Using LMZ30604EVM-001, LMZ30604EVM-002, LMZ30606EVM-003

User's Guide

Literature Number: SNVU296
JULY 2013

LMZ30604EVM-001/LMZ30602EVM-002/LMZ30606EVM-003, 2-A to 6-A Simple Switcher Power Module

1 Introduction

The LMZ30604EVM-001, LMZ30602EVM-002, LMZ30606 Evaluation Module (LMZ3060xEVM-00x) is designed as an easy to use platform that facilitates an extensive evaluation of the features and performance of the Simple Switcher power module. The EVM PCB may be configured with one of three devices (see Table 1).

Table 1. LMZ3060xEVM-00x Device Configuration

DEVICE	TITLE
LMZ30602	2.95 to 6-V input, 2-A output sync. step-down converter with PWM
LMZ30604	2.95 to 6-V input, 4-A output sync. step-down converter with PWM
LMZ30604	2.95 to 6-V input, 6-A output sync. step-down converter with PWM

This user guide provides information on the correct usage of the EVM and an explanation of the numerous test points on the board.

2 Description

The EVM features a LMZ3060x synchronous buck power module configured for operation with typical 3.3-V and 5-V input bus applications. The output voltage can be set to one of five popular values by using a simple configuration jumper. In similar fashion, the switching frequency can be set to one of four values by use of a jumper. The full rated output current can be supplied by the EVM. A minimal amount of input and output capacitance is used on the board. Component pads are provided for additional input and output capacitors if desired. Monitoring test points are provided to allow measurement of efficiency, power dissipation, input ripple, output ripple, line and load regulation, and transient response. Control test points are provided for use of the PWRGD, Inhibit/UVLO, synchronization, and slow-start/tracking features of the device. The EVM uses a recommended PCB layout that maximizes thermal performance and minimizes output ripple and noise.

3 Getting Started

Figure 1 highlights the user interface items associated with the EVM. The polarized V_{IN} Power terminal block is used for connection to the host input supply and the polarized V_{OUT} Power terminal block is used for connection to the load. The terminal blocks can except up to 16 AWG wire.

The V_{IN} monitor and V_{OUT} monitor test points located near the power terminal blocks are intended to be used as voltage monitoring points where voltmeters can be connected to measure V_{IN} and V_{OUT}. The voltmeter references should be connected to any of the four V_{IN}/V_{OUT} monitor grounds test points located between the power terminal blocks. Do not use these V_{IN} and V_{OUT} monitoring test points as the input supply or output load connection points. The PCB traces connecting to these test points are not designed to support high currents.

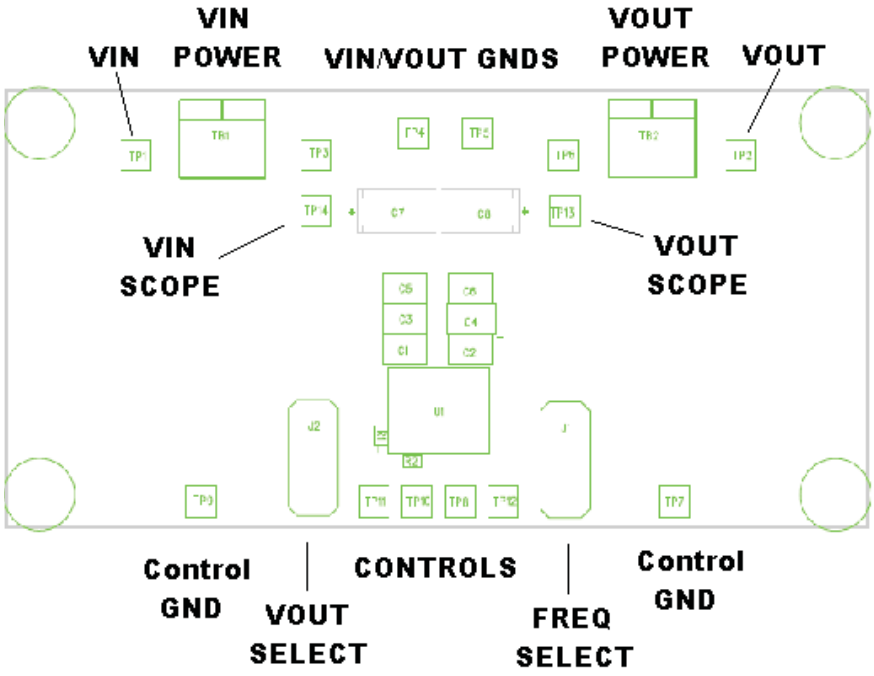

Figure 1. LMZ3060xEVM-00x User Interface

The V_{IN} scope and V_{OUT} scope test points can be used to monitor V_{IN} and V_{OUT} waveforms with an oscilloscope. These test points are intended for use with un-hooded scope probes. The scope probe tip should be connected to the socket labeled VIN or VOUT, and the scope ground barrel should lean against to the test point labeled GND. The GND TP may need to be cut or bent slightly to hold the probe barrel.

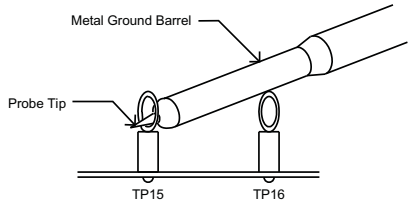

Figure 2. Tip and Barrel Measurement

The control test points located directly below the LMZ3060x device are made available to test the features of the device. Any external connections made to these test points should be referenced to either of the two control ground test points located along the bottom of the EVM. Refer to Section 4 of this user guide for more information on the individual control test points.

The V_{OUT}-select and F_{SW}-select configuration jumpers are provided for selecting the desired output voltage and appropriate switching frequency. Before applying power to the EVM, ensure that the jumpers are present and properly positioned for the intended output voltage. Refer to Table 2 for the recommended jumper settings. Always remove input power before changing the jumper settings.

Once the jumper settings have been confirmed, configure the host input supply to apply the appropriate bus voltage listed in Table 2 and confirm that the selected output voltage is obtained.

Table 2. Output Voltage and Switching Frequency Jumper Settings

V_{OUT} SELECT	LMZ30602, F_{SW} SELECT	LMZ30604, F_{SW} SELECT	LMZ30606, F_{SW} SELECT	V_{IN} BUS VOLTAGE
3.3 V	1.5 MHz	1 MHz	1 MHz	5 V
2.5 V	1.5 MHz	1 MHz	1 MHz	5 V
1.8 V	1 MHz	1 MHz	1 MHz	5 V or 3.3 V
1.2 V	750 kHz	750 kHz	750 kHz	5 V or 3.3 V
0.8 V	650 kHz	650 kHz	650 kHz	5 V or 3.3 V

4 Test Point Descriptions

Fourteen wire-loop test points have been provided as convenient connection points for digital voltmeters (DVM) or oscilloscope probes to aid in the evaluation of the device. A via labled PH is available near U1 to scope on the switching frequency. A description of each test point is listed in Table 3

Table 3. Test Point Descriptions

TEST POINT	DESCRIPTION
VIN	Input voltage monitor. Connect DVM to this point for measuring efficiency.
VOUT	Output voltage monitor. Connect DVM to this point for measuring efficiency, line regulation, and load regulation.
GND	Input and output voltage monitor grounds (located between terminal blocks). Reference the above DVMs to any of these four ground points.
VIN (scope)	Input voltage scope monitor. Connect an oscilloscope to this set of points to measure input ripple voltage.
VOUT (scope)	Output voltage scope monitor. Connect an oscilloscope to this set of points to measure output ripple voltage and transient response.
PWRGD	Monitors the power good signal of the device. This is an open drain signal that requires an external pull-up resistor to V_{IN} if monitoring is desired. A 10-kΩ to 100-kΩ pull-up resistor is recommended. PWRGD is high if the output voltage is within 92% to 106% of its nominal value.
INH/UVLO	Connect this point to control ground to inhibit the device. Allow this point to float to enable the device. Do not use a pull-up resistor. An external resistor can be connected from this point to control ground to increase the under-voltage lockout (UVLO) of the device.
RT/CLK	Connects to the RT/CLK pin of the device. An external clock signal can be applied to this point to synchronize the device to an appropriate frequency.
SS/TR	Connects to the internal slow-start capacitor of the device. An external capacitor can be connected from this point to control ground to increase the slow-start time of the device. This point can also be used as an input for tracking applications.
GND	Control grounds (located along bottom of EVM). Reference any signals associated with the control test points to either of these two ground points.

5 Operation Notes

The UVLO threshold of the factory-stock EVM is approximately 3.05 V with 0.3 V of hysteresis. The input voltage must be above the UVLO threshold in order to startup the device. The UVLO threshold can be increased by adding a resistor to the INH/UVLO test point as described above. After startup, the minimum input voltage to the device must be at least 2.95 V or (V_{OUT} + 1.1 V), whichever is greater, in order to produce a regulated output. The maximum operating input voltage for the device is 6 V. Refer to the device datasheet for further information on the input voltage range and UVLO operation.

After application of the proper input voltage, the output voltage of the device will ramp to its final value in approximately 1 ms. If desired, this soft-start time can be increased by adding a capacitor to the SS/TR test point as described above. Refer to the device datasheet for further information on adjusting the soft-start time.

Table 1 lists the recommended switching frequencies for each of the V_{OUT} selections. These recommendations cover operation over a wide range of input voltage and output load conditions. Several factors such as duty cycle, minimum on-time, minimum off-time, and current limit influence selection of the appropriate switching frequency. In some applications, other switching frequencies might be used for particular output voltages, depending on the above factors. Refer to the device datasheet for further information on switching frequency selection, including synchronization.

6 LMZ3060xEVM-00x Schematic

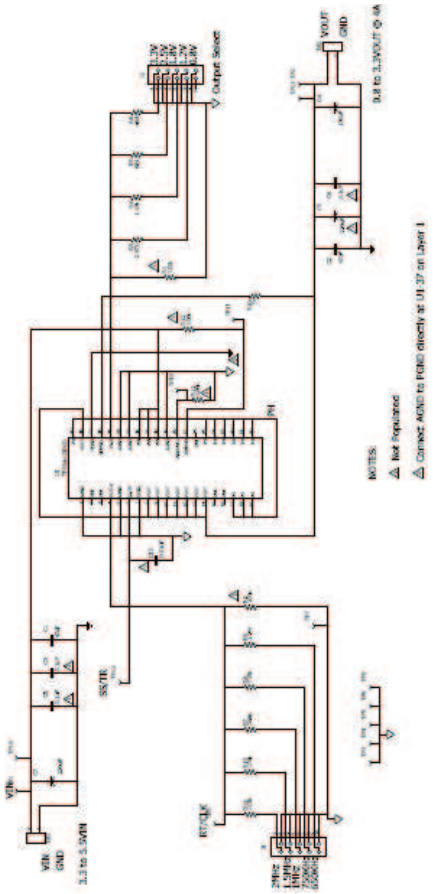

Figure 3. LMZ3060xEVM-00x Schematic

7 PCB Layouts

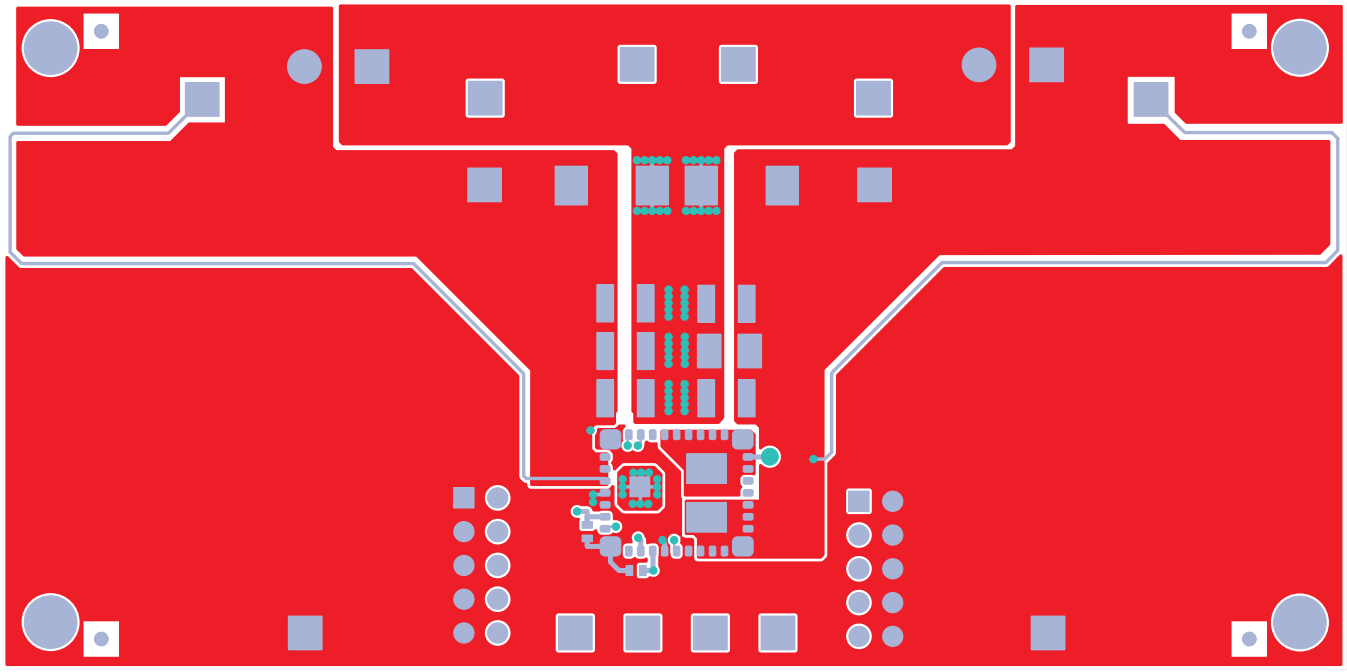

Figure 4. Top Layer

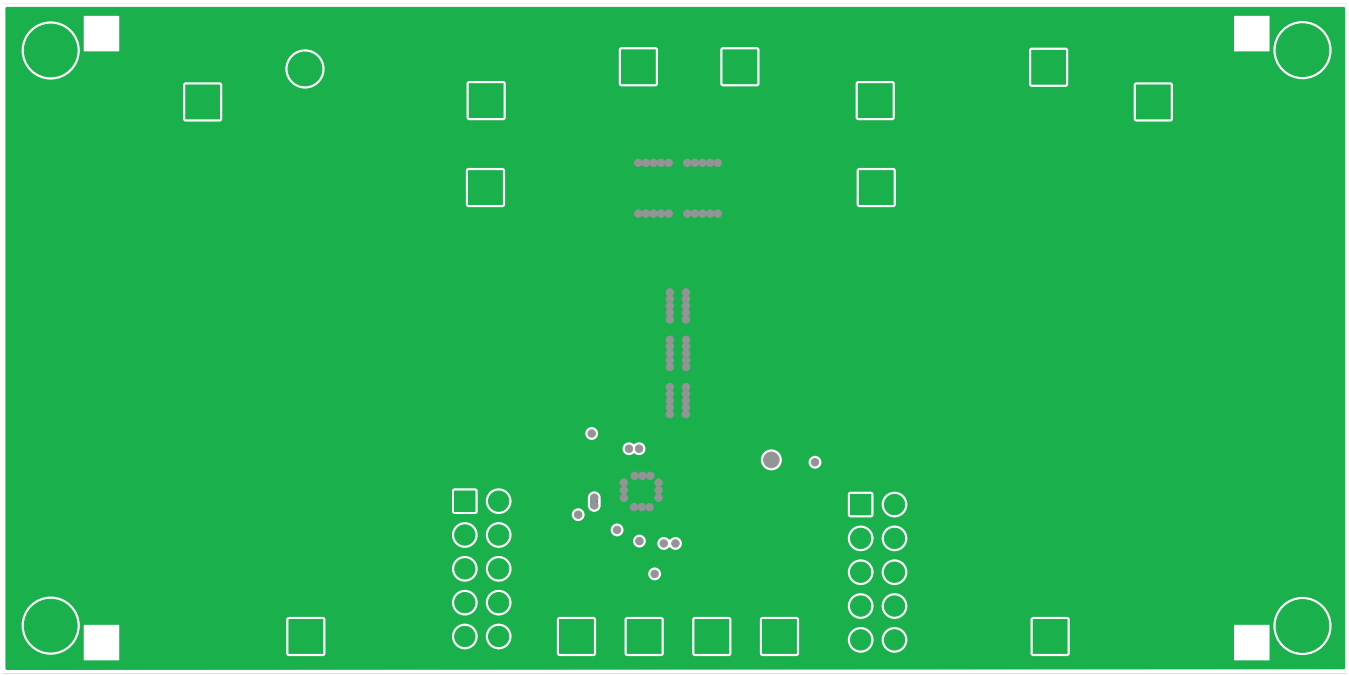

Figure 5. Internal 1 Layer

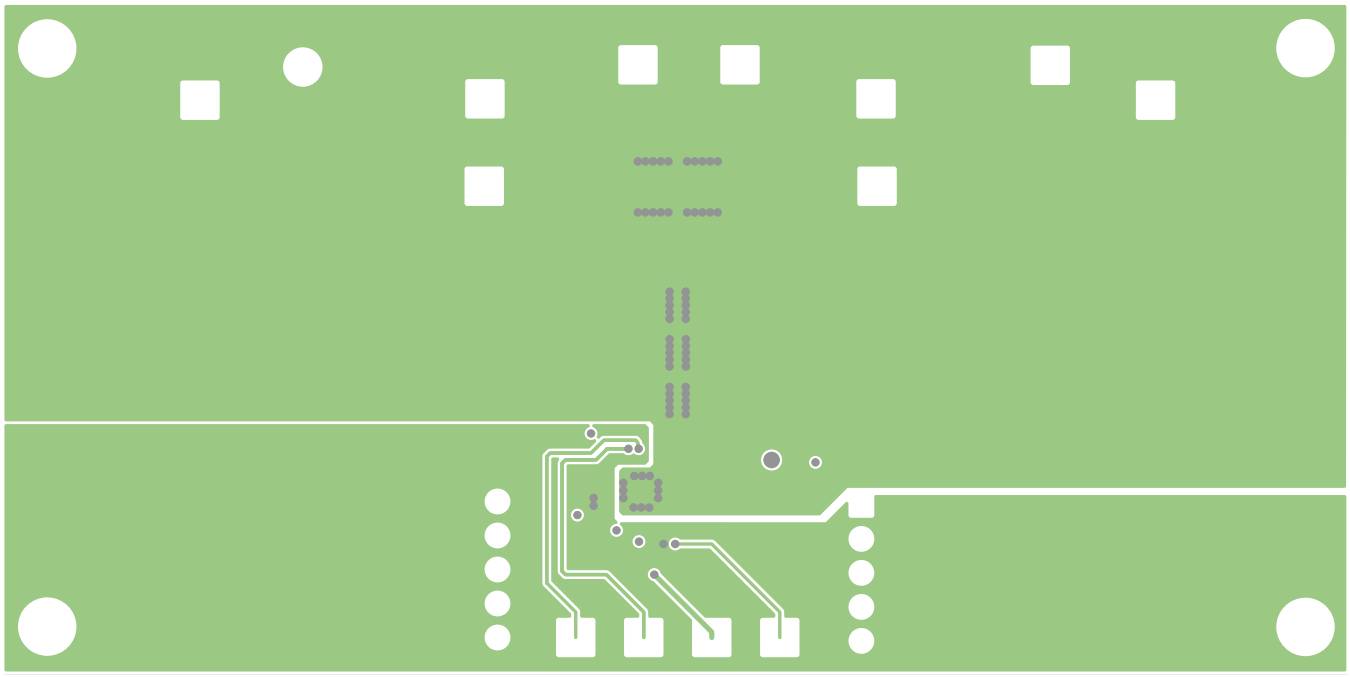

Figure 6. Internal 2 Layer

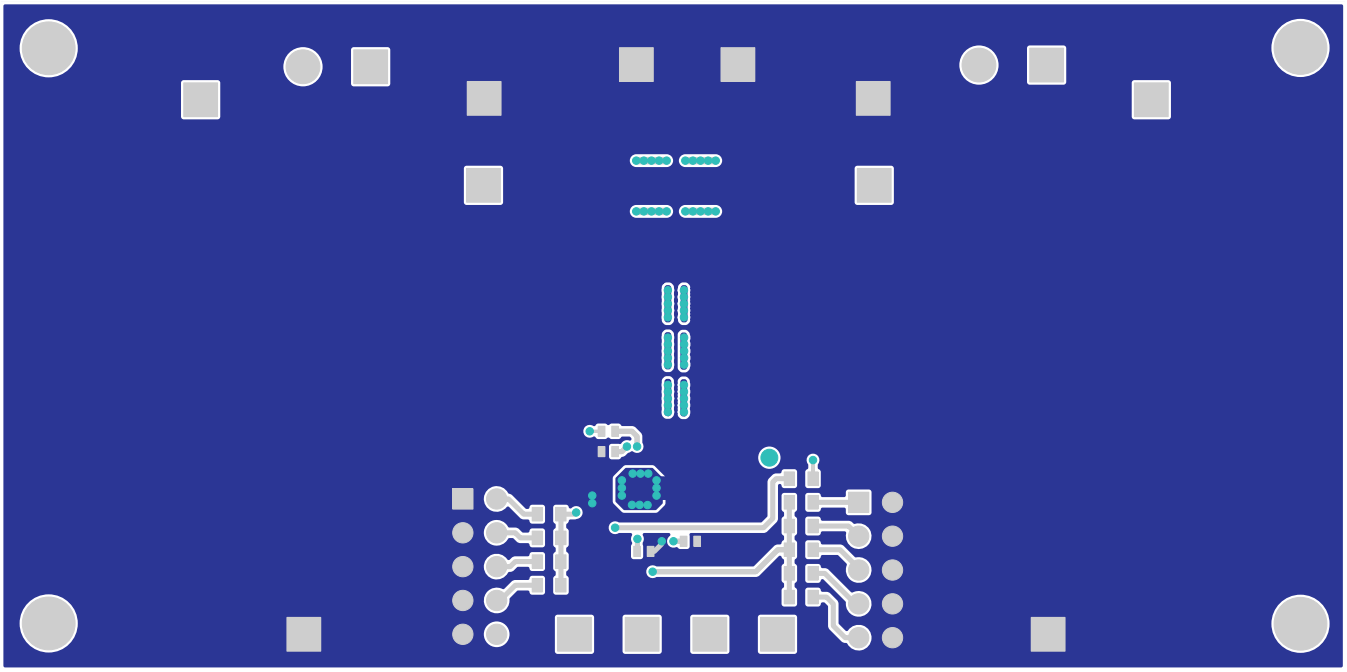

Figure 7. Bottom Layer

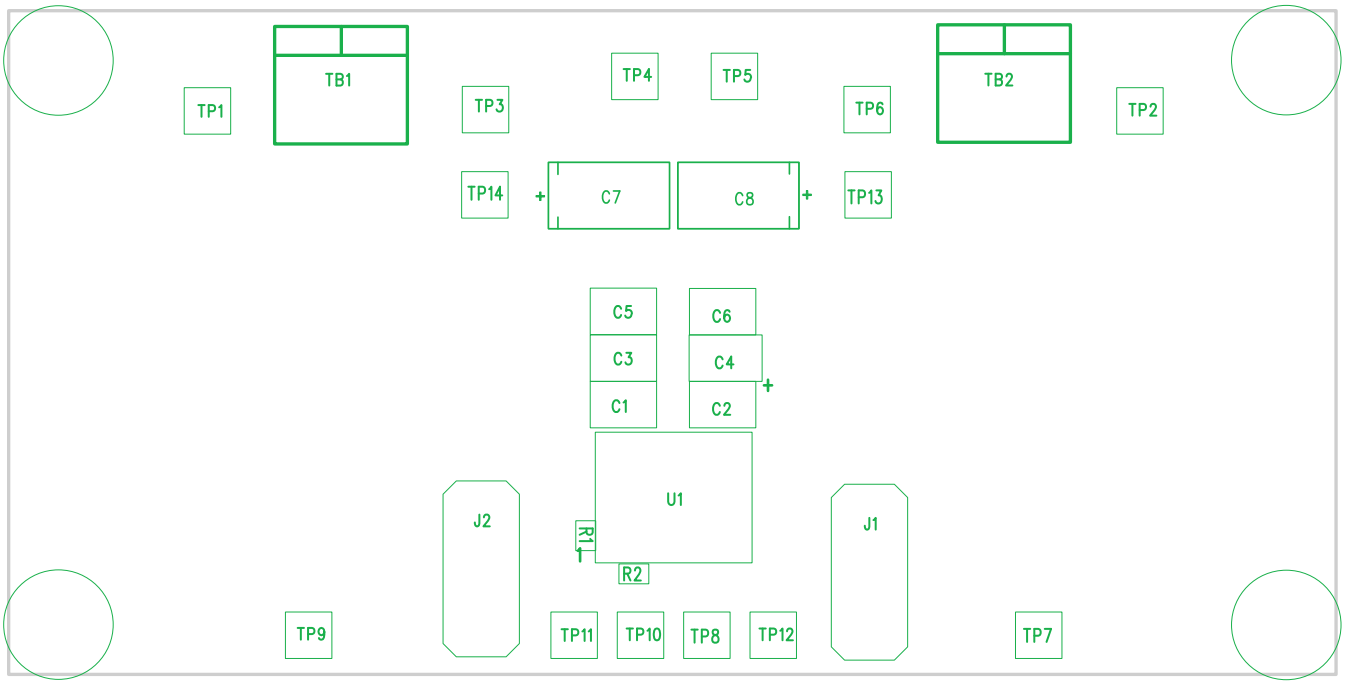

Figure 8. Top Assembly

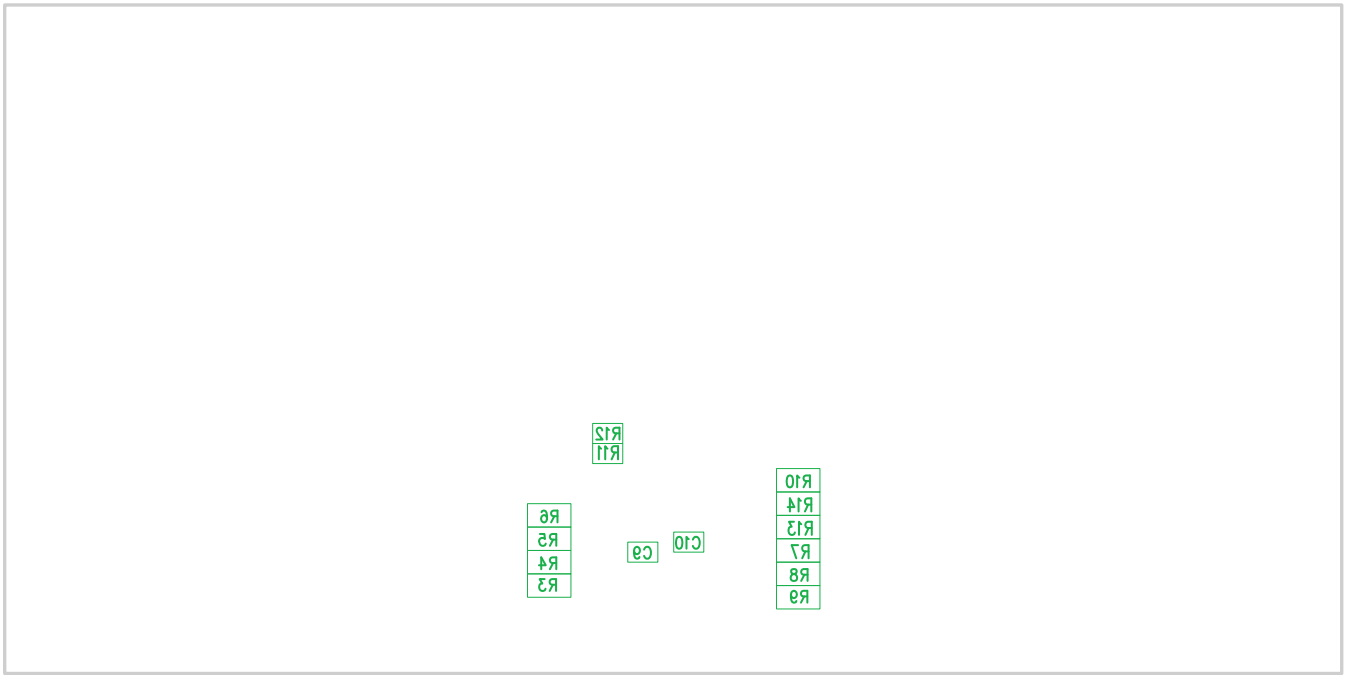

Figure 9. Bottom Layer

8 List of Material

Table 4. LMZ3060xEVM-00x List of Material

-003	-002	-001	REF DES	DESCRIPTION	Part Number	MFR
1	1	1	C1	Capacitor, ceramic, 10 V, x5R, 10%, 47 µF, 1210	GRM32ER61A476K	Murata
1	1	1	C2	Capacitor, ceramic, 6.3 V, x5R, 20%, 47 µF, 1210	GRM32ER60J476M	Murata
1	1	1	C7	Capacitor, polymer, 10 V, 20%, 220 µF, D3L	10TPE220ML	Sanyo
0	0	0	C8	Capacitor, polymer, 10 V, 20%, 220 µF, D3L	10TPE220ML	Sanyo
1	1	1	C4	Capacitor, polymer, 6.3 V, 20%, 100 µF, B2	6TPE100MPB	Sanyo
0	0	0	C3, C5, C6	Capacitor, ceramic, 0.1 µF, 1210	Std	STD
0	0	0	10	Capacitor, ceramic, 0.01 µF, 0402	STD	STD
2	2	2	J1-2	Header, male 2 x 5 pin, 100-mil spacing, 0.100 inch x 5 inch x 2 inch	PEC05DAAN	Sullins
1	1	1	R3	Resistor, chip, 1/16 W, 1%, 2.87 kΩ, 0603	STD	STD
1	1	1	R4	Resistor, chip, 1/16 W, 1%, 1.15 kΩ, 0603	STD	STD
1	1	1	R5	Resistor, chip, 1/16 W, 1%, 681 Ω, 0603	STD	STD
1	1	1	R6	Resistor, chip, 1/16 W, 1%, 464 Ω, 0603	STD	STD
1	1	1	R7	Resistor, chip, 1/16 W, 1%, 348 kΩ, 0603	STD	STD
1	1	1	R8	Resistor, chip, 1/16 W, 1%, 715 kΩ, 0603	STD	STD
1	1	1	R9	Resistor, chip, 1/16 W, 1%, 1.2 MΩ, 0603	STD	STD
1	1	1	R10	Resistor, chip, 1/16 W, 5%, 0 Ω, 0603	STD	STD
1	1	1	R13	Resistor, chip, 1/16 W, 1%, 174 kΩ, 0603	STD	STD
1	1	1	R14	Resistor, chip, 1/16 W, 1%, 113 kΩ, 0603	STD	STD
0	0	0	R1, R2, R11, R12	Resistor, chip, 1/16 W, 1%, 100 kΩ, 0402	Std	Std

Table 4. LMZ3060xEVM-00x List of Material (continued)

-003	-002	-001	REF DES	DESCRIPTION	Part Number	MFR
2	2	2	TB1-2	Terminal block, 2 pin, 15 A, 5.1 mm, 0.40 inch x 0.35 inch	ED120/2DS	OST
8	8	8	TP1, TP2 TP8 TP10- TP14	Test point, white, thru hole, 5012, 0.125 inch x 0.125 inch	5012	Keystone
6	6	6	TP3-7 TP9	Test point, black, thru hole, 5011, 0.125 inch x 0.125 inch	5011	Keystone
0	0	1	U1	6-V input, 4-A Output Sync. Step-Down Converter with PWM, QFN	LMZ30604RKG	TI
0	1	0	U1	6-V input, 2-A Output Sync. Step-Down Converter with PWM, QFN	LMZ30604RKG	TI
1	0	0	U1	6-V input, 6-A Output Sync. Step-Down Converter with PWM, QFN	LMZ30604RKG	TI
1	1	1		PCB, 0.063 inch H x 1.9 inch L x 3.9 inch W	PWR059	ANY
2	2	2		Conn jumper shorting gold flash	SPC02SYAN	Sullins
4	4	4		Bumpon hemisphere 0.44 inch x 0.20 inch clear, 0.440 inch Dia x 0.200 inch H	SJ-5303	3M

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Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of EVMs for RF Products in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM’s electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI’s recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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