User's Guide

LMK6EVM User's Guide

ABSTRACT

The LMK6EVM provides a complete evaluation platform to evaluate the clock performance and flexibility of the Texas Instruments LMK6x Ultra-Low Jitter BAW Oscillator family. This EVM can be used as a flexible clock source for compliance testing, performance evaluation, and initial system prototyping. The onboard edge-launch SMA ports provide access to the configurable clock output of the LMK6x, which allows the device to interface with test equipment and reference boards using commercially available coaxial cables, adapters, or baluns (not included).

The LMK6x is a lower-power clock oscillator using TI's BAW technology. The LMK6x is available in two package sizes, DLE (3.2 mm × 2.5 mm) and DLF (2.5 mm × 2.0 mm), and four different output formats: LVCMOS, LVPECL, LVDS, and HCSL. Both footprints are included on the EVM with independent termination networks. The termination scheme can be modified by the user for the desired output format. The LMK6EVM is not populated with an LMK6x device, so the user can choose the desired variant for evaluation.

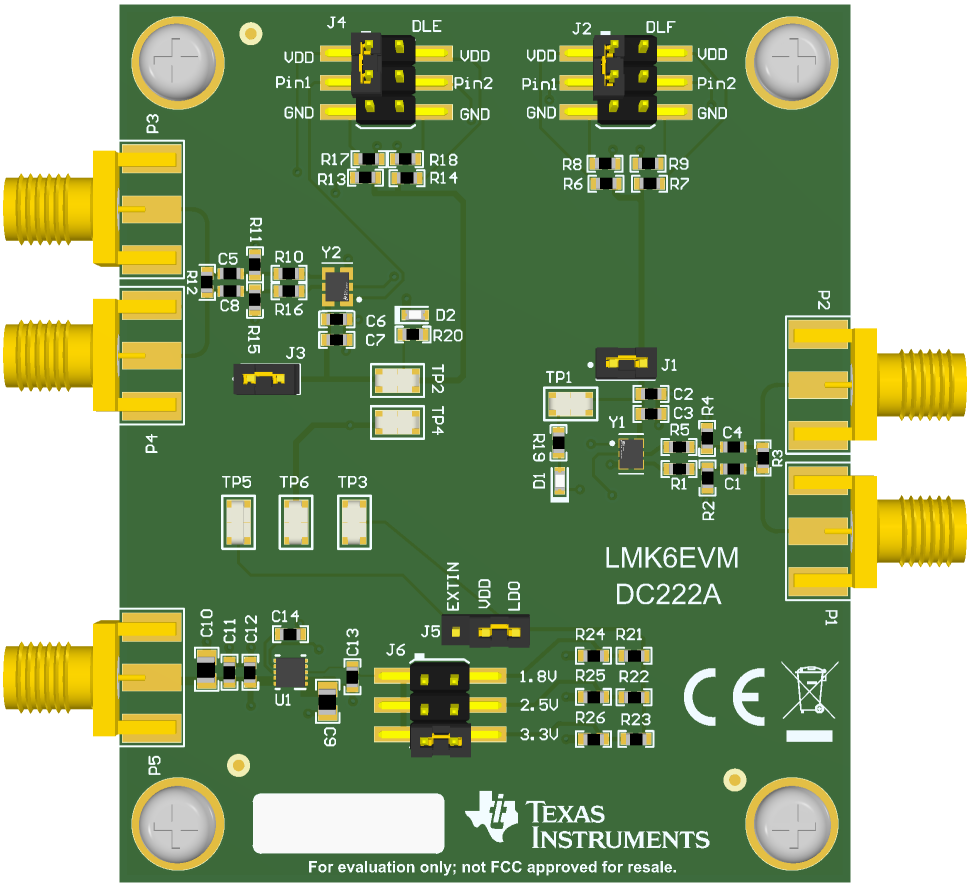

Figure 1-1. LMK6EVM Evaluation Board

Table of Contents

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

1.1 Evaluation Module Contents

The box contains:

- One LMK6EVM board (DCC222A)

1.2 Evaluation Setup Requirement

The evaluation requires the following hardware:

- A DC power supply
- An oscilloscope
- A signal analyzer (optional)
- A LMK6x Device

1.3 Resources

See the *LMK6x Low Jitter, High-Performance BAW Oscillator* data sheet for more information about the LMK6x devices.

2 Setup

2.1 Connection Diagram

Figure 2-1 shows the LMK6EVM (DCC222A) connection diagram. To test LMK6xDLF variants (DLF 2.5 mm × 2.0 mm package), the device should be soldered on Y1 and P1, and P2 can be connected to an oscilloscope or phase noise analyzer to evaluate the device output. Similarly for LMK6xDLE variants (DLE 3.2 mm × 2.5 mm package), the device should be soldered on Y2 and P3, and P4 will be used accordingly to measure the output. Note that for LMK6C variants with an LVCMOS output format, only the positive clock output connection will be used. The 4-pin LMK6C variants can share the same footprint as the 6-pin LMK6D/P/H variants. The corner pins are shared, but the middle pins are left unused for the LMK6C devices.

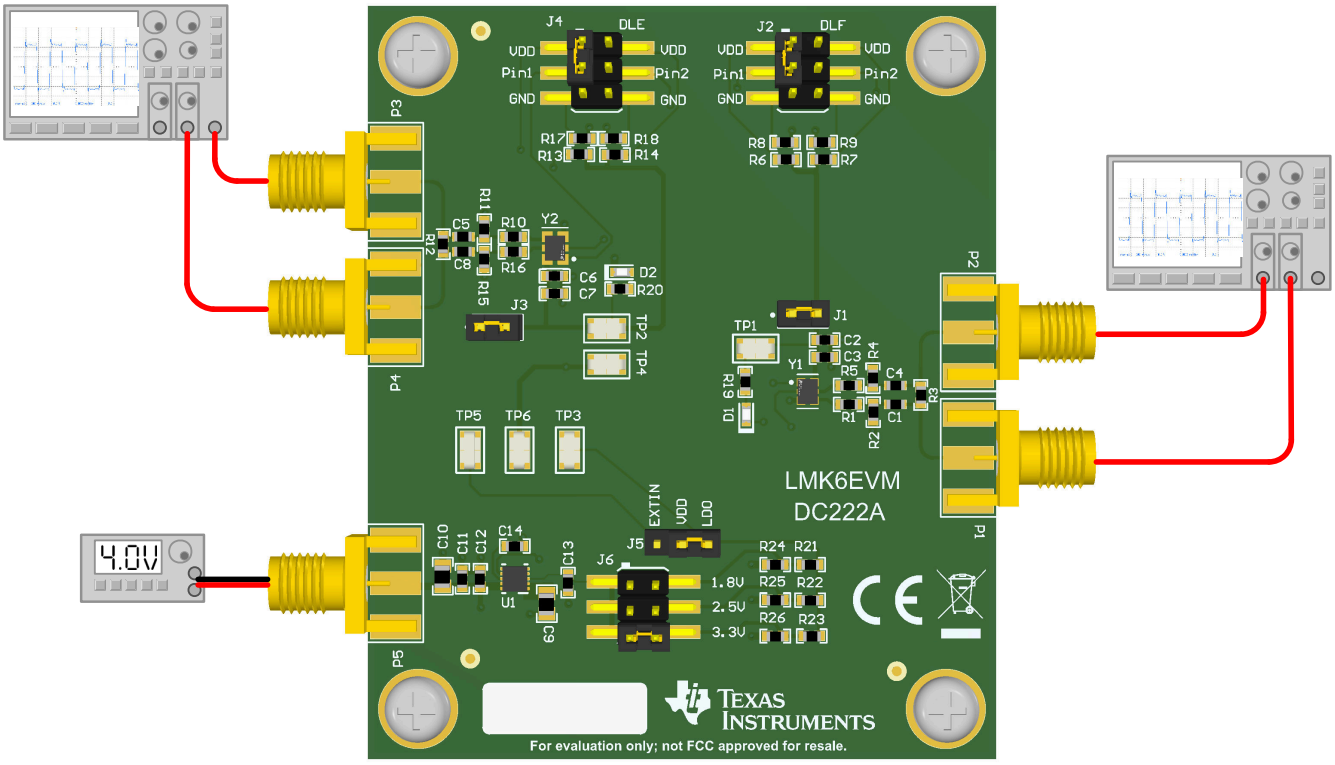

Figure 2-1. Connection Diagram

2.2 Power Supply

Apply 4 V to the VDDin SMA connector (P5). The onboard voltage regulator will provide 1.8 V, 2.5 V, or 3.3 V to the LMK6X devices based on the jumper selection on J6.

2.3 Clock Output

To test the clock output of Y1, connect P1 (+) and P2 (–) SMA connectors to an oscilloscope or phase noise analyzer. To test the clock output of Y2, use P3 (–) and P4 (+). The output frequency, amplitude, and common-mode voltage will depend on the LMK6x variant that is attached to the board, as well as the termination scheme.

2.4 EVM Strap Options

2.4.1 J1 Header

Put the short across J1 to provide the supply voltage to Y1.

2.4.2 J2 Header

J2 is used to pull pin 1 and pin 2 of Y1 to VDD/GND to select the output enable (OE) pin of the LMK6x device. LMK6PA/LMK6DA/LMK6HA variants use pin 1 for OE, and LMK6PB/ LMK6DB/LMK6HB variants use pin 2. All 4-pin LMK6C variants use pin 1 for OE.

2.4.3 J3 Header

Put the short across J3 to provide the supply voltage to Y2.

2.4.4 J4 Header

J4 is used to pull pin 1 and pin 2 of Y2 to VDD/Gnd to select the output enable (OE) pin of the LMK6x device. The LMK6PA/LMK6DA/LMK6HA variants use pin 1 for OE, and the LMK6PB/ LMK6DB/LMK6HB variants use pin 2. All 4-pin LMK6C variants use pin 1 for OE.

2.4.5 J5 Header

To use the onboard voltage regulator for the LMK6x device, put the short across pin 1 and pin 2 of the J5 header. Otherwise, put the short across pin 2 and pin 3 of the J5 header to use the external power supply directly.

2.4.6 J6 Header

J6 is used to select the output voltage of the onboard voltage regulator.

2.5 Configuring the Clock Output Termination

The LMK6EVM comes pre-populated with an AC-coupled LVCMOS termination. The termination can be modified by the user to support LVPECL, LVDS, and HCSL output formats according to the component values in the table below.

Table 2-1. Output Termination Schemes for Y1

OUTPUT FORMAT	COUPLING	COMPONENT	VALUE
LVPECL	AC	R1, R5	0 Ω
		R2, R4	150 Ω
		C1, C4	0.01 uF
		R3	DNP
	DC(1)	R1, R5, C1, C4	0 Ω
		R2, R3, R4	DNP
LVDS (2)	AC	R1, R5	0 Ω
		R3	100 Ω
		C1, C4	0.01 uF
		R2, R4	DNP
	DC	R1, R5, C1, C4	0 Ω
		R3	100 Ω
		R2, R4	DNP

Table 2-1. Output Termination Schemes for Y1 (continued)

OUTPUT FORMAT	COUPLING	COMPONENT	VALUE
HCSL	AC	R1, R5	0 Ω
		R2, R4	50 Ω
		C1, C4	0.01 uF
		R3	DNP
	DC	R1, R5, C1, C4	0 Ω
		R2, R4	50 Ω
		R3	DNP

(1) 50 Ω to Vcc – 2 V termination is required on the receiver
(2) 100-Ω differential termination (R3) is provided on the LMK6EVM. Removing the differential termination on the EVM is possible if the differential termination is available on the receiver

Table 2-2. Output Termination Schemes for Y2

OUTPUT FORMAT	COUPLING	COMPONENT	VALUE
LVPECL	AC	R10, R16	0 Ω
		R11, R15	150 Ω
		C5, C8	0.01 uF
		R12	DNP
	DC(1)	R10, R16, C5, C8	0 Ω
		R11, R12, R15	DNP
LVDS(2)	AC	R10, R16	0 Ω
		R12	100 Ω
		C5, C8	0.01 uF
		R11, R15	DNP
	DC	R10, R16, C5, C8	0 Ω
		R12	100 Ω
		R11, R15	DNP
HCSL	AC	R10, R16	0 Ω
		R11, R15	50 Ω
		C5, C10	0.01 uF
		R12	DNP
	DC	R10, R16, C5, C8	0 Ω
		R11, R15	50 Ω
		R12	DNP

(1) 50 Ω to Vcc - 2 V termination is required on the receiver
(2) 100-Ω differential termination (R3) is provided on the LMK6EVM. Removing the differential termination on the EVM is possible if the differential termination is available on the receiver

3 Typical Measurement

3.1 Phase Noise

Figure 3-1 shows the typical phase noise for the LMK6EVM populated with the 156.25-MHz variant of the LMK6H/LMK6P.

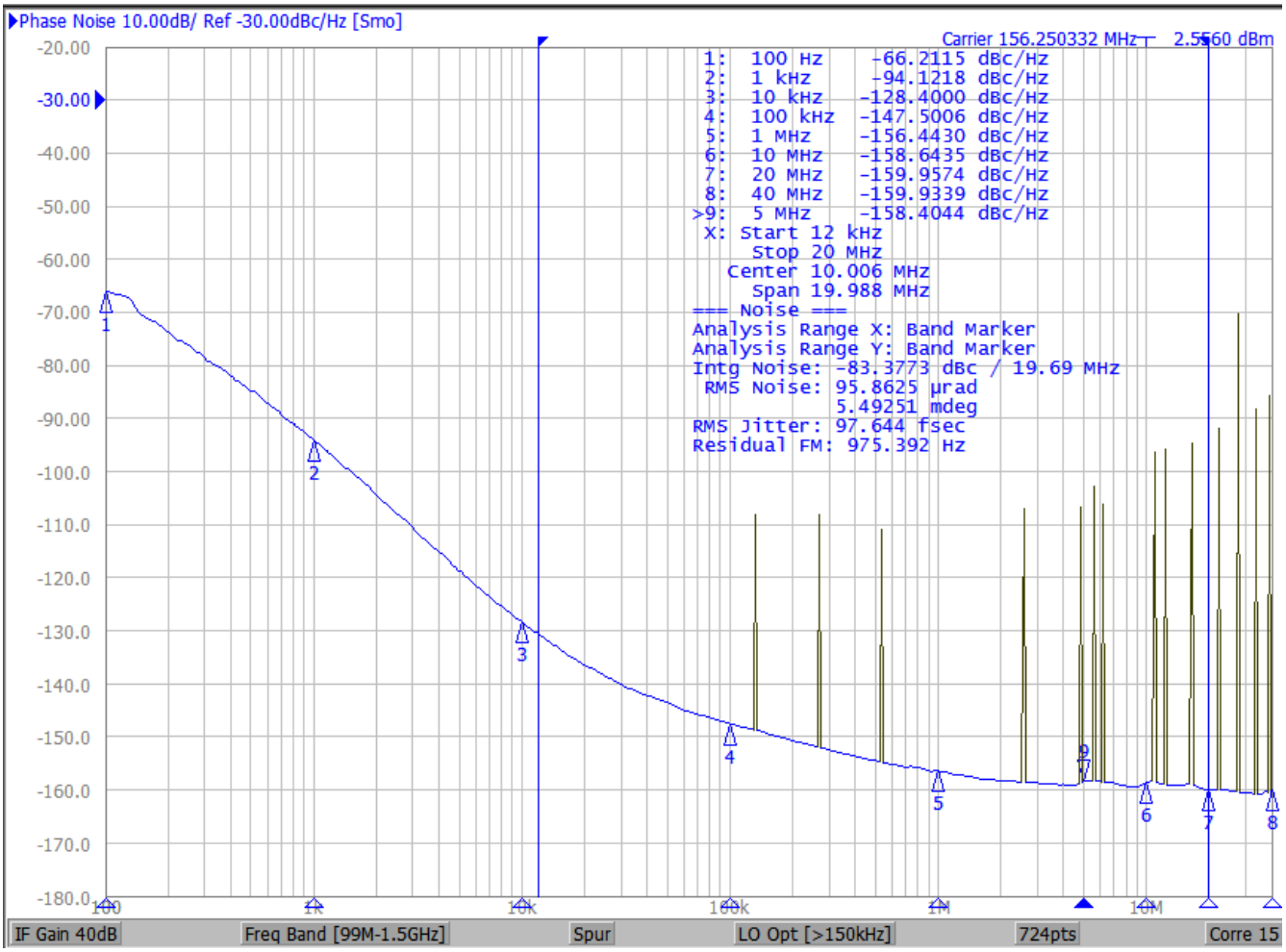

Figure 3-1. LMK6E6EVM Phase Noise

4 Schematic

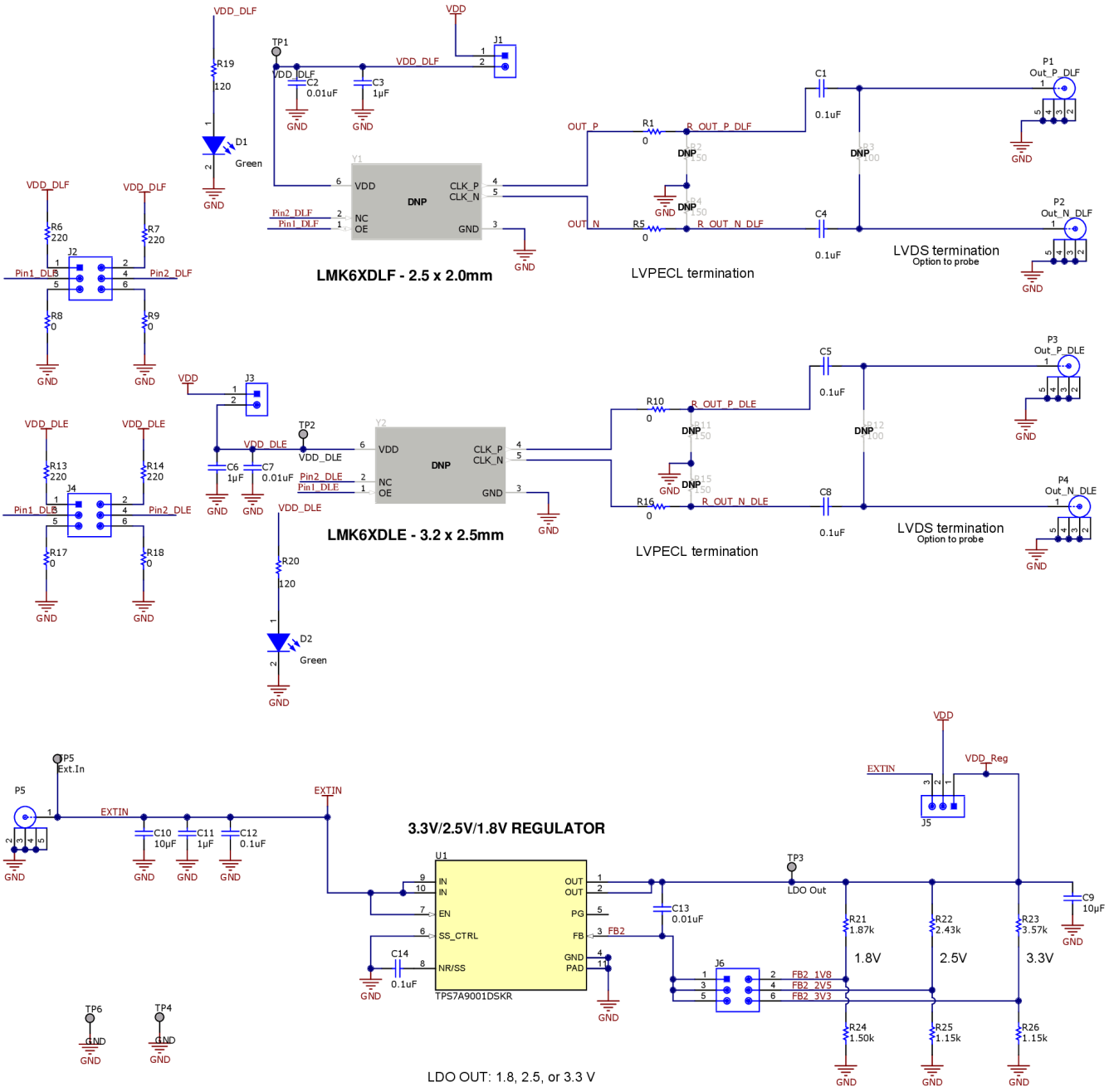

Figure 4-1. Schematic

5 PCB Layout and Layer Stack-Up

5.1 PCB Layer Stack-Up

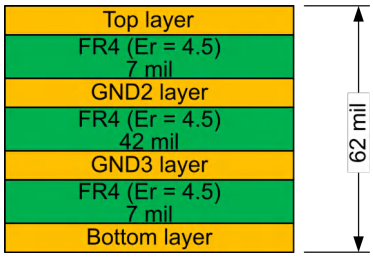

Figure 5-1. PCB Layer Stack-Up

5.2 PCB Layout

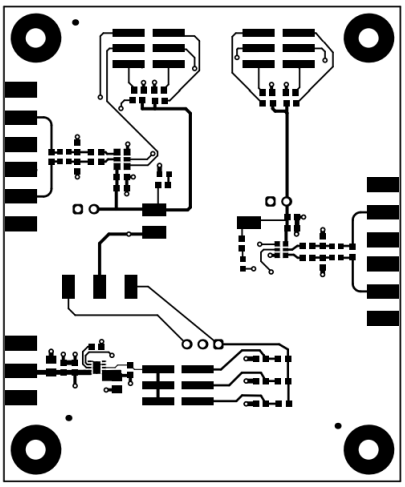

Figure 5-2. Top Layer

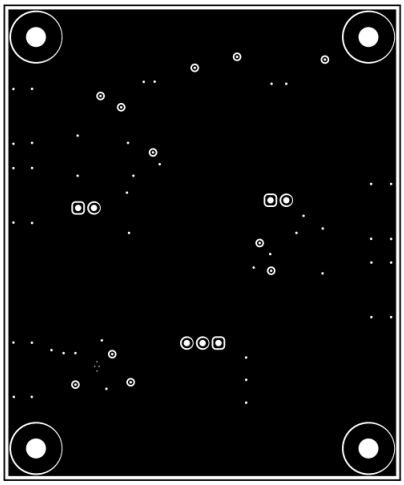

Figure 5-3. GND Layer

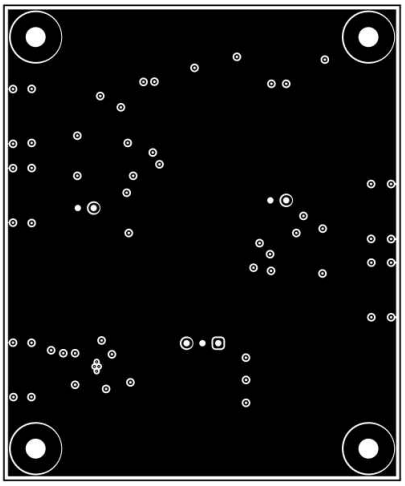

Figure 5-4. GND Layer

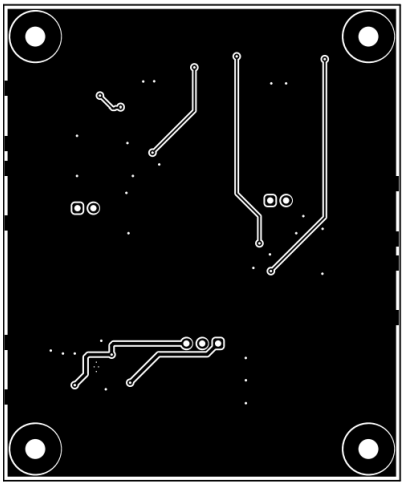

Figure 5-5. Bottom Layer

6 Bill of Materials

Designator	Description	Manufacturer	PartNumber	Quantity
C1, C4, C8, C12, C14	CAP, CERM, 0.1 uF, 16 V, +/- 5%, X7R, 0603	Kemet	C0603C104J4RACTU	5
C2, C7	CAP, CERM, 0.01 uF, 100 V, +/- 5%, X7R, 0603	AVX	06031C103JAT2A	2
C3, C6, C11	CAP, CERM, 1 µF, 16 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	TDK	CGA3E1X7R1C105K080AC	3
C9, C10	CAP, CERM, 10 uF, 16 V, +/- 20%, X7R, 0805	Taiyo Yuden	EMK212BB7106MG-T	2
C13	CAP, CERM, 0.01 uF, 50 V, +/- 5%, X7R, 0603	Kemet	C0603C103J5RACTU	1
D1, D2	LED, Green, SMD	Lite-On	LTST-C190GKT	2
H1, H2, H3, H4	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	B&F Fastener Supply	NY PMS 440 0025 PH	4
H5, H6, H7, H8	Standoff, Hex, 0.5"L #4-40 Nylon	Keystone	1902C	4
J1, J3	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S	2
J2, J4, J6	Header, 2.54mm, 3x2, Gold, Black, SMT	Sullins Connector Solutions	GBC03DABN-M30	3
J5	Header, 100mil, 3x1, Gold, TH	Samtec	TSW-103-07-G-S	1
LBL1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10	1
P1, P2, P3, P4, P5	Connector, End launch SMA, 50 ohm, SMT	Cinch Connectivity	142-0701-851	5
R1, R5, R8, R9, R10, R16, R17, R18	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06030000Z0EA	8
R6, R7, R13, R14	RES, 220, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603220RJNEA	4
R19, R20	RES, 120, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603120RJNEA	2
R21	RES, 1.87 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06031K87FKEA	1
R22	RES, 2.43 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06032K43FKEA	1
R23	RES, 3.57 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06033K57FKEA	1
R24	RES, 1.50 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06031K50FKEA	1
R25, R26	RES, 1.15 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06031K15FKEA	2

Designator	Description	Manufacturer	PartNumber	Quantity
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6	Shunt, 100mil, Gold plated, Black	Samtec	SNT-100-BK-G	6
TP1, TP2, TP3, TP4, TP5, TP6	Test Point, Miniature, SMT	Keystone	5019	6
U1	500mA High-Accuracy Low-Noise Low-Dropout (LDO) Voltage Regulator, DSK0010A (WSON-10)	Texas Instruments	TPS7A9001DSKR	1
C5	CAP, CERM, 0.1 uF, 16 V, +/- 5%, X7R, 0603	Kemet	C0603C104J4RACTU	0
FID1, FID2, FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	0
R2, R4, R11, R15	RES, 150, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603150RJNEA	0
R3, R12	RES, 100, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603100RFKEA	0
Y1	High-Performance BAW Oscillator; <125fs, +/- 25ppm, pin 1Active high; 2.5V/3.3V, -40C to 85C and DLF package	Texas Instruments	LMK6XDLF	0
Y2	High-Performance BAW Oscillator; <125fs, +/- 25ppm, pin 1Active high; 2.5V/3.3V, -40C to 85C and DLE package	Texas Instruments	LMK6XDLE	0

7 Revision History

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

Changes from Revision * (April 2022) to Revision A (December 2022)	Page
• Changed the LMK6E6EVM-1/LMK6F6EVM to LMK6EVM	3

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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

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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

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

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3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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.

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