EVM User's Guide: TLV3607 TLV3607EVM

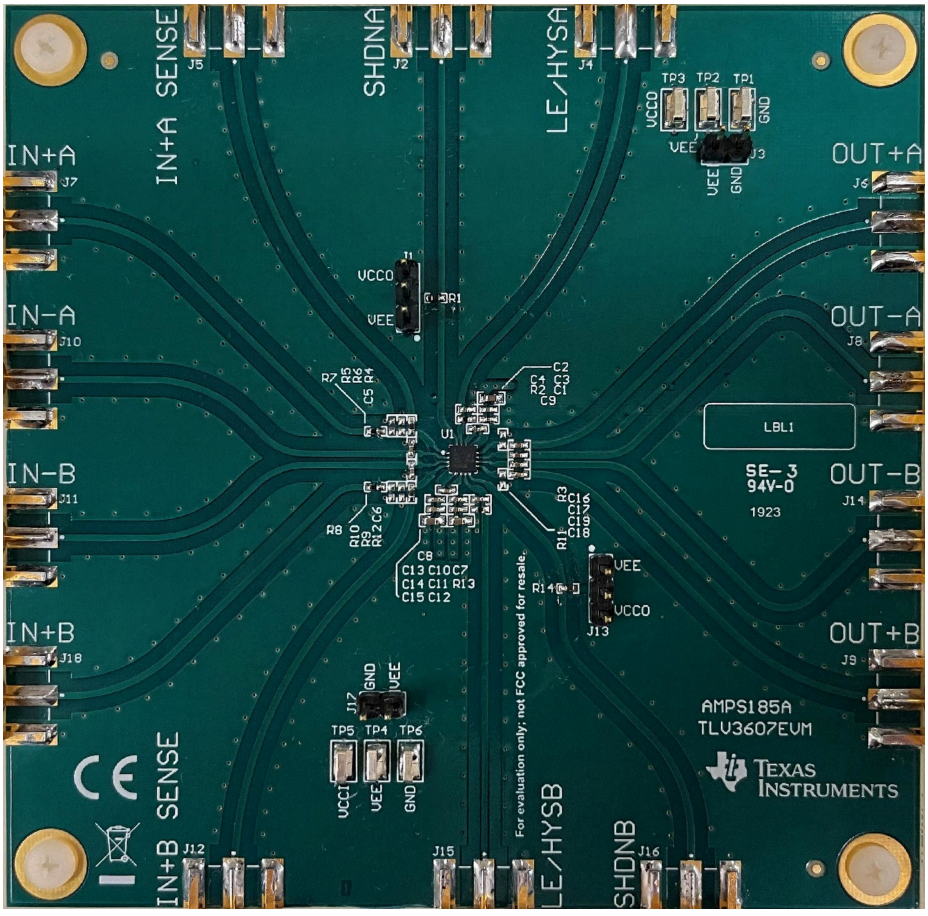
TLV3607 Evaluation Module

Description

The TLV3607EVM is an evaluation board designed to evaluate the high-speed dual channel TLV3607 comparator. The TLV3607EVM has layout options intended to simply evaluate timing performance with different measurement tools. The output of the TLV3607 is designed for low-voltage differential signals (LVDS), which provide high-speed signals to interconnect devices such as FPGAs with minimal power dissipation.

Features

- Low propagation delay
- Low overdrive dispersion
- High toggle frequency
- Narrow pulse width detection capability
- LVDS output
- Low input offset voltage
- RTE Package 16-pin WQFN



TLV3607EVM Board (Top View)

1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the functionality and set up procedure of the evaluation board TLV3607EVM, which is designed to evaluate the performance of the high-speed dual channel TLV3607 comparator. Information such as the contents of the kit, specifications of the device, and recommended equipment for the set up is also included. Although TLV3607 can be operated in either single or split supply configuration, this user's guide will assume single supply is used.

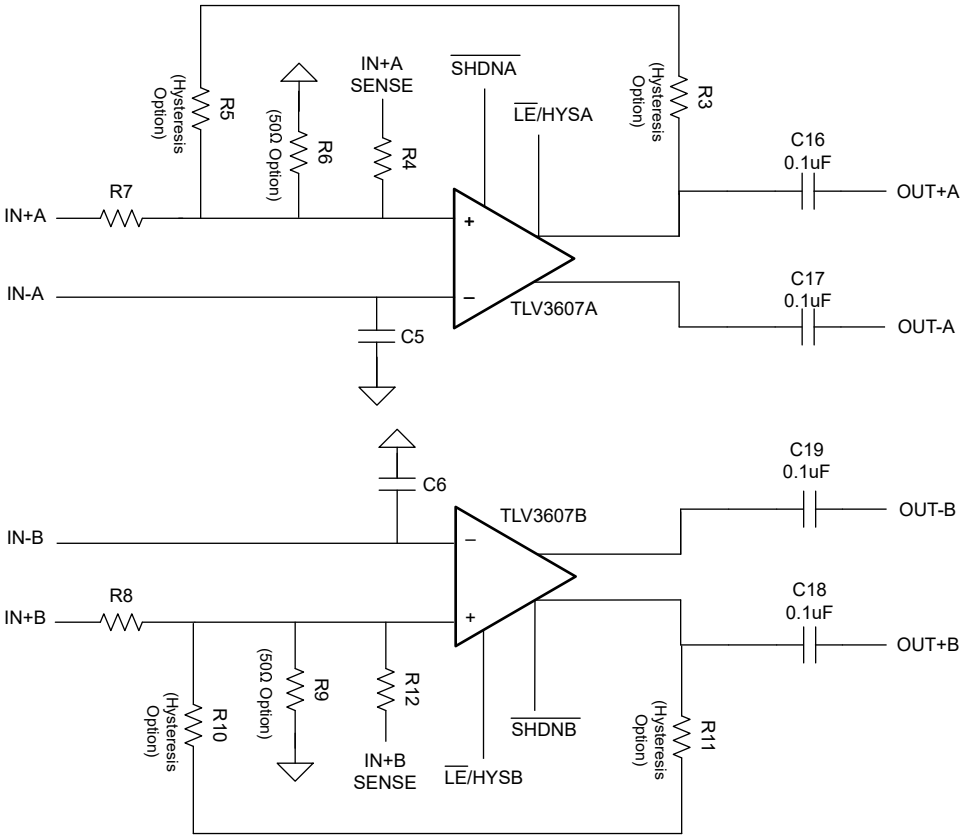


Figure 1-1. TLV3607EVM Block Diagram

1.2 Kit Contents

The kit comes with the following:

- 1 x TLV3607EVM
- 4 x jumper caps

1.3 Specification

- Supply Range: +2.4 V to +5.5 V
- Input Common Mode Voltage Range: (VEE - 0.2 V) to (VCCI + 0.2 V)

Table 1-1. TLV3607EVM SMA and Test Point to DUT Pin Mapping

TLV3607EVM CONNECTIONS	
SMA J7: IN+A SMA J5: IN+A SENSE	IN+A (Pin 1)
SMA J10: IN-A	IN-A (Pin 2)
SMA J11: IN-B	IN-B (Pin 3)
SMA J18: IN+B SMA J12: IN+B SENSE	IN+B (Pin 4)
Test Point 5: VCCI	VCCI (Pin 5)
Test Point 2 and 4: VEE	VEE (Pin 6, 14)
SMA J15: $\overline{\text{LE}}$/HYSB	$\overline{\text{LE}}$/HYSB (Pin 7)
SMA J16: $\overline{\text{SHDNB}}$	$\overline{\text{SHDNB}}$ (Pin 8)
SMA J9: OUT+B	OUT+B (Pin 9)
SMA J14: OUT-B	OUT-B (Pin 10)
SMA J8: OUT-A	OUT-A (Pin 11)
SMA J6: OUT+A	OUT+A (Pin 12)
Test point 3: VCCO	VCCO (Pin 13)
SMA J4: $\overline{\text{LE}}$/HYSA	$\overline{\text{LE}}$/HYSA (Pin 15)
SMA J2: $\overline{\text{SHDNA}}$	$\overline{\text{SHDNA}}$ (Pin 16)
Test Points 1 and 6: GND	System Ground

Note

There are only sense lines for the non-inverting inputs (IN+A SENSE and IN+B SENSE).

1.4 Device Information

The following device is used in this evaluation module:

- TLV3607RTER

2 Hardware

2.1 Recommended Equipment Setup

- Power Supply
- High Speed Functional Generator with fast rise/fall time recommended (≤ 500 ps)
- High Speed Oscilloscope with 50-Ω terminations
- SMA Cables/adapters
  - All sensed input signals and output signals must have matched cable lengths
    - IN+A SENSE, IN+B SENSE, OUT+A, OUT-A, OUT+B, OUT-B

2.2 Board Setup

2.2.1 Power Supplies

The TLV3607EVM can operate from +2.4V to +5.5V in either single or split supply configuration. Connect VCCI and VCCO to TP5 and TP3, respectively. For single supply configuration, connect system ground to TP1 and TP6; use J3 and J17 to connect VEE to GND. This user's guide assumes single supply configuration is used.

If split supply configuration is desired, then connect VEE to TP2 and TP4; connect GND to TP1 and TP6. This configuration can be desirable if the reference voltage is at GND or if there is a need to zoom into the amplitude of the input as much as possible.

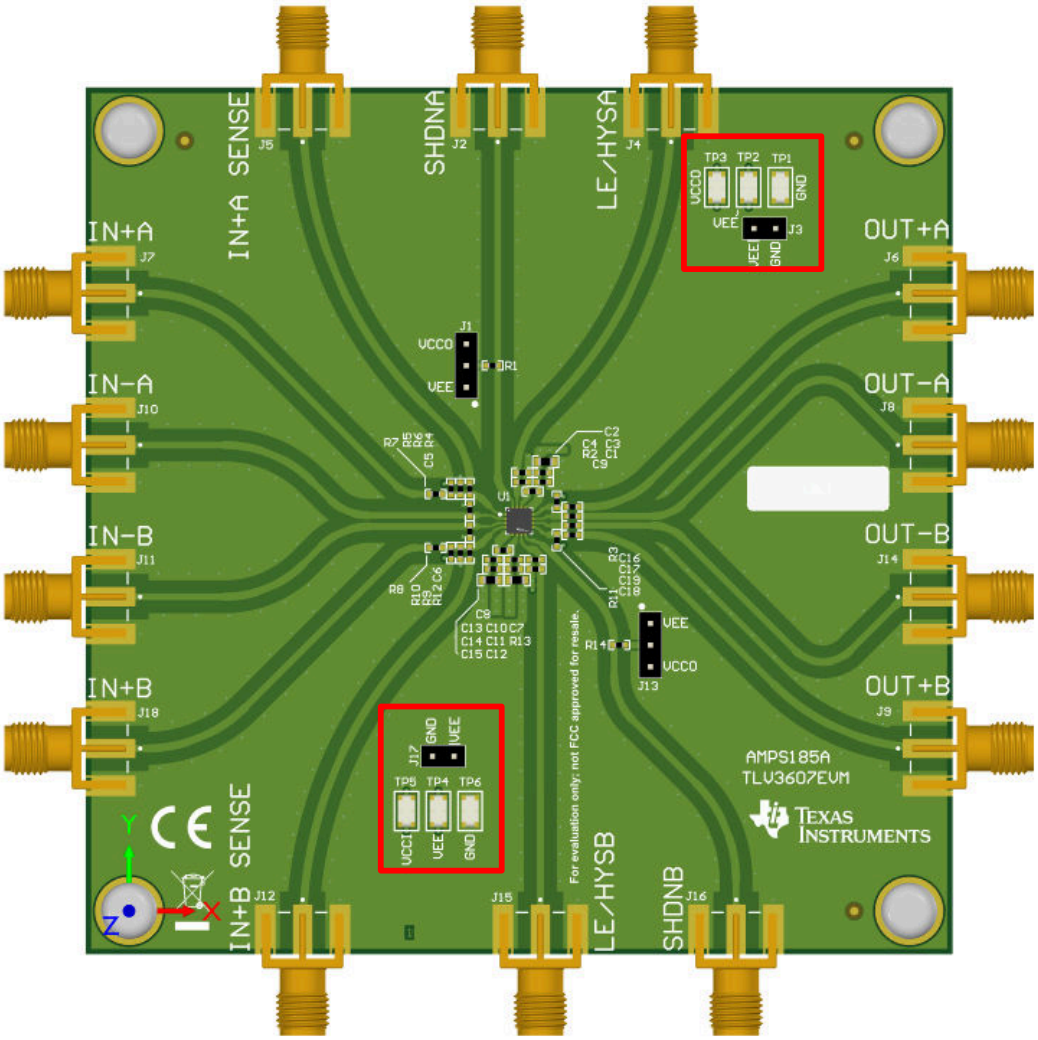


Figure 2-1. TLV3607EVM Power Supplies Connection

2.2.2 Inputs

Resistors R4 and R12 are 0-Ω resistors. The non-inverting input terminals (IN+A and IN+B) have corresponding sense lines so that the inputs to the device can be terminated on the lines with 50-Ω to an oscilloscope. This allows the input signals to be observed with minimal loading and distortion. There are also optional input resistors (R6 and R9) for direct 50-Ω termination if required by the input signal generator, otherwise the input resistors can be left uninstalled.

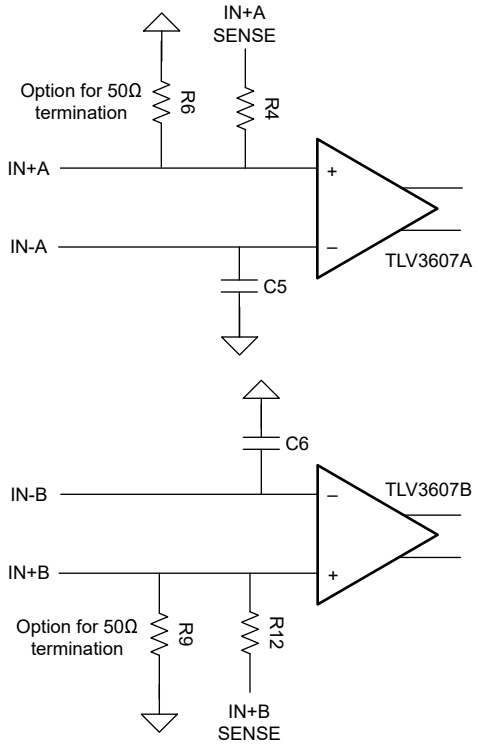


Figure 2-2. Input Side Block Diagram

The TLV3607 can be put in either active or shutdown mode through the $\overline{\text{SHDNA}}$ and $\overline{\text{SHDNB}}$ pins. Each channel of the TLV3607 is in shutdown mode when their respective shutdown pins are tied to VEE though jumpers J1 and J13; otherwise the pins can be left open or tied to VCCO. If necessary to dynamically control when the device shutdowns, then a pulsing signal can be applied to SMA connectors J2 and J16.

The TLV3607 utilizes pins $\overline{\text{LE}}$/HYSA and $\overline{\text{LE}}$/HYSB to adjust the internal hysteresis of the comparator through the attachment of a external resistors R2 and R14 connecting to VEE. R2 and R14 are 150-kΩ resistors to allow for 30 mV of internal hysteresis, but these resistors can be replaced accordingly to desired amount of hysteresis. C4 and C7 are 100 pF capacitors for extra filtering.

Alternatively, these pins also have a latch functionality. If the pin is connected to VEE, then the device holds the output state for as long as the pin remains connected to that voltage. If the pin is connected to VCC, then the device functions normally with no hysteresis. However, if necessary to dynamically control when the device latches, then a pulsing signal can be applied to SMA connectors J4 and J15.

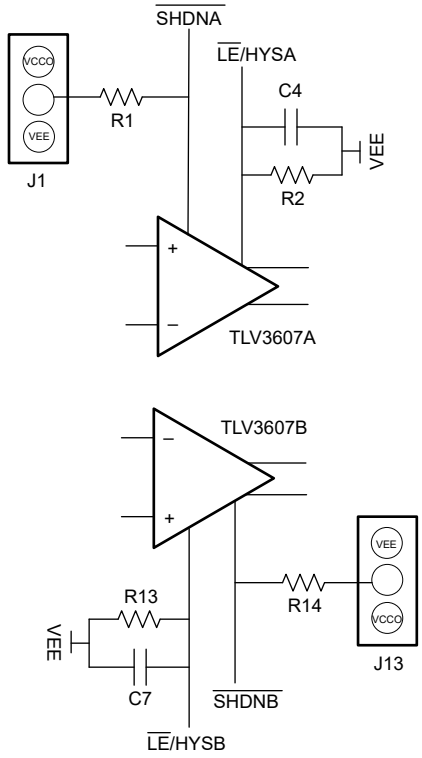


Figure 2-3. $\overline{\text{SHDN}}$ and $\overline{\text{LE}}$/HYS Side Block Diagram

2.2.3 Outputs

C16, C17, C18, and C19 are installed with 0.1-uF capacitors. If a 100-Ω differential probe is unavailable to measure the LVDS output, then these capacitors allow for the AC portion of the signal to be seen on a 50-Ω terminated scope. Keep in mind that any duty cycle other than 50% results in a DC portion of the signal that is not halfway between V_{OH} and V_{OL}. As mentioned earlier, this is due to the charging and discharging of the capacitors. A higher duty cycle results in a higher DC output voltage because the capacitors are charging more than the capacitors are discharging.

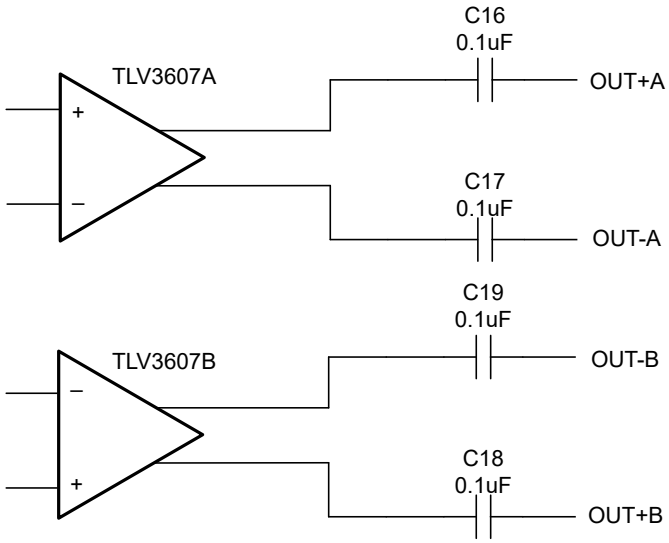


Figure 2-4. Output Side Block Diagram

2.2.4 Hysteresis

The TLV3607 utilizes pins $\overline{LE}$/HYSA and $\overline{LE}$/HYSB to adjust the internal hysteresis of the comparator through the attachment of a external resistors R2 and R14 connecting to VEE. These resistors can be replaced accordingly to desired amount of hysteresis. A curve of hysteresis versus resistance is provided below to provide guidance in setting the desired amount.

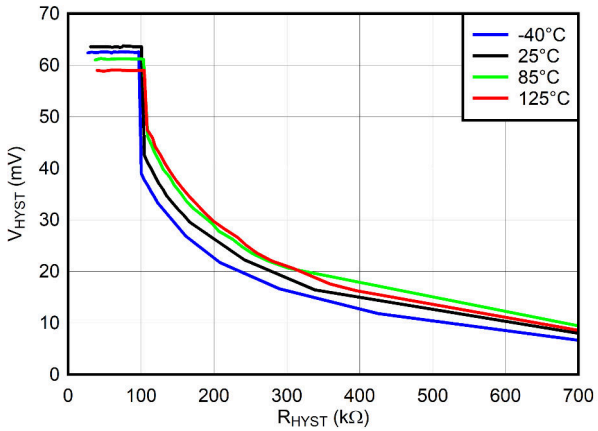


Figure 2-5. V_{HYST} (mV) vs. R_{HYST} (kΩ)

The TLV3607EVM is also able to support external hysteresis for each non-inverting input. Input resistors R7 and R8 are 0-Ω resistors but can be replaced accordingly for desired amount of hysteresis. For channel A, the feedback resistor is the combination of R5 and R3. Likewise, for channel B, the feedback resistor is the combination of R10 and R11. All resistors must be populated. If no external hysteresis is required, then these optional feedback resistors can be left uninstalled.

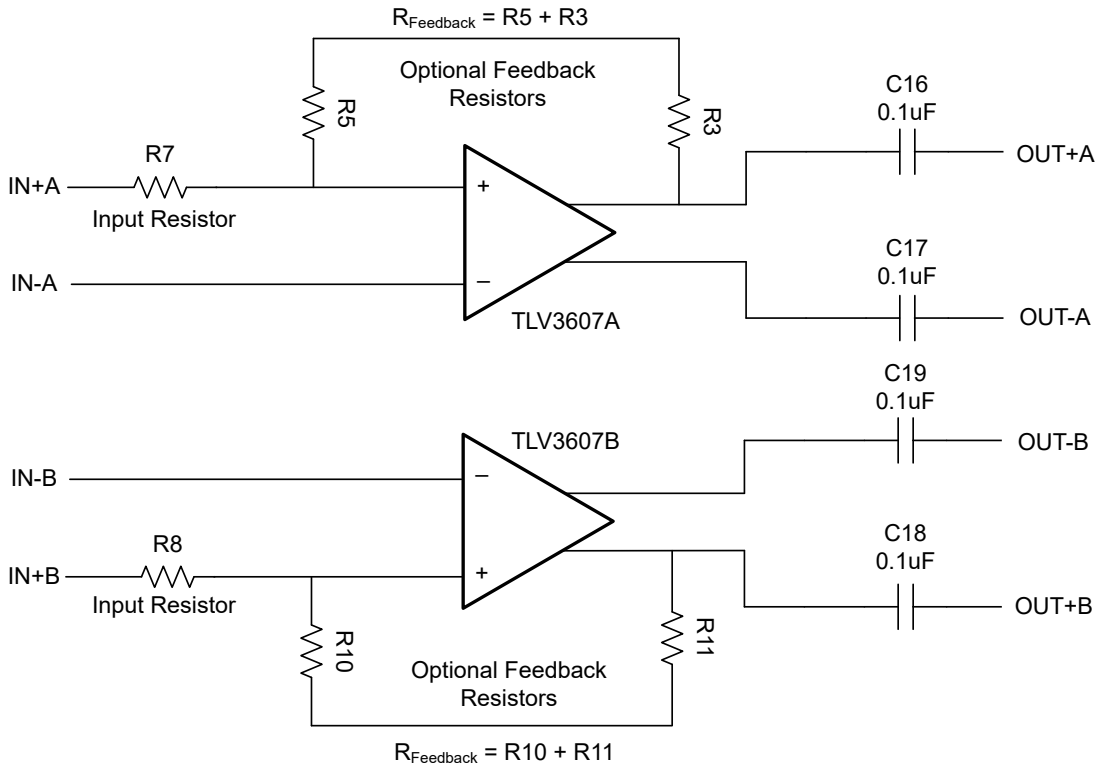


Figure 2-6. Hysteresis Block Diagram

2.3 Quick-Start Procedure

Note

Do not turn on power supply until all connections to the device are made to the board.

The procedures listed below are the steps for a quick-start set-up using channel A.

1. Set VCCI/VCCO Power Supply to 5.0 V and disable the power supply output.
2. Since the same power supply is used for both VCCI and VCCO, connect positive terminal supply to TP5 and TP3, and negative terminal to TP6.
3. Connect VEE and GND via jumper J17 and J3.
4. Connect $\overline{\text{SHDNA}}$ to VCCO via jumper J1 and $\overline{\text{SHDNB}}$ to VEE via jumper J13. This sets Channel A in active mode and Channel B in shutdown mode.
5. Verify that cables connecting to IN+A SENSE, OUT+A, and OUT-A are matched length and impedance. Perform any de-skewing if necessary. Set the function generator (50-Ω terminated) to produce a square wave output with 400mVpp at 10 MHz, with a DC offset of 0.300 V. Disable the signal generator output. Connect the output to IN+A.
6. Set one of the outputs of the DC power supply to 300 mV. Disable the power supply output. Connect the output to IN-A.
7. Connect OUT+A and OUT-A to a 50-Ω terminated channel on the oscilloscope.
8. Connect IN+A SENSE, to another 50-Ω terminated scope channel.
9. Enable the VCCI/VCCO power supply.
10. Verify the total supply current is < 18 mA.
11. Enable the signal generator.
12. Monitor and verify the inputs from IN+A SENSE.
13. Monitor and verify the outputs for OUT+A and OUT-A.

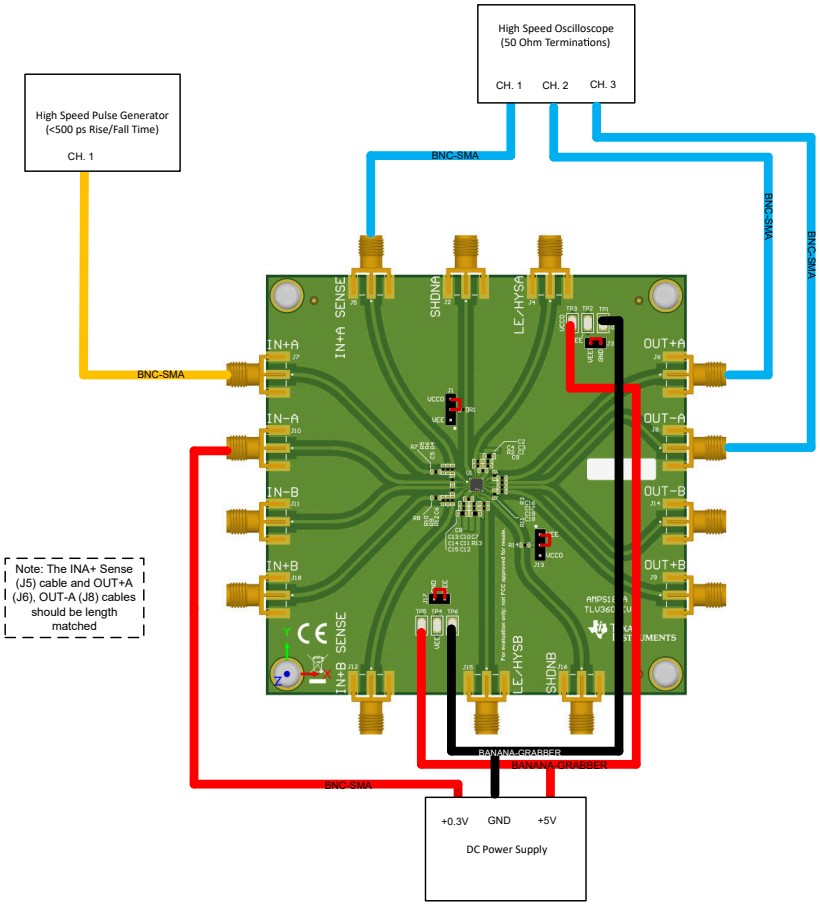


Figure 2-7. TLV3607EVM Quick Start Setup

Next, is a scope shot capture of the inputs and outputs described in the quick-start procedure.

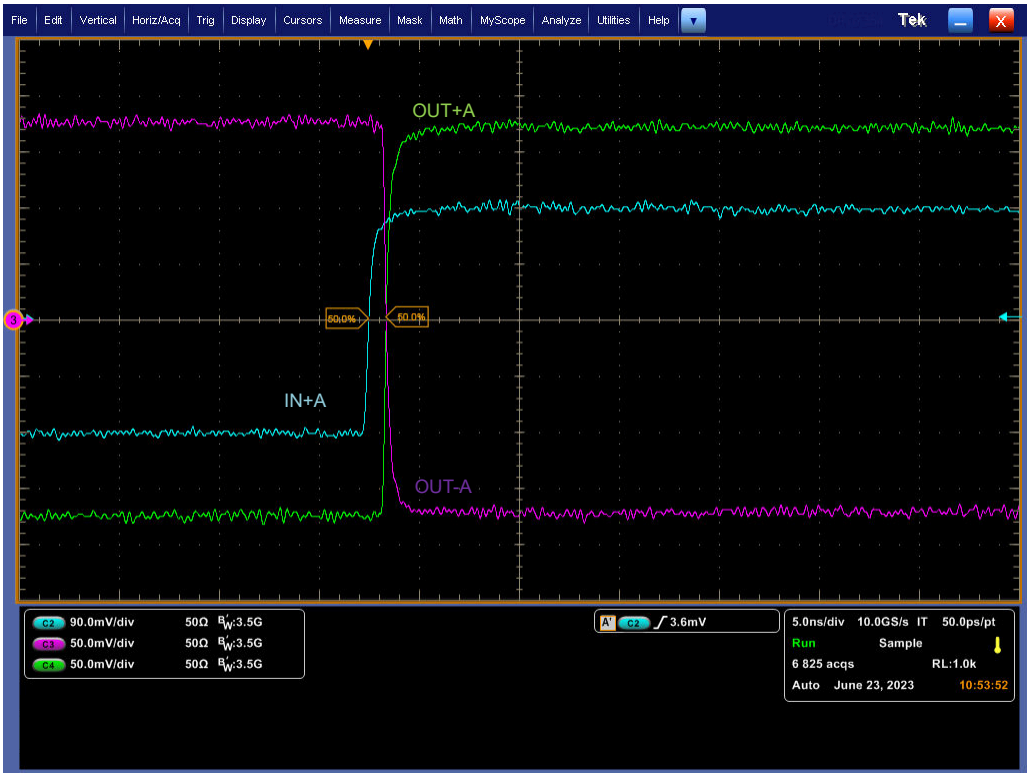


Figure 2-8. Quick-Start Example

3 Hardware Design Files

3.1 Schematic

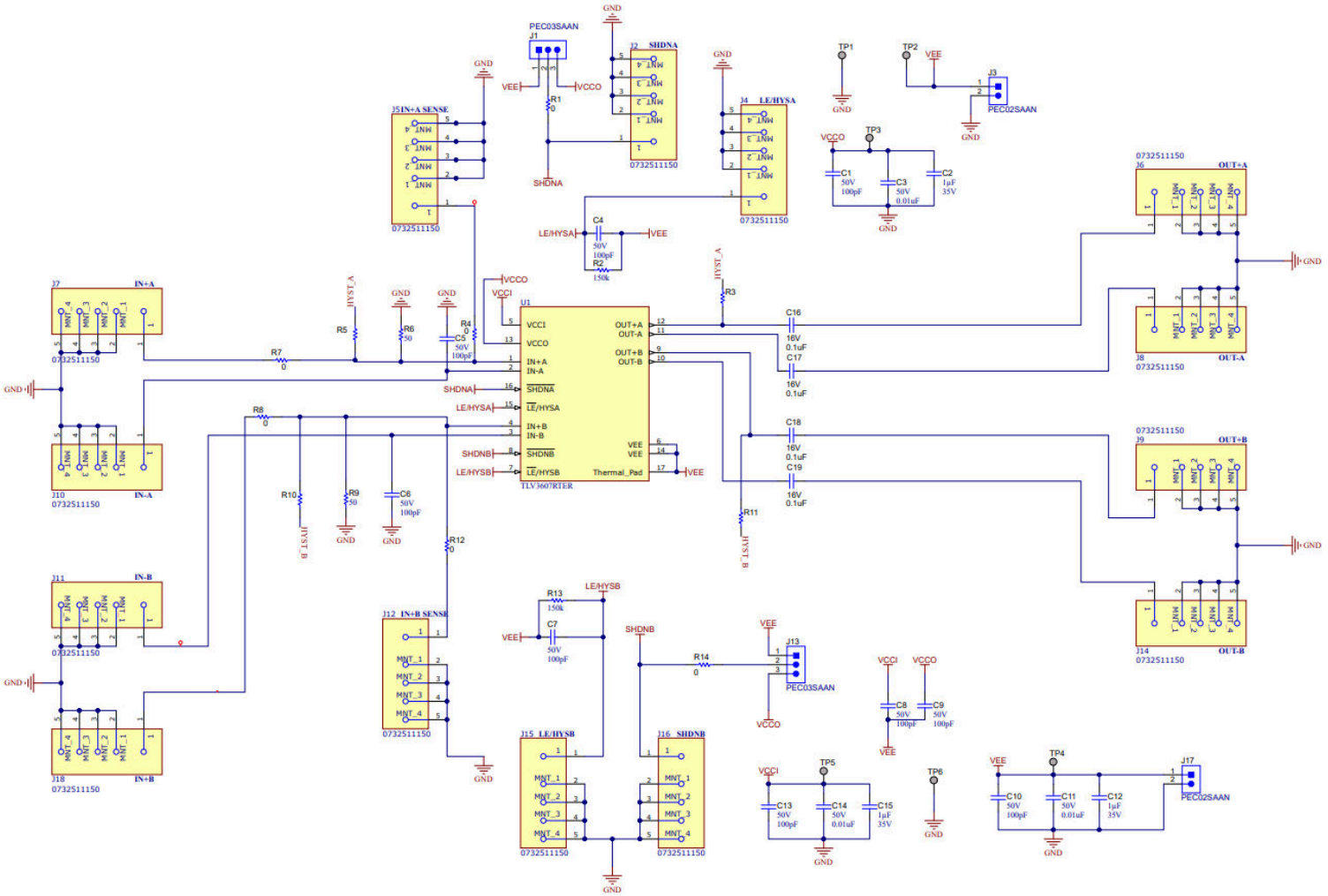


Figure 3-1. TLV3607EVM Schematic

3.2 PCB Layouts

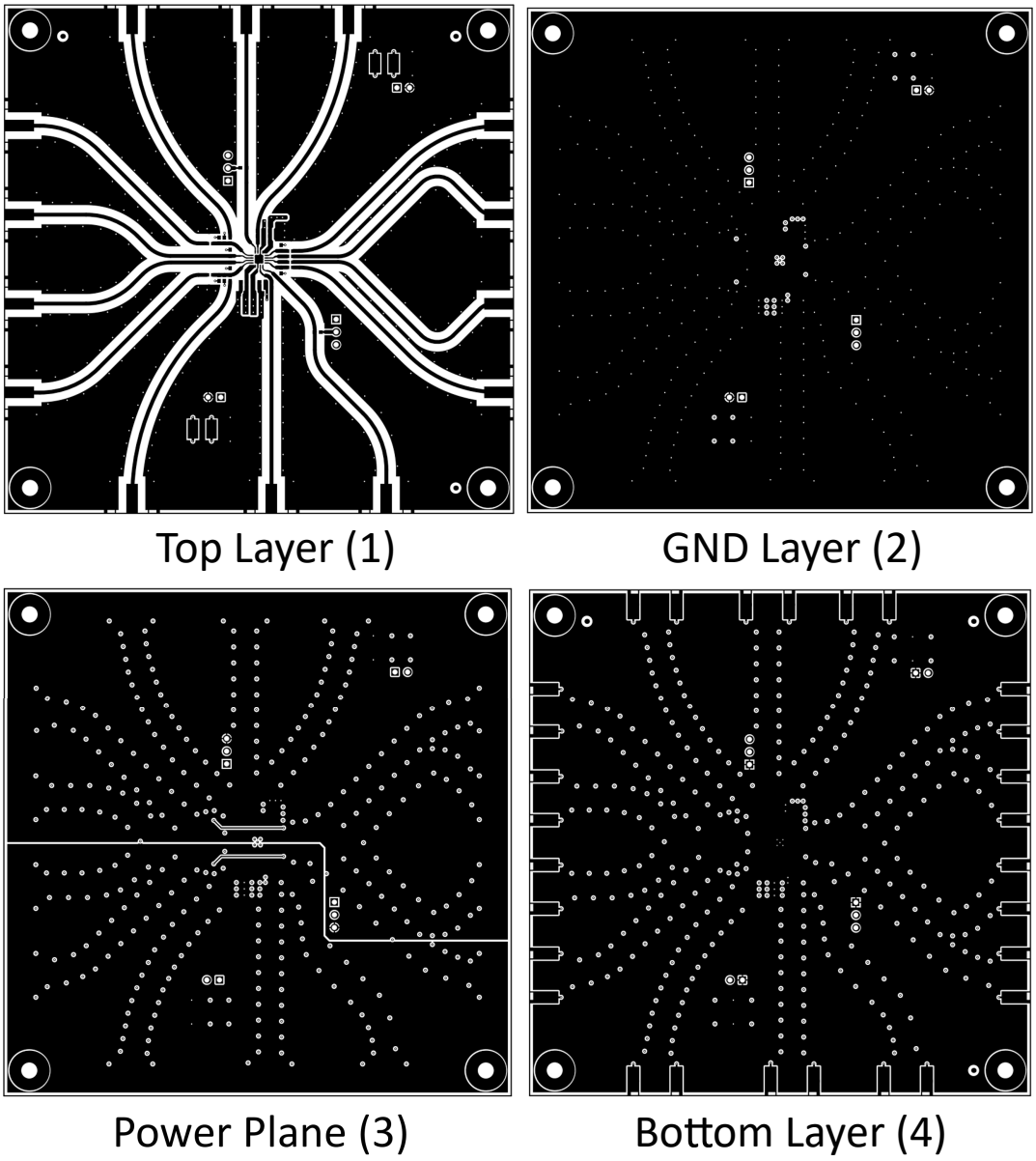


Figure 3-2. Layers

3.3 Bill of Materials

Table 3-1. Bill of Materials (BOM)

DESIGNATOR	QTY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER
C1, C4, C5, C6, C7, C8, C9, C10, C13	9	100 pF	CAP, CERM, 100 pF, 50 V, +/- 10%, X7R, 0402	0402	885012205055	Wurth Elektronik
C2, C12, C15	3	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, 0603	0603	C1608X7R1V105K080AC	TDK
C3, C11, C14	3	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0402	0402	GRM155R71H103KA88D	MuRata
C16, C17, C18, C19	4	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	C0402C104K4RACAUTO	Kemet
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J13	2		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
J2, J4, J5, J6, J7, J8, J9, J10, J11, J12, J14, J15, J16, J18	14		SMA Connector Receptacle, Female Socket 50Ohm Board Edge, End Launch Solder		0732511150	Molex Inc
J3, J17	2		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
R1, R4, R7, R8, R12, R14	6	0	RES, 0, 0%, 0.2 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0EDHP	Vishay-Dale
R2, R13	2	150k	RES, 150 k, 1%, 0.063 W, 0402	0402	CRCW0402150KFKED	Vishay-Dale
TP1, TP2, TP3, TP4, TP5, TP6	6		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone
U1	1		800-ps High-Speed RRI Comparator with LVDS Outputs	WQFN16	TLV3607RTER	Texas Instruments
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R3, R5, R10, R11	0	0	RES, 0, 0%, 0.2 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0EDHP	Vishay-Dale
R6, R9	0	50	RES, 50, 0.1%, 0.5 W, 0402	0402	FC0402E50R0BTBST1	Vishay Thin Film

4 Additional Information

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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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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.

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