LMK60XXEVM, LMK62XXEVM

User's Guide

Literature Number: SNAU209A
December 2016–Revised February 2017

LMK60XXEVM, LMK62XXEVM User's Guide

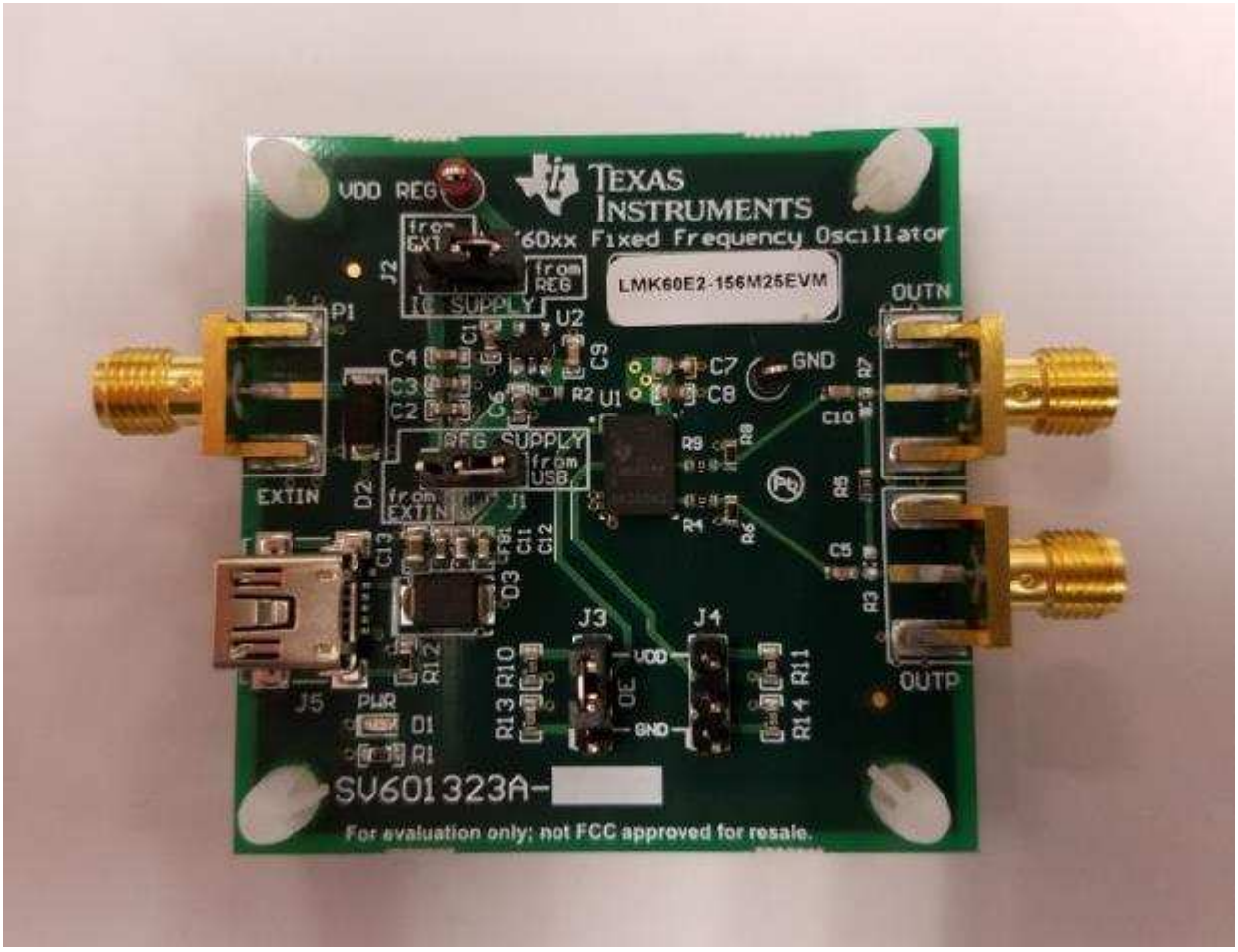


Figure 1. LMK60E2-156M25EVM Photo

Table 1. Ordering Information

EVM ID	DEVICE ID	DEVICE PACKAGE
LMK60E2-156M25EVM	LMK60E2-156M25SIA	5 mm x 7 mm 6-pin QFM (SIA)
LMK62E2-156M25EVM	LMK62E2-156M25SIA	5 mm x 3.2 mm 6-pin QFM (SIA)

1 Overview

The LMK6XXX EVM provides a complete platform to evaluate the clock performance of the Texas Instruments LMK60XX (5 x 7 mm package) and LMK62XX (5 x 3.2 mm package) Ultra-Low Jitter Crystal Oscillator family with a diverse selection of output frequencies and formats.

This User's Guide documents the configuration options and features of the EVM, as well as suggested test setups for rapid evaluation of the device. For illustration purposes, the LMK60XXEVM is shown. The LMK62XXEVM is identical, but features a 5x3.2mm oscillator package instead of the 5x7mm package of the LMK60XXEVM.

The LMK6XXX EVM can be used as a clock source for compliance testing, performance evaluation, and initial system prototyping. The onboard edge-launch SMA ports provides access to the LMK6XXX ultra low jitter clock outputs for interfacing to test equipment and reference boards using commercially available coaxial cables, adapters, or baluns (not included). This connectivity enables integrated system level testing between TI's LMK6XXX and third-party FPGA/ASIC/SoC reference boards.

2 Features

- Preconfigured onboard terminations
- Flexible EVM power options
  - Ultra Low Noise LP5907 LDO for supply input up to 5.5 V
  - mini USB or edge launch SMA
- Small Form Factor (2" x 1.8")

3 EVM Configuration

The LMK6XXX is a ultra low jitter crystal oscillator with simple power supply requirements and comes in a wide variety of output formats and frequencies. To support a wide range of evaluation use cases, the EVM was designed for maximum flexibility so various configurations options that are not required in all typical system applications have been included. Several default EVM configurations are available to easily evaluate the performance of LMK6XXX oscillator family members.

This section describes the jumpers and connectors on the EVM, as well as how to connect, set-up, and use the LMK6XXX EVM. When operating the LMK6XXX EVM, the power supply and clock outputs can be connected to the SMA ports shown in Figure 2. Additionally, the USB port can be used to power the entire LMK6XXX EVM without the need for external power supplies. These SMA ports are labeled in the top silkscreen layer.

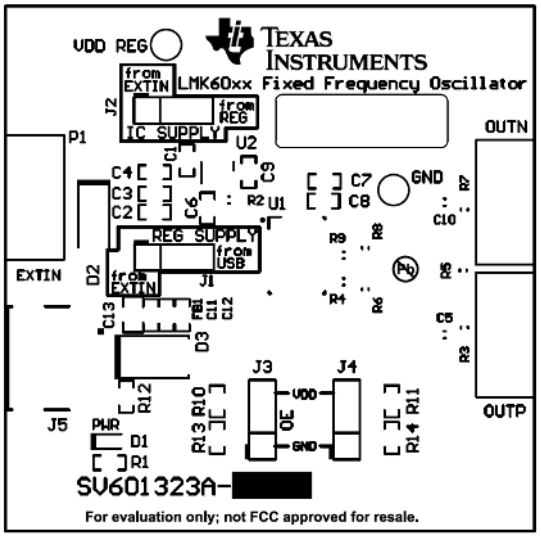


Figure 2. LMK60XX EVM Board Layout

3.1 Configuring the Power Supply

The LMK6XXX devices feature a single VDD supply pin that operates from 3.3V (+ 5%). This supply can be powered directly on the EVM from an external supply or through an on-board LDO regulator. Although the LMK6XXX oscillators have integrated LDO regulators for excellent power-supply-ripple-rejection (PSRR), the EVM's on-board regulator (U1) can allow a higher supply voltage (up to 5.5 V) to power the EVM. The direct external supply or on-board regulator can be independently routed for the VDD supply pin by configuring the power terminals and jumpers shown in Figure 3. J5 (USB mini connector) is the default power supply for the EVM, featuring a low noise regulator for voltage step down. Power SMA Port EXTIN (P1) provides an alternative connector style to apply power using coax cables. Using EXTIN while connected to USB power is not required but can be useful when testing with externally regulated supplies.

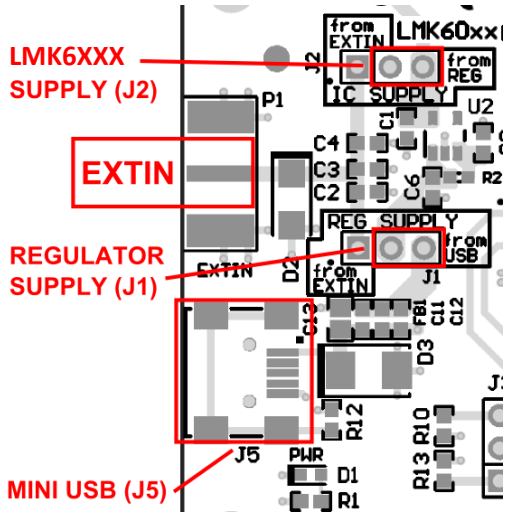


Figure 3. Power Terminals and Jumpers

Table 2 summarizes the EVM power configurations to connect and route power to the onboard LDOs and LMK6XXX oscillator. Refer to the EVM schematic for more details.

Table 2. Power Configurations

MODE	EXTIN VOLTAGE	J1 SETTING[1]	J2 SETTING [1]
USB Powered [2]		from USB	from REG
External Power + LDO	4.3 V to 5.5 V	from EXTIN	
External Power	3.3 V	Remove Jumper	from EXTIN

(1) Markings surrounding J1 or J2 indicate the orientation of jumper settings
(2) USB cable must be connected to J7 for operation

NOTE: Power delivery over the USB interface is subject to limitations of specific USB ports. Certain systems may require the use of an external supplied power source for proper operation.

3.2 Configuring the Control Pins

The LMK6XXX EVM has a single control pin dedicated to output enable control. Jumper J3 is routed to Pin 1 of the LMK6XXX device for Output Enable control. The positive logic of the OE pin is described in Table 3. (1)

(1) Jumper J4 is for evaluation of devices that feature control on Pin 2. LMK6XXX devices require Pin 2 to have No Connection.

Table 3. Control Pin Interface

COMPONENT	NAME	DESCRIPTION	
J3	OE	OE (Output Enable) state disables oscillator output while keeping PLL circuitry active.	
		OE	**Output Status**
		GND	Output Disabled
		VDD	Output Enabled

3.3 Configuring the Clock Output

The LMK6XXX's differential output is routed via 50 ohm single ended traces to SMA ports (OUTN and OUTP) through AC coupling capacitors. Depending on the EVM variant (LVPECL, LVDS, or HCSL devices), the default population of series resistors (R4 and R9), emitter resistors (R6 and R8), and differential resistors (R3, R5, and R7) are pre-populated to recommended values. Although reconfiguring of the EVM is not required, common output format terminations are shown in Table 4. The output termination schematic is shown in Figure 4, which is common to all EVM variants.

Table 4. Output Termination Schemes

OUTPUT FORMAT	COUPLING(1)	COMPONENT	VALUE
LVPECL	AC	R4, R9	0 Ω
		R6, R8	150 Ω
		C5, C10	0.01 uF
		R3, R5, R7	DNP
	DC(2)	R4, R9, C5, C10	0 Ω
		R3, R5, R6, R7, R8	DNP
LVDS(3)	AC	R3, R4, R7, R9	0 Ω
		R5(4)	100 Ω
		C5, C10	0.01 uF
		R6, R8	DNP
	DC	R3, R4, R7, R9, C5, C10	0 Ω
		R5(4)	100 Ω
		R6, R8	DNP
HCSL	DC	R4, R9	0 Ω
		R6, R8	50 Ω
		C5, C10	0 Ω
		R3, R5, R7	DNP

(1) All variants are AC coupled by default.
(2) 50 ohm to Vcc-2 V termination is required on receiver.
(3) 100 ohm differential termination (R5) is provided on the LMK6XXX EVM. Removing the differential termination on the EVM is possible if the differential termination is available on the receiver.
(4) Remove if termination is provided by other means (e.g. receiver termination, oscilloscope termination, etc.)

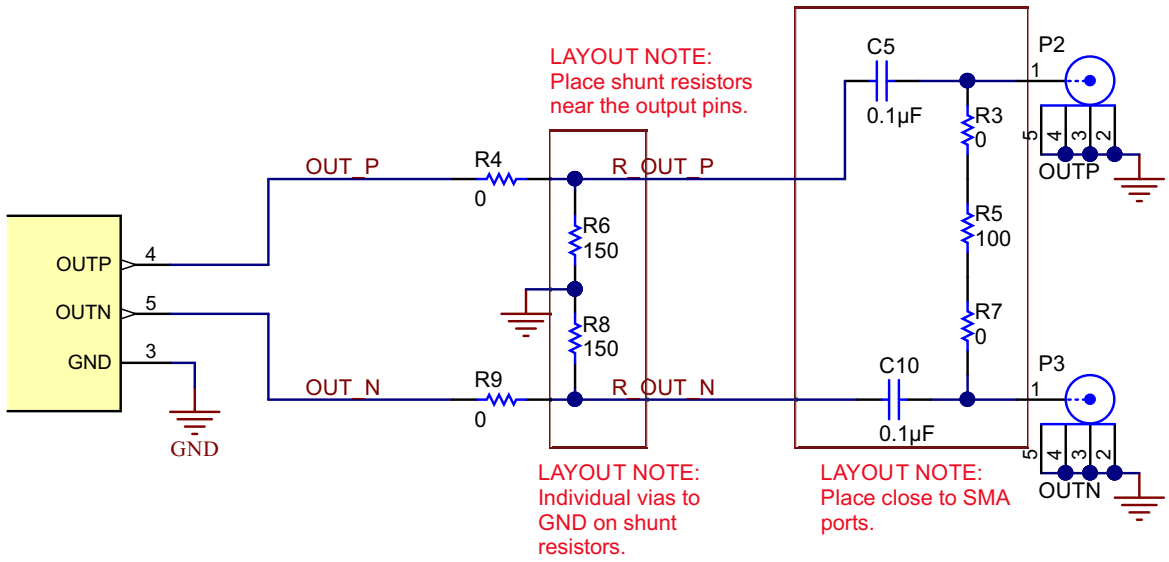


Figure 4. LMK6XXX Termination Schematic

4 EVM Quick Start Guide

The following guide allows the user to quickly configure the LMK6XXX EVM to evaluate performance.

1. Confirm the EVM power configuration is set accordingly per Table 2. By default, the LMK6XXX power jumpers are configured in USB Powered mode using the on-board LDO and is supplied power over USB.
2. Ensure the OE jumper (J3) is set to VDD
3. Observe any active output clock on OUTN and OUTP SMA ports.
   (a) Default EVM configurations are AC coupled and terminations are preconfigured per each device variant (LVPECL, LVDS, or HCSL).
   (b) Use 50 Ω coax cables to connect the test equipment to the output SMA ports. If single-ended measurements are being made, terminate the unused SMA port with a 50 Ω load.
   (c) Power LED D1 should be illuminated when the EVM is powered on.
4. OE can be toggled to enable or disable the output status per Table 3.

5 Recommended Test Equipment

For making accurate measurements on ultra-low noise/jitter, high-speed clock signals, the following instruments are recommended:

- Source Signal Analyzer: Keysight/Agilent E5052 for phase noise/jitter measurements
- Oscilloscope: Agilent DSA90000A series (or equivalent) for AC measurements and time-domain jitter analysis with jitter software package
- Balun: M/A-COM H-183-4 (30-3000 MHz) 180° coupler, or equivalent

6 Example Performance Measurements

RMS Jitter and phase noise measurements were taken on the differential output clock was measured using a balun to a Keysight/Agilent E5052B. Some phase noise plots are provided below.

Table 5. Typical Output RMS Jitter Summary(1)(2)

Parameter	Test Conditions	RMS Jitter (fs),12k-20M band, spurs off	MIN	TYP	MAX	Unit
RJ	RMS Phase Jitter(3) (12 kHz - 20 MHz) (1 kHz - 5 MHz)	f_{OUT}≥ 100 MHz, Integer-N PLL, All Output Types		150	300	fs RMS

(1) Phase Jitter measured with Agilent E5052 signal source analyzer using differential to single ended converter (buffer or balun.)
(2) All measurements are AC coupled with recommended board terminations as in Table 4.
(3) Ensured by characterization.

Typical Performance Plots

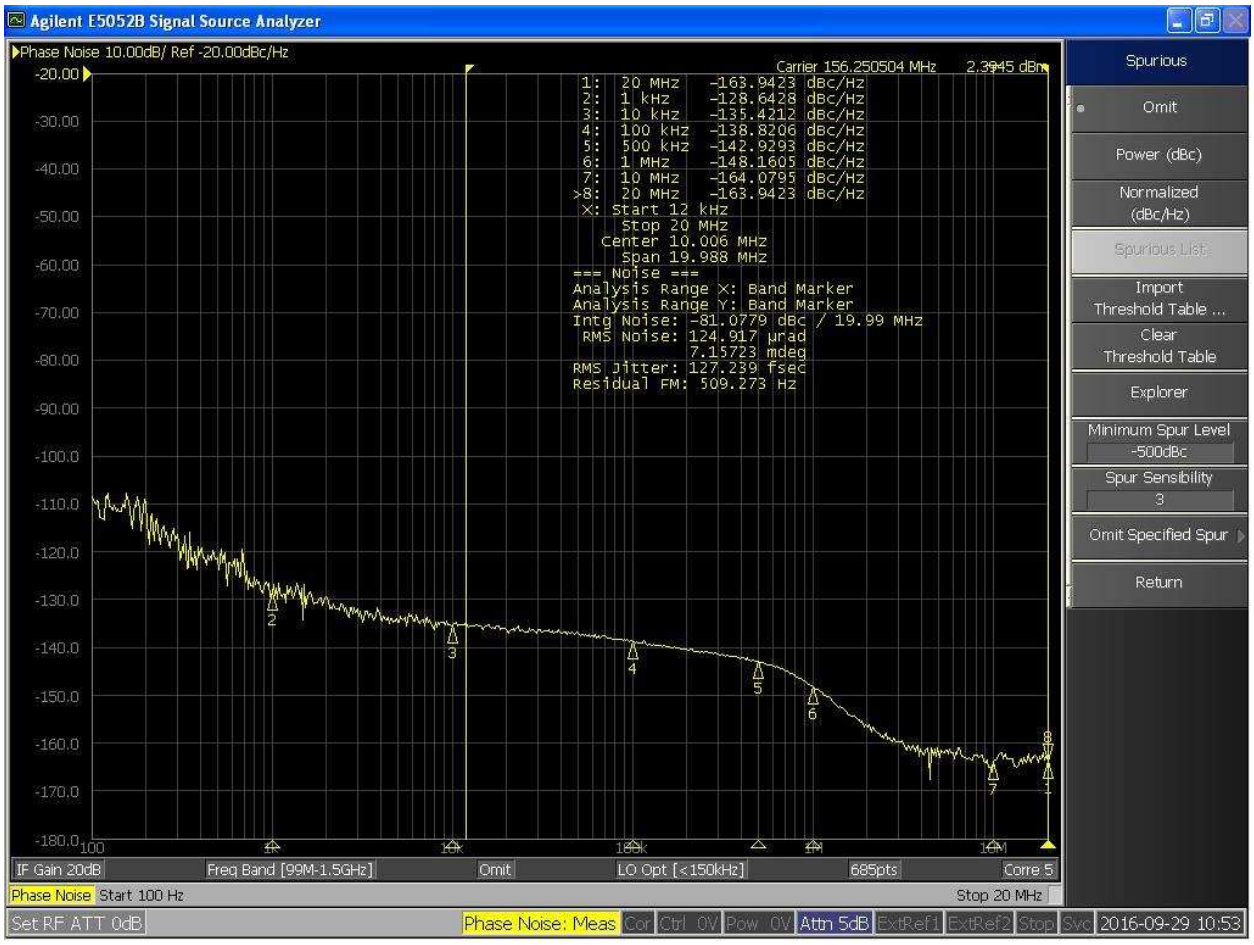


Figure 5. Phase Noise of LVPECL Differential Output at 156.25 MHz

7 EVM Design

NOTE: The layout and schematic in this section is shown for the LMK60XXEVM. The LMK62XXEVM is identical, but features a 5x3.2mm oscillator footprint instead of the 5x7mm footprint of the LMK60XXEVM.

7.1 EVM Layout

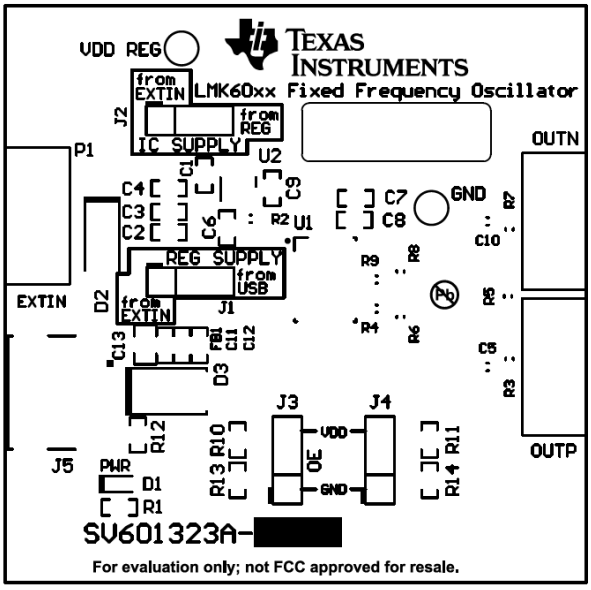


Figure 6. Top Overlay

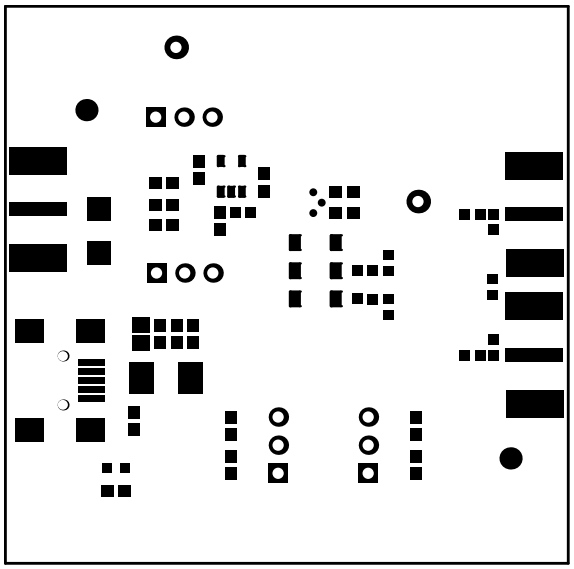


Figure 7. Top Solder Mask

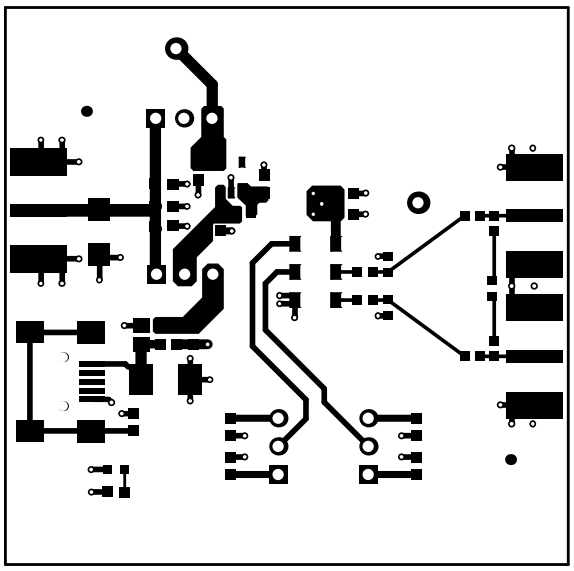


Figure 8. Layer 1 (Top Side)

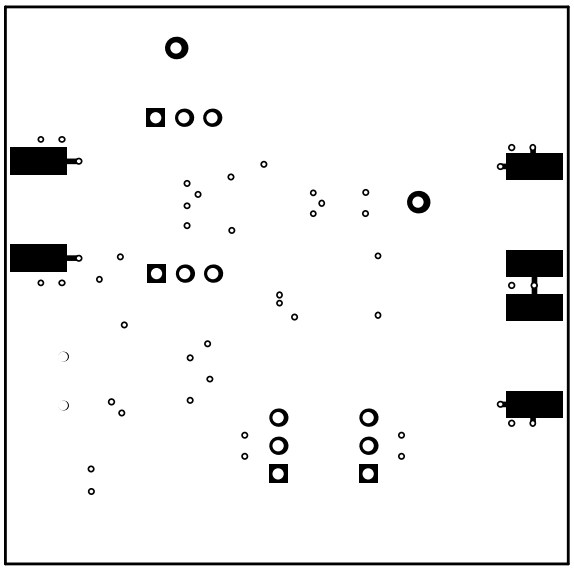


Figure 9. Layer 4 (Bottom Side, View From Bottom)

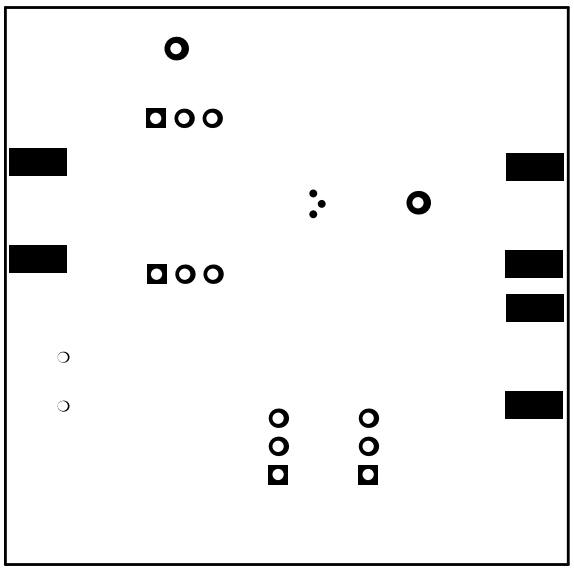
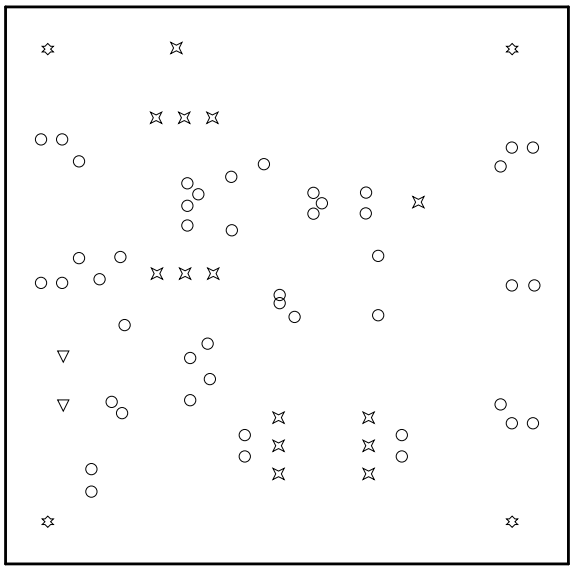


Figure 10. Bottom Solder Mask



Symbol	Hit Count	Tool Size	Plated	Hole Type
○	46	13mil (0.33mm)	PTH	Round
▽	2	35.433mil (0.9mm)	NPTH	Round
⌑	14	40mil (1.016mm)	PTH	Round
✡	4	157mil (3.988mm)	NPTH	Round
	66 Total			

Figure 11. Drill Drawing

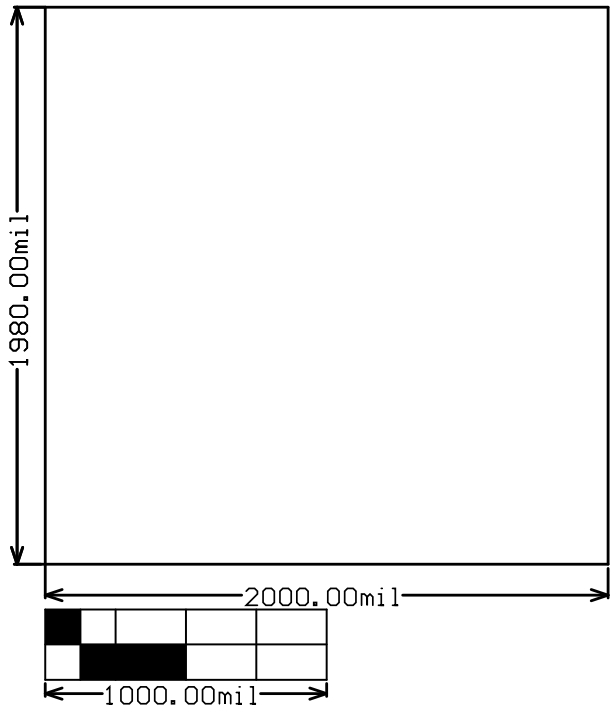


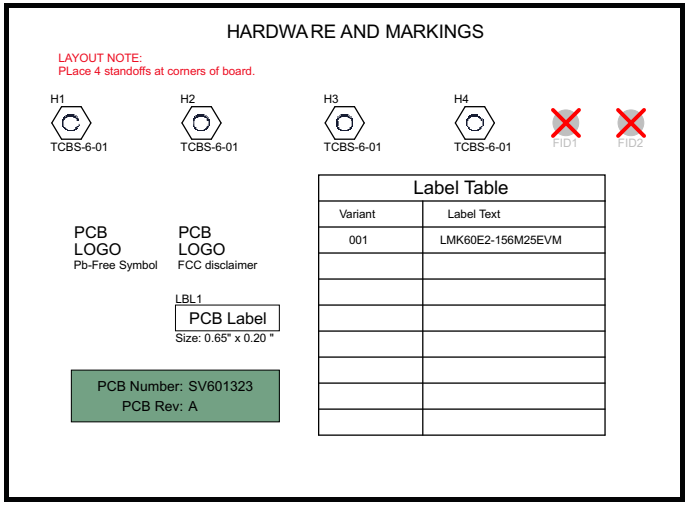
Figure 12. Board Dimensions

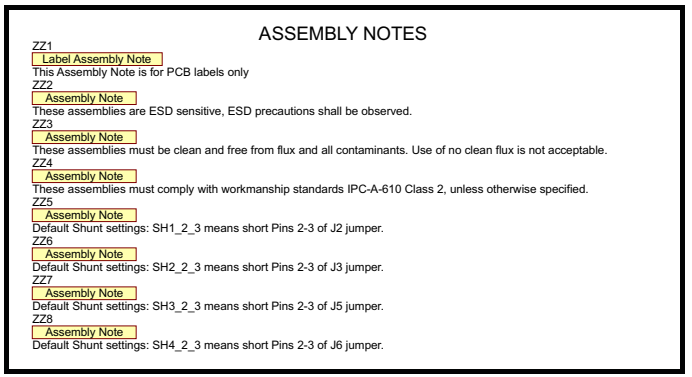
7.2 EVM Schematics

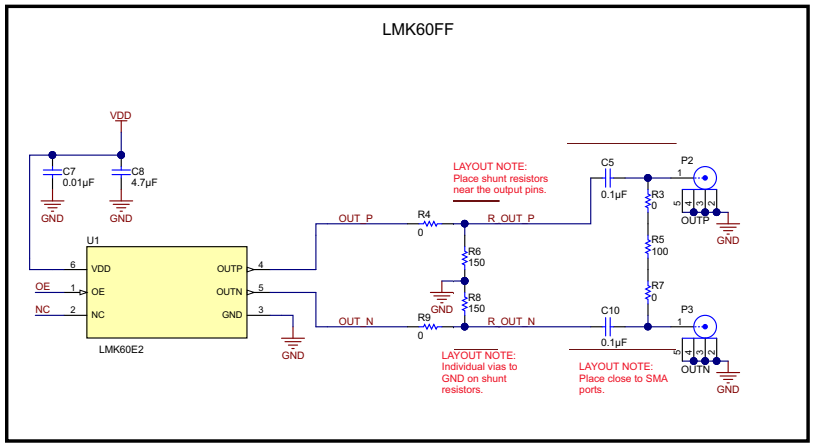
DIMENSIONS:
-- Rectangular shape with height minimized (SMA spacing + board stand offs)
-- Final PCB thickness 62 mil +/- 10% ****

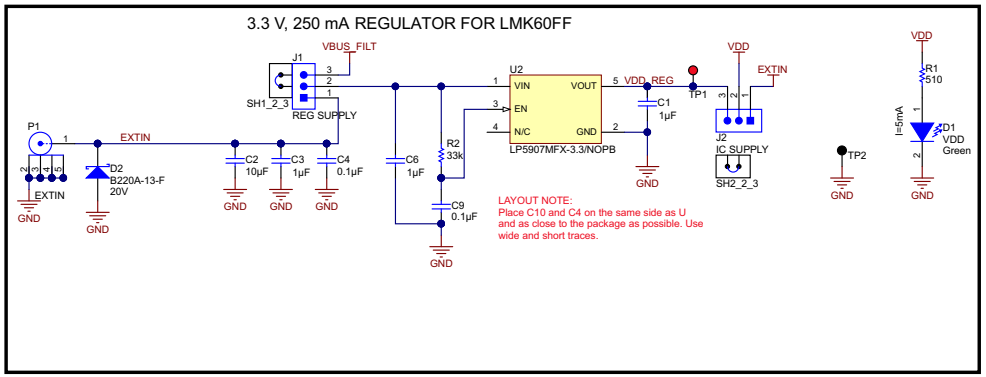
STACKUP:
-- Layer 1: Device layer, Power/GPIO Jumper/Switches, RF microstrip from DUT to SMA, USB connector, Silkscreens + Labeling
===== FR4: 8 mil
-- Layer 2: Ground Plane
===== FR4: 38 mil
-- Layer 3: Split Power planes for USB circuitry and DUT circuitry
===== FR4: 8
-- Layer 4: USB circuitry

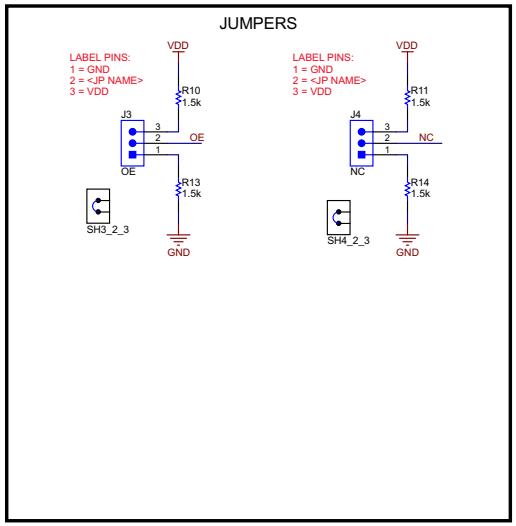
Controlled Impedance Traces
-- TOP: 13 mil traces to be 50 ohm Zo +/- 5% reference to L2

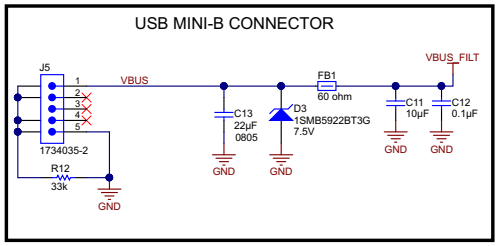












7.3 Bill of Materials[1]

[1] Bill of Materials is configured for LVPECL AC. For LVDS and HCSL variants, see Table 4.

DESIGNATOR	DESCRIPTION	MFR	PART NUMBER	QTY
C1, C3, C6	CAP, CERM, 1uF, 10V, +/-10%, X5R, 0603	Kemet	C0603C105K8PACTU	3
C2, C11	CAP, CERM, 10uF, 10V, +/-20%, X5R, 0603	TDK	C1608X5R1A106M	2
C4, C5, C7, C9, C10, C12	CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603	Kemet	C0603C104J4RACTU	6
C8	CAP, CERM, 4.7 µF, 10 V, +/-10%, X5R, 0603	Kemet	C0603C475K8PACTU	1
C13	CAP, CERM, 22uF, 10V, +/-20%, X5R, 0805	Taiyo Yuden	LMK212BJ226MG-T	1
D1	LED, Green, SMD	Lite-On	LTST-C190GKT	1
D2	Diode, Schottky, 20V, 2A, SMA	Diodes Inc.	B220A-13-F	1
D3	Diode, Zener, 7.5V, 550mW, SMB	ON Semiconductor	1SMB5922BT3G	1
FB1	Ferrite Bead, 60 ohm @ 100 MHz, 3.5 A, 0603	TDK	MPZ1608S600A	1
H1, H2, H3, H4	HEX STANDOFF SPACER, 9.53 mm	Richco Plastics	TCBS-6-01	4
J1, J2, J3	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S	3
J5	Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT	TE Connectivity	1734035-2	1
P1, P2, P3	Connector, End launch SMA, 50 ohm, SMT	Emerson Network Power	142-0701-851	3
PCB1	Printed Circuit Board	Any	SV601249	1
R1	RES, 510, 5%, 0.1 W, 0603	Vishay-Dale	CRCW0603510RJNEA	1
R2, R12	RES, 33k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW060333K0JNEA	2
R4, R9	RES, 0 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06030000Z0EA	2
R6, R8	RES, 150, 5%, 0.1 W, 0603	Vishay-Dale	CRCW0603150RJNEA	2
R10, R13	RES, 1.5k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06031K50JNEA	2
SH1_2_3, SH2_2_3, SH3_2_3	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	3
TP1	Test Point, Miniature, Red, TH	Keystone	5000	1
TP2	GND	Keystone	5001	1
U1	LMK60XX/LMK62XX High-Performance Ultra-Low Jitter Oscillator	Texas Instruments	LMK60XX/LMK62XX[1]	1
U2	ULTRA LOW-NOISE, 250-mA LINEAR REGULATOR FOR RF AND ANALOG CIRCUITS REQUIRES NO BYPASS CAPACITOR, DBV0005A	Texas Instruments	LP5907MFX-3.3/NOPB	1
R3, R7	RES, 0 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06030000Z0EA	0
R5	RES, 100, 1%, 0.1 W, 0603	Vishay-Dale	CRCW0603100RFKEA	1

[1] For full list of part numbers, see Table 1

Revision History

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

Changes from Original (December 2016) to A Revision	Page
• Added LMK62XXEVM to User's Guide	2

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.

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。
http://www.tij.co.jp/lsds/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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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。
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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

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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