



# MASTERFLUX

**Brushless DC Motor Controller  
Product Specification  
Assembly 025A0122**

March 6, 2007

## Revision History

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**600A0529 Rev. A**

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## Device Overview

### Features

- **Locked rotor detection**
- **Motor Drive FET thermal shutdown**
- **Motor case thermal shutdown**
- **Under/Over voltage shutdown**
- **Low speed protection**
- **Current limiting**
- **Fault output**
- **Tachometer output**
- **Fused motor voltage (Vm) connector**
- **2 Fan Power Outputs**

### General Product Description

The 025A0122 Motor Controller is designed to provide efficient control and monitoring of a DC powered brushless hermetic compressor. The controller provides a constant speed as specified by the speed set-point input, independent of motor voltage and load unless one of the following limitations is exceeded.

Current limit, this is where the average current the motor requires to maintain the commanded speed exceeds 45 amps.

If the load requires more than 45 amps then the speed will be reduced accordingly.

Voltage limitation, this is where the motor supply voltage is not high enough to achieve the commanded speed.

Fault conditions are monitored continuously. Upon detection of a fault, the motor is shut down. The motor controller will make up to eleven attempts to restart the motor after the fault condition is cleared.

The controller will indicate the fault state by a TTL level output.

For a Locked Rotor fault or An Under Voltage fault or Over Voltage fault the controller will delay for ten seconds before attempting to restart the motor and also delay for ten seconds between subsequent start attempts.

For an Over Temperature fault the controller will delay for five seconds before attempting a restart and also delay for five seconds between subsequent restart attempts. Once the fault condition is cleared and the motor is restarted then the TTL level fault indicator is cleared.

If the motor fails to start after eleven tries for a Locked Rotor fault or an Over Temperature fault it will cease trying to restart the motor and power must be cycled off and on before the motor can be restarted.

The speed set-point is controlled by a 0 to 5 volt non-isolated analog input.

The controller provides a TTL level tachometer output.



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Control and indicator signals connect to a six pin Molex header.

The motor drive transistors are cooled by a large aluminum finned heatsink. A temperature sensor embedded in the heatsink measures the heatsink temperature. The motor controller will shut down the motor if the heatsink temperature exceeds 85° C. The heatsink provides the mounting points for the assembly with two threaded holes at each end. The heatsink is electrically isolated from the circuitry. There is no input fusing or reverse polarity protection provided.

The controller operates from 0° to 50° C.

The PCA conformal coating is a UL recognized type SR (silicone resin) based material to protect it from corrosion.

The controller is capable of controlling the following compressor models.

SIERRA02-0434Y3

## Operation

### ***Power On/Off Switch***

There are two options for switching the controller on and off. **Option one** applies continuous power to the controller output drive circuitry and using a low current switch to supply power to (turn on) the control electronics. **Note:** When using this option bear in mind that there may be a substantial inrush current when the switch is turned on, if not limited by external components. The inrush current should be considered when selecting this switch. The motor controller handles the high current switching for the motor. With this option a small amount of leakage current will be present in the off state. **Option two** is to use a high current switch to apply power to the controller output drive circuitry, and the control electronics with a jumper connected to enable the drive. With this option there is no leakage current in the off state. With either option the onboard microcontroller will start a 2 second delay timer which allows time for the power supply to stabilize. After the delay, the motor will start provided that the external speed control is set for greater than 0 RPM.

**Note:** The controller presents a capacitive load to the system. On initial application of power, a substantial in-rush current will result if not limited by external components.

### ***Speed Control***

The speed setpoint is controlled by a 0 to 5 volt analog non-isolated input. Zero volts commands zero RPM, 4.75 to 5 volts commands the maximum speed of 6500 RPM. At startup the motor controller will run the motor at 3000 RPM for a period of thirty seconds in order to ensure proper oiling of the mechanism and after ten seconds the controller will run the motor at the commanded speed. If the motor is commanded to run below 1800 RPM (But not 0 RPM) then the command will be interpreted as 1800 RPM. If for any



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reason (such as excessive load) the motor should slow down to 1500 RPM the controller will output a fault and the motor will be shut down. The motor controller will run the motor at the setpoint speed independent of the load on the motor and the motor voltage provided that the speed is not limited by the motor voltage or maximum current. Five volts and ground are available on the control connector. Connect five volts to one leg of a 10K Ohm potentiometer. Connect the other to ground. Connect the wiper of the potentiometer to the speed input for variable speed operation.

### ***Tachometer Output***

The motor speed is indicated by a 0 to 5 volt square wave non- isolated output. The frequency of the square wave is proportional to motor speed.  $RPM = 2.5 \times Hz$ .

### ***Fault Indicator Output***

The controller will signal a fault condition by outputting a logic high value on the fault indicator output. The fault indicator will be active after a stall is detected, or an under or over voltage or over temperature condition of either the heatsink or the shell temperature sensor.

### ***Fan Power***

12 volts is available at two, 2 pin straight friction lock connectors which each provide a regulated 12 volts and ground for powering two DC fans if required. Whenever the control circuitry is switched on power is provided to these two connectors.

### ***Motor Voltage (VM)***

The motor voltage ( $V_M$ ) is brought out through a 0.5 amp re-settable fuse (F1) to pin 1 of a three pin connector JP6. Pin 2 of JP6 is connected to Ground and pin 3 is not used.

## **Electrical Ratings / Specifications**

### ***Absolute Maximum Ratings***

| <b>Parameter</b>             | <b>Min.</b> | <b>Max.</b> | <b>Units</b> |
|------------------------------|-------------|-------------|--------------|
| $V_M$                        | 0           | 35          | V            |
| Speed Setpoint               | -0.3        | 5.05        | V            |
| Power On/Off                 | 0           | 35          | V            |
| Fault output current sourced |             | -25         | mA           |
| Fault output current sunk    |             | 25          | mA           |



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## Electrical Characteristics

| Parameter  | Conditions                    | Min. | Nom. | Max. | Units |
|--|-------------------------------|------|------|------|-------|
| V <sub>CC</sub>  | I <sub>OUT</sub> < 50 mA      | 4.75 | 5.0  | 5.25 | V     |
| <b>Tachometer</b>  |                               |      |      |      |       |
| Output Low Voltage   | I <sub>OL</sub> = 0.4 mA      |      |      | 0.6  | V     |
| Output High Voltage  | I <sub>OH</sub> = -0.1 mA     | 2.2  |      |      | V     |
| <b>Fault</b>   |                               |      |      |      |       |
| Output Low Voltage   | I <sub>OL</sub> = 8.5 mA      |      |      | 0.6  | V     |
| Output High Voltage  | I <sub>OH</sub> = -3.0 mA     | 4.05 |      |      | V     |
| <b>Voltage Fault</b>   |                               |      |      |      |       |
| High Voltage Shutdown  |                               | 29.1 | 30   | 30.9 | V     |
| High Voltage Resume  |                               | 28.1 | 29   | 29.9 | V     |
| V <sub>HS</sub> - V <sub>HR</sub>  |                               | 0.9  |      |      |       |
| Low Voltage Shutdown   |                               | 8.6  | 9    | 9.4  | V     |
| Low Voltage Resume   |                               | 9.6  | 10   | 10.4 | V     |
| <b>Temperature Fault</b>   |                               |      |      |      |       |
| High Temp Shutdown   |                               | 80   | 85   | 90   | °C    |
| High Temp Resume   |                               | 75   | 80   | 85   | °C    |
| T <sub>HS</sub> - T <sub>HR</sub>  |                               | 4    |      |      | °C    |
| <b>Power On/Off</b>  |                               |      |      |      |       |
| Current  | V <sub>M</sub> = 9 V (Note 1) |      |      | 1    | A     |
| <b>V<sub>M</sub></b>   |                               |      |      |      |       |
| Operating Range  |                               | 9    |      | 30   | V     |
| Current  | Power On/Off >= 9 V (Note 1)  |      |      | 45   | A     |
| <b>JP2/JP3 Fan Power</b>   |                               |      |      |      |       |
| JP2  | 100ma Maximum                 | 11.4 | 12   | 12.6 | V     |
| JP3  | 100ma Maximum                 | 11.4 | 12   | 12.6 | V     |
| <b>Motor Speed</b>   |                               |      |      |      |       |
| Minimum Speed  | Command voltage<br>0          | 1700 | 1800 | 1900 | RPM   |
| Maximum Speed  | Command voltage<br>4.75 to 5  | 6400 | 6500 | 6600 | RPM   |
| Note 1: Measured current is steady state. The controller presents a capacitive load to the system. On initial application of power, a substantial in-rush current will result if not limited by external components. |                               |      |      |      |       |

## Connectors

### Power

Motor power (V<sub>M</sub>) is supplied through the power connector. The power connector is a Packard Metri-Pack 630 series part number 12129938. The mating connector part



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number is 12129939. Connect the positive voltage to the red connector. Connect the return to the black connector.

## Control

The control connector, reference designator JP1, is a six pin shrouded header, AMP part number 5-103639-5. The mating connector is AMP part number 104257-5.

### JP1

| Pin | Signal Name     | Type   |
|-----|-----------------|--------|
| 1   | Ground          | Output |
| 2   | Power On/Off    | Input  |
| 3   | Fault           | Output |
| 4   | Tachometer      | Output |
| 5   | +5 Volts        | Output |
| 6   | Speed set-point | Input  |

## Fan Power

The unit provides two fan power connectors JP2, and JP3. The connectors provide regulated 12 VDC. The connectors are 2 pin straight friction lock headers AMP part number 640456-2 mating connector 770602-2.

### JP2

| Pin | Signal Name       | Type   |
|-----|-------------------|--------|
| 1   | +12 Volt Fan High | Output |
| 2   | Ground            | Output |

### JP3

| Pin | Signal Name       | Type   |
|-----|-------------------|--------|
| 1   | +12 Volt Fan High | Output |
| 2   | Ground            | Output |



## Compressor

The three phase wires, reference designators M1, M2, and M3 have AMP Faston connectors, part number 61187-1. The shell temperature switch wires, reference designators JP4, have AMP Faston connectors, part number 2-520128-2.

| Wire Color | Signal Name              | Type         |
|------------|--------------------------|--------------|
| Blue       | Phase A                  | Output       |
| Orange     | Phase B                  | Output       |
| Yellow     | Phase C                  | Output       |
| Black      | Shell Temperature Switch | Input/Output |
| Black      | Shell Temperature Switch | Input/Output |

## Shell Temp Switch

JP4 is a two pin header with latch, Molex part number 70543-0001 for connection of the shell temp switch cable (supplied). The mating connector is Molex part number 50-57-9402.

JP4

|   | Signal Name              | Type         |
|---|--------------------------|--------------|
| 1 | Shell Temperature Switch | Input/Output |
| 2 | Shell Temperature Switch | Input/Output |

## V<sub>m</sub> OUT

The unit provides access to the motor voltage V<sub>m</sub> through a re-settable 0.5 amp fuse F1 to a 3 pin header with latch JP6 Molex Part number 70543-0002. The mating connector is Molex Part number 14-56-7032.

JP6

| Pin | Signal Name    | Type   |
|-----|----------------|--------|
| 1   | V <sub>m</sub> | Output |
| 2   | Ground         | Output |
| 3   | No connection  |        |



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