LMR36506RREVM User's Guide

The Texas Instruments LMR36506RREVM evaluation module help designers evaluate the operation and performance of the LMR36506 wide-input buck converters. The LMR36506 is an easy-to-use synchronous step-down DC/DC converter capable of driving up to 0.6 A of load current from an input voltage of up to 65 V. The LMR36506RREVM features an output voltage of 3.3 V or 5 V and a switching frequency of 1 MHz. See the *LMR36506 3-V–65-V, 0.6-A Ultra-Small Synchronous Buck Converter with 4 µA I_Q* data sheet for additional features, detailed descriptions, and available options.

Table 1. Device and Package Configurations

EVM	U1	FREQUENCY	SPREAD SPECTRUM	CURRENT	PIN 1 TRIM
LMR36506RREVM	LMR36506RRPE	1000 kHz	Disabled	0.6 A	RT with PFM

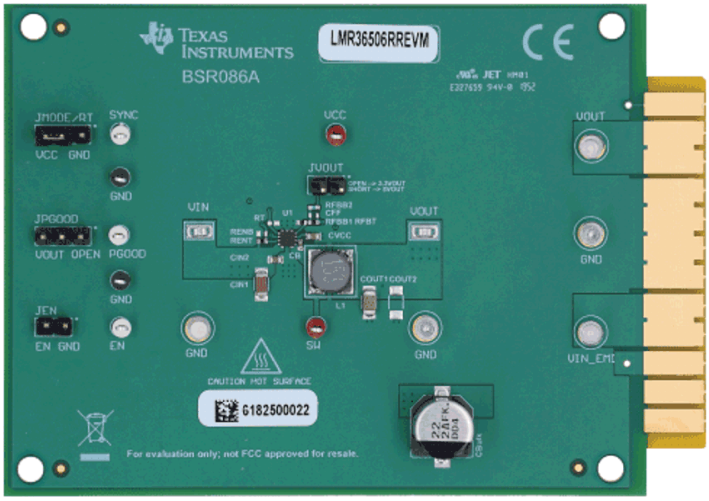

Figure 1. LMR36506RREVM Board

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Trademarks

All trademarks are the property of their respective owners.

1 Setup

This section describes the test points and connectors on the EVM and how to properly connect, set up, and use the LMR36506RREVM.

1.1 Test Points

The test points on the top of the board can be used for connecting to the input and output of the EVM. See Figure 2 for typical test setup. The functions of the test points connections are:

- **VIN_EMI —** Input supply to EVM including an EMI filter. Connect to a suitable input supply. Connect at this point for conducted EMI test.
- **GND —** Ground connection for the input supply as well as test points for ground connection
- **VIN —** Input supply to the IC. Can be connected to DMM to measure input voltage after EMI filter
- **VOUT —** Output voltage test point of EVM. Can be connected to a desired load
- **EN —** This test point is connected to the EN pin. By default, there is a pullup resistor R2 (RENT) to VIN to enable the IC.
- **PGOOD —** This test point is connected to the PGOOD pin from the IC. It is an open-drain output of the PGOOD pin. Can be tied to external supply through a pullup resistor or left open
- **SYNC —** In a **MODE/SYNC** trim part, this test point is connected to the SYNC pin of the IC. Can be connected to an external clock to synchronize the IC. Make sure R4 (RMODE) is installed and R5 (RT) is not installed. In a **RT** trim part, this test point is connected to the RT pin of the IC when the R4 (RMODE) is installed.
- **VCC —** This test point is connected to the VCC pin.
- **SW —** This test point is connected to the switch node.

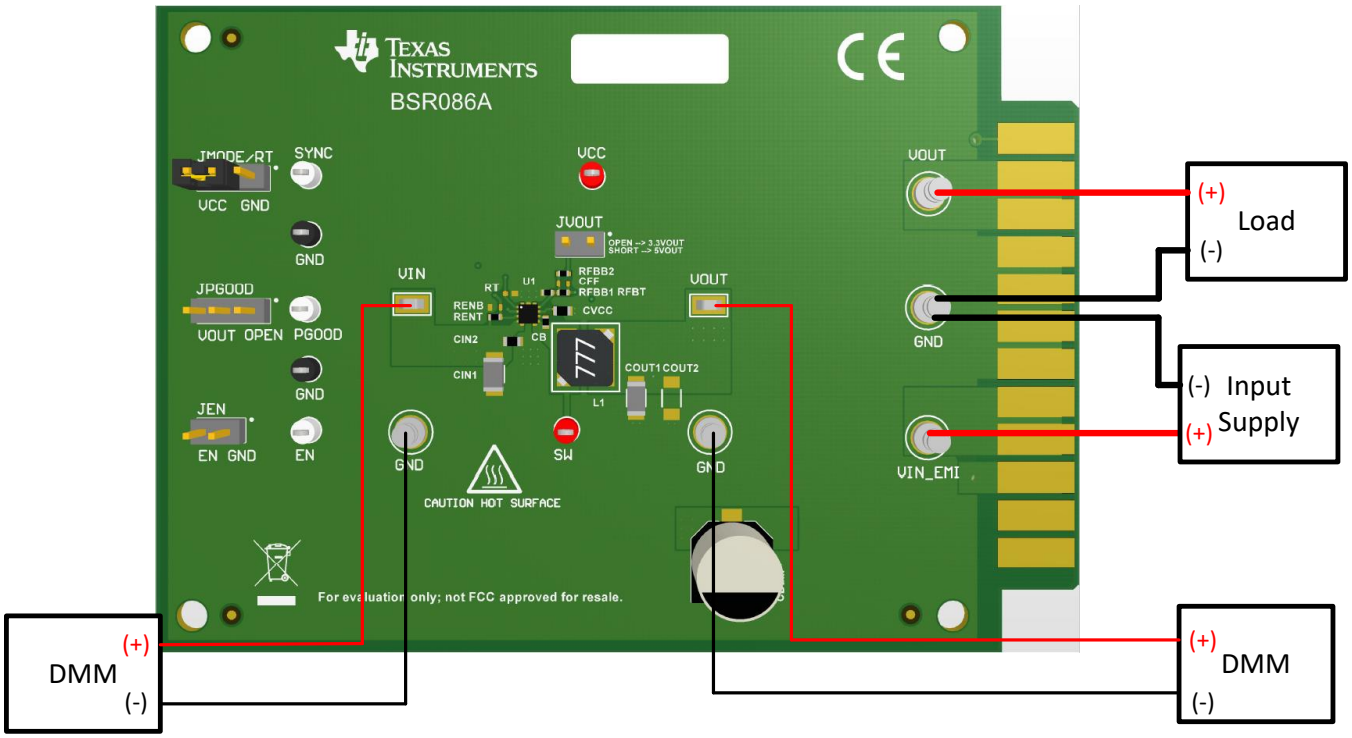

Figure 2. EVM Board Connections

1.2 Jumpers

See Figure 3 for jumper locations.

- **JEN -** This jumper allows the ENABLE input to be connected to GND in order to disable the IC. By default, this jumper is left open since there is a pullup resistor R2 (RENT) to VIN to enable the IC.
- **JPGOOD -** Use this jumper to select how the PGOOD pin can be connected. A jumper can be used to connect pin 2 and 3. In this configuration, the PGOOD pin will be pulled up to VOUT through R9 (RPGOOD) with a value of 100 kΩ. By default, this jumper is left open.
- **JMODE/RT -** Use this jumper to select the mode of operation in a **MODE/SYNC** trim part. Connecting a jumper between pin 1 and 2 cause the IC to operate in PFM (Pulse Frequency Modulation) mode for a higher efficiency at light load. A jumper between pin 2 and pin 3 causes the IC to operate in FPWM mode (Forced Pulse Width Modulation) mode. By default, the jumper is connected between pin 1 and 2.
  In an **RT** trim part, connecting this jumper from pin 1 and 2 sets the switching frequency to 2.2 MHz and connecting this jumper from pin 2 and 3 sets the switching frequency to 1 MHz. See the *LMR36506 3-V–65-V, 0.6-A Ultra-Small Synchronous Buck Converter with 4 µA I_Q* data sheet for more information on switching frequency configuration.
- **JVOUT** This jumper can be used to select the output voltage on the EVM. Leaving the jumper open sets the EVM output voltage to 3.3 V whereas adding a jumper sets the output voltage on the EVM to be 5 V.

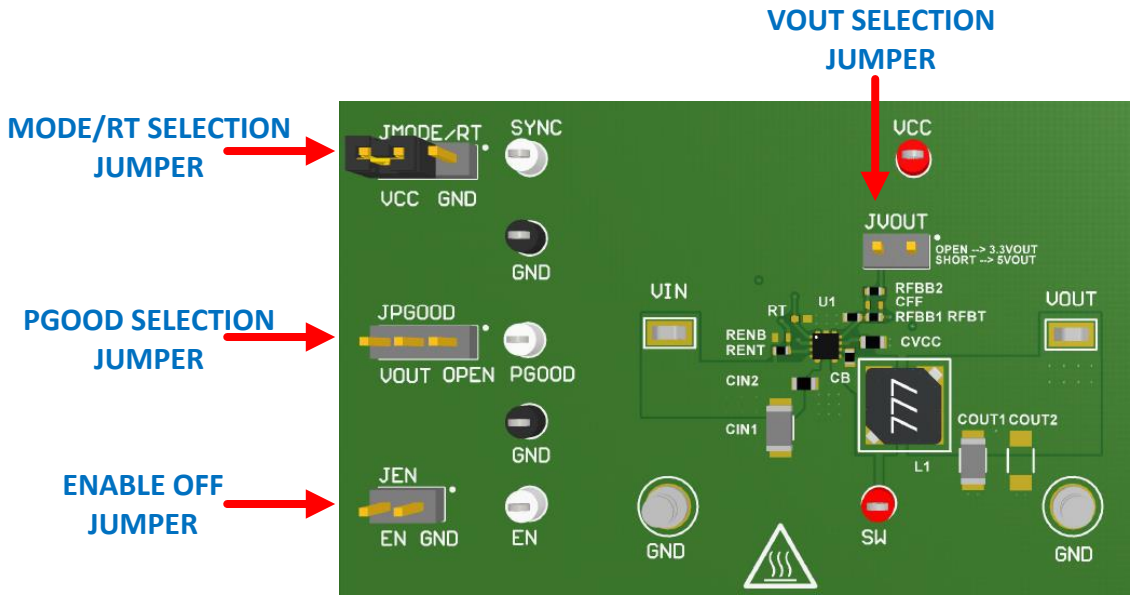

Figure 3. Jumper Locations

2 Operation

2.1 Quick Start

1. Connect the voltage supply between the VIN_EMI and GND test points.
2. Connect the load between the VOUT and GND test points.
3. Set the supply voltage at an appropriate level between 5.5 V to 65 V. Set the current limit of the supply to an appropriate level.
4. Turn on the power supply. With the default configuration, the EVM powers up and provides V_{OUT} = 3.3 V.
5. Monitor the output voltage. The maximum load current must be 0.6 A with the LMR36506 device.

3 Schematic

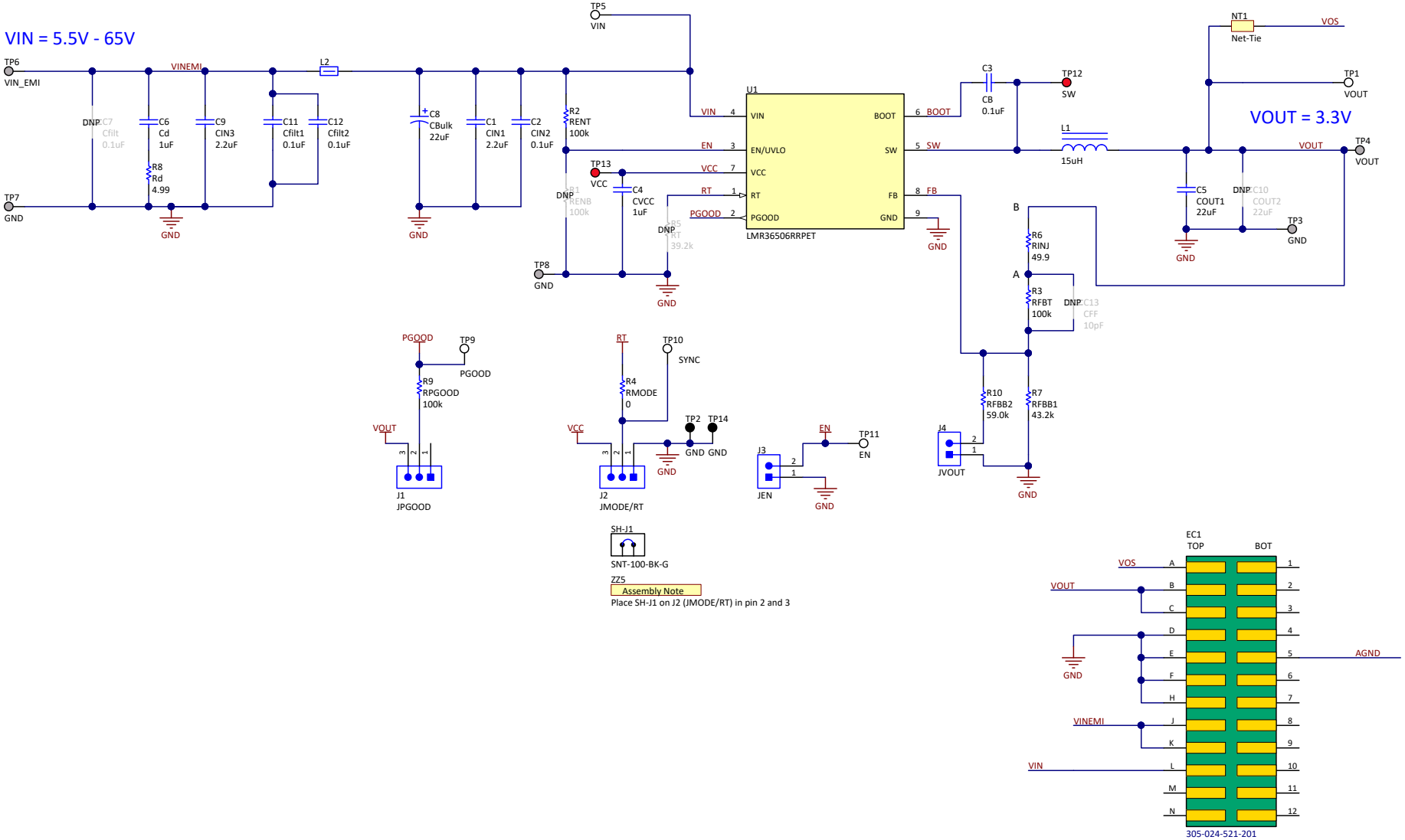

Figure 4. LMR36506RREVM Schematic

4 Board Layout

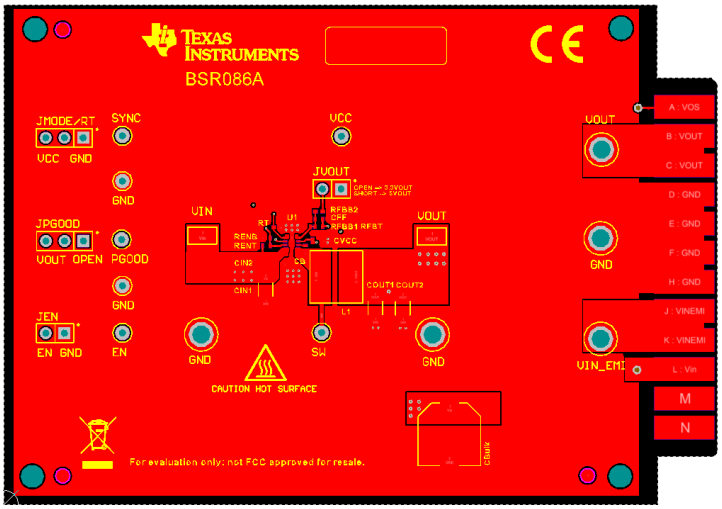

Figure 5. Top View of EVM

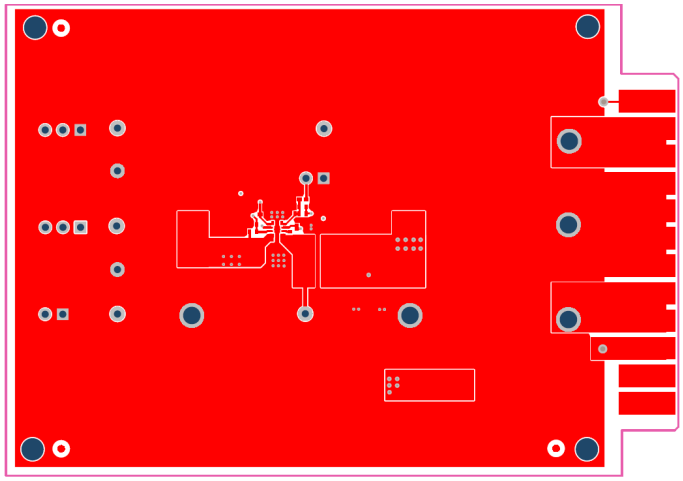

Figure 6. EVM Top Copper Layer

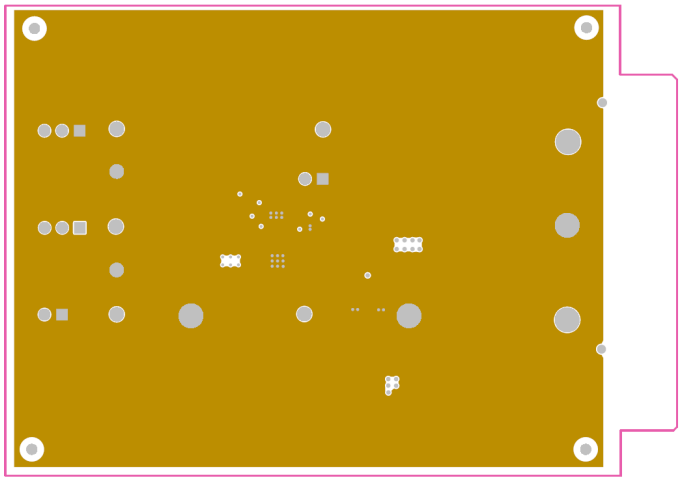

Figure 7. EVM Mid Layer One

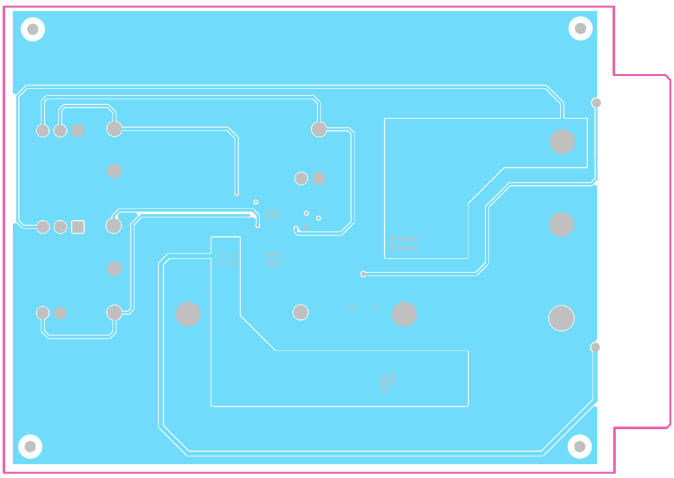

Figure 8. EVM Mid Layer Two

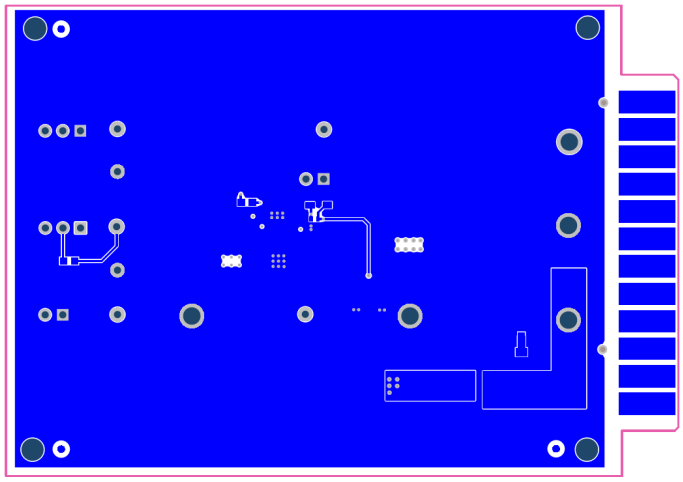

Figure 9. EVM Bottom Copper Layer

5 Bill of Materials

Table 2. Bill Of Materials

DESIGNATOR	COMMENT	DESCRIPTION	MANUFACTURER	PART NUMBER	QUANTITY
C1, C9	CIN1, CIN3	CAP, CERM, 2.2 µF, 100 V, ±10%, X7S, AEC-Q200 Grade 1, 1206	TDK	CGA5L3X7S2A225K160AB	2
C2	CIN2	CAP, CERM, 0.1 µF, 100 V, ±10%, X7R, 0603	MuRata	GRM188R72A104KA35D	1
C3	CB	CAP, CERM, 0.1 µF, 16 V, ±10%, X7R, 0402	MuRata	GCM155R71C104KA55D	1
C4	CVCC	CAP, CERM, 1 µF, 16 V, ±10%, X7R, 0603	Wurth Elektronik	885012206052	1
C5	COUT1	CAP, CERM, 22 µF, 10 V, ±10%, X7R, AEC-Q200 Grade 1, 1206	MuRata	GCM31CR71A226KE02	1
C6	Cd	CAP, CERM, 1 µF, 100 V, ±10%, X7R, 1206	TDK	C3216X7R2A105K160AA	1
C7	Cfilt	CAP, CERM, 0.1 µF, 100 V, ±10%, X7R, AEC-Q200 Grade 1, 0805	TDK	CGA4J2X7R2A104K125AA	0
C8	CBulk	CAP, AL, 22 µF, 100 V, ±20%, 1.3 Ω, AEC-Q200 Grade 2, SMD	Panasonic	EEE-FK2A220P	1
C10	COUT2	CAP, CERM, 22 µF, 10 V, ±10%, X7R, AEC-Q200 Grade 1, 1206	MuRata	GCM31CR71A226KE02	0
C11, C12	Cfilt1, Cfilt2	CAP, CERM, 0.1 µF, 100 V, ±10%, X7R, AEC-Q200 Grade 1, 0805	TDK	CGA4J2X7R2A104K125AA	2
C13	CFF	CAP, CERM, 10 pF, 50 V, ±5%, C0G/NP0, AEC-Q200 Grade 1, 0402	TDK	CGA2B2C0G1H100D050BA	0
FID1, FID2, FID3, FID4, FID5, FID6	Fiducial	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	0
J1, J2	JPGOOD, JMODE/RT	Header, 100 mil, 3x1, Gold, TH	Samtec	HTSW-103-07-G-S	2
J3, J4	JEN, JVOUT	Header, 100 mil, 2x1, Gold, TH	Samtec	HTSW-102-07-G-S	2
L1	MSS6132-153MLB	Inductor, Shielded Drum Core, Ferrite, 15 µH, 1.56 A, 0.14 Ω, SMD	Coilcraft	MSS6132-153MLB	1
L2	FBMH3225HM601NT	Ferrite Bead, 600 Ω at 100 MHz, 3 A, 1210	Taiyo Yuden	FBMH3225HM601NT	1
LBL1	THT-14-423-10	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10 000 per roll	Brady	THT-14-423-10	1
R1	RENB	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW0402100KFKED	0
R2, R3	RENT, RFBT	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW0402100KFKED	2
R4	RMODE	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06030000Z0EA	1
R5	RT	RES, 39.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW040239K2FKED	0
R6	RINJ	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW040249R9FKED	1
R7	RFBB1	RES, 43.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW040243K2FKED	1
R8	Rd	RES, 4.99, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW06034R99FKEA	1
R9	RPGOOD	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603100KFKEA	1
R10	RFBB2	RES, 59.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	Vishay-Dale	CRCW040259K0FKED	1
SH-J1	SNT-100-BK-G	Shunt, 100mil, Gold plated, Black	Samtec	SNT-100-BK-G	1
TP1, TP5	VOUT, VIN	Test Point, Miniature, SMT	Keystone	5015	2
TP2, TP14	GND	Test Point, Miniature, Black, TH	Keystone	5001	2
TP3, TP4, TP6, TP7, TP8	GND, VOUT, VIN_EMI, GND, GND	Terminal, Turret, TH, Double	Keystone	1502-2	5
TP9, TP10, TP11	PGOOD, SYNC, EN	Test Point, Miniature, White, TH	Keystone	5002	3
TP12, TP13	SW, VCC	Test Point, Miniature, Red, TH	Keystone	5000	2
U1	LMR36506RRPET	LMR36506 Wide Input 65-V Synchronous, DC-DC Buck Converter, RPE0009A (VQFN-9)	Texas Instruments	LMR36506RRPET	1

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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*:

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   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。
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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西新宿三井ビル

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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.

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