

TPS92512EVM-001 High-Current Buck Regulator With Analog and PWM Dimming for High Brightness LEDs

1 Introduction

The TPS92512EVM-001 evaluation module (EVM) helps designers evaluate the operation and performance of the TPS92512HV buck switching regulator designed for high-current LED-drive applications. The TPS92512HV device is designed to control the drive of high-brightness light emitting diodes and features a wide input voltage range (4.5 V to 60 V), PWM dimming capability, analog dimming capability, adjustable/syncable switching frequency, and input undervoltage protection.

2 Warnings

Observe the following precautions when using the TPS92512EVM-001.

WARNING

DO NOT STARE DIRECTLY INTO THE LED LIGHT SOURCE. Intense light sources have a high-secondary blinding effect. A temporary reduction in visual acuity and afterimages can occur, leading to irritation, annoyance, visual impairment, and even accidents—depending on the situation. Always consider the use of light filtering and darkening protective eyewear and be fully aware of surrounding laboratory-type set-ups when viewing intense light sources to minimize or eliminate such risks in order to avoid accidents related to temporary blindness.

WARNING

Do not stare at the operating LED (Risk Group1 [RG1]). See IEC32471-1 ed1.0:2009-08 for risk group definitions.

3 Description

The TPS92512EVM-001 provides a high-brightness LED driver based on the TPS92512HV buck regulator. It is designed to operate with an input voltage in the range of 12 V to 48 V. The EVM is set up for a default output current of 1.5 A for an LED stack between approximately 5 V and 25 V. The TPS92512 device helps provide high efficiency, good line regulation, low output ripple, and a wide dimming range.

3.1 Typical Applications

This converter design describes an application of the TPS92512HV device as an LED driver with the specifications described in [Table 1](#). For applications with a different input voltage range or different output voltage range refer to the TPS92512 data sheet.

3.2 Features

3.2.1 Connector Description

This section describes the connectors and test points on the EVM and how to properly connect, setup, and use the TPS92512EVM-001.

3.2.1.1 J1, LED+, LED-

The screw-down connector, J1, and the test posts marked LED+ and LED- are for connecting the LED load to the board. The leads to the LED load should be twisted and kept as short as possible to minimize voltage drop, inductance, and EMI transmission. This design is for approximately 2 to 7 white LEDs.

3.2.1.2 J2, VIN, GND

The screw-down connector, J2, and the test posts marked VIN and GND are for connecting the EVM to the DC input voltage supply. The input supply ground should be connected to J2 or the GND test post directly next to J2. One other GND test point is provided on the board that can also be used for all purposes but input power.

3.2.1.3 UVLO

The test point UVLO connects directly to the UVLO pin of the TPS92512 device. The voltage range is 0 V to 4.5 V if driven externally. The UVLO resistor divider should be used for the UVLO function, but the UVLO voltage can be monitored with this test point. Pulling UVLO to GND will also serve to disable the part and put it into low power shutdown mode.

3.2.1.4 PDIM

The PDIM test point connects directly to the PDIM pin of the TPS92512 device. Leave open for normal operation. If PWM dimming is used, apply a square wave with a low level of GND and a high level of between 2 V and 4.5 V. The dimming frequency range is 100 Hz to 1 kHz.

3.2.1.5 SYNC

The SYNC test point is AC coupled to the RT/CLK pin of the TPS92512 device through a 4.02-k Ω resistor in series with a 470-pF capacitor. Apply a square wave with a low level of GND and a high level of 3.3 V to synchronize the switching frequency to the applied frequency. The frequency range of SYNC is 200 kHz to 2 MHz.

3.2.1.6 IADJ

The IADJ test point connects directly to the IADJ pin of the TPS92512 device. The default is pulled high through a 10M resistor to VIN resulting in an ISENSE voltage of 300mV. The range on the IADJ pin is 180 mV to 1.8 V and the corresponding ISENSE voltage is $V_{IADJ} / 6$.

3.2.1.7 PH

A large via, labelled PH, is included and sized specifically to receive the probe tip of a standard 10x probe. Use this via to monitor the switching waveform at the PH pin of the device.

4 Electrical Performance Specifications

Table 1. TPS92512EVM-001 Electrical Performance Specifications

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT CHARACTERISTICS					
Voltage range		12		48	V
Maximum input current			1.5		A
Input UVLO setting			11.5		V
OUTPUT CHARACTERISTICS					
Output voltage, VOUT	LED+ to LED-	5		25	V
Output current		1.425	1.5	1.575	A
Output current ripple			20		mApp
Analog dimming range	IADJ = 180 mV to 1.8 V	10:1			
PWM dimming range	250-Hz PWM	100:1			
SYSTEMS CHARACTERISTICS					
Efficiency	Input voltage = 24 V, 4 LEDs		93%		
Switching frequency			570		kHz

5 Schematic

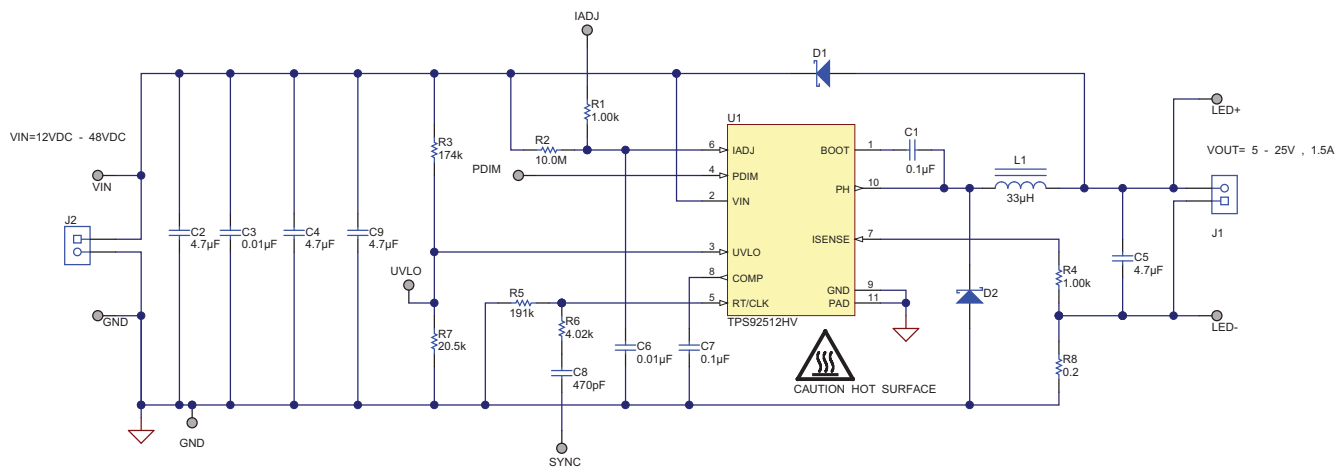
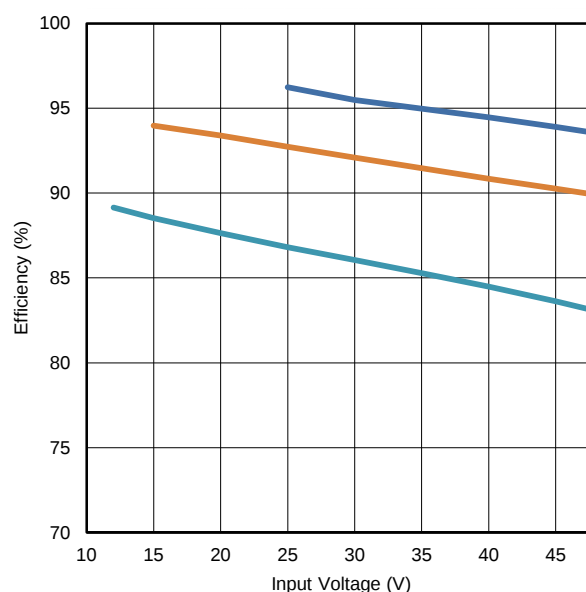


Figure 1. TPS92512EVM-001 Schematic

6 Performance Data and Typical Characteristic Curves

Figure 2 through Figure 8 show the typical performance curves for the TPS92512EVM-001. Unless otherwise noted, $V_{IN} = 24\text{ V}$ and 3 LED output.

6.1 Efficiency



Top = 7 LEDs

Middle = 4 LEDs

Bottom = 2 LEDs

Figure 2. Efficiency vs Input Voltage

6.2 Line Regulation

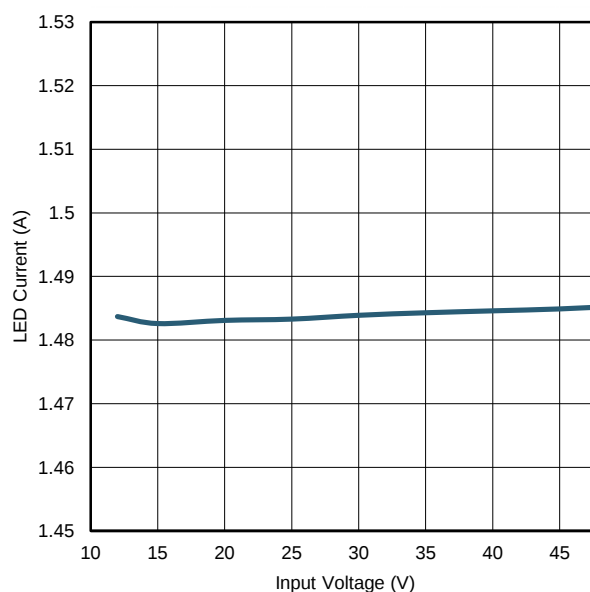


Figure 3. Output Current vs Input Voltage

6.3 PWM Dimming

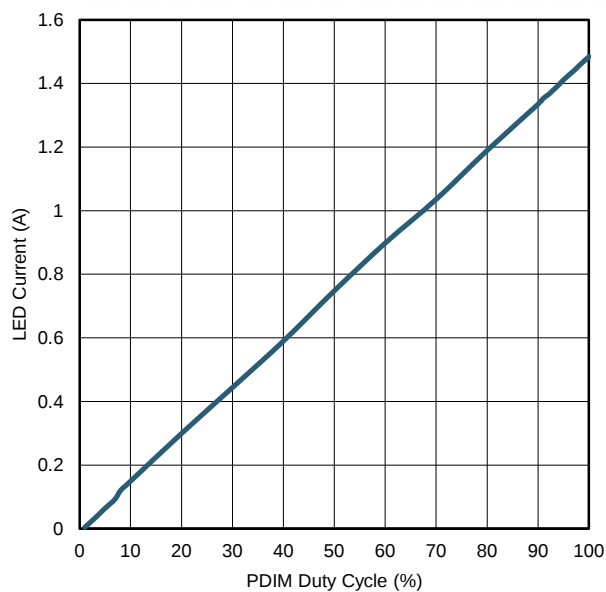


Figure 4. Output Current vs PWM Duty Cycle (250Hz)

6.4 Analog Dimming

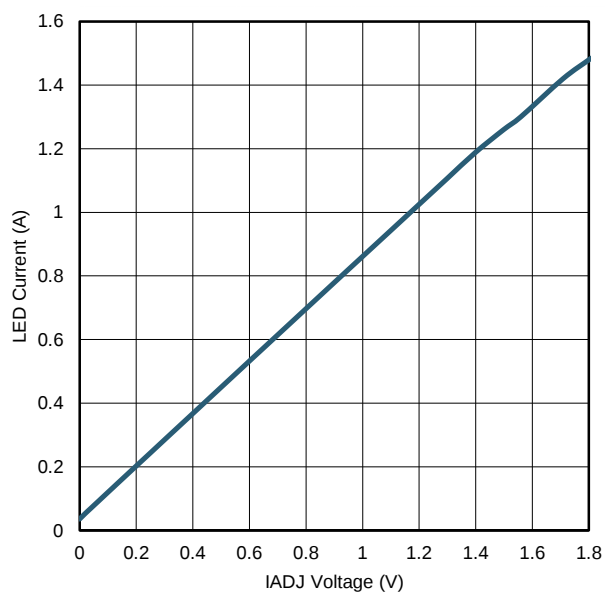


Figure 5. Output Current vs IADJ Voltage

6.5 PWM Dimming Waveforms

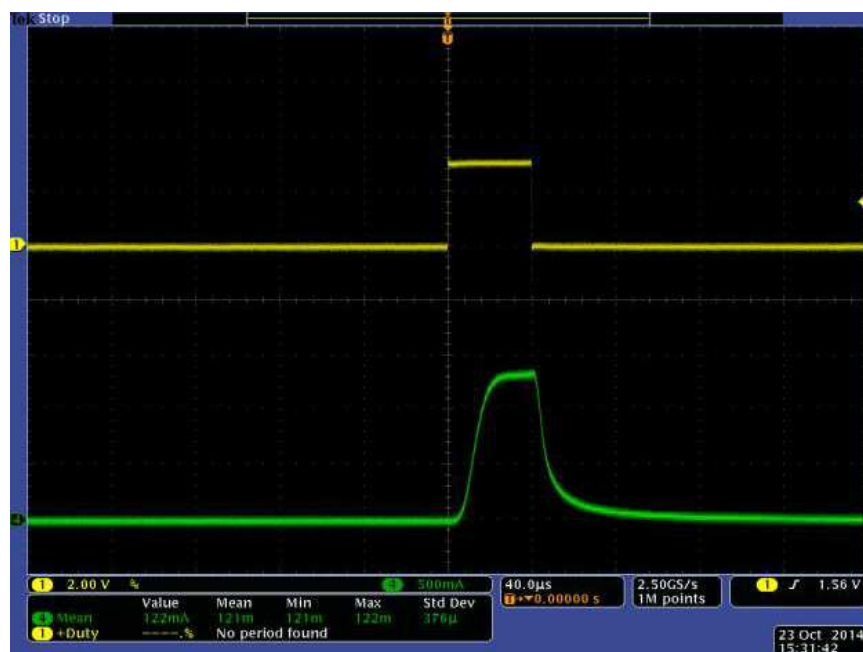


Figure 6. 1% Duty Cycle, 250-Hz PWM Dimming

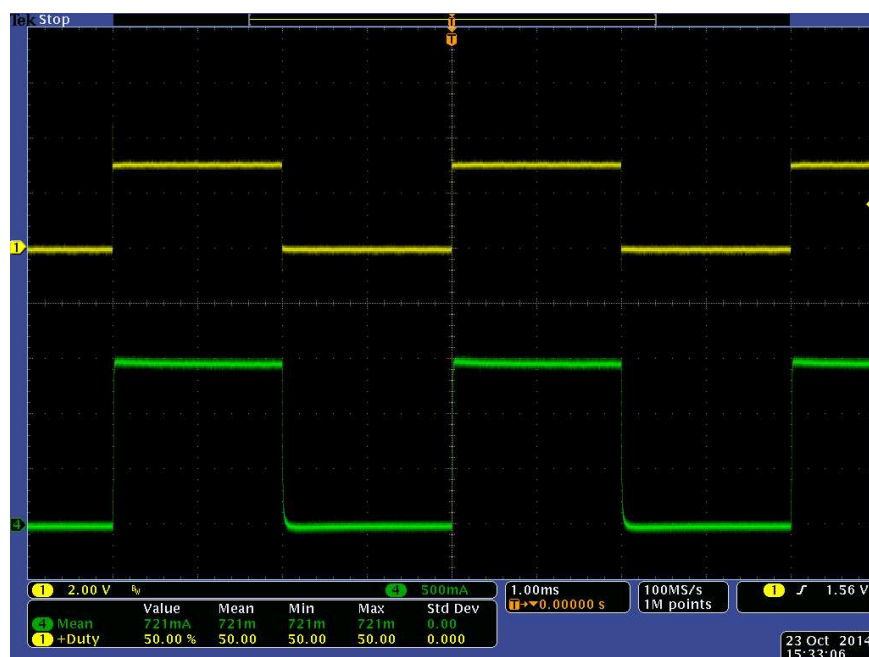


Figure 7. 50% Duty Cycle, 250-Hz PWM Dimming



Top = PDIM Bottom = LED Current
Figure 8. 99% Duty Cycle, 250-Hz PWM Dimming

7 TPS92512EVM-001 PCB layout

Figure 9 and Figure 10 show the design of the TPS92512EVM-001 printed circuit board.

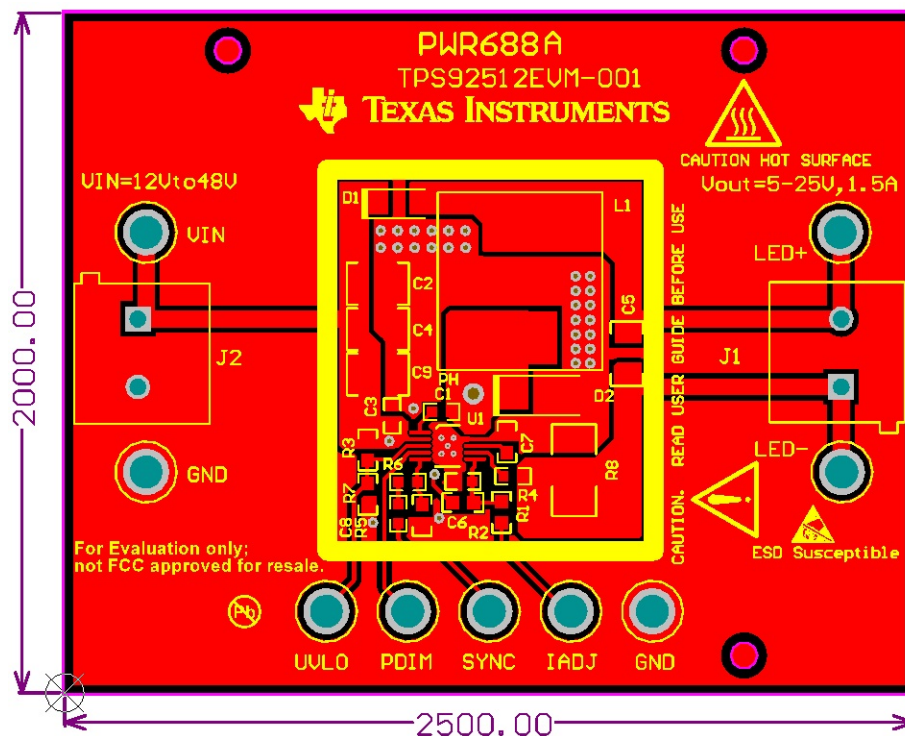


Figure 9. Top Layer and Top Overlay (Top View)

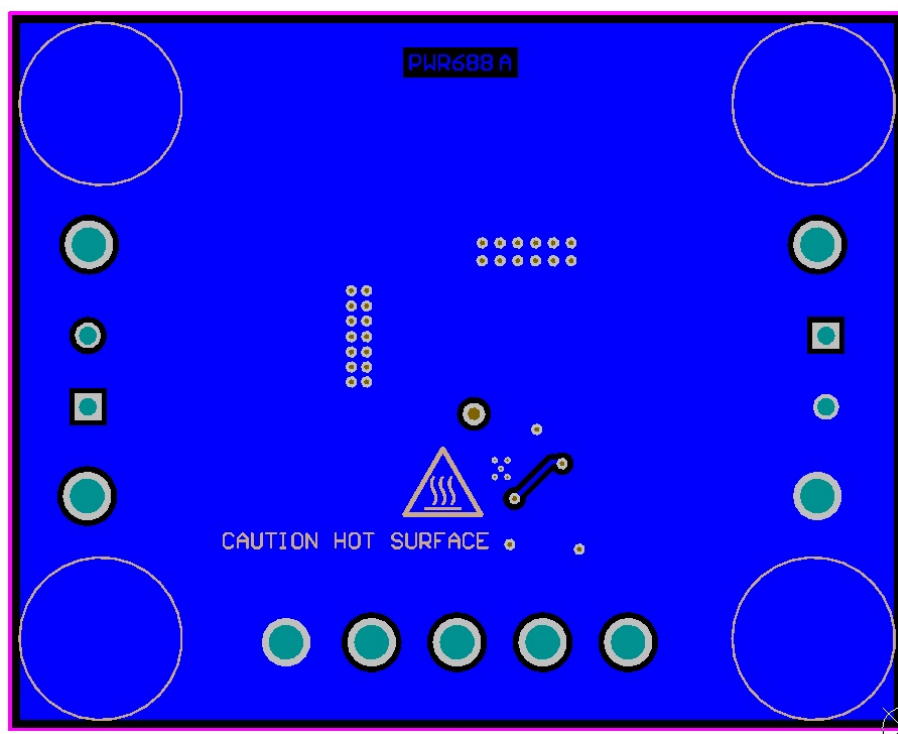


Figure 10. Bottom Layer and Bottom Overlay (Bottom View)

8 Bill of Materials

Table 2 lists the TPS92512EVM-001 components list according to the schematic shown in Figure 1.

Table 2. Bill of Materials

REFERENCE DESIGNATOR	QTY	VALUE	DESCRIPTION	SIZE	PART NUMBER	MFR
C1	1	0.1 μ F	CAP, CERM, 0.1 μ F, 25 V, $\pm$ 10%, X5R	0603	885012206071	Würth
C2, C4, C9	3	4.7 μ F	CAP, CERM, 4.7 μ F, 100 V, $\pm$ 10%, X7S	1210	C3225X7S2A475K200AB	TDK
C3, C6	2	0.01 μ F	CAP, CERM, 0.01 μ F, 100 V, $\pm$ 10%, X7R	0603	06031C103KAT2A	AVX
C5	1	4.7 μ F	CAP, CERM, 4.7 μ F, 25 V, $\pm$ 10%, X7R	1206	885012208068	Würth
C7	1	0.1 μ F	CAP, CERM, 0.1 μ F, 50 V, $\pm$ 10%, X7R	0603	885012206095	Würth
C8	1	470 pF	CAP, CERM, 470 pF, 50 V, $\pm$ 10%, X7R	0603	885012206081	Würth
D1	1	800 mV at 500 mA	DIODE SCHOTTKY 80 V 0.5 A	SOD-123	MBR0580-TP	Micro Commercial Co
D2	1	850 mV at 2 A	DIODE SCHOTTKY 80 V 2 A	DO-214AC, SMA	CDBA280-G	Comchip Technology
L1	1	33 μ H	Inductor, Shielded Drum Core, Ferrite, 33 μ H	1246	744771133	Würth
J1, J2	2		Connector, rising clamp, 2 pins, 5mm pitch		691123710002	Würth
R1, R4	1	1 k Ω	RES, 1 k Ω , 1%, 0.1W	0603	CRCW06031K00FKEA	Vishay-Dale
R2	1	10 M Ω	RES, 10 M Ω , 1%, 0.1 W	0603	CRCW060310M0FKEA	Vishay-Dale
R3	1	174 k Ω	RES, 174 k Ω , 1%, 0.1 W	0603	CRCW0603174KFKEA	Vishay-Dale
R5	1	191 k Ω	RES, 191 k Ω , 1%, 0.1 W	0603	CRCW0603191KFKEA	Vishay-Dale
R6	1	4.02 k Ω	RES, 4.02 k Ω , 1%, 0.1W	0603	CRCW06034K02FKEA	Vishay-Dale
R7	1	20.5 k Ω	RES, 20.5 k Ω , 1%, 0.1 W	0603	CRCW060320K5FKEA	Vishay-Dale
R8	1	0.2	RES, 0.2, 1%, 1 W	2010	CSRN2010FKR200	Stackpole Electronics Inc
U1	1		TPS92512 2.5A Buck Current Regulator for High-Brightness LEDs with Integrated Analog Current Adjust	DGQ0010D	TPS92512HV	Texas Instruments

Revision History

Changes from Original (February 2015) to A Revision	Page
- Changed the PART NUMBER and MFR of C1, C5, C7, C8, and L1 in Table 2..... - Added J1, J2 to Table 2	9 9

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

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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

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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.*

3.2 Canada

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.

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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. 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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