MainProbeX-V RS485 - User Guide
Version 1.0 – March 2025

Disclaimer

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WORLD CLASS FLOWMETERS

Contents

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Warranty

Mainstream Measurements Ltd warrants that the MainProbeX is free from defects in material and workmanship and operate substantially as described in this manual.

If, during the warranty period specified below, the MainProbeX is shown to the reasonable satisfaction of Mainstream Measurements Ltd to be faulty and not to operate substantially as described in this manual, Mainstream Measurements Ltd will repair or replace the MainProbeX.

Mainstream Measurements Ltd will not be responsible for any failure of the MainProbeX caused by incorrect installation or extreme operating conditions and will not in any event be liable for any loss consequential or otherwise, caused by any error, defect, or failure of the MainProbeX, howsoever arising, including but not limited to loss of use, loss of data, loss of profit or loss of contract. The warranty period is 24 months from the date of shipment.

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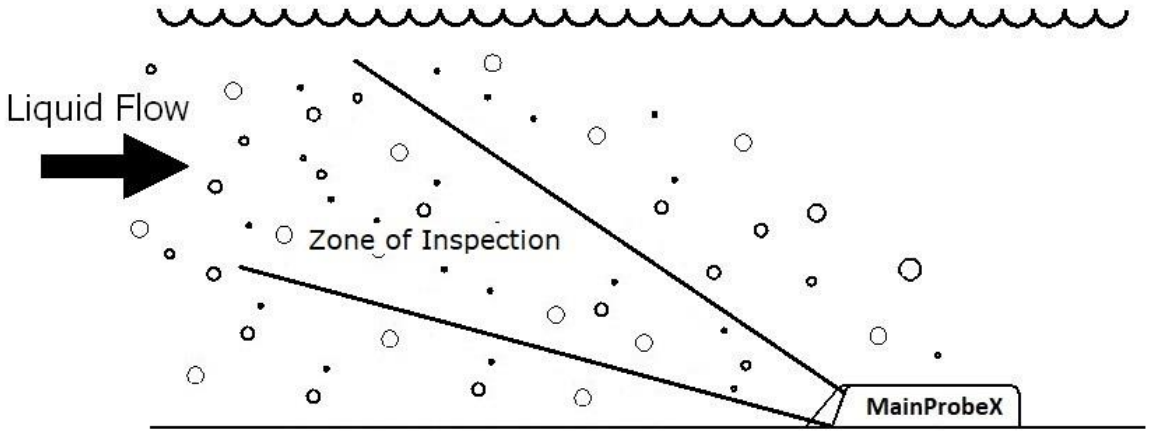
1. HOW IT WORKS

MainProbeX is a streamlined probe which operates immersed in the flowing liquid.

The MainProbeX velocity probe transmits ultrasound into the liquid, to create a **Zone of Inspection.** Containing two ultrasonic grid patterns.



Bubbles or solid particles carried through this Zone of Inspection by the flow, even when present in only very minute quantities, reflect ultrasound back to the velocity probe. **This produces a signal quality measurement and a velocity histogram.**

The **signal quality** is the percentage of the ultrasound signal that contains verified velocity information. A high signal quality confirms the integrity of the measurement.

The processing within the MainProbeX extracts signals received from the two grids patterns and determines the time that the tracer takes to travel the distance between then. The velocity is determined by the spatial separation of the grids divided by the time shift.

The signal processing strategy is effective, even though at any point in time, the Zone of Inspection may contain none, a few, or a very large number of tracers.

The measurement identifies periods when little or no velocity information is contained in the received ultrasound and ignores these signals. Only signals containing useful velocity information are processed, thereby reducing measurement uncertainty.

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1.1. TROUBLESHOOTING USING MAINPROBEX DIAGNOSTICS

Features unique to MainProbeX are signal quality measurement and the velocity histogram display.

These features enable assessment of the installation of the probe.

Signal quality measurement is a unique feature to the MainProbeX. High signal quality confirms the measurement integrity. Monitoring changes in the signal quality gives insight into changes in the flow measurement installation and is a powerful tool to assist the flowmeter maintenance.

When insufficient targets are present, the MainProbeX signal quality falls indicating that measurement is no longer possible. MainProbeX can produce a measurement failure signal.

The measurement range in the forward and reverse direction is identical. This information produces truly bi-directional velocity measurement.

MainProbeX measures the velocity of each target that travels through the sensing volume and **generates a histogram** of these velocity measurements. When velocity data is transferred to the velocity histogram, the magnitude of the ultrasound signal is ignored. Only the velocity is used. The effects of target reflectivity or amplitude are therefore eliminated.

2. MAINPROBEX APPLICATIONS

The MainProbeX velocity sensor is designed to measure the velocity of liquids in open channels and part-filled pipes. Applications include sewer and effluent flow monitoring, river and stream flow measurement, wastewater treatment, industrial flow metering and irrigation systems.

The MainProbeX velocity sensor uses Communicator software which supplies functions to configure the MainProbeX velocity sensor according to the requirements of the measurement application, to test the velocity sensor, to extract diagnostic information from the velocity sensor, to view velocity measurement data in real time.

The MainProbeX velocity sensor can be used in:

- circular, rectangular and oval pipes;
- semi-circular, rectangular, trapezoidal, triangular channels;
- complete and/or mixed sections.

Immediate installation of the sensor is possible under any existing conditions, and a high level of measurement precision and reliability is guaranteed.

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3. PHYSICAL INTERFACE SETUP

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

Insulation colour	Purpose
Yellow	RS485 Half Duplex B-
Brown	RS485 Half Duplex A+
Red	Power (+ve)
Black	Power (-ve)
Clear	Screen

Input voltage (1 device on bus): 6V – 28V

Input voltage (>1 device on bus): 7V – 28V

RS485 Drive capability: 25 unit loads RS485 Input impedance of device: 0.32unit load

Screen connection: Should be connected to 0V or terminated.

Line termination: See official Modbus documentation.

Below, is an example of how the MainProbeX should be connected to an RS485 to USB adapter cable.

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

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4. MAINPROBEX COMMUNICATOR SOFTWARE

MainProbeX Communicator is Windows software which allows the MainProbeX to be configured and managed. MainProbeX Communicator acts as a Modbus client device.

MainProbeX Communicator is provided by USB drive or from the web site.

4.1. Installing Communicator

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

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

Any USB drive provided by Mainstream or "MainProbeX 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.

4.2. .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.

4.3. Connecting to MainProbeX

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

4.4. Connections settings

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

CONNECT– 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 to reveal all the settings).

The **MODBUS ADDRESS** box is used to specify which Modbus Address 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 MainProbeXs are attached to the bus. Default address is 1

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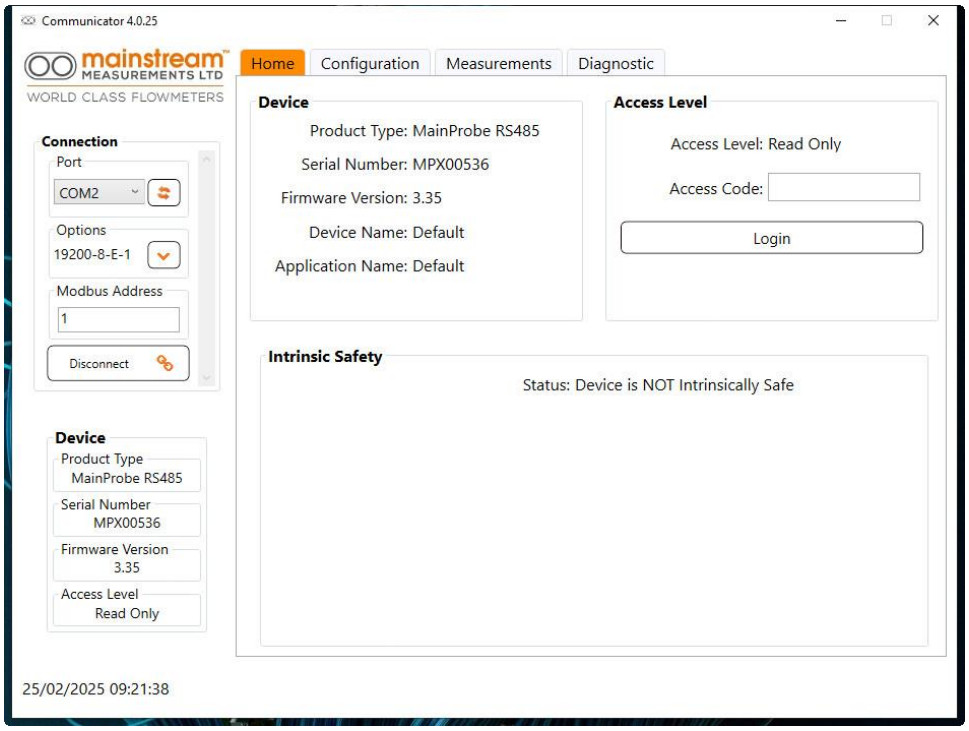
The address can be entered as a single number (between 1-247), for example, "1" or "123". Or the address can be entered as a range, for example, "1-3" or "100-120".

Scanning each address can take up to 3 seconds.

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



4.5. Accessing the MainProbeX

Ensure the MainProbeX is connected to the RS485 to USB adapter cable correctly and the device is powered.

To communicate with the MainProbeX you must know the current **communications settings**. Ensure these settings are selected in the left-hand pane of Communicator. By default settings are as follows:

Baud rate: 19200, Parity: Even, Stop bits: 1, Modbus Address: 1

The correct COM port can be found by navigating to the windows "device manager", expanding the "Ports (COM & LPT) section, un-plugging and plugging-in the USB adapter should identify the COM port being used to host the RS485 to USB adapter.

Click the **Connect** button to detect the MainProbeX. If multiple devices are connected to the RS485 bus, they can be scanned simultaneously using a hyphen in the Modbus Address box, (e.g., 1-3, would scan address's 1, 2 and 3).

Once the connection is successful, you are now in a session with the MainProbeX.

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4.6. Access Level

The Login button is used to change the access mode of the connected MainProbeX, you must be connected to a MainProbeX before clicking this button. Initially the software will log you in as **READ ONLY.**

Once connected to a MainProbeX, Communicator will issue regular messages to the MainProbeX 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 MainProbeX, 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 MainProbeX will evaluate the access code you have submitted.

If the MainProbeX 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.

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**	BASIC used to modify Modbus (Baud Rate, Parity, Modbus Address) and Velocity (Measurement Interval) settings.
Advanced	**5678**	ADVANCED used to modify all other configurable settings.

An incorrect password or closing the software, will cause the MainProbeX to reset and revert to Read-Only mode.

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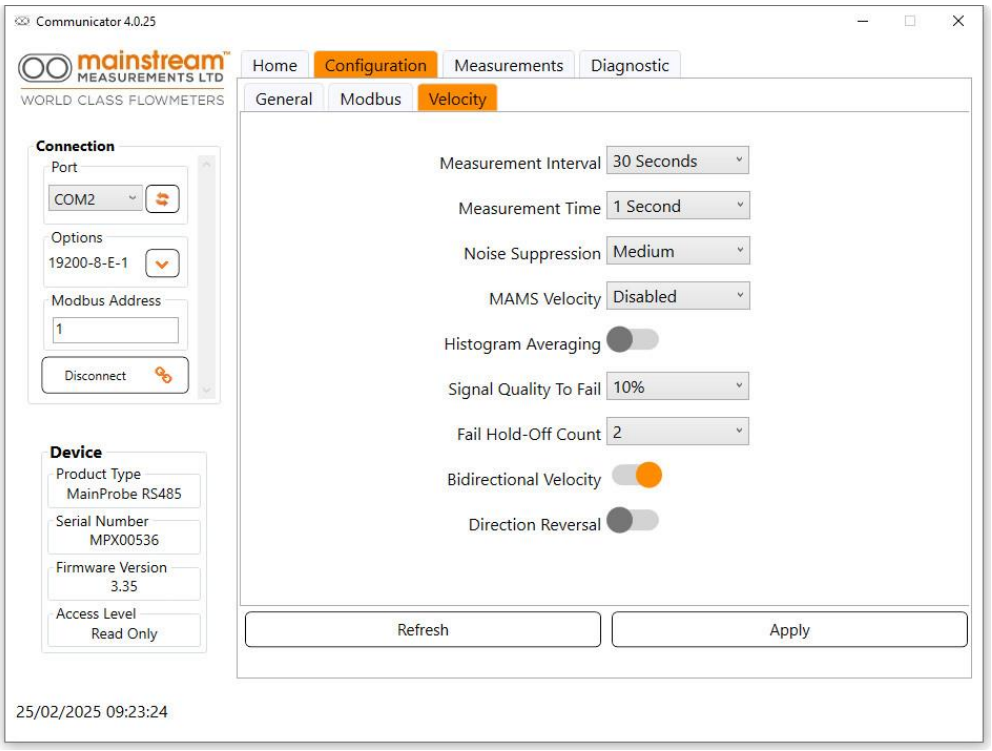
4.7. Configuration

Once you have logged into the unit (if necessary), any changes you make will need to be written to the MainProbeX, this can be done using the **APPLY** button.

Clicking the **REFRESH** button will update the information shown on the current tab.



(ADVANCED mode only)

Clicking the **Reset to Defaults** button will restore the defaults for the Velocity tab.

Once you have configured the device, verify your installation by viewing the Measurements tab.

4.7.1. Measurement Interval

The measurement time is the time elapsed between successive measurements of the liquid flow rate. This can be Continuous, 15 secs, 30 secs, 1 min, 2 min, 5 mins, 10 mins, 15 mins, 20 mins, 30 mins, 1 hour.

4.7.2. Measurement Time

The measurement time is the time that the MainProbeX requires to make a velocity measurement. Rapidly varying flows require a short response time. For slower flows a longer response time may be appropriate.

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4.7.3. Noise Suppression

This allows for unwanted background noise from the signals to be reduced. Noise suppression can reduce the effects of acoustic noise.

4.7.4. Mainstream Adaptive Measurement System (MAMS)

MAMS automatically adjusts the ultrasonic signal acquisition time based on flow conditions, so that each velocity measurement is based on the same quantity of information regardless of the signal quality. For example, if the signal quality is low, it increases the measurement time and thereby increases the quantity of signal processed. Conversely if the signal quality is high, it decreases the measurement time. This means that if the flow conditions are favourable, there will be a reduction in measurement time and therefore less power consumed.

4.7.5. Fail Hold Off Count

Where the signal quality drops below a configured parameter selected by the user, the probe will take a number of sequential velocity measurements before the measured velocity is set to zero.

4.7.6. Bi-Directional Velocity

When enabled, forward flows (towards the probe nose) are represented as positive velocities and reverse flows are represented as negative velocities. When disabled, both forward and reverse flows are represented as positive velocities.

4.7.7. Directional Reversal

When enabled, forward flows (towards the probe nose) are represented as negative velocities and reverse flows are represented as positive velocities.

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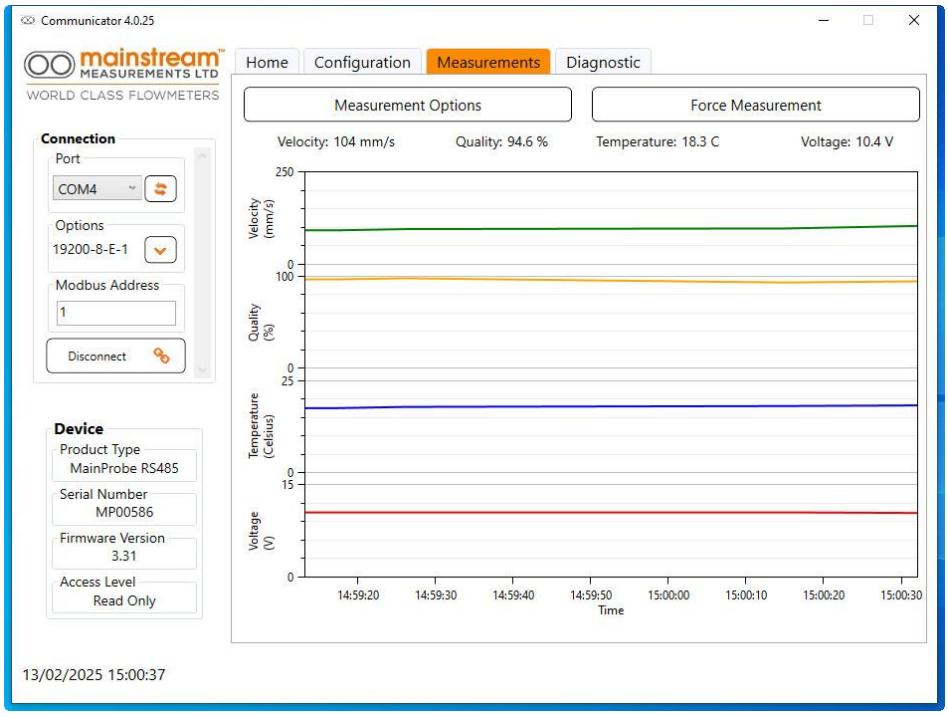
4.8. Measurements



These are graphs representing the readings. The legend above the graphs displays the last reading.

You can manually invoke a measurement using the **FORCE MEASUREMENTS** button.

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4.9. SIGNALS

4.9.1. Signals

The Signals function gives access to data captured from the MainProbeX velocity sensor. This shows the transmit and receive signals in synchronisation.

4.9.2. Signal Quality

The received ultrasound is processed to extract bursts of signal containing verifiable velocity information. Only these signals bursts are used to determine the flow velocity, the remainder of the signal is ignored, thereby ensuring measurement integrity. The signal quality is the percentage of ultrasound signal that contains verified velocity information. A high signal quality confirms the integrity of the measurements.

4.9.3. Signal Quality to Fail

The signal quality to fail is the value of the measured ultrasound signal quality below which it is considered unsafe to determine the flow velocity from the velocity histogram data. When the signal quality falls below the signal quality to fail, the MainProbeX gives the velocity measurement as zero.

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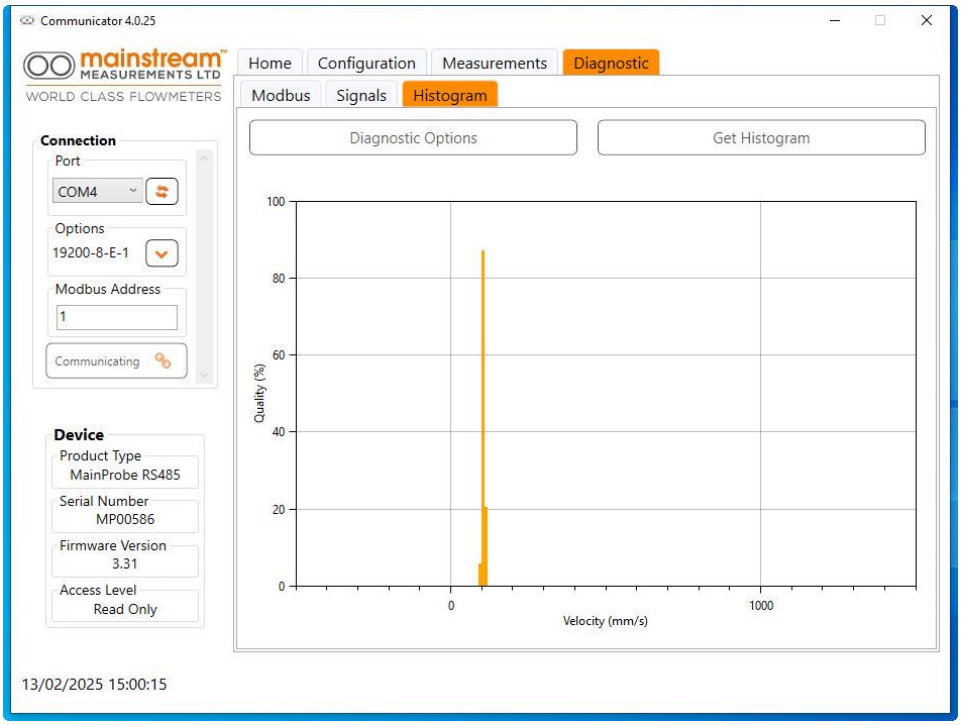
4.10. HISTOGRAM



4.10.1. Histogram Averaging

The histogram shows the distribution of tracer velocities in the Zone of Inspection of the MainProbeX**.** It shows the relative amounts of the ultrasound signal corresponding to each flow velocity. Histogram averaging may be set to either DISABLED or ENABLED.

The normal setting is DISABLED. When histogram averaging is DISABLED, each velocity measurement is based only on information accumulated during the latest measurement interval.

When histogram averaging is ENABLED, part of the information from the previous measurement interval is retained and combined with new information accumulated during the measurement period. This has the effect of smoothing changes in the measurement and can be used to improve measurement repeatability whilst conserving power consumption.

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5. MODBUS INTERFACE DESCRIPTION

5.1. Modbus Response Time

MainProbeX behaves as a server responding to queries from the Modbus client. MainProbeX guarantees to respond to the client with a maximum latency of 1 second.

5.2. Supported Modbus Function Codes

All data in the MainProbeX is stored in **16-bit holding registers.** The registers 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 supported.

5.3. Supported Modbus Exception Codes

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

Exception code 2 - Illegal Data Address - The data address received in the query is not an allowable register address for the MainProbeX.

Exception code 3 - Illegal Data Value – The request targets non-contiguous registers or an incorrect quantity of registers.

5.4. Byte Ordering

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 arrive **first**.

When more than one 16-bit register is requested, these 16-bit words are arranged into 32-bit values. To extract 32-bit data types 2 holding registers should be requested.

Within each 32-bit value the **least significant word**, is sent **first.** This has been set in accordance with the demands of most Modbus client requirements.

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5.5. Supported Data Types

Supported data types are the standard Int16, Int32, float and string. Two addition MML custom data types are also supported – mnemonic and date. Details of the structure of all six of these formats can be found in Appendix A

Note: Several configuration data registers designated as Int32 have valid values that can be represented by an Int16, i.e. the most significant word is always zero. It is allowable to access these registers as Int16.

5.6. Access Levels

MainProbeX features an Access Mode system which allows various categories of user to operate the product. The Access Modes are Read Only, Basic and Advanced.

At power on the Access Mode is Read Only. This prevents unintended changes to the device configuration.

The Basic Access Mode is primarily intended for use by an installer and allows the measurement interval and communication parameters to be set.

In the Advanced Access Mode changes to all user configurable settings are permitted. Diagnostic features are available in all Access Modes.

Access Mode selection is made by writing a PIN to the Access Code register. The current Access Mode can be determined by reading the Access Mode register.

5.7. Boundary Checking and Default Values

Several holding registers on the MainProbeX contain configuration data for Modbus communications and flow velocity measurement. These have minimum and maximum values to which they are restricted.

These registers also have a default value. Writing the value 0xffff to any of these configuration data registers (assuming the current access mode permits writing to the register) will install the default value.

Any attempt to write a value to a register which is outside the specified range and not 0xffff will be ignored.

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The acceptable range of values and the default value for each configuration register is tabulated below.

Parameter	Minimum	Maximum	Default
Communications Configuration			
Baud Rate	0 (2400 Baud)	6 (115200 Baud)	3 (19200 Baud)
Parity	0 (No parity)	2 (Even parity)	2 (Even parity)
Modbus Server Address	1	247	1
Measurement Configuration			
Measurement Interval	0 (Continuous)	10 (1 Hour)	2 (30 Seconds)
Measurement Time	1 (1 Second)	10 (10 Seconds)	1 (1 Second)
Noise Suppression	0 (Low)	2 (High)	1 (Medium)
MAMS Velocity	0 (Disabled)	3 (500 mm/s)	0 (Disabled)
Histogram Averaging	0 (Disabled)	1 (Enabled)	0 (Disabled)
Signal Quality to Fail	0 (10%)	3 (25%)	0 (10%)
Fail Hold-Off Count	0	5	2
Bi-Directional Velocity	0 (Disabled)	1 (Enabled)	1 (Enabled)
Velocity Direction Reversal	0 (Disabled)	1 (Enabled)	0 (Disabled)

5.8. Modbus Registers

5.8.1. Device Identification

An array of registers is available to provide a complete description of the MainProbeX product. These registers are read-only and can be reached in all Access Modes.

Register Name	Address / Register Count / Type	Description
Product Type	40036/16 String	Identifies the specific product variant within the Mainstream product range, e.g. MainProbeX IS
Serial Number	40714/16 String	Unique factory assigned MainProbeX serial number.
Hardware Version	40052/2 Mnemonic	Identification to provide traceability of the MainProbeX hardware.
Manufacture Date	40730/2 Date	Date of final assembly of the MainProbeX product.
Intrinsic Safety Status	40054/2 Int32	Indicates whether the MainProbeX is an ATEX certified product.
Firmware Version	40732/2 Mnemonic	Identifies the version number of the active firmware.

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5.8.2. Access Control

The following registers are used to discover and set the user Access Mode. These registers are read/write in all Access Modes.

Note that if, for a period of two minutes, the MainProbeX device does not receive a Modbus request that is addressed to it, the Access Mode will automatically revert to Read Only.

Register Name	Address / Register Count / Type	Description
Access Code	41134/2 Int32	Writing to this register sets the Access Mode. Valid codes are - 0x00001234 – Basic Mode (binary 4660) 0x00005678 – Advanced Mode (binary 22136) Writing any other value selects Read Only Mode. Reading the register returns 0.
Access Mode	41132/2 Int32	Reading this register returns an integer value representing the active Access Mode. 0 = Read Only 1 = Basic Mode 2 = Advance Mode Writing to the register has no effect.

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5.8.3. Communications Configuration

The following registers configure the MainProbeX communications settings. In order to write to these registers, the Access Mode must first be set to Basic or Advanced.

Register Name	Address/Registers Data Type	Description
Device Address	41144/2 Int32	Integer value representing the MainProbeX Modbus server address. Writing to this register immediately updates the Modbus server address. Valid values are 1 to 247 inclusive. All other values are ignored with the exception of 0xffff which sets the value to 1 which is the default server address.
Baud Rate	41136/2 Int32	Integer value representing the serial communications baud rate setting. Valid values are - 0 = 2400 baud 1 = 4800 baud 2 = 9600 baud 3 = 19200 baud 4 = 38400 baud 5 = 57600 baud 6 = 115200 baud All other values are ignored with the exception of 0xffff which sets the value to 3 to select the default 19200 baud rate. Writing to this register does not change the baud rate being used by the MainProbeX. Set the Device Restart register to 0 to update the active baud rate and parity settings to those stored in the respective registers.
Parity	41142/2 Int32	Integer value representing the serial communications parity setting. Valid values are - 0 = No parity 1 = Odd parity 2 = Even parity All other values are ignored with the exception of 0xffff which sets the value to 2 for the default even parity. Writing to this register does not change the parity being used by the MainProbeX. Set the Device Restart register to 0 to update the active baud rate and parity settings to those stored in the respective registers.

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Device Restart	41146/2 Int32	Set this register to 0 to trigger a restart of the MainProbeX firmware. This updates the serial communications to use the settings stored in the baud rate (41136) and parity (41142) registers. Power cycling the MainProbeX has the same effect. Reading this register always returns 1.

5.8.4. Velocity Measurement Configuration

The following registers configure the MainProbeX velocity measurement settings. An explanation of the function of each configuration parameter can be found on Pages 10 to 14.

Reading these registers always returns the active configuration setting.

To write to these registers the Access Mode must first be set to Advanced. The one exception to this rule is the Measurement Interval register which can also be written when the Access Mode is Basic.

Register Name	Address/Registers Data Type	Description
Measurement Interval	41158/2 Int32	Integer value representing the time interval between the start of each measurement. Writing to this register also resets the Measurement Interval timer. The next scheduled measurement will start after the set Measurement Interval has elapsed. Valid values are - 0 = Continuous 1 = 15 seconds 2 = 30 seconds 3 = 1 minute 4 = 2 minutes 5 = 5 minutes 6 = 10 minutes 7 = 15 minutes 8 = 20 minutes 9 = 30 minutes 10 = 1 hour All other values are ignored with the exception of 0xffff which sets the value to 2 for the default 30 second Measurement Interval.
Measurement Time	41156/2 Int32	Integer value representing the duration (in seconds) of the ultrasonic signals captured for each velocity measurement. Valid values are 1 to 10 inclusive. All other values are ignored with the exception of 0xffff which sets the value to 1 for the default 1 second Measurement Time.

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Noise Suppression	41338/2 Int32	Integer value that determines the level of noise suppression applied to the ultrasound signals. Valid values are - 0 = Low 1 = Medium 2 = High All other values are ignored with the exception of 0xffff which sets the value to 1 to install the default Medium Noise Suppression setting.
MAMS Velocity	41340/2 Int32	Integer value representing the flow velocity above which MAMS is effective. Valid values are - 0 = Disabled 1 = 100 mm/s 2 = 250 mm/s 3 = 500 mm/s All other values are ignored with the exception of 0xffff which sets the value to 0 to configure the default state with MAMS disabled.
Histogram Averaging	41356/2 Int32	Integer value that determines whether the velocity histogram is reset at the start of each measurement. Valid values are - 0 = Disabled 1 = Enabled All other values are ignored with the exception of 0xffff which sets the default value to 0 with Histogram Averaging disabled.
Signal Quality to Fail	41344/2 Int32	Integer value representing the minimum signal quality required to validate a velocity measurement. Valid values are - 0 = 10% 1 = 15% 2 = 20% 3 = 25% All other values are ignored with the exception of 0xffff which sets the default value to 0 for 10% Signal Quality to Fail.
Fail Hold-Off Count	41352/2 Int32	Integer value representing the number of sequential velocity measurements with signal quality below the Signal Quality to Fail that must occur before the measured velocity is set to zero. Valid values are 0 to 5 inclusive. All other values are ignored with the exception of 0xffff which sets the Fail Hold-Off Count to the default value 2.

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Bidirectional Velocity	41334/2 Int32	Integer value that determines how reverse flow velocities are interpreted. When enabled, forward flows (towards the probe nose) are represented as positive velocities and reverse flows are represented as negative velocities. When disabled, both forward and reverse flows are represented as positive velocities. Valid values are - 0 = Disabled 1 = Enabled All other values are ignored with the exception of 0xffff which sets Bidirectional Velocity to the default Enabled state.
Direction Reversal	41354/2 Int32	Integer value that determines whether the sign of the measured velocity is altered to change the apparent direction of the flow. Valid values are - 0 = Disabled 1 = Enabled All other values are ignored with the exception of 0xffff which sets Direction Reversal to the default Disabled state.

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5.8.5. Velocity Measurement Results

The following registers hold the results of the most recent measurement cycle. With the exception of the Measurement Complete register, which can be written to in any Access Mode, all these registers are Read Only and writing to them has no effect.

Register Name	Address/Registers Data Type	Description
Measurement Complete	41374/2 Int32	Integer value indicating whether the MainProbeX is actively making a velocity measurement. Possible values are - 0 = Measurement in Progress 1 = Measurement Complete Unless the register is already 0, setting the register to 0 forces the MainProbeX to start a new velocity measurement. This also resets the Measurement Interval timer. Writing any other value is ignored.
Velocity (mm/s)	41376/2 float	Reading this register returns the most recent velocity measurement in mm/s.
Velocity (cm/s)	41378/2 float	Reading this register returns the most recent velocity measurement in cm/s.
Velocity (m/s)	41380/2 float	Reading this register returns the most recent velocity measurement in m/s.
Velocity (in/s)	41382/2 float	Reading this register returns the most recent velocity measurement in in/s.
Velocity (ft/s)	41384/2 float	Reading this register returns the most recent velocity measurement in ft/s.
Velocity (ft/min)	41386/2 float	Reading this register returns the most recent velocity measurement in ft/min.
Signal Quality (%)	41388/2 float	Reading this register returns the most recent signal quality measurement in %.
Temperature (ºC)	41390/2 float	Reading this register returns the most recent temperature measurement in degrees Celsius.
Temperature (ºF)	41392/2 float	Reading this register returns the most recent temperature measurement in degrees Fahrenheit.
Supply Voltage (V)	41394/2 float	Reading this register returns the most recent power supply voltage reading in volts.

6. APPENDIX A - SUPPORTED DATA FORMATS

MainProbeX supports six data types; the standard Int16, Int32, float and string, plus two addition custom data types, mnemonic and date. Details of the structure of all six of these formats is presented below.

Int16- Constructed from a single 16-bit register

The 16-bit integer decimal number:	"4660"	
Can be expressed as the bytes:	"12 34"	**(AB)**
These will be received from the MainProbeX as:	"12 34"	**(AB)**
The register address for this data would be:	"12 34 = 4xxxx"	**(AB)**

Int32 – Constructed using 2, concatenated 16-bit registers:

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

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.

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

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

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 MainProbeX 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)**

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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 MainProbeX 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"	**(A**B**)**

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 MainProbeX manufacture date.

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

Taking a measurement

There are four possible trigger sources that can result in the MainProbeX taking a measurement **(velocity, signal quality, temperature and supply voltage)**.

1. **Powering up the MainProbeX.**
2. **The measurement interval timer elapsing.**
3. **Writing a 0 to the "Measurements Complete" register.**
4. **On Demand or Force Measurement.**

When set, every time the Measurement Interval elapses, a measurement is taken.

When a set of measurements is taken, the "Measurements Complete" register 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" register will force the device to take a measurement, provided the device is not already busy taking a measurement.

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

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

The procedure for manual measurement taking should be as follows:

1. Check the Measurements Complete register is set to a 1 (device not currently busy).
2. Write a 0 to the Measurements Complete register.
3. Read the Measurements Complete register periodically (1s intervals), until the register 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 register.
5. Once the measurements are complete. The user can read the desired velocity register depending on their preferred unit.

For standard applications where a velocity reading is taken regularly, it is simpler to set the MainProbeX to a preset measurement interval and poll velocity at a regular interval controlled by the Modbus master device. The previously described sequence is only necessary 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, responses slow. If it can be avoided, it is better to avoid sending large data requests to the device during a measurement.

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