



# MASTERFLUX

**Sierra 80 Volt**

**Brushless DC Motor Controller  
Product Specification**

**Assembly 025F0139**

600A0620

Rev. A

December 2, 2008

## Revision History

EC #	Date	Rev	Description	By
EC22908	12/2/08	A	First issue	D. Stahl



## **WARRANTY INFORMATION**

### **IMPORTANT PRODUCT NOTICE AND WARRANTY INFORMATION**

All statements, technical information or data related to Masterflux products are based on information believed to be reliable. However, no representation or warranty, express or implied, is made as to their completeness, accuracy, fitness for a particular purpose or any other matter, including, without limitation, that the practice or application of any such statements, technical information or data is free of patent infringement or other intellectual property misappropriation.

All information provided in this specification is intended for persons having the requisite knowledge, skill, and expertise to properly and completely evaluate such information. Masterflux shall not be responsible or liable for the use, application or implementation of the information provided herein, and all such information is to be used at the risk, and in the sole judgment and discretion, of such persons, their employees, advisors and agents and only after their independent evaluation and determination that the product is suitable for the application intended by such persons.

Masterflux is not in the business of providing technical, engineering or operational information for a fee, and, therefore, any such information is provided as an accommodation and without charge. Masterflux reserves the right to make changes to its products or to discontinue any product at any time without notice, and advises customers to obtain the latest relevant information prior to ordering.

### **Limited WARRANTY; DISCLAIMER OF WARRANTY; LIMITED REMEDY; LIMITED LIABILITY**

All Masterflux products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including, but not limited to, those pertaining to warranty (as stated in its “Warranty to Original Equipment Manufacturers”), patent infringement, and limitation of liability.

MASTERFLUX MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE INCLUDING, WITHOUT LIMITATION, ANY WARRANTY THAT MASTERFLUX PRODUCTS ARE SUITABLE OR FIT FOR USE IN ANY HUMAN SAFETY OR LIFE SUPPORT SYSTEMS. If a Masterflux product is found to be defective in materials or workmanship within the warranty period set forth in the “Warranty to Original Equipment Manufacturers,” Masterflux’s sole and exclusive obligation, exercisable in its sole discretion, shall be to repair or replace the product or refund the purchase price of the product as more fully set forth in the “Warranty to Original Equipment Manufacturers.”

**Masterflux will not be liable for any loss or damage arising from any Masterflux product, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, even if Masterflux shall have been advised of the possibility of such potential loss or damage.**



## 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**
- **Serial port for Diagnostics information**

### General Product Description

The 025F0139 Motor Controller has been 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 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 and load exceeds 30 amps. If the load requires more than 30 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 command is controlled by a 0 to 5 volt non-isolated analog input. The controller provides a TTL level tachometer output.

Power is supplied through two Wurth Elektronik press fit connectors. Control and indicator signals connect to a six pin Molex header.

The motor drive transistors are cooled by a 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 will operate 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:  
SIERRA04-0982Y3.

**Note:** See sales representative for complete list.

## Operation

### ***ON/OFF and Speed Control***

The (non-isolated) analog speed input provides the ON/OFF and speed control. When the speed input is less than 0.5V the motor is stopped. When the speed input is between 0.8V and 1.0V the motor is commanded ON at which point the motor will run at 3000 RPM for a period of thirty seconds in order to ensure proper oiling of the mechanism. After the thirty second time the motor will run at the commanded speed. The speed input is scaled to 1.0V is 1800 RPM and 5.0V is 6500 RPM. If for any 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 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.



## Electrical Ratings / Specifications

### *Absolute Maximum Ratings*

Parameter	Min.	Max.	Units
V <sub>M</sub>	0	130	V
Speed Set-point (non isolated)	-0.3	5.05	V
Fault output current sourced (non isolated)		-10	mA
Fault output current sunk (non isolated)		10	mA

### *Operating Conditions*

Parameter	Comments	Min.	Max.	Units
Operating Temperature Range		0	50	°C
Heatsink Temperature			85	°C



## Electrical Characteristics

Parameter	Conditions	Min.	Nom.	Max.	Units
V <sub>CC</sub>	I <sub>OUT</sub> < 50 mA	4.95	5.0	5.05	V
<b>Tachometer Output</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 Output</b>					
Output Impedance	All		200		Ohms
Output Low Voltage	I <sub>OL</sub> = 1.0 mA			0.8	V
Output High Voltage	I <sub>OH</sub> = -3.0 mA	3.4			V
<b>Voltage Fault</b>					
High Voltage Shutdown (V <sub>HS</sub> )		93	97	101	V
High Voltage Resume (V <sub>HR</sub> )		91	95	99	V
Hysteresis (V <sub>HS</sub> - V <sub>HR</sub> )		1			V
Low Voltage Shutdown (V <sub>LS</sub> )		57	60	63	V
Low Voltage Resume (V <sub>LR</sub> )		61	64	67	V
Hysteresis (V <sub>LR</sub> - V <sub>LS</sub> )		2			V
<b>Temperature Fault</b>					
High Temp Shutdown (T <sub>HS</sub> )		80	85	90	°C
High Temp Resume (T <sub>HR</sub> )		75	80	85	°C
T <sub>HS</sub> - T <sub>HR</sub>		4			°C
<b>V<sub>M</sub></b>					
Operating Range		68		90	V
Current	(Note 1)			30	A
<b>Motor Speed</b>					
Off				0.5	V
Minimum Speed	Command voltage 1	1700	1800	1900	RPM
Maximum Speed	Command voltage 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 ( $V_M$ ) is supplied through the power connectors J1 and J2. The power connectors are Wurth Elektronik part number 7461098. The shank accepts an M6 metric nut for connecting to a ring terminal or similar connector (nut and cable not supplied). Connect the positive voltage to (J1). Connect the return to (J2).

Pin	Signal Name	Type
J1	+V <sub>M</sub>	Input
J2	Ground	Input

### 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.

Pin	Signal Name	Type
1	Ground	Output
2	N.C.	N.C.
3	Fault	Output
4	Tachometer	Output
5	+5 Volts	Output
6	Speed set-point	Input

### Compressor

The three compressor phase leads A, B, and C connect to the three connectors with the corresponding labels. The connectors are Wurth Elektronik part number 7461383. The shank accepts an M5 metric nut for connecting to a ring terminal or similar connector (nut and cable not supplied).

#### Note:

When fabricating the compressor cable/wiring harness, AMP Faston connectors, part number 61187-1 can be used for connecting to the three terminals on the compressor.





## Compressor Shell Temperature Switch

JP4 is a two pin header with latch, Molex part number 70543-0001 for connection to the normally closed compressor shell temperature switch (cable not 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

## Serial Port

The serial Port connector (JP5) is a 4 Pin shrouded header with latch Molex part # 70543-0038, mating connector is Molex part number 14-56-7042.

JP5

Pin	Signal Name	Type
1	Vcc	
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 – Volts

Current – average current delivered to motor

Motor Speed – actual speed in RPM

Fault – in the event of a fault a brief description of the fault is reported (see below)



<b>Fault Reporting</b>	
STALLED	If the controller detects a locked rotor it will shut down the motor, delay for 10 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 indicator output. The controller will continually attempt to restart the motor. If the controller is successful in restarting the motor, the fault indicator will be deactivated after 30 seconds.
STARTUP FAILED	The controller will detect if the motor has failed to start. After a 10 second pause the controller will attempt to restart the motor. If the motor does not start after 10 attempts, the controller will indicate a fault condition by activating the fault indicator output. The controller will continually attempt to start the motor. If the controller is successful in starting the motor, the fault indicator will be deactivated after 30 seconds.
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 will 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 power must be cycled to clear this fault.



<b>Fault Reporting</b>	
<b>CONTROLLER OVERHEAT</b>	If the controller (heatsink) temperature rises above 85°C the controller will shut down the motor and delay for 5 seconds. After the delay period the controller will recheck the module temperature. If the temperature has fallen below 80 °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 80 °C.
<b>LOW SPEED</b>	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 10 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.

