

TPS2543EVM User's Guide

This user's guide describes the evaluation module (EVM) for the TPS2543. TPS2543 is a USB charging port power switch and controller for charging host ports and dedicated charging ports.

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1 Description

The TPS2543EVM allows reference circuit evaluation of the TI TPS2543 USB charging port power switch and controller.

1.1 Features

- USB Charging Port Power Switch and Controller
- Meets Battery Charging Specification BC1.2 for DCP and CDP
- Meets Chinese Telecommunications Industry 2.0 Standard YD/T 1591-2009
- Compatible With USB 2.0 and 3.0 Power Switch Requirements
- Adjustable Current Limit, 230 mA–2800 mA Typical
- Fast Overcurrent Response – 1.5 μ s Typical
- 73-m Ω High-Side MOSFET
- 2.6-GHz Bandwidth USB 2.0 Data Switch
- EVM supports USB 3.0 data passthrough
- TPS2544EVM-064 and TPS2546EVM-064 are also available for order

1.2 Applications

- USB Ports/Hubs
- Notebook PCs

1.3 Glossary of Terms

- Charging downstream port (CDP)
 - A downstream port that complies with the USB 2.0 definition of a host or a hub, and additionally defines a handshake on DP/DM to identify a BC 1.1 compliant host to a BC 1.1 compliant portable device
 - BC 1.1 allows a high-speed portable device to draw 900 mA and low-speed or full-speed device to draw 1500 mA
 - BC 1.2 intention is to allow all devices to draw 1500 mA
 - BC 1.2 corrects BC 1.1 to ensure USB host provides 5 V at >1500 mA
- Standard downstream port (SDP)
 - USB 2.0 defined port currently adopted by most USB ports
 - Portable device is allowed to draw 100 mA initially and request additional current over USB communications in 100-mA steps up to a maximum of 500 mA
 - USB host required to provide at least 500 mA at 5 V
 - Portable device must draw less than 2.5 mA when in USB Suspend due to the absence of USB communication
- Dedicated charging port (DCP) as defined in BC 1.1
 - BC 1.1 defines a dedicated charging port as a downstream port on a device that outputs power through a USB connector, but is not capable of enumerating a downstream device.
 - Wall adapter must source between 500 mA and 1500 mA.
 - Portable device may attempt to draw 1800 mA in order to force the wall adapter into constant-current mode.
 - BC 1.2 intention is to allow DCP to current limit above 1800 mA
- YD/T 1591-2006, updated 2009
 - PROC Telecommunications Standard
 - Defines wall-adaptor requirements
 - Rated current between 500 mA–1500 mA with defined I-V curve

NOTES:



Figure 1. TPS2543EVM Schematic

3 General Configuration and Description

3.1 Physical Access

Table 1 lists the TPS2543EVM connector functionality, Table 2 describes the test point availability and Table 3 describes the jumper functionality.

Table 1. Connector Functionality

Connector	Label	Description
J1	AUX	Auxiliary high-current input connector
J2	USB INPUT	USB input port
J3	POWER+DATA	Charging port
D1 (RED)	FAULT	Fault LED
D2 (GREEN)	VOUT-ON	USB output powered
D3 (RED)	STATUS	STATUS pin LED

Table 2. Test Points

Test Point	Color	Label	Description
TP1	WHT	DP-OUT	Data+ out
TP2	WHT	DM-OUT	Data- out
TP3	RED	IN	Power bus input
TP4	RED	VOUT	Power bus output
TP5	SM	GND	Power bus GND
TP6	SM	GND	Power bus GND
TP7	ORG	DP-IN	Data+ in
TP8	ORG	DM-IN	Data- in
TP9	WHT	FAULT	Fault pin
TP10	WHT	STATUS	Status pin

Table 3. Jumpers

Jumper	Label	Description
JP1	VIN	Power bus input. Install shunt to allow charger source to power TPS2543 and downstream circuitry.
JP2	VOUT	Power bus output. Install shunt to allow charger source to power downstream devices.
JP3	CTL3	CTL3. See MODE truth table.
	CTL2	CTL2. See MODE truth table.
	CTL1	CTL1. See MODE truth table.
	EN	TPS2543 enable select. Install shunt to disable TPS2543.
	ILIM	ILIM select. Install shunt to select ILIM_LO (0.6 A typical ILIM). Remove shunt to select ILIM_HI (2.8A typical ILIM).

Table 4. TPS2543 Mode Truth Table

CTL1	CTL2	CTL3	ILIM_SEL	Mode
0	0	0	X	OUT discharge, power switch OFF
0	0	1	0	Dedicated charging port, auto-detect, without power-wake function
0	0	1	1	Dedicated charging port, auto-detect, with power wake function ⁽¹⁾
0	1	1	0	Dedicated charging port, auto-detect, with load detection disabled
0	1	1	1	Dedicated charging port, auto-detect, with load detection enabled ⁽²⁾
1	0	0	X	Dedicated charging port, BC 1.2 only, ILIM_HI or ILIM_LO is selected to set I_{OS} by ILIM_SEL.
1	0	1	X	Dedicated charging port, Divider1 mode only, ILIM_HI or ILIM_LO is selected to set I_{OS} by ILIM_SEL.
X	1	0	X	Standard downstream port, USB 2.0 mode, ILIM_HI or ILIM_LO is selected to set I_{OS} by ILIM_SEL.
1	1	0	1	Standard downstream port, USB 2.0 mode, ILIM_LO is selected to set I_{OS} , no discharge to or from 1111
1	1	1	1	Charging downstream port, BC 1.2, with load detection enabled ⁽²⁾

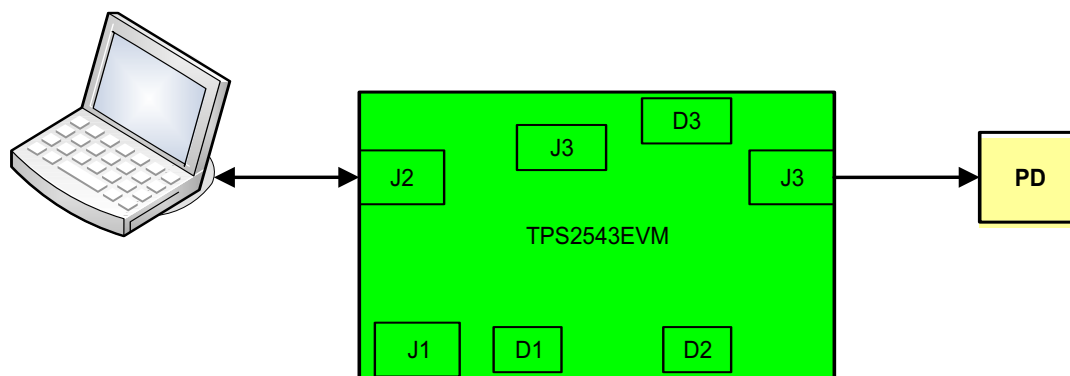
⁽¹⁾ Current limit (I_{OS}) is automatically changed, I_{OS} is I_{OS_PW} while no load, I_{OS} is switched to the value set by ILIM_HI and STATUS is active-low while with load

⁽²⁾ ILIM_HI is selected to set I_{OS} , ILIM_LO is selected to set load-detection current threshold (I_{LD})

3.2 Test Setup

Figure 2 shows a typical test setup for TPS2543EVM. Connect J2 to the PC either directly (insert J2 into available/accessible PC USB port) or using any Type A Male to Type A Female USB v2.0 extension cable. USB power and data are available at J3.

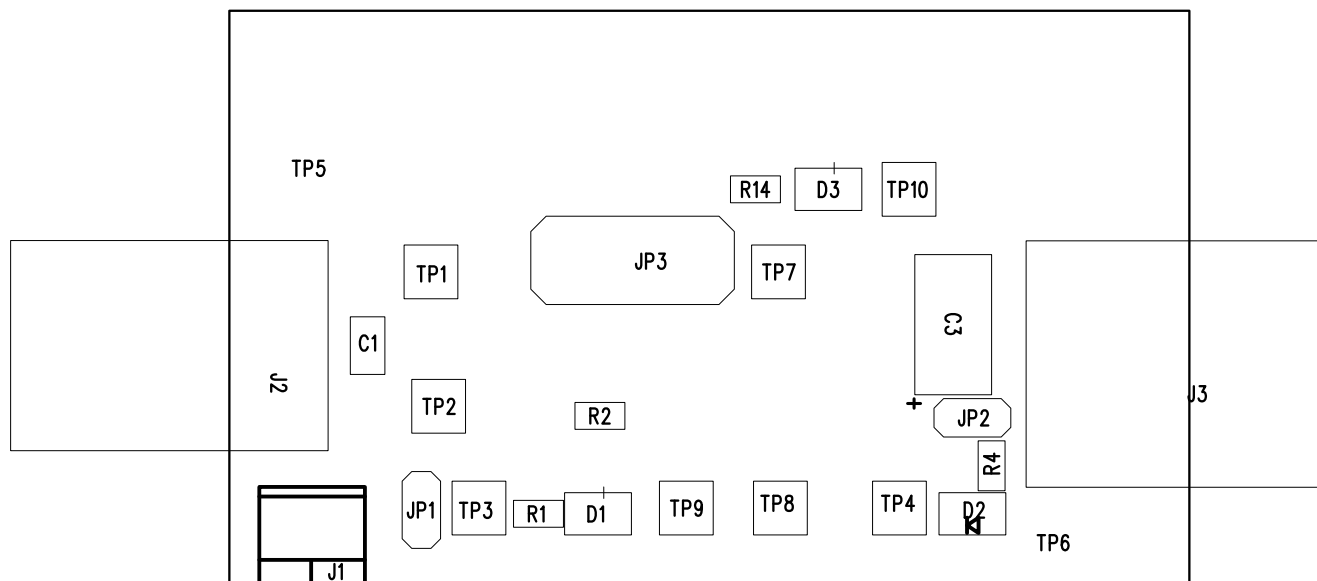
PC (USB charging source)


Figure 2. Typical TPS2543EVM Test Setup

4 EVM Assembly Drawings and Layout Guidelines

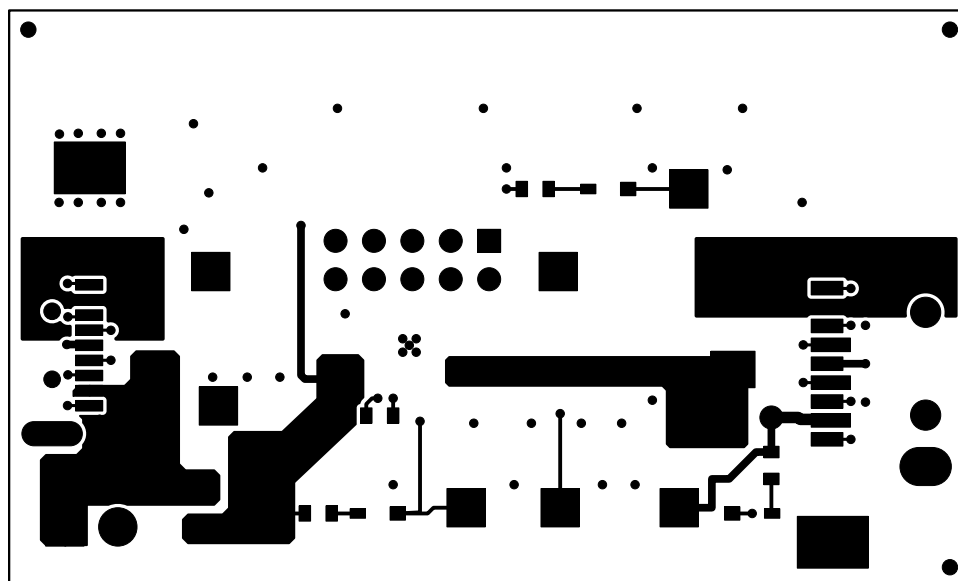
4.1 PCB Drawings

The following figures show component placement and layout of the EVM.



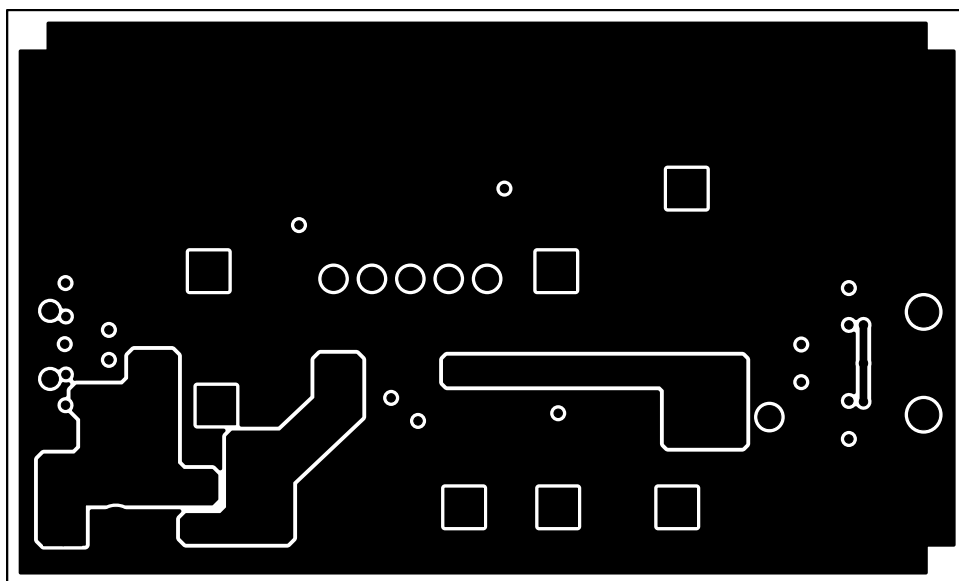
K001

Figure 3. Top Side Placement



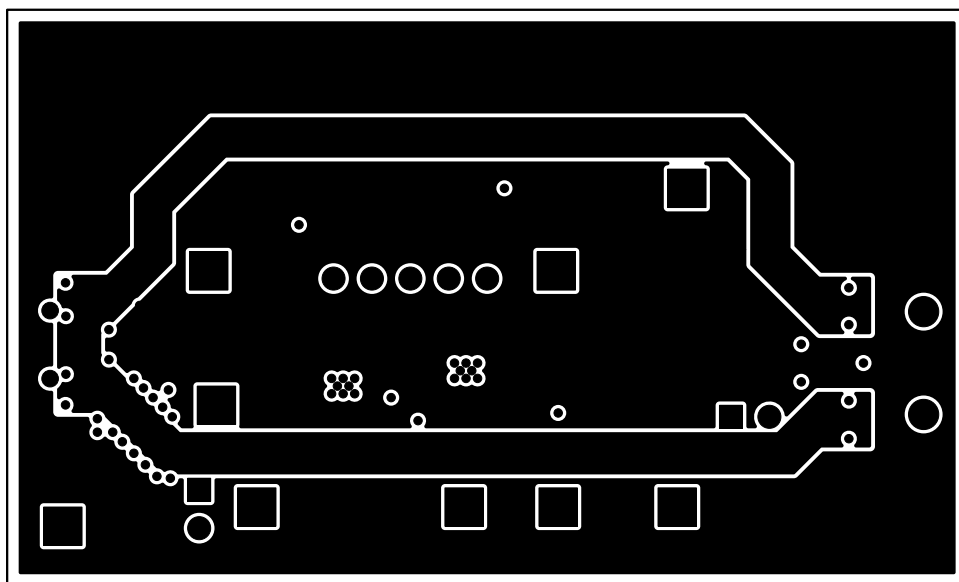
K002

Figure 4. Top Side Routing



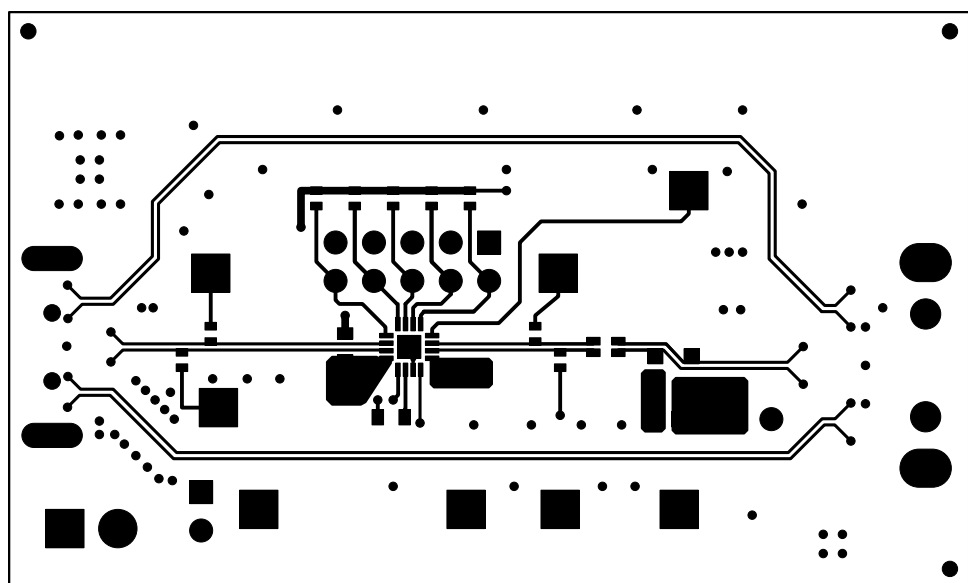
K003

Figure 5. Layer Two Routing



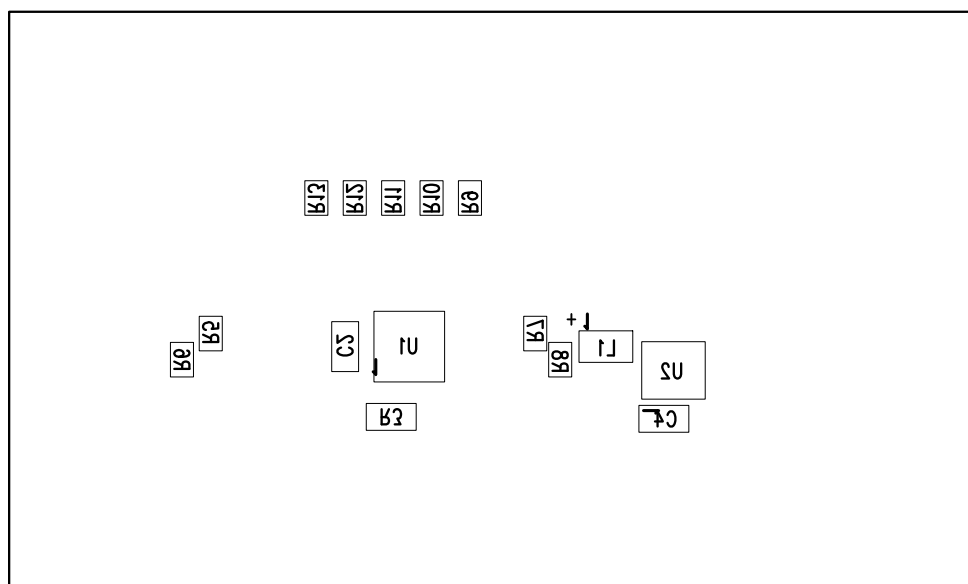
K004

Figure 6. Layer Three Routing



K005

Figure 7. Figure 7. Bottom Side Routing



K006

Figure 8. Bottom Side Placement

4.2 Layout Guidelines

- TPS2543 placement: Place the TPS2543 near the USB output connector and 150- μ F OUT pin filter capacitor. Connect the exposed pad to the GND pin and the system ground plane using an array of vias.
- IN pin bypass capacitance: Place the 0.1- μ F bypass capacitor near the IN pin and make the connection using a low-inductance trace.
- DP-OUT/DM-OUT, DP-IN/DM-IN traces: Route these traces as controlled-impedance differential pairs per the USB-2.0 specification. Minimize the use of vias in the high-speed data lines. [Figure 7](#) provides a good signal-routing example for the high-speed data traces. In this example, the data pairs are routed as edge-coupled microstrips with nominal differential impedance of 90 Ω . The reference plane is tied to GND and is shown in [Figure 6](#). Ensure that the reference plane is void of cuts or splits above the differential pairs to prevent impedance discontinuities.

5 Bill of Materials

Table 5. TPS2543EVM Bill of Materials

REFDES	Count	Value	Description	Size	Part Number	Supplier
C1	1	10 μ F	Capacitor, ceramic, 10-V, X5R, 10%	0805	Std	Std
C2, C4	2	0.1 μ F	Capacitor, ceramic, 50-V, X7R, 10%	0603	Std	Std
C3	1	150 μ F	Capacitor, tantalum, low-ESR, 10-V, $\pm$ 10%	7343 (D)	TPSD157K010R0100	AVX
D1, D3	2	LN1271R	Diode, LED, red, 10-mA, 0.4-mcd	0.114 $\times$ 0.049 inch (2.9 $\times$ 1.25 mm)	LN1271RTR	Panasonic
D2	1	LN1371G	Diode, LED, green, 10-mA, 2.6-mcd	0.114 $\times$ 0.049 inch (2.9 $\times$ 1.25 mm)	LN1371GTR	Panasonic
J1	1	ED555/2DS	Terminal block, 2-pin, 6-A, 3.5-mm	0.27 $\times$ 0.25 inch (6.86 $\times$ 6.35 mm)	ED555/2DS	OST
J2	1	692 112 030 100	Connector, SMT, USB 3.0 plug with clip, type A	12 mm $\times$ 21 mm	692 112 030 100	Würth Elektronik
J3	1	692 122 030 100	Connector, SMT, USB 3.0 horizontal, type A	12 mm $\times$ 15 mm	692 122 030 100	Würth Elektronik
JP1, JP2	2	PEC02SAAN	Header, male 2-pin, 100-mil spacing	0.100 inch (2.54 mm) $\times$ 2	PEC02SAAN	Sullins
JP3	1	PEC05DAAN	Header, male 2 $\times$ 5-pin, 100-mil spacing	0.100 inch (2.54 mm) $\times$ 5 $\times$ 2	PEC05DAAN	Sullins
L1	1	370 Ω	Choke, common-mode	0.050 $\times$ 0.080 inch (1.27 $\times$ 2.03 mm)	0805USB-372ML or 744231371	Coilcraft or Würth Elektronik
R1, R4, R14	3	2 k Ω	Resistor, chip, 1/16-W, 1%	0603	Std	Std
R2	1	16.9 k Ω	Resistor, chip, 1/16-W, 1%	0603	Std	Std
R3	1	80.6 k Ω	Resistor, chip, 1/16-W, 1%	0603	Std	Std
R5–R13	9	100 k Ω	Resistor, chip, 1/16-W, 1%	0402	Std	Std
TP1, TP2, TP9, TP10	4	5012	Test point, white, through-hole	0.125 $\times$ 0.125 inch (3.18 $\times$ 3.18 mm)	5012	Keystone
TP3, TP4	2	5010	Test point, red, through-hole	0.125 $\times$ 0.125 inch (3.18 $\times$ 3.18 mm)	5010	Keystone
TP5, TP6	2	5016	Test point, SM	0.185 $\times$ 0.135 inch (3.81 $\times$ 3.43 mm)	5016	Keystone
TP7, TP8	2	5013	Test point, orange, through-hole	0.125 $\times$ 0.125 inch (3.18 $\times$ 3.18 mm)	5013	Keystone
U1	1	TPS2543RTE or TPS2544RTE or TPS2545RTE or TPS2546RTE	USB charging-port power switch controller with load detect/status	QFN-16	TPS2543RTE or TPS2544RTE or TPS2545RTE or TPS2546RTE	TI
U2	1	TPD2E001DZDR	IC, low-capacitance 2-chan $\pm$ 15-kV ESD-protection array	SOP	TPD2E001DZDR	TI

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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.

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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

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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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.

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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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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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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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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.

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