User's Guide

TPS74701EVM-177, TPS74801EVM-177 Evaluation Module

ABSTRACT

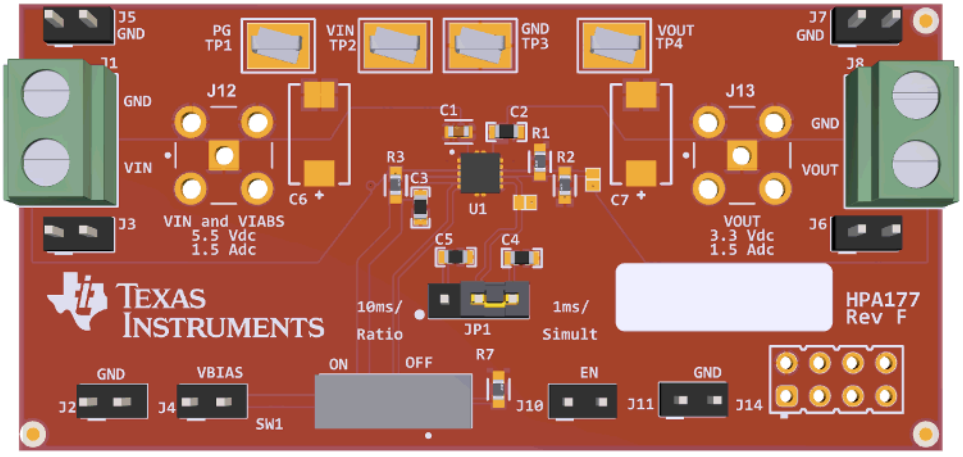

Figure 1-1. TPS74x01EVM-177 Evaluation Module (EVM)

This user's guide describes the characteristics, operation, and use of the TPS74x01EVM-177 evaluation module (EVM). This EVM contains either the TPS74701 or TPS74801 low-dropout linear regulator device. This user's guide includes EVM specifications, recommended test setup, test results, bill of materials (BOM), and a schematic diagram.

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Trademarks

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1 Introduction

The Texas Instruments TPS74x01EVM-177 evaluation module uses the TPS74701 or TPS74801 low-dropout linear regulator device. These regulators require a low-power bias voltage, V_{BIAS}, and a power input voltage, V_{IN}. These two regulators are capable of providing output voltages down to 0.8 V and have an integrated supervisory circuit with open-drain output that goes to high impedance when the output voltage reaches regulation (power good or PG). The TPS74701 and TPS74801 can provide up to 0.5 A and 1.5 A of output current, respectively, and each has a soft start (SS) pin which allows the user to set the linear ramp rate for the output voltage at start-up. The purpose of the EVM is to facilitate evaluation of the TPS74x01 devices.

1.1 Performance Specification Summary

Table 1-1 provides a summary of the TPS74x01EVM-177 performance specifications. All specifications are provided for an ambient temperature of 25°C.

Table 1-1. Typical Performance Specification Summary

	Condition	Voltage Range (V)			Current Range (mA)		
		Min	Typ	Max	Min	Typ	Max
V_{BIAS} supply	TPS74801EVM-177 (HPA177-001), V_{IN} = V_{BIAS}, I_{OUT} = 1.5 A	2.83(1)	5	5.5		5	
	TPS74701EVM-177 (HPA177-002), V_{IN} = V_{BIAS}, I_{OUT} = 0.5 A	2.7(1)	5	5.5		5	
V_{IN} supply	TPS74801EVM-177 (HPA177-001), V_{BIAS} – V_{OUT} ≥ 3.25 V, I_{OUT} = 1.5 A	1.395(1)		5.5(2)			1500
	TPS74701EVM-177 (HPA177-002), V_{BIAS} – V_{OUT} ≥ 1.62 V, I_{OUT} = 0.5 A	1.35(1)		5.5(2)			500
V_{OUT}	TPS74801EVM-177 (HPA177-001)	1.17(3)	1.20	1.23(3)			1500(2)
V_{OUT}	TPS74701EVM-177 (HPA177-002)	1.17(3)	1.20	1.23(3)			500(2)

(1) This voltage is the minimum voltage to provide the maximum output current in the table assuming the typical V_{BIAS} voltage is applied. Lower output currents are achievable with lower V_{IN} and V_{BIAS} voltages. See the data sheet for V_{IN} to V_{OUT} and V_{BIAS} to V_{OUT} dropout data.

(2) Linear regulator power dissipation is computed as $P_D = (V_{IN} – V_{OUT}) \times I_{OUT}$. As specified in the data sheet, the regulator package has a finite power dissipation rating depending on the ambient temperature, board type, and airflow. Using any V_{IN} or V_{OUT} voltages other than the typical voltages recommended in the table or using the EVM in an environment with an ambient temperature higher than 25°C significantly reduces the maximum allowed output current. See the data sheet for the regulator package thermal resistance data, and see the *Digital Designer's Guide to Linear Voltage Regulators and Thermal Management* application note for a full explanation.

(3) The EVM uses ±1% feedback resistors. Therefore, the EVM output tolerance is the ±2% internal reference tolerance plus $2 \times (1 – V_{REF}/V_{OUT}) \times TOL_{FBRES} = 2 \times (1– 0.8\ V/1.2\ V) \times ±1\% = 0.67\%$ or ±2.67%. Tighter tolerance feedback resistors must be used for tighter output tolerance.

1.2 Modifications

The TPS74x01EVM-177 board is designed with devices having 0603 or larger footprint to aid user customization of the EVM. A real implementation can occupy less total board space.

Changing components can improve or degrade EVM performance. For example, adding a larger output capacitor reduces output voltage undershoot but lengthens response time after a load transient event. Inductive leads from the V_{IN} pin power supply can cause droop during a load transient. Adding a larger input capacitor reduces droop at the V_{IN} pin.

2 Input and Output Connector Descriptions

2.1 J1–VIN/GND

This terminal block has both a positive and ground return connection to the power input (V_{IN}) supply. The leads to the input supply must be twisted and kept as short as possible.

2.2 J2–GND

This header is the return connection for the bias (V_{BIAS}) supply.

2.3 J3–VIN

This header is a positive connection to the power input supply (V_{IN}). Use this header for low power (for example, $I_{IN} = I_{OUT} < 1$ A) evaluation or as a voltage test point.

2.4 J4–VBIAS

This header is the positive connection for the bias (V_{BIAS}) supply.

2.5 J5–GND

This header is a ground return connection to the power input (V_{IN}) supply. Use this header for low power (for example, $I_{IN} = I_{OUT} < 1$ A) evaluation or as a ground test point.

2.6 J6–VOUT

This header is the positive connection for the output load on V_{OUT}. Use this header for low power (for example, $I_{IN} = I_{OUT} < 1$ A) evaluation only or as a voltage test point.

2.7 J7–GND

This header is the ground return connection for the output load. Use this header for low power (for example, $I_{IN} = I_{OUT} < 1$ A) evaluation or as a ground test point.

2.8 J8–VOUT/GND

This terminal block has both a positive and ground return connection for the output load. The leads to the output load must be twisted and kept as short as possible.

2.9 J10–EN

This header is a connection to the enable pin (EN), which is also connected to the middle pin of S1. When S1 is OFF, the EN pin is pulled to ground through a pulldown resistor. When applying an external signal to drive EN, S1 must be in the OFF position.

2.10 J11–GND

This header is a ground connection.

2.11 J12-VIN/GND

This SMA connector has both a positive and ground return connection to the power input (V_{IN}) supply. This facilitates probe connections and readings.

2.12 J13-VOUT/GND

This SMA connector has both a positive and ground return connection to the power input (V_{OUT}) supply. This facilitates probe connections and readings.

2.13 JP1–1 ms/Simult Versus 10 ms/Ratio

For the TPS74701 and TPS74801, this jumper allows the user to choose either a 1-ms or 10-ms soft-start time for the output voltage. Leaving the jumper open results in the output voltage ramping up with a default soft-start time of 500 µs.

2.14 S1

This switch connects to the EN pin of the device and allows the user to turn the device ON or OFF by connecting the enable (EN) pin to either V_{BIAS} or ground through a pulldown resistor.

2.15 TP1

This test point is a Kelvin test point to V_{PG}.

2.16 TP2

This test point is a Kelvin test point to V_{IN}.

2.17 TP3

This test point is a Kelvin test point to IC ground.

2.18 TP4

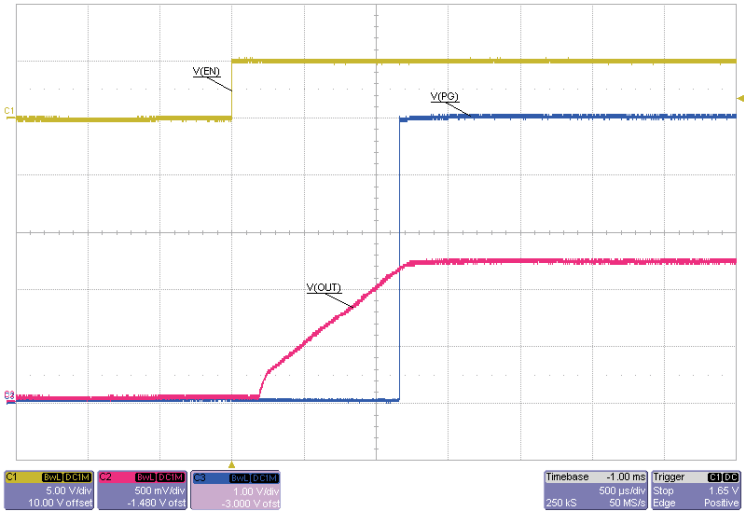
This test point is a Kelvin test point to V_{OUT}.

3 Test Setup

The absolute maximum voltage allowed on the BIAS, IN, or EN pins is 6 V. The TPS74701 and TPS74801 devices are designed to operate with V_{IN} and V_{BIAS} less than or equal to 5.5 V. To enable the regulator, switch S1 to the ON position. When connecting external loads, use short, twisted leads to minimize DC drop at the connector and inductive voltage dip after a transient load is removed.

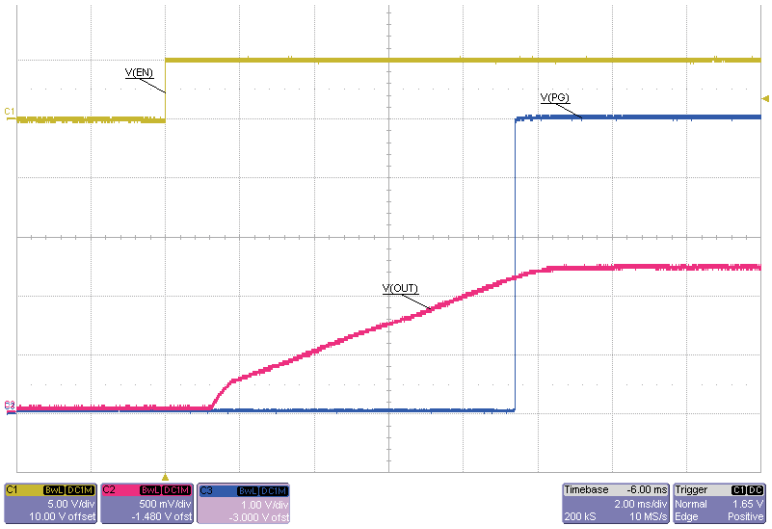
4 Test Results

Figure 4-1 and Figure 4-2 depict the test results at T_A = 25°C using this EVM.



V_{IN} = 1.8 V, V_{BIAS} = 5.0 V, I_{OUT} = 500 mA

Figure 4-1. TPS74701 and TPS74801 Start-Up in 1 ms With PG



V_{IN} = 1.8 V, V_{BIAS} = 5.0 V, I_{OUT} = 500 mA

Figure 4-2. TPS74701 and TPS74801 Start-Up in 10 ms With PG

5 Board Layout

Board layout is important for improving power supply rejection ratio (PSRR) and lowering noise. Figure 5-1, Figure 5-2, Figure 5-3, and Figure 5-4 show the board layout for the HPA177 EVM. The switching nodes with high-frequency noise are isolated from the noise-sensitive feedback circuitry. See the data sheet for more specific layout guidelines.

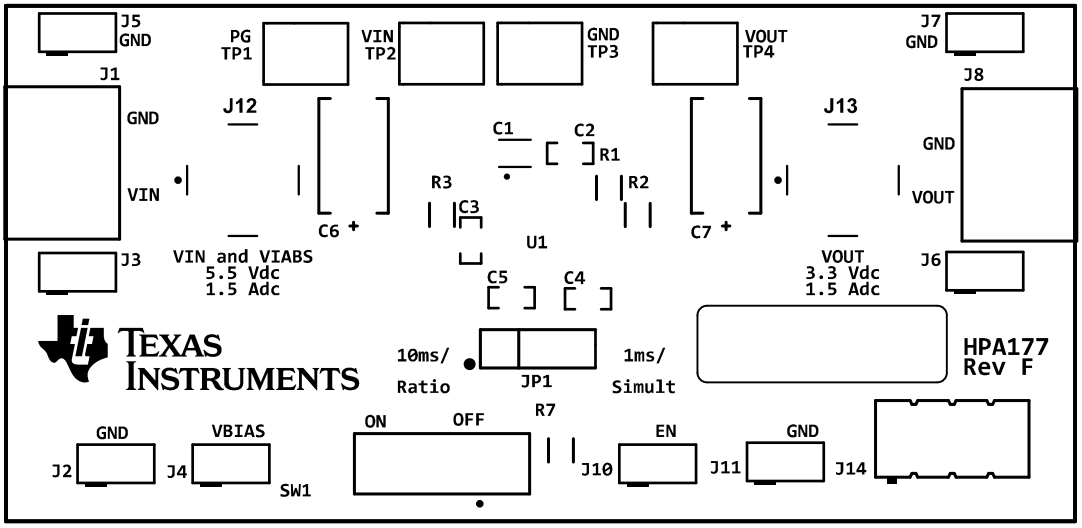


Figure 5-1. Top Overlay

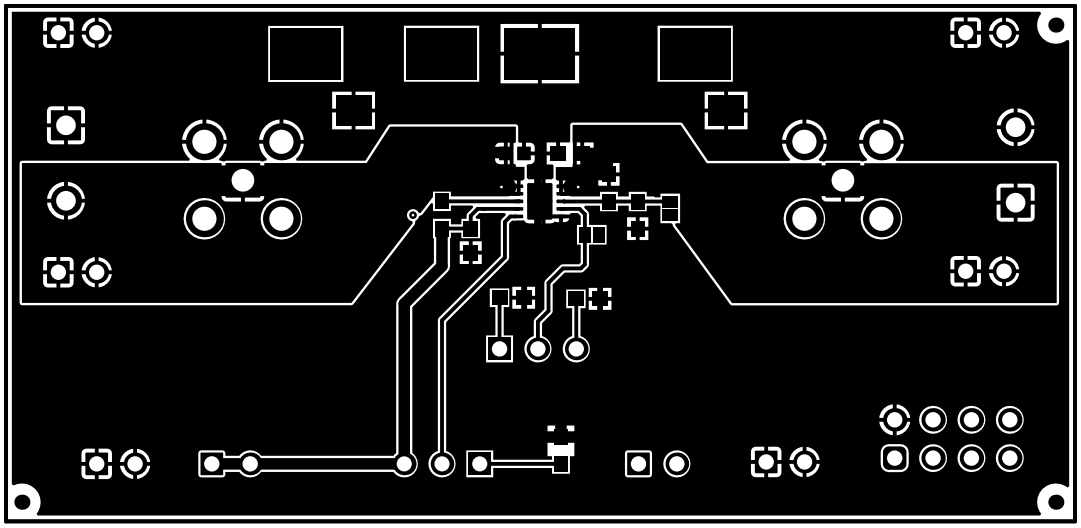


Figure 5-2. Top Layer

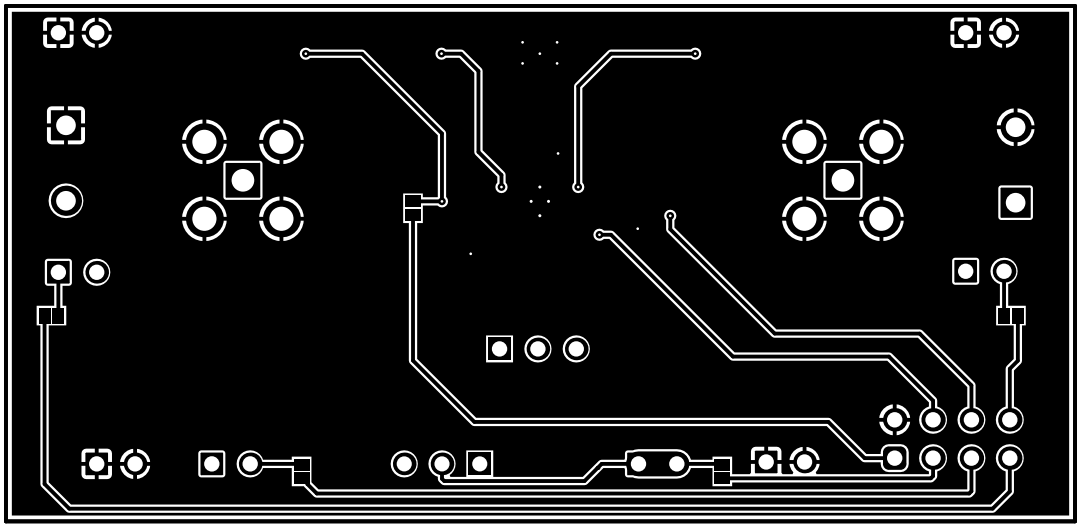


Figure 5-3. Bottom Layer

Figure 5-4. Bottom Overlay

6 Bill of Materials and Schematic

Table 6-1. HPA177 Bill of Materials

Count		RefDes	Value	Description	Size	Part Number	MFR
-001	-002						
1	0	U1		IC, 1.5A LDO Regulator with Soft-Start	SON-10	TPS74801DRCRM3	TI
0	1	U1		IC, 500mA LDO With Programmable Soft Start	SON-10	TPS74701DRCRM3	TI
1	1	C1	1.0 µF	Chip Capacitor,0603,X5R,25V,1uF,±10%	0603	C0603X5R250-105KNE	Venkel
2	2	C3, C2	4.7 µF	Chip Capacitor,0603,X5R,6.3V,4.7uF,±10%	0603	C0603X5R6R3-475KNE	Venkel
1	1	C4	560 pF	Chip Capacitor,0603,C0G,50V,560pF,±1%	0603	C0603C0G500-561FNE	Venkel
1	1	C5	5600 pF	Chip Capacitor,0603,C0G,50V,5600pF,±5%	0603	C0603C0G500-562JNP	Venkel
2	2	J1, J8		Terminal Block, Wire to Board, 2pin, 16A, 5mm		691137710002	Würth Elektronik
8	8	J2, J3, J4, J5, J6, J7, J10, J11		Header, 100mil, 2x1, Tin, TH	100mil x 2	PEC02SAAN	Sullins Connector Solutions
1	1	JP1		Header, 100mil, 3x1, Tin, TH	100mil x 2	PEC03SAAN	Sullins Connector Solutions
1	1	R1	2.49 kΩ	Chip Resistor,0603,1/16W,2.49k,±1%	0603	CR0603-16W-2491FT	Venkel
1	1	R2	4.99 kΩ	Chip Resistor,0603,1/16W,4.99k,±1%	0603	CR0603-16W-4991FT	Venkel
1	1	R3	10 kΩ	Chip Resistor,0603,1/16W,10k,±1%	0603	CR0603-16W-1002FT	Venkel
1	1	R7	100 kΩ	Chip Resistor,0603,1/16W,100k,±1%	0603	CR0603-16W-1003FT	Venkel
1	1	SH-J1	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtech
1	1	SW1		Slide Switch, 30 V, -20 to 70 °C, 3-Pin TH	EG1218	EG1218	E-Switch
4	4	TP1, TP2, TP3, TP4		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone Electronics
0	0	C6, C7	330 µF			2917	
0	0	J12, J13		SMA Connector Jack, Female Socket 50Ohm Through Hole Solder	CONN_RF_7MM00_7MM00	RF2-04A-T-00-50-G	Adam Tech
0	0	J14		Header, 2.54mm, 4x2, Gold, TH			
0	0	J15, J16, J17, J18, J19, J20, J21		Solder Shorting Jumper		JMP-36-30X40SMT	

6.1 Schematic Drawing

Figure 6-1 is the schematic for the TPS74x01EVM-177.

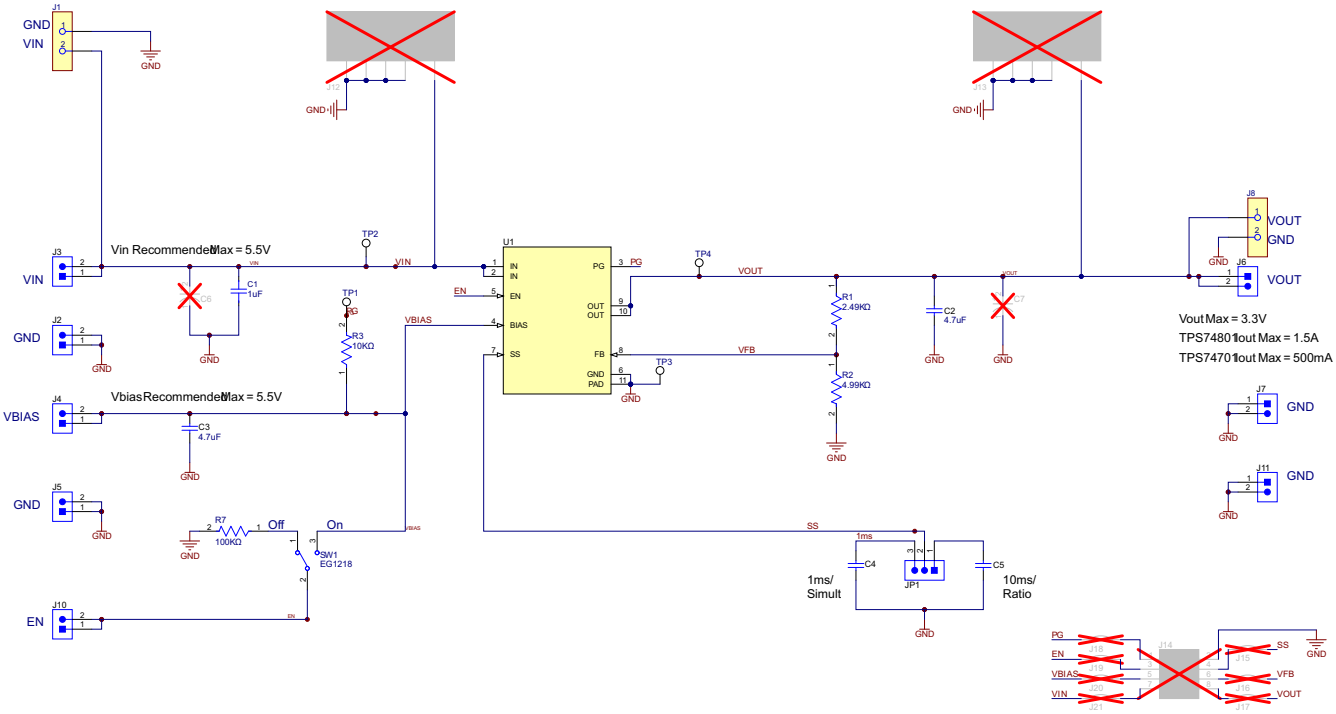


Figure 6-1. Schematic

7 Revision History

Changes from Revision A (December 2007) to Revision B (May 2023) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document. 1
- Added board image of TPS74x01EVM-177 to front page. 1
- Deleted header information for unused header *J9-TRACK IN* . 3
- Added information for *S1* switch described in Section 2.14 . 3
- Changed board layout images to reflect changes to EVM layout and silkscreen. 6
- Added Figure 5-4 to Section 5 to show the bottom overlay of the HPA177 EVM. 6
- Added and deleted information in the Table 6-1 to reflect changes to EVM layout and changes to populated components on the EVM . 8
- Changed Figure 6-1 to reflect the current TPS74x01EVM-177 schematic . 9

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   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.

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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

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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。

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

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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.

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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.

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:*

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