MASTERFLUX

Brushless DC Motor Controller Specification
Assemblies 025F0140-01, -02, -03, -04, -05

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Revision History

Initials	**Date**	**Description**	**Rev**
RT	12/12/06	Initial Release – EC15205	A
JM	1/28/09	Added -05 Voltage code References- EC23512	B

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General Product Description

The 025F0140 Motor Controller has been designed to provide efficient control and fault monitoring of a DC powered brushless hermetic compressor. The controller will provide a constant speed as specified by the speed command inputs unless one of the following limitations are exceeded. Power limitation, this is where the average power the drive is producing exceeds 2500 watts. This is calculated by Power out = motor supply * average motor current. If the load requires more than 2500 watts 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 and or power.

There are four variants of the 025F0140 controller (025F0140-01, 025F0140-02, 025F0140-03, 025F0140-04, and 025F0140-05). Each have application specific voltage limits.

An isolated user interface including an RS-232 serial port is supplied. Run/Stop and speed are controlled by a 0 to 5V analog input, or 0 – 90% PWM input. When the speed input is1V or less or the duty cycle is less than 10%, the motor is stopped. When the analog input is 1V, or the PWM input is 10% the motor will run at 1800 RPM. When the analog input is at 5V, or the PWM input is 90% the motor will run at 6500. Tachometer output is an open collector output signal with 5K pull up resistor. The output frequency is 0 to 2.6Khz. When the controller is commanded to run from a stopped condition it will run the motor at 3000 RPM for 30 seconds after which point it will run the motor at the commanded input speed.

The following fault conditions are monitored continuously: under/over voltage, over-current, drive over-temperature, pump over-temperature, low speed and locked rotor. Upon detection of a fault, the controller will shut down the motor. Depending on the cause of the fault the controller may pause to allow time for the fault to clear and then attempt to restart the motor. The fault handling behavior is described further in the fault reporting section. The controller will indicate the fault-state by a TTL output.

Two one-position screw lug connectors are provided for connecting the input power to the controller. Three one-position screw lug connectors will provide connection to the motor outputs for the compressor. A two position locking connector is supplied to connect to the shell temperature switch from the compressor. The isolated control and indicator signals connect to an eight pin locking Molex header. Each connector function is labeled on the printed circuit board. The RS-232 serial port is provided through a nine-pin male dsub connector. The connector pin outs are defined in appendix A.

The motor drive transistor assembly is cooled by a large aluminum finned heat sink. A temperature sensor embedded in the power assembly measures the module temperature. The heat sink provides the mounting points for the assembly with threaded holes at each end. An optional machined heat sink with gasket sealing for thru panel mounting will be available. The heat sink is electrically isolated from the circuitry.

Absolute Maximum Ratings			
Parameter	**Min.**	**Max.**	**Units**
V_M input voltage (steady state)	0	450	V
V_M input voltage (transient, slew rate)		1	V/mS
Analog Speed input (referenced to –Vuser)	-0.3	+5Vuser + 0.3	V
Digital Speed input (referenced to –Vuser)	-0.3	+5Vuser + 0.3	V
Fault output (referenced to –Vuser)	-0.3	+5Vuser + 0.3	V
Fault output current sourced		10	mA
Fault output current sunk		10	mA
Tachometer output current sunk	1		mA
Tachometer output (referenced to –Vuser)	-0.3	+5Vuser + 0.3	V
Storage Temperature	-40°	85°	°C
	-40°	185°	°F

Operating Conditions			
Parameter	**Min.**	**Max.**	**Units**
025F0140-01			
V_M Input power (D.C.)	90	165	V
V_M low voltage shutdown	75	90	V
V_M high voltage shutdown	165	190	V
025F0140-02			
V_M Input power (D.C.)	115	325	V
V_M low voltage shutdown	95	115	V
V_M high voltage shutdown	325	375	V
025F0140-03			
Input power (D.C.)	120	420	V
V_M low voltage shutdown	100	120	V
V_M high voltage shutdown	420	450	V
025F0140-04			
V_M Input power (D.C.)	55	110	V
V_M low voltage shutdown	45	55	V
V_M high voltage shutdown	110	130	V
025F0140-05			
V_M Input power (D.C.)	75	125	V
V_M low voltage shutdown	65	75	V
V_M high voltage shutdown	125	140	V
All Models			
V_M input current		27	A
Standby power		3	W
Efficiency (at 1500 watt output, 3000 rpm)	95		%
Ambient	0 32	65 149	°C °F
Relative Humidity Range	IEC68-2-30, Damp heat-cyclic 20 – 90% non-condensing @ 0°C (32°F) to 50°C (122°F)		

Note: 65 °C is the ambient temperature that the electronics are rated for. The maximum temperature the heatsink can reach before the microprocessor shuts the drive off is 100 °C (212 °F)
The system designer must provide sufficient airflow to keep the heatsink temperature below its shutdown threshold at the maximum ambient temperature and maximum loading conditions. The controller may fault on over heat sink temperature before reaching the maximum rated current if air flow is insufficient.

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Electrical Characteristics Parameter	Conditions	Min.	Max.	Units
Isolated +5V User Supply	Iout <= 50 mA	4.95V	5.05V	V
Fault Output Low Voltage	I_{OL} = 8mA		0.6	V
Fault Output High Voltage	I_{OH} = -3mA	4		V
Tachometer Output Low Voltage	I_{OL} = 1mA		0.3	V
Analog Speed Input impedance			10K	Ohms
Analog input tolerance	All	+/- 0.1		V
Analog input vs motor speed **See Note 1.**	input <= 0.5V input = 1.0V input = 5.0V	0 1700 6400	 1900 6600	RPM
Digital Speed tolerance	All	+/- 1		%
Digital Speed Input low voltage	+5Vuser = 5.0V		0.8	V
Digital Speed Input high voltage	+5Vuser = 5.0V	4.0		
Digital Speed Input current			5	uA
Digital PWM input vs motor speed **See Note 2.**	PWM input <=15% PWM input = 20% PWM input = 80%	0 1700 6400	 1900 6600	RPM
V_M - Ripple Current RMS	Input 20A, 100VDC		6	A
V_M - Average Input Current			27	A
V_M - charging current limiting see **See Note 3.**	On initial application of power		5	A
V_M - Fuse			30	A
Module Over temperature	All conditions	90 194	110 230	°C °F

Note 1: The 0 - 5VDC analog signal will provide the speed command. Once the input has gone above the start threshold (1.0V) the input will have to go below 0.5V to turn off (0.5V hysteresis).
Note 2: The 20 – 80% PWM signal will provide the speed command. Once the input has gone above the start threshold (20% duty cycle) the input will have to go below 15% duty cycle to turn off (5% hysteresis).
Note 3: To stay within the current ratings of the in-rush current limiting circuit, the power supply voltage transients must be less than 1 V/mS.

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 - module 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)

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. 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 20 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 2 minutes. 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.

MODULE OVERHEAT	If the module temperature rises above 100 °C (212 °F) the controller will shut down the motor and delay for 2 minutes. After the delay period the controller will recheck the module temperature. If the temperature has fallen below 100 °C (212 °F) 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 module temperature. The controller will restart the motor and deactivate the fault indicator when the module temperature falls below 100 °C (212 °F).
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
CALIBRATION_TIMEOUT, EEPROM_WRITE_FAILURE	A self-calibration is performed the first time power is applied to the drive. The calibration constants are determined and written to EEPROM. This one-time operation occurs during functional test at the manufacturer. These error messages should not occur in the field.

Appendix A

8-pin User Interface Connector Signal Description:

(Molex part number: 70543-0042 eight pin locking connector, mating connector: Molex part number 50-57-9408.)
Pin-1: NC
Pin-2: -V user (isolated user supply return)
Pin-3: -V user (isolated user supply return)
Pin-4: Digital speed command (input)
Pin-5: Tachometer (output)
Pin-6: +5V user (isolated user supply)
Pin-7: Analog speed command (input)
Pin-8: Fault (output)

2-pins for Motor Power Connection:

Pin-1: +Vm
Pin-2: -Vm

2-pin Compressor Temperature Connector Description:

(Molex part number 70543-0001 two pin locking connector, recommended mating connector Molex part number 50-57-9402)
Pin-1: +Stemp
Pin-2: -Stemp

3-pin for Motor Connector:

Pin-1: Motor Phase A (output)
Pin-2: Motor Phase B (output)
Pin-3: Motor Phase C (output)

9-pin Male RS-232 Serial connector:

(Amp part number 3-338309-2)
Pin-2: Rx
Pin-3: Tx
Pin-5: Ground

Appendix B Configurations

The following controller model numbers have been tested with the listed compressors:

Model	Supported Compressor
025F0140-01	SIERRA05-0434XX SIERRA05-0982XX
025F0140-02	SIERRA06-0434XX SIERRA06-0982XX
025F0140-03	SIERRA06-0982XX
025F0140-04	SIERRA04-0434XX SIERRA04-0982XX SIERRA17-0434XX SIERRA17-0982XX
025F0140-05	SIERRA04-0434XX SIERRA04-0982XX