EVM User's Guide: UCC57142EVM

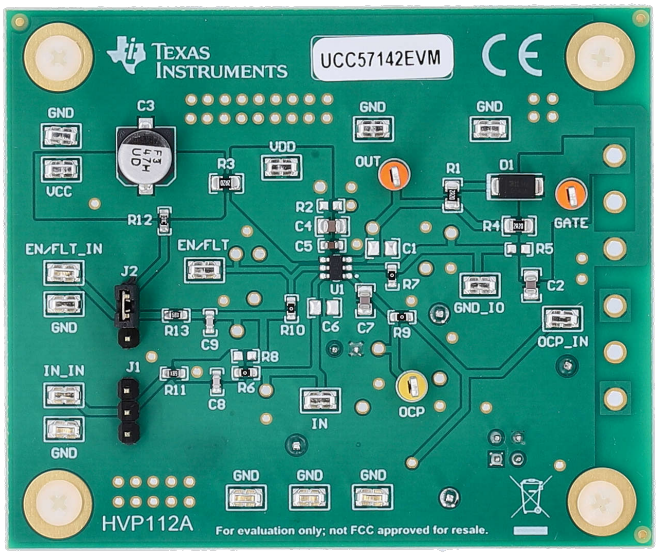
UCC57142 Evaluation Module

Description

The UCC57142EVM is designed to primarily evaluate the UCC57142 functionality. The performance of the driver can be evaluated for capacitive loads or power devices with TO-220 footprints. The UCC57142EVM evaluation board allows for connection to various test points, such as IN, EN/FLT, OCP, and OUT, via surface-mount test points. The UCC57142EVM can support different UCC57142 variants via jumpers. The UCC57142EVM is also compatible with other gate drivers in the DBV package through board modifications.

Features

- Test points allow probing all the key pins of the UCC57142
- Allows quick verifications of most of the data sheet parameters
- Compatibility across all UCC57142 variants and other TI gate drivers in DBV package
- External TO-220 power device low-side connection
- PCB layout optimized for bias supply bypassing capacitor and gate resistor selection



UCC57142 Evaluation Module

1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the characteristics, operation, and use of the UCC57142 Evaluation Module (EVM). A complete schematic diagram, PCB layouts, and BOM are included in this document. This family of drivers provides overcurrent protection and effectively drives MOSFET, SiC MOSFET, and IGBT power switches.

1.2 Kit Contents

The UCC57142EVM kit includes:

- UCC57142 EVM
- Generic evaluation kit user's guide

1.3 Specification

For the full range of recommended operating specifications and design guidelines for driving loads, see the *UCC5714x-Q1 High-Speed, Low-Side Gate Driver With Over Current Protection* data sheet.

CAUTION

The UCC57142EVM is designed for low-voltage evaluation only, and is not certified for evaluation for voltages beyond the absolute maximums listed in the electrical specifications. Do **not** evaluate high-voltage parameters with this board.

1.4 Device Information

The UCC57142 is a 30V, single-channel low-side gate driver with 3A peak source and 3A peak sink current for driving Si MOSFETs, SiC MOSFETs, and IGBT. The UCC57142 also features overcurrent protection (OCP), fault signal output, and UVLO protection rated at 12.5V. The UCC57142 has low propagation delay and fast rise and fall time. The UCC57142 inputs can tolerate signals as high as 30V and as low as -5V regardless of the VDD voltage, enhancing the driver robustness. The UCC57142EVM board can be used to evaluate other pin-to-pin compatible parts in the supported packages.

For detailed device information, see the *UCC5714x-Q1 High-Speed, Low-Side Gate Driver With Over Current Protection* data sheet.

2 Hardware

2.1 Additional Images

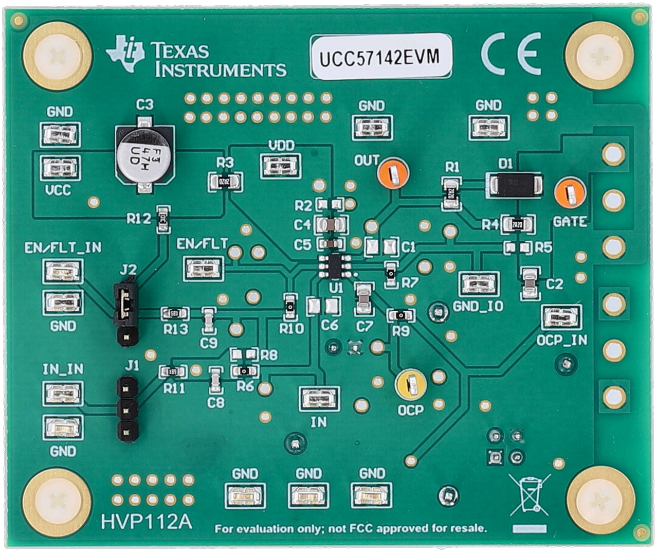


Figure 2-1. Front Side of the UCC57142EVM, Which Supports the UCC57142 and UCC57148 ICs

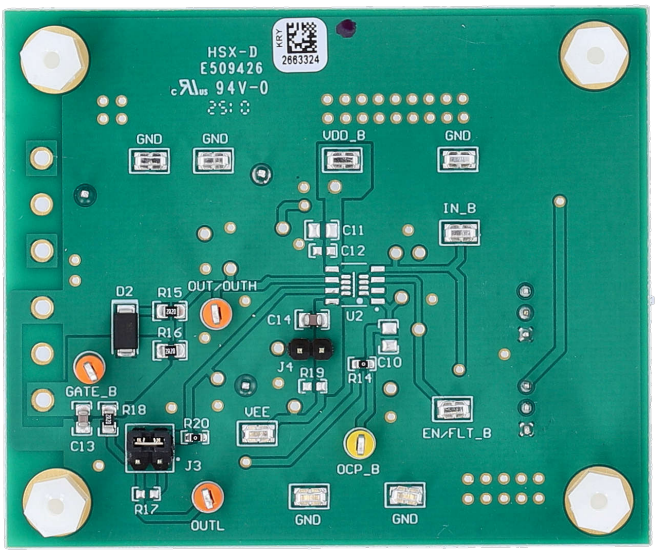


Figure 2-2. Back Side of the UCC57142EVM, Which Supports the UCC57132B and UCC57138C ICs

2.2 Power Requirements

Parameter	Min	Typ	Max	Unit
Input and Output Characteristics				
Input V_{DD}	14.5(1)		26	V
Input V_{IN}	-2		26	V
Input $V_{EN/FLTb}$	0		26	V
Input V_{OCP}	-5		10	V
System Characteristics				
Switching Frequency	0	100	500	kHz

(1) The UCC57142EVM also supports the UCC57148 IC. In this case, the minimum input V_{DD} is 8.5V.

2.3 Setup for Different UCC57142 Variants

The UCC57142EVM comes installed with the UCC57142 variant of the UCC57142 family of drivers, and the EVM out-of-the-box is set up according to that variant. The UCC57148 is the 8V UVLO variant. The UCC5714x is used for negative overcurrent protection.

The UCC57142 family of drivers comes in two more variants: the UCC57132B, which supports bipolar-voltage and has 12.5V UVLO, and the UCC57138C, which has split output and has 8V UVLO. Both the UCC57132B and UCC57138C variants are used for positive overcurrent protection.

The UCC5714x uses the top side of the EVM, and the UCC5713x uses the bottom side of the EVM. Only one IC should be populated on the EVM at a time.

Because each UCC5713x variant has slightly different pinouts, the EVM has jumpers to support the different variants. Jumpers J3 and J4 allow the use to short or open between connectors depending on which variant is being used. Figure 2-3 shows how J3 and J4 must be configured with each UCC5713x variant. Do not short more than one connection on J3. Please ensure to populate C11 and C12 with VDD bypass capacitors (minimum recommended for C11 is 1µF and C12 is 0.1µF).

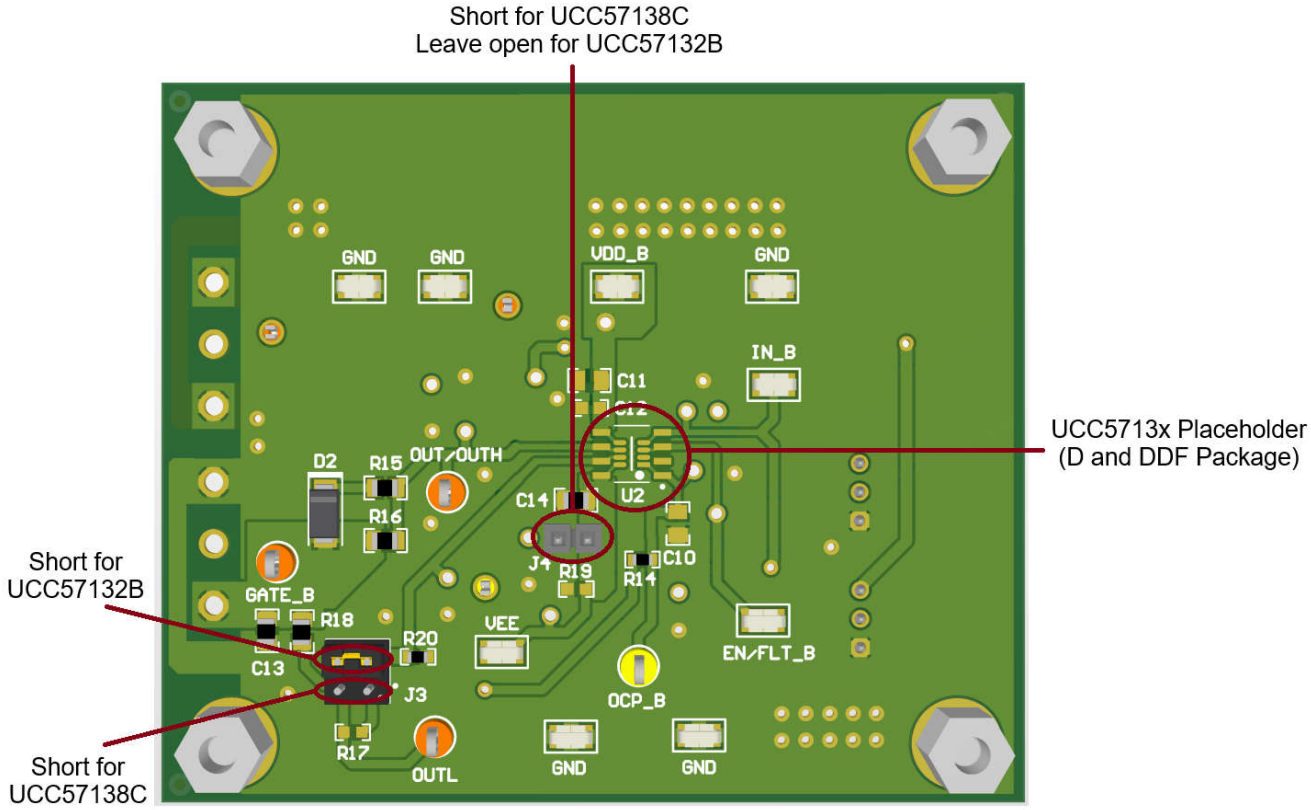


Figure 2-3. Jumper J3 and J4 Selection for Each UCC5713x IC Variant

In addition to jumpers J3 and J4, there is also an option to solder 0Ω jumper resistors (R17, R19, and R20) for a low-parasitic way to short connections. The bottom side of the EVM out-of-the-box is set up for the UCC57132B variant, which has R20 installed on the board. Resistors R17 and R19 are not installed. If the UCC57138C variant is being used, R20 must be desoldered. Table 2-1 lists a guide to soldering or desoldering the 0Ω jumper resistors for each UCC5713x variant.

Table 2-1. Resistor Solder Guide for UCC5713x

Device	R17	R19	R20
UCC57132B	Desolder	Desolder	Solder
UCC57138C	Solder	Solder	Desolder

2.4 I/O Description

Table 2-2. UCC57142EVM Top Side I/O Description

Pin	Description
VCC	Positive supply input for EVM. Used for top side and bottom side of EVM.
IN_IN	Input signal input for EVM. Used for top side and bottom side of EVM.
EN/FLT_IN	Enable and fault signal input for EVM. Used for top side and bottom side of EVM.
OCP_IN	Overcurrent protection input for EVM. Used for top side and bottom side of EVM.
VDD	Test point of UCC57142 IC VDD pin.
IN	Test point of UCC57142 IC IN pin.
EN/FLT	Test point of UCC57142 IC EN/FLTb pin.
OCP	Test point of UCC57142 IC OCP pin.
GATE	Load test point for top side of EVM.
OUT	Test point of UCC57142 IC OUT pin.
GND_IO	Ground of UCC57142 IC. Doubles as multi-use I/O for other gate drivers in DBV package.
GND	Ground of EVM. Multiple test points.

Table 2-3. UCC57142EVM Bottom Side I/O Description

Pin	Description
VDD_B	Test point of UCC5713x IC VDD pin.
VEE	Negative supply input and test point of UCC57132B IC variant.
IN_B	Test point of UCC5713x IC IN pin.
EN/FLT_B	Test point of UCC5713x IC EN/FLTb pin.
OCP_B	Test point of UCC5713x IC OCP pin.
GATE_B	Load test point for bottom side of EVM.
OUT/OUTH	Test point of UCC5713x IC OUT pin. OUTH is used only for UCC57138C variant.
OUTL	Test point of UCC57138C IC OUTL pin.
GND	Ground of EVM. Multiple test points.

2.5 Jumper Information

Table 2-4. Jumpers

Jumper	Name	Description
J1	EN/FLT_IN to VCC pullup	Pulls EN/FLT signal input to high by connecting to VCC
J2	IN_IN to VCC pullup	Pulls IN signal input to high by connecting to VCC
J3	Pin 7 designator	Allows pin 7 compatiblity with other UCC5713x variants
J4	Pin 8 designator	Allows pin 8 compatiblity with other UCC5713x variants

2.6 DBV Package Compatibility

The UCC57142EVM can be made compatible with several other TI gate drivers that use the DBV (SOT-23) package through modifying the top side of the EVM. The following TI gate drivers (and their variants) are supported: UCC27511, UCC27517, UCC27518, UCC27519, UCC27531, UCC27532, UCC27533, UCC27536, UCC27537, and UCC44273.

Note

The UCC57142EVM is primarily designed for use with the UCC57142 family of drivers. Optimal performance is not ensured if the EVM is used for other devices.

2.6.1 UCC27511 Modification

The UCC57142EVM out-of-the-box can be made compatible with the UCC27511 through the following modifications:

1. Remove any jumpers present on the EVM.
2. Remove R1, R3, R7, and D1.
3. Short C4, and C5.
4. Populate R5 with gate resistor.
5. Replace C7 with a 1µF capacitor (VDD bypass capacitor).

Table 2-5 lists how the I/O headers are used for the UCC27511.

Table 2-5. Header Functionality

EVM Header	Function
OCP / OCP_IN	VDD pin / VCC signal input
GND_IO	OUTH pin
OUT / Gate	OUTL pin / Gate
VDD / VCC	GND pin / unused
EN/FLT / EN/FLT_IN	IN- pin / IN- signal input(1)
IN / IN_IN	IN+ pin / IN+ signal input(1)

(1) The UCC27511 requires the input pins to be biased for proper operation. If using the driver in non-inverting configuration, then bias IN- pin to GND. If using the driver in inverting configuration, then bias IN+ pin to VDD. Bias the pins using the appropiate headers.

2.6.2 UCC27517 and UC27533 Modification

The UCC57142EVM out-of-the-box can be made compatible with the UCC27517 and UCC27533 through the following modifications:

1. Remove any jumpers present on the EVM.
2. Remove R1, D1, C3, and C4.
3. Short R11.
4. Adjust C8 to your desired load value.
5. Adjust R6 to your desired gate resistance.
6. Replace C7 with a 1µF capacitor (VDD bypass capacitor).

Table 2-6 lists how the I/O headers will be used for the UCC27517 and UCC27533.

Table 2-6. Header Functionality

EVM Header	Function
OCP / OCP_IN	VDD pin / VDD signal input
GND_IO	GND pin
OUT / Gate	IN+ pin / IN+ signal input(1)
VDD / VCC	IN- pin / IN- signal input(1)
EN/FLT / EN/FLT_IN	Unused
IN / IN_IN	OUT pin / Gate

(1) The UCC27517 requires the input pins to be biased for proper operation. If using the driver in non-inverting configuration, then bias IN- pin to GND. If using the driver in inverting configuration, then bias IN+ pin to VDD. Bias the pins using the appropiate headers.

2.6.2.1 UCC27518, UCC27519, UCC27536, and UCC27537 Modification

The UCC57142EVM out-of-the-box can be made compatible with the UCC27518, UCC27519, UCC27536, and UCC27537 through the following modifications:

1. Remove any jumpers present on the EVM.
2. Remove R1, R3, R6, C4, and D1.
3. Adjust C5 to the desired load value.
4. Populate C6 with 1µF capacitor (VDD bypass capacitor).

Table 2-7 lists how the I/O headers are used for the UCC27518, UCC27519, UCC27536, and UCC27537.

Table 2-7. Header Functionality

EVM Header	Function
OCP / OCP_IN	EN pin / EN signal input
GND_IO	GND pin
OUT / Gate	IN pin / IN signal input
VDD / VCC	OUT pin / unused
EN/FLT / EN/FLT_IN	Unused
IN_IN	VDD pin / unused

2.6.3 UCC27531 and UCC27532 Modification

The UCC57142EVM out-the-box can be made compatible with the UCC27531 and UCC27532 through the following modifications:

1. Remove any jumpers present on the EVM.
2. Remove R1, R3, R4, R7, R13, C4, C9, and D1.
3. Short R8, R11, and C5.
4. Adjust R6 and R10 to your desired gate resistance
5. Adjust C8 to your desired load value.
6. Populate C1 with a 1µF capacitor (VDD bypass capacitor)

Table 2-8 lists how the I/O headers will be used for the UCC27531 and UCC27532.

Table 2-8. Header Functionality

EVM Header	Function
OCP / OCP_IN	EN pin / EN signal input
GND_IO	IN pin
OUT / Gate	VDD pin / unused
VDD / VCC	GND pin / unused
EN/FLT / EN/FLT_IN	OUTL pin / unused
IN / IN_IN	OUTH pin / Gate

2.6.4 UCC44273 Modification

The UCC57142EVM out-the-box can be made compatible with the UCC44273 through the following modifications:

1. Remove any jumpers present on the EVM.
2. Remove R3, R6, C4, and C5.
3. Short R2.
4. Populate C6 with a 1µF capacitor (VDD bypass capacitor).

Table 2-9 lists how the I/O headers will be used for the UCC44273.

Table 2-9. Header Functionality

EVM Header	Function
OCP / OCP_IN	IN pin / IN signal input
GND_IO	GND pin
OUT / Gate	OUT pin / Gate
VDD / VCC	OUT pin / unused
EN/FLT / EN/FLT_IN	Unused
IN / IN_IN	VDD pin / VCC input signal

3 Implementation Results

3.1 Equipment Setup

This evaluation is to test the UCC57142EVM functionality out of the box. The assumption is that the user did not make any adjustments to the board.

3.1.1 Power Supply

- DC power supply #1
  - Voltage setting: 15V
  - Current limit: 0.1A
- DC power supply #2
  - Voltage setting: 5V
  - Current limit: 0.1A

3.1.2 Function Generator

Table 3-1. Function Generator Setup

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

3.1.3 Oscilloscope

Table 3-2. Oscilloscope Setup

	Bandwidth	Coupling	Termination	Scale Settings	Inverting
Channel 1-4	500MHz or above	DC	1MΩ or automatic	10 × or automatic	OFF

3.1.4 Digital Multimeter (DMM)

DMM #1 with voltage and current above 26V and 1A, for example: Fluke 187

3.2 Bench Setup

Follow the connection procedure below and Figure 3-1 can be used as a reference.

- Make sure all the output of the function generator, and voltage source are off before connection.
- Function generator Ch-A channel applied on IN_IN.
- Power Supply:
  - **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.
  - **Power supply #2:** negative node connected to OCP_IN and positive node connected to GND or GND_IO (whichever is more convenient), this makes it so OCP_IN sees **-5V, not 5V**.
- Oscilloscope:
  - **VDD Signal:** Connect oscilloscope Ch-1 probes to test points marked as **VDD to GND**, smaller measurement loop is preferred.
  - **IN Signal:** Connect oscilloscope Ch-2 probes to test points marked as **IN to GND**, smaller measurement loop is preferred.
  - **OUT Signal:** Connect oscilloscope Ch-3 probes to test points marked as **GATE to GND**, smaller measurement loop is preferred.
  - **FLTb Signal:** Connect oscilloscope Ch-4 probes to test points marked as **EN/FLT to GND**, smaller measurement loop is preferred.

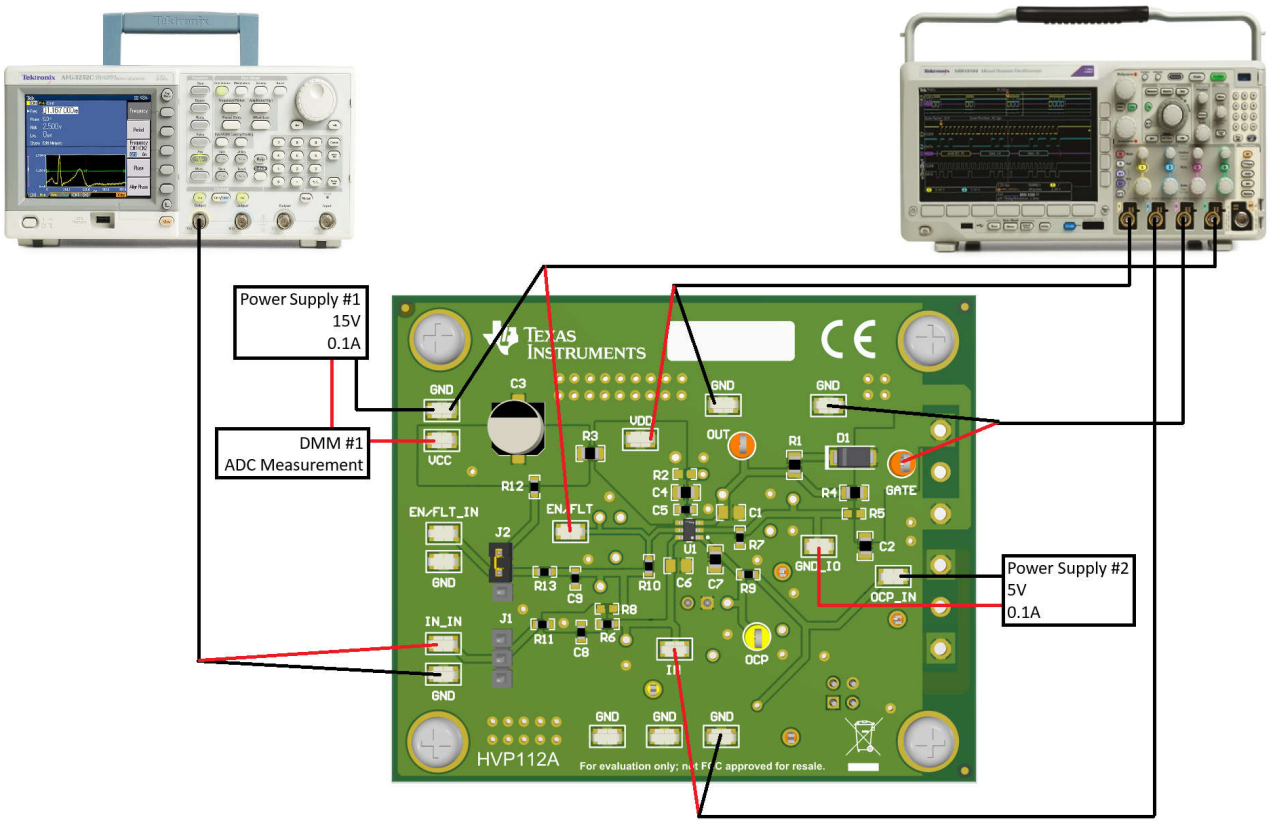


Figure 3-1. Bench Setup Diagram

3.3 Procedure and Results

1. Before powering up the test procedure, ensure that the connections are correct as shown as in section 6.
2. Turn on PSU #1 and check the current on DMM #1. If the current shown is **less than 1.25mA**, then the initial setup is correct.
3. Turn on function generator output and examine for the following conditions:
   a. The current on DMM #1 with the function generator ON should be **2.5mA±1.0mA**.
   b. Check the FLTb and OUT signals. **FLTb** should be high and **OUT** should be stable. Refer to Figure 3-2 for details.
   c. Turn on PSU #2, and check the FLTb and OUT signals. **Both signals** should be low. Refer to Figure 3-3 for details. If the signals are not low, then please recheck PSU #2 connections.
   d. Turn off PSU #2 and recheck the FLTb and OUT signals. **FLTb** should be high and **OUT** should be stable. Refer to Figure 3-2 for details.
4. Once testing is satisfied, power down the EVM by following the order:
   a. Disable function generator.
   b. Disable Power supply #2.
   c. Disable Power supply #1.
   d. Disconnect cables and probes.

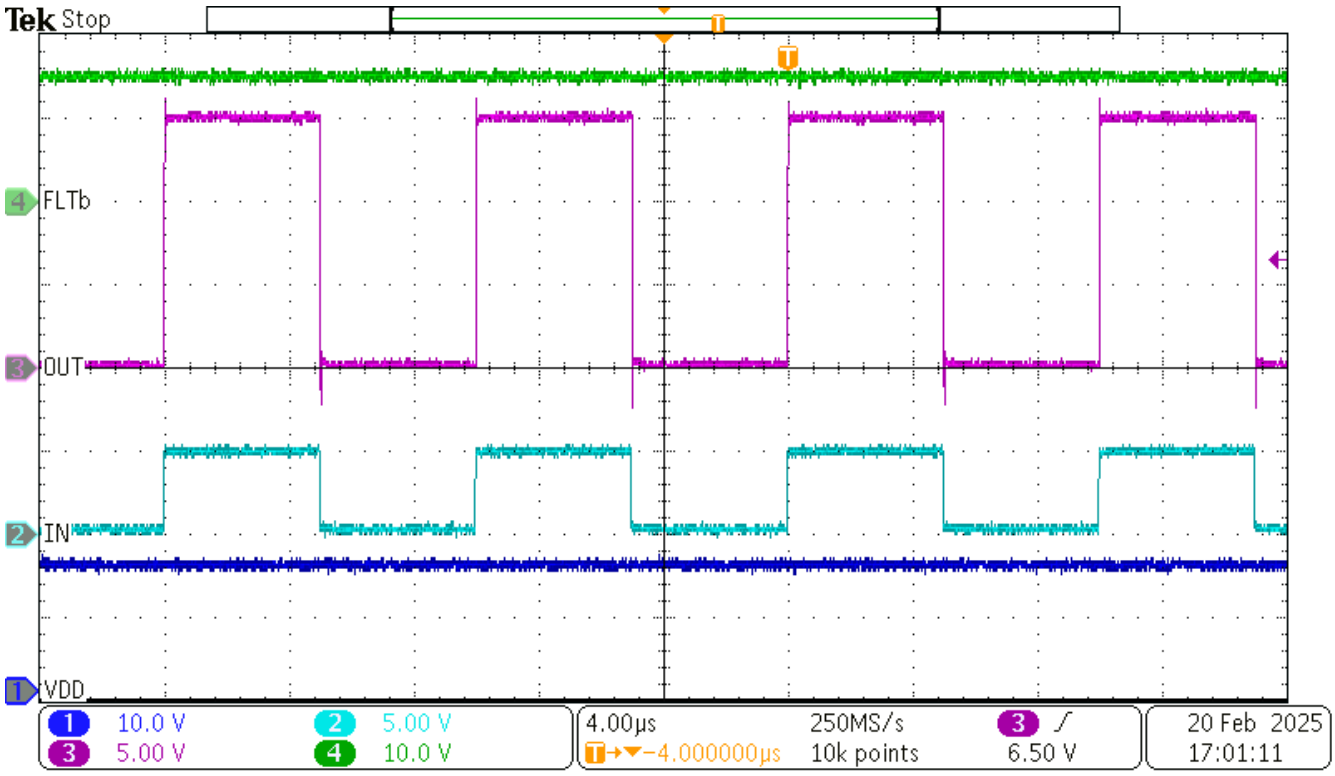


Figure 3-2. Reference Waveforms For When PSU #2 is Off

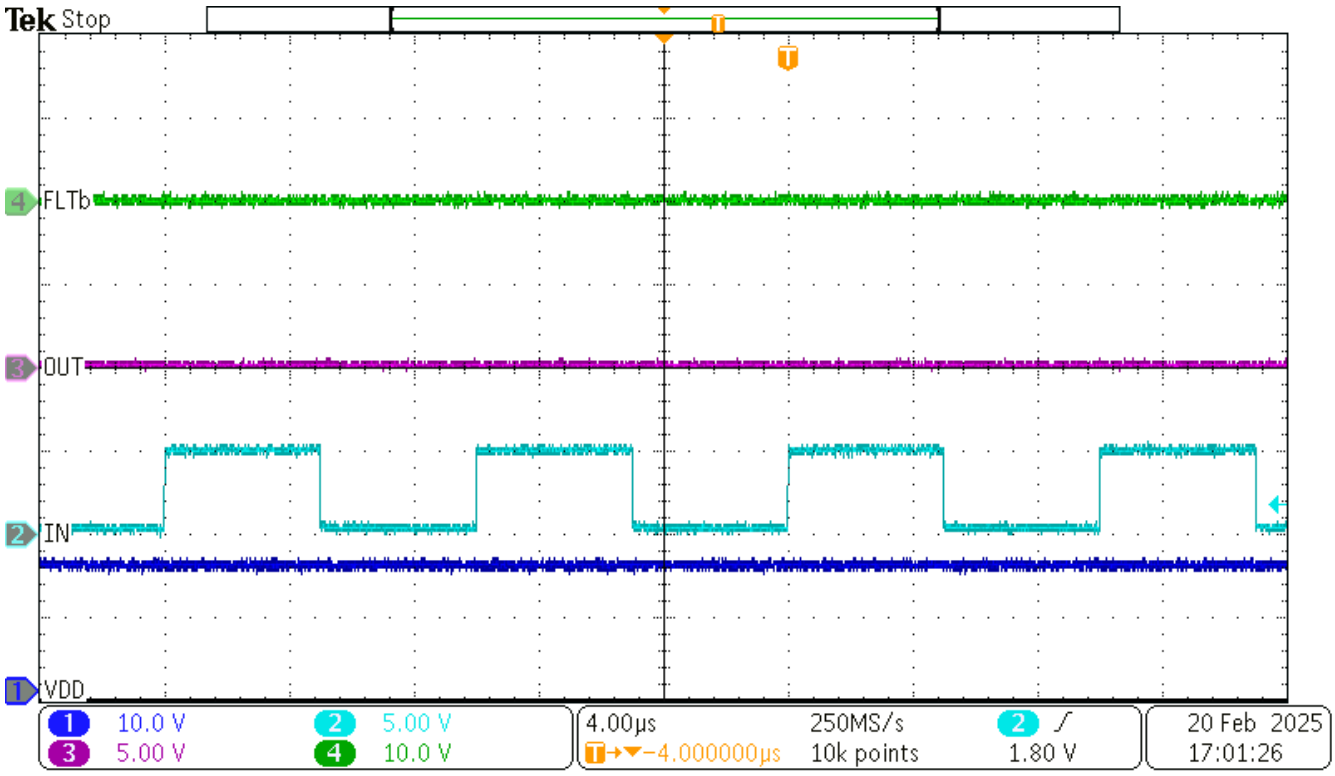


Figure 3-3. Reference Waveforms For When PSU #2 is On

3.4 Typical Performance Waveforms

3.4.1 Normal Operation

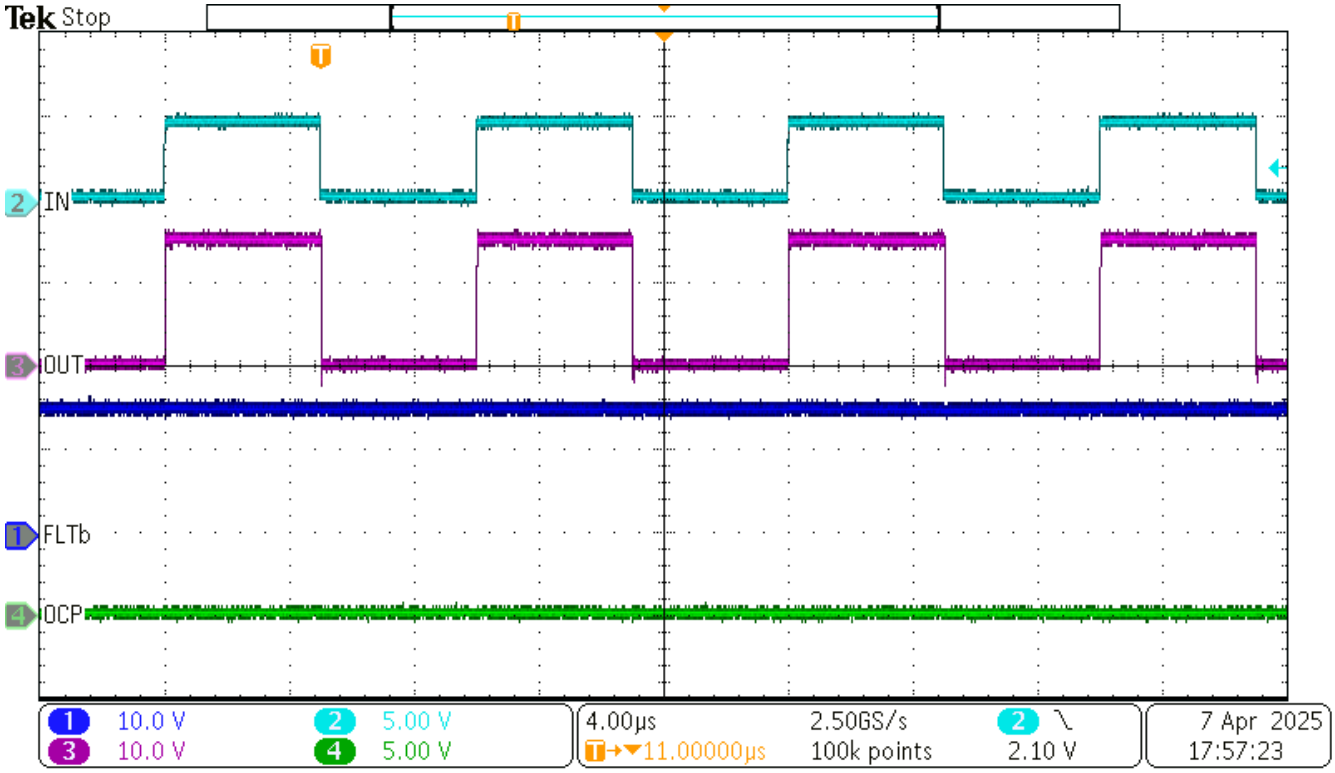


Figure 3-4. Normal Operation of the UCC57142

3.4.2 Overcurrent Protection Feature

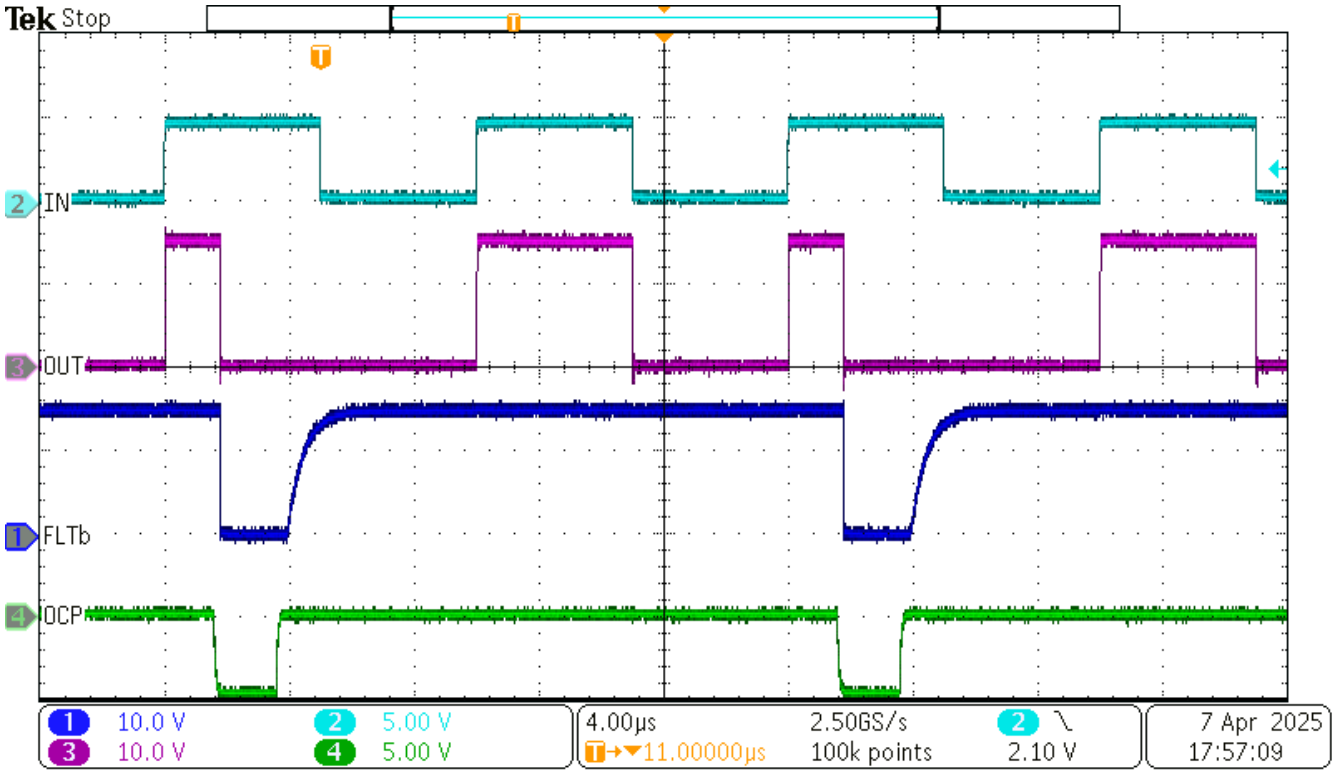


Figure 3-5. Overcurrent Protection Feature of the UCC57142

4 Hardware Design Files

4.1 Schematic

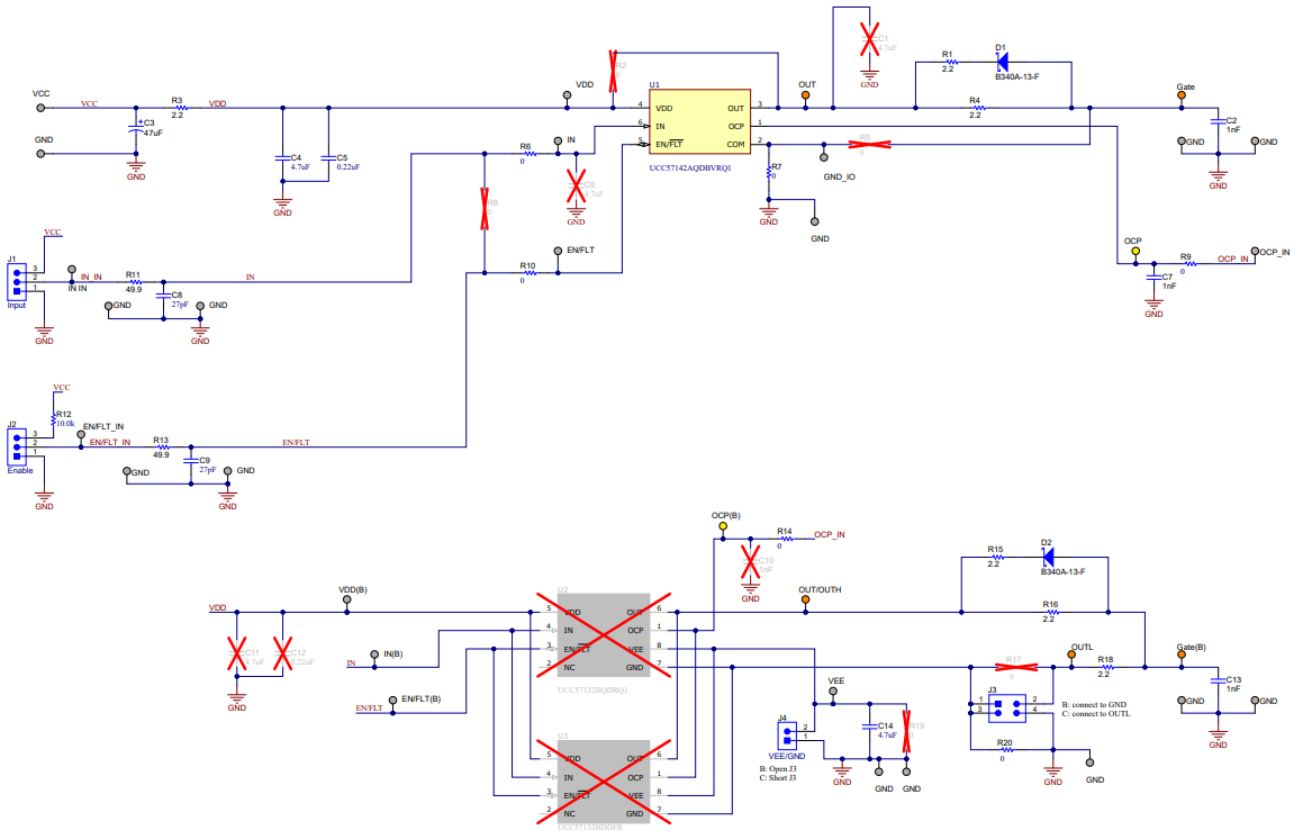


Figure 4-1. UCC57142EVM Schematic

4.2 PCB Layouts

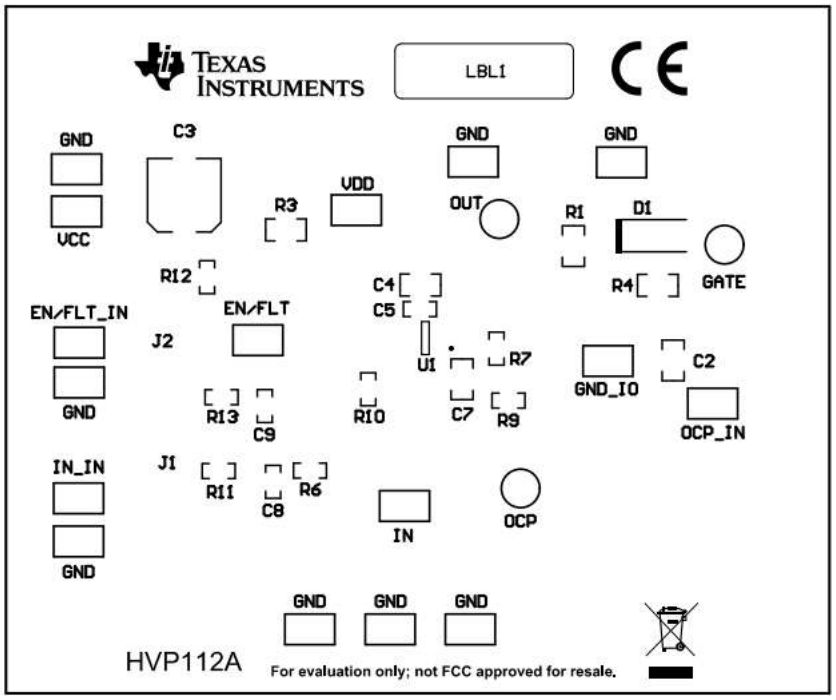


Figure 4-2. Top Overlay

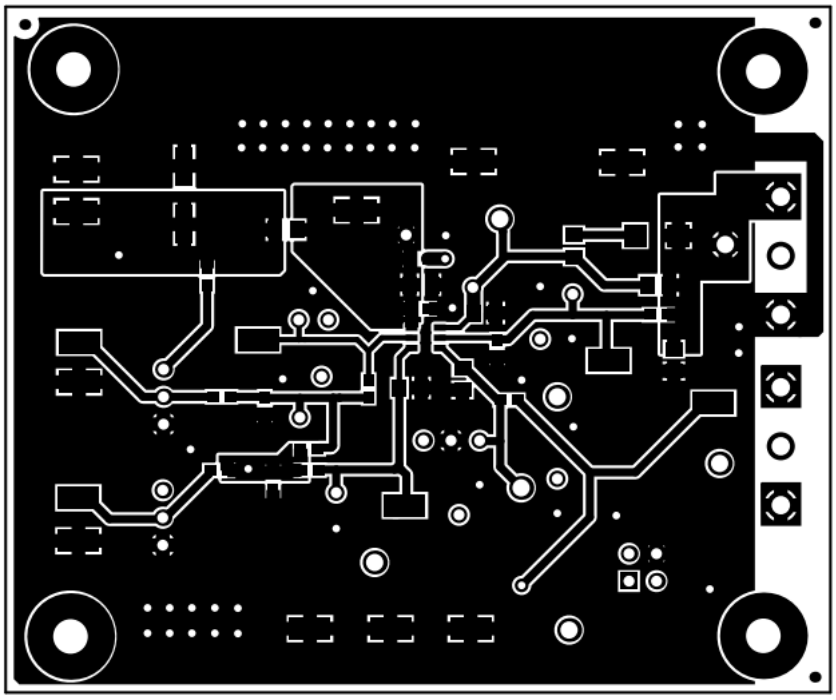


Figure 4-3. Top Layer

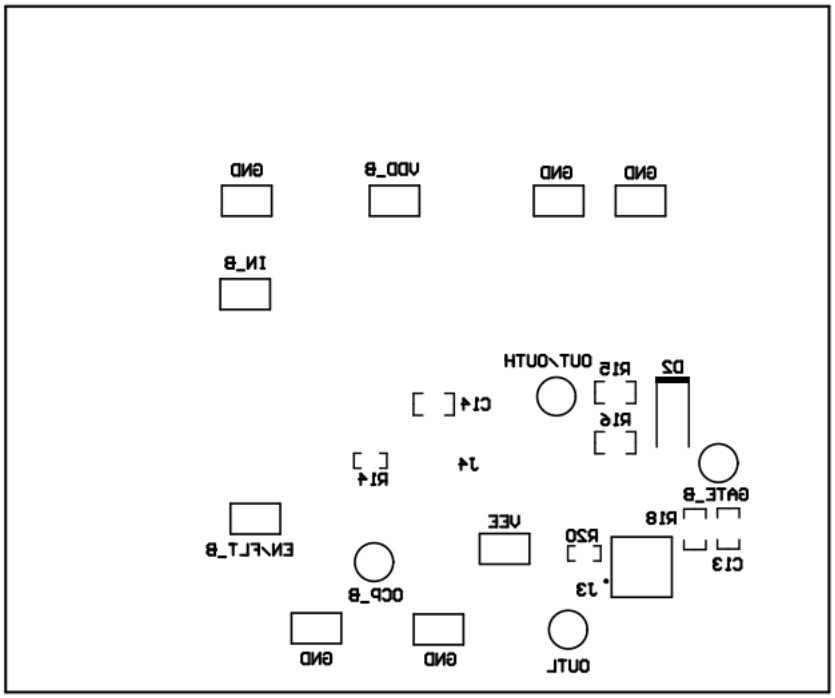


Figure 4-4. Bottom Overlay

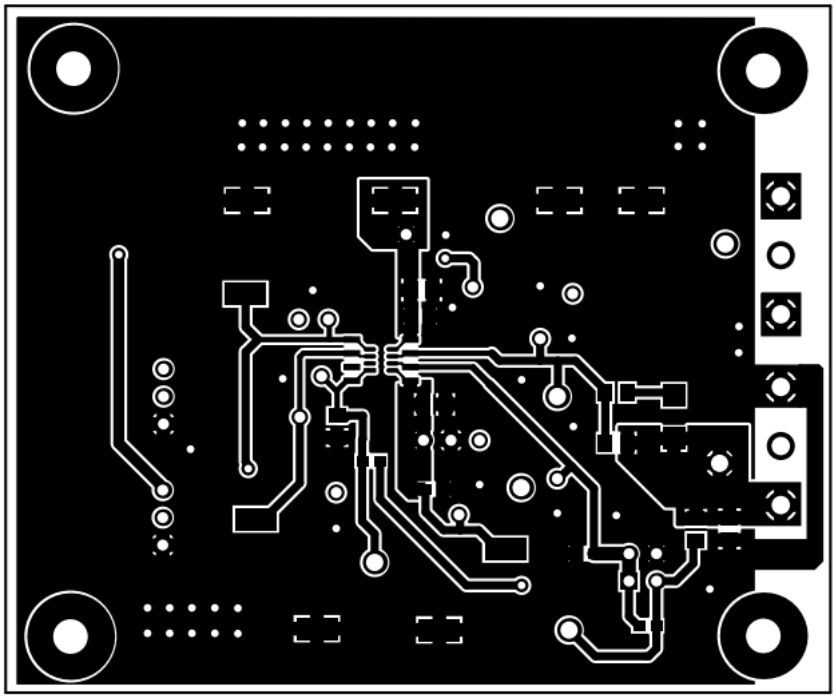


Figure 4-5. Bottom Layer

4.3 Bill of Materials (BOM)

Table 4-1. Bill of Materials (BOM)

Designator	Quantity	Description
C2, C7, C13	3	CAP, CERM, 1000 pF, 50 V, +/- 5%, X7R, 0805
C3	1	CAP, AL, 47 µF, 50 V, +/- 20%, 0.68 ohm, SMD
C4, C14	2	CAP, CERM, 4.7 µF, 35 V, +/- 10%, X7R, 0805
C5	1	CAP, CERM, 0.22 µF, 50 V, +/- 10%, X7R, 0603
C8, C9	2	CAP, CERM, 27 pF, 50 V, +/- 5%, C0G/NP0, 0603
D1, D2	2	Diode, Schottky, 40 V, 3 A, SMA
H1, H2, H3, H4	4	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead
H5, H6, H7, H8	4	Standoff, Hex, 0.5"L #4-40 Nylon
J1, J2	2	Header, 2.54 mm, 3x1, Tin, TH
J3	1	Header, 100mil, 2x2, Tin, TH
J4	1	Header, 2.54 mm, 2x1, Tin, TH
LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll
R1, R3, R4, R15, R16, R18	6	RES, 2.2, 5%, 0.125 W, AEC-Q200 Grade 0, 0805
R6, R7, R9, R10, R14, R20	6	RES, 0, 5%, 0.1 W, 0603
R11, R13	2	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603
R12	1	RES, 10.0 k, 1%, 0.1 W, 0603
SH-J1, SH-J3	2	Shunt, 100mil, Gold plated, Black
TP1, TP2, TP21, TP24, TP25	5	Test Point, Multipurpose, Orange, TH
TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP22, TP23, TP26, TP27, TP28, TP29, TP30, TP31, TP32	25	Test Point, Miniature, SMT
TP12, TP20	2	Test Point, Multipurpose, Yellow, TH
U1	1	UCC57142AQDBVRQ1

5 Compliance Information

The UCC57142EVM is in compliance with RoHS and REACH.

6 Additional Information

6.1 Trademarks

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

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

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

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

2 *Limited Warranty and Related Remedies/Disclaimers*:

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

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

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

WARNING

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

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

NOTE:

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

3 *Regulatory Notices:*

3.1 *United States*

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

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

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

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

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

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

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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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。

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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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