



PROLON

Technical Reference Guide

Manual for Wiring, Installation and Setup of Prolon Systems

Version 6

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Section 1

Introduction



*The New Standard in Light Commercial
Building Automation*

About Us

Founded in 1998, Prolon is a manufacturer of an HVAC control system dedicated to small and medium sized commercial buildings. Its product lineup consists of application-specific configurable controllers designed for all types of HVAC equipment, meeting the needs of retro-fit as well as new construction projects.

The entire control product line offering is meant to be both easy to install and accessible for all mechanical and service HVAC contractors.



Prolon Key Concepts

Application-specific controllers

All Prolon controllers are ready for field installation with their application-specific preset inputs and outputs. (Consult section #4 to view the input/output configuration of each device)

There are more than 20x applications to choose from, ranging from packaged roof-top A/C units, make up air units, heat pumps, VAV boxes, boilers, chillers, pumps, control valves and much more! This vast number of available applications ensures that Prolon controllers are flexible and adaptable to all types of systems found in commercial building spaces.

Stand-alone -or- Networked

Controllers may operate independently from one another, since each is designed to be stand alone, and has the necessary inputs to collect all sensor data required by its sequence.

The same controllers can be tied together, so to exchange and share data on a communication network, further expanding their functions and capabilities. Up to 127x controllers can communicate as such on a global network.

Free software driven

Prolon goes above and beyond the competition with its Prolon Focus software platform. Here's why:

Focus is a free utility software used to access and navigate within the Prolon ecosystem. It is complete with built-in graphics and intuitive configuration menus, so no programming is involved.

Prolon controllers are easily configurable through Focus; all settings, setpoints and sequences can be viewed, adjusted, and modified using either the Focus software or the Focus mobile app (Android + iOS).

There are no licensing or renewal fees, downloading and using Focus is totally free!

Focus allows local and remote access to any system, with email alerts and datalogging built-in options.

Prolon Product Guide

VC2000 Series

VAV Controller

- Pressure Dependent or Pressure Independent
- VAV and VVT configurations out of the box
- Compatible with FPB's, hot water / electric reheat coils, zone valves, baseboards, in-floor heating and more
- Perfect for pneumatic retrofits
- Multizone sequence



NC2000 Series

Network Controller

- Centralize scheduling in a single device with up to 16 separate 24/7/365 schedules
- Receive email alarms to be alerted of any situation in a matter of minutes
- Monitor and configure your system remotely
- Data trending available to monitor the performance of your system



Wall Temperature Sensors

T200, T500 and T1000

- With or without digital display (LCD Screen)
- Configure every parameter of a VAV Controller *
- Use remote sensor(s) for space temperature averaging *
- Choose among a variety of casing and label colors!

T1100 Thermostat

- Configurable menus on the digital display
- Control fans, reheat coils, valves and baseboards
- Radiant floor sequence available



Bluetooth Adapter

PL-485-BT

- Connect any laptop, smartphone or tablet to any Prolon device.
- Compatible with iOS and Android devices equipped with Bluetooth LE
- Range extends up to 300ft
- Rechargeable battery allows for up to 15 hours of continual use or 22 hours of intermittent use



*T1000 only

M2000 & C1050 Series

Rooftop Controller

- Compatible with both VAV & VVT systems
- Available for zoning, as well single-space rooftop units
- Internal schedule with 24/7/365 scheduling
- Demand-control ventilation available

Boiler Controller

- 4x boiler stages or modulating boilers
- 2x pumps (with fail-over sequence)
- Lead/Lag + Equal runtime sequences
- Loop temperature setpoint with outside reset scale

FlexIO Controller

- Control Temperature, Pressure, Humidity and much more!
- Set up a controller to do exactly what YOU need it to do in a matter of MINUTES!
- Configure it for multiple side loops

Humidity Controller (C1050 only)

- Add humidity to your system during the dry season!
- Humidity setpoint with outside reset scale with high limit
- Dehumidification sequence available

Makeup Air Unit Controller (M2000 only)

- Space temperature control and outdoor temperature reset
- Exhaust fan, fresh air damper and supply fan safety interlocks
- Integral, modulating or staged cooling
- Building static pressure control

Heat Pump Controller

- Water or Air sourced heat pumps
- Compatible with dual fuel units
- Control multiple compressors, auxiliary heat, fan, and economizer
- Multiple safety sequences to ensure maximum protection of your equipment!

Chiller Controller

- Designed for both air and water-cooled chiller systems
- Up to two chillers / 4x cooling stages
- Fixed or reset-based supply water setpoint
- 2x pumps with lead/lag & fail-safe sequence

Fan Coil Unit Controller

- Compatible with 2-pipe and 4-pipe water systems
- Multi speed fan control option
- 2-pipe heat-cool changeover logic with purge cycle sequence
- Separate aux heat output available

Waterloop Controller (C1050 only)

- Manage your closed loop cooling tower
- Monitor supply and return water temperatures
- Control spray pump, valve, fan + VFD and single-stage boiler



Factory Wired Control Cabinets

Proton offers its M2000 and C1050 controllers in prewired, UL certified NEMA1 panels ready for installation on any project. Their compact design allows multiple panels to be installed in a tight workspace and leave a clean, professional appearance.

Single controller panel

- Your choice of a M2000 or C1050 controller
- Compact size: 16”(H), 12” (W), 6” (D)
- Comes with isolation relays on all digital outputs
- Built-in disconnect switch with slow-blow 3A fuse



Dual controller panel

- More efficient install footprint in tight areas
- Mix & match any two controllers, M2000 or C1050
- Compact size: 20” (H), 16” (W), 6” (D)
- Same features as single controller panel



Master panel

- Space saving solution combines the NC2000 with any single M2000 or C1050 controller
- A single Master Panel is all that’s needed to monitor an entire project, regardless of size or complexity
- Available 10” touchscreen display for local access and system configuration



NC2000 panel

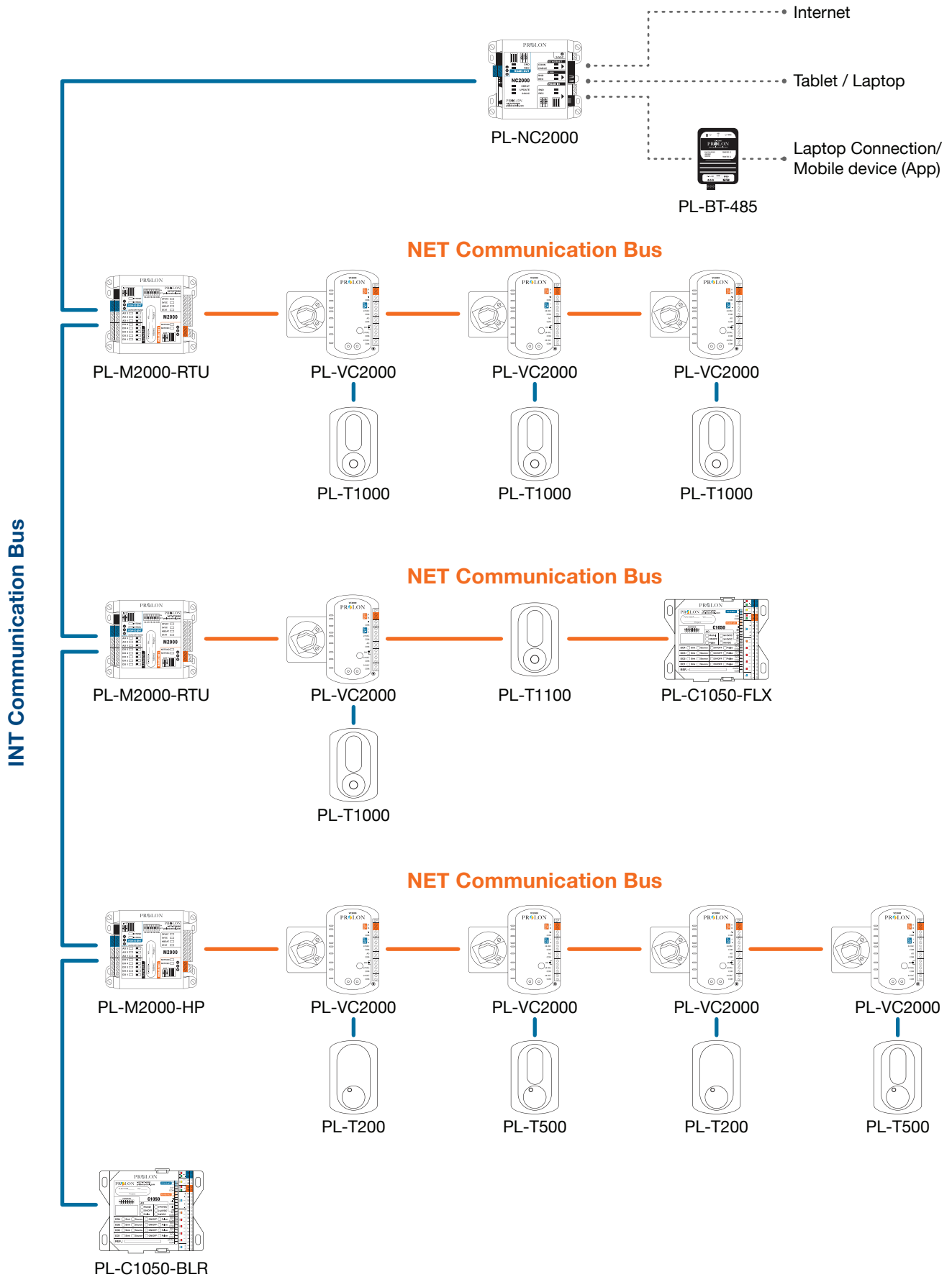
- Complete communication & interface package to access Proton systems
- Allows remote internet access for control and monitoring, email alerts and trend logs
- Distribute schedules, outside air temperature and other data to networked controllers
- Available 10” touchscreen display for local access and system configuration



Section 2

System Architecture

Typical Prolon System Architecture



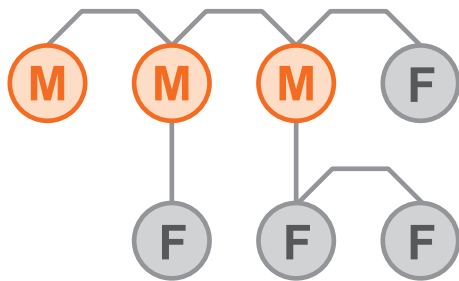
Master - Follower Communication Principle

Although they can all operate as stand-alone, Proton controllers, once they are connected, all play a specific role on a network, which is determined by their application firmware: They are either a Master or a Follower.

Master Controller

These devices are designed to communicate with one or multiple Follower controllers placed under their authority. The Master broadcasts valuable data as well as inquiries to the Followers, the latter replying with heat, cool and other various demands. The Master then operates its control sequence based on the received data. Master controllers, however, may also operate on their own as stand-alone devices.

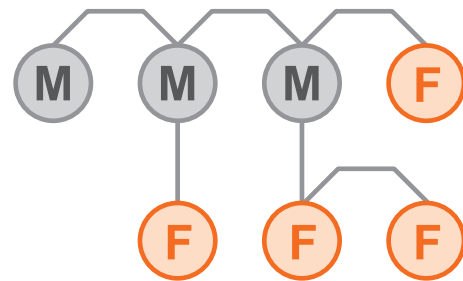
Proton Master controllers include: The Zoning Rooftop Unit (RTU), the Zoning Heat Pump (HP), the Make Up Air Unit (MUA), the Hydronics (HYD), as well as the Network Controller (NC).



Follower Controller

These devices may operate stand-alone and are not necessarily required to be placed under the authority of any Master controller to work properly. However, should they be connected to one, Follower controllers will receive useful information such as Occupancy schedules, Outside Air and Supply Air Temperatures, Math functions and much more, hence adding to their functionality and sometimes eliminating the need to setup additional inputs of their own.

List of Follower Controllers include: the Single-Zone Rooftop (RTUS) the Single-Zone Heat Pump (HPS), the Zone controllers (VAV), the T1100 Thermostat, the Boiler (BLR), Chiller (CHL), Fan Coil Unit (FCU), Water Loop (WLC), Humidity (HU) and FlexIO (FLX) controllers.



It should be noted that the status of Master or Follower is not related to the hardware, but the software application profile downloaded into each controller. As such, a Master controller could be reprogrammed into a Follower, and vice-versa.

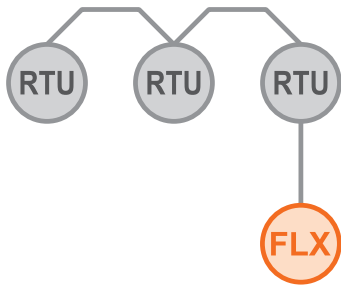
Also, communication and exchange can only happen between a Master and Follower controllers. No two Masters can communicate together, nor can two or more Followers.

Function-Related Network Positioning of Controllers

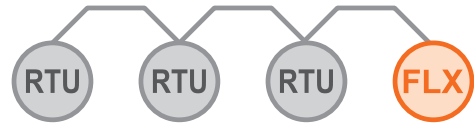
Some specific Follower controllers will gain added functionality or will help bring extra features to Master controllers, when they are connected on the Master's network (NET), instead of being connected on the main Interface (INT) comm bus. This creates interesting design options, as the physical location of many Follower controllers within a given network will ultimately determine their functionality.

Such is the case with the ProLon FlexIO controller (C1050-FLX / M2000-FLX) that can either work stand-alone but also under the authority of a Master controller such as the Roof Top Unit (C1050-RTU / M2000-RTU). The FlexIO controller then becomes an I/O expansion module, further pushing the design possibilities of the RTU controller.

Example #1



Example #2



INT/NET Communication Bus Hierarchy

All controllers, thermostats and communicating wall sensors have at least one, if not two communication ports, allowing them to communicate on various network buses at once.

INT Communication Bus

Also known as “**Interface**”, is the upper echelon communication bus connecting the Network Controller (NC), if present, with various Master controllers and/or other stand-alone devices. INT is also the name given to the two-node communication link used between a Digital Wall Sensor (T200, T500, T1000) and its single-zone controller (VAV, RTUS, HPS, FCU).

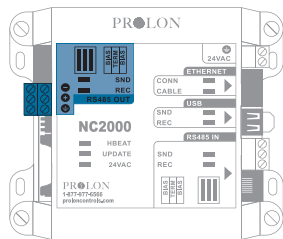
NET Communication Bus

Also known as “**Network**”, this communication bus is used by **Master controllers** to allow them to talk with their own group of Follower controllers. **NOTE:** a Master controller is not an absolute requirement for Follower controllers to operate properly, as they can work stand alone.

Port availabilities per controller

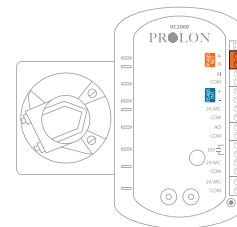
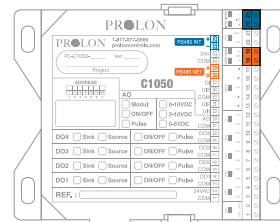
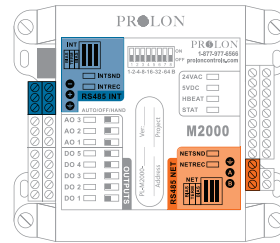
PL-NC2000

- 2 ports, RS485 OUT (equivalent to INT port) and RS485 IN (used for PC connection only, not to be connected directly to controllers)



PL-M2000, PL-C1050 and PL-VC2000

- 2 ports, INT and NET



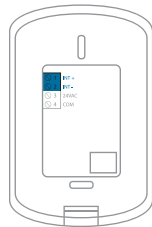
PL-T1100

- 1 port, NET only



PL-T1000, PL-T500 and PL-T200

- 1 port, INT only



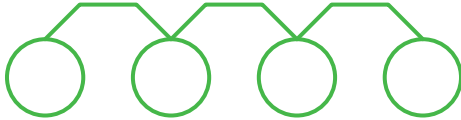
Section 3

Network Topology

Network Layout

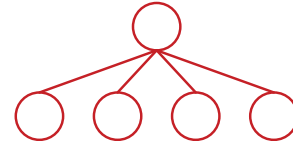
Acceptable

Whether it's on the **INT** or **NET** comm networks, all Proton controllers communicate over an RS-485 network topology, that requires a DAISY CHAIN wiring configuration. Each daisy chain segment is an open loop design, with two distinct extremities to the chain (a beginning and an end). Also, there are never more than two wire pairs meeting at any controller junction.

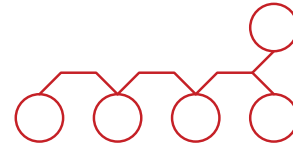


Not acceptable

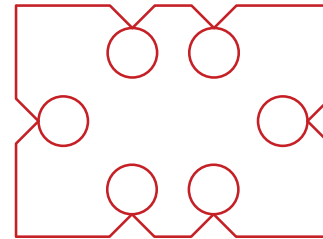
- A Star configuration is not acceptable



- "T-Tapping" is not acceptable



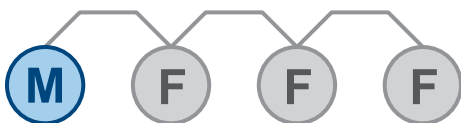
- A closed loop is not acceptable



Master Location Within its Own Network

On any network segment hosting a **Master** controller, the physical positioning of that **Master** relative to other follower controllers within the daisy chain layout is irrelevant, provided the daisy chain layout is respected. As such, it is not necessary to position any Master at the "beginning" of any network, should that prove inconvenient.

Example #1



Example #2



Addressing Principles

All Proton controllers must have a valid address to be able to communicate on a network. Some Proton controllers use physical dipswitches, others **must** be addressed using software or a digital wall sensor with display. (Consult section #5: "Controller addressing methods")

Note: Possible addresses range between 1 and 127.

Acceptable

- Sequential addressing is acceptable



- Non-sequential addressing is acceptable



Not acceptable

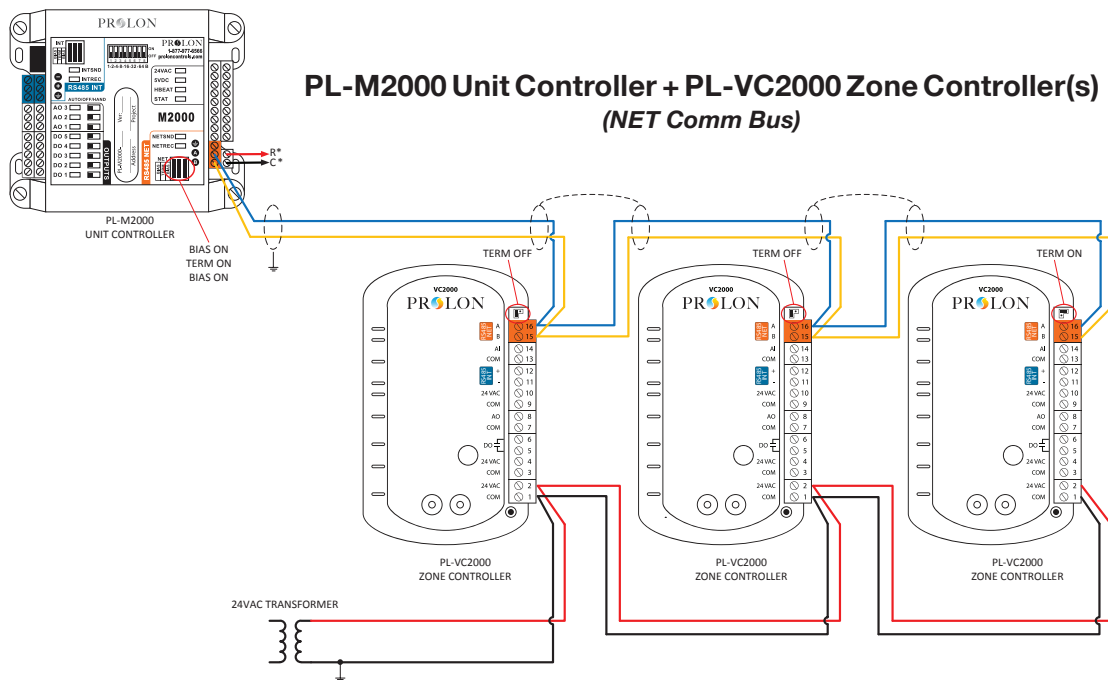
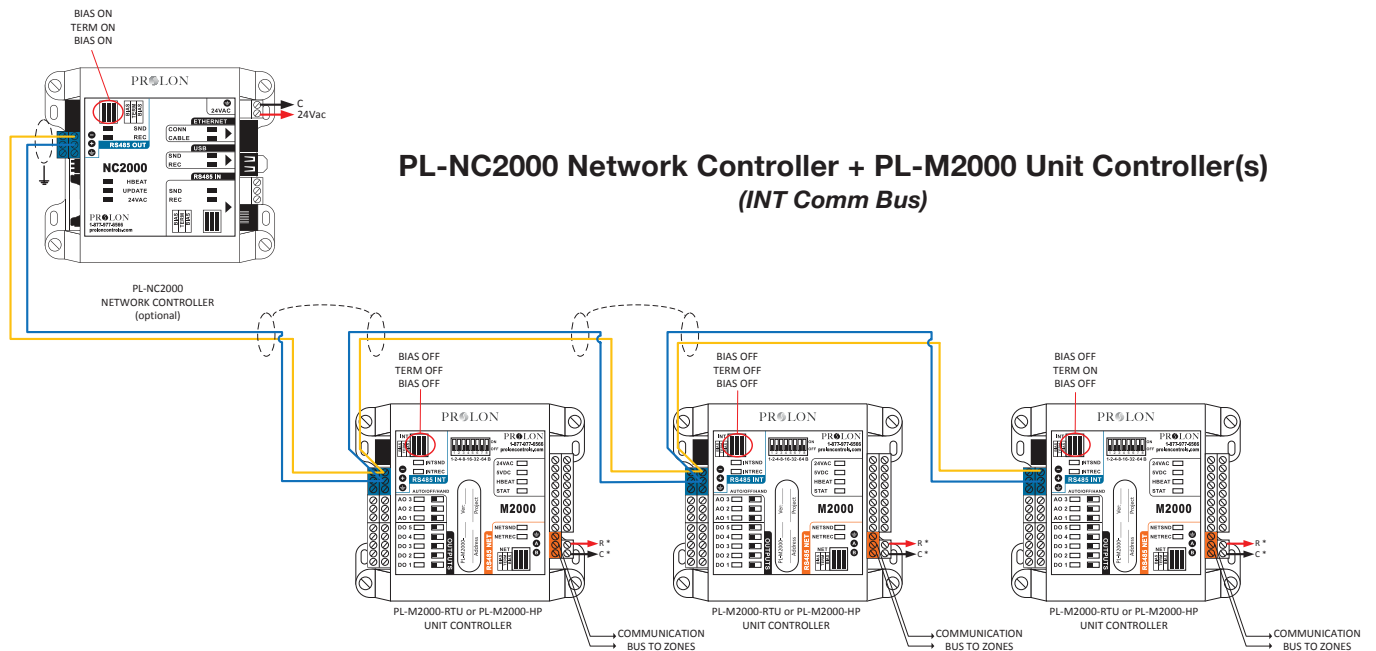
- Controllers that have no valid address WILL NOT COMMUNICATE. (Ex: addressing dipswitches set to OFF)



- Each address must be UNIQUE and never replicated within the entire network, even if controllers are located on different communication bus segments.



Typical Prolon Wiring Schematics

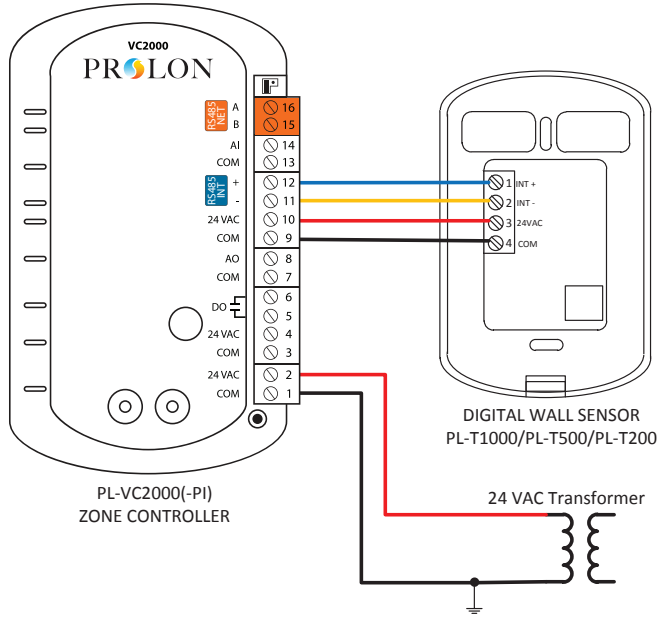


Note for both diagram

1. Recommended wiring for communication: #22/2, stranded, twisted and shielded, low-capacitance.
2. Recommended wiring for 24vac supply: #18/2, stranded.

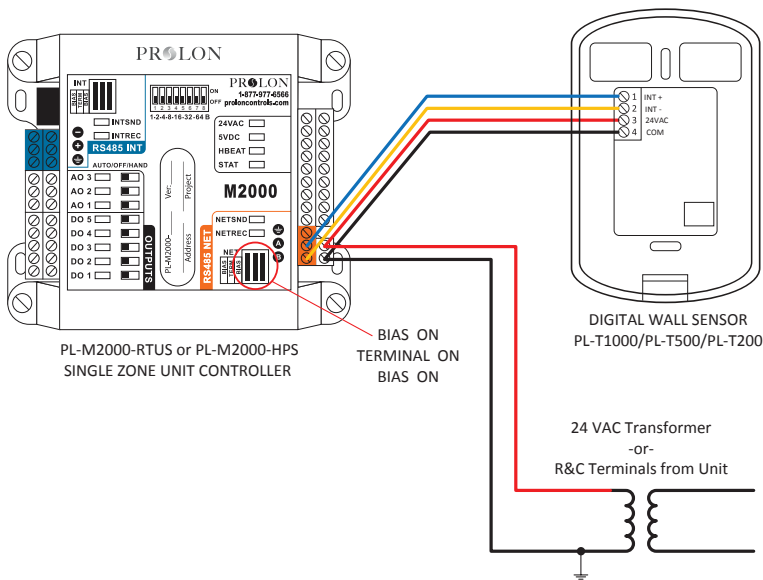
*Connect "24VAC" and "C" terminals to "R" and "C" terminals respectively on A/C control board.

Typical ProLon Wiring Schematics



PL-VC2000 Zone Controller + Digital Wall Sensor

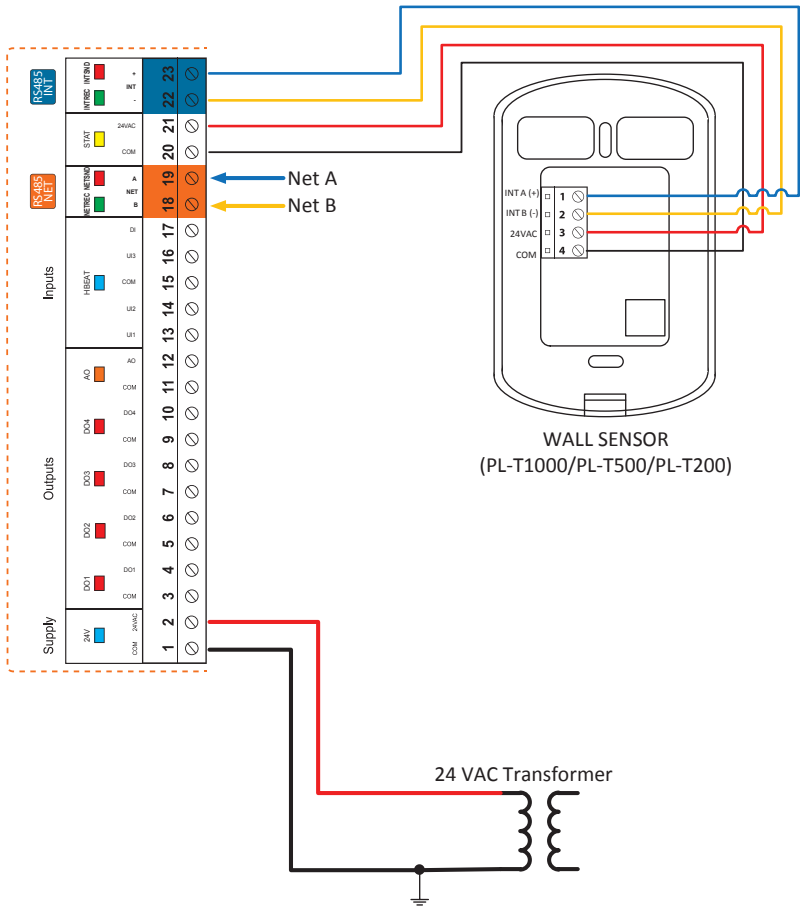
- Recommended wiring for communication: #22/2, stranded, twisted and shielded, low-capacitance.
- Recommended wiring for 24vac supply: #18/2, stranded.



PL-M2000 Single-Zone Unit Controller + Digital Wall Sensor

- Recommended wiring for communication: #22/2, stranded, twisted and shielded, low-capacitance.
- Recommended wiring for 24vac supply: #18/2, stranded.

**Connect "24VAC" and "C" terminals to "R" and "C" terminals respectively on A/C control board.*



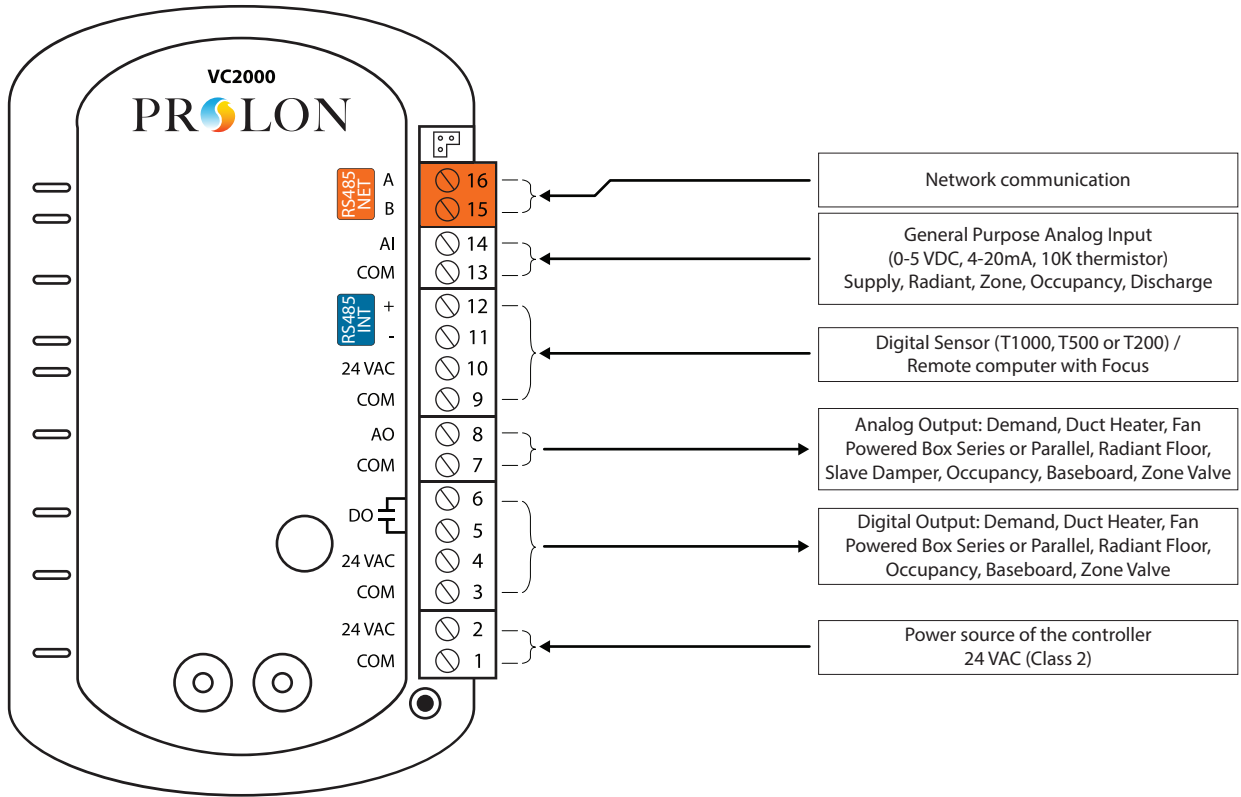
PL-C1050 Single-Zone Controller + Digital Wall Sensor

- Recommended wiring for communication: #22/2, stranded, twisted and shielded, low-capacitance.
- Recommended wiring for 24vac supply: #18/2, stranded.

Section 4

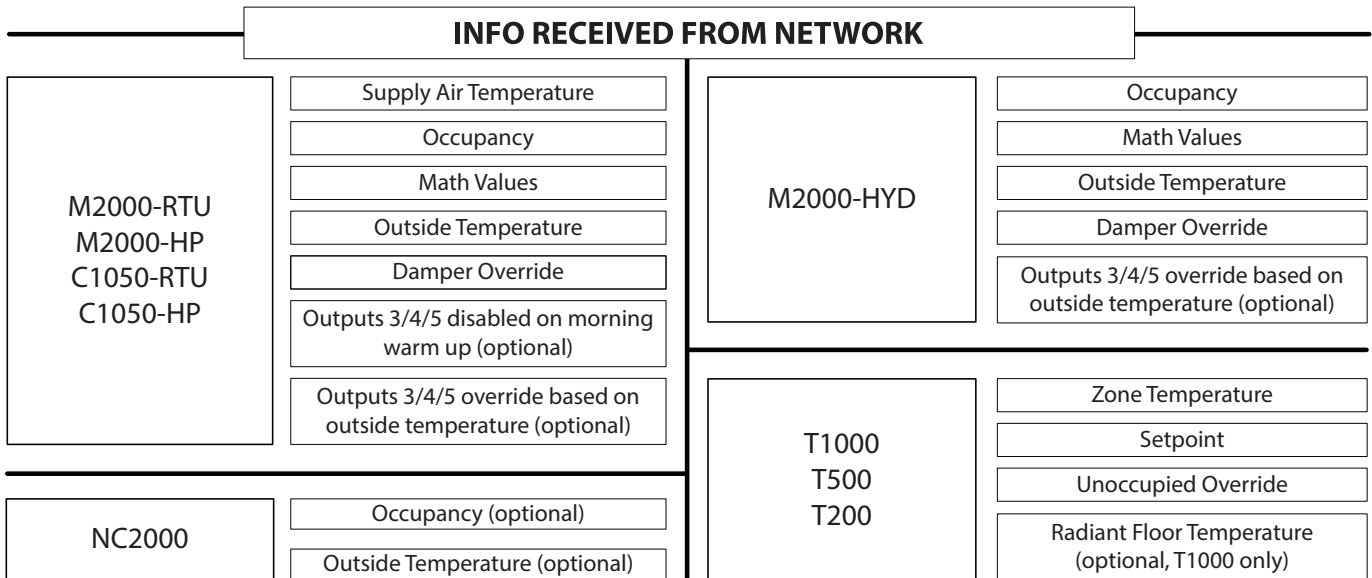
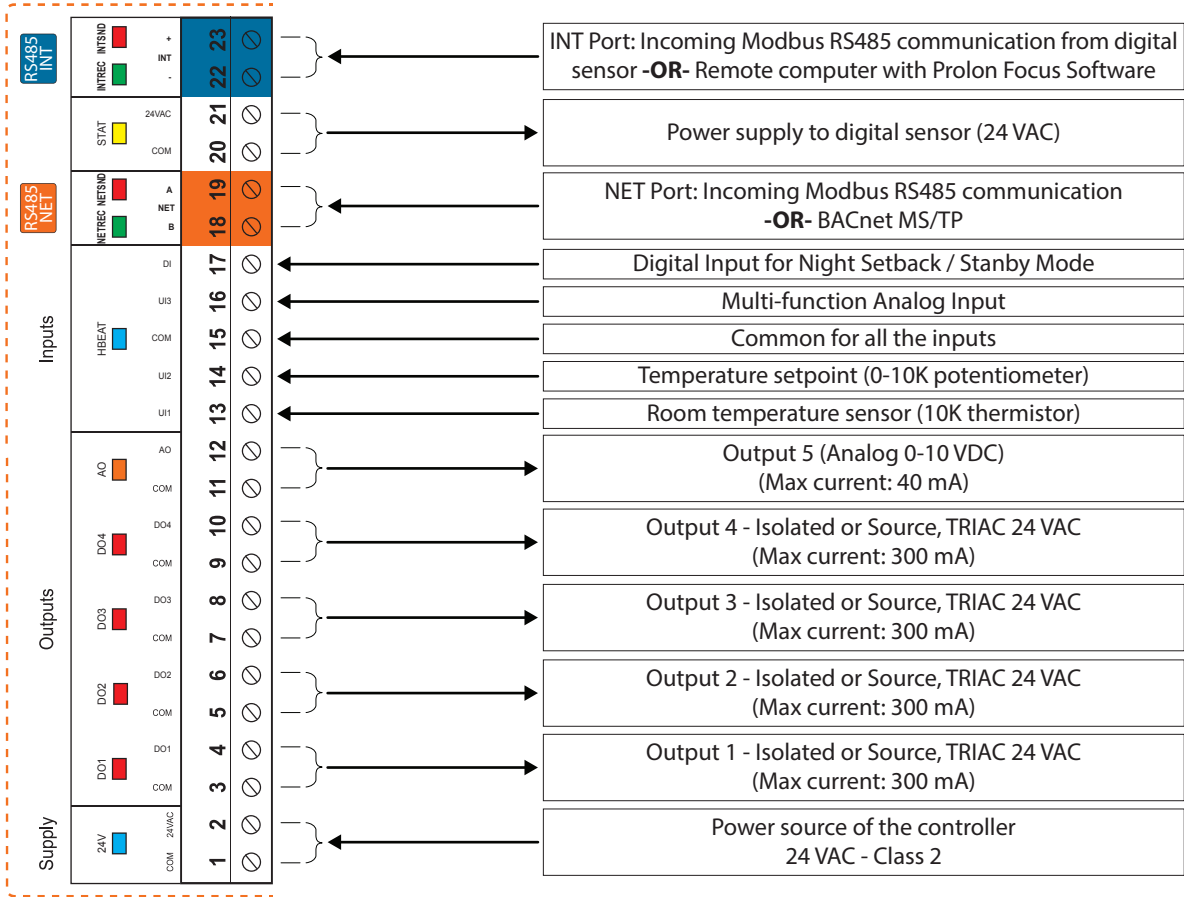
I/O and Wiring Diagrams

PL-VC2000(-PI) (VAV)

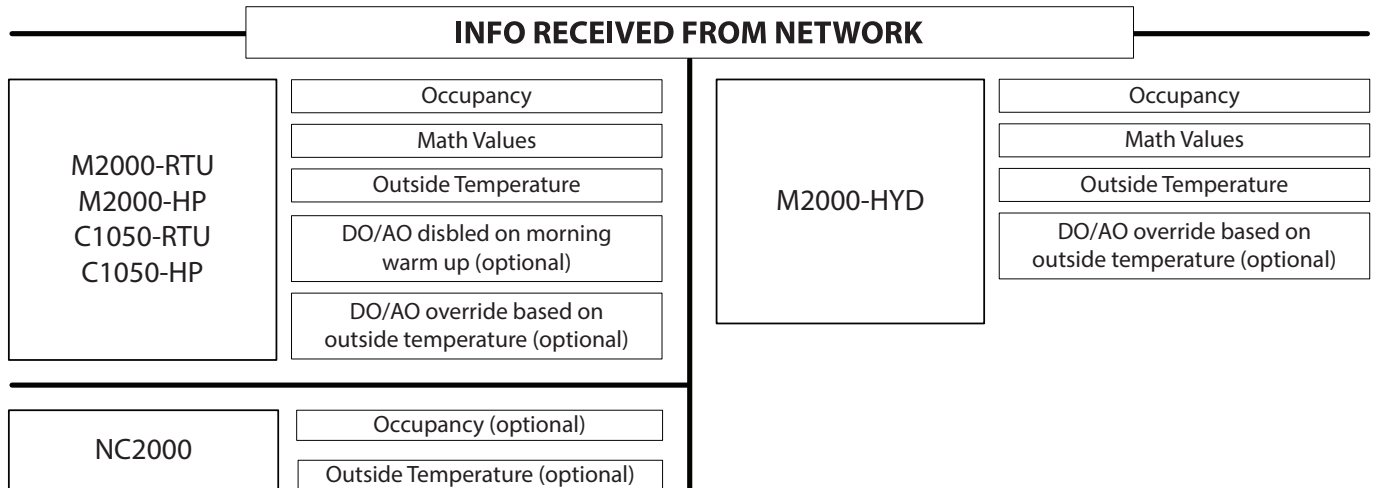
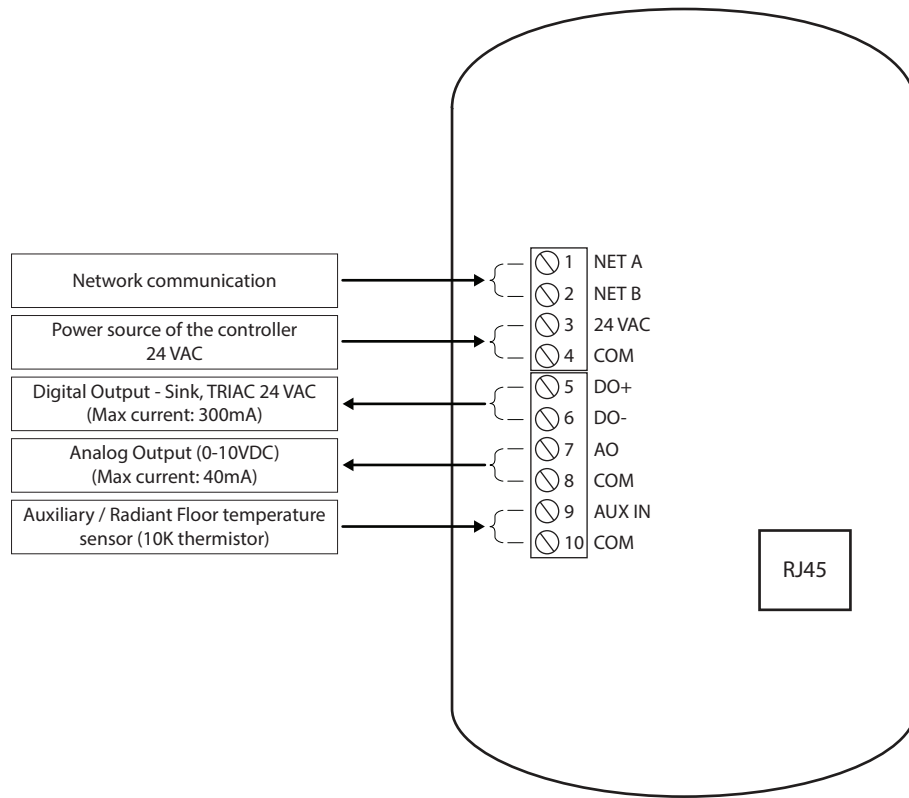


INFO RECEIVED FROM NETWORK			
M2000-RTU M2000-HP C1050-RTU C1050-HP	Supply Air Temperature	M2000-HYD	Occupancy
	Occupancy		Math Values
	Math Values		Outside Temperature
	Outside Temperature		Damper Override
	Damper Override		DO/AO override based on outside temperature (optional)
	DO/AO disabled on morning warm-up (optional)		
	DO/AO override based on outside temperature (optional)	T1000 T500 T200	Zone Temperature
			Setpoint
			Unoccupied Override
			Radiant Floor Temperature (optional, T1000 only)
NC2000	Occupancy (optional)		
	Outside Temperature (optional)		

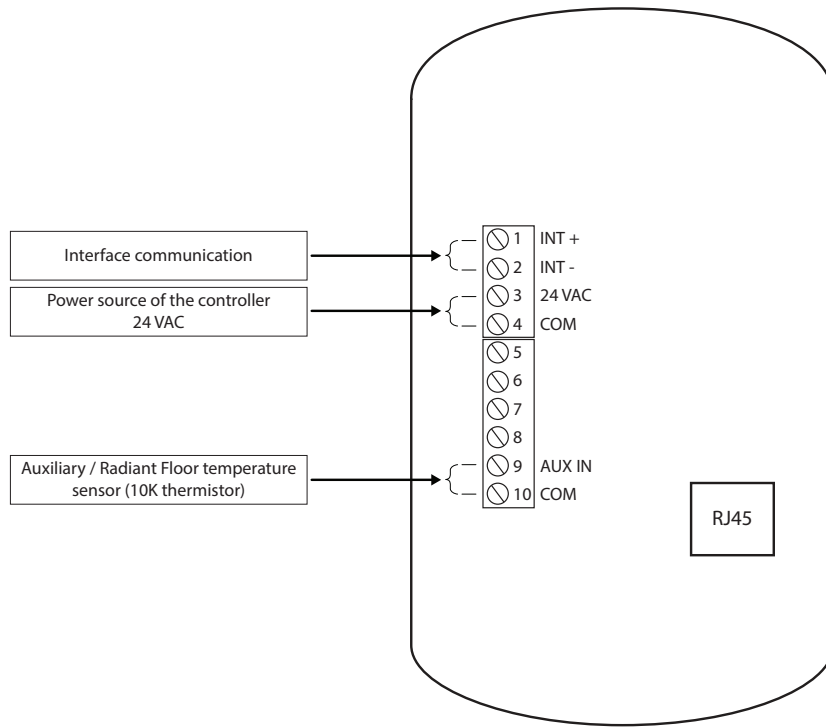
PL-C1050-VAV



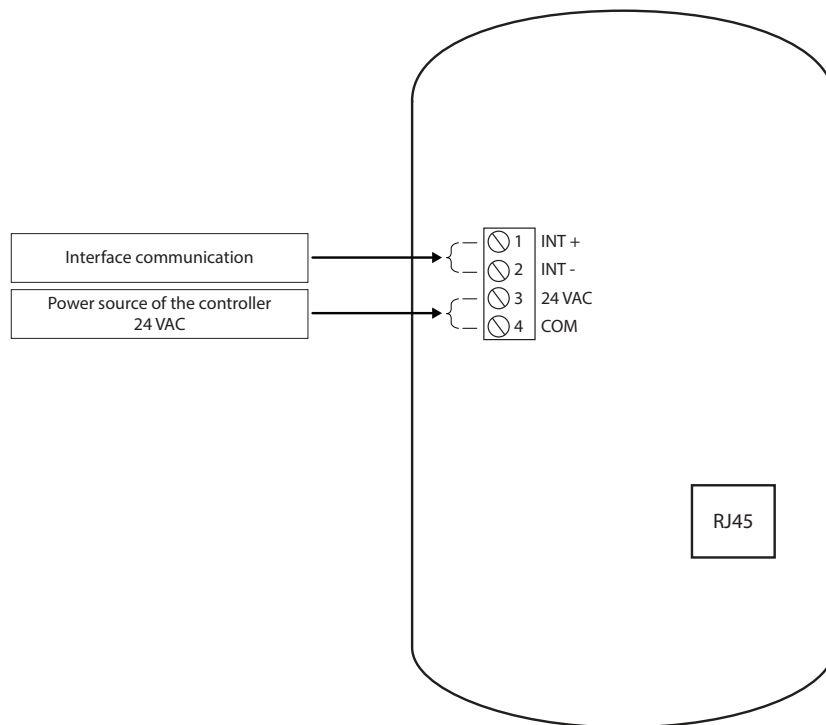
PL-T1100 (Thermostat)



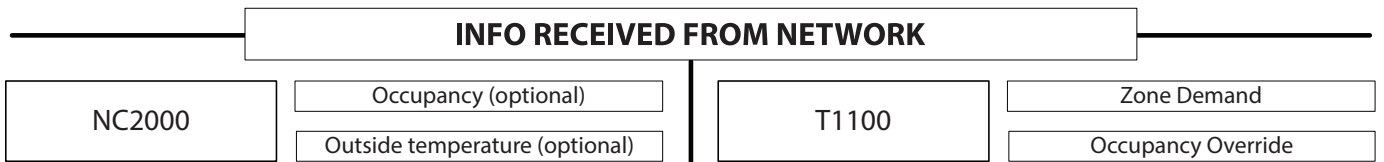
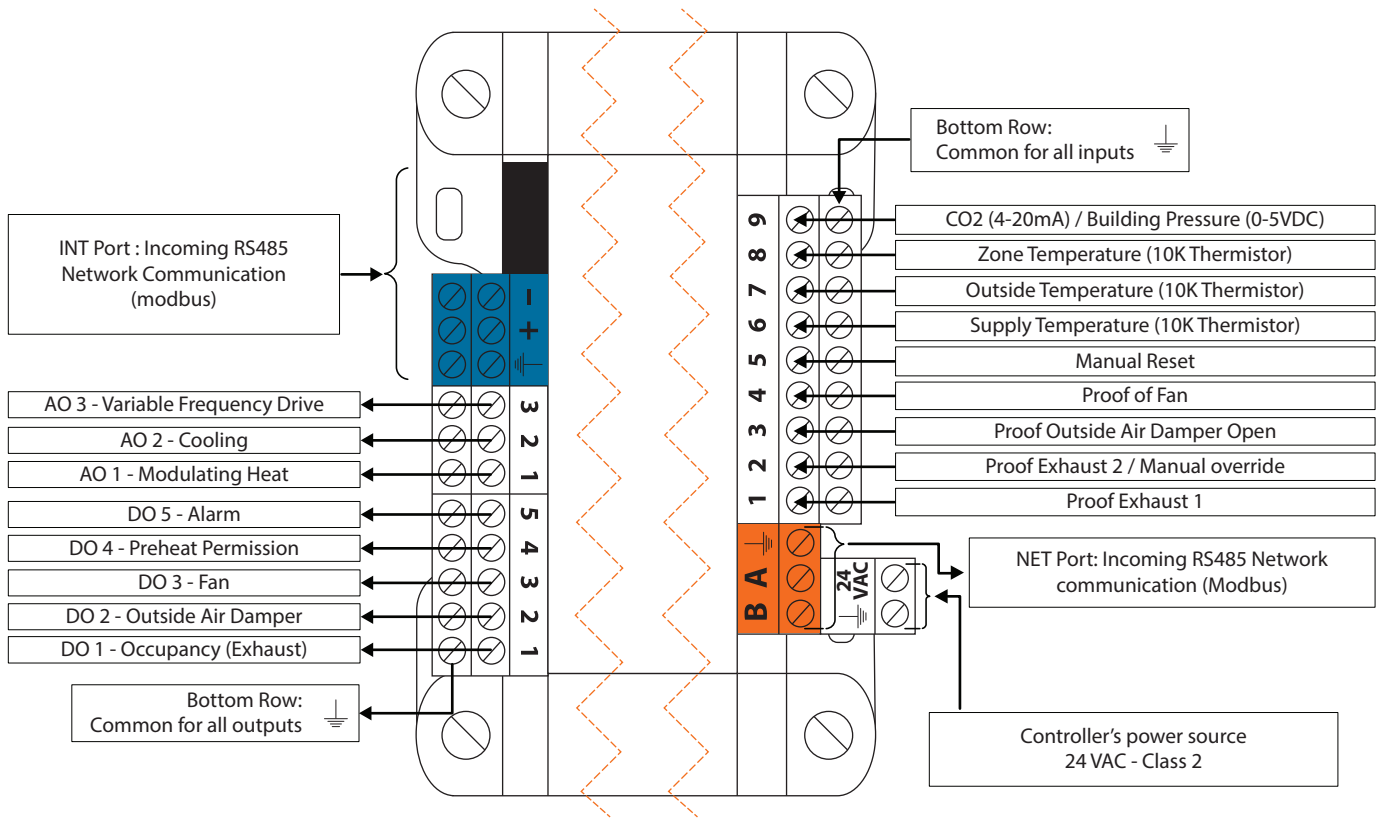
PL-T1000 (Digital Wall Sensor)



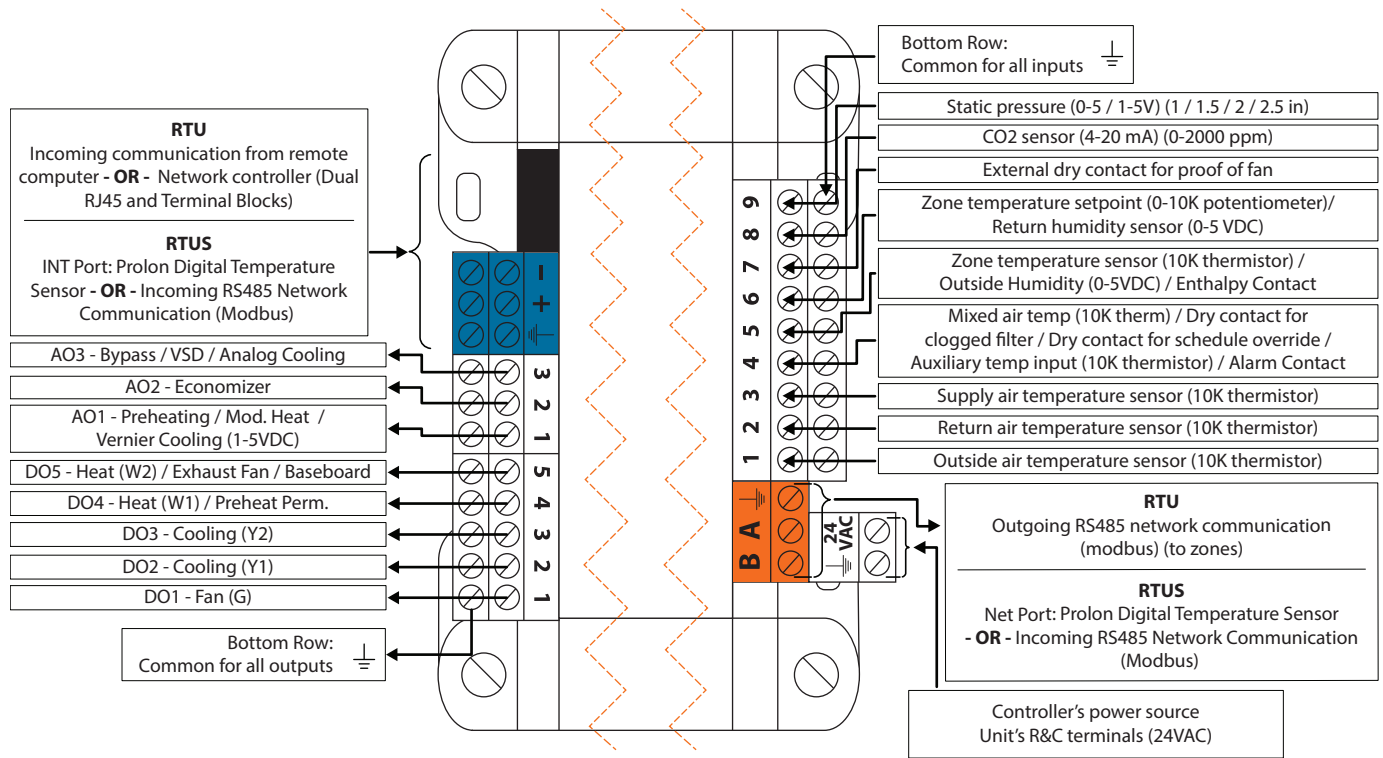
PL-T500 / PL-T200 (Digital Wall Sensor)



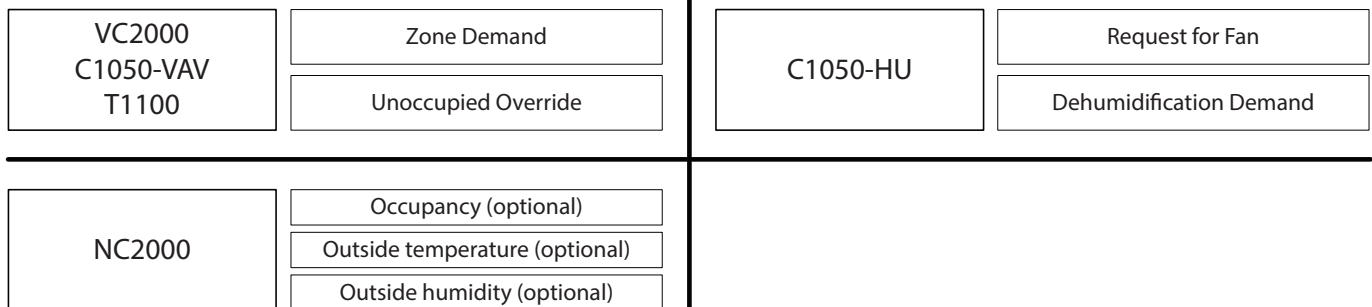
PL-M2000-MUA (Air Make-Up)



PL-M2000-RTU/RTUS (Zoning & Single-Zone Rooftop Controller)



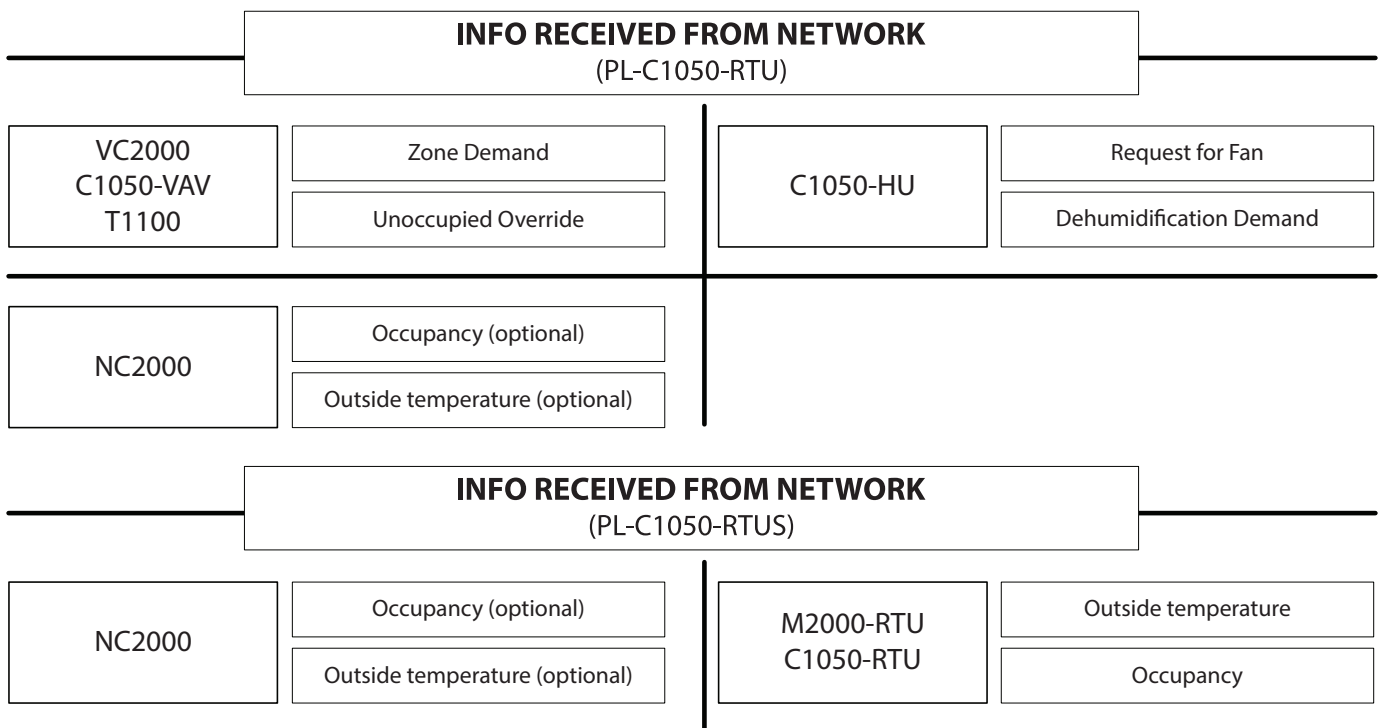
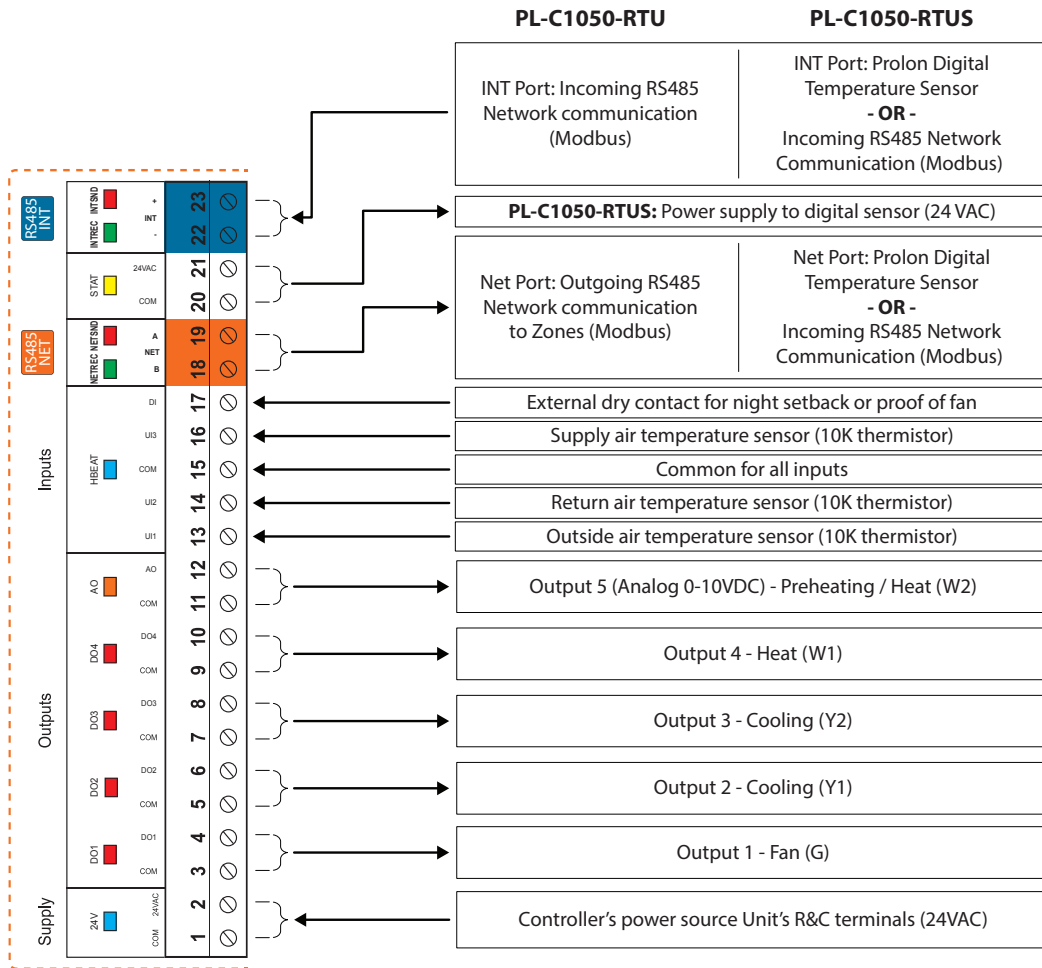
INFO RECEIVED FROM NETWORK (PL-M2000-RTU)



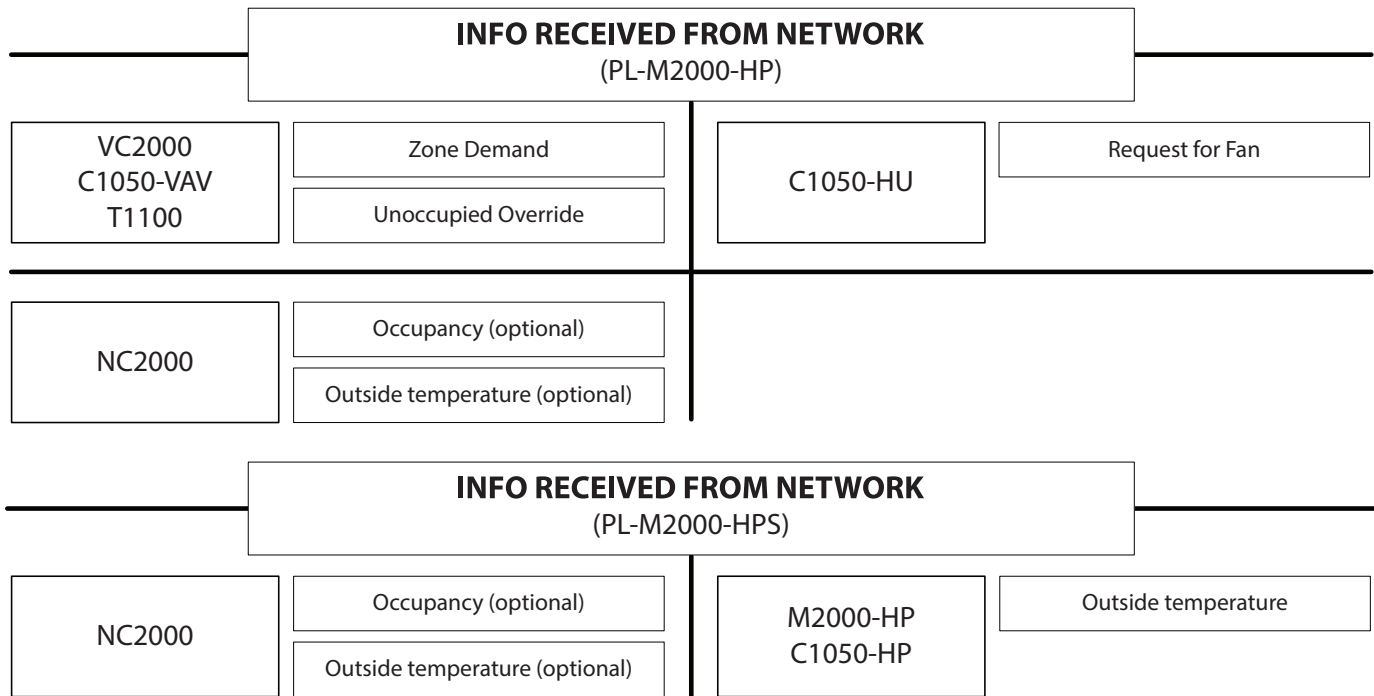
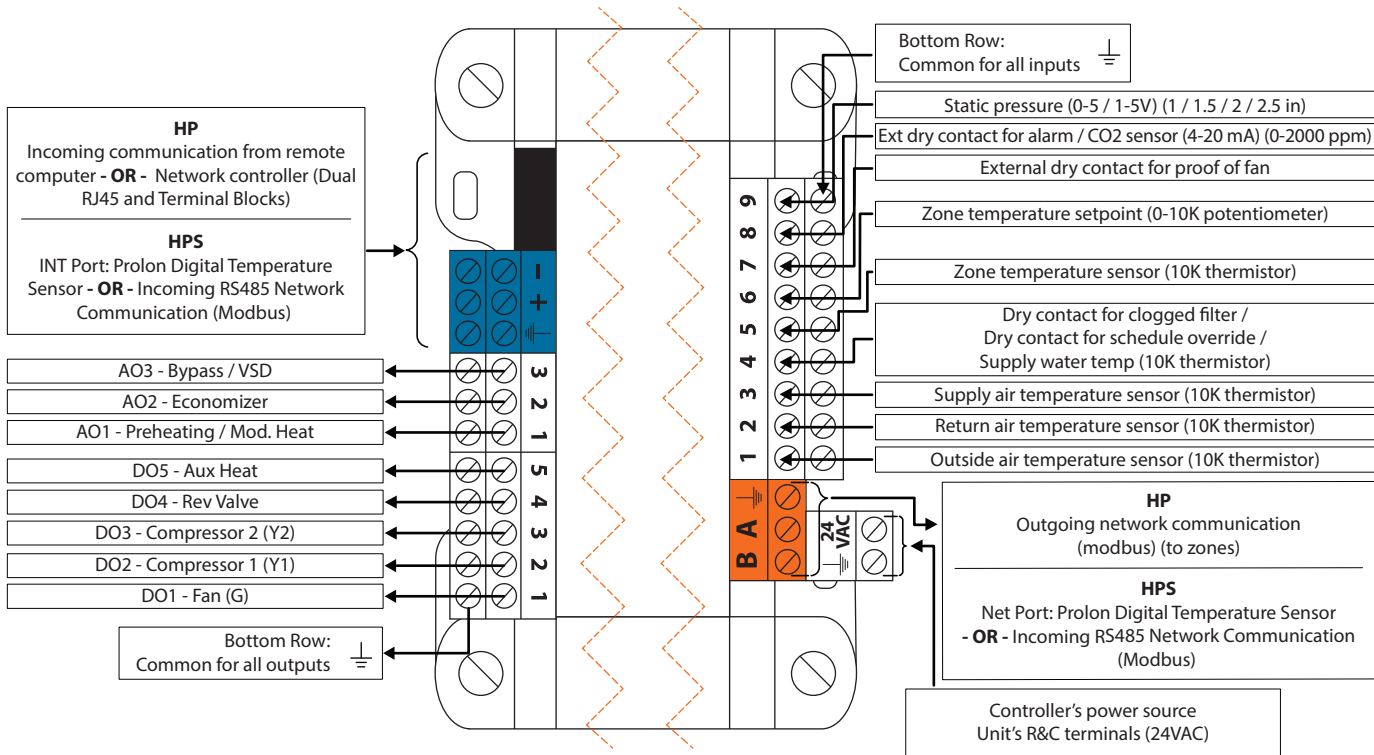
INFO RECEIVED FROM NETWORK (PL-M2000-RTUS)



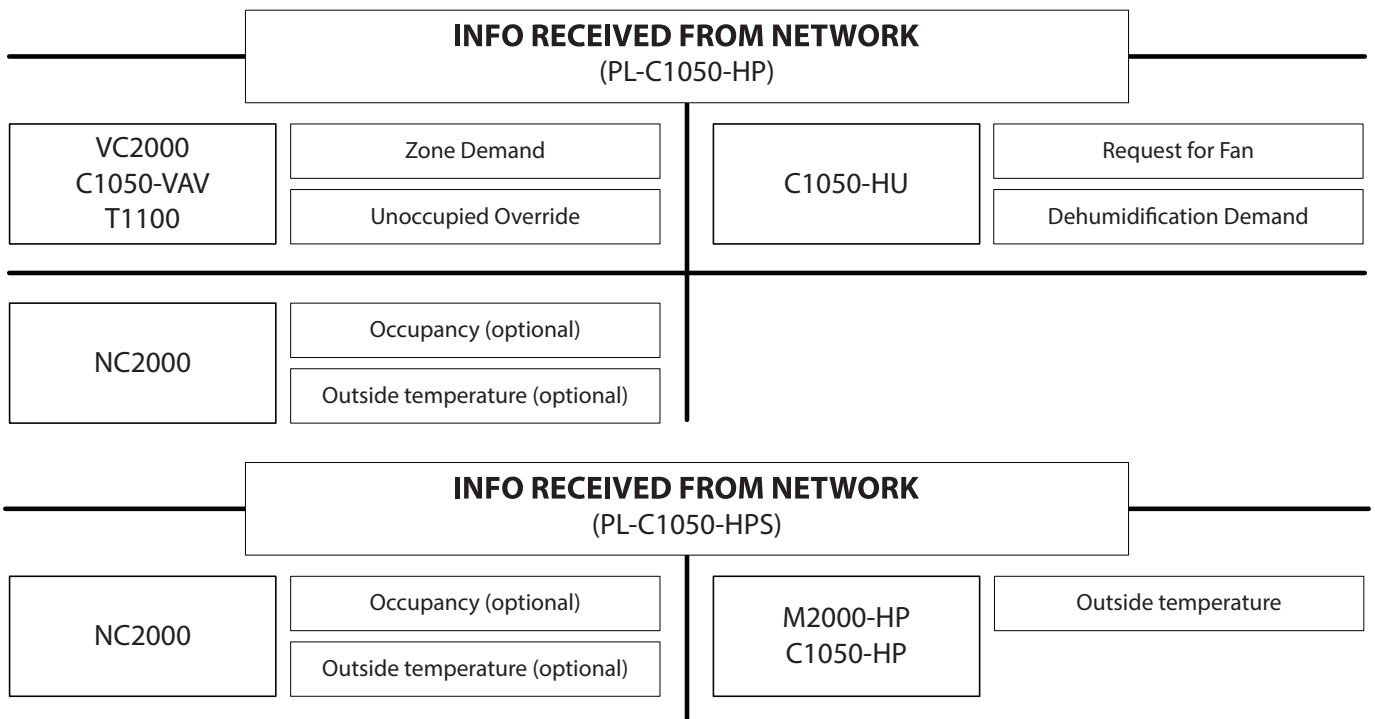
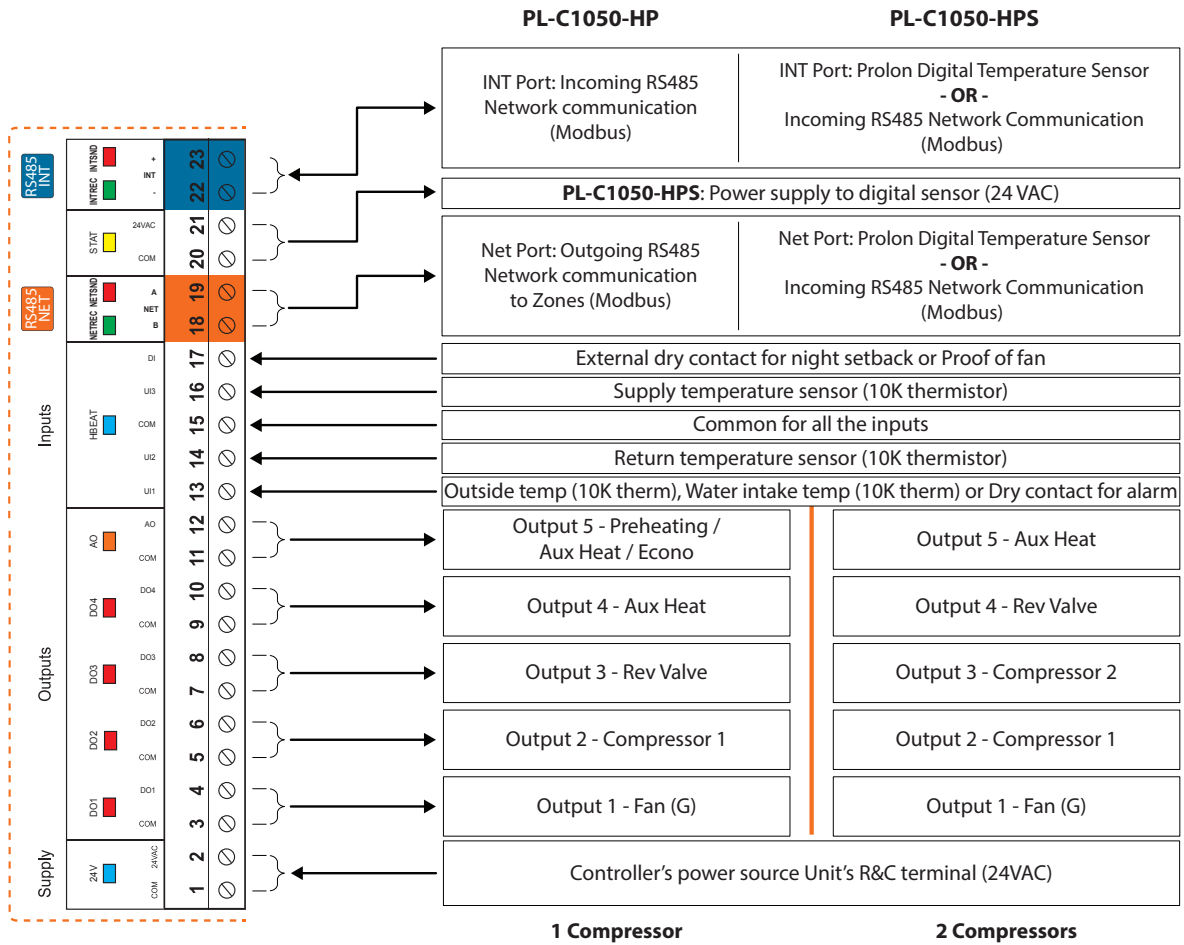
PL-C1050-RTU/RTUS (Zoning & Single-Zone Rooftop Controller)



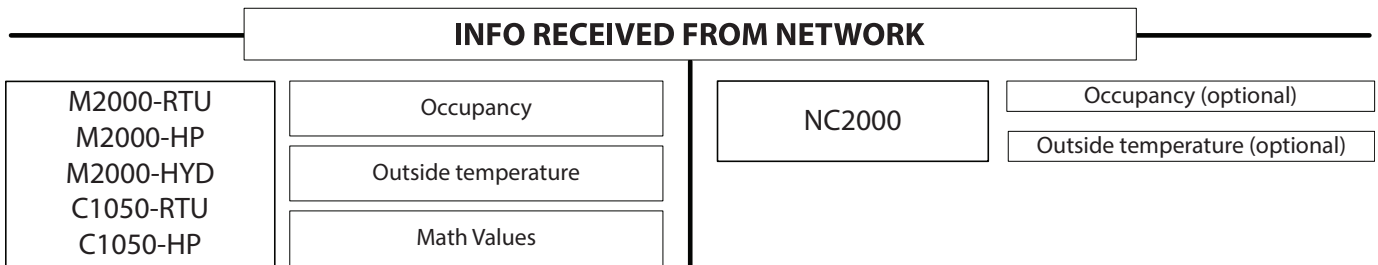
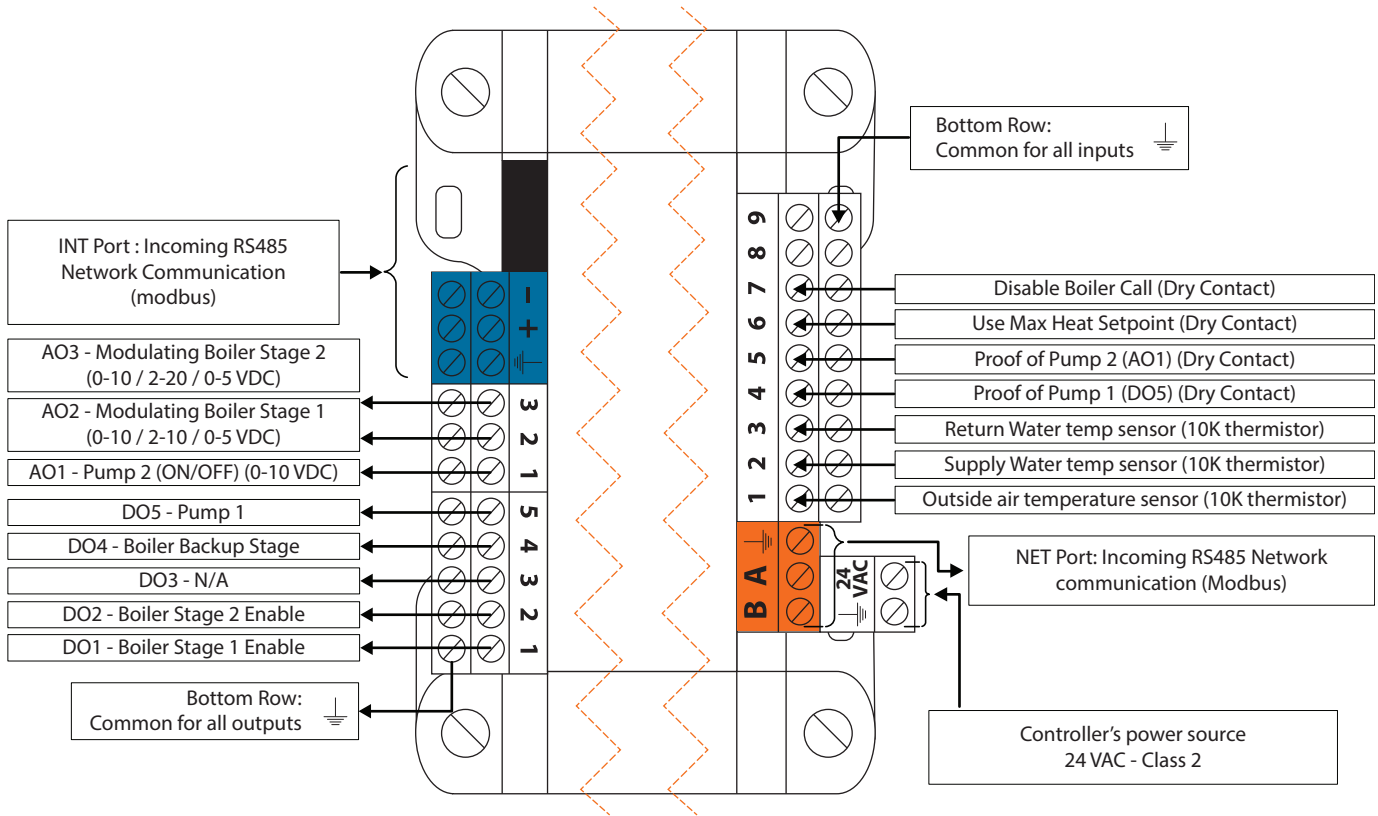
PL-M2000-HP/HPS (Zoning & Single-Zone Heat Pump Controller)



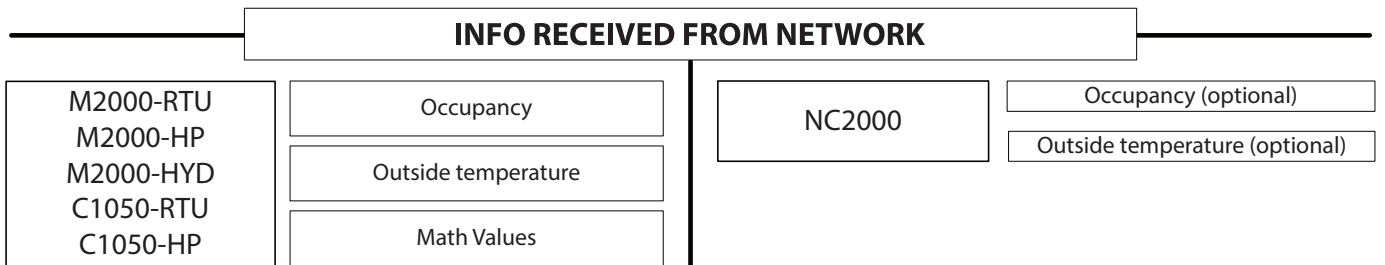
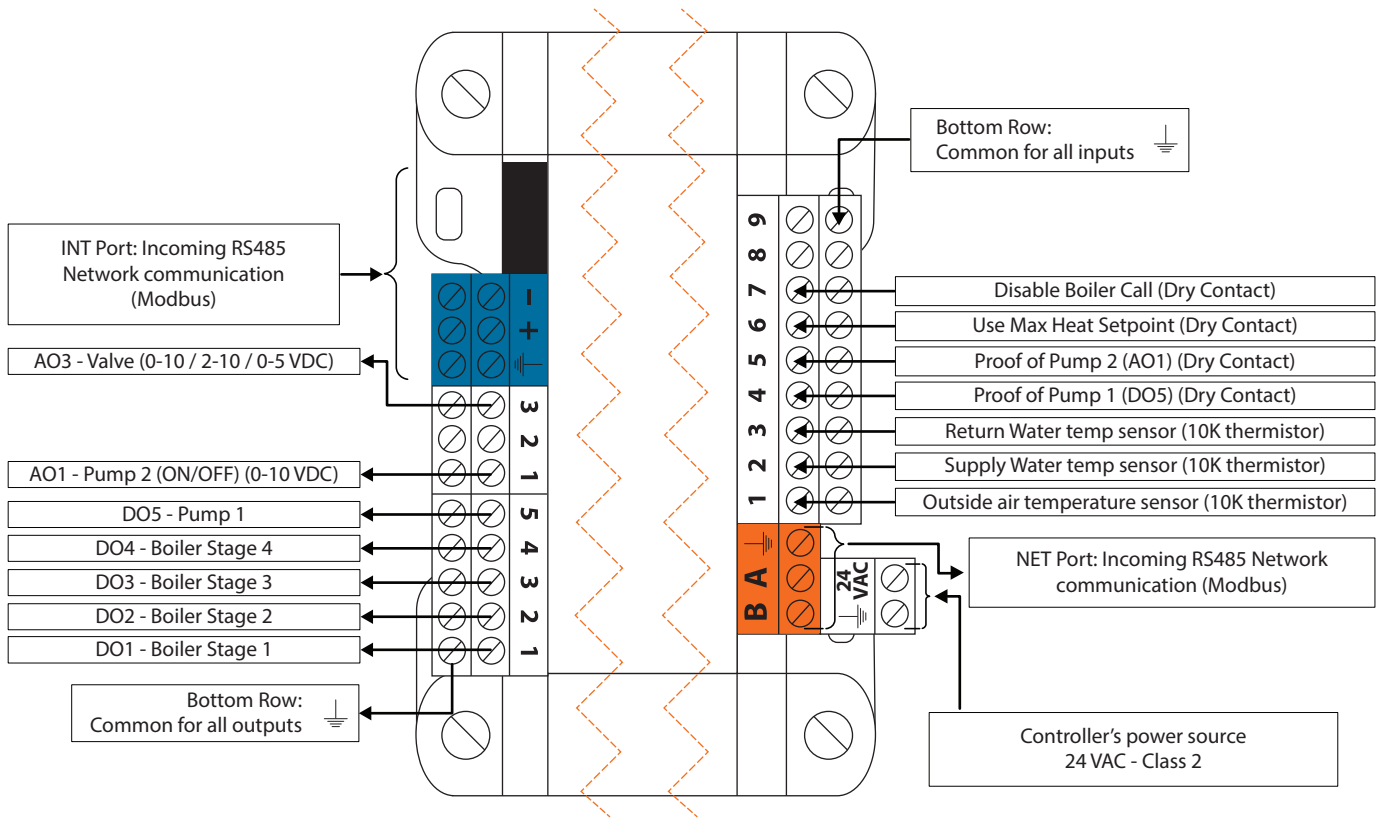
PL-C1050-HP/HPS (Zoning & Single-Zone Heat Pump Controller)



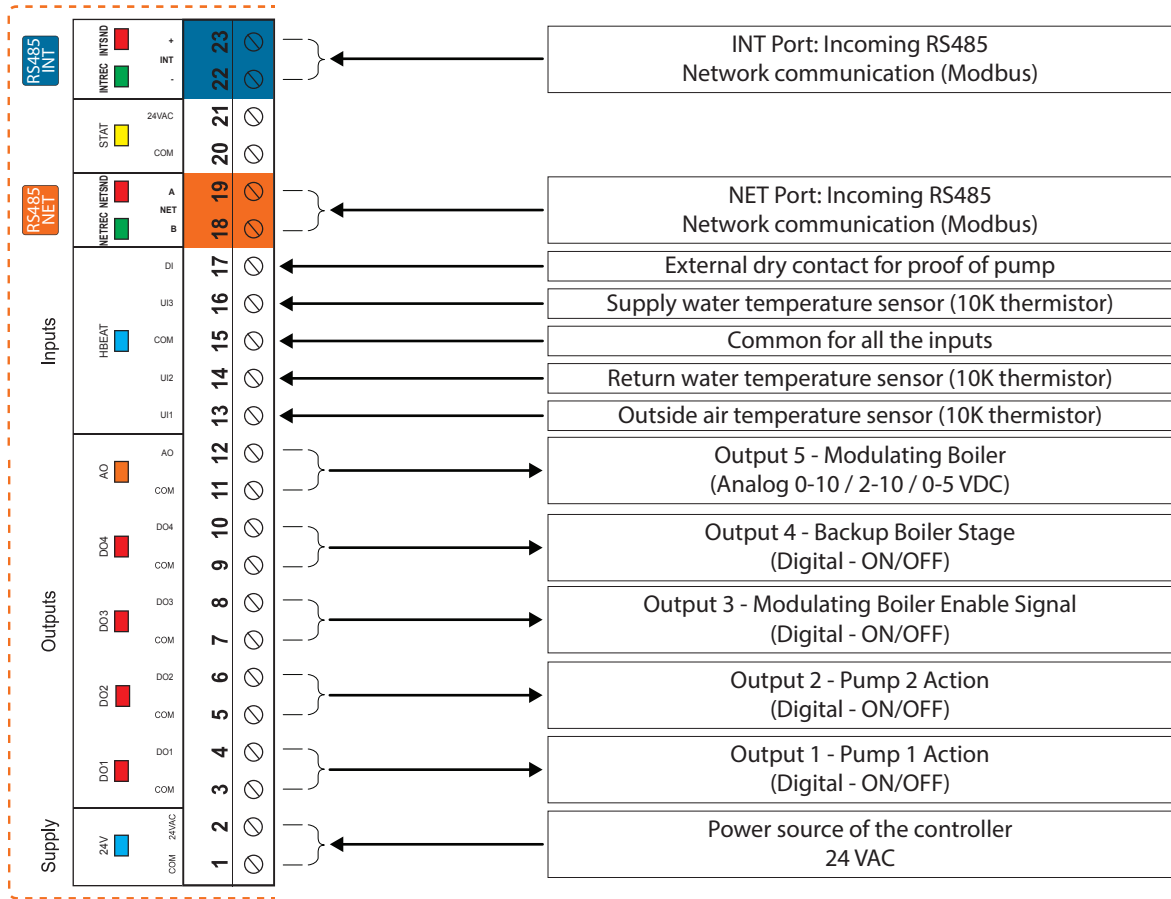
PL-M2000-BLR (Modulating Boiler)



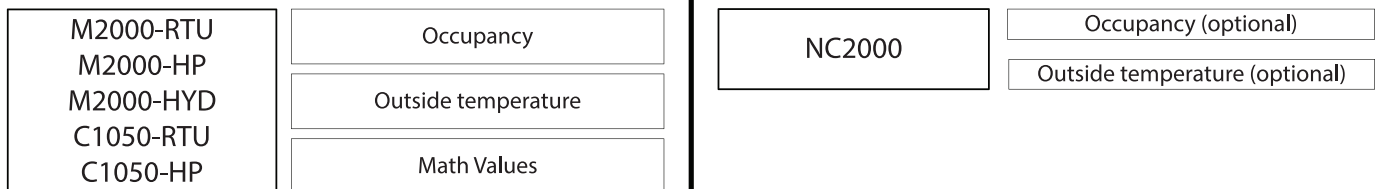
PL-M2000-BLR (Staged Boiler)



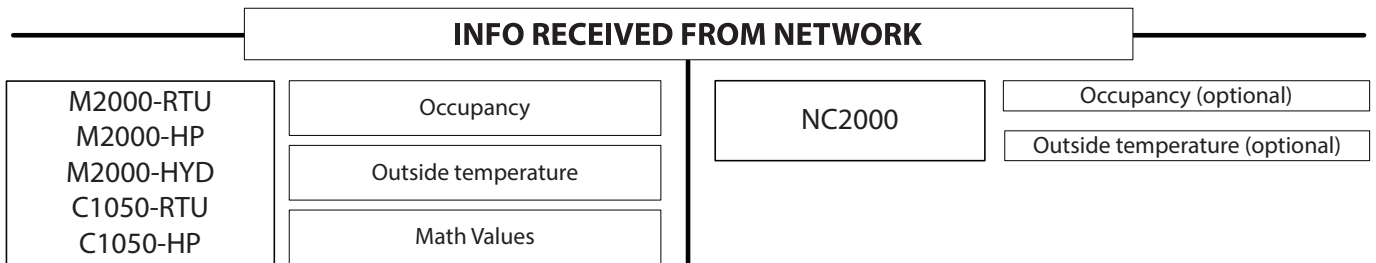
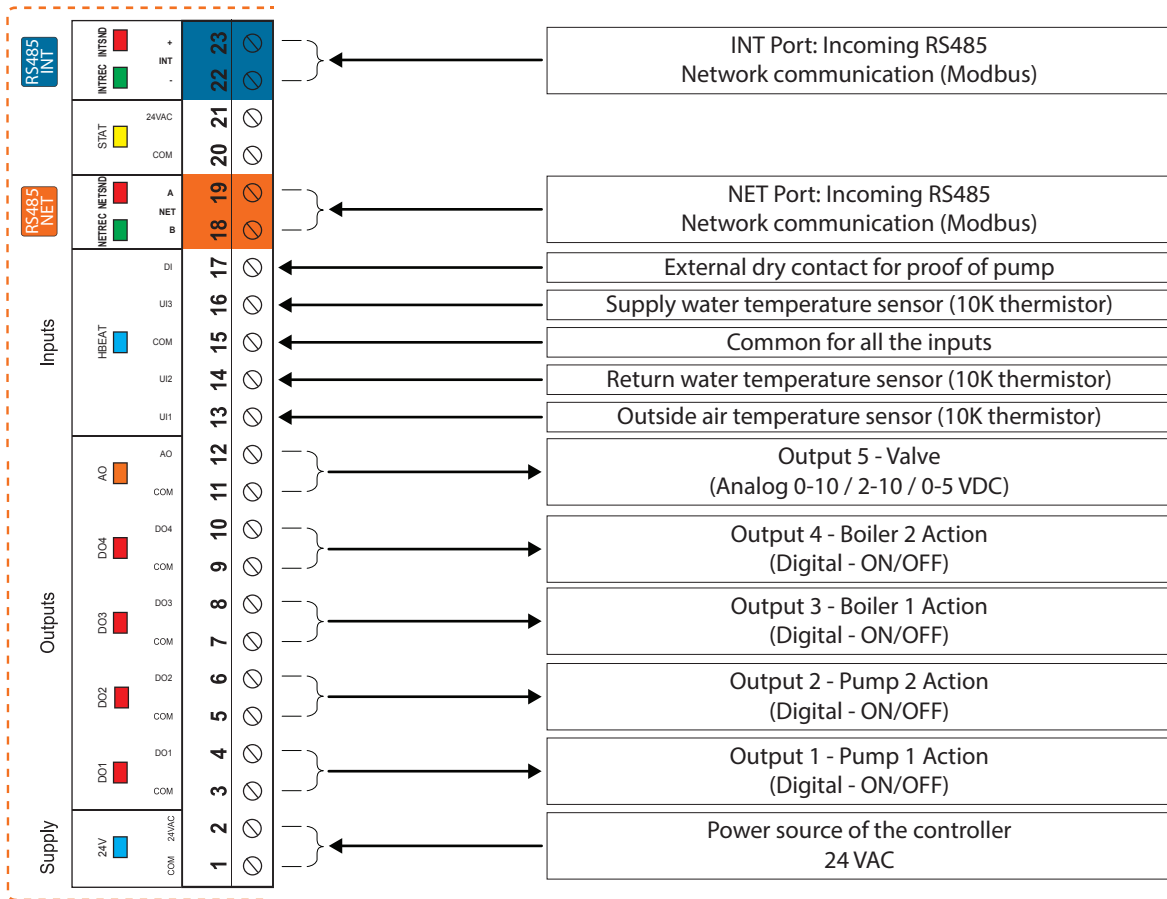
PL-C1050-BLR (Modulating Boiler)



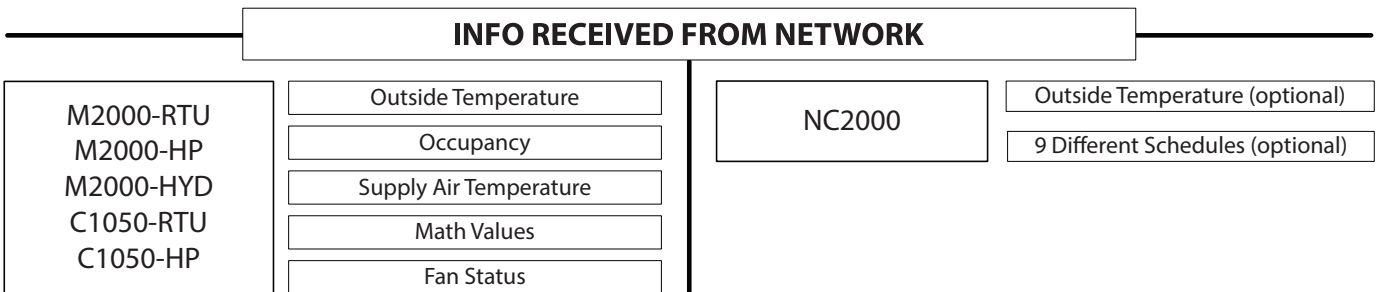
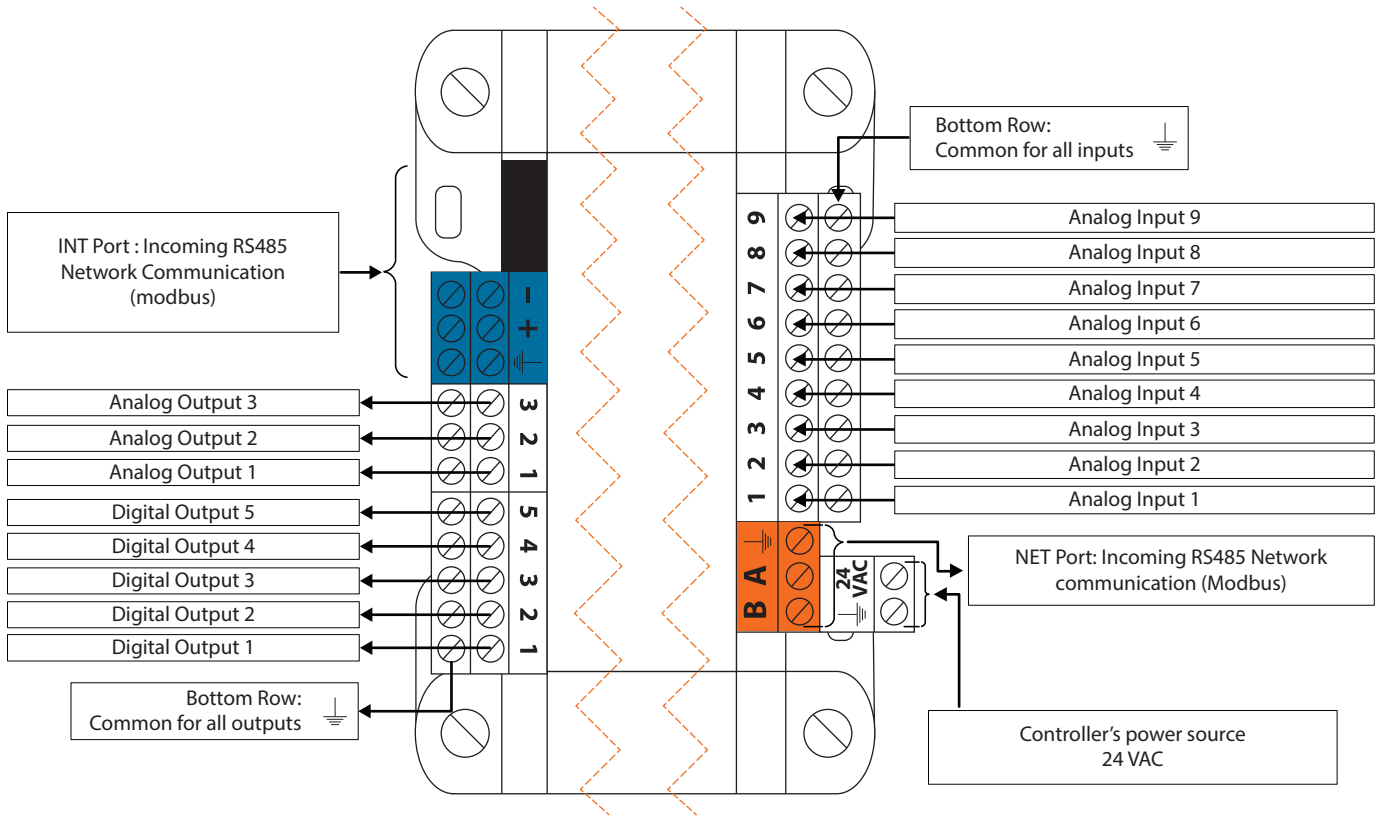
INFO RECEIVED FROM NETWORK



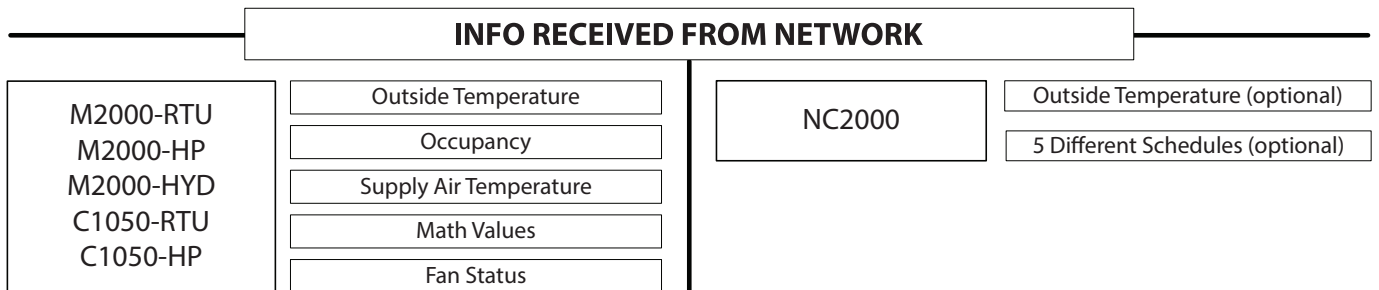
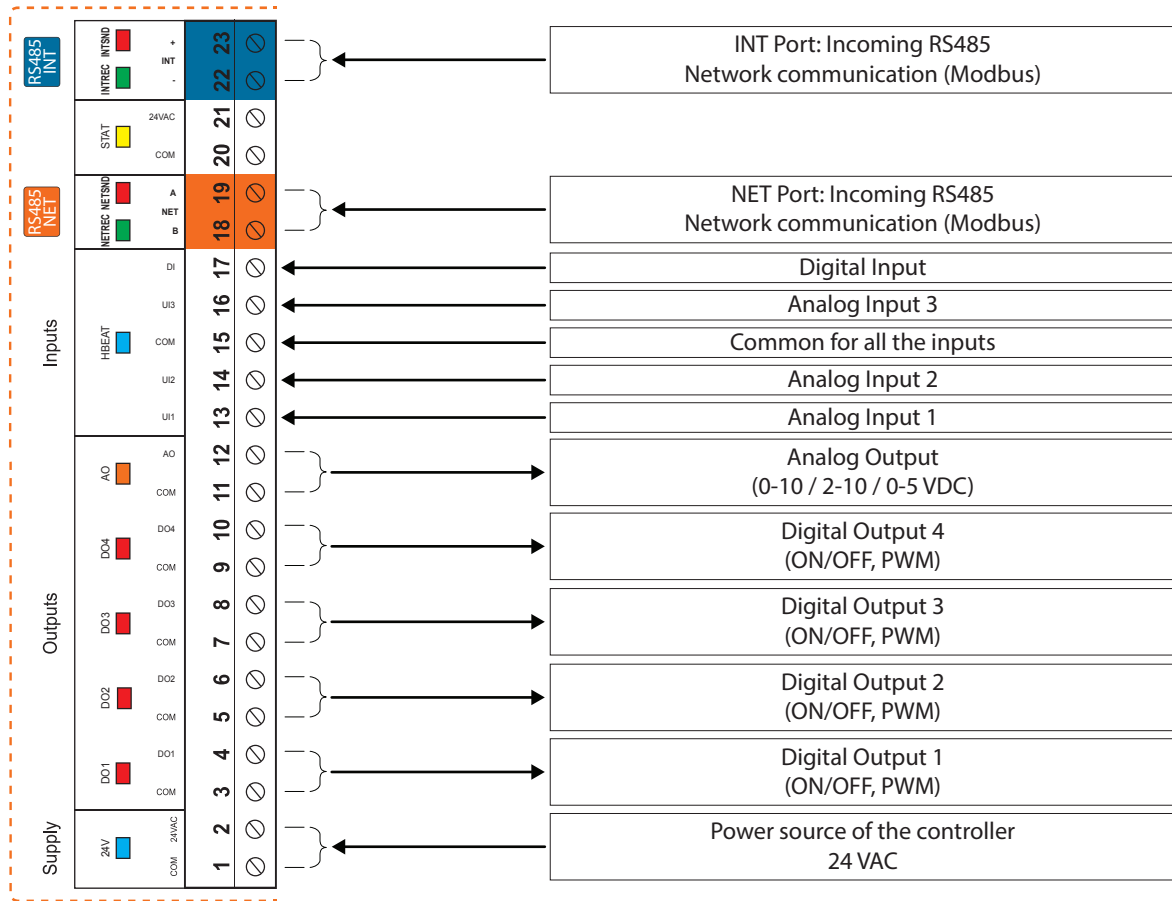
PL-C1050-BLR (Staged Boiler)



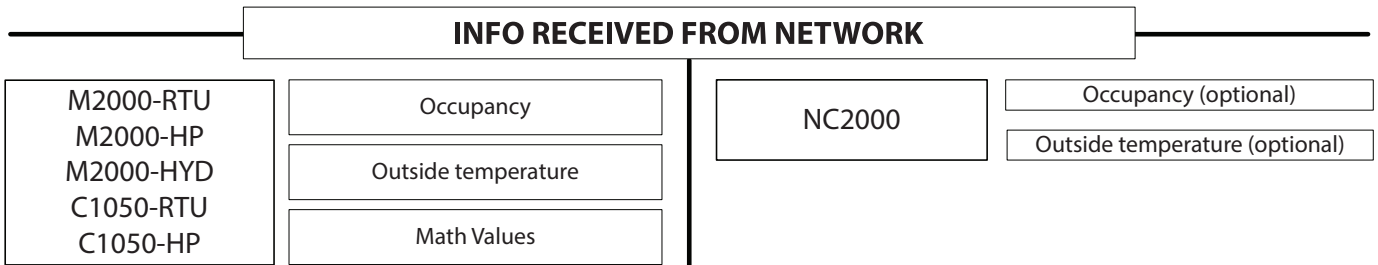
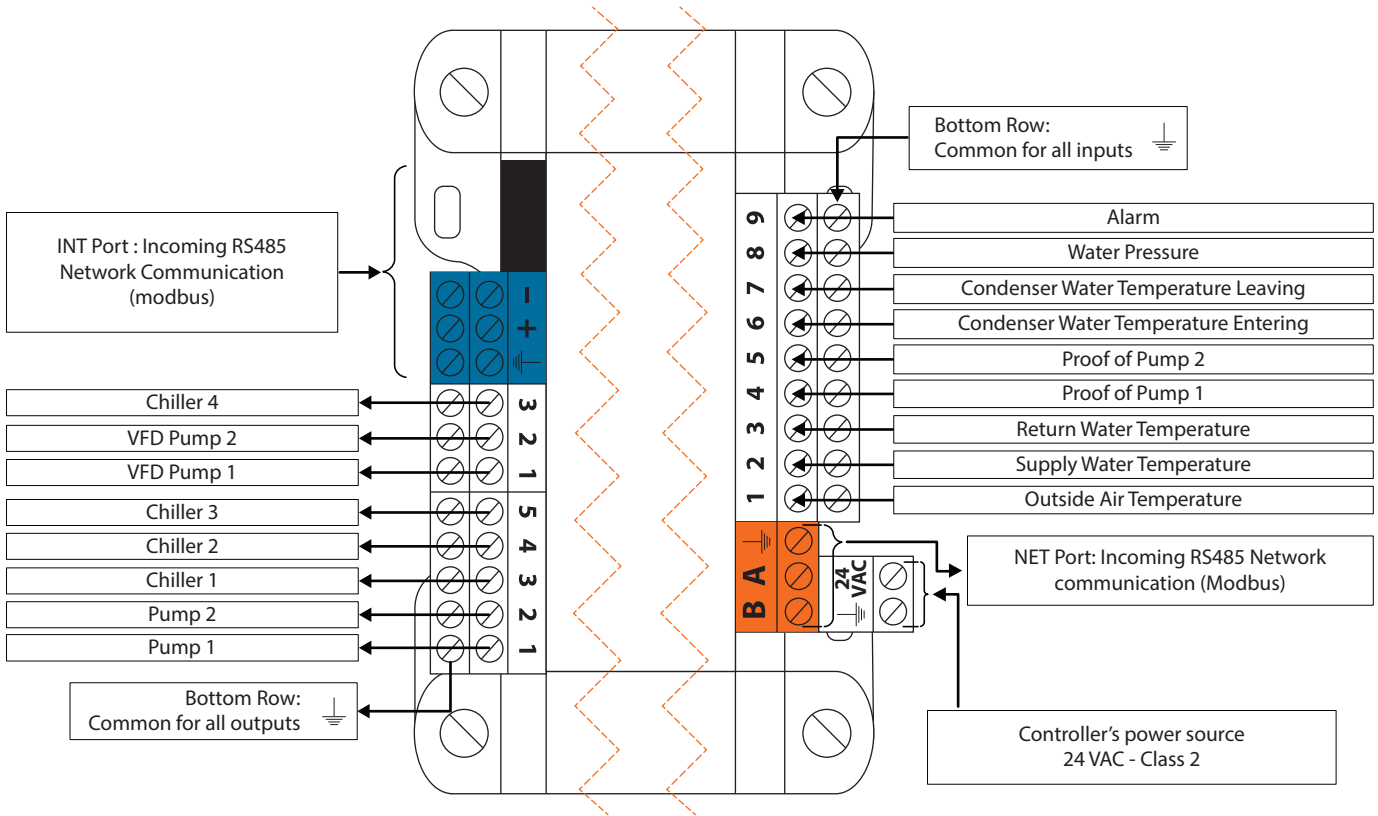
PL-M2000-FLX (FlexIO Controller)



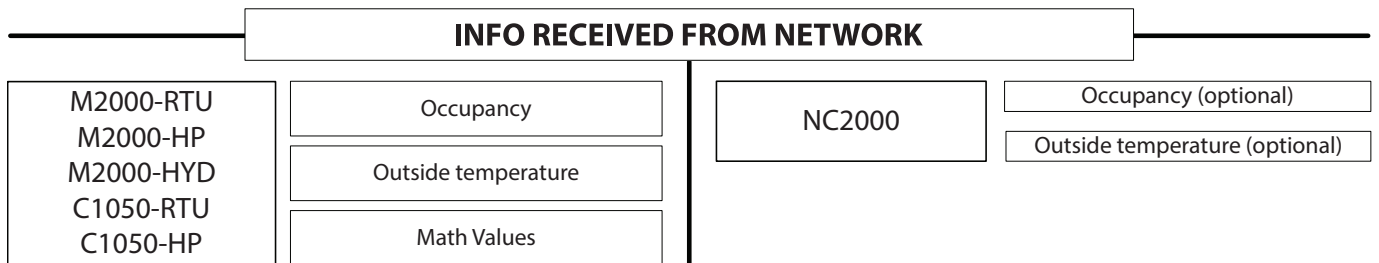
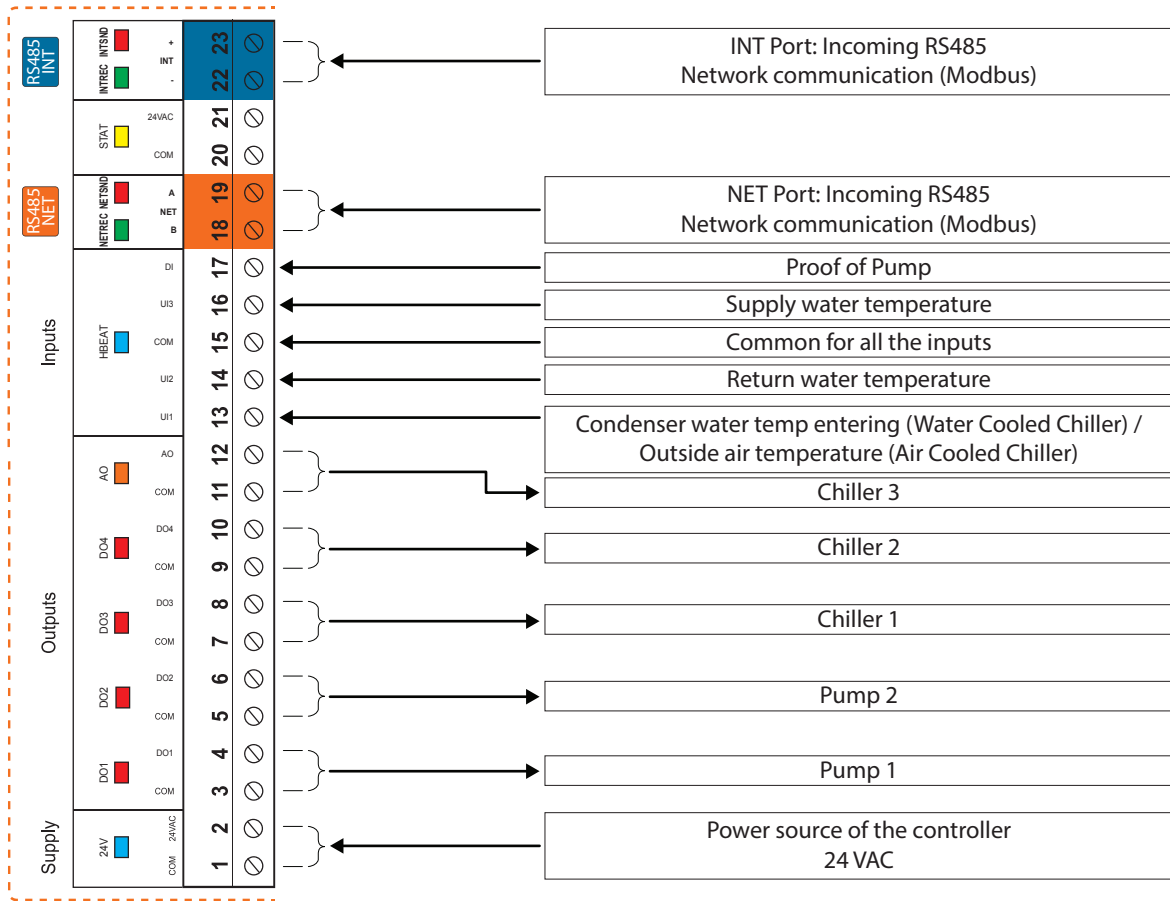
PL-C1050-FLX (FlexIO Controller)



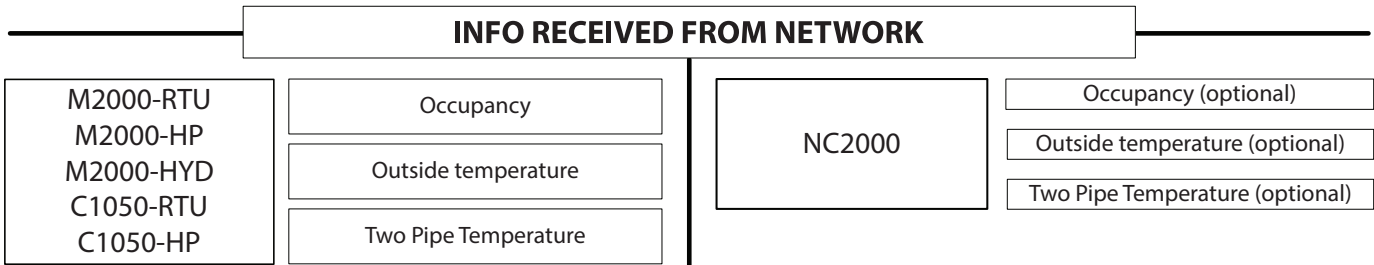
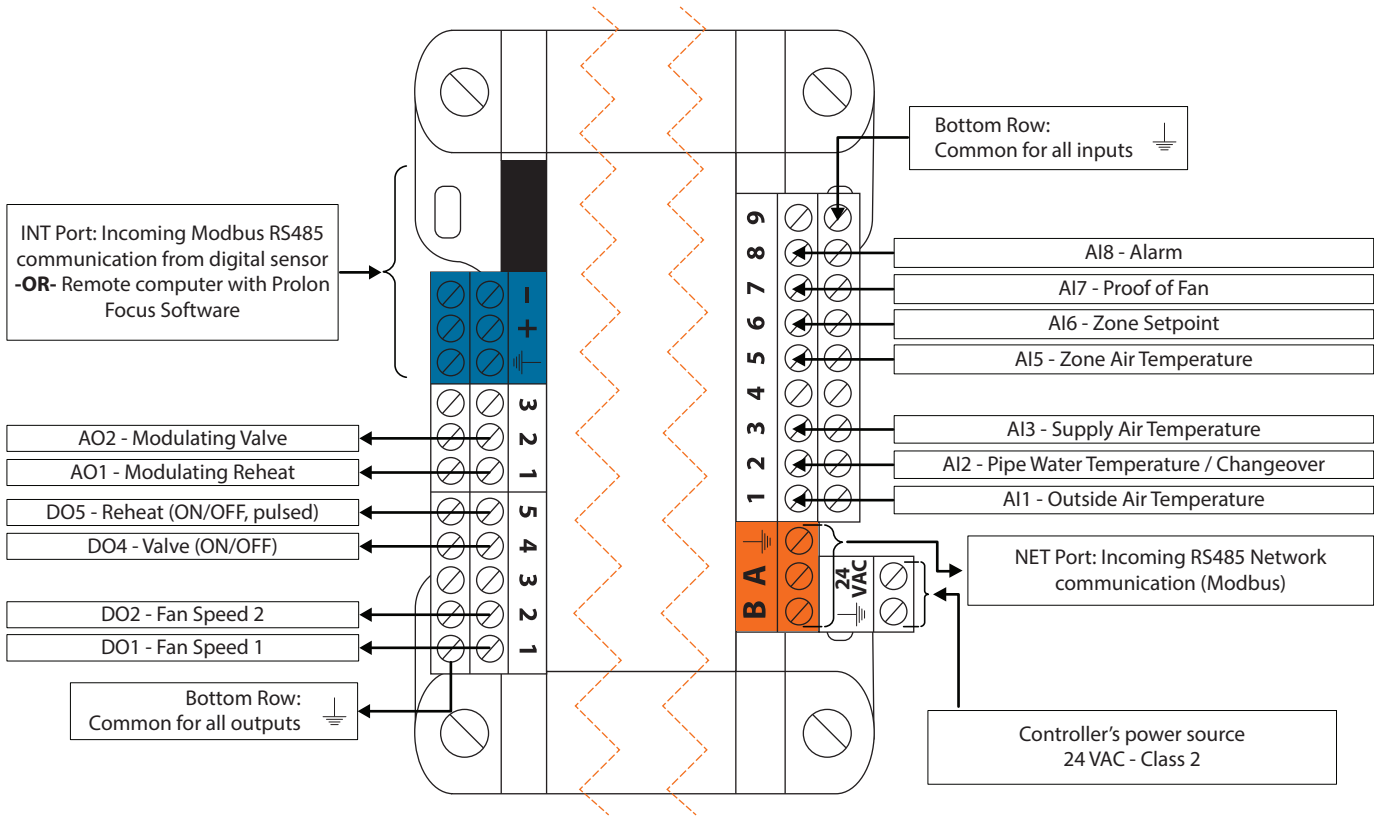
PL-M2000-CHL (Chiller Controller)



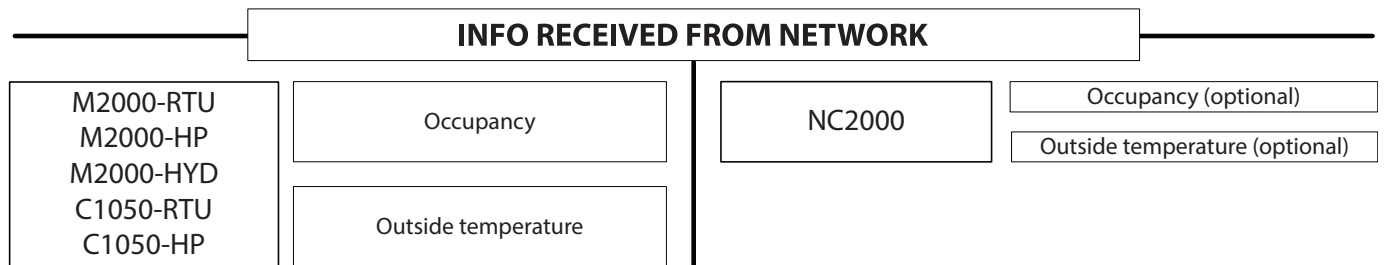
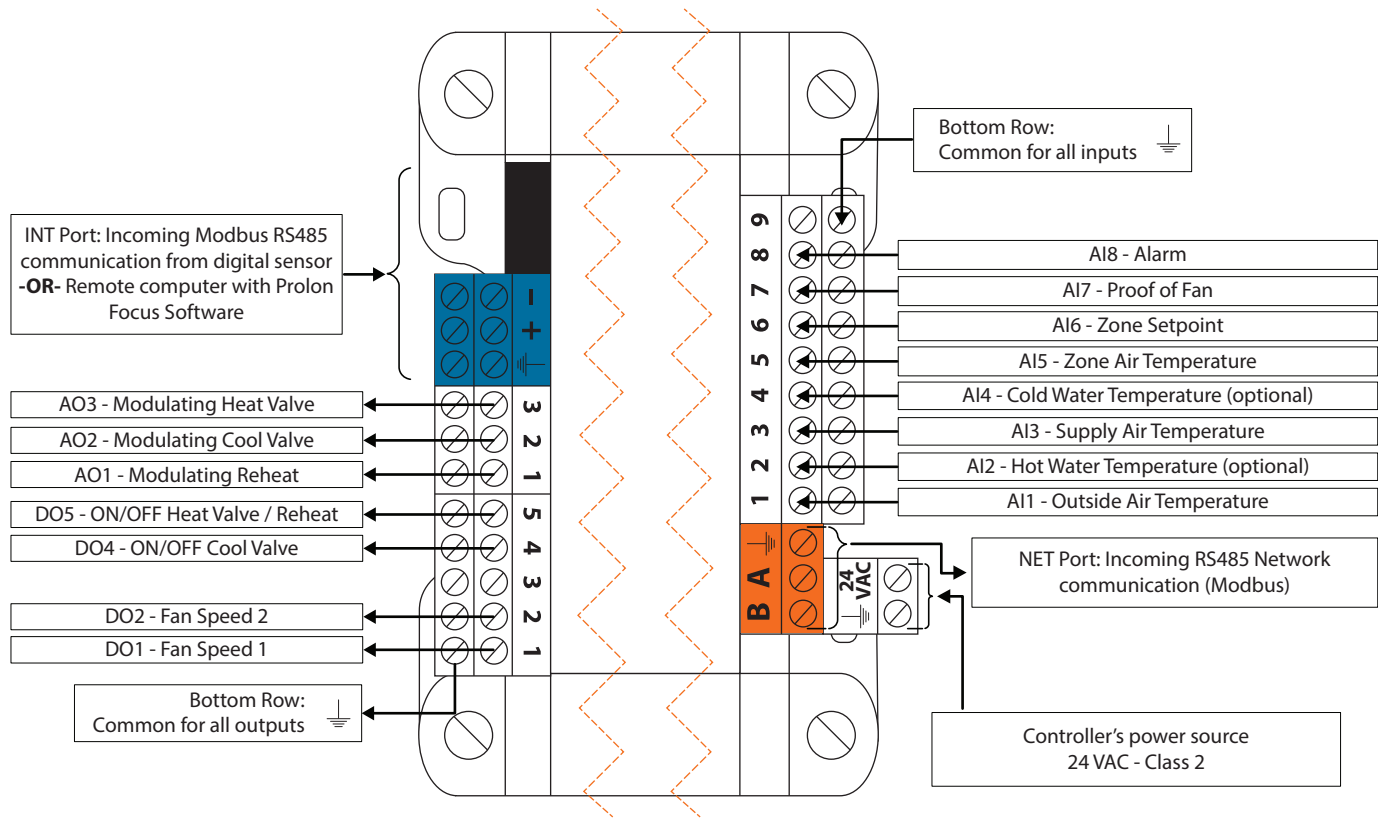
PL-C1050-CHL (Chiller Controller)



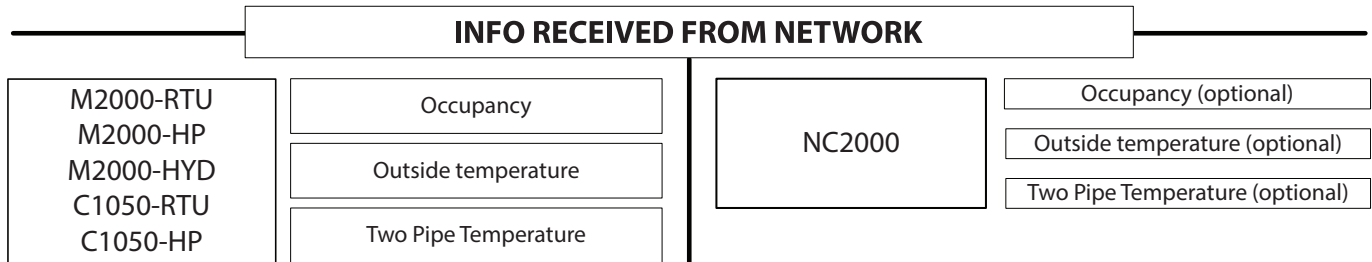
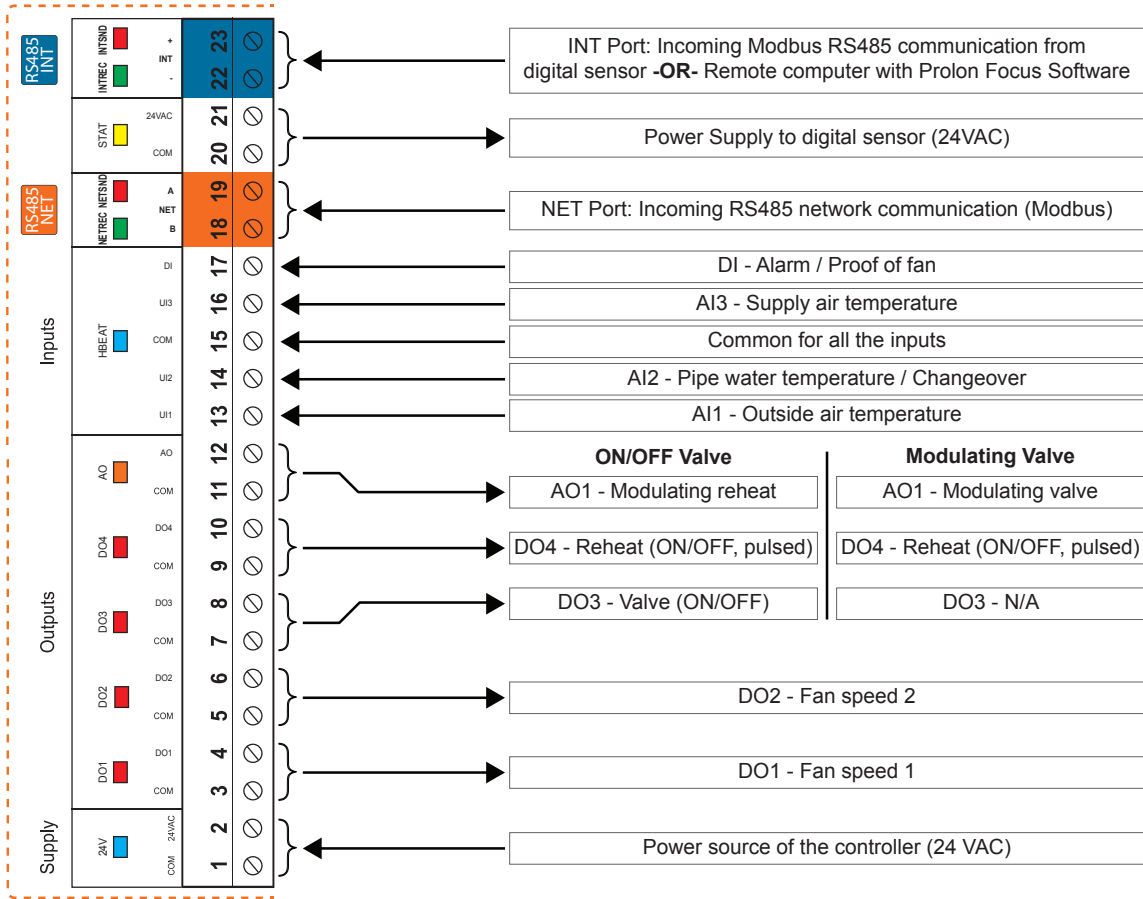
PL-M2000-FCU (Fan Coil Unit Controller with two-pipe system)



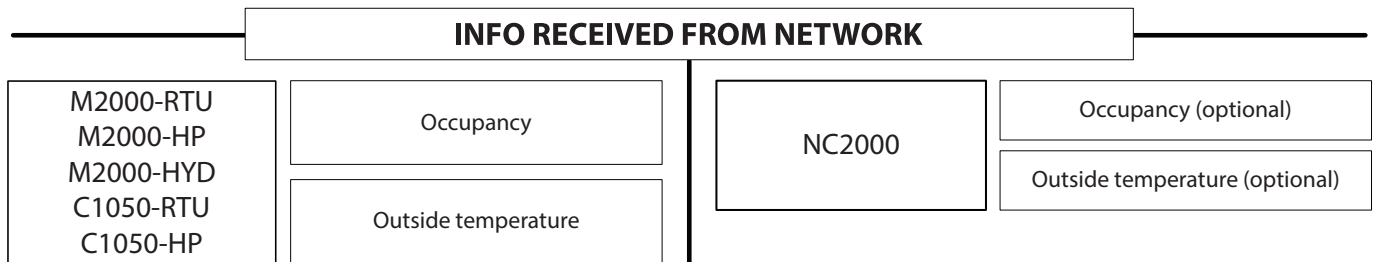
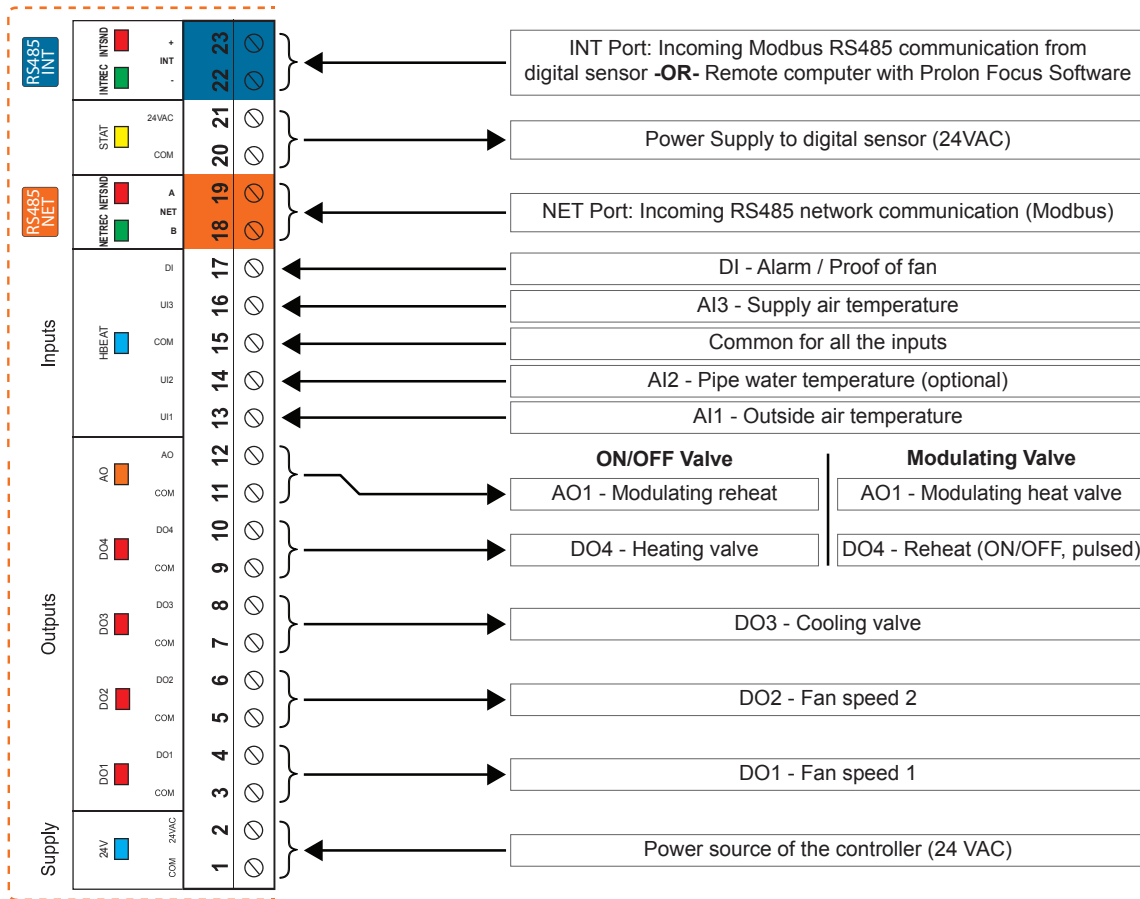
PL-M2000-FCU (Fan Coil Unit Controller with four pipe system)



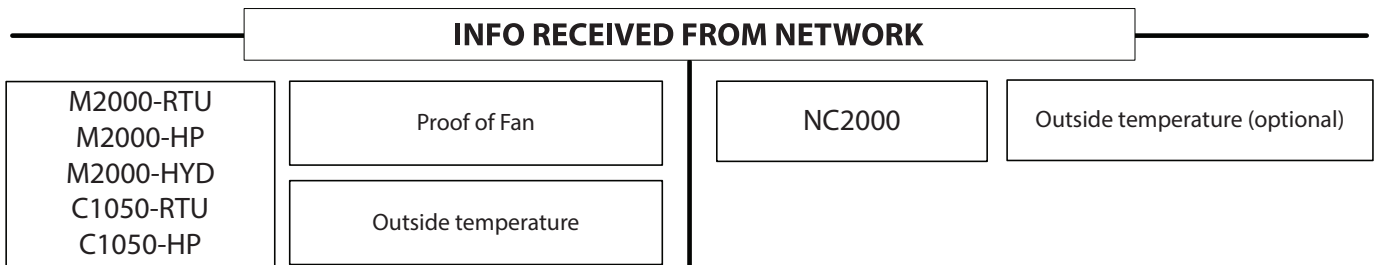
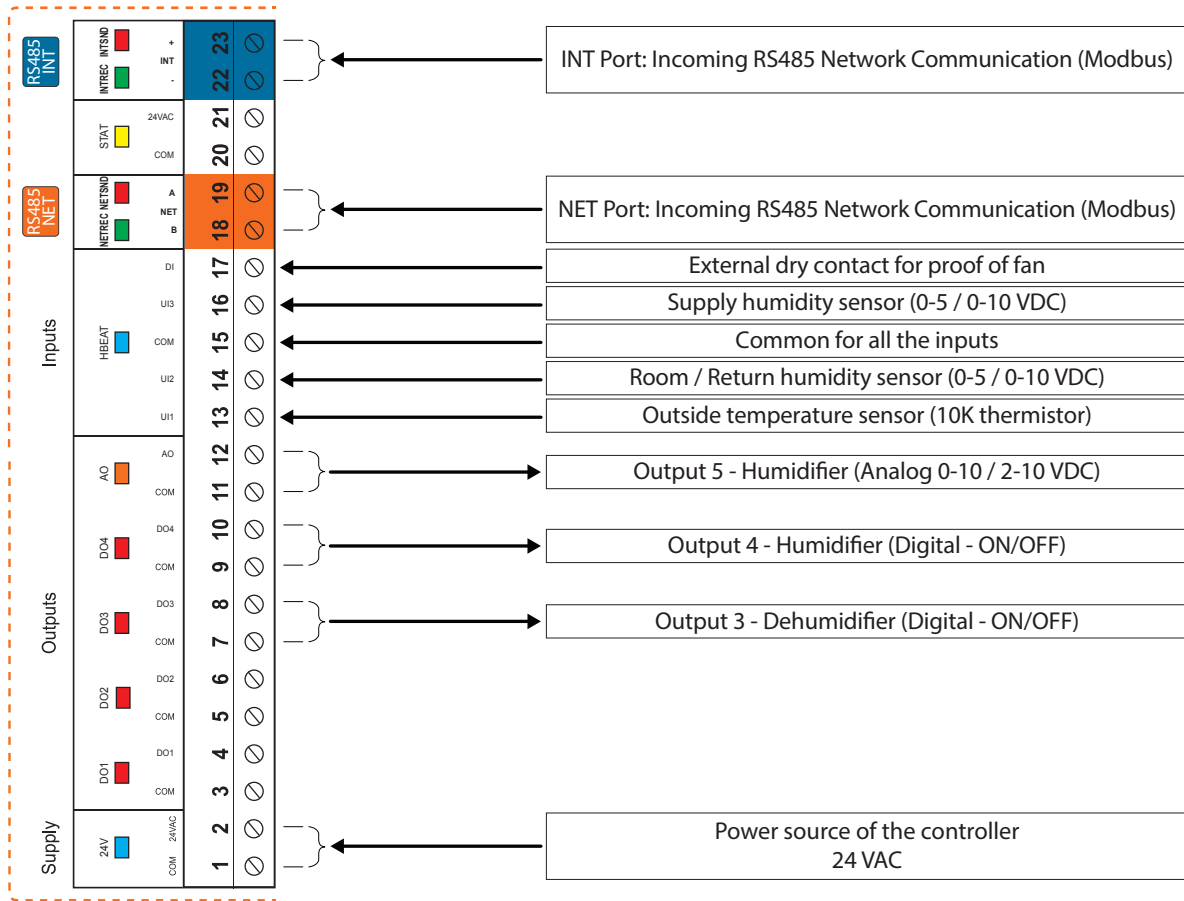
PL-C1050-FCU (Fan Coil Unit Controller with two-pipe system)



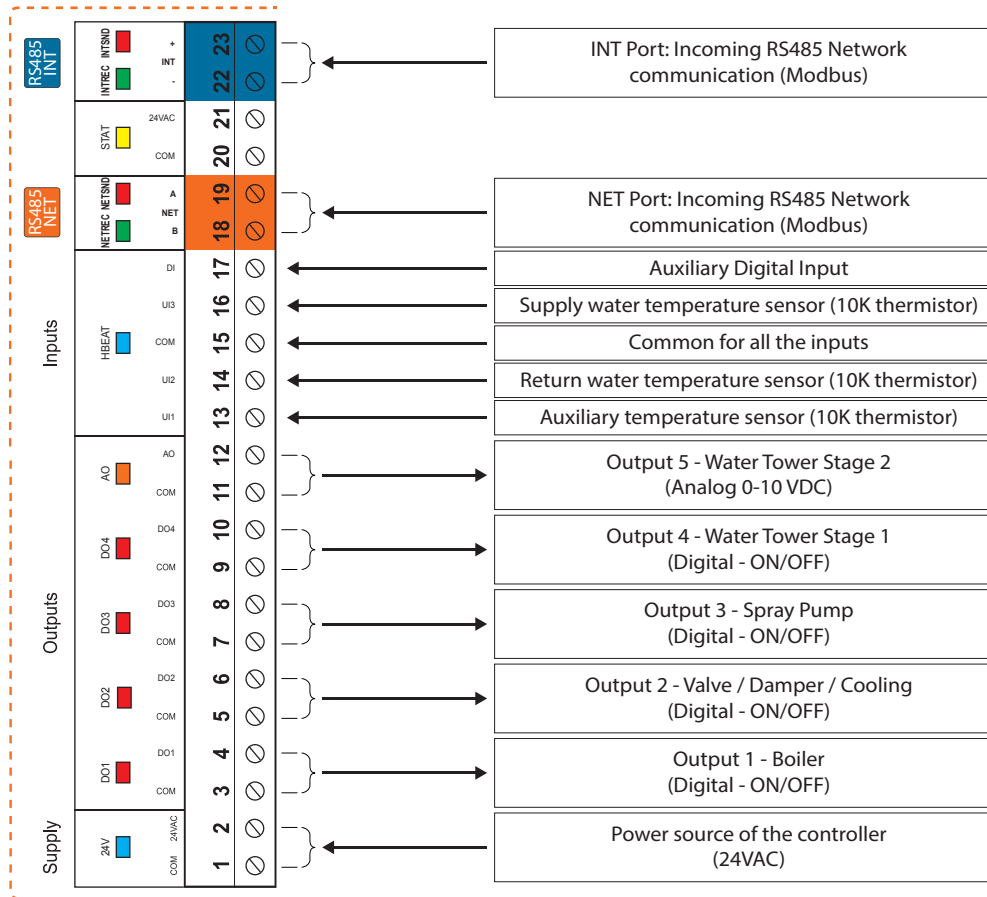
PL-C1050-FCU (Fan Coil Unit Controller with four pipe system)



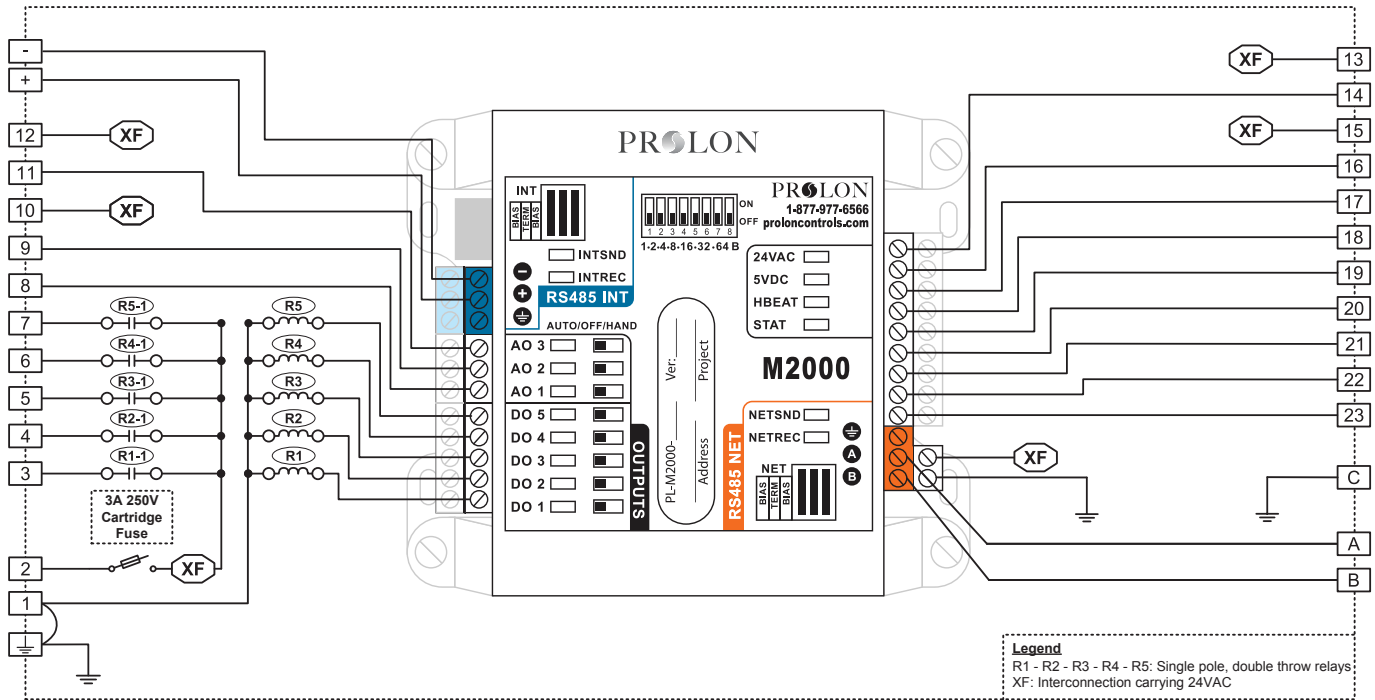
PL-C1050-HU (Humidity Controller)



PL-C1050-WLC (Water Loop Controller)



Panel Wiring Single M2000 (PL-PANEL-M2000-RTU)



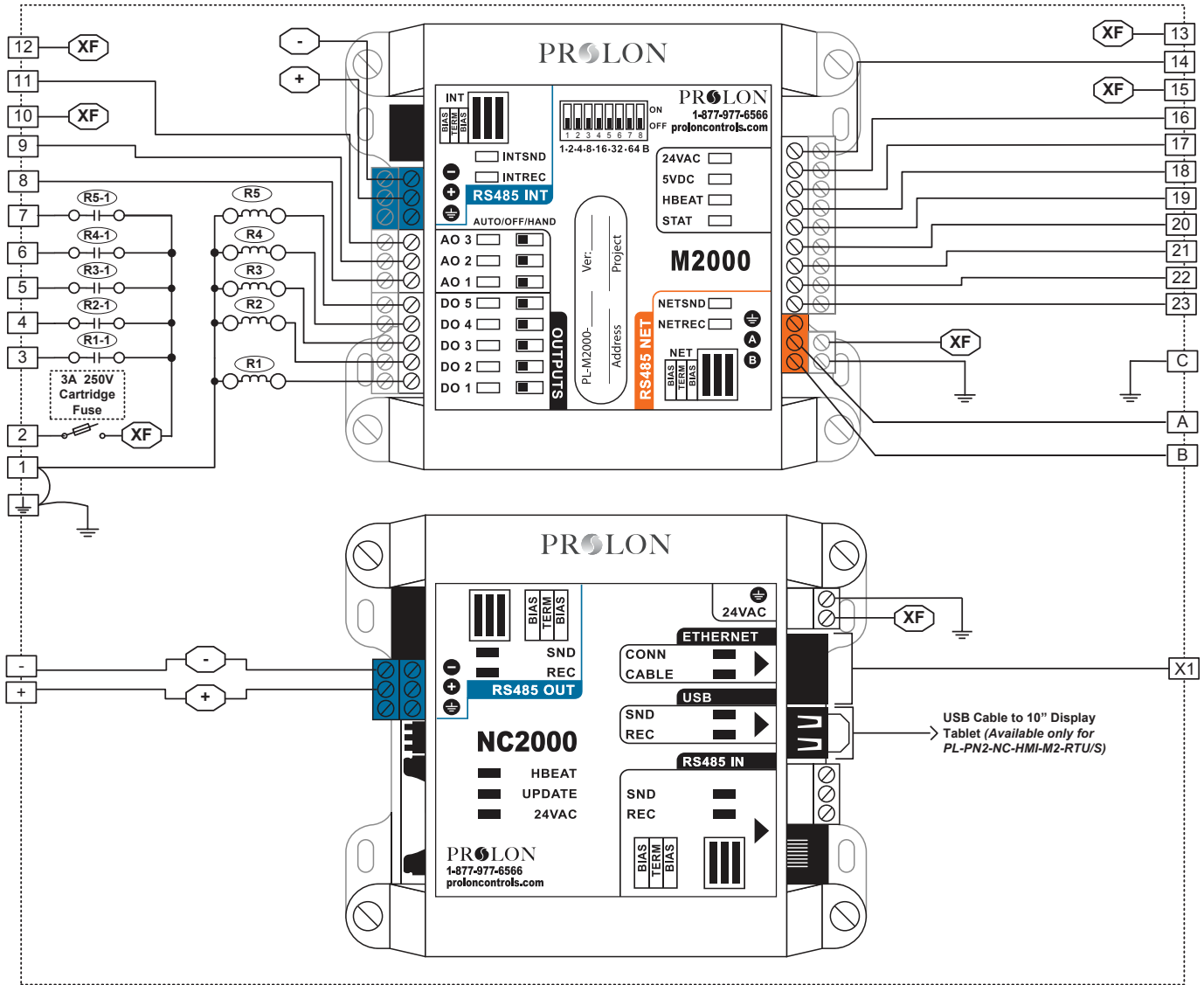
Field Wiring Details

ALL TERMINALS: Use Copper Conductors Only, 105°C/220°F, Maximum Torque Conductor Mounting: 0.5Nm

Terminal	Function	Ratings
⏚	GROUND	N/A
1	Power Supply Input Common	N/A
2	Power Supply Input 24VAC	24VAC, 3A, 60Hz
3	Fan Output (G)	24VAC, 300mA
4	Cooling Output 1 (Y1)	24VAC, 300mA
5	Cooling Output 2 (Y2)	24VAC, 300mA
6	Heating Output 1 (W1)	24VAC, 300mA
7	Heating Output 2 (W2) or Exhaust Fan	24VAC, 300mA
8	Modulating Heating Output	0-10VDC, 40mA
9	Economizer Control Output	0-10VDC, 40mA
10	Economizer Supply	24VAC, 8.5VA
11	Bypass or VFD Control Output	0-10VDC, 40mA
12	Bypass or VFD Supply	24VAC, 5VA
13	Static Pressure Sensor Supply	24VAC, 0.03A
14	Static Pressure Sensor Input Signal	0-5VDC, 5uA

Terminal	Function	Ratings
15	CO2 Sensor Supply	24VAC, 6.7VA
16	CO2 Sensor Input Signal	4-20mA, 1-5VDC
17	Dry Contact for Proof of Fan	N/A
18	Zone Setpoint Potentiometer (0-9K)	N/A
19	Zone Temperature Thermistor (10K Type 3)	N/A
20	Variable Function Temperature Sensor	N/A
21	Supply Air Temperature Thermistor (10K Type 3)	N/A
22	Return Air Temperature Thermistor (10K Type 3)	N/A
23	Outside Air Temperature Thermistor (10K Type 3)	N/A
+	M2000 RS485 INT A (+)	N/A
-	M2000 RS485 INT B (-)	N/A
A	M2000 RS485 NET A (+)	N/A
B	M2000 RS485 NET B (-)	N/A
C	COMMON	N/A

Panel Wiring Master (PL-PANEL-NC2000)



Legend:

(XF) Interconnection carrying 24 VAC

(+) Interconnection carrying M2000 INT A(+)

(-) Interconnection carrying M2000 INT B(-)

(R1) (R2) (R3) (R4) (R5) Single pole, double throw relay

Section 5

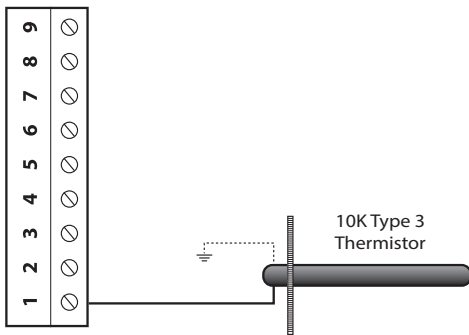
Connections, Setup & Start-up

Connecting Sensors & Peripherals

Prolon controllers come equipped with one or more inputs designed to monitor the many variables required by their control sequences (temperature, humidity, pressure, dry contact, etc.). These inputs all share a single electrical common connection. (Refer to I/O section for specific hardware / profile input configuration.)

Temperature

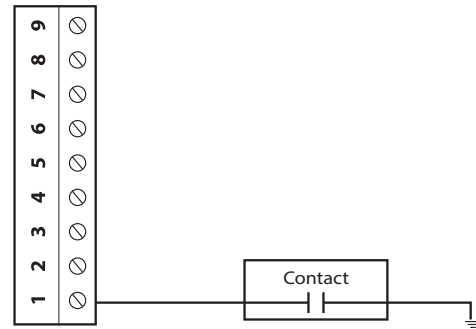
Prolon uses 10k Ω thermistor standard (type 3) temperature sensors. These are non-polarity sensitive, with one wire going to the input terminal, the other to the common strip.



Dry contact

An isolated dry contact is used to confirm an on-off status such as occupancy, proof of equipment (fans, pumps, etc.) or other digital logic. Contact must be non-polarity sensitive and connect with one end going to the input terminal and the other to the common strip.

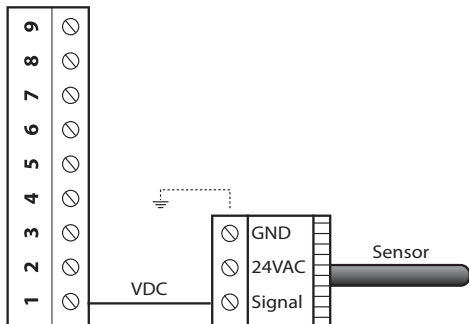
***** DO NOT APPLY 24VAC DIRECTLY ON ANY INPUTS*****



Active signals

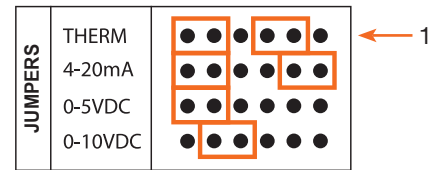
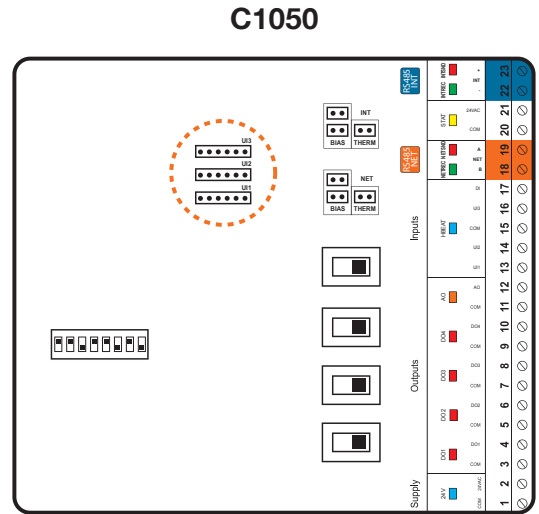
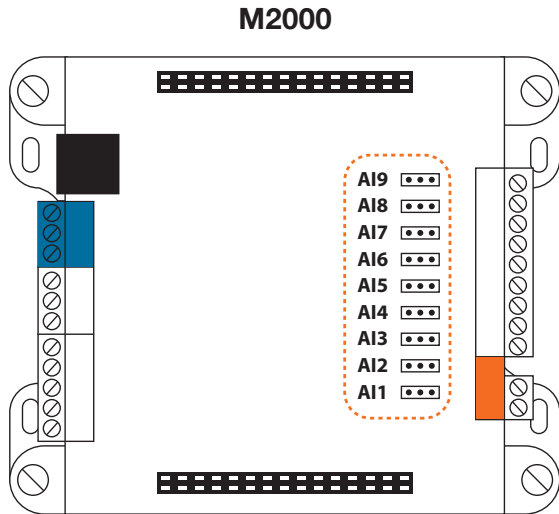
Prolon controllers may read signals from active transmitters such as humidity, pressure, CO₂, gas levels, etc. Standard signals accepted are either current (4-20mA) or voltage (0-5Vdc/1-5Vdc/0-10Vdc*). The positive signal polarity connects to the input terminal, the negative polarity to the common strip.

*C1050 only



Input Jumper Configuration

The VC2000, C1050 and M2000 ProLon controllers come equipped with analog input configuration jumpers that allow the user to select the signal mode of the associated analog input. These come factory-set for their given application but can be modified in the field to accommodate the signal provided by an active transmitter, or when the controller is reprogrammed into another application with different input signal mapping.

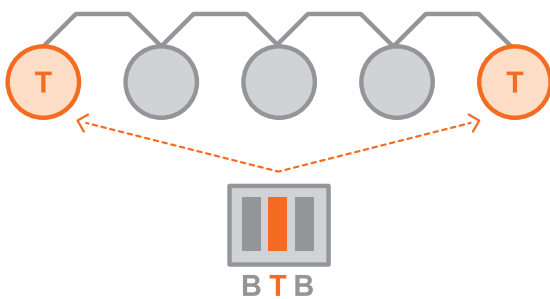


1. Thermistor & Dry Contact

Term / Bias Resistors (Jumpers)

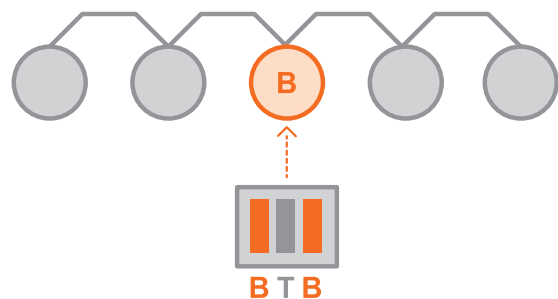
EOL (End-of-Line) or TERM resistors

On any network segment, regardless of quantity of devices, controllers at both extremities of the daisy-chain should have their TERM jumpers set to ON, all other controllers should have them OFF.



BIAS resistors

On any network segment, a single controller must have both BIAS jumpers set to ON, all other controllers should have them OFF



Controller Addressing Methods

PL-VC2000

The PL-VC2000 VAV controller hardware platform has no dipswitches for addressing, and must be addressed either via software, or using a digital wall sensor with display (PL-T1000 or PL-T500) .



PL-T1100

The PL-T1100 Wall Thermostat does not have dipswitches for addressing. It has a factory default address of #101, which can be changed via software or the keypad menu structure on the device (see Thermostat Hardware Guide for menu structure).

NOTE: if connecting multiple PL-T1100 Thermostats, be sure to modify the addresses so each thermostat address becomes UNIQUE before attempting any networked communication with them.

PL-M2000 and PL-C1050

These two models are addressed using dipswitches located on the controller itself:



The address becomes the sum of the numerical value held by each switch that is set to ON, all seven having a different value, doubling with every switch. In this example, switches 1, 2, 4 and 6 are ON, so the address of the device is:

$$1 + 2 + 8 + 32 = 43$$

If all dipswitches are OFF, then the controller has no valid address and WILL NOT COMMUNICATE. If all 7x switches are set to ON, then the highest address value is reached = 127, The 8th switch is reserved and is not used for addressing.

PL-NC2000

The PL-NC2000 Network Controller hardware platform does not have dipswitches for addressing. It has a default factory address of #99 and can be only modified via software.

PL-T1000, PL-T500 and PL-T200

Prolon Digital Wall Sensors (PL-T1000/T500/T200) DO NOT HAVE ADDRESSES.

Cabling

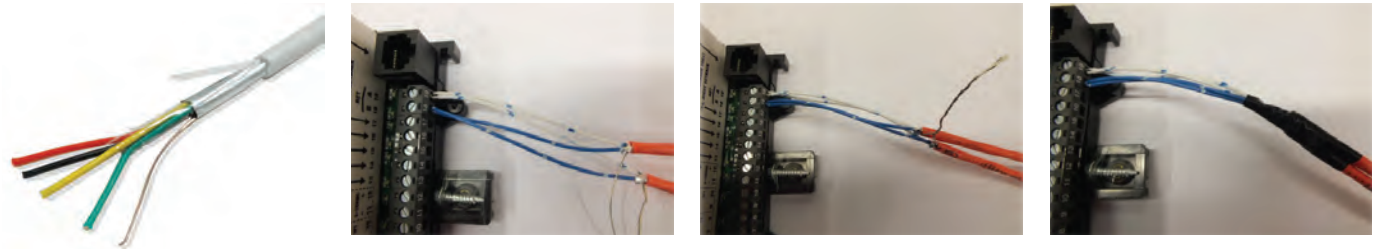
Prolon controllers use readily available HVAC industry standard wiring for its connections. Some care must be taken however in choosing the proper wire for the application.

- **Passive temperature sensors:** Twisted & shielded control wire, typically #18 gauge.
- **Power supply / control outputs:** LVT low voltage control cable, #18 gauge or bigger, depending on load.
- **Communication network:** Twisted & shielded, low-capacitance RS-485 network approved cable. Typically, #22 gauge*. Maximum network segment length: 1000m (3250ft).
- **Communicating wall sensors (T200/T500/T1000):** One pair each of power and communication cables, **-or-** a single twisted & shielded #20 or #22 gauge 4-conductor cable.

Best practices

Whenever used, shielded cable must be grounded at one end only. Multiple shielded segments must have their shields tied together at every junction, but still only grounded at one end.

Prolon recommends using new wiring only throughout project, as existing field wiring may not perform as needed.



System Start-up

Before powering up any Prolon control system for the first time, a safety check list should be performed on all devices, their wiring, and connections. This will ensure a successful start-up. (Consult: Installation Checklist PL-INSTL-CHECKLIST-EN document for complete details).

Although not exhaustive, that list should include:

- Checking the power supply source
- Shielding and grounding of appropriate cables
- Addressing the controllers
- Setting up Termination / Bias resistors where needed
- Powering up and checking indicator light behavior

Power Supply Source

Supply to controllers must be 24VAC +/- 10%. The transformers used must have their common tab grounded to earth. All controllers must share same the same 24vac Live -vs- Neutral terminal connections, as incorrect supply voltage polarity may not cause damage but will cause communication failure until corrected.

Addressing Controllers

All controllers must have a valid address (anywhere from #1 to #127) to be able to communicate on a network. Even if left standalone, zone controllers (C1050, VC2000) must still have an address to communicate with their own digital wall sensor.

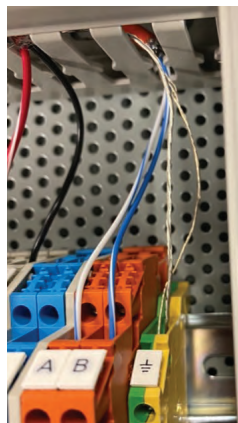
- C1050 & M2000 controllers use dipswitches to set their address. They have no default addresses
- NC2000 Network Controller uses virtual addressing. It has factory set default address: #99
- T1100 Thermostat uses virtual addressing. It has factory set default address: #101
- VC2000 VAV controller uses virtual addressing. It has no default address

Terminating & Bias Resistors

Each communication segment of a networked system must have Terminating (end-of-line) as well as BIAS resistors enabled. Check that the terminating resistor jumpers are enabled only on each of the two opposite controllers on the communication segment. Also, a single controller must have its BIAS resistor jumpers enabled as well (Consult section #4 for details).

Grounding of Cables

Communication bus shield on any segment (INT & NET) must be grounded at only one end of the segment, joined between all networked controllers, and left isolated at the other end. (Consult PL-INSTL-WIRING-EN for complete details).



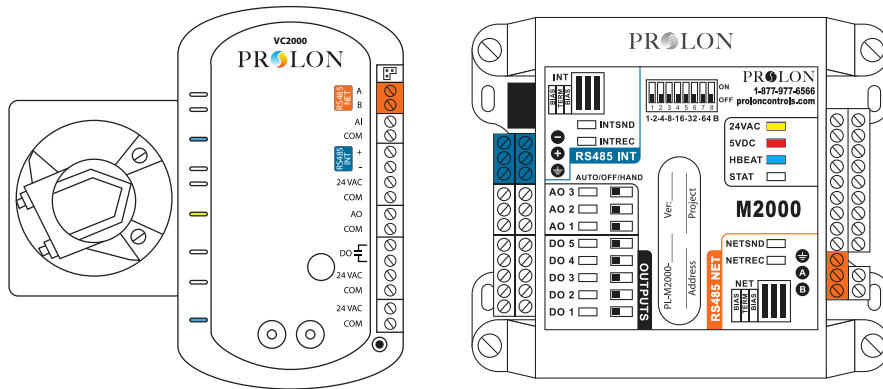
Shielded sensor wire, when used, must only be grounded at one extremity, typically at the Master controller end.

Powering Up Controllers

Upon power up, each ProLon controller will display a solid 24VAC power light, as well as a flashing blue heartbeat light (HBEAT). The heartbeat confirms normal controller operation.

Typically, air handler controllers (RTU/S, HP/S, FCU, MUA) are powered from the unit's own 24VAC source. Zone controllers and thermostats use dedicated supply transformers. (Consult the ProLon PL-TRA-Startup-EN Installation & Startup Guide for more details)

For addition details, you may also consult the ProLon Troubleshooting guide.



Communication

Any master controller (RTU, HP, MUA, etc.) will automatically establish communication with its follower controllers upon start up.

A few seconds after powering up, check the master's network communication status lights NETSND / NETREC, as they should blink together at regular intervals, confirming communication with follower controllers.

Inspect zone and/or associated follower controllers, as their own communication status lights (NETSND / NETREC should blink at the same interval as the master controller.

Section 6

TREE-COM Wireless Communication Module

PL-TREE-COM Principles

1. The Prolon PL-TREE-COM is a wireless communication device that transmits and receives Modbus RS485 data over radio frequency communication (2.4GHz)
2. Its goal is to wirelessly extend, complement, or replace standard RS485 wired daisy-chains, where a physical connection would be impractical or uneconomical. (Figure 1)
3. The TREE-COM modules communicate on dedicated wireless subnet "channels", where a unique "ROOT" module talks with one or multiple "LEAF" units on the same channel.
 - 3a) Channel identification is made through dipswitches. Up to 128 different channels may be created.
 - 3b) All TREE-COM communicating on a given channel must be set to the same dipswitch channel number.
 - 3c) These dipswitches are not to be mistaken with the controllers' Modbus address, they are for channel identification only. (Figure 2)
 - 3d) The "ROOT" module is always connected to a Modbus "Master" device, the "LEAF" always connect to "follower" devices.

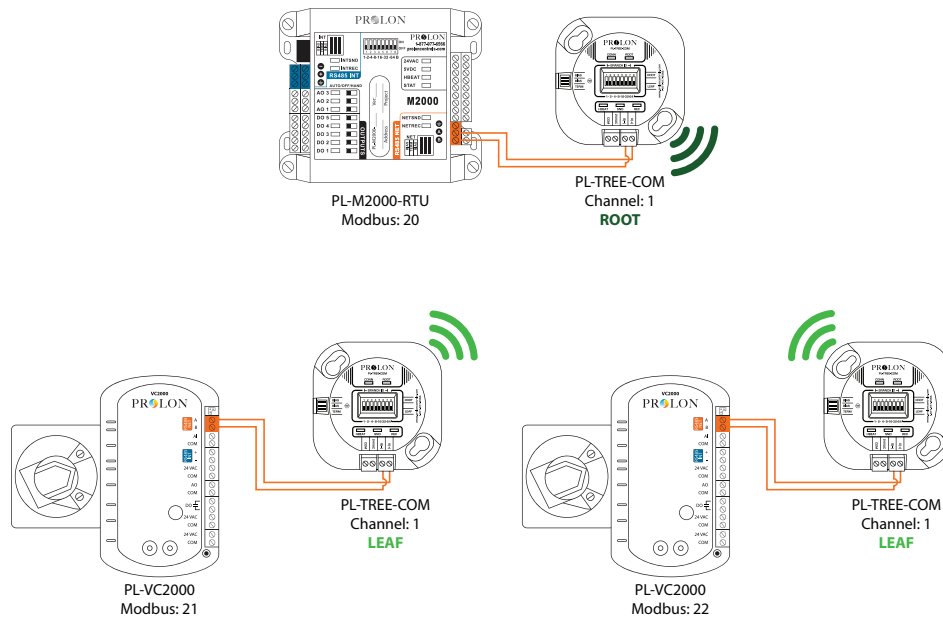


Figure 1

4. Each wireless segment must have one TREE-COM set as a "ROOT".
 - 4a) The "ROOT"/"LEAF" function is activated using dipswitch number #8. (Figure 2)
 - 4b) There can only be one "ROOT" on any given segment.
 - 4c) The "ROOT" can have as many "LEAF" modules as needed by the Prolon system.
 - 4d) The PL-TREE-COM, set as a "ROOT", communicates with all its "LEAF" modules

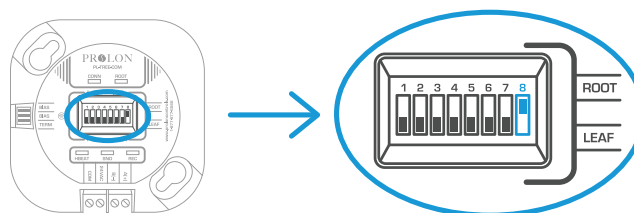


Figure 2

5. Channel number configuration

A unique channel number on each TREE-COM must be configured by setting the first 7 switches on the channel number dipswitch block to the desired value.

These switches are numbered from 1 to 7 and represent a binary value from 0 to 64 (0, 1, 2, 4, 8, 16, 32, 64 respectively). The value of each switch that is in the ON position is added together to form the numerical value of the TREE-COM channel used.

The example on Figure 3 shows switches 1, 2 and 4 on the ON position. So the corresponding values are 1, 2 and 8, giving a sum of 11. ($1+2+8=11$)

TREE-COM modules allow the use of up to 128 channel numbers.



Figure 3

6. Operational range

6a) The PL-TREE-COM can be oriented in any direction when operating under 200ft of range.

6b) The PL-TREE-COM can cover distances up to 2500 ft when oriented properly. (Figure 4)

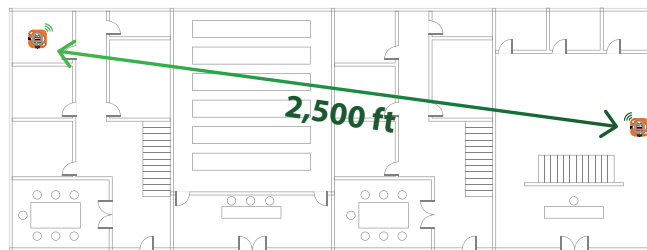


Figure 4

6c) The PL-TREE-COM radio wave pattern is directional, meaning the signal beam, while able to radiate everywhere, will travel farther in one specific direction. The built-in antenna is aligned with its front cover (face with the lights and dipswitches). In order to achieve maximum range, or communicate through complex building structure, both PL-TREE-COM modules communicating together should have their faceplates facing each other. Signal quality (read at the "LEAF" module) must be at least 30% to achieve proper communication. (Figure 5)

NOTE: Aligning TREE-COM modules face to face is highly recommended for distances beyond 200 ft.

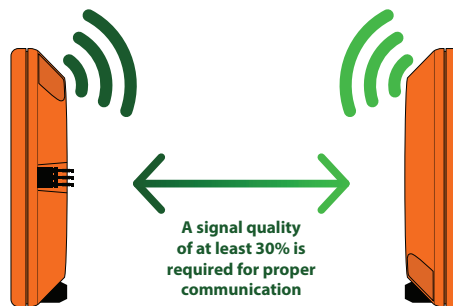


Figure 5

7. Weatherproof enclosures

Should a PL-TREE COM module need to be installed outdoors, we recommend installing it in a plastic or resin NEMA 4 type enclosure, do not install inside a metal enclosure, since it will block all radio signals.

8. LEDS

The PL-TREE-COM comes equipped with five LEDs to indicate device status. (Figure 6)

- 8a) **HBEAT (BLUE)**: This LED simply indicates that the device is powered and operating. It should blink once every second, regardless of RS485 or Wireless communication.
- 8b) **CONN (BLUE)***: This LED indicates if other devices have been found on the same subnet as this device. If so, then the devices are ready to share their RS485 information.
- 8c) **ROOT (YELLOW)**: This LED indicates if this device has been set as a “ROOT” using dipswitch #8. When the LED is ON, this device is set as the ROOT for its subnet. If the LED is off, it is instead a “LEAF”.
- 8d) **SND (RED)**: This LED indicates if data is being transmitted on the RS485 bus. Blinking occurs in quick short bursts.
- 8e) **REC (GREEN)**: This LED indicates if data is being received from the RS485 bus. Blinking occurs in quick short bursts.

**Once a successful connection is established between a “ROOT” and one or more multiple “LEAF” devices, their individual CONN blue lights will turn on. The connection process may take up to 7 minutes to complete.*

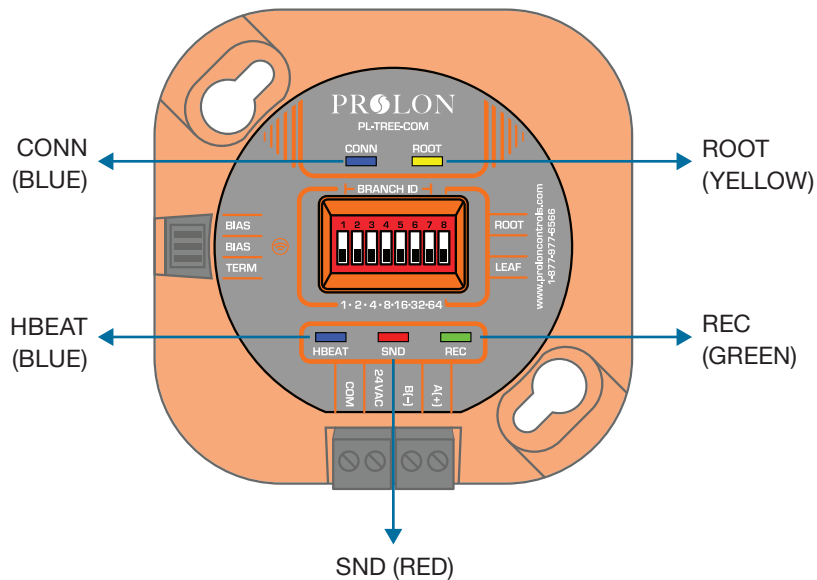


Figure 6

9. Setting bias and terminating resistors

The PL-TREE-COM comes with jumpers to enable RS485 bias and terminating resistors. Bias and terminating resistors are used to stabilize an RS485 network. Terminating resistors should be placed at each extremity of an RS485 bus. Both bias resistors should be activated at a single node on the RS485 bus, but the location of the node is not important

The jumper to activate the resistors are identified on the PL-TREE-COM via the front label. The resistors are activated when the jumper covers both header pins for a given resistor.

10. Firmware compatibility

The PL-TREE-COM is designed to work with same generation products (v.7.5.0 or later), but can be retrofitted into existing systems, provided that the controllers using TREE-COM modules are compatible. This is especially important with Modbus “Master” devices, that must comply with the TREE-COM’s specific communication characteristics.

- 10a) When a PL-NC2000 is present, it must have firmware version 7.5.0 or later to support TREE-COM communication.
- 10b) Any Digital wall sensor (T200/T500/T1000) connected to a TREE-COM must have firmware version 7.5.0 or later to support TREE-COM communication.
- 10c) Other Modbus Master controllers (RTU, HP, etc.) using older firmware may still work properly with TREE-COM modules. It is strongly recommended however to update them for best communication performance
- 10d) Follower controllers are not affected by firmware version, all are compatible with the TREE-COM.

PL-TREE-COM Installation Scenarios

Single-Zone Unit Controllers with Digital Wall Sensor

The RTUS, HPS or FCU controllers can be connected to their respective communicating digital wall sensor, using the PL-TREE-COM device. ****Important** A PL-RS wall sensor CANNOT be connected using a PL-TREE-COM (M2000 only).**

1. The PL-TREE-COM connected to the communicating wall sensor must be set as the "ROOT".
2. The PL-TREE-COM connected to the Single-Zone Unit Controller must be set as the "LEAF".
3. Both TREE-COM modules must have their dipswitches set for the same channel number

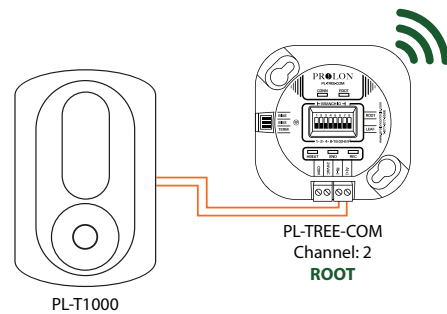
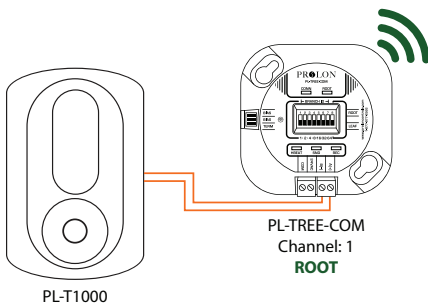
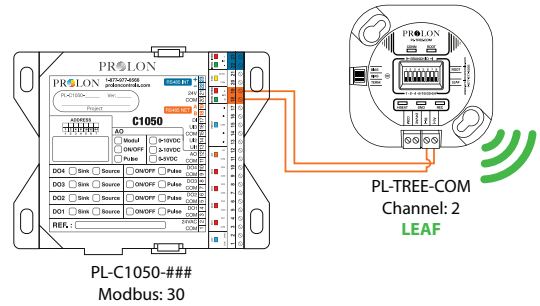
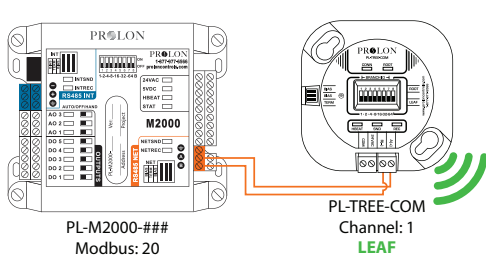


Figure 7

Figure 8

VAV Zone controllers with Digital Wall Sensor

The PL-VC2000 or C1050 VAV controllers can be connected to a communicating digital wall sensor (T1000, T500, T200) using a PL-TREE-COM. (Figure 9)

1. The PL-TREE-COM connected to the communicating wall sensor NEEDS to be set as the "ROOT". (INT port)
2. The PL-TREE-COM connected to the VAV controller must be set as the "LEAF". (INT port)
3. Both TREE-COM modules must have their dipswitches set for the same channel number.

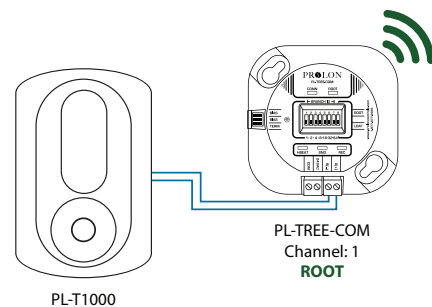
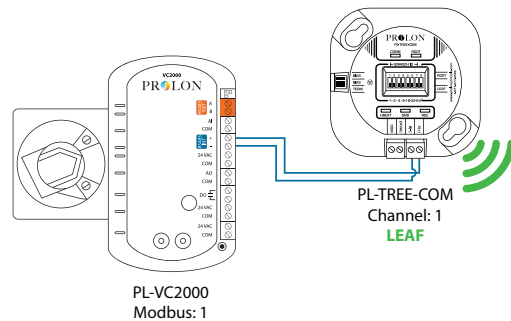


Figure 9

Master Controller with multiple Follower Controllers (fully wireless network)

Follower Controllers (VC2000, C1050-VAV, T1100, FLX, BLR, etc.) can be connected wirelessly to a Master Unit Controller such as a PL-M2000-HP or RTU or a PL-C1050-RTU or HP.

1. Each controller must have its own dedicated PL-TREE-COM device
2. The PL-TREE-COM connected to each Follower Controller must be in set as the "LEAF". (NET Port)
3. The PL-TREE-COM connected to the Master Controller must be set as the "ROOT". (NET Port)
4. All PL-TREE-COM modules must have their dipswitches set for the same channel number.

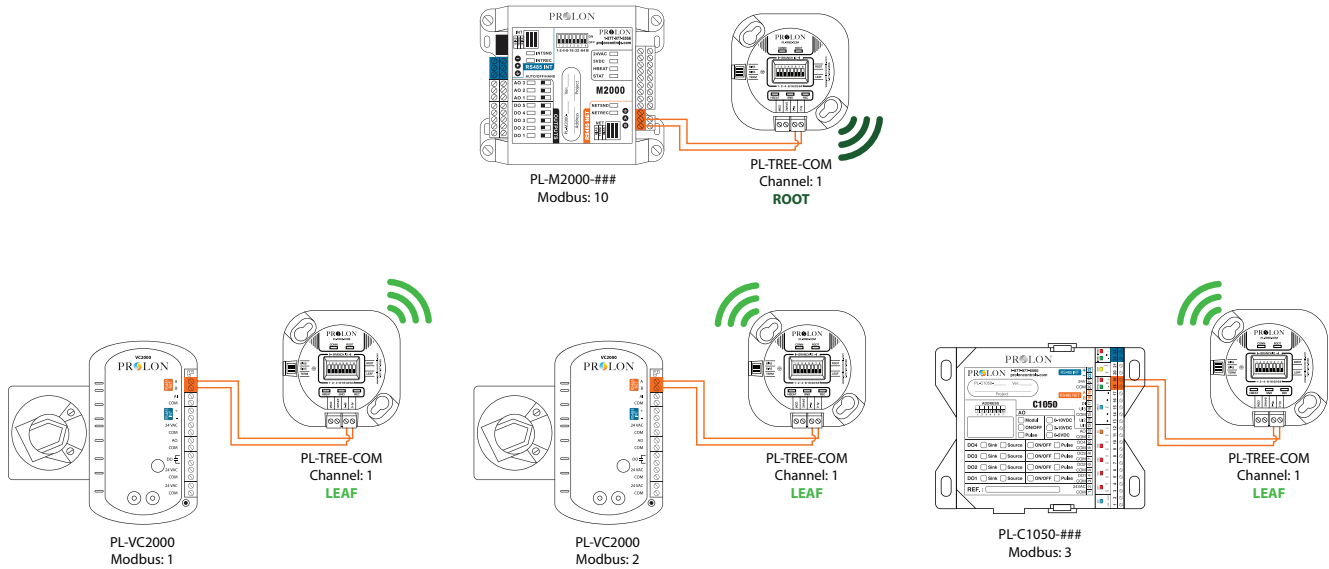


Figure 10

PL-TREE-COM Installation Scenarios

Master Controller with multiple Follower Controllers (wired/wireless - hybrid network)

Example 1

It is possible to create hybrid networks, where wireless communication supports and complements wired daisy-chains. In this situation, a PL-TREE-COM will be added to the daisy-chain to gap the link between the Master and all its Followers. (Figure 11)

1. The PL-TREE-COM on the M2000 Master's side must be connected in the NET port and be set as the "ROOT".
2. The Followers Network PL-TREE-COM can be inserted anywhere within their own wired daisy-chain. This device must be set as the "LEAF".
3. Both TREE-COM modules must have their dipswitches set for the same channel number.

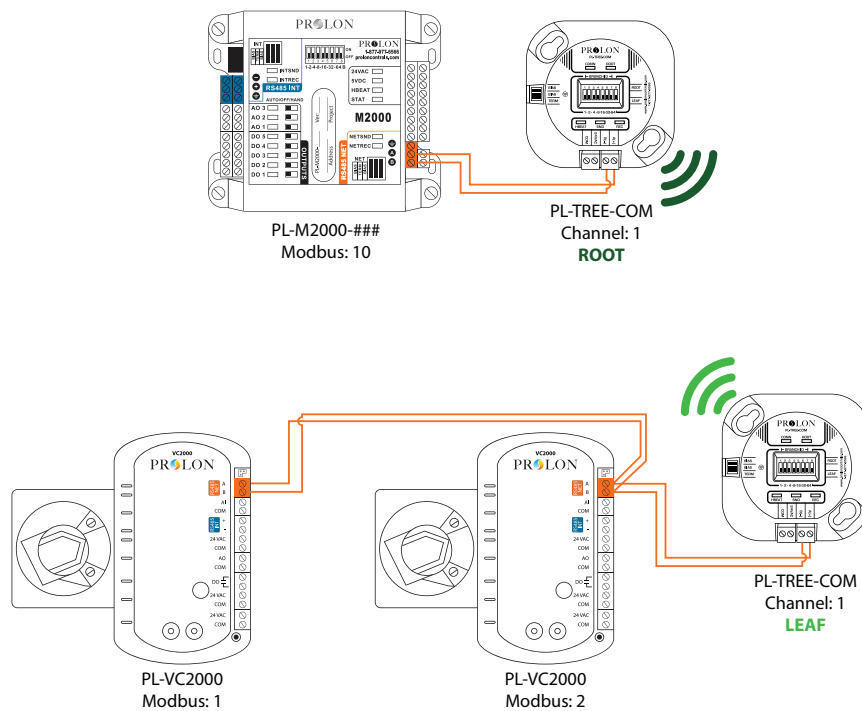


Figure 11

Example 2

A wired communication network can be spliced and re-united using TREE-COM modules, regardless of their location within a ProLon network. (Figure 12)

1. The TREE-COM that is hardwired to the Modbus Master (PL-M2000-RTU) must be set in "ROOT" mode
2. The TREE-COM hardwired to the Follower controllers must be set to "LEAF" mode.
3. TREE-COM modules must have their dipswitches set for the same channel number.
4. The TREE-COM modules will act like a virtual segment of wire.

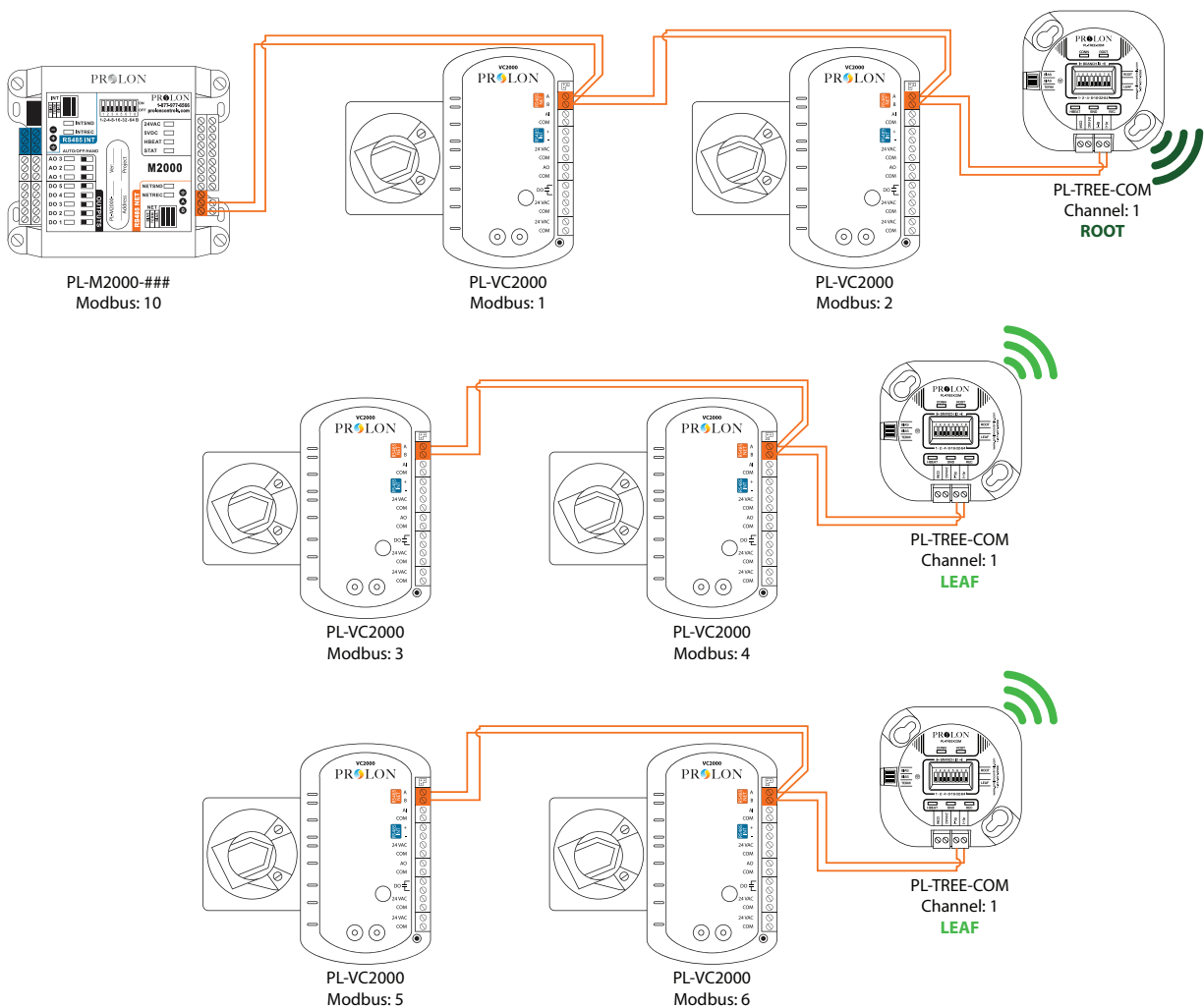


Figure 12

PL-TREE-COM Installation Scenarios

PL-NC2000 connected to a group of Master (PL-M2000 or PL-C1050)

The communication network between any Master Controller and the PL-NC2000 can be connected wirelessly using the PL-TREE-COM. (Figure 13)

1. The PL-TREE-COM connected to the PL-NC2000 via the RS-485 OUT port must be set as the "ROOT".
2. The PL-TREE-COM connected to individual PL-M2000, or PL-C1050 via the INT communication port must be set as the "LEAF".
3. All PL-TREE-COM modules must have their dipswitches set for the same channel number.

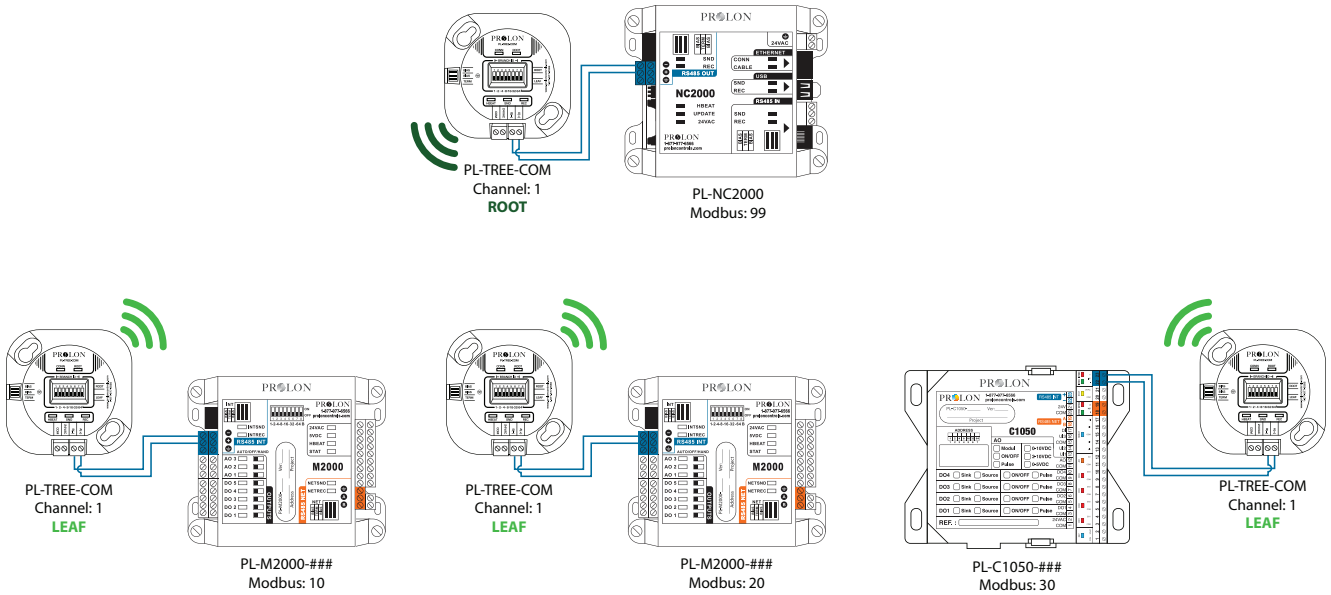


Figure 13

Measuring Signal Quality with NFC

1. The incoming signal quality from a "ROOT" must be measured at a "LEAF" device, using the Prolon Focus app on a mobile device with NFC capabilities.
2. A measurement only becomes possible on a "LEAF" device, once it has established a connection with its "ROOT" module.
3. Measuring a "ROOT" module using NFC will not yield signal quality, but rather number of associated "LEAF" modules it is able to communicate with.
4. To use this feature, the NFC function must first be enabled on the mobile device.
5. The NFC reading may take a few seconds to display.

NOTE: We recommend that you remove any casing from your mobile device if you are experiencing trouble connecting.

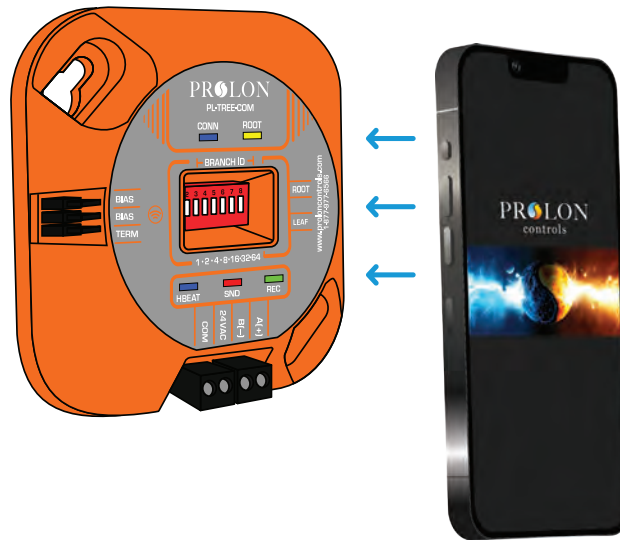
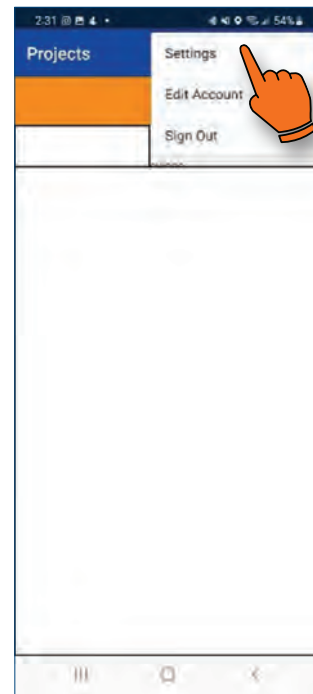


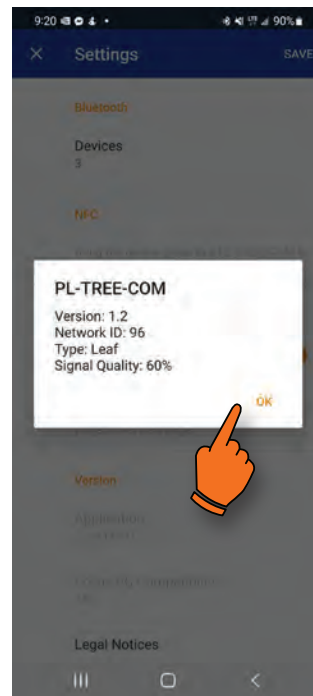
Figure 14

Android



1. To access NFC, tap on the vertical ellipsis icon at the top right of the screen.

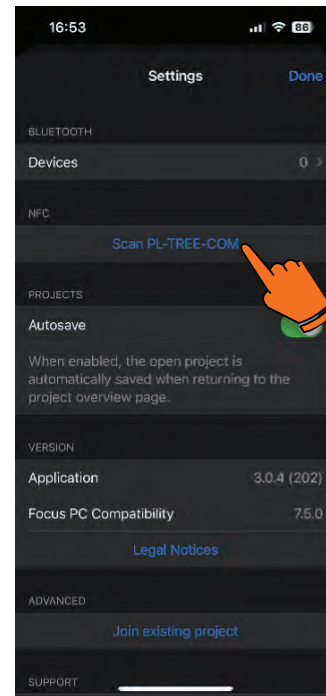
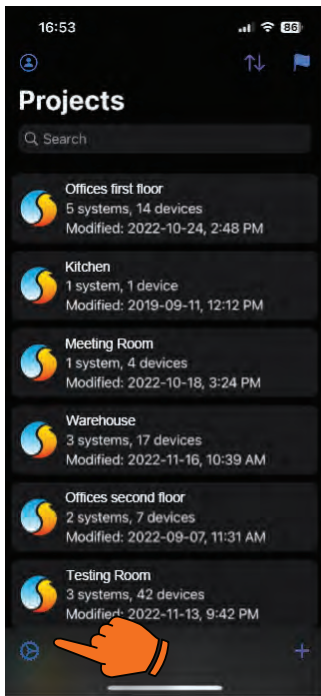
2. Tap on "Settings".



3. Approach and hold the back of the mobile device very near the powered up TREE-COM module.

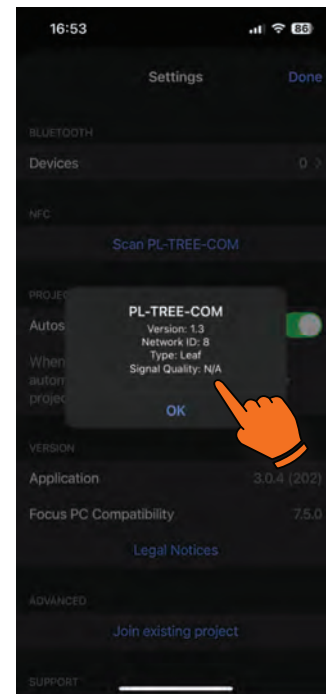
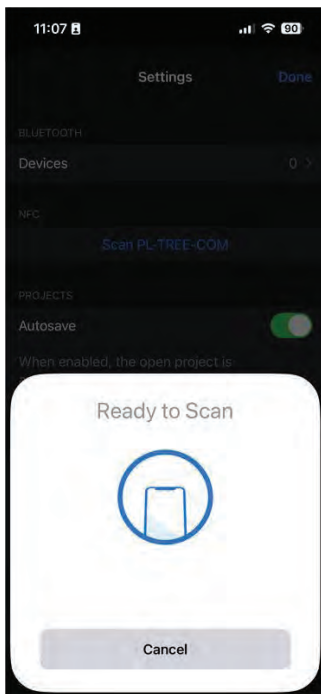
4. Once detected, a popup will show you the information about the TREE-COM found. Tap OK to go back to the settings.

Once on the settings page, hold your phone (back of the phone) close to the face of a powered-up PL-TREE-COM device.



1. To scan the TREE-COM, tap on the settings icon in the left bottom corner.

2. Tap on "Scan PL-TREE-COM".



3. When ready to detect, approach and hold the back of the mobile device very near the powered up TREE-COM module.

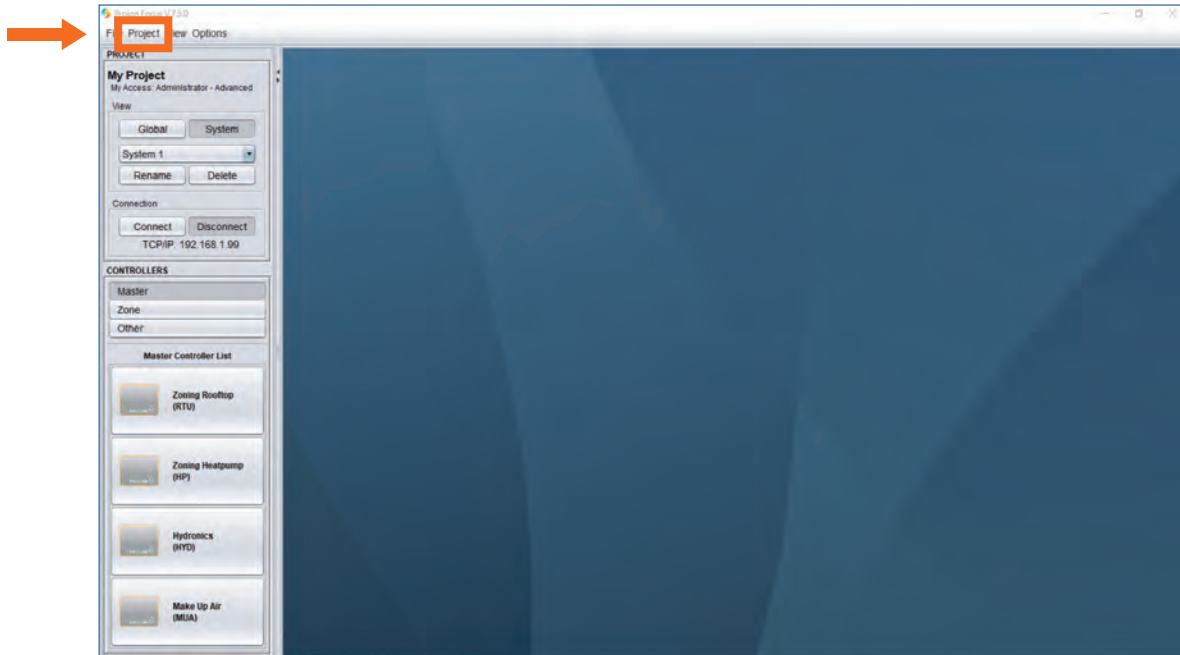
4. Once detected, a popup will show you the information about the TREE-COM found. Tap OK to go back to the settings.

NOTE: We recommend that you remove any casing from your mobile device should you experience trouble connecting.

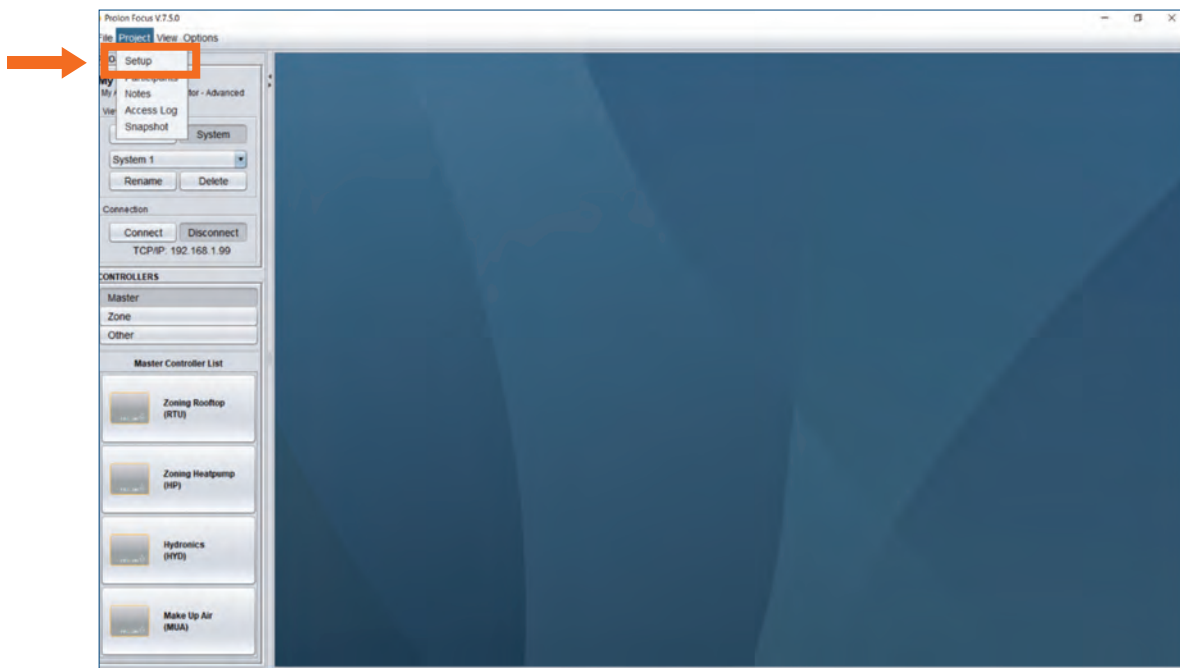
Low Signal Quality Best Practices (Focus PC only)

A signal quality of 30% to 60% is considered low quality. To communicate successfully with signals in this range, it is best to increase the number of retries in Focus (PC) to 10 or 20 attempts, so to reduce the likelihood of failure. Here is the procedure:

1. Click on “Project” on the top left of your Focus screen.



2. Click on “Setup”.



3. Click on "Connection".

The screenshot shows the 'Project Setup' dialog box with the 'Connection' tab selected. The 'Connection' tab is highlighted with an orange box, and an orange arrow points to it from the right. The dialog box contains the following fields:

- Project Name: My Project
- Address:
- City:
- Country: Canada
- Province/State: Quebec
- Company:

Buttons for 'Save' and 'Cancel' are at the bottom.

4. Enter the desired Retry number.

The screenshot shows the 'Project Setup' dialog box with the 'Connection' tab selected. The 'Communication Settings' section is visible, and the 'Retries' field is highlighted with an orange box, with an orange arrow pointing to it from the right. The 'Retries' field contains the value '10'. Other settings include:

- Type: TCP/IP
- Internal IP: 192.168.1.99
- External IP:
- Data Refresh Rate: 3 sec
- Timeout: 1500 msec
- Poll Delay: 50 msec

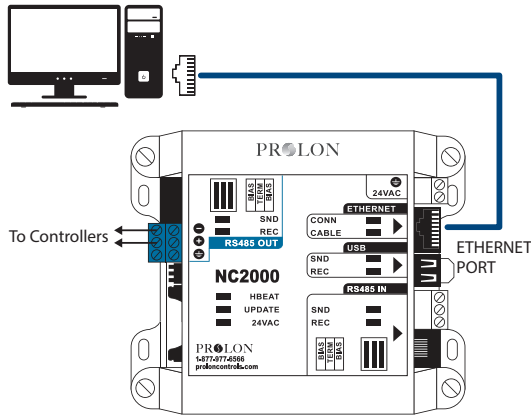
Buttons for 'Save' and 'Cancel' are at the bottom.

Section 7

Connection Using Laptop

How to Connect a Computer to Prolon Controllers

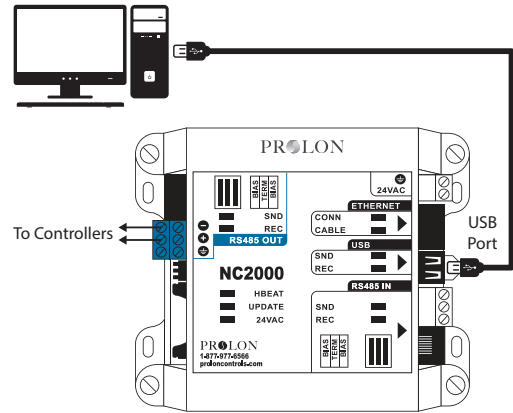
IP Connection



PL-NC2000 (Network Controller)

Use this method to connect to a PL-NC2000 over an IP Connection. **NOTE:** The computer and the PL-NC2000 must be on the same subnet to communicate. Use a CAT5e cable.

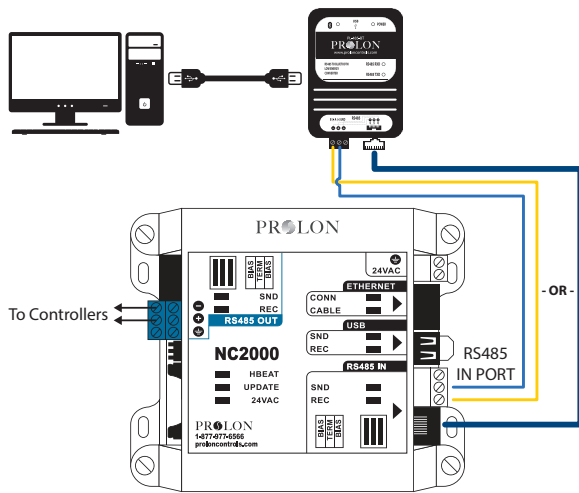
USB Connection



PL-NC2000 (Network Controller)

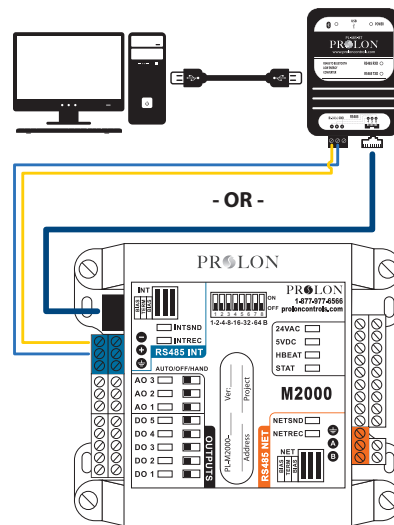
Use this method to connect to a PL-NC2000 with a USB cable. **NOTE:** Use a Type-A to Type-A USB Cable. (Available only for Windows based computers)

PL-485-BT Connection*



PL-NC2000 (Network Controller)

Use this method to connect to a PL-NC2000 using the PL-485-BT converter. **NOTE:** USB Cable (Type A to Type B) and CAT5e cable are provided with PL-485-BT converter.



PL-M2000-XXX (Unit Controller)

Use this method to connect to a PL-M2000-XXX using the PL-485-BT converter. **NOTE:** USB Cable (Type A to Type B) and CAT5e cable are provided with PL-485-BT converter.

* The PL-485-BT converter can be used to connect a PC/Mobile device to ANY Prolon controller. This example only shows connections to PL-M2000-XXX and PL-NC2000.

Section 8

Navigating Using Laptop & Prolon Focus

Prolon Focus - Computer Access and Controller

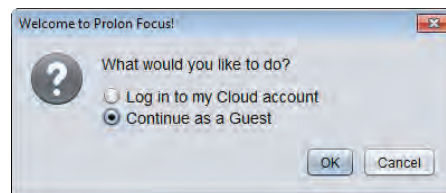
For more detailed information, please consult the Prolon User Guide document, and/or any Focus Guide relevant to the controller(s) you are working with.

Computer and software

- To avoid problems and delays, make sure to follow these guidelines.
- Use a laptop computer (with Windows 7 or later OS) equipped with the most recent version of **Prolon Focus**. Visit our website (www.proloncontrols.com) to download the latest version.
- If you are using a Prolon RS485 communication interface (PL-485-USB, PL-485-BT) for the first time, you must install the driver software that comes with it. This driver is included in the Focus software download package.
- Once installed, you must validate the communication port (COM) number your computer assigned to that interface.
- To find out, research and click on the “**Device Manager**” section of your computer. Click on “**Ports COM & LPT**”. The COM port identified as: “**USB Serial Port COMx**” or “**RS485 Isolated Port COMx**” or Silicon Labs CP210x USB to UART bridge (COMx), will be the one to use.

Opening a session on Prolon Focus

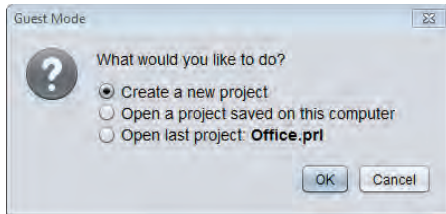
- First, connect the RS485 communication interface to your computer’s USB outlet. On the PL-485-BT interface there is a power switch, turn it on.
- Connect either the CAT5e socket with a RJ45 male cable **-or-** screw type terminal block outlet of the interface to the matching port connection of the Prolon controller you wish to communicate with: (see section #7 for connection details)
 - > On the NC-2000, it is the **RS485 IN** on the lower right (RJ45 socket or screw terminal block)
 - > On the M2000, it is the **RS485 INT** on the upper left (any of the twin RJ45 sockets or terminal blocks)
 - > On all other controllers, it will typically be the **RS485 INT**, unless it is already connected to another device, such as a wall sensor, in which case it would be the **RS485 NET**.
- Launch the Focus software by double-clicking on the Prolon icon located on your computer’s desktop.
- Upon opening the software, the following window will appear:
 - > Log in my Cloud account
 - > Continue as a Guest
- Select: “Continue as a guest”. *



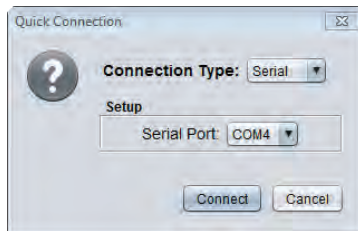
**Guest mode will be used for the purpose of this guide. For Cloud account information, please refer to the Prolon Focus User Guide.*

Guest Mode

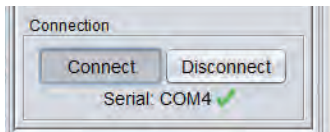
- Upon selecting Guest mode, the following window will appear:
 - > Create a new project.
 - > Open a project saved on this computer.
 - > Open last project.
- Select: “**Create a new project**”.



- Upon selecting a new project, Focus will ask the user how to connect to the system:
 - > Serial connection: choose this option to connect to a NC-2000 using a USB cable, or any Proton controller using a USB-to-RS485 interface.
 - > IP connection: choose this option to connect to a NC-2000 over the Ethernet port using a static IP address.
 - > Modem connection: choose this option to connect to any controller using a dial-up modem.
 - > Cloud connection: choose this option to connect to a NC-2000 via Cloud communication (not available in Guest mode)
- Select: “**Serial**” connection type.



- Select amongst the list of communication port numbers available the one matching the interface you previously retrieved.
- A message will appear in the left task bar under the “**connection**” section to confirm the port is opened, showing a green check mark.

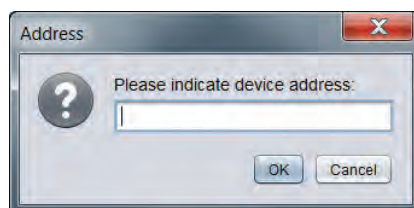


Setting up a new zoning system (manually)

- From the “**Controller**” section on the left task bar, choose the proper control type category (Master, Zone or Other).
- Drag -and- drop, -or- double click the desired controller icon (eg: “**Rooftop**” for a C1050 RTU or M2000 RTU air conditioning controller).



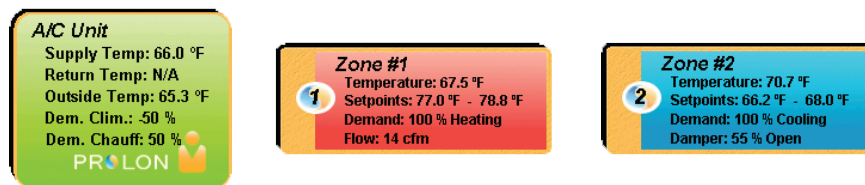
- Enter the communication address (as determined on the controller by the addressing dipswitch positions).



- A bright colored icon (green, red, or blue) will appear at the top of the screen, symbolizing the unit.
- If the controller created is a “**Master**”, such as the RTU, move the mouse’s cursor and point the icon, right-click on the mouse to browse the command menu.
- Click on “**Get List**”, the unit controller will scan its’ network and update the list of zones under its authority, and the zone icons will begin to appear on screen.



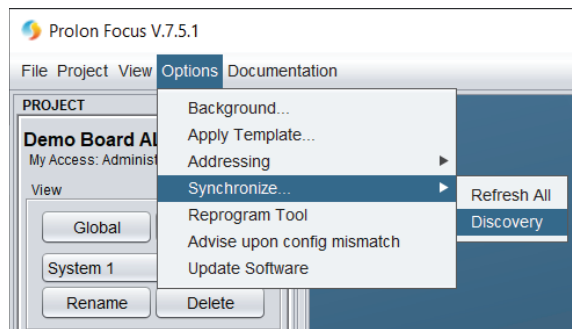
- Validate the list of zones, checking all addresses and making sure they have all shown up, according to the project’s intended design. If some expected icons are missing, ensure that the controls are supplied with 24VAC. Check the connection to the power supply and to the network (those connections are polarity sensitive) and last, check on the controller card the status of the following blinking LED’s: hbeat, netrec and netsnd.
- Confirm that all the zones appear in one of the following three colors according to their request: green= satisfied, red=heating, blue=cooling.



- Should an icon appear in grey, communication is lost to that zone.

Creating multiple systems (Auto Discovery)

- If connecting to a NC-2000 Network Controller instead, Focus offers an alternate method of finding and creating multiple controllers (and systems) on screen.
- From the top of the Focus screen simply click on: “**Options**”, then “**Synchronize**” and “**Discovery**”. Clicking OK will allow Focus to scan the entire network for controllers and pull in any device answering the call.



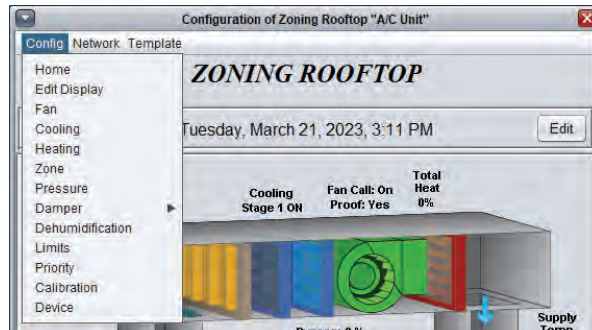
Configuring the controllers

- Each controller on a project may need to be configured with settings different than those provided by the factory default values. It is the user’s sole responsibility to make sure all controllers are indeed configured per the required application and control sequence. (For more details, please refer to each controller’s Focus Guide.)

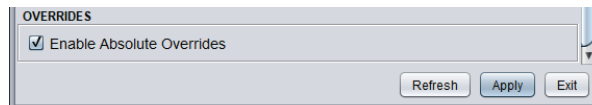
Testing the System

Absolute override authorization

- Back to the RTU unit controller, double-click the icon and select the “**Config**” menu on the top left corner. Then select “**Edit display**” from the menu.

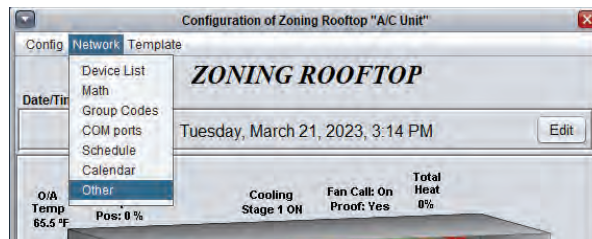


- At the bottom of this page check the “**Enable Absolute Overrides**” and click “**OK**” to confirm your acceptance.
- Then click “**Apply**”.



Adjusting the bypass damper

- Click on the “**Home**” button in the upper right to return to the unit controller's home page, click on “**Network**” then “**Other**” at the bottom of the list.

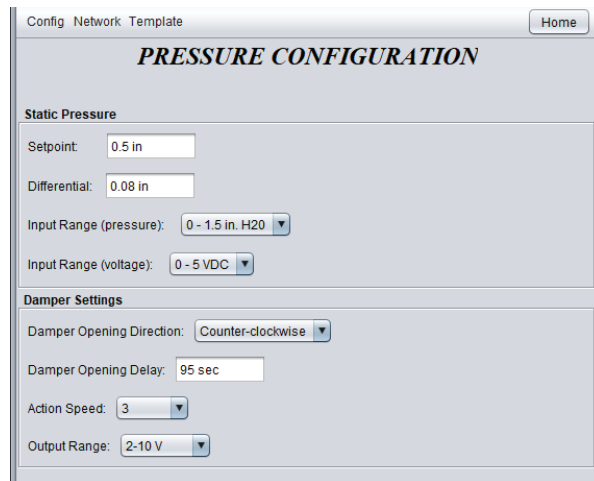


- Check the “**Zone Damper Override**”, enter 100% and click “**Apply**”.



- Wait for all the zone dampers to display 100% open on the screen. If this has not been checked before, physically confirm that the dampers are open. If necessary, inverse the zone(s) damper's opening direction (see instructions below).
- Return to the home page and make sure the bypass damper is fully closed (0%). Validate physically.
- Read the static pressure value on the home screen and then adjust the set point by increasing it by 20% of the reading. To do so, click on “**Config**” then “**Pressure**” to access the pressure management menu for the bypass damper. Adjust the set point according to your calculations and adjust the differential to 20% of the set point value.

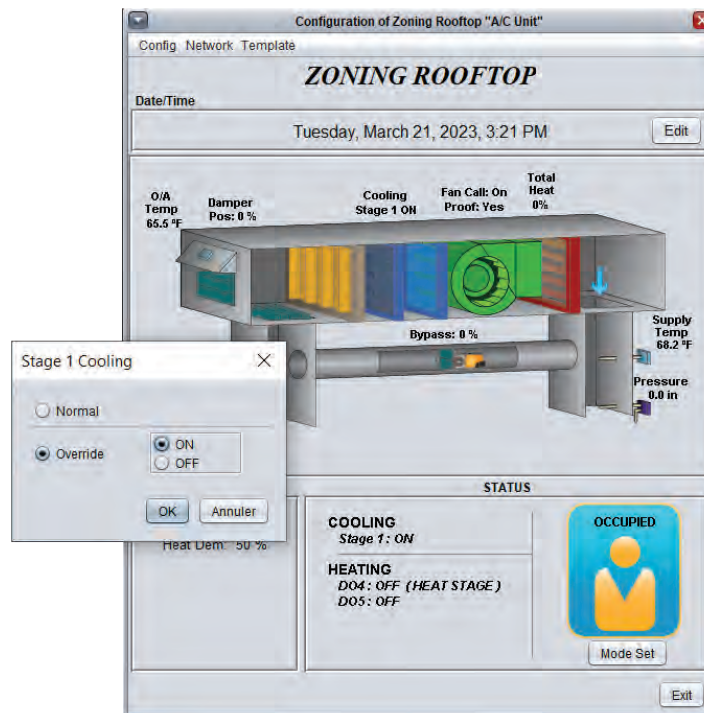
- Eg: pressure read: 0.20", adjust set point to (pressure read + 20%) = 0.24", 0.05" = differential.



- Return to the “**Zone Damper Override**” and enter 25%, click “**Apply**”.
- Check the bypass damper opening on the home page as well as physically according to the increase in pressure. Inverse the opening direction of the bypass damper if need be.
- Return to the home page, click “**Network**” and then “**Other**”. Remove the “**Zone Damper Override**”, press “**Apply**”.

Cooling and heating operations

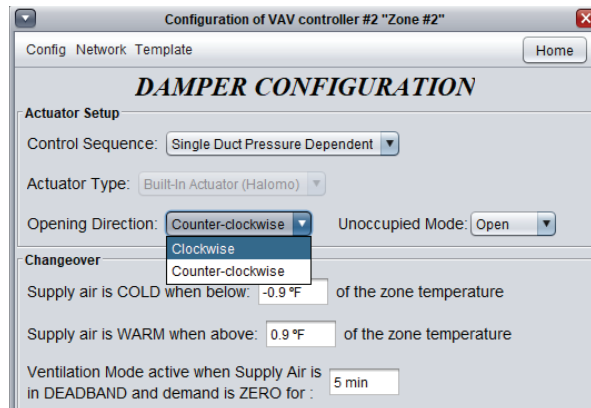
- From the home page of the unit controller, point and right-click each item to be checked to activate the override mode. You can check the economizer’s damper(s) (if applicable), the cooling stage(s), the heating stage(s) and/or the modulating heating output from the unit. Physically check the proper functioning of each of these elements.



- Return to the “**Edit Display**” menu and remove the absolute overrides and click “**Apply**”.

Inverting a zone damper's opening direction

- To invert the damper's opening direction, double-click the zone controller icon to open its menu, then double-click directly on the zone damper shown on the screen. You then access the page: **"Damper Configuration"**.



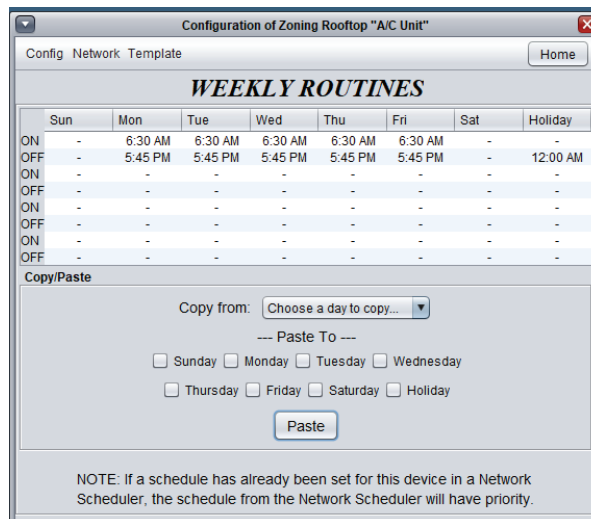
- At the bottom of this page, **"Damper Setup"**, choose the correct opening direction (clockwise or counterclockwise) and then click **"Apply"**. Physically confirm.

Date and time

- From the unit controller's home screen, check that the date and time are correct. To modify them, click on **"Edit"** and then click **"Copy"** to copy the computer's date and time, or manually type the change then click **"OK"**.

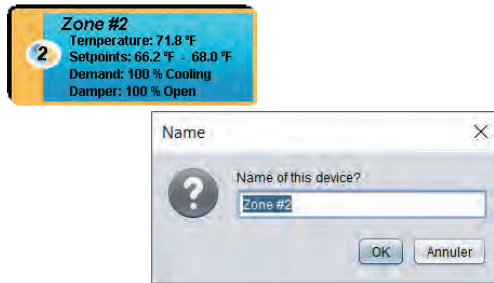
Schedule

- Also from the unit's home screen, click **"Network"** and then **"Schedule"** to access the schedule configuration page.
- Double-click the **"ON"** line in the **"Monday"** column. While the cursor flashes in the middle of this period, type the start **"Occupied"** period. Eg: 6 to start the 'occupied' period at 6:00am or 630 for 6:30am.
- Double-click the **"OFF"** line in the **"Monday"** column. While the cursor flashes in the middle of this period, enter the time to end the **"Occupied"** period. Eg 16 for 16:00 (4:00pm) or 1745 for 17:45 (5:45pm).
- To copy a schedule, click the day to copy on the **"Copy from"** dropdown list and then check the other days which will have the same schedule in the **"Paste to"** list. Click **"Paste"** and then click **"Apply"**.



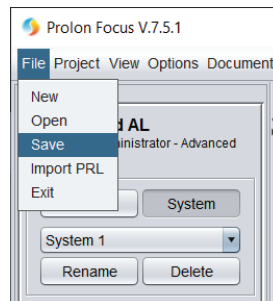
Rename zones and units

- From the basic system screen, right-click a zone or unit controller's icon, select "**Rename**" and type the zone or unit's name and click "**OK**".



Save

- Click on "**File**" in the upper left corner. Choose "**Save**" or "**Save As...**" to save the configuration file (.prl file).



Exit

- Click on "**File**" in the upper left corner, choose "**Exit**" or click on the X in the upper right corner to close Focus.

Advanced Configurations

- Focus provides many other settings to optimize the operation of your systems. However this guide is a quick start guide, we invite you to consult the complete documentation online www.prononcontrols.com.

Section 9

Setting Up a Zoning System (Focus Software)

Setting up a Zoning System with Prolon

The Prolon Control System can be configured for 2 kinds of HVAC zoning system principles, which are commonly known as “VAV” systems and “Changeover Bypass” systems.

The following principles are general descriptions of HVAC zoning applications. Although common, these principles must not be interpreted as absolute guidelines when doing system design. Each HVAC installation is different and unique, and there are endless variations based on these principles.

VAV System Principle

VAV systems (Variable Air Volume) typically have a central A/C unit (rooftop, split system, heat pump, etc.) providing conditioned air to a number of zones through a network of ventilation ducts. Each zone is independent and equipped with a damper that opens or closes to satisfy space temperature demand. These systems generally supply cooling only to the zones at all times when the building is occupied. The target discharge temperature for the cool air supplied by the A/C unit is either fixed or reset by another variable, such as outdoor or return air temperature. With a VAV system, as a zone calls for cooling, its damper opens to let cool air enter the space. It eventually closes as the zone becomes satisfied. If the call is for heating, the damper remains closed since it is designed to strictly provide cooling. In this instance, the VAV Controller sequence is considered to be “Cooling Only”. Should heating be required in the space, the zone must be equipped with a terminal duct heater, used to reheat the incoming air into the zone. When such a zone calls for heating, the damper opens to an intermediate position, giving proper air flow to the duct heater so it can reheat the incoming cool air from the central A/C unit and provide warm/hot air to the space. In this instance, the VAV Controller is considered to be “Cooling Only with Reheat”. VAV systems are very common in applications where cooling loads are prevalent year round.

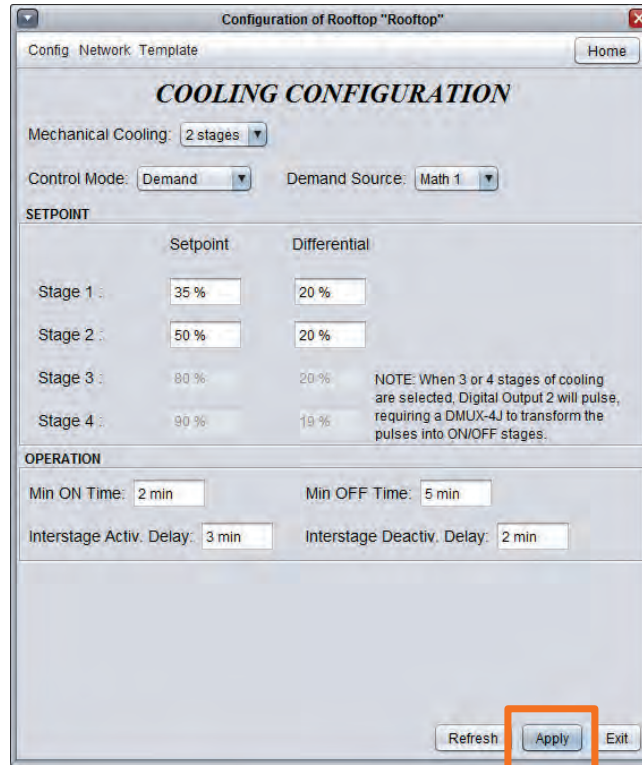
Changeover Bypass System Principle *(also known as “VVT”, or Variable Volume and Temperature)*

Changeover Bypass systems (or “VVT”) are very similar to VAV systems as they too have a central A/C unit providing conditioned air to zones equipped with dampers. They differ however by using A/C units that provide either cooling or heating to the zones. Since the A/C unit changes its supply over from heating to cooling and vice-versa to satisfy various heating and cooling demands, its supply temperature is always variable. Each zone calculates its own demand and factors in a voting weight which will determine how much of an influence it will have on the system (if every zone has the same voting weight, every zone has equal influence). The A/C Unit Controller receives and analyzes these demands, and will then decide to provide heating or cooling based on a user-defined strategy (highest heat/cool call, weighted average, etc.). This is known as a demand-based system. Additionally, the zones have a changeover logic of their own; each Zone Controller “knows” whether the supply air temperature fed is cool or hot, and therefore will only modulate its damper to open if the supply air available matches its own demand. Each zone may also be equipped with a duct heater for additional heating capabilities. “VVT” systems are common in applications where heating and cooling loads change year round.

1 - Creating a Changeover Bypass System ("VT")

1.1 - Applying a Configuration Change

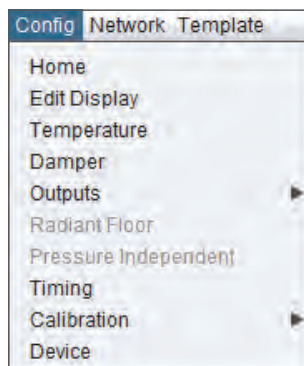
When making changes to a controller, do not forget to press the "Apply" button (located on the bottom right of every configuration menu) to upload the changes to the controller. If the "Apply" button is not pressed, the change will not be uploaded to the controller.



1.2 - Configuring a Zone Demand and Voting Weight (Zone Controller menu)

1.2.1 - Zone Demand

- Open a Zone Controller by double-clicking on its icon.
- On the top left of the screen, select "Config" and then "Temperature".



- In the “Temperature” menu, the “Proportional”, “Cooling Integral” and “Heating Integral” values will determine how quickly a zone’s demand will increase or decrease depending on the space temperature and the cooling and heating setpoints. (See Annex A for details).

PI controller

Proportional :

Cooling Integral : Heating Integral :

Setpoints

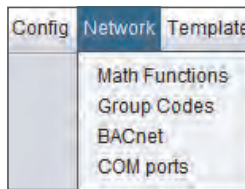
Default Heating Setpoint: Min Deadband:

Best Practices:

It is recommended to set the Cooling Integral and Heating Integral to 30min each. It is not recommended to set the integrals to less than 10 min as this may cause severe zone temperature swings.

1.2.2 - Zone Voting Weight

- On the top left of the screen, select “Network” and then “Group Codes”.



- In the “Group Codes” menu, select the zone’s weight in the “Global Group” (defaulted at 1). If the user desires a zone to have a greater influence on the system, increase the weight. If the user desires a zone to NOT have any influence on the system, configure the weight to zero.

Configuration of VAV controller #1 "Zone"

Config Network Template Home

GROUP CODES

Group #	Weight
First Group	
<input type="text" value="0"/>	<input type="text" value="0"/>
Second Group	
<input type="text" value="0"/>	<input type="text" value="0"/>
Third Group	
<input type="text" value="0"/>	<input type="text" value="0"/>
Global Group	
Global	<input type="text" value="1"/>

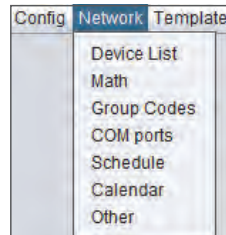
Refresh Apply Exit

Best Practices:

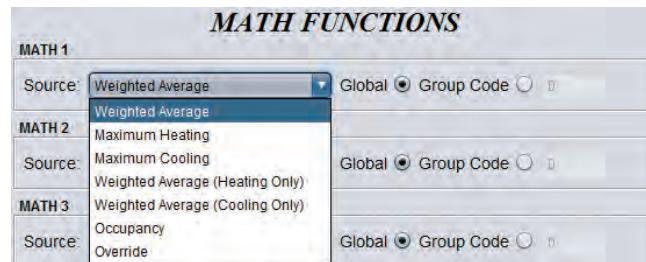
On most systems, it is best to leave the individual zone weight at its default (1). Should you need to increase a zone's specific weight, set it to 2 or 3. Above that, the influence from any given zone becomes too great and may create a system imbalance.

1.3 - Configuring a Math Function (Unit Controller Menu)

- Open a Unit Controller (Zoning Rooftop or Zoning Heat Pump Controller) by double-clicking on its icon.
- On the top left of the screen, select “Network” and then “Math”.



- Select the Math Functions as follows:
 - > Math 1 -> Weighted Average (Cooling only)*
 - > Math 2 -> Weighted Average (Heating only)**



* *Weighted Average (Cooling only): this is calculated by multiplying the demand of each follower with a COOLING DEMAND by its respective weight and adding them together. The result is then divided by the total weight of zones in the system. This provides a math function whose final result is more influenced by the zones with greater weight. (See Annex B)*

** *Weighted Average (Heating only): this is calculated by multiplying the demand of each follower with a HEATING DEMAND by its respective weight and adding them together. The result is then divided by the total weight of zones in the system. This provides a math function whose final result is more influenced by the zones with greater weight. (See Annex B)*

Best Practices:

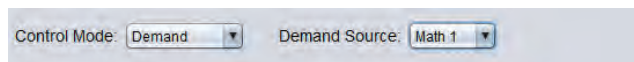
- If you are setting up a system with few zones (i.e. 2 or 3 zones), in most cases it may be more appropriate to set the Math 1 to “Maximum Cooling” and Math 2 to “Maximum Heating”, so the unit will respond to the zone with the highest cooling or heating demand.
- If you are setting up a system with more than a few zones (i.e. 4 zones or more), it is best to select the “Weighted Average (Cooling Only)” and “Weighted Average (Heating Only)” functions, as seen above.
- Keep the Math function toggle to “Global”. It is not recommended to use “Group Code” (used for more advanced and specific applications, not seen in this guide).

1.4 - Assign Math Functions to Cooling and Heating Outputs (Unit Controller Menu)

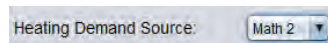
- On the top left of the screen, select “Config” and then “Cooling”.



- In the “Cooling” menu, set the “Cooling Demand Source” to “Math 1”.



- In the “Heating” menu, set the “Heating Demand Source” to “Math 2”.



With this configuration, the Cooling in the Unit Controller will be activated based on the values coming from the Math 1 function, which is a weighted average of all cooling demands from all the followers. The Heating in the Unit Controller will be activated based on the values coming from the Math 2 function, which is a weighted average of all heating demands from all the followers. (SEE SECTION 3.2).

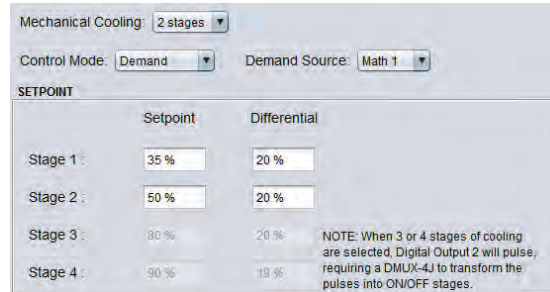
1.5 - Configuring the Cooling

- On the top left of the screen, select “Config” and then “Cooling”.



1.5.1 - Unit with Cooling Stages (On-Off)

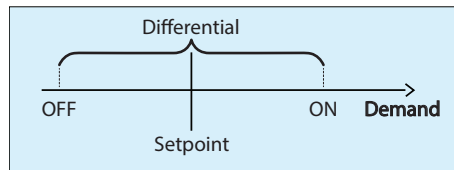
- Set the Control Mode to “Demand”.
- Select how many cooling stages in the “Mechanical Cooling” dropdown list (up to 4x stages).



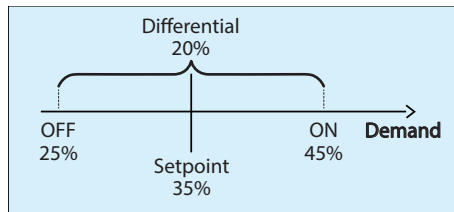
	Setpoint	Differential
Stage 1 :	35 %	20 %
Stage 2 :	50 %	20 %
Stage 3 :	80 %	20 %
Stage 4 :	90 %	13 %

NOTE: When 3 or 4 stages of cooling are selected, Digital Output 2 will pulse, requiring a DMUX-4J to transform the pulses into ON/OFF stages.

- The setpoint and differential values determine when the cooling stage turns on, and when it turns off. The differential is centered on the setpoint.



- Looking at Stage 1, with a setpoint of 35% and a differential of 20%.



- Stage 1 will be activated once the demand (source: Math 1) reaches the following point:

$$\begin{aligned} \text{Stage 1 On} &= \text{Setpoint} + 1/2 (\text{Differential}) \\ \text{Stage 1 On} &= 35\% + 1/2 (20\%) = 45\% \end{aligned}$$

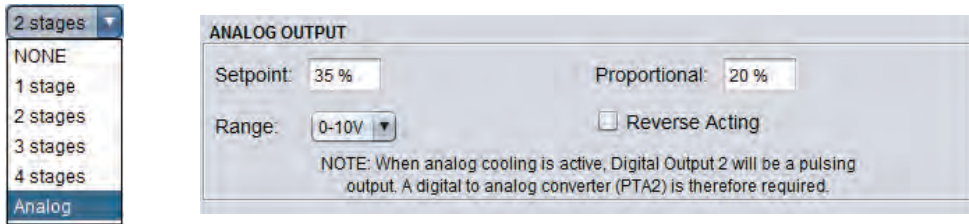
- When Stage 1 is activated, the unit will supply cool air to the zones.
- All VAV zones with a cooling demand will open their dampers. All zones with a heating demand will close their dampers to their minimal positions (unless duct heater reheat has been enabled).
- As the zones receive cool air, their individual cooling demands will decrease, thus directly affecting Math 1. As a result, Math 1 will decrease.
- Stage 1 will be deactivated once the demand (source: Math 1) reaches the following point:

$$\begin{aligned} \text{Stage 1 Off} &= \text{Setpoint} - 1/2 (\text{Differential}) \\ \text{Stage 1 Off} &= 35\% - 1/2 (20\%) = 25\% \end{aligned}$$

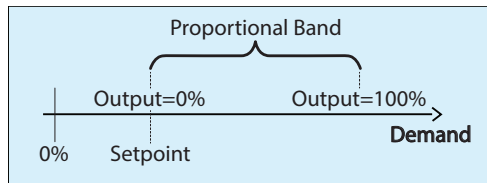
- Configure additional cooling stages as needed using the same guidelines.

1.5.2 - Unit with Analog Cooling (Modulating)

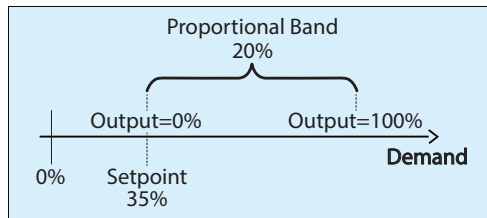
- Select "Analog" in the "Mechanical Cooling" dropdown list.



- The setpoint value indicates when the cooling is activated, and the proportional value is the 0-100% output range.



- Looking at the modulating cooling, with a setpoint of 35% and a proportional band of 20%.



- The Analog Output will begin to increase its voltage when the demand (source: Math 1) reaches 35%. As the cooling demand increases, the voltage output will increase proportionally. Once the cooling demand reaches 55% (setpoint + proportional band), the output will be 100%.
- Look at the following example for a 50% cooling demand:

$$\text{Setpoint} = 35\% \quad \text{Demand} = 50\%$$

$$\text{Voltage output} = \frac{\text{Demand} - \text{Setpoint}}{\text{Proportional Band}} \times 10\text{Vdc} = \frac{50 - 35}{20} \times 10\text{Vdc} = 7.5\text{Vdc}$$

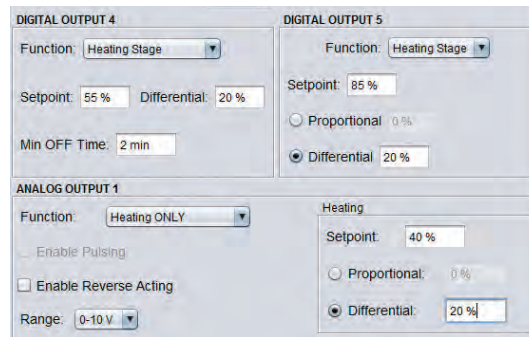
1.6 - Configuring the Heating

- On the top left of the screen, select "Config" and then "Heating".

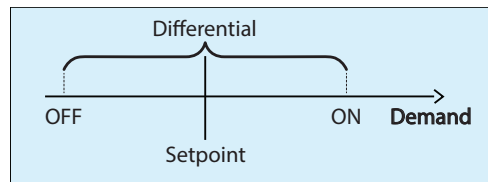


1.6.1 - Unit with Heating Stages (On-Off)

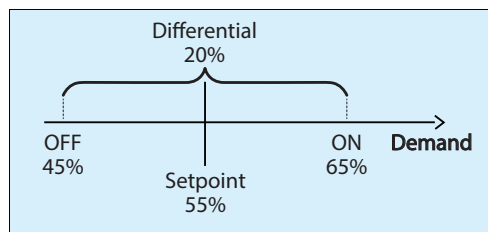
- Choose which available outputs will be used for the heating stages (Digital Output 4, Digital Output 5 and/or Analog Output 1). Each output has a dropdown menu. If a specific output is not being used, set it to “OFF” in the output’s respective dropdown list.



- If using Analog Output 1 to control an on-off heating stage, be sure to select “Differential”. (“Proportional” is used for a modulating output, details in Section 3.5.2)
- The setpoint and differential values determine when the heating stage turns on, and when it turns off. The differential is centered on the setpoint.



- Looking at Stage 1, with a setpoint of 55% and a differential of 20%.



- Stage 1 will be activated once the demand (source: Math 2) reaches the following point:

$$\begin{aligned} \text{Stage 1 On} &= \text{Setpoint} + 1/2 (\text{Differential}) \\ \text{Stage 1 On} &= 55\% + 1/2 (20\%) = 65\% \end{aligned}$$

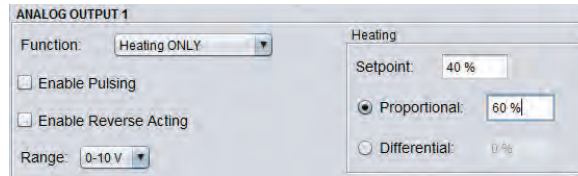
- When Stage 1 is activated, the unit will supply warm/hot air to the zones.
- All VAV zones with a heating demand will open their dampers. All zones with a cooling demand will close their dampers to their minimal positions.
- As the zones receive warm/hot air, their individual heating demands will decrease, thus directly affecting Math 2. As a result, Math 2 will decrease.
- Stage 1 will be deactivated once the demand (source: Math 2) reaches the following point:

$$\begin{aligned} \text{Stage 1 Off} &= \text{Setpoint} - 1/2 (\text{Differential}) \\ \text{Stage 1 Off} &= 55\% - 1/2 (20\%) = 45\% \end{aligned}$$

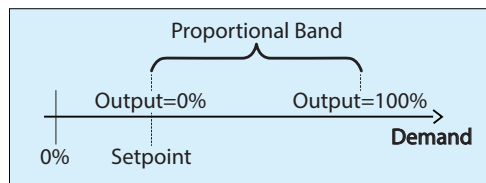
- Configure additional heating stages as needed using the same guidelines.

1.6.2 - Unit with Analog Heating (Modulating)

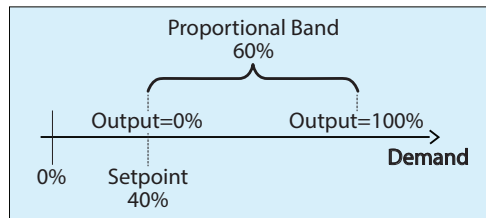
- Disable Digital Output 4 and Digital Output 5 by setting them to “OFF” in their respective dropdown list.
- Select “Heating” in Analog Output 1.
- Select “Proportional”.



- The setpoint value indicates when the heating is activated, and the proportional value is the 0-100% output range.



- Looking at the modulating heat, with a setpoint of 40% and a proportional band of 60%.



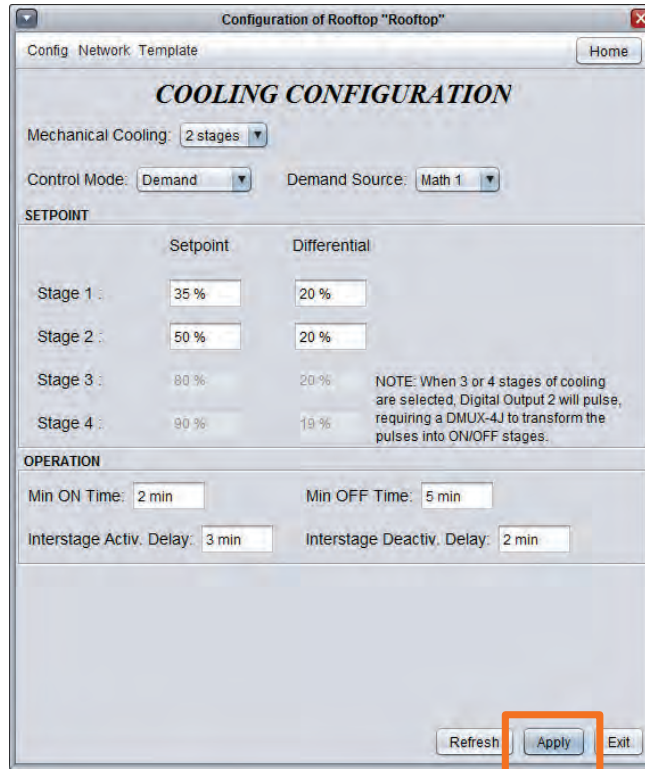
- The Analog Output 1 will begin to increase its voltage when the demand (source: Math 2) reaches 40%. As the heating demand increases, the voltage output will increase proportionally. Once the demand reaches 100%, the output will be 100%.
- Look at the following example for a 80% heating demand:

$$\text{Voltage output} = \frac{\text{Demand} - \text{Setpoint}}{\text{Proportional Band}} \times 10\text{Vdc} = \frac{80 - 40}{60} \times 10\text{Vdc} = 6.67 \text{Vdc}$$

2 - Creating a VAV System (Variable Air Volume)

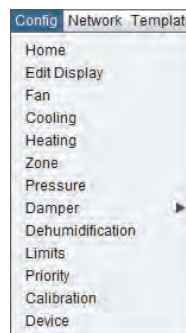
2.1 - Applying a Configuration Change

When making changes to a controller, do not forget to press the « Apply » button (located on the bottom right of every configuration page) to upload the changes to the controller. If the "Apply" button is not pressed, the change will not be uploaded to the controller.

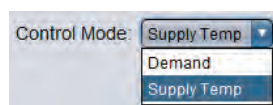


2.2 - Configuring the Cooling Stages

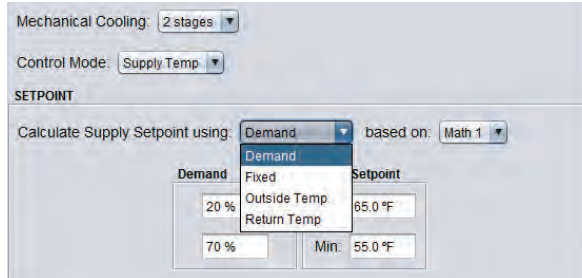
- On the top left of the screen, select "Config" and then "Cooling".



- Set the Control Mode to "Supply Temp".

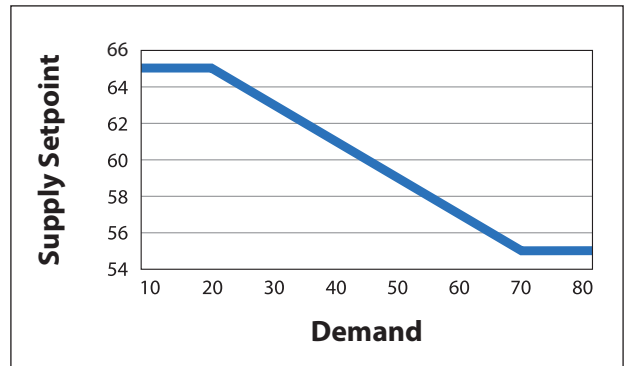
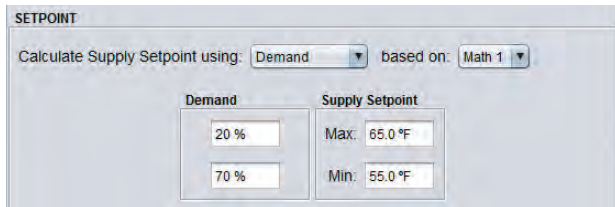


- Choose how to calculate the Supply Temperature according to the following options:
 - > Demand (default)
 - > Fixed
 - > Outside Temp (i.e. outside temperature reset)
 - > Return Temp (i.e. return temperature reset)



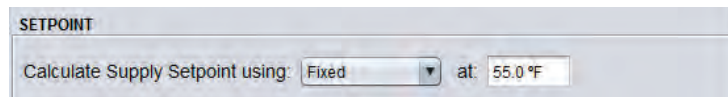
2.2.1 - Calculate Supply Setpoint Using "Demand"

By setting "Calculate Supply Setpoint using Demand", the target discharge temperature in the supply will be reset based on the demand coming from a Math function (in this case, source Math 1). See SECTION 3.2 for more details on the Math functions.



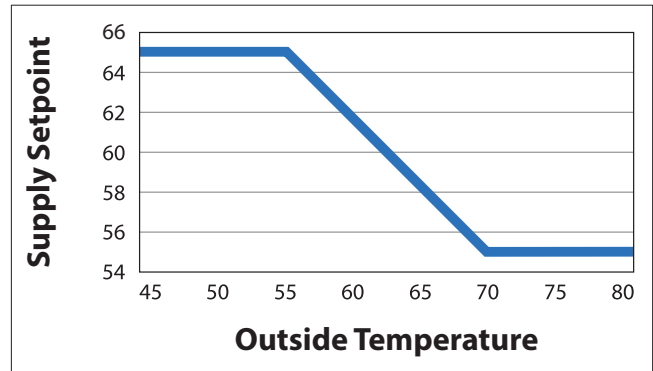
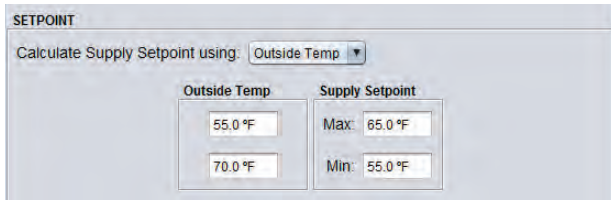
2.2.2 - Calculate Supply Setpoint Using "Fixed"

By setting "Calculate Supply Setpoint using Fixed", the target discharge temperature in the supply is fixed, and will not vary.



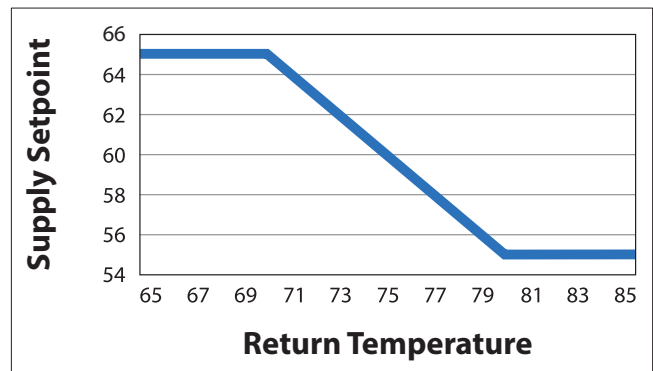
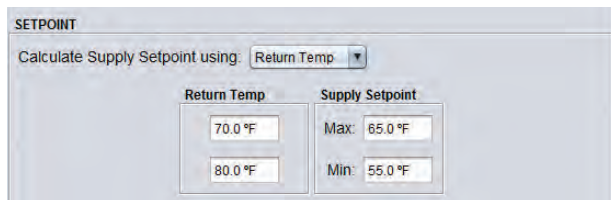
2.2.3 - Calculate Supply Setpoint Using “Outside Temperature”

By setting “Calculate Supply Setpoint using Outside Temp”, the target discharge temperature in the supply will be reset based on the outside temperature.



2.2.4 - Calculate Supply Setpoint Using “Return Temperature”

By setting “Calculate Supply Setpoint using Return Temp”, the target discharge temperature in the supply will be reset based on the return temperature.



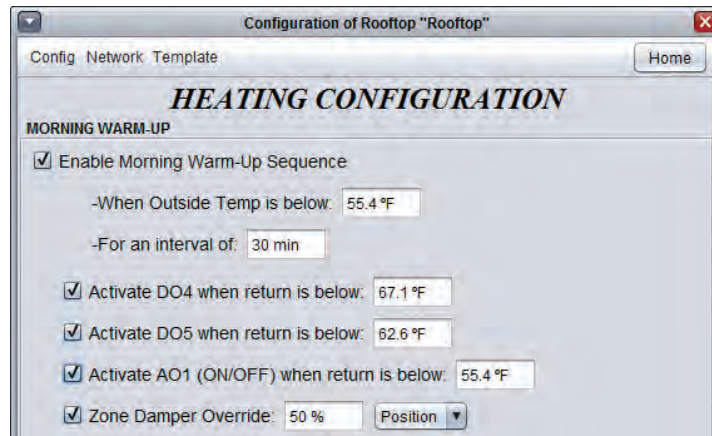
2.3 - Configuring the Morning Warm-Up

When the cooling mode is set to “Supply Temp”, the heating configuration menu will automatically update to display the morning warmup setup.

- On the top left of the screen, select “Config” and then “Heating”.



- Click the “Enable Morning Warm-Up Sequence” checkbox. This sequence will be enabled upon a transition from “Unoccupied” to “Occupied”.



- Enter the Outside Temperature below which the “Morning Warm-Up Sequence” is enabled (Default 55.4°F).
- Enter the interval of time for which the “Morning Warm-Up Sequence” is enabled (Default 30min).
- Click the appropriate checkbox to activate Digital Output 4, Digital Output 5 and Analog Output 1 based on the mechanical equipment’s setup. The outputs will activate their respective heating stages if the return air temperature is below their indicated value.
- In this example:
 - > Digital Output 4 will activate its heating stage if the return temperature is below 67.1°F
 - > Digital Output 5 will activate its heating stage if the return temperature is below 62.6°F
 - > Analog Output 1* will activate its heating stage if the return temperature is below 55.4
 - > These values can be changed to suit the specific requirements of the project.
- * *Analog Output 1 will have to be ON-OFF , i.e. 0VDC (OFF) or 10VDC (ON). If a digital contact is required, use a 10VDC relay.*
- Click the “Zone Damper Override” checkbox to force all zone dampers to a specific position when the Morning Warm-Up Sequence is active.

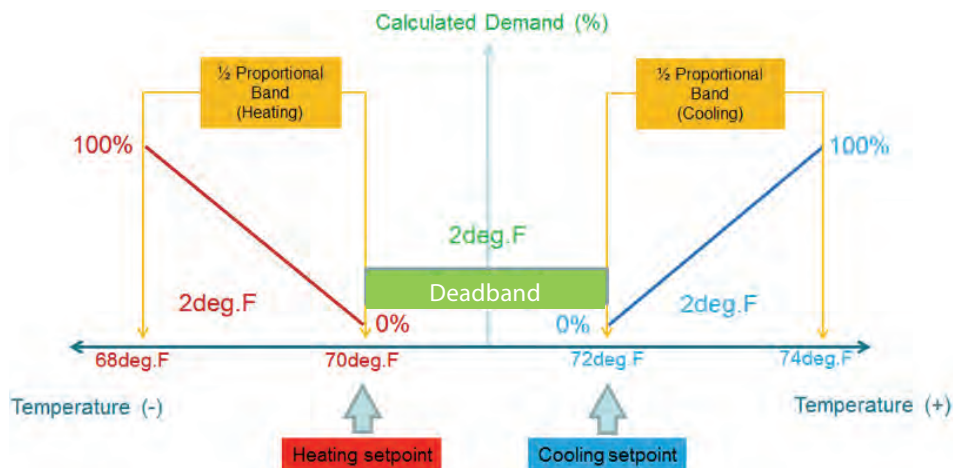
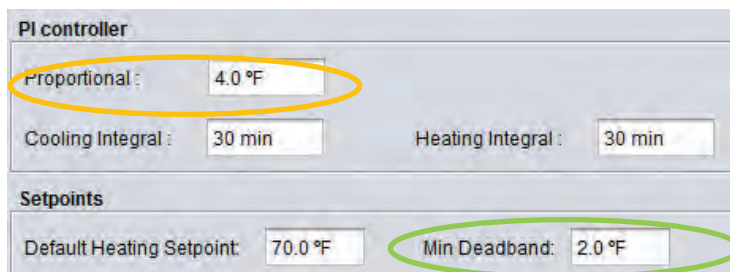
Annex A (Proportional + Integral Control)

This annex explains in detail how a zone's demand is calculated. A zone's demand is calculated by **adding the integral component to the proportional component**.

Proportional Component

Key Concepts

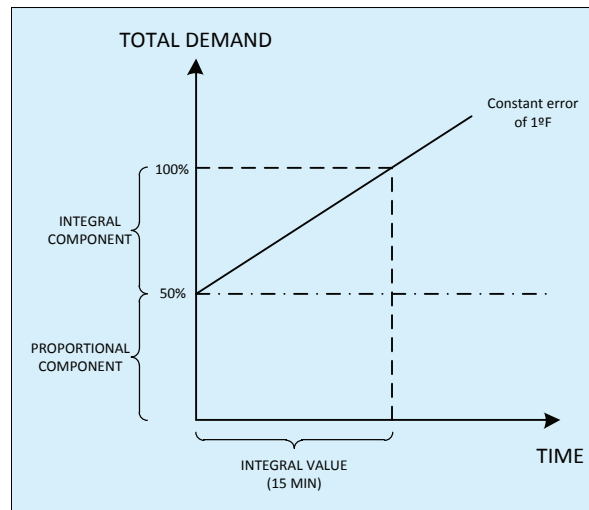
- **Heating Setpoint:** temperature below which a heating demand will be created. In the graphic above, heating setpoint= 70°F, and is usually set by the wall sensor setpoint adjustment dial or touchpad.
- **Cooling Setpoint:** temperature above which a cooling demand will be created. In the graphic above, cooling setpoint = 72°F and is usually set by the wall sensor setpoint adjustment dial or touchpad.
- **Deadband:** temperature band between the heating and cooling setpoints, at which the space has a 0% demand, and the zone is considered to be satisfied. In the graphic above, deadband = 2.0°F and can be configured in the "Min Deadband" box.
- **Proportional Band:** Temperature band divided into 2 halves, with one half placed below the Heating Setpoint, and the other half placed above the Cooling Setpoint. Each half band represents the temperature deviation from setpoint needed to create a 100% demand.



Integral Component

Key Concepts

- The Proportional Component is not enough to satisfy the zone demand.
- As long as there is a Proportional Component, the Integral Component will increase **with time**.
- Cooling integral: Amount of time for the Integral Component of the demand to equalize the Proportional Component for a cooling demand.
- Heating integral: Amount of time for the Integral Component of the demand to equalize the Proportional Component for a heating demand.



Scenario

Consider the following situation:

- Space Temperature = 69°F
- Heating Setpoint = 70°F // Cooling Setpoint = 72°F
- Proportional Band = 4°F
- Heating Integral = 30min // Cooling Integral = 30min
- The space temperature **has remained constant for 15 minutes**

Here is how we calculate the zone demand:

$$\text{Zone Demand} = \text{Proportional Component} + \text{Integral Component}$$

Proportional Component

$$\text{Proportional Component} = \frac{\text{Heating Setpoint} - \text{Space Temperature}}{1/2 \text{ Proportional Band}} \times 100 \%$$

$$\text{Proportional Component} = \frac{70 \text{ }^\circ\text{F} - 69 \text{ }^\circ\text{F}}{1/2 (4 \text{ }^\circ\text{F})} \times 100 \%$$

$$\text{Proportional Component} = \frac{1 \text{ }^\circ\text{F}}{2 \text{ }^\circ\text{F}} \times 100 \% = 0.5 \times 100 \%$$

$$\text{Proportional Component} = 50 \%$$

Integral Component

$$\text{Integral Component} = \frac{\text{Time Elapsed}}{\text{Integral Time}} \times \text{Proportional Component}$$

$$\text{Integral Component} = \frac{15 \text{ minutes}}{30 \text{ minutes}} \times 50 \%$$

$$\text{Integral Component} = 0.5 \times 50 \%$$

$$\text{Integral Component} = 25 \%$$

Zone Demand

$$\text{Zone Demand} = \text{Proportional Component} + \text{Integral Component}$$

$$\text{Zone Demand} = 50 \% + 25 \%$$

$$\text{Zone Demand} = 75 \%$$

After 15 minutes have elapsed, and the space temperature having remained at 69°F, the zone will have a 75% heating demand.

Annex B (Math Function Examples)

In this annex, a scenario is presented. Using different configurations previously explained in this guide, we will see the different Math Function results, depending on which strategy is chosen.

Scenario

A rooftop unit is controlled with a PL-M2000-RTU Zoning Controller, and the system has 10x VAV zones.

Each zone creates its own individual demand, either heating or cooling demand, from 0 to 100%. Each zone also has its own voting weight (for more details, see SECTION 3.1 CONFIGURE A ZONE DEMAND AND VOTING WEIGHT).

Note: In Proton Focus, the heating demands are POSITIVE values, and cooling demands are NEGATIVE values.

Each of the 10 VAV zones has the following heating or cooling demands:

Zone #1: 100% Heating demand, voting weight of 1

Zone #2: 100% Heating demand, voting weight of 1

Zone #3: 75% Heating demand, voting weight of 2

Zone #4: 10% Heating demand, voting weight of 1

Zone #5: 0% demand, voting weight of 1

Zone #6: 25% cooling demand, voting weight of 2

Zone #7: 35% Cooling demand, voting weight of 1

Zone #8: 45% Cooling demand, voting weight of 1

Zone #9: 100% Cooling demand, voting weight of 1

Zone #10: 100% Cooling demand, voting weight of 2

In the Unit Controller:

- The Cooling action will be driven by Math 1
- The Heating action will be driven by Math 2

(For more details, see SECTION 3.2 CONFIGURE A MATH FUNCTION)

The following is how the math functions are calculated

Configuration 1: Using Weighted Average Functions (Cooling/Heating only)

- Select Math 1 as “Weighted Average (Cooling only)”
- Select Math 2 as “Weighted Average (Heating only)”

$$\text{Math 1} = \frac{(-25 \times 2) + (-35 \times 1) + (-45 \times 1) + (-100 \times 1) + (-100 \times 2)}{1 + 1 + 2 + 1 + 1 + 2 + 1 + 1 + 1 + 2} = -33.1\%$$

$$\text{Math 2} = \frac{(100 \times 1) + (100 \times 1) + (75 \times 2) + (10 \times 1)}{1 + 1 + 2 + 1 + 1 + 2 + 1 + 1 + 1 + 2} = 27.7\%$$

Configuration 2: Using Maximum Cooling/Heating Functions

- Select Math 1 as “Maximum Cooling”
- Select Math 2 as “Maximum Heating”

$$\text{Math 1} = \text{Maximum } (-25; -35; -45; -100; -100) = -100\%$$

$$\text{Math 2} = \text{Maximum } (100; 100; 75; 10) = 100\%$$

Configuration 3: Using Weighted Average Functions

- Select Math1 as “Weighted Average”

$$\text{Math 1} = \frac{(100 \times 1) + (100 \times 1) + (75 \times 2) + (10 \times 1) + (0 \times 1) + (-25 \times 2) + (-35 \times 1) + (-45 \times 1) + (-100 \times 1) + (-100 \times 2)}{1 + 1 + 2 + 1 + 1 + 2 + 1 + 1 + 1 + 2} = -5.4\%$$

