

## **DSP-BASED MOTOR CONTROLLER FOR THREE-PHASE BRUSHLESS DC MOTORS**

### **FEATURES / BENEFITS**

- Embedded Motor Control DSP (ADMCF328) improves higher level system integration and flexibility
- 7A phase current (cycle-by-cycle current limit)
- Hall Effect sensor based; sensorless control optional for improved reliability
- Logic supplies (+15V/+5V) generated onboard, eliminating external parts
- Serial port for isolated RS-232 interface allows system level control
- Direction and velocity control
- 2.5 Inch diameter to fit inside motor housing

### **APPLICATIONS**

- Fans
- Pumps
- Compressors

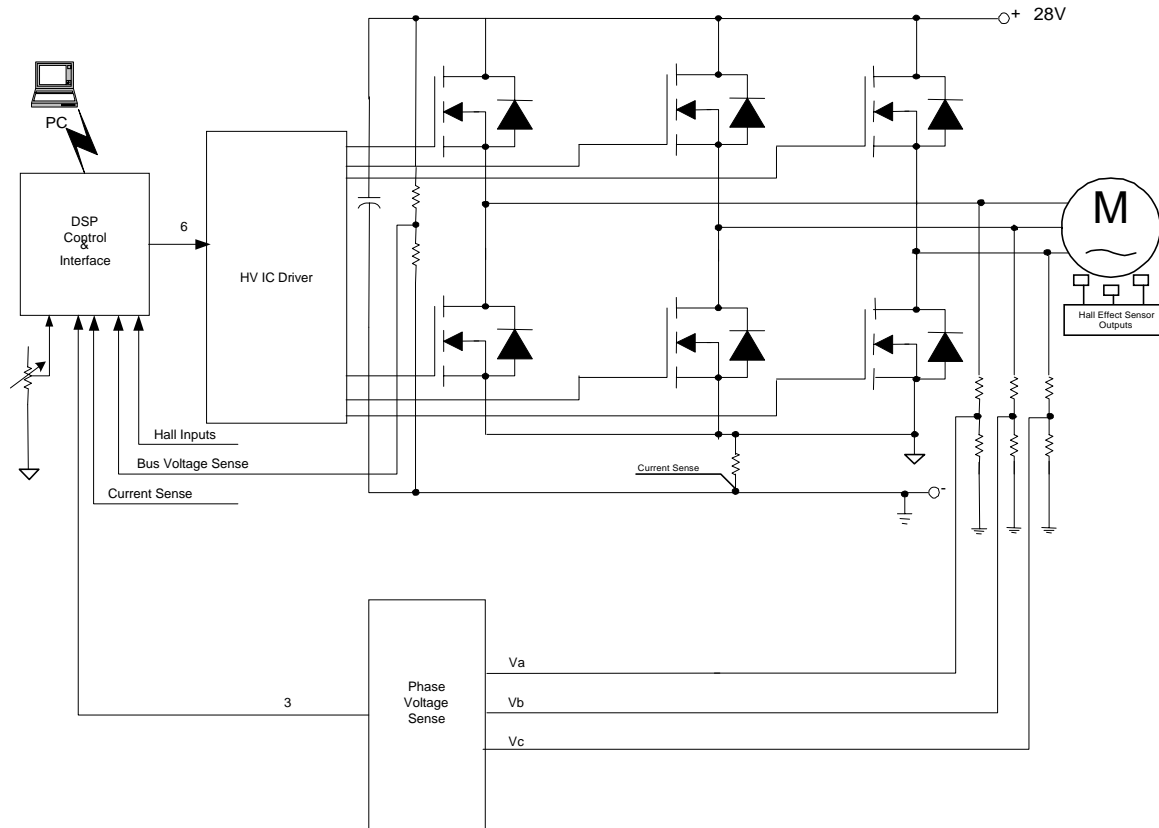
### **DESCRIPTION**

The OMC510 is a DSP-based three-phase brushless DC motor controller intended to replace the analog controller to improve system integration, efficiency, flexibility, and reliability while reducing the overall system cost. The standard OMC510 is configured for commutation via Hall effect sensor feedback. In this configuration, the Hall effect sensor outputs provide discrete absolute rotor position for commutation. The Hall effect sensor outputs are fed into the control port, level shifted onboard from 15V to 5V, then fed directly into the DSP. Based on this information, velocity is determined. Alternatively, the OMC510 can be configured for commutation via sensorless control. Three resistor divider networks are provided onboard for back EMF measurements. In this configuration, the inactive winding is used to measure the back EMF, and based on these measurements, estimates of position and velocity are derived. Consult the factory for details.

The OMC510 requires a single ended 28V supply for operation. The logic voltage supplies (15V and 5V) are derived onboard. The OMC510 will accommodate either an analog or digital command input. For the latter, a serial port is provided onboard to interface with an isolated RS-232 communications port. The OMC510 provides direction control as well as current limit for over-current protection.

The OMC510 is a 2.5 inch diameter circuit board assembly designed for small size and low cost, and it is ideal for installation inside a motor housing. The assembly process includes chip-on-board technology for the driver and power stages to maximize the power density and surface mount technology for the control stage. The small size, low cost and performance of the OMC510 make it an ideal control solution for applications including fans, pumps and compressors.

# SIMPLIFIED BLOCK DIAGRAM



## CHARACTERISTICS

Maximum Ratings					
Peak Motor Supply Voltage			V <sub>pk</sub>	32	
Input Voltage (Analog/Digital)			V	-0.3 to +3.3 / -0.3 to +5.3	
Operating Ambient Temperature			°C	0 to +85	
Storage Temperature			°C	-20 to +125	
Nominal Power Ratings			Module Thermal & Mechanical Characteristics		
Motor Supply Voltage	V <sub>DC</sub>	28	Thermal Resistance (Junction to Ambient)	°C/W	55
Continuous Current	A <sub>RMS</sub>	7	Max. Ambient Temperature	°C	85
Current Overload	%	200 for 3 Sec; 150 for 1 min.	Dimensions (Ø)	in./mm	2.50 / 63.5

## PERFORMANCE SPECIFICATIONS

Speed Regulation:	$\pm 2$ RPM
Speed Accuracy:	$\pm 0.1$ %
Velocity Bandwidth:	> 100 Hz
Constant Torque/ Speed Range:	50:1
Starting Torque:	Start into locked rotor
Torque Response:	1.5 mSec

## FUNCTIONAL DESCRIPTION

### Inverter

The three-phase inverter consists of power MOSFETs which utilize advanced processing techniques to 9876s controlled to regulate the shaft speed with a Proportional-Integral (PI) regulator.

### Current Sense

A single precision current sense resistor (1% tolerance), combined with a sophisticated algorithm, eliminates the need for separate phase current sense resistors while still providing disturbance torque information to improve the efficiency and robustness of the system.

### Gate Drive

The gate drive section incorporates high speed power MOSFET drivers with independent high and low side referenced output channels. The gate driver design, in conjunction with the inverter design, provides for low noise inverter operation.

### Protection

Protection from short circuit conditions is provided by disabling the controller without damage to the inverter. Under-voltage protection is provided in the gate drive section thus preventing damage to the inverter due to insufficient gate drive voltage.

### PWM System

Space Vector Modulation (SVM) is employed to provide better bus utilization, lower torque ripple, and lower commutation losses than the standard sinusoidal PWM method. In addition, other benefits of SVM versus the sinusoidal PWM method include ease of control and quicker response.

### Motor Control Algorithms

The OMC510 can be configured for trapezoidal drive using either Hall effect sensors for absolute rotor position feedback or a sensorless Back-EMF zero crossing detection scheme. Consult the factory for ordering information.

### Speed Regulator

The OMC510 accepts speed commands from either an isolated RS-232 port or an analog input (0 to 3V). The speed command is compared with the estimated shaft speed and the motor torque is controlled to regulate the shaft speed with a Proportional-Integral (PI) regulator.

## I/O & RS-232 SPECIFICATIONS

### Analog Inputs

1 analog input—0 to 3V input with 10-bit resolution. This input is the speed input.

### Logic Inputs

2 logic inputs—2V threshold. These inputs are the direction and reset inputs.

### RS-232 Communications

All control functions and data are available through an isolated RS-232 port. A serial cable, complete with isolated RS-232 circuitry can be provided by the factory. Consult the factory for details.

## MODE of OPERATION

### Speed Mode

The OMC510 accepts speed commands from either an isolated RS-232 port or an analog input. The speed command is compared with the estimated shaft speed and the motor torque is controlled to regulate the shaft speed with a Proportional-Integral (PI) regulator.

## PINOUT

PIN #	NAME
J1-1	Direction
J1-2	Speed In
J1-3	Reset
J1-4	Aux PWM
J1-5	Logic Gnd
J1-6	TFS1
J1-7	RFS1
J1-8	+5V
J1-9	Logic Gnd
J1-10	Reset RS232
J1-11	DR1B
J1-12	Logic Gnd
J1-13	DT1
J2-1	+15V
J2-2	HALL 1
J2-3	HALL 2
J2-4	HALL 3
J2-5	N/C
J2-6	Logic Gnd
VBUS	Voltage Bus
BRTN	Bus Return
PH A	Phase A
PH B	Phase B
PH C	Phase C

## PIN DESCRIPTIONS / FUNCTIONALITY

Direction (J1-1)—This logic input is used to select the motor direction.

Speed In (J1-2)—This input is the analog command input to the OMC510.

Reset (J1-3)— A logic low at this input initiates a complete hardware reset of the DSP.

Aux\_PWM (J1-4)—This output is an auxiliary PWM output.

Logic\_Gnd (J1-5)—This pin provides the reference point for the command section.

TFS1 (J1-6)—This pin is left open during normal operation. It is dedicated for engineering purposes only.

RFS1 (J1-7)—This pin is left open during normal operation. It is dedicated for engineering purposes only.

+5V (J1-8)—This supply is provided for the RS-232 interface. Note that an isolated RS-232 interface is offered with the OMC510. Consult the factory for more information.

Logic\_Gnd (J1-9)—This pin provides the reference point for the +5V supply.

Reset\_RS-232 (J1-10)— A logic low at this input initiates a complete hardware reset of the DSP. This reset is provided through the RS-232 interface.

DR1B (J1-11)—This pin is dedicated as the data receive pin for the RS-232 interface. Note that an isolated RS-232 interface is offered with the OMC510. Consult the factory for more information.

Logic\_Gnd (J1-12)—This pin provides the reference point for the RS-232 interface.

DT1 (J1-13)—This pin is dedicated as the data transmit pin for the RS-232 interface. Note that an isolated RS-232 interface is offered with the OMC510. Consult the factory for more information.

+15V (J2-1)—This supply is provided for the Hall effect sensor bias.

Hall\_1 (J2-2)—This pin is dedicated to the phase A Hall effect sensor output.

Hall\_2 (J2-3)—This pin is dedicated to the phase B Hall effect sensor output.

Hall\_3 (J2-4)—This pin is dedicated to the phase C Hall effect sensor output.

Logic\_Gnd (J2-6)—This pin provides the reference point for the +15V supply.

Voltage Bus (VBUS)—This terminal is connected to the positive terminal of the 28V supply.

Bus Return (BRTN)—This terminal is connected to the negative terminal of the 28V supply.

Phase A (PH\_A)—This terminal is connected to the phase A motor lead.

Phase B (PH\_B)—This terminal is connected to the phase B motor lead.

Phase C (PH\_C)—This terminal is connected to the phase C motor lead.

## APPLICATION NOTE

### SETUP

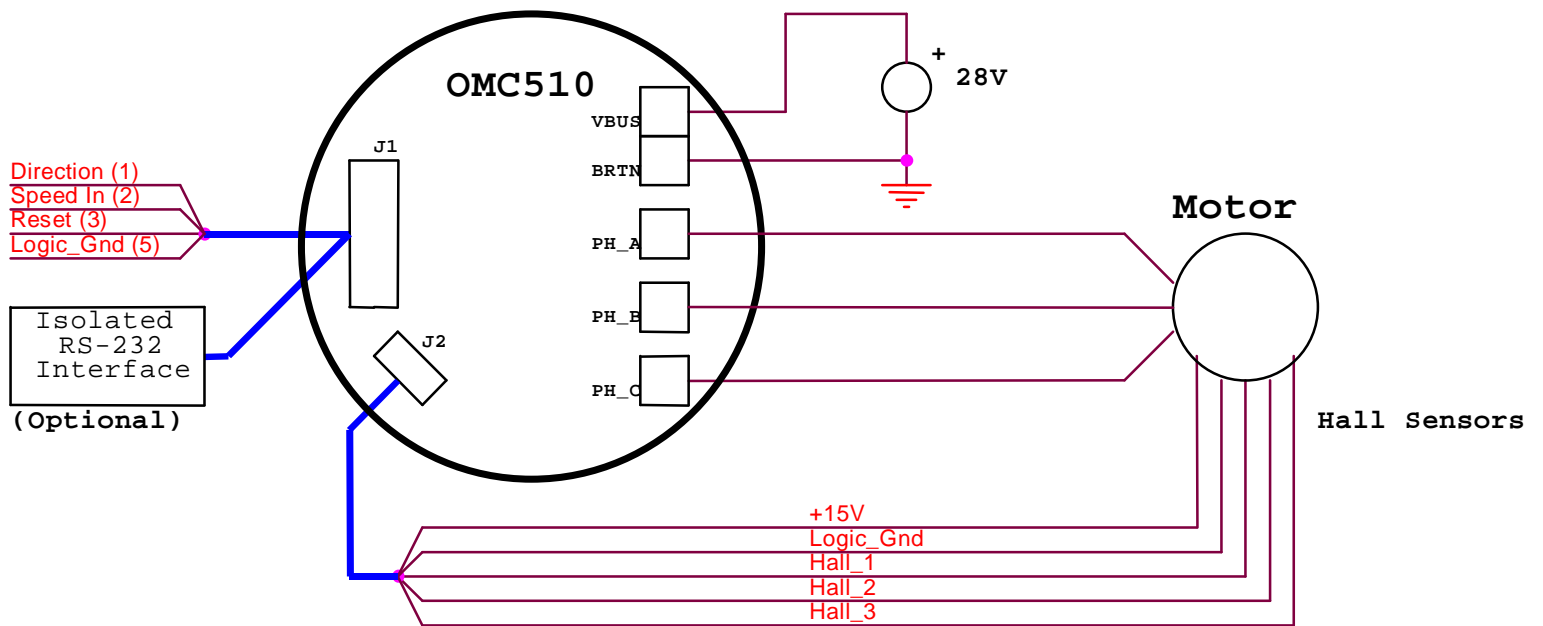
The OMC510 is a DSP-based motor controller providing speed control proportional to the command input voltage. This command can be provided by way of either an analog or a digital interface. The Figure 1-- Interconnection Diagram is representative of a typical configuration.

The OMC510 provides two micro-miniature 1.25mm headers (J1 and J2) for easy interface to command and control (J1) and to the Hall effect sensors (J2). To mate with the headers, reference Molex receptacle housing part numbers 51021-1300 (mate to J1) and 51021-0600 (mate to J2), and crimp terminal series 50058. An accessory cable for command and control, including an in-line isolated RS-232 interface, can be provided. Consult the factory for details. To interface with the 28V power supply and the motor phase leads, plated through holes, sized to accommodate up to #18 AWG wire, are provided for solder termination.

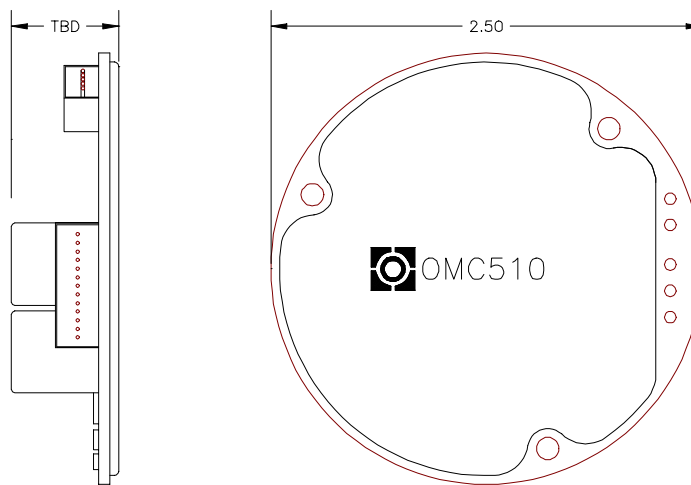
### OPERATION

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**FIGURE 1 --INTERCONNECTION DIAGRAM**



**FIGURE 2 --MECHANICAL OUTLINE**