User's Guide
SLLU239–March 2016

TUSB322 Evaluation Module

This document describes how to use TUSB322 EVM.

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1 What is the TUSB322 EVM?

The TUSB322 EVM is designed to evaluate TUSB322 devices. The EVM can be configured to operate in DFP, UFP, or DRP mode via DIP switch selection or I^{2}C control. All of the control inputs are also selectable via DIP switch configuration. The TUSB322 devices can be used with legacy USB systems or USB Type-C™ systems for evaluation purposes.

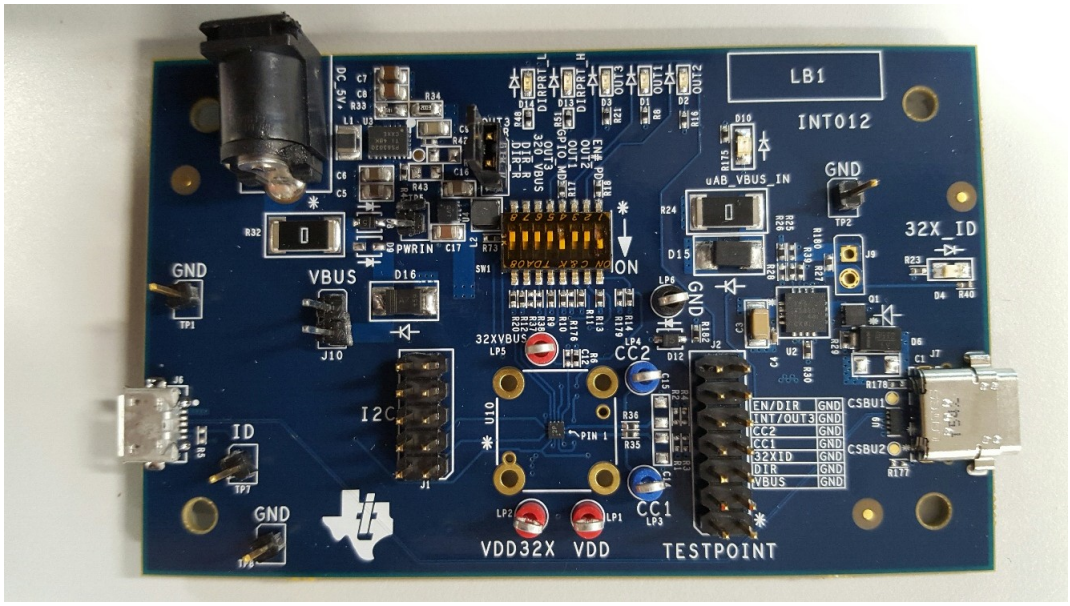

Figure 1. TUSB322EVM Board

2 TUSB322 EVM Features

With different configurations, this EVM is used for the evaluation of DFP, UFP, or DRP Type-C implementation. The EVM can also be configured to operate in I^{2}C or GPIO mode. The default configuration is I^{2}C.

This section describes EVM features that enable evaluation of Type-C implementations in different modes of operation.

2.1 Power

Power the EVM by USB VBUS or 5- to 5.5-V DC IN through a power jack J3 (2-mm positive tip, 6.5-mm negative outer shield).

Provide the VBUS via a legacy connection or Type-C connection. When the EVM operates in DFP mode, the VBUS is provided through a micro-AB connector J4, if the board is connected to a USB host or VBUS source. When the EVM operates in UFP mode, the VBUS is provided through Type-C connector J5 if the board is connected to a USB host or VBUS source through a Type-C Cable. The 5-V DC IN(J3) can also be used to supply power if a stand-alone operation is desired without connecting to a USB VBUS power source. Due to diode and IR drop in the test setup, the VBUS on the connector may be below the desired level. The board is designed to take up to 5.5 V through DC_5V IN or TP5 (PWRIN) header for test purposes.

It is important to have the power supply configuration match the J8 shunt configuration as described in Table 1.

Table 1. J8 Shunt Configuration

Shunt Position	Power Configuration	Description
J8.1 to J8.2	Self-powered UFP operation	EVM powered via 5-V barrel jack J3 while the TUSB322 is configured as UFP or attached as UFP while configured as DRP
J8.2 to J8.3	Bus-powered UFP operation	EVM powered via VBUS coming through the USB Type-C connector J5 while the TUSB322 is configured as UFP or attached as UFP while configured as DRP
J8 open	DFP operation	EVM powered via VBUS coming through the micro-AB connector J4 or 5-V barrel jack J3 while TUSB322 is configured as DFP or attached as DFP while configured as DRP

Test loops and headers to power rails and GND are provided for test purposes. Some power rails can be isolated from the main power supply by removing ferrite beads or passive components. Refer to the schematics for power rail connection details. Do not supply external power through the test headers and loops unless the power rail has been isolated from other power sources. In normal operation, power must be provided through the USB connectors or DC power barrel only: J4, J5, or J3.

2.2 VBUS

2.2.1 VBUSOff time

To meet the VBUSOff time of 650 ms, remove the 10-µF capacitor C1. The current limiting can be reduced to 3–3.5 A by changing the R30 value to 47 kΩ.

2.2.2 VBUS Min Level

VBUS provided on J1 or J6 may be lower than 4.75 V. For bus-powered devices to be attached to the EVM for test purposes, TI recommends using a 5.5-V external power supply through J5 or TP5.

DIP switch (SW1) is provided to configure the EVM in different modes of operation (see Table 2).

Table 2. DIP Switch (SW1) Configuration Descriptions

Reference Designator	SW Control Function	Default Switch Setting	Description
SW1.1	EN# for TUSB322	ON	EN# = High if SW1.1 = OFF
			EN# = Low if SW1.1 = ON
SW1.2	OUT2	OFF	OUT2 = SCL with a pullup if SW1.2 = OFF
			OUT2 connected to LED if SW1.2 = ON
SW1.3	OUT1	OFF	OUT1 = SDA with a pullup if SW1.3 = OFF
			OUT1 connected to LED if SW1.3 = ON
SW1.4	ADDR	OFF	For I^2C mode of operation: ADDR = High if SW1.4 = OFF and R9 installed ADDR = Low if SW1.4 = ON
			For GPIO mode of operation: SW1.4 = OFF
SW1.5	INT	OFF	INT = High if SW1.5 = OFF
			INT = OUT3 if SW1.5 = ON
SW1.6	320_VBUS	OFF	320_VBUS = high/low or open if option resistors are populated. Don't care in normal operation.
SW1.7	RSVD	OFF	Reserved for future use. Must remain OFF for normal operation.
SW1.8	RSVD	OFF	Reserved for future use. Must remain OFF for normal operation.

2.3 I²C

Access the I²C bus through headers J1 or J2. 4.7-kΩ pullups to 3.3 V are added on I²C SCL and SDA. The ADDR pin can be pulled high or low through DIP SW configuration described in Table 2. The ADDR pin determines bit 1 of the TUSB322 I²C address as high or low. J1 is intended to match the Aardvark™ I²C programmer dongle pinout.

2.4 LEDs

Table 3 describes the LEDs provided for easier debug purposes.

Table 3. LED Description

Reference Designator	LED Name	Description
D1	OUT1	Valid only in GPIO mode. Illuminates if OUT1 pin driven low.
D2	OUT2	Valid only in GPIO mode. Illuminates if OUT2 pin driven low.
D3	OUT3	Valid only in GPIO mode. Illuminates if OUT3 pin driven low.
D4	320 ID	Illuminates if ID pin of TUSB322 is driven low
D10	POWER	Illuminates if 5-V power is available.
D11	DIR_H	Illuminates if DIR is driven high (is illuminated high by default unless driven low)
D12	DIR_L	Illuminates if DIR is driven low

NOTE: The OUT1, OUT2, and OUT3 LEDs are used in the GPIO mode of operation. The DIP SW must be configured accordingly to configure the TUSB322 EVM in GPIO mode of operation.

3 TUSB322 EVM Configuration Examples

This section provides different configuration examples of the TUSB322 EVM: DRP, DFP, or UFP operation. The PORT pins and the I^2C must be programmed for the corresponding mode of operation. No external 5-V DC IN is needed, unless the board is to operate standalone without any connections to the USB upstream or downstream port.

3.1 UFP Operation

The board can be configured to operate in UFP mode by configuring the MODE_SELECT I^2C register setting. Set the Mode_Select bits at addr0x0A bit 5:4 to 01b.

Figure 2 illustrates an example configuration using HD3SS2522 and TUSB322 EVMs. The HD3SS2522 is TI's DFP CC controller compliant to USB Type-C spec v1.1.

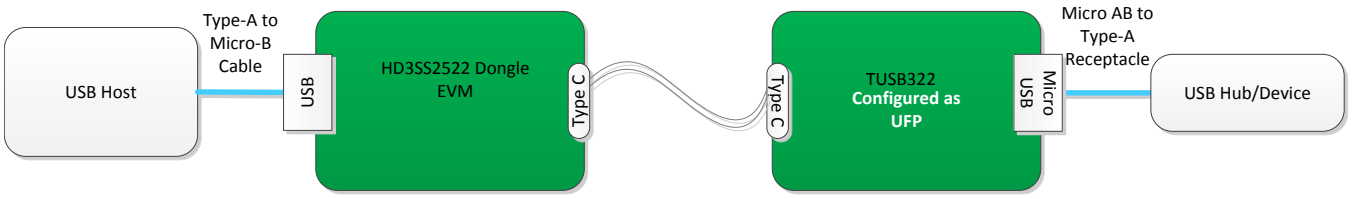

Figure 2. Configuration Using HD3SS2522 and TUSB322 EVMs

Use the following steps for UFP operation setup and configuration:

1. Configure DIP switches as shown in Table 4:

Table 4. DIP Switch (SW1) Configuration Using HD3SS2522 and TUSB322 EVMs

Reference Designator	SW Control Function	Switch Setting
SW1.1	EN#	ON
SW1.2	OUT2	OFF
SW1.3	OUT1	OFF
SW1.4	ADDR	OFF
SW1.5	INT	OFF
SW1.6	320_VBUS	Don't care
SW1.7	RSVD	OFF
SW1.8	RSVD	OFF

2. Connect HD3SS2522 EVM to a USB host
3. Connect TUSB322 to the HD3SS2522 using a Type-C cable. VBUS is provided over the Type-C cable connection. LED D9 illuminates on the TUSB322 board. D3 and D4 light up on the HD3S2522 indicating an UFP connection. Refer to the HD3SS2522 user's manual (SLLU215) for details on the HD3SS2522 EVM operation. D11 or D12 illuminated depending on the orientation of the Type-C plug connection.
4. USB devices plugged into the micro-AB USB receptacle(J4) of the TUSB322 UFP EVM should enumerate at USB2 speed: high speed (HS), full speed (FS), or low speed (LS).

3.2 DFP Operation

The board can be configured to operate in DFP mode by configuring the MODE_SELECT I^2C register setting. Set the Mode_Select bits at addr0x0A bit 5:4 to 10b.

Figure 3 illustrates an example configuration using a TUSB322 EVM and a TUSB320LA/HA EVM. The TUSB322 is configured as DFP, the TUSB320LA/HA configured as UFP. Refer to section 3.1 of the TUSB320LA/HA EVM users manual for TUSB320 UFP EVM configuration.

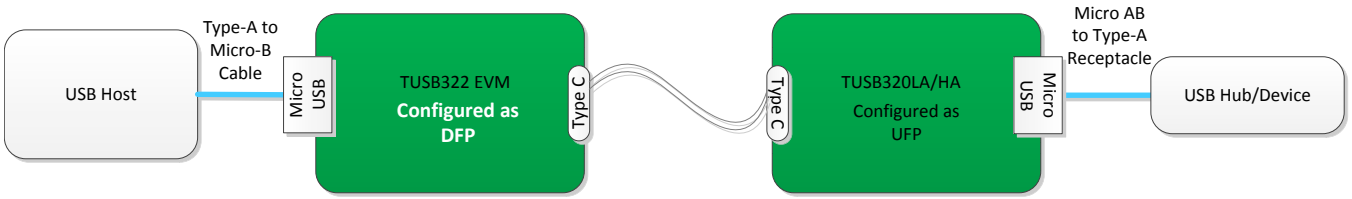

Figure 3. Configuration Using TUSB322 and TUSB320LA/HA EVMs

Use the following steps for DFP operation setup and configuration:

1. Configure DIP switches as shown in Table 5:

Table 5. DIP Switch (SW1) Configuration Using TUSB322 and TUSB320LA/HA EVMs

Reference Designator	SW Control Function	Switch Setting
SW1.1	EN#	ON
SW1.2	OUT2	OFF
SW1.3	OUT1	OFF
SW1.4	ADDR	OFF
SW1.5	INT	OFF
SW1.6	320_VBUS	Don't care
SW1.7	RSVD	OFF
SW1.8	RSVD	OFF

2. Connect the TUSB322 DFP EVM to a legacy USB host using a Type-A to micro-B cable via a micro-AB connector(J4) provided on board. LED D9 illuminates by the VBUS provided by the legacy USB host over the Type-A to micro-B cable connection.
3. Connect TUSB320LA/HA UFP EVM to the TUSB322 DFP EVM using a Type-C Cable. The TUSB322 UFP EVM is powered by VBUS provided over the Type-C cable connection. LED D10 on the TUSB322 UFP EVM should light up. Attach the TUSB322 DFP EVM to the Type-C cable, D4 should light up indicating the ID pin has been driven low from the TUSB322. D11 or D12 illuminated depending on the orientation of the Type-C plug connection.
4. The USB device plugged into the micro-AB USB receptacle (J6) of the TUSB322 UFP EVM should enumerate at USB2 speed: HS, FS, or LS.

3.3 DRP Operation

The board can be configured to operate in DRP mode by configuring the MODE_SELECT I^2C register setting. The TUSB322 comes up in DRP operation by default; therefore, there is no need to reconfigure the MODE_SELECT register after power-on. However, if the MODE_SELECT register setting has been reprogrammed, they must be cleared to 00b for DRP operation.

Figure 4 illustrates an example configuration using HD3SS2522 and TUSB322 EVMs. The HD3SS2522 is TI's DFP CC controller, compliant to USB Type-C spec v1.1.

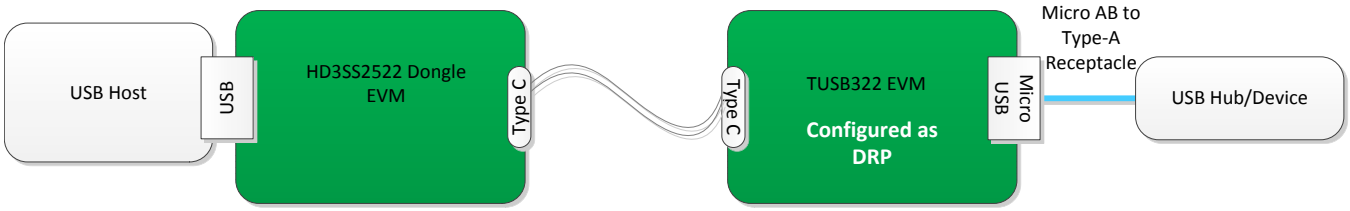

Figure 4. Configuration Using HD3SS2522 and TUSB322 EVMs

Use the following steps for DRP operation setup and configuration when using an HD3SS2522 EVM and a TUSB322 EVM:

1. Configure SW1 switches as shown in Table 6:

Table 6. DIP Switch (SW1) Configuration Using HD3SS2522 and TUSB322 EVMs

Reference Designator	SW Control Function	Switch Setting
SW1.1	EN#	ON
SW1.2	OUT2	OFF
SW1.3	OUT1	OFF
SW1.4	ADDR	OFF
SW1.5	INT	OFF
SW1.6	320_VBUS	Don't care
SW1.7	RSVD	OFF
SW1.8	RSVD	OFF

2. Connect HD3SS2522 EVM to a USB host
3. Connect TUSB322 to the HD3SS2522 using a Type-C cable. VBUS should be provided over the Type-C cable connection. LED D10 lights on the TUSB322 board. D11 or D12 illuminated depending on the orientation of the Type-C plug connection.
   D3 and D4 should light up on the HD3S2522, indicating an UFP connection. Refer to the HD3SS2522 user's manual (SLLU215) for details on the HD3SS2522 EVM operation.
4. USB devices plugged into the micro-AB USB receptacle (J6) of the TUSB322 UFP EVM should enumerate at USB2 speed: HS, FS, or LS.

Figure 5 illustrates an example configuration using two TUSB322 EVMs: one configured as DRP, the other configured as UFP.

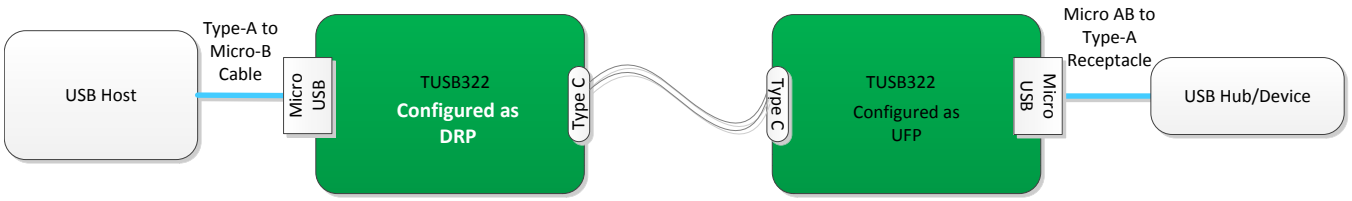

Figure 5. Configuration Using Two TUSB322 EVMs

Use the following steps for DRP and UFP operation setup and configuration when using two TUSB322 EVMs:

1. Configure SW1 switches as shown in Table 7:

Table 7. DRP and UFP DIP Switch (SW1) Configuration Using Two TUSB322 EVMs

Reference Designator	SW Control Function	Switch Setting
SW1.1	EN#	ON
SW1.2	OUT2	OFF
SW1.3	OUT1	OFF
SW1.4	ADDR	OFF
SW1.5	INT	OFF
SW1.6	320_VBUS	Don't care
SW1.7	RSVD	OFF
SW1.8	RSVD	OFF

2. Connect TUSB322 DRP EVM to a legacy USB host using a Type-A to micro-B cable via micro-AB connector (J4) provided on board. LED D9 lights up by the VBUS provided by the legacy USB host over the Type-A to micro-B cable connection.
3. Connect TUSB322 UFP EVM to the TUSB322 DFP EVM using a Type-C cable. The TUSB322 UFP EVM is powered by VBUS provided over the Type-C cable connection. LED D9 on the TUSB322 UFP EVM should also light up. Attach the TUSB322 DFP EVM to the Type-C cable, D4 should light up indicating the ID pin has been driven low from the TUSB322. D11 or D12 illuminated depending on the orientation of the Type-C plug connection.
4. The USB device plugged into the micro-AB USB receptacle (J6) of the TUSB322 UFP EVM should enumerate at USB2 speed: HS, FS, or LS.

NOTE: Two TUSB322 EVMs can be used for DRP to DRP connection. In this configuration, TI recommends you do not connect the EVM to legacy USB systems as the role cannot be predicted until both sides enter the attach state. This configuration can be used for evaluation purposes with 5 V provided via DC (in J5) on both boards. One of the TUSB320HA EVMs can be configured to be a preferred SRC or SNK by enabling TRY.SRC or TRY.SNK feature via I^2C access. Refer to the device datasheet for details on enabling this feature.

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

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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

3.3 *Japan*

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

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of 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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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.

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.

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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