Installation

Before installation

⚠ **WARNING:** Read this manual carefully before installing and operating the SMD3. Observe the following safety instructions.

Qualified personnel

⚠ **WARNING:** All work described in this document may only be carried out by persons who have suitable technical training and the necessary experience or who have been instructed by the end-user of the product.

⚠ **WARNING:** Without proper training and necessary experience, damage to the equipment or personal injury might result.

⚠ **DANGER:** Danger of electric arcing! Never plug or unplug any connector while powered. Plugging or unplugging a motor while powered may damage or destry the driver output stage

Additional safety and warning notices

Unpacking

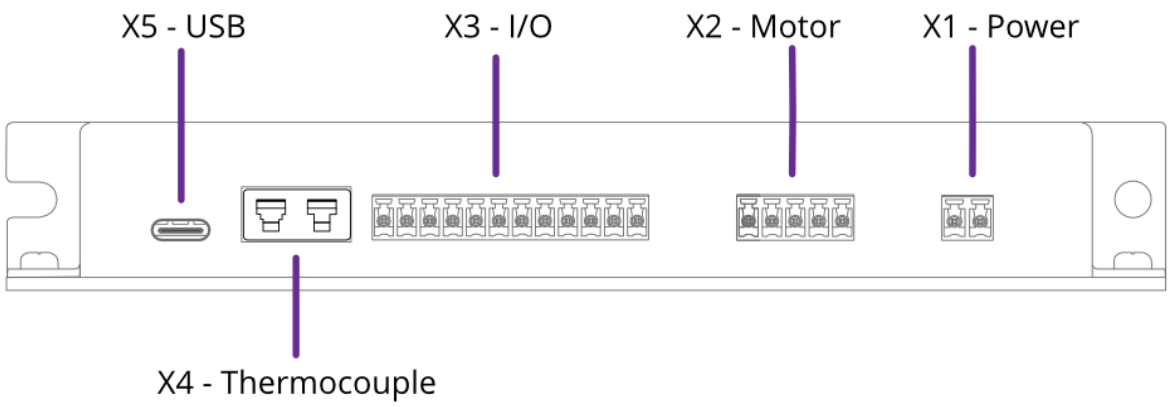
On receipt of the instrument remove all packing material and check that all items on the delivery note have been received. Report any damage or shortages to the company or distributor who supplied the instrument. The packing material has been specially designed to protect the instrument and should be retained for possible future use.

Mechanical installation

The SMD3 may be mounted via the front panel and or underside flanges, in any orientation. Forced air ventilation is not required. The ambient operating temperature range is 10 °C to 60 °C.

Connecting

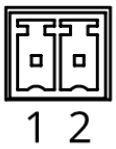
Rear panel



The Power, Motor and I/O sockets use 3.5 mm pitch pluggable rewireable terminal blocks. These are suitable for 28 – 16 AWG (1.5 mm^2 max.) stranded wire. Strip insulation to approx. 6 – 7 mm before securing the wire in the terminal block.

Connectors are supplied for X1, X2, X3 and X4. Replacement connectors are available from IMO Precision Controls, part number 20.1550M/X-E where 'X' is the number of ways. For example, the part number for the power connector pluggable terminal block would be 20.1550M/2-E. These are readily available from electronics distributors.

X1 - Power



1	GND
2	V+

Power input for both internal logic circuits and the motor itself.

The power supply must meet the following requirements:

- 15 – 67 V DC regulated supply, 30 W minimum
- Reinforced or double insulation between mains and supply output

DANGER: Danger of electric arcing! Never plug or unplug the connector while powered.

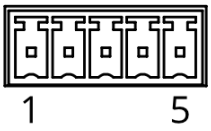
⚠ **CAUTION**: In the event of reverse polarity, a short circuit will occur between GND and V+ through an internal power diode. Therefore, an external fuse must be installed in the supply line.

The fuse should be sized:

- Greater than the current consumption of the SMD3 when operating the connected motor
- Less than the maximum current output of the power supply
- Considering the voltage of the supply

ℹ **INFORMATION:** Choice of input voltage affects motor performance; operating at the maximum voltage possible (67 Vdc) will maximise motor torque at higher speeds.

X2 - Motor



1	GND
2	Phase A1
3	Phase A2
4	Phase B1
5	Phase B2

Motor output. Connection of the motor to the vacuum feedthrough, and vacuum feedthrough to the SMD3 is discussed in section Motor Wiring.

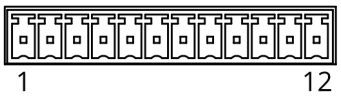
Custom motor cables must be built to the following specification to ensure continued compliance with EMC standards and correct function:

- Four cores, comprising two twisted pairs plus screen. A foil screen plus drain wire is acceptable; a foil plus braid screen is better
- The screen must be connected via as short a wire as possible to pin 1, 'GND', using insulated wire
- Rated voltage >= 300 V rms
- Rated current > 1.5 A rms

Maximum cable length is limited by the resistance of the cores; total round trip cable resistance per phase should be kept to less than few ohms. Consult the cable manufacturers data for these details.

DANGER! Danger of electric arcing! Never plug or unplug the connector while powered! Plugging or unplugging motor while powered may damage or destroy the driver output stages.

X3 - I/O



1	GND
2	RTD B2
3	RTD B1
4	RTD A
5	LIMIT 1 / Positive
6	LIMIT 2 / Negative
7	FAULT
8	RESET
9	SDE COM
10	STEP
11	DIR
12	EN

RTD

For motors equipped with an RTD instead of a thermocouple, make the RTD connection here. If the RTD is not required, leave the connections open.

Limits

There are two limits inputs; they can be configured to stop the motor on one or both limits being triggered. A limit input is triggered by shorting it to pin 1, ‘GND’, usually with a mechanical switch mounted on the mechanism that the motor is driving. Logic level signals, for example, from optical or hall effect sensors may also be used.

Limit 1 applies when the motor position counter is incrementing, and limit 2 applies when the motor position counter is decrementing.

Limits inputs include a pullup resistor. See section Limits for details.

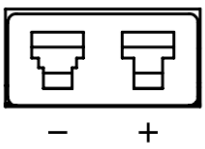
Fault output and reset

The SMD3 disables the motor under certain fault conditions, see section Faults. When this happens, the open collector ‘FAULT’ output on pin 7 is set and may be used to signal to an external controller that the SMD3 is in a fault state.

Fault states are latching; once set the fault condition must be removed and the fault reset before normal operation may resume using either a remote interface command (see CLR) or pulling the ‘RESET’ signal on pin 8 to ‘GND’. This does not apply to the ‘EN’ (enable) input when in step direction mode, i.e. the enable input is not latching, and normal operation will resume immediately on restoring the enable input state. See section Faults for details.

Step, Direction and Enable
The step direction enable interface is an industry standard interface allowing an external motion controller to generate stepping sequences, bypassing the SMD3’s internal motion controller. The inputs are galvanically isolated with three opto-isolators with bi-directional LEDs, and share a common connection, ‘SDE COM’ on pin 9. See section Step/Direction for details

X4 - Thermocouple



-	T/C -
+	T/C +

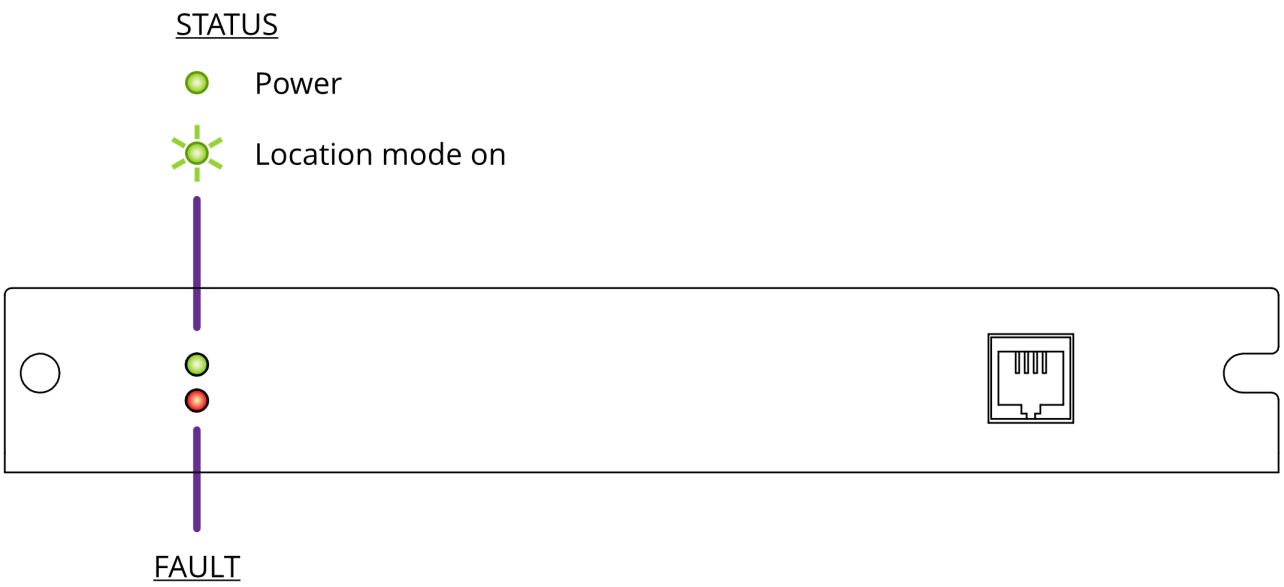
The thermocouple lead for motors equipped with the standard K-Type thermocouple should be connected here. If using a motor equipped with an RTD, this connection may be left open. Be sure to select the correct sensor type, see section Temperature sensor selection.
The connection is for use with a standard IEC Miniature K-Type thermocouple plug. These are colour coded green for K-Type thermocouples.

X5 - USB

USB Type-C connection. The connection is reversible, and the plug may be inserted either way up.

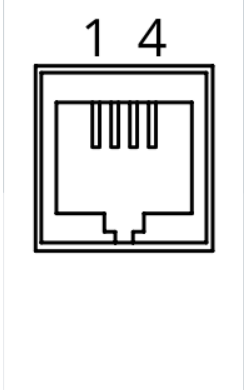
The SMD3 appears as a virtual COM port when connected to the PC. No additional drivers are required. Configure and control the SMD3 using the supplied SMD3 software, a terminal program, or your own application. AML supply a C# API, available on our website to help customers implement their own applications faster.

Front panel



The fault indicator flashes or remains lit if the SMD3 is in a fault state (see section Faults for fault indications). When a fault is present, motor operation is disabled.

X6 - Joystick



1	GND
2	CW
3	CCW

	4	DETECT

For connection of a two-button joystick allowing basic motor control, for example, during commissioning. AML supply the SMD3 Joystick, part number ‘SMD3JOY’ for this purpose. On connection, the SMD3 automatically switches to joystick mode.

- If designing your own joystick or device to connect to this port:
- Inputs have internal pull-ups.
- Activate the function by shorting ‘CW’, ‘CCW’ or ‘DETECT’ to pin 1, ‘GND’.
- Pin 4, ‘DETECT’ is used to signal to the SMD3 that the joystick is connected and trigger automatic switch to joystick mode. If not required, leave the pin unconnected. This requires joystick mode to be manually selected.

Logic level signals may also be used; 12 V max.

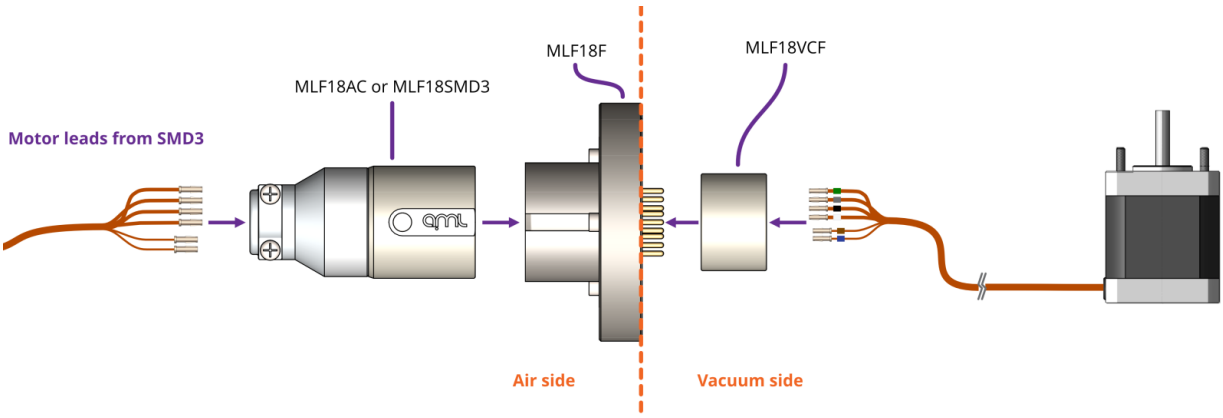
Motor wiring

Overview

Connecting motors inside a vacuum chamber to the SMD3 comprises two tasks:

- Wiring the motor to a vacuum feedthrough installed in the chamber wall.
- Wiring the vacuum feedthrough to the SMD3.

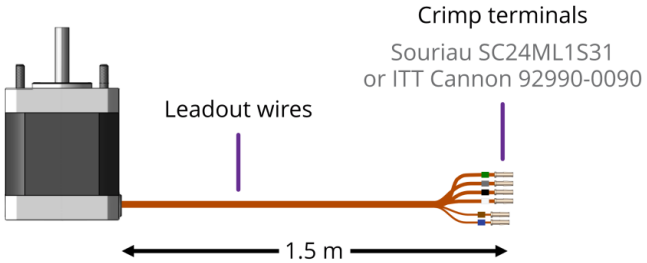
AML supply vacuum feedthroughs, ready-made cabling, and components allowing custom cables to be easily manufactured. A typical setup is shown below and used for illustration throughout this section.



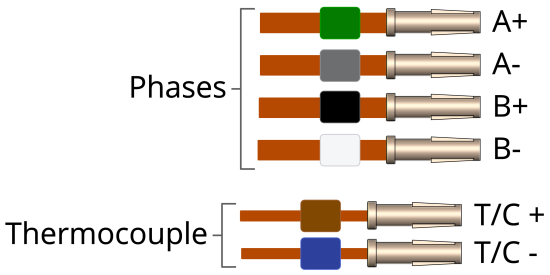
INFORMATION: Verify that the motor is working correctly before sealing the vacuum chamber. Rectifying mistakes afterwards is inconvenient.

Lead identification

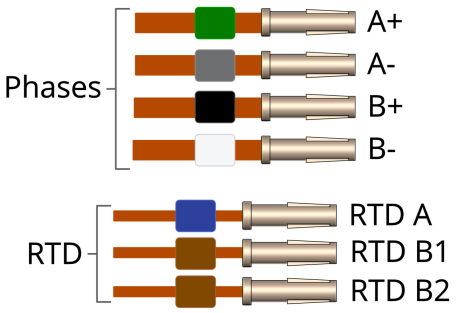
The motor leadout wires are self-coloured polyimide film-wrapped, silver-plated OFHC solid copper and each is fitted with a 1.5 mm crimp socket terminal. They are supplied fitted with UHV compatible coloured glass beads for identification. The phase leadout wires are much thicker than the thermocouple leadouts. The leadout wires of each phase should be twisted together.



Motors equiped with a ***Thermocouple:***



Motors equiped with an ***RTD:***



If the identification beads have been removed, the wires can be identified using an inexpensive multimeter, and a magnet. The multimeter must be capable of measuring resistance with a resolution of about 1 ohm.

Thermocouple Leadouts

The thermocouple wires are much thinner than the phase leads, and there are two of them. If three wires are present, the motor has an RTD installed, see below for details. The thermocouple is insulated from the rest of the motor.

The two leads are of different material; one is made from Alumel, which is weakly magnetic, and the other Chromel, which is not. Use a magnet to find the Alumel wire, then connect as shown below.

Lead	Connected to terminal marked	
Alumel	Alumel, N, - (minus) or coloured blue	
Chro-mel	Chromel, P, + (plus) or coloured brown	

RTD Leadouts

As per the thermocouple leads, but three instead of two leads. These must be identified by resistance; one pair of wires are connected at the motor end. These will measure a few ohms depending on cable length and are the ‘B1’ and ‘B2’ connections, which are interchangeable. The remaining wire is the ‘A’ connection and should measure around 100 ohms to either ‘B1’ or ‘B2’.

Lead	Connected to terminal marked	
A	A, or coloured blue	
B1	Chromel,B1, or coloured brown	
B2	B2, or coloured brown	

Phase leadouts

These are the four thicker leadouts. Identify the two motor phases by their resistance, which will be in the range of 3 to 15 ohms, depending on the motor type. There is no electrical connection between the two phases, to the thermocouple/RTD or the case of the motor. Most of the resistance is in the windings of the motor and is virtually unaffected by shortening of the leads. Connect each phase to the appropriate drive terminals. The resistance of the wires from the feedthrough to the drive must be less than a few ohms.

Note regarding reversal of rotation

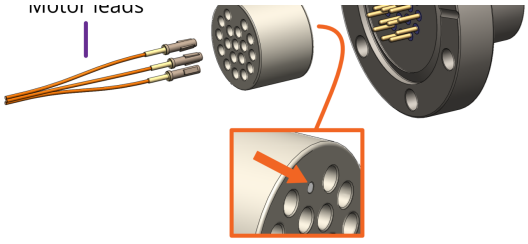
Upon completion of wiring, there is a 50 % probability that the direction of rotation will be reversed from the desired or conventional sense. To rectify this, exchange the connections to one of the phases. For example, locate the Phase A + and Phase A − connections, and swap them around. This can be done on air or vacuum side while the chamber is still open.

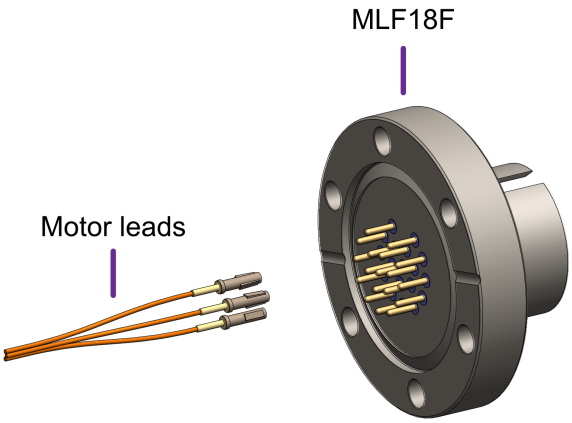
Wiring motor to the vacuum feedthrough

The MLF18F feedthrough has 18 x 1.5 mm gold-plated feedthrough pins and is suitable for up to three motors fitted with thermocouples or up to two motors fitted with 3-wire RTDs. An internal bakeable connector, MLF18VCF, is available into which the crimp terminals on the motor leads are inserted. This significantly reduces the risk of short-circuits and makes the installation more convenient.

Using the MLF18F feedthrough and MLF18VCF vacuum side connector:

Alternatively, plug crimps directly onto the feedthrough pins of the MLF18F:



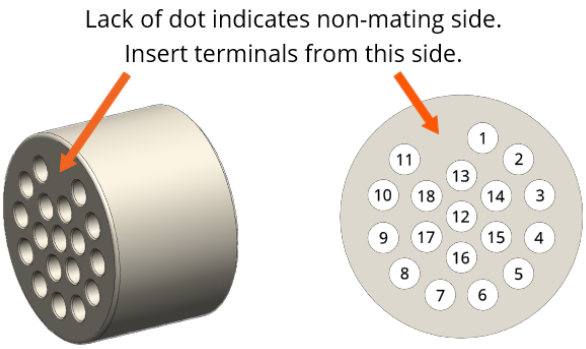


Mating side identified by dot. Motor lead terminals should be inserted in the other side.

Standard pinout for the MLF18VCF

The illustration below shows the view into the non-mating side of the connector, into which the motor leads should be inserted, as shown below.

Connection	Colour	Motor 1	Motor 2
Phase A1	Green	1	7
Phase A2	Grey	3	9
Phase B1	Black	2	8
Phase B2	White	4	10
Thermocouple +	Brown	5	11
Thermocouple -	Blue	6	12
RTD A	Blue	13	16
RTD B1	Brown	14	17
RTD B2	Brown	15	18



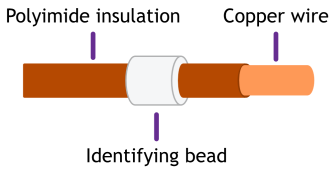
Using other feedthroughs

AML stepper motors can be ordered with either a K-Type thermocouple, or 3-wire PT100 RTD. The former requires 6 pins, and the latter 7 pins.

When using motors installed with a thermocouple, it is not necessary to use a thermocouple vacuum feedthrough or extension wires, as the error introduced by incompatible feedthrough material is usually less than 5 °C and the temperature measurement is not required to be very precise.

Preparation of motor leadouts for connection to other feedthroughs

If making custom terminations for the motor leads, the installed crimps must be removed, and the wire ends stripped of insulation. Standard motors are fitted with Polyimide film-wrapped leads (illustrated below), and radiation-hard motors are fitted with polyimide enamelled leads.



Polyimide is strong, flexible and abrasion-resistant and therefore difficult to strip. The simplest method of stripping polyimide film is to cut a ring with a sharp knife and withdraw the cylinder of insulation over the end of the wire.
Be careful not to mark the conductor surface with the knife. Strip the enamelled radiation-hard leads by scraping with a sharp knife. Either type of lead may be stripped with a suitable high-speed rotary stripper. Do not use a thermal stripper.

Wiring between drive and vacuum feedthrough

AML supply the MLF18SMD3 lead for use with the SMD3 and MLF18F feedthrough. It allows connection of up to two drives and motors installed in one vacuum chamber. Alternatively, AML supply the MLF18AC; which can be used to make custom leads to mate with the MLF18F feedthrough. This is supplied with a kit that includes the crimps and a grounding lead attached to the connector shell, as well as instructions for their use. The SMD3 is supplied with a kit of matching connectors.

Leads between the MLF18AC and SMD3 should be assembled according to the following guidance for safe, reliable operation and continued compliance with EMC standards.

Cable requirements

- Quantity of cores as required; (one motor requires 6 cores when fitted with a thermocouple, or 7 if fitted with an RTD). The cable must be screened. A foil screen plus drain wire is acceptable; a foil plus braid screen is better.
- The screen must be connected via as short a wire as possible to pin 1, ‘GND’ of the motor connector, using insulated wire.
- Rated voltage >= 300 V rms
- Rated current > 1.5 A rms

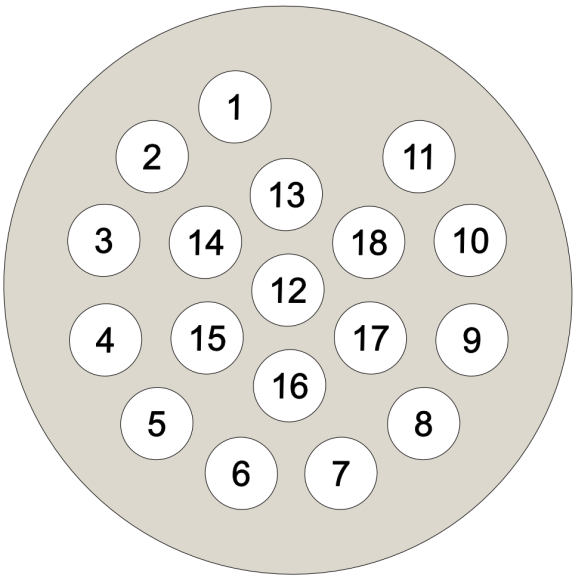
- Cable cores must be twisted together in pairs, using one pair per phase, one pair for the thermocouple, and a group of three for the RTD. This reduces radiated emissions from the cable and improves immunity of the RTD and thermocouple signals to the motor.
- Maximum cable length is limited by round trip resistance, which should be less than a few ohms. Review cable manufacturers data to obtain this figure.

Wiring up to the MLF18AC airside connector

The MLF18AC is supplied with comprehensive instructions detailing correct usage of the connector. The pinout to match with the standard MLF18F + MLF18VCF pinning described in section Motor wiring is shown below. Note that the illustration shows the MLF18AC looking into the non-mating side of the connector, i.e. the side into which crimps are inserted.

Connection	Colour	Motor 1	Motor 2
Phase A1	Green	1	7
Phase A2	Grey	3	9
Phase B1	Black	2	8
Phase B2	White	4	10
Thermocouple +	Brown	5	11
Thermocouple -	Blue	6	12
RTD A	Blue	13	16
RTD B1	Brown	14	17
RTD B2	Brown	15	18

Looking into the non-mating face of the MLF18AC, into which crimps are inserted



Wiring up to the SMD3

The cable shield must be connected to X2 (Motor connector), pin 1, GND, as described in the ‘Cable requirements’ section above.

Wire the motors leads to X2 (Motor connector) following the pinout shown in section X2-Motor.

For a motor installed with a thermocouple, split off the thermocouple leads close to the SMD3, keeping them twisted together and install in the thermocouple connector provided, following the pinout shown in section X4-Thermocouple.

For a motor installed with an RTD, split off the three RTD leads close to the SMD3, keeping them twisted together, and wire into the RTD A (pin 4), RTD B1 (pin 3) and RTD B2 (pin 2) positions of X3 (I/O connector), see section X3-I/O
