TPS7B7702-Q1 Evaluation Module

This user's guide describes the characteristics, operation, and use of the TPS7B7702-Q1 evaluation module (EVM). A complete schematic diagram, printed-circuit board layouts, and bill of materials are also included.

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1 Introduction

The Texas Instruments TPS7B7702-Q1 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS7B7702-Q1 dual-channel antenna LDO. For more information on the TPS7B7702-Q1 device, see the data sheet (SLVSCE8).

The EVM contains one linear regulator (see Table 1).

Table 1. Device and Package Configurations

Regulator	IC	Package
U1	TPS7B7702QPWPRQ1	16-pin PWP

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2 Connector Descriptions, Setup, and Operation

This section describes the jumpers and connectors on the EVM as well and how to properly connect, set up, and use the TPS7B7702-Q1 EVM.

2.1 Input and Output (I/O) Connector Descriptions

TP1/VIN – This test point provides an input power supply to power the EVM which allows measurement of the input voltage from the VIN pin of the regulator.

J1/VIN connector – This connector directly connects the VIN pin to the input power supply. Left open, this connector could protect the EN1/EN2 from input reverse polarity connection when EN1/EN2 is tied to VIN.

S1/EN1 toggle switch – This switch provides a quick way to reset channel 1 of the regulator by pushing the button.

S2/EN2 toggle switch – This switch provides a quick way to reset channel 2 of the regulator by pushing the button.

J2/EN1 connector – This connector is used to set the enable voltage of channel 1. Short pin 1 and pin 2 to set EN1 voltage to GND, short pin 2 and pin 3 to set EN1 voltage to VIN.

J3/EN2 connector – This connector is used to set the enable voltage of channel 2. Short pin 1 and pin 2 to set EN2 voltage to GND, short pin 2 and pin 3 to set EN2 voltage to VIN.

J4/$\overline{\text{SENSE_EN}}$ connector – This connector is used to set the $\overline{\text{SENSE_EN}}$ pin voltage for the regulator.

J5/$\overline{\text{SENSE_SEL}}$ connector – This connector is used to set the $\overline{\text{SENSE_SEL}}$ pin voltage for the regulator. By default setting of J4 and J5, the current of SENSE1 and SENSE2 will reflect the channel 1 and channel 2 output current of the regulator correspondingly.

$\overline{\text{SENSE_SEL}}$	$\overline{\text{SENSE_EN}}$	SENSE1 Status	SENSE2 Status
LOW	LOW	CH1 current	CH2 current
HIGH	LOW	CH2 current	HIGH impedance
X	HIGH	HIGH impedance	HIGH impedance

For more information, refer to the *Current Sense Multiplexing* section of the datasheet (SLVSCE8).

TP2/REG_OUT1 – This test point is the power output of channel 1 of the regulator allowing direct attachment of a load which also allows measurement of the channel 1 output voltage of the regulator.

TP3/VOUT1 – This test point is the output voltage of channel 1 of the regulator with an inductor inserted between the OUT1 pin and the load.

TP4/ REG_OUT2 – This test point is the power output of channel 2 of the regulator allowing direct attachment of a load which also allows measurement of the channel 2 output voltage of the regulator.

TP5/VOUT2 – This test point is the output voltage of channel 1 of the regulator with an inductor inserted between the OUT2 pin and the load.

J6/FB1 connector – This connector is used to set the channel 1 output voltage of the regulator. Connect pin 1 and pin 2 to set FB1 voltage to be 0 V, channel 1 will work as a switch in on-state, connect pin 2 and pin 3 to set channel 1 output voltage to 8.5 V (default setup).

J7/FB2 connector – This connector is used to set the channel 2 output voltage of the regulator. Connect pin 1 and pin 2 to set FB2 voltage to be 0 V, channel 2 will work as a switch in on-state, connect pin 2 and pin 3 to set channel 2 output voltage to 5.0 V (default setup).

TP10/VCC – This test point allows measurement of the VCC pin output voltage of the regulator.

TP11/SENSE1 – This test point allows measurement of the sense voltage of channel 1.

TP12/SENSE2 – This test point allows measurement of the sense voltage of channel 2.

J8/CH1 current limit connector – This connector is used to set the output current limit of channel 1. Leave this connector open to set the output current limit to 300 mA (default setup), short this connector to set the output current limit to the internal current limit level.

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J9/CH2 current limit connector – This connector is used to set the output current limit of channel 2. Leave this connector open to set the output current limit to 300 mA (default setup), short this connector to set the output current limit to the internal current limit level.

TP9/ERR – This test point allows measurement of the ERR pin voltage of the regulator.

J10/Error indicator connector – This connector is used to connect the Error LED indicator D2 to VCC.

TP6/TP7/TP8/TP13/TP14/GND – GND is the ground return for the regulator. The EVM provides 7 GND test points to allow the user to power up the EVM, to connect the load, and to attach an oscilloscope ground lead.

2.2 Setup

The input voltage range for the antenna LDO TPS7B7702-Q1 is 4 V to 40 V. The EVM can support up to 300 mA of load current for each channel. Using the following steps to setup the EVM:

1. Set the power supply for the input, VIN, to 12 V and set current limit to 1.2 A
2. Connect pin 2 and pin 3 of both J2 and J3 to setup EN, connect pin 1 and pin 2 of both J4 and J5 to set up sense function, connect pin 2 and pin 3 of both J6 and J7 to setup VOUT
3. Connect the input power supply positive lead to VIN/TP1 and the negative lead to GND/TP6
4. Apply the load between REG_OUT1/TP2 or VOUT1/TP3 and GND/TP7 for channel 1
5. Apply the load between REG_OUT2/TP4 or VOUT2/TP5 and GND/TP8 for channel 2

2.3 Operation

The TPS7B7702-Q1 will power-up after the VIN voltage has exceeded the UVLO rising threshold.

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3 Board Layout

The printed-circuit board (PCB) offers footprints for the TPS7B7702-Q1 device.

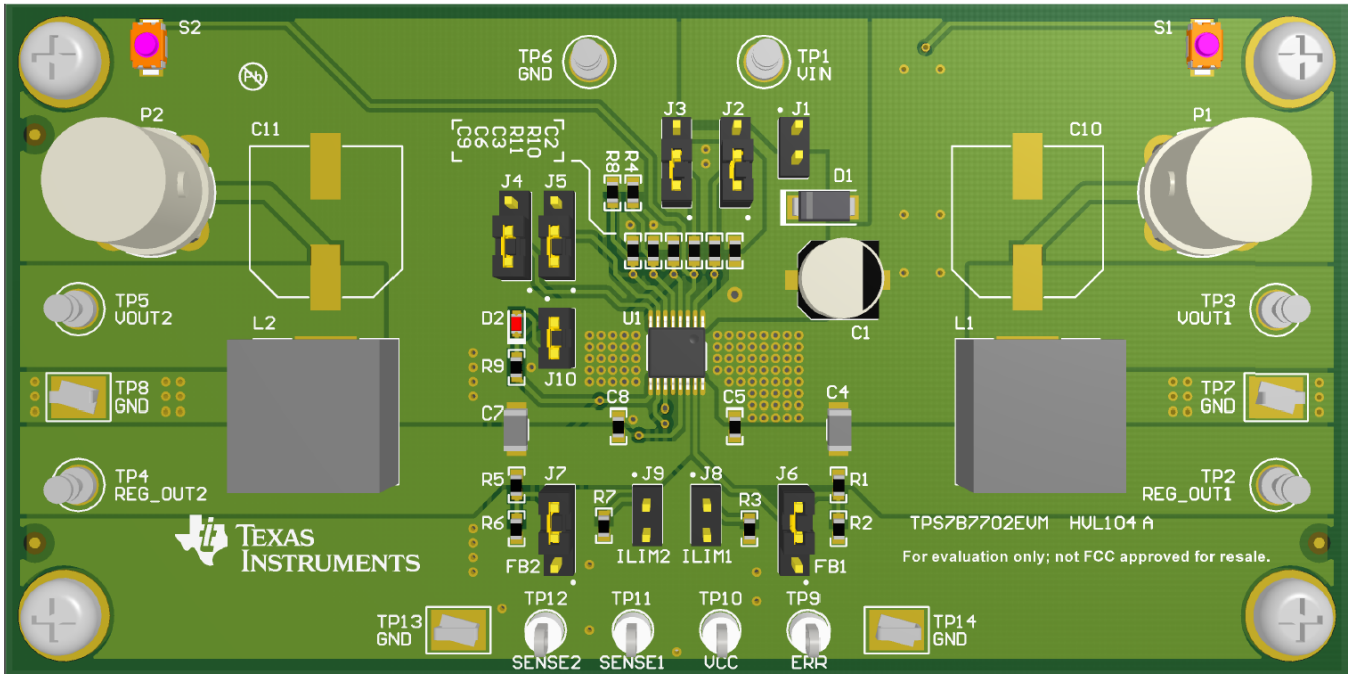


Figure 1. TPS7B7702EVM Component Placement (Assembly Top View)

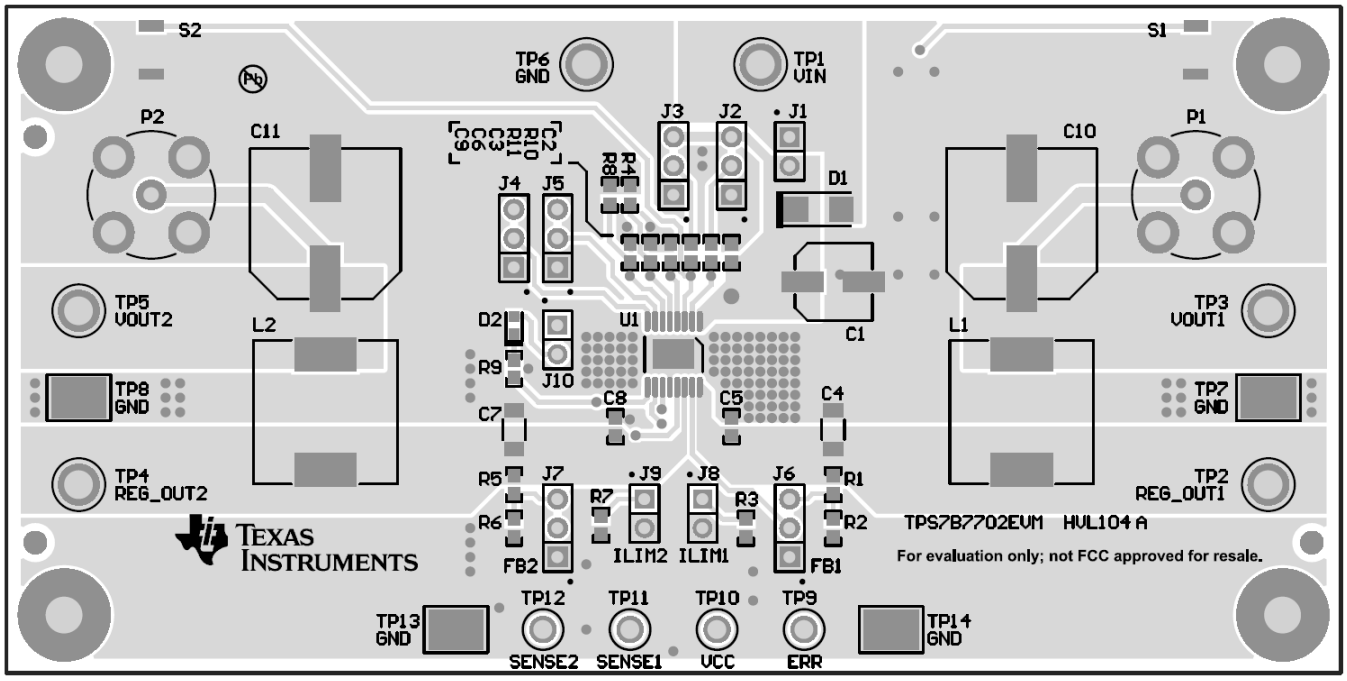


Figure 2. TPS7B7702EVM Top Layer Routing

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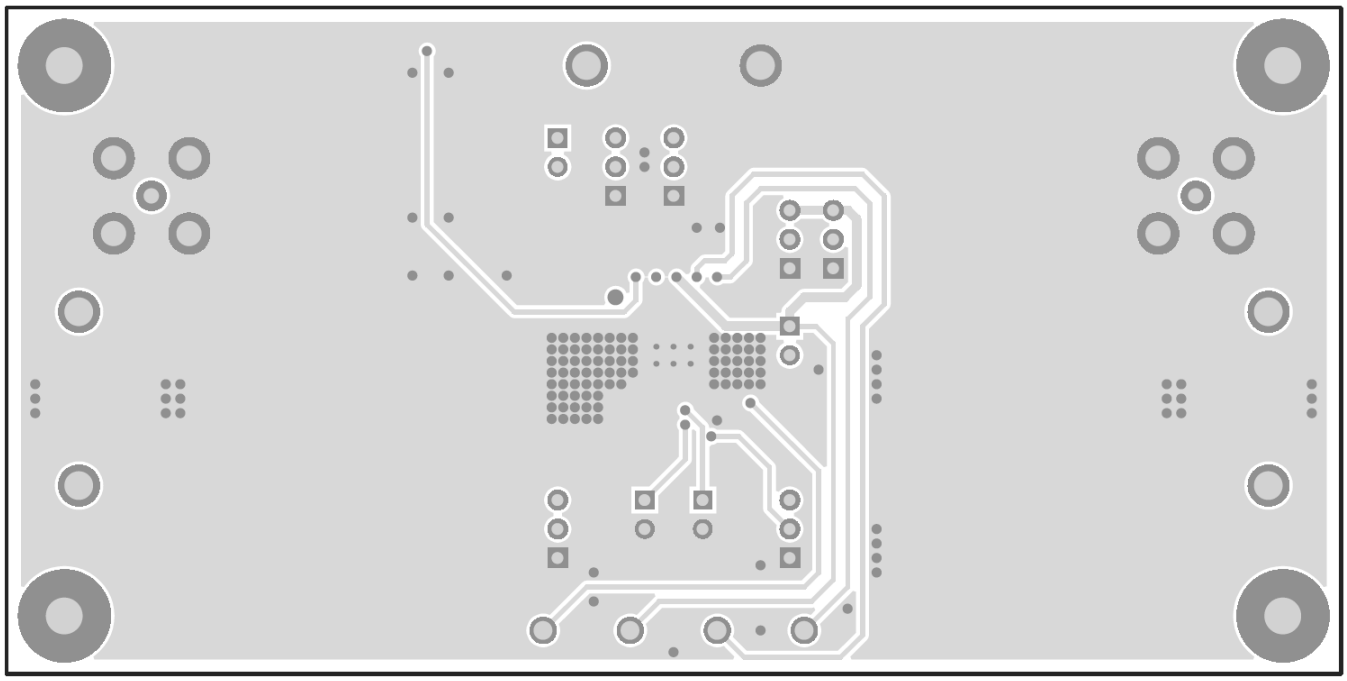


Figure 3. TPS7B7702EVM Bottom Layer Routing

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4 Schematic and Bill of Materials

4.1 Schematic

Figure 4 illustrates the TPS7B7702EVM schematic.

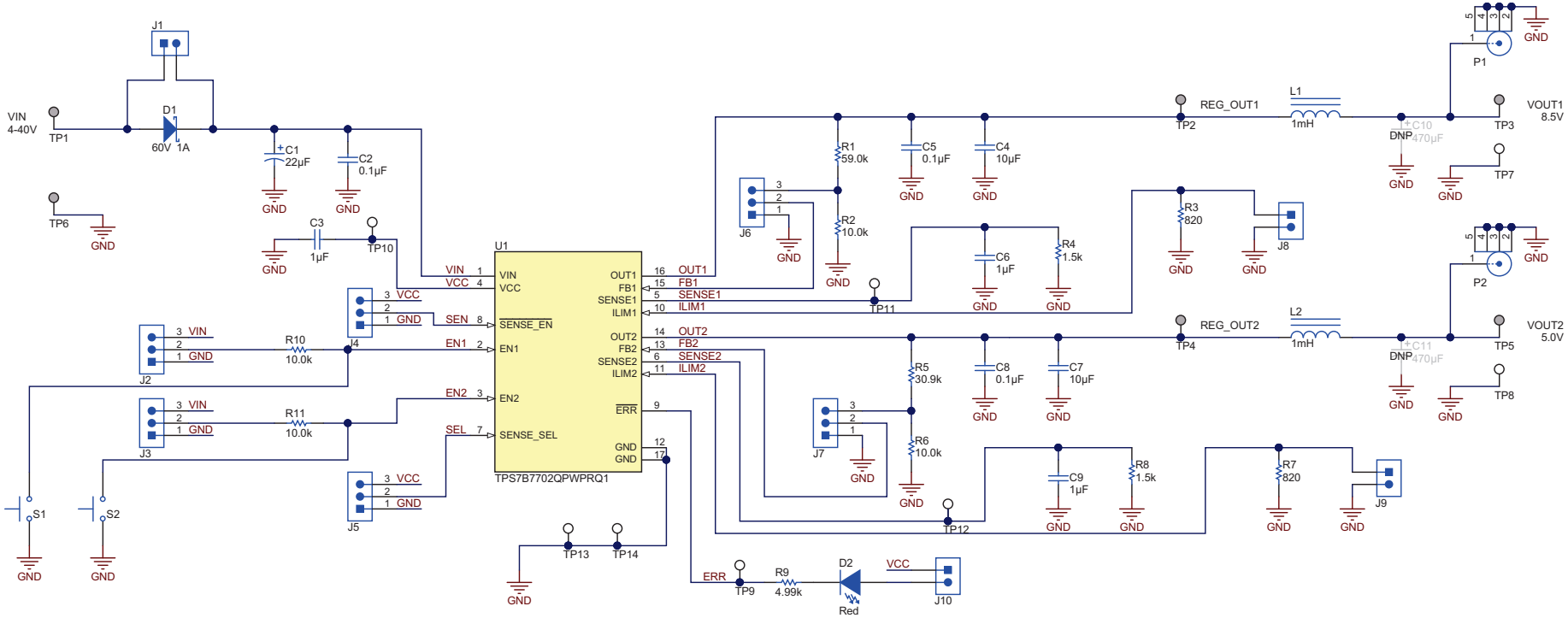


Figure 4. TPS7B7702EVM Schematic

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4.2 Bill of Materials

Table 2 lists the TPS7B7702EVM bill of materials.

Table 2. Bill of Materials(1)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB	1		Printed Circuit Board		HVL104	Any		
C1	1	22uF	CAP, AL, 22 µF, 50 V, +/- 20%, 2 ohm, SMD	F55	EMVY500ADA220MF55G	Nippon Chemi-Con		
C2, C5, C8	3	0.1uF	CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0603	0603	GRM188R71H104KA93D	MuRata		
C3, C6, C9	3	1uF	CAP, CERM, 1 µF, 50 V, +/- 10%, X5R, 0603	0603	GRM188R61H105KAALD	MuRata		
C4, C7	2	10uF	CAP, CERM, 10 µF, 50 V, +/- 10%, X5R, 1206_190	1206_190	CGA5L3X5R1H106K160AB	TDK		
D1	1	60V	Diode, Schottky, 60 V, 1 A, SMA	SMA	CD214A-B160LF	Bourns		
D2	1	Red	LED, Red, SMD	Red LED, 1.6x0.8x0.8mm	LTST-C190CKT	Lite-On		
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply		
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone		
J1, J8, J9, J10	4		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec		
J2, J3, J4, J5, J6, J7	6		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec		
L1, L2	2	1mH	Inductor, Drum Core, Ferrite, 1 mH, 0.7 A, 1.65 ohm, SMD	12x10x12mm	SRR1210-102M	Bourns		
P1, P2	2		Connector, TH, BNC	Amphenol_112404	112404	Amphenol Connex		
R1	1	59.0k	RES, 59.0 k, 1%, 0.1 W, 0603	0603	CRCW060359K0FKEA	Vishay-Dale		
R2, R6, R10, R11	4	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale		
R3, R7	2	820	RES, 820, 5%, 0.1 W, 0603	0603	CRCW0603820RJNEA	Vishay-Dale		
R4, R8	2	1.5k	RES, 1.5 k, 5%, 0.1 W, 0603	0603	CRCW06031K50JNEA	Vishay-Dale		
R5	1	30.9k	RES, 30.9 k, 1%, 0.1 W, 0603	0603	CRCW060330K9FKEA	Vishay-Dale		
R9	1	4.99k	RES, 4.99 k, 1%, 0.1 W, 0603	0603	CRCW06034K99FKEA	Vishay-Dale		
S1, S2	2		Switch, Push Button, SMD	2.9x2x3.9mm SMD	SKRKAEE010	Alps		
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7	7	1x2	Shunt, 100mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP5, TP6	6	Double	Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone		
TP7, TP8, TP13, TP14	4	SMT	Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone		
TP9, TP10, TP11, TP12	4	White	Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone		
U1	1		Dual Channel Antenna LDO with Current Sense, 4.5 to 40 V Vin, 1.5 to 20 V Vout, -40 to 125 degC, PWP0016D	PWP0016D	TPS7B7702QPWPRQ1	Texas Instruments		None
C10, C11	0	470uF	CAP, AL, 470 µF, 50 V, +/- 20%, ohm, SMD	KG5	EMVA500ATR471MKG5S	Nippon Chemi-Con		
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		

(1) Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.

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Revision History

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

Changes from Original (March 2015) to A Revision	Page
• Changed schematic image.	6

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      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.*

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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

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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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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

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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.

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