enable*) will be unlatched.

Toggle *AFCMeterX.Control.Meter.Disable* controller tag in order to command the meter to be disabled.

The logic will continuously analyze the meter enabled status. After the logic determines that a specific meter is disabled (*AFCMeterX.Status.Enabled = 0*) the command bit (*AFCMeterX.Control.Meter.Disable*) will be unlatched.

[-] AFCMeter01	{...}
[-] AFCMeter01.Control	{...}
[-] AFCMeter01.Control.Meter	{...}
[-] AFCMeter01.Control.Meter.Enable	0
[-] AFCMeter01.Control.Meter.Disable	0

Note: DO NOT create a rung in logic to constantly enable and/or disable the meter. The command bit should be toggled only once in order to enable or disable the meter.

15.3 Wallclock

After the module powers up, it will not perform flow calculation until it receives valid wallclock information from the processor. The sample ladder logic uses the processor internal clock as the source of the wallclock information.

Configure the processor time and date information:

- 1 Right-click on **CONTROLLER MVI56E-AFC** folder of the *Controller Organizer* pane of RSLogix.
- 2 Click on **PROPERTIES**.
- 3 Select the **DATE/TIME** tab.
- 4 Enter a valid date and time information.

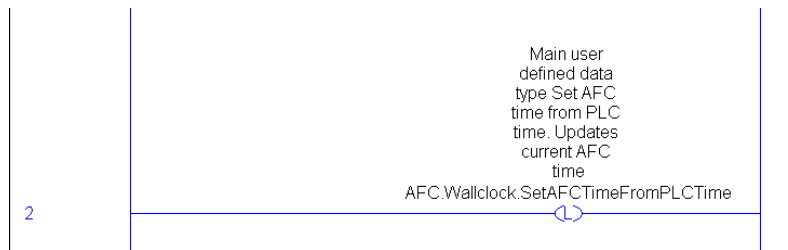
To enable Local Date Time:

- 1 Enable bit "**AFC.Wallclock.EnableLocalDateTime**"
- 2 Toggle "**AFC.Wallclock.SetAFCTimeFromPLCTime**"

After the *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit is toggled, the logic will move the date and time information from the processor to the AFC module.

[-] AFC:Wallclock	{...}
[-] AFC:Wallclock.GetAFCTime	0
[-] AFC:Wallclock.SetAFCTimeFromPLCTime	0
[-] AFC:Wallclock.EnableLocalDateTime	0
[-] AFC:Wallclock.AFCTime	{...}
[+] AFC:Wallclock.AFCTime.Year	0
[+] AFC:Wallclock.AFCTime.Month	0
[+] AFC:Wallclock.AFCTime.Day	0
[+] AFC:Wallclock.AFCTime.Hour	0
[+] AFC:Wallclock.AFCTime.Minute	0
[+] AFC:Wallclock.AFCTime.second	0

The *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit is latched in the power up routine, in order stay synchronized with the PLC.



After the ladder logic receives the input block back from the module it unlatches the *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit.

You may want to periodically synchronize the processor and the module’s wallclock, especially when the date and time information is received from a remote station. In this case, further ladder logic is required from you to periodically toggle the *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit. It is recommended to set the Wallclock time every 2 hours.

15.4 Meter Profile

The logic constantly reads each meter profile. The meter profile informs each meter type (linear or differential), product group (gas or liquid) and primary input type (standard or rate integration).

The *AFCMeterX.Profile* controller tag stores the profile information for each meter run:

AFCMeter1.Profile - Meter 1 Profile

AFCMeter2.Profile - Meter 2 Profile

...

AFCMeter16.Profile - Meter 16 Profile

The controller tags are interpreted as follows:

Controller Tag	Value	Description
<i>AFCMeterX.Profile.MeterType</i>	0	Meter x is Differential Meter
<i>AFCMeterX.Profile.MeterType</i>	1	Meter x is a Linear Meter
<i>AFCMeterX.Profile.ProductGroup</i>	0	Meter x uses a Gas product
<i>AFCMeterX.Profile.ProductGroup</i>	1	Meter x uses a Liquid product
<i>AFCMeterX.Profile.PrimaryInput</i>	0	Meter x uses a standard primary input
<i>AFCMeterX.Profile.PrimaryInput</i>	1	Meter x uses a rate integration primary input
<i>AFCMeterX.Profile.AOIMismatch</i>	0	Meter x AOI matches the modules meter x configuration
<i>AFCMeterX.Profile.AOIMismatch</i>	1	Meter x AOI does not match the modules meter x configuration

The example below shows a situation where Meter 0 is configured as a differential meter, uses a gas product and has a standard primary input.

[-] <i>AFCMeter01.Profile</i>	{...}
[-] <i>AFCMeter01.Profile.MeterType</i>	0
[-] <i>AFCMeter01.Profile.ProductGroup</i>	0
[-] <i>AFCMeter01.Profile.PrimaryInput</i>	0
[-] <i>AFCMeter01.Profile.AOIMismatch</i>	0

15.5 Meter Process Variables

In order to perform flow calculation the module must receive the meter process variables from the processor.

For each possible combination, the following variables are used:

15.5.1 Meter Type = Differential & Product Group = Gas

Process Input	Controller Tag	Data Type
Differential Pressure	AFCMeterX.ProcessVariables.DifferentialPressure	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL

Where x can assume values between 1 and 16.

[-] AFCMeter01.ProcessVariables	{...}
[-] AFCMeter01.ProcessVariables.DifferentialPressure	0.0
[-] AFCMeter01.ProcessVariables.FlowRate	0.0
[-] AFCMeter01.ProcessVariables.Temperature	0.0
[-] AFCMeter01.ProcessVariables.Pressure	0.0

15.5.2 Meter Type = Differential & Product Group = Liquid

Process Input	Controller Tag	Data Type
Diff Pressure	AFCMeterX.ProcessVariables.DifferentialPressure	REAL
Water %	AFCMeterX.ProcessVariables.Water_Percent	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL
Density	AFCMeterX.ProcessVariables.Density	REAL

Where x can assume values between 1 and 16.

[-] AFCMeter02.ProcessVariables	{...}
[-] AFCMeter02.ProcessVariables.DifferentialPressure	0.0
[-] AFCMeter02.ProcessVariables.FlowRate	0.0
[-] AFCMeter02.ProcessVariables.Temperature	0.0
[-] AFCMeter02.ProcessVariables.Pressure	0.0
[-] AFCMeter02.ProcessVariables.Density	0.0
[-] AFCMeter02.ProcessVariables.WaterPercent	0.0

15.5.3 Meter Type = Linear & Product Group = Gas

Process Input	Controller Tag	Data Type
Pulse Frequency	AFCMeterX.ProcessVariables.Frequency	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL
Pulse Count	AFCMeterX.ProcessVariables.MeterPulses	DINT

Where x can assume values between 1 and 16.

[-] AFCMeter09.ProcessVariables	{...}
[-] AFCMeter09.ProcessVariables.PulseFrequency	2.0
[-] AFCMeter09.ProcessVariables.Temperature	130.0
[-] AFCMeter09.ProcessVariables.Pressure	3.0
[+] AFCMeter09.ProcessVariables.MeterPulses	1

15.5.4 Meter Type = Linear & Product Group = Liquid

Process Input	Controller Tag	Data Type
Pulse Frequency	AFCMeterX.ProcessVariables.PulseFrequency	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL
Pulse Count	AFCMeterX.ProcessVariables.MeterPulses	DINT
Density	AFCMeterX.ProcessVariables.Density	REAL
Water Percent	AFCMeterX.ProcessVariables.Water_Percent	REAL

Where x can assume values between 1 and 16.

[-] AFCMeter11.ProcessVariables	{...}
[-] AFCMeter11.ProcessVariables.PulseFrequency	5.105708
[-] AFCMeter11.ProcessVariables.Temperature	31.66667
[-] AFCMeter11.ProcessVariables.Pressure	425.0
[-] AFCMeter11.ProcessVariables.Density	800.0
[-] AFCMeter11.ProcessVariables.WaterPercent	0.0
[+] AFCMeter11.ProcessVariables.MeterPulses	0

16 CompactLogix Ladder Logic Details

This section shows how you can extract important information from the sample logic without requiring you to know the details of how the sample logic actually works. For most applications it will be enough to refer only to the controller tags in order to perform the tasks.

Note: The tag name shown below is an example meter name and can be one of many different references based on Meter number, Meter Type, or personal preference for how you would like to name the individual meter runs. For example if using our sample ladder logic, some Meter names are AFCMeter01DifferentialGas, AFCMeter02DifferentialLiquid, AFCMeter03LinearGas, and AFCMeter04LinearLiquid.

16.1 Enable Status

Each meter run will only perform flow calculation while it is enabled. However, you cannot change a meter type, product group or units while the meter is enabled.

Warning: Changing meter types, product groups or units while the meter is enable will reset the entire meter configuration to default (depending on the new selections), including erasure/deletion of all historical records (archives) and accumulator values of the previously configured meter run. This is the case regardless of who does the reconfiguration (PLC, , or external Modbus Client).

In order to accomplish this, you have to disable the meter, change meter type, product or units and then enable the meter again. The meters can be enabled or disabled from logic or EAFC Manager.

The logic constantly reads each meter enable/disable status from the MVI69E-AFC. Refer to *AFCMeterX.Status.Enabled* data structure for each meter status. Each variable should be interpreted as:

AFCMeterX.Status.Enabled = 0 => Meter x is Disabled

AFCMeterX.Status.Enabled = 1 => Meter x is Enabled

- AFCMeter01	{ ... }
+ AFCMeter01.Control	{ ... }
- AFCMeter01.Status	{ ... }
- AFCMeter01.Status.Meter	{ ... }
- AFCMeter01.Status.Meter.Enabled	1
- AFCMeter01.Status.Meter.EnableAlarm	0

16.2 Enable/Disable Meter

Each meter can be enabled or disabled through logic. Refer to the *AFCMeterX.Control.Meter* data structure. Toggle *AFCMeterX.Control.Meter.Enable* controller tag in order to command the meter to be enabled.

The logic will continuously analyze the meter enabled status. After the logic determines that a specific meter is enabled (*AFCMeterX.Status.Enabled = 1*) the command bit (*AFCMeterX.Control.Meter.Enable*) will be unlatched.

Toggle *AFCMeterX.Control.Meter.Disable* controller tag in order to command the meter to be disabled.

The logic will continuously analyze the meter enabled status. After the logic determines that a specific meter is disabled (*AFCMeterX.Status.Enabled = 0*) the command bit (*AFCMeterX.Control.Meter.Disable*) will be unlatched.

[-] AFCMeter01	{...}
[-] AFCMeter01.Control	{...}
[-] AFCMeter01.Control.Meter	{...}
AFCMeter01.Control.Meter.Enable	0
AFCMeter01.Control.Meter.Disable	0

Note: DO NOT create a rung in logic to constantly enable and/or disable the meter. The command bit should be toggled only once in order to enable or disable the meter.

16.3 Wallclock

After the module powers up, it will not perform flow calculation until it receives valid wallclock information from the processor. The sample ladder logic uses the processor internal clock as the source of the wallclock information.

Configure the processor time and date information:

- 1 Right-click on **CONTROLLER MVI69E-AFC** folder of the *Controller Organizer* pane of RSLogix.
- 2 Click on **PROPERTIES**.
- 3 Select the **DATE/TIME** tab.
- 4 Enter a valid date and time information.

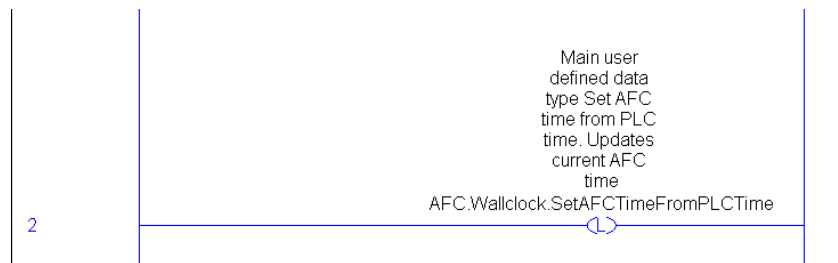
To enable Local Date Time:

- 1 Enable bit "*AFC.Wallclock.EnableLocalDateTime*"
- 2 Toggle "*AFC.Wallclock.SetAFCTimeFromPLCTime*"

After the *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit is toggled, the logic will move the date and time information from the processor to the MVI69E-AFC.

[-] AFC.Wallclock	{...}
- AFC.Wallclock.GetAFCTime	0
- AFC.Wallclock.SetAFCTimeFromPLCTime	0
- AFC.Wallclock.EnableLocalDateTime	0
[-] AFC.Wallclock.AFCTime	{...}
+ AFC.Wallclock.AFCTime.Year	0
+ AFC.Wallclock.AFCTime.Month	0
+ AFC.Wallclock.AFCTime.Day	0
+ AFC.Wallclock.AFCTime.Hour	0
+ AFC.Wallclock.AFCTime.Minute	0
+ AFC.Wallclock.AFCTime.second	0

The *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit is latched in the power up routine, in order stay synchronized with the PLC.



After the ladder logic receives the input block back from the module it unlatches the *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit.

You may want to periodically synchronize the processor and the module's wallclock, especially when the date and time information is received from a remote station. In this case, further ladder logic is required from you to periodically toggle the *AFC.Wallclock.SetEAFCTimeFromPLCTime* bit. It is recommended to set the Wallclock time every 2 hours.

16.4 Meter Profile

The logic constantly reads each meter profile. The meter profile informs each meter type (linear or differential), product group (gas or liquid) and primary input type (standard or rate integration).

The *AFCMeterX.Profile* controller tag stores the profile information for each meter run:

AFCMeter1.Profile - Meter 1 Profile

AFCMeter2.Profile - Meter 2 Profile

...

AFCMeter12.Profile - Meter 12 Profile

The controller tags are interpreted as follows:

Controller Tag	Value	Description
<i>AFCMeterX.Profile.MeterType</i>	0	Meter x is Differential Meter
<i>AFCMeterX.Profile.MeterType</i>	1	Meter x is a Linear Meter
<i>AFCMeterX.Profile.ProductGroup</i>	0	Meter x uses a Gas product
<i>AFCMeterX.Profile.ProductGroup</i>	1	Meter x uses a Liquid product
<i>AFCMeterX.Profile.PrimaryInput</i>	0	Meter x uses a standard primary input
<i>AFCMeterX.Profile.PrimaryInput</i>	1	Meter x uses a rate integration primary input
<i>AFCMeterX.Profile.AOIMismatch</i>	0	Meter x AOI matches the modules meter x configuration
<i>AFCMeterX.Profile.AOIMismatch</i>	1	Meter x AOI does not match the modules meter x configuration

The example below shows a situation where Meter 0 is configured as a differential meter, uses a gas product and has a standard primary input.

[-] <i>AFCMeter01.Profile</i>	{...}
[-] <i>AFCMeter01.Profile.MeterType</i>	0
[-] <i>AFCMeter01.Profile.ProductGroup</i>	0
[-] <i>AFCMeter01.Profile.PrimaryInput</i>	0
[-] <i>AFCMeter01.Profile.AOIMismatch</i>	0

16.5 Meter Process Variables

In order to perform flow calculation the module must receive the meter process variables from the processor.

For each possible combination, the following variables are used:

16.5.1 Meter Type = Differential & Product Group = Gas

Process Input	Controller Tag	Data Type
Differential Pressure	AFCMeterX.ProcessVariables.DifferentialPressure	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL

Where x can assume values between 1 and 12.

[-] AFCMeter01.ProcessVariables	{...}
[-] AFCMeter01.ProcessVariables.DifferentialPressure	0.0
[-] AFCMeter01.ProcessVariables.FlowRate	0.0
[-] AFCMeter01.ProcessVariables.Temperature	0.0
[-] AFCMeter01.ProcessVariables.Pressure	0.0

16.5.2 Meter Type = Differential & Product Group = Liquid

Process Input	Controller Tag	Data Type
Diff Pressure	AFCMeterX.ProcessVariables.DifferentialPressure	REAL
Water %	AFCMeterX.ProcessVariables.Water_Percent	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL
Density	AFCMeterX.ProcessVariables.Density	REAL

Where x can assume values between 1 and 12.

[-] AFCMeter02.ProcessVariables	{...}
[-] AFCMeter02.ProcessVariables.DifferentialPressure	0.0
[-] AFCMeter02.ProcessVariables.FlowRate	0.0
[-] AFCMeter02.ProcessVariables.Temperature	0.0
[-] AFCMeter02.ProcessVariables.Pressure	0.0
[-] AFCMeter02.ProcessVariables.Density	0.0
[-] AFCMeter02.ProcessVariables.WaterPercent	0.0

16.5.3 Meter Type = Linear & Product Group = Gas

Process Input	Controller Tag	Data Type
Pulse Frequency	AFCMeterX.ProcessVariables.Frequency	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL
Pulse Count	AFCMeterX.ProcessVariables.MeterPulses	DINT

Where x can assume values between 1 and 12.

[-] AFCMeter09.ProcessVariables	{...}
[-] AFCMeter09.ProcessVariables.PulseFrequency	2.0
[-] AFCMeter09.ProcessVariables.Temperature	130.0
[-] AFCMeter09.ProcessVariables.Pressure	3.0
[+] AFCMeter09.ProcessVariables.MeterPulses	1

16.5.4 Meter Type = Linear & Product Group = Liquid

Process Input	Controller Tag	Data Type
Pulse Frequency	AFCMeterX.ProcessVariables.PulseFrequency	REAL
Temperature	AFCMeterX.ProcessVariables.Temperature	REAL
Pressure	AFCMeterX.ProcessVariables.Pressure	REAL
Pulse Count	AFCMeterX.ProcessVariables.MeterPulses	DINT
Density	AFCMeterX.ProcessVariables.Density	REAL
Water Percent	AFCMeterX.ProcessVariables.Water_Percent	REAL

Where x can assume values between 1 and 12.

[-] AFCMeter11.ProcessVariables	{...}
[-] AFCMeter11.ProcessVariables.PulseFrequency	5.105708
[-] AFCMeter11.ProcessVariables.Temperature	31.66667
[-] AFCMeter11.ProcessVariables.Pressure	425.0
[-] AFCMeter11.ProcessVariables.Density	800.0
[-] AFCMeter11.ProcessVariables.WaterPercent	0.0
[+] AFCMeter11.ProcessVariables.MeterPulses	0

17 Molar Analysis (For Gas Product Only)

If the application uses a chromatograph device to send the molar concentrations to the module, the sample ladder may dynamically supply all molar concentrations to the AFC module.

Initially, you should select (check) the "Selected" check boxes for all elements using (clicking on the **COMPONENTS** button (version 2.05.000 or later) or **ANALYSIS** button (version 2.04.000 or older) at the *Meter Configuration* window).

In order to write the molar concentration values from the ladder logic, set the *AFCMeter01.Analysis.Trigger* bit to 1. Also select the stream to be updated through *AFCMeter01.Analysis.Stream* controller tag (select 0 for the current active stream).

If you select other stream than the one selected, the new molar analysis will only be visible through once that stream is later selected as the new active one.

- AFCMeter08.Analysis	{...}
- AFCMeter08.Analysis.Trigger	0
+ AFCMeter08.Analysis.Stream	0
+ AFCMeter08.Analysis.Error	{...}
+ AFCMeter08.Analysis.Components	{...}
+ AFCMeter08.ResetAccumulators	{...}

After that, any molar concentration configuration performed through will be overwritten by the ladder logic.

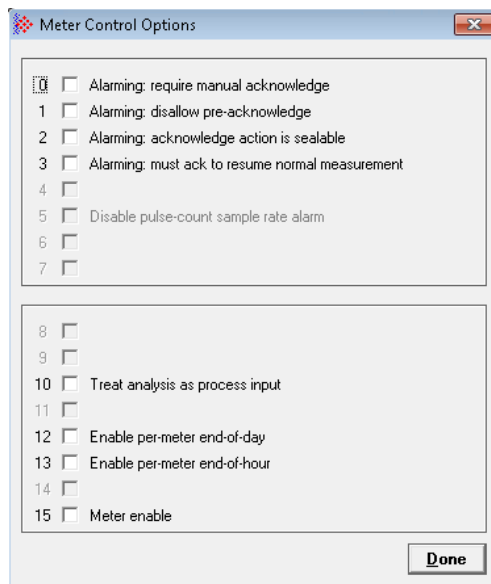
Refer to the *Meters[x].Analysis* controller tag in order to move the concentrations for each meter (x assumes values between 0 and 15).

- AFCMeter08.Analysis.Components	{...}
- AFCMeter08.Analysis.Components.C1	0.0
- AFCMeter08.Analysis.Components.N2	0.0
- AFCMeter08.Analysis.Components.CO2	0.0
- AFCMeter08.Analysis.Components.C2	0.0
- AFCMeter08.Analysis.Components.C3	0.0
- AFCMeter08.Analysis.Components.H2O	0.0
- AFCMeter08.Analysis.Components.H2S	0.0
- AFCMeter08.Analysis.Components.H2	0.0
- AFCMeter08.Analysis.Components.CO	0.0
- AFCMeter08.Analysis.Components.O2	0.0
- AFCMeter08.Analysis.Components.IC4	0.0
- AFCMeter08.Analysis.Components.NC4	0.0
- AFCMeter08.Analysis.Components.IC5	0.0
- AFCMeter08.Analysis.Components.NC5	0.0
- AFCMeter08.Analysis.Components.C6	0.0
- AFCMeter08.Analysis.Components.C7	0.0
- AFCMeter08.Analysis.Components.C8	0.0
- AFCMeter08.Analysis.Components.C9	0.0
- AFCMeter08.Analysis.Components.C10	0.0
- AFCMeter08.Analysis.Components.He	0.0
- AFCMeter08.Analysis.Components.Ar	0.0
- AFCMeter08.Analysis.Components.NeoC5	0.0
- AFCMeter08.Analysis.Components.UxUser1	0.0

The sum of all concentration should be 1. The chromatograph can measure values which total is slightly less (or more) than 1. In this case you should configure the *Normalization Error Tolerance* parameter in in order to make sure that the module will not generate any alarms.

When the module detects that a molar concentration value has changed it will generate an event. However, when the values are updated from ladder logic using a chromatograph device it is not convenient to generate an alarm every time a concentration value changes. In this case you may configure the module to not generate any alarms when a molar value is modified.

In the *Meter Control Options* dialog window, select the **TREAT ANALYSIS AS PROCESS INPUT** check box:



AFCMeter01.Analysis

This stores the analysis configuration to be used for the streams configured for high precision analysis. The sub-elements are defined as follows:

Tag	Description
.Trigger	Set to 1 to update the stream analysis with the data at <i>.Components</i> . The sample logic will automatically reset the bit after requesting the update once.
.Stream	Select the stream number to be updated with the molar data
.Error	
.Components	Contains the molar components in low precision (32-bit floating-point values)

AFCMeterDifferentialGas.Analysis.Error

Shows the molar analysis configuration information.

1 Stream Analysis Assignment.

2 *AFCMeterDifferentialGas.Analysis.Error*

3 Analysis Precision (*AFCMeterDifferentialGas.Analysis.Error.StreamNotConfigured*)

The status information is automatically updated by the sample logic upon the following events:

- After module power up.
- After analysis trigger.

Updating the High Precision Molar Analysis

To update the molar analysis with high precision data, follow these steps.

- 1 Set the stream number through *AFCMeter01.Analysis.Stream*.
- 2 Enter the molar analysis through *AFCMeter01.Analysis.Components*. For the example below the components are set as C1 = 0.7 (70%) and N2 = 0.3 (30%).
- 3 Set the *AFCMeter01.Analysis.Trigger* value as 1.
- 4 Observe *AFCMeter01.Analysis.Trigger* bit automatically reset to 0.

[-] AFCMeter08.Analysis.Components	{...}
AFCMeter08.Analysis.Components.C1	0.7
AFCMeter08.Analysis.Components.N2	0.3
AFCMeter08.Analysis.Components.CO2	0.0
AFCMeter08.Analysis.Components.C2	0.0
AFCMeter08.Analysis.Components.C3	0.0
AFCMeter08.Analysis.Components.H2O	0.0
AFCMeter08.Analysis.Components.H2S	0.0
AFCMeter08.Analysis.Components.H2	0.0
AFCMeter08.Analysis.Components.CO	0.0

- 5 Refer to EAFC Manager to observe the updated molar analysis:

Component Analysis, Stream 1

Mole fraction	Component	Mole fraction	Component
0.7000000	C1 methane	0.0000000	iC5 iso-pentane
0.3000000	N2 nitrogen	0.0000000	nC5 normal pentane
0.0000000	CO2 carbon dioxide	0.0000000	C6 hexane
0.0000000	C2 ethane	0.0000000	C7 heptane
0.0000000	C3 propane	0.0000000	C8 octane
0.0000000	H2O water	0.0000000	C9 nonane
0.0000000	H2S hydrogen sulphide	0.0000000	C10 decane
0.0000000	H2 hydrogen	0.0000000	He helium
0.0000000	CO carbon monoxide	0.0000000	Ar argon
0.0000000	O2 oxygen		neoC5 neopentane
0.0000000	iC4 iso-butane		Ux user1
0.0000000	nC4 normal butane		Uy user2
0.0000000	C6+ hexanes+	1.0000000	Total mole fraction

Specific gravity: 0.6
 Heating value: 0 MJ/kg
 Basis: Deliv Dry Wet
 Calc: AGA 8 Detail

Copy From: Meter number 1, Stream number 1, Analysis SG, HV, options
 Read: Analysis SG, HV, options
 Write: Analysis SG, HV, options
 Result: Commlink is unavailable

The concentration in the fluid of "N2 nitrogen" as a molar fraction; a number between 0 and 1.

18 Site Status on PLC

Ladder logic continuously reads the site status from the AFC module. The following controller tags are used:

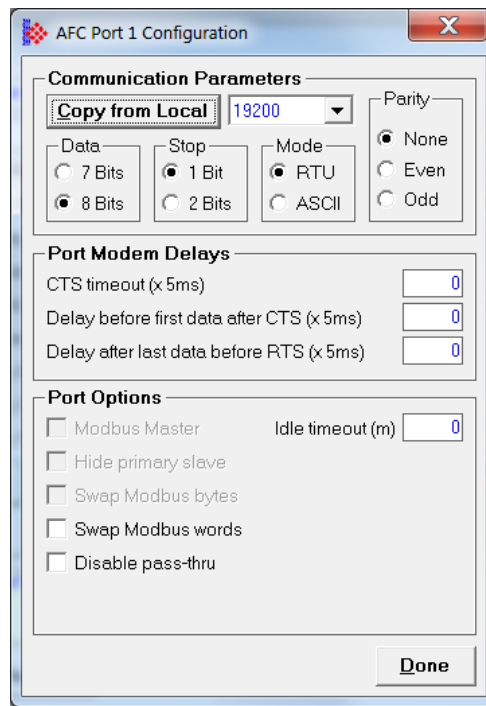
Parameter	Controller Tag
AFC Active	AFC.SiteStatus.AFCActive
Checksum Alarms	AFC.SiteStatus.ChecksumAlarms
PLC Halted	AFC.SiteStatus.PLC_Halted
Cfg Changed	AFC.SiteStatus.Cfg_changed
Power Up	AFC.SiteStatus.Powerup
Cold Start	AFC.SiteStatus.ColdStart
Modbus Master is pending	AFC.SiteStatus.ModbusMasterPending
Modbus Master is complete	AFC.SiteStatus.ModbusMasterComplete
Modbus Pass-thru pending	AFC.SiteStatus.ModbusPassThruPending
Version 2.06 or later	AFC.SiteStatus.CalibrationRequest
Prover is enabled	AFC.SiteStatus.ProverEnabled

[-] AFC.SiteStatus	{...}
[-] AFC.SiteStatus.AFCActive	1
[-] AFC.SiteStatus.ChecksumAlarms	0
[-] AFC.SiteStatus.Reserved2	0
[-] AFC.SiteStatus.Reserved3	0
[-] AFC.SiteStatus.PLCHalted	0
[-] AFC.SiteStatus.CfgChanged	1
[-] AFC.SiteStatus.Powerup	0
[-] AFC.SiteStatus.ColdStart	0
[-] AFC.SiteStatus.ModbusMasterPending	0
[-] AFC.SiteStatus.ModbusMasterComplete	0
[-] AFC.SiteStatus.ModbusPassThruPending	0
[-] AFC.SiteStatus.CalibrationRequest	0
[-] AFC.SiteStatus.ProverEnabled	0
[-] AFC.SiteStatus.Reserved13	0
[-] AFC.SiteStatus.Reserved14	0
[-] AFC.SiteStatus.Reserved15	0

18.1 Modbus Master

This block performs an arbitrary data transfer between the PLC and external Modbus slaves connected to AFC module's Serial 2, provided that Serial 2 is configured as a Modbus master. Any data transfer to or from a slave's holding registers, input registers, output coils, or input status may be implemented using this function; equivalent Modbus function codes are 1, 2, 3, 4, 15, and 16. In addition, capability is provided for access to a slave's "long remote" (32-bit) registers where the slave implements them; in particular, Daniel-style long integer (5000 series) and floating point (7000 series) registers are accessible. Any data words not relevant to the command are ignored upon output (to the AFC module) and zero upon input (from the AFC module).

This feature requires Serial 2 to be configured as a Modbus master through as follows:



In order to enable this functionality set *AFC.ModbusMaster.Enable* controller tag bit to 1. Select the command index to be executed (0 to 9) through *AFC.ModbusMaster.CommandIndex*.

[-] AFC.ModbusMaster	{...}
[-] AFC.ModbusMaster.Enable	1
[+] AFC.ModbusMaster.CommandIndex	0
[+] AFC.ModbusMaster.Command	{...}

The user should configure the following parameters for the command to be sent:

Parameter	Use this Controller Tag	Description
Enable	<i>AFC.ModbusMaster.Command[0].Config.Enable</i>	This value should be set as 1 in order to enable the command. If this value is 0 the module will ignore the Modbus master command
Function Type	<i>AFC.ModbusMaster.Command[0].Config.FunctionType</i>	0 = Read from Modbus slave 1 = Write to Modbus slave
Register Bank	<i>AFC.ModbusMaster.Command[0].Config.RegisterBank</i>	0 = Holding Register 1 = Input Register
Data Type = Bit	<i>AFC.ModbusMaster.Command[0].Config.DataType.Bit</i>	0 = Do not use bit 1 = Use bit
Data Type = Word	<i>AFC.ModbusMaster.Command[0].Config.DataType.Word</i>	0 = Do not use word 1 = Use word
Data Type = Long	<i>AFC.ModbusMaster.Command[0].Config.DataType.Long</i>	0 = Do not use long 1 = Use long
Data Type = Long Remote	<i>AFC.ModbusMaster.Command[0].Config.DataType.LongRemote</i>	0 = Do not use long remote 1 = Use long remote
Swap Bytes	<i>AFC.ModbusMaster.Command[0].Config.SwapOption.SwapWords</i>	0 = Do not swap words 1 = Swap words
Swap Words	<i>AFC.ModbusMaster.Command[0].Config.SwapOption.SwapBytes</i>	0 = Do not swap bytes 1 = Swap bytes
Type swap	<i>AFC.ModbusMaster.Command[0].Config.TypeSwap</i>	This value is calculated by ladder logic and must not be modified
Slave Address	<i>AFC.ModbusMaster.Command[0].Config.SlaveAddress</i>	Modbus slave address
Modbus Address	<i>AFC.ModbusMaster.Command[0].Config.ModbusAddress</i>	Register address in the Modbus slave
Element Count	<i>AFC.ModbusMaster.Command[0].Config.ElementCount</i>	Number of elements to be transferred
Transaction Number	<i>AFC.ModbusMaster.Command[0].Output.TransactionID</i>	This number will be echoed in the input block. It allows to multiplex more than one command in the same logic.
Modbus data	<i>AFC.ModbusMaster.Command[0].Data</i>	Read or Write Modbus Data

The following variables are automatically built by the ladder logic and the user does not have to modify these values:

AFC.ModbusMaster.Command[0].Config.TypeSwap

AFC.ModbusMaster.Command[0].Config

[-] AFC.ModbusMaster.Command	{...}
[-] AFC.ModbusMaster.Command[0]	{...}
[-] AFC.ModbusMaster.Command[0].Config	{...}
[-] AFC.ModbusMaster.Command[0].Config.Enable	0
[-] AFC.ModbusMaster.Command[0].Config.FunctionType	0
[-] AFC.ModbusMaster.Command[0].Config.RegisterBank	0
[-] AFC.ModbusMaster.Command[0].Config.DataType	{...}
[-] AFC.ModbusMaster.Command[0].Config.DataType.Bit	0
[-] AFC.ModbusMaster.Command[0].Config.DataType.Word	0
[-] AFC.ModbusMaster.Command[0].Config.DataType.Long	0
[-] AFC.ModbusMaster.Command[0].Config.DataType.LongRemote	0
[+] AFC.ModbusMaster.Command[0].Config.SwapOption	{...}
[+] AFC.ModbusMaster.Command[0].Config.TypeSwap	0

- If the Modbus Master command is set as a Read function type the data will be read to the following controller tag:
AFC.ModbusMaster.Command[0].Data
- If the Modbus Gateway command is set as a Write function type the data will be written from the following controller tag:
AFC.ModbusMaster.Command[0].Data
- If any Modbus error occurs it will be copied to the following data tag:
AFC.ModbusMaster.Command[0].ErrorCode

The valid Modbus error codes are listed below:

Error	Description
=0	No error
>0	Modbus exception code or communication error Modbus exception codes are issued by the responding slave and listed in commonly available Modbus protocol manuals; they lie between 1 and 127, and include: 1 Illegal function 2 Illegal address 3 Illegal data value

Communication errors are issued by the AFC module:

Error	Description
500	CTS timeout
501	Receive timeout
502	Bad framing
503	Buffer overrun
504	Bad checksum/CRC
505	Wrong slave

Error	Description
506	Wrong function code
507	Wrong length
<0	Configuration, parameter, or logic error: -1 Master Port not configured -2 Master Port never used -3 Bad Slave Address -4 Bad Direction/Target -5 Bad Datum Size/Swap Options -6 Bad number of data items

18.2 Modbus Pass-Through

In order to use pass-through, enable the following controller tag:

AFC.ModbusPassThru.Enable (BOOL)

AFC.SiteStatus.ModbusPassThruPending is set when data is available. The PLC must acknowledge receipt by setting *AFC.ModbusPassThru.GetMessage*.

AFC.ModbusPassThru.ReadDataWord (word commands)

AFC.ModbusPassThru.ReadDataBit (bit commands)

- AFC.ModbusPassThru	{ ... }
- AFC.ModbusPassThru.Enable	0
- AFC.ModbusPassThru.MessagePresent	0
- AFC.ModbusPassThru.GetMessage	0
- AFC.ModbusPassThru.FunctionBitWrite	0
- AFC.ModbusPassThru.OverflowError	0
+ AFC.ModbusPassThru.ModbusAddress	0
+ AFC.ModbusPassThru.RegisterCount	0
+ AFC.ModbusPassThru.ReadDataWord	{ ... }
+ AFC.ModbusPassThru.ReadDataBit	{ ... }

18.3 Modbus Gateway

The ladder logic can be used to read or write data from one of the internal Modbus Slaves (primary or virtual). Also, any data that is not part of the *AFCMeterX.CalculationResults* must be read through the Modbus Gateway blocks.

Each block can transfer up to 200 words of data and uses a specific *AFC.ModbusGateway* controller tag. Each one of these tags must be configurable in order to read or write data between the module and the processor.

Perform the following steps to use the Modbus Gateway blocks:

- 1 Identify how many words (total) will be transferred. The sample ladder supports up to 2000 words.
- 2 Based on the number of registers to be transferred, calculate how many Modbus Gateway blocks will be necessary. Each block contains up to 200 registers.
Example: If 700 registers will be used to transfer data, 4 Modbus Gateway blocks will be required.
- 3 The maximum number of supported commands by the sample ladder is 10.
- 4 Refer to the Modbus Dictionary dialog box in and identify the addresses of all registers in the Primary Slave.
- 5 Using EAFC Manager, re-map the registers from the Primary Slave to the Virtual Slave (refer to EAFC Export Utility User Manual for more information about this subject).

6 In the sample ladder logic, configure each Modbus Gateway Block using the following controller tags:

Parameter	Controller Tag	Values
Enable Transaction	AFC.ModbusGateway.Command[0].Config.Enable	0 = The module will ignore this request 1 = The module will process this request.
Start Register	AFC.ModbusGateway.Command[0].Config.StartRegister	Start register in the Modbus Slave to be written or read from
Register Count	AFC.ModbusGateway.Command[0].Config.RegisterCount	Number of words to be written or read between the module and the processor. Maximum of 200 words is supported per command.
Function Type	AFC.ModbusGateway.Command[0].Config.FunctionType	0 = Read from AFC module 1 = Write to AFC module
Register Type	AFC.ModbusGateway.Command[0].Config.RegisterType	0 = Holding Register 1 = Input Register
Slave Type	AFC.ModbusGateway.Command[0].Config.SlaveType	0 = Primary Slave 1 = Virtual Slave

Note: It is strongly suggested that you first configure all parameters having the *Enable* bit set to 0. After the configuration is finished than the *Enable* bit can be set to 1.

Example 1 - Modbus Gateway Function

In order to write 40 words from the processor to the Primary Modbus Slave starting at holding register address 2000, the *AFC.ModbusGateway.Command[0]* block should be configured as follows:

[-] AFC.ModbusGateway.Command[0].Config	{...}
AFC.ModbusGateway.Command[0].Config.Enable	1
[+] AFC.ModbusGateway.Command[0].Config.StartRegister	2000
[+] AFC.ModbusGateway.Command[0].Config.RegisterCount	40
AFC.ModbusGateway.Command[0].Config.FunctionType	1
AFC.ModbusGateway.Command[0].Config.RegisterType	0
AFC.ModbusGateway.Command[0].Config.SlaveType	0
AFC.ModbusGateway.Command[0].Trigger	0
[-] AFC.ModbusGateway.Command[0].Data	{...}

Refer to the *AFC.ModbusGateway.Command[0].Config.FunctionType* controller tags depending on the configured function type.

19 Diagnostics and Troubleshooting

AFC modules have the following communication connections on the module:

- Two RS-232/422/485 Application ports
- One Ethernet port

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

- LEDs
- Meter Alarms
- Checksum Alarms
- Events
- Audit Scan

19.1 MVI56E-AFC LEDs and Alarm Information

The non-scrolling LEDs indicate the module’s operating status as follows:

LED Label	Color	Status	Indication
APP	Red or Green	OFF	The module is not receiving adequate power or is not securely plugged into the rack. May also be OFF during configuration download.
		GREEN	The MVI56E-AFC is working normally.
		RED	The most common cause is that the module has detected a communication error during operation of an application port. The following conditions may also cause a RED LED: <ul style="list-style-type: none"> ▪ The firmware is initializing during startup ▪ The firmware detects an on-board hardware problem during startup ▪ Failure of application port hardware during startup ▪ The module is shutting down
OK	Red or Green	OFF	The module is not receiving adequate power or is not securely plugged into the rack.
		GREEN	The module is operating normally.
		RED	The module has detected an internal error or is being initialized. If the LED remains RED for over 10 seconds, the module is not working. Remove it from the rack and re-insert it to restart its internal program.
ERR	Red		When flashing, the LED indicates that at least one meter is in alarm state. Please refer to the Meter Monitor or the PLC meter tags for additional meter alarm information.

19.2 MVI69E-AFC LEDs

LED	Status	Description
MTR		(Metering) Indicates meter-enable and alarm status
	Steady Green	Meters enabled, none in alarm
	Blinking Yellow/Dark	No meters enabled
	Blinking Red/Dark	Meter alarms detected (Meters in alarm are enabled).
W&M		(Weights and Measures) Inactive
COM		Modbus Communications Activity (network or serial)
	Steady Green	A Modbus transaction is in progress
	Steady Dark	No active Modbus Transactions
NVM		(Non-Volatile Memory) Indicates general NV memory state, including cold-start and/or checksum alarms
	Steady Green	Module is out of cold-start and no outstanding checksum alarms
	Blinking Green/Red	Module is out of cold-start, but checksum alarms exist
	Blinking Yellow/Dark	Module is in cold-start state (needs configuration), and no checksum alarms
	Blinking Yellow Red	Module is in cold-start state, and checksum alarms exist
BP		(Backplane) Indicates backplane status, including communication with the PLC
	Steady Green	Module running, backplane online to PLC
	Blinking Green/Dark	Module running, PLC offline
	Steady Yellow	Module initializing
OK		(General status) Indicates overall module health
	Steady Green	Module is healthy and operating correctly
	Dark	Module is non-operational, or no power
	Steady Red	Module is frozen; Call Technical Support

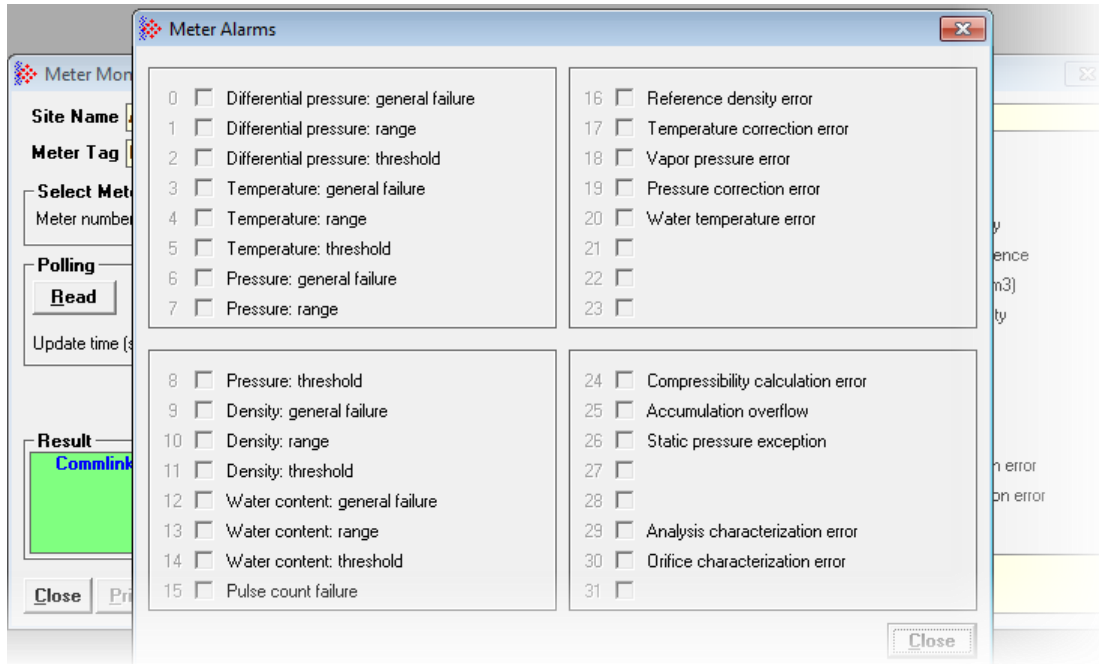
19.3 NVRAM LEDs

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

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

19.4 Meter Alarms

If the module is generating unexpected data, verify if the meter has any alarms. Some alarms may be caused by an issue that could potentially affect the calculation results. Each archive 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 EAFC Manager.

The alarms are listed in the following table. Of the Alarm Codes listed, the values depend on both the selected *Product Group* and the firmware version.

Alarm	Description
Pulse frequency input failure	The pulse frequency process input has detected a process-input alarm, and the last-verified process-input value has been substituted. For more information, see <i>Input scaling, pulse frequency</i> points in the EAFC Manager's Modbus Dictionary.
Pulse frequency input out of range	The pulse frequency process input is outside its configured allowable range, and the last-verified process-input value has been substituted. For more information, see <i>Input scaling, pulse frequency</i> points in the EAFC Manager's Modbus Dictionary.
Pulse frequency input outside threshold limits	The pulse frequency process input has exceeded a configured threshold limit; no substitution has been made. For more information, see <i>Input scaling, pulse frequency</i> points in the EAFC Manager's Modbus Dictionary.
Temperature: input failure	The temperature process input has encountered a failure, and the last-verified process-input value has been substituted. For more information, see <i>Input scaling, temperature</i> points in the EAFC Manager's Modbus Dictionary.

Alarm	Description
Temperature: input out of range	The temperature process input is outside its configured allowable range, and the last-verified process-input value has been substituted. For more information, see <i>Input scaling, temperature</i> points in the EAFC Manager's Modbus Dictionary.
Temperature: Input outside threshold limits	The temperature process input has exceeded a configured threshold limit. No substitution has been made. For more information, see <i>Input scaling, temperature</i> points in the EAFC Manager's Modbus Dictionary.
Pressure input failure	The pressure process input has encountered a failure, and the last-verified process-input value has been substituted. For more information, see <i>Input scaling, pressure</i> points in the EAFC Manager's Modbus Dictionary.
Pressure: input out of range	The pressure process input is outside its configured allowable range, and the last-verified process-input value has been substituted. For more information, see <i>Input scaling, pressure</i> points in the EAFC Manager's Modbus Dictionary.
Pressure: input outside threshold limits	The pressure process input has exceeded a configured threshold limit. No value substitution has been made. For more information, see <i>Input scaling, pressure</i> points in the EAFC Manager's Modbus Dictionary.
Density input failure	The density process input has encountered a failure, and the last-verified process-input value has been substituted. The PLC supplies a density value over the backplane and this alarm applies to the input density value being invalid. For more information, see <i>Input scaling, density</i> points in the EAFC Manager's Modbus Dictionary.
Density input out of range	The density process input is outside its configured allowable range, and the last-verified process-input value has been substituted. The PLC supplies a density value over the backplane and this alarm applies to the input density value being invalid. For more information, see <i>Input scaling, density</i> points in the EAFC Manager's Modbus Dictionary.
Density input outside threshold limits	The density process input has exceeded a configured threshold limit. No value substitution has been made. The PLC supplies a density value over the backplane and this alarm applies to the input density value being invalid. For more information, see <i>Input scaling, density</i> points in the EAFC Manager's Modbus Dictionary.
Pulse count failure	A failure of the pulse counting hardware has been detected. While this alarm is active, the latest received pulse count persists. Therefore, pulse increments are zero and no accumulation is registered.
Reference density error	The density correction calculation has failed, usually (but not necessarily) due to an input value being outside the range of values that are valid for the calculation. For more information, see <i>Reference density error</i> points in the EAFC Manager's Modbus Dictionary.
Temperature correction error	The temperature correction calculation has failed, usually (but not necessarily) due to an input value being outside the range of values that are valid for the calculation. For more information, see <i>Temperature correction error</i> points in the EAFC Manager's Modbus Dictionary.
Vapor pressure error	The vapor pressure correlation calculation has failed, usually (but not necessarily) due to an input value being outside the range of values that are valid for the calculation. For more information, see <i>Vapor pressure error</i> points in the EAFC Manager's Modbus Dictionary.
Pressure correction error	The pressure correction calculation has failed, usually (but not necessarily) due to an input value being outside the range of values that are valid for the calculation. For more information, see <i>Pressure correction error</i> points in the EAFC Manager's Modbus Dictionary.
Water temperature error	The water temperature correction calculation has failed, usually (but not necessarily) due to an input value being outside the range of values that are valid for the calculation. For more information, see <i>Water temperature error</i> points in the EAFC Manager's Modbus Dictionary.

Alarm	Description
Water salinity error	The water salinity calculation has failed, usually (but not necessarily) due to an input value being outside the range of values that are valid for the calculation. For more information, see <i>Water salinity error</i> points in the EAFC Manager's Modbus Dictionary.
Accumulation overflow	An accumulator increments in a single scan that is unreasonable (i.e. Less than 0 or greater than 1,000,000,000), is ignored and the alarm is raised.
Static pressure exception	Absolute static pressure is unreasonably low and has been adjusted. For more information, see <i>Static pressure exception</i> points in the EAFC Manager's Modbus Dictionary.

A process input “failure” is reported by setting any of the process-input alarms, except for the “threshold” alarms which are warnings that do not require further action by the module. Failure alarms are called “substitutable” because they replace the raw input value with a “known-good” value.

There are two serious alarms that report process-input values that cannot be used:

- 1) *Transmitter Failure* reported by the PLC to indicate that the value supplied shall be ignored because its source is unavailable.
- 2) *Invalid Format* reported by the EAFC because the IEEE floating-point value received is a NAN or INF that cannot be used further in computations.

For these alarms, the substituted “known-good” value is either:

- The “last-good” value (The latest verified process-input value received in this measurement session); or
- 0 (zero), if no “last-good” value exists because one has not yet been obtained in the measurement session*. The substituted zero could raise further alarms in later calculation steps, especially if the process input is a density.

If the alarm is not serious, then the value can enter computations. The first computation checks the value against the operating range configured for the input, which can raise range alarms. If a range alarm is present, the “known-good” value is the endpoint of the operating range whose limit is exceeded.

Two additional alarms can be produced:

- 1) A *Sample rate* alarm, when enabled, reports that the rate of delivery of the process input is too slow. This alarm is used when compliance with certain measurement standards that mandate minimum process input delivery rates is monitored. No value substitution is made.
- 2) A *Pulse fidelity error* alarm records an associated dual-channel pulse-counting hardware unit has detected a discrepancy between the two channels. This alarm requires acknowledgement. Whereas the (single) pulse train delivered to the module continues to be used for measurement, its reliability is uncertain. No value substitution is made.

*A measurement session for a meter begins when the meter transits into *Enabled* state, either (a) by changing state from *Disabled*, or (b) consequent to a module restart.

19.5 Checksum Alarms

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

During power-up, the checksum is verified, and upon failure the alarm bit is latched and the checksum corrected. The alarm bit remains latched, even through subsequent power cycles, until it is explicitly cleared from an external source such as EAFC Manager. Refer to *Viewing Checksum Alarms* section for more information. Refer to the Monitor link on the module's website.

19.6 Events

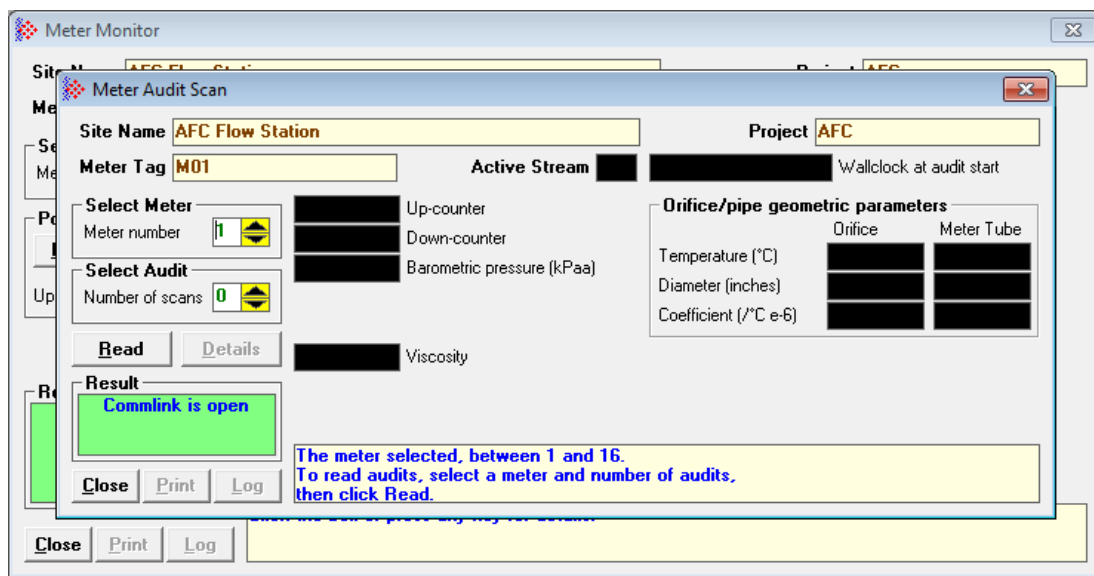
The AFC module records up to 2000 events during module operation.

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

Refer to the *Events* section 6 for more information about event monitor.

19.7 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 MVI56E-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, click the **LOG** button to log the results, click the **PRINT** button to print the log.
- 4 Notice 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.

Audit Scan Data Display

Meter Tag: DIE_AFC_M1 Scan: 1

0	Temperature Floating point	0	Net accum: totalizer (MMCF)
0	Pressure Floating point	0	Net accum: residue (MMCF)
0	Temperature (°F)	0	Net increment (MMCF)
0	Pressure (psig)	0	Net flow rate (MMCF/d)
0	Pulse frequency (Hz)	0	Energy accum: totalizer (MBTU)
24	K factor	0	Energy accum: residue (MBTU)
1	Meter factor	0	Energy increment (MBTU)
0.561434	Specific gravity	0	Energy flow rate (MBTU/h)
1.00051	Fpv	0	Mass accum: totalizer (lb)
0.9970248	Compressibility, flowing	0	Mass accum: residue (lb)
0.9980413	Compressibility, reference	0	Mass increment (lb)
1.130528	Temperature factor	0	Mass flow rate (lb/h)
0.9976918	Pressure factor	Click Me	Analysis
1.129069	C prime, C'		
0	Analysis characterization error		
0	Compressibility calculation error		
0	Gross accum: totalizer (MMCF)		
0	Gross accum: residue (MMCF)		
0	Gross increment (MMCF)		
0	Gross flow rate (MMCF/d)		

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 for 2 scans:

E AFC-56(16) Audit Date: 16-09-2016 16:18:07
 Site Name: MVI Flow Station
 Project: EAFC

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

EAFC-56(16) Audit

Date: 16-09-2016 16:18:08

Site Name: MVI Flow Station

Project: EAFC

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	0,000062

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 error	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

20 Meter Extended Totalizers

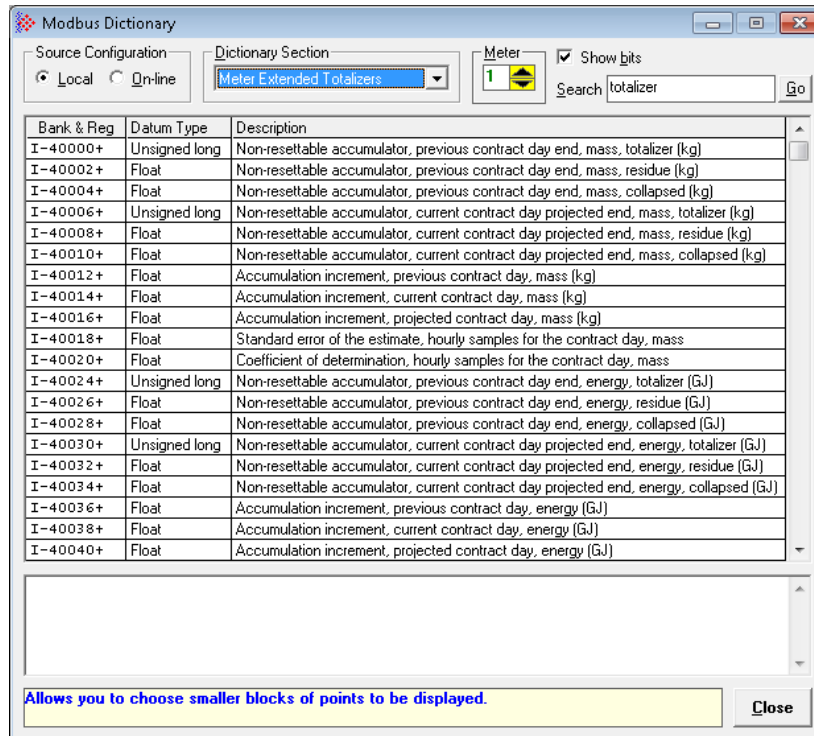
20.1 Retrieving the Data

This feature provides the new allocation of per-meter input registers. Primary slave blocks starting at Pi40000 for 16000 registers (i.e., through Pi55999 with 1000 registers per meter) for 16 meters of the 56E; 12-meter 69E stops at Pi51999. So M1 at 40000, M2 at 41000, etc.

New dictionary section “TlZr” (starting at Modbus Dictionary section “Extended Totalizers”, one 300-input register instance per meter.

- Meter-relative addresses Mi01000 thru Mi01299. Mapped to primary slave as first 300 registers of the new 1000-register allocation. So M1’s TlZr is at Pi40000 thru Pi40299, M2’s TlZr at Pi41000-Pi41299, etc.

Note: The remaining 700 registers of the new 1000-register per-meter allocation have not yet been assigned and access thereto elicits an “Illegal Address” Modbus exception.



To the following values:

I-40224+	Float	Non-resettable accumulator, previous contract month end, gross, residue (MCF)
I-40226+	Float	Non-resettable accumulator, previous contract month end, gross, collapsed (MCF)
I-40228+	Unsigned long	Non-resettable accumulator, current contract month projected end, gross, totalizer (MCF)
I-40230+	Float	Non-resettable accumulator, current contract month projected end, gross, residue (MCF)
I-40232+	Float	Non-resettable accumulator, current contract month projected end, gross, collapsed (MCF)
I-40234+	Float	Accumulation increment, previous contract month, gross (MCF)
I-40236+	Float	Accumulation increment, current contract month, gross (MCF)
I-40238+	Float	Accumulation increment, projected contract month, gross (MCF)
I-40240+	Float	Standard error of the estimate, daily samples for the contract month, gross
I-40242+	Float	Coefficient of determination, daily samples for the contract month, gross
I-40294+	Unsigned long	Extended totalizers, timestamp, previous contract month end
I-40296+	Unsigned long	Extended totalizers, timestamp, current contract month projected end

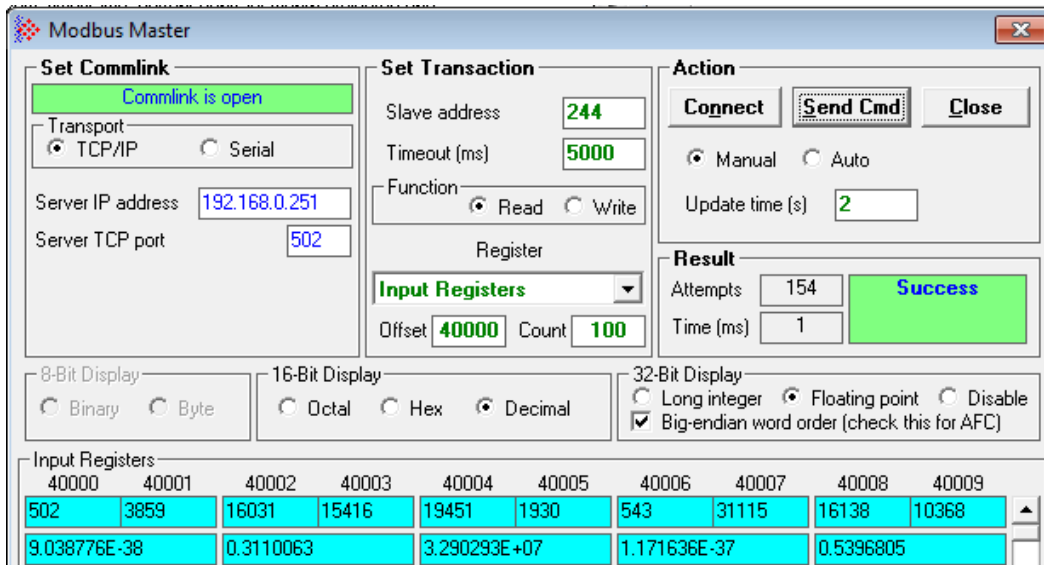
The total accumulation is maintained in two parts; this point, the "totalizer", is the integral part and is stored as an unsigned 32-bit integer value, and the next point, the "residue", is the fractional part and is stored as a floating point value. To determine the total accumulation, add together the totalizer and the residue.

Allows you to choose smaller blocks of points to be displayed.

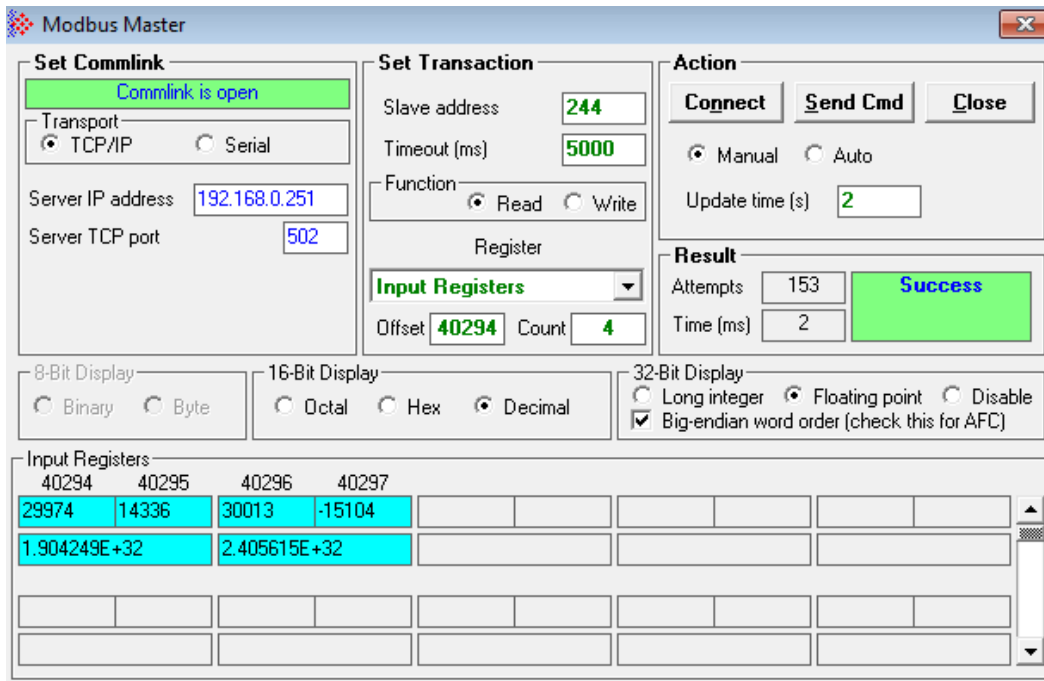
Close

20.2 Viewing Data Values

As shown by the Modbus Address, these points are accessible using Modbus Master.



To the following values:



The parameters above are grouped and organized in following manner:

The first 3 double words of this group (I-40000+, I-40002+, I-40004+) show a single accumulation as (a) a totalizer-residue pair of double words and (b) a float-collapsed double word. The pair of double words are (1) unsigned 32-bit integer totalizer (the integral part) and (b) the 32-bit floating-point residue (fractional part, always < 1.0); the 3rd double word is that same value as a single 32-bit float.

Interpreting the set of totalizer in registers 40000-40001 as a 32-bit integer, one can use below formula:

If Low Order Register is positive use the formula: $Tot = HOR * 65536 + LOR$

If Low Order Register is negative use the formula $Tot = (HOR + 1) * 65536 + LOR$ or $(HOR * 65536 + (LOR + 65536))$

Input Registers					
40000	40001	40002	40003	40004	40005
502	3859	16031	15416	19451	1930
9.038776E-38		0.3110063		3.290293E+07	

Interpreting the above set of registers yield $502 * 65536 + 3859 = 32902931$, combining that with the residue in registers 40002-40003 yields 32902931.311063 , and rounding that to 7 significant digits yields the single 32-bit float in registers 40004-40005 as $3.290293E+07$. This triplet of double words is the "NR accumulator, previous contract day end, mass". The next triplet is the same for "current contract day".

Interpreting these triplet double words in same manner:

40006	40007	40008	40009	40010	40011
543	31115	16138	10368	19463	-8605
1.171636E-37		0.5396805		3.561716E+07	

$543 * 65536 + 31115 = 35617163$ combining that with the residue in registers 40008-40009 yields 35617163.5396805 , and rounding that to 7 significant digits yields the single 32-bit float in registers 40010-40011 as $3.561716E+07$.

Following that are 6 floats: (1) increment for the previous period, (2) increment for the current period until now, (3) increment projected for the current period ending in the future,

40012	40013	40014	40015	40016	40017
18981	-22050	18528	-28282	18981	-22044
2714232		229958.1		2714233	

These above numbers will differ depending on the process input values but you can see with above values that value in 40012+ and 40016+ will be the same or very close to the same number if there is constant positive flow to the systems without change for long period of time. This is because the Accumulation increment, projected contract day, mass is calculated using linear regression and if the slope of the line is constant with collected data, you will expect the amount the of accumulation increment for previous contract day to be same or very close to be the same as the Accumulation increment, for projected contract day. You can also see that value in 40014+ will be less in value than the value in 40016 since 40014+ is the Accumulation increment, current contract day (until now). This value is expected increase as the time passes if there is positive flow to the system.

40018	40019	40020	40021	40022	40023
0	0	0	0	0	0
0		0		0	

(4-5) statistical properties which are not calculated at this moment and should appear as zero, and (6) an unallocated 32-bit slot.

- I-40000+ Non-resettable accumulator, previous contract day end, mass, totalizer (lb)
- I-40002+ Non-resettable accumulator, previous contract day end, mass, residue (lb)
- I-40004+ Non-resettable accumulator, previous contract day end, mass, collapsed (lb)
- I-40006+ Non-resettable accumulator, current contract day projected end, mass, totalizer (lb)
- I-40008+ Non-resettable accumulator, current contract day projected end, mass, residue (lb)
- I-40010+ Non-resettable accumulator, current contract day projected end, mass, collapsed (lb)
- I-40012+ Accumulation increment, previous contract day, mass (lb)
- I-40014+ Accumulation increment, current contract day, mass (lb)
- I-40016+ Accumulation increment, projected contract day, mass (lb)
- I-40018+ Standard error of the estimate, hourly samples for the contract day, mass
- I-40020+ Coefficient of determination, hourly samples for the contract day, mass
- I-40022+ Unallocated register

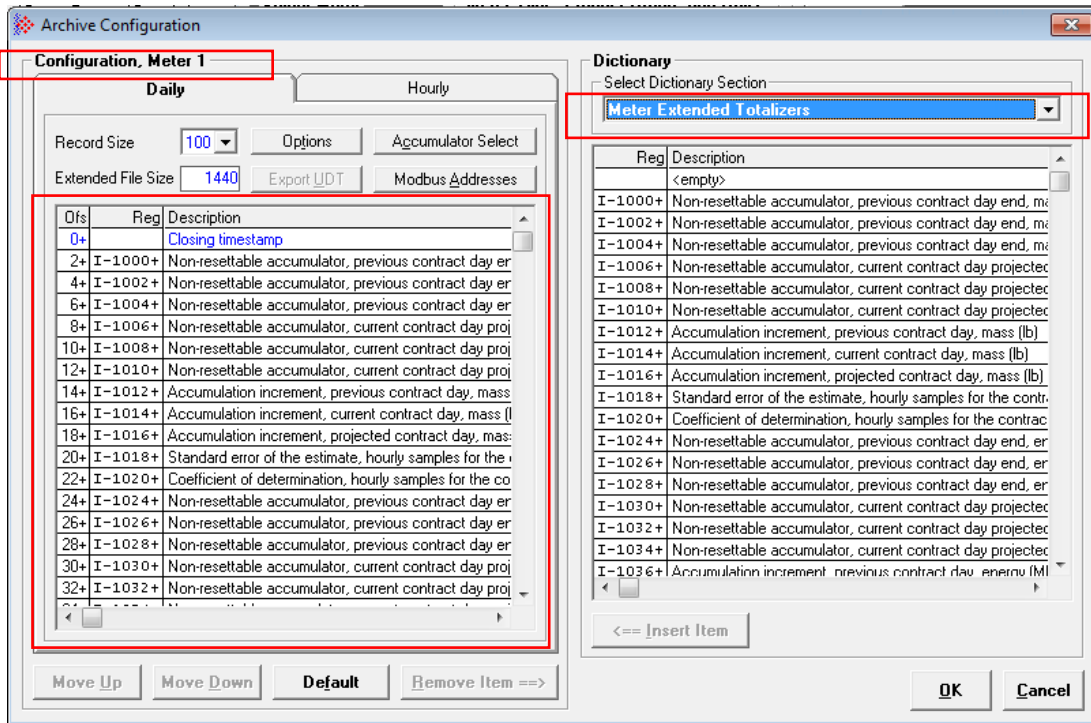
Then, this entire structure (above) is iterated 5 more times, for "energy", "net (volume)", "gross (volume)", "gross standard (volume)", and "water", availability of each depending on product group.

Finally, 3 more 32-bit quantities: (1) timestamp (Unix-epoch) of previous contract period end, (2) timestamp of projected current contract period end, and (3) unallocated.

All of the above are for "contract day"; this entire structure is iterated once again for "contract month".

- The "TlZr" points are available for mapping to archive records and backplane-return packets. (see Modbus Dictionary for details.)

Meter Extended Totalizers are available to be accessed by both Daily and Hourly Archive Configurations:



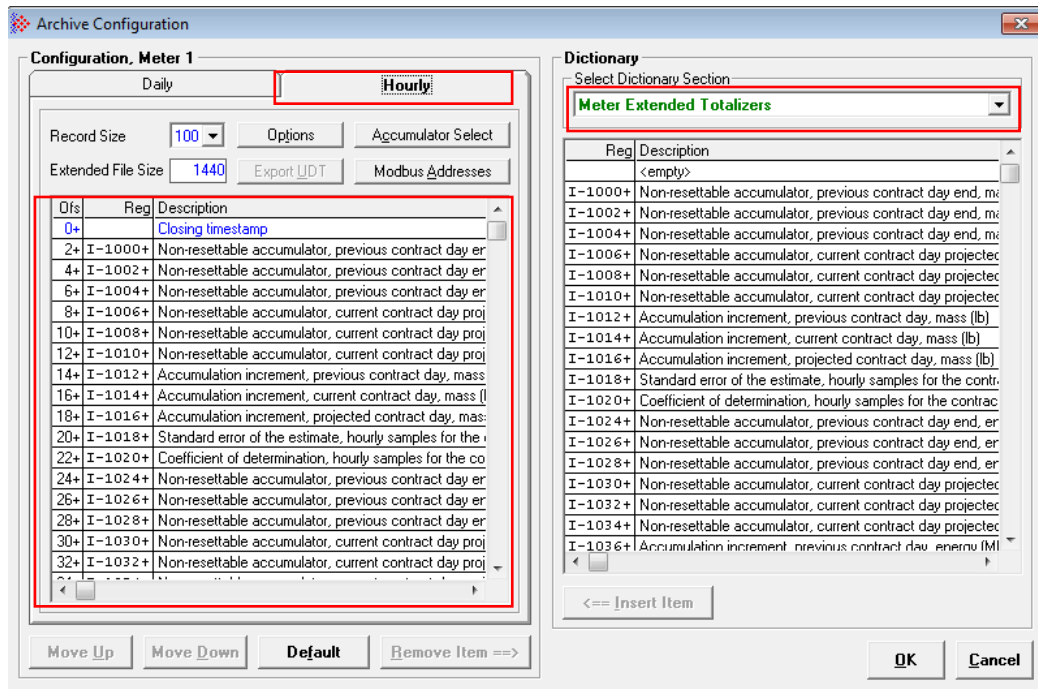
Select Meter Meter **1**

Select Archives Daily Hourly Ages: **0** to **100**
 Daily file: 0 current, 1 to 10 loca

Description \ Age	Current
Non-resettable accumulator, previous contract day end, mass, tota	69802985
Non-resettable accumulator, previous contract day end, mass, resid	0.6654956
Non-resettable accumulator, previous contract day end, mass, coll	6.980298E+07
Non-resettable accumulator, current contract day projected end, m	72517216
Non-resettable accumulator, current contract day projected end, m	0.7892456
Non-resettable accumulator, current contract day projected end, m	7.251722E+07
Accumulation increment, previous contract day, mass (lb)	2714231
Accumulation increment, current contract day, mass (lb)	1406122
Accumulation increment, projected contract day, mass (lb)	2714231
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, m	0
Non-resettable accumulator, previous contract day end, energy, tol	1668389
Non-resettable accumulator, previous contract day end, energy, re:	0.7276574
Non-resettable accumulator, previous contract day end, energy, cc	1668390
Non-resettable accumulator, current contract day projected end, et	1733263
Non-resettable accumulator, current contract day projected end, et	0.6996033
Non-resettable accumulator, current contract day projected end, et	1733264
Accumulation increment, previous contract day, energy (MMBTU)	64873.97
Accumulation increment, current contract day, energy (MMBTU)	33608.32

Description \ Age	Current
Accumulation increment, projected contract day, energy (MMBTU)	64873.97
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, er	0
Non-resettable accumulator, previous contract day end, net, totaliz	1644127
Non-resettable accumulator, previous contract day end, net, residu	0.4923078
Non-resettable accumulator, previous contract day end, net, collap	1644128
Non-resettable accumulator, current contract day projected end, ne	1708058
Non-resettable accumulator, current contract day projected end, ne	0.0171783
Non-resettable accumulator, current contract day projected end, ne	1708058
Accumulation increment, previous contract day, net (MCF)	63930.53
Accumulation increment, current contract day, net (MCF)	33119.56
Accumulation increment, projected contract day, net (MCF)	63930.52
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, ne	0
Non-resettable accumulator, previous contract day end, gross, tota	505870
Non-resettable accumulator, previous contract day end, gross, resi	0.7297459
Non-resettable accumulator, previous contract day end, gross, coll.	505870.7
Non-resettable accumulator, current contract day projected end, gr	525541
Non-resettable accumulator, current contract day projected end, gr	9.988791E-02

Description \ Age	Current
Accumulation increment, projected contract day, net (MCF)	63930.52
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, ne	0
Non-resettable accumulator, previous contract day end, gross, tota	505870
Non-resettable accumulator, previous contract day end, gross, resi	0.7297459
Non-resettable accumulator, previous contract day end, gross, coll.	505870.7
Non-resettable accumulator, current contract day projected end, gr	525541
Non-resettable accumulator, current contract day projected end, gr	9.988791E-02
Non-resettable accumulator, current contract day projected end, gr	525541.1
Accumulation increment, previous contract day, gross (MCF)	19670.37
Accumulation increment, current contract day, gross (MCF)	10190.34
Accumulation increment, projected contract day, gross (MCF)	19670.37
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, gr	0
Extended totalizers, timestamp, previous contract day end	-2147408896
Extended totalizers, timestamp, current contract day projected end	-2147299200
Non-resettable accumulator, previous contract month end, mass, to	66630897
Non-resettable accumulator, previous contract month end, mass, re	8.044434E-02
Non-resettable accumulator, previous contract month end, mass, c	6.66309E+07



Select Meter: Meter 1 | Select Archives: Daily Hourly | Ages: 0 to 100 | Hourly file: 0 current, 1 to 14 loc

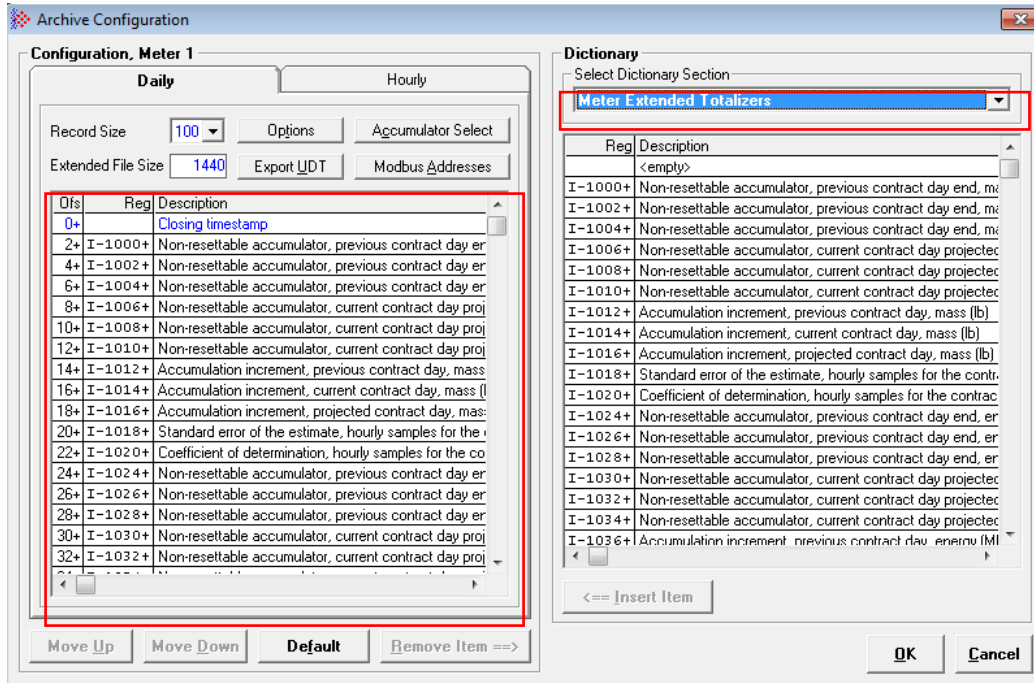
Description \ Age	Current
Non-resettable accumulator, previous contract day end, mass, tota	69802985
Non-resettable accumulator, previous contract day end, mass, resia	0.6654956
Non-resettable accumulator, previous contract day end, mass, coll	6.980298E+07
Non-resettable accumulator, current contract day projected end, m	72517216
Non-resettable accumulator, current contract day projected end, m	0.7877884
Non-resettable accumulator, current contract day projected end, m	7.251723E+07
Accumulation increment, previous contract day, mass (lb)	2714231
Accumulation increment, current contract day, mass (lb)	1347691
Accumulation increment, projected contract day, mass (lb)	2714231
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, m	0
Non-resettable accumulator, previous contract day end, energy, tot	1668389
Non-resettable accumulator, previous contract day end, energy, re	0.7278574
Non-resettable accumulator, previous contract day end, energy, cc	1668380
Non-resettable accumulator, current contract day projected end, er	1733263
Non-resettable accumulator, current contract day projected end, er	0.6995618
Non-resettable accumulator, current contract day projected end, er	1733264
Accumulation increment, previous contract day, energy (MMBTU)	64873.97
Accumulation increment, current contract day, energy (MMBTU)	32211.72

Description \ Age	Current
Accumulation increment, projected contract day, energy [MMBTU]	64873.97
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, er	0
Non-resettable accumulator, previous contract day end, net, totaliz	1644127
Non-resettable accumulator, previous contract day end, net, residu	0.4923078
Non-resettable accumulator, previous contract day end, net, collap	1644128
Non-resettable accumulator, current contract day projected end, ne	1708058
Non-resettable accumulator, current contract day projected end, ne	1 716089E-02
Non-resettable accumulator, current contract day projected end, ne	1708058
Accumulation increment, previous contract day, net [MCF]	63930.53
Accumulation increment, current contract day, net [MCF]	31743.27
Accumulation increment, projected contract day, net [MCF]	63930.52
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, ne	0
Non-resettable accumulator, previous contract day end, gross, tota	505870
Non-resettable accumulator, previous contract day end, gross, resi	0.7297459
Non-resettable accumulator, previous contract day end, gross, coll	505870.7
Non-resettable accumulator, current contract day projected end, gr	529541
Non-resettable accumulator, current contract day projected end, gr	9 985395E-02

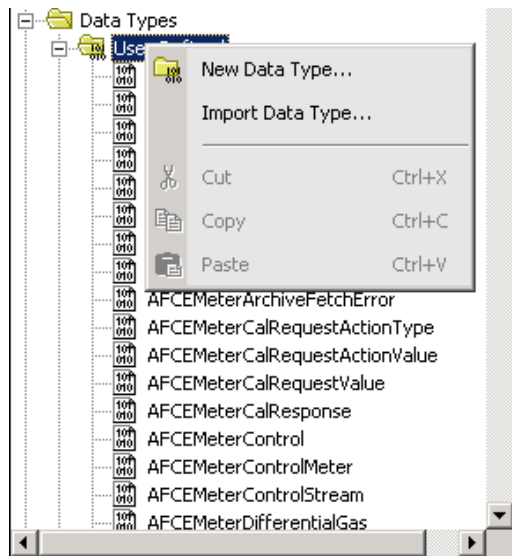
Description \ Age	Current
Accumulation increment, projected contract day, net [MCF]	63930.52
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, ne	0
Non-resettable accumulator, previous contract day end, gross, tota	505870
Non-resettable accumulator, previous contract day end, gross, resi	0.7297459
Non-resettable accumulator, previous contract day end, gross, coll	505870.7
Non-resettable accumulator, current contract day projected end, gr	529541
Non-resettable accumulator, current contract day projected end, gr	9 985395E-02
Non-resettable accumulator, current contract day projected end, gr	529541.1
Accumulation increment, previous contract day, gross [MCF]	19670.37
Accumulation increment, current contract day, gross [MCF]	9766.883
Accumulation increment, projected contract day, gross [MCF]	19670.37
Standard error of the estimate, hourly samples for the contract day,	0
Coefficient of determination, hourly samples for the contract day, gr	0
Extended totalizers, timestamp, previous contract day end	-2147408896
Extended totalizers, timestamp, current contract day projected end	-2147299200
Non-resettable accumulator, previous contract month end, mass, te	66630897
Non-resettable accumulator, previous contract month end, mass, te	0.044434E-02
Non-resettable accumulator, previous contract month end, mass, c	6 66309E+07

The “Tlizr” points are also available for mapping to archive records and exporting those archives as UDTs to be accessed in the Controller Tags in RSLogix.

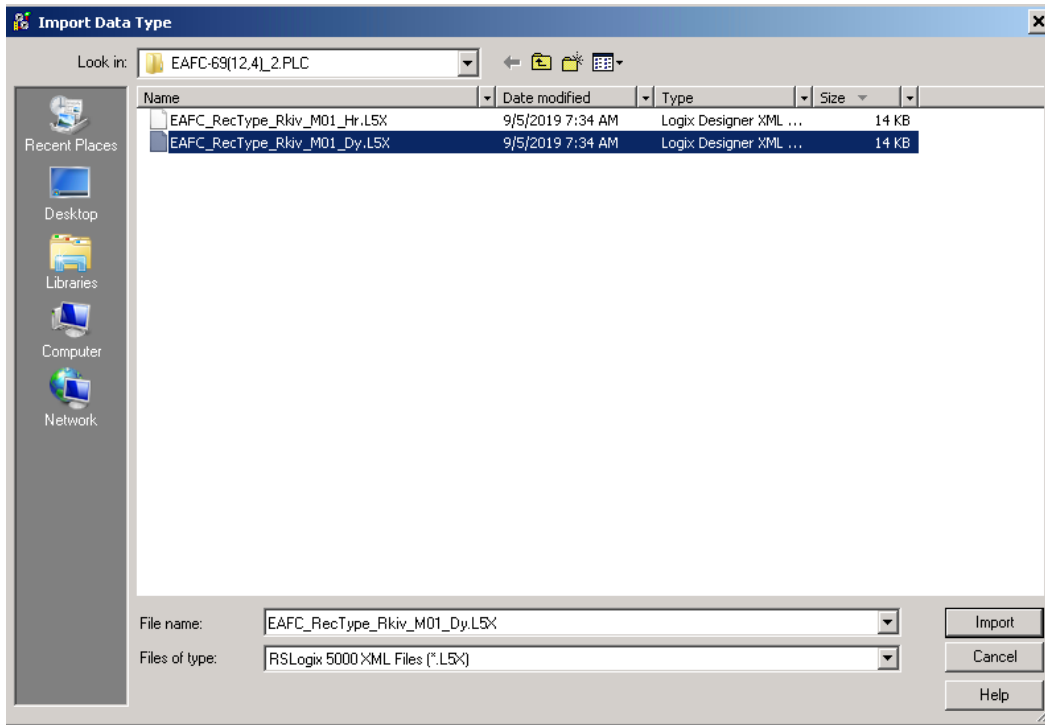
- 1 Create the list of the Archives in the Archive Configuration then export the UDT.



- 2 Import Data Type



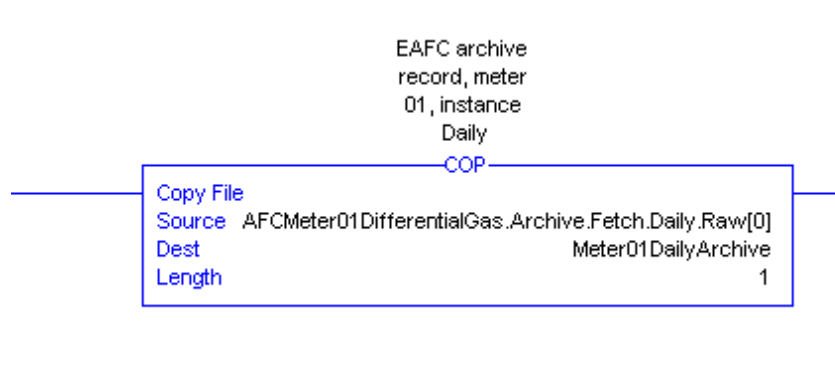
3 Choose the Archive data UDT that was exported:



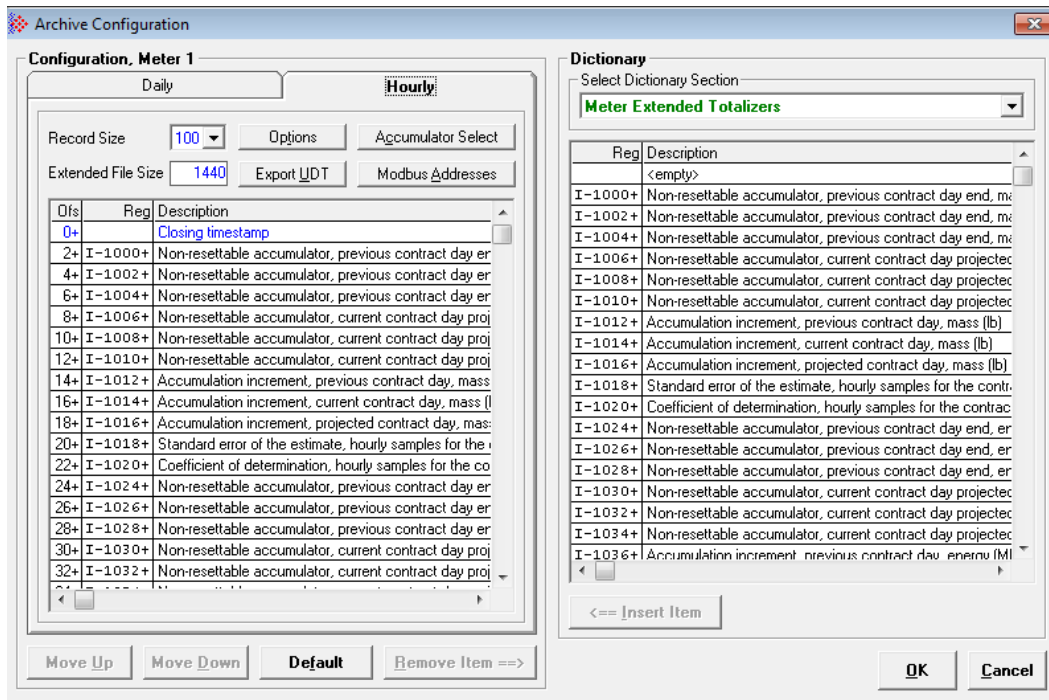
4 Create a Controller Tag with the Data Type of the UDT which was created after importing the UDT:



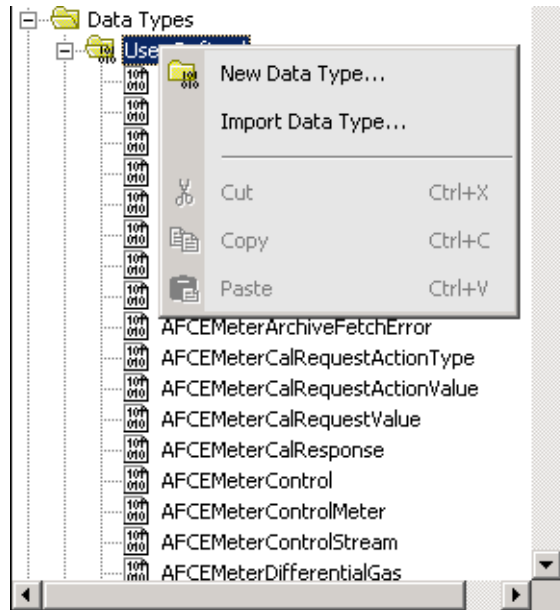
5 Create a COP Instruction to copy the raw data into the tags that was created above:



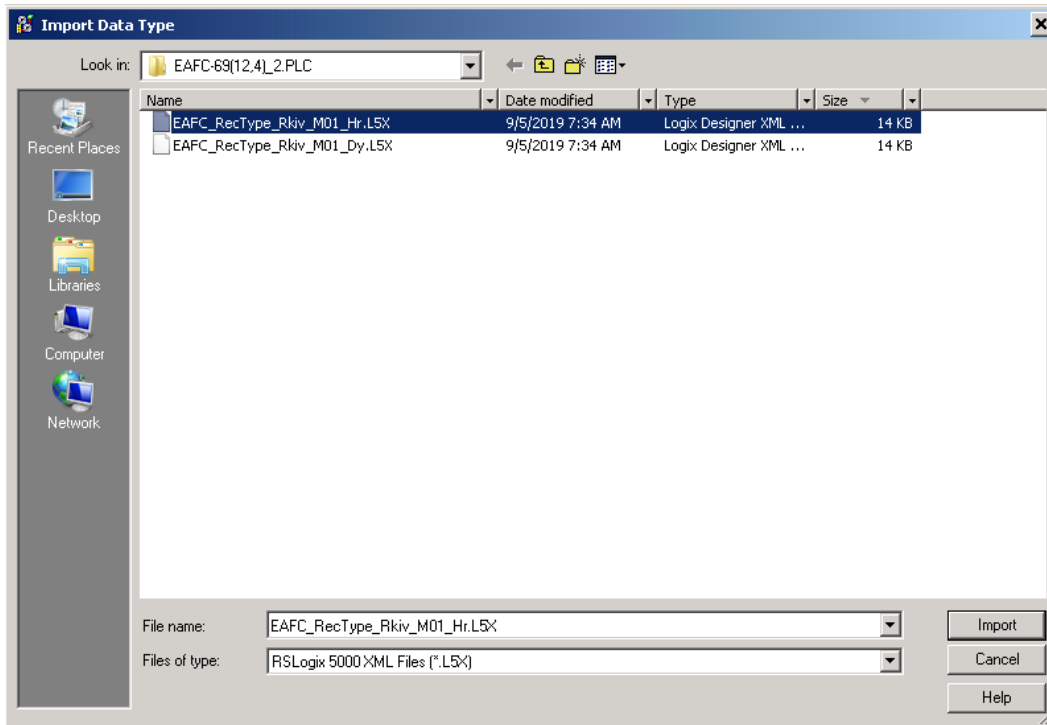
Name	Value
[-] Meter01DailyArchive	{...}
[-] Meter01DailyArchive.Tstp	2013120000
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_AcEP_Totl	59674696
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_AcEP_Rsdu	0.3573768
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_AcEP_FpAc	59674696.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_AcEN_Totl	59679225
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_AcEN_Rsdu	0.15458089
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_AcEN_FpAc	59679224.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_DItP	4523.228
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_DItC	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_DItN	4528.7974
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_StpS	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Ms_StpR	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_AcEP_Totl	1426309
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_AcEP_Rsdu	0.25189573
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_AcEP_FpAc	1426309.3
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_AcEN_Totl	1426417
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_AcEN_Rsdu	0.4965719
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_AcEN_FpAc	1426417.5
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_DItP	108.11156
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_DItC	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_DItN	108.244675
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_StpS	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Eg_StpR	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_AcEP_Totl	1405567
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_AcEP_Rsdu	0.53787416
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_AcEP_FpAc	1405567.5
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_AcEN_Totl	1405674
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_AcEN_Rsdu	0.20837018
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_AcEN_FpAc	1405674.3
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_DItP	106.539314
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_DItC	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_DItN	106.670494
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_StpS	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Nt_StpR	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_AcEP_Totl	432469
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_AcEP_Rsdu	0.7563459
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_AcEP_FpAc	432469.75
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_AcEN_Totl	432502
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_AcEN_Rsdu	0.5771026
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_AcEN_FpAc	432502.56
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_DItP	32.780396
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_DItC	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_DItN	32.820755
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_StpS	0.0
[-] Meter01DailyArchive.TICp_Dy_TICv_Gr_StpR	0.0
[-] Meter01DailyArchive.TICp_Dy_TstP	2013120000
[-] Meter01DailyArchive.TICp_Dy_TstN	2013206400
[-] Meter01DailyArchive.TICp_Mo_TICv_Ms_AcEP_Totl	59602243
[-] Meter01DailyArchive.TICp_Mo_TICv_Ms_AcEP_Rsdu	0.44525278
[-] Meter01DailyArchive.TICp_Mo_TICv_Ms_AcEP_FpAc	59602244.0



6 Import Data Type



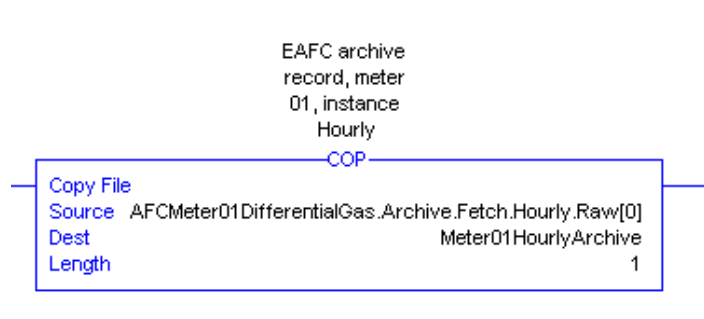
7 Choose the Archive data UDT that was exported:



8 Create a Controller Tag with the Data Type of the UDT which was created after importing the UDT:



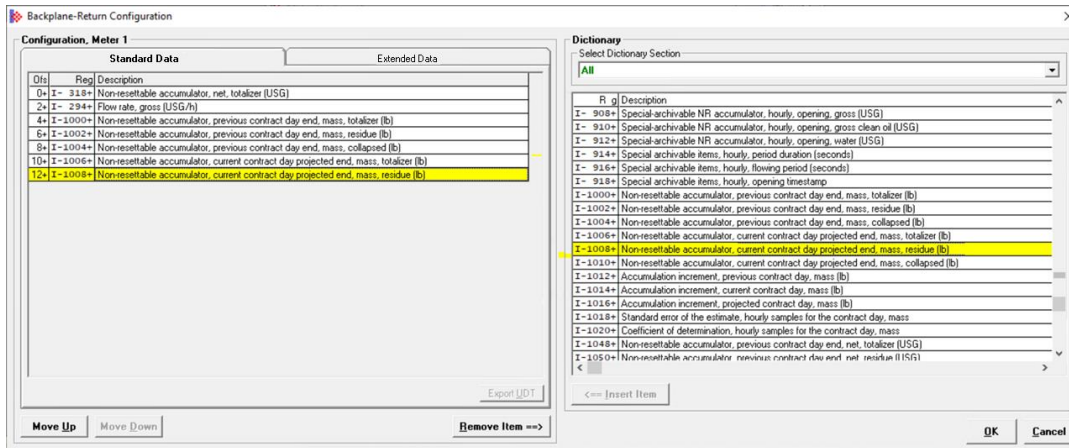
9 Create a COP Instruction to copy the raw data into the tags that was created above:



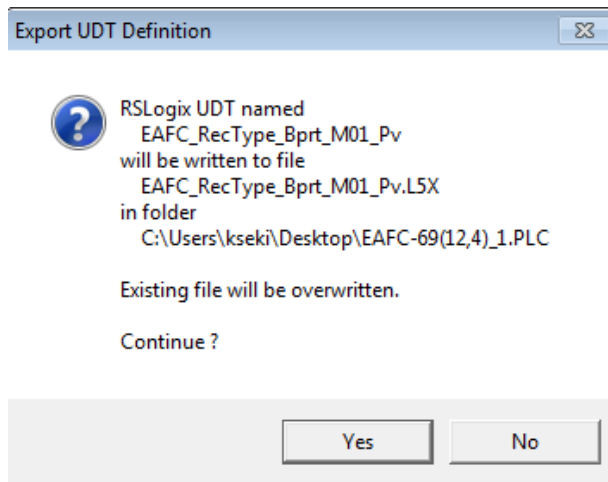
Name	Value
[-] Meter01HourlyArchive	{...}
[-] Meter01HourlyArchive.Tstp	2016104397
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_AcEP_Totl	59828479
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_AcEP_Rsdu	0.5990524
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_AcEP_FpAc	59828480.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_AcEN_Totl	59832985
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_AcEN_Rsdu	0.098249905
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_AcEN_FpAc	59832984.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_DtP	4528.351
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_DtC	2357.944
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_DtN	4505.499
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_StpS	0.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Ms_StpR	0.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_AcEP_Totl	1429984
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_AcEP_Rsdu	0.8894249
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_AcEP_FpAc	1429984.9
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_AcEN_Totl	1430092
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_AcEN_Rsdu	0.5772439
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_AcEN_FpAc	1430092.6
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_DtP	108.23401
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_DtC	56.35821
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_DtN	107.68782
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_StpS	0.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Eg_StpR	0.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_AcEP_Totl	1409189
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_AcEP_Rsdu	0.7214428
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_AcEP_FpAc	1409189.8
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_AcEN_Totl	1409295
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_AcEN_Rsdu	0.8431811
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_AcEN_FpAc	1409295.9
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_DtP	106.65999
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_DtC	55.538605
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_DtN	106.121735
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_StpS	0.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Nt_StpR	0.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_AcEP_Totl	433584
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_AcEP_Rsdu	0.24260622
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_AcEP_FpAc	433584.25
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_AcEN_Totl	433616
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_AcEN_Rsdu	0.8945208
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_AcEN_FpAc	433616.9
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_DtP	32.817524
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_DtC	17.088316
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_DtN	32.651917
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_StpS	0.0
[-] Meter01HourlyArchive.TICp_Dy_TICv_Gr_StpR	0.0
[-] Meter01HourlyArchive.TICp_Dy_TstP	2016057600
[-] Meter01HourlyArchive.TICp_Dy_TstN	2016144000
[-] Meter01HourlyArchive.TICp_Mo_TICv_Ms_AcEP_Totl	59742440
[-] Meter01HourlyArchive.TICp_Mo_TICv_Ms_AcEP_Rsdu	0.9893722
[-] Meter01HourlyArchive.TICp_Mo_TICv_Ms_AcEP_FpAc	59742440.0

Access the meter extended totalizer through backplane-return packets. Standard data, if left unchanged, is automatically part of the imported Add-On Instruction. However, if you would like to change the Standard Data mapping, you can remove data points using the menu below and map other data. Once you have selected the data mapping importing the data is as follows:

1 Set up Backplane-Return Configuration as below:



- 2 Make sure to save the EAFC file after setting up the Backplane-Return Configuration so that the **EXPORT UDT** button will be selectable.
- 3 Click **EXPORT UDT** button.




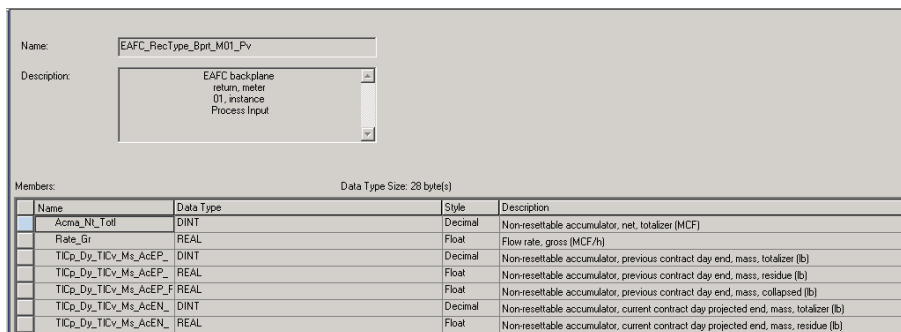
- 4 After Exporting the UDT, you can now import that same .L5X file to access configured tags via *BackPlaneReturn.ProcessInput* tags in the Controller Tags.

20.2.1 Implementation

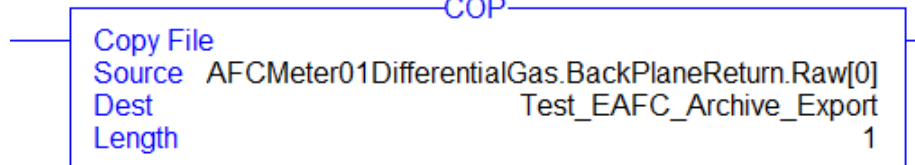
- 1 From within RSLogix Controller Organizer, navigate to **DATA TYPES > USER-DEFINED**.
- 2 Right-click on **USER-DEFINED**.
- 3 Select **Import Data Type...**
- 4 In the *Import Data Type* window, select the UDT (.L5X file) to import.
- 5 Select **Import...**
- 6 Click **OK** to import the UDT.

The procedure above will create a UDT in the **Data Type > User-Defined Folder** in RSLogix.

 EAFC_RecType_Bprt_M01_Pv



EAFC backplane
 return, meter 01,
 instance Process
 Input
 COP



- 7 Create a unique tag of the imported data type.

Use a *COP* (Copy) instruction with the *Source* as the first element of the meter *BackplaneReturn* tag. The *Dest* (Destination) is a newly created tag of the imported data type. The length is 1. Make sure that the data type matches the data that you want to view.

[-] Test_EAFC_Archive_Export			
[+] Test_EAFC_Archive_Export.Acma_Nt_Totl	1677681		Decimal
[-] Test_EAFC_Archive_Export.Rate_Gr	819.5985		Float
[+] Test_EAFC_Archive_Export.TICp_Dy_TICv_Ms_AcEP_Totl	69802985		Decimal
[-] Test_EAFC_Archive_Export.TICp_Dy_TICv_Ms_AcEP_Rsdu	0.66549563		Float
[-] Test_EAFC_Archive_Export.TICp_Dy_TICv_Ms_AcEP_FpAc	69802984.0		Float
[+] Test_EAFC_Archive_Export.TICp_Dy_TICv_Ms_AcEN_Totl	72517216		Decimal
[-] Test_EAFC_Archive_Export.TICp_Dy_TICv_Ms_AcEN_Rsdu	0.7720032		Float

20.3 Accumulator Projection

“Tizr” is populated by new functionality: “Accumulator projection”. Behind the scenes, samples of all meter non-resettable accumulators are captured every minute, linearly regressed with a history of previously collected samples, and results used to predict (“project”) expected accumulations at the end of certain currently ongoing periods.

These predictions, and the history of recorded samples, supply the data used in maintaining the contents of the meter’s extended totalizer registers.

20.3.1 Projection Periods

Two projection periods include Daily and Monthly

Daily

Daily projection is to the end of the current contract day according to the meter’s effective “end-of-day minute” aka “contract hour”. (Hourly sample data)

Monthly

(Daily sample data) Monthly projection is to the end of the current contract month, which is the contract hour of the 1st day of the next month (or that of the brand-new current calendar month if current time is on the 1st but before the contract hour).

59 times out of 60 these per-minute samples are short-lived, being discarded and overwritten when the next per-minute sample is taken. But, if the time of the sample is the minute of the hour that is configured for the meter’s “end-of-day minute” that sample is recorded in the NV history for use in future regression calculations. (This “minute of the hour” is what follows the colon “:” of the contract hour configuration; for example, if contract hour is 8:30 am, then the “minute” is the “30”.) So one of these NV samples occurs every hour, and one of those hourly samples occurs every day at the moment of the contract hour. The hourly samples go into the history for the daily projection, and the daily samples go into the monthly projection history.

- The daily projection history records the 60 most recent hourly samples, i.e. spanning an interval of 2½ days into the past. The monthly projection history records the most recent 64 daily samples, i.e. spanning an interval of just over 2 months into the past.
- Along with the separate history files for the separate projection periods, a third history file exists, which supplies its contents to both the daily and monthly projection calculations. This history records samples taken upon the occurrence of “significant” events; such an event is one that would trigger the posting of an archive record when the archive file is configured for “archive upon event”. This history has capacity for 100 of the most recent event-triggered samples.

- The linear regression logic does not necessarily input all available historical samples together with the latest ephemeral one-minute sample; instead, it filters the available samples according to a range of timestamps, or “timespan”, inputting those samples that are within the timespan but ignoring all others. The valid timespan extends 2 hours into the future, to allow for small adjustments to the wallclock up to and including a one-hour setback of the clock that would occur on the autumn change from daylight back to standard time.

The valid timespan also extends a variable duration into the past, separately for each of the projection periods. This variability is configured in two points of the meter configuration, the two bytes of meter-relative holding register Mh00038 (M1 at 8038, M2 at 9038, ...), one byte for each projection period. (see the Modbus Dictionary description of those “accumulator projection lookback timespan” points for details.)

- By default the **daily** projection inputs the hourly and event-triggered samples that are at least as new as 24 hours old (and no newer than 2 hours into the future), and the **monthly** projection inputs the daily and event-triggered samples that are at least as new as 30 days old (and no newer than 2 hours into the future).

21 Daily and Monthly Formula Calculations

Notes:

Variable b = Slope

Variable ? = Interpret

Y prime (with long line) is rejected by y. y represents the projected value of y.

$$r = \frac{\sum((x - \text{avg}_1(x)) * (y - \text{avg}_1(y)))}{\sqrt{(\sum((x - \text{avg}_1(x))^2) * \sum((y - \text{avg}_1(y))^2))}}$$

$$S_{y_1} = \sqrt{(\sum((y - \text{avg}_1(y))^2) / (n - 1))}$$

$$S_{x_1} = \sqrt{(\sum((x - \text{avg}_1(x))^2) / (n - 1))}$$

$$b = r * S_{y_1} / S_{x_1}$$

$$a = \text{avg}_1(y) - b * \text{avg}_1(x)$$

$$S = \text{sqrt}(\sum(y' - \text{avg}_1(y))^2 / (n - 2))$$

$$R^2 = \sum((y' - \text{avg}_1(y))^2) / \sum((y - \text{avg}_1(y))^2)$$

The number of samples must be greater than 2 in order to perform statistics.

Variable	Description
x	Time of sample, in seconds since 1/1/1970 00:00:00
b	Linear slope
a	Linear intercept
y'	Linear projection. y' = a+bx
S	Standard error of the regression. Sometimes called the standard error of the estimate. Provides the absolute measure of the typical distance that the data points fall from the regression line. S is in units of the sample. This statistic indicates how far the data points are from the regression line on average.
R ²	R-squared. Provides the relative measure of the percentage of the sample variance, from 0 to 100%. Higher R-squared values typically mean that the data points are closer to the fitted values.
n	The number of samples must be greater than 2 in order to perform statistics.

22 Configuration File Management Reference

22.1 Loading an Existing Project

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

To load an existing project:

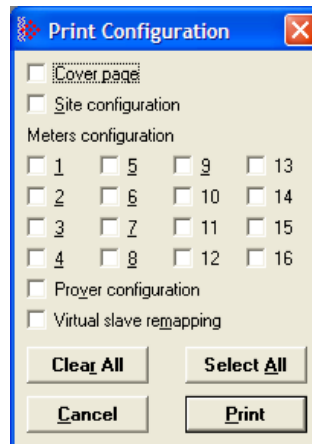
- 1 In EAFC Manager, open the **FILE** menu.
- 2 In the *File* menu, choose **LOAD**. This action opens a dialog box that shows a list of project files (EAFC files) in the current folder.
- 3 Choose the project to load, and then click **OPEN**.

22.2 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 open the print dialog for printing.

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

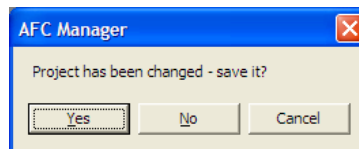
22.3 Resetting Configuration Parameters

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 EAFC 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**.

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



- 4 Click **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. Then you can save your project to retry the reset.

22.4 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 or with EAFC 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 module. The date/time information used is the same as the processor, therefore you should use the configuration tool for your processor to verify that the processor has valid date/time data. If the processor wallclock is not valid (for example if the year = 1900), the module will not accept the command. You may easily determine if the wallclock is running by performing two consecutive read operations in the Meter Monitor.

- 3** Make sure that the meter does not have any alarms. A meter alarm may affect flow calculation. Monitor 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.

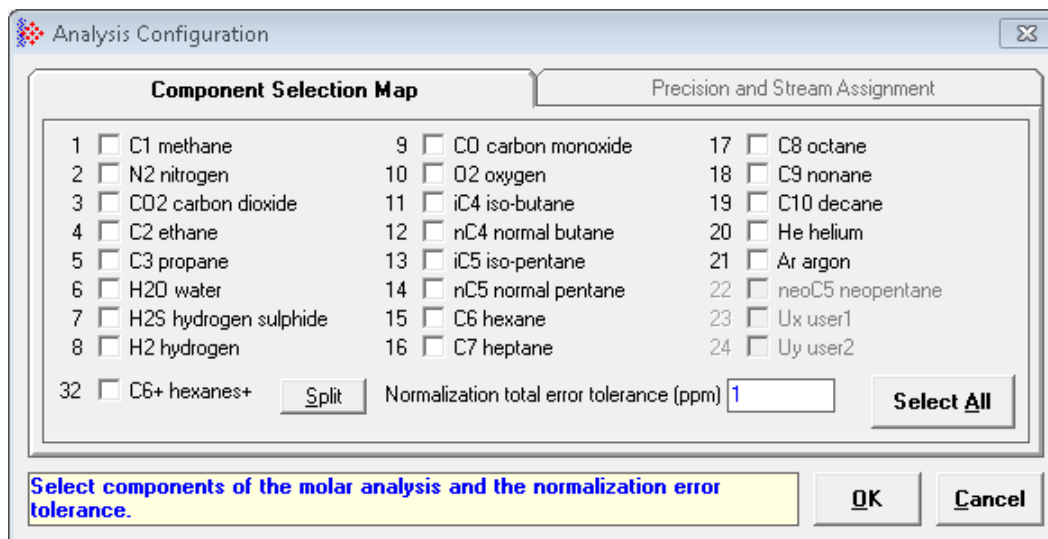
23 Gas Component Analysis (Molar Analysis) Configuration

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	50 kPaa (7.3 psia)	110 kPaa (16 psia)	101.325 kPaa (14.73 psia)

23.1 Entering Molar Concentrations

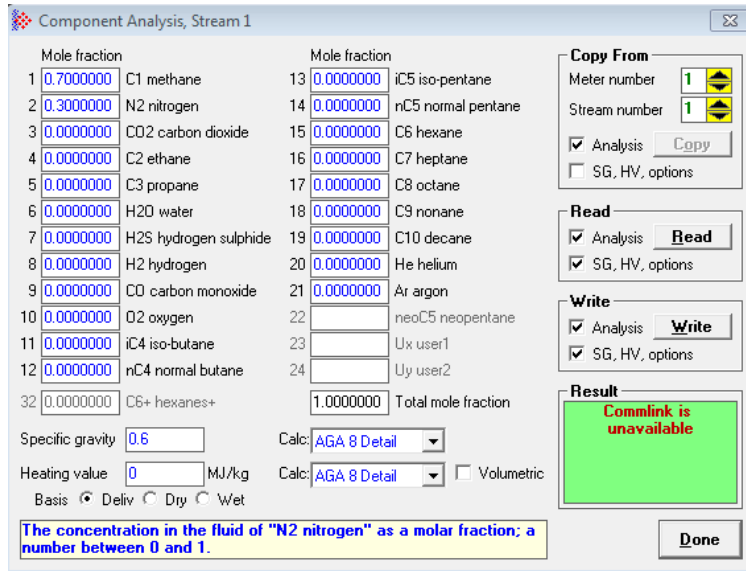
- 1 From the *Meter Configuration* dialog, click **READ** to retrieve the Molar Analysis settings from the module, or click **WRITE** to send the *Molar Analysis* settings from the PC to the module. A dialog opens to confirm your local port settings.
- 2 To enter gas molar concentrations, click the **ANALYSIS CONFIG** button on the *Meter Configuration* dialog box and select the **COMPONENT SELECTION MAP** tab. This area of the *Meter Configuration* dialog box is visible when the product type is Gas.



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

Note: The sample ladder logic assumes that all components are selected so it is suggested to check all components for compatibility with the sample ladder logic.

- 4 Next, enter the molar concentration for each component. Click the **ANALYSIS** button in the *Meter Configuration* dialog to open the *Component Analysis* dialog box.
- 5 Because the module uses the *Detail Characterization Method*, you must enter a complete molar analysis for the gas.



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

For example, when you enter:

C1 Molar Fraction = 0.8

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

Note: If you would like to input this data as a percentage instead of molar fraction, select **FILE > PREFERENCES** and change the value of *Show analysis molar concentrations in...* to **PERCENT**.

23.2 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%. Or fractions between 0 and 1 that sum exactly to 1.0000. Real devices, however, usually produce a total slightly different from 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 1.0000 (= 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 round-off error when converting concentrations to the format required by the MVI56E-AFC (which is molar fractions in floating-point. The default Meter Configuration sets this value to 1 ppm to allow for round-off error when summing the concentration values to exactly 1.000000; it is not recommended to set this value to 0.

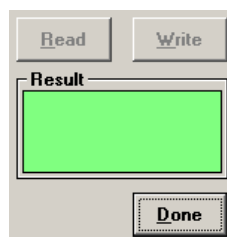
If the concentration total differs from 100% by more than the tolerance, the module raises the alarm.

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

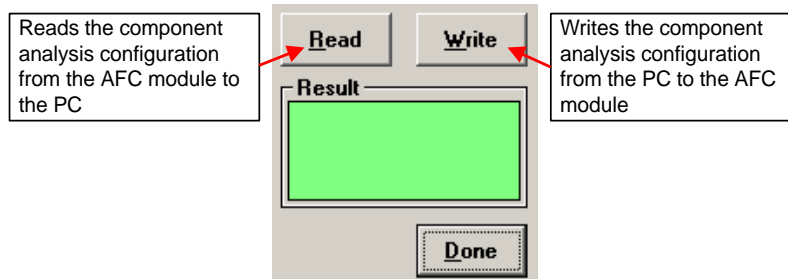
23.3 Transferring the Analysis

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

If the Molar Analysis **WRITE** and **READ** buttons are currently disabled, it indicates that does not acknowledge that the current module meter configuration and the local PC component selections 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:

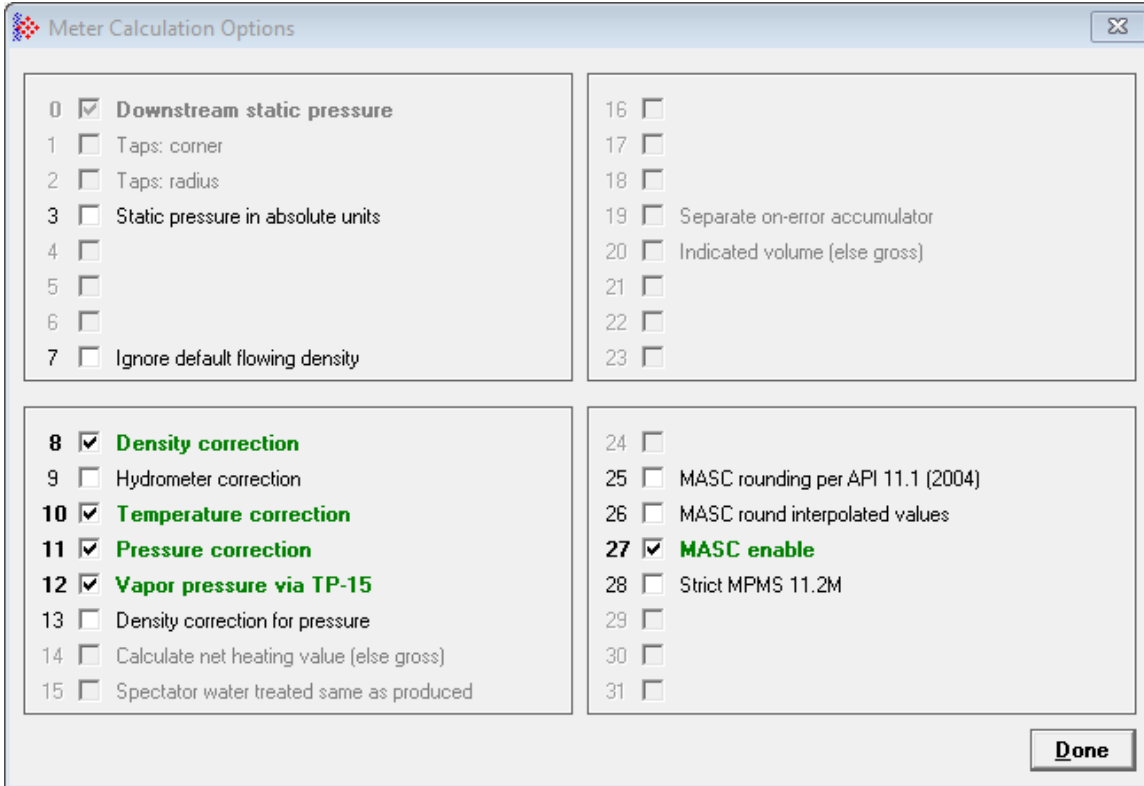
Message	Description
Success	Transfer was successfully completed
Time out	Transfer was not completed. Check communication parameters.
Illegal Data Value	The values entered are not acceptable. Make sure the values have a valid format.

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 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 EAFC Managersoftware.

24 Meter Calculation Options

Use the *Meter Calculations Options* to choose the required calculation parameters. Please note that the available options within this dialog are dependent on the meter type. Options that are not applicable to the meter type are not enabled and cannot be selected.



The following table describes the functions of each parameter.

Parameter	Description
Downstream Static Pressure	<p>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:</p> $\text{upstream pressure} = \text{downstream pressure} + \text{differential pressure}$ <p>If the pressure is measured from a downstream tap (typical), this parameter must be checked.</p>

Parameter	Description
Taps: Corner and Taps: Radius	<p>These options select the minor adjustments to the AGA3 calculations that depend on the precise geometry of the pressure taps.</p> <p>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.</p>
Static pressure in absolute units	<p>If this option is clear, then static pressure input is in gauge units and absolute pressure is calculated by adding the barometric pressure configured in register H-130. If this option is set, then static pressure input is in absolute units (pressure above vacuum). In this case, if the input value is less than a very small minimum value (arbitrarily chosen as 0.001000 kPa absolute), then in order to avoid arithmetic faults, the input is raised to that minimum for further calculations and the calculation alarm "Static pressure exception" is raised: See "Meter Calculation Alarms" for more information. The default setting is clear.</p>
Ignore default flowing density	<p>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 MVI56E-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).</p>
Density correction, Hydrometer correction, Temperature correction, and Pressure correction	<p>You should consider these options to select or unselect API2540 calculations for liquid measurement, depending on the requirements of the project.</p> <p>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.</p>
Vapor pressure via MPMS11.2.5 (Technical Paper #15)	<p>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".</p> <p>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.</p> <p>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 MPMS11.2.5 ("Technical Paper #15") is a correlation for calculating the equilibrium (vapor) pressure for typical hydrocarbon fluids (for example, propane) from density and temperature.</p>

Parameter	Description
Density correction for pressure	<p>This option, effective only when option "Density Correction" is selected, enables the effect of pressure to be included in the density correction calculation.</p> <p>When cleared, only the effect of temperature is considered.</p>
Calculate net heating value (else gross)	<p>With this option clear, calculated energy content of the stream is the gross heating value in which the 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 the 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.</p>
Spectator water treated same as produced	<p>"Spectator" water in a gas stream is water vapor content delivered as a non-zero concentration in the input gas analysis. With this option clear, the only effect of spectator water upon heating value is to limit that value by diluting the gas stream with non-combustible material. If this option is set, then spectator water is treated as if it were produced water, so that if gross heating value is selected by having option <i>Calculate net heating value</i> clear both spectator water and water produced by the combustion together are deemed to be condensed to the liquid state and the latent heat released from both is included in the energy content. Note that if net heating value is selected then setting this option has no effect as all water, both spectator and produced, is deemed to remain in the gaseous state and the effect of spectator water is again limited to mere dilution of the combustibles and consequent limiting of heating value.</p> <p>See also the stream setting <i>Heating value basis</i> for the effect of that setting on the deemed spectator water content.</p>
Separate on-error accumulator	<p>This option selects how quantity accumulation proceeds when the meter is in an error alarm condition. When this option is clear (the default), all primary and derived quantity increments are totalized into their respective accumulator registers regardless of the presence of any error alarm condition, the same as when no error alarm condition is present. When this option is set, however, and an error alarm condition is present:</p> <ul style="list-style-type: none"> ▪ The increment of the meter's primary measured quantity (e.g., "gross volume" for a turbine meter, or "mass" for an orifice meter) continues to be totalized into its usual accumulator registers. ▪ The primary measured quantity is also totalized into the "in error alarm" accumulator for the active stream (registers at I-400). ▪ All derived increments, that is, all but that of the primary measured quantity, are deemed to be zero so that their respective accumulators are not advanced. <p>When no error alarm condition is present, accumulation proceeds normally and the "in error alarm" accumulator is not advanced.</p> <p>Flow rates, including those of derived quantities, are not affected by this option.</p>

Parameter	Description
Indicated volume (else gross)	<p>This option selects whether to include the effect of the meter factor in the values of recorded quantities nominally labeled as “gross volume”. These quantities appear, for example, in these locations:</p> <ul style="list-style-type: none"> ▪ The “Accumulator increment” ▪ The “Flow rate” ▪ The “Non-resettable accumulator” <p>This option, if set, is effective only if both of the following additional conditions are met: The meters device type is “Linear”. The primary input’s “Measured quantity” is “Volume” For example, turbine and positive displacement meters. The measurement calculation divides the input pulse count (or frequency) by the K-factor to yield the “indicated volume” in engineering volume units, which is what the meter is telling us that it is reading (at flowing conditions). The indicated volume is then multiplied by the meter factor to yield the “gross volume”, with the effect of the meter factor included. If the option is set (and effective), then the quantity recorded is “indicated volume”, with the effect of the meter factor excluded (and in this case, most displays show “indicated” instead of “gross”).</p> <p>Note that this option only selects which of the two quantities is to be recorded; both quantities are always calculated, and “gross volume” (which includes the effect of the meter factor) is always used for calculating further derived quantities such as net volume and mass.</p>
MASC rounding per API 11.1 (2004)	<p>When this option is set, EAFC Manager will round intermediate liquid calculations (such as CTLs, water cuts, shrinkage factors, and densities) using methods prescribed in API MPMS 11.1 (2004) before using the values in calculations.</p> <p>When this option is clear, the values will be used without rounding.</p>
MASC round interpolated values	<p>When this option is set, the firmware will round interpolated values to 6 significant digits before using the values in calculations.</p> <p>When this option is clear, the interpolated values will be used without rounding.</p> <div style="background-color: #f0f0f0; padding: 5px; margin-top: 10px;"> <p>Note: Because the MASC interpolation tables use single-precision floating point numbers, if <i>MASC round interpolated values</i> is not selected, this could result in artificial digits in the interpolated values, which are calculated using double-precision floating point numbers.</p> </div>
MASC enable	<p>When this option is set, MASC calculations are enabled for oil-water emulsion (Crd) meters using the US system of units. For more information on MASC, see Chapter 29.</p>

Parameter	Description
Strict MPMS 11.2M	<p>This option selects the method of calculating CPL (“Correction for the effect of pressure”) for NGL/LPG product streams.</p> <p>By default, with this option clear, CPL for NGL/LPG products is calculated according to API MPMS Chapter 11.2.1 and 11.2.2 with their inputs and outputs in US units (temperature in °F, densities as Rd60 or °API, pressures in psi) converted as needed from/to the user’s selected units.</p> <p>When this option is set and effective, CPL is calculated according to API MPMS Chapters 11.2.1M and 11.2.2M, with their inputs and outputs in SI units (temperature is °C, densities as kg/m³, pressures in kPa) converted as needed. This option, if set, is effective only if all these additional conditions are also met:</p> <ul style="list-style-type: none"> ▪ The meter’s product group is one of the NGL/LPG groups and ▪ The meter’s reference (base) temperature is exactly 15°C for SI units, or 59°F for US units and ▪ Meter calculation option “Pressure correction” is set. <p>If pressure correction is not enabled, then the CPL calculation does not occur and CPL acquires a default value (typically 1.0). For all other reference temperatures of NGL/LPG products, this option is ineffective and the non-“M” standards are used. For non-NGL/LPG products, other standards are applicable and this option is not meaningful.</p>

25 General Reference

25.1 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 or via communications networks such as HART, Modbus, or EtherNet/IP depending on the supported communications networks of the instrumentation.
- Number of meter channels: 12 (MVI69E-AFC) or 16 (MVI56E-AFC) meters. The module is recognized by the processor and an input/output module.
- Configuration is downloaded over Ethernet by way of the Modbus TCP/IP servers or delivered by user-defined ladder.

Calculation Methods

- Refer to section 27.2 for supported measurement standards.

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

Product Measurement: Hydrocarbon gases and liquids including refined products, produced, or injected water.

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 up to 60 days for each meter run (1440 records per channel)
- Daily for up to 1440 daily records (for each meter run)
- On-board archive storage (for 100-word records, 14 hourly and 10 daily)
- Extended Archive feature supports up to 1440 daily archives and 1440 hourly archives stored on Flash card
- Each record consists of nearly 100 process and other variables. All archived data is selectable 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.

Other Features

- Event Log with 2000-event buffer and timestamp.
- Alarm Log with 2000-alarm buffer and timestamp.
- Virtual Slave with 20,000 re-mappable Modbus registers for contiguous SCADA polling.
- Security control via operator login with password and granted privileges. (Regulatory compliance via physical W&M seal)

25.1.1 Online Communication & Configuration

The module is designed for online configuration via any of the communication channels (serial, network). A user-friendly Windows 10-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.

25.1.2 Reports

- **Event Log Report:** Each change to security-sensitive configuration data (for example, orifice diameter) is date and time stamped and mapped to the local Modbus memory map. This log can be imported into any spreadsheet program and saved to disk or printed to a local printer.
- **Hourly and Daily Archive Reports:** Available via Modbus communication. 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.

25.1.3 Modbus Interface

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

- Ports 1 and 2 support RS-232, RS-422 and RS-485 modes
- Supports baud rates of 9600 through 230500 baud
- All ports may be configured for RTU or ASCII Modbus mode
- The Ethernet port supports a standard RJ45 connection.
- 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 2 can be configured as a Modbus master node to support polling of devices such as a gas chromatograph (not to be used to poll instrumentation such as MVTs and Coriolis meters as the polling rate of the port is not fast enough to stay within API specifications)
- 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.

25.1.4 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.

25.1.5 Hardware Specifications (MVI56E-AFC)

Specification	Description
Backplane Current Load	800 mA @ 5 Vdc 3 mA @ 24 Vdc
Operating Temperature	0°C to 60°C (32°F to 140°F)
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Shock	30 g operational, 50 g non-operational Vibration: 5 g from 10 Hz to 150 Hz
Relative Humidity	5% to 95% (with no condensation)
LED Indicators	Module Status, Backplane Transfer Status, Application Status, Serial Activity
Application ports (Modbus 1 & Modbus 2)	
Full hardware handshaking control, providing radio, modem and multi-drop support	
App Ports (Modbus 1 & 2)	RJ45 (DB-9M with supplied cable) RS-232, RS-485, RS-422 jumper selectable RS-232 handshaking configurable 500 V Optical isolation from backplane
Shipped with Unit	RJ45 to DB-9M cables for each port

25.1.6 Hardware Specifications (MVI69E-AFC)

Specification	Description
Backplane Current Load	500 mA @ 5 Vdc (Power supply distance rating of 4)
Operating Temperature	0°C to 60°C (32°F to 140°F)
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Shock	30g operational 50g non-operational 5g from 10 to 150 Hz
Relative Humidity	5% to 95% RH, with no condensation
LED Indicators	Module Status, Backplane Transfer Status, Application Status, Serial Activity
1 Ethernet Application Port	10/100 Mbps, RJ45 Link and Activity LED Auto crossover (Auto MDIX)
Application ports (Modbus 1 & Modbus 2)	
Full hardware handshaking control, providing radio, modem and multi-drop support	
App Ports (Modbus 1 & 2)	RJ45 (DB-9M with supplied cable) RS-232, RS-485, RS-422 jumper selectable RS-232 handshaking configurable 500V optical isolation from backplane Full hardware handshaking control, providing radio, modem and multi-drop support
Shipped with Unit	RJ45 to DB-9M cables for each port

25.2 Measurement Compliance Standards

Document	Title	Published
AGA Report No. 3	Orifice Metering of Natural Gas	
AGA Report No. 3, Part 1 (API MPMS Chapter 14.3.1)	General Equations and Uncertainty Guidelines	Errata (2013) 4th Edition (Sep 2012) 3rd Edition (Oct 1990)
AGA Report No. 3, Part 2 (API MPMS Chapter 14.3.2)	Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids – Concentric Square-edged Orifice Meters, Specifications and Installation Requirements	Errata (2017) 5th Edition (Mar 2016) Reaffirmed (Mar 2006) 2nd Printing (Jun 2003) 4th Edition (Apr 2000)
AGA Report No. 3, Part 3 (ANSI/API MPMS Chapter 14.3.3)	Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids – Concentric Square-edged Orifice Meters, Natural Gas Applications	4th Edition (Nov 2013) Reaffirmed (Feb 2009) 2nd Printing (Jun 2003) 3rd Edition (Aug 1992)
AGA Report No. 3, Part 4 (API MPMS Chapter 14.3.4) (GPA 8185-92, Part 4)	Natural Gas Fluids Measurement – Concentric Square-Edged Orifice Meters. Part 4: Background, Development, Implementation Procedures and Subroutine Documentation	Reaffirmed (Mar 2006) 3rd Printing (Jun 2003) 2nd Printing (Aug 1995) 3rd Edition (Oct 1992)
AGA Report No. 7	Measurement of Natural Gas by Turbine Meters	Revised (Feb 2006)
AGA Report No. 8, Part 1	Thermodynamic Properties of Natural Gas and Related Gases. DETAIL and GROSS Equations of State	3rd Edition (Apr 2017) 2nd Edition (Nov 1994)
AGA Report No. 9	Measurement of Gas by Multipath Ultrasonic Meters	3rd Edition (Jul 2017) 2nd Edition (Apr 2007)

Document	Title	Published
API MPMS Chapter 11 Physical Properties Data (Volume Correction Factors)		
API MPMS Chapter 11.1 (ASTM D 1250-04) (IP 200/04)	Standard Document and API 11.1 VCF Application Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils	Reaffirmed (Aug 2012) (May 2004)
API MPMS Chapter 11.2	Data File of Chapters 11.2.2 and 11.2.2M	1 st Edition (Aug 1984)
API MPMS Chapter 11.2.2	Compressibility Factors for Hydrocarbons: 0.350-0.637 Relative Density (60 °F/60 °F) and -50°F to 140°F Metering Temperature	Reaffirmed (Sep 2017) 2 nd Edition (Oct 1986)
API MPMS Chapter 11.2.2M	Compressibility Factors for Hydrocarbons: 350-637 Kilograms per Cubic Meter Density (15°C) and -46°C to 60°C Metering Temperature	Reaffirmed (Sep 2017) 1 st Edition (Oct 1986)
API MPMS Chapter 11.2.4 (GPA Technical Paper 27)	Temperature Correction for the Volume of NGL and LPG Tables 23E, 24E, 53E, 54E, 59E, 60E	Reaffirmed (Oct 2012) 1 st Edition (Sep 2007)
API MPMS Chapter 11.2.5 (GPA Technical Paper 15)	A Simplified Vapor Pressure Correlation for Commercial NGLs	Reaffirmed (Sep 2017) 1 st Edition (Sep 2007)
API MPMS Chapter 12 Calculation of Petroleum Quantities		
API MPMS Chapter 12.2.1	Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors. Part 1: Introduction	Reaffirmed (Mar 2014) Errata 1 (Jul 2009) 2 nd Edition (May 1995)
API MPMS Chapter 12.2.2	Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors. Part 2: Measurement Tickets	Reaffirmed (Feb 2016) 3 rd Edition (Jun 2003)
API MPMS Chapter 12.2.3	Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors. Part 3: Proving Reports	Reaffirmed (May 2014) 1 st Edition (Oct 1998)
API MPMS Chapter 14 Natural Gas Fluids Measurement		
API MPMS Chapter 14.2 (AGA Report No. 8)	Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases	3 rd Printing (Nov 2003) 2 nd Printing (Jul 1994) 2 nd Edition (Nov 1992)
API MPMS Chapter 14.3.1 (AGA Report No. 3, Part 1)	Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids – Concentric, Square-edged Orifice Meters. Part 1: General Equations and Uncertainty Guidelines	Errata (Jul 2013) 4 th Edition (Sep 2012) 3 rd Edition (Oct 1990)

Document	Title	Published
API MPMS Chapter 14.3.2 (AGA Report No. 3, Part 2) (GPA 8185-00, Part 2)	Natural Gas Fluids Measurement – Concentric, Square-edged Orifice Meters. Part 2: Specification and Installation Requirements	Errata (2017) 5 th Edition (Mar 2016) Reaffirmed (Mar 2006) 2 nd Printing (Jun 2003) 4 th Edition (Apr 2000)
API MPMS Chapter 14.3.3 (AGA Report No. 3, Part 3) (GPA 8185, Part 3) (ANSI/API 2590-1991, Part 3)	Natural Gas Fluids Measurement – Concentric, Square-Edged Orifice Meters. Part 3: Natural Gas Applications	4 th Edition (Nov 2013) Reaffirmed (Feb 2009) 2 nd Printing (Jun 2003) 3 rd Edition (Aug 1992)
API MPMS Chapter 14.3.4 (AGA Report No 3, Part 3) (GPA 8185-92, Part 4)	Natural Gas Fluids Measurement – Concentric Square-Edged Orifice Meters. Part 4: Background, Development, Implementation Procedures and Subroutine Documentation	Reaffirmed (Mar 2006) 3 rd Edition (Nov 1992)
API MPMS Chapter 14.5 (GPA Standard 2172-09)	Calculation of Gross Heating Value, Relative Density, Compressibility and Theoretical Hydrocarbon Liquid Content for Natural Gas Mixtures for Custody Transfer	Reaffirmed:(Feb 2014) 3 rd Edition (Jan 2009)
API MPMS Chapter 14.9 (AGA Report No. 11)	Measurement of Natural Gas by Coriolis Meter	2 nd Edition (Feb 2013)
API MPMS Chapter 20	Allocation Measurement of Oil and Natural Gases	
API MPMS Chapter 20.1	Allocation Measurement	Reaffirmed (Oct 2016) 1 st Edition (Sep 1993)

Document	Title	Published
API MPMS Chapter 21	Flow Measurement Using Electronic Metering Systems	
API MPMS Chapter 21.1 (ANSI/API MPMS Ch. 21.1-2011) (AGA Report No. 3)	Electronic Gas Measurement	2 nd Edition (Feb 2013)
API MPMS Chapter 21.2	Electronic Liquid Volume Measurement Using Positive Displacement and Turbine Meters	Reaffirmed (Oct 2016) 1 st Edition (Jan 1998)
GPA 2145-16	Table of Physical Properties for Hydrocarbons and Other Compounds of Interest to the Natural Gas and Natural Gas Liquid Industries	Revised (2016) Adopted (1942)
GPA Technical Paper 15 (API MPMS Chapter 11.2.5)	A Simplified Vapor Pressure Correlation for Commercial NGLs	Reaffirmed (Sep 2017) 1 st Edition (Sep 2007)
GPA Technical Paper 27 (API MPMS Chapter 11.2.4)	Temperature Correction for the Volume of NGL and LPG Tables 23E, 24E, 53E, 54E, 59E, 60E	Reaffirmed (Oct 2012) 1 st Edition (Sep 2007)
GPSA Engineering Data Book	SI	14 th Edition (2017)
GPSA Engineering Data Book	FPS	13 th Edition (2017)
ISO 5167	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full	
ISO 5167-1	General principles and requirements	(2003)
ISO 5167-2	Orifice plates	(2003)
ISO 5167-3	Nozzles and Venturi nozzles	(2003)
ISO 5167-4	Venturi tubes	(2003)
ISO 5167-5	Cone meters	(2016)
ISO 6976	Natural Gas – Calculation of calorific values, density, relative density and Wobbe indices from composition	(2016)

Please see full listing on the MVI56E-AFC and MVI69E-AFC datasheets at:
www.prosoft-technology.com

26 Basic Metering According to Meter type

26.1 Orifice (Include V-cone): Uses AGA3 (2012) / ISO 5167

Output of the calculation is mass flow rate, which is divided by density to get volume and then integrated over time for accumulation.

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.

26.2 Pulse: Both Gas and Liquid

Gross Volume is (pulses) / (K-factor) * (meter factor), according to API MPMS Ch 12.2 (1981, 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.

26.3 Correction Factors According to Product Phase

26.3.1 Gas

Compressibility is calculated according to the Detail Characterization Method of AGA8 (1994). 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.

26.3.2 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 Product Density at either standard or flowing conditions.

26.4 Gas Pulse Measurement

The standard applied is AGA7, which is merely a combination of the Pulse: Both Gas and Liquid (page 214) 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 and now 2013 edition.

26.5 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.

26.6 Non-Standard Reference Conditions

For both liquids and gases, the AFC modules permit 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 (1994) standard for compressibility Z together with the "real" gas law $PV=ZNRT$.

For liquids, correction factors for non-standard reference conditions 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-27 are extended with the CPL calculations of (old) MPMS Chapter 11.2 in a manner analogous to that of the 2004 Chapter 11.1. In all cases, the density input to these calculations is the density at standard API base conditions.

26.7 Archiving and Event Log

Accumulation and data recording for gas-phase archives conform to the requirements of API MPMS Ch 21.1 (2013). Liquid-phase archives conform to API MPMS Ch 21.2.

26.8 Liquid Correction Factor Details

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-27 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 MPMS11.2.5 September 2007.

26.9 Compressibility Factor F

(According to MPMS Ch 11.2 (US) or 11.2M (SI) 1986)

- Vapor pressure correlation according to GPA MPMS11.2.5 September 2007.
- 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

27 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.

For a complete listing of configurable archive registers, please refer to the archive configuration functions.

27.1 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 "+" suffix (for example 0+) it means that the data is a 32-bit quantity that 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.

27.2 Timestamp Date and Time Format

The date and time format used in the archives is stored as a Unix Timestamp of number of seconds since 1970-01-01, as a 32-bit integer.

27.3 Pre-defined Header

These archive areas are included in the default archive data, and cannot be reconfigured by the user.

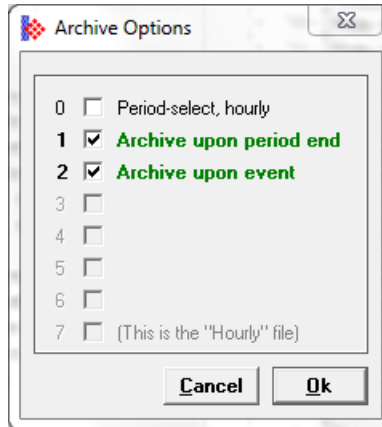
Start Offset	End Offset	Data Format	Type	Description
0	1	Timestamp	Snapshot	Closing timestamp of archive

Additional areas are also included in the default archive data, according to the meter type and product group associated with the meter.

28 Archive Configuration

28.1 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, by default, 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 exhibits 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. The firmware and EAFC Manager allow the default configuration to be changed. Refer to “Editing the Archive Structure”.

28.2 Archive Generation

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

- Upon period end
- Upon event
- Upon processor command

Using EAFC Manager (**METER CONFIGURATION > ARCHIVE CONFIG > OPTIONS**), you can configure when archives are generated; upon period end and/or event. By default, the archives are generated upon period end and event.

If the archive is configured to be created upon period end, it will be periodically (daily or hourly) generated at the time configured by the End-of-day minute and End-of-hour minute parameters (**PROJECT > SITE CONFIGURATION**) or by those parameters of meter configuration if enabled.

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

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

28.3 Archive Types

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

Archive Type	Period	Period End	Number of 100-Word Archives Stored Locally
Hourly	60 minutes (1 hour)	Set by <i>End-of-Hour Minute</i> parameter	14
Daily	1440 minutes (1 day)	Set by <i>End-of-Day Minute</i> parameter	10

The *Period End* parameters must be set using EAFC Manager (*Site Configuration* and/or *Meter Configuration*) The default value is zero for both archive types which means that:

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

For example, if the parameters are configured as follows:

End-of-day minute = 480

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

End-of-hour minute = 30

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

28.4 Archive Order

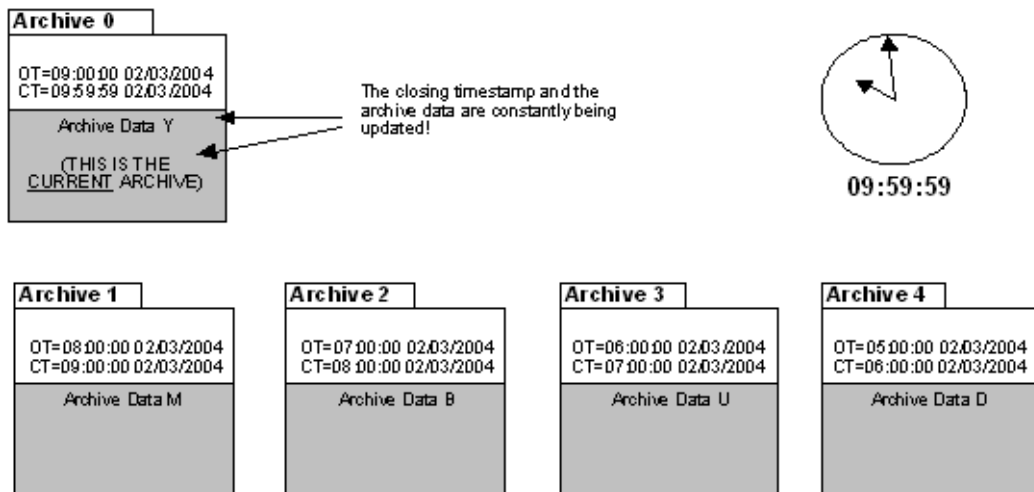
An important concept regarding this topic is the archive order. Understanding this simple concept is essential when reading archive data (through the backplane or Modbus Master). Each archive has a number (its "age") that labels its position in the archive queue. The following table shows the archive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

Archive Age	Register Types	Description
0	Input Register	Current archive
Selected	Holding Register	Selected archive

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

The current archive is stored in the primary slave's input register bank and is directly accessible with a Modbus Read command. Recent past archives are stored locally in non-volatile memory; however, they are not directly addressable by Modbus, but must be fetched using the same method as is used for fetching extended archives. See Section 16.8.

The following illustration shows an example for hourly archives:



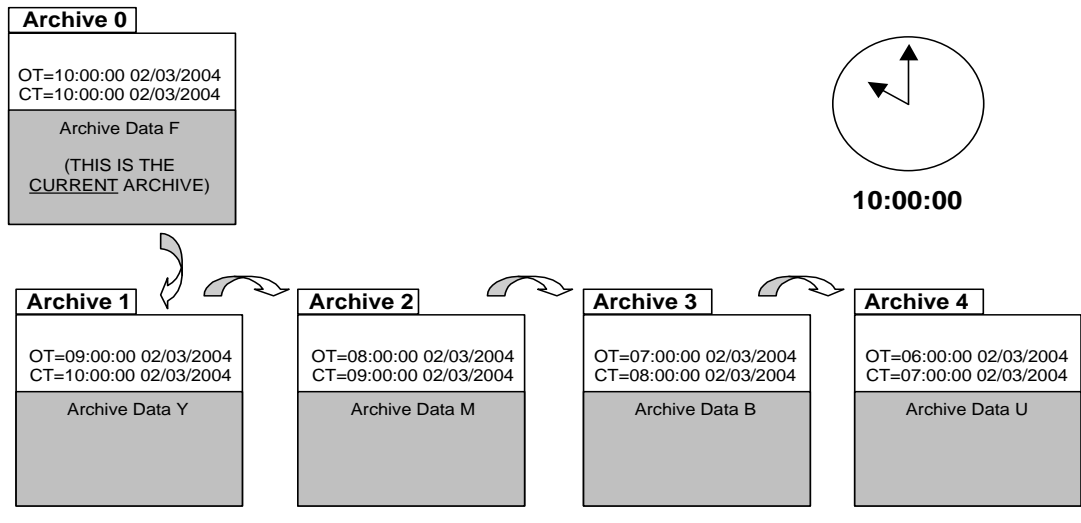
Where:

OT = Opening Time Stamp (if mapped)

CT = Closing Time Stamp

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

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



Where:

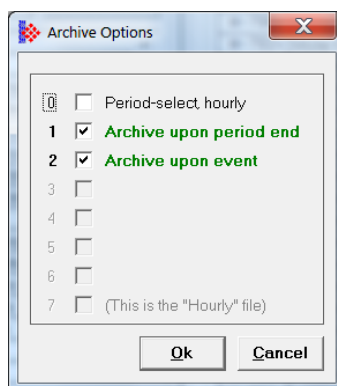
OT = Opening Time Stamp (if mapped)

CT = Closing Time Stamp

28.5 Archive Options

The module also allows you to configure whether the archives should be automatically generated upon period end and/or event. EAFC Manager supports this feature through the archive options window as shown in the following example:

Note: Access *Archive Options* from the *Archive Configuration* page by clicking on the **OPTIONS** button.



By default, the module is configured to generate archives upon period end and event. The module is not configured by default to reset the resettable accumulators upon period end or event. To do so, go to the *Resettable Accumulator Select* dialog and then click the **OPTIONS** button.

28.6 Archive Locations

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

The following table shows the current archive (Archive 0) location in the Primary Modbus Slave for each of the 16 meters. These addresses refer to the input register bank.

Archive 0 - Current Archives

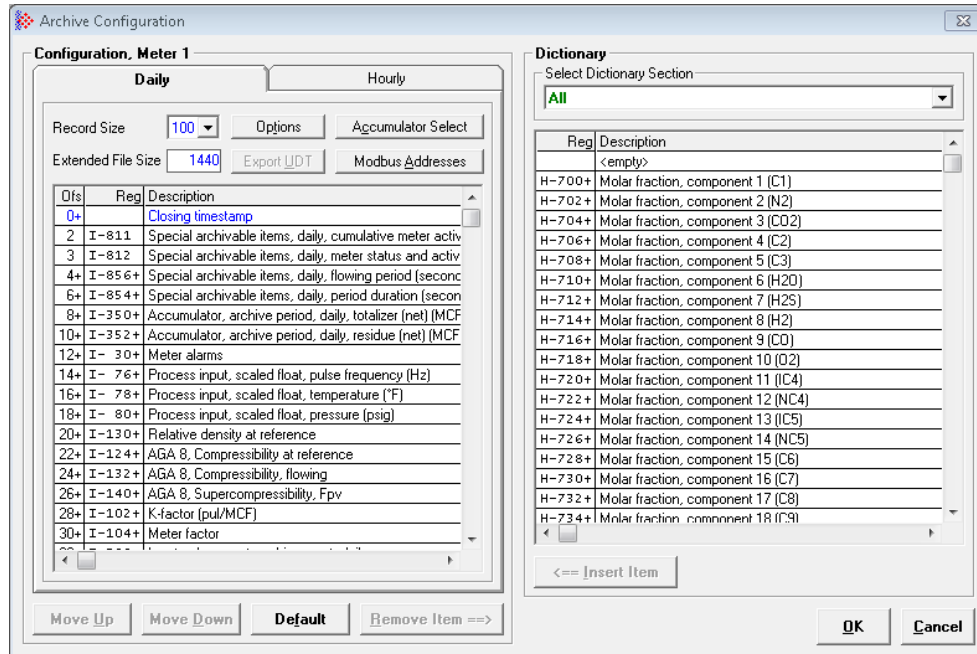
Meter	Start Daily Archive (Input Registers)	End Daily Archive (Input Registers)	Start Hourly Archive (Input Registers)	End Hourly Archive (Input Registers)
1	600	699	700	799
2	1600	1699	1700	1799
3	2600	2699	2700	2799
4	3600	3699	3700	3799
5	4600	4699	4700	4799
6	5600	5699	5700	5799
7	6600	6699	6700	6799
8	7600	7699	7700	7799
9	8600	8699	8700	8799
10	9600	9699	9700	9799
11	10600	10699	10700	10799
12	11600	11699	11700	11799
13	12600	12699	12700	12799
14	13600	13699	13700	13799
15	14600	14699	14700	14799
16	15600	15699	15700	15799

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

28.7 Editing the Archive Structure

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

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



The module reserves 1060 words for daily archives and 1440 words for hourly archives per meter run in local non-volatile memory of the module. Because the default configuration sets the record size for 100 words, it means that the maximum (default) number of archives per meter channel stored in local memory is 10 for daily and 14 hourly records.

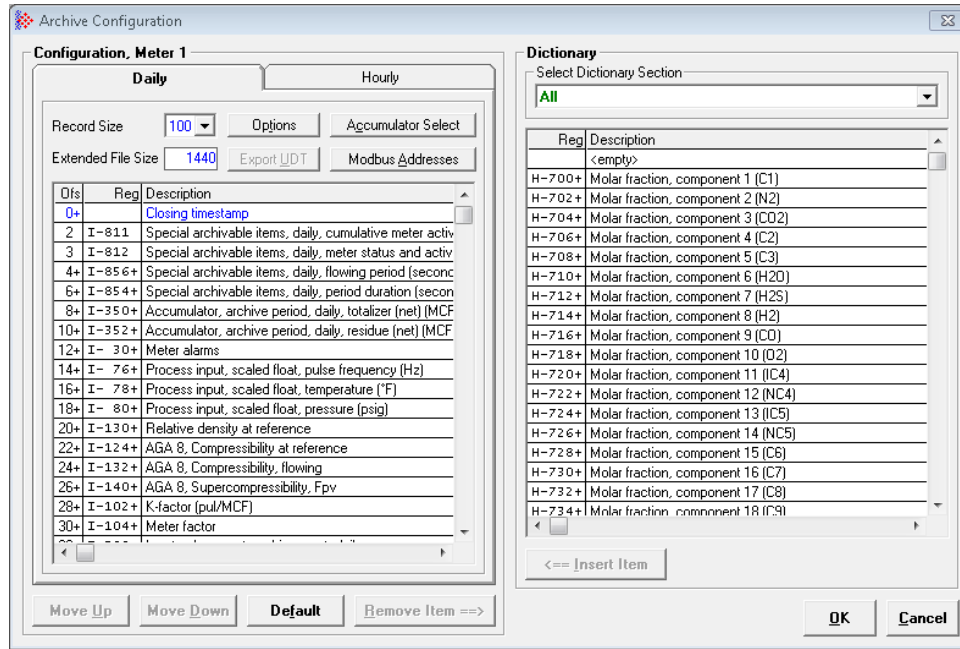
The “extended file size” parameter is used to alert the module to store additional records to the flash card on the module. The default value of 35 for daily, and 840 for hourly records provides data storage for 35 days of daily records, and 35 days of hourly records. If it is desired to extend the data storage of the module, “extended file size” can be increased to a maximum of 1440 records for both daily and hourly data. This will give a total of just under 4 years of daily records (3.94), and up to 60 days of hourly data.

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

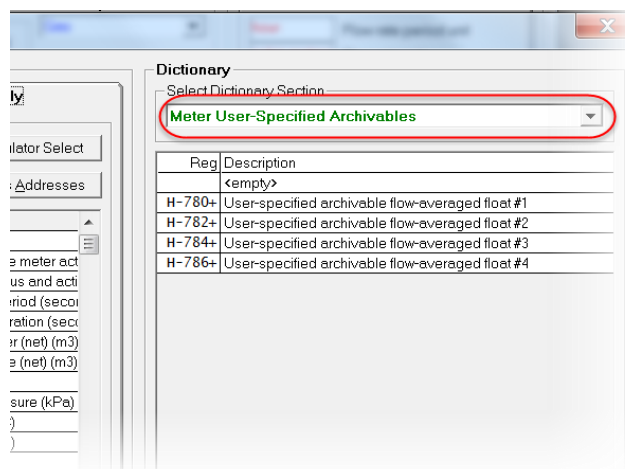
- Mass
- Energy (Gas product only)
- Net Volume
- Gross Volume
- Gross Standard
- Water Volume (Liquid product only)

28.7.1 User-Specified Archivables

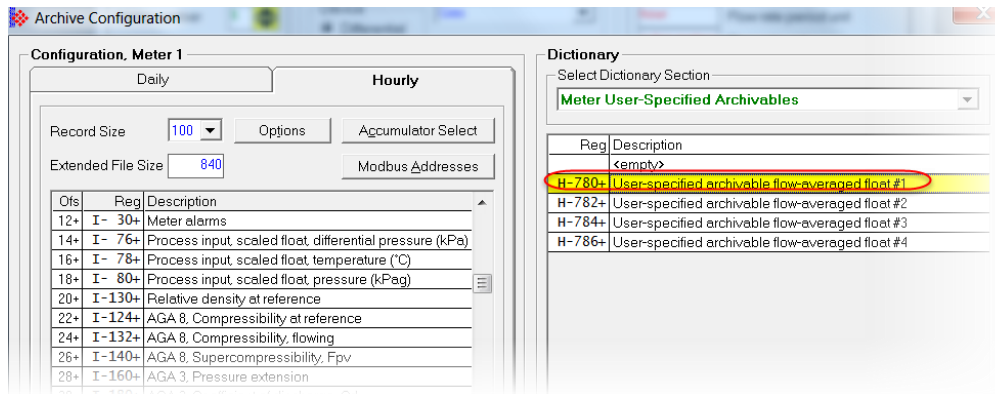
The AFC modules support a Modbus dictionary section called User-specified archivables (Musr/11). Writing to these registers do not trigger events. These points are useful only when mapped to an archive record and writing to user-defined fields requires that an operator privilege map must have Logging bit (17) set.



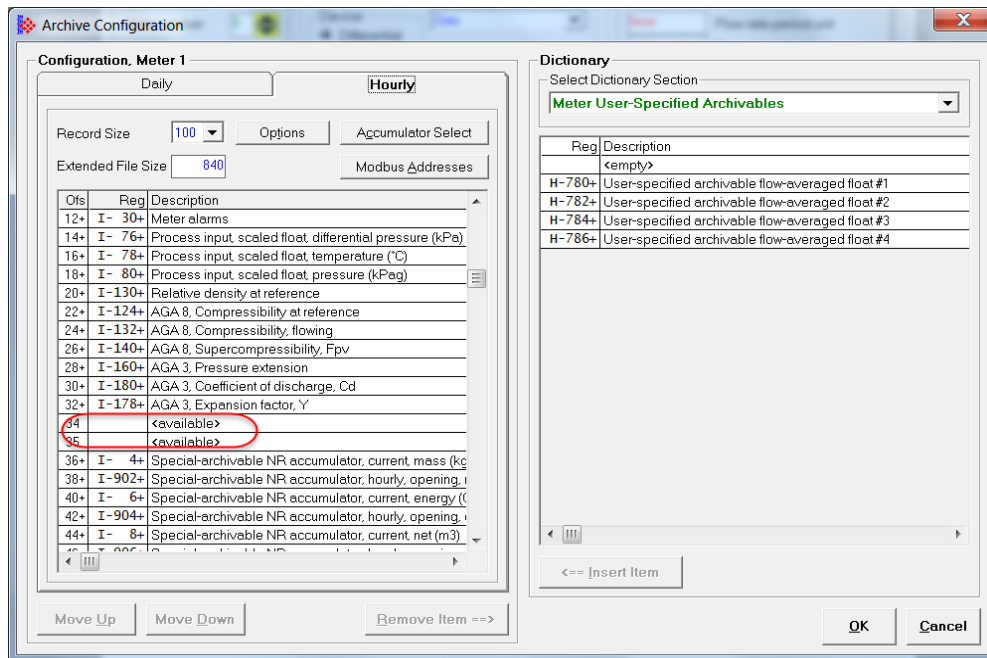
- 1 Open the Archive Configuration window.
- 2 From the *Dictionary* section, select **METER USER-SPECIFIED ARCHIVABLES**. This displays the register addresses available for user-defined archives for the selected meter.



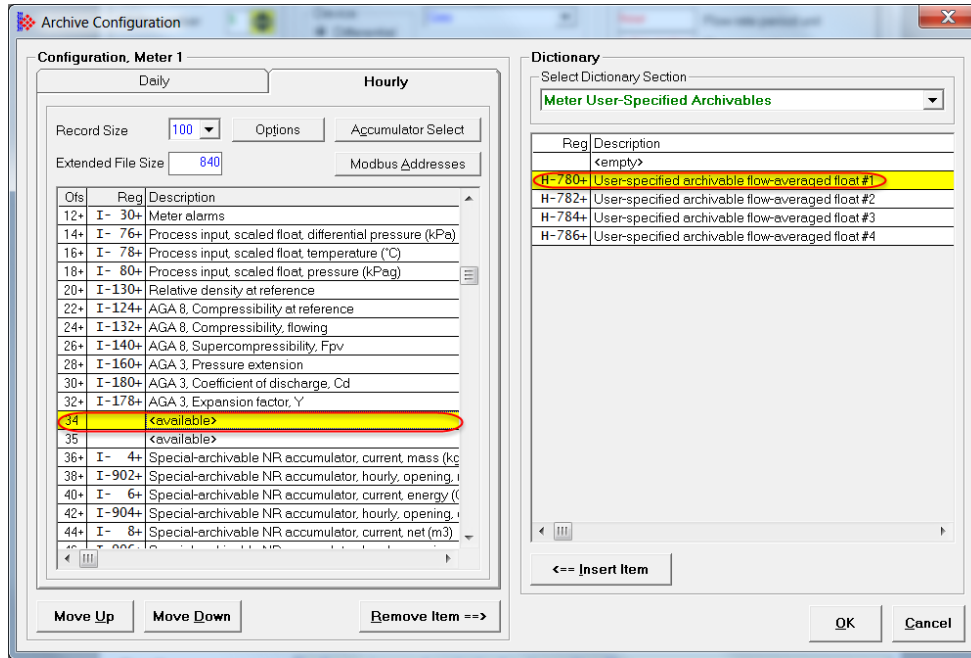
3 Highlight one of the Meter User-Specified Archivables.



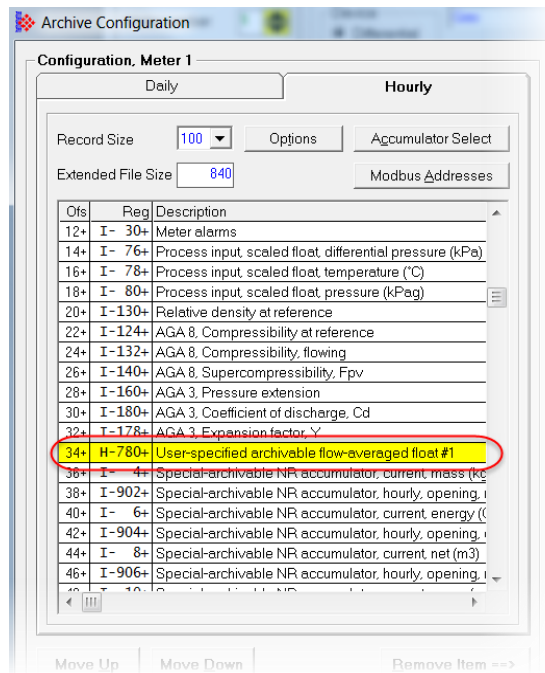
4 From the Configuration, Meter 1 side (left), scroll through the list to locate two available empty Modbus register locations.



5 Click on the first available location.



6 Click the **INSERT ITEM** button. This moves the Dictionary selection to the archive area.



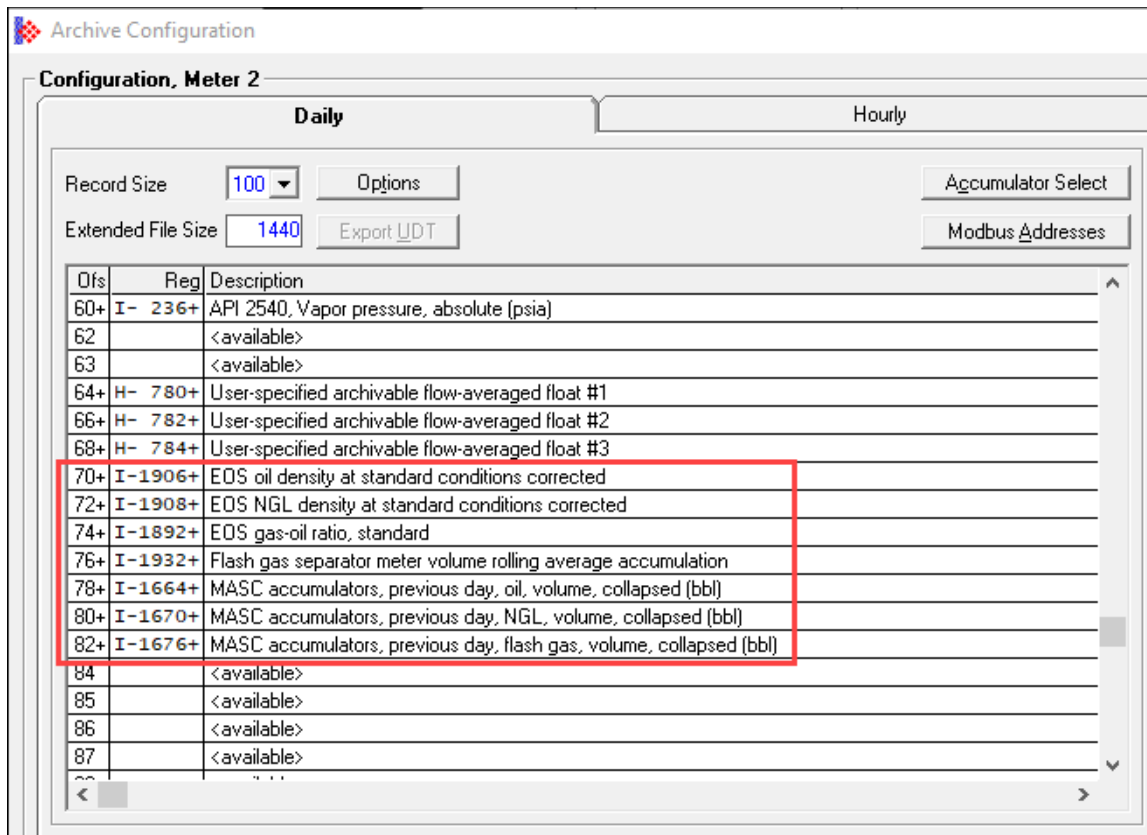
7 Click **OK**.

28.7.2 MASC Default Archive Configuration

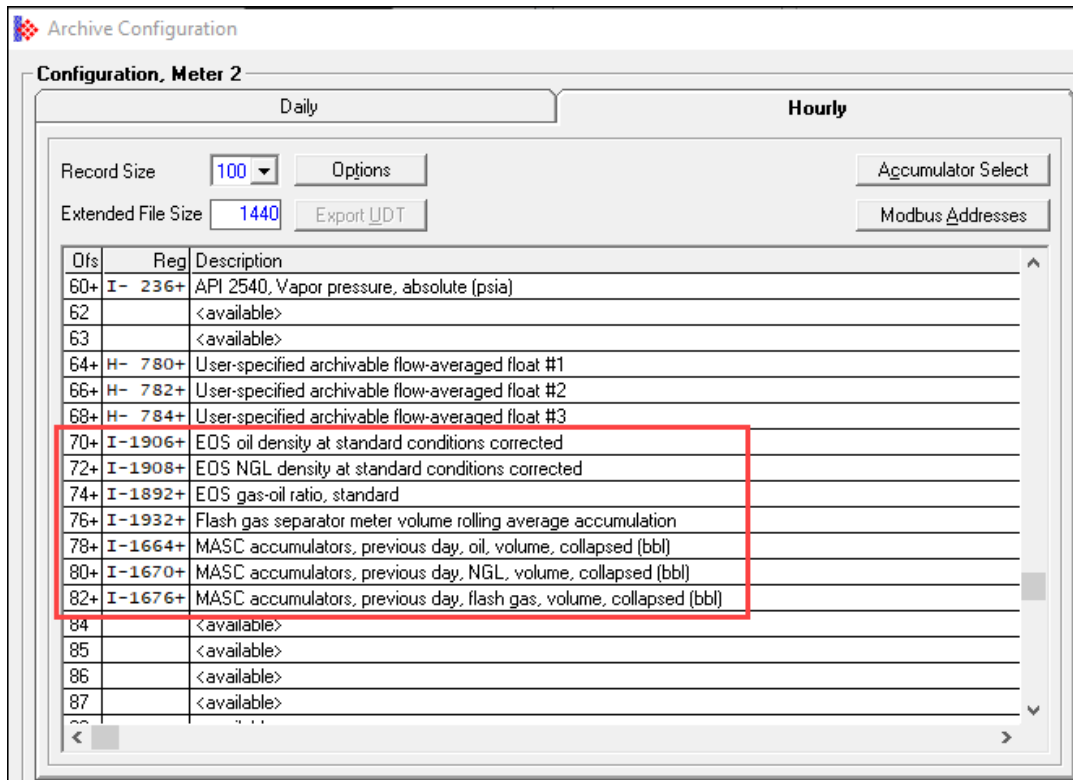
If you choose to enable mass allocation shrinkage calculations (MASC), EAFC Manager will give you the option to reinitialize the archive configuration files to the MASC default archive configuration, as explained in section 29.2. If you choose to do so, the following data points will be added to the daily and hourly default archive configuration:

Offset	Register	Description
70+	I- 1906+	EOS oil density at standard conditions corrected
72+	I- 1908+	EOS NGL density at standard conditions corrected
74+	I- 1892+	EOS gas-oil ratio, standard
76+	I- 1932+	Flash gas separator meter volume rolling average accumulation
78+	I- 1664+	MASC accumulators, previous day, oil, volume, collapsed (bbl)
80+	I- 1670+	MASC accumulators, previous day, NGL, volume, collapsed (bbl)
82+	I- 1676+	MASC accumulators, previous day, flash gas, volume, collapsed (bbl)

The MASC items would appear as follows in the daily archive configuration:



The MASC items would appear as follows in the hourly archive configuration:



For more information see section 29, “Mass Allocation Shrinkage Calculation (MASC).”

28.8 Retrieving Archives

The module implements an easy way to retrieve archives from the Modbus database. To learn how to retrieve archives, click **ARCHIVE CONFIG** on the *Meter Configuration* dialog box, and then click **MODBUS ADDRESSES**.

For each archive file the module reserves a block of 100 Holding registers to hold the *Selected Archive*, as listed in the following table:

Meter	Daily Archive Start (Holding Register)	Daily Archive End (Holding Register)	Hourly Archive Start (Holding Register)	Hourly Archive End (Holding Register)
1	8800	8899	8900	8999
2	9800	9899	9900	9999
3	10800	10899	10900	10999
4	11800	11899	11900	11999
5	12800	12899	12900	12999
6	13800	13899	13900	13999
7	14800	14899	14900	14999
8	15800	15899	15900	15999
9	16800	16899	16900	16999
10	17800	17899	17900	17999
11	18800	18899	18900	18999
12	19800	19899	18900	18999
13	20800	20899	20900	20999

Meter	Daily Archive Start (Holding Register)	Daily Archive End (Holding Register)	Hourly Archive Start (Holding Register)	Hourly Archive End (Holding Register)
14	21800	21899	21900	21999
15	22800	22899	22900	22999
16	23800	23899	23900	23999

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

Meter	Open Daily Archive Select Address	Open Hourly Archive Select Address
1	8006	8007
2	9006	9007
3	10006	10007
4	11006	11007
5	12006	12007
6	13006	13007
7	14006	14007
8	15006	15007
9	16006	16007
10	17006	17007
11	18006	18007
12	19006	19007
13	20006	20007
14	21006	21007
15	22006	22007
16	23006	23007

Use the following procedure to retrieve archives:

- 1 Write the desired archive age to the correct *Archive Select* register.
- 2 Read the archive data from the holding register address for the desired meter number and archive type (daily or hourly).

Example:

To read Meter 2 Hourly Archive Number 277:

- 1 Write a value of '277' to Modbus Holding Register 9007.
- 2 Read the archive record data starting at holding register 9900.

28.9 Archive Reports

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

- Text
- Comma Separated

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

```

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

```

Meter 16:
Tag                                                    M01
Archive                                                33

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

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

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

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

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

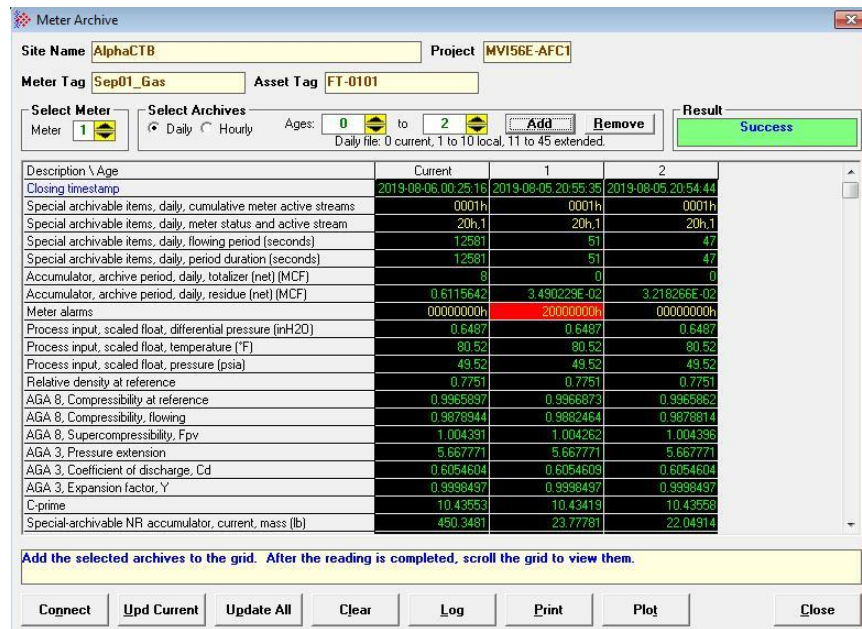
28.10 Meter Archive

The *Meter Archive* dialog box opens when you choose **ON-LINE > 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 and daily archives. The daily archives are 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
- Etc...



Parameter	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 EAFC Manager:

EAFC-56(16,4) [4.00] Daily Archive Date: 3/30/2016 8:41:48 AM
 Site Name: AFC Flow Station
 Project: MVI56E-AFC
 File: C:\USERS\BILL\DESKTOP\PROJECTS\MVI56E_AFC\4.00\REGRESSIONTEST\REGRESSION

Meter 7:	M07
Tag	Current
Archive	
Closing timestamp	2016-03-30.15:41:02
Special archivable items, daily, cumulative meter active streams	0001h
Special archivable items, daily, meter status and active stream	00h,1
Special archivable items, daily, flowing period (seconds)	16
Special archivable items, daily, period duration (seconds)	16
Accumulator, archive period, daily, totalizer (net) (m3)	0
Accumulator, archive period, daily, residue (net) (m3)	1.948033E-03
Meter alarms	00000000h
Process input, scaled float, differential pressure (kPa)	1
Process input, scaled float, temperature (°C)	2
Process input, scaled float, pressure (kPag)	3
Process input, scaled float, density (kg/m3)	800
Process input, scaled float, water content (%)	1
API 2540, Density at reference (kg/m3)	787.8859
API 2540, Temperature and pressure correction factor, CTPL	1.01282
AGA 3, Density extension	28.28427
AGA 3, coefficient of discharge, cd	0.6056831
<not used>	0
<not used>	0
API 2540, vapor pressure, absolute (kPaa)	0
Special-archivable NR accumulator, current, mass (kg)	17.60646
Special-archivable NR accumulator, daily, opening, mass (kg)	16.07164
<not used>	0
<not used>	0
<not used>	0
<not used>	0
Special-archivable NR accumulator, current, net (m3)	0.0223461
Special-archivable NR accumulator, daily, opening, net (m3)	2.039822E-02
Special-archivable NR accumulator, current, gross (m3)	2.228687E-02
Special-archivable NR accumulator, daily, opening, gross (m3)	2.034398E-02
Special-archivable NR accumulator, current, gross clean oil (m3)	2.206516E-02
Special-archivable NR accumulator, daily, opening, gross clean oil (m3)	2.014157E-02
Special-archivable NR accumulator, current, water (m3)	2.230505E-04
Special-archivable NR accumulator, daily, opening, water (m3)	2.036059E-04
Active Streams	
Stream was active	1
Alarm Bits	
bit 0 Differential pressure: general failure	-
bit 1 Differential pressure: range	-
bit 2 Differential pressure: threshold	-
bit 3 Temperature: general failure	-
bit 4 Temperature: range	-
bit 5 Temperature: threshold	-
bit 6 Pressure: general failure	-
bit 7 Pressure: range	-
bit 8 Pressure: threshold	-
bit 9 Density: general failure	-
bit 10 Density: range	-
bit 11 density: threshold	-
bit 12 water content: general failure	-
bit 13 water content: range	-
bit 14 water content: threshold	-
bit 15 Pulse count failure	-
bit 16 Reference density error	-
bit 17 Temperature correction error	-
bit 18 Vapor pressure error	-
bit 19 Pressure correction error	-
bit 20 Water Temperature error	-

28.11 Common Addressing Primary & Virtual Slaves

Modbus addressing common to both Primary and Virtual slaves.

Address	Type	Description
Ch00000	Char	Firmware product code, group Low byte: platform High byte: application class
Ch00001	Char	Firmware product code, item Low byte: number of streams High byte: number of meters
Ch00002	Int	Firmware version number Low byte: minor version number High byte: major version number
Ch00003	Int	Firmware revision number
Ch00004 to Ch00005	Int	Serial number

Ch00006	Bm	<p>Site status</p> <p>bit 0 - EAFC 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. Set while backplane communication is faulty, which typically occurs when the PLC is switched to program mode. The behavior of the MVI56E-AFC under this condition depends on 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.</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, MVI56E-AFC's non-volatile storage is checked for validity, by verifying checksums 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. 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.</p> <p>bit 8 - [reserved]</p> <p>bit 9 - [reserved]</p> <p>bit 10 – W&M lock switch status</p> <p>bit 11 – Watchdog status</p> <p>bit 12 - [reserved]</p> <p>bit 13 - [reserved]</p> <p>bit 14 - [reserved]</p>
---------	----	--

Address	Type	Description
		bit 15 - [reserved]
Ch00007	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.
Ch00008 to Ch00009	Wd	[reserved]
Ch00010 to Ch00011	Bm	Unix epoch (seconds from 1970-01-01)
Ch00012 to Ch00017	Wd	Wallclock (Y,M,D,h,m,s) The wallclock has a resolution of 1 second.
Ch00020 to Ch00047	--	
Ch00048 to Ch00099	Wd	Reserved for diagnostics.

29 Mass Allocation Shrinkage Calculation (MASC)

This chapter describes the Mass Allocation Shrinkage Calculation (MASC) feature of the AFC modules.

29.1 Background

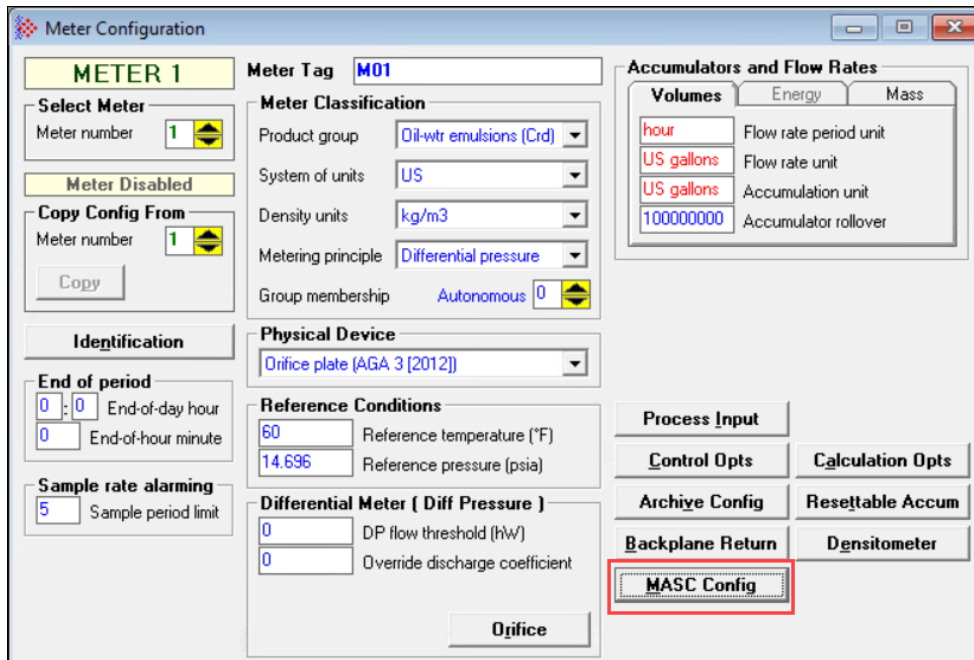
To calculate the additional mass and volume flow rates determined from the mass allocation shrinkage calculations (MASC), the calculations depend upon eight properties of the hydrocarbon mixture which must be pre-determined (as functions of temperature and pressure) using an equation of state (EOS). Tables expressing the relationships between temperature, pressure, and seven of these eight properties are provided as meter configuration input data. On each meter calculation, the flowing temperature and pressure process inputs are interpolated within each table to derive the appropriate hydrocarbon property value. These derived hydrocarbon property values are referred to as intermediate calculation results which are then used in the mass allocation shrinkage calculations for the related mass and volume flow rates.

29.2 Configuring and Enabling Mass Allocation Shrinkage Calculations

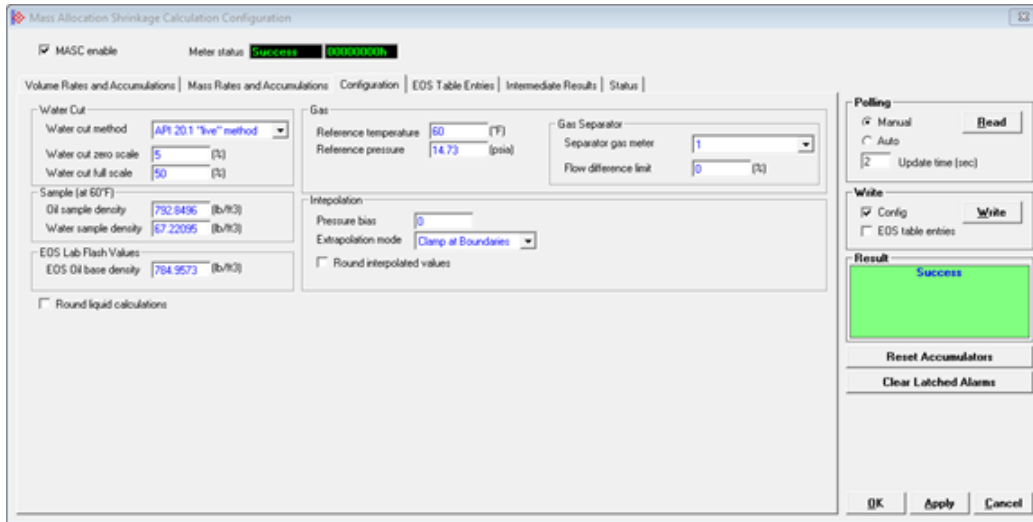
Take the following steps to configure and enable mass allocation shrinkage calculations.

- 1 From the *Meter Configuration* dialog, select **MASC CONFIG**.

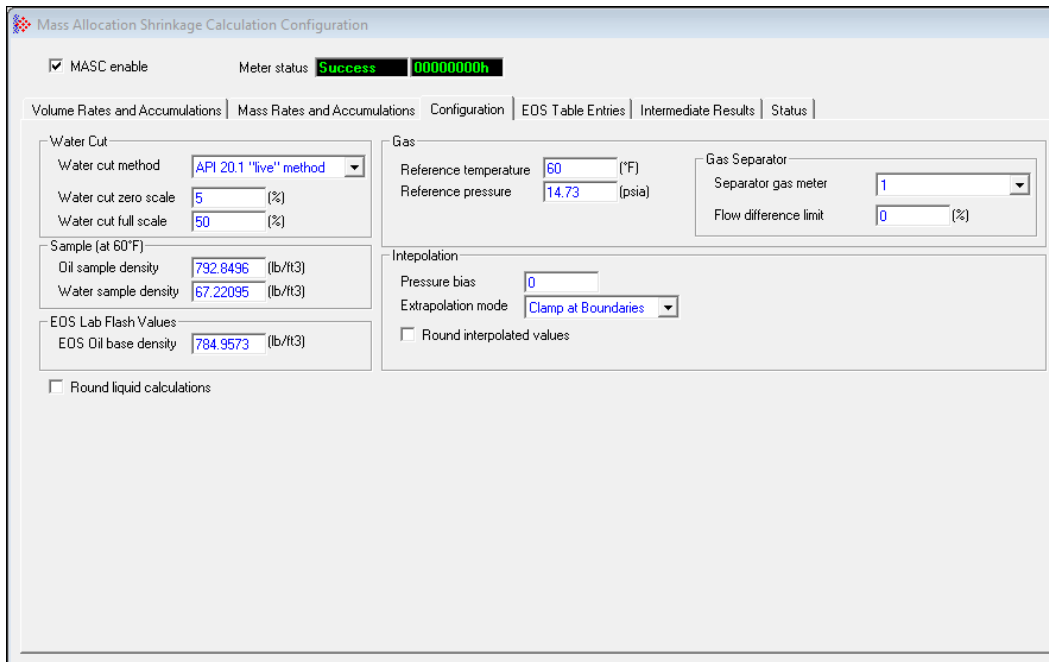
Note: The **MASC CONFIG** button appears only when you select *Oil-wtr emulsions (Crd)* for the product group and *US* for the system of units.



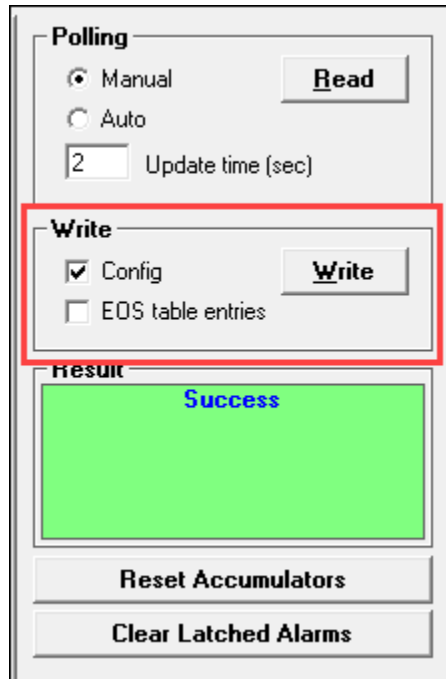
The *Mass Allocation Shrinkage Calculation Configuration* dialog displays.



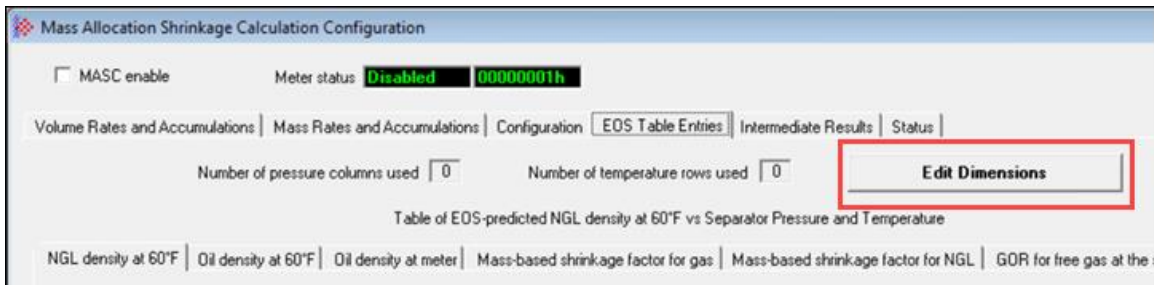
- 2 Complete MASC configuration on the *Configuration* tab. For descriptions of these parameters, see section 29.6.4



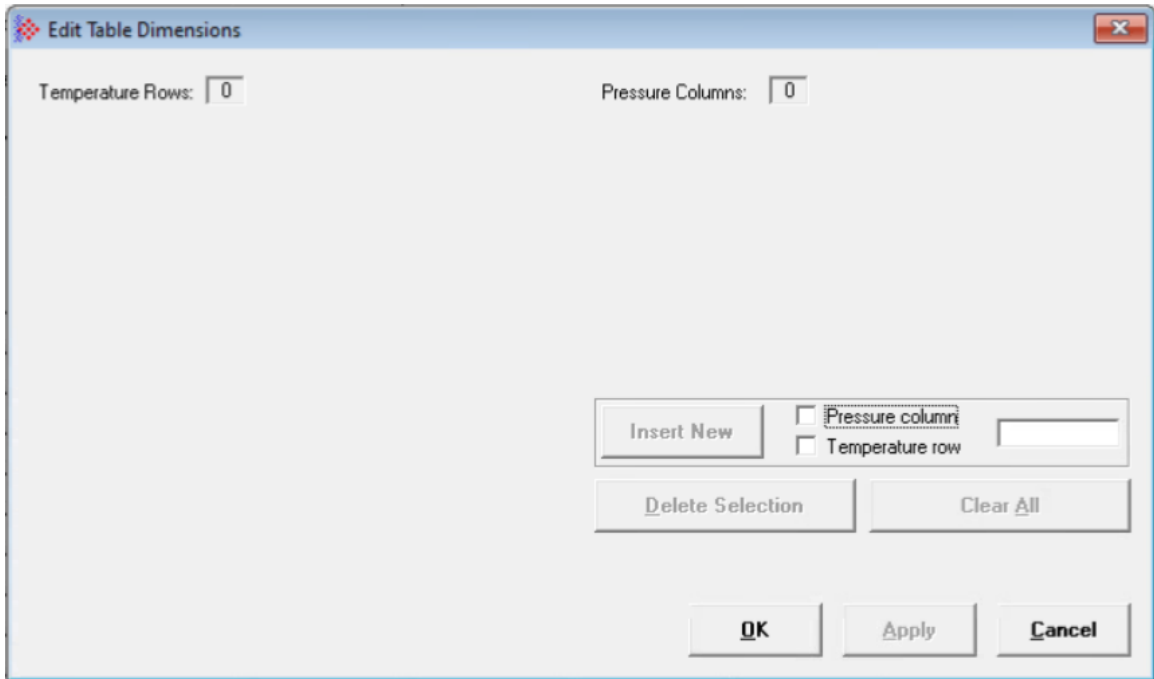
- 3 In the *Write* area of the dialog, make sure the *Config* check box is selected and then click **WRITE**.



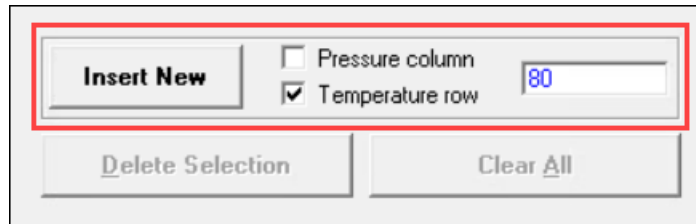
- 4 Go to the *EOS Table Entries* tab and select **EDIT DIMENSIONS**.



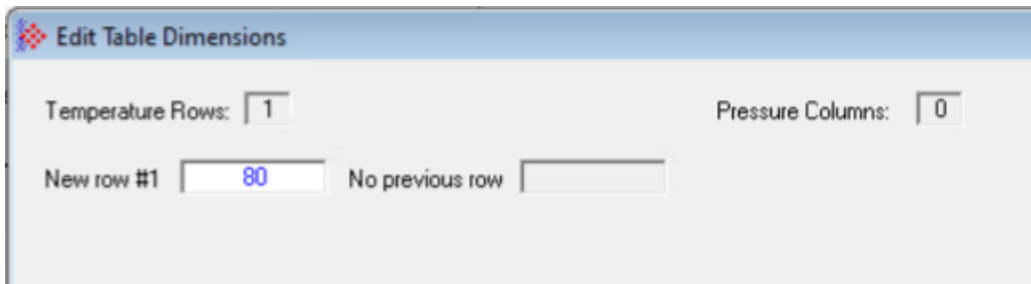
The *Edit Table Dimensions* dialog displays.



- 5 To add a row to the table, select *Temperature row*, enter a header value, and select **INSERT NEW**.

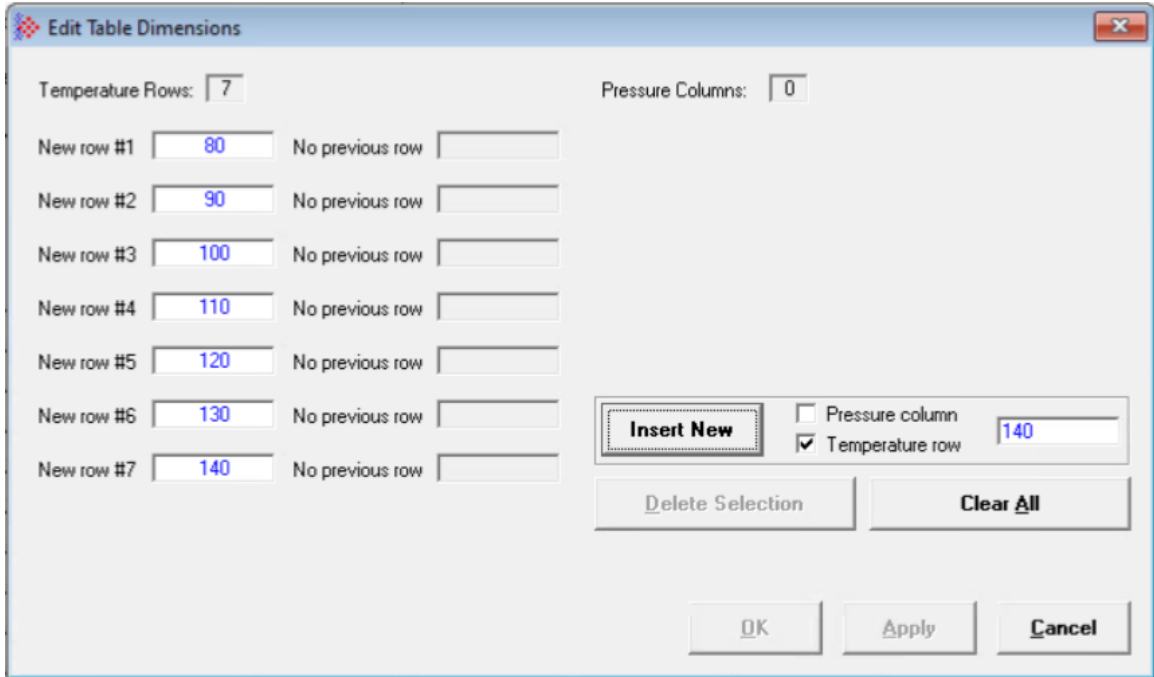


The new temperature row is added to the list.

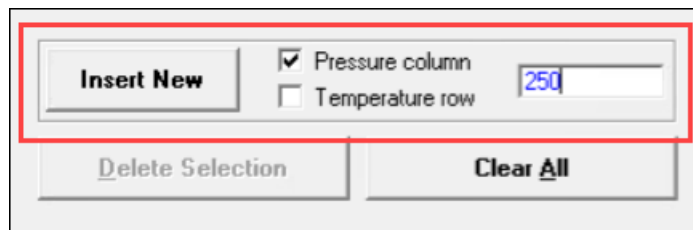


6 Repeat step 5 to add the remaining rows.

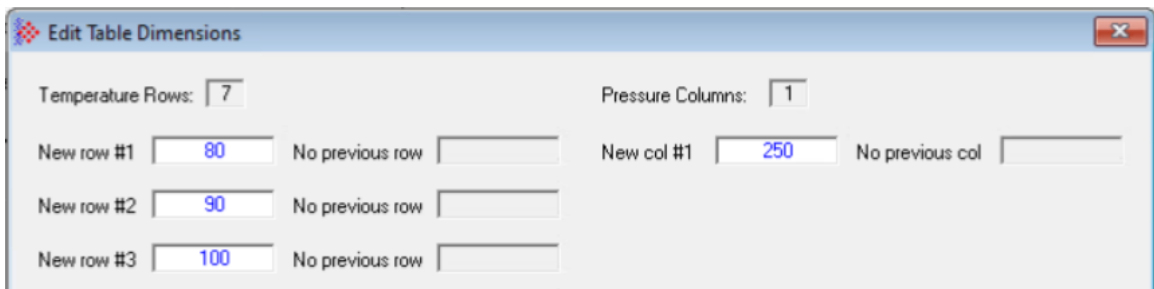
Note: Header values for temperature rows must be in ascending order. The minimum number of rows is 2. The maximum is 7.



7 To add a column to the table, select *Pressure column*, enter a header value, and select **INSERT NEW**.

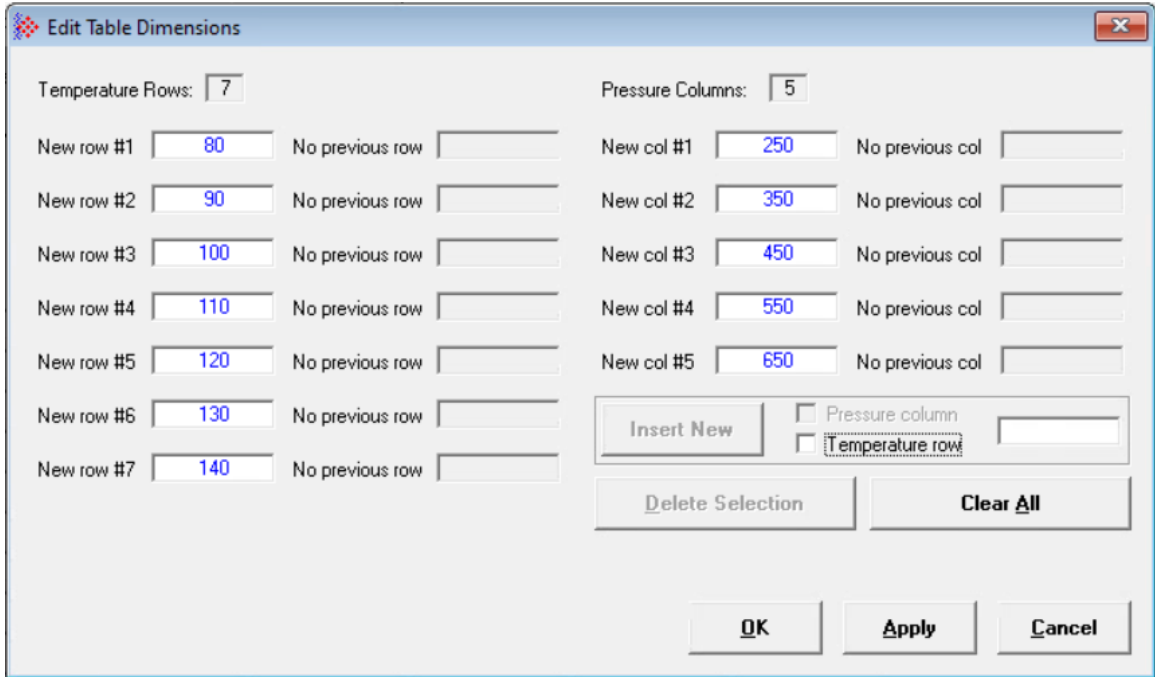


The new pressure column is added to the list.



8 Repeat step 7 to add the remaining columns.

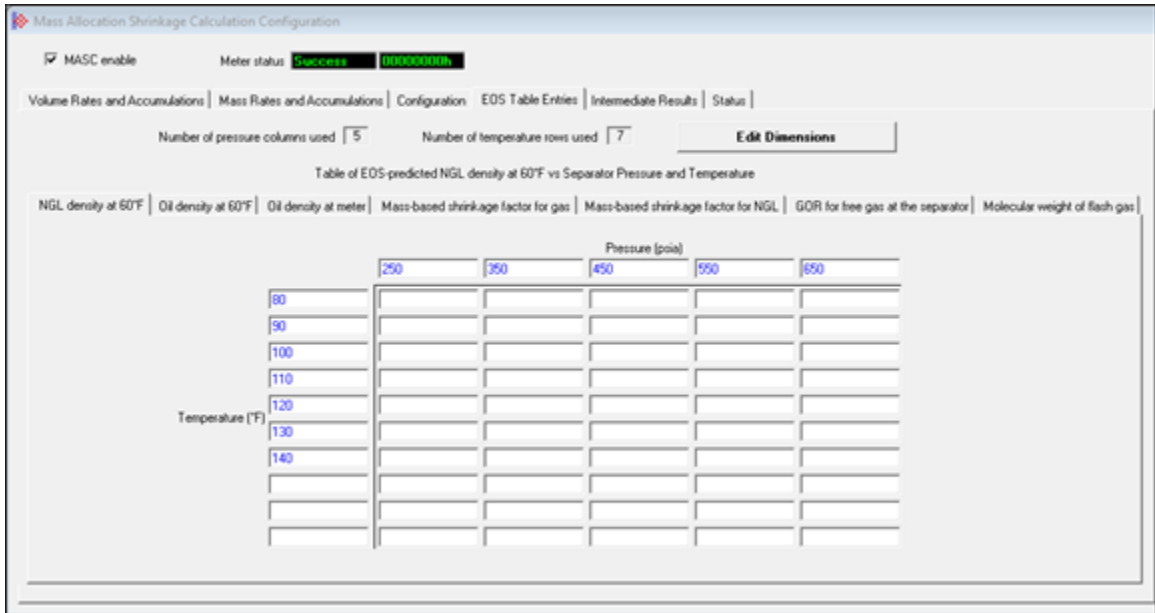
Note: Header values for pressure columns must be in ascending order. The minimum number of columns is 2. The maximum is 5.



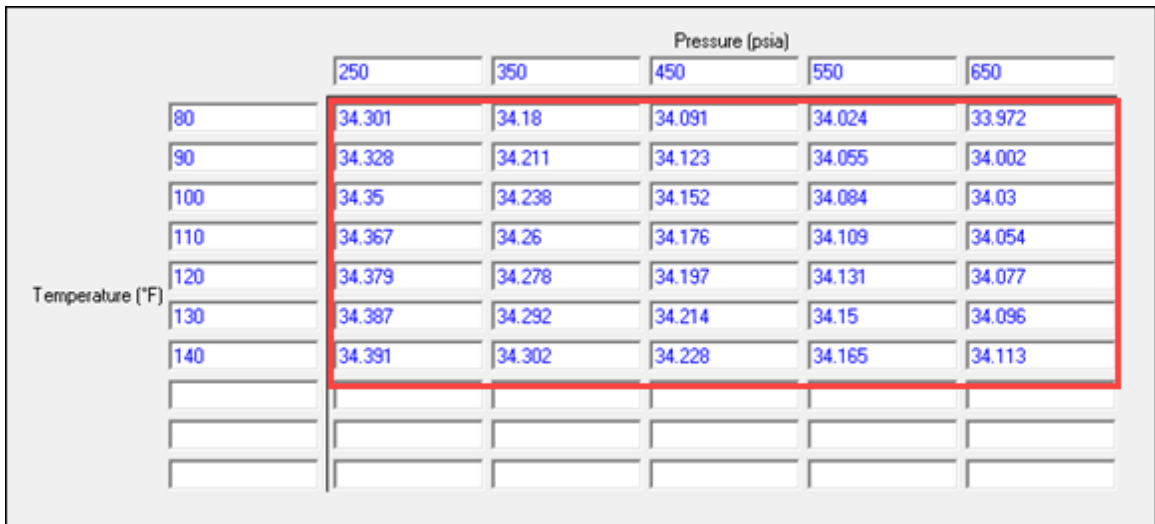
9 To save the table dimensions and close the dialog, select **OK**. To save the table dimensions without closing the dialog, select **APPLY**.

The *EOS Table Entries* tab updates with the new table dimensions.

Note: The same row and column headers are used for all seven EOS tables.

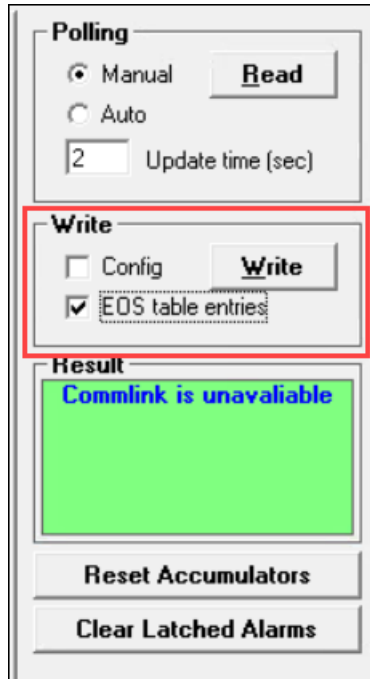


- 10 On the *NGL density at 60°F* tab, enter a density value for each temperature-pressure combination.



11 In the *Write* area of the dialog, select *EOS table entries* and then click **WRITE**.

Note: It is also possible to write both the configuration data and EOS table entries to the module simultaneously by selecting both *Config* and *EOS table entries* before clicking **WRITE**.



The table data is written to the module.

12 Select the *Oil desnity at 60°F* tab, enter a density value for each temperature-pressure combination. and write the data to the module. Repeat this for each of the other EOS tables.

13 Select MASC enable.

Mass Allocation Shrinkage Calculation Configuration

MASC enable Meter status: **Success** **00000000h**

Volume Rates and Accumulations | Mass Rates and Accumulations | **Configuration** | EOS Table Entries | Intermedi

Water Cut

Water cut method: API 20.1 "live" method

Water cut zero scale: 5 (%)

Water cut full scale: 50 (%)

Gas

Reference temperature: 60 (°F)

Reference pressure: 14.73 (psia)

Sample (at 60°F)

Oil sample density: 792.8496 (lb/ft3)

Water sample density: 67.22095 (lb/ft3)

EDS Lab Flash Values

EDS Oil base density: 784.9573 (lb/ft3)

Interpolation

Pressure bias: 0

Extrapolation mode: Clamp at Boundaries

Round interpolated values

Round liquid calculations

Note: When you enable MASC calculations, EAFC Manager will ask if you want to reinitialize the archive configuration files to the MASC default archive configuration. For more information on this configuration, see section 28.7.2.

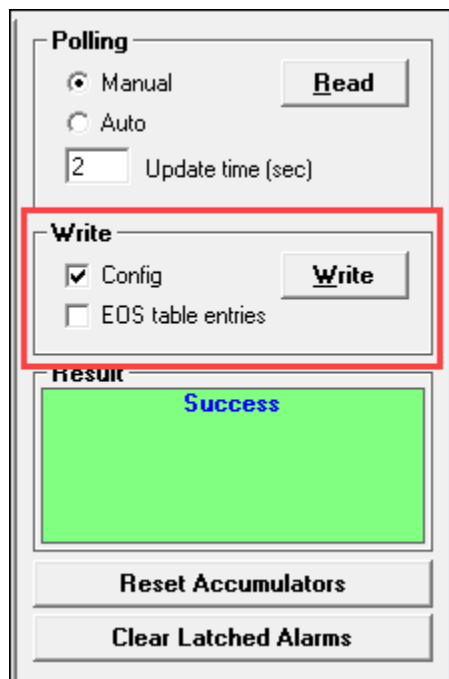
To use the MASC default archive configuration, select **YES**. To leave the default archive configuration as is, select **NO**.

Accept Archive Changes

Do you want to re-initialize the archive configuration files to the MASC default archive configuration?
WARNING: When a new archive configuration is downloaded to a running module, the archive file will be initialized and all data in it will be lost.

Yes No

- 14 In the *Write* area of the dialog, make sure the *Config* check box is selected and then click **WRITE**.



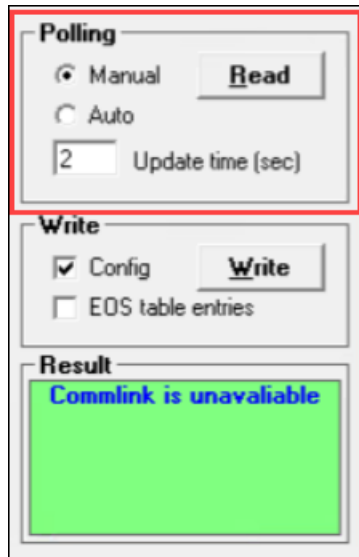
EAFC Manager begins MASC calculations.

29.3 Viewing MASC Results

After you enable mass allocation shrinkage calculations, you can view the results on the following tabs of the *Mass Allocation Shrinkage Calculation Configuration* dialog:

- *Volume Rates and Accumulations* – See section 29.6.2.
- *Mass Rates and Accumulations* – See section 29.6.3.
- *Intermediate Results* – See section 29.6.6.
- *Status* – See section 29.6.7.

Results on these tabs are updated each time the meter is polled. EAFC Manager will poll the data relevant to the tab that is currently open.



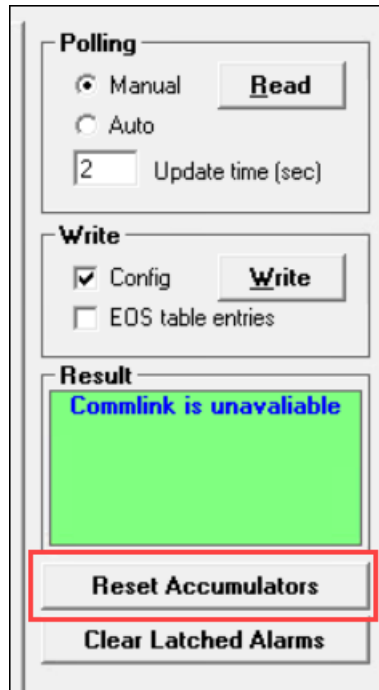
For more details about how the polling feature works, see “Read and Write Commands” in section 29.6.8.

29.4 Resetting Accumulators

Note: Accumulators in the firmware are independent of accumulators used in the meter's liquids calculations.

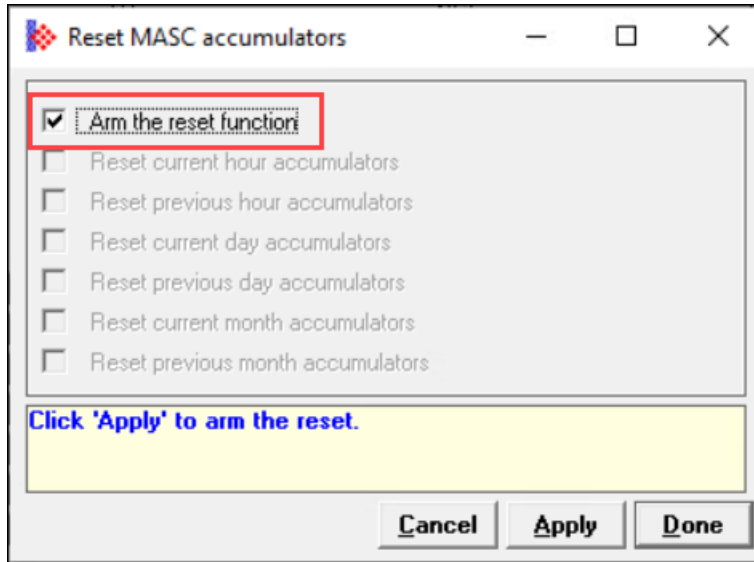
Take the following steps to reset MASC accumulators.

- 1 From the *Mass Allocation Shrinkage Calculation Configuration* dialog, select **RESET ACCUMULATORS**.



The *Reset MASC accumulators* dialog displays.

2 Select *Arm the reset function*.

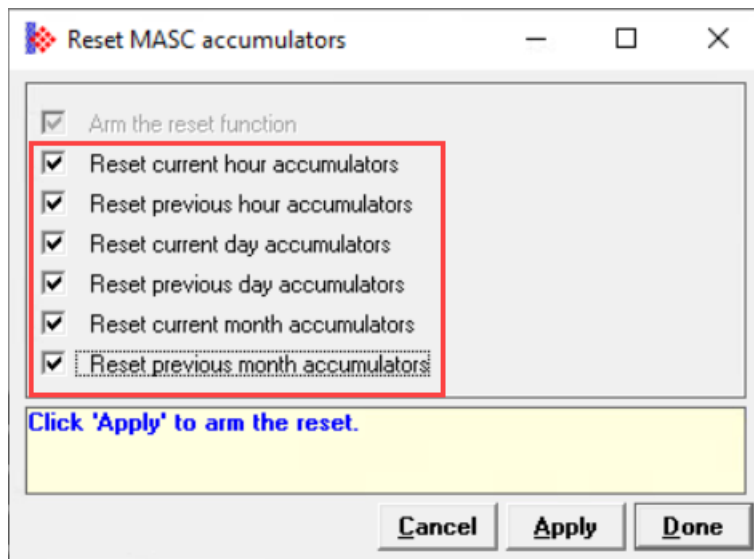


3 Select **APPLY**.

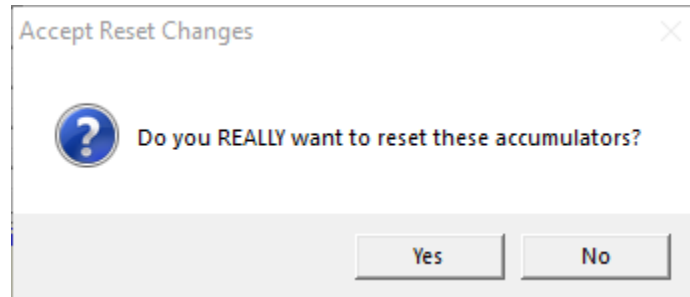
The accumulator reset process is armed at this point. The other options in the *Reset Accumulators* area are now available for selection. If no selection is made within 60 seconds, the reset process will automatically disarm.

Note: To disarm the reset process at this point, select **APPLY** before making any selections.

4 Select the accumulators you wish to reset.



- 5 Select **APPLY**.
- 6 In the confirmation dialog that displays, select **YES**.



EAFM Manager resets the selected accumulators and disarms the reset process.

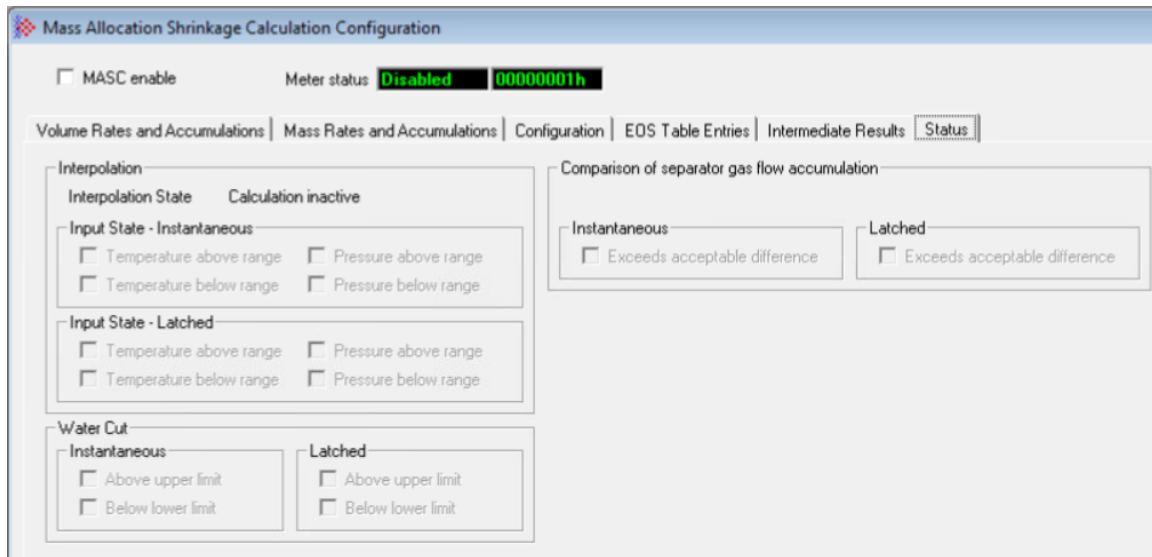
When changes are written to the database (by selecting *Config* and then clicking **WRITE**), mass and volume totals for the selected accumulators will be reset (except for gross mass and gross volume) and the reset process will be disarmed.

29.5 MASC Alarms

29.5.1 Viewing Alarms

MASC alarms display on the *Status* tab of the *Mass Allocation Shrinkage Calculation Configuration* dialog. Instantaneous and latched alarms are provided for the following:

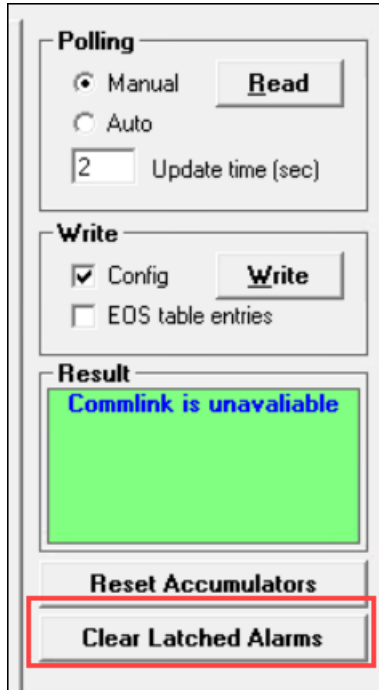
- Input state – These alarms are set if the temperature or pressure values are outside the ranges defined by the *Zero scale* and *Full scale* parameters in the *Process Inputs* dialog.
- Water cut – These alarms are set if the water cut falls outside the range defined by the *Water cut zero scale* and *Water cut full scale* parameters on the *Configuration* tab.
- Comparison of separator gas flow accumulation – These alarms are set if the measured and predicted separator free gas accumulations are currently outside the specified difference range.



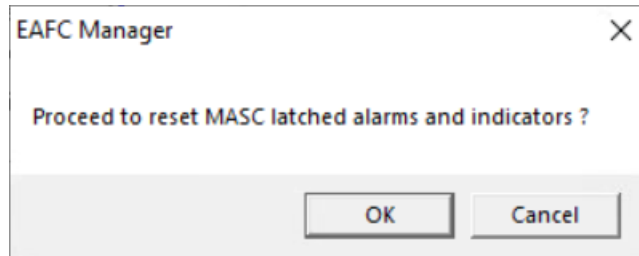
29.5.2 Clearing Latched Alarms

When a latched alarm is set, the alarm bit remains latched until it is explicitly cleared from the *Mass Allocation Shrinkage Calculation Configuration* dialog by taking the following steps.

- 1 From the *Mass Allocation Shrinkage Calculation Configuration* dialog, select **CLEAR LATCHED ALARMS**.



- 2 In the confirmation dialog that displays, select **OK**.



All latched alarms are cleared.

29.6 MASC Configuration Reference

This section defines the parameters found on the tabs of the *Mass Allocation Shrinkage Calculation Configuration* dialog.

29.6.1 MASC Enable and Meter Status

The following two parameters display at the top of the *Mass Allocation Shrinkage Calculation* dialog.

Parameter	Description
MASC enable	Select this check box to enable MASC calculations for oil-water emulsion (Crd) meters using the US system of units.
Meter status	These two read-only fields display a code and text description indicating the success of the MASC calculations. Possible values are as follows: <ul style="list-style-type: none"> ▪ 0 – Disabled ▪ 1 – Enabled

29.6.2 Volume Rates and Accumulations Tab

The *Volume Rates and Accumulations* tab displays the following volume flow rates and accumulations for the selected meter.

	Gross volume Bbl/day	Unshrunk oil volume Bbl/day	Oil volume Bbl/day	NGL volume Bbl/day	Flash gas volume MSCF/day	Water volume Bbl/day	Standared water volume Bbl/day
Flowrate	3778.652	1793.762	540.7.823	302.1891	228.5154	102.7123	101.9634
	Gross volume Bbls	Unshrunk oil Bbls	Oil volume Bbls	NGL volume Bbls	Flash gas volume Bbls	Water volume Bbls	Standared water volume Bbls
	Totalize Residue	Totalize Residue	Totalize Residue	Totalize Residue	Totalize Residue	Totalize Residue	Totalize Residue
Current hour	953 0.525396	1892 0.4523675	68 0.3495291	418 0.5253237	45 0.416184	13 0.3074436	0 0.0000000
Last hour	1894 0.1333739	3742 0.2211043	1744 0.3587736	8224 0.2568227	896 0.4232598	263 0.3275966	30 0.4811792
Today	953 0.525396	1892 0.4523675	68 0.3495291	418 0.5253237	45 0.416184	13 0.3074436	0 0.0000000
Yesterday	138625 0.4836881	237713 0.3822283	12124 0.8138467	37168 0.2738288	6232 0.8432559	1513 0.6327983	334 0.3831163
Month	13128 0.2582076	23862 0.4588425	12213 0.1625237	37362 0.3431962	3228 0.2882822	1520 0.6388254	332 0.4428884
Prev month	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Total Accum	6136281 0.3287772	22811245 0.2591728	503399741 0.2821225	8368822 0.2886755	3189822 0.9188825	38222 0.3851281	23874133 0.9154582

Note: Fields on the *Volume Rates and Accumulations* tab are read-only.

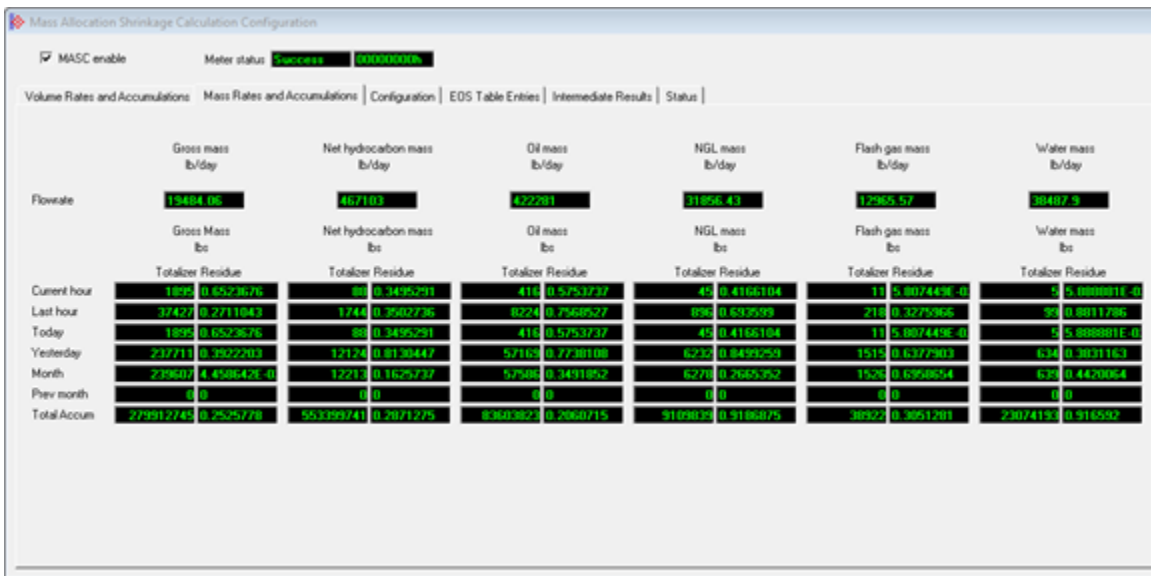
The Volume Rates and Accumulations parameters are described in the following table:

Parameter	Description
Flowrates	
Gross volume Bbl/day	Gross volume for the associated meter.
Unshrunk oil volume Bbl/day	Net hydrocarbon volume (after removal of S&W) at meter conditions.
Oil volume Bbl/day	Stock tank crude oil volume at standard conditions.
NGL volume Bbl/day	NGL volume at standard conditions.
Flash gas volume Bbl/day	Flash gas volume at standard conditions.

Parameter	Description
Water volume Bbl/day	Water volume at meter conditions.
Std water volume Bbl/day	Stock tank water volume at standard conditions.
Accumulators	The bottom portion of the tab displays the totalizer and residue accumulations for gross volume, unshrunk oil volume, oil volume, NGL volume, flash gas volume, water volume, and standard water volume.

29.6.3 Mass Rates and Accumulations Tab

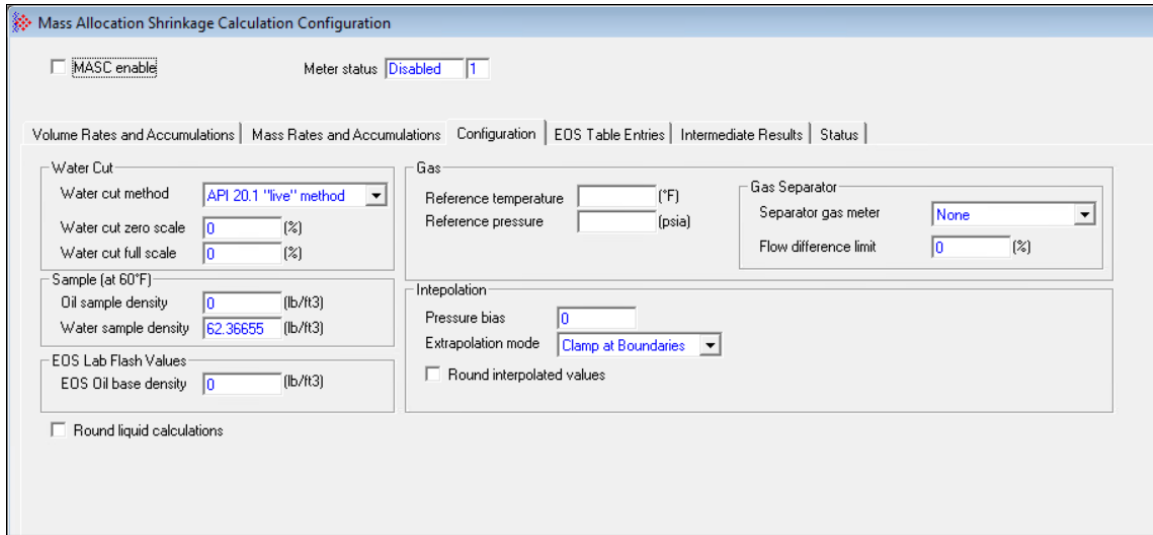
The *Mass Rates and Accumulations* tab displays mass flow rates and accumulations for the selected meter.



The Mass Rates and Accumulations parameters are described in the following table:

Parameter	Description
Flowrates	
Gross mass lb/day	Gross mass for the associated meter.
Net hydrocarbon mass lb/day	Net hydrocarbon mass (after removal of S&W).
Oil mass lb/day	Stock tank crude oil mass.
NGL mass lb/day	NGL mass.
Flash gas mass lb/day	Flash gas mass.
Water mass lb/day	Water mass.
Accumulators	The bottom portion of the tab displays the totalizer and residue accumulations for gross mass, net hydrocarbon mass, oil mass, NGL mass, and flash gas mass.

29.6.4 Configuration Tab



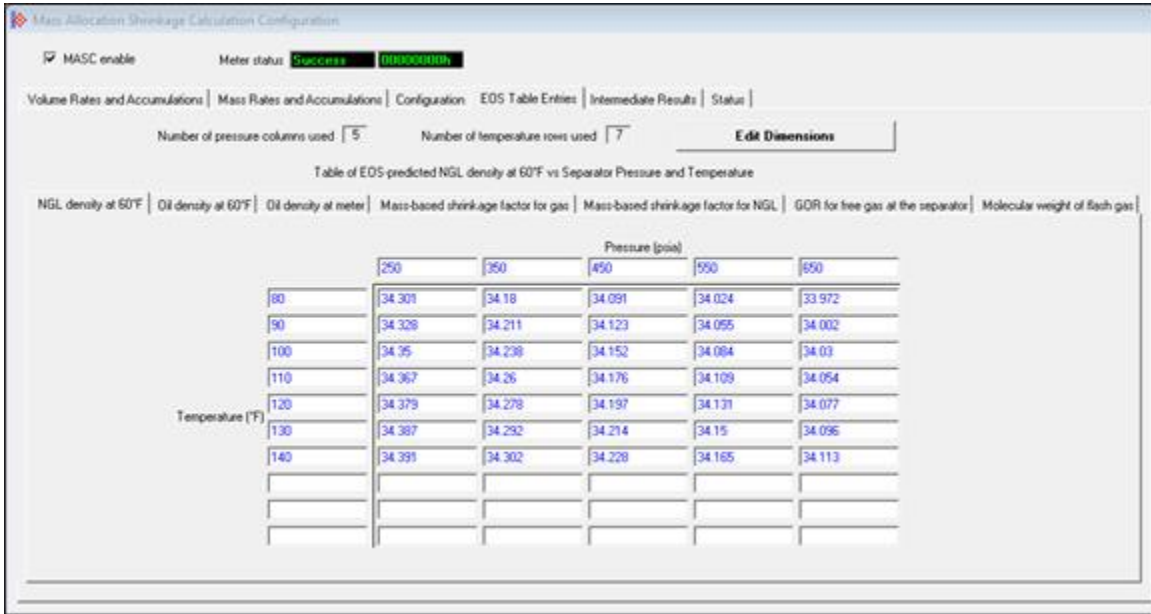
The MASC configuration parameters are described in the following table:

Parameter	Description
Water Cut	
Water cut method	<p>The method by which water cut will be calculated. Options are as follows:</p> <ul style="list-style-type: none"> Static – a water cut value derived from a static sample is entered on the meter’s configuration inputs tab. Live – the water cut is provided via a live water cut instrument. The source of the dynamic water cut value is configured on the meter’s configuration inputs tab. Density – EAFC Manager calculates the water cut value using the emulsion density value configured for the meter and computed water and hydrocarbon densities at meter conditions. <p>Note: The <i>Water cut method</i> value may also be configured in the <i>Process Input Ranges</i> dialog, as explained in the “Process Input Ranges” section of the AFC Setup and Configuration Guide.</p>
Water cut zero scale	<p>Sets the lowest acceptable value of water cut. When water cut is below this value, an alarm is generated and the previous value of water cut is used. Value is in percent.</p>
Water cut full scale	<p>Sets the highest acceptable value of water cut. When water cut is above this value, an alarm is generated and the previous value of water cut is used. Value is in percent.</p> <p>Note: The <i>Water cut zero scale</i> and <i>Water cut full scale</i> values may also be configured in the <i>Process Input Ranges</i> dialog, as explained in the “Process Input Ranges” section of the AFC Setup and Configuration Guide.</p>
Sample (at 60° F)	
Oil sample density	<p>Oil sample density at standard conditions.</p> <p>Note: The Oil sample density value can also be configured in the <i>Stream</i> section of the <i>Meter Configuration</i> dialog. For more information see the “Configuring Liquid Parameters” chapter of the AFC Setup and Configuration Guide.</p>

Parameter	Description
EOS Lab Flash Values	
Note: The <i>EOS Oil base density</i> and <i>Round liquid calculations</i> parameters can also be configured in the stream configuration section under stream parameters.	
EOS Oil base density	The oil base density derived from the Equation of State (EOS) for cases in which the EOS performs a virtual flash of the hydrocarbon. This value is used in the calculation for density correction factor.
Rounding per API 11.1 (2004)	When this option is set, intermediate values (CTLs, water cuts, shrinkage factors, and densities) are rounded using methods prescribed in API MPMS 11.1 (2004) before being used in further calculations.
Gas	The parameters in this section display read-only values from the separator gas meter. These fields will be blank if a gas meter is not configured.
Reference temperature	The temperature base used to define a standard cubic foot of gas. The default value is 60° F.
Reference pressure	The pressure base used to define a standard cubic foot of gas. The default value is 14.696 psia.
Gas Separator	
Separator gas meter index	Select the number of the configured gas meter. This is the meter from which the values of <i>Reference temperature</i> and <i>Reference pressure</i> are read.
Flow difference limit	If the <i>Separator gas meter index</i> is not set to 0 (unspecified), the firmware compares the measured free gas flow rate to the EOS-predicted free gas flow rate. This parameter specifies an allowable range for difference between the measured and EOS-predicted free gas flow.
Interpolation	
Pressure bias	Amount to bias the input pressure value to interpolation table pressure units. Note: The Pressure bias value may also be configured in the <i>Process Input Ranges</i> dialog, as explained in the "Process Input Ranges" section of the AFC Setup and Configuration Guide.
Extrapolation mode	The desired behavior when input pressure or temperature is outside of the table ranges. Options are as follows: <ul style="list-style-type: none"> • Clamp at Boundary – the interpolation logic will return the value from the nearest boundary of the table. • Maintain Last – the program will ignore the input values and will continue to use the prior interpolated value until inputs fall back within the table ranges
Round interpolated values	When this option is set, the firmware will round interpolated values to 6 significant digits before using the values in calculations. When this option is clear, the interpolated values will be used without rounding. Note: Because the MASC interpolation tables use single-precision floating point numbers, if <i>MASC round interpolated values</i> is not selected, this could result in artificial digits in the interpolated values, which are calculated using double-precision floating point numbers.

29.6.5 EOS Table Entries Tab

On the EOS Table Entries tab, you specify the dimensions and data values for each of the EOS tables.



The EOS Table Entries parameters are described in the following table:

Parameter	Description
Number of pressure columns used	The number of columns of pressure data used in the EOS tables. This value applies to all 7 EOS tables.
Number of temperature rows used	The number of rows of temperature data used in the EOS tables. This value applies to all 7 EOS tables.
Edit Dimensions	Click this button to edit the number of pressure columns and number of temperature rows as well as the header values for each. Note: Updates to the number of pressure columns or number of temperature rows will be applied to all EOS tables. Changes to pressure column headers or temperature row headers will also be applied to all tables.
EOS Table Tabs	The <i>EOS Table Entries</i> tab contains the following seven tabs, one for each of the EOS tables. Each table maintains interpolation table data for one of the seven input parameters to MASC calculations.
NGL density at 60°F	This table displays the interpolated values for the density of natural gas liquids at a given set of pressure and temperature values. Density of NGL at standard conditions as predicted by the EOS model.
Oil density at 60°F	Density of oil at standard conditions as predicted by the EOS model. This density is based on modeling of the field flash process.
Oil density at meter	Density of oil at meter temperature and pressure as predicted by the EOS model.
Mass-based shrinkage factor for gas	Mass-based shrinkage factor for flash gas.
Mass-based shrinkage factor for NGL	Mass-based shrinkage factor for NGL.

Parameter	Description
GOR for free gas at the separator	EOS-predicted gas-oil-ratio of free gas to stock tank oil. This is related to free gas exiting the separator.
Molecular weight of flash gas	Molecular weight of the flash gas as predicted by the EOS model.
EOS Table Column and Row Headings	
Pressure Column Headers	Each column is headed by a pressure value. All tables share the same pressure column heading values, which can be edited via the EDIT DIMENSIONS button.
Temperature Row Headers	Each row begins with a temperature row heading value (to the left). All tables share the same temperature row heading values, which can be edited via the EDIT DIMENSIONS button.
Table Values	Once the table dimensions are defined, you must enter an EOS value for each temperature-pressure combination in the table, as described in section 29.2.

29.6.6 Intermediate Results Tab

The *Intermediate Results* tab displays the results of intermediate calculations used in the creation of the EOS tables.

The screenshot shows the 'Intermediate Results' tab of the 'Mass Allocation Shrinkage Calculation Configuration' window. The window title is 'Mass Allocation Shrinkage Calculation Configuration'. At the top, there is a 'MASC enable' checkbox which is checked, and a 'Meter status' indicator showing 'Success' and '00000000h'. Below this are several tabs: 'Volume Rates and Accumulations', 'Mass Rates and Accumulations', 'Configuration', 'EOS Table Entries', 'Intermediate Results' (which is selected), and 'Status'. The main content area is divided into several sections:

- Current Values:** Pressure (404.696 psia), Temperature (100 °F), Emulsion density (47.00003 lb/ft³).
- Interpolated Values:** NGL density at 60°F, EOS (34.2036 lb/ft³); Oil density at 60°F, EOS (49.4308 lb/ft³); Oil density at meter, EOS (45.91436 lb/ft³); Mass-based shrinkage factor for gas (0.0277574); Mass-based shrinkage factor for NGL (0.0682); Mass-based shrinkage factor for oil (0.9040426); GOR for free gas at the separator (3412.804 SCF/STB); Molecular weight of flash gas (21.8642 lb/lb-mole).
- Water Cut:** Volumetric S&W fraction (5.415894E-02); Mass-based S&W fraction (7.612459E-02).
- Corrected Values:** Density correction factor (1.010054); Standard oil density (49.9278 lb/ft³); Standard NGL density (34.5475 lb/ft³).
- Separator Gas Comparison:** Gross volume (4485.448 MSCF); EOS volume (5000.708 MSCF); Difference (11.48735 %).
- Oil:** Sample density at 60°F (49.496 lb/ft³); CTL at sample conditions (1); CTL at meter conditions (1); Density at meter conditions (46.376 lb/ft³); Oil base density EOS lab flash (49.0033 lb/ft³); Oil base density for CTL (49.496 lb/ft³).
- Water:** Sample density at 60°F (67.22095 lb/ft³); CTL at sample conditions (1); CTL at meter conditions (0.0); Density at meter conditions (0.0 lb/ft³); CPL at meter conditions (0.0).
- Gas:** Standard molar density (0.0 lb-mole/MSCF).

The Intermediate Results parameters are described in the following table:

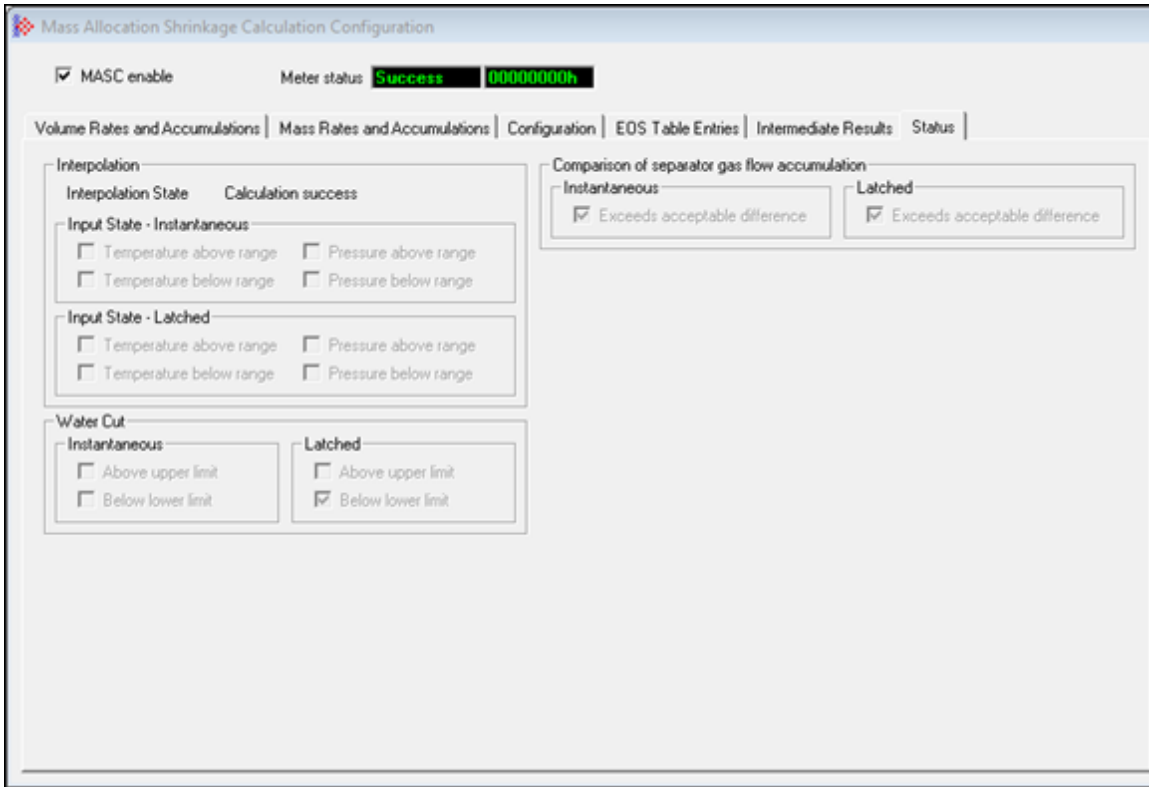
Note: Fields on the *Intermediate Results* tab are read-only.

Parameter	Description
Current Values	
Pressure	Pressure value read from the specified pressure input source biased by the specified bias amount. This value is used to interpolate a value between two known pressure values in the property tables. Units are in psia.
Temperature	Temperature value read from the specified temperature input source. This value is used to interpolate a value between two known temperature values in the property tables. Units are in degrees F.
Emulsion density	The meter's density value converted (if necessary) to units of lb/ft ³ .
Interpolated Values	
NGL density at 60°F, EOS	Interpolated value for standard NGL density in lb/ft ³ .
Oil density at 60°F, EOS	Interpolated value for standard oil density in lb/ft ³ .
Oil density at meter, EOS	Interpolated value for oil density at meter conditions lb/ft ³ .
Mass-based shrinkage factor for gas	Interpolated value for shrinkage factor of gas.
Mass-based shrinkage factor for NGL	Interpolated value for shrinkage factor of NGL.
Mass-based shrinkage factor for oil	Interpolated value for mass-based shrinkage factor of oil.
GOR for free gas at the separator	Interpolated value for EOS-predicted free gas-to-stock-tank-oil-ratio. Units are in SCF/STB.
Molecular weight of flash gas	Interpolated value for molecular weight of flash gas in units of lb/lb-mole.
Water Cut	
Volumetric S&W fraction	Volumetric fractional water cut at meter conditions.
Mass-based S&W fraction	Mass fractional water cut.
Corrected Values	
Density correction factor	Correction factor calculated by relating $Rho_{Oil,60,EOS,labflash}$ to sample density.
Standard oil density	EOS-predicted (interpolated) oil density at standard conditions with the density correction factor applied. Units are in lb/ft ³ .
Standard NGL density	EOS-predicted (interpolated) NGL density at standard conditions with the density correction factor applied. Units are in lb/ft ³ .
Separator Gas Comparison	
Gross volume	Accumulated volume of free gas exiting the separator as measured by the specified gas meter and scaled by the specified scale factor. This value is updated ten times per rolling average period (60 minutes). Units are in MSCF.
EOS volume	Accumulated volume of free gas exiting the separator as calculated from the interpolated EOS gas oil ratio and PEPMAS calculated oil stock tank rate. This value is updated ten times per rolling average period. Units are in MSCF.
Difference	Percentage difference between measured and EOS-calculated free gas accumulation over the specified rolling average period. This value is updated ten times per rolling average period.

Parameter	Description
Oil	
Sample density at 60°	Sample oil density corrected to 60°F and converted to units of lb/ft ³ (if necessary).
CTL at sample conditions	Correction factor for temperature of oil at sample conditions. This value is always 1.0.
CTL at meter conditions	Correction factor for temperature of oil at meter conditions. This value is only used to correct static water cuts to dynamic conditions. If water cut type is not set to Static (Sample), this value is not actively calculated and may appear as zero.
Density at meter conditions	EOS-predicted (interpolated) oil density at meter conditions in units of lb/ft ³ .
Oil base density EOS lab flash	User-input density value in lb/ft ³ and rounded as specified by the configuration.
Oil base density for CTL	User-input density value in lb/ft ³ and rounded as specified by the configuration.
Water	
Sample density at 60°	Sample water density corrected to 60°F and converted to units of lb/ft ³ (if necessary).
CTL at sample conditions	Correction factor for temperature of water at sample conditions. This value is always 1.0.
CTL at meter conditions	Correction factor for temperature of water at meter conditions.
Density at meter conditions	EOS-predicted (interpolated) water density at meter conditions.
CPL at meter conditions	Correction factor for pressure of water at meter conditions.
Gas	
Standard molar density	Conversion factor calculated from gas law and the configured gas temperature and pressure base condition values. Units are in lb-mole/MSCF.

29.6.7 Status Tab

The *Status* tab displays alarms associated with mass allocation shrinkage calculations.



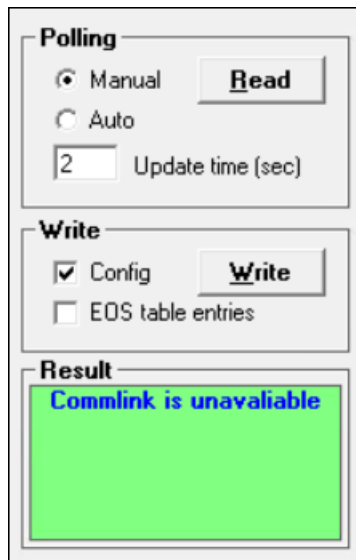
The Status parameters are described in the following table:

Parameter	Description
Interpolation	
Interpolation State	Indication of the success of the interpolation logic. Possible values are as follows: <ul style="list-style-type: none"> ▪ Calculation inactive ▪ Calculation success ▪ Input(s) out of range: value(s) clamped ▪ Input(s) out of range: output frozen
Input State – Instantaneous	Indicates whether the temperature and/or pressure input values are currently outside of the ranges defined by the pressure columns and temperature rows of the EOS tables.
Input State – Latched	Indicates whether the temperature and/or pressure input values have been outside of the EOS table ranges since the last reset of these latched flags. For more information see “Clearing Latched Alarms” in section 29.5.2.

Parameter	Description
Water Cut – Instantaneous	Indicates whether the water cut is currently outside of the specified range. These alarms are set or cleared on each calculation scan.
Water Cut – Latched	Indicates whether the water cut has been outside of the specified range since the last reset of these latched flags. If an instantaneous alarm is set, then the corresponding latched alarm is also set, but is not cleared until the user clears the latched state (as opposed to the instantaneous states which automatically cleared when not meeting the alarm condition). For more information see “Clearing Latched Alarms” in section 29.5.2.
Comparison of separator gas flow accumulation	
Comparison Result – Instantaneous	Indicates whether measured and predicted separator free gas accumulations are currently outside the specified difference range.
Comparison Result - Latched	Indicates whether measured and predicted separator free gas accumulations have been outside the specified difference range since the last reset of this latched flag. For more information see “Clearing Latched Alarms” in section 29.5.2.

29.6.8 Read and Write Commands

This section explains the options available for reading and writing data to the module. These are located on the right side of the *Mass Allocation Shrinkage Calculation Configuration* dialog.



Polling

Parameter	Description
Manual	When <i>Manual</i> is selected, the user must click READ to poll the module.
Auto	Select <i>Auto</i> to enable automatic polling at a frequency determined by the <i>Update time (sec)</i> value.

Note: Auto-polling applies only when you are viewing the *Mass Rates and Accumulations*, *Volume Rates and Accumulations*, *Intermediate Results*, or *Status* tab. When viewing the *Configuration* or *EOS Table Entries* tab, EAFC Manager will poll the meter once and then automatically switch to Manual mode.

Parameter	Description
Update time (sec)	If <i>Auto</i> is selected, the <i>Update time</i> value specifies the frequency of polling in seconds.
Read button	Click READ to poll the module. Data read from the module will display on the tabs of the Mass Allocation Shrinkage Calculation Configuration dialog.

Write

Parameter	Description
Config	Select the <i>Config</i> check box to write MASC configuration to the module.
EOS table entries	Select the <i>EOS table entries</i> check box to write EOS table entries to the module.
Write button	Click WRITE to write the selected data to the module. To write both MASC configuration and EOS table data to the module, select both check boxes.

Result

The *Result* area displays the results of the most recent read or write action.

30 Meter Stream Configuration

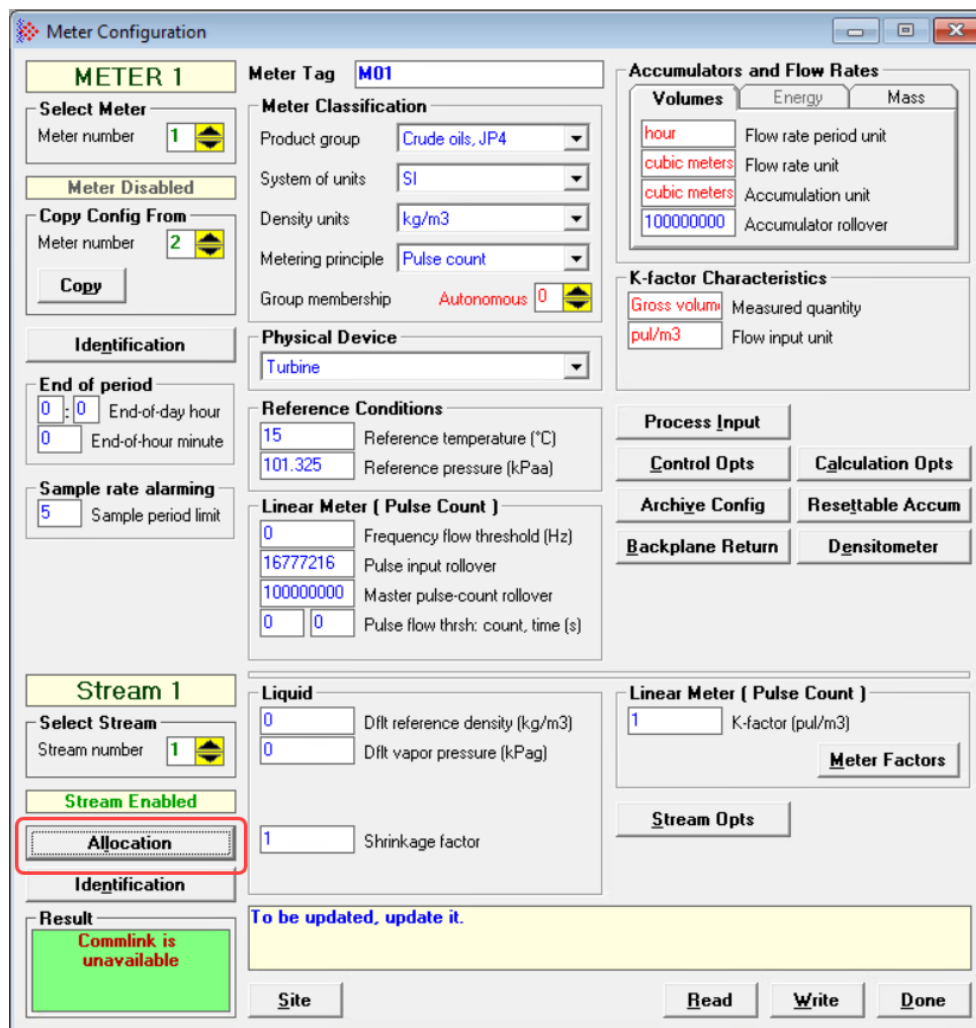
30.1 Overview

The AFC module supports a total of 64 streams that can be managed both at a global level and on a per-meter basis in the *Meter Stream Configuration* dialog. The default meter stream configuration is dependent on the firmware version as explained in the following sections.

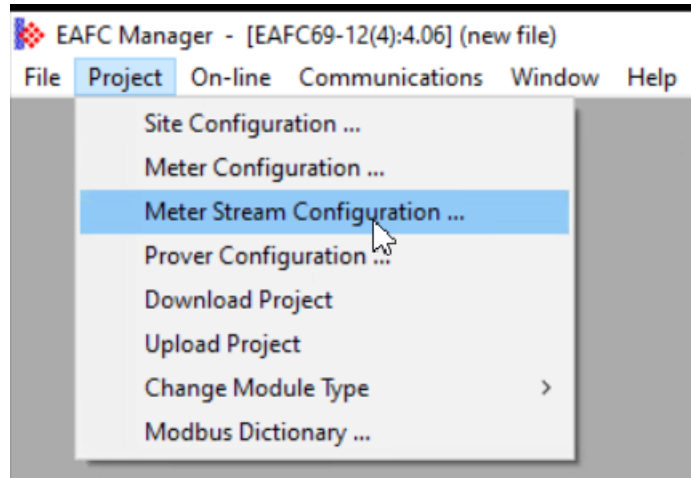
30.1.1 Overview of the Meter Stream Configuration Dialog

You can access the *Meter Stream Configuration* dialog in either of the following ways:

- Select **ALLOCATION** in the *Meter Configuration* dialog.



- Select **PROJECT > METER STREAM CONFIGURATION**.



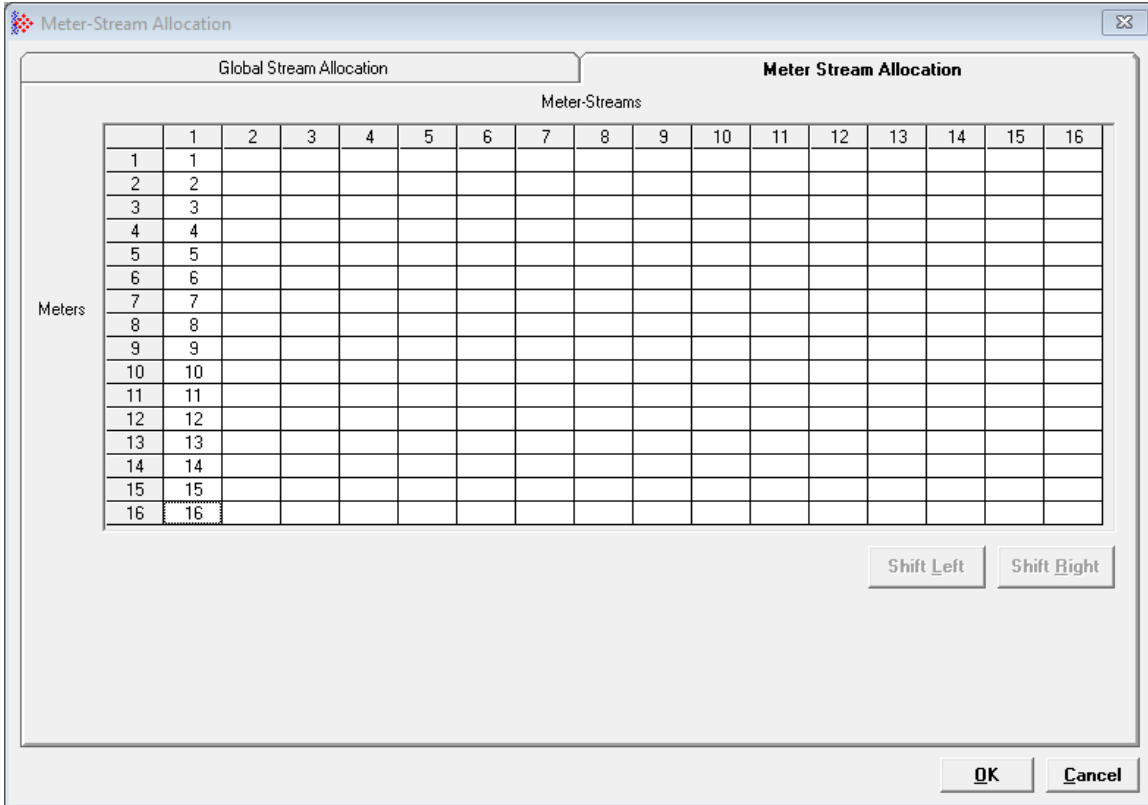
The *Global Stream Allocation* tab of the *Meter Stream Configuration* dialog provides a global view of all meter streams and their associated meters. Each row in this table represents a global stream (1 through 64), and each column represents a meter (1 through 16 for the MVI56E-AFC or 1 through 12 for the MVI69E-AFC). A marker in each row indicates the meter to which the global stream is allocated. The *N/A* column indicates which meters are unallocated.

For example, the MVI56E-AFC module’s default global stream allocation for firmware version 4.06 is as follows:

The screenshot shows the 'Meter-Stream Allocation' dialog box with the 'Global Stream Allocation' tab selected. The grid displays the allocation of 25 global streams to 16 meters. The 'N/A' column is empty, indicating all meters are allocated.

	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		○															
2			○														
3				○													
4					○												
5						○											
6							○										
7								○									
8									○								
9										○							
10											○						
11												○					
12													○				
13														○			
14															○		
15																○	
16																	○
17	○																
18	○																
19	○																
20	○																
21	○																
22	○																
23	○																
24	○																
25	○																

The *Meter Stream Allocation* tab provides a per-meter view of the allocation configuration. Each row in this table represents a meter, and each column represents one of 16 meter streams. Currently allocated streams are indicated by the numbers 1 through 64, which correspond to the 64 global streams. For example, the MVI56E-AFC module’s default meter stream allocation for firmware version 4.06 is as follows:



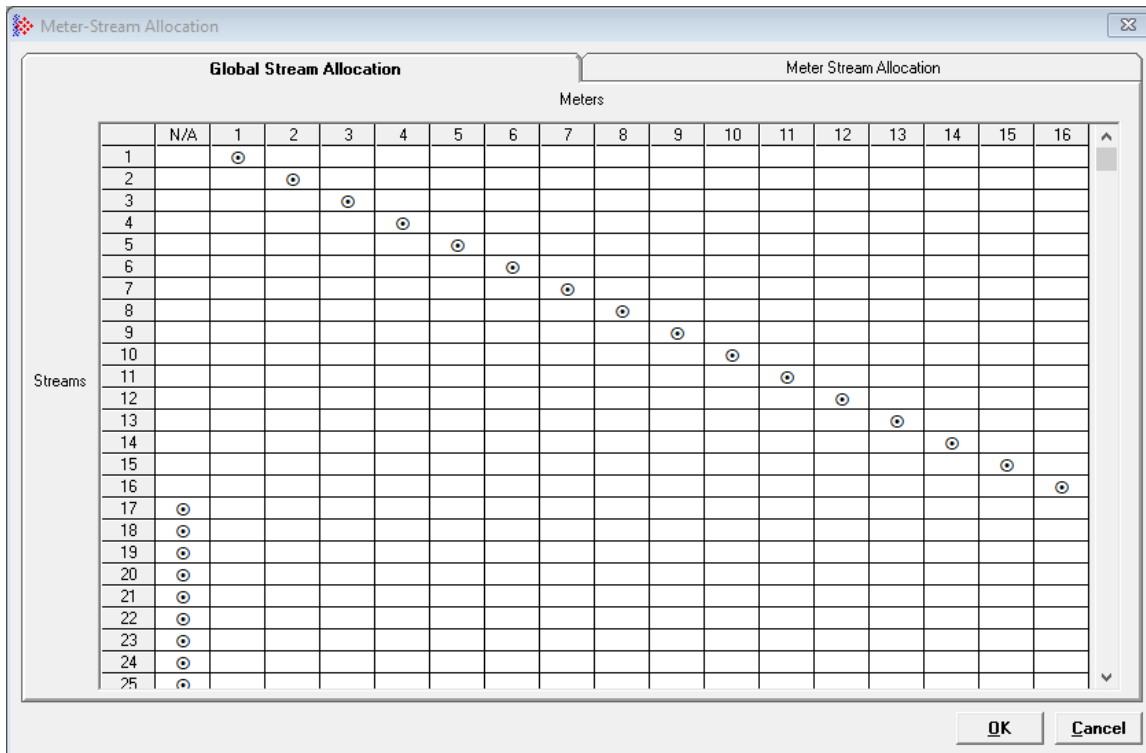
30.1.2 Default Configuration for Firmware Version 4.06

For new meter stream configurations using firmware version 4.06, the first meter stream for each meter is allocated to the corresponding global stream. For example, the first meter stream of meter 1 is allocated to global stream 1, the first meter stream of meter 2 is allocated to global stream 2, and so on. It is not possible to change the allocation for the first 16 global streams in the MVI56E-AFC or the first 12 global streams in the MVI69E-AFC.

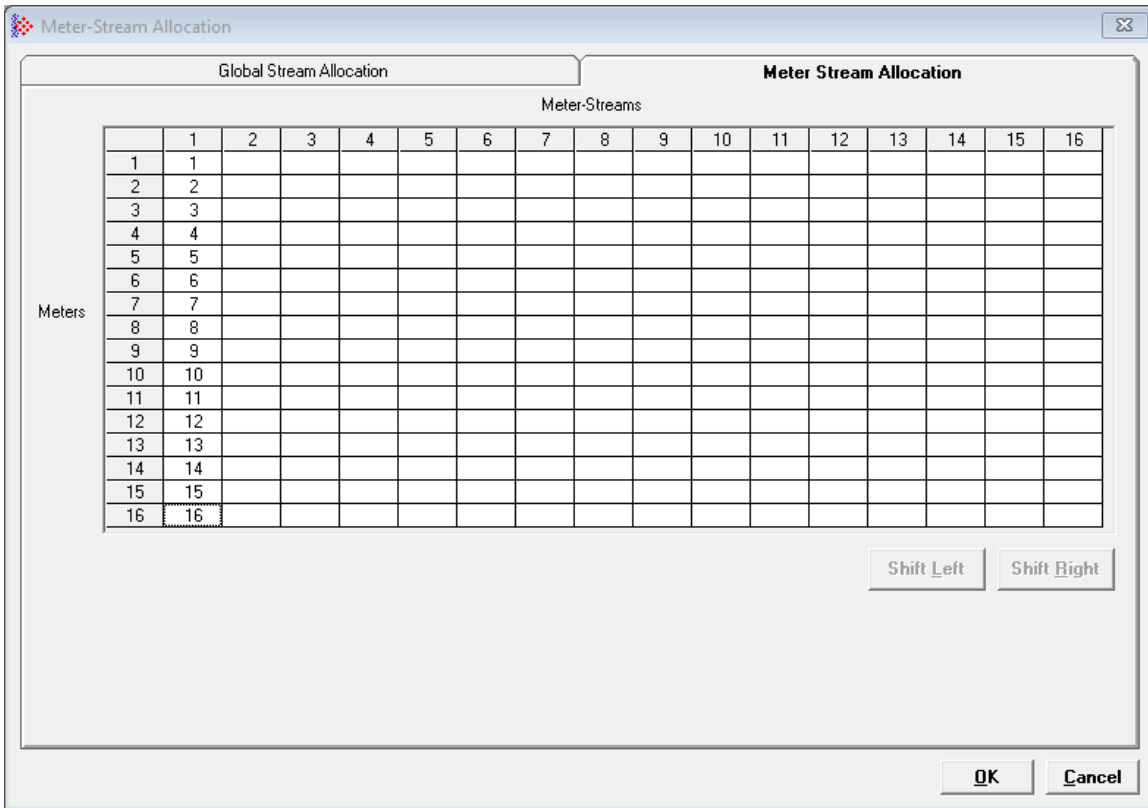
The remaining global streams (17 through 64 for the MVI56E-AFC and 13 through 64 for the MVI69E-AFC) are unallocated by default. You may allocate these global streams to meter streams 2 through 16 of any meter. A single meter can have up to 16 streams.

MVI56E-AFC

The MVI56E-AFC module's default global stream configuration for firmware version 4.06 is shown in the following screen capture of the *Global Stream Allocation* tab. Global streams 1 through 16 are allocated to meters 1 through 16. Global streams 17 through 64 are not allocated.

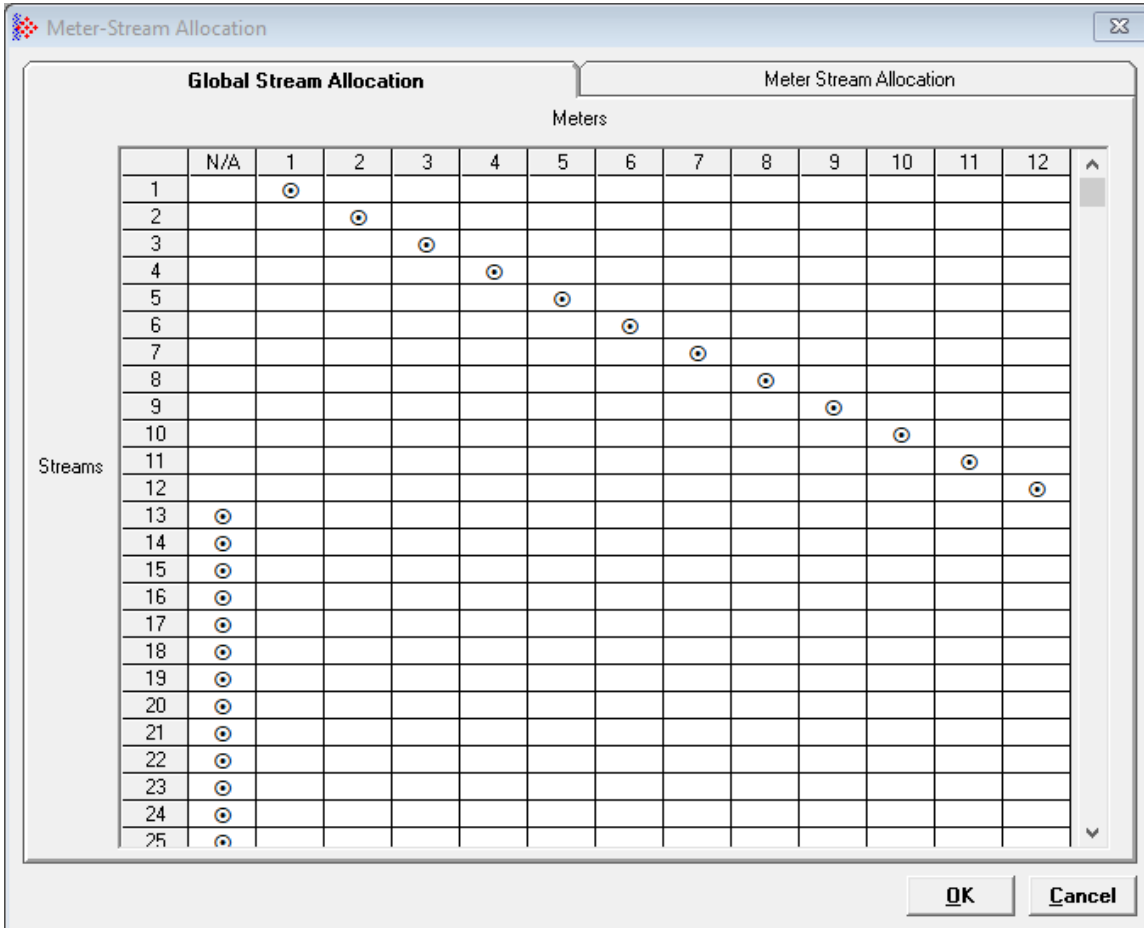


The MVI56E-AFC module's default meter stream configuration for firmware version 4.06 is shown in the following screen capture of the *Meter Stream Allocation* tab. Global streams 1 through 16 are allocated to meters 1 through 16 as meter stream 1.

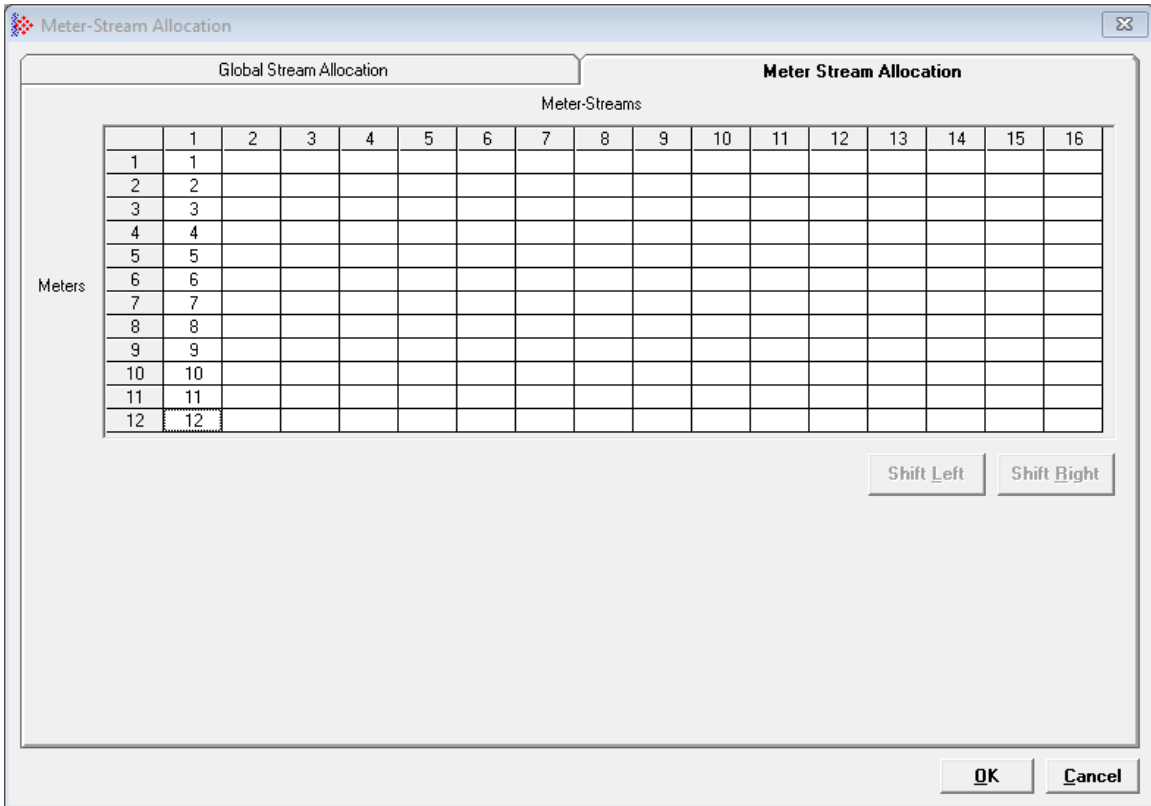


MVI69E-AFC

The MVI69E-AFC module’s default global stream configuration for firmware version 4.06 is shown in the following screen capture of the *Global Stream Allocation* tab. Global streams 1 through 12 are allocated to meters 1 through 12. Global streams 13 through 64 are not allocated.



The MVI56E-AFC module's default meter stream configuration for firmware version 4.06 is shown in the following screen capture of the *Meter Stream Allocation* tab. Global streams 1 through 12 are allocated to meters 1 through 12 as meter stream 1.



30.1.3 Default Configuration for Firmware Version 4.05 or Earlier

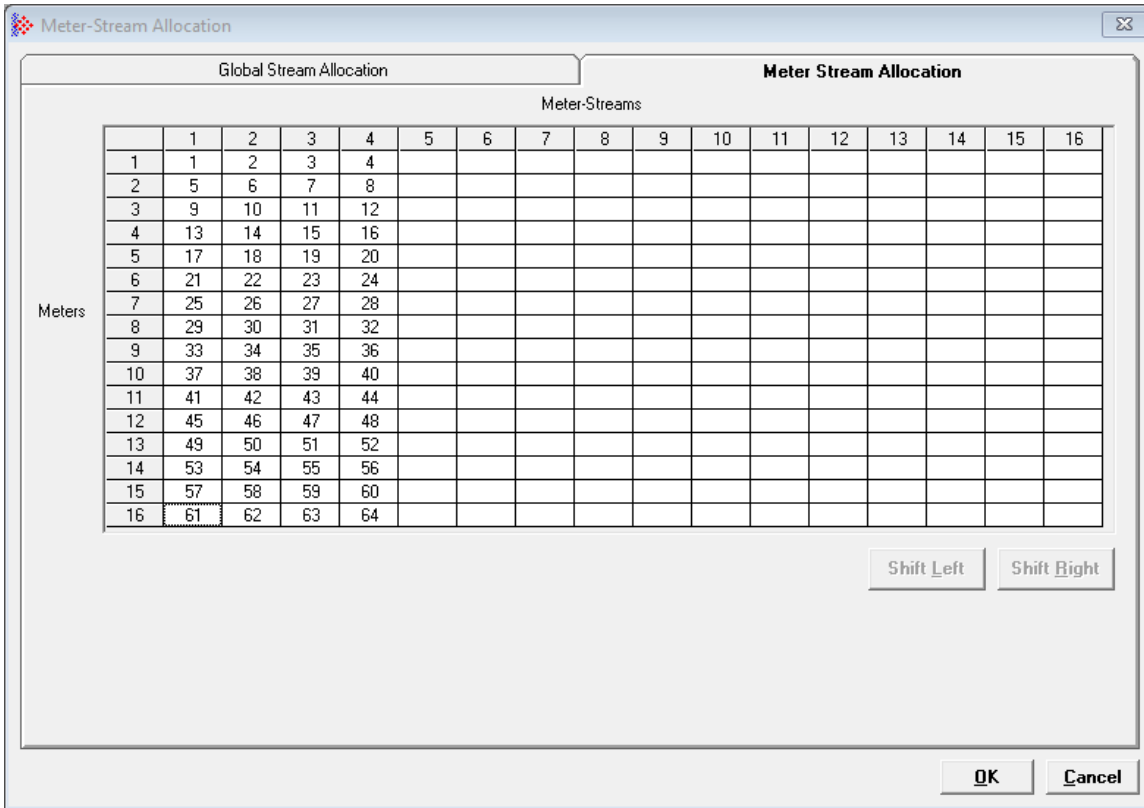
With firmware version 4.05 or earlier, four streams are allocated to each meter by default. The first four global streams are allocated to meter 1, the second four global streams are allocated to meter 2, and so on. It is not possible to change this configuration in version 4.05 or earlier.

MVI56E-AFC

The MVI56E-AFC module's default global stream configuration for firmware version 4.05 or earlier is shown in the following screen capture of the *Global Stream Allocation* tab. Global streams 1 through 64 are allocated to meters 1 through 16, with global streams 1 through 4 allocated to meter 1, global streams 5 through 8 allocated to meter 2, and so on.

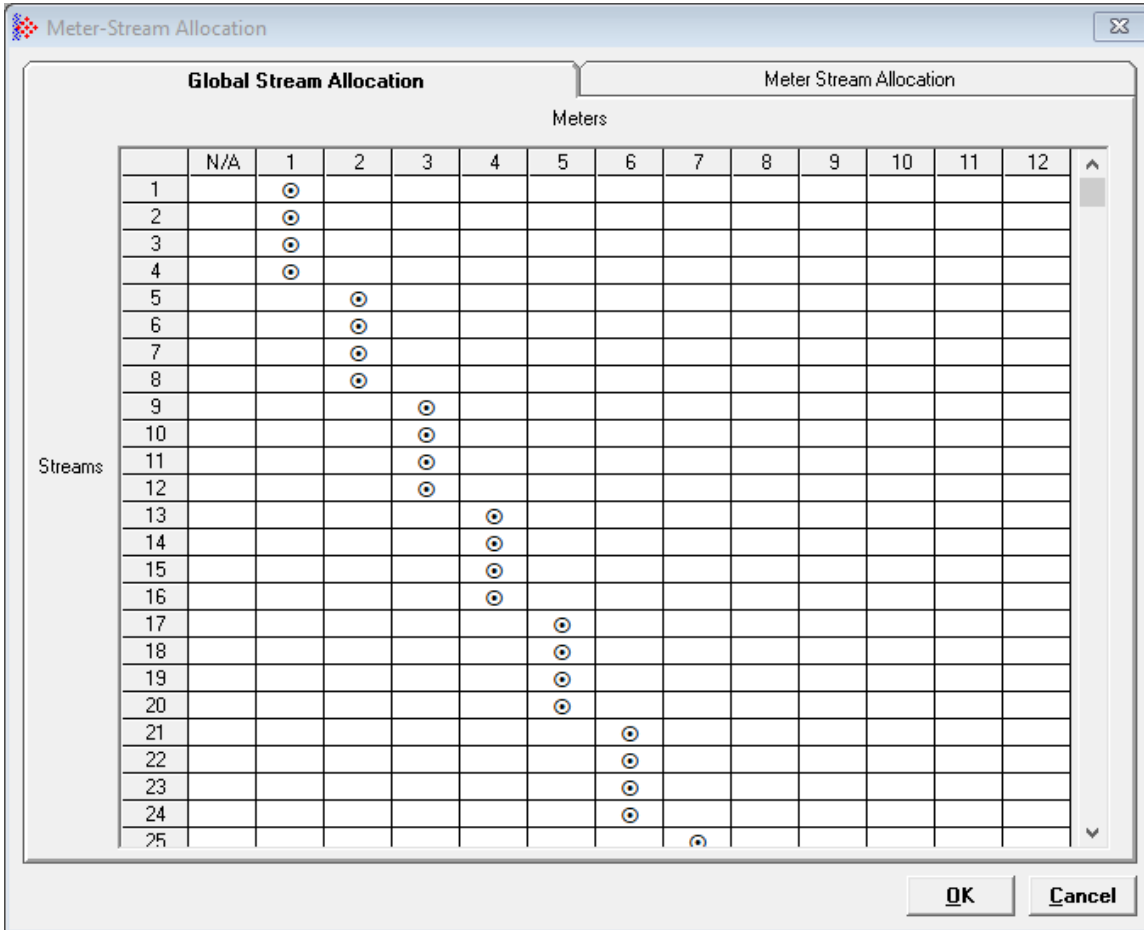
	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		○															
2		○															
3		○															
4		○															
5			○														
6			○														
7			○														
8			○														
9				○													
10				○													
11				○													
12				○													
13					○												
14					○												
15					○												
16					○												
17						○											
18						○											
19						○											
20						○											
21							○										
22							○										
23							○										
24							○										
25								○									

The MVI56E-AFC module’s default meter stream configuration for firmware version 4.05 or earlier is shown in the following screen capture of the *Meter Stream Allocation* tab. Global streams 1 through 64 are allocated to meters 1 through 16 as meter streams 1 through 4.

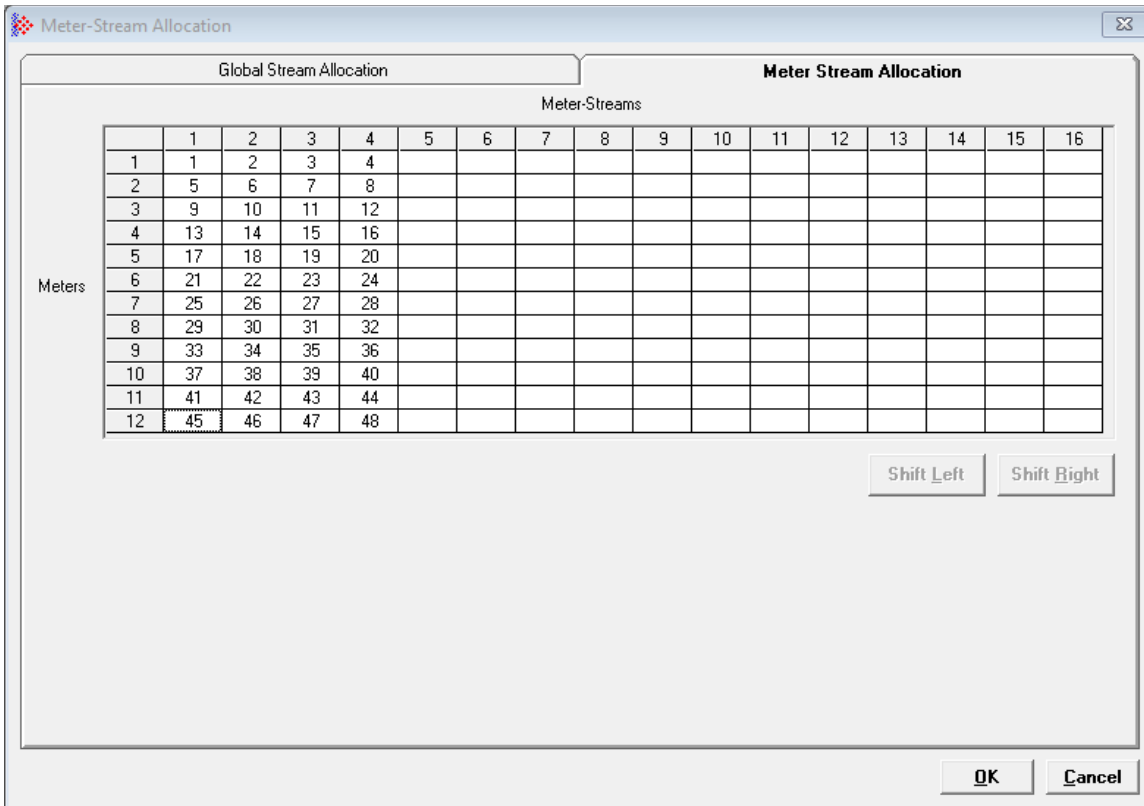


MVI69E-AFC

The MVI69E-AFC module’s default global stream configuration for firmware version 4.05 or earlier is shown in the following screen capture of the *Global Stream Allocation* tab. Global streams 1 through 48 are allocated to meters 1 through 12, with global streams 1 through 4 allocated to meter 1, global streams 5 through 8 allocated to meter 2, and so on.



The MVI69E-AFC module’s default meter stream configuration for firmware version 4.05 or earlier is shown in the following screen capture of the *Meter Stream Allocation* tab. Global streams 1 through 48 are allocated to meters 1 through 16 as meter streams 1 through 4.



30.1.4 Default Configuration After Upgrading from 4.05 or earlier to 4.06

After an upgrade from firmware version 4.05 or earlier to firmware version 4.06, the default configuration of four streams per meter is carried over to version 4.06, but it is altered as explained in the following two sub-sections.

The allocation for the first meter stream for each meter cannot be changed. The remaining meter streams may be changed, as explained in section 30.2.2.

MVI56E-AFC

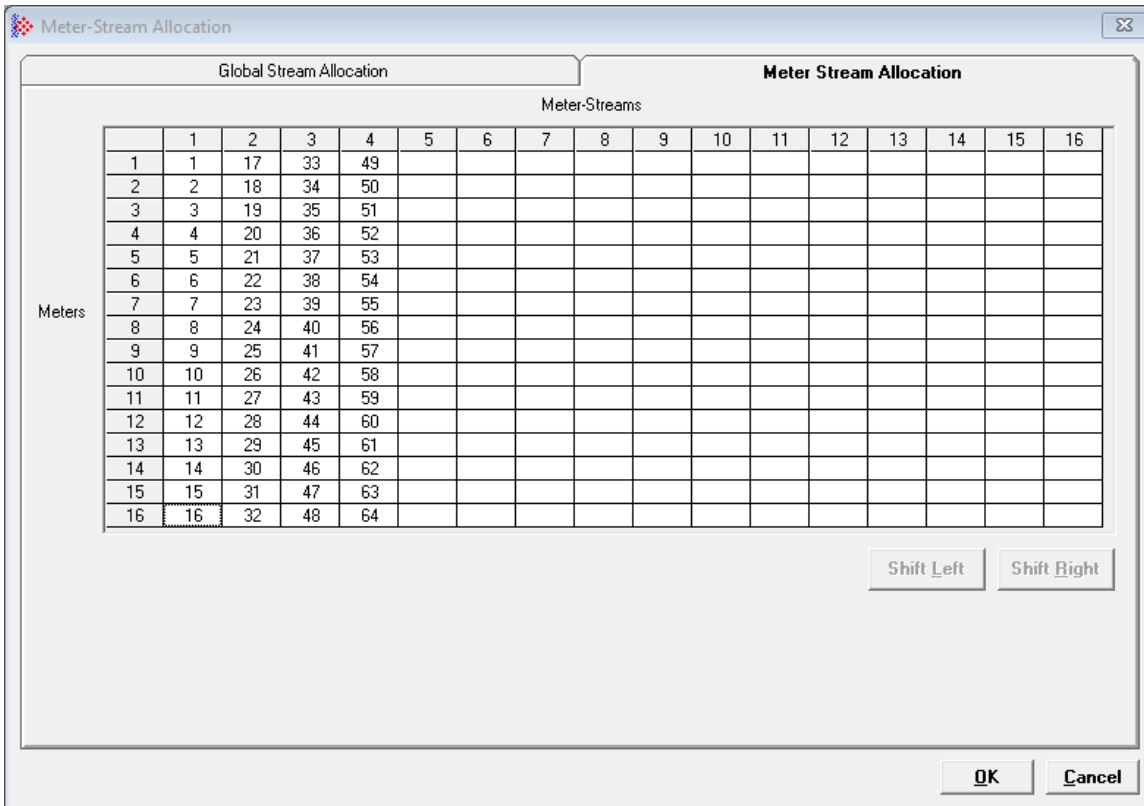
An MVI56E-AFC global stream configuration that has been upgraded from firmware version 4.05 or earlier to 4.06 is shown in the following screen capture of the *Global Stream Allocation* tab. Global streams are allocated as follows:

- Global streams 1 - 16 are allocated to meters 1 - 16 as meter stream 1.
- Global streams 17 - 32 are allocated to meters 1 - 16 as meter stream 2.
- Global streams 33 - 48 are allocated to meters 1 - 16 as meter stream 3.
- Global streams 49 - 64 are allocated to meters 1 - 16 as meter stream 4.

The screenshot shows a window titled "Meter-Stream Allocation" with a tab labeled "Global Stream Allocation". The window contains a grid with "Streams" on the vertical axis (numbered 1 to 25) and "Meters" on the horizontal axis (numbered 1 to 16). A column labeled "N/A" is to the left of meter 1. Small circles with a dot in the center are placed in the grid cells to indicate allocations. The pattern shows that for each meter, the first four streams are allocated to it, and this pattern repeats for all 16 meters.

Streams	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		○															
2			○														
3				○													
4					○												
5						○											
6							○										
7								○									
8									○								
9										○							
10											○						
11												○					
12													○				
13														○			
14															○		
15																○	
16																	○
17		○															
18			○														
19				○													
20					○												
21						○											
22							○										
23								○									
24									○								
25										○							

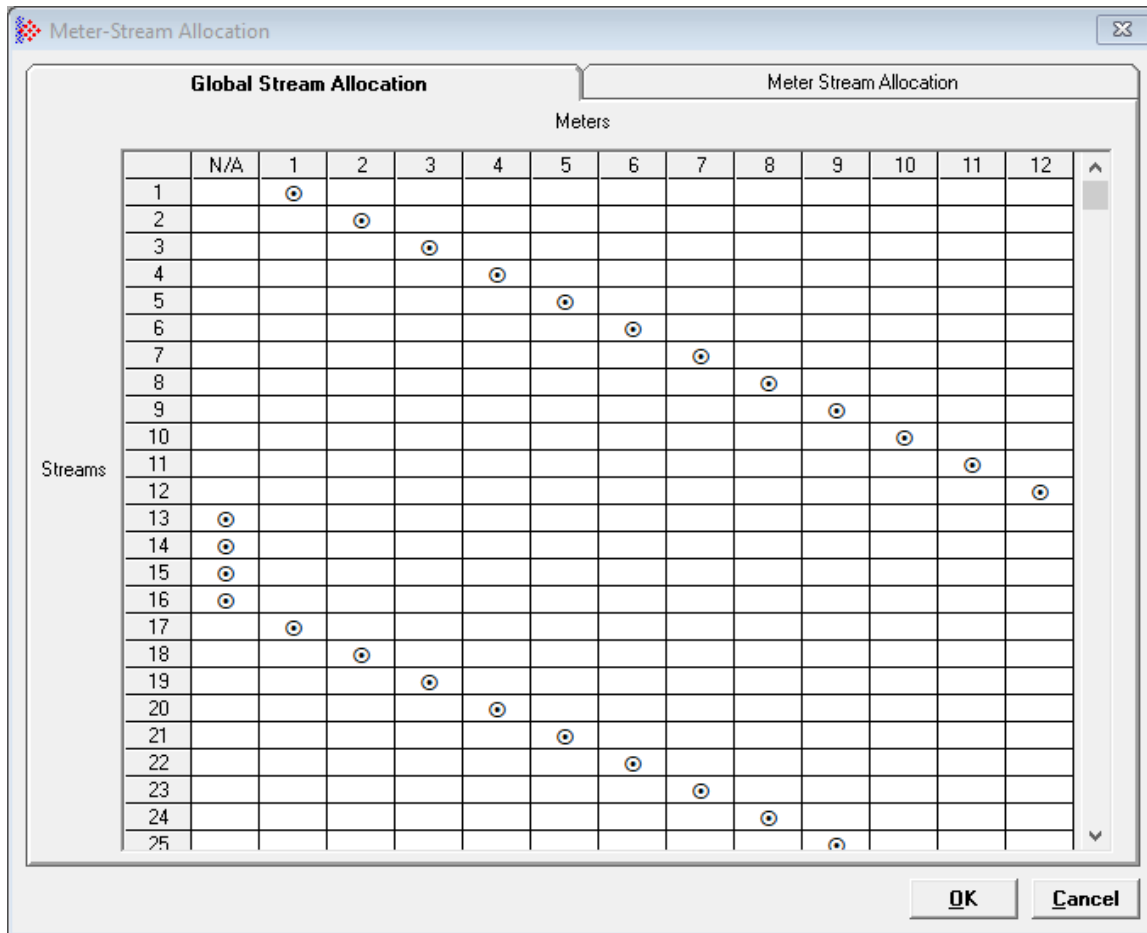
The corresponding default meter stream configuration after upgrading from firmware version 4.05 or earlier to 4.06 is shown in the following screen capture of the *Meter Stream Allocation* tab.



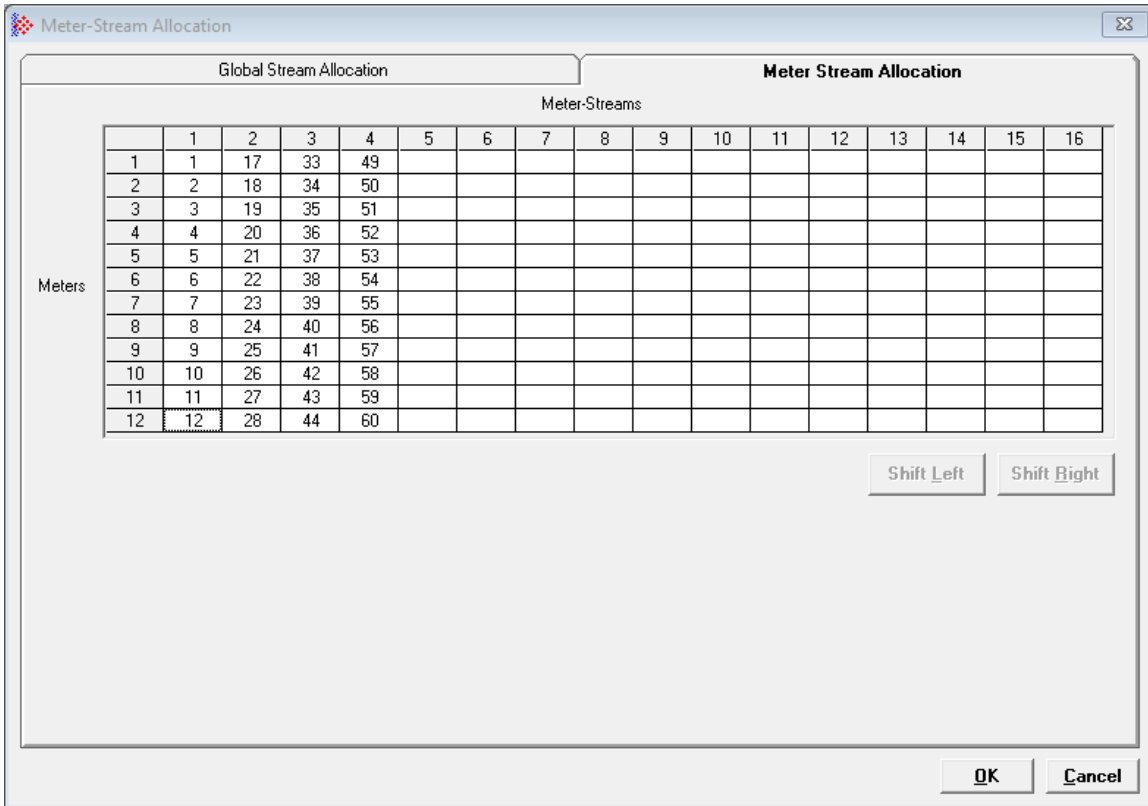
MVI69E-AFC

An MVI69E-AFC global stream configuration that has been upgraded from firmware version 4.05 or earlier to 4.06 is shown in the following screen capture of the *Global Stream Allocation* tab. Global streams are allocated as follows:

- Global streams 1 - 12 are allocated to meters 1 - 12 as meter stream 1.
- Global streams 13 - 16 are not allocated.
- Global streams 17 - 28 are allocated to meters 1 - 12 as meter stream 2.
- Global streams 29 - 32 are not allocated.
- Global streams 33 - 44 are allocated to meters 1 - 12 as meter stream 3.
- Global streams 45 - 48 are not allocated.
- Global streams 49 - 60 are allocated to meters 1 - 12 as meter stream 4.
- Global streams 61 - 64 are not allocated.



The corresponding default meter stream configuration after upgrading from firmware version 4.05 or earlier to 4.06 is shown in the following screen capture of the *Meter Stream Allocation* tab.



30.2 Configuring the Meter Stream Allocation

30.2.1 Rules and Limitations

With firmware version 4.06, you can modify the default meter stream allocation using the *Meter Stream Configuration* dialog. The process for doing so is outlined in section 30.2.2.

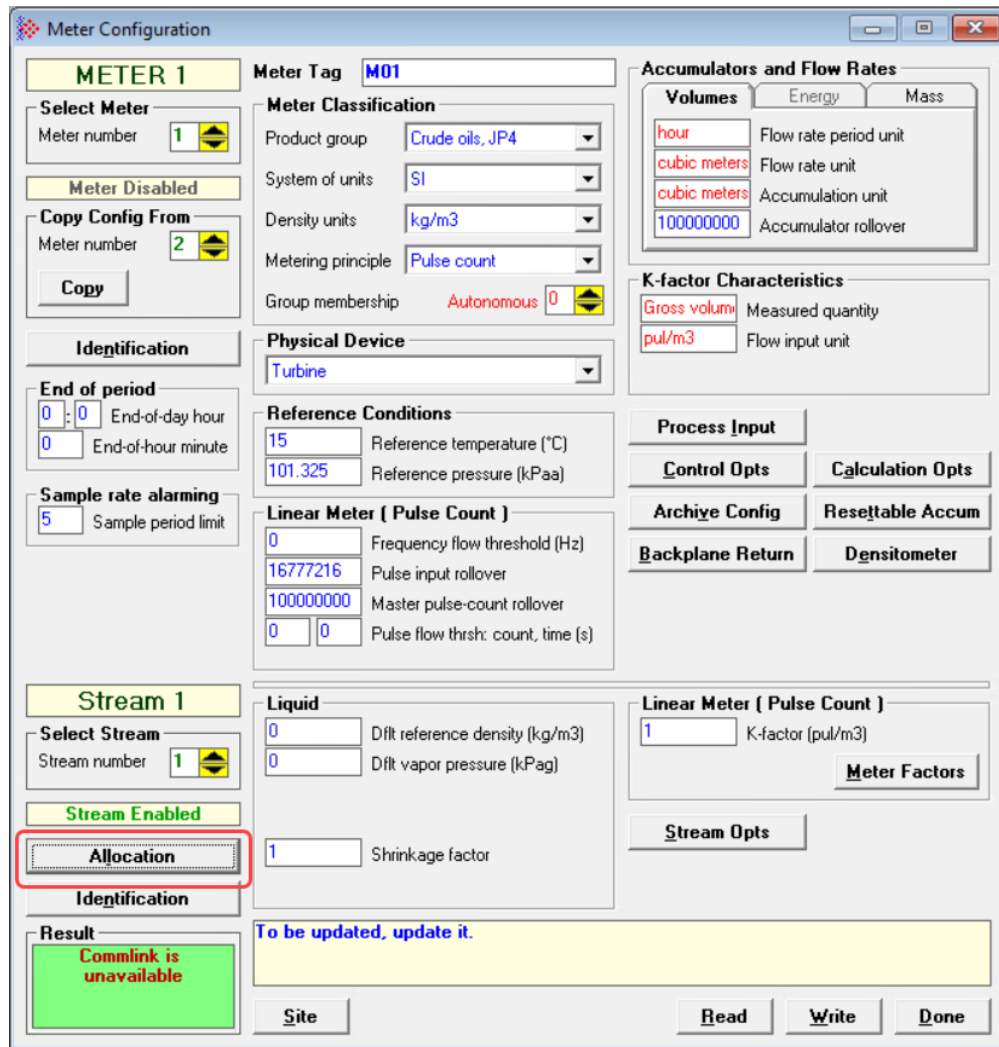
When modifying the meter stream allocation, keep in mind the following rules and limitations:

- On the *Meter Stream Allocation* tab, when you shift a stream left or right, the stream data is preserved under the new per-meter stream index.
- If you allocate (add) a new global stream to a meter stream, at a meter stream index that was previously allocated, the data from the previous meter stream will be copied to the new meter stream.
- If you allocate (add) a new global stream to a previously unallocated meter stream index, the new meter stream data will be initialized with the default configuration consistent with the meter.
- If you unallocate (delete) a global stream from a previously allocated per-meter stream index, the previous stream data is erased.
- It is not allowed to perform additions and deletions for the same meter in the same Modbus transaction.
- If a meter is a member of a meter group, only its first meter stream will be included in the group. Any additional meter streams will be ignored.
- Changes to an active meter stream are not permitted.

30.2.2 Change the Meter Stream Configuration

Note: Both *Plant* and *Process & Control* privileges are required to modify the meter stream configuration. For more information on privileges, see chapter 2.

- 1 From the *Meter Configuration* dialog, select **ALLOCATION**.



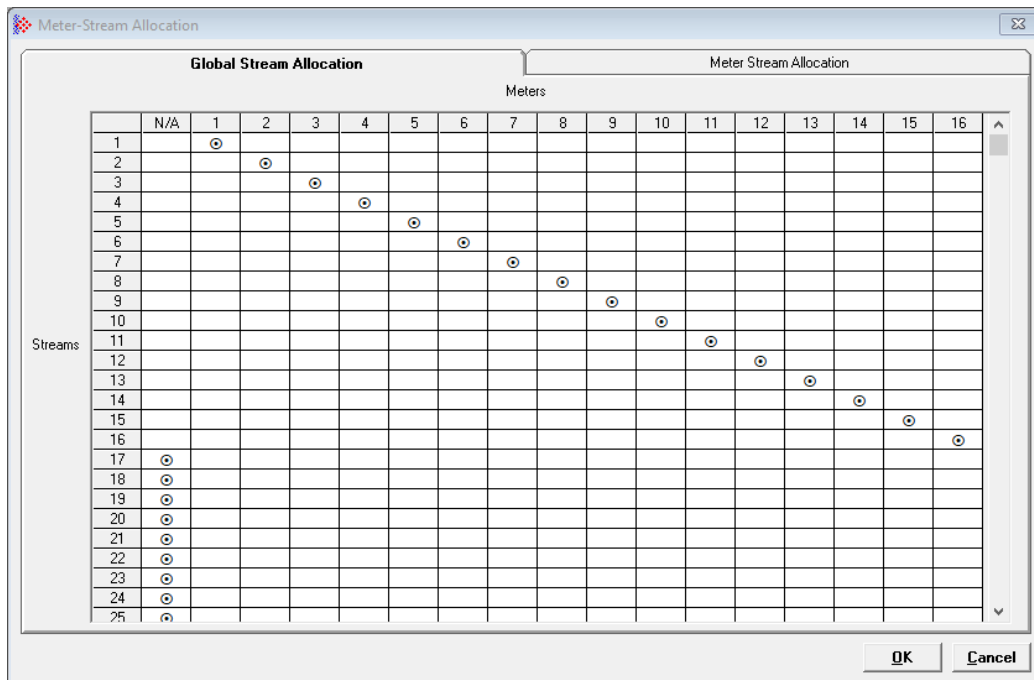
The *Meter Stream Configuration* dialog displays.

Note: If you are using a firmware version earlier than 4.06, the *Meter Stream Configuration* dialog will be read-only.

- 2** From the *Global Stream Allocation* tab, you can make any of the following changes:
- Allocate a new global stream to a meter stream by selecting the cell at the intersection of the global stream's row and the meter's column.
 - Change the allocation of a global stream from one meter stream to another by selecting the cell that corresponds to the new meter stream.
 - Unallocate a global stream by clicking in the *N/A* column in the global stream's row.

Note: You cannot make changes to meter stream 1 for each meter (global streams 1 through 16 for the MVI56E-AFC or global streams 1 through 12 for the MVI69E-AFC).

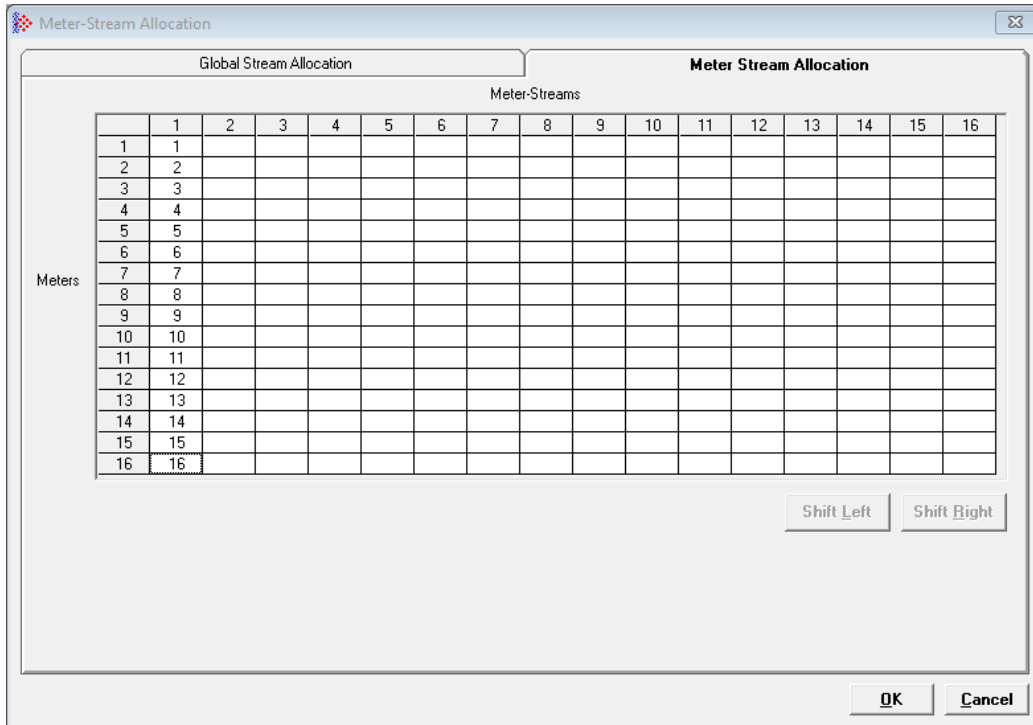
Note: Changes made on the *Global Stream Allocation* tab will be reflected on the *Meter Stream Allocation* tab as well.



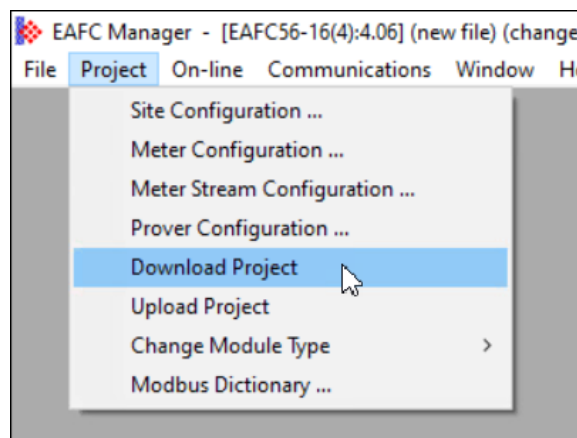
- 3 Select the *Meter Stream Allocation* tab. From this tab you can move a global stream to a different meter-stream position by selecting the stream and then selecting either **SHIFT LEFT** or **SHIFT RIGHT**.

Note: The first meter stream allocation for each meter (column 1) is fixed and cannot be shifted right. It is also not possible to shift a different global stream into the first column.

Note: Changes made to the allocation on the *Meter Stream Allocation* tab will be reflected on the *Global Stream Allocation* tab as well.



- 4 After completing your changes, select **OK**. This saves your changes to the local computer.
- 5 To download your changes to the module, select **PROJECT > DOWNLOAD PROJECT**.



31 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

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
+2L	By	Dly1	Delay before first data after CTS
+2H	By	Dly1	Delay after last data before ~RTS
+3	Wd		[reserved]

The CTS timeout and both delays are in units of 5 ms, 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 to 255 (where 0 implies the default of 10, that is, one second), and is significant only for the last port when configured as a Modbus master. The idle timeout is in minutes with valid values from 0 to 255 where 0 implies the default of 2, and causes a logout of a logged-in Modbus slave session that has remained idle for this period of time. The UART parameters and port options word is a bitmap:

Bit	Parameter	Value
bits 0 to 2	Baud	000: none; see below 001: 9600 baud 010: 19200 baud 111: 28800 baud 100: 38400 baud 101: 57600 baud 110: 115200 baud 111: 230400 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 role	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 2 for the bitmap (19200, N, 8, 1, RTU, slave, primary, noswap, passthru) and 0 for all timeouts and delays. The message transmission procedure is:

- Raise RTS
- If TmoC is zero ignore CTS, else wait up to TmoC (5 ms intervals) for CTS
- Delay for Dly1 (5 ms intervals)
- Transmit message
- Delay for Dly0 (5 ms intervals)
- Drop RTS

32 Product Group Standards

The *Product Group* represents what you are measuring (i.e., gas or liquid). The *Product Group* drop-down list allows you to select the appropriate *Product Group* for your application.

The screenshot shows the configuration interface for 'METER 1'. The 'Meter Tag' is 'M01'. The 'Meter Classification' section is expanded, showing a dropdown menu for 'Product group' with the following options: Gas (selected), Crude oils, JP4, NGLs, LPGs, Refined products (xJP4), Lubricating oils, Special applications, Oil-wtr emulsions (Crd), and Oil-wtr emulsions (NGL). Other sections include 'Select Meter' (Meter number 1), 'Meter Disabled', 'Copy Config From' (Meter number 1), 'Identification' (End of period 0:0), 'Physical Device' (Orifice plate (AGA 3 [2012])), and 'Reference Conditions'.

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

- For "Gas", the calculation uses AGA8 (with optionally ISO6976) and either AGA3 (optionally ISO5167-2) or AGA7 Standards.
- For hydrocarbon liquids, the calculation uses the MPMS Ch 11.
 - "Crude, JP4" uses the "A" tables.
 - "NGLs, LPGs" uses the "E" tables. 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.
 - Produced/Injected Water uses the water temperature correction of MPMS Ch 20.1

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 (with optionally ISO6976) and either AGA3 (optionally ISO5 167-2) or AGA7 Standards
Liquid (hydrocarbon)	MPMS Ch 11.
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 (All)
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 (All)
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). 	"A" tables (All)
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). 	"E" tables (All)
Refined Products <ul style="list-style-type: none"> ▪ Use for gasolines, jet fuels (except JP4), and fuel oils 	"B" tables (All)
Lubricating Oils	"D" tables (All)
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 (All)

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 (with optionally ISO6976) and either AGA3 (optionally ISO5 167-2)
Differential	Liquid	API2540, AGA3
Linear	Gas	AGA8, AGA7
Linear	Liquid	API2540, MPMS ch12.2

33 Important Information About Bogus IPs

Certain IPs are considered bogus by the module. A bogosity is the appearance of an IP whose value should not or must not appear in the context in which it appears.

For example, the Network interface configuration 192.168.0.255/24 is bogus because that IP is the broadcast address for its subnet and therefore should be unavailable for assignment as the host IP of a real interface. This configuration would result in failure.

A Modbus TCP/IP connection attempt must be made by a real host. A calling host IP of 0.0.0.0 is bogus because that IP is the network address of the host's subnet, regardless of the length of the network prefix.

The AFC module checks for, and appropriately handles these issues whenever they occur with the following aims:

- Maximize the likelihood of successful network configuration by strictly validating the configuration before attempting to apply it.
- Maximize security by refusing to accept connections that might be suspicious.

Certain IPs and ranges have special meanings. Almost all of these IPs are bogus in the AFC's Modbus TCP/IP environment:

- **0.0.0.0/0** - This range encompasses all IPs that can exist. That is, the entire IP4 universe. IP ranges are used in the AFC module when specifying whitelist entries. Depending on the remainder of the whitelist entry, an entry that specifies this range is either bogus or empty (unused).
- **0.0.0.0/32** - This single IP means the local network (all interfaces that can send packets to each other without having to be routed to a different network). This entry is bogus when it appears as the source IP in a Modbus TCP/IP connection attempt, and is therefore bogus when appearing as a whitelist entry.
- **255.255.255.255/32** - This single IP means the local network broadcast address (All interfaces that can be reached from the sending host without traveling through a router to a different network). This entry is bogus when it appears as a source IP in a Modbus TCP/IP connection attempt and is therefore bogus when appearing in a whitelist entry.
- **127.0.0.0/8** - IPs in this range are loopback IPs; a packet whose source or destination address is this range should never appear outside its host. The MVI56E-AFC does not implement Modbus TCP/IP client functionality. Therefore:
 - A connection attempt with a loopback source address occurs "on the wire" and is therefore bogus.
 - A Modbus TCP/IP server with a loopback network interface address cannot receive connection attempts and is therefore non-functional and treated as bogus.

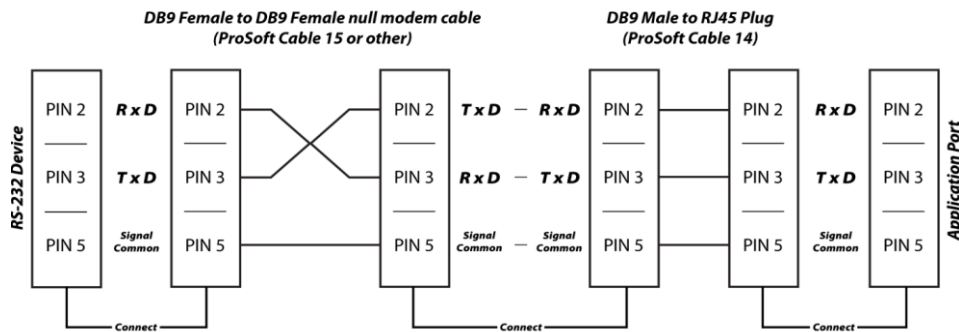
34 Cable Connections

The application ports on the AFC module support RS-232, RS-422, and RS-485 interfaces. Please inspect the module to ensure that the jumpers are set correctly to correspond with the type of interface you are using.

Note: When using RS-232 with radio modem applications, some radios or modems require hardware handshaking (control and monitoring of modem signal lines). Enable this in the configuration of the module by setting the *CTS Timeout* parameter to a non-zero value.

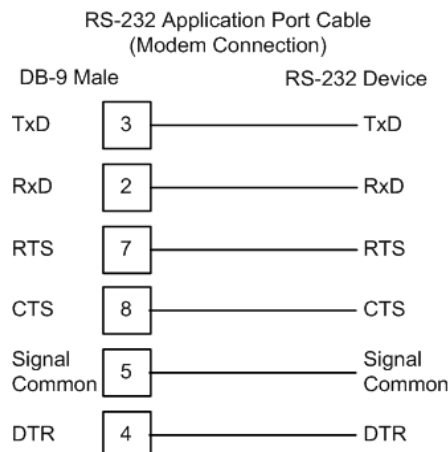
34.1 RS-232 Application Port(s)

When the RS-232 interface is selected, the use of hardware handshaking (control and monitoring of modem signal lines) is user definable. If no hardware handshaking will be used, here are the cable pinouts to connect to the port.



34.1.1 RS-232: Modem Connection (Hardware Handshaking Required)

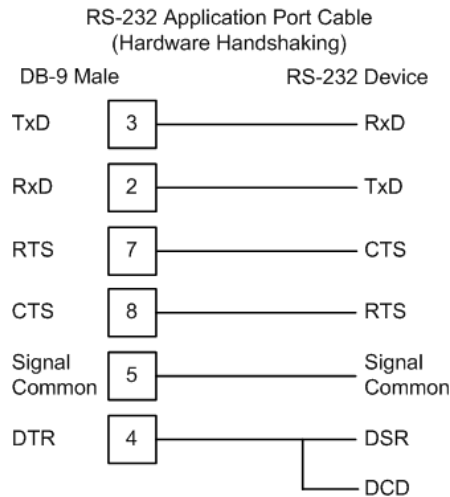
This type of connection is required between the module and a modem or other communication device.



The *CTS timeout* parameter for the port configuration should be set to a non-zero value for most modem applications.

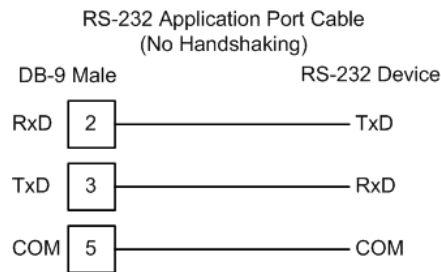
34.1.2 RS-232: Null Modem Connection (Hardware Handshaking)

This type of connection is used when the device connected to the module requires hardware handshaking (control and monitoring of modem signal lines).

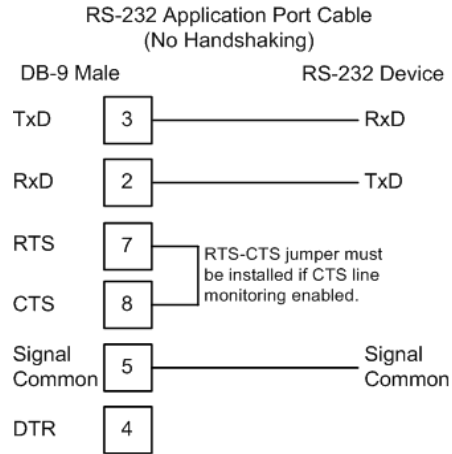


34.1.3 RS-232: Null Modem Connection (No Hardware Handshaking)

This type of connection can be used to connect the module to a computer or field device communication port.

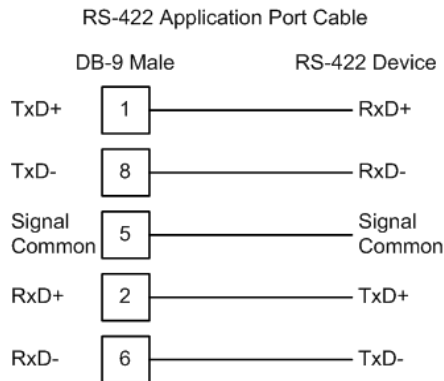


Note: For most null modem connections where hardware handshaking is not required, the *CTS Timeout* parameter should be set to **0** and no jumper will be required between Pins 7 (RTS) and 8 (CTS) on the connector. If the port is configured with the *CTS Timeout* set to a **NON-ZERO VALUE**, then a jumper is required between the RTS and the CTS lines on the port connection.



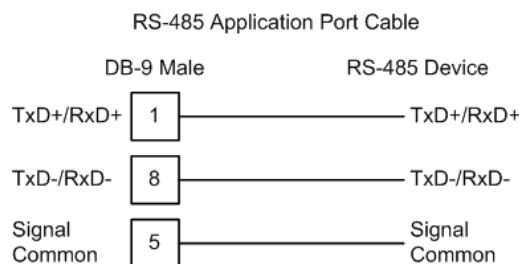
34.2 RS-422 Application Port(s)

The RS-422 interface requires a single four or five wire cable. The Common connection is optional, depending on the RS-422 network devices used. The cable required for this interface is shown below:



34.3 RS-485 Application Port(s)

The RS-485 interface requires a single two or three wire cable. The Common connection is optional, depending on the RS-485 network devices used. The cable required for this interface is shown below:

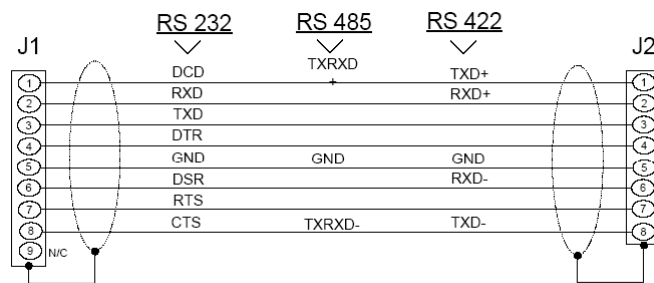
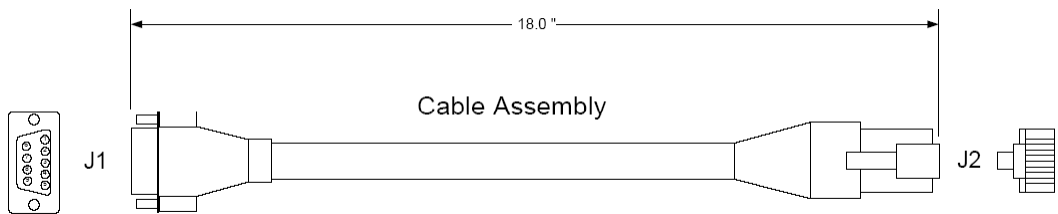


Note: Terminating resistors are generally not required on the RS-485 network, unless you are experiencing communication problems that can be attributed to signal echoes or reflections. In these cases, installing a 120-ohm terminating resistor between pins 1 and 8 on the module connector end of the RS-485 line may improve communication quality.

RS-485 and RS-422 Tip

If communication in the RS-422 or RS-485 mode does not work at first, despite all attempts, try switching termination polarities. Some manufacturers interpret + and -, or A and B, polarities differently.

34.4 DB9 to RJ45 Adaptor (Cable 14)



Wiring Diagram

35 Support, Service & Warranty

35.1 Contacting Technical Support

ProSoft Technology, Inc. is committed to providing the most efficient and effective support possible. Before calling, please gather the following information to assist in expediting this process:

- Product Version Number
- System architecture
- Network details

If the issue is hardware related, we will also need information regarding:

- Module configuration and associated ladder files, if any
- Module operation and any unusual behavior
- Configuration/Debug status information
- LED patterns
- Details about the interfaced serial, Ethernet or Fieldbus devices

Note: For technical support calls within the United States, ProSoft Technology's 24/7 after-hours phone support is available for urgent plant-down issues.

North America (Corporate Location)	Europe / Middle East / Africa Regional Office
Phone: +1.661.716.5100 info@prosoft-technology.com Languages spoken: English, Spanish REGIONAL TECH SUPPORT support@prosoft-technology.com	Phone: +33.(0)5.34.36.87.20 france@prosoft-technology.com Languages spoken: French, English REGIONAL TECH SUPPORT support.emea@prosoft-technology.com
Latin America Regional Office	Asia Pacific Regional Office
Phone: +52.222.264.1814 latinam@prosoft-technology.com Languages spoken: Spanish, English REGIONAL TECH SUPPORT support.la@prosoft-technology.com	Phone: +60.3.2247.1898 asiapc@prosoft-technology.com Languages spoken: Bahasa, Chinese, English, Japanese, Korean REGIONAL TECH SUPPORT support.ap@prosoft-technology.com

For additional ProSoft Technology contacts in your area, please visit:
www.prosoft-technology.com/About-Us/Contact-Us.

35.2 Warranty Information

For complete details regarding ProSoft Technology's TERMS & CONDITIONS OF SALE, WARRANTY, SUPPORT, SERVICE, and RETURN MATERIAL AUTHORIZATION INSTRUCTIONS, please see the documents at:
www.prosoft-technology.com/legal

Documentation is subject to change without notice.