AN-2089 LMZ14203H/02H/01H Evaluation Board

1 Introduction

The LMZ14203H/02H/01H SIMPLE SWITCHER® power modules for high output voltage are easy-to-use DC-DC solutions 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 LMZ14203H/02H/01H Evaluation Board is configured for 12V output voltage from 15V to 42V input. The precision enable input allows for programmable UVLO of the input supply. The resistor voltage divider R_{ENT} and R_{ENB} set the input UVLO threshold. Connect the V_{IN} turret terminal to the EN turret on the board to enable operation.

The external soft-start capacitor C_{SS} facilitates controlled startup output rise time. The resistors R_{FBT} and R_{FBB} set the output voltage. An output feed-forward capacitor C_{FF} across the upper feedback resistor trims for optimum transient response. The control loop operates well with low ESR output capacitors such as ceramic and polymer electrolytic capacitors. The resistor R_{ON} sets the operating frequency. See datasheet for component selection details.

The LMZ14203H/02H/01H PCB layout offers excellent thermal performance, achieving junction-to-ambient thermal resistance θ_{JA} of 14.9°C/W. The evaluation board with its default Bill of Materials offers great EMI performance, complying with the EN 55022 Class B radiated emissions standard. The solution also complies with the CISPR22 conducted emissions standard with the addition of a small input filter.

2 Board Specifications

- V_{IN} = 15V to 42V
- V_{OUT} = 12V
- 3A max load at 24V_{IN} and 65°C T_{AMB}
- Low radiated EMI (EN 55022 Class B compliant)
- 400kHz switching frequency
- Enable UVLO set at 13.5V
- θ_{JA} = 14.9°C/W
- 4 copper layers
- 2 oz copper on top and bottom layer
- 1 oz copper on internal layers
- 6.985 cm x 7.620 cm (2.75 in x 3 in) with 1.575 cm (.062 in) thickness of FR4 laminate material

3 Additional Footprints

Additional component mounting pads are available to experiment with alternative input and output capacitor combinations or a zener clamp on the enable input. See Figure 6 for corresponding schematic locations.

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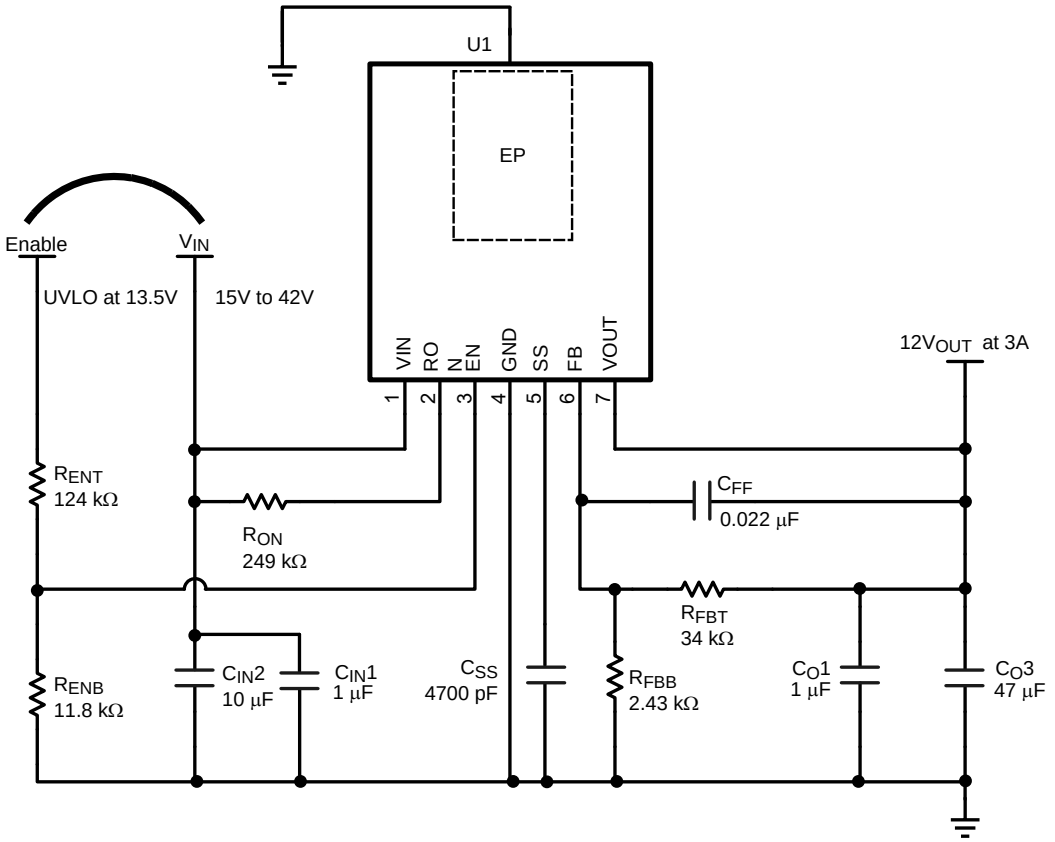

Figure 1. Evaluation Board Schematic

Table 1. LMZ1420xH Bill of Materials, V_{IN} = 15V to 42V, V_{OUT} = 12V, $I_{OUT\ (MAX)}$ = 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_{O3}	47 µF, 35 mΩ, 16V, Polymer	7343-43	KEMET	T525D476M016ATE035	1
C_{FF}	0.022 µF, X7R, 100V	0805	AVX	08051C223JAT2A	1
C_{SS}	4700 pF, X7R, 25V	0805	AVX	08053A472JAT2A	1
R_{ENB}	11.8 kΩ	0805	Panasonic	ERJ-6ENF1182V	1
R_{ENT}	124 kΩ	0805	Panasonic	ERJ-6ENF1243V	1
R_{FBT}	34 kΩ	0805	Vishay-Dale	CRCW080534K0FKEA	1
R_{FBB}	2.43 kΩ	0805	Panasonic	ERJ-6ENF2431V	1
R_{ON}	249 kΩ	0805	Vishay-Dale	CRCW0805249KFKEA	1

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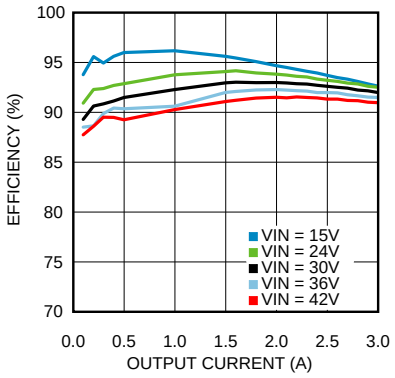
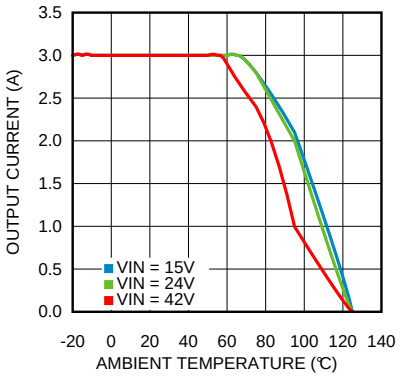
4 Performance Characteristics

Unless otherwise specified the following conditions apply: V_{IN} = 24V, V_{OUT} = 12V, T_{AMB} = 25°C

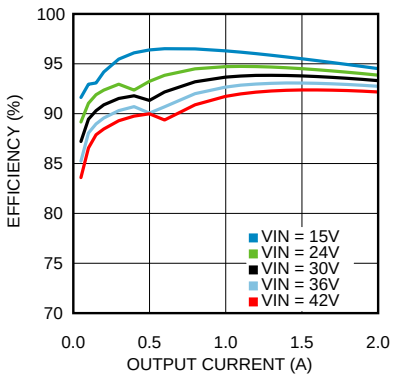
LMZ14203H Efficiency



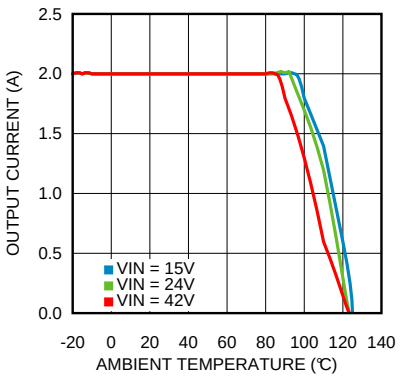
LMZ14203H Thermal Derating



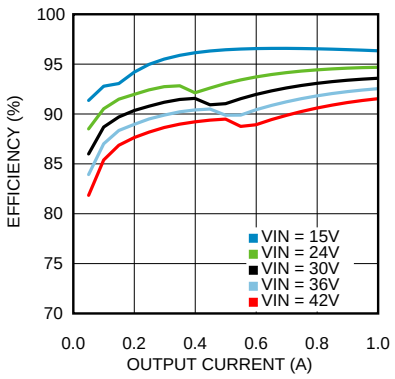
LMZ14202H Efficiency



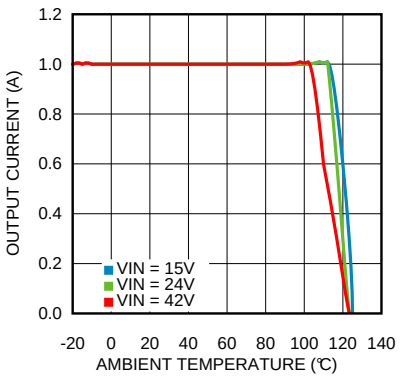
LMZ14202H Thermal Derating



LMZ14201H Efficiency



LMZ14201H Thermal Derating



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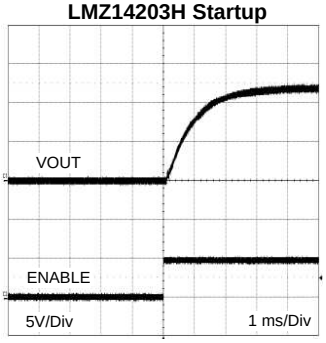
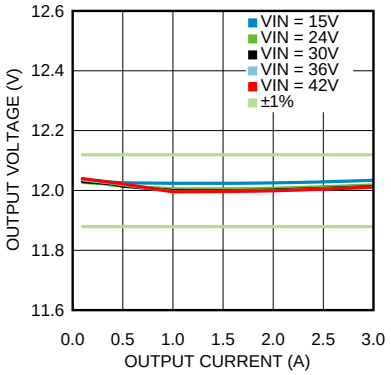
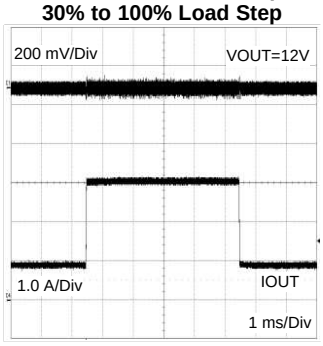
LMZ14203H Startup



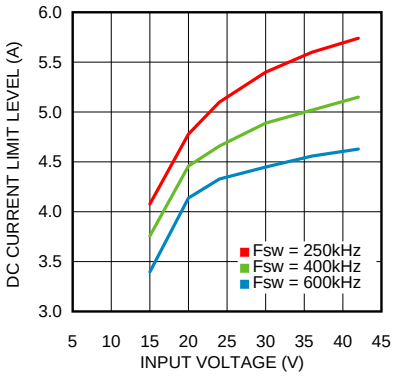
LMZ14203H Line and Load Regulation



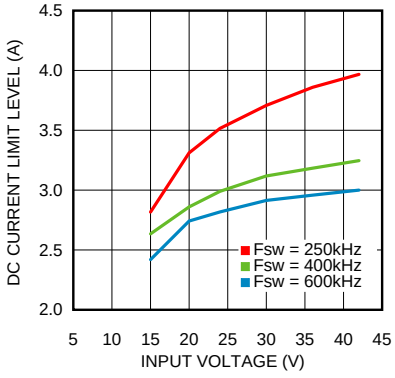
LMZ14203H Transient Response 30% to 100% Load Step



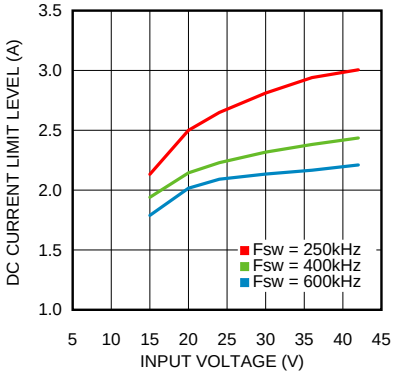
LMZ14203H Current Limit



LMZ14202H Current Limit



LMZ14201H Current Limit



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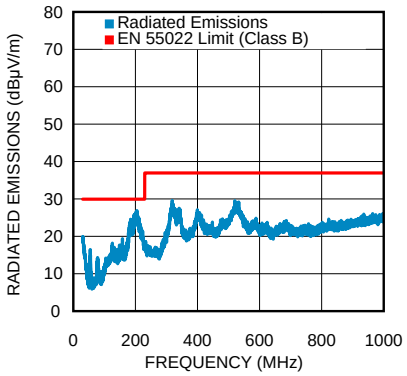
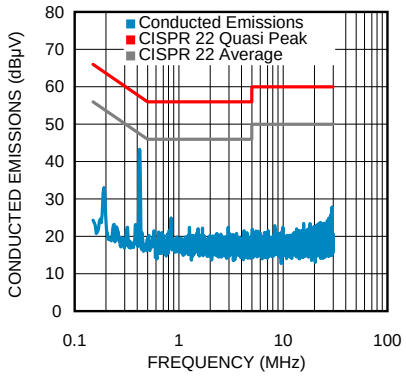
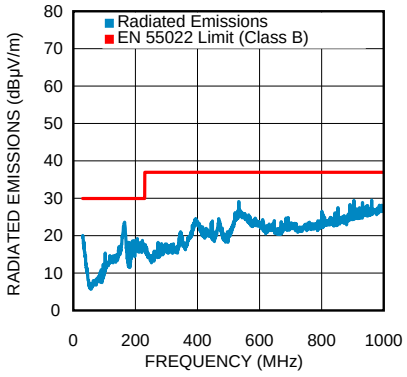
LMZ14203H Radiated EMI, I_{OUT} = 3A



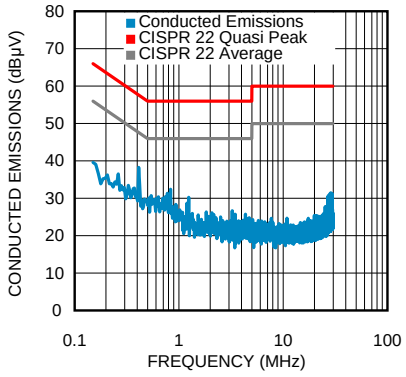
LMZ14203H Conducted EMI, I_{OUT} = 3A with 3.3µH 2x10µF LC line filter added



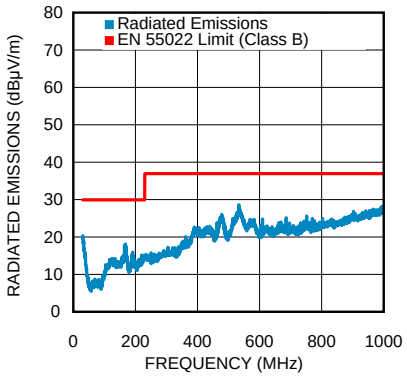
LMZ14202H Radiated EMI, I_{OUT} = 2A



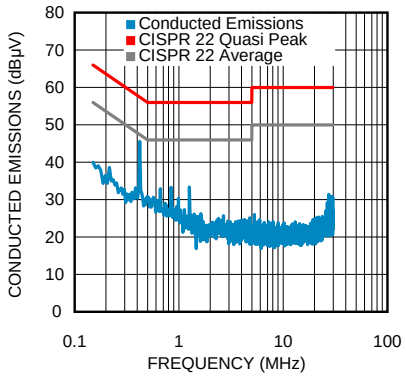
LMZ14202H Conducted EMI, I_{OUT} = 2A with 3.3µH 2x10µF LC line filter added



LMZ14201H Radiated EMI, I_{OUT} = 1A



LMZ14201H Conducted EMI, I_{OUT} = 1A with 3.3µH 1µF LC line filter added



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5 PCB Layout Diagrams

Gerber and CAD files can be download from the LMZ14203H product folder.

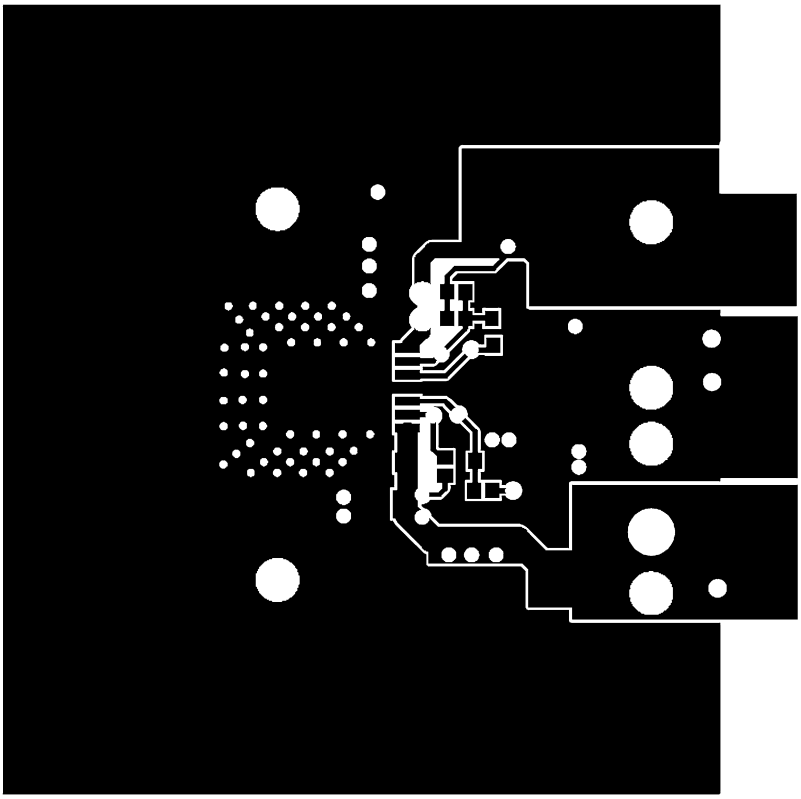

Figure 2. Top Layer

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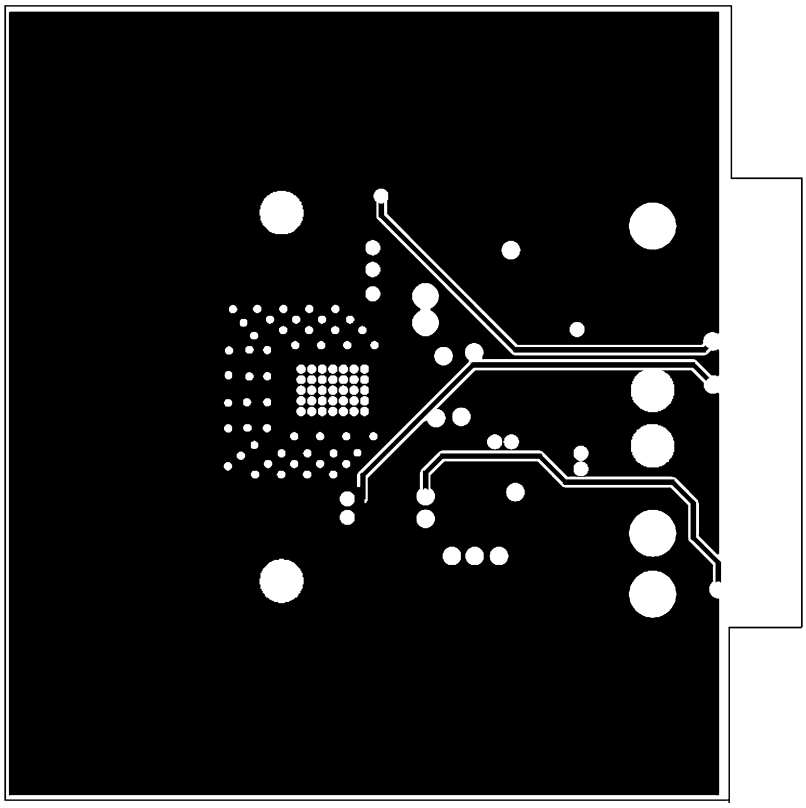

Figure 3. Internal Layer I (Ground)
Heat Sinking Layer

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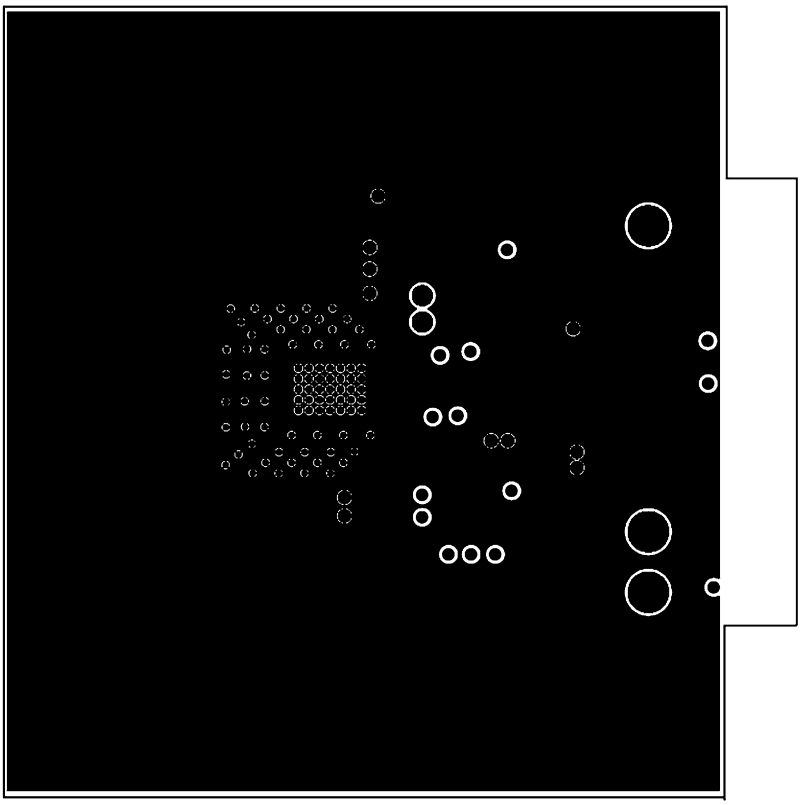

Figure 4. Internal Layer II (Ground)
Heat Sinking Layer

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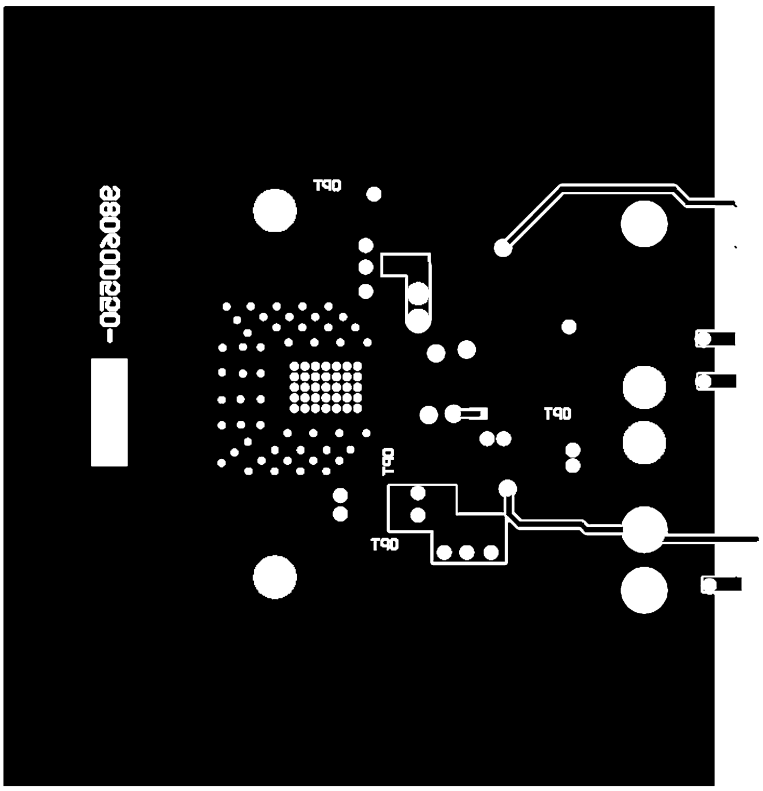

Figure 5. Bottom Layer (Ground and Routing)
Heat Sinking Layer

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6 PCB Schematic

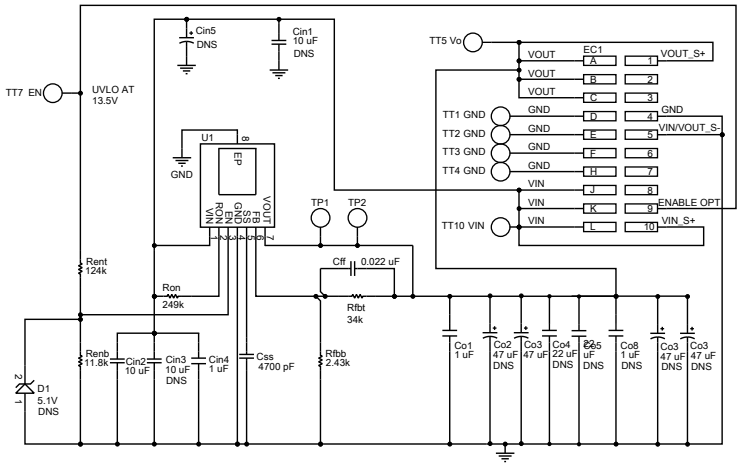

Figure 6. Detailed Schematic
DNS = Component not installed

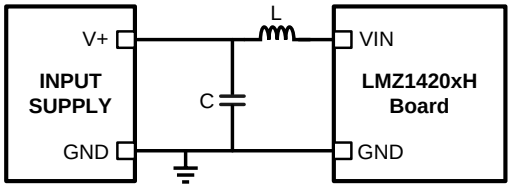

Figure 7. Conducted EMI LC Filter Configuration

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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.

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3.1 *United States*

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

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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