



MASTERFLUX

**Brushless DC Motor Controller
Product Specification
Assembly 025F0216**




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Procedure Number
600A0947 Rev. D

Revision History

ECN #	Date	Rev	Description	By
EC45901	5/29/12	A	Initial Release	Z. Sheu
EC47286	8/7/12	B	Updated speed difference value	Z. Sheu
EC63683	01/27/15	C	Correct interface connector part number	D. Stahl
EC80062	08/14/17	D	Added Agency Approval	S. Lavey

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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**
- **2 Fan Power Outputs (optional)**
- **Fault code LED**
- **Dual Compressor Control**
- **UL listed**

General Product Description

The motor controller is set up for “Dual Compressor” control and consists of two 025F0216 controllers linked together via the JP3 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 3 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 ± 375 RPM. If the difference in speed between the two controllers ever exceeds ± 375 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 maintaining for the commanded speed exceeds 45 amps. If the load requires more than 45 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 “MASTER” and “SLAVE” compressors are stopped. The faulted controller will indicate the fault state by a TTL level output on the fault output pin and flash a fault code on the fault LED (See Fault Indicator Output section for flash codes). There is a delay of twenty seconds following any fault condition, excluding serial communication error, before the controller attempts to restart. Once a fault condition is cleared and the motor has restarted, the TTL level fault indicator is cleared.

The speed set-point is controlled by a 0V to 5V non-isolated analog input. The controller provides a TTL level tachometer output. Control and indicator signals connect to an eight pin Molex header.

The motor drive transistors are cooled by a large aluminum finned heat sink. A temperature sensor embedded in the heatsink measures the heatsink temperature. The motor controller will shut down the motor if the heatsink temperature exceeds 100° 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 is specified to operate at an ambient temperature from 0° to 65° 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.

SIERRA03-0982Y3

Note: See sales representative for complete list.

Agency Approval

Underwriters Laboratory (File E197896)
CE





Operation

Power On/Off Switch

There are two options for switching the controller on and off.

- **Option one** applies continuous power to the controller and a low current switch to enable (turn on) the drive. 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 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 running the motor at 3000 RPM for a period of 30 seconds to ensure proper oiling of the compressor.

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 set-point is only connected to the “MASTER” controller. The slave controller receives the start/stop and speed commands from the “MASTER” over the serial link.

The speed set-point is controlled by a 0V to 5V analog non-isolated input. The voltage ranging from 0V to 1V commands 0 RPM, 1V through 4.75V commands 1800-6500 RPM, and 4.75V to 5V commands the maximum speed of 6500 RPM. At startup, the “MASTER” motor controller will run the motor at 3000 RPM for a period of thirty seconds and the “SLAVE” controller will also run at 3000 RPM for thirty seconds to ensure proper oiling of the mechanism. After the startup, the controller will run the motors at the commanded speed.

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.

5V and ground are available on the control connector. Connect 5V 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

A 0V to 5V non-isolated tachometer pulse indicates motor speed. The frequency of the pulse is proportional to motor speed. Motor RPM = $2.5 \times \text{Hz}$

Fault Indicator Output

The controller will signal a fault condition by outputting a logic high value on the fault output at JP5 Pin 8. The controller also indicates a fault condition by flashing the on board fault LED. The flashing pattern will be $\frac{1}{4}$ second on and $\frac{1}{4}$ second off for each count, dwell for $2\frac{1}{2}$ seconds, and then repeat until the fault(s) are cleared. Listed below are the fault codes.

# of Flashes	Fault Type
1	Over Current
2	Over Voltage
3	Under Voltage
4	Controller Overheat
5	Motor Overheat
6	Stalled / Startup Failed
7	Low Speed / Excessive Differential
8	Serial Communication Error


Fan Power

An option is provided for two 2 pin straight friction lock connectors which each provide a regulated 12V 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	63	V
Speed Set-point	-0.3	5.05	V
Power On/Off	0	63	V
Fault output current sourced		-4	mA
Fault output current sunk		4	mA

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Electrical Characteristics

Parameter	Conditions	Min.	Nom.	Max.	Units
V _{CC}	I _{OUT} < 50 mA	4.75	5.0	5.25	V
Tachometer					
Output Low Voltage	I _{OL} = 0.4 mA			0.6	V
Output High Voltage	I _{OH} = -0.1 mA	2.2			V
Fault					
Output Low Voltage	I _{OL} = 1 mA			0.6	V
Output High Voltage	I _{OH} = -1 mA	4.05			V
Voltage Fault					
High Voltage Shutdown		57.9	59.9	61.9	V
High Voltage Resume		56.9	58.9	60.9	V
V _{HS} - V _{HR}		1			V
Low Voltage Shutdown		18	19	20	V
Low Voltage Resume		19	20	21	V
Temperature Fault					
High Temp Shutdown		95	100	105	°C
High Temp Resume		90	95	100	°C
T _{HS} - T _{HR}		5			°C
V_M					
Operating Range		20		57	V
Current	(Note 1)			45	A
Fan Power					
JP1	100ma Maximum	11.4	12	12.6	V
JP2	100ma Maximum	11.4	12	12.6	V
Motor Speed					
Motor Off (Note 2)	Nominal Command Voltage 0 to 1V	0	0	0	RPM
Minimum Speed (Note 2)	Nominal Command voltage 1V	1700	1800	1900	RPM
Maximum Speed (Note 2)	Command voltage 4.75V to 5V	6400	6500	6600	RPM
<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> <p>Note 2: Slave speed ±375 RPM of “MASTER” actual speed.</p>					



Connectors

Power

Motor power (V_M) is supplied through two Würth Elektronik press fit connectors located at J1 and J2. Both are 5M threaded studs

Pin	Signal Name	Type
J1	+48 Volts	Input
J1	Ground	Input

Control

The control connector, reference designator JP5, is an 8 pin shrouded header, Molex part # 70543-0042. The mating connector is Molex part number 50-57-9408.

JP5

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

Fan Power

The unit provides two fan power connectors JP1, and JP2. The connectors provide regulated 12 VDC. The connectors are 2 pin straight friction lock headers Molex part number 22-23-2021 mating connector 22-01-2027.

JP1

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

JP2

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



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Compressor

The compressor output is supplied through three Würth Elektronik press fit connectors located at J3, J4, and J5.

Pin	Signal Name	Type
J3	Phase A	Output
J4	Phase B	Output
J5	Phase C	Output

Shell Temp Switch

The shell temperature connector is Molex part number 70543-0001 two pin locking connector, recommended mating connector Molex part number 50-57-9402. Connect to a normally closed switch.

JP6

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

Serial Port

The serial Port connector (JP3) is a 4 Pin shrouded header with latch Molex part # 70543-0038. The mating connector is Molex part number 50-57-9404. MasterFlux serial interface cable part number 040A0162 is used to connect “MASTER” and “SLAVE” controllers.

JP3

Pin	Signal Name	Type
1	V _{CC}	
2	Tx	Output
3	Rx	Input
4	Ground	

The serial interface is configured for 19.2K baud, 8 data bits, 1 stop bit, no parity, and no flow control. The controller serial port is intended for linking master and slave together only. No diagnostic information is available.



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Fault Reporting	
STALLED	If the controller detects a locked rotor it will shut down the motor, delay for 20 seconds and attempt to restart the motor. The controller will continually attempt to restart the motor. After ten attempts the fault indicator will be activated.
STARTUP FAILED	The controller will detect if the motor has failed to start. After a 20 second pause the controller will attempt to restart the motor. The controller will continually attempt to restart the motor. After ten attempts the fault indicator will be activated.
MOTOR OVERHEAT	If the compressor shell temperature switch opens, the controller will shut down the motor and delay for 5 seconds. The controller will indicate the fault condition by activating the fault indicator. 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 restart the motor and deactivate the fault indicator.
UNDER / OVER VOLTAGE	If the motor voltage is outside of the operating limits, the controller will shut down the motor and delay for 10 seconds. After the delay period, the controller will recheck the voltage conditions. If the voltage is within the operating limits the motor will restart.
OVER CURRENT	Hard current limit – if the controller detects an over-current condition it will shut down the motor and activate the fault indicator. The controller will delay 60 seconds then attempt to restart. After 10 over current faults the power must be cycled to clear this fault.
CONTROLLER OVERHEAT	If the controller (heatsink) temperature rises above 100°C the controller will shut down the motor and delay for 10 seconds. After the delay period the controller will recheck the module temperature. If the temperature has fallen below 95 °C the controller will restart the motor. The controller will indicate a fault condition by activating the fault indicator. The controller will continue to monitor the heatsink temperature. The controller will restart the motor and deactivate the fault indicator when the heatsink temperature falls below 95 °C.
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 the motor, delay for 20 seconds and attempt to restart the motor. If the motor does not restart after 10 attempts, the controller will indicate a fault condition by activating the fault output. The controller will continually attempt to restart the motor. If the controller is successful in restarting the motor and maintaining a speed above 1500 RPM for 30 seconds, the fault indicator will be deactivated



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Firmware Port

The PCB includes provision for a firmware port which is a 10 dual row header (JP4) Molex part #90131-0125. The mating connector is Molex part number 90143-0010

JP4

Pin	Signal Name	Type
1	Ground	Input
2	Icc Data	Input/Output
3	Ground	Input
4	Icc Clock	Input/
5	Ground	Input
6	Reset	Input
7	V _{CC}	Output
8	V _{PP}	Input
9	N.C.	N.C.
10	Ground	Input

RoHS Compliance

This assembly is compliant to the RoHS directive set forth by the European Union