

TPS62410-Q1 Evaluation Module for 3.6 V Dual Step-Down Converter User's Guide

The Texas Instruments TPS62410Q1-EVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS62410-Q1 dual step-down converter. This document describes how to setup and configure the EVM for operation. The document also includes the board layout, schematic, and bill of materials (BOM) for the EVM.

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1 Introduction

The TPS62410Q1-EVM evaluation module (EVM) (Figure 1) helps designers evaluate the operation and performance of the TPS62410-Q1 dual step-down converter. The TPS62410Q1-EVM contains two synchronous buck converters that operate at an output of 1.2 V and 1.8 V. The input of the dual step-down converter can range from 2.5 V to 6 V. Additionally, both buck converters operate at a fixed switching frequency of 2.25 MHz, with the option of entering a Power Save Mode to maintain high efficiency.

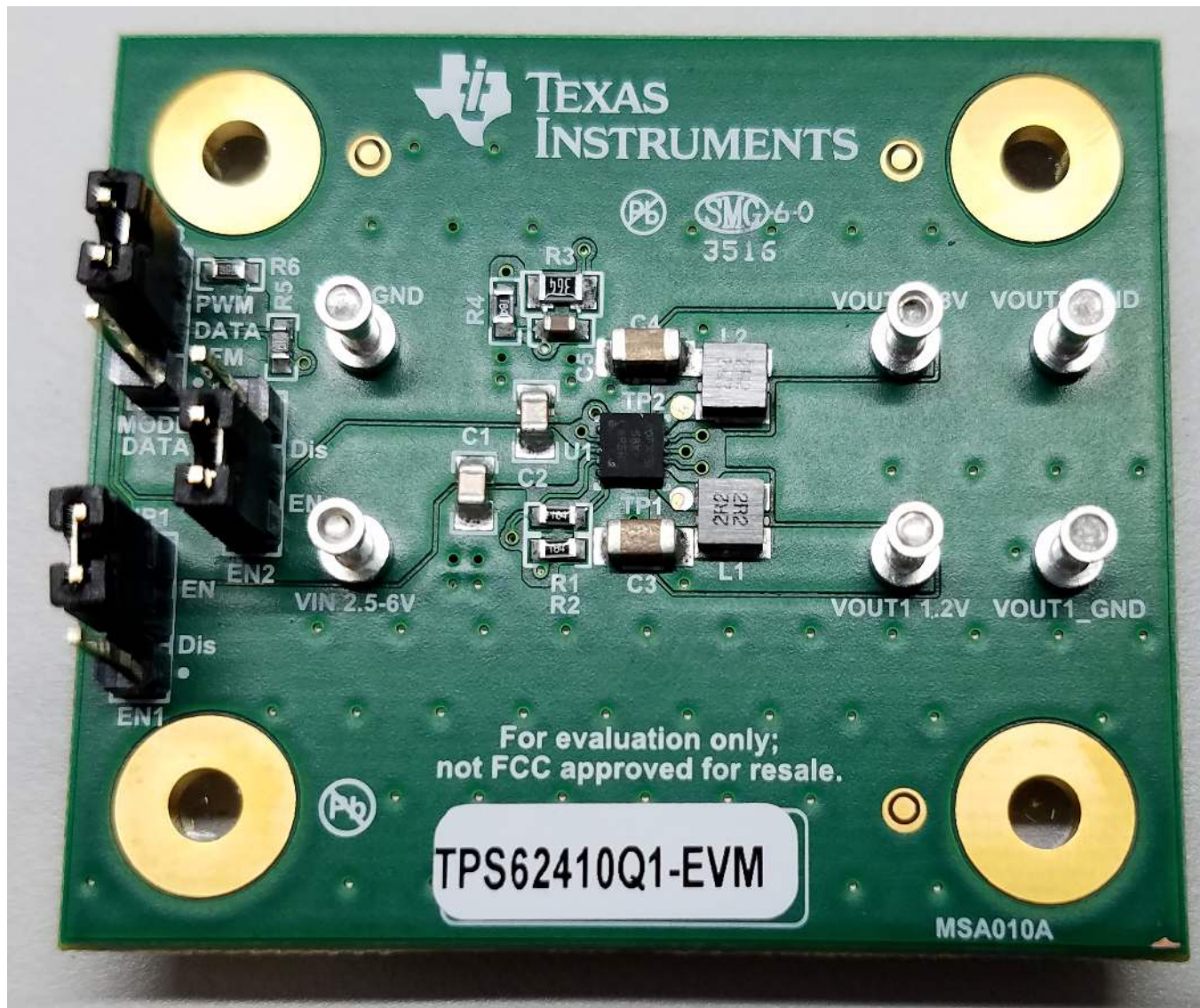
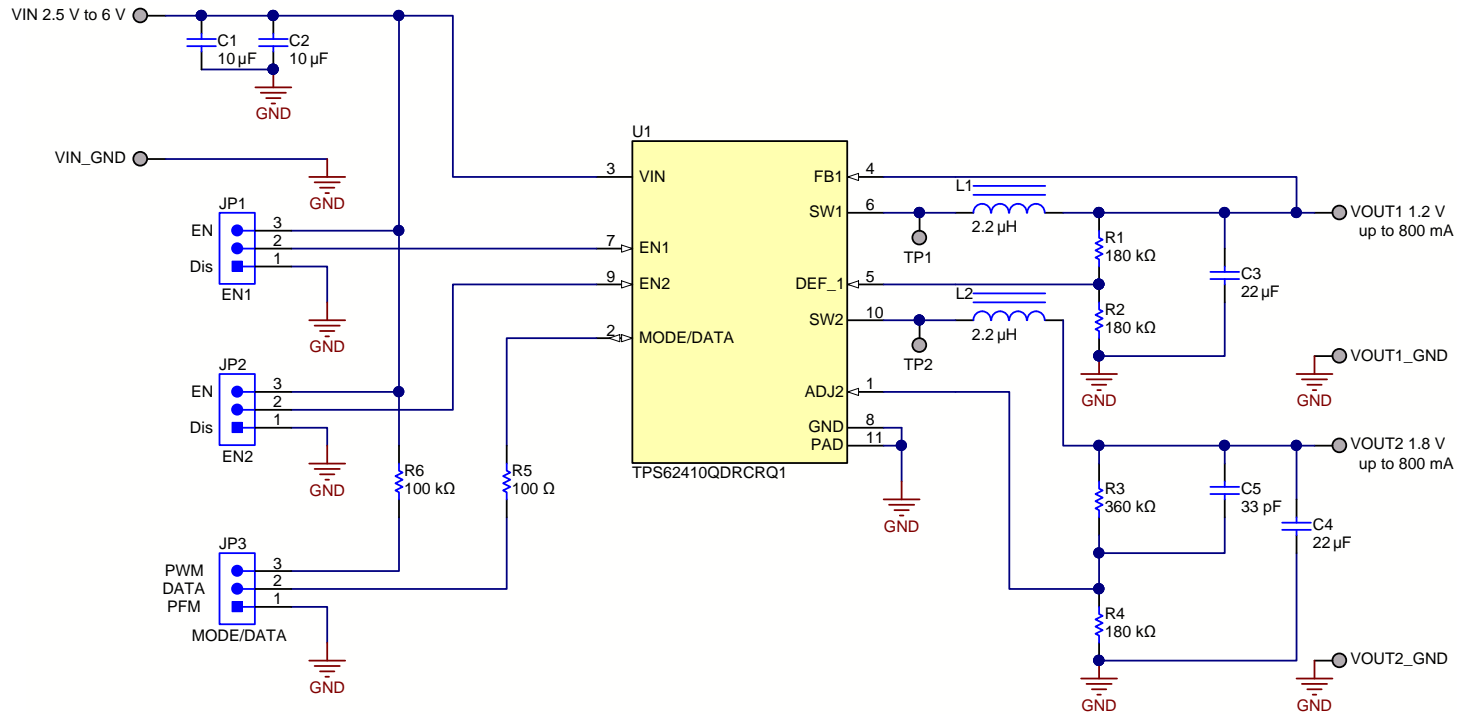


Figure 1. TPS62410Q1-EVM Board

2 Schematic, Bill of Materials, and Layout

This section provides a detailed description of the TPS62410Q1-EVM Schematic, BOM, and Layout.

2.1 Schematic



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Figure 2. TPS62410Q1-EVM Schematic

2.2 Bill of Materials

Table 1. Bill of Materials (BOM)

Designator	Quantity	Value	Description	Package Reference	Part Number
!PCB	1		Printed Circuit Board		MSA010
C1, C2	2	10uF	CAP, CERM, 10 μ F, 10 V, \pm 10%, X7R, 0805	0805	GCM21BR71A106KE2 2L
C3, C4	2	22uF	CAP, CERM, 22 μ F, 6.3 V, \pm 20%, X7R, AEC-Q200 Grade 1, 1206_190	1206_190	CGA5L1X7R0J226M16 0AC
C5	1	33pF	CAP, CERM, 33 pF, 50 V, \pm 5%, COG/NP0, AEC-Q200 Grade 0, 0603	0603	CGA3E2NP01H330J08 0AA
H1, H2, H3, H4	4		Bumpon, Hemisphere, 0.44 X 0.20, Clear	Transparent Bumpon	SJ-5303 (CLEAR)
JP1, JP2, JP3	3		Header, 100mil, 3x1, Gold, TH	Header, 100mil, 3x1, TH	HTSW-103-07-G-S
L1, L2	2	2.2uH	Inductor, 2.2 μ H, 1.8 A, 0.094 ohm, SMD	SMD, 2-Leads, Body 3x3mm	78438335022
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10
R1, R2, R4	3	180k	RES, 180 k, 0.1%, 0.1 W, 0603	0603	RG1608P-184-B-T5
R3	1	360k	RES, 360 k, 0.1%, 0.125 W, 0805	0805	RG2012P-364-B-T5
R5	1	100	RES, 100, 1%, 0.1 W, 0603	0603	CRCW0603100RFKEA
R6	1	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	CRCW0603100KFKEA
SH-J1, SH-J2, SH-J3	3	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA
U1	1		2.25MHz 2x800mA Dual Step Down Converter In Small 3x3mm QFN Package, DRC0010J	DRC0010J	TPS62410QDRCRQ1
VIN 2.5–6V, VIN_GND, VOUT1_GND, VOUT2_GND, VOUT1 1.2V, VOUT2 1.8V	6		PCB Pin, Swage Mount, TH	PCB Pin(2505-2)	2505-2-00-44-00-00-07-0
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A

2.3 Layout and Component Placement

Board layout is critical for all high frequency, switch-mode power supplies. [Figure 3](#) through [Figure 8](#) show the board layout for the TPS62410Q1-EVM PCB. The nodes with high-switching frequencies and currents are kept as short as possible to minimize trace inductance. Careful attention has been given to the routing of high-frequency current loops. Additionally, the board uses a single-point grounding scheme. See the TPS62410-Q1 datasheet ([SLVSAA8](#)) for specific layout guidelines.

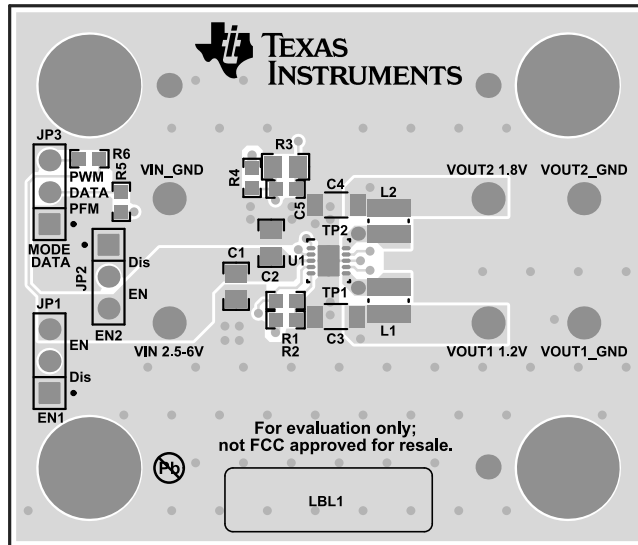


Figure 3. Top Layout Composite

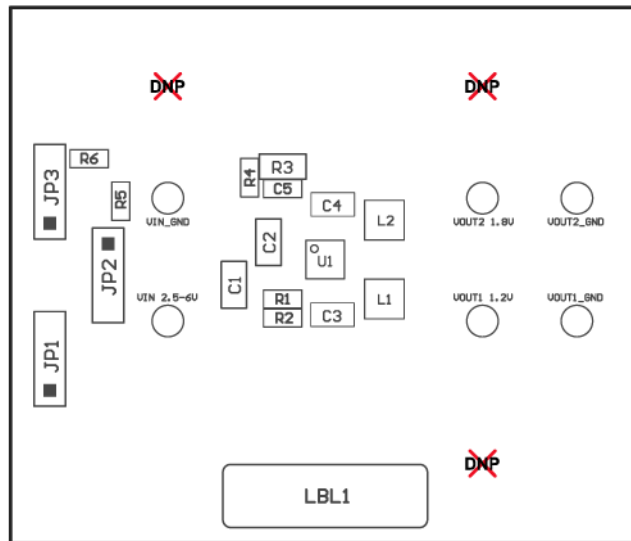


Figure 4. Top Overview

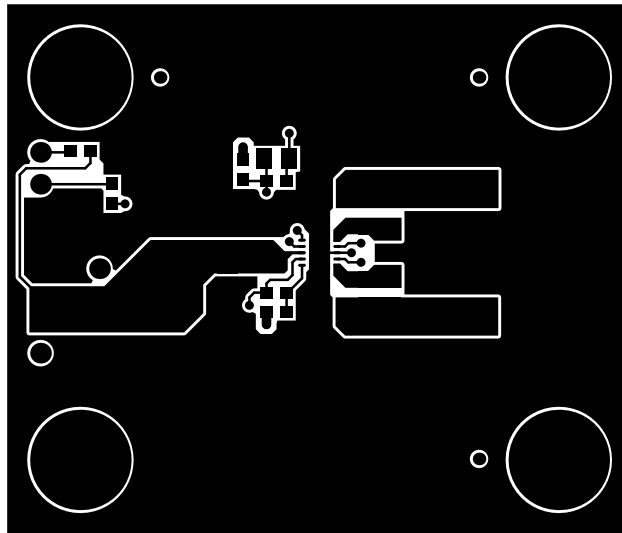


Figure 5. Top Layer

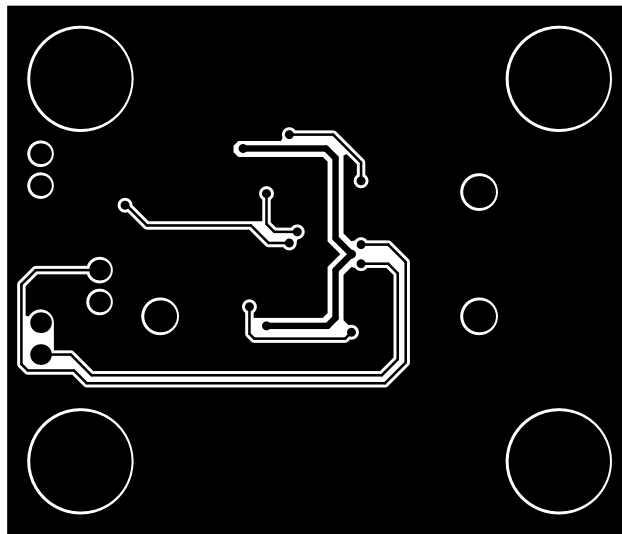


Figure 6. Bottom Layer

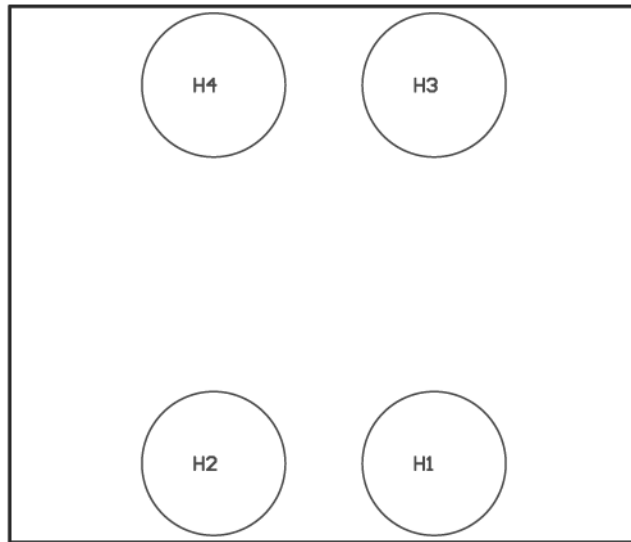


Figure 7. Bottom Overview

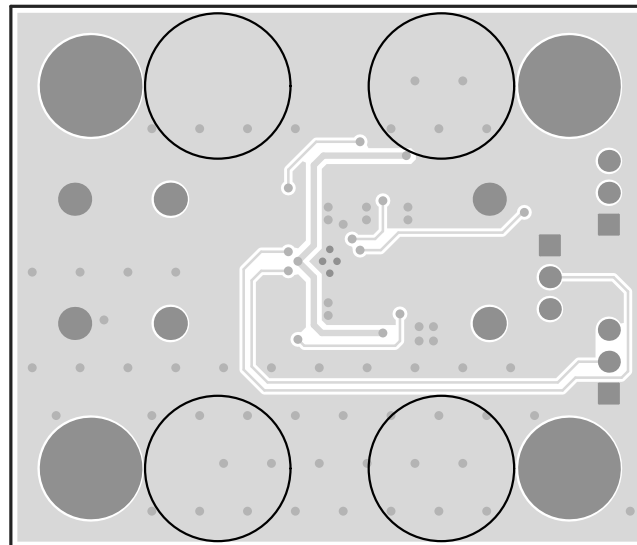


Figure 8. Bottom Layout Composite

3 Setup and Operation

This section describes the connectors, jumpers, and test points on the EVM and how to connect, set up, and properly use the TPS62410Q1-EVM. An example of the EVM operation is also included.

3.1 Input and Output Connector Descriptions

The EVM terminal descriptions are in [Table 2](#).

Table 2. Terminal Descriptions

TERMINAL	DIRECTION	DESCRIPTION
VIN (2.5V–6V)	Input	This terminal is the power input terminal for the device. Adjacent to this terminal is the VIN_GND reference ground. Use these terminals to attach the EVM to a cable harness.
VOUT1 (1.2V)	Output	This terminal is the output terminal for the TPS62410-Q1. Adjacent to this terminal is the VOUT1_GND reference ground, which is closely coupled with the VIN_GND.
VOUT2 (1.8V)	Output	This terminal is the output terminal for the TPS62410-Q1. Adjacent to this terminal is the VOUT2_GND reference ground, which is closely coupled with the VIN_GND.
VIN_GND	GND	These terminals are the ground terminals for the TPS62410-Q1.
VOUT1_GND		
VOUT2_GND		

3.2 Jumper Settings

The descriptions for the jumper settings are in the following sections.

3.2.1 EN1 and EN2

EN1 (JP1) and EN2 (JP2) are the jumpers ([Figure 9](#)) for enabling the switch-mode converters. The rail is enabled when the respective jumper is high and disabled when the jumper is low.

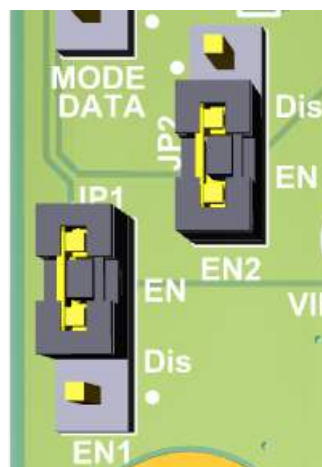


Figure 9. Enable Jumper Settings

3.2.2 MODE/DATA

MODE/DATA (JP3) connects to the MODE/DATA pin of the TPS62410-Q1 for selecting the operating mode of TPS62410-Q1 (Figure 10). When the EasyScale interface is not in use, use JP3 to select between fixed PWM mode and Power Save Mode. The converter operates in a fixed-frequency PWM mode when there is an installed jumper between PWM and DATA, pulling the pin high. Connecting DATA and PFM pulls the MODE/DATA pin low and allows the converter to use power-saving PFM mode at low-output currents.

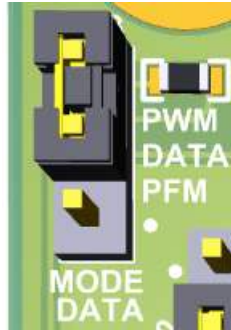


Figure 10. Mode Jumper Settings

3.3 Test Points

There are two test points: TP1 and TP2. These test points are located on the switching output (SW1, SW2) of each buck converter to measure the output voltage at the device before the signal goes through the external inductor and resistor divider.



Figure 11. Test Points

3.4 Setup

The TPS62410-Q1 needs an input voltage between 2.5 V and 6 V. The input voltage must be higher than the highest output voltage in order to maintain voltage regulation (allows for some dropout).

Configure the jumper on JP3 to desired setting. This jumper configures the MODE/DATA pin of the TPS62410-Q1. Normally, there is a jumper between PWM and DATA, which provides a pull-up resistor for the MODE/DATA pin and forces the bucks into PWM-mode, even at light loads. When the EasyScale interface is not in use, using JP3 can drive the MODE/DATA pin to a logic high (short PWM and DATA) or low (short DATA and PFM).

Configure JP1 and JP2 as desired. Placing a jumper pin on the EN side enables the corresponding converter of the TPS62410-Q1. Placing a jumper pin on the Dis side disables the corresponding converter of the TPS62410-Q1.

NOTE: JP1 and JP2 must be either enabled or disabled. These pins should not be left floating.

3.5 Basic Operation

Once the EVM is correctly set up, power may be applied to the board. Current load may also be applied up to 800 mA. In the following paragraphs are some the tests and data recorded for each buck converter.

3.5.1 Load Transient Example

To test the load transient in PWM mode, apply a current load sequence of 60 mA to 540 mA to 60 mA. The resulting load transient response is shown in [Figure 12](#) for VOUT1 rising edge, [Figure 13](#) for VOUT1 falling edge, [Figure 14](#) for VOUT2 rising edge, and [Figure 15](#) for VOUT2 falling edge. Note that the output voltages are AC coupled.

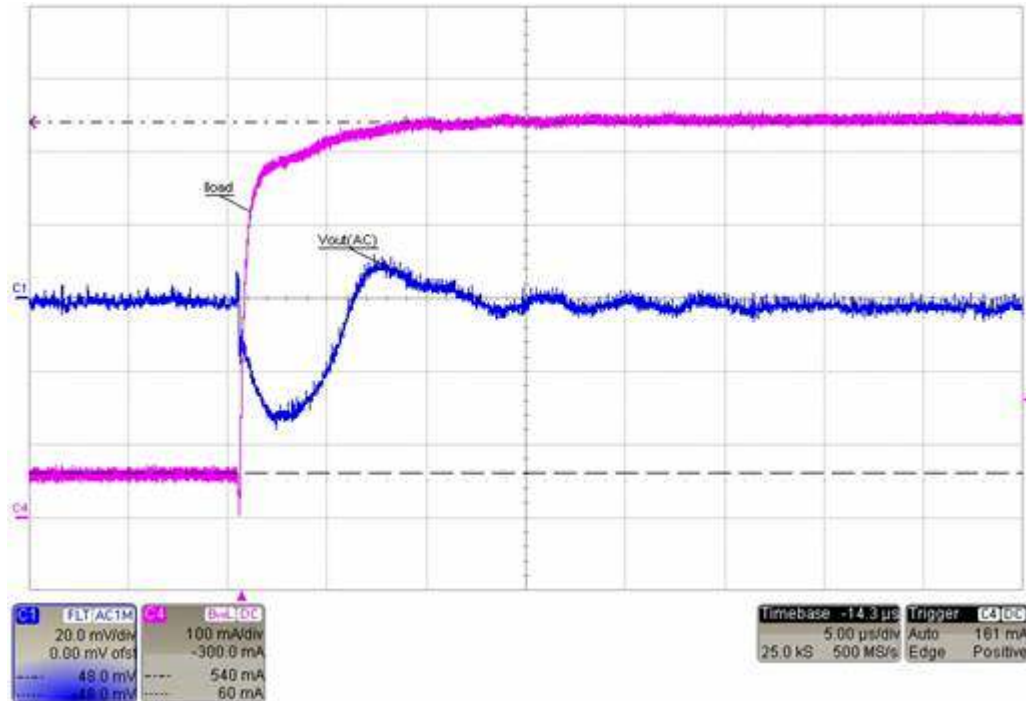


Figure 12. PWM Load Transient Response: VOUT1 Rising Edge

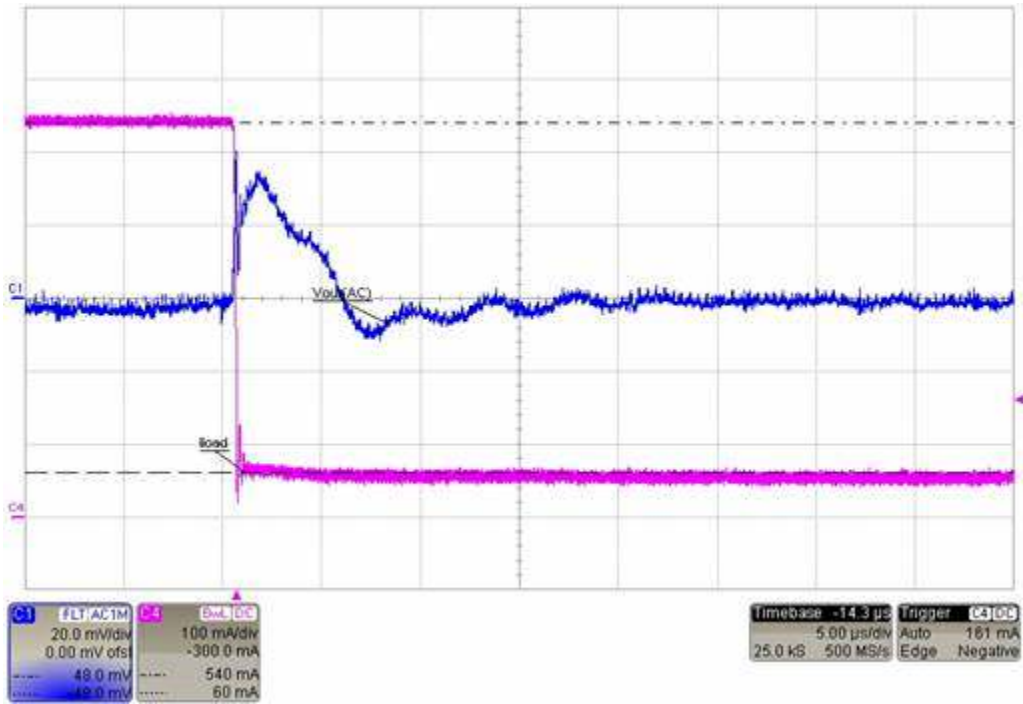


Figure 13. PWM Load Transient Response: VOUT1 Falling Edge

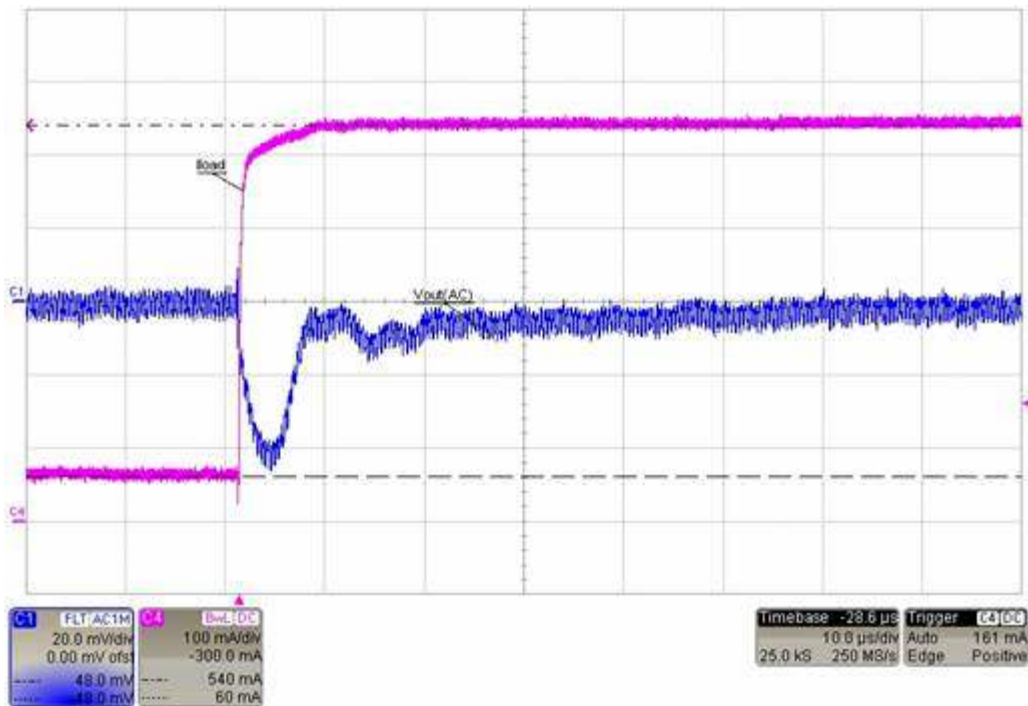


Figure 14. PWM Load Transient Response: VOUT2 Rising Edge

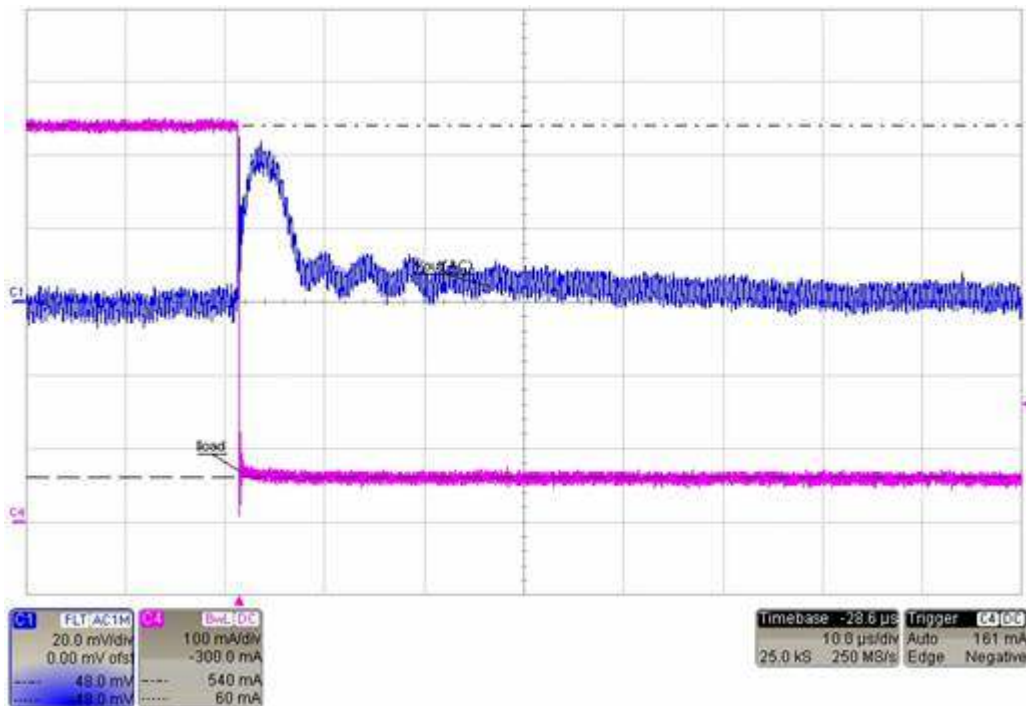


Figure 15. PWM Load Transient Response: VOUT2 Falling Edge

To test the load transient in PFM mode, apply a current load sequence of 0 mA to 60 mA to 0 mA. The resulting load transient response is shown in Figure 16 for VOUT1 rising edge, Figure 18 for VOUT1 falling edge, VOUT2and VOUT2 . Note that the output voltages are AC coupled.

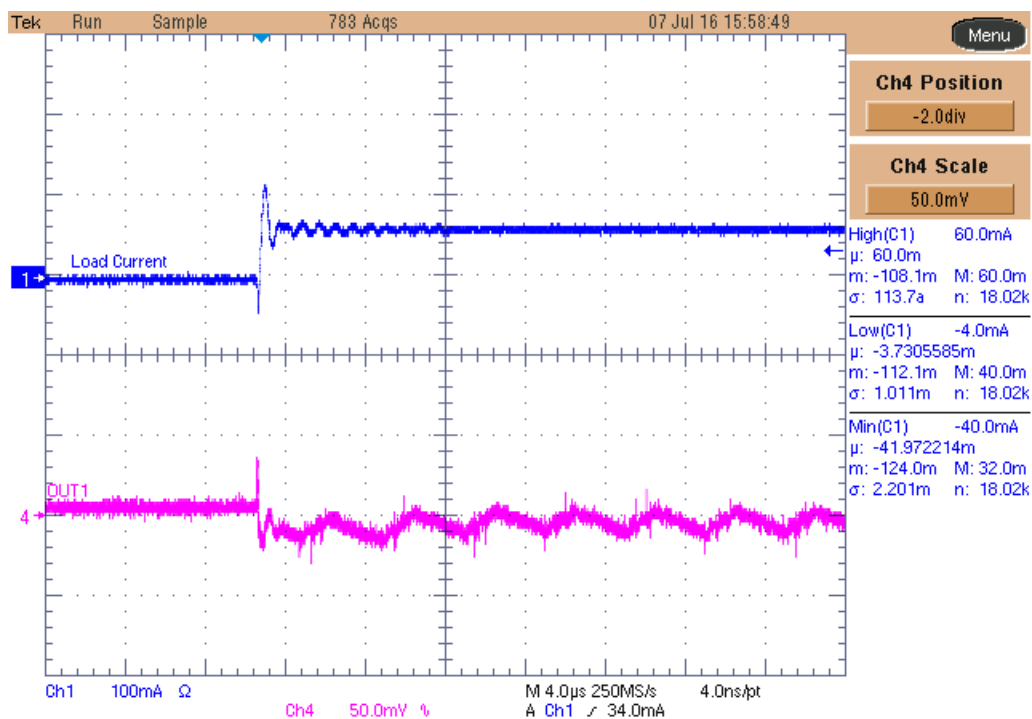


Figure 16. PFM Load Transient Response: VOUT1 Rising Edge

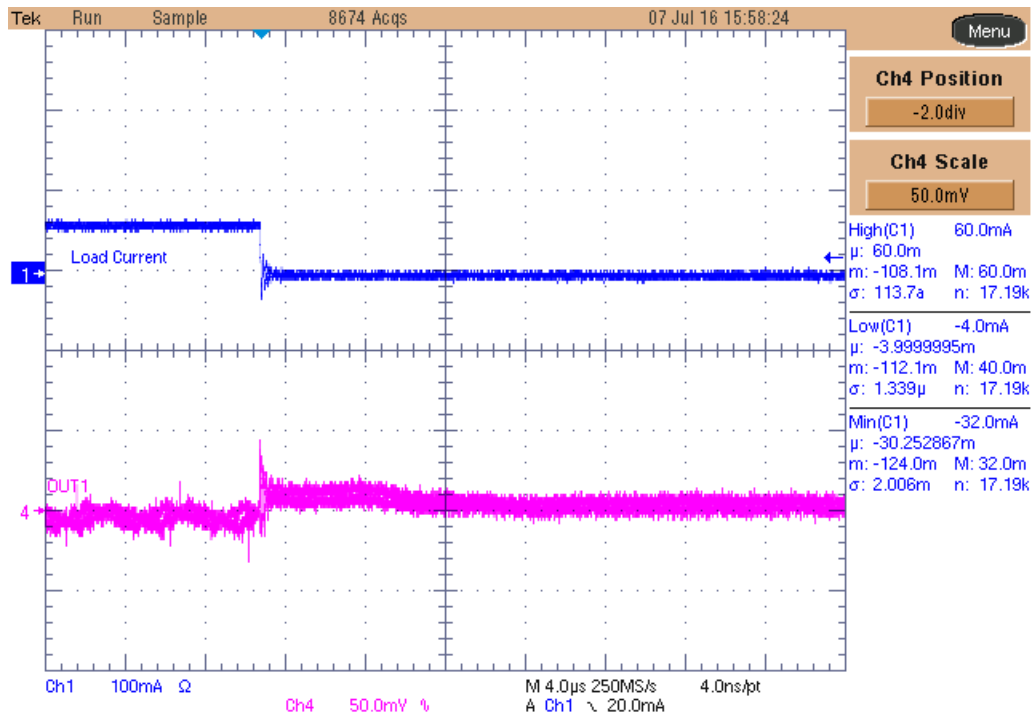


Figure 17. PFM Load Transient Response: VOUT1 Falling Edge

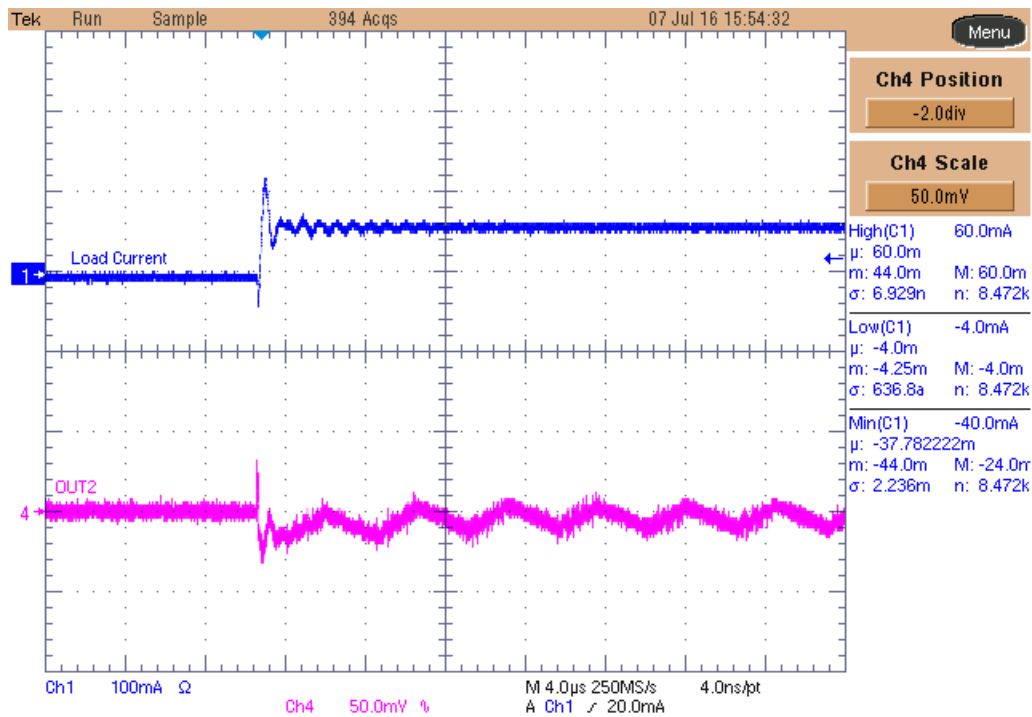


Figure 18. PFM Load Transient Response: VOUT2 Rising Edge

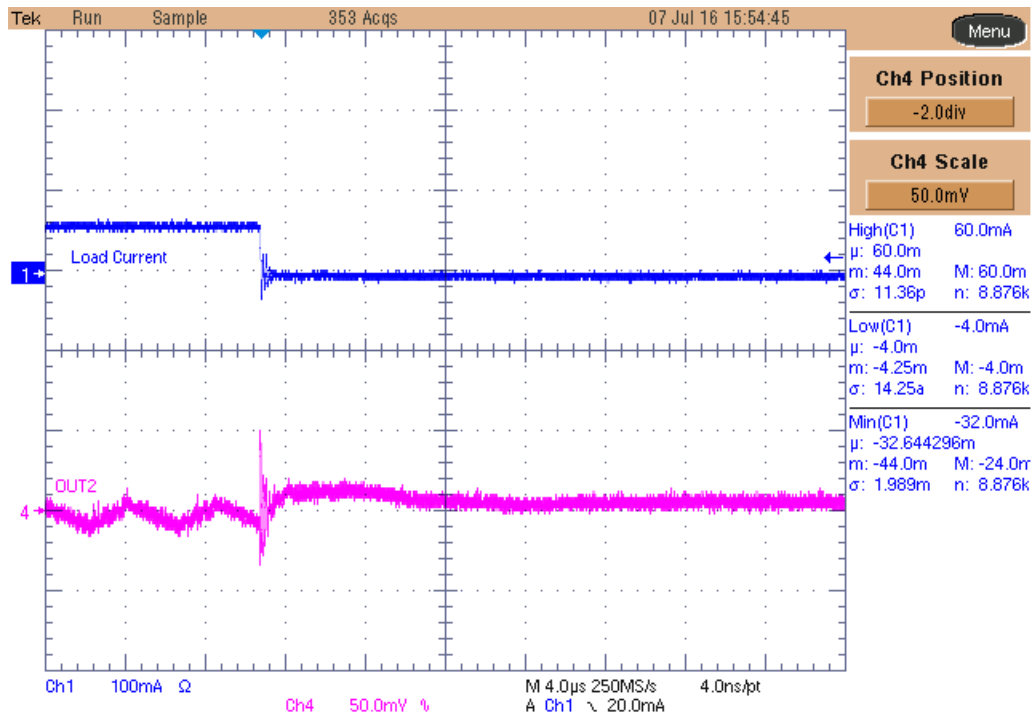


Figure 19. PFM Load Transient Response: VOUT2 Falling Edge

3.5.2 Line Transient Example

To test the line transient in PWM mode, apply a varying voltage input of 3.6 V to 4.6 V to 3.6 V. The resulting line transient response is shown below for VOUT1 (Figure 20) and VOUT2 (Figure 21). Note that the output voltages are AC coupled.

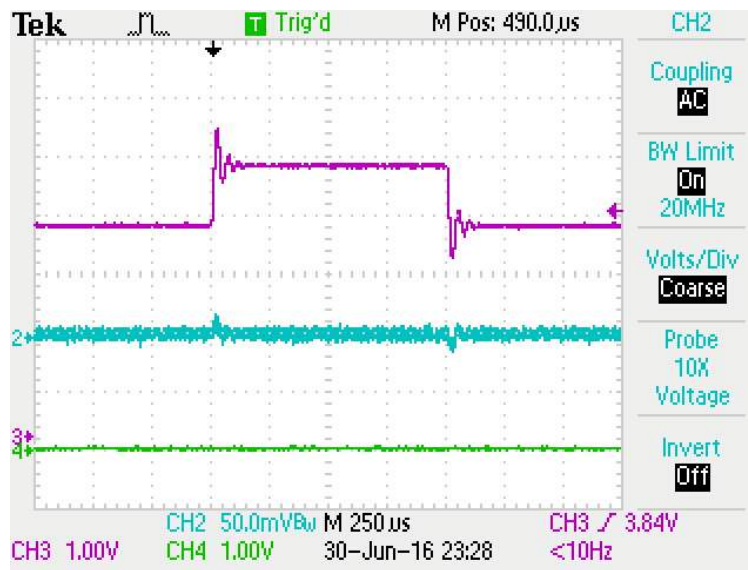


Figure 20. Line Transient Response: VOUT1

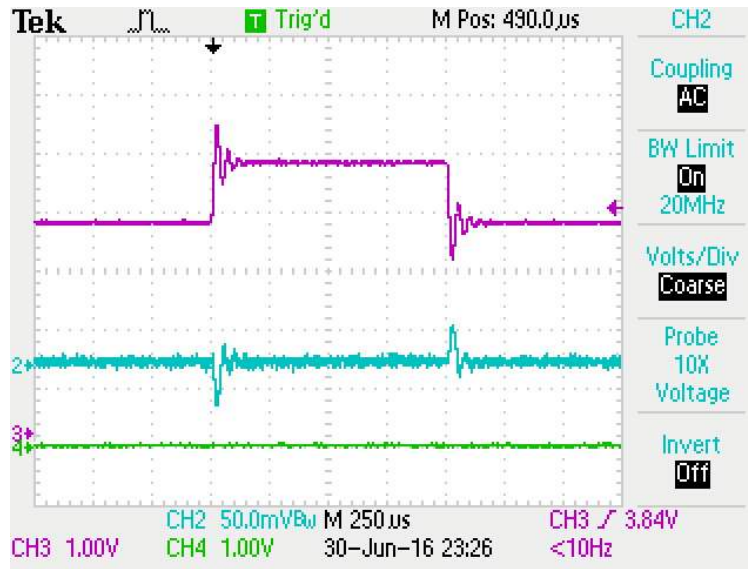


Figure 21. Line Transient Response: VOUT2

4 Related Documentation

[TPS62410-Q1, 2.25MHz 2x800mA Dual Step Down Converter In Small 3x3mm QFN Package](#) data sheet (SLVSAA8)

Revision History

DATE	REVISION	NOTES
October 2016	*	Initial Release

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
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 - 2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
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 - 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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.
3. *Regulatory Notices:*
 - 3.1 *United States*
 - 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.

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

Concerning EVMs Including Radio Transmitters:

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.

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.

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

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

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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