

# LM5160 Fly-Buck (Isolated Buck) User's Guide

## User's Guide



Literature Number: SNVU408A  
October 2014–Revised February 2015

<b>1</b>	<b>Introduction</b> .....	<b>4</b>
<b>2</b>	<b>Background</b> .....	<b>4</b>
<b>3</b>	<b>Setup</b> .....	<b>4</b>
	3.1 Input/Output Connector Description .....	4
	3.2 Operation.....	5
<b>4</b>	<b>Board Layout</b> .....	<b>5</b>
<b>5</b>	<b>Schematic</b> .....	<b>6</b>
<b>6</b>	<b>Bill of Materials</b> .....	<b>7</b>
<b>7</b>	<b>Performance Curves with LM5160</b> .....	<b>9</b>
	<b>Revision History</b> .....	<b>11</b>

## List of Figures

1	Top Assembly Layer.....	5
2	Top Copper .....	5
3	Bottom Copper .....	6
4	LM5160 Fly-Buck EVM Schematic .....	6
5	Fly-Buck Schematic with LM5160A .....	7
6	Line and Load Regulation .....	9
7	Efficiency vs $I_{OUT2}$ with Default Board Configuration .....	9
8	Efficiency vs $I_{OUT2}$ with Alternate Configuration.....	9
9	Load Transient at $V_{IN} = 24\text{ V}$ $I_{OUT2} = 100\text{ mA}$ to $300\text{ mA}$ .....	9
10	$V_{IN}$ Startup Waveform at $I_{OUT2} = 200\text{ mA}$ and $I_{OUT1} = 0\text{ A}$ .....	9
11	Primary Switch Node at $V_{IN} = 24\text{ V}$ and $I_{OUT2} = 200\text{ mA}$ .....	9
12	Secondary-side Short at $I_{OUT2} = 600\text{ mA}$ and $I_{OUT1} = 200\text{ mA}$ (Tx: Würth Elektronik #: 744873220).....	10

## List of Tables

1	Default Board Specification with LM5160 .....	4
2	Alternate Configuration with LM5160 .....	4
3	LM5160DNTFBKEVM Bill of Materials for 300 kHz Configuration .....	7
4	Bill of Materials for Alternate Configuration .....	8

# LM5160 User's Guide

---



---



---

## 1 Introduction

The LM5160NDNTFBKEVM evaluation module (EVM) helps designers evaluate the operation and performance of the LM5160 in the Fly-Buck™ (isolated buck) configuration. The Fly-Buck topology is derived from the synchronous buck topology by replacing the buck inductor with a coupled inductor (transformer) to produce both primary (non-isolated) and secondary (isolated) outputs. This user guide details the specification of the EVM and includes complete application schematic, bill of materials (BOM), setup instructions, and performance curves. The LM5160 device name is used generically throughout this document and represents both the LM5160 and LM5160A unless stated otherwise. The only difference between the two is the ability to connect an external voltage source to the VCC pin of the LM5160A.

## 2 Background

The application schematic is designed to operate from a 24 V nominal bus with the input voltage ranging from 18 V to 32 V. It is capable of supplying 12 V with the secondary load rated to 400 mA at the isolated output. The nominal switching frequency is 300 kHz. The high side and low side MOSFETs are integrated in the LM5160 and LM5160A. The EVM is designed to demonstrate a small solution size in the WSON-12 lead-less package for low power isolated bias applications.

**Table 1. Default Board Specification with LM5160**

INPUT	FREQUENCY	VOUT1	ISOLATED $V_{OUT}$	$I_{OUT}$
VIN = 18 V – 32 V	300 kHz	8 V	12 V	0 – 400 mA

The EVM can also be arranged with an alternate configuration shown in [Table 2](#) using some simple modifications. The changes in the BOM for the alternate configuration is shown in [Table 4](#). This configuration is optimized for lower power, high efficiency application.

**Table 2. Alternate Configuration with LM5160**

INPUT	FREQUENCY	VOUT1	ISOLATED $V_{OUT}$	$I_{OUT}$
VIN = 18 V – 32 V	160 kHz	10 V	15 V	0-200 mA

## 3 Setup

This section describes the connectors and test-points on the EVM as well as how to properly connect, setup and use the LM5160DNTFBKEVM with the LM5160.

### 3.1 Input/Output Connector Description

**J1 – Output** is the isolated output voltage for the converter. The terminal block provides  $V_{OUTISO}$  (+) and isolated ground (-) connection to allow the user to attach the EVM to a load.

**J2 – Output** is the primary non-isolated regulated output voltage for the converter. The terminal block provides VOUT1 (+) and ground (-) connection to allow the user to attach the EVM to a load.

**J3 – Input** is the power input terminal for the converter. The terminal block provides input  $V_{IN}$ (+) and ground (-) connections to allow the user to attach the EVM to a power supply.

**TP1 – (SW1)** allows the user to connect a scope probe to observe the primary side switching node of the converter.

### 3.2 Operation

For proper operation of the Fly-Buck converter, gradually increase the input voltage applied across J3. The load on the secondary output (**J1**) with primary output (**J2**) unloaded, should not exceed 400 mA which corresponds to 30 Ω. If the primary is loaded, the combined load on the two outputs should not exceed 600 mA. The coupled inductor (transformer) **T1** utilized in this board is optimized for small solution size and is not rated for the peak current limit of LM5160. If short circuit protection is required, **T1** should be replaced with a coupled inductor (flyback transformer) with primary side saturation current rating greater than the peak current limit of LM5160.

When the input voltage exceeds approximately 18 V, the primary and secondary outputs (**J2** and **J1**) power up to approximately 8 V and 12 V respectively.

The frequency of operation is set using the  $R_{ON}$  resistor (R7)

$$f_{SW} = \frac{V_{OUT1}}{1 \times 10^{-10} \times R_{ON}} \quad (1)$$

The primary output voltage can be set with the feedback divider resistors R8 and R9, using the following equation:

$$V_{OUT1} = \left(1 + \frac{R8}{R9}\right) \times 2 \text{ V} \quad (2)$$

The secondary output is related to the primary output voltage by the transformer turns ratio:

$$V_{OUTISO} = V_{OUT1} \times \frac{N2}{N1} - V_F \quad (3)$$

where  $N2/N1$  is the turns ratio and  $V_F$  is the forward voltage drop of the secondary rectifier diode. There is some additional drop because of the leakage inductance and resistance of windings.

## 4 Board Layout

Figure 1, Figure 2, and Figure 3 show the board layout for the LM5160DNTFBKVM PCB. The WSON package offers an exposed thermal pad for enhanced thermal performance. The IC must be soldered properly to the copper landing on the PCB for optimal performance. The EVM is a two layer board.

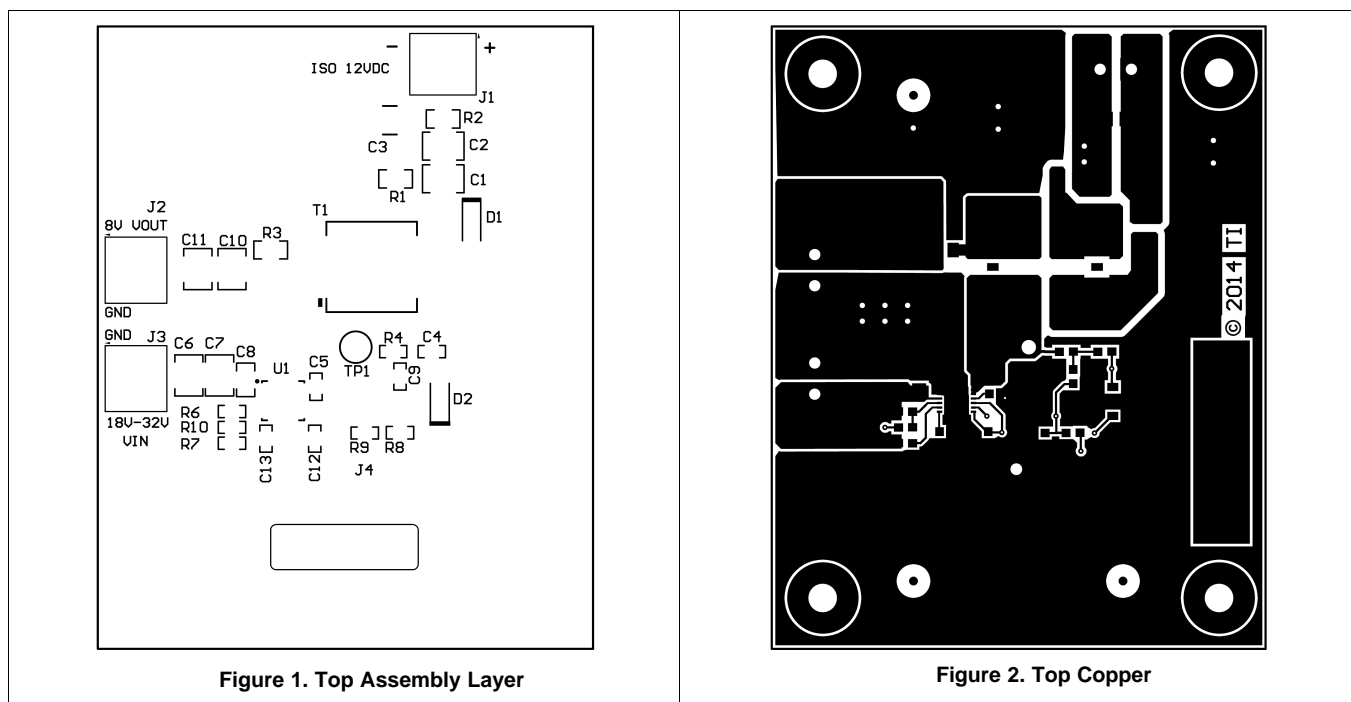


Figure 1. Top Assembly Layer

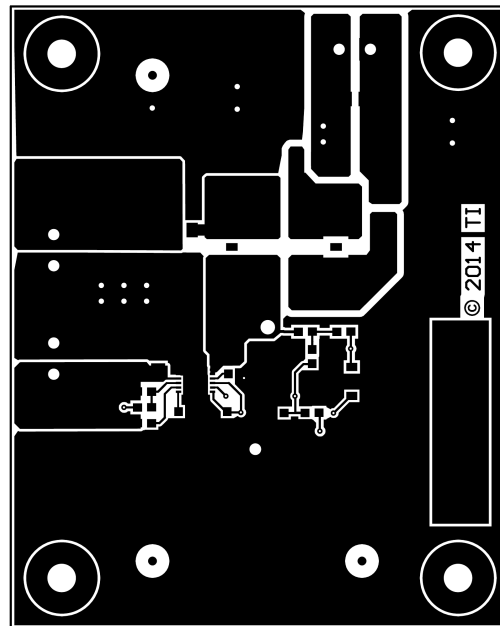


Figure 2. Top Copper

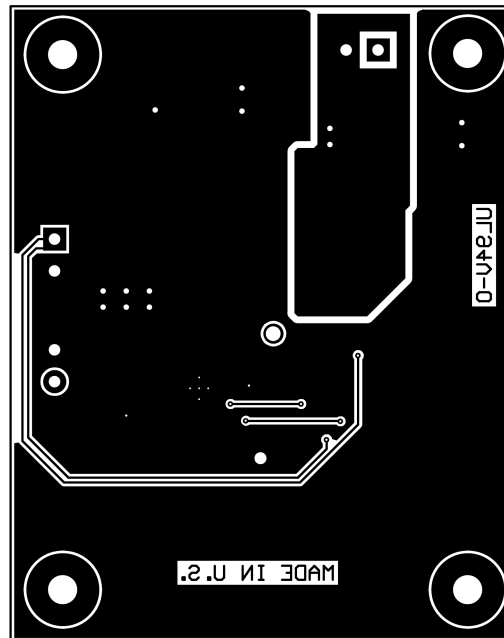


Figure 3. Bottom Copper

## 5 Schematic

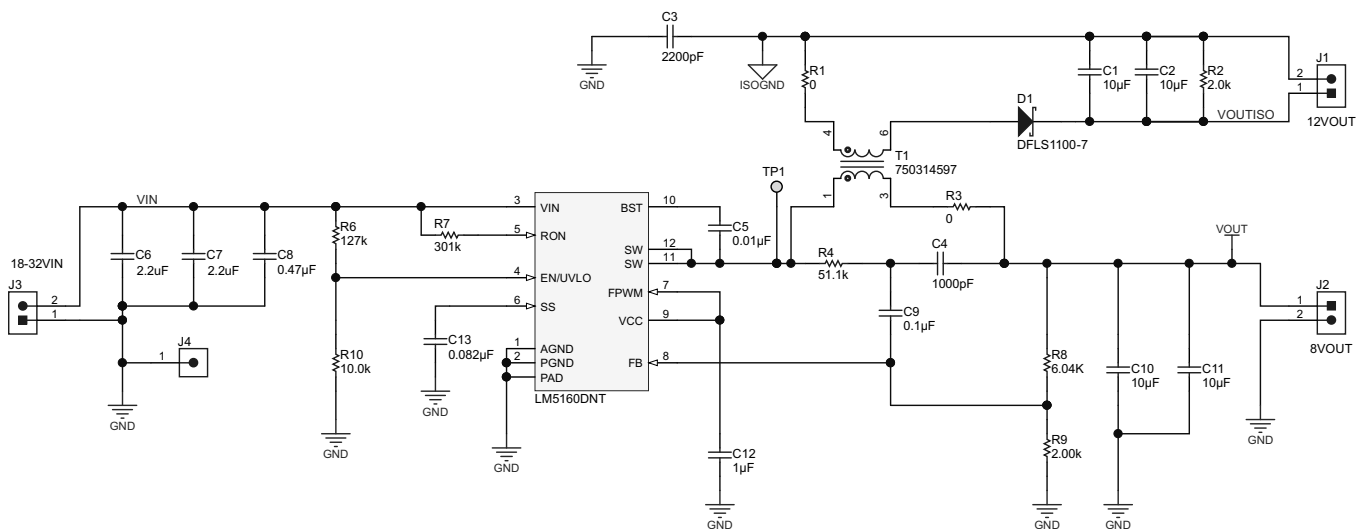
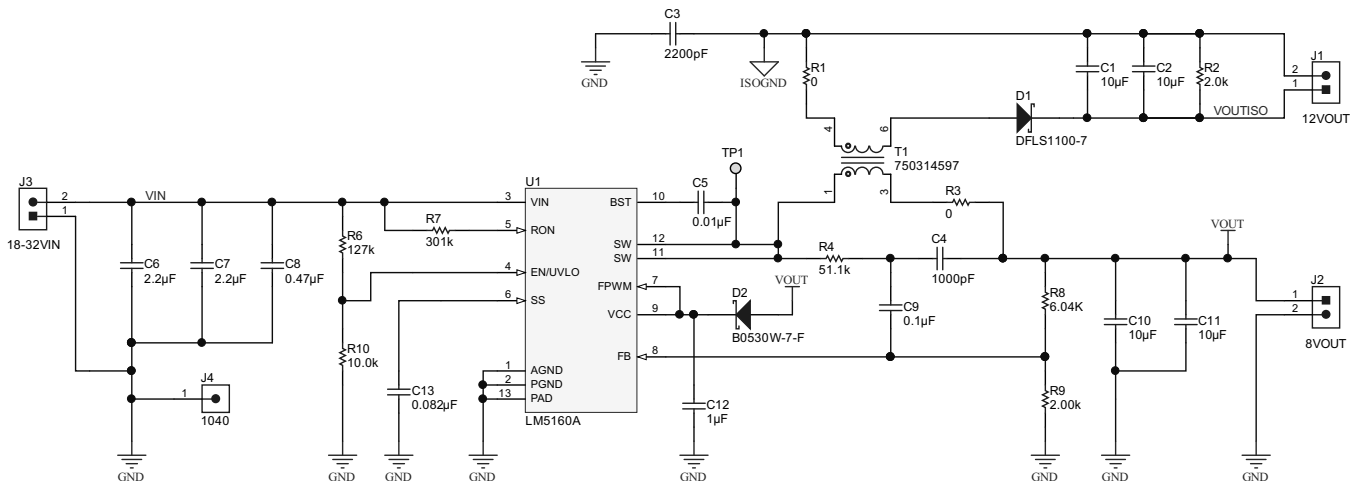


Figure 4. LM5160 Fly-Buck EVM Schematic

Figure 5 below shows the Fly-buck configuration using LM5160A with the VCC being powered from the VOUT (8VOUT, Primary) through diode D2 for improved efficiency requirements. When evaluating the LM5160A, the designer can use the standard LM5160DNTFBKEVM by simply replacing the LM5160 IC with the LM5160A. No other components on board need to be replaced or removed. In the standard EVM, when used with the LM5160, the placeholder for diode D2, as given in Figure 1, must remain unpopulated under all cases. For more information about the difference between the LM5160A and the LM5160, please refer to the LM5160 Datasheet ([SNVSA03](#)).


**Figure 5. Fly-Buck Schematic with LM5160A**

## 6 Bill of Materials

**Table 3. LM5160DNTFBKEVM Bill of Materials for 300 kHz Configuration**

COUNT	REF DES	DESCRIPTION	SIZE	MFR	PART NUMBER
4	C1, C2, C10, C11	CAP, CERM, 10 µF, 35 V, ±10%, X7R,	1210	MuRata	GRM32ER7YA106KA12L
1	C3	CAP, CERM, 2200 pF, 2000 V, ±10%, X7R	1812	TDK	C4532X7R3D222K
1	C4	CAP, CERM, 1000 pF, 16 V, ±10%, X7R	603	MuRata	GRM188R71C102KA01D
1	C5	CAP, CERM, 0.01 µF, 16 V, ±10%, X7R	603	MuRata	GRM188R71C103KA01D
2	C6, C7	CAP, CERM, 2.2 µF, 100 V, X7R, 10%	1210	Murata	GRM32ER72A225KA35K
1	C8	CAP, CERM, 0.47 µF, 100 V, ±10%, X7R	805	MuRata	GRM21BR72A474KA73L
1	C9	CAP, CERM, 0.1 µF, 25 V, ±5%, X7R	603	AVX	06033C104JAT2A
1	C12	CAP, CERM, 1 µF, 16 V, ±10%, X7R	603	TDK	C1608X7R1C105K
1	C13	CAP, CERM, 0.082 µF, 16 V, ±10%, X7R	603	MuRata	GRM188R71C823KA01D
1	D1	Diode, Schottky, 100 V, 1 A	PowerDI123	Diodes Inc.	DFLS1100-7
1	D2	Diode, Schottky, 30 V, 0.5 A (LM5160A only)	SOD-123	Diodes Inc.	B0530W-7-F(Unpopulated)
3	J1, J2, J3	Terminal Block, 6 A, 3.5 mm Pitch, 2-Pos, TH	7.0x8.2x6.5 mm	On-Shore Technology	ED555/2DS
2	R1, R3	RES, 0 Ω, 5%, 0.125 W	805	Vishay-Dale	CRCW08050000Z0EA
1	R2	RES, 2.0 kΩ, 5%, 0.125 W	805	Vishay-Dale	CRCW08052K00JNEA
1	R4	RES, 51.1 kΩ, 1%, 0.1 W	603	Yageo	RC0603FR-0751K1L
1	R6	RES, 127 kΩ, 1%, 0.1 W	603	Yageo	RC0603FR-07127KL
1	R7	RES, 301 kΩ, 1%, 0.1 W	603	Vishay-Dale	CRCW0603301KFKEA
1	R8	RES, 6.04 kΩ, 1%, 0.1 W	603	Vishay-Dale	CRCW06036K04FKEA
1	R9	RES, 2.00 kΩ, 1%, 0.1 W	603	Vishay-Dale	CRCW06032K00FKEA
1	R10	RES, 10.0 kΩ, 1%, 0.1 W	603	Vishay-Dale	CRCW060310K0FKEA
1	T1	Transformer, 60 µH, SMT, 0.840 A	13.36x8.64x10.16 mm	Würth Elektronik	750314597
1	TP1	Test Point, Multipurpose, Yellow, TH	Testpoint	Keystone	5014
1	U1	IC, PWM, COT Regulator	DNT0012B	Texas Instruments	LM5160DNT

**Table 4. Bill of Materials for Alternate Configuration**

COUNT	REF DES	DESCRIPTION	SIZE	MFR	PART NUMBER
4	C1, C2, C10, C11	CAP, CERM, 10 $\mu$ F, 35 V, $\pm$ 10%, X7R,	1210	MuRata	GRM32ER7YA106KA12L
1	C3	CAP, CERM, 2200 pF, 2000 V, $\pm$ 10%, X7R	1812	TDK	C4532X7R3D222K
1	C4	CAP, CERM, 1000 pF, 16 V, $\pm$ 10%, X7R	603	MuRata	GRM188R71C102KA01D
1	C5	CAP, CERM, 0.01 $\mu$ F, 16 V, $\pm$ 10%, X7R	603	MuRata	GRM188R71C103KA01D
2	C6, C7	CAP, CERM, 2.2 $\mu$ F, 100 V, X7R, 10%	1210	Murata	GRM32ER72A225KA35K
1	R8	RES, 8.2 k $\Omega$ , 1%, 0.1 W, 0603	603	Standard	Standard
1	R7	RES, 698 k $\Omega$ , 1%, 0.1 W, 0603	603	Standard	Standard
1	C4	CAP, CERM, 3300 pF, 16 V, $\pm$ 10%, X7R	603	Standard	Standard
1	R2	RES, 5.1 k $\Omega$ , 5%, 0.125 W	805	Standard	Standard
1	D1	Diode, Schottky, 60 V, 1A	PowerDI123	Diodes Inc.	DFLS160-7
1	C8	CAP, CERM, 0.47 $\mu$ F, 100 V, $\pm$ 10%, X7R	805	MuRata	GRM21BR72A474KA73L
1	C9	CAP, CERM, 0.1 $\mu$ F, 25 V, $\pm$ 5%, X7R	603	AVX	06033C104JAT2A
1	C12	CAP, CERM, 1 $\mu$ F, 16 V, $\pm$ 10%, X7R	603	TDK	C1608X7R1C105K
1	C13	CAP, CERM, 0.082 $\mu$ F, 16 V, $\pm$ 10%, X7R	603	MuRata	GRM188R71C823KA01D
1	D1	Diode, Schottky, 100 V, 1 A	PowerDI123	Diodes Inc.	DFLS1100-7
1	D2	Diode, Schottky, 30 V, 0.5 A (LM5160A only)	SOD-123	Diodes Inc.	B0530W-7-F(Unpopulated)
3	J1, J2, J3	Terminal Block, 6 A, 3.5 mm Pitch, 2-Pos, TH	7.0x8.2x6.5 mm	On-Shore Technology	ED555/2DS
2	R1, R3	RES, 0 $\Omega$ , 5%, 0.125 W	805	Vishay-Dale	CRCW08050000Z0EA
1	R4	RES, 51.1 k $\Omega$ , 1%, 0.1 W	603	Yageo	RC0603FR-0751K1L
1	R6	RES, 127 k $\Omega$ , 1%, 0.1 W	603	Yageo	RC0603FR-07127KL
1	R7	RES, 301 k $\Omega$ , 1%, 0.1 W	603	Vishay-Dale	CRCW0603301KFKEA
1	R9	RES, 2.00 k $\Omega$ , 1%, 0.1 W	603	Vishay-Dale	CRCW06032K00FKEA
1	R10	RES, 10.0 k $\Omega$ , 1%, 0.1 W	603	Vishay-Dale	CRCW060310K0FKEA
1	T1	Transformer, 60 $\mu$ H, SMT, 0.840 A	13.36x8.64x10.16 mm	Würth Elektronik	750314597
1	TP1	Test Point, Multipurpose, Yellow, TH	Testpoint	Keystone	5014
1	U1	IC, PWM, COT Regulator	DNT0012B	Texas Instruments	LM5160DNT



7 Performance Curves with LM5160

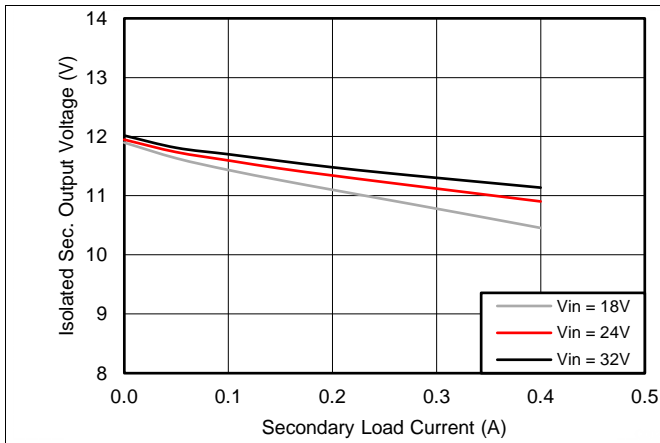


Figure 6. Line and Load Regulation

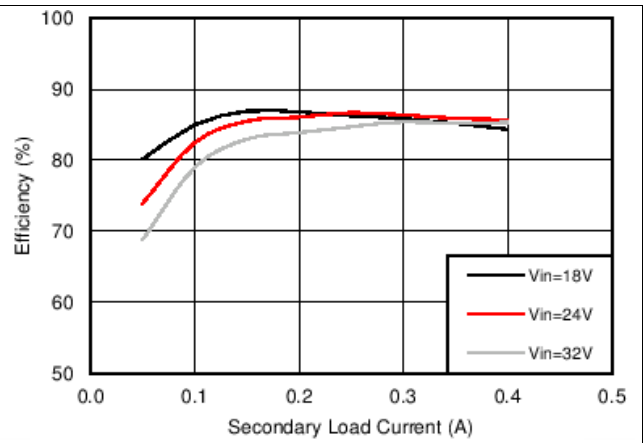


Figure 7. Efficiency vs  $I_{OUT2}$  with Default Board Configuration

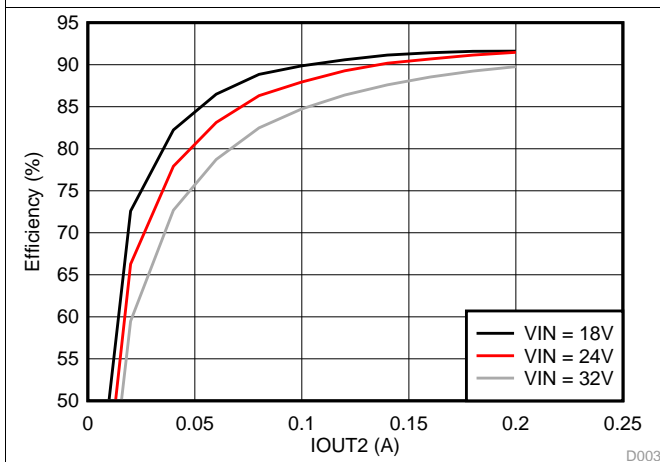


Figure 8. Efficiency vs  $I_{OUT2}$  with Alternate Configuration

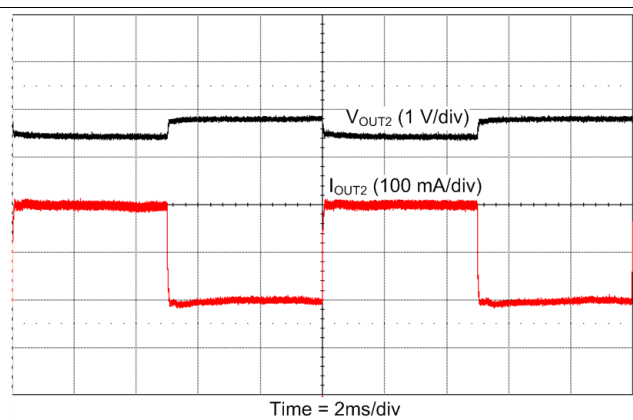


Figure 9. Load Transient at  $V_{IN} = 24 V$   
 $I_{OUT2} = 100 mA$  to  $300 mA$

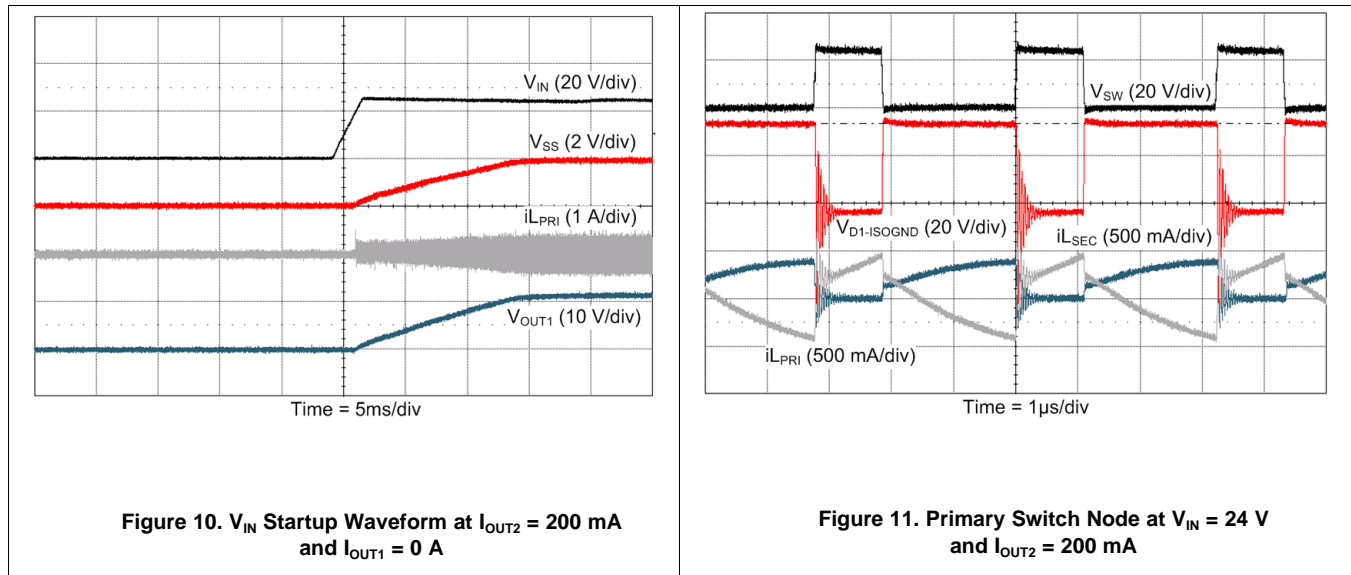


Figure 10.  $V_{IN}$  Startup Waveform at  $I_{OUT2} = 200\text{ mA}$  and  $I_{OUT1} = 0\text{ A}$

Figure 11. Primary Switch Node at  $V_{IN} = 24\text{ V}$  and  $I_{OUT2} = 200\text{ mA}$

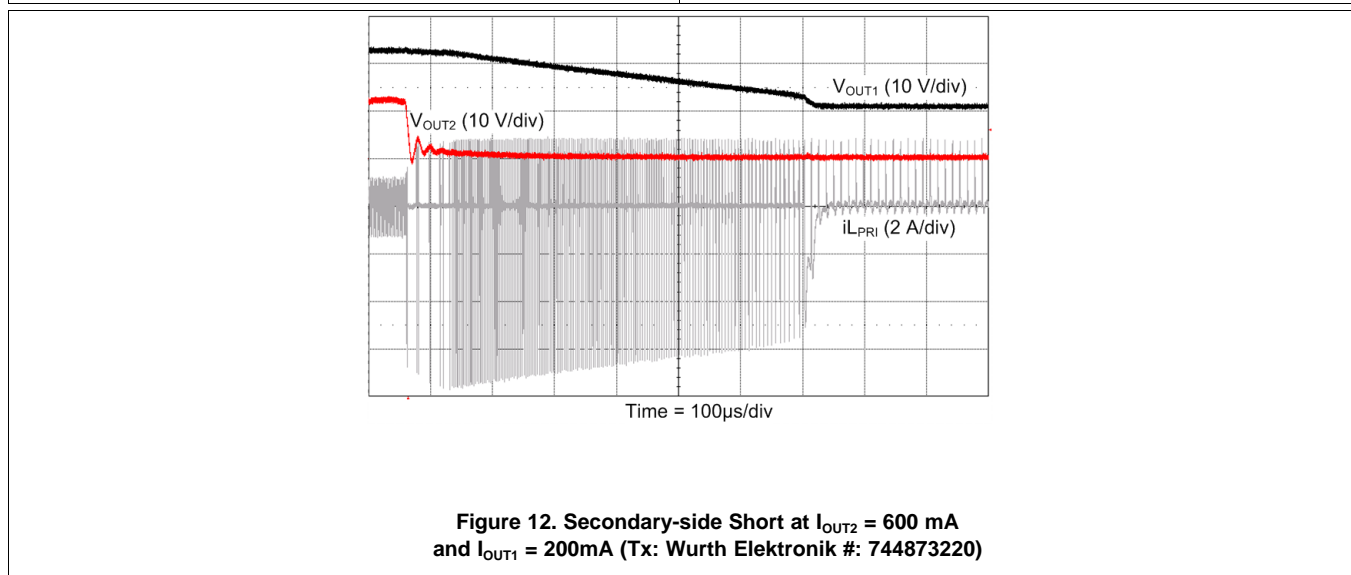


Figure 12. Secondary-side Short at  $I_{OUT2} = 600\text{ mA}$  and  $I_{OUT1} = 200\text{ mA}$  (Tx: Würth Elektronik #: 744873220)

---

## Revision History

<b>Changes from Original (October 2014) to A Revision</b>	<b>Page</b>
• Added LM5160A to Background .....	4
• Added new paragraph for LM5160A .....	6
• Added D2 Schottky Diode information to Bill of Materials .....	7
• Added D2 Schottky Diode information to Bill of Materials for Alternate Configuration .....	8

---

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

## STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (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 semiconductor 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.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 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.
  - 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
  - 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.

### 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 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/llds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/llds/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。[http://www.tij.co.jp/llds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page)

#### 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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL 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 HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS AND CONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)