MainProbe User Manual

Revision 1.12

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Disclaimer

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1: Introduction

The MainProbe is an integrated measurement platform, meaning it requires no system unit or external processing module to support its operation. It is an invasive, ultrasonic probe intended for open-channel or part filled pipe flow solutions.

The MainProbe houses enough processing power to provide the standard functionality originally featured on Mainstream transmitters. While still maintaining the same ultrasound technology used in the previous Mainstream velocity probe. Technology known for its reliability, accuracy, and its proven track record in measurement applications throughout the world.

The MainProbe can be interfaced with using either a Modbus-RTU client or the MainProbe Communicator software. Both interfaces provide full access to all of the features available on the MainProbe, including full product configuration.

For information on how to interface with the MainProbe using the MainProbe Communicator software, see section 3: .

For information on how to interface with the MainProbe using a Modbus-RTU client, see section 4.

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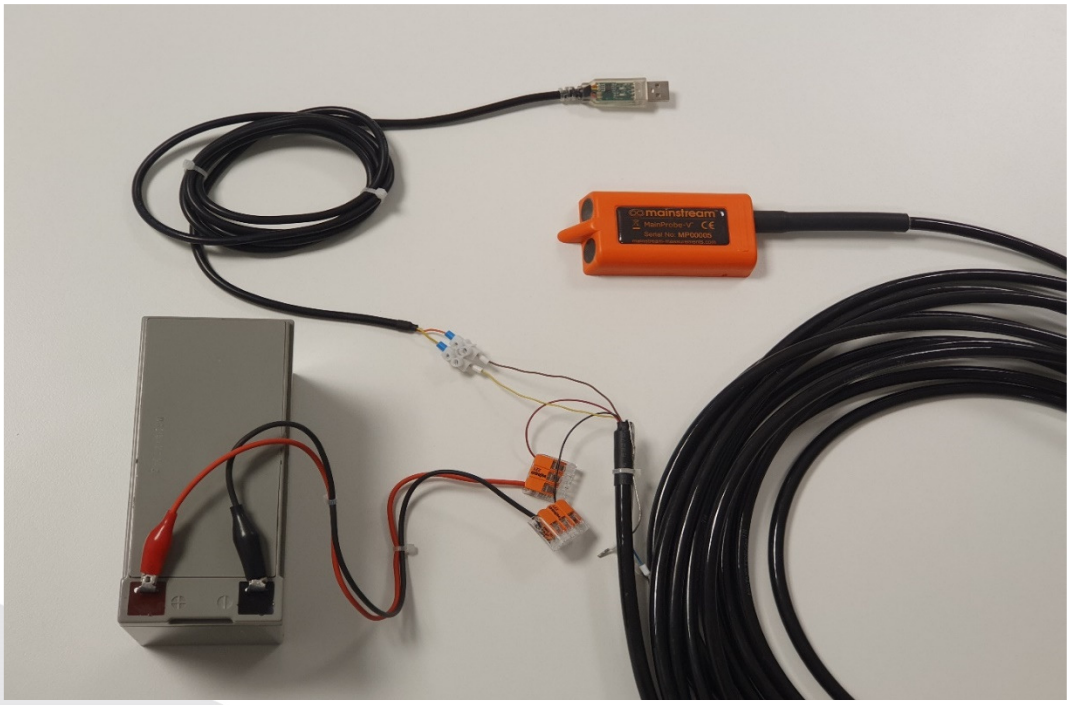
2: Physical Interface Setup

Listed below are the functions for each wire contained in the MainProbe-V RS485 cable.

Insulation colour	Purpose
Yellow	RS485 Half Duplex B-
Brown	RS485 Half Duplex A+
Red	Power (+ve)
Black	Power (-ve)
Blue	Reserved/Not fitted
White	Reserved/Not fitted
Clear	Screen

Input voltage (1 device on bus): 5V – 28V
Input voltage (>1 device on bus): 7V – 28V
RS485 Drive capability: 10 unit loads RS485 Input impedance of device: $^1/_8$ unit load
Screen connection: Should be connected to 0V or terminated.
Line termination: See official Modbus documentation.

For additional details on maximum & minimum operating conditions, see section 13: .
Below, is an example of how the MainProbe should be connected to an RS485 to USB adapter cable.



As always when dealing with electrical connections, care must be taken to avoid short circuits etc when wiring up the MainProbe to the power supply.

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3: MainProbe Communicator Software

MainProbe Communicator is Windows software which allows the MainProbe to be configured and managed. MainProbe Communicator acts as a Modbus client device, thus, no other Modbus client can be active on the bus while the MainProbe Communicator is being used.

MainProbe Communicator is ether provided by USB drive, or from our web site.

3.1: Installing Communicator

Minimum system requirements: Windows 10, .NET 5.0.1(*) desktop runtime SDK.

(*) Or better. Some Windows PC's will have the .NET 5 desktop runtime SDK installed already. Some may require manual installation.

Any USB drive provided by Mainstream or "MainProbe Communicator.zip" file, will a include a setup file for Communicator. This setup file will install Communicator in a folder of the user's choice.

3.2: .NET 5.x

If you install Communicator and try to run the software without the .NET 5.x installed, you will be shown an error message, prompting you to install the .NET runtime, clicking yes on this message will direct you to a Microsoft webpage where .NET can be downloaded. At time of writing this is https://dotnet.microsoft.com/download/dotnet/5.0 . Ensure you download the **x64** SDK.

You can now run Communicator.

3.3: Running Communicator 1.0.0

If you have an older version of Communicator, you will need the instructions at the end of this manual, Alternatively, download the latest version from our web site.

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3.4: Connecting to MainProbe

After you have started Communicator, you will need to connect to the MainProbe device. The definitions below assume you have the correct physical connections to the MainProbe using an RS485 to USB converter to allow a connection to the product to be made via a PC.

Communications settings

On the left-hand side there are menu items to setup the communications between the device and your computer.

Scan – The **Port** box is used to specify which COM port the connection is on. The button to the right will scan the ports on your PC for appropriate connections.

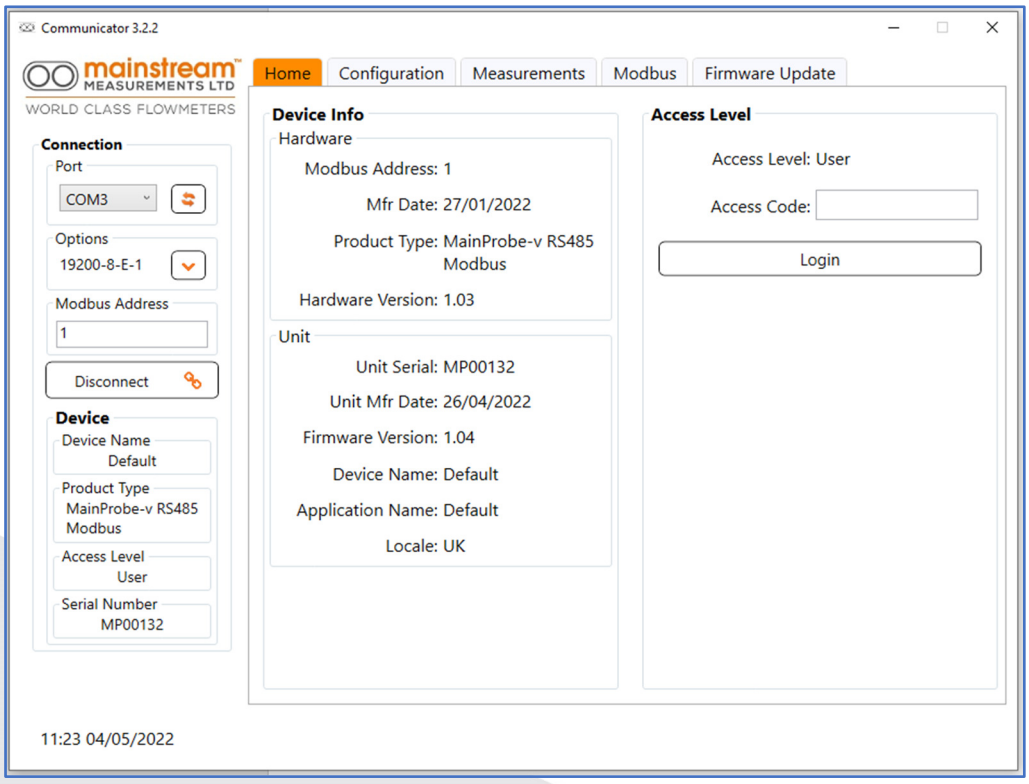
The **Options** box is used to specify the usual COM port settings (Hint, press the button next to the Options box).

The **Modbus address** box is used to specify which Modbus Address's the software should interrogate. The button next to it will trigger a sequence of Modbus messages which will interrogate the attached Modbus bus, to determine if one or more MainProbes are attached to the bus.

The address can be entered as a single number (between 1-247), for example, "1" or "123". Or the address can be entered as a range, for example, "1-3" or "100-120".

Scanning each address can take up to 3 seconds.

If a MainProbe is found during the scan, its details will be displayed in a panel on the left of the dashboard (pictured below).



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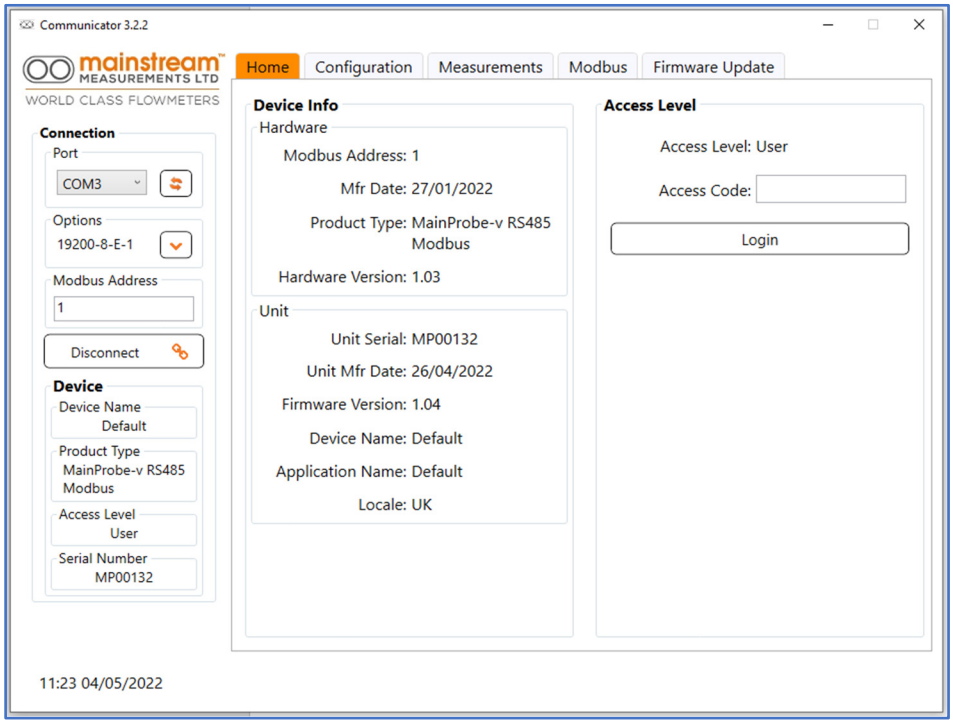
3.5: Communicator tabs

Home tab

As well as showing Device information and provides the interface for users to login to the Probe.



Access Level – The Login button is used to change the access mode of the connected MainProbe, you must be connected to a MainProbe before clicking this button. Initially the software will log you in as a ***User.***

Once connected to a MainProbe, Communicator will issue regular messages to the MainProbe to prevent the firmware from reaching its communications timeout. If the communications timeout (2 minutes 30 seconds) elapses without a message being sent to the MainProbe, the probe will automatically return itself to Read-Only mode.

Enter a 4-digit, numerical Access Code into the **Access Code** text box before clicking the Login button.

Upon clicking the Login button, the MainProbe will evaluate the access code you have submitted. If the MainProbe determines the access code submitted is valid, it will automatically update to the Access Mode, this change will be reflected on the Communicator interface, in the **Access Mode** text box. Shown on the right, is a successful login, to Admin mode.

If an invalid Access Code is entered, the MainProbe will return to Read-Only mode.

Valid Access Codes are listed below:

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Access Mode	Access Code	Description
Read-Only	**0000**	Used to force measurements, edit measurement units, and view the device configuration.
Engineer/Basic	**1234**	Same as Read-Only mode + used to alter communications settings, custom device name, measurement interval and restore default settings.
Admin/Advanced	**5678**	Same as Engineer mode + used to modify all other configurable settings.

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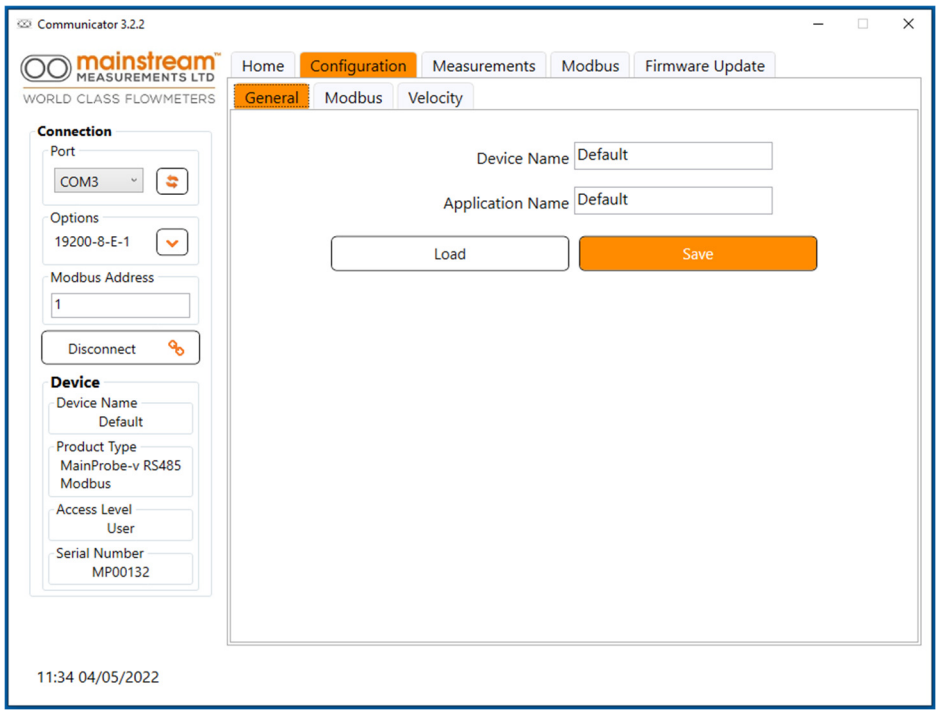
Configuration tab

This tab features three sub-tabs. The General Tab is used to configure the two alphanumeric ID labels , these can be set to whatever the user wants. The Modbus-RTU sub-tab is used to configure the Modbus communications system on the MainProbe, providing access to parameters used to control the RS485 driver and to adjust the Modbus address of the MainProbe. These are the settings which will be written into the memory of the MainProbe. This is a different menu to that used to connect to the MainProbe, but of course there has to be a correlation between the settings to be set to communicate to the MainProbe, and the settings in the MainProbe itself.

The Velocity Sensor sub-tab provides access to configuration parameters for the ultrasonic velocity sensor on the MainProbe, allowing factors such as the measurement interval and measurement time, to be adjusted.



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Measurements tab

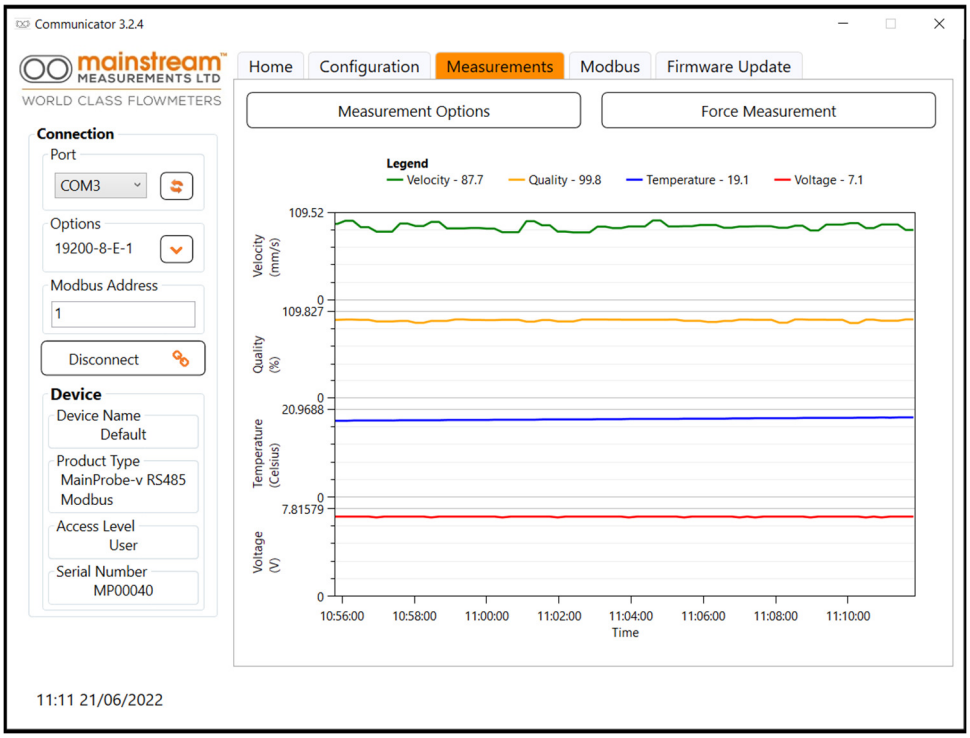
This tab provides access to the date from the MainProbe. The tab features four graphs. These show the current (and recent past) state of the velocity, temperature, signal quality and voltage of the MainProbe.

Clicking on a graph line will give the value at that moment.

Buttons:

The Measurement Options button allows the user to select which graphs are to be displayed, the units used to express the velocity and temperature can also be changed in this menu.

The Force Measurement button tells the device to perform a measurement at that moment. This is useful for checking installations especially when the interval between measurements has been set to a long time.



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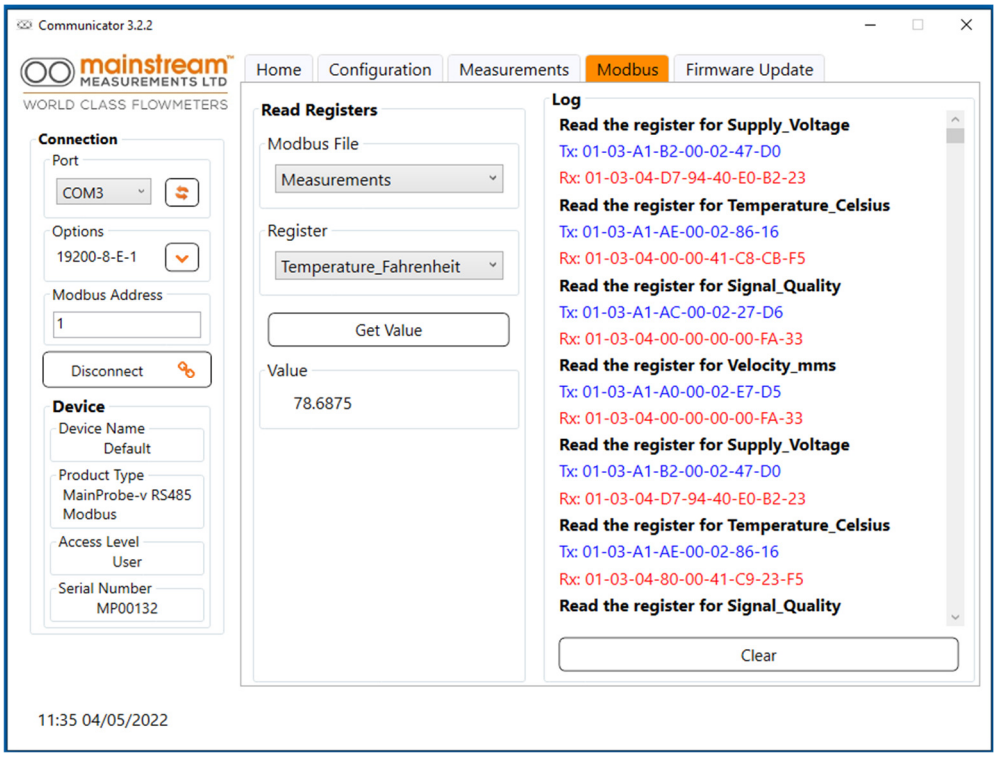
Modbus tab

This tab shows a log of Modbus messages send and received from the MainProbe. A control on the tab allows for simple format Modbus messages to be sent to the MainProbe. These are grouped into Hardware, Configuration, Unit and Measurements and simulate the normal operation of the Communicator. This feature may be used to help set-up or debug the MainProbe.



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4: Modbus Interface

4.1: Supported Modbus function codes

All data in the MainProbe is stored in **16-bit holding registers**, these can be accessed using the following function codes.

3 – Read multiple holding register(s)

6 – Write to single holding register

Note that only one holding register can be written to, per Modbus message. Function code 16 (write multiple holding registers) is not available.

4.2: Supported Modbus exception codes

Exception code 1 - Illegal Function - The function code received in the query is not supported by the server.

Exception code 2 - Illegal Data Address - The data address received in the query is not an allowable register address for the server. More specifically, the combination of register address and register count is invalid. For a controller with 100 registers, (first register addressed as 0, and the last, as 99). If a request is submitted with a starting register address of 96 and a quantity of registers of 4, then this request will successfully operate on registers 96, 97, 98, 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 5, then this request will fail with Exception Code 0x02 "Illegal Data Address" since it attempts to operate on registers 96, 97, 98, 99 and 100, and there is no register with address 100.

Exception code 3 - Illegal Data value - Exception code 3 is used to help express violations to the permissions system. If the user requests a register that they do not have permission to access in their current user mode, exception code 3 is sent.

4.3: Supported Data Types

Byte arrangement is fixed to a **low word first, high byte first** configuration.

This means that for every 16-bit word requested from the device, of the two bytes received, the **most significant byte** will be sent **first**.

When more than one 16-bit register is requested, these 16-bit words are arranged into 32-bit values. Within each 32-bit value, the **pairs of words** are sent in reverse order. So, the **least significant word**, is sent **first** (this is because the lease significant word holds the lowest value Modbus address, thus the). This has been set in accordance with the demands of most Modbus client requirements.

float- Constructed using 2, concatenated 16-bit registers:

The floating-point number:	"212.549530"	**(ABCD)**
Can be expressed as the bytes:	"43 54 8C AE"	**(ABCD)**
These will be received from the MainProbe as:	"8C AE 43 54"	**(CDAB)**
The register addresses for this data would be:	"8C AE = 4xxxx"	**(CD)**
	"43 54 = 4xxxx+1"	**(AB)**

int32 – Constructed using 2, concatenated 16-bit registers:

The 32-bit integer decimal number:	"305419896"	**(ABCD)**
Can be expressed as the bytes:	"12 34 56 78"	**(ABCD)**
These will be received from the MainProbe as:	"56 78 12 34"	**(CDAB)**
The register addresses for this data would be:	"12 34 = 4xxxx"	**(CD)**
	"56 78 = 4xxxx+1"	**(AB)**

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Many of the registers in the device are listed as 32-bit integers, many of them will never reach values which require more than 16 bits to express, for these registers it is simpler to only read the least significant 16-bits of these 32-bit values.

string – Standard string storage format is used, where bytes are stored in 32-bit words, each segment in reverse order (little endian). These strings are null terminated.

The ASCII string:	"V e l o"	**(ABCD)**
Will be received from the MainProbe as:	"e V o l"	**(BADC)**
Translated as	"65 56 6F 6C"	**(BADC)**
The register addresses for this data would be:	"65 56 = 4xxxx"	**(BA)**
	"6C 6F = 4xxxx+1"	**(DC)**

Mnemonic – A big-endian string format used to store specific character strings not more than 32-bits in length. Usually used to represent parameters such as firmware version numbers. Because these are fitted into a 32-bit word they are not null-terminated.

The ASCII string:	"V e l o"	**(ABCD)**
Will be received from the MainProbe as:	"l o V e"	**(CDAB)**
Translated as	"6C 6F 56 65"	**(CDAB)**
The register addresses for this data would be:	"65 56 = 4xxxx"	**(CD)**
	"6C 6F = 4xxxx+1"	**(AB)**

MML Date Format – A representation of a UK format date. Hexadecimal numbers are used to represent decimal values – example 0x31 is used to represent 31(decimal). This is usually used to represent parameters such as the MainProbe manufacture date.

The date:	"31st April 2021"	**(UK Date format)**
Will be sent from the MainProbe as:	"31 04 20 21"	**(Hexadecimal)**

4.4: Boundary checking

Some holding registers on the MainProbe have maximum and minimum values to which they are restricted.

If the user writes a value to one of these parameters (assuming they have permission to write to the given parameter in their current access mode) which exceeds the below specified boundaries, the MainProbe will restore the default value for that parameter.

Parameter	Maximum value	Minimum value	Default value
Restore Default Hardware Settings	1 (Restore defaults)	0 (Do nothing)	0 (Do nothing)
Restore Default Unit Settings	1 (Restore defaults)	0 (Do nothing)	0 (Do nothing)
Baud Rate	6 (115200 Baud)	0 (2400 Baud)	3 (19200 Baud)
Stop Bits	2 (2 Stop bits)	1 (1 Stop bit)	1 (1 Stop bit)
Data Bits	8 (8 Data bits)	7 (7 Data bits)	8 (8 Data bits)
Parity	2 (Even parity)	0 (No parity)	2 (Even parity)
Modbus Server Address	247	1	1
Measurement Interval	10 (1 Hour)	0 (On demand)	2 (30 Seconds)
Measurement Time	10 (10 Seconds)	1 (1 Second)	1 (1 Second)
Bi-Directional Velocity	1 (Enabled)	0 (Disabled)	1 (Enabled)
Transmit Power Tag	1 (Enabled)	0 (Disabled)	1 (Enabled)
Noise Suppression	2 (High)	0 (Low)	1 (Medium)
MAMS Cycle Count	3 (High Limit)	0 (MAMS Off)	2 (Medium Limit)

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Histogram Averaging	1 (Enabled)	0 (Disabled)	0 (Disabled)
Velocity Direction Reversal	1 (Enabled)	0 (Disabled)	0 (Disabled)
Restore Default Configuration Settings	1 (Restore defaults)	0 (Do nothing)	0 (Do nothing)
Measurements Complete	1 (MainProbe has completed its most recent measurement.)	0 (MainProbe busy taking a measurement.)	1 (MainProbe has completed its most recent measurement.)
Restore Default Measurement Settings	1 (Restore defaults)	0 (Do nothing)	0 (Do nothing)

4.5: Supported Modbus holding registers

To extract a 32-bit data types, 2 holding registers should be requested.

The MainProbe-V RS485 features an access mode system which allows access to be granted and revoked to different parameters on the product, to allow varying types of users to operate the product, without the risk of misconfiguration. The permissions are assigned to each parameter and listed below. For more information on this system, see section 6:

Parameter Name	**Modbus Register Address / Reg. Count**	**Description / Data type / Default value /**	**Access Mode**		
			Adv.	**Basic**	**Read Only**
Hardware File					
Hardware Manufacture Date	40034 / 2	Hexadecimal representation of the date upon which the product was assembled in the Mainstream factory. Data type: MML Date Format Default value: Specific to unit.	Rd. Only	Rd. Only	Rd. Only
Product Type	40036 / 16	Description of the specific product variant within the MainProbe product range. Data type: String Default value: "MainProbe-V RS485"	Rd. Only	Rd. Only	Rd. Only
Hardware Version	40052 / 2	Describes the version number of the circuit board contained in the probe. Data type: Mnemonic Default value: Specific to unit.	Rd. Only	Rd. Only	Rd. Only
Restore Default Hardware Settings	40710 / 2	Reserved for future use, has no effect on the above parameters. Data type: Int32 Default value: 0 Upon being written to, this parameter will immediately restore itself to its own default value.	Rd. Wr.	Rd. Only	Rd. Only
Unit File					
Unit Serial Number	40714 / 16	Unique, factory assigned serial number for the probe. Data type: String Default value: Specific to unit.	Rd. Only	Rd. Only	Rd. Only
Unit Manufacture Date	40730 / 2	Hexadecimal representation of the date upon which the assembly of the product was finished. Data type: MML Date Format Default value: Specific to unit.	Rd. Only	Rd. Only	Rd. Only
Firmware Version	40732 / 2	Describes the version number of the firmware currently running on the probe. Data type: Mnemonic Default value: Specific to unit.	Rd. Only	Rd. Only	Rd. Only

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Device Name	40990 / 16	User configurable, 32-character string used to identify an individual probe. Data type: String Default value: "Default "	Rd. Wr.	Rd. Wr.	Rd. Only
Application Name	41006 / 16	User configurable 32-character string used to identify the name of the application at which the probe is situated. Data type: String Default value: "Default "	Rd. Wr.	Rd. Wr.	Rd. Only
Device Locale	41022 / 2	Integer value representing the factory fixed locale the probe has been assigned. 0 = UK. 1 = FR. 2 = IT. 3 = CL. 4 = JP. 5 = ES. 6 = US. 7 = KR. Data type: Int32 Default value: Specific to unit.	Rd. Only	Rd. Only	Rd. Only
Restore Default Unit Settings	41130 / 2	When this parameter is set to a 1 the following parameters will be restored to their default values. Device Name Application Name Upon being written to, this parameter will immediately restore itself to its own default value. Data type: Int32 Default value: 0	Rd. Wr.	Rd. Only	Rd. Only
Configuration File					
Access Mode	41132 / 2	Integer value that represents the current access mode of the probe, for more information on the MainProbe access mode system please see section 6: 0 = Read-Only mode. 1 = Basic mode. 2 = Advanced mode. Data type: Int32 Default value: 0 (Read-Only Mode)	Rd. Only	Rd. Only	Rd. Only
Access Code	41134 / 2	Upon writing a valid access code to this parameter, the MainProbe will automatically update its access mode to correspond with the access code submitted. Access code for Read-Only mode = 0x00000000 Access code for Basic mode = 0x00001234 Access code for Advanced mode = 0x00005678 If an invalid access code is written, the probe will automatically return to Read-Only mode. Parameter will accept any 32-bit value. Data type: Int32 Default value: Parameter will always read as 0x50415353 (Or, "PASS" in ASCII).	Rd. Wr.	Rd. Wr.	Rd. Wr.
Baud Rate	41136 / 2	Integer value that represents the baud rate selected by the user for the serial communications.	Rd. Wr	Rd. Wr.	Rd. Only

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		Writing to this parameter will not affect the baud rate being used by the probe. To switch the baud rate used by the probe, to the baud rate you have written to this parameter, the "Update Communications" parameter must be set to a 1. This will trigger an update of the communications settings. 0 = 2400 Baud. 1 = 4800 Baud. 2 = 9600 Baud. 3 = 19200 Baud. 4 = 38400 Baud. 5 = 57600 Baud. 6 = 115200 Baud. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 3 (19200 Baud).			
Stop Bits	41138 / 2	Integer value that represents the number of stop bits selected by the user for the serial communications. Writing to this parameter will not affect the number of stop bits being used by the probe. To switch the number of stop bits used by the probe, to the number you have written to this parameter, the "Update Communications" parameter must be set to a 1. This will trigger an update of the communications settings. 1 = 1 Stop bit. 2 = 2 Stop bits. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 1 (1 Stop bit).	Rd. Wr.	Rd. Wr.	Rd. Only
Data Bits	41140 / 2	Integer value that represents the number of data bits selected by the user for the serial communications. Writing to this parameter will not affect the number of data bits being used by the probe. To switch the number of data bits used by the probe, to the number you have written to this parameter, the "Update Communications" parameter must be set to a 1. This will trigger an update of the communications settings. 7 = 7 Data bit. 8 = 8 Data bits. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Currently, only 8-bit communications are available, this parameter cannot be written to. Data type: Int32 Default value: 8 (8 Data bits).	Rd. Only	Rd. Only	Rd. Only
Parity	41142 / 2	Integer value that represents the type of parity selected by the user for the serial communications. Writing to this parameter will not affect the type of parity being used by the probe. To switch the type of parity used by the probe, to the type of parity you have written to this parameter, the "Update Communications"	Rd. Wr.	Rd. Wr.	Rd. Only

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		parameter must be set to a 1. This will trigger an update of the communications settings. 0 = No parity. 1 = Odd Parity. 2 = Even Parity. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 2 (Even parity).			
Modbus Server Address	41144 / 2	Integer value that represents the current Modbus server address for the MainProbe, unlike the other communications parameters, this value does not require the "Update Communications" parameter to be set to alter the address used by the probe, writing to this parameter will have an immediate effect on the probe. Valid address values are 1-247 (inclusive). Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 1 Please see Known Issues Appendix	Rd. Wr.	Rd. Wr.	Rd. Only
Update Communications	41146 / 2	Set this register to any value other than its default value to trigger an update of the probe's serial communications. Power cycling the MainProbe will also have the same effect as setting this parameter to a 1. This will ensure the values you have written to the following parameters: Baud Rate Stop Bits Data Bits Parity Are used for serial communications. Once the probe's serial communications have been updated, this parameter is immediately restored to its own default value. Data type: Int32 Default value: 1	Rd. Wr.	Rd. Wr.	Rd. Only
Measurement Time	41156 / 2	Integer value representing the duration of each ultrasonic velocity measurement. Valid measurement time values: 1 – 10 (inclusive). Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 1 (1 Second).	Rd. Wr.	Rd. Only	Rd. Only
Measurement Interval	41158 / 2	Integer value representing the time interval between the start of each measurement. 0 = On demand (No regular measurement is taken measurements must be manually invoked, see section 0 for more information on triggering measurements). 1 = 15 Seconds. 2 = 30 Seconds. 3 = 1 Minute. 4 = 2 Minutes.	Rd. Wr.	Rd. Wr.	Rd. Only

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		5 = 5 Minutes. 6 = 10 Minutes. 7 = 15 Minutes. 8 = 20 Minutes. 9 = 30 Minutes. 10 = 1 Hour. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int 32 Default value 2 (30 Seconds).			
Bi-Direction Velocity	41334 / 2	Integer value that controls how reverse flow velocities are interpreted. 0 = Disabled. Reverse flow velocities are represented as positive numbers. Forward flow velocities are also represented as positive numbers. 1 = Enabled. Reverse flow velocities are represented as negative numbers. Forward flow velocities are represented as positive numbers. (The above assumes that "Velocity Direction Reversal" is disabled.) NOTE: This function should not be enabled if it is likely that the flow will not be clearly in one direction or the other. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: int32 Default value: 1 (Enabled).	Rd. Wr.	Rd. Only	Rd. Only
Transmit Power	41336 / 2	Feature allowing the user to control the amplitude of the ultrasonic vibrations transmitted into the fluid from the MainProbe. This can be used to aid noise reduction, for more information on variable transmit power, see section 8: 0 = Low power. 1 = High power. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 1 (High power).	Rd. Wr.	Rd. Only	Rd. Only
Noise Suppression	41338 / 2	Used to help reduce the impact of noise in difficult, or turbulent flow applications. Adjusting the noise suppression level can contribute to an increased signal quality. 0 = Low. 1 = Medium. 2 = High. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 1 (Medium Noise Suppression).	Rd. Wr.	Rd. Only	Rd. Only
MAMS Cycle count	41340 / 2	Used to adjust the quantity of information required for MainProbe to automatically end a measurement before the specified	Rd. Wr.	Rd. Only	Rd. Only

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		measurement time has elapsed. For more information on MAMS see section 7. 0 = MAMS Off. 1 = High limit. 2 = Medium limit. 3 = Low limit. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 2 (Medium limit).			
Histogram Averaging	41342 / 2	Feature used to help smooth any sudden changes in flow velocity. Providing a more accurate representation of the average flow velocity over time. When enabled, the velocity value given by the MainProbe will be an average value including the most recent velocity measurement and half of the previous velocity measurement. 0 = Disabled. 1 = Enabled. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 0 (Disabled).	Rd. Wr.	Rd. Only	Rd. Only
Velocity Direction Reversal	41354 / 2	When enabled the MainProbe will perform an additive inversion (sign change) on the velocity value for all following velocity measurements. This allows the MainProbe to be installed facing downstream or upstream. 0 = Disabled. Use this setting when the probe is mounted with its nose facing upstream. 1 = Enabled. Use this setting when the probe is mounted with its nose facing downstream. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: int32 Default value: 0	Rd. Wr.	Rd. Only	Rd. Only
Reboot Product	41370 / 2	When this parameter is set to any value other than its default value the MainProbe firmware will reboot, this parameter will immediately be returned to its default value. Data type: Int32 Default value: 0	Rd. Wr.	Rd. Wr.	None
Restore Default Configuration Settings	41372 / 2	When this parameter is set to a 1 the following parameters will be restored to their default values. Baud Rate Stop Bits Data Bits Parity Modbus Server Address High Byte First High Word First Measurement Time Measurement Interval Bi-Directional Velocity	Rd. Wr.	Rd. Only	Rd. Only

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		Transmit Power Noise Suppression MAMS Cycle Count Histogram Averaging Signal Quality Cut Off Velocity Fail Holdoff Count Velocity Direction Reversal Upon being written to, this parameter will immediately restore itself to its own default value. Data type: Int32 Default value: 0			
Measurements File					
Measurements Complete	41374 / 2	Provides an indication as to whether the probe is currently busy taking a measurement or if the probe has completed taking a measurement its most recent measurement. If measurements are requested while the MainProbe is busy taking a measurement, the readings from the previous measurement will be returned. This parameter can be used to ensure that only up-to-date measurements are read. This parameter can also be used to manually force the MainProbe to take a measurement by setting the parameter to a 0. For more information on taking a measurement see section 0. 0 = MainProbe busy taking a measurement. 1 = MainProbe has completed its most recent measurement and the measurands can be read. Set parameter to a 0 to force the probe to take a measurement. Setting this parameter to any value outside of the above listed values will return the parameter to its default value. Data type: Int32 Default value: 1 (Measurements complete).	Rd. Wr.	Rd. Wr.	Rd. Wr.
Velocity (mm/s)	41376 / 2	Returns the most recent velocity measurement in mm/s. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Velocity (cm/s)	41378 / 2	Returns the most recent velocity measurement in cm/s. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Velocity (M/s)	41380 / 2	Returns the most recent velocity measurement in M/s. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Velocity (in/s)	41382 / 2	Returns the most recent velocity measurement in in/s. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Velocity (ft/s)	41384 / 2	Returns the most recent velocity measurement in ft/s. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Velocity (ft/min)	41386 / 2	Returns the most recent velocity measurement in ft/min. Data type: Float	Rd. Only	Rd. Only	Rd. Only

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		Default value: 0.0			
Signal quality (%)	41388 / 2	Returns the signal quality of the most recent velocity measurement in %. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Temperature ($°C$)	41390 / 2	Returns the most recent temperature reading in degrees Celsius. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Temperature ($°F$)	41392 / 2	Returns the most recent temperature reading in degrees Fahrenheit. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Supply Voltage (V)	41394 / 2	Returns the most recent supply voltage reading in Volts. Data type: Float Default value: 0.0	Rd. Only	Rd. Only	Rd. Only
Velocity signals	41468 / 500	A snapshot of the ultrasonic signals received by the probe during its last measurement. These can be viewed using the MainProbe Communicator software or by manually interpreting the data stored in this parameter. For further details on how this data is structured see section 9: Data type: Int16 Default value: 0	Rd. Only	Rd. Only	Rd. Only
Histogram	42218 / 400	Provides a record of each of the separate velocities identified during the most recent measurement. This histogram provides an indication of the relative length of time each velocity was measured for. The final flow velocity calculated by the MainProbe will be the moment of this histogram. If "Histogram Averaging" is enabled, these velocities will be compiled with half of the velocities identified during the previous measurement. Providing a more accurate representation of the average flow velocity over time. This information can be viewed using the MainProbe Communicator software or by manually interpreting the data stored in this parameter. For further details on how this data is structured see section 9: . Data type: Int32 Default value: 0x7FFFFFFF, 0x0000000… (Repeating pattern).	Rd. Only	Rd. Only	Rd. Only
Restore Default Measurement Settings	42624 / 2	When this parameter is set to a 1 the following parameters will be restored to their default values. Measurements Complete Velocity (mm/s) Velocity (cm/s) Velocity (M/s) Velocity (in/s) Velocity (ft/s) Velocity (ft/min) Signal Quality (%) Temperature ($°C$) Temperature ($°F$) Supply Voltage (V) Velocity Signals	Rd. Wr.	Rd. Only	Rd. Only

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		Histogram If the probe has been connected to the MainProbe Communicator software and you have altered the any of the units in the "Measurements" tab, these units will also be restored to their default settings. Upon being written to, this parameter will immediately restore itself to its own default value. Data type: Int32 Default value: 0			

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5: Taking a Measurement

When a "measurement" is taken, the MainProbe will perform a full set of sensor readings and update every measurand on the product.

There are three possible trigger sources that can result in the MainProbe taking a measurement.

1: Powering the MainProbe.

2: The measurement interval timer elapsing.

3: Writing a 0 to the "Measurements Complete" parameter.

When the MainProbe is initially powered, it will automatically take a measurement (Measurement time and all other configuration settings are retained throughout a power cycle, therefore, the measurement will be taken as per any previous configuration). The start up measurement feature can save power in various scenarios. For example, where a third-party device is used to power the MainProbe at a regular interval and leave the probe unpowered during the interval between measurements.

The interval timer can be set to a variety of intervals, once this interval has elapsed, a measurement is taken **(velocity, signal quality, temperature and supply voltage)**.

When a measurement is being taken, the "Measurements Complete" parameter, is set to a **0**, it can be used as an indicator to determine when a measurement has been completed.

Writing a **0** to the "Measurements Complete" parameter will force the device to take a measurement, provided the device is not already busy taking a measurement.

If the "Measurements Complete" parameter is set to a 0 (measurement in progress), and the user also tries to set the parameter to a 0, no additional measurement will be forced or queued. The user should check that the Measurements Complete parameter is set to a 1 (no measurement in progress) before attempting to force a measurement.

Similarly, if the user manually invokes a measurement using the Measurements Complete parameter and the measurement interval timer then elapses, triggering a measurement. This second, interval triggered, measurement will not be performed, and the device will wait for the next interval to elapse before performing another measurement.

The procedure for manual measurement taking should be as follows:

1: Check the "Measurements Complete" parameter is set to a 1 (No measurement in progress).

2: Write a 0 to the "Measurements Complete" parameter.

3: Read the "Measurements Complete" parameter periodically (1s intervals), until the parameter reads back a 1, velocity should not be read.

4: If the measurement time is known to the user, you can reduce bus accesses by waiting for at least this duration of time to elapse before re-checking the Measurements Complete parameter.

5: Once the measurements are ready the user can read the velocity and the signal quality. Thus if readings are below the desired signal quality they can be discarded.

For standard applications where a velocity reading is taken regularly, it is simpler to set the MainProbe to a preset measurement interval and poll velocity at a regular interval controlled by the Modbus master device. The previously described sequence is only recommended where longer or abnormal durations are required between measurements and the user does not wish to waste any power taking additional measurements. Note that during high measurement times with short intervals, the device may be busy more often than it is not, making access difficult. If it can be avoided, it is better to avoid sending large data requests to the device during a measurement.

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6: Access Modes

The MainProbe features an access mode system, the system uses a password (or Access Code) input to provide varying levels of access to the MainProbe's configuration. This means the product can be passed between different users, without the risk of accidental misconfiguration.

6.1: The access modes (Passwords)

Read Only (0000) - User is "Logged out" of the product, although the password "0000" can be used to access this mode, if a wrong password is entered, the MainProbe will default to Read-Only mode. Hence, this mode can be considered as unprotected. In Read-Only mode, no write access is given to any configuration parameters. The user can read measurement data and force measurements (see section 0). This access mode is intended for providing base functions without compromising security or configuration.

If an incorrect access code (password) is entered, the MainProbe will automatically default to Read-Only mode.

Upon powering-up, the unit will automatically default to Read-Only mode.

When the MainProbe Communicator software is closed, the MainProbe is set back to Read Only Mode.

Engineer/Basic (1234)

- End user access level intended for rental user with a limited experience of the product. Write access is given for application-orientated parameters what may need to be altered on-site. No write access is given for the more in-depth aspects of the products configuration. This is a password protected mode.

Admin/Advanced (5678)

- An access mode intended for experienced users, or distributors operating a rental service. This access mode provides maximum access to the MainProbe's configuration. Some parameters will still appear as read only. These parameters are intended to be educational, providing feedback to the user as to the configuration of the product. This is a password protected mode.

6.2: Access levels

Read write - A parameter with this access level will allow the user to see and modify its value in the MainProbe Communicator software and will allow the user to access it using Modbus function codes 03 and 06.

Read only - A parameter with this access level will allow the user to see its value in the MainProbe Communicator software and will allows the user to access it using Modbus function code 03. If the user attempts to access a read only parameter using Modbus function code 06 (write to holding register) exception code 03 will be returned to the user exception code 03 is used to express a permission violation, (for further details on exception codes, see section 4.2:).

6.3: Communications timeout

To avoid a user leaving the probe logged into Basic mode or Advanced mode, the MainProbe features a communications timeout system. This system monitors the serial communications lines of the product. If a duration of more than **2 minutes 30 seconds** elapses since any data was sent to the MainProbe the unit will default back to Read-Only mode.

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6.4: Changing access mode

The MainProbe can be accessed via multiple interfaces, the Access Modes system is governed by the probe itself (not the MainProbe Communicator Software).

Any time an Access Code is submitted to the MainProbe, a request is issued to change the Access Mode. If the MainProbe finds the Access Code submitted to be valid for one of its Access Modes, it will automatically switch to that Access Mode.

There is no issue with entering an Access Code for the Access Mode the MainProbe is currently in (for example, switching from, Basic mode, to Basic mode).

6.4.1: Using the Modbus interface

The below sequence is the recommended method for changing the MainProbe Access Mode using a Modbus client device. The Modbus register addresses for each parameter can be found in section 4.5:

1: Read the current "Access Mode" and ensure the MainProbe is not already in the desired Access Mode.

2: Write a valid Access Code to the least significant word (lowest Modbus Register Address) of the Access Code parameter. The Access Code should be written in hexadecimal format. For an Access Code of "1234" (Engineer/Basic mode), register 41134, should be set to a value of 4660 (0x1234 in decimal).

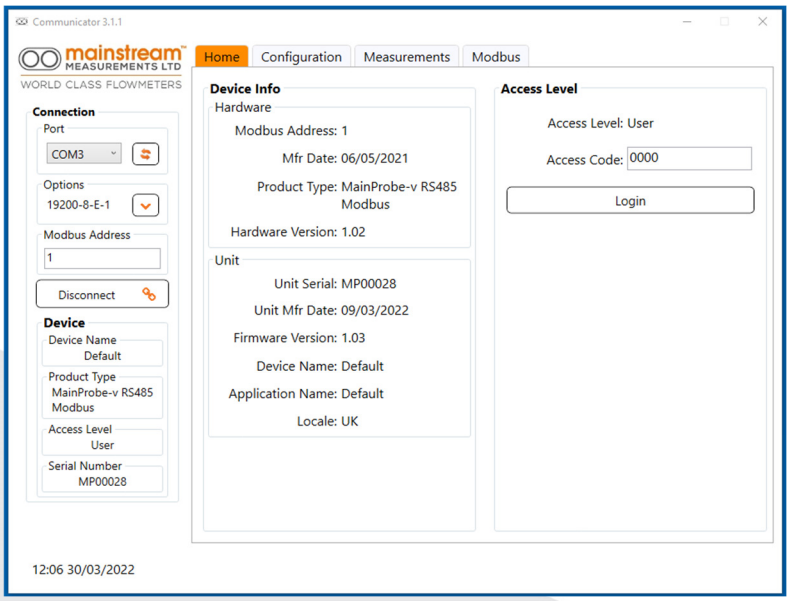
The reply received from the MainProbe when writing to this register, will not echo the value you have written, the Access Code is always masked when read out (see section 4.5:).

3: Read the current "Access Mode" to see if the MainProbe has accepted your Access Code. If your Access Code has been accepted the MainProbe will have automatically switched its Access Mode.

For details on the values read out from the Access Mode register, see section 4.5: .

6.4.2: Using Communicator

To change Access Mode using Communicator, you must first Scan for your MainProbe and Connect to it, (for more information on connecting to a MainProbe, see section 3). Once connected, navigate to the "Home" tab on Communicator, where you will be shown the current Access Mode, type a valid Access Code into the Access code field and click the Login button (or press the return key).



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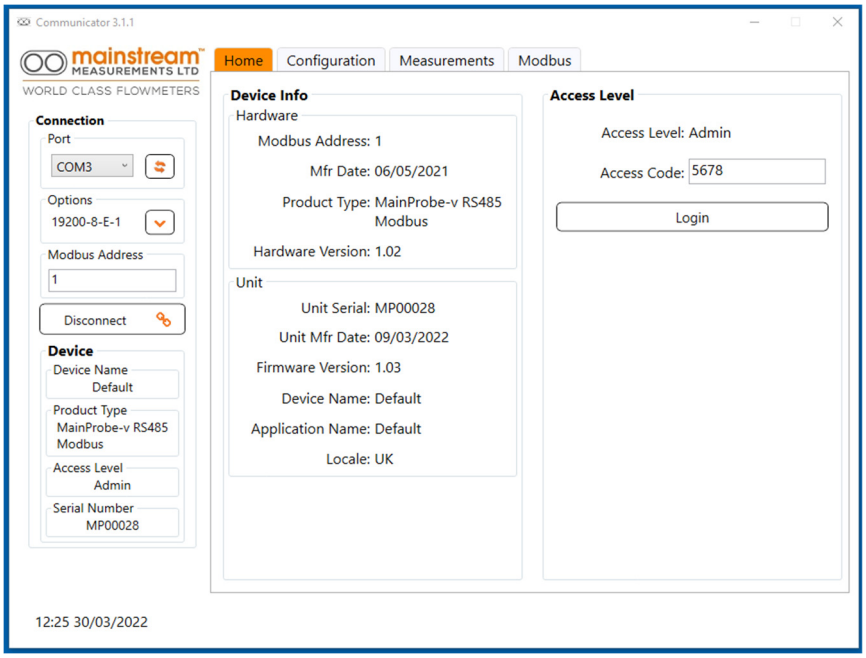
After approximately 3 seconds the MainProbe will report a successful change in Access Mode.



If an invalid code is entered, the MainProbe will default back to Read-Only mode and this will be shown on the user interface.

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7: Mainstream Adaptive Measurement System (MAMS)

MAMS is a feature new to the MainProbe and allows the probe to adapt to the environment in which it is operating, automatically reducing its power consumption where possible. While still upholding the same reliable measurement standards found on all Mainstream products.

Fundamentally, the MAMS system allows the MainProbe to finish a measurement early if a suitable amount of velocity information has been acquired by the sensor.

The MainProbe measures the flow velocity by processing the ultrasound signals reflected from tracers (air bubbles & particulate matter etc.) carried by the flow.

At a high flow velocity more tracers are carried past the sensor in a time interval than at a low velocity. Consequently, at a high flow velocity the sensor receives information at a higher rate than at a low velocity. It may be possible to reduce the sampling time (and therefore the power used) by reducing the MAMS Cycle Count parameter so that the optimum number of readings are taken for that particular environment.

MAMS works by basing each velocity measurement on processing the same fixed quantity of information. When this information limit has been reached the measurement is terminated (regardless of whether the probe has been run for the full specified measurement time). Thus, as the velocity increases, MAMS automatically reduces the measurement time.

By basing each velocity measurement on a fixed quantity of information, the MAMS feature ensures that Mainstream delivers consistent measurement performance under all flow conditions and, whenever possible, reduces the measurement time which saves power.

This fixed quantity of information required to complete a measurement can be controlled by the user using the MAMS Cycle Count parameter, more information on how to access this parameter can be found in section 4.5: .

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8: Transmit Power

The MainProbe uses Piezo crystal components to produce ultrasonic waves, these waves are used to measure the velocity of particulate matter and other tracers in the flow. The MainProbe features the capability to vary the intensity of these sound waves. The Transmit Power parameter can be accessed via Modbus or the MainProbe Communicator software, the parameter can only be written to in Advanced mode and has two available settings.

The settings available are, high power and low power. Details of how to set this parameter using the Modbus interface can be found in section4.5.

The recommended setting for this parameter is high power.

Low power may be useful in scenarios where large tracers are present, which produce larger ultrasound reflections. These large reflections can lower the signal quality of the reading.

Lowering the power of the ultrasound that the probe transmits, will reduce the size of these reflections, helping to increase the signal quality.

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9: Velocity Diagnostics

There are two forms of velocity diagnostics featured on the MainProbe, these are identical to the diagnostics provided with the previous Mainstream velocity probe and consist of the velocity signals graph and the velocity histogram. Both of which provide insight into the measurements the MainProbe is taking and can indicate where attention is required to get the most out of the sensor platform. They are equivalent to having an oscilloscope monitoring the signals received from the probe.

The *Velocity Histogram* shows a representation of the signals that have been determined to be correct for each given velocity. These will tend to peak around the mean velocity for any given time period. A high signal quality figure confirms the integrity of the measurement and health of the velocity probe.

The *Velocity Signals* graph provides a representation of the ultrasonic signals received by the probe during its most recent measurement. In this histogram there should be two signals displayed, one is out of phase from the other. A perfect signal will be shown by 2 perfect, out of phase, waves. As the signal degrades they will become less uniform. This may influence siting of the probe and signal quality setting etc.

Possible issues seen with these diagnostics:

- If there is only one signal/wave then the probe itself may be faulty.
- If two almost flat-line signals are seen then check that the probe is submerged.
- If the wave shows noisy, ragged low amplitude signals then the probe may be submerged in silt/sludge or similarly obscured..

An additional output from the measurement algorithm is the signal quality and this indicates the degree of agreement between the two signals. The velocity signals function is captured from the MainProbe. A high signal quality confirms the integrity of the measurement and health of the velocity probe. Dependent upon the quality of the signal this will be calculated as a percentage.

The received ultrasound signal is processed to produce a histogram of the flow velocities. This data is computed by the MainProbe. This provides a visual representation of data distribution of the velocities in the flow and gives the mean flow velocity. Only signals containing verified velocity information are used, thereby ensuring measurement integrity. Multiplying the flow cross-section by data from the velocity histogram gives the flow rate.

As a Modbus product, the MainProbe offers the user the opportunity to request both the velocity signals graph and the velocity histogram in a numerical format over Modbus, as opposed to manually viewing them on a graph in Communicator. This means the diagnostics data can be exported from the probe and stored for later interpretation. For Modbus register information see section 4.5: . Once the numerical representation of the desired diagnostics has been polled from the MainProbe, it can be interpreted using the below described format.

9.1: Velocity Histogram:

The MainProbe is designed to operate from -5m/s to -10mm/s and from +10mm/s to +5m/s flow velocity, the cell resolution of the histogram 10mm/s.

The histogram cells are named using the velocity at the uppermost boundary of the cell. For example, the 1000mm/s cell on the histogram, refers to the velocity values that were smaller than or equal to 1000mm/s, but greater than 990mm/s, which is the name of the previous cell.

Therefore, the histogram features 1001 cells (described as 0-1000).

Cell 1000 (the right most cell of the histogram), is used to store velocity values greater than 5000mm/s.

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For every measurement the MainProbe takes, signals are recorded by the MainProbe which represent the flow velocity. Each segment of these signals that is verified by the probe as useable, has a velocity associated with it, Therefore, for each measurement taken, several different individual velocity values are deduced (one velocity from each part of verified signal). These velocity values are compiled into a histogram, where the height of each cell in the histogram, is proportional to the amount of time the probe spent detecting the velocity represented by that cell.

Histogram storage format:

There are 200, 32bit integers stored in the Histogram parameter. These 32bit integers can be accessed as pairs of 16-bit Modbus registers (see section 4.5:).

The histogram parameter only stores the cells of the histogram with data in.

Cell representation:

Cell height represents the amount of time the probe spent detecting a given velocity during its measurement.

Cell height is an arbitrary number and is limited to a maximum of 23000, per second of measurement time.

Hence, during a 10s measurement, it is possible that a maximum cell height of 230000 could occur.

Expressing the histogram:

The first 32-bit integer in the histogram parameter (first 2, 16-bit Modbus registers) represents the cell number (from 0-999 inclusive) of one of the verified velocities found during the duration of the measurement. The second 32-bit integer represents the height of the previously inferred cell. This pattern continues for the entire histogram parameter, over the 400, 16-bit registers in the parameter, this allows up to 100 different velocities to be expressed, (2, 32-bit integers/ 4, 16-bit Modbus registers required per velocity).

0x7FFFFFFF is used to represent an unused cell, once the first unused cell is reached, the histogram is complete.

The information below is a representation of a histogram containing 4 used cells values.

32bit integers	Cell value	Description
Histogram[0] (signed Int32)	-1100	Represents the cell that encompasses all velocities found <= -1100mm/s and > -1110mm/s
Histogram[1] (unsigned Int32)	200	200 Samples taken at this velocity.
Histogram[2] (signed Int32)	-5000	Represents the cell that encompasses all velocities found <= -5000mm/s
Histogram[3] (unsigned Int32)	900	900 Samples taken at this velocity.
Histogram[4] (signed Int32)	5000	Represents the cell that encompasses all velocities found <= 5000mm/s and > 4990mm/s
Histogram[5] (unsigned Int32)	120	120 Samples taken at this velocity.
Histogram[6] (signed Int32)	5001	Represents the cell that encompasses all velocities found > 5000mm/s
Histogram[7] (unsigned Int32)	100	100 Samples taken at this velocity.
Histogram[8] (signed Int32)	-1180 (not how these are not all in order as they occur on the x-axis).	Represents the cell that encompasses all velocities found <= -1180mm/s and > -1190mm/s
Histogram[9] (unsigned Int32)	3921	3921 Samples taken at this velocity.

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Histogram[10] (signed Int32)	0x7FFFFFFF (Cannot be 0xFFFFFFFF as this is -1, a valid value)	Denotes beginning of unused cells
Histogram[11] (unsigned Int32)	0	No duration relevant.
(All cells items in array from here on will follow the pattern set out by Histogram[10] and Histogram[11]).		

The above table should generate 5 lines on the histogram. Each representing 1 of the velocity ranges detected during the measurement. The dominant velocity clearly being between -1180mm/s and -1190mm/s, this being the velocity range in which the probe spent the most time during its measurement.

Note that this is not a representation of what a velocity histogram might look like when the MainProbe is operating in situ. The values in this histogram were chosen specifically to demonstrate the format of the histogram registers.

9.2: Velocity Signals

The velocity signals parameter provides a snapshot of the ultrasonic signals received by the probe during the first second, of its most recent measurement.

Velocity signals storage format:

- The Velocity signals are be represented by two lines on the same line graph.
- The maximum Y value of either of the two lines, is 255 and the minimum value is 0. Therefore, every point plotted on the graph can be expressed in a single byte.

The points are grouped into pairs (one point for each line). Therefore, for every 16-bit integer received from the MainProbe, one increment on the X-axis can be fulfilled (each increment on the X-axis, holds 2 points, one for each line on the graph).

Therefore each 16-bit Modbus register received when polling the "Velocity Signals" parameter, represents one increment on the x-axis. These 16-bit registers can then be split into two 8-bit integers to isolate each of the two lines.

The order the points appear on the x-axis, is the same order in which the Modbus registers occur in the Modbus table.

Thus, if register 41468 represents the start of the velocity signals registers, the two points stored in register 41468 should be placed at position 0 on the x-axis, and the two points stored in register 41478 should be placed at position 10 on the x-axis

500, 16-bit registers are available in the parameter. Therefore, the X-axis should be 500 increments wide.

The two lines on the graph are known as I and Q. Where the first byte in each 16-bit integer represents orange line on the graph displayed in the MainProbe Communicator software, while the black line is represented by the second byte in each register.

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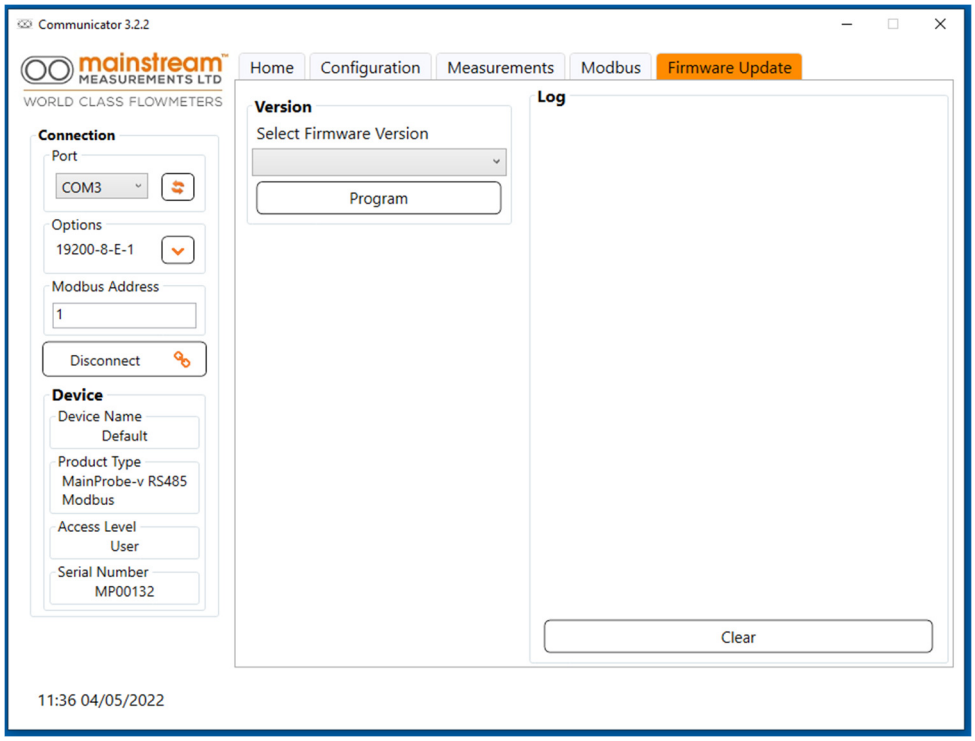
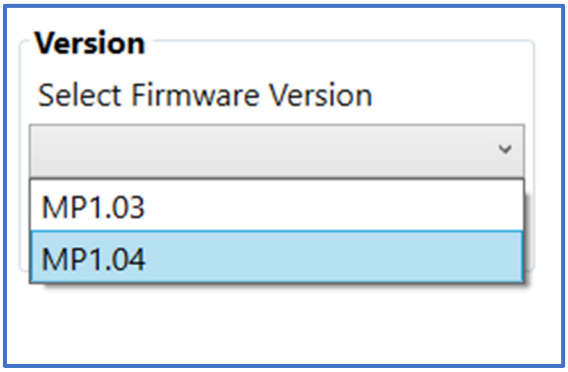
10: Updating MainProbe Firmware

It may be necessary to upgrade the firmware on your MainProbe.

To do this navigate to the Firmware Update tab. In this tab you will be able to select the Firmware Version you require (usually the most up to date version) as per the figure below.

Once you press the Program button the software will take about 20 seconds to perform the update. During this time you should not disconnect the MainProbe or power the MainProbe or the PC down.





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11: Mechanical specifications

Materials: Streamlined PVC-U moulding and polyurethane cable
Dimensions: 105 mm long x 50 mm wide x 20 mm high
Cable: Six core with 2 x power; 2 x twisted pair comms; screened
Weight: 850 gm including standard 10 m cable length
Max cable length: 500 m
Environmental protection: Totally encapsulated to IP68
Operating temperature: -10°C to 80°C

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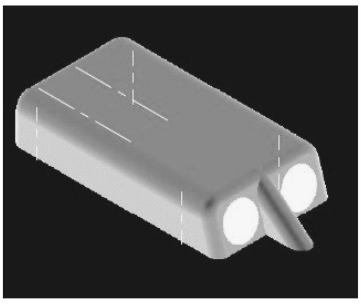
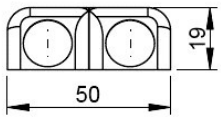
12: Installation of the MainProbe

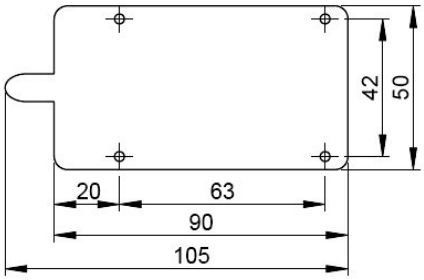
The Mainstream MainProbe sensor consists of a streamlined injection moulded µPVC body 105 mm long x 50 mm wide x 19 mm high. The sensor operates immersed in the flowing liquid. The maximum working temperature of the sensor is 85°. At the front of the sensor facing in to the flow are two "eyes" which use ultrasound to interrogate the moving liquid. The sensor body contains circuits to generate this ultrasound and process the ultrasonic signals. The Mainstream velocity sensor is connected to the system unit via a reinforced cable that supplies electrical power to the velocity sensor and carries data back to the system unit. The standard length of velocity sensor cable is 10 metres. Sensors can be supplied with longer cable lengths up to a maximum of 500 metres. Increasing the length of the velocity sensor cable does not degrade flow measurement performance.

12.1: Dimensions and fixing template

Below are the dimensions of the velocity sensor in addition to centre distances for the M3 threaded inserts for fixing the sensor to the support used for installation. The M3 fixing screws for the sensor should of a length not greater than 4-5 mm + the thickness of the support plate used.







12.2: Installation

The velocity sensor is designed to operate immersed in liquid; therefore it is usually installed at the bottom of the channel or pipe where the measurement is to be taken. To this effect there are supports and accessories available depending on the installation required, i.e. for circular pipe sections, semi-circular pipe sections, and rectangular or trapezoidal channel sections.

12.3: Equipment for installing the sensor

To install the sensor in a flat-bottomed rectangular or trapezoidal channel, support plates are fixed to the bottom of the channel using bolts or brackets that meet the specific requirements.

To install the sensor in channels or pipes where it is not possible to stop flow, a support bracket can be used for the velocity sensor. The sensor is anchored to a square tube which will ensure the

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correct positioning of the sensor with respect to the flow and which can be easily removed for maintenance purposes.

12.4: Equipment for installing the sensor in circular pipe sections

To install the velocity sensor in circular pipe sections, suitable ring supports in stainless steel can be used, complete with an upper expander which allows the ring to be expanded against the internal walls of the pipe. (Please note we do not supply these)

The lower base of the ring has the sensor anchoring holes, and the cable should be fastened with cable ties along the ring perimeter, which exit from the upper part of the pipe, to avoid the creation of any obstructions to flow.

It is advisable to cover the semi-section of the ring where the cable passes with high strength adhesive tape, to protect the cable better and increase the hydrodynamics of the support.

The upper expander makes it possible to reduce the ring diameter for easy insertion into the pipe. Subsequently opening it provides a high level of strength combined with increased grip against the internal pipe surfaces. This makes it possible to keep the sensor in the correct position, with as little obstruction as possible in the pipe.

Visit the following URL link for examples of sensor installation and where to install the sensor.

https://mainstream-measurements.com/wp-content/uploads/2021/01/Example-of-Sensor-Installation.pdf.pdf

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13: Technical reference

13.1: Velocity sensor

Resolution: **1mm/s**
Operating range: **-5 m/s to -10 mm/s and 10 mm/s to 5 m/s**
Minimum operating depth: **30mm**
Zone of inspection:
Processing time:

13.2: Temperature sensor

Resolution: **0.1°C**
Accuracy: **+/-0.5°C**
Measurable temperature range: **-10°C to 80°C**

13.3: Power supply sensor

Resolution: **10mV**
Accuracy: **+/-100mV**

13.4: Miscellaneous

Startup time: **~60ms**
Measurement processing time: **~400ms** (per 1 of measurement time.)
Power consumption: **25mA whilst measuring and less than 2mA idle**

13.5: Compliance

MainProbe has been tested for compliance to CE and UKCA standards and the results are shown below:

Test	Standard	Level	Performance
Radiated Emission	EN 61326-1	30MHz to 1GHz	Class B
ESD	EN 61000-4-2	4kV contact, 8kV air	Criteria A
Radiated RF Immunity	EN 61000-4-3	80MHz to 2.7GHz @ 10V/m	Criteria A
EFT	EN 61000-4-4	1kV	Criteria A
Conducted RF Immunity	EN 61000-4-6	150kHz to 80MHz @ 10V	Criteria A

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14: Appendix - Running Communicator V1.0.0

14.1: Connecting to MainProbe

If you have an older version of Communicator you will need these instructions. Alternatively, download the latest version from our web site.

After you have started Communicator you will need to connect to the MainProbe device. The definitions below assume you have the correct physical connections to the MainProbe using an RS485 to USB converter to allow a connection to the product to be made via a PC.

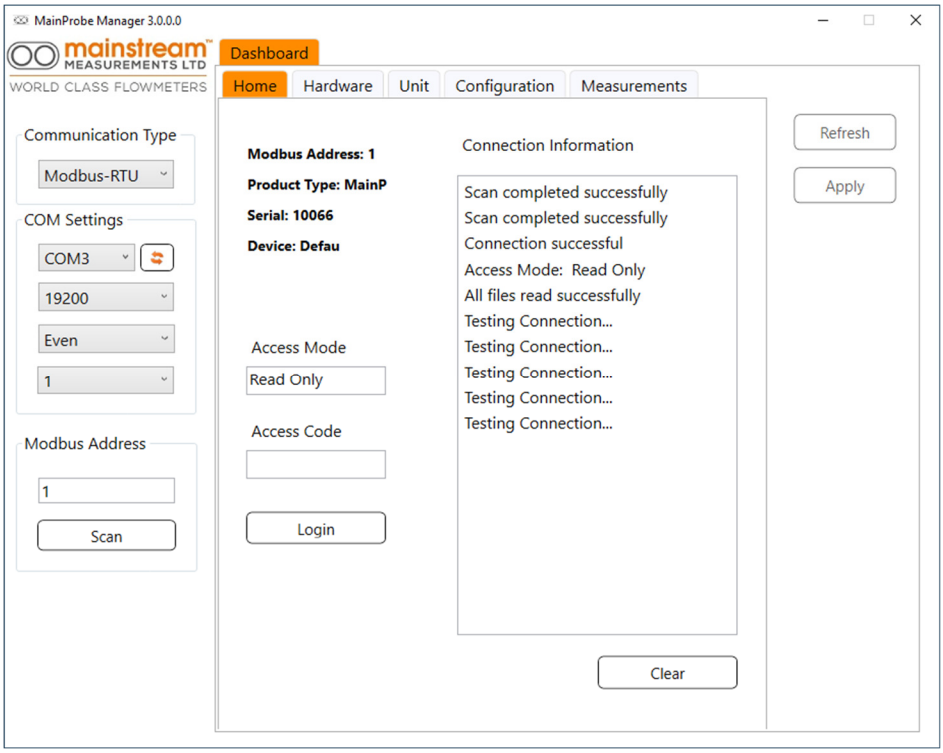
Scan – The Scan button triggers a sequence of Modbus messages which will interrogate the attached Modbus bus, to determine if one or more MainProbes are attached to the bus.

The **Modbus address** box is used to specify which Modbus Address's the software should interrogate.

The address can be entered as a single number (between 1-247), for example, "1" or "123". Or the address can be entered as a range, for example, "1-3" or "100-120".

Scanning each address can take up to 3 seconds.

If a MainProbe is found during the scan, its details will be displayed in a panel on the left of the dashboard (pictured below).



Connect – Once a scan has been completed and Communicator has successfully identified one or more MainProbe devices attached to the bus, these devices can then be configured. To configure a device, you must first connect to it. Clicking the connect button will enter a session with the selected MainProbe.

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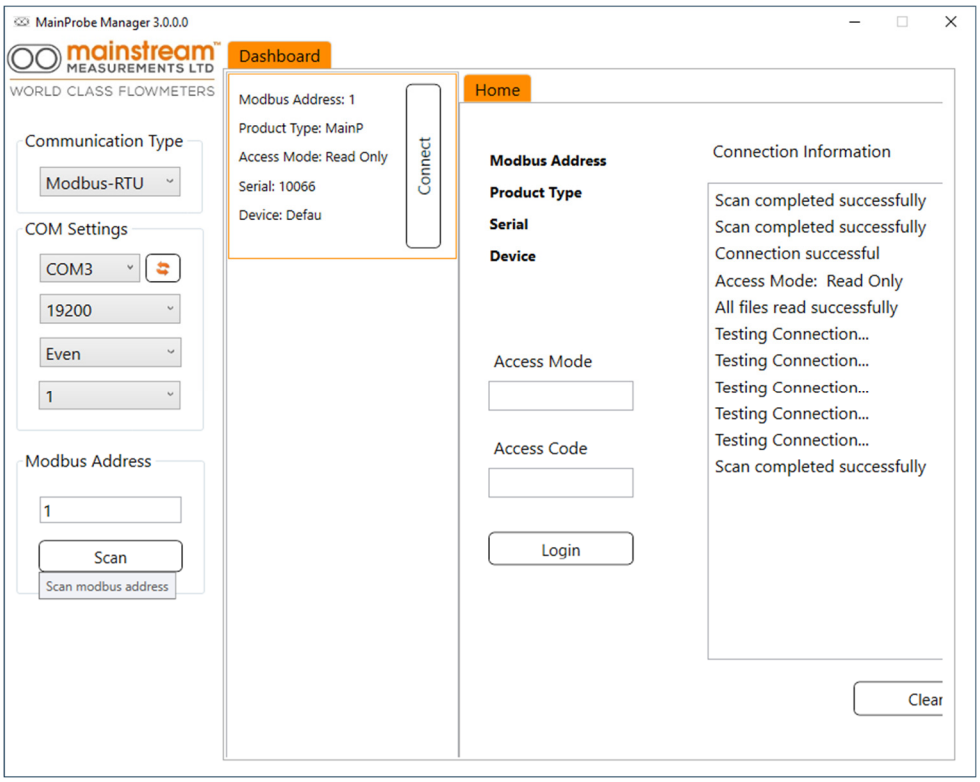

Login – The Login button is used to change the access mode of the connected MainProbe, you must be connected to a MainProbe before clicking this button.

Once connected to a MainProbe, Communicator will issue regular messages to the MainProbe to prevent the firmware from reaching its communications timeout. If the communications timeout (2 minutes 30 seconds) elapses without a message being sent to the MainProbe, the probe will automatically return itself to Read-Only mode.

Enter a 4-digit, numerical Access Code into the **Access Code** text box before clicking the Login button.

Upon clicking the Login button, the MainProbe will evaluate the access code you have submitted. If the MainProbe determines the access code submitted is valid, it will automatically update to the Access Mode, this change will be reflected on the Communicator interface, in the **Access Mode** text box. Shown on the right, is a successful login, to Advanced mode.

If an invalid Access Code is entered, the MainProbe will return to Read-Only mode.

Valid Access Codes are listed below:

Access Mode	**Access Code**	Description
Read-Only	**0000**	Used to force measurements, edit measurement units, and view the device configuration.
Basic	**1234**	Same as Read-Only mode + used to alter communications settings, custom device name, measurement interval and restore default settings.
Advanced	**5678**	Same as basic mode + used to modify all other configurable settings.

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14.2: Communicator Buttons

Refresh – The refresh button will initiate a file read operation, where a file is read from the MainProbe into the software UI, updating the information displayed by the UI.

The Refresh button will update the tab that is currently being viewed by the user and any additional sub-tabs. Clicking the Refresh button while viewing the Velocity Sensor sub-tab within the Configuration tab, will update both the Velocity Sensor sub-tab and the Modbus-RTU sub-tab, but any tabs outside of the Configuration tab (such as the Measurements tab) will not change.

Apply – The Apply button will initiate a file write operation, where a file is written from the software UI into the MainProbe. The Apply button will compile a file to write, containing only the parameters that have undergone a change, since they were last read from the device.

If a parameters value is the same as its last known value, it will not be written into the device.

After the file write operation is completed a file read operation is carried out to ensure the file write was successful and that the information on the UI is up to date, this is carried out automatically.

If you attempt to change the current tab without applying any changes you have made, you will be asked if you would like to apply the changes you have made, to the MainProbe. If you click yes, the software will write the contents of the tab (and any corresponding sub-tabs) into the unit, as though the apply button had been clicked and then continue its switch to your desired tab. If you choose no, the software will restore the tab to show the set of values most recently read from the MainProbe.

Force measurements – This button is new to the MainProbe and allows the user to manually force the MainProbe to take a measurement, meaning the user no longer has to wait for their measurement interval to elapse before they can see an up-to-date measurement. This feature can be useful during installation when you may wish to take multiple readings in quick succession to ensure the validity of the probes installation.

The button initiates a routine that uses the Measurements Complete register to trigger a measurement and to determine if that measurement has finished. The routine instigated by this button is the same routine detailed in section 0

The Force Measurements button appears on all 3 sub-tabs of the Measurements tab, each of these 3 buttons results in the same action being performed by the probe.

When a measurement is forced, a new set of readings are products, this will include velocity, signal quality, temperature and power supply voltage. For every velocity reading that is taken, a new velocity signals graph and velocity histogram are also produced. Hence, clicking the Force measurements button will affect all 3 sub-tabs of the measurements tab, simultaneously, the button does not need to be clicked for each sub-tab separately. The button is featured on each sub-tab, for convenience.

Important: This button will not update the values displayed to the user on the UI. It will simply force the measurement to take a measurement and store the data. In order to display this data on the UI the Refresh button must then be clicked, this will read the new measurement data, from the MainProbe, into the UI.

Restore defaults – This button is only accessible in Advanced mode, when clicked, the button will first ask the user if they are sure they would like restore default settings. If you click no, the message box will disappear, and the user can continue to use the software. If you click yes, the software will send a command to the probe, this will immediately restore default values to specific registers on each tab.

When the defaults are restored while viewing the **Hardware** tab no changes are made to the data on the tab, the function on this tab is reserved for future use.

When the defaults are restored while viewing the **Unit** tab, the following parameters are restored to their corresponding default values:	
Parameter	**Default Value**

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Device Name	"Default "
Application Name	"Default "

When the defaults are restored while viewing the **Configuration** tab, the following parameters are restored to their corresponding default values:

Parameter	**Default Value**	**Parameter**	**Default Value**
Baud Rate	19200	Bi-Directional Velocity	On
Stop Bits	1	Transmit Power	High
Data Bits	8	Noise Suppression	Medium
Parity	Even	MAMS Cycle Count	Medium
Modbus Server Address	1	Histogram Averaging	Off
High Byte First	Off	Signal Quality Cut Off	10%
High Word First	On	Velocity Fail Holdoff Count	3
Measurement Time	1 Second	Velocity Direction Reversal	Off
Measurement Interval	30 Seconds		

When the communications parameters (baud rate, stop bits, data bits, parity and Modbus Server Address) are restored to their default values, the Communicator interface will automatically re-configure its communications parameters to match the default values. Communicator will also, automatically adjust its communications parameters to match any **manual** changes made to the MainProbe communications parameters.

When the defaults are restored while viewing the **Measurements** tab, the following parameters are restored to their corresponding default values:

Parameter	**Default Value**	**Parameter**	**Default Value**
Measurements Complete	1	Signal Quality (%)	0.0
Velocity (mm/s)	0.0	Temperature ($°C$)	0.0
Velocity (cm/s)	0.0	Temperature ($°F$)	0.0
Velocity (M/s)	0.0	Supply Voltage (V)	0.0
Velocity (in/s)	0.0	Velocity Signals	Blank
Velocity (ft/s)	0.0	Histogram	Blank
Velocity (ft/min)	0.0		

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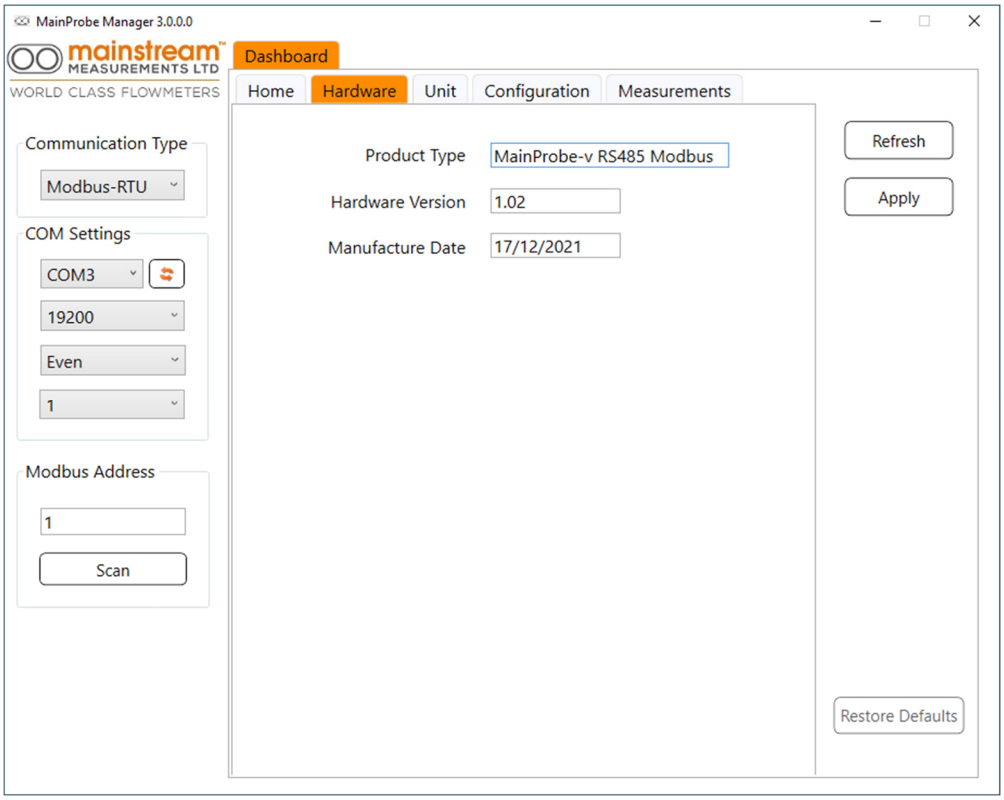
14.3: Communicator tabs

Hardware tab

This tab provides information detailing the exact hardware used to manufacture the MainProbe, this can be used to help trace the origins of the components in the probe. None of the parameters on this tab can currently be written to in any of the Access Modes.



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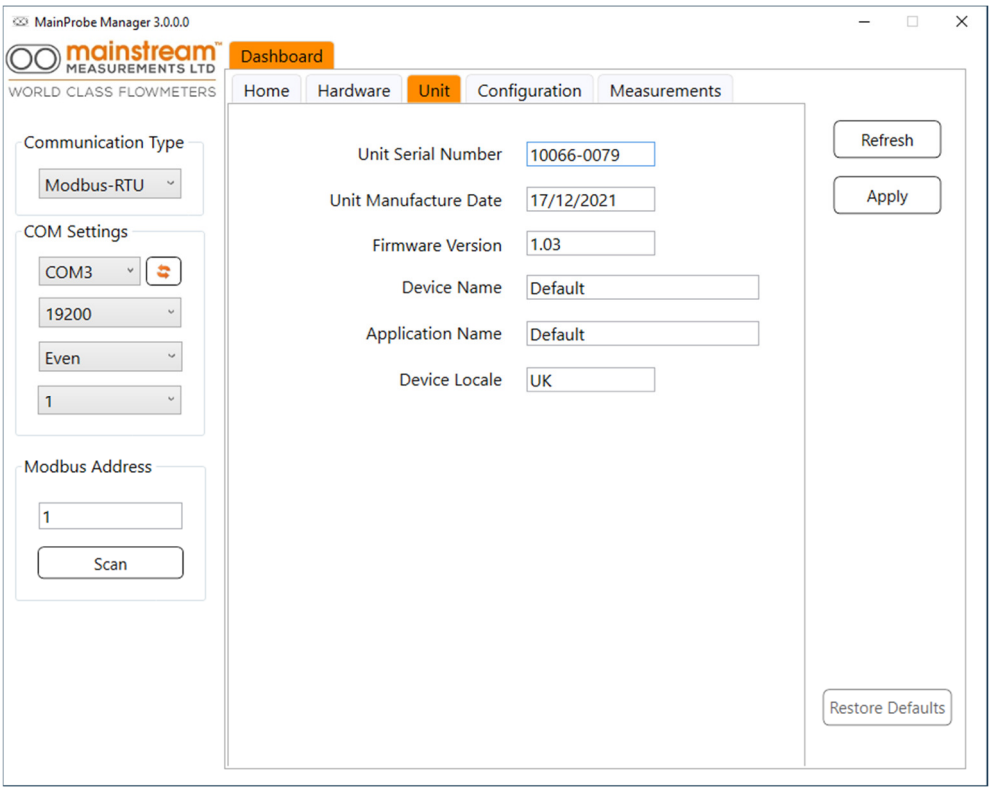
Unit tab

This tab provides information about your specific MainProbe in addition to application specific data. This tab can be used to help identify a device when physical access to the device is not possible. Details such as the unit's serial number are available. The MainProbe can also be given a custom name, allowing it to be easily identified when on a bus with other MainProbes. This name will be shown to the user in the scan window.



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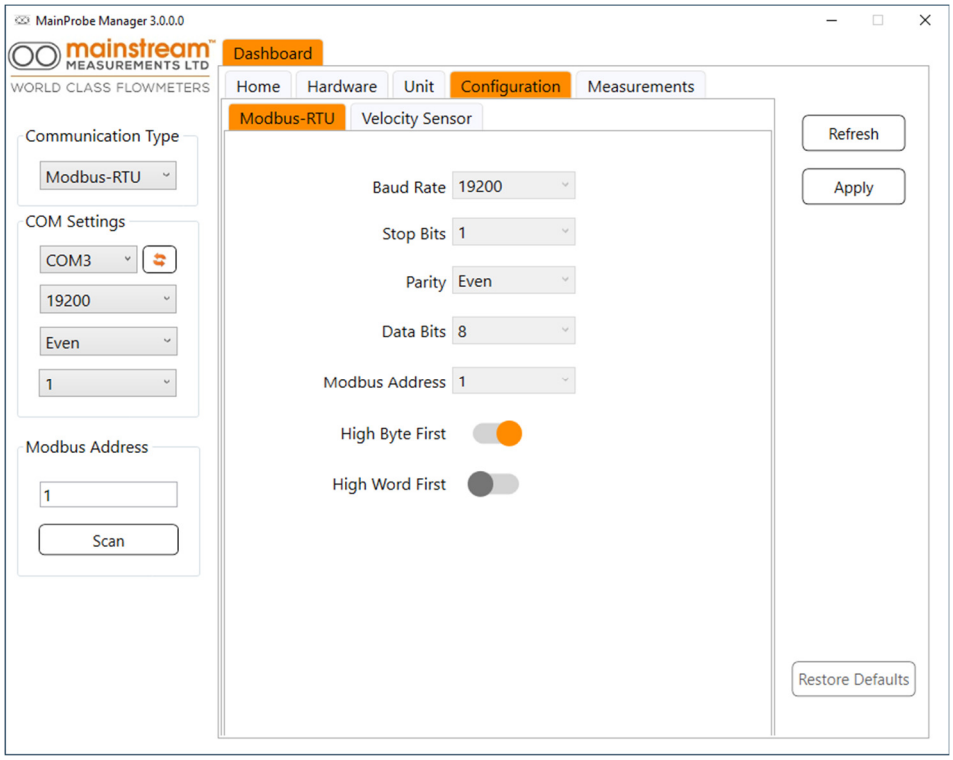
Configuration tab

This tab features two sub-tabs. The Modbus-RTU sub-tab is used to configure the Modbus communications system on the MainProbe, providing access to parameters used to control the RS485 driver and to adjust the Modbus address of the MainProbe. The Velocity Sensor sub-tab provides access to configuration parameters for the ultrasonic velocity sensor on the MainProbe, allowing factors such as the measurement interval and measurement time, to be adjusted.



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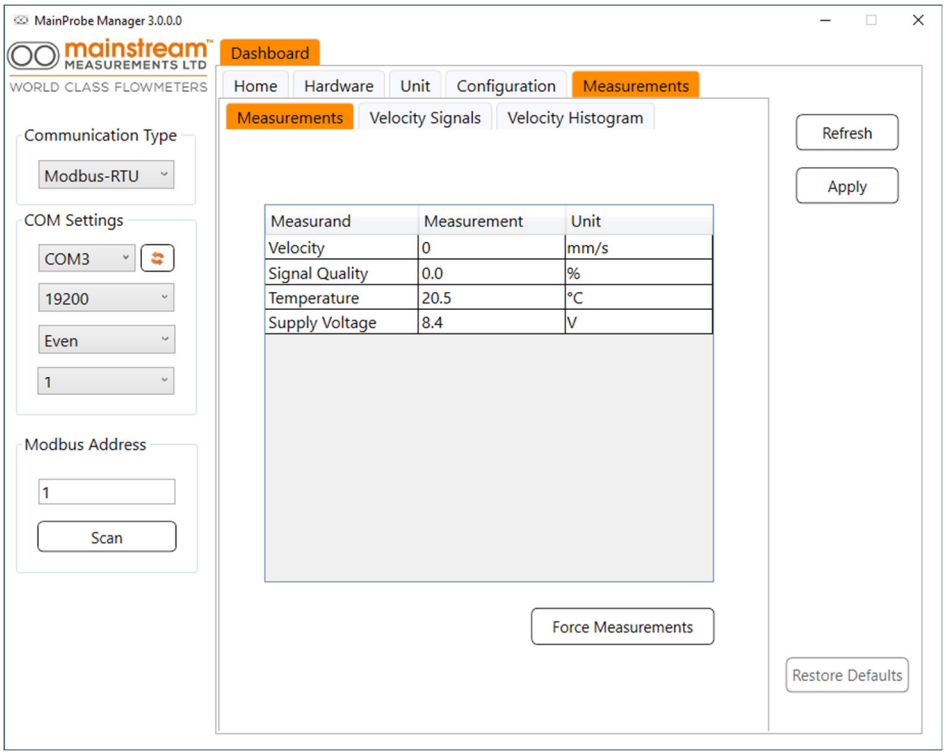
Measurements tab

This tab provides access to the Measurands derived from the sensor hardware on board the MainProbe. The tab features three sub-tabs. The Measurements sub-tab gives a numerical read-out of all of the most recent sensor data gathered by the MainProbe. The units used to express these parameters can be altered here (in any Access Mode). If the apply button is clicked after changing the unit of a measurand, this preference will be retained by the MainProbe and the same unit will be used until it is changed again. When the unit for a measurand is changed the number of decimal places displayed to the user for that measurand also changes, this ensures that only relevant, accurate data is displayed to the user.

More information on the Force Measurements button can be found in section 14.2



The Velocity Signals sub-tab and the Velocity Histogram sub-tab provide diagnostics data for the most recent velocity reading taken by the probe. More information on the velocity diagnostics can be found in section 9:

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15: Appendix – Best Use Of The MainProbe

15.1: Siting the MainProbe

For best results careful siting of the MainProbe is essential. We recommend the following

- If possible have around 2-3 metres of water without obstacles ahead of the Probe.
- Do not have the Probe within range of a pipe bend or other obstruction.
- Do not use more than one ultrasonic device in the same flow – unless they are pointing in different directions away from each other.
- For best results the water flow should be laminar.

15.2: Power efficiency

When controlled from the Communicator application the Probe will be powered continually, however using other equipment, for example an RTU, it may be possible to power-up the Probe, take a reading and power it down. Therefore, the average power consumption will eb greatly reduced.

15.3: Measurement efficiency

The Probe takes approximately 1.7s to perform a measurement. Therefore, although setting a poll time of less than 2s is possible it is not effective.

16: Appendix – Known Issues in Software and Firmware

16.1: Modbus Address Handling

All versions of MainProbe firmware up to and including 1.04 have the following issue.

If resetting the Modbus address the MainProbe will immediately, upon writing to Register 41144 (Modbus Server Address), use that new Modbus address. Consequently, there will be a discontinuity between the communication settings of the host and the Probe and the two will disconnect.

To reconnect with your equipment (or Communicator) you must use the new Modbus Server Address in your Comms settings. You will then regain communication.

If you then want to change other comms settings (for example baud rate) you can do so, and then use the Update Communications register to action this (41146), alternatively you can use the Reboot Product register (41370) to perform a Probe reboot (This is very fast) which will accomplish the same thing.

16.2: Communicator: Disconnected Behaviour

When running Communicator, you should explicitly 'disconnect' from the device when you need to. There is an issue where, if the device is powered down, Communicator will continue top operate as if it is connected. The consequence is that although readings will cease, when the unit is repowered Communicator will immediately resume. It will not show that there has been a dropout and will give the impression that the readings have been continuous.

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