Using the UCC27288EVM

This user's guide describes the characteristics, operation, and use of the UCC27288 Evaluation Module (EVM). A complete schematic diagram, PCB layouts, and BOM are included in this document.

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Trademarks

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1 Introduction

The UCC27288EVM is designed to primarily evaluate the UCC27288 performance. This driver is a 100-V boot voltage, high-side, low-side driver with 2.5-A peak source and 3.5-A sink current for driving two N-channel MOSFETs. The same board can be used to evaluate other pin-to-pin compatible parts in the supported package. The UCC27288 has low propagation delay and low propagation delay matching between the high- and low-side rising and falling edges of the driver outputs for reliable timing of the gate-drive signals. The UCC27288 inputs can tolerate signals as high as 16 V regardless of the V_{DD} voltage which enhances device robustness.

The UCC27288 driver includes an enable function which enables the driver outputs when pulled high, and disables the driver into a very low standby current mode when low. The UCC27288 also includes an interlock feature which sets both LO and HO driver outputs low when both LI and HI inputs are high at the same time. This prevents turning on the high-side and low-side MOSFETs at the same time enhancing robustness of the power train design.

2 Description

The EVM is developed in such a way that the UCC27288 driver performance can be evaluated and compared to data sheet parameters, or externally connected to power devices with provisions for source and sink gate-resistance flexibility. The UCC27288EVM evaluation board uses surface-mount test points allowing connection to LI, HI, VDD, and HB inputs. A variety of other test points are available for probing the UCC27288. The input bias is configured such that the VHB-VHS high-side bias can be sourced from VCC, or an external additional bias can be added to provide VHB-VHS directly. The high- and low-side driver output returns are separated on HS and GND respectively to allow evaluation of the UCC27288 HS negative voltage capabilities. For detailed device information, see the *UCC27288 120-V Half-Bridge Driver without Bootstrap Diode Data Sheet*.

2.1 Features

The EVM supports the following features:

- EVM for the low-voltage features of the UCC27288 gate driver
- 6-V to 16-V VCC power supply range
- TTL-compatible inputs
- PCB layout optimized for bias supply bypassing cap, gate-drive resistance selection
- Capacitive load, external gate drive resistor and diode for gate drive network evaluation
- Allows quick verification of most of the data sheet parameters
- Test points allow probing all the key pins of the UCC27288

2.2 I/O Description

Table 1 details the connection descriptions.

Table 1. Connection Descriptions

Pins	Description
VCC	V_{CC} positive input test point. Powers IC VDD pin, use 6-V to 16-V range.
VDD	V_{DD} positive input of UCC27288 IC
GND	Multiple test points. V_{CC} negative input, HI_IN,LI_IN, and ENA_IN negative inputs, and ground at UCC27288 IC
HI_IN	High-side input to EVM
HI	High-side input pin, HI
LI_IN	Low-side input to EVM
LI	Low-side input pin, LI
ENA_IN	Enable input to EVM. Connect to GND to disable driver.
VHB	HB pin voltage
HO LD	High-side output at capacitive load
HO	High-side output pin
HS	High-side driver return pin. Usually connected to high-side MOSFET source.
LO LD	Low-side output at capacitive load
LO	Low-side output pin

3 Electrical Specifications

For the full range of recommended operating specifications and design guidelines for driving loads, see the *UCC27288 120-V Half-Bridge Driver without Bootstrap Diode Data Sheet*.

CAUTION

The UCC27288EVM is designed for low-voltage evaluation only, and is not certified for evaluation with voltages beyond the absolute maximums listed in the electrical specifications. Do **not** evaluate high-voltage parameters with this board.

4 Test Summary

4.1 Definitions

This procedure details how to configure the UCC27288EVM evaluation board. Within this test procedure, the following naming conventions are applied. See the UCC27288EVM *Bench Setup Diagram and Configuration*, Figure 1, for details.

DMM: Digital multimeter

EVM: Evaluation module

4.2 Equipment

4.2.1 Power Supply

DC power supply with voltage and current above 20 V and 1 A, for example: Agilent E3634A

4.2.2 Function Generator

Two-channel function generator over 10 MHz, for example: Tektronics AFG3252

4.2.3 DMM

DMM with voltage and current above 25 V and 1 A, for example: Fluke 187

4.2.4 Oscilloscope

Four channel oscilloscope with 500 MHz or greater bandwidth, for example: DPO 7054

4.3 Equipment Setup

4.3.1 DC Power Supply Settings

- DC power supply #1
  - Voltage setting: 12 V
  - Current limit: 0.05 A

4.3.2 Digital Multi-Meter Settings

- DMM #1
  - DC current measurement, auto-range. Expected current is within 1 mA to 15 mA.

4.3.3 Two-Channel Function Generator Settings

Table 2 displays the two-channel function generator settings.

Table 2. Two-Channel Function Generator Settings

	Mode	Frequency	Width	Delay	High	Low	Output Impedance
Channel A	Pulse	100 kHz	2.5 µs	0 us	5 V	0 V	High Z
Channel B			2.5 µs	5 µs			

The UCC27288 interlock function will result in HO and LO in the low state if HI and LI are high at the same time.

4.3.4 Oscilloscope Settings

Table 3 details the oscilloscope settings.

Table 3. Oscilloscope Settings

	Bandwidth	Coupling	Termination	Scale Settings	Inverting
Channel A	500 MHz or above	DC	1 MΩ or automatic	10 × or automatic	OFF
Channel B					

4.3.5 Bench Setup Diagram

The bench setup diagram includes the function generator and oscilloscope connections.

Use the following connection procedure, refer to Figure 1.

- First, make sure the output of the function generator and power supplies are disabled before connection.
- Apply function generator channel-A on HI_IN-GND.
- Apply function generator channel-B on LI_IN-GND.
- Power supply #1: apply positive lead to current input of DMM #1 and current output of DMM #1 to test point VCC; apply negative lead to test point GND.
- Apply oscilloscope channel-1 probes on HO LD-HS, minimizing the loop area as much as possible. Note the scope ground is connected to HS test point.
- Apply oscilloscope channel-2 probes on LO LD-GND, minimizing the loop area as much as possible.

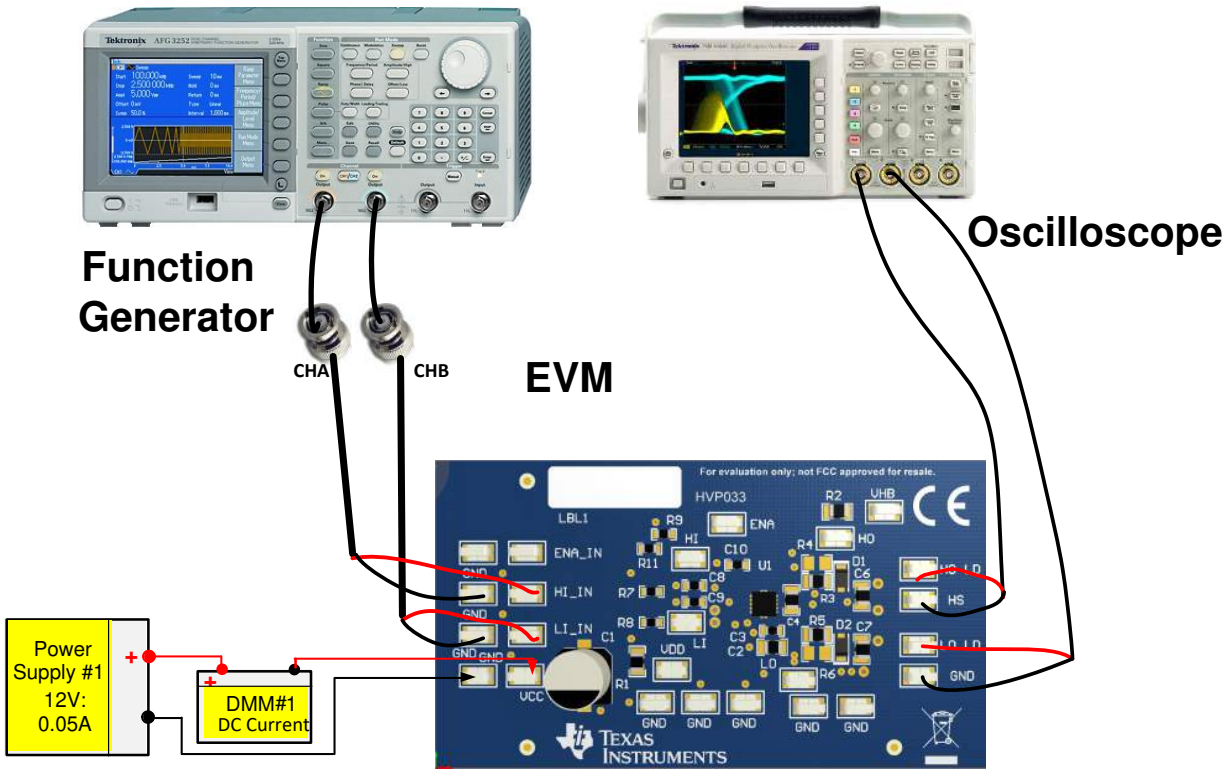

Figure 1. Bench Setup Diagram and Configuration

5 Power Up and Power Down Procedure

5.1 Power Up

1. Before beginning the power up test procedure, verify the connections with Figure 1.
2. Enable supply #1, if the current on DMM1 is more than 0.25 mA and less than 0.71 mA, everything is set correctly.
3. Enable function generator outputs channel-A and channel-B.
4. The following conditions should be present:
    1. Stable pulse output on channel-1 and channel-2 in the oscilloscope, refer to Figure 2
    2. Frequency measurement should be 100 kHz, ±5 kHz or equal to the programmed function generator frequency
    3. DMM #1 should display around 4.6 mA, ±2 mA with the default load capacitance of 1.0 nF. For more information about operating current, see the *UCC27288 120-V Half-Bridge Driver without Bootstrap Diode Data Sheet*.
5. Connect ENA_IN test point to GND test point with a jumper. The pulse outputs on channel-1 and channel-2 will cease operation and the voltage level should be near ground.

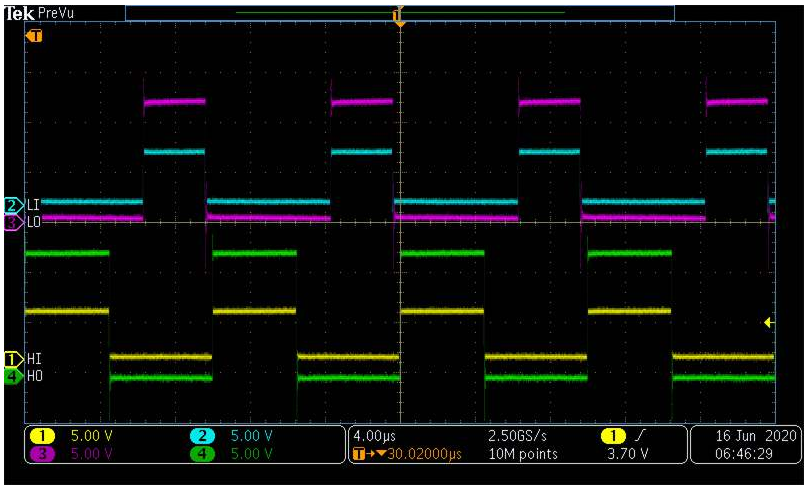

Figure 2. Example Input and Output Waveforms
(Green and Magenta are PWM Inputs, Yellow and Blue are Driver Outputs)

5.2 Power Down

Use the following steps to power down the EVM:

1. Disable function generator
2. Disable power supply #1
3. Disconnect cables and probes

6 Operation With External Bootstrap Diode

The UCC27288EVM has an internal bootstrap diode included, the series resistor (R10) is not populated. This allows the user to evaluate pin-compatible drivers that do not have the internal bootstrap diode which is included with the UCC27288 high-side and low-side driver.

As a general guideline, when using the external bootstrap diode a resistance value of 2.2 Ω to 10 Ω is recommended. Install R10 1206 size resistor for evaluation of pin-compatible drivers without the internal bootstrap diode.

7 Typical Performance Waveforms (C_L = 1800 pF)

7.1 Propagation Delays

The following waveforms illustrate the HI input and HO output on the top traces, and the LI input and LO output on the bottom traces in each plot.

To evaluate propagation delays and rising and falling details, it is recommended to have scope probe connections with short ground leads, see Figure 3 and Figure 4.

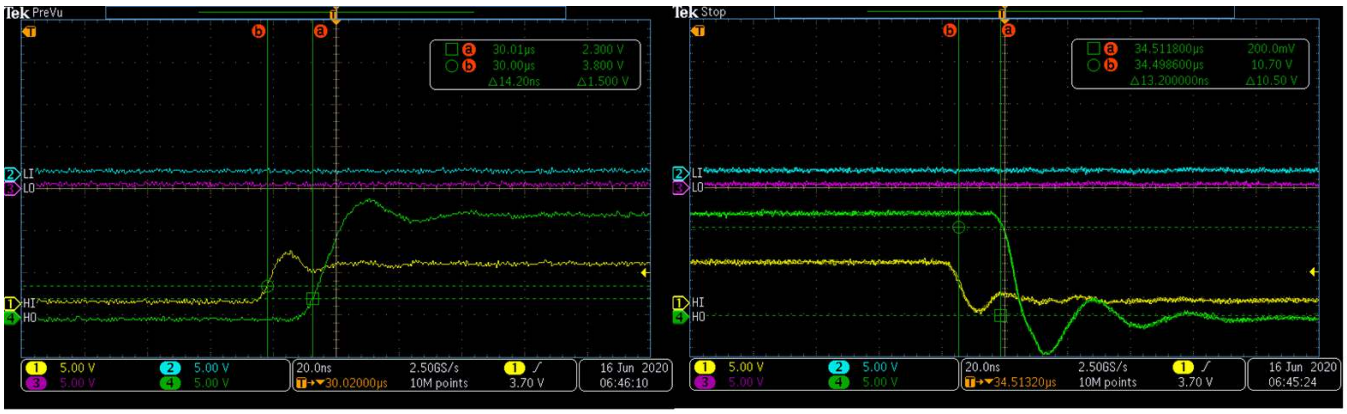

Figure 3. HI and HO Propagation Delay Waveforms
(Green and Magenta are PWM Inputs, Yellow and Blue are Driver Outputs)

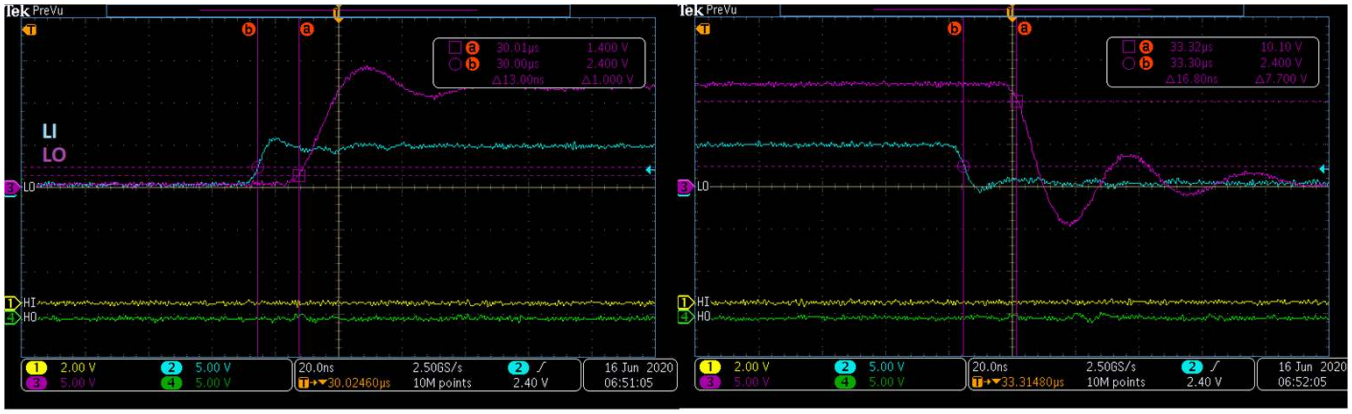

Figure 4. LI and LO Propagation Delay Waveforms
(Green and Magenta are PWM Inputs, Yellow and Blue are Driver Outputs)

8 Schematic

Figure 5 shows the UCC27288EVM schematic diagram.

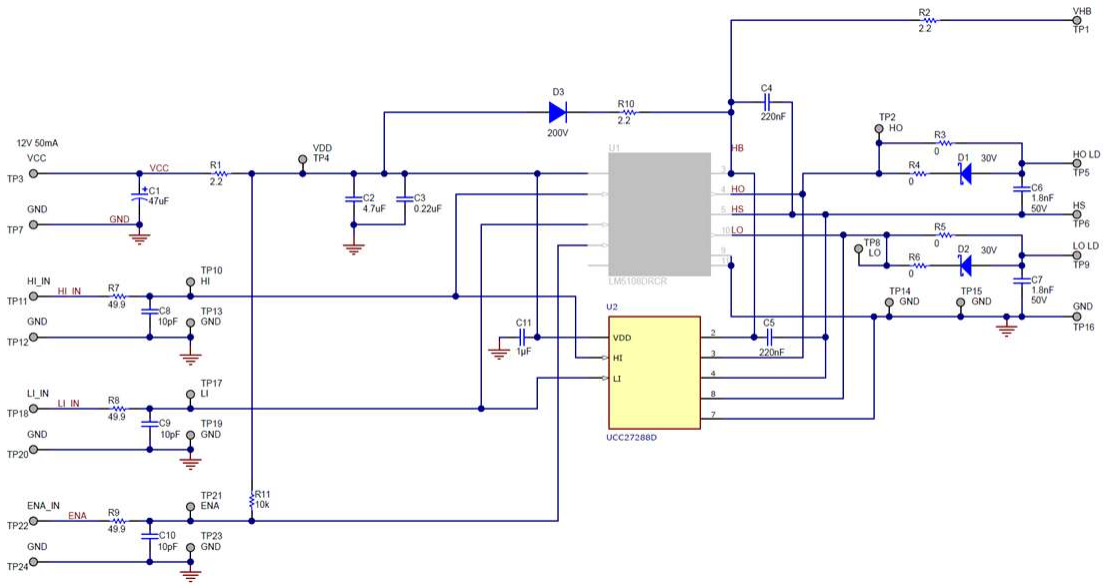

Figure 5. UCC27288EVM Schematic

U2 is not installed since it is an alternate driver IC used on a different board assembly variation.

9 Layout Diagrams

Figure 6 through Figure 11 show the PCB layout information for the UCC27288EVM.

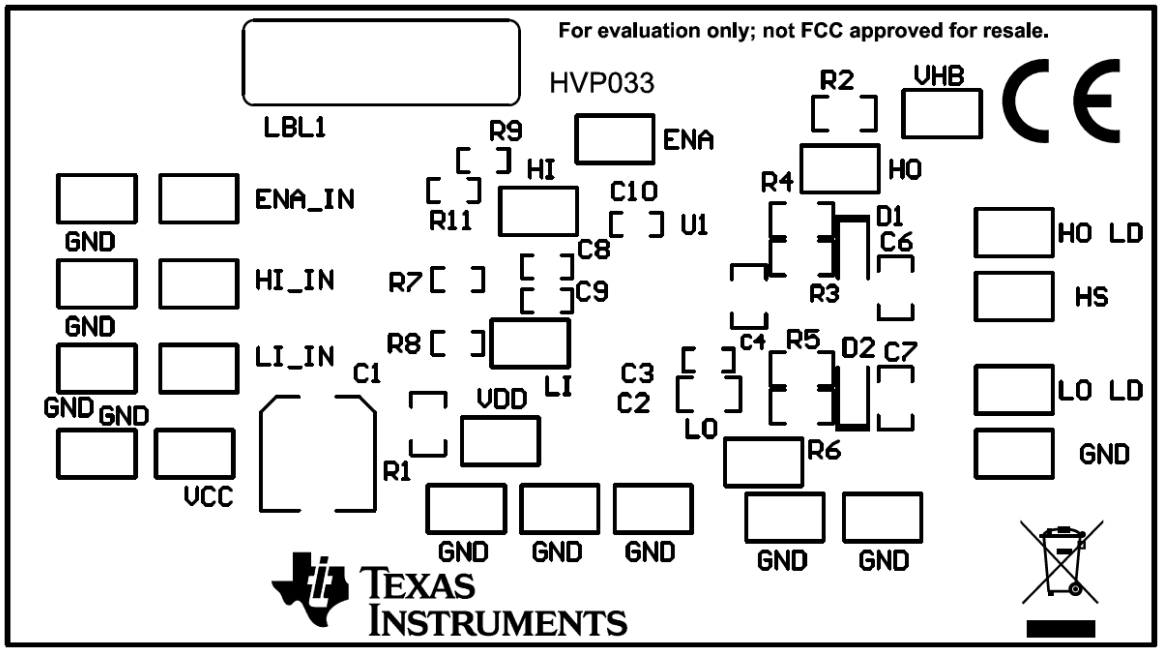

Figure 6. Top Overlay

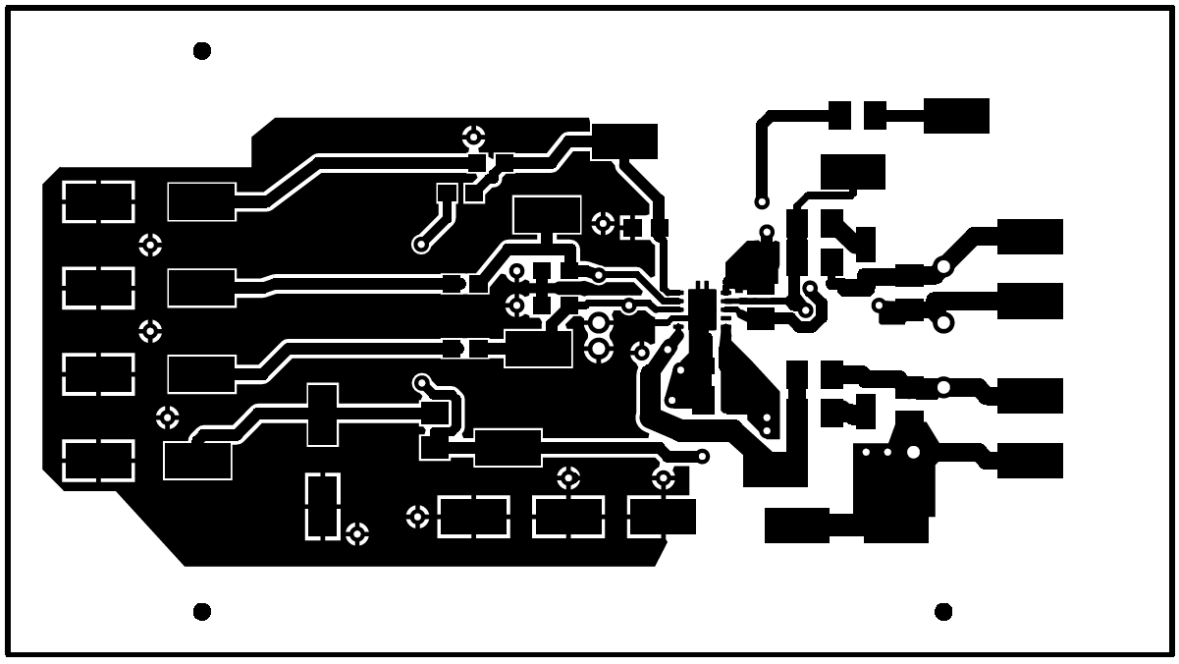

Figure 7. Top Layer

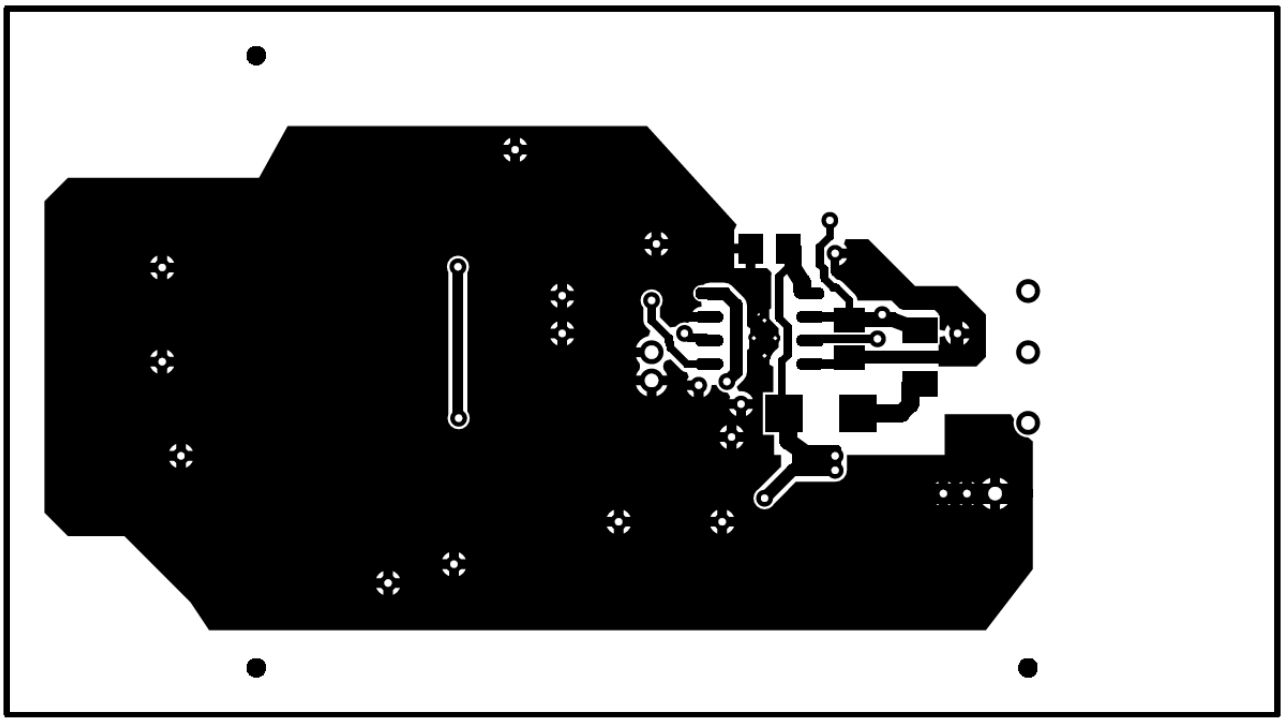

Figure 8. Bottom Layer

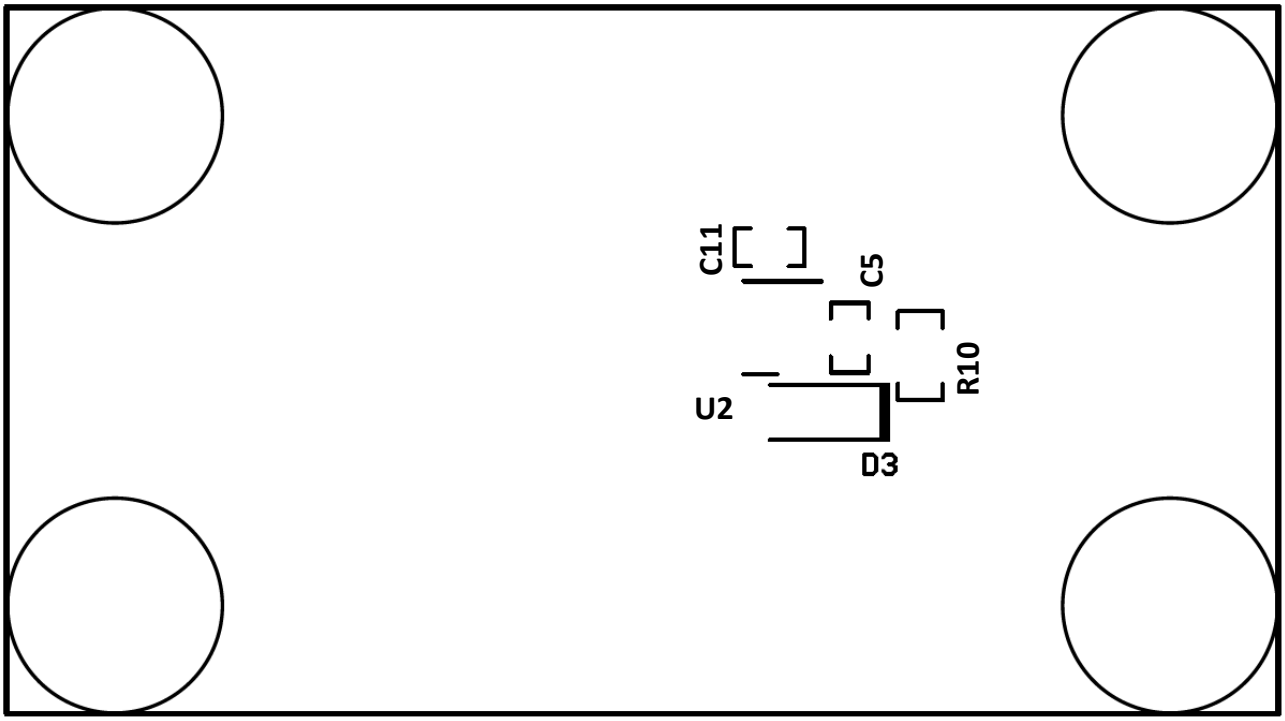

Figure 9. Bottom Overlay

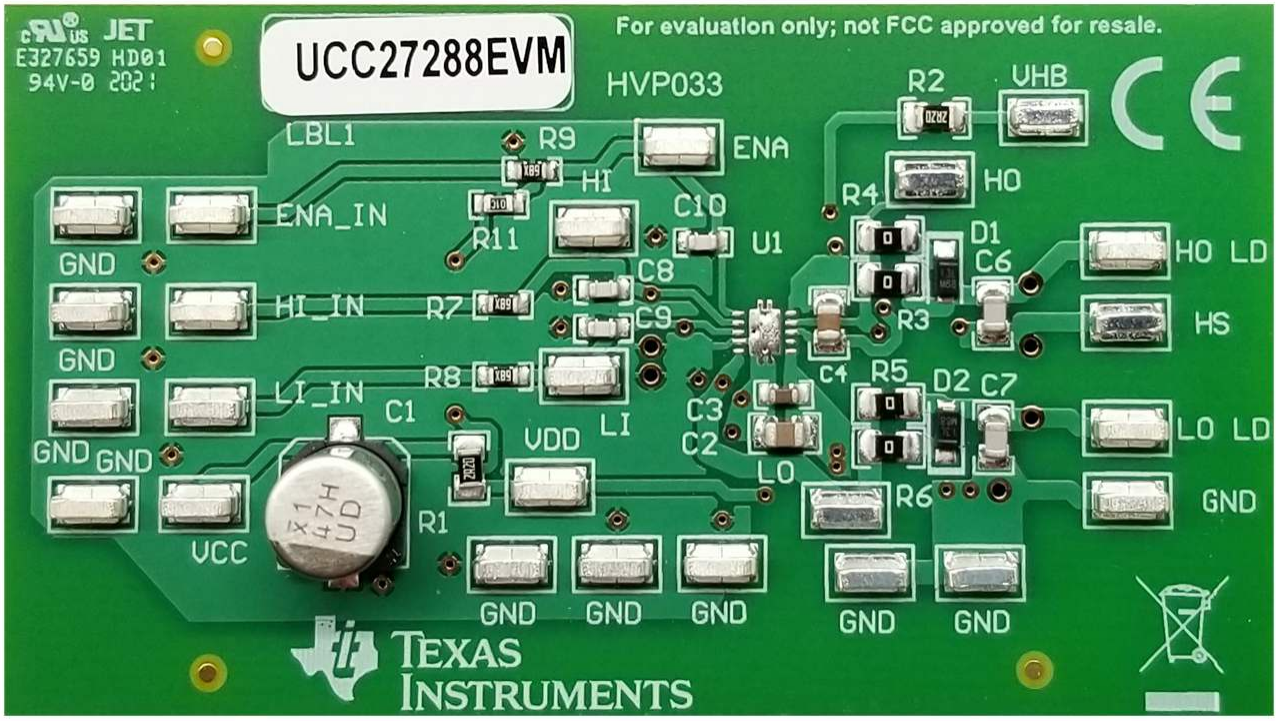

Figure 10. Top Image

Figure 11. Bottom Image

10 Bill of Materials

Table 4 lists the UCC27288EVM bill of materials.

Table 4. UCC27288EVM Bill of Materials

DES	QTY	Description	Part Number	Manufacturer
C1	1	CAP, AL, 47 µF, 50 V, ±20%, 0.68 ohm, SMD	UUD1H470MCL1GS	Nichicon
C2	1	CAP, CERM, 4.7 µF, 25 V, ±10%, X7R, 0805	C2012X7R1E475K125AB	TDK
C3	1	CAP, CERM, 0.22 µF, 50 V, ±10%, X7R, 0603	C1608X7R1H224K080AB	TDK
C4, C5	2	CAP, CERM, 0.22 uF, 50 V, ±10%, X7R, 0805	C0805C224K5RACTU	TDK
C6, C7	2	CAP, CERM, 1800 pF, 50 V, ±5%, X7R, 0805	C0805C102J5RACTU	Kemet
C8, C9, C10	3	CAP, CERM, 10 pF, 50 V, ±5%, C0G/NP0, 0603	C0603C100J5GACTU	Kemet
D1, D2	2	Diode, Schottky, 30 V, 1 A, AEC-Q101, MicroSMP	MSS1P3L-M3/89A	Vishay-Semiconductor
D3	1	Diode, Ultrafast, 200 V, 1 A, SMA	ES1D-13-F	Diodes Inc.
H1, H2, H3, H4	4	Bumpon, Hemisphere, 0.44 X 0.20, Clear	SJ-5303 (CLEAR)	3M
LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
R1, R2	2	RES, 2.2, 5%, 0.125 W, 0805	CRCW08052R20JNEA	Vishay-Dale
R3, R4, R5, R_6	2	RES, 0, 5%, 0.125 W, 0805	RC0805FR-074R02L	Yageo America
R7, R8, R9	3	RES, 49.9, 1%, 0.1 W, 0603	CRCW060349R9FKEA	Vishay-Dale
R11	1	RES, 10 k, 5%, 0.1 W, 0603	RC1608J103CS	Samsung Electro-Mechanics
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22, TP23, TP24	24	Test Point, Miniature, SMT	5019	Keystone
U1	1	110-V, 2.5-A 3.5-A Peak, 8-V UVLO, High-Side/Low-Side Driver, DRC0010J (VSON-10)	UCC27288D	Texas Instruments

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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

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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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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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:*

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