TPS62065/67EVM

This user's guide describes the characteristics, operation, and use of the TPS62065-67EVM-347 evaluation module (EVM). The TPS62065-67EVM-347 is a fully assembled and tested platform for evaluating the performance of both the TPS62065 and TPS62067 2-A step-down converters. This document includes schematic diagrams, printed circuit board (PCB) layout, bill of materials, and test data. Throughout this document, the abbreviations *EVM*, *TPS62065/67EVM*, and the term *evaluation module* are synonymous with the TPS62065-67EVM-347 unless otherwise noted.

Contents

1 Introduction 2
2 Electrical Performance Specifications 2
3 TPS62056/67EVM Schematic 3
4 Connector and Test Point Descriptions 4
5 Test Configuration 6
6 TPS62065/67EVM Test Data 8
7 TPS62065/67EVM-347 Assembly Drawings and Layout 12
8 Bill of Materials 18

List of Figures

1 TPS62065EVM Schematic 3
2 TPS62067EVM Schematic 3
3 Hardware Board Connection 6
4 TPS62065, TPS62067 Efficiency vs Load Current 8
5 TPS62065 Startup into 2.2-Ω Load 8
6 TPS62067 Startup into 2.2-Ω Load 9
7 TPS62067 Shutdown: No Load 9
8 TPS62065 Output Voltage Ripple (PFM Mode) 10
9 TPS62065 Output Voltage Ripple (PWM Mode) 10
10 TPS62065 Gain and Phase vs Frequency 11
11 TPS62065 Gain and Phase vs Frequency 11
12 TPS62065/67EVM Component Placement (Top View) 13
13 TPS62065/67EVM Top-Side Copper (Top View) 14
14 TPS62065/67EVM Internal Layer 1 (X-Ray View, from Top) 15
15 TPS62065/67EVM Internal Layer 2 (X-Ray View, from Top) 16
16 TPS62065/67EVM Bottom-Side Copper (Bottom View) 17

List of Tables

1 TPS62065/67EVM Performance Characteristics 2
2 TPS62065/67EVM Bill of Materials 18

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1 Introduction

The TPS62065-67EVM-347 is a fully assembled and tested pair of PCBs for evaluating the TPS62065 and TPS62067 2-A step-down converters. The EVM comes configured with both a TPS62065 IC and a TPS62067 IC; there are two PCBs, one for each respective step-down converter IC.

1.1 Features

- Input voltage range: 2.9 V to 6.0 V
- Adjustable output voltage: 0.8 V to VIN
- Up to 2.0-A output current
- 3-MHz switching frequency
- Power Good output (TPS62067EVM only)
- Clock dithering

1.2 TPS62065/67 Applications

The TPS62065 and TPS62067 step-down converters are ideal for these applications:

- POL
- Digital cameras
- PDAs, pocket PCs
- Portable media players
- DSP supply

2 Electrical Performance Specifications

Table 1 summarizes the TPS62065/67EVM performance specifications.

Table 1. TPS62065/67EVM Performance Characteristics

Parameter	Symbol	Notes and Conditions	Min	Typ	Max	Units
Input Characteristics						
Input Voltage	VIN		2.9	3.6	6.0	V
Input Undervoltage Lockout (UVLO)	V_{IN_UVLO}	Falling	1.73	1.78	1.83	V
		Rising	1.9	1.95	1.99	V
Output Characteristics						
Line Regulation				0		%/V
Load Regulation				–0.5		%/A
Output Current	I_{OUT}				2000	mA
Forward Current Limit High-Side and Low Side MOSFET	I_{LIMF}		2300	2750	3300	mA
System Characteristics						
Switching Frequency	f_{SW}		2600	3000	3400	kHz
Peak Efficiency	η_{pk}			95%		
Full Load Efficiency	η	VIN = 5.0 V, VOUT = 1.8 V I_{OUT} = 2,000 mA		82%		

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3 TPS62056/67EVM Schematic

Figure 1 shows the TPS62065EVM schematic. Figure 2 illustrates the TPS62067EVM schematic.

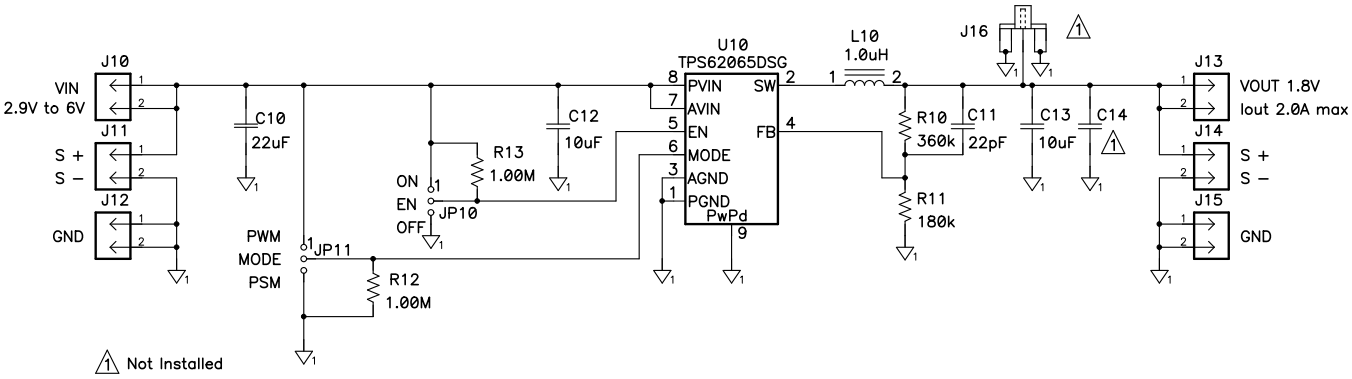


Figure 1. TPS62065EVM Schematic

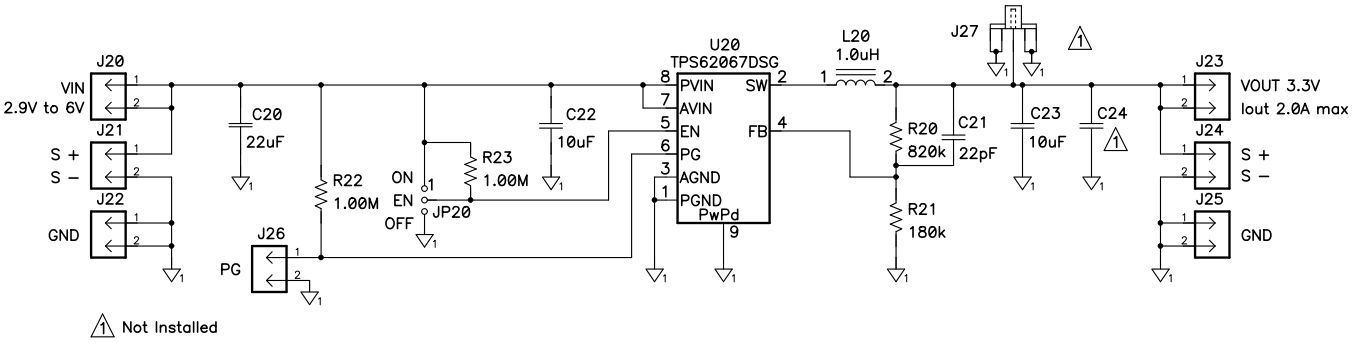


Figure 2. TPS62067EVM Schematic

NOTE: These diagrams are provided for reference only. See Table 2, the Bill of Materials, for specific component values.

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4 Connector and Test Point Descriptions

4.1 Enable Jumpers/Switches: TPS62065EVM

4.1.1 J10 VIN

This header is the positive connection to the input power supply. The power supply must be connected between J10 and J12 (GND). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 2.9 V and 6.0 V.

4.1.2 J11 S+/S–

J11 S+/S– are the sense connections for the input of the converter. Connect a voltmeter, or the sense connection of a power supply or oscilloscope, to this header.

4.1.3 J12 GND

This header is the return connection to the input power supply. Connect the power supply between J12 and J10 (VIN). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 2.9 V and 6.0 V.

4.1.4 J13 VOUT

This header is the positive output of the step-down converter. The output voltage of the TPS62065 is adjustable with feedback resistors R10 and R11. On the EVM, the output voltage is set to 1.8 V by default.

NOTE: A feed-forward capacitor is required. Refer to the TPS6206x data sheet (SLVS833) for detailed information.

4.1.5 J14 S+/S–

J14 S+/S– are the sense connections for the output of the converter. Connect a voltmeter, or the sense connection of an electronic load or oscilloscope, to this header.

4.1.6 J15 GND

J15 is the return connection of the converter. A load can be connected between J15 and J13 (V_{OUT}). The converter is capable of carrying a load current up to 2000 mA.

4.1.7 JP10 EN

This jumper enables/disables the TPS62065 on the EVM. Shorting jumper JP10 between the center pin and *On* turns on the unit. Shorting the jumper between center pin and *Off* turns the unit off. A 1-MΩ pull-up resistor is connected between VIN and EN. Removing jumper JP10 turns on the converter.

4.1.8 JP11 MODE

This jumper enables/disables the power-saving mode under light loads. Shorting jumper JP11 between the center pin and PWM disables the power-saving mode; If the power save mode is disabled, the converter operates in forced PWM mode over the entire load current range. Shorting the jumper between the center pin and PSM enables the power-saving mode. The device operates in power-saving mode under light load conditions. See the TPS6206x data sheet (SLVS833) for a detailed description of this configuration. A 1-MΩ pulldown resistor is connected between GND and MODE. By removing JP11, the converter operates in power-saving mode under light load conditions.

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4.1.9 J16 VOUT (SMA)

This SMA connector is connected to the output voltage of the TPS62065. It can be used to easily analyze the noise spectrum of the output voltage with a spectrum analyzer. By default, J16 is not assembled on the EVM.

4.2 Enable Jumpers/Switches: TPS62067EVM

4.2.1 J20 VIN

This header is the positive connection to the input power supply. The power supply must be connected between J20 and J22 (GND). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 2.9 V and 6.0 V.

4.2.2 J21 S+/S–

J21 S+/S– are the sense connections for the converter input. Connect a voltmeter, or the sense connection of a power supply or an oscilloscope, to this header.

4.2.3 J22 GND

This header is the return connection to the input power supply. Connect the power supply between J22 and J20 (VIN). The leads to the input supply should be twisted and kept as short as possible. The input voltage must be between 2.9 V and 6.0 V.

4.2.4 J23 VOUT

This header is the positive output of the step-down converter. The output voltage of the TPS62067 is adjustable with the feedback resistors R20 and R21. On the EVM, the output voltage is set to 3.3 V by default.

NOTE: There is a feed-forward capacitor required. Refer to the TPS6206x data sheet (SLVS833) for detailed information.

4.2.5 J24 S+/S–

J24 S+/S– are the sense connections for the converter output. Connect a voltmeter, or the sense connection of an electronic load or an oscilloscope, to this header.

4.2.6 J25 GND

J25 is the return connection of the converter. A load can be connected between J25 and J23 (V_{OUT}). The converter is capable of a load up to 2000 mA load current.

4.2.7 J26 PG

PG (Power Good) is an open-drain output. A 1-MΩ pull-up resistor is connected between VIN and PG. This circuit is active once the device is enabled. It is driven by an internal comparatir that is connected to the FB voltage. The PG output provides a high-level output once the FB voltage reaches 95% of its nominal value. The PG output provides a low-level output when the FB voltage falls below 90% of its nominal value.

NOTE: This function is only available on the TPS62067EVM.

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4.2.8 JP20 EN

This jumper enables/disables the TPS62067 device on the EVM. Shorting jumper JP20 between the center pin and *On* turns on the unit. Shorting the jumper between center pin and *Off* turns the unit off. A 1-MΩ pull-up resistor is connected between VIN and EN. Removing jumper JP20 also turns on the converter.

4.2.9 J27 VOUT (SMA)

This SMA connector is connected to the output voltage of the TPS62067. It can be used to easily analyze the noise spectrum of the output voltage with a spectrum analyzer. By default, J27 is not assembled on the EVM.

5 Test Configuration

5.1 Hardware Setup

Figure 3 illustrates a typical hardware test configuration.

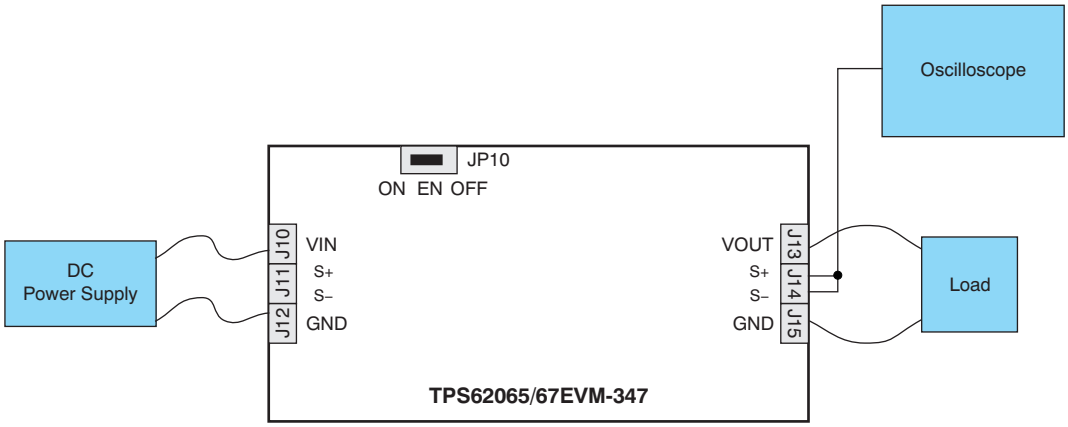


Figure 3. Hardware Board Connection

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5.2 Testing Procedure

Follow these procedures when configuring the EVM for testing.

CAUTION

Many of the components on the TPS62065/67EVM-347 are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap, bootstraps, or mats at an approved ESD workstation. An electrostatic smock and safety glasses should also be worn.

1. Connect a dc power supply between J10 and J12 on the TPS62065EVM, or J20 and J22 on the TPS62067EVM. Please note that the input voltage should be between 2.9 V and 6.0 V. Keep the wires from the input power supply to the EVM as short as possible and twisted.
2. Connect a dc voltmeter or oscilloscope to the output sense connection of the EVM (J14 on the TPS62065EVM, J24 on the TPS62067EVM).
3. A load can be connected between J13 and J15 on the TPS62065EVM, or J23 and J25 on the TPS62067EVM.
4. To enable the converter, connect the shorting bar on JP10 (JP20) between EN and ON on the TPS62065EVM (TPS62067EVM).
5. The TPS62065EVM has a feature to allow the user to switch between Power-Save Mode under light loads and forced PWM mode; this feature is enabled or disabled with jumper JP11. This feature is only available on the TPS62065EVM.
6. The TPS62067EVM has a PG (Power Good) output. The PG pin on the TPS62067 is connected to J26. PG is an open-drain output. The output is pulled up with a 1-MΩ pull-up resistor (R22) to VIN. This feature is only available on the TPS62067EVM.

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6 TPS62065/67EVM Test Data

Figure 4 through Figure 11 present typical performance curves for the TPS62065/67EVM. Actual performance data can be affected by measurement techniques and environmental variables; therefore, these curves are presented for reference and may differ from actual results obtained by some users.

Efficiency

Figure 4 shows the typical efficiency performance for the TPS62065 and TPS62067.

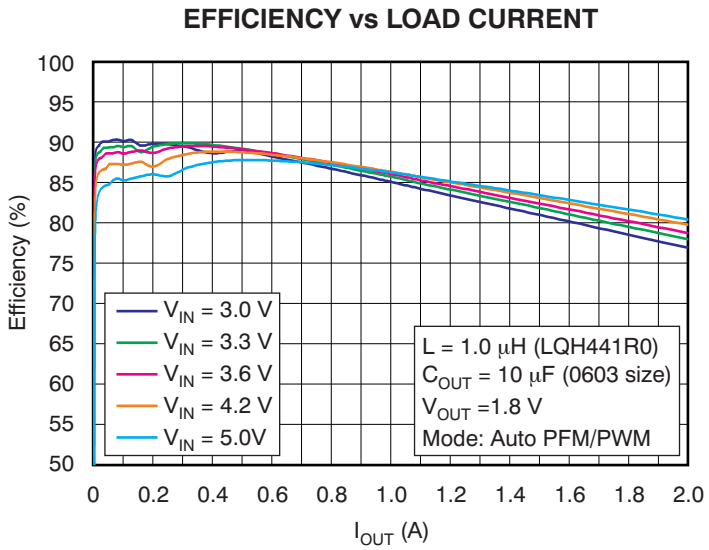


Figure 4. TPS62065, TPS62067 Efficiency vs Load Current

6.1 Start-up: TPS62065

Figure 5 shows the typical start-up performance for the TPS62065 using the TPS62065EVM.

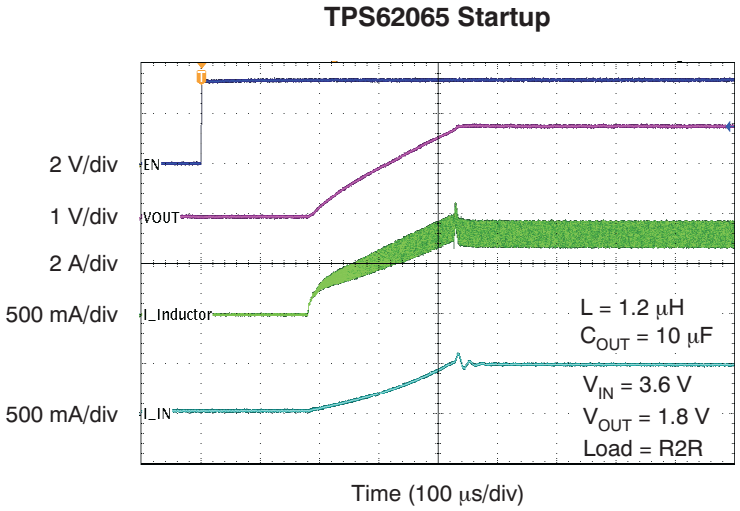


Figure 5. TPS62065 Startup into 2.2-Ω Load

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6.2 Start-up and Shutdown: TPS62067

Figure 6 and Figure 7 illustrate the typical start-up and shutdown behavior, respectively, for the TPS62067, using the TPS62067EVM.

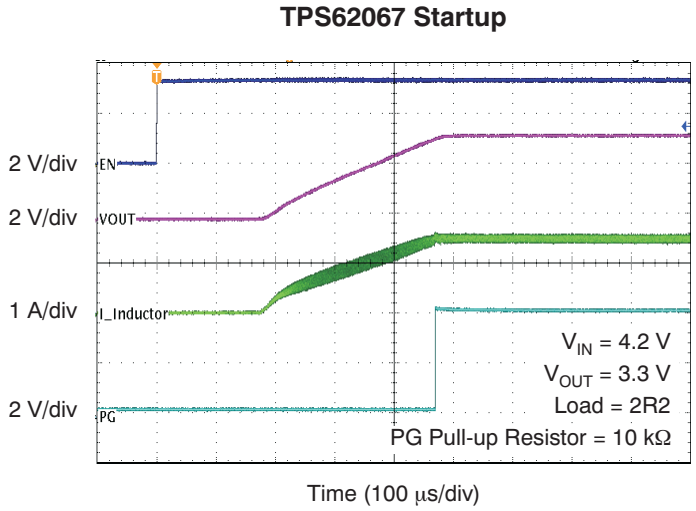


Figure 6. TPS62067 Startup into 2.2-Ω Load

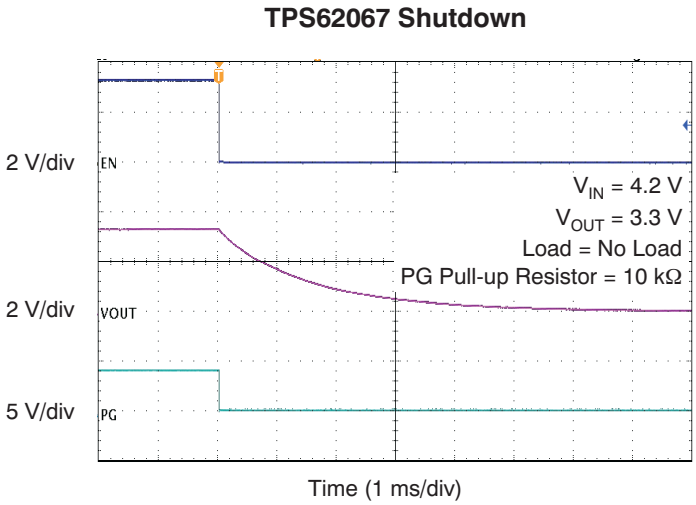


Figure 7. TPS62067 Shutdown: No Load

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6.3 Output Voltage Ripple

Figure 8 and Figure 9 show the typical output voltage ripple for the TPS62065 in PFM and PWM modes, respectively, with the TPS62065EVM.

TYPICAL OUTPUT VOLTAGE RIPPLE (PFM MODE)

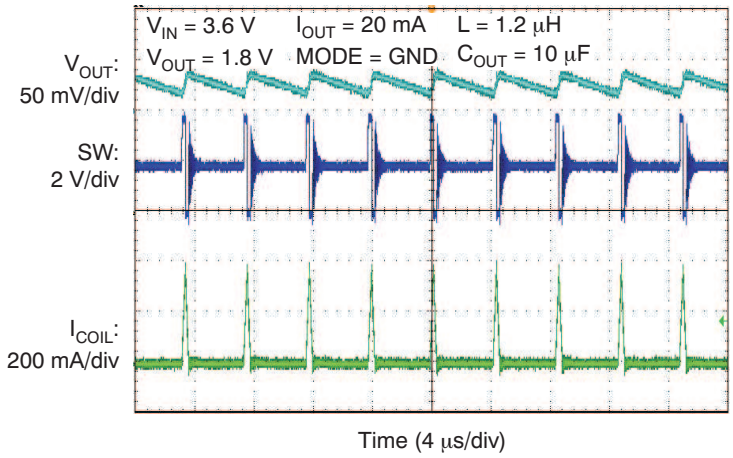


Figure 8. TPS62065 Output Voltage Ripple (PFM Mode)

TYPICAL OUTPUT VOLTAGE RIPPLE (PWM MODE)

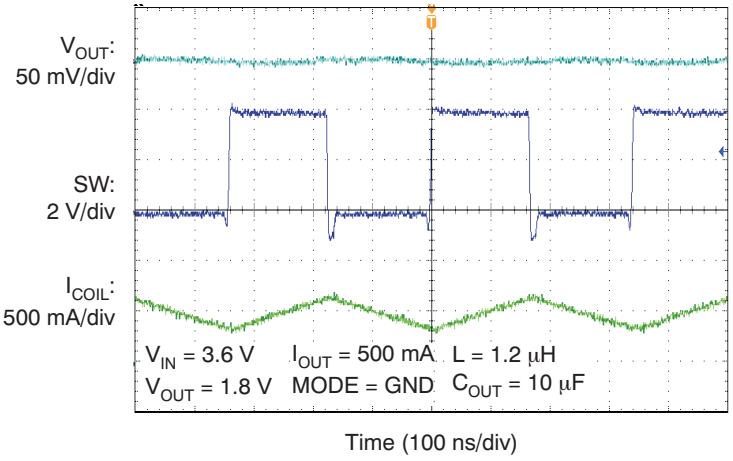
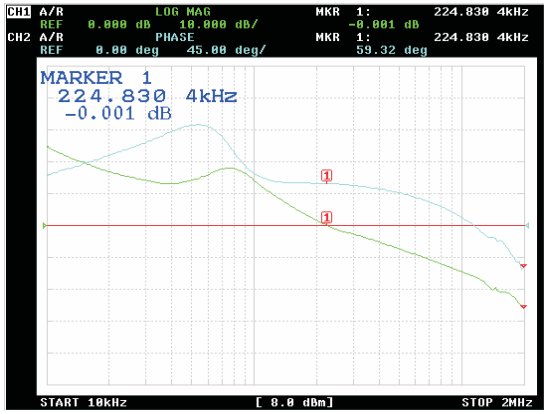


Figure 9. TPS62065 Output Voltage Ripple (PWM Mode)

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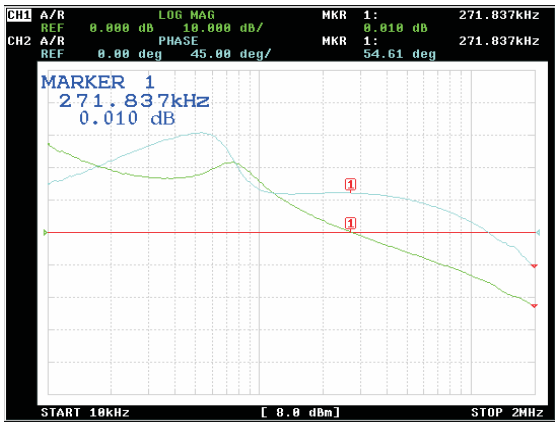
6.4 Control Loop Bode Diagrams: TPS62065

Figure 10 and Figure 11 illustrate typical TPS62065 gain and phase performance versus frequency at VIN = 3.6 V and 5.0 V, respectively, using the TPS62065EVM.



Conditions: VIN = 3.6 V, VOUT = 1.8 V, I_{OUT} = 1.6 A; bandwidth: 224 kHz, phase margin: 59°

Figure 10. TPS62065 Gain and Phase vs Frequency



Conditions: VIN = 5.0 V, VOUT = 1.8 V, I_{OUT} = 1.6 A; bandwidth: 271 kHz, phase margin: 54°

Figure 11. TPS62065 Gain and Phase vs Frequency

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7 TPS62065/67EVM-347 Assembly Drawings and Layout

Figure 12 through Figure 16 show the design of the TPS62065/67EVM-347 printed circuit boards. This EVM has been designed using a four-layer, 1-ounce copper-clad PCB (1.5" x 1.8") with all components in an active area on the top side of the board. All active traces to the top and bottom layers to allow the user to easily view, probe, and evaluate the TPS62065/67 control ICs in a practical application environment. Moving components to both sides of the PCB or using additional internal layers can offer additional size reduction for space-constrained systems.

NOTE: Board layouts are not to scale. These figures are intended to show how the board is laid out; they are not intended to be used for manufacturing TPS62065/67EVM-347 PCBs.

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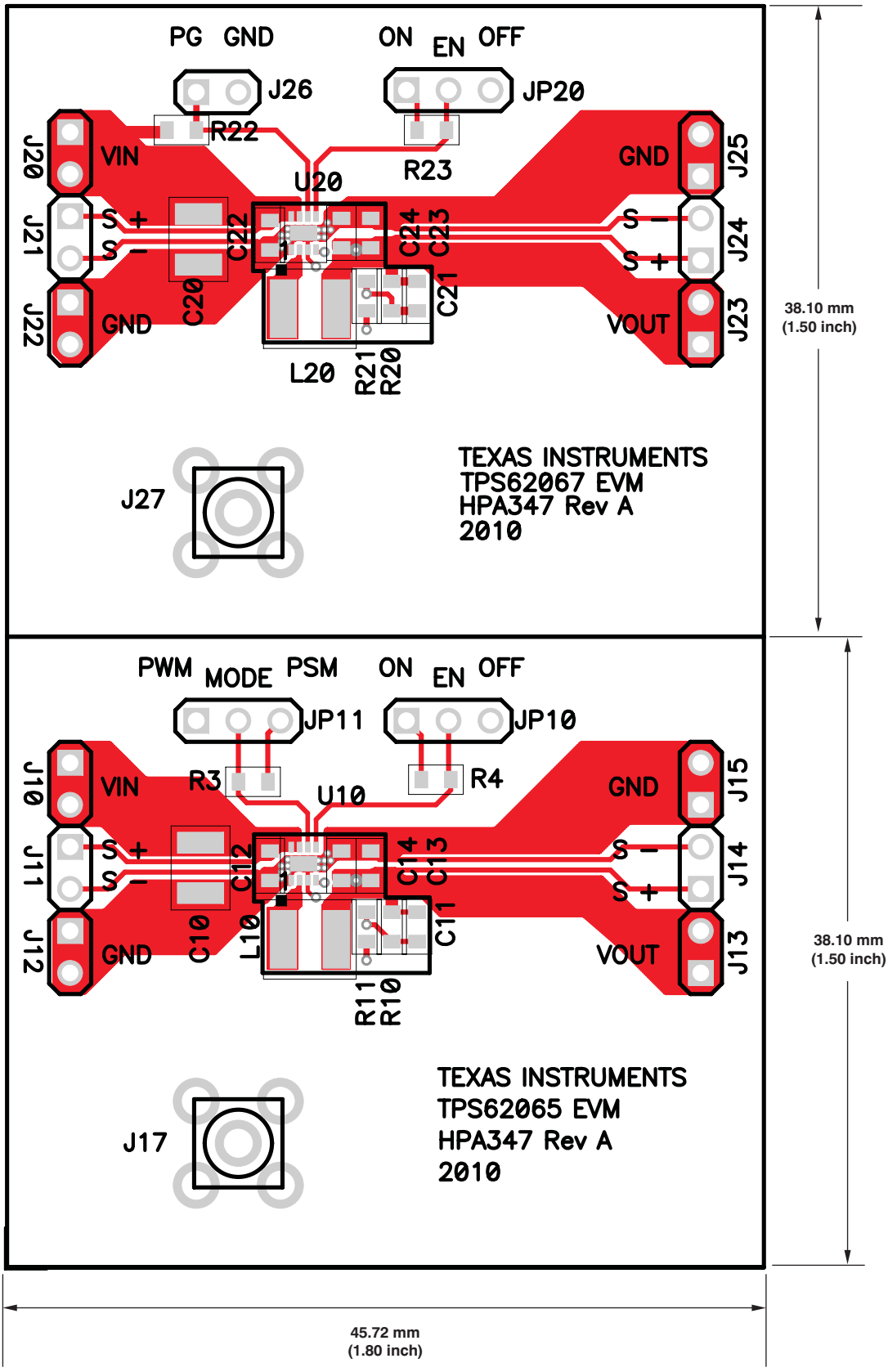


Figure 12. TPS62065/67EVM Component Placement (Top View)

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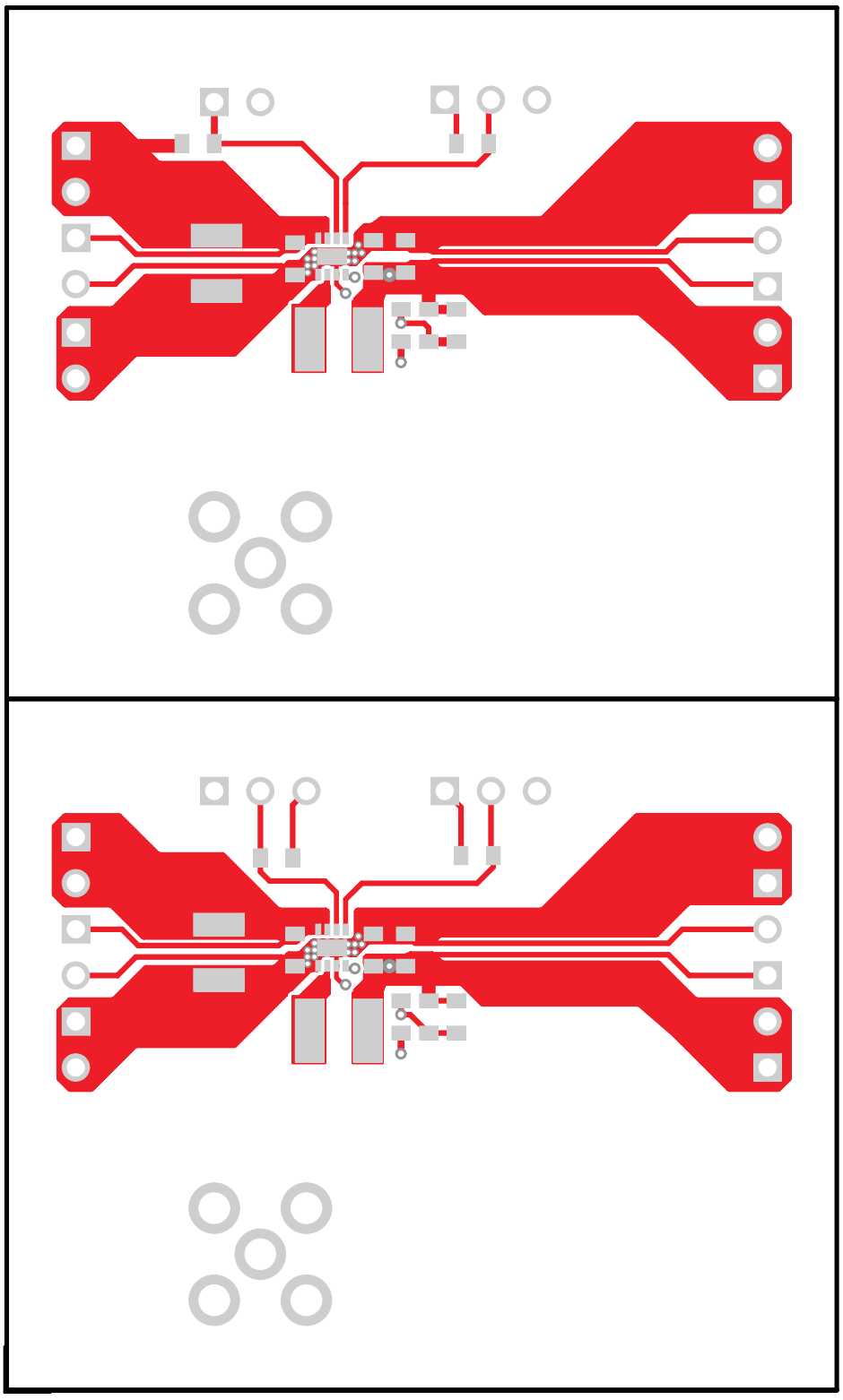


Figure 13. TPS62065/67EVM Top-Side Copper (Top View)

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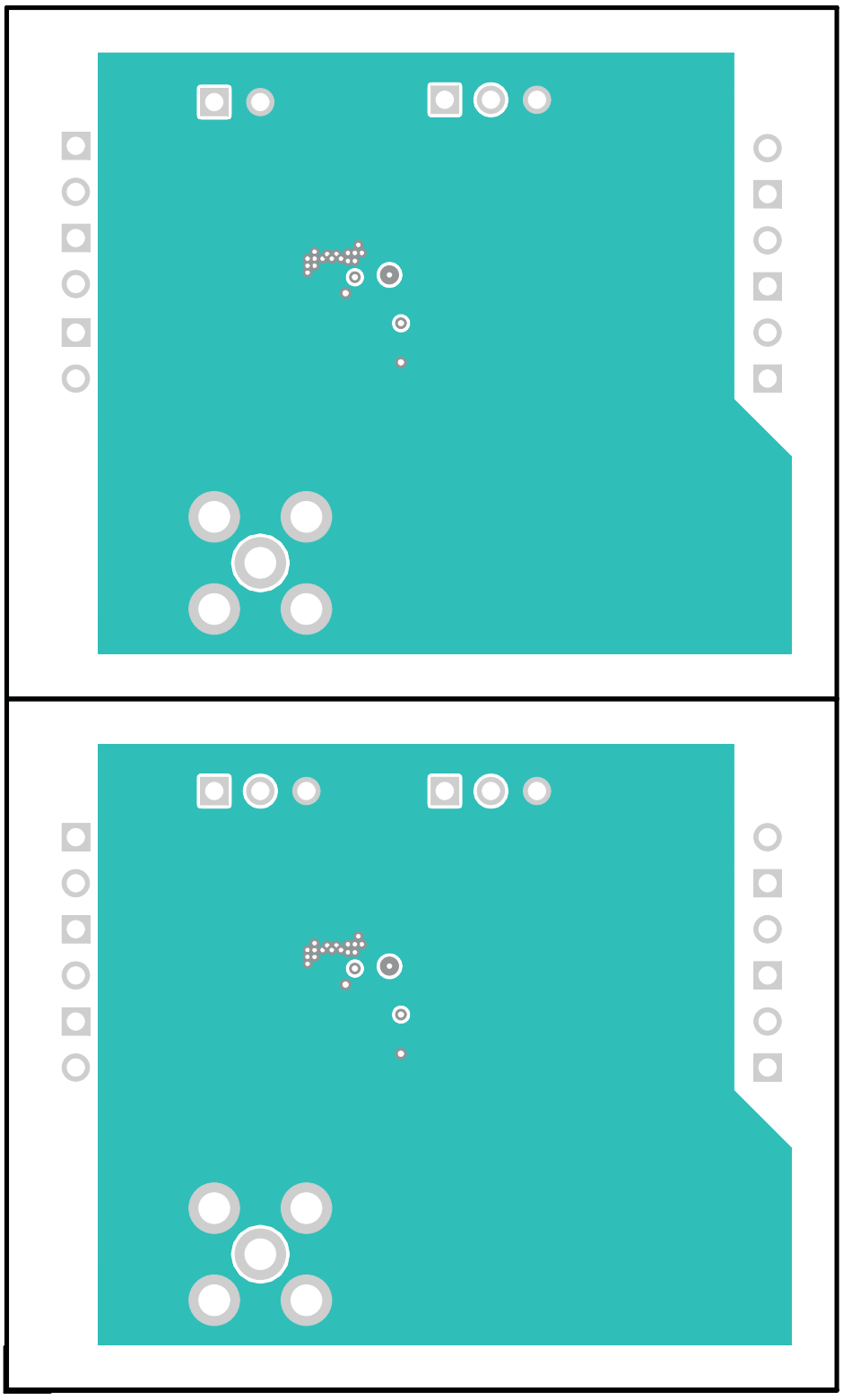


Figure 14. TPS62065/67EVM Internal Layer 1 (X-Ray View, from Top)

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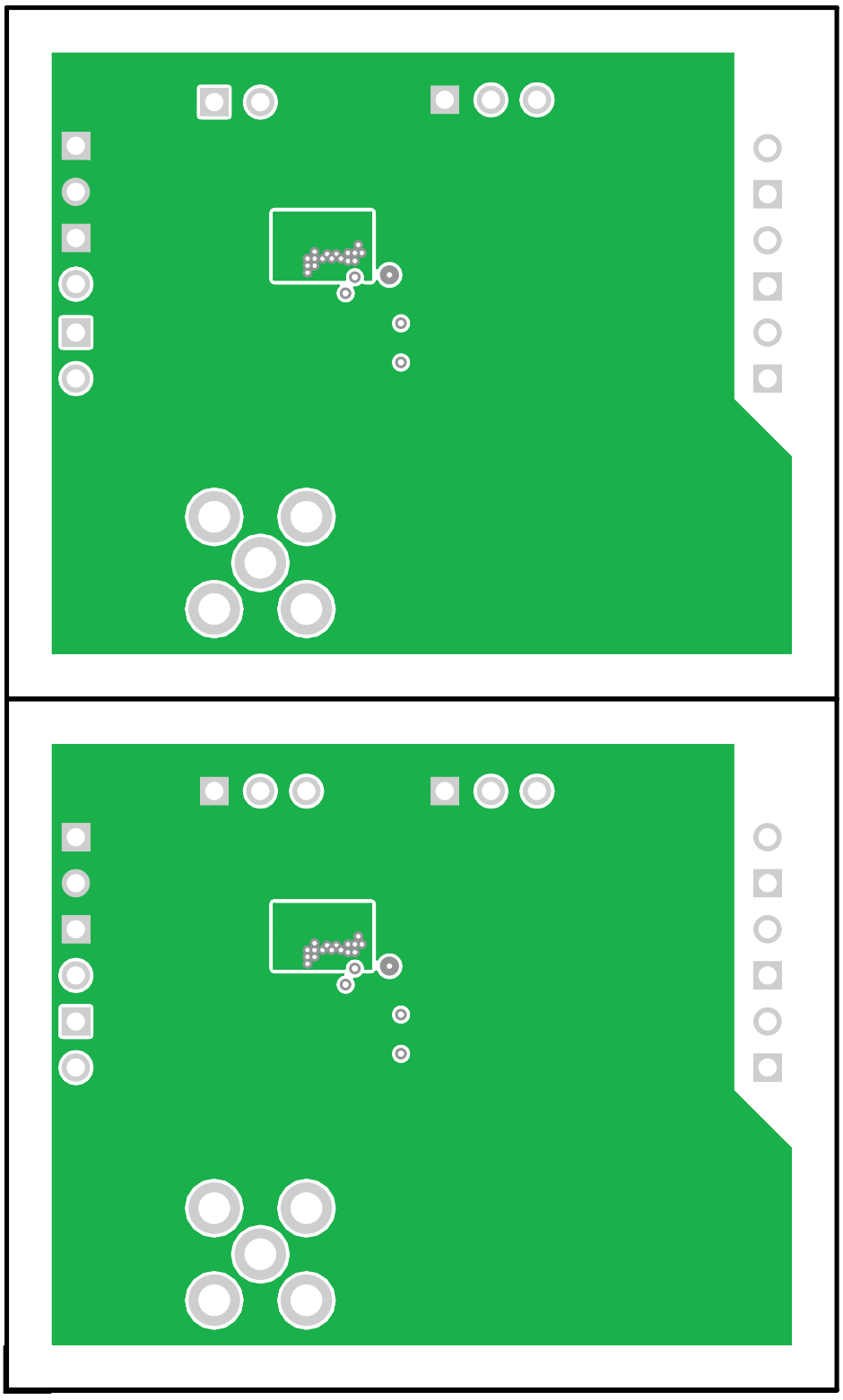


Figure 15. TPS62065/67EVM Internal Layer 2 (X-Ray View, from Top)

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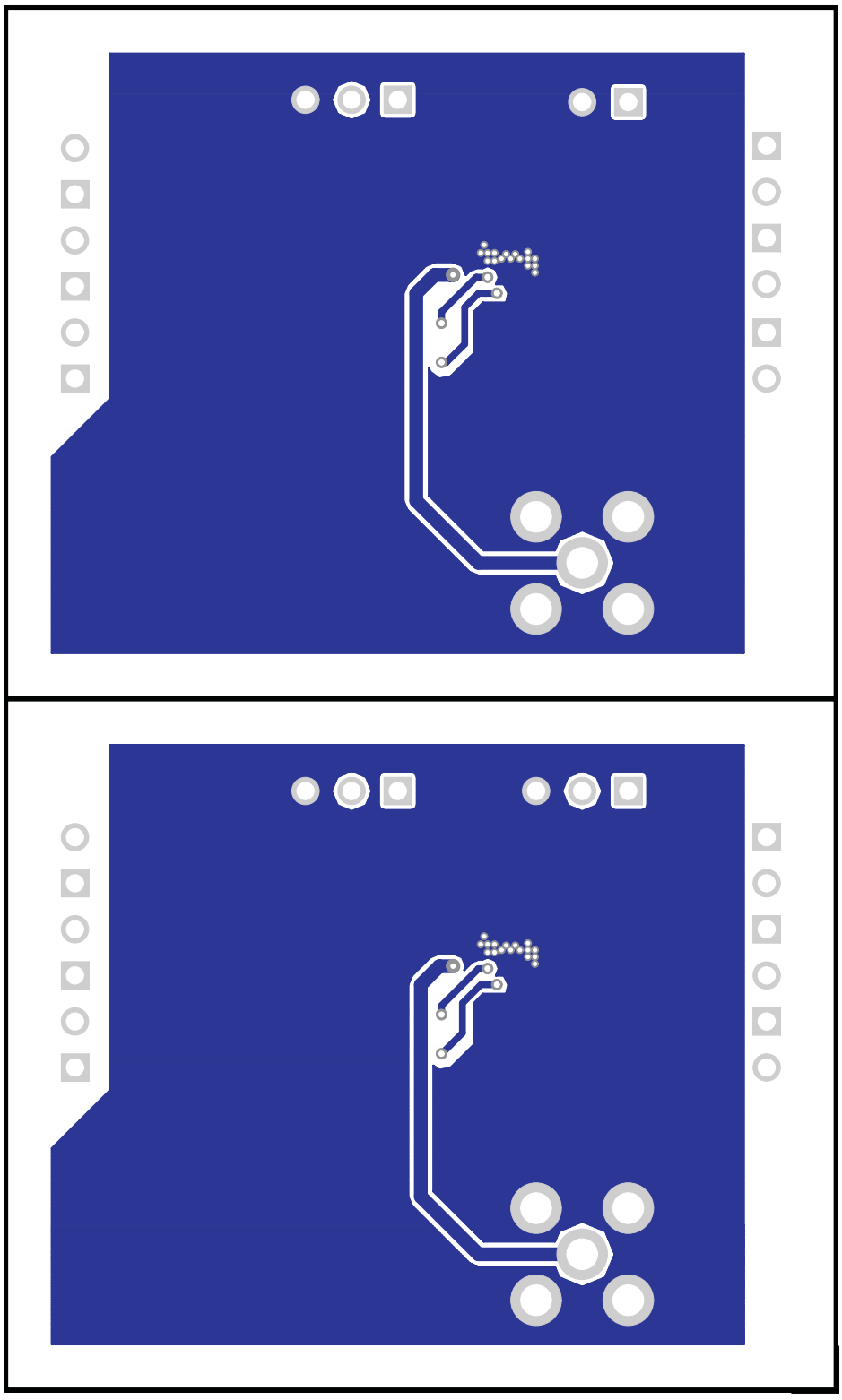


Figure 16. TPS62065/67EVM Bottom-Side Copper (Bottom View)

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8 Bill of Materials

Table 2 lists the bill of materials for the TPS62065/67EVM.

Table 2. TPS62065/67EVM Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
2	C10, C20	22 µF	Capacitor, ceramic, 10 V, X7R, 10%	1210	GRM32ER71A226K	MuRata
2	C11, C21	22 pF	Capacitor, ceramic, 10 V, C0G, 5%	0603	Standard	Standard
4	C12, C13, C22, C23	10 µF	Capacitor, ceramic, 6.3 V, X5R, 20%	0603	GRM188R60J106ME47D	muRata
0	C14, C24	Open	Capacitor, ceramic, 6.3 V, X5R, 20%	0603	GRM188R60J106ME47D	muRata
0	J16, J27	Open	Connector, SMA , straight, PC mount	0.210 in^2	901-144-8RFX	AMP
2	L10, L20	1.0 µH	Inductor, chip coil, ±30%	1515	LQH44PN1R0NP0L	Murata
1	R10	360 kΩ	Resistor, chip, 1/16W, 1%	0603	Standard	Std
2	R11, R21	180 kΩ	Resistor, chip, 1/16W, 1%	0603	Standard	Std
1	R20	820 kΩ	Resistor, chip, 1/16W, 1%	0603	Standard	Std
4	R12, R13, R22, R23	1.00 MΩ	Resistor, chip, 1/16W, 1%	0603	Standard	Std
1	U10	TPS62065DSG	IC, step-down converter, 3 MHz, 2 A	SON-8	TPS62065DSG	TI
1	U20	TPS62067DSG	IC, step-down converter, 3 MHz, 2 A	SON-8	TPS62067DSG	TI

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Revision History

Changes from Original (March 2010) to A Revision	Page
• Changed Table 1	2
• Changed title of Figure 14 From: TPS62065/67EVM Internal Layer 2 To: TPS62065/67EVM Internal Layer 1	15
• Changed title of Figure 15 From: TPS62065/67EVM Internal Layer 1 To: TPS62065/67EVM Internal Layer 2	16

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

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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 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.

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/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。
http://www.tij.co.jp/lsds/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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2. 実験局の免許を取得後ご使用いただく。
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西新宿三井ビル

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

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