



## ABSTRACT

This user's guide describes the characteristics, operation, and use of the UCC27624EVM Evaluation Module (EVM). A complete schematic diagram, PCB layouts, and BOM are included in this document.

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## Trademarks

All trademarks are the property of their respective owners.

## 1 Introduction

The UCC27624EVM is designed to primarily evaluate the UCC27624 performance. The UCC27624 is a 30-V dual channel low-side driver with 5-A peak source and 5-A peak sink current for driving Si/IGBTs/SiC and GaN FETs. The UCC27624EVM board can be used to evaluate other pin-to-pin compatible parts in the supported package. The UCC27624 has low propagation delay and low propagation delay matching between the respective channels rising and falling edges of the driver outputs for reliable timing of the gate-drive signals. The UCC27624 inputs can tolerate signals as high as 26 V regardless of the VDD voltage which enhances device robustness.

The UCC27624 driver includes EN pins which enable the driver's outputs when pulled high, and disables the driver into a low standby current mode when low.

## 2 Description

The UCC27624EVM is designed to primarily evaluate the UCC27624 functionality. The driver's performances can be evaluated for capacitive loads and/or power devices with provisions for TO-220 footprints. The UCC27624EVM evaluation boards use surface-mount test points allowing connections to INA, INB, ENA, ENB, VDD, OUTA and OUTB UCC27624. For detailed device information, see the [UCC27624 30-V 5-A Dual Channel Low-Side Driver Data Sheet](#).

### 2.1 Features

The EVM supports the following features:

- EVM for the low-voltage features of the UCC27624 gate driver
- 4.5-V to 26-V VCC power supply range
- 5-A source, 5-A sink current
- -10V input voltage capability
- TTL-compatible inputs
- PCB layout optimized for bias supply bypassing cap, gate-drive resistance selection
- Capacitive load, external gate drive resistor and TO-220 footprint for N-ch MOSFETs gate drive network evaluation
- Ability to parallel both OUTA and OUTB channels for higher pulsed output current
- Allows quick verification of most of the data sheet parameters
- Test points allow probing all the key pins of the UCC27624

## 2.2 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 26-V range.
VDD	V <sub>DD</sub> positive input of UCC27624 IC
GND	Multiple test points. VCC negative input, HI_IN, LI_IN, and ENA_IN negative inputs, and ground at UCC27624 IC
INA_IN+	Channel-A PWM signal
INB_IN-	Channel-B PWM signal
INA	INA input pin
INB	INB input pin.
ENA_IN	Enable A input. Connect to GND to disable ch-A
ENB_IN	Enable B input. Connect to GND to disable ch-B
Gate_A	OUTA output at capacitive load and gate
Gate_B	OUTB output at capacitive load and gate
OUTA	OUTA output at driver's pin of UCC27624
OUTB	OUTB output at driver's pin of UCC27624

## 3 Electrical Specifications

For the full range of recommended operating specifications and design guidelines for driving loads, see the *UCC27624 Datasheet*.

### CAUTION

The UCC27624EVM 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 UCC27624EVM evaluation board. Within this test procedure, the following naming conventions are applied. See the UCC27624EVM *Bench Setup Diagram and Configuration*, [Figure 4-1](#), for details.

**DMM:** Digital multimeter

**EVM:** Evaluation module

### 4.2 Equipment

#### 4.2.1 Power Supply

DC power supply with voltage and current above 26-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 26 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 4-1](#) displays the two-channel function generator settings.

**Table 4-1. Two-Channel Function Generator Settings**

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

### 4.3.4 Oscilloscope Settings

Table 4-2 details the oscilloscope settings.

**Table 4-2. Oscilloscope Settings**

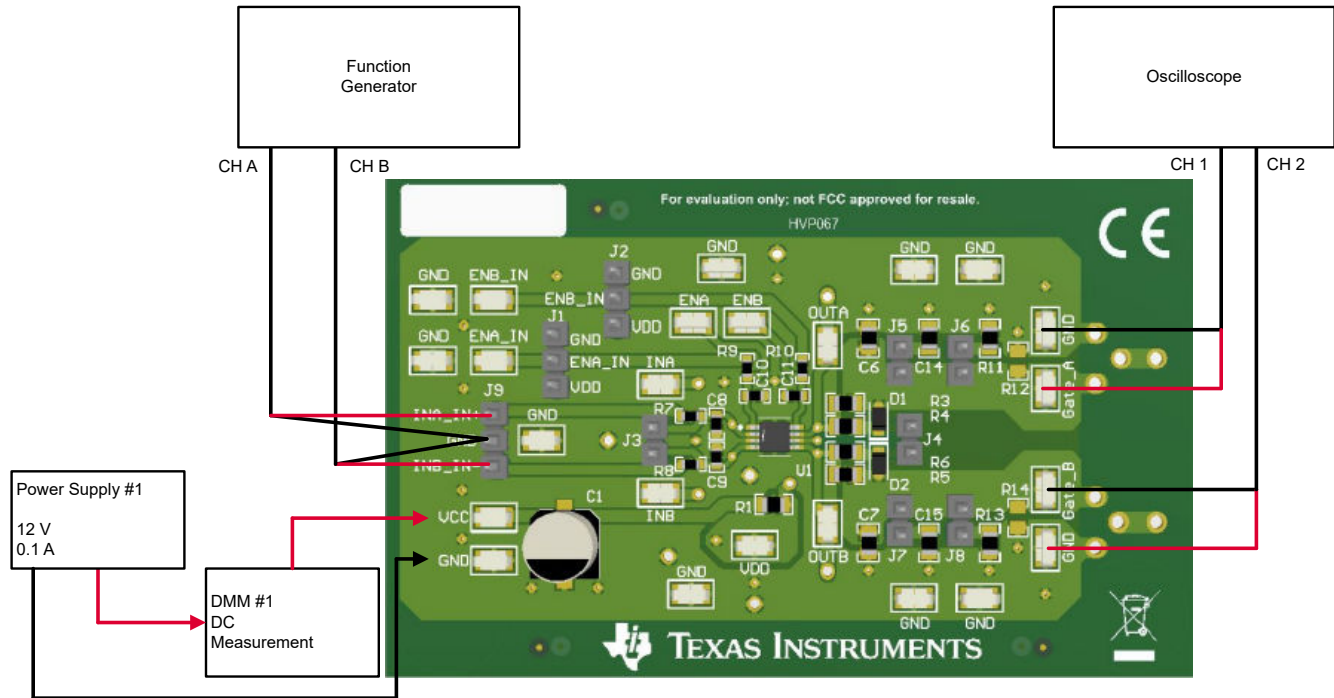
	Bandwidth	Coupling	Termination	Scale Settings	Inverting
Channel A	500 MHz or above	DC	1 MΩ or automatic	10 × or automatic	OFF
Channel B					

### 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 4-1.

- Make sure all the output of the function generator, voltage source are disabled before connection.
- Function generator Ch-A channel applied on INA\_IN+, see in Figure 4-1.
- Function generator Ch-B channel applied on INB\_IN-, see in Figure 4-1.
- 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 4-1.
- Connect oscilloscope Ch-1 probes to test points marked as Gate\_A, smaller measurement loop is preferred; see in Figure 4-1.
- Connect oscilloscope Ch-2 probes to test points marked as Gate\_B, smaller measurement loop is preferred; see in Figure 4-1.



**Figure 4-1. 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 4-1](#).
2. Enable supply #1, if the current on DMM1 is more than 0.25 mA and less than 0.8 mA, everything is set correctly.
3. Enable function generator outputs channel-A and channel-B.
4. The following conditions should be present:
  - a. Stable pulse output on channel-1 and channel-2 in the oscilloscope, refer to
  - b. Frequency measurement should be 100 kHz,  $\pm 5$  kHz or equal to the programmed function generator frequency
  - c. DMM #1 should display around 4.6 mA,  $\pm 2$  mA with the default load capacitance of 1.0 nF. For more information about operating current, see the [UCC27624 30-V 5-A Dual Channel Low-Side Driver Data Sheet](#).
5. Connect ENA\_IN and ENB\_IN test points to GND test point with jumpers. The pulse outputs on channel-1 and channel-2 will cease operation and the voltage level should be near ground.

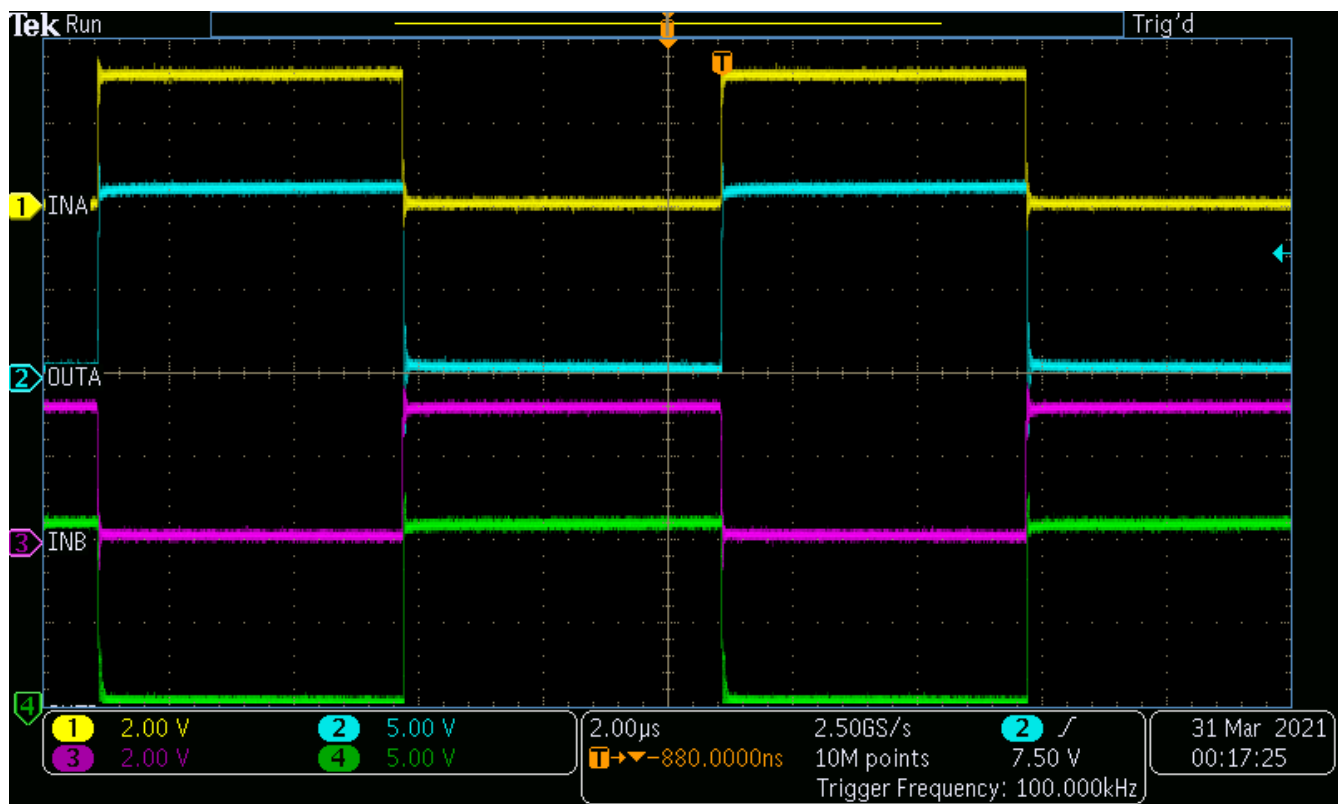


Figure 5-1. Example Input and Output Waveforms

### 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 Typical Performance Waveforms ( $C_L = 1800\text{ pF}$ )

### 6.1 Propagation Delays

The following waveforms illustrate the INx inputs and OUTx output.

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

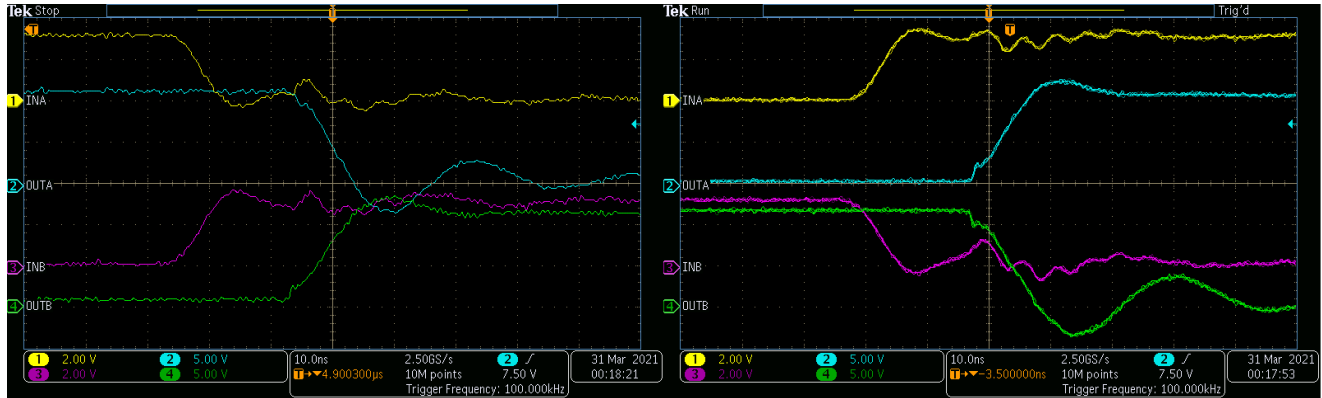
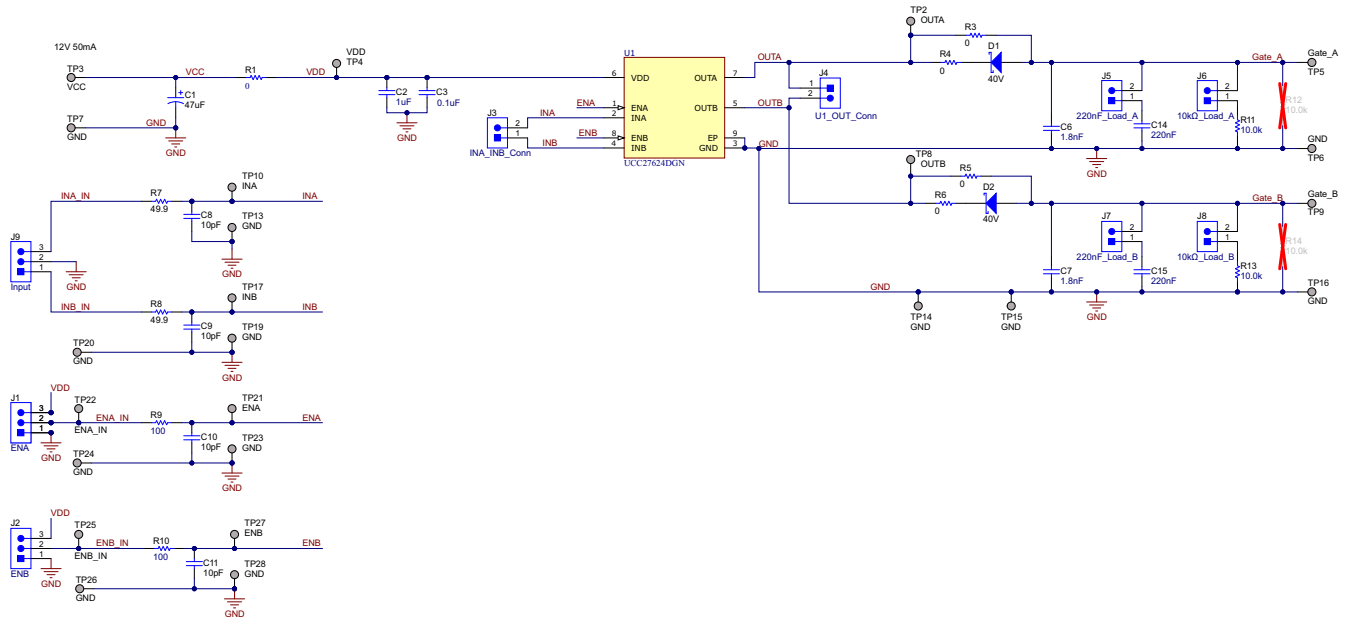


Figure 6-1. IN+ to OUT Propagation Delay Waveforms

## 7 Schematic

Figure 7-1 shows the UCC27624EVM schematic diagram.



**Figure 7-1. UCC27624EVM Schematic**

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



## 8 Layout Diagrams

Figure 8-1 through Figure 8-6 show the PCB layout information for the UCC27624EVM.

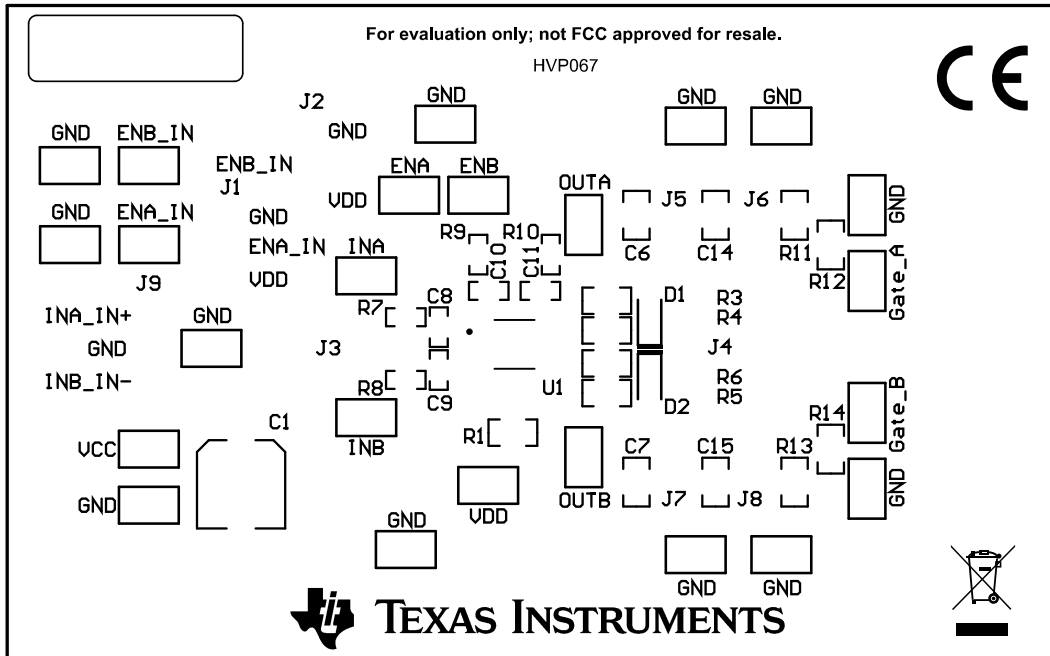


Figure 8-1. Top Overlay

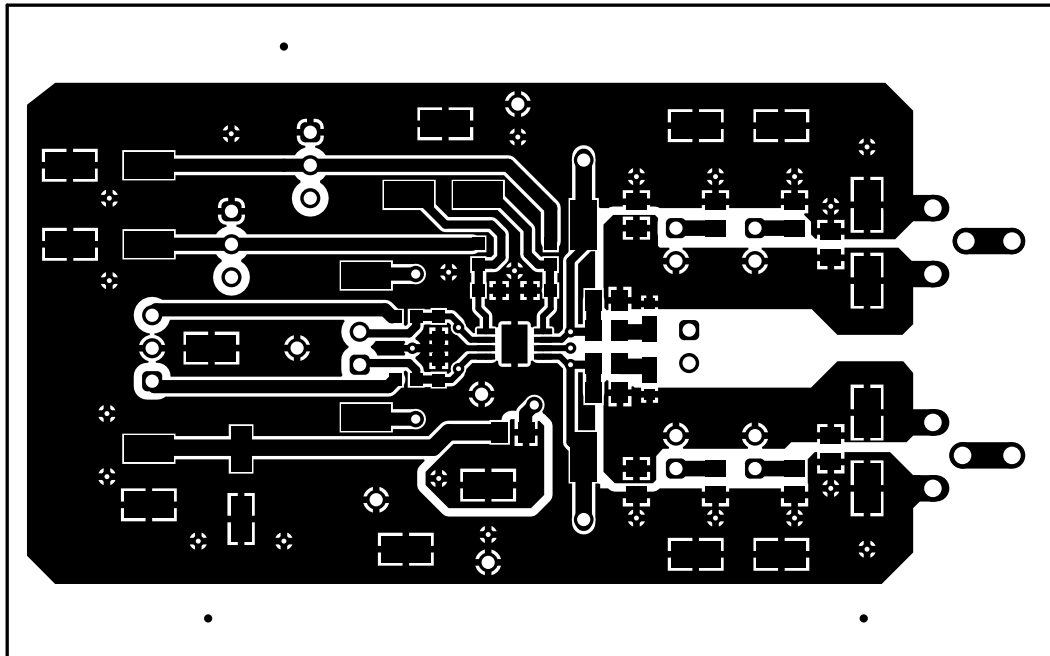


Figure 8-2. Top Layer

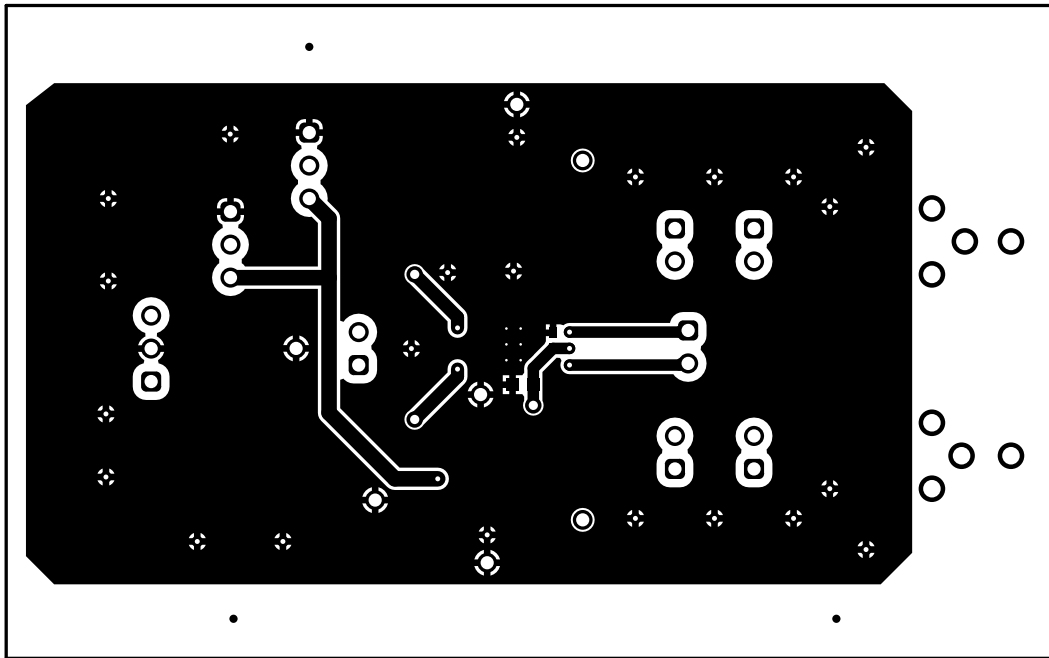


Figure 8-3. Bottom Layer

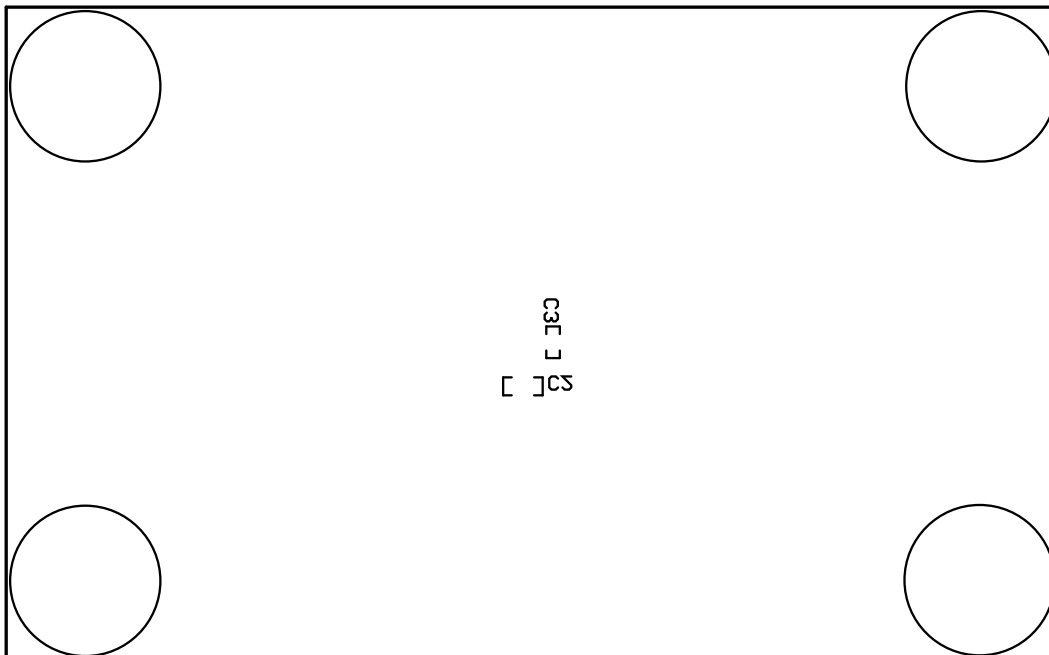


Figure 8-4. Bottom Overlay

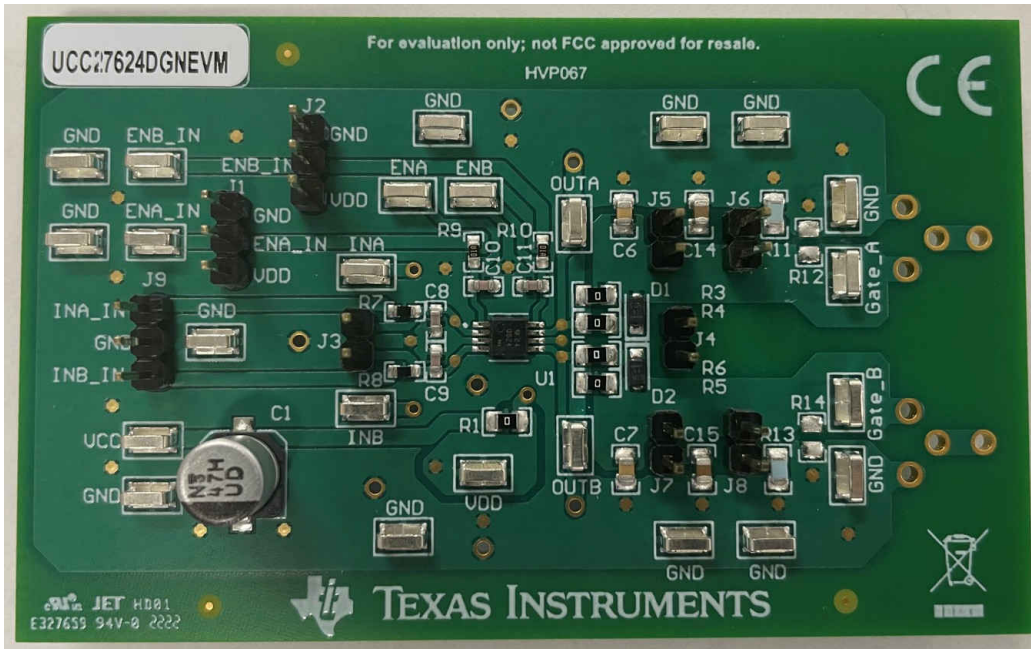


Figure 8-5. Top Image

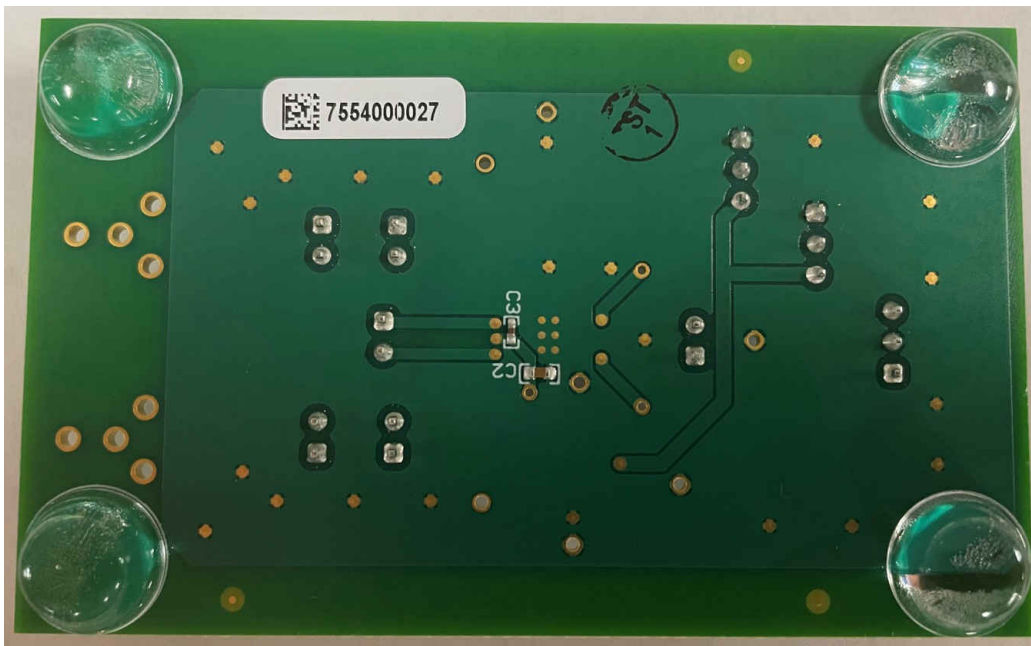


Figure 8-6. Bottom Image

## 9 List of Materials

**Table 9-1. UCC27624EVM List of Materials**

Quantity	Description	Description
1	C1	CAP, AL, 47 uF, 50 V, +/- 20%, 0.68 ohm, SMD
2	C2, C12	CAP, CERM, 1 uF, 50 V, +/- 10%, X6S, 0603
2	C3, C13	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0402
2	C6, C7	CAP, CERM, 1800 pF, 50 V, +/- 10%, X7R, 0805
4	C8, C9, C10, C11	CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, 0603
2	C14, C15	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0805
2	D1, D2	Diode, Schottky, 30 V, 1 A, AEC-Q101, MicroSMP
6	FID1, FID2, FID3, FID4, FID5, FID6	Fiducial mark. There is nothing to buy or mount.
4	H1, H2, H3, H4	Bumpon, Hemisphere, 0.44 X 0.20, Clear
1	J1	Header, 2.54 mm, 3x1, Tin, TH
1	J2	Header, 2.54 mm, 3x1, Tin, TH
1	J3	Header, 2.54 mm, 2x1, Tin, TH
1	J4	Header, 2.54 mm, 2x1, Tin, TH
1	J5	Header, 2.54 mm, 2x1, Tin, TH
1	J6	Header, 2.54 mm, 2x1, Tin, TH
1	J8	Header, 2.54 mm, 2x1, Tin, TH
1	J9	Header, 2.54 mm, 3x1, Tin, TH
1	LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll
1	R1	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805
4	R3, R4, R5, R6	RES, 0, 5%, 0.125 W, 0805
2	R7, R8	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603
2	R9, R10	RES, 100, 0.01%, 0.1 W, AEC-Q200 Grade 0, 0603
4	R11, R12, R13, R14	RES, 10.0 k, 1%, 0.2 W, 0805
1	TP2	Test Point, Miniature, SMT
1	TP3	Test Point, Miniature, SMT
1	TP4	Test Point, Miniature, SMT
1	TP5	Test Point, Miniature, SMT
12	TP6, TP7, TP13, TP14, TP15, TP16, TP19, TP20, TP23, TP24, TP26, TP28	Test Point, Miniature, SMT
1	TP8	Test Point, Miniature, SMT
1	TP9	Test Point, Miniature, SMT
1	TP10	Test Point, Miniature, SMT
1	TP17	Test Point, Miniature, SMT
1	TP21	Test Point, Miniature, SMT
1	TP22	Test Point, Miniature, SMT
1	TP25	Test Point, Miniature, SMT
1	TP27	Test Point, Miniature, SMT

**Table 9-1. UCC27624EVM List of Materials (continued)**

Quantity	Description	Description
1	U1	UCC27624 Dual, 5A, High-Speed Low-Side Power MOSFET Driver, with Negative Input Voltage Ability, D0008A (SOIC-8)

## 10 Bill of Materials

**Table 10-1. Bill of Materials**

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
-4	IPCB	1		HVP067	Any	Printed Circuit Board	
-3	C1	1	47uF	UUD1H470MCL1GS	Nichicon	CAP, AL, 47 uF, 50 V, +/- 20%, 0.68 ohm, SMD	6.3x7.7
-2	C2	1	1uF	C1608X6S1H105K080AC	TDK	CAP, CERM, 1 uF, 50 V, +/- 10%, X6S, 0603	603
-1	C3	1	0.1uF	C1005X7R1H104K050BB	TDK	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0402	402
0	C6, C7	2	1800pF	08055C182KAT2A	AVX	CAP, CERM, 1800 pF, 50 V, +/- 10%, X7R, 0805	805
1	C8, C9, C10, C11	4	10pF	C0603C100J5GACTU	Kemet	CAP, CERM, 10 pF, 50 V, +/- 5%, COG/NP0, 0603	603
2	C14, C15	2	0.22uF	C0805C224K5RACTU	Kemet	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0805	805
3	D1, D2	2	40V	MSS1P4-M3/89A	Vishay-Siliconix	Diode, Schottky, 40 V, 1 A, MicroSMP	MicroSMP
4	FID4, FID5, FID6	3		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
5	H1, H2, H3, H4	4		SJ-5303 (CLEAR)	3M	Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon
6	J1, J2, J9	3		TSW-103-07-T-S	Samtec	Header, 2.54 mm, 3x1, Tin, TH	Header, 2.54 mm, 3x1, TH
7	J3, J4, J5, J6, J7, J8	6		TSW-102-07-T-S	Samtec	Header, 2.54 mm, 2x1, Tin, TH	Header, 2.54 mm, 2x1, TH
8	LBL1	1		THT-14-423-10	Brady	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch
9	R1	1	0	ERJ-6GEY0R00V	Panasonic	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805
10	R3, R4, R5, R6	4	0	MCR10EZPJ000	Rohm	RES, 0, 5%, 0.125 W, 0805	805
11	R7, R8	2	49.9	CRCW060349R9FKEA	Vishay-Dale	RES, 49.9, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603

**Table 10-1. Bill of Materials (continued)**

Item #	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
12	R9, R10	2	100	RNCF0603TKY100R	Stackpole Electronics Inc	RES, 100, 0.01%, 0.1 W, AEC-Q200 Grade 0, 0603	603
13	R11, R13	2	10.0k	MCU08050C1002FP500	Vishay/Beyschlag	RES, 10.0 k, 1%, 0.2 W, 0805	805
14	TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP13, TP14, TP15, TP16, TP17, TP19, TP20, TP21, TP22, TP23, TP24, TP25, TP26, TP27, TP28	24		5019	Keystone	Test Point, Miniature, SMT	Test Point, Miniature, SMT
15	U1	1		UCC27624DGN	Texas Instruments	30-V, 5-A Dual-Channel Low-Side Gate Driver with -10-V Input Capability	VSSOP8
16	FID1, FID2, FID3	0		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
17	R12, R14	0	10.0k	MCU08050C1002FP500	Vishay/Beyschlag	RES, 10.0 k, 1%, 0.2 W, 0805	805

## 11 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
September 2022	*	Initial Release

## 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 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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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 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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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。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page)  
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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.

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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.
  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.
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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, INDEMNITY 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.

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