

EVM User's Guide: LMK6LEVM

LMK6L Evaluation Module

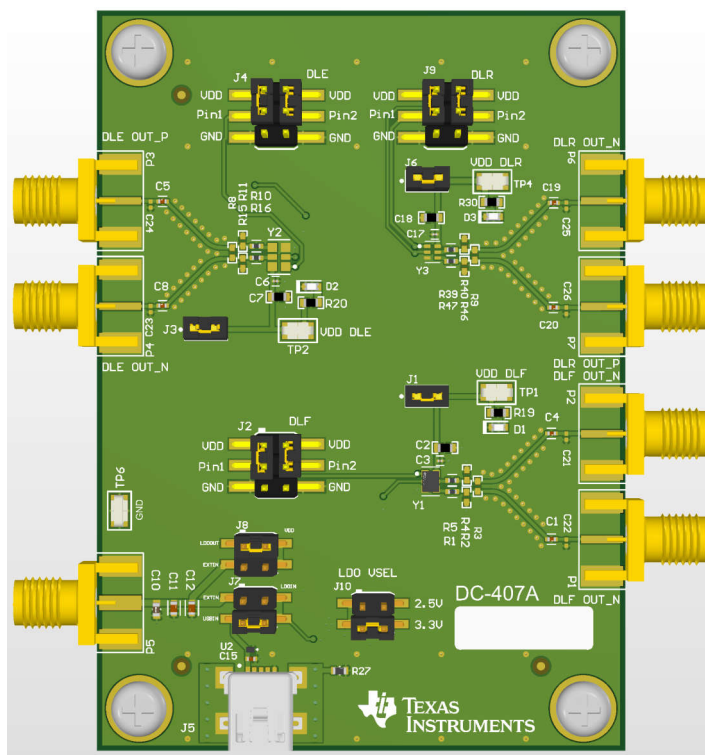


1 Description

The LMK6LEVM provides a complete evaluation platform to evaluate the clock performance and flexibility of the Texas Instruments LMK6L Ultra Low Jitter, High-performance 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 LMK6L, which allows the device to interface with test equipment and reference boards using commercially available coaxial cables, adapters, or baluns (not included).

2 Features

- Contains footprints for three standard 6-pin oscillator packages: DLE (3.2mm × 2.5mm), DLF (2.5mm × 2.0mm), and DLR (2.0mm × 1.6mm)
- Onboard voltage regulator to generate standard supply voltages (2.5V, 3.3V)
- Can be powered using USB only, option for external power supply



LMK6LEVM Evaluation Board

3 Evaluation Module Overview

3.1 Introduction

The LMK6L is an ultra-high-performance clock oscillator using TI's BAW technology. The LMK6L is available in three package sizes: DLE (3.2mm × 2.5mm), DLF (2.5mm × 2.0mm), and DLR (2.0mm × 1.6mm). All three footprints are included on the EVM with independent termination networks. By default, the LMK6LEVM is populated with a 625MHz AC-LVPECL variant of LMK6L with a DLF package size (Y1). The DLE and DLR footprints are left unpopulated so the user can solder the desired frequency variant for evaluation.

The LMK6L is powered entirely using USB and the onboard voltage regulator. An external power supply can also be used for evaluation.

To begin evaluating the LMK6L BAW oscillator, use a matched pair of SMA coaxial cables to connect the clock output to test equipment such as an oscilloscope or phase noise analyzer, or use the output directly as a clock source for another reference board.

3.2 Kit Contents

The box contains:

- One LMK6LEVM board (DC407A)

3.3 Specifications

- Supports standard frequencies from 50MHz to 2.5GHz
- ±20ppm total frequency stability inclusive of all factors, including 10 years aging
- Ultra-Low jitter: 35fs max RMS jitter for Fout = 625MHz
- Operating temperature range of -40°C to +85°C

4 Implementation Results

4.1 Evaluation Setup Requirement

The evaluation requires the following hardware:

- DC power supply or USB power supply
- Oscilloscope
- Signal analyzer (optional)

4.2 Setup

4.2.1 Connection Diagram

Figure 4-1 shows the LMK6LEVM connection diagram. The top region of the board contains 3 zones for each package size. Each zone contains a footprint to populate a LMK6L oscillator (Y1, Y2, Y3), a jumper to pull the oscillator pin 1 and 2 high or low (J2, J4, J9), and an output termination network with an SMA connector (P1-P4, P6, P7).

The bottom-left region of the board contains jumpers for configuring the power supply network. Provide input power using the included USB cable, or an external supply connected to the EXTIN SMA connector (P5).

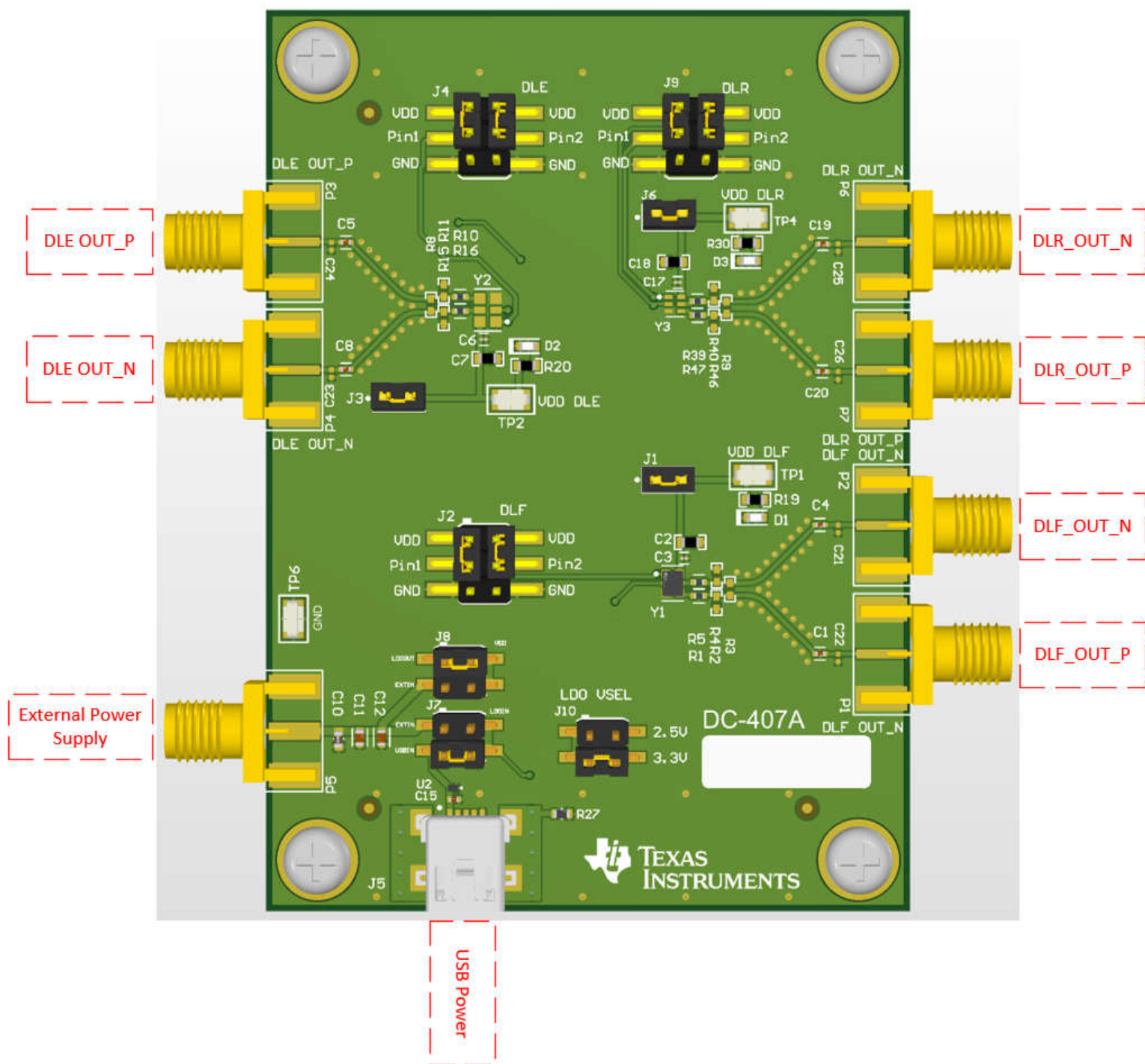


Figure 4-1. Connection Diagram

4.2.2 Power Supply

Set the jumpers according to the table below.

Table 4-1. Power Supply Jumper Configuration

Input Source	Voltage Regulator	Pins to Short on J7	Pins to Short on J8
5V USB	LDO	3-4	1-2
EXTIN	LDO	1-2	1-2
	Bypass	open	3-4

To use the onboard voltage regulators, apply between 3.6V and 5V to the EXTIN SMA connector (P5), or supply 5V using the mini USB connector. The voltage regulator provides 2.5V or 3.3V to the LMK6L device based on the jumper selection of J10.

To bypass the onboard voltage regulators and use an external supply directly, remove the jumper from J7 and short pins 3-4 on J8.

4.2.3 Clock Output

To test the clock output of Y1, connect the P1 and P2 SMA connectors to an oscilloscope or phase noise analyzer. Similarly, to test the clock output of Y2 or Y3, connect P3-P4 or P6-P7 respectively to an oscilloscope or phase noise analyzer.

4.2.4 EVM Header Configuration

[Table 4-2](#) summarizes the EVM header configurations to connect and route power to the VDD domains of the individual devices, in addition to the individual output enable (OE), standby (ST), or frequency select (FSEL) pins depending on the device populated.

Table 4-2. EVM Header Configurations

Component	Name	Description
J7, J8	VDD	VDD Supply Voltage Source J7: Tie pins 3-4 (default) J8: Tie pins 1-2 (default) By default, VDD is sourced from USB power supply and onboard LDO. See Table 4-1 for more details
J10	VDD_Reg	VDD_Reg Voltage Level Tie pins 3-4 (default): Selects VDD = 3.3V Tie pins 1-2: Selects VDD = 2.5V
J2, J4, J9	Oscillator pin 1 and 2 (OE and FSEL)	Oscillator Pin 1 (OE) Tie pins 1-3 (default): Pull LMK6L OE to VDD, clock output is enabled Tie pins 3-5: Pull LMK6L OE to GND, clock output is disabled Oscillator Pin 2 (FSEL) Tie pins 2-4 (default): Pull LMK6L FSEL to VDD, output frequency = 312.5MHz Tie pins 4-6: Pull LMK6L FSEL to GND, output frequency = 156.25MHz Jumper removed: LMK6L FSEL is internally biased to mid-level, output frequency = 625MHz

4.2.5 Configuring the Output Clock Termination

The LMK6LEVM comes pre-populated with an AC-coupled termination designed for LP-HCSL, LVDS, AC-LVPECL, and custom swing output formats. For the LVDS, AC-LVPECL, and custom swing output types, terminate the output with a 100Ω differential termination. If the output is AC-coupled, terminate the P and N channels with 50Ω tied to a bias voltage to set the desired common mode voltage.

For LP-HCSL, the output can interface with a high-impedance load to provide the full signal swing. Unlike conventional HCSL drivers, no external termination resistors are required.

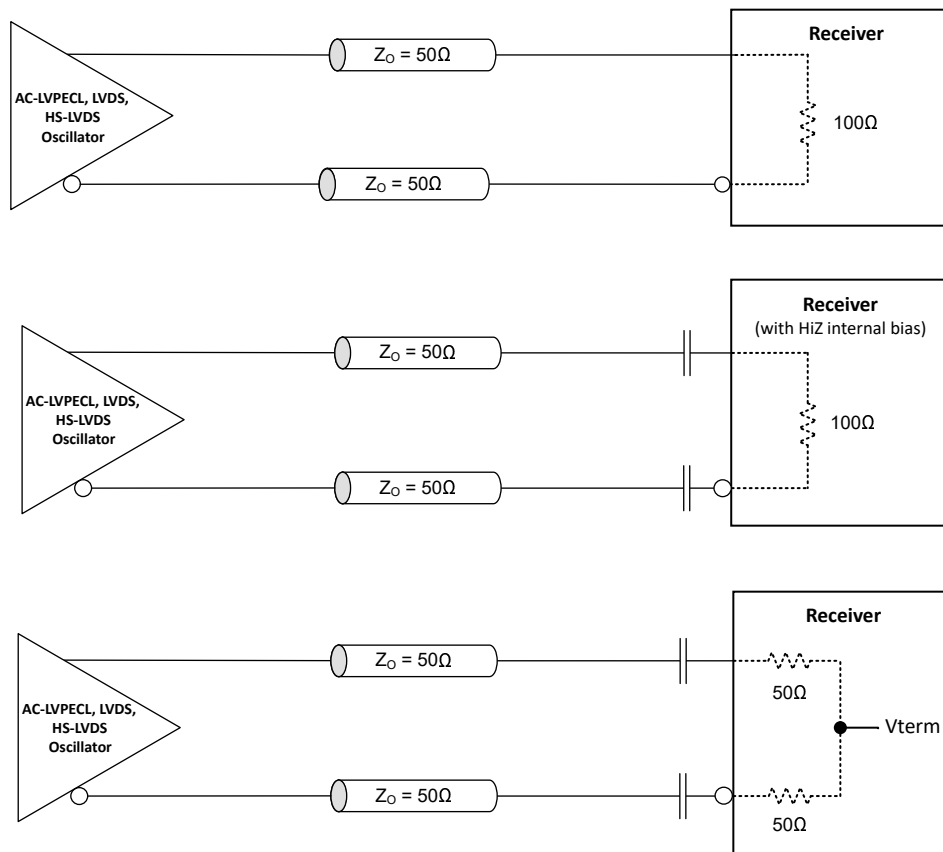


Figure 4-2. AC-LVPECL, LVDS, and Custom Swing Output Terminations

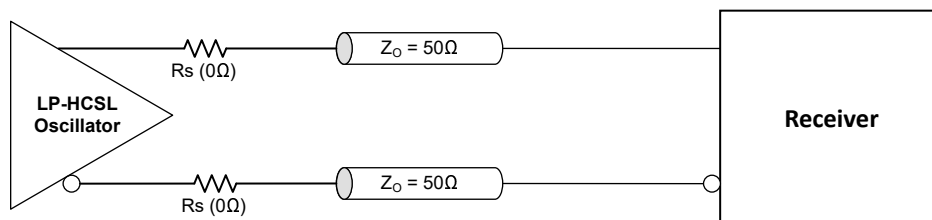


Figure 4-3. LP-HCSL Output Termination

4.3 Performance Data and Results

4.3.1 Typical Measurement

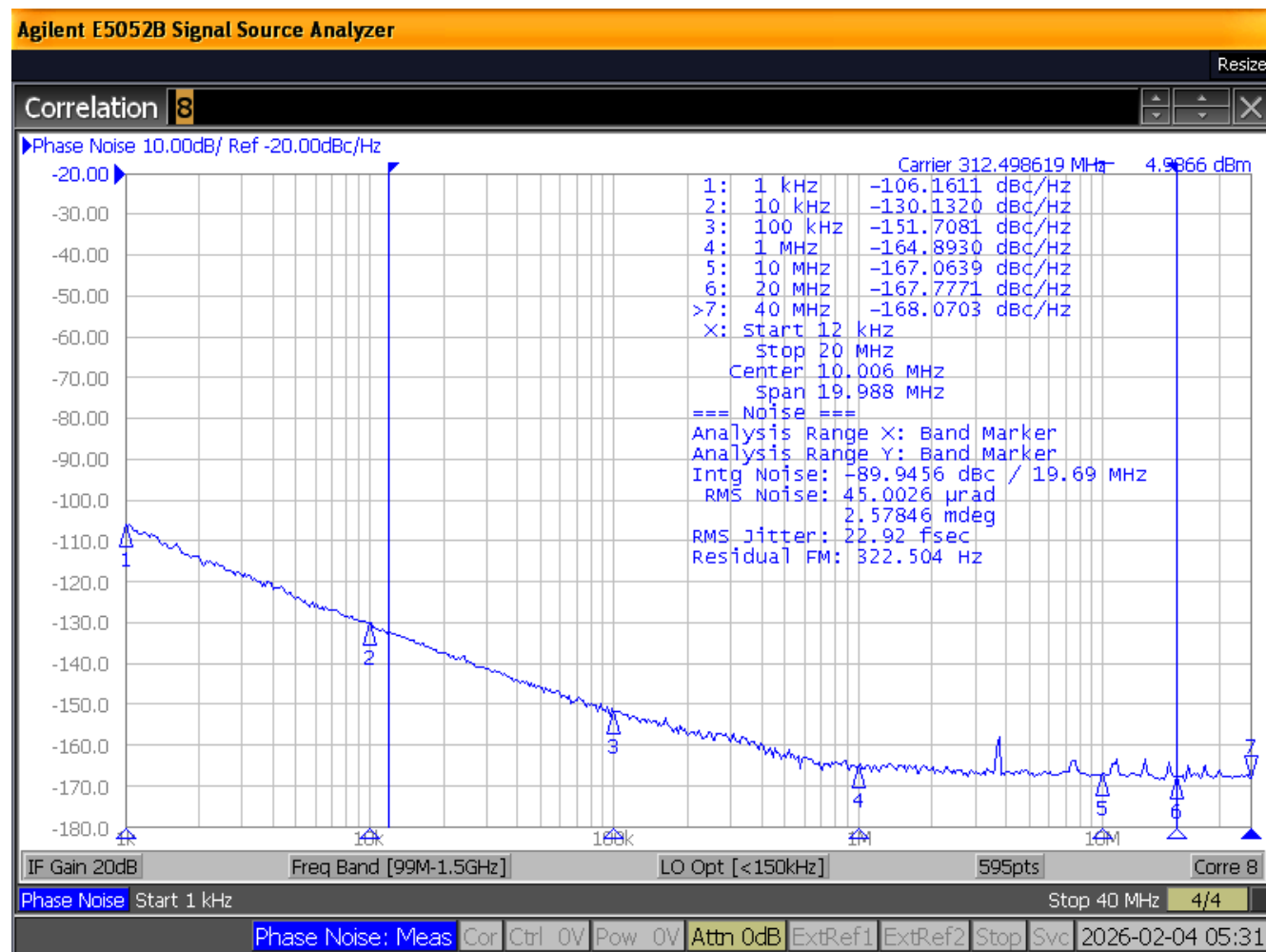


Figure 4-4. Phase Noise Plot of 312.5MHz LMK6L Variant

5.1 Schematics



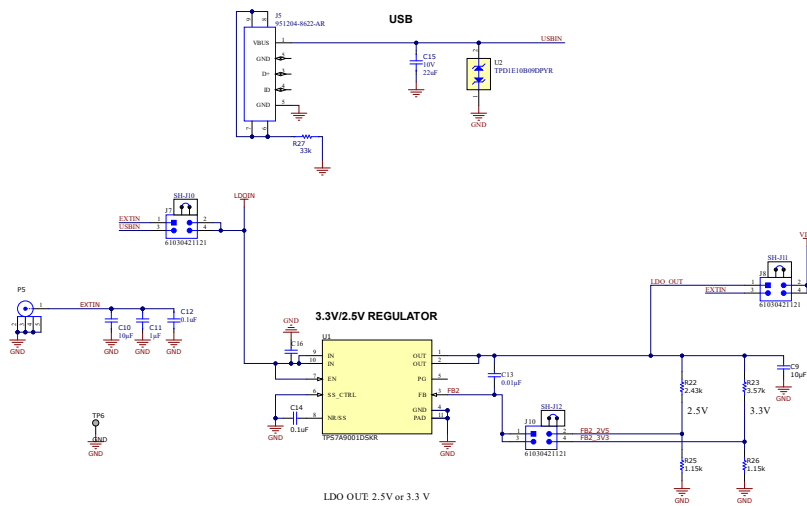


Figure 5-2. Schematic - Power Supply

5.2 PCB Layout and Layer Stack-Up

5.2.1 PCB Layer Stack-Up

#	Name	Material	Type	Weight	Thickness	Dk
	Top Overlay		Overlay			
	Top Solder	Solder Resist	Solder Mask		0.4mil	4
1	Top Layer		Signal	1oz	1.4mil	
	Dielectric 1	MT40	Prepreg		10mil	3.45
2	Int1 (GND)		Signal	1oz	1.4mil	
	Dielectric 2	FR4	Core		32.87mil	4.8
3	Int2 (PWR)		Signal	1oz	1.4mil	
	Dielectric 3	MT40	Prepreg		10mil	3.45
4	Bottom Layer		Signal	1oz	1.4mil	
	Bottom Solder	Solder Resist	Solder Mask		0.4mil	4
	Bottom Overlay		Overlay			

Figure 5-3. PCB Layer Stack-Up

5.2.2 PCB Layout

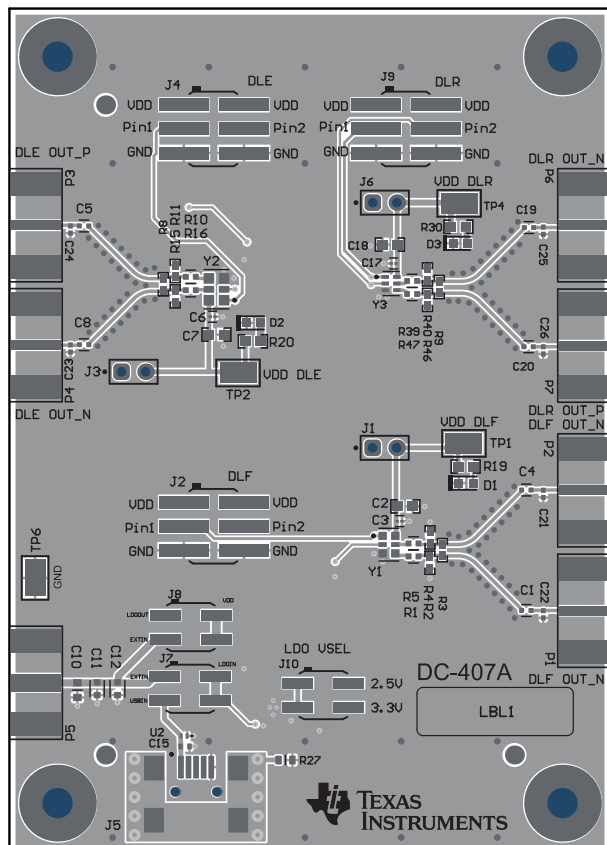


Figure 5-4. Top View Composite

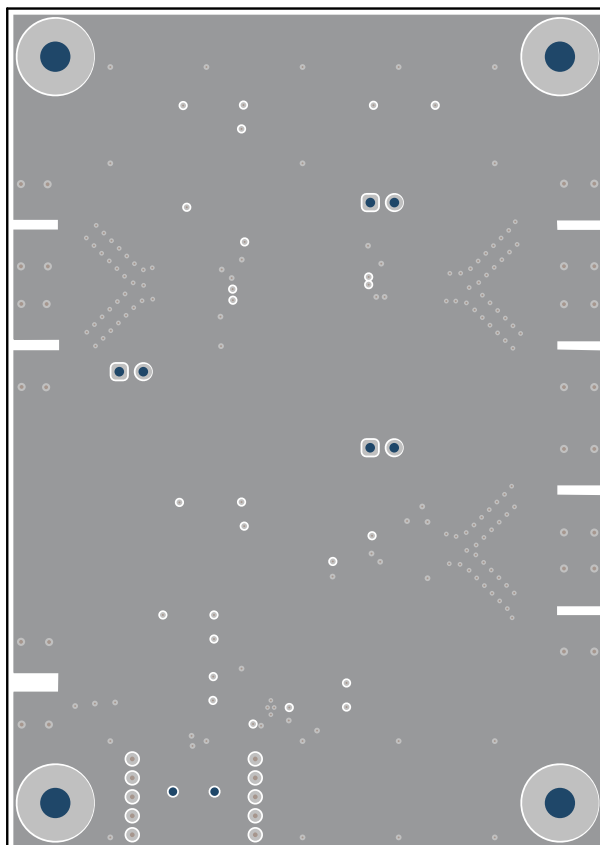


Figure 5-5. GND Layer

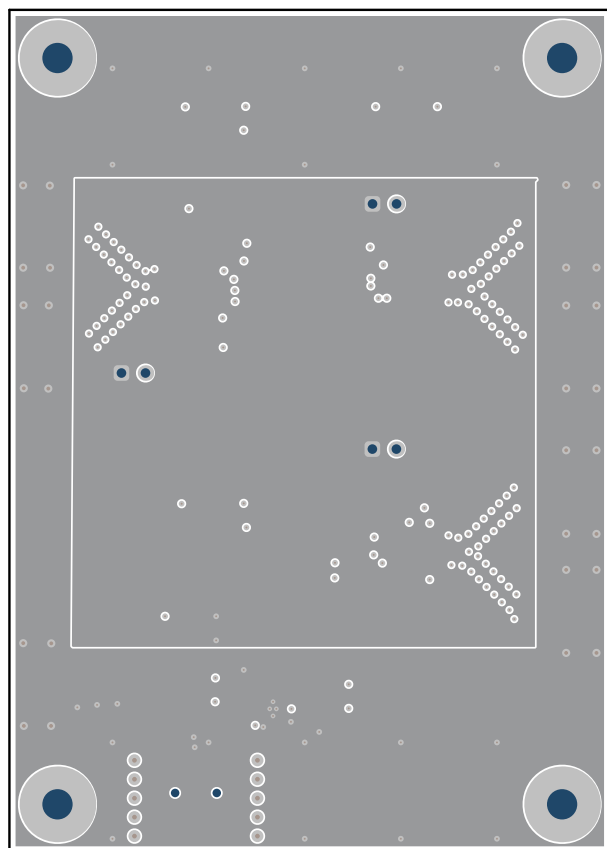


Figure 5-6. PWR Layer

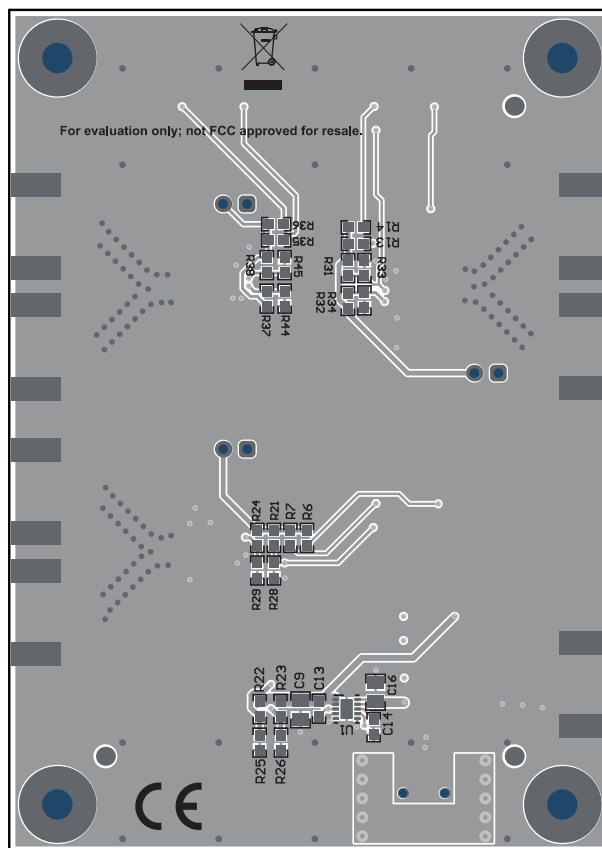


Figure 5-7. Bottom View Composite

5.3 Bill of Materials (BOM)

Bill of Materials

Designator	Description	Manufacturer	PartNumber	Quantity
C1, C4, C5, C8, C19, C20	0.1 μ F $\pm$ 10% 10V Ceramic Capacitor X7R 0402 (1005 Metric)	Wurth Electronics	8.85012E+11	6
C2, C7, C18	CAP, CERM, 1 μ F, 16V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	TDK	CGA3E1X7R1C105K080A C	3
C3, C6, C17	0.1 μ F $\pm$ 10% 16V Ceramic Capacitor 0201 (0603 Metric)	Passive Plus	0201BB104KW160	3
C9, C16	CAP, CERM, 10 μ F, 16V, +/- 20%, X7R, 0805	Taiyo Yuden	EMK212BB7106MG-T	2
C10	10 μ F $\pm$ 20% 25V Ceramic Capacitor X5R 0603 (1608 Metric)	Murata Electronics	ZRB18AR61E106ME01L	1
C11	1 μ F $\pm$ 10% 16V Ceramic Capacitor X7S 0603 (1608 Metric)	Murata	GRM188C71C105KA12D	1
C12	0.1 μ F $\pm$ 10% 16V Ceramic Capacitor X7R 0603 (1608 Metric)	Murata Electronics North America	GCJ188R71C104KA01D	1
C13	CAP, CERM, 0.01 μ F, 25V, +/- 1%, C0G/ NP0, 0603	Kemet	C0603C103F3GACTU	1
C14	CAP, CERM, 0.1 μ F, 16V, +/- 5%, X7R, 0603	Kemet	C0603C104J4RACTU	1
C15	Chip Multilayer Ceramic Capacitors for General Purpose, 0402, 22 μ F, X5R, 15%, 20%, 10V	Murata	GRM158R61A226ME15D	1
D1, D2, D3	LED, Green, SMD	Lite-On	LTST-C190GKT	3
H1, H2, H3, H4	Machine Screw, Round, #4-40 $\times$ 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, J6	Header, 100mil, 2x1, Gold, TH	Samtec	TSW-102-07-G-S	3
J2, J4, J9	Header, 2.54mm, 3x2, Gold, Black, SMT	Sullins Connector Solutions	GBC03DABN-M30	3
J5	Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT	TE Connectivity	1734035-2	1
J7, J8, J10	Header, 2.54mm, 2x2, Gold, SMT	Wurth Elektronik	61030421121	3
P1, P2, P3, P4, P5, P6, P7	Connector, End launch SMA, 50 Ω , SMT	Cinch Connectivity	142-0701-851	7
R1, R5, R10, R16, R39, R47	RES Thick Film, 0 Ω , 0.2W, 0402	Vishay Dale	CRCW04020000Z0EDHP	6
R6, R7, R13, R14, R35, R36	RES, 220, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603220RJNEA	6
R19, R20, R30	RES, 120, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603120RJNEA	3
R22	RES, 2.43k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06032K43FKEA	1
R23	RES, 3.57k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06033K57FKEA	1
R25, R26	RES, 1.15k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06031K15FKEA	2
R27	33k Ω $\pm$ 0.1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thin Film	Panasonic	ERA-3AEB333V	1
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12	Shunt, 100mil, Gold plated, Black	Samtec	SNT-100-BK-G	12
TP1, TP2, TP4, TP6	Test Point, Miniature, SMT	Keystone	5019	4

Designator	Description	Manufacturer	PartNumber	Quantity
U1	500mA High-Accuracy Low-Noise Low-Dropout (LDO) Voltage Regulator, DSK0010A (WSON-10)	Texas Instruments	TPS7A9001DSKR	1
U2	Single-Channel ESD Protection in 0402 Package With 10pF Capacitance and 9V Breakdown, DPY0002A (X1SON-2)	Texas Instruments	TPD1E10B09DPYR	1
Y1	LMK6L_DLF	Texas Instruments	LMK6LPK625000FDLFR	1
C21, C22, C23, C24, C25, C26	Cap Ceramic 2pF 50V C0G ± 0.1 pF SMD 0402 +125°C Paper T/R	Samsung	CL05C020BB5NNNC	0
FID1, FID2, FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	0
R2, R4, R11, R15, R40, R46	RES, 210, 1%, 0.063W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW0402210RFKED	0
R3, R8, R9	RES, 100, 1%, 0.125W, AEC-Q200 Grade 1, 0402	AT Ceramics	ATC504L1000FTNCFT	0
R21, R24, R28, R29, R31, R32, R33, R34, R37, R38, R44, R45	RES, 10.0k, 1%, 0.1 W, 0603	Yageo	RC0603FR-0710KL	0
Y2	LMK6L_DLE	Texas Instruments	LMK6L_DLE	0
Y3	LMK6L_DLR6A	Texas Instruments	LMK6L_DLR6A	0

6 Additional Information

Trademarks

All trademarks are the property of their respective owners.

7 Related Documentation

See the [LMK6Lx Ultra Low Jitter, High-performance BAW Oscillator Datasheet](#) for more information about the LMK6L devices.

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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 instructions, 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/sds/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>

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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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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:

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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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