Quantum
Liquid Turbine/Positive Displacement (PD) Programmable Controller Flow Computer (PCFC) Loadable Function Block User Guide

890 USE 140 00 Version 1.0

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Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

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DANGER

DANGER indicates an imminently hazardous situation, which, if not avoided, **will result** in death, serious injury, or equipment damage.

WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

PLEASE NOTE

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About the Book

At a Glance

Document Scope

As a user's reference guide, this manual is for an advanced audience with knowledge of liquid flow measurement technology. Different levels of user knowledge are considered in this manual to make it available for all users. Neither knowledge of flow measurement nor expertise in PLC programming is needed to use the PCFC block. However, there are certain features that require some level of advanced knowledge of liquid flow measurement or PLC programming.

Validity Note

The data and illustrations found in this book are not binding. We reserve the right to modify our products in line with our policy of continuous product development. The information in this document is subject to change without notice and should not be construed as a commitment by Schneider Electric.

Software License

The loadable is a single-use software license.

Related Documents

Title of Documentation	Reference Number
Quantum Automation Series Hardware Reference Guide	840USE10000
Concept User Manual Version 2.5 - SR2	840USE49311
Modicon A120 Series I/O Modules User Guide	890USE10900
ProWORX NxT User's Guide, Version 2.10	372SPU68001
ProWORX32 Programming Software for PLCs User Guide	372SPU78001
Spectrum Controls Counter/Flow Meter Input Module Installation Instructions	0300185-01 Rev. A

Product Related Warnings

Schneider Electric assumes no responsibility for any errors that may appear in this document. If you have any suggestions for improvements or have found errors in this publication, please notify us.

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When controllers are used for applications with technical safety requirements, please follow the relevant instructions.

Failure to use Schneider Electric software or approved software with our hardware products may result in improper operating results.

Failure to observe this product related warning can result in injury or equipment damage.

User Comments

We welcome your comments about this document. You can reach us by e-mail at TECHCOMM@modicon.com

Part I
Introduction to Liquid Flow Principles and Hardware

I

At a Glance

Purpose

This unit presents an overview of liquid flow principles and details the Quantum hardware designed for use where the API 21.2 Audit Trail formatting standard is needed.

What's in this Part?

This part contains the following chapters:

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1. Overview of the Programmable Controller Flow Computer

1

1.1. Overview

1.1.1. PLC-Based Flow Computer

Extend a PLC’s functionality by adding Loadable Function Blocks to the 984 Ladder Logic instruction set. Loadables cannot be modified, but they can be configured for specific applications.

The PCFC loadable function block ("PCFC") embeds a virtual Liquid Flow Computer (designed to the API 2540 standard) into the PLC environment, creating a PLC-based Liquid Flow Computer. The PCFC meters hydrocarbon liquids by using software (Loadable) and hardware (PLC and special I/O). Use the PCFC for volume corrections, meter proving and data logging/reporting.

The hardware provides an interface to devices such as positive displacement meters, turbine meters, densitometers, temperature transducers, and pressure transducers.

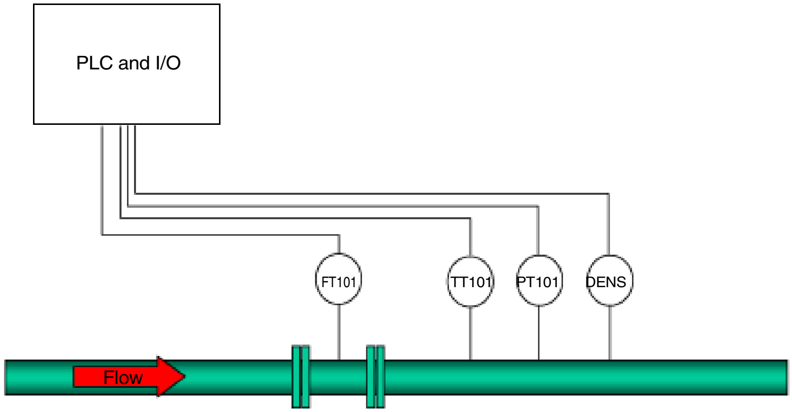
1.1.2. Product Volume Measurement Capabilities

The PCFC can be used to measure the volume for the following types of hydrocarbon products:

Table 5A, 23A, 53A and 6A, 24A, 54A Generalized Crude Oil	
Table 5B, 23B, 53B and 6B, 24B, 54B Generalized Products:	
0 API and 37 API RD 1.7600 to .8398	#6 fuel oil heating fuel premium diesel fuel oil PA fuel oils LLS LT fuels oil fuel oil low sulphur fuel #2 furnace oil furnace oil auto diesel diesel fuel gas oil #2 burner fuel
37 API and 50 API RD .8399 to .7796	jet fuel A jet kerosene aviation jet A kerosene aviation turbine fuel stoddard solvent white kerosene
50 API to 85 API RD .7797 to .6536	premium gas gasoline unleaded gasoline motor spirit clear gasoline low lead gas motor gasoline catalyst gas alkylate catalytic cracked gasoline
Table 5D, 23D, 53D and 6D, 24D, 54D Lubrication Products	
Table 23E and Table 24E for NGLs/LPGs Imperial	
Table 53 and Table 54 for NGLs/LPGs Metric	

1.1.3. Flow Measurement Application: Single Run

The following diagram shows a "single run" flow measurement application.



FT101 Flow Transducer (primary element)

TT101 Temperature Transducer

PT101 Pressure Transducer

DENS Densitometer

In the preceding diagram, the Flow Transducer (FT101) produces a signal, which feeds directly to the turbine meter card (AC/VCR) or is converted by a signal conditioner (pre-amp).

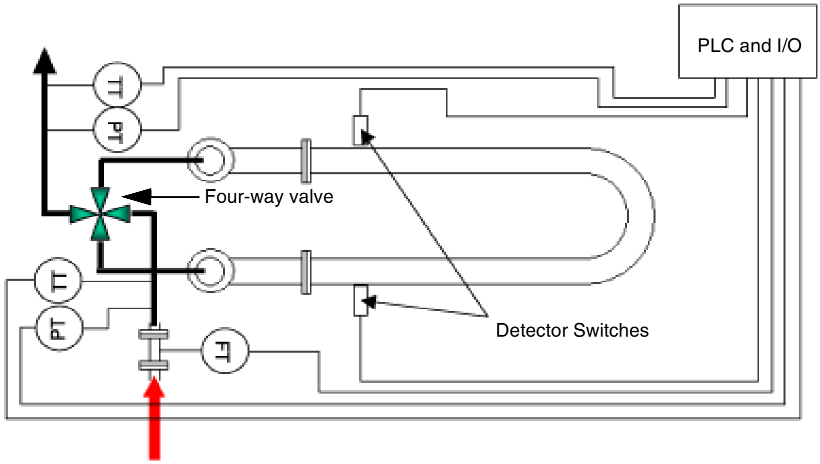
The turbine meter card accumulates the pulses both for real-time process of the flow and for system analysis (events and alarms). Process variables (temperature, pressure, and density) are collected in real-time and made available to the PLC Flow Computer. The system provides both the pulses and process variables to the PLC Flow Computer, which uses the data for real-time flow and volume corrections for both pressure and temperature compensation.

Enter the data from any one of these process variables either manually through a human-machine interface (HMI), communication port, or analog signal. Produce reports (batch end and timed) using a communications protocol (Modbus, ASCII, or another). Reports may be stored and then retrieved.

Configure (program) the PCFC with user selections, either SCADA host, HMI/ graphics display, Web pages in the 140 NOE 771 10, or PLC programming software.

1.1.4. Flow Measurement Application: Single Run with Meter Proving

The following diagram shows a simple flow measurement application with meter proving.



FT Flow Transducer (primary element)

PT Pressure Transducer

TT Temperature Transducer

In the preceding diagram, the Flow Transducer (FT) produces a signal, which feeds directly to the turbine meter card (AC/VCR) or is converted by a signal conditioner (pre-amp).

The turbine meter card accumulates the pulses both for real-time process of the flow and for system analysis (events and alarms).

The turbine meter card has prover switches (unidirectional and bidirectional). The prover switches wait for the proving run to be armed with a detector switch. Once armed, the prover accumulator counts the pulses to the next detector switch. (The pulse interpolation method for pulse fidelity is available on select cards only.)

Process variables (temperature, pressure, and density) are collected in real-time and made available to the PLC Flow Computer. The system provides pulses and process variables for real-time flow and volume corrections (pressure and temperature compensation).

1.1.5. PLC Liquid Flow Features Table

The following table describes the PLC's liquid flow functions.

To perform	Use		
Feature	**Function Block**	**PLC Hardware**	**I/O Hardware**
• Simple Flow Measurement (16 Runs total) • Reports and Data Logging	PCFC and TMCI (Minimum 16k PLC memory)	Quantum 140 CPU 113 0X 140 CPU 434 12A 140 CPU 534 14A	Quantum 140 EHC 204 00sc (4 CH) 140 EHC 208 00sc (8 CH) (VRC, 5, 12, 24 VDC)
• Flow Measurement with Meter Proving (16 Runs Total No Pulse Fidelity) • Large and Small volume proving (Double Chronometry) • Pulse Fidelity • Reports and Data Logging	PCFC and TMCI (Minimum 16k PLC memory)	Quantum 140 CPU 113 0X 140 CPU 434 12A 140 CPU 534 14A	Quantum 140 MPM 204 00sc (4 CH)

Note: Number of runs and the choice of proving or reporting may impact the total number of runs that a system can support.

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2. Turbine Meter Flow Module

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At a Glance

Purpose

This material provides a description of the turbine meter flow card that can be used with the Quantum PLC. This information is provided to help a user or programmer select, configure, and install the turbine meter flow modules. Wiring diagrams of the applicable Quantum modules are included.

What's in this Chapter?

This chapter contains the following topics:

2.1. Flow Measurement Cards—Quantum

2.1.1. Overview

The Quantum flow measurement cards include:
- 140 EHC 204 00sc
- 140 EHC 208 00sc

These Quantum cards are obtained from Spectrum Controls, a Schneider alliance partner.

2.1.2. Quantum Configuration

Configure these Quantum cards with the Spectrum Controls SCIOCFG.EXE utility. See the Spectrum SCIOCFG installation documentation and other applicable configuration documents for information about installing and using Spectrum modules. The Spectrum utility and documentation is included on a floppy and ships with each module.
The following default settings are for the Quantum 140 EHC 204 00sc and 140 EHC 208 00sc modules.

Configuration Variable	**Value**
Input Range	Select valid range for application. For instance, AC for direct to turbine; and 5, 12, and 24 VDC for pre-amp (all channels)
Counter Mode*	Uni-Directional (All channels)
Counter Size*	24 bit 16M (All channels)
Rate Scale*	0.1Hz (All channels)
Filters	Select valid range for application. For instance, 30Khz Digital filter for noisy DC input voltages and 15Khz Analog for AC inputs.
Autocycle Delay Time*	0 (must be set to zero)
*These values must be set to the default values shown.	

Note: The values listed for Input Range, Counter Mode, Counter Size, and Rate Scale must be set for all channels.

For more detailed information on Spectrum Controls' modules, check the URL:
`http://www.spectrumcontrols.com/schneider.html`

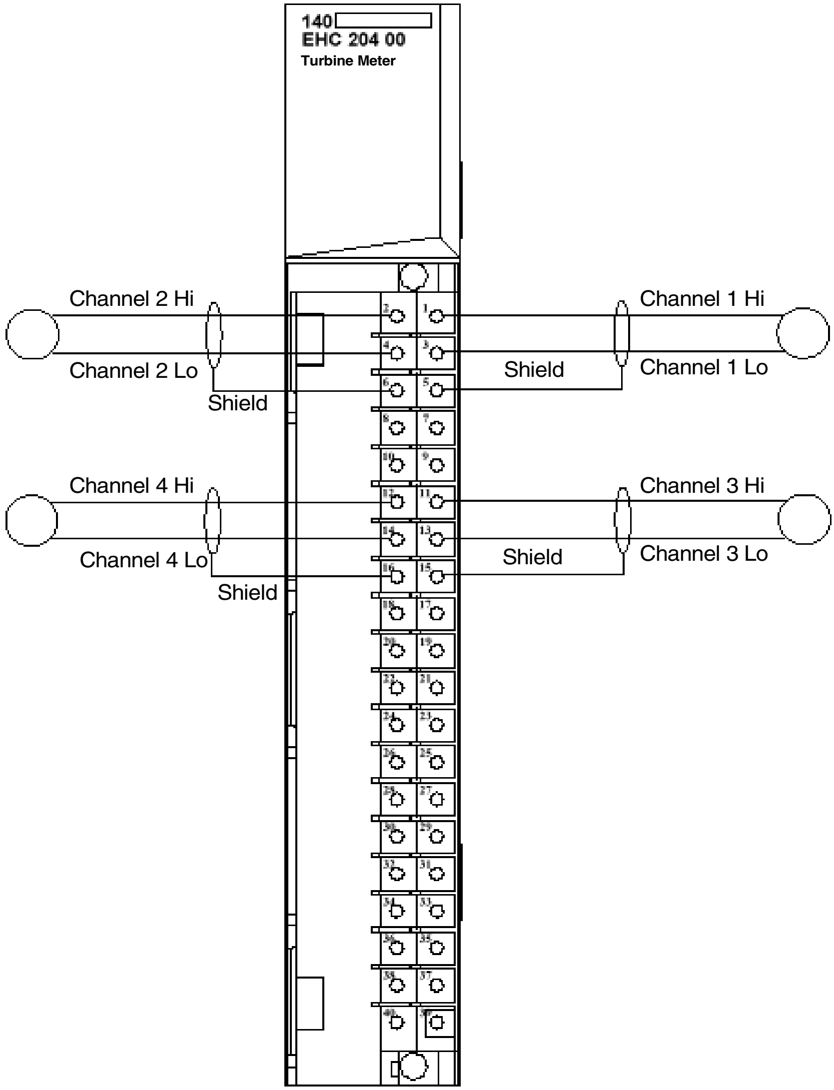
2.1.3. Specifications

The following table provides the specifications for the 140 EHC 204 00sc and 140 EHC 208 00sc cards.

Characteristic	**4 channel/8 channel**
Number of Channels	4/8 channels of counter inputs 4/8 input enable and gate control lines
Input Registers Required	9/9
Output Registers Required	6/10
LEDs	7/11: one each for Ready, Active, Fault, Channel
Input Modes	DC counter, AC flow meter
Counter Speed	● 50 kHz maximum
Input Frequency	● 50 kHz maximum
Minimum Pulse Time ● DC Mode ● External Enable/DIsable and Gate Input (Meter Proving)	 ● 10 microseconds ● Enable and disable setup time = 10 microseconds
Accuracy ● Counter Mode ● Frequency Instantaneous Mode	 ● +/-1 count ● 0.8% @ 50 kHz 0.1 Hz resolution
Count Value Range	Low range 64K. Extended range 16M.
Nominal Input Impedance	15K ohms
Counter Voltage Input	Programmable: AC; and 5, 12, 24 VDC
Channel Update Time ● Without scaling ● With Scaling	 ● <1 ms per channel ● <1.5 ms per channel
Power Dissipation	4.1/6.6 watts (maximum)
Backplane Current Draw	470 mA/670 mA @ 5V (maximum)
Isolation Voltage	1000 VDC wiring to backplane/chassis to ground
Environmental Conditions ● Operational Conditions ● Storage Temperature ● Relative Humidity	 ● 0 to 60 degrees C (32 to 140 degrees F) ● -40 to +85 degrees C (-40 to 185 degrees F) ● 5 to 95% (non-condensing)
Certifications	UL/cUL (Class I, Div. 2, Groups A, B, C, D) CE per Council Directive 89/336/EEC for EMC

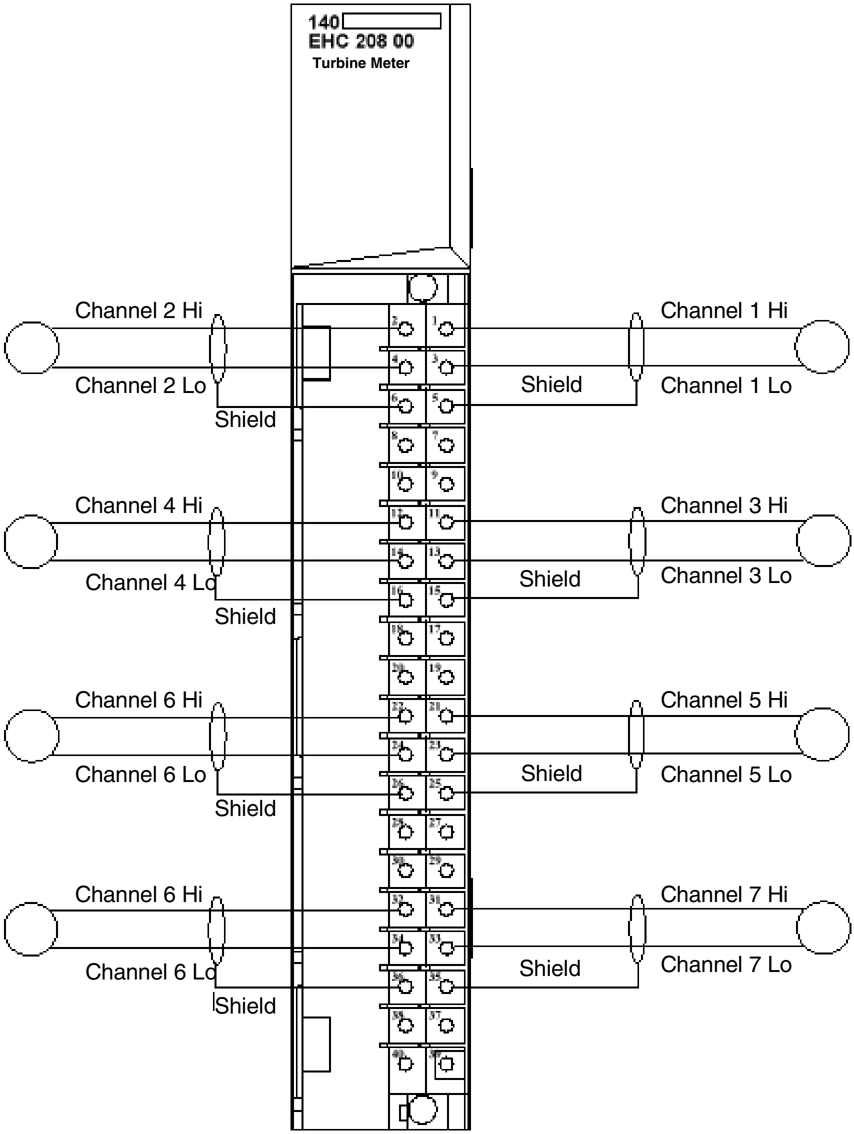
2.1.4. Flow Measurement Card 140 EHC 204 00sc: Wiring Diagram

The following illustration provides the wiring diagram for the flow measurement card 140 EHC 204 00sc.



F2.1.5. low Measurement Card 140 EHC 208 00sc: Wiring Diagram

The following illustration provides the wiring diagram for the flow measurement card 140 EHC 208 00sc.



2.2. Meter Proving Card—Quantum 140 MPM 204 00sc

2.2.1. Overview

The Quantum meter proving card is

- 140 MPM 204 00sc

The card is a 4-channel meter-proving/flow-meter module. The card can be used to perform chronometry calculations. This module is one of the optional modules that can be used on a Quantum PLC system, comprised of a Quantum module and loadable software. This module will perform functions traditionally performed by standalone flow computers, but with all the advantages of a PLC.
The module has four signal inputs and four detector switch inputs for ball detectors. It supports:

- pulse interpolation method double chronometry per API 2540 specifications (*Manual of Petroleum Measurement Standards*, Chapter 4, Section 6)
- pulse fidelity per API 2540 specifications (*Manual of Petroleum Measurement Standards*, Chapter 5, Section 5, to level B).

2.2.2. Quantum Meter Proving Card Required Configuration Settings

The following values can be used for the 140 MPM 204 00sc.

Configuration Variable	**Value**
Input Voltage Ranges	Select valid range for application. For instance, AC for direct to turbine and 5, 12, and 24 VDC for pre-amp. A value must be selected for each channel.
Gate Voltage Range	Select valid range for the prover detector switches. A value must be selected for each channel where meter proving will be used.
Filters	Select valid range for application. For instance, 30Khz Digital filter for noisy DC input voltages and 15Khz analog for AC inputs.
Counter Size*****	24 bit 16M. Must set for all channels.
Signal Timeout	Select valid range for the frequency readout zeroing. This is for the slower meter frequencies when the frequency range of the meter is known. A reading time-out in seconds is applied and the meter frequency reading (*Contents: 4x + 34 ... 35 Field (RD, FLOAT), p. 87*) is zeroed out (set to zero) so the pipeline will not appear to be flowing when it has already stopped and is waiting for the Max Frequency Timeout. For instance, with a meter frequency of 1 pulse every 1 minute set value to 61 to 65 seconds.
Autocycle Delay Time*****	0 (must be zero)
*****These values must be set to default values shown.	

Note: The values listed for Autocycle Delay Time and Counter Size must be set for all channels. Also, the value for Gate Voltage Rating must be set in channels where meter proving will be used.

2.2.3. Specifications

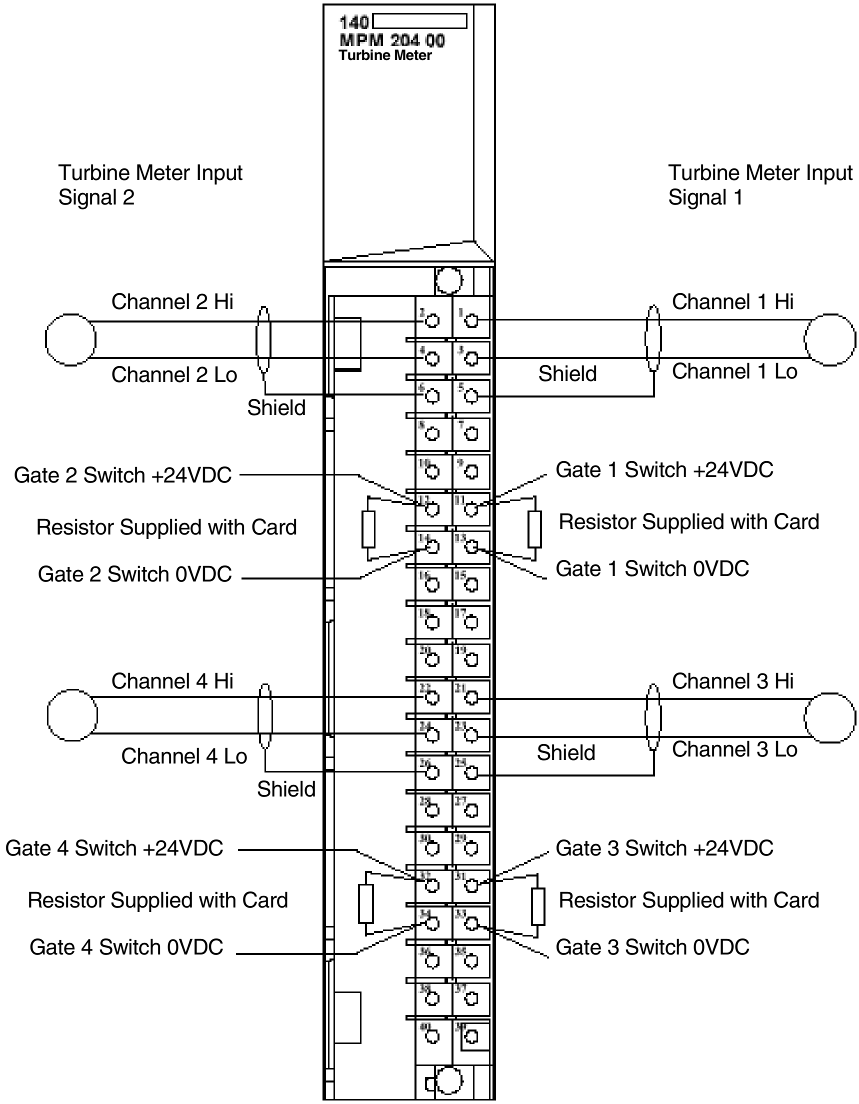
The following table provides the specifications of the 140 MPM 204 00sc:

Characteristic	Value
Number of Input Channels	4
Number of External Counter Enable Inputs	4
Input Registers Required	11
Output Registers Required	6
LEDs	11: Ready, Active, Fault, and Channel Status (8 LEDs)
Input modes	DC Counter, AC Flow Meter
Input Voltage Ranges	AC (50mVP – 75VP); 5, 12, 24 VDC
Enable Input	5 VDC (will also work with 12 and 24 VDC inputs)
Input Frequency	50 Khz maximum
Minimum Pulse Time ● DC Mode ● External Enable/Disable and Gate Input (Meter Proving)	 ● 10 microseconds ● Enable and disable setup time in 10 microseconds
Accuracy ● Counter Mode ● Frequency Instantaneous Mode	 ● +/-1 count ● 0.8% @ 50 kHz (0.1 Hz resolution)
Count Value Range	Low range 64k, Extended range 16 M
Programmable Scaling	K, M, and R factor
Channel Update Time ● without scaling ● with scaling	 ● < 1 ms per channel ● < 1.5 ms per channel
Output modes	frequency, counter
Programmable Counter Functions	start/stop/preset
Alarm and Zero Flags	Programmable counter alarm flags and zero flags in counter and frequency modes
Software-selectable filters	30 Khz digital, 15 Khz analog
Channel-to-backplane isolation	1000 VDC
Channel-to-channel isolation	0 V
Power Dissipation	6.6 Watts (maximum)
Backplane Current Draw	670 mA @ 5 V (maximum
Environmental Conditions ● Operational Conditions	 ● 0 to 60 degrees C (32 to 140 degrees F

Characteristic	Value
• Storage Temperature • Relative Humidity	• -40 to +85 degrees C (-40 to 185 degrees F • 5 to 95% (non condensing)
Certifications	UL/cUL (Class I, Div. 2, Groups A, B, C, D) CE per council Directive 89/336/EEC for EMC

2.2.4. Wiring Diagram (140 MPM 204 00sc Meter Proving Card)

The following illustration provides the wiring diagram for the 140 MPM 204 00sc:



Part II Standard Metering and Meter Proving

II

At a Glance

Purpose

This unit describes the function blocks used for standard metering and standard proving.

What's in this Part?

This part contains the following chapters:

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3. TMCI Function Block

3

At a Glance

Purpose

This chapter describes the structure representation, operation, and configuration of the TMCI function block.

What's in this Chapter?

This chapter contains the following sections:

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3.1 TMCI Representation and Operation

At a Glance

Purpose

This section describes the block structure representation and operation of the turbine meter card interface (TMCI) loadable.

What's in this Section?

This section contains the following topics:

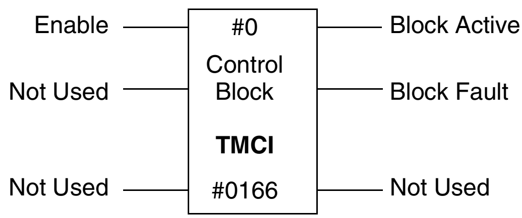
3.1.1. TMCI Function Block Structure

3.1.1.1. Overview

The TMCI is a 984 Ladder Logic loadable that manages communication between the PCFC and the turbine meter module. The block requires 165 registers. Only one is needed for communicating with the 16 PCFC blocks that can be configured.

3.1.1.2. Block Structure Diagram

The block structure is illustrated below.



3.1.1.3. Inputs

The TMCI has three control inputs:
- **Top** input node enables the function block.
- **Middle** is not used.
- **Bottom** is not used.

3.1.1.4. Outputs

The TMCI has three possible outputs.
- **Top** output is a copy of the top node input.
- **Middle** output turns ON when the function block has detected an error.
- **Bottom** is not used.

3.1.1.5. Top Node Content

The top node must contain a constant value of #0.

3.1.1.6. Middle Node Content

The 4x register entered in the middle node is the first of 166 contiguous holding registers that comprise the control block.

3.1.1.7. Bottom Node Content

The bottom node must contain a constant (#0166) representing the length of the control block in registers.

3.1.2. TMCI Operation

3.1.2.1. TMCI Block

The PLC program can have only one TMCI block. Place the TMCI block to be scanned before all the PCFC blocks that occur in logic.

Note: If there is NO TMCI "0" block, or more than one TMCI block, either the blocks will not be scanned or they will not operate.

3.2 TMCI Configuration

At a Glance

Purpose

This section describes the configuration registers of the TMCI function block.

What's in this Section?

This section contains the following topics:

3.2.1. TMCI Register Summary

3.2.1.1. Overview

The following material provides a summary of the TMCI function block registers. For a description of the abbreviations and terms used in register descriptions, see the *Glossary, p. 265*.

Note: Writing to read (RD) registers can cause inaccurate results or one of the following behaviors: (1) the controller does not work, (2) the controller locks up, or (3) a function block will not work. To prevent this situation, do NOT write to read (RD) registers. Writable registers (**WR**) are marked in **bold**.

3.2.1.2. Summary: TMCI Setup and Diagnostic Data Registers

The following table summarizes the set of TMCI registers that contain setup and diagnostic data.

Register	Access	Data Type	Comment
4x + 0	RD	HEX	Revision (X.XX)
4x + 1	**WR**	BIN	Command Word 1
4x + 2	RD	BIN	Fault Word 1

For more information about the setup and diagnostic registers 4x + 0, +1, see *TMCI Setup and Diagnostic Data (4x + 0; +1, Revision Number and Command Word 1) Registers, p. 39*.

3.2.1.3. Summary: TMCI Meter Card One Registers

The following table summarizes the set of TMCI registers that contain meter card one data.

Register	Access	Data Type	Comment
4x +3	**WR**	UINT	Meter card type
4x +4	**WR**	UINT	Meter card starting 3x input register For 300123 enter "123"
4x +5	**WR**	UINT	Meter card starting 4x output register For 400123 enter "123"

3.2.1.4. Summary: TMCI Meter Card Two Registers

The following table summarizes the set of TMCI registers that contain meter card two data.

Register	Access	Data Type	Comment
4x +6	**WR**	UINT	Meter card type
4x +7	**WR**	UINT	Meter card starting 3x input register For 300123 enter "123"
4x +8	**WR**	UINT	Meter card starting 4x output register For 400123 enter "123"

3.2.1.5. Summary: TMCI Meter Card Three Registers

The following table summarizes the set of TMCI registers that contain meter card three data.

Register	Access	Data Type	Comment
4x +9	**WR**	UINT	Meter card type
4x +10	**WR**	UINT	Meter card starting 3x input register For 300123 enter "123"
4x +11	**WR**	UINT	Meter card starting 4x output register For 400123 enter "123"

3.2.1.6. Summary: TMCI Meter Card Four Registers

The following table summarizes the set of TMCI registers that contain meter card four data.

Register	Access	Data Type	Comment
4x +12	**WR**	UINT	Meter card type
4x +13	**WR**	UINT	Meter card starting 3x input register For 300123 enter "123"
4x +14	**WR**	UINT	Meter card starting 4x output register For 400123 enter "123"
4x +15	**WR**	UINT	Zero Flow Reading Timer

Note: Registers 4x + 16 through 4x + 165 are reserved for system use.

3.2.2. TMCI Setup and Diagnostic Data (4x + 0; +1, Revision Number and Command Word 1) Registers

3.2.2.1. Overview

The following material provides a detailed description of the content for each TMCI function block register.

3.2.2.2. Contents: 4x + 0 Register (RD, HEX)

TMCI Revision Number (X.XX)
Displays current function block revision number. Format is (X.XX).
For example, hex 0100 indicates revision 1.0.

3.2.2.3. Bit Summary: 4x + 1 Register (WR, BIN)

Command Word 1
This register contains specific user-entered commands

Bit	Description	Bit	Description
1 MSB	Card One Select	9	Reserved for system use
2	Card Two Select	10	Reserved for system use
3	Card Three Select	11	Reserved for system use
4	Card Four Select	12	Reserved for system use
5	API Audit Trail	13	Reserved for system use
6	Reserved for system use	14	Reserved for system use
7	Reserved for system use	15	Reserved for system use
8	Reserved for system use	16	Reserved for system use

3.2.2.4. Bit Contents: 4x + 1 Register (WR, BIN)

Detailed bit descriptions of command word 1:

Bit(s)	Description
Bit 1	**Card One Select** If Bit 1 is ON, there is a physical card to be scanned. If Bit 1 is OFF, the block is disabled. **Note:** There must be at least one card configured; if there is only one card, it must be the first card.
Bit 2	**Card Two Select** If Bit 2 is ON, and Bit 1 (Card One Select) is also on, then there is a physical card to be scanned. If Bit 2 is OFF, then no card is scanned for logical card two.
Bit 3	**Card Three Select** If Bit 3 is ON, and Bit 2 (Card Two Select) is also on, then there is a physical card to be scanned. If Bit 3 is OFF, then no card is scanned for logical card three.
Bit 4	**Card Four Select** If Bit 4 is ON, and Bit 3 (Card Three Select) is also on, then there is a physical card to be scanned. If Bit 4 is OFF, then no card is scanned for logical card four.
Bit 5	**API Audit Trail** This bit is used for the API 21.2 Audit Trail. If ON and the AUDT block is configured, the TMCI block will be locked down immediately. No changes can be made to the configuration. If there is no AUDT block or AUDT is not configured, this bit will reset. **Note:** Schneider Electric recommends that you set up all configurations before turning this bit ON. See the *AUDT Function Block , p. 143* for further explanation of API 21.2 Audit functions.
Bit 6	Reserved for system use
Bit 7	Reserved for system use
Bit 8	Reserved for system use
Bit 9	Reserved for system use
Bit 10	Reserved for system use
Bit 11	Reserved for system use
Bit 12	Reserved for system use
Bit 13	Reserved for system use
Bit 14	Reserved for system use
Bit 15	Reserved for system use
Bit 16 (LSB)	Reserved for system use

Note: Reminder
- Card one must always be configured, even if no other cards are configured.
- Each configured card must immediately follow the previous configured card
- There can be no unconfigured cards between configured cards.
- Unconfigured cards can occur only after all configured cards.

3.2.3. TMCI Setup and Diagnostic Data (4x + 2, Fault Word 1) Register

3.2.3.1. Bit Summary: 4x + 2 Register (RD, BIN)

Fault Word 1
Each bit in this word represents a particular fault that the function block has detected. The following table summarizes the bits in the fault word (details follow):

Bit	Description	Bit	Description
1 MSB	Card One Invalid	9	Bottom Node Invalid
2	Card Two Invalid	10	Invalid Card Configuration
3	Card Three Invalid	11	Reserved for system use
4	Card Four Invalid	12	Reserved for system use
5	Invalid Card Type	13	Reserved for system use
6	Invalid Card 3x Register	14	Reserved for system use
7	Invalid Card 4x Register	15	Reserved for system use
8	Top Node Invalid	16	Reserved for system use

3.2.3.2. Bit Contents: 4x + 2 Register (RD, BIN)

The following table provides detailed descriptions of the bits in the fault word:

Bit(s)	Description
Bit 1	**Card One Invalid** Bit 1 is turned ON when the configuration for Card One is invalid. When this bit is set, a corresponding error flag will denote the specific error.
Bit 2	**Card Two Invalid** Bit 2 is turned ON when the configuration for Card Two is invalid. When this bit is set, a corresponding error flag will denote the specific error.
Bit 3	**Card Three Invalid** Bit 3 is turned ON when the configuration for Card Three is invalid. When this bit is set, a corresponding error flag will denote the specific error.
Bit 4	**Card Four Invalid** Bit 4 is turned ON when the configuration for Card Four is invalid. When this bit is set, a corresponding error flag will denote the specific error.
Bit 5	**Invalid Card Type** Bit 5 is turned ON when an invalid card type has been entered into the "card type" field. An error flag will be set that denotes the card in which the fault occurred.
Bit 6	**Invalid Card 3x Register** Bit 6 is turned ON when an invalid pointer to the Traffic Cop 3x register for the Card has been entered. An error flag will be set that denotes the card in which the fault occurred.
Bit 7	**Invalid Card 4x Register** Bit 7 is turned ON when an invalid pointer to the Traffic Cop 4x register for the Card has been entered. An error flag will be set that denotes the card in which the fault occurred.
Bit 8	**Top Node Invalid** Bit 8 is turned ON when the value in the top node of the block is not "0". **Note:** Only one instance of the block is allowed in logic.
Bit 9	**Bottom Node Invalid** Bit 9 is turned ON when the value in the bottom node of the block is not valid (See Number of Block Register Required). **Note:** Only one instance of the block is allowed in logic.
Bit 10	**Invalid Card Configuration** Bit 10 is turned ON when: ● Meter Card One is not configured, or ● There is an unconfigured meter card in between configured cards. For instance, when Card One and Card Three are configured but Card Two is not configured. See the reminder note following this table.
Bit 11	Reserved for system use
Bit 12	Reserved for system use

Bit(s)	Description
Bit 13	Reserved for system use
Bit 14	Reserved for system use
Bit 15	Reserved for system use
Bit 16 (LSB)	Reserved for system use

Note: Reminder
- Card one must always be configured, even if no other cards are configured.
- Each configured card must immediately follow the previous configured card
- There can be no unconfigured cards between configured cards.
- Unconfigured cards can occur only after all configured cards.

3.2.4. TMCI Meter Card Registers

3.2.4.1. Contents: 4x + 3, 6, 9, 12 Registers (WR, UINT)

Meter Card Type

These multiple register fields contain data about the meter cards used.
There are three meter modules for the Quantum line; each module has a different functionality.
Valid choices for the Quantum platform are

Module	Number of Channels	TMCI Meter Card Type Register Contents
140 EHC 204 00	4 channel	204
140 EHC 208 00	8 channel	208
140 MPM 204 00	4 channel	2041

3.2.4.2. Possible Card Combinations

The system can handle a maximum of four cards with four channels each, or two cards with eight channels each. Any combination is allowed. Combinations are not to exceed 16 channels.

	Logical Card				
	1	**2**	**3**	**4**	
					Examples of Module Combinations
Possible Card Channel Combinations	4	4	4	4	*
	8	8	-	-	(2) 140EHC20800
	4	8	4	-	*
	8	4	4	-	*
	4	4	8	-	Four possible combinations exist **1.** (1) 140MPM20400; (1) 140EHC20400; (1) 140EHC20800; or **2.** (1) 140EHC20400; (1) 140MPM20400; (1) 140EHC20800; or **3.** (2) 140MPM20400; (1) 140EHC20800; or **4.** (2) 140EHC20400; (1) 140EHC20800
*Example not provided					

3.2.5. TMCI and Quantum Functionality Chart

3.2.5.1. Meter Modules Functionality Chart: Quantum Platform

The following Quantum modules are available for performing metering tasks using the TMCI loadable function block.

TMCI functions on the Quantum platform:

Part Number	Description of Module Function
140 EHC 204 00	Four channel inputs allow for direct input from turbine meter/PD meter (mV "VRC", 5 VDC, 12 VDC, and 24 VDC). Inputs are field-selectable per channel pairs. Frequency ranges from 50 Khz to .8 Hz. Module can reside in local or remote drops.
140 EHC 208 00	Eight channel inputs allow for direct input from turbine meter/PD meter (mV "VRC", 5 VDC, 12 VDC, and 24 VDC). Inputs are field-selectable per channel pairs. Frequency ranges from 50 Khz to .8Hz. Module can reside in local or remote drops
140 MPM 204 00	Four channel inputs allow for direct input from turbine meter (mV "VRC", 5 VDC, 12 VDC, and 24 VDC). Inputs are field-selectable per channel pair. Frequency ranges from 50 Khz to 1 pulse every two minutes. Module can reside in local or remote drops. Zero-flow timer allows an adjustable time-out based on frequency. Pulse fidelity is field-selectable per channel pair (API 2540, Chapter 5, Section 5, Level B). The module supports pulse-interpolation method: Double Chronometry as a standard during proving cycle (API 2540 Chapter 4, Section 6). Prover switches are integrated into the turbine meter card and are available to ladder logic. Prover switch voltages are field-selectable 5 VDC, 12 VDC, and 24 VDC and are configured per channel.

4. PCFC Function Block

4

At a Glance

Purpose

This chapter describes the representation, operation, and configuration of the PCFC function block.

What's in this Chapter?

This chapter contains the following sections:

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4.1 PCFC Representation and Operation

At a Glance

Purpose

This section describes the representation and operation of the PCFC function block.

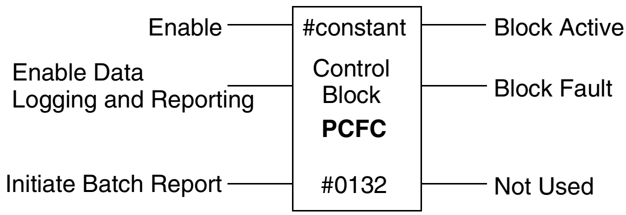
What's in this Section?

This section contains the following topics:

4.1.1. PCFC Function Block Structure

4.1.1.1. Block Structure Diagram

The block structure is illustrated below.



4.1.1.2. Inputs

The PCFC has three control inputs:

- **Top** input node enables the function block.
- **Middle** input node enables data logging and reports generation.
- **Bottom** input node initiates a new batch report and must be a positive transition contact. See *Data Logging and Report Generation, p. 115* for a detailed explanation on data logging and report generation.

4.1.1.3. Outputs

The PCFC has three outputs.

- **Top** output is a copy of the top node input.
- **Middle** output turns ON when the function block has detected an error.
- **Bottom** is not used.

4.1.1.4. Top Node Content

The top node must contain a constant value from 0 to 15. Each number represents a unique PCFC block in the PLC ladder logic program. There can be a maximum of 16 PCFC blocks in the PLC program with each one having a unique number for the top node.

4.1.1.5. Middle Node Content

The 4x register entered in the middle node is the first of 132 contiguous holding registers that comprise the control block.

4.1.1.6. Bottom Node Content

The bottom node must contain a constant (#0132) representing the length of the control block in registers.

4.1.2. PCFC Operation

4.1.2.1. Master PCFC Block

The PLC program can have up to 16 PCFC blocks. One of the PCFC blocks must be a "MASTER" with the top node being 0. The master PCFC block allows for one PCFC block to be executed per PLC scan, to reduce PLC scan time. Place the master PCFC block to be the first of the PCFC blocks to occur in logic.

Note: If there is NO Master "0" block, the blocks will not be scanned nor function.

4.2 PCFC Configuration

At a Glance

Purpose

This section provides a detailed description of the configuration for the 4x registers of the PCFC function block.

What's in this Section?

This section contains the following topics:

4.2.1. PCFC Register Summary

4.2.1.1. Overview

The following material provides an overview of the 4x register content for the PCFC function block. For a description of the abbreviations and terms used in register descriptions, see the glossary.

> **Note:** Writing to read (RD) registers in can cause inaccurate results or one of the following behaviors (1) the controller does not work, (2) the controller locks up, or (3) a function block will not work. To prevent this situation, do NOT write to read (RD) registers. Writable registers (**WR**) are marked in **bold**.

4.2.1.2. Summary: PCFC Setup and Diagnostic Data Registers

The following table summarizes the set of PCFC registers that contain setup and diagnostic information.

Register	Access	Data Type	Comment
4x + 0	RD	HEX	PCFC Revision Number (X.XX) For setup and diagnostic information, see *PCFC Setup and Diagnostic Data (4x + 0; +1, Revision Number and Command Word 1) Registers, p. 61*.
4x + 1	**WR**	BIN	Command Word 1 For setup and diagnostic information, see *PCFC Setup and Diagnostic Data (4x + 0; +1, Revision Number and Command Word 1) Registers, p. 61*.
4x + 2	**WR**	BIN	Command Word 2 For setup and diagnostic information, see *PCFC Setup and Diagnostic Data (4x + 2, Command Word 2) Register, p. 66*.
4x + 3	RD	BIN	Fault Word 1 For setup and diagnostic information, see *PCFC Setup and Diagnostic Data (4x + 3, Fault Word 1) Register, p. 71*.
4x + 4	RD	BIN	Fault Word 2 For setup and diagnostic information, see *PCFC Setup and Diagnostic Data (4x + 4, Fault Word 2) Register, p. 75*.
4x + 5	RD	BIN	Status Word For setup and diagnostic information, see *PCFC Setup and Diagnostic Data (4x + 5, Status Word) Register, p. 78*.

4.2.1.3. Summary: PCFC Flow Card Setup Registers

The following table summarizes the set of PCFC block registers that represent flow card setup.

Register	Access	Data Type	Comment
4x +6	**WR**	UINT	Meter Run Number For example: Runs 1 to 16
4x +7	**WR**	UINT	TMCI Block Starting 4x Registers For example: 400123 enter "123"

For more information, see *Flow Card Setup Registers, p. 81*.

4.2.1.4. Summary: PCFC Product Data Registers

The following table summarizes the set of PCFC block registers that represent product data.

Register	Access	Data Type	Comment
4x + 8	**WR**	UINT	Product Type
4x + 9	**WR**	UINT	Product Name
4x + 10	RD	HEX	First API Table Used
4x + 11	RD	HEX	Second API Table Used
4x + 12 ... + 13	**WR**	FLOAT	Sediment and Water % CSW Meter

For more information, see *Product Data Registers, p. 82*.

4.2.1.5. Summary: PCFC Real-Time Correction Factor Registers

The following table summarizes the set of PCFC block registers that represent real-time correction factor data.

Register	Access	Data Type	Comment
4x + 14 ... + 15	RD	FLOAT	Calculated CTL
4x + 16 ... + 17	RD	FLOAT	Calculated CPL
4x + 18 ... + 19	RD	FLOAT	Calculated Meter Factor (After proving run)

For more information, see *Real-Time Correction Factor Registers, p. 85*.

4.2.1.6. Summary: PCFC Meter Setup / Real-Time Data Registers

The following table summarizes the set of PCFC block registers that represent meter setup / real-time data.

Register	Access	Data Type	Comment
4x + 20 ... + 23	**WR**	ASCII (8)	Serial Number of Meter
4x + 24 ... + 27	**WR**	ASCII (8)	Meter ID
4x + 28	**WR**	UINT	Meter Size
4x + 29	**WR**	UINT	Meter Type
4x + 30 ... + 31	RD	UDINT	Meter Raw Counts Channel A
4x + 32 ... + 33	RD	UDINT	Meter Raw Counts Channel B (Pulse fidelity only)
4x + 34 ... + 35	RD	FLOAT	Meter Frequency
4x + 36 ... + 37	**WR**	FLOAT	Meter Factor
4x + 38 ... + 39	**WR**	FLOAT	Meter K Factor (1.0 – 65535.0)
4x + 40 ... + 41	RD	FLOAT	Meter Composite C Factor

For more information, see *Meter Setup / Real-Time Data Registers, p. 86*.

4.2.1.7. Summary: PCFC Real-Time Metering Data Registers

The following table summarizes the set of PCFC block registers that represent real-time metering data.

Register	Access	Data Type	Comment
4x + 42 ... + 43	RD	FLOAT	Indicated Standard Volume "Gross Volume" (Barrels or Cubic inches / Hour)
4x + 44 ... + 45	RD	FLOAT	Gross Standard Volume "Net Volume" (Barrels or Cubic inches / Hour)
4x + 46 ... + 47	RD	FLOAT	Net Standard Volume (Barrels or Cubic inches / Hour)
4x + 48 ... + 49	RD	FLOAT	Sediment & Water Volume (Barrels or Cubic inches / Hour)
4x + 50 ... + 51	RD	UDINT	Indicated Standard Volume Accumulator (Barrels or Cubic inches) Channel A
4x + 52 ... + 53	RD	UDINT	Indicated Standard Volume Accumulator (Barrels or Cubic inches) Channel B
4x + 54 ... + 55	RD	UDINT	Gross Standard Volume Accumulator (Barrels or Cubic inches)
4x + 56 ... + 57	RD	FLOAT	Corrected Product Density API 60 or API 15 if Metric

For more information, see *Real-Time Metering Data Registers, p. 88*.

4.2.1.8. Summary: PCFC Report Setup Data Registers

The following table summarizes the set of PCFC block registers that represent report setup data.

Register	Access	Data Type	Comment
4x + 58	**WR**	UINT	Reserved for system use
4x + 59	**WR**	UINT	Start of Day ‘Hour’ (0-23 military)
4x + 60	**WR**	UINT	Start of Day ‘Minute’ (0-59)
4x + 61	**WR**	UINT	Report Address Modulo 10000 High Word (00XX)
4x + 62	**WR**	UINT	Report Address Modulo 10000 Low Word (XXXX)

For more information, see *Report Setup Registers, p. 89*.

4.2.1.9. Summary: PCFC SCADA Data in Implied Decimal Format Registers

The following table summarizes the set of PCFC block registers that represent SCADA data in implied decimal format.

Register	Access	Data Type	Comment
4x + 63	RD	INT	Temperature (XXX.XX)
4x + 64	RD	INT	Pressure (XXX)
4x + 65	RD	INT	Gravity / Density (.XXXXX) or (XXX.X)

For more information, see *SCADA Data in Implied Decimal Format Registers, p. 90*.

4.2.1.10. Prover Data Registers

The following table summarizes the set of PCFC block registers that represent prover data.

Register	Access	Data Type	Comment
4x + 66	**WR**	UINT	Internal Diameter of the Pipe
4x + 67	**WR**	UINT	Wall Thickness of the Pipe
4x + 68	**WR**	UINT	Modulus of Elasticity for the Pipe Material x 10^5
4x + 69	**WR**	UINT	Coefficient of Cubic Expansion per ° F or °C of the pipe material
4x + 70 ... + 71	**WR**	UDINT	Base Volume of Prover @ 60°F 0 PSI (Barrels or Cubic inches)
4x + 72	**WR**	UINT	Number of Consecutive Proving Runs
4x + 73	RD	UINT	Current Number of the Consecutive Proving Runs
4x + 74 ... + 75	RD	UDINT	Prover Raw Counts
4x + 76 ... + 77	RD	FLOAT	Calculated CTS
4x + 78 ... + 79	RD	FLOAT	Calculated CPS

For more information, see *Prover Data Registers, p. 91*.

4.2.1.11. Summary: PCFC Real-Time Process Variables Registers

The following table summarizes the set of PCFC block registers that represent real-time process variables.

Register	Access	Data Type	Comment
4x + 80	**WR**	UINT	Specific Gravity / Density Raw Counts (Meter)
4x + 81	**WR**	UINT	Specific Gravity / Density Conversion Range (Meter)
4x + 82 ... + 83	**WR**	FLOAT	Specific Gravity / Density High Engineering Units (Meter)
4x + 84 ... + 85	**WR**	FLOAT	Specific Gravity / Density Low Engineering Units (Meter)
4x + 86 ... + 87	**WR**	FLOAT	Specific Gravity / Density Scaled Output (Meter)
4x + 88	**WR**	UINT	Temperature Raw Counts (Meter)
4x + 89	**WR**	UINT	Temperature Conversion Range (Meter)
4x + 90 ... + 91	**WR**	FLOAT	Temperature High Engineering Units (Meter)
4x + 92 ... + 93	**WR**	FLOAT	Temperature Low Engineering Units (Meter)
4x + 94 ... + 95	**WR**	FLOAT	Temperature Scaled Output (Meter)
4x + 96	**WR**	UINT	Pressure Raw Counts (Meter)
4x + 97	**WR**	UINT	Pressure Conversion Range (Meter)
4x + 98 ... + 99	**WR**	FLOAT	Pressure High Engineering Units (Meter)
4x + 100 ... + 101	**WR**	FLOAT	Pressure Low Engineering Units (Meter)
4x + 102 ... + 103	**WR**	FLOAT	Pressure Scaled Output (Meter)
4x + 104	**WR**	UINT	Temperature Raw Counts (Prover)
4x + 105	**WR**	UINT	Temperature Conversion Range (Prover)
4x + 106 ... + 107	**WR**	FLOAT	Temperature High Engineering Units (Prover)
4x + 108 ... + 109	**WR**	FLOAT	Temperature Low Engineering Units (Prover)
4x + 110 ... + 111	**WR**	FLOAT	Temperature Scaled Output (Prover)
4x + 112	**WR**	UINT	Pressure Raw Counts (Prover)
4x + 113	**WR**	UINT	Pressure Conversion Range (Prover)
4x + 114 ... + 115	**WR**	FLOAT	Pressure High Engineering Units (Prover)
4x + 116 ... + 117	**WR**	FLOAT	Pressure Low Engineering Units (Prover)
4x + 118 ... + 119	**WR**	FLOAT	Pressure Scaled Output (Prover)

For more information, see *Real-Time Process Variables Registers, p. 94*.

4.2.1.12. Summary: PCFC Pulse Fidelity Registers

The following table summarizes the set of PCFC block registers that represent pulse fidelity data.

Register	Access	Data Type	Comment
4x + 120			Reserved for system use
4x + 121			Reserved for system use
4x + 122			Reserved for system use
4x + 123	**WR**	UINT	Pulse Fidelity Frequency Threshold (Pulse Fidelity only)
4x + 124	**WR**	UINT	Number of Count Errors in a Batch (Pulse Fidelity only)
4x + 125	RD	UINT	Common Mode Errors (Pulse Fidelity only)

For more information, see *Pulse Fidelity Registers, p. 98*.

4.2.1.13. Summary: PCFC Program Diagnostics Registers

The following table summarizes the set of PCFC block registers that represent program diagnostics data.

Register Offset	Access	Data Type	Comment
4x + 126	**WR**	UINT	Number of Filter Samples
4x + 127	**WR**	UINT	Base Temperature
4x + 128	RD	UINT	Program Step
4x + 129	RD	UINT	Error Code
4x + 130			Reserved for system use
4x + 131			Reserved for system use

For more information, see *Program Diagnostic Data Registers, p. 99*.

4.2.2. PCFC Setup and Diagnostic Data (4x + 0; +1, Revision Number and Command Word 1) Registers

4.2.2.1. Overview

The following material provides a detailed description of the content of the 4x + 0 (Revision Number) and 4x +1 (Command Word 1) registers of the PCFC function block.

4.2.2.2. Contents: 4x + 0 Register (RD, HEX)

PCFC Revision Number (X.XX)
Displays the current function block's revision number. Format is (X.XX).
For example, hex 100 indicates revision 1.00.

4.2.2.3. Bit Summary: 4x + 1 Register (WR, BIN)

Command Word 1
This register contains user defined commands for the block. The following table provides a summary of the bits in the Command Word 1:

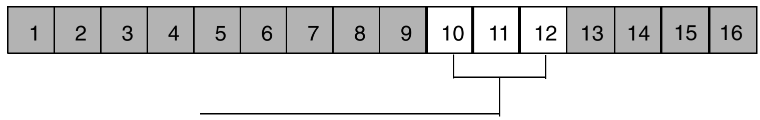
Bit	Description	Bit	Description
1 MSB	M Factor Retroactive on Batch Ticket	9	Meter Proving Used
2	CPL Forced to 1.0	10	Previous Batch Report
3	API 21.2 Audit Trail	11	Previous Batch Report
4	Corrected Density	12	Previous Batch Report
5	Hydrometer Correction	13	Specific Gravity/API Gravity
6	Specific Gravity/Density Input Mode	14	Measurement method
7	Pressure Input Mode (Meter)	15	Pressure Conversion Units
8	Temperature Input Mode (Meter)	16	Temperature Conversion Units

4.2.2.4. Bit Contents: 4x + 1 Register (WR, BIN)

The following table provides a detailed description of the bits that are used in Command Word 1:

Bit(s)	Description
Bit 1 MSB	**M Factor Retroactive on Batch Ticket** If this bit is ON and the M Factor has changed, then the new M Factor will be used to recalculate the batch ticket. (The new M Factor will take effect immediately and will update GSV and NSV values.) If this bit is OFF, then it is assumed that the user will trigger batch change on the event of a new M Factor. **Note:** M Factor needs to be updated manually by user after prove.
Bit 2	**CPL Forced to 1.0** If this bit is ON, then the CPL is set to 1.0 regardless of product or API table selected. When this bit is used, the bit immediately forces a value of 1.0 into the CPL register. Use this bit carefully. See *Real-Time Correction Factor Registers, p. 85*. **Note:** For products not supported by tables.
Bit 3	**API 21.2 Audit Trail** If this bit is ON, then the block will log data per the API 21.2 audit trail. **Note:** To use this feature, see *AUDT—Summary: Block Registers, p. 161*.
Bit 4	**Corrected Density** If this bit is ON, then the value entered into 4x + 80 (Raw) or 4x + 86 (Scaled) is corrected density. If this bit is OFF, then the value entered into 4x + 80 (Raw) or 4x + 86 (Scaled) is an uncorrected density in either Relative Density/SG or API.
Bit 5	**Hydrometer Correction** If this bit is ON, then no Hydrometer correction is used. If this bit is OFF, then Hydrometer correction is used. The hydrometer correction is used only if the density entered was obtained by using a glass hydrometer. Normally, if a densiometer is used, no hydrometer correction is needed. **Note:** See densiometer manufacturer's specifications for hydrometer corrections.
Bit 6	**Specific Gravity/Density Input Mode** If this bit is ON, then the SG/Density is entered as a scaled floating-point value in 4x + 86. If this bit is OFF, then the Specific Gravity/Density is entered as raw counts into 4x + 80 and the block calculates the SG/Density scaled output and places the result in 4x + 86 as floating point. **Note**: If Bit 3 of Command Word 1 is on, then Bit 6 of Command Word 1 will be set to OFF. However, the value may be forced, For more information, see the AUDT block chapter, *Force a Process Variable, p. 158*.

Bit(s)	Description
Bit 7	**Pressure Input Mode (Meter)** If this bit is ON, then the pressure is entered as a scaled floating-point value in 4x + 102. If this bit is OFF, then the pressure is entered as raw counts into 4x + 96 and the block calculates the pressure scaled output and places the result in 4x + 102 as floating point. **Note**: If Bit 3 of Command Word 1 is on, then Bit 6 of Command Word 1 will be set to OFF. However, the value may be forced, For more information, see the AUDT block chapter, *Force a Process Variable, p. 158*.
Bit 8	**Temperature Input Mode (Meter)** If this bit is ON, then the temperature is entered as a scaled floating-point value in 4x + 94. If this bit is OFF, then the temperature is entered as raw counts into 4x + 88 and the block calculates the temperature scaled output and places the result in 4x + 94 as floating point. **Note**: If Bit 3 of Command Word 1 is on, then Bit 6 of Command Word 1 will be set to OFF. However, the value may be forced, For more information, see the AUDT block chapter, *Force a Process Variable, p. 158*.
Bit 9	**Meter Proving Used** If this bit is ON, then this block uses all functions and variables associated with meter proving. If this bit is OFF, then the block only performs standard metering. **Note**: If Bit 3 of Command Word 1 is on, then Bit 6 of Command Word 1 will be set to OFF. However, the value may be forced, For more information, see the AUDT block chapter, *Force a Process Variable, p. 158*.

Bit(s)	Description
Bit 10 – 12	**Previous Batch Report** The bit pattern (0 to 7) represents the number of previous batch reports to include in the ticket area. A binary value of 0 represents zero previous batch reports and a value of 7 will allow for seven previous batch reports to be logged. **Command Word 1:** Number of batches to log in ticket block.  001 = Log up to 1, previous batch 1 010 = Log up to 1, previous batch 2 011 = Log up to 1, previous batch 3 100 = Log up to 1, previous batch 4 101 = Log up to 1, previous batch 5 110 = Log up to 1, previous batch 6 111 = Log up to 1, previous batch 7 **Note:** The Real Time Clock must be enabled and set to a valid time before Report Generation will log data.
Bit 13	**Specific Gravity/API Gravity** If this bit is ON, then API Gravity is entered into the SG_Density fields (4x + 86) under the "Real Time Process Variables" group. If this bit is OFF, then Specific Gravity is entered into the SG_Density fields (4x + 86) under the "Real Time Process Variables" group. **Note 1:** If the PCFC function block is configured in metric mode, this bit has no effect. **Note 2:** If Bit 6 is OFF, the SG/Density data is entered into the (4x + 80) field.
Bit 14	**Measurement Method** Select CTL, CPL Calculation Method (OFF = Imperial, ON = Metric). If this bit is ON, use API Tables: 53 and 54. If this bit is OFF, use API tables: 5, 6, 23, and 24. **Note:** This bit selects the general measurement method used for all calculations in the block.

Bit(s)	Description
Bit 15	**Pressure Conversion Units** If this bit is ON and Bit 14 of Command Word 1 is ON (Metric), then pressure is in PSIG and will be converted KPA. If this bit is OFF and Bit 14 of Command Word 1 is ON (Metric), then the pressure is in KPA. If this bit is ON and Bit 14 of Command Word 1 is OFF (Imperial), then pressure is in KPA and will be converted to PSIG. If this bit is OFF and Bit 14 of Command Word 1 is OFF (Imperial), then the pressure is in PSIG. **Note:** Bit 15 affects all pressures in the block. For example, if this bit is set to PSIG then all pressures are assumed to be in PSIG. Bit 14 = 1 (Metric), Bit 15 = 0 "KPA" Bit 14 = 1 (Metric), Bit 15 = 1 "PSIG" converted to "KPA" Bit 14 = 0 (Imperial), Bit 15 = 0 "PSIG" Bit 14 = 0 (Imperial), Bit 15 = 1 "KPA" converted to "PSIG"
Bit 16 (LSB)	**Temperature Conversion Units** Select Temperature Units (OFF is °F, ON is °C). If this bit is ON and Bit 14 of Command Word 1 is ON (Metric), then temperature is in Fahrenheit and will be converted Celsius. If this bit is OFF and Bit 14 of Command Word 1 is ON (Metric), then the temperature is in Degrees C°. If this bit is ON and Bit 14 of Command Word 1 is OFF (Imperial), then temperature is in Degrees °C and will be converted to Fahrenheit. If this bit is OFF and Bit 14 of Command Word 1 is OFF (Imperial), then the temperature is in Degrees °F. **Note:** Bit 16 affects all temperatures in the block. For example, if this bit is set to Fahrenheit then all temperatures are assumed to be in Fahrenheit. Bit 14 = 1 (Metric), Bit 16 = 0 "°C" Bit 14 = 1 (Metric), Bit 16 = 1 "°F" converted to "°C" Bit 14 = 0 (Imperial), Bit 16 = 0 "°F" Bit 14 = 0 (Imperial), Bit 16 = 1 "°C" converted to "°F"

4.2.3. PCFC Setup and Diagnostic Data (4x + 2, Command Word 2) Register

4.2.3.1. Overview

The following material provides a detailed description of the content of the 4x + 2 (Command Word 2) register of the PCFC function block.

4.2.3.2. Bit Summary: 4x + 2 Register (WR, BIN)

Command Word 2

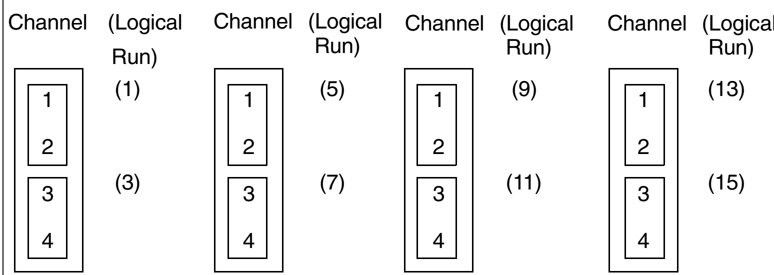
This register contains a continuation of user defined commands for the block. The following table provides a summary of the bits in the Command Word 2:

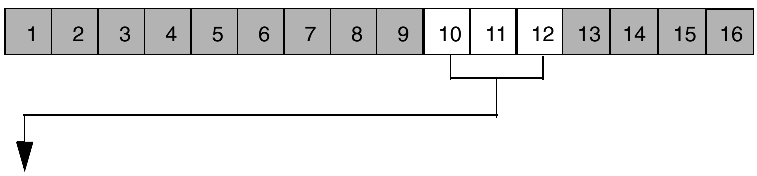
Bit	Description	Bit	Description
1 MSB	Automatic Proving	9	Flow Rate Filter
2	Force CPS to 1.0	10	Previous Prove Report
3	Prove Flow ISV/GSV	11	Previous Prove Report
4	Pulse Fidelity	12	Previous Prove Report
5	Meter Phasing	13	User Base Temperature
6	Bidirectional Prover	14	GSV Calc/GSV Accumulator
7	Pressure Input Mode (Prover)	15	Abort Prove Report
8	Temperature Input Mode (Prover)	16	Start Proving Run

4.2.3.3. Bit Contents: 4x +2 Register (WR, BIN)

The following table provides a detailed description of the bits that are used in Command Word 2:

Bit(s)	Description
Bit 1 (MSB)	**Automatic Proving** If this bit is ON, the value in the Calculated Meter Factor (4x + 18) register is automatically transferred to the M Factor register (4x + 36). If this bit is OFF, the Calculated Meter Factor is displayed only and must be transferred manually. **Note:** While this bit is ON, the value is transferred continuously from Calculated to Meter Factor (use a positive transition contact). If there is no previous calculated M Factor and the value is zero, nothing will be transferred. However, if the Calculated Meter Factor becomes a non-zero value, then that value will be transferred to the Meter Factor field.
Bit 2	**Force CPS to 1.0** If this bit is ON, then the CPS value will be forced to 1.0. This is used for provers with a double wall to equalize the pressure inside and outside the calibrated chamber. In this case the inner measuring section of the prover is not subjected to a net internal pressure, and the walls of this inner chamber do not stretch elastically. Therefore, CPS = 1.0000
Bit 3	**Prove Flow ISV/GSV** If this bit is OFF, then the Prove Report flow rate (+ 190 Average ISV / GSV Flow Rate) will be in ISV. If this bit is ON, then in GSV.

Bit(s)	Description
Bit 4	**Pulse Fidelity** If this bit is ON, then pulse fidelity is performed (Per API 2540 Chapter 5 Section 5 Level B). Only channels 1 and 3 (on the four channel cards) are to be used for this function (for channel 1 the following channel is used "channel 2"). A maximum of four pulse fidelity cards can be placed in a system.  Example: In card two of a system, if the logical run number is Logical Run 7, then the next logical run number that can be used is Logical Run 9, because Run Logical Run 8 is used with Logical Run 7. **Note:** There are 16 logical runs in a system. When Pulse Fidelity is used, the first run selected must be an odd number. This fact applies to the physical module channels (signal and gate). Furthermore, if pulse fidelity is enabled for every channel, there are only 8 physical runs possible in a system. Pulse Fidelity errors can only be reset on a batch change.
Bit 5	**Meter Phasing** If this bit is OFF, Bit 5 indicates that the phase relationship between the applicable channel pair is 90 degrees. When Bit 5 is set to 1, the phase relationship is 180 degrees. This information is important when pulse fidelity is being monitored, because the phase relationship is continuously monitored.
Bit 6	**Bidirectional Prover** If this bit is ON, the prover is Bidirectional having a forward pass with two detector switches and a Reverse pass across the same two switches for a total of four pulses of the detector switch. If this bit is OFF, then the prover is a Uni-directional prover with one pass and two detector switches for a total of two pulses of the detector switches.
Bit 7	**Pressure Input Mode (Prover)** If this bit is ON, then the pressure is entered as a scaled floating-point value in 4x + 118. If this bit is OFF, then the pressure is entered as raw counts into the 4x + 112 register. The block calculates the pressure scaled output and places the result in the 4x + 118 register as floating point.

Bit(s)	Description
Bit 8	**Temperature Input Mode (Prover)** If this bit is ON, then the temperature is entered as a scaled floating-point value in 4x + 110. If this bit is OFF, then the temperature is entered as raw counts into the 4x + 110 register. The block calculates the temperature scaled output and places the result in to the 4x + 104 register as floating point.
Bit 9	**Flow Rate Filter** If this bit is ON, then the all flow rates are sampled at 500ms and the number of samples is 20. This flow rate data is used in a "weighted" average to determine the flow rate. **Note:** If a Fidelity error occurs while Pulse Fidelity is being used, the filter will be bypassed until the error is corrected.
Bit 10 - 12	**Previous Prove Reports** The bit pattern (0 to 4) represents the number of previous proving reports to include in the ticket area. A binary value of 0 represents zero previous proving reports and a value of 4 will allow for four previous proving reports to be logged. **Command Word 2:** Number of batches to log in ticket block.  001 = Log up to 1, previous prove report 1 010 = Log up to 2, previous prove report 2 011 = Log up to 3, previous prove report 3 100 = Log up to 4, previous prove report 4 **Note:** The Real Time Clock must be enabled and set to a valid time before Report Generation will log data.
Bit 13	**User Base Temperature** If this bit is ON, then a user defined temperature is entered in the 4x + 127 register. If this bit is OFF, then a standard reference temperature of 15° is used. **Note**: Bit 13 is only valid for the following API tables: ● 53A ● 53B ● 53D ● 54A ● 54B ● 54D These factors affect metric pressures only.

Bit(s)	Description
Bit 14	**GSV Calc/GSV Accumulator** If this bit is ON, then there is a separate accumulator for the GSV and it is totally independent of the ISV accumulator. If this bit is OFF, then the GSV is calculated based on the ISV accumulator. **Note:** If a separate accumulator is used, then the ISV and GSV will not track each other based on product change or rollover. For example: Given that ISV = 1 and GSV = 9,999,207. After ISV rolls over, GSV will not roll over until it reaches 10,000,000 because GSV has an independent accumulator.
Bit 15	**Abort Prove Report** If this bit is ON, then the current Prove Report is aborted. When Bit 15 is used, it discards the report information and does not transfer it to the previous prove report area. **Note:** This bit must be set with a single positive transition. The bit will reset itself to zero. The report will not clear until a new report is generated by setting "Start Proving Run" bit 16 Command Word 2 to 1.
Bit 16 (LSB)	**Start Proving Run** If this bit is ON, then the proving cycle has started and the system will look for the prover detector switches. This also starts the report generation; it is triggered for every proving run in a cycle until the number of runs entered into "Number of consecutive proving runs" is equal. **Note:** This bit must be set with a single positive transition. The bit will reset itself to zero for the next run.

4.2.4. PCFC Setup and Diagnostic Data (4x + 3, Fault Word 1) Register

4.2.4.1. Overview

The following material provides a detailed description of the content of the 4x + 3 (Fault Word 1) register of the PCFC function block.

4.2.4.2. Bit Summary: 4x + 3 Register (RD, BIN)

Fault Word 1

Each bit in this word represents a particular fault that the function block has detected. The following table provides a summary of the bits in Fault Word 1:

Bit	Description	Bit	Description
1 MSB	Invalid Constant in Top Node	9	Invalid Pressure Input (Meter)
2	Address to Report Area Invalid	10	Invalid Temperature Input (Meter)
3	Time of Day Clock Invalid/Not Set	11	Pressure Under Range
4	Min. Density Exceeded	12	Pressure Over Range
5	Max. Density Exceeded	13	Temperature Under Range
6	Invalid Pressure Conversion Range (Meter)	14	Temperature Over Range
7	Invalid Temperature Conversion Range (Meter)	15	Invalid CPL Calculation
8	Invalid Constant in Bottom Node	16	Invalid CTL Calculation

4.2.4.3. Bit Contents: 4x + 3 Register (RD, BIN)

The following table provides a detailed description of the bits in Fault Word 1:

Bit 1 (MSB)	**Invalid Constant in Top Node** The correct constant has not been entered in the top node of the function block. The function block will not perform any calculations. Value must be between 0 and 15. No duplicate values allowed.
Bit 2	**Address to Report Area Invalid** This fault will only apply if the function block is enabled for reporting (middle input ON). This bit will be set if the user-supplied, 6-digit address to the report storage area in the PLC is invalid. The six digit address is stored in the 4x + 61 and 4x + 62 registers. The address will be invalid if it is not configured or overlaps other block addresses. Also, the address will be invalid if the address value plus the report area size exceeds the configured number of registers in the PLC (See *Data Logging and Report Generation, p. 115*).
Bit 3	**Time of Day Clock Invalid/Not Set** This fault will only apply if the function block is enabled for reporting. This bit will come ON if the user-supplied offset to the time of day clock in the PLC is invalid. The offset will be invalid if a value of 0 is supplied. Also, the offset will be invalid if the offset value plus the 8 holding registers used by the time of day clock exceeds the configured amount of holding registers in the PLC. This Fault will also be generated if the TOD clock is not set for example, Month = 0, Day=0, Day of week=0, etc. The TOD clock can be configured, but it must be set to a valid time/date either by the programming panel, ladder logic, or by a communication link.
Bit 4	**Min. Density Exceeded** The current calculated density has exceeded the minimum density for the current product being monitored. For example, if crude oil or refined products are being monitored, this bit will come ON if the current API density is less than 0. The table in *Data Logging and Report Generation, p. 115* lists the ranges of acceptable densities for each type of product.
Bit 5	**Max. Density Exceeded** The current calculated density has exceeded the maximum density for the current product being monitored. For example, if crude oil is being monitored, this bit will come ON if the current API density is greater than 100. If refined products are being monitored, this bit will come ON if the current API density is greater than 85. The table in *Flow Equations and Algorithms, p. 233* lists the ranges of acceptable densities for each type of product.

Bit 6	**Invalid Pressure Conversion Range (Meter)** An invalid conversion range was entered into the "Pressure Conversion Range" field. See *Analog Input Conversion Ranges, p. 253* for possible conversion ranges.
Bit 7	**Invalid Temperature Conversion Range (Meter)** An invalid conversion range was entered into the "Temperature Conversion Range" field. See *Analog Input Conversion Ranges, p. 253* for possible conversion ranges.
Bit 8	**Invalid Constant in Bottom Node** The correct constant has not been entered in the bottom node of the function block. The function block will not perform any calculations.
Bit 9	**Invalid Pressure Input (Meter)** The raw counts from the device (analog module) are not in the linear conversion range selected by the user. **Note:** If raw counts are correct See *Analog Input Conversion Ranges, p. 253* for possible conversion ranges.
Bit 10	**Invalid Temperature Input (Meter)** The raw counts from the device (analog module) are not in the linear conversion range selected by the user. **Note:** If raw counts are correct see *Analog Input Conversion Ranges, p. 253* for possible conversion ranges.
Bit 11	**Pressure Under Range** The scaled pressure output is equal to or less than the value entered for low engineering units (LEU 4x). **Note:** If both Pressure Over Range and Under Range bits are ON, then the process variable is out of usable or "process range" (Pressure > 50,000 and Pressure < 0).
Bit 12	**Pressure Over Range** The scaled pressure output is equal to or greater than the value entered for high engineering units (HEU 4x). **Note:** If both Pressure Over Range and Under Range bits are ON, then the process variable is out of usable or "process range" (Pressure > 50,000 and Pressure < 0).
Bit 13	**Temperature Under Range** The scaled temperature output is equal to or less than the value entered for low engineering units (LEU 4x). **Note:** If both Temperature Over Range and Under Range bits are ON, then the process variable is out of usable or "process range" (Temperature > 500 and Temperature < -200).
Bit 14	**Temperature Over Range** The scaled temperature output is equal to or greater than the value entered for high engineering units (HEU 4x). **Note:** If both Temperature Over Range and Under Range bits are ON, then the process variable is out of usable or "process range" (Temperature > 500 and Temperature < -200).

Bit 15	**Invalid CPL Calculation** There is invalid data in the CPL calculation. This bit will also be set if there is an invalid temperature or pressure reading. **Note:** CPL will use the last known valid value until the error is cleared.
Bit 16	**Invalid CTL Calculation** There is invalid data in the CTL calculation. The Gravity/Density or Temperature entered is out of range for the API tables. If the value is in range for the selected table when this error occurs, the error occurs because the API table does not define the range. See *Flow Equations and Algorithms, p. 233* for ranges on specific tables and the API 2540 for the specific values defined in tables. **Note:** CTL will use the last known valid value until the error is cleared.

4.2.5. PCFC Setup and Diagnostic Data (4x + 4, Fault Word 2) Register

4.2.5.1. Overview

The following material provides a detailed description of the content of the 4x + 4 (Fault Word 2) register of the PCFC function block.

4.2.5.2. Bit Summary: 4x + 4 Register (RD, BIN)

Fault Word 2

Each bit in this word represents a particular fault that the function block has detected. The following table provides a summary of the bits that are used in Fault Word 2:

Bit	Description	Bit	Description
1 MSB	Pulse Fidelity Error	9	Specific Gravity/Density Under Range
2	Min./Max. Prove Runs Exceeded	10	Specific Gravity/Density Over Range
3	Pipe Wall Thickness Exceeded	11	Not Used
4	Pipe Inside Diameter Exceeded	12	Function Not Available with Hardware
5	Pipe Elasticity Invalid	13	Invalid IEEE Floating Point Number
6	Pipe Coefficient of Thermal Expansion Invalid	14	Invalid 4x TMCI Pointer
7	Invalid Specific Gravity/Density Conversion Range	15	Invalid Base Volume of Prover
8	Invalid Specific Gravity/Density Input	16	Invalid Meter Run Number

4.2.5.3. Bit Contents: 4x + 4 Register (RD, BIN)

The following table provides a detailed description of the bits that are used in Fault Word 2:

Bit 1 (MSB)	**Pulse Fidelity Error** There is a pulse fidelity error (for example, count, sequence, frequency, or phase).
Bit 2	**Min./Max. Prove Runs Exceeded** An invalid range was selected for the number of consecutive proving runs. The range is 2 to 10. Any number outside that range will generate this fault.
Bit 3	**Pipe Wall Thickness Exceeded** An invalid value was entered in (4x + 67). (See *Prover Data Registers, p. 91*)
Bit 4	**Pipe Inside Diameter Exceeded** An invalid value was entered in (4x + 66). (See *Prover Data Registers, p. 91*)
Bit 5	**Pipe Elasticity Invalid** An invalid value was entered in (4x + 68). (See *Prover Data Registers, p. 91*)
Bit 6	**Pipe Coefficient of Thermal Expansion Invalid** An invalid value was entered in (4x + 69). (See *Prover Data Registers, p. 91*)
Bit 7	**Invalid Specific Gravity/Density Conversion Range** An invalid conversion range was entered into the "Gravity / Density Conversion Range" field. See *Analog Input Conversion Ranges, p. 253* for possible conversion ranges.
Bit 8	**Invalid Specific Gravity/Density Input** The raw Specific Gravity/Density value 4x + 80 is outside the linear conversion range. See table for valid ranges. **Note:** If a raw value goes out of range, the scaled value will hold the last current (Valid) value until a valid value is entered.
Bit 9	**Specific Gravity/Density Under Range** The scaled Specific Gravity/Density output is equal to or less than the value entered for low engineering units (LEU) (4x + 84).
Bit 10	**Specific Gravity/Density Over Range** The scaled temperature output is equal to or greater than the value entered for high engineering units (HEU) (4x + 82).
Bit 11	**Not Used**
Bit 12	**Function Not Available with Hardware** If Bit 12 is ON, the option selected in the Command Words is not available with the Turbine/Counter card selected. For instance, if meter proving is selected and the 140 EHC 204 00sc is selected, this error will be generated. **Note:** See *TMCI and Quantum Functionality Chart, p. 46* for card functionality. Not all cards support all the options in the PCFC block.

Bit 13	**Invalid IEEE Floating Point Number** An invalid floating point number (wrong data type) has been entered into a register. **Note**: The register where the first error occurred is stored in 4x + 129. An invalid floating point number error may also trigger other errors, for example, an invalid CTL Calculation error occurs if the Scaled Temperature Out was in error.
Bit 14	**Invalid 4x TMCI Pointer** The 4x register pointer is either invalid or out of range for the PLC's configured 4x register. The PLC configuration must have 165 contiguous registers after the pointer.
Bit 15	**Invalid Base Volume of Prover** If 0, then Prover Volume is invalid. **Note:** A zero in either one of these registers will generate a fault.
Bit 16 (LSB)	**Invalid Meter Run Number** An invalid meter run 4x + 6 number has been entered. Valid ranges are 1 to 16. If Pulse Fidelity is ON and the Meter Run Number is Even, an attempt has been made to use a reserved Meter Run Number. Pulse Fidelity is only valid on Odd run numbers 1,3,5,7,9,11,13, and 15. (See Meter Run Number for more information).

4.2.6. PCFC Setup and Diagnostic Data (4x + 5, Status Word) Register

4.2.6.1. Overview

The following material provides a detailed description of the content of the 4x + 5 (Status Word) register of the PCFC function block.

4.2.6.2. Bit Summary: 4x + 5 Register (RD, BIN)

Status Word

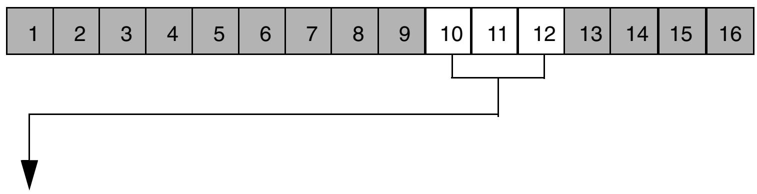
This register contains information on process and Turbine Meter Card status. Note setting bits in this register is not considered indication of a fault and does not trigger a fault on the block. However, users may want to alarm these points based on their standard practices. The following table provides a summary of the bits that are used in the Status Word:

Bit	Description	Bit	Description
1 MSB	Pulse Fidelity Channel A/B	9	Reserved for system use
2	CPL Forced to 1.0	10	Meter Proving Gate Status
3	Prove Counter Not Zero	11	Meter Proving Gate Status
4	CPS Forced to 1.0	12	Meter Proving Gate Status
5	Pulse Fidelity Sequence Error	13	Reserved for system use
6	Pulse Fidelity Phase Error	14	Reserved for system use
7	Pulse Fidelity Frequency Error	15	Proving Report Done
8	Pulse Fidelity Count Error	16	Proving Run in Process

4.2.6.3. Bit Contents: 4x + 5 Register (RD, BIN)

The following table provides a detailed description of the bits that are used in the Status Word:

Bit 1	**Pulse Fidelity Channel A/B** This bit indicates which channel is currently being used as the reference channel: 1 = A, 0 = B. If an error occurs, then the flowing logic applies to the status bit. If ON, then channel A is being used as the primary channel for data and channel B has failed. If OFF, then channel B is the primary channel and channel A has failed. During normal operating conditions, "No Errors," this bit will be ON.
Bit 2	**CPL Forced to 1.0** If ON, then bit 2 of Command Word 1 has been set to 1. This bit acknowledges the fact that the product selected does not have a true CPL of 1.0, but that the CPL has been manually set to 1.0.
Bit 3	**Prove Counter Not Zero** If the "Start Prove Run" bit 16 Command Word 2 is ON and the prover counter has not reset to zero, this bit will be ON. When the Block has successfully reset, the counter the bit will be OFF.
Bit 4	**CPS Forced to 1.0** The CPS value has been forced to 1.0. This setting is used for provers with a double wall, which equalizes the pressure inside and outside the calibrated chamber. In this case, the inner measuring section of the prover is not subjected to a net internal pressure, and the walls of this inner chamber do not stretch elastically. Therefore, CPS = 1.0000
Bit 5	**Pulse Fidelity Sequence Error** When pulse fidelity checking is enabled, Bit 5 indicates a sequence error. The error detector continuously samples the inputs. If three sequence errors are detected in one minute, a sequence error occurs, and BIt 5 is turned ON. This result is a real-time error flag to be used by the user. **Note:** Bit 5 does not generate an error and is not latched.
Bit 6	**Pulse Fidelity Phase Error** When pulse fidelity checking is enabled, Bit 6 indicates a phase error. The error detector continuously samples the inputs. If Bit 6 is ON, a Sequence error has occurred. This is a real-time error flag to be used by the user. **Note:** This bit does not generate an error and is not latched.
Bit 7	**Pulse Fidelity Frequency Error** When pulse fidelity checking is enabled, Bit 7 indicates a frequency error. The error detector continuously samples the inputs. If Bit 7 is ON a Sequence error has occurred. This is a real-time error flag to be used by the user. **Note:** This bit does not generate an error and is not latched.

Bit 8	**Pulse Fidelity Count Error** When pulse fidelity checking is enabled, Bit 8 indicates a count error. The error detector continuously samples the inputs. The system generates a Pulse Fidelity Count error if the count difference between the two channels is greater than the preset value in (4x + 124). If Bit 8 is ON, a count error has occurred. This result is a real-time error flag for the user. **Note:** This bit does not generate an error and is not latched.
Bit 9	Reserved for system use
Bits 10-12	**Meter Proving Gate Status** **Previous Prove Reports** The bit pattern (0 to 4) represents the status of each detector switch as it occurs.  000 = Waiting for First Detector Switch 001 = First Detector Switch Occurred 010 = Second Detector Switch Occurred 011 = Third Detector Switch Occurred (Bidirectional only) 100 = Fourth Detector Switch Occurred (Bidirectional ony)
Bit 13	Reserved for system use
Bit 14	Reserved for system use
Bit 15	**Proving Report Done** If ON, then the Proving report is complete. **Note:** This bit can be used to signal either a SCADA, HMI, or Operator that the report is complete.
Bit 16 (LSB)	**Proving Run in Process** When ON, this bit signifies that a proving run is in progress (for example, Uni-Directional Prover the first detector switch has been made and the counter is counting). When the last switch (#2 for unidirectional, #4 for bidirectional) is made, the Proving Run in Process bit will turn OFF. If OFF, there is no proving being performed.

4.2.7. Flow Card Setup Registers

4.2.7.1. Contents: 4x + 6 Register (WR, UINT)

Meter Run Number

This number represents the meter run in the PLC system. The block only needs to have a unique number from 1 to 16.
Meter Run Numbers are indirectly associated with the channel of the hardware card. There are 16 logical channels in memory that can be configured. The logical channels and the hardware channels are associated based on the combination of cards used in the system.

That is, if you have four 140MPM20400sc cards (four channels), then
- channel 1 of the second card is Meter Run Number 5
- channel 1 of the third card is Meter Run Number 9
- channel 1 of the fourth card is Meter Run Number 13

When using Pulse Fidelity, only odd-numbered runs can be selected. Furthermore, Pulse Fidelity uses two channels (this Meter Run Number and the next Meter Run Number) because pulse fidelity is indirectly associated with a channel that is not available for use. That is, if run 1 is selected, a block cannot be configured as run 2. However, if 3 is not configured as Pulse Fidelity, 4 can be used as a standard channel. If an invalid number is entered, a fault is generated and the block will not be scanned until corrected.

4.2.7.2. Contents: 4x + 7 (WR, UINT)

TMCI Block Starting 4x Registers

The contents of this register point to the registers that are in the TMCI register table for the cards controlled by this block. If an invalid number is entered, a fault is generated and the block will not be scanned until corrected.
For example: 400123 enter "123"

4.2.8. Product Data Registers

4.2.8.1. **Contents: 4x + 8 Register (WR, UINT)**	**Product Type** This register monitors the type of product flowing through the pipe. Enter the number corresponding to the type of product monitored: • 0 = Crude Oil • 1 = Refined (Fuel Oil, Jet, Jet - Gas, Gas) • 2 = Lubricating Oil • 3 = LPGs/NGLs (Requires the use of function blocks T23E and T24E.) If product type is less than 0, product type will be set to 0. If product type is greater than 3, product type will be set to 3. For further information on product type selections, see the table following (the Product Type Information table).
4.2.8.2. **Contents: 4x + 9 Register (WR, UINT)**	**Product Name** This register contains a number from 0 to 15 that represents a product name that the user determines (e.g. 1 = Crude Oil, 2= Premium, etc.). This number is just a label and is used to retrieve the previous Meter Factor for that product that was stored. The product type value is assigned by the user. **Note:** If the Product Name is a number greater than 15, the Product Name will be set to 15. **Note:** The product data is stored in a table. See *The Last Meter Factor Table, p. 133*.
4.2.8.3. **Contents: 4x + 10 Register (RD, HEX)**	**First API Table Used** This register displays the first API table in the CTL calculation or a zero if not required.
4.2.8.4. **Contents: 4x + 11 Register (RD, HEX)**	**Second API Table Used** This register displays the second API table in the CTL calculation or the only table used depending on the table, for example, entering a corrected gravity/density will cause this to occur.
4.2.8.5. **Contents: 4x + 12 ... + 13 Field (WR, FLOAT)**	**Sediment and Water % CSW Meter** Enter the percentage of sediment and water determined by a representative sample of liquid being measured. It represents the non-hydrocarbon portion of the liquid in whole percents e.g. 100% = 1.0, 3% = .03. **Note:** If a value larger that 1 is entered, then the value will be set to 1. Zero is a valid number and will be treated as no sediment and water content in the crude. If a number entered is less than zero, the number will be set to zero.

4.2.8.6. Product Type Information

API Gravity (Imperial).

API Gravity (Imperial)		
0=Crude	**1=Products**	**2=Lubricating Oil**
Input	**Input**	**Input**
Temperature Range 0 to 300 °F all Tables		
API Gravity 0 to 100	API Gravity 0 to 85	API Gravity -10 to 45
Table 5A	**Table 5B**	**Table 5D**
Output Ref. to 60 °F	Output Ref. to 60 °F	Output Ref. to 60 °F
Corrected API 0 to 100	Corrected API Gravity 0 to 85	Corrected API Gravity -10 to 45
Table 6A	**Table 6B**	**Table 6D**
CTL	CTL	CTL

Specific Gravity (Imperial).

Specific Gravity (Imperial)			
0=Crude	**1=Products**	**2=Lubricating Oil**	**3=NGLs**
Input	**Input**	**Input**	**Input**
Temperature Range 0 to 300 °F all Tables			
Specific Gravity .611 to 1.076	Specific Gravity 0.653 to 1.076	Specific Gravity .800 to 1.164	Specific Gravity .2100 to .7400
Table 23A	**Table 23B**	**Table 23D**	**Table 23E**
Output Ref. to 60 °F	Output Ref. to 60 °F	Output Ref. to 60 °F	Output Ref. to 60 °F
Specific Gravity .611 to 1.076	Specific Gravity 0.653 to 1.076	Specific Gravity .800 to 1.164	Specific Gravity .2100 to .7400
Table 24A	**Table 24B**	**Table 24D**	**Table 24E**
CTL	CTL	CTL	CTL

Density (Metric Gravity).

Density (Metric Gravity)		
0=Crude	**1=Products**	**2=Lubricating Oil**
Input	**Input**	**Input**
Temperature Range -18 to 150 °C all Tables except 53D and 54D, which are -20 to 150°C		
Density 610 to 1075 kg/m^3	Density 653 to 1075 kg/m^3	Density 800 to 1164 kg/m^3
Table 53A	**Table 53B**	**Table 53D**
Output Ref. to 15 °C	Output Ref. to 15 °C	Output Ref. to 15 °C
Density 610 to 1075 kg/m^3	Density 653 to 1075 kg/m^3	Density 800 to 1164 kg/m^3

Table 54A	Table 54B	Table 54D
CTL	CTL	CTL

4.2.9. Real-Time Correction Factor Registers

4.2.9.1. Contents: 4x + 14 ... + 15 Field (RD, FLOAT)

Calculated CTL
Calculated correction factor for temperature of liquid. The equation is listed in *Flow Equations and Algorithms, p. 233*.

4.2.9.2. Contents: 4x + 16 ... + 17 Field (RD, FLOAT)

Calculated CPL
Calculated correction factor for pressure of liquid. The equation is listed in *Flow Equations and Algorithms, p. 233*.

4.2.9.3. Contents: 4x + 18 ... + 19 Field (RD, FLOAT)

Calculated Meter Factor (After proving run)
Provides the calculated meter factor for the last proving run. This factor then is manually entered in to the Meter M Factor field 4x + 36 ... +37 under the "Meter Setup Data" group (see *Meter Setup / Real-Time Data Registers, p. 86*).
Note: Meter Factor is only transferred if the Automatic Prove bit is set to 1.

4.2.10. Meter Setup / Real-Time Data Registers

4.2.10.1. Contents: 4x + 20 ... 23 Field (WR, ASCII (8))

Serial Number of Meter (Optional)
The meter serial number may be stored in these four registers. Enter alphanumeric data in ASCII format (for instance, PF11741G).

4.2.10.2. Contents: 4x + 24 ... 27 Field (WR, ASCII (8))

Meter ID (Optional)
The meter ID may be stored in these four registers. Enter alphanumeric data in ASCII format (for instance, AXF11201).

4.2.10.3. Contents: 4x + 28 Register (WR, UINT)

Meter Size
The size of the meter is stored and displayed in integer format.
For example: A meter that is 10.000 is displayed as 10.000 x 1,000 = 10,000.

4.2.10.4. Contents: 4x + 29 Register (WR, UINT)

Meter Type
The type of the meter is stored and displayed in integer format. This field is user defined and can be any value between 0 and 65535.
1 = Turbine
2 = Positive Displacement

4.2.10.5. Contents: 4x + 30 ... 31 Field (RD, UDINT)

Meter Raw Counts Channel A
This register displays the contents of the flow card channel indicated by the card setup registers. The counts are stored in a unsigned double integer format (two registers).
Note: This multiple register field is a double unsigned integer using two consecutive registers (for example, 400100 and 400101). If the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 42638 and 400101 = 53134. However, if 400100 is looked at as a 32-bit unsigned integer, the value 5219982 will be displayed.

4.2.10.6. Contents: 4x + 32 ... 33 Field (RD, UDINT)

Meter Raw Counts Channel B (Pulse Fidelity only)
This multiple register field displays the contents of the flow card channel that is indicated by the card setup registers. The counts are stored in a unsigned double integer format (two registers).

Note: This multiple register field is a double unsigned integer using two consecutive registers (for example, 400100 and 400101). If the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 42638 and 400101 = 53134. However, if 400100 is looked at as a 32-bit unsigned integer, the value 5219982 will be displayed.

4.2.10.7. Contents: 4x + 34 ... 35 Field (RD, FLOAT)

Meter Frequency

This is the frequency of the Meter and it is displayed in floating point.

4.2.10.8. Contents: 4x + 36 ... 37 Field (WR, FLOAT)

Meter Factor

Enter the M factor of the meter. The meter M factor is used to apply a corrective offset or calibration value against a K factor. The meter M factor range is 0.5000 to 1.9999 with 1.0000, meaning no error exists, and thus no correction made. If the value entered is below .5000 then it is set to .5000. If the value is above 1.9999 then the value will be set to 1.9999.

4.2.10.9. Contents: 4x + 38 ... 39 Field (WR, FLOAT)

Meter K Factor (1.0-65355.0)

Enter the K factor of the meter. The meter K factor is typically located on the meter housing. The K factor informs the function block on how many pulses to count before incrementing an internal counter. The meter K factor range is 1.0 to 65535.0. If the value is 0, then it will be set to 1.

Note: K factors larger than 65535.0 may be entered, but those values are NOT supported.

4.2.10.10. Contents: 4x + 40 ... 41 Field (RD, FLOAT)

Meter Composite C Factor

The C factor of the meter is simply (K * M).

4.2.11. Real-Time Metering Data Registers

4.2.11.1. Contents: 4x + 42 ... + 43 Field (RD, FLOAT)

Indicated Standard Volume "Gross Volume" (Barrels or Cubic Inches / Hour)
The calculated ISV flow rate in barrels or cubic inches per hour. The ISV flow rate is calculated from the equations in *Flow Equations and Algorithms, p. 233*.

4.2.11.2. Contents: 4x + 44 ... + 45 Field (RD, FLOAT)

Gross Standard Volume "Net Volume" (Barrels or Cubic Inches / Hour)
The calculated GSV flow rate in barrels or cubic inches per hour. The GSV flow rate is calculated from the equations in *Flow Equations and Algorithms, p. 233*.

4.2.11.3. Contents: 4x + 46 ... + 47 Field (RD, FLOAT)

Net Standard Volume (Barrels or Cubic Inches / Hour)
The calculated net flow rate in barrels or cubic inches per hour. The net flow rate is calculated from the equations in *Flow Equations and Algorithms, p. 233*.

4.2.11.4. Contents: 4x + 48 ... + 49 Field (RD, FLOAT)

Sediment & Water Volume (Barrels or Cubic Inches / Hour)
The calculated S&W flow rate in barrels or cubic inches per hour. The S&W flow rate is calculated from the equations in *Flow Equations and Algorithms, p. 233*.

4.2.11.5. Contents: 4x + 50 ... + 51 Field (RD, UDINT)

Indicated Standard Volume Accumulator (Barrels or Cubes) Channel A
Accumulates the ISV barrels or cubic inches. Range is 9,999,999 unsigned double integer. The accumulator rolls over at 9,999,999.

4.2.11.6. Contents: 4x + 52 ... + 53 Field (RD, UDINT)

Indicated Standard Volume Accumulator (Barrels or Cubes) Channel B (Pulse Fidelity only)
Accumulates the ISV barrels or cubic inches. Range is 9,999,999 unsigned double integer. The accumulator rolls over at 9,999,999.

4.2.11.7. Contents: 4x + 54 ... + 55 Field (RD, UDINT)

Gross Standard Volume Accumulator (Barrels or Cubes)
Accumulates the GSV barrels or cubic inches. Range is 9,999,999 unsigned double integer. The accumulator rolls over at 9,999,999.

4.2.11.8. 4x + 56 ... + 57 Field (RD, FLOAT)

Corrected Product Density API 60 or API 15 if Metric
Corrected Gravity or Density depending upon which table has been selected.

4.2.12. Report Setup Registers

4.2.12.1. Contents: 4x + 58 Register

Reserved for system use

4.2.12.2. Contents: 4x + 59 Register (WR, UINT)

Start of Day 'Hour' (0 - 23 military)
This register is used only if reporting is enabled.This field is the hour at which a new day is determined to start. The value is entered in military time (0 - 23).

4.2.12.3. Contents: 4x + 60 Register (WR, UINT)

Start of Day 'Minute' (0 - 59)
This register is used only if reporting is enabled. This field is the minute at which a new day is determined to start. The value entered is in the range (0 - 59).

4.2.12.4. Contents: 4x + 61 Register (WR, UINT)

Report Address Modulo 10000 High Word (XX0000)
Registers 4x + 61 and 4x + 62 contain the 4x or 6x register address, in Modulo 10000 format, signifying the beginning of the report logging area. This field contains the two most significant digits of that 6-digit address.
For example, if the report logging area begins at 401000, then enter 40 into this register. If report area begins at 412000, enter 41 into this register.If the report logging area begins at 623000, then enter 62 into this register.

4.2.12.5. Contents 4x + 62 Register (WR, UINT)

Report Address Modulo 10000 Low Word (40XXXX)
Registers 4x + 61 and 4x + 62 contain the 4x or 6x register address, in Modulo 10000 format, signifying the beginning of the report logging area. This field contains the four least significant digits of that 6-digit address.
For example, if the report logging area begins at 401000, enter 1000 into this register. If report area begins at 412000, enter 2000 in this register. If the report logging area begins at 623000, enter 3000 into this register.

4.2.13. SCADA Data in Implied Decimal Format Registers

4.2.13.1. Contents: 4x + 63 Register (RD, INT)	**Temperature (XXX.XX)** The temperature scaled in engineering units in implied decimal format For example: 100 x 175.3° = 17530)
4.2.13.2. Contents: 4x + 64 Register (RD, INT)	**Pressure (XXX)** The pressure scaled in engineering units in implied decimal format For example: 150 = 150)
4.2.13.3. Contents: 4x + 65 Register (RD, INT)	**Gravity / Density (.XXXXX) or (XXX.X)** The Gravity / Density scaled in engineering units in implied decimal format For example: For all tables 10,000 x 0.6578 = 6578 or for API 79.3 x 10 = 793).

4.2.14. Prover Data Registers

4.2.14.1.
Contents: 4x + 66 Register (WR, UINT)

Internal Diameter of the Pipe
Internal diameter of the pipe is stored and displayed in integer format.
For example: A pipe with a ID of 10.000 is displayed / entered as 10.000 x 1,000 = 10,000. (Metric: 311.1 mm x 10 = 3111)
Min. = 5.000 (1270 mm)
Max. = 30.000 (7620 mm)

4.2.14.2.
Contents: 4x + 67 Register (WR, UINT)

Wall Thickness of the Pipe
The wall thickness of the pipe is stored and displayed in integer format.
For example: A pipe with a wall thickness of .3650 is displayed / entered as .3650 x 10,000 = 3650. (Metric: 12.45 mm x 100 = 1245)
Min. = .2500 (6.00 mm)
Max. = 1.000 (25.40 mm)

4.2.14.3.
Contents: 4x + 68 Register (WR, UINT)

Modulus of Elasticity for the pipe material x 10^5
The Modulus of elasticity for pipe material. This value is displayed in millions.
For example: Mild Carbon Steel has modulus of elasticity value of 30,000,000 and it is displayed / entered as 30,000,000 / 100,000 = 300. (Per PSI) (Metric: 193,000,000/100,000. = 1930 (Per KpA))
Min. = 200 (1500)
Max. = 320 (2100)

4.2.14.4.
Contents: 4x + 69 Register (WR, UINT)

Coefficient of Cubic Expansion per °F or °C of the Pipe Material
The mean coefficient of cubical expansion per degree of the pipe material. This value is entered in integer format.
For example: Mild Carbon Steel has a coefficient of cubic expansion value of .0000186 /F and is entered as 10,000,000 x .0000186 = 186. (Metric: .0000518/c x 10,000,000 = 518)
Min. = 150 (300)
Max. = 300 (520)

4.2.14.5. Contents: 4x + 70 ... + 71 Field (WR, UDINT)

Base Volume of Prover @ 60°F 0 PSI (Barrels, Cubes)

This is the Base Volume of the Prover provided from the last water draw calibration run. The counts are stored in a double integer format (two registers) and an implied decimal point is used.

For example: A count of 12.462801 would be displayed as 12.462801 x 1,000,000 = 12462801.

Note: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101. If the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed. To convert this value for display, use the ITOI block. (See *Integer-to-Integer (ITOI) Function Block, p. 243*)

+71: Max. = 4, 294,967, 265

4.2.14.6. Contents: 4x + 72 Register (WR, UINT)

Number of consecutive proving runs

This is the number of consecutive proving runs that a proving report will use to calculate the new meter factor. The minimum number of consecutive proves is 2 and the maximum is 10. Any number outside that range will generate a fault.

4.2.14.7. Contents: 4x + 73 Register (RD, UINT)

Current Number of the Consecutive Proving Runs

This displays the current proving run in the proving report.

4.2.14.8. Contents: 4x + 74 ... + 75 Field (RD, UDINT)

Prover Raw Counts

This is a display of the contents of the flow card prover channel indicated by the card setup registers (This is a read-only register and is for display only). The counts are stored in a unsigned double integer format (two registers) and an implied decimal point is used.

For example: A count of 70000.1234 would be displayed as 70000.1234 x 10,000 = 700001234.

Note: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101. If the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed.

4.2.14.9. 4x + 76 ... + 77 Field (RD, FLOAT)

Calculated CTS

The correction for the effect of temperature on steel (CTS) is stored in floating point format.

For example: 1.00028 CTS

See *Flow Equations and Algorithms, p. 233* for equation.

4.2.14.10. 4x + 78 ... + 79 Field (RD, FLOAT)

Calculated CPS

The correction for the effect of pressure on steel (CPS) is stored in floating point format.

For example: 1.00023 CTS

4.2.15. Real-Time Process Variables Registers

4.2.15.1. Contents: 4x + 80 Register (WR, UINT)

Specific Gravity / Density Raw Counts (Meter)
The raw value coming from the analog input card.

4.2.15.2. Contents: 4x + 81 Register (WR, UINT)

Specific Gravity / Density Conversion Range (Meter)
Enter the value representing the conversion range supported by the analog input card being used. See *Analog Input Conversion Ranges, p. 253* for valid analog input conversion ranges.

4.2.15.3. Contents: 4x + 82 ... +83 Field (WR, FLOAT)

Specific Gravity / Density High Engineering Units (Meter)
Enter the maximum Density in engineering units the function block can calculate from the raw value.

4.2.15.4. Contents: 4x + 84 ... +85 Field (WR, FLOAT)

Specific Gravity / Density Low Engineering Units (Meter)
Enter the minimum Density in engineering units the function block can calculate from the raw value.

4.2.15.5. Contents: 4x + 86 ... +87 Field (WR, FLOAT)

Specific Gravity / Density Scaled Output (Meter)
The Specific Gravity / Density scaled in engineering units.
If Bit 6 of Command Word 1, PCFC is ON, then the value is manually entered.
If Bit 6 of Command Word 1, PCFC is OFF, the scaled temperature is calculated from the raw value and the conversion range used.
Bit 4 of Command Word 1, PCFC determines if the value entered is Specific Gravity (bit 4 = 0) or API 60 (bit 4 = 1).

4.2.15.6. Contents: 4x + 88 Register (WR, UINT)

Temperature Raw Counts (Meter)
The raw value coming from the analog input card.

4.2.15.7. Contents: 4x + 89 Register (WR, UINT)

Temperature Conversion Range (Meter)
Enter the value representing the conversion range supported by the analog input card being used. See *Analog Input Conversion Ranges, p. 253* for valid analog input conversion ranges.

4.2.15.8. Contents: 4x + 90 ... + 91 Field (WR, FLOAT)	**Temperature High Engineering Units (Meter)** Enter the maximum temperature in engineering units the function block can calculate from the raw value.
4.2.15.9. Contents: 4x + 92 ... + 93 Field (WR, FLOAT)	**Temperature Low Engineering Units (Meter)** Enter the minimum temperature in engineering units the function block can calculate from the raw value.
4.2.15.10. Contents: 4x + 94 ... + 95 Field (WR, FLOAT)	**Temperature Scaled Output (Meter)** The temperature scaled in engineering units. The scaled temperature is calculated from the raw value and the conversion range used.
4.2.15.11. Contents: 4x + 96 Register (WR, UINT)	**Pressure Raw Counts (Meter)** The raw value coming from the analog input card.
4.2.15.12. Contents: 4x + 97 Register (WR, UINT)	**Pressure Conversion Range (Meter)** Enter the value representing the conversion range supported by the analog input card being used. See *Analog Input Conversion Ranges, p. 253* for valid analog input conversion ranges.
4.2.15.13. Contents: 4x + 98 ... + 99 Field (WR, FLOAT)	**Pressure High Engineering Units (Meter)** Enter the maximum pressure in engineering units the function block can calculate from the raw value.
4.2.15.14. Contents: 4x + 100 ... + 101 Field (WR, FLOAT	**Pressure Low Engineering Units (Meter)** Enter the minimum pressure in engineering units the function block can calculate from the raw value.
4.2.15.15. Contents: 4x + 102 ... + 103 Field (RD, FLOAT)	**Pressure Scaled Output (Meter)** The pressure scaled in engineering units. The scaled pressure is calculated from the raw value and the conversion range used.

4.2.15.16. Contents: 4x + 104 Register (WR, UINT)

Temperature Raw Counts (Prover)
The raw value coming from the analog input card.

4.2.15.17. Contents: 4x + 105 Register (WR, UINT)

Temperature Conversion Range (Prover)
Enter the value representing the conversion range supported by the analog input card being used. See *Analog Input Conversion Ranges, p. 253* for valid analog input conversion ranges.

4.2.15.18. Contents: 4x + 106 ... + 107 Field (WR, FLOAT)

Temperature High Engineering Units (Prover)
Enter the maximum temperature in engineering units the function block can calculate from the raw value.

4.2.15.19. Contents: 4x + 108 ... + 109 Field (WR, FLOAT)

Temperature Low Engineering Units (Prover)
Enter the minimum temperature in engineering units the function block can calculate from the raw value.

4.2.15.20. Contents: 4x + 110 ... + 111 Field (WR, FLOAT)

Temperature Scaled Output (Prover)
The temperature scaled in engineering units. The scaled temperature is calculated from the raw value and the conversion range used.

4.2.15.21. Contents: 4x + 112 Register (WR, UINT)

Pressure Raw Counts (Prover)
The raw value coming from the analog input card.

4.2.15.22. Contents: 4x + 113 Register (WR, UINT)

Pressure Conversion Range (Prover)
Enter the value representing the conversion range supported by the analog input card being used. See *Analog Input Conversion Ranges, p. 253* for valid analog input conversion ranges.

4.2.15.23. Contents: 4x + 114 ... + 115 Field (WR, FLOAT)

Pressure High Engineering Units (Prover)
Enter the maximum pressure in engineering units the function block can calculate from the raw value.

4.2.15.24. Contents: 4x + 116 ... + 117 Field (WR, FLOAT

Pressure Low Engineering Units (Prover)

Enter the minimum pressure in engineering units the function block can calculate from the raw value.

4.2.15.25. Contents: 4x + 118 ... + 119 Field (WR, FLOAT)

Pressure Scaled Output (Prover)

The pressure scaled in engineering units. The scaled pressure is calculated from the raw value and the conversion range used.

4.2.16. Pulse Fidelity Registers

4.2.16.1. Contents: 4x + 120 Register

Reserved for System Use

4.2.16.2. Contents: 4x + 121 Register

Reserved for System Use

4.2.16.3. Contents: 4x + 122 Register

Reserved for System Use

4.2.16.4. Contents: 4x + 123 Register (WR, UINT)

Pulse Fidelity Frequency Threshold (Pulse Fidelity Only)
Sets the minimum frequency at which pulse fidelity will operate.
Note: When pipeline flow is starting or stopping, the turbine will oscillate while it is not operating above optimal rating (the flow range the meter was designed for). This information is provided with your meter and some flow information is stamped on the meter itself.

4.2.16.5. Contents: 4x + 124 Register (WR, UINT)

Number of Count Errors in a Batch (Pulse Fidelity Only)
Enter the acceptable number of count errors during a batch run.

4.2.16.6. Contents: 4x + 125 Register (RD, UINT)

Common Mode Errors (Pulse Fidelity Only)
This is an eight-bit counter used to count common errors. These errors are caused when both input signals transition at the same time (in pulse fidelity).

4.2.17. Program Diagnostic Data Registers

4.2.17.1. Contents: 4x + 126 Register (WR, UINT	**Filter Sample Rate** Enter a number between 0 and 1200 for the sample rate at which the frequency of the meter is calculated. **Note:** The value in this field is x 10 ms.
.4.2.17.2. Contents: 4x + 127 Register (WR, UINT)	**Base Temperature** This register is used to change the base temperature at which the liquid is corrected to K. For example, 30.0C° = (30.0 x 100) = 3000; enter into the register field.
4.2.17.3. Contents: 4x + 128 (RD, UINT)	**Program Step** The equations in the block are broken up into steps. This register can be used as a heart beat to determine if the block is functioning properly.
4.2.17.4. Contents: 4x + 129 (RD, UINT)	**Error Code** This displays the first error code for the block. Code 9999 is normal. Codes 0 to 118 represent the implied 4x register number that is in fault. For example: 65 would be calculated CTL 4x + 14 ... +15. Codes 0 to 118 imply that the register has had an invalid IEEE floating point number entered into the block.
4.2.17.5. Contents: 4x + 130 Register	**Reserved for System Use**
4.2.17.6. Contents: 4x + 131	**Reserved for System Use**

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5. T23E Function Block

5

At a Glance

Purpose

This material describes the block structure representation, operation, and configuration of the T23E function block.

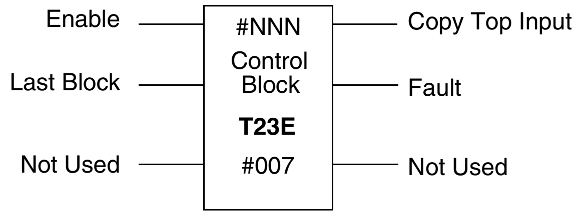
What's in this Chapter?

This chapter contains the following topics:

5.1. T23E Function Block Structure

5.1.1. Block Structure Diagram

The block structure is illustrated below.



5.1.2. Inputs

T23E has three control inputs.

- **Top** input node enables the function block.
- **Middle** input node determines the last T23E block by setting this input ON. This determination is achieved by shorting the pin to the power rail.
  Note: Short if there is only one block configured. Otherwise, the block will not operate.
- **Bottom** Not used.

5.1.3. Outputs

T23E can produce three possible outputs.

- **Top** output is a copy of the top node input.
- **Middle** output turns ON when the function block has detected a fault. (Faults are also indicated in the PCFC block fault word.)
  Possible faults are listed below:
  - Block pointers are invalid. These pointer must point to configured 4x registers.
  - Block pointers overlap PCFC registers.
  - Temperature / Density is outside of GPA TP-25 Table 23E range.
  - Bottom Node has incorrect number of use registers for the block.
  - Top Node has invalid node number.
- **Bottom** output is NOT used.

5.1.4. Top Node Content

The top node is the instance number of the block in the system. This number must be a unique number between 0 and 15 (there must be no unused numbers or gaps between numbers; otherwise, the block will NOT function). Thus, there are only 16 blocks maximum allowed in a system.

Note: Note the instance number must match the top node numbering of the PCFC and T24E blocks.

5.1.5. Middle Node Content

The 4x register entered in the middle node is the first of 6 contiguous holding registers that comprise the control block.

5.1.6. Bottom Node Content

The bottom node must contain a constant #0006 representing the length of the control block in 4x registers.

5.2. T23E Operation

5.2.1. T23E Block Operation

This block was designed to convert an uncorrected density to a corrected density of 60F (15°C). This block is used in conjunction with the T24E and PCFC blocks to create a complete system for calculating NGLs / LPGs volume correction factors. This block is designed to communicate directly with the PCFC and T24E blocks and is not intended to be used without either. If a density is already corrected and a CTL is desired, the T23E block must still be used.

> **Note:** The T23E block does not support metric NGLs/LPGs. If metric support is needed, use T23E and T24E in imperial mode and select the process values to be converted from Celsius to Fahrenheit and Kpa to PSIG.
>
> The CTL and CPL should be a very close approximation to the existing standard.

5.2.2. Using the API 21.2 Audit Trail Formatting Standard

When using the API 21.2 Audit Trail formatting standard, the first four blocks must be used (for example 0, 1,2, and 3, Top node address). Blocks that do not require the API 21.2 Audit Trail formatting standard may use any number between 0 to 3. If the API 21.2 Audit Trail formatting standard is not used, then there are no special requirements and any number can be used as long as it follows the Top node address of the corresponding PCFC and T24E blocks. Once the API 21.2 Audit Trail formatting standard has been enabled, the values in the T23E are not accessible for the user to change. A password must be entered into the AUDT block to allow variable access. Therefore, Schneider Electric recommends that all parameters be entered before the API 21.2 Audit Trail bit has been enabled in Command Word 1, Bit 3 in the PCFC block and also set in Command Word 1, Bit 5 of the TMCI block.

5.3. T23E Function Block Configuration

5.3.1. Overview

The following material provides an overview of the T23E function block's register contents. A table that summarizes the register's contents and a detailed description of each register is provided.

5.3.2. Summary: Setup and Diagnostic Data Registers

The following data summarizes the contents of the registers.

Register	Access	Data Type	Comment
4x + 0	RD	HEX	T23E Revision Number (X.XX)
4x + 1	**WR**	UINT	Pointer to table in the T24E block
4x + 2	**WR**	UINT	Pointer to table in the PCFC block
4x + 3	RD	HEX	T23E Status
4x + 4	RD	INT	T23E Program Counter
4x + 5	RD	INT	T24E Program Counter
4x + 6	RD		Reserved for System Use

5.3.3. Contents: 4x + 0 Register (RD, HEX)

T23E Revision Number (X.XX)
Displays current function block revision number. Format is (X.XX).For example, hex 0100 indicates revision 1.00.

5.3.4. Contents: 4x + 1 Register (WR, UINT)

T24E Block Pointer
This is a pointer to the middle node of the corresponding T24E block in the system, which will interface with the current T23E. The number is entered without the preceding data type 4 e.g. 401256 is entered as 1256.

5.3.5. Contents: 4x + 2 Register (WR, UINT)

PCFC Block Pointer
This is a pointer to the middle node of the PCFC block where NGL / LPG calculations are required. The number is entered without the preceding data type 4 e.g. 401256 is entered as 1256.

5.3.6. Contents: 4x + 3 Register (RD, HEX)

T23E Program Status

This register contains communication status information and processing status of the block.

Bit	Description	Bit	Description
1 MSB	Calculation done (If = 1)	9	Reserved for system use
2	Control returned from T24E (If = 1)	10	Reserved for system use
3	Reserved for system use	11	Reserved for system use
4	Indicates first scan through main block loop (If = 1)	12	Reserved for system use
5	Calculation error occurred. Notifies T24E block (If = 1)	13	Pass control to T24E (If = 1)
6	Reserved for system use	14	Reserved for system use
7	Reserved for system use	15	T24E calculating (If = 1)
8	Reserved for system use	16 LSB	Error in calculation (If = 1) Bit 1, Fault Word 1 in PCFC tracks this bit or with T24E register 4x + 7, Bit 16

5.3.7. Contents: 4x + 4 Register (RD, INT)

T23E Program Counter

5.3.8. Contents: 4x + 5 Register (RD, INT)

T24E Program Counter

Either 10 (calculating) or 90 (resetting).
This register has no connection with 4x + 8 register in T24E.

5.3.9. Contents: 4x + 6 Register

Reserved for System Use

6. T24E Function Block

6

At a Glance

Purpose

The material describes the block structure presentation, operation, and configuration of the T24E Function Block.

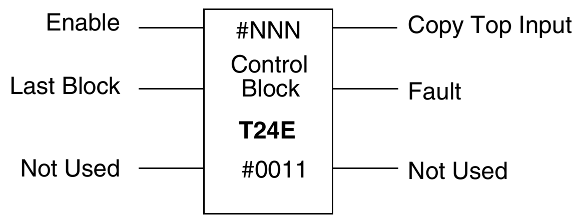
What's in this Chapter?

This chapter contains the following topics:

6.1. T24E Function Block Structure

6.1.1. Block Structure Diagram

The block structure is illustrated below.



6.1.2. Inputs

T24E has three control inputs.

- **Top** Enables the function block.
- **Middle** Used to determine the last T24E block. This determination is achieved by shorting the pin to the power rail.
  Note: The pin must be shorted if there is only one block; otherwise, block will not operate.
- **Bottom** Not used.

6.1.3. Outputs

T24E can produce three possible outputs.

- **Top** Copy of the top node input
- **Middle** Turns ON when the function block has detected a fault.
  Possible faults are listed below:
  - Block pointers are incorrect, not pointing to a valid 4x register.
  - Block pointers overlap PCFC; cannot be the same nor overlap.
  - Temperature / Density is outside of GPA TP-25 Table 24E range.
  - Bottom Node has incorrect number of use registers for the block.
  - Top Node has invalid node number.

  Faults are also indicated in the PCFC block fault word.
- **Bottom** Not used

6.1.4. Top Node Content

The top node is the instance number of the block in the system. This must be a unique number between 0 and 15 (there must be no unused numbers or gaps between numbers otherwise the block will not function). Thus there are only 16 blocks maximum allowed in a system.

> **Note:** The instance number must match the top node numbering of the PCFC and T23E blocks.

6.1.5. Middle Node Content

The 4x register entered in the middle node is the first of 11 contiguous holding registers that comprise the control block.

6.1.6. Bottom Node Content

The bottom node must contain a constant #0011 representing the length of the control block in 4x registers.

6.2. T24E Operation

6.2.1. T24E Block Operation

This block was designed to convert a corrected density to a CTL value. This block is used in conjunction with the T23E and PCFC blocks to create a complete system for calculating NGLs / LPGs volume correction factors. This block is designed to communicate directly with the PCFC and T23E blocks and is not intended to be used without either. If a density is already corrected and a CTL is desired, the T23E block must still be used.

6.2.2. Using the API 21.2 Audit Trail

When using the API 21.2 Audit Trail formatting standard, the first four blocks must be used (for example 0,1,2, and 3 Top node address). Blocks that do not require the API 21.2 Audit Trail formatting standard may use any number after 0 to 3. If the API 21.2 Audit Trail formatting standard is not used, then there are no special requirements, and any number can be used as long as it follows the Top node address of the corresponding PCFC and T23E. Once the API 21.2 Audit Trail formatting standard has been enabled, the values in the T24E are not accessible for the user to change. A password must be entered into the AUDT block to allow variable access. Therefore, it is recommend that all parameters be entered before the Audit Trail has been enabled.

6.3. T24E Function Block Configuration

6.3.1. Overview

The following material provides an overview of the T24E function block's register contents. The section begins with a table that summarizes the register's contents. Following the table is a detailed description of each register.

6.3.2. Summary: Setup and Diagnostic Data Registers

The following data summarizes the contents of the registers.

Register	Access	Data Type	Content
4x + 0	RD	HEX	T24E Revision Number (X.XX)
4x + 1	RD		Reserved for System Use
4x + 2	RD		Reserved for System Use
4x + 3	RD		Reserved for System Use
4x + 4	RD		Reserved for System Use
4x + 5	RD		Reserved for System Use
4x + 6	RD		Reserved for System Use
4x + 7	RD	HEX	T24E Status
4x + 8	RD	INT	T24E Program Step
4x + 9	RD	UINT	PCFC Middle Node Address Modulo 10000 Low Word
4x + 10	RD		Reserved for System Use

6.3.3. Contents: 4x + 0 Register (RD, HEX)

T24E Revision Number (X.XX)
Displays current function block revision number. Format is (X.XX).For example, hex 0100 indicates revision 1.00.

6.3.4. Contents: 4x + 1 Register

Reserved for System Use

6.3.5. Contents: 4x + 2 Register

Reserved for System Use

6.3.6. Contents: 4x + 3 Register

Reserved for System Use

6.3.7. Contents: 4x + 4 Register

Reserved for System Use

6.3.8. Contents: 4x + 5 Register

Reserved for System Use

6.3.9. Contents: 4x + 6 Register

Reserved for System Use

6.3.10. Contents: 4x + 7 Register (RD, HEX)

T24E Status

This register contains communication status of the block with respect to T23E and also indicates processing status.

Bit	Description	Bit	Description
1 MSB	Calculation done (If = 1)	9	Reserved for system use
2	Reserved for system use	10	Reserved for system use
3	Reserved for system use	11	Reserved for system use
4	Reserved for system use	12	Reserved for system use
5	Error status from T23E block (error if = 1)	13	Reserved for system use
6	Reserved for system use	14	Reserved for system use
7	Reserved for system use	15	Indicates block working to T23E (If = 1)
8	Reserved for system use	16 LSB	Indicates calculation error. Bit 1, Fault Word 1 in PCFC tracks this bit or with T23E register 4x + 3, Bit 16.

6.3.11. Contents: 4x + 8 Register (RD, INT)

T24E Program Step

The equations in the block are broken up into steps. This register can be used as a heart beat to determine if the block is function properly.

6.3.12. Contents: 4x + 9 Register (RD, UINT)

PCFC Middle Node Address Modulo 10000 Low Word

This register should be the lower digits of the PCFC middle node.
For example, if the middle node is 400300, this value will be 300.

6.3.13. Contents: 4x + 10 Register

Reserved for System Use

Part III Data Logging and Report Generation

III

At a Glance

Purpose

This part explains how to configure reporting and, in detail, the information available from the reports generated by the PCFC "virtual flow computer." The data logging in the PCFC was designed to meet the requirements of the API 2540, Chapter 21, Section 2, Part 10 Auditing and Reporting Requirements and industry acceptable practices.
Reports are generated in the PLC's memory and can be accessed or printed by a number of methods, for example HMI, serial printer, or SCADA.
The data can be viewed in real time from any of the previously mentioned devices. However, if the API 2540 21.2 Audit Trail Option is being used, only those PCFC blocks that are not protected by the AUDT block will be visible. For more information see the AUDT block in this manual.

What's in this Part?

This part contains the following chapters:

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7. Data Logging and Report Generation

7

At a Glance

Purpose

This chapter describes the data logging and report generation features of the PCFC.

What's in this Chapter?

This chapter contains the following topics:

7.1. Overview of Data Logging and Reports

7.1.1. Data Logging

For historical analysis, the PCFC function block has the ability to log data to a PLC's holding registers. When this option is selected, 492 registers are allocated to log the data to in either 4x or 6x registers.

Discussed later but presented here for convenience, there are four control table registers that must be configured for proper data logging to occur. Also, the time of day clock in the PLC must be configured.

Register	Content		
4x + 59	**WR**	UINT	Start of Day 'Hour' (0 - 23 military)
4x + 60	**WR**	UINT	Start of Day 'Minute' (0 - 59)
4x + 61	**WR**	UINT	Report Address Modulo 10000 High Word (00XX)
4x + 62	**WR**	UINT	Report Address Modulo 10000 Low Word (XXXX)

7.1.2. Types of Reports

The data storage area consists of three types of reports:
- batch end
  (triggered by a positive transition on the bottom input of the PCFCC block)
- timed
  - daily
  - monthly
- meter proving

These reports are triggered based on the report type such as batch (event triggered) or daily (time triggered).
The following table shows how the data storage area is subdivided by report type. Using bits 10 – 12 in the Command Word 1, PCFC the user can configure the number of previous batch reports. The address in the table below starts at the value in the 4x + 61 and 4x + 62 register.
For example: If 4x + 61 contains 40 and 4x + 62 contains 18000, 4x + 0 in the table is located at 418000. (See *Report Setup Registers, p. 89*)

Report Register	Report Type
4x +0 .. + 40	Current Batch
4x +41 .. + 81	Previous Batch
4x +82 .. + 122	Previous Batch - 1
4x +123 .. + 163	Previous Batch - 2
4x +164 .. + 204	Previous Batch - 3
4x +205 .. + 245	Previous Batch - 4
4x +246 .. + 286	Previous Batch - 5
4x +287 .. + 327	Previous Batch - 6
4x +328 .. + 368	Current Day
4x +369 .. + 409	Previous Day
4x +410.. + 450	Current Month
4x +451.. + 491	Previous Month

7.1.3. Report Register Contents

Each report consumes 41 registers. The function block stores the following data into each report. The following table provides a description of each register used to configure the parameters for the report. The address starts at the 4x + 61 and 4x + 62 register.

Register Usage	Data Type	Data Description
4x +0	UINT	The Month when Report Started
4x +1	UINT	The Day when Report Started
4x +2	UINT	The Hour when Report Started
4x +3	UINT	The Minute when Report Started
4x +4	UINT	The Month when Report Ended
4x +5	UINT	The Day when Report Ended
4x +6	UINT	The Hour when Report Ended
4x +7	UINT	The Minute when Report Ended
4x +8 .. + 9	FLOAT	Average Temperature
4x +10 .. + 11	FLOAT	Average Pressure
4x +12 .. + 13	FLOAT	Average Density Corrected
4x +14 .. + 15	FLOAT	Average CTL
4x +16 .. + 17	FLOAT	Average CPL
4x +18 .. + 19	FLOAT	Average Meter Factor
4x +20	UINT	Average Temperature INT
4x +21	UINT	Average Pressure INT
4x +22	UINT	Average Density INT Corrected
4x +23	UINT	Average CTL Integer Portion
4x +24	UINT	Average CTL Decimal Portion
4x +25	UINT	Average CPL Integer Portion
4x +26	UINT	Average CPL Decimal Portion
4x +27	UINT	Average Meter Factor INT
4x +28	UINT	ISV Barrels or Cubes Modulo High
4x +29	UINT	ISV Barrels or Cubes Modulo Low
4x +30.. + 31	UDINT	ISV Accumulator Channel A ISV accumulator will roll over at 9,999,999

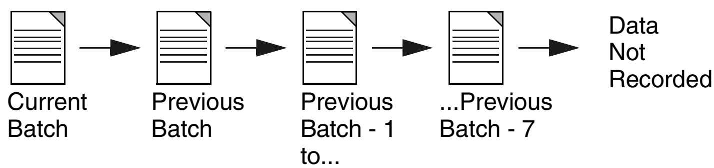
Register Usage	Data Type	Data Description
4x +32 .. + 33	UDINT	ISV Accumulator Channel B ISV accumulator will roll over at 9,999,999
4x +34 .. + 35	UDINT	GSV Accumulator Channel GSV accumulator will roll over at 9,999,999
4x +36	UINT	GSV Barrels or Cubes Modulo High
4x +37	UINT	GSV Barrels or Cubes Modulo Low
4x +38	UINT	Average S W
4x +39	UINT	NSV Barrels or Cubes Modulo High
4x +40	UINT	NSV Barrels or Cubes Modulo Low

7.2. Batch Reports

7.2.1. Batch Report Sequence

The batch reports only use the following reports:
- Current Batch
- Previous Batch –1
- Previous Batch –2
- Previous Batch –3
- Previous Batch –4
- Previous Batch –5
- Previous Batch –6
- Previous Batch –7

The batch reports are event-triggered by the third input of the block (Initiate Batch Report). The function block has the ability to manage batches. A batch's time frame can be different from batch to batch unlike daily and monthly reports. Batch reports are completed and subsequently started when input #3 is activated (positive transition). For historical analysis the function block will maintain a maximum of 7 previous batch reports. The number of batch reports is selectable by modifying bits 10 – 12 in Command Word 1 of the PCFC block. (See *Bit Summary: 4x + 1 Register (WR, BIN), p. 61*) Upon a new batch report, all older reports are shifted down until the oldest batch report gets deleted from the storage area.
The sequence is shown here.



7.2.2. Current Batch

The Current Batch displays the batch in progress. All values are being constantly updated until timed report (Daily or Monthly report) or "Batch" report is triggered by Input three of the function block. The Current Batch information is then moved to the Previous Batch Report for historical data.

7.2.3. Previous Batch

The Previous Batch holds historical data from the current batch prior to the "Initiate Batch Report" (Third Input) being triggered.

If bit 1 of Command Word 1 of the PCFC block (M Factor Retroactive on Batch Ticket) is ON, then the last value in the Meter Factor field will be used to recalculate the entire batch using the new Meter Factor. (See *Bit Summary: 4x + 1 Register (WR, BIN), p. 61*) The last meter factor will then be moved to the Average Meter Factor Field in the report (if bit 1 of Command Word 2 of the PCFC block (Automatic Prove) bit is set to 1 (See *Bit Summary: 4x + 2 Register (WR, BIN), p. 66*)).

7.2.4. Sample Batch End Report

Here is a sample Batch End report.

BATCH END REPORT					
Date: 09/26/01		Time: 14:07		Ticket#: 1211	
Product #: 12		API Table Selected: 23B/24B			
Meter Run ID	101	102	105	109	
Batch Start Date	9/25/01	9/25/01	9/25/01	9/25/01	
Batch Start Time	9:00	3:00	6:00	6:30	
Batch End Date	09/26/01	9/25/01	09/26/01	09/26/01	
Batch End TIme	14:27	10:05	12:01	16:12	
Batch ISV Barrels	150123	120089	170891	200123	
Batch GSV Values	140001	100999	160912	190050	
Batch Flow Weighted Averages					
Temperature Deg. F	85.1	85.1	85.5	85.2	85.2
Pressure PSIG	150	151	150	149	152
Flowing Density API	64.1	64.1	63.7	63.9	63.9
Density Temp Deg. F	85.1	85.1	85.5	85.2	85.2
CTL	1.00251	1.00251	1.00257	.987341	.987341
CPL	1.0051	1.0051	1.0051	1.0051	1.0051
Meter Factor	1.0009	.9876	1.0001	1.2041	1.0023
K Factor	1000	987	1011	1055.5	1000

7.3. Timed Reports

7.3.1. Types of Timed Reports

The time-driven reports include daily and monthly reports. The Current Batch, Current Day, Current Month will all initially display the same data until the Current Day, Current Month has expired.

7.3.2. Daily Reports

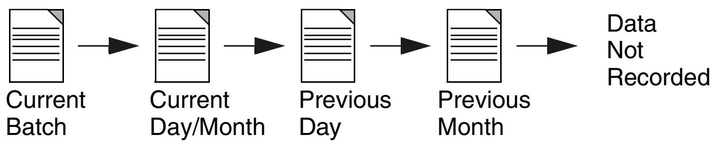
The function block will complete and then start a new daily report at the hour and minute supplied by the user. The function block will maintain information for the current day and the previous day.

7.3.3. Monthly Reports

The function block will complete and then start a new monthly report at the hour and minute supplied by the user on the first of every month. The function block will maintain information for the current month and the previous month.

7.3.4. Timed Report Sequence

The sequence is shown here.



7.3.5. Time-of-Day Clock

The PLC's Time of Day (TOD) clock determines the end of a Current Day report. For example: The current time of the PLC is January 25, 2001 14:35 The Start of Day Hour register is set to 15 hundred hours and the Start of Day Minute register is set to 00. When the Day register increments to the next day the 26th the report will not be generated until the hour and minutes are greater than the Start of Day registers i.e. at time equal January 26, 2001 15:01.

7.4. Meter Proving Reports Overview

7.4.1. Enabling Proving Reports

The PCFC function block has the ability to log Proving data to PLC holding registers for historical analysis. This report is available when standard data logging is enabled. Further, the "Meter Proving Used" bit 9 of Command Word 1, PCFC must be ON and the number of proving runs (set in the 4x + 6 register of the PCFC) must be greater than zero. When this option is selected, 1263 registers are allocated to log the data to in either 4x or 6x registers regions. The prove ticket size is 227 registers. The last Meter Factor table is 128 registers in length. The report registers start at the address set up in the 4x + 61 and 4X + 62 registers.

Note: If 16 PCFC blocks are configured with batch and proving reports, the minimum report size area is 28,080 registers.

7.4.2. Data Storage Layout of Proving Reports

The layout below shows how the data storage area is subdivided by report type. Using bits 10 – 12 in Command Word 2, the user can configure the number of previous prove reports.

Proving Report Register Layout Table

Report Register	Report Type
4x +492 .. + 718	Current Proving Report
4x +719 .. + 945	Previous Proving Report - 1
4x +946 .. + 1172	Previous Proving Report - 2
4x +1173 .. + 1399	Previous Proving Report - 3
4x +1400 .. + 1626	Previous Proving Report - 4
4x +1627 .. + 1754	Last Meter Factor table

Note: Selecting Proving Reports
Meter Proving Reports automatically include Batch and Timed Reports. The total number of registers used will be 1,755, 4x or 6x. See page *Overview of Data Logging and Reports, p. 116*.

7.5. Meter Proving Report Details (Registers 4x + 0 through 4x + 19)

7.5.1. Overview

This unit describes the meter proving report words for registers 4x + 0 through 4x + 19.

The registers are referenced with respect to the beginning of each of the Proving Reports listed in the Proving Report Register Layout Table in the section*Data Storage Layout of Proving Reports, p. 123*. For example, register 4x+1 displays the Day in a Proving Report. In the first Previous Proving Report, the Day is register 4x + 720. In the second Previous Proving Report, the Day is register 4x + 947. In the third Previous Proving Report, the Day is register 4x + 1174. In the fourth Previous Proving Report, the Day is register 4x + 1401. The system allows only four Previous Proving Reports.

7.5.2. 4x +0 Register (UINT)

Month
The month when the report started, in integer format.

7.5.3. 4x +1 Register (UINT)

Day
The day when the report started, in integer format.

7.5.4. 4x +2 Register (UINT)

Hour
The hour when report started (Military 0 to 23 Hr.), in integer format.

7.5.5. 4x +3 Register (UINT)

Minute
The minute when report started (Military 0 to 59 Min.), in integer format.

7.5.6. Contents: 4x +4 Register (UINT)

Pipe Internal Diameter
Internal diameter of the pipe is stored and displayed in integer format (for instance, a pipe with an internal diameter of 10.000 is displayed as 10.000 x 1,000 = 10,000).

7.5.7. Contents: 4x +5 Register (UINT)

Pipe Wall Thickness
The wall thickness of the pipe is stored and displayed in integer format (for instance, a pipe with a wall thickness of .3650 is displayed as .3650 x 10,000 = 3650).

7.5.8. Contents: 4x +6 Register (UINT)

Pipe Elasticity
The Modulus of elasticity for pipe material. This value is displayed in millions (for instance, Mild Carbon Steel has a pipe elasticity value of 30,000,000 and is displayed as 30,000,000 / 100,000 = 300).

7.5.9. Contents: 4x +7 Register (UINT)

Cubic Expansion

The mean coefficient of cubical expansion per degree of the pipe material. This value is displayed in integer format (for instance, Mild Carbon Steel has a cubic expansion value of .000186/°F and is displayed as 10,000,000 x .0000186 = 186).

7.5.10. Contents: 4x +8 Register (UINT)

API Tables

This field stored the API table used to obtain the CTL. If there are two tables used to calculate the CTL only the last table is displayed.

For instance, Crude Oil is used and Table 5A and Table 6A are used to calculate CTL. Only Table 6A will appear in the field.

7.5.11. Contents: 4x +9 Register (UINT)

Product Name

A number from 0 to 15 that represents a product name that the user determines (for instance, 1 = Crude Oil, 2= Premium, etc.). This field is used to retrieve the previous Meter Factor for that product that was stored.

Note: A zero means product names are not used and no previous meter factor will be stored.

7.5.12. Contents: 4x +10 ... +13 Register (ASCII)

Meter Serial Number

The meter serial number may be stored in these four registers. Enter alphanumeric data in ASCII format (for instance, PF11741G).

7.5.13. Contents: 4x +14 ... +17 Register (ASCII)

Meter ID

The meter serial number may be stored in these four registers. Enter alphanumeric data in ASCII format (for instance, AXF11201).

7.5.14. Contents: 4x +18 Register (UINT)

Meter Size

The size of the meter is stored and displayed in integer format (for instance, a meter that is 10.000 is displayed as 10.000 x 1,000 = 10,000).

7.5.15. Contents: 4x +19 Register (UINT)

Meter Type

The type of the meter is stored and displayed in integer format. This field is user defined and can be any value between 0 and 65535 (for instance, 1= Turbine 2= Positive Displacement).

7.6 Meter Proving Report Details (Registers 4x + 20 through 4x + 179)

7.6.1. Overview

This unit describes the meter proving report words for registers 4x + 20 through 4x + 179, which are 160 registers allotted for proving runs. A system may have 10 prove runs, and each run has 16 registers.

This unit presents the contents of the registers followed by a table indicating which registers are dedicated to which run and a table displaying the register functions.

The registers are referenced with respect to the registers in the Proving Report Register Layout Table. (See *Data Storage Layout of Proving Reports, p. 123*)

For example, register 4x + 20 of the Current Proving Report is register 4x + 492 + 20 or register 4x + 512.

7.6.2. Contents of Registers

Total Pulses

Total of pulses for a complete run, regardless of whether or not it is a Bi-directional or Uni-directional prover. The counts are stored in a double integer format (two registers) and an implied decimal point is used. For instance, a count of 70000.1234 is displayed as 70000.1234 x 10,000 = 700001234.

Note: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101.

For example, if the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed.

Temperature Prover

Temperature at the Prover, displayed in floating point (for instance, 53.4 degrees).

Temperature Meter

Temperature at the Meter, displayed in floating point (for instance, 53.4 degrees).

Pressure Prover

Pressure at the Prover, displayed in floating point (for instance, 131.8 PSIG).

Pressure Meter

Pressure at the Meter, displayed in floating point (for instance, 131.8 PSIG).

Flow Rate

Gross Standard Volume flow rate, displayed in floating point (for instance, 1172.4 BBL/Hr).

Corrected Gravity
Corrected API gravity, displayed in floating point (for instance, 64.1 API 60).

Meter Frequency
Frequency of the Meter, displayed in floating point (for instance, 340.1 Hz).

7.6.3. Register Detail: Prover Runs

Registers assigned to a prover run

Run Number	Registers Dedicated to the Run
1	4x + 20 through 4x + 35
2	4x + 36 through 4x + 51
3	4x + 52 through 4x + 67
4	4x + 68 through 4x + 83
5	4x + 84 through 4x + 99
6	4x + 100 through 4x + 115
7	4x + 116 through 4x + 131
8	4x + 132 through 4x + 147
9	4x + 148 through 4x + 163
10	4x + 164 through 4x + 179

7.6.4. Register Detail: Functions

Register functions

Run	Total Pulses	Temperature Prover	Temperature Meter	Pressure Prover	Pressure Meter	Flow Rate	Corrected Gravity	Meter Frequency
	UDINT	FLOAT	FLOAT	FLOAT	FLOAT	FLOAT	FLOAT	FLOAT
1	4x + 20 ... 21	4x + 22 ... 23	4x + 24 ... 25	4x + 26 ... 27	4x + 28 ... 29	4x + 30 ... 31	4x + 32 ... 32	4x + 34 ... 35
2	4x + 36 ... 37	4x + 38 ... 39	4x + 40 ... 41	4x + 42 ... 43	4x + 44 ... 45	4x + 46 ... 47	4x + 48 ... 49	4x + 50 ... 51
3	4x + 52 ... 53	4x + 54 ... 55	4x + 56 ... 57	4x + 58 ... 59	4x + 60 ... 61	4x + 62 ... 63	4x + 64 ... 65	4x + 66 ... 67
4	4x + 68 ... 69	4x + 70 ... 71	4x + 72 ... 73	4x + 74 ... 75	4x + 76 ... 77	4x + 78 ... 79	4x + 80 ... 81	4x + 82 ... 83
5	4x + 84 ... 85	4x + 86 ... 87	4x + 88 ... 89	4x + 90 ... 91	4x + 92 ... 93	4x + 94 ... 95	4x + 96 ... 97	4x + 98 ... 99
6	4x + 100 ... 101	4x + 102 ... 103	4x + 104 ... 105	4x + 106 ... 107	4x + 108 ... 109	4x + 110 ... 111	4x + 112 ... 113	4x + 114 ... 115
7	4x + 116 ... 117	4x + 118 ... 119	4x + 120 ... 121	4x + 122 ... 123	4x + 124 ... 125	4x + 126 ... 127	4x + 128 ... 129	4x + 130 ... 131
8	4x + 132 ... 133	4x + 134 ... 135	4x + 136 ... 137	4x + 138 ... 139	4x + 140 ... 141	4x + 142 ... 143	4x + 144 ... 145	4x + 146 ... 147
9	4x + 148 ... 149	4x + 150 ... 151	4x + 152 ... 153	4x + 154 ... 155	4x + 156 ... 157	4x + 158 ... 159	4x + 160 ... 161	4x + 162 ... 163
10	4x + 164 ... 165	4x + 166 ... 167	4x + 168 ... 169	4x + 170 ... 171	4x + 172 ... 173	4x + 174 ... 175	4x + 176 ... 177	4x + 178 ... 179

7.7. Meter Proving Report Details (Registers 4x + 180 through 4x + 226)

7.7.1. Overview

This section describes the meter proving report words for registers 4x + 180 through 4x + 226.

7.7.2. Contents: 4x +180 Register (UDINT)

Average Proving Pulses
Average of the total pulses for all runs. The counts are stored in a double integer format (two registers) and an implied decimal point is used. For instance, a count of 70000.1234 is displayed as 70000.1234 x 10,000 = 700001234.
Note: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101.
For example, if the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed.

7.7.3. Contents: 4x +182 ... +183 Field (FLOAT)

Average Temperature at the Prover
Average Temperature at the Prover for all runs, displayed in floating point (for instance, 53.4 degrees).

7.7.4. Contents: 4x +184 ... +185 Field (FLOAT)

Average Temperature at the Meter
Average Temperature at the Meter for all runs, displayed in floating point (for instance, 53.4 degrees).

7.7.5. Contents: 4x +186 ... +187 Field (FLOAT)

Average Pressure at the Prover
Average Pressure at the Prover for all runs, displayed in floating point (for instance, 131.8 PSIG).

7.7.6. Contents: 4x +188 ... +189 Field (FLOAT)

Average Pressure at the Meter
Average Pressure at the Meter for all runs, displayed in floating point (for instance, 131.8 PSIG).

7.7.7. Contents: 4x +190 ... +191 Field (FLOAT)

Average ISV / GSV Flow Rate
Average Indicated Standard Volume / Gross Standard flow rate for all runs. Displayed in floating point (for instance, 1172.4 BBL/Hr).
Note: This field will display ISV if Bit 3 of Command Word 2 is OFF and GSV if ON.

7.7.8. Contents: 4x +19 2... +193 Field (FLOAT)

Average API Corrected Gravity
Average corrected API gravity for all runs, displayed in floating point (for instance, 64.1 API 60).

7.7.9. Contents: 4x +194 ... +195 Field (FLOAT)	**Average Meter Freq** Average frequency of the Meter for all runs, displayed in floating point (for instance, 340.4 Hz).
7.7.10. Contents: 4x +196 ... +197 Field (UDINT)	**Base Volume Prover** Base Volume of the Prover provided from the last water draw calibration run. The counts are stored in a double integer format (two registers) and an implied decimal point is used (for instance, a count of 12.462801 is displayed as 12.462801 x 1,000,000 = 12462801). **Note**: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101. For example, if the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed.
7.7.11. Contents: 4x +198 ... +199 Field (FLOAT)	**CTS** Correction for the effect of temperature on steel (CTS) is stored in floating point format (for instance, 1.00028 CTS).
7.7.12. Contents: 4x +200 ... +201 Field (FLOAT)	**CPS** Correction for the effect of pressure on steel (CPS) is stored in floating point format (for instance, 1.00023 CTS).
7.7.13. Contents: 4x +202 ... +203 Field (FLOAT)	**CTL** Correction for the effect of temperature on liquid (CTL) is stored in floating point (for instance, .98162 CTL).
7.7.14. Contents: 4x +204 ... +205 Field (FLOAT)	**CPL** Correction for the effect of pressure on liquid (CPL) is stored in floating point (for instance, 1.00071 CPL).
7.7.15. Contents: 4x+206 ... +207 Field (FLOAT)	**Total ISV BBLs** The value of the ISV totalizer at the beginning of the batch / prove report in double integer format (0 to 9,999,999 BBLs).
7.7.16. Contents: 4x +208 ... +209 Field (FLOAT)	**Batch ISV BBLs** The value of the Batch ISV when the first proving run started. Stored in unsigned integer format (0 to 65535 BBLs)

7.7.17. Contents:
4x +209 ... +210
Field (FLOAT)

Calculated Meter Factor
The calculated Meter Factor based on the number of consecutive runs made during the prove report. Stored in floating point format (for instance, 1.00230 M Factor)

7.7.18. Contents:
4x +211 ... +212
Field (FLOAT)

% Change in MF to Prev. MF
The percentage of change in the MF from the previous MF. Stored in floating point format (2% = 0.02).

7.7.19. Contents:
4x +213 ... +214
Field (FLOAT)

K Factor
This is the K Factor (pulses per unit volume) of the meter during the proving run. Stored in floating point format (for instance, 1055.250).

7.7.20. Contents:
4x +215 ... +216
Field (UINT)

Calculated K Factor
This is the K factor that has been calculated based on the new Meter Factor. This number can be used to adjust the Meter Factor to 1.0 if desired.
Stored in floating point format (1052.828).

7.7.21. Contents:
4x +217 ... +218
Field (FLOAT)

CCFP
Combined Correction Factor Prover (See *Flow Equations and Algorithms, p. 233* for Prover calculations). Stored in floating point format (1.0057).

7.7.22. Contents:
4x +219 ... +220
Field (FLOAT)

CCFM
Combined Correction Factor Meter (See *Flow Equations and Algorithms, p. 233* for Meter calculations). Stored in floating point format (1.0057).

7.7.23. Contents:
4x +221 ... +222
Field (UDINT)

Corrected Prover Volume
The corrected volume of the prover (See *Flow Equations and Algorithms, p. 233* for Prover Calculations). This is the calculated Corrected Prover Volume. It is stored in a double integer format (two registers) and an implied decimal point is used (for instance, A count of 12.462801 is displayed as 12.462801 x 1,000,000 = 12462801).
Note: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101.
For example, if the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed.

7.7.24. Contents: 4x +223 ... +224 Field (UDINT)

Corrected Meter Volume

The corrected volume of the prover (See *Flow Equations and Algorithms, p. 233* for Prover Calculations). This is the calculated Corrected Prover Volume. It is stored in a double integer format (two registers) and an implied decimal point is used. For instance, a count of 12.462801 is displayed as 12.462801 x 1,000,000 = 12462801).

Note: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101.

For example, if the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed.

7.7.25. Contents: 4x +225 ... +226 Field (UDINT)

Metered Volume

The Metered volume is the Total Average Counts / K Factor. This is the calculated Metered Volume. It is stored in a double integer format (two registers) and an implied decimal point is used. For instance, a count of 12.434211 is displayed as 12. 434211 x 1,000,000 = 12434211).

Note: This multiple register field is a double unsigned integer using two consecutive registers such as 400100 and 400101.

For example, if the value of the register is viewed as a single unsigned register, the value would be represented as: 400100 = 11218 and 400101 = 10681. However, if 400100 is viewed as a 32-bit unsigned integer the value 700001234 will be displayed.

7.8. The Last Meter Factor Table

7.8.1. Overview

The Last Meter Factor table stores the Last Meter Factor used for the specific product used. For instance, Premium Gasoline ISV Flow Rate 1201 BBL /HR On 3/22/02 with a meter factor of 1.0029.
The Last Meter Factor Table can hold up to 16 different products. When a new Meter Factor is calculated, the previous Meter Factor is used. The loadable looks at the product name, finds the previous Meter Factor, and applies it to the new Meter Factor calculation. Data is stored based on its product name (located in the 4x + 9 register in the PCFC block) in the loadable.

7.8.2. Accessing Values in the Last Meter Factor Table

To access the values in the table by product name and field, use the following formula:

```
Table Offset + Offset + (Product Name x 8) = Desired Value
```

- Table Offset is the combination of the contents of the 4x + 61 and 4x + 62 registers + 1627

$$\{4x + 61, 4x + 62\} + 1627$$

  For example:
  - 4x + 61 = 40
  - 4x + 62 = 9000
  - Table offset = 410627
- Offset is the field selected from the following list. (See page *Meter Proving Report Details (Registers 4x + 0 through 4x + 19), p. 124*.)
  - 0 = Meter Factor
  - 2 = Ave ISV
  - 4 = Month
  - 5 = Day
  - 6 = Hour
  - 7 = Min.
- Product Name is the record (row).

7.8.3. Example: Premium Gasoline

In our example, Premium is the Product Name, which is equivalent to an integer value of 4, and the desired value is Last Meter Factor.

- 1627 + 0 + (4x8) = 32, and the last meter factor table starts at offset 1627.
- 1627 + 0 + 32 = 1659, and if your report starting address was 1100, then the actual address would be 2759.

7.8.4. Register Contents by Offset

The following sections describe the last meter factor words, listed in order of offset.

7.8.5. Contents: 4x +0 ... +1 (Product Name * 8) (FLOAT)

Last Meter Factor (0 to 15)
The last Meter Factor Stored for this product. This value is used to compare the new Meter Factor against the old value.

7.8.6. Contents: 4x +2 ... +3 (Product Name * 8) (FLOAT)

Indicated Standard Volume BBL/HR (0 to 15)
Average ISV flow rate at the Last Meter Factor stored.

7.8.7. Contents: 4x +4 (Product Name * 8) (UINT)

Last Month (0 to 15)
Date when the Last Meter Factor was calculated.

7.8.8. Contents: 4x +5 (Product Name * 8) (UINT)

Last Day (0 to 15)
Date when the Last Meter Factor was calculated.

7.8.9. Contents: 4x +6 (Product Name * 8) (UINT)

Last Hour (0 to 15)
Time when the Last Meter Factor was calculated.

7.8.10. Contents: 4x +7 (Product Name * 8) (UINT)

Last Min. (0 to 15)
Time when the Last Meter Factor was calculated.

7.9. Sample Meter Proving Report

7.9.1. Report Sample

Sample meter proving report.

Meter Proving Report			Date: 08-03 Time: 10:11			Prove Data:		
Diameter Inches: 10000			Wall Thick In: 365			Elasticity: 30 x 10^6		
Cubic Exp.: .186 x 10 ^-4			Table Selected: 24A			Product Name: 7		
Meter Data								
Serial Number: PF11741G			Meter ID: AXF11201			Meter Size: 50000		
Meter Type: 1			Total BBL: 9,999,999			Batch Net BBLs: 1619		
Previous M.F.: 1.0025 @ ISV BBL/H: 1185.9 Date: 07-29 Time: 14:31								
Data From Consecutive Prove Runs:								
Run	Counts Total	Temperature Deg. F		Pressure PSIG		Flowrate ISV.BBL/H	Density @60F	Meter Freq
		Prover	Meter	Prover	Meter			
1	13120.0	53.4	53.4	131.8	131.8	1172.3	64.1	340.0
2	13121.0	53.4	53.4	131.6	131.6	1172.7	64.1	341.1
3	13121.0	53.4	53.4	131.3	131.3	1172.0	64.1	342.0
4	13122.0	53.4	53.4	131.0	131.0	1172.4	64.1	342.0
5	13122.0	53.4	53.4	131.1	131.1	1172.5	64.1	342.0
Avg	13121.2	53.4	53.4	131.4	131.4	1175.5	64.1	341.42
K Factor: 1055.25		Max. Count Dev Between Runs .02%				15. New K Factor: 1052.828		

Calculated Data for Prover	
1. Base Volume of Prover, Barrels	12.462800
2. Correction Factor for the Effect of Temperature on Steel (CTSP)	.99990
3. Correction Factor for the Effect of Pressure on Steel (CPSP)	1.00010
4. Correction Factor for the Effect of Temperature on a Liquid (CTLP)	1.00470
5. Correction Factor for the Effect of Pressure on a Liquid (CPLP)	1.00100
6. Combined Correction Factor (Lines 2 x 3 x 4 x 5)	1.0057
7. Corrected Prover Volume, Barrels (Line 1 x Line 6)	12.533840
Calculated Data for Meter	
8 Metered Volume, Barrels	12.434211
9. Correction Factor for the Effect of Temperature on a Liquid (CTLM)	1.00470
10. Correction Factor for the Effect of Pressure on a Liquid (CPLM)	1.00100
11. Combined Correction Factor (Lines 9 x 10)	1.0057
12. Corrected Meter Volume, Barrels (Line 8 x Line 11)	12.505080
13. Meter Factor (Line 7 / Line 12)	1.0023
14. % Change In Meter Factor From Previous Meter Factor	.02

7.10. Data Logging Operation

7.10.1. Enabling Logging

The function block will log data to the user defined storage area as long as input #2 of the function block is enabled.

7.10.2. Data Logging Configuration

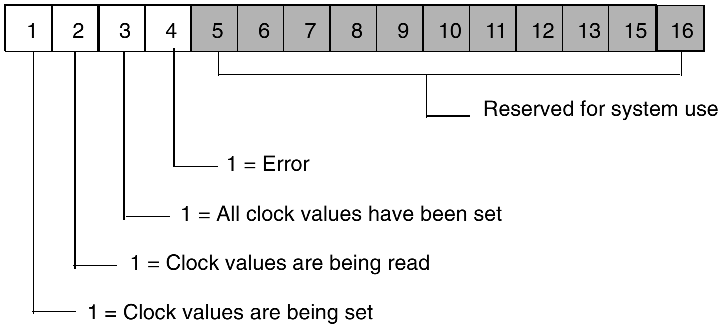
There are five control table registers that must be configured for proper data logging to occur.

Register	Content		
4x + 59	**WR**	UINT	Start of Day ‘Hour’ (0 - 23 military)
4x + 60	**WR**	UINT	Start of Day ‘Minute’ (0 - 59)
4x + 61	**WR**	UINT	Report Address Modulo 10000 High Word (00XX)
4x + 62	**WR**	UINT	Report Address Modulo 10000 Low Word (XXXX)

7.11. Configuring the Time-of-Day Clock

7.11.1. Time-of-Day Clock: First Register (4x + 0)

When a 4x holding register assignment is made in the Concept panel software's configurator for the time of day (TOD) clock, that register and the next seven consecutive registers (4x .. 4x + 7) are set aside in the PLC configuration to store TOD information.
The block of registers is implemented as follows:



7.11.2. Time-of-Day Clock: Registers 4x + 1 ... 4x + 7

The next seven consecutive registers represent time-of-day clock values as shown here.

Register	Value
4x + 1	Day of week (Sunday = 1, Monday = 2, etc.)
4x + 2	Month of the year (Jan. = 1, Feb. = 2, etc.)
4x + 3	Day of the month (1 ... 31)
4x + 4	Year (00 ... 99) (01 = 2001, 02 = 2002, etc.)
4x + 5	Hour in military time (0 ... 23)
4x + 6	Minute (0 ... 59)
4x + 7	Second (0 ... 59)

7.11.3. Time-of-Day Clock Example

For example, if you configured register 40500 for your TOD clock, set the bits appropriately as shown above, then read the clock values at 9:25:30 on Tuesday, July 16, 2001, the register values displayed in Decimal format would read:

Register	Value
40500	24576
40501	3
40502	7
40503	16
40504	1
40505	9
40506	25
40507	30

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Part IV API 21.2 Audit Trail Function

IV

At a Glance

Purpose

This unit describes the AUDT function block, which enables to log and store records using the API 21.2 Audit Trail formatting standard.

What's in this Part?

This part contains the following chapters:

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8. AUDT Function Block

8

At a Glance

Purpose

This material describes the block structure representation, operation, and configuration of the AUDT Function Block.

What's in this Chapter?

This chapter contains the following sections:

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8.1 AUDT Representation and Operation

At a Glance

Purpose

This section describes the block structure representation and operation of the AUDT function block.

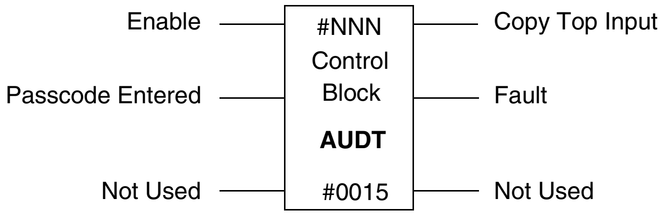
What's in this Section?

This section contains the following topics:

8.1.1. AUDT Function Block Structure

8.1.1.1. Block Structure Diagram

The block structure is illustrated below.



8.1.1.2. Inputs

AUDT has three control inputs.

- **Top**—Enables the function block.
- **Middle**—Used to indicate the user has entered a passcode in the 4x table. This input must be used with a positive transition contact.
- **Bottom**—Not Used.

8.1.1.3. Outputs

AUDT can produce three possible outputs.

- **Top**—Copy of the top node input.
- **Middle**—Output turns ON when the function block has detected a fault. Possible faults are listed below:
  - Block pointers are incorrect; not pointing to a valid configured 4x register and table length for the PCFC block.
  - Bottom Node has incorrect number of use registers for the block.
  - Top Node has invalid node number.
  - Faults are also indicated in the PCFC block fault word.
- **Bottom**—Not Used.

8.1.1.4. Top Node Content

The top node must be zero.

8.1.1.5. Middle Node Content

The 4x register entered in the middle node is the first of 15 contiguous holding registers that comprise the control block.

8.1.1.6. Bottom Node Content

The bottom node must contain a constant #0015 representing the length of the control block in 4x registers.

8.1.2. AUDT Operation

8.1.2.1. AUDT Block Operation

The AUDT block provides a system of security and of Audit logging for the liquid flow loadable block suite (per the API 2540 Chapter 21 Flow Measurement Using Electronic Metering Systems Section 2 Part 10 Auditing and Reporting Requirements). In a single PLC, the AUDT block only supports the first four instances of a liquid flow loadable function block. However, an additional 12 virtual flow computers may exist in the system but have no protection or audit trail 21.2 security.

The AUDT block provides three access levels of security: Operator, Technician, and Privileged. Each access level builds on the next level. Without the proper access level, no changes (flow parameters, configuration, or asset information) may be made to the block.

The block provides several different logging and reporting databases.

Log	Function
Configuration	Tracks changes made by the user and logs old and new values, time and date, User ID, and Accumulated flow at the time of change
Alarm	Records PCFC alarms in the system, old values, new values, time, date, User ID, and Accumulated flow at the time of change
Event	Records PCFC events in the system, old values, new values, time, date, User ID, and Accumulated flow at the time of change

The audit trail logs are in a protected memory location that is not accessible either to ladder-logic programming or to communications links into the PLC. The log data can only be viewed through the 4x or 6x registers that are configured to view a copy of the data in the logs.

There can only be one AUDT block in a system. This block was designed to store and process the API 21.2 Audit Trail. When using the API 21.2 Audit Trail the first four blocks of the PCFC are the **only blocks** that can be used with the AUDT block (for example: 0, 1, 2, and 3 Top node address). Blocks that do not require Audit Trail may use any number after 0 to 3. A Passcode must be entered into the AUDT block to allow changing of flow element and parameters. Changes may be made directly to the block.

Note: Complete Downloads
Once the AUDT block has been configured and running in a working system, on-line changes can be made without affecting log contents. However, a complete download will destroy all logged information.

8.1.3. AUDT Setup

8.1.3.1. Platforms Supported

The AUDT function block is supported on the following PLCs.

Product Family	Product Number
Quantum	140 CPU 434 12A
	140 CPU 534 12A

Note: If you are not using on of these PLCs, you will be unable to run the AUDT block.

8.1.3.2. Initial Setup of the PCFC Block and TMCI Block

Schneider Electric recommends that all parameters in all blocks be entered before enabling the AUDT block. Once the block has been enabled and the TMCI and PCFC audit trail command bits have been set to 1, the TMCI and PCFC blocks will not allow further modification without Passcode permissions.

The block can support up to four API 21.2 Audit Trail formatting standards at a time depending upon the memory that is available in the controller. The memory used for the audit trail formatting standard consumes program logic space. So, only controllers with a minimum 32K of user programming space will be able to use the AUDT block.

The following activities should be performed in the order indicated.

Step	Action
1	Program TMCI and PCFC block parameters.
2	Enable the AUDT block.
3	Set the audit trail command bits in the PCFC (Command Word 1, bit 3) and TMCI (Command Word 1, bit 5) blocks.
4	Logout of the AUDT block.
5	Login to the AUDT block. Once logged in to the AUDT block, you can **1.** Make changes to block parameters, and **2.** System logs changes.

8.1.3.3. Determining How Much Memory Is Needed

The heap size of the loadable is used to store the audit trail so it must be adjusted to allow for the number of audit trails desired.
AUDT Heap Size Table

Number of Audit Trails	Heap Size Needed in Paragraphs
1	2975
2	5950
3	8925
4	11900

8.1.3.4. Configuring AUDT Block—First Time

All configuration information for the AUDT block must be filled in first before the AUDT block can be locked down.
Before attempting to log into the AUDT block, the TMCI Audit Trail bit must be ON, and at least the first PCFC block (block zero) Audit Trail bit must be ON. Otherwise, the AUDT block will not allow the user to login.
Minimum configuration requirements:

AUDT Block Registers	Minimum Configuration	Requirements
4x + 1, Bit 1	Command Word	Configured for at least one audit trail ("Audit Trail PCFC 0" set to 1)
4x + 3	First PCFC Block Pointer	Must point to a valid PCFC block This register contains the 4x address without the '4.' For example, 413570 is entered as 13570.
4x + 7	Report Address Modulo 10000 High Word	Set to report area and used to view audit trail logs, for example: 40 or 60
4x + 8	Report Address Modulo 10000 Low Word	Set to report area and used to view audit logs as above, for example, 1000

Log into the AUDT block as a privileged user and then logout.

The block is now initialized and is locked down. No changes can be made until the user access Passcode is entered. (See *Default Passcodes, p. 151*)

8.1.4. AUDT Security

8.1.4.1. Login Procedure

Log into the system using the AUDT block.

To access security level parameters or functions,

Step	Action
1	Enter the User Identification (4x + 9).
2	Enter the User Passcode (4x + 10).
3	Toggle the middle input (Positive Transition) of the AUDT block.

Correct and incorrect login results are described here.

User ID and Passcode	Result
Correct	The block clears the Passcode register and sets to 1 bit 16 of the Fault Word (4x + 2). **Note**: This action will not generate a fault on the block. An Alarm log entry will be made recording the user ID, time, and data stamp.
Incorrect	Block clears both fields and makes an entry in the Alarm log

Note: Logging in while logged in
Attempting to log in to the AUDT block while already logged in, can cause unexpected block operation.

8.1.4.2. Default Passcodes

Passcodes for each user level

User Level	Type of User	Default Passcode
100	Privileged	12345
200	Technician	1234
300	Operator	123

8.1.4.3. Logout Procedure

Setting bit 12 ("Logout All") of the AUDT Command Word logs the user out. An Alarm log entry will be created, and bit 16 of the fault word ("User Logged In") will be set to zero.
Note: If you are not logged into the AUDT, then the "Logout All" bit will not reset to zero.

8.1.4.4. Changing a Passcode

Passcodes can only be changed by the Privileged access level. To change a passcode you must login as a Privileged user. (See *Contents: 4x + 9 Register (WR, UNIT), p. 172*)

To change a Privileged passcode:

Step	Action
1	Enter the User Identification = 100.
2	Enter the passcode desired in the Passcode field (0 to 65535).
3	Set bit 10 of the Command Word in the AUDT block to 1. **Note:** If the passcode has been changed successfully, then the User ID and Passcode field will be cleared.

To change a Technician or Operator passcode:

Step	Action
1	Enter the User Identification = 200 or 300.
2	Enter the passcode desired in the Passcode field (0 to 65535).
3	Set bit 11 of the Command Word in the AUDT block to 1. **Note:** If the passcode has been changed successfully, then the User ID and Passcode field will be cleared.

8.1.4.5. Procedure for Lost Passcode

Note: RECOVERING A PASSCODE
If for some reason the Privileged passcode is changed or lost, there is no way to recover it. The user/programmer must reload the program to unlock the system. Downloading a new program will destroy all log information.

8.1.5. AUDT Audit Trail Records

8.1.5.1. Reading Audit Trail Records

The audit trail logs are in a protected memory location, which is not accessible either to ladder logic programming or to communications links into the PLC. The log data can only be viewed through the 4x or 6x registers set up as "memory windows," which view a copy of the data in the logs.

Note: All access levels can read the audit trail logs.

User must log in with at least Operator access to view log data. (See *Login Procedure, p. 151*)

Step	Action
1	Enter the PCFC block number (top node value) containing the audit log data in the Block Select field (4x+11).
2	Enter the type of record in the Record Type field (4x+12). The table below lists valid record types and log parameters for each type.

Log table

Record Type		Range	No Records	View Register Location
0	Configuration	(0 to 499)	500	4x +0
1	Alarm	(0 to 249)	250	4x +0
2	Event	(0 to 249)	250	4x +0
3	Base Configuration	(0 to 0)	1	4x +24
4	Current Configuration	(0 to 0)	1	4x +24
5	Batch Report	(0 to 11)	12	4x +108
6	Prove Report	(0 to 3)	4	4x +150
7	Last Meter Factor Table (read)	(0 to 15)	16	4x +376
8	Last Meter Factor Table (write)	(0 to 15)	16	4x + 376

Continuing from Step 4,

Step	Action
3	Enter the record number of the record to view in the Record Select field (4x+13). See the log table preceding for the number of records in the log. If a record type has one record, then 0 should be entered in the Record Select field. The log records are stored in a ring buffer. The ring buffer fills from record 0 to the end of the buffer. Once the buffer is full, the next record will be record 0 again. This overwrites the previous data in record 0. The next record will be record 1 again and so forth. This implies that the Current Record field (4x+14) does not necessarily indicate the number of records in the log.

The record will be visible at the register offset shown in the 'View Register Location' column of the table. See the table in the section *Understanding the Solution to the Example, p. 155*. 4x+0 is the location referenced by the values in the Report Area Type (4x+7) and Report Area Offset (4x+8) registers of the AUDT block. The other offset values are referenced with respect to 4x+7 and 4x+8. See Section 8.3 AUDT Configuration-Report Registers for a detailed explanation of the register layout for each record type.

Note: About record types Certain record types share the same view register locations, for example, Configuration / Alarm / Event (4x+0), Base Configuration / Current Configuration (4x+24). Thus, only one record of one of these types may be viewed at a time.

8.1.6. AUDT Audit Trail Records an Example

8.1.6.1. An Example Configuration

Look at record 202 in the Configuration log of PCFC block 0. The Technician passcode is 1234. The AUDT block is located at 400800. The audit logging area begins at 611000.

8.1.6.2. Understanding the Solution to the Example

First, Log in

Step	Action
1	Set 4x+9 to 200. 200 is Technician level.
2	Set 4x+10 to 1234. 1234 is the default passcode for a Technician.
3	Toggle middle input on AUDT block.
4	Result **1.** 4x+10 is set to 0 by the block. **2.** Fault word, bit 16 is set (=1). You are now logged into the block.

Next, enter PCFC number and record type.

Step	Action
1	Set 4x+11 to 0. 0 is the PCFC block number.
2	Set 4x+12 to 0. 0 is the Configuration record type)
3	Result **1.** 4x+14 shows 333 (or some other current record number).

Then, enter record number to view.

Step	Action
1	Set 4x+13 to 202. 202 is the record number to view.
2	Set up RDE to view registers 611000 - 611023 according to data types shown in section Table of Configuration, Alarm, and Event Records. (See *Table of Configuration, Alarm, and Event Records, p. 177*)
3	Result **1.** Parameters for record 202 now visible in RDE as shown in table below.

8.1.6.3. Example Configuration Table for Record 202

Table generated

Configuration Record	Value	Report Register
Configuration Number	202	4x + 0
Record Month	02	4x + 1
Record Day	23	4x + 2
Record Year	03	4x + 3
Record Hour	09	4x + 4
Record Minute	35	4x + 5
Record Second	32	4x + 6
User Identification	200	4x + 7
Parameter Index	21	4x + 8
Alarm / Event Value	0	4x + 9
Old Value Binary Format	0	4x + 10
New Value Binary Format	0	4x + 11
Old Value UINT Format	0	4x + 12
New Value UINT Format	0	4x + 13
Old Value UDINT Format	0	4x + 14 ... 15
New Value UDINT Format	0	4x + 16 ... 17
Old Value FLOAT Format	0.9991	4x + 18 ... 19
New Value FLOAT Format	0.9993	4x + 20 ... 21
ISV Accumulated	123451	4x + 22 ... 23

The preceding table is a sample of a Configuration record for the 202nd record.

Note: The sample was recorded on Feb. 23, 2003 at 9:35AM 32 seconds. The user was a Technician. The parameter changed was Meter Factor (21 see Parameter table). Old value was 0.9991, new value, 0.9993. The ISV totalizer was 123451 bbls accumulated.

8.1.6.4. Record Contents

Each audit log record contains fields for Old and New Value in several formats for example, UINT, FLOAT. The data will be displayed only in one format. The display format depends on the value in Parameter Index.

Snapshot of the audit log record starting at Parameter Index and ending at New Value FLOAT format

Parameter Index	21
Alarm / Event Value	0
Old Value Binary Format	0
New Value Binary Format	0
Old Value UINT Format	0
New Value UINT Format	0
Old Value UDINT Format	0
New Value UDINT Format	0
Old Value FLOAT Format	0.9991
New Value FLOAT Format	0.9993

From the preceding example, the Record Type is 0 (Configuration), and the Parameter Index is 21. Using the table in (*AUDT Report Logging—Detail: Index of Configuration Parameters, p. 181*), find Parameter Index 21 (Meter Factor).

The table entry for Index 21

Parameter Index	Data Type	Description of the Data
21	FLOAT	**Meter Factor** Displays the Old and New Value for the parameter.

From the table entry, we see the Meter Factor (Parameter Index 21) is Data Type FLOAT. So, the data values appear in the Old Value FLOAT Format and New Value FLOAT Format registers. The Description field gives the name of the parameter described by the Parameter Index.

8.1.6.5. Force a Process Variable

The system allows the forcing of process variables for purposes such as no online densitometer (to enter a gravity) or faulty pressure transducer. Forcing is monitored and logged. When a force has occurred, the force values are not recorded in the configuration log but are recorded in the batch end reports and prove reports

When the AUDT block is used, the system by default makes the process variables' Raw Data fields (PCFC block 4x + 80, 4x + 88, 4x + 96, 4x + 104, 4x + 112) into pointers to input 3x registers. Thus, no forcing of variables is allowed. When the Process Variable Force mode is used, any or all variables can be manually set.

To force a process variable, the user must log in as a Technician or higher and set the appropriate force bit (bits 5-8 depending on which PCFC values will be forced) in the Command Word of the AUDT block. Once this bit is set to 1, the user / programmer can configure from where the process variables will receive their data.

This process is achieved by setting the command words in the PCFC block. For the Meter side, use Command Word 1 bits 6, 7, and 8; and for the Prover side, use Command Word 2, bits 7 and 8 (See PCFC documentation for complete instructions). Once the appropriate bits have been set, log out of the AUDT block.

The user / programmer can now force values in the fields that were set to be forced in the PCFC blocks selected. Use the Scaled Output field of the associated process variable (for example: if Specific Gravity / Density was selected then Specific Gravity / Density Scaled Output 4x + 86 will be used to enter a SG or density manually).

Example:

Step	Action
1	Login: as Technician
2	AUDT block: Set Command Word, bit 5 to 1 (indicates PCFC equal to zero).
3	PCFC block (zero): Set Command Word One, bit 6 to 1.
4	In floating point format, manually enter a SG or Density into 4x + 86, the PCFC block zero (0).
5	Logout.

8.1.6.6. Change value in Last Meter Factor Table

The last meter factor table stores the last meter factor used for that product, ISV flow rate, and time and date. When starting a system for the first time, the M factor table values need to be initialized.

Perform the following steps.

Step	Action
1	Login to the AUDT block (any access level).
2	Enter the PCFC block desired in the Block Select register (4x + 11). 0 to 3 are valid values
3	Enter "8" in the Record Type register (4x + 12), an entry that allows writing to the Last Meter Factor table. **Note**: The product names 0 to 15 (PCFC block, register 4x + 9) are directly correlated to the record numbers 0 to 15 in the Last Meter Factor Table. For example, if Premium Gasoline = 3 in the Product Name field in PCFC, then the Last Meter Factor table record = 3.
4	Enter data in the View Register Location for the Last Meter Factor Table (4x + 376).
5	If additional records will be initialized, go to Step 2 and repeat for the next record(s).
6	Once the data has been entered, enter a 7 in the record type field and review the data entries. This action ends the editing process.

8.2 AUDT Configuration—Block Registers

At a Glance

Purpose

This section describes in detail the block registers of the AUDT function block.

What's in this Section?

This section contains the following topics:

8.2.1. AUDT—Summary: Block Registers

8.2.1.1. Overview

This unit provides a table summarizing the AUDT registers: access rights, data type, and contents.

Note: Writing to read (RD) registers can cause inaccurate results or one of the following behaviors: (1) the controller does not work, (2) the controller locks up, or (3) a function block will not work. To prevent this situation, do NOT write to read (RD) registers. Writable registers (**WR**) are marked in **bold**.

8.2.1.2. Summary: Setup and Diagnostic Data Registers

Register Summary: AUDT Function Block.

Block Register	Access	Data Type	Comment
4x + 0	RD	HEX	**AUDT Revision Number (X.XX)** For more information, see *Contents: 4x + 0 Register (RD, HEX), p. 163*.
4x + 1	**WR**	BIN	**Command Word** For more information, see *Bit Summary: 4x + 1 Register (WR, BIN), p. 163*.
4x + 2	RD	BIN	**Fault Word** For more information, see *Bit Summary: 4x + 2 Register (WR, BIN), p. 166*.
4x + 3	**WR**	UINT	**Pointer to table in the First PCFC block** For more information, see *Contents: 4x + 3 Register (WR, UINT), p. 169*.
4x + 4	**WR**	UINT	**Pointer to table in the Second PCFC block** For more information, see *Contents: 4x + 4 Register (WR, UINT), p. 170*.
4x + 5	**WR**	UINT	**Pointer to table in the Third PCFC block** For more information, see *Contents: 4x + 5 Register (WR, UINT), p. 170*.
4x + 6	**WR**	UINT	**Pointer to table in the Fourth PCFC block** For more information, see *Contents: 4x + 6 Register (WR, UNIT), p. 171*.
4x + 7	**WR**	UINT	**Report Area Type 4x / 6x** For more information, see *Contents: 4x + 7 Register (WR, UNIT), p. 171*.

Block Register	Access	Data Type	Comment
4x + 8	**WR**	UINT	**Report Area Offset** For more information, see *Contents: 4x + 8 Register (WR, UNIT), p. 171*.
4x + 9	**WR**	UINT	**User Identification Number** For more information, see *Contents: 4x + 9 Register (WR, UNIT), p. 172*.
4x + 10	**WR**	UINT	**User Passcode** For more information, see *Contents: 4x + 10 Register (WR, UNIT), p. 172*.
4x + 11	**WR**	UINT	**Block Select** For more information, see *Contents: 4x + 11 Register (WR, UINT), p. 173*.
4x + 12	**WR**	UINT	**Record Type** For more information, see *Contents: 4x + 12 Register (WR, UNIT), p. 173*.
4x + 13	**WR**	UINT	**Record Select** For more information, see *Contents: 4x + 13 Register (WR, UNIT), p. 174*.
4x + 14	**WR**	UINT	**Current Record** For more information, see *Contents: 4x + 14 Register (WR, UINT), p. 174*.

8.2.2. AUDT—Detail: 4x + 0 ... + 8, Setup and Diagnostic Data Registers

8.2.2.1. Overview

This unit provides a detailed description of the contents of the 4x + 0 and 4x + 1 AUDT registers.

8.2.2.2. 4x + 0 Register (RD, HEX)

AUDT Revision Number (X.XX)
Displays current function block revision number. Format is (X.XX).For example, hex 0100 indicates revision 1.00.

8.2.2.3. Bit Summary: 4x + 1 Register (WR, BIN)

Command Word
This register contains specific commands to the block entered by the user. The following table is a summary of the bits in the command word:

Bit	Description	Bit	Description
1 MSB	PCFC 0 Audit Trail	9	Reserved for system use
2	PCFC 1 Audit Trail	10	Change Privileged Passcode
3	PCFC 2 Audit Trail	11	Change Technician / Operator Passcode
4	PCFC 3 Audit Trail	12	Logout All
5	Force Process Variables PCFC 0	13	Clear Audit Trail PCFC 0
6	Force Process Variables PCFC 1	14	Clear Audit Trail PCFC 1
7	Force Process Variables PCFC 2	15	Clear Audit Trail PCFC 2
8	Force Process Variables PCFC 3	16 LSB	Clear Audit Trail PCFC 3

8.2.2.4. Bit Contents: 4x + 1 Register (WR, BIN)

The following table describes in detail the function of each bit.

Bit	Description
Bit 1 MSB	**PCFC 0 Audit Trail** If this Bit is ON, space has been allocated for one Audit Trail of PCFC block 0. **Note**: Heap size for the loadable should be set depending on the number of audit trails. (See *Determining How Much Memory Is Needed , p. 150*)
Bit 2	**PCFC 1 Audit Trail** If this Bit is ON, space has been allocated for two Audit Trails of PCFC block 1. **Note**: Heap size for the loadable should be set depending on the number of audit trails. (See *Determining How Much Memory Is Needed , p. 150*)
Bit 3	**PCFC 2 Audit Trail** If this Bit is ON, space has been allocated for three Audit Trails of PCFC block 2. **Note**: Heap size for the loadable should be set depending on the number of audit trails. (See *Determining How Much Memory Is Needed , p. 150*)
Bit 4	**PCFC 3 Audit Trail** If this Bit is ON, space has been allocated for four Audit Trails of PCFC block 3. **Note**: Heap size for the loadable should be set depending on the number of audit trails. (See *Determining How Much Memory Is Needed , p. 150*)
Bit 5	**Force Process Variables PCFC 0** This allows the Process Variables to be forced in block zero. This is used for forcing or manually entering a process variable e.g. manually setting Specific Gravity because there is no densitometer.
Bit 6	**Force Process Variables PCFC 1** This allows the Process Variables to be forced in block one. This is used for forcing or manually entering a process variable e.g. manually setting Specific Gravity because there is no densitometer.
Bit 7	**Force Process Variables PCFC 2** This allows the Process Variables to be forced in block two. This is used for forcing or manually entering a process variable e.g. manually setting Specific Gravity because there is no densitometer.
Bit 8	**Force Process Variables PCFC 3** This allows the Process Variables to be forced in block three. This is used for forcing or manually entering a process variable e.g. manually setting Specific Gravity because there is no densitometer.
Bit 9	Reserved for system use
Bit 10	**Change Privileged Passcode** This bit is used to change the Passcode for Privileged access level. The user must be logged in a Privileged user. **Note:** Set this bit to 1 with a positive transition contact, and bit will reset itself automatically. If user is not logged in as Privileged bit will not reset.

Bit	Description
Bit 11	**Change Technician / Operator Passcode** This bit is used to change the Passcode for Technician and Operator access levels. The user must be logged in a Privileged user. **Note:** Set this bit to 1 with a positive transition contact, and bit will reset itself automatically. If user is not logged in as Privileged bit will not reset.
Bit 12	**Logout All** This bit logs out all users from the AUDT block and system. Set this bit to 1 with a positive transition contact, and bit will reset automatically. **Note:** If the user is not currently logged in this bit has no effect and will not clear itself.
Bit 13	**Clear Audit Trail PCFC 0** Set this bit to clear the Audit Trail Base Configuration for PCFC Block 0. **Note:** This action requires privileged user ID status and a valid Passcode. No other Level is valid.
Bit 14	**Clear Audit Trail PCFC 1** Set this bit to clear the Audit Trail Base Configuration for PCFC Block 1. **Note:** This action requires privileged user ID status and a valid Passcode. No other Level is valid.
Bit 15	**Clear Audit Trail PCFC 2** Set this bit to clear the Audit Trail Base Configuration for PCFC Block 2. **Note:** This action requires privileged user ID status and a valid Passcode. No other Level is valid.
Bit 16 LSB	**Clear Audit Trail PCFC 3** Set this bit to clear the Audit Trail Base Configuration for PCFC Block 3. **Note:** This action requires privileged user ID status and a valid Passcode. No other Level is valid.

8.2.2.5. Bit Summary: 4x + 2 Register (WR, BIN)

Fault Word

This register contains the specific faults that the function block has detected.

Fault Word Bits: Summary

Bit	Description	Bit	Description
1 MSB	Top Node Invalid	9	API Audit Mem Fail One
2	Bottom Node Invalid	10	API Audit Mem Fail Two
3	Record Out of Range	11	API Audit Mem Fail Three
4	PCFC Not Present	12	API Audit Mem Fail Four
5	First PCFC 4x Pointer Invalid	13	Invalid Block Configuration
6	Second PCFC 4x Pointer Invalid	14	Invalid Log Pointer
7	Third PCFC 4x Pointer Invalid	15	TMCI Pointer Invalid
8	Fourth PCFC 4x Pointer Invalid	16 LSB	User Logged In

8.2.2.6. Bit Contents: 4x + 2 Register (WR, BIN)

Fault Word Bits: Contents

Bit	Description
Bit 1 MSB	**Top Node Invalid** Value entered in the Top Node of the AUDT block is NOT zero. **Note:** There can only be one instance of the AUDT block.
Bit 2	**Bottom Node Invalid** The value in the bottom node is not valid. Enter the exact number of registers the block requires. **Note:** See block representation for number of register required.
Bit 3	**Record Out of Range** The record selected is out of range for the type of record. **Note:** See Record Type field for more information on records.
Bit 4	**PCFC Not Present** One of the PCFC blocks using the audit trail either ● Does NOT exist, or ● Is NOT running For example: Top input is not shorted to the power rail. When this error occurs, an Alarm record will be written to the appropriate log. **Note:** This error does not affect the recording or use of the other meters in the system.
Bit 5	**First PCFC 4x Pointer Invalid** The pointer entered for the first PCFC block is invalid. The register must contain a non-zero number that is in the configured 4x register space, and there must be enough 4x registers configured to support block operation. **Note:** If this fault occurs the block will not operate until fault is resolved.
Bit 6	**Second PCFC 4x Pointer Invalid** The pointer entered for the Second PCFC block is invalid. The register must contain a non-zero number that is in the configured 4x register space, and there must be enough 4x registers configured to support block operation. **Note:** If this fault occurs the block will not operate until fault is resolved.
Bit 7	**Third PCFC 4x Pointer Invalid** The pointer entered for the Third PCFC block is invalid. The register must contain a non-zero number that is in the configured 4x register space, and there must be enough 4x registers configured to support block operation. **Note:** If this fault occurs the block will not operate until fault is resolved.
Bit 8	**Fourth PCFC 4x Pointer Invalid** The pointer entered for the Fourth PCFC block is invalid. The register must contain a non-zero number that is in the configured 4x register space, and there must be enough 4x registers configured to support block operation. **Note:** If this fault occurs the block will not operate until fault is resolved.

Bit	Description
Bit 9	**API Audit Mem Fail One** There is not enough free memory in the PLC to store the Audit Trail. • Ensure heap size is correctly set in the loadable. (See *Determining How Much Memory Is Needed , p. 150*) • Check application program size and verify there is enough room store the Audit Trail. The AUDT block only supports the Quantum 534 and 434.
Bit 10	**API Audit Mem Fail Two** There is not enough free memory for two (2) Audit Trails in this system. • Ensure heap size is correctly set in the loadable. (See *Determining How Much Memory Is Needed , p. 150*) • Check application program size and verify there is enough room store the Audit Trail. The AUDT block only supports the Quantum 534 and 434.
Bit 11	**API Audit Mem Fail Three** There is not enough free memory for three (3) Audit Trails in this system. • Ensure heap size is correctly set in the loadable. (See *Determining How Much Memory Is Needed , p. 150*) • Check application program size and verify there is enough room store the Audit Trail. The AUDT block only supports the Quantum 534 and 434.
Bit 12	**API Audit Mem Fail Four** There is not enough free memory for four (4) Audit Trails in this system. • Ensure heap size is correctly set in the loadable. (See *Determining How Much Memory Is Needed , p. 150*) • Check application program size and verify there is enough room store the Audit Trail. The AUDT block only supports the Quantum 534 and 434.
Bit 13	**Invalid Block Configuration** Audit Trails must be selected in order. When using multiple audit trails (multiple PCFC blocks), Bits 1-4 of the Command Word must be set in sequential order with no gaps. See the table "Setting the bit order," which follows the description of Bit 16.
Bit 14	**Invalid Log Point** The pointer entered in "Report Area Type" 4x / 6x (4x + 7) and "Report Area Offset" (4x + 8) registers is not valid. The pointer is either • Zero, or • The Starting Address + Total Report Length is outside the register area mapped in the PLC configuration.

Bit	Description
Bit 15	**TMCI Pointer Invalid** The pointer entered in the PCFC block 4x table that points to the TMCI block is invalid. **Note:** If this fault occurs, the block will not operate until the fault is resolved.
Bit 16 LSB	**User Logged In** This event bit does not trigger a fault output on the block. The purpose is to notify the user / programmer that someone is currently logged into the block and can make changes.

Setting the bit order

Configuration Status					
	Command Word Bit	**1**	**2**	**3**	**4**
Valid Configuration		1	1	1	0
Invalid Configuration		1	1	0	1

8.2.2.7. Contents: 4x + 3 Register (WR, UINT)

Pointer to Table in First PCFC Block

This register contains the value in the middle node in the first PCFC block to have an Audit Trail without the leading digit '4.'

Only the first four blocks can use the API Audit Trail (Top Node numbers from 0 to 3 on the PCFC).

When programming, ensure that the middle node of the PCFC matches the top node of the PCFC block. The address number is entered without the preceding data type 4, for example, 401256 is entered as 1256; 412560, as 12560.

WARNING

UNINTENDED CONTROLLER OPERATION

If you assign the wrong address in this register, you could cause the following:

- Stop the block from functioning, or
- Cause the program logic to behave erratically, or
- Stop the controller or lock it up.

Enter the correct middle address of the PCFC block.

Failure to follow this precaution can result in death, serious injury, or equipment damage.

8.2.2.8. Contents: 4x + 4 Register (WR, UINT)

Pointer to Table in Second PCFC Block

This register contains the value in the middle node in the second PCFC block to have an Audit Trail.
Only the first four blocks can use the API Audit Trail (Top Node numbers from 0 to 3 on the PCFC).
When programming, ensure that the middle node of the PCFC matches the top node of the PCFC block. The address number is entered without the preceding data type 4, for example, 401256 is entered as 1256; 412560, as 12560.

WARNING

UNINTENDED CONTROLLER OPERATION

If you assign the wrong address in this register, you could cause the following:
- Stop the block from functioning, or
- Cause the program logic to behave erratically, or
- Stop the controller or lock it up.

Enter the correct middle address of the PCFC block.

Failure to follow this precaution can result in death, serious injury, or equipment damage.

8.2.2.9. Contents: 4x + 5 Register (WR, UINT)

Pointer to Table in Third PCFC Block

This register contains the value in the middle node in the Third PCFC block to have an Audit Trail.
Only the first four blocks can use the API Audit Trail (Top Node numbers from 0 to 3 on the PCFC).
When programming, ensure that the middle node of the PCFC matches the top node of the PCFC block. The address number is entered without the preceding data type 4, for example, 401256 is entered as 1256; 412560, as 12560.

WARNING

UNINTENDED CONTROLLER OPERATION

If you assign the wrong address in this register, you could cause the following:
- Stop the block from functioning, or
- Cause the program logic to behave erratically, or
- Stop the controller or lock it up.

Enter the correct middle address of the PCFC block.

Failure to follow this precaution can result in death, serious injury, or equipment damage.

8.2.2.10. Contents: 4x + 6 Register (WR, UNIT)

Pointer to Table in Fourth PCFC Block

This register contains the value in the middle node in the fourth PCFC block to have an Audit Trail.
Only the first four blocks can use the API Audit Trail (Top Node numbers from 0 to 3 on the PCFC).
When programming, ensure that the middle node of the PCFC matches the top node of the PCFC block. The address number is entered without the preceding data type 4, for example, 401256 is entered as 1256; 412560, as 12560.

WARNING

UNINTENDED CONTROLLER OPERATION

If you assign the wrong address in this register, you could cause the following:
- Stop the block from functioning, or
- Cause the program logic to behave erratically, or
- Stop the controller or lock it up.

Enter the correct middle address of the PCFC block.

Failure to follow this precaution can result in death, serious injury, or equipment damage.

8.2.2.11. Contents: 4x + 7 Register (WR, UNIT)

Report Area Type 4x / 6x
Report Address Modulo 10000 High Word (00XX)

The 4x+7 and 4x+8 registers define the starting address of several registers used to display audit log data. This area pointed to by this address acts as a window into the audit log which allows the user to view audit log data. The actual log is maintained internally and is not available to the user other than using this 'window.'
This field contains the two most significant digits of that 6-digit address (the first part of the 4x or 6x address in Modulo 10000 format). For example, if the report area address is 401000, enter 40 in this field. If the report area address is 623000, enter 62 in this field.

8.2.2.12. Contents: 4x + 8 Register (WR, UNIT)

Report Area Offset
Report Address Modulo 10000 Low Word (XXXX)

The 4x+7 and 4x+8 registers define the starting address of several registers used to display audit log data. This area pointed to by this address acts as a window into the audit log which allows the user to view audit log data. The actual log is maintained internally and is not available to the user other than using this 'window'.
This field contains the four least significant digits of that 6-digit address (the remainder part of the 4x or 6x address in Modulo 10000 format). For example, if the report area address is 401000, enter 1000 in this field. If the report area address is 623000, enter 3000 in this field.

8.2.3. AUDT—Detail: 4x + 9 and 4x + 10, User Name and Passcode Registers

8.2.3.1. Contents: 4x + 9 Register (WR, UNIT)

User Identification Number

User enters assigned identification number.

For a description of the access level, see below. Also see the parameter index for more information.

User ID	Access Level	Descriptions of rights
100	Privileged	• Complete access to all variables • Destruction of Audit Logs • Creating Passcodes **Note:** The default Passcode is 12345.
200	Technician	This access level allows • Access to many functions • Access to all entries (Except Passcode creation and destruction of logs) (See *Parameters and Functions — User Security Access Levels, p. 256*) Within the flow computer fields, allows • Transducer Manual overrides (if applicable) • Product Gravity Overrides • Prover Operations • Batching Operations **Note:** The default Passcode for this level is 1234.
300	Operator	• Access for Batching and Proving operations See User Security Access Level Table for Parameter and Functions. **Note:** The default Passcode for this level is 123.

8.2.3.2. Contents: 4x + 10 Register (WR, UNIT)

User Passcode

Enter the Passcode for the Audit Trail block valid numbers are between 1 and 65535.

Note: As soon as the Passcode is entered and the middle input is set high, the Passcode field is cleared.

- If a valid (correct) Passcode is entered, access will be granted and will generate an Event Log entry with the users id and time and date.
- If an invalid (NOT correct) Passcode is entered, the User Id and Passcode fields are cleared.

To determine if logged in, look at bit 16 of the Fault Word (4x + 2) of the AUDT block.

8.2.4. AUDT—Detail: 4x + 11 to 4x + 14, the Record Registers

8.2.4.1.
Contents: 4x + 11 Register (WR, UINT)

Block Select

Enter the Top Node number of the PCFC block's Audit Trail to be read.
Valid ranges are 0 to 3 only.
Note: If a value is set which is outside of this range or the number of blocks configured, the block will automatically set to 0.

8.2.4.2.
Contents: 4x + 12 Register (WR, UNIT)

Record Type

This field contains the record type to read from the log database. There are eight different type of logs.

Record Type	Record Type Description
0	Configuration
1	Alarm
2	Event
3	Base Configuration
4	Current Configuration
5	Batch Report
6	Prove Report
7	Last Meter Factor Table (read)
8	Last Meter Factor Table (write)
Note: For record types 3 to 6, once the record type has been entered, the field will be set to zero.	

For detailed information on the logs, see API Audit Trail 21.2 Report logging section.

8.2.4.3.
Contents: 4x + 13
Register (WR, UNIT)

Record Select

Enter the record number to view. The record type determines in which table of registers the data will be displayed. Ensure the record number falls within the valid range.

Record Type	Record Type Description	Record Number Range	Number of Records
0	Configuration	(0 to 499)	500
1	Alarm	(0 to 249)	250
2	Event	(0 to 249)	250
3	Base Configuration	(0)	1
4	Current Configuration	(0)	1
5	Batch Report	(0 to 11)	12
6	Prove Report	(0 to 3)	4
7	Last Meter Factor Table (read)	(0 to 15)	16
8	Last Meter Factor Table (write)	(0 to 15)	16
Note: If an invalid range has been entered, the Record Select field will be over written with a zero.			

For detailed information on the logs, see API Audit Trail 21.2 Report logging section.

8.2.4.4.
Contents: 4x + 14
Register (WR, UINT)

Current Record

Displays the next current record to write for the block and record type selected. For example, if Current Record = 11, then there are 11 actual records (counting zero) and the block is prepared to write the 12th record.

8.3 AUDT Configuration—Report Registers

At a Glance

Purpose

Report logs are divided into five view windows:
- configuration, alarm, and event report
- base configuration/current configuration report
- batch report
- prover report
- last meter factor table

The address of these view windows is located in the 4x + 7 ... +8 register in the AUDT block.
The view windows allow you to view individual records of the various reports.

What's in this Section?

This section contains the following topics:

8.3.1. AUDT Report Logging—Detail: Report Registers—Configuration, Alarm, and Event Logs

8.3.1.1. Configuration Log Records

The configuration log contains data on the changes in the configuration (Per API 2540 Chapter 21 Section 2 12.3.2 and 123.3). The configuration log is stored in a ring buffer. When the number of log entries reaches the maximum limit, the oldest log entry is over written with the new configuration. The configuration log stores the last 500 changes made to the base configuration. The configuration log can be erased to store a new configuration with the right user privileges.

8.3.1.2. Alarm Log Records

The alarm log is triggered either by the two fault words in the PCFC block, or by a fault word in the TMCI and a fault word in the AUDT block itself. The alarm log displays the value of the process variable that is associated with the alarm along with a time and date stamp, alarm value and parameter index number, which identifies the alarm. The alarm log is stored in a ring buffer so when the number of alarms reaches the maximum limit, the oldest alarm is over written with the new alarm.

8.3.1.3. Event Log Records

The event log is triggered by one status event word in the PCFC block. The event log displays the value of the process variable that is associated with the event along with a time and date stamp, event value, and parameter index number (identifies event). The event log is stored in a ring buffer so when the number of events reaches the maximum limit, the oldest event is over written with the new event.

8.3.1.4. Table of Configuration, Alarm, and Event Records

The previously defined fields: Block Select (4x + 11), Record Type (4x + 12), and Record Select (4x + 13) determine which Audit Trail record type and record number that is displayed in the table below.
This table is a common structure for the Configuration, Alarm, and Event records.

Report Register	Access	Data Type	Comment
4x + 0	RD	UINT	**Configuration / Alarm / Event Number** This field is for displaying the chronological order of Configuration (0 to 499) / Alarms / Events (0 to 249) as they occurred. **Note:** The Alarm log is a ring buffer. If the Event Counter rolls over to 0, the rollover indicates that 249 was the last alarm to occur.
4x + 1	RD	UINT	**Record Month** This field displays the month when the Alarm / Event occurred.
4x + 2	RD	UINT	**Record Day** This field displays the Day when the Alarm / Event occurred.
4x + 3	RD	UINT	**Record Year** This field displays the Year when the Alarm / Event occurred.
4x + 4	RD	UINT	**Record Hour** This field displays the Hour when the Alarm / Event occurred.
4x + 5	RD	UINT	**Record Minute** This field displays the Minute when the Alarm / Event occurred.
4x + 6	RD	UINT	**Record Second** This field displays the Second when the Alarm / Event occurred.
4x + 7	RD	UINT	**User Identification** This field displays the Current User Identification code that is logged into the system. This is used with the Configuration and Events records (It is possible to have a current user during an Alarm if a user is logged into the AUDT block at the time of Alarm).

Report Register	Access	Data Type	Comment
4x + 8	RD	UINT	**Parameter Index** This field displays the parameters affected and provides information on the record type. For example, Parameter Index # 21 is a configuration record that has to do with Meter Factor. All register values relate to the Meter Factor.
4x + 9	RD	UINT	**Alarm / Event Value** This field displays the new value of the Alarm / Event. This Field is used only for an Alarm or Event record.
4x + 10	RD	UINT	**Old Value Binary Format** This field displays the value previous to the one shown in the New Value field (Intended to be viewed in Binary format). **Note:** This field is not used with Alarm Records.
4x + 11	RD	UINT	**New Value Binary Format** This field displays the new value that is currently being used (intended to be viewed in Binary format).
4x + 12	RD	UINT	**Old Value UINT Format** This field displays the value previous to the one shown in the New Value field (Intended to be viewed unsigned integer format). **Note:** This field is not used with Alarm Records.
4x + 13	RD	UINT	**New Value UINT Format** This field displays the new value that is currently being used (intended to be viewed in unsigned integer format).
4x + 14 ... +15	RD	UINT	**Old Value UDINT Format** This field displays the value previous to the one shown in the New Value field (Intended to be viewed in unsigned long integer format). **Note:** This field is not used with Alarm Records.
4x + 16 ... +17	RD	UINT	**New Value UDINT Format** This field displays the new value that is currently being used (intended to be viewed in unsigned long integer format).

Report Register	Access	Data Type	Comment
4x + 18 ... +19	RD	UINT	**Old Value FLOAT Format** This field displays the value previous to the one shown in the New Value field (Intended to be viewed Floating point or Real format). **Note:** This field is not used with Alarm Records.
4x + 20 ... +21	RD	UINT	**New Value FLOAT Format** This field displays the new value that is currently being used (intended to be viewed in Floating point or Real format).
4x + 22 ... +23	RD	UDINT	**ISV Accumulated** This field displays the accumulated Indicated Standard Volume value at the time of the Alarm / Event.

8.3.2. AUDT Report Logging—Log Types

8.3.2.1. Overview

This unit presents a summary of the AUDT log types available.

8.3.2.2. Log Types

The AUDT block report-logging function stores eight different types of logs.

- Log types zero (0) through seven (7) are read only.
  Read Only logs cannot be modified in any way.
- Log type eight (8) is a write (with Passcode).

The following table shows the different log types that can be viewed. The log type determines in which table of registers the data appears.

Log Type	Log Type Description	Log Number Range	Number of Records (Changes)
0	Configuration	(0 to 499)	500
1	Alarm	(0 to 249)	250
2	Event	(0 to 249)	250
3	Base Configuration	(0 to 0)	1
4	Current Configuration	(0 to 0)	1
5	Batch Report	(0 to 11)	12
6	Prove Report	(0 to 3)	4
7	Last Meter Factor Table (Read)	(0 to 15)	16
8	Last Meter Factor Table (**Write**)	(0 to 15)	16

8.3.3. AUDT Report Logging—Detail: Index of Configuration Parameters

8.3.1. Overview

This material describes all possible values for the Parameter Configuration Index.

The following table provides descriptions for each index number.

Parameter Index	Data Type	Description of the Data
0	BIN	**Command Word 1** Displays the Old and New Value for the parameter.
1	BIN	**Command Word 2** Displays the Old and New Value for the parameter.
2	BIN	**Fault Word 1** See below the Alarm Logs parameter index 201 to 216. (See *Alarm Log Parameters, p. 185*)
3	BIN	**Fault Word 2** See below the Alarm Logs parameter index 301 to 316. (See *Alarm Log Parameters, p. 185*)
4	BIN	**Status Events Word** See below the Event Logs parameter index 401 to 416. (See *Event Log Parameters, p. 189*)
5	UINT	**Meter Run** For example: 1 to 16 Displays the Old and New Value for the parameter.
6	UINT	**TMCI Block Starting 4x** Displays the Old and New Value for the parameter.
7	UINT	**Product Type** Displays the Old and New Value for the parameter.
8	UINT	**Product Name** Displays the Old and New Value for the parameter.
9	FLOAT	**Sediment and Water % CSW** Displays the Old and New Value for the parameter.
10	FLOAT	**Calculated Meter Factor (After proving run)** Displays the Old and New Value for the parameter.
11	ASCII (2)	**Serial Number of Meter** Displays the Old and New Value for the parameter.
12	ASCII (2)	**Serial Number of Meter** Displays the Old and New Value for the parameter.
13	ASCII (2)	**Serial Number of Meter** Displays the Old and New Value for the parameter.

Parameter Index	Data Type	Description of the Data
14	ASCII (2)	**Serial Number of Meter** Displays the Old and New Value for the parameter.
15	ASCII (2)	**Meter ID** Displays the Old and New Value for the parameter.
16	ASCII (2)	**Meter ID** Displays the Old and New Value for the parameter.
17	ASCII (2)	**Meter ID** Displays the Old and New Value for the parameter.
18	ASCII (2)	**Meter ID** Displays the Old and New Value for the parameter.
19	UINT	**Meter Size** Displays the Old and New Value for the parameter.
20	UINT	**Meter Type** Displays the Old and New Value for the parameter.
21	FLOAT	**Meter Factor** Displays the Old and New Value for the parameter.
22	FLOAT	**Meter K Factor 1.0 - 65535.0** Displays the Old and New Value for the parameter.
23	UINT	**4X Offset to Time of Day Clock** Displays the Old and New Value for the parameter.
24	UINT	**Start of Day ’Hour’ (0 - 23 military)** Displays the Old and New Value for the parameter.
25	UINT	**Start of Day ’Minute’ (0 - 59)** Displays the Old and New Value for the parameter.
26	UINT	**Report Address Modulo 10000 High Word (00XX) For example, 4x or 6x** Displays the Old and New Value for the parameter.
27	UINT	**Report Address Modulo 10000 Low Word (XXXX)** Displays the Old and New Value for the parameter.
28	UINT	**Internal Diameter of the Pipe** Displays the Old and New Value for the parameter.
29	UINT	**Wall Thickness of the Pipe** Displays the Old and New Value for the parameter.
30	UINT	**Modulus of Elasticity for the Pipe Material x 10^5** Displays the Old and New Value for the parameter.
31	UINT	**Coefficient of Cubic Expansion per ° F or °C of the Pipe Material** Displays the Old and New Value for the parameter.

Parameter Index	Data Type	Description of the Data
32	UDINT	**Base Volume of Prover @ 60°F / 15 °C 0 PSI (Barrels) / M^3** Displays the Old and New Value for the parameter.
33	UINT	**Number of Consecutive Proving Runs** Displays the Old and New Value for the parameter.
34	UINT	**Gravity / Density Conversion Range** Displays the Old and New Value for the parameter.
35	FLOAT	**Gravity / Density High Engineering Units** Displays the Old and New Value for the parameter.
36	FLOAT	**Gravity / Density Low Engineering Units** Displays the Old and New Value for the parameter.
37	UINT	**Temperature Conversion Range (Meter)** Displays the Old and New Value for the parameter.
38	FLOAT	**Temperature High Engineering Units (Meter)** Displays the Old and New Value for the parameter.
39	FLOAT	**Temperature Low Engineering Units (Meter)** Displays the Old and New Value for the parameter.
40	UINT	**Pressure Conversion Range (Meter)** Displays the Old and New Value for the parameter.
41	FLOAT	**Pressure High Engineering Units (Meter)** Displays the Old and New Value for the parameter.
42	FLOAT	**Pressure Low Engineering Units (Meter)** Displays the Old and New Value for the parameter.
43	UINT	**Temperature Conversion Range (Prover)** Displays the Old and New Value for the parameter.
44	FLOAT	**Temperature High Engineering Units (Prover)** Displays the Old and New Value for the parameter.
45	FLOAT	**Temperature Low Engineering Units (Prover** Displays the Old and New Value for the parameter.
46	UINT	**Pressure Conversion Range (Prover)** Displays the Old and New Value for the parameter.
47	FLOAT	**Pressure High Engineering Units (Prover)** Displays the Old and New Value for the parameter.
48	FLOAT	**Pressure Low Engineering Units (Prover)** Displays the Old and New Value for the parameter.
49	UINT	**Pulse Fidelity Frequency Threshold** Displays the Old and New Value for the parameter.
50	UINT	**Pulse Fidelity Batch Count Errors** Displays the Old and New Value for the parameter.

Parameter Index	Data Type	Description of the Data
51	UINT	**Filter Samples** Displays the Old and New Value for the parameter.
52	UINT	**Base Temperature** Displays the Old and New Value for the parameter.
53	UINT	**TMCI Command Word** Displays the Old and New Value for the parameter.
54	UINT	**Meter Card Type One** Displays the Old and New Value for the parameter.
55	UINT	**Meter Card Starting One 3x** Displays the Old and New Value for the parameter.
56	UINT	**Meter Card Starting One 4x** Displays the Old and New Value for the parameter.
57	UINT	**Meter Card Type Two** Displays the Old and New Value for the parameter.
58	UINT	**Meter Card Starting Two 3x** Displays the Old and New Value for the parameter.
59	UINT	**Meter Card Starting Two 4x** Displays the Old and New Value for the parameter.
60	UINT	**Meter Card Type Three** Displays the Old and New Value for the parameter.
61	UINT	**Meter Card Starting Three 3x** Displays the Old and New Value for the parameter.
62	UINT	**Meter Card Starting Three 4x** Displays the Old and New Value for the parameter.
63	UINT	**Meter Card Type Four** Displays the Old and New Value for the parameter.
64	UINT	**Meter Card Starting Four 3x** Displays the Old and New Value for the parameter.
65	UINT	**Meter Card Starting Four 4x** Displays the Old and New Value for the parameter.
66	UINT	**Zero Flow Reading Timer** Displays the Old and New Value for the parameter.
Legend **HEX** - Hexadecimal 0 to FFFF **INT** - Integer **FLOAT** - 3.4 x 10^-38 to 3.4 x 10^38 **UINT** - Unsigned Integer 0 to 65535 **UDINT** - Unsigned Double Integer 0 to 4,294,967,295		

8.3.4. AUDT Report Logging—Detail: Index of Alarm Log Parameters

8.3.4.1. Alarm Log Parameters

The AUDT function block defines all of the data that is collected by the block, and for easier identification of that data, the AUDT function block assigns each data item an index number shown in register 4x + 8.

The following table describes the contents of registers 4x + 7 and up. (See *Table of Configuration, Alarm, and Event Records, p. 177*) The parameter index is shown in register 4x + 8 and other registers will be filled in as described below.

Parameter Index	Data Type	Description of the Data	Data Type for Process Variable
201	BIN	**Invalid Top Node** Does not display New Value. This is a base programming error and the PCFC block will not function. This error should not occur during normal operation unless the program has changed. This will generate a PCFC Not Present fault in the AUDT block and be recorded in the alarm log. **Note:** Invalid Top Node may not generate a 201 error in the log due to the nature of the error. It will however generate an error which will be logged in the Alarm log under 501 PCFC Not Present.	NONE
202	BIN	**Address to Report Area Invalid** Displays New Value of the Report Address Modulo Hi and Low fields in UINT format.	UINT
203	BIN	**Time of Day Clock Invalid / Not Set** Displays New Value of the 4x Offset to Time of Day Clock field in UINT format.	UINT
204	BIN	**Minimum Density Exceeded** Displays New Value of the Gravity / Density Scaled Output field in FLOAT format. Note: This error may occur if a value is uncorrected and a CTL error occurs. Is not generating a proper corrected density according to the API table.	FLOAT
205	BIN	**Maximum Density Exceeded** Displays New Value of the Gravity / Density Scaled Output field in FLOAT format.	FLOAT
206	BIN	**Invalid Pressure Conversion Range** Displays Pressure Conversion Range (Meter) in the New Value field in FLOAT format.	FLOAT

Parameter Index	Data Type	Description of the Data	Data Type for Process Variable
207	BIN	**Invalid Temperature Conversion Range** Displays Temperature Conversion Range (Meter) in the New Value field in UINT format.	UINT
208	BIN	**Invalid Bottom Node** Does not display an old and New Value. This is a base programming error and the PCFC block will not function. This error should not occur during normal operation unless the program has changed. This will generate a PCFC Not Present fault in the AUDT block, and the error will be recorded in the alarm log. **Note:** Invalid Bottom Node may not generate a 208 error in the log due to the nature of the error. It will however generate error will be logged in the Alarm log under 501 PCFC Not Present.	NONE
209	BIN	**Pressure Input Invalid** Displays New Value of the Pressure Raw Counts (Meter) field in UINT format. **Note:** This error is due to an invalid 3x pointer.	UINT
210	BIN	**Temperature Input Invalid** Displays New Value of the Temperature Raw Counts (Meter) field in UINT format. **Note:** This error is due to an invalid 3x pointer.	UINT
211	BIN	**Pressure Under Range** Displays New Value of the Pressure Scaled Output field in FLOAT format.	FLOAT
212	BIN	**Pressure Over Range** Displays New Value of the Pressure Scaled Output field in FLOAT format.	FLOAT
213	BIN	**Temperature Under Range** Displays New Value of the Temperature Scaled Output field in FLOAT format.	FLOAT
214	BIN	**Temperature Over Range** Displays New Value of the Temperature Scaled Output field in FLOAT format.	FLOAT
215	BIN	**Invalid CPL Value** Displays Process Variable Meter Pressure in the New Value field.	FLOAT

Parameter Index	Data Type	Description of the Data	Data Type for Process Variable
216	BIN	**Invalid CTL Value** Displays Process Variable Meter Temperature in the New Value field.	FLOAT
301	BIN	**Pulse Fidelity Error** Displays the New Value of the Pulse Fidelity status flags which are found in the Status events word. **Note:** The other flags are masked out. All data is in the second nibble from the left 0000 1111 0000 0000 (msb).	BIN
302	BIN	**Min / Max Prove Runs Exceeded** Displays "Number of Consecutive Proving Runs" in the New Value field.	UINT
303	BIN	**Invalid Pipe Wall Thickness** Displays "Wall Thickness of the Pipe" in the New Value field.	UINT
304	BIN	**Invalid Pipe Inside Diameter** Displays "Internal Diameter of the Pipe" in the New Value field.	UINT
305	BIN	**Invalid Modulus of Elasticity** Displays "Modulus of Elasticity for the Pipe Material x 10^5" in the New Value field.	UINT
306	BIN	**Invalid Coefficient of Cubic Expansion per degree pipe material** Displays "Coefficient of Cubic Expansion per Degree Pipe Material" in the New value field.	UINT
307	BIN	**Invalid Specific Gravity / Density Conversion Range** Displays "Specific Gravity / Density Conversion Range" in the New Value field.	UINT
308	BIN	**Invalid Specific Gravity / Density Input** Displays "Specific Gravity / Density Raw Counts" in the New Value field.	UINT
309	BIN	**Invalid Specific Gravity / Density Under Range** Displays "Specific Gravity / Density Scaled Output" in the New Value field.	FLOAT
310	BIN	**Invalid Specific Gravity / Density Over Range** Displays "Specific Gravity / Density Scaled Output" in the New Value field.	FLOAT

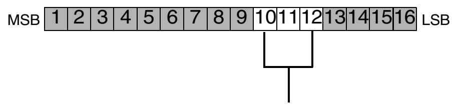
Parameter Index	Data Type	Description of the Data	Data Type for Process Variable
311	BIN	**Invalid Product Choice** Displays "Product Type" in the New Value field.	FLOAT
312	BIN	**Function Not Available with Hardware** Displays the New Value in the UDINT format field. **Note:** The values are Command Word One and Two. Command Word One holds the first 16 bits, and Command Word Two, the second 16 bits. (Change the radix to BIN to view the individual bit settings).	UDINT
313	BIN	**Invalid IEEE Floating Point Format Number** Displays "Error Code" in the New Value field.	FLOAT
314	BIN	**Invalid 4x TMCI Pointer** Displays "TMCI Block Starting 4x Output Register" in the New Value field.	UINT
315	BIN	**Invalid Base Volume of Prover** Displays "Base Volume of Prover" in the New Value field.	UDINT
316	BIN	**Invalid Meter Run Number** Displays "Meter Run" in the New Value field.	UINT

8.3.5. AUDT Report Logging—Detail: Index of Event Log Parameters

8.3.5.1. Event Log Parameters

The AUDT function block defines all of the data that is collected by the block, and for easier identification of that data, the AUDT function block assigns each data item an index number.
The following table provides descriptions for each index number.

Parameter Index	Parameter Type	Description	Record Field
401	BIN	**Pulse Fidelity Channel A / B** Displays "Status Events" in the Old and New Binary fields.	BIN
402	BIN	**CPL Forced to 1.0** Displays "Status Events" in the Old and New Binary fields.	BIN
403	BIN	**Prove Counter Not Zero** Displays "Status Events" in the Old and New Binary fields.	BIN
404	BIN	**CPS Forced to 1.0** Displays "Status Events" in the Old and New Binary fields.	BIN
405	BIN	**Pulse Fidelity Error Sequence** Displays "Status Events" in the Old and New Binary fields.	BIN
406	BIN	**Pulse Fidelity Error Phase** Displays "Status Events" in the Old and New Binary fields.	BIN
407	BIN	**Pulse Fidelity Error Frequency** Displays "Status Events" in the Old and New Binary fields.	BIN
408	BIN	**Pulse Fidelity Error Count** Displays "Status Events" in the Old and New Binary fields.	BIN
409	BIN	**Reserved for system use**	

Parameter Index	Parameter Type	Description	Record Field
410	BIN	**Meter Proving Gate Status** Displays "Status Events" in the Old and New Binary fields. The bit pattern (0 to 4) represents the status of each detector switch as it occurs.  000 = Waiting for First Detector Switch 001 = First Detector Switch Occurred 010 = Second Detector Switch Occurred 011 = Third Detector Switch Occurred 100 = Fourth Detector Switch Occurred **Note:** 1 to 2 for unidirectional provers and 1 to 4 for bidirectional provers.	
411	BIN	**Reserved for system use**	
412	BIN	**Reserved for system use**	
413	BIN	**Reserved for system use**	
414	BIN	**Reserved for system use**	
415	BIN	**Proving Report Done** Displays "Status Events" in the Old and New Binary fields.	
416	BIN	**Proving Run in Process** Displays "Status Events" in the Old and New Binary fields.	
501	BIN	**PCFC Not Present** This error is generated from the AUDT block. It indicates that the AUDT block and PCFC are not communicating. Therefore no old and new value will be displayed.	
502	BIN	**Reserved for system use**	
503			
504			

8.3.6. AUDT Report Logging—Detail: Report Registers—Base Configuration/ Current Configuration Logs

8.3.6.1. Table of Base Configuration Records

Base Configuration Log Registers

Report Register	Access	Data Type	Comment
4x + 24	**WR**	BIN	Command Word 1
4x + 25	**WR**	BIN	Command Word 2
4x + 26	**WR**	UINT	Flow Card Number, for example 1, 2, 3, 4
4x + 27	**WR**	UINT	TMCI Starting 4x register
4x + 28	**WR**	UINT	Product Type (0 - 2)
4x + 29	**WR**	UINT	Product Name (0 - 15)
4x + 30 ... +31	**WR**	FLOAT	Sediment and Water % CSW
4x + 32 ... +33	**WR**	FLOAT	Calculated Meter Factor
4x + 34	**WR**	ASCII	Serial Number of the Flow Meter
4x + 35	**WR**	ASCII	Serial Number of the Flow Meter
4x + 36	**WR**	ASCII	Serial Number of the Flow Meter
4x + 37	**WR**	ASCII	Serial Number of the Flow Meter
4x + 38	**WR**	ASCII	Meter Identification or PI & D
4x + 39	**WR**	ASCII	Meter Identification or PI & D
4x + 40	**WR**	ASCII	Meter Identification or PI & D
4x + 41	**WR**	ASCII	Meter Identification or PI & D
4x + 42	**WR**	UINT	Size of the Meter
4x + 43	**WR**	UINT	Type of Meter Used
4x + 44 ... +45	**WR**	FLOAT	Meter M Factor
4x + 46 ... +47	**WR**	FLOAT	Meter K Factor
4x + 48	**WR**	UINT	Pointer to Time of Day Clock
4x + 49	**WR**	UINT	Hour of the Start of Day (Military)
4x + 50	**WR**	UINT	Minute of the Start of Day
4x + 51	**WR**	UINT	Reference Type to Store Log Information
4x + 52	**WR**	UINT	Reference Offset to Store Log Information to
4x + 53	**WR**	UINT	Internal Diameter of the Pipe

Report Register	Access	Data Type	Comment
4x + 54	**WR**	UINT	Wall Thickness of the Pipe
4x + 55	**WR**	UINT	Modules of Elasticity for the Pipe Material
4x + 56	**WR**	UINT	Coefficient of Cubic Expansion per Degree F or C
4x + 57	**WR**	UDINT	Base Volume of the Prover @ 60 F and 0 PSI (Barrels)
4x + 59	**WR**	UINT	Number of Consecutive Proving Runs
4x + 60	**WR**	UINT	Density Raw Counts
4x + 61	**WR**	UINT	Determines which linear data range to use for the Calculation of Scaled Density
4x + 62... +63	**WR**	FLOAT	Density High Engineering Unit
4x + 64 ... + 65	**WR**	FLOAT	Density Low Engineering Unit
4x + 66	**WR**	UINT	Raw Analog Temperature Input
4x + 67	**WR**	UNIT	Determines which linear data range to use for the Calculation of Scaled Temperature
4x + 68 ... +69	**WR**	FLOAT	Temperature High Engineering Unit
4x + 70 ... +71	**WR**	FLOAT	Temperature Low Engineering Unit
4x + 72	**WR**	UINT	Raw Analog Pressure Input
4x + 73	**WR**	UINT	Determines which linear data range to use for the Calculation of Scaled Pressures
4x + 74 ... +75	**WR**	FLOAT	Pressure High Engineering Unit
4x + 76 ... + 77	**WR**	FLOAT	Pressure Low Engineering Unit
4x + 78	**WR**	UNIT	Raw Analog Temperature Input
4x + 79	**WR**	UINT	Determines which linear data range to use for the Calculation of Scaled Temperature
4x + 80 ... +81	**WR**	FLOAT	Temperature High Engineering Unit
4x + 82 ... +83	**WR**	FLOAT	Temperature Low Engineering Unit
4x + 84	**WR**	UINT	Raw Analog Pressure Input
4x + 85	**WR**	UNIT	Determines which linear data range to use for the Calculation of Scaled Temperature.

8.3.6.2. Table of Current Configuration Records

Current Configuration Log Registers

Report Register	Access	Data Type	Comment
4x + 86 ... +87	**WR**	FLOAT	Pressure High Engineering Unit
4x + 88 ... +89	**WR**	FLOAT	Pressure Low Engineering Unit
4x + 90	**WR**	UINT	Frequency at which Pulse Fidelity stops monitoring
4x + 91	**WR**	UINT	TMCI Starting 4x register
4x + 92	**WR**	UINT	Number of samples used to smooth the frequency (3 mi)
4x + 93	**WR**	UINT	Base Temperature of the VCF Calculations 60F / 15 C
4x + 94	**WR**	BIN	Command Word 1
4x + 95	**WR**	DEC	Flow Card Number, for example 1, 2, 3, 4
4x + 96	**WR**	DEC	Flow Card Number Starting 3x register
4x + 97	**WR**	DEC	Flow Card Number Starting 4x register
4x + 98	**WR**	DEC	Flow Card Number, for example 1, 2, 3, 4
4x + 99	**WR**	DEC	Flow Card Number Starting 3x register
4x + 100	**WR**	DEC	Flow Card Number Starting 4x register
4x + 101	**WR**	DEC	Flow Card Number, for example 1, 2, 3, 4
4x + 102	**WR**	DEC	Flow Card Number Starting 3x register
4x + 103	**WR**	DEC	Flow Card Number Starting 4x register
4x + 104	**WR**	DEC	Flow Card Number, for example 1, 2, 3, 4
4x + 105	**WR**	DEC	Flow Card Number Starting 3x register
4x + 106	**WR**	DEC	Flow Card Number Starting 4x register
4x + 107	**WR**	DEC	Flow Rate Reading Time Out

8.3.7. AUDT Report Logging—Detail: Report Registers—Batch Logs

8.3.7.1. Table of Batch Log Records

Batch Log Records Registers

Report Register	Access	Data Type	Comment
4x + 108	**WR**	UINT	The Month when Report Started
4x + 109	**WR**	UINT	The Day when Report Started
4x + 110	**WR**	UINT	The Hour when Report Started
4x + 111	**WR**	UINT	The Minute when Report Started
4x + 112	**WR**	UINT	The Month when Report Ended
4x + 113	**WR**	UINT	The Day when Report Ended
4x + 114	**WR**	UINT	The Hour when Report Ended
4x + 115	**WR**	UINT	The Minute when Report Ended
4x + 116 ... +117	**WR**	FLOAT	Average Temperature
4x + 118 ... +119	**WR**	FLOAT	Average Pressure
4x + 120 ... +121	**WR**	FLOAT	Average Density Corrected
4x + 122 ... +123	**WR**	FLOAT	Average CTL
4x + 124 ... +125	**WR**	FLOAT	Average CPL
4x + 126 ... +127	**WR**	FLOAT	Average Meter Factor
4x + 128 ... +129	**WR**	UINT	Average Temperature INT
4x + 129	**WR**	UINT	Average Pressure INT
4x + 130	**WR**	UINT	Average Density INT Corrected
4x + 131	**WR**	UINT	Average CTL Integer Portion
4x + 132	**WR**	UINT	Average CTL Decimal Portion
4x + 133	**WR**	UINT	Average CPL Integer Portion
4x + 134	**WR**	UINT	Average CPL Decimal Portion
4x + 135	**WR**	UINT	Average Meter Factor INT
4x + 136	**WR**	UINT	ISV Barrels, Cubes Modulo High
4x + 137	**WR**	UINT	ISV Barrels, Cubes Modulo Low

Report Register	Access	Data Type	Comment
4x + 138 ... +139	**WR**	UDINT	ISV Accumulator Channel A ISV accumulator will roll over at 9,999,999
4x + 140 ... +141	**WR**	UDINT	ISV Accumulator Channel B
4x + 142 ... +143	**WR**	UDINT	GSV Accumulator Channel GSV accumulator will roll over at 9,999,999
4x + 144	**WR**	UINT	GSV Barrels or Cubes Modulo High
4x + 145	**WR**	UINT	GSV Barrels or Cubes Modulo Low
4x + 146	**WR**	UNIT	Average S W
4x + 147	**WR**	UINT	NSV Barrels or Cubes Modulo High
4x + 148	**WR**	UNIT	NSV Barrels or Cubes Modulo Low

8.3.8. AUDT Report Logging—Detail: Report Registers—Prover Logs

8.3.8.1. Table of Prover Logs Records

Prover Log Records Registers

Report Register	Access	Data Type	Comment
4x + 150	**WR**	UINT	Month
4x + 151	**WR**	UINT	Day
4x + 152	**WR**	UINT	Hour
4x + 153	**WR**	UINT	Minute
4x + 154	**WR**	UINT	Pipe Internal Diameter
4x + 155	**WR**	UINT	Pipe Wall Thickness
4x + 156	**WR**	UINT	Elasticity
4x + 157	**WR**	UINT	Cubic Exp.
4x + 158	**WR**	UINT	API Tables
4x + 159	**WR**	UINT	Product Name
4x + 160 ... +163	**WR**	ASCII	Meter Serial Number
4x + 164 ... +167	**WR**	ASCII	Meter ID
4x + 168	**WR**	UINT	Meter Size
4x + 169	**WR**	UINT	Meter Type
4x + 170 ... 185	**WR**	UDINT	Run 1 Meter Proving Report See the Register Functions table following.
4x + 186 ... 201	**WR**	FLOAT	Run 2 Meter Proving Report See the Register Functions table following.
4x + 202 ... 217	**WR**	FLOAT	Run 3 Meter Proving Report See the Register Functions table following.
4x + 218 ... 233	**WR**	FLOAT	Run 4 Meter Proving Report See the Register Functions table following.
4x + 234 ... 249	**WR**	FLOAT	Run 5 Meter Proving Report See the Register Functions table following.
4x + 250 ... 265	**WR**	FLOAT	Run 6 Meter Proving Report See the Register Functions table following.
4x + 266 ... 281	**WR**	FLOAT	Run 7 Meter Proving Report See the Register Functions table following.
4x + 282 ... 297	**WR**	FLOAT	Run 8 Meter Proving Report See the Register Functions table following.

Report Register	Access	Data Type	Comment
4x + 298 ... 313	WR	FLOAT	Run 9 Meter Proving Report See the Register Functions table following.
4x + 314 ... 329	WR	FLOAT	Run 10 Meter Proving Report See the Register Functions table following.
4x + 330	**WR**	UDINT	Average Proving Pulses
4x + 332 ... +333	**WR**	FLOAT	Average Temperature at the Prover
4x + 334 ... +335	**WR**	FLOAT	Average Temperature at the Meter
4x + 336 ... +337	**WR**	FLOAT	Average Pressure at the Prover
4x + 338 ... +339	**WR**	FLOAT	Average Pressure at the Meter
4x + 340 ... +341	**WR**	FLOAT	Average ISV / GSV Flow Rate
4x + 342 ... +343	**WR**	FLOAT	Average API Corrected Gravity
4x + 344 ... +345	**WR**	FLOAT	Average Meter Frequency
4x + 346 ... +347	**WR**	UDINT	Base Volume Prover
4x + 348 ... +349	**WR**	FLOAT	CTS
4x + 350 ... +351	**WR**	FLOAT	CPS
4x + 352 ... +353	**WR**	FLOAT	CTL
4x + 354 ... +355	**WR**	FLOAT	CPL
4x + 356 ... +357	**WR**	FLOAT	Total ISV BBLs
4x + 358 ... +359	**WR**	FLOAT	Batch ISV BBLs
4x + 359 ... +360	**WR**	FLOAT	Calculated Meter Factor
4x + 361 ... +362	**WR**	FLOAT	% Change in MF to Prev. MF

Report Register	**Access**	**Data Type**	**Comment**
4x + 363 ... +364	**WR**	FLOAT	K Factor
4x + 365 ... +366	**WR**	UINT	Calculated K Factor
4x + 367 ... +368	**WR**	FLOAT	CCFP
4x + 369 ... +370	**WR**	FLOAT	CCFM
4x + 371 ... +372	**WR**	UDNIT	Corrected Prover Volume
4x + 373 ... +374	**WR**	UDINT	Corrected Meter Volume
4x + 375 ... +376	**WR**	UDINT	Metered Volume

8.3.8.2.Register Functions

Table of functions

Run	Total Pulses	Temperature Prover	Temperature Meter	Pressure Prover	Pressure Meter	Flow Rate	Corrected Gravity	Meter Frequency
	UDINT	FLOAT	FLOAT	FLOAT	FLOAT	FLOAT	FLOAT	FLOAT
1	4x + 170 ... 171	4x + 172 ... 173	4x + 174 ... 175	4x + 176 ... 177	4x + 178 ... 179	4x + 180 ... 181	4x + 182 ... 183	4x + 184 ... 185
2	4x + 186 ... 187	4x + 188 ... 189	4x + 190 ... 191	4x + 192 ... 193	4x + 194 ... 195	4x + 196 ... 197	4x + 198 ... 199	4x + 200 ... 201
3	4x + 202 ... 203	4x + 204 ... 205	4x + 206 ... 207	4x + 208 ... 209	4x + 210 ... 211	4x + 212 ... 213	4x + 214 ... 215	4x + 216 ... 217
4	4x + 218 ... 219	4x + 220 ... 221	4x + 222 ... 223	4x + 224 ... 225	4x + 226 ... 227	4x + 228 ... 229	4x + 230 ... 231	4x + 232 ... 233
5	4x + 234 ... 235	4x + 236 ... 237	4x + 238 ... 239	4x + 240 ... 241	4x + 242 ... 243	4x + 244 ... 245	4x + 246 ... 247	4x + 248 ... 249
6	4x + 250 ... 251	4x + 252 ... 253	4x + 254 ... 255	4x + 256 ... 257	4x + 258 ... 259	4x + 260 ... 261	4x + 262 ... 263	4x + 264 ... 265
7	4x + 266 ... 267	4x + 268 ... 269	4x + 270 ... 271	4x + 272 ... 273	4x + 274 ... 275	4x + 276 ... 277	4x + 278 ... 279	4x + 280 ... 281
8	4x + 282 ... 283	4x + 284 ... 285	4x + 286 ... 287	4x + 288 ... 289	4x + 290 ... 291	4x + 292 ... 293	4x + 294 ... 295	4x + 296 ... 297
9	4x + 298 ... 299	4x + 300 ... 301	4x + 302 ... 303	4x + 304 ... 305	4x + 306 ... 307	4x + 308 ... 309	4x + 310 ... 311	4x + 312 ... 313
10	4x + 314 ... 315	4x + 316 ... 317	4x + 318 ... 319	4x + 320 ... 321	4x + 322 ... 323	4x + 324 ... 325	4x + 326 ... 327	4x + 328 ... 329

8.3.9. AUDT Report Logging—Detail: Report Registers—Last Meter Factor Table

8.3.9.1. Last Meter Factor Table

The Last Meter Factor table stores the last meter factor used for the specific product processed. For example, here is a sample entry: Premium Gasoline ISV Flow Rate 1201 BBL /HR On 3/22/02 with a meter factor of 1.0029.

The Last Meter Factor Table can hold up to 16 different products. When a new meter factor is calculated, the previous meter factor is used. The loadable looks at the product name, finds the previous meter factor, and applies it to the new meter factor calculation. Data is stored based on Product Name (the PCFC register 4x + 9.

Last Meter Factor Table Registers

Report Register	Access	Data Type	Comment
4x + 377 ... +378 (Product Name * 8)	**WR**	FLOAT	Last Meter Factor (0 to 15)
4x + 379 ... +380 (Product Name * 8)	**WR**	FLOAT	Indicated Standard Volume BBL/HR (0 to 15)
4x + 381 (Product Name * 8)	**WR**	UINT	Last Month (0 to 15)
4x + 382 (Product Name * 8)	**WR**	UINT	Last Day (0 to 15)
4x + 383 (Product Name * 8)	**WR**	UINT	Last Hour (0 to 15)
4x + 384	**WR**	UINT	Last Min. (0 to 15)

Part V Function Block Installation

V

At a Glance

Purpose

This material describes installing the function blocks.

What's in this Part?

This part contains the following chapters:

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9. Installing the PCFC Loadables Using Concept Panel Software

9

At a Glance

Purpose

This material describes how to install the loadables and configure the Quantum hardware using Concept 2.5 SR2 panel software. If you are using ProWORX, skip this material and proceed to *Installing the PCFC Loadables Using ProWORX NxT or ProWORX32 Panel Software, p. 221*.

What's in this Chapter?

This chapter contains the following topics:

9.1 Setting Parameters and Unpacking Loadables Using Concept

9.1.1. Overview

Installing the loadables consists of the following procedures.

Procedure	See
1	*Setting Parameters and Unpacking Loadables Using Concept, p. 204*
2	*Loading the Loadables Using Concept, p. 209*
3	*Selecting the Quantum Hardware Module Using Concept, p. 211*
4	*Configuring the I/O Drops Using Concept, p. 213*
5	*Setting the Module's Personality Using Concept, p. 215*

Note: Before attempting to complete these procedures, you should be familiar with Concept software and PLC programming and are ready to configure the hardware and software for the liquid loadable.

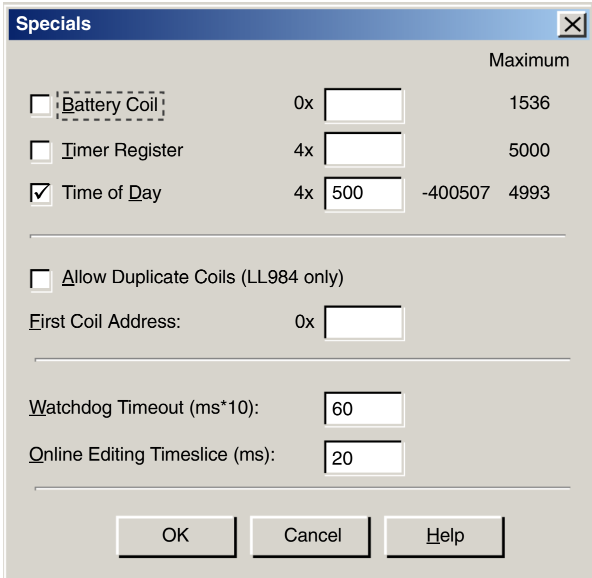
Note: Concept 2.5 SR2 or higher may be used to load and configure the Liquid loadable blocks. However, Concept panel software does not provide DX zoom screens for configuration of the block. The files required to add DX zoom screens to Concept are provided on the PCFC Loadable CD.

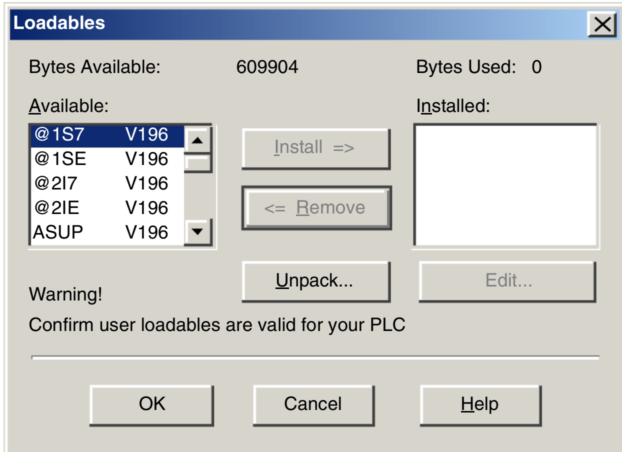
Note: The Liquid loadables are only available in 984LL. However, controllers with enough memory can run 984LL and IEC in the same PLC.

9.1.2. Setting Parameters

To install the loadable and associate zoom screens,

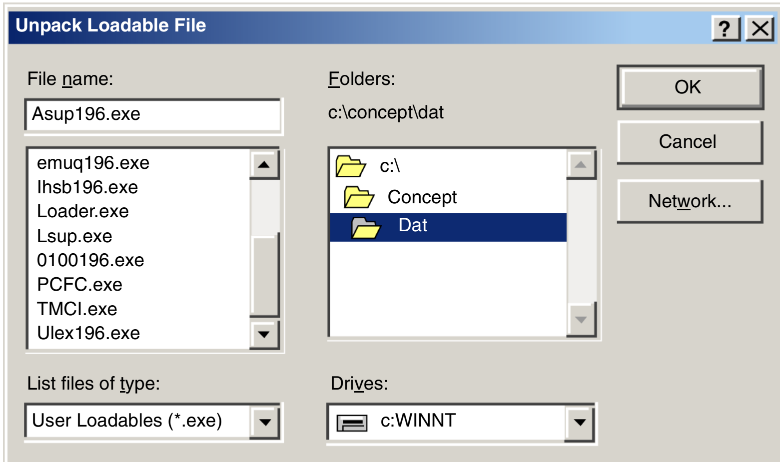
Step	Action
1	Insert the Liquid Flow Loadable CD (Part Number 309 ULD 454 00) into the CDROM drive and copy the contents of the directory: `<cd drive>:\loadable` to the Concept "dat" directory. For example: If your CD drive is drive `e:\` and Concept is installed in `c:\cc25sr2\dat`, copy the files from `e:\loadable` to `c:\cc25sr2\dat`.
2	Copy the files in the Concept directory on the CD to the Concept install directory. Example: If your CD drive is drive e:\ and Concept is installed in c:\cc25sr2 on the local drive, copy the files from e:\concept to c:\cc25sr2.
3	Create a backup directory in the Concept install directory.
4	Copy the files wi.dll and dxzoom.dll FROM the Concept install directory to the backup directory.
5	If Concept 2.5 SR2 is installed, copy the files from the CD directory concept\25sr2_files to the Concept install directory. If Concept 2.6 SR1 is installed, copy the files from the CD directory concept\26sr1_files to the Concept install directory. Copy the .dll files from the Concept directory on the CD to the Concept install directory.
6	Start the Concept software.
7	From the Main Menu, choose **File** | **Open** or **File** | **New Project**.
8	From the Main Menu, choose **Project** | **Configurator**.
9	On the *PLC Configuration* screen, double click the mouse on **PLC Type:** and choose the appropriate PLC.

Step	Action
10	From the Main Menu, select **Configure Specials** and then select **Time of Day Clock**, or in the *PLC Configuration* screen, double click the **Specials** box. The *Specials* dialog appears. 
11	Enter the starting register for the **Time of Day** clock.
12	Click **OK**.

Step	Action
13	From the Main Menu, select **Configure Loadables**, or *PLC Configuration* screen, double click the **Loadables** box. The *Loadables* dialog appears. 

9.1.3. Unpacking Loadables

To unpack the loadables,

Step	Action
1	Click on **Unpack**. The *Unpack Loadable File* dialog appears. 
2	Using the Unpack Loadable File dialog, find the directory/drive where the LSUP.EXE is located.
3	Select **LSUP.EXE** and click **OK**. Repeat this step for **TMCI.exe** and **PCFC.exe**. As each of these loadables is unpacked, it creates a copy (called LSUP V196, TMCI V196, and PCFC V196, respectively). Each copy appears in the Left pane of the dialog box in Step 9. If there is a conflict with an existing Opcode, any unique Opcode that is not taken will work. Default Opcodes: LSUP = FF TMCI = 21 PCFC = 1F For more information on Opcodes, see the Concept online documentation. When this step is complete leave this dialogue box open to complete the next step. The loadables are now ready to be installed.
4	**Note:** The preceding procedure is for a simple system. Other liquid flow blocks may be added by following the same setup.

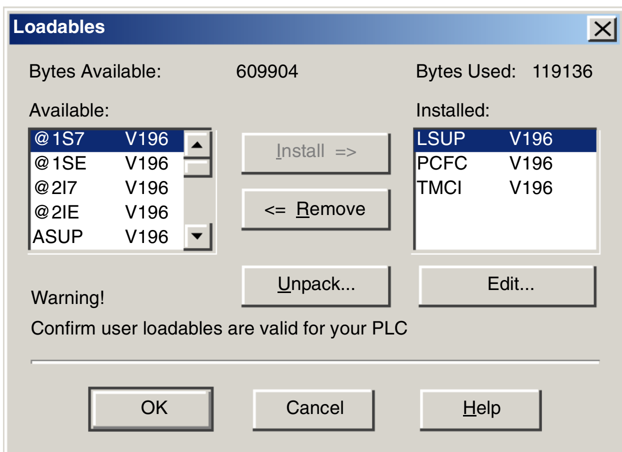
9.2. Loading the Loadables Using Concept

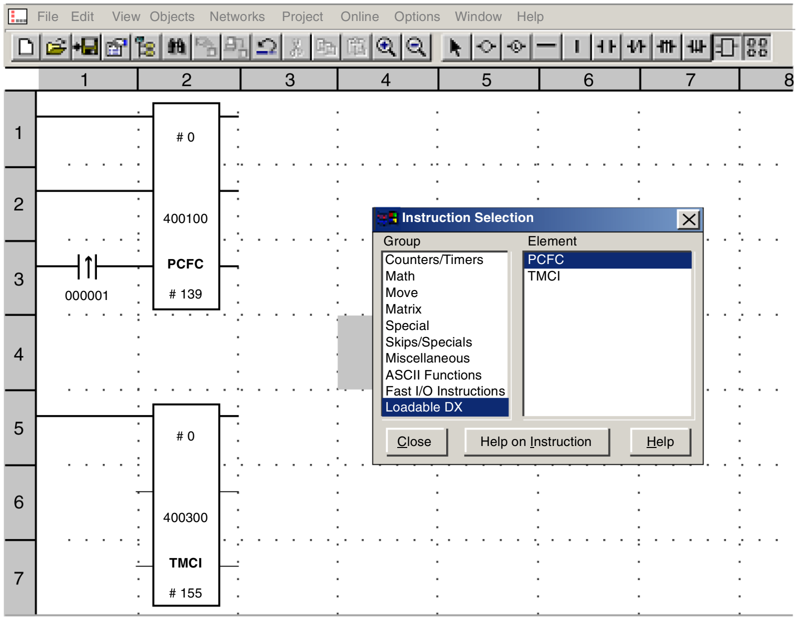
9.2.1. Loading the Loadables

After completing the first stage of installation, use the following procedure to load the loadables.

	WARNING
	UNINTENDED CONTROLLER OPERATION The LSUP.EXE must be the first block in the configuration. Otherwise, the controller may not operate properly. **Failure to follow this precaution can result in death, serious injury, or equipment damage.**

Step	Action
1	Select PCFC V196 in the left panel of the *Loadables* dialog and click on Install =>. Repeat for TMCI V196 and any other loadables to be used. Lastly, select LSUP V196 in the left panel of the Loadables dialog and click on Install =>. (Note: LSUP V916 must be the last block installed and FIRST in the list of Installed: loadables.) The *Installed* field of the dialog will list the installed blocks as shown here:



Step	Action
2	Check that the blocks are now available from the 984 DX loadable library in a 984LL section, as shown below. 
3	Close the Concept software. To continue installing on a Quantum hardware platform, proceed to *Selecting the Quantum Hardware Module Using Concept, p. 211*.

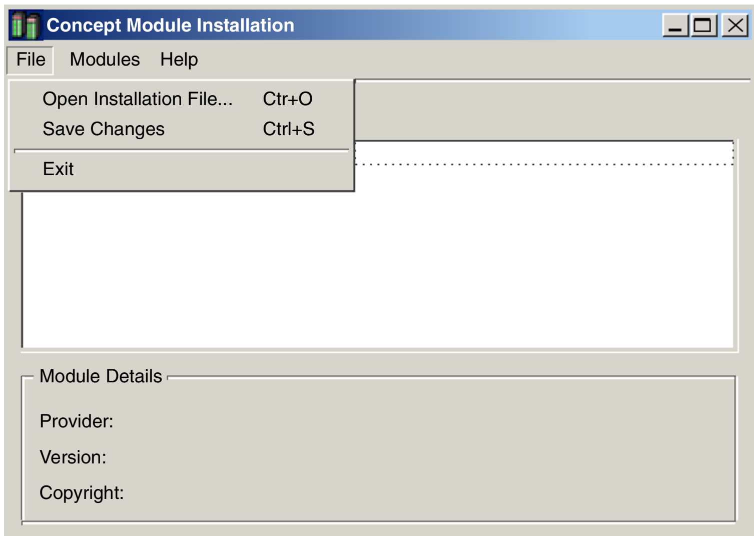
9.3. Selecting the Quantum Hardware Module Using Concept

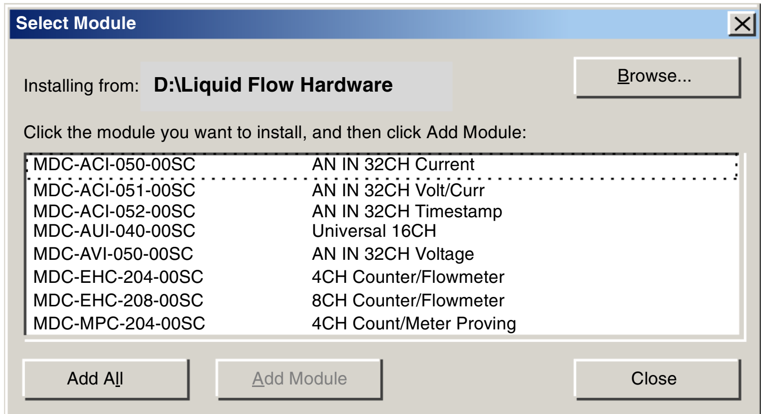
9.3.1. Are You in the Right Place?

This section describes the second stage of PCFC loadable installation on Quantum hardware. If you have not completed the first stage of installation, go back to *Setting Parameters and Unpacking Loadables Using Concept, p. 204*.

9.3.2. Selecting the Quantum Hardware Module

Use the following procedure to configure Quantum hardware.

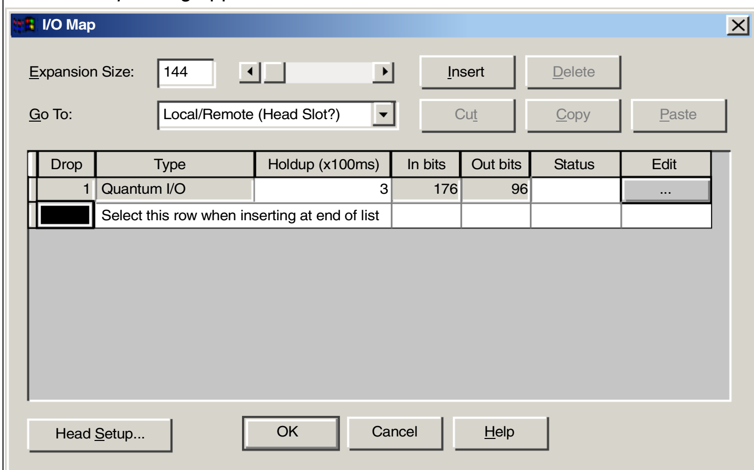
Step	Action
1	Run the **ModConnect Tool**. (Find this in the program group where Concept was installed.) The *Concept Module Installation* dialog appears. 
2	From the Main Menu, choose **File** → **Open Installation File**

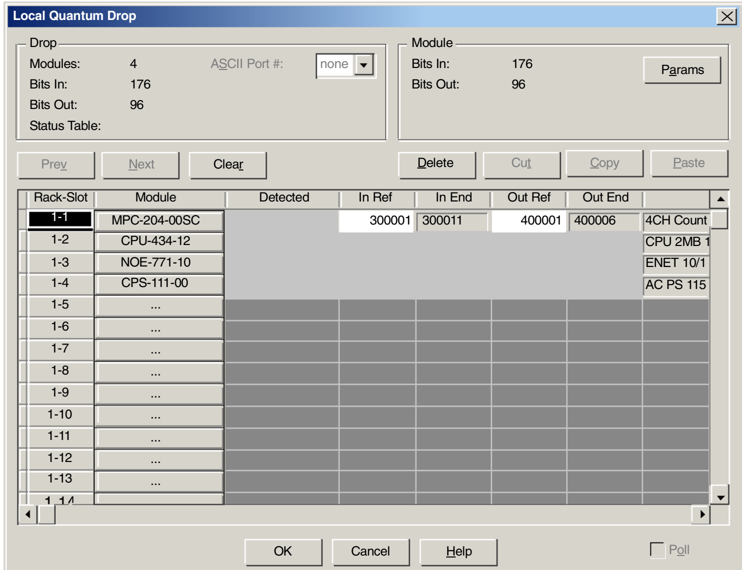
<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>3</td><td>Select the drive and path of the floppy included with the Spectrum Controls module.
To install a Quantum module, select the file called Spectrum.MDC. The Select Module dialog appears.

</td></tr>
<tr><td>4</td><td>Select the part number of the module you intend to install.
Click Add Module and then Close.
Exit the program. When prompted to save you changes click Yes. (For a description of the modules and their functionality see TMCI Function Block, p. 31.)</td></tr>
<tr><td>5</td><td>Exit the ModConnect Tool. The Module is now available from the Concept I/O pick list, and you can configure the I/O drops.</td></tr>
</table>

9.4. Configuring the I/O Drops Using Concept

9.4.1. Configuring the I/O Drops

After selecting the Quantum module, use the following procedure to configure the I/ O drops.

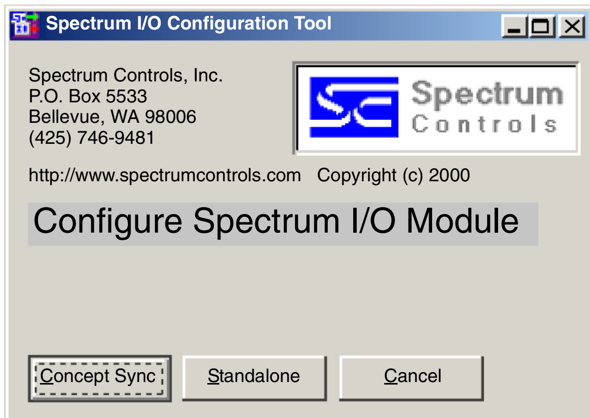
Step	Action
1	Start the Concept software and open the Project you created.
2	From the Main Menu, choose **Project** → **Configurator**. The *PLC Configuration* dialog appears.
3	Choose **Configure** → **I/O Map...** The *I/O Map* dialog appears. 

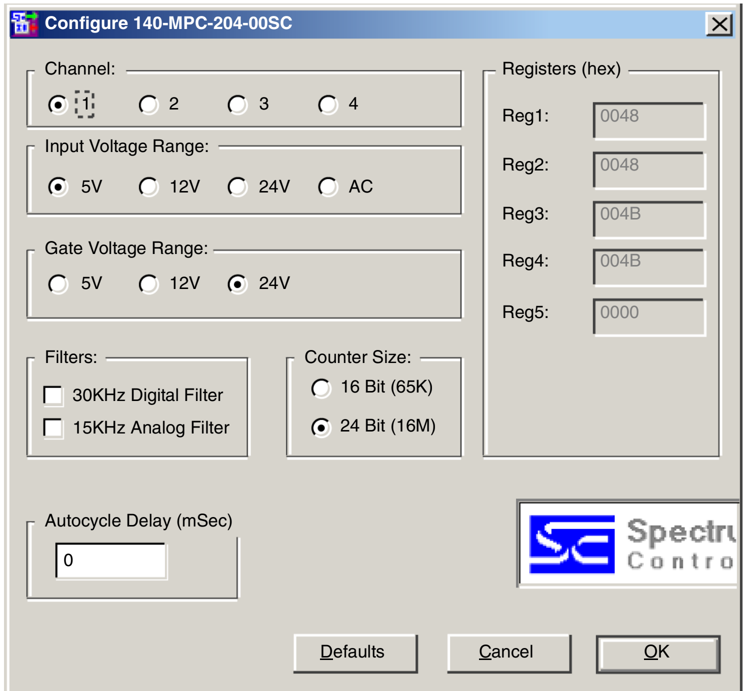
Step	Action
4	Click on the button with the three dots "..." under the *Edit* column. The *Local Quantum Drop* dialog appears. 
5	Click on the button with the three dots "..." under the *Module* column and select the module you wish to configure. Enter the Traffic Cop data into the *In Ref* and *Out Ref* columns. NOTE: Do **NOT** click OK at this point. Leave the *Local Quantum Drop* window open for the next procedure.

9.5. Setting the Module’s Personality Using Concept

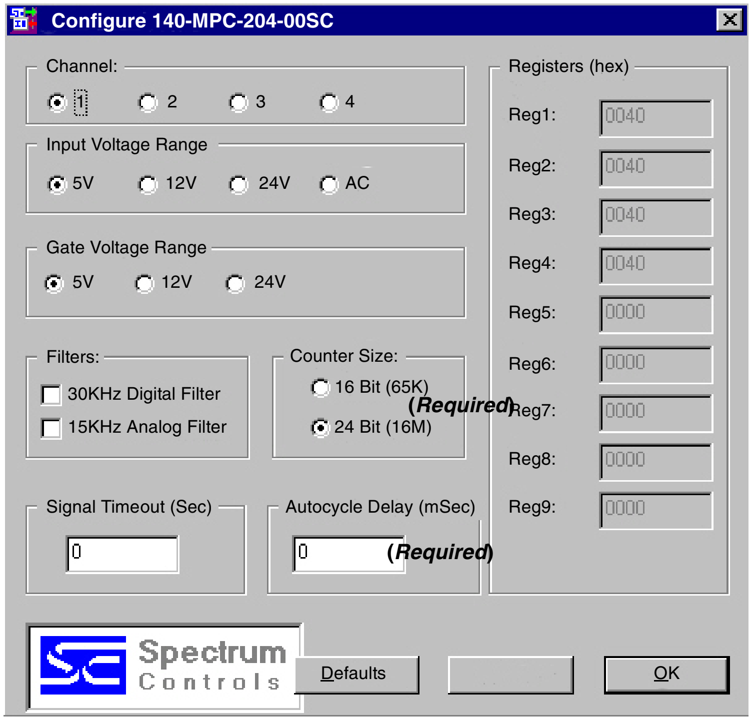
9.5.1. Setting the Module’s Personality

After configuring the I/O drops, use the following procedure to set the module’s personality.

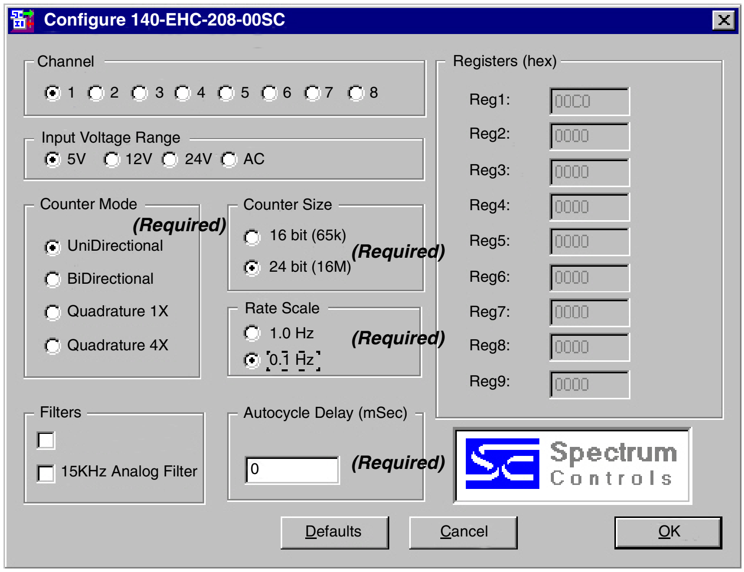
Step	Action
1	Run the SCIOCFG.EXE utility program. This program is located on the floppy that came with the Spectrum Controls module. Double click the SCIOCFG.EXE icon. The *Spectrum I/O Configuration Tool* dialog appears. 
2	Click on **Concept Sync**. The Spectrum I/O Configuration Tool dialog window is minimized. The tool is still running, waiting for you to perform the next step.

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>3</td><td>Click on the Params button in the Local Quantum Drop dialog (which should still be open from the previous phase of the installation).
A Configure dialog appears. The name of the dialog includes the name of the selected module (for instance, 140-MPC-204-00SC, as shown below). Options in the dialog vary depending on which module is selected. (For a description of the modules and their functionality see Turbine Meter Flow Module, p. 19.)

</td></tr>
</table>

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>4</td><td>Choose the appropriate options.
The fields marked "(Required)" must be set to the values shown or the loadable block will not function correctly. For the MPM module:



If the flow meter does not use a pre-amp, then select "AC" for the input voltage range.
If the meter does include a pre-amp then see the manufacturer’s data sheet for the output voltage. For the "Gate Voltage Range" or Detector switch voltage, this is the excitation voltage applied to the switches.
Note: The 140 EHC 204 00sc and 140 EHC 208 00sc do not use the Gate Voltage Range and are not capable of doing meter proving.</td></tr>
</table>

Step	Action
5	The fields marked "(***Required***)" must be set to the values shown or the loadable block will not function correctly. For the EHC modules:  Click **OK** to set the changes and close the *Configure* dialog.

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10. Installing the PCFC Loadables Using ProWORX NxT or ProWORX32 Panel Software

10

At a Glance

Purpose

This material describes how to install the loadables and use the loadables with the ProWORX NxT or ProWORX32 panel software. If you are using Concept, skip this material and proceed to *Installing the PCFC Loadables Using Concept Panel Software, p. 203*.

What's in this Chapter?

This chapter contains the following topics:

10.1. Understanding the ProWORX Installation Procedure

10.1.1. Prerequisites for Installation with ProWORX

Note: Before attempting to complete these procedures, you should be familiar with the ProWORX software and PLC programming, and you are ready to configure the hardware and software for the liquid loadable.

To install the PCFC function block into the PLC configuration, these loadables must be supplied:
- LSUP.EXE
- PCFC.EXE
- TMCI.EXE

Additional loadables may be installed as well as custom register editor screens for either ProWorx NxT or ProWorx32.

10.1.2. Load LSUP.EXE First Requirement

The LSUP.EXE loadable must be listed as the first loadable in the PLC configuration, followed by the PCFC.EXE loadable. If this order is not followed the PCFC.EXE loadable function block will not execute properly.

WARNING

UNINTENDED CONTROLLER OPERATION

The LSUP.EXE must be the first block in the configuration. Otherwise, the controller may not operate properly.

Failure to follow this precaution can result in death, serious injury, or equipment damage.

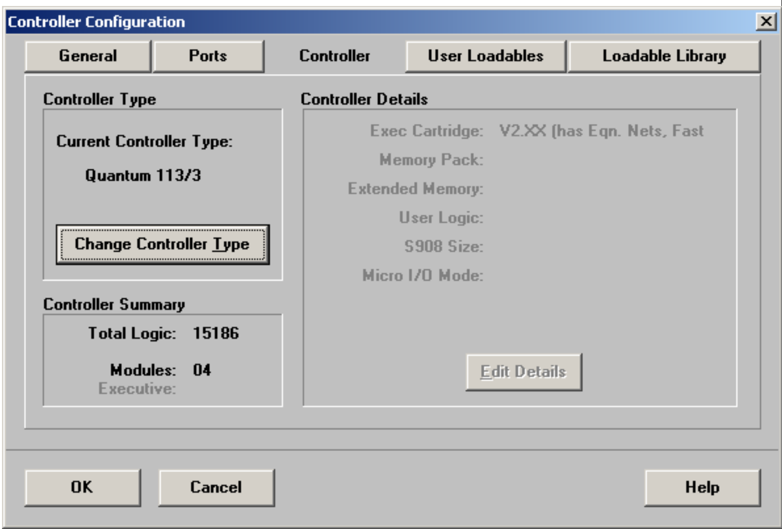
10.1.3. More Information on Configuring User-Loadable Function Blocks

Refer to your PLC software manual for instructions on configuring user loadable function blocks.

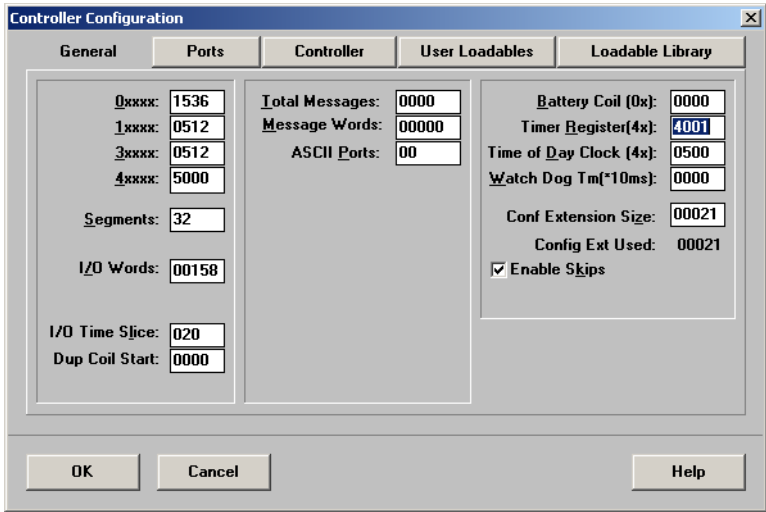
10.2. Installing the Loadables Using ProWORX

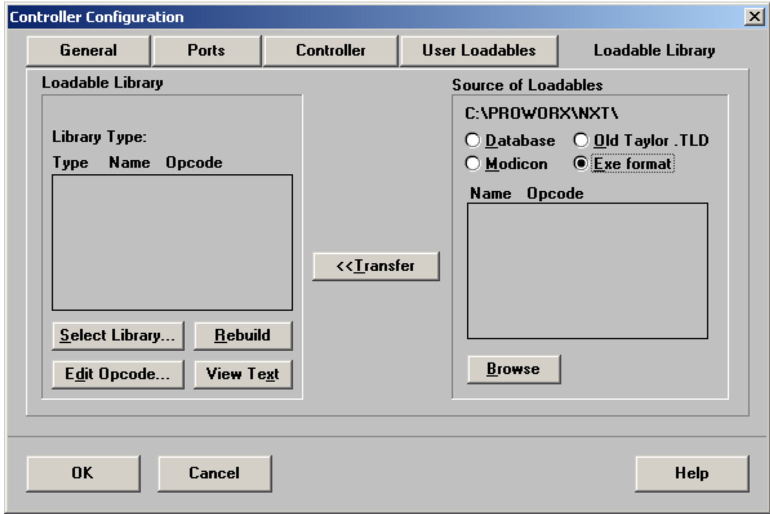
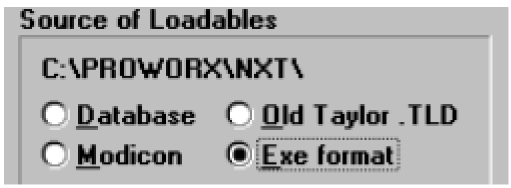
10.2.1. Installing the Loadables Using ProWORX

Use this procedure to install the loadables.

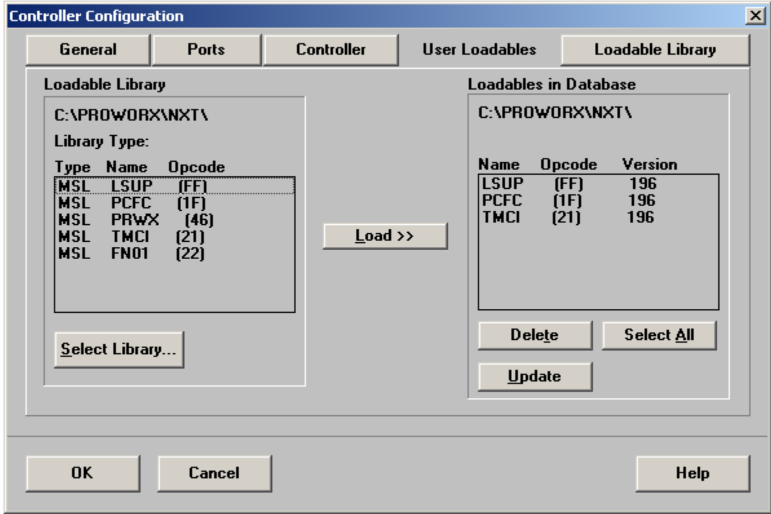
<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>1</td><td>Insert the Liquid Flow Loadable CD (Part Number 309 ULD 454 00) into the CD-ROM drive.
Depending on the ProWORX version, copy the contents of:
<cd drive>:\Loadable
into the \PROWORX\NXT\ subdirectory.</td></tr>
<tr><td>2</td><td>Copy the contents of <cd dirve>:\ProWorx_NxT into the PROWORX\NXT directory.</td></tr>
<tr><td>3</td><td>If audit logging will be used (AUDT), the AUDT block must be modified to correctly use PLC memory. Run the batch file which begins with the number of audit logs needed.
Example: If 3 audit logs will be used, run the 3AUDTLOGS.bat file before starting ProWorx.</td></tr>
<tr><td>4</td><td>Start ProWORX. From the Main Menu, choose File → Open or File → New.
Note: Refer to the ProWORX manual for information on creating and opening projects</td></tr>
<tr><td>5</td><td>From the ProWORX Main Menu, choose Configuration → Configuration .
The Controller Configuration dialog appears.


</td></tr>
</table>

Step	Action
6	Click **Change Controller Type**. Note: Refer to the ProWORX manual and *PLC Liquid Flow Features Table, p. 17* for information on selecting controller type.
7	Choose the appropriate PLC.
8	From the ProWORX Main Menu, choose **Configuration** → **Configuration**. The *Controller Configuration* dialog appears. 
9	Select the *General* Tab at the top of the box. In the *Time of Day Clock (4x)* enter the starting register for the Time of Day Clock. Click **OK**.

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>10</td><td>From the ProWORX Main Menu, choose Configuration → Configuration.
The Controller Configuration dialog appears.

</td></tr>
<tr><td>11</td><td>Select the Loadable Library tab at the top of the box.
In the Source of Loadables area, click the Exe Format button to turn it on.


Click on the Browse button to select the .exe files.</td></tr>
<tr><td>12</td><td>Select all of the .exe files in the list and click <<Transfer to copy them to your library.</td></tr>
</table>

Step	Action
13	From the ProWORX Main Menu, choose **Configuration** → **Configuration**. The *Controller Configuration* dialog appears. 
14	Select the *User Loadables* tab at the top of the box.
15	Click **Select Library...** A dialog appears, listing available libraries. Select **LSUP**, **PCFC**, and **TMCI** (and T23E, T24E, AUDT, ITOI if these loadables will be used). Click **OK**. The library names appear in the *Loadable Library* list. to add it to the *Loadables in Database* list.
16	Click on the **LSUP** line in the *Library Type* list, then click **Load>>** to add it to the *Loadables in Database* list. **NOTE:** It is very important to load LSUP first.
17	Click on the **PCFC** line in the *Library Type* list, then click **Load>>** to add it to the *Loadables in Database* list.
18	Click on the **TMCI** line in the *Library Type* list, then click **Load>>** to add it to the *Loadables in Database* list.
19	Repeat Step 16 for other liquid flow loadables.
20	Click **Update** and then click **OK**. The loadables are now available for use in ladder logic.

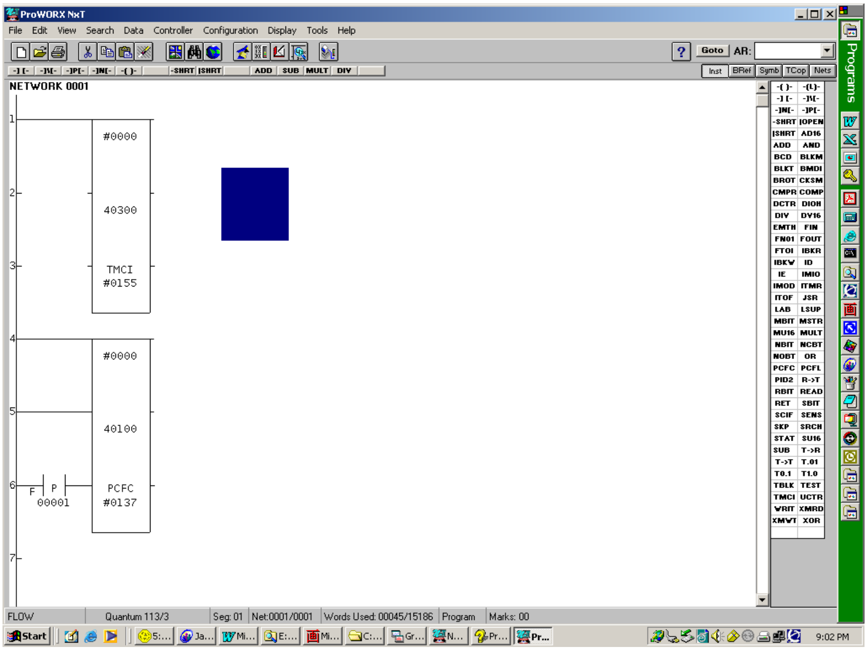
10.2.2. ProWORX 32 Installation

ProWorx32 installation is similar to NxT. The directory name for the install is PROWORX\32.
Contents of <cd drive>:\ProWORX32 directory should be copied to C:\ProWORX\32\Scripts.
Contents of <cd drive>:\Loadable directory should be copied to c:\PROWORX\32.

10.3. Using the Loadables in Ladder Logic

10.3.1. Using the Loadables in Ladder Logic

Once you have installed the loadables, you can use them in ladder logic. They are listed in alphabetic order in the Instruction panel on the right side of the ProWORX screen. You can use drag and drop methods to insert blocks into the logic. (For more information on ladder logic programming see the ProWORX manual or online documentation.)



After inserting loadable blocks into logic, configure the blocks by doing the following:

Step	Action
1	Select the block.
2	Right click on the block.
3	Select Register Editor.
4	Enter data in the registers.

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Appendices

What's in this Appendix?

The appendix contains the following chapters:

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A. Flow Equations and Algorithms

A

A.1. Flow Equations and Algorithms

A.1.1. API References

All Flow equations used in the PCFC block are referenced from the API Standard 2540.

A.1.2. Flow Rate at Flowing Conditions: Bbls / Hr

$$\text{Indicated Volume} = \frac{\text{MeterFrequency}}{\text{NominalKFactor}} \times 3600$$

A.1.3. Net Flow Rate at Base Conditions: Bbls / Hr (API 2540 Chapter 12 Section 2 Part 1.10.2)

$$\text{Gross Standard Volume} = \text{IV} \times \text{CTL} \times \text{CPL} \times \text{MF}$$

A.1.4. Correction for Sediment and Water (CSW) (API 2540 Chapter 12 Section 2 Part 1.11.7)

$$\text{CSW} = [1 - (\%\text{S\&W} / 100)]$$

A.1.5. Determination of Net Standard of Volume (API 2540 Chapter 12 Section 2 Part 1.10.3)

$$\text{Net Standard Volume} = \text{GSV} \times \text{CSW}$$

A.1.6. Determination of S&W Volume (API 2540 Chapter 12 Section 2 Part 1.10.4)

$$\text{Sediment Water Volume} = \text{GSV} - [\text{GSV} \times \langle 1 - [\%\text{S\&W}] / 100 \rangle]$$

A.1.7. Calculated K Factor

Some sites choose to keep the Meter Factor to a value of 1.0 by changing the K Factor.

$$1 / \text{Meter Factor} \times \text{K Factor} = \text{Calculated K Factor}$$

A.1.8. Correction Factor for Temperature of Liquid (CTL) in Imperial Mode (API 2540 Chapter 11.1 Volume X, ANSI/ ASTM D1250-1980)

$$CTL = \exp[\langle 0 - \alpha T\rangle \times \Delta T \times \langle 0.8 \times \alpha T \times \Delta T\rangle]$$

Where:

$$\Delta T = \text{Current Temperature} - 60°F$$

$$\alpha T = \frac{K_0 + \langle K_1 \times \rho T\rangle}{\rho T^2} \quad \text{OR} \quad \alpha T = A + \left[\frac{\beta}{(\rho T)^2}\right]$$

$$\rho_t[Kg/m^3] = \frac{141.5 \times 999.012}{\text{Current Density API} + 131.5}$$

$$\rho_t = \text{Density at temperature t}$$

$$API = \text{Observed API Gravity}$$

$$999.012 = \text{Density of water at } 60°F,\ Kg/m^3$$

Tables

Tables 5&6	API Range	K0	K1	K2
A	0.0 to 100	341.0957	0.0	0.0
B	52.0 to 85.0	192.4571	0.2438	0.0
B	48.0 to 52.0	1489.0670	0.0	-0.00186840
B	37.0 to 48.0	330.3010	0.0	0.0
B	0.0 to 37.0	103.8720	0.2701	0.0
D	-10.0 to 45.0	0.0	0.3488	0.0

API Gravity *(Imperial)*		
0 = Crude	**1 = Product**	**2 = Lubricating Oil**
Input	**Input**	**Input**
Temperature Range 0 to 300 °F all Tables		
API Gravity 0 to 100	API Gravity 0 to 85	API Gravity -10 to 45
Table 5A	**Table 5B**	**Table 5D**
Corrected API 0 to 100	Corrected API Gravity 0 to 85	Corrected API Gravity -10 to 45
Table 6A	**Table 6B**	**Table 6D**
CTL	CTL	CTL
Output Ref. to 60 °F	**Output Ref. to 60 °F**	**Output Ref. to 60 °F**

Tables 23 & 24	Relative Density	K0	K1	K2
A	0.6110 to 1.0760	341.0957	0.0	0.0
B	0.6530 to 0.7705	192.4571	0.2438	0.0
B	0.7710 to 0.7885	1489.0670	0.0	-0.00186840
B	0.7890 to 0.8395	330.3010	0.0	0.0
B	0.8400 to 1.0750	103.8720	0.2701	0.0
D	0.8000 to 1.1640	0.0	0.3488	0.0

Specific Gravity *(Imperial)*		
0 = Crude	**1 = Product**	**2 = Lubricating Oil**
Input	**Input**	**Input**
Temperature Range 0 to 300 °F all Tables		
Specific Gravity .611 to 1.076	Specific Gravity 0.653 to 1.076	Specific Gravity .800 to 1.164
Table 23A	**Table 23B**	**Table 23D**
Specific Gravity .611 to 1.076	Specific Gravity 0.653 to 1.076	Specific Gravity .800 to 1.164
Table 24A	**Table 24B**	**Table 24D**
CTL	CTL	CTL
Output Ref. to 60 °F	**Output Ref. to 60 °F**	**Output Ref. to 60 °F**

A.1.9. Correction Factor for Pressure of Liquid (CPL) in Imperial Mode (API 2540 Chapter 12 Section 2 Part 1.11.1.2

$$\mathrm{CPL} = \frac{1}{\left[1 - \left(\frac{\mathrm{Pressure} \times \mathrm{Ctable}}{100000}\right)\right]}$$

A.1.10. Compressibility Factor Calculations (API 2540 Chapter 11.2.1 Compressibility Factors for Hydrocarbons: 0 to 90 API)

Where:

A.1.11. Correction Factor for Temperature of Liquid (CTL) in Metric Mode (API 2540 Chapter 11.1 Volume X, ANSI/ASTM D1250-1980)

$$CTL = \exp[(0 - \alpha T) \times \Delta T \times (1 + (0.8 \times \alpha T \times \Delta T))]$$

Where:

$$\Delta T = \text{Current Temperature} - 15°C$$

$$\alpha T = \frac{[K_0 + (K_1 \times \rho T)]}{(\rho T)^2} \quad \text{OR} \quad \alpha T = A + \left[\frac{B}{(\rho T)^2}\right]$$

$$\rho T\left[\frac{Kg}{m^3}\right] = \text{Product Density Corrected to } 15°C$$

Tables

Tables 53 & 54	Density Kg/m	K0	K1	K2
A	6110 to 1075	613.9723	0.0	0.0
B	653 to 770	346.4228	0.4388	0.0
B	770 to 788	2680.3206	0.0	-0.00336312
B	788 to 839	594.5470	0.0	0.0
B	839 to 1075	186.9696	0.4862	0.0
D	800 to 1164	0.0	0.6278	0.0

Density *(Metric Gravity)*		
0 = Crude	**1 = Product**	**2 = Lubricating Oil**
Input	**Input**	**Input**
Temperature Range -18 to 150 °C all Tables except (53D &54D -20 to 150 °C)		
Density 610 to 1075 kg/m^3	Density 653 to 1075 kg/m^3	Density 800 to 1164 kg/m^3
Table 53A	**Table 53B**	**Table 53D**
Density 610 to 1075 Kg/m	Density 653 to 1075 Kg/m	Density 800 to 1164 Kg/m
Table 54A	**Table 54B**	**Table 54D**
CTL	CTL	CTL
Output Ref. to 15 °C	**Output Ref. to 15 °C**	**Output Ref. to 15 °C**

Density *(Metric Gravity)*		
0 = Crude	**1 = Product**	**2 = Lubricating Oil**

Input	Input	Input
Temperature Range -18 to 150 °C all Tables except (59D & 60D -20 to 150 °C)		
Density 610 to 1075 kg/m^3	Density 653 to 1075 kg/m^3	Density 800 to 1164 kg/m^3
Table 59A	**Table 59B**	**Table 59D**
Density 610 to 1075 kg/m^3	Density 653 to 1075 kg/m^3	Density 800 to 1164 kg/m^3
Table 60A	**Table 60B**	**Table 60D**
CTL	CTL	CTL
Output Ref. to @ 20 °C	**Output Ref. to @ 20 °C**	**Output Ref. to @ 20 °C**
Tables 59 and 60 for standard reference temperature of 20°C are also included for crude oils, petroleum products and lubricating oils which has been adopted by ISO as international standard ISO 91-2, Petroleum Measurement Tables - Part 2: Tables based on a reference temperature of 20°C.		

A.1.12. Correction Factor for Pressure of Liquid (CPL) in Metric Mode (API 2540 Chapter 12 Section 2 Part 1.11.1.2)

$$CPL = \frac{1.0}{(1.0 - F(P - P_E))}$$

Where

T =	**Product Temperature in degrees C**
p=	Product Standard Density in Kg/L (i.e. $Kg/m^3 \times 0.001$)
P=	Product Pressure in Kpag
P_E=	Product Equilibrium Pressure in Kpag. Equals 0 or product vapor.

A.1.13. Compressibility Factor Calculations (API 2540 Chapter 11.2.1M Compressibility Factors for Hydrocarbons: 638 – 1074Kg/m)

$$F = a + bT + \frac{c}{\rho^2} + \frac{dT}{\rho^2}$$

$$F = \frac{e^F}{1,000,000.0}$$

Compressibility Constants:

a=	-1.6208
b=	0.00021592
c=	0.87096
d=	0.0042092

A.1.14. Averaging (API 2540 Chapter 21 Section 2, 9.2.13.2 Averaging Techniques)

The function block averages temperature, pressure, density, and meter M factor for reports. The average for each entity is a function of the barrels produced. The average formula is shown below.

$$\text{New Average} = \frac{\text{Previous Gross Barrels} \times \text{Previous Average} + \text{New Gross}}{\text{Previous Gross Barrels} + \text{New Gross}}$$

A.1.15. Correction for the effect of temperature against steel, Cts (API 2540 Chapter 12 Section 2,12.2.5.1)

$$Cps = 1 + (T - 60)y$$

Where:

T =	Temperature of the container walls
y =	Coefficient of cubical expansion per degrees of the material of which the container is made

---

A.1.16. Correction for the effect of Pressure against steel, Cts (API 2540 Chapter 12 Section 2,12.2.5.2)

$$Cps = 1 + \left(\frac{PD}{Et}\right)$$

Where:

P =	Internal pressure
D =	internal diameter
E =	modulus of elasticity for the container material
t =	wall thickness of the container

A.1.17. Combined Correction Factor (CCF) (API 2540 Chapter 12 Section 2, 12.2.5.5 Combined Correction Factor)

$$\mathrm{CCF} = C_{TS} \times C_{PS} \times C_{TL} \times C_{PL} \text{ and } C_{SW}$$

A.1.18. K-Factors and Composite K-Factors (KFs, CKFs) (API 2540 Chapter 12 Section 2 Part 1, 1.11.5)

$$\mathrm{NewKF} = (\mathrm{OldKF}) / \mathrm{MF}$$

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B. Integer-to-Integer (ITOI) Function Block

B

At a Glance

Purpose

This chapter describes the ITOI function block.
This block is used with the PCFC block to convert prover raw count values and base volume of the prover into single, 16-bit word parts. This allows SCADA hosts and human-machine interfaces (HMI) that don't support 32-bit unsigned long integers to read and write such values.

What's in this Chapter?

This chapter contains the following sections:

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B.1 Representation of the ITOI Function Block

At a Glance

Purpose

This section describes the block structure representation and operation of the ITOI function block.

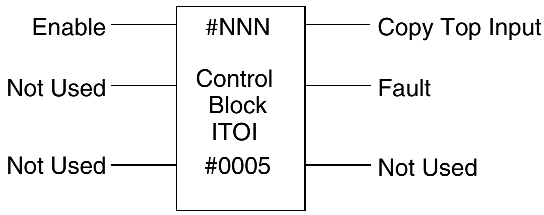
What's in this Section?

This section contains the following topics:

B.1.1. ITOI Block Structure Representation

B.1.1.1. ITOI Block Structure Diagram

The block structure is diagrammed below.



B.1.1.2. Inputs

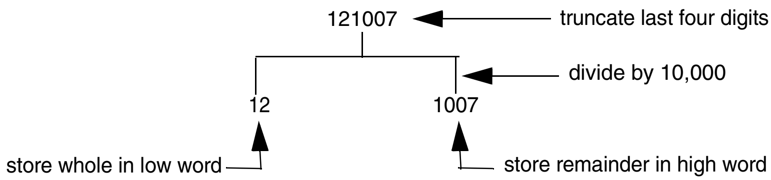
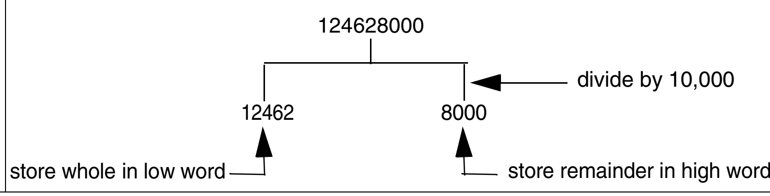
The ITOI block has three control inputs:
- **Top** input node enables the function block.
- **Middle** not used.
- **Bottom** not used.

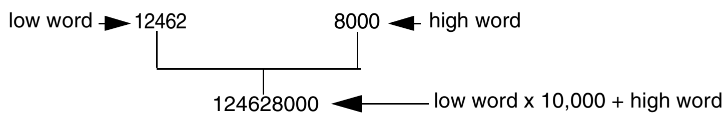
B.1.1.3. Outputs

The ITOI block has three outputs.
- **Top** output is a copy of the top node input.
- **Middle** output turns ON when the function block has detected an error.
- **Bottom** is not used.

B.1.1.4. Top Node Content

There are three function codes available on the ITOI function block, as described here. All examples shown assume that the ITOI block middle node is 400100.

Function	Description
#01	**Convert a Prove Count** The convert prove count function truncates the last for digits of the prover count value (basically removes the fraction value that was obtained by double chronometry). The function divides the raw prover count by 10,000 and stores the whole portion in the lower register and the reminder in the high register. For example: ● 400101 = 121007 (UDINT) ● 400103 = 12 (UINT) ● 400104 = 1007 (UINT) **Note:** If small volume proving "double chronometry" is used, do not use this function. Example: Raw Count 1210071325. 
#02	**Convert BVP to two implied registers.** The function 02 converts the base volume of the prover into two implied register fields. This is so the HMI or SCADA that cannot handle 32 bit integer numbers can read them in two implied 16bit integer fields. For example: ● 400101 = 124628000 (UDINT) ● 400103 = 12462 (UINT) ● 400104 = 8000 (UINT) Example: Base Volume Prover 124628000. 

<table>
<tr><th>Function</th><th>Description</th></tr>
<tr><td>#03</td><td>Convert two implied registers to BVP.
The function 03 does the opposite of function 02 by taking the two implied register and making them one 32 bit integer. This is so the HMI or SCADA that cannot handle 32 bit integer numbers can write them.
For Example:
● 400101 = 12462 (UINT)
● 400102 = 8000 (UINT)
● 400103 = 124628000 (UDINT)
Example: Base Volume Prover Registers 12462 8000


</td></tr>
</table>

B.1.1.5. Middle Node Content

The 4x register entered in the middle node is the first of 5 contiguous holding registers that comprise the control block.

B.1.1.6. Bottom Node Content

The bottom node must contain a constant (#0005) representing the length of the control block in registers.

B.1.2. ITOI Block Operational Representation

B.1.2.1. Operation

The ITOI block is used with the PCFC block to convert prover raw count values and base volume of the prover into single, 16-bit word parts. This allows SCADA hosts and human-machine interfaces (HMI) that don't support 32-bit unsigned long integers to read and write such values.

B.2 ITOI Function Block Configuration Overview

At a Glance

Purpose

This section summarizes the configuration of the ITOI function block

What's in this Section?

This section contains the following topics:

B.2.1. ITOI Configuration

B.2.1.1. Overview

The following sections provide an overview of ITOI function block register contents. Details about the registers appear in the next section, *ITOI Setup and Diagnostic Data Configuration Details, p. 252*.
(For a description of the abbreviations and terms used in register descriptions, see *Glossary, p. 265*.

B.2.1.2.Setup and Diagnostic Data Registers Overview

The following table lists the ITOI block registers that represent setup and diagnostic data.

Register	**Comment**		
4x + 0	RD	HEX	Revision (X.XX)
4x + 1	**WR**	UINT	Implied Decimal Low Word
4x + 2	**WR**	UINT	Implied Decimal High Word
4x + 3	**WR**	UINT	Implied Decimal Low Word (Converted)
4x + 4	**WR**	UINT	Implied Decimal High Word (Converted)

For setup and diagnostic register details, see *ITOI Setup and Diagnostic Data Configuration Details, p. 252*.

B.2.2. ITOI Setup and Diagnostic Data Configuration Details

B.2.2.1. Overview

This section provides details about the configuration of ITOI control blocks.

B.2.2.2. 4x + 0 (RD, HEX)

Revision (X.XX)

B.2.2.3. 4x + 1 (WR, UINT)

Implied Decimal Low Word A
Enter or move the low word of an UDINT into this register for conversion. The results are stored in 4x + 2 and 4x + 3.
Note: The values in the register are not modified in any way.

B.2.2.4. 4x + 2 (WR, UINT)

Implied Decimal High Word B
Enter or move the high word of an UDINT into this register for conversion. The results are stored in 4x + 2 and 4x + 3.
Note: The values in the register are not modified in any way.

B.2.2.5. 4x + 3 (WR, UINT)

Implied Decimal Low Word C
This register contains low word of the converted value.

B.2.2.6. 4x + 4 (WR, UINT)

Implied Decimal High Word D
This register contains high word of the converted value.

C. Analog Input Conversion Ranges

C

C.1. Analog Input Conversion Ranges

C.1.1. Ranges Table

The analog input conversion ranges are shown here.

984 Ranges	
0	0000 .. 4095
1	4096 .. 8192
2	0000 .. 8192
3	0001 .. 5999
4	0001 .. 7499
5	0001 .. 9999
6	0001 .. 14999
7	Reserved
Quantum Engineering Ranges	
8	768 .. 64768
9	16768 .. 48768
10	0 .. 64000
11	0 .. 32000
12	6400 .. 32000
Quantum Thermocouple Ranges	
13	TC Degrees (-454 .. +3308)
14	TC 0.1 Degrees (-4540 .. +32767)
15	TC Raw Units (0 .. 65535)
Quantum Volt Meter Ranges	
16	-10000 .. +10000
18	-5000 .. +5000
20	0 .. 10000

984 Ranges	
22	0 .. 5000
24	1000 .. 5000
25	0 .. 4000
Additional Ranges	
30	-32000 .. +32000

Note: If an invalid range is entered, the default range (0 to 4095) will be used.

D. User Security Access Levels

D

At a Glance

Purpose

This material presents the user security access levels.

What's in this Chapter?

This chapter contains the following topics:

D.1. User Security Access Levels — Parameters and Functions — PCFC

D.1.1. Parameters and Functions — User Security Access Levels

User Security Access-Level Table for Parameters and Functions

Parameter Description	Access		
	Operator	Technician	Privileged
Clear Logs and reports	No	No	Yes
Change Passcodes	No	No	Yes
Print Audit Trail	Yes	Yes	Yes
Force Process Variables in PCFC	No	Yes	Yes
Add Audit Trails	No	Yes	Yes
Command Word 1 - bit 1 Retro MF Batch	No	Yes	Yes
Command Word 1 - bit 2 Set CPL to 1.0	No	Yes	Yes
Command Word 1 - bit 3 API Trial Disable	No	No	Yes
Command Word 1 - bit 4 Corrected Density	No	Yes	Yes
Command Word 1 - bit 5 Hydrometer	No	Yes	Yes
Command Word 1 - bit 6 Force Density	No	Yes	Yes
Command Word 1 - bit 7 Force Press	No	Yes	Yes
Command Word 1 - bit 8 Force Temp	No	Yes	Yes
Command Word 1 - bit 9 Meter Proving Used	No	Yes	Yes
Command Word 1 - bit 10 No Batch Report	Yes	Yes	Yes
Command Word 1 - bit 11 No Batch Report	Yes	Yes	Yes
Command Word 1 - bit 12 No Batch Report	Yes	Yes	Yes
Command Word 1 - bit 13 API / SG	No	Yes	Yes
Command Word 1 - bit 14 Metric / Imperial	No	Yes	Yes
Command Word 1 - bit 15 Press M / I	No	Yes	Yes
Command Word 1 - bit 16 Temp M / I	No	Yes	Yes
Command Word 2 - bit 1 Auto Prove	No	Yes	Yes
Command Word 2 - bit 2 Force CPS to 1.0	No	Yes	Yes
Command Word 2 - bit 3 Flow ISV / GSV	Yes	Yes	Yes
Command Word 2 - bit 4 Pulse Fidelity	No	Yes	Yes
Command Word 2 - bit 5 Meter Phasing	No	Yes	Yes
Command Word 2 - bit 6 Bi - Directional	No	Yes	Yes
Command Word 2 - bit 7 Force Press	No	Yes	Yes
Command Word 2 - bit 8 Force Temp	No	Yes	Yes

Parameter Description	Access		
	Operator	Technician	Privileged
Command Word 2 - bit 9 Flow rate Filter	No	Yes	Yes
Command Word 2 - bit 10 No. Prove Report	Yes	Yes	Yes
Command Word 2 - bit 11 No. Prove Report	Yes	Yes	Yes
Command Word 2 - bit 12 No. Prove Report	Yes	Yes	Yes
Command Word 2 - bit 13 User Base Temp	No	Yes	Yes
Command Word 2 - bit 14 GSV / GSV Accum.	No	Yes	Yes
Command Word 2 - bit 15 Abort Prove	Yes	Yes	Yes
Command Word 2 - bit 16 Start Prove Run	Yes	Yes	Yes
Meter Run, For example: 1 to 16 Displays the Old and New value for the parameter.	No	No	Yes
TMCI Block Starting 4x Displays the Old and New value for the parameter.	No	No	Yes
Product Type Displays the Old and New value for the parameter.	Yes	Yes	Yes
Product Name Displays the Old and New value for the parameter.	Yes	Yes	Yes
Sediment and Water % CSW Displays the Old and New value for the parameter.	Yes	Yes	Yes
Serial Number of Meter Displays the Old and New value for the parameter.	No	No	Yes
Meter ID Displays the Old and New value for the parameter.	No	No	Yes
Meter Size Displays the Old and New value for the parameter.	No	No	Yes
Meter Type Displays the Old and New value for the parameter.	No	No	Yes
Meter K Factor 1.0 - 65535.0 Displays the Old and New value for the parameter.	No	No	Yes
4X Offset to Time of Day Clock Displays the Old and New value for the parameter.	No	No	Yes
Start of Day 'Hour' (0 - 23 military) Displays the Old and New value for the parameter.	No	No	Yes
Start of Day 'Minute' (0 - 59) Displays the Old and New value for the parameter.	No	No	Yes
Report Address Modulo 10000 High Word (00XX), For example: 4x or 6x Displays the Old and New value for the parameter.	No	No	Yes

Parameter Description	Access		
	Operator	Technician	Privileged
Report Address Modulo 10000 Low Word (XXXX) Displays the Old and New value for the parameter.	No	No	Yes
Internal Diameter of the Pipe Displays the Old and New value for the parameter.	No	No	Yes
Wall Thickness of the Pipe Displays the Old and New value for the parameter.	No	No	Yes
Modulus of Elasticity for the Pipe Material x 10^5 Displays the Old and New value for the parameter.	No	No	Yes
Coefficient of Cubic Expansion per ° F or °C of the Pipe Material Displays the Old and New value for the parameter.	No	No	Yes
Base Volume of Prover @ 60°F / 15 °C 0 PSI (Barrels) / M^3 Displays the Old and New value for the parameter.	No	No	Yes
Number of Consecutive Proving Runs Displays the Old and New value for the parameter.	No	No	Yes
Gravity / Density Conversion Range Displays the Old and New value for the parameter.	No	Yes	Yes
Gravity / Density High Engineering Units Displays the Old and New value for the parameter.	No	No	Yes
Gravity / Density Low Engineering Units Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature Conversion Range (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature High Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature Low Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure Conversion Range (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure High Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure Low Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature Conversion Range (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature High Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes

Parameter Description	Access		
	Operator	**Technician**	**Privileged**
Temperature Low Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure Conversion Range (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure High Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure Low Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Pulse Fidelity Frequency Threshold Displays the Old and New value for the parameter.	No	No	Yes
Pulse Fidelity Batch Count Errors Displays the Old and New value for the parameter.	No	Yes	Yes
Filter Samples Displays the Old and New value for the parameter.	No	Yes	Yes
Base Temperature Displays the Old and New value for the parameter.	No	Yes	Yes

D.2. User Security Access Levels — Parameters and Functions — TMCI

D.2.1. Parameters and Functions — User Security Access Levels

User Security Access-Level Table for Parameters and Functions

Parameter Description	Access		
	Operator	Technician	Privileged
TMCI Block Starting 4x Displays the Old and New value for the parameter.	No	No	Yes
Product Type Displays the Old and New value for the parameter.	Yes	Yes	Yes
Product Name Displays the Old and New value for the parameter.	Yes	Yes	Yes
Sediment and Water % CSW Displays the Old and New value for the parameter.	Yes	Yes	Yes
Serial Number of Meter Displays the Old and New value for the parameter.	No	No	Yes
Meter ID Displays the Old and New value for the parameter.	No	No	Yes
Meter Size Displays the Old and New value for the parameter.	No	No	Yes
Meter Type Displays the Old and New value for the parameter.	No	No	Yes
Meter K Factor 1.0 - 65535.0 Displays the Old and New value for the parameter.	No	No	Yes
4X Offset to Time of Day Clock Displays the Old and New value for the parameter.	No	No	Yes
Start of Day ’Hour’ (0 - 23 military) Displays the Old and New value for the parameter.	No	No	Yes
Start of Day ’Minute’ (0 - 59) Displays the Old and New value for the parameter.	No	No	Yes
Report Address Modulo 10000 High Word (00XX), For example: 4x or 6x Displays the Old and New value for the parameter.	No	No	Yes
Report Address Modulo 10000 Low Word (XXXX) Displays the Old and New value for the parameter.	No	No	Yes
Internal Diameter of the Pipe Displays the Old and New value for the parameter.	No	No	Yes
Wall Thickness of the Pipe Displays the Old and New value for the parameter.	No	No	Yes

Parameter Description	Access		
	Operator	Technician	Privileged
Modulus of Elasticity for the Pipe Material x 10^5 Displays the Old and New value for the parameter.	No	No	Yes
Coefficient of Cubic Expansion per ° F or °C of the Pipe Material Displays the Old and New value for the parameter.	No	No	Yes
Base Volume of Prover @ 60°F / 15 °C 0 PSI (Barrels) / M^3 Displays the Old and New value for the parameter.	No	No	Yes
Number of Consecutive Proving Runs Displays the Old and New value for the parameter.	No	No	Yes
Gravity / Density Conversion Range Displays the Old and New value for the parameter.	No	Yes	Yes
Gravity / Density High Engineering Units Displays the Old and New value for the parameter.	No	No	Yes
Gravity / Density Low Engineering Units Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature Conversion Range (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature High Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature Low Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure Conversion Range (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure High Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure Low Engineering Units (Meter) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature Conversion Range (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature High Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Temperature Low Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure Conversion Range (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Pressure High Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes

Parameter Description	Access		
	Operator	Technician	Privileged
Pressure Low Engineering Units (Prover) Displays the Old and New value for the parameter.	No	Yes	Yes
Pulse Fidelity Frequency Threshold Displays the Old and New value for the parameter.	No	No	Yes
Pulse Fidelity Batch Count Errors Displays the Old and New value for the parameter.	No	Yes	Yes
Filter Samples Displays the Old and New value for the parameter.	No	Yes	Yes
Base Temperature Displays the Old and New value for the parameter.	No	Yes	Yes
TMCI Command Word Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Type One Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting One 3x Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting One 4x Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Type Two Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting Two 3x Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting Two 4x Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Type Three Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting Three 3x Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting Three 4x Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Type Four Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting Four 3x Displays the Old and New value for the parameter.	No	No	Yes
Meter Card Starting Four 4x Displays the Old and New value for the parameter.	No	No	Yes

Parameter Description	Access		
	Operator	**Technician**	**Privileged**
Zero Flow Reading Timer Displays the Old and New value for the parameter.	No	No	Yes

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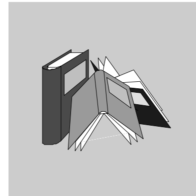
Glossary



A

API Gravity

Measure of the density or gravity of liquid petroleum products in the United States. Derived from the relative density in accordance with the following equation:

$$\text{Gravity at } 60°\text{F} = \left(\frac{141.5}{\text{relative density } 60 / 60°\text{ F}}\right) - 131.5$$

API gravity is expressed in degrees, 10 degrees API being equivalent to 1.0, the specific gravity of water.

B

Barrel (bbl)

Unit of volume equal to 9,702.0 cubic inches or 42 US gallons.

Base Volume Prover (BVP or BPV)

The volume of the prover at base conditions as shown on the calibration certificate and obtained arithmetically by three consecutive successful calibrated prover volumes (this is usually provided by a third party).

BPV

See Base Volume Prover.

BVP

See Base Volume Prover.

C

CPL Volume correction for temperature.

CPS Correction factor for the effect of pressure on steel

CTL Volume correction for pressure.

CTS Correction factor for the effect of temperature on steel.

Cubic Meter ($M^{3)}$. Unit of volume equal to 1,000,000.0 milliliters), or 1,000.0 liters.

D

Density The mass or weight of a substance per unit volume. For instance, specific gravity, relative density, and API gravity are units of density.

F

FLOAT -3.4×10^{38} to 3.4×10^{38}

G

Gross Standard Volume Gross standard volume. The volume is correct for base conditions and for meter accuracy. Sometimes known as the Net Volume.

Gross Volume Occasional synonym for Indicated Standard Volume.

GSV See Gross Standard Volume.

H

HEX Hexadecimal 0 to FFFF

I

Indicated Standard Volume (ISV) Equal to raw meter pulses/K Factor, with no correction factors. Sometimes known as the Gross Volume.

INT Integer +32767 to –32767

ISV See Indicated Standard Volume.

K

K Factor (KF) The number of meter pulses per unit volume (for instance, 200 pulses/bbl). This can usually be found tagged on the body of the meter and may change if the meter was rebuilt.

KF See K Factor.

M

Meter Factor (MF) A dimensionless value obtained by dividing the volume of the liquid passed through the prover, corrected to standard conditions during proving, by the indicated standard volume as registered by the meter.

MF See Meter Factor.

N

Net Standard Volume (NSV)	Gross standard volume corrected for non-merchantable quantities such as sediment and water.
Net Volume	Occasional synonym for Gross Standard Volume.

R

RD	Read Register is read only.
Relative Density	Ratio of the weight of a given volume to the weight of an equal volume at the same temperature. Sometimes known as RD.

S

S&W V	See Sediment & Water Volume.
Sediment & Water Volume (S&W V)	This is the volume of all non merchantable quantities such as sediment and water in bbl / hr.
SG	See Specific Gravity.
Specific Gravity (SG)	See Relative Density.

U

UINT	Unsigned Integer 0 to 65535

W

WR Write/Read Register; can be written and read by the user programmer.

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