

EVM User's Guide: TPS7A78EVM-041

TPS7A78EVM-041 Evaluation Module



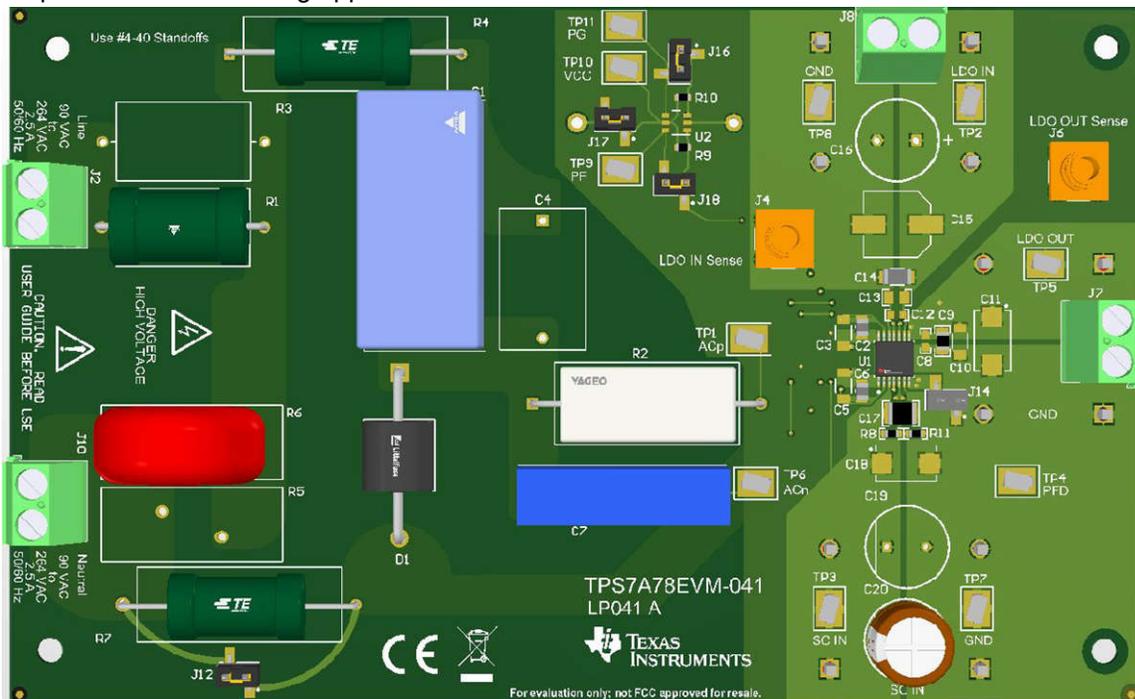
Description

Texas Instruments' TPS7A78EVM-041 helps design engineers evaluate the operation and performance of the TPS7A78 smart linear voltage regulator for possible use in their own circuit application. This particular EVM is intended for evaluation purposes and is not intended to be an end product. The EVM configuration contains a single 3.6-V output regulator optimized for e-metering applications. The

TPS7A78EVM-041 regulates V_{AC} supply to 3.6-V DC supply and can source up to 30 mA (max) current.

Features

- Non-isolated power device for VAC 90-264VAC
- Supports output voltages from 1.25V to 5 V
- Cap-drop capacitor can be 1/4th the size of traditional devices
- Power good



TPS7A78EVM-041 PCB

1 Evaluation Module Overview

1.1 Introduction

The EVM also features a power-fail detection signal and a power-good indication signal to warrant a V_{AC} supply failure and to indicate to a microcontroller (MCU) that the regulated DC voltage is greater than 90% of the targeted regulation DC voltage.

This user's guide describes the operational use of the TPS7A78EVM-041 evaluation module (EVM) to evaluate a wide range of applications, and must not be used as a reference design for optimized minimum size devices. The EVM is built to be used for the demonstration and evaluation of the TPS7A78, non-isolated smart linear voltage regulator (LDO). Included in this user's guide are setup and operating instructions, thermal and layout guidelines, a printed circuit board (PCB) layout, a schematic diagram, pre-compliance surge voltage survival data, and a bill of materials (BOM).

Throughout this document, the terms *demonstration kit*, *evaluation board*, and *evaluation module* are synonymous with the TPS7A78EVM-041.

1.2 Kit Contents

The purchase of this EVM kit includes 1 TPS7A78EVM-041 circuit board, EVM disclaimer note, High Voltage read me literature, all surrounded by anti-static foam in a cardboard box.

1.3 Specification

This evaluation module has been created to help engineering testing occur on the TPS7A78. The device has not been designed as a reference design for optimized minimum size devices and must not be utilized as such. This module allows the user to test both Full-Bridge (FB) configurations, as well as Half-Bridge (HB) configurations. See [Section 2.2.12](#) for more information on setup. The EVM comes preset to be operated in the HB configuration.

1.4 Device Information

This EVM contains one TPS7A78 120-mA smart AC/DC LDO linear voltage regulator to be evaluated under varying usage conditions.

The following related documents are available through the Texas Instruments web site at www.ti.com.

Table 1-1. Related Documentation

Device	Literature Number
TPS7A78	SBVS343

2 Hardware

2.1 Setup

Operate the test equipment using the following steps:

1. Turn on the AC power supply.
2. Vary the respective load and input voltage, as necessary, for test purposes.

2.1.1 Full-Bridge (FB) Test Equipment Connection

Figure 2-1 shows a FB connection diagram.

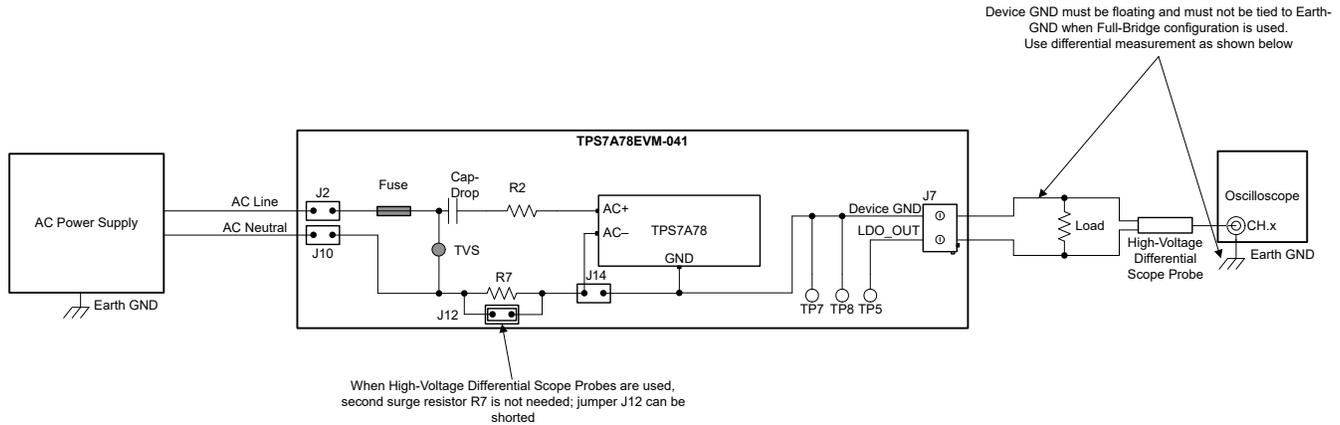


Figure 2-1. Proper Test Equipment Connections for the FB EVM Configuration

2.1.2 Half-Bridge (HB) Test Equipment Connection

Figure 2-2 shows a HB connection diagram.

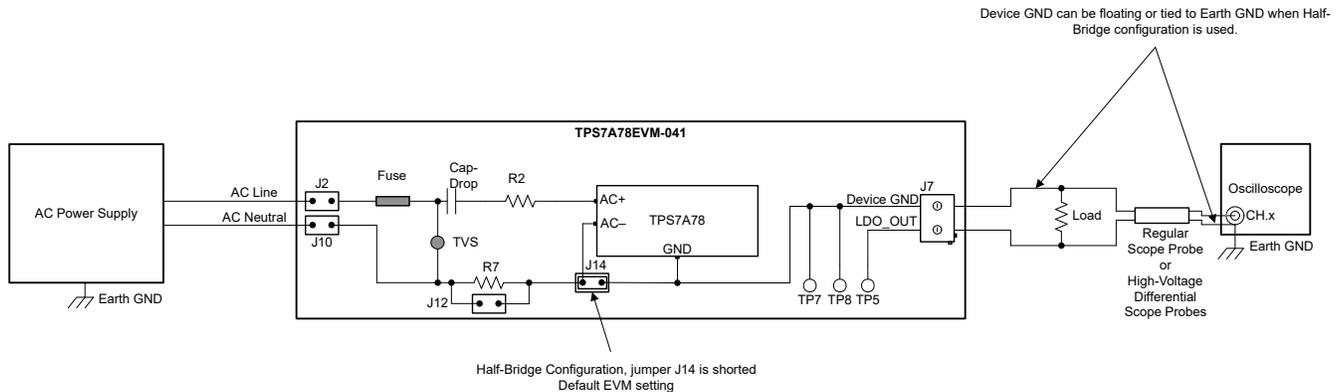


Figure 2-2. Proper Test Equipment Connections for the Half-Bridge (HB) EVM Configuration

To verify proper connectivity:

1. Set the AC input power supply to 120 V_{AC} and 60 Hz, and turn the power supply off.
2. Connect the line lead from the AC power supply to the line pin on the J2 connector of the EVM.
3. Connect the neutral lead from the AC power supply to the neutral pin on the J10 connector of the EVM.
4. Connect a 0-mA to 30-mA load between J3 connector, to LDO_OUT, and J11 connector, to GND, of the EVM.

2.2 Jumper Information

2.2.1 J1: LDO_IN

LDO Input Jumper, connect supply to this jumper to provide LDO_IN pin with the input voltage.

2.2.2 J2: Line VAC

J2 is a screw terminal allowing access to Line VAC to provide VAC voltage to the device. These rails can be supplied with 90-264 VAC up to 2.5A 50/60Hz. Input AC power-supply connector. Make sure that the AC input power supply is turned off before making the connection to the EVM. The AC supply line lead must be connected to the line pin on the J2 connector, whereas the neutral lead must be connected to the neutral pin on the J10 connector to verify proper operation of the TPS7A78 LDO.

Note

If the AC supply line and neutral leads are flipped when connected to the J2 connector, then the TPS7A78 device GND pin is referenced to the AC supply line and only floating measurement equipment must be used.

2.2.3 J3: LDO_OUT

J3 is connected to the LDO_OUT signal of the LDO. This is where the load for the LDO regulated output rail is to be connected. The regulated output can supply up to 300 mA at a maximum voltage of 5.5V.

2.2.4 J4: LDO_IN Sense

J4 is an SMA connector that is a kelvin connection to sense the LDO_IN rail for measurement purposes.

2.2.5 J5: SCIN

J5 is the banana plug connected to the SCIN pin of the device allowing the pin to be driven effectively.

2.2.6 J6: LDO_OUT Sense

J6 is an SMA connector that is a kelvin connection to sense the LDO_OUT rail for measurement purposes.

2.2.7 J7: LDO_OUT/GND

J7 is a screw terminal allowing for alternate load connections to the LDO_OUT regulated output rail.

2.2.8 J8: LDO_IN/GND

J8 is a screw terminal allowing for alternate connections to the LDO_IN input rail and GND.

2.2.9 J9, J11, J13: GND

J9, J11, and J13 are all banana connectors to the GND plane on the board and device.

2.2.10 J10: Neutral VAC

J10 is a screw terminal allowing access to the Neutral portion of VAC to provide VAC voltage to the device. These rails can be supplied with 90-264 VAC up to 2.5A 50/60Hz.

2.2.11 J12: Second Surge Resistor Jumper

J12 is a 2 pin header allowing the bypass of the R7 surge resistor that is not required for operation.

2.2.12 J14: Full-Bridge (FB) and Half-Bridge(HB) Configurations

This EVM comes configured for half-bridge (HB) configuration usage, when J14 jumper is connected. However, to use the full-bridge (FB) configuration, leave jumper J14 open. HB configuration is achieved by tying VAC neutral to the TPS7A78 device GND pin, whereas in FB configuration VAC neutral is connected to the AC- pin and the device GND pin tracks VAC neutral and therefore must be floating.

2.2.13 J15: LDO Pin test header

J15 contains a header that is tied to each of the pins on the device allowing for test and debug analysis in the case of operational failure.

2.2.14 J16 and J18: Power-Good (PG) and Power-Fail (PF) Signals

The TPS7A78 device has two open-drain signals (power-good and power-fail) that are both pulled up to VLDO_IN by default. Because of the high-impedance open-drain logic, the AC supply frequency noise can be present on those signals when pulled high. A low-impedance digital buffer isolation circuit is recommended, such as the U2 device that is depopulated on the default EVM setup, to obtain noise-free PG and PF signals. Jumpers J16 and J18 connect the device PG and PF signals directly to the TP11 and TP9 test points because the digital buffer circuit is not populated with the default EVM setting.

2.2.15 J17: Coin Cell Buffer VCC Jumper

J17 contains a jumper that allows the VCC pin of the buffer to be connected to the coin cell footprint placed on this layout. This allows battery supply to the buffer for clean regulated power.

Note

When an external DC voltage is used to pullup the PG and PF pins, this external supply must be a floating supply when FB configuration is used. For HB configuration, the device GND can be tied to Earth-GND, and the external pullup supply can be referenced to the device GND.

2.3 Test Points

Table 2-1. Test Point Functions

TEST POINTS	NAME	DESCRIPTION
TP1	AC+	AC supply line input to the device after the cap-drop capacitor and surge resistor.
TP2	LDO_IN	Charge-pump output pin
TP3	SC_IN	Rectified DC voltage pin; see the TPS7A78 Application and Implementation section for the proper setting of your application requirement.
TP4	PFD	Power-fail detect pin.
TP5	LDO_OUT	Regulated DC output pin.
TP6	AC-	AC supply neutral input to the device after the cap-drop capacitor and surge resistor.
TP7	GND	Device GND connected to the thermal pad.
TP8	GND	
TP9	PF	Power-fail pin.
TP10	Buffer VCC	VCC pin of the buffer circuitry.
TP11	PG	Power-good pin.

3 Implementation Results

3.1 Performance Data and Results

Table 3-1 lists the electrical specifications for the TPS7A78EVM-041 evaluation module.

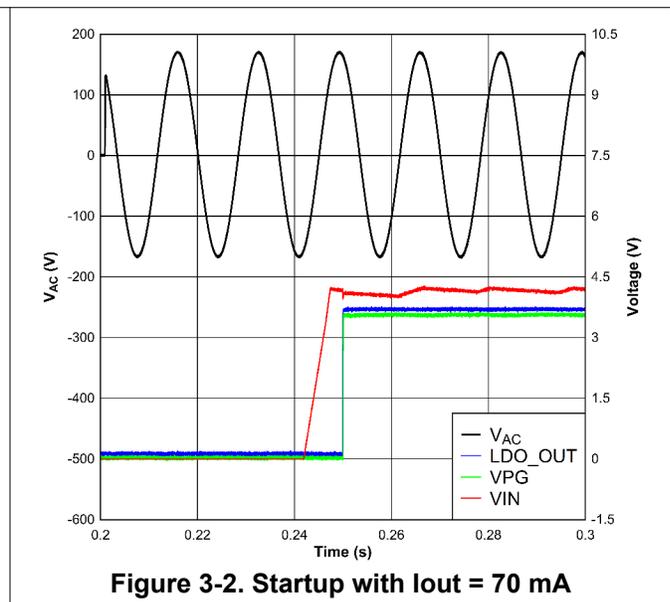
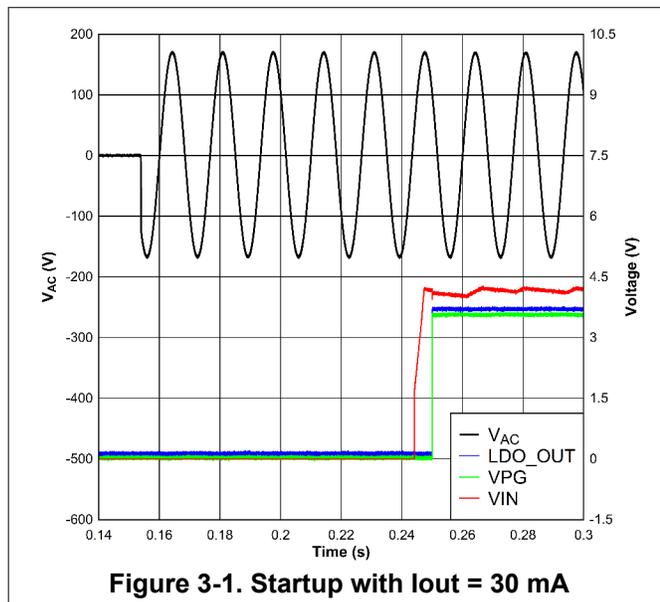
Table 3-1. TPS7A78EVM-041 Electrical Performance Specifications⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS					
V_{AC}	AC input (RMS)	90	120	264	V
f_{AC}	Line frequency HB/FB		30/60		Hz
OUTPUT CHARACTERISTICS					
V_{LDO_OUT}	Output voltage	$V_{AC} = 120\text{ V (60 Hz)}$	3.6	3.699	V
V_{LDO_OUT} ripple	Output ripple voltage	$V_{AC} = 120\text{ V (60 Hz)}$	10		mVpp
I_{OUT}	Output current	$V_{AC} = 120\text{ V (60 Hz)}$	3	55 ⁽³⁾	mA

- (1) All measurements are done with a half-bridge (HB) default EVM setting 25 or 30 Hz (unless otherwise noted). 50 and 50 Hz figures are associated with the full-bridge (FB) configuration.
- (2) Output current level is determined by the size of the cap-drop (C_{15}), the size of the bulk capacitor (C_8), and the device configuration. When V_{AC} is 70 V (60 Hz), the EVM can source 16 mA (max); see Section 2.1 for EVM configuration and proper connection of test equipment.
- (3) When V_{AC} is 120 V (60 Hz), the EVM can source 55 mA (max) with a full-bridge configuration.

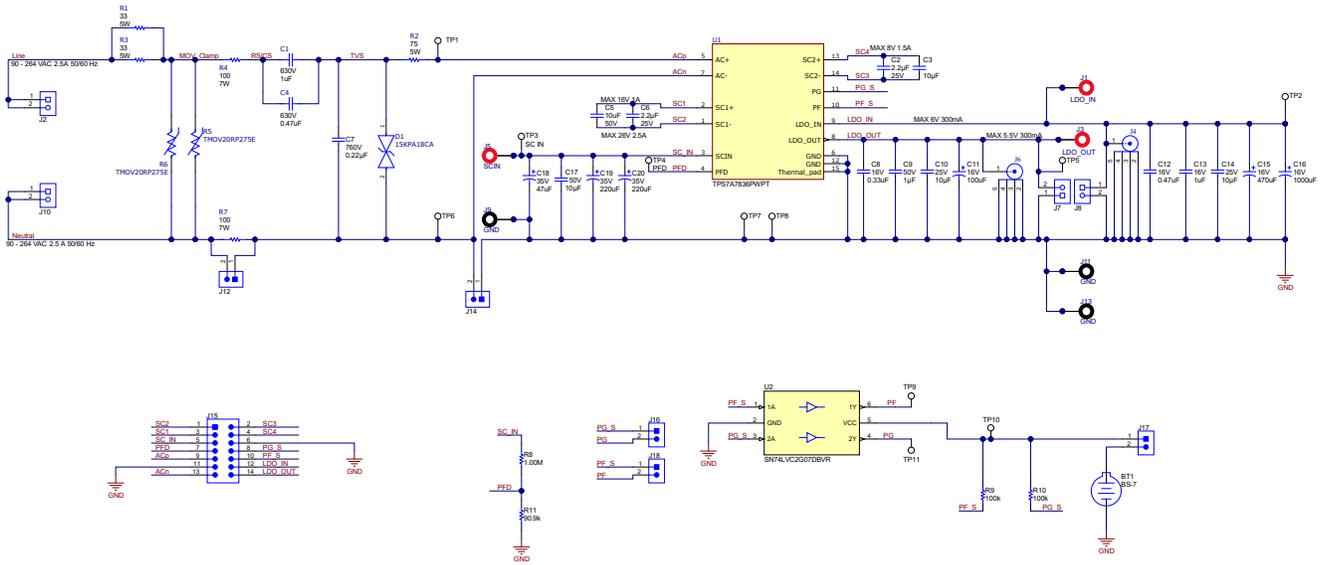
Startup

Two examples of typical startup behavior for the TPS7A78EVM-041 are shown below. Figure 3-1 showcases startup with the maximum rated output current of 30 mA. Figure 3-2 showcases startup and output current of 70 mA. While the EVM has only been designed up to 30 mA, the second startup shows that, with proper configuration, the EVM can be utilized to cover the full current spectrum of the TPS7A78 device.



4 Hardware Design Files

4.1 Schematic



4.2 PCB Layouts

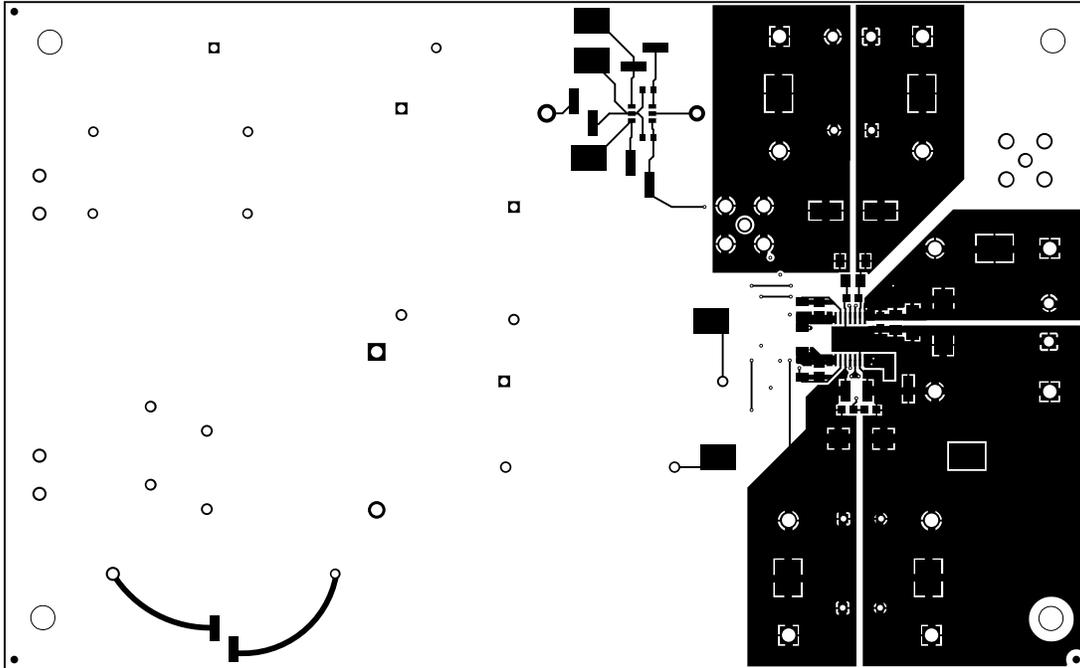


Figure 4-2. Top Layer

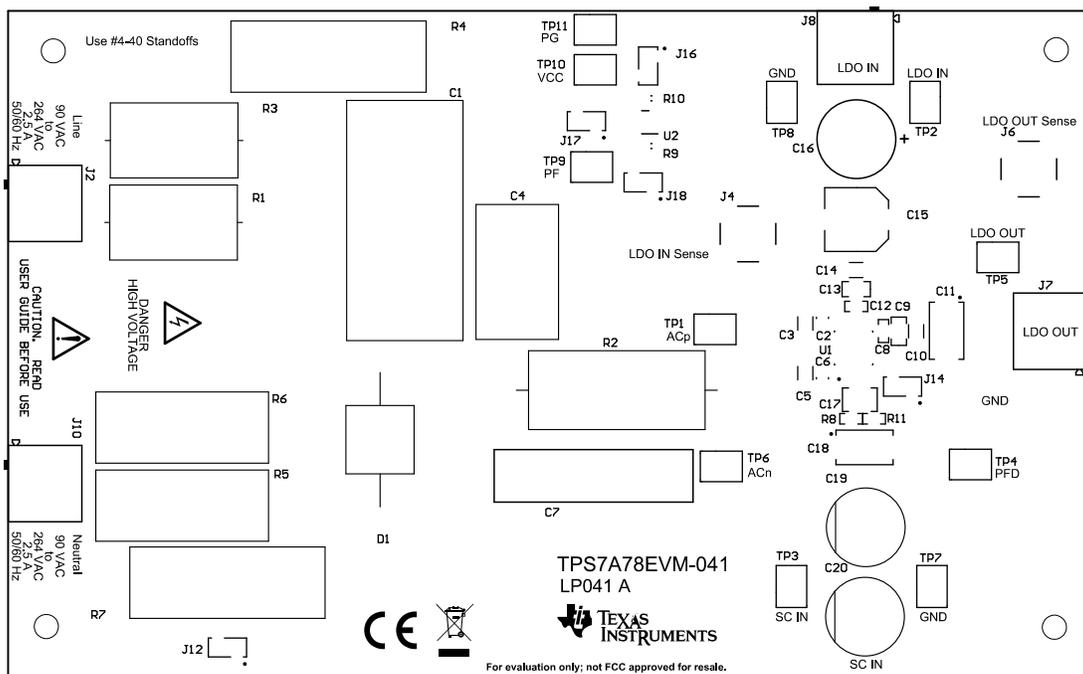


Figure 4-3. Top Layer Overlay

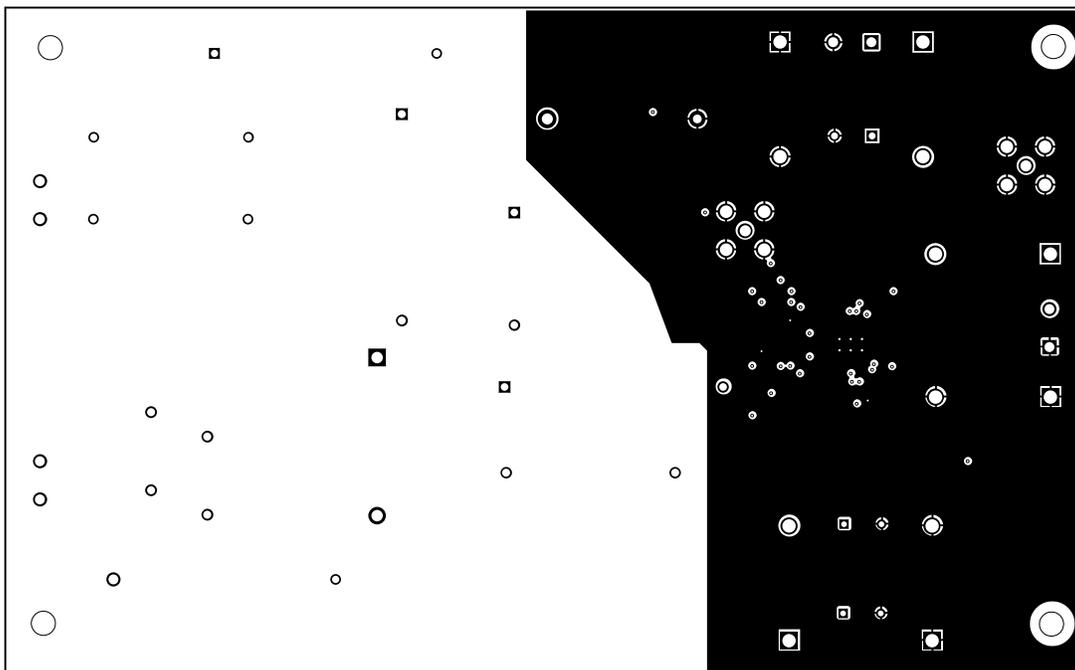


Figure 4-4. Signal Layer 2

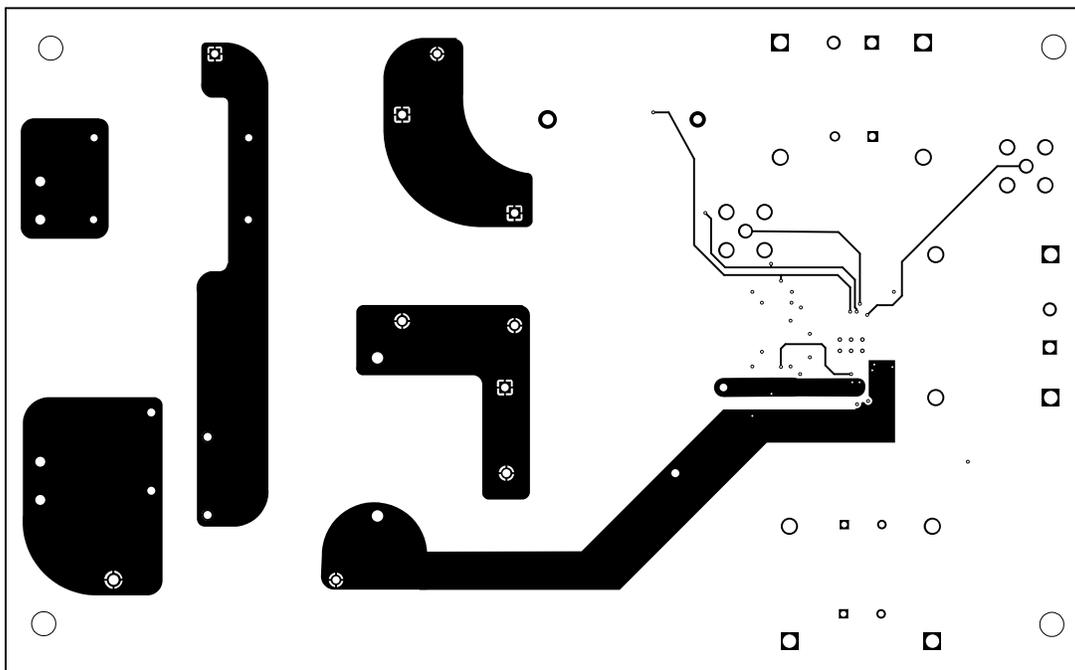


Figure 4-5. Signal Layer 3

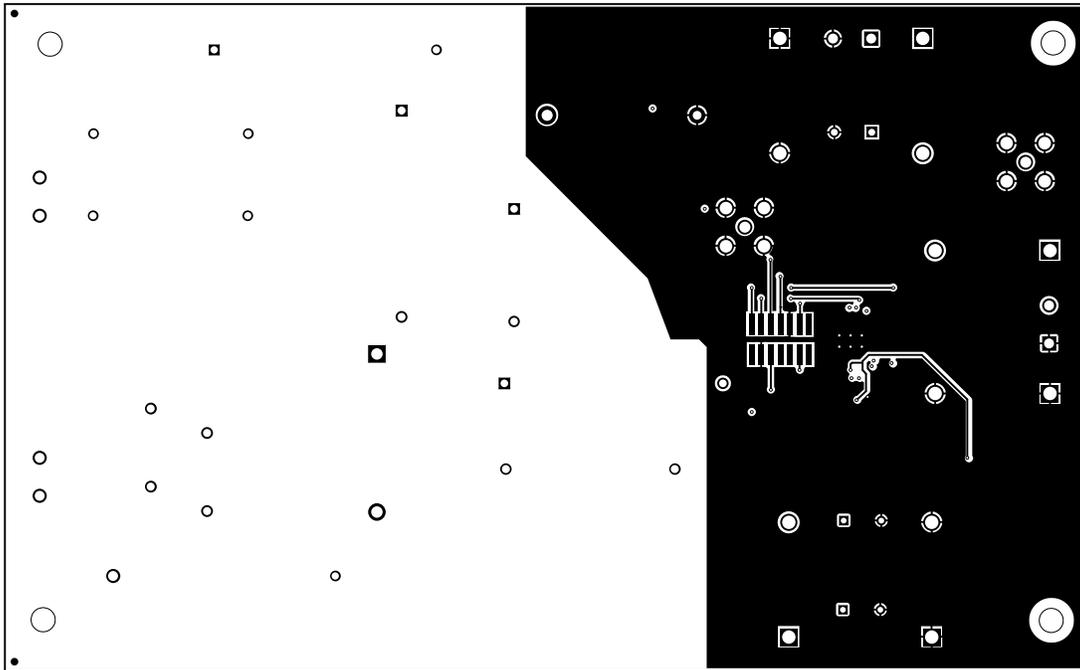


Figure 4-6. Bottom Layer

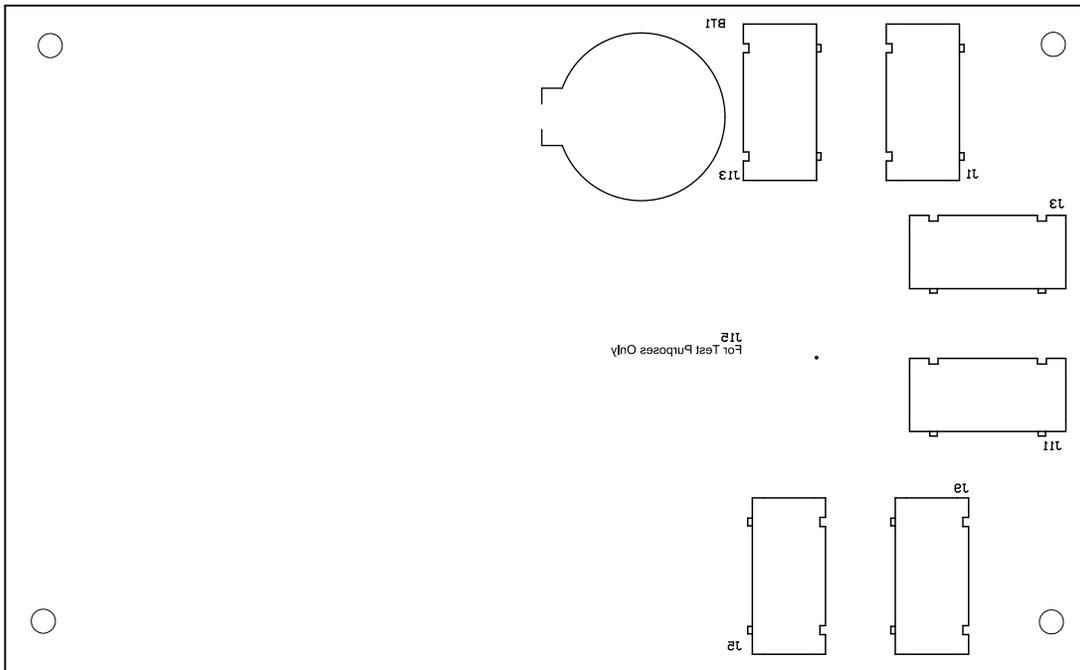


Figure 4-7. Bottom Layer Overlay

4.3 Bill of Materials (BOM)

Table 4-1. TPS7A78EVM-041 BOM

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		LP041	Any		
C1	1	1 μ F	Cap Film 1 μ F 310VAC PET 10% 31.5 X 15 X 25 mm RDL 27.5mm Bulk	RADIAL	F17725102000	Vishay		
C2, C6	2	2.2 μ F	CAP, CERM, 2.2 μ F, 25 V, +/- 10%, X7R, 0805	0805	08053C225KAT 2A	AVX		
C7	1	0.22 μ F	CAP, Film, 0.22 μ F, X1 330 VAC, +/- 10%, TH	26.5x7mm	B32913A3224K 000	TDK		
C9	1	1 μ F	CAP, CERM, 1 μ F, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0805	0805	GCM21BR71H 105KA03K	MuRata		
C14	1	10 μ F	CAP, CERM, 10 μ F, 25 V,+/- 10%, X7R, 1206	1206	C3216X7R1E1 06K160AB	TDK		
C17	1	10 μ F	CAP, CERM, 10 μ F, 50 V,+/- 10%, X7R, 1210	1210	CL32B106KBJ NNWE	Samsung Electro- Mechanics		
C20	1	220 μ F	220 μ F 35 V Aluminum Electrolytic Capacitors Radial, Can 7000 Hrs @ 105°C	RADIAL	EKY-350ELL22 1MJC5S	United Chemi- Con		
D1	1		30.9V Clamp 488.7A Ipp Tvs Diode Through Hole P600	AXIAL	15KPA18CA	Littelfuse Inc		
FID1, FID2, FID3, FID4, FID5, FID6	6		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
J1, J3, J5	3		Standard Banana Jack, insulated, 10 A, red	571-0500	571-0500	DEM Manufacturing		
J2, J7, J8, J10	4		Terminal Block, 5.08 mm, 2x1, TH	2POS Terminal Block	1715721	Phoenix Contact		
J4, J6	2		SMA Straight Jack, Gold, 50 Ohm, TH	SMA Straight Jack, TH	901-144-8RFX	Amphenol RF		
J9, J11, J13	3		Standard Banana Jack, insulated, 10 A, black	571-0100	571-0100	DEM Manufacturing		
J12, J14, J16, J17, J18	5		Header, 100mil, 2x1, Tin, SMD	SMD, 2-Leads, Body 200x100mil	TSM-102-01-T- SV-P-TR	Samtec		
R1	1	33	33 Ohms \pm 5% 5W Through Hole Resistor Axial Flame Retardant Coating, Fusible, Pulse Withstanding, Safety Wirewound	AXIAL	AC050000B330 9J6BCS	Vishay		
R2	1	75	75 Ohms \pm 5% 5W Through Hole Resistor Axial Anti- Arc, Flame Proof, Moisture Resistant, Safety Wirewound	AXIAL	SQP500JB-75R	Yageo		

Table 4-1. TPS7A78EVM-041 BOM (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R4, R7	2	100	100 Ohms \pm 5% 7W Through Hole Resistor Axial Flame Retardant Coating, Pulse Withstanding, Safety Wirewound	AXIAL	EP7WS100RJ	TE		
R6	1		430 V 10 kA Varistor 1 Circuit Through Hole Disc 20 mm	RADIAL	TMOV20RP275 E	Littelfuse		
R8	1	1.00Me g	RES, 1.00 M, 1%, 0.1 W, 0603	0603	RC0603FR-071 ML	Yageo		
R9, R10	2	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100 KFKEA	Vishay-Dale		
R11	1	90.9k	RES, 90.9 k, 1%, 0.1 W, 0603	0603	RC0603FR-079 0K9L	Yageo		
SH-J1, SH- J2, SH-J3, SH-J4	4	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000 -DA	3M
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11	11		Test Point, Compact, SMT	Testpoint_Keysto ne_Compact	5016	Keystone		
U1	1		Linear Voltage Regulator IC 1 Output 120 mA 14-HTSSOP	HTSSOP14	TPS7A7836PW PT	Texas Instruments		

5 Compliance Information

The TPS7A78EVM-041 has undergone pre-compliance testing for ESD, Surge, and Conducted Emissions, and has passed the tests, as specified in [Section 5.1](#).

5.1 Compliance and Certifications

Precompliance for EMI and Conducted Emissions

The TPS7A78EVM-041 has completed pre-compliance testing for Conducted Emissions using two different input filters. [Section 5.1.1](#) provides passing test results using resistors and capacitors only on the input of the TPS7A78. [Section 5.1.2](#) provides passing test results using resistors, capacitors and inductors on the input of the TPS7A78.

The following is pre-compliance data that was grabbed from an oscilloscope. The Yellow curve is the Quasi-peak of the EVM; this curve needs to stay below the top red line, which is the limit for a passing test for the Quasi-peak voltage value. The green curve is the average voltage value of the EVM; this curve needs to stay below the bottom red line, which is the limit for a passing test for the average voltage value. Passing testing conditions are presented in the following sub-sections.

5.1.1 Passing Pre-Compliance Conducted Emission Test Results Using Capacitors and Resistors in the Input Filter

In the pre-compliance testing, the EVM has passed FCC Part 15 and CISPR 22 CLASS B CONDUCTED EMI LIMIT tests. The EVM passing the standard utilizing the configuration of the board with capacitors and resistors in the input filter is shown below.

Section 5.1.1 curves all configured with the following: $T_J = 25\text{ }^\circ\text{C}$, $LDO_OUT = 3.6\text{ V}$, $V_{AC} = 120\text{ V}$, $R_4 = 100\text{ }\Omega$, $C_7 = 100\text{ nF}$, $R_2 = 75\text{ }\Omega$, $I_{OUT} = 60\text{ mA}$ (unless otherwise noted)



Figure 5-1. FB, $C_7 = 220\text{ nF}$

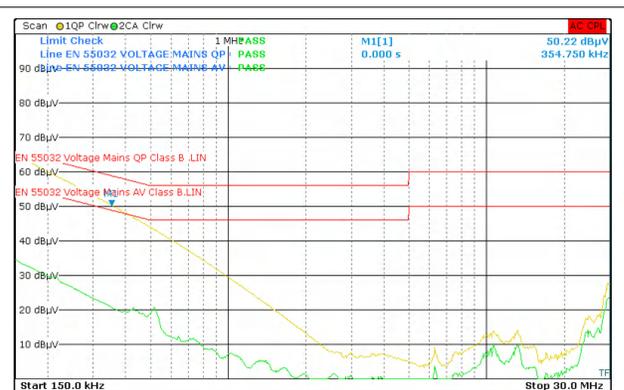


Figure 5-2. FB, $V_{AC} = 240\text{ V}$

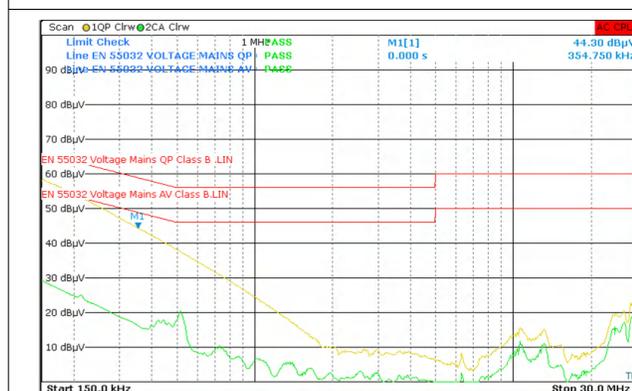


Figure 5-3. FB, $V_{AC} = 240\text{ V}$, $C_7 = 220\text{ nF}$

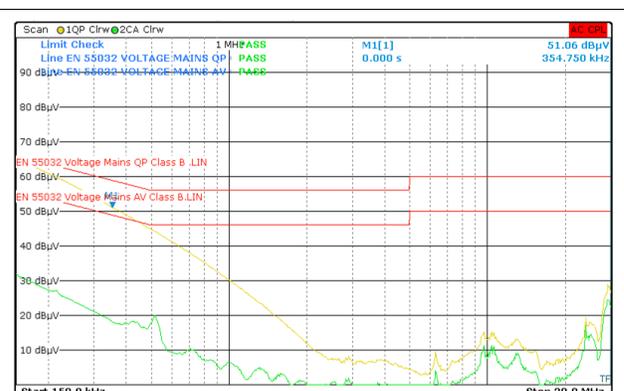


Figure 5-4. HB, $I_{out} = 30\text{ mA}$

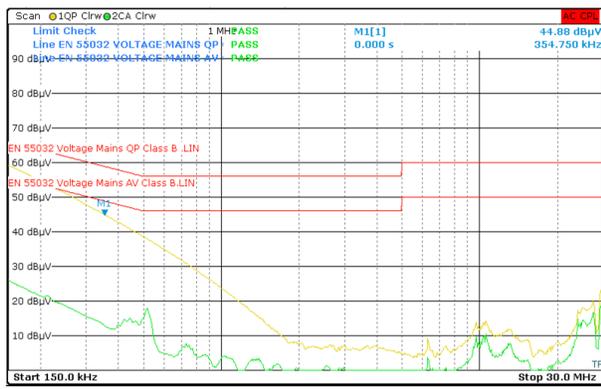


Figure 5-5. HB, Iout = 30 mA, C7 = 220 nF

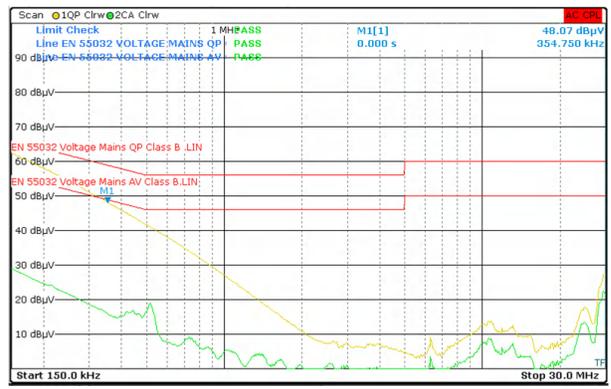


Figure 5-6. HB, V_{AC} = 240 V, Iout = 30 mA

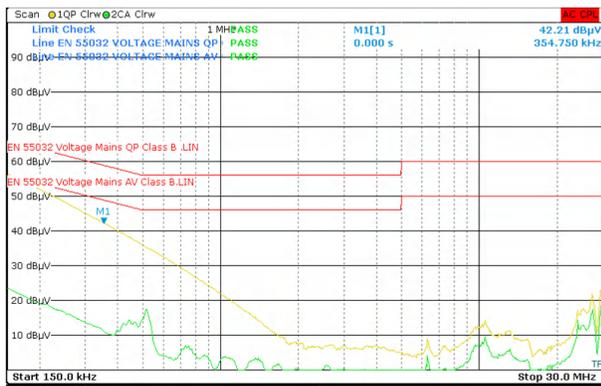


Figure 5-7. HB, V_{AC} = 240 V, Iout = 30 mA, C7 = 220 nF

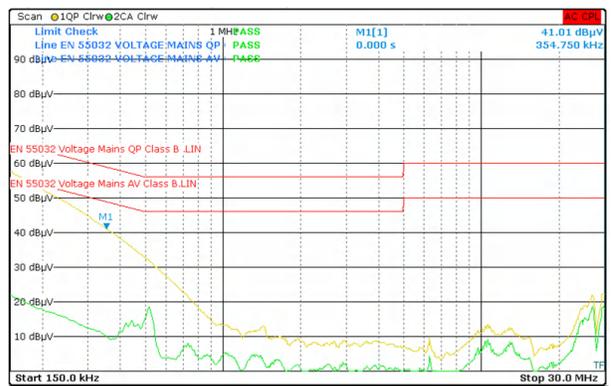


Figure 5-8. HB, LDO_OUT = 5 V, IOUT = 30 mA

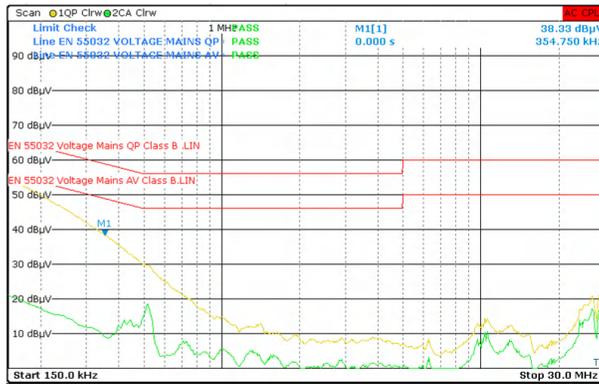


Figure 5-9. HB, V_{AC} = 240 V, LDO_OUT = 5 V, IOUT = 30 mA

5.1.2 Passing Pre-Compliance Conducted Emission Test Results Using Capacitors, Resistors and Inductors in the Input Filter

In the pre-compliance testing, the EVM has passed FCC Part 15 and CISPR 22 CLASS B CONDUCTED EMI LIMIT tests. The EVM passing the standard utilizing an introduced inductance in the loop on the R4 resistor footprint is shown below.

Section 5.1.2 curves all configured with the following: $T_J = 25\text{ }^\circ\text{C}$, $LDO_OUT = 3.6\text{ V}$, $V_{AC} = 120\text{ V}$, $R4 = 100\text{ }\Omega$, $C7 = 100\text{ nF}$, $R2 = 75\text{ }\Omega$, $I_{OUT} = 60\text{ mA}$ (unless otherwise noted)

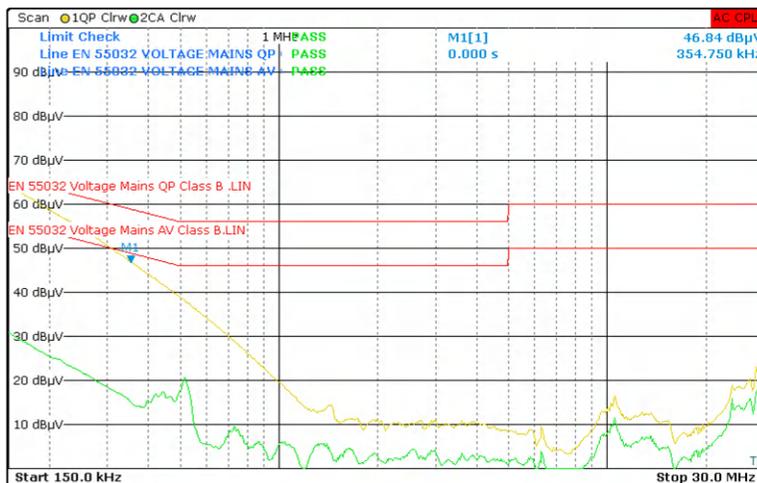


Figure 5-10. FB, Iout = 30 mA, R4 = 100 uH

5.2 Surge Testing

Pre-compliance surge testing was performed in accordance with IEC 61000-4-5. The EVM was tested for proper functionality before and after the pre-compliance test was performed to confirm proper operation of the LDO. In each surge test, the EVM passed the level 4 test limits.

5.3 EFT Compliance

Pre-compliance EFT testing was performed in accordance with IEC 61000-4-4. The EVM was tested for proper functionality before and after the pre-compliance test was performed to confirm proper operation of the LDO. In each EFT test, the EVM passed the level 4 test limits.

5.4 ESD Compliance

Pre-compliance ESD testing was performed in accordance with IEC 61000-4-2. The EVM was tested for proper functionality before and after the pre-compliance test was performed to confirm proper operation of the LDO. In each ESD test, the EVM passed the level 3 test limits.

6 Additional Information

6.1 Trademarks

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: 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 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 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。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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

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東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/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。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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- 4 *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 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 MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS 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 EPIDEMIC FAILURE WARRANTY OR 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 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, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 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. 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 OR THE USE OF THE EVMS , 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 TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM 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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