LM43600PWPEVM User Guide

Introduction

The Texas Instruments LM43600PWPEVM evaluation module (EVM) helps designers evaluate the operation and performance of the LM43600 wide-input voltage Simple Switcher® buck regulator. The device offers configurability in a 1 V to 28 V output voltage, synchronous rectification and a 200 kHz to 2.2 MHz adjustable frequency range. It also offers external frequency synchronization, power good (PG) flag, and a precision enable to program undervoltage lockout (UVLO) and internal compensation. The LM43600PWPEVM is configured for an output voltage of 3.3 V and a switching frequency of 500 kHz. Refer to the LM43600 datasheet for additional features, detailed description and available options.

The EVM contains one DC-DC converter (See Table 1).

Table 1. Device and Package Configurations

CONVERTER	IC	PACKAGE
U1	LM43600	(PWP) HTSSOP-16

Setup

This section describes the test points and connectors on the EVM and how to properly connect, set up and use the . Please refer to Figure 1 for a top view of the EVM and relative placement of theLM43600PWPEVM different test points and edge connector.

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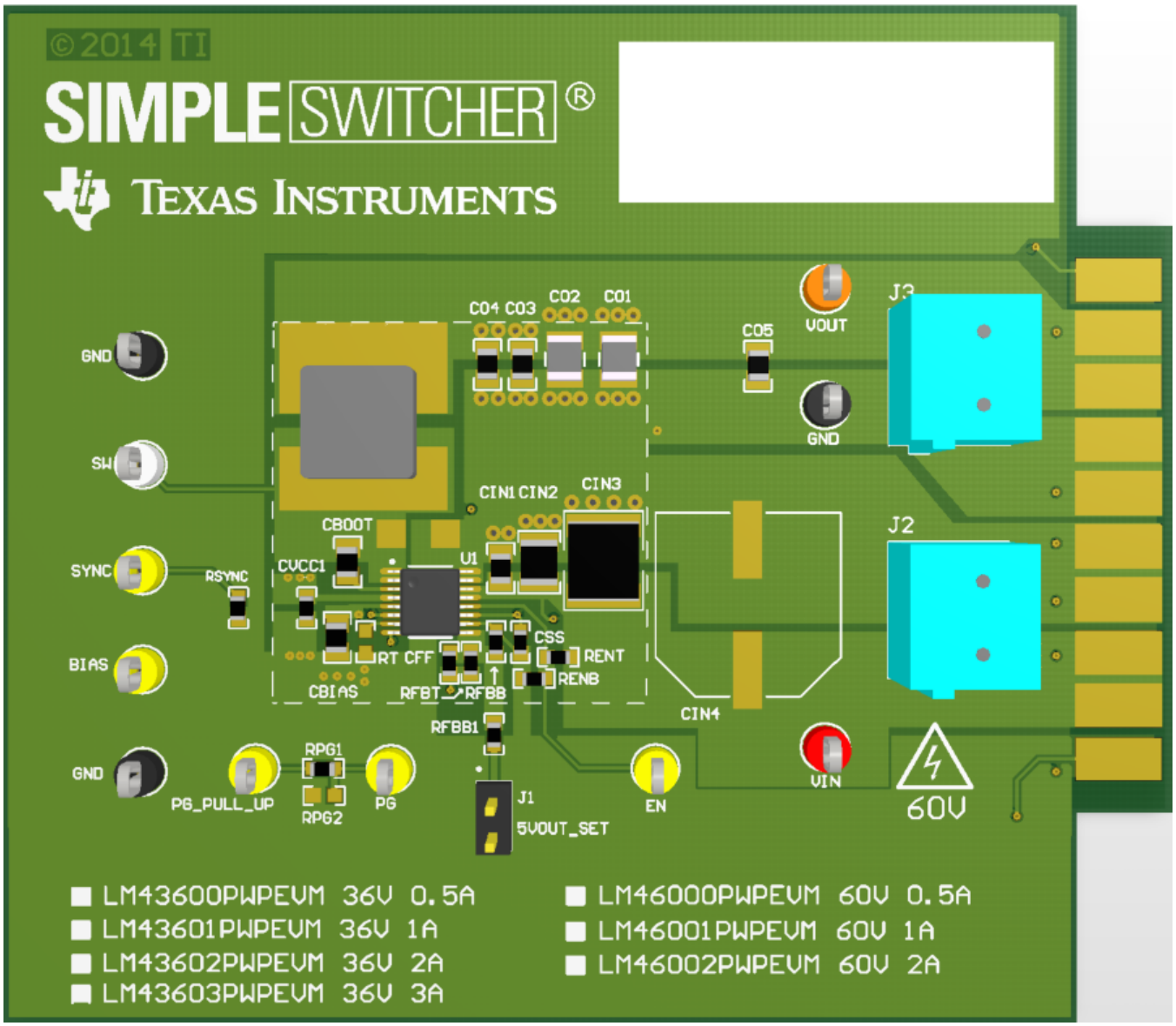


Figure 1. Top View of LM43600PWPEVM

1 Input/Output (I/O) Connector Description

VIN – Terminal on J2— is the power input terminal for the converter. The terminal edge connector also provides a power (VIN) and ground (GND) connection to allow the user to attach the EVM to a cable harness.

VOUT – Terminal on J3— is the regulated output voltage for the converter. The terminal edge connector also provides a power (VOUT) and ground (GND) connection to allow the user to attach the EVM to a cable harness.

GND – Terminal on J2 and J3— are the ground reference for the converter. The terminal edge connector also provides a GND connection for attaching the EVM to a cable harness.

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EN – Testpoint—is used to enable the converter by supplying a voltage greater than 2.2 V (typ) or just to monitor the voltage on this pin whenever a resistor divider is in place (for precision enable applications). The LM43600PWPEVM is built for a precision enable application with resistors RENT and RENB pre-assembled. The regulator will be enabled when VIN > 3.5 V. This threshold can be calculated by:

$$Enable_Voltage = VIH_EN \cdot \left(1 + \frac{RENT}{RENB}\right) \quad (1)$$

where

- VIH_EN is 2.2 V (typ)

PG – Testpoint—is used to monitor the power good flag. This flag indicates whether the output voltage has reached its regulation point. This pin is an open-drain output that requires a pullup resistor to the appropriate logic voltage (any voltage less than 14 V). A pre-installed resistor RPG1 of 100 kΩ is tied to the PG pin and brought out to the PG_PULL UP test point.

PG_PULL UP – Testpoint—is the top connection of the pre-assembled 100-kΩ RPG1 pullup resistor that ties directly to the open-drain PG pin. Supply an appropriate voltage to this test point, or tie it directly to the VOUT test point to observe the PG flag operation.

BIAS – Testpoint—is used to monitor the BIAS voltage. A pre-installed capacitor of 4.7 µF is connected from the BIAS pin to ground (GND). This node is connected to VOUT through a zero Ohm resistor pre-installed on the bottom layer, labeled (RBIAS).

SYNC – Testpoint —is the input terminal for an optional external input clock to the converter. The external clock frequency must be between 200 kHz and 2.2 MHz, if used. A pulldown resistor of 100 kΩ (RSYNC) is installed on the EVM.

SW – Testpoint—is used to monitor the voltage on the switch pin and the switching frequency of the voltage regulator. Remove this test point before making any electromagnetic interference (EMI) measurements.

VSUPPLY – Edge Connector pin #9—is used to supply the input voltage through an on board LC filter (if one is needed for conducted EMI/EMC measurement). The Lin and Cd component pads are located on the bottom side of the EVM. Please refer to the EVM schematic for initial suggestion of component values.

2 Setup

Set the input voltage (VIN) range for the converter between the operating voltage range of 3.5 V to 36 V. If a load is driven, it should be applied to the VOUT terminal and should not exceed the maximum load current of 0.5 A.

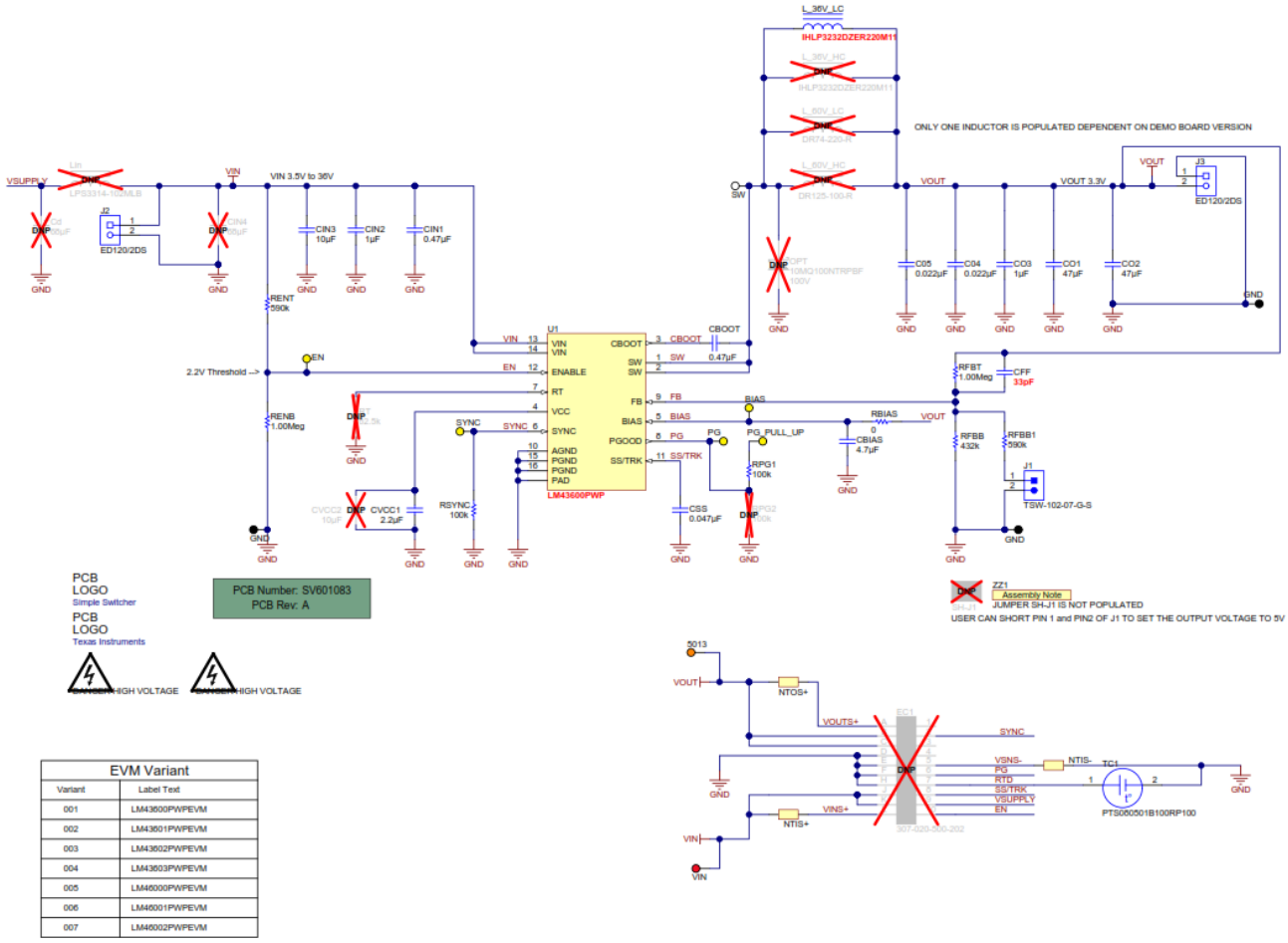
3 Operation

For proper operation of the LM43600, VIN, GND, and VOUT should be properly configured as stated above. In this configuration, the device will start up when power is applied and the output voltage of the regulator (VOUT) will come up to the proper value. The default setting for output voltage of the is 3.3 V. Other output voltages can be set by replacing the feedback pin resistor dividers RFBT and RFBB; please consult the datasheet for proper selection of these resistor LM43600PWPEVM values.

The default frequency for the LM43600PWPEVM is 500 kHz. If other frequencies are desired, within the frequency range of 200 kHz and 2.2 MHz, the RT resistor value can be changed. Please consult the datasheet for proper selection of the RT resistor. You must change inductor (L_36V_LC) and total output capacitance for proper control loop operation.

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Schematic



EVM Variant	
Variant	Label Text
001	LM43600PWPEVM
002	LM43601PWPEVM
003	LM43602PWPEVM
004	LM43603PWPEVM
005	LM46000PWPEVM
006	LM46001PWPEVM
007	LM46002PWPEVM

Figure 2. LM43600PWPEVM Schematic

Board Layout

Figure 3 through Figure 7 show the board layout for the LM43600PWPEVM. The EVM offers resistors, capacitors and test points to configure the output voltage, precision enable pin, set frequency and external clock synchronization.

The PWP HTSSOP-16 package offers an exposed thermal pad which must be soldered to the copper landing on the PCB for optimal thermal performance. The PCB consists of a 4-layer design. There are 2-oz copper planes on the top and bottom and 1-oz copper mid-layer planes to dissipate heat with an array of thermal vias under the thermal pad to connect to all four layers.

Test points have been provided for ease of use to connect the power supply, required load and to monitor critical signals. The 12-pin edge connector can also be used to facilitate the use of a cable harness if one is required (Mating connector part number: 307-020-500-202 by EDAC Inc).

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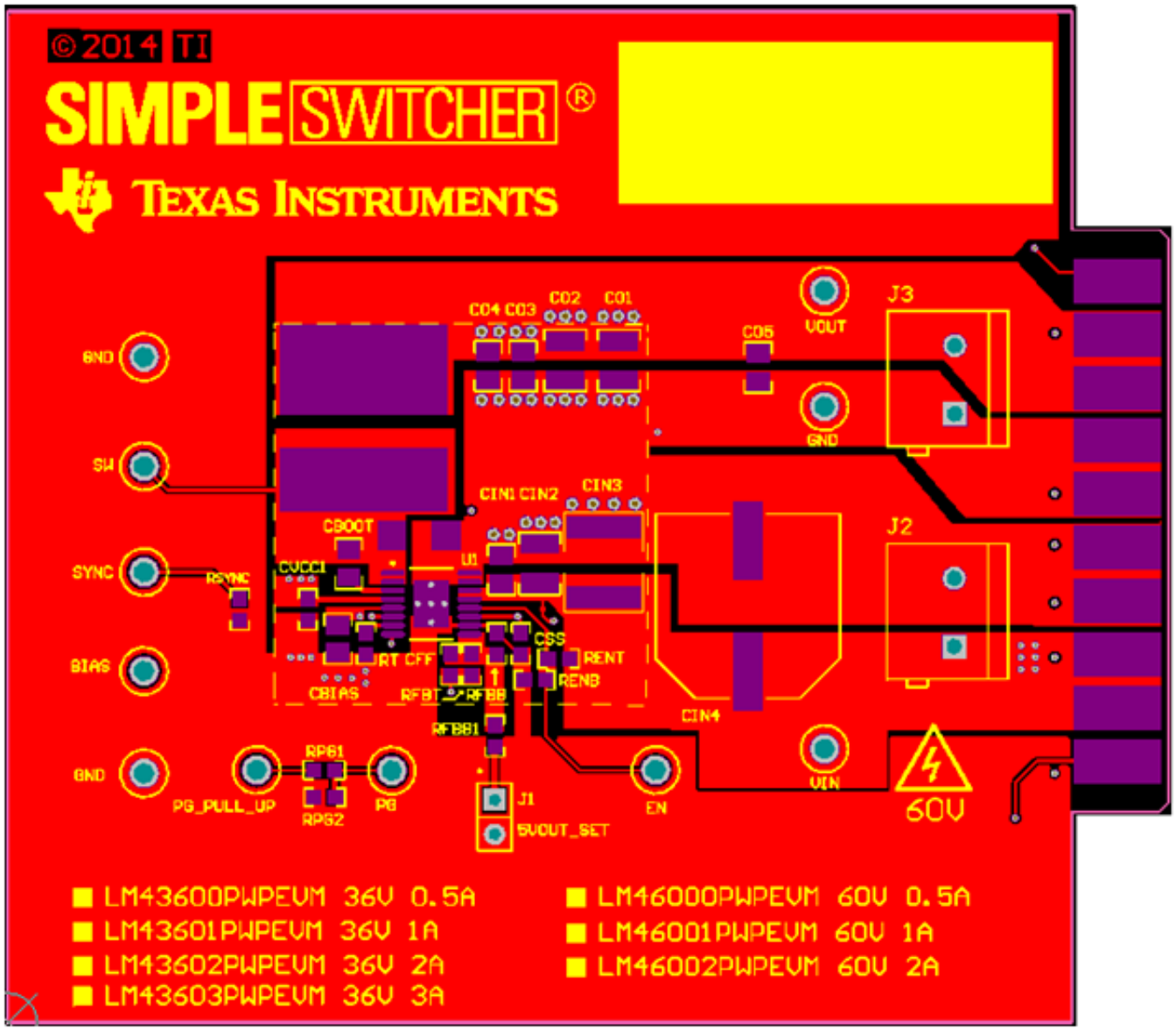


Figure 3. Top Assembly Layer

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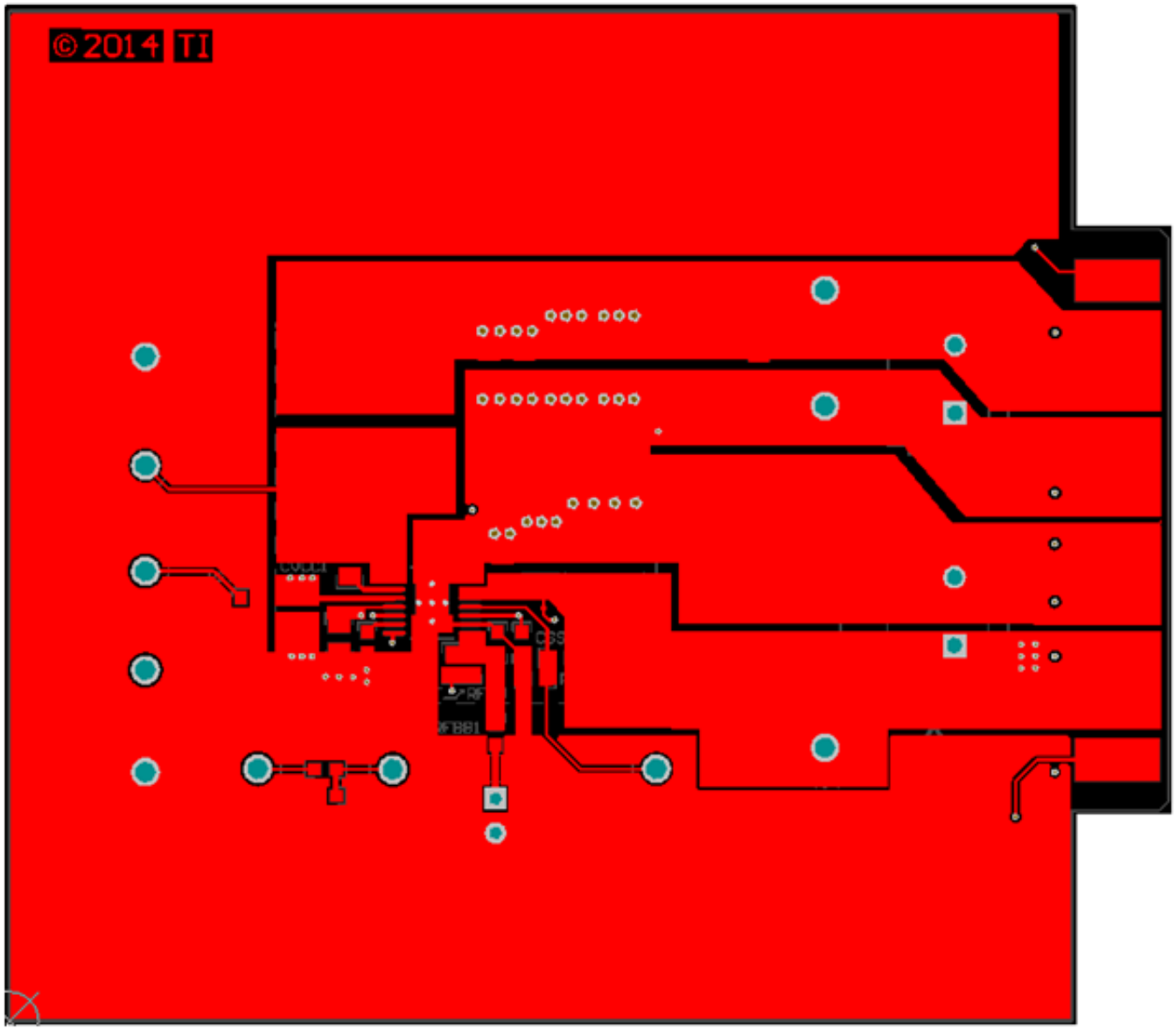


Figure 4. Top Layer Routing

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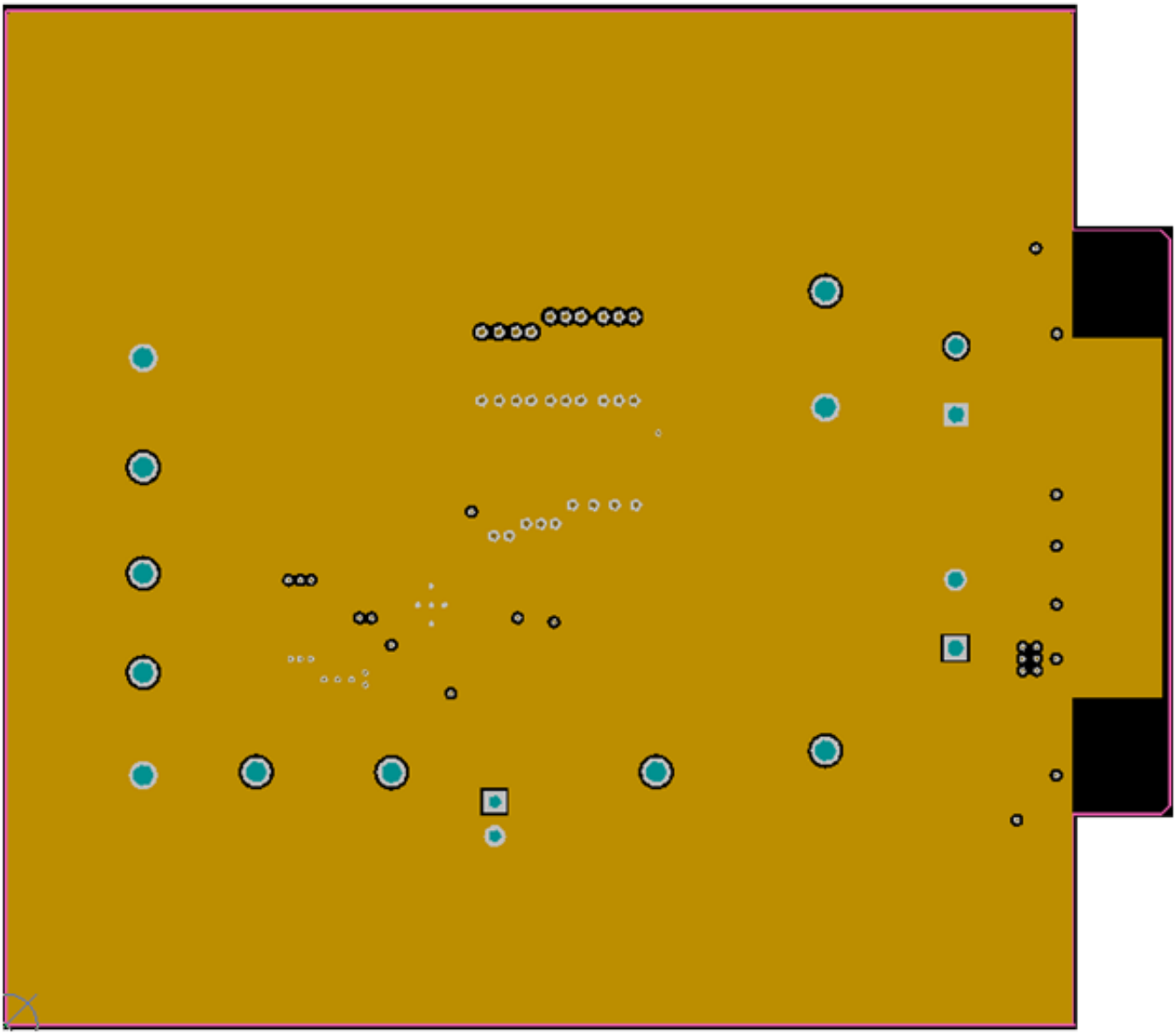


Figure 5. Mid Layer 1 Ground Plane

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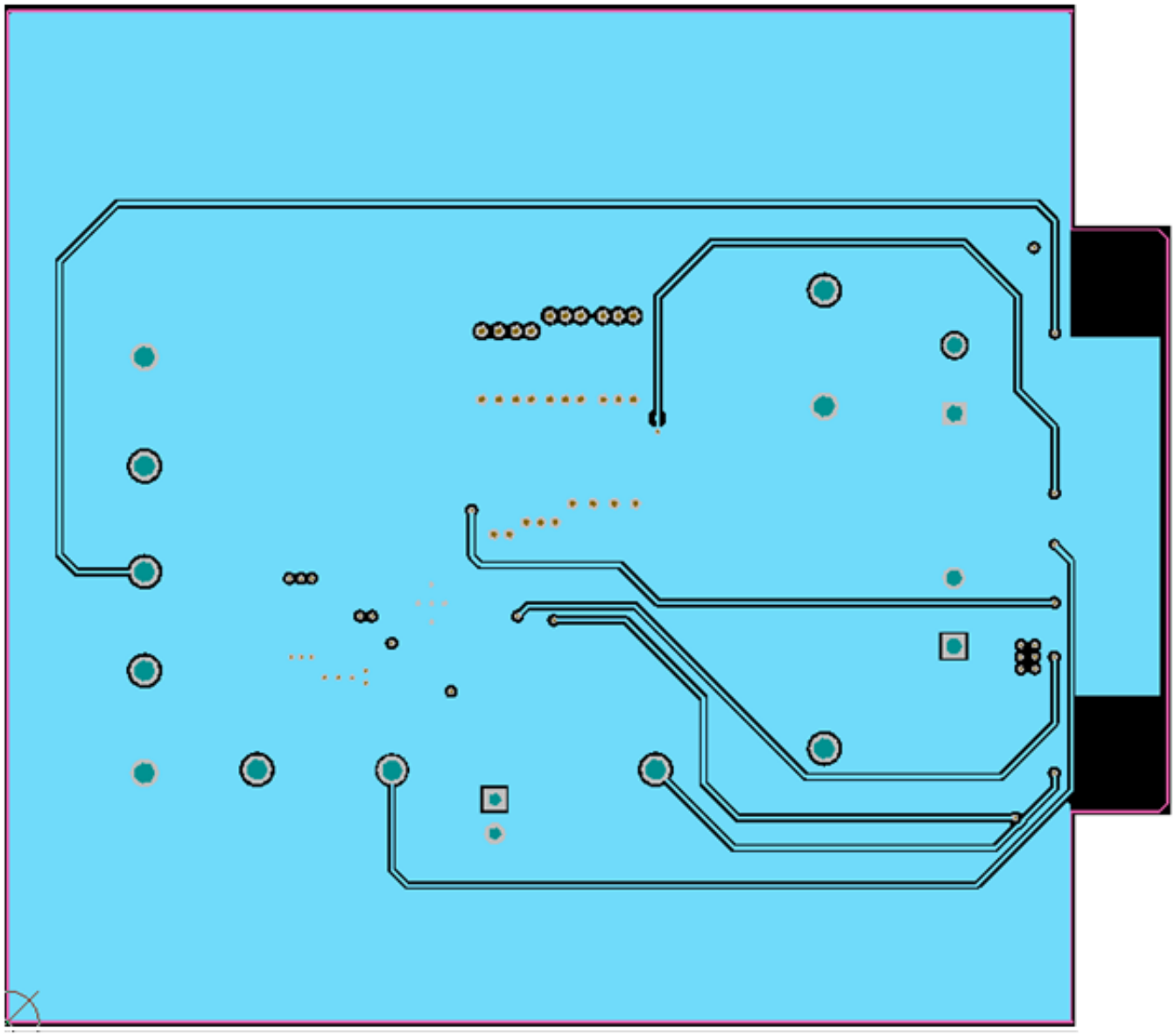


Figure 6. Mid Layer 2 Routing

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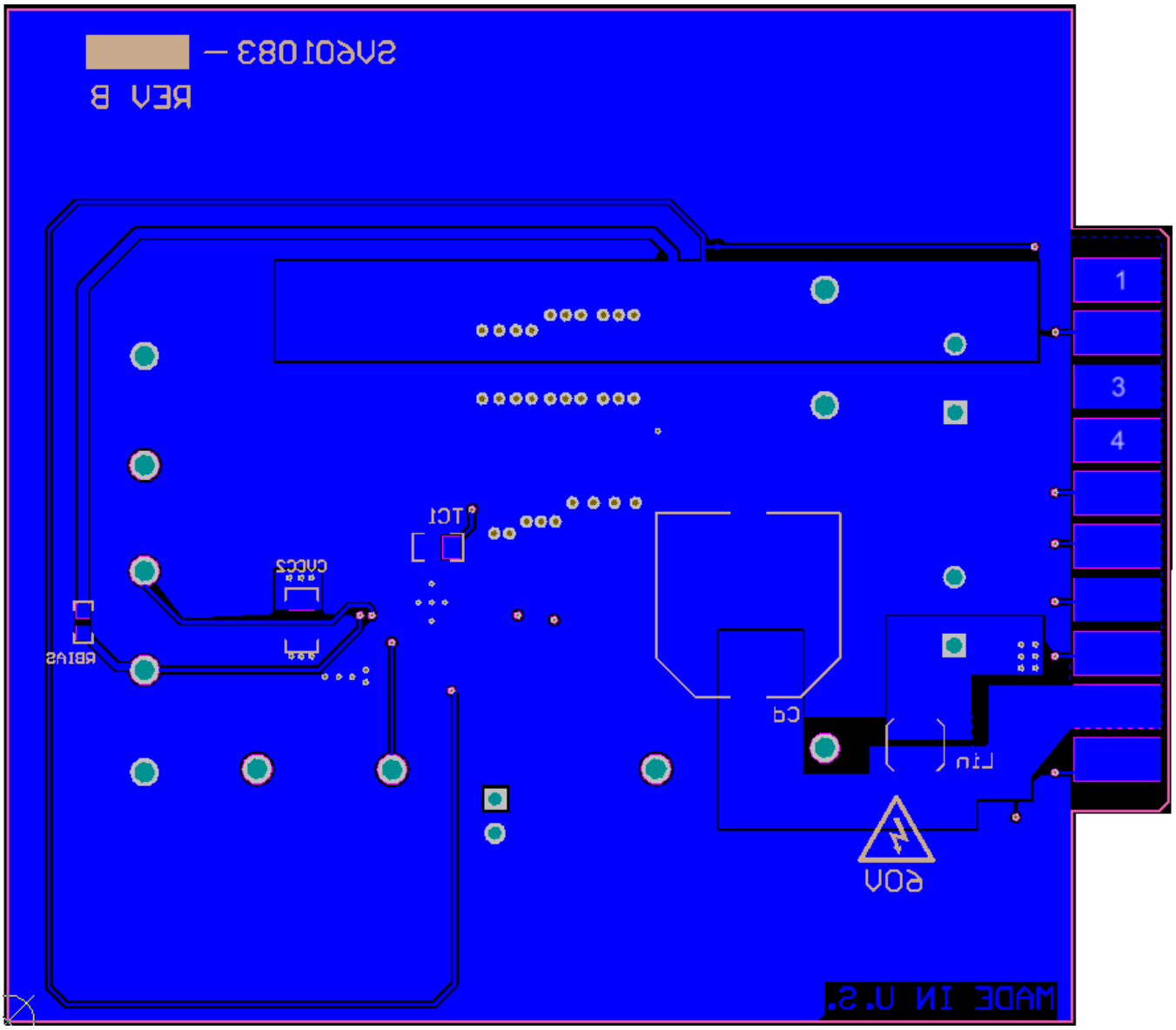


Figure 7. Bottom Layer Routing

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Table 2. LM43600PWPEVM Bill of Materials (BOM) for 500 kHz Configuration

Designator	Description	Manufacturer	PartNumber	Quantity
!PCB	Printed Circuit Board	Any	SV601083	1
C04, C05	CAP, CERM, 0.022µF, 100V, +/-5%, X7R, 0805	AVX	08051C223JAT2A	2
CBIAS	CAP, CERM, 4.7µF, 50V, +/-10%, X5R, 0805	TDK	C2012X5R1H475K125AB	1
CBOOT	CAP, CERM, 0.47uF, 16V, +/-10%, X7R, 0805	Kemet	C0805C474K4RACTU	1
CFF	CAP, CERM, 33pF, 50V, +/-5%, C0G/NP0, 0603	Kemet	C0603C330J5GACTU	1
CIN1	CAP, CERM, 0.47µF, 100V, +/-10%, X7R, 0805	MuRata	GRM21BR72A474KA73L	1
CIN2	CAP, CERM, 1µF, 100V, +/-10%, X7R, 1210	TDK	C3225X7R2A105K200AA	1
CIN3	CAP, CERM, 10µF, 100V, +/-20%, X7S, 2220	TDK	C5750X7S2A106M	1
CO1, CO2	CAP, CERM, 47uF, 10V, +/-20%, X7R, 1210	MuRata	GRM32ER71A476ME15L	2
CO3	CAP, CERM, 1µF, 25V, +/-10%, X5R, 0805	AVX	08053D105KAT2A	1
CSS	CAP, CERM, 0.047µF, 50V, +/-10%, X7R, 0603	TDK	C1608X7R1H473K	1
CVCC1	CAP, CERM, 2.2µF, 10V, +/-10%, X7R, 0603	MuRata	GRM188R71A225KE15D	1
J1	Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	Samtec	TSW-102-07-G-S	1
J2, J3	TERMINAL BLOCK 5.08MM VERT 2POS, TH	On-Shore Technology	ED120/2DS	2
L_36V_LC	Inductor, Shielded, Powdered Iron, 22 µH, 3.3 A, 94.2 mohm, SMD	Vishay-Dale	IHLP3232DZER220M11	1
RBIAS	RES, 0 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06030000Z0EA	1
RENB, RFBT	RES, 1.00Meg ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW06031M00FKEA	2
RENT, RFBB1	RES, 590k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603590KFKEA	2
RFBB	RES, 432k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603432KFKEA	1
RPG1, RSYNC	RES, 100k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603100KFKEA	2
RTD	TEMP SENSOR RTD 100 OHM 0805	VISHAY	PTS080501B100RP100	1
TP1	Test Point, TH, Multipurpose, Orange	Keystone	5013	1
TP2	Test Point, TH, Multipurpose, Red	Keystone	5010	1
TP3	Test Point, TH, Multipurpose, White	Keystone	5012	1
TP5, TP9, TP10	Test Point, TH, Multipurpose, Black	Keystone	5011	3
TP6, TP7, TP8, TP10, TP11	Test Point, TH Multipurpose, Yellow	Keystone	5014	5
U1	3.5 - 36V 0.5A Step Down Converter	Texas Instruments	LM43600PWP	1
Cd, CIN4	CAP, AL, 68µF, 100V, +/-20%, 0.32 ohm, SMD	Panasonic	EEV-FK2A680Q	0
CVCC2	CAP, CERM, 10µF, 10V, +/-20%, X7R, 1206	TDK	C3216X7R1A106M	0
Lin	Inductor, Shielded Drum Core, Ferrite, 1µH, 2A, 0.06 ohm, SMD	Coilcraft	LPS3314-102MLB	0
L_60V_LC	Inductor, Shielded Drum Core, Ferrite, 22µH, 1.75A, 0.0925 ohm, SMD	Coiltronics	DR74-220-R	0
L_60V_HC	Inductor, Shielded Drum Core, Ferrite, 10µH, 5.35A, 0.0189 ohm, SMD	Coiltronics	DR125-100-R	0
OPT	Diode, Schottky, 100V, 1.5A, SMA	International Rectifier	10MQ100NTRPBF	0
RPG2	RES, 100k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW0603100KFKEA	0
RT	RES, 82.5k ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060382K5FKEA	0
SH-J1	Shunt, 100mil, Gold plated, Black	3M	969102-0000-DA	0

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      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      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.

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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.*

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3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

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This device complies with Industry Canada license-exempt RSS standard(s). 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.

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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.

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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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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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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.

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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.

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