DRV8353Rx-EVM User's Guide

This document is provided with the DRV8353Rx-EVM customer evaluation module (EVM) as a supplement to the *DRV835x 100-V Three-Phase Smart Gate Driver* data sheet. This user's guide details the hardware implementation of the EVM.

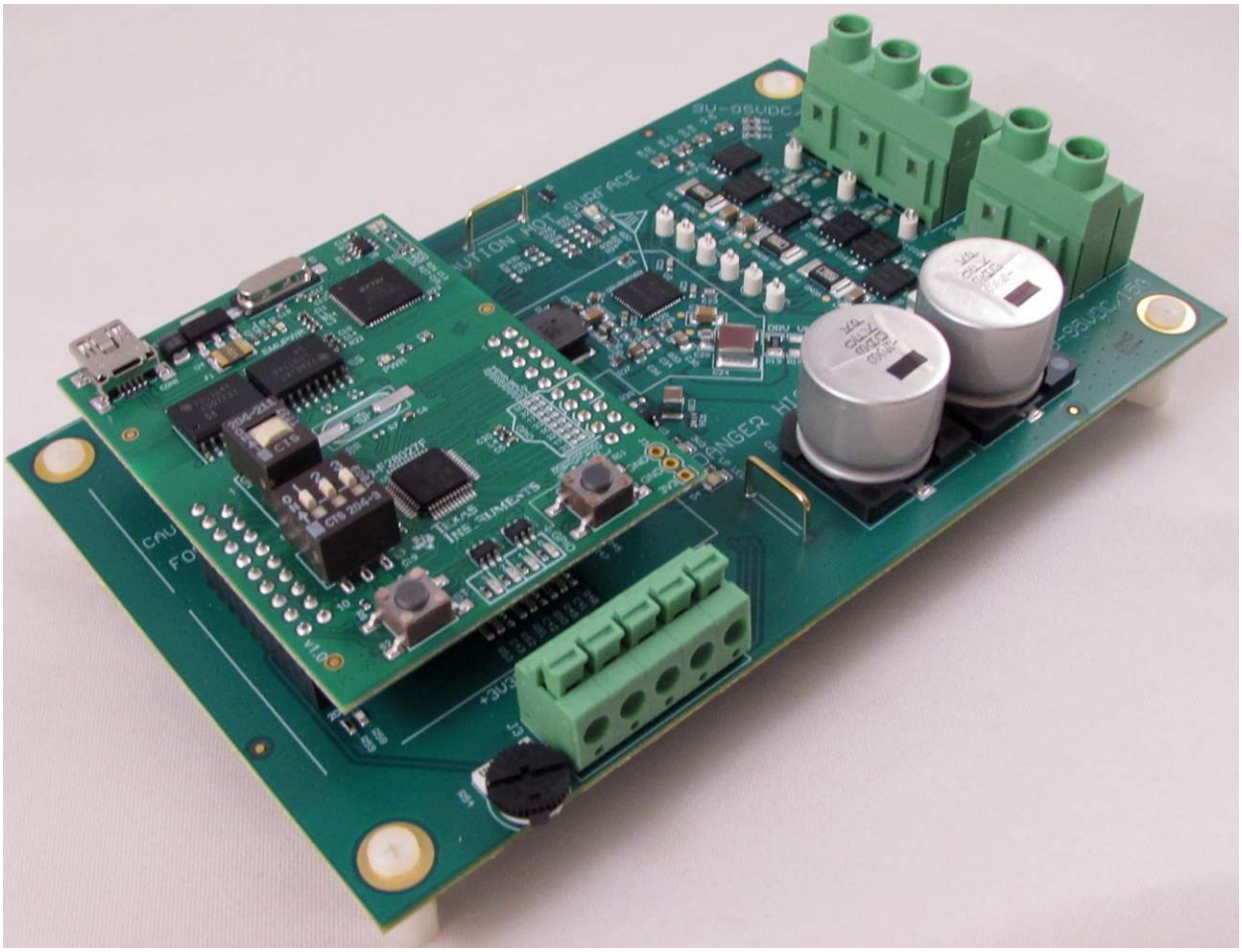

Figure 1. DRV8353RS-EVM

NOTE: Operate this EVM only at the default IDRIVE setting 150mA/300mA sink/source current.

CAUTION

The DRV8353Rx-EVMs are designed to be evaluated only with the ISO-F28027F MCU PCB accompanying this kit. This MCU PCB is a specially modified version of the LAUNCHXL-F28027F that maintains functionality as the LaunchPad™ development kit while maintaining USB isolation from high voltage transient feedback up to the 3000 V_{RMS}. The 3.3V_{DC} power to the ISO-F28027F is provided from this EVM. Make sure ISO-F28027F's S4 switch is set to OFF and S1 to ON-ON-ON.

WARNING

Although the ISO-F28027F MCU PCB provides isolation of up to 3000 V_{RMS} to the USB, the DRV8353Rx-EVM itself is considered an electrically live EVM and is not intended nor designed for isolation voltage testing. Voltages exceeding the standard EVM ratings as specified on the data sheet may cause personal injury, electrical shock hazard, damage the EVM, or a combination.

Additionally, do not leave power connections to the EVM connected while not in operation.

For power up, follow the sequence of first making sure all external connections are completed except the USB. Then, apply power to the power connector. Once the 3.3 V_{DC} LED is on, connect the USB to the computer. If the correct firmware is loaded, LP_LED will constantly be asserted high with an orange emission.

WARNING

Hot surface. Contact may cause burns. Do not Touch.

WARNING

High Voltage. Electric shock is possible when connecting board to live wire. The board should be handled with care by a professional.

For safety, use of isolated test equipment with overvoltage and overcurrent protection is highly recommended.

CAUTION

Do not leave the EVM powered when unattended.

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1 Introduction

1.1 Overview

The DRV8353Rx is a gate driver IC for three-phase motor drive applications. It provides three high-accuracy trimmed and temperature compensated half-bridge drivers, each capable of driving high-side and low-side N-type MOSFETs.

Both SPI and hardware interface variants provide fault reporting and modifiable parameter settings such as current control options for slew rate control of the gate drivers and protection features.

Tagging along with the hardware of DRV8353Rx, the TMS320F28027F microcontroller based board has loaded reference software that provides the necessary gating pulses to the DRV8353Rx to control the BLDC motors using the InstaSPIN-FOC™ software.

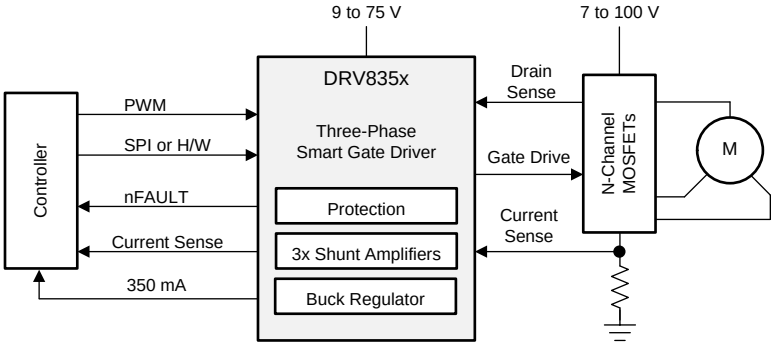

Figure 2. Block Diagram

1.2 Purpose and Scope

This document is designed to be used as a startup guide and to supplement the DRV835X + TMS320F28027F BLDC motor control demo code kit. This document is intended for the engineers involved in the design, implementation, and validation of DRV835X + TMS320F28027F reference software.

The scope of this document is to provide the user with a guide to evaluate the DRV8353Rx device with a TMS320F28027F isolated board. This document covers the hardware connections required between DRV8353Rx and the MCU board. When the HW connections are complete, the user is required to download the necessary tools and SW to spin a motor.

The reference SW is composed of InstaSPIN™ software with field-oriented control algorithm for BLDC motor identification and control. For additional information on these algorithms, refer to *InstaSPIN-FOC™ and InstaSPIN-MOTION™ User's Guide* and *TMS320F28026F, TMS320F28027F InstaSPIN™-FOC Software Technical Reference Manual*

2 Hardware and Software Overview

2.1 Hardware Connections Overview – DRV8353Rx-EVM + ISO-F28027F

Hardware Connections Overview 2 shows the significant blocks of the hardware where the DRV8353Rx-EVM is mounted on the ISO-F28027F. The DRV8353Rx-EVM is designed for an input supply from 9 V_{DC} to 95 V_{DC} and up to 15-A continuos drive current. It comes with three half h-bridges capable of driving a three-phase BLDC motor implementing sensored or sensorless control. Hall sensor pins a, b, c are connected to pins J2-3, J2-5, and J2-15 of the J2 female header on the motor driver PCB. The 3.3 V_{DC} supply to the Hall sensors is supplied from the 3.3V LDO on the EVM.

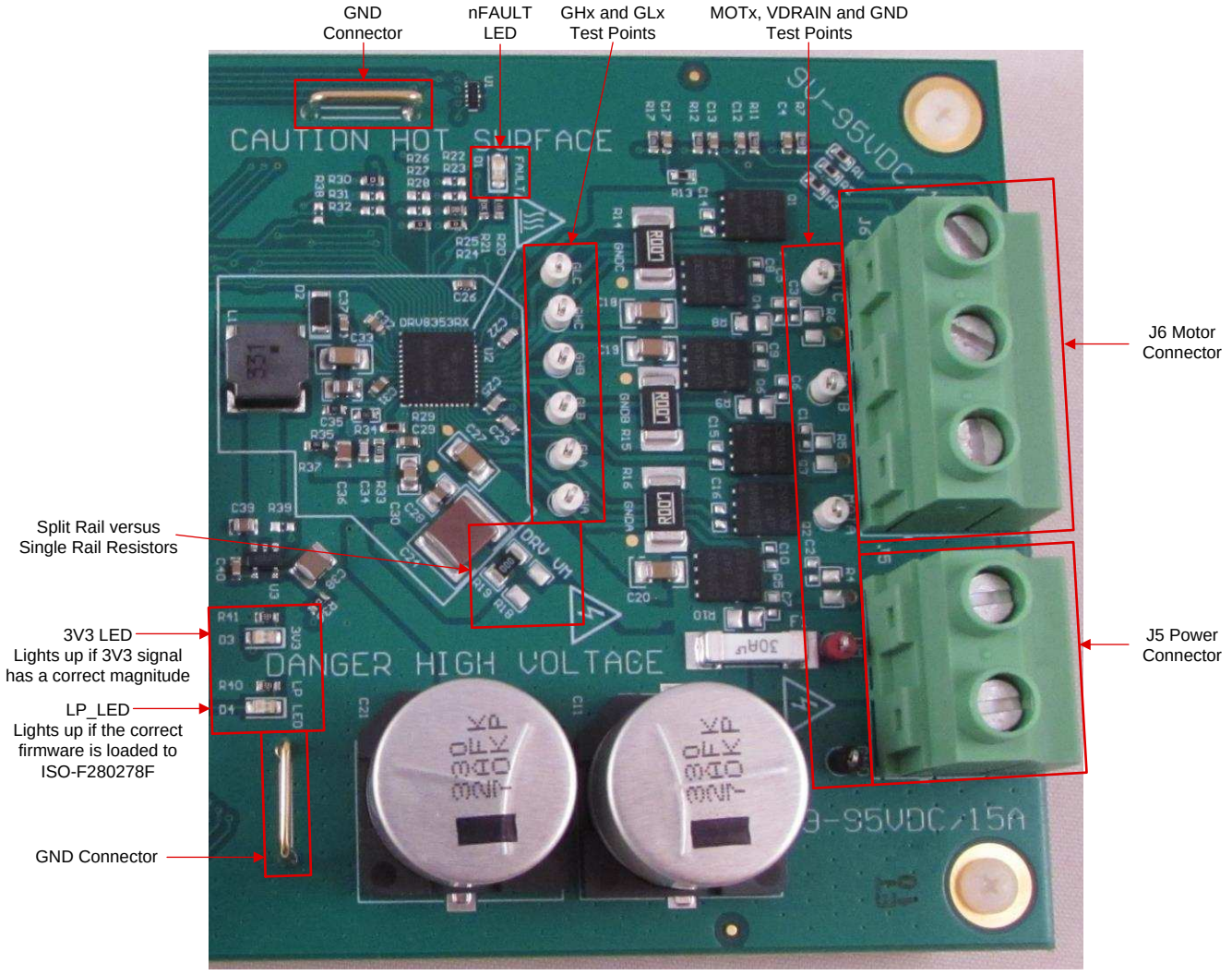

Figure 3. Hardware Connections Overview 1

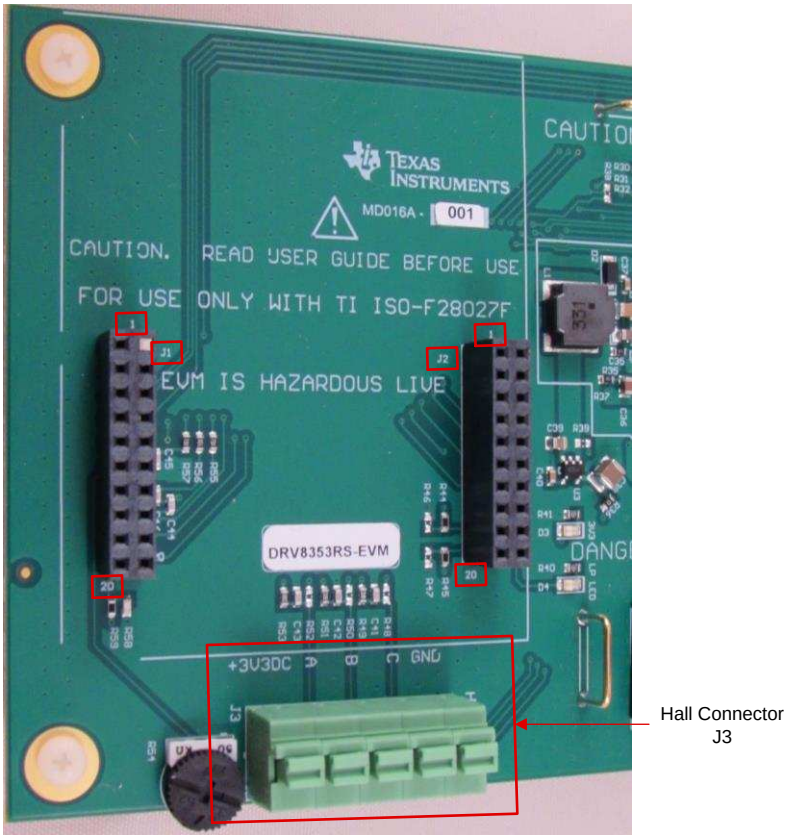

Figure 4. Hardware Connections Overview 2

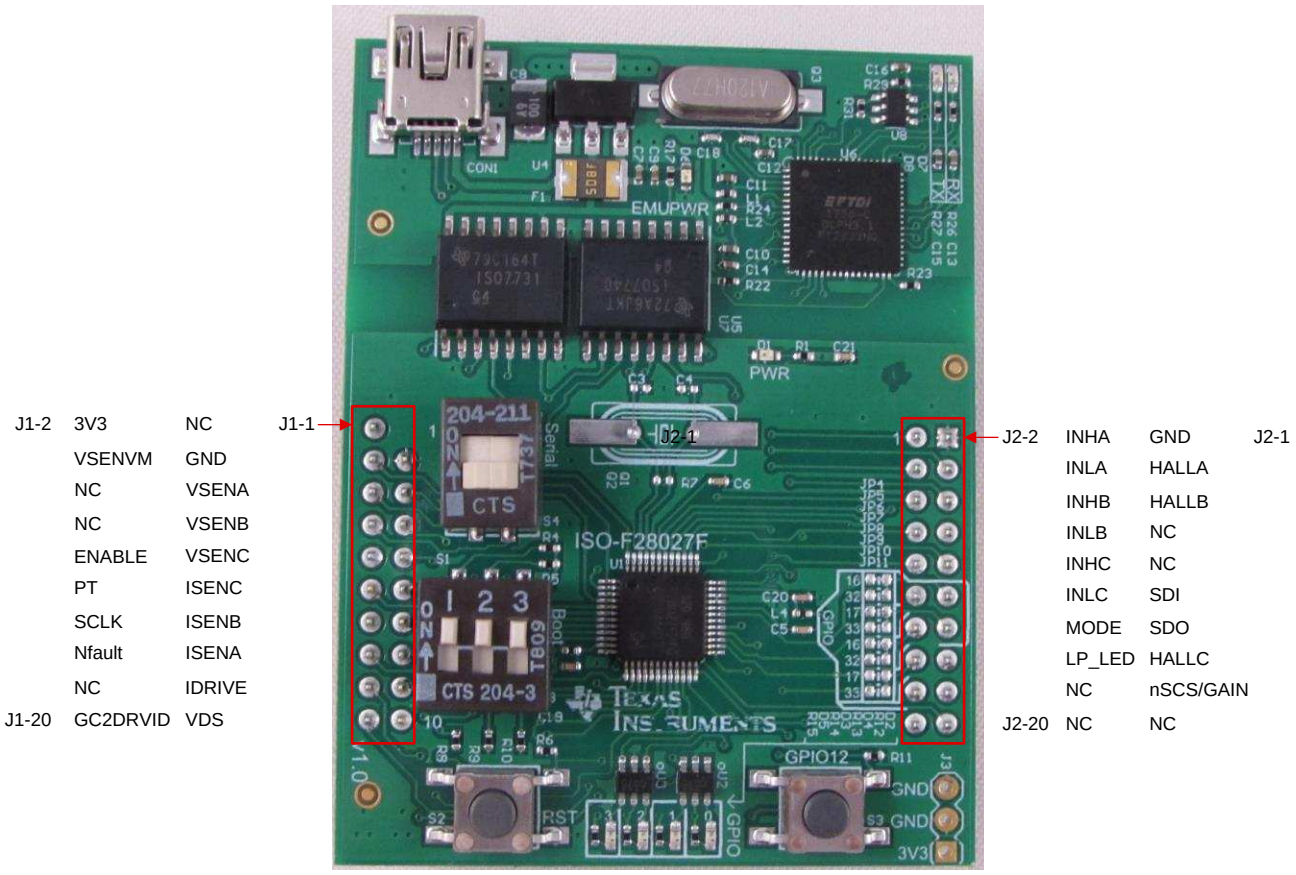

Figure 5. Hardware Connections Overview 3

2.2 Connection Details

Figure 3 shows the power connector and motor phase connector. A supply voltage ranging from 9 V_{DC} to 95 V_{DC} connected to the voltage supply pins is acceptable. The DRV8353Rx-EVMs are designed to operate in single rail (VM = VDRAIN) and split rail (separate power nodes VM and VDRAIN). VM has an operating range of $9V_{DC}$-$75V_{DC}$, while VDRAIN has an operating range of $7V_{DC}$-$100V_{DC}$. By default, the EVMs work in split rail configuration, with VM power derived from the12 V_{DC} drop down output of the LM5008A. For single rail configuration, connect R18 and disconnect R19. The LM5008A's power input is the VDRAIN rail connecting to the power connectorJ5. Three phases of the BLDC motor are connected to the three-phase motor socket J6 provided on the DRV8353Rx-EVM.

WARNING

To minimize the risk of potential shock hazard and personal injury, remove all power interface connections and interfaces to the DRV8353Rx-EVM when not in use.

Figure 5 shows the jumper pin connections required for the proper functioning of the software.

Figure 5 shows where the Mini-USB cable can be plugged in to power the ISO-F28027F FTDI programmer and provide communication between the TMS320F28027F firmware and GUI.

2.3 Fault Handling and Switch Functionality

See the *DRV835x 100-V Three-Phase Smart Gate Driver* data sheet for more information on DRV8353Rx fault support

One push button switch is dedicated on the ISO-F28027F development kit to reset the firmware (RST). This switch is configured in the reference software.

2.4 Interfacing DRV8353Rx-EVM and ISO-F28027F

The DRV8353Rx-EVM has 40 female header pins with different functions. These pins are interfaced with the ISO-F28027F development kit, which is mapped appropriately to receive the functionality of the motor driver's header pins. These 40 pins are grouped into 4 ports. The following tables list the interfacing of these ports with the TMS320F28027F device.

Table 1. DRV8353Rx-EVM J1 Pin Connections

J1 Pin Number	DRV8353Rx-EVM Function	TMS320F28027F Function	Description
2	3.3 V	3.3 V	3.3 V MCU supply
1	Leaded Pin Hole	No Pin Extruded	Leaded pin hole
4	VSENVM	ADC channel – A6	Sensing VM supply voltage
3	GND	GND	GND connection
6	No function	UART RX to MCU	No function
5	VSENA	ADC channel – A7	Sensing A phase voltage
8	No function	UART TX to MCU	No function
7	VSENB	ADC channel – A3	Sensing B phase voltage
10	ENABLE	I/O pin with Interrupt	Logic low to enter a low-power sleep mode
9	VSENC	ADC channel – A1	Sensing C phase voltage
12	POT	ADC channel – A4	Optional POT to vary the voltage 0-3.3 V on pin
11	ISENC	ADC channel – A0	Sensing C phase current
14	SCLK	UCBOCLK – SPI CLK	Secondary function for pin SPI CLK
13	ISENB	ADC channel – B1	Sensing B phase current
16	NFAULT	I/O pin with Interrupt	Pulled logic low during a fault condition

Table 1. DRV8353Rx-EVM J1 Pin Connections (continued)

J1 Pin Number	DRV8353Rx-EVM Function	TMS320F28027F Function	Description
15	ISENA	ADC channel – B3	Sensing A phase current
18	No function	I/O pin	Software debug pins (optional)
17	IDRIVE	I/O pin	Sets gate drive peak current, 7-level input pin (DRV8353RH devices only)
20	EVM ID	ADC channel – b7	EVM identification with voltage divider. DRV8353RS with R58 = 6.04k, DRV8353RH with R58 = 8.06k
19	VDS	I/O pin	Sets VDS monitor threshold voltage, 7-level input pin (DRV8353RH devices only)

Table 2. DRV8353Rx-EVM J2 Pin Connections

J2 Pin Number	DRV8353Rx-EVM Function	ISO-F28027F Function	Description
2	INHA	EPWM1A	Secondary function, output to generate PWM for A phase high-side switches
1	GND	GND	GND connections
4	INLA	EPWM1B	Secondary function, output to generate PWM for A phase low-side switches
3	HALLA	SPI enable	Hall sensor A feedback from motor
6	INHB	EPWM2A	Secondary function, output to generate PWM for B phase high-side switches
5	HALLB	I/O PIN with Interrupt	Hall sensor B from motor
8	INLB	EPWM2B	Secondary function, output to generate PWM for B phase low-side switches
7	No function	I/O pin	No function
10	INHC	EPWM3A	Secondary function, output to generate PWM for C phase high-side switches
9	No function	RST	No function
12	INLC	EPWM3B	Secondary function, output to generate PWM for C phase low-side switches
11	SDI	UCBOSIMO	Secondary function for data input to DRV835xx
14	MODE	I/O pin	Sets the input control mode, 4-level input pin (DRV8353RH devices only)
13	SDO	UCBOSOMI	Secondary function for data output from DRV835xx
16	LED	I/O pin	Visual feedback for faults.
15	HALLC	I/O pin With Interrupt	Hall sensor C feedback from motor
18	EVM ID	I/O pin	Not for evaluation purposes
17	nSCS/GAIN	I/O PIN with Interrupt	Active low enables serial interface communication Sets the gain of the shunt amplifiers, 4-level input pin (DRV8353RH devices only)
20	EVM ID	I/O pin	Not for evaluation purposes
20	No connect	I/O pin	Not used

3 GUI Application Initialization

3.1 Hardware Setup

The hardware required to run the motor control is the ISO-F28027F development kit, the DRV8353Rx-EVM, a Mini-USB cable, and a power supply with a DC output from $9V_{DC}$ to $95V_{DC}$. Follow these steps to start up the DRV8353Rx-EVM:

Step 1. Dock the ISO-F28027F development kit to the DRV8353Rx-EVM to through the two 40-pin headers J1 and J2.

NOTE: Observe the correct polarity of the 40-pin isolated board headers. The ISO-F28027F header J1 should be connected to DRV8353Rx-EVM header J1 (header with the polarized pin) and ISO-F28027F header J2 should be connected to DRV8353Rx-EVM header J2.

Step 2. Connect the three phases from the brushless DC motor to the J6 connector on the DRV8353Rx-EVM module. Phase A, B, and C are labeled MOTA, MOTB, and MOTC in white silkscreen on the PCB top layer.

NOTE: If using the sensored firmware on the ISO-F28027F development kit, connect a brushless DC motor Hall sensor inputs to header J3. If using sensorless firmware header J3 can be left unconnected.

NOTE: If using 1x PWM Mode with the **sensored firmware** R48, R50, and R52 must be populated with 0-Ω resistors to connect the Hall sensor input signals to the DRV.

Step 3. Connect the DC power supply to header J5. The EVM has a 30 A rated fuse to protect against large inrush current situations.

NOTE: Observe the correct polarity of +VM and GND connections on the DRV8353Rx-EVM connection J5

Step 4. Turn on the power supply and power up the PCB. VDRAIN connects directly to the LM5008A, which ouputs 12 V_{DC} to VM (split rail configuration) and to the 3.3 V_{DC} LP2992 LDO.

Step 5. Connect a Mini-USB cable to the ISO-F28027F development kit and computer.

3.2 EVM Default Component Configurations

Both EVMs have R19 connected and R18 disconnected for split rail configuration. These connections must be switched for VM = VDRAIN. The LM5008A is used in the split rail configuration to power the VM rail with 12 V_{DC}. The buck's power input comes from VDRAIN. The 12 V_{DC} is also the power input to the LP2992IM5 LDO that outputs 3.3 V_{DC}. If the LMR5008A is set to output 3.3 V_{DC}, disconnect the R36 LDO output of $3.3V_{DC}$ and connect the 3.3 V_{DC} nodes to the buck output by connecting R39. For high-speed switching evaluation, this EVM can connect RC snubbers to the low side and high side switch nodes and one can further evaluate slew rate performance of device with VGS capacitors. All of these components are do-not populate (DNP) by default. Evaluate the half-bridge section of the schematic for information on component designators.

The DRV8353RH-EVM is set by default to be evaluated with the IDRIVE at 150/300 mA, VDS sense at 0.2 V_{DC}, MODE to 3x PWM, and GAIN to 10 V/V. To modify these values, refer to the data sheet for how to setup these input pin structures.

The schematic can be found in the Design Files link in the DRV8353RS-EVM and DRV8353RH-EVM tool page.

4 References

See these documents for additional reference:

- Texas Instruments, *DRV8353Rx-EVM EVM User's Guide*

- Texas Instruments, *DRV835x-EVM InstaSPIN™ Software Quick Start Guide*
- Texas Instruments, *DRV835x 100-V Three-Phase Smart Gate Driver* data sheet
- Texas Instruments, *InstaSPIN-FOC™ and InstaSPIN-MOTION™ User's Guide*
- Texas Instruments, *LM5008A 100-V 350-mA Constant On-Time Buck Switching Regulator* data sheet
- Texas Instruments, *TMS320F2802x Piccolo™ Microcontrollers* data sheet
- Texas Instruments, *TMS320F28026F, TMS320F28027F InstaSPIN-FOC™ Software Technical Reference Manual*

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