EVM User's Guide: MCT8317EVM
MCT8317EVM Evaluation Module

TEXAS INSTRUMENTS

ABSTRACT

This document is provided with the MCT8317 customer evaluation module (EVM) as a supplement to the MCT8317x data sheet (MCT8317 Three-Phase Sensorless-Trapezoidal BLDC Motor Driver). This User's Guide details the hardware implementation of the EVM and how to setup and power the board.

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Trademarks

LaunchPad™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

1 Cautions and Warnings

Observe the following cautions and warnings as printed on the EVM board.

HOT SURFACE:

Caution Hot Surface! Contact may cause burns. Do not touch. Please take the proper precautions when operating.

2 Introduction

The MCT8317 is a 4.5-V to 20-V, 5-A peak integrated three-phase gate driver IC with sensorless trapezoidal for motor drive applications. It provides three accurately trimmed and temperature compensated half-bridge MOSFETS, gate drivers, charge pump, current sense amplifier, linear regulator for the external load and adjustable buck regulator. The I2C interface variant (MCT8317) also provides a standard I2C interface for configuring the various device settings and reading fault diagnostic information through an external controller.

The MCT8317EVM includes an onboard FTDI chip to convert USB communication from the micro-USB connector into UART and an onboard MSP430FR2355 MCU to interface with the MCT8317. It can also provide SPI communication for the SPI variant of the MCT8317 device. There are many user-selectable jumpers, resistors, connectors, and test points to evaluate many features of the device and configure device-specific settings.

This document serves as a startup guide to supplement the MCT8317EVM. It is intended for engineers to design, implement, and validate reference hardware for the MCT8317 device.
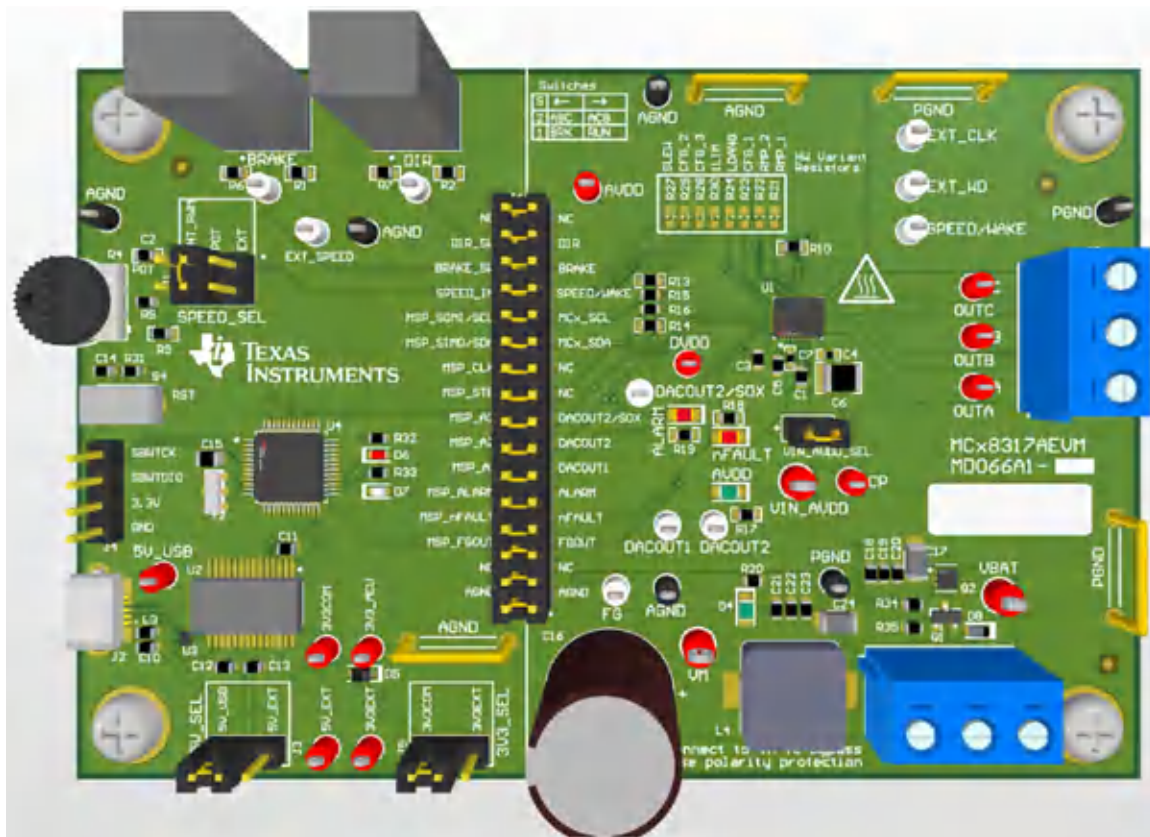

Figure 2-1. MCT8317EVM Printed Circuit Board (PCB - Top View)

3 Quick Start Guide

The MCT8317EVM requires a power supply source, which has a recommended operating range from a 4.5-V to 20-V. To setup and power the EVM, follow the sequence below:

1. Connect motor phases to A, B, C on connector J8.
2. Do not turn on the power supply yet. Connect motor supply to VBAT/VM and PGND on connector J7.
   a. To enable reverse polarity protection and Pi filter, connect to VBAT. Note that when connecting to VBAT, VM will be VM – 0.7 V less, due to a diode drop in the reverse-polarity protection circuit.
   b. To disable reverse-polarity protection and the Pi filter, connect to VM.

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3. Select J3 to 5V_USB and J5 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 powerup.
6. Flip the switch S1 to the right to configure BRAKE = RUN and switch S2 to the left to configure DIR = ABC.
7. Turn on the motor power supply.
8. Use the potentiometer R4 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 6) to monitor real-time speed of the motor, put the MCT8317 into a low-power sleep mode, and read status of the LEDs.
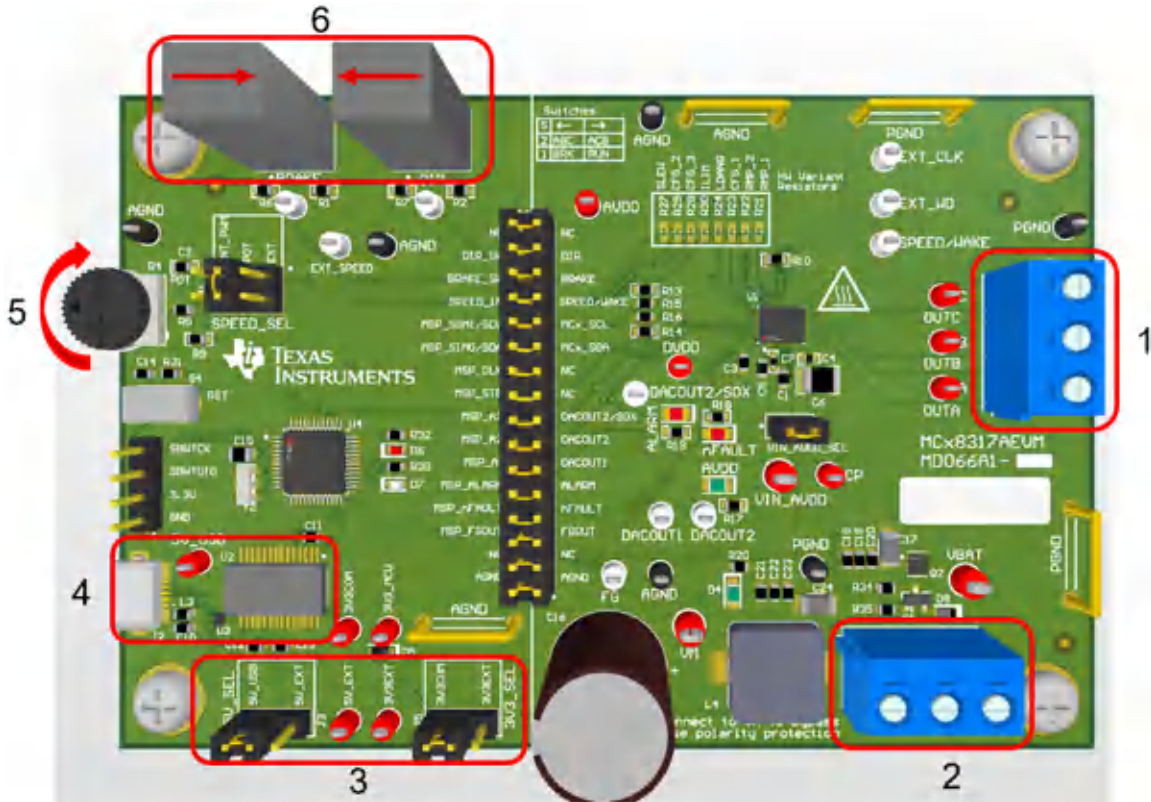

Figure 3-1. Reference for Quick Start Guide

4 Hardware and Software Overview

4.1 Hardware Connections Overview – MCT8317EVM

Figure 4-1 shows the major blocks of MCT8317EVM evaluation module. The MCT8317EVM is designed for an input supply from 4.5-V to 20-V. The MCT8317 includes three integrated half-bridges and implements a sensorless Trapezoidal algorithm to spin a motor with up to 5-A peak current.
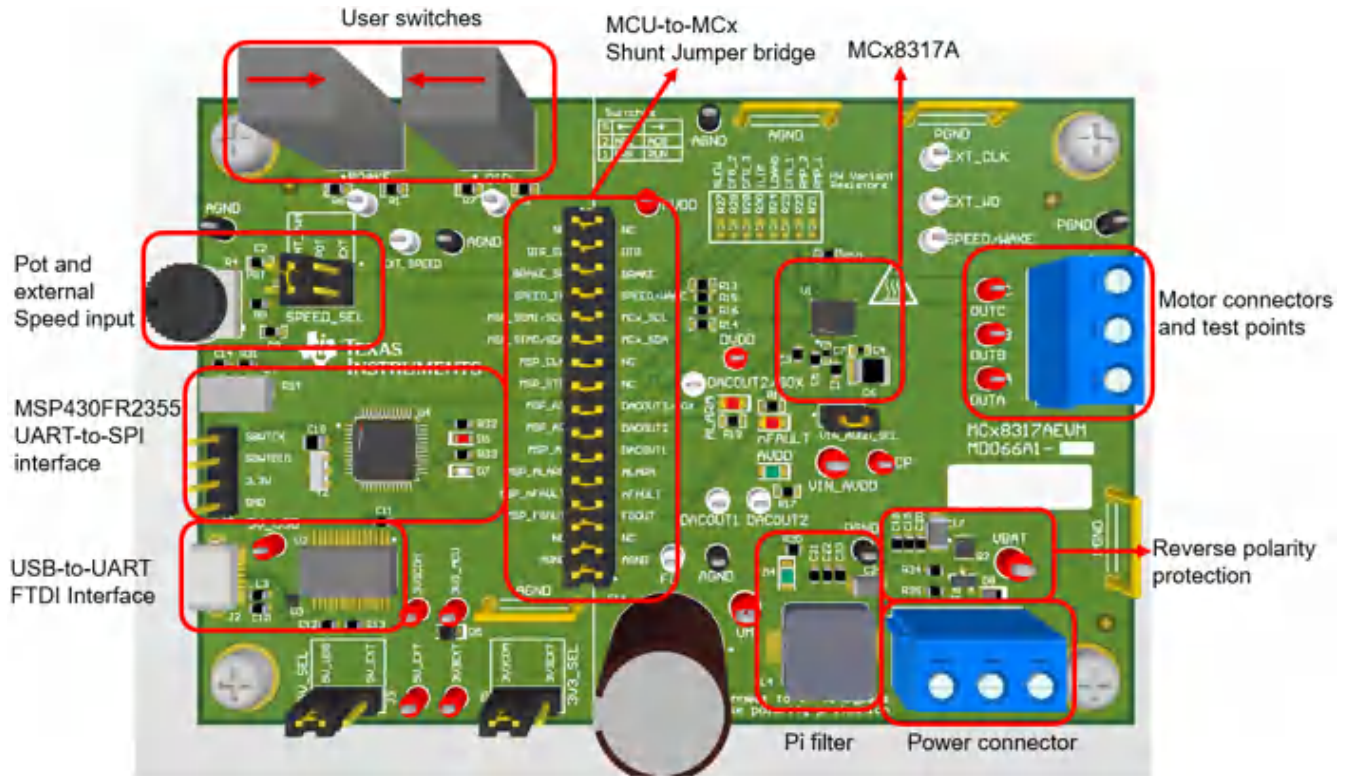
Figure 4-1. MCT8317EVM Major Hardware Blocks

4.2 Connection Details

Figure 4-2 shows the connections made to the MCT8317EVM in order to spin a 3-phase sensorless Brushless-DC motor.

An 4.5-V to 20-V power supply or battery is connected to the VBAT or VM and PGND terminals on connector J7. There is a reverse polarity protection and Pi filter implemented on the VBAT and PGND terminals. To bypass the reverse polarity protection and Pi filter, connect the power supply to the VM terminal or VM test point on the board and PGND.

The three phases of the BLDC motor connect directly to the A, B, and C terminals of the screw terminal connector J8 provided on the MCT8317EVM.
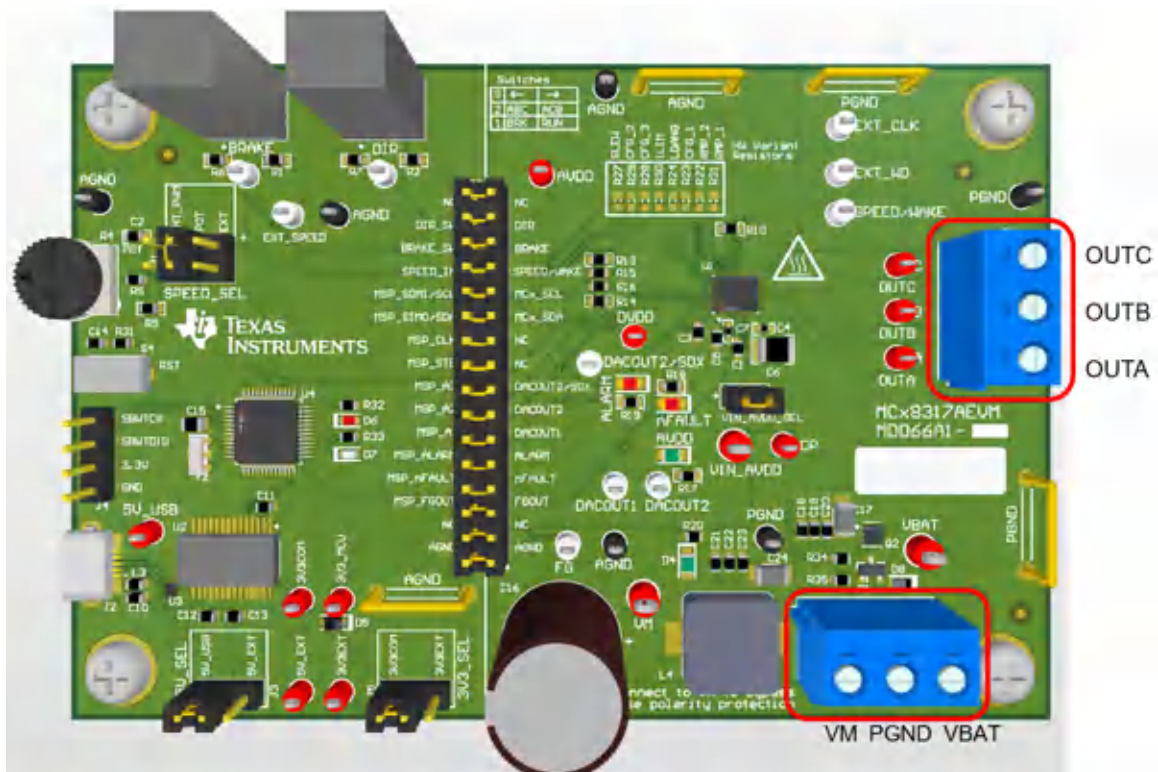
Figure 4-2. Connections from Motor to MCT8317EVM

Figure 4-3 MSP430FR2355 Microcontrollershows where the micro-USB cable is plugged into the MCT8317EVM to provide communication between evaluation module and GUI. The USB data and 5 V power from the USB is converted into UART data and 3.3 V power 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 limit to 30 mA. If the user wishes to supply more current to these rails, they may use the 5V_SEL jumper J3 and 3V3_SEL jumper J5 to connect external power rails.
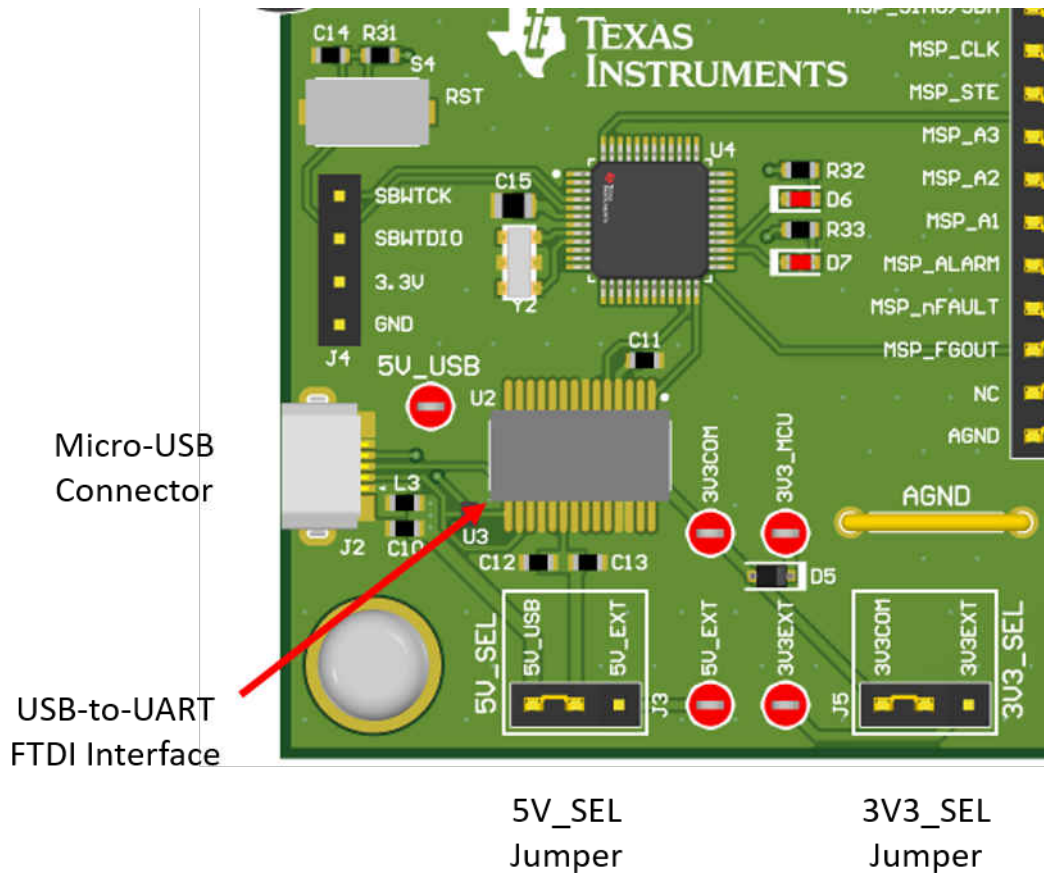
Figure 4-3. Micro-USB Connector and UART for MCT8317EVM

4.3 MSP430FR2355 Microcontroller & User Interface

The MCT8317EVM includes the MSP430FR2355 low-power MCU (as shown in Figure 4-4) to communicates via I2C with the MCT8317.

In order to program the MSP430FR2355, an external MSP430 FET programmer must be connected to the Spy-Bi-Wire (SBW) interface connector J4. Many MSP430 LaunchPad™ provide an onboard eZ-FET Debug Probe that can be jumper-wired to the MCT8317EVM to flash the firmware into the MSP430FR2355 microcontroller.

The user can use the Reset (RST) button at any time to reset and restart the MCU program. Two active-low LEDs, D6 and D7, can be used for debug purposes as well.

Finally, a shunt jumper bridge on the 32-pin connector J6 ties all signals between the microcontroller and MCT8317. These jumpers can be inserted or removed as needed in order to isolate the microcontroller from the gate driver. This allows for microcontroller signal debugging or using the MCT8317EVM as a standalone gate driver with an external microcontroller.
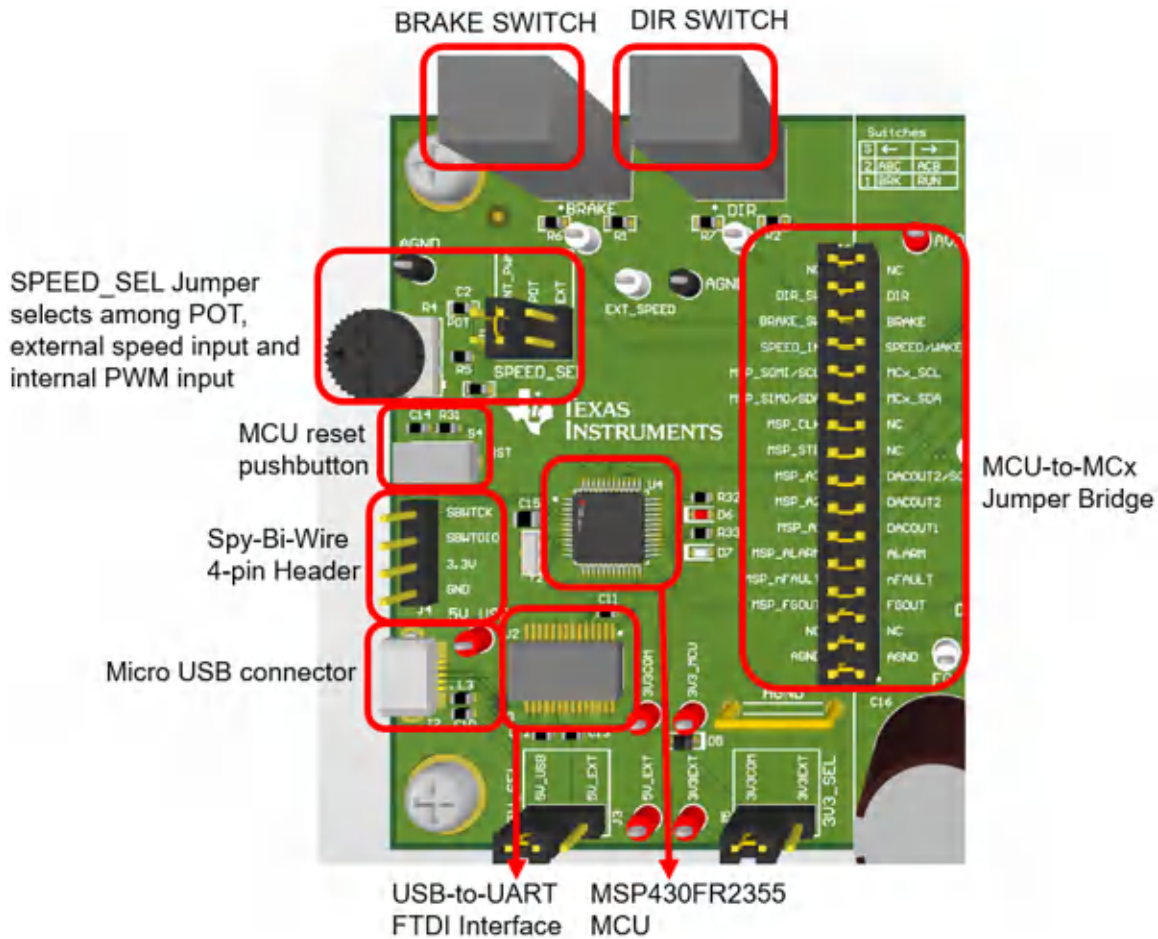
Figure 4-4. MSP430FR2355 MCU and User Interface on MCT8317EVM

4.4 LED Lights

The MCT8317EVM has 7 status LEDs implemented that provide the status of power supplies and functionalities of the evaluation module. By default, the VM LED and 3.3 V Buck LEDs will light up when the board is powered and the program has been flashed onto the microcontroller. Table 4-1 shows LED descriptions including those that are on during power up in bold and Figure 4-5 shows the locations of the LEDs.

Table 4-1. Description of MCT8317EVM LEDs (default in bold after powerup)

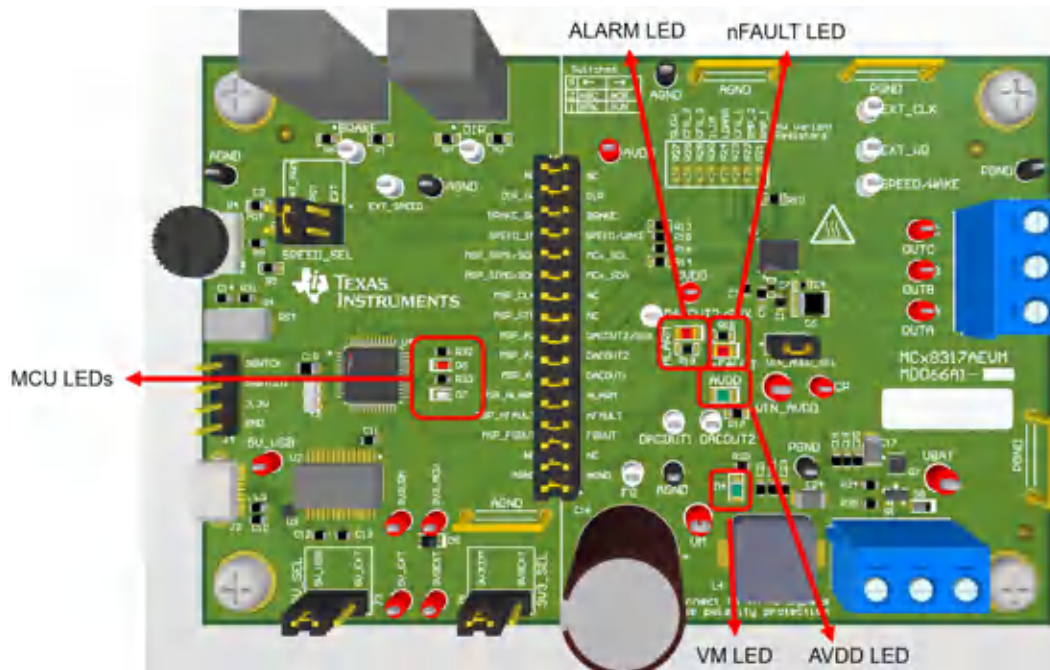| Designator	Name	Color	Description
D1	**AVDD**	**GREEN**	**Lights up when AVDD is turned ON.**
D2	nFAULT	Red	Lights up when fault condition has occurred on MCT8317
D3	ALARM	Red	Lights up when alarm condition has occurred on MCT8317
D4	**VM**	**Green**	**Lights up when voltage is applied on VM.**
D6	**MSP_LED1**	**Red**	**Used for UART or debugging**
D7	MSP_LED2	Red	Used for UART or debugging

Figure 4-5. MCT8317EVM LEDs

4.5 User-Configurable Settings

The MCT8317EVM includes a variety of user-selectable jumpers, switches, and resistors on the entirety of the evaluation board to configure settings. Table 4-2 summarizes all of these configurable settings.

Table 4-2. Description of User-Selectable Settings on MCT8317EVM (Default in Bold)

Designator	Setting Name	Description	Layer	Position	Function
J5	3V3_SEL	Select 3.3 V for MCU power	Top	J5 = 3V3EXT	External
				J5 = 3V3COM	**From FTDI (30 mA)**
J3	5V_SEL	Select 5 V for FTDI power	Top	J3 = 5V_EXT	External
				J3 = 5V_USB	**From USB power (500 mA)**
J1	SPEED_SEL	Selects SPEED input source	Top	J1 = EXT	External EXT_SPEED test point
				J1 = POT	**From Potentiometer R4**
				J1 = INT_PWM	From internal PWM. PWM Duty cycle can be varied by rotating the POT R4.

Table 4-2. Description of User-Selectable Settings on MCT8317EVM (Default in Bold) (continued)

Designator	Setting Name	Description	Layer	Position	Function
J6	MSP to MCx Shunt jumper bridge	Connects signals from MCU and user switches to MCx8316A when jumpers are inserted	Top	**NC**	**NC**
				DIR_SW	**DIR**
				BRAKE_SW	**BRAKE**
				SPEED_IN	**SPEED/WAKE**
				MSP_SOMI/SCL	**MCx_SCL**
				MSP_SIMO/SDA	**MCx_SDA**
				MSP_CLK	**NC**
				MSP_STE	**NC**
				MSP_A3	**DACOUT2/SOX**
				MSP_A2	**DACOUT2**
				MSP_A1	**DACOUT1**
				MSP_ALARM	**ALARM**
				MSP_nFAULT	**nFAULT**
				MSP_FGOUT	**FGOUT**
				NC	**NC**
				AGND	**AGND**
S1	BRAKE	Turns on all low-side MOSFETs	Top	**Left**	**Brake enabled**
				Right	Brake disabled
S2	DIR	Controls direction of motor	Top	**Left**	**ABC**
				Right	ACB

5 Hardware Setup

The hardware required to run the motor is the MCT8317EVM, a Micro-USB cable, and a power supply with a DC output from 4.5-V to 20-V. Follow these steps to start up the MCT8317EVM:

1. Connect the DC power supply to header J7. Connect to VBAT and PGND to apply reverse polarity protection and the pi filter to the EVM. Otherwise, connect to VM and PGND to bypass the reverse polarity protection and pi filter.
2. Apply user configurable jumper settings. See Section 4.5 section for more information.
3. Flash program into the MCU as described in Section 4. Launch the GUI in GUI Composer and disconnect the 4-pin JTAG connections.
4. Connect a Micro-USB cable to the MCT8317EVM and computer.
5. Turn on the power supply and power up the PCB.

If using the MCT8317EVMj with an external microcontroller, remove all shunt jumpers from jumper bridge J6. Connect with external jumpers to the left side of the jumper bridge from the external MCU.

6 MCT8317A GUI Application

The MCT8317EVM includes a USB-UART interface, using a MSP430FR2355 microcontroller, that serves as a communication bridge between a host PC and the MCT8317 device for configuring various device settings and reading fault diagnostic information. A MCT8317A GUI is available to interface with and configure the MCT8317 using this communication interface.

Access the MCT8317A GUI through the TI Cloud Gallery.

6.1 Running the GUI

The MCT8317A GUI can be run directly inside a web browser (supported in Google Chrome and Firefox).
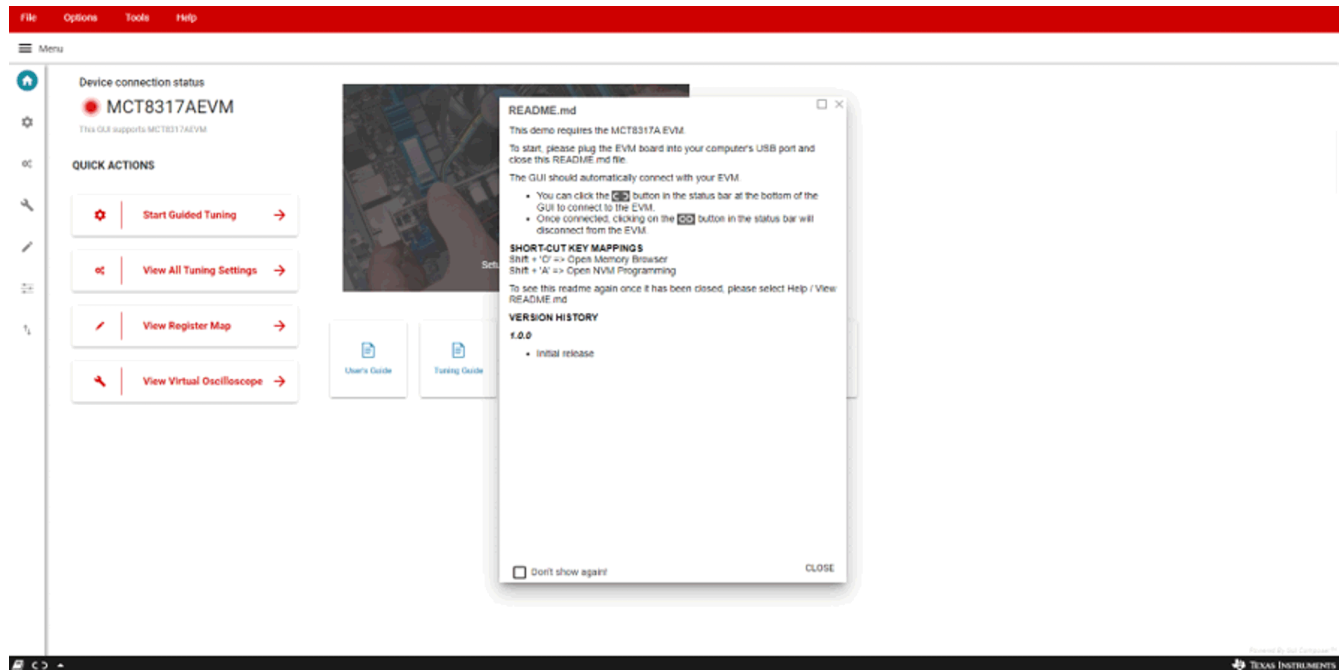
Figure 6-1. MCT8317A GUI

Once the GUI is loaded, follow the step-by-step Guided Tuning section of the GUI to configure the device.

6.2 Offline Installer

Alternatively, the MCT8317A GUI can be downloaded and installed offline using the download feature in the TI Cloud Gallery. Here are the steps to install offline MCT8317A GUI.

1. Go to dev.ti.com/gallery and search for "MCT8317".
2. Place the cursor on the download (down arrow) button.
3. Select the approprioate operating system (Linux, MAC or Windows) and click the operating system. (Note: Do not click the runtime)
4. A zip file will begin downloading. Unzip the file and click the .exe file to install the offline MCT8317A GUI.

7 MSP430FR2355 Interface Firmware

The MSP430FR2355 on the MCT8317EVM comes pre-programmed with the firmware necessary for communicating with the PC GUI and the MCT8317. In order to reprogram or flash custom code on the MSP430FR2355, you will need an external MSP430 LaunchPad™ that includes the eZ-FET Debug Probe. In this example, we use the MSP-EXP430FR2355 LaunchPad Development Kit to provide the debug probe. Follow the steps below to download the code for the MCT8317EVM to use with the GUI.

7.1 Downloading Code Composer Studio and Importing MSP430FR2355 Interface Firmware Code

1. Extract the "MCT8317EVM_MSP430FR2355_Firmware_GUI.zip" to a location on the computer.
2. Download the latest version of Code Composer Studio. This will set up a ti folder in the directory C:\ti.

   a. Accept all agreements, default install locations, and hit "Next" to proceed through menus.
   b. In the "Select Components" window, ensure 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 "MCT8317EVM_MSP430FR2355_Firmware_GUI" folder installed from step 1.

6. Import the project "MCT8317EVM_MSP430FR2355_Firmware_GUI" into your workspace as shown in Figure 7-1.
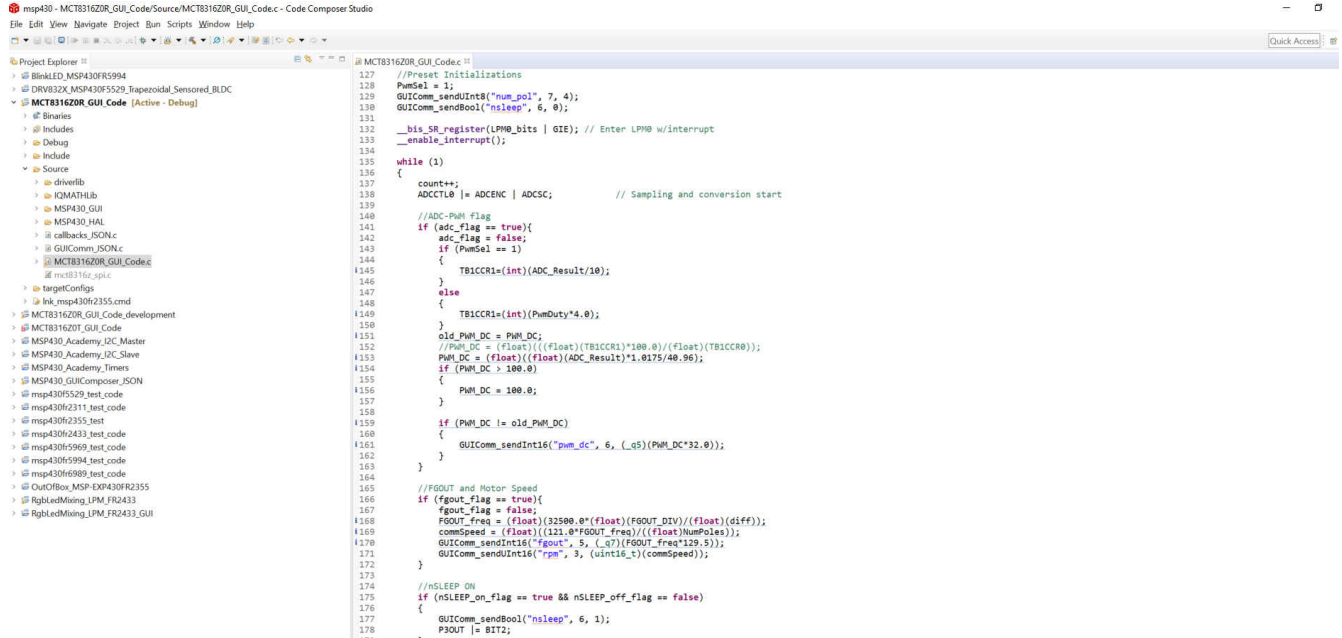

Figure 7-1. MSP430FR2355 Interface Firmware Code in Code Composer Studio

7.2 Using the eZ-FET to Program the MSP430FR2355

The eZ-FET Debug Probe on the MSP430FR2355 LaunchPad uses a SPI-by-Wire JTAG interface to program the MSP430FR2355 MCU on the MCT8317EVM. Consult the MSP430 LaunchPad Development Kits for MSP430 LaunchPads that 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, SBWTCK, and SBWTDIO signals to their respective pins on J4 of the MCT8317EVM as shown in Table 7-1 and Figure 7-2.
3. Connect a micro-USB cable to the MSP430 LaunchPad and the PC.
4. Click on the Build Project icon or "Ctrl" + B to ensure 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 SPI-by-Wire jumpers, and unplug the micro-USB cable from the MSP430 LaunchPad.

Table 7-1. SPY-BI-Wire Connections Needed to Program MSP430FR2355

MSP430 LaunchPad™ (eZ-FET Debug Probe Side) (J101)	MCT8317EVM 4-pin SPI-by-Wire Header (J4)
GND	GND
3V3	3.3V
SBWTDIO	SBWTDIO
SBWTCK	SBWTCK
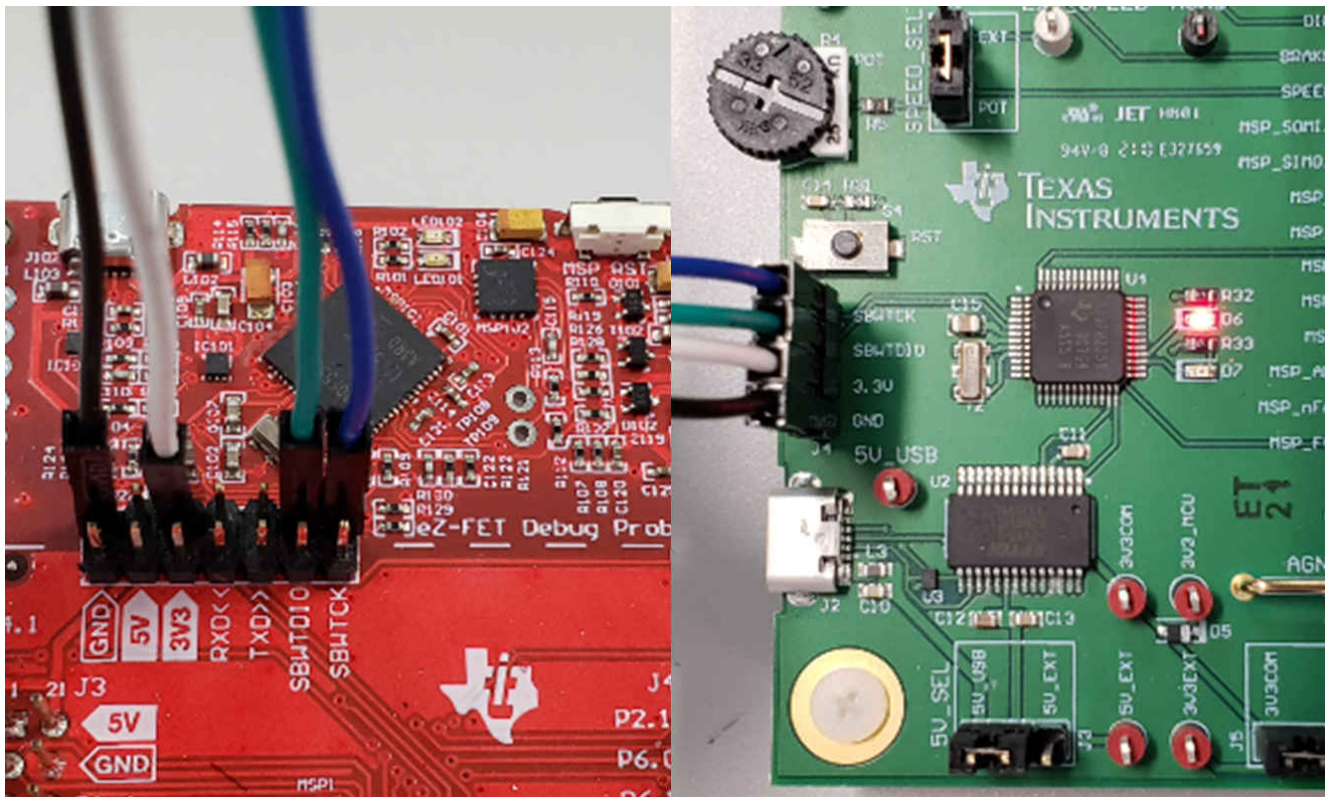
Figure 7-2. MSP430 LaunchPad™ eZ-FET Probe Connected to MCT8317EVM

8 Schematics

8.1 Main Supply and Pi Filter
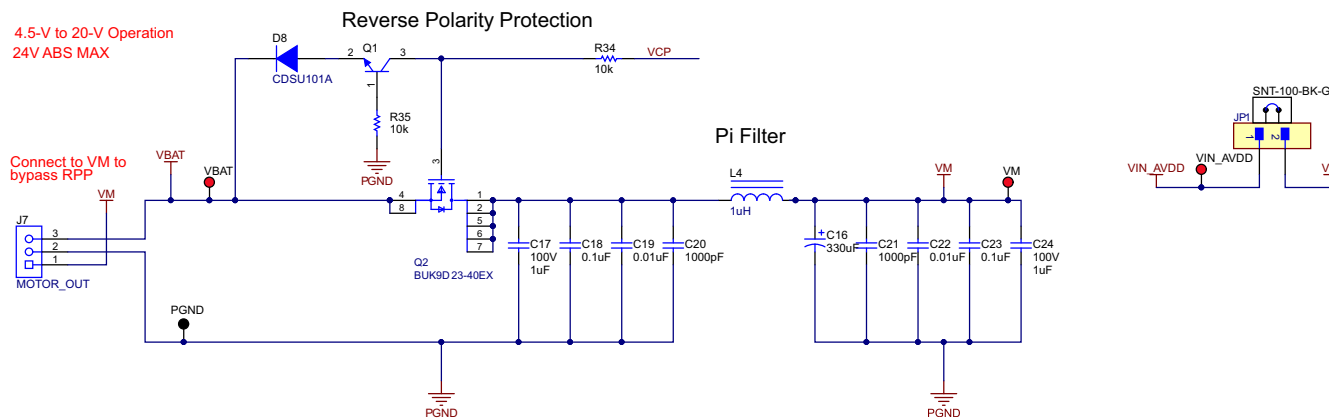
Figure 8-1. Main Supply and Pi Filter Schematic

8.2 Connectors and Interface
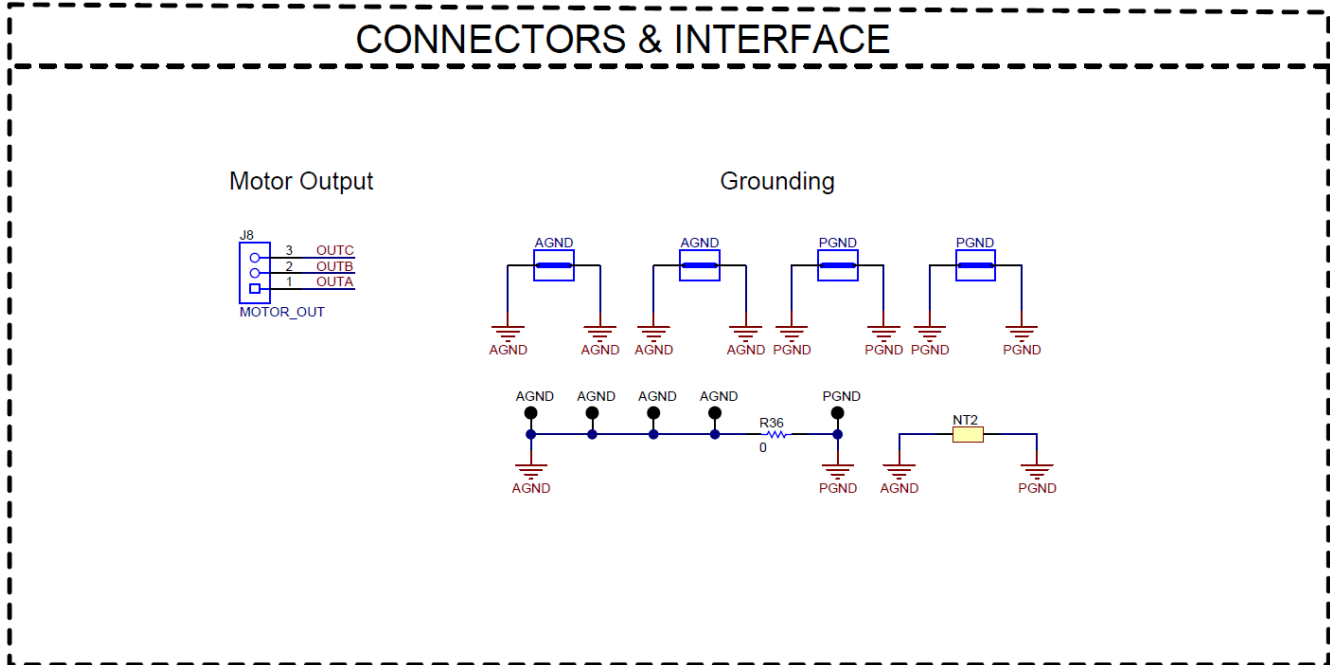
Figure 8-2. Connectors and Interface Schematic

8.3 USB to UART
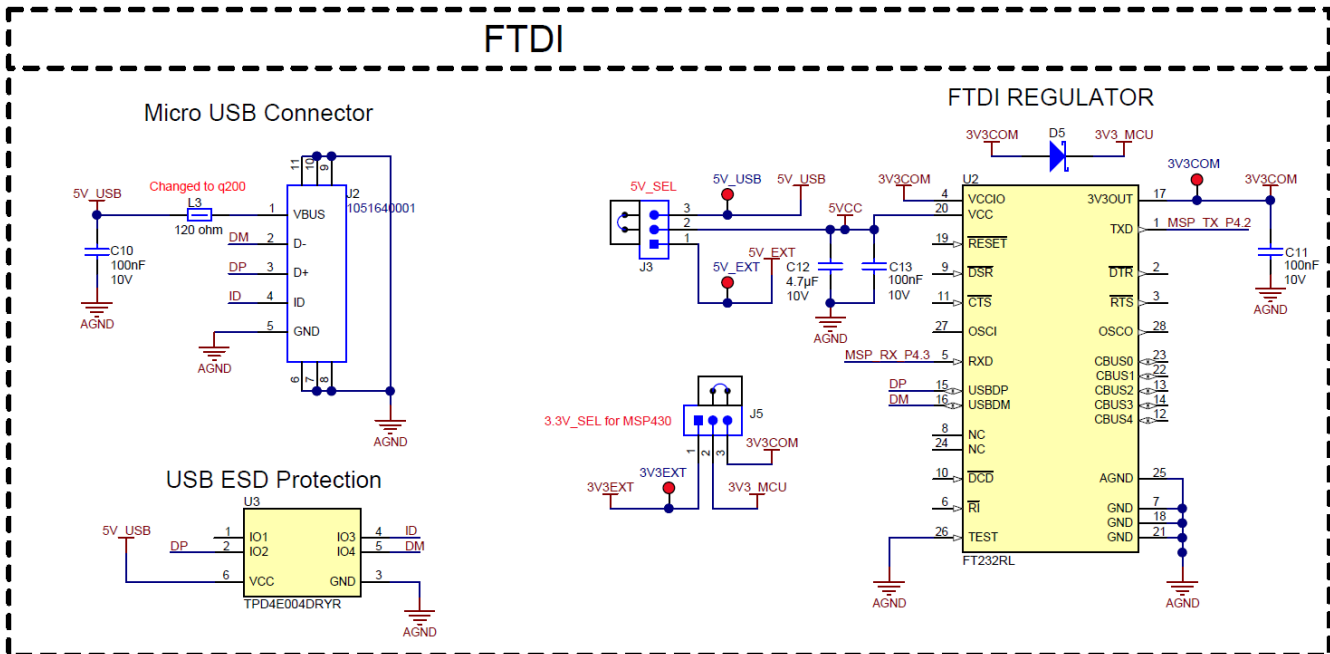
Figure 8-3. USB to UART Schematic

8.4 MCU Programming and Debug
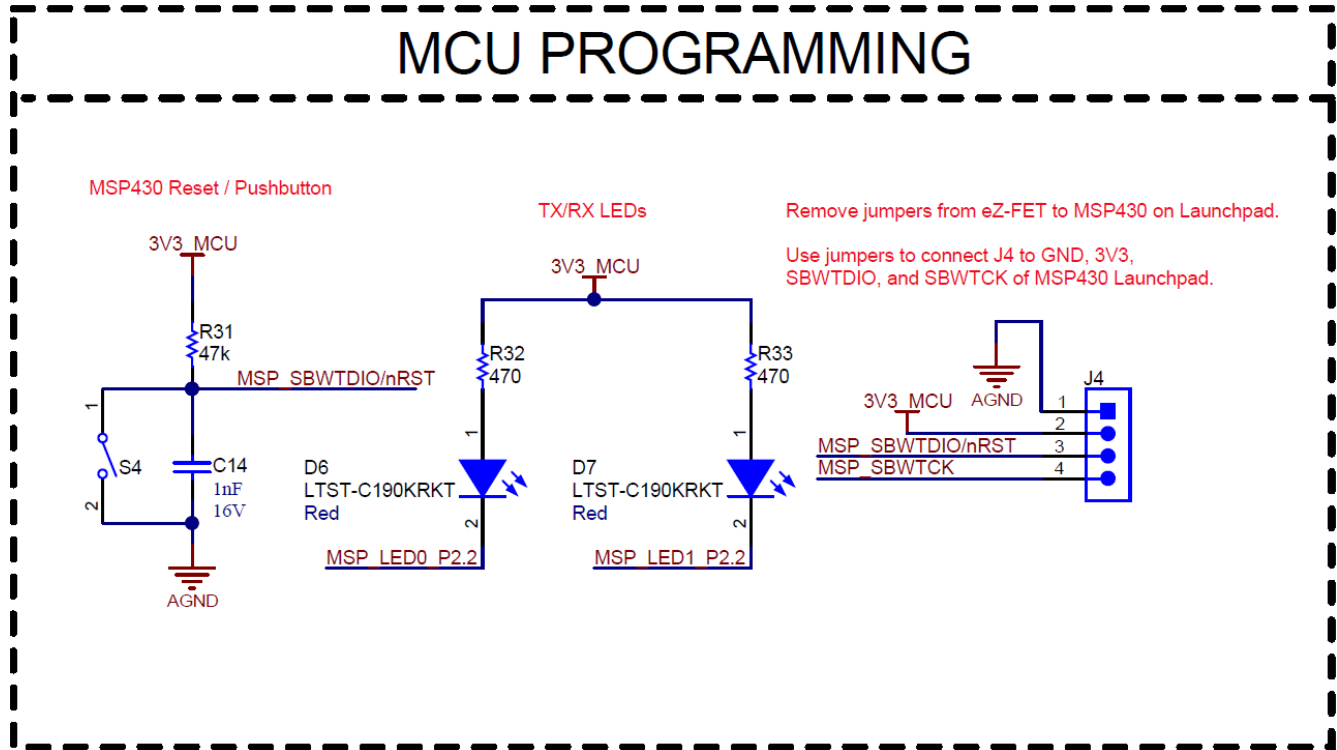
Figure 8-4. MCU Programming and Debug Schematic
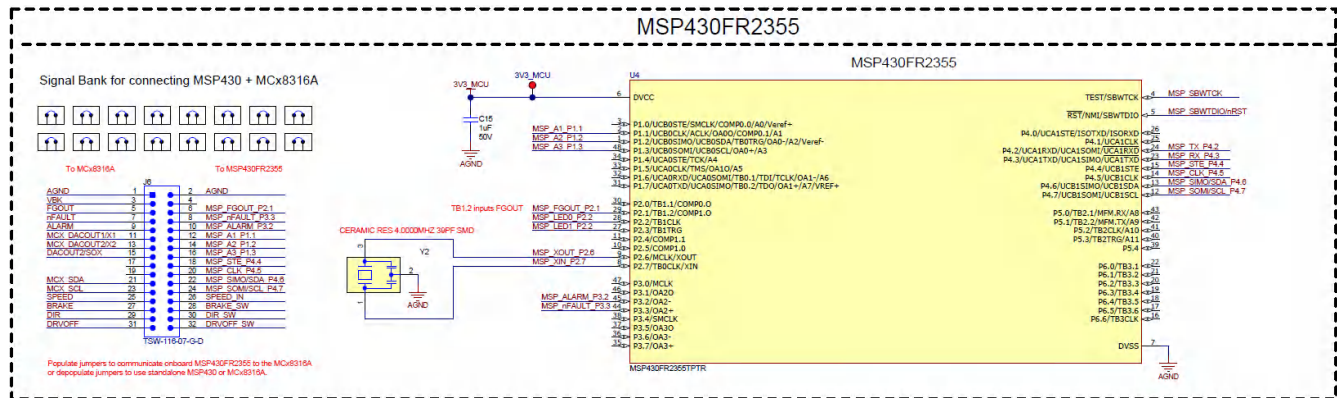
8.5 MSP430FR2355 MCU

Figure 8-5. MSP430FR2355 MCU Schematic

8.6 MCT8317 3-Phase Sensorless Trapezoidal Integrated Driver
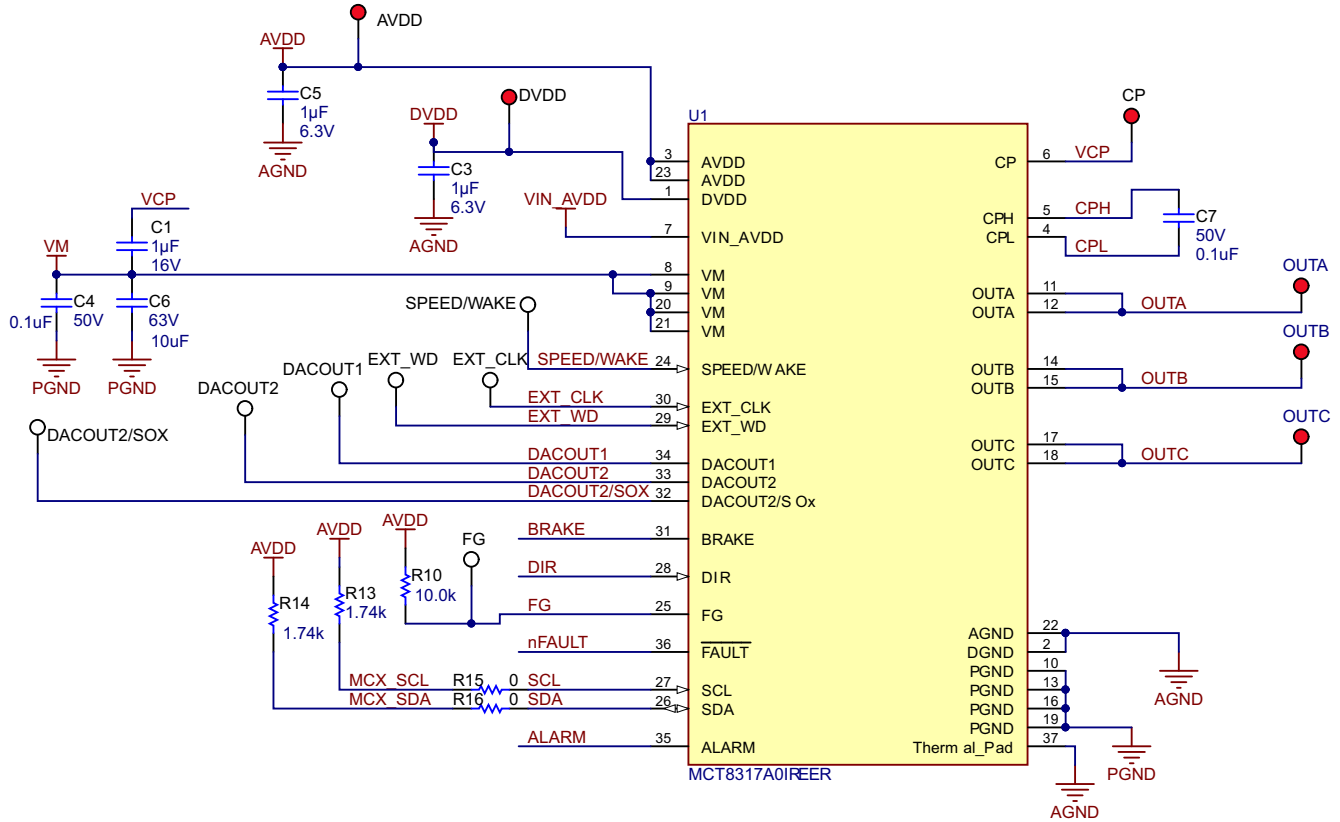
Figure 8-6. MCT8317 3-Phase Sensorless Trapezoidal Integrated Driver Schematic

8.7 Status LEDs
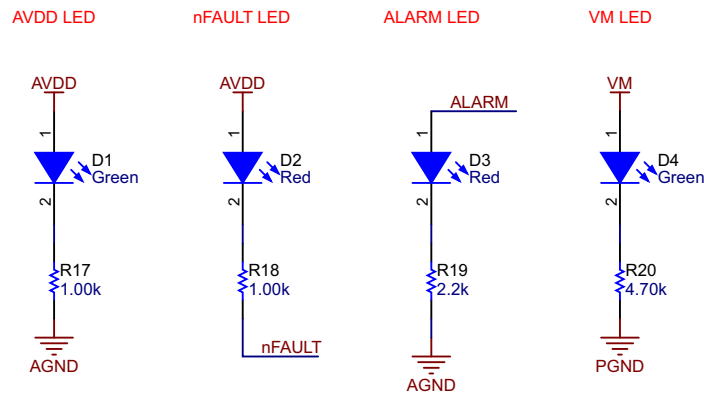
Figure 8-7. Status LEDs Schematic

8.8 Switches and Speed Input
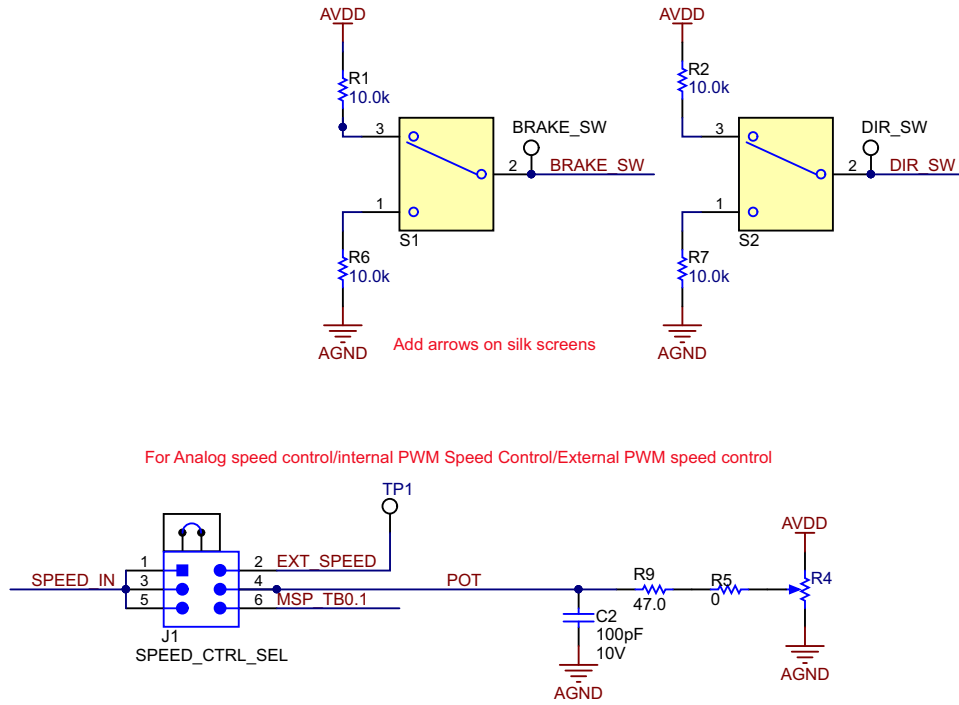
Figure 8-8. Switches and Speed Input

9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
December 2022	*	Initial Release

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