



*User's Guide  
February 2016*

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# TUSB542 Evaluation Module

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## ABSTRACT

This is the user guide for the evaluation module (EVM) of the TUSB542. The purpose of this user guide is to facilitate an easy evaluation process of the TUSB542 USB 3.0 SuperSpeed Re-Driver.

The contents of this user's guide are meant to provide an overview of the TUSB542, which includes highlighting its key features, operating conditions, and how to setup this EVM for use in a system level evaluation.

The construction of the TUSB542 EVM also serves as a reference design that can be easily modified for any intended application. Target applications include Cell Phones, Computers, Docking Stations and TVs. Schematic and layout information is included at the end of this manual.

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## Introduction

The TUSB542 is a dual channel USB 3.0 SuperSpeed re-driver supporting systems with Type-C connectors. The device complies with USB 3.1 spec revision 1.0 (Gen I), supporting electrical idle condition and low frequency periodic signals (LFPS) for USB power management modes.

The device offers programmable equalization and transmitter de-emphasis that extends the interconnect distance between two devices. Also, the device supports low power modes when unplugged. The device can also function in USB compliance mode to test the transmitter for compliance to voltage and timing specifications per USB compliance specs.

This EVM was designed to be used as a medium connection between a USB host and a USB device via Type-C connector. The interface to the EVM consists of a USB 3.0 Type C Receptacle and a USB 3.0 Type B Receptacle. Therefore, in order to connect the EVM to your system set up, you will most likely need 1 USB 3.0 Standard Type A→B cable and 1 USB Type-C to Type-A adapter(Or Cable). Your test setup should look similar to the figure below:

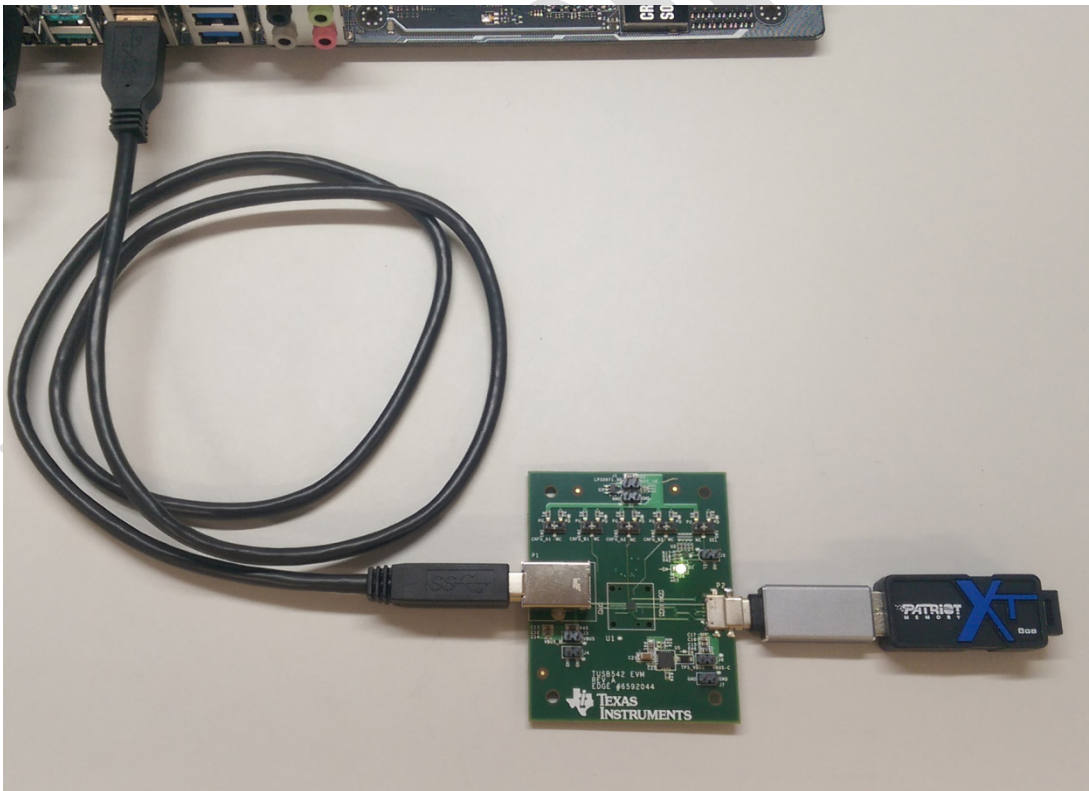


Figure 1. TUSB542EVM Typical System Setup

## TUSB542 EVM Kit Contents

This EVM kit should contain the following items:

- TUSB542 EVM board
- TUSB542EVM User's Manual

## Description of EVM Board

The TUSB542 EVM is designed to provide easy evaluation of the TUSB542 device. It is also meant to serve as a reference design to show a practical example of how to use the device in a mass-production system. Figure 2 highlights the jumpers and switch installed on this EVM and Table 1 highlights their functionality and configuration.

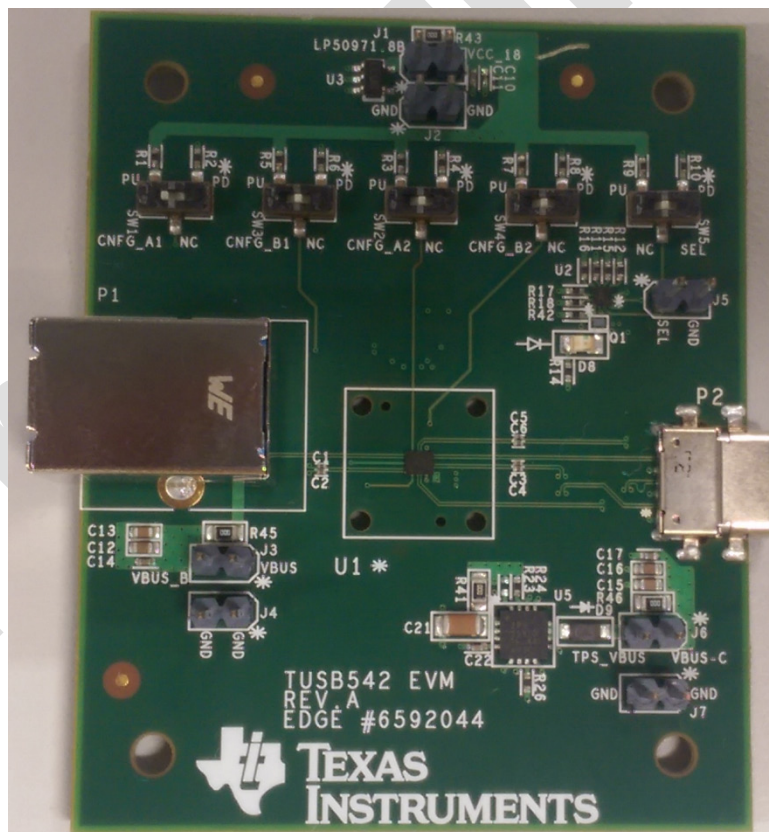


Figure 2. – TUSB542 EVM [Top Side]

Switch/Jumpers	Functionality and Configuration
SW1	<b>CNFG_A1</b>
	1 = Pull-Down 2 = NC 3 = Pull-Up
SW2	<b>CNFG_A2</b>
	1 = Pull-Down 2 = NC 3 = Pull-Up
SW3	<b>CNFG_B1</b>
	1 = Pull-Down 2 = NC 3 = Pull-Up
SW4	<b>CNFG_B2</b>
	1 = Pull-Down 2 = NC 3 = Pull-Up
SW5	<b>SEL</b>
	1 = Pull-Down 2 = NC (Internal Pull-Up) 3 = Pull-Up
J1	<b>1.8V VCC</b>
	J1-1 = Regulator Output J1-2 = TUSB542 1.8V Vcc
J2	<b>GND</b>
	J2-1 = GND J2-2 = GND
J3	<b>Type-B VBUS</b>
	J3-1 = Type B Connector VBUS J3-2 = Regulator Input (VBUS_B)
J4	<b>GND</b>
	J4-1 = GND J4-2 = GND
J5	<b>SEL</b>
	J5-1 = SEL J5-2 = GND
J6	<b>Type-C VBUS</b>
	J6-1 = Type-C Connector VBUS J6-2 = TPS25910 5V Output (VBUS)
J7	<b>GND</b>
	J7-1 = GND J7-2 = GND

Table 1. – TUSB542 EVM Jumper / Switch Description and Settings

## Selecting Equalization and De-emphasis Levels for TUSB542

The equalization, de-emphasis and output swing levels of each channel are configured via the CNFG\_A1, CNFG\_A2, CNFG\_B1 and CNFG\_B2 pin states. Table 2 lists all possible EQ, DE and OS levels that can be achieved with the TUSB542:

Ch1 (AP-Redriver)		DE_AP (dB)	OS_AP (V)	EQ_AP (dB)	Ch2 (Redriver-Conn)		DE_Conn (dB)	OS_Conn (V)	EQ_Conn (dB)
CNFG_A1	CNFG_B1				CNFG_A2	CNFG_B2			
Low	Low	3.5	1.1	3	Low	Low	6	1.1	0
	Float	3.5	0.9	3		Float	3.5	1.1	0
	High	0	1.1	3		High	3.5	0.9	0
Float	Low	0	0.9	3	Float	Low	6	0.9	0
	Float	3.5	1.1	0		Float	3.5	1.1	6
	High	3.5	0.9	0		High	3.5	0.9	6
High	Low	0	1.1	0	High	Low	6	1.1	6
	Float	0	0.9	0		Float	6	0.9	6
	High	6	1.1	6		High	6	1.1	9

Table 2. – TUSB542 Equalization and De-emphasis Selection Table

## Monitoring the device current

The TUSB542 EVM includes the option of monitoring the current draw of the device. In order to enable this feature, the following steps must be taken:

1. Un-install the shunt located at JMP1 and remove R43.
2. Obtain a power supply with the ability to display its current draw (or connect a current meter in series to the power supply)
3. Connect to 1.8V of external power source to VCC\_18V (J1-2) and GND of the external supply to a convenient GND location on the EVM (J2-2).
4. Turn on your power supply and observe the measured current on your power supply display (or current meter)

## PCB Construction

This section discusses the construction of the EVM boards. It includes the board schematics and layout files to show how the board was built.

### TUSB542 EVM Board Schematics

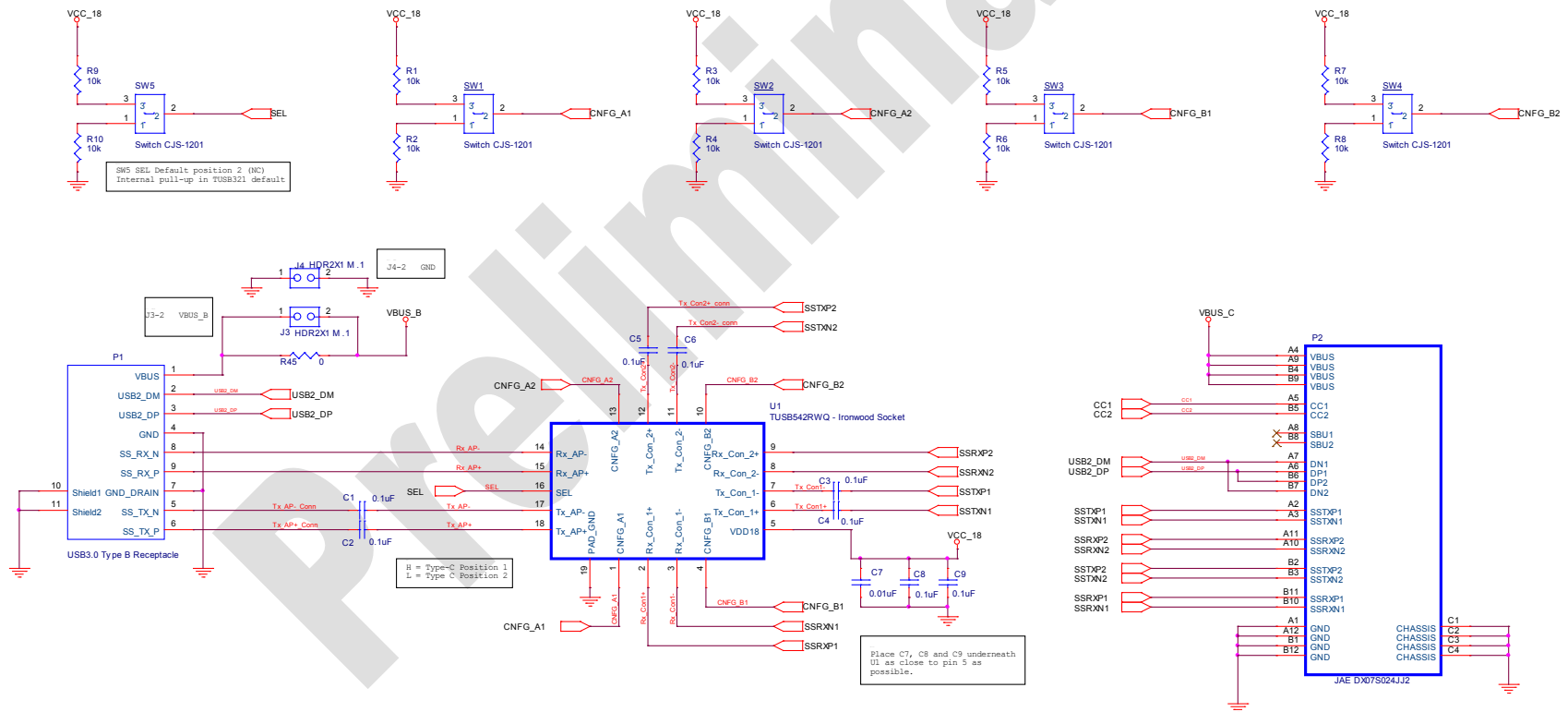


Figure 3. – TUSB542 EVM Schematic [High Speed Pins / Config]

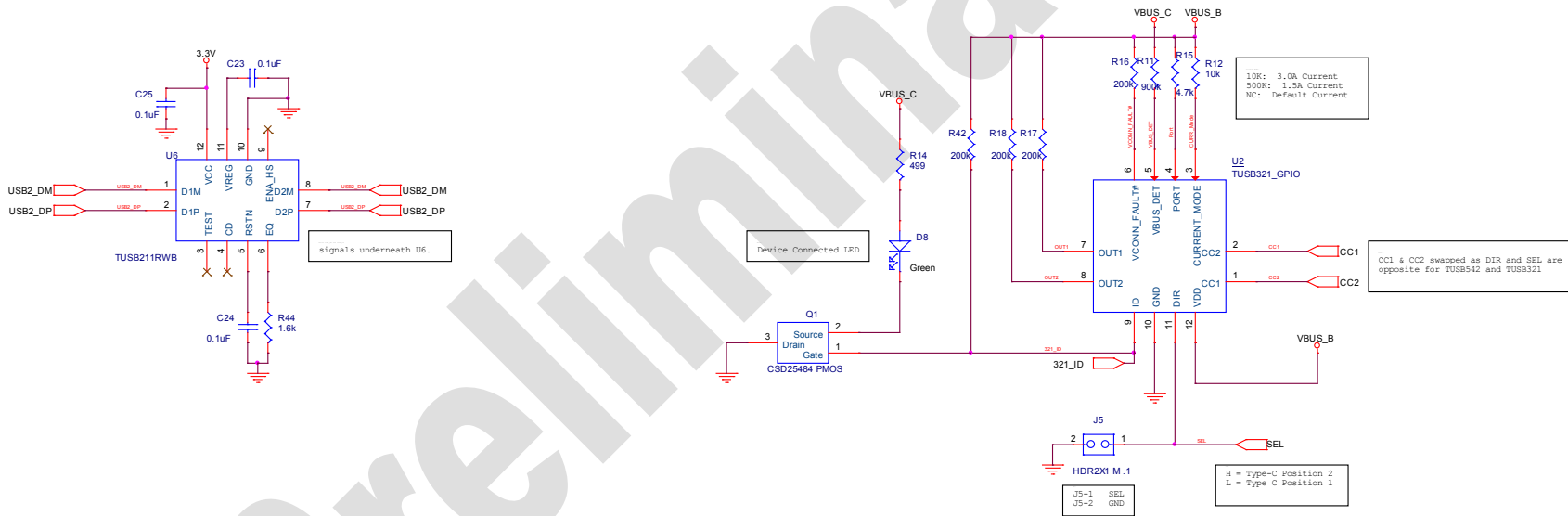


Figure 4. – TUSB211, TUSB321



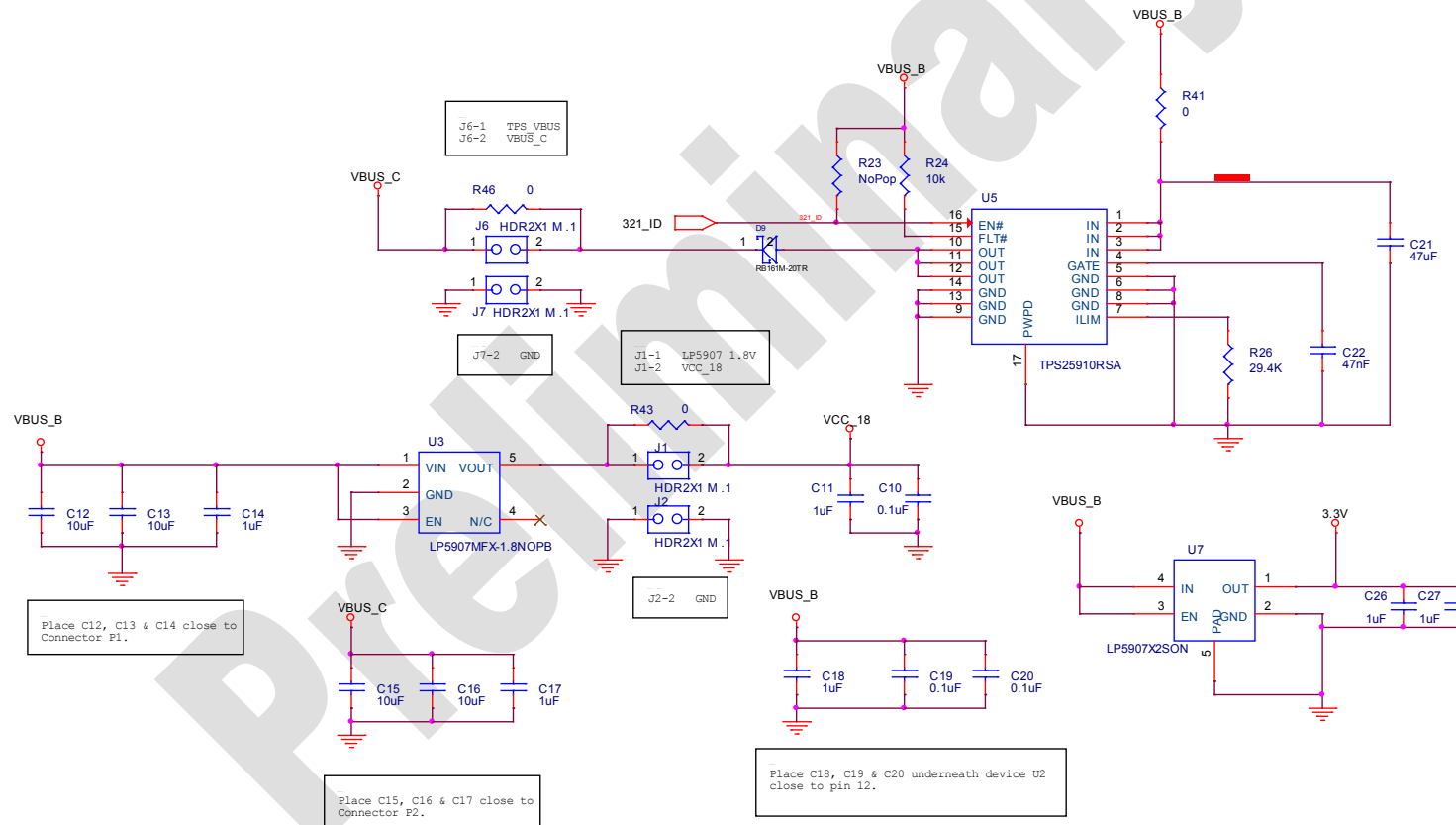


Figure 5. – Power

## TUSB542 EVM Board Layout

This EVM was designed to show the implementation on a 6-layer board.

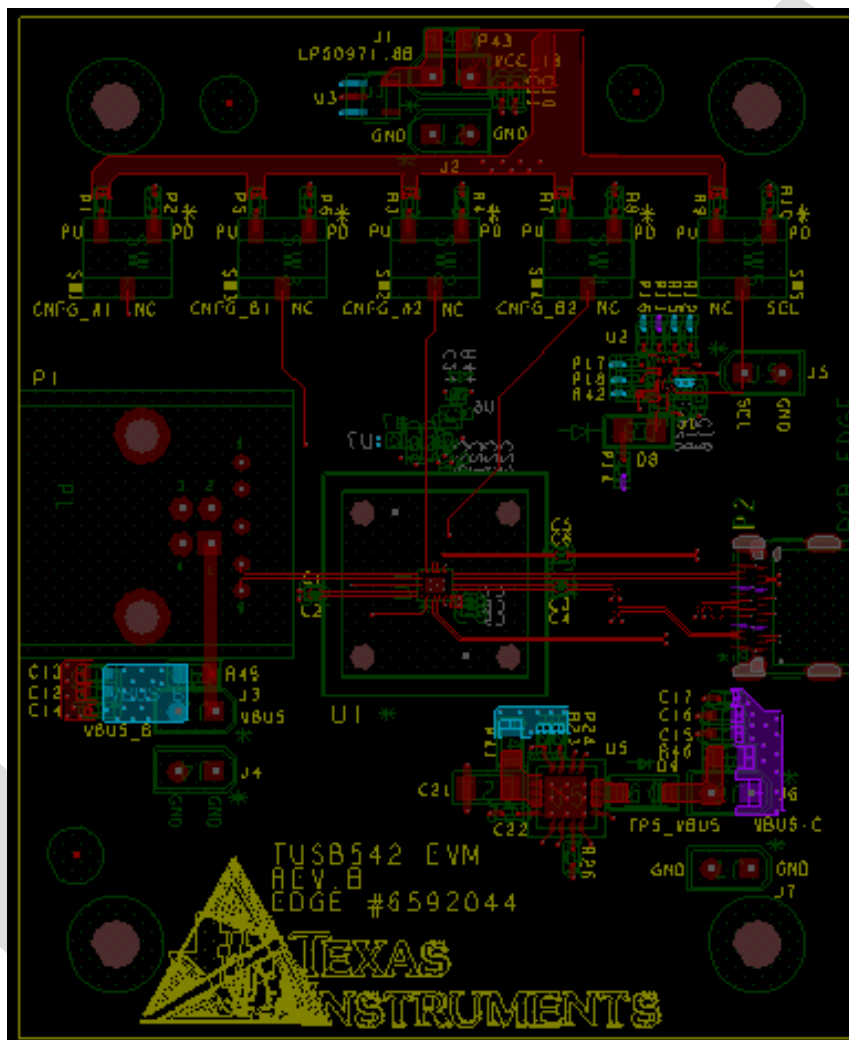


Figure 6. – TUSB542 EVM Layout Layer 1 [Top]

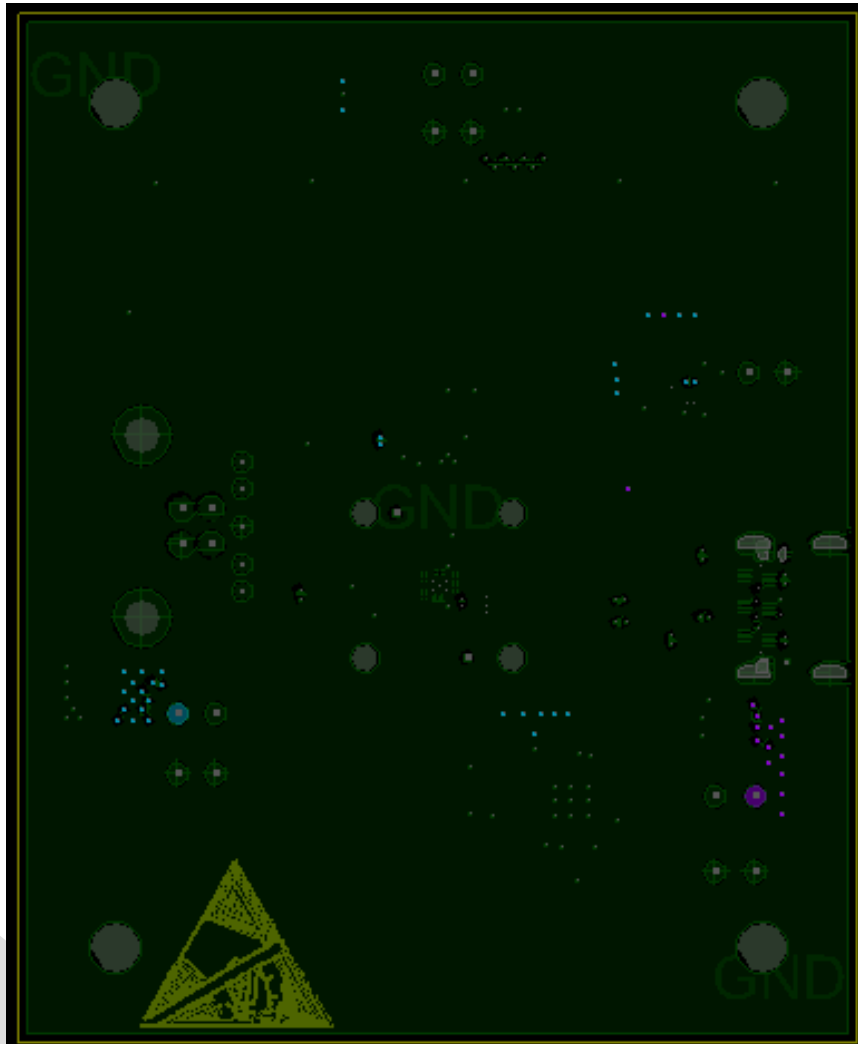


Figure 7. – TUSB542 EVM Layout Layer 2 [GND]

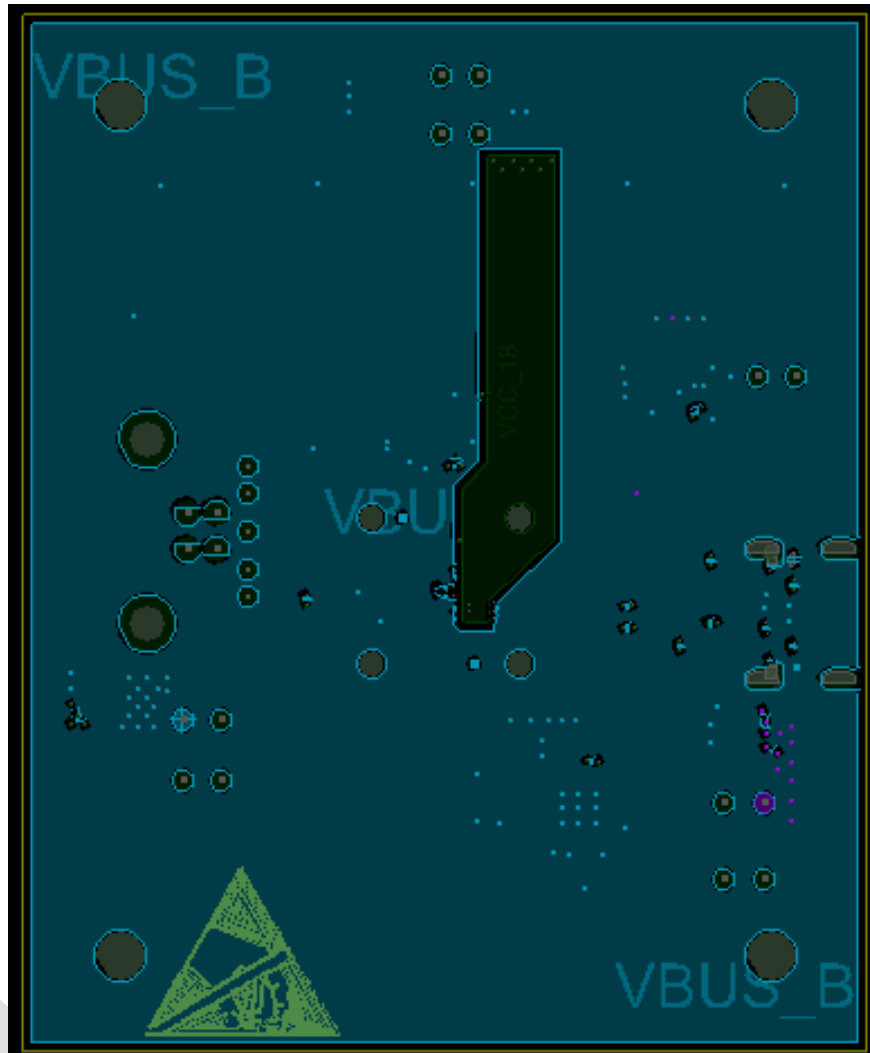


Figure 8. – TUSB542 EVM Layout Layer 3 [Power]

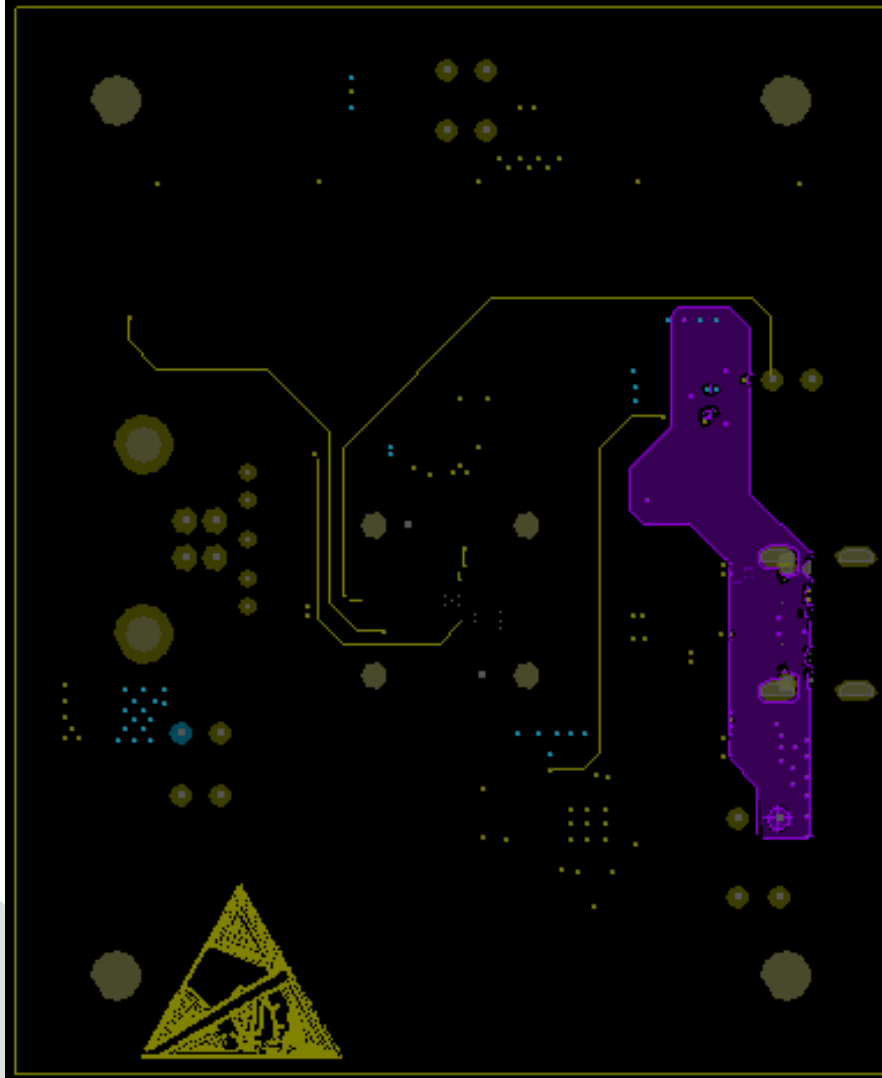


Figure 9. – TUSB542 EVM Layout Layer 4 [Power/Signal]

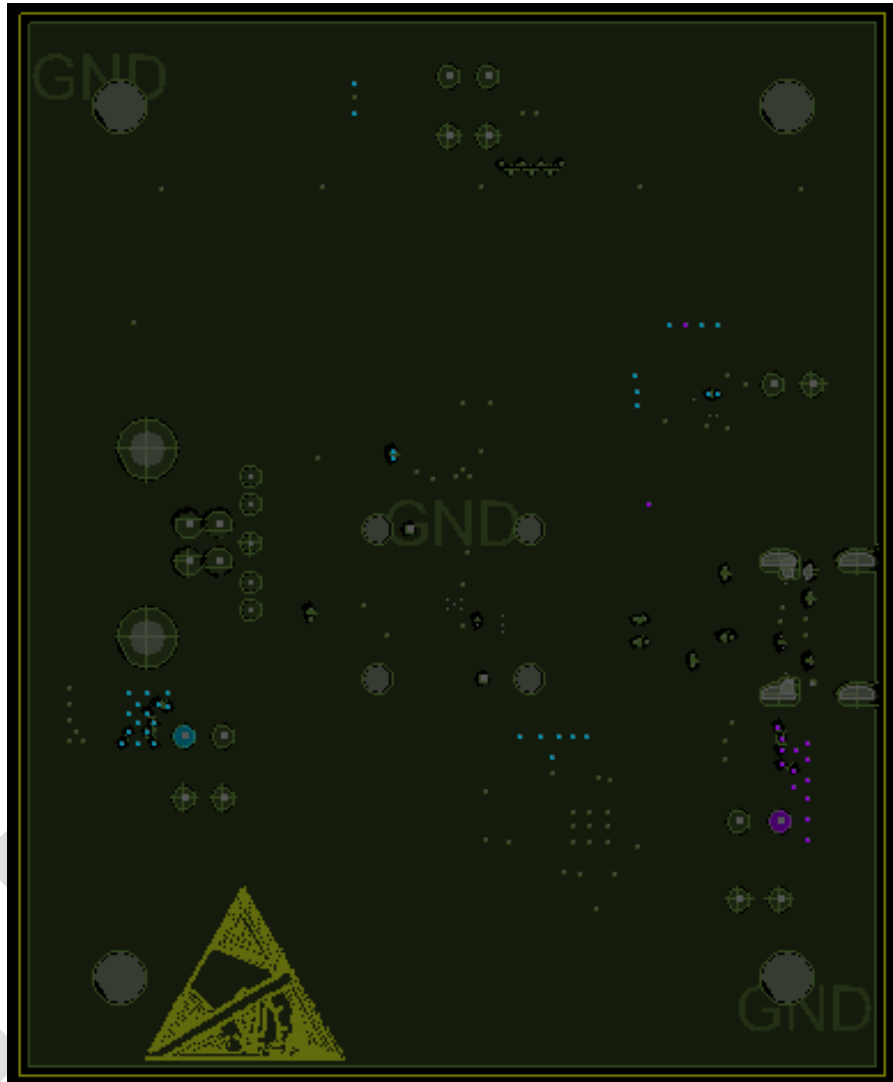


Figure 10. – TUSB542 EVM Layout Layer 5 [GND]

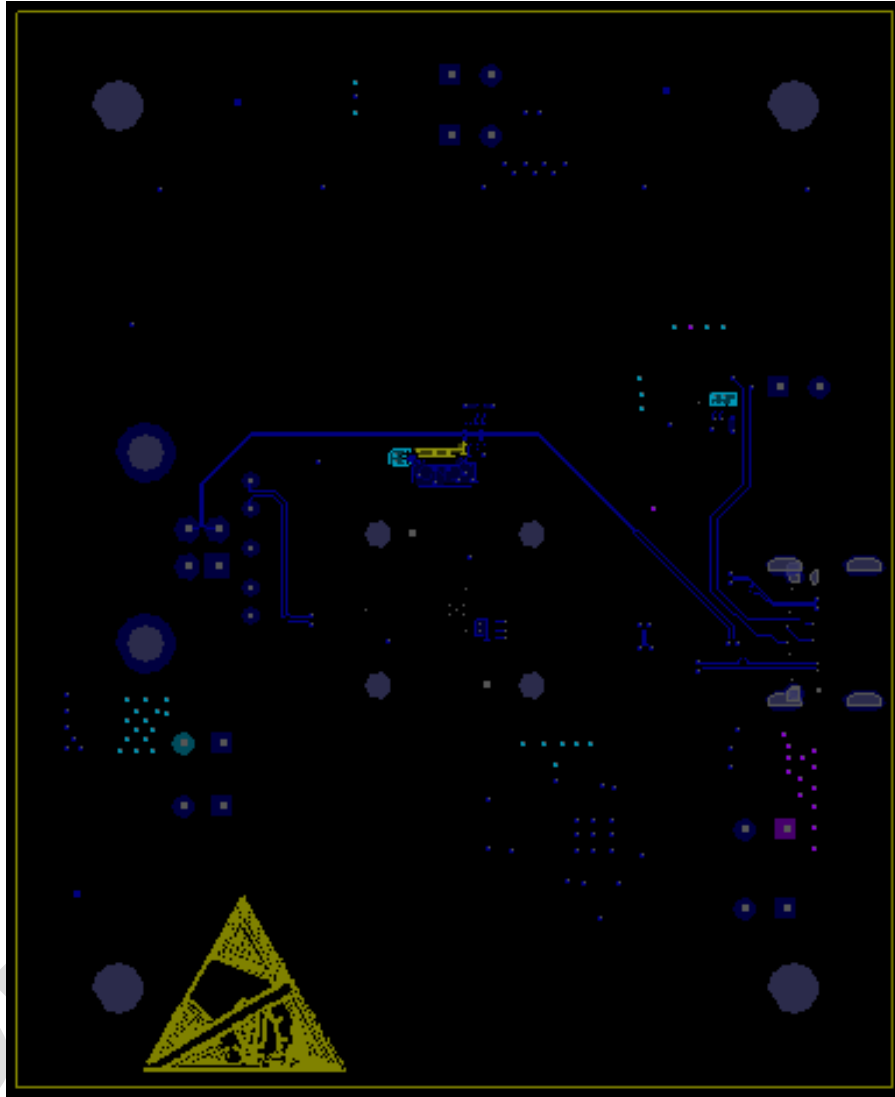


Figure 11. – TUSB542 EVM Layout Layer 6 [Bottom]

## TUSB542 EVM Material Listing

Below is a table of the complete BOM for the TUSB542 EVM.

Item	Qty	Reference	Value	Part Description	Manufacturer	Manufacturer Part Number
1	14	C1,C2,C3,C4,C5,C6,C8,C9,C10, C19,C20,C23,C24,C25	0.1uF	Capacitor	TDK	C0603X7S1A104M030BC
2	1	C7	0.01uF	Capacitor	TDK	C0603X5R1A103K030BA
3	6	C11,C14,C17,C18,C26,C27	1uF	Capacitor	TDK	C1005X5R1A105K050BB
4	4	C12,C13,C15,C16	10uF	Capacitor	TDK	C1608X5R0J106M080AB
5	1	C21	47uF	Capacitor	TDK	C3216X6S0J476M160AB
6	1	C22	47nF	Capacitor	TDK	C1005X7R1C473K050BC
7	1	D8		LED	LITE-ON	LTST-C170KGKT
8	1	D9		Schottky	Rohm Semiconductor	RB161M-20TR
9	7	J1,J2,J3,J4,J5,J6,J7	HDR2x1 M .1	2-Pin Header	Sullins Connector Solutions	S1012E-02
10	1	P1		USB3 Type B Receptacle	Würth Electronics	692221030100
11	1	P2		Type C USB Connector	JAE	DX07S024JJ3R1300
12	Q1			PMOS FET	Texas Instruments	CSD25484F4T
13	12	R1,R2,R3,R4,R5,R6,R7,R8, R9,R10,R12,R24	10K	Resistor	Panasonic Electronic Components	ERJ-2GEJ103X
14	1	R11	900K	Resistor	Panasonic Electronic Components	ERJ-2RKF9093X
15	1	R14	499	Resistor	Panasonic Electronic Components	ERJ-2RKF4990X
16	1	R15	4.7K	Resistor	Panasonic Electronic Components	ERJ-2GEJ472X
17	4	R16,R17,R18,R42	200k	Resistor	Panasonic Electronic Components	ERJ-2RKF2003X
18	1	R23	10K (No Pop)	Resistor		



19	1	R26	29.4K	Resistor	Panasonic Electronic Components	ERJ-2RKF2942X
20	4	R41,R43,R45,R46	0	Resistor	Panasonic Electronic Components	ERJ-6GEY0R00V
21	1	R44	1.6k	Resistor	Panasonic Electronic Components	ERJ-1GEF1601C
22	5	SW1,SW2,SW3,SW4,SW5		Switch	Copal Electronics	CJS-1201TA
23	1	U1		USB3 Switch / Redriver	Texas Instruments	TUSB542RWQ
24	1	U2		CC Controller	Texas Instruments	TUSB321
25	1	U3		1.8V LDO	Texas Instruments	LP5907MFX-1.8NOPB
26	1	U5		Power Switch	Texas Instruments	TPS25910RSA
27	1	U6		USB 2.0 Redriver	Texas Instruments	TUSB211RWB
28	1	U7		3.3V LDO	Texas Instruments	LP5907SNX-3.3/NOPB

Table 3. – TUSB542 EVM Bill of Materials

Preliminary

## 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.
  - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software
  - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
  - 2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
  - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
  - 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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/llds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page)  
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。[http://www.tij.co.jp/llds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page)

#### 4 *EVM Use Restrictions and Warnings:*

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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