TPS61021A-PWR723 Evaluation Module

This user's guide describes the characteristics, operation, and the use of the TPS61021EVM-723 evaluation module (EVM). The EVM contains the TPS61021A, which is a 3-A boost converter with 0.5-V ultra-low input voltage. This user's guide includes EVM specifications, recommended test setup, test results, a schematic diagram, bill of materials (BOM), and the board layout.

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1 Introduction

1.1 Performance Specification

Table 1 provides a summary of the TPS61021A EVM performance specifications. All the specifications are given for an ambient temperature of 25°C.

Table 1. Performance Specification Summary

Specification	Test Conditions	MIN	TYP	MAX	Unit
Input voltage		0.9	2.4	3.2	V
Output voltage	TPS61021A EVM, V_{IN} = 2.4 V, I_O ≤ 2 A	3.2	3.3	3.4	V
Output current	V_{IN} = 1.2 V			1	A
	V_{IN} = 2.4 V			2.3	A

1.2 Modification

The printed-circuit board (PCB) for this EVM is designed to accommodate some modifications by the user. The external component can be changed according to the real application.

1.3 Input Capacitor

A 150-µF tantalum capacitor, C1, is added as the input capacitor in the EVM. The ESR of the tantalum capacitor is 0.1 Ω, to damp the ringing of the input voltage when the EVM is powered by a power supply with a long cable. The capacitor is not required for proper operation and can be removed in a real application.

1.4 Feedforward Capacitor

A feedforward capacitor, C7 in Figure 7, is used to improve the phase margin of the boost converter. Equation 1 calculates the zero frequency formed by the feedforward capacitor C7, and the resistor R1 of the feedback resistor divider.

$$f_z = \frac{1}{2\pi \times R1 \times C7} \quad (1)$$

TI recommends setting f_z at 50 kHz to boost the phase margin at the crossover frequency. When R1 = 316 kΩ, C7 is 10 pF on the EVM.

2 Setup

This section describes how to properly connect, set up, and use the TPS61021EVM-723.

2.1 Input/Output Connector Descriptions

The following :

J1-VIN	Positive input connection from the input supply for the EVM
J2-GND	Return connection from the input supply for the EVM
J5-VOUT	Positive connection for the output voltage
J6-GND	Return connection for the output voltage
J7-EN	EN pin input jumper. Place a jumper across EN and pin 1 to turn on the IC, place a jumper across EN and pin 3 to turn off the IC

3 Test Results

3.1 Startup Waveform

The startup waveform is shown in Figure 1.

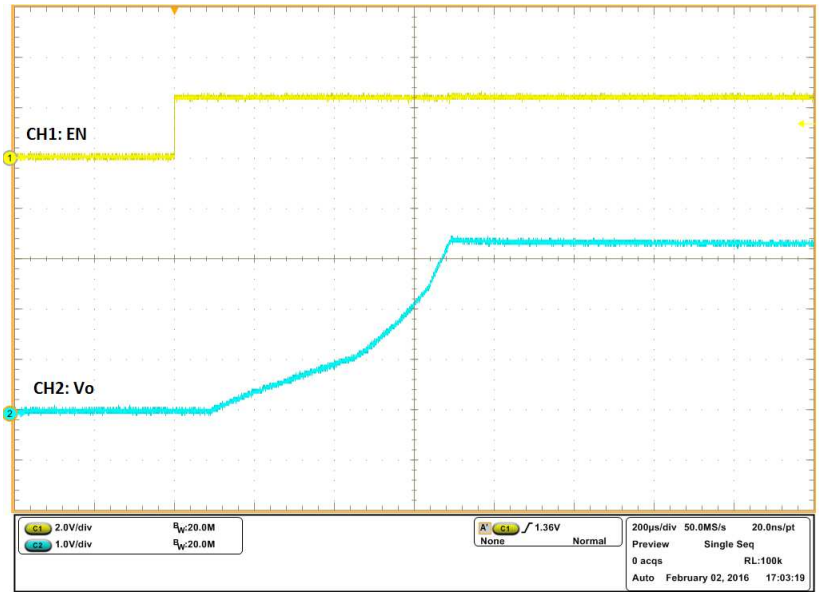

Figure 1. Startup Waveforms (No Load)

3.2 Efficiency

The conversion efficiency is shown in Figure 2.

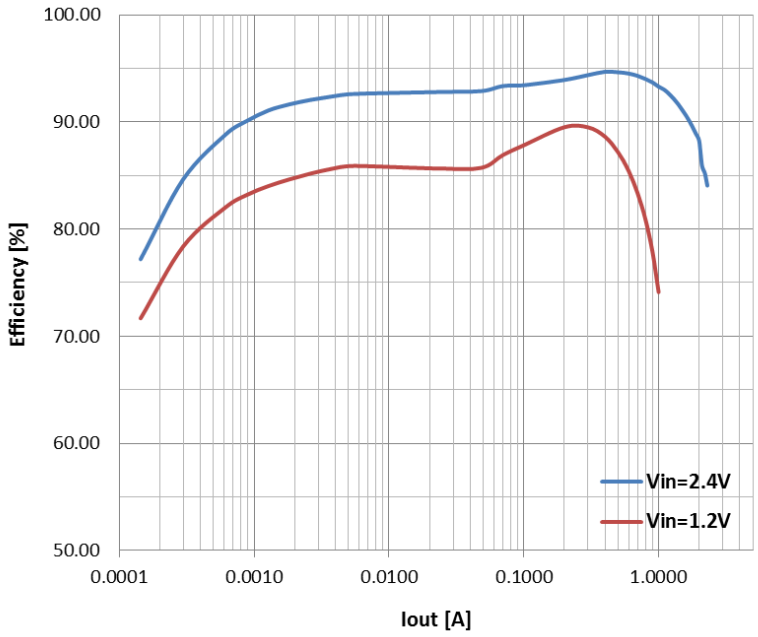

Figure 2. TPS61021A EVM Efficiency vs Load Current

3.3 Load Transient

The load transient waveform is shown in Figure 3. Note that the effective output capacitance is about 31 µF under V_O = 3.3 V DC bias, although two 22-µF ceramic capacitors are used in the EVM. Larger effective capacitance helps to improve the load transient.

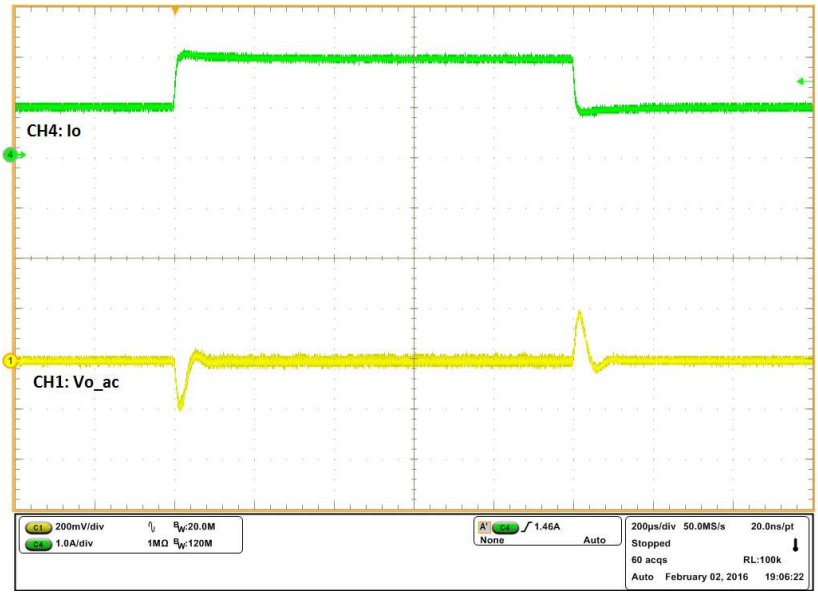

Figure 3. Load Transient (V_O = 3.3 V, I_O = 1 A to 2 A)

3.4 Loop Characteristics

The loop Bode plot is shown in Figure 4.

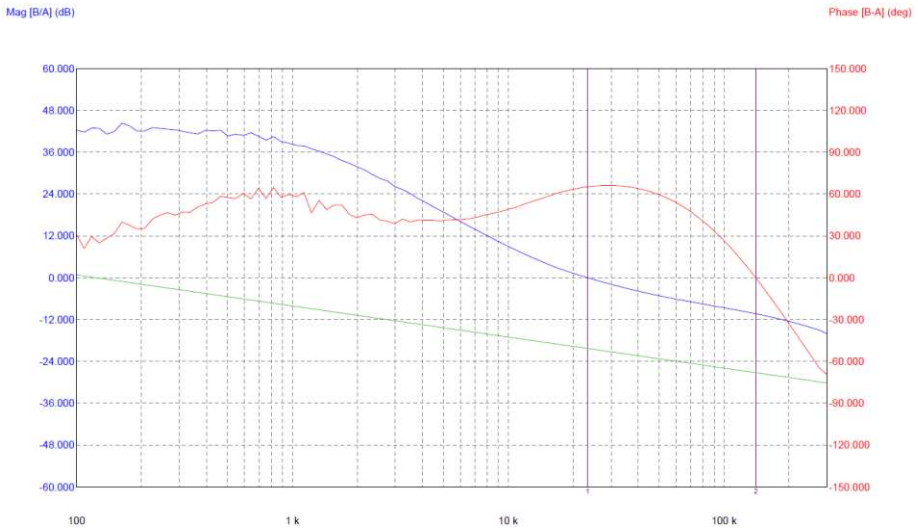

Figure 4. Loop Bode Plot (V_{IN} = 2.4 V, V_O = 3.3 V / I_O = 2 A)

3.5 Output Voltage Ripple

Figure 5 shows the output voltage ripple , switching waveforms, and the inductor current ripple in CCM mode.

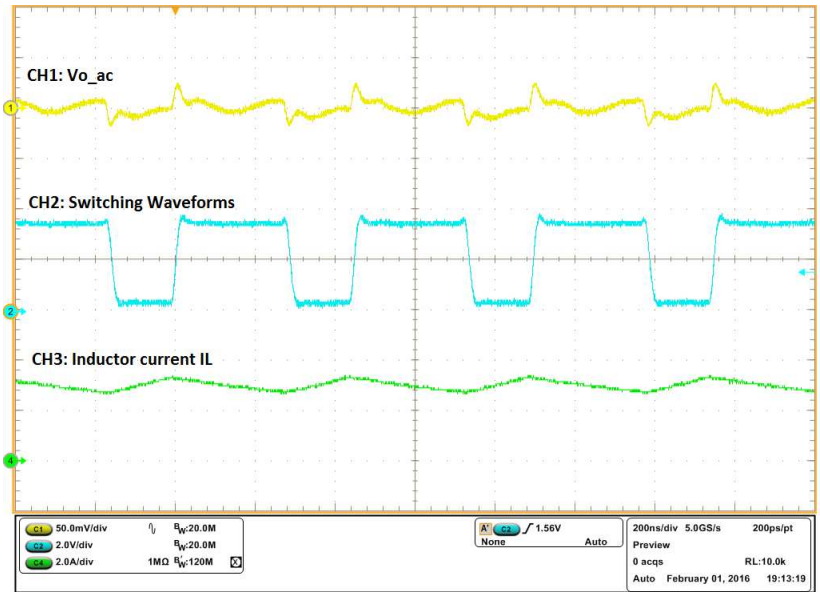

Figure 5. Output Ripple in CCM (V_{IN} = 2.4 V, V_O = 3.3 V / I_O = 2 A)

Figure 6 shows the output voltage ripple, switching waveforms, and the inductor current ripple in PFM mode when the converter is operating at light load.

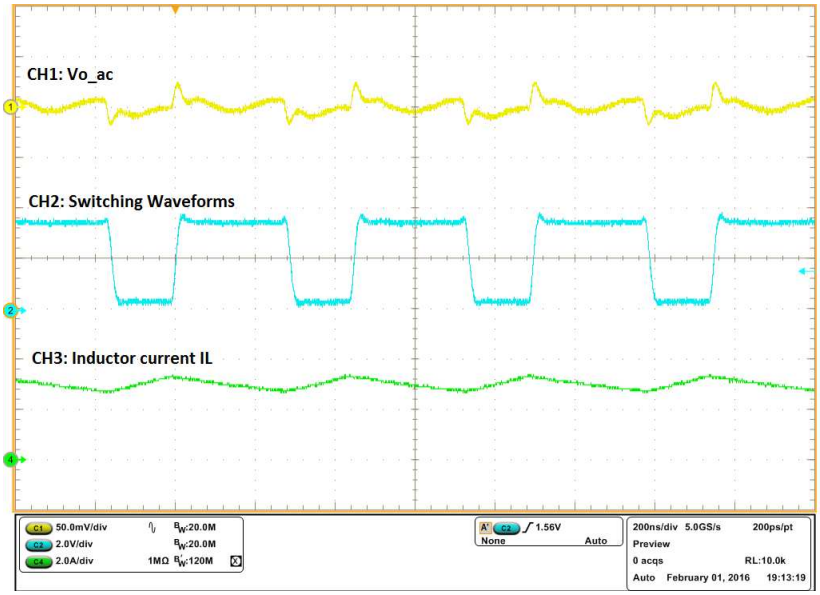

Figure 6. Output Ripple in PFM (V_{IN} = 2.4 V, V_O = 3.3 V / I_O = 160 mA)

4 Schematic and Bill of Materials

This section provides the TPS61021EVM-723 schematic, bill of materials (BOM), and board layout.

4.1 Schematic

Figure 7 illustrates the EVM schematic.

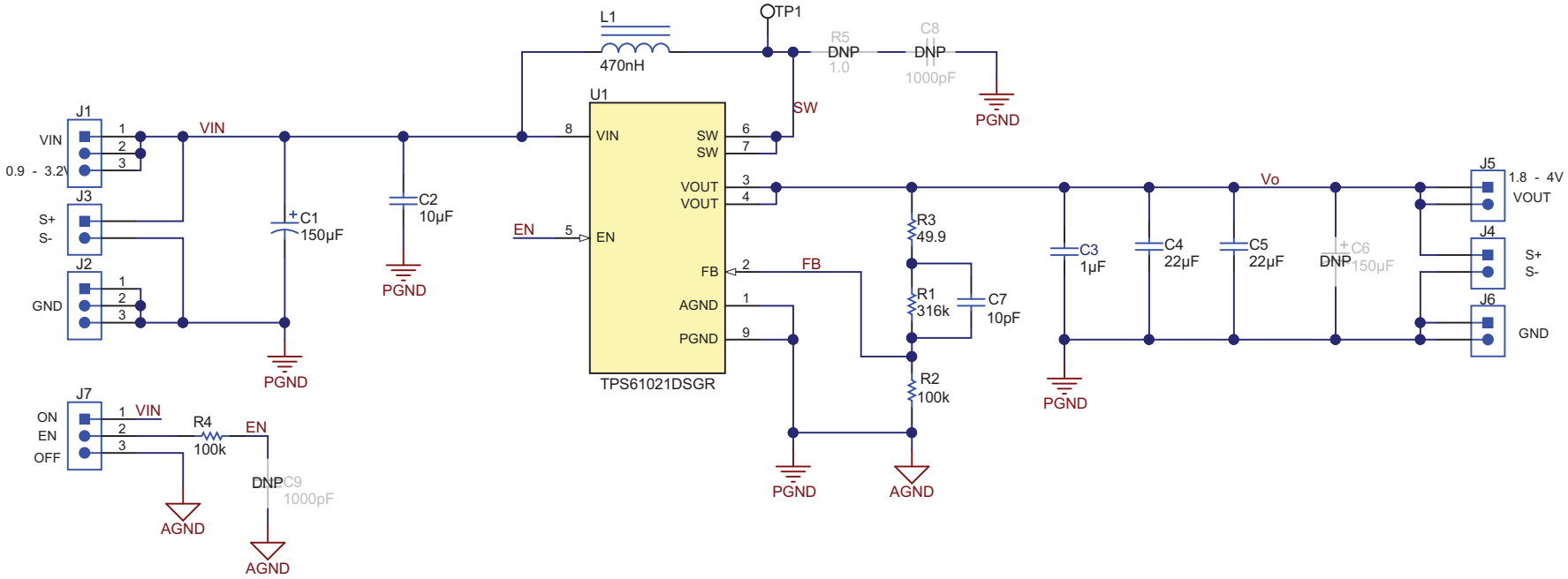

Figure 7. TPS61021EVM-723 Schematic

4.2 Bill of Materials

Table 2 displays the EVM bill of materials.

Table 2. TPS61021EVM-723 Bill of Materials

Designator	QTY	Value	Description	Package	Part Number	MFG
C1	1	150uF	CAP, TA, 150 µF, 10 V, +/- 10%, 0.1 ohm, SMD	7343-31	T495D157K010ATE100	Kemet
C2	1	10uF	CAP, CERM, 10 µF, 6.3 V, +/- 20%, X5R, 0603	0603	GRM188R60J106ME47D	MuRata
C3	1	1uF	CAP, CERM, 1 µF, 25 V, +/- 10%, X7R, 0603	0603	GRM188R71E105KA12D	MuRata
C4, C5	2	22uF	CAP, CERM, 22 µF, 10 V, +/- 20%, X5R, 0805	0805	GRM21BR61A226ME44L	MuRata
C7	1	10pF	CAP, CERM, 10 pF, 100 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C2A100JA01D	MuRata
J1, J2, J7	3		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J3, J4, J5, J6	4		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
L1	1	470nH	Inductor, Shielded, Composite, 470 nH, 3.5 A, 0.0076 ohm, SMD	SMD, 4x4x1.5mm	XFL4015-471MEC	Coilcraft
R1	1	316k	RES, 316 k, 1%, 0.1 W, 0603	0603	RC0603FR-07316KL	Yageo America
R2, R4	2	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R3	1	49.9	RES, 49.9, 1%, 0.1 W, 0603	0603	RC0603FR-0749R9L	Yageo America
U1	1		3-A BOOST CONVERTER WITH 0.5V ULTRA-LOW INPUT VOLTAGE, DSG0008A	DSG0008A	TPS61021ADSGR	Texas Instruments
C6	0	150uF	CAP, TA, 150 µF, 10 V, +/- 10%, 0.1 ohm, SMD	7343-31	T495D157K010ATE100	Kemet
C8, C9	0	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 10%, X7R, 0603	0603	C0603C102K5RACTU	Kemet
R5	0	1.0	RES, 1.0, 5%, 0.1 W, 0603	0603	CRCW06031R00JNEA	Vishay-Dale

5 Board Layout

Figure 8 and Figure 9 show the design of the TPS61021EVM-723 PCB layout.

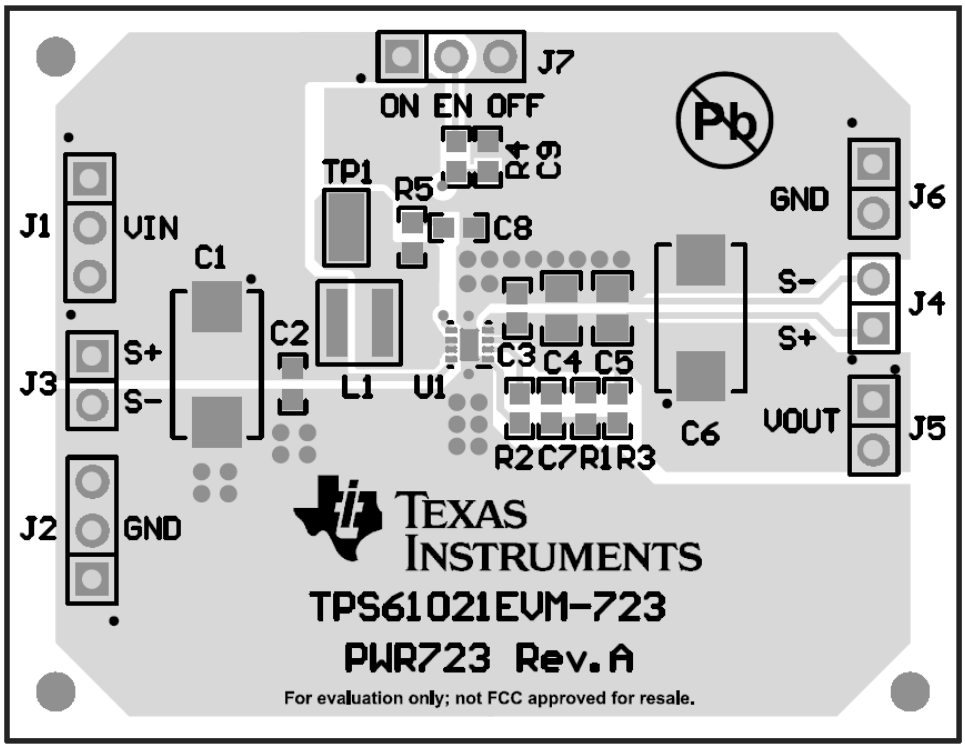

Figure 8. TPS61021EVM-723 Top-Side Layout

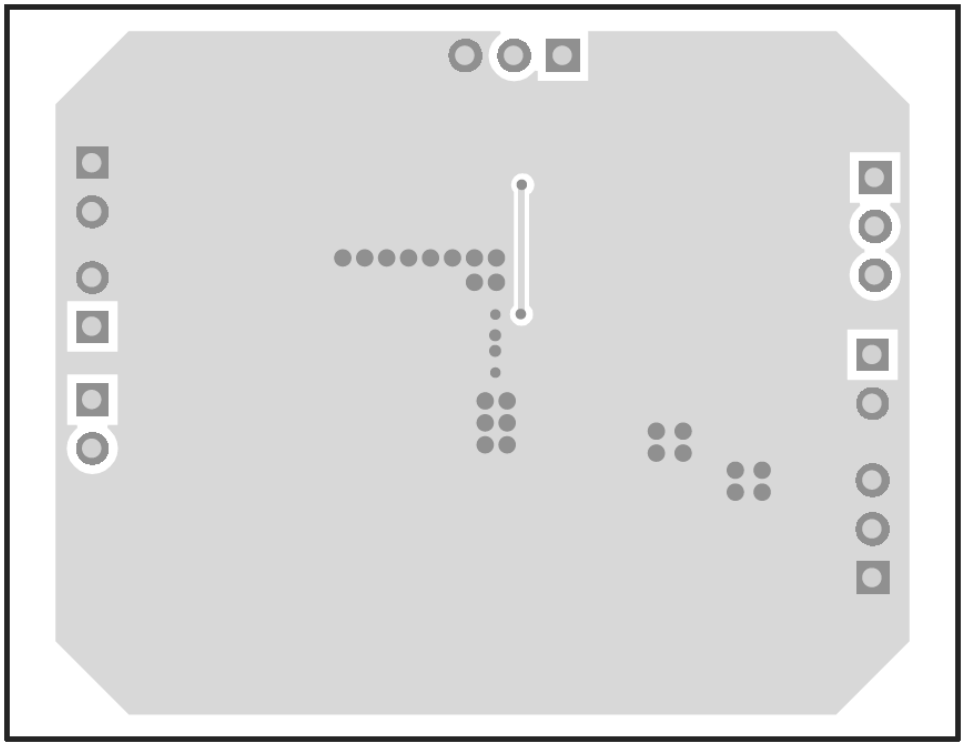

Figure 9. TPS61021EVM-723 Bottom-Side Layout

Revision History

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

Changes from Original (February 2016) to A Revision	Page
• Changed device name to TPS61021A throughout document.	1

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      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*

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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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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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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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4.3.2 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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