EVM User's Guide: DRV8844AEVM

DRV8844A Evaluation Module

Description

The DRV8844A evaluation module (EVM) allows for easy evalutation of the DRV8844A motor driver. The EVM has been programmed and configured to work out of the box and begin spinning motors right away. The EVMs showcase a quad 1/2 H-Bridge DC motor driver that can drive up to four soleniods, two brushed-DC motors, and other loads. The DRV8844A also supports the connection of sense resistors on each individual Half-Bridge enabling current sensing at system level for applications such as motor control.

Features

- Onboard 3.3V Buck Converter for digital voltage supply
- Main signal header with removable shunts to disconnect main signals going to the motor driver IC from the MCU
- Onboard switches to select direction and decay mode
- Onboard potentiometers to control speed of motor
- Floating Input Buffers Allow Dual (Bipolar) Supplies (up to ±32.5V)
- Separate Power Grounds for connection of Sense Resistors

1 DRV8844AEVM PCB

Figure 1-1 shows the DRV8844AEVM PCB

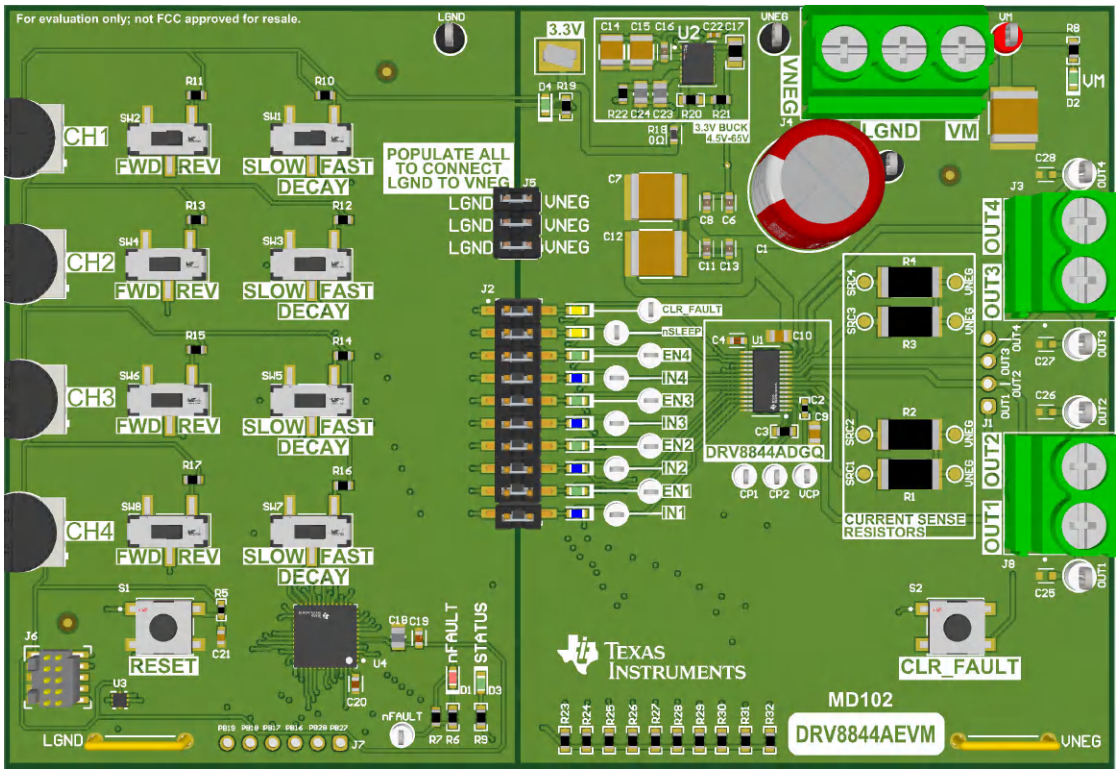

Figure 1-1. DRV8844AEVM Image

2 Evaluation Module Overview

2.1 Introduction

This document is provided as a supplement to the DRV8844A data sheet. The document details the hardware implementation of the DRV8844AEVM customer evaluation module (EVM).

The DRV8844A customer evaluation module (EVM) is a platform revolving around the DRV8844A, a medium voltage, quadruple half-H-bridge driver. This device is designed to drive four independent inductive or resistive loads, such as solenoids, relays, or lamps. The EVM can also drive two brushed DC motors. The EVM houses an MSPM0 microcontroller with a 10-pin connector for flashing firmware. The EVMs are all be preprogramed with firmware. The EVM uses potentiometers and switches to control the speed, direction, and decay mode with onboard LEDs to help visualize which channels are receiving inputs signals. The microcontroller firmware offers the generation of all the control signals often employed to enable or disable the power stage and four PWM's to articulate each power output with a configurable duty cycle.

This user guide details the operation of the EVM, as well as the hardware configurability of the evaluation module.

2.2 Kit Contents

Table 2-1. Kit Content

ITEM	QUANTITY
DRV8844AEVM	1

2.3 Specifications

The DRV8844AEVM is preprogrammed with firmware for evaluation. A 10-pin connected is available onboard if user wants to reflash onboard MCU (MSPM0G1107) with customer firmware. A buck converter supplies 3.3V rail to power MCU from VM supply voltage. The J2 signal header uses removable shunts to pass the signals from the MCU to the motor driver. Remove any of these shunts to easily jump in external control signals to the driver. Provide an external motor power supply to the J4 screw terminal within the operating range of the device. The DRV8844A supports an 8V to 65V operating supply voltage range.

2.4 Device Information

The DRV8844A has a recommended maximum voltage supply of 60V and can supply up to 2.5A peak or 1.75A RMS output current per channel (with proper PCB heatsinking at 24V and 25°C) per H-bridge.

The documents in Table 2-2 provide information regarding Texas Instruments integrated circuits used in the assembly of the EVM. This users guide is available from the TI web site under literature number SLVUD80. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions are available from the TI web site at www.ti.com, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Table 2-2. Related Device Documentation

Description	Data sheet
Motor Driver	DRV8844A
MSPM0 MCU	MSPM0G1107
Buck Converter	TPSM365R3

3 Evaluation Module Operation

The DRV89644 provides four individually controllable 1/2-H-bridge drivers. The devices is used to drive two DC motors, four solenoids, or other loads. The DRV89644EVM allows for users to easily control input signals using four potentiometers designated to control each channel.

When driving loads such as solenoids, the INx input pins directly control the state (high or low) of the OUTx outputs; the ENx input pins enable or disable the OUTx driver.

INx	ENx	OUTx
X	0	Z
0	1	L
1	1	H

For EVM operation, the inputs can be utilized to control the pulse-width modulation (PWM). The adjustability of the potentiometer-controlled inputs can be used to control the speed of brushed-DC motors. Using the direction and decay switches on the EVM, each channel can be configured to drive ia brushed-DC motor in various directions and decay modes.

IN1	EN1	IN2	EN2	FUNCTION
PWM	1	0	1	Forward PWM, slow decay
0	1	PWM	1	Reverse PWM, slow decay
1	PWM	0	PWM	Forward PWM, fast decay
0	PWM	1	PWM	Reverse PWM, fast decay

Note: Using the direction and decay mode switches assumes the load is a brushed-DC motor or solenoid connected in an H-bridge connection (across the corresponding outputs). Input channels 3 & 4 can be used in the same configuration as input channels 1 & 2 above to control brushed-DC motor connected across OUT3-OUT4.

3.1 Input Control

The EVM features four onboard potentiometers that send an analog voltage inputs to the MCU that are converted into proportional PWM signals that go to the corresponding inputs on the DRV8844A.

The onboard switches select the direction and decay mode for each channel. The switch configuration and potentiometer used for speed control depends on the load configuration. The DRV8844A is a four-channel independent half-bridge driver, which means all four channels are individually controllable. Please follow Figure 3-1 for details on how to connect and control different load configurations.

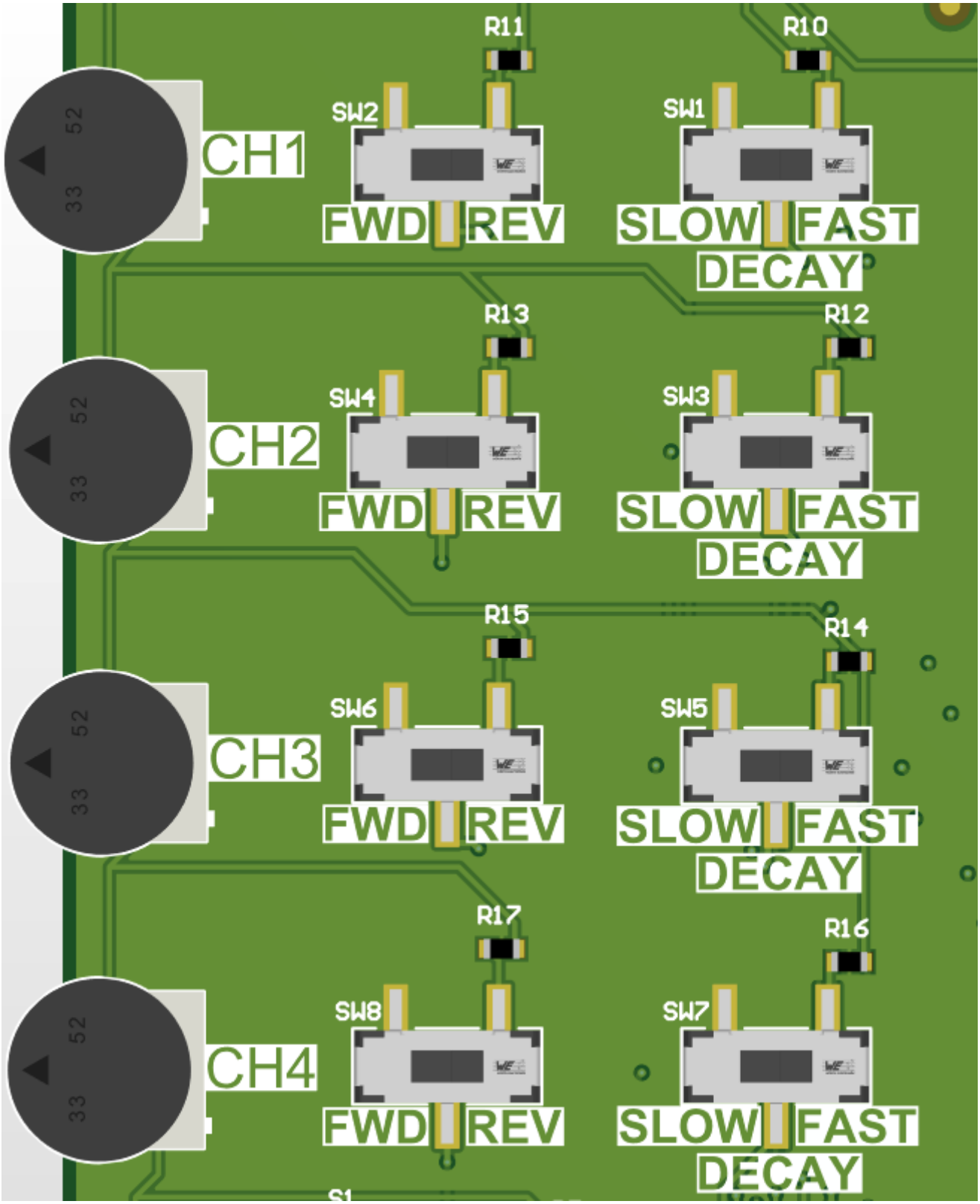

Figure 3-1. Input Potentiometers with Direction and Decay Switches

3.1.1 Brushed-DC Control

When driving a brushed-DC motor with the DRV8844AEVM, the motor terminals either needs to be connected across OUT1 to OUT2 or OUT3 to OUT4. While driving a load connect across OUT1 to OUT2, the direction and decay switches are in the same setting. The speed of the motor can then be controlled with CH1 potentiometer.

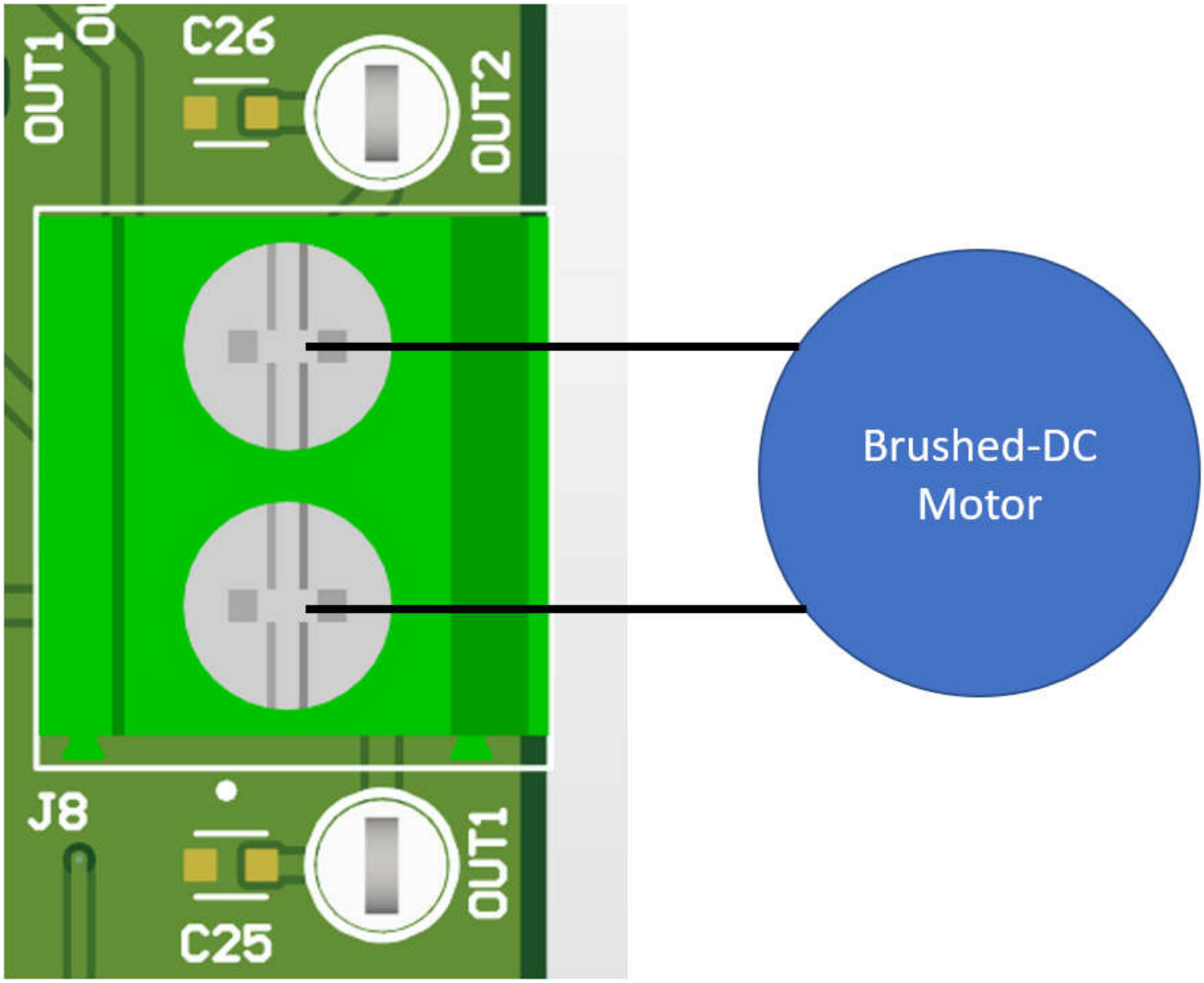

Figure 3-2. Brushed-DC Motor Connection

For example, when Channel 1 & Channel 2 FWD and SLOW DECAY are both selected (switches to left position) while a brushed-DC motor is connected across OUT1 to OUT2, then CH1 potentiometer drives a motor in the forward direction switching between a forward drive and slow decay state. The potentiometer varies the duty cycle of the inputs between 0% to 100%.

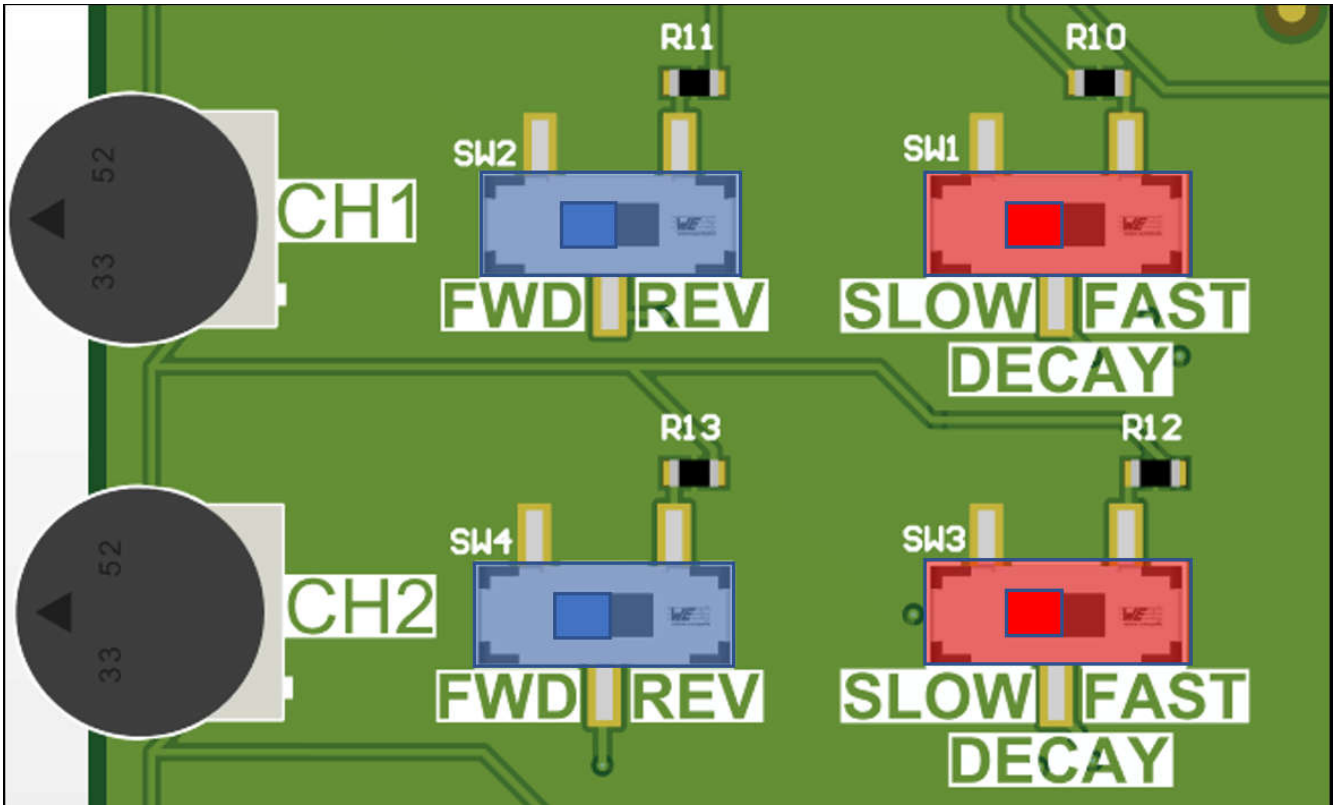

Figure 3-3. Input Switch Configuration for Brushed-DC Motor Connection (Forward-Slow Decay)

3.2 LEDs

While using fast or slow decay to drive a load with PWM control, either the INx or ENx input signals uses PWM. To help visualize and eliminate confusion of which signal is using PWM or which is static GPIO, the DRV89644EVM has LEDs associated with each signal. When configured for slow decay, the PWM signal is applied to the INx pin (blue LED) and for fast decay the PWM signal is applied to the ENx pin (green LED). When LED with PWM dims and brighten depending on the duty cycle position of the potentiometer – OFF corresponding to 0% and full brightness corresponding to 100% duty cycle. CLR_FAULT and nSLEEP signals are displayed with yellow LEDs. ON LED corresponds to 3.3V to pin.

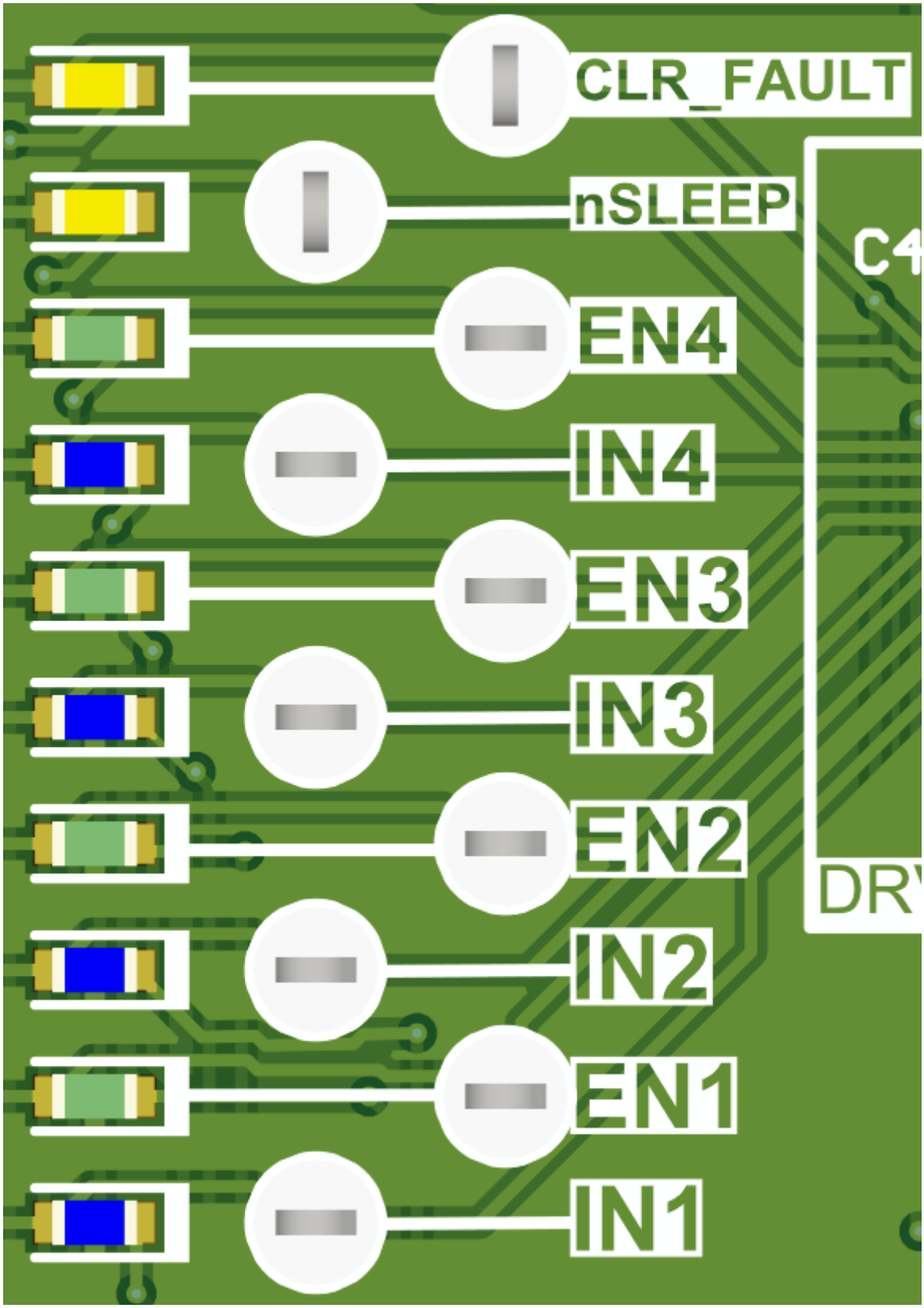

Figure 3-4. Onboard LED Signals

3.3 EVM Description

Please refer to Figure 3-5 and Table 3-1 for the location and description of components, jumpers, and switches on the board. These jumpers are used to maintain proper functionality and the switches allow various direction and decay mode selection.

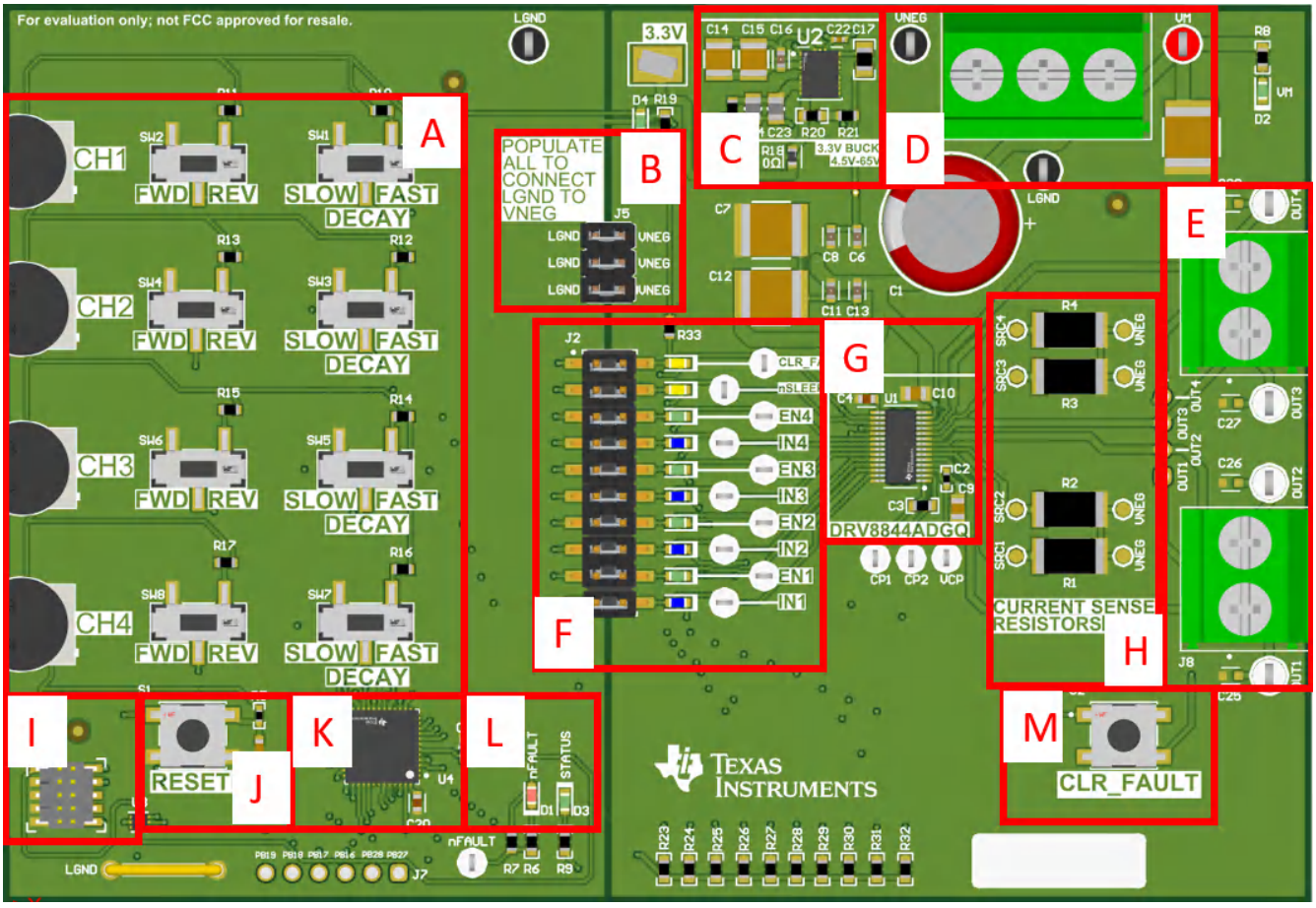

Figure 3-5. DRV8844AEVM Description

Table 3-1. DRV8844AEVM Description

LABEL	DESCRIPTION
A	Input potentiometers with direction and decay switches.
B	All three jumpers on J5 is populated when connected LGND to VNEG.
C	Buck converter to supply 3.3V to board and MCU.
D	Main power supply.
E	Output terminals for load connection.
F	All jumpers on J2 is populated when using the onboard MCU to control the DRV8844A. Colored LEDs are used to help identify which signal is being used as input to the DRV8844A.
G	DRV8844A
H	Independent channel current sense resistors.
I	10-pin programming header. Used to flash new firmware to the MCU.
J	Reset MCU button.
K	MSPM0G1107 MCU.
L	Fault and status LEDs.
M	Clear fault button.

3.4 Power Connections and Ground Planes

This EVM offers access to the Motor Voltage (VM) power rail via a terminal block (J4). A set of test clips in parallel with the terminal block allows monitoring of the input power rail.

Since the DRV8844A can be utilized with either split power supplies (+VM/VNEG) or with a single power supply (+VM), jumpers on J5 allow the LGND and VNEG nodes to be connected together when using the single power-supply implementation.

The VM must be applied according to the parameters recommended in the DRV8844A data sheet.

NOTE: Due to high current capabilities populate all three jumper shunts on J5 from VNEG to LGND.

3.5 Test Points

Test points surrounding the DRV8844A allow access to monitoring all control and output signals.

3.6 Jumpers

The EVM contains one row of ten 2-pin jumpers (J2), which are removable to isolate the microcontroller resource as a controlling source to the power stage. If a particular signal is interfaced externally, attach the controlling signal to either the test stakes or the driver side of J2.

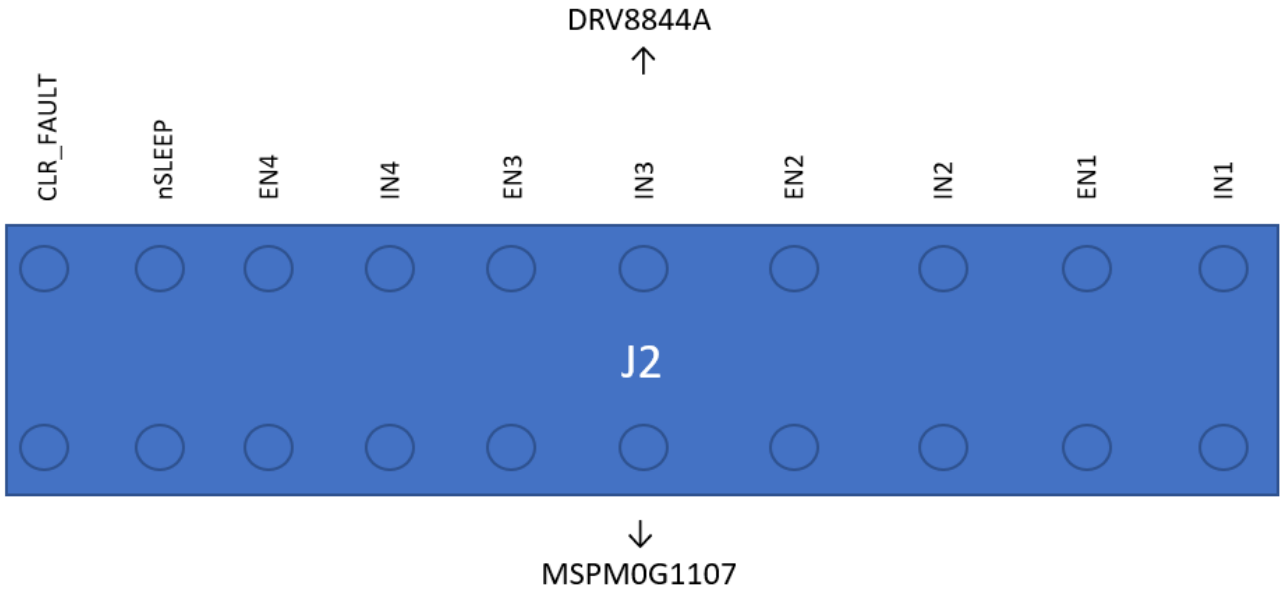

Figure 3-6. DRV8844A Jumpers

3.7 Power Outputs

There are two ways of connecting the desired load into the EVM: four pin header (J1) or four position terminal block (J2).

4 Hardware Design Files

The schematics, bill of materials (BOM), and PCB layout for each EVM can be downloaded on the product folder page under the Design Files section.

4.1 Schematics

DRV8844A Schematic below shows the schematics for DRV8844AEVM. The schematic files can be downloaded under the Hardware Design Files from the EVM tool folder under the Design Files section on the EVM product page.

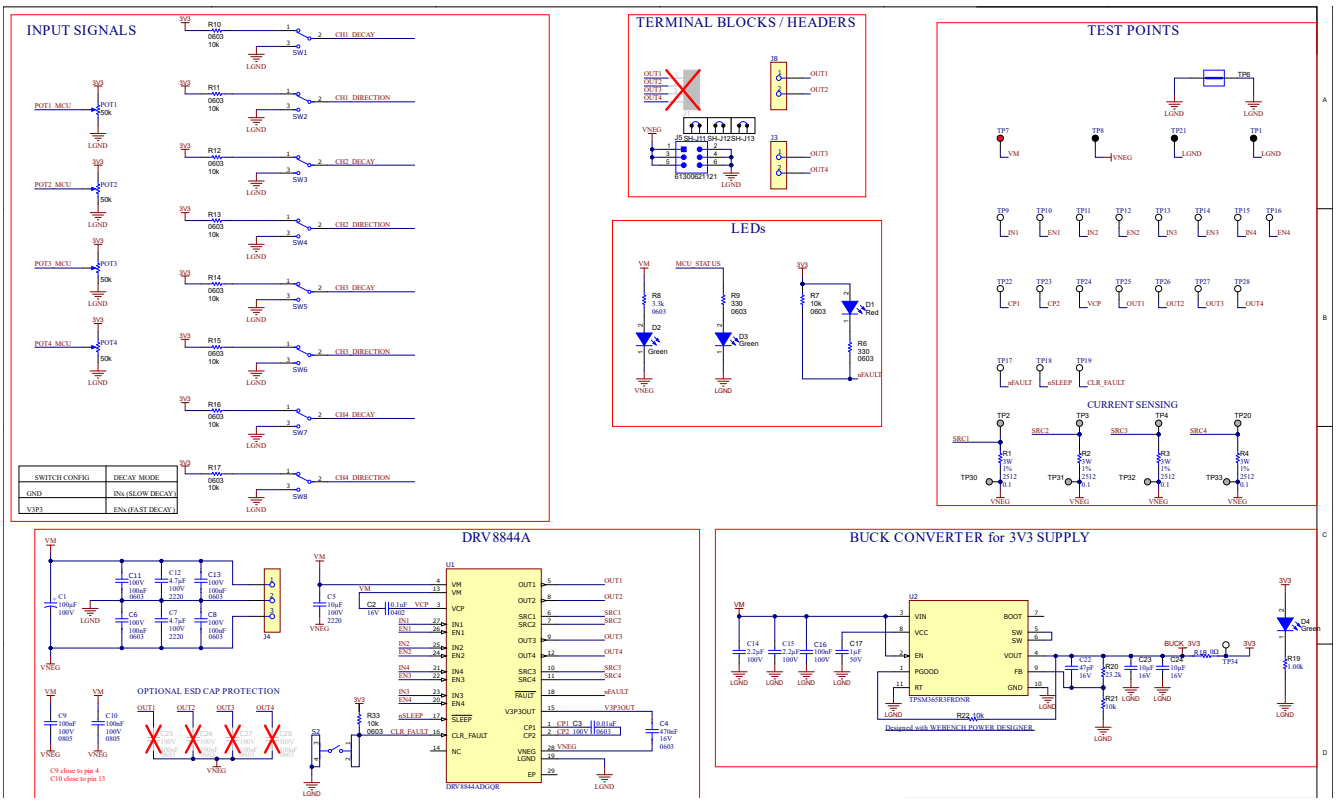

Figure 4-1. DRV8844A Schematic

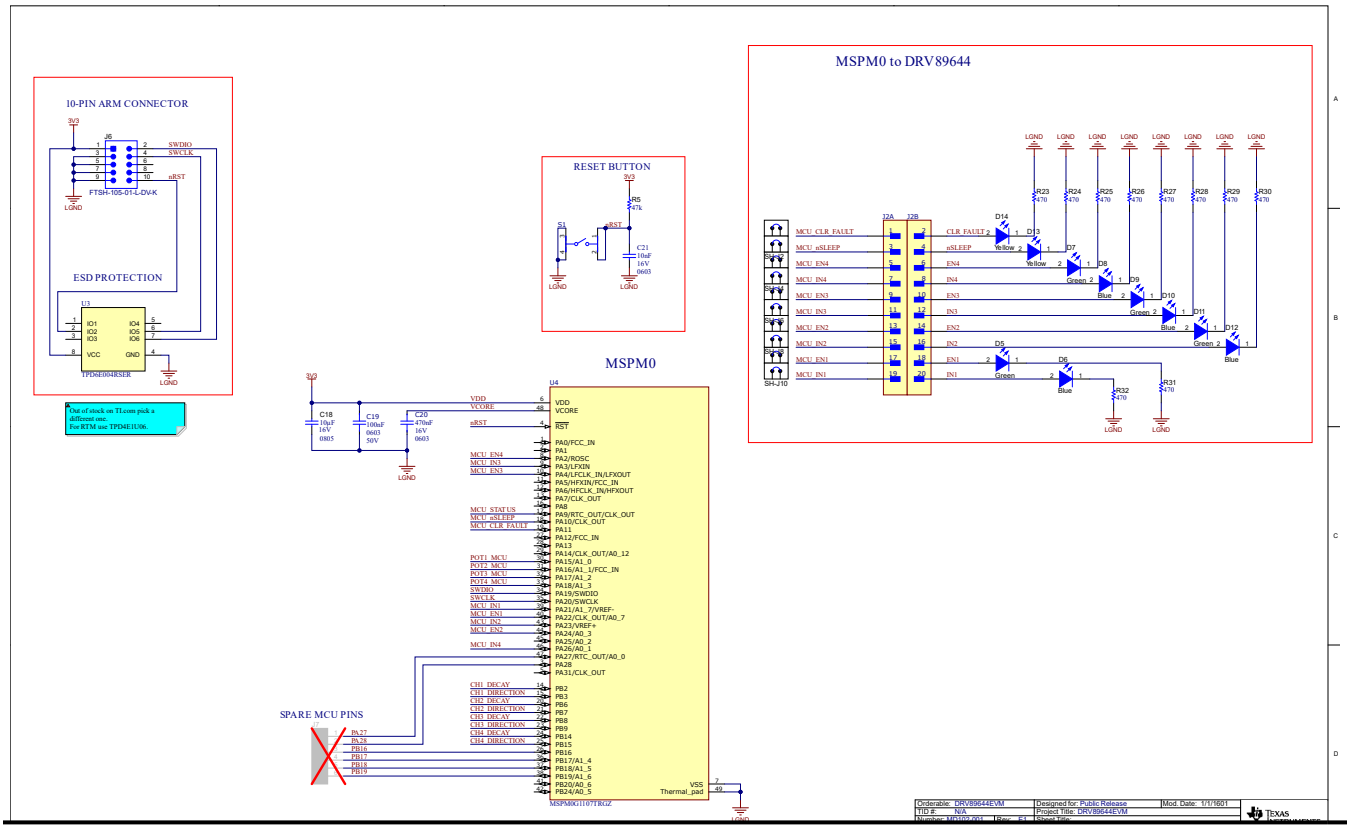

Figure 4-2. MCU Schematic

4.2 PCB Layouts

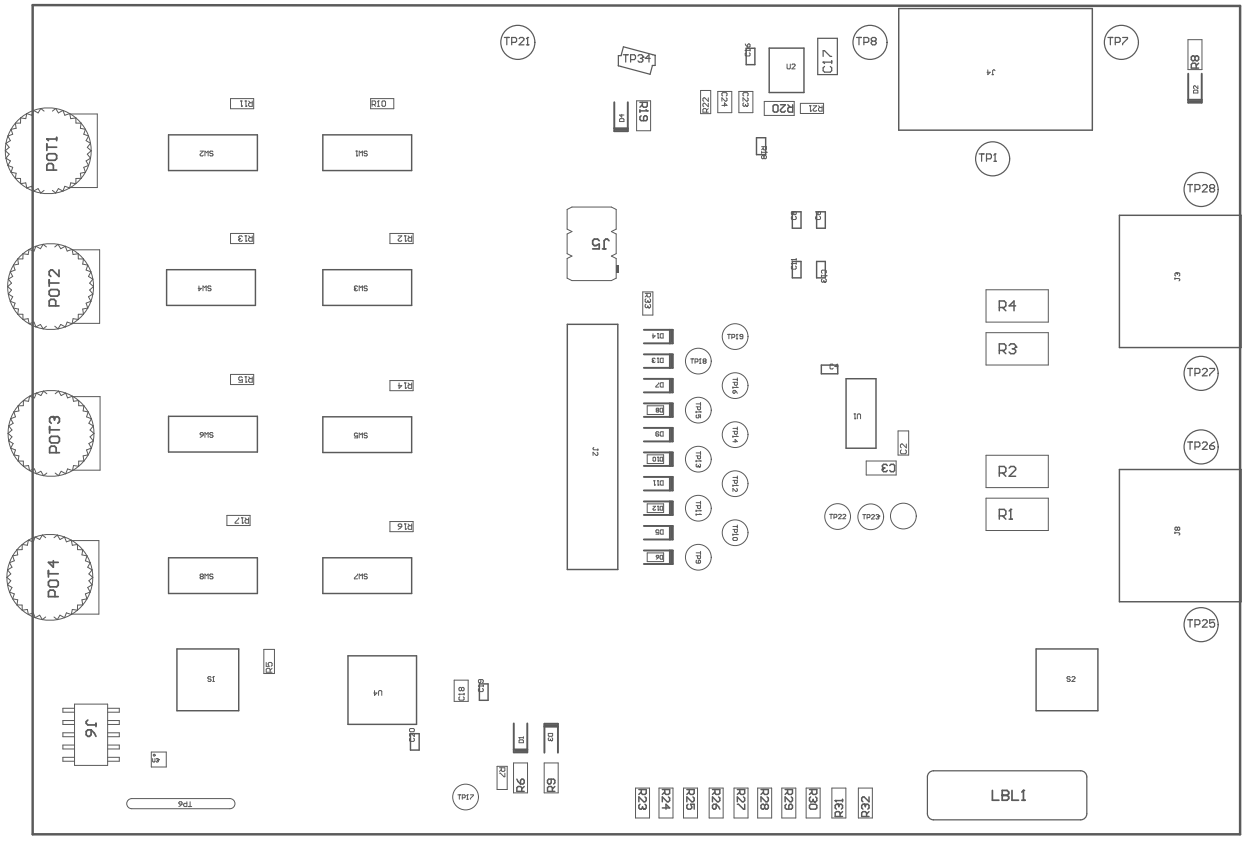

Figure 4-3. DRV8844AEVM Assembly Drawings

4.3 Bill of Materials

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
!PCB	1		Printed Circuit Board		MD102-001	Any
C1	1	100µF	WCAP-ATET Aluminum Electrolytic Capacitor, Radial, THT, D13 x H25mm, 100µF, 100V	Through hole	860130878011	Wurth Elektronik
C2	1	0.1uF	CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0402	0402	885012205037	Wurth Elektronik
C3	1	0.01uF	CAP, CERM, 0.01µF, 100V,+/-10%, X7R, 0603	0603	885012206114	Wurth Elektronik

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
C4, C20	2	470nF	0.47µF ±10% 16V Ceramic Capacitor X7R 0603 (1608 Metric)	0603	885012206050	Wurth Electronics
C5	1	10µF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 2220, X7R Class II, 10µF, 100VDC	2220	885012214001	Wurth Elektronik
C6, C8, C11, C13, C16	5	100nF	0.1µF ±10% 100V Ceramic Capacitor X7R 0603 (1608 Metric)	0603	885012206120	Wurth Electronics
C7, C12	2	4.7µF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 2220, X7R Class II, 4.7µF, 100VDC	2220	885012214003	Wurth Elektronik
C9, C10	2	100nF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0805, X7R, 100nF, 100VDC	0805	885012207128	Wurth Elektronik
C14, C15	2	2.2µF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 1210, X7R, 2.2µF, 100VDC	1210	885012209071	Wurth Elektronik
C17	1	1uF	CAP, CERM, 1uF, 50V, +/- 10%, X7R, 0805	0805	C2012X7R1H105K125AB	TDK
C18, C23, C24	3	10uF	CAP, CERM, 10µF, 16V,+/- 20%, X5R, 0805	0805	885012107014	Wurth Elektronik
C19	1	100nF	0.1µF ±10% 50V Ceramic Capacitor X7R 0603 (1608 Metric)	0603	885012206095	Wurth

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
C21	1		WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X7R, 10nF, 16VDC	0603	885012206040	Wurth Elektronik
C22	1	47pF	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0402, NP0, 47pF, 16VDC	0402	885012005029	Wurth Elektronik
D1	1	Red	LED, Red, SMD	LED_0603	150060RS75000	Wurth Elektronik
D2, D3, D4, D5, D7, D9, D11	7	Green	LED, Green, SMD	LED_0603	150060VS75000	Wurth Elektronik
D6, D8, D10, D12	4	Blue	LED, Blue, SMD	LED_0603	150060BS75000	Wurth Elektronik
D13, D14	2	Yellow	LED, Yellow, SMD	LED_0603	150060YS75000	Wurth Elektronik
H9, H10, H11, H12	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)	3M
J2	1		Connector Header Surface Mount 20 position 0.100" (2.54mm)	HDR20	61032021121	Wurth
J3, J8	2		2 Position Wire to Board Terminal Block Horizontal with Board 0.250" (6.35mm) Through Hole	CONN_TERM_BLOCK2	691250610002	Wurth Electronics
J4	1		3 Position Wire to Board Terminal Block Horizontal with Board 0.250" (6.35mm) Through Hole	HDR3	691250610003	Wurth
J5	1		Header, 2.54mm, 3x2, Gold, TH	Header, 2.54mm, 3x2, TH	61300621121	Wurth Elektronik
J6	1		Header(Shrouded), 1.27mm, 5x2, Gold, SMT	Header(Shrouded), 1.27mm, 5x2, SMT	FTSH-105-01-L-DV-K	Samtec
POT1, POT2, POT3, POT4	4	50k	Trimming Potentiometer, 50K, 0.5W, TH	9.53x8.89mm	3352T-1-503LF	Bourns
R1, R2, R3, R4	4	0.1	RES, 0.1, 1%, 3 W, 2512	2512	CRA2512-FZ-R100ELF	Bourns

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R5	1	47k	RES, 47 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040247K0JNED	Vishay-Dale
R6, R9	2	330	RES, 330, 5%, 0.1 W, 0603	0603	RC0603JR-07330RL	Yageo
R7, R10, R11, R12, R13, R14, R15, R16, R17, R21, R22	11	10k	RES, 10 k, 5%, 0.1 W, 0603	0603	RC0603JR-0710KL	Yageo
R8	1	3.3k	RES, 3.3 k, 5%, 0.1 W, 0603	0603	RC0603JR-073K3L	Yageo
R18	1	0Ω	0 Ohms Jumper 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	0603	ERJ-3GEY0R00V	Panasonic
R19	1	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	0603	RC0603FR-071KL	Yageo
R20	1	23.2k	RES, 23.2 k, 1%, 0.1 W, 0603	0603	RC0603FR-0723K2L	Yageo
R23, R24, R25, R26, R27, R28, R29, R30, R31, R32	10	470	RES, 470, 5%, 0.1 W, 0603	0603	RC0603JR-07470RL	Yageo
S1, S2	2		Tactile Switch SPST-NO Top Actuated Surface Mount	SMT_SW_6MM2_6MM2	430481025816	Wurth Electronics
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13	13		Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black	60900213421	Wurth Elektronik
SW1, SW2, SW3, SW4, SW5, SW6, SW7, SW8	8		WS-SLSV SMT Mini Slide Switch Same Side Connection, 9.0 x 3.5mm	SMT_SW_9MM0_3MM5	450406020024	Wurth
TP1, TP8, TP21	3		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone Electronics

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
TP5, TP6	2		1mm Uninsulated Shorting Plug, 10.16mm spacing, TH	Shorting Plug, 10.16mm spacing, TH	D3082-05	Harwin
TP7	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone Electronics
TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP22, TP23, TP24	14		Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone Electronics
TP25, TP26, TP27, TP28	4		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone Electronics
TP34	1		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone Electronics
U1	1		DRV8844ADGQR	VSSOP28	DRV8844ADGQ	Texas Instruments
U2	1		3V to 65V Input, 1V to 13V Output, 600mA Synchronous Buck Converter Power Module in a HotRod QFN Package	QFN-FCMOD11	TPSM365R3FRDNR	Texas Instruments
U3	1		Low-Capacitance + / - 15kV ESD Protection Array for High-Speed Data Interfaces, 6 Channels, -40 to +85 degC, 8-pin UQFN (RSE), Green (RoHS & no Sb/Br)	RSE0008A	TPD6E004RSER	Texas Instruments
U4	1		Mixed-Signal Microcontrollers	VQFN48	MSPM0G1107TRGZ	Texas Instruments
C25, C26, C27, C28	0	100nF	0.1µF ±10% 100V Ceramic Capacitor X7R 0603 (1608 Metric)	0603	885012206120	Wurth Electronics
J1	0		Header, 2.54mm, 4x1, Gold, TH	Header, 2.54mm, 4x1, TH	61300411121	Wurth Elektronik
J7	0		Header, 2.54mm, 6x1, Gold, TH	Header, 2.54mm, 6x1, TH	61300611121	Wurth Elektronik

5 Trademarks

All trademarks are the property of their respective owners.

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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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

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.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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