BOOSTXL-DRV8301 Hardware User's Guide

This user's guide details the hardware systems and operation of the Booster Pack for the BOOSTXL-DRV8301 Motor Drive.

Contents

1 BOOSTXL-DRV8301 PCB (3-D Views) 2
2 Introduction to the BOOSTXL-DRV8301 3
2.1 Features 3
2.2 Pinout 4
3 Getting Started 4
3.1 Requirements 4
3.2 Configuring the LaunchPad 5
3.3 Connecting the Hardware 6
4 Demo Application 6
5 Detailed Hardware Description 6
5.1 DC Bus and Phase Voltage Sense 6
5.2 Low-Side Current Shunt Sense 7
5.3 Booster Pack PWM Signals 8
5.4 Booster Pack GPIO Signals 8
5.5 Hardware Files (Schematic and Gerber) 8

List of Figures

1 PCB Top 3-D View 2
2 PCB Bottom 3-D View 2
3 BOOSTXL-DRV8301 on Top of LAUNCHXL-F28027F 3
4 Booster Pack Pinout 4
5 LAUNCHXL-F28027F Configurations 5
6 Voltage Sense Configuration 6
7 Current Sense Configuration 7
8 OPA2374 External Amplifier 8

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1 BOOSTXL-DRV8301 PCB (3-D Views)

The following views are 3-D models of the BOOSTXL-DRV8301 Motor Drive Booster Pack.

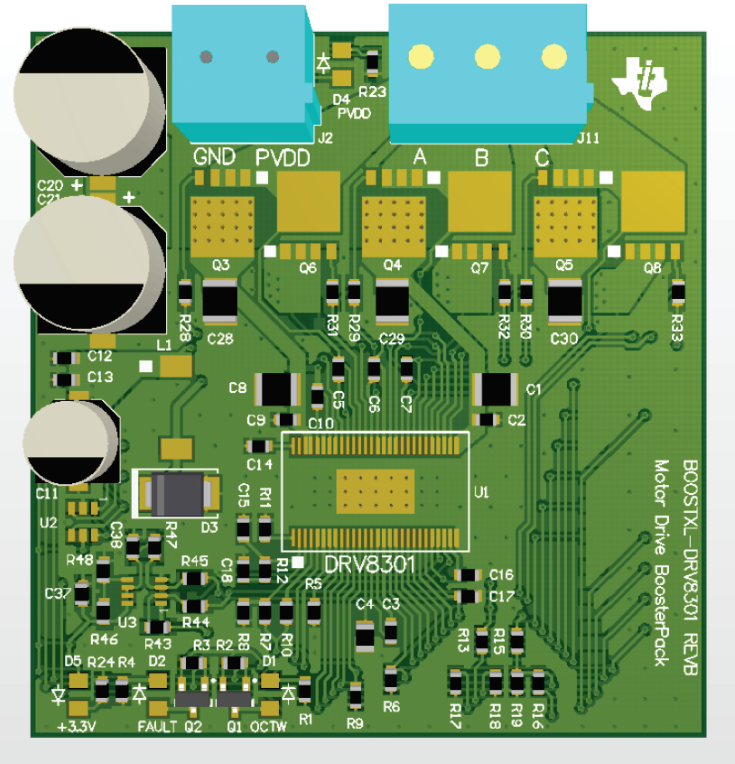

Figure 1. PCB Top 3-D View

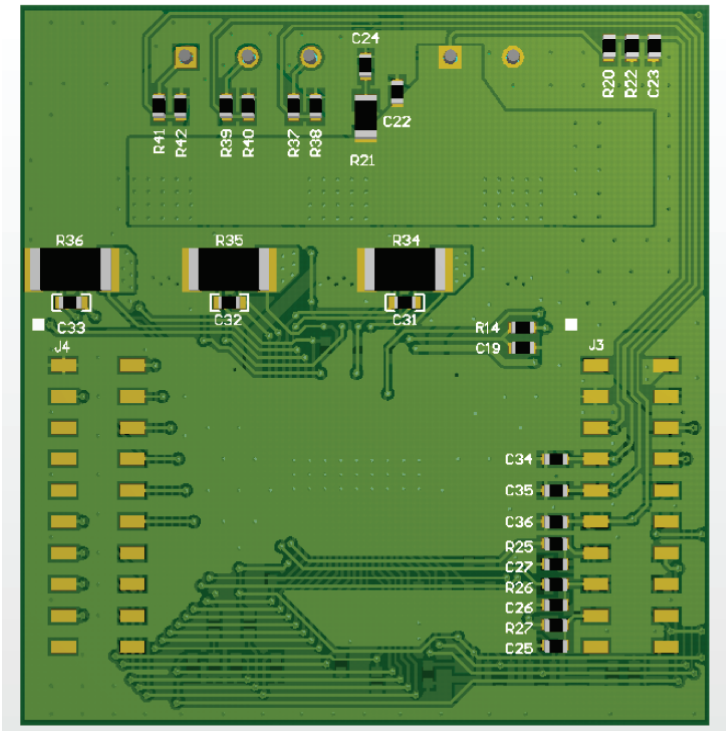

Figure 2. PCB Bottom 3-D View

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2 Introduction to the BOOSTXL-DRV8301

Learn more about the Motor Drive Booster Pack based on the DRV8301 3-phase pre-driver and CSD18533Q5A N-channel NexFET™ power MOSFETs. This Booster Pack provides a complete 3-phase drive stage to evaluate motor applications.

2.1 Features

- Complete 3-phase drive stage in a small form factor (2.2 in. × 2.3 in.)
- Supports 6 to 24 V and up to 10-A RMS (14-A Peak)
- 6× CSD18533Q5A N-Channel NexFET Power MOSFETs (< 6.5 mΩ)
- Individual phase and DC bus voltage sense
- Low-side current shunt sense on each phase
- Fully protected drive stage including short circuit, thermal, shoot-through, and undervoltage protection
- Integrated 1.5-A step-down buck converter
- Combine with compatible LaunchPad XL kits to create a complete 3-phase motor drive control platform
- Optimized for the Piccolo LAUNCHXL-F28027F LaunchPad to support the InstaSPIN™ FOC sensorless control solution

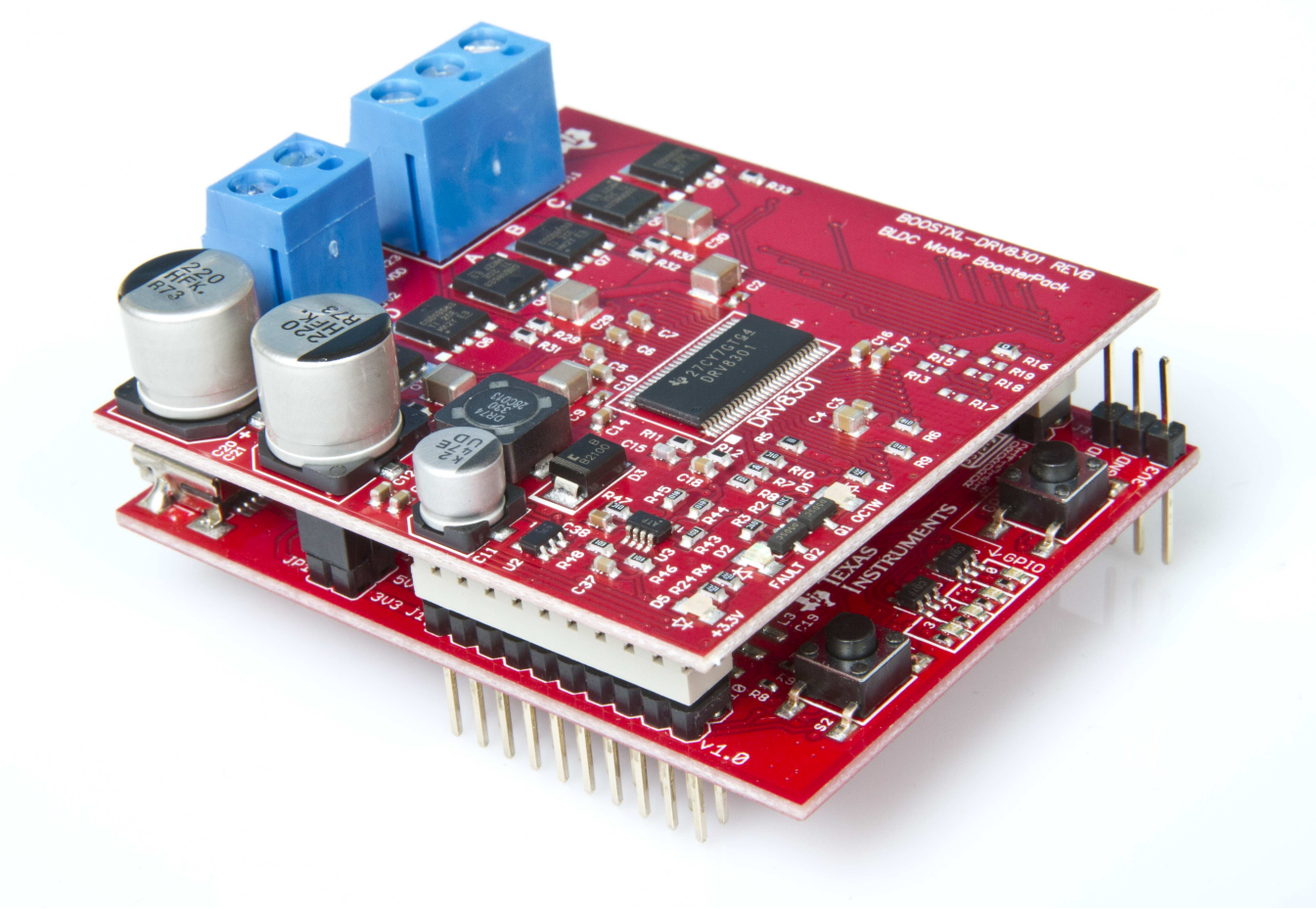

Figure 3. BOOSTXL-DRV8301 on Top of LAUNCHXL-F28027F

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2.2 Pinout

The BOOSTXL-DRV8301 brings out a combination of power, control, and feedback signals to the XL LaunchPad headers.

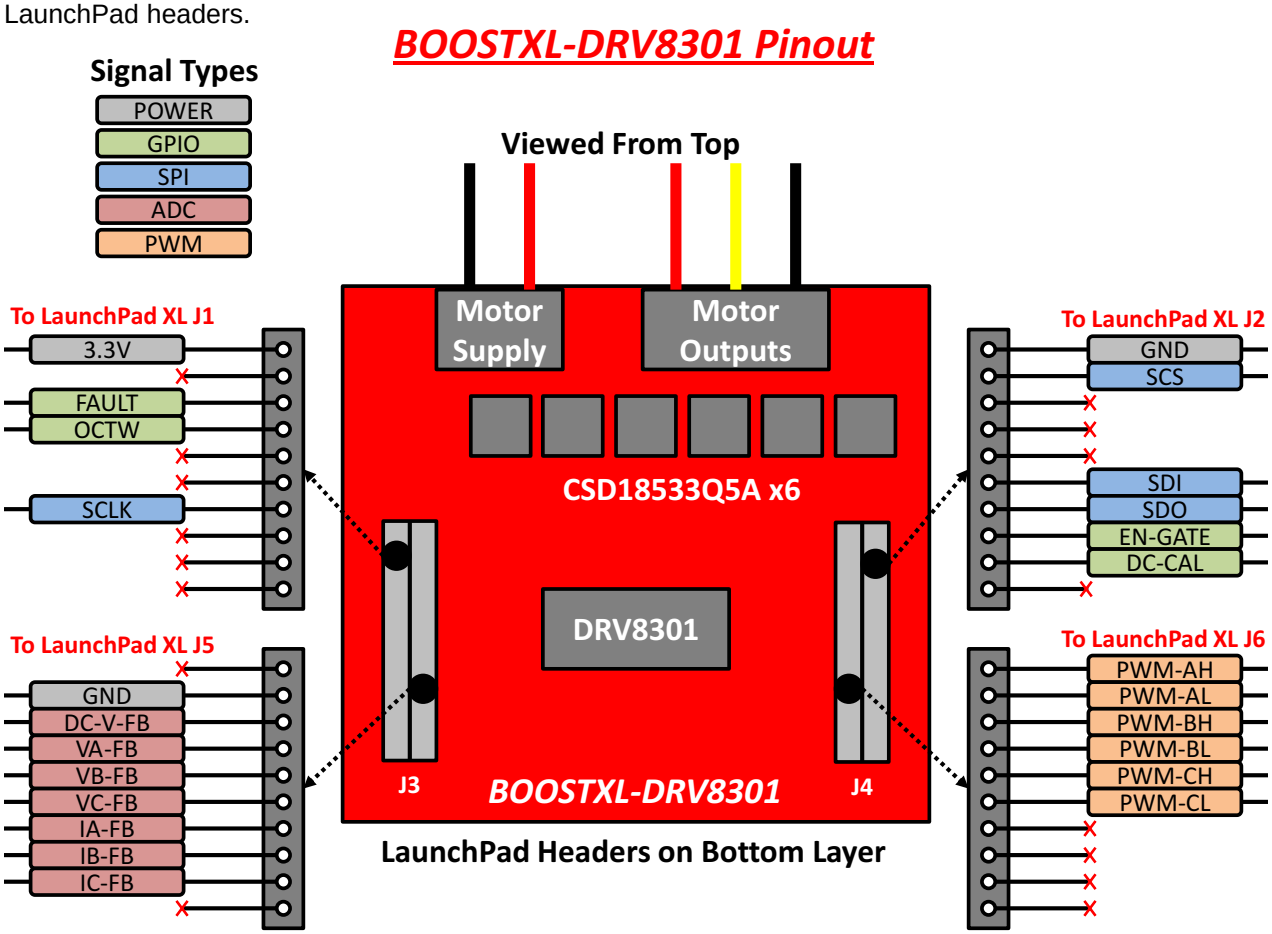

Figure 4. Booster Pack Pinout

- Onboard step-down buck converter of the DRV8301 device to provide 3.3-V power to the LaunchPad
- Fault reporting through the nFAULT and nOCTW signals
- SPI interface to set device configuration, operating parameters, and read out diagnostic information
- Independent control through three or six PWM inputs
- Voltage sense for the DC bus and each phase output (scaled for 6-V to 24-V operation)
- Low-side current shunt sensing on each phase (scaled for 0-A to 14-A peak operation)

3 Getting Started

3.1 Requirements

The Motor Drive Booster Pack is not a standalone evaluation kit. It requires a compatible XL LaunchPad to provide the appropriate control signals. The Motor Drive Booster Pack and compatible XL LaunchPad also require a 3-phase motor and sufficient power supply.

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3.2 Configuring the LaunchPad

The BOOSTXL-DRV8301 Motor Drive Booster Pack supplies 3.3-V power to the LaunchPad through the onboard 1.5-A step-down buck converter of the DRV8301. TI™ recommends removing the jumper on the LaunchPad that connects the 3.3-V emulation and controller power supplies.

The BOOSTXL-DRV8301 nFAULT and nOCTW signals share lines with the LaunchPad UART RX and TX signals. To see proper nFAULT and nOCTW reporting on the onboard LEDs and microcontroller GPIO, disconnect the UART lines from the emulation side of the LaunchPad to the microcontroller.

Ex. LAUNCHXL-F28027F

Remove the 3.3-V jumper, JP1, for the LAUNCHXL-F28027F LaunchPad. Turn switch S4 OFF (UART connection to emulation hardware) on the LaunchPad.

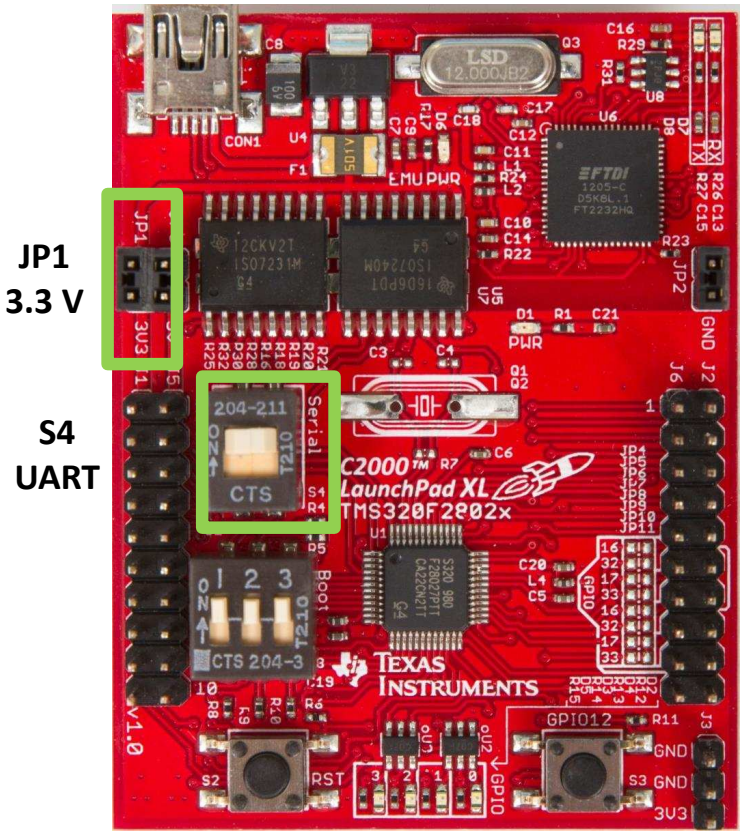

Figure 5. LAUNCHXL-F28027F Configurations

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3.3 Connecting the Hardware

1. Plug the Motor Drive Booster Pack onto the LaunchPad as shown in Figure 3. The terminal block headers should be oriented towards the USB connector.
2. Connect the 3-phase motor to the terminal block header, J11. The motor connections are labeled A, B, and C, but can connect in any order.
3. Connect the power supply, which powers the Motor Drive Booster Pack's DRV8301 3-Phase Pre-Driver and Drive Stage, to the terminal block header, J2. The connections have been labeled PVDD and GND. For full performance, ensure the current supply is sufficient for the motor. The Motor Drive Booster Pack has a designed operating range from 6 to 24 V, up to 10-A RMS (14-A peak). (1)
4. Enable the power supply.
5. Enable the control algorithm and spin the motor. The BOOSTXL-DRV8301 Booster Pack combined with a compatible XL LaunchPad provides a complete motor drive and control evaluation platform. The Piccolo LAUNCHXL-F28027F LaunchPad works with the TI InstaSPIN™ FOC to provide a sensorless control solution. To get started with InstaSPIN-FOC download and run MotorWare and review the LAUNCHXL and BOOSTXL resources.

4 Demo Application

As mentioned previously, the BOOSTXL-DRV8301 Motor Drive Booster Pack is optimized to work with Piccolo LAUNCHXL-F28027F LaunchPad to provide a complete motor drive and control platform. To quickly make the 3-phase motors spin, see InstaSPIN-FOC sensorless control solution. Multiple projects, labs, and an easy-to-use GUI are available with MotorWare, available at http://www.ti.com/tool/motorware with detailed documentation and user guides.

5 Detailed Hardware Description

The BOOSTXL-DRV8301 Motor Drive Booster Pack is a complete drive stage for a 3-phase application. This Motor Drive Booster Pack consists of the DRV8301 pre-driver and CSD18533Q5A N-Channel NexFET™ Power MOSFETs. See the respective data sheets for the DRV8301 and CSD18533Q5A for more information concerning the individual devices.

5.1 DC Bus and Phase Voltage Sense

The Motor Drive Booster Pack is designed with voltage sense circuits on the DC bus (PVDD) and each half-bridge outputs (phases A, B, and C). These circuits (shown in Figure 6) consist of a voltage divider with a filtering capacitor to reduce high-frequency noise on the ADC pins. These circuits are scaled for 26.314 V, with a filter pole location of 364.692 Hz. The high-side resistors for the phase outputs are located near the motor output header, J11, whereas the low side resistors and filtering capacitors are located near the ADC inputs on the Booster Pack to LaunchPad header, J3, for improved noise reduction. This requirement and the calculations are described in the InstaSPIN™ FOC User's Guide in Chapter 5.

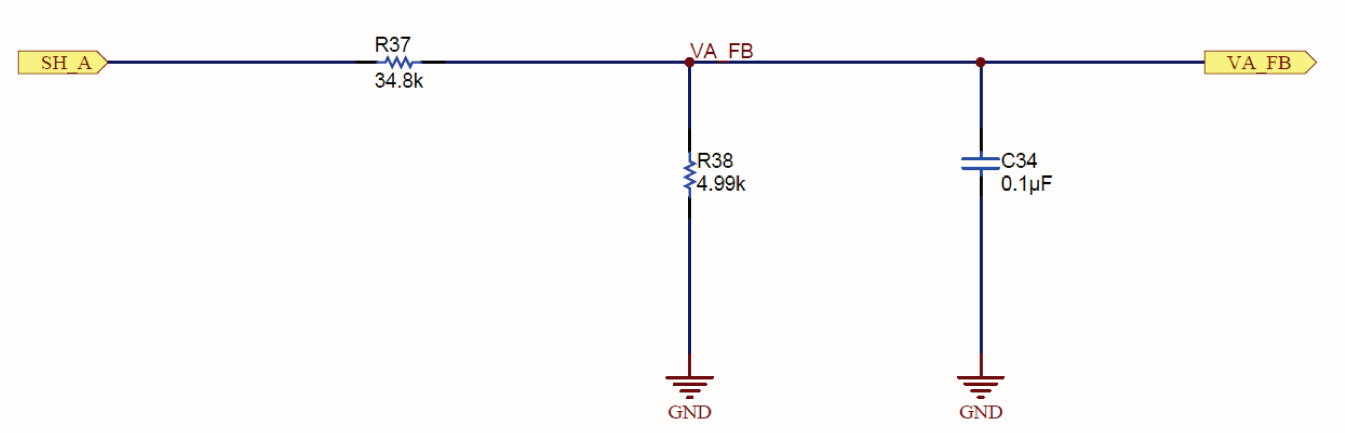

Figure 6. Voltage Sense Configuration

(1) At high currents, the drive stage can increase to high temperatures

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5.2 Low-Side Current Shunt Sense

The Motor Drive Booster Pack has low side current shunt sense for each half-bridge (phases A, B, and C). The current sense setup takes advantage of the dual shunt current amplifiers (phases A and B) of DRV8301 and an external TI OPA2374 CMOS operation amplifier (phase C). The configuration for the low-side sense resistor is shown in Figure 7. The amplifier senses voltage across a 0.01-Ω sense resistor through differential connections. The current measurement is scaled for ±16.5 A. This requirement and the calculations are described in the InstaSPIN™ FOC User's Guide in Chapter 5.

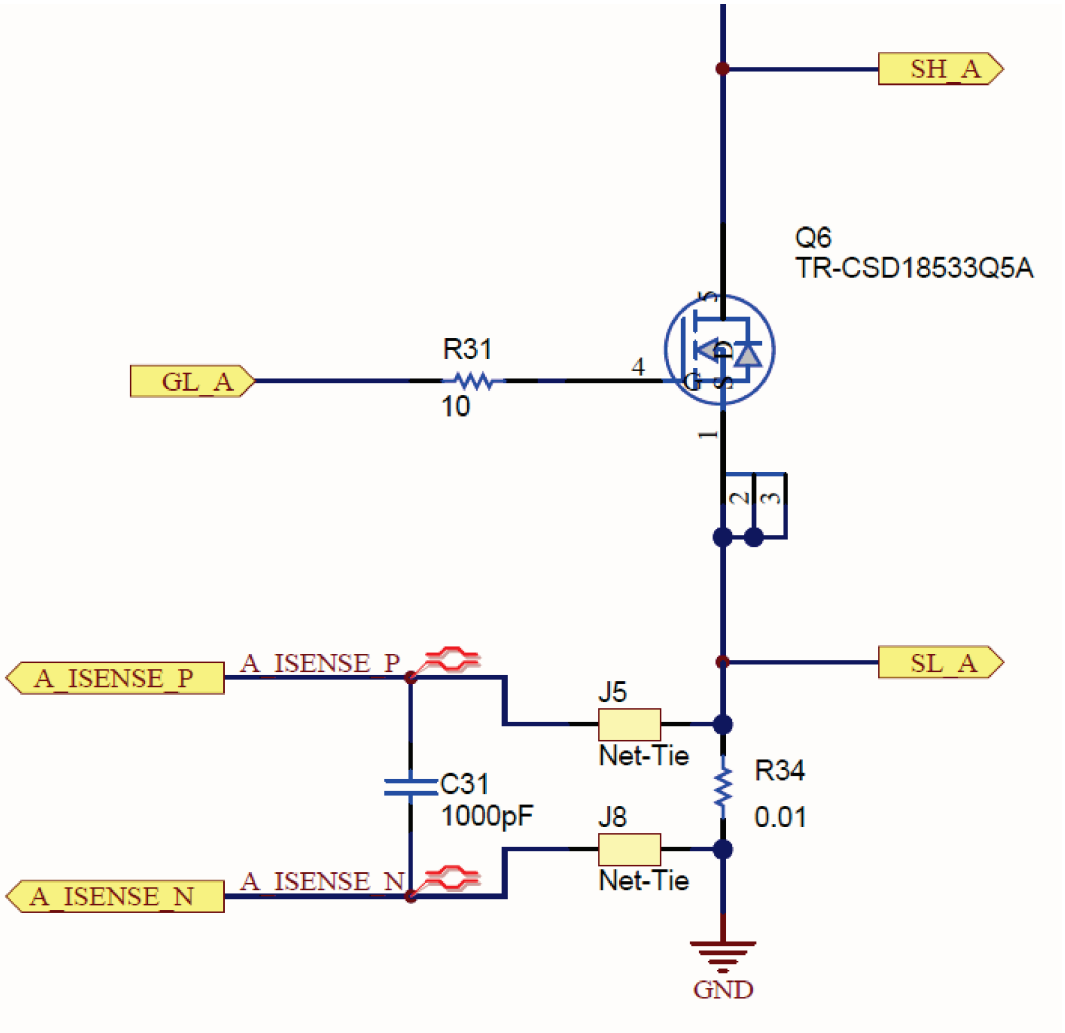

Figure 7. Current Sense Configuration

The configuration for the external OPA2374 (phase C current sense), shown in Figure 8, is set to closely mirror the internal amplifiers of the DRV8301. The gain is set to 10 with a reference voltage of approximately 1.65 V.

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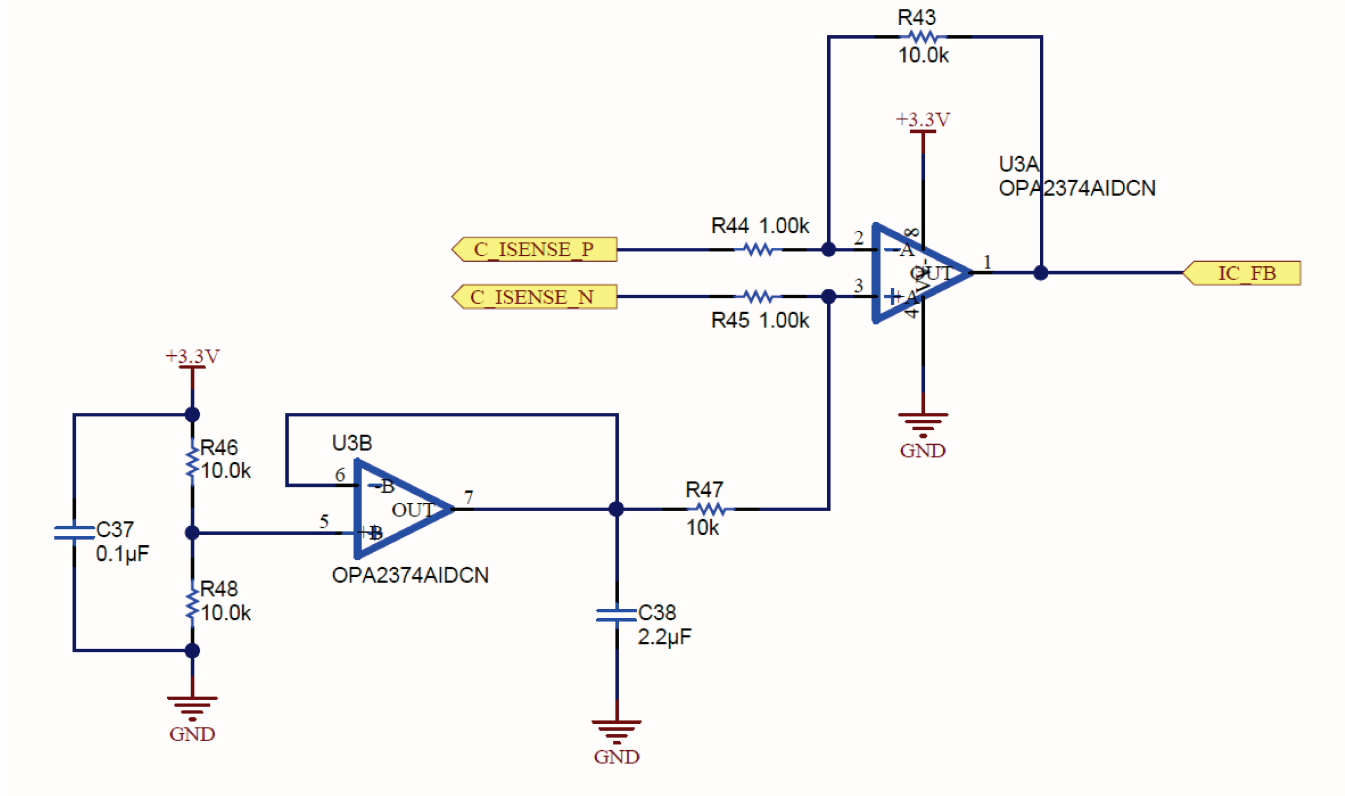

Figure 8. OPA2374 External Amplifier

5.3 Booster Pack PWM Signals

The DRV8301 can be configured for two different PWM control modes outlined further in the DRV8301 datasheet. These control modes give PWM control through three or six independent inputs. Six-input PWM mode gives independent control of the low-side and high-side gates for each half-bridge. Three-input PWM mode gives control of the high side gates and low-side control by an internally generated complementary signal with minimum internal dead time.

5.4 Booster Pack GPIO Signals

The Motor Drive Booster Pack 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 report indicator; specific fault status can be obtained through the status registers
2. nOCTW – Overcurrent, overtemperature, or both warning indicator, specific OCTW status can obtained through the status registers
3. EN_GATE – Enables gate driver and current shunt amplifiers
4. DC_CAL – When high, device shorts inputs of shunt amplifiers and disconnects loads; the LaunchPad XL calibrates DC offset

5.5 Hardware Files (Schematic and Gerber)

The complete design files are in the tool folder (www.ti.com/drv8301-boosterpack) including the schematic, Gerbers, layout files, PCB views, and bill of materials.

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