TPS65320EVM

The Texas Instruments TPS65320EVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS65320 switch-mode power-supply with linear voltage regulator. This document describes the setup and the input/output connections of the EVM. Included are the board layout, schematic, and bill of materials.

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1 Introduction

The EVM contains one dc-dc converter with integrated LDO (See Table 1).

Table 1. Device and Package Configurations

Converter	IC	Package
U1	TPS65320QPWPQ1	HTSSOP-14

PowerPAD is a trademark of Texas Instruments.

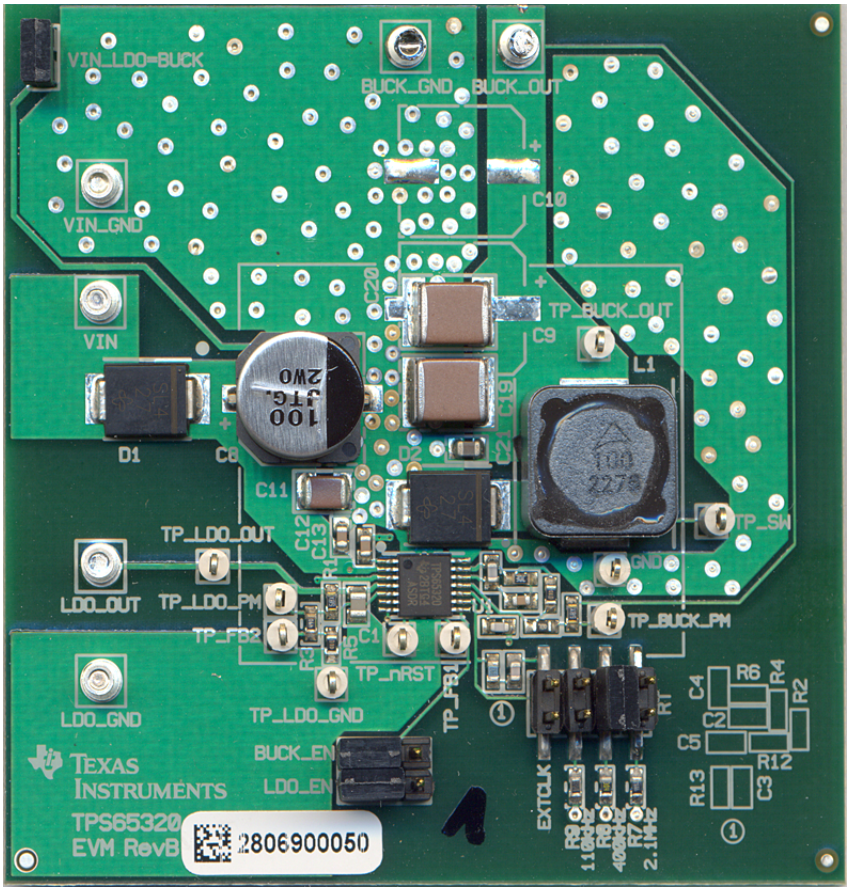

Figure 1. EVM Photo

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to connect, set up, and use the TPS65320EVM properly.

2.1 Input/Output Connector Description

Terminals:

VIN – Input is the power input terminal for the device. Adjacent to it is the VIN_GND reference ground. Use those terminals to attach the EVM to a cable harness.

BUCK_OUT – Output is the output terminal for the TPS65320 switch-mode regulator. Adjacent to it is the BUCK_GND reference ground, which is closely coupled with the VIN_GND.

LDO_OUT – Output is the output terminal for the TPS65320 linear regulator. Adjacent to it is the LDO_GND reference ground, which connects to the VIN-GND/BUCK_GND only underneath the IC.

Jumpers:

RT is the jumper used to select the switching frequency for the switch-mode regulator. The jumper places a pulldown resistor to set the frequency to approximately 110 kHz, 400 kHz, or 2.1 MHz. If applying an external clock, use the pin nearer to the edge of the board for the GND connection.

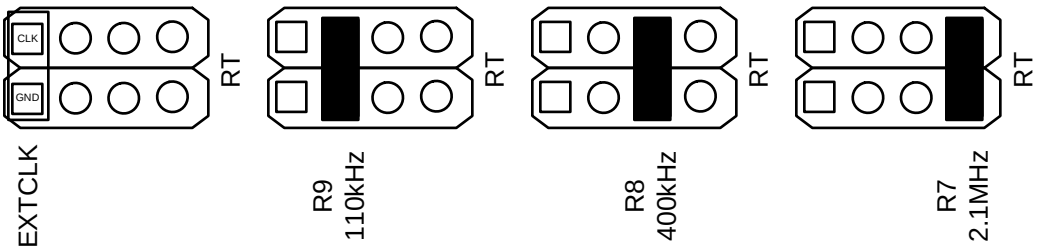

Figure 2. RT Jumper Settings

BUCK_EN and LDO_EN are the jumpers used to enable the switch-mode converter and the LDO, respectively. Setting either jumper high enables its respective rail; a low setting disables it. Note: manual installation of the jumper may cause ringing, potentially asserting nRST low. One must cycle power if this happens. To avoid ringing, use a signal generator to drive the enable pins (connect signal to center pin, GND to the pin nearest to the RT-jumpers) .

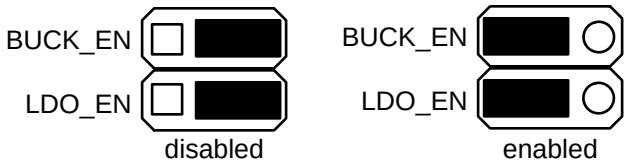

Figure 3. Enable Jumper Setting

VIN_LDO=BUCK should always be installed to supply the LDO.

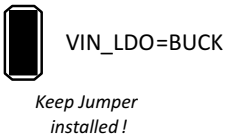

Figure 4. VIN_LDO=BUCK Jumper Setting

Figure 4.

Test Points

- GND — Ground
  TP_ LDO_GND — Ground connected to GND-plane used for LDO (connected to GND only underneath the IC)
- TP_BUCK_OUT — BUCK output
- TP_BUCK_PM — Test point to allow easy access for gain-phase analysis for BUCK
- TP_FB1 — Test point of feedback-divider input for BUCK
- TP_SW — Buck phase pin
- TP_LDO_OUT — Linear regulator output
- TP_LDO_PM — Test point to allow easy access for gain-phase-analysis for LDO
- TP_FB2 — Test point of feedback-divider input for LDO
- TP_nRST — Reset output for LDO

2.2 Operation

The input voltage range for the converter is 4 volts to 40 volts.

For proper operation of the TPS65320EVM, configure BUCK_EN, LDO_EN, and RT properly, using the jumper terminals.

- BUCK_EN — enabled (left)
- LDO_EN — enabled (left)
- RT — 400 kHz (R8)

In this configuration, both regulators turn on when power is applied. Disable the regulators using the enable jumpers.

With the BUCK disabled, the LDO supply comes from VIN; consider the power dissipation at high VIN. TP_VIN_LDO is at GND level in this condition.

To change the switching frequency, power down the device before moving the jumper. If an external clock is applied, remove any jumper installed on RT; however, if the external clock is missing without a jumper installed, the buck does not regulate.

Table 2. Regulator Configuration

Regulator	Output Voltage	Maximum Output Current
BUCK	5 V	3.2 A
LDO	3.3 V	0.28 A

Note: the output capacitors of the BUCK regulator are 25-V types, supporting up to 18 V of Vout. In case of higher output voltage, TI recommends replacing these with capacitors having higher voltage ratings.

Low switching frequencies, high load transients, or limited allowed deviation of Vout, may require larger capacitance values. If needed, use the footprints of the unassembled electrolytic capacitor C10. Low-ESR capacitors also further reduce the coupled noise from the buck to the LDO.

On the EVM, a soft-start capacitor (C6) of 2.2 nF is installed, setting the time to approximately 700 µs. For other soft-start-times, the capacitor may be replaced.

3 Board Layout

Figure 5, Figure 6, and Figure 7 show the board layout for the TPS65320EVM. The EVM offers resistors and jumpers to program the switching frequency. Use of the provided jumpers enables the individual regulators.

The TPS65320 converter offers high efficiency, but does dissipate power. The PowerPAD™ package offers an exposed thermal pad to enhance thermal performance. A solder connection between the thermal pad and the copper landing on the PCB is necessary. The copper landing connects to the GND-plane with multiple thermal vias for optimal performance.

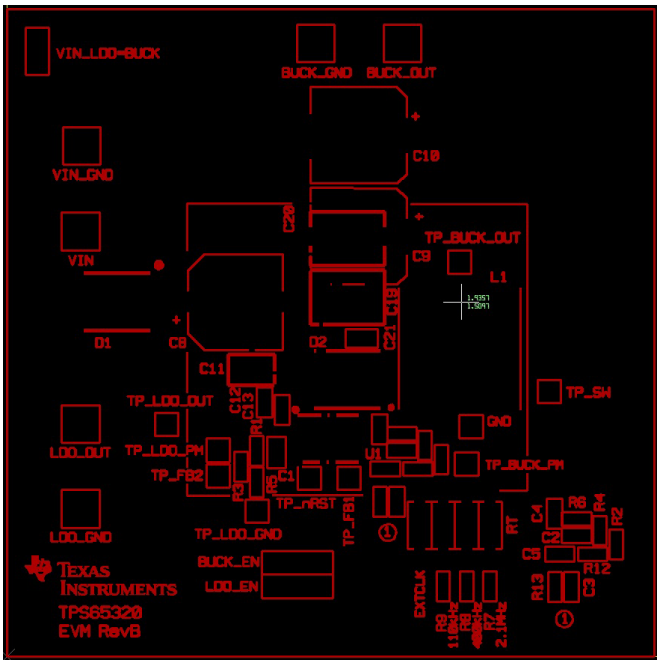

Figure 5. Silkscreen Layout

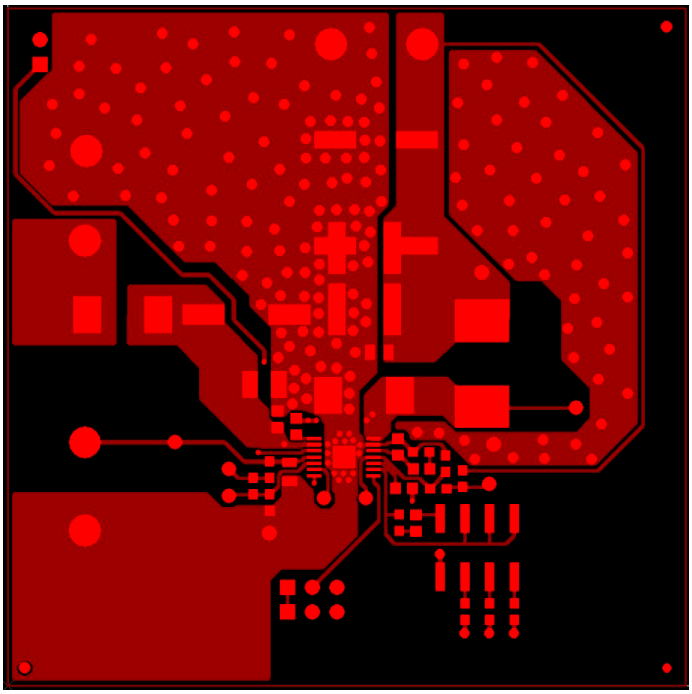

Figure 6. Top Layer Routing

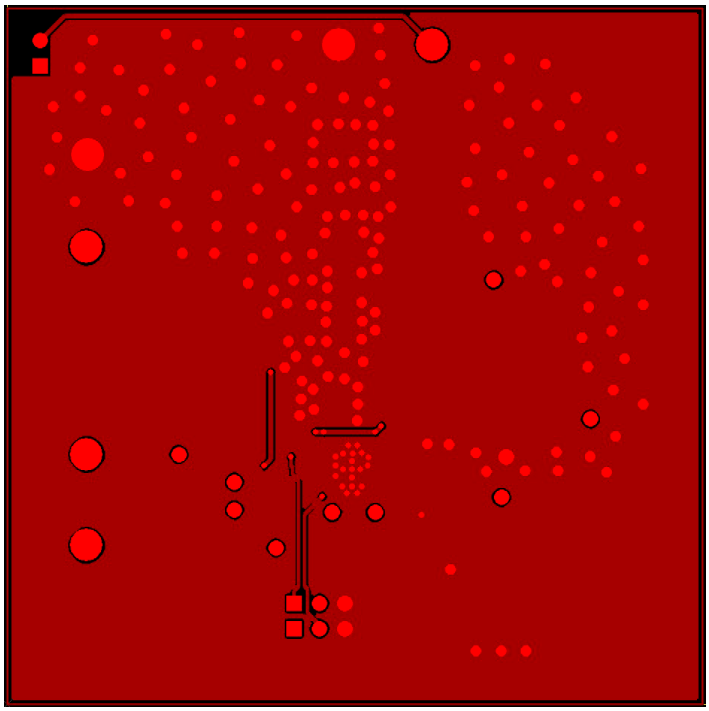

Figure 7. Bottom Layer Routing

4 Schematic

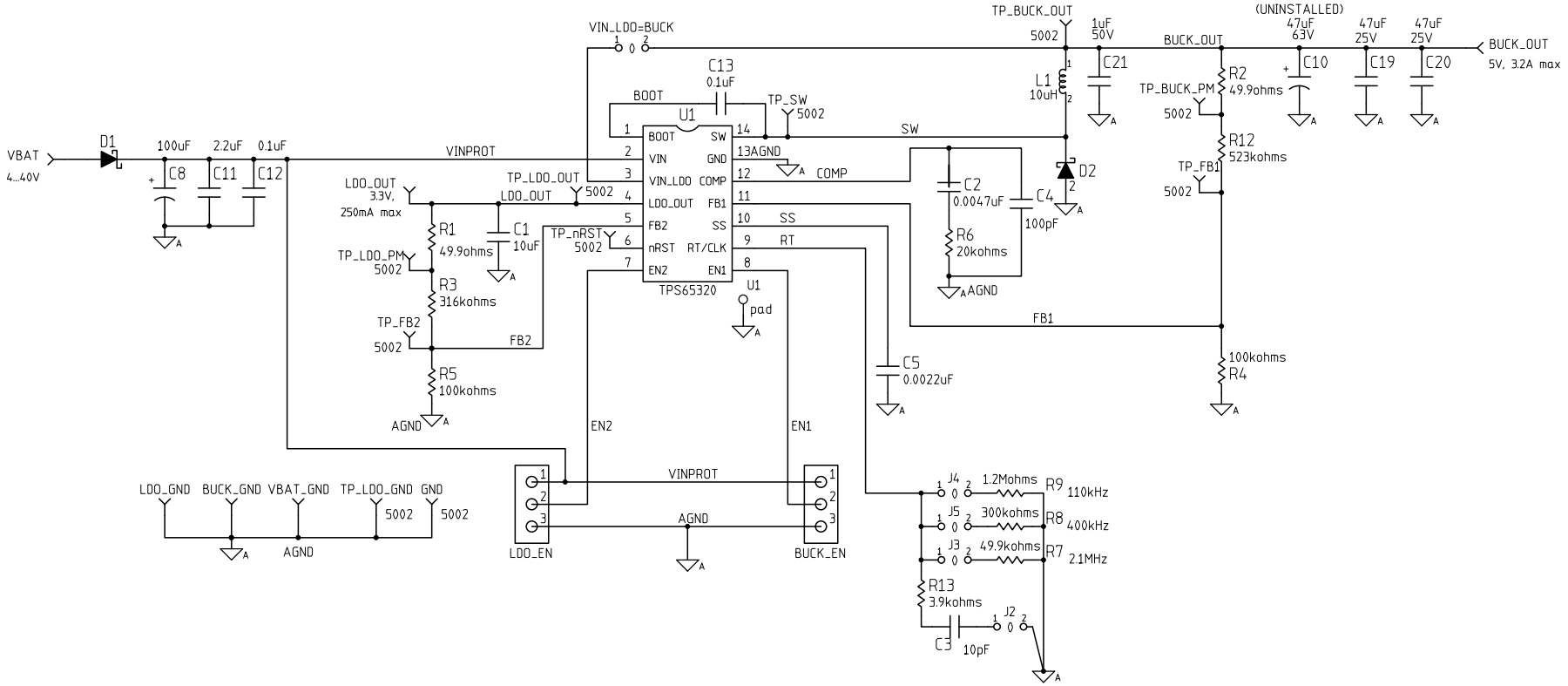

Figure 8. TPS65320EVM Schematic

5 Bill of Materials

Table 3. TPS65320EVM Bill of Materials

Item	QTY	MFG	MFG Part Number	REF DES	Value or Function
1	2	FISCHER	SL LP 1 097 3 G	BUCK_EN, LDO_EN	Header, THU, 1×3, 2.54 mm
2	2	TDK	CKG57NX7S1E476M	C19, C20	Capacitor, SMT, ceramic, 47-µF, 25-V, 20%, X7S
3	1	AVX	06035C222JAT2A	C5	Capacitor, SMT, 0603, ceramic, 0.0022-µF, 50-V, 5%, X7R
4	1	KEMET	C0603C100J5GAC	C3	Capacitor, SMT, 0603, ceramic, 10-pF, 50-V, 5%, COG(NPO)
5	1	KEMET	C0603C101J5GAC	C4	Capacitor, SMT, 0603, ceramic, 100-pF, 50-V, 5%, COGR
6	1	KEMET	C0603C472J5RAC	C2	Capacitor, SMT, 0603, ceramic, X7R, 0.0047-µF, 50-V, 5%
7	1	KEMET	C0805C104K1RAC	C13	Capacitor, SMT, 0805, ceramic, 0.1 µF, 100-V, 10%, X7R
8	1	TAIYO YUDEN	EMK212BJ106KG	C1	Capacitor, SMT, 0805, ceramic, 10-µF, 16-V, 10%, X5R
9	0	MURATA	GRM21BR71H105KA12L	C21	CAPACITOR,SMT,0805,CERAMIC,1.0uF,50V ,10%,X7R
10	2	KEMET	C1210C225K1RAC	C11, C12	Capacitor, SMT, 1210, ceramic, 2.2-µF, 100-V, 10%, X7R
11	1	PANASONIC	EEE-TG1J101UP	C8	Capacitor, SMT, 2P, electrolytic, 100-µF, 63-V, 20%, -40~125C
12	1	PANASONIC	EEETG1J470P (UN)	C9, C10	Uninstalled capacitor, SMT, 2P, electrolytic, 47-µF, 63-V, 20%, –40 to 125ºC
13	2	VISHAY	SL44-E3/57T	D1, D2	Schottky barrier rectifier, SMT, 40-V, 4 A
14	1	TI	TPS65320	U1	Power-management IC, SMT, HTSSOP, 14P
15	1	EPCOS	B82477P4103M000	L1	Inductor, SMT, 10-µH, 20%, 5.8-A, shield, 2P
16	5	FISCHER	SL 11 SMD 062	VIN_LDO=BUCK, J2, J3, J4, J5	Jumper, SMD, 2P, 2.54
17	2	VISHAY	CRCW0603100KF	R4, R5	Resistor, SMT, 0603, 1%, 1/10W, 100-kΩ
18	1	VISHAY	CRCW06031M20F	R9	Resistor, SMT, 0603, 1%, 1/10W, 1.20-MΩ
19	1	VISHAY	CRCW060320K0F	R6	Resistor, SMT, 0603, 1%, 1/10W, 20.0-kΩ
20	1	VISHAY	CRCW0603300KF	R8	Resistor, SMT, 0603, 1%, 1/10W, 300-kΩ
21	1	VISHAY	CRCW0603316KF	R3	Resistor, SMT, 0603, 1%, 1/10W, 316-kΩ
22	1	VISHAY	CRCW06033K90F	R13	Resistor, SMT, 0603, 1%, 1/10W, 3.90-kΩ
23	1	VISHAY	CRCW060349K9F	R7	Resistor, SMT, 0603, 1%, 1/10W, 49.9-kΩ
24	2	VISHAY	CRCW060349R9F	R1, R2	Resistor, SMT, 0603, 1%, 1/10W, 49.9-Ω
25	1	VISHAY	CRCW0603523KF	R12	Resistor, SMT, 0603, 1%, 1/10W, 523-kΩ
26	6	MILL-MAX	2505-2-00-44-00-00-07-0	BUCK_GND, BUCK_OUT, LDO_GND, LDO_OUT, VIN, VIN_GND	Test points, THU, 1P
27	10	KEYSTONE	5002	TP_FB1, TP_FB2, GND, TP_LDO_GND, TP_BUCK_OUT, TP_BUCK_PM, TP_LDO_OUT, TP_LDO_PM, TP_SW, TP_nRST	Test point,THU, miniature, 0.1 LS, 120 TL, white, 1P
28	1	ANY	TPS65320EVM_PCB	PCB	PCB

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General Statement for EVMs including a radio

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

For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

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

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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

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

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

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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

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

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EVALUATION BOARD/KIT/MODULE (EVM)
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3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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

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