Using the TPS40322EVM-074

User's Guide

Literature Number: SLUU926
May 2012

Dual-Phase, Single-Output, Synchronous Buck Converter

1 Introduction

The TPS40322EVM-074 evaluation module (EVM) is a dual-phase single output synchronous buck converter. The EVM delivers 1.2 V at 30 A from a DC input voltage that ranges from 4.5 V up to 15 V. The module uses the TPS40322 Dual Output or Two-Phase Synchronous Buck Controller and the CSD87330Q3D Synchronous Buck NexFET™ Power Block in a 500-kHz application.

2 Description

TPS40322EVM-074 is designed to convert a regulated 4.5-V_{DC} to 15-V_{DC} bus into a high-current regulated 1.2-V_{DC} output. This output is capable of supplying up to 30 A of load current. The TPS40322EVM-074 is designed to demonstrate the TPS40322 in a typical regulated bus to dual-phase, single-output, low-voltage application while providing a number of test points to evaluate the performance of the TPS40322 in a given application.

2.1 Typical Applications

- Multiple Rail Systems
- Telecom Base Stations
- Switcher/Router Networking
- xDSL Broadband Access
- Server and Storage Systems

2.2 Features

- 4.5-V to 15-V Input Range
- 1.2-V Fixed Output
- 30-A_{DC} Steady-State Current
- 500-kHz Switching Frequency, (per phase)
- Inductor DCR Current Sensing
- Voltage Mode Feedback Control with Input Feed Forward

3 Electrical Performance Specifications

Table 1. TPS40322EVM-074 Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics					
V_{IN}, Voltage range		4.5		15.0	V
Maximum input current	$V_{IN} = V_{IN(min)}$, $I_{OUT} = I_{OUT(max)}$		9.5		A
No load input current	$V_{IN(min)} \le V_{IN} \le V_{IN(max)}$, $I_{OUT} = I_{OUT(min)}$		57		mA
Output Characteristics					
V_{OUT}, Output voltage	$I_{OUT(min)} \le I_{OUT} \le I_{OUT(max)}$		1.2		V
I_{OUT}, Output load current	$V_{OUT(min)} \le V_{OUT} \le V_{OUT(max)}$	0		30	A
Output voltage regulation	Line regulation: $V_{IN(min)} \le V_{IN} \le V_{IN(max)}$, $I_{OUT} = I_{OUT(max)}$			0.5	%
	Load regulation: $I_{OUT(min)} \le I_{OUT} \le I_{OUT(max)}$			0.5	%
Output voltage ripple	$I_{OUT} = I_{OUT(max)}$			24	mV_{pp}
Output over current	$V_{IN(min)} \le V_{IN} \le V_{IN(max)}$		32		A
Systems Characteristics					
Switching frequency	per phase		500		kHz
Peak efficiency	V_{IN} = 4.5 V, I_{OUT} = 7 A		92%		
Full load efficiency	V_{IN} = 8 V , $I_{OUT} = I_{OUT(max)}$		88%		
Operating temperature			25		ºC

4 Schematic

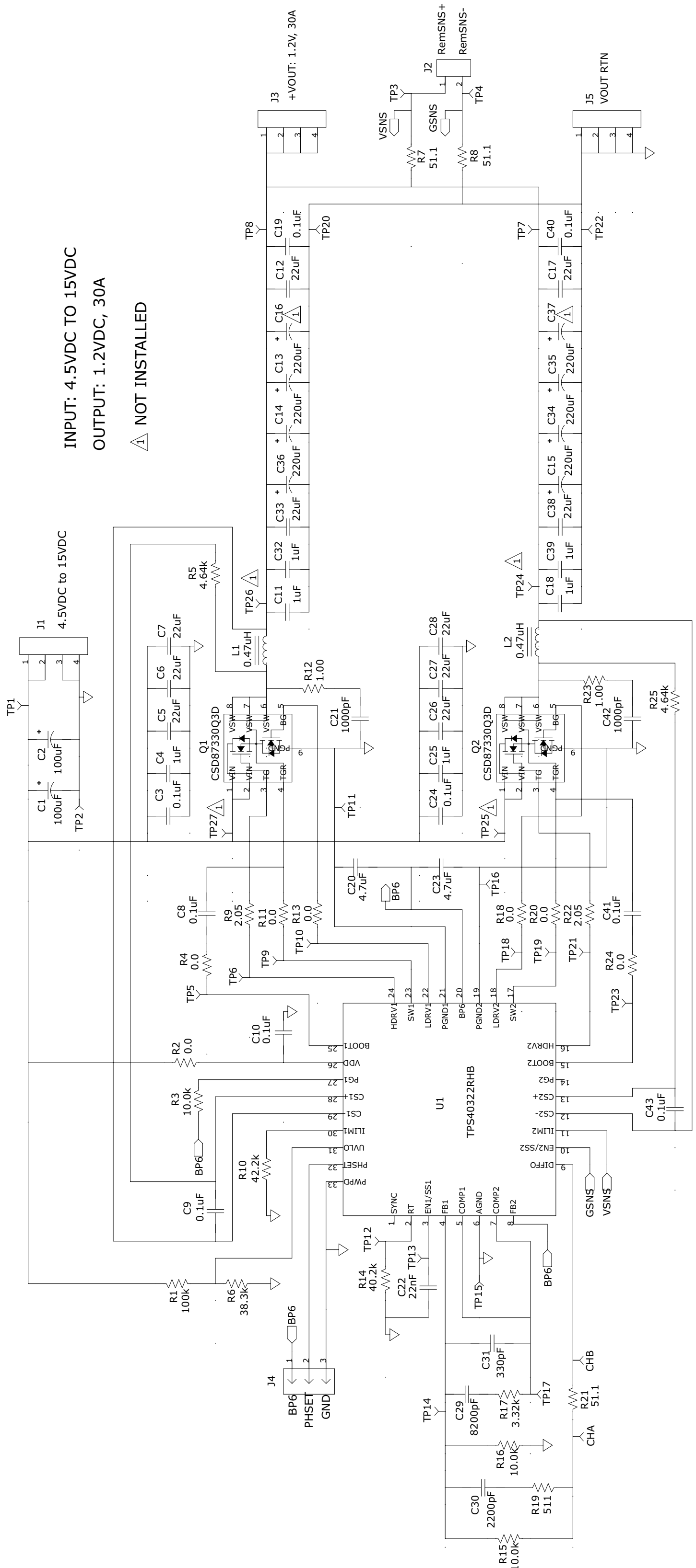

Figure 1. TPS40322EVM-074 Schematic

5 Test Setup

5.1 Test Equipment

Voltage Source: The input DC voltage source (V_{SOURCE}) shall be a 0-V to 15-V variable DC source capable of 10 A_{DC} at 4.5 V_{DC}. Connect V_{SOURCE} to J1 as shown in Figure 2.

Multimeters:

- **Volt meter, V1:** 0 V_{DC} to 15 V_{DC} for input voltage measurement.
- **Volt meter, V2:** 0 V_{DC} to 5 V_{DC} for output voltage measurement.
- **Current meter, A1:** 0 V_{DC} to 10 A_{DC} for input current measurement.
- **Current meter, A2:** 0 A_{DC} to 30 A_{DC} for output current measurement.
- **Current shunt:** a resistive shunt (i.e. 1-V/100-A shunt) may be used instead of A2 to monitor the output current. When using a resistor shunt, a volt meter, V3, shall be used to measure the voltage drop across the shunt in order to monitor the output current.

Output Load: Load, an electronic constant current mode load capable of 0 A_{DC} to 30 A_{DC} at 1.2 V shall be used for LOAD

Oscilloscope: A digital or analog oscilloscope can be used to measure the ripple voltage on VOUT. The oscilloscope should be set for 1-MΩ impedance, 20-MHz bandwidth, AC coupled. Test points TP8 and TP20 or test points TP7 and TP22 can be used to measure the ripple on V_{OUT}. Use the tip and barrel method sown in Figure 2 to avoid inducing additional noise due to the large ground loop area that would result from using the probes ground lead.

Recommended Wire Gauge:

- **V_{SOURCE} to J1:** The connection from V_{SOURCE} to the J1 connector of the EVM can carry as much as 10 A_{DC}. The wire gauge shall be 14 AWG minimum and no longer than 2 feet for each connection, V_{SOURCE}+ to J1+, and V_{SOURCE}- to J1-.
- **EVM to LOAD:** The connection from J3 of the EVM to the LOAD can carry as much as 30 A_{DC}. The wire gauge shall be two 10 AWG wires in parallel and no longer than 2 feet for each connection, J3 to Load+, including the current meter or the shunt, and LOAD- to J5.

Fan: This evaluation module includes components that can get hot to the touch. A small fan capable of 200 LFM to 400 LFM is required at all times during testing.

5.2 Recommended Test Setup

Shown in Figure 2 is the basic test set up recommended to evaluate the TPS40322EVM-074.

Working at an ESD workstation, make sure that any wrist straps, bootstraps or mats are connected referencing the user to earth ground before power is applied to the EVM. Electrostatic smock and safety glasses should also be worn.

- **Input connections:** Prior to connecting the DC input source, V_{SOURCE}, it is advisable to limit the source current from V_{SOURCE} to 10 A maximum. Make sure V_{SOURCE} is initially set to 0 V and connected as shown in Figure 2.
- **Output connections:** Connect Load to J3 and J5, as shown in Figure 2. Set LOAD to constant current mode to sink 0 A before V_{SOURCE} is applied. Connect voltmeter V2 across TP3 and TP4 as shown in Figure 2.

  If using a shunt to monitor output current, connect the shunt in series with LOAD and connect voltmeter V3 across it to monitor the output current.
- **Other connections:** Place Fan as shown in Figure 2 and turn on, making sure air is flowing across the EVM at all times.

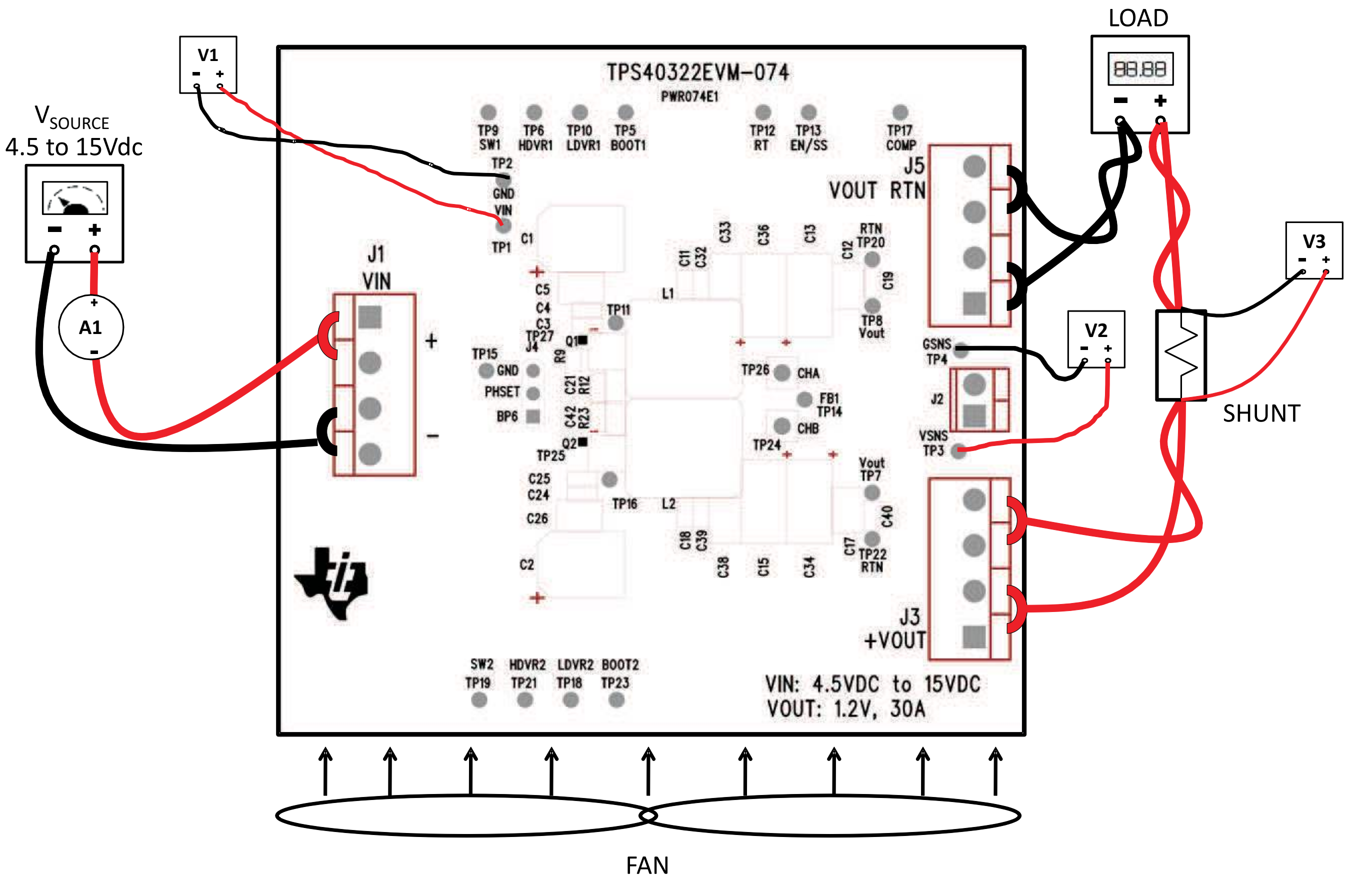

Figure 2. TPS40322EVM-074 Recommended Test Setup

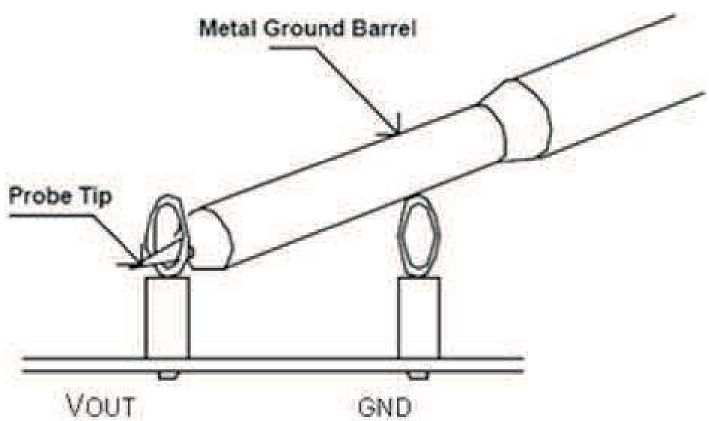

Figure 3. Tip and Barrel Voltage Ripple Measurement

5.3 List of Test Points

Table 2. Test Point Functional Descriptions

TEST POINT	NAME	DESCRIPTION
TP1	VIN	Input voltage positive sense point, reference to TP2
TP2	GND	Input voltage negative sense point, reference for TP1
TP3	VSNS	Remote sense +, reference to TP4
TP4	GSNS	Remote sense -, reference for TP3
TP5	BOOT1	Boot strap supply for channel 1 high side FET, reference to TP11
TP6	HDRV1	Gate drive output for channel 1 high side FET, reference to TP11
TP7	+VOUT	Output voltage sense for channel 2, reference to TP22
TP8	+VOUT	Output voltage sense for channel 1, reference to TP20
TP9	SW1	Output 1 switch node, reference to TP11
TP10	LDRV1	Gate drive output for channel 1 low side FET, reference to TP11
TP11	PGND1	Power ground for channel 1
TP12	RT	Oscillator test point, reference to TP2
TP13	EN1/SS1	Enable and soft start, reference to TP2
TP14	FB1	Inverting input to error amplifier, reference to TP15
TP15	AGND	Analog ground
TP16	PGND2	Power ground for channel 2
TP17	COMP	Error amplifier output, reference to TP15
TP18	LDRV2	Gate drive output for channel 2 low side FET, reference to TP16
TP19	SW2	Output 2 switch node, reference to TP16
TP20	RTN	VOUT RTN, reference for TP8
TP21	HDRV2	Gate drive output for channel 2 high side FET, reference to TP16
TP22	RTN	VOUT RTN, reference for TP7
TP23	BOOT2	Boot strap supply for channel 2 high side FET, reference to TP16
TP24	+VOUT	Test pad for power stage efficiency measurement, reference to TP16
TP25	VIN	Test pad for power stage efficiency measurement, reference to TP16
TP26	+VOUT	Test pad for power stage efficiency measurement, reference to TP11
TP27	VIN	Test pad for power stage efficiency measurement, reference to TP11
CHA	CHA	Output loop injection point, reference to TP15
CHB	CHB	Output loop injection point, reference to TP15

6 Test Procedure

6.1 Load Regulation Measurement Procedure

1. Ensure the LOAD is set to constant-current mode and to set to sink 0 A.
2. Increase V_{SOURCE} from 0 V to 4.5 V_{DC}. VOUT should be in regulation once V1 shows VIN is 4.5 V or greater.
3. Vary LOAD from 0 A to 30 A. VOUT should remain within regulation per Table 1.

6.2 Line Regulation Measurement Procedure

1. Set LOAD to constant-current mode and to set to sink 30 A.
2. Vary V_{SOURCE} so that V1 measures 4.5 V_{DC} to 15.0 V_{DC}. VOUT should remain within regulation per Table 1.

6.3 Control Loop Gain and Phase Measurement Procedure

1. Connect a 1-kHz to 1-MHz isolation transformer to CHA and CHB, referenced to TP15.
2. Connect the input signal amplitude measurement probe (Channel A) to CHA with the ground lead connected to TP15.
3. Connect the output signal amplitude measurement probe (Channel B) to CHB with the ground lead connected to TP15.
4. Inject a 25-mV, or less, signal across CHA and CHB through the isolation transformer.
5. Sweep the frequency from 100 Hz to 1 MHz with 1-Hz or lower post filter.
6. Control loop gain can be measured by 20 x LOG(ChB/ChA)
7. Control loop phase is measured by the phase difference between ChA and ChB.
8. Disconnect the isolation transformer from the EVM before making other measurements. The signal injection into the feedback may interfere with the accuracy of other measurements.

6.4 Enabling/Disabling the Outputs

1. The User may disable the output by shorting TP13 (EN/SS) to ground.
2. Enable the output by removing the short from TP13 (EN/S) and leaving TP13 open.

6.5 Equipment Shutdown

1. Shut down LOAD.
2. Shut down V_{SOURCE}.
3. Shut off fan.

7 Performance Data and Typical Characteristic Curves

Figure 4 through Figure 13 present typical performance curves for the TPS40322EVM-074. Since actual performance data can be affected by measurement techniques and environmental variables, these curves are presented for reference and may differ from actual field measurements.

7.1 Efficiency

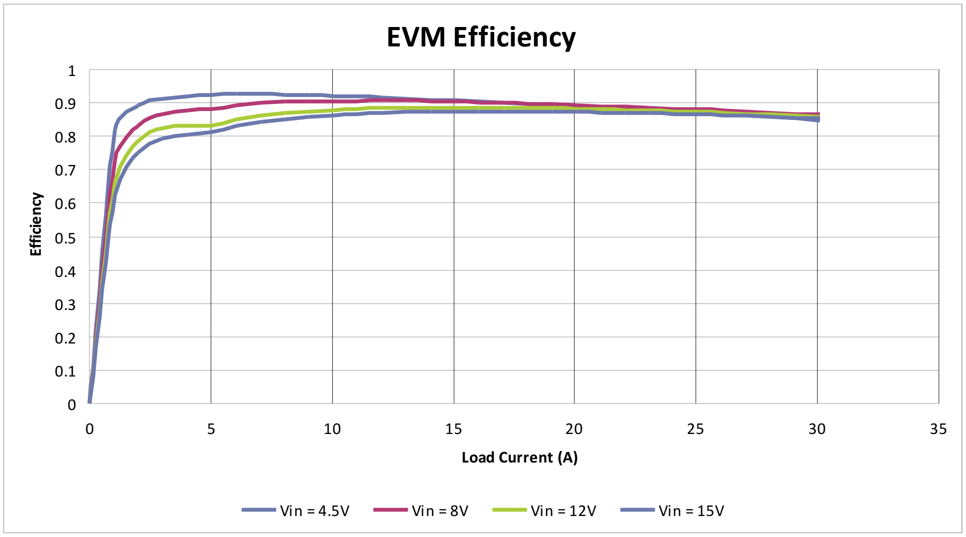

Figure 4. TPS40322EVM-074EVM Efficiency, (data measured from TP1 to TP3)

7.2 Power Loss

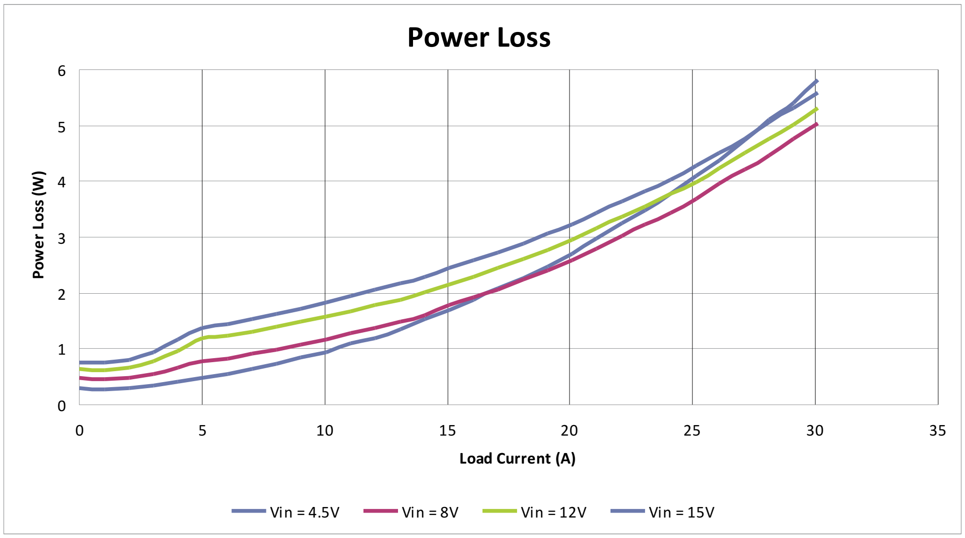

Figure 5. TPS40322EVM-074 Power Stage Power Loss, (data measured from TP25 and TP27 to TP24 and TP26)

7.3 Load Regulation

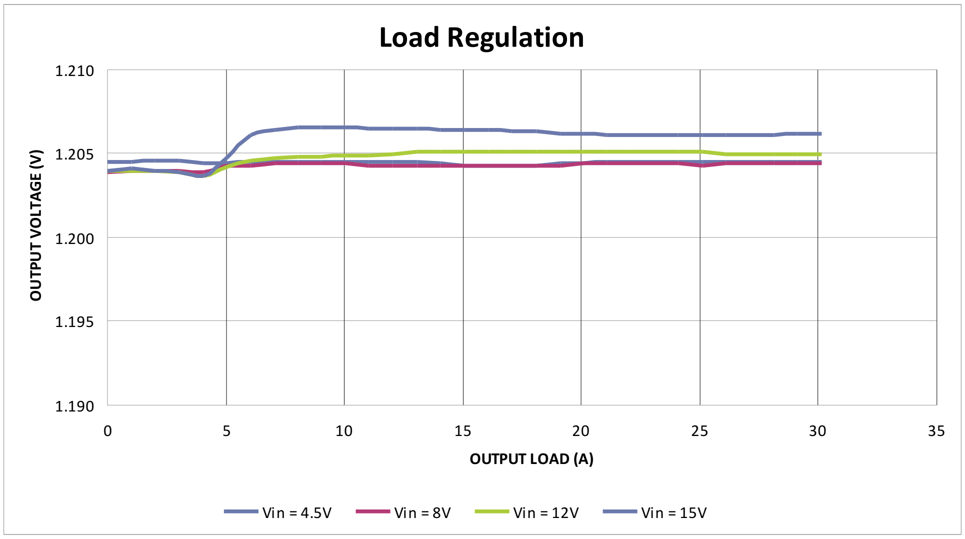

Figure 6. TPS40322EVM-074 Load Regulation

7.4 Line Regulation

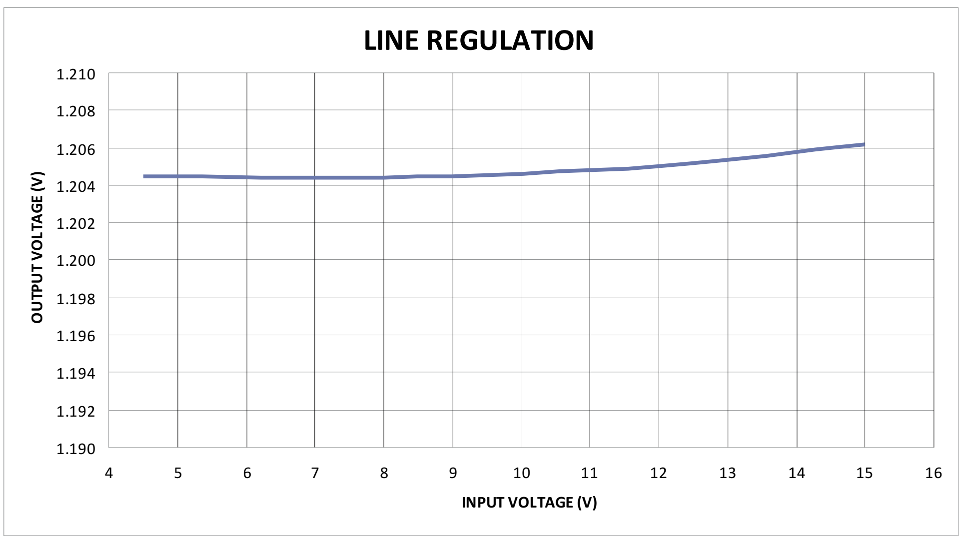

Figure 7. TPS40322EVM-074 Line Regulation

7.5 Bode Plot

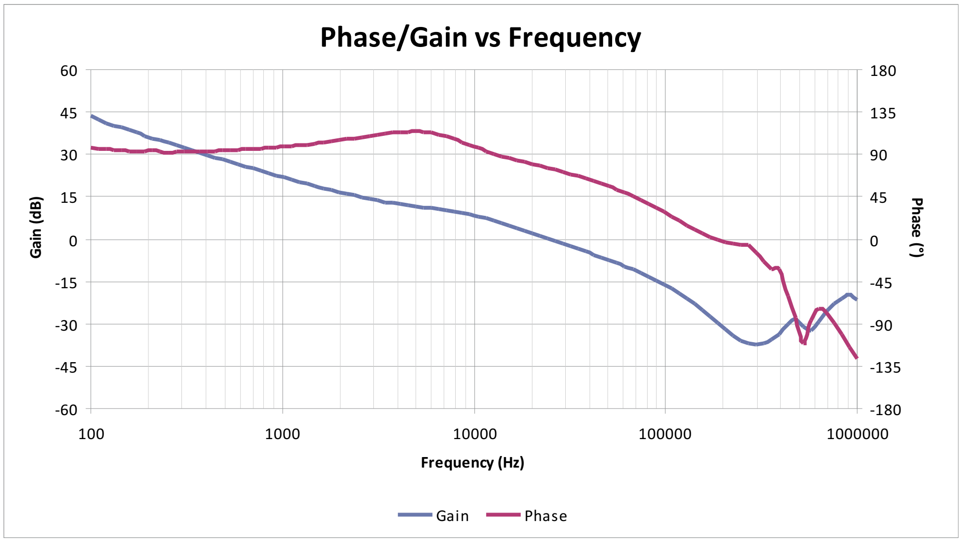

Figure 8. TPS40322EVM-074 Loop Response Gain and Phase (V_{IN} = 8 V I_{OUT} = 30 A, 76 degrees of phase margin at f_{CO} = 24 kHz)

7.6 Output Ripple

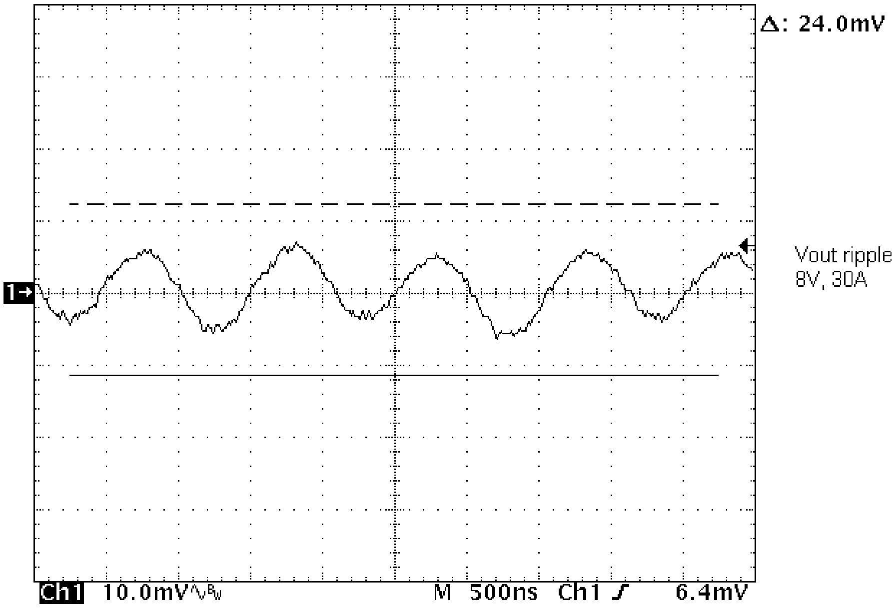

Figure 9. Output Ripple, V_{IN} = 8 V, I_{OUT} = 30 A

7.7 Switching Waveforms

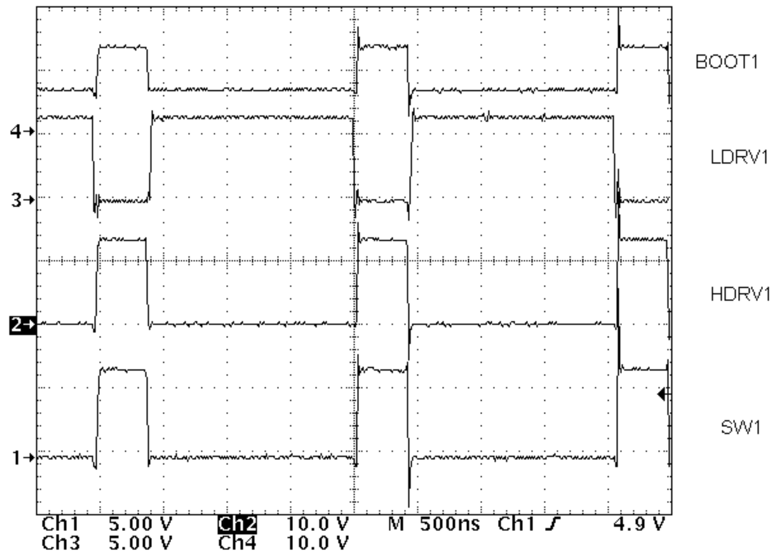

Figure 10. Switching Waveforms, (Ch1 = SW1, Ch2 = HDRV1, Ch3 = LDRV1, Ch4 = BOOT1, V_{IN} = 8 V, I_{OUT} = 30 A)

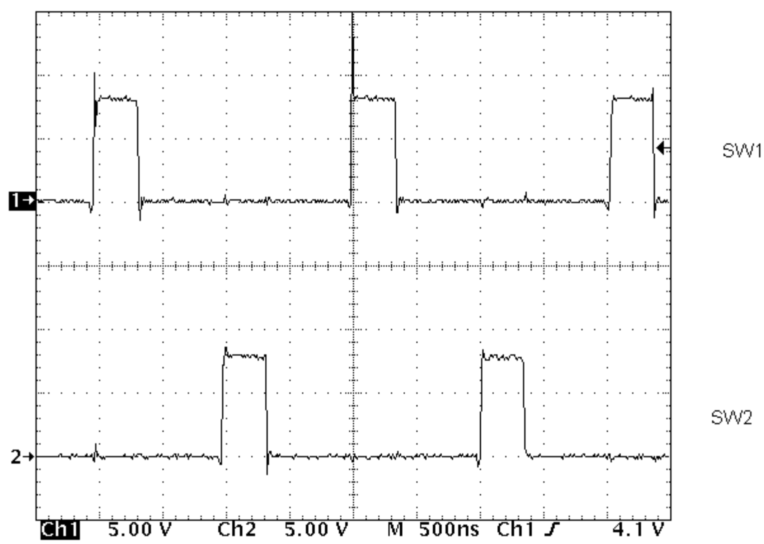

Figure 11. Switch Nodes, (Ch1 = SW1, Ch2 = SW2, V_{IN} = 8 V, I_{OUT} = 30 A)

7.8 Turn-On Waveform

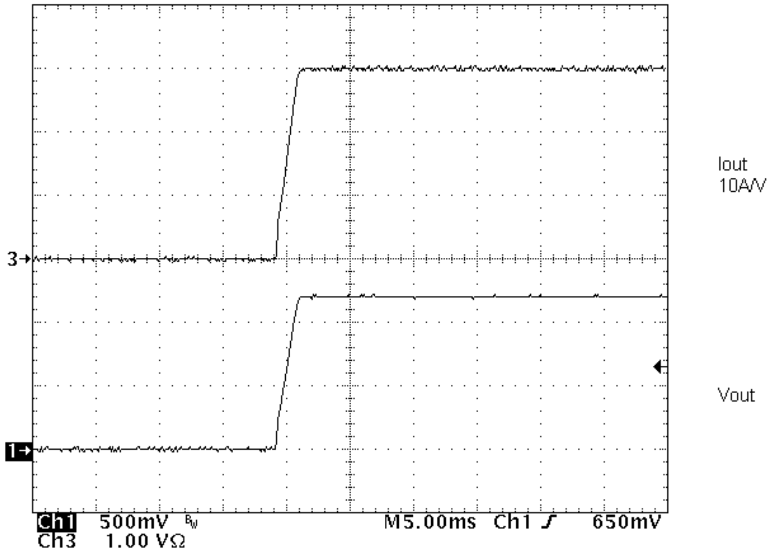

Figure 12. Enable turn on waveform, (Ch1 = V_{OUT}, Ch2 = I_{OUT}, V_{IN} = 8 V, I_{OUT} = 30 A (10 A/V scale))

7.9 Turn-Off Waveform

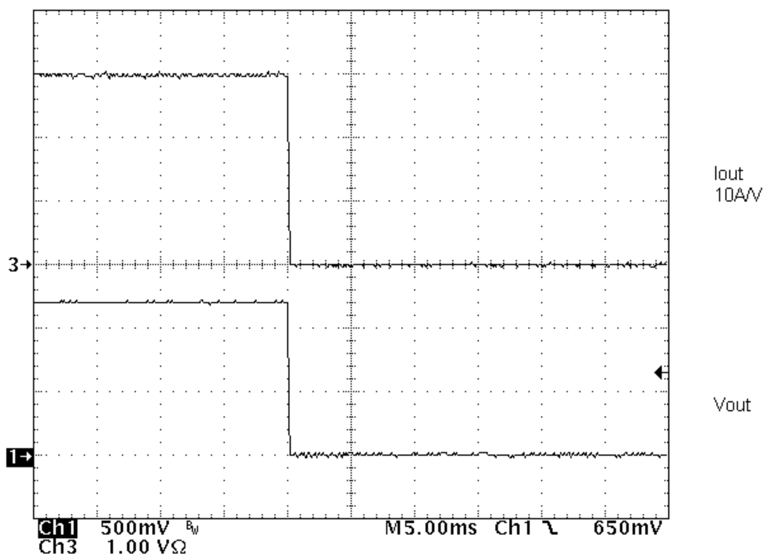

Figure 13. Enable turn off waveform, (Ch1 = V_{OUT}, Ch2 = I_{OUT}, V_{IN} = 8 V, I_{OUT} = 30 A (10 A/V scale))

8 EVM Assembly Drawings and PCB Layout

Figure 14 through Figure 23 show the design of the TPS40322EVM-074 printed circuit board, PWR074.

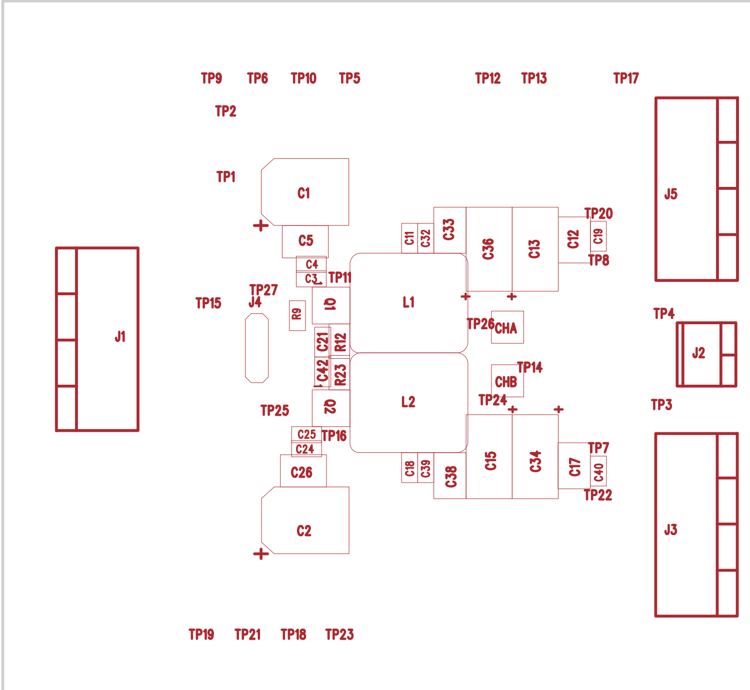

Figure 14. TPS40322EVM-074 Top Layer Assembly Drawing (top view)

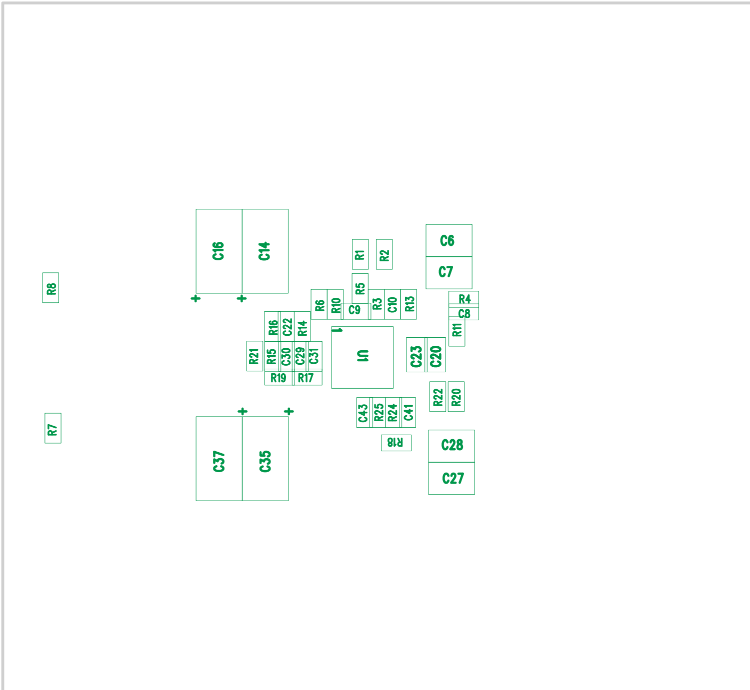

Figure 15. TPS40322EVM-074 Bottom Assembly Drawing (bottom view)

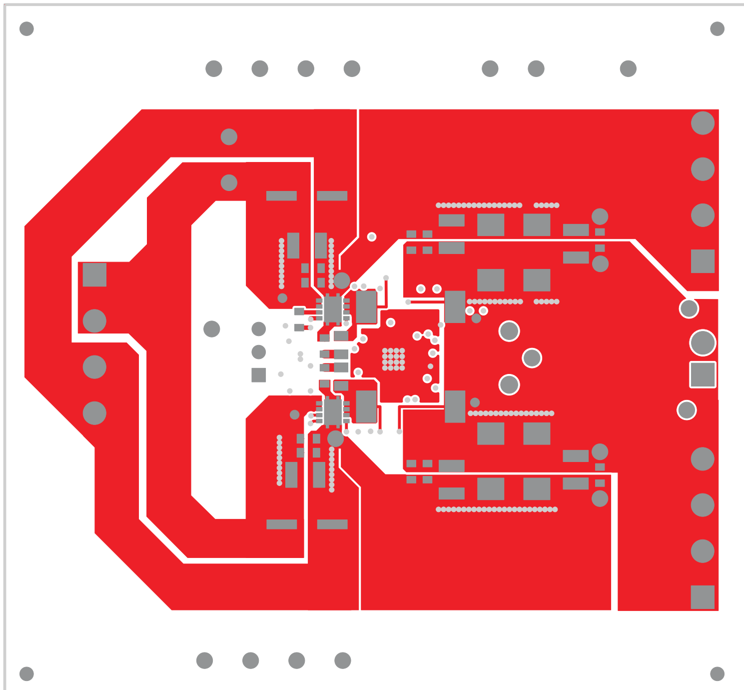

Figure 16. TPS40322EVM-074 Top Copper (top view)

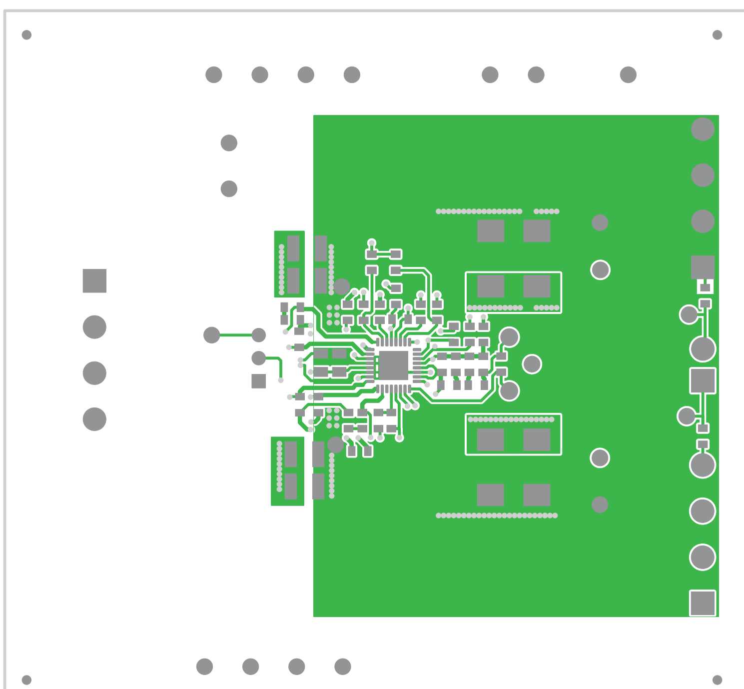

Figure 17. TPS40322EVM-074 Bottom Copper (bottom view)

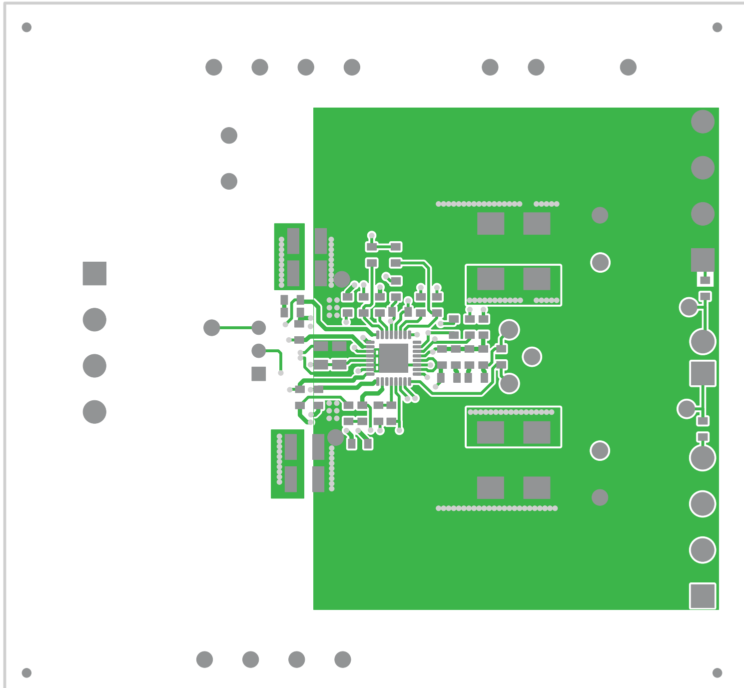

Figure 18. TPS40322EVM-074 Internal Layer 1 (top view)

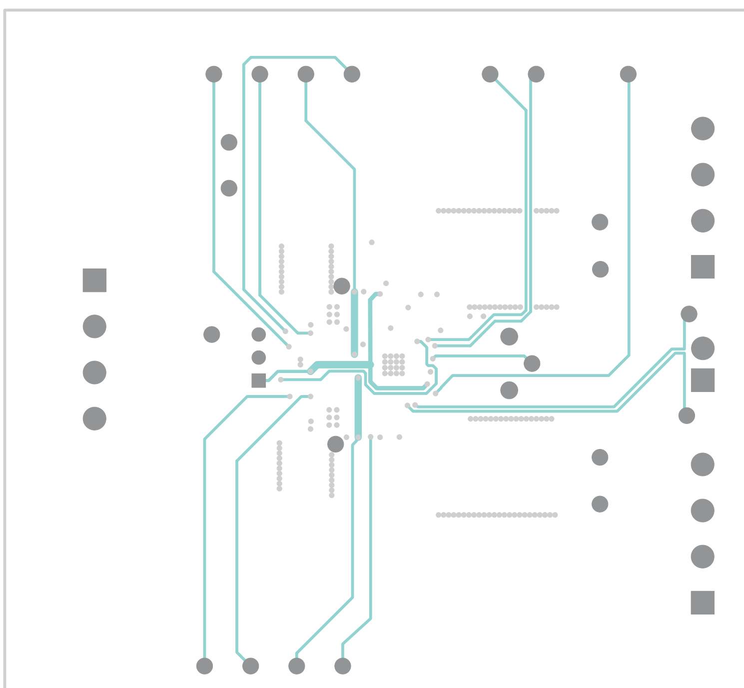

Figure 19. TPS40322EVM-074 Internal Layer 2 (top view)

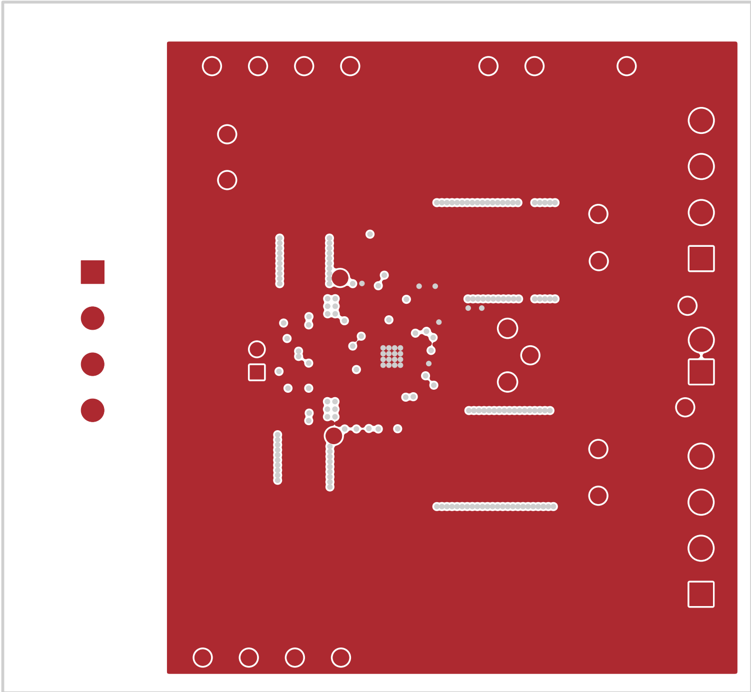

Figure 20. TPS40322EVM-074 Internal Layer 3 (top view)

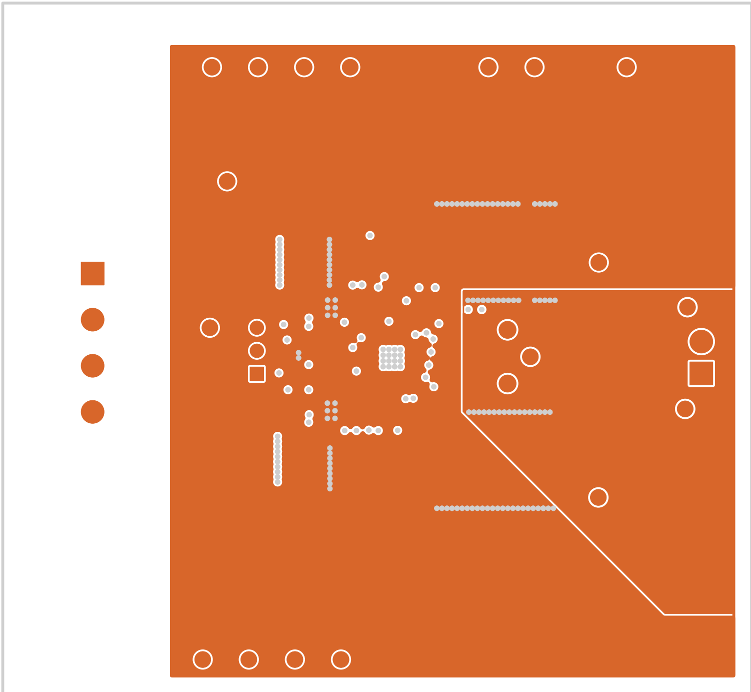

Figure 21. TPS40322EVM-074 Internal Layer 4 (top view)

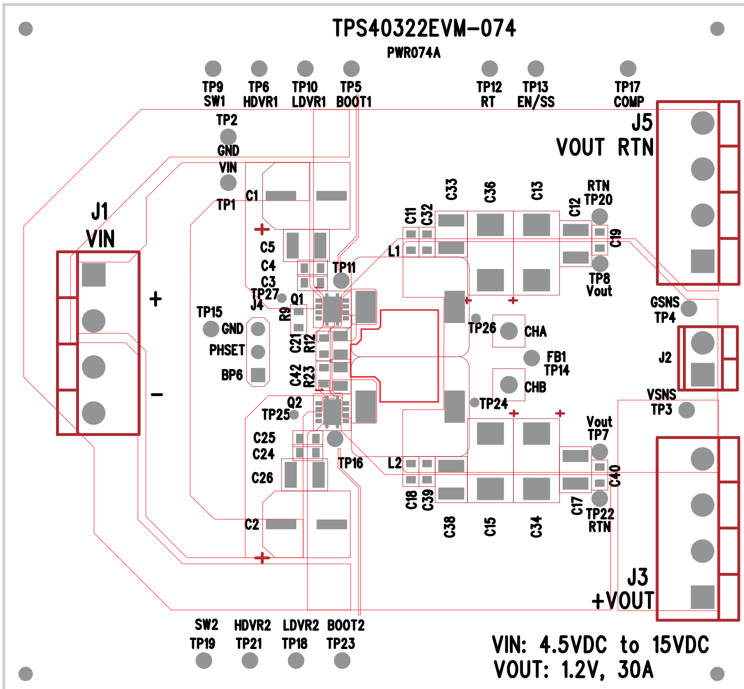

Figure 22. TPS40322EVM-074 Top Silk (top view)

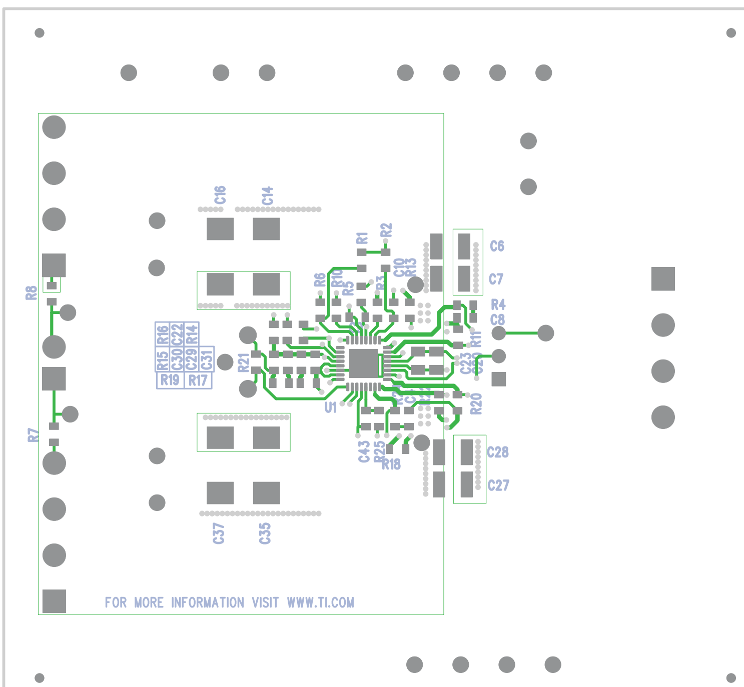

Figure 23. TPS40322EVM-074 Bottom Silk (bottom view)

9 List of Materials

The EVM components list according to the schematic shown in Figure 1.

Table 3. TPS40322EVM-074 List of Materials

COUNT	REF DES	DESCRIPTION	PART NUMBER	MFR
2	C1, C2	Capacitor, aluminum, 100 µF, 25 V, ±20%, Code D	EEE-FPE101XAP	Panasonic
6	C13, C14, C15, C34, C35, C36	Capacitor, aluminum, 220 µF, 4 V, 5 mΩ, ±20%, 7343	EEFSE0G221R	Panasonic
0	C16, C37	Capacitor, aluminum, Open, 4 V, ±20%, 7343	Std	Std
2	C20, C23	Capacitor, ceramic, 4.7 µF, 16 V, X7R, ±10%, 0805	Std	Std
2	C21, C42	Capacitor, ceramic, 1000 pF, 50 V, X7R, ±10%, 0603	Std	Std
1	C22	Capacitor, ceramic, 22 nF, 50 V, X7R, ±10%, 0603	Std	Std
1	C29	Capacitor, ceramic, 8200 pF, 50 V, X7R, ±10%, 0603	Std	Std
9	C3, C8, C9, C10, C19, C24, C40, C41, C43	Capacitor, ceramic, 0.1 µF, 25 V, X7R, ±10%, 0603	Std	Std
1	C30	Capacitor, ceramic, 2200 pF, 16 V, X7R, ±10%, 0603	Std	Std
1	C31	Capacitor, ceramic, 330 pF, 50 V, X7R, ±10%, 0603	Std	Std
6	C4, C11, C18, C25, C32, C39	Capacitor, ceramic, 1 µF, 25 V, X7R, ±10%, 0603	Std	Std
10	C5, C6, C7, C12, C17, C26, C27, C28, C33, C38	Capacitor, ceramic, 22 µF, 25 V, X7R, ±10%, 1210	GRM32ER71E226KE15L	Murata Electronics
2	L1, L2	Inductor, 0.47 µH, 0.8 mΩ, 20.5 A, ±20%, 10.0 mm x 10.9 mm	7443330047	Wurth Elektronik
2	Q1, Q2	MOSFET, Synchronous Buck NexFET™ Power Block, QFN-8 power	CSD87330Q3D	Texas Instruments
1	R1	Resistor, chip, 100 kΩ, 1/10 W, ±1%, 0603	Std	Std
1	R10	Resistor, chip, 42.2 kΩ, 1/10 W, ±1%, 0603	Std	Std
2	R12, R23	Resistor, chip, 1 Ω, 1/8 W, ±1%, 0805	Std	Std
1	R14	Resistor, chip, 40.2 kΩ, 1/10 W, ±1%, 0603	Std	Std
1	R17	Resistor, chip, 3.32 kΩ, 1/10 W, ±1%, 0603	Std	Std
1	R19	Resistor, chip, 511 Ω, 1/10 W, ±1%, 0603	Std	Std
7	R2, R4, R11, R13, R18, R20, R24	Resistor, chip, 0 Ω, 1/10 W, ±200 ppm/°C, 0603	Std	Std
3	R3, R15, R16	Resistor, chip, 10.0 kΩ, 1/10 W, ±1%, 0603	Std	Std
2	R5, R25	Resistor, chip, 4.64 kΩ, 1/10 W, ±1%, 0603	Std	Std
1	R6	Resistor, chip, 38.3 kΩ, 1/10 W, ±1%, 0603	Std	Std
3	R7, R8, R21	Resistor, chip, 51.1 Ω, 1/10 W, ±1%, 0603	Std	Std
2	R9, R22	Resistor, chip, 2.05 Ω, 1/10 W, ±1%, 0603	Std	Std
1	U1	Dual Synchronous Buck Controller, QFN-32	TPS40322RHB	Texas Instruments
1	-	PCB, 3.325 inch x 3.0 inch x 0.062 inch	PWR074	Any

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 4.5 VDC to 15 VDC and the output voltage range of 1.1 VDC to 1.3 VDC.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 50°C. The EVM is designed to operate properly with certain components above 50°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

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The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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http://www.tij.co.jp

EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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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 which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

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