User's Guide
SLVU554–October 2011

TLV70130EVM-077

This user's guide describes operational use of the TLV70130EVM-077 evaluation module (EVM) as a reference design for engineering demonstration and evaluation of the TLV70130, low-dropout (LDO) linear regulator. Included in this user's guide are setup instructions, a schematic diagram, layout and thermal guidelines, a bill of materials, and test results.

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1 Introduction

The Texas Instruments TLV70130EVM-077 EVM helps design engineers to evaluate the operation and performance of the TLV701xx family of linear regulators for possible use in their own circuit applications. This particular EVM configuration contains a single linear regulator with internal current limit. The TLV701xx series of LDO regulators exhibit ultralow quiescent current that is virtually constant over the complete range of load and thermal specifications. The TLV701xx series is available in a 3-mm x 3-mm SOT23-5 package. The regulator, including external components, is capable of delivering up to 150 mA to the load depending on the input/output power dissipation across the part. The TLV701xx is stable with any capacitor > 0.47 µF; however, for conservative design practice accounting for widely varying noise environments, and dynamic line/load conditions, a 1-µF input and output capacitor have been used in the design.

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TLV70130EVM.

2.1 Input/Output Connectors and Jumper Descriptions

2.1.1 J1 – VIN

J1 is the input power supply voltage connector. Twist the positive input lead and ground return lead from the input power supply, and keep them as short as possible to minimize EMI transmission. Add additional bulk capacitance between J1 and J3 if the supply leads are greater than 6 inches. For example, an additional 47-µF electrolytic capacitor connected from J1 to ground can improve the transient response of the TLV70130, while eliminating unwanted ringing on the input due to long-wire connections.

2.1.2 J2 – VOUT

J2 is the regulated output voltage connector.

2.1.3 J3 – GND

J3 is the ground-return connector for the input power supply.

2.1.4 J4 – GND

J4 is the output ground-return connector

2.2 Equipment Setup

- Turn off the input power supply after verifying that its output voltage is set to greater than 3.2 V (24 V maximum). Connect the positive voltage lead from the input power supply to VIN, at the J1 connector of the EVM. Connect the ground lead from the input power supply to GND at the J3 connector of the EVM.
- Connect desired load (≤ 150 mA) between an OUT pin at connector J2 and a GND pin at connector J4.

3 Operation

- Turn on the input power supply. For initial operation, set the input power supply, VIN – J1, to 5 V.
- Vary the respective loads and VIN voltages as necessary for test purposes.

4 Test Results

This section provides typical performance waveforms for the TLV70130EVM-077 printed-circuit board (PCB).

4.1 Turnon Sequence

Figure 1 shows the turnon characteristic where VIN is switched on to 5 V and the output drives a 100-mA load. The output (C1, red) shows a fairly monotonic rise time of approximately 120 ms.

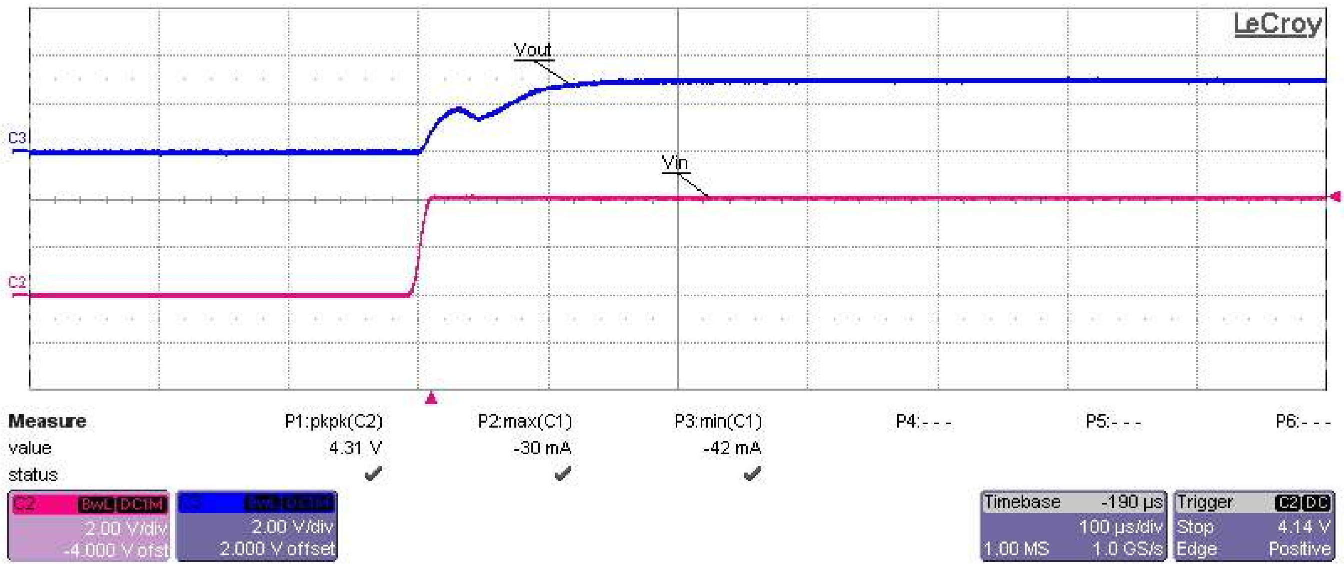

Figure 1. Start-Up Sequence

4.2 Output Load Transient

Figure 2 shows the load transient response (OUT - C1, yellow) for a full-load step transient from 0 mA to 150 mA (C4, green). VIN is set at 5 V.

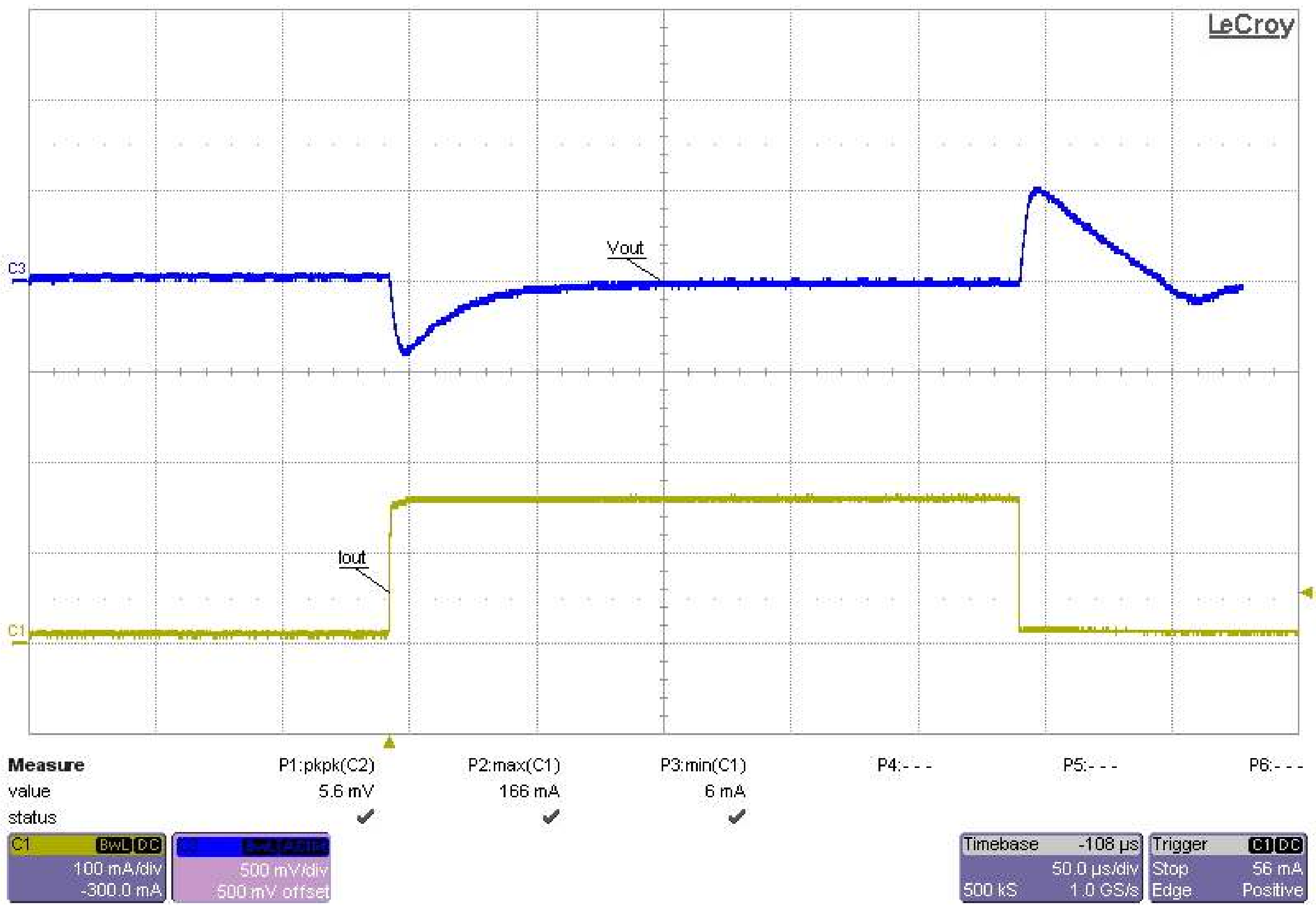

Figure 2. Load Step and Transient Response

5 Thermal Guidelines and Layout Recommendations

Thermal management is a key component of design of any power converter and is especially important when the power dissipation in the LDO regulator is high. Use the following formula to approximate the maximum power dissipation for the particular ambient temperature: courtesy

$$T_J = T_A + P_D \times \theta_{JA}$$

Where T_J is the junction temperature, T_A is the ambient temperature, P_D is the power dissipation in the device (W), and θ_{JA} is the thermal resistance from junction to ambient. All temperatures are in degrees Celsius. The maximum silicon junction temperature, T_J, must not be allowed to exceed 150°C. The layout design must use copper trace and plane areas effectively, as thermal sinks, in order not to allow T_J to exceed the absolute maximum rating under all temperature conditions and voltage conditions across the part.

The designer must consider carefully the thermal design of the PCB for optimal performance over temperature. For this EVM, Figure 4 shows the PCB top GND plane has six, 6-mil, thermal via connections to the bottom-side copper GND plane to dissipate heat. The PCB is a two-layer board with 2-oz copper on top and bottom layers. The YFF package drawing can be found at the Texas Instruments Web site in the product folder for the TLV701xx LDO regulator.

Table 1 repeats information from the Dissipation Ratings Table of the TLV701xx data sheet for comparison with the thermal resistance, θ_{JA}, calculated for this EVM layout to show the wide variation in thermal resistances for given copper areas. The High-K value is determined using a standard JEDEC High-K (2s2p) board having dimensions of 3-inch x 3-inch with 1-ounce internal power and ground planes and 2-oz copper traces on top and bottom of the board.

Table 1. Thermal Dissipation Rating

Board	Package	$R_{\theta JA}$	$T_A \leq 25°C$ Power Rating	$T_A = 70°C$ Power Rating	($T_A = 85°C$) Power Rating
High-K [(1)]	DBV	213.1°C/W	470 mW	258 mW	188 mW

(1) The JEDEC High-K (2s2p) board design used to derive this data was 3-inch × 3-inch, multilayer board with 1-ounce internal power and ground planes and 2-ounce copper traces on top and bottom of the board.

The thermal resistance for the TLV70130EVM-077, $R_{\theta JA}$, is the measured value for this particular layout scheme. The actual allowable power dissipation on your PCB is a strong function of your layout.

6 Board Layout

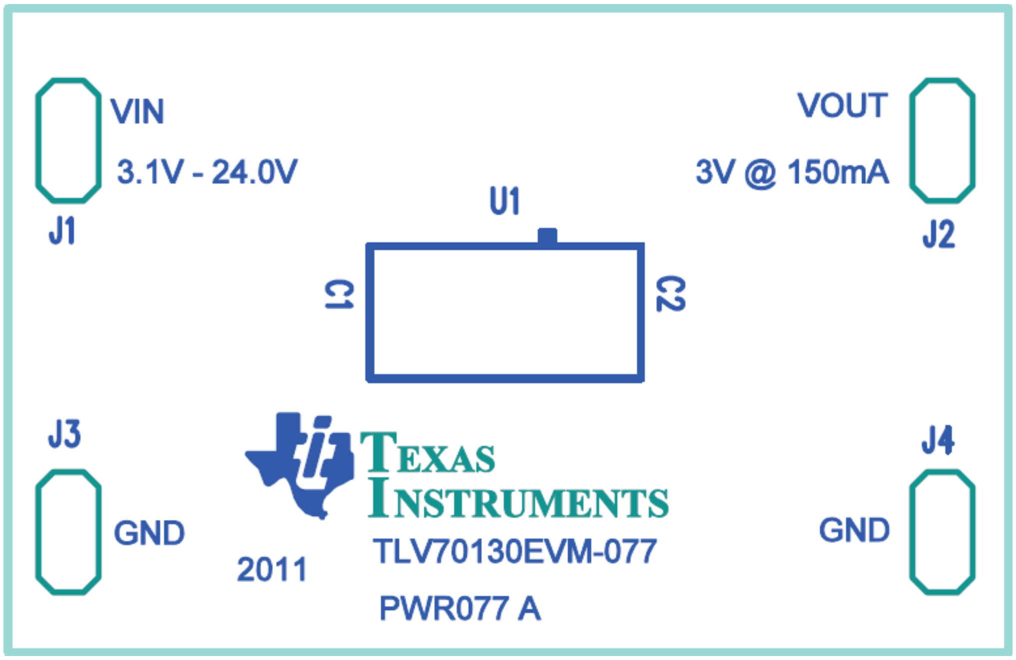

Figure 3. Top-Layer Silkscreen

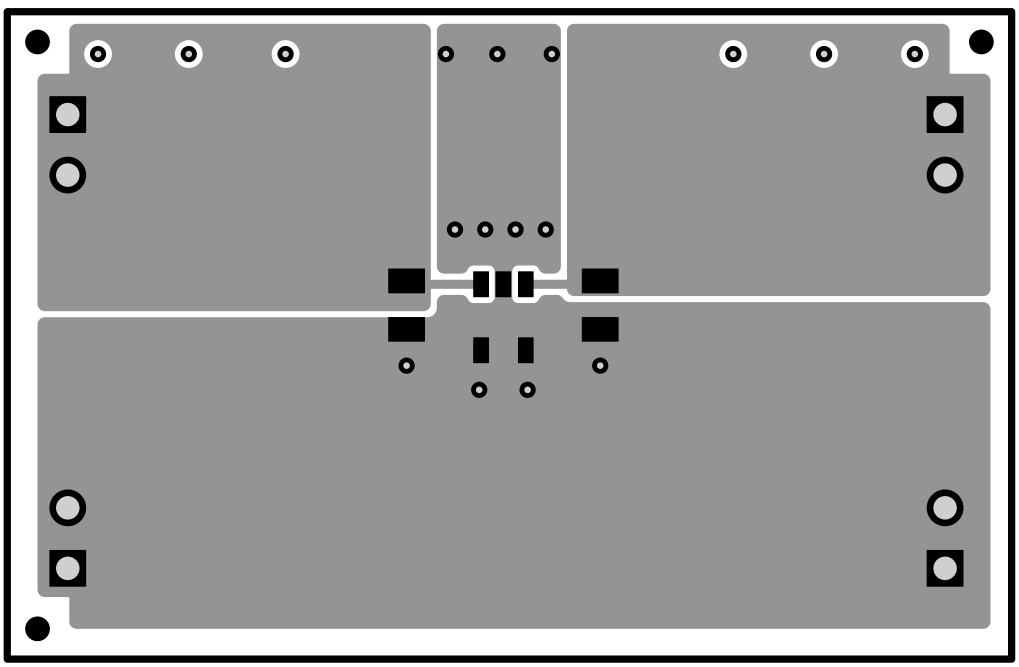

Figure 4. Top-Layer Routing

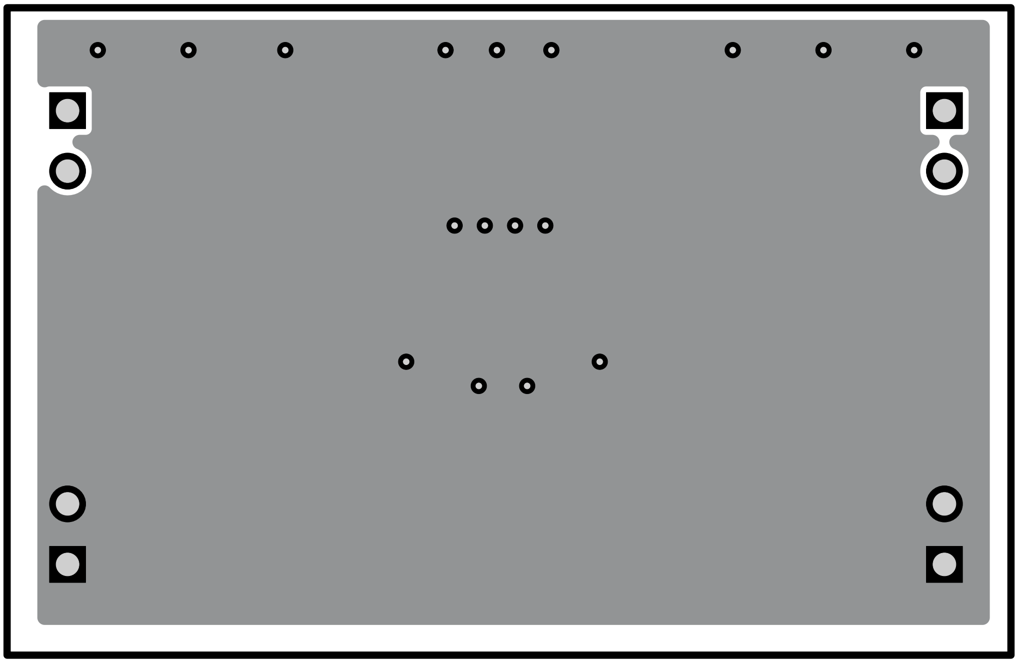

Figure 5. Bottom-Layer Routing

7 Schematic and Bill of Materials

7.1 Schematic

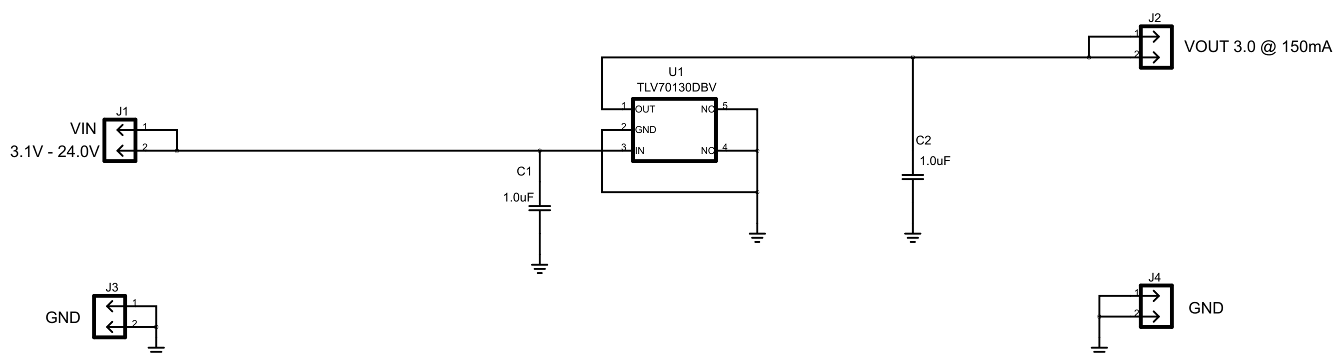

Figure 6. TLV70130EVM-077 Schematic

7.2 Bill of Materials

Table 2. TLV70130EVM-077 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	1.0uF	Capacitor, Ceramic, 35V, X7R, 10%	0805	STD	STD
1	C2	1.0uF	Capacitor, Ceramic, 10V, X7R, 10%	0805	STD	STD
4	J1-4	PEC02SAAN	Header, 2-pin, 100mil spacing	0.100 in x 2	PEC02SAAN	Sullins
1	U1	TLV71730DBV	IC, 24-V Input Voltage, 150-mA, Ultralow IQ Low-Dropout Regulators	SOT-23	TLV71730DBV	TI
1	—		PCB, 1.660 In x 1.070 In x 0.062 In		PWR077	Any

Notes:
1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's components.

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It is important to operate this EVM within the input voltage range of -3.1 V to 24 V and the output voltage range of 3 V .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. 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 125° C. The EVM is designed to operate properly with certain components above 125° C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

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.

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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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