



MASTERFLUX

Sierra Dual 24 Volt

**Brushless DC Motor Controller
Product Specification**

Assembly 025F0348

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|  MASTERFLUX | Brushless DC Motor Controller Product Specification Assembly 025F0348 | Procedure Number 600A1480 Rev. B |
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Revision History

| ECN # | Date | Rev | Description | By |
|---------|----------|-----|-----------------------|----------|
| EC77363 | 03/15/17 | A | Initial Release | K. Jones |
| EC81620 | 11/15/17 | B | Added Agency Approval | S. Lavey |

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 (V_M) connector**
- **2 Fan Power Outputs**
- **Serial port for Diagnostics information**
- **Logic power on/off control**
- **Auto detect master slave configuration**

General Product Description

The motor controller is set up for “Dual Compressor” control and consists of two 025F0348 controllers linked together via the JP5 serial interface connector. Only the speed command is wired to the “MASTER” controller. When the “MASTER” initially receives a run command, it will run at 3000 RPM for 5 seconds and then command the “SLAVE” controller to run at 3000 RPM for 30 seconds.

After the start-up procedure, both controllers will begin operating at the commanded speed. The “MASTER” controller monitors and tracks the “SLAVE” controller speed to within ± 250 RPM. If the difference in speed between the two controllers ever exceeds ± 250 RPM, a speed fault occurs and compressor operation stops. Loss of serial communication between the two controllers also triggers a communication fault and stops operation of the compressor. Attempts to restart operation begin once communication has been reestablished and faults are cleared.

The controller provides a constant speed as specified by the “MASTER” speed set-point input. The speed set-point is independent of motor voltage and load unless one of the following limitations is exceeded.

- Current Limit - Occurs when the average current the motor requires to maintain the commanded speed exceeds 55 amps. If the load requires more than 55 amps then the speed will be reduced accordingly.
- Voltage Limit – When the motor supply voltage is not high enough to achieve the commanded speed.

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Fault conditions are continuously monitored. Upon detection of a fault, both compressors stop and display a fault output followed by a 30 second delay. After the delay and all faults are cleared, the “MASTER” controller will attempt the start-up sequence described above.

The speed command is controlled by a 0 to 5 volt non-isolated analog input. The controller provides a TTL level tachometer output. The control and indicator signals connect to a six pin Molex header.

The motor drive transistors are cooled by an aluminum finned heatsink. A temperature sensor embedded in the heatsink 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 is coated with a type SR (silicone resin) based material to protect it from corrosion. Material is UL recognized.

The controller is capable of controlling the following compressor models:

MX01-0716Y3R134

Note: See sales representative for complete list.

Agency Approval

Underwriters Laboratory (File E197896)
CE



Operation

Master-Slave assignment

The motor controller is set up for “Dual Compressor” control and consists of two 025F0348 controllers linked together via JP5 serial interface connector. Only the speed command is wired to the “MASTER” controller. Upon initial power up each controller looks to see if a speed command is present. If the controller detects a speed command it is assigned as the “MASTER” controller. The other controller is then set as the “SLAVE” through the serial port.

When two “MASTER” controllers are detected, the controllers will stay in the faulted state and the power must then be cycled. Additionally, a fault will occur if the “SLAVE” controller receives a speed input after the “MASTER” and “SLAVE” assignments have been set. Both controllers will fault if the serial communication is lost. Once communication has been reestablished, the controllers will turn off the fault indicators and attempt to start given the presence of a speed command.

ON/OFF and Speed Control

The (non-isolated) analog speed input provides the ON/OFF and speed control. The speed command is only wired to the “MASTER” controller. When the “MASTER” speed input is less than 0.5V the compressor is stopped. If the “MASTER” speed input is between 0.8V and 1.0V the compressor is commanded ON at which point the compressor will run at 3000 rpm for 5 seconds then command the “SLAVE” controller to run at 3000 rpm for 30 seconds. After the start-up procedures, both controllers will run at the commanded speed.

The speed input is scaled from 1.0V to 5.0V and 1800 RPM to 6500 RPM, respectively. If for any reason (such as excessive load) the motor should slow down to 1500 RPM, the controllers will output a fault and the compressors will shut down. The controller will run the compressor at the set-point 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.

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.



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

Fan power is provided via two 2 pin straight friction lock connectors. Each provide a regulated 12 volts and ground for powering two DC fans. Whenever the control circuitry is switched on power is provided to these two connectors.

Electrical Ratings / Specifications

Absolute Maximum Ratings

| Parameter | Min. | Max. | Units |
|---|-------------|-------------|--------------|
| V_M | 0 | 35 | V |
| Speed Set-point (non isolated) | -0.3 | 5.05 | V |
| Power On/Off | 0 | 35 | V |
| Fault output current sourced (non isolated) | | -25 | mA |
| Fault output current sunk (non isolated) | | 25 | mA |

Operating Conditions

| Parameter | Comments | Min. | Max. | Units |
|-----------------------------|-----------------|-------------|-------------|--------------|
| Operating Temperature Range | | 0 | 50 | °C |
| Heatsink Temperature | | -40 | 105 | °C |

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Electrical Characteristics

| Parameter | Conditions | Min. | Nom. | Max. | Units |
|---|--|-------------|-------------|-------------|--------------|
| V _{CC} | I _{OUT} < 50 mA | 4.75 | 5.0 | 5.05 | V |
| Tachometer Output | | | | | |
| Output Low Voltage | I _{OL} = 0.4 mA | | | 0.6 | V |
| Output High Voltage | I _{OH} = -0.1 mA | 2.2 | | | V |
| Fault Output | | | | | |
| Output Low Voltage | I _{OL} = 8.5 mA | | | 0.6 | V |
| Output High Voltage | I _{OH} = -3.0 mA | 4.05 | | | V |
| Voltage Fault | | | | | |
| High Voltage Shutdown | | 28.5 | 30 | 31.5 | V |
| High Voltage Resume | | 28.5 | 29 | 30.5 | V |
| Hysteresis (V _{HS} - V _{HR}) | | 1 | | | V |
| Low Voltage Shutdown | | 8.5 | 9 | 9.5 | V |
| Low Voltage Resume | | 9.5 | 10 | 10.5 | V |
| Temperature Fault | | | | | |
| High Temp Shutdown | | 95 | 100 | 105 | °C |
| High Temp Resume | | 90 | 95 | 100 | °C |
| T _{HS} - T _{HR} | | 5 | | | °C |
| Power On/Off | | | | | |
| Current | V _M = 9V (Note 1) | | | 1 | A |
| V_M | | | | | |
| Operating Range | | 9 | | 30 | V |
| Current | (Note 1) | | | 55 | A |
| JP2/JP3 Fan Power | | | | | |
| JP2 | 100ma Maximum | 11.4 | 12 | 12.6 | V |
| JP3 | 100ma Maximum | 11.4 | 12 | 12.6 | V |
| Motor Speed Input | | | | | |
| Off | Voltage must go below 0.5 to turn off (hysteresis) | | | 0.5 | V |
| Minimum Speed | 0.8 to 1.0 | 1700 | 1800 | 1900 | RPM |
| Maximum Speed | 4.75 to 5 | 6400 | 6500 | 6600 | RPM |
| Speed differential fault | | | 250 | | RPM |
| Speed differential fault time | | | 30 | | seconds |
| <p>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.</p> | | | | | |



Connectors

Power

Motor power (V_M) is supplied through a 4-position Metri-Pack connector part number 12052623. The part number for the pins is 12066493.

Control (JP1)

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

| 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 (JP2 and JP3)

The two connectors, JP2 and JP3 are for connecting fans. The connectors each provide regulated 12 VDC. The connectors are 2 pin straight friction lock headers AMP part number 640456-2. The mating connector is Amp part number 770602-2.

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

Compressor

The three motor phase windings A, B, and C of the compressor is supplied through an AMP Faston connector, part number (1) 62057-1 and (2) 62057-7.

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Compressor Shell Temperature Switch (JP4)

The shell temperature input terminals are AMP Part# 2-520128-2.

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

V_M OUT (JP6)

The PCB includes a provision for the motor voltage V_M to be brought out through poly-fuse F1 to a 3 pin header with latch JP6 Molex Part # 70543-0002 mating connector is Molex Part # 14-56-7032.

| Pin | Signal Name | Type |
|-----|----------------|--------|
| 1 | V _M | Output |
| 2 | Ground | Output |
| 3 | No connection | |

Serial Port (JP5)

The serial port connector is a 4 Pin shrouded header with latch Molex part # 70543-0038, mating connector is Molex part number 14-56-7042.

| Pin | Signal Name | Type |
|-----|-----------------|--------|
| 1 | V _{cc} | |
| 2 | Transmit | Output |
| 3 | Receive | Input |
| 4 | Ground | |

The serial interface is intended for diagnostic purposes during the product development phase in an Electro Static Discharge (ESD) controlled environment. A serial interface adapter is required to connect to the serial port on a computer. The serial interface is configured for 19.2 K baud, 8 data bits, 1 stop bit, no parity, and no flow control. The controller will report the following operating parameters once per second over the serial interface:

- Temperature – Heatsink temperature in °C
- Power Supply – Voltage
- Current – Average current delivered to motor
- Motor Speed – Actual speed in RPM
- Fault – In the event of a fault, a description of each is provided below.

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| Fault Reporting | |
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| STALLED | If the controller detects a locked rotor it will shut down both compressors, set the fault outputs, and then delay for 30 seconds. After the delay, the controller will deactivate the fault indicator then attempt to restart the compressor. If the motor does not restart after eleven attempts, the system will lock and power must then be cycled off and on before the motors can be restarted. |
| STARTUP FAILED | The controller will detect if the compressor has failed to start. If the compressor fails to start both compressors will stop and set the fault outputs then delay for 30 seconds. After the 30 second delay the controller will deactivate the fault indicator then attempt to restart the compressors. If the motor does not restart after eleven attempts, the system will lock and power must then be cycled off and on before the motors can be restarted. |
| MOTOR OVERHEAT | If the compressor shell temperature switch opens, the controller will shut down both compressors set the fault outputs then delay for 30 seconds. After the delay period the controller will recheck the compressor shell temperature switch state. If the compressor shell temperature switch is closed the controller will attempt restart the compressor and deactivate the fault indicator. If the controller gets eleven motor overheat conditions, the power must be cycled off and on before the motor can be restarted. |
| UNDER / OVER VOLTAGE | If the input voltage is outside of the operating limits, the controller will shut down both compressors set the fault outputs then delay for 30 seconds. After the delay period, the controller will recheck the voltage conditions. If the voltage is within the operating limits the controllers will deactivate the fault indicator then attempt to restart. |
| OVER CURRENT | Hard current limit – If a current limit is detected both controllers will shut down the compressors set the fault outputs then delay for 30 seconds. After the delay period, the controller will recheck the conditions. If the condition is within the operating limits the controllers will deactivate the fault indicator then attempt to restart. |
| CONTROLLER OVERHEAT | If the compressor heatsink temperature rises above 85°C the controller will shut down both compressors set the fault outputs then delay for 30 seconds. After the delay period the controller will recheck the controller temperature. When the controller temperature is within specification the controller will attempt restart the compressor and deactivate the fault indicator. If the controller gets eleven motor overheat conditions, the power must be cycled off and on before the motor can be restarted. |
| LOW SPEED | The compressor must maintain a minimum speed of 1500 RPM for proper lubrication. If the controller detects a low speed condition it will shut down both compressors set the fault outputs then delay for 30 seconds. After the delay, the controller will deactivate the fault indicator then attempt to restart the compressor. If the controller gets eleven low speed conditions, the power must be cycled off and on before the motor can be restarted. |