*EVM User's Guide: MCF8329EVM*

# *MCF8329 Evaluation Module*

## Description

The MCF8329EVM allows users to evaluate the performance of a MCF8329 motor driver. The EVM includes an onboard FTDI chip to convert USB communication, from the micro-USB connector, into UART. An onboard MSP430FR2355 microcontroller (MCU) translates the UART communication into either control signals or SPI formatted data, which is sent to the MCF8329 device. There are many user-selectable jumpers, resistors, connectors, and test points to assist with evaluating the many features of the MCF8329 IC and the configurable device-specific settings.

## Get Started

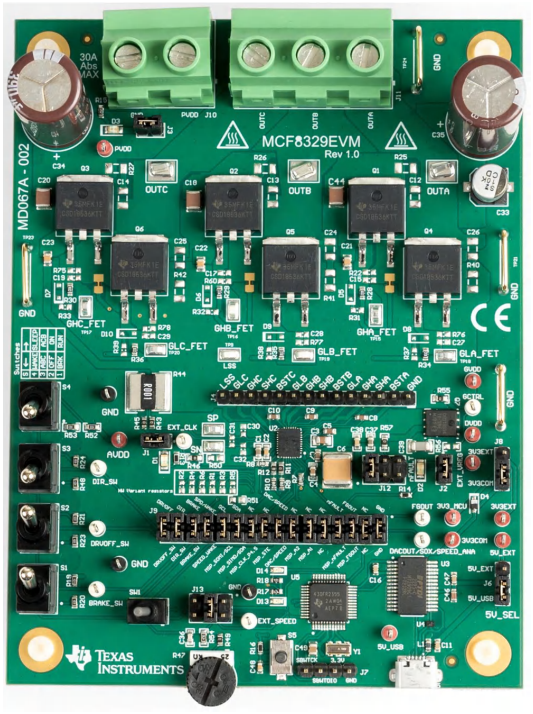
1. Download the latest design files from the MCF8329EVM tool page on ti.com
2. Download the latest version of the Motor Studio GUI and firmware from the Motor Studio tool page on ti.com

## Features

- GUI software to simplify the MCx tuning process and performance evaluation
- MCU-to-MCx shunt jumper header with removable shunts to disconnect main signals going to the motor driver IC from the MCU
  - The shunts can be removed if the user desires to control the MCF8329 IC with an external MCU or to use the EVM MCU to control an external MCF8329 IC

## Applications

- Cordless vacuum
- Cordless garden tools
- CPAP machine
- Ventilator
- Server fans




**MCF8329EVM (Top View)**

# 1 Evaluation Module Overview

## 1.1 Introduction

This document is provided with the MCF8329 customer evaluation module (EVM) as a supplement to the MCF8329 data sheet. This user's guide details the hardware setup instructions, GUI installation, and usage instructions.

**CAUTION**

Hot surface temperature

The EVM can have high surface temperatures marked by the FIRE triangular symbol on the EVM. Avoid toughing the marked hot surface are when driving high currents to prevent potential burn damage.

## 1.2 Kit Contents

Table 1-1 lists the contents of the EVM kit. Contact the Texas Instruments Product Information Center nearest to you if any components are missing. TI highly recommends that users check the TI website at https://www.ti.com to verify that the latest version of the related software is being used.

**Table 1-1. Kit Contents**

| Item | Quantity |
|---|---|
| MCF8329EVM | 1 |
| USB A Male-to-USB B Micro Male Cable | 1 |

## 1.3 Specification

The MCF8329EVM can support voltages up to 60 V and currents up to 30 A. To prevent damage to both the IC and the EVM, confirm that these voltage and current specifications are not exceeded.

## 1.4 Device Information

The MCF8329 is a 4.5-V to 60-V, three-phase brushless-DC gate driver IC with code-free sensorless field oriented control (FOC) for motor drive applications. The device provides three half-bridge gate drivers, each capable of driving high-side and low-side N-channel power MOSFETs. The device generates the correct gate drive voltages using an internal charge pump and enhances the high-side MOSFETs using a bootstrap circuit. A trickle charge pump is included to support 100% duty cycle. The gate drive architecture supports peak gate drive currents up to 1-A source and 2-A sink.

The internal sensorless FOC algorithm is highly configurable through register settings in a non-volatile EEPROM ranging from motor start-up behavior to closed loop operation, which allows for the device to operate stand-alone once the device has been configured. Motor current is sensed using an integrated current sense amplifier supporting a single external shunt resistor. The device can receive a speed command through a PWM input, analog voltage, variable frequency square wave, or I2C command. There are a large number of protection features integrated into the MCF8329, intended to protect the device, motor, and system against fault events.

# 2 Hardware

## 2.1 Quick Start Guide

The MCF8329EVM requires a power supply source, which has a recommended operating range from a 4.5-V to 60-V. To setup and power the EVM, follow the sequence below:

1. Connect motor phases to A, B, and C on connector J11.
2. Do not turn on the power supply yet. Connect the motor supply to PVDD and GND on connector J10.
3. Select J6 to 5V_USB and J8 to 3V3COM to power MSP430 from USB power supply.
4. Connect the micro-USB cable into the computer.
5. Turn the potentiometer fully clockwise to set the motor to zero speed upon power up.
6. Flip the switch S1 to the top to configure BRAKE = RUN, switch S2 to the top to configure DRVOFF = ON, switch S3 to the bottom to configure DIR = ABC, and switch S4 to the bottom to configure WAKE.
7. Flip the switch SW1 to left to configure SPEED/WAKE pin to SPEED mode and DACOUT/SOx/SPEED_ANA pin to DACOUT mode. Note that flipping the switch SW1 to right configures SPEED/WAKE pin to WAKE mode and DACOUT/SOx/SPEED_ANA pin to SPEED_ANA mode. When SW1 is flipped to right, switch S4 can be used to put the device in SLEEP or WAKE mode and potentiometer R47 can be used to apply analog voltage to the DACOUT/SOx/SPEED_ANA pin.
8. Set J12 to leftmost position (closer to C6) to apply AVDD to VREG.
9. Set J13 to middle position to apply the analog voltage from potentiometer R47 to the SPEED/WAKE pin.
10. Turn on the motor power supply.
11. Use the potentiometer R47 to control the speed of the motor and the switches to disable the motor driver, change the direction, or apply a brake to the motor. Optionally, use the GUI (as shown in Section 3) to monitor the real-time speed of the motor, put the MCF8329 into a low-power sleep mode, and read status of the LEDs.

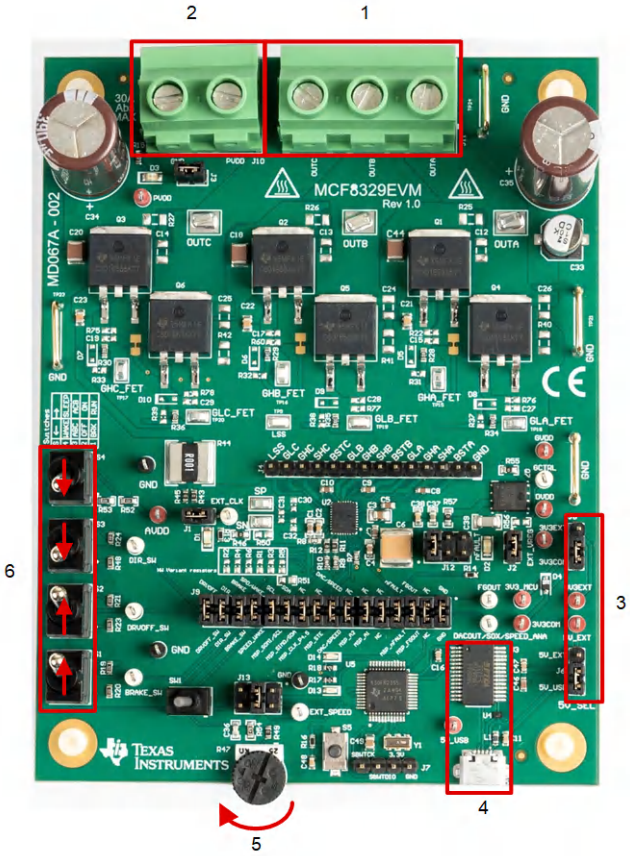



**Figure 2-1. Reference for Quick Start Guide**

## 2.2 Hardware Setup

The hardware required to run the motor is the MCF8329EVM, a micro-USB cable, and a power supply with a DC output from 4.5-V to 60-V. Follow these steps to start up the MCF8329EVM:

1. Connect the DC power supply to header J10. Connect to PVDD and GND.
2. Apply user configurable jumper settings. See Section 2.7 for more information.
3. Flash the firmware into the MCU as described in Section 3.4. Launch Motor Studio and disconnect the 4-pin JTAG connections.
4. Turn on the power supply to power up the MCF8329EVM.
5. Connect a Micro-USB cable to the MCF8329EVM and computer.

If using the MCF8329EVM with an external microcontroller, then remove all shunt jumpers from jumper bridge J9. Connect with external jumpers to the right side of the jumper bridge from the external MCU.

## 2.3 Hardware Connections Overview

Figure 2-2 shows the major blocks of MCF8329EVM. The MCF8329EVM is designed for an input supply from 4.5 V to 60 V at 30 A max. The MCF8329EVM includes a power stage with six external N-channel power MOSFETs (part number: CSD18536KTTT) and passive components. The MCF8329EVM also includes a 1 mΩ current sense shunt resistor and an external N-channel MOSFET controlled by GCTRL to generate VREG. For interfacing with the GUI, the MCF8329EVM has an onboard FTDI chip and MSP430.

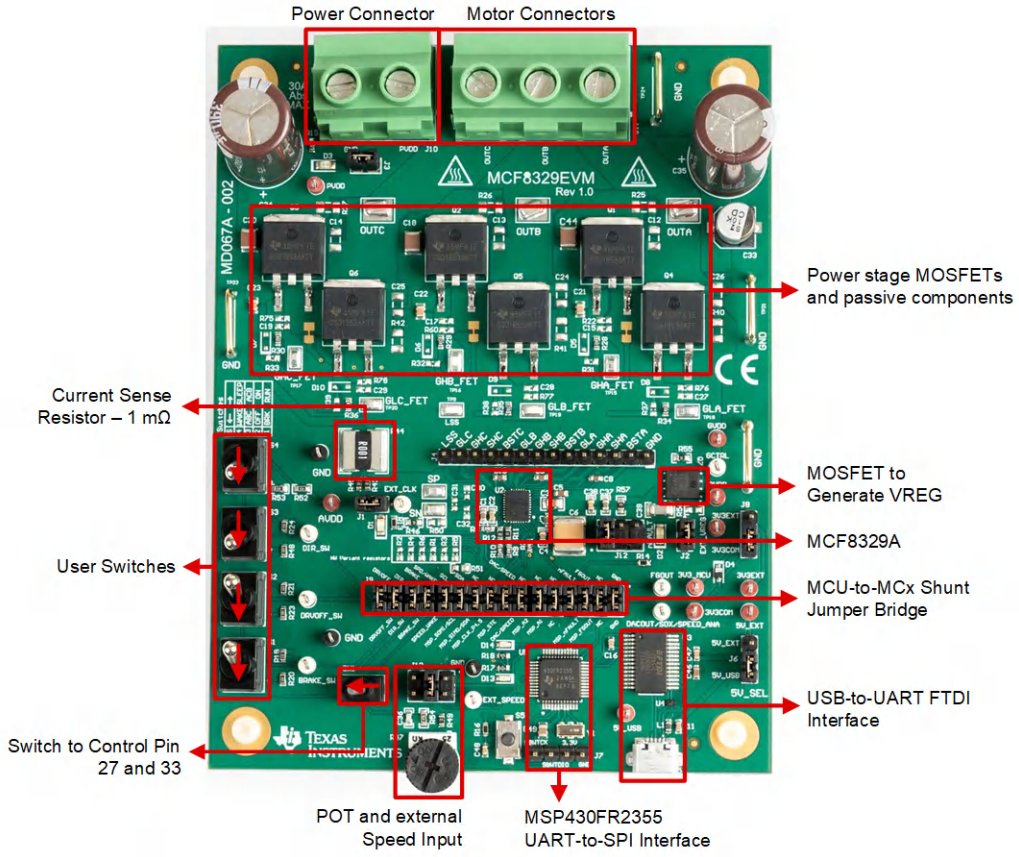



**Figure 2-2. MCF8329EVM Major Hardware Blocks**

## 2.4 Connection Details

Figure 2-3 outlines which connections must be made to the MCF8329EVM in order to spin a 3-phase sensorless brushless-DC motor.

Connect a 4.5-V to 60-V power supply to the PVDD and GND terminals on connector J10.

Connect the three phases of the BLDC motor to the A, B, and C terminals of the screw terminal connector J11.

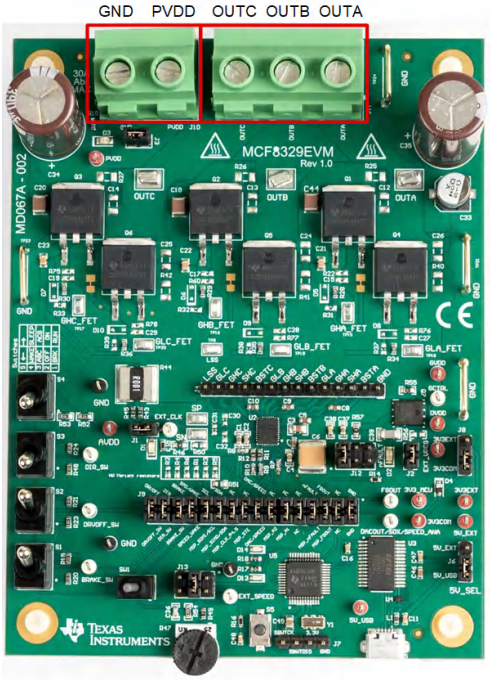



**Figure 2-3. Connections from Motor to MCF8329EVM**

Figure 2-4 shows where the micro-USB cable is plugged into the MCF8329EVM to provide communication between evaluation module and GUI. The USB data and 5 V power from the USB is converted, by the FTDI chip, into UART data and 3.3 V power which is used to power the MSP430FR2355 microcontroller. The 5 V from the USB power is limited to 500 mA and the 3.3 V from the FTDI chip is limited to 30 mA. If the user wants to supply more current to these rails, then use the 5V_SEL jumper J6 and 3V3_SEL jumper J8 to connect external power rails.

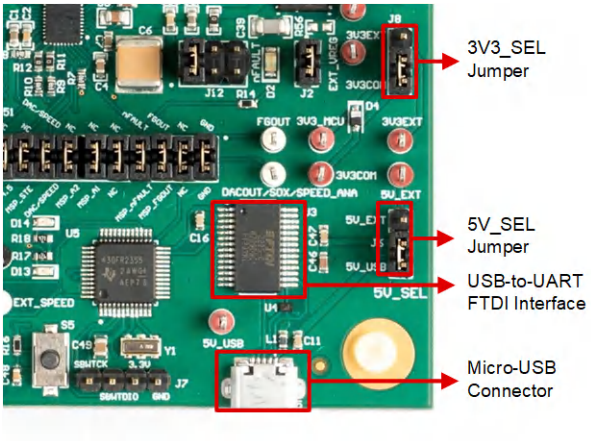



**Figure 2-4. Micro-USB connector and USB-to-UART interface**

## 2.5 MSP430FR2355 Microcontroller

The MCF8329EVM includes a MSP430FR2355 low-power MCU, shown in Figure 2-5, to communicate via I2C with the MCF8329 IC.

To program the MSP430FR2355, an external MSP430 FET programmer must be connected to the Spy-Bi-Wire (SBW) interface connector J7. Many MSP430 LaunchPads™ provide an onboard eZ-FET Debug Probe that can be jumper-wired to the MCF8329EVM to flash the firmware into the onboard MSP430FR2355 microcontroller.

The user can use the Reset (RST) button at any time to restart the MCU program. Two active-low LEDs, D13 and D14, can be used for debug purposes as well.

The 32-pin shunt jumper bridge J9 ties all signals between the microcontroller and MCF8329 IC. These jumpers can be inserted or removed as needed to isolate the microcontroller from the gate driver. This allows for microcontroller signal debugging or using the MCF8329EVM as a standalone gate driver with an external microcontroller.

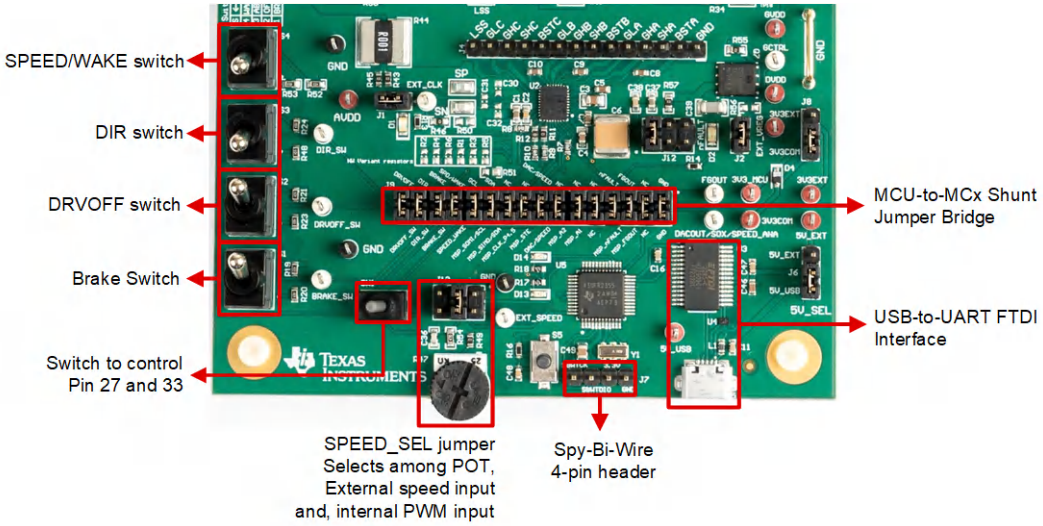



**Figure 2-5. MSP430FR2355 MCU on MCF3829EVM**

## 2.6 LED Lights

The MCF8329EVM has 5 status LEDs that provide the status of power supplies and functions of the evaluation module. By default, the PVDD LED and AVDD LED lights up when the board is powered and the program has been flashed onto the microcontroller. Table 2-1 shows LED descriptions including those that are on during power up in bold with Figure 2-6 showing the locations of the LEDs.

**Table 2-1. Description of MCF8329EVM LEDs (Default in Bold After Power Up)**

| Designator | Name | Color | Description |
|---|---|---|---|
| D1 | 3.3V | Green | Lights up when AVDD is turned ON |
| D2 | nFAULT | Red | Lights up when fault condition has occurred on MCF8329 |
| D3 | PVDD | Green | Lights up when voltage is applied on PVDD |
| D13 | MSP_LED1 | Red | Used for UART or debugging |
| D14 | MSP_LED2 | Red | Used for UART or debugging |

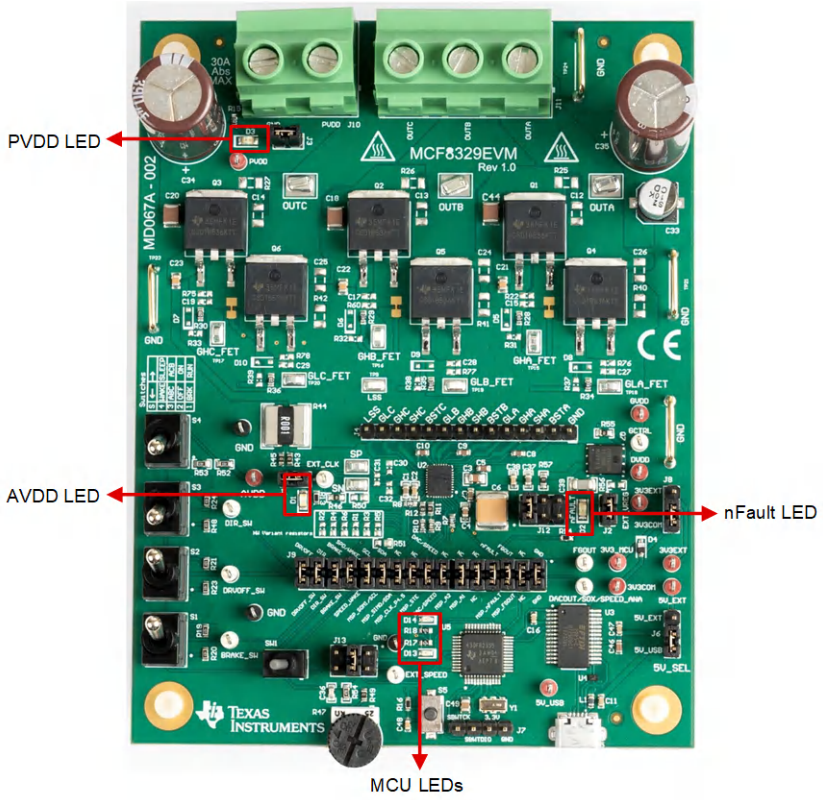



**Figure 2-6. MCF8329EVM LED Locations**

## 2.7 User Configurable Settings

The MCF8329EVM includes a variety of user-selectable jumpers, switches, and resistors on the entirety of the evaluation board to configure settings. Table 2-2 summarizes all of these configurable settings.

**Table 2-2. Description of User-Selectable Settings on MCF8329EVM (Default in Bold)**

| Designator | Setting Name | Description | Layer | Position | Function |
|---|---|---|---|---|---|
| J8 | 3V3_SEL | Select 3.3 V source for MCU power | Top | J8 = 3V3EXT | External |
| | | | | J8 = 3V3COM | From FTDI (30 mA) |
| J6 | 5V_SEL | Select 5 V source for FTDI power | Top | J6 = 5V_EXT | External |
| | | | | J6 = 5V_USB | From USB power (500 mA) |
| J13 | SPEED_SEL | Selects SPEED input source | Top | J13 = EXT | External EXT_SPEED test point |
| | | | | J13 = POT | From Potentiometer R47 |
| | | | | J13 = INT_PWM | From internal PWM. PWM Duty cycle can be varied by rotating the POT R47 |
| J9 | MSP to MCx Shunt jumper bridge | Connects signals from MVU and user switches to MCF8329 when jumpers are inserted | Top | DRVOFF_SW | DRVOFF |
| | | | | DIR_SW | DIR |
| | | | | BRAKE_SW | BRAKE |
| | | | | SPEED_WAK | SPEED/WAKE |
| | | | | MSP_POCI/SCL | SCL |
| | | | | MSP_PICO/SDA | SDA |
| | | | | MSP_CLK | NC |
| | | | | MSP_STE | NC |
| | | | | DAC/SPEED | DAC/SPEED |
| | | | | MSP_A2 | NC |
| | | | | MSP_A1 | GCTRL |
| | | | | NC | NC |
| | | | | MSP_nFAULT | nFAULT |
| | | | | MSP_FGOUT | FGOUT |
| | | | | NC | NC |
| | | | | GND | GND |
| J12 | VREG_SEL | Selects VREG power supply | Top | Left position | VREG powered by AVDD |
| | | | | Middle position | VREG powered externally |
| | | | | Right position | VREG powered by MOSFET Q7 |
| J1 | AVDD LED | Connects AVDD LED to 3.3 V pull up | Top | Connected | D1 lights up when AVDD is turned ON |
| J2 | nFAULT LED | Connects nFAULT LED to 3.3 V pull up | Top | Connected | D2 Lights up when nFAULT is pulled low |
| J3 | PVDD LED | Connects PVDD LED to 3.3 V pull up | Top | Connected | D3 lights up when voltage is applied to PVDD |
| S1 | Brake | Turns on all low-side MOSFETs | Top | Bottom | Break enabled |
| | | | | Top | Brake disabled |
| S2 | DRVOFF | Disables gate drivers | Top | Bottom | MCF8329 Disabled |
| | | | | **Top** | MCF8329 Disabled |
| S3 | DIR | Controls direction of motor rotation | Top | Bottom | ABC |
| | | | | Top | ACB |
| S4 | SPEED/WAKE | Pulls SPEED/WAKE pin to AVDD and GND | Top | Bottom | SPEED/WAKE pin pulled to AVDD |
| | | | | Top | SPEED/WAKE pin pulled to GND |

**Table 2-2. Description of User-Selectable Settings on MCF8329EVM (Default in Bold) (continued)**

| Designator | Setting Name | Description | Layer | Position | Function |
|---|---|---|---|---|---|
| SW1 | N/A | Configure SPEED/WAKE pin to SPEED mode and DACOUT/SOx/ SPEED_ANA pin | Top | Left | Configure SPEED/Wake pin to SPEED mode and DCAOUT/SOx/ SPEED/ANA pin to DACOUT mode |
| | | | | Right | Configure SPEED/WAKE pin to WAKE mode and DACOUT/SOx/ SPEED_ANA pin to SPEED_ANA mode |

# 3 Software

## 3.1 Firmware and GUI Application

The MCF8329EVM includes a USB-to-UART interface, using a MSP430FR2355 microcontroller, that serves as a communication bridge between a host PC and the MCF8329 device for configuring various device settings and reading fault diagnostic information.

The MCF8329EVM is supported on the Motor Studio GUI which can be used to configure the MCF8329 though this communication interface. The Motor Studio GUI simplifies the tuning process of the MCF8329 by offering guided tuning instructions, a virtual oscilloscope for real-time variable monitoring, and more. The latest version of the Motor Studio GUI can be downloaded on ti.com.

By default, the onboard MSP430 microcontroller already contains the firmware needed to communicate with the Motor Studio GUI. If there is a firmware update or the GUI does not connect to the EVM, then the user must flash the firmware code into the MSP430 by following the steps outlined in Section 3.4.

Flashing the firmware code onto the MSP430 requires an integrated development environment (IDE) and an eZ-FET Debug Probe. The following example uses the Code Composer Studio™(CCS) IDE and the MSP-EXP430FR2355 LaunchPad™ Development Kit to provide the eZ-FET Debug Probe.

## 3.2 Downloading and Running Motor Studio

1. Connect the MCF8329EVM as described in Section 2.2.
2. Download the latest version of the Motor Studio GUI.
3. Once the Motor Studio GUI is installed, run the Motor Studio GUI application.
4. Click the red *Setup Now* button under *Hardware Setup* on the bottom right side of the window.
5. After setting up the hardware settings of the MCF8329EVM, click on the *Quick Spin* option to begin configuring the device.

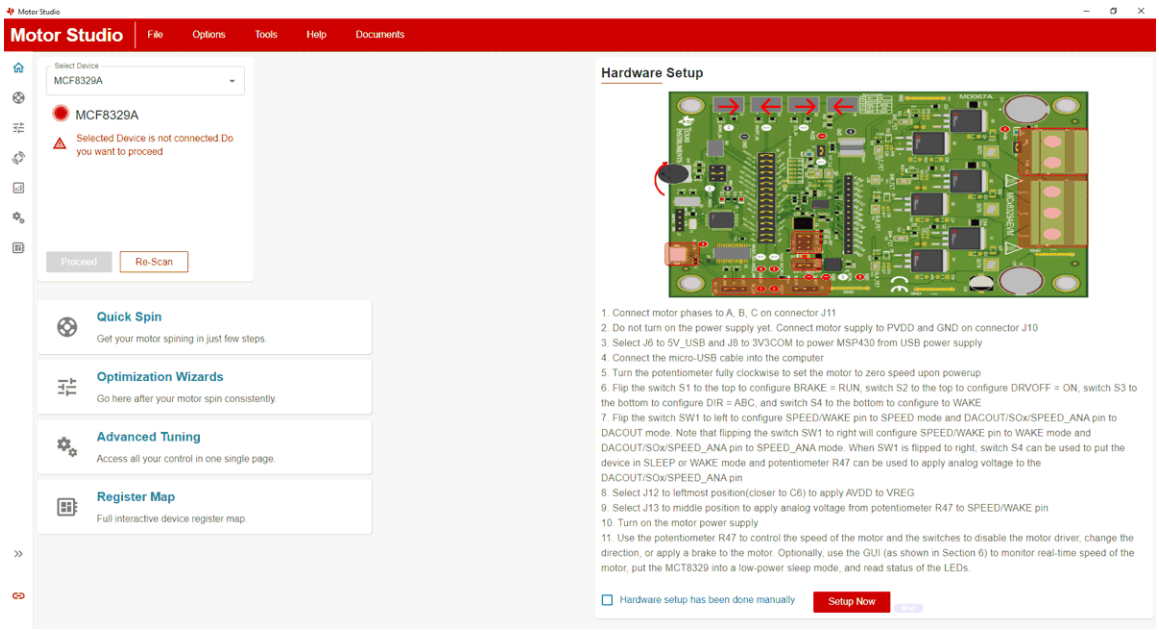



**Figure 3-1. Motor Studio GUI MCF8329A Home Page**

### 3.3 Downloading Code Composer Studio and Importing GUI Firmware

1. Download and extract the Motor Studio firmware to a location on your computer.
2. Download the latest version of Code Composer Studio to set up a folder in the directory C:\ti.
   a. Accept all agreements, default install instructions, and select *Next* to proceed through the menus.
   b. In the *Selected Components* window, make sure to check *MSP430 Low-Power MCUs* to install the required packages for the MSP430 Launchpad Evaluation Kits.
3. After installing, run CCS and select a folder or the default to use as the workspace to store any new projects. The location and naming convention can be changed based on the user's preference. Click the OK button to accept.
4. In CCS, click on the Project tab and select *Import CCS Projects*. Click on *Browse*.
5. Select the folder created in step 1 by extracting the Motor Studio firmware.
6. Import the project into your workspace as shown in Figure 3-2

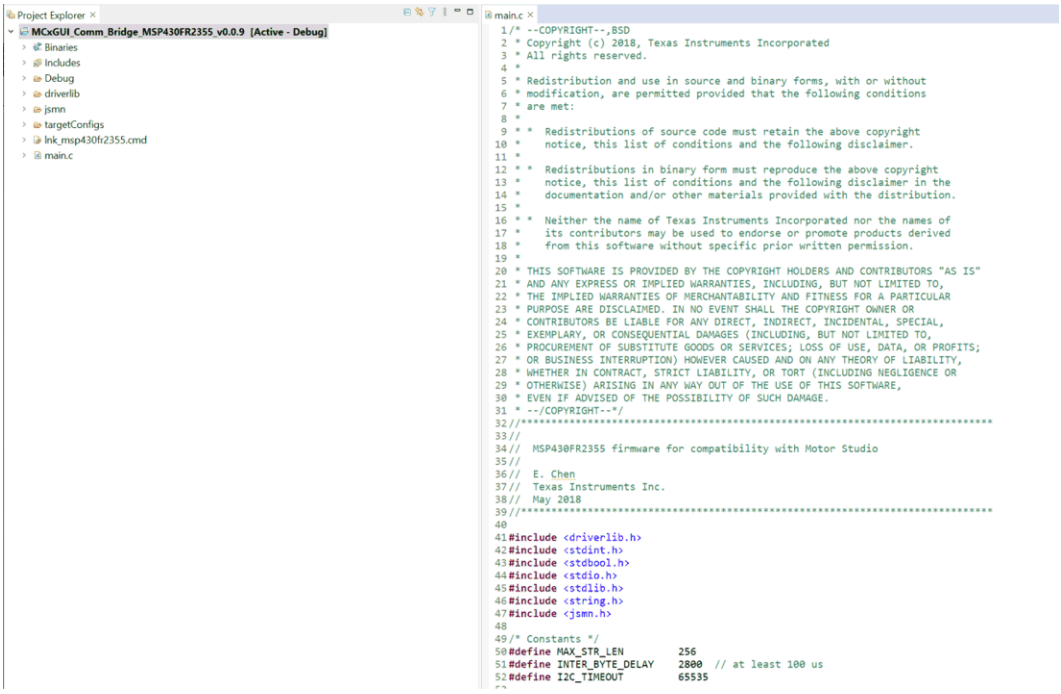



**Figure 3-2. MSP430FR2355 Interface Firmware Code in Code Composer Studio**

## 3.4 Using eZ-FET to Program the Onboard MSP430FR2355

The eZ-FET Debug Probe on the MSP430FR2355 LaunchPad uses a Spy-Bi-Wire JTAG interface to program the MSP430FR2355 MCU on the MCF8329EVM. Consult the MSP430 Launchpad Development Kits for MSP430 Launchpad the include an onboard eZ-FET Debug Probe.

1. Remove the GND, 3V3, SBWTDIO, and SBWTCK jumpers from the MSP430 LaunchPad.
2. Connect the top pins on the eZ-FET side of the LaunchPad of the GND, 3V3, SBWTDIO, SBWTCK signals to their respective pins on J7 of the MCF8329EVM as shown in Table 3-1 and Figure 3-3.
3. Connect a micro-USB cable to the MSP430 LauchPad and the PC.
4. Click on the Build Project icon or CTRL+B to make sure the project builds successfully. Accept any updates if needed from the console
5. Click on Debug Project to set up a debug session and press the Play button to run the code.
6. Stop the debug session, close Code Composer Studio, disconnect the Spy-Bi-Wire jumpers, and unplug the micro-USB cable from the MSP430 LaunchPad.

**Table 3-1. Spy-Bi-Wire Connections Needed to Program the MSP430FR2355**

| MSP430 LaunchPad (eZ-FET Debug Probe Side) (J101) | MCF8329EVM 4-pin Spy-Bi-Wire Header (J7) |
|---|---|
| GND | GND |
| 3V3 | 3V3 |
| SBWTDIO | SBWTDIO |
| SBWTCK | SBWTCK |

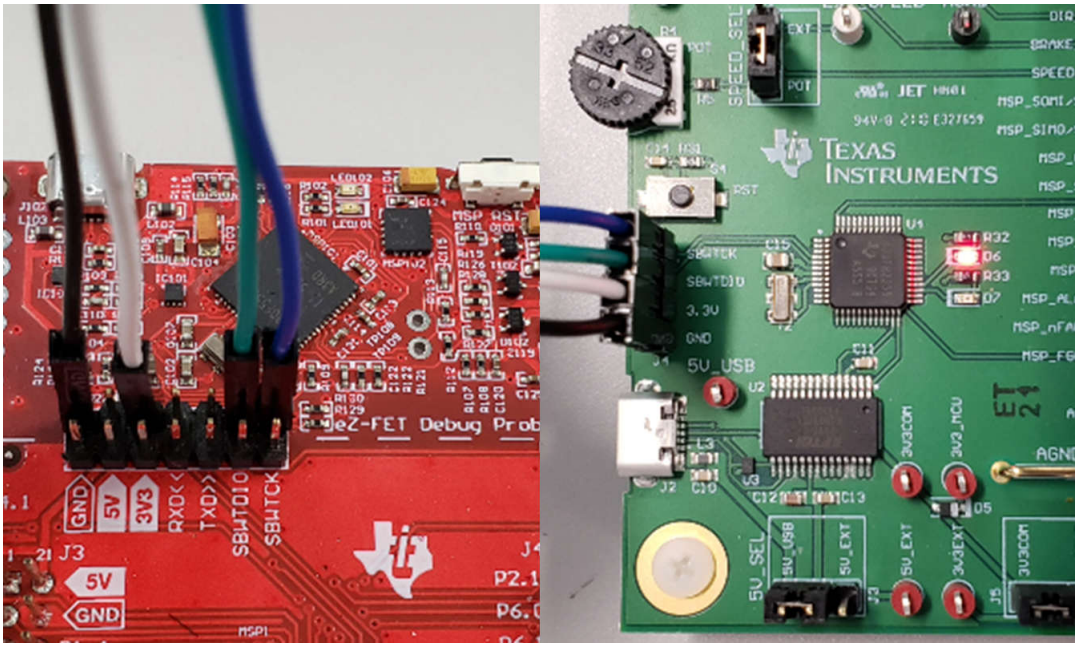



**Figure 3-3. MSP430 LaunchPad eZ-FET Debug Probe Connected to MSP430FR2355**

# 4 Hardware Design Files

## 4.1 Schematics

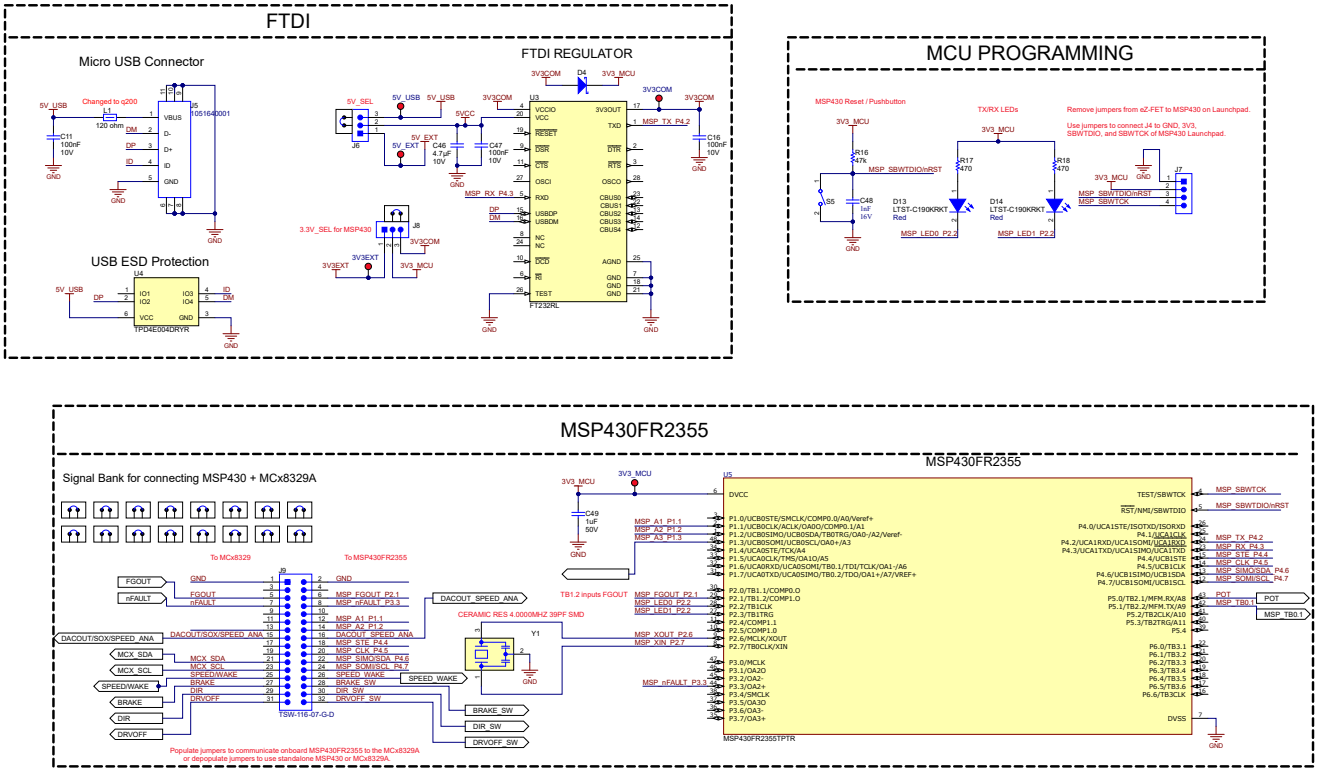



**Figure 4-1. Interfaces**

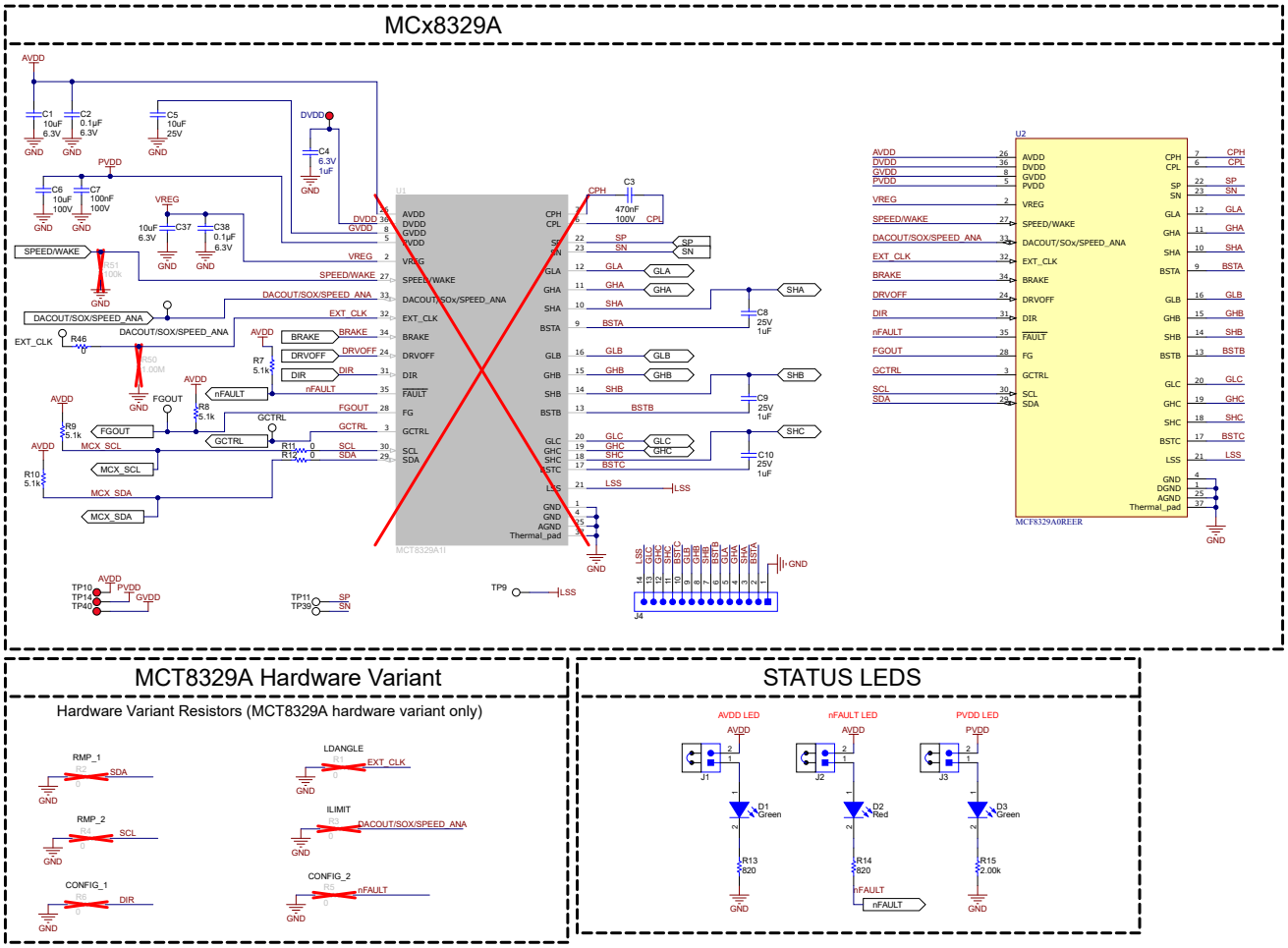



**Figure 4-2. Driver**

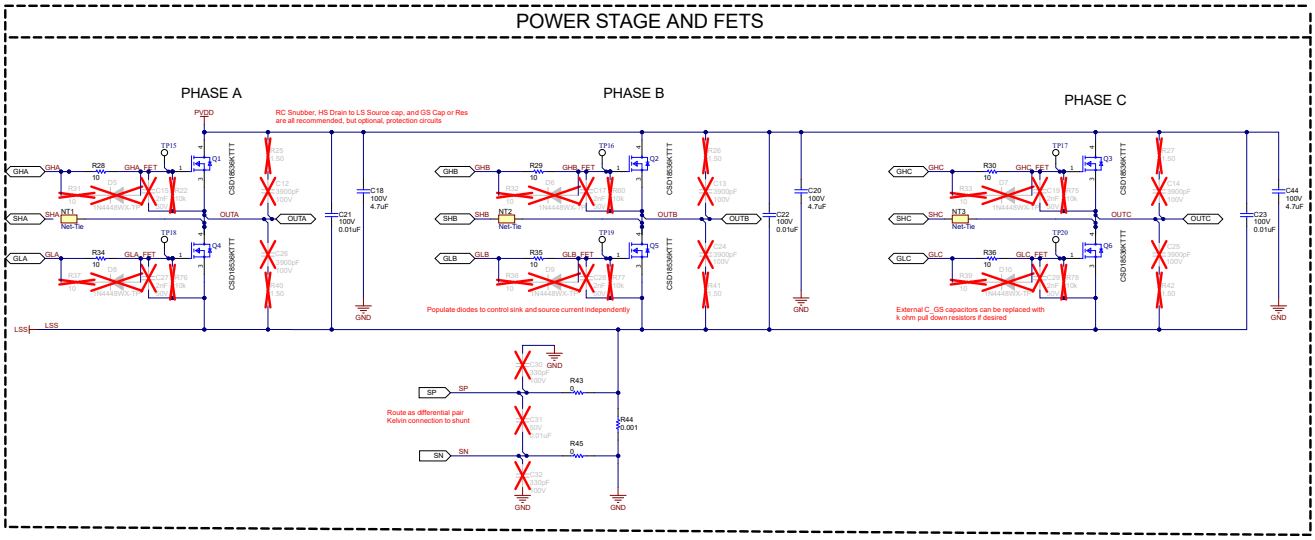



**Figure 4-3. MOSFETs and Power Stage**

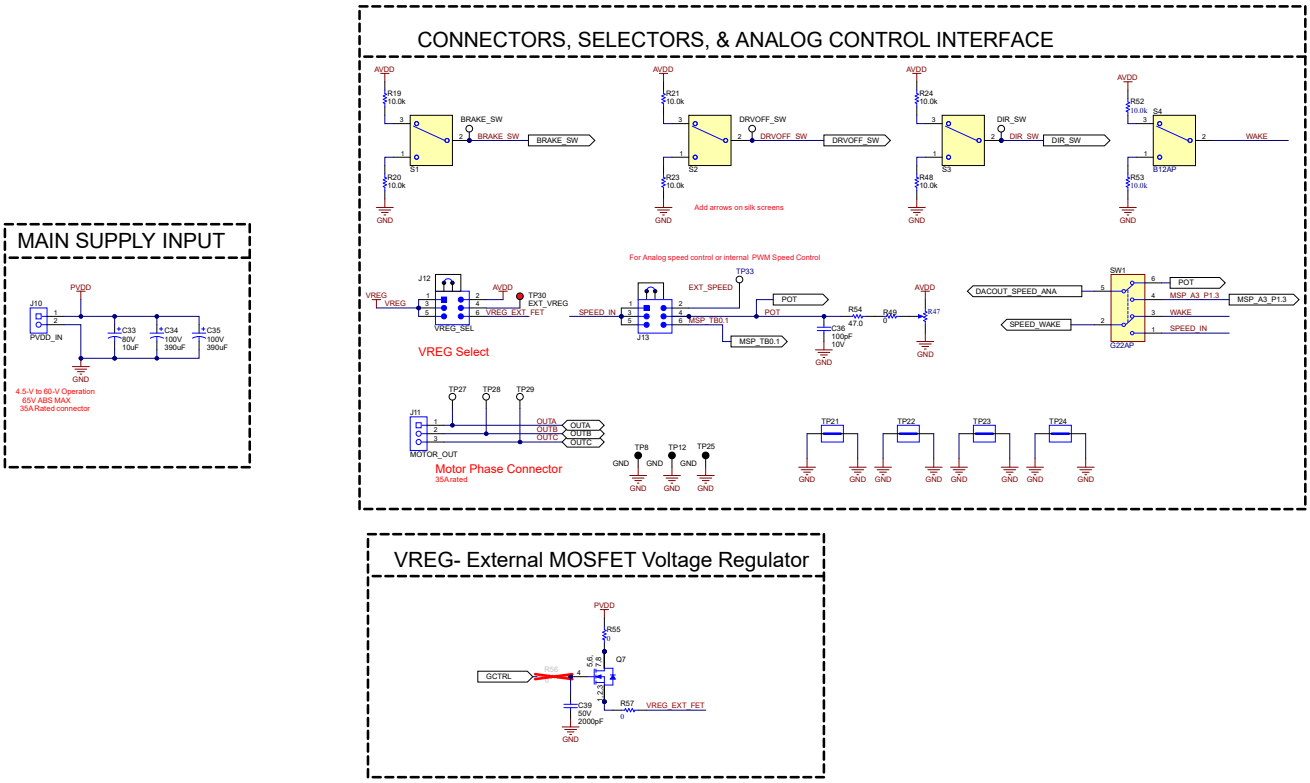



**Figure 4-4. Power and Connectors**

## 4.2 PCB Layouts

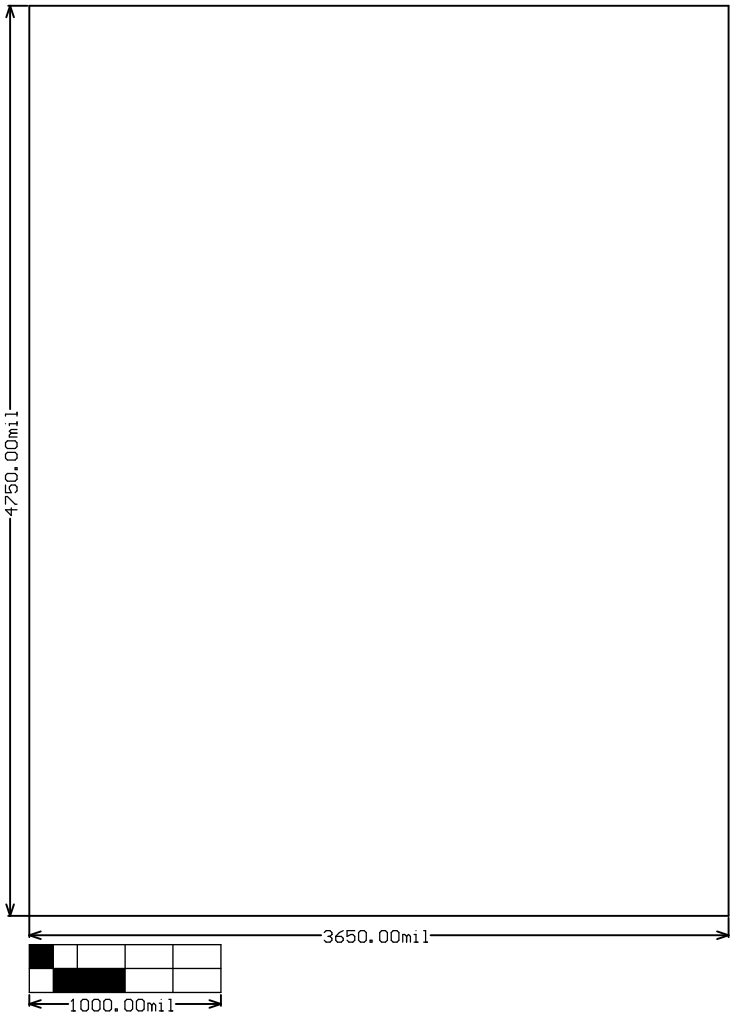



**Figure 4-5. EVM Board Dimensions**

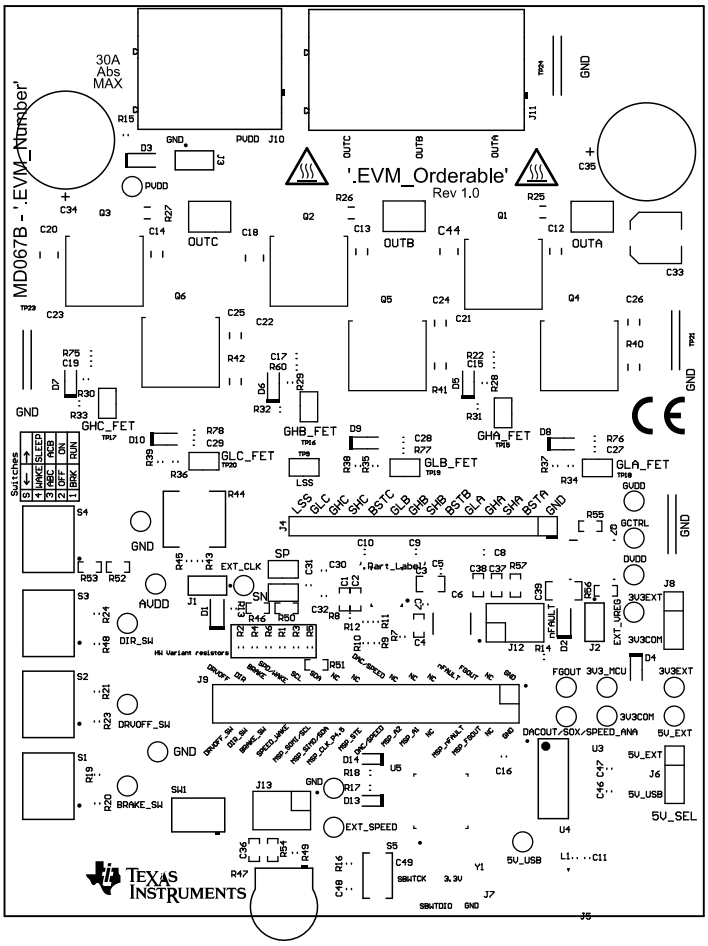



**Figure 4-6. EVM Top Overlay**

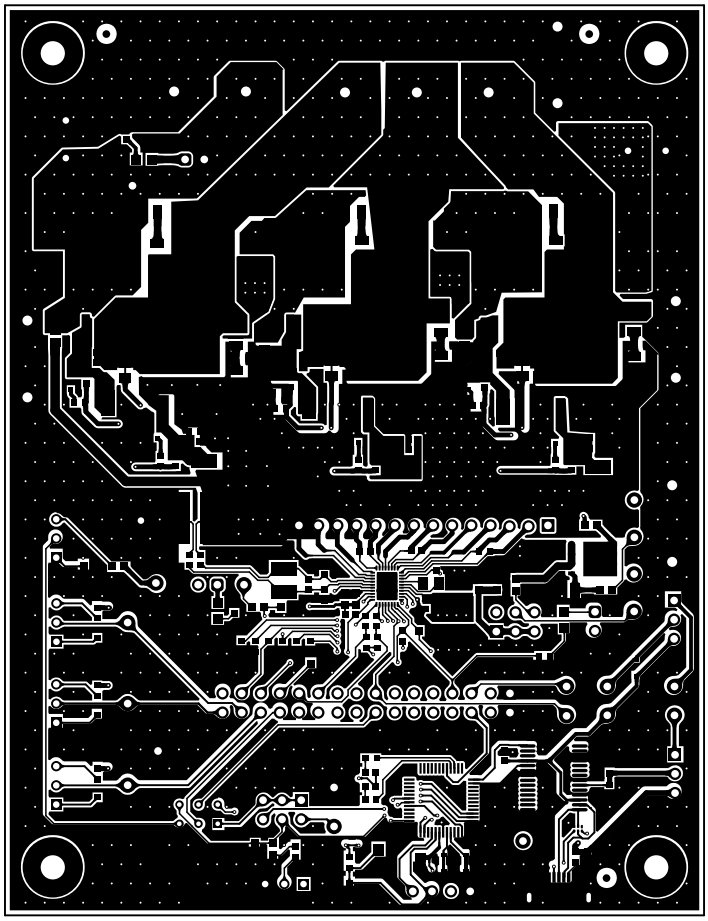


**Figure 4-7. EVM Top Layer**

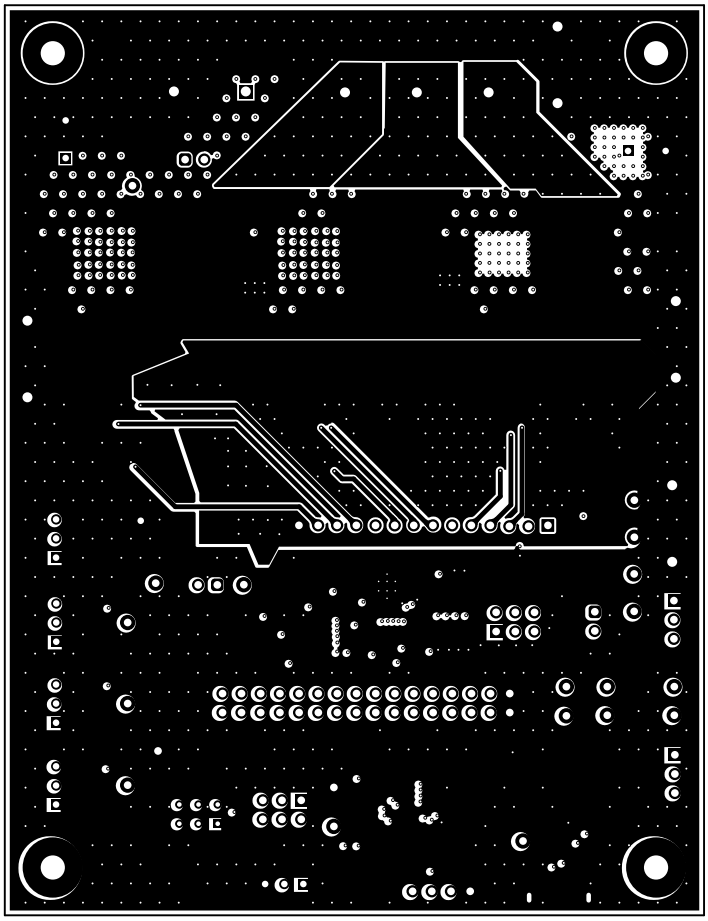


**Figure 4-8. EVM Signal Layer 1**

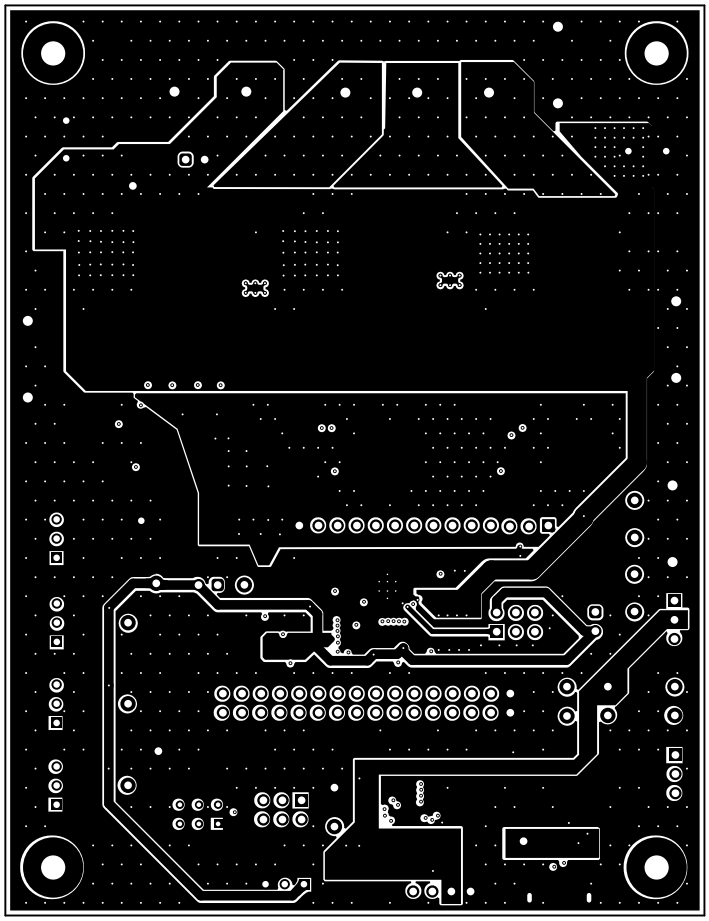


**Figure 4-9. EVM Signal Layer 2**

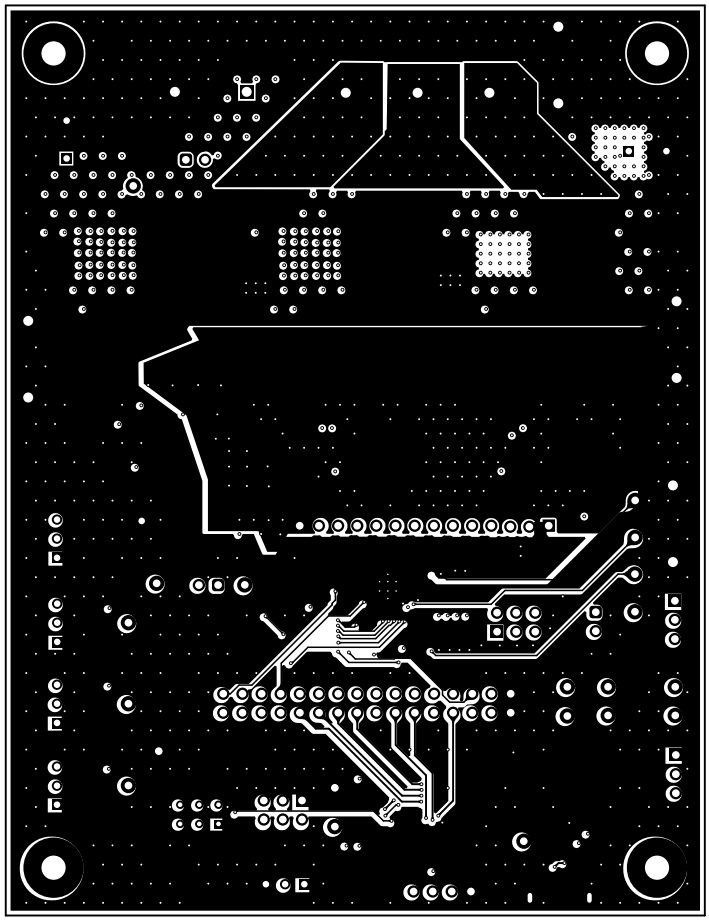


**Figure 4-10. EVM Bottom Layer**

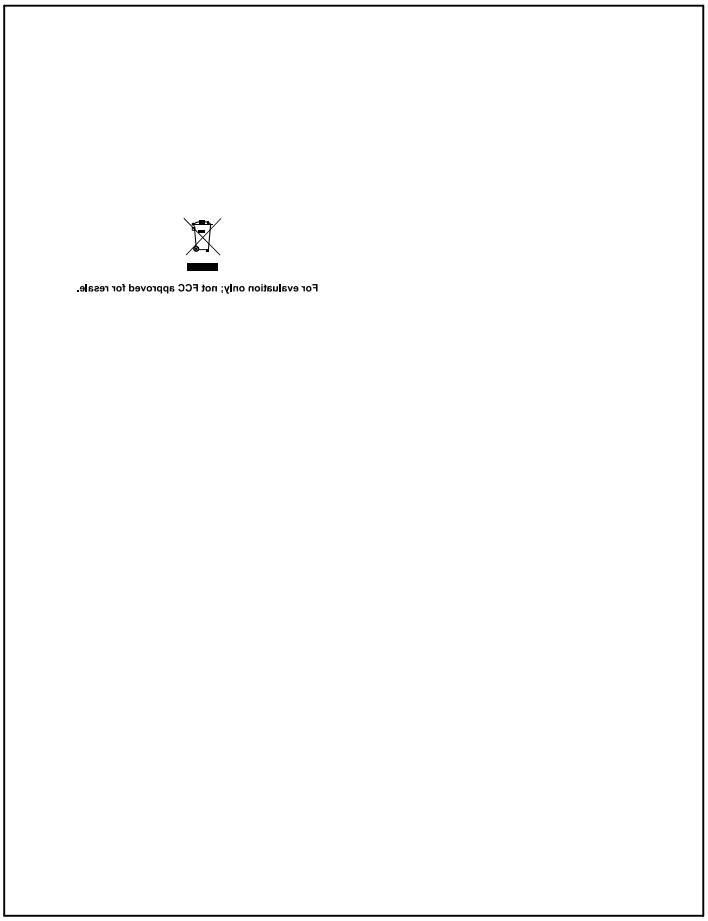



**Figure 4-11. EVM Bottom Overlay**

## 4.3 Bill of Materials (BOM)

**Table 4-1. Bill of Materials**

| Designator | Quantity | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| C1, C37 | 2 | 10uF | CAP, CERM, 10 uF, 6.3 V, +/- 20%, X5R, 0603 | 603 | C0603C106M9PACTU | Kemet |
| C2, C38 | 2 | 0.1uF | CAP, CERM, 0.1 µF, 6.3 V,+/- 10%, X5R, 0603 | 603 | C0603C104K9PAC7867 | Kemet |
| C3 | 1 | 0.47uF | CAP, CERM, 0.47 uF, 100 V, +/- 10%, X7R, 0805 | 805 | GRM21BR72A474KA73L | MuRata |
| C4 | 1 | 1uF | CAP, CERM, 1 uF, 6.3 V, +/- 10%, X5R, 0603 | 603 | GRM188R60J105KA01D | MuRata |
| C5 | 1 | 10uF | CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603 | 603 | C1608X5R1E106M080AC | TDK |
| C6 | 1 | 10uF | CAP, CERM, 10 uF, 100 V, +/- 20%, X7R, 2220 | 2220 | 22201C106MAT2A | AVX |
| C7 | 1 | 0.1uF | CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, 0603 | 603 | GRM188R72A104KA35J | MuRata |
| C8, C9, C10 | 3 | 1uF | CAP, CERM, 1 uF, 25 V, +/- 10%, X5R, 0603 | 603 | C1608X5R1E105K080AC | TDK |
| C11, C16, C47 | 3 | 0.1uF | CAP, CERM, 0.1 uF, 10 V, +/- 10%, X7R, 0603 | 603 | 0603ZC104KAT2A | AVX |
| C18, C20, C44 | 3 | 4.7uF | CAP, CERM, 4.7 uF, 100 V, +/- 10%, X7S, 1210 | 1210 | GRM32DC72A475KE01L | MuRata |
| C21, C22, C23 | 3 | 0.01uF | CAP, CERM, 0.01 uF, 100 V, +/- 5%, X7R, 0805 | 805 | 08051C103JAT2A | AVX |
| C33 | 1 | 10uF | CAP, AL, 10 uF, 80 V, +/- 20%, 2.4 ohm, SMD | F80 | EMZA800ADA100MF80G | Chemi-Con |
| C34, C35 | 2 | 390uF | CAP, AL, 390 uF, 100 V, +/- 20%, 0.026 ohm, TH | D12.5xL35mm | EKYB101ELL391MK35S | Chemi-Con |
| C36 | 1 | 100 pF | CAP, CERM, 100 pF, 10 V, +/- 10%, X7R, 0603 | 603 | 0603ZC101KAT2A | AVX |
| C39 | 1 | 2000 pF | CAP, CERM, 2000 pF, 50 V,+/- 5%, C0G/NP0, 1206 | 1206 | 12065A202JAT2A | AVX |
| C46 | 1 | 4.7uF | CAP, CERM, 4.7 uF, 10 V, +/- 20%, X7R, 0603 | 603 | GRM188Z71A475ME15D | MuRata |
| C48 | 1 | 1000 pF | CAP, CERM, 1000 pF, 16 V, +/- 10%, X7R, 0603 | 603 | 8.85012E+11 | Wurth Elektronik |
| C49 | 1 | 1uF | CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0805 | 805 | 8.85012E+11 | Wurth Elektronik |
| D1, D3 | 2 | Green | LED, Green, SMD | LED_0805 | LTST-C170KGKT | Lite-On |
| D2 | 1 | Red | LED, Red, SMD | Red 0805 LED | LTST-C170KRKT | Lite-On |
| D4 | 1 | 40 V | Diode, Schottky, 40 V, 0.75 A, AEC-Q101, SOD-323 | SOD-323 | BAT165E6327HTSA1 | Infineon Technologies |
| D13, D14 | 2 | Red | LED, Red, SMD | Red LED, 1.6x0.8x0.8mm | LTST-C190KRKT | Lite-On |
| H1, H2, H3, H4 | 4 | | Standoff, Hex, 1"L #4-40 Nylon | Standoff | 1902E | Keystone |
| H5, H6, H7, H8 | 4 | | Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead | Screw | NY PMS 440 0025 PH | B&F Fastener Supply |
| J1, J2, J3 | 3 | | Header, 100mil, 2x1, Gold, TH | 2x1 Header | TSW-102-07-G-S | Samtec |

**Table 4-1. Bill of Materials (continued)**

| Designator | Quantity | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| J4 | 1 | | Header, 100mil, 14x1, Gold, TH | 14x1 Header | TSW-114-07-G-S | Samtec |
| J5 | 1 | | Receptacle, USB 2.0, Micro B, 5 Position, R/A, SMT | Receptacle, USB 2.0, Micro B, 5 Pos, 0.65mm Pitch, R/A, SMT | 1051640001 | Molex |
| J6, J8 | 2 | | Header, 100mil, 3x1, Gold, TH | PBC03SAAN | PBC03SAAN | Sullins Connector Solutions |
| J7 | 1 | | Header, 100mil, 4x1, Gold, TH | 4x1 Header | TSW-104-07-G-S | Samtec |
| J9 | 1 | | Header, 100mil, 16x2, Gold, TH | 16x2 Header | TSW-116-07-G-D | Samtec |
| J10 | 1 | | Terminal Block, 9.52mm, 2x1, R/A, TH | Terminal Block, 2x1, Pitch 9.52mm | 1902547 | Phoenix Contact |
| J11 | 1 | | Terminal Block, 9.52mm, 3x1, R/A, TH | Terminal Block, 3x1, Pitch 9.52mm | 1904150 | Phoenix Contact |
| J12, J13 | 2 | | Header, 100mil, 3x2, Gold, TH | 3x2 Header | TSW-103-07-G-D | Samtec |
| L1 | 1 | | Inductor, Ferrite Bead, Ferrite, 3 A, 120 ohm, AEC-Q200 Grade 1, SMD | 603 | BLM18SG121TZ1D | MuRata |
| Q1, Q2, Q3, Q4, Q5, Q6 | 6 | | MOSFET 60-V, N channel NexFET power MOSFET, single D2PAK, 1.6 mOhm 3-DDPAK/ TO-263 -55 to 175 | DDPAK | CSD18536KTTT | Texas Instruments |
| Q7 | 1 | 60 V | MOSFET, N-CH, 60 V, 50 A, DQJ0008A (VSONP-8) | DQJ0008A | CSD18534Q5A | Texas Instruments |
| R7, R8, R9, R10 | 4 | 5.1k | RES, 5.1 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 603 | CRCW06035K10JNEA | Vishay-Dale |
| R11, R12, R43, R45, R46, R49, R55, R57 | 8 | 0 | RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 603 | ERJ-3GEY0R00V | Panasonic |
| R13, R14 | 2 | 820 | RES, 820, 5%, 0.1 W, 0603 | 603 | RC0603JR-07820RL | Yageo |
| R15 | 1 | 2.00k | RES, 2.00 k, 0.1%, 0.1 W, 0603 | 603 | RG1608P-202-B-T5 | Susumu Co Ltd |
| R16 | 1 | 47k | RES, 47 k, 5%, 0.1 W, 0603 | 603 | RC0603JR-0747KL | Yageo |
| R17, R18 | 2 | 470 | RES, 470, 5%, 0.1 W, 0603 | 603 | RC0603JR-07470RL | Yageo |
| R19, R20, R21, R23, R24, R48, R52, R53 | 8 | 10.0k | RES, 10.0 k, 0.05%, 0.1 W, AEC-Q200 Grade 0, 0603 | 603 | ERA-3ARW103V | Panasonic |
| R28, R29, R30, R34, R35, R36 | 6 | 10 | RES, 10, 5%, 0.1 W, AEC-Q200 Grade 0, 0603 | 603 | CRCW060310R0JNEA | Vishay-Dale |

**Table 4-1. Bill of Materials (continued)**

| Designator | Quantity | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| R44 | 1 | 0.001 | RES, 0.001, 1%, 4 W, RES_2725 | RES_2725 | CSS2725FT1L00 | Stackpole Electronics Inc |
| R47 | 1 | 25 kohm | Trimmer Potentiometer, 25kohm, 0.5W, TH | 9.53x8.89mm | 3352T-1-253LF | Bourns |
| R54 | 1 | 47 | RES, 47.0, 0.1%, 0.1 W, 0603 | 603 | RT0603BRD0747RL | Yageo America |
| S1, S2, S3, S4 | 4 | | SWITCH TOGGLE SPDT 0.4VA 28 V | 6.8x23.1x8.8mm | B12AP | NKK Switches |
| S5 | 1 | | Switch, Tactile, SPST, 12 V, SMD | SMD, 6x3.9mm | 4.34121E+11 | Wurth Elektronik |
| SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16, SH-J17, SH-J18, SH-J19, SH-J20, SH-J21, SH-J22, SH-J23, SH-J24 | 23 | 1x2 | Shunt, 100mil, Gold plated, Black | Shunt | SNT-100-BK-G | Samtec |
| SW1 | 1 | | Switch, DPDT, On-On, 0.4 VA, 28 V, TH | DPDT Switch, 4.5x7mm | G22AP | NKK Switches |
| TP1, TP10, TP14, TP30, TP40, TP41, TP42, TP43, TP44, TP45 | 10 | | Test Point, Miniature, Red, TH | Red Miniature Testpoint | 5000 | Keystone |
| TP2, TP3, TP4, TP5, TP26, TP31, TP32, TP33 | 8 | | Test Point, Miniature, White, TH | White Miniature Testpoint | 5002 | Keystone |
| TP8, TP12, TP25 | 3 | | Test Point, Miniature, Black, TH | Black Miniature Testpoint | 5001 | Keystone |
| TP9, TP11, TP15, TP16, TP17, TP18, TP19, TP20, TP39 | 9 | | Test Point, Miniature, SMT | Testpoint_Keystone_Miniature | 5015 | Keystone |
| TP21, TP22, TP23, TP24 | 4 | | 1 mm Uninsulated Shorting Plug, 10.16mm spacing, TH | Shorting Plug, 10.16mm spacing, TH | D3082-05 | Harwin |
| TP27, TP28, TP29 | 3 | | Test Point, Compact, SMT | Testpoint_Keystone_Compact | 5016 | Keystone |
| U2 | 1 | | Sensorless Field Oriented Control (FOC) Three-phase BLDC Gate Driver | WQFN36 | MCF8329A0REER | Texas Instruments |
| U3 | 1 | | USB to Serial UART, SSOP28 | SSOP28 | FT232RL | FTDI |

**Table 4-1. Bill of Materials (continued)**

| Designator | Quantity | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| U4 | 1 | | 4-Channel ESD Protection Array for High-Speed Data Interfaces, DRY0006A (USON-6) | DRY0006A | TPD4E004DRYR | Texas Instruments |
| U5 | 1 | | CPU16 MSP430™ FRAM Microcontroller IC 16-Bit 24 MHz 32 KB (32K x 8) FRAM 48-LQFP (7x7) | LQFP48 | MSP430FR2355TPTR | Texas Instruments |
| Y1 | 1 | | Resonator, 4 MHz, 39 pF, AEC-Q200 Grade 1, SMD | 4.5x1.2x2 mm | CSTCR4M00G55B-R0 | MuRata |

# 5 Additional Information

## 5.1 Trademarks

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