

AN-2084 LMZ1420xEXT / LMZ1200xEXT Evaluation Board

1 Introduction

The LMZ1420xEXT and LMZ1200xEXT SIMPLE SWITCHER® power modules are easy-to-use DC-DC solution capable of driving up to a 3A load with exceptional power conversion efficiency, output voltage accuracy, line and load regulation. They are available in an innovative package that enhances thermal performance and allows for hand or machine soldering.

The LMZ14203EXT/2EXT/1EXT can accept an input voltage rail between 6V and 42V and the LMZ12003EXT/2EXT/1EXT can accept an input voltage rail between 4.5V and 20V. The devices can deliver an adjustable and highly accurate output voltage as low as 0.8V and as high as 6V. The control structure is constant on-time with input voltage feed forward. This creates a nearly constant switching frequency across the input voltage range. The control loop operates well with low ESR output capacitors such as ceramics. An output feed-forward capacitor across the upper feedback resistor trims for optimum transient response. The precision enable input allows for programmable UVLO of the input supply. The external soft-start capacitor facilitates controlled startup output rise time. The LMZ1420xEXT and LMZ1200xEXT family is a reliable and robust solution with the following features: lossless cycle-by-cycle valley current limit to protect for over current or short-circuit fault, thermal shutdown, input under-voltage lock-out, and will start up into a pre-biased output. The LMZ1420xEXT and LMZ1200xEXT families are shock and vibration certified and rated for operation down to -55°C .

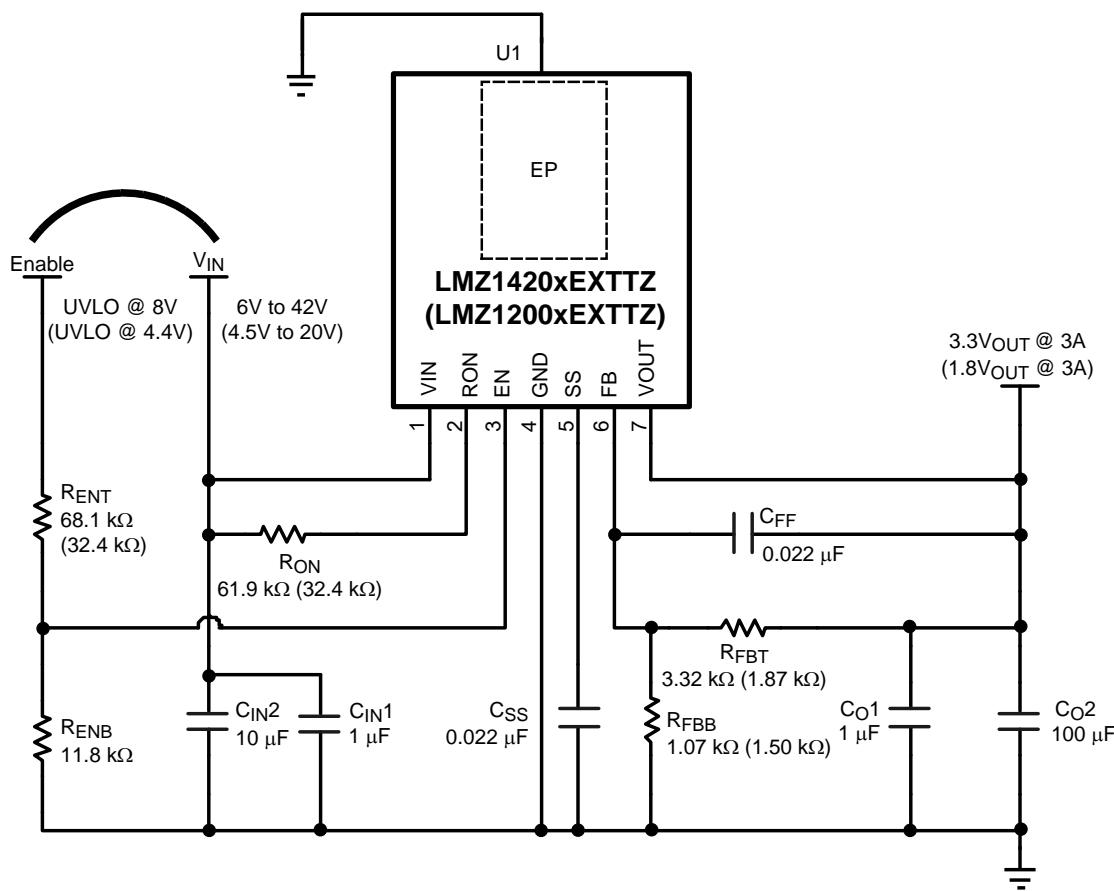
2 Board Specifications

- LMZ1420xEXT $V_{\text{IN}} = 6\text{V}$ to 42V
- LMZ1420xEXT enable UVLO = 8V
- LMZ1420xEXT $V_{\text{OUT}} = 3.3\text{V}$
- LMZ1200xEXT $V_{\text{IN}} = 4.5\text{V}$ to 20V
- LMZ1200xEXT enable UVLO = 4.5V
- LMZ1200xEXT $V_{\text{OUT}} = 1.8\text{V}$
- Operates at full load up to 80°C ambient at 12V input
- $\theta_{\text{JA}} = 20^{\circ}\text{C} / \text{W}$, $\theta_{\text{JC}} = 1.9^{\circ}\text{C} / \text{W}$
- Designed on four layers, all four layers are 1 oz. copper weight
- The two internal ground planes are identical
- Measures 1.705 in. x 3.03 in. (4.33 cm x 7.7cm) and is 62mil (.062") thick of FR4 laminate material

For additional circuit modifications refer to the Design Consideration section of the LMZ1420xEXT or LMZ1200xEXT data sheet. For negative output voltage connections see AN-2027.

3 Additional Footprints

Additional component mounting pads are available to experiment with alternative C_{in} and C_{out} combinations or a zener clamp on the enable input. See [Figure 6](#) for corresponding schematic locations.



**Figure 1. Evaluation Board Schematic
(LMZ1200xEXT 1.8V application values shown in parentheses)**

4 Bill of Materials

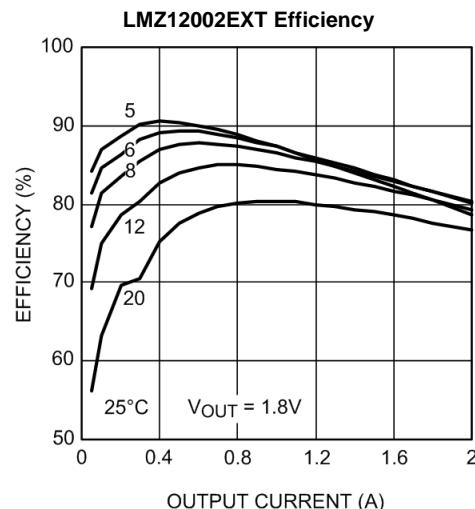
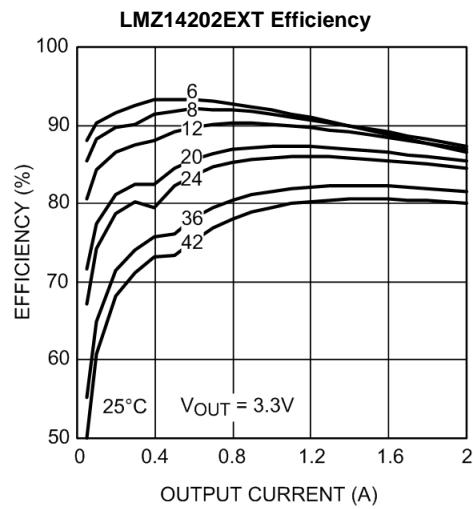
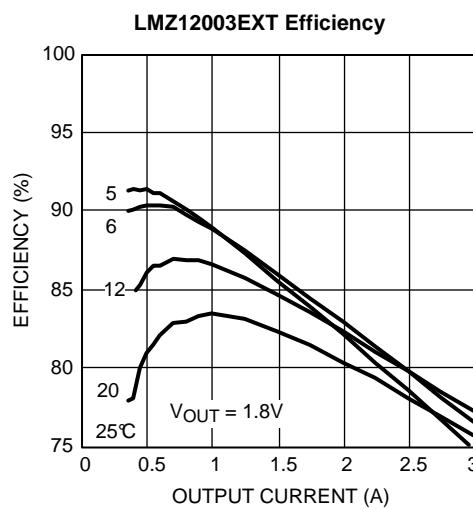
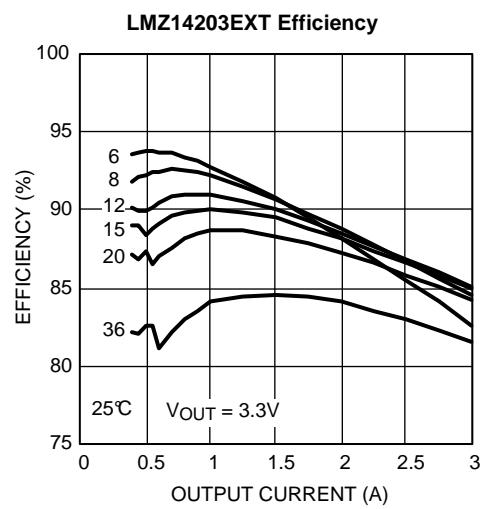
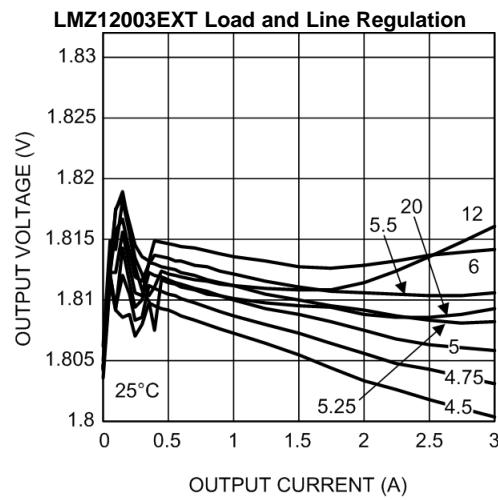
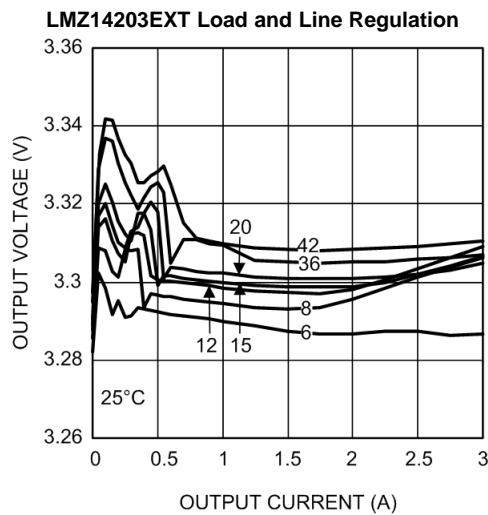
Table 1. LMZ1420xEXT Bill of Materials, $V_{IN} = 8V$ to $42V$, $V_{OUT} = 3.3V$, $I_{OUT (MAX)} = 3A / 2A / 1A$

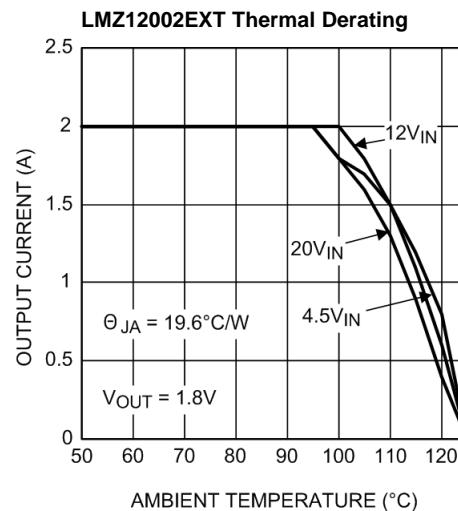
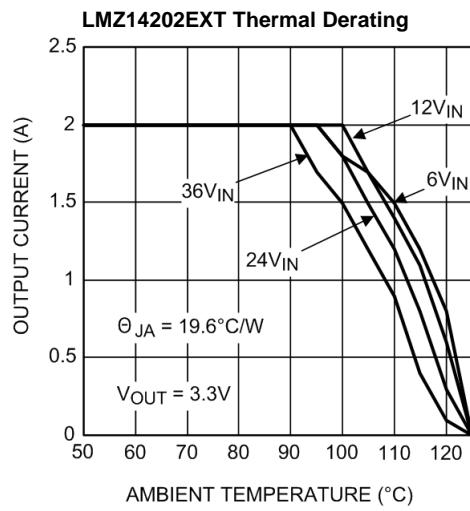
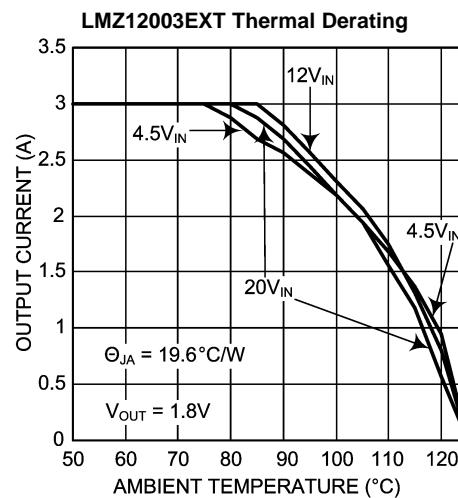
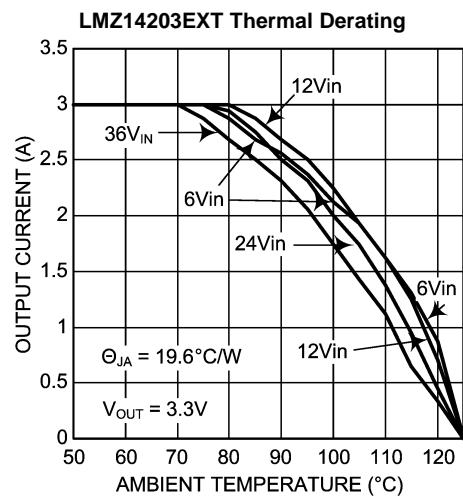
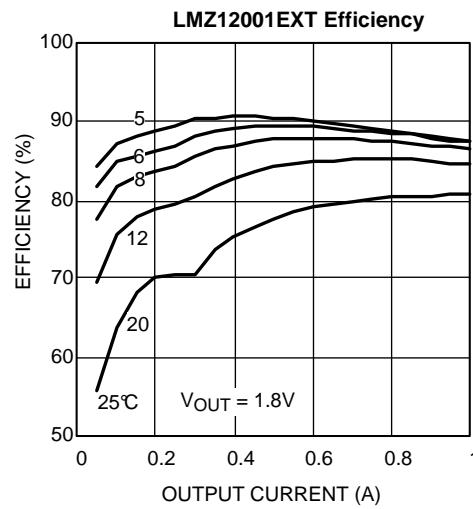
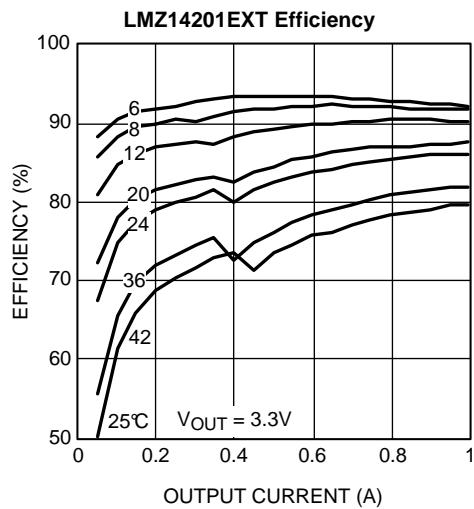
Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	SIMPLE SWITCHER®	PFM-7	Texas Instruments	LMZ14203 or LMZ14202 or LMZ14201	1
C_{IN4}, C_{O1}	1 μF , X7R, 50V	1206	Taiyo Yuden	UMK316B7105KL-T	2
C_{IN2}	10 μF , X5R, 50V	1210	Taiyo Yuden	UMK325BJ106MM-T	1
C_{O2}	100 μF , X5R, 6.3V	1210	Taiyo Yuden	JMK325BJ107MM-T	1
C_{SS}, C_{FF}	0.022 μF , X7R, 100V	0805	AVX	08051C223JAT2A	2
R_{ENB}	11.8k	0805	Panasonic	ERJ-6ENF1182V	1
R_{ENT}	68.1 k Ω	0805	Panasonic	ERJ-6ENF6812V	1
R_{FBT}	3.32 k Ω	0805	Vishay-Dale	CRCW08053K32FKEA	1
R_{FBB}	1.07 k Ω	0805	Panasonic	CRCW080534K8FKEA	1
R_{ON}	61.9 k Ω	0805	Panasonic	ERJ-6ENF6192V	1

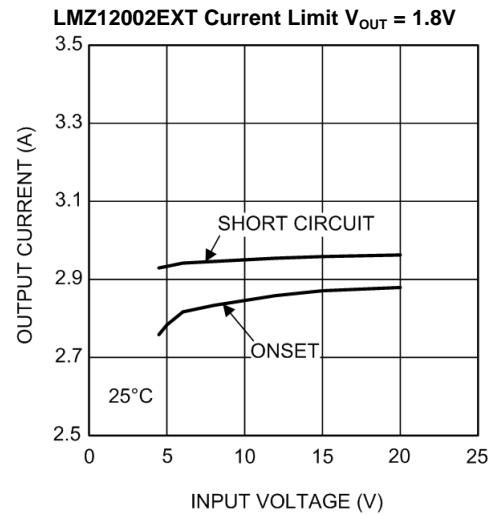
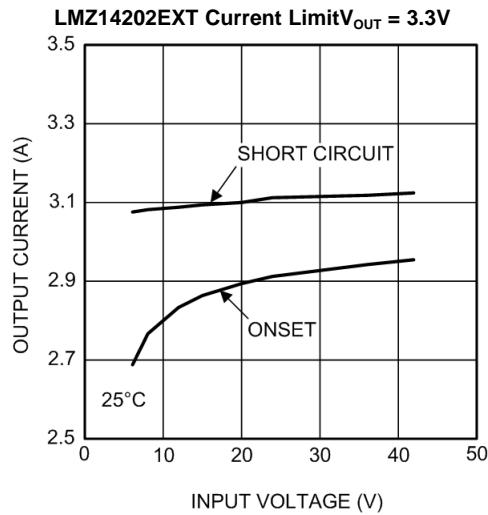
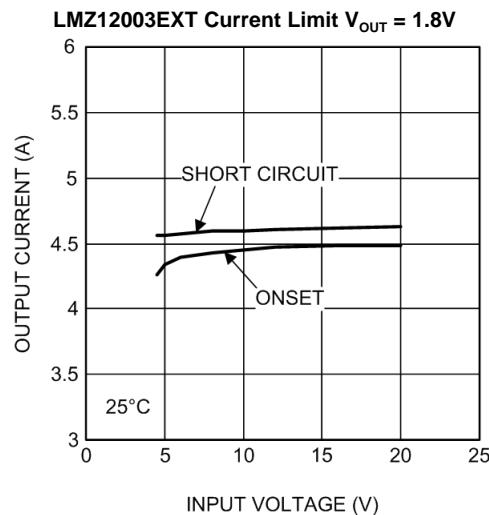
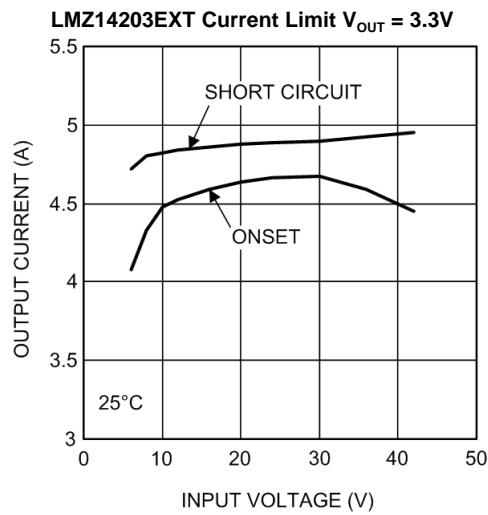
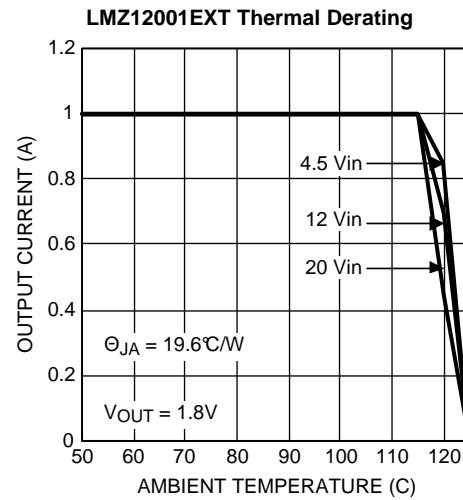
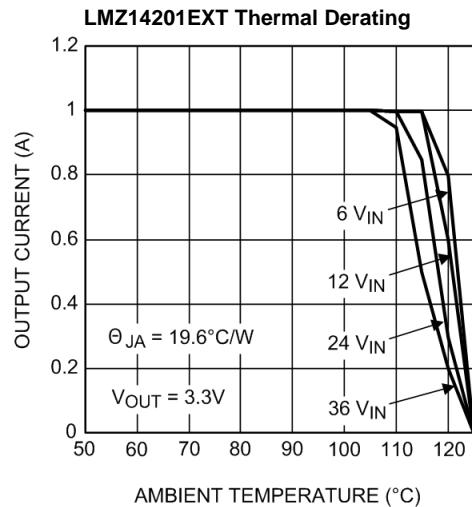
Table 2. LMZ1200xEXT Bill of Materials, $V_{IN} = 4.5$ to $20V$, $V_{OUT} = 1.8V$, $I_{OUT (MAX)} = 3A / 2A / 1A$

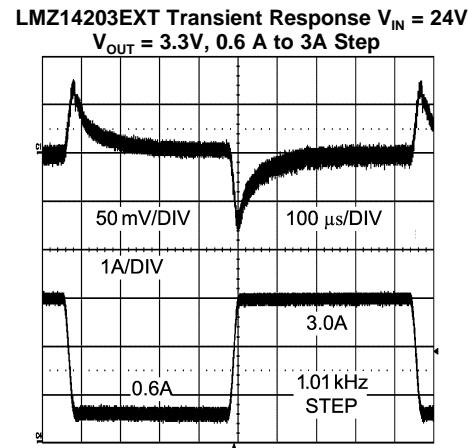
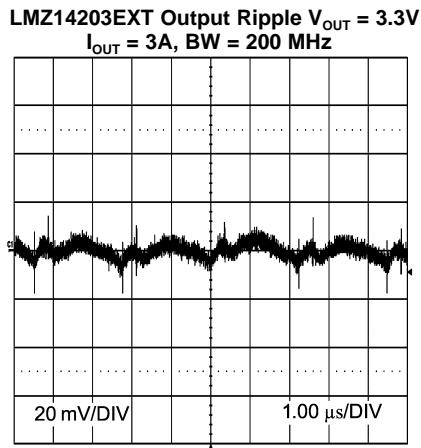
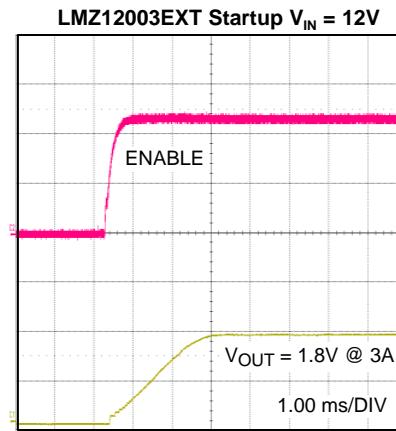
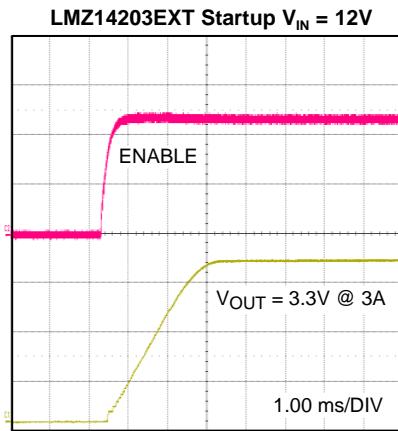
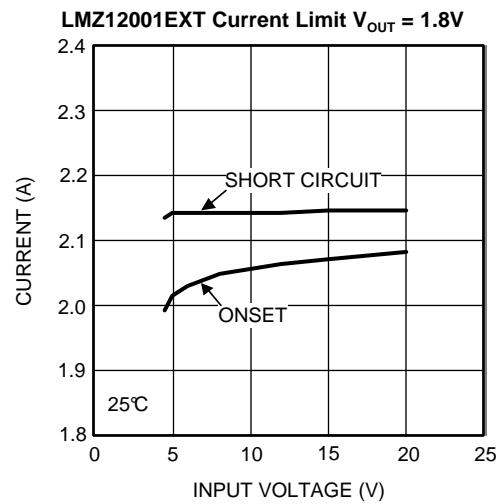
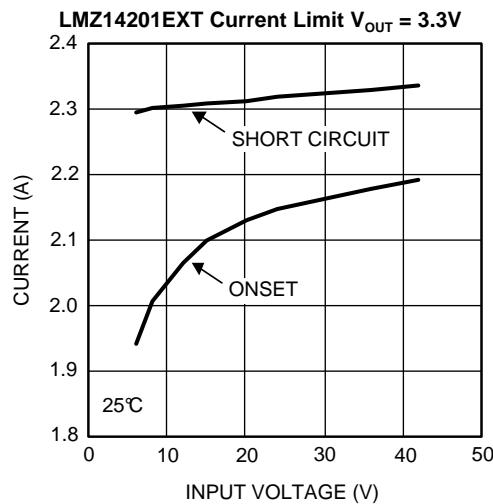
Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	SIMPLE SWITCHER®	PFM-7	Texas Instruments	LMZ12003 or LMZ12002 or LMZ12001	1
C_{IN4}, C_{O1}	1 μF , X7R, 50V	1206	Taiyo Yuden	UMK316B7105KL-T	2
C_{IN2}	10 μF , X5R, 50V	1210	Taiyo Yuden	UMK325BJ106MM-T	1
C_{O2}	100 μF , X5R, 6.3V	1210	Taiyo Yuden	JMK325BJ107MM-T	1
C_{SS}, C_{FF}	0.022 μF , X7R, 100V	0805	AVX	08051C223JAT2A	2
R_{ENB}	11.8k	0805	Panasonic	ERJ-6ENF1182V	1
R_{ENT}	32.4k Ω	0805	Panasonic	ERJ-6ENF3242V	1
R_{FBT}	1.87 k Ω	0805	Vishay-Dale	CRCW08051K87FKEA	1
R_{FBB}	1.50 k Ω	0805	Panasonic	CRCW08051K50FKEA	1
R_{ON}	32.4k Ω	0805	Panasonic	ERJ-6ENF3242V	1

5 Performance Characteristics









6 PCB Layout Diagrams

Gerber and CAD files can be download from the LMZ14203EXT product folder.

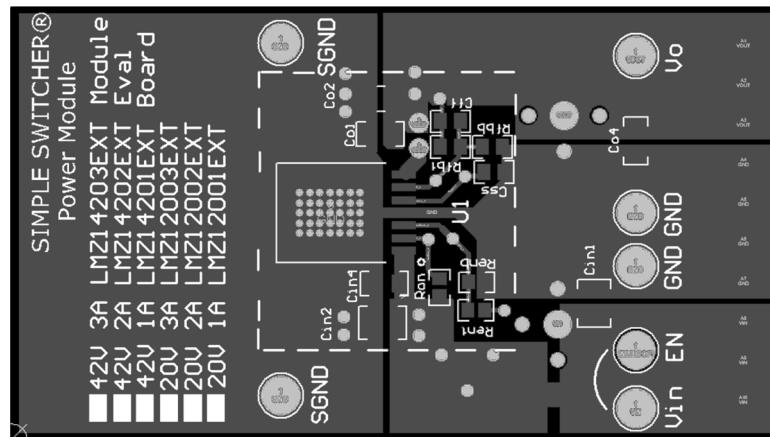


Figure 2. Top Layer

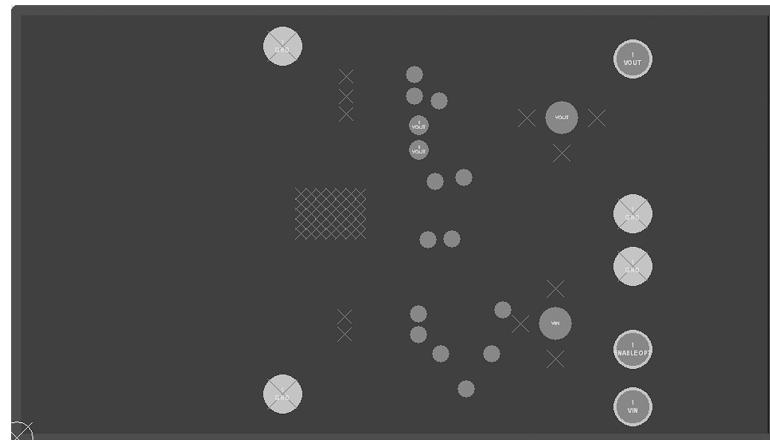


Figure 3. Internal Layer I (Ground)
Heat Sinking Layer

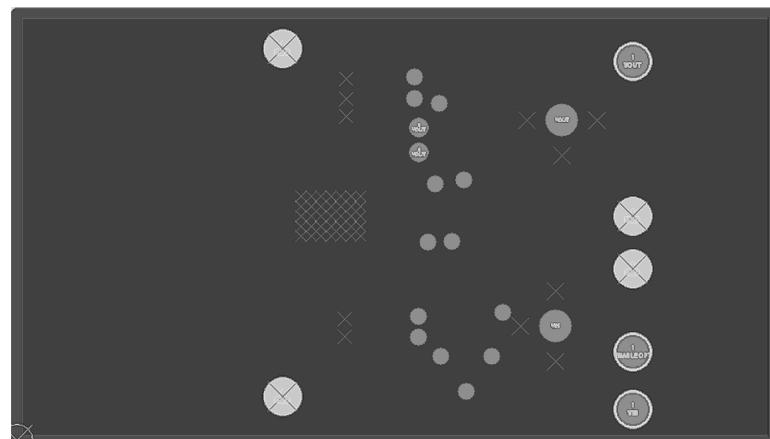


Figure 4. Internal Layer II (Ground)
Heat Sinking Layer

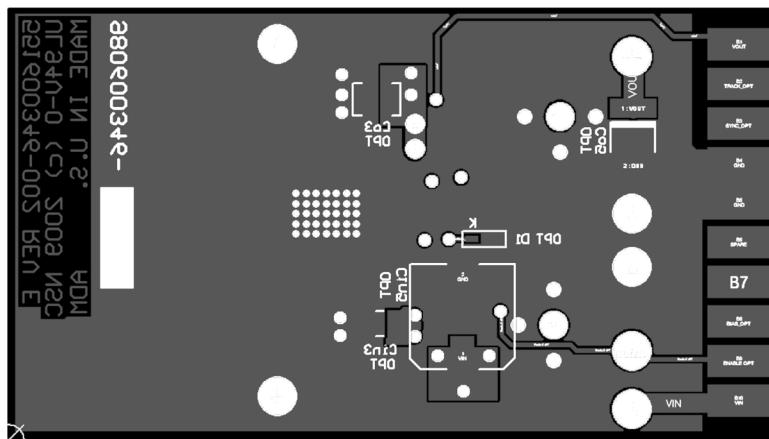
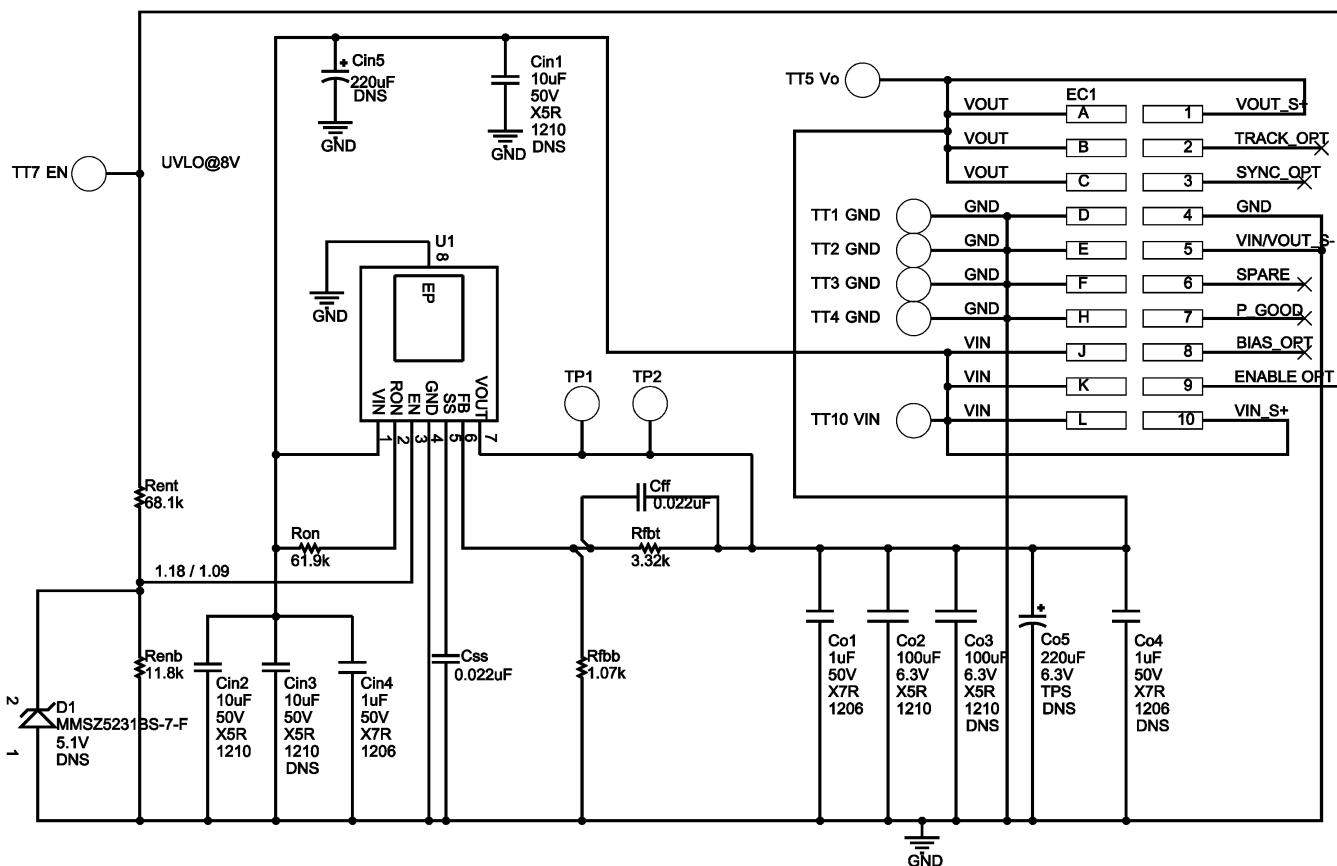


Figure 5. Bottom Layer (Ground and Routing) Heat Sinking Layer



**Figure 6. LMZ14203EXT PCB CAD package schematic
DNS = Component not installed**

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- 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 DEGRADATION 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 isotope 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/lsts/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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東京都新宿区西新宿6丁目24番1号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsts/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.

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