TUSB320 Evaluation Module

This document describes how to use TUSB320 evaluation module (EVM).

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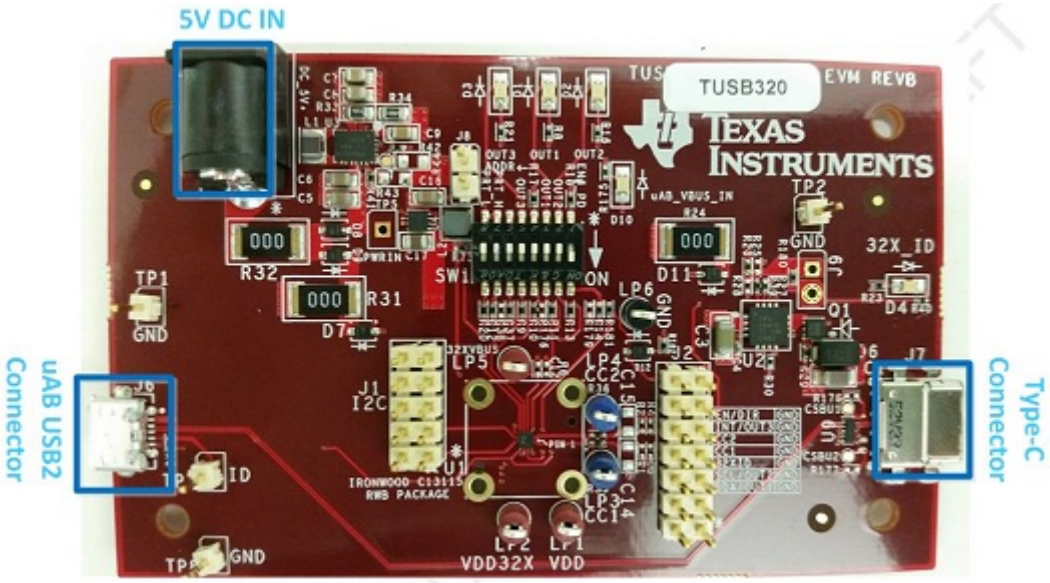
1 What is the TUSB320 EVM?

The TUSB320 EVM is designed to evaluate TUSB320 devices. The EVM can be configured to operate in DFP, UFP, or DRP mode via DIP switch selection and/or I2C control. All of the control inputs are also selectable via DIP switch configuration. The TUSB320 devices can be used with legacy USB systems or Type-C systems for evaluation purposes.



2 TUSB320 EVM Features

The EVM can be configured to be used for the evaluation of DFP, UFP, or DRP Type-C implementation. The EVM can also be configured to operate in I2C or GPIO mode. Default configuration is I2C.

This section describes features provided by the EVM to enable users to evaluate Type-C implementations in different modes of operation.

2.1 Power

The EVM can be powered by USB VBUS or 5-V to 5.5-V DC IN through a power jack J5 (2 mm positive tip, 6.5 mm negative outer shield). The VBUS can be provided via a legacy connection or Type-C connection. When the EVM operates in DFP mode, the VBUS is provided through micro-AB connector J6, 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 J1, if the board is connected to a USB host or VBUS source through a Type-C cable. The 5-V DC IN (J5) can also be used to supply power if a stand-alone operation is desired without connecting to a USB VBUS power source. If D9 is installed on the board, **do not connect** the EVM to a USB Host system through the micro-AB USB2 connector(J6) at the same time 5 V is supplied through 5-V DC IN J5 or Type-C Connector J7. Due to diode/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.

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/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: J7, J6, or J5.

2.2 VBUS

2.2.1 VBUSOff time

To meet the VBUSOff time of 650 ms, remove the 10-µF capacitor C1 . Current limiting can be reduced to 3 A–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.

2.3 DIP Switch Setting

The DIP switch (SW1) is provided to configured the EVM in different modes of operation.

Table 1. DIP Switch Modes of Operation

Reference Designator	SW Control Function	Default Switch Setting	Description
SW1.1	EN#	ON	EN_N= High, if SW1.1 = OFF EN_N = 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 SW1.2 = OFF OUT2 connected to LED, if SW1.2 = ON
SW1.4	ADDR	OFF	For I2C mode of operation: ADDR = High, if SW1.4 = OFF ADDR = Low, if SW1.4 = ON For GPIO mode of operation: Remove R12 and 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	PORT_H	OFF	PORT = Open, if SW1.7 = OFF PORT = High, if SW1.7 = ON
SW1.8	PORT_L	ON	PORT = Open, if SW1.8 = OFF PORT = Low, if SW1.8 = ON

2.4 I2C

The I2C bus can be accessed through a header: 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 Section 2.3, DIP Switch Setting. The ADDR pin determines the last bit of the TUSB320 I2C address to be high or low. J1 is intended to match the Aardvark I2C programmer dongle pinout

2.5 LEDs

Several LEDs are provided for easier debug purposes.

Table 2. LEDs Debug Descriptions

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 the ID pin of TUSB320 is driven low.
D10	POWER	Illuminates if 5-V power is available.

Note that the OUT1, OUT2, OUT3 LEDs are used in GPIO mode of operation. The DIP SW must be configured accordingly to configure TUSB320 EVM in GPIO mode of operation. The LED may light up dim even when OUT pins are not driven due to a pullup to 3.3 V.

3 TUSB320 EVM Configuration Examples

This section provides different configuration examples of the TUSB320 EVM: DRP, DFP or UFP operation. The PORT pins and the I2C 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 using the PORT pin on the board or I2C register setting. If the PORT pin is to be used, SW1.8 must be switched ON and the Mode_Select bits at addr0x0A bit 5:4 must be set to 00b. The Mode_Select is 00b by default so there is no need to re-program unless it has been reconfigured for other modes of operation.

Figure 1 describes an example configuration using HD3SS2522 and TUSB320 EVMs. The HD3SS2522 is a TI's DFP CC controller compliant to USB Type-C spec v1.1.

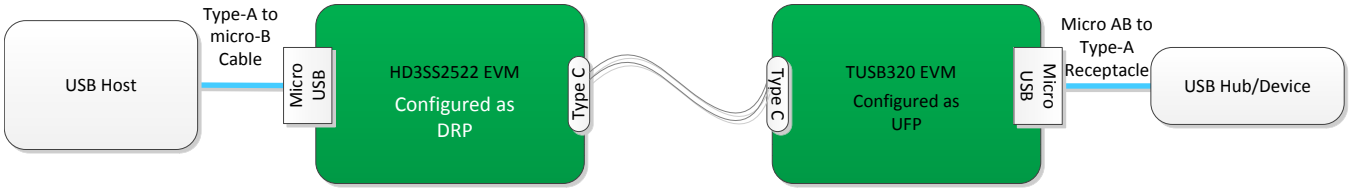


Figure 1. Example Configuration Using HD3SS2522 and TUSB320 EVMs

1. TUSB320 UFP: Configure the DIP switches as shown in Table 3.

Table 3. TUSB320 UFP DIP Switch SW1 Settings

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	PORT_H	OFF
SW1.8	PORT_L	ON

2. Connect the HD3SS2522 EVM to a USB host.
3. Connect TUSB320 to the HD3SS2522 using a Type-C Cable. VBUS should be provided over the Type-C cable connection. LED D10 should illuminate on the TUSB320 board. D3 and D4 should illuminate on the HD3S2522 indicating an UFP connection. Please refer to the HD3SS2522 users manual (SLLU215) for the details of the HD3SS2522 EVM operation.
4. USB devices plugged into the Micro AB USB receptacle(J6) of the TUSB320 UFP EVM should enumerate at USB2 speed: HS, FS, or LS.

3.2 DFP Operation

The board can be configured to operate in DFP mode using the PORT pin on the board or I2C register setting. If the PORT pin is to be used, the SW1.7 must be switched ON and the Mode_Select bits at addr0x0A bit 5:4 must be set to 00b. The Mode_Select is 00b by default, so there is no need to reprogram unless it has been reconfigured for other modes of operation.

Figure 2 describes an example configuration using two TUSB320 EVMs: one configured as DFP, the other configured as UFP. Refer to Section 3.1 for TUSB320 UFP EVM configuration.

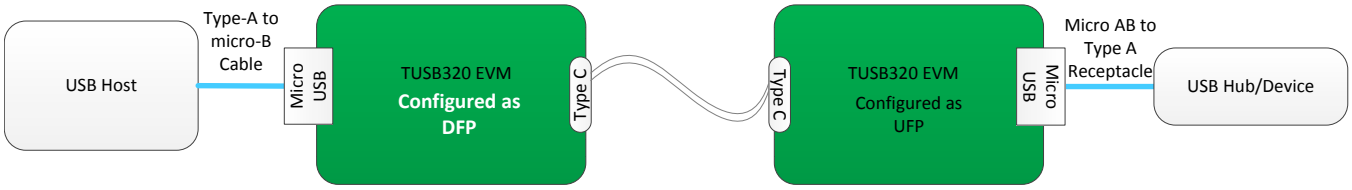


Figure 2. Example Configuration Using Two TUSB320 EVMs

1. Configure TUSB320 DFP EVM DIP switch SW1 as shown in Table 4.

Table 4. TUSB320 DFP EVM DIP Switch SW1 Configuration

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	PORT_H	ON
SW1.8	PORT_L	OFF

2. Connect TUSB320 DFP EVM to a legacy USB host using a Type-A to micro-B cable via micro-AB connector (J5) provided on board. The LED D10 should illuminate by the VBUS provided by the legacy USB host over the Type-A to micro-B cable connection.
3. Connect TUSB320 UFP EVM to the TUSB320 DFP EVM using a Type-C Cable. The TUSB320 UFP EVM should be powered by VBUS provided over the Type-C cable connection. The LED D10 on the TUSB320 UFP EVM should also light up. Upon the Type-C cable, attach to the TUSB320 DFP EVM, D4 should light up indicating the ID pin has been driven low from the TUSB320.
4. USB device plugged into the micro-AB USB receptacle(J6) of the TUSB320 UFP EVM should enumerate at USB2 speed: HS, FS, or LS.

3.3 DRP Operation

The board can be configured to operate in DFP mode using the PORT pin on the board or I2C register setting. If PORT pin is to be used, the SW1.7 must be switched ON and the Mode_Select bits at addr0x0A bit 5:4 must be set to 00b. The Mode_Select is 00b by default, so there is no need to reprogram unless it has been reconfigured for other modes of operation. It is important that both SW settings are in the OFF position to have the PORT input to the TUSB320 open.

Figure 3 illustrates an example configuration using HD3SS2522 and TUSB320 EVMs. The HD3SS2522 is TI's DFP CC controller, compliant to USB Type-C spec v1.1.

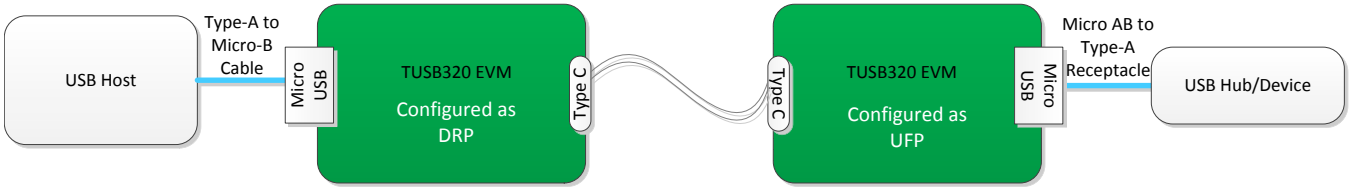


Figure 3. Example Configuration Using HD3SS2522 and TUSB320 EVMs

1. Configure the TUSB320 DRP EVM DIP switch SW1 as shown in Table 5.

Table 5. TUSB320 DRP EVM DIP Switch SW1

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	PORT_H	OFF
SW1.8	PORT_L	OFF

2. Connect the HD3SS2522 EVM to a USB host.
3. Connect the TUSB320 to the HD3SS2522 using a Type-C cable. VBUS should be provided over the Type-C cable connection. LED D10 should light up on the TUSB320 board. D3 and D4 should light up on the HD3S2522 indicating an UFP connection. Please refer to HD3SS2522 users manual (SLLU215) for details on the HD3SS2522 EVM operation.
4. USB devices plugged into the micro-AB USB receptacle(J6) of the TUSB320 UFP EVM should enumerate at USB2 speed: HS, FS, or LS.

Figure 4 describes an example configuration using two TUSB320 EVMs: one configured as DRP, the other configured as UFP. Refer to Section 3.1 for TUSB320 UFP EVM configuration.

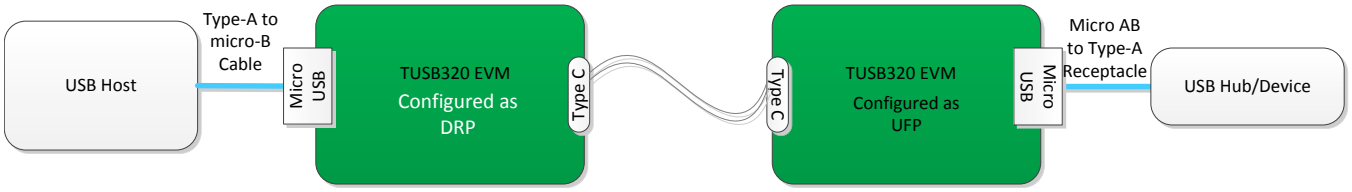


Figure 4. Example Configuration Using Two TUSB320 EVMs

1. Configure the TUSB320 DRP DIP switch SW1 as shown in Table 6.

Table 6. TUSB320 DRP DIP Switch SW1 Configuration

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	PORT_H	OFF
SW1.8	PORT_L	OFF

2. Connect the TUSB320 DRP EVM to a legacy USB host using a Type-A to micro-B cable via micro-AB connector (J5) provided on the board. The LED D1, D2, and D3 should be lit up by the VBUS provided by the legacy USB host over the Type-A to micro-B cable connection.
3. Connect the TUSB320 UFP EVM to the TUSB320 DFP EVM using a Type-C cable. The TUSB320 UFP EVM should be powered by VBUS provided over the Type-C cable connection. The LED D10 on the TUSB320 UFP EVM should also light up. Upon the Type-C cable attach to the TUSB320 DFP EVM, D4 should light up indicating the ID pin has been driven low from the TUSB320.
4. The USB device plugged into the micro-AB USB receptacle (J6) of the TUSB320 UFP EVM should enumerate at USB2 speed: HS, FS, or LS.

NOTE: Two TUSB320 EVMs can be used for DRP to DRP connection. In this configuration, it is not recommended to connect the EVM to legacy USB systems as the role cannot be predicted until both sides enters the attach state. This configuration can be used for evaluation purposes with 5 V provided via DC IN (J5) on both boards.

4 Schematics

Figure 5, Figure 6, and Figure 7 illustrate the TUSB320 EVM revision B schematics.

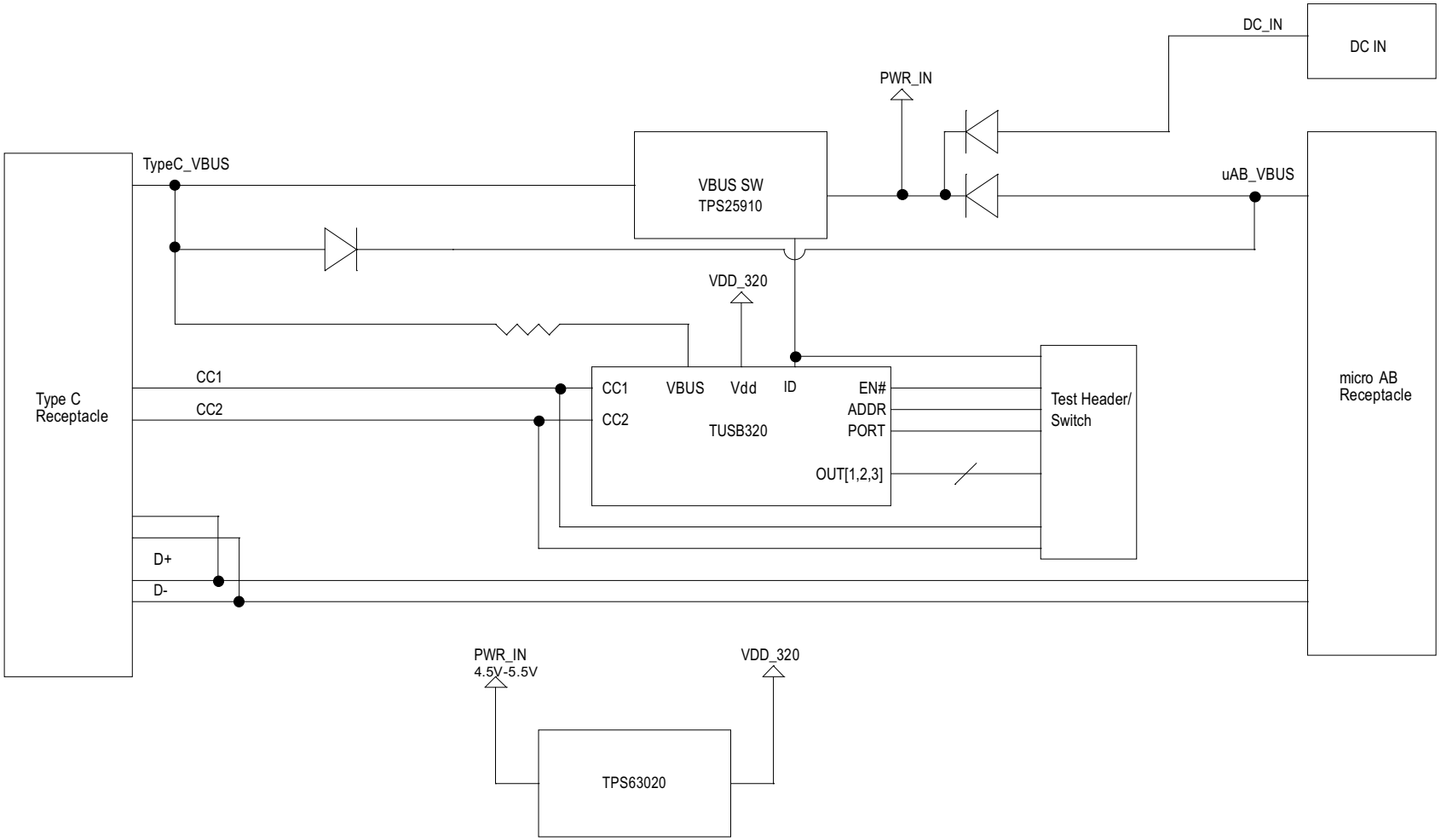


Figure 5. TUSB320 EVM Schematic

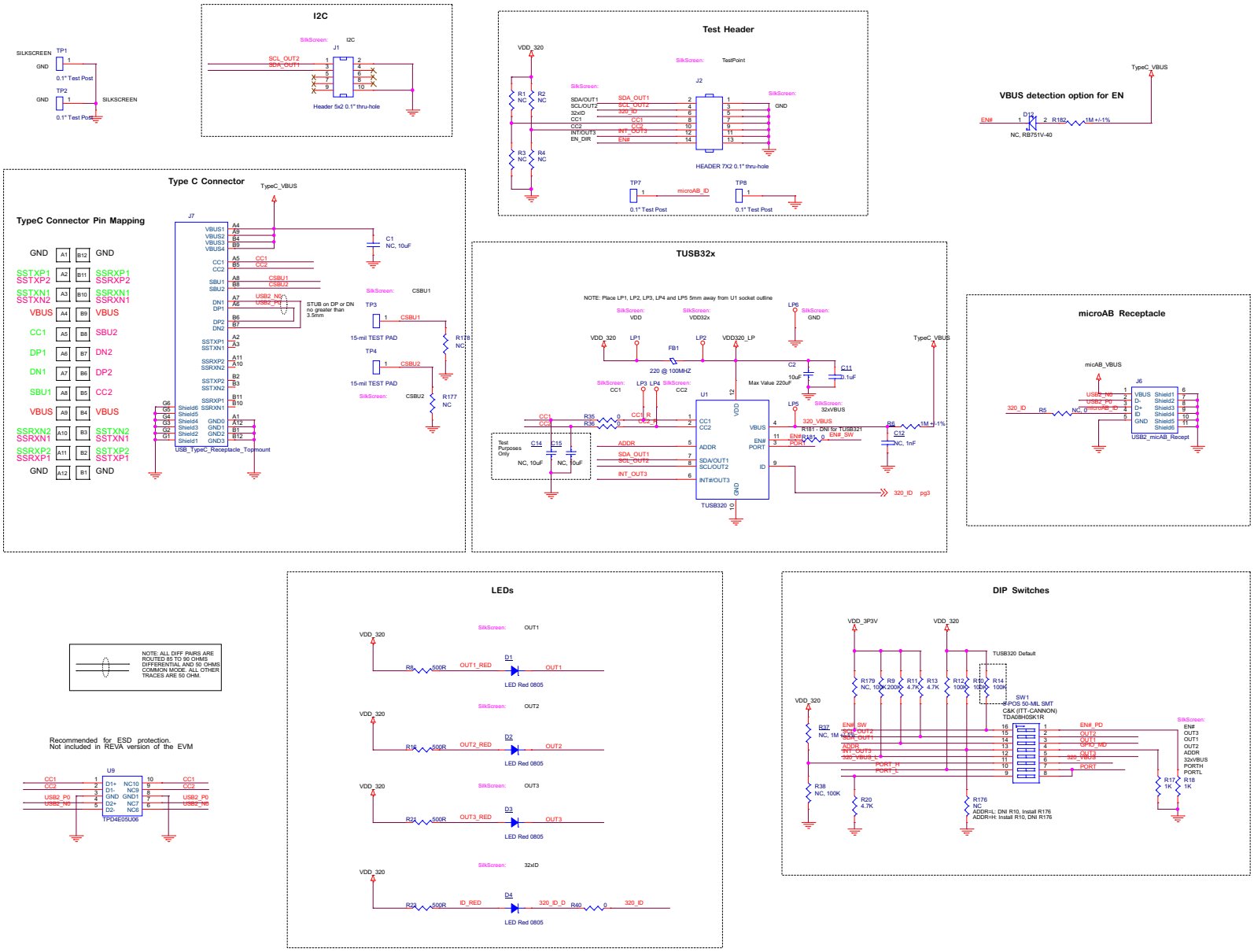


Figure 6. TUSB320 EVM Components

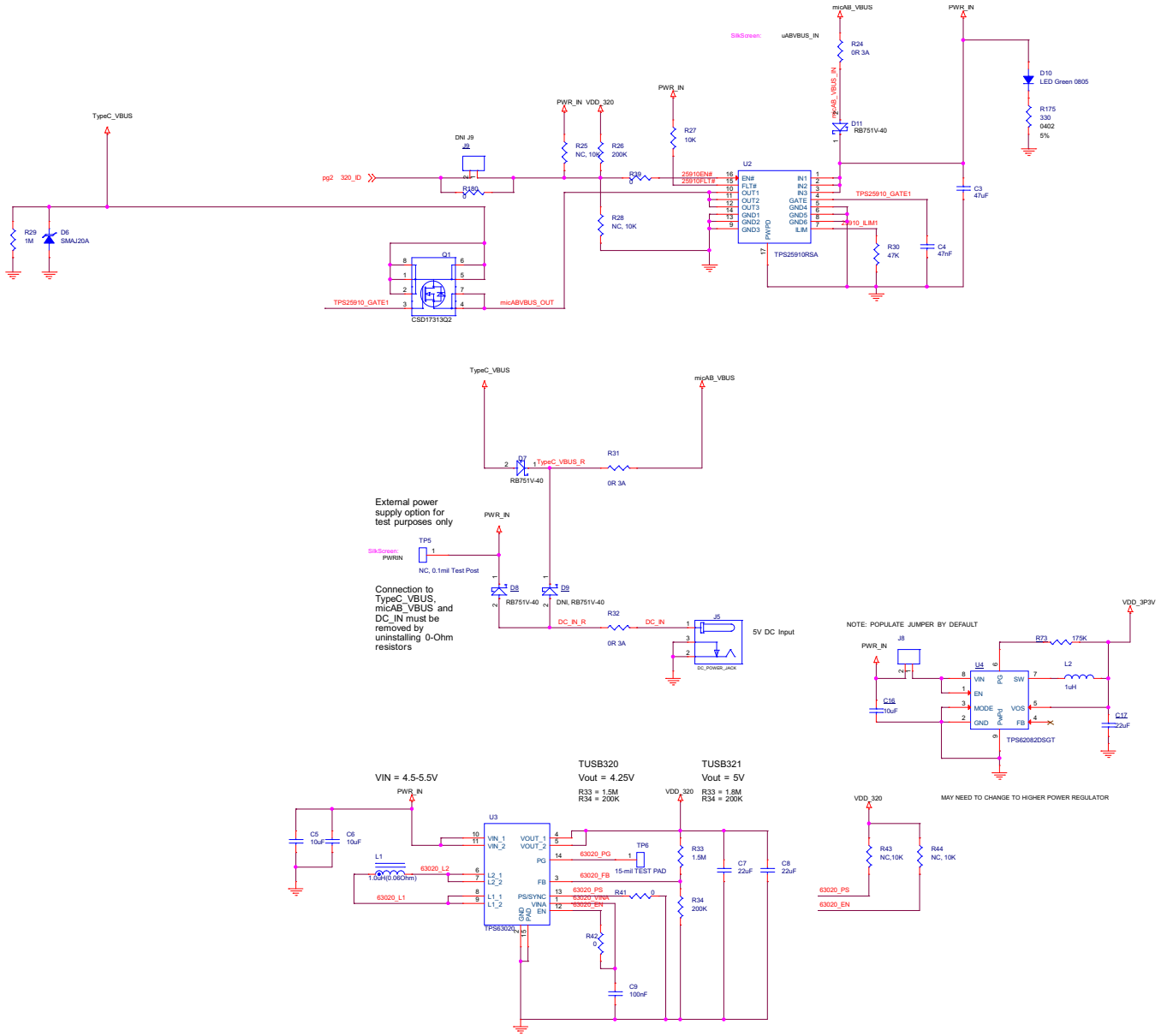


Figure 7. TUSB321 EVM Power

Revision History

Changes from A Revision (August 2015) to B Revision **Page**

- Changed voltage powering the EVM from 5 V, to a range of 5 V to 5.5 V, in the first paragraph of the *Power* section..... 3
- Added *VBUS* section..... 3

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Revision History

Changes from Original (June 2015) to A Revision **Page**

- Added two sentences to the end of the first paragraph in the *Power* section..... 3
- Added 'J1' to the first sentence of the *I2C* section..... 4
- Added sentence to the end of the first paragraph of the *I2C* section..... 4
- Added *Schematics* section..... 9

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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      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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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 *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.

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