EVM User's Guide: LMR66430-2EVM

LMR66430-Q1 Evaluation Module

Description

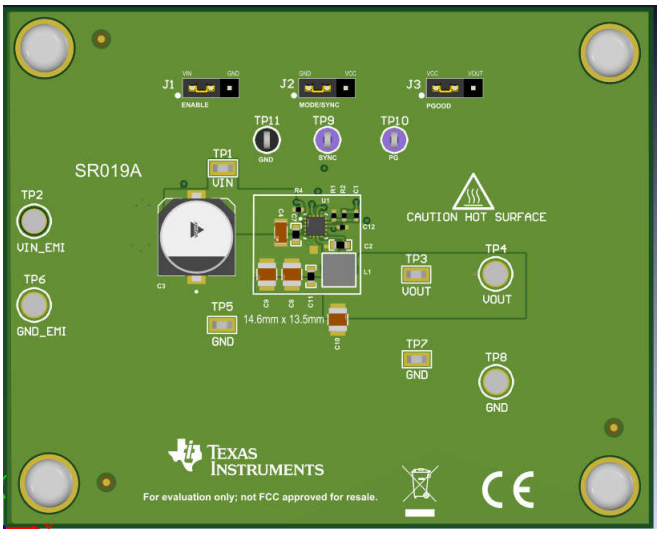
The LMR66430-Q1 is an easy-to-use, synchronous, step-down voltage converter. The EVM is capable of delivering up to 3 A of load current from an input voltage of up to 36 V. The LMR66430-2EVM features an output voltage of 5 V and a switching frequency of 2.2 MHz. By default, this EVM is populated with the LMR66430MC5RXBRQ1. The LMR66430-2EVM is capable of supporting the entire LMR664x0-Q1 and LMQ664x0-Q1 family of devices by exchanging the default IC with other variants in the family including the non-automotive grade devices.

Features

- Wide input voltage range of 3 V to 36 V
- Fixed 5-V output, with optional feedback divider footprints
- Fixed 2.2 MHz switching frequency with external sync capability and mode select
- Input, differential EMI filter for compliance testing

Applications

- Advanced driver assistance systems: radar ECU
- Infotainment & cluster: head unit, eCall
- Body electronics & lighting



LMR66430-2EVM Board

1 Evaluation Module Overview

1.1 Introduction

The Texas Instruments' LMR66430-2EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LMR66430-Q1, wide-input voltage, buck converter. The step-down EVM provides an automotive, 12 V battery design. The EVM operates at 2.2 MHz and is constructed on a 4-layer PCB. The LMR66430-2EVM is optimized for CISPR 25 Class 5 compliance and automotive, thermal performance.

CAUTION

	**Caution**	Hot surface. Contact can cause burns. Do not touch.

1.2 Kit Contents

The box includes the LMR6630-2EVM on nylon standoffs for evaluating on a lab bench. Contact the Texas Instruments Product Information Center nearest (or E2E forum) if any components are missing or the EVM is defective.

1.3 Specification

	MIN	TYP	MAX
VIN	3 V	12 V	36 V
VOUT		5 V	
IOUT	0		3 A

1.4 Device Information

Table 1-1. Device and Package Configurations

EVM	U1	FREQUENCY	SPREAD SPECTRUM	CURRENT	PIN 13
LMR66430-2EVM	LMR66430MC5RXBRQ1	2200 kHz	Enabled	3 A	MODE/SYNC

2 Hardware

2.1 Setup

This section describes the test points and connectors on the EVM and how to properly connect, set up, and use the LMR66430-Q1 EVM.

2.1.1 Test Points

See Figure 2-1 for typical test setup. The functions of the test point connections are:

- **VIN_EMI —** Input supply to EVM.
- **GND_EMI —** Ground connection for the input supply.
- **VIN —** Input supply to the IC. Can be connected to a digital multimeter to measure the input voltage after EMI filter.
- **VOUT —** Output voltage test point of EVM. Can be connected to a desired load.
- **GND —** Ground test point.
- **PG —** This test point is connected to the PGOOD pin from the IC.
- **SYNC —** This test point can also be connected to an external clock to synchronize the IC.
- **GND—** This test point represents the analog ground test point and is connected to the ground plane.

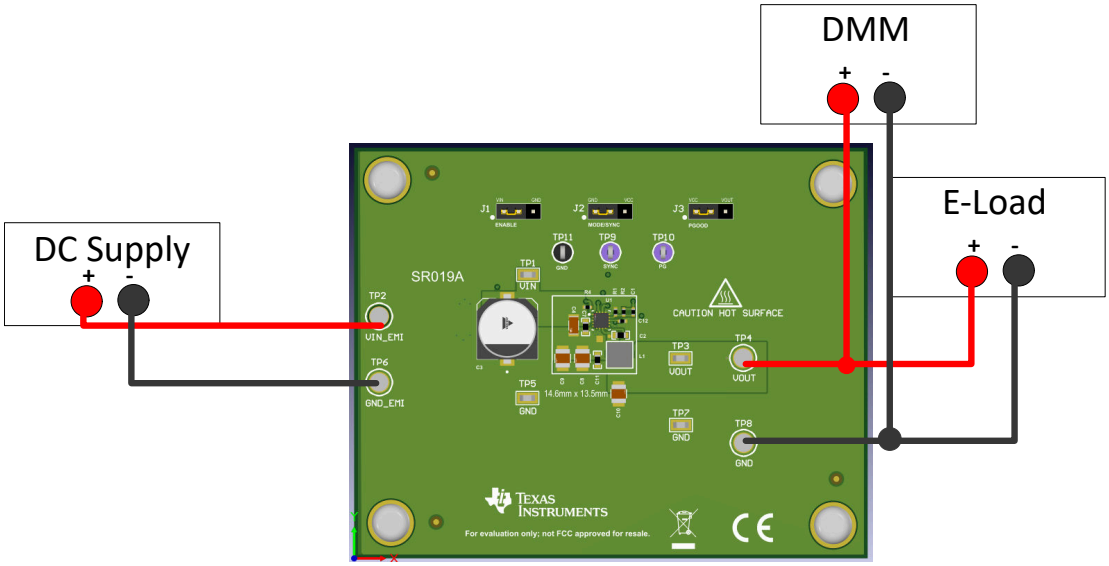


Figure 2-1. EVM Board Connections

2.1.2 Jumpers

- **J1 —** Connect J1:1-2 to enable the device or J1:2-3 to disable the device. To evaluate a unique EN_UVLO, please utilize the equations provided in the data sheet for calculating R5, then populate on the EVM, and remove the J1 jumper.
- **J2—** Connect J2:1-2 to put the device in Auto mode or J2:2-3 for FPWM (fixed frequency). If synchronization to an external clock source is required, remove J2 jumper and hook-up clock to test point "SYNC."
- **J3 —** PG is an open-drain, output signifying VOUT regulation. Connect J3:1-2 for VCC (3V) pull-up voltage, or, J3:2-3 for VOUT pull-up voltage. Note, the max voltage PG can sustain is 20 V.

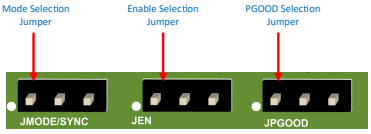


Figure 2-2. Jumper Locations

2.2 Operation

2.2.1 Quick Start

1. Connect the voltage supply between the VIN_EMI and GND_EMI supply connections.
2. Connect the load between the VOUT and GND test points.
3. Set the supply voltage at an appropriate level between 6 V to 36 V. Set the current limit of the supply to at least the max, evaluated load current.
4. Turn on the power supply. With the default configuration, the EVM powers up and provides V_{OUT} = 5 V.
5. Monitor the output voltage. The maximum load current is rated at 3 A with the LMR66430-Q1 device.

3 Implementation Results

3.1 Test Results

3.1.1 LMR66430-2EVM Test Results

3.1.1.1 Noise and Thermal Performance

Conducted Emissions

The LMR66430-2EVM was evaluated on a CISPR 25, Class 5, pre-compliance, conducted emissions (CE) setup. The LMR66430-2EVM was evaluated with a 13.5V input supply and 3 A resistive load. CISPR 25, Class 5, CE scan (150kHz to 108MHz) provides the scan results showing a passing result by approximately 10 dB for both average and peak detect.

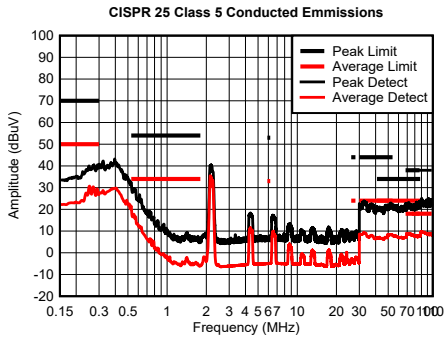


Figure 3-1. CISPR 25, Class 5, CE scan (150kHz to 108MHz)

Thermal Capture

The LMR66430-2EVM was evaluated with a 13.5V input and a resistive load. Thermal capture with 2 A Load and Thermal capture with 3 A Load demonstrate the case, temperature rise from room temperature (25°C). This gives a good approximation to the junction temperature with the temperature gradient being very small across the thin case and junction.

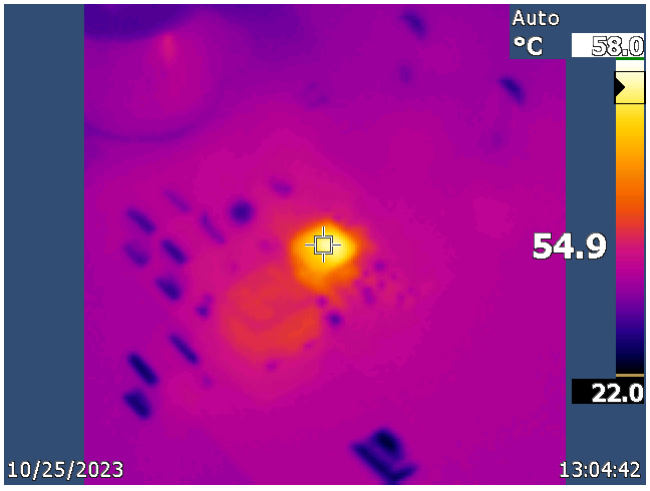


Figure 3-2. Thermal capture with 2 A Load

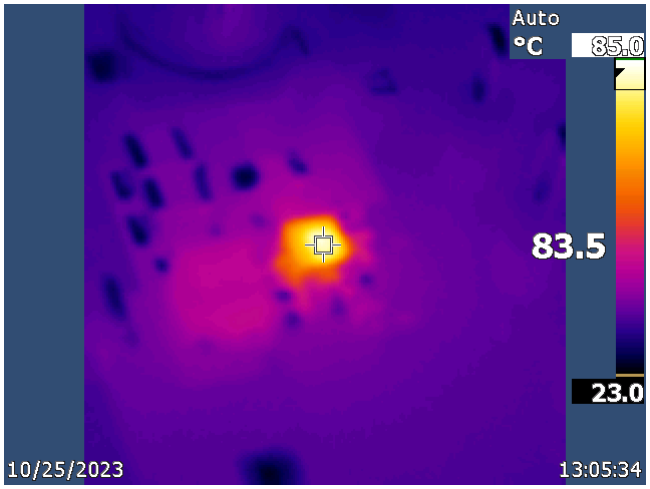


Figure 3-3. Thermal capture with 3 A Load

4 Hardware Design Files

4.1 Schematic

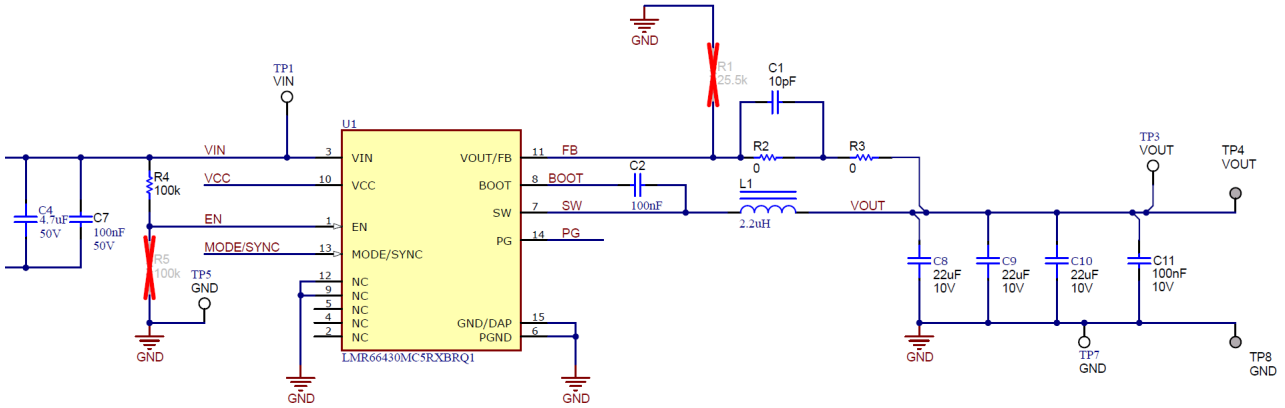


Figure 4-1. LMR66430-2EVM Schematic-Buck

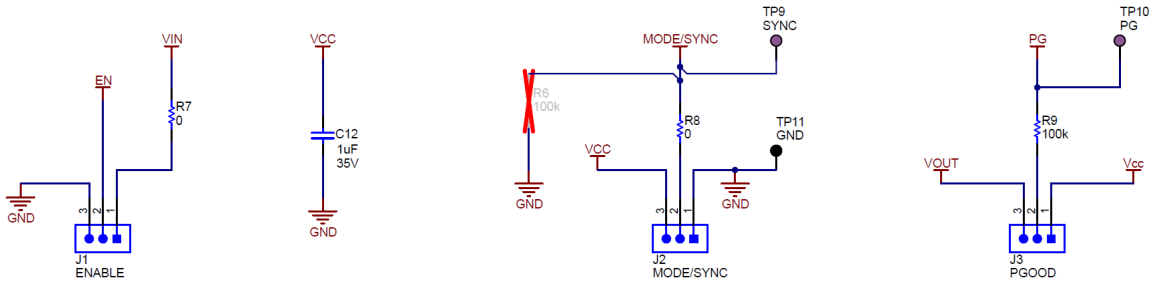


Figure 4-2. LMR66430-2EVM Schematic-Jumpers

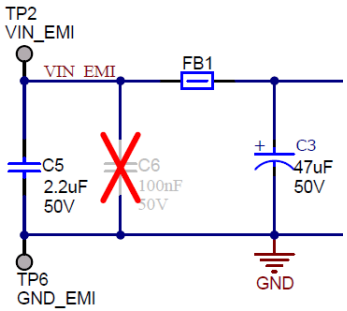


Figure 4-3. LMR66430-2EVM Schematic-Differential Filter

4.2 PCB Layout

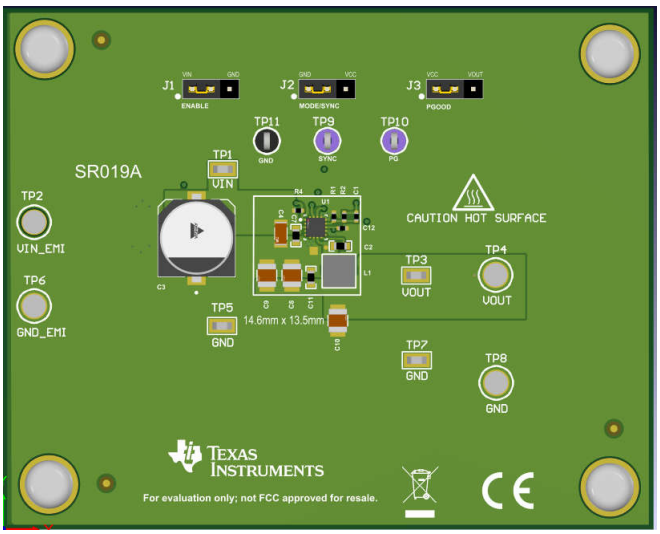


Figure 4-4. Top View of EVM

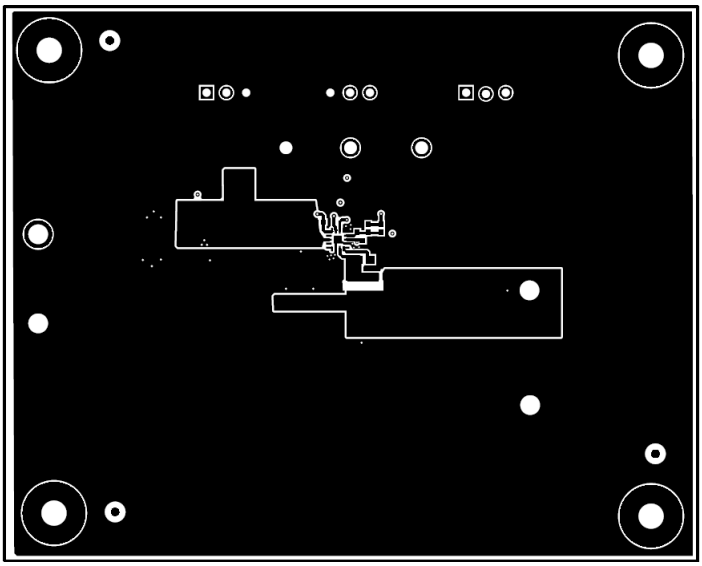


Figure 4-5. EVM Top Copper Layer

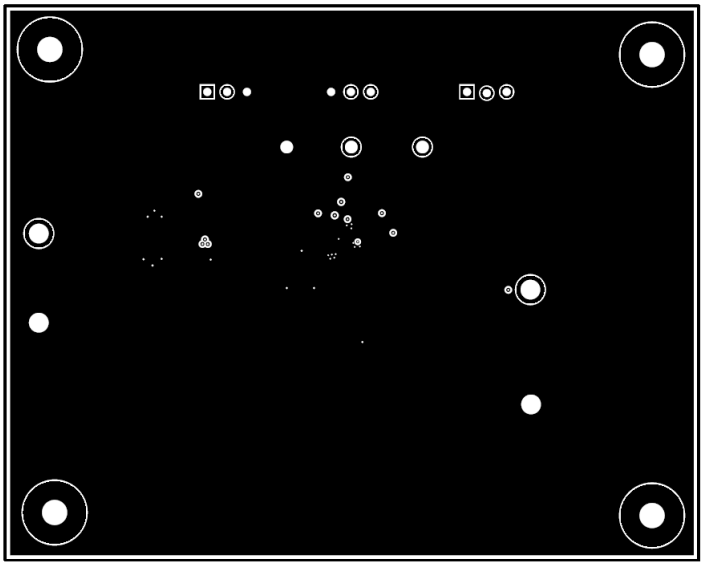


Figure 4-6. Mid-Layer One

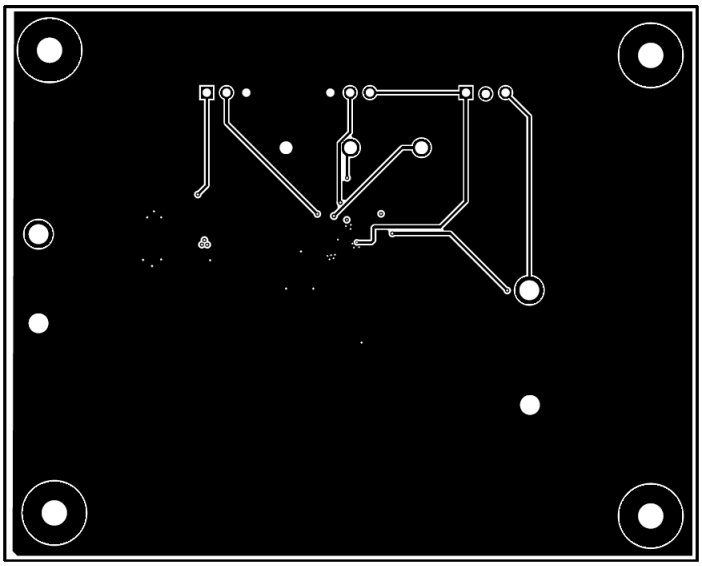


Figure 4-7. Mid-Layer Two

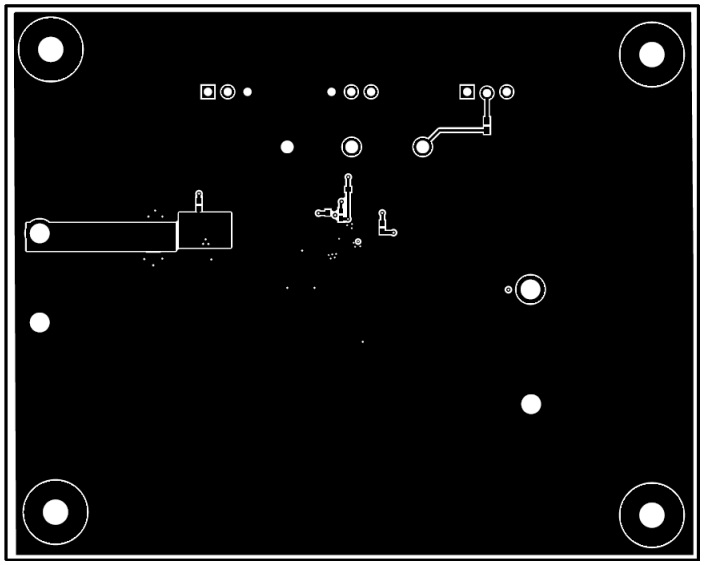


Figure 4-8. EVM Bottom Copper Layer

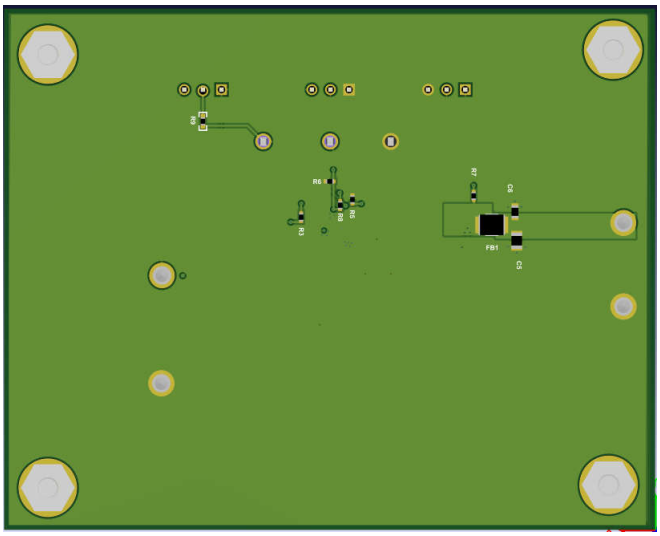


Figure 4-9. Bottom View of EVM

4.3 Bill of Materials

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1	1	10 pF	CAP, CERM, 10 pF, 10 V,+/- 2.5%, C0G/NP0, 0402	0402	C0402C100C8GACTU	Kemet
C2, C7	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	885012206095	Wurth Elektronik
C3	1		47 µF 50 V Aluminum Electrolytic Capacitors Radial, Can - SMD 1500 Hrs @ 125°C	RADIAL	MAL214699101E3	Vishay BC Components
C4	1		4.7µF ±10% 50 V Ceramic Capacitor X7R 1206 (3216 Metric)	1206	885012208094	Wurth Electronics
C5	1	2.2uF	CAP, CERM, 2.2 uF, 50 V, +/- 10%, X5R, 0805	0805	C2012X5R1H225K125AB	TDK
C8, C9, C10	3	22 µF	Ceramic Capacitor for Automotive 22uF ±10% 10VDC X7R 1210 Embossed T/R	1210	GCM32ER71A226KE12L	Murata
C11	1	0.1uF	CAP, CERM, 0.1 uF, 10 V, +/- 10%, X7R, 0603	0603	0603ZC104KAT2A	AVX
C12	1	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X5R, 0402	0402	GRM155R6YA105KE11D	MuRata
FB1	1	600 ohm	Ferrite Bead, 600 ohm @ 100 MHz, 3 A, 1210	1210	FBMH3225HM601NT	Taiyo Yuden
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, J2, J3	3		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L1	1	2.2uH	Inductor, Shielded, Composite, 2.2 uH, 6.1 A, 0.0201 ohm, AEC-Q200 Grade 1, SMD	4x4mm	XEL4030-222MEB	Coilcraft
R2, R3, R7, R8	4	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RK73Z1ETTP	KOA Speer
R4	1	100k	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ104X	Panasonic
R9	1	100k	RES, 100 k, 1%, 0.0625 W, AEC-Q200 Grade 0, 0402	0402	AC0402FR-07100KL	Yageo America
SH-J1, SH-J2, SH-J3	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP3, TP5, TP7	4		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
TP2, TP4, TP6, TP8	4		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
TP9, TP10	2		Test Point, Multipurpose, Purple, TH	Purple Multipurpose Testpoint	5129	Keystone
TP11	1		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone

Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U1	1		36-V, 3-A Ultra-Small Synchronous Automotive Step-Down Converter with Integrated VIN Bypass and CBOOT Capacitors	WQFN15	LMR66430MC5RXBRQ1	Texas Instruments
C6	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	885012206095	Wurth Elektronik
R1	0	25.5k	RES, 25.5 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040225K5FKED	Vishay-Dale
R5	0	100k	RES, 100 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GEJ104X	Panasonic
R6	0	100k	RES, 100 k, 1%, 0.0625 W, AEC-Q200 Grade 0, 0402	0402	AC0402FR-07100KL	Yageo America

5 Additional Information

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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.

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   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE 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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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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西新宿三井ビル

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.

6. *Disclaimers:*

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