

# Caldon USM Advisor Software User Manual

# For use with Multipath Ultrasonic Flow Meters

		Caldon USM Advisor	– <b>– ×</b>
File	Main Conf	ig	
Menu	▼ 🔜	FT-322 [ MM2   S/N 5951 ]	
		Meter View	
Ŀ			Meter 🗾 21 Aug 2019 03:48:25 PM
		Measurement Results	Meter Health 💿
		Flow Rate 311.6 bbl/h	30 Days
		Totalizer 3141155 m <sup>3</sup>	22-Jul-19 15:00 06-Aug-19 15:00 21-Aug-19 15:00
	88	Flow Velocity 1.687 m/s	5 Days
		Speed Of Sound 1395.5 m/s	16-Aug-19 15:30 19-Aug-19 03:30 21-Aug-19 15:30
AGA		Temperature 19.8 °C	
SOS		Pressure 1.0 bar g	24 Hours
		Viscosity 11.3 cSt	20-Aug-19 15:30 21-Aug-19 03:30 21-Aug-19 15:30
$\mathcal{M}$	n [@]	Density 862.1 kg/m³	No Data Normal Warning Alarm
		Profile Check	Path Check
	(())		Path 1 Path 1
			Path 2
dinte			Path 3
$\checkmark$	i iõi		Path 4
_			Path 5
50			Path 6
X			Path 7
			Path 8
		Asymmetry and Flatness     Swird and Flatness	10-Aug-19 15:30 19-Aug-19 03:30 21-Aug-19 15:30
		Smithanis Plane Dalatike	Alarm
Version 1.	0.27A [17082019]	Welcome, Administrator	Login Time Out : 05:00 21 Aug 2019 03:43:38 PM

# **Important Safety Information**

	Terms	Used	in	This	Manual
--	-------	------	----	------	--------

4	Caution	Caution, risk of electric shock.
4	Attention	Attention, risque d'électrocution.
<u>^</u>	WARNING lead to persor	A warning identifies information about practices or circumstances that can nal injury or death, property damage, or economic loss.
	AVERTISSEMI des circonstar matériels ou d	ENT Un avertissement identifie des informations sur des pratiques ou nces pouvant entraîner des blessures corporelles ou la mort, des dommages les pertes économiques.
Caution	Caution stat personal inju	ements Indicate actions or procedures which, if not performed correctly, may lead to ary or incorrect function of the instrument or connected equipment.
Attention	Indiquez les vent entraîn connecté.	actions ou les procédures qui, si elles ne sont pas effectuées correctement, peu- er des blessures ou un mauvais fonctionnement de l'instrument ou de l'équipement
Note In	dicates additional	information about specific conditions or circumstances that may affect instrument operation.
Remarque	Indique de affecter le	s informations supplémentaires sur des conditions ou des circonstances spécifiques pouvant fonctionnement de l'instrument.

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# Section 1 - Introduction

# Description

The Caldon USM Advisor is used as a PC diagnostic tool for a wide variety of multipath ultrasonic flow meter models and pipeline interface detectors. This manual covers the use of the software to diagnose problems, update the input and output scaling, and configuration/calibration of these devices. The Caldon USM Advisor software, equipped with easy to interpret live and historical data, is intended to work with one or multiple multipath ultrasonic flow meters to provide an easy and user-friendly system used to quickly and accurately calibrate, monitor, and maintain these meters over their life cycle.

The Caldon USM Advisor implements a state-of-the-art fingerprinting feature that enables users monitoring the system to capture a collection of reference points over a range of conditions in order to better monitor each meter. This is done by comparing operational data to the fingerprint data captured during optimal operating conditions. By comparing the meter operation to these points over time, patterns can be detected that indicate a reduction of efficiency, need for recalibration, or scheduling of preventative maintenance. Early preventative maintenance predicted through the use of the Caldon USM Advisor software may significantly prolong the life of connected multipath ultrasonic meters and may additionally reduce the downtimes for those meters.

Note This version of software has been designed to work with G3 transmitters that were introduced in 2015, and up. The electronics prior to 2016 is referred to as the G2 electronics.

This manual assumes the user understands the troubleshooting techniques covered in the IOM manuals and/or has been trained by Sensia personnel on these techniques. This manual also assumes that the user is familiar with the use of Windows and PC computers.

Note For the definitions of terms used throughout the manual, refer to the Glossary, page 95.

# **System Requirements**

Requires a PC (preferably a laptop) installed with Windows XP or later operating system with at least one free serial communications (COM) port or an Ethernet port.

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# Section 2 - Specifications

# **Meter Explorer Navigation**

The top-level meter navigation is used to see an overview of a number of meters and to organize a selection of meters in different locations and job sites. It can allow the user to briefly view the meters and see if there are any imminent failures or issues that may need to be addressed. The meters are referred to as "Tags", and each "Tag" is organized inside three levels of differentiation in order to ensure that the user may easily determine exactly where the meter is located and what job is utilizing it.

# Home View

The Home View (Figure 2.1) is divided into two sections: the tree structure view which shows the organized view of all of the groups of meters, and the meter explorer view which gives a snapshot of all the meters associated with the selected tree. The user may use the meter explorer view to do a high-level check on all the meters to ensure they are operating correctly. From this view the user may then go into a specific meter in order to diagnose a potential issue, operate on, or capture pertinent data from the meter.



Figure 2.1 - Home View - Meter Explorer

The following legend can be used to interpret the status of a meter over a given historical snapshot:

- **Green** Normal/healthy status
- Amber CBM (condition-based monitoring) or fingerprint warning
- **Red** Meter failure
- Grey No data available

Current status of a meter (shown beside each meter tag):

- Green Normal/healthy status
- Amber Currently has a CBM (condition-based monitoring) or fingerprint warning
- **Red** The meter currently has a failure present
- White No meter has been assigned to the tag
- Grey Currently not receiving data from the meter
- Arrow Backfill download of historic data in progress for meter

The user may add/edit operators, levels, or "tags" (meters) through the Configuration Menu (Figure 2.2) by clicking the *Config* button.

					Caldon L	USM Ac	dvisor	r							-	
ile	Main Con	fig														
₩,	(+			(Ŧ	<b>I</b> ⊕											
Manage Operator	Level 1	Level 2	Level 3	New Tag	Manage Meter											
		Manag	e Meter													

Figure 2.2 - Configuration Menu

Operator. The operator is the specific company for which a meter or a number of meters are associated.

**Level 1.** The top level of the tree is Level 1 which can be used as a way to group metering stations. Level 1 may be used to represent a geographical location but may also be used to identify any group of assets.

**Level 2.** Level 2 will typically be an asset such as an offshore installation or metering station at a terminal, but the definition can be flexible to allow for systems such as pipelines. When adding or editing a Level 2 group will be assigned to a Level 1 Group and an operator.

Level 3. Level 3 will typically represent metering systems under which Tags can be grouped.

**Tag.** When configuring and managing meters the application uses the Tag which represents the identification of the meter that is installed. The Tag will normally be in the same format as identified on the P&ID (piping and instrument diagram).

Note All three levels must be created in order to create Tags (to which meters can be assigned).

#### **Managing Meters**

From Home View, the user may go to the Config menu and enter the Managing Meter screen (Figure 2.3). On this screen the user may add or edit the available meters and their parameters (Figure 2.4).

	Add Meter		and the second	A second second						
Drag	a column hea	der and drop i	it here to group by t	that column						
			D	Station	Suctor	Tan	Meter	Type	Serial Number	Communication
	Edit	Delete	Kegion	Station	System	iag	meter	·Jbc	Schortwinder	communication

Figure 2.3 - Managing Meter Screen

Add New I	Meter		X
Operator	Drop Oil	Select Type	тср 💌
Level 1	Blue Ocean Field 🔹	Ip Address	Enter IP Address
Level 2	Alpha 🔻	Modbus Port Number	502
Level 3	Oil Export	Slave Id	1
Tag Name	FT-STUK	CBM Port Number	49502
Meter Name	Meter Name	Username	admin
Description	Description	Password	admin
Model	LEFM220Ci 🔹	Auto Backfill	Enable
Meter Size	6 Inch 🔻	Modbus Mapping	Custom Mapping
		Sa	ve Cancel

Figure 2.4 - Add/Edit Meter Dialog

#### **Meter Overview**

The Meter Overview sections give the user a snapshot of the operation of the selected meter. The purpose of this is to help users who are tasked with monitoring many meters at a time. Instead of having to go deep into a meter immediately, the user may pull up snapshots of the meter's health and details in order to see at a glance if there are any obvious inefficiencies or impending failures.



#### **Meter View**

The Meter View (Figure 2.5) is displayed when the user double-clicks the tag in the Home View (page 3) to enter into a specific meter. The initial screen that appears gives an overview of the measurement results, meter health, profile check, and path check. To gain additional information for each of these four sections, the user may click the maximize icon in that is at the top-right of each respective box.

In this overview, the meter limits, CBM (condition-based monitoring) limits, and fingerprint limits are in view for the meter history (over 30 days, 5 days, and 24 hours). The meter limits are the hard limits (alarms) that indicate when the meter has exceeded the specifications for the meter. The CBM (condition-based monitoring) limits are warning limits that give the user an indication that the flow through the meter is outside the range of acceptable flow set to for acceptable performance of the flow. The fingerprint limits compare the data of the meter to that of the recorded fingerprints (selected data, presumably with the optimal data), showing how far the current flow in the meter is from operating at optimal efficiency.



Figure 2.5 - Meter View



# Meter Details

The Meter Details (Figure 2.6) gives an overview of the parameters of the current meter that the user has currently selected. This is useful during setup to ensure all the entered parameters are correct.



Figure 2.6 - Meter Details

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# Section 3 - Installation

The software is available for download from https://sensiaglobal.com/Measurement. From this website, click on *Caldon USM Advisor Download*, navigate to the "Software" section, and click *Caldon USM Advisor Software* to download the program. Use the following steps to proceed with installation of the software:

1. Browse to the "CaldonUSMAdvisor\_Installer.zip" folder on your computer, right-click, select *Extract All*, and select a location where the folder should be unzipped.

Note To go immediately to the unzipped folder, check the box next to "Show extracted files when complete".

- 2. Click CaldonUSMAdvisor\_Installer.exe to access the software installation options.
- 3. Follow the on screen prompts.

#### First Time Starting Caldon USM Advisor

1. Click the Caldon USM Advisor desktop icon, or select **Start>Programs>Sensia>Caldon USM Advisor**. The initial login screen will appear (Figure 3.1). Refer to for additional setup procedures.



Figure 3.1 - Administrator Login

2. The default user profile will be **Administrator**, and the default password is: **Admin**. When signed in, the program will be on the Home screen, ready for setup to begin (Figure 3.2).

	Caldon USM Advisor		-		×
Meter Details	Meter Explorer				
File     Main     Config       Meter Details     ▼     Image: Config       ▲     Canada     ■       ▲     ♥     Alberta       ▲     ♥     Oli Export       ●     FT-100       ●     FT-201	Meter Explorer				
Version 1.0.26 [15072019] Welcome, Adm	inistrator	Login Time Out : 05:00	20 Aug 20:	19 01:49:	11 PM

Figure 3.2 - Initial Setup in Meter Explorer

At this point it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program. Follow these steps to change the administrator password:

3. Click *File*. The File Menu will appear (Figure 3.3). Select *Change Password*, and follow the prompts to continue.



Figure 3.3 - File Menu

# **Organizing Meters**

To ensure that identifying a particular meter among many referenced meters, the meters may be organized in the meter explorer tree. The Caldon USM Advisor is designed with 3 levels of differentiation between locations or groups, sites, and areas or applications within that site. The meters (referred to as Tags) are organized under these levels. These three levels are flexible, and can be used in whatever method is most convenient and makes the most sense for the application. Levels and Tags can be added by clicking the *Config* button at the top-left of the application to go to the Config Menu (Figure 3.4).





The user may add or edit level and tags within the Meter Explorer (page 3) by left-clicking to select the level or tag, and then right-clicking the level or tag to bring up the item options dropdown menu. To quickly create levels and tags, the user may wish to create all of the Level 1 regions, and then use the Meter Explorer (page 3) to create all of the subsequent levels and tags within each region.

## Adding and Editing Level 1

This level allows the user to provide a name (i.e. region) and a description that best classifies the top level of the location or application of the meters grouped under it (Figure 3.5).

# Adding and Editing Level 2

This level allows the user to specify the operator, and to provide a detailed physical location and description of the site where the grouped meters are located (Figure 3.6). To add an operator, refer to Setting up a New Operator, page 23.

## Adding and Editing Level 3

This level allows the user to provide a descriptive label and description for the tags grouped under it (Figure 3.7).

		Add New Level 2	X	Add New Level 3		X
		Level 1	Level 1	Level 1	Level 1	•
		Level 2	Name	Level 2	Level 2	۳
Add New Level 1	<b>N</b>	Description	Description	Level 3	Name	
		Operator	Drop Oil	Description	Description	
Name	Enter Region Name	Address	Address			
Description	Enter Description	City/State	City/State			
		Country	Country			
		Postal Code	Postal Code			
OK	Cancel	]				
		OK	Cancel	OK	Cancel	
Figure 3.5 -	Create Level 1	Figure 3.6 -	Create Level 2	Figure 3.7 -	Create Level 3	

#### Adding and Editing Tags

The tag (Figure 3.8) allows the user to create a name for the associated meter and a description to further aid in the identification of the meter. In this way, the user may conform the tag to the predefined identification schemes already in use.

Add New Tag			X
Level 1	Blue Ocea	n Field	•
Level 2	Alpha		*
Level 3	Oil Export		
Tag	Тад		
Description	Descriptio	n	
OK		Cance	1

Figure 3.8 - Create Tag for Meter

#### **Connecting to the Meter**

To connect to an installed multipath ultrasonic meter, begin by adding it to an existing path previously created on the Meter Explorer. If the necessary levels have not yet been created, then it is recommended to add or edit the levels on the Meter Explorer before adding any meters. In this way the meters can be organized into the appropriate categories when they are added to the software.

#### **Connecting Meters to Tags**

When all of the levels and tags have been created and organized as per the organizational guidelines for each company or region, the user will then wish to connect meters to each tag. To do this, the user will use the Meter Explorer (). The user will select a tag, then right-click that tag to bring up the item options dropdown menu, and select the Add Meter. The Add Meter dialog (Figure 3.9) will appear.

Depending on the configuration of the network, further configuration of the communication settings (i.e. TCP or SE-RIAL) may be required. For TCP, see Network Settings, page 12. For SERIAL, see Serial Settings, page 13.

Add New I	Meter		X
Operator	Drop Oil	Select Type	тср
Level 1	Blue Ocean Field 🔹	Ip Address	Enter IP Address
Level 2	Alpha 🔻	Modbus Port Number	502
Level 3	Oil Export 🔹	Slave Id	1
Tag Name	FT-STUK *	CBM Port Number	49502
Meter Name	Meter Name	Username	admin
Description	Description	Password	admin
Model	LEFM220Ci 🔹	Auto Backfill	Enable
Meter Size	6 Inch 💌	Modbus Mapping	Detault Mapping     Custom Mapping
		Sa	ve Cancel

Figure 3.9 - Add Meter



# **Network Settings**

Click the Configuration button to access the configuration settings. The user will then need to log in as Administrator or as an Engineer in order to access the configuration menus (Figure 3.10). If this is the first time, the Administrator password will be Admin. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program. For additional information on the Configuration Menu, refer to Configuration Settings, page 31. It is important set up the communication parameters as per the direction of the network administrator in order to ensure the communication with the device is successful, and that the IP address assigned to the device will not conflict with another device on the network.

 $\land$ 

WARNING While logged into configuration mode, a change might influence the metrology aspects (e.g. CT approved systems). It is recommended that the user validate any proposed changes before making any changes in these menus.

		-	Caldo	n USM A	dvisor					-		×
File Menu	Main Cont	fig FT-101 [ STUK meter   S/N	123456780042]									
	<b>1</b>	Configuration Setting	gs									
Ē									Meter	19 Jul 201	9 11:42:	10 AM
		Comm Units	A/I A/O	Pulse	Meter Limits	CBM Limits	Finger print	AGA / SOS	Config			
					C	ommunica	tion					
	88	DHCP										
		IP Address	192 168	0	30							
AGA /		Subnet Mask	255 255	255	192							
		Default Gateway	0 0	0	0							
$\mathcal{M}$		MAC Address	00-00-00-00-00		]							
		Baud	19200		19200		• 19	200				
	()	Databits	8		8		• 8		*			
		Parity		•			•		•			
	$\odot$	Stop bits	1		1		• 1		*			
		Slave ID	1		1		1					
8												
							F	Refresh	Write to Mete	r	Cancel	
Version 1.0	.26 [15072019]	Welcome, Administrator							Login Time Out : 05	:00   22 Aug	2019 01:4	6:10 PM

Figure 3.10 - Configuration Menu

The initial display when the user logs into the Communication Settings represents the settings that are currently stored in the meter. The user may changed these and write them to the meter, or they may re-read them by clicking *Refresh*. Once the communication settings have been verified, click *Write to Meter*. For more information, refer to Communication Settings, page 33.

If there are connection issues, refer to Troubleshooting a Connection Failure, page 14.

**DHCP.** Default is static IP (DHCP is unchecked). If checked, this will assign a new IP Address to the meter each time it connects to the network.

IP Address. Default is 192.168.1.100. The label assigned to the device when it connects to the network.

**Subnet Mask.** Default is 255.255.255.0. The 32-bit number that masks an IP address, and divides the IP address into network address and host address.

**Default Gateway.** Default is 192.168.1.1. The node in a computer network using the internet protocol suite that serves as the forwarding host (router) to other networks when no other route specification matches the destination IP address of a packet.

MAC Address. Read Only. Shows the unique identifier assigned to a network interface controller.



# **Serial Settings**

Click the Configuration button to access the configuration settings. The user will then need to log in as Administrator or as an Engineer in order to access the configuration menus (Figure 3.11). If this is the first time, the Administrator password will be Admin. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program. For additional information on the Configuration Menu, refer to Configuration Settings, page 31. It is important set up the communication parameters as per the direction of the network administrator in order to ensure the communication with the device is successful, and that the Slave ID assigned to the device is not already utilized.



WARNING While logged into configuration mode, a change might influence the metrology aspects (e.g. CT approved systems). It is recommended that the user validate any proposed changes before making any changes in these menus.

			C	aldon USM A	dvisor					-	. 🗆	×
File Menu	Main Conti	FT-101 [ STUK meter   S/N	123456780042]									
	· <del>2</del> ·	Configuration Setting	gs									
									Meter	19 Jul 2	019 11:42	:10 AM
B	$\geq$	Comm Units	A/I A/O	Pulse	Meter Limits	CBM Limits	Finger print	AGA / SOS	Config			
					C	ommunica	ation					
	8%	DHCP										
-		IP Address	192 168	0	30							
AGA /		Subnet Mask	255 255	255	192							
303		Default Gateway	0 0	0	0							
$\sim$		MAC Address	00-00-00-00-00-	00								
		Baud	19200	•	19200		• 1920	0	*			
	(())	Databits	8		8		• 8					
		Parity					•		•			
	$\odot$	Stop bits	1	•	1		• 1		•			
-		Slave ID	1		1		1					
8												
							Ref	resh	Write to Meter	,	Cancel	
Version 1.0.2	26 [15072019]	Welcome, Administrator							Login Time Out : 05:	00   22 Au	g 2019 01:	46:10 PM

Figure 3.11 - Configuration Menu

The initial display when the user logs into the Communication Settings represents the settings that are currently stored in the meter. The user may changed these and write them to the meter, or they may re-read them by clicking *Refresh*. Once the communication settings have been verified, click *Write to Meter*. For more information, refer to Communication Settings, page 33.

If there are connection issues, refer to Troubleshooting a Connection Failure, page 14.

**Baud.** Default is *19200*. The configured data transmission speed between the host and slave. Shown in bits per second. The maximum configured baud rate is 115200, and the minimum is 4800.

Databits. Default is 8. The number of bits used to represent one character of data. Can be configured for 7 or 8 bits.

Parity. Default is None. The error detection through the use of the parity bit can be either ignored, or set as odd or even.

Stop bits. Default is 1 bit. The number of bits used to signal the end of a frame. This can be either 1 or 2 bits.

**Slave ID.** Default is *1*. The unique number assigned to a Modbus slave device in order to distinguish it from other connected devices. Each address may be set to any address from 1-247, or it may be set to 0 to be ignored.

# **Troubleshooting a Connection Failure**

After installation, it may happen that the meter does not appear to be communicating with the Caldon USM Advisor software. There are two major areas to check in order to determine the source of the issue: electrical checkpoints and software checkpoints.

# **Electrical Checkpoints**

Electrical checkpoints refers to the physical wiring to or from the flow meter. There may be additional electrical checkpoints beyond what is mentioned here, and so it is recommended that the user first refer to the hardware manual that accompanies their flow meter to verify that the hardware installation is correct. However, here are a few areas that could cause intermittent or broken connections:

- **Power Supply Wiring.** Indicated by intermittent communication or no communication with the meter. Check to make sure that the power supply wiring is not broken or damaged, and verify that the power supply capacity is sufficient for the loading required by the flow meter and any other devices reliant on the supply.
- **Communication Wiring.** Indicated by not being able to Read/Write to the flow meter. Check to make sure that all of the Ethernet or serial communication wires are connected, or that they are not damaged or broken. This will prevent the software from reading or writing to the meter.
- Analog Input Wiring. Indicated by not being able to read the values in the Configuration Menu. Check to make sure that there are no breaks in the analog input wiring, and verify that the loading does not exceed the maximum specified by the flow meter or analog output device.
- Analog Output Wiring. Indicated by the analog readout device(s) not receiving data from the analog outputs on the meter. Check to make sure that there are no breaks in the analog output wiring, and verify that the loading does not exceed the maximum specified by the flow meter or analog readout device.
- **Pulse Output Wiring.** Indicated by the pulse readout device(s) not receiving data from the pulse outputs on the meter. Check to make sure that there are no breaks or excessive noise present in the pulse output wiring.

#### Software Checkpoints

- Ethernet Communication. Indicated by intermittent or no communication to/from the meter. Verify that the flow meter is connected to the network and has been assigned an IP address, and that the subnet mask and default gateway match the network configuration. Verify that the IP address assigned to the meter matches the address specified in the Caldon USM Advisor software. Contact the network administrator to verify that the IP address assigned to the meter does not conflict with another device on the network.
- Serial Communication. Indicated by intermittent or no communication to/from the meter. Verify that the flow meter settings match the Modbus network settings for baud rate, data bits, parity, and stop bits. Verify that the slave ID assigned to the meter matches the slave ID specified in the Caldon USM Advisor software. Contact the network administrator to verify that the slave ID assigned to the meter does not conflict with another device on the Modbus network.
- Analog Input/Analog Output/Pulse Output. Indicated by incorrect readings from input/output. Verify the input/ output settings for high and low readings. Use the Force Output feature on the analog output device to verify the maximum and minimum current received by the flow meter. Use the Force Output feature on the flow meter to verify the maximum and minimum current or pulse data received by the analog or pulse readout device.

# Adding/Editing/Removing User Profiles

In setting up the software, it is important to create all the users that will be accessing the program, and to assign to them the appropriate levels of access. The list of users and access levels are as follows:

- Administrator. Includes privileges to add/edit/delete users, add/remove levels and tags (meters), fingerprint, view individual meters, and to configure and control the connected meters.
- **Engineer.** Includes privileges to add/edit/delete levels and tags (meters), fingerprint, view individual meters, and to configure and control the connected meters.
- Technician. Includes privileges to add/edit/delete levels and tags (meters) and view individual meters.
- User. Includes privilege to add/edit/delete levels and tags (meters) and view individual meters (except the ultrasonic waveforms).

To manage users and current user profile, refer to the following procedures:

- Setting up a New User, page 16
- Manage Existing User, page 18
- Remove Existing User, page 20
- Edit Current User Profile, page 22

#### Setting up a New User

1. Log in as Administrator. If this is the first time, the default password is **Admin**. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program.

Click *File* on the top panel menu (Figure 3.12) to open up the File Menu (Figure 3.13).



Figure 3.13 - File Menu

2. Click Manage User to open up the Manage User Menu (Figure 3.14).

				Caldon USM Advisor					-		×
1	File Main	Config									
	Add New User								T	fotal Reco	rd: 0
Dr	ag a column he	ader and drop it	here to group by that column								
	Edit	Delete	Username	User Level	First Name	Last Name	Designation				
Ver	sion 1.0.26 [150	72019]   Welco	me, Administrator				Login	Time Out : 05:00	22 Aug 2	019 03:07	00 PM

Figure 3.14 - Manage User Menu

- 3. Click Add New User to open up the Add New User dialog (Figure 3.15). Fill in the necessary information, and click *OK* when finished to save the new user profile.
- Note The user of that account will need to login (with the default password **Password@1**) and change the password for their personal account.

Add New User			X					
Login ID	Login ID							
First Name	First Name							
Last Name	Last Name							
Email	Email Email							
Designation Designation								
User Level	Engineer		•					
	Default Password is : Passw	ord@1						
	0	к	Cancel					

Figure 3.15 - Add New User Dialog

#### Manage Existing User

1. Log in as Administrator. If this is the first time, the default password is **Admin**. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program.

Click File on the top panel menu (Figure 3.16) to open up the File Menu (Figure 3.17).



Figure 3.17 - File Menu

2. Click Manage User to open up the Manage User Menu (Figure 3.18).

				Caldon USM Advisor					-		×
File	Main	Config									
Ad	d New User								To	tal Reco	rd: 2
Drag	a column head	der and drop it	here to group by that column								
	Edit	Delete	Username	User Level	First Name	Last Name	Designation				
>	Edit	Delete	Eng10	Level 1 privileges	Engineer	Ten	EE				
	Edit	Delete	Tech10	Level 2 privileges	Technician	Ten	ET				
Versio	n 1.0.26 [15072	2019]   Welco	ome, Administrator				Login	Time Out : 05:00	10 Sep 20	19 10:48:	03 AM

Figure 3.18 - Manage User Menu

3. Click *Edit* beside a user profile to open the Edit User dialog (Figure 3.19) for that profile. Edit the information as needed, and then click *OK* to save the changes.

Edit User Profile	X
Login ID	Administrator
First Name	Administrator
Last Name	Last Name
Email	-
Designation	Admin
User Level	Admin

OK Cancel
-----------

Figure 3.19 - Edit User Dialog

#### Remove Existing User

1. Log in as Administrator. If this is the first time, the default password is **Admin**. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program.

Click *File* on the top panel menu (Figure 3.20) to open up the File Menu (Figure 3.21).



Figure 3.21 - File Menu

2. Click *Manage User* to open up the Manage User Menu (Figure 3.22). Click *Delete* beside the user profile that needs to be removed.

				Caldon USM Advisor					- 1	□ ×
File	e Main	Config								
Ad	ld New User								Total	Record :
Drag	a column head	der and drop it	here to group by that column							
	Edit	Delete	Username	User Level	First Name	Last Name	Designation			
>	Edit	Delete	Eng10	Level 1 privileges	Engineer	Ten	EE			
	Edit	Delete	Tech10	Level 2 privileges	Technician	Ten	ET			
	4 0 00 14 5 0 7							T: 0 . 05.00		
Versio	in 1.0.26 [150/2	1013]   Welco	ome, Administrator				Login	Time Out : 05:00	10 Sep 2019	10:48:03 AN

Figure 3.22 - Manage User Menu

#### Change Current User Password

1. Click *File* on the top panel menu (Figure 3.23) to open up the File Menu (Figure 3.24).

File Main	Caldon USM Advisor _	×
	Figure 3.23 - Top Panel Menu	
$\bigcirc$	Caldon USM Advisor —	×
C		
📲 Sign Out		
User Profile		
Change Password		
Manage User		
🗙 Exit		

Figure 3.24 - File Menu

2. Click *Change Password* to open the Change Password dialog (Figure 3.25). Enter the old and new password, and then click *OK* to save the new password.

	Enter Password	0
New Password	Enter Password	٩
Confirm New Password	Enter Password	۲

Figure 3.25 - Change Password Dialog

#### Edit Current User Profile

1. Click *File* on the top panel menu (Figure 3.26) to open up the File Menu (Figure 3.27).

1 M-1- C5-	Caldon USM Advisor	
Main Conlig	Figure 2.20 Tan Banal Manu	
	Figure 3.26 - Top Pariel Menu	
	Caldon USM Advisor	_
$\checkmark$		
📒 Sign Out		
User Profile		
Change Password		
Manage User		
Download Config		
Dotions		

Figure 3.27 - File Menu

2. Click *User Profile* to open the Edit User Profile dialog (Figure 3.28). Edit or fill in the information as necessary, and click *OK* when finished to save the changes.

Jser Profile	x
Login ID	Administrator
First Name	Administrator
Last Name	Last Name
Email	-
Designation	Admin
User Level	Admin

ОК	Cancel

Figure 3.28 - Edit User Profile Dialog

#### **Common Setup Procedures**

For step-by-step instructions on how to complete the basic setup of a meter and users, refer to the following:

- Setting up a New Operator, page 23
- Setting up a New Meter, page 24
- Setting up Meter Limits, page 27
- Setting up CBM Limits, page 29

#### Setting up a New Operator

1. Open up the Config Menu (Figure 3.29) on the top of the application, and click *Manage Operator*.



Figure 3.29 - Config Menu

2. The List Operator dialog (Figure 3.30) will appear. Click Add Operator.

List	Operator		X
A	dd Operator		Total Record : 2
	Edit	Delete	Name
>	Edit	Delete	Drop Oil
	Edit	Delete	Oil Etc

Figure 3.30 - List Operator

3. The Add Operator dialog (Figure 3.31) will appear. Upload the image and company name, and then click OK.

Add Operator	X
Company Logo	NO IMAGE AVAILABLE
Company Name	Upload Picture Company Name



Figure 3.31 - Add Operator Dialog

#### Setting up a New Meter

1. Begin at the Home View (Figure 3.32).

Before starting to add a meter, check that the desired path exists for that meter. If the desired path already exists, skip to step 6 (page 25) to create a Tag for the new meter, otherwise continue. It is necessary to setup all three levels and then the user may assign a meter to the created Tag.



Figure 3.32 - Home Screen

2. Let's begin creating a path by clicking to open up the Config Menu (Figure 3.33) on the top of the application.

					Caldon l	JSM Advisor —	
File	Main Con	fig					
±	(+	<del>(</del> +	<b>e</b>	<b>e</b>	Ē.		
Manage Operator	Level 1	Level 2	Level 3	New Tag	Manage Meter		
		Manag	e Meter				

Figure 3.33 - Config Menu

3. Click Level 1, and the Level 1 dialog (Figure 3.34) will appear. Fill in the information, and then click OK.

Add New Level 1	X
Name	Enter Region Name
Description	Enter Description
OK	Cancel

Figure 3.34 - Level 1 Dialog

4. Click *Level 2*, and the Level 2 dialog (Figure 3.35) will appear. Fill in the information, and then click *OK*. If the Operator does not exist, refer to Setting up a New Operator, page 23.

Add New Level 2	X
Level 1	Level 1
Level 2	Name
Description	Description
Operator	Drop Oil
Address	Address
City/State	City/State
Country	Country
Postal Code	Postal Code



Figure 3.35 - Level 2 Dialog

5. Click Level 3, and the Level 3 dialog (Figure 3.36) will appear. Fill in the information, and then click OK.

Add New Level 3	X
Level 1	Level 1
Level 2	Level 2
Level 3	Name
Description	Description

ОК	Cancel
ÖK	currect



6. Click New Tag, and the Level 3 dialog (Figure 3.37) will appear. Fill in the information, and then click OK.

Add New Tag	X
Level 1	Level 1
Level 2	Level 2
Level 3	Level 3
Tag	Tag
Description	Description

OK	Cancel

Figure 3.37 - New Tag Dialog

7. Click *Manage Meter* to enter into the Manage Meter menu, and then click *Add Meter* to open the Add New Meter dialog (Figure 3.38). Fill in the information, and click *OK*. If the Operator does not exist, refer to Setting up a New Operator, page 23.

		Caldon USM Advisor										-		×		
Fil	e Main	Config														
	Add Meter	]													Total Re	cord : 2
Drag																
	Edit	Delete	Level 1	Level 2	Level 3	Tag	Meter	Serial Number	Com	munication						
>	Edit	Delete	Level 11	Level 22	Level 33	FT-200	Flow Meter 200	Default012345678	тср							
	Edit	Delete	Level 1	Level 2	Level 3	FT-101	STUK meter	123456780042	тср	p						
Add New Meter																
		Operator Drop Oil				Select	Type	ТСР		•	1					
			Level 1 Level 1				Ip Ad	In Address Enter IP Address								
			Level 2 +				Modbus Port Nu	dbus Port Number 502								
				Level	Level 3 🔹			Sla	we ld	1						
				Tag Nam	FT-100	)		CBM Port Nu	mber	49502	49502					
			N	Veter Nam	Meter	Name	Userr	name	admin							
				Descriptio	ption Description			Pass	word	admin						
			Se	Serial Number Serial Number												
			Model LEFM220Ci T													
			Meter Size 6 Inch *				r									
									Sav	/e	Cano	el				
Versi	on 1.0.26 [1507	2019] Welc	ome, Adm	inistrator					_			Login Tim	ne Out : 05:00	06 Sep 2	019 01:11	:28 PM

Figure 3.38 - Add New Meter Dialog

#### Setting up Meter Limits

The Meter Limits are setup with default values from the meter specification, which are sufficient for standard meter monitoring. If needed, these limits may be optimized for a specified application. Based on the specification of the installation Sensia can provide an optimized set of Meter and CBM (condition-based monitoring) Limits.



- 1. First, make sure to select a meter that is to be configured from the Meter Explorer on the Home View Once in Meter View 1, go to the Configuration Settings tab:
- 2. The Configuration Settings login (Figure 3.39) will appear. Sign in as either an Engineer profile or as the Administrator. If this is the first time, the Administrator password will be **Admin**. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program.



Figure 3.39 - Configuration Setting Login

3. Once logged in, go to the Meter Limits tab (Figure 3.40).

		Caldon USM Advisor											-		×
File	Main Config														
Menu	•	FT-101 [ STUK	( meter   S/I	N 12345678	0042]										
		Configurat	ion Settir	ngs											
L.										Meter	19 Ju	1 2019	11:42:1	0 AM	
								CDM							
	$\geq$	Comm	Units	A/I	A/O	Pulse	Limits	Limits	print	SOS	Config				
		_	_	_	_	_			_		_				
		Path		Min P	erformance/06	۱	A	Jarm Limit	s						<b>_</b>
	ጜሌ	Faul	Active	WHITE P		,									
		Path 1 50						50							
			Path 2		50			50							
sos			Path 3		50		50								
_	_	Path 4 5			50		50								
200			Path 5		50			50		_					
000	3)	Path 6			50	50			_						
		Path / 50					50								
	(( <u>^</u> ))	50				30									
			Parameter	Asymm	Asymmetry 0.05		High		Active						
				Flatr	ness	0.45	1.05			-					
	िंग			S	Swirl _	0.12	0.12			1					
				Plane Bala	ince (	0.95	1.05								
54		Parameter				Value	Active								
$\frown$	Ē	Max			Max Gain (dB	)	80								
		Max Gain Split (dB)				)	5		$\checkmark$	_					•
							Read From	Meter	Write To M	/leter	Save		Ca	ncel	
Version 1.0.26	5 [15072019]   1	Nelcome, Adm	inistrator								Login Time Out : 05:	00   30	Aug 20	19 03:49	:31 PM

Figure 3.40 - Meter Limits

- 4. The Meter Limits are setup with common defaults. The user should use the provided meter specifications to determine what the meter limits should be set at.
- 5. After the user has set the meter limits and verified that the limits conform to the specifications from the meter, or specified by the organizational policy, then click Write to Meter.
- 6. Click Read from Meter and verify the settings have all been written into the meter correctly.
### Setting up CBM Limits

The CBM (condition-based monitoring) Limits are setup with default values which are sufficient for standard CBM (condition-based monitoring) of the acceptable flow conditions. If needed, these limits may be optimized for a specified application. Based on the specification of the installation Sensia can provide an optimized set of Meter and CBM (condition-based monitoring) Limits.

- 1. First, make sure to select a meter that is to be configured from the Meter Explorer on the Home View . Once in Meter View \_\_\_\_\_, go to the Configuration Settings tab:
- 2. The Configuration Settings login (Figure 3.41) will appear. Sign in as either an Engineer profile or as the Administrator. If this is the first time, the Administrator password will be **Admin**. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program.

		Caldon USM Advisor		- 0	×
File	Main C	onfig			
Menu		E FT-101 [ STUK meter   S/N 123456780042 ]			
	. 9	Configuration Settings			
			Meter	19 Jul 2019 11:42	:10 AM
		Comm Units A/I A/O Pulso Meter CBM Finger AGA/	Config		
AGA / SOS		User Verification Form			
$\mathcal{M}$		Username Administrator T Password Enter Password T			
	(())	Confirm Cancel			
8					
Version 1.0	0.26 [15072019	Welcome, Administrator	Login Time Out : 05:00	30 Aug 2019 03	15:58 PN

Figure 3.41 - Configuration Setting Login

3. Once logged in, go to the CBM Limits tab (Figure 3.42).

				Cal	ldon USM Ad	lvisor							×
File	Main Config	9											
Menu	-	FT-101 [ STU	JK meter   S/N 12	3456780042 ]									
	. • .	Configura	ation Settings										
L.										Meter	19 Jul 2019	11:42:1	0 AM
_	_												
		Comm	Units	A/I A/O	Pulse	Meter Limits	CBM Limits	Finger print	AGA / SOS	Config			
											_		
			Wa	rning Limits				Baseline	e Gain Paran	neter			<b>A</b>
	E.8.8		Min Performance (%)		Max Turbu (%)	ulence			Gain (dB)	Path Length			
	<u> </u>	Active					Pat	h l	60	32.873			
		Path 1	90	120	0.15		Pat	h 2	60	49.258			
AGA /		Path 2	90	120	0.15		Pat	th 3	60	49.258			
505		Path 3	90	120	0.15		Pat	h 4	60	32.874			
		Path 4	90	120	0.15		Pat	<i>t</i> h 5	60	32.874			
$h\Lambda\Lambda\Lambda$		Path S	90	120	0.15		Pat	<i>t</i> h 6	60	49.258			
	20/200	Path 6	90	120	0.15		Pat	źh 7	60	49.257			
		Path 7	90	120	0.15		Pat	h 8	60	32.873			
	((^))	Path 8	90	120	0.15	i i							
			Wa	rning Limits									
		Param	ieter	Low H	igh A	ctive							
<u>v</u>	101		Asymmetry	0.97 1.	03	$\checkmark$							
			Flatness	0.55 0	.9	$\checkmark$							
			Swirl	-0.1 0	1	<ul> <li>Image: A start of the start of</li></ul>							
		PI	ane Balance	0.97 1.	03								
		F	Relative Gain	0.9 1	.1								
		0	Gain Flatness	0.9 1	.1								•
										Save	Ca	ancel	
Version 1.0.2	6 [15072019]	Welcome, Ad	ministrator							Login Time Out : 05:00	30 Aug 20	019 03:54	:29 PM

#### Figure 3.42 - CBM Limits

4. The CBM Limits are setup with common defaults. Using the process parameters and the acceptable variations, the user may determine limits that are useful in their process. These limits should be less stringent than the Meter Limits, such that there is a sufficient buffer between these process inefficiency "warnings" and the hardware specifications of the meter (Meter Limits).

## **Configuring Flow Meter System Parameters**

When a meter is setup in Meter Explorer, further configuration may not be necessary, because many of the settings will be automatically be retrieved from the meter, and the CBM limits are set by Sensia to represent common settings. However, it is still recommended that the user use the configuration menu to verify the configuration setup. The user may validate a variety of settings, including: communication settings, inputs and outputs, meter limits, CBM (condition-based monitoring) limits, fingerprint settings, smart alarm configurations, AGA/SOS (Speed of Sound) settings, and settings stored in the meter's Modbus map.



## **Configuration Settings**

The Configuration Settings (Figure 3.43) allow the user to fully setup the meter parameters, the source and output measurements, meter units, meter limits, CBM (condition-based monitoring) limits, fingerprinting parameters and limits, smart alarms configured by the user for the specific processes, AGA/SOS settings, and take full control over the meter through the Modbus interface and modify individual Modbus configuration registers, if desired.

Note To access the Configuration Settings, the user must use log in as the Administrator or with an Engineer profile.



A/I

WARNING While logged into configuration mode, a change might influence the metrology aspects (e.g. CT approved systems). It is recommended that the user validate any proposed changes before making any changes in these menus.

-					Galdon U	SM Advisor									×
File	Main Confi	g Data													
Menu		FT-1014 [ Met	er 14   S/N	11014001]											
		Configurati	on Settin	igs											
ш												Meter	5/19/2	020 8:05	04 AM
			Halta			Dulan	Meter	CBM	Finger	Alarm	AGA/	Config			
	2		Units			- dise	Limits	Limits	print	Config	505	Coming			
-	-														
	6.88														
AGA															
SOS						User Veri	fication Form	1							
							Username	Astenante	alor						
$\sqrt{N}$							Passaned	Cater Day	and a						
-							Turring	Enter Pos	214040						
	(())														
								Confirm		Cancel					
	(Q)														
-															
X															
-	_														
_															
Ver 1.0.368	Welcome, Adm	ninistrator									T	me Out : 05:0	0 5/1	9/2020 9:	19:58 AM

Figure 3.43 - Configuration Settings

Comm Communication Settings. Allows the user to modify the serial and Ethernet settings for the connected meter.

Units Meter Units. This sets the units for the incoming parameters from the connected meter.

**Analog Input Settings.** Configures the source and ranges for each of the incoming parameters. The user may choose to hard code the values from a downloaded calibration file, use the calculated values based on the meter parameters, source the values from an analog input/RTD, or source from a Modbus register.

Analog Output Settings. Configures the data source being outputted and the data range.

Pulse

Pulse Output Settings. Configures the pulse output parameters.



Meter Limits. Defaults are the standard meter limits. These are hard limits that if exceeded may result in damage to the connected meter.

CBM Limits **CBM Limits.** Defaults are the standard CBM (condition-based monitoring) limits. These are soft limits that if exceeded will cause warnings and may result in reduced efficiency of the meter. These limits are purposed to be set below the meter limits in order to aid in preventing the system from reaching a state at which the meter may be operating outside of the desired performance band.



**Fingerprint Parameters and Settings.** Allows the user to select relevant parameters to use for fingerprinting, set the acceptable range for these parameters, interval, and configure the ordinates of velocity, pressure, temperature, and SOS (Speed Of Sound) that will be fingerprinted against.



AGA /

sos

**Smart Alarm Configuration.** Gives the user the option to create a set of intelligent alarms that will specifically identify issues when combinations of alarms are active. Instead of detailed analysis, this gives the user the option to proactively set parameter condition sets that will immediately identify a potential issue in the flow line.

**AGA/SOS Settings.** Allows the user to setup the composition and the source for the temperature and pressure. This allows the system to compare a calculation of the SOS and compare it to the SOS read from the meter, and then give a percent deviation for analysis.



**Configuration via Modbus.** This feature gives the user access to directly modify the Modbus registers. This allows the user to make configuration changes via the Modbus registers instead of using the dialogs included in the program. This is not recommended, as an incorrect entry could cause a failure in the system. This feature is reserved for advanced users only.

### **Comm** Communication Settings

The Communication Settings (Figure 3.44) define the Ethernet and serial parameters for connecting to and communicating with the meter. These settings may be found in the Configuration Setting menu. To access these settings the user must log in as the administrator. The settings that appear upon login (or if the user presses *Refresh*) are the current settings stored in the meter.

Note The Ethernet settings should only be changed as authorized and directed by the site network administrator. This will ensure the this installation does not interfere with any present or future installations. The user should configure the DHCP, IP Address, Subnet Mask, and Default Gateway as per the specific direction of the network administrator.

	MD.		Caldon US	M Adviso	or -								×
File Main Config Dat	ta   [Test 14   S/N 11	014001]											-
	juration Setting	<u>]</u> 5	-										
									M	eter 📕	6/23/20	20 10:05:	09 AM
	m Units	АЛ	A/0	Pulse	Meter Limits	CBM Limits	Finge print	Alarm Config	AGA / SOS	Config			
					C	ommunica	tion						
	DHCP												
99	IP Address	192	168	1	14								
AGA/	Subnet Mask	255	255	255	0								
Def	ault Gateway	192	168	0	1								
	Baud	19200		¥	19200		× 1	9200	×				
	Databits	8		¥	8		~ 8		¥				
	Parity	Odd		~	Odd		~ C	ldd	*				
	Stop bits	1		۷	1		× 1		Ŷ				
	Slave ID	1			1		] [1						
							Read	from Meter	Write to	Meter		Cancel	
Ver 1.0.37A Welcome, Administrator	R.								Time	Out : 05:0	0 6/23/	2020 11:1	7:59 AM

Figure 3.44 - Communication Settings

After the Ethernet has been configured as per the direction of the network administrator, the serial ports should be configured as per the settings for the connected devices. If, at any point, the IP address or Slave ID used to connect to the software is changed then the meter connection settings in the Meter Explorer will need to be updated to match the new settings as well. See Managing Meters, page 4 to change the meter connection settings.



The Meter Units (Figure 3.45) can be used to define the incoming units for the connected flow meter. These will already be defaulted in the meter, so changing these should only be done in conjunction with the installation of the meter to match the meter's specifications.

			Caldon USM	M Advisor										×
File	Main Config	) Data												
Menu		FT-1014 [ Test 14   S/N 11014001 ]												
	· ? .	Configuration Settings												
L L										N	/leter 📕	6/23/20	20 10:05:0	09 AM
	$\geq$	Comm Units All	A/O	Pulse	Meter Limits	CBN	A ts	Finger print	Alarm Config	AGA / SOS	Config			
						Un	its							
	88					Flow	ft³/h							
-	-				Tot	alizer	ft³		_	*				
AGA /					Tempe	rature	'F			*				
303					Dre	cci ire	insi a			*				
						asure .	pars	,						
VVV	S.				Fluid Ve	locity	tt/s							
				5	peed of S	ound	ft/s			*				
					D	ensity	lb/ft	1		*				
	$\odot$													
-														
X	Ŧ													
							[	Read fro	m Meter	Write	to Meter		Cancel	
Ver 1.0.37A	Welcome, Adn	inistrator								Tim	e Out : 05:00	6/23/	2020 11:1	8:31 AM

Figure 3.45 - Meter Units

## Analog Input Settings

Configures the source and ranges for each of the incoming parameters. The user may choose to hard code the values from a downloaded calibration file, source the values from an analog input/RTD, or source from a Modbus register.



Figure 3.46 - Analog Input Settings

## A/O Analog Output Settings

The Analog Output Settings (Figure 3.47) configure the process variable being outputted and the boundary electrical outputs in relation to the boundary of the process variable output. After setting these and wiring up this output to the analog readout device it is important to go to the Force Output Menu (page 47) found in the Action Menu (page 45) in order to test and calibrate to the min and max outputs.



Figure 3.47 - Analog Output Settings

### Pulse Output Settings

The Pulse Output Settings (Figure 3.48) configure the pulse output parameters. Use the parameters of the pulse input readout device to set the output parameters of the meter. After setting these and wiring up this output to the pulse readout device it is important to go to the Force Output Menu (page 47) found in the Action Menu (page 45) in order to test and calibrate to the min and max outputs.



Figure 3.48 - Pulse Output Settings

Meter

Limits

## Meter Limits Settings

The Meter Limits (Figure 3.49) are hard limits that if exceeded may result in the connected meter or flow line not meeting defined specifications without causing an alert. Defaults are the standard meter limits. Once the meter has custody transfer approval, a hardware switch will be installed. This will prevent changes to the meter settings, as changes may void the custody transfer approval.



WARNING Changing these parameters may void custody transfer approval. Check the custody transfer guidelines before proceeding. Additionally, these limits should not be altered unless the currently configured limits do not conform with the meter specifications (i.e. if the limits cannot be read from the meter), or if the operator requires stricter limits than the default specifications.



Figure 3.49 - Meter Limits

#### **CBM** Limits **CBM** Limits Settings

The CBM (condition-based monitoring) Limits (Figure 3.50) are soft limits that if exceeded will cause warnings and may result in reduced efficiency of the meter. These limits are purposed to be set below the meter limits, preventing the system from reaching a state at which the meter may exceed defined specifications. Defaults are the standard CBM (condition-based monitoring) limits.

After configuring the CBM (condition-based monitoring) limits, the user may use Save to define the entered CBM (condition-based monitoring) limits for the selected meter, or the user may use Save to Default to define the entered CBM (condition-based monitoring) limits as a new set of default CBM (condition-based monitoring) limits for all meters.



Figure 3.50 - CBM Limits

Finger

print

## Fingerprint Settings

The Fingerprint Settings (Figure 3.51) will allow the user to select the fingerprint parameters and tolerances, standard deviation interval, and select and configure the ordinates for velocity, pressure, temperature, and/or SOS (Speed Of Sound) that will be fingerprinted.

For assistance in configuring these settings, contact Sensia at Technical Support Contact Information, page i. For steps to follow to configure these settings, see Configuring Fingerprint Settings, page 82.



Figure 3.51 - Fingerprint Parameters and Settings

## Alarm Config Smart Alarm Configuration

The Smart Alarm Configuration (Figure 3.52) is designed to reduce the amount of work that the user needs to do to interpret and process the information shown in the software. Where the fingerprinting allows the user to watch the performance of the flow line relative to the optimal conditions, the smart alarms help the user quickly and effortlessly determine the most likely cause of a drop in performance or identification of an issue with the flow.

During alarm creation (shown for "Gas Trapped" in Figure 3.53, page 42) the user will have the option to enter in the flow and path parameter values that characterize the condition that the alarm will identify. Once the smart alarms have been created in the software once, then they need not be created for any other meters using the Caldon USM Advisor. Instead of re-creating these alarms, the user may export all of the created alarms and then import them into new or existing meter configurations.

				Caldon USM Advisor					- 0	×
File	Main Confi	9								
Menu		MM2 [ FT-312   S/N	5951 ]							
	<b>P</b>	Configuration Se	ettings	n e s n'i						
								Meter	4/10/2020 12	:48:50 PM
	$\left \right>$	Comm	s A/I	A/O Pulse	Meter Limits Lin	BM Finger nits print	Alarm Config	AGA / SOS		
					Smart Alarm	Configuration				
	88	AddNew		Export	mport				Total	Record : 1
	9	Drag a column head	der and drop it	here to group by that co	lumn					
AGA /		Edit	Delete	Name				Description		
505		> Edit	Delete	Gas Trapped	(	Gas Trepped in top o	of Liquid Mete	er		-
Ŵ										
	Ø									
*										

Figure 3.52 - Smart Alarm Configuration List of Configured Alarms



Figure 3.53 - Smart Alarm Configuration (Creating "Gas Trapped" alarm)

#### AGA/ sos AGA and Speed of Sound (SOS) Settings

The AGA/SOS Settings (Figure 3.54) allow the user to setup the composition and the source for the temperature and pressure. This allows the system to compare a calculation of the SOS and compare it to the SOS read from the meter, and then give a percent deviation for analysis.



Figure 3.54 - AGA/SOS Settings

Config

## Configuration via Modbus

The Configuration via Modbus (Figure 3.55) gives the user access to directly modify the configuration Modbus registers. This allows the user to make configuration changes via the Modbus registers instead of using the dialogs included in the program. This is not recommended, as an incorrect entry could cause a failure in the system. This feature is reserved for advanced users only.

			l I	Caldon USM Adv	isor			=		×
File	Main Confi	ig D	ata							
Menu		FT-10	14 [ Test 14   S/N	11014001]						
	. 9.	Conf	figuration Set	tings						
L						Me	eter 📕   6/	23/2020	0 10:05:0	9 AM
		Cor	mm Units	A/I A/O Pul	se Meter CBM Finger Alarm	AGA / SOS	Config			
					Configuration					
	[ <u>&amp;</u> &	S	elect Path:							
		Drag	a column head	er and dron it here to group by th	at column					
AGA/		Ţ	Address T	Register <b>T</b>	Description T	Current T	Value	т Ту	ype T	-
SOS		1	0	NumberPaths	Number of acoustic paths configured in flowmet	4	4	U	JSHORT	
		2	2	FiringPulseWidth	Defines the period of the pulse - based on transc	2000	2000	U	JSHORT	_
$\sim VV$		3	4	NumberDrivePulses	Number of pulses sent.	2	2	U	JSHORT	
_	_	4	6	TriggerOffset	Defines which half cycle of the received signal is	1	1		SHORT	
	(( ))	5	8	NumberZCDsUsed	Defines the number of zero crossings to be used	1	1	L	JSHORT	
		6	10	OrderSelect	OrderSelect	1	1	L	JSHORT	
		7	12	GSSEnable	Enables/disables the global synchronization sign	0	0	L	JSHORT	
	0	8	14	ISSFiringInterval	Defines the GSS period.	6000	6000	U	JSHORT	-
_		9	16	PathValidDelay	Number of cycles spent in Pre-valid State	2	2	L	JSHORT	
5.4		10	18	AppCyclePeriod	Cycle for application (updating Modbus)	1	1	L	JSHORT	_
$\frown$	<b>—</b>	11	22	MedianFiltSize		3	3	L	JSHORT	
		12	28	AutoGain	Auto Gain Enable	1	1	L	JSHORT	v
					Load from File Save to File	Read fro	m Meter	Write	to Meter	r
Ver 1.0.37A	Welcome, Ad	ministrat	tor			Time	Out:05:00	6/23/20	020 11:22	:59 AM

Figure 3.55 - Configuration via Modbus



# Action Menu

The Action Menu (Figure 3.56) can be used for calibration, read/writing input/holding Modbus registers, commissioning a meter, or resetting settings. Since these are sensitive operations, the user must be logged in as the Administrator to access these features.



Cal

Cal

Reset

WARNING While logged into action mode, a change might influence the metrology aspects (e.g. CT approved systems). It is recommended that the user validate any proposed changes before making any changes in these menus.

	Caldon USM Advisor		- 🗆 ×
File Main Co Menu 💌 🖬	hg FT-101 [ STUK meter   S/N 123456780042 ]		
	Action Meter		
		Meter	19 Jul 2019 11:42:10 AM
	Zero Force Cal Cal Output Read/ Unput Output Reset		
AGA/ SOS	User Verification Form		
	Username Administrator Password Enter Password @		
	Confirm Cancel		
1			
<b>X</b> .			
Version 1.0.26 [15072019]	Welcome, Administrator	Login Time Out : 05:00	03 Sep 2019 08:57:23 AM

Figure 3.56 - Action Menu

Zero Configuration. Used to calibrate each path to be zero at a known static condition where there is no flow through each path.

**Force Output.** Used to force the analog and pulse outputs to send a specified signal in order to test the correct reading of those outputs, and for dry calibration of the analog inputs.

Analog Input Calibration. Used to calibrate each input individually during the commissioning process.

**Cal** Output **Analog Output Calibration.** Used to calibrate the meter analog outputs during the commissioning process.

Read/Write Modbus Register. Used to read or write to an input or holding Modbus register in the meter.

**Parameter Reset.** Used to set or reset parameters in the meter. This will be especially important when first commissioning a meter, or debugging a meter that is not operating as expected.

## Zero Configuration

The Zero Configuration (Figure 3.57) will show the current flow rate and delta over time, and then based on the values received from the meter, propose a new zero point for the meter. The band on the delta T graph turns green once the delta T values become low enough, and stable enough, to be considered a valid zero. The user may then use the flow rate graph to confirm if a stable zero flow has been achieved. This is useful during the initial configuration after the meter has been installed. By setting a zero flow point, the meter will show the actual flow during processes, because the perceived flow during a stop will be deprecated from the signal value received from each path. This is important because if the zero is not set, then there will be transient readings present in the data.

Aenu		FT-1015 [ Demo 15   S/N 11015001 ]		
		Action Meter		Meter 5/19/2020 11:43:17 AN
		Zero Force Cal Cal Cal Read P	teset	
-	-		Meter Zero	
	[. <u>8</u> %]	Flowrate	3000	Delta T
AGA/		633127.1 -	2500 -	
505		633127.1 -	2000 -	
M		633127 -	1500 -	
		633126.9 -	1000 -	
		633126.9 -	500 -	
7	$\bigcirc$	633126.8 12:42:47 12:43:36 12:44:25 12:45:14 12:46:03 12:44	0	12;45:14 12;46:03 12;46:52 12;47;47
-	-	Path 1 Path 2	Path 3 Path 4 Path 5 Path 6	Path 7 Path 8
$\times$	Ł	Proposed Zero         1,833.892         2,755.902         2           Stability         0.049         0.038	0.000         0.000         0.000         0.000           .753.936         1.833.892         1.833.876         2.753.936         2           0.052         0.049         0.038         0.052         0.052	2.753.920 1.833.876 0.048 0.038
				Accept
er 1.0.368	Welcome Adr	ninistrator		Time Out : 05:00 5/19/2020 12:49

Figure 3.57 - Zero Configuration Menu

# Force Output Force Analog and Pulse Outputs

After installation it is important to be able to test the outputs of the meter in order to electrically calibrate the analog and pulse readout devices. In order to assist with this calibration process, the software provides the Force Analog and Pulse Outputs screen (Figure 3.58) as an option to simulate current (mA) and frequency (in Hz) values electrically. The readout device can then be calibrated to these values, thereby removing any incremental offset that might exist due to an unknown impedance in the wiring.

For configuration of these outputs, refer to Analog Output Settings, page 36 and Pulse Output Settings, page 37.

				Caldon USM	Advisor			- 0	×
File	Main Confi	3							
Menu		MM2 [ FT-312   S/N 595	51]						
	<b>....</b>	Action Meter					<b>6 1</b>		
Ŀ							Meter	4/10/2020 1:00:2	8 PM
		Zero Force Output	Cal Input	Cal Output	Read/ Write Reset				
					Forci	ng Output			
	ያየም				Analo	og Output			
-	_	Analog Output 1	8	mA	Flow	507.49 m³/h			
AGA 7 SOS							Force Analog Output	Cancel	
		Analog Output 2	12	mA	Flow	1014.97 m³/h			
000	N/M						Force Analog Output	Cancel	
					Puls	e Output			
		Frequency	0	Hz	Flow :	0 m³/h			
	ि						Force Pulse Output	Cancel	
<u> </u>	$\sim$								
Ŕ									

Figure 3.58 - Force Analog and Pulse Outputs Menu

#### **Cal** Input Analog Input Calibration

After installation and wiring is completed, calibration of the RTD and analog inputs will be required. The Input Calibration screen (Figure 3.59) allows the user to see the minimum and maximum current and count values being received and set the device appropriately.

For configuration of the analog inputs, refer to Analog Input Settings, page 35.



Figure 3.59 - Analog Input Calibration Menu

## Cal Output Calibration

After installation and wiring is completed, verification of the calibration of the analog outputs may be required. The Output Calibration screen (Figure 3.60) allows the user to see the minimum and maximum current and count values being outputted and set the device appropriately.

For configuration of the analog inputs, refer to Analog Output Settings, page 36.



Figure 3.60 - Analog Output Configuration Menu

#### Read/ Write Modbus Registers

The Read & Write Modbus Registers screen (Figure 3.61) is useful for modifying input or holding Modbus registers in the meter. It is recommended that only advanced users utilize this feature and that this feature only be utilized in between processes, when the flow line is not operating.



WARNING Changing these values during a process could cause unexpected and potentially harmful results.



Figure 3.61 - Read & Write Modbus Registers Menu

## Reset Parameter Reset

The Parameter Reset screen (Figure 3.62) allows the user to sync the clock to the computer time, acknowledge the activated alarms, reset a connected totalizer to factory defaults, reinitialize the setting for the normalized velocity, toggling the demo mode in the software, and clearing the connected SD card to make room for more data.

WARNING There is a risk that if the totalizers are reset or the inserted SD card is erased, then traceability may be lost. Before executing these actions be sure that all of the data is backed up.



Figure 3.62 - Parameter Reset Menu

This page is left blank intentionally.

# Section 4 - Operation

The operational section of the manual will provide a detailed description of each of the operational views that will be accessed during operation of the meter. Each of these views are made up of an initial screen that gives the user a summary of the current status of the meter. If more in-depth information is needed, then each view will also give the user additional views to provide this insight.



## **Profile View**

The Profile View (Figure 4.1) contains detailed information on the flow characteristics within the pipe. The Profile View displays the hydraulic parameters (i.e. flow velocity, asymmetry, flatness, swirl, and plane balance) indicating the performance of the meter. The Profile view gives the user the option to view either live data for normalized axial and transverse velocity or historical data for the other hydraulic parameters. This menu allows the user to piece together a comprehensive picture of the profile of the flow through the meter. (For definition of terms, refer to the Glossary, page 95)

		Caldon USM Advisor		-		×
File	Main Confi					
Menu	▼ =₽	MM2 [FT-312   S/N 5951 ]				
		Profile View				
			Meter 📒	4/10/2020	12:15:4	0 PM
E		Profile View - Global [5 Days]		$\cap$	0	
		End : 4/10/2020 12:11 PM				
	<u>.</u>	Gain Flatness				
AGA / SOS		SOS Flatness				
$\sim$		Asymmetry				
		Flatness				
		Swirl				
		Plane Balance				
V	Ø	4/5/2020 12:00 PM 4/8/2020 12:00 AM		4/10/20	20 12:0	D PM
X		No Data Normal Warning Alarm				
		Live Q			2	*
Ver 1.0.340	Welcome, Adr	ninistrator	Time Out : 05:00	4/10/20	20 12:11	:54 PM

Figure 4.1 - Profile View



### **Global View**

The Global View (shown in Figure 4.1) gives the user the option to look at each of the individual hydraulic parameters over time to see where the meter may have gone outside of the CBM (condition-based monitoring) or Fingerprint limits (shown as Warning in yellow) or the meter limits (shown as Alarm in red), which will give an indication of the performance of the flow over time.



Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.



**End Date/Time** - use this to specify the end date and time for the span of days selected via the zoom option.



**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

## Live Live View

The Live View (Figure 4.2) shows the live display of the velocity profile, which gives the user a graphical representation of the normalized axial and transverse flow through the pipe. Together these can give the user an indication of the disturbance of the flow in the pipe.



Figure 4.2 - Live View



Fingerprint - hides the historical data and shows the fingerprint limits.



The Asymmetry vs Flatness View (Figure 4.3) is a boxplot of asymmetry versus flatness. This will show the current value (as a solid point), historic data (as hollow points), Meter Alarm Limits, and CBM (condition-based monitoring) Warning Limits. The boxpot will show the ratio of the flow velocity on the outside to the inside of the meter (on the x-axis) versus the ratio of the flow velocity on the top half to the bottom half of the meter (on the y-axis). Within defined bounds the health of the meter and the connected pipes are predictable. However, outside these bounds, the performance of the flow through the meter and connected pipe may be negatively affected.

(For definition of terms, refer to the Glossary, page 95)



Figure 4.3 - Asymmetry vs Flatness View

Fingerprint - hides the historical data and shows the fingerprint limits.

# Swirl vs Plane Balance View

The Swirl vs Plane Balance View (Figure 4.4) shows the boxplot view of swirl versus plane balance. This will show the current value, historic data Meter Alarm Limits and, if enabled, CBM (condition-based monitoring) Warning Limits. The boxplot of the ratio of angular momentum to axial momentum versus the ration of the left side to the right side gives the user information regarding dynamic pressure differentials within the pipe. Within defined bounds the longevity of the meter and the connected pipes are predictable, However, outside these bounds, the performance of the flow through the meter and connected pipe will be affected.

(For definition of terms, refer to the Glossary, page 95)



Figure 4.4 - Swirl vs Plane Balance View

Fingerprint - hides the historical data and shows the fingerprint limits.

# Deep Dive View

The Deep Dive View (Figure 4.5) provides detailed view of the parameters. While the previous active screen was flow profile view. The flow profile parameters that may be further analyzed by deep dive are: Gain Flatness, SOS Flatness, Asymmetry, Flatness, Swirl, and Plane Balance. Each parameter will be either displayed over time (for the selected period 1 day, 5 days, or 30 days) or versus the span of velocities in the selected time period (1 day, 5 days, or 30 days).

		Caldon USM Advisor	-		×
File Menu	Main Confic	) MM2 [FT-312   S/N 5951 ]			
		Profile View			
ш		Meter	4/10/2020	12:22:52	PM
		Swirl vs Time [5 Days]	$\land$	¢	9
	:88	End : 4/10/2020 12:19 PM III Prev. Next		Gain Flatnes	55
AGA / SOS		0.12		SOS Flatnes	55
M		000		$\cap$	
	(	-0.12 -			
	$\bigcirc$	-0.24		C	
8		transition in the second			
		$\blacksquare$ $\mathcal{V}$ $\bigcirc$ $\bigcirc$			
Ver 1.0.34D	Welcome, Adn	inistrator Time Out : 05:0	0 4/10/20	20 12:19:11	1 PM

Figure 4.5 - Deep Dive View



Time - displays the performance of the path(s) over time (as shown in Figure 4.5).



**Flow Velocity** - displays the performance of the path(s) over the range of flow velocities seen within the specified span of days.



Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

**End Date/Time** - use this to specify the end date and time for the span of days selected via the zoom option.



**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).



## Path View

The Path View displays the status and data for each path in the meter. If there is an inefficiency or an issue with one or more of the meter paths, this view allows the user to see which specific paths are exhibiting inefficiencies or alarms, and may give the user data specifying how far outside the bounds for a specific parameter this path(s) is operating and for how long the path(s) have been in an inefficient or alarm state. (For definition of terms, refer to the Glossary, page 95)



### **Global View**

The Global View (Figure 4.6) displays the historic status (CBM, condition-based monitoring, and fingerprint warnings shown in yellow and meter limit alarms shown in red). Hovering over a path will reveal the condition (Normal, Warning, or Alarm) and the date and time for the condition band.



Figure 4.6 - Path View



Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.



End : 4/14/2020 12:05 PM

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

## Live Global Live View

The Global Live View (Figure 4.7) shows the status of each parameter for each meter path. If there is a suspected issues, then this view will give a live feed of what parameter for that path(s) is not operating within the preconfigured meter limits (shown in red).



Figure 4.7 - Global Live View

# % Performance View

The Performance View (Figure 4.8) displays the historical performance percentage status (CBM, condition-based monitoring, and fingerprint warnings shown in yellow and meter limit alarms shown in red). Hovering over a path will reveal the condition (Normal, Warning, or Alarm) and the date and time for the condition band. In order to have a more detailed view of the data when diagnosing the cause of an inefficiency or alarm, the user may select the Deep Dive feature (shown on page 62).

(For definition of terms, refer to the Glossary, page 95)

		Caldon USM Advisor		-		×
File	Main Config	) NAU2 LET 212 LEAL 6051 1				
vienu		Path View				
G			Meter 📕	4/10/202	0 12:25:0	2 PM
		Path View - Performance [5 Days]	~~~~	(	وو	٥
	Eas	End : 4/10/2020 12:21 PM				_
	5380	Path 1				
AGA /		Path 2				
SOS		Path 3				
		Path 4				
$\mathbb{V}$	N/W	Path 5				
	(()))	Path 6				
Ŀ		Path 7				
1-1	തി	Path 8				
Ľ		4/5/2020 12:15 PM 4/8/2020 12:15 AM		4/10/	2020 12:1	5 PM
X		No Data Normal Warning Alarm				_
		Live Q			2	\$
er 1.0.340	Welcome, Adn	inistrator	ime Out : 05:00	4/10/2	020 12:21	27 PM

Figure 4.8 - Performance View



**Zoom -** use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.



**End Date/Time** - use this to specify the end date and time for the span of days selected via the zoom option.



**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

## Live **Performance Live View**

The Performance Live View (Figure 4.9) will give a live feed of the performance percentage for each the path with an overlap of the preconfigured limits (CBM, condition-based monitoring, warning limits shown in yellow and meter limits shown in red). If a path is not within the preconfigured boundaries, then additional information (if needed) is available in the Performance Deep Dive View, page 62.



Figure 4.9 - Performance Live View

# Performance Deep Dive View

The Performance Deep Dive View (Figure 4.10) gives the option to look more deeply at the performance of each path over a span of time or in relation to the fluid velocities seen over a span of days (1, 5, or 30 days) prior to the selected start date.

		Caldon USM Advisor		-	•	×
File	Main Confi	Data FT-SFRIALI SFRIALI S/N 1012022581111				
		Path View				
L			Meter 📕	5/7/2020	3:45:43	8 PM
	$\geq$	Performance vs Time [5 Days]	~~~ (		وه	5
	Eng	End : 5/7/2020 3:43 PM 🇱 Prev. Next All Paths *				
	1980	120.00				-
AGA /		100.00				
_		80.00 -				
$\mathcal{M}$		60.00 -				
		40.00				
		20.00 -				
	ന	0.00				-
( v			3.43 Pr			
8			Con-			
-	-				1	

Figure 4.10 - Performance Deep Dive



**Flow Velocity** - displays the performance of the path(s) over the range of flow velocities seen within the specified span of days.



4/14/2020 12:05 PM

Next

Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

**Time** - displays the performance of the path(s) over time.

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

All Up

**Path**(s) - is the selection of the path(s) displayed in the deep dive as well as the measurement of the path(s) either upstream or downstream.

Note: Selecting a specific path (instead of All Up or All Dn) will enable the warning and alarm limits for that specified path to be enabled. In this way the user may determine which paths, and direction(s) of those paths, are outside of the warning and alarm limits.



## Gain View

The Gain View (Figure 4.11) displays the status (CBM, or condition-based monitoring, and fingerprint warnings shown in yellow and meter limit alarms shown in red). Hovering over a path will reveal the condition (Normal, Warning, or Alarm) and the date and time for the condition band. In order to have a more detailed view of the data when diagnosing the cause of an inefficiency or alarm, the user may select the Deep Dive feature (shown on page 65).

(For definition of terms, refer to the Glossary, page 95)

81		Caldon USM Advisor		-		×
File	Main Config					
Menu	▼ -₽	MM2 [FT-312   S/N 5951 ]				_
		Path View				
Ŀ			Meter	4/10/202	0 12:25:3	3 PM
		Path View - Gain [5 Days]	~~~	$( \cdot )$	وو	٩
		End : 4/10/2020 12:21 PM 🇱 Prev. Next				
	E3820	Dath 1				_
AGA / SOS		Path 2				
_	_	Path 3				
hAA		Path 4				
000	20,55	Path 5				
	((^))	Path 6		B		
		Path 7				
0-0	തി	Path 8				
Ľ		4/5/2020 12:15 PM 4/8/2020 12:15 AM		4/10/	2020 12:1	5 PM
X		No Data Warning Warning Alarm				
		Live Q			2	*
Ver 1.0.34	D Welcome Adr	ninistrator	Time Out : 05:00	4/10/2	020 12:21	:49 PM

Figure 4.11 - Gain View



Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End : 4/14/2020 12:05 PM

Prev.

Next

**End Date/Time** - use this to specify the end date and time for the span of days selected via the zoom option.

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

## Live Gain Live View

The Gain Live View (Figure 4.12) will give a live feed of the gain for each the path with an overlap of the preconfigured limits (CBM, or condition-based monitoring, warning limits shown in yellow and meter limits shown in red). If a path is not within the preconfigured boundaries, then additional information (if needed) is available in the Gain Deep Dive View, page 65.



Figure 4.12 - Gain Live View

Fingerprint - hides the CBM (condition-based monitoring) and meter limits and shows the fingerprint limits.
# 🤄 Gain Deep Dive View

The Gain Deep Dive View (Figure 4.13) gives the option to look more deeply at the gain, gain split, and relative gain of each path over a span of time or in relation to the fluid velocities seen over a span of days (1, 5, or 30 days) prior to the selected start date.



Figure 4.13 - Gain Deep Dive



Time - displays the gain of the path(s) over time.



**Flow Velocity** - displays the gain of the path(s) over the range of flow velocities seen within the specified span of days.



Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End :	4/14/2020	12:05	PM	

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.



All Up

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

**Path**(s) - is the selection of the path(s) displayed in the deep dive as well as the measurement of the path(s) either upstream or downstream.

Note: Selecting a specific path (instead of All Up or All Dn) will enable the warning and alarm limits for that specified path to be enabled. In this way the user may determine which paths, and direction(s) of those paths, are outside of the warning and alarm limits.

#### Section 4

## Signal to Noise Ratio View

The Signal to Noise Ratio View (Figure 4.14) displays the status (CBM, or condition-based monitoring, and fingerprint warnings shown in yellow and meter limit alarms shown in red). Hovering over a path will reveal the condition (Normal, Warning, or Alarm) and the date and time for the condition band. In order to have a more detailed view of the data when diagnosing the cause of an inefficiency or alarm, the user may select the Deep Dive feature (shown on page 68).

(For definition of terms, refer to the Glossary, page 95)

		Caldon USM Advisor		-		×
File	Main Config					
Menu	•	MM2 [FT-312   S/N 5951 ]				_
		Path View				
ш			Meter 📒	4/10/2020	12:25:46	5 PM
	$\geq$	Path View - Signal to Noise Ratio [5 Days]		$(\cdot)$	وو	5
	E o o	End : 4/10/2020 12:22 PM 🇱 Prev. Next				
	F340	Path 1				
AGA /		Path 2				
SOS		Path 3 Path 3			- 1980	
M		Path 4				
	375	Path 5 Path 5				
R	(( ))	Path 6				
		Path 7				
	101	Path 8				
	$\sim$	4/5/2020 12:15 PM 4/8/2020 12:15 AM		4/10/2	020 12:15	5 PM
X		No Data Normal Warning Alarm				_
		Live Q Q			کنی	\$
Ver 1.0.34D	Welcome, Adn	ninistrator	Time Out : 05:0	0 4/10/20	20 12:22:	06 PM

Figure 4.14 - Signal to Noise View



**Zoom -** use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.



4/14/2020 12:05 PM

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

### Live Signal to Noise Live View

The Signal to Noise Ratio Live View (Figure 4.15) will give a live feed of the signal to noise ratio for each the path with an overlap of the preconfigured limits (CBM, or condition-based monitoring, warning limits shown in yellow and meter limits shown in red). If a path is not within the preconfigured boundaries, then additional information (if needed) is available in the Signal to Noise Ratio Deep Dive View, page 68.



Figure 4.15 - Signal to Noise Ratio Live View



Fingerprint - hides the CBM (condition-based monitoring) and meter limits and shows the fingerprint limits.

# Jer .

### Signal to Noise Ratio Deep Dive View

The Signal to Noise Deep Dive View (Figure 4.16) gives the option to look more deeply at the signal to noise ratio of each path over a span of time or in relation to the fluid velocities seen over a span of days (1, 5, or 30 days) prior to the selected start date.



Figure 4.16 - Signal to Noise Ratio Deep Dive



**Time** - displays the signal to noise ratio of the path(s) over time.

**Flow Velocity** - displays the signal to noise ratio of the path(s) over the range of flow velocities seen within the specified span of days.



4/14/2020 12:05 PM

Next

Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

All Up

Prev

**Path(s)** - is the selection of the path(s) displayed in the deep dive as well as the measurement of the path(s) either upstream or downstream.

Note: Selecting a specific path (instead of All Up or All Dn) will enable the warning and alarm limits for that specified path to be enabled. In this way the user may determine which paths, and direction(s) of those paths, are outside of the warning and alarm limits.

## Speed of Sound View

The Speed of Sound View (Figure 4.17) displays the status (CBM, or condition-based monitoring, and fingerprint warnings shown in yellow and meter limit alarms shown in red). Hovering over a path will reveal the condition (Normal, Warning, or Alarm) and the date and time for the condition band. In order to have a more detailed view of the data when diagnosing the cause of an inefficiency or alarm, the user may select the Deep Dive feature (shown on page 71).

(For definition of terms, refer to the Glossary, page 95)

		Caldon USM Advisor		-		×
File	Main Config					
Menu	▼ ₽	MM2 [FT-312   S/N 5951 ]				
		Path View				
Ŀ			Meter 🗾	4/10/2020	12:25:54	4 PM
		Path View - Speed Of Sound [5 Days]	***	$( \cdot )$	وو	<u>ه</u>
		End : 4/10/2020 12:22 PM				
	5382	Parts 1				_
AGA SOS		Path 2				
-	_	Path 3				
$h\Lambda\Lambda$		Path 4				
		Path 5				
	((^))	Path 6				
		Path 7				
	វិតា	Path 8				
		4/5/2020 12:15 PM 4/8/2020 12:15 AM		4/10/2	020 12:15	5 PM
X		No Data Normal Warning Alarm				_
		Live Q Q			2	\$
Var 1024	D Welcome Ada	anistratos 1	Time Out . 05:00	4/10/20	120 12.22	21 DM

Figure 4.17 - Speed of Sound View



Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

4/14/2020 12:05 PM

Prev.

Next

option.

Previous/Next - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

### Live Speed of Sound Live View

The Speed of Sound Live View (Figure 4.18) will give a live feed of the relative speed of sound in each the path with an overlap of the preconfigured limits (CBM, or condition-based monitoring) warning limits shown in yellow and meter limits shown in red). If a path is not within the preconfigured boundaries, then additional information (if needed) is available in the Speed of Sound Deep Dive View, page 71.



Figure 4.18 - Speed of Sound Live View

Fingerprint - hides the CBM (condition-based monitoring) and meter limits and shows the fingerprint limits.

# 🤄 Speed of Sound Deep Dive View

The Speed of Sound Deep Dive View (Figure 4.19) gives the option to look more deeply at the speed of sound of each path over a span of time or in relation to the fluid velocities seen over a span of days (1, 5, or 30 days) prior to the selected start date.

E I	Main Confi	Caldon USM Advisor		-	۰	×
Menu		FT-SERUAL [ S./N 101202258111 ]				
		Path View				2.01.1
-			Meter	5/7/20	20 5:50:1	3 PM
		Speed Of Sound vs Time [5 Days]	~~~ (	7)	وو	
	For	End : 5/7/2020 3:48 PM 🇱 Prev. Next All Paths				_
	Even	0.300 -				
AGA/		0.200				-1
-		0.100 -				
M		0.000			-	- 1
		-0.100 -				
		-0.200				_
1-0	ଲ	-0.300	2			
Ľ		the second second	3.46 Day			
1		d d d	56 ag			
-						
Ver 1.0.368	Welcome, Adr	ninistrator	Time Out : 05:00	5/7/	2020 3:48	57 PM

Figure 4.19 - Speed of Sound Deep Dive



Time - displays the speed of sound of the path(s) over time.



**Flow Velocity** - displays the speed of sound of the path(s) over the range of flow velocities seen within the specified span of days.



Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End :	4/14/2020	12:05	PM	8
-			_	

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.

Prev.	Next

All Up

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

**Path**(s) - is the selection of the path(s) displayed in the deep dive as well as the measurement of the path(s) either upstream or downstream.

Note: Selecting a specific path (instead of All Up or All Dn) will enable the warning and alarm limits for that specified path to be enabled. In this way the user may determine which paths, and direction(s) of those paths, are outside of the warning and alarm limits.

#### Section 4

## Turbulence View

The Turbulence View (Figure 4.20) displays the status (CBM, or condition-based monitoring, and fingerprint warnings shown in yellow and meter limit alarms shown in red). Hovering over a path will reveal the condition (Normal, Warning, or Alarm) and the date and time for the condition band. In order to have a more detailed view of the data when diagnosing the cause of an inefficiency or alarm, the user may select the Deep Dive feature (shown on page 74).

(For definition of terms, refer to the Glossary, page 95)

31		Caldon USM Advisor				×
File	Main Confic					
vlenu	▼ ₽	MM2 [ FT-312   S/N 5951 ]				_
		Path View				
Ē			Meter	4/10/202	0 12:26:4	1 PM
	$\geq$	Path View - Turbulence [5 Days]	**	$( \cdot )$	وو	3
	E.a.	End : 4/10/2020 12:22 PM 🗰 Prev. Next				
	5380	Path 1				
AGA		Path 2				
SOS		Dath 3				
$\sim 00$		Patri 4				
		Path 5				
	(())	Path 6				
		Path 7				
1	101	Path 8				
		4/5/2020 12:15 PM 4/8/2020 12:15 AM		4/10/2	2020 12:1	5 PM
X		No Data Normal Warning Alarm				
		Live Q Q			2	\$

Figure 4.20 - Turbulence View



**Zoom -** use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.



End : 4/14/2020 12:05 PM

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

#### Live Turbulence Live View

The Turbulence Live View (Figure 4.21) left graph will give a live feed of the turbulence in each the path with an overlap of the preconfigured limits (CBM, or condition-based monitoring, warning limits shown in yellow). The right graph is the chordal view and gives an average of the two coinciding chordal paths in the meter (i.e. Path 1 & 8, Path 2 & 7, Path 3 & 6, and Path 4 & 5). If one or more paths are not within the preconfigured boundaries, then additional information (if needed) is available in the Turbulence Deep Dive View, page 74.



Figure 4.21 - Turbulence Live View

Fingerprint - hides the CBM (condition-based monitoring) limits and shows the fingerprint limits.

## Turbulence Deep Dive View

The Turbulence Deep Dive View (Figure 4.22) gives the option to look more deeply at the turbulence of each path over a span of time or in relation to the fluid velocities seen over a span of days (1, 5, or 30 days) prior to the selected start date.



Figure 4.22 - Turbulence Deep Dive



Time - displays the turbulence of the path(s) over time.



**Flow Velocity** - displays the turbulence of the path(s) over the range of flow velocities seen within the specified span of days.

Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.



**End Date/Time** - use this to specify the end date and time for the span of days selected via the zoom option.

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

**Path**(s) - is the selection of the path(s) displayed in the deep dive as well as the measurement of the path(s) either upstream or downstream.



Note: Selecting a specific path (instead of All Up or All Dn) will enable the warning and alarm limits for that specified path to be enabled. In this way the user may determine which paths, and direction(s) of those paths, are outside of the warning and alarm limits.



#### **Trending View**

The Trending View (Figure 4.23) is a platform to enable the user to look at the relationships between parameters within a specified time span (1, 5, or 30 days) prior to the specified end date and time. By selecting specific pairings of parameters together, the user may be able to see patterns that show an undesired level of wear on the meter, inefficiency in the flow, or patterns that indicate impending failure. An example of this is the pressure versus fluid velocity. If the pressure is disproportionately increasing to the fluid velocity, then there may be an impending failure.

(For definition of terms, refer to the Glossary, page 95)

		Caldon USM Advisor	-		R.	×
File	Main Config	) Data				
Menu	-	FT-STUK [ Meter13   S/N 11013001 ]				
		Trending				
Ŀ		Meter	7/6/	2020 8:1	15:36	AM
		Trending [5 Days]				
		End : 7/6/2020 9:21 AM 🇱 Prev. Next Primary : Flow Rate 💌 Secondary : Temperature 🔻				
e		1600000 -		Ĩ	2000	)
	1 280	1400000 -				
AGA		1200000 -			1500	5
sos		1000000 -				ą
		200000 -		4	1000	peratu
NV		للَّــــــــــــــــــــــــــــــــــ	-	- 10		Tem
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E.		200000 -				
0-0	6	0		-	0	
Ľ	<b>U</b>	21 any 21 any 21 any				
50						
X		N N N N N				
Ver 10 27	Malaama Ada	initianan Time Out (DED	7	16/2020	0.22.0	0.444

Figure 4.23 - Trending View

Zoom - use to zoom into 1 day or zoom out to 30 days. Default display is 5 days.

End : 4/14/2020 12:05 PM

Next

End Date/Time - use this to specify the end date and time for the span of days selected via the zoom option.

**Previous/Next** - use to go to scroll to previous set of data or the next set of data (for the setting at 1, 5, or 30 days).

**Primary Variable** - selection of the variable expressed by the red plot. The range is shown on the left side of the graph.

**Secondary Variable** - selection of the variable expressed by the blue plot. The range is shown on the right side of the graph.

#### AGA/ SOS AGA10/SOS View

The AGA10/SOS View (Figure 4.24) compares the calculated value from the composition of the gas to the calculated value of the SOS (Speed Of Sound) through the mixture, and gives the percentage difference (CBM, or condition-based monitoring, and fingerprint warnings shown in yellow and meter limit alarms shown in red). The user may set warning and alarm limits in the configuration to indicate when the percent difference deviates beyond tolerable values (refer to AGA and Speed of Sound (SOS) Settings, page 43).

(For definition of terms, refer to the Glossary, page 95)

		Caldon USM Advisor		-		×
File	Main Confi	g Data				
Menu		FT-STUK [ Meter13   S/N 11013001 ]				
	<b>2</b>	AGA SOS % Discrepancy				
			Meter 📕	7/6/2020	8:15:36	5 AM
		AGA SOS Deviation [5 Days]				
$\equiv$	$\mathbf{Z}$	End : 7/6/2020 9:56 AM 🇱 Prev. Next				
		30.00				
	<u>.</u>	20.00				-
AGA / SOS		10.00			_	-
200		0.00 -				-
000		-10.00				-
F		-20.00				-
	গ্ৰি	-30.00				_
×		The second secon	13200.936 AN			
		<b>Q</b>				
Ver 1.0.37A	Welcome, Adr	ninistrator	Time Out : 05:00	7/6/20	20 9:57:	06 AM

Figure 4.24 - AGA10 View

### Download Historical Data (CBM Back Fill)

The CBM Back Fill (Figure 4.25) is used by the Caldon USM Advisor to provide continuity for a meter. The USM Advisor is developed to continuously monitor the data and Sensia also advises to do so but if this is not possible (remote location with no Ethernet) or a temporary communication failure (breakage in wiring) than your valuable data is stored inside the electronics of the meter. This data may then be read back at a later time when connection is re-established. This feature gives the user the option to bring in records (either in minutes, hours, or days).

The CBM Back Fill feature is useful when troubleshooting recurring issues or failures. The user may, in this case, use historical data dating back days, months, or even years in order to determine the causes of inefficiencies or failures, and the symptoms detected before an impending failure becomes unavoidable.

Note While the meter is connected, it is not necessary to collect historical data as the program automatically collects and stores the data.



Figure 4.25 - CBM Back Fill Download

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### Section 5 - Maintenance & Troubleshooting

Features are built into the Caldon USM Advisor software to give the user the information necessary to recognize when processes need to be undertaken to optimize the performance of the connected meter(s). Optimizing the meters and performing preventative maintenance are important for ensuring accuracy in the information output, and in preventing meter or flow line failures. Using the information provided by the meter (particularly the fingerprint comparison views) the user can create predictable maintenance schedules for each meter. The user may also analyze the meter health using this same information and historical data from the life cycle of previous meters.



### **Meter Diagnostics**

Meter Diagnostics (Figure 5.1) gives a live view of parameters related to turbulence, velocity, status, performance, gain, signal to noise ratio, and signal amplitude. The collection of these parameters aids the user in performing internal metering diagnostics for checking the structural integrity of the internal wall of the meter, determining efficiency of each path, or troubleshooting issues for one or more paths within the meter. A user may watch these parameters while running diagnostic tests in order to ensure that each path operates within the expected acceptable ranges.

If there are automated or "self-diagnostic routines" built into the meter, then the user may access the values in the Modbus registers though the Modbus map. To viewing these registers, go to Configuration via Modbus, page 44.

			Caldon	USM Advisor						- 🗆	×
File	Main Confi	ig									
Menu		MM2 [ FT-312   S/N 5951 ]									
	. 9 .	Meter Diagnostics									
								M	eter 📰   4/1	0/2020 12:36	28 PN
		Flatness	0.66	514 Flow Velo	city		0.0062 m/s F	low Rate		1.1	l m³/h
=		Asymmetry	1.04	80 Speed Of	Sound		1464.0 m/s N	Aeter Factor		1.00000	)
		Swirl	0.0	116			Т	emperature		18.3	°C
		Plane Balance	1.00	06			P	ressure		1.0	) bar g
	<u>888</u>	Parameter	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Unit
		TUp	151918.9	246823.8	246655.7	151589.5	152076.6	246775.2	246578.5	151450.2	ns
AGA /		TDown	151917.3	246823.3	246655.7	151590.4	152075.5	246773.7	246578.2	151454.0	ns
305		DeltaT	-0.1	1.5	-0.7	-1.2	0.9	2.9	1.2	4.6	ns
0.0		Turbulence	260.888	17.100	35.058	12.849	18.997	9.598	20.461	4.406	%
$\sim$ VV		SOS	1462.6	1463.7	1465.0	1464.1	1461.6	1463.3	1464.4	1467.6	m/s
	_	Velocity	-0.0006	0.0067	-0.0032	-0.0098	0.0073	0.0130	0.0052	0.0381	m/s
	(( ))	VNorm	0.7351	1.1133	1.0498	0.7020	0.7013	1.1095	1.0553	0.7241	
		Status	0	0	0	0	0	0	0	0	
		% Performance	100	100	100	100	100	100	100	100	%
Ī	(O)	Gain Up	39.8	44.6	46.0	36.5	36.4	44.4	45.0	36.8	dB
_		Gain Down	39.8	44.5	46.0	36.7	36.3	44.2	45.1	36.9	dB
5.4		SNR Up	967.0	670.0	576.0	1497.0	1472.0	337.0	583.0	842.0	
$\frown$		SNR Down	1068.0	655.0	561.0	1349.0	1363.0	330.0	599.0	875.0	
		SigAmpThrUp	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2490	
		SigAmpThrDn	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2500	0.2446	

Figure 5.1 - Meter Diagnostics

# M Waveform View

The Waveform (Figure 5.2) view gives the user a display of the ultra-sonic waveforms for each path going upstream and downstream that are coming off of the meter. This view will display both the waveform and the triggering point on the waveform for both the upstream and downstream signals, with the signal normalized to the triggering point on the waveform. In order to take a closer look at a waveform, the user may use the icon on the top right corner of any of the waveform windows to view an expanded window of that waveform.

The Waveform view is especially useful if there is reason to believe that there is a signal error in a particular path. The user may then compare the relative amplitudes, triggering points, and characteristics of the waveforms in that path. In particular, if the amplitudes are not within the acceptable limits for the signal frequency, or the triggering point on the up and down waveforms is mismatched, then there may be an issue with the transmitter. Additionally, by viewing the upstream and downstream signals side by side a user may determine if an ultrasonic module is damaged, if a path is obstructed, or if there is a flow anomaly. A flow anomaly (which may indicate the uniformity of the flow is changing unexpectedly, identified by large spikes in interference) is useful to identify as it may help identify a variety of issues that include, but not limited to, high turbulence or pressure differentials within the pipe, or even fracturing upstream in the flow line.



Figure 5.2 - Waveform view

## Fingerprint View

The Fingerprint View (Figure 5.3) is used to capture fingerprints, particularly early in the life of a meter., Each fingerprint is meant to be a collection of reference points over a range of conditions. These collections of fingerprints can then compared to data retrieved as the meter ages to give an indication of the flow line and meter performance over time. As in most CBM (condition-based monitoring) systems, the checks that users are generally concerned about are:

- **Functional Checks.** Determines degradation in the ultrasonic meter functionality since the initial data logging began.
- **Process Condition Checks.** The diagnostic data collected demonstrating that the transfer of the meter calibration is valid. This information is used to detect evidence of blockage, contamination or wall roughness changes over the life of the meter.
- Measurement Integrity Checks. Compares the ultrasonic meter-calculated speed of sound (SOS) against the value according to the calculated AGA 10 standard based on external measurement of pressure, temperature and gas composition within acceptable tolerances. This can give an indication of accumulating build up of contaminants on the sensor transducers.

The fingerprint data captured in this view aids in performing these checks with a high level of accuracy. These checks are accomplished through the comparison of the performance in these fingerprint conditions to real-time and historic data. This high level of accuracy, compared to other systems, stems from comparing incoming data to the optimal performance of the installed meter's data in the actual flow line, as opposed to a generalized mathematical model.

In this view, the user selects the time periods that they wish to bring in data in from, and then they may create a fingerprint out of that data. This may be done for one or multiple time periods. The value shown in the "New" column is the number of records in which all of the fingerprint conditions are met.

- To set up the fingerprint settings, refer to Configuring Fingerprint Settings, page 82. The fingerprint data that is captured can be configured to include: velocity, pressure, temperature, and/or SOS (Speed Of Sound).
- To create a fingerprint, refer to Creating a Fingerprint, page 85.



Figure 5.3 - Fingerprint view

#### **Configuring Fingerprint Settings**

1. Go to the Configuration Settings tab: 🔘

The Configuration Settings login (Figure 5.4) will appear. Sign in as either an Engineer profile or as the Administrator. If this is the first time, the Administrator password will be **Admin**. If not done already, it is important to change the administrator password on the program so as to protect the entered information and configuration settings, and to prevent unauthorized usage of the program.



Figure 5.4 - Configuration Setting Login

2. Once logged in, go to the Fingerprint Settings (Figure 5.5).

		Caldon US	d Advisor				- 🗆	×
	Main Confi	9						
Menu	▼ ⊨	FT-101 [ STUK meter   S/N 123456780042 ]						
		Configuration Settings						
<b>[</b> .]						Meter	19 Jul 2019 11:4	2:10 AM
_								
		Comm Units A/I A/O Pu	lse Limits	CBM Limits	Finger AGA / print SOS	Config		
_			Fing	gerprint Toleranc	es			
	8	Parameter	Low	High	Active			
		Asymmetry	0.01	0.01				
		Flatness	0.05	0.05				
AGA / SOS		Swirl	0.05	0.05				
		Plane Balance	0.01	0.01				
		Relative Gain	0.05	0.05				
$\gamma \gamma \gamma$		Gain Split	0.05	0.05				
_	_	Gain Flatness	0.05	0.05				
		Signal to Nosie Ratio	25	25				
Ŀ		SOS Deviation (%)	0.05	0.05				
_		SUS Fid(riess	0.05	0.05				
	ित		0.02	0.02				- 1
Ŀ				Ordinates				
		Velocity 6 - Enable Pressure	3 🔻 🗆 En	able Tempera	ture 3 🔹 🗆 E	nable SOS	3 🔻 🗌 Enab	e
X				Bins Setup				
		1st Ordinate 2nd	Ordinate		3rd Ordinate	4t	h Ordinate	
		Velocity						
		0						•
Version 1.0	0.26 [15072019]	Welcome, Administrator				Login Time Out : 0	5:00   30 Aug 2019 03	:54:50 PM

Figure 5.5 - Fingerprint Settings

- 3. Define the settings that define what qualifies as an acceptable fingerprint. These can be as specific or as general as is necessary for the process and the meter being used. It is important to note that the information gathered will be useful in determining the need for recalibration, degradation of the meter, and visible patterns in the beginning of the meter's life. Here are some useful notes for configuring each parameter and setting its tolerances:
  - Asymmetry. The bulk average velocity of the top half of the meter over that of the bottom half of the meter.
  - Flatness. The ratio of the velocity of the outside measurement paths over the inside measurement paths.
  - Swirl. The ratio of angular momentum to axial momentum.
  - Plane Balance. The ratio of the velocity between the left plane versus the right plane.
  - Relative Gain. The gain of one path in relation to the median gain of all of the paths together.
  - Gain Split. The gain of one path in relation to the gain of the entry path.
  - Gain Flatness. The measurement of the gain variation over the flow velocity.
  - Signal to Noise Ratio. The ratio of the strength of the ultrasonic signal to that of noise interference (i.e. vibration in the pipe), expressed in decibels.
  - SOS Deviation (%). The ratio of the measured SOS versus the calculated SOS.
  - SOS Flatness. The SOS of the outside measurement paths versus the inside measurement paths.
  - Turbulence (%). The calculation of the affect of internal friction versus ratio of the flow.

4. Choose which ordinates (velocity, pressure, temperature, or SOS) to fingerprint to, select number of ranges for each of the selected ordinates (up to 6), and the fill in the ranges (as shown in Figure 5.6).

			Caldon USM Advisor		- 🗆 ×
File Menu	Main Confi	9 FT-101 [ STUK meter   S/N 12345678	1042 ]		
		Configuration Settings			
<b>L</b>				Meter 1	.9 Jul 2019 11:42:10 AM
		Comm Units A/I	A/O Pulse Meter CBM Finge print	r AGA / Config	
		Turbulence (%)	0.02 0.02		A
	<u>~</u> &&		Ordinates		
		Velocity 6 🗸 🗹 Enabl	Pressure 3 - Enable Temperature	3 🔹 🗆 Enable SOS	3 🔹 🗌 Enable
AGA /			Bins Setup		
303		1st Ordinate	2nd Ordinate 3rd Or	rdinate 4th Ordi	nate
		Velocity	]		
VVV	M.	0			
		20			
	( <u>(</u> ))	40			
_		50			
	101	70			
Ŀ		85			
		100			
X			Standard Deviations		
		Interval 3			
				Save	Cancel
Version 1.0.2	26 [15072019]	Welcome, Administrator		Login Time Out : 05:00	11 Sep 2019 10:18:10 AM

Figure 5.6 - Fingerprint Setting cont'd

5. Finally choose the standard deviation interval (see Figure 5.6), and click *Save* to store the fingerprint settings. These fingerprint settings will now be used to filter acceptable fingerprint data when a fingerprint is created in the Finger-print View.

#### Creating a Fingerprint

1. In a selected meter, click on the Fingerprint button to go to the Fingerprint View (Figure 5.7).

				Caldon USM Advisor							
File	Main	Confi	g								
Menu			FT-101 [ STUK met	er   S/N 12345678004	42]						
	. 9		Fingerprint								
									Meter	19 Jul 2019 11:42:10 AM	
E		>	Start : 8/29/201	9 12:00 AM 🏭 En	d : 8/30/201	9 12:00 AM 🚻	Search	1		Total Record : 0	
	8	₽ -									
AGA / SOS			- Selection N/A	to N/	A	Add Data		Clear Da	ita		
			Velocity	Current (n)	New (n)	Append/Replace					
$\sim$ V v			0 - 20	0		Ignore					
			20 - 40	0		Ignore					
	()	))	40 - 50	0		Ignore					
			50 - 70	0		Ignore					
			70 - 85	0		Ignore					
Ū.	0	3	85 - 100	0		Ignore					
8											
									Create	Cancel	
Version 1.0	.26 [150720	19]	Welcome, Administr	ator					Login Time Out : (	05:00   29 Aug 2019 01:00:17 PM	

Figure 5.7 - Fingerprint View

2. Using the Start and End, select a period of time (date and time) to view. When the period of time has been selected, click *Search* to view the data. Use the sliders seen on either side of the screen to narrow the area of interest.

				Caldon USM	Advisor			–
File	Main Confi	g						
Menu	¥ =	FT-101 [ STUK mete	er   S/N 11013001 ]					
		Fingerprint						
							Meter	E   22 Jul 2019 10:22:53 AM
		Start : 7/21/201	9 12:00 AM 📗 En	d : 7/23/2019	12:00 AM 🗰	earch		Total Record : 893
$\equiv$		Monda	y, July 22, 2019					
	_	100						
	6.88							
AGA /		0						
SOS		Selection 7/22/20	19 12:00 AM to 7/2	22/2019 4:20 PM	Add Data	Clear	Data	
		Velocity	Current (n)	New (n)	Append/Replace			
$\sim 0.0$		0 - 20			Ignore			
	=	20 - 40	0		Ignore			
	(( ))	40 - 50			Ignore			
		50 - 70	0		Ignore			
		70 - 85	0		Ignore			
$\checkmark$	(Q)	85 - 100	0		Ignore			
X								
						[	Create	Cancel
Version 1.0	.26 [15072019]	Welcome, Administra	ator				Login Time Out	: 05:00 22 Jul 2019 04:20:51 PM

Figure 5.8 - Displayed Data in Time Period

3. Once the data has been selected with the window, click *Add Data* (Figure 5.9).

				Caldon USM	Advisor				- 6	×
File Main	Confi	g								
Menu	VB	FT-101 [ STUK mete	r   S/N 11013001 ]							
	φ.	Fingerprint								
								Meter 📰   2	2 Jul 2019 10:	23:00 AM
		Start : 7/21/201	9 12:00 AM 🗰 En	d : 7/23/2019	12:00 AM 🗰 Se	arch			Total Rec	ord : 2333
	2	100 Sunday	, July 21, 2019				Monday, July 22,	2019		
		100								
	<u></u> ዲጼ									
	_	N								1
AGA /		0								
505		Selection 7/21/20	19 12:00 AM to 7/2	22/2019 4:20 PM	Add Data 💦	C	lear Data			
	6	Velocity	Current (n)	New (n)	Append/Replace					
$\sim 00$		0 - 20			Ignore					
_		20 - 40			Ignore					
	())	40 - 50			Ignore					
	-	50 - 70			Ignore					
		70 - 85			Ignore					
	61	85 - 100	0		Ignore					
-										
5	1									
		L					Creat	e	Cancel	_
Version 1.0.26 (65)	10100	Websers Adapt to					1		22.141.2010	24-21-02-01

Figure 5.9 - Add Selected Data

4. The added data will now appear in the pending fingerprint (Figure 5.10). Inspect the added data, and determine if it is the optimal capture for the parameters selected in the fingerprint settings. To remove this data, click *Clear Data*, and repeat steps 2 & 3.

				Caldon USM 4	Advisor					-		×
File I	Main Confi	9										
Menu	▼ +Þ	FT-101 [ STUK mete	r   S/N 11013001 ]									
	9	Fingerprint										
<b>L</b>									Meter 📕	22 Jul 2	019 10:23:	:30 AM
		Start : 7/21/201	9 12:00 AM 🎹 En	d: 7/23/2019	12:00 AM	Search				Т	otal Record	d : 2333
	ک	100 Sunday	Sunday, July 21, 2019 Monday, July 22, 2019									
	58%											
	_											1
AGA /		0					r		1			
303		Selection 7/21/20	9 12:00 AN to 7/2	22/2019 4:20 PM	Add Da	ta	Cle	ar Data				
0.0.0		Velocity	Current (n)	New (n)	Append/Replace	•						
$\sim$ VV	1. All	0 - 20			Ignore							
	_	20 - 40			Ignore							
	(( ))	40 - 50			Ignore							
		50 - 70	0	0	Ignore							
		70 - 85	0	2333	Append							
	101	85 - 100		Ű	Ignore							
	_											
5%												
	-											
								Cre	ate		Cancel	=
Version 1.0.26	5 [15072010]	Welcome Administra	tor					Loair	Time Out - 05	00 22 1	1 2019 044	21-30 PM

Figure 5.10 - Data Added to Fingerprint

5. When the data has been confirmed to be sufficient to capture, click *Create*, and the dialog will appear to for creating a fingerprint (Figure 5.11). Label the fingerprint, and then press *OK* to finish creating the fingerprint.

		Caldon USM Advisor			– = ×
File Main Co	onfig				
Menu 🔽	FT-101 [ STUK meter   S/N 110130	01]			
	Fingerprint				
		24		Meter 2	2 Jul 2019 10:24:05 AM
00	Start : 7/21/2019 12:00 AM	End : 7/23/2019 12:00 AM	A 🔛 Search		Total Record : 2333
	Sunday, July 21, 2019			Monday, July 22, 2019	
					1
AGA /	0 P	rompt	×		
	Selection 7/21/2019 12:00 AM	Telerik.Windows.	Controls.DialogParameters	Clear Data	
	Velocity Current				
	0 - 20		OK Cancel	1	
	20 - 40	Ignore			
	40 - 50	0 Ignore	<u></u>		
	50 - 70	Ignore	*		
<b>(</b> )	70 - 85	2333 Appen	d		
	85 - 100	Ignore	3		
XĿ					
				Create 5	Cancel
Version 1.0.26 [15072019]	Welcome, Administrator			Login Time Out : 05:00	22 Jul 2019 04:22:01 PM

Figure 5.11 - Create Fingerprint from Selected Data



### Alarm View

Alarm View (Figure 5.12) is a set of the historic alarms that have occurred over a defined time period, made up of a list of the instances when the meter limits or CBM (condition-based monitoring) limits have been exceeded. The CBM (condition-based monitoring) limits being exceeded will usually indicate that the flow line is not operating at optimal efficiency or that the flow line may be experiencing increased wear. These limits being exceeded may result in the power consumption increasing, which could inflate the production cost.

The meter limits are set (usually by parameters provided by the meter) to indicate when the flow is operating outside of defined specifications, which could result in a risk of failure if exceeded for an extended length of time. For some meter limits, there may need for emergency protocols in place to ensure that the flow line does not leak or burst, causing injury to personnel or environmental damage. Exceeding the meter limits may also result in health and safety hazards. Excessive vibration has been closely related to increased noise during production, and therefore increased impact on the health of the staff in charge. Prevalence of conditions such as retinal detachment and hearing loss induced by noise can be reduced by addressing the conditions causing the meter limits to be exceeded. Implementing good predictive maintenance actions will not only reduce the environmental impact by avoiding all these wastes but will also have a much lower productive cost.

8			Caldon	USM Advisor	e.					×
File	Main Confi	9								
Menu	I 🗾	FT-1234 [ Den	no Meter   S/N 101202258001 ]							
		Alarm								
								Meter 📕   4/7/2	2020 3:56:22	2 PM
		Start : 4/	7/2020 12:00 AM 🎹 End :	4/8/2020	12:00 AM 🎹	Search		Acknowledge All	Total Record	: 81
		Drag a colum	nn header and drop it here to gr	oup by that o	column					
		ACK	T Alarm Name T	Source T	Status T	Acknowledged T	Action Time T	Normal Time 🛛 🕇	Ack Time	7
	<u>የ</u> የ	ACK	Path Gain Split Chg: Path 6	Meter	Active		2/12/2020 11:46:00 AM			
-	_	ACK	Path Gain Split Chg: Path 1	Meter	Active		2/12/2020 11:46:00 AM			
AGA /		ACK	Path Gain Split Chg: Path 2	Meter	Active	8	2/12/2020 11:46:00 AM			
505		ACK	Path Gain Split Chg: Path 3	Meter	Active		2/12/2020 11:46:00 AM			
		ACK	Path Gain Split Chg: Path 4	Meter	Active		2/12/2020 11:46:00 AM			
MN		ACK	Path Gain Split Chg: Path 5	Meter	Active		2/12/2020 11:46:00 AM			
		ACK	Meter State Chg: Path Faile	Meter	Active	0	2/3/2020 1:29:00 PM			-
		ACK	Meter State Chg: Sos Alarm	Meter	Active	0	2/3/2020 1:29:00 PM			
1		ACK	Path Gain Split Chg: Path 4	Meter.	Inactive		2/12/2020 11:46:00 AM	2/12/2020 11:47:00 AM	л .	
_		ACK	Path Gain Split Chg: Path 5	Meter	Inactive	(1)	2/12/2020 11:46:00 AM	2/12/2020 11:47:00 AM	и	
	$\hat{\mathbf{O}}$	ACK	Path Gain Split Chg: Path 6	Meter	Inactive	0	2/12/2020 11:46:00 AM	2/12/2020 11:47:00 AM	n	
		ACK	Meter State Chg: Path Faile	Meter	Inactive	(i)	2/12/2020 11:46:00 AM	2/12/2020 11:47:00 AM	A	
50		ACK	Meter State Chg: Sos Alarm	Meter	Inactive		2/3/2020 1:29:00 PM	2/3/2020 1:31:00 PM		
X		ACK	Path Gain Split Chg: Path 1	Meter	Inactive		2/12/2020 11:46:00 AM	2/12/2020 11:47:00 AM	А	
		4 ACX	Path Gain Solit Cho: Path 2	Meter	Inactive	m	2/12/2020 11-46-00 AM	2/12/2020 11-47-00 41	el.	• •
		нч	н						Page 1	of 3
Ver 1.0.34C	Welcome, Adr	ministrator						Time Out : 05:00 4	/7/2020 4:55	53 PM

Figure 5.12 - Alarms View

To sort the alarms by category or type, left click on the Alarm Name.

			Caldon USM Advisor				– 🗆 ×		
File	Main Config	9							
Menu		MM2 [ FT-312   5	5/N 5951 ]						
	· 9 ·	Alarm					1.		
<b>L</b>						Meter 📒 4	4/10/2020 12:48:50 PM		
		Start : 4/10	/2020 12:00 AM 🗰 End : 4/11/2020 1	12:00 AM 🗰 Search		Acknowledge Al	Total Record : 136		
	ک	Drag a column	Drag a column header and drop it here to group by that column						
		ACK T	Alarm Name	Source T Status T A	cknowledged <b>T</b>	Action Time <b>Y</b>	Normal Time		
	582	ACK	Path Vot Chg: Path 4	Select All	×	4/8/2020 12:10:00 PM			
		ACK	Path Vot Chg: Path 5	Meter State Chg: Asymmet	tr 📥	4/8/2020 12:13:00 PM			
AGA /		ACK	Meter State Chg: Asymmetry Ration	Meter State Chg: Fluid Der	15	4/9/2020 7:23:00 AM			
303		ACK	Path Valid Chg: Path 4	Meter State Chg: Fluid Visi		4/8/2020 12:03:00 PM	4/9/2020 4:16:00 A!		
0.00		ACK	Meter State Chg: Fluid Density Out Of Ran	Meter State Chg: Sos Alarr	n	4/8/2020 12:46:00 PM	4/9/2020 4:16:00 At		
$\sim VV$	S.	ACK	Meter State Chg: Fluid Viscosity Out Of Ra	Path Valid Chg: Path 1	-	4/8/2020 12:46:00 PM	4/9/2020 4:16:00 At		
_	_	ACK	Path Vot Chg: Path 2	Path Valid Chg: Path 2		4/8/2020 12:13:00 PM	4/9/2020 4:24:00 At		
E	(( ))	ACK	Path Vot Chg: Path 3	Path Valid Chg: Path 3		4/8/2020 12:13:00 PM	4/9/2020 4:24:00 At		
		ACK	Path Vot Chg: Path 4	Path Valid Chg: Path 4		4/8/2020 12:16:00 PM	4/9/2020 4:24:00 At		
		ACK	Path Vot Chg: Path 6	•	×	4/8/2020 12:11:00 PM	4/9/2020 4:24:00 At		
Ū,	<b>[0]</b>	ACK	Path Vot Chg: Path 1	Show rows with value that		4/9/2020 4:22:00 AM	4/9/2020 4:41:00 Al		
_	_	ACK	Path Vot Chg: Path 5	Is equal to	*	4/8/2020 12:13:00 PM	4/9/2020 4:41:00 At		
5.4		ACK	Meter State Chg: Sos Alarm		аA	4/8/2020 12:06:00 PM	4/9/2020 4:42:00 At		
$\frown$		ACK	Path Vot Chg: Path 6	And	*	4/8/2020 12:16:00 PM	4/8/2020 12:14:00 P		
		4		is equal to	¥		¥		
		н н н	н		aA		Page 1 of 5		
Ver 1.0.34D	Welcome, Adr	ministrator		Filter Clear Filt	er	Time Out : 05:00	4/10/2020 12:46:09 PM		

Figure 5.13 - Alarms View (Source tab)

## Event View

Event View (Figure 5.14) is a set of historic events that have occurred during the operation of the meter, and can be viewed over a defined period of time. These events contain user logins, configurations and calibrations, fingerprint generation, changes in settings, actions performed using the actions menu, report generation, or data download. This view acts as a running log for all events for easy traceability, acting as an audit trail of user actions. Simply choose a time period to view all the events that have occurred in that period. For generating an Event Report for a specific time period may be created (refer to Events Report, page 93).

			Caldon USM Advi	isor		- · • ×
Henu	Main Cont	9 FT-1234 [ Demo Meter   5/N	101202258001 ]			
	. 9 .	Events				
L						Meter 📕   4/7/2020 4:02:27 PM
		Start : 4/7/2020 12:00	AM 🇱 End :	4/8/202	0 12:00 AM 🗰 Search	Total Record : 1
	2_	Drag a column header and	drop it here to group by the	at colum	n	
		Date Time	Type	Ŧ	Name	r Descriptions T
	38	4/7/2020 4:04:09 PM	USM Advisor		System Login - Settings Page	Administrator logged in as Admin
-	0	4/7/2020 3:23:01 PM	USM Advisor		System Login	Added new user: Administrator
AGA /		4/7/2020 3:22:14 PM	USM Advisor		System Login	Added new user: Administrator
SOS		4/7/2020 3:20:59 PM	USM Advisor		System Login	Added new user: Administrator
		4/7/2020 2:30:48 PM	USM Advisor		System Login	Administrator logged in as Admin
$\sim 10$		4/7/2020 8:26:09 AM	USM Advisor		System Login - Settings Page	Administrator logged in as Admin
	- AN	4/7/2020 7:53:14 AM	USM Advisor		System Login - Settings Page	Administrator logged in as Admin
	11 ( )	4/7/2020 7:51:35 AM	USM Advisor		System Login - Settings Page	Administrator logged in as Admin
		4/7/2020 6:42:12 AM	USM Advisor		System Login - Settings Page	Administrator logged in as Admin
	-	4/7/2020 6:41:07 AM	USM Advisor		System Login - Settings Page	Administrator logged in as Admin
19 A	101	4/7/2020 6:40:10 AM	USM Advisor		System Login	Administrator logged in as Admin

Figure 5.14 - Events View



#### Reports

In Reports (Figure 5.15) the user may create a number of reports from the historical data that has been collected. Each report has been designed to give a unique insight into a meter's operation and can be used either as a historical record or as a diagnostic tool. These reports can be used for predictive analysis, as well as for verifying that the meter was being operated within the desired specifications.

		Caldon USM Advisor		-		×
File	Main (	onfig				
Menu		FT-1234 [ Meter13   S/N 11013001 ]				
	2	Reports				
Ŀ		/	Meter	5/5/202	0 11:07:2	2 AM
		Report Period : O Daily O Monthly O Snapshot O Data Log				
		Start : 5/5/2020 6:00 AM III End : 5/6/2020 6:00 AM III				
	E F R R	Include Report Cover				
	= <u>138</u>	O Verification Snapshot				
		O Waveforms				
AGA / SOS		O Fingerprint				
_		O Configuration				
$\mathcal{M}$						
*						
		Generate Report				
Ver 1.0.36	A Welcome	Administrator	Time Out : 05:00	5/5/2	020 12:07	7:46 PM

Figure 5.15 - Reports

#### Snapshot Reports

During the operation of the flow line it will be important to capture the performance of each individual meter at different points in time, since it may not always be possible to do a deep analysis into each meter individually, unless there is a warning or an error. It is therefore necessary to generate reports that give a basic summary of the performance for a specified time period from the historical meter data. For this purpose the Caldon USM Advisor provides the option to create a variety of snapshot reports.

#### Verification Snapshot Report

The Verification Snapshot Report will give an easy to read summary to verify the flow line is operating within minimal acceptable boundaries over the specified period of time. The verification report includes:

- Configuration audit
- Summary of hydraulic conditions
- Minute average log
- Graphical charts for:
  - Turbulence
  - Signal to noise ratio
  - Gain
  - Hydraulic (normalized axial and transverse flow velocity)
  - Asymmetry vs flatness
  - Swirl vs plane balance.

#### Waveform Snapshot Report

The Waveform Snapshot Report will show each upstream and downstream waveform for each path, normalized to the peak seen after the set trigger point. If there is an observed difference between the upstream and the downstream waveforms, then this report is a useful document to send to a technician that will be tasked with investigating and/or recalibrating the ultrasonic meter on site.

#### Fingerprint Snapshot Report

The Fingerprint Snapshot Report allows the user to report on the fingerprint limits set on a particular day for auditing purposes. The user must begin by selecting the fingerprint to report on from the drop down list. It is recommended that the user do this regularly after fingerprinting in order to verify that the fingerprint limits, and make adjustments as necessary for the optimal performance of the meter and connected flow line.

#### Calibration Snapshot Report

The Calibration Snapshot Report will create a table showing each Modbus register used for calibration and the value stored in that register for the day selected. In order to provide clarity, the data type, Modbus address, and a description are also provided. After creating this report it is recommended that the user compare the values to previous reports, and noted changes, to validate that the configuration settings are accurate.

#### Daily and Monthly Reports

In order to have organized records over the life of a meter, and to give periodic updates, the user may wish to generate reports for a selected day or month. In order to provide optimal flexibility for the type of reporting desired, the software provides six different report types: verification, historic status, hydraulic parameters, path diagnostics, alarms, and event reports.

#### Verification Report

The Verification Summary Report gives the user a daily or monthly summary of the meter performance on the key metrics used in the program. With this information, the user may quickly verify that the meter is operating as expected. In the event that the report indicates that there is a potential issue that requires a more indepth investigation, then the report will give the user a starting point to begin the investigation, and quickly identify and fix the issue(s).

#### Historic Status Time Range Report

The Historic Status Time Range report will give a one page summary of the status of the parameters over the specified time period (one day or one month). These reports may be useful if what is needed is simply visual confirmation of the proper operation of the flow line.

#### Hydraulic Parameters Report

The Hydraulic Parameters Report gives a summary of the hydraulic parameters (i.e. using flow velocity, asymmetry, flatness, swirl, and plane balance). The report will show the number of points collected over the time period and plot them for each graph, superimposing the CBM (condition-based monitoring) limits and meter limits that had been previously configured. This report will give a quick look at the characteristics of the flow vs the acceptable limits.

#### Path Diagnostics Report

The Path Diagnostic Report gives a summary of the flow performance, gain, signal to noise, speed of sound, and turbulence for the flow line and for the upstream and downstream for each path over the specified period of time. If there is an issue that is being seen in a specific path, the user can generate this report in order to further diagnose or to create a record of the issue/issues being observed over the specified time period.

#### Alarms Report

The Alarm Report creates a list of all the alarms that have been generated over the specified time period. Through this list, a user can identify which alarms have been activated under specific processes. The detailed information that the Alarm Report gives may help users detect a pattern of when alarms are activate, or an increasing incidence of the meter flagging an alarm condition.

#### **Events Report**

The Events Report creates a list of all the user initiated actions (i.e. logins, fingerprint creation, configuration changes, etc.) that have occurred over the specified time period. By daily or monthly generating the Events Report a user can track all changes, and ensure that if there are configuration corrections that are necessary then these changes and the user making them are recorded.

#### Data Log

The Data Log is a powerful feature that enables a user to send information to a remote location for further data analysis, The log generated is a CSV file containing all of the historical data recorded for a set time period, or for all time (if this option is selected). Using the Data Log CSV file, a remote user can populate a local installation of the Caldon USM Advisor software application, and analyze this information in a detailed manner. This page is left blank intentionally.

#### Glossary

Flow Rate. Unit volume per unit time moving through the meter.

Temperature. The temperature of the product flowing through the meter.

Pressure. The pressure of the product flowing through the meter.

**Viscosity.** The magnitude of the flow resistance for the product flowing through the meter.

Density. The measurement of the mass per unit volume of the product flowing through the meter.

Meter Velocity. Velocity of a product flowing through a meter at a specific time.

**Speed of Sound.** The measurement or calculation of the speed of a set frequency sent through a product flowing through a meter.

Flatness. The ratio of the outside measurement paths over the inside measurement paths.

Asymmetry. The bulk average velocity of the top half of the meter over that of the bottom half of the meter.

Swirl. The ratio of angular momentum to axial momentum.

Turbulence. The calculation of the affect of internal friction has on the ratio of the flow.

Gain. The output flow rate magnification with respect to input flow rate.

Gain Split. The gain of one path in relation to the gain of the entry path.

Relative Gain. The gain of one path in relation to the median gain of all of the paths together.

Gain Flatness. The measurement of the gain variation over the flow velocity.

SOS Flatness. The SOS of the outside measurement paths versus the inside measurement paths.

Plane Balance. The ratio of the velocity between the left plane versus the right plane.

Performance. A percentage representing the output flow over the optimal flow under the input conditions.

**Signal To Noise Ratio.** The ratio of the strength of the ultrasonic signal to that of noise interference (ex. Vibration in the pipe), expressed in decibels.

**Meter Alarms.** Alert when the value recorded is outside the specifications for the meter, or optimized hardware limits set for the meter application.

**CBM Warnings.** Alert when the value recorded is outside the CBM (condition-based monitoring) warning limits saved within the database. These limits are for alerting the user when the flow conditions have gone outside of the acceptable defined range.

**Fingerprint warnings.** Alert when the value recorded is outside the recorded reference points in previously captured fingerprints.

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### Appendix A - Publisher Notes

### SUPPORT

For further support, contact:

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