

# EM9xx Embeddable Controller

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Datasheet Rev 1.03

- Different available actuator options
- Compact footprint
- Simple to maintain by hotel staff
- OTA firmware upgrade
- Support for most HVAC types, such as FCU, PTAC, VRF/VRV
- Advanced energy conservation algorithms
- Dry contact, temperature sensor and current probe inputs
- Built for a circular economy – repairable and refurbishable



The EM9xx is a family of smart controllers that perform specific functions for room automation systems. Typical applications include HVAC control, protocol conversions and various signal sensing functions. The compact size of these controllers allows to implant them in tight spaces, such as fan coil units, PTACs, and VRF/VRV indoor units.

The modular setup supports that different actuator capabilities can be offered, each with special and optimized features for a particular application. From a general purpose 5-relay controller EM901 that is ideal for fan coil unit (FCU) and packaged terminal air conditioners (PTAC), to highly specialized versions, such as the EM908 model specifically built for Daikin VRV units.

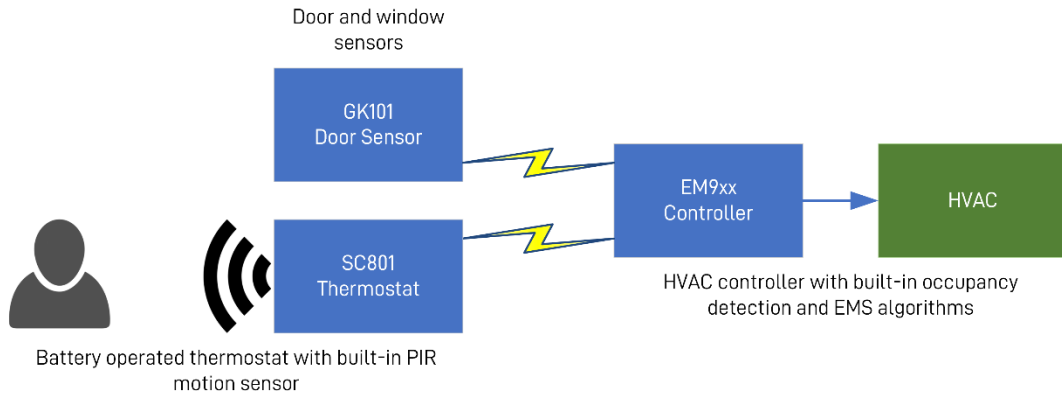
Equipped with headers to add additional temperature sensors and current probes, the EM9xx family can be a central part of advanced diagnostics and M&V (measurement and verification) applications. This can be helpful to minimize operational costs and the building operator can 'look' into the controlled device from remote without having to physically access the device. Given that the EM9xx and its controlled device is often placed at difficult to reach locations, this can mean significant labor savings.

The EM9xx is also specifically designed for the circular economy where a malfunctioning device is not automatically discarded into a landfill. Its modular construction allows AuVerte to offer repair and refurbishment services and thereby reducing the amount of e-waste that would normally be associated with a build-and-toss model. This can also benefit the owner as repaired units can be returned to the site at lower costs than a complete replacement with a new device.

## Typical Application

### Guestroom Energy Management

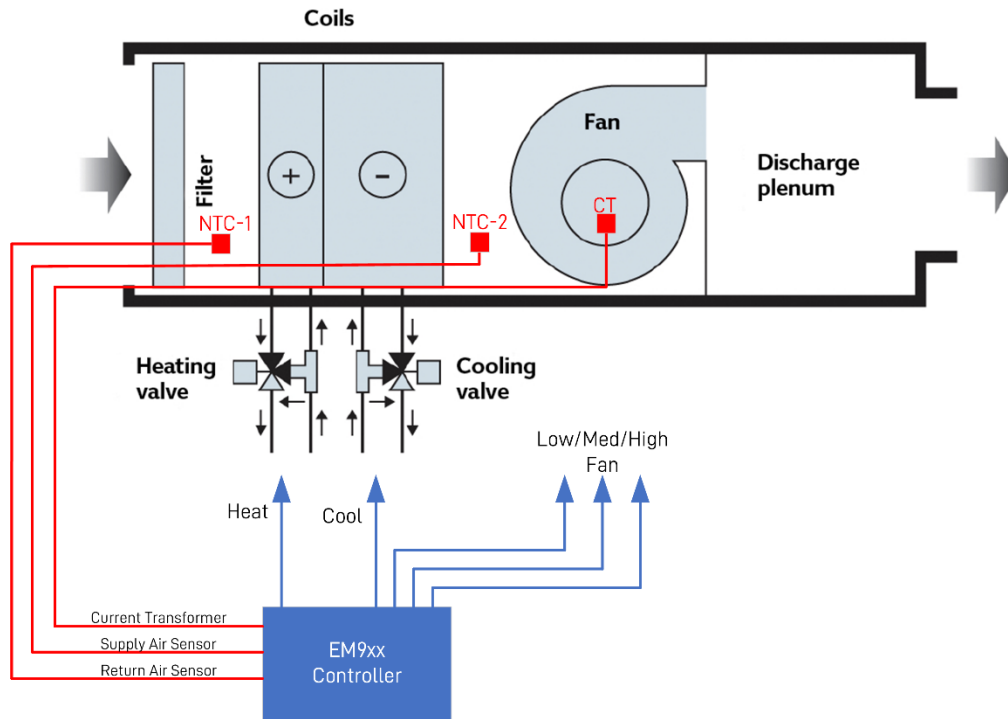
The EM9xx features prominently in energy management application for hotel guestrooms. A typical topology of such an application is shown in the figure below. In this case, the EM9xx is the central controller that operates the HVAC equipment of the space. Its sensory inputs are coming from a set of battery-operated sensors, such as door and window sensors, and a battery-operated thermostat. With these sensors, the EM9xx can determine the room occupancy and operate the HVAC according to predefined sequence of operations that properly trade-off comfort requirements and the opportunities to conserve energy.



## Measurement and Verification (M&V)

The EM9xx controller can also be a strong part in the M&V domain. In the example below, we see how the EM9xx can be used to measure return and supply temperatures of a fan coil unit and how a current transformer can be used to monitor the power consumption of the fan motor. Internal diagnostics can be used to detect potential failure modes at the earliest indication of abnormal operating parameters.

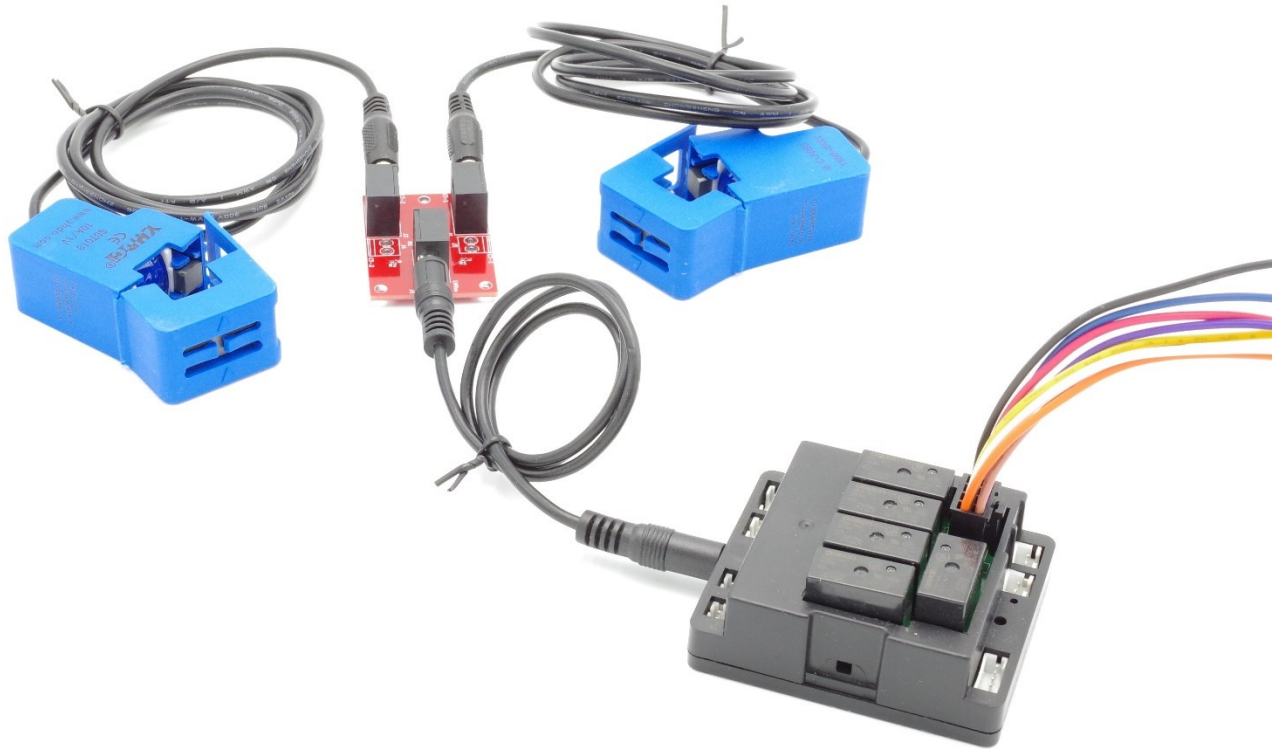
As the sensors are configurable, other M&V activities can be supported and AuVerte continuously expands the M&V capabilities of its software.



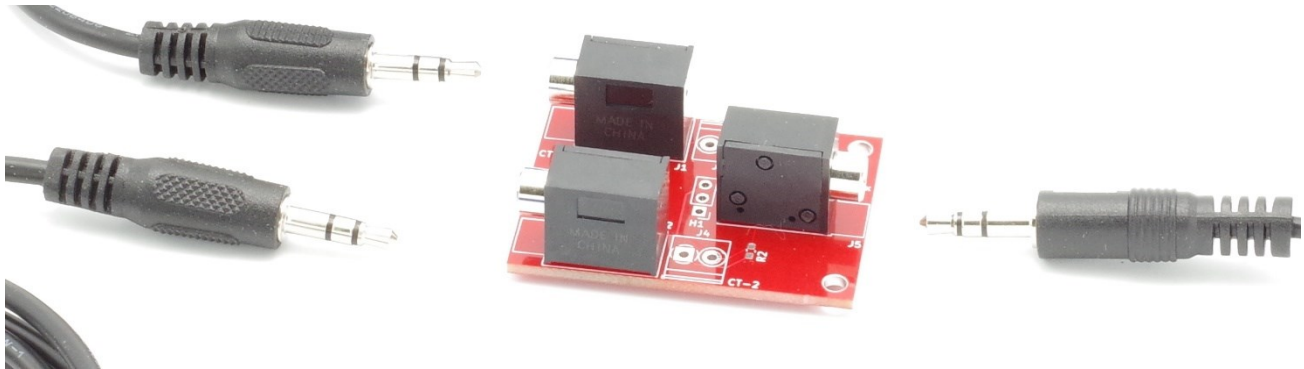
To the right, we see the setup of an EM901 in combination with an off-the-shelf current transformer.



The EM9xx controller can support two current transformer probes in combination with the optional EMX-CT (PN002041) signal splitter. A simple setup that contains two CTs is shown in the image below.



EMX-CT current transformer splitter for CTs with 3.5mm headers.



EMX-CT variant with screw terminal for current probes that come with pigtail wires.

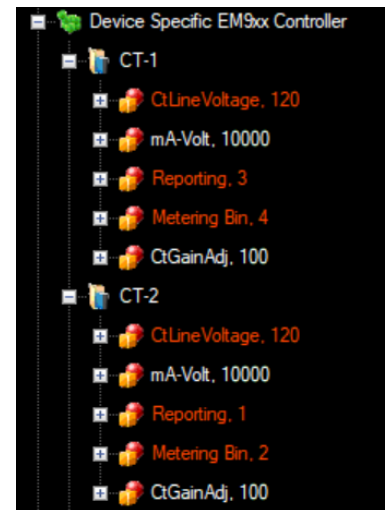


To the right, we show the configuration of the CT inputs for an EM9xx controller. In order to provide the wattage of the load, we need to configure the nominal supply voltage of the current that is being measured by the CT probe. In the example, both CTs measure power at a 120VAC environment.

The “mA-Volt” parameter defines the CT current measured that produces 1V of output signal. In the example to the right, we have 10A sensors, meaning it takes 10,000 mA to produce 1V of output signal.

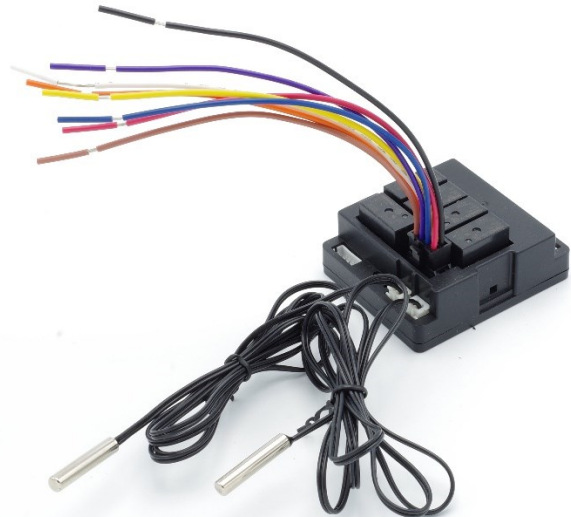
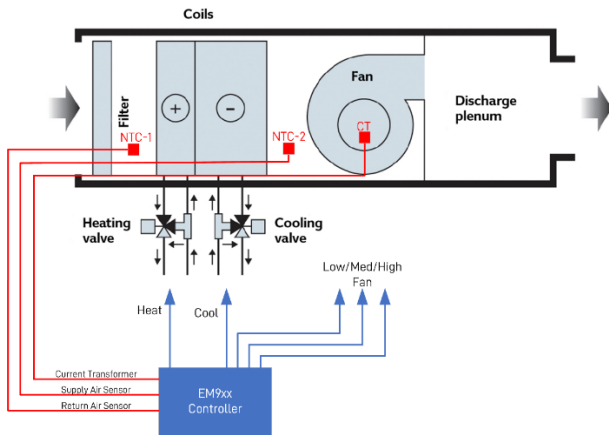
The “Reporting” and “Metering Bin” fields define how often this power reading needs to be reported to the cloud and to which electric meter this measurement belongs. The metering bin allows for example to keep track separately of compressor power and fan power.

The “CtGainAdj” is to finetune measurement inaccuracy should they be shown to exist. We can use this to compensate for empirically shown errors introduced by phase shifts between the voltage and the amperage of the load (cos phi).

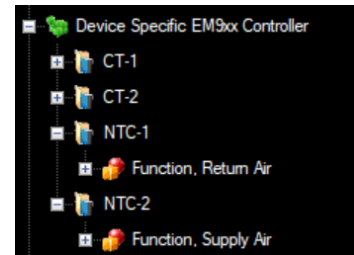


### Advanced Instrumentation

In some instances, the temperature measured at the thermostat location is insufficient for providing accurate comfort management. On other occasions, additional temperature sensors provide for improved diagnostics and preemptive alarming. In the example below, we for example desire to measure the return-air and supply-air on a fan coil unit. Alternatively, we might be interested to measure the temperature of supply and discharge water, the pipe temperatures on the low-pressure and high-pressure side of a compressor, or the temperature of the compressor itself. To support all these applications, the EM9xx controller provides two 10k NTC temperature sensor headers.



The image to the right shows the configuration of the two temperature probes. For each probe, the system integrator can assign a function that are then used to report to the cloud and that also being used in the controls algorithm to make improved controls decisions.



## EM9xx Headers

The image to the right lists the common headers on any EM9xx controller.

**Analog In 2:** 0-10VDC analog input. Pin 1: GND, Pin 2: 0-10VDC input. 2-pin, 2.0mm spaced Leoco header.

**Analog In 1:** Same as Analog In 1.

**CT Input:** 3.5mm audio jack for one or two Current Transformers (CT). For two sensors, the EMX-CT breakout adapter is needed.

**Sensor Bus:** A future expansion to connect a number of different signal sensors to the EM9xx controller. 3-pin, 2.0mm spaced Leoco header.

**Serial Port:** A future expansion that requires the transmission and reception of data using a serial port. 4-pin, 2.0mm spaced Leoco header.

**NTC-2:** 10k temperature probe input. 2-pin, 2.5mm spaced Leoco header.

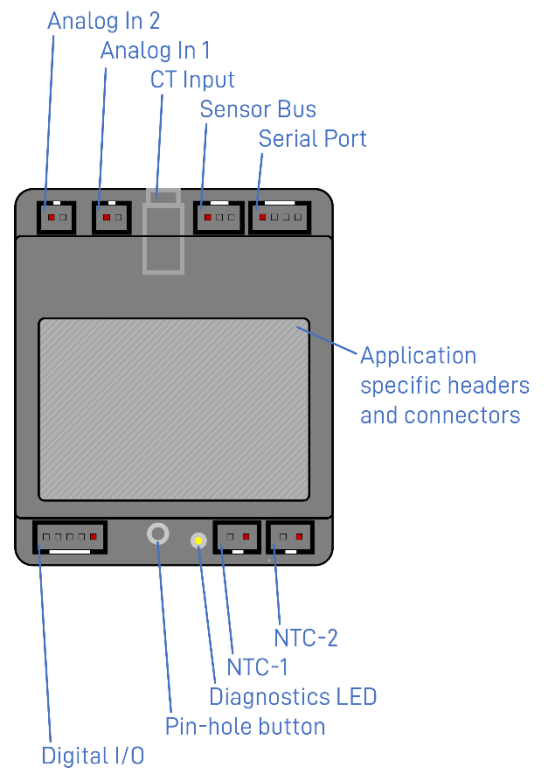
**NTC-1:** Same as NTC-2

**Diagnostic LED:** Blink pattern used to provide basic device status information.

**Pin-hole button:** Simple means to provide user controller of the device.

**Digital I/O:** A future expansion that provides three digital I/O signals that are typically used for end-switches, or similar applications. 5-pin, 2.0mm spaced Leoco header.

In the center of the device, we find an opening where the model specific headers, terminals and connectors are located. Refer to the model specific explanations of how these connectors are being used.



## Specifications

### User Interface

|             |                                     |
|-------------|-------------------------------------|
| Push button | Used for RF binding and diagnostics |
| Status LED  | Used to indicate operational status |

### Sensor Inputs

|       |  |
|-------|--|
| NTC-1 | 10k NTC temperature sensor header, Leoco 2.5mm 2 pin<br><br>Range: -50 to 150 °C<br><br>Accuracy: +/- 1 °C for range 0 to 100 °C   |
| NTC-2 | Same as NTC1   |
| CT-1  | Current transformer with 1V output, such as a 10A/1V model.<br><br>Configurable line voltage and CT parameters.<br><br>True-RMS.<br><br>Accuracy: Approximately Class 5.0 (depends on various external aspects, such as the used CT and load power line factor).<br><br>3.5mm audio jack |
| CT-2  | Same as above. Alternate signal input on same 3.5mm audio jack as above.   |

### Radio

|                       |  |
|-----------------------|--|
| Standard              | IEEE 802.15.4  |
| Frequency band        | ISM 2.4 GHz  |
| Interference immunity | DSSS (Direct sequence spread spectrum)                                   |
| Data rate             | 250 kbps   |
| Antenna               | Built-in   |
| Indoor range          | Up to 50 m (150 ft)  |
| Transmit power        | +3 dBm   |
| Receiver sensitivity  | -95 dBm  |
| Channels              | 16 (11 to 26, default 25)  |
| Protocol              | AuVerte mesh, IPv6 over 802.15.4 with forward error correction (FEC-ECC) |

### Software

|                |   |
|----------------|---|
| IPv4           | ICMP, IP, UDP, DHCP (C413 model only)   |
| IPv6           | ICMPv6, IP, UDP, CoAP   |
| Encryption     | AES128  |
| Hashing        | SHA256, AES-CMAC  |
| Key Exchange   | ECDH  |
| Routing        | UDP – AuVerte mesh<br>IPv6 – IPv6 over 802.15.4   |
| App Security   | DTLS  |
| Cyber security | Packet authentication, packet inspection, certificate-based access control, configurable encryption keys with no backdoors, JTAG disabled<br><br>Configurable port-based firewall |

### Device

|          |   |
|----------|---|
| Power    | Model dependent   |
| Mounting | Placed inside electrical box or HVAC equipment cavities |

### Environmental and Physical Specification

|                           |   |
|---------------------------|---|
| Dimensions                | 66mm x 56mm x 31mm  |
| Weight                    | Model specific  |
| Operating temperature     | 10 °C to 40 °C (50 °F to 104 °F)  |
| Storage temperature       | -20 °C to 50 °C (-4 °F to 122 °F)   |
| Operating humidity        | 10 % to 95 %RH, non-condensing  |
| Storage humidity          | 5 % to 90 %RH, non-condensing   |
| Electromagnetic emissions | FCC Part 15C<br>EN 62311 (EMR)<br>ETSI EN 300 328 (2.5GHz ISM Band)<br>ETSI EN 301489 (EMC) |
| Safety approvals          | EN62368-1   |
| Environmental             | RoHS  |
| Cleaning                  | Mild cleaning liquid, soft towel  |
| Recycling                 | Model specific  |



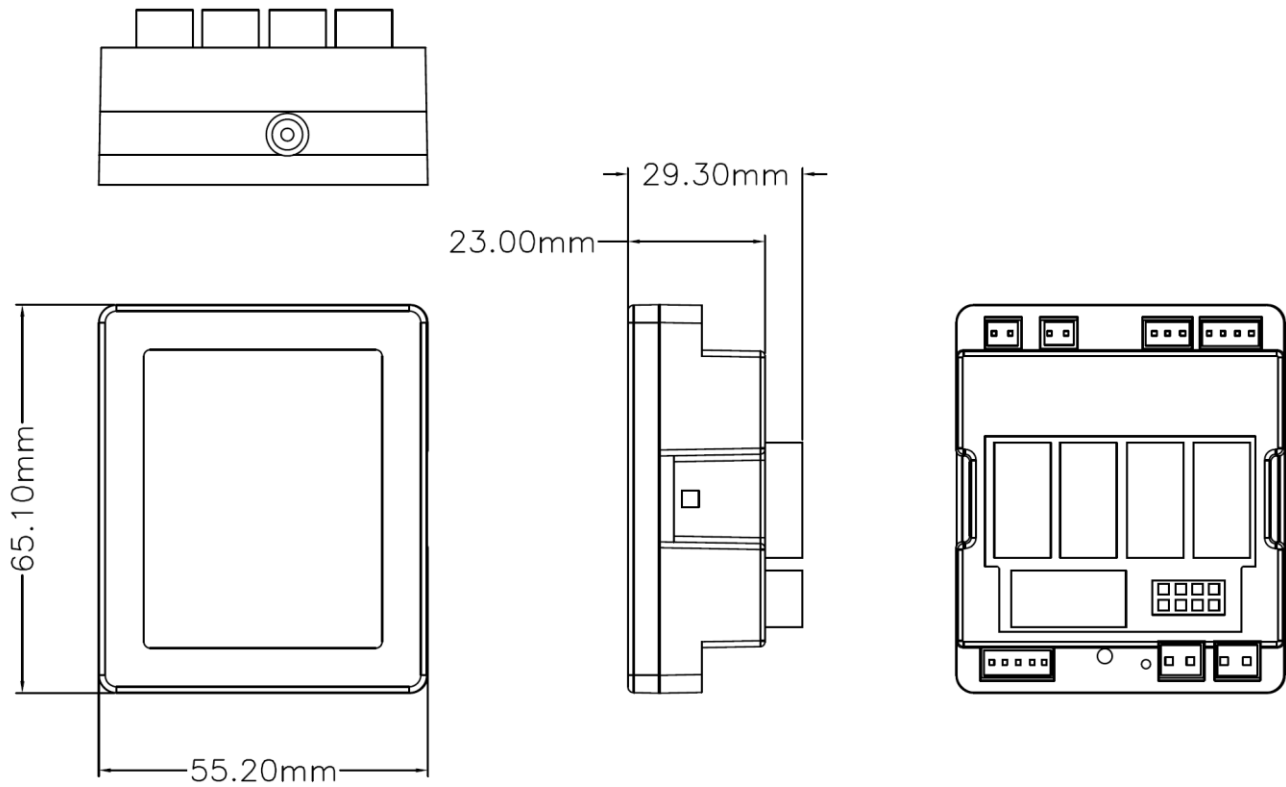
**Ordering Information**

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|                 |  |
|-----------------|--|
| Part numbers    | 003021.EM901 (Relay-5)<br>003021.EM902 (Modbus/RS485)<br>003021.EM904 (Trane/York)<br>003021.EM908 (Daikin)<br>003021.EM913 (Ethernet) |
| Package content | EM9xx controller, harness  |
| Color Options   | Dark gray  |
| Options         | NTC temperature sensors<br>CT Current transducers<br>CT Dual Channel Breakout (PN002041)   |

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## Model EM901: Relay-5



### Power

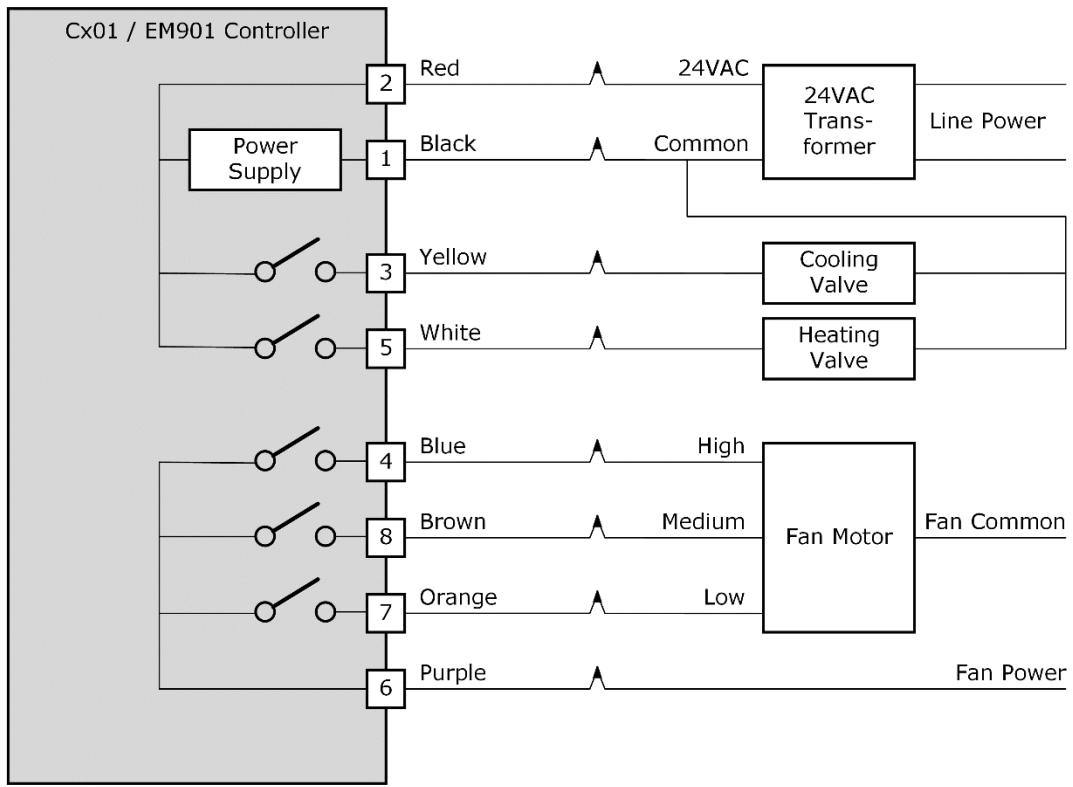
- |       |   |
|-------|---|
| Power | <ul style="list-style-type: none"> <li>• 12VDC / 150mA</li> <li>• 24VAC / 75mA</li> </ul> |
|-------|---|

### Actuation

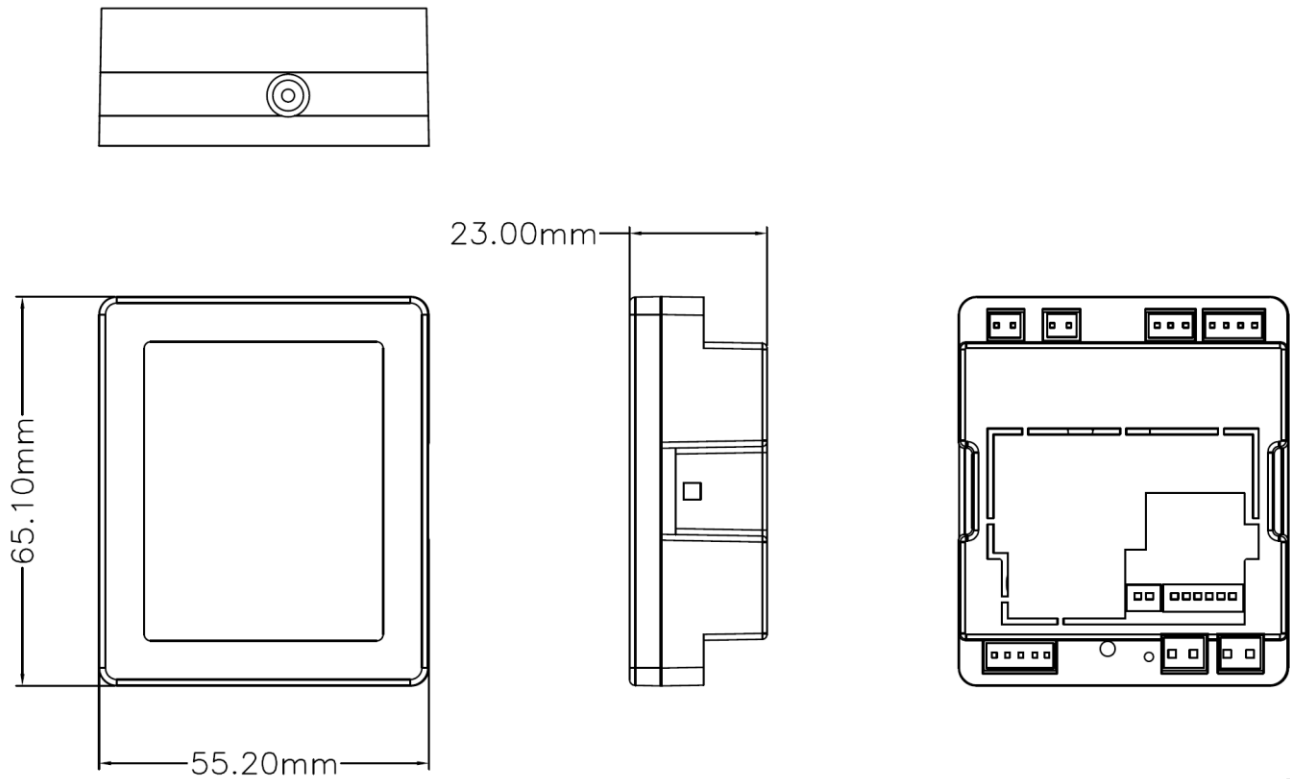
- |             |   |
|-------------|---|
| Relays type | <ul style="list-style-type: none"> <li>• 5 relays with maximal contact rating of 277VAC, 10A</li> </ul> |
|-------------|---|

- |                          |  |
|--------------------------|--|
| Relay application rating | <ul style="list-style-type: none"> <li>• 48VAC/DC, 3A</li> </ul> |
|--------------------------|--|

Typical EM901 Wiring Diagram



## Model EM902: ModBus/RS485



□

### Power

- |       |   |
|-------|---|
| Power | <ul style="list-style-type: none"> <li>• 12VDC / 100mA</li> <li>• 24VAC / 50mA</li> </ul> |
|-------|---|

### Communication

- |       |   |
|-------|---|
| RS485 | <ul style="list-style-type: none"> <li>• EIA-485-A</li> <li>• Modbus</li> </ul> |
|-------|---|

### Actuation / Outputs

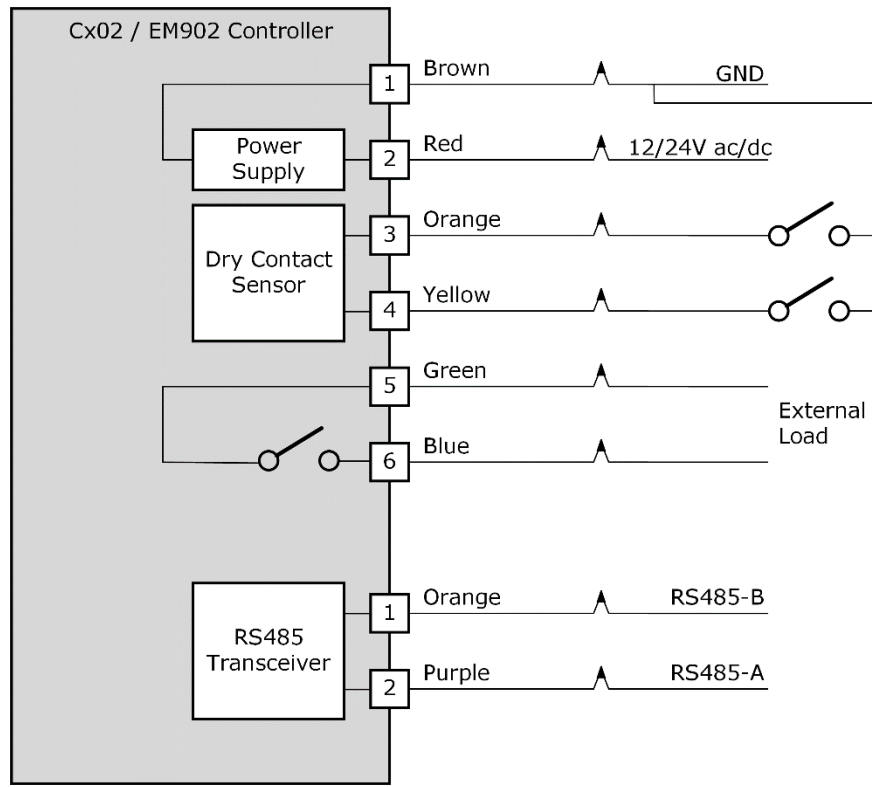
- |            |   |
|------------|---|
| Relay type | <ul style="list-style-type: none"> <li>• Single relay with a contact rating of 30V, 1A</li> </ul> |
|------------|---|

- |                          |  |
|--------------------------|--|
| Relay application rating | <ul style="list-style-type: none"> <li>• 24V, 0.25A</li> </ul> |
|--------------------------|--|

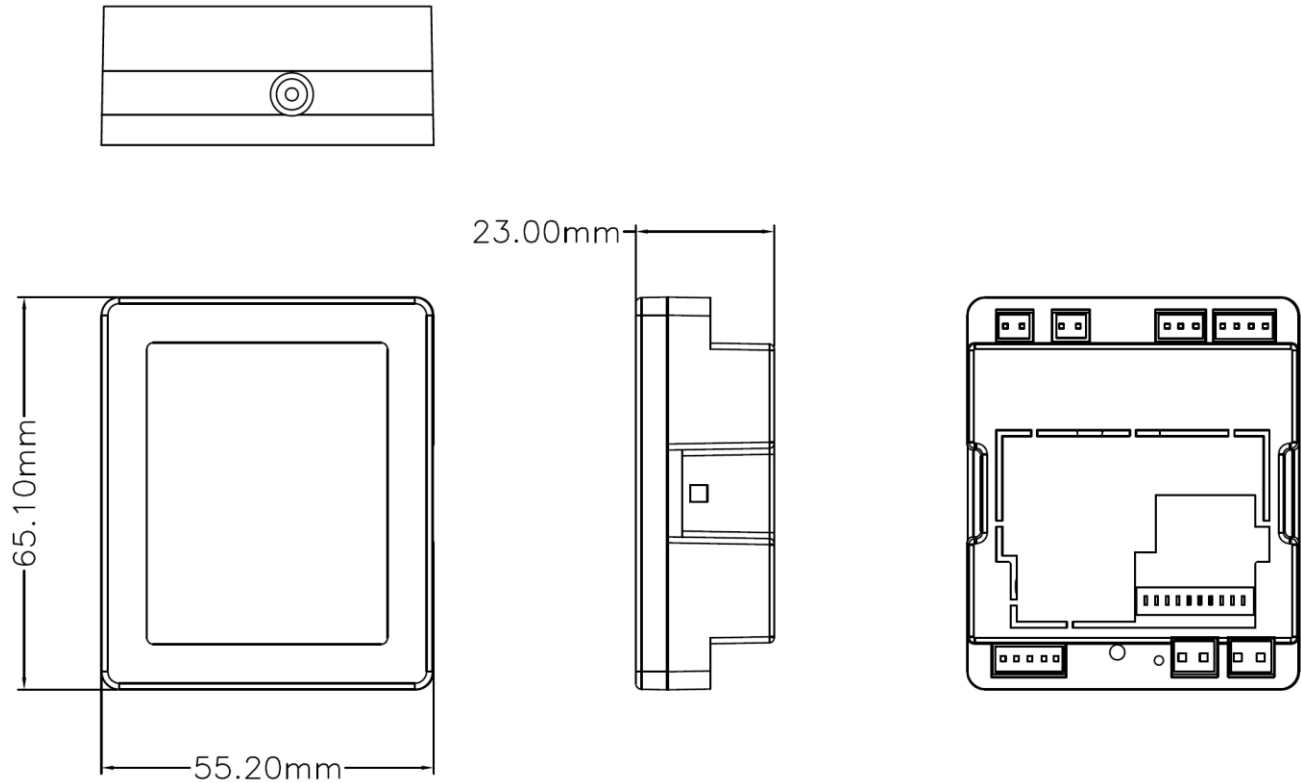
### Inputs

- |                   |  |
|-------------------|--|
| Dry contact input | <ul style="list-style-type: none"> <li>• 2 dry contact inputs with probing current up to 20mA each</li> <li>• Dry contact inputs connected externally to ground</li> </ul> |
|-------------------|--|

Typical EM902 Wiring Diagram



## Model EM904: Trane/York



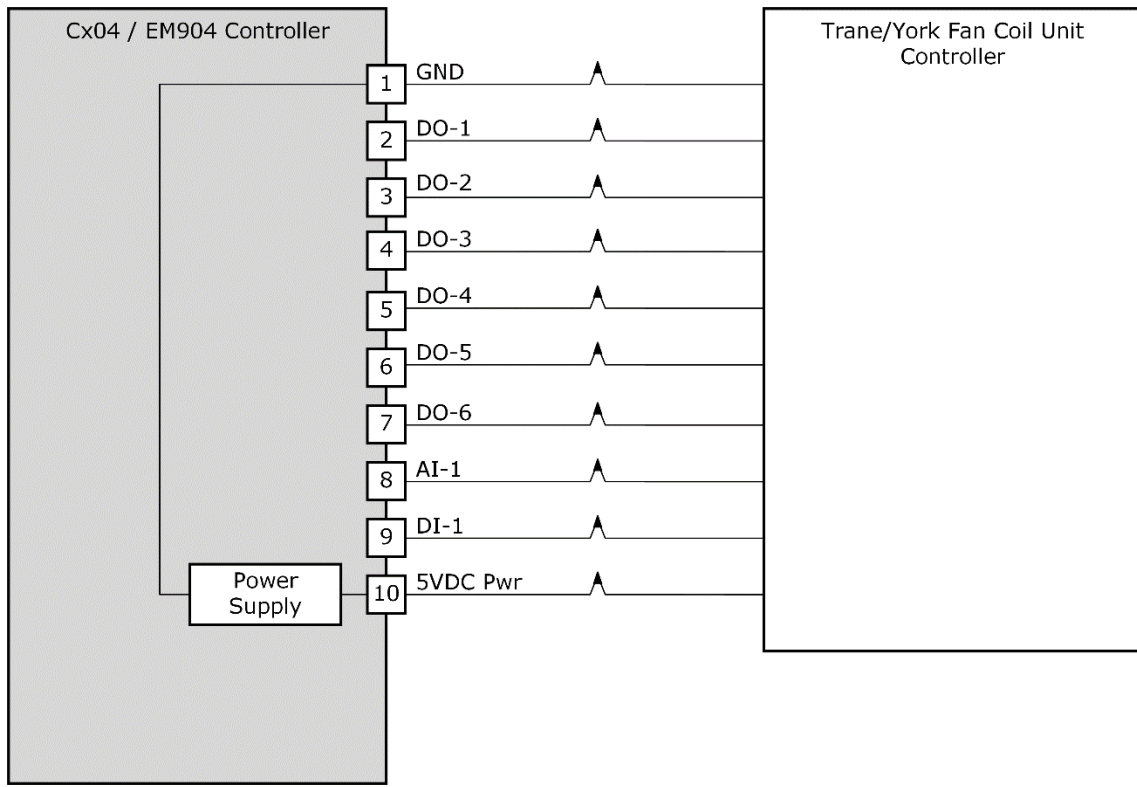
### Power

|       |              |
|-------|--------------|
| Power | 5VDC / 100mA |
|-------|--------------|

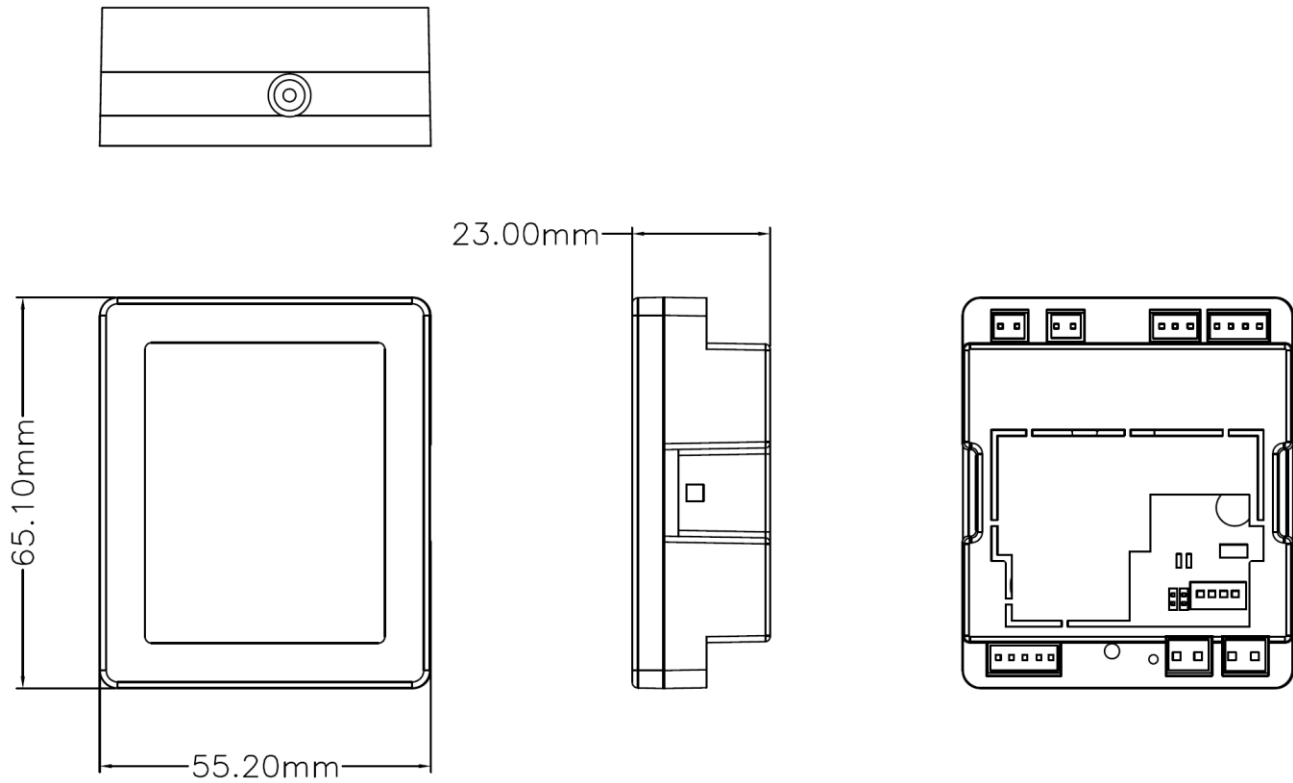
### Actuation / Outputs

|               |   |
|---------------|---|
| Compatibility | <ul style="list-style-type: none"><li>• P/N260201-100Q Relay Controller</li></ul> |
|---------------|---|

Typical EM904 Wiring Diagram



## Model EM908: Daikin



### Power

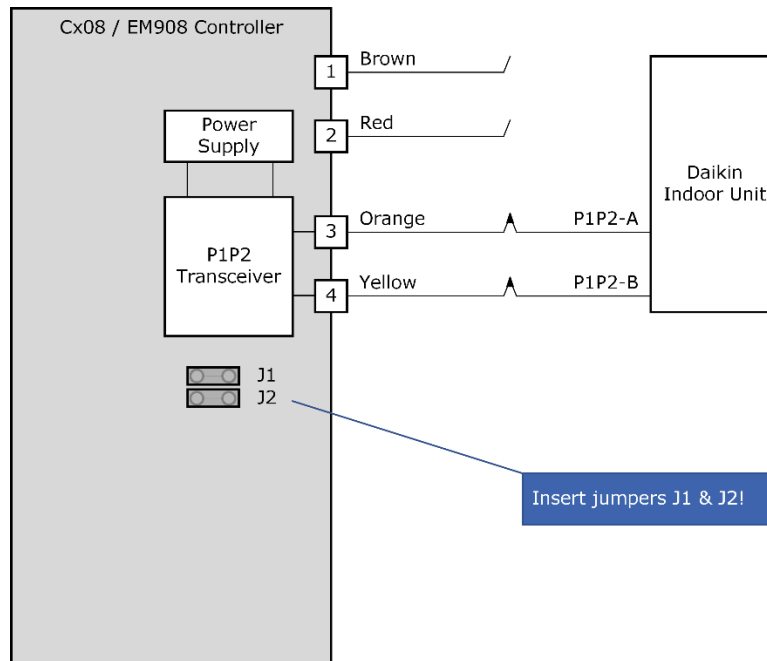
- |       |   |
|-------|---|
| Power | <ul style="list-style-type: none"> <li>• 16VDC / 40mA</li> <li>• P1P2 (16VDC) / 40mA</li> </ul> |
|-------|---|

### Actuation / Outputs

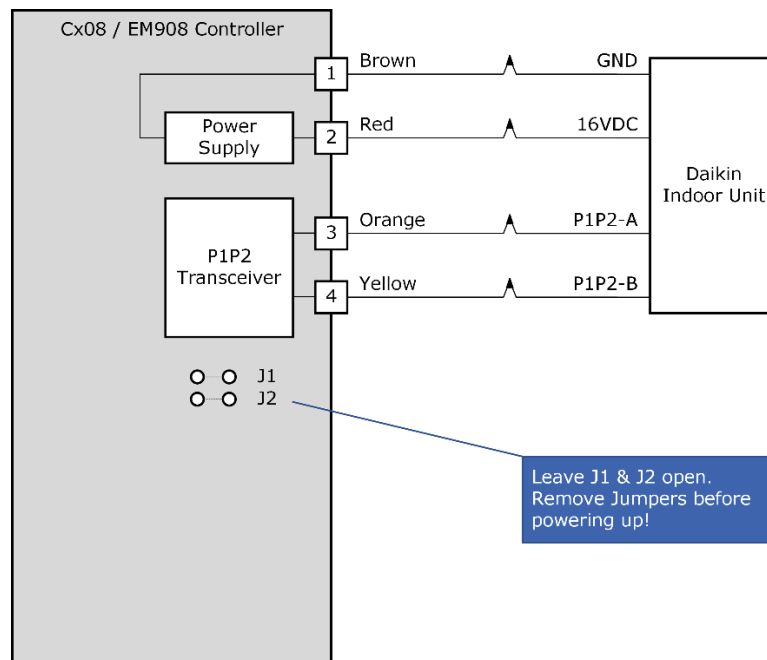
|                  |  |
|------------------|--|
| Compatibility    | <ul style="list-style-type: none"> <li>• Daikin VRV indoor units</li> </ul>  |
| Scalability      | <ul style="list-style-type: none"> <li>• 1 – 4 indoor units</li> </ul>   |
| Control scheme   | <ul style="list-style-type: none"> <li>• Synchronized mode and setpoints across all the connected indoor units</li> </ul>  |
| Special features | <ul style="list-style-type: none"> <li>• Optionally controllable from Daikin central controller</li> <li>• Read/Write of indoor unit field settings</li> <li>• Read/Write of Daikin network address (group code)</li> <li>• Indoor unit bypass mode</li> </ul> |



Typical EM908 Wiring Diagram

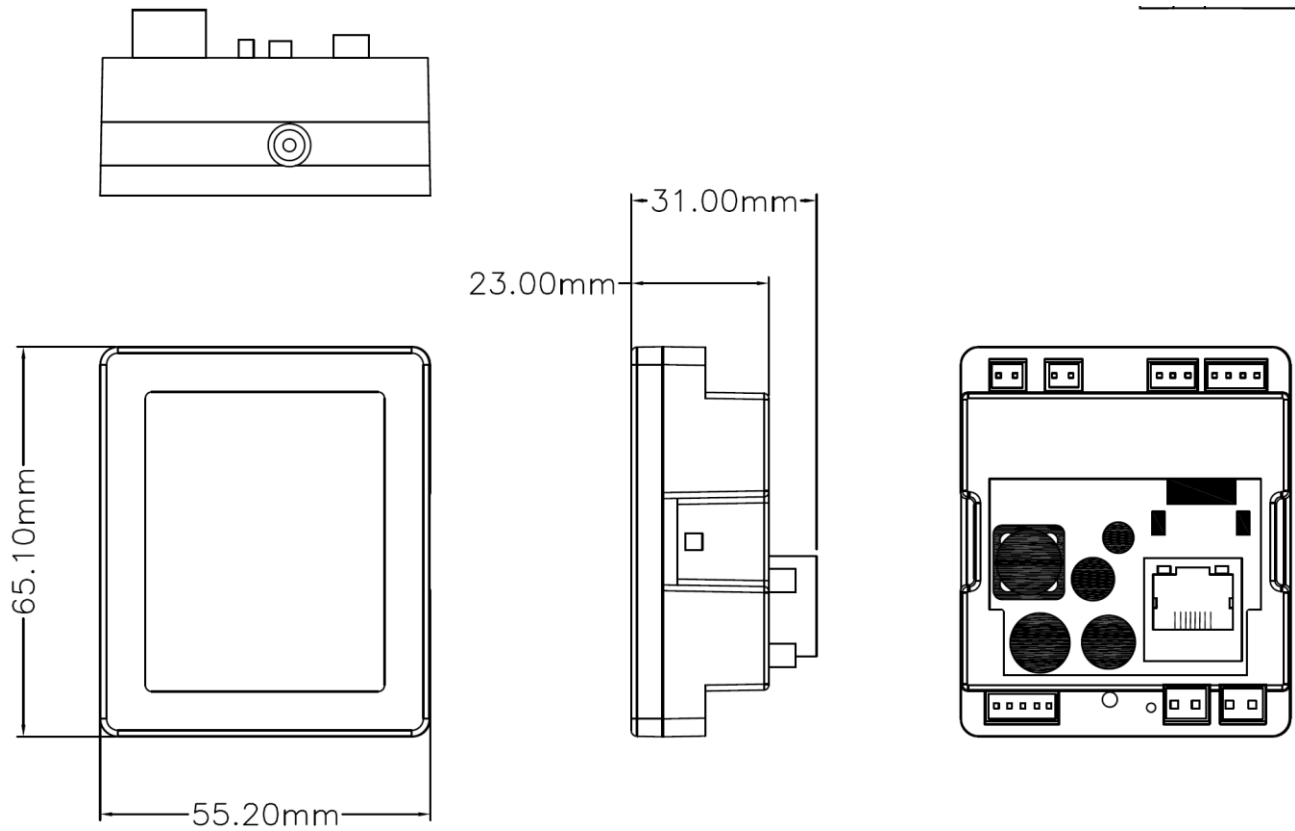


Wiring diagram when the controller is powered by P1P2 communication wires from Daikin IDU



Wiring diagram when the controller is separately powered from the Daikin IDU

## Model EM913: Ethernet

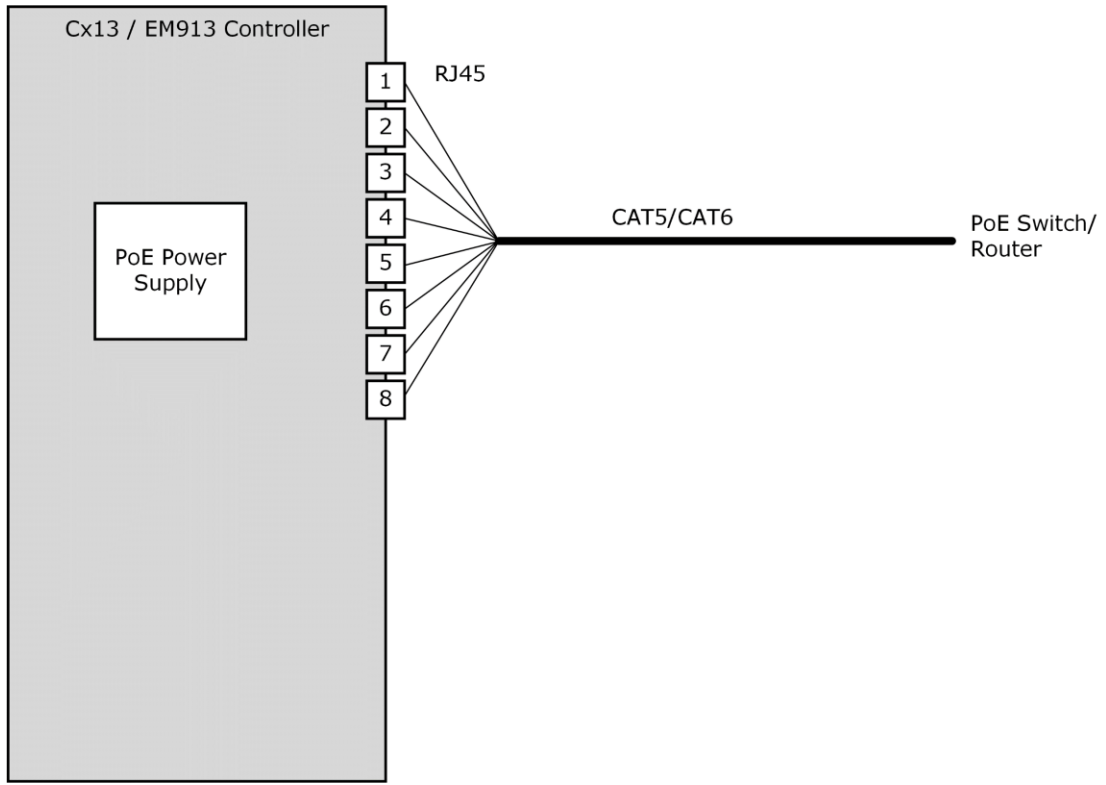


### Power

Power

- IEEE 802.3af-2003
- Hot-swap support
- Power consumption less than 3W

Typical EM913 Wiring Diagram



**FCC Warning**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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

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

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.