MX7M Cold Cathode Ionization Gauge
Instruction Manual
Rev G

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1. Introduction

1.1 Disclaimer

1.1.1 All information in this manual is subject to change without notice. The Fredericks Company assumes no responsibility for inaccuracies in product specifications or any liability arising from product use. Please contact Televac® at sales@frederickscompany.com or call +1 215 947 2500 with comments or questions.

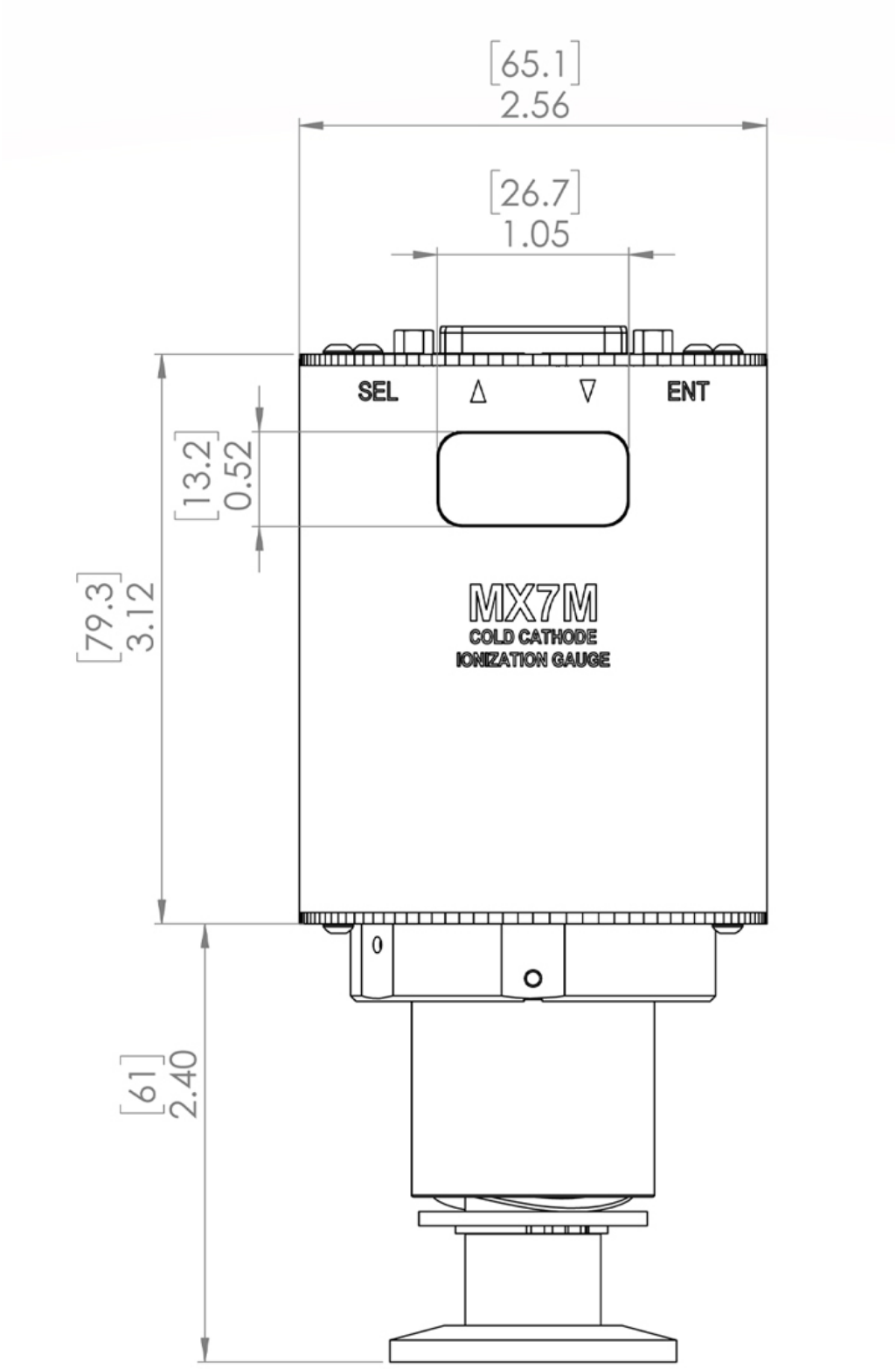
1.2 Description

1.2.1 The MX7M is cold cathode ionization gauge with a measurement range of $5*10^{-11}$ Torr to $1*10^{-2}$ Torr. It utilizes a Televac® cold cathode ionization sensor in the inverted magnetron configuration with part numbers 2-8950-KF25 (KF25 flange version), 2-8950-KF40 (KF40 flange version), 2-8950-KF16 (KF16 flange version) or 2-8950-CF40 (CF40 flange version). It has a two-color OLED display with selectable units of Torr, Millibar, and Kilopascal. Settings can be changed through RS-485 communications with a PC, through USB communications with a PC, or through the unit's front panel using four capacitive touch buttons located on the top of the unit. The MX7M has two set points, one relay and one open collector, and a selectable analog output option. The analog output is a configurable 0-10 V output that includes options for linear, linear-by-decade, and logarithmic formats.

1.3 Specifications

Operating Range	$5*10^{-11}$ to $1*10^{-2}$ Torr
Communications	RS-485 and USB
Programmable Set Points	2
Set Point 1	Open Collector
Set Point 2	Relay
Analog Output	Configurable 0 to 10 V DC
Supply Voltage	+22 to +26 V DC
Maximum Power	8 W
Calibration Medium	Dry air or nitrogen
Overpressure	150 PSI
Digital Output Resolution	2 significant digits with exponent
Analog Output Resolution	16 bits
Operating Temperature	0 °C to 50 °C
Storage Temperature	-20 °C to 60 °C
Bakeout Temperature	250° C (electronics removed)
Response Time	≤ 1 second
Accuracy	
$1*10^{-9}$ to $1*10^{-3}$ Torr	±30%
Analog Output	± 10 mV
Display Readable Distance	3 m (10 feet)

1.4 Dimensions



2. Safety Information

2.1 General Safety Information

2.1.1 In these instructions the word “product” refers to the MX7M and all of its approved parts and accessories. NOTE: These instructions do not and cannot provide for every contingency that may arise in connection with the installation, operation, or maintenance of this product. Should you require further assistance, please contact Televac® at the email address found in the footer of this manual.

2.1.2 This product has been designed and tested to offer reasonably safe service provided in it is installed, operated and serviced in strict accordance with these safety instructions.

2.1.3 These safety precautions must be observed during all phases of operation, installation, and service of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Televac® disclaims all liability for the customer’s failure to comply with these requirements.

2.1.3.1 **READ** Instructions – Read all safety and operating instructions before operating the product.

2.1.3.2 **RETAIN** instructions – Retain the safety and operating instructions for future reference.

2.1.3.3 **HEED** warnings – Adhere to all warnings on the product and in the operating instructions.

2.1.3.4 **FOLLOW** instructions – Follow all operating and maintenance instructions.

2.1.3.5 **ACCESSORIES** – Do not use accessories not recommended in this manual as they may require a technician to restore the product to its normal operation.

2.1.4 The MX7M has voltages up to 4500 volts. As such, it represents a shock hazard and should be handled with caution. Any disassembly of the gauge should be carried out by a trained professional and with the power disconnected.

2.1.5 Do not substitute parts or modify instrument. Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modifications to the product. Return the product to Televac® for service and repair to ensure that safety features are maintained. Do not use this product if it has unauthorized modifications.

3. Quick Start Guide

3.1 Check what you've received

3.1.1 Compare what you've received to your purchase order.

3.2 Safety Instructions

3.2.1 Review all safety instructions outlined in Section 2.

3.3 Connect Power

3.3.1 Connect a 24V power supply to the unit. See the pin out in Section 4.2 for more information.

3.4 Check the Measurement Screen

3.4.1 The unit should power up and display "OFF" on the measurement screen. Do not attempt to turn on the high voltage.

3.5 Power down the MX7M

3.5.1 Power down the MX7M, and install it on a vacuum stand for use.

4. Set Up

4.1 Installation

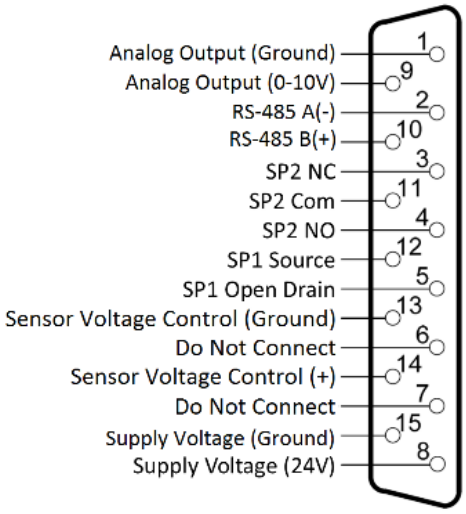
4.1.1 Each MX7M is designed to be used in conjunction with a 7M sensor. The 7M sensor can be mounted in any position however it is recommended to mount it away from any contaminants that might be in the system as over time this can affect the measurement accuracy. Mounting the 7M sensor close to the area where vacuum measurement is desired is preferred to increase the accuracy. Each 7M sensor has a key that only allows for the MX7M to mate with the sensor in the proper orientation. Rotate the MX7M until the correct alignment is obtained and the MX7M is able to slide onto the 7M sensor. Connect the power connector to the top of the unit and be sure to tighten the screws so that a firm connection is maintained.

4.1.2 Try to avoid connecting the MX7M to the vacuum chamber by long or narrow piping as this may affect the accuracy and response time of the unit. Avoid mounting the unit near a heater within the chamber as this may affect the measurement accuracy. Excessive vibration of the unit may affect accuracy and decrease the life of the unit. Exposure to oils and other contaminants will decrease the accuracy and decrease the life of the sensor. Do not expose the unit to corrosive gases.

4.2 Electrical Information

4.2.1 Power connectors and adapters for use with the MX7M are available for purchase from Televac®. Operators wishing to create their own adapters should refer to the pin out of the MX7M below. Each connection labeled “Floating” has no connection and should remain so.

Pin	Description
1	Analog Output (Ground)
2	RS-485 A(-)
3	SP2 NC
4	SP2 NO
5	SP1 Open Drain
6	Do Not Connect
7	Do Not Connect
8	Supply Voltage
9	Analog Output (0-10 V)
10	RS-485 B(+)
11	SP2 Com
12	SP1 Source
13	Sensor Voltage Control
14	Sensor Voltage Control
15	Supply Voltage (Ground)



4.3 Turning the High Voltage On and Off

4.3.1 The MX7M has an operating range that does not include measurement above $1*10^{-2}$ Torr. If the unit is operated above $1*10^{-2}$ Torr, the sensor will be damaged and electrical arcing inside the sensor may occur. To prevent this, the unit should be paired with a low vacuum gauge, such as the MX4A or MX2A, to ensure safe operation.

4.3.2 The MX7M provides two control methods for toggling the high voltage; Menu Control and Pin Control. To select which method is used, navigate to the Vsense Control menu screen and select either Menu or Pins. Pin Control is provided through pins 13 and 14 of the MX7M connector.

4.3.3 To turn on the sensor when Menu Control is selected, use one of the following two options: from the Measurement Screen, press SEL to navigate to the Vsense Control, then press ENT to unlock the control, press UP to toggle the status to ON, and then press ENT to save the change. The high voltage should now turn on. In Menu Control mode, the high voltage can also be toggled by sending the appropriate command to turn on the sensor through RS-485 or USB Communications. To turn off the sensor in Menu Control mode, navigate to the Vsense Control screen, press ENT to unlock the menu, press UP to toggle the status to OFF, and press ENT to save the change. Alternatively, when in Menu Control mode, the user may send the appropriate command to turn off the sensor through RS-485 or USB Communications.

4.3.4 To turn on the sensor when Hardware Control is selected, short pins 13 and 14 together. To turn off the sensor, open the path between pins 13 and 14. This functionality is included to easily interface with a low vacuum gauge, such as the Televac® MX2A or MX4A, to automatically control the unit via an open collector or relay. For more information see Application Note AN 3023.

4.3.5 To protect the sensor from damage, if the sensor high voltage is toggled on when in either Menu Control or Pin Control mode the pressure is above $1*10^{-2}$ Torr, overcurrent protection will turn the sensor off. If the sensor is in Menu Control mode, then a command to turn on the sensor will need to be sent via communication or through the front panel to toggle the high voltage on again. If Pin Control is enabled, then the unit will attempt every to turn the high voltage on every 60 seconds until overcurrent protection does not occur.

5. Menu Navigation

5.1 Description

5.1.1 The MX7M contains many operator customizable features. Changing these features is possible through the menu or via RS-485 or USB communications. To navigate the menu simply use the buttons found on top of the MX7M. The four buttons include the SEL button, an UP arrow, a DOWN arrow, and an ENT button. Using the SEL button allows the operator to change between menu categories. Using the ENT button allows the user to enable value editing and save values in addition to toggling between options where appropriate. Using the UP and DOWN arrows allows navigation through menu options. The UP and DOWN arrow buttons are also used to edit values.

5.2 Menu Structure

- 5.2.1 Measurement
- 5.2.2 High Voltage Toggle
- 5.2.3 System Settings
  - 5.2.3.1 Units
    - 5.2.3.1.1 Torr
    - 5.2.3.1.2 mbar
    - 5.2.3.1.3 Pa
  - 5.2.3.2 Gas Type
    - 5.2.3.2.1 Hydrogen
    - 5.2.3.2.2 Helium
    - 5.2.3.2.3 Neon
    - 5.2.3.2.4 Argon
    - 5.2.3.2.5 Krypton
    - 5.2.3.2.6 Carbon Dioxide
  - 5.2.3.3 Resolution
    - 5.2.3.3.1 Low Resolution
    - 5.2.3.3.2 High Resolution
  - 5.2.3.4 Vsense Control
    - 5.2.3.4.1 Menu Control
    - 5.2.3.4.2 Pin Control
  - 5.2.3.5 Diagnostics
    - 5.2.3.5.1 FW Date
    - 5.2.3.5.2 FW Version
- 5.2.4 Calibration
  - 5.2.4.1 $1*10^{-6}$ Torr
  - 5.2.4.2 $1*10^{-5}$ Torr
  - 5.2.4.3 $1*10^{-4}$ Torr
  - 5.2.4.4 $1*10^{-3}$ Torr
  - 5.2.4.5 Analog Output Adjustment
- 5.2.5 Set Points
  - 5.2.5.1 SP1 Off
  - 5.2.5.2 SP1 On
  - 5.2.5.3 SP2 Off
  - 5.2.5.4 SP2 On
- 5.2.6 Output
  - 5.2.6.1 Linear
    - 5.2.6.1.1 10 V Pressure
    - 5.2.6.1.2 0 V Pressure (Non-settable)
  - 5.2.6.2 Linear by Decade
  - 5.2.6.3 Linear by Decade 7F
  - 5.2.6.4 Logarithmic
    - 5.2.6.4.1 10 V Pressure
    - 5.2.6.4.2 0 V Pressure
  - 5.2.6.5 Logarithmic 2
    - 5.2.6.5.1 10 V Pressure
    - 5.2.6.5.2 1 V Pressure
  - 5.2.6.6 RS-485 Output
    - 5.2.6.6.1 Address
    - 5.2.6.6.2 Baud Rate

6. Explanation of Menu Items and Navigation

6.1 Measurement

6.1.1 The measurement screen contains the reading of the sensor in easy-to-read blue digits and includes units. In addition to the digital reading, the yellow bar on the measurement screen provides an analog indication of the pressure based on a logarithmic scale. At $1*10^{-2}$ Torr the yellow bar should stretch across the width of the screen. At $1*10^{-11}$ Torr the yellow bar will disappear, and at $7*10^{-7}$ Torr, the yellow bar will be approximately half way across the screen.

6.1.2 The sensor high voltage must be turned on to display a reading. If the high voltage is not on, the measurement screen will display "OFF". When the high voltage is toggled on, the unit will display "Starting" until the unit has reached a steady measurement. Once a steady measurement is obtained, it will be displayed. If the unit goes into overcurrent protection mode, the display will read "Over". If Pin Control is enabled, the unit will attempt to start every 60 seconds. If overcurrent protection mode continues upon an attempted start, the unit will continue to read "Over". If Menu Control is enabled, the unit will display "OFF" and the high voltage will need to be turned on again. See Section 4.3 for more details. If the high voltage is enabled and the pressure is below $1*10^{-11}$ Torr, then the unit will display "Low" to indicate that the pressure is below the measurable limit.

6.2 High Voltage Toggle

6.2.1 If the unit is in Menu Control Mode, then the user must turn on the high voltage by sending a command over communications or by navigating to the High Voltage Toggle menu screen. Once at the High Voltage Toggle screen, press ENT to unlock the screen, press UP or DOWN to change the setting, and then press ENT to save the change. The high voltage will then turn on and a pressure indication will be displayed on the Measurement Screen. If the pressure is too high, the unit will go into overcurrent protection mode and the high voltage will turn off. To restart the unit once a safe pressure has been achieved at the gauge, simply repeat the steps to turn on the high voltage

6.3 System Settings

6.3.1 The system settings menu contains the ability to change the measurement units, apply a gas correction factor, change the digital resolution to display an extra digit, and set the Vsense Control method for the unit. There is also a diagnostic screen for use by Televac® service representatives to troubleshoot the unit.

6.3.1.1 To modify the system settings
6.3.1.2 Navigate to the measurement screen.
6.3.1.3 Press SEL twice.
6.3.1.4 Press UP and DOWN arrows to navigate between panes under the system settings heading.
6.3.1.5 Press ENT to unlock the specific screen. ADJ will appear at the top of screen to show that the unit is unlocked and that a change can be made.
6.3.1.6 Press UP or DOWN to select between the options available.
6.3.1.7 Press ENT to save the changes or SEL to navigate away without saving. ADJ will disappear from the screen after either ENT or SEL has been pressed.

6.3.2 **Units**

6.3.2.1 The MX7M has three selectable units to choose from: Torr, mbar, and Pascal. When changing units, all of the relevant settings previously saved in the unit will be converted to the appropriate units.

6.3.3 Gas Type

6.3.3.1 The MX7M is an indirect pressure sensor and its accuracy will be affected by the presence of gases other than nitrogen. The MX7M has the ability to apply correction factors for six pre-defined gases: hydrogen, helium, neon, argon, krypton, and carbon dioxide. These correction factors have been experimentally determined by Televac® to yield the maximum accuracy available. Conversion factors for use with the MX7M when gases to be measured are other than Nitrogen are listed. For users wishing to manually apply the conversion, multiply the unit reading by the factor in the table below to convert to the correct pressure reading.

Gas Type	Conversion Factor
Nitrogen	1.00
Hydrogen	3.00
Helium	8.90
Neon	4.30
Argon	0.84
Krypton	0.59
Carbon Dioxide	0.69

6.3.4 Resolution

6.3.4.1 The MX7M displays two significant digits by default (low resolution). The user may choose to operate the gauge in high resolution mode in which the unit will display three significant digits.

6.3.5 High Voltage Control

6.3.5.1 The MX7M has an upper range of $1*10^{-3}$ Torr and will be damaged by use above this pressure. Toggling of the unit on and off can be accomplished via software, through the menu or via communications, or hardware means, via two pins on the DB-15 connector. For more information on the difference between hardware and software control, see Section 4.3.

6.3.6 Diagnostics

The MX7M contains a diagnostic screen for use by Televac® service representatives to troubleshoot the unit. The Diagnostic screen contains the FW version of the unit and the date the software was last revised.

6.4 Calibration

6.4.1 To ensure that the unit always displays with the most accuracy, the MX7M includes a number of operator-configurable calibration points. While the MX7M is factory calibrated, the use of the included calibration points may become necessary after extended use, contamination, etc. If accuracy is critical, it is recommended to return the sensor to Televac® for NIST-traceable calibration.

6.4.2 The unit should only be calibrated when under vacuum and a NIST-traceable calibrate reference is available. Any change of calibration values by the customer voids any Televac® calibration and should only be used in when in line with a defined quality system.

6.4.3 To modify the calibration settings:

6.4.3.1 Navigate to the measurement screen.

6.4.3.2 Press SEL three times.

6.4.3.3 Press the UP and DOWN arrows to navigate between panes under the calibration heading.

6.4.3.4 Press ENT to select the calibration point.

6.4.3.5 Press UP or DOWN until the unit matches the reference in use for calibration.

6.4.3.6 Press ENT to save the adjustment. Press SEL to exit without saving.

6.4.3.7 Note 1: Calibration should be performed in the following order: $1*10^{-6}$ Torr adjustment, $1*10^{-5}$ Torr adjustment, $1*10^{-4}$ Torr adjustment, $1*10^{-3}$ Torr adjustment. Failing to calibrate -in this order will result in inaccuracies.

6.4.3.8 Note 2: Changing calibration settings voids NIST-Traceable calibrations!

6.4.4 **10^{-6} Torr**

6.4.4.1 The $1*10^{-6}$ calibration point allows the gauge to adjust the pressure reading at $1*10^{-6}$ Torr. This calibration point should not be used to adjust the gauge reading below a reference pressure of $5*10^{-7}$ Torr or above $2*10^{-6}$ Torr.

6.4.5 **10^{-5} Torr**

6.4.5.1 The $1*10^{-5}$ calibration point allows the gauge to adjust the pressure reading at $1*10^{-5}$ Torr. This calibration point should not be used to adjust the gauge reading below a reference pressure of $5*10^{-6}$ Torr or above $2*10^{-5}$ Torr.

6.4.6 **10^{-4} Torr**

6.4.6.1 The $1*10^{-4}$ calibration point allows the gauge to adjust the pressure reading at $1*10^{-4}$ Torr. This calibration point should not be used to adjust the gauge reading below a reference pressure of $5*10^{-5}$ Torr or above $2*10^{-4}$ Torr.

6.4.7 **10^{-3} Torr**

6.4.7.1 The $1*10^{-3}$ calibration point allows the gauge to adjust the pressure reading at $1*10^{-3}$ Torr. This calibration point should not be used to adjust the gauge reading below a reference pressure of $5*10^{-4}$ Torr or above $2*10^{-3}$ Torr.

6.4.8 **Analog Output Adjustment**

6.4.8.1 The MX7M allows for an offset calibration of the MX7M to provide maximum accuracy for users where long cable lengths are affecting the accuracy. To calibrate the analog output, adjust the pressure of the vacuum system to a stable pressure corresponding to the value near the maximum analog output. Measure the analog output with a volt meter, compare the displayed pressure on the gauge to the calculated pressure based on the analog output, and adjust the calibration until the displayed pressure and calculated pressure match. See section 7.

6.5 Set Points

6.5.1 The MX7M contains two set points for the convenience of the operator. Set point 1 is an N-Channel 60 V MOSFET open collector. It has a maximum current rating of 1 A. The data sheet can be found at www.vishay.com/docs/69958/si2308bds.pdf. Set point 2 is a relay with a maximum switching voltage of 220 V DC (250 V AC) and a maximum switching current of 2 A. The data sheet can be found at www.te.com/catalog/pn/en/1393788-3.

6.5.2 To modify the set point settings

- 6.5.2.1 Navigate to the measurement screen.
- 6.5.2.2 Press SEL four times.
- 6.5.2.3 The set point screen contains set point 1 off.
- 6.5.2.4 To access set point 1 on, set point 2 off, or set point 2 on, press DOWN from the initial set point screen.
- 6.5.2.5 When the correct set point is selected, press ENT to unlock the set point adjustment screen.
- 6.5.2.6 Press UP and DOWN to change the value.
- 6.5.2.7 When the desired reading is reached, press ENT to save the change or SEL to navigate away without saving the change.

6.6 Output

6.6.1 The MX7M provides a user selectable analog output as well as RS-485 and USB digital outputs.

6.6.2 To modify the output settings:

- 6.6.2.1 Navigate to the measurement screen.
- 6.6.2.2 Press SEL five times.
- 6.6.2.3 Press UP and DOWN to navigate between the analog output and RS-485 screens.
- 6.6.2.4 When the desired field is present, press ENT to enter the heading.
- 6.6.2.5 To change the desired setting, press ENT to unlock the setting.
- 6.6.2.6 Press UP or DOWN to adjust the setting.
- 6.6.2.7 Press ENT to save the setting or SEL to navigate away without saving.

6.6.3 Analog Output

- 6.6.3.1 The types of analog output are listed below. For more information on the types of output, please see Section 7.

  - 6.6.3.1.1 Linear
    - 6.6.3.1.1.1 10 V
    - 6.6.3.1.1.2 0V (non-settable)
  - 6.6.3.1.2 Linear by Decade
  - 6.6.3.1.3 Logarithmic
    - 6.6.3.1.3.1 10 V
    - 6.6.3.1.3.2 0 V

6.6.4 RS-485 Output

- 6.6.4.1 The RS-485 settable fields are listed below. Please see the Section 9 for more details and a complete list of commands. Listed below are the fields within the RS-485 Output screen.

  - 6.6.4.1.1 Address
  - 6.6.4.1.2 Baud Rate

7. Analog Output

7.1 Description

7.1.1 The MX7M provides the option for outputting the pressure reading in an analog form. Operators who wish to use PLCs to monitor processes should find this function useful. There are three different analog output formats to choose between. The formats include Logarithmic, Linear by Decade, and Linear.

7.2 Linear

7.2.1 The Linear output covers a select range of the MX7M with a linear scale. The 10 Volt or full-scale value of the output can be selected from the following values: $1*10^{-5}$ Torr, $1*10^{-4}$ Torr, or $1*10^{-3}$ Torr. The scale extends three decades below the full-scale value. Three decades below the 10 V value is the 0 V value. This corresponds to the low end of the range and output below the 0 V value is not available. For a wider range use a different analog output format. Note that only the 10 V exponent is selectable. When navigating through the menu, the 0 V exponent will be viewable but not settable. Use the high value ($1.0*10^{H}$) exponent H in the following equation to convert the voltage output to pressure:

$$Voltage\ Output\ \times 10^{H-1} = Pressure$$

7.2.2 To select the Linear output, navigate to the Analog Output screen, press ENT, and then use the UP or DOWN arrow to select Linear. Press ENT to save the change. Then press DOWN once to navigate to the Output High screen. Press ENT to unlock the screen and press UP or DOWN to select the full-scale pressure for the analog output.

7.3 Linear by Decade

7.3.1 The Linear by Decade output spans the entire range of the MX7M. It uses the units digit of the voltage reading to communicate the decade of the pressure reading and the units after the decimal to communicate the specific pressure using the very generalized expression below, where A, B, C, and D are digits ranging from 0-9:

$$Voltage = A.BCD\ \rightarrow Pressure(Torr) -\ 10^{A-11} * .BCD$$

7.3.2 For example, a voltage reading of 8.367 Volts corresponds to a pressure of $3.67*10^{-4}$ Torr.

$$10^{8-11} * .367 -\ 10^{-3} * .367 *\ 10^{-4}\ Torr$$

7.3.3 To select the Linear by Decade output, navigate to the Analog Output screen, press ENT, and then use the UP or DOWN arrow to select Linear by Decade. Press ENT to save the change.

7.4 Logarithmic

7.4.1 The Logarithmic output covers the entire range of the MX7M, or can be used with a selected range. To use this output, the user must select an exponent that corresponds to 10 V DC and the exponent that corresponds to 0 V DC. The exponent chosen for this format uses the formula below to convert the output voltage into a pressure measurement. Note that H is the exponent of the 10 V value and L is the exponent of the 0 V DC value. “Voltage” is the analog output voltage.

$$Span = \frac{10}{\mathrm{H} - \mathrm{L}}$$

$$Offset = 0 - L$$

$$Pressure(Torr) = 10^{\left(\frac{voltage}{Span} - offset\right)}$$

7.4.2 For example, with the logarithmic range set to a 0 V value of $1*10^{-7}$ and a 10 V value of $1*10^{-3}$ and a voltage reading of 3.075 Volts, the pressure corresponds to:

$$Span = \frac{10}{-3 - (-7)} = 2.5$$

$$Offset = 0 - (-7) = 7$$

$$Pressure(Torr) = 10^{\frac{3.075}{2.5} - 7} = 1.7 * 10^{-6}\ Torr$$

7.4.3 To select the Logarithmic output, navigate to the Analog Output screen, press ENT, and then use the UP or DOWN arrow to select Logarithmic option. Press ENT to save the change. Press the DOWN arrow to navigate to the 10 V DC exponent selection screen. Press ENT to unlock and then the UP or DOWN arrow to select the value. Press ENT to save the value. Press the DOWN arrow to navigate to the 0 V DC exponent selection screen. Press ENT to unlock the screen and the UP or DOWN arrow to select the 0 V DC value.

7.5 Logarithmic 2

7.5.1 The Logarithmic 2 output covers the entire range of the MX7M, or can be used with a selected range. To use this output, the user must select an exponent that corresponds to 10.0 V DC and the exponent that corresponds to 1.0 V DC. The exponent chosen for this format uses the formula below to convert the output voltage into a pressure measurement. Note that H is the exponent of the 10.0 V DC value and L is the exponent of the 1.0 V DC value. "Voltage" is the analog output voltage. Any values below $5*10^{-11}$ Torr will output 1.0 V DC.

$$Span = \frac{H - L}{9}$$

$$Pressure(Torr) = 10^{(span * (voltage - 1)) + L}$$

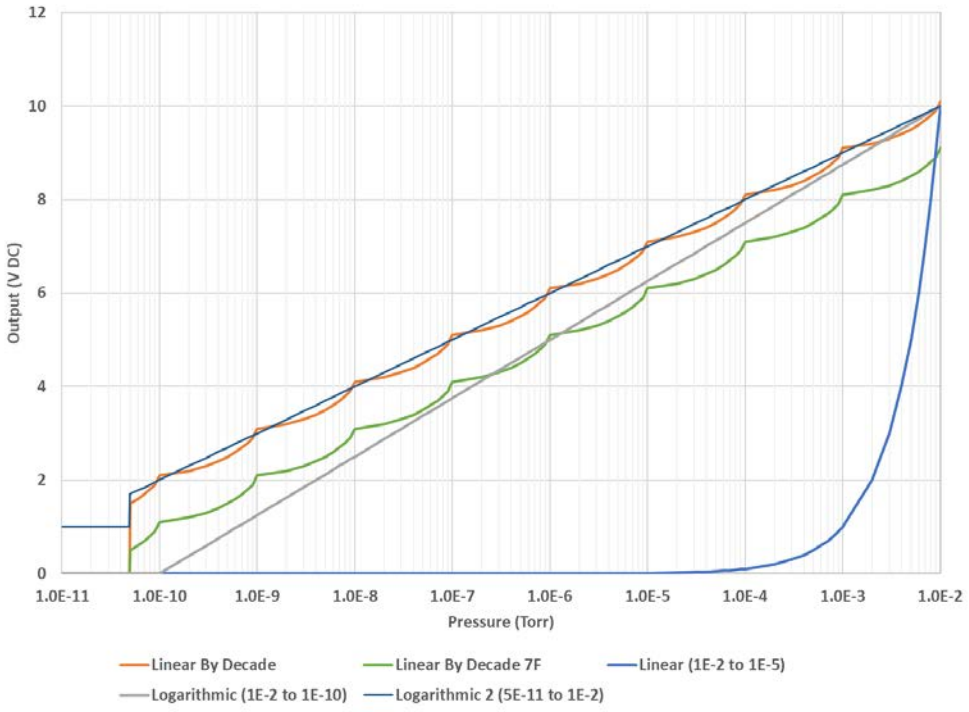
7.5.2 For example, with the logarithmic range set to a 1.0 V DC value of $1*10^{-11}$ and a 10.0 V DC value of $1*10^{-2}$ and a voltage reading of 3.100 V DC, the pressure corresponds to:

$$Span = \frac{-2 - (-11)}{9} = 1$$

$$Pressure(Torr) = 10^{(1*(3.100 - 1))+(-11)} = 1.3 * 10^{-9}\ Torr$$

7.5.3 To select the Logarithmic 2 output, navigate to the Analog Output screen, press ENT, and then use the UP or DOWN arrow to select Logarithmic 2 option. Press ENT to save the change. Press the DOWN arrow to navigate to the 10 V DC exponent selection screen. Press ENT to unlock and then the UP or DOWN arrow to select the value. Press ENT to save the value. Press the DOWN arrow to navigate to the 1 V DC exponent selection screen. Press ENT to unlock the screen and the UP or DOWN arrow to select the 1 V DC value.

Selected analog output graphs for different scaling and high and low values are shown below:



8. Cleaning the MX7M Sensor

8.1 Cleaning Instructions

8.1.1 Remove the sensor from the electronics assembly by loosening the two set screws in the base of the electronics. A .050” Allen wrench is necessary for this step.

8.1.2 Remove the six bolts from the top of the unit. These require a 7/64 Allen wrench.

8.1.3 The MX7M ships by default with a copper gasket to allow customers to use the full range of the MX7M. Any standard CF16 gasket will work with the MX7M. Once the bolts are removed, the used copper gasket can be pulled free and discarded. Be sure not to scratch the knife-edge surface.

8.1.4 If the gasket has been replaced with an O-ring, handle the O-ring gently and wash with isopropyl alcohol, methanol, or DI water. Wipe with a lint-free cloth.

8.1.5 Wipe the inside of the tube with scotch-brite or similar. Do not use steel wool due to the magnets present in the sensor.

8.1.6 If wiping the inside of the tube does not remove all build up, bead blast the vacuum wetted portions of the anode assembly at 30 PSI using 70 to 140 mesh glass beads (labeled with red and blue in the diagram). Be careful not to damage the knife edge of the sensor.

8.1.7 Blast the vacuum wetted portions of the body with glass beads (labeled with blue in the diagram), concentrating on the pole piece and “O” ring areas, but making sure to clean all surfaces wetted to vacuum. If the threaded end of the tube needs to be cleaned, it can be bead blasted as well.

8.1.8 After cleaning, use compressed dry nitrogen to remove any residual glass beads or dust from the sensor.

8.1.9 Wipe the anode with scotch-brite or similar. Blow with compressed dry nitrogen.

8.1.10 Install a new gasket or cleaned O-ring and seat the anode.

8.1.11 Before replacing the bolts, observe the keyway locations line up between the anode and the body.

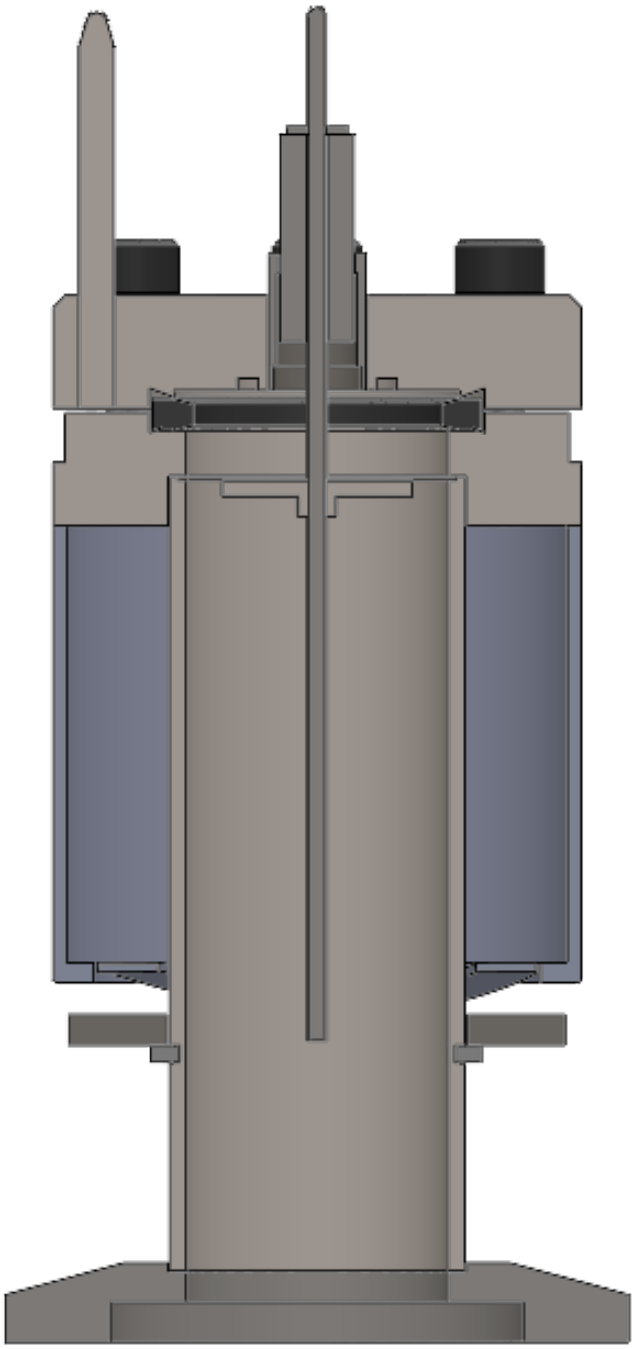
8.1.12 Replace bolts and tighten.

8.1.13 Insert sensor into the electronics and tighten the set screws.

8.1.14 Reinstall the sensor on the vacuum chamber.

8.1.15 Allow several hours for the sensor to degas when your system is pumped down to high vacuum.

8.1.16 If properly cleaned and assembled, the sensor is ready for use without re-calibration unless NIST traceable calibration is required.



8.2 Replacement Part Numbers

Description	Part Number
MX7M Anode Assembly	1-7900-011
MX7M Electronics Assembly	2-8950-000
DN16 Copper Gasket	6-4200-031
DN16 Viton O-Ring	6-4200-030

9. RS-485 and USB Communications

9.1 Description

9.1.1 This gauge communicates with the host computer through an RS-485 or USB interface. Each communication correspondence consists of a command line sent by the host computer and a response from the gauge.

9.1.2 To communicate with the MX7M via RS-485, the user must have an RS-485 capable device to send commands to the MX7M. Each command must be preceded by a *, the address, and will be an S, R, W, RC, or WC.

9.1.3 To communicate with the MX7M via USB, the user must have a USB capable device to send commands to the MX7M. Each command must be preceded by a * and will be an S, R, W, RC, or WC. Because USB is a serial bus, the unit address is omitted from commands. See the Communications Specifications heading for information on what settings are necessary to properly communicate with the MX7M.

9.2 Changing Communications Settings

9.2.1 The communication parameters, (baud rate, address, etc.), are changed through the local menu. Please see Section 6 in this manual entitled Explanation of Menu Items and Navigation for more information on navigating and editing within the menu. Below are provided some specifics on the RS-485 and USB Communications of the MX7M.

9.3 Communications Specifications

9.3.1 RS-485 Communications Specifications

Interface	RS-485 compatible
Data Transfer Method	Synchronous/half duplicate method
Baud Rate	9600/19200/38400/57600/115200
Data Format	1 start bit, 8 data bits, 0 parity bits, 1 stop bit
Error Detection	Parity bit
Parity Bit	None
Stop Bit	1
Transfer Distance	Max 100 meters

9.3.2 USB Communications Specifications

Interface	USB type B receptacle on module
Type	USB 2.0
Class	USB communications device class (USB CDC)
Baud Rate	115200
Transfer Distance	Max 5 meters

9.4 RS-485 and USB Command List

9.4.1 RS-485 and USB Status Commands

Command	Response	Description
S1	ppsee	Read pressure data where ppsee is: pp = mantissa s = sign (0 negative, 1 positive) ee = exponent
S2	abcdef	Read firmware version (6-digit number)

9.4.2 RS-485 and USB General Read Commands

Command	Response	Description
R1	xx	Read units, where xx is: PA = Pa TR = Torr MB = mbar
R2	ppseePPSEE	Read set point values, where: Set point 2 ON given by ppsee Set point 2 OFF given by PPSEE pp or PP = mantissa s or S = sign (0 = negative, 1 = positive) ee or EE = exponent
R3	xx	Read resolution, where xx is: LO = low HI = high
R5	xyzzabb	Read analog output range, where: x = 1 (linear), 2 (log), 3 (linear-by-decade), 4 (linear-by-decade 7F), 5 (logarithmic 2) y = high value exp sign (0 negative, 1 positive) zz = high value exponent a = low value exp sign (0 negative, 1 positive) bb = low value exponent
R6	xx	Read gas type, where xx is: N2 = Nitrogen H2 = Hydrogen NE = Neon C2 = Carbon Dioxide AR = Argon HE = Helium KR = Krypton
R7Y	ppseePPSEE	Read SPL (ppsee) and SPH (PPSEE) settings: Y = 1 (Open Collector) Y = 2 (Relay) pp or PP = mantissa s or S = sign (0 = negative, 1 = positive) ee or EE = exponent
R8	x	Read sensor voltage control, where x is: 1 = menu control 2 = pin control
R10	x	Read high voltage state, where x is: 0 = off 1 = on

9.4.3 RS-485 and USB General Write Commands

Command	Response	Description
W1xx	xx	Set units, where xx is: PA = Pa TR = Torr MB = mbar
W3	xx	Toggle resolution, where xx is: LO = low HI = high
W51yzz	1yzz	Set analog output format to linear: yzz = high value y = high value exp sign (0 negative, 1 positive) zz = high value exponent
W52yzzabb	2yzzabb	Set analog output format to logarithmic: yzz = high value abb = low value y = high value exp sign (0 negative, 1 positive) zz = high value exponent a = low value exp sign (0 negative, 1 positive) bb = low value exponent
W53	3	Set analog output format to linear-by-decade
W54yzzabb	4	Set analog output format to linear-by-decade 7F
W55	5yzzabb	Set analog output format to logarithmic 2: yzz = high value abb = low value y = high value exp sign (0 negative, 1 positive) zz = high value exponent a = low value exp sign (0 negative, 1 positive) bb = low value exponent
W6xx	xx	Set gas type, where xx is: N2 = Nitrogen AR = Argon H2 = Hydrogen HE = Helium NE = Neon KR = Krypton C2 = Carbon Dioxide Response is new gas type
W7YppsePPSE	ppseePPSEE	Set thresholds for set point Y, where: ppsee = SPL PPSEE = SPH Response is new threshold settings for SPL (ppsee) and SPH (PPSEE): Y = 1 (Open Collector) Y = 2 (Relay)
W8x	x	Set sensor voltage control, where x is: 1 = menu control 2 = pin control
W10x	x	Set high voltage state, where x is: 0 = off 1 = on Response is new high voltage setting.

9.4.4 RS-485 and USB Calibration Commands

Command	Response	Description
RC1	xyy	Read 1E-6 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99)
RC2	xyy	Read 1E-5 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99)
RC3	xyy	Read 1E-4 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99)
RC4	xyy	Read 1E-3 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99)
RC5	xyy	Read analog output adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99)
WC1xyy	ppsee	Set 1E-6 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99) Response is new pressure reading in format: pp = mantissa s = sign (0 = negative, 1 = positive) ee = exponent
WC2xyy	ppsee	Set 1E-5 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99) Response is new pressure reading in format: pp = mantissa s = sign (0 = negative, 1 = positive) ee = exponent
WC3xyy	ppsee	Set 1E-4 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99) Response is new pressure reading in format: pp = mantissa s = sign (0 = negative, 1 = positive) ee = exponent
WC4xyy	ppsee	Set 1E-3 calibration adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99) Response is new pressure reading in format: pp = mantissa s = sign (0 = negative, 1 = positive) ee = exponent
WC5xyy	ppsee	Write analog output adjustment xyy: x = sign (0 negative, 1 positive) yy = calibration value (00 to 99) Response is pressure reading in format: pp = mantissa s = sign (0 = negative, 1 = positive) ee = exponent

9.4.5 USB Commands for Setting RS-485 Communications Settings

Command	Response	Description
C1	xxxx	Return serial baud rate, where xxxx is: 0096 = 9600 0192 = 19200 0384 = 38400 0576 = 57600 1152 = 115200 Returns new value before changing
C1xxxx	xxxx	Set serial baud rate, where xxxx is: 0096 = 9600 0192 = 19200 0384 = 38400 0576 = 57600 1152 = 115200 Returns new value before changing
C2	x	Read RS-485 address, where x is 0 to F
C2xx	x	Set RS-485 address, where x is 0 to F Returns new value before changing

9.5 RS-485 Command Examples

9.5.1 All examples assume address 0.

Command	Output	Description
***0R1<cr>**	PA	Units are in Pa
	TR	Units are in Torr
	MB	Units are in mbar
***0R2<cr>**	ppseePPSEE	Lower set point 1 given by ppsee Upper set point 1 given by PPSEE
***0R3<cr>**	ppseePPSEE	Set point 2 ON given by ppsee Set point 2 OFF given by PPSEE
***0W1PA<cr>**	PA	Set units to Pa
***0W1TR<cr>**	TR	Set units to Torr
***0W1MB<cr>**	MB	Set units to mbar
***0W4AR<cr>**	AR	Change gas type to argon
***0S1<cr>**	50011	Pressure reading is 5.0E-11
***0RC1<cr>**	005	Read 1E-6 Torr adjustment which is -5
***0RC2<cr>**	010	Read 1E-5 Torr adjustment which is -10
***0RC3<cr>**	105	Read 1E-4 Torr adjustment which is 5
***0RC4<cr>**	110	Read 1E-3 Torr adjustment which is 10
***0WC1000<cr>**	10006	Set 1E-6 Torr adj to 0, reading is 1.0E-6
***0WC2099<cr>**	10005	Set 1E-5 Torr adj to -99, reading is 1.0E-5
***0WC3199<cr>**	10004	Set 1E-4 Torr adj to 99, reading is 1.0E-4
***0WC4050<cr>**	10003	Set 1E-3 Torr adj to -50, reading is 1.0E-3

9.6 USB Command Examples

9.6.1 Note that all USB commands are the same as the RS-485 commands with the asterisk and address prefix omitted.

Command	Output	Description
R1<cr>	PA	Units are in Pa
	TR	Units are in Torr
	MB	Units are in mbar
R2<cr>	ppseePPSEE	Lower set point 1 given by ppsee Upper set point 1 given by PPSEE
R3<cr>	ppseePPSEE	Set point 2 ON given by ppsee Set point 2 OFF given by PPSEE
W1PA<cr>	PA	Set units to Pa
W1TR<cr>	TR	Set units to Torr
W1MB<cr>	MB	Set units to mbar
W4AR<cr>	AR	Change gas type to argon
S1<cr>	50011	Pressure reading is 5.0E-11
RC1<cr>	005	Read 1E-6 Torr adjustment which is -5
RC2<cr>	010	Read 1E-5 Torr adjustment which is -10
RC3<cr>	105	Read 1E-4 Torr adjustment which is 5
RC4<cr>	110	Read 1E-3 Torr adjustment which is 10
WC1000<cr>	10006	Set 1E-6 Torr adj to 0, reading is 1.0E-6
WC2099<cr>	10005	Set 1E-5 Torr adj to -99, reading is 1.0E-5
WC3199<cr>	10004	Set 1E-4 Torr adj to 99, reading is 1.0E-4
WC4050<cr>	10003	Set 1E-3 Torr adj to -50, reading is 1.0E-3

9.7 RS-485 and USB Communications Error Codes

Error Code	Description
0N0001<cr>	Command error: an invalid character was sent for the command or an invalid number after the character
0N0002<cr>	Units error: an invalid parameter was sent after a command specifier

9.8 Firmware Updates

9.8.1 The MX7M has the ability to update the firmware when in the field over the USB communications. For more information on updating the firmware, please contact sales@frederickscompany.com.