Using the UCC27532EVM-538

User's Guide

Literature Number: SLUUAP9A
August - Revised September 2013

WARNING

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and the safety of those working around you. Contact TI's Product Information Center http://support/ti./com for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and/or burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise, and knowledge of electrical safety risks in development and application of high-voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments. If you are not suitably qualified, you should immediately stop from further use of the HV EVM.

1. **Work Area Safety:**
   (a) Keep work area clean and orderly.
   (b) Qualified observer(s) must be present anytime circuits are energized.
   (c) Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
   (d) All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50 V_{RMS}/75 VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
   (e) Use a stable and non-conductive work surface.
   (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
2. **Electrical Safety:**
   (a) De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM power has been safely de-energized.
   (b) With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
   (c) Once EVM readiness is complete, energize the EVM as intended.

   WARNING: while the EVM is energized, never touch the EVM or its electrical circuits as they could be at high voltages capable of causing electrical shock hazard.
3. **Personal Safety:**
   (a) Wear personal protective equipment e.g. latex gloves and/or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.
4. **Limitation for Safe Use:**
   (a) EVMs are not to be used as all or part of a production unit.

Using the UCC27532EVM-538

1 Introduction

The UCC27532EVM-538 is a fully isolated gate driver daughter card that provides a test platform for a quick and easy startup of the UCC27532DBV driver device. Measuring 1.475 inch x 1.320 inch and powered by two external supplies (10 V and 12 V), and featuring all necessary input and outputs on standard 6-pin and 3-pin, 100-mil connectors, this EVM can be directly plugged into a power stage board and used for the evaluation as an isolated driver suitable for driving power converter applications. The EVM delivers a 20 V to -5 V output differential gate drive which can be used to drive SiC power MOSFETs and Si IGBTs with a negative turn-off voltage. This EVM provides drive signals across an isolated boundary, enabling it to drive low or high-side switches. This EVM is intended as an evaluation tool for the UCC27532 and is not intended for use as an end product.

2 Description

The UCC27532EVM-538 is intended to be used as an evaluation tool for the UCC27532DBV driver, providing all of the necessary hardware. All input and outputs of the EVM can be accessed through jumpers on the bottom side of the EVM, providing the ability to plug directly into a power stage. The EVM needs two DC power supply inputs (one 12 V and one 10 V) and a 0-V to 5-V input PWM signal to deliver a typical output differential of 25 V (-5 V to 20 V) between the GATE and SOURCE pins of the EVM. The EVM employs on-board isolators and isolated bias supplies to deliver a compact, isolated gate driver module solution that can be interfaced with power stages to quickly evaluate the operation of UCC27532 device.

CAUTION

High Voltage Potential See Section 5.1.

2.1 Features

- SiC MOSFET and IGBT Driver Daughter Card with Input and Output Isolation
- -5-V Gate to Source Voltage (VGE)
- Isolated Input for Device use as High-Side or Low-Side Driver
- Small Design with Standard Jumpers
  (on bottom side for easy plug-in functionality)

2.2 Typical Applications

- Gate Drive for IGBTs and emerging power devices such as SiC MOSFETs
- Switch-Mode Power Supplies, DC-to-DC Converters
- Solar Inverters, Motor Control, UPS
- HEV and EV Chargers
- Home Appliances
- Renewable Energy Power Conversion

2.3 Typical Application Diagrams

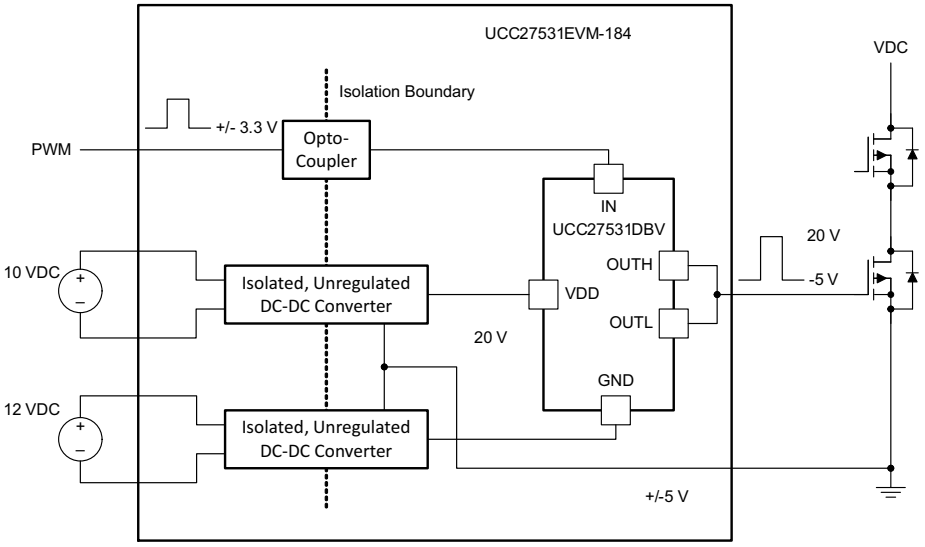

Figure 1. Low-Side Driver Configuration

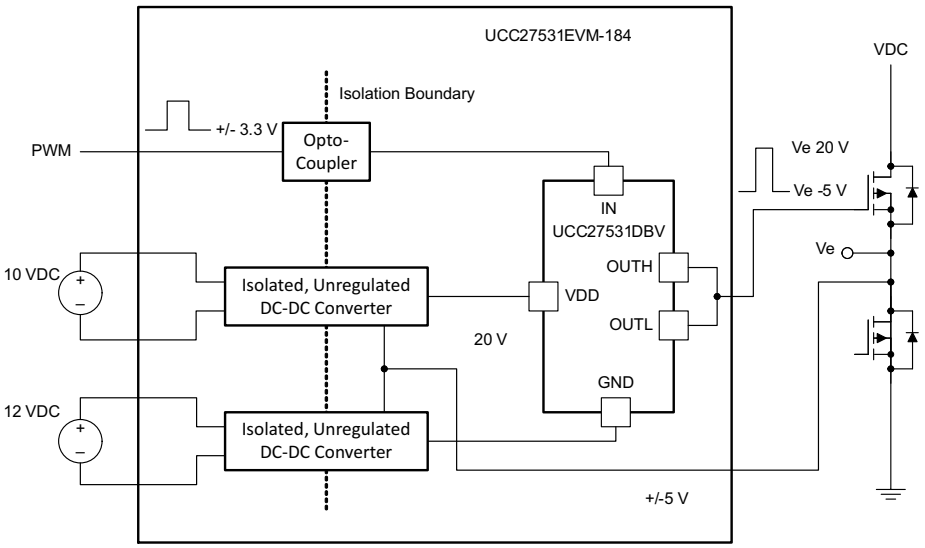

Figure 2. High-Side Driver Configuration

CAUTION

High voltage potential.

The high-side application can have high voltages on the output side of the isolation barrier (depending upon the value of VDC). See Section 5.1.

2.4 UCC27532EVM-538 Device Function

The UCC27532EVM-538 is powered by two external supplies:

1. V_{CC_HIGH} (10 V)
2. V_{CC_LOW} (12 V)

V_{CC_HIGH} is fed to the isolated, non-regulated DC-to-DC converter RP1212D (X2), creating 20 V relative to SOURCE. The V_{CC_LOW} is fed to another isolated, non-regulated DC-to-DC converter RP1205S (X1) which creates -5 V relative to SOURCE. The total differential of 25 V powers the UCC27352DBV device (between VDD and GND) allowing for the GATE output to swing from -5 V to 20 V relative to the SOURCE pin of the EVM.

2.4.1 PWM Input

UCC27532 features non-inverting input to output logic. The PWM input is fed to the opto-coupler, isolating the input signal for use with the UCC27532DBV through the INPUT_HIGH pin. Pulling INPUT_HIGH high turns on the output of the UCC27532 (GATE pin), and pulling INPUT_HIGH low turns off the output.

2.4.2 Floating Signal Nodes

The UCC27532DBV input pin (IN, pin #2) has an internal pull-down resistor. Leaving this node floating pulls IN low and therefore the output GATE to low. The Enable pin (EN, pin #1) is internally pulled up to VDD, the UCC27532 output is enabled by default. In the EVM, UCC27532 Enable pin is in floating condition.

3 Electrical Performance Specifications

Table 1. UC27532EVM-538 Performance Specifications

PARAMETER		CONDITION	MIN	TYP	MAX	UNITS
Input Characteristics						
V_{CC_HIGH}	10 V	V_{IN1}	8.8	10	13.2	V
V_{CC_LOW}	12 V	V_{IN2}	8.8	12	13.2	
INPUT_HIGH	Input PWM signal	High	2.75	3.3	5.5	
		Low	V_{SS}	V_{SS}	2.0	
Output Characteristics DC						
$G_{T\text{-}DRV\ high}$	High		17.5	20	24	V
$G_{T\text{-}DRV\ low}$	Low			-5.0		

4 Schematic

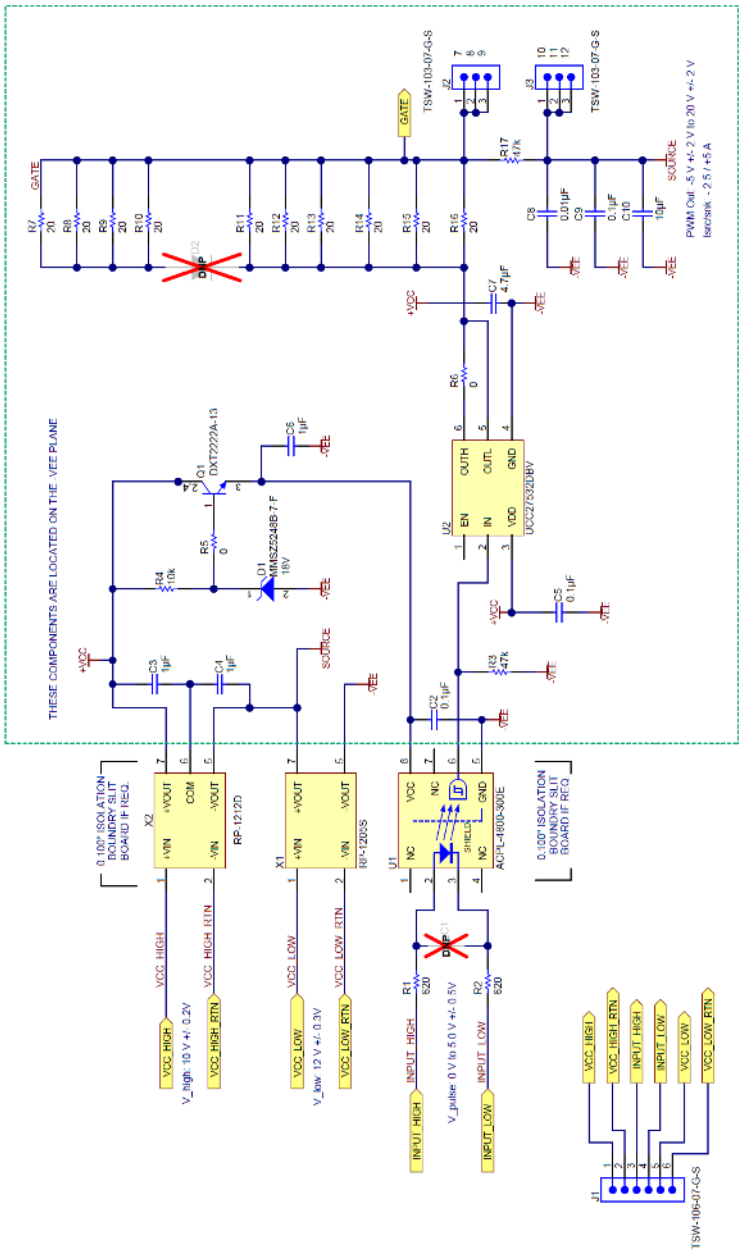

Figure 3. UCC27532EVM-538 Schematic

5 Test Setup

5.1 Test Equipment

Safety: This evaluation module is not encapsulated. If not trained in the proper safety of handling and testing of power electronics, please do not test this evaluation module. It is recommended that all external wires used be insulated 24 AWG or heavier.

CAUTION

High voltage potential when using the UCC27532EVM device as a high-side driver, it is possible that the output side of the isolation barrier rest at a high voltage. This is dependent on the application. Proper precautions and safety procedures should be followed while testing or handling the device in these applications.

Operation temperature should be at room temperature.

Do not leave EVM powered when unattended.

Dual DC Power Supply: Dual DC power supply capable of providing at least 12 V and 10 V with a current limit of 1 A.

Signal Generator: Digital signal generator capable of producing at least one single ended CMOS type signal for PWM input.

Oscilloscope: Oscilloscope with at least two channels of analog type that is capable of 100-MHz bandwidth with high impedance scope probes capable of handling 50 V.

Voltmeter: Digital voltmeter capable of monitoring input DC voltages, or other nodes around the EVM (This can be omitted if the DC power supply monitors its own voltage and current levels.

Voltmeter: External output load such as a 1.8-nF capacitor.

Output Load: External output load such as a 1.8-nF capacitor.

5.2 Recommended Test Setup

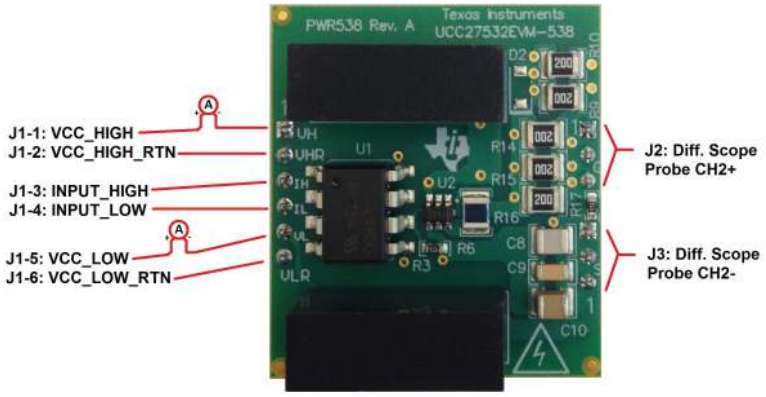

Figure 4. Recommended Test Setup

5.3 List of Test Points and Jumpers

The functions of each test point and jumper shown in Table 2

Table 2. List of Test Points and Jumpers

JUMPER	NAME/NODE	DESCRIPTION
J1.1	VCC_HIGH	10-V positive input for EVM power
J1.2	VCC_HIGH_RTN	10-V negative input for EVM power
J1.3	INPUT_HIGH	PWM positive input terminal
J1.4	INPUT_LOW	PWM negative input terminal
J1.5	VCC_LOW	12-V positive input for EVM power
J1.6	VCC_LOW_RTN	12-V negative input for EVM power
J2	GATE	Output to GATE
J3	SOURCE	Output to SOURCE

6 Test Procedure

Set up the EVM based on Figure 2.

6.1 Input to Output

1. Place a 1.8-nF capacitor at the output between GATE and SOURCE.
2. Power the board with 12 V across V_{CC_LOW} and $V_{CC\_LOW\_RTN}$, setting a current limit below 1 A.
3. Power the board with 10 V across V_{CC_HIGH} and $V_{CC\_HIGH\_RTN}$, setting a current limit below 1 A.
4. Adjust the signal generator to produce a signal between 2.75 V and 5.5 V driven to a 50-Ω termination, at a frequency of 20 kHz and a 50% duty cycle.
5. Place input signal on INPUT_HIGH with reference to INPUT_LOW.
6. Input and output waveforms can be measured between INPUT_HIGH and INPUT_LOW pins on J1 connector and GATE and SOURCE pins on connectors J2 and J3 respectively.

7 Performance Data, Typical Characteristic Curves, and Test Verification Waveforms

NOTE: The following data is provided for the EVM, not for the UCC27532DBV device itself, as this is designed as a plug-in module. For direct UCC27532DBV data, see the UCC27532DBV datasheet on www.ti.com.

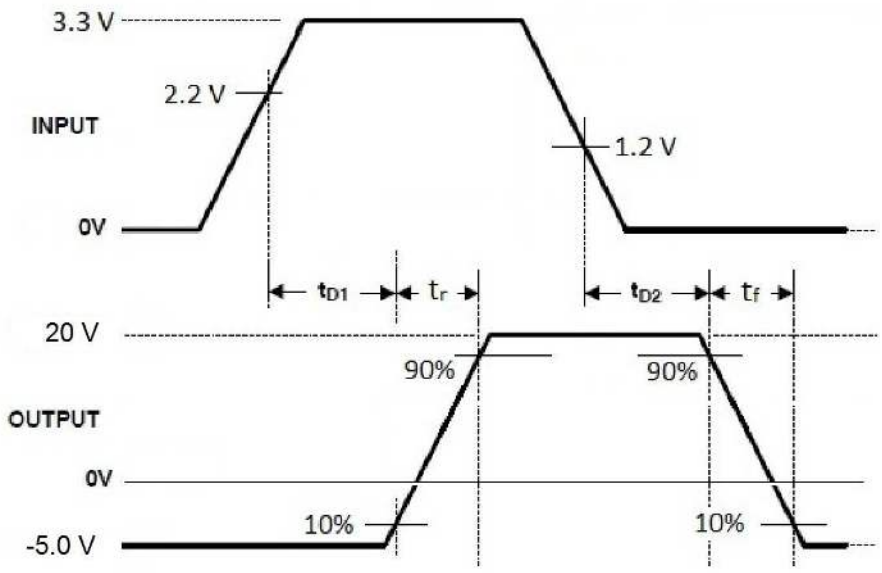

Figure 5. UCC27532EVM-538 Input vs. Output waveforms

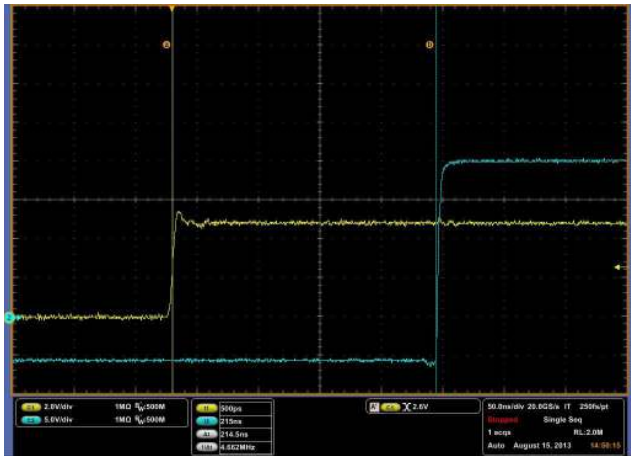

Figure 6. UCC27532DBV Input vs. Output PWM Propagation Delay (high)

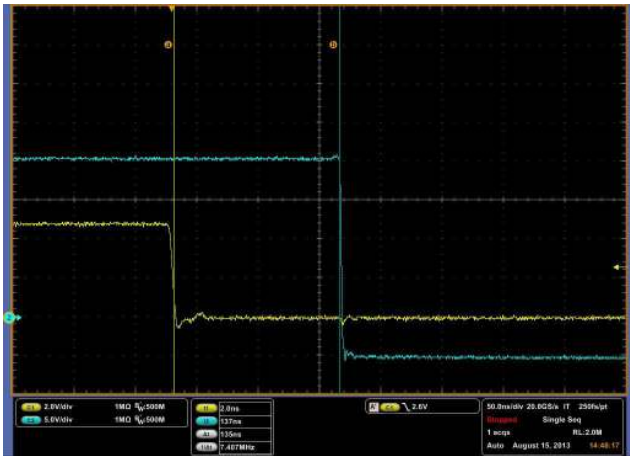

Figure 7. UCC27532DBV Input vs. Output PWM Propagation Delay (Low)

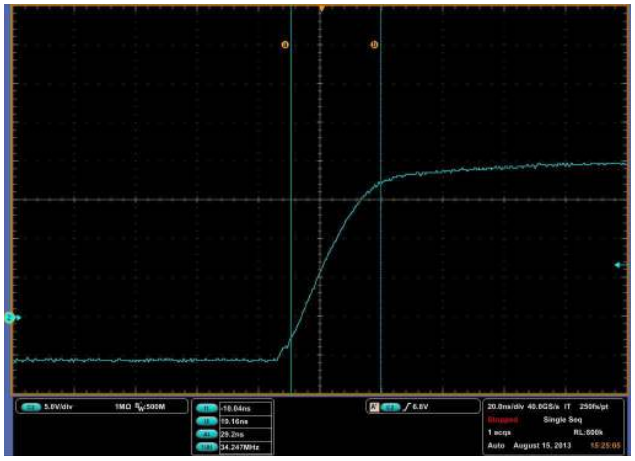

Figure 8. UCC27532DBV Input vs. Output PWM Rise Time

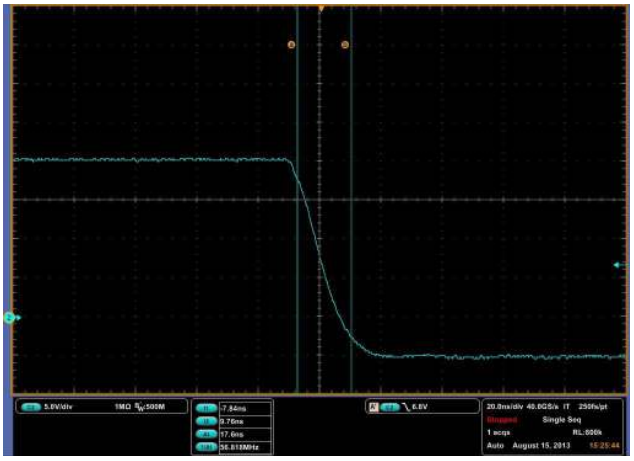

Figure 9. UCC27532DBV Input vs. Output PWM Fall Time

7.1 Propagation Delay, Rise, and Fall times Results

Table 3. EVM Test Results of Delay, Rise, and Fall Times

	$T_{D(on)}$	$T_{D(off)}$	T_R	T_F
OUTPUT	215 ns	135 ns	29.2 ns	17.6 ns

8 EVM Assembly Drawing and PCB Layout

The following figures (Figure 10 through Figure 13) show the design of the UCC27532EVM-538 printed circuit board. PCB dimensions: L x W = 2.000 inch x 1.850 inch, PCB material: FR4 or compatible, two layers and 1-oz copper on each layer.

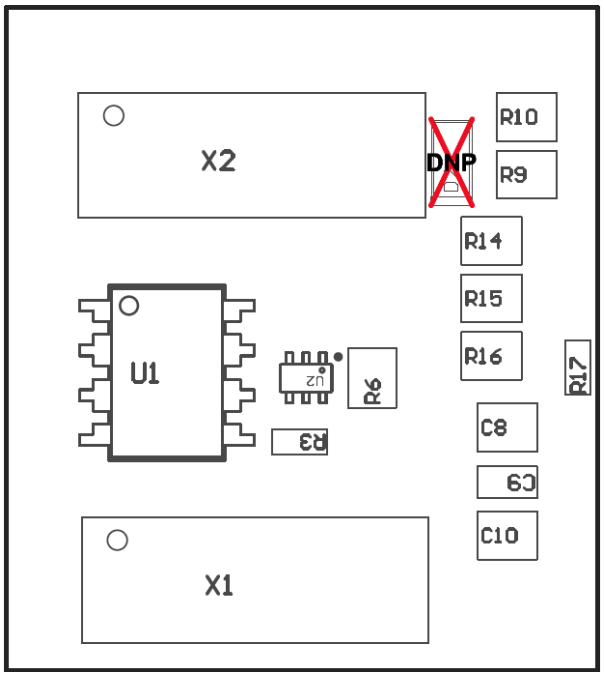

Figure 10. UCC27532EVM-538 Top Layer Assembly Drawing (top view)

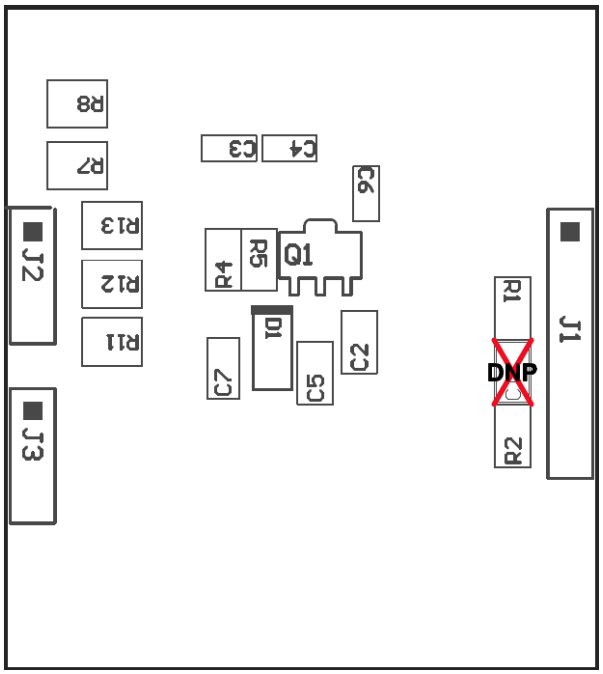

Figure 11. UCC27532EVM-538 Top Layer Assembly Drawing (top view)

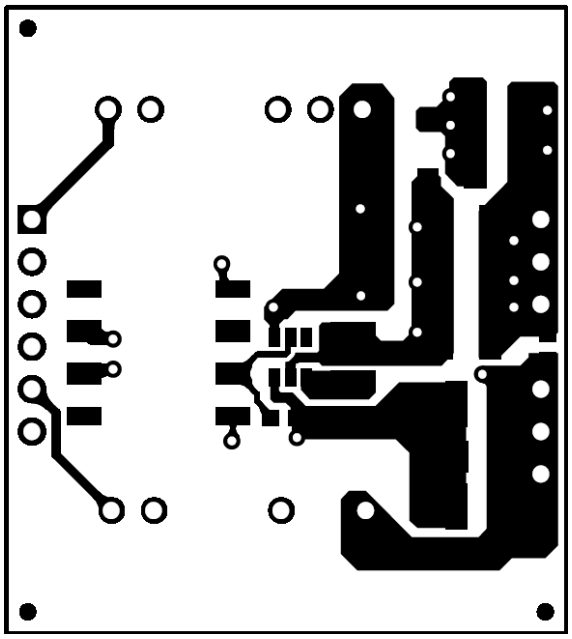

Figure 12. UCC27532EVM-538 Top Copper (top view)

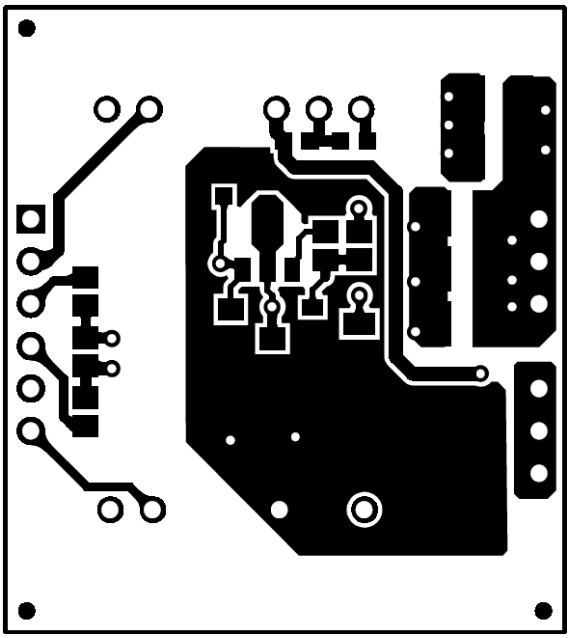

Figure 13. UCC27532EVM-538 Bottom Copper (top view)

9 List of Materials

The UCC27532EVM-538 components list according to the schematic shown in Figure 1.

Table 4. UCC27532EVM-538 List of Materials

Designator	Quantity	Description	Part Number	Manufacturer
!PCB1	1	Printed Circuit Board	PWR538	Any
C2, C5	2	Capacitor, ceramic, 0.1 µF, 50 V, ±10%, X7R, 0805	08055C104KAT2A	AVX
C3, C4, C6	3	Capacitor, ceramic, 1 µF, 25 V, ±10%, X5R, 0603	C1608X5R1E105K080AC	TDK
C7	1	Capacitor, ceramic, 4.7 µF, 50 V, ±10%, X5R, 1206	GRM319R61H475KA12	MuRata
C8	1	Capacitor, ceramic, 0.01 µF, 50 V, ±5%, C0G/NP0, 1210	12105A103JAT2A	AVX
C9	1	Capacitor, ceramic, 0.1 µF, 50 V, ±10%, X7R, 1206	12065C104KAT2A	AVX
C10	1	Capacitor, ceramic, 10 µF, 16 V, ±10%, X5R, 1210	1210YD106KAT2A	AVX
D1	1	Diode, Zener, 18 V, 500 mW, SOD-123	MMSZ5248B-7-F	Diodes Inc.
FID1, FID2, FID3, FID4, FID5, FID6	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
J1	1	Header, TH, 100 mil, 6 x 1, gold plated, 230 mil above insulator	TSW-106-07-G-S	Samtec Inc
J2, J3	2	Header, TH, 100 mil, 3 x 1, gold plated, 230 mil above insulator	TSW-103-07-G-S	Samtec Inc
Q1	1	Transistor, NPN, 40 V, 0.6 A, SOT-89	DXT2222A-13	Diodes Inc.
R1, R2	2	Resistor, 620 Ω, 5%, 0.125 W, 0805	ERJ-6GEYJ621V	Panasonic
R3, R17	2	Resistor, 47k Ω, 5%, 0.1 W, 0603	RC0603JR-0747KL	Yageo America
R4	1	Resistor, 10k Ω, 5%, 0.125 W, 0805	ERJ-6GEYJ103V	Panasonic
R5	1	Resistor, 0 Ω, 5%, 0.125 W, 0805	RC0805JR-070RL	Yageo America
R6	1	Resistor, 0 Ω, 5%, 0.25 W, 1210	MCR25JZHJ000	Rohm
R7, R8, R9, R10, R11, R12, R13, R14, R15, R16	10	Resistor, 20 Ω, 5%, 0.5 W, 1210	ERJ-14YJ200U	Panasonic
U1	1	OptoCoupler, IPM, 5 MBd, Gull-Wing, 8-SMD, 8-Pin DIP 100-mil, Gull-wing	ACPL-4800-300E	Avago
U2	1	2.5 A and 5 A, 35-V_{MAX} VDD FET and IGBT Single-Gate Driver, DBV0006A	UCC27532DBV	Texas Instruments
X1	1	CONV DC/DC 1W 12VIN 5VOUT SIP7	RP-1205S	Recom Power
X2	1	CONV DC/DC 1W DL ±12VOUT SIP7	RP-1212D	Recom Power
D2	0	Diode, Switching, 100 V, 0.2 A, SOD-123	MMSD4148T1G	ON Semiconductor

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.

3 *Regulatory Notices:*

   3.1 *United States*

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

      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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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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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.

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