Brushless DC Motor Controller
Product Specification
Assembly 025A0148

September 16, 2009

600A0656 Rev. D

Revision History

ECN #	Date	Rev	Description	By
EC24771	4/3/09	A	Initial Release	D. Stahl
EC27601	8/7/09	B	Updated Fault times and added LED error flash codes	J. Mommerency
EC28096	090409	C	Changed UV to 19V	D. Stahl
EC28318	091609	D	Changed fault timer to match software	D. Stahl

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Device Overview

Features

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- **Motor Drive FET thermal shutdown**
- **Motor case thermal shutdown**
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- **Fault output**
- **Tachometer output**
- **2 Fan Power Outputs (optional)**
- **Fault code LED**

General Product Description

The 025A0148 Motor Controller employs the use of an ST microprocessor for control of the motor resulting in improved control/performance over the previous motor controller and will also provide several options not available with the previous Motor Controller. These options will be described later in this document.

The 025A0148 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 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 attempt 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, Stall fault or Start up Failed fault the controller will delay for 20 seconds before attempting to restart. For Under Voltage fault, Over Voltage fault or Module Overheat fault the controller will delay for ten seconds before attempting to restart. For the Shell Over Temperature fault the controller will delay for five seconds then recheck the shell input. If the shell input is not active the controller will attempt a restart. Once the fault condition is cleared and the motor is restarted then the TTL level fault indicator is cleared. For an Over-current fault the controller will delay for sixty seconds before attempting to restart. If ten Over-current faults occur the controller will cease trying to restart the motor and power must be cycled off and on. Each fault is also displayed by flashing an onboard LED. See fault code section for flash codes.

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

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 in order 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 controlled by a zero to five volt analog non-isolated input. Zero through one volt commands 1800 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 thirty seconds the controller will run the motor at the commanded speed. If for any reason (such as excessive load or low voltage) the motor should slow down to 1500 RPM the controller will output a fault and the motor will be shut down due to a low speed. The compressor needs to run faster that 1500 RPM for proper oiling. 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 current limit. 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

A 0 to 5 volt non-isolated tachometer pulse indicates motor speed. The frequency (F) of the pulse is proportional to motor speed. Motor RPM = 2.5 X F in 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 ¼ second on and ¼ second off for each count then dwell 2 1/2 seconds and repeat until the fault(s) are cleared. Listed below are the fault codes.

1 flash – Over Current
2 flashes – Over Voltage
3 flashes – Under Voltage
4 flashes – Controller Overheat
5 flashes – Motor Overheat
6 flashes – Stalled
7 flashes – Low Speed
8 flashes – Startup Failed

Fan Power

An option is provided for 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.

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
Storage Temperature	-40	+85	℃

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
JP2/JP3 Fan Power					
JP2	100ma Maximum	11.4	12	12.6	V
JP3	100ma Maximum	11.4	12	12.6	V
Motor Speed					
Minimum Speed	Command voltage 0V to 1V	1700	1800	1900	RPM
Maximum Speed	Command voltage 4.75V to 5V	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 connector. The power connector is a Packard Metri-Pack 630 series part number 12129938. The mating connector part number is 12129939.

JP2

Pin	Signal Name	Type
A	+48 Volts	Input
B	Ground	Input

Control

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

JP1

Pin	Signal Name	Type
1	NC	NC
2	Ground	Output
3	Power On/Off	Input
4	+Vm 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

Compressor

The compressor wire harness connector is a Packard Metri-Pack 630 series part number 12052623. The mating connector part number is 12015664.

Pin	Signal Name	Type
A	Phase A	Output
B	Phase B	Output
C	Phase C	Output
D	Not Used	Not Used

Shell Temp Switch

The shell temperature switch wire harness connector is an AMP Universal Mate-N-Lock part number 350778-1. The mating connector part number is 350777-1. 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 (JP5) is a 4 Pin shrouded header with latch Molex part # 70543-0038, mating connector is Molex part number 14-56-7042.

JP3

Pin	Signal Name	Type
1	Vcc	
2	Data	I/O
3	Clock	I/O
4	Ground	

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)

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 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 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

Firmware Port

The PCB includes provision for a firmware port which is a 10 dual row header (JP7) Molex part # 90131-0125, mating connector is Molex part number 90143-0010. JP7 will not be populated except when used for development.

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	Vcc	Output
8	Vpp	Input
9	N.C.	N.C.
10	Ground	Input