# Vision V120™ , M91™ PLC User Guide

**V120-22-RA22**
**M91-2-RA22**

## General Description

The products listed above are micro-PLC+HMIs, rugged programmable logic controllers that comprise built-in operating panels.

Detailed Installation Guides containing the I/O wiring diagrams for these models, technical specifications, and additional documentation are located in the Technical Library in the Unitronics website: https://unitronicsplc.com/support-technical-library/

## Alert Symbols and General Restrictions

When any of the following symbols appear, read the associated information carefully.

| Symbol | Meaning | Description |
|---|---|---|
| ⚡ | Danger | The identified danger causes physical and property damage. |
| ⚠ | Warning | The identified danger could cause physical and property damage. |
| *Caution* | Caution | Use caution. |

- Before using this product, the user must read and understand this document.
- All examples and diagrams are intended to aid understanding, and do not guarantee operation. Unitronics accepts no responsibility for actual use of this product based on these examples.
- Please dispose of this product according to local and national standards and regulations.
- Only qualified service personnel should open this device or carry out repairs.

⚡
- Failure to comply with appropriate safety guidelines can cause severe injury or property damage.

⚠
- Do not attempt to use this device with parameters that exceed permissible levels.
- To avoid damaging the system, do not connect/disconnect the device when power is on.

## Environmental Considerations

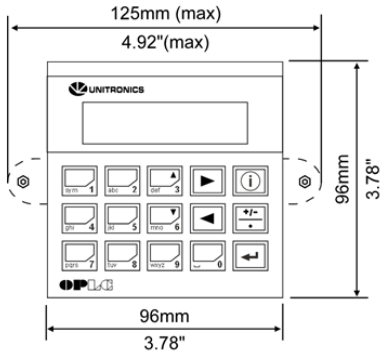
⚡
- Do not install in areas with: excessive or conductive dust, corrosive or flammable gas, moisture or rain, excessive heat, regular impact shocks or excessive vibration, in accordance with the standards given in the product's technical specification sheet.
- Do not place in water or let water leak onto the unit.
- Do not allow debris to fall inside the unit during installation.

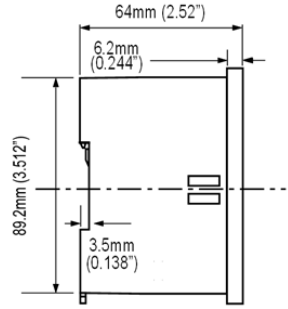
⚠
- Ventilation: 10mm space required between controller's top/bottom edges & enclosure walls.
- Install at maximum distance from high-voltage cables and power equipment.

## Mounting

Note that figures are for illustrative purposes only.

**Dimensions**



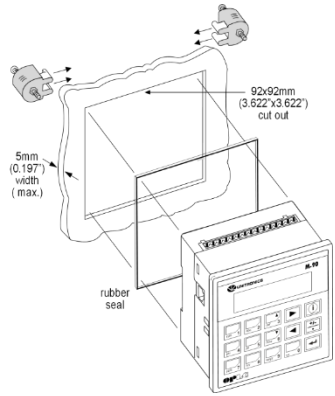




| Model | Cut-out | View area |
|---|---|---|
| V120 | 92x92 mm (3.622"x3.622") | 57.5x30.5mm (2.26"x1.2") |
| M91 | 92x92 mm (3.622"x3.622") | 62x15.7mm (2.44"x0.61") |

### Panel Mounting

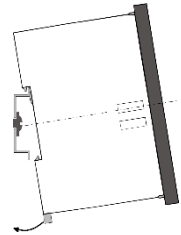
Before you begin, note that the mounting panel cannot be more than 5 mm thick.

1. Make a panel cut-out of the appropriate size:
2. Slide the controller into the cut-out, ensuring that the rubber seal is in place.
3. Push the mounting brackets into their slots on the sides of the panel as shown in the figure below.
4. Tighten the bracket's screws against the panel. Hold the bracket securely against the unit while tightening the screw.
5. When properly mounted, the controller is squarely situated in the panel cut-out as shown in the accompanying figures.




## DIN-rail Mounting

1. Snap the controller onto the DIN rail as shown in the figure to the right.



2. When properly mounted, the controller is squarely situated on the DIN-rail as shown in the figure to the right.


## Wiring

| | |
|---|---|
| ⚠ | ▪ Do not touch live wires. |
| ⚠ | ▪ This equipment is designed to operate only in SELV/PELV/Class 2/Limited Power environments.<br>▪ All power supplies in the system must include double insulation. Power supply outputs must be rated as SELV/PELV/Class 2/Limited Power.<br>▪ Do not connect either the 'Neutral or 'Line' signal of the 110/220VAC to device's 0V pin.<br>▪ All wiring activities should be performed while power is OFF.<br>▪ Use over-current protection, such as a fuse or circuit breaker, to avoid excessive currents into the power supply connection point.<br>▪ Unused points should not be connected (unless otherwise specified). Ignoring this directive may damage the device.<br>▪ Double-check all wiring before turning on the power supply. |
| *Caution* | ▪ To avoid damaging the wire, do not exceed a maximum torque of:<br>- Controllers offering a terminal block with pitch of 5mm: 0.5 N·m (5 kgf·cm).<br>- Controllers offering a terminal block with pitch of 3.81mm f 0.2 N·m (2 kgf·cm).<br>▪ Do not use tin, solder, or any substance on stripped wire that might cause the wire strand to break.<br>▪ Install at maximum distance from high-voltage cables and power equipment. |

## Wiring Procedure

Use crimp terminals for wiring;

- Controllers offering a terminal block with pitch of 5mm: 26-12 AWG wire (0.13 $mm^2$ –3.31 $mm^2$).
- Controllers offering a terminal block with pitch of 3.81mm: 26-16 AWG wire (0.13 $mm^2$ – 1.31 $mm^2$).

1. Strip the wire to a length of 7±0.5mm (0.270–0.300").
2. Unscrew the terminal to its widest position before inserting a wire.
3. Insert the wire completely into the terminal to ensure a proper connection.
4. Tighten enough to keep the wire from pulling free.

## Wiring Guidelines

- Use separate wiring ducts for each of the following groups:
  - Group 1: Low voltage I/O and supply lines, communication lines.
  - Group 2: High voltage Lines, Low voltage noisy lines like motor driver outputs.

  Separate these groups by at least 10cm (4"). If this is not possible, cross the ducts at a 90˚angle.
- For proper system operation, all 0V points in the system should be connected to the system 0V supply rail.
- Product-specific documentation must be fully read and understood before performing any wiring.

Allow for voltage drop and noise interference with input lines used over an extended distance.
Use wire that is properly sized for the load.

## Earthing the product

To maximize system performance, avoid electromagnetic interference as follows:

- Use a metal cabinet.
- Connect the 0V and functional ground points (if exist) directly to the earth ground of the system.
- Use the shortest, less than 1m (3.3 ft.) and thickest, 2.08mm² (14AWG) min, wires possible.

## UL Compliance

The following section is relevant to Unitronics' products that are listed with the UL.

The following models: V120-22-T1, V120-22-T2C, V120-22-UA2, V120-22-UN2, M91-2-R1, M91-2-R2C, M91-2-R6, M91-2-R6C, M91-2-T1, M91-2-T2C, M91-2-UA2, M91-2-UN2 are UL listed for Hazardous Locations.

The following models: V120-22-R1, V120-22-R2C, V120-22-R34, V120-22-R6, V120-22-R6C, V120-22-RA22, V120-22-T1, V120-22-T2C, V120-22-T38, V120-22-UA2, V120-22-UN2, M91-2-FL1, M91-2-PZ1, M91-2-R1, M91-2-R2, M91-2-R2C, M91-2-R34, M91-2-R6, M91-2-R6C, M91-2-RA22, M91-2-T1, M91-2-T2C, M91-2-T38, M91-2-TC2, M91-2-UA2, M91-2-UN2, M91-2-ZK, M91-T4-FL1, M91-T4-PZ1, M91-T4-R1, M91-T4-R2, M91-T4-R2C, M91-T4-R34, M91-T4-R6, M91-T4-R6C, M91-T4-RA22, M91-T4-T1, M91-T4-T2C, M91-T4-T38, M91-T4-TC2, M91-T4-UA2, M91-T4-UN2, M91-T4-ZK are UL listed for Ordinary Location.

For models from series M91, that include "T4" in the Model name, Suitable for mounting on the flat surface of Type 4X enclosure.
For examples: M91-T4-R6

### UL Ordinary Location

In order to meet the UL ordinary location standard, panel-mount this device on the flat surface of Type 1 or 4 X enclosures

## UL Ratings, Programmable Controllers for Use in Hazardous Locations, Class I, Division 2, Groups A, B, C and D

These Release Notes relate to all Unitronics products that bear the UL symbols used to mark products that have been approved for use in hazardous locations, Class I, Division 2, Groups A, B, C and D.

*Caution*

- This equipment is suitable for use in Class I, Division 2, Groups A, B, C and D, or Non-hazardous locations only.
- Input and output wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.
- WARNING—Explosion Hazard—substitution of components may impair suitability for Class I, Division 2.
- WARNING – EXPLOSION HAZARD – Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
- WARNING – Exposure to some chemicals may degrade the sealing properties of material used in Relays.
- This equipment must be installed using wiring methods as required for Class I, Division 2 as per the NEC and/or CEC.

## Panel-Mounting

For programmable controllers that can be mounted also on panel, in order to meet the UL Haz Loc standard, panel-mount this device on the flat surface of Type 1 or Type 4X enclosures.

## Relay Output Resistance Ratings

The products listed below contain relay outputs:

Programmable controllers, Models: M91-2-R1, M91-2-R2C,M91-2-R6C, M91-2-R6

- When these specific products are used in hazardous locations, they are rated at 3A res.
- when these specific products are used in non-hazardous environmental conditions, they are rated at 5A res, as given in the product's specifications.

## Temperature Ranges

Programmable Logic Controllers, Models, M91-2-R1, M91-2-R2C, M91-2-R6C.

- When these specific products are used in hazardous locations, they may be used only within a temperature range of 0-40ºC (32- 104ºF).
- When these specific products are used in non-hazardous environmental conditions, they function within the range of 0-50ºC (32- 122ºF) given in the product's specifications.

## Removing / Replacing the battery

When a product has been installed with a battery, do not remove or replace the battery unless the power has been switched off, or the area is known to be non-hazardous.

Please note that it is recommended to back up all data retained in RAM, in order to avoid losing data when changing the battery while the power is switched off. Date and time information will also need to be reset after the procedure.

## UL des zones ordinaires:

Pour respecter la norme UL des zones ordinaires, monter l'appareil sur une surface plane de type de protection 1 ou 4X

## Certification UL des automates programmables, pour une utilisation en environnement à risques, Class I, Division 2, Groups A, B, C et D.

Cette note fait référence à tous les produits Unitronics portant le symbole UL - produits qui ont été certifiés pour une utilisation dans des endroits dangereux, Classe I, Division 2, Groupes A, B, C et D.

*Attention*

- Cet équipement est adapté pour une utilisation en Classe I, Division 2, Groupes A, B, C et D, ou dans Non-dangereux endroits seulement.
- Le câblage des entrées/sorties doit être en accord avec les méthodes de câblage selon la Classe I, Division 2 et en accord avec l'autorité compétente.
- AVERTISSEMENT: Risque d'Explosion – Le remplacement de certains composants rend caduque la certification du produit selon la Classe I, Division 2.
- AVERTISSEMENT - DANGER D'EXPLOSION - Ne connecter pas ou ne débranche pas l'équipement sans avoir préalablement coupé l'alimentation électrique ou la zone est reconnue pour être non dangereuse.
- AVERTISSEMENT - L'exposition à certains produits chimiques peut dégrader les propriétés des matériaux utilisés pour l'étanchéité dans les relais.
- Cet équipement doit être installé utilisant des méthodes de câblage suivant la norme Class I, Division 2 NEC et /ou CEC.

## Montage de l'écran:

Pour les automates programmables qui peuvent aussi être monté sur l'écran, pour pouvoir être au standard UL, l'écran doit être monté dans un coffret avec une surface plane de type 1 ou de type 4X.

## Certification de la résistance des sorties relais

Les produits énumérés ci-dessous contiennent des sorties relais:

- Automates programmables, modèles : M91-2-R1, M91-2-R6C, M91-2-R6, M91-2-R2C
- Lorsque ces produits spécifiques sont utilisés dans des endroits dangereux, ils supportent un courant de 3A charge résistive.
- Lorsque ces produits spécifiques sont utilisés dans un environnement non dangereux, ils sont évalués à 5A res, comme indiqué dans les specifications du produit Plages de temperatures.

## Plages de température

Les Automates programmables, modèles: M91-2-R1, M91-2-R2C, M91-2-R6C.

- Dans un environnement dangereux, ils peuvent être seulement utilisés dans une plage de température allant de 0 et 40° C (32- 104ºF).
- Dans un environnement non dangereux, ils peuvent être utilisés dans une plage de température allant de 0 et 50º C (32- 122ºF).

## Retrait / Remplacement de la batterie

Lorsqu'un produit a été installé avec une batterie, retirez et remplacez la batterie seulement si l'alimentation est éteinte ou si l'environnement n'est pas dangereux.
Veuillez noter qu'il est recommandé de sauvegarder toutes les données conservées dans la RAM, afin d'éviter de perdre des données lors du changement de la batterie lorsque l'alimentation est coupée. Les informations sur la date et l'heure devront également être réinitialisées après la procedure.

# V120-22-RA22 Graphic Operator Panel & Programmable Logic Controller

24VDC, 12 pnp/npn digital inputs, including 2 analog inputs*, 2 temperature measurement inputs**, high-speed counter/shaft encoder input, 8 relay outputs, 2 analog outputs, I/O expansion port, 2 RS232/RS485 ports

| **Power supply** | 24VDC |
|---|---|
| Permissible range | 20.4VDC to 28.8VDC with less than 10% ripple |
| Maximum current consumption | 250mA@24VDC |
| | |
| **Digital inputs** | 12 pnp (source) or npn (sink) inputs. See Note 1. |
| Nominal input voltage | 24VDC. See Note 2. |
| Input voltages for pnp (source): | 0-5VDC for Logic '0'<br>17-28.8VDC for Logic '1' |
| Input voltages for npn (sink): | 17-28.8VDC/<1mA for Logic '0'<br>0-5VDC/>3mA for Logic '1' |
| Input current | 3.7mA@24VDC |
| Input impedance | 6.5KΩ |
| Response time (except high-speed inputs) | 10mS typical |
| Galvanic isolation | None |
| Input cable length | Up to 100 meters, unshielded |
| | |
| **High-speed counter** | Specifications below apply when inputs are wired for use as a high-speed counter input/shaft encoder. See Notes 3 and 4. |
| Resolution | 32-bit |
| Input frequency | 10kHz max. |
| Minimum pulse | 40µs |

Notes:

1. All 12 inputs can be set to pnp (source) or npn (sink) via a single jumper and appropriate wiring.
2. npn (sink) inputs use voltage supplied from the controller's power supply.
3. Input #0 can function as either high-speed counter or as part of a shaft encoder. In each case, high-speed input specifications apply. When used as a normal digital input, normal input specifications apply.
4. Input #1 can function as either counter reset, or as a normal digital input; in either case, specifications are those of a normal digital input. This input may also be used as part of a shaft encoder. In this case, high-speed input specifications apply.

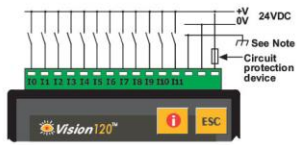
* These inputs can function as normal digital inputs or analog inputs (voltage/current), in accordance with jumper settings and wiring connections.

** These inputs can function as normal digital inputs, RTD, or thermocouple inputs, in accordance with jumper settings and wiring connections.

**Warnings**:

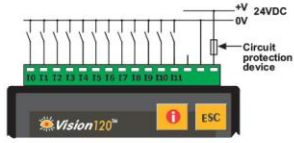
- Unused pins should not be connected. Ignoring this directive may damage the controller.
- Improper use of this product may severely damage the controller.
- Refer to the controller's User Guide regarding wiring considerations.
- Before using this product, it is the responsibility of the user to read the product's User Guide and all accompanying documentation.

**Power supply, pnp (source) inputs connection**

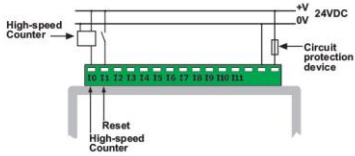



Note:
To avoid electromagnetic interference, mount the controller in a metal panel/cabinet and earth the power supply. Earth the power supply signal to the metal using a wire whose length does not exceed 10cm. If your conditions do not permit this, do not earth the power supply.

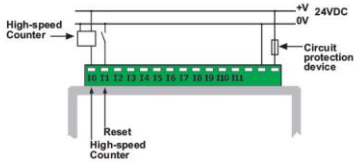
**npn (sink) inputs connection**



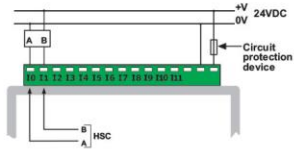

**pnp (source) high-speed counter connection**




**npn (sink) high-speed counter connection**




**Shaft encoder connection**



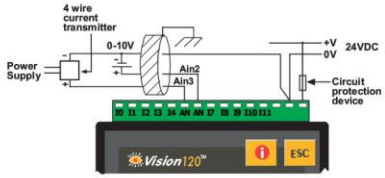
| Analog Inputs | Two 14-bit, multi-range inputs:<br>0-10V, 0-20mA, 4-20mA<br>See Note 1 |
|---|---|
| Conversion method | Voltage to Frequency |
| Input impedance | 12.77KΩ for voltage<br>37Ω for current |
| Isolation | None |
| **Normal mode** | |
| Resolution at 0-10V, 0-20mA | 14-bit (16384 units) |
| Resolution at 4-20mA | 3277 to 16383 (13107 units) |
| Conversion time | 100mSec minimum per input<br>(according to filter type) |
| **Fast mode** | |
| Resolution at 0-10V, 0-20mA | 12-bit (4096 units) |
| Resolution at 4-20mA | 819 to 4095 (3277 units) |
| Conversion time | 30mSec minimum per input<br>(according to filter type) |
| Absolute maximum rating | ±15V for voltage<br>±30mA for current |
| Linearity error | 0.04% maximum of full scale |
| Error limit | 0.4% of input value |
| Status indication | Yes, see Note 2 |

Notes:

1. Inputs #5 and #6 can each function as an analog input, related to signal 0V, in accordance with jumper settings and wiring connections.
2. The analog value can also indicate faults, as shown below:

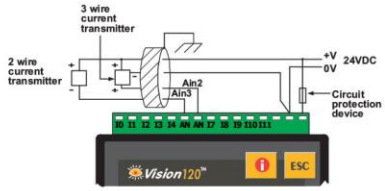
| Value: 12-bit (Fast mode) | Value: 14-bit (Normal mode) | Input value deviates: |
|---|---|---|
| -1 | -1 | Slightly **below** the input range. |
| 4096 | 16384 | Slightly **above** the input range. |
| 32767 | 32767 | Greatly **above or below** the input range. |

### Voltage / Current connection




Notes:
a. Shields should be connected at the signals' source.
b. The 0V signal of the analog input must be connected to the controller's 0V.

### Current connection




Notes:
a. Shields should be connected at the signals' source.
b. The 0V signal of the analog input must be connected to the controller's 0V.

| Thermocouple inputs | Two differential inputs.<br>See Note 1. |
|---|---|
| Input type | Thermocouple. See Note 2. |
| Input ranges | As shown in the table below |
| Isolation | None |
| Conversion method | Voltage to Frequency |
| Resolution | 0.1°C / 0.1°F |
| Conversion time | 100mSec minimum per input<br>(according to filter type) |
| Input impedance | >10MΩ |
| Cold junction compensation | local, automatic |
| Cold junction compensation error | ±1.5°C / ±2.7°F maximum |
| Absolute maximum rating | ±0.6 VDC |
| Linearity error | 0.04% maximum of full scale |
| Error limit | 0.4% of input value |
| Status indication | None |
| Warm-up time | ½ hour typically,<br>±1°C / ±1.8°F repeatability |

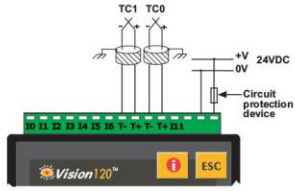
Notes:

1. Thermocouple #0: use Input #10 as positive input & Input #9 as negative input.
   Thermocouple #1: use Input #8 as positive input & Input #7 as negative input.
   To use inputs as thermocouple, set the relevant jumpers and use appropriate wiring.
2. The device can also measure voltage within the range of -5 to 56mV, at resolution of 0.01mV. The device can also measure raw value frequency.

**Table 1: input ranges**

| Type | Temperature range | Wire color | |
|---|---|---|---|
| | | ANSI (USA) | BS 1843 (UK) |
| mV | -5 to 56mV | - | - |
| B | 200 to 1820°C<br>(300 to 3276°F) | + Grey<br>- Red | + None<br>- Blue |
| E | -200 to 750°C<br>(-328 to 1382°F) | + Violet<br>- Red | + Brown<br>- Blue |
| J | -200 to 760°C<br>(-328 to 1400°F) | + White<br>- Red | + Yellow<br>- Blue |
| K | -200 to 1250°C<br>(-328 to 2282°F) | + Yellow<br>- Red | + Brown<br>- Blue |
| N | -200 to 1300°C<br>(-328 to 2372°F) | + Orange<br>- Red | + Orange<br>- Blue |
| R | 0 to 1768°C<br>(32 to 3214°F) | + Black<br>- Red | + White<br>- Blue |
| S | 0 to 1768°C<br>(32 to 3214°F) | + Black<br>- Red | + White<br>- Blue |
| T | -200 to 400°C<br>(-328 to 752°F) | + Blue<br>- Red | + White<br>- Blue |

### Thermocouple connection




Note:
Shields should be connected at the signals' source.

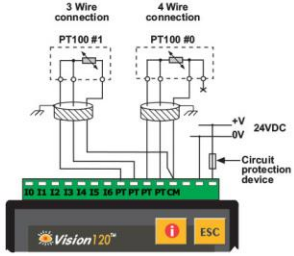
| RTD inputs | Two PT100 inputs. See Note 1. |
|---|---|
| Input ranges | -200 to 600°C (-328 to 1100°F)<br>1 to 320 ohms |
| Isolation | None |
| Measurement resolution | 0.1°C / 0.1°F |
| Conversion method | Voltage to Frequency |
| Conversion time | 300mSec minimum per input<br>(according to filter type) |
| Input impedance | >10MΩ |
| Auxiliary current for PT100 | 150µA typical |
| Linearity error | 0.04% max. of full scale |
| Error limit | 0.4% of input value |
| Status indication | Yes, see Note 2 |

Notes:

1. PT100 #0: use Input #9 & Input #10, related to CM signal (Input #11).
   PT100 #1: use Input #7 & Input #8, related to CM signal (Input #11).
   To use inputs as PT100, set the relevant jumpers and use appropriate wiring.
2. The analog value can also indicate faults, as shown below:

| Value | Possible Cause |
|---|---|
| 32767 | Sensor is not connected to input, or value exceeds the permissible range |
| -32767 | Sensor is short-circuited |

### PT100 connection

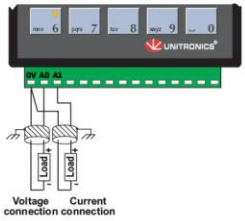



Note:
a. Shields should be connected at the signals' source.
b. 4 wire PT100 can be used by leaving one of the sense leads unconnected.

| Analog outputs | Two 12-bit analog outputs:<br>0-10V, 4-20mA, See Note |
|---|---|
| Load impedance | 1kΩ minimum - voltage<br>500Ω maximum - current |
| Galvanic isolation | None |
| Resolution | 12-bit (4096 units) |
| Conversion time | Synchronized to scan time |
| Linearity error | ±0.1% |
| Operational error limits | ±0.2% |

Note :
Each analog output range is defined by wiring, jumpers and within the controller's software.

### Analog outputs connection



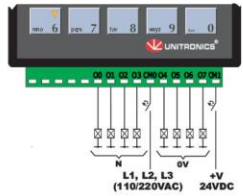

Notes:
a. Shields should be earthed, connected to the earth of the cabinet.
b. The 0V signal of the analog outputs must be the same 0V used by the controller's power supply.

| Relay outputs | 8 relays (in 2 groups) See Note |
|---|---|
| Output type | SPST-NO (Form A) |
| Type of relay | Tyco PCN-124D3MHZ<br>or compatible |
| Isolation | by relay |
| Output current (resistive load) | 3A max per output<br>8A max total for common |
| Rated voltage | 250VAC / 30VDC |
| Minimum load | 1mA@5VDC |
| Life expectancy | 100k operations at maximum load |
| Response time | 10mS (typical) |
| Contact protection | External precautions required<br>(see below) |

Note:
Outputs #0, #1, #2 and #3 share a common signal.
Outputs #4, #5, #6 and #7 share a common signal.

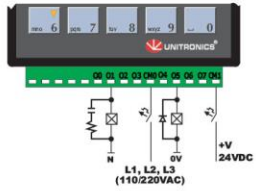
### Relay outputs connection

- Each Output group can be wired separately to either AC or DC as shown below.
- The power signals in the illustration below are isolated from the controller's power signals.




**Increasing Contact Life Span**
To increase the life span of the relay output contacts and protect the device from potential damage by reverse EMF, connect:

- a clamping diode in parallel to each inductive DC load.
- an RC snubber circuit in parallel with each inductive AC load.



| Graphic Display | STN, LCD display |
|---|---|
| Illumination backlight | LED, yellow-green, software-controlled |
| Display resolution | 128x64 pixels |

| Keypad | Sealed membrane |
|---|---|
| Number of keys | 16 |

| Program | |
|---|---|
| Application memory | 448K |
| Memory Bits (coils) | 4096 |
| Memory Integers (registers) | 2048 |
| Long Integers (32 bit) | 256 |
| Double Word (32 bit unsigned) | 64 |
| Floats | 24 |
| Timers | 192 |
| Counters | 24 |
| Data Tables | 120K (RAM) / 64K (FLASH) |
| HMI displays | Up to 255 |
| Execution time | 0.8µs for bit operations |

| RS232/RS485 serial ports | Used for:<br>• Application Download/Upload<br>• Application Testing (Debug)<br>• Connect to GSM or standard telephone modem:<br>- Send/receive SMS messages<br>- Remote access programming<br>• RS485 Networking |
|---|---|
| **RS232** (see note) | 2 ports |
| Galvanic isolation | None |
| Voltage limits | ±20V |
| **RS485** (see note) | 2 ports |
| Input voltage | -7 to +12V differential max. |
| Cable type | Shielded twisted pair, in compliance with EIA RS485 |
| Galvanic isolation | None |
| Nodes | Up to 32 |
| Baud rate | 110 – 57600 bps |

Note:
RS232/RS485 is determined by jumper settings and wiring.
Refer to the controller's User Guide regarding communications.

| I/O expansion port | Up to 128 additional I/Os, including digital & analog I/Os, temperature and weight inputs and more. (number of I/Os may vary according to expansion model) |
|---|---|

| Miscellaneous | |
|---|---|
| Clock (RTC) | Real-time clock functions (Date and time). |
| Battery back-up | 7 years typical at 25°C, battery back-up for RTC and system data, including variable data. |
| Battery | Coin type, 3V lithium battery, CR2450 |
| Weight | 317g (11.2 oz.) |
| Operational temperature | 0 to 50°C (32 to 122°F) |
| Storage temperature | -20 to 60°C (-4 to 140°F) |
| Relative Humidity (RH) | 5% to 95% (non-condensing) |
| Mounting method | DIN-rail mounted (IP20/NEMA1)<br>Panel mounted (IP65/NEMA4X) |

# M91-2-RA22 Operator Panel & Programmable Logic Controller

24VDC, 12 digital inputs, including 2 analog inputs*, 2 temperature measurement inputs** and high-speed counter/shaft encoder input, 8 relay outputs, 2 analog outputs, I/O expansion port, RS232/RS485 port

| | |
|---|---|
| **Power supply** | 24VDC |
| Permissible range | 20.4VDC to 28.8VDC with less than 10% ripple |
| Maximum current consumption | 220mA@24VDC |
| | |
| **Digital inputs** | 12 pnp (source) or npn (sink) inputs. See Note 1. |
| Nominal input voltage | 24VDC<br>See Notes 2. |
| Input voltages for pnp (source): | 0-5VDC for Logic '0'<br>17-28.8VDC for Logic '1' |
| Input voltages for npn (sink): | 17-28.8VDC/<1mA for Logic '0'<br>0-5VDC/>3mA for Logic '1' |
| Input current | 3.7mA@24VDC |
| Input impedance | 6.5KΩ |
| Response time (except high-speed inputs) | 10mS typical |
| Galvanic isolation | None |
| Input cable length | Up to 100 meters, unshielded |
| | |
| **High-speed counter** | Specifications below apply when inputs are wired for use as a high-speed counter input/shaft encoder. See Notes 3 and 4. |
| Resolution | 16-bit |
| Input frequency | 10kHz max. |
| Minimum pulse | 40µs |

Notes:

1. All 12 inputs can be set to pnp (source) or npn (sink) via a single jumper and appropriate wiring.
2. npn (sink) inputs use voltage supplied from the controller's power supply.
3. Input #0 can function as either high-speed counter or as part of a shaft encoder. In each case, high-speed input specifications apply. When used as a normal digital input, normal input specifications apply.
4. Input #1 can function as either counter reset, or as a normal digital input; in either case, specifications are those of a normal digital input.
   This input may also be used as part of a shaft encoder.
   In this case, high-speed input specifications apply.

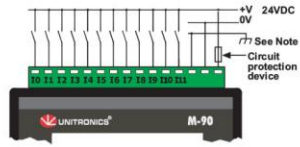
* These inputs can function as normal digital inputs or analog inputs (voltage/current), in accordance with jumper settings and wiring connections.

** These inputs can function as normal digital inputs, RTD, or thermocouple inputs, in accordance with jumper settings and wiring connections.

**Warnings**:

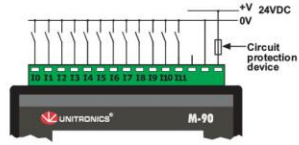
- Unused pins should not be connected. Ignoring this directive may damage the controller.
- Improper use of this product may severely damage the controller.
- Refer to the controller's User Guide regarding wiring considerations.
- Before using this product, it is the responsibility of the user to read the product's User Guide and all accompanying documentation.

**Power supply, pnp (source) inputs connection**

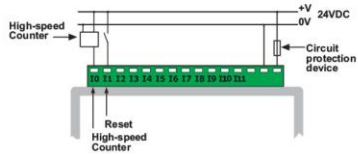



Note:
To avoid electromagnetic interference, mount the controller in a metal panel/cabinet and earth the power supply. Earth the power supply signal to the metal using a wire whose length does not exceed 10cm. If your conditions do not permit this, do not earth the power supply.

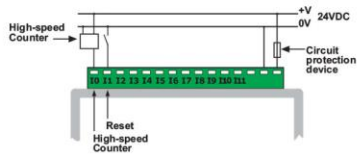
**npn (sink) inputs connection**



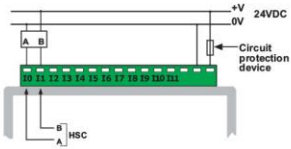

**pnp (source) high-speed counter connection**




**npn (sink) high-speed counter connection**




**Shaft encoder connection**



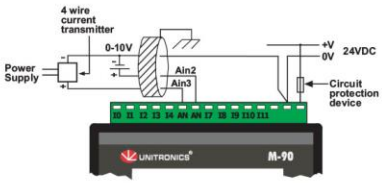
| Analog Inputs | Two 14-bit, multi-range inputs:<br>0-10V, 0-20mA, 4-20mA<br>See Note 1 |
|---|---|
| Conversion method | Voltage to Frequency |
| Input impedance | 12.77KΩ for voltage<br>37Ω for current |
| Isolation | None |
| **Normal mode** | |
| Resolution at 0-10V, 0-20mA | 14-bit (16384 units) |
| Resolution at 4-20mA | 3277 to 16383 (13107 units) |
| Conversion time | 100mSec minimum per input<br>(according to filter type) |
| **Fast mode** | |
| Resolution at 0-10V, 0-20mA | 12-bit (4096 units) |
| Resolution at 4-20mA | 819 to 4095 (3277 units) |
| Conversion time | 30mSec minimum per input<br>(according to filter type) |
| Absolute maximum rating | ±15V for voltage<br>±30mA for current |
| Linearity error | 0.04% maximum of full scale |
| Error limit | 0.4% of input value |
| Status indication | Yes, see Note 2 |

Notes:

1. Input #5 and input #6 can be used as analog inputs, related to signal 0V, in accordance with jumper settings and wiring connections.
2. The analog value can also indicate faults, as shown below:

| Value: 12-bit (Fast mode) | Value: 14-bit (Normal mode) | Input value deviates: |
|---|---|---|
| -1 | -1 | Slightly **below** the input range. |
| 4096 | 16384 | Slightly **above** the input range. |
| 32767 | 32767 | Greatly **above or below** the input range. |

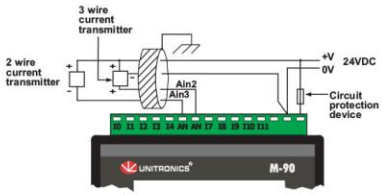
### Voltage / Current connection




Notes:

a. Shields should be connected at the signals' source.
b. The 0V signal of the analog input must be connected to the controller's 0V.

### Current connection




Notes:

a. Shields should be connected at the signals' source.
b. The 0V signal of the analog input must be connected to the controller's 0V.

| Thermocouple inputs | Two differential inputs.<br>See Note 1. |
|---|---|
| Input type | Thermocouple. See Note 2. |
| Input ranges | As shown in the table below |
| Isolation | None |
| Conversion method | Voltage to Frequency |
| Resolution | 0.1°C / 0.1°F |
| Conversion time | 100mSec minimum per input<br>(according to filter type) |
| Input impedance | >10MΩ |
| Cold junction compensation | local, automatic |
| Cold junction compensation error | ±1.5°C / ±2.7°F maximum |
| Absolute maximum rating | ±0.6 VDC |
| Linearity error | 0.04% maximum of full scale |
| Error limit | 0.4% of input value |
| Status indication | None |
| Warm-up time | ½ hour typically,<br>±1°C / ±1.8°F repeatability |

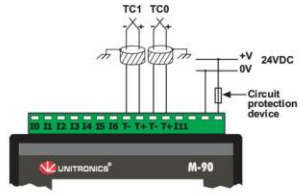
Notes:

1. Thermocouple #0: use Input #10 as positive input & Input #9 as negative input.
   Thermocouple #1: use Input #8 as positive input & Input #7 as negative input.
   To use inputs as thermocouple, set the relevant jumpers and use appropriate wiring.
2. The device can also measure voltage within the range of -5 to 56mV, at resolution of 0.01mV. The device can also measure raw value frequency.

**Table 1: input ranges**

| Type | Temperature range | Wire color | |
|---|---|---|---|
| | | ANSI (USA) | BS 1843 (UK) |
| mV | -5 to 56mV | - | - |
| B | 200 to 1820°C<br>(300 to 3276°F) | + Grey<br>- Red | + None<br>- Blue |
| E | -200 to 750°C<br>(-328 to 1382°F) | + Violet<br>- Red | + Brown<br>- Blue |
| J | -200 to 760°C<br>(-328 to 1400°F) | + White<br>- Red | + Yellow<br>- Blue |
| K | -200 to 1250°C<br>(-328 to 2282°F) | + Yellow<br>- Red | + Brown<br>- Blue |
| N | -200 to 1300°C<br>(-328 to 2372°F) | + Orange<br>- Red | + Orange<br>- Blue |
| R | 0 to 1768°C<br>(32 to 3214°F) | + Black<br>- Red | + White<br>- Blue |
| S | 0 to 1768°C<br>(32 to 3214°F) | + Black<br>- Red | + White<br>- Blue |
| T | -200 to 400°C<br>(-328 to 752°F) | + Blue<br>- Red | + White<br>- Blue |

### Thermocouple connection




Note:
Shields should be connected at the signals' source.

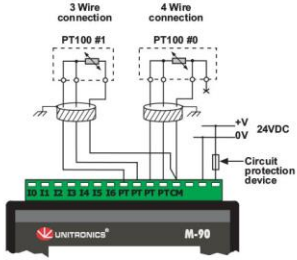
| RTD inputs | Two PT100 inputs. See Note 1. |
|---|---|
| Input range | -200 to 600°C (-328 to 1100°F)<br>1 to 320 ohm |
| Isolation | None |
| Measurement resolution | 0.1°C / 0.1°F |
| Conversion method | Voltage to Frequency |
| Conversion time | 300mSec minimum per input<br>(according to filter type) |
| Input impedance | >10MΩ |
| Auxiliary current for PT100 | 150µA typical |
| Linearity error | 0.04% max. of full scale |
| Error limit | 0.4% of input value |
| Status indication | Yes, see Note 2 |

Notes:

1. PT100 #0: use Input #9 & Input #10, related to CM signal (Input #11).
   PT100 #1: use Input #7 & Input #8, related to CM signal (Input #11).
   To use inputs as PT100, set the relevant jumpers and use appropriate wiring.
2. The analog value can also indicate faults, as shown below:

| Value | Possible Cause |
|---|---|
| 32767 | Sensor is not connected to input, or value exceeds the permissible range |
| -32767 | Sensor is short-circuited |

### PT100 connection



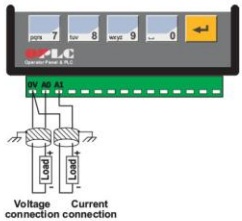

Note:

a. Shields should be connected at the signals' source.
b. 4 wire PT100 can be used by leaving one of the sense leads unconnected.

| Analog outputs | Two 12-bit analog outputs:<br>0-10V, 4-20mA, See Note |
|---|---|
| Load impedance | 1kΩ minimum - voltage<br>500Ω maximum - current |
| Galvanic isolation | None |
| Resolution | 12-bit (4096 units) |
| Conversion time | Synchronized to scan time |
| Linearity error | ±0.1% |
| Operational error limits | ±0.2% |

Note :
Each analog output range is defined by wiring, jumpers and within the controller's software.

### Analog outputs connection




Notes:

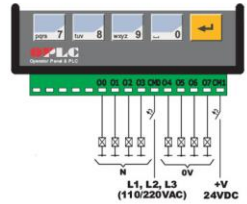
a. Shields should be earthed, connected to the earth of the cabinet.
b. The 0V signal of the analog outputs must be the same 0V used by the controller's power supply.

| Relay outputs | 8 relays (in 2 groups) See Note |
|---|---|
| Output type | SPST-NO (Form A) |
| Type of relay | Tyco PCN-124D3MHZ<br>or compatible |
| Isolation | by relay |
| Output current (resistive load) | 3A max per output<br>8A max total for common |
| Rated voltage | 250VAC / 30VDC |
| Minimum load | 1mA@5VDC |
| Life expectancy | 100k operations at maximum load |
| Response time | 10mS (typical) |
| Contact protection | External precautions required<br>(see below) |

Note:
Outputs #0, #1, #2 and #3 share a common signal.
Outputs #4, #5, #6 and #7 share a common signal.

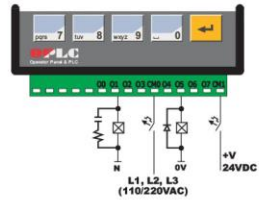
### Relay outputs connection

- Each Output group can be wired separately to either AC or DC as shown below.
- The power signals in the illustration below are isolated from the controller's power signals.




**Increasing Contact Life Span**
To increase the life span of the relay output contacts and protect the device from potential damage by reverse EMF, connect:

- a clamping diode in parallel to each inductive DC load.
- an RC snubber circuit in parallel with each inductive AC load.



| Display | STN, LCD display |
|---|---|
| Illumination | LED yellow-green backlight |
| Display size | 2 lines, 16 characters long |
| Character size | 5 x 8 matrix, 2.95 x 5.55mm |

| Keypad | Sealed membrane |
|---|---|
| Number of keys | 15 |

| PLC program | |
|---|---|
| Ladder Code Memory (virtual) | 36K |
| Memory Bits (coils) | 256 |
| Memory Integers (Registers) | 256 |
| Timers | 64 |
| Execution time | 12µsec. for bit operations |
| Database | 1024 integers (indirect access) |
| HMI displays | 80 user-designed displays |
| HMI variables | 64 HMI variables are available to conditionally display and modify text, numbers, dates, times & timer values. The user can also create a list of up to 120 variable text displays, totaling up to 2K. |

| RS232/RS485 serial port | Used for:<br>• Application Download/Upload<br>• Application Testing (Debug)<br>• Connect to GSM or standard telephone modem:<br>- Send/receive SMS messages<br>- Remote access programming<br>• RS485 Networking |
|---|---|
| **RS232** (see note) | 1 port |
| Galvanic isolation | None |
| Voltage limits | ±20V |
| **RS485** (see note) | 1 port |
| Input voltage | -7 to +12V differential max. |
| Cable type | Shielded twisted pair, in compliance with EIA RS485 |
| Galvanic isolation | None |
| Nodes | Up to 32 |
| Baud rate | 110 – 57600 bps |

Note:
RS232/RS485 is determined by jumper settings and wiring as described in the document "M91 RS485 Port Settings" packaged with the controller.

| I/O expansion port | Up to 96 additional I/Os, including digital & analog I/Os, temperature and weight inputs and more. (number of I/Os may vary according to expansion model) |
|---|---|

| Miscellaneous | |
|---|---|
| Clock (RTC) | Real-time clock functions (Date and Time). |
| Battery back-up | 7 years typical at 25°C, battery back-up for RTC and system data, including variable data. |
| Weight | 314g (11.1 oz.) |
| Operational temperature | 0 to 50°C (32 to 122°F) |
| Storage temperature | -20 to 60°C (-4 to 140°F) |
| Relative Humidity (RH) | 5% to 95% (non-condensing) |
| Mounting method | DIN-rail mounted (IP20/NEMA1)<br>Panel mounted (IP65/NEMA4X) |

# I/O Jumper Settings

The tables below show how to set a specific jumper to change the functionality of a specific input.
To open the controller and access the jumpers, refer to the directions at the end of these specifications.

**Important:** Incompatible jumper settings and wiring connections may severely damage the controller.

## Temperature measurement Inputs

**Inputs # 7-10**

**JP5, JP6, JP7**
**Input #9 and Input #10 (universal input No.0)**

| To use as | JP5 | JP6 | JP7 |
|---|---|---|---|
| Normal digital inputs* | A | A | A |
| Thermocouple input (See Note 1) | B | B | B |
| PT100 input (See Note 2) | B | A | B |

Notes:

1. Thermocouple input is between Input #10 (T+) and Input #9 (T-).
2. PT100 input is connected to Input #9 and Input #10, related to CM signal (Input #11).

**JP1, JP2. JP3**
**Input #7 and Input #8 (universal input No.1)**

| To use as | JP1 | JP2 | JP3 |
|---|---|---|---|
| Normal digital inputs* | A | A | A |
| Thermocouple input (See Note 1) | B | B | B |
| PT100 input (See Note 2) | B | A | B |

Notes:

1. Thermocouple input is between Input #8 (T+) and Input #7 (T-).
2. PT100 input is connected to Input #7 and Input #8, related to CM signal (Input #11).

**JP11**
**Input #11**

| To use as | JP11 |
|---|---|
| Normal digital input* | A |
| CM signal for PT100 inputs | B |

## Analog (Voltage/Current) Inputs

**Inputs # 5-6**

**JP8, JP9**
**Input #6 (universal input No. 2)**

| To use as | JP8 | JP9 |
|---|---|---|
| Normal digital input* | A | A |
| Analog input - voltage | B | A |
| Analog input - current | B | B |

**JP4, JP10**
**Input #5 (universal input No. 3)**

| To use as | JP4 | JP10 |
|---|---|---|
| Normal digital input* | A | A |
| Analog input - voltage | B | A |
| Analog input - current | B | B |

*Default factory setting

**JP12**
**Input type (for all digital inputs)**
see Note

| To use as | JP12 |
|---|---|
| npn (sink) | A |
| pnp (source)* | B |

Note:
Inputs #0-4, and #5-11 when these are set as normal digital inputs.

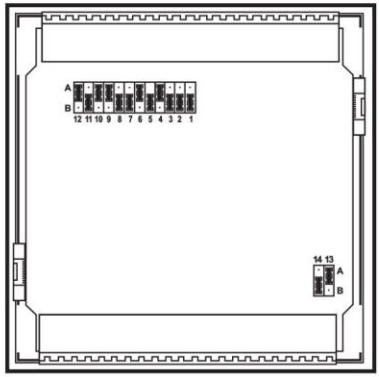
**JP13**
**Analog output #0**

| To use as | JP13 |
|---|---|
| Voltage* | A |
| Current | B |

**JP14**
**Analog output #1**

| To use as | JP14 |
|---|---|
| Voltage* | A |
| Current | B |

*Default factory setting




**In this figure, the jumper settings will cause the inputs and the analog outputs to function as follows:**

Universal Input #0 (Input #9 and #10): PT100 input, related to the CM Signal (input#11)

Universal Input #1 (Input #7 and Input #8): Termocouple input

Universal Input #2 (Input #6): Voltage input related to 0V

Universal Input #3 (Input #5): Normal npn, 24VDC digital input

Input#0 to Input #4: npn, 24VDC digital inputs.

(Note that these inputs can only function as normal digital inputs.)

Analog output #0: Voltage output

Analog output #1: Current output

## Communication Ports

Note that different controller models offer different serial and CANbus communication options. To see which options are relevant, check your controller's technical specifications.

- Turn off power before making communications connections.

*Caution*
- Note that the serial ports are not isolated.
- Signals are related to the controller's 0V; the same 0V is used by the power supply.
- Always use the appropriate port adapters.

### Serial Communications

This series comprises 2 serial port can be set to either RS232 or RS485 according to jumper settings. By default, the ports are set to RS232.

Use RS232 to download programs from a PC, and to communicate with serial devices and applications, such as SCADA.

Use RS485 to create a multi-drop network containing up to 32 devices.

*Caution* ■ The serial ports are not isolated. If the controller is used with a non-isolated external device, avoid potential voltage that exceeds ± 10V.

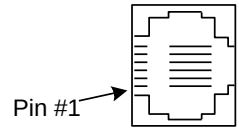
**Pinouts**

The pinouts below show the signals between the adapter and port.

| RS232 | |
|---|---|
| **Pin #** | **Description** |
| 1* | DTR signal |
| 2 | 0V reference |
| 3 | TXD signal |
| 4 | RXD signal |
| 5 | 0V reference |
| 6* | DSR signal* |

| RS485 | |
|---|---|
| **Pin #** | **Description** |
| 1 | A signal (+) |
| 2 | (RS232 signal) |
| 3 | (RS232 signal) |
| 4 | (RS232 signal) |
| 5 | (RS232 signal) |
| 6 | B signal (-) |

**Controller Port**



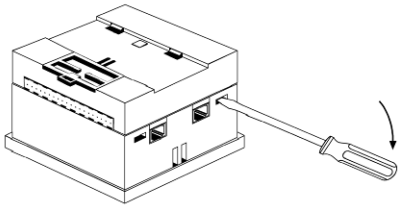

*Standard programming cables do not provide connection points for pins 1 and 6.

**RS232 to RS485: Changing Jumper Settings**

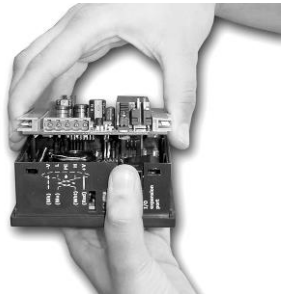
- To access the jumpers, open the controller and then remove the module's PCB board. Before you begin, turn off the power supply, disconnect and dismount the controller.
- When a port is adapted to RS485, Pin 1 (DTR) is used for signal A, and Pin 6 (DSR) signal is used for signal B.
- If a port is set to RS485, **and** flow signals DTR and DSR are not used, the port can also be used to communicate via RS232; with the appropriate cables and wiring.

- Before performing these actions, touch a grounded object to discharge any electrostatic charge.
- Avoid touching the PCB board directly. Hold the PCB board by its connectors.

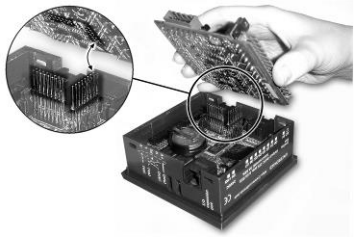
## Opening the controller



1. Turn power off before opening the controller.
2. Locate the 4 slots on the sides of the controller.
3. Using the blade of a flat-bladed screwdriver, gently pry off the back of the controller.



4. Gently remove the top PCB board:
    a. Use one hand to hold the top-most PCB board by its top and bottom connectors.
    b. With the other hand, grasp the controller, while keeping hold of the serial ports; this will keep the bottom board from being removed together with the top board.
    c. Steadily pull the top board off.
5. Locate the jumpers, and then change the jumper settings as required.



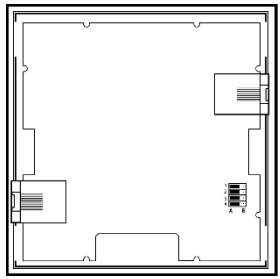
6. Gently replace the PCB board. Make certain that the pins fit correctly into their matching receptacle.
    a. Do not force the board into place; doing so may damage the controller.
7. Close the controller by snapping the plastic cover back in its place. If the card is placed correctly, the cover will snap on easily.

## M91: RS232/RS485 Jumper Settings

| RS232/RS485 Jumper Setting | | |
|---|---|---|
| **To use as** | **Jumper 1** | **Jumper 2** |
| **RS232*** | A | A |
| **RS485** | B | B |

| RS485 Termination | | |
|---|---|---|
| **Termination** | **Jumper 3** | **Jumper 4** |
| **ON*** | A | A |
| **OFF** | B | B |

*Default factory setting.

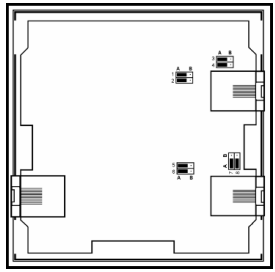


## V120: RS232/RS485 Jumper Settings

| | Jumper Settings | | |
|---|---|---|---|
| | **Jumper** | **RS232*** | **RS485** |
| **COM 1** | 1 | A | B |
| | 2 | A | B |
| **COM 2** | 5 | A | B |
| | 6 | A | B |

| RS485 Termination | | |
|---|---|---|
| **Jumper** | **ON*** | **OFF** |
| 3 | A | B |
| 4 | A | B |
| 7 | A | B |
| 8 | A | B |

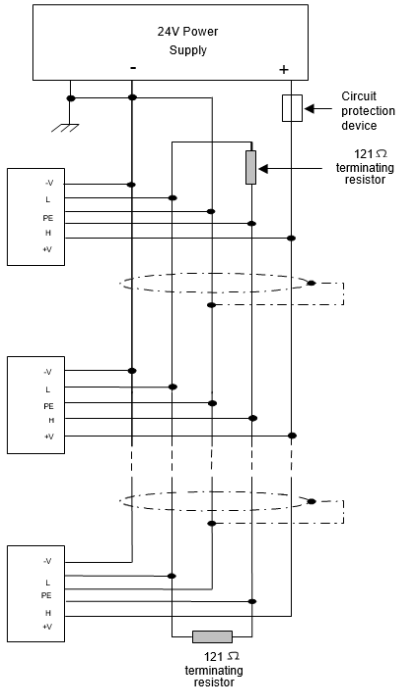
*Default factory setting.



## CANbus

These controllers comprise a CANbus port. Use this to create a decentralized control network of up to 63 controllers, using either Unitronics' proprietary CANbus protocol or CANopen.

The CANbus port is galvanically isolated.




### CANbus Wiring

Use twisted-pair cable. DeviceNet® thick

shielded twisted pair cable is recommended.

Network terminators: These are supplied with the controller. Place terminators at each end of the CANbus network.

Resistance must be set to 1%, 1210, 1/4W.

Connect ground signal to the earth at only one point, near the power supply.

The network power supply need not be at the end of the network

### CANbus Connector