SN65LVPE512 EVM

The SN65LVPE512 is a dual-channel, single lane USB 3.0 redriver and signal conditioner that supports data rates of 5 Gbps. This document explains how to use the LVPE512 EVM to easily evaluate the functionality of this device in various applications.

This EVM acts as a modifiable reference design for the SN65LVPE512 that allows this device to be used in a wide variety of applications and configurations. Table 1 explains how to modify these configuration settings by using the switches on the EVM. Example applications for this device include notebooks, desktops, docking stations, servers, and workstations. Schematics, printed-circuit-board (PCB) layout images, and a bill of materials (BOM) for this module are included in this user's guide.

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1 Introduction

The SN65LVPE512 is a dual-channel, single lane USB 3.0 redriver and signal conditioner supporting data rates of 5 Gbps. The device complies with USB 3.0 specification revision 1.0, supporting electrical idle condition and low-frequency periodic signals (LFPS) for USB 3.0 power management modes.

The SN65VLPE512 minimizes signal degradation effects such as crosstalk and inter-symbol interference (ISI) that limit interconnect distance between two devices. The input stage of each channel offers adjustable equalization that compensates for the distortion the USB 3.0 input signal experienced. The output stage offers adjustable de-emphasis that will compensate for distortion the output signal will experience. The optimal equalization and de-emphasis levels will depend on the length of the input and output interconnections. The SN65VLPE512 provides a unique way to tailor output de-emphasis on a per-channel basis with use of the DE and OS pins. All TX and RX equalization and de-emphasis settings are programmed by six 3-state pins as shown in Table 1.

2 LVPE512 Evaluation Module

This sections contains the kit contents and operational description of the EVM as well as configuration instructions and suggested default settings.

3 Kit Contents

- 1 SN65LVPE512 Evaluation Module
- This user manual

3.1 Operational Description of EVM

This EVM facilitates the simple evaluation of the LVPE512 USB 3.0 redriver by providing an easy and efficient method for changing the configuration settings of the device. Physical switches on the EVM are used to modify these settings by altering the state of the programmable 3-state configuration pins. Further information on how to use these switches to configure the device is found in Table 1.

The EVM board includes one USB 3.0 plug and one USB 3.0 receptacle to allow for device interconnections. The EVM board is powered by a 3.3-V supply voltage, which is derived from the internal VBUS power supply of the USB connection, therefore, no external power source is required for the EVM to operate.

Table 1. Configuration of EVM

Switch	Pin Description	Switch Position and Corresponding Setting
SW1	DE1 (De-emphasis channel 1)	1: –3.5 dB 2: 0 dB 3: –6.0 dB
SW2	EQ1 (Equalization channel 1)	1: 7 dB 2: 0 dB 3: 15 dB
SW3(1)	OS1 (Output swing channel 1)	1: 1105 mVpp 2: 1241 mVpp 3: 1324 mVpp
SW4	DE2 (De-emphasis channel 2)	1: –3.5 dB 2: 0 dB 3: –6.0 dB
SW5	EQ2 (Equalization channel 2)	1: 7 dB 2: 0 dB 3: 15 dB
SW6(1)	OS2 (Output swing channel 2)	1: 1105 mVpp 2: 1241 mVpp 3: 1324 mVpp
SW7	EN_RXD	1: Enabled 2: N/A (two position switch) 3: Sleep Mode

(1) SW3, SW6 have incorrectly labeled settings on their silkscreen.

Table 1. Configuration of EVM (continued)

Switch	Pin Description	Switch Position and Corresponding Setting
SW9	Power source selection	1: 3.3 V from Regulator 2: N/A (two position switch) 3: VCC from external source on JMP1
SW10	NC	N/A

Table 2. Suggested Default Settings

Switch	Pin Description	Switch Position and Corresponding Setting
SW1	DE1 (De-emphasis channel 1)	2: 0 dB
SW2	EQ1 (Equalization channel 1)	2: 0 dB
SW3	OS1 (Output swing channel 1)	2: 1241 mVpp
SW4	DE2 (De-emphasis channel 2)	2: 0 dB
SW5	EQ2 (Equalization channel 2)	2: 0 dB
SW6	OS2 (Output swing channel 2)	2: 1241 mVpp
SW7	EN_RXD	1: Enabled
SW9	Power source selection	1: 3.3 V from USB VBUS
SW10	NC	N/A

4 PCB Construction

This section contains the EVM board schematics and the PCB board layouts.

4.1 EVM Board Schematics

Figure 1 through Figure 4 illustrate the SN65LVPE512 EVM schematics.

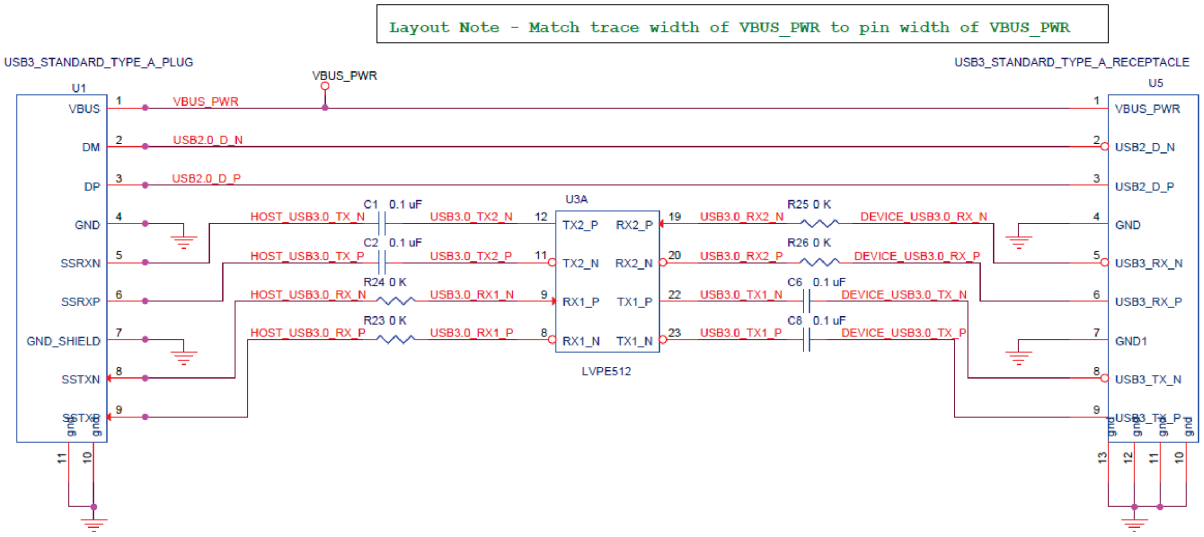


Figure 1. Schematic of High Speed Pins

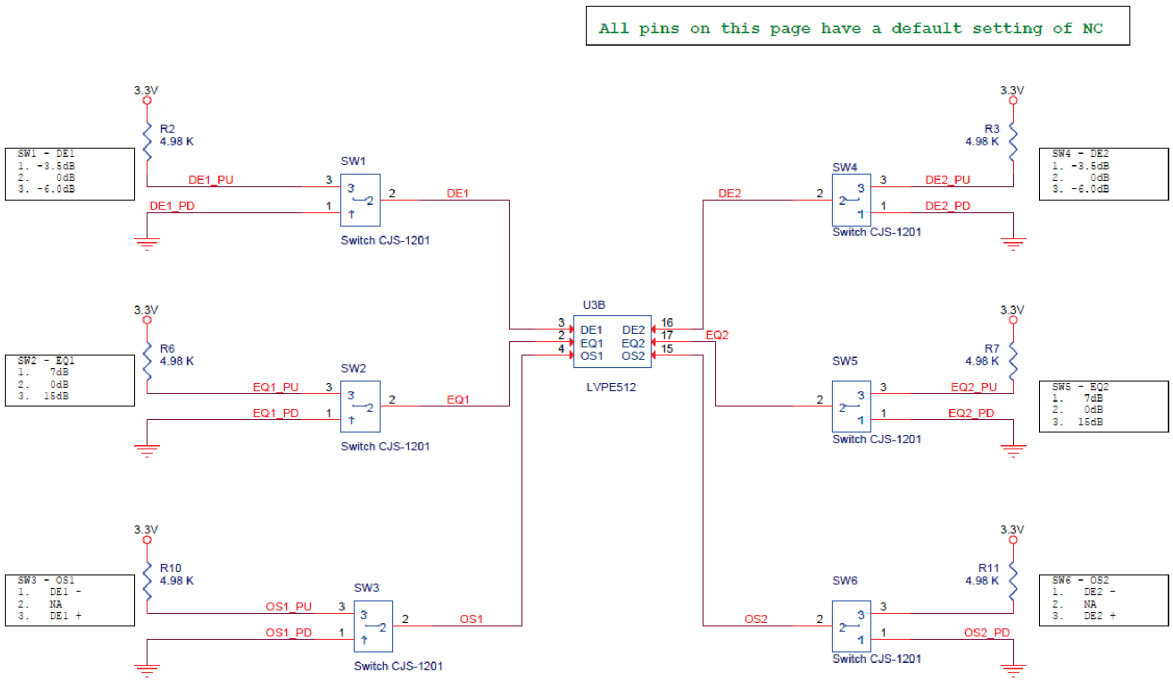
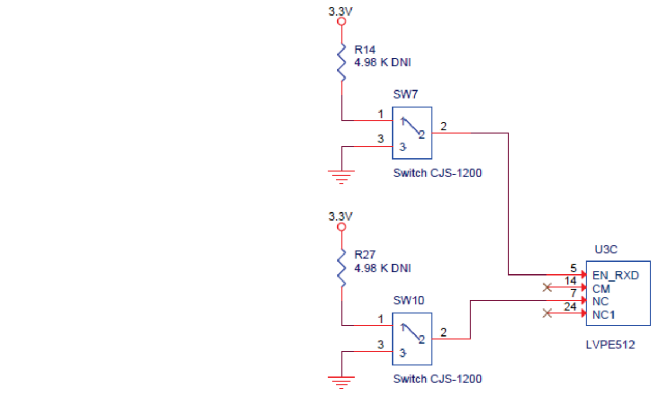


Figure 2. Schematic of EQ Control Pins



EN_RXD default value = 3.3 V (internally pulled up by LVPE512)

Switch on pin 7 added for 502B compatibility

Figure 3. Schematic of Device Control Pins

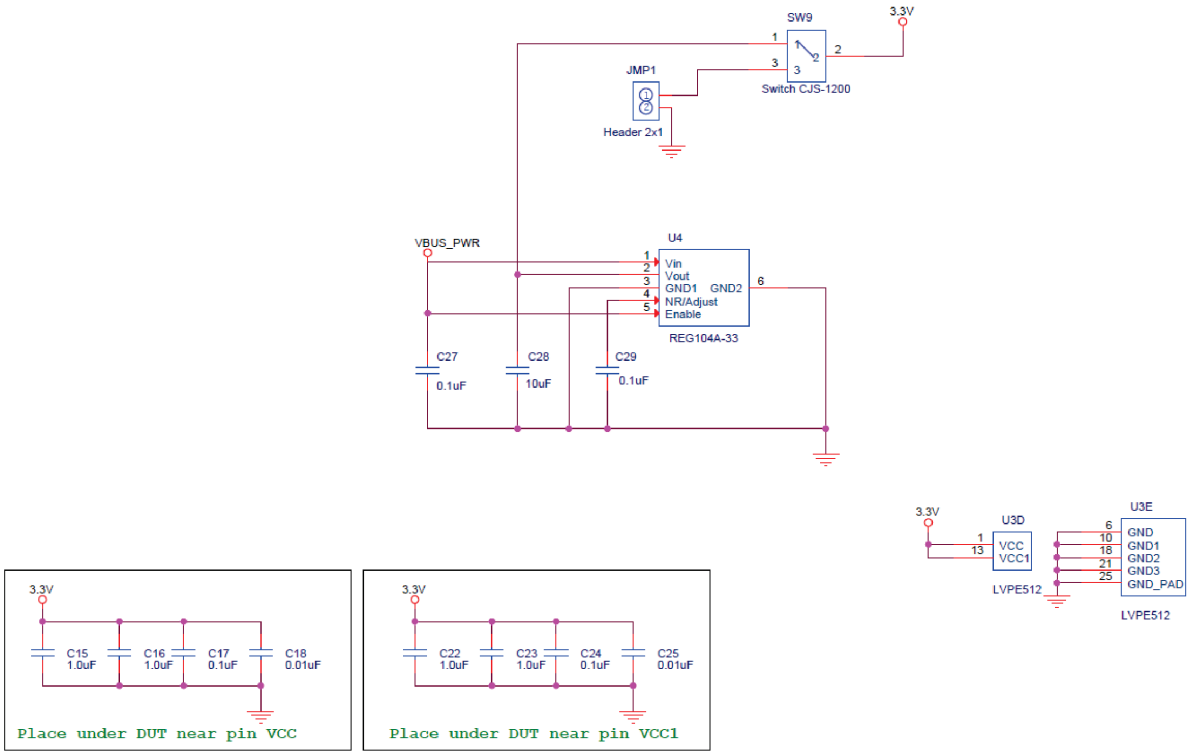


Figure 4. Schematic of Power Pins

4.2 EVM PCB Layout

Figure 5 through Figure 8 illustrate the SN65LVPE512 PCB layouts.

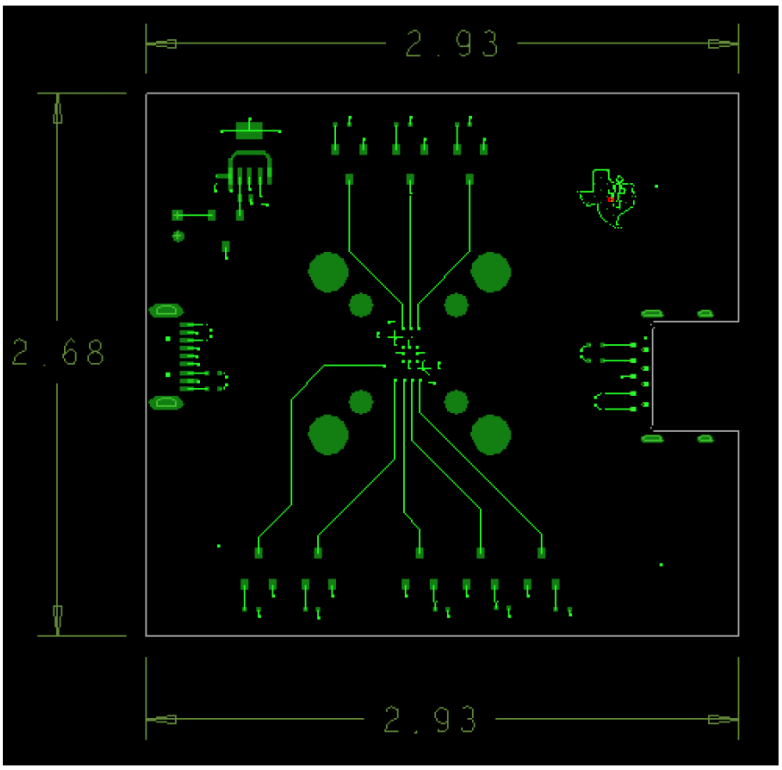


Figure 5. PCB Layout of Top Layer

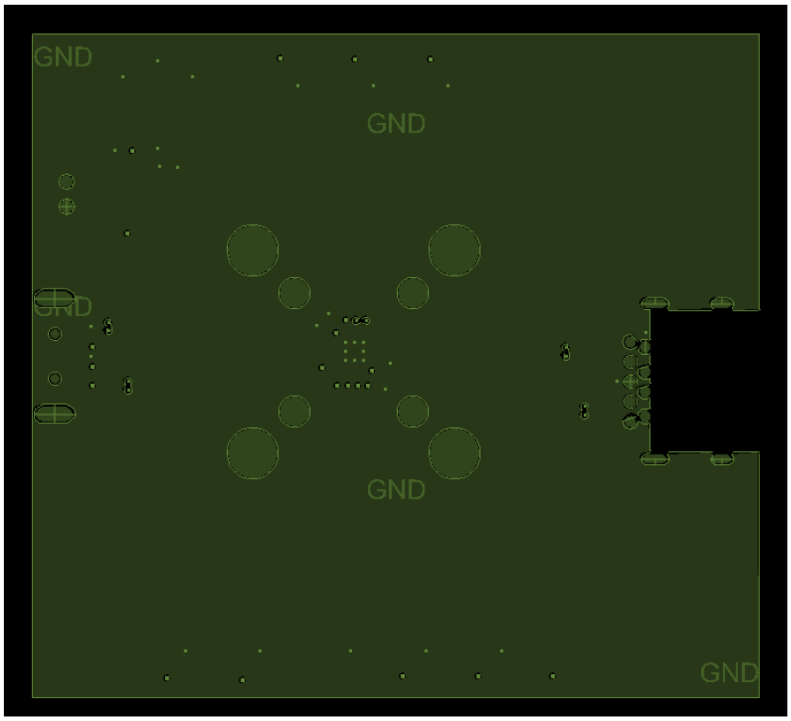


Figure 6. PCB Layout Second Layer

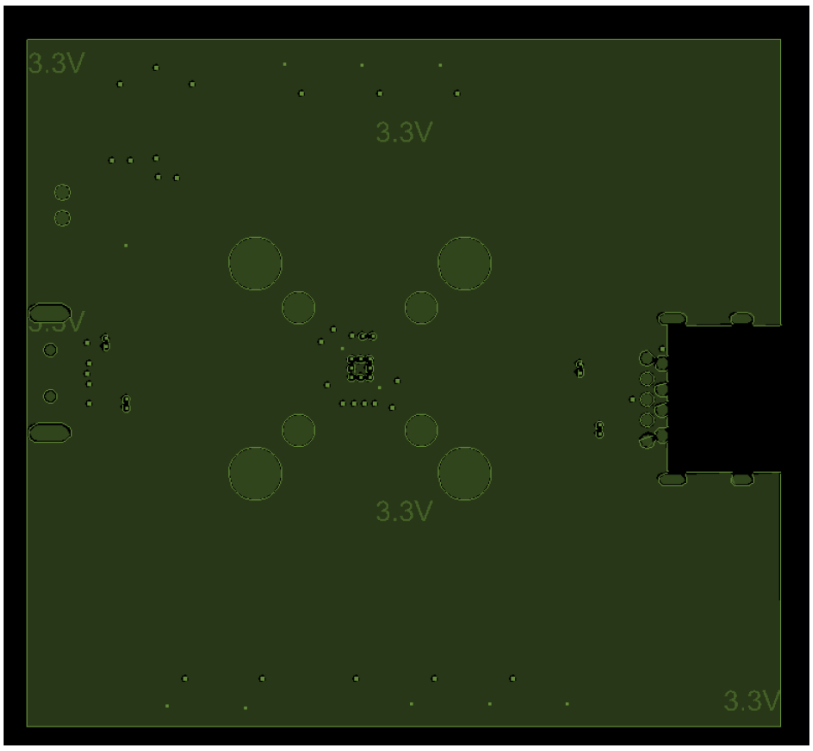


Figure 7. PCB Layout of Third Layer

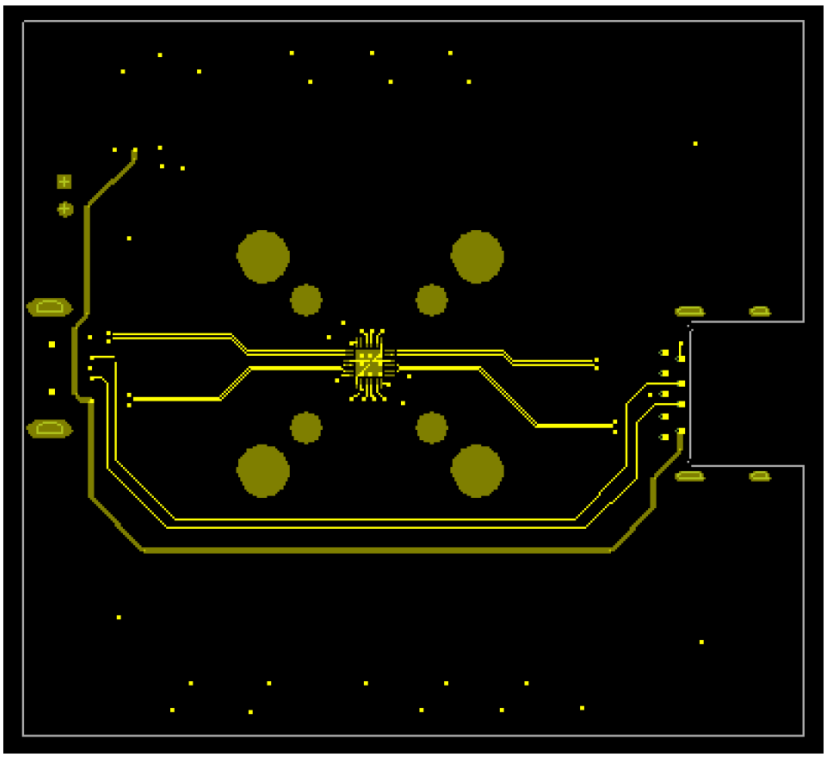


Figure 8. PCB Layout of Bottom Layer

4.3 EVM PCB Fabrication

The EVM board is a 4-layer board constructed of FR4-PolyClad 370 material. The board consists of a signal layer on top, a ground layer, a power layer, and another signal layer on the bottom. The impedance of the differential traces is 100 Ω. Other traces have an impedance of 50 Ω.

NOTE: In order to achieve the desired impedance, it is recommended that you consult your board manufacturer for their process and design requirements.

5 EVM Bill of Materials

Table 3 lists the SN65LVPE512 EVM BOM.

Table 3. SN65LVPE512 EVM Bill of Materials

QTY	Reference	Value	Digi-Key P/N	PCB Footprint	Manufacturer P/N
4	C1, C2, C6, C8	0.1 µF	490-3167-2-ND	cc0201	GRM033R60J104KE19D
4	C15, C16, C22, C23	1.0 µF	490-1320-2-ND	cc0402	GRM155R60J105KE19D
4	C17, C24, C27, C29	0.1 µF	587-1227-2-ND	cc0402	LMK105BJ104KV-F
2	C18,C25	0.01 µF	399-1011-2-ND	cc0402	C0402C100J5GACTU
1	C28	10 µF	587-3383-2-ND	cc0603	JMK107ABJ106MAHT
1	JMP1	Header 2x1	10046483-202HLF-ND	berg2	10046483-202HLF
6	R2 ,R3, R6, R7, R10, R11	4.98 K	311-4.99KHRCT-ND	r0603	RC0603FR-074K99L
2	R14, R27	4.98 K DNI	311-4.99KHRCT-ND	r0603	RC0603FR-074K99L
4	R23, R24, R25, R26	0 K	311-0.0GRCT-ND	r0603	RC0603JR-070RL
6	SW1–SW6	Switch CJS-1201	563-1023-1-ND	CJS-1200B	CJS-1201TA
3	SW7, SW9, SW10	Switch CJS-1200	563-1022-1-ND	CJS-1200B	CJS-1200TB
1	U1	USB3_STANDARD_ TYPE_A_PLUG	732-3157-ND	usb3_plug_wurth_elektronik	6.92112E+11
1	U3	LVPE512	SN65LVPE512RMQR-ND	24QFN04_0_50	SN65LVPE512RMQR
1	U4	REG104A-33	REG104GA-3.3-ND	DCQ_R-PDSO-G6	REG104GA-3.3
1	U5	USB3_STANDARD_ TYPE_A_RECEPTACLE	732-3148-1-ND	usb3_recpt_wurth_elektronik	6.92121E+11

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   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      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.*

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.

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.

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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3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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If User uses EVMs in Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs 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 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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西新宿三井ビル

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4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should 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 also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

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4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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