Using the TPS53317AEVM-726

User's Guide

TEXAS INSTRUMENTS

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User's Guide
SLUUBD2–November 2015

TPS53317AEVM-726 D-CAP+™ Mode Synchronous Step-Down Integrated FETs Converter

1 Introduction

The TPS53317AEVM-726 evaluation module (EVM) is a synchronous buck regulator featuring TPS53317A. The TPS53317A is a fully integrated synchronous buck regulator employing D-CAP+™ technology.

2 Description

The TPS53317AEVM-726 is designed to use a 1.2-V voltage rail to produce a regulated 0.6-V output at up to 6-A load current. The TPS53317AEVM-726 is designed to demonstrate the TPS53317A in a typical low voltage application while providing a number of test points to evaluate the performance of the TPS53317A.

2.1 Typical Applications

- VTT terminators
- Low-voltage applications for 0.9-V to 6-V step-down rails

2.2 Features

The TPS53317AEVM-726 features:

- Integrated droop support
- External tracking support
- Selectable switching frequency settings (600 kHz and 1 MHz)
- Selectable light-load operation modes (auto-skip and forced CCM)
- Selectable valley overcurrent limit
- PGOOD function
- Convenient test points for probing critical waveforms

D-CAP+ is a trademark of Texas Instruments.

3 Electrical Performance Specifications

Table 1 contains the TPS53317AEVM-726 electrical performance specifications.

Table 1. TPS53317AEVM-726 Electrical Performance Specifications(1)

Parameter	Test Conditions	MIN	TYP	MAX	Units
Input Characteristics					
Voltage range	V_{IN}	1.1	1.2	1.3	V
Maximum input current	V_{IN} = 1.2 V, I_{OUT} = 6 A		3.8		A
No load input current	V_{IN} = 1.2 V, I_{OUT} = 0 A under PWM mode, f_{SW} = 600 kHz		25		mA
Output Characteristics					
Output voltage			0.6		V
Output voltage regulation	Setpoint accuracy (V_{IN} = 1.2 V, I_{OUT} = 0 A, non-droop)	-2%		2%	
	Line regulation (V_{IN} = 1.1 V – 1.3 V, I_{OUT} = 6 A, non-droop, f_{SW} = 600 kHz)			0.1%	
	Load regulation, (V_{IN} = 1.2 V, I_{OUT} = 0 A – 6 A, non-droop, f_{SW} = 600 kHz)			0.5%	
Output voltage ripple	V_{IN} = 1.2 V, I_{OUT} = 6 A		10		mVpp
Output load current		0		6	A
Over current limit valley			7.6/5.4		
Systems Characteristics					
Switching frequency			600/1000		kHz
Peak efficiency	V_{IN} = 1.2 V, I_{OUT} = 1.6 A under PWM mode, f_{SW} = 600 kHz		86.9%		
Full load efficiency	V_{IN} = 1.2 V, I_{OUT} = 6 A under PWM mode, f_{SW} = 600 kHz		78.9%		
Operating temperature			25		ºC

(1) Jumpers set to default locations, See Section 6 of this user's guide

4 Schematic

Figure 1 illustrates the EVM schematic.

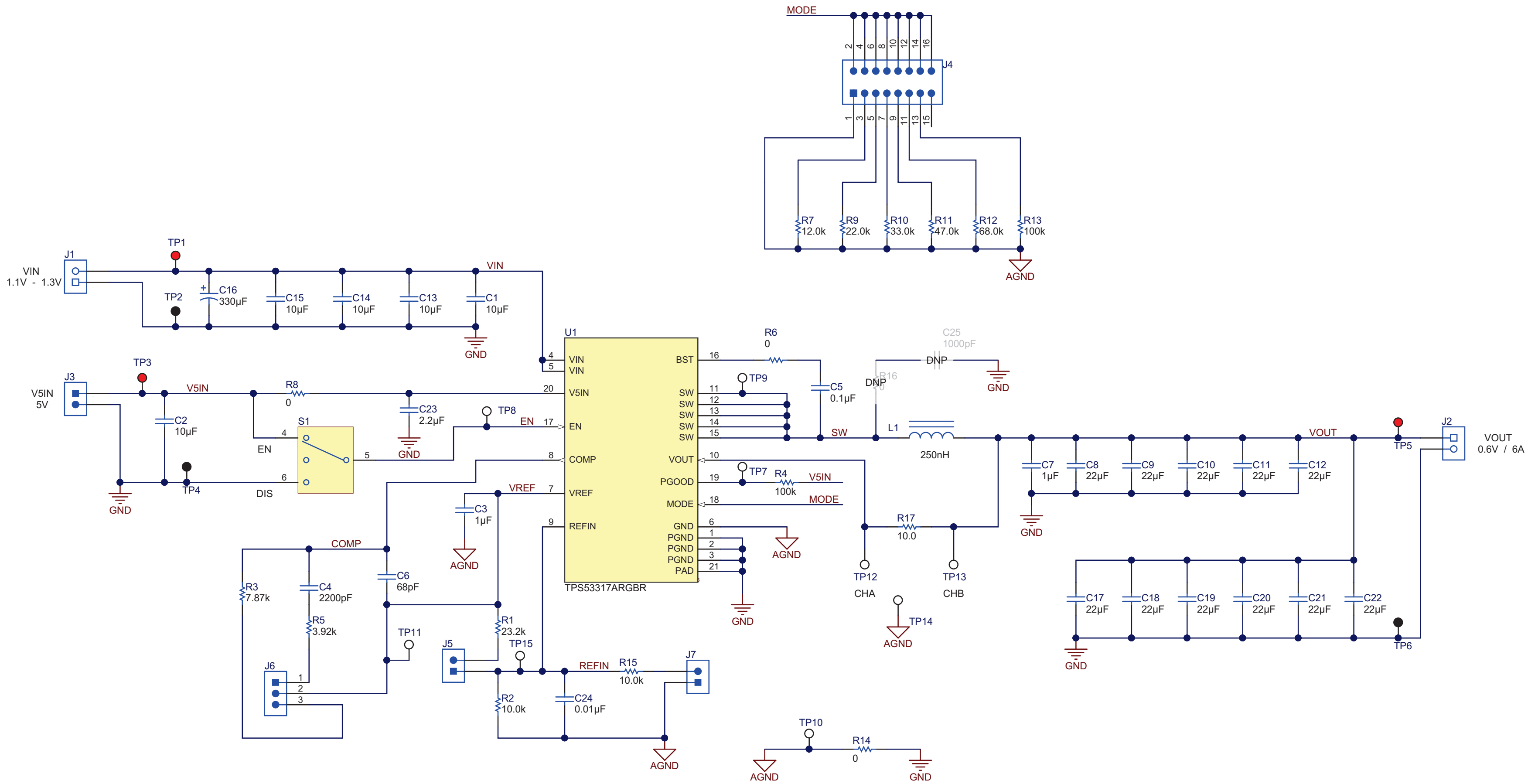

Figure 1. TPS53317AEVM-726 Schematic

5 Test Setup

5.1 Test Equipment

Voltage Source:

- **VIN:** The input voltage source VIN should be a 0-V to 6-V variable DC source capable of supplying 8 A_{DC}. Connect VIN to J1 as shown in Figure 3.
- **V5IN:** The V5IN voltage source should be a 5-V DC source capable of supplying 1 A_{DC}. Connect V5IN to J3 as shown in Figure 3.

Multimeters:

- **V1:** VIN at TP1 (VIN) and TP2 (PGND), 0-V to 6-V voltmeter
- **V2:** V5IN at TP3 (V5IN) and TP4 (PGND)
- **V3:** VOUT at TP5 (VOUT) and TP6 (PGND)
- **A1:** VIN input current, 0 A_{DC} to 8 A_{DC} Ammeter

Output Load: The output load should be an electronic constant resistance mode load capable of 0 A_{DC} to 10 A_{DC}

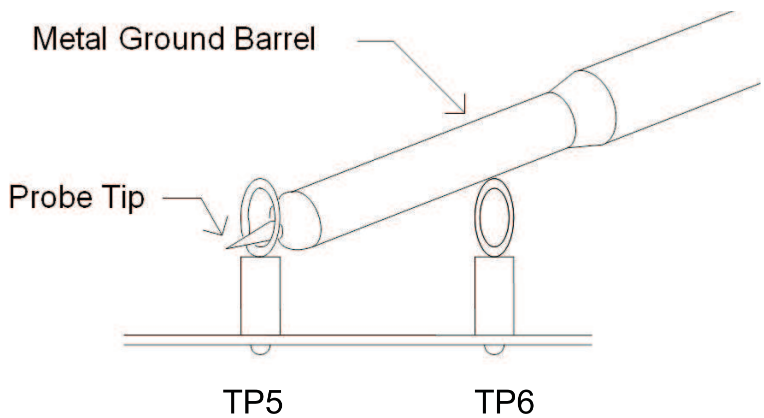

Figure 2. Tip and Barrel Measurement for VOUT Ripple

Fan: Some of the components in this EVM may approach temperatures of 55ºC during operation. A small fan capable of 200 LFM to 400 LFM is recommended to reduce component temperatures while the EVM is operating. The EVM should not be probed while the fan is not running.

Recommended Wire Gauge:

- ***VIN to J1 (1.2-V input):*** The recommended wire size is 1x AWG #14 per input connection, with the total length of wire less than 4 feet (2 feet input, 2 feet return).
- ***J2 to LOAD:*** The minimum recommended wire size is 1x AWG #14, with the total length of wire less than 4 feet (2-feet output, 2-feet return)
- ***V5IN to J3 (5-V input):*** The recommended wire size is 1x AWG #16 per input connection, with the total length of wire less than 4 feet (2-feet input, 2-feet return).

5.2 Recommended Test Setup

Figure 3 is the recommended test set up to evaluate the TPS53317AEVM-726. 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.

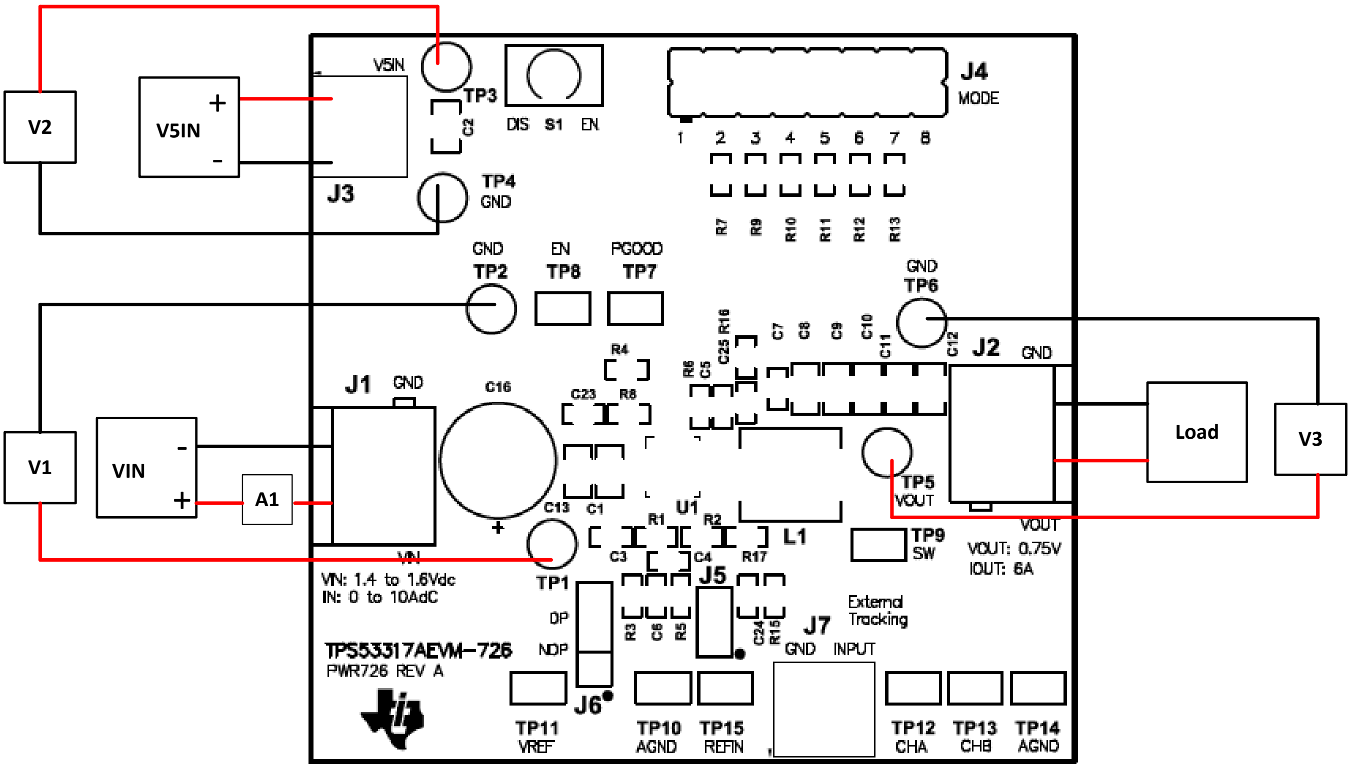

Figure 3. TPS53317AEVM-726 Recommended Test Set Up

Input Connections:

1. Prior to connecting the DC input source VIN, it is advisable to limit the source current from VIN to 8 A maximum. Make sure VIN is initially set to 0 V and connected to J1 as shown in Figure 3.
2. Connect a current meter A1 between VIN and J1 to measure the input current.
3. Connect a voltmeter V1 at TP1 (VIN) and TP2 (PGND) to measure the input voltage.
4. Prior to connecting the 5-V DC source V5IN, it is advisable to limit the source current from V5IN to 1 A maximum. Make sure V5IN is initially set to 0 V and connected to J3 as shown in Figure 3.
5. Connect a voltmeter V2 at TP3 (V5IN) and TP4 (PGND) to measure the V5IN voltage.

Output Connections:

1. Connect Load to J2 and set Load to constant resistance mode to sink 0 A_{DC} before VIN is applied.
2. Connect a voltmeter V3 at TP5 (VOUT) and TP6 (PGND) to measure the output voltage.

Other Connections: Place a Fan as shown in Figure 3 and turn on, making sure air is flowing across the EVM.

6 Configurations

All Jumper selections should be made prior to applying power to the EVM. User can configure this EVM per following configurations.

6.1 Mode Selection

The MODE can be set by J4.

6.1.1 Default setting: MODE5

Table 2. MODE Selection

Jumper Setting	Mode	Mode Resistances (kΩ)	Light-Load Power-Saving Mode	Switching Frequency (kHz)	Overcurrent Limit (OCL) Valley (A)
1st (1-2 pin shorted)	1	0	Skip	600	7.6
2nd (3-4 pin shorted)	2	12		600	5.4
3rd (5-6 pin shorted)	3	22		1000	5.4
4th (7-8 pin shorted)	4	33		1000	7.6
5th (9-10 pin shorted)	5	47	PWM	600	7.6
6th (11-12 pin shorted)	6	68		600	5.4
7th (13-14 pin shorted)	7	100		1000	5.4
8th (15-16 pin shorted)	8	Open		1000	7.6

6.2 Droop/Non-Droop Configuration

The droop function can be configured by J6.

6.2.1 Default Setting: Non-Droop

Table 3. Droop Configuration

Jumper Setting	Droop Configuration
Top(1-2 pin shorted)	Droop
Bottom(2-3 pin shorted)	Non-droop

6.3 External Tracking Selection

The external tracking can be configured by J5. If jumper J5 is shorted, the internal 2-V VREF voltage is used to set the target output voltage to be 0.6 V. If jumper J5 is open, the external reference between 0.9 V to 4.0 V can be applied to J7. The output voltage will be regulated to ½ of the external reference voltage. For example, applying 1.5 V to J7, the output voltage is 0.75 V.

6.3.1 Default setting: No External Tracking

Table 4. External Tracking Configuration

Jumper Setting	External Tracking Configuration
Short	No external tracking
Open	External tracking

6.4 Enable Selection

The controller can be enabled and disabled by S1.

6.4.1 Default setting: Switch to disable the controller

Table 5. Enable Selection

Switch Setting	Enable Selection
DIS	Disable the controller
EN	Enable the controller

7 Test Procedure

7.1 Line/Load Regulation and Efficiency Measurement Procedure

1. Set up EVM as described in Figure 3.
2. Ensure Load is set to constant resistance mode and to sink 0 A_{DC}.
3. Ensure all jumpers and switch configuration settings per Section 6.
4. Increase V5IN from 0 V to 5 V. Using V2 to measure V5IN voltage.
5. Increase VIN from 0 V to 1.2 V. Using V1 to measure VIN voltage.
6. Set switch S1 to EN to enable the controller.
7. Use V3 to measure VOUT voltage, A1 to measure VIN current.
8. Vary Load from 0 A_{DC} to 6 A_{DC}, VOUT should remain in load regulation.
9. Vary VIN from 1.1 V to 1.3 V, VOUT should remain in line regulation.
10. Set switch S1 to DIS to disable the controller.
11. Decrease Load to 0 A.
12. Decrease VIN to 0 V.
13. Decrease V5IN to 0 V.

7.2 Control Loop Gain and Phase Measurement Procedure

TPS53317AEVM-726 contains a 10-Ω series resistor in the feedback loop for loop response analysis.

1. Set up EVM as described in Figure 3.
2. Connect isolation transformer to test points marked TP12 and TP13.
3. Connect input signal amplitude measurement probe (channel A) to TP12. Connect output signal amplitude measurement probe (channel B) to TP13.
4. Connect ground lead of channel A and channel B to TP14.
5. Inject around 40 mV or less signal through the isolation transformer.
6. Sweep the frequency from 100 Hz to 1 MHz with 10 Hz or lower post filter. The control loop gain and phase margin can be measured.
7. Disconnect isolation transformer from bode plot test points before making other measurements (signal injection into feedback may interfere with accuracy of other measurements).

7.3 List of Test Points

Table 6. The Functions of Each Test Points

Test Points	Name	Description
TP1	VIN	Input voltage
TP2	PGND	PGND for VIN
TP3	V5IN	5-V power supply for analog circuits and gate drive
TP4	PGND	PGND for V5IN
TP5	VOUT	Output voltage
TP6	PGND	PGND for VOUT
TP7	PGOOD	Power good
TP8	EN	Enable pin
TP9	SW	Switching node
TP10	AGND	Signal ground
TP11	VREF	Internal 2-V reference voltage output
TP12	CHA	Input A for loop injection
TP13	CHB	Input B for loop injection
TP14	AGND	Signal ground
TP15	REFIN	Target output voltage input

7.4 Equipment Shutdown

1. Shut down VIN
2. Shut down V5IN
3. Shut down Load
4. Shut down FAN

8 Performance Data and Typical Characteristic Curves

Figure 4 through Figure 15 present typical performance curves for TPS53317AEVM-726.

8.1 Efficiency

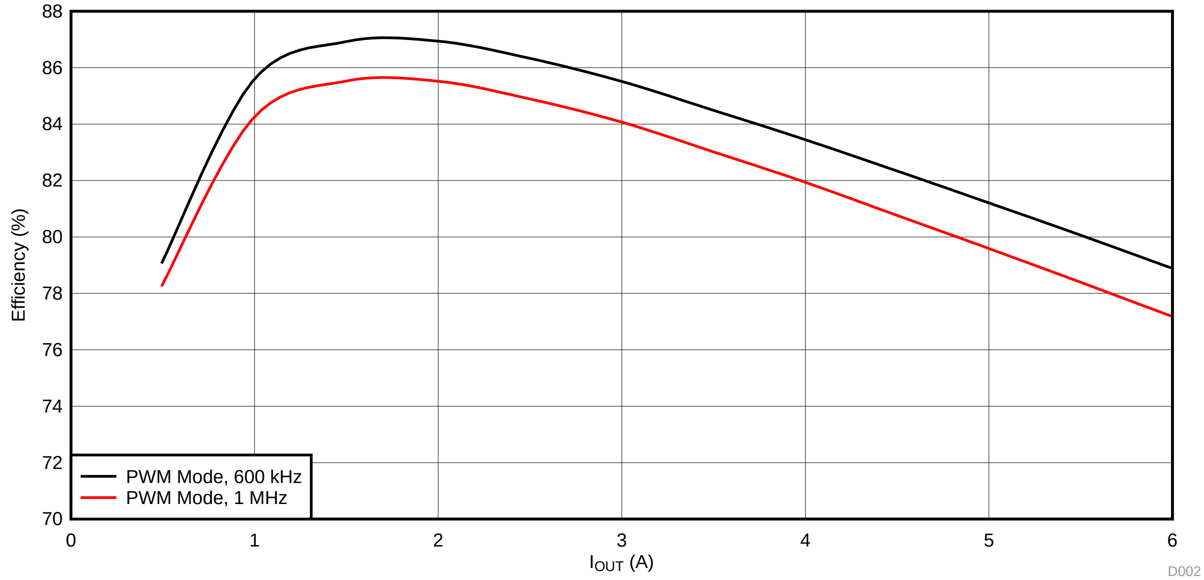

Figure 4. Efficiency

8.2 Load Regulation

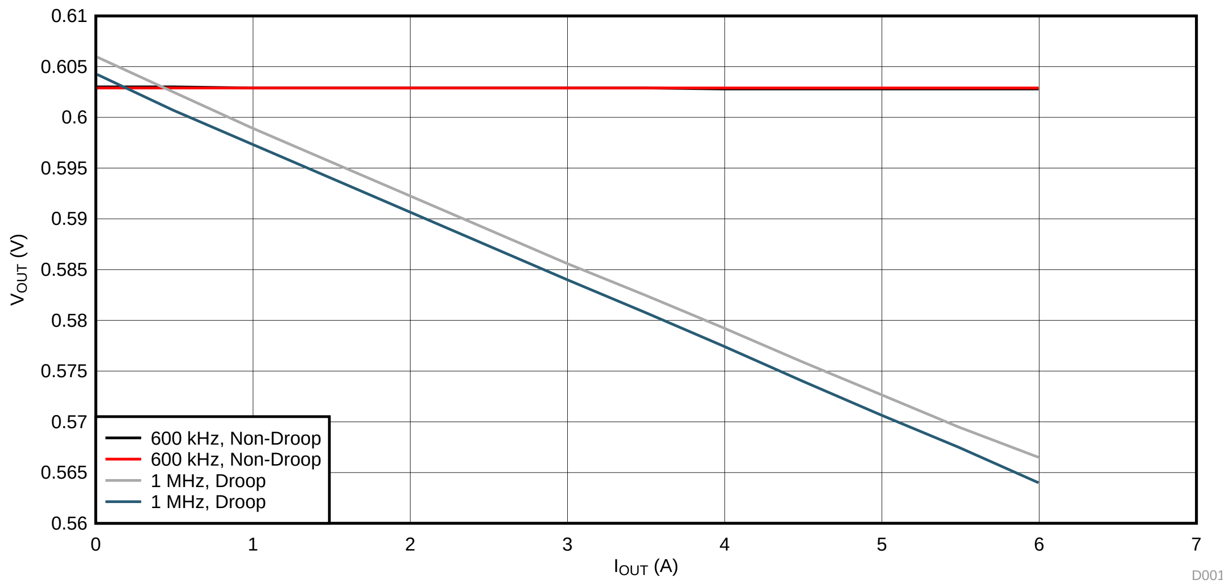

Figure 5. Load Regulation

8.3 Output Transient

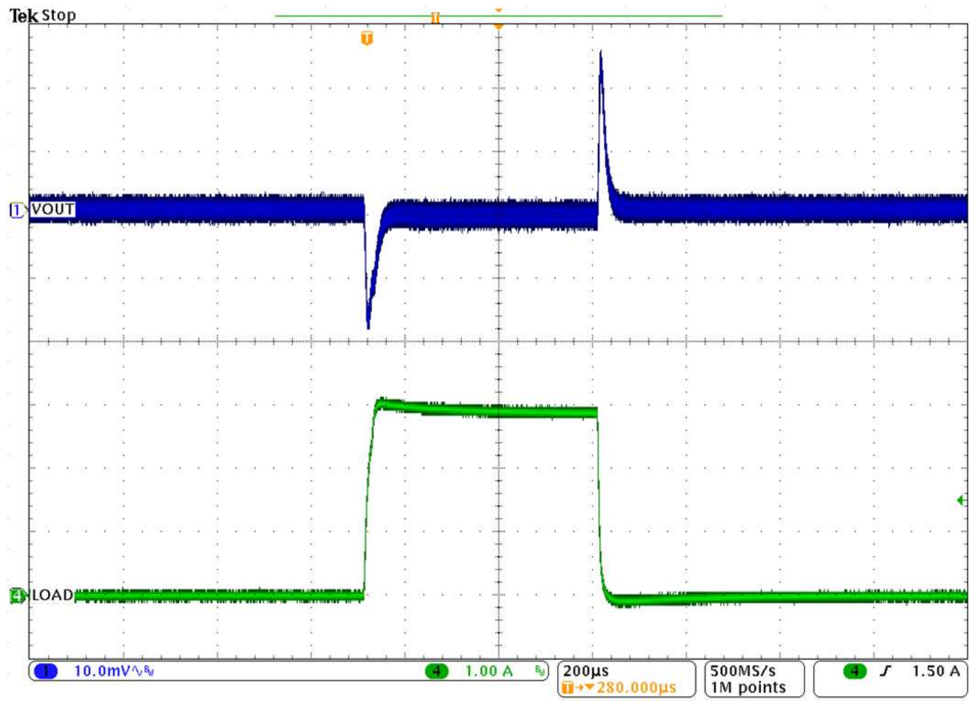

Figure 6. Output Load 0-A to 3-A Transient (1.2-V V_{IN}, 0.6-V V_{OUT}, PWM Mode, f_{SW} = 600 kHz)

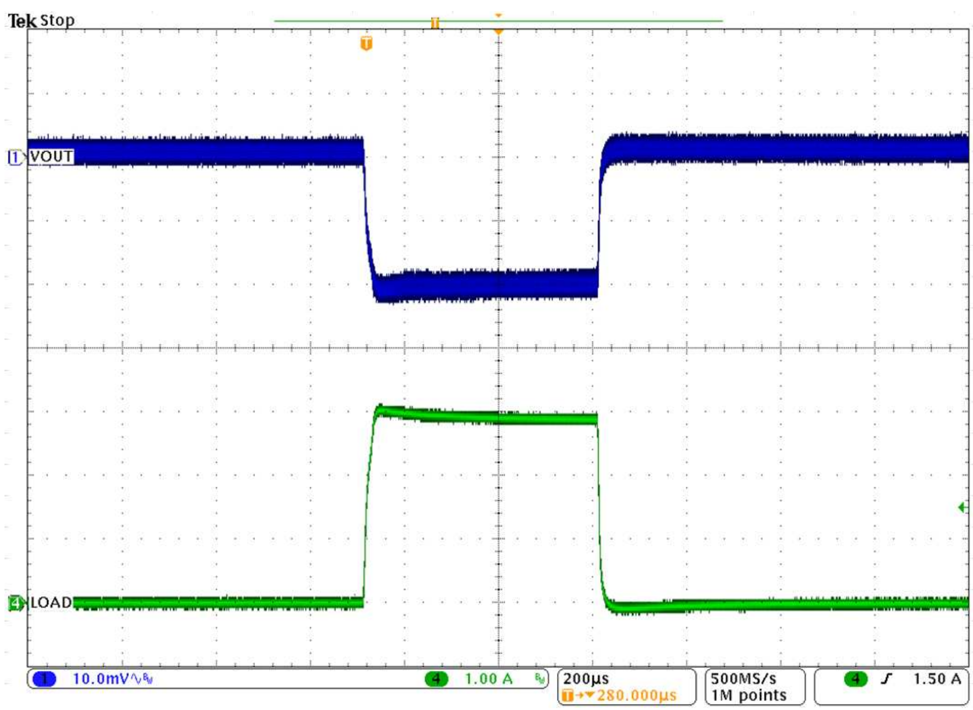

Figure 7. Output Load 0-A to 3-A Transient with Droop (1.2-V V_{IN}, 0.6-V V_{OUT}, PWM Mode, f_{SW} = 600 kHz)

8.4 Output Ripple

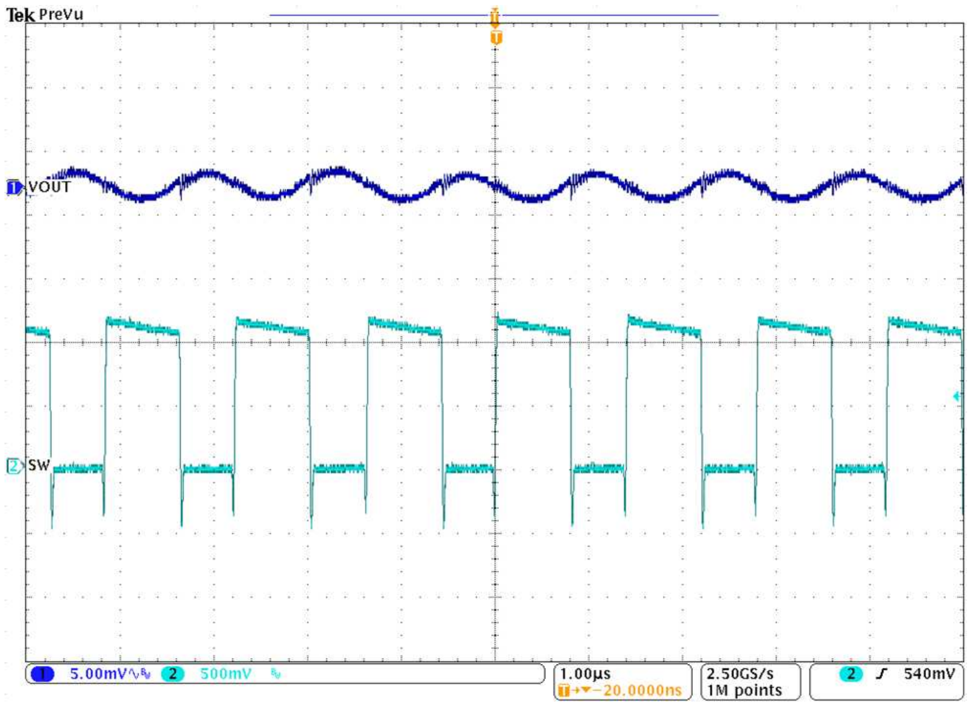

Figure 8. Output Ripple
(1.2-V V_{IN}, 0.6-V V_{OUT}, 3-A I_{OUT}, f_{SW} = 600 kHz)

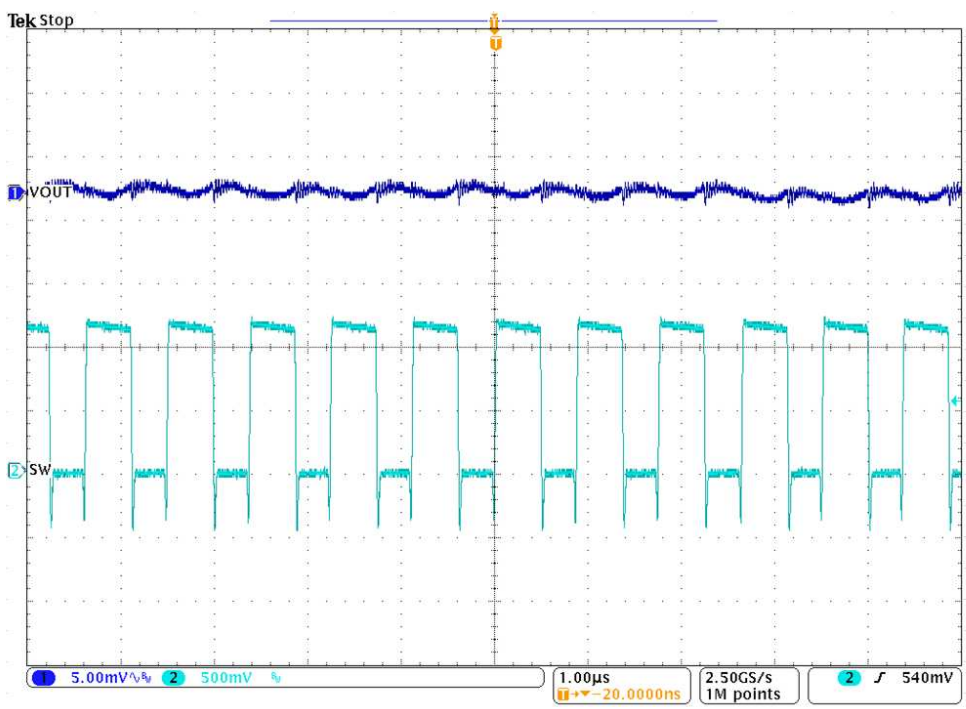

Figure 9. Output Ripple
(1.2-V V_{IN}, 0.6-V V_{OUT}, 3-A I_{OUT}, f_{SW} = 1 MHz)

8.5 Switching Node

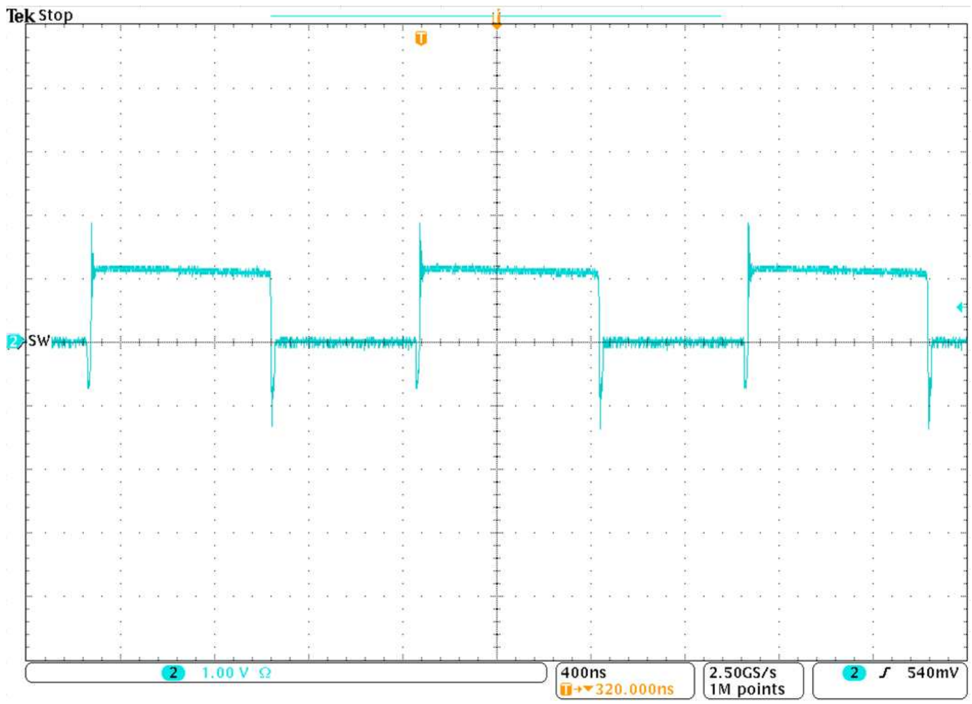

Figure 10. Switching Node
(1.2-V V_{IN}, 0.6-V V_{OUT}, 3-A I_{OUT}, f_{SW} = 600 kHz)

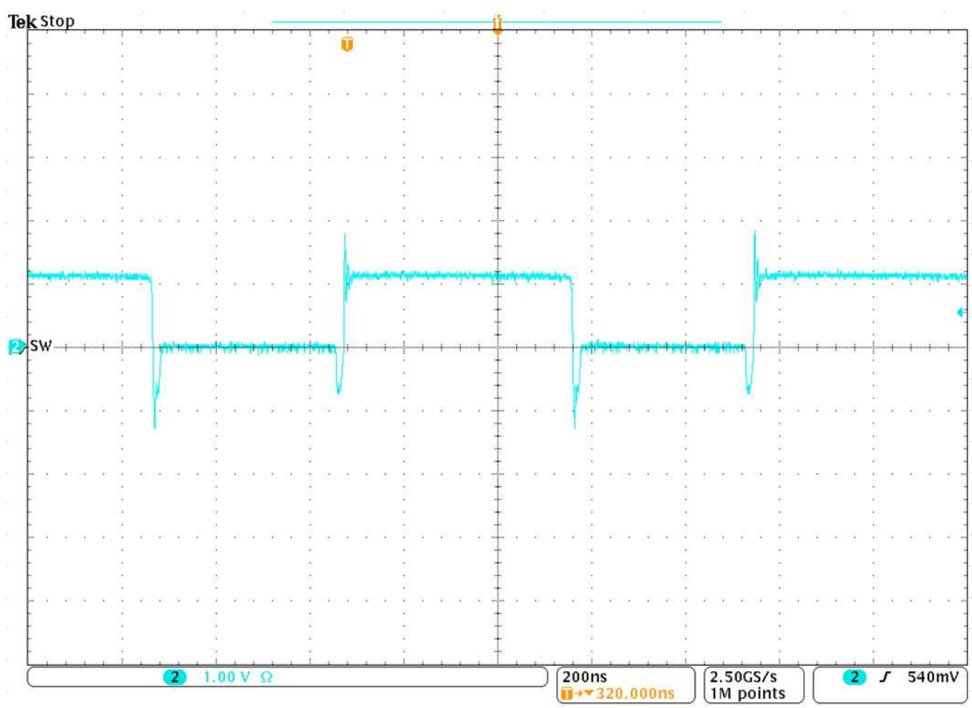

Figure 11. Switching Node
(1.2-V V_{IN}, 0.6-V V_{OUT}, 3-A I_{OUT}, f_{SW} = 1 MHz)

8.6 Enable Turn On / Turn Off

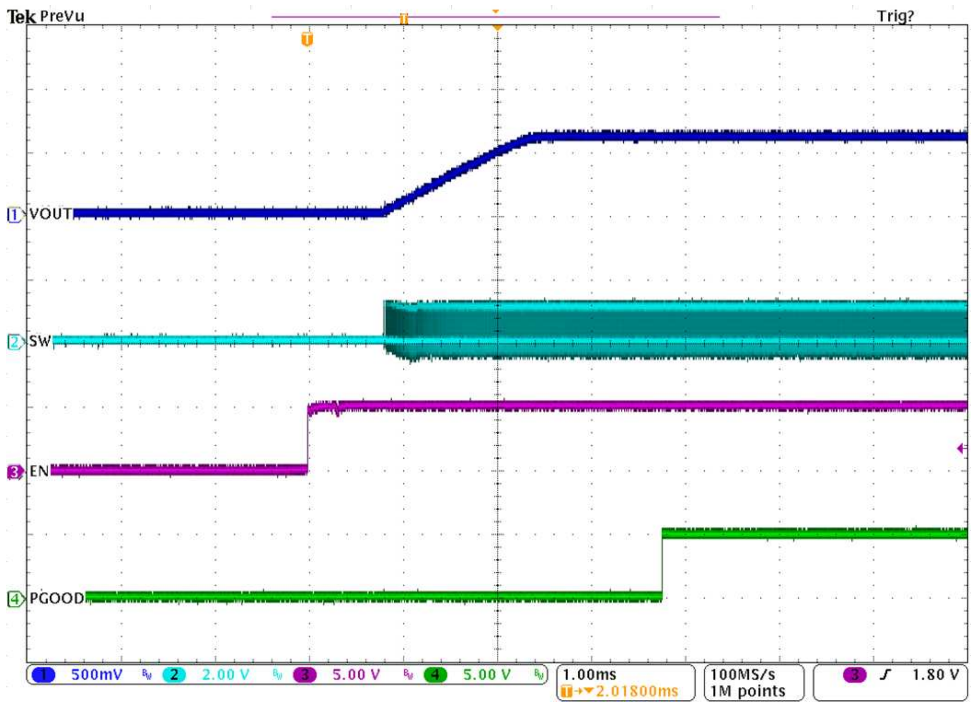

Figure 12. Turn-On Waveform
(1.2-V V_{IN}, 0.6-V V_{OUT}, 3-A I_{OUT})

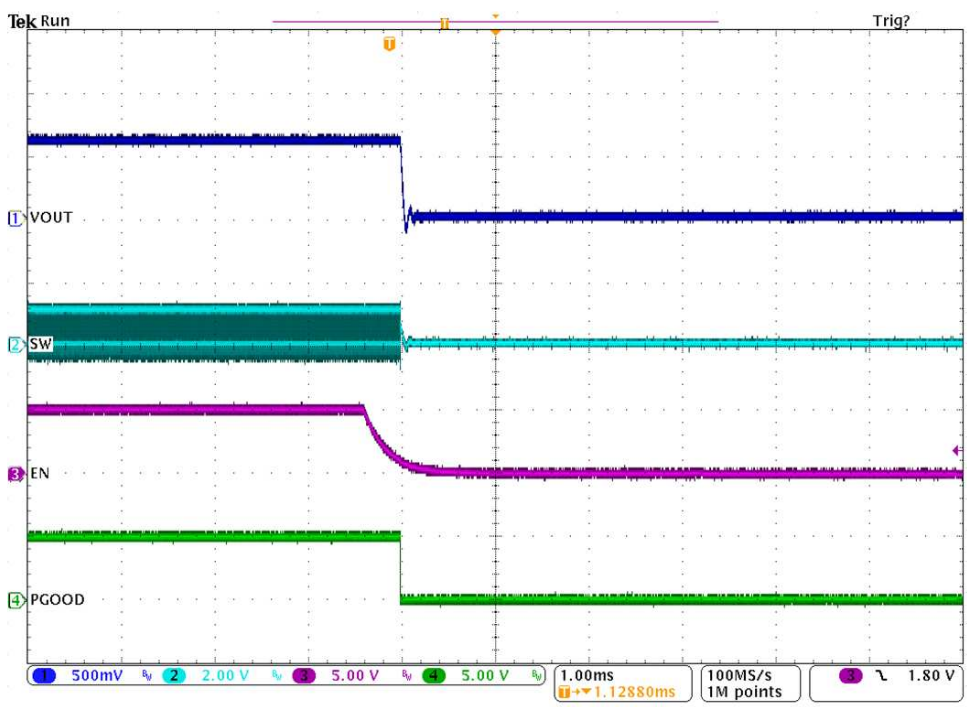

Figure 13. Turn-Off Waveform
(1.2-V V_{IN}, 0.6-V V_{OUT}, 3-A I_{OUT})

8.7 Pre-Bias Turn-On

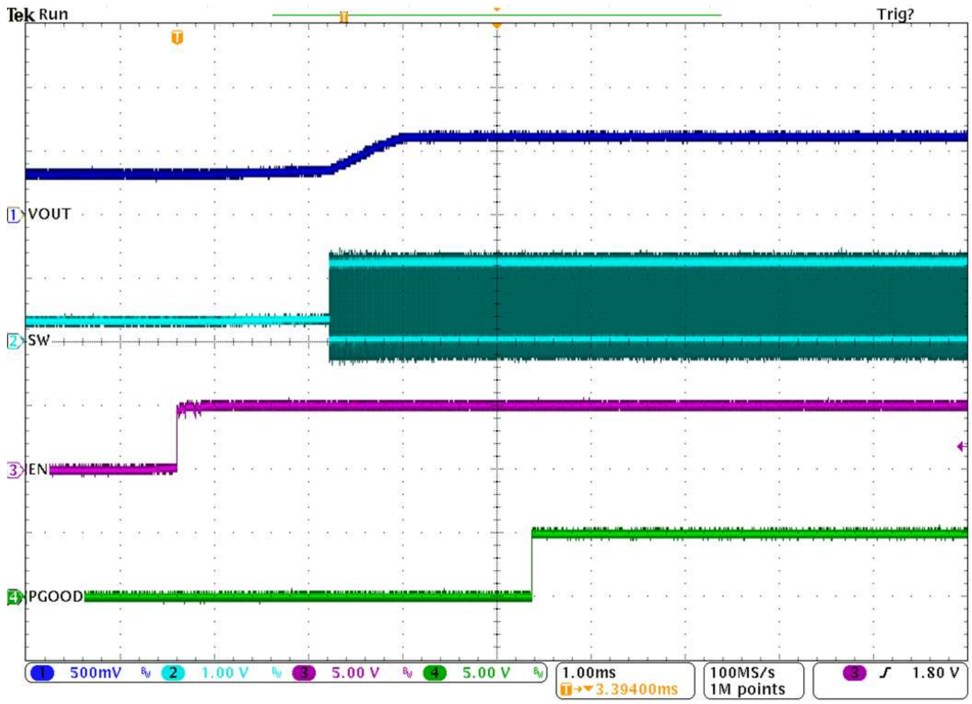

Figure 14. Pre-Bias Turn-On Waveform
(1.2-V V_{IN}, 0.6-V V_{OUT}, 0-A I_{OUT}, 0.3-V Pre-Bias)

8.8 Bode Plot

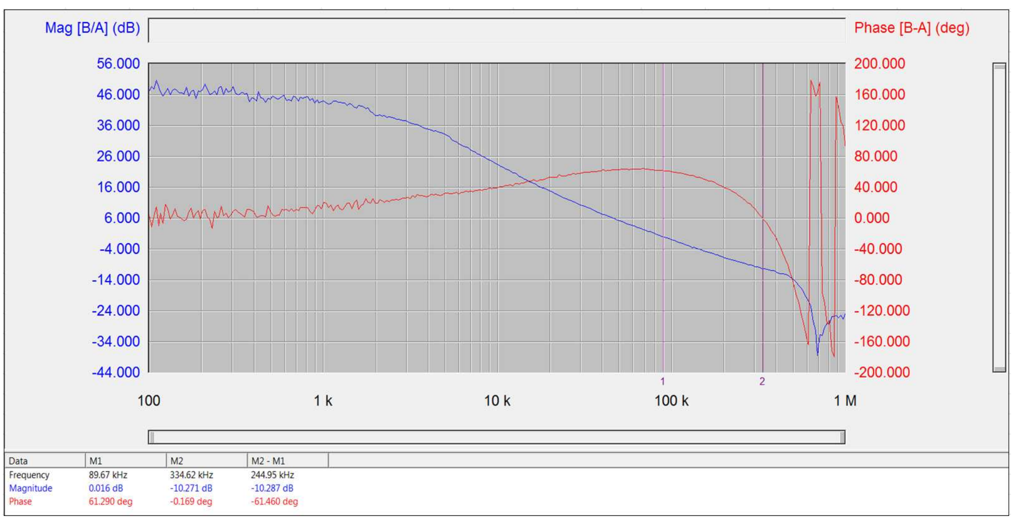

Figure 15. Loop Gain
(1.2-V V_{IN}, 0.6-V V_{OUT}, 3-A I_{OUT}, PWM Mode, f_{SW} = 600 kHz, Non-Droop)

8.9 Thermal Image

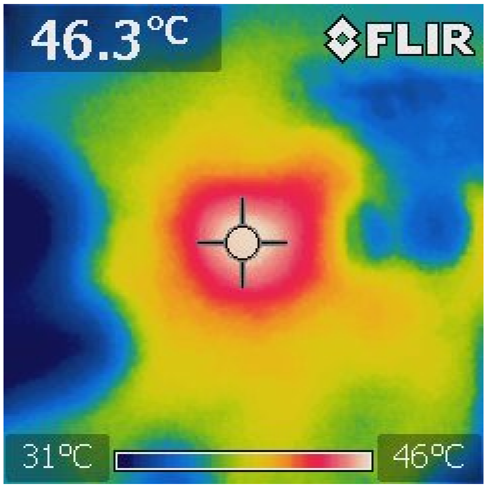

Figure 16. Thermal Image
(1.2-V V_{IN}, 0.6-V V_{OUT}, 6-A I_{OUT}, PWM Mode, f_{SW} = 600 kHz)

9 EVM Assembly Drawing and PCB Layout

The following figures (Figure 17 through Figure 22) show the design of the TPS53317AEVM-726 printed circuit board. The EVM has been designed using 4-Layers, 2-oz copper circuit board.

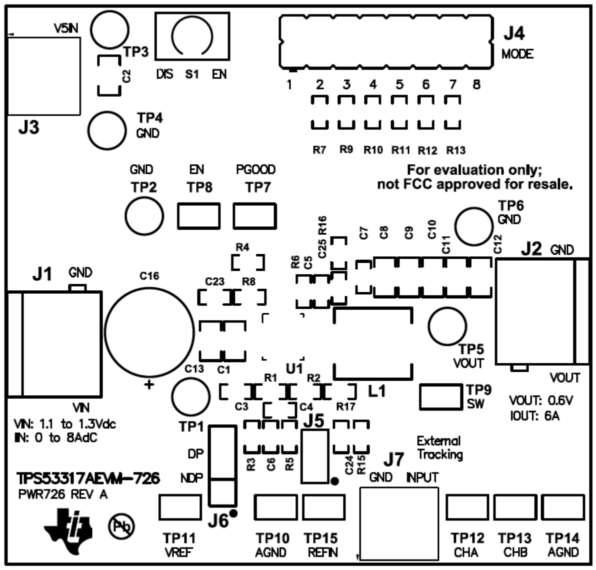

Figure 17. TPS53317AEVM-726 Top Layer Assembly Drawing (Top View)

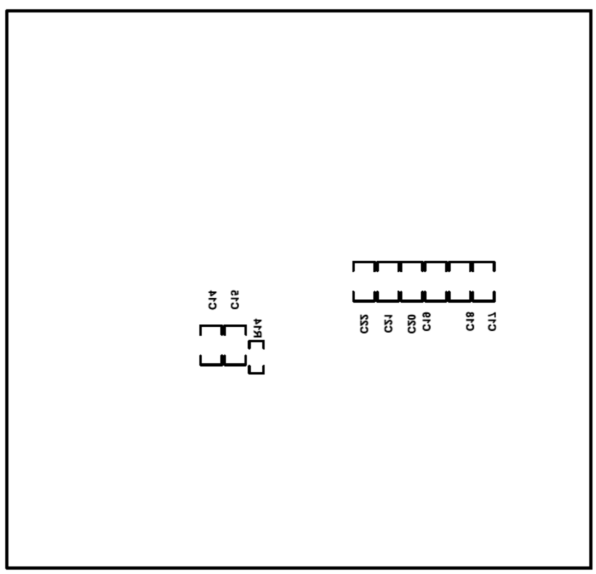

Figure 18. TPS53317AEVM-726 Bottom Assembly Drawing (Bottom View)

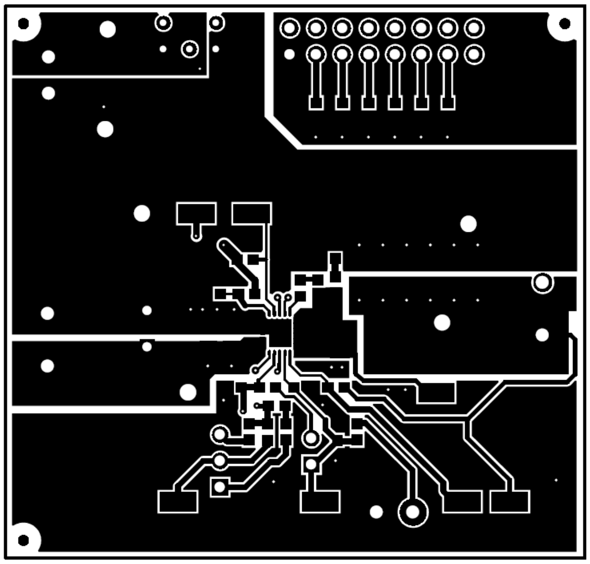

Figure 19. TPS53317AEVM-726 Top Copper (Top View)

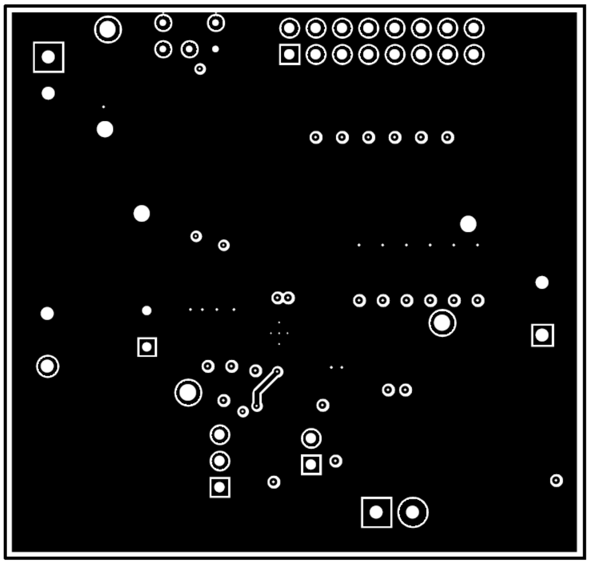

Figure 20. TPS53317AEVM-726 Layer 2 (Top View)

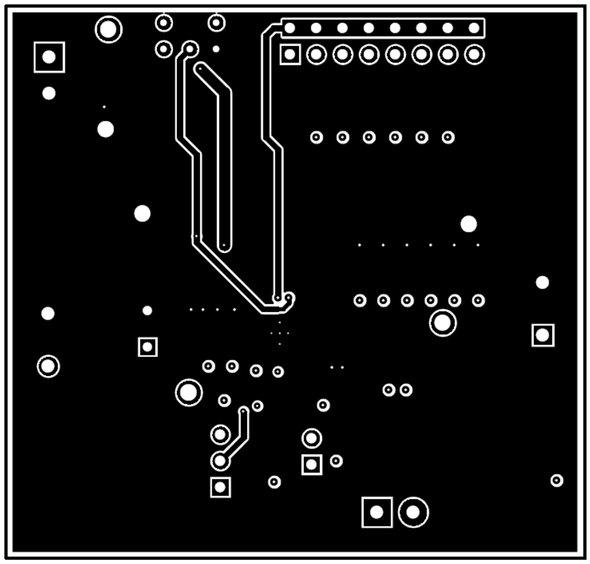

Figure 21. TPS53317AEVM-726 Layer 3 (Top View)

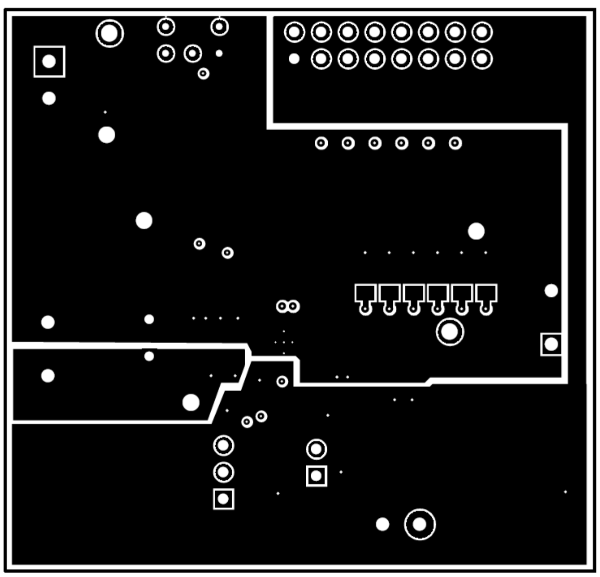

Figure 22. TPS53317AEVM-726 Bottom Layer (Top View)

10 List of Materials

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

Table 7. TPS53317AEVM-726 List of Materials

Qty	Designator	Description	Part Number	Manufacturer
4	C1, C13, C14, C15	CAP, CERM, 10 µF, 16 V, +/- 10%, X5R, 0805	STD	STD
1	C2	CAP, CERM, 10 µF, 10 V, +/- 10%, X5R, 0805	STD	STD
2	C3, C7	CAP, CERM, 1 µF, 25 V, +/- 10%, X5R, 0603	STD	STD
1	C4	CAP, CERM, 2200 pF, 16 V, +/- 10%, X7R, 0603	STD	STD
1	C5	CAP, CERM, 0.1 µF, 25 V, +/- 10%, X7R, 0603	STD	STD
1	C6	CAP, CERM, 68 pF, 50 V, +/- 5%, C0G/NP0, 0603	STD	STD
11	C8, C9, C10, C11, C12, C17, C18, C19, C20, C21, C22	CAP, CERM, 22 µF, 6.3 V, +/- 20%, X5R, 0805	STD	STD
1	C16	CAP, Aluminum Polymer, 330 µF, 10 V, +/- 20%, 0.017 ohm, TH	STD	STD
1	C23	CAP, CERM, 2.2 µF, 10 V, +/- 10%, X5R, 0603	STD	STD
1	C24	CAP, CERM, 0.01 µF, 25 V, +/- 10%, X7R, 0603	STD	STD
2	J1, J2	TERMINAL BLOCK 5.08MM VERT 2POS, TH	ED120/2DS	On-Shore Technology
2	J3, J7	Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	ED555/2DS	On-Shore Technology
1	J4	Header, 2.54 mm, 8x2, Tin, Vertical, TH	PEC08DAAN	Sullins Connector Solutions
1	J5	Header, 100mil, 2x1, Tin, TH	PEC02SAAN	Sullins Connector Solutions
1	J6	Header, 100mil, 3x1, Tin, TH	PEC03SAAN	Sullins Connector Solutions
1	L1	Inductor, Shielded, Ferrite, 250 nH, 19.2 A, 0.0023 ohm, SMD	SPM6530T-R25M230	TDK
1	R1	RES, 23.2 k, 1%, 0.1 W, 0603	STD	STD
2	R2, R15	RES, 10.0 k, 1%, 0.1 W, 0603	STD	STD
1	R3	RES, 7.87 k, 1%, 0.1 W, 0603	STD	STD
1	R4	RES, 100 k, 1%, 0.1 W, 0603	STD	STD
1	R5	RES, 3.92 k, 1%, 0.1 W, 0603	STD	STD
3	R6, R8, R14	RES, 0, 5%, 0.1 W, 0603	STD	STD
1	R7	RES, 12.0 k, 1%, 0.1 W, 0603	STD	STD
1	R9	RES, 22.0 k, 1%, 0.1 W, 0603	STD	STD
1	R10	RES, 33.0 k, 1%, 0.1 W, 0603	STD	STD
1	R11	RES, 47.0 k, 1%, 0.1 W, 0603	STD	STD
1	R12	RES, 68.0 k, 1%, 0.1 W, 0603	STD	STD
1	R13	RES, 100 k, 1%, 0.1 W, 0603	STD	STD
1	R17	RES, 10.0, 1%, 0.1 W, 0603	STD	STD
1	S1	Switch, Toggle, SPDT 1Pos, TH	G12AP	NKK Switches
3	SH-J4, SH-J5, SH-J6	Shunt, 100mil, Gold plated, Black	969102-0000-DA	3M
3	TP1, TP3, TP5	Test Point, Multipurpose, Red, TH	5010	Keystone
3	TP2, TP4, TP6	Test Point, Multipurpose, Black, TH	5011	Keystone
9	TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15	Test Point, Miniature, SMT	5015	Keystone

Table 7. TPS53317AEVM-726 List of Materials (continued)

Qty	Designator	Description	Part Number	Manufacturer
1	U1	6-A Output D-CAP+ Mode Synchronous Step-Down, Integrated-FET Converter for DDR Memory Termination	TPS53317ARGBR	Texas Instruments

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FCC Warning

This evaluation board/kit 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 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments 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.

EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of and the output voltage range of .

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 . The EVM is designed to operate properly with certain components above 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

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.

【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。

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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:*

   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 ANDCONDITIONS 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.

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