PROLON

HARDWARE GUIDE

Rooftop Controller M2000 Series

Specifications and Operational Guide

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[IMPORTANT INFORMATION - READ BEFORE YOU BEGIN]

For simplicity and consistency, temperature values shown in this document are displayed in Fahrenheit (°F). Prolon Focus can be configured by the user to display either Fahrenheit (°F) or Celsius (°C) based on preference or regional requirements.

Prolon products also support metric and imperial measurement options, where applicable.

Product availability, features, and specifications may vary by region.

Images and information are provided for reference only and may change without notice.

General Information

PL-M2000 Rooftop Controller

Description

The Prolon PL-M2000-RTU Rooftop controller is a microprocessor-based controller designed to operate rooftops or other mechanical HVAC systems. It uses PI (Proportional-Integral) control loops and acts as a master when used on a network with Prolon zone controllers.

General Behaviour

Although fully configurable, the Prolon PL-M2000 Rooftop controller uses pre-established control sequences or ''profiles'' to operate specific HVAC equipment with dedicated output functions. These can be fully optimized to obtain the best results for each type of system. Numerous parameters enable the modification or fine tuning of the fan, the cooling outputs, the action of the heating outputs (On-or-Off / pulsed / modulating), the bypass or VFD and outside air dampers, the CO_2 levels, the proportional bands, integration times, differentials, operational ranges, setpoints and a whole range of limits and safeguards. The various programming options also allow the user to modify the schedule, unoccupied mode settings, morning warm-up and supply air pre-heating sequences as well as the network demand control strategy best suited for the building space it is controlling. All these parameters can be accessed by using the Prolon Focus software.



Operating Sequence

General

The Prolon PL-M2000-RTU Rooftop controller receives readings from five different temperature sensors: outside air, return air, supply air, mixed air and zone air. In addition to the temperature sensors, it also has inputs for the static pressure, CO_2 levels and proof of fan. It operates on a configurable schedule using an internal real time clock. Also, as a Master device, it receives data from the zone controllers sent over the network bus. The controller then analyzes all the data and demands sent by the zones and commands the appropriate outputs to respond accordingly, within parameters set by the temperature sensors and other safety limits. The Master sends back information on its network such as supply air temperature, occupancy status and other relevant data for the zone controllers to use.

Occupied Mode

The controller operates the fan. When there is a cooling demand from the zones, the Rooftop controller will activate the cooling outputs as long as all temperature limits, delays and other related parameters are respected. Once the demand is satisfied, the outputs are deactivated within the prescribed minimum on/off time delays.

When there is a heating demand from the zones, the Rooftop controller will activate the heating outputs as long as all temperature limits, delays and other related parameters are respected. Once the demand is satisfied, the outputs are deactivated within the prescribed minimum on/off time delays.

When the CO_2 levels become too high, the Rooftop controller will open the outside air damper as long as all temperature limits, delays and other related parameters are respected. Once the CO_2 levels return to normal, the outside air damper returns to its previous position.

When there is no cooling or heating demand from the zones, only the fan is enabled. If the heating equipment permits, a supply air pre-heating sequence may be enabled. This allows cold mixed air to be heated to a more comfortable level for subsequent use by the zones for ventilation.

Unoccupied Mode

The fan can be configured to operate in intermittent mode. When there is a cooling or heating demand from any single zone, the Rooftop controller will activate the fan and the necessary cooling or heating outputs as long as all temperature limits, delays and other related parameter are respected. Once the demand is satisfied, the fan and any cooling/heating outputs are deactivated within the min. on/off time delays set.

During the unoccupied period, the Rooftop controller can be driven by the highest demand on the network and will operate the fan and relevant outputs accordingly.

Component Identification

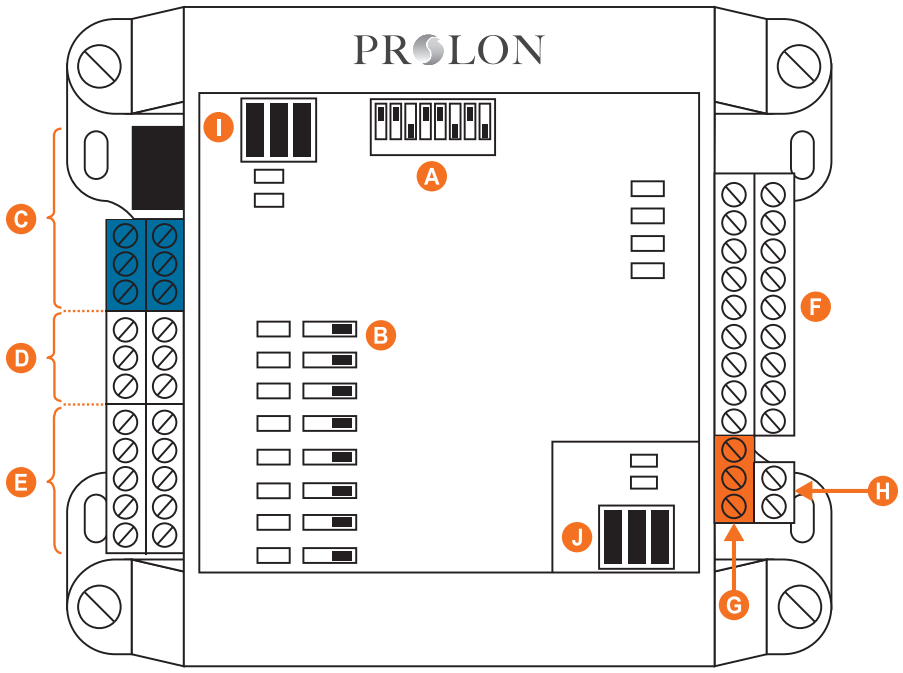


Figure 1 - Component Identification

Legend:

A - Addressing Dipswitch

B - AUTO/OFF/HAND Switches

C - RS485 INT port for interface communication (RJ45 plug and screw connectors are in parallel)

D - Analog outputs (3)

E - Digital outputs (5)

F - Analog inputs (9)

G - RS485 NET port for network communication

H - Terminal block for 24VAC (Class 2 transformer)

I - Jumpers for terminating and bias resistors for the INT port

J - Jumpers for terminating and bias resistors for the NET port

LEDs and Switches

The PL-M2000 has various LEDs which are linked to different functions and outputs of the controller. Each LED is individually identified to help the user make a quick visual diagnostic of the controller's activity and status.

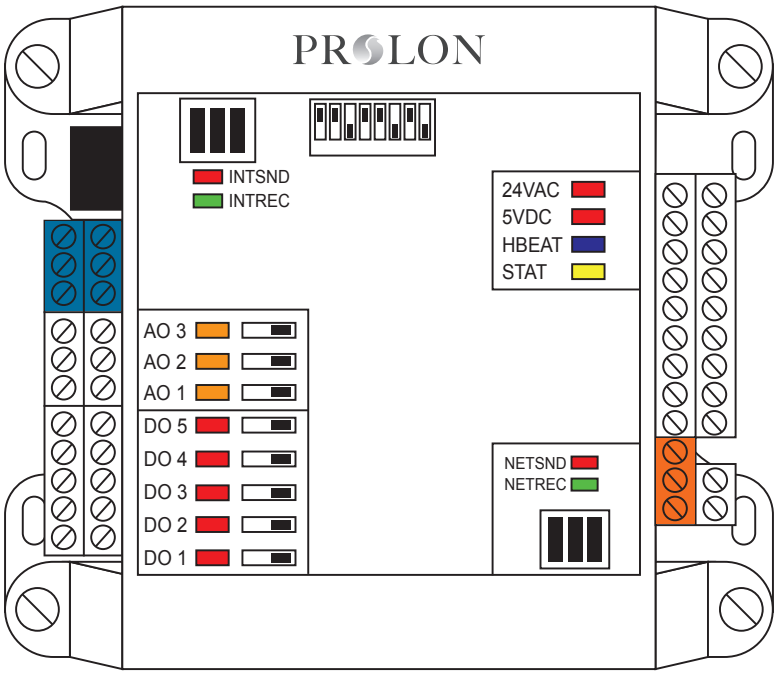


Figure 2 - LEDs Identification

LED Descriptions

- **24 VAC**: The PL-M2000 is receiving 24 VAC from the power source.
- **5V DC**: The microchip and other components on the PL-M2000 are being powered successfully by a 5VDC source derived from the 24VAC source.
- **HBEAT**: When this LED is blinking, the microchip is active and the controller's program is running (normal). When this LED is ON and steady, the PL-M2000 is inactive and the microchip is awaiting programming (you must use Prolon's Focus software to reprogram the microchip).
- **STAT**: Reserved.
- **NETSND**: Indicates the transmission of data onto the network communication bus.
- **NETREC**: Indicates reception of data from the network communication bus.
- **INTSND**: Indicates the transmission of data onto the interface communication bus.
- **INTREC**: Indicates the reception of data from the interface communication bus.
- **AO3**: The intensity of the LED represents the voltage present on analog output 3.
- **AO2**: The intensity of the LED represents the voltage present on analog output 2.
- **AO1**: The intensity of the LED represents the voltage present on analog output 1.
- **DO5**: Represents the activity of digital output 5.
- **DO4**: Represents the activity of digital output 4.
- **DO3**: Represents the activity of digital output 3.
- **DO2**: Represents the activity of digital output 2.
- **DO1**: Represents the activity of digital output 1.

HAND/OFF/AUTO Switches

Each output on the PL-M2000 has a dedicated switch that lets the user manually override the activity of the output. “HAND” mode (switch at rightmost position) fully activates the output (24 VAC for digital outputs, 10VDC for analog outputs). “OFF” (switch at center) deactivates the output and “AUTO” (switch at left) returns control of the output to the program in the PL-M2000’s microchip.

Jumpers

The PL-M2000 has jumpers that are externally accessible (see Figure 3), as well as jumpers that are inside the controller on the top internal board (see Figure 4), that allow for configuration of various hardware elements.

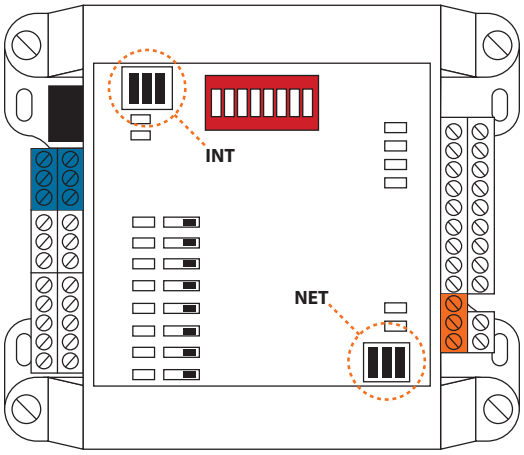


Figure 3 - Location of the EXTERNAL jumpers

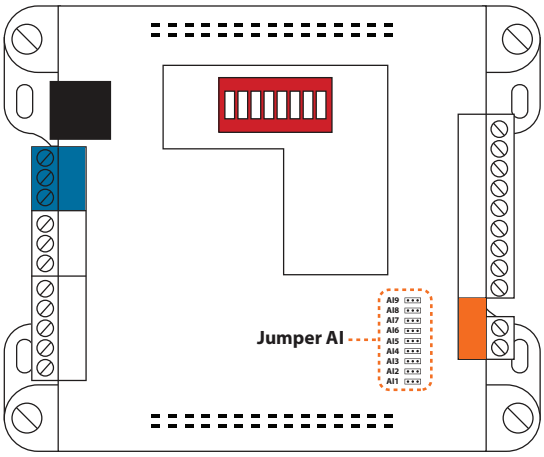


Figure 4 - Location of the INTERNAL jumpers

- **INT**: These are the jumpers for the bias and terminating resistors used for the interface communication bus. See the Prolon network guide for information about bias and terminating resistors. (See Figure 5)
- **NET**: These are the jumpers for the bias and terminating resistors used for the network communication bus. See the Prolon network guide for information about bias and terminating resistors. (See Figure 5)
- **AI 1 - 9**: These jumpers allow the user to select the signal mode of the associated analog input. (See Figure 6)

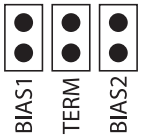


Figure 5 - INT and NET jumpers



Figure 6 - AI jumpers

Input and Output Identification

All the inputs and outputs of the PL-M2000 use pluggable screw type terminal blocks with elevator style clamping, which make connections easier and more secure.

For incoming communication from a remote computer or network controller, dual RJ45 type connectors are available in parallel with screw type terminal blocks. The RJ45 connectors allow the use of premade CAT5 cables for simple plug-and-play RS485 communication. These RJ45 connectors follow the Modbus pinout specification for RS485 communication.

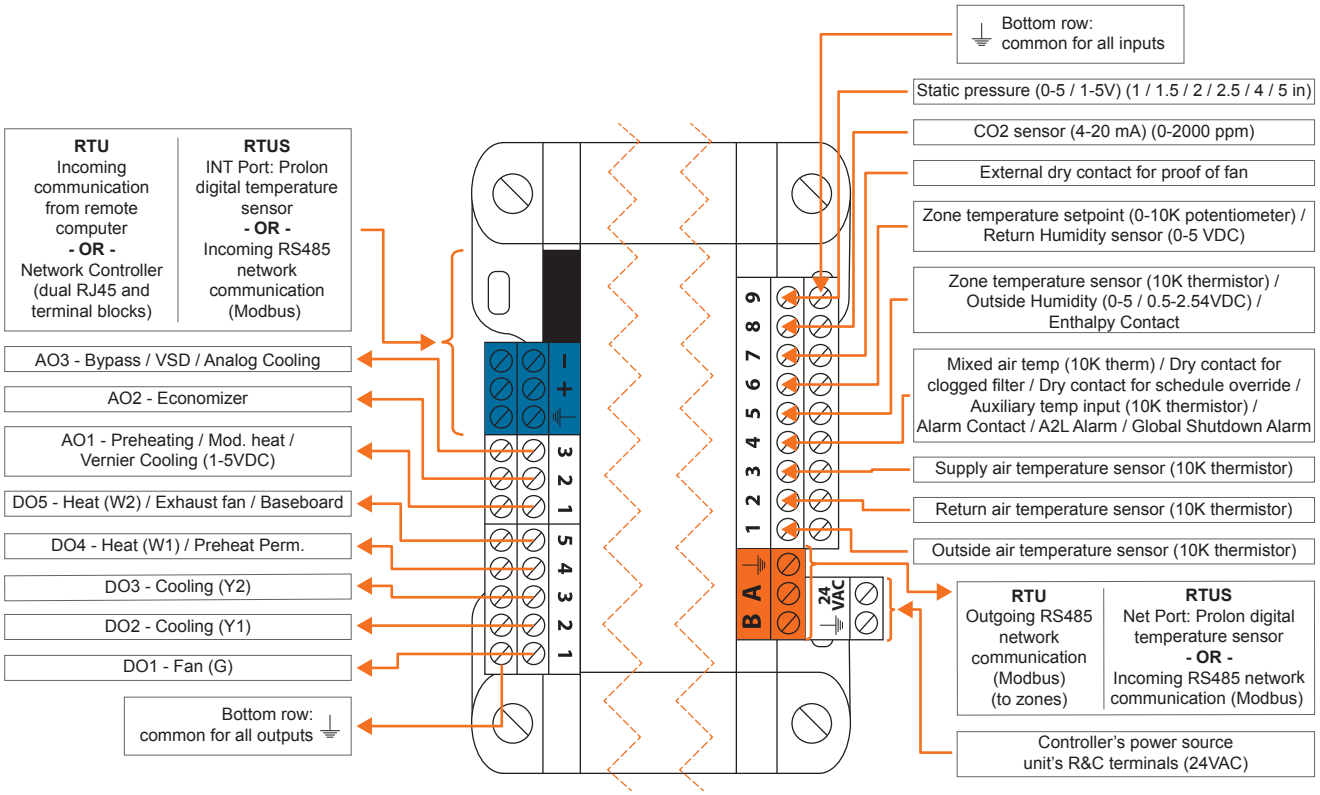


Figure 7 - Input and Output Identification

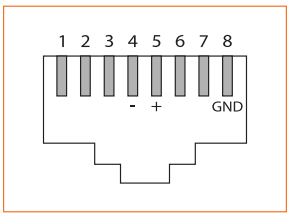


Figure 8 - RJ45 Pinout

Addressing Dipswitch Configuration for Network Communication

For proper communication, a unique address must be configured on each controller by setting the first 7 switches on the addressing dipswitch bloc to the desired value. The dipswitch bloc is located on the front section of the PL-M2000-RTU.

These switches are numbered from 1 to 7 and represent a binary value from 1 to 64 (1, 2, 4, 8, 16, 32, and 64 respectively). The last switch (#8) is reserved. The value of each switch that is in the ON position is added together to form the numerical address of the controller.

The example in Figure 9 shows the switches 1, 2 and 4 in the ON position. Therefore, the corresponding values are 1, 2 and 8, giving an address sum of 11.

The Prolon network allows a maximum of 127 addresses; therefore 127 controllers.



Figure 9 - Addressing Dipswitch

Temperature Sensors

The PL-M2000 Rooftop controller has four analog inputs that monitor outside air, supply air, return air and mixed air temperatures (see Figure 10) and will integrate these readings into its control sequence. The sensors used are standard 10k type thermistors that share a single common connection.

Alternatively, the supply air temperature can be retrieved from a zone controller that has its own supply sensor and belongs to the PL-M2000's network.

The outside air temperature can also be provided by an alternate source. If a network controller is present on the network, it can retrieve the outside temperature reading from one controller and distribute it to any other controllers on the network.

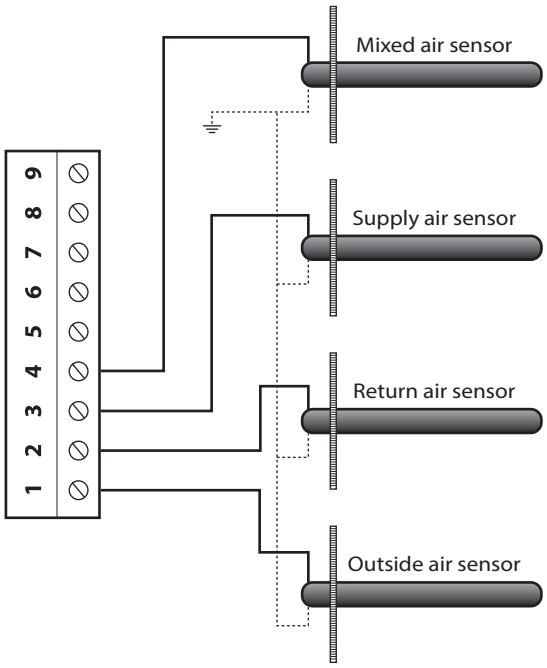


Figure 10 - Connecting the Temperature Sensors

Room Sensors

The PL-M2000-RTU can receive the setpoint and temperature from a specific room when a PL-RS analog thermostat is connected to it. The PL-M2000 will then automatically integrate this information into its control sequence. The setpoint may also simply be set by software. The PL-RS series room sensors are connected using a 3-conductor cable.

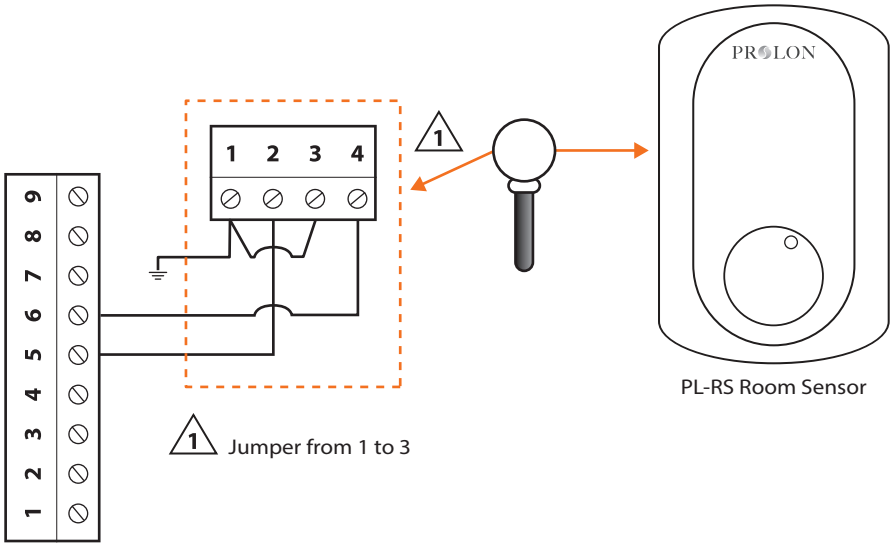


Figure 11 - Typical Wiring of the PL-RS Room Sensor to the Controller

Proof of Fan

The PL-M2000-RTU has an analog input dedicated to the proof of fan signal. Please refer to Figure 12 to see how to correctly connect it to analog input 7. To indicate proof of fan, the contact must be closed. If no proof of fan signal is available, you must short analog input 7, or else the controller will interpret the absence of signal as a fan malfunction and no heating or cooling action will be taken.

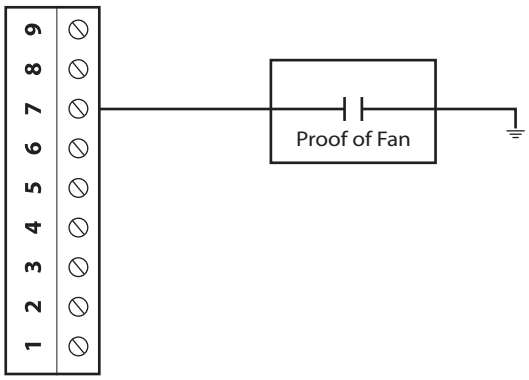


Figure 12 - Connecting the Proof of Fan Contact to the Controller

Dry Contact for Clogged Filter or Schedule Override

Analog input 4 on the PL-M2000-RTU can also be configured as a dry contact input for either a clogged filter sensor or as a schedule override input. Please refer to Figure 13 to see proper connection.

- **Clogged filter sensor**: To indicate that the filter is clogged, the contact must be closed.
- **Schedule Override**: Closing the contact causes the PL-M2000 to immediately return to occupied mode from unoccupied mode. The PL-M2000 remains in occupied mode as long as the contact is held closed. If it was already in occupied mode, there is no change.

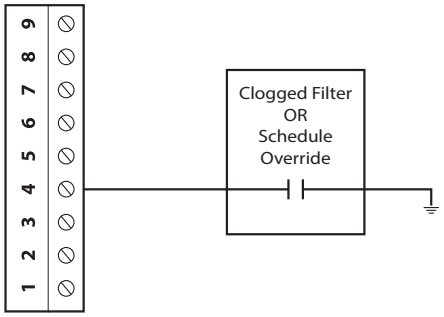


Figure 13 - Connecting the Dry Contact Input to the Controller

Dry Contact for A2L Alarm or Global Shutdown

Analog input 4 on the PL-M2000-RTU can also be configured as a dry contact input for either a A2L Alarm of Global Shutdown Alarm. Please refer to Figure 14 to see proper connection.

- **A2L Alarm Input**: In this mode, a closed contact indicates that the A2L alarm (a leak of flammable A2L refrigerants) is active. Under an A2L alarm, the RTU Controller will command all follower VAV controllers to open their dampers to their maximum position to vent the refrigerant.
- **Global Shutdown Status**: In this mode, a closed contac indicates that the Global Shutdown mode is activated. Additionally, the RTU controller will begin continuously broadcasting the Global Shutdown status to all its followers. During Global Shutdown mode, the RTU controller will turn the main fan OFF, and any outputs associated with Fan activity (cooling/heating) will be turned OFF as well. VAV Controllers will close their dampers to 0% and turn OFF outputs configured as Duct Heater or Fan Powered Box.

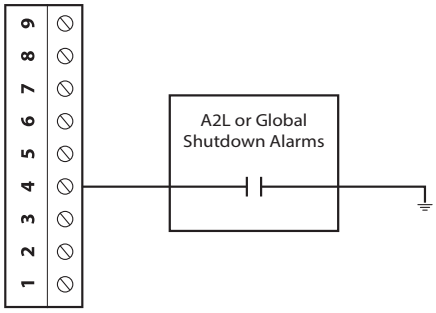


Figure 14 - Connecting the Dry Contact Input to the Controller

Relative Humidity

Analog inputs 5 and 6 on the PL-M2000 rooftop controller can be configured to measure relative humidity.

- **Outside Humidity**: Outside Humidity will be measured on Analog Input 5 when the Economizer mode is set to ***Single Enthalpy*** or ***Differential Enthalpy***. In either of these setups, the inputs signal should be 0-5VDC.
- **Return Humidity**: Return Humidity will be measured on Analog Input 6 when the Local Dehumidification sequence is enabled, or if Economizer mode is set to ***Differential Enthalpy***. The input can accept two different signal types:
  - 0-5 VDC
  - 0.5-2.54 VDC (ex.: Tekmar 086 series)

It is important to configure the controller with the correct input settings via the Prolon Focus software.

The internal jumpers for both Humidity inputs should be set to "Voltage" mode (see p.8). Figure 15 shows the typical wiring connection for the sensors:

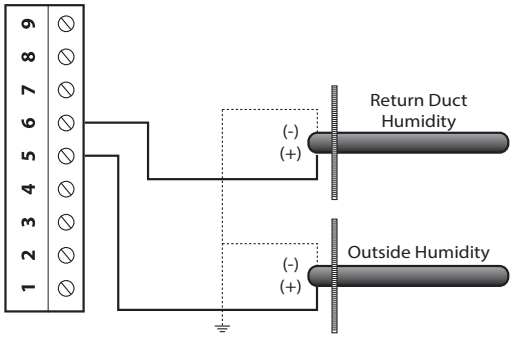


Figure 15 - Connecting the Relative Humidity Sensors

CO_2 Sensor

Analog Input 8 on the PL-M2000 rooftop controller can be configured to measure CO_2 gas concentrations. The input is expecting a 4-20mA signal for a range of 0-2000ppm, so the internal jumper should be set to "4-20mA" mode (see p.8).

Figure 16 shows the typical wiring connection for the CO_2 sensor:

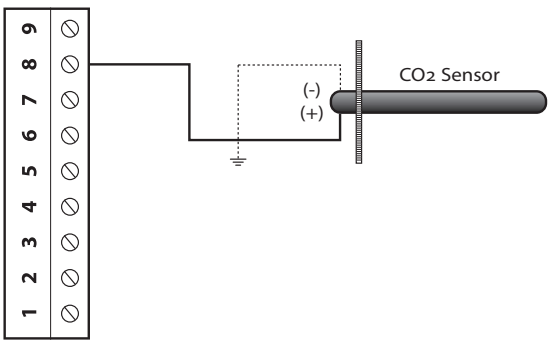


Figure 16 - Connecting the CO_2 sensor

Static Pressure

Analog Input 9 on the PL-M2000 rooftop controller can be configured to measure static pressure. The controller accepts a variety of sensor signals:

- **Voltage**:
  - 0-5 VDC
  - 1-5 VDC
- **Pressure**:
  - 0 – 1.0 inches H20
  - 0 – 1.5 inches H20
  - 0 – 2.0 inches H20
  - 0 – 2.5 inches H20
  - 0 – 4.0 inches H20
  - 0 – 5.0 inches H20

It is important to configure the controller with the correct input settings via the Prolon Focus software.

The internal jumper should be set to “Voltage” mode (see p.8). Figure 17 shows the typical wiring connection for the sensor.

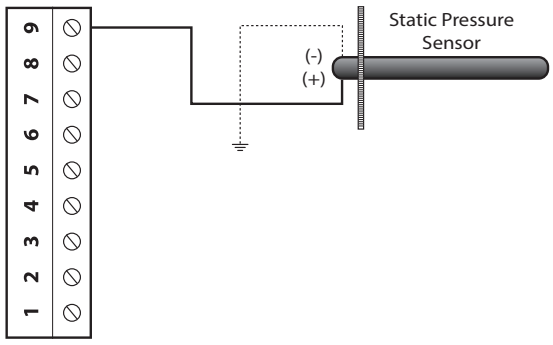


Figure 17 - Connecting the pressure sensor

Outputs

The PL-M2000 Rooftop controller contains 8 customizable outputs; five triac ON/OFF outputs (24VAC) and three analog outputs (0-10VDC). Output configuration is performed via the Prolon Focus software.

An integrated resettable fuse protects each of the outputs of the PL-M2000 against current surges and short circuits. This protection will cut the current to the output as soon as an overload condition is detected. The fuse is a round, yellow-coloured PTC that will change to orange and heat up on an overload condition. Once power has been removed from the PL-M2000, the fuse will cool down and automatically reset. Fix the faulty wiring and you will be able to activate the output once again.

Output Specifications

Output	Type	Action	Application
DO 1	Triac source 24VAC, Max Current: 300 mA	On-or-Off	Fan (G)
DO 2	Triac source 24VAC, Max Current: 300 mA	On-or-Off	Cooling (1st Stage) (Y1)
DO 3	Triac source 24VAC, Max Current: 300 mA	On-or-Off	Cooling (2nd Stage) (Y2)
DO 4	Triac source 24VAC, Max Current: 300 mA	On-or-Off	Heating (W1) / Preheat Permission
DO 5	Triac source 24VAC, Max Current: 300 mA	On-or-Off	Heating (W2) / Exhaust Fan (Power Exhaust or Ventilation) / Baseboard
AO 1	Configurable Analog Output: - 0 to 10 VDC - 2 to 10 VDC - 0 to 5 VDC Max Current: 40 mA	Modulating Proportional / Pulse / On-or-Off	Preheating/ Modulating Heating/ Vernier Cooling
AO 2	Configurable Analog Output: - 0 to 10 VDC - 2 to 10 VDC Max Current: 40 mA	Modulating Proportional	Economizer
AO 3	Configurable Analog Output: - 0 to 10 VDC - 2 to 10 VDC Max Current: 40 mA	Modulating Proportional	Bypass / Variable Speed Drive/ Analog Cooling

Typical Connection of Triac Outputs 1 to 5

On the PL-M2000 Rooftop controller, all triac outputs produce a 24 VAC live voltage when activated. Note that all output voltages originate from a single voltage supply: the equipment's transformer. Consequentially, only the live side of the output connections are usually needed; these are on the top row (see figure 18). The bottom row is the common (GND).

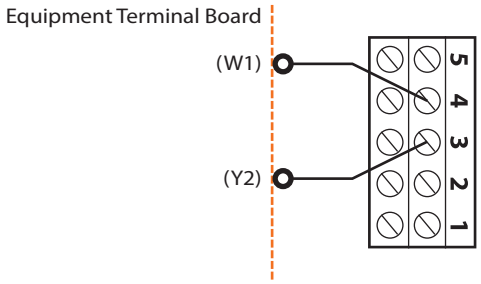


Figure 18 - Connection of Digital Output 3 and 4

Typical Connection of Analog Outputs 1 to 3

For all analog outputs, the common is found on the bottom row terminal blocks, and the active signals are found on the top row terminal blocks (see Figure 19). Analog outputs 1 can be configured to modulate a 0-10 VDC load, to pulse a 0 or 10 VDC triac relay or to control a 10 VDC On/Off relay. Analog outputs 2 and 3 can only modulate a DC load (0-10 VDC or 2-10 VDC).

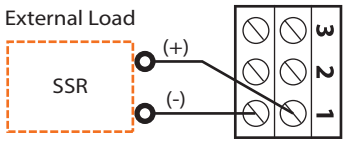


Figure 19 - Connecting Analog Output 1 (External Power)

UMX-4 Connection on Digital Output 2 for 3 or 4 Stage Cooling

When 3 or 4 stages of cooling are required, the Rooftop controller must be equipped with a UMX-4. The UMX-4 PWM input is connected to Digital Output 2 on the Rooftop controller.

The UMX-4 must be configured to "Single Unit UMX Control" in "RTU Controller PWM" mode. This can be achieved by setting the dipswitches as follows:

Switch	1	2	3	4	5	6	7	8
State	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF

The "Input Selection Jumper" needs to be set to "PW / 0-5VDC".

The UMX-4 outputs are then connected to the rooftop unit (see figure 20). Each of the UMX-4 outputs have connections for "Normally Closed" and "Normally Open" operation, so use the connection that is compatible with your rooftop unit. For more information on the UMX-4, consult the Specification Sheet and the Installation Guide for the UMX-4.

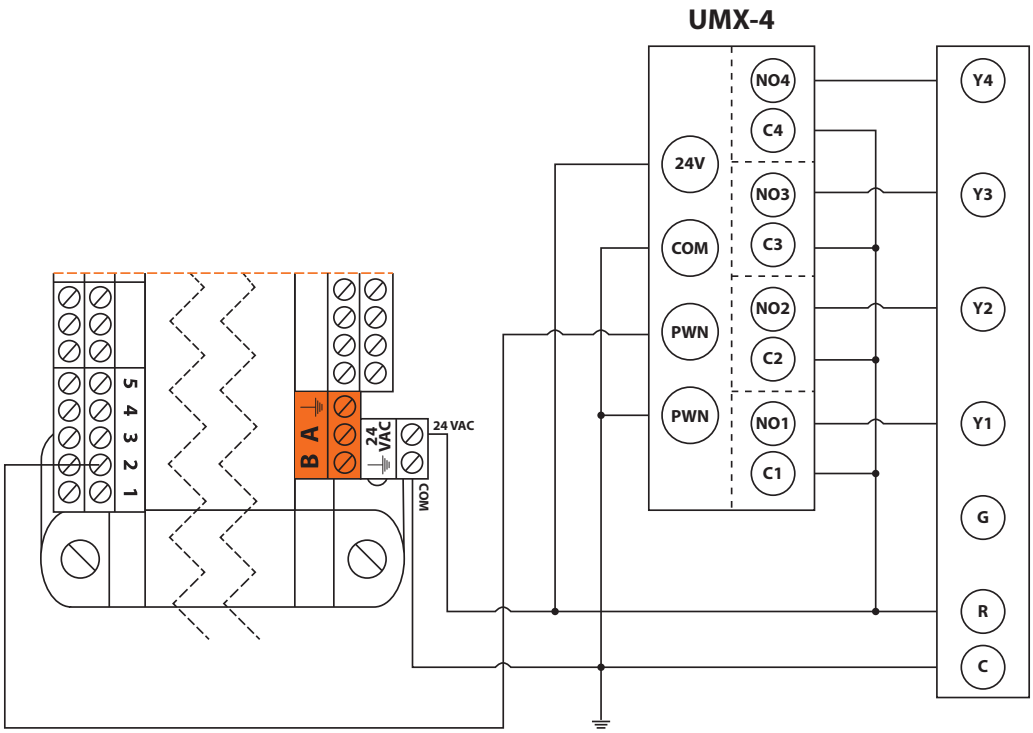


Figure 20 - Connecting the UMX-4 (Powered by PL-M2000)

DMUX-4J Connection on Digital Output 2 for 3 or 4 Stage Cooling

When 3 or 4 stages of cooling are required, the PL-M2000 Rooftop controller must be equipped with a DMUX-4J. The DMUX-4J input is only connected to Digital Output 2 on the PL-M2000 Rooftop controller. The DMUX-4J must be configured to "Sequenced Relay Control" with a 1 second pulse resolution. The "Triac Input Selection" jumper must be set to normal signal input and the "Power Type Selection" jumper must be set to AC power. The DMUX-4J outputs are then connected to the rooftop unit (see figure 21). Each of the DMUX-4J outputs have connections for "Normally Closed" and "Normally Open" operation, so use the connection that is compatible with your rooftop unit. For more information on the DMUX-4J, consult the Specification Sheet and the Installation Guide for the DMUX-4J.

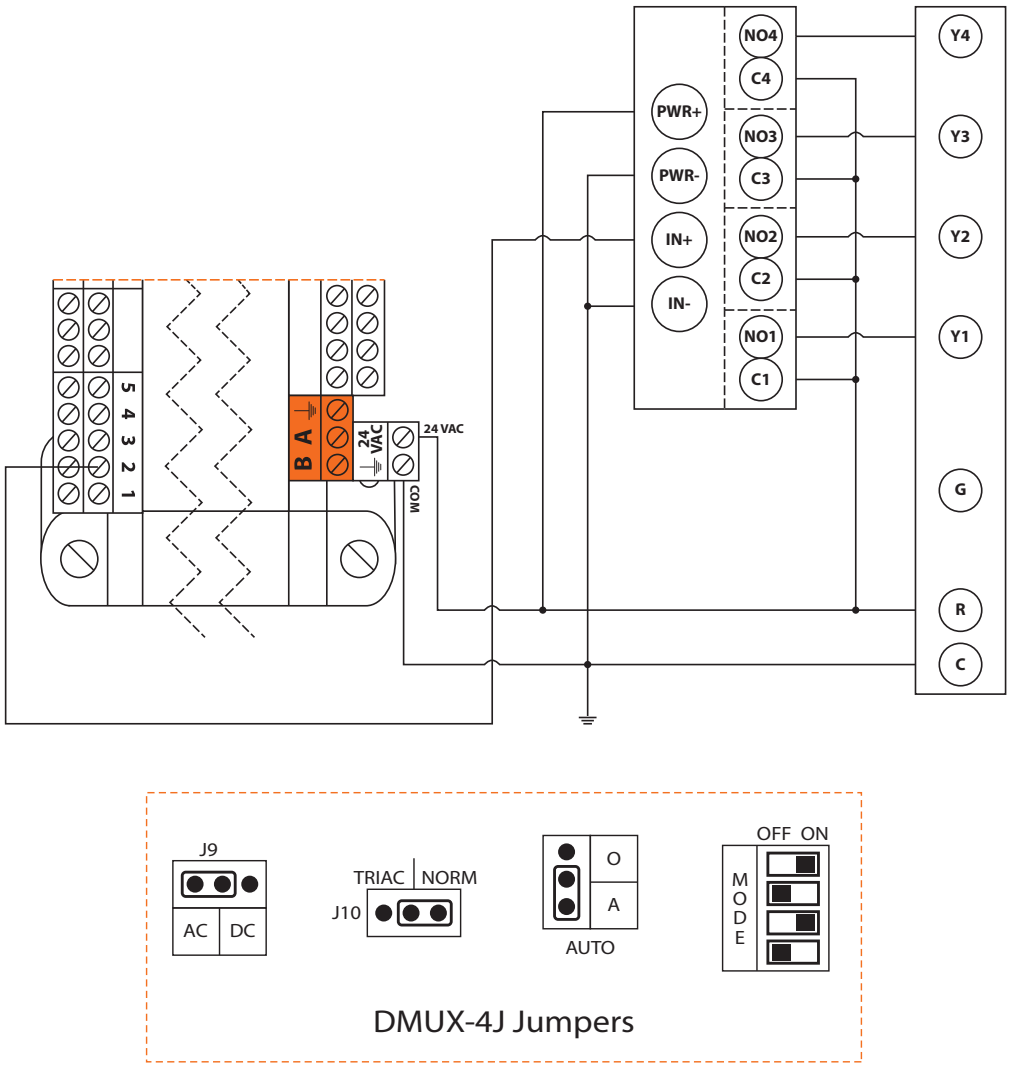


Figure 21 - Connecting the DMUX-4J (Powered by PL-M2000)

PTA2 Connection on Digital Output 2 for Analog Cooling

When proportional modulating cooling is required, the PL-M2000 Rooftop controller must be equipped with a PTA2 v.1. interface to create an analog 0-10Vdc output signal. The PTA2 input is connected to Digital Output 2 on the PL-M2000 Rooftop controller. The input pulse range must be set to 0.1-10 sec. For more information on the PTA2, consult the Specification Sheet and the Installation Guide for the PTA2.

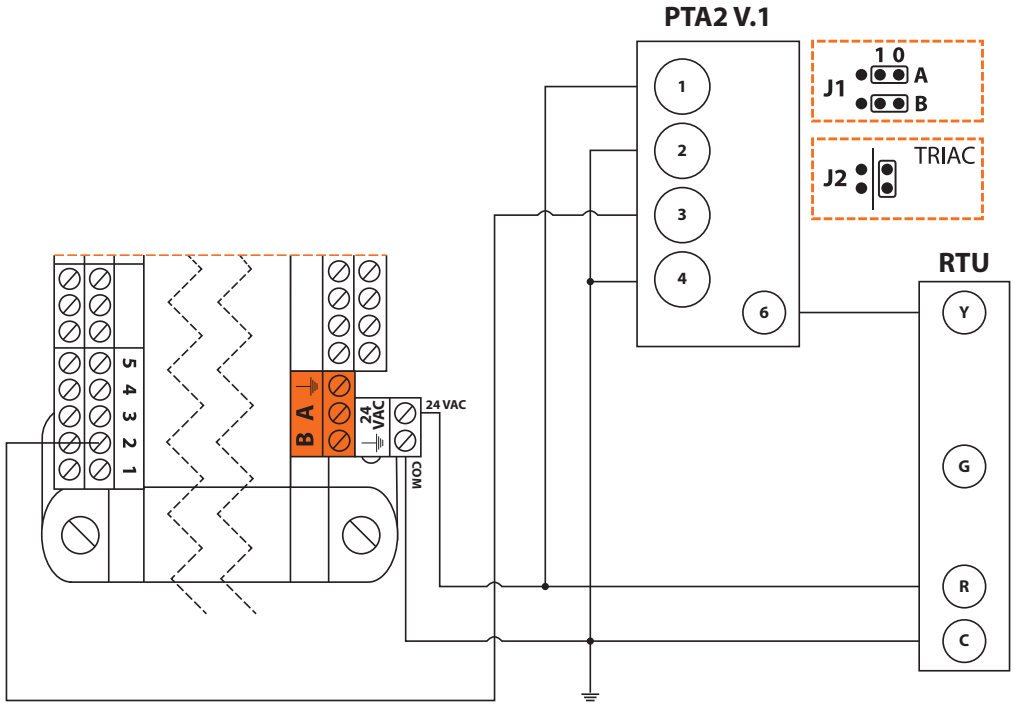


Figure 22 - Connecting the PTA2 (Powered by PL-M2000)

Power Source

The PL-M2000 controller is powered by the HVAC equipment's 24 VAC power supply (class 2) by connecting the common (''C'' wire) to the "COM" terminal block and the live (''R'' wire) to the "24 VAC" terminal block (see Figure 23). The common for all inputs and outputs is the same as the power source's common. All output power sources also originate from the HVAC equipment's power source.

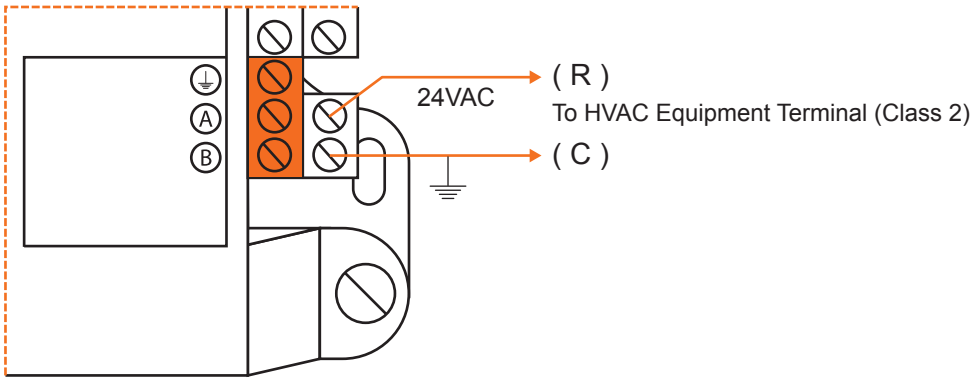


Figure 23 - Connecting the 24VAC Power Source

Network Communication

The Prolon PL-M2000 Rooftop controller is designed to work with the Prolon zone controllers. When they are networked, the Rooftop and zone controllers all communicate in real-time. The network connections are made using the network terminal blocks located on the PL-M2000 controller (see Figure 24).

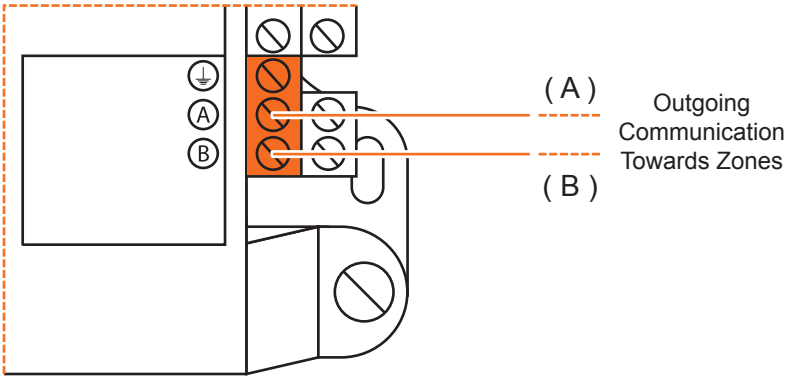


Figure 24 - Connecting to the Network

Technical Specifications

Supply: 24 VAC ±10%, 50/60 Hz, Class 2

Power: 5 VA (Consumption), 40 VA (Input)

Inputs: 9 configurable analog inputs (outside temperature / return / supply / mixed air / room, dry contact for clogged filter / schedule override / proof of fan / room setpoint / CO_2 levels / static pressure / auxiliary temp). Input signals (thermistor / dry contact / 4-20mA / 0-5 VDC, RH%) individually configurable for each input

Digital Outputs: 5 triac outputs, 10-30 VAC source, 300 mA max (resettable fuse)

Analog Outputs: 3 x 0-10 VDC outputs, 40 mA max

Indication lights (LED): State of each output / Communication / Power / State of microprocessor

Microprocessor: PIC18F6722, 8 bits, 40 MHz, 128KB FLASH memory

Casing: Molded ABS, UL94-HB

Communication: Modbus RTU (RS485) up to 127 nodes

Baud Rates: 9600, 19200, 38400, 57600, 76800, 115200

Connection: Removable screw-type terminal blocks (max 16 AWG) and RJ45 modular jacks

Dimensions: 5.39" x 4.41" x 2.25" (137 mm x 112 mm x 57 mm)

Weights: 1.05 lbs (0.48 kg)

Environment: -4 to 122 °F (-20 to 50 °C) Non-Condensing

Certification: UL916 Energy Management Equipment, CAN/CSA-C22.2, RoHS, FCC part 15: 2012 class B

The performance specifications are nominal and conform to acceptable industry standards. Prolon Inc. will not be liable for damages resulting from misapplication or misuse of its products.

- cULus Listed; UL 916 Energy Management Equipment, File E364757, Vol.1
- CAN/CSA-C22.2 No. 2015-12, Signal Equipment
- FCC Compliant to CFR47, Part 15, Subpart B, Class B
- Industry Canada (IC) Compliant to ICES-003, Issue 5: CAN ICES-3 (B)/NMB-3(B)
- RoHS Directive (2002/95/EC)

FCC User Information

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Caution: Any changes or modifications not approved by Prolon can void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Industry Canada

This Class (B) digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment regulations.

Cet appareil numérique de la Classe (B) respecte toutes les exigences du Réglement sur le matériel brouilleur du Canada.

Overall Dimensions

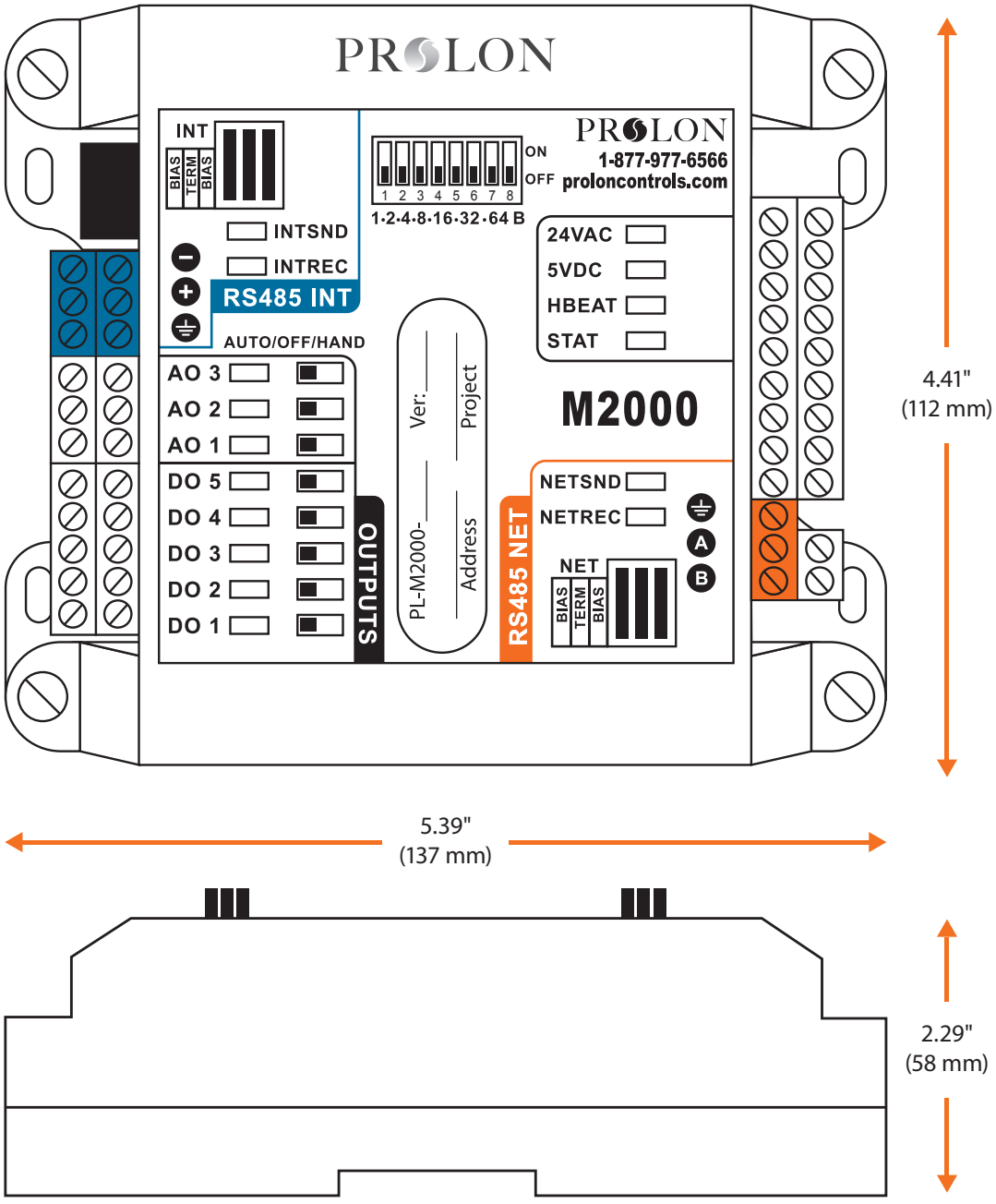


Figure 25 - PL-M2000 Size Diagram

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