

# EVM User's Guide: UCC27332Q1EVM

## UCC27332-Q1 Evaluation Module



### Description

The UCC27332Q1EVM is designed to provide an easy to use tool to evaluate the UCC27332-Q1 performance. The UCC27332-Q1 is a 20-V, single channel low-side driver with 9-A peak source and 9-A peak sink current for driving Si/IGBTs and GaN FETs. The UCC27332Q1EVM board can be used to evaluate other pin-to-pin compatible parts in the 3x3mm MSOP package.

### Get Started

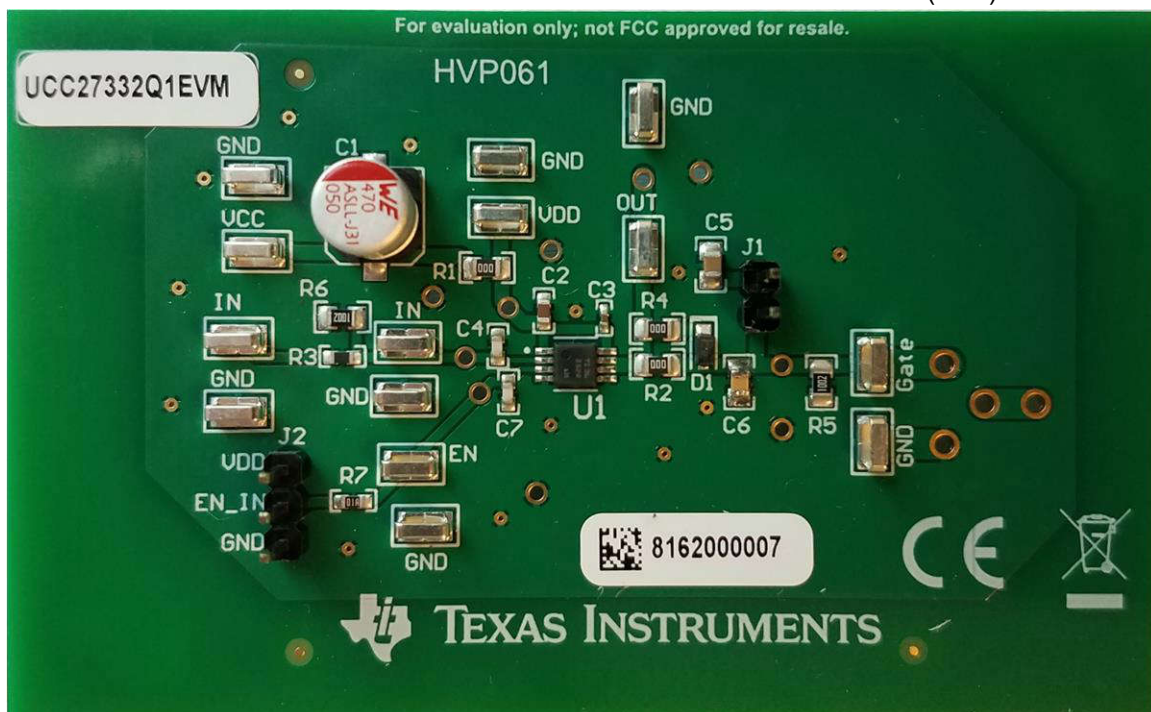
1. Order the EVM on [ti.com](https://www.ti.com).
2. Review the user's guide.
3. Download the comprehensive reference design files from the [product folder](#).
4. See the latest data sheet ([SLUSEW3](#)).

### Features

- EVM for the low-voltage features of the UCC27332-Q1 gate driver.
- 4.5-V to 18-V VCC power supply range.
- 9-A source, 9-A sink current.
- -5V input voltage capability on IN input pin.
- TTL-compatible inputs.
- PCB layout optimized for bias supply bypassing capacitors placement, gate-drive resistance network selection.
- Evaluate capacitive load, external gate drive resistor network.
- Available in 3 mm x 3 mm MSOP8 package.
- Test points allow probing all the key pins of the UCC27332-Q1.

### Applications

- Automotive DC-DC converters
- [Automotive on-board charger](#)
- Telecom DC-DC converters
- Power factor correction (PFC) circuits



# 1 Evaluation Module Overview

## 1.1 Introduction

The UCC27332Q1EVM is designed to primarily evaluate the UCC27332-Q1 performance. The UCC27332Q1EVM board can be used to evaluate other pin-to-pin compatible parts in the 3x3mm MSOP package.

This user's guide describes the characteristics, operation, and use of the UCC27332-Q1 Evaluation Module (EVM). A complete schematic diagram, PCB layouts, and BOM are included in this document. This family of devices provides high source and sink current drivers for driving Si MOSFETs and IGBTs.

## 1.2 Kit Contents

Quantity	
1	UCC27332Q1EVM

## 1.3 Specification

For the full range of recommended operating specifications and design guidelines for driving loads, see the UCC27332 20-V, 9-A single channel low-side driver data sheet ([SLUSEW3](#)).

## 1.4 Device Information

The UCC27332-Q1 is a 20-V, single channel low-side driver with 9-A peak source and 9-A peak sink current for driving Si FET's, IGBTs and GaN FETs. The UCC27332-Q1 has low propagation delays and fast rise (13 ns) and fall (9 ns) times driving a 10 nF load for reliable timing of the gate drive signals. The high drive strength can effectively drive high Qg MOSFET loads in a variety of end equipment applications. The wide operating voltage range of 4.5V to 18 V allows for driving power devices including GaN FET's, Si FET's and IGBT's.

## 2 Hardware

### 2.1 Additional Images

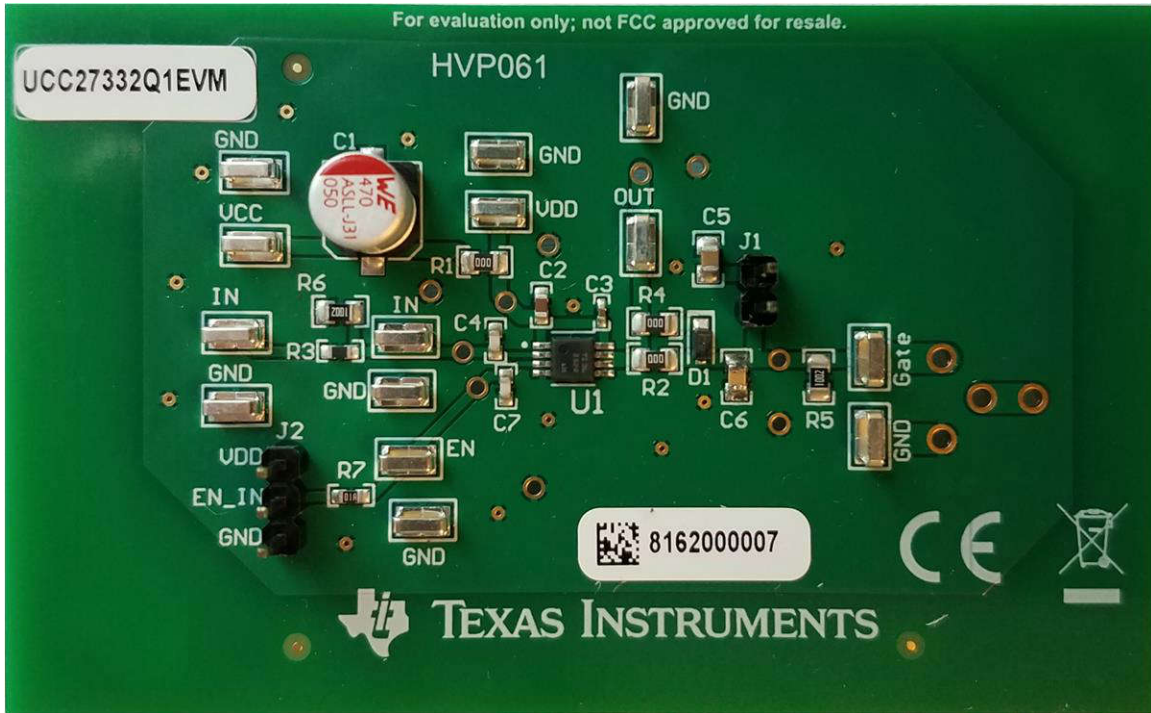


Figure 2-1. Top Image

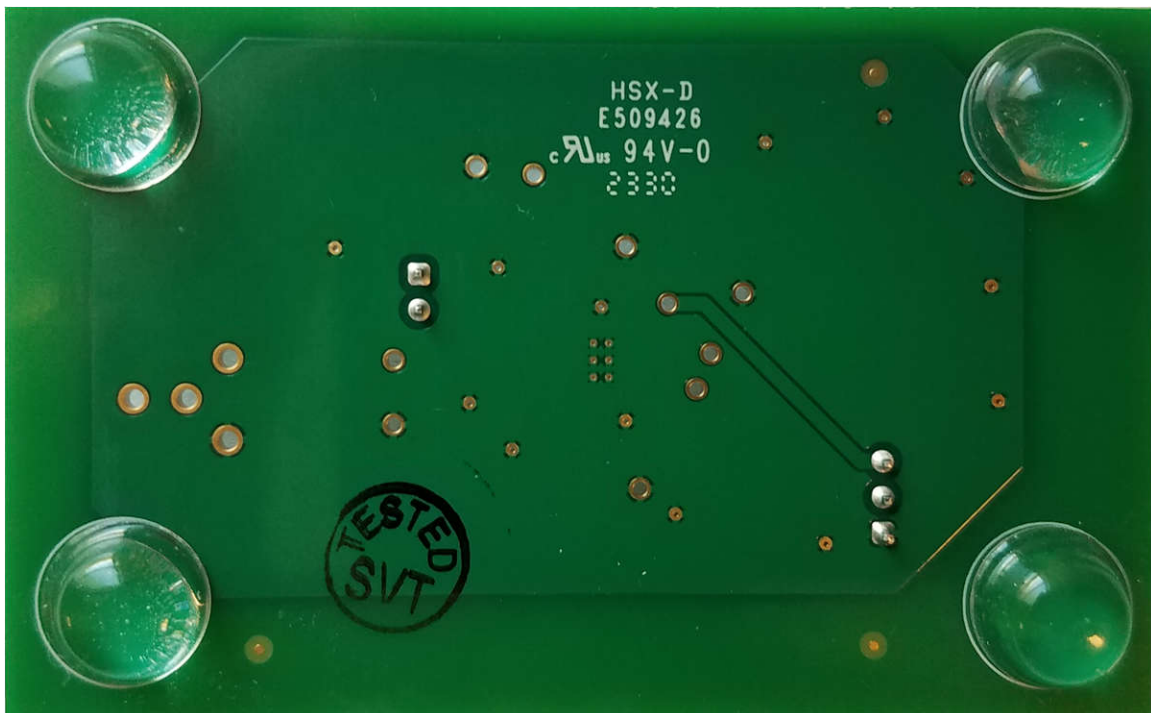


Figure 2-2. Bottom Image

## 2.2 Hardware Description

The UCC27332Q1EVM is designed to primarily evaluate the UCC27332-Q1. The driver's performance can be evaluated while driving capacitive loads and/or power devices with provisions for TO-220 footprints. The UCC27332Q1EVM evaluation board has surface-mount test points allowing connection to IN, EN, VDD and OUT pins to evaluate the UCC27332-Q1 in the 3x3 MSOP package. The EVM is set up to evaluate the UCC27332-Q1 DGN in a non-inverting configuration to drive various capacitive and resistive loads with a default configuration using a 1.8nF capacitive load.

The UCC27332-Q1 has low propagation delays and fast rise (13 ns) and fall (9 ns) times driving a 10 nF load for reliable timing of the gate drive signals. For detailed device information, see the UCC27332 20-V, 9-A single channel low-side driver data sheet ([SLUSEW3](#)).

### 2.2.1 I/O Description

[Table 2-1](#) details the connection descriptions.

**Table 2-1. Connection Descriptions**

Pins	Description
VCC	V <sub>CC</sub> positive input test point. Powers IC VDD pin, use 4.5-V to 18-V range
VDD	V <sub>DD</sub> positive input of UCC27332-Q1 IC
GND	Multiple test points. V <sub>CC</sub> negative input, IN, EN, OUT and Gate ground reference, and ground at UCC27332-Q1 IC
IN_IN	IN PWM signal
EN_IN	EN PWM signal
IN	IN input pin
EN	EN input pin
Gate	OUT output at capacitive load
OUT	OUT output at driver's pin

## 3 Implementation Results

### 3.1 Electrical Specifications

For the full range of recommended operating specifications and design guidelines for driving loads, see the UCC27332 20-V, 9-A single channel low-side driver data sheet ([SLUSEW3](#)).

#### CAUTION

The UCC27332Q1EVM is designed for low-voltage evaluation only, and is not certified for evaluation with voltages beyond the absolute maximum listed in the electrical specifications. Do not evaluate high-voltage parameters with this board.

### 3.2 Test Summary

#### 3.2.1 Definitions

This procedure details how to configure the UCC27332Q1EVM evaluation board. Within this test procedure, the following naming conventions are applied. See the UCC27332Q1EVM *Bench Setup Diagram and Configuration*, [Figure 3-1](#), for details.

**DMM:** Digital multimeter

**EVM:** Evaluation module

#### 3.2.2 Equipment

##### 3.2.2.1 Power Supply

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

##### 3.2.2.2 Function Generator

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

##### 3.2.2.3 DMM

DMM with voltage and current above 30 V and 1 A, for example: Fluke 187.

##### 3.2.2.4 Oscilloscope

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

#### 3.2.3 Equipment Setup

##### 3.2.3.1 DC Power Supply Settings

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

##### 3.2.3.2 Digital Multi-Meter Settings

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

##### 3.2.3.3 Two-Channel Function Generator Settings

The UCC27332Q1EVM requires one function generator setting while grounding EN.

**Table 3-1. Two-Channel Function Generator Settings**

	Mode	Frequency	Width	Delay	High	Low	Output Impedance
Channel A	Pulse	100 kHz	2.5 $\mu$ s	0 us	5 V	0 V	High Z

### 3.2.3.4

### 3.2.3.5 Oscilloscope Settings

Table 3-2 details the oscilloscope settings.

**Table 3-2. 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					

### 3.2.3.6 Bench Setup Diagram

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

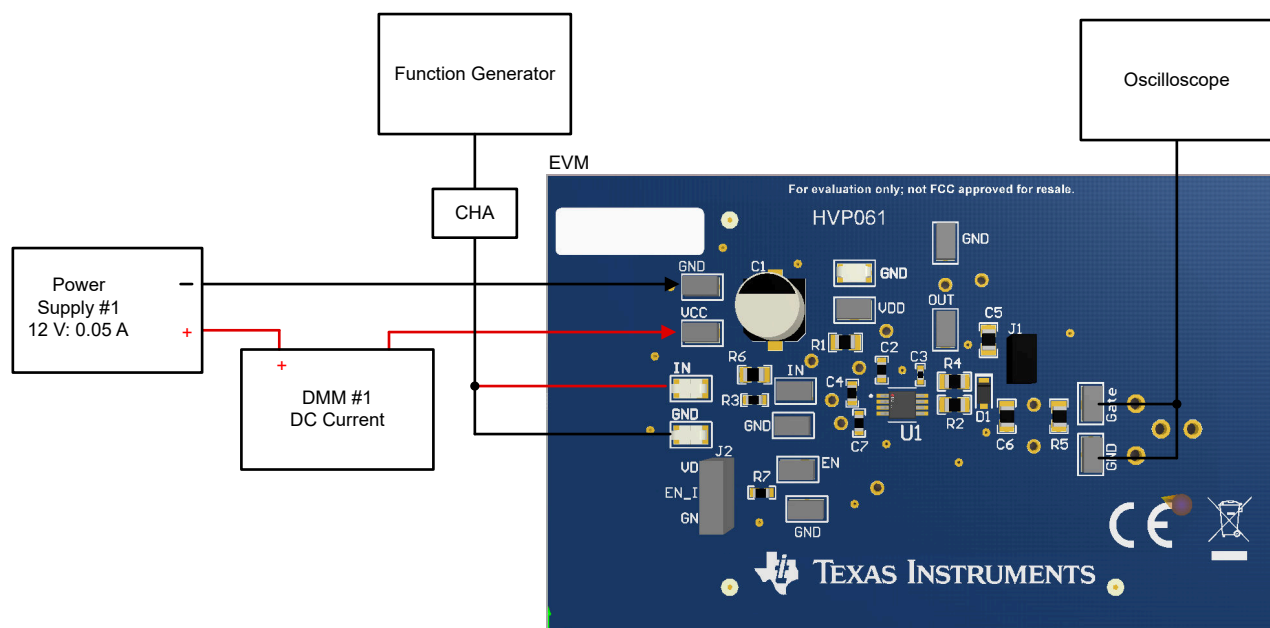
Use the following connection procedure and refer to Figure 3-1.

For the UCC27332Q1EVM, the connection procedure is as follows:

- First, make sure the output of the function generator and power supplies are disabled before connection.
- Apply function generator channel-A positive on IN and negative to GND.

See in Figure 3.1.

- Power supply #1: positive node connected to input of DMM #1 and DMM #1 output connected to test point marked as VCC, negative node of Power Supply #1 connected directly to test point marked as GND; see in Figure 3-1.
- Connect oscilloscope Ch-1 probes to test points marked as Gate and GND, smaller measurement loop is preferred; see in Figure 3-1.



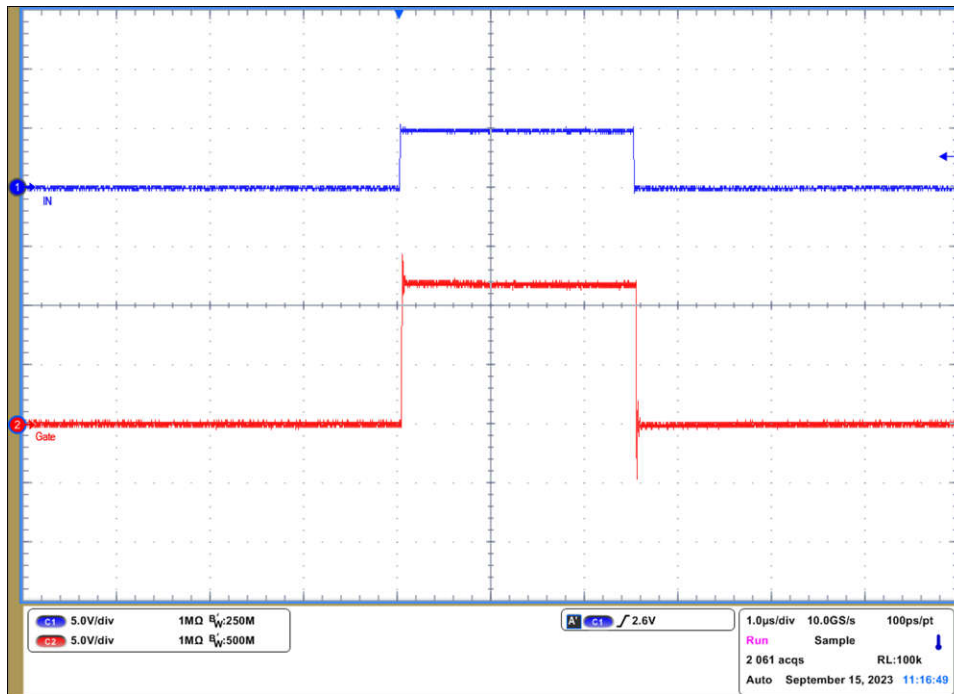
**Figure 3-1. Bench Setup Diagram and Configuration**



### 3.3 Power Up and Power Down Procedure

#### 3.3.1 Power Up

1. Before beginning the power up test procedure, verify the connections with [Figure 3-1](#).
2. Enable supply #1, if the current on DMM1 is more than 0.05 mA and less than 0.3 mA, everything is set correctly.
3. Turn on Channel A of function generator.
4. The following behavior should be observed:
  - a. Stable pulse output on channel-1 and channel-2 of the oscilloscope, refer to [Figure 3-2](#).
  - b. Frequency measurement is 100 kHz,  $\pm 5$  kHz or equal to the programmed function generator frequency.
  - c. DMM #1 displays around 2.9 mA,  $\pm 0.75$  mA with the default load capacitance of 1.8 nF. For more information about operating current, see the [UCC27332Q1 Single Channel 20 V 9 A High Speed Low Side Gate Driver Data Sheet](#).



**Figure 3-2. Example Input and Output Waveforms (Blue is the PWM Input, Red is the Driver Output)**

#### 3.3.2 Power Down

Use the following steps to power down the EVM:

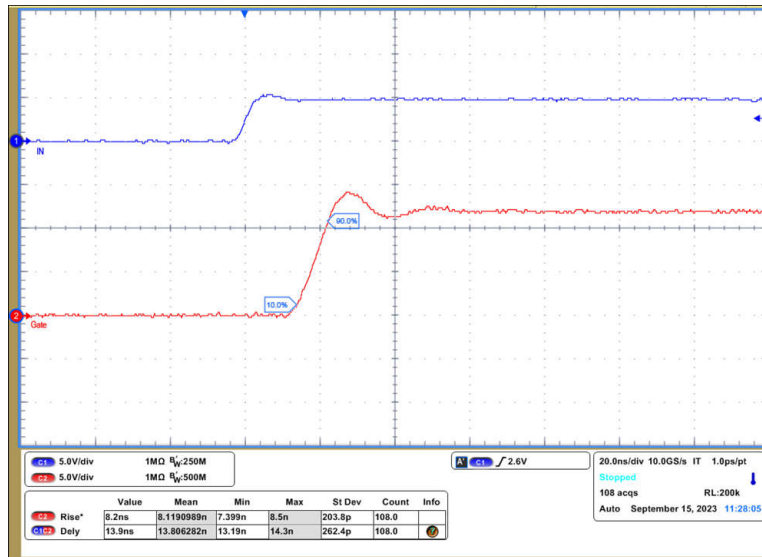
1. Disable function generator.
2. Disable power supply #1.
3. Disconnect cables and probes.

### 3.4 Typical Performance Waveforms ( $C_L = 1800$ pF)

#### 3.4.1 Propagation Delays

The following waveforms illustrate the IN input and OUT output.

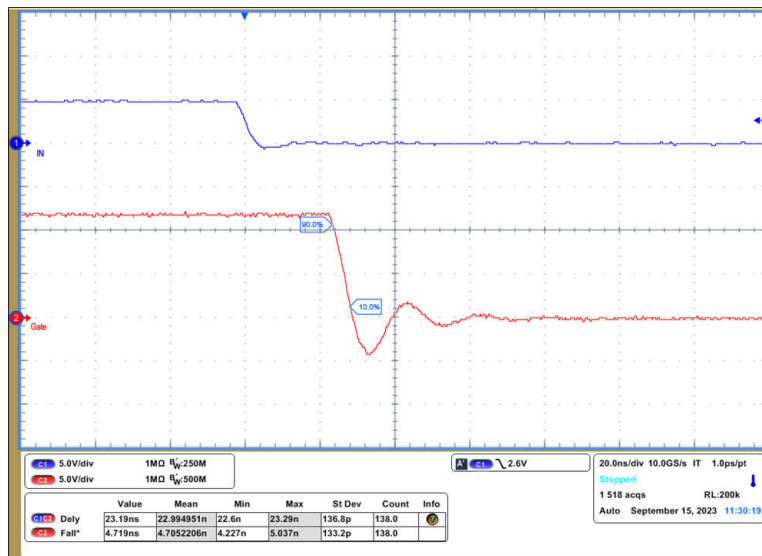
To evaluate propagation delays and rising and falling details, TI recommends to have scope probe connections with short ground leads.



**Figure 3-3. Rise Time and Rising Propagation Delay**

#### Note

To evaluate data sheet timing parameters, change C6 to 10 nF.



**Figure 3-4. Fall Time and Falling Propagation Delay**

#### Note

To evaluate data sheet timing parameters, change C6 to 10 nF.



## 4 Hardware Design Files

### 4.1 Schematic

Figure 4-1 shows the UCC27332Q1EVM schematic diagram.

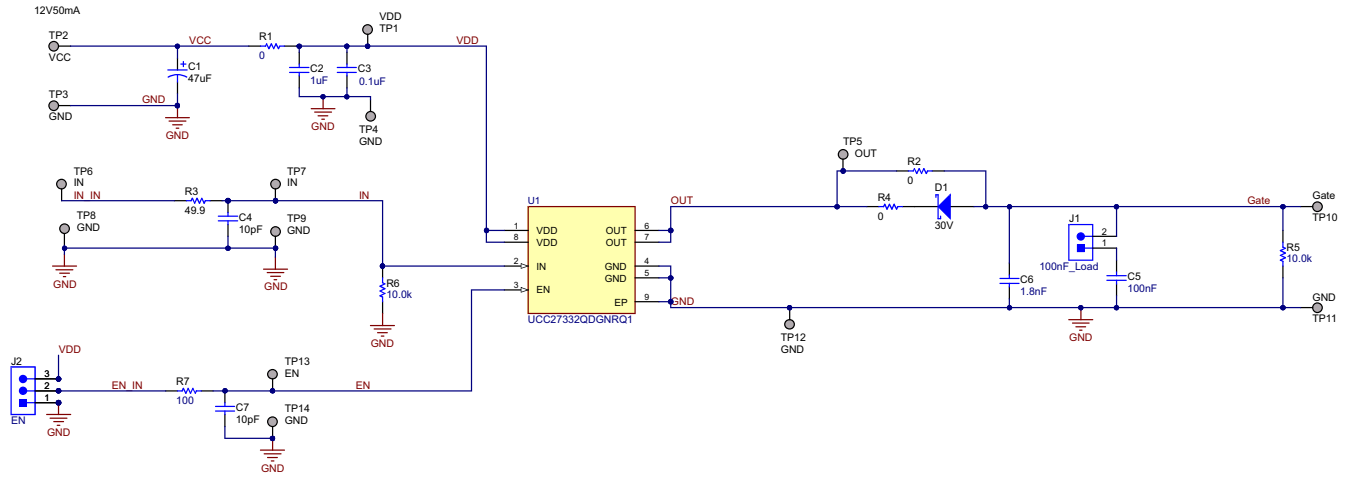
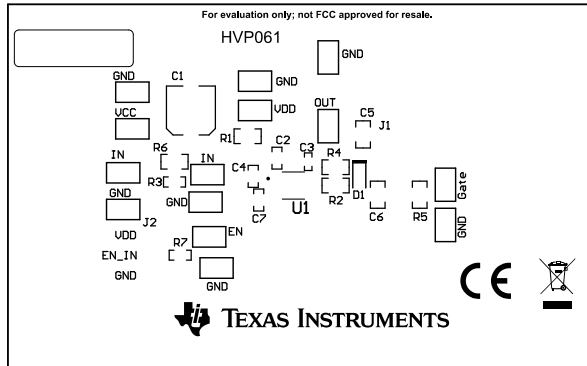


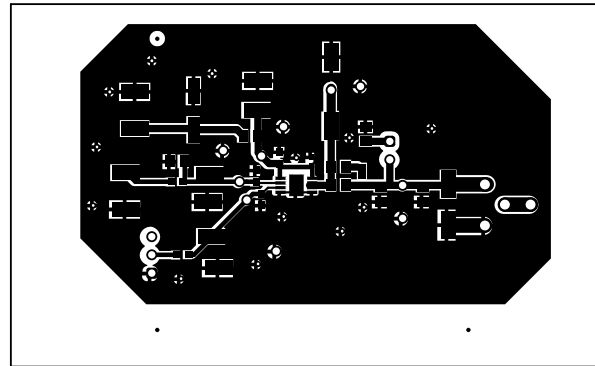
Figure 4-1. UCC27332Q1EVM Schematic

## 4.2 PCB Layouts

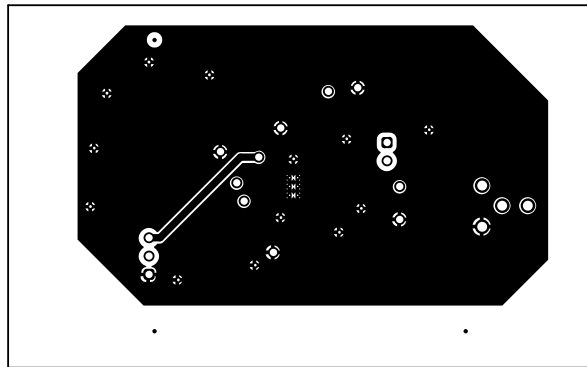
Figure 4-2 through Figure 4-5 show the PCB layout information for the UCC27332Q1EVM.



**Figure 4-2. Top Overlay**



**Figure 4-3. Top Layer**



**Figure 4-4. Bottom Layer**



**Figure 4-5. Bottom Overlay**

### 4.3 Bill of Materials

Table 4-1 provides the UCC27332Q1EVM list of materials.

**Table 4-1. UCC27332Q1EVM Bill of Materials**

QUANTITY	DESIGNATOR	DESCRIPTION
1	C1	CAP, AL, 47 uF, 50 V, +/- 20%, 0.68 ohm, SMD
1	C2	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0603
1	C3	CAP, CERM, 1.0 uF, 50 V, +/- 10%, X7R, 0402
2	C4, C7	CAP, CERM, 10 pF, 50 V, +/- 5%, COG/NPO, 0603
1	C5	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0805
1	C6	CAP, CERM, 1800 pF, 50 V, +/- 10%, X7R, 0805
1	D1	Diode, Schottky, 30 V, 1 A, AEC-Q101, MicroSMP
1	J1	Header, 2.54 mm, 2x1, Tin, TH
1	J2	Header, 2.54 mm, 3x1, Tin, TH
1	R1	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805
2	R2, R4	RES, 0, 5%, 0.125 W, 0805
1	R3	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603
2	R5, R6	RES, 10.0 k, 1%, 0.2 W, 0805
1	R7	RES, 100, 1% 0.1W, 0603
14	TP1 - TP14	Test Point, Miniature, SMT
1	TP10	Test Point, Miniature, SMT
1	TP17	Test Point, Miniature, SMT
1	U1	UCC27332-Q1 20-V, 9-A Single Channel Low Side Gate Driver with -5-V Input Capability for Automotive Applications

### 5 Additional Information

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All trademarks are the property of their respective owners.

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  - 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.
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  - 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 DEGRADATION 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/llds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/llds/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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#### 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.
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