BOOSTXL-DRV8305EVM User's Guide

This document is provided with the BOOSTXL-DRV8305EVM customer evaluation module (EVM) as a supplement to the DRV8305 datasheet (SLVSCX2). This user guide provides details on the setup and hardware implementation of the BoosterPack.

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1.1 PCB 3-D Views

Figure 1 shows the top view of the BOOSTXL-DRV8305EVM board. Figure 2 illustrates the BoosterPack header signals.

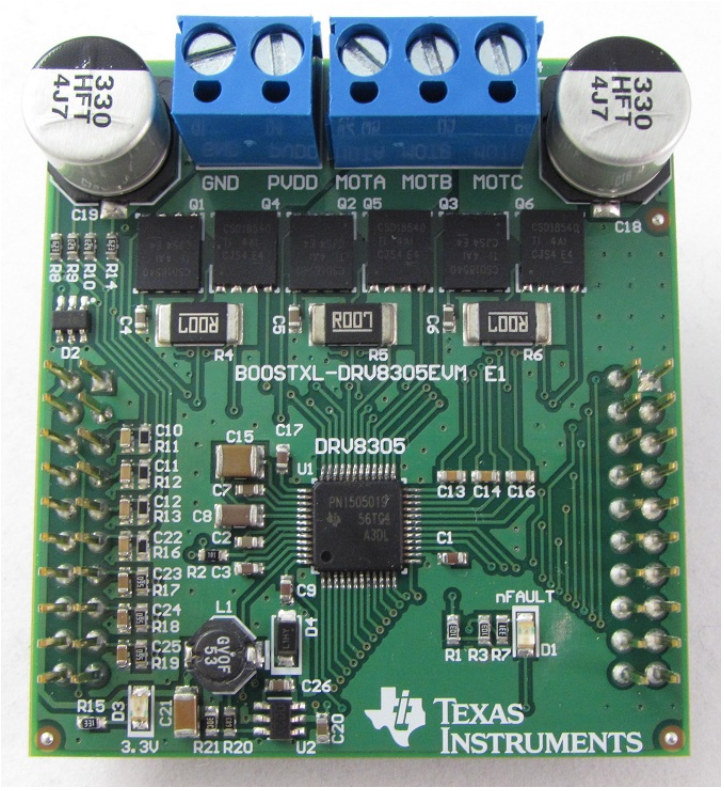

Figure 1. PCB Image (From Above)

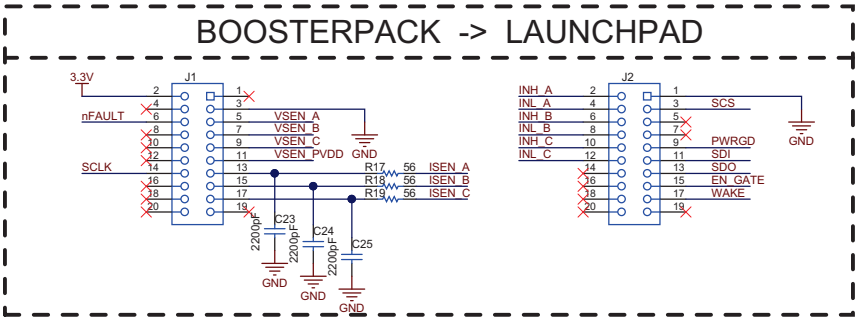

Figure 2. BoosterPack Header Signals

1.2 PCB 3-D Views

Figure 3 and Figure 4 illustrate the top and bottom three-dimensional PCB views.

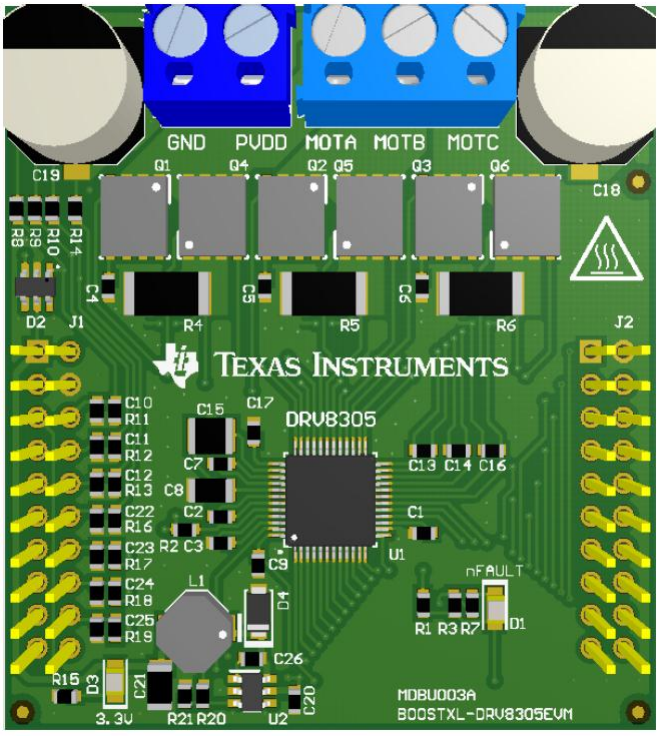

Figure 3. 3-D Top View

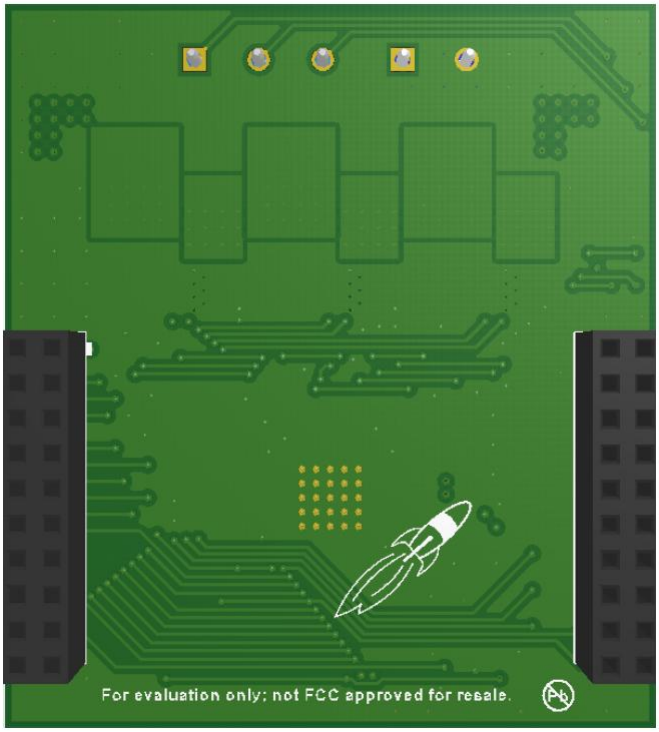

Figure 4. 3-D Bottom View

2 Introduction

The BOOSTXL-DRV8305EVM BoosterPack is a complete 3-phase driver stage in order to evaluate motor application with the DRV8305 motor gate driver. It utilizes a compact and modular form factor for ease of use and is designed to dock with compatible TI LaunchPads for a complete motor control system.

2.1 Features

The following lists the BOOSTXL-DRV8305EVM features:

- Complete 3-phase drive stage in a compact form factor (2.0 in x 2.2 in)
- Supports 4.4- to 45-V voltage supply and up to 15-A RMS (20-A peak) drive current
- 6x CSD18540Q5A N-Channel NexFET™ Power MOSFETs (1.8 mΩ)
- Individual motor phase and DC bus voltage sense
- Low-side current shunt sense for each half-bridge
- Fully protected drive stage including short circuit, thermal, shoot-through, and undervoltage protection
- LMR16006 wide voltage input, 0.6-A step down buck regulator for MCU supply
- Combine with compatible LaunchPad XL kits to create a complete 3-phase motor control platform
- Optimized for the Piccolo LAUNCHXL-F28027F LaunchPad to support the InstaSPIN™-FOC sensorless motor control solution

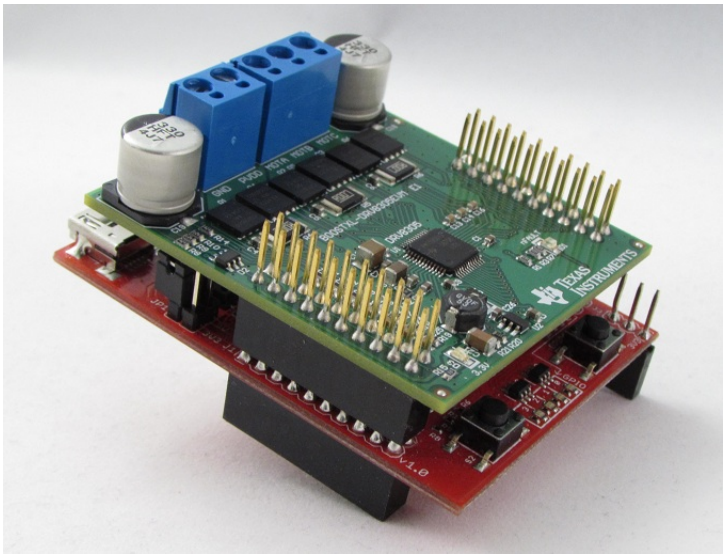

Figure 5. BOOSTXL-DRV8305EVM With LAUNCHXL-F28027F

2.2 Pinout

The BOOSTXL-DRV8305EVM brings out a mixture of power, control, and feedback signals to the XL LaunchPad headers.

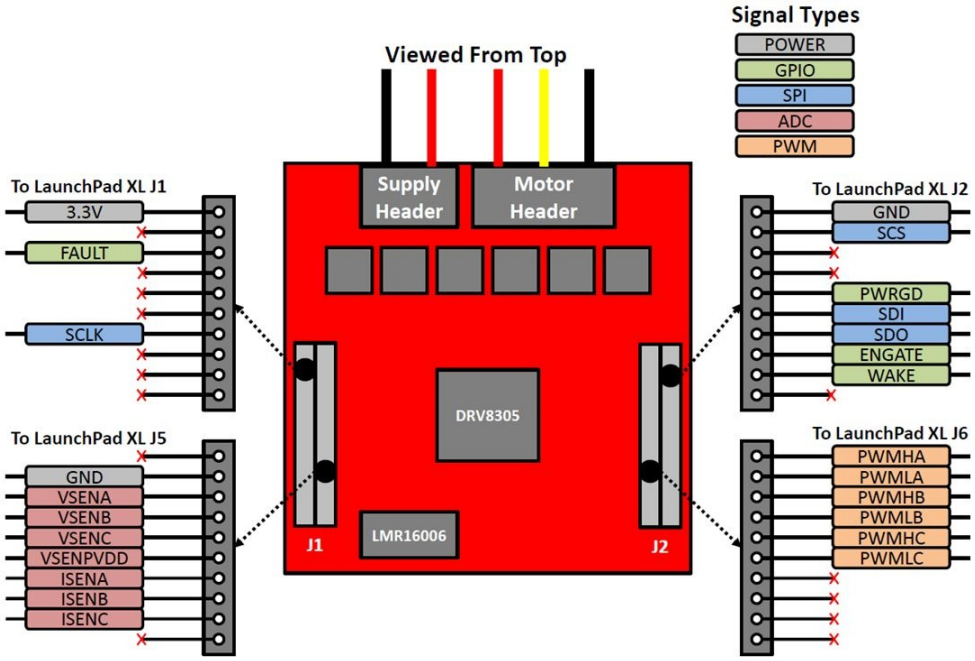

Figure 6. BOOSTXL-DRV8305EVM Pinout

- Terminal block headers for the power supply and motor connections
- Onboard LM16006 step-down buck regulator to provide 3.3-V power to the LaunchPad
- Fault reporting through the nFAULT and PWRGD signals
- SPI interface to set device configuration, operating parameters, and read out diagnostic information
- Voltage sense for the voltage supply bus and each phase output (scaled for 4.4- to 45-V operation)
- Low-side current shunt sensing on each phase (scaled for 0- to 20-A peak current operation)

3 Getting Started

3.1 Requirements

The BOOSTXL-DRV8305EVM is not a standalone motor control kit and requires a compatible XL LaunchPad to provide the appropriate motor control signals. The BOOSTXL-DRV8305EVM has been specifically designed for the LAUNCHXL-F28027F InstaSPIN-FOC LaunchPad. In addition to the BoosterPack and a compatible XL LaunchPad, a 3-phase motor and sufficient power supply are required.

3.2 Configuring the LaunchPad

The BOOSTXL-DRV8305EVM BoosterPack supplies 3.3 V to the LaunchPad through the onboard LMR16006 0.6-A, step-down buck regulator. It is recommended to remove the jumpers on the LaunchPad that connect the emulation and controller power supplies. The LaunchPad communication lines should also be configured to ensure proper operation from the host PC.

Example: LAUNCHXL-F28027F

For the LAUNCHXL-F28027F LaunchPad, remove the JP1 (3.3 V), JP2 (GND), and JP3 (5 V) jumpers to isolate the two power supply domains (MCU and Emulator).

The S1 switch should be set to the ON-ON-ON position to allow for a JTAG debug connection. The S4 switch should be moved to the OFF position to allow for the nFAULT pin from the DRV8305 to report correctly.

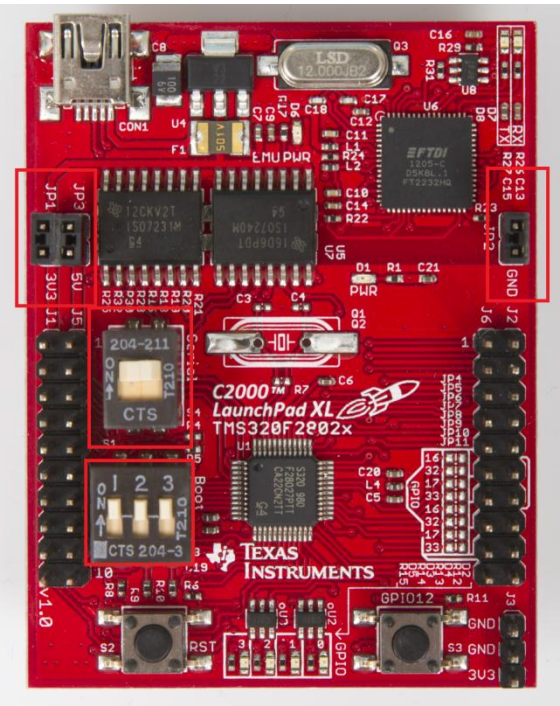

Figure 7. LAUNCHXL-F28027F Configuration

3.3 Connecting the Hardware

Use the following steps to connect the hardware:

1. Plug the BOOSTXL-DRV8305EVM BoosterPack onto the LaunchPad as shown in Figure 5. The terminal block headers should be oriented towards the USB connector and the 20-pin headers (J1 and J2) should align properly.
2. Connect the 3-phase motor to the terminal block header J4. The motor connections have been labeled with A, B, and C but can be connected in any order.
3. Connect the power supply, that will power the BoosterPack's DRV8305 3-phase gate driver, 3-phase power stage, and LMR16006 buck regulator to the terminal block header J3. The connections have been labeled PVDD and GND. For full performance, ensure the supply can support as much current as your motor may demand. The BoosterPack has a designed operating range from 4.4- to 45-V with up to 15-A RMS (20-A peak) of phase output current.

WARNING

At high currents the drive stage can increase to high temperatures. Use proper handling procedures.

4. Enable the power supply. A fault may appear on the nFAULT LED. This is normal and should be cleared when the status registers are read or EN_GATE is taken HIGH.
5. Enable the control algorithm and begin spinning the motor. The BOOSTXL-DRV8305EVM BoosterPack combined with a compatible XL LaunchPad will provide a complete motor drive and control evaluation platform. With the Piccolo LAUNCHXL-F28027F LaunchPad you can take full advantage of **TI's InstaSPIN™-FOC sensorless control solution**. To get started with InstaSPIN-FOC (http://www.ti.com/instaspin-foc) download and run MotorWare (http://www.ti.com/tool/motorware), reviewing the LAUNCHXL and BOOSTXL resources.

4 Demo Application

The BOOSTXL-DRV8305EVM BoosterPack has been optimized to work together with the Piccolo LAUNCHXL-F28027F LaunchPad to provide a complete motor drive and control evaluation platform. To quickly get your 3-phase motor spinning, see TI's InstaSPIN-FOC sensorless control solution at http://www.ti.com/tool/motorware. Multiple projects, labs, and an easy to use GUI are available with TI MotorWare available at http://www.ti.com/tool/motorware, with detailed documentation and user guides.

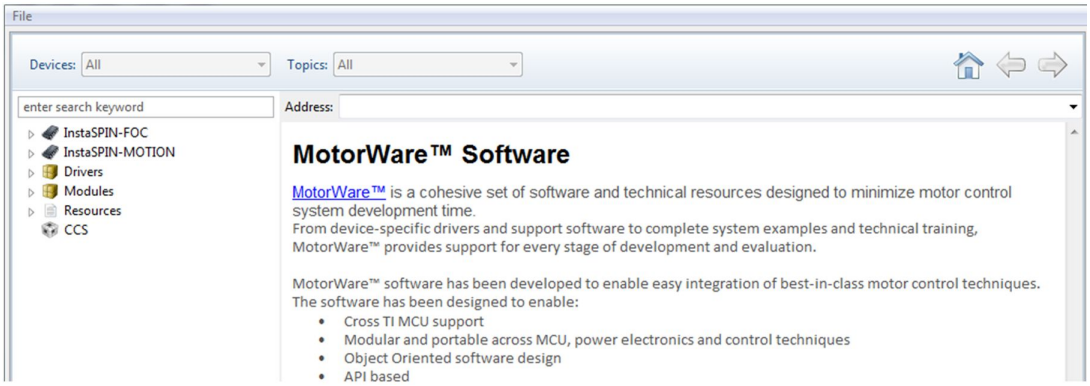

Figure 8. MotorWare

5 Detailed Hardware Description

The BOOSTXL-DRV8305EVM BoosterPack is a complete drive stage for 3-phase motor applications. The design consists of the DRV8305 motor gate driver, CSD18540Q5B N-Channel NexFET Power MOSFETs, and LMR16006 buck regulator. See the respective datasheets for the DRV8305 (SLVSCX2), CSD18540Q5B (SLPS488), and LMR16006 (SNVSA24) for more information concerning each device.

5.1 DC Bus and Phase Voltage Sense

The BoosterPack has been designed with voltage sense circuits on the DC bus (PVDD) and each half-bridge outputs (phases A, B, and C). These circuits, shown Figure 9, consist of a voltage divider with a filtering capacitor to reduce high frequency noise on the ADC pins. These circuits have been scaled to support 4.4 to 45 V. The high-side resistors for the phase outputs are located near the motor output header (J4) while the low-side resistors and filtering capacitors are located near the ADC pins on the BoosterPack to LaunchPad header (J1) for improved noise reduction purposes.

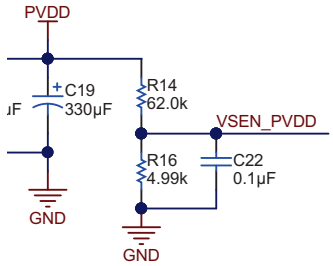

Figure 9. Voltage Sense

To achieve higher resolution voltage feedback, the scaling can be adjusted by replacing the high-side resistors with a lower value.

Example: For a 12-V system, R8, R9, R10, and R14 could be replaced with 22-kΩ resistors to approximately triple the voltage resolution. The new full scale voltage would be 17.85 V.

5.2 Low-Side Current Shunt Sense

The BoosterPack has low-side current shunt sense for each half-bridge (phases A, B, and C). The current sense setup takes advantage of the DRV8305's triple shunt current amplifiers (phases A, B, and c). The configuration for the low-side sense is shown in Figure 9. The differential amplifier senses voltage across a 0.007-Ω power sense resistor with differential connections. The differential voltage is then amplified by 10 V/V and centered at 1.65 V to allow for sensing both positive and negative currents. The sense resistor has been scaled for 0- to 20-A peak currents.

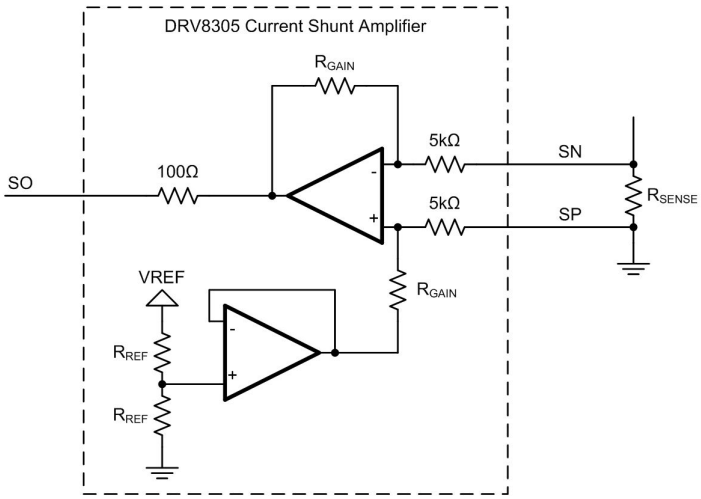

Figure 10. Current Sense

5.3 BoosterPack GPIO Signals

The Motor Drive BoosterPack brings out the GPIO signals for the DRV8301 to the LaunchPad XL. These signals are described in detail in the following list and further information can be found in the DRV8301 datasheet.

1. **nFAULT:** Fault indicator, specific FAULT status can be obtained through the status registers
2. **PWRGD:** Watchdog and LDO regulator status indicator
3. **EN_GATE:** Enables gate driver and current shunt amplifiers
4. **WAKE:** Used to bring the device out of its low power sleep mode.

5.4 DRV8305 Status and Control Registers

The DRV8305 provides extensive fault reporting and device configuration through an SPI interface and internal registers. There are two categories of registers: status and control. Status registers provide information about device faults and warnings. This information can include items ranging from IC overtemperature to MOSFET overcurrent events. The control registers allow various device parameters to be modified to suit system requirements. These parameters include but are not limited to gate drive current, dead times, current shunt amplifier configurations, and fault reporting modes. For specific information concerning the DRV8305 registers, refer to the datasheet (SLVSCX2).

The InstaSPIN GUI allows easy access to read and modify the DRV8305's internal registers. These can be accessed on the DRV8305 tab of the InstaSPIN Universal GUI.

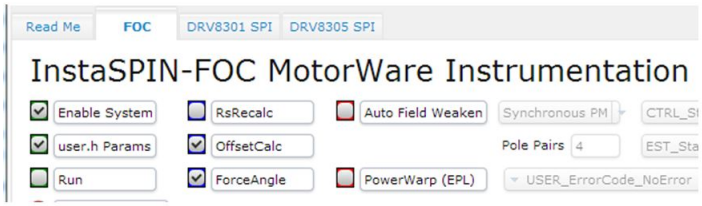

Figure 11. Enable System

Power to the BoosterPack needs to be supplied and **Enable System** needs to be checked to allow SPI reads and writes. The DRV8305 SPI tab displays a map of the DRV8305 internal registers, both status and control. To read from the registers, select the **Read** button. The register map will update with the current register values. To write to the registers, make the desired change in the map and select the **Write** button. Manual reads or writes to individual registers can be made with the **Manual Write** and **Manual Read** buttons (in decimal).

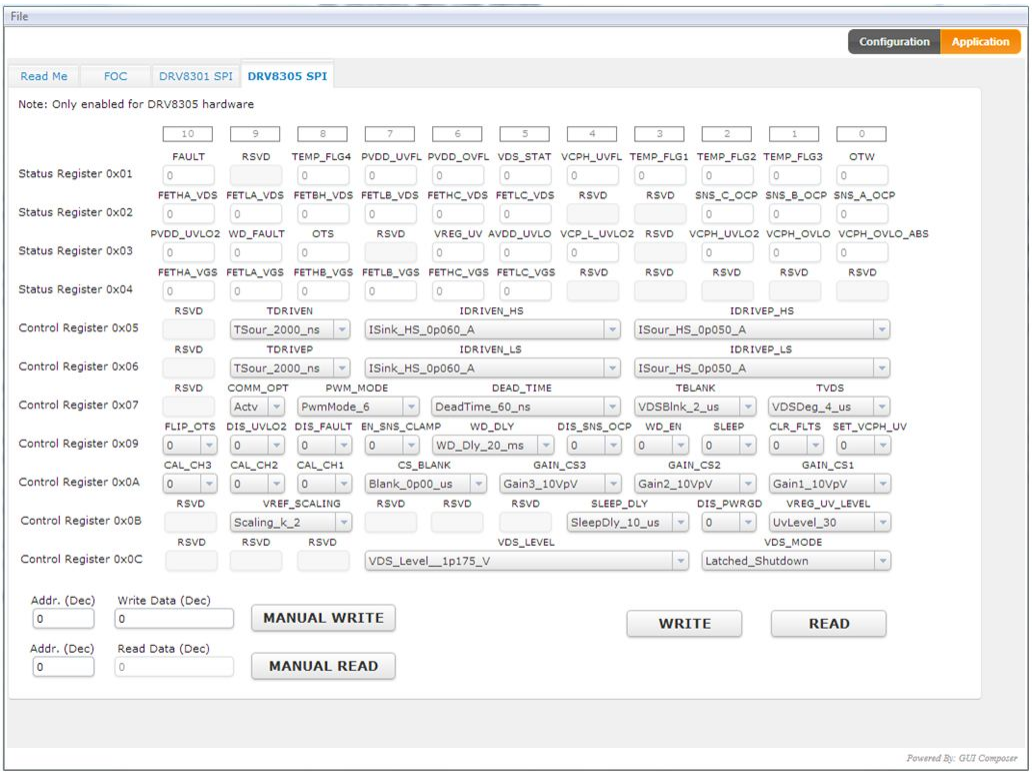

Figure 12. DRV8305 SPI Registers

5.5 BOOSTXL-DRV8305EVM Schematic

Figure 13 illustrates the BOOSTXL-DRV8305EVM schematic.

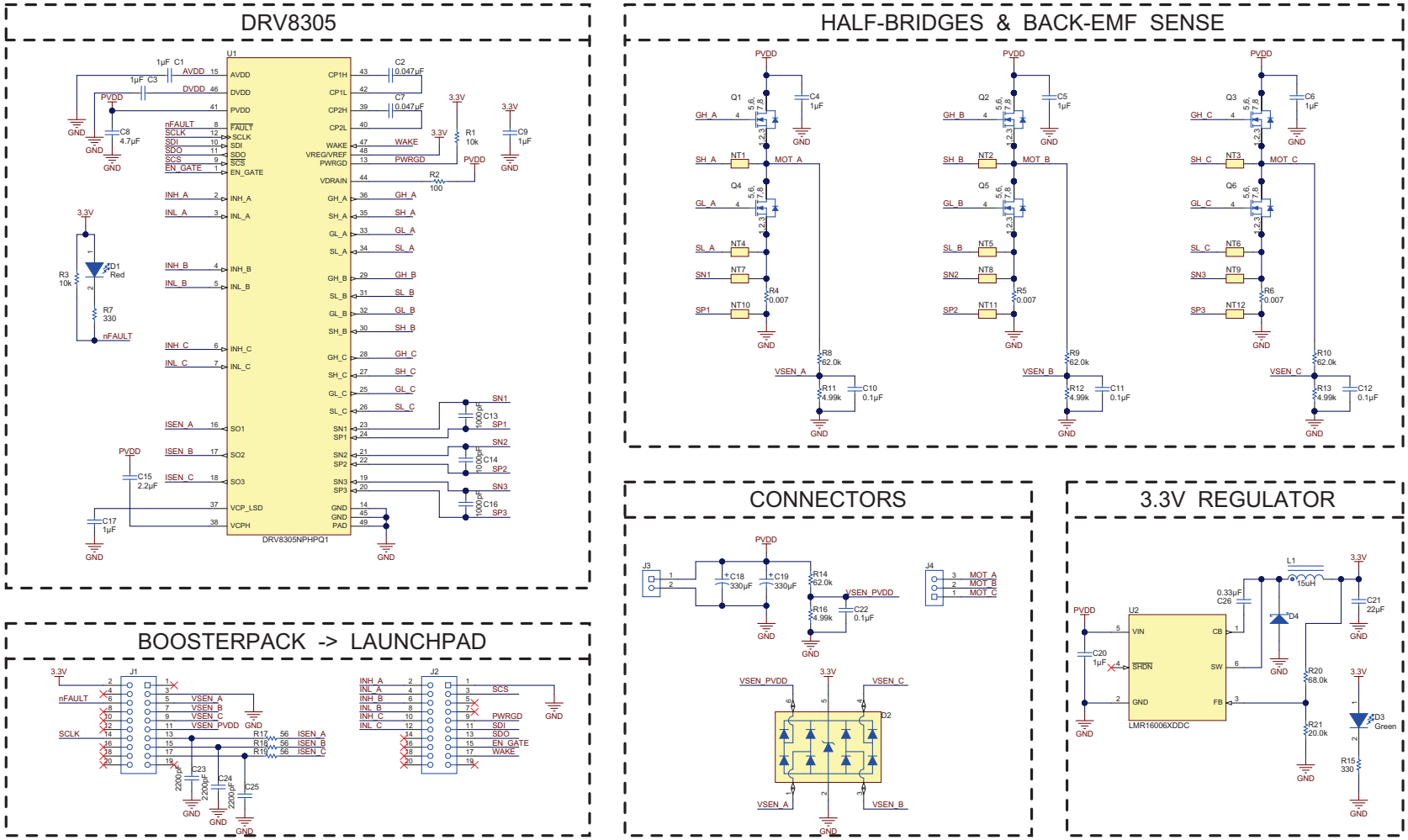

Figure 13. BOOSTXL-DRV8305EVM Schematic

5.6 Hardware Source Files

The complete design files can be found on the tool folder, including the schematic, Gerbers, designs files, PCB views, and bill of materials.

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

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3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

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Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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