EVM User's Guide: DRV8363-Q1EVM

DRV8363-Q1 Evaluation Module

Description

The DRV8363-Q1EVM is a 30A, 3-phase brushless DC drive stage based on the DRV8363-Q1 gate driver for BLDC motors.

The EVM allows quick evaluation of the DRV8363-Q1 device which spins a BLDC motor with trapezoidal commutation and control.

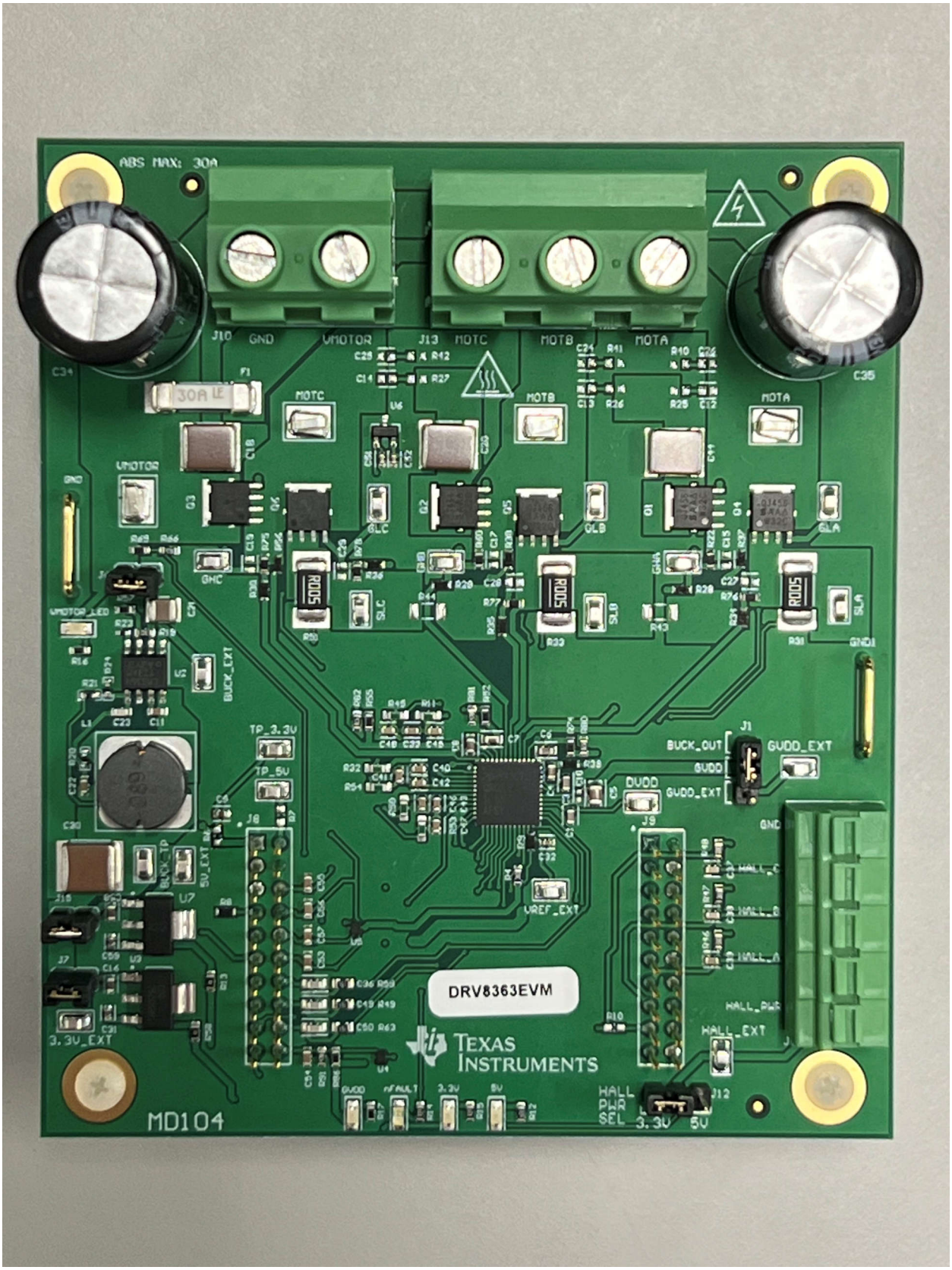
Status LEDs for all power supplies as well as a Fault LED are included for user feedback. The C2000 launchpad (LAUNCHXL-F280049C) is required for this kit and is used to control the DRV8363-Q1 as well as monitor and report faults.

Features

- 8V to 85V maximum operation with support for 12V to 48V applications
- 100% duty cycle PWM control, with 1A/2A peak gate drive
- 32 configurable IDRIVE steps for fine slew rate tuning
- 3x integrated CSAs with low input offset drift
- 5V and 3.3V on-board LDOs.

Applications

- Appliances, cordless garden and power tools, lawn mowers
- Brushless-DC (BLDC) motor modules and PMSM
- Fans, pumps, and servo drives
- E-bikes, e-scooters, and e-mobility
- Cordless vacuum cleaners
- Drones, industrial and logistics robots, and RC toys



DRV8363-Q1EVM

1 Evaluation Module Overview

1.1 Introduction

This document is provided with the DRV8363-Q1 customer evaluation module (EVM) as a supplement to the DRV8363-Q1 data sheet. The user's guide details the hardware implementation of the EVM.

This document is designed to be used as a startup guide to the DRV8363-Q1EVM and LAUNCHXL-F280049C device. This document is intended for the engineers involved in the design, implementation, and validation of DRV8363-Q1 + TMS320F280049C reference software.

The scope of this document is to provide the user with a guide to evaluate the DRV8363-Q1 device with a TMS320F280049C board. This document covers the hardware connections required between boards and external motor/supplies. When the hardware connections are complete, the user can access the necessary tools and software to spin a motor using the online GUI.

The reference software is composed of GuiComposer software with sensored trapezoidal algorithm for BLDC motor control.

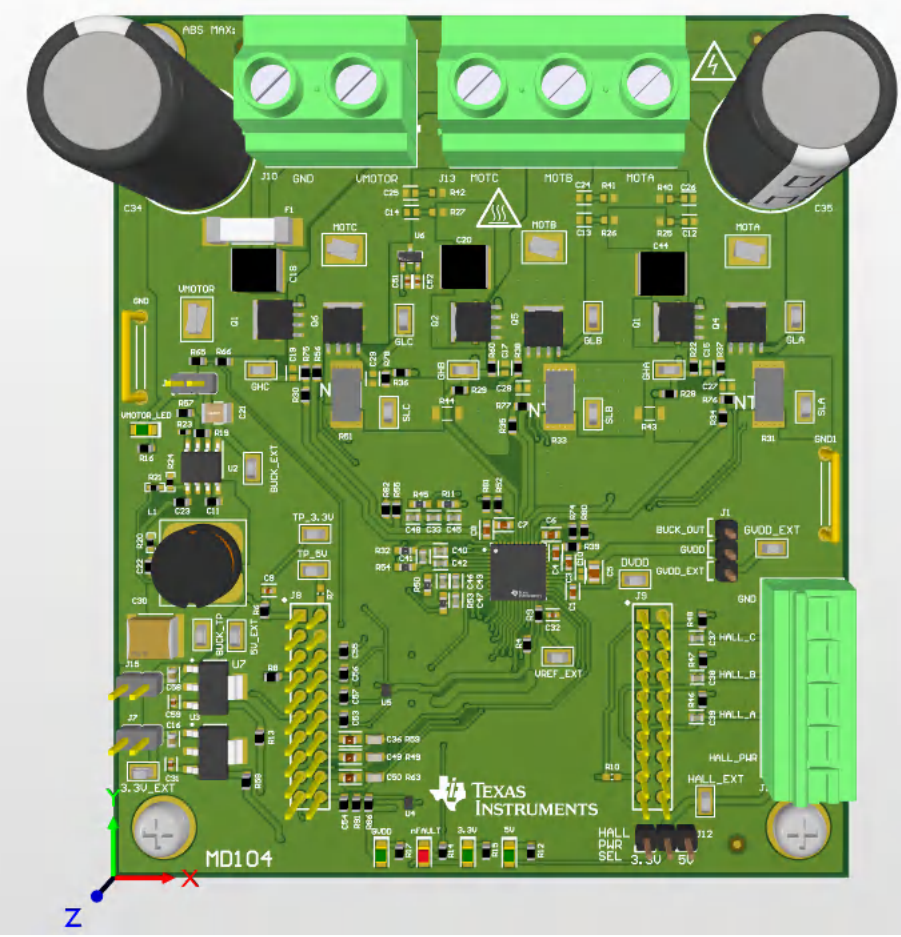


Figure 1-1. DRV8363-Q1EVM

CAUTION

The DRV8363-Q1EVM is designed to be evaluated only with the LAUNCHXL-F280049C MCU PCB, which must be ordered separately.

WARNING

Voltages exceeding the standard EVM ratings as specified on the data sheet can 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.

WARNING

	**Hot surface**	Contact can cause burns. Do not touch.

WARNING

	**High Voltage**	For safety, use of isolated test equipment with overvoltage and overcurrent protection is highly recommended. Electric shock is possible when connecting board to live wire. The board must be handled with care by a professional.

1.2 Kit Contents

Item	Description	Quantity
DRV8363-Q1EVM	PCB	1
Box	Cardboard box	1
Label	Standard label	1
Foam	Antistatic foam	2
Literature	EVM disclaimers	1

1.3 Device Information

The DRV8363-Q1 enables customers to evaluate the motor performance within the gate driver system. The DRV8363-Q1 implements features such as enhanced Smart Gate Drive and expanded device protection features, making the device an excellent choice for applications such as power tools, appliances, pumps, and fans. The device supports 12V, 24V, and 48V applications while allowing up to 85V VDRAIN abs max to support power supply transients.

2 Hardware

2.1 Hardware Connections Overview – DRV8363-Q1EVM + LAUNCHXL-F280049C

The following section describes the EVM hardware and connections to the external supply, hall sensors, PC via USB, and motor.

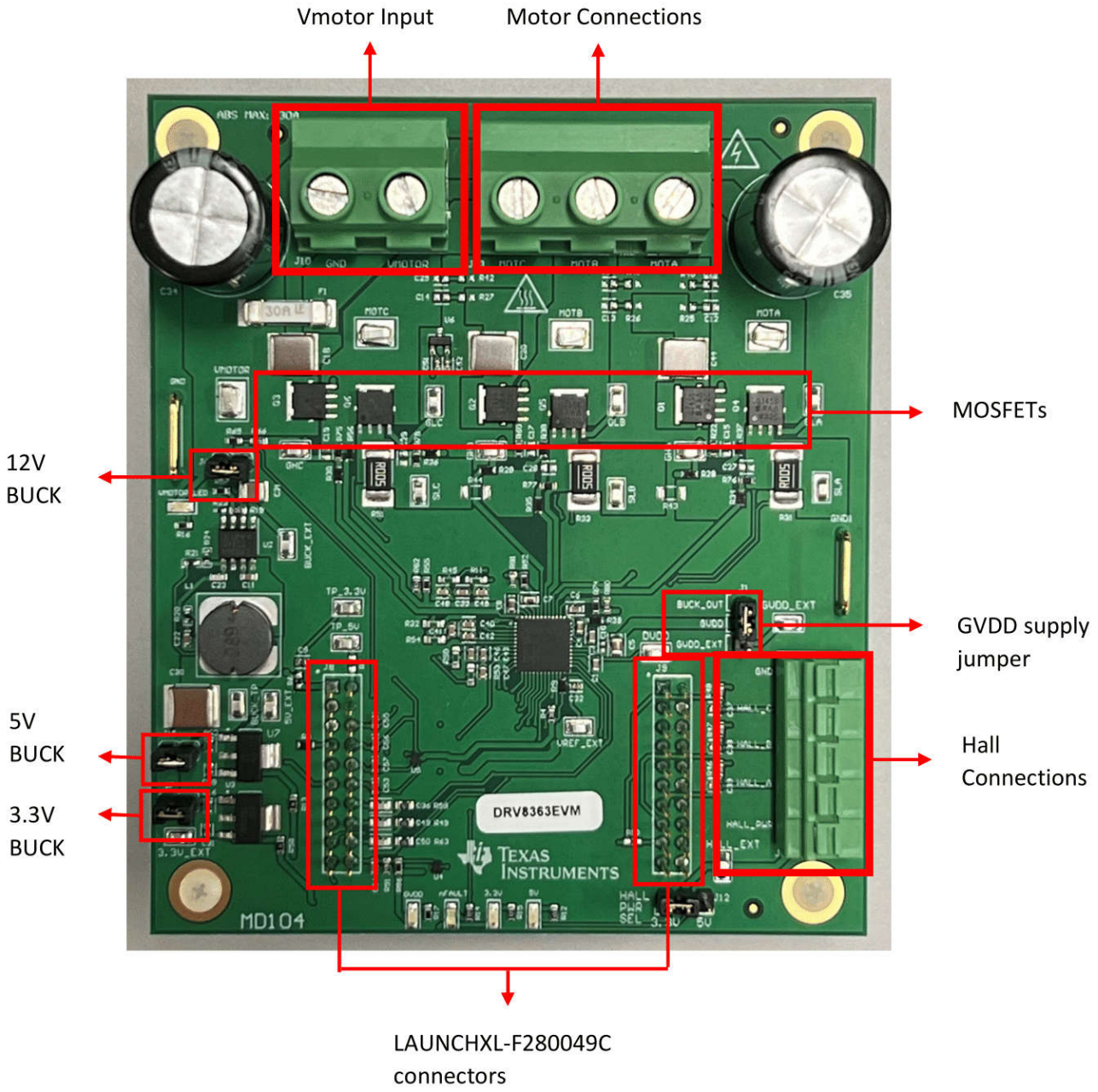


Figure 2-1. EVM Board Overview

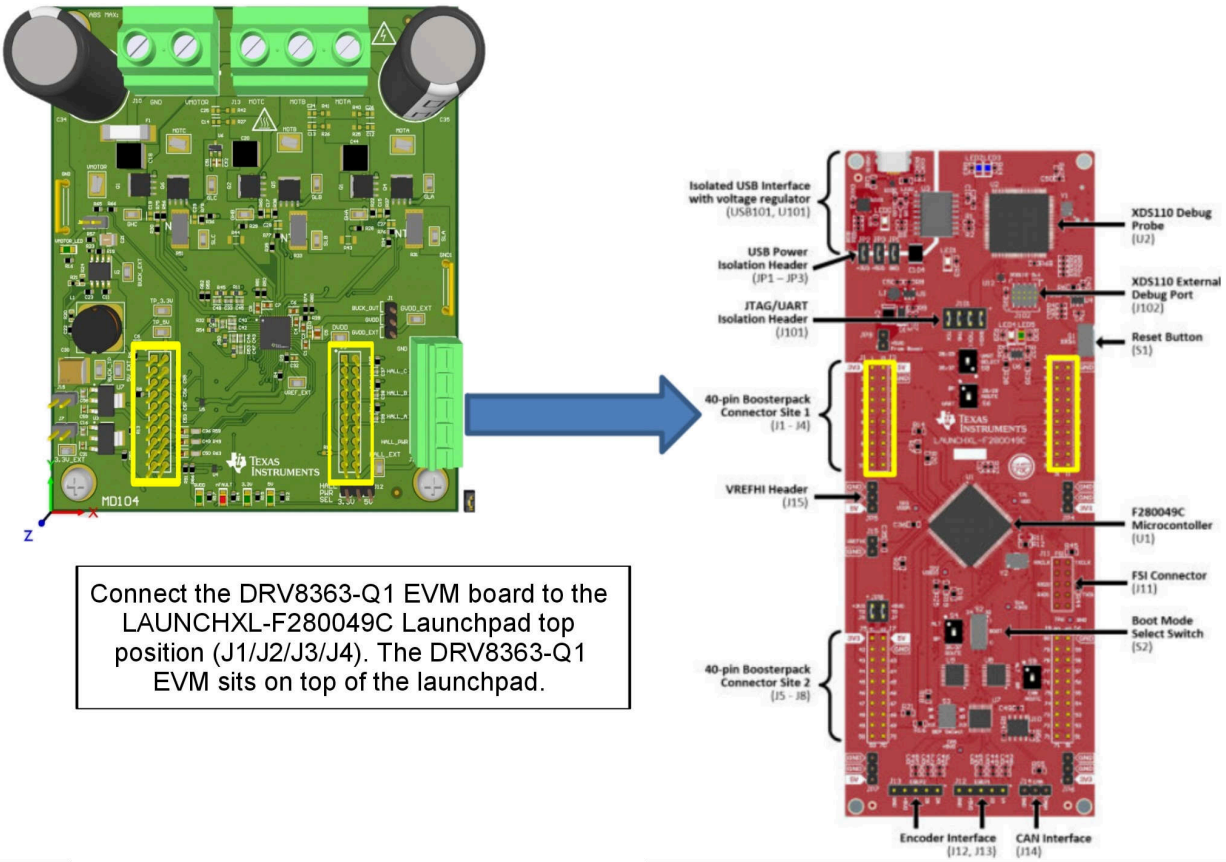


Figure 2-2. DRV8363-Q1EVM Mating to LAUNCHXL-F280049C

The DRV8363-Q1EVM must plug into the LAUNCHXL-F280049C Launchpad headers closest to the USB port as shown above.

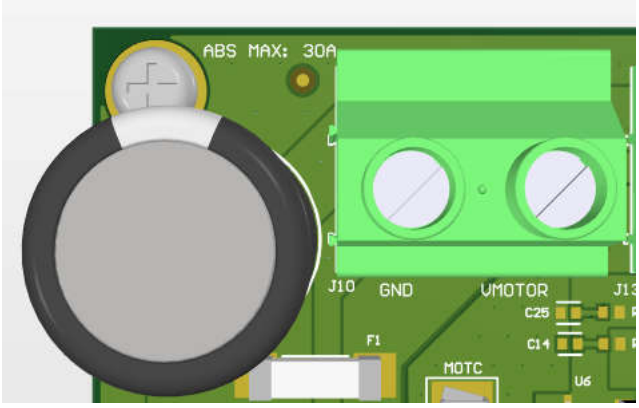


Figure 2-3. VMOTOR Input (J10)

WARNING

To minimize the risk of potential shock hazard and personal injury, remove all power connections and interfaces to the DRV8363-Q1EVM when not in use.

The DRV8363-Q1EVM is designed for an input supply from $8V_{DC}$ to $48V_{DC}$ and up to 30A continuous drive current (in-line fuse limited). The input connects to J10 with the noted polarity. VMOTOR test point connects to

the same node but must not be used for high current input. VMOTOR input is fused with a 30A fuse and the input connector is rated for 32A.

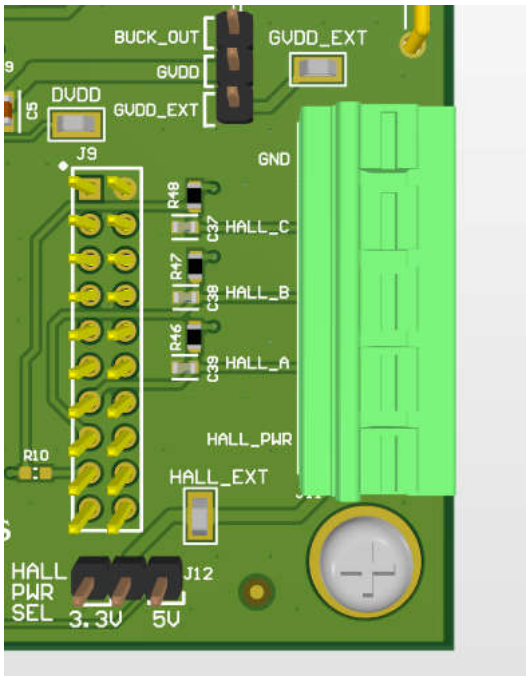


Figure 2-4. Hall Sensor Input and Power Connections (J11)

Hall sensors are connected to J11 including Hall power and GND. The EVM offers $3.3V_{DC}$ and $5V_{DC}$ on-board LDOs to supply to the Hall sensor power input. External hall power can be input through the HALL_EXT test point if a different supply or voltage level is desired. To use the included 3.3V LDO to power the halls, connect J12 on the left side to pins 1:2 as shown. To use the included 5V LDO to power the halls, connect J12 on the right side to pins 2:3. To use an external supply, connect the power supply to HALL_EXT or pin 2 of J12. To insert or remove wires/terminals on J11, use a flat blade screwdriver to push down the respective tab on top of the J11 connector.

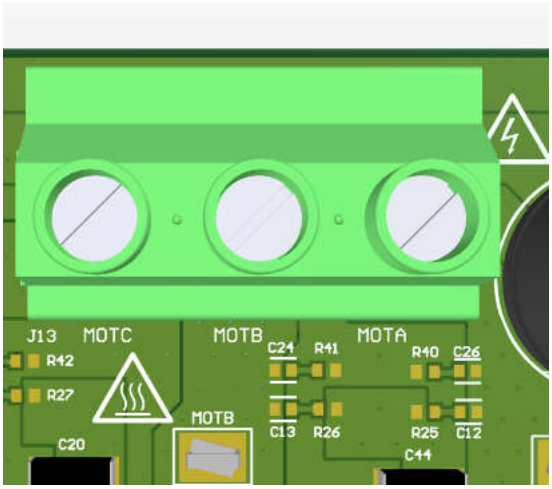


Figure 2-5. Motor Phase Connector (J13)

WARNING

Motor Phase connections must match the hall sensor connection sequence. For example, MOTA must match HALL_A, MOTB must match HALL_B, MOTC must match HALL_C. The phases must also be in sequential order; A, then B, then C.

If the motor phases do not match the hall sensors or the connections are made out of order, then the motor does not spin smoothly and current consumption increases.

The three phase inputs of the motor connect to MOTA/MOTB/MOTC through connector J13.

2.2 Faults, Indicators, and Jumper Settings

The DRV8363-Q1 implements Bootstrap Undervoltage, GVDD Undervoltage, VDS and VGS monitoring, and Thermal Shutdown in case of overtemperature. See the DRV8363-Q1 data sheet for more information on DRV8363-Q1 fault support.

Status LEDs for the 3.3V, 5V, PVDD, GVDD, and FAULT are included and shown below.

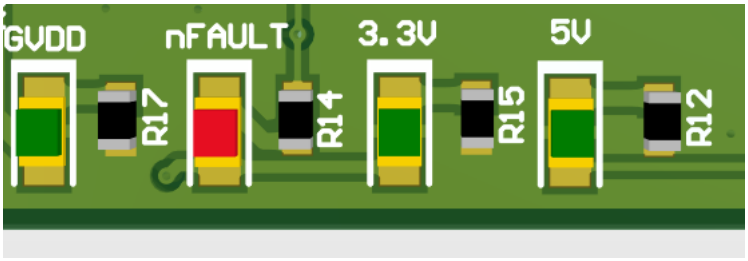


Figure 2-6. Status LEDs

The FAULT LED lights up if the EVM senses a fault and the same fault is reported in the SPI register. See the complete data sheet for fault response and corrective actions.

The nFAULT LED lights up when the board is powered, until logic high is applied to nSLEEP pin.

The Faults can be reset in the GUI software using the CLEAR FAULTS button. More details on the GUI can be found in Section 3.

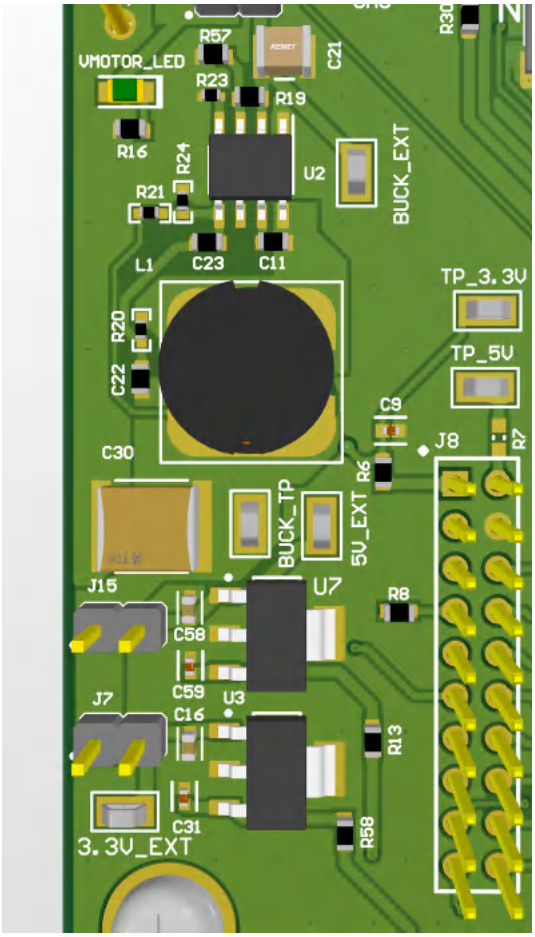


Figure 2-7. On-Board VMOTOR Buck, 3.3V LDO, and 5V LDO

The EVM includes a buck regulator for reducing VMOTOR to 12V in case regulation is required. The buck feeds into the 3.3V LDO and 5V LDO, which powers the EVM 3.3V and 5V rails.

Jumper J6 connects VMOTOR to the buck (default). Remove this jumper if you want to power down the buck regulator.

Jumper J7 connects the PVDD buck output (12V) to the 3.3V LDO (default). Remove this jumper if you want to power down the 3.3V rail.

Jumper J15 connects the PVDD buck output (12V) to the 5V LDO (default). Remove this jumper if you want to power down the 5V rail.

GVDD is powered by the buck output (12V) by default, but can configured for external supply support by placing J1 shunt on pins 1:2 as shown.

2.3 EVM Hardware Quick-Start

This section describes the steps to prepare the DRV8363-Q1EVM for first motor spin-up. This section assumes the default jumper positions mentioned above are used.

1. Plug the DRV8363-Q1EVM onto the upper position of the LAUNCHXL-F280049C board.
2. Connect motor phase connections to the respective MOTA/MOTB/MOTC inputs on J13, making sure to match A, B, and C.
3. Connect the Hall sensor connections, Hall power, and ground to J11. Make sure that Hall A, B, and C are in the correct order.
4. Connect the provided micro-USB cable to the LAUNCHXL-F280049C.
5. Populate JP1, JP2, and JP3 on LAUNCHXL-F280049C to maintain Launchpad receives power from USB.

6. Connect VMOTOR and GND to connector J10. A low current limit of 300mA on the VMOTOR supply is recommended for first power-up to verify the EVM is connected correctly. If there is no issue upon power-up, then the current limit can be raised to allow for current based on your motor specifications. VMOTOR range is 8V to 48V.
7. Start the GUI per the instructions below in Section 3.1.

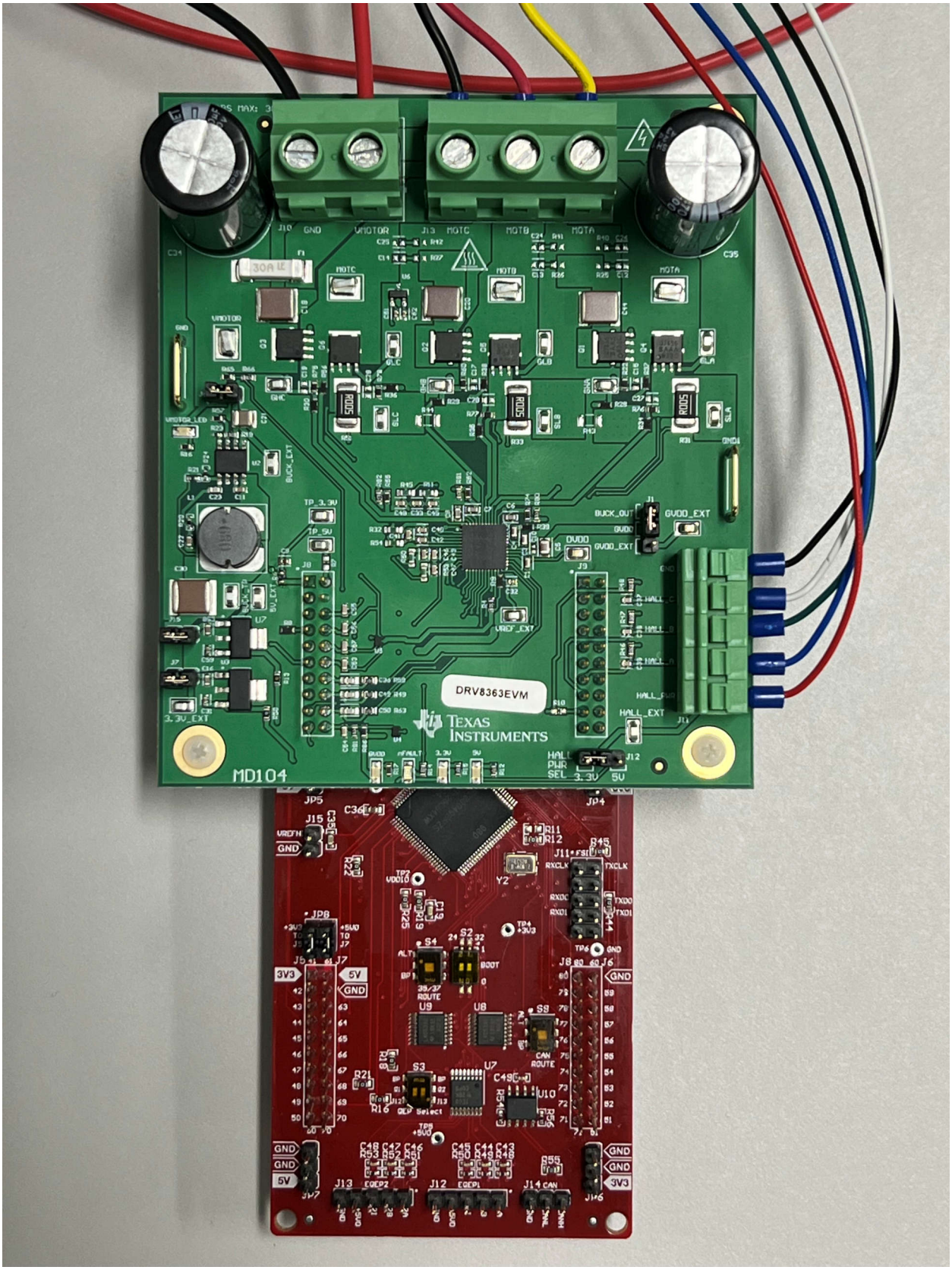


Figure 2-8. DRV8363-Q1EVM connected with Launch Pad

3 Software

3.1 DRV8363-Q1 EVM GUI Software

This section details the features of the EVM GUI Software. The GUI is written in GUI Composer and is available on the development software gallery at dev.ti.com/gallery.

Figure 3-1. DRV8363-Q1EVM GUI Software

The GUI connects and programs the C2000 MCU on the LAUNCHXL-F280049C board when launched, assuming the board is connected/powered.

Once the hardware is connected, the FAULT Status and Voltage Monitors match the EVM. If these do not match, then please remove EVM power and recheck the setup.

To spin the motor:

1. Launch the GUI located on dev.ti.com/gallery.
2. Take the DRV8363-Q1 out of sleep mode by toggling nSLEEP to WAKE.
   a. The DRV8363-Q1 reports no faults (Fault LED green on GUI, no red nFAULT LED on the EVM) and VMOTOR/GVDD voltage is reported by the GUI.
3. Set higher VDS trigger level using SPI if loading the motor greater than ~1.5A
   a. Example: Write register 0x1A with 0x2666
4. Set Acceleration Delay (update rate) of Duty cycle and increase PWM Duty Cycle using the slider or text input.
5. The motor now spins.

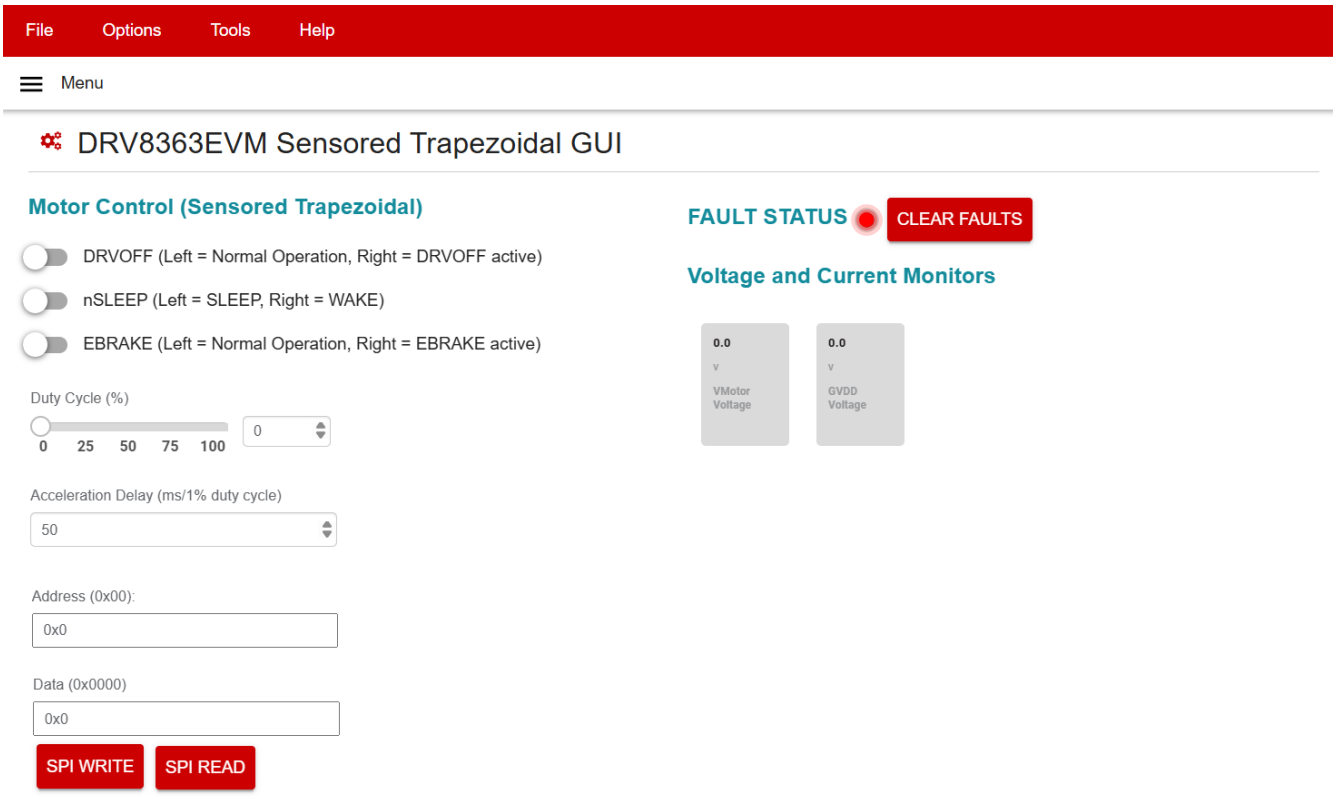


Figure 3-2. DRV8363-Q1EVM GUI

To Read and Write SPI registers:

1. Enter the Address in Hex (0x00) in the **Address (0x00)** field.
2. Enter the data (for write transaction) in the **Data (0x0000)** field. For Read transactions, the data is Don't Care and is ignored.
3. IMPORTANT: Click anywhere on the screen to deselect the text input field before clicking SPI WRITE or SPI READ button.
4. Click **SPI WRITE** or **SPI READ** to send the command to the DRV8363-Q1. (If the text field is not deselected first, then click the **SPI WRITE** or **SPI READ** a second time to execute the transaction

4 Hardware Design Files

4.1 Schematics

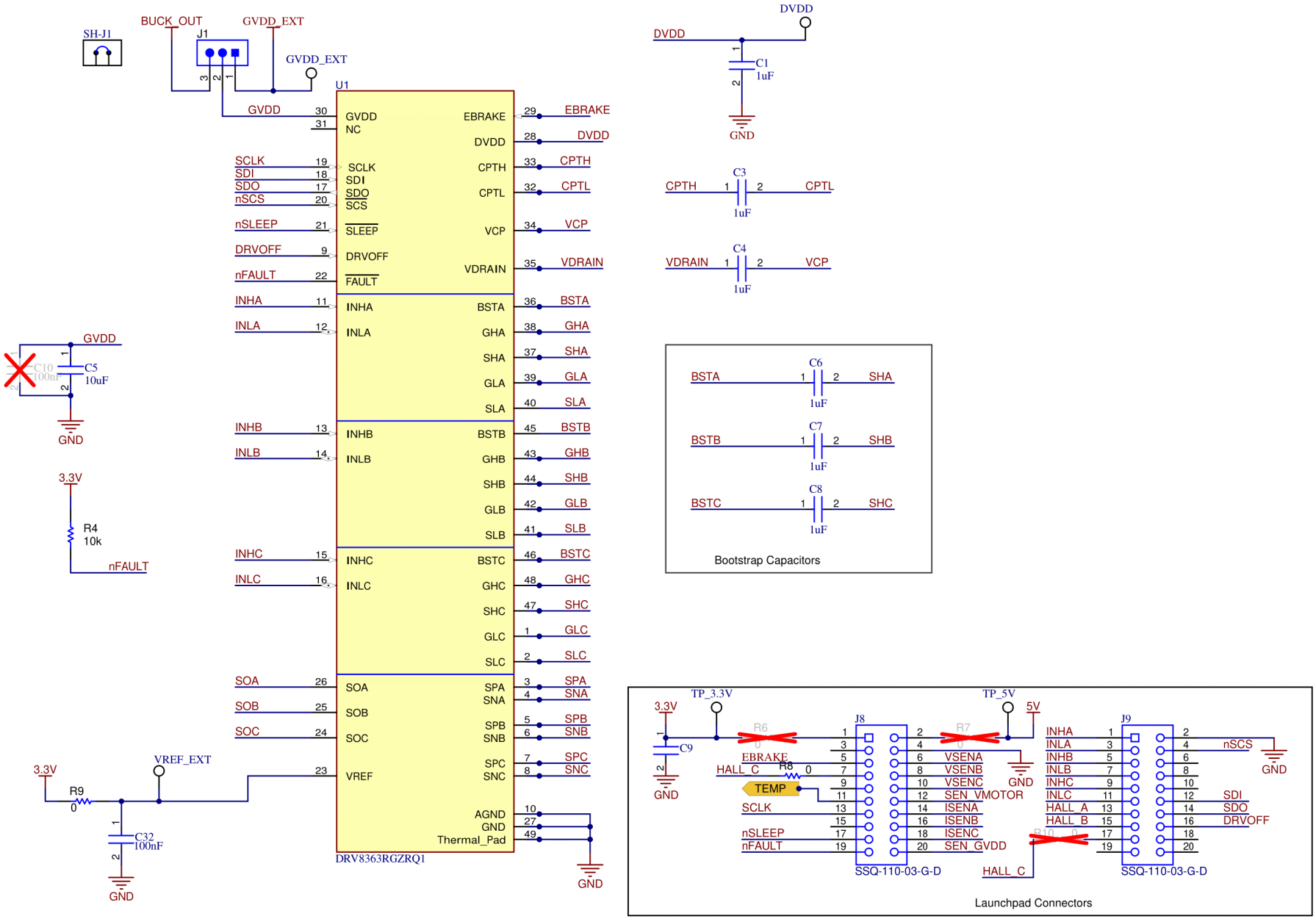


Figure 4-1. Schematic 1

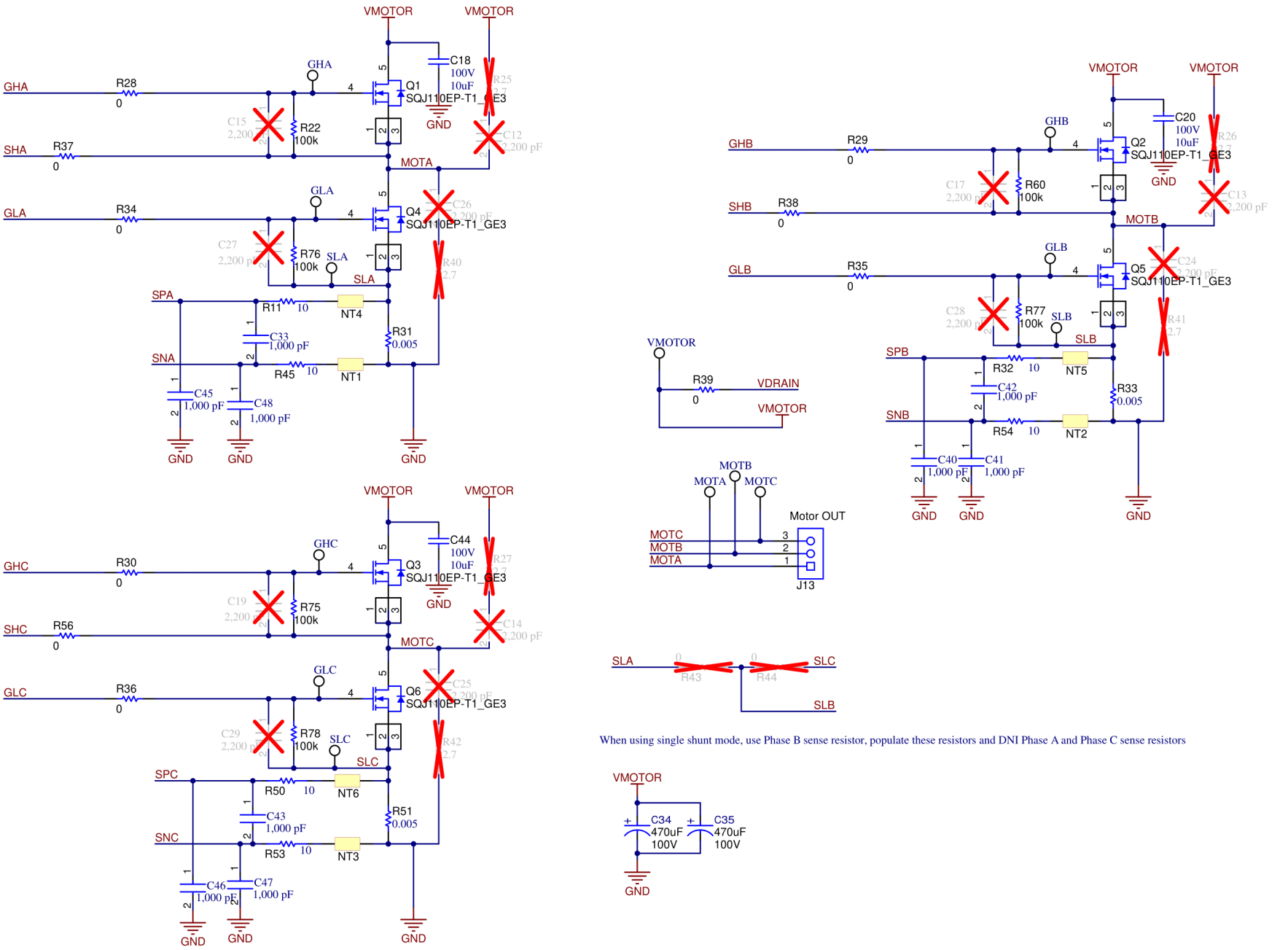


Figure 4-2. Schematic 2

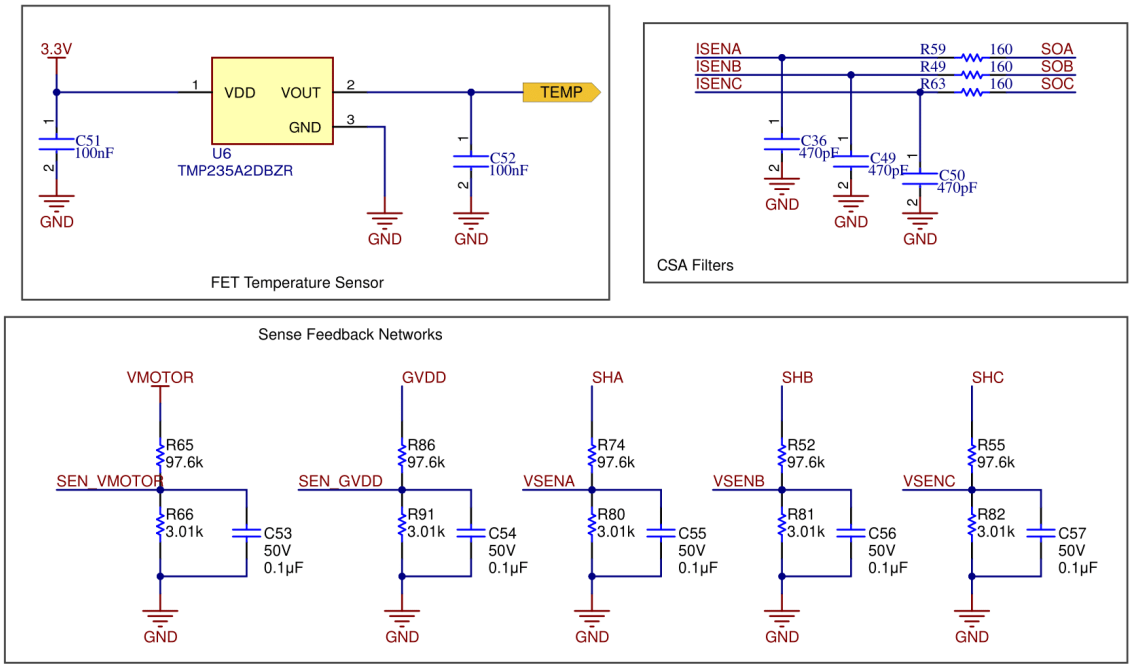


Figure 4-3. Schematic 3

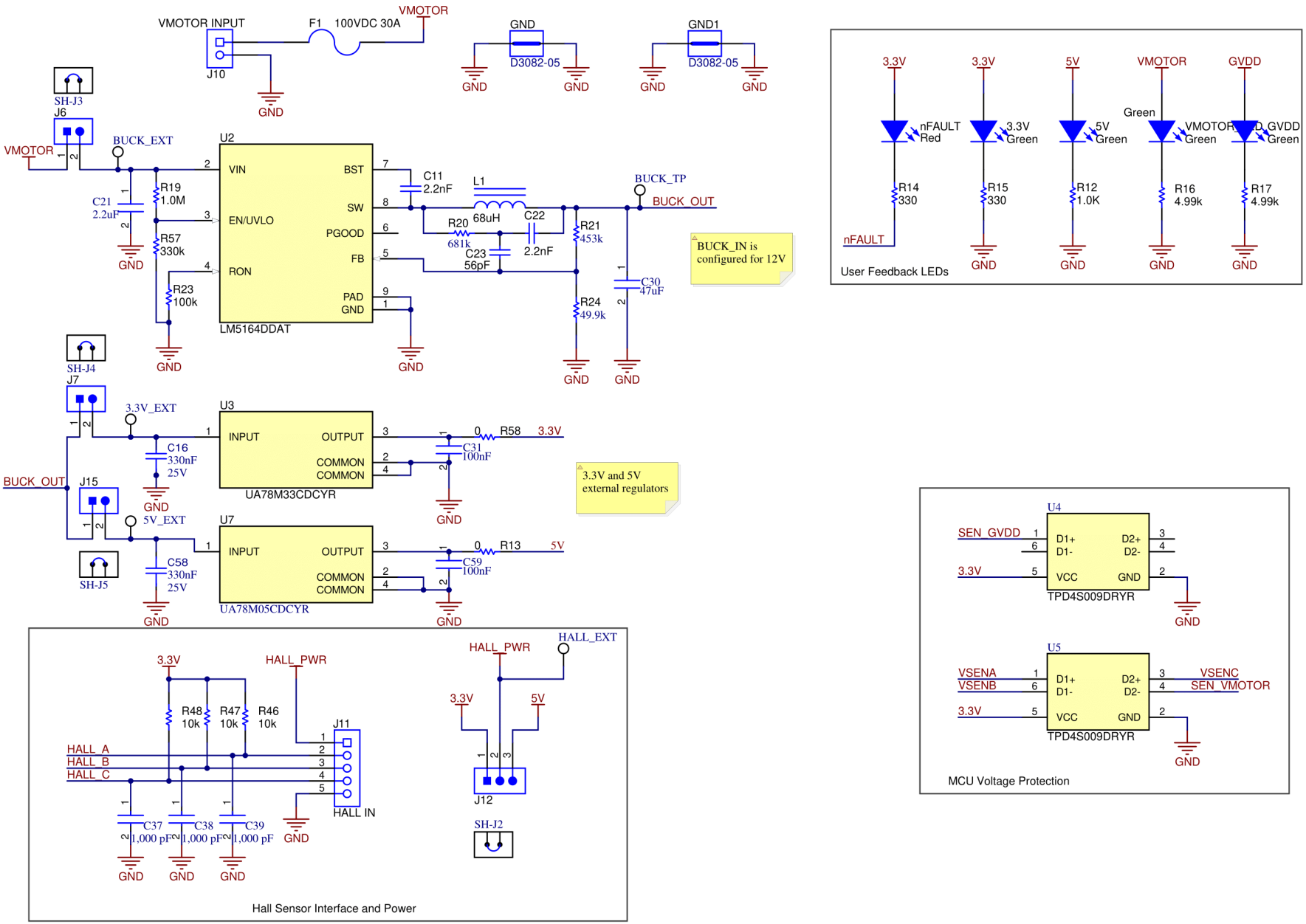


Figure 4-4. Schematic 4

4.2 PCB Layouts

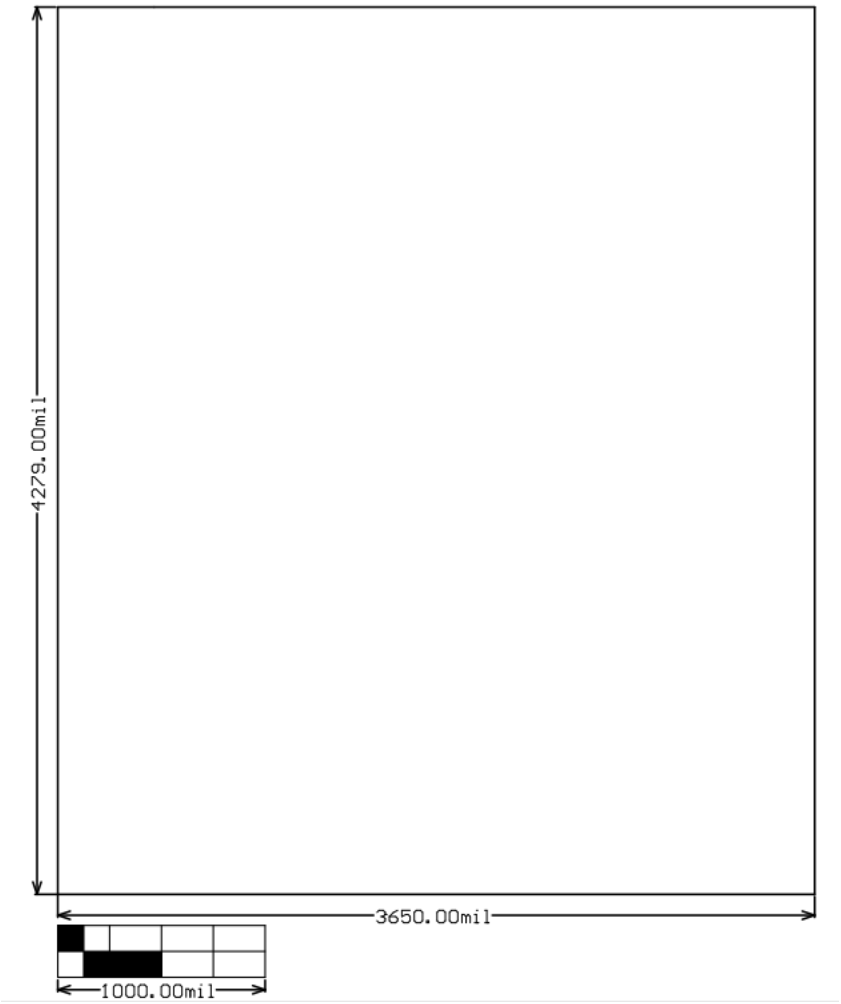


Figure 4-5. EVM Dimensions

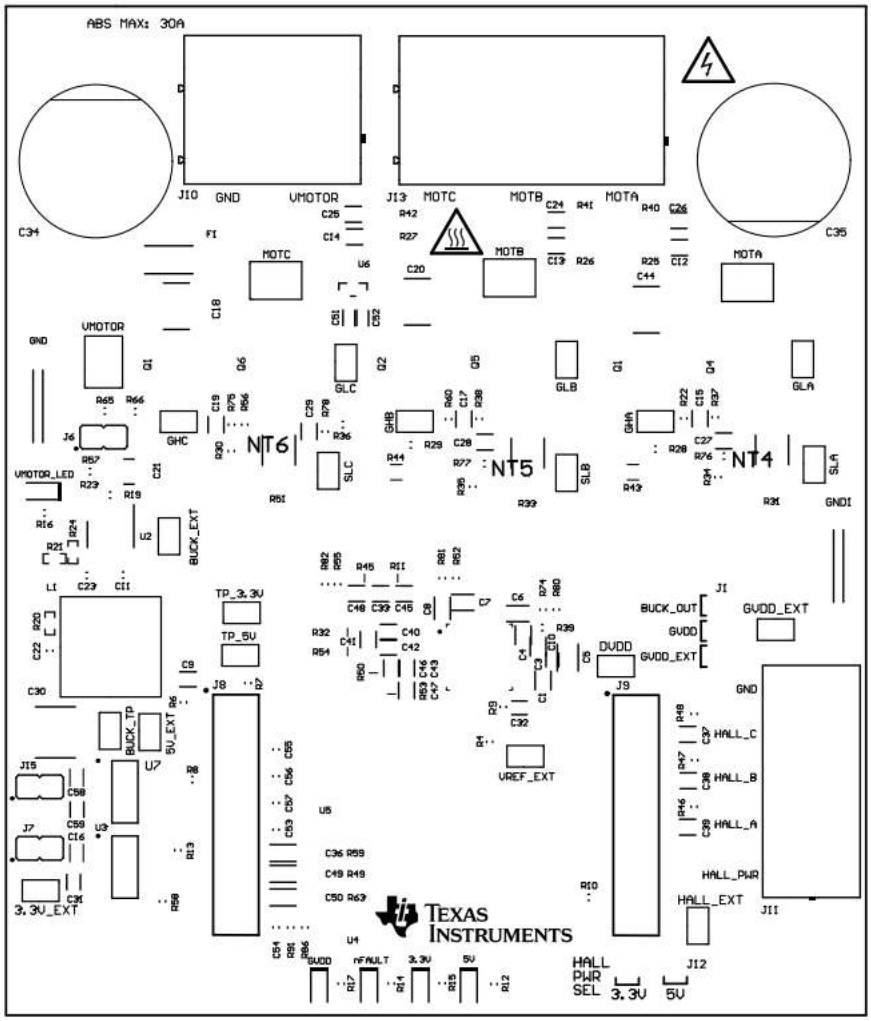


Figure 4-6. EVM Top Overlay

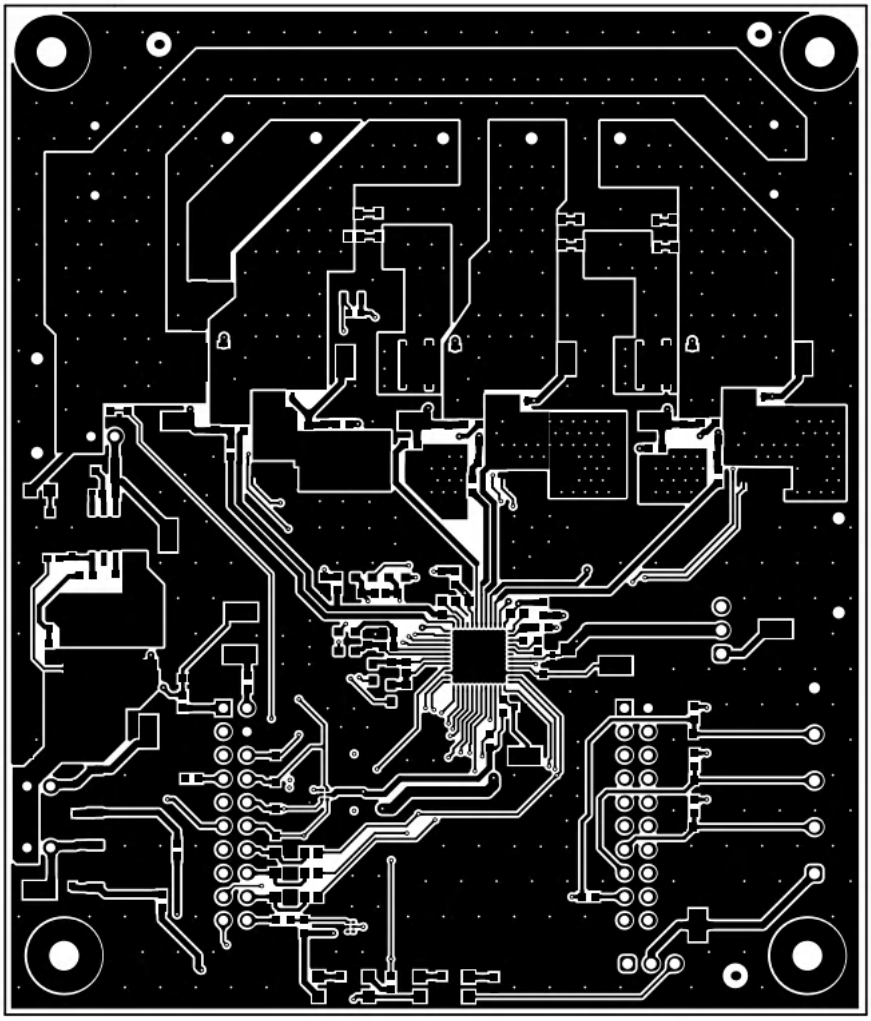


Figure 4-7. EVM Top Layer

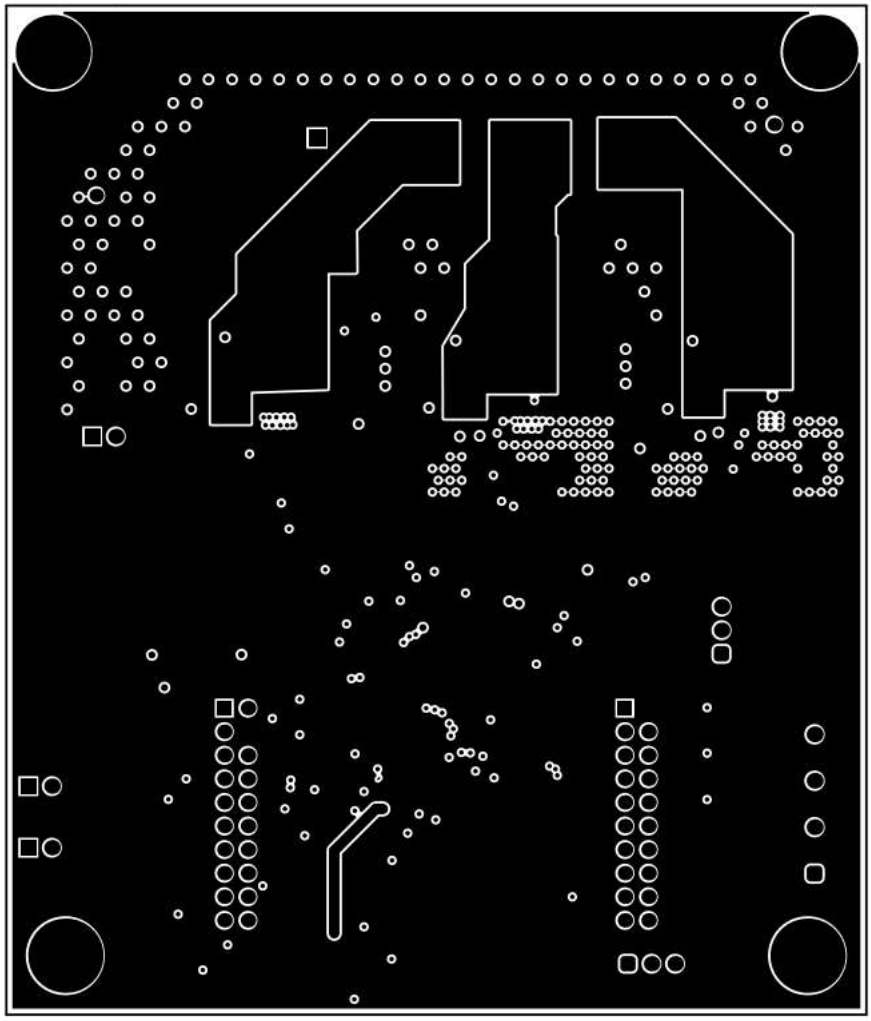


Figure 4-8. EVM Signal Layer 1

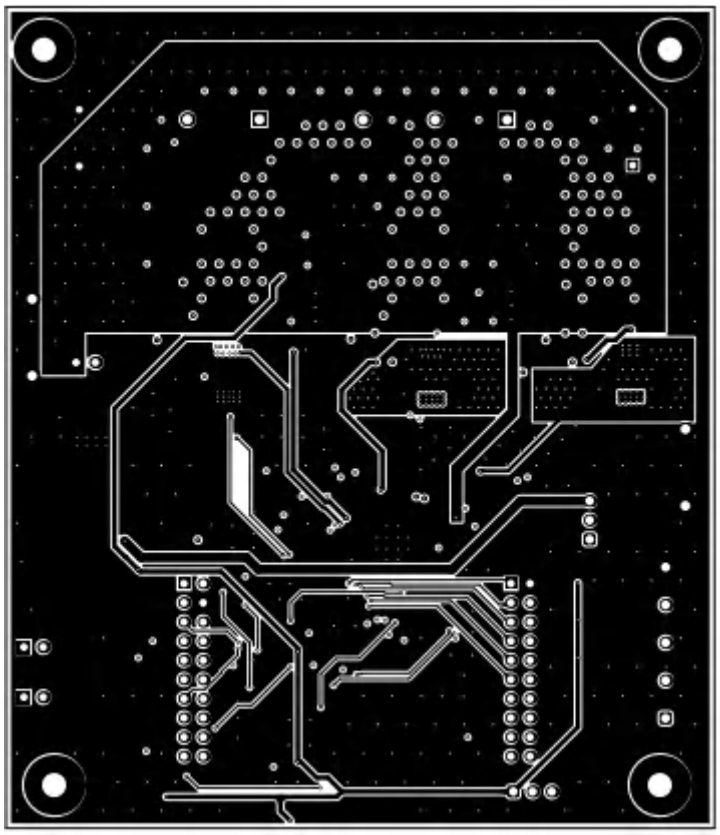


Figure 4-9. EVM Signal Layer 2

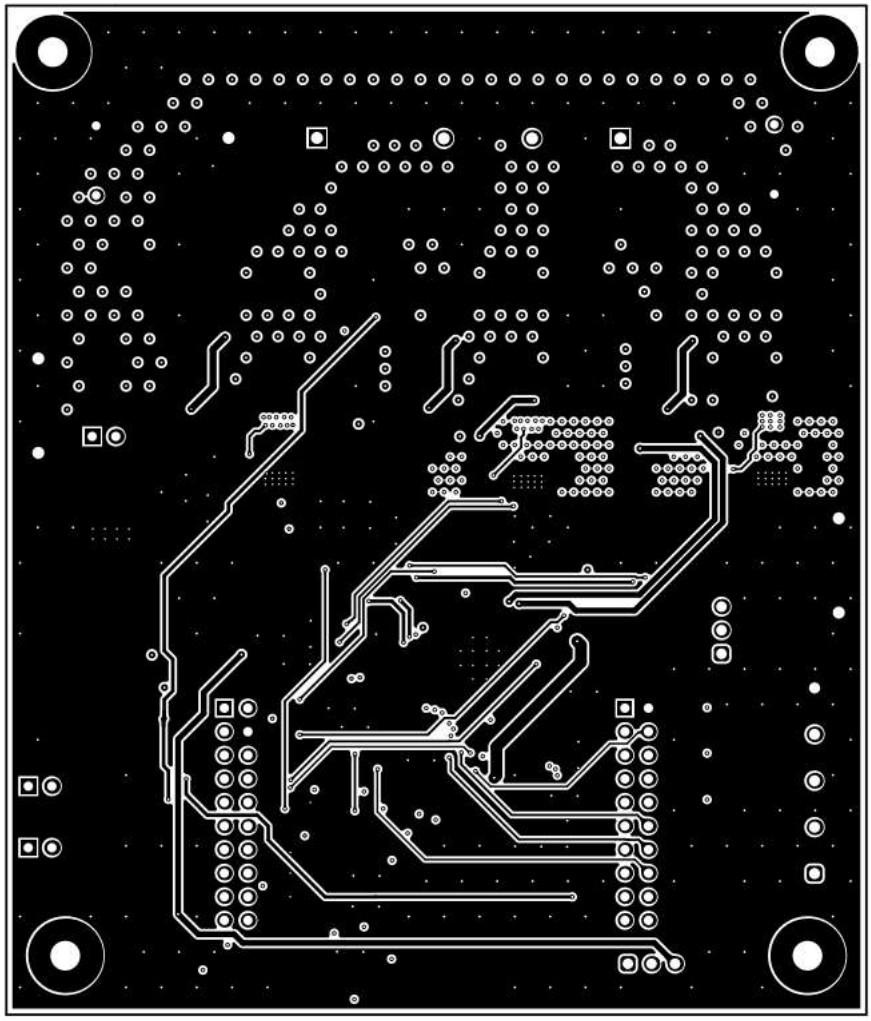


Figure 4-10. EVM Bottom Layer

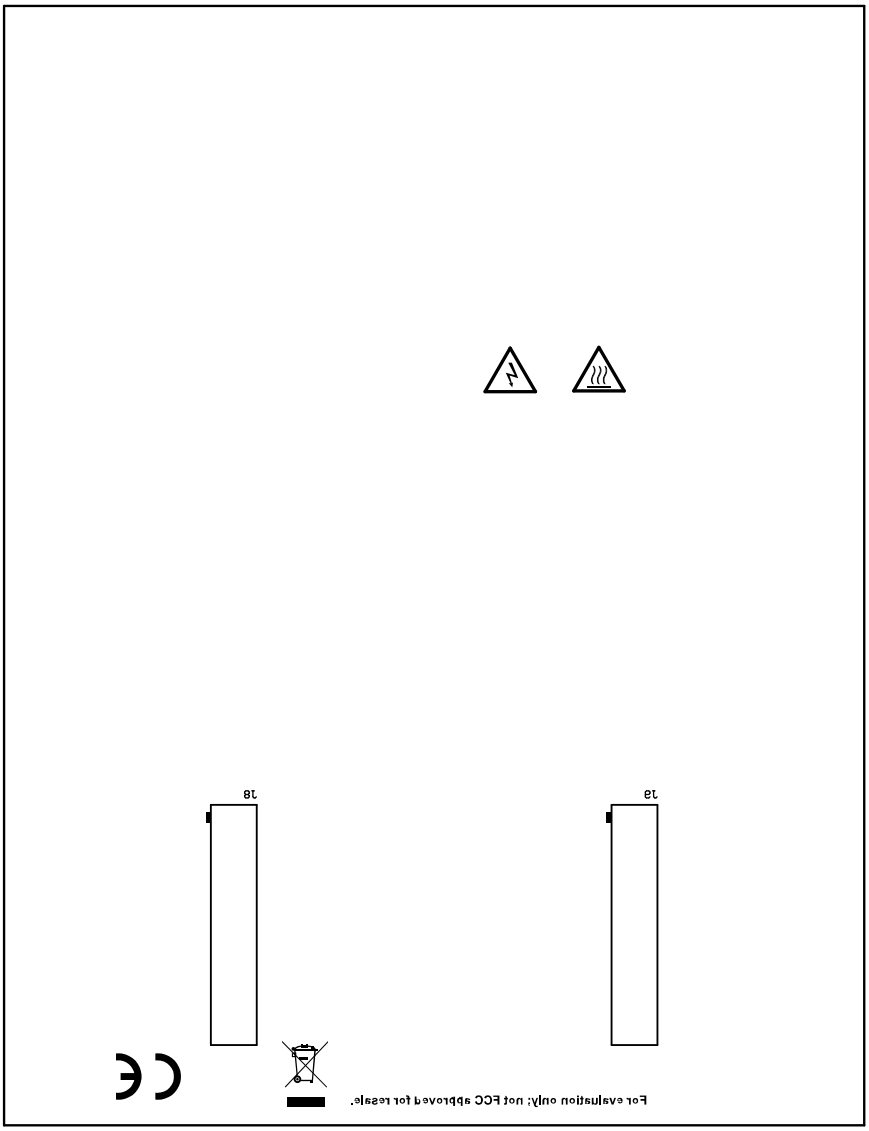


Figure 4-11. EVM Bottom Overlay

4.3 Bill of Materials (BOM)

Bill of Materials

Comment	Description	Designator	Footprint	LibRef	Quantity
	LED, Green, SMD	3.3V, 5V, GVDD	LED_LTST-C171	CMP-0002830-3	3
5015	Test Point, Miniature, SMT	3.3V_EXT, 5V_EXT, BUCK_EXT, BUCK_TP, DVDD, GHA, GHB, GHC, GLA, GLB, GLC, GVDD_EXT, HALL_EXT, SLA, SLB, SLC, TP_3.3V, TP_5V, VREF_EXT	Testpoint_Keystone_Miniature	CMP-0055152-2	19
1uF	Multi-Layer Ceramic Capacitor 1uF 25V X7R ±10% 0603 Paper T/R GRT188R71E105KE13D, Multi-Layer Ceramic Capacitor 1uF 25V X7R ±10% 0603 Paper T/R	C1, C3, C4, C5, C6, C7, C8	FP-GRT188-0_1-e0_2_0_5-IPC_C	CMP-06035-050353-1	7
GRT155R61C225KE13J	Multi-Layer Ceramic Capacitor 2.2uF 16V X5R ±10% 0402 Paper T/R	C9	FP-GRT155-0_2-IPC_A	CMP-06035-019999-1	1
GCM155R71E104KE02D	Ceramic Capacitor for Automotive 100nF ±10% 25VDC X7R 0402 Paper T/R	C10	FP-GCM155-0_05-IPC_B	CMP-06035-054272-1	1
CGA3E2X7R2A222K080AA	CAP, CERM, 2200pF, 100V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	C11, C22	0603L	CMP-0007085-4	2
C0603C222K1RACAUTO	CAP CER 2200PF 100V X7R 0603	C12, C13, C14, C15, C17, C19, C24, C25, C26, C27, C28, C29	FP-C0603C-CF-MFG	CMP-03020-029902-1	12
CGA3E3X7R1E334K080AB	Cap Ceramic 330nF 25V X7R 10% Pad SMD 0603 +125°C Automotive T/R	C16, C58	FP-CGA3E3X7R1E334K080AB_0603-MFG	CMP-0030960-1	2
CGA9N3X7S2A106K230KE	CAP, CERM, 10uF, 100V,+/- 10%, X7S, AEC-Q200 Grade 1, 2220	C18, C20, C44	2220_280L	CMP-0064964-2	3
C1210C225K1RACAUTO	CAP CER 2.2UF 100V X7R 1210 AEC-Q200	C21	FP-C1210C225K1RACAUTO-MFG	CMP-03020-034647-1	1
C0603C560J1RACAUTO	CAP, CERM, 56pF, 100V, +/- 5%, 0603, AEC-Q200	C23	0603L	CMP-0007275-4	1
CGA9N3X7R1E476M230KB	Cap Ceramic 47uF 25V X7R 20% Pad SMD 2220 +125°C Automotive T/R	C30	FP-CGA9P-IPC_A	CMP-08246-000867-1	1

Comment	Description	Designator	Footprint	LibRef	Quantity
GCM155R71C104KA55J	Ceramic Capacitor for Automotive 100nF ±10% 16VDC X7R 0402 Paper T/R	C31, C32, C51, C52, C59	FP-GCM155-0_05-IPC_A	CMP-2008-03712-2	5
C0603C102K4RACAUTO	CAP CER SMD 0603 1000PF 10% X7R	C33, C37, C38, C39, C40, C41, C42, C43, C45, C46, C47, C48	FP-C0603C-CF-MFG	CMP-03020-019178-1	12
ESH477M100AM2AA	470µF 100V Aluminum Electrolytic Capacitors Radial, Can 2000Hrs @ 105°C	C34, C35	FP-ESH477M100AM2AA_RADIAL-MFG	CMP-0120361-1	2
CL10C471JB81PNL	Cap Ceramic 470pF 50V C0G ±5% Pad SMD 0603 +125°C T/R	C36, C49, C50	FP-CL10-IPC_A	CMP-13271-000890-1	3
C0603C104K5RACAUTO	CAP, CERM, 0.1µF, 50V,+/-10%, X7R, AEC-Q200 Grade 1, 0603	C53, C54, C55, C56, C57	0603L	CMP-0079602-1	5
100VDC 30A	Fuse, 30A, 250 VAC, 100VDC, SMD	F1	Fuse_0463	CMP-0077200-3	1
Fiducial	Fiducial mark. There is nothing to buy or mount.	FID1, FID2, FID3	Fiducial10-20	CMP-0077181-1	3
D3082-05	1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	GND	Harwin_D3082-05	CMP-0075110-1	1
1902E		H1, H2, H3, H4	Keystone_1902E	CMP-0003611-1	4
NY PMS 440 0025 PH	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	H5, H6, H7, H8	NY PMS 440 0025 PH	CMP-0003617-1	4
61300311121	Header, 2.54mm, 3x1, Gold, TH	J1, J12	WURTH_61300311121	CMP-0054796-4	2
PBC02SAAN	Header, 100mil, 2x1, Gold, TH	J6, J7, J15	Sullins_PBC02SAAN	CMP-0054566-1	3
SSQ-110-03-G-D	Receptacle, 2.54mm, 10x2, Gold, TH	J8, J9	Samtec_SSQ-110-03-x-D	CMP-0075613-1	2
VMOTOR INPUT	Terminal Block, 9.52mm, 2x1, R/A, TH	J10	Phoenix_1902547	CMP-0055527-1	1
HALL IN	Terminal Block, 5mm, 5x1, R/A, TH	J11	Phoenix_1792892	CMP-0055532-1	1
Motor OUT	Terminal Block, 9.52mm, 3x1, R/A, TH	J13	Phoenix_1904150	CMP-0055528-1	1
SDR1006-680KL	Inductor, Drum Core, Ferrite, 68uH, 1.1A, 0.22ohm, SMD	L1	SDR1006	CMP-0057541-2	1
5016	Test Point, Compact, SMT	MOTA, MOTB, MOTC, VMOTOR	Testpoint_Keystone_Compact	CMP-0055153-2	4
	LED, Red, SMD	nFAULT	LED_LTST-C170_Red	CMP-0002829-3	1

Comment	Description	Designator	Footprint	LibRef	Quantity
SQJ110EP-T1_GE3	MOSFET, N-CH, 100V, 170A, AEC-Q101, PowerPAK_SO-8L	Q1, Q2, Q3, Q4, Q5, Q6	PowerPAK_SO-8L	CMP-0001028-3	6
CRCW060310K0JNEA	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	R4, R46, R47, R48	0603L	CMP-0025701-4	4
RCS06030000Z0EA	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	R6, R7, R8, R9, R10, R28, R29, R30, R34, R35, R36, R37, R38, R39, R56	0603L	CMP-0081973-1	15
CPF-A-0603B10RE	10 Ohms ±0.1% 0.063W, 1/16W Chip Resistor 0603 (1608 Metric) Anti-Sulfur, Automotive AEC-Q200, Moisture Resistant Thin Film	R11, R32, R45, R50, R53, R54	FP-CPF-A-0603B10RE_0603-MFG	CMP-0097543-1	6
CRCW0603330RJNEA	RES, 330, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	R12, R14, R15	0603L	CMP-0025785-4	3
CRCW06030000Z0EA	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	R13, R58	0603L	CMP-0025697-4	2
CRCW06034K99FKEA	RES, 4.99 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	R16, R17	0603L	CMP-0022458-4	2
CRCW06031M00JNEA	RES, 1.0M, 5%, 0.1W, AEC-Q200 Grade 0, 0603	R19	0603L	CMP-0025736-4	1
ERJ-2RKF4992X	RES, 681k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402, RES, 49.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	R20, R24	0402	CMP-0026702-1	2
ERJ-2RKF4533X	RES, 453 k 1%, 0.1 W, AEC-Q200 Grade 0, 0402	R21	0402	CMP-0026702-1	1
CRCW0603100KFKEA	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	R22, R60, R75, R76, R77, R78	0603L	CMP-0021990-4	6
CRCW0402100KFKED	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	R23	0402L	CMP-0025950-3	1
2.7	2.7, 0.125W, 0603, AEC-Q200	R25, R26, R27, R40, R41, R42	RESC1608X55X30LL20T10	CMP-2000-01928-1	6
CRE2512-FZ-R005E-3	RES, 0.005, 1%, 3 W, AEC-Q200 Grade 0, 2512	R31, R33, R51	CRE2512-R5_R9	CMP-0015751-2	3
CRCW12060000Z0EAC	Jumper 0.25W, 1/4W Chip Resistor 1206 (3216 Metric) - Thick Film	R43, R44	FP-CRCW12060000Z0EAC_1206-MFG	CMP-0094724-1	2
160	160, 0.1W, 0603, AEC-Q200 ERJ-3GEYJ161V	R49, R59, R63	RESC1608X55X30ML15T15	CMP-2000-00728-1	3
CRCW060397K6FKEA	RES, 97.6 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	R52, R55, R65, R74, R86	0603L	CMP-0022663-4	5

Comment	Description	Designator	Footprint	LibRef	Quantity
CRCW0603330KJNEA	RES, 330 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	R57	0603L	CMP-0025784-4	1
CRCW06033K01FKEA	RES, 3.01 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	R66, R80, R81, R82, R91	0603L	CMP-0022371-4	5
SNT-100-BK-G	Shunt, 100mil, Gold plated, Black	SH-J1, SH-J2, SH-J3, SH-J4, SH-J5	SNT-100-BK-G	CMP-0003623-3	5
DRV8363RGZRQ1	48V Battery Three-Phase Smart Gate Driver with Accurate Current Sensing and Advanced Monitoring	U1	RGZ0048L-MFG	CMP-0122985-1	1
LM5164DDAT	100V Low IQ Synchronous Buck Regulator, DDA0008E (SOIC-8)	U2	DDA0008E_N	CMP-0080798-1	1
UA78M33CDCYR	500mA, 25V, Linear Voltage Regulators, DCY0004A (SOT-223-4)	U3	DCY0004A_N	CMP-0080825-1	1
TPD4S009DRYR	4-Channel ESD Solution for High-Speed Differential Interface, DRY0006A (USON-6)	U4, U5	DRY0006A	CMP-0043120-3	2
TMP235A2DBZR	Temperature Sensor Analog, Local -40°C ~ 150°C 10mV/°C SOT-23-3	U6	DBZ0003A-MFG	CMP-0088337-2	1
UA78M05CDCYR	500mA, 25V, Linear Voltage Regulators, DCY0004A (SOT-223-4)	U7	DCY0004A_N	CMP-0080822-1	1
Green	LED, Green, SMD	VMOTOR_LED	LED_LTST-C171	CMP-0002830-3	1

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

6 References

See these documents for additional reference:

- Texas Instruments, *DRV8363-Q1 data sheet*
- Texas Instruments, *TMS320F280049C Product Page*
- Texas Instruments, *LAUNCHXL-F280049C Product Page*

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

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.

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
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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2. 実験局の免許を取得後ご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

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7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

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