# M10 series

## Universal Device Interface

## User Manual


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# 3 Safety Information

This unit is designed for compliance with harmonized electrical safety standard EN61010-1:2000. It must be used in accordance with its specifications and operating instructions. Operators of the unit are expected to be qualified personnel who are aware of electrical safety issues. The customer's Responsible Body, as defined in the standard, must ensure that operators are provided with the appropriate equipment and training.

The unit is designed to make measurements in **Measurement Category I** as defined in the standard.

Although the M10 does not generate dangerous voltages, nor is it designed to measure directly such voltages, in your application it may be controlling power supplies that do. Appropriate precautions must be taken.

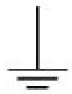
The unit must not be operated unless correctly assembled in its case. Only Service Personnel, as defined in EN61010-1, should attempt to work on the disassembled unit, and then only under specific instruction from Pyramid Technical Consultants, Inc. or their authorized distributors.

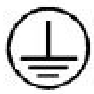
The unit is designed to operate from +24VDC power, with a maximum current requirement of 250mA. A suitably rated power supply module is available as an option.

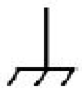
The unit must be grounded by secure connection to a grounded conducting surface. If the unit is mounted on an insulating surface, then one of the four mounting screws must be re-assigned as a grounding connection.

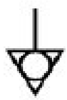
Some of the following symbols may be displayed on the unit, and have the indicated meanings.

 Direct current

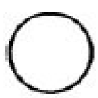
 Earth (ground) terminal

 Protective conductor terminal

 Frame or chassis terminal

 Equipotentiality

 Supply ON

 Supply OFF

 CAUTION – RISK OF ELECTRIC SHOCK

 CAUTION – RISK OF DANGER – REFER TO MANUAL

# 4 Models

| | |
|---|---|
| M10 | Universal device interface with two analog outputs, two analog inputs, four TTL outputs, four TTL inputs. |
| M10-CMR | Universal device interface with two analog outputs, two analog inputs, four TTL outputs, four TTL inputs. Enhanced common mode rejection ratio on analog inputs. |
| M10P | Universal device interface with two analog outputs, two analog inputs, four TTL outputs, four TTL inputs. Digital pulse train output facility. |
| M10C | Universal device interface with one 0-20 mA output, one analog output, two analog inputs, four TTL outputs, four TTL inputs. Digital pulse train output facility. |

# 5 Scope of Supply

M10 model as specified in your order.

USB memory stick containing:

- Data sheet
- User manual
- PSI diagnostic software files
- PTC DiagnosticG2 software files
- IG2 interface software for EPICS
- Power supply

Optional items as specified in your order.

OEM customers may not receive all the items listed.

# 6 Optional Items

## 6.1 Power supplies

PSU24-40-1. +24 VDC 1.66 A PSU (100-250 VAC, 50-60 Hz, IEC C14 3-pin plug receptacle) with output lead terminated in 2.1mm threaded jack.

## 6.2 Data cables

CAB-ST-HCS-10-ST Fiber-optic cable, 200 µm silica, ST terminated, 10’.

Other lengths available.

## 6.3 Test connectors

Loopback test connector for the M10.

## 6.4 Fiber-optic loop

A360 fiber-optic loop controller / Ethernet adaptor.

A500 intelligent real-time controller with Ethernet interface.

A560 intelligent real-time controller with Ethernet interface.

## 6.5 DIN rail mount

MTG-DIN35-11462. Mounting adaptor for 35mm standard DIN rail. M10 can be mounted along or across the rail.

# 7 Intended Use and Key Features

## 7.1 Intended Use

The M10 is intended for general control and monitoring applications using analog voltages in the +/-10 V range, 0 to 20 mA currents (M10C only) and TTL level digital inputs and outputs. A typical application would be the remote control and monitoring of a power supply. The analog outputs would set voltage and current commands or compliance limits, the analog inputs would monitor actual voltage and current. The digital outputs can be assigned to functions such as enable, reset and so on, and the digital inputs can monitor status bits.

The M10 has design features which make it tolerant of electrically noisy environments, but the place of use is otherwise assumed to be clean and sheltered, for example a laboratory or light industrial environment. The unit may be used stand-alone, or networked with other devices and integrated into a larger system. Users are assumed to be experienced in the general use of precision electronic circuits for sensitive measurements, and to be aware of the dangers that can arise in high-voltage circuits.

## 7.2 Key Features

Analog inputs configurable for 5 V or 10 V range, unipolar or bipolar.

Fast digital inputs and outputs.

On-board digital averaging of analog inputs.

Very low transition transients on analog outputs between DAC levels, compatible with control of wideband devices.

Built-in configurable slew-rate limiting (M10, M10-CMR).

Inputs and outputs can be set and read at over 10 kHz, if communications rates to the host system allow, permitting waveform output with synchronized data collection.

Can be operated in a fiber-optic serial communication loop with up to fifteen other devices.

100BaseT Ethernet interfacing to a host computer available through the A360, A500 and A560 loop controllers.

# 8 Specification

| *Analog outputs* | |
|---|---|
| Number and type | M10, M10-CMR, M10-P: Two, bipolar +/-10 V outputs.<br>M10C: One 0-20 mA current output, one bipolar +/-10 V output. |
| Compliance | M10, M10-CMR, M10-P: +/-5 mA for both +/- 10V outputs<br>M10C: +/-10 V for 0-20 mA output, +/-5 mA for +/- 10V output. |
| Settling time | < 8 µs to within 10 mV for any step |
| Output slew rate | > 0.5 V $usec^{-1}$ (unless software limit is applied) |
| Noise | < 0.5 mV rms measured by loopback to analog inputs, with line frequency averaging.<br>Typical rms noise measured with external DVM < 50 µV. |
| Crosstalk | < 1 mV for 10V output on other channel |
| Thermal stability | < 200 µV $C^{-1}$ |
| Resolution | 16 bit over full range. |
| Linearity | 0.1 % of full scale maximum deviation of any point from linear fit to all points over full span. |

| *Analog inputs* | |
|---|---|
| Number and type | Two, differential bipolar, input range software selectable from 0 to +5 V, +/-5 V, 0 to +10 V, +/-10 V |
| Configuration | Differential, high impedance |
| Common mode rejection | > 20 dB (50 dB high CMRR version available as option -CMR) |
| Input protection | 10 kohm series input on + and - inputs. |
| Noise | < 0.5 mV rms with line frequency averaging.<br>Typical measured rms noise with shorted inputs:<br>< 100 µV at 1e-4 s averaging<br>< 20 µV at 1e-2 s averaging<br>< 6 µV at 1 s averaging |
| Crosstalk | < 1 mV with 10 VDC on other input<br>< 30 mV with 10 VAC 1 MHz on other input |
| Digitization | 16 bit over full range |
| Sample rate | 50 kSa/s on each input |

| | |
|---|---|
| Linearity | 0.1 % maximum deviation of any point from linear fit to all points over full span. |

| | |
|---|---|
| *Digital outputs* | |
| Number and type | Four, TTL levels |
| Current compliance | 3 mA (source or sink) |
| Series resistance | 100 ohm built-in |

| | |
|---|---|
| *Digital inputs* | |
| Number and type | Four, TTL levels |
| Configuration | Active low with internal 50 kohm pull up to +5V |
| Logic sense | Software configurable allocation of logic states to TTL levels |

| | |
|---|---|
| *Pulse train feature (M10-P only)* | |
| Minimum pulse length | 12.5 nsec |
| Pulse train frequency | 2.3 kHz to 40 MHz |
| Number of puilses | 1 to 65535 |

| | |
|---|---|
| *Controls and displays* | |
| Controls | 16 position rotary switch for loop address selection |
| Displays | Four LEDs (power, activity, network, device). |

| | |
|---|---|
| *Interfacing* | |
| Communications | Fiber optic (10 Mbit/sec) |

| | |
|---|---|
| *Power* | |
| Power input | +24 VDC (+12 V, -4 V), 150 mA typical, 200 mA maximum, excluding any direct user load. |

| | |
|---|---|
| *Physical* | |
| Case | Stainless steel. |
| Case protection rating | The case is designed to rating IP43 (protected against solid objects greater than 1 mm in size, protected against spraying water). |
| Weight | 0.24 kg (0.55 lb). |
| Operating environment | 0 to 35 C (15 to 25 C recommended to reduce drift and offset)<br>< 80% humidity, non-condensing<br>vibration < 0.2 g all axes (1 to 1000Hz) |

| | |
|---|---|
| Shipping and storage environment | -10 to 50C<br>< 80% humidity, non-condensing<br>vibration < 2 g all axes, 1 to 1000 Hz |
| Dimensions | (see figures 1 and 2, all versions identical). |

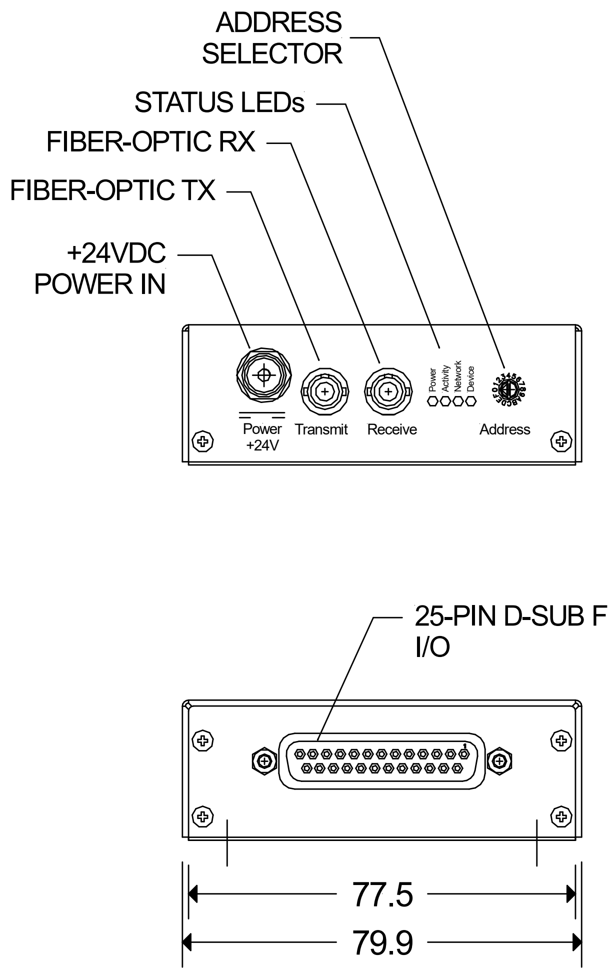



*Figure 1. M10 chassis end panels. Dimensions mm.*

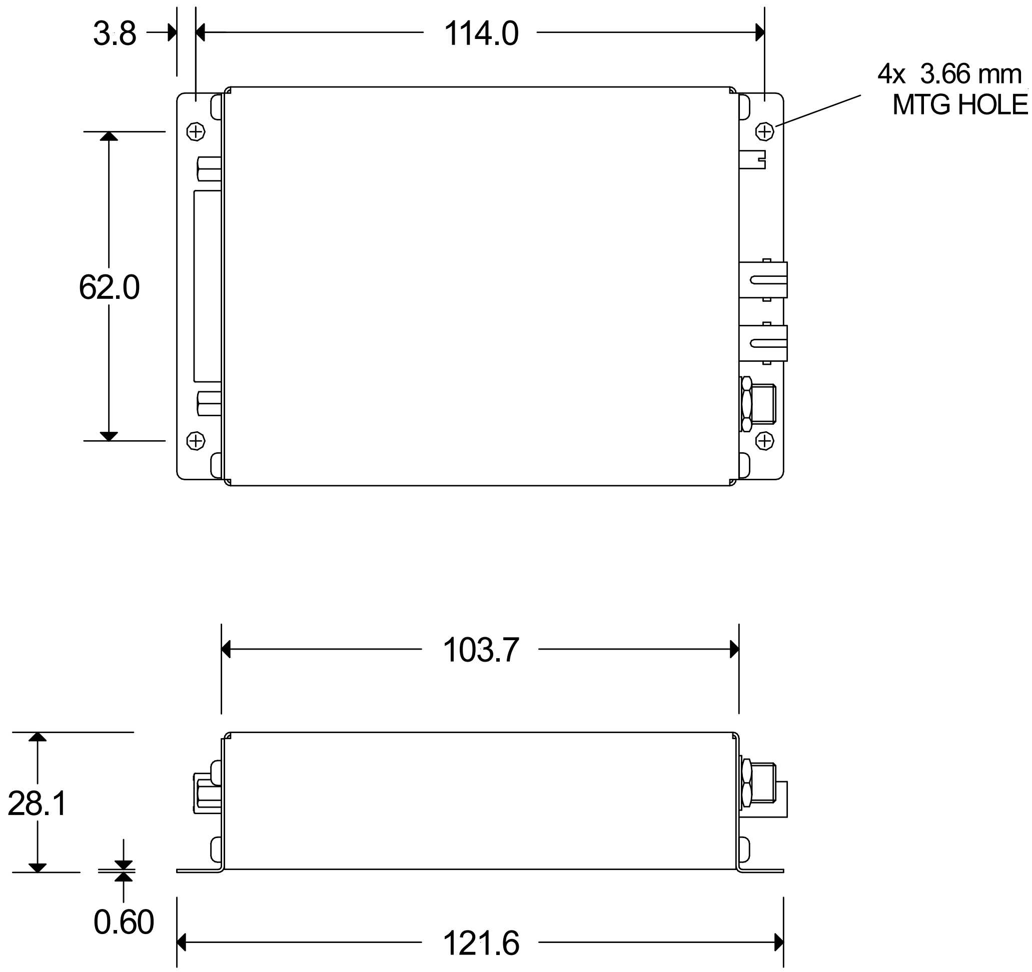



*Figure 2. M10 case plan and side views. Dimensions mm.*

# 9 Installation

## 9.1 Mounting

The M10 may be mounted in any orientation, or may be simply placed on a level surface. A fixed mounting to a secure frame is recommended in a permanent installation for best low current performance, as this can be degraded by movement and vibration. Four M3 clear holes are provided in the base flange on a 62 mm by 114 mm rectangular pattern (see figure 2). An adaptor for 35 mm EN 50022 DIN rail is available.


*Figure 3. DIN rail mounting.*

The mounting position should allow sufficient access to connectors and cable bend radii. Leave 60mm clearance at either end for mating connectors and cable radii.

Best performance will be achieved if the M10 is in a temperature-controlled environment. No forced-air cooling is required, but free convection should be allowed around the case.

## 9.2 Grounding and power supply

A secure connection should be made via the mounting flange to local ground potential. If the unit is mounted on an insulating surface, then one of the four mounting screws must be re-assigned as a grounding connection.

+24 VDC power should be provided from a suitably-rated power supply with the following minimum performance:

| | |
|---|---|
| Output voltage | +24 +/- 0.5 VDC |
| Output current | 300 mA minimum, 2000 mA maximum |
| Ripple and noise | < 100 mV pk-pk, 1 Hz to 1 MHz |

| | |
|---|---|
| Line regulation | < 240 mV |

The M10 is tolerant of line voltage in the range 18 VDC to 36 VDC, although we recommend using a 24 V supply with reasonable output regulation, as indicated. The M10 includes an internal automatically re-setting PTC fuse rated at 1.1 A. However the external supply should in no circumstances be rated higher than the M10 connector limit of 5 A, and a maximum of 2.0 A is recommended.

The 24V power passes through the fuse, and is then made available on the pins 14, 1 of the 25-way D signal connector, where you can use it to power other equipment, subject to the power supply and fuse limits (figure 4). These signal connector pins may alternatively be used to provide 24V power to the M10 instead of the 2.1 mm power jack. Note that the input fuse is bypassed in this case, so you should make suitable arrangements to limit the amount of current that can be supplied.

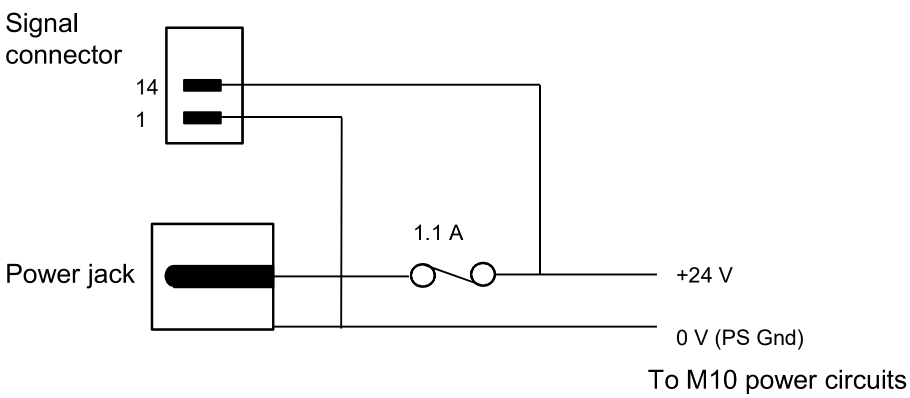



*Figure 4. M10 24V power input.*

The M10 also provides +5 VDC on pin 21 of the signal connector, returned to digital ground on pins 9 or 13. This can be used to power devices with a +5V requirement, to a maximum of 500 mA.

## 9.3 Connection to equipment

### 9.3.1 Typical setup

Figure 5 shows a typical installation to control a power supply in schematic form. An M10 provides a current program and voltage compliance limit, and reads back actual current and voltage from the power supply monitor output. Digital outputs are used to enable the supply, and reset its fault condition. Digital inputs are used to monitor its enabled and fault states. The M10 is on a fiber-optic communication loop, under control of one of the Pyramid Technical Consultants, Inc. loop controllers (A360, A500, A560). Software on the host computer exposes the I/O provided by the M10, and thus allows remote control of the power supply. You can set application unit scaling in the M10 PSI Diagnostic calibration so that you set and read back the values in appropriate physical units.

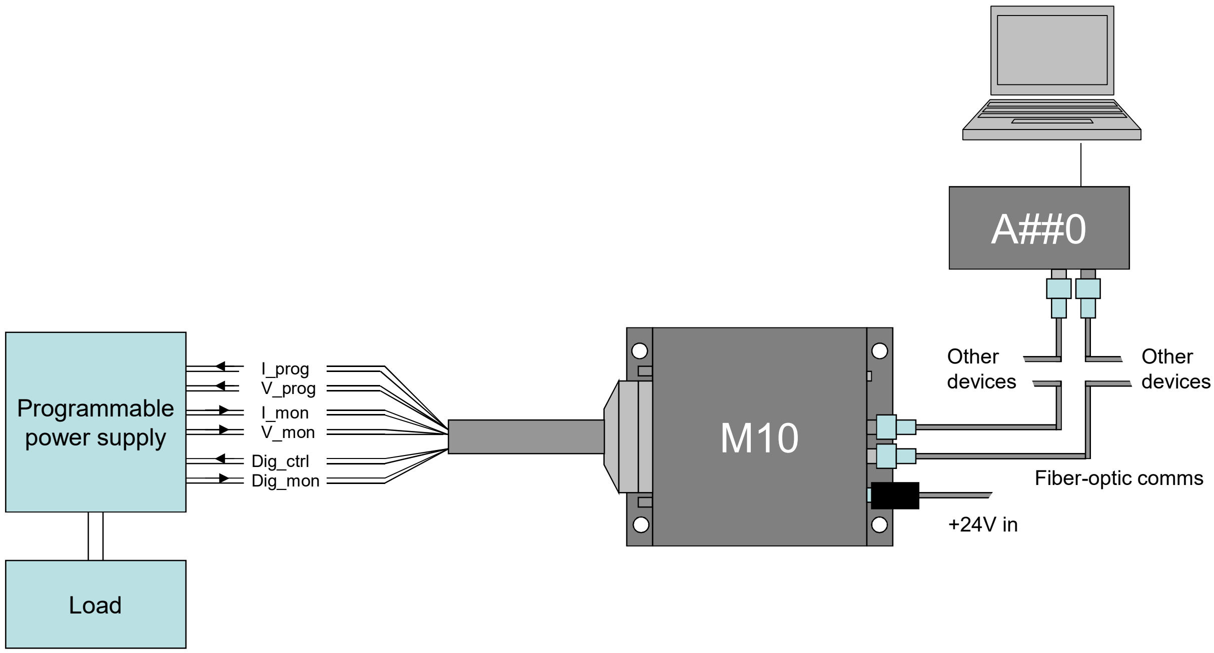



*Figure 5. Schematic M10 installation for remote control of a power supply*

Typical M10 applications involve its use as part of a large control system integrated under one or more A500 or A560 controllers. The M10 may be the only device on the loop, or one of up to fifteen devices. As the number of devices is increased, the loop bandwidth has to be shared, so for fast control you would generally keep the number of devices on each loop to the minimum.

The M10 has very low glitch energy when its analog outputs change from one DAC setting to another, so it is well-suited to the control of fast power supplies such as those for electrostatic or magnetic beam scanners. An arbitrary output waveform table can be sent out at more than 5 kHz (200 µsec per value) when under control of an A500 or A560 real-time loop controller.

### 9.3.2 Signal cables

Try to locate the M10 as close to the equipment being controlled as possible. The best arrangement is to mount it directly on the equipment or in the same cabinet. The longest transmission distance is thus handled by the fiber-optic lines, which are completely immune to electrical noise. If long signal cables from the M10 to the device being controlled are unavoidable, then you should observe the following precautions.

Long signal cables increase the chances of picking up unwanted signals and noise on the analog voltage lines. A maximum length of 10 m is advised, and you should use good quality shielded cable, with twisted pair cores for the analog inputs (analog in + and -) and outputs (analog out and AGND). Connect the cable screens to the M10 case, using the shell of the D connector, and leave them unconnected at the other end. In some cases, you may get better noise performance by reversing this screen connection arrangement.

The 0-20 mA output of the M10C version has better ability to be delivered over long cables without degradation, and you may use cable lengths up to 100 m.

If you are working with fast digital output pulses from the M10P, you should also be careful with long cable runs. To avoid pulse distortion, use matched impedance (typically 100 to 150 ohm) screened twisted pair cores (digital output and DGND) for each fast digital signal, and terminate the line with 100 or 150 ohms at the receiving end.

# 10 Getting Started using the Pyramid Diagnostic Host Programs

Usually you will use a custom application to communicate with the M10, either one you write yourself using the software interfaces available from Pyramid Technical Consultants, Inc., or one that is supplied by Pyramid. However you can get started immediately using one of the Diagnostic host programs. These are available for free download from www.ptcusa.com, and are provided with the M10 for end-user customers. There are two generations of the Diagnostic software, and the M10 is compatible with both.

**PTC Diagnostic G1,** also known as **PSI Diagnostic**. This software supports all Pyramid products, apart from G2 devices. It allows you to connect the M10 via an A500 controller. Ethernet communications use UDP with an added reliability layer.

**PTC Diagnostic G2**. This software supports all G2 devices such as the A360, A560, I128, F460, and C400, plus a growing selection of other Pyramid devices, including the M10. It allows you to connect the M10 via any G2 loop controller, any other G2 device with a fiber optic port, plus the A500. Ethernet communications use TCP/IP and UDP.

Both Diagnostics are standalone Windows programs which allow you to set outputs and read, graph and log data from the M10. Their user interfaces are similar. For some applications one of the Diagnostic programs may be adequate for all of your data acquisition needs. In any event it is useful to understand what you can do with the Diagnostic programs, because they expose all of the functions of the devices they connect to. Application programmers will find this useful to help decide which functions to implement in their own host software.

It is useful to understand what you can do with the Diagnostic programs, because they expose all of the functions of the M10. Application programmers will find it useful to help decide which functions to implement in their host software.

## 10.1 Preparing the M10 for operation

Inspect the unit carefully to ensure there is no evidence of shipping damage. If there appears to be damage, or you are in doubt, contact your supplier before proceeding.

Connect 24 V DC power but no other connections. The LEDs will go through a startup sequence when the power is applied. All four LEDs light, then the power LED stays lit while the other three indicators light in sequence. When the M10 has started correctly, and prior to connecting to a controller, the power LED will remain lit and the device LED will flash, showing that the device has automatically started measuring data.

It is simplest to start with to connect the M10 directly to a loop controller as the only device on the loop. The address switch can be set to anything between 1 and 15. Figure 6 shows a connection to an A500.

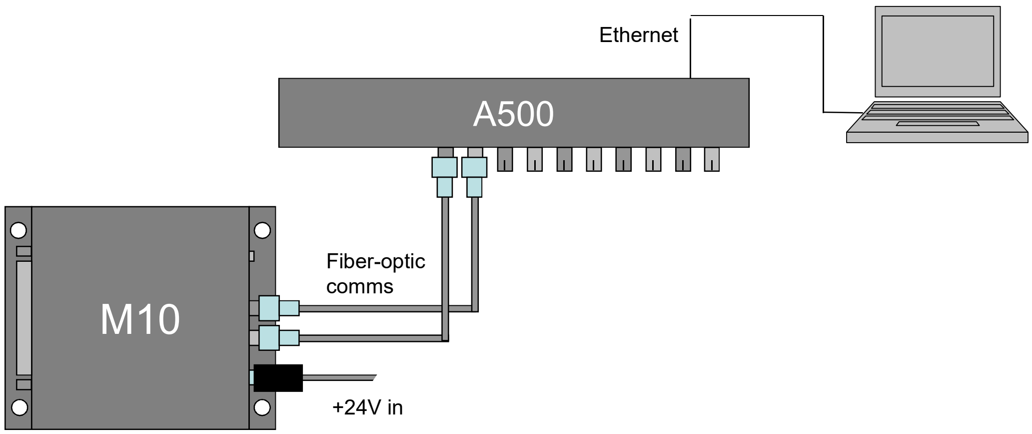



*Figure 6. Example of a connection to the M10 via an A500 and Ethernet.*

## 10.2 Installing and using the PSI Diagnostic Program

If you are an end-user, your M10 was shipped with a USB memory stick with the installation files you need. We recommend that you copy the files into a directory on your host PC. Check the Pyramid Technical Consultants, Inc. web site at www.ptcusa.com for the latest version.

The program runs under the Microsoft Windows operating system with the 4.0 .NET framework. This has to be installed before the PSI Diagnostic. Most new PCs have .NET already installed. It can be downloaded from the Microsoft web site at no charge. The Pyramid installer will prompt you if you need to update the version on your computer.

Install the PSI Diagnostic by running the PTCDiagnosticSetup.msi installer, and following the screen prompts. Once the program has installed, you can run it at once. It will allow you to connect to the M10, and, depending upon your setup, multiple additional devices at the same time. The Diagnostic uses the concepts of ports and loops to organize the connected devices. A port is a communications channel from your PC, such as a COM port, a USB port or Ethernet port. Each port can be a channel to one or more loops, and each loop may contain up to 15 devices.

### 10.2.1 Establishing communication with the M10

Start the PSI Diagnostic. It will search the available ports on your computer and present a search list in an autodetect utility window. Figure 7 shows a case where the program found two serial ports and a network adaptor. We'll work through an example where the connection to the M10 is via an A500 at IP address 192.168.100.238. We can add this specific address to the network search to avoid the need to broadcast to the whole LAN by typing the address followed by a colon and the standard port number 100, as shown in the figure, and clicking "Add IP".

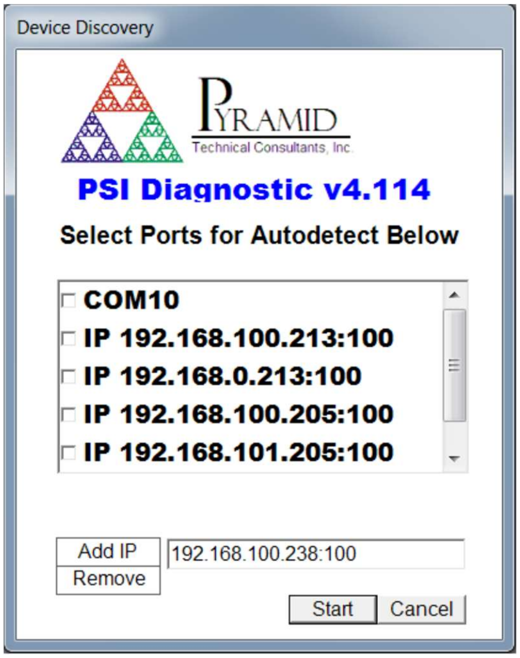



*Figure 7. PSI Diagnostic Search Utility – adding a target IP address and port*

Check that the target port is checked for inclusion in the search and click the "Start" button. The autodetection process will start (figure 7).

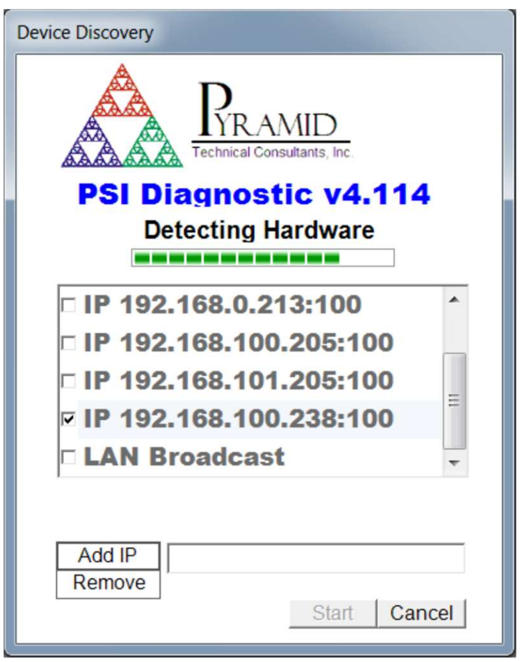



*Figure 8. PSI Diagnostic Search Utility – detection in progress*

After a few seconds the program should find the M10 (plus any other devices you have connected). The System pane will show a tree of all the discovered devices. On the M10 itself you should see the network LED illuminate regularly to show that loop messages are being processed.

### 10.2.2 Data tab

Clicking on the M10 entry in the explorer list will open the M10 window (figure 9). The device will be acquiring data using default settings and you should see background noise values for both channels. The Device LED on the M10 will flash to show acquisition is in progress (it will turn off if you abort the acquisition). You can display the signals either as a scrolling value against time graph (like a chart recorder) or as an analog bargraph. Toggle to one of the fixed Y scales if you want to inhibit autoscaling of the graph.


*Figure 9. Data tab: Strip chart display.*

Select one of the fixed Y scales if you want to inhibit autoscaling of the graph. You can display the analog signals either as a scrolling value against time graph (like a chart recorder) or as an analog bargraph. The scope display mode looks the same as the strip chart, but the data is displayed without scrolling for each 256 readings.

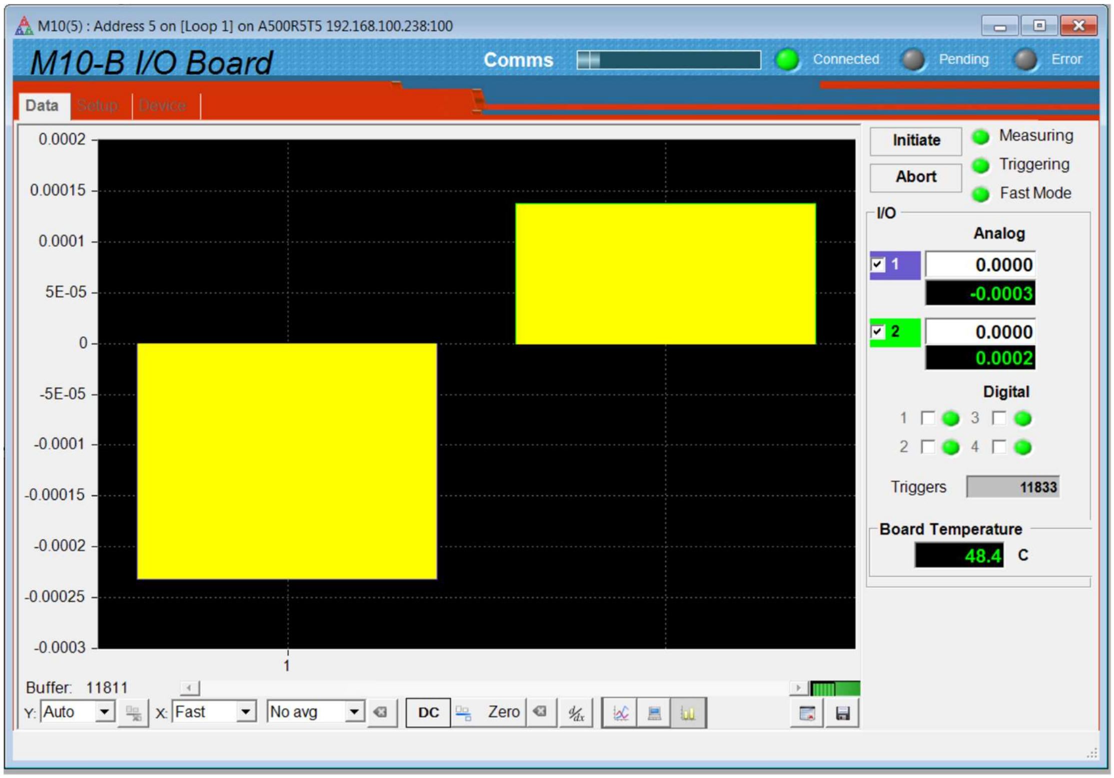
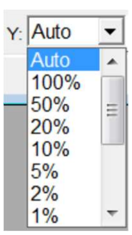
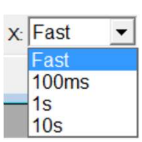
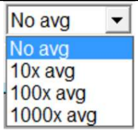
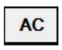
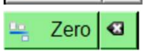
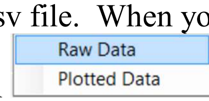



*Figure 10. Data tab: bargraph display.*

Try out the various screen controls and readouts to see their effect.

| | |
|---|---|
| Initiate / Abort | These buttons start and stop data acquisition. LEDs indicate whether the M10 is measuring, triggered or streaming data to the controller in fast mode. On the M10, you will see the Device LED flashing when readings are being taken, and off when data taking is aborted. |
| Analog inputs (ADCs) | The two analog inputs are continuously updated (green text on black background) while the M10 is acquiring data. The displayed values are Input_voltage * Gain - Offset. The offset and gain values are set on the Setup tab (see next section). The colour codes show which are the corresponding traces on the graphic display, and you can suppress plotting of any channel by unchecking it. This does not affect the data logging – all channels are always logged. |
| Analog outputs (DACs) | You can set the two analog outputs (black text on white background). The new value will be sent out as soon as you press the enter key, or click in another parameter field. The values that are sent out in volts are (Raw_value – Offset)*Gain, up to the +/- 10V limit. The offset and gain values are set on the Setup tab (see next section).<br><br>If you have selected the check box to use the application calibration on the Setup tab, and supplied physical units, then these will be displayed on the Data tab alongside the relevant channel. |

| | |
|---|---|
| Digitals | Four check boxes allow you to set the corresponding digital outputs high. Four LEDs show the states of the digital inputs. By default the LED is illuminated if the input is TTL high, but this logic can be inverted using controls on the Setup tab. |
| Triggers | This counter shows the number of readings made by the M10 since the last initiate. The number of readings you can log on the host computer may be less, depending on the number of readings you request, the averaging period and the available data rate up to the loop controller and the host computer. |
| Temperature | This is a readback of the internal temperature of the M10 in degrees centigrade. |
| Buffer   | The PSI Diagnostic collects data coming from the M10 into a buffer, with a rate that is the lesser of the actual acquisition rate or the X axis rate setting. The buffer contents can be cleared with the Clr button ( ), or can be written to a .csv file with the save button ( ). The buffer number shows how much data is currently in the buffer. The maximum allowed is 65535 bytes, after which the buffer wraps around to overwrite the earliest values.<br><br>You can toggle data plotting and accumulation into the buffer with the Run Plot control ( / ). When the accumulation is halted, then the slider is enabled, which allows you to scroll back through the data when in strip chart mode. |
| Y:   | This drop-down controls the vertical scaling of the data plot. You can select automatic scaling or various fixed proportions of the nominal 10 V full scale. |
| Display only positive values  | This control is enabled for fixed vertical scaling. It toggles the graphic from a display that is symmetric around 0 to one that shows only 10% of the vertical scale in the negative direction. |
| X:   | This drop down controls how fast new points are added to the data plot and the data log. For example, if your acquisition settings generate a value every 100 msec but you have 1 second selected on this control, then every tenth reading will be stored. |
| Filtering | The PSI Diagnostic can apply a filter to the plotted data to allow you to pick small signals out of noise. This filter is independent of, and additional to, the block averaging filtering implemented by the M10 itself. The PSI Diagnostic filter is a simple IIR type, $Y_{plot\ N} = Y_{new}/A +$ |

| | |
|---|---|
|   | $(1-1/A)Y_{plot\_N-1}$, where $Y_{new}$ is the latest reading, $Y_{plot\_N}$ is the current value to be plotted, $Y_{plot\_N-1}$ is the prior plotted value and A is the averaging value from the pull-down menu. You clear and restart the filter at any time by pressing the reset button .<br>The filtering affects the graphed data and digital displays. If you choose to save the buffered data, you will have the opportunity to save the raw values or the filtered values. |
| DC/AC<br>  /   | The DC/AC toggle removes the DC component from the strip chart or scope mode graphic data, but does not affect the digital display nor the logged data. |
| Zero correction<br>  /<br>  | When you press zero, the current values are captured and subtracted from all subsequent readings as displayed on all the graphic and digital displays, until you press the clear zeroes button . If you choose to save the buffered data, you will have the opportunity to save the raw values or the zero offset corrected values. |
| Differential display  | When this control is pressed, the graphic changes to display the difference between successive readings. The buffered data is not affected. |
| Graphic mode<br> | You can plot the data as a rolling strip chart or a bar chart (histogram). The scope mode is a variant of the strip chart. Instead of a rolling chart, the graphic is refreshed as a whole for each 256 samples. In histogram mode you can place a cursor on a particular channel to read out its value. |
|  | Clear buffered data. Values are cleared from the PSI Diagnostic data buffer, but any acquisition in progress continues and timestamps are not reset. |
|  | Save data buffer contents to csv file. When you click this button you will see a drop down selection   which allows you to save either the raw data, or the values with the PSI Diagnostic zero offset and averaging |

### 10.2.3 Setup tab

Click on the “Setup” tab. Here you can alter scaling, polarities, input filtering and calibration values and setup pulse train conditions for the digital outputs.

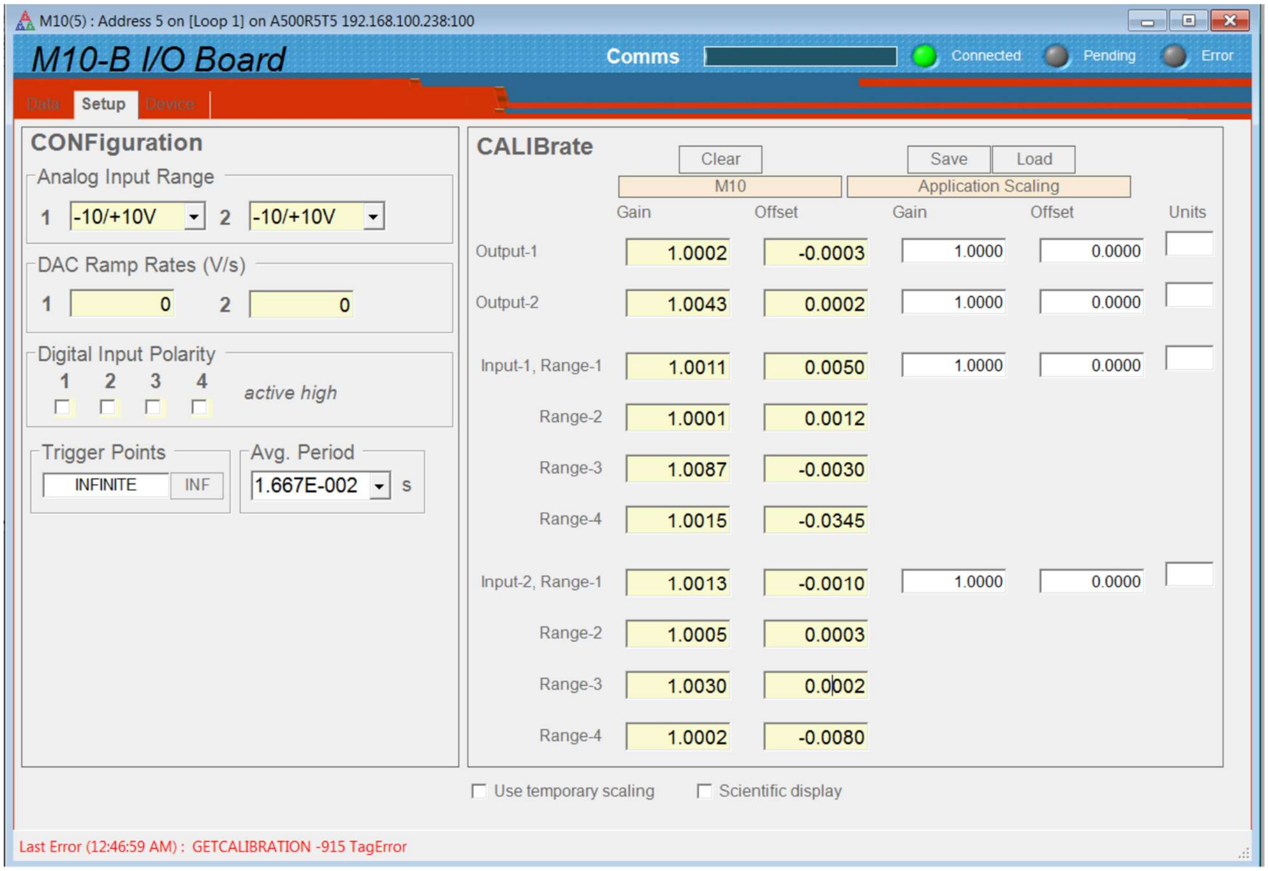



*Figure 11. Setup tab.*

| | |
|---|---|
| Analog input range | The span of the analog inputs can be individually selected from the four options (0 to +5, 0 to +10, +/-5, +/-10). The range of the selection is mapped onto the ADC range; thus for example if your signal will not fall outside the range 0 to +5 V, you can select this range and thus reduce the size of one bit by a factor of four compared to the +/- 10 V range. |
| Digital input polarity | Check the boxes to change the digital input logic to active high from the default active low. |
| Averaging period | The two analog inputs are converted in the M10 at 50 kSa/s. A digital filter then averages the samples over the selected period to give the final values that are transmitted back to the host system. The M10 starts up with the integration period set to the inverse of the mains frequency, as set on the Device tab. |
| Calibrate | Factors can be entered here to compensate any small errors in the offsets and gains of the analog inputs and outputs. These are factory set, and should not need further alteration. See section 12 for more details. |

### 10.2.4 Device tab

Click on the “Device” tab. You can check the communication link status, read the M10 manufacturing serial number and verify the versions of the hardware and firmware. On the right is the firmware update utility. You can use this to download firmware updates (.hex files) downloaded from the Pyramid Technical Consultants, Inc. web site.

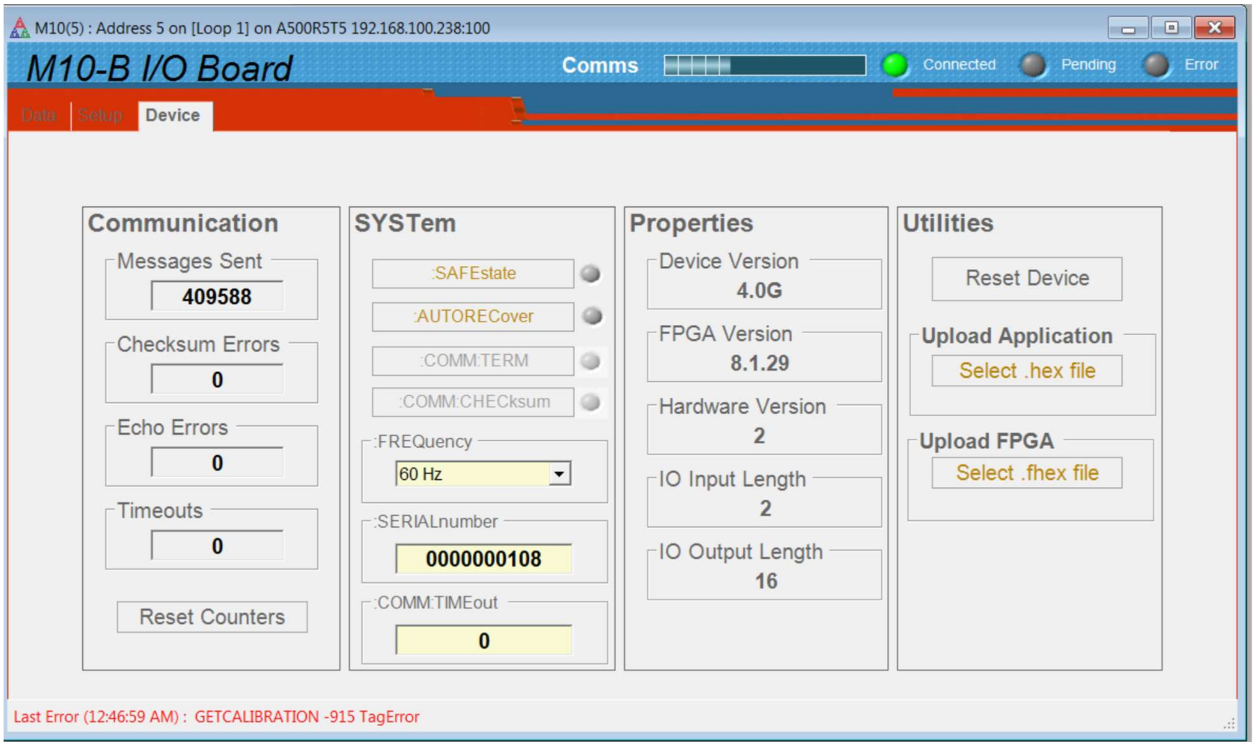



*Figure 12. Device tab, showing firmware update utility controls.*

| | |
|---|---|
| Communication | The counters show details of the communications between the M10 and its host. You can click the Reset Counters button to reset the fields to zero. |
| System controls | Pressing :SAFEstate sets a mode in which the M10 goes to a defined safe state (all outputs zeroed) if it does not communicate with its host controller in the timeout period in seconds set by the :COMM:TIMEout parameter. If communications are restored, then the M10 will re-assert its prior output state. If you want to disable this feature, set the timeout to 0.<br><br>Pressing :AUTOrecover sets a state in which the M10 will attempt to restart automatically if it detects data corruption.<br><br>The COMM:Term and COMM:Checksum controls are not used on the M10. You can ignore them when using the PSI Diagnostic |

| | |
|---|---|
| | The system controls are software password protected, so you will see a red warning message at the bottom of the window when you use them. The PSI Diagnostic automatically sends the password. |
| Frequency | This parameter sets the averaging period that will be used by default on power up. You should set it to the local line frequency. |
| SerialNumber | This is the manufacturing serial number of your device, and should be left unchanged. |
| Comm:Timeout | The time period in seconds without communications before the M10 goes to the safe state. Set to zero if you don't want this feature. |
| Select .hex file | This button starts the M10 PIC firmware update process. It opens a file selection dialog. When you select a hex file it will start uploading to the M10 immediately. Upon completion the M10 will restart automatically, and you will see the new Device Version number displayed. See section 16 for more details. |
| Select .fhex file | This button starts the M10 FPGA firmware update process. It opens a file selection dialog. When you select a fhex file it will start uploading to the M10 immediately. Upon completion you will need to power cycle the M10, which will cause the new code to be loaded. You will see the new FPGA Version number displayed. See section 16 for more details. |
| Reset | This button causes a full warm reset of the M10. All outputs will go to zero during the reset, then will be set back to their prior settings by the PSI Diagnostic. |

## 10.3 Installing and using the PTC G2 Diagnostic Program

The PTC Diagnostic G2 host software provides the same user functions as the PSI Diagnostic, and has a similar look and feel, but it is built on a different software foundation. Unlike the PSI Diagnostic, the PTC Diagnostic G2 uses the same DLL function libraries that Pyramid uses to build user applications. These libraries can be provided to customers who want to build their own applications. The G2 Diagnostic can often provide faster average data rates to the host by its use of block data transfers. If you need a Diagnostic to operate the M10 in conjunction with G2 devices such as the A560, I128, and C400, then you must use the PTC Diagnostic G2.

PTC Diagnostic G2 can coexist with the PSI Diagnostic on the same computer. Both programs can in fact communicate with an A500 or A560 the M10 at the same time (the PSI Diagnostic must be launched first), although this is not generally recommended, as the results could be very confusing.

Since the two programs are similar, we shall concentrate on the differences.

Download the PTC Diagnostic G2 installer (.msi file) or find the copy on the USB memory stick if you purchased the M10 as an end-user. We recommend that you copy the installer file into a directory on your host PC. Check the Pyramid Technical Consultants, Inc. web site at www.ptcusa.com for the latest version.

The program runs under the Microsoft Windows operating system with the 4.0 .NET framework. This has to be installed before the PSI Diagnostic. Most new PCs have .NET already installed, or it can be downloaded from the Microsoft web site at no charge. The Pyramid installer will prompt you if you need to update the version on your computer.

### 10.3.1 Establishing communication with the M10

Start the PTC Diagnostic G2. The program expects all connections to devices like the M10 be via Ethernet ports, whether through dedicated loop controllers like the A500, A560 and A360, or via other Ethernet-enabled devices that support slave devices, such as the I128. Unlike the PSI Diagnostic, you do not need to specify the IP address. When you launch the program, it will open the Discover Devices dialog. Pressing the Discover Controllers button will give you a list of available controllers. The search will include all devices visible on your accessible subnet, including any on the far end of a VPN link. In the following example the search has found various controller controllers. If your target controller is not discovered, then you can force it to be probed by adding its IP address specifically. Unlike the PSI Diagnostic, you do not need to include a port number. The A60 Recovery entry is a diagnostic utility used for some G2 devices, which you can ignore.

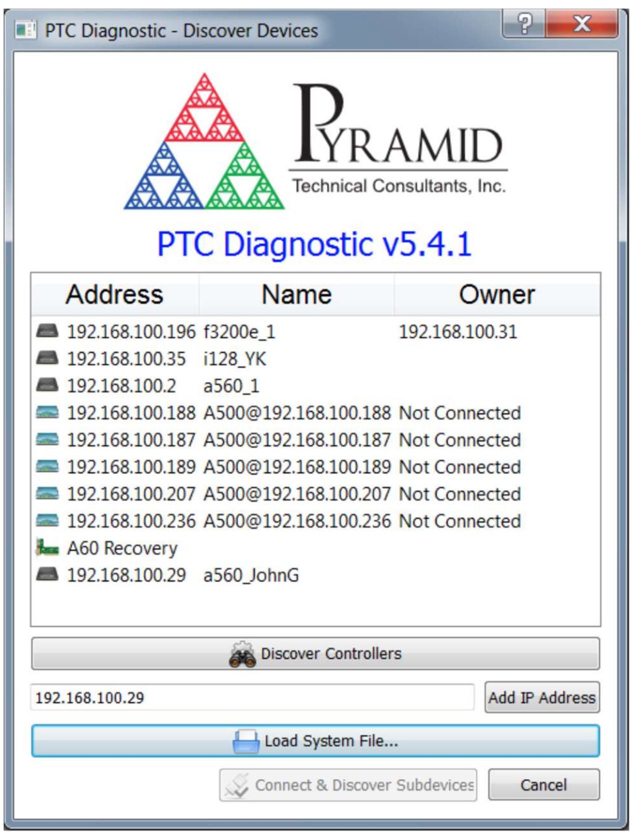



*Figure 13. PTC Diagnostic G2 discovery dialog after Discover Controllers.*

Highlight the target device, which is an A560 at 192.168.100.29 in this example, to enable the Connect & Discover Subdevices button. Clicking this should result in the controller appearing in the System area on the left, with its connected sub-devices shown.

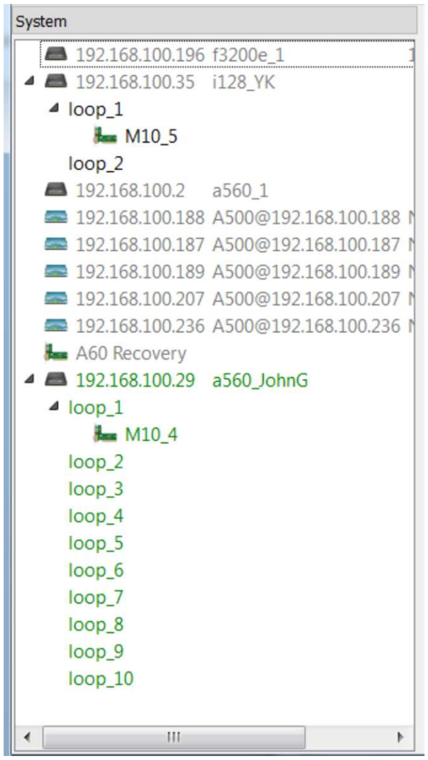



*Figure 14. System pane showing an M10 connected via an A560 controller*

Clicking on the M10 entry opens a window for it, with the same basic strip chart and histogram graphing options, and digital displays as used in the PSI Diagnostic.

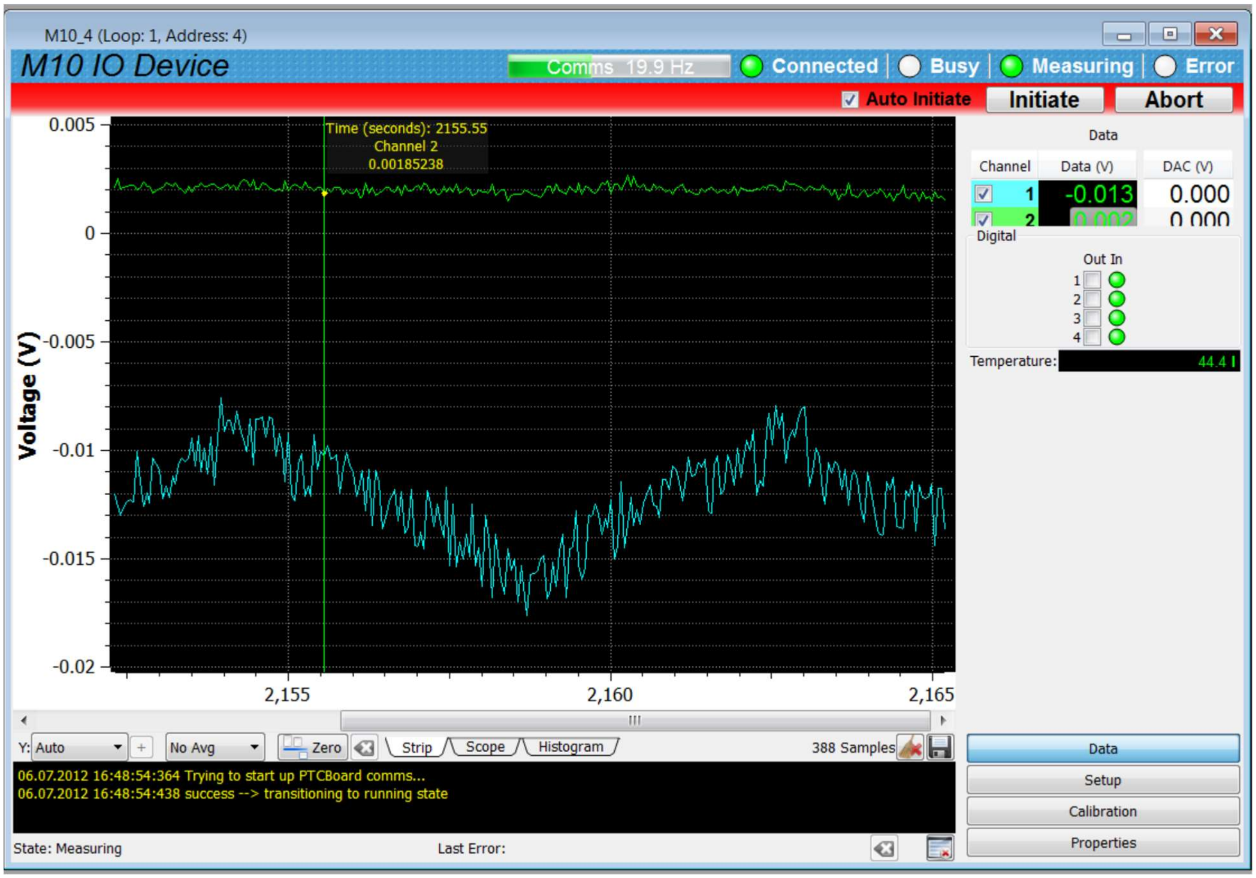



*Figure 15. M10 data display in PTC Diagnostic G2*

Checking the Auto Initiate button causes the program to automatically start data taking after you make any change to the M10 parameters.

The Setup and Calibration buttons access areas that provide the same functions as the PSI Diagnostic Setup tab. PTC Diagnostic G2 does not support application calibration in its current version.

The firmware update utility is accessed on the Properties area.

# 11 Interfacing to EPICS via IG2

## 11.1 What is EPICS?

The Experimental Physics and Industrial Control System (EPICS, http://www.aps.anl.gov/epics/) is:

"A set of Open Source software tools, libraries and applications developed collaboratively and used worldwide to create distributed soft real-time control systems for scientific instruments such as particle accelerators, telescopes and other large scientific experiments. EPICS uses Client/Server and Publish/Subscribe techniques to communicate between the various computers. Most servers (called Input/Output Controllers or IOCs) perform real-world I/O and local control tasks, and publish this information to clients using the Channel Access (CA) network protocol. CA is specially designed for the kind of high bandwidth, soft real-time networking applications that EPICS is used for, and is one reason why it can be used to build a control system comprising hundreds of computers."

Pyramid supplies an executable called IG2 which embeds an open source Channel Access Server from the EPICS community. This allows connection via the Ethernet interface. IG2 is configured for the devices you wish to connect using editable xml files. Once IG2 is running on a computer in your network, then any other computer can run a client program which can display and control the process variables for the devices. In the simple network in figure 16, the process variables of an M10 attached to an A360 via fiber optics, are exposed to the network by the IG2 service running on a server computer. One or more client GUI computers can then access the values.

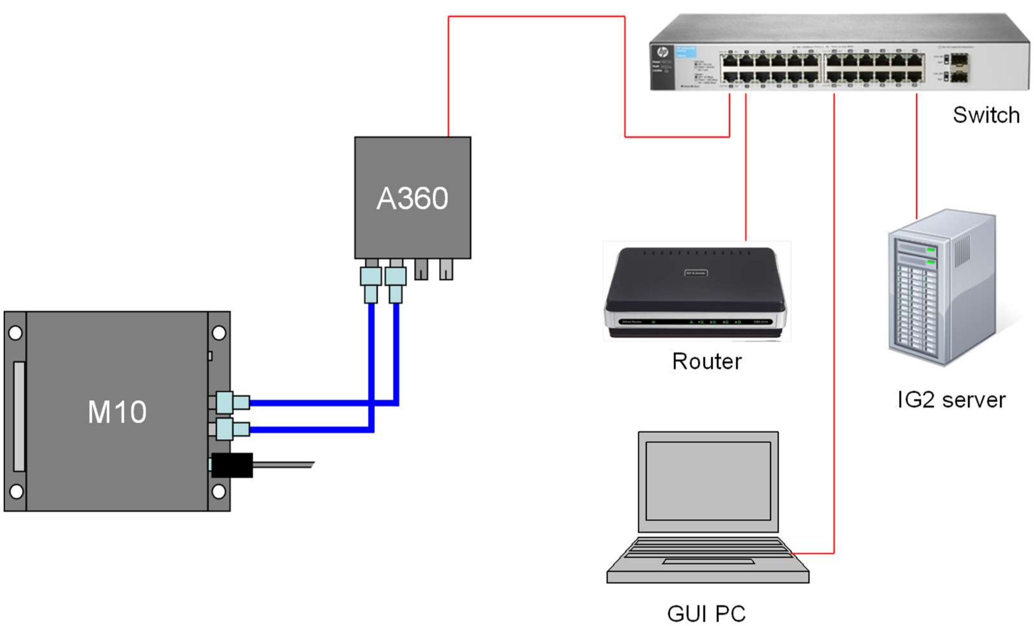



*Figure 16. Example network for EPICS communications.*

There is a wide range of client interfaces from the EPICS community, including interfaces for C++, C#, Java, Python, Labview ™, and Matlab ™. The Control System Studio, or CS Studio, (http://controlsystemstudio.github.io/) is a set of ready-made tools built on Java and Eclipse (http://www.eclipse.org/ ) that allows users to get started with little or no programming required. There are various logging, plotting, post-processing and alarm point tools. A fully-featured "drag and drop" user interface editor (BOY) allows quite complex customized user interfaces to be created with minimum development time. As an example, the following screenshot shows a simple user interface created in the CS Studio BOY OPI editor. The M10 was assumed to be controlling a high voltage power supply.

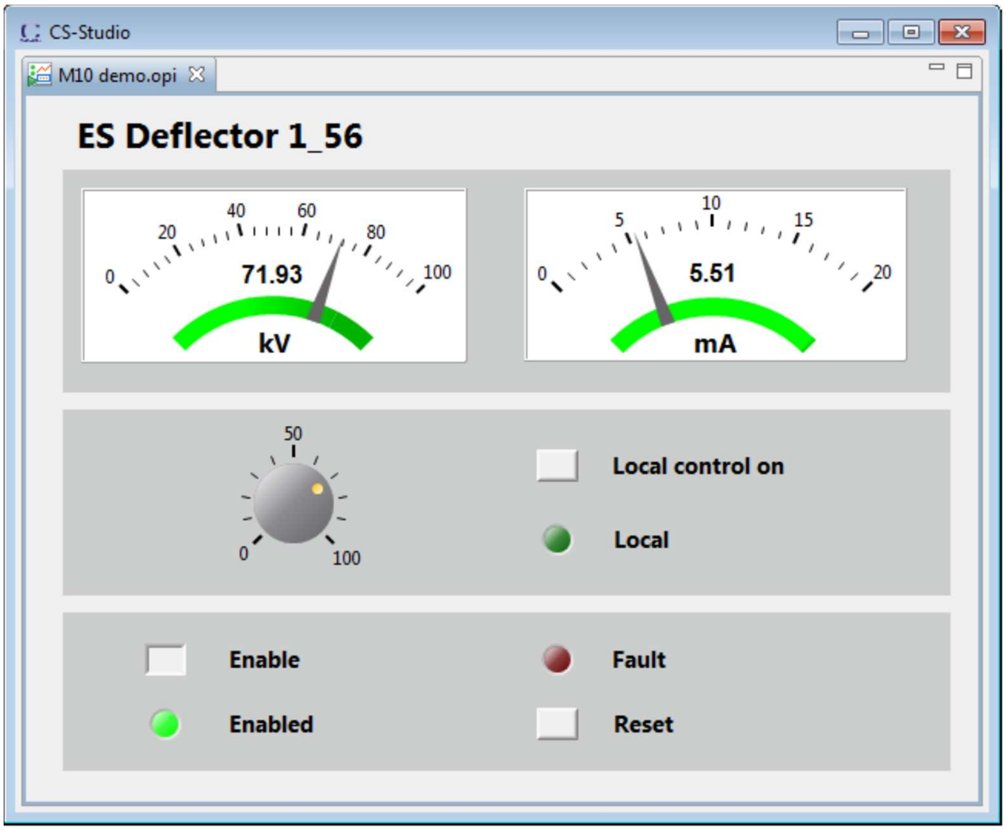



*Figure 17. Example user screen created using CS Studio BOY.*

## 11.2 Installing and Configuring IG2

The IG2 package is available to users of Pyramid products. It is supplied as a zip file which should be de-compressed and the entire folder moved to the computer that will act as the server. The server and the user interface computer can be the same machine. The loop controller, the server and the user interface computer should be able to communicate with each other over your network.

In the folders you have saved, there is an xml files in the \service subdirectory that need to be edited to customize your particular setup. IG2 looks for the file "system.xml" in the \service subdirectory to establish the configuration of the system. You can locate system.xml elsewhere than the default location, or give it a different name, in which case you need to specify the path and file name by means of an argument in the command line that launches IG2.

The system file comprises a header section on the xml schema, which does not need to change. Then comes a description of the user interface host computer, descriptions of the fiber optic loop controller devices in your system and descriptions of the devices attached to loops. You don't have to describe every device and every input/output point that is present in your system, but only the ones that you expose in the system file will be visible to EPICS.

The simplified example in figure 18 illustrates the xml schema. The analog inputs and outputs are scaled to suit the application. The A360 is supporting the M10 as the only looped device.

The convention of "wires" for Pyramid device process variables, and the fixed names of those wires for each supported product, are described in the document "ig2_scripting_v#.#.pdf", where #.# is the document revision number, included with each release. The document also describes how you can scale the values, for example to convert voltages from general purpose I/O devices to physical units relevant to the item they are controlling, and how you can set up monitoring against tolerance bands.

The choice of a corresponding working name for each wire is up to the user; it is sensible to choose something descriptive that is relevant to what you are measuring or controlling. We nevertheless recommend a naming convention that makes it clear whether a value is a readback or control (the prefixes c_ and r_ are used in the example), which particular device the value is associated with, and a number or letter to indicate the channel for multichannel devices.

```xml
<?xml version="1.0" encoding="iso-8859-1"?>
<system
  xmlns="http://www.ptcusa.com"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.ptcusa.com A510.xsd" type="pyramid" >
  <hosts>
    <!-- NOTE: the ip address does not matter for bcs, but may be required to be present -->
    <host ip="192.168.1.64" name="PTCE_Server" localhost="true" />
  </hosts>

  <loopcontrollers>
    <loopcontroller type="A360" name="A360_1" ip="192.168.1.68" >
      <loops>
        <!-- A1:LOOP1 *************************************************************************************   -->
         <loop number="1" name="Slave_device_loop">
          <boards>
           <board type="M10" name="m10_1" address="1">
              <channels>
                    <channel name="r_m10_1_ain1" wire="analog_in_1" scaleB="10"/>
                    <channel name="r_m10_1_ain2" wire="analog_in_2" scaleB="2" scaleC="0.3"/>
                    <channel name="c_m10_1_aout1" wire="analog_out_1" scaleB="10" limitLow="0" limitHigh="100"/>
                    <channel name="c_m10_1_aout2" wire="analog_out_2" />
                    <channel name="r_m10_1_din1" wire="digital_in_1" />
                    <channel name="r_m10_1_din2" wire="digital_in_2" />
                    <channel name="r_m10_1_din3" wire="digital_in_3" />
                    <channel name="c_m10_1_dout1" wire="digital_out_1" />
                    <channel name="c_m10_1_dout2" wire="digital_out_2" />
                    <channel name="c_m10_1_dout3" wire="digital_out_3" />
              </channels>
           </board>
         </boards>
       </loop>
      </loops>
    </loopcontroller>
  </loopcontrollers>

  <interpreter>
    <devices>
        <epicscas type="epicscas" name="epics_server" />
    </devices>
  </interpreter>

 </system>
```

*Figure 18. Example xml system configuration file for IG2 / EPICS.*

Once you have created and saved your system file, you can run the IG2 service executable. If the server has a display, you will see a console window that shows the connection process and then records subsequent control value changes sent to the M10. The names you declared will now be recognized as process variables by any EPICS-compatible client program.

**CAUTION**

Don't try to control the M10 simultaneously from an EPICS client and from a Diagnostic. The results will be confusing. In particular, if you attempt to run the IG2 service and PTC DiagnosticG2 on the same computer, the communications will conflict.

# 12 Circuit overview

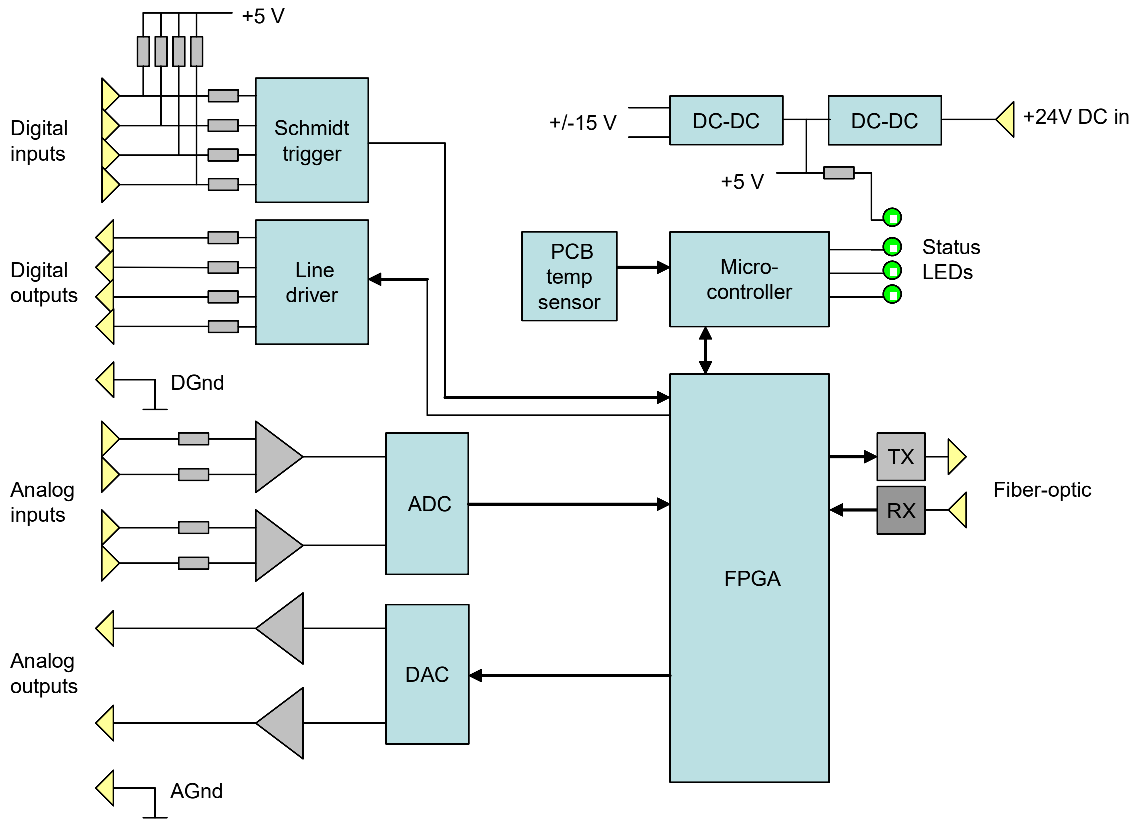



*Figure 19. M10 block schematic.*

A field programmable gate array (FPGA) handles all input output, and communicates with the PIC microcontroller via an internal bus. The microcontroller stores calibration values in its internal EEPROM.

Digital inputs have weak (50 kohm) pull-ups to 5V, and are buffered by Schmidt triggers. Digital outputs are buffered by line drivers.

The analog inputs are connected to differential amplifiers and then to a 100 kSa/sec ADC which multiplexes the two inputs, so that each is sampled at 50 kSa/sec. Any ADC over-ranges are flagged and communicated to the host computer along with the digital input bit pattern. The analog outputs are generated by a dual DAC and buffered by unity gain amplifier circuits.

In the M10C variant, the second analog output is used to drive a built-in current source with 0 to 20 mA span. When the correct M10C firmware is installed, then the current output can be controlled directly between two conditions by the state of digital input 1. When the bit is set high, then the last commanded value is output. When it is low, then zero current is output (with the calibration offset applied).

An on-board thermistor is used to measure the M10 temperature. It is read by a 10-bit ADC integrated in the PIC microcontroller.

# 13 Electrical interfacing

The following diagrams illustrate the internal interfacing circuits of the M10, and the options for connecting the M10 outputs and inputs to various configurations in the sending or receiving device.

## 13.1 Analog inputs

The analog inputs pass via 10k current limiting resistors to a precision differential instrumentation amplifier.

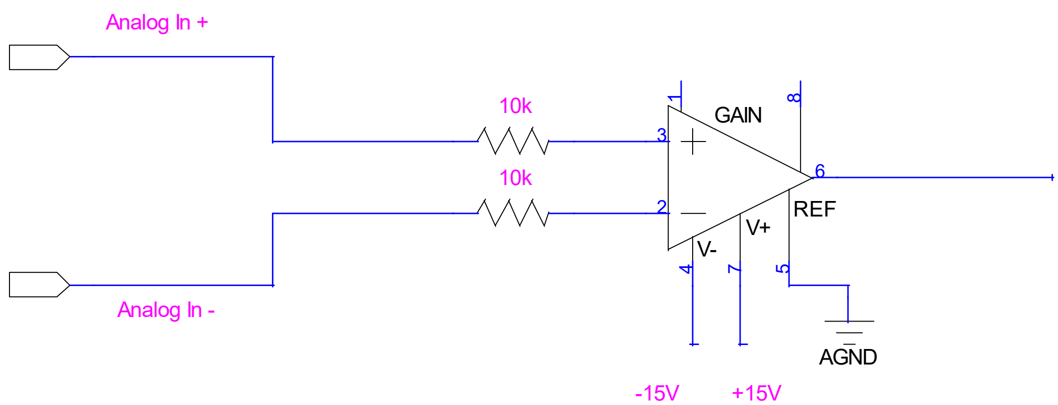



*Figure 20. Analog input circuit.*

### 13.1.1 Differential signal source

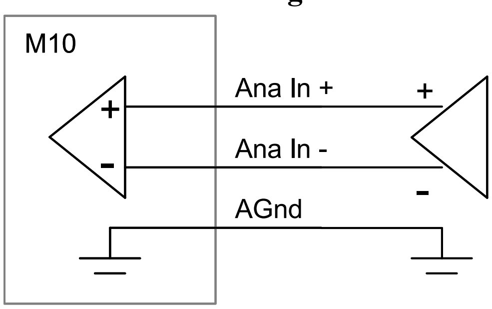



*Figure 21. M10 connection to a differential analog voltage source.*

### 13.1.2 Single-ended signal source

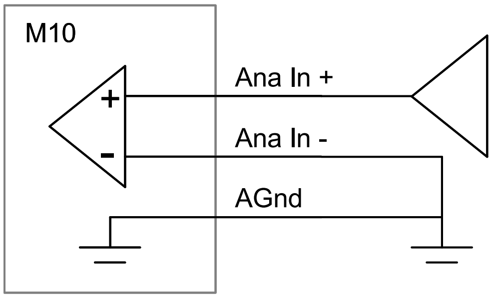



*Figure 22. M10 connection to a single-ended analog voltage source.*

## 13.2 Analog outputs

The analog outputs are single ended, buffered by a stage with close to unity gain with 100 ohm current limiting impedance.

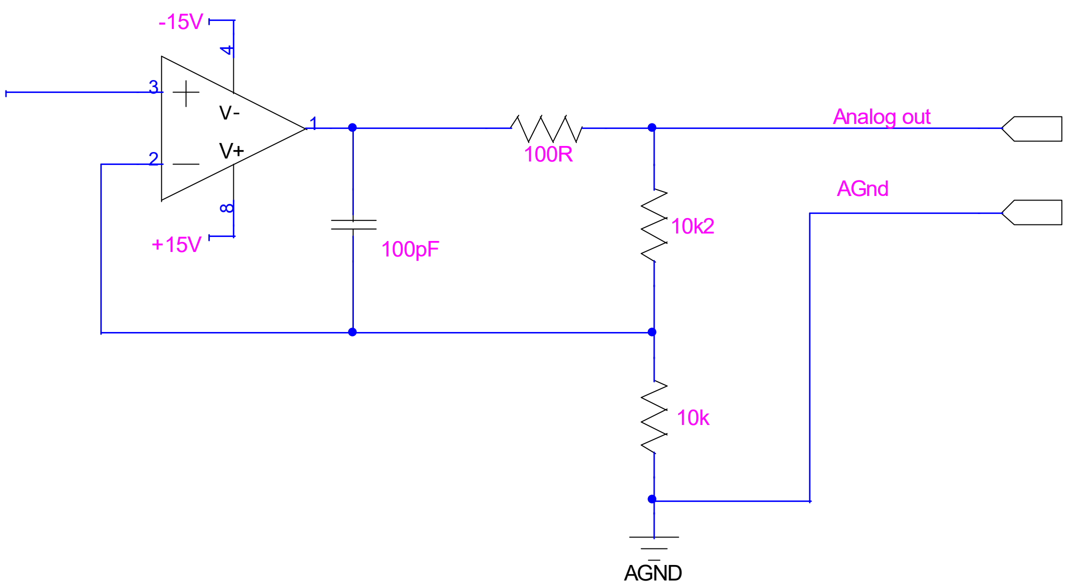



*Figure 23. Analog output circuit.*

#### 13.2.1 Differential destination

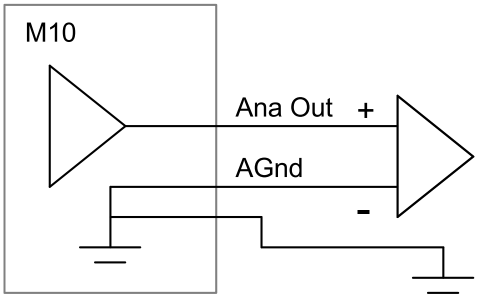



*Figure 24. M10 connection to a differential analog voltage destination.*

#### 13.2.2 Single-ended destination

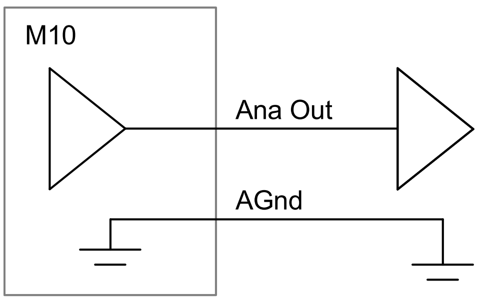



*Figure 25. M10 connection to a single-ended analog voltage destination.*

#### 13.2.3 Current output to differential destination

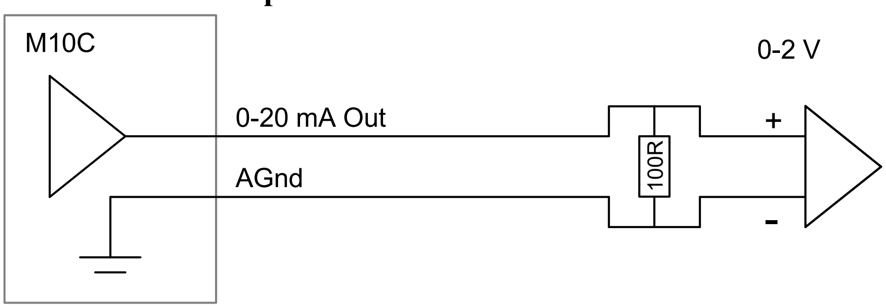



*Figure 26. M10C current output to a differential analog voltage destination with terminating resistor.*

Note that the current loop configuration is especially convenient if the analog signal needs to pass through an interlock chain before it reaches is target. Normally-open relays can simply be placed in series in the line prior to the destination, as shown below.

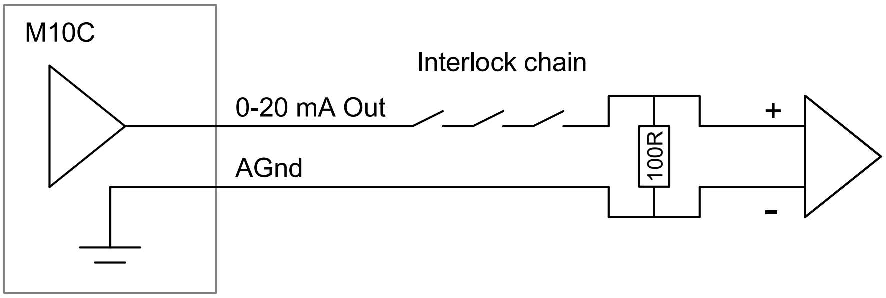



*Figure 27. Analog current output showing external interlock chain.*

### 13.2.4 Current output to single-ended destination

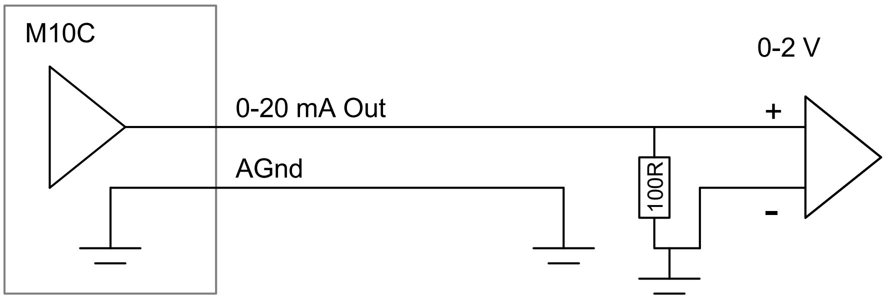



*Figure 28. M10C current output to a single-ended analog voltage destination with terminating resistor.*

## 13.3 Digital inputs

The digital inputs are pulled up to +5V and protected by 500 ohm current limiting resistors.

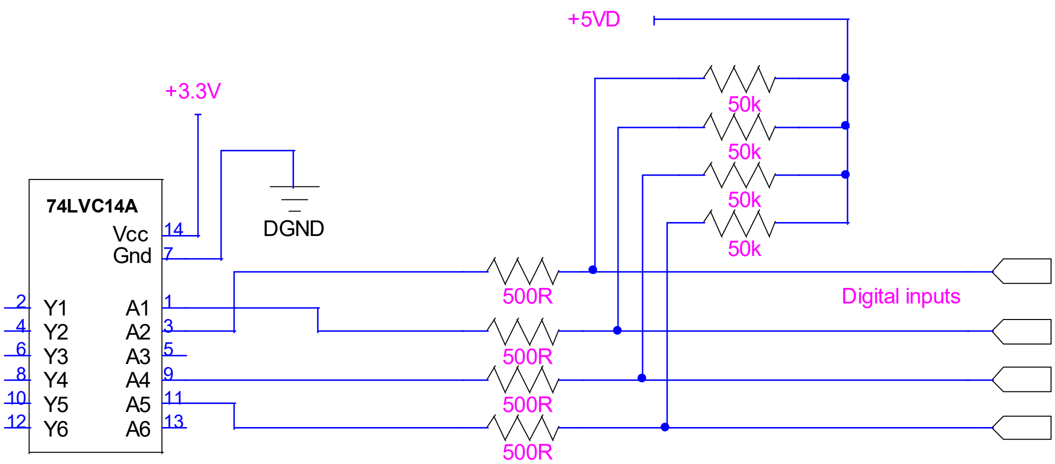



*Figure 29. M10 digital inputs.*

### 13.3.1 TTL source

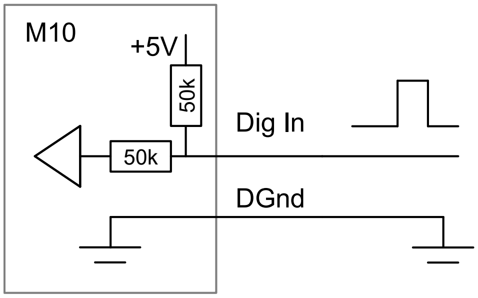



*Figure 30. M10 digital input from a TTL source.*

### 13.3.2 Relay source

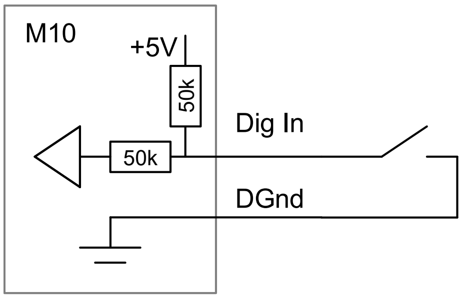



*Figure 31. M10 digital input from a volts-free relay contact pair.*

### 13.3.3 Opto-coupler source

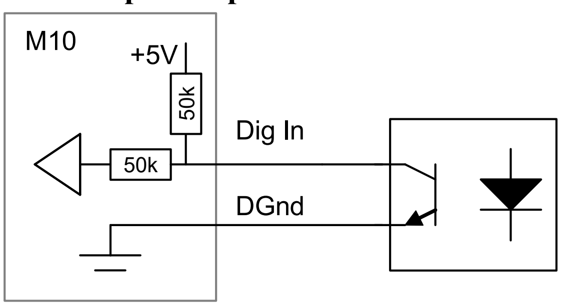



*Figure 32. M10 digital input from an opto-coupler phototransistor.*

## 13.4 Digital outputs

The digital outputs are buffered by a TTL line driver and current limited by 100 ohm series resistors.

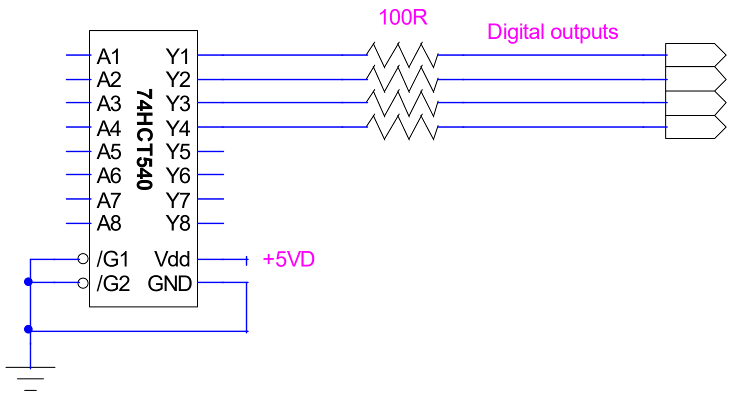



*Figure 33. Digital output circuit.*

### 13.4.1 TTL loads

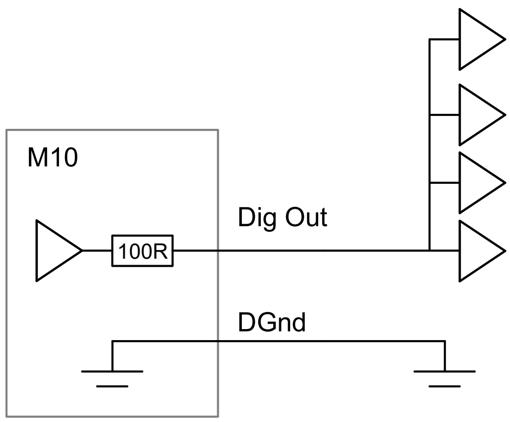



*Figure 34. M10 digital output to TTL loads, with fanout.*

### 13.4.2 Relay solenoid load

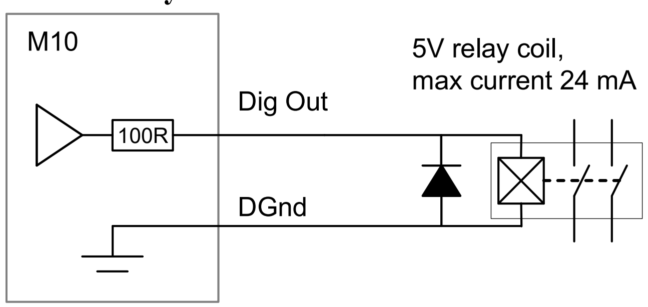



*Figure 35. M10 digital output to relay solenoid.*

A snubber diode must be fitted as shown, 1N4004 or similar.

### 13.4.3 Opto-coupler photodiode load

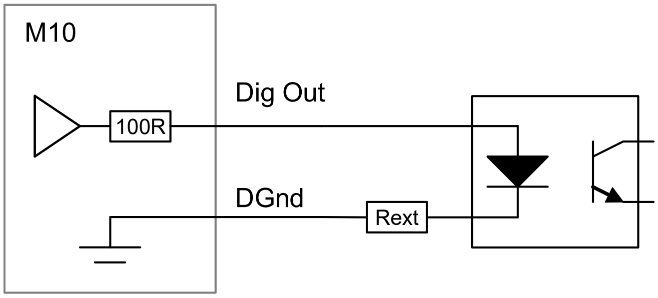



*Figure 36. M10 digital output optocoupler photodiode.*

The external series resistor should be chosen to suit the specified forward diode current, I, required to turn on the opto-coupler.

Rext ≈ (4 / I) – 100

# 14 Calibration

## 14.1 M10 Calibration Factors

Ideally the M10 would output and input perfectly accurate analog voltages. In practice small circuit offsets and gain errors result in small inaccuracies. The M10 stores calibration factors ("Permanent calibration") that allow these to be compensated, increasing the absolute accuracy of the device by an order of magnitude.

There is a gain and offset factor for each analog output, and a gain and offset factor for each range of each analog input. The values can be viewed on the setup tab in either version of Diagnostic host. The factors are determined using high-precision test equipment and stored in the M10 internal memory as part of the manufacturing process, or if the unit is returned for recalibration. The parameters are reloaded whenever the M10 is powered up.

The permanent calibration factors are applied as follows:

Output: $V_{out} = Gain*(V_{raw} – Offset)$

where $V_{out}$ is the voltage sent out by the M10, and $V_{raw}$ is the voltage that would be sent out if there was no calibration.

Input: $V_{read} = Gain*V_{in} – Offset$

where $V_{in}$ is the actual input voltage and $V_{read}$ is the displayed value.

## 14.2 Application Calibration Factors

Application calibration factors are provided to allow you to map the native voltage range of the M10 onto the output and readback of a power supply or similar device that it is controlling. The temporary calibration is applied on top of the permanent calibration, when the "Use temporary scaling" option is checked.

The simplest way to appreciate this function is to consider an example. Say we have a high voltage power supply, designed by a rather confused engineer, that outputs -50 kV to +50 kV linearly in response to a control input of 0 to +5 V. It has a linear readback of -10 V to +10 V corresponding to -50 kV to +100 kV. We want to enter and read back values in kV on the M10 diagnostic, and we know that the permanent calibration is good so that the M10 outputs and inputs are accurate in voltage. When we have selected the analog input and output pair we shall use, we can enter "kV" in the units field so that the Data tab readings are labeled appropriately.

For the output,

$$V_{out} = Gain*(V_{set} + Offset),$$

so for the example, we put Gain = 0.05 and Offset = 50.

For the input, we would use the +/- 10V range, and

$$V_{read} = Gain*V_{in} – Offset,$$

so for the example, Gain = 6.25 and Offset = -12.5.

In practice you may be able measure the response of the power supply by independent means as a function of the M10 output and input values with the temporary calibration disabled, to obtain the necessary parameters.

Notice that this procedure is most intuitive when you can associate one M10 analog input and output pair to setting and reading back one parameter, so that the physical units are common. For example, analog output 1 could be calibrated as described to provide a command in kV, and analog input 1 would be used to read back the corresponding monitor value also scaled in kV. Then we might use analog input 2 to readback and scale a monitored current in mA. The following figure shows how this might look.

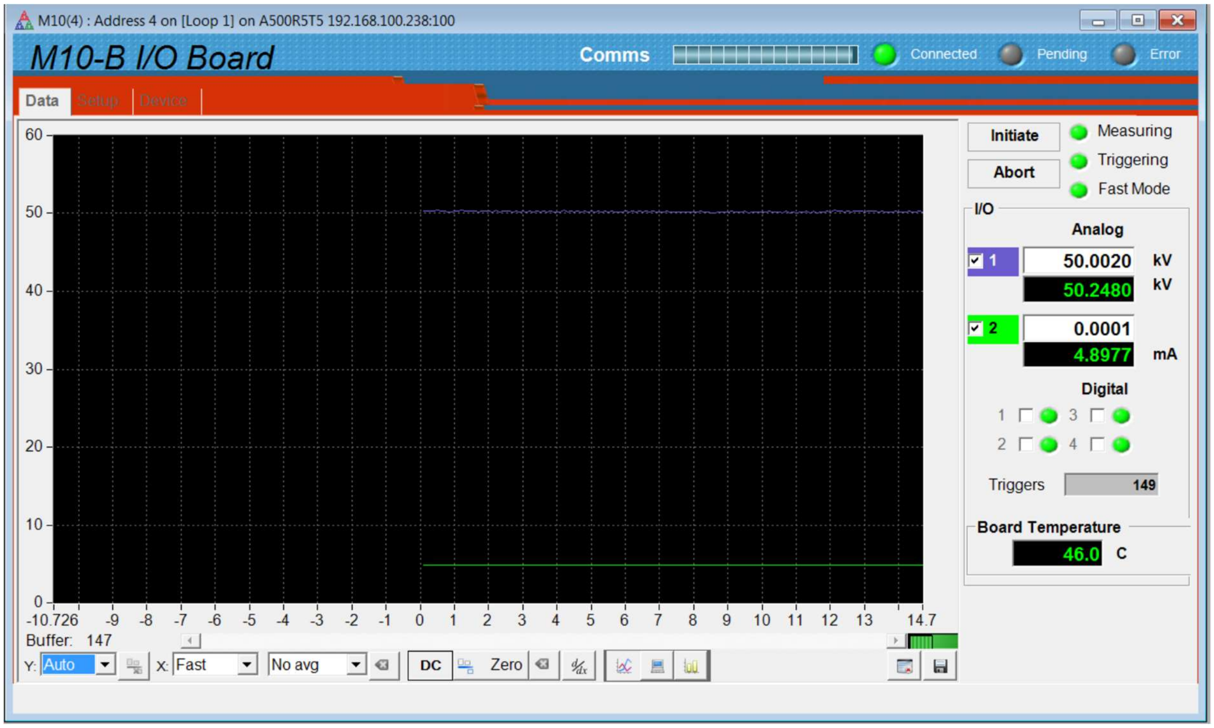


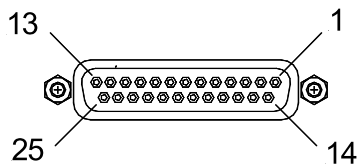

*Figure 37. Using application scaling.*

# 15 Connectors

## 15.1 Front panel connectors

### 15.1.1 Analog and digital I/O

Twenty-five pin Dsub female.

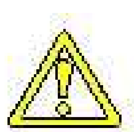



(External view on connector / solder side of mating plug)

| | | | |
|---|---|---|---|
| 1 | PSU ground (0V) | 14 | +24 VDC input or output |
| 2 | Shield (M10 case) | 15 | Analog ground |
| 3 | Analog in 1 + | 16 | Analog in 1 - |
| 4 | Digital out 1 | 17 | Digital out 2 |
| 5 | Analog in 2 + | 18 | Analog in 2 - |
| 6 | Analog ground | 19 | Analog out 1 |
| 7 | Analog ground | 20 | Analog out 2 |
| 8 | Analog ground | 21 | +5V digital out |
| 9 | Digital ground | 22 | Digital out 3 |
| 10 | Digital out 4 | 23 | Digital ground |
| 11 | Digital in 4 | 24 | Digital in 3 |
| 12 | Digital in 2 | 25 | Digital in 1 |
| 13 | Digital ground | | |

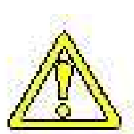
On the M10C model, the 0-20 mA current output is from pin 20 to any analog ground.

CAUTION



Do not connect +24 V to any of the inputs or outputs.

CAUTION



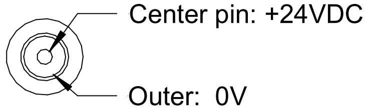
Digital inputs should not lie outside the range 0 to +5.5 V or damage may result.

Analog inputs should not lie outside the range +/- 15V or damage may result.

## 15.2 Rear panel connectors

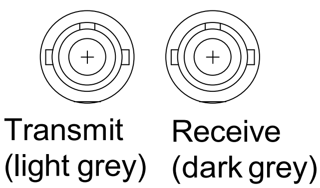
### 15.2.1 Power input

2.1 mm threaded jack. To mate with Switchcraft S761K or equivalent




### 15.2.2 Fiber-optic communications

ST bayonet. To mate with ST male terminated fiber optic cable. Recommended cable types 1 mm plastic (such as Avago HFBR-EUS-500) or 200 um silica (such as OCS BC03597-10 BL). Signal: 650 nm light (red).



# 16 Controls and Indicators

## 16.1 Front panel controls

None.

## 16.2 Rear panel controls

### 16.2.1 Address switch

16 position rotary switch setting device address. Choice of address is arbitrary, but each device in a fiber-optic loop system must have a unique address.

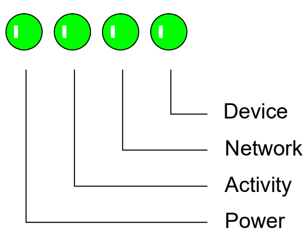
| Setting | Function |
|---|---|
| 0 | (Reserved to loop controller) |
| 1-F (decimal 1 to 15) | Available address settings. |

## 16.3 Front panel indicators

None.

## 16.4 Rear panel indicators

Quad green LED.




### 16.4.1 Power

Green LED. On = input power is present; internal DC-DC converters are running.

### 16.4.2 Activity

Green LED. Flashes for 100 msec when M10 has received new analog or digital output setting.

### 16.4.3 Network

Green LED. Flashes when M10 is processing messages on the fiber-optic channel.

### 16.4.4 Device

Green LED. Flashes on for 100 msec with period (250 msec + averaging time) when M10 is initiated and acquiring data.

## 16.5 Internal settings

We do not recommend that you open the M10 case unless specifically instructed to do so by your supplier or Pyramid Technical Consultants, Inc. The most likely reason is that you need to connect an M10 rev 3 via an A200, instead of the default which covers the A360, A500 and A560. Otherwise, there are no user-serviceable parts inside.

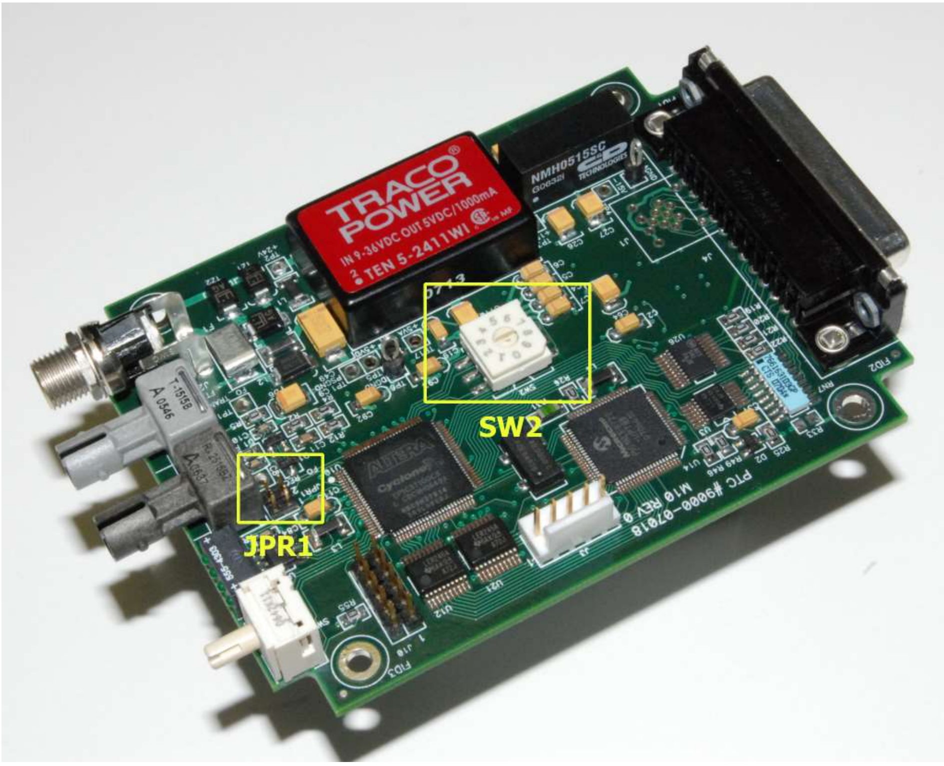



*Figure 38. Location of internal switches and jumpers. Sw2 is not present in the rev 4 M10 (M10 and M10D).*

#### 16.5.1 SW2 settings

Communications mode switch. This switch is only fitted to rev 3 and earlier M10s and the M10C. Only 10 Mbps 9 bit binary is supported in the rev 4 M10, with 4.1D or later PIC firmware. ASCII communications are no longer supported.

| Setting | Function |
|---|---|
| 0 | 9 bit binary, 10 Mbps |
| 1 | 8 bit binary, 3 Mbps |
| 2 | 8 bit binary, 115.2 kbps |
| 3 | 8 bit binary, 57.6 kbps |
| 4 | 8 bit binary, 19.2 kbps |
| 5 | ASCII, 3 Mbps |
| 6 | ASCII, 115.2 kbps |
| 7 | ASCII, 57.6 kbps |
| 8 | ASCII, 19.2 kbps |
| 9 | (Reserved) |

### 16.5.2 JPR1 settings

Device identification.

| Links | Function |
|---|---|
| None | Standard M10 mode. |
| 1 | Set these jumpers to select the 0-20mA output feature for the M10C. This requires the latest firmware for the M10C as described in section 20. |
| 2 | |

The link 1 only setting is associated with the use of the XM01 adaptor.

# 17 Software updates

The M10 has three embedded firmware releases.

| Firmware | Function |
|---|---|
| FPGA (.pof file) | General logic, loop message passthrough, ADC reading and averaging |
| PIC Boot (.hex file) | Boot up, code upload |
| PIC Application (.hex file) | Main application; calibration, conversion to floating point values, range control, HV PSU control, actuator I/O control, host communications, SCPI instrument model. |

## 17.1 FPGA firmware updates

To update the FPGA, click the “Select .fhex file” button under Upload FPGA on the Device tab, and navigate to the relevant file. The code will then load. The process takes about 20 seconds.

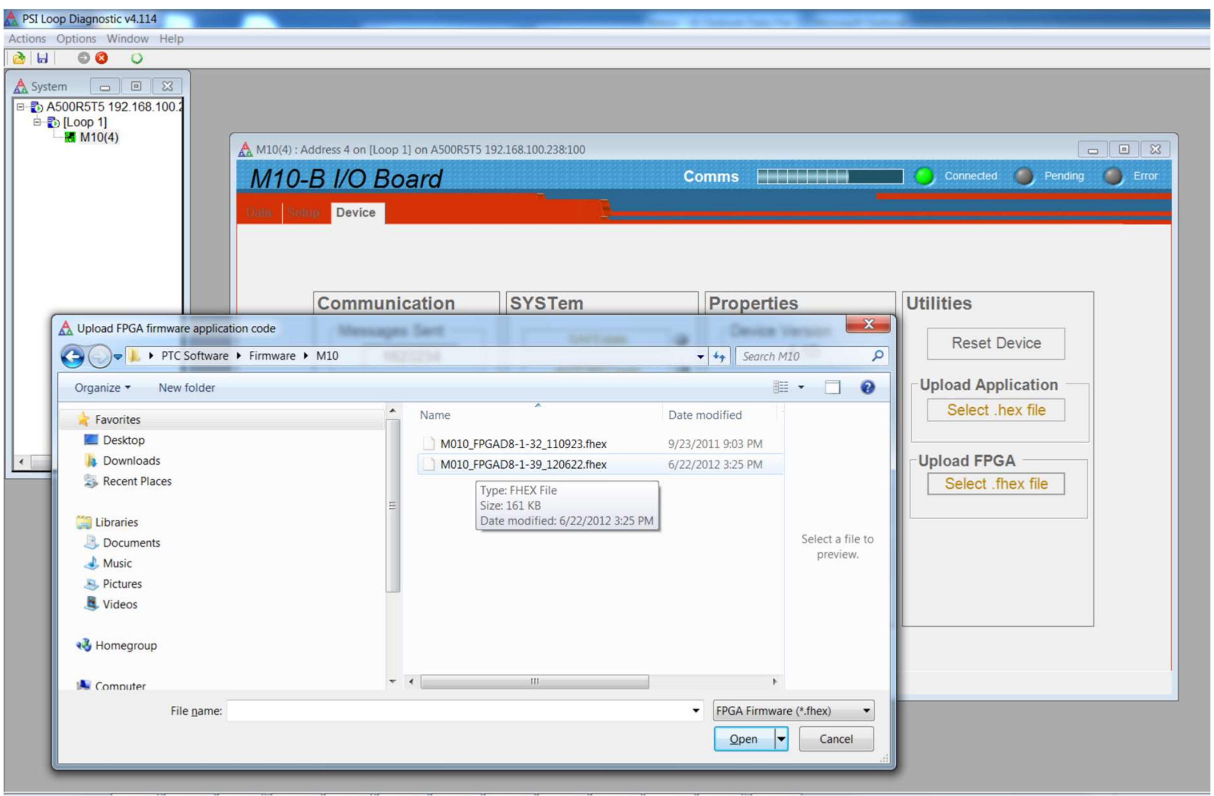



*Figure 39. Selecting the fhex file to load.*

When the upload is complete, you will get a prompt to power cycle the M10 in order to load the new code.

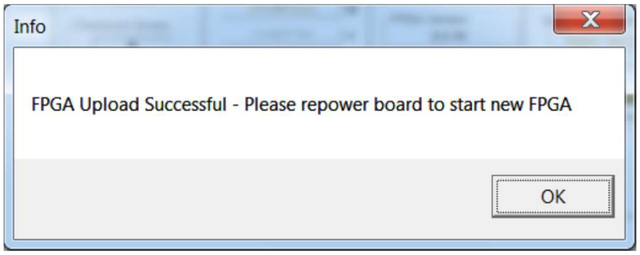



*Figure 40. Restart prompt after FPGA update.*

If the FPGA upload fails for any reason such as loss of power during the upload, or data corruption, then the M10 may not be able to communicate. In the unlikely circumstance that this happens, it can be recovered using an FPGA programming tool and the .pof version of the FPGA code. Contact your supplier or Pyramid Technical Consultants who will arrange for the unit to be repaired.

The PIC microcontroller application code may be updated periodically to add new operating features. New code releases will be provided by your supplier, or can be downloaded from the Pyramid Technical Consultants, Inc. website. The hex file can be loaded using the PSI Diagnostic host without any need to access the unit. The upload can be performed directly from the PC host. On the Device tab, click the “Select .hex file” button and navigate to the relevant file. The code will then load. The process takes about 20 seconds, and the M10 will start running the new code immediately.

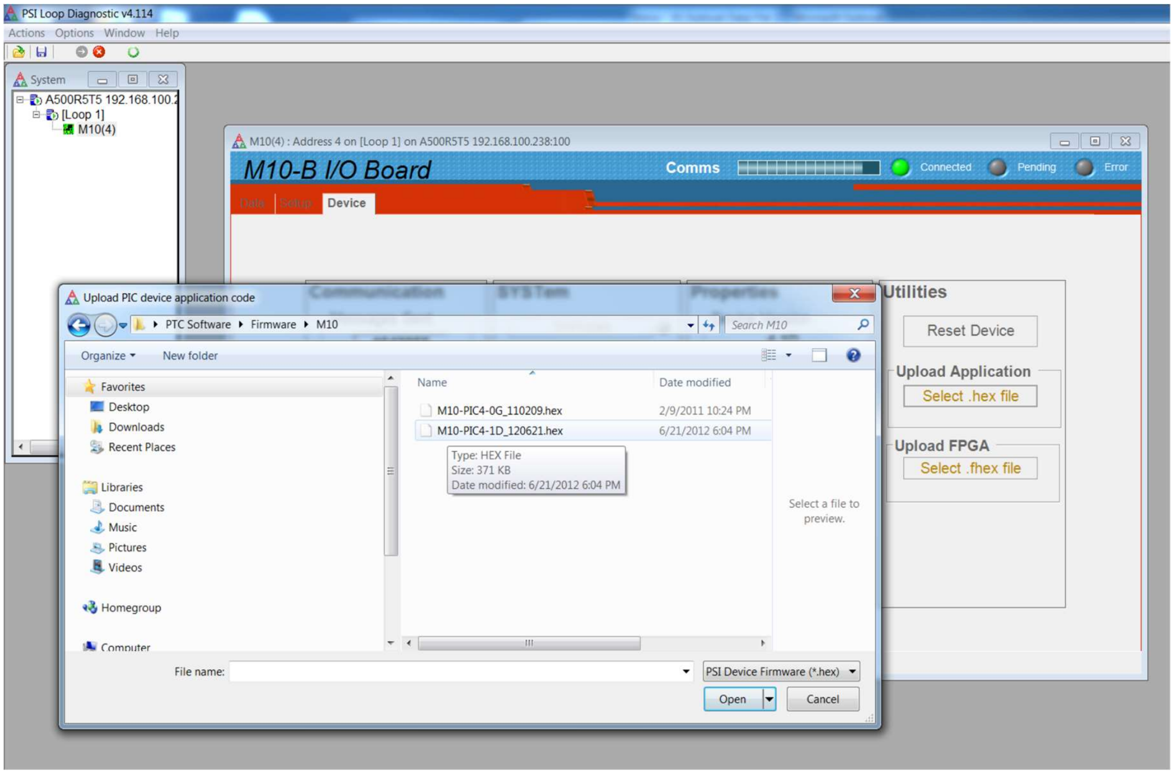



*Figure 41. Selecting the hex file to load.*

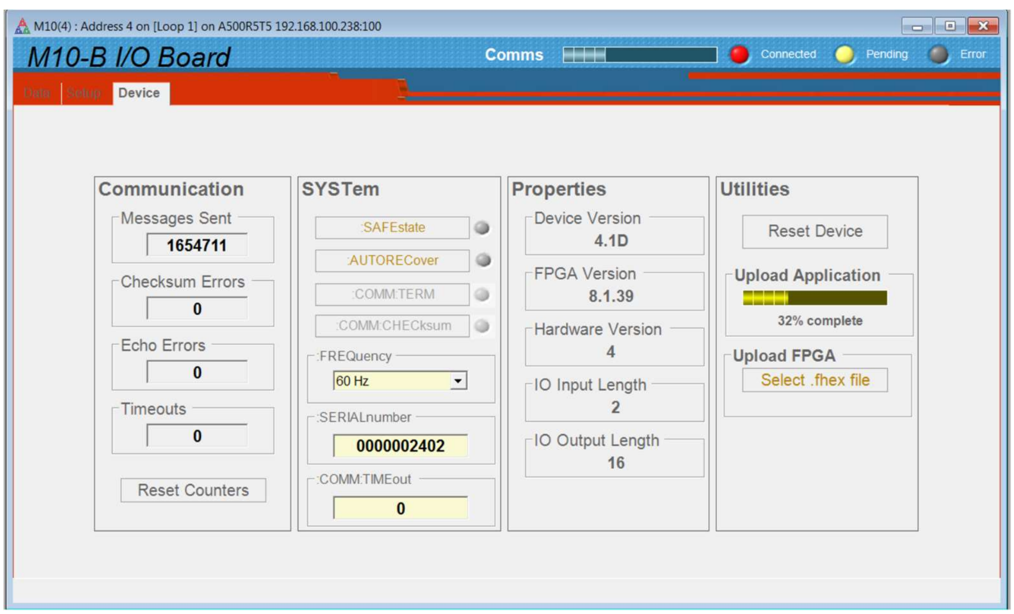



*Figure 42. Firmware upload in progress*

# 18 Controlling Analog Output Ramp Rate

It may not always be appropriate to make large steps in the M10 analog outputs. For example, if the M10 is controlling a power supply driving an inductive load, then a demand for a sudden step in current may cause the power supply to hit its voltage compliance limit, and perhaps loose regulation. One way to manage this is to command the M10 to make a series of small steps and thus simulate a smooth ramp. Doing this via a sequence of commands may impose an unacceptable load on the communications, however.

M10 firmware 4.1D or later allows a limiting slew rate to be set, in volts per second, with the ramp waveform generated internally by the M10 itself. The host software only needs to send the target voltage and the ramp is computed and executed by the M10.

The ramp rate value is exposed in PSI Diagnostic version 4.112 and later, on the setup tab.

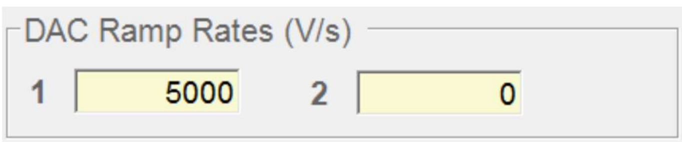



*Figure 43. Ramp rate limit controls in the PSI Diagnostic*

If the ramp rate is set to zero, then the feature is disabled, and the output will change as fast as the M10 internal amplifiers will allow. Figure 44 shows a 5V step without rate limiting; the main linear portion of the change occurs at 6.6e5 V $s^{-1}$.

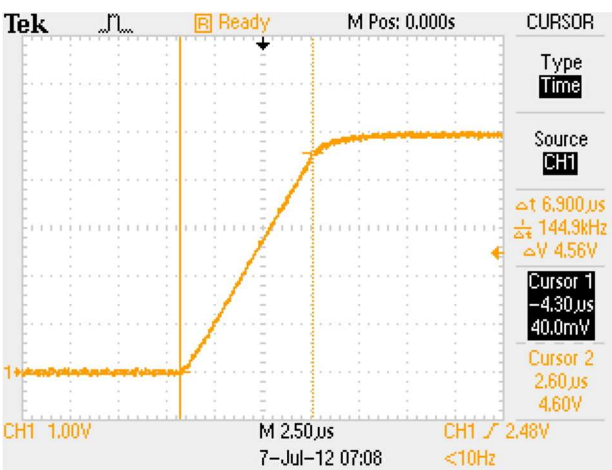



*Figure 44. M10 analog output step without ramp rate limiting*

Setting a non-zero value sets the ramp rate in V $sec^{-1}$. The M10 will execute a staircase of small, short steps to closely approximate a smooth slope at the requested rate. The fine detail of this staircase is constrained ultimately by the minimum time between steps (four microseconds) and the smallest voltage step (one bit = 0.3 mV). Figure 45 shows the results for the same step with the rate set to 50000 V s-1, and to 5000 V s-1.

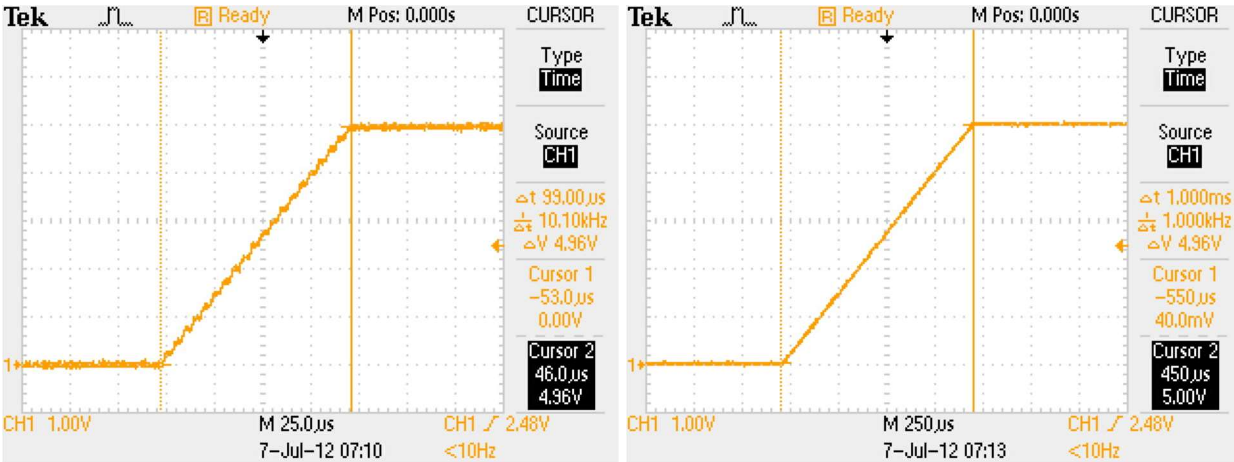



*Figure 45. M10 analog output step with ramp rate limiting at 50000 V $s^{-1}$ (left) and 5000 V $s^{-1}$ (right)*

# 19 Pulse output feature

The M10-P version with PIC firmware up to 4.0G can put out a well-controlled sequence of pulses on any or all of the four digital outputs. This feature is useful for test of pulse counting systems. Within the pulse-pair resolution pulse duration capabilities of the system being tested, a particular number of pulses output by the M10P show be counted by the pulse counting system, irrespective of changes to the pulse length and period.

A typical application is to use the TTL pulses to drive a pulser LED in a scintillator-photomultiplier detector, as illustrated in figure 45. An A500-GC commands a particular pulse train on from the M10, and then counts the resulting pulses on its scaler board. The complete pulse counting system is therefore validated.

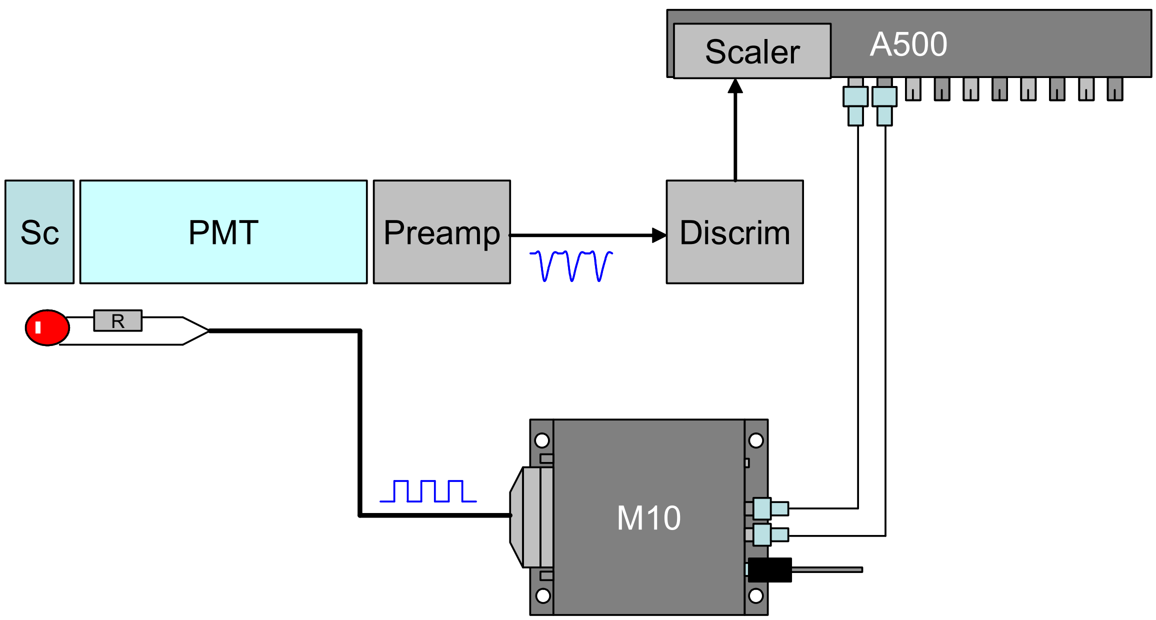



*Figure 46. Use of the M10P to generate a pulse train for a pulser LED to test a pulse counting system.*

If the cable from the M10-P to the LED is long, and you want to send fast pulses, then you are advised to try to impedance match the transmission line as far as possible. The 100R - 150R series resistor at the LED and appropriate screened twisted pair cable can achieve reasonable matching.

The controls for the pulse output feature are exposed in PSI Diagnostic software versions up 4.9, but not in later versions. Figure 47 shows a setup that gives five and seven pulses on digital outputs 1 and 3 respectively, with the digital output 3 being inverted. The resulting output when the pulsing is initiated from the data screen is shown in figure 46. The pulse period and high time are set in units of 12.5 nsec, and the period must exceed the high time by at least one unit. The maximum values for the times are 65553, and this is also the maximum pulse count.

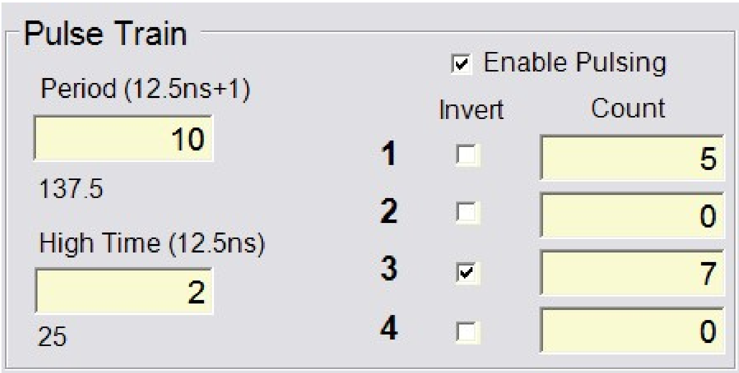



*Figure 47. Example PSI diagnostic setup for pulse output.*

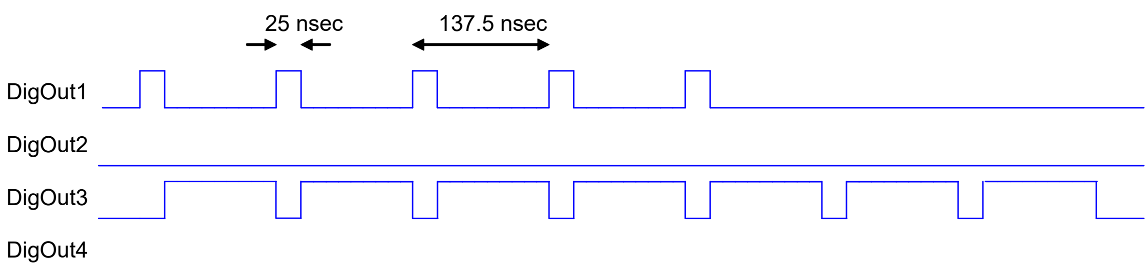



*Figure 48. Schematic illustration of the resulting pulse output.*

# 20 Versions and Compatibility

There are some compatibility constraints for the various versions of the M10. We recommend the configurations shown below. However if you have M10s embedded in a complex system running application-specific host software, you should not change your firmware or software versions without consulting your supplier or Pyramid Technical Consultants, Inc.

**M10 rev 4 or rev 3 with analog slew rate control, M10D**

| | | |
|---|---|---|
| | M10 PIC | 4.1D or later |
| | M10 FPGA | 8.1.39 or later |
| | A500 DSP | 5.43 or later |
| | A500 FPGA | 2.7.42 or later |
| | A500 Ethernet | 8.5 |
| ***or*** | A560 | 0.6.138.30 |
| | PSI Diagnostic | 4.114 or later |
| ***or*** | PTC G2 Diagnostic | 5.4.1 or later |

(Slew rate control will be exposed in a future revision of the PTC G2 Diagnostic)

**M10C (0-20 mA current output)**

| | | |
|---|---|---|
| | M10C PIC | 4.1D or later |
| | M10C FPGA | 8.1.44 |
| | A500 DSP | 5.43 or later |
| | A500 FPGA | 2.7.42 or later |
| | A500 Ethernet | 8.5 |
| | PSI Diagnostic | 4.114 or later |

**M10P (rev 3 PCB) with digital pulse output feature**

| | | |
|---|---|---|
| | M10 PIC | 4.0G |
| | M10 FPGA | 8.1.26 |
| | A500 DSP | 5.36 |
| | A500 FPGA | 2.7.178 |
| | A500 Ethernet | 8.5 |
| | PSI Diagnostic | 4.99 or earlier |

The M10C and M10P use the same circuit board as the M10 rev3, but with alternative parts fitted. The M10 rev 4 uses a different circuit board.

Recent versions of the M10 can also be connected as slaves to any G2 series controller such as the A360, A560, I128, F460, C400 and others.  Contact Pyramid Technical Consultants, Inc. for latest information on compatibility.  Use of the G2 platform gives access to EPICS via the IG2 channel access server software.

# 21 Fault-finding

| Symptom | Possible Cause | Confirmation | Solution |
|---|---|---|---|
| Incorrect analog input readings | Incorrect connection to the differential input. Voltage must appear across the + and - pins. | Check connection arrangement against the examples in section 13. | Use appropriate connection. |
| | Incorrect range selected | Change to range 4 and recheck | Use an appropriate range for the size of signal. |
| | Calibration incorrect or corrupted | Check calibration values for erratic values. | Contact supplier or Pyramid Technical Consultants, Inc. |
| | Application scaling factors have been enabled in error, or are incorrect for the application. | Check whether application scaling has been enabled, and whether the values are sensible. | Use the appropriate scaling for your application. |
| Incorrect analog output values | Terminating impedance is too low. | Disconnect load and re-measure. | Ensure load is within the current compliance of the analog outputs. |
| M10C 0 – 20 mA current incorrect | Terminating impedance is too high | Short, or reduce terminating impedance to 500 ohm or less. | Ensure load is within the voltage compliance of the 0 – 20 mA output. |
| High noise levels | Integration time too short for signal being measured | Noise level reduces with integration period | Use an appropriate integration time for the signal level. |
| Analog in signals respond very slowly | Averaging period has been set very long | Reduce period | Set averaging appropriate to the required time resolution and noise levels |

| | | | |
|---|---|---|---|
| | Line voltage pickup | Noise level drops sharply if integration period is 16.7 msec (60 Hz) or 20 msec (50 Hz) | Keep M10 and signal cables clear of unscreened high current mains voltage. Use integration periods (N/line frequency). |
| Digital input not registering signal as expected | Incorrect electrical connection to target device, typically lack of appropriate ground path. | Check that unloaded output changes as expected with a loop back connector | Correct electrical configuration (see section 12) |
| Unable to set digital outputs as expected | Incorrect electrical connection to target device, typically lack of appropriate ground path. | Check that unloaded output changes as expected with a loop back connector or by direct measurement | Correct electrical configuration (see section 12) |
| | | | |
| Unable to communicate with M10 | Duplicate address setting | Check address against expected address in host software. | Use correct switch setting. Switches can be changed while the unit is operating. |
| | Communication link timeout | | Investigate and fix communications issue. Use a longer timeout setting if necessary. |
| | RX and TX cables cross connected somewhere in loop. | Network LED not lit. | Correct cabling. |
| | Fiber optics are damaged | Inspect fibers, especially the connectors. Check light can be seen through fiber. Exchange fibers and retry | Fit new fibers or re-terminate as necessary. |
| | Incorrect setting of SW2 (hardware rev 3 or earlier only) | | Contact your supplier or Pyramid Technical |

| | | | |
|---|---|---|---|
| | | | Consultants, Inc. Refer to section 15. |
| Unable to connect to M10C | Using PTC G2 Diagnostic which does not support the M10C. | Check Diagnostic type and version. | Use the PSI Diagnostic to connect to the M10C. |
| Communications interruptions | Other processes on PC host interfering with comms ports. | | Use a dedicated PC with simple configuration and minimum number of processes running. |
| PSI Diagnostic will not connect to devices | Two copies of program running | | Run a single instance only |
| Random changes to parameters | Another host program is interacting with the same M10. | Check software running on hosts that could access the M10. | Run a single host program only. |
| Analog outputs slow to change. | Ramp rate limit parameter has been applied. | Check setting of ramp rate parameter. | Set appropriate value, or 0 to disable the ramp rate limitation. |
| No pulse output | Pulsing mode not supported | Check hardware and firmware versions (see section 19). | Use the correct hardware and software versions, |
| | Enable pulse feature not enabled. | Check if feature is selected in the PSI Diagnostic. | Check enable pulse out box in PSI Diagnostic |

# 22 Maintenance

The M10 does not require routine maintenance or calibration. There is risk of contamination which may degrade performance if the case is opened. There are no user-serviceable parts inside.

The M10 is fitted with a 1.1 A automatically resetting positive temperature coefficient (PTC) fuse in the 24 VDC input. No user intervention is required if the fuse operates due to overcurrent. The fuse will reset when the overcurrent condition ends.

# 23 Returns procedure

Damaged or faulty units cannot be returned unless a Returns Material Authorization (RMA) number has been issued by Pyramid Technical Consultants, Inc.  If you need to return a unit, contact Pyramid Technical Consultants at support@ptcusa.com, stating

- model
- serial number
- nature of fault

An RMA will be issued, including details of which service center to return the unit to.

# 24 Support

Manual and software driver updates are available for download from the Pyramid Technical Consultants website at **www.ptcusa.com**. Technical support is available by email from support@ptcusa.com. Please provide the model number and serial number of your unit, plus relevant details of your application.

# 25 Disposal

We hope that the M10 gives you long and reliable service.  The M10 is manufactured to be compliance with the European Union RoHS Directive 2002/95/EC, and as such should not present any health hazard.  Nevertheless, when your device has reached the end of its working life, you must dispose of it in accordance with local regulations in force.  If you are disposing of the product in the European Union, this includes compliance with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC.  Please contact Pyramid Technical Consultants, Inc. for instructions when you wish to dispose of the device.

# 26 Declaration of Conformity

## Declaration of Conformity

Issued by: Pyramid Technical Consultants, Inc.
1050 Waltham Street, Lexington MA 02421, USA

The undersigned hereby declares, on behalf of Pyramid Technical Consultants, Inc. that the referenced products conform to the provisions as listed. Refer to the document: *Extension of testing and analysis to the PTC product line, December 10, 2007* and the *I400 Technical Construction File* for detailed testing information.

| | |
|---|---|
| Product: | M10 / M10C Multifunction I/O, H10 Field Probe Controller, B10A / B10B / B10C Digital I/O |
| Year of initial manufacture: | 2007 |
| Applicable Directives: | 73/23/EEC Low Voltage Directive:<br>Laws for electrical equipment within certain voltage limits<br><br>89/336/EEC – EMC Directive:<br>Laws relating to electromagnetic compatibility |
| Applicable Standards: | IEC 610101:2002 (2nd Edition)<br>UL 61010-1:2004<br>EN 61326: 1997+A1:1998+A2:2001<br>EN 55011:1998, A2:2002<br>EN 61000-6-2:2001 – Electromagnetic Compatibility Generic Standard, Immunity for Industrial Applications |
| Issuing Agencies: | Safety: TUV Rheinland North America.<br>12 Commerce Rd, Newtown, CT 06470 USA<br><br>EMC: TUV Rheinland North America.<br>12 Commerce Rd, Newtown, CT 06470 USA |
| Applicable Markings: | TUV, FCC, CE |
| Authorized by: | President, Pyramid Technical Consultants, Inc. |
| Date: | July 24, 2008 |

The Technical Construction File required by theses Directives are maintained at the offices of Pyramid Technical Consultants, Inc, 1050 Waltham Street, Lexington MA 02421, USA
A copy of this file is available within the EU at the offices of Pyramid Technical Consultants Europe, Ltd, 2 Chanctonbury View, Henfield BN5 9TW, United Kingdom.

# 27 Revision History

The release date of a Pyramid Technical Consultants, Inc. user manual can be determined from the document file name, where it is encoded yymmdd. For example, M10_UM_080105 would be a M10 manual released on 5 January 2008.

| ***Version*** | ***Changes*** |
|---|---|
| M10_UM_080714 | First general release |
| M10_UM_080724 | Add ASCII communications information |
| M10_UM_081027 | Add Declaration of Conformity |
| M10_UM_120709 | Major revision covering new software and hardware.<br>- add information about PTC G2 Diagnostic<br>- add section on ramp rate limiting<br>- remove ASCII communications section (no longer supported)<br>- add compatibility section<br>- add disposal section |
| M10_UM_120716 | Minor corrections following review. |
| M10_UM_141205 | Update specifications table<br>Add information on DIN rail mounting.<br>Identify M10P and M10D as separate versions.<br>Add section on IG2 and EPICS interfacing. |
| M10_UM_150225 | Update specifications table |
| M10_UM_1700307 | Correct number of analog inputs and outputs in description of Diagnostic G2 screens. |
| M10_UM_1900331 | Corrected jumper settings for M10C. |