SOM9300
DSP-Based Motor Control Kit
## Revision History

<table>
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<tr>
<th>Revision</th>
<th>Date</th>
<th>Description of Revision</th>
<th>Date Approved</th>
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<tr>
<td>01</td>
<td>8/26/99</td>
<td>Preliminary Release</td>
<td></td>
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<tr>
<td>02</td>
<td>3/1/00</td>
<td>Engineering Release</td>
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<tr>
<td>03</td>
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<td>Revise Section 2.4</td>
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1.0 Introduction

Thank you for your interest in the SOM9300 DSP-Based Motor Control Kit, intended to demonstrate the first of a series of DSP-based motor controllers forPermanent Magnet Synchronous machines. This unit is a combination of advanced packaging of power electronics and modern DSP-based control algorithms. The SOM9300 demonstrates the control of a brushless motor using any one of two control algorithms: (1) Hall effect sensor feedback, trapezoidal drive, and (2) sensorless Extended Kalman Estimator (EKE), sinusoidal drive. In addition, the SOM9300 features direction control, cycle-by-cycle current limit, torque control for fast response to disturbances, and velocity output feedback.

1.1 Document Overview

This document introduces the SOM9300 and provides you, the user, with the information necessary to install and operate the motor control kit.

1.2 Technical Support

For technical support of the SOM9300 motor control kit, please contact:

Omnirel, LLC
Phone: (978)534-5776
Fax: (978)537-4246
Email: tech_support@omnirel.com
2.0 Installation

2.1 Hardware Overview

The SOM9300 motor control kit consists of three major building blocks: (1) control and interface board with DSP, voltage and current sense and isolated RS-232 interface; (2) integrated power module, and (3) motor. Refer to Figure 1—SOM9300 Motor Control Kit Block Diagram.

The control and interface board incorporates the Analog Devices ADMC331 single chip motor control DSP, voltage and current sense and signal conditioning circuitry, and isolated RS-232 interface circuitry, and the integrated power module houses the three-phase PWM inverter and the high-side/low-side drivers. The control and interface board and the power module are assembled to a standard heat sink to make up the DSP Control and Power Module. The motor is a Kollmorgen RBE(H)-00710 series brushless motor with hall sensor feedback.

![Figure 1—SOM9300 Motor Control Kit Block Diagram](image)
Refer to Figure 2, below, for a detailed photograph of the control and interface board and the integrated power module.

**Figure 2**

2.2 Software Overview

The SOM9300 demonstrates the control of the brushless motor using any one of two control algorithms: (1) Hall effect sensor feedback, trapezoidal drive, and (2) sensorless EKE, sinusoidal drive.
Algorithm (1)—Hall Effect Sensor Feedback, Trapezoidal Drive:

This algorithm has been incorporated into the SOM9300 for the user who has an interest in and some knowledge of DSP-based motor controls. For this unit, this algorithm was developed for the three-phase brushless motor with Hall effect sensors for rotor position feedback. Traditionally, this control scheme is required for commutation of the brushless dc motor.

The brushless dc motor requires six discrete absolute rotor positions, whereas the Permanent Magnet Synchronous motor requires continuous and instantaneous absolute rotor position. Therefore, the position feedback required for the brushless dc motor is much simpler. In addition, the control algorithm for the brushless dc motor is less complex. Refer to Figure 3 for the brushless dc (trapezoidal) sensor algorithm.

Algorithm (2)—Sensorless EKE, Sinusoidal Drive:

This algorithm has been incorporated into the SOM9300 for the user who has an interest in the control of the brushless motor without absolute rotor position feedback—sensorless control. Compared to the control algorithm required for the traditional brushless dc motor (see Figure 3), this algorithm is much more complex. Refer to Figure 4 for the sensorless algorithm.

When a brushless motor is driven as a trapezoidal motor, only two of the three motor windings are active at any point in time, thus one winding is inactive. When the motor is running, the back EMF is measured at the inactive winding, and the estimated rotor position and velocity are derived. For simplicity, if the affects of switching transients in the system are ignored and steady state conditions are assumed for a given electrical position, the back EMF measurements prove to be non-linear functions of both velocity and position. The EKE is used to estimate the velocity and position based on these non-linear measurements.

When a brushless motor is driven as a sinusoidal motor, all three motor windings may be active at a point in time. Therefore, the measurement technique described above is not applicable. Additional measurement—i.e. measurement of phase currents—is required.
Figure 3—Sensor Algorithm

Figure 4—Sensorless Algorithm
2.3 Requirements

The following equipment is required to setup and operate your motor control kit:

- Power supply (+28V/5A)
- Power supply for RS-232 (Isolated +5V Logic)
- PC with Win95/Win98, CDROM drive, 3.5” floppy drive, RS-232 COM port

2.4 Hardware Installation

2.4.1 Jumper settings:

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Pin Setting</th>
<th>Function</th>
</tr>
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<tbody>
<tr>
<td>JP11</td>
<td>1 to 2</td>
<td>Disables Switch Reluctance input (PWMSR) of DSP</td>
</tr>
<tr>
<td>JP12</td>
<td>2 to 3</td>
<td>Enables data output driver of EEPROM</td>
</tr>
<tr>
<td>JP13</td>
<td>1 to 2</td>
<td>Selects active HI PWM</td>
</tr>
<tr>
<td>JP14</td>
<td>1 to 2</td>
<td>Enables DSP</td>
</tr>
</tbody>
</table>

2.4.2 Switch settings:

<table>
<thead>
<tr>
<th>Switch</th>
<th>Switch Setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Depressed</td>
<td>Initiates complete hardware reset of DSP</td>
</tr>
<tr>
<td>S2</td>
<td>I</td>
<td>Configures current sense feedback for Phase C</td>
</tr>
<tr>
<td>S2</td>
<td>V</td>
<td>Configures voltage sense feedback for Phase C</td>
</tr>
<tr>
<td>S3</td>
<td>I</td>
<td>Configures current sense feedback for Phase B</td>
</tr>
<tr>
<td>S3</td>
<td>V</td>
<td>Configures voltage sense feedback for Phase B</td>
</tr>
<tr>
<td>S4</td>
<td>I</td>
<td>Configures current sense feedback for Phase A</td>
</tr>
<tr>
<td>S4</td>
<td>V</td>
<td>Configures voltage sense feedback for Phase A</td>
</tr>
</tbody>
</table>

**Note:** Feedback select switches—S2, S3 and S4—shall be set to current sense position “I”.

**Caution:** Ensure that the 28V and the isolated 5V power supplies are ‘OFF’ before proceeding.

2.4.3 Connect positive lead of 28V power supply (#16 AWG minimum, #14 AWG maximum) to JP8-1 (+).
2.4.4 Connect negative lead of 28V power supply (#16 AWG minimum, #14 AWG maximum) to JP8-3 (•).

2.4.5 Connect positive lead of isolated 5V power supply to JP6-1 (pin closest to R8).

2.4.6 Connect negative lead of isolated 5V power supply to JP6-3.

2.4.7 Connect serial cable to RS-232 connector, JP5.

2.5 Software Installation

2.5.1 The SOM9300 is configured to demonstrate the first of two algorithms—Hall effect sensor feedback, trapezoidal drive. The EEPROM labeled ‘Sensor 0710’ has been installed in the DIP socket at U2.

Caution: Ensure that the 28V power supply is ‘OFF’ before proceeding.

To configure the SOM9300 to demonstrate the second algorithm—sensorless EKE, sinusoidal drive—replace the EEPROM labeled ‘Sensor 0710’ with the EEPROM labeled ‘SinEKE 0710’ which is provided with the kit.

2.5.2 Install SOM9300.zip from the disk provided. The disk contains the graphical user interface (GUI) for the both the sensored and sensorless algorithms and for the manual.

3.0 Operation

3.1 Set the 28V power supply to ‘ON’.

3.2 Select the SOM9300 GUI, then invoke the GUI by setting the Power On switch to ‘ON’. Refer to Figure 5—Screen Capture of GUI (note that the GUI shown is for reference only)

3.3 Select the serial (COM) port.

Note: After the motor is running, use only the stop button to stop the motor. Do not change direction and do not set the power switch to ‘OFF’ before stopping the motor.
3.4 Set the desired speed by either sliding the bar in the speed control window or setting the desired speed in the Requested speed box.

3.5 Set the desired acceleration by sliding the bar in the Slow/Fast (acceleration) window.

3.6 Select the desired direction.

**Note:** The Coast/Brake feature is inactive on this version SOM9300.

3.7 Click the Start/Stop button to run/stop the motor.

**Note:** After the motor is running, use only the stop button to stop the motor. Do not change direction and do not set the power switch to ‘OFF’ before stopping the motor.

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**Figure 5—Screen Capture of GUI**
4.0 Bibliography

The following references have proven to be useful for this development effort, and they should prove to be useful in the investigation of control of Permanent Magnet Synchronous machines.


