TLV61220EVM-120, Low-Input Voltage, Step-Up Converter Evaluation Module

This user's guide describes the characteristics, operation, and use of the TLV61220EVM-120 evaluation module (EVM). This EVM demonstrates the Texas Instruments TLV61220 synchronous boost converter. The input voltage range of the TLV61220 is 0.7 V to 5.5 V, allowing the device to operate from one-cell to three-cell battery configurations in addition to a single-cell Li-ion battery. This user's guide includes setup instructions, schematic diagram, bill of materials, and printed-circuit board layout drawings for the EVM.

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1 Introduction

The TLV61220EVM-120 evaluation module (EVM) helps designers evaluate the operation and performance of the TLV61220 boost converter. The TLV61220 is an adjustable output version that can be set between 1.8 V and 5.5 V. The output of this EVM is set to 3.3-V out. The output voltage can be changed between 1.8 V and 5.5 V by adjusting the value of R1 and R2. See Table 1 for common output voltages and recommended values for R1 and R2; also see the data sheet of the TLV61220 (SLVSB53) for more information. The device is packaged in a 6-pin, thin, SOT-23 package (DBV).

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TLV61220EVM-120.

2.1 Input and Output Connections and Jumper Descriptions

- **J1-J3: Input Connections**

  This is the connection for the leads from the input source. Connect the positive connection to the Vin (J1) and the negative connection to the GND (J3).

- **J4-J6: Output Connections**

  This is the connection for the output of the TLV61220EVM-120. Connect the positive connection of the load to the Vout (J4) and the negative connection to the GND (J6).

- **JP1-EN: Enable pin**

  This is the enable input for the device. Place a shorting jumper across the ON and EN pins of JP1 to enable the integrated circuit (IC). Place a shorting jumper across the OFF and EN pins of JP1 to disable the IC. A shorting jumper must be installed on JP1 in either the ON or OFF positions. A pullup resistor is used to enable the IC in case the jumper is not installed.

- **J2-J5: Vin Sense and Vout Sense**

  The two connectors are not installed, but if very accurate measurements of input or output voltage are required, J2 or J5 can be installed for the measurements. Traces on the printed-circuit board (PCB) connect to the input or output capacitor and run independent of the output and ground lines to the two connectors.

2.2 Modifications

These evaluation modules are designed to provide access to the features of the TLV61220. However, some modifications can be made to this module.

2.2.1 Output Voltage

The output voltage of this part is set by the resistor divider network of R1 and R2. To change the output voltage of the EVM, it is necessary to change the value of resistors. The value of R1 for a specific output voltage and specific resistor R2 can be calculated using Equation 1:

$$R1 = R2 (Vout/0.5 – 1) \quad (1)$$

Table 1 lists the R1 and R2 values for some common output voltages. The values given in Table 1 are standard values, not the exact value calculated using Equation 1.

Table 1. Changing Output Voltage With R1 and R2

Vout (V)	R1 (kΩ)	R2 (kΩ)
5	1000	110
4.2	1000	137
3.6	1000	162
3.3	1000	178
3	1000	200
2.5	1000	249
2	499	165

Table 1. Changing Output Voltage With R1 and R2 (continued)

Vout (V)	R1 (kΩ)	R2 (kΩ)
1.8	499	191

3 Operation

Connect the positive input power supply to the Vin (J1) and GND (J3). Typical input voltage is 0.7 V to 3.3 V for this configuration of output voltage. The TLV61220EVM-120 has a maximum input voltage of 5.5 V with correct output voltage.

Connect the desired load between the Vout (J4) and GND (J6). The TLV61220 maximum output current depends on the conversion ratio between input and output along with Vout; consult the data sheet for additional information.

Configure jumper JP1 as required; the EN pin is not pulled up or down inside the device or on the EVM. JP1 must be installed for proper operation. ON is normal operation. In the OFF position, the device is shut down, and switching has stopped.

Note that the device does not disconnect the input from the output during a shutdown condition. The voltage is reduced through impedance of the TLV61220 and varies with load; at light load, voltage drop is approximately 700 mV.

4 Test Results

This section provides typical performance waveforms for the TLV61220EVM-120 characteristic of this EVM design. For more information, see the Typical Characteristics section of the TLV61220 data sheet. This EVM uses the same inductors and capacitors as those used for characterization in the data sheet. Performance is consistent with that shown in the data sheet.

4.1 Continuous-Current Mode Operation

Figure 1 shows the output voltage ripple, the SW node, and the inductor current during continuous-current operation of the TLV61220. The measurements are done with 1.2-V input voltage, 1.8-V output voltage, and 50-mA load.

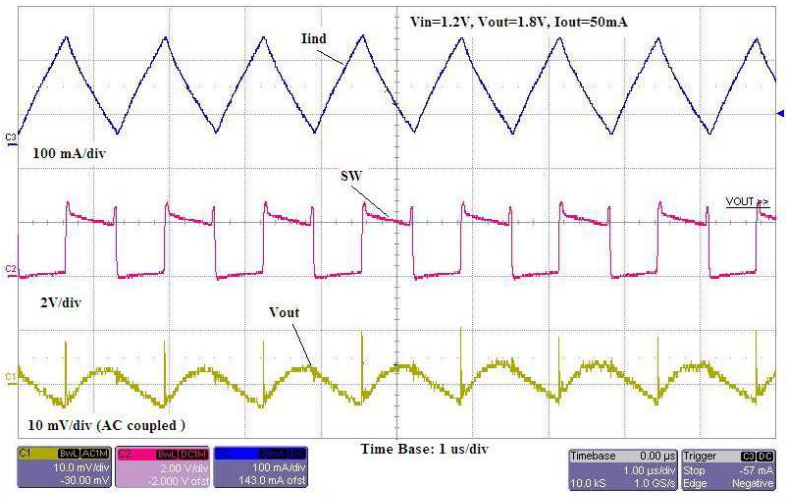

Figure 1. Continuous-Current Operation, TLV61220EVM

Figure 2 shows the output voltage ripple, the SW node, and the inductor current during discontinuous-current operation of the TLV61220. The measurements are done with 1.2-V input voltage, 1.8-V output voltage, and 10-mA load.

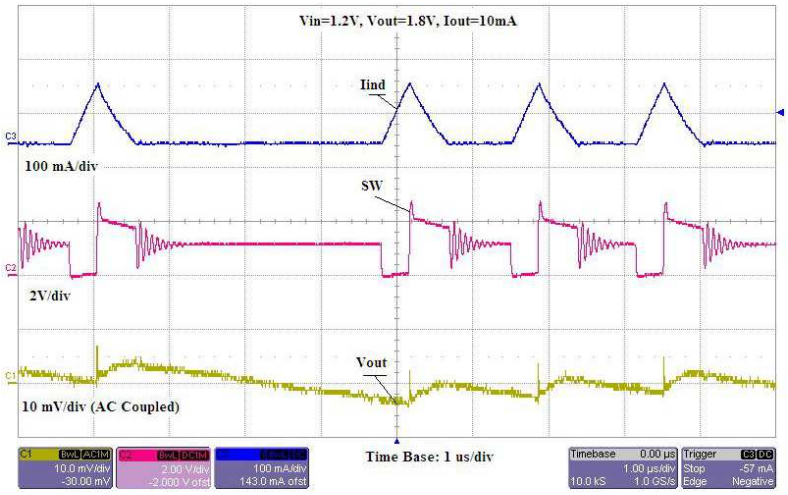

Figure 2. Discontinuous-Current Operation, TLV61220EVM

4.2 Start-Up After Enable

Figure 3 shows the output voltage, the SW node voltage, enable, and the inductor current during start-up using enable of the TLV61220. The measurements are done with 0.7-V input voltage, 1.8-V output voltage, and 12-mA load.

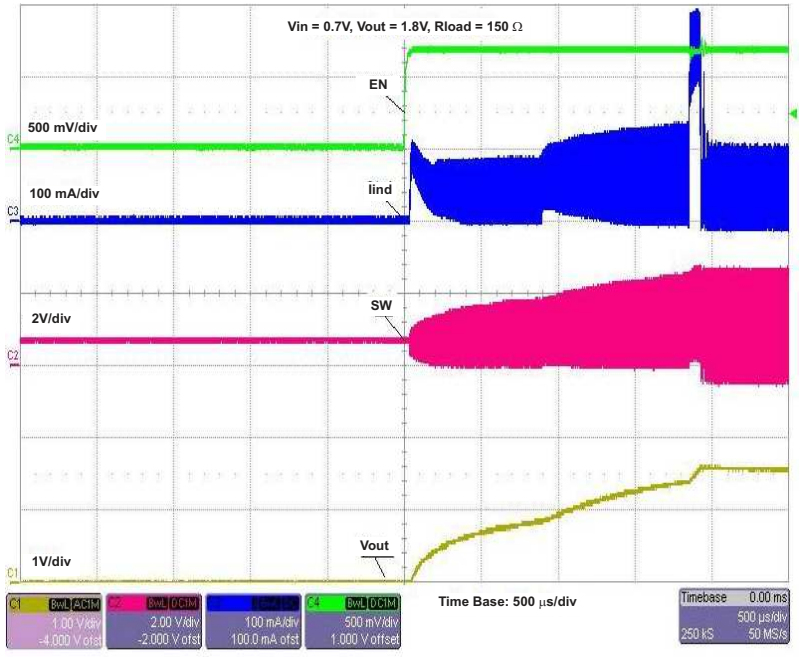

Figure 3. Start-Up After Enable

4.3 Load Transient

Figure 4 shows the output voltage during load transient. The measurements are done with 1.2-V input voltage, 3.3-V output voltage, and 0-mA to 50-mA load step.

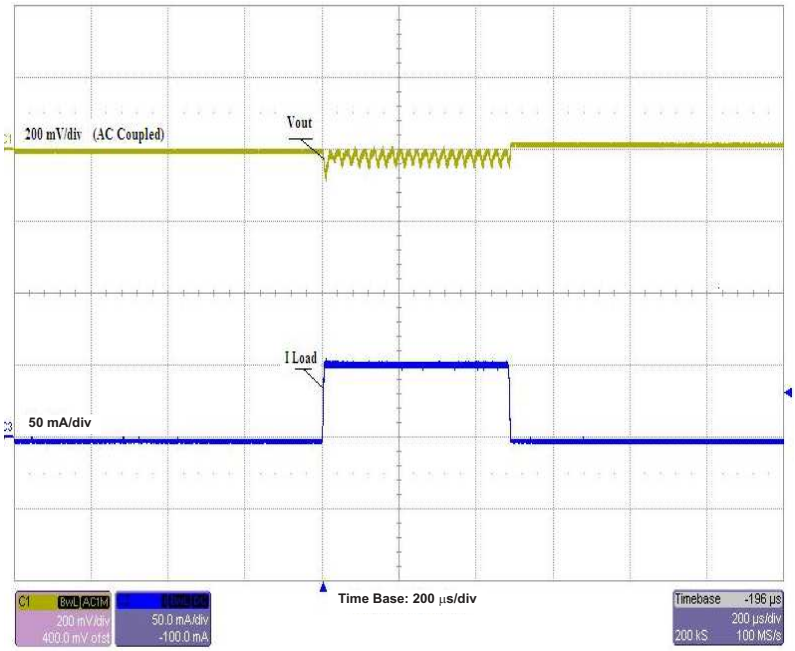

Figure 4. Load Transient

4.4 Efficiency

Figure 5 shows the efficiency for the TLV61220 at an ambient temperature of 25°C for Vin= 0.7 V, 1.2 V, 1.5 V, and 3 V. The output voltage is set to 3.3 V.

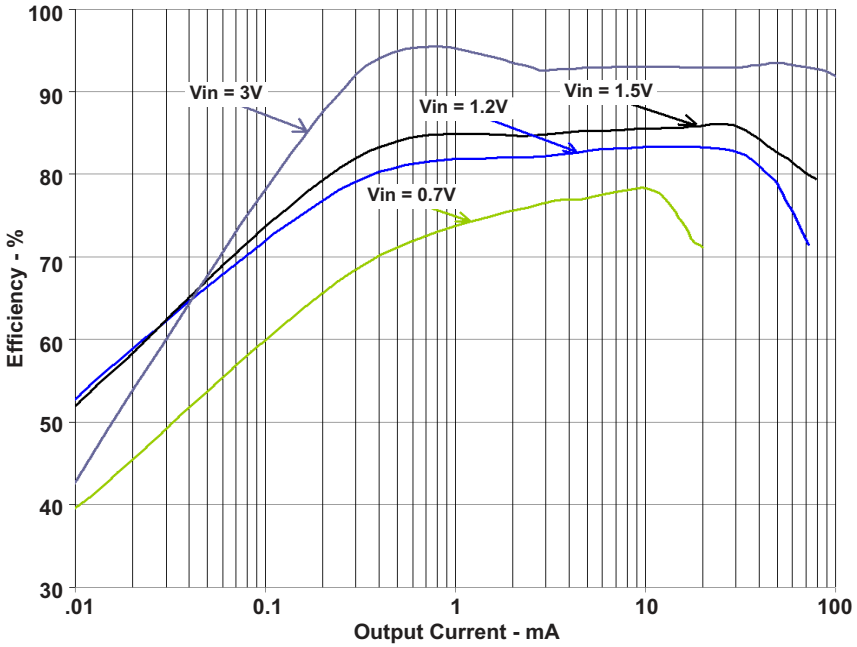

Figure 5. TLV61220 Efficiency

5 Board Layout

This section provides a description of the TLV61220EVM-120, board layout, and layer illustrations.

5.1 Layout Description

Board layout is critical for all high-frequency, switch-mode power supplies. If the layout is not done carefully, the regulator can show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current path and for the power ground tracks. The input and output capacitor, as well as the inductor, must be placed as close as possible to the IC. Use a common ground node for power ground to minimize the effects of ground noise. Figure 6 through Figure 8 show the board layout for the TLV61220EVM-120 PCB.

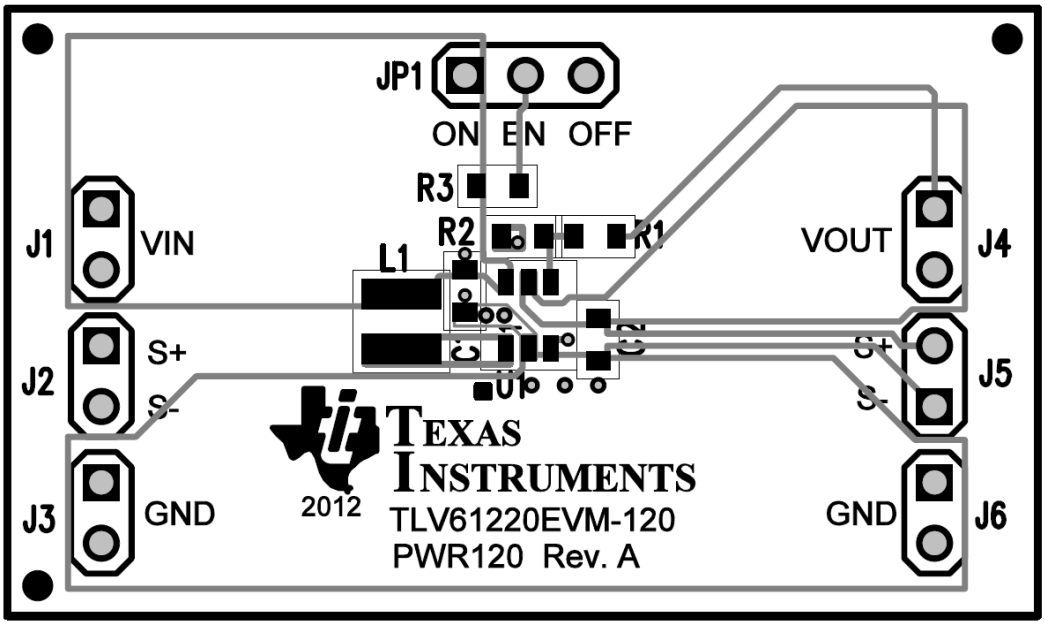

Figure 6. Top Silk

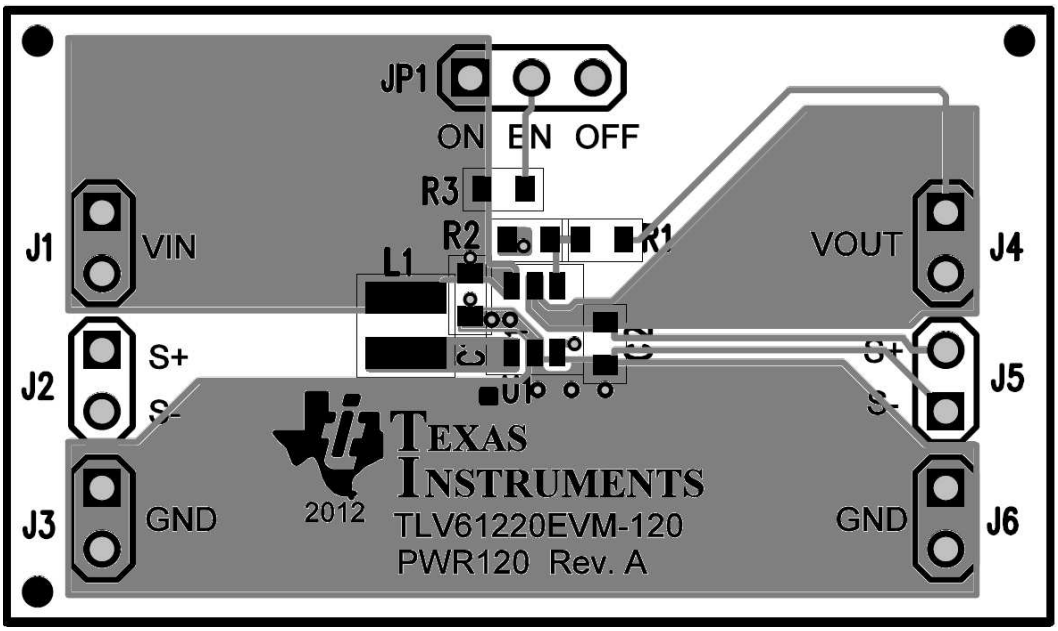

Figure 7. Top Layer

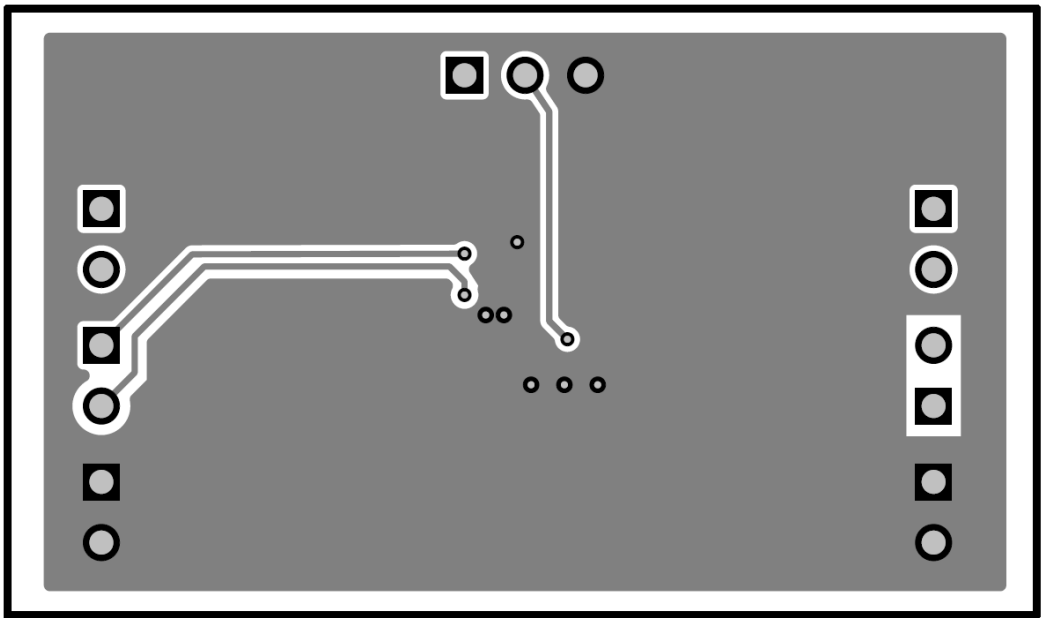

Figure 8. Bottom Layer

6 Schematic

Figure 9 is the schematic for the TLV61220 evaluation module.

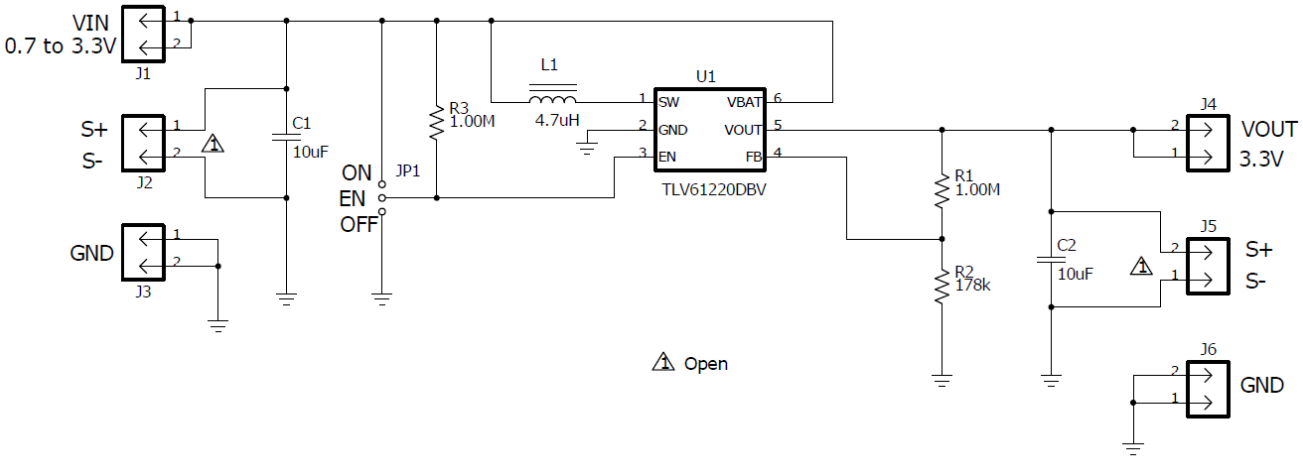

Figure 9. Schematic

7 Bill of Materials

Table 2 presents the bill of materials for the TLV61220 evaluation module.

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
2	C1-2	10uF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	Std	Std
1	L1	4.7uH	Inductor, SMT Power 2.2 A	0.080 x 0.080 inch	EPL3010-472ML	Coilcraft
2	R1,R3	1.00M	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R2	178k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	U1	TLV61220DBV	IC, High Efficient, Tiny 1 Cell Li-Ion or 1-3 Cells Alk/NiCd/NiMH Boost Converter	DBV-6	TLV61220DBV	TI

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 unclean flux is unacceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Reference designators are marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's components.

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

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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.

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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.

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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.

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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
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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.

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FCC Interference Statement for Class A EVM devices

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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.

Concernant les EVMs avec appareils radio

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

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)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
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.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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