HD3SS2522 EVM

This document describes how to use and configure the HD3SS2522 EVM.

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1 Overview

1.1 HD3SS2522 EVM Introduction

The HD3SS2522 EVM is a printed-circuit board (PCB) created to help customers evaluate the Type C interface. This EVM can also be used as a hardware reference design for any implementation using the HD3SS2522 with a Type C connector. PCB design files can be provided upon request to aid with PCB design using the HD3SS2522. The layout files (available upon request) can be used as a guideline to implement the HD3SS2522 with illustrations of the routing/placement rules. Note that the EVM design includes test components for evaluation purposes which may not be applicable for production.

This EVM includes on-board connectors for legacy USB connection for evaluation purposes. The EVM can be plugged into any systems with a Type A receptacle to evaluate the Type C implementation using the HD3SS2522.

1.2 HD3SS2522 EVM Contents

The major components of the EVM follow:

- HD3SS2522
- USB3 Standard Type A Plug
- USB3 Type C Receptacle
- DIP SW for Type C current configuration

1.3 HD3SS2522 EVM Board Description

Figure 1 illustrates the HD3SS2522 EVM board.

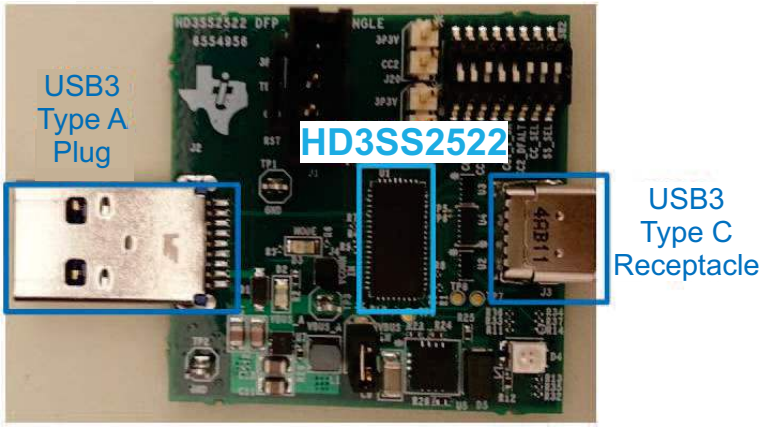


Figure 1. HD3SS2522 EVM (Top Side)

2 Hardware Description

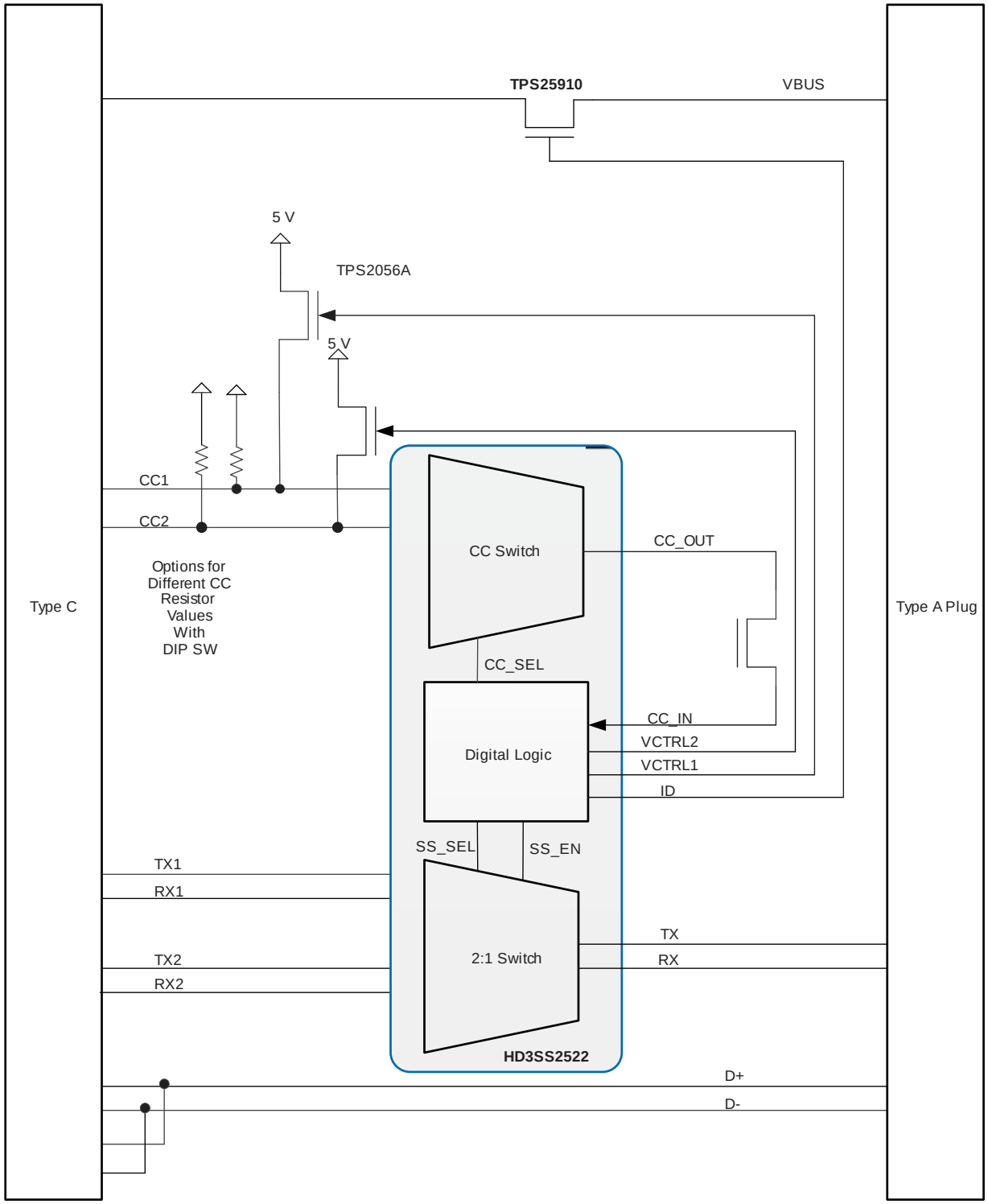


Figure 2. HD3SS2522 EVM Block Diagram

2.1 Connectors

The EVM has two USB connectors: USB3 standard Type A plug and USB3 Type C receptacle, J2 and J3, respectively. The EVM can be plugged into any USB host system with a Type A receptacle to evaluate Type C implementations with HD3SS2522.

2.2 Power

2.2.1 VBUS

The EVM operates off of the 5-V VBUS input from the legacy Type A USB connection. The VBUS input from the legacy connection J2 is passed through to the Type C connector through the power switch U5 which is enabled only if the ID is driven low by the HD3SS2522. VBUS can be supplied externally via J18 to test higher than legacy USB current (500 mA or 900 mA) delivery over Type C connection. Current limiting over VBUS is configurable by changing the value of R26. Refer to TPS25910 (SLUSAR6D) datasheet for configuration details.

2.2.2 VCONN

The EVM can provide VCONN over a CC pin based upon Type C plug orientation and Ra detection. The HD3SS2522 determines the plug orientation and enables VCONN over unused CC pin upon detection of Ra. The default voltage for VCONN is 5 V. If other VCONN voltage levels are to be tested, voltage can be supplied via J4.

2.3 Reset

C6 and R1 are placed to control the RST ramp time to the digital logic part of the HD3SS2522 device. A reset switch SW1 is also provided for manual reset after the device has been powered on.

2.4 LED

An LED is provided to indicate the status of the HD3SS2522 based upon the CC configuration of the device. The default LED configurations are listed in Table 1, but the EVM or HD3SS2522 firmware can be reconfigured to have the LED report other status.

Table 1. Default LED Configurations

LED_COLOR	Control Signal	LED Status Description
LED_RED(1)	VCTRL1#	VCONN is provided on CC1
LED_YLW	VCTRL2#	VCONN is provided on CC2
LED_GRN	ID	VBUS is provided as the port is identified as DFP

(1) If the red LED is on, it blocks out other colors.

2.5 DIP Switch

DIP switch is provided to configure CC for different Type C current mode operations. Using the DIP switch, the HD3SS2522 can be configured to support default, mid- or high-current mode: 500 mA/900 mA, 1.5 A, or 3 A, respectively. The IMODE must be configured to match the CC resistor setting for the corresponding current configuration. Table 2 shows the DIP switch setting for each mode of operation.

Table 2. DIP Switch Settings

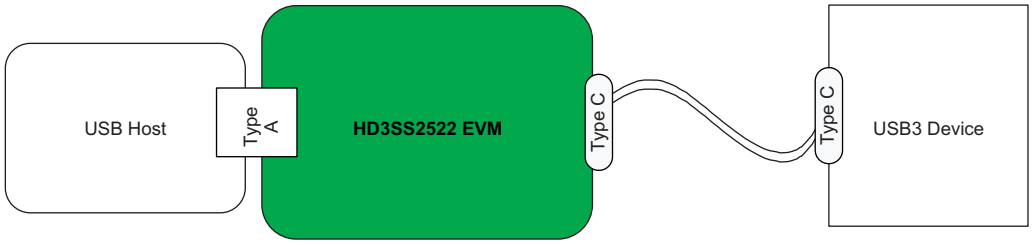
Selection	SW Pin	SW Position for Default Current Operation	SW Position for 1.5-A Current Operation	SW Position for 3-A Current Operation
CC2_3A	SW2.1	OFF	OFF	ON
CC2_1_5A	SW2.2	OFF	ON	OFF
CC2_DEFAULT	SW2.3	ON	OFF	OFF
CC1_3A	SW2.4	OFF	OFF	ON
CC1_1_5A	SW2.5	OFF	ON	OFF
CC1_DEFAULT	SW2.6	ON	OFF	OFF
IMODE1 (1)	SW2.7	OFF	OFF	ON
IMODE2 (1)	SW2.8	OFF	ON	ON

(1) Silk Screen label on these signals are incorrect. CC_SEL should be IMODE1, SS_SEL should be IMODE2.

2.5.1 CC Selection

If CC resistance outside the range provided in the EVM needs to be tested, CC resistance can be provided via J19 and/or J20. These headers must be left open if the DIP SW is used for CC resistance selection as shown in Table 2. If external resistance is to be provided through J19 and/or J20, the corresponding DIP switch must be flipped to the OPEN/OFF position.

3 Quick Start Guide



1. Plug the EVM into a USB host with a Type A receptacle via J2
2. Plug a USB device or hub over Type C cable and/or connector

4 AC Coupling Cap Placement Recommendation

The EVM does not have AC capacitors as the EVM is intended to be used with systems that have capacitors placed per the corresponding interface specification.

This section describes guidelines for placing the components including AC coupling capacitors in a system implementation with HD3SS2522.

Figure 3 through Figure 5 depict the AC coupling capacitor placement examples. It is recommended to place the capacitors as shown for the backward compatibility and interoperability purposes as some of the existing USB systems may present Vcm, exceeding the typical range of 0–2 V on SS differential pairs.

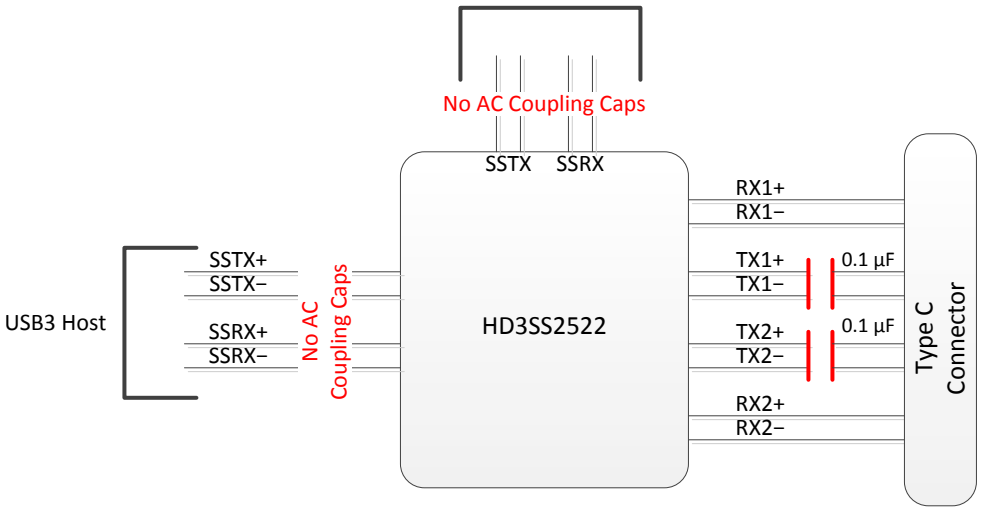


Figure 3. HD3SS2522 USB Host Implementation Example With 0 V < SSTX/RX Vcm < 2 V

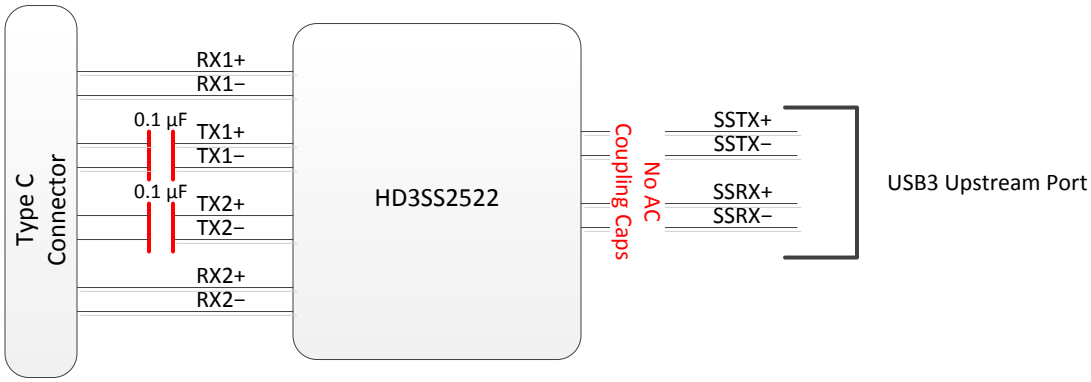


Figure 4. HD3SS2522 USB Upstream Implementation Example With 0 V < SSTX/RX Vcm < 2 V

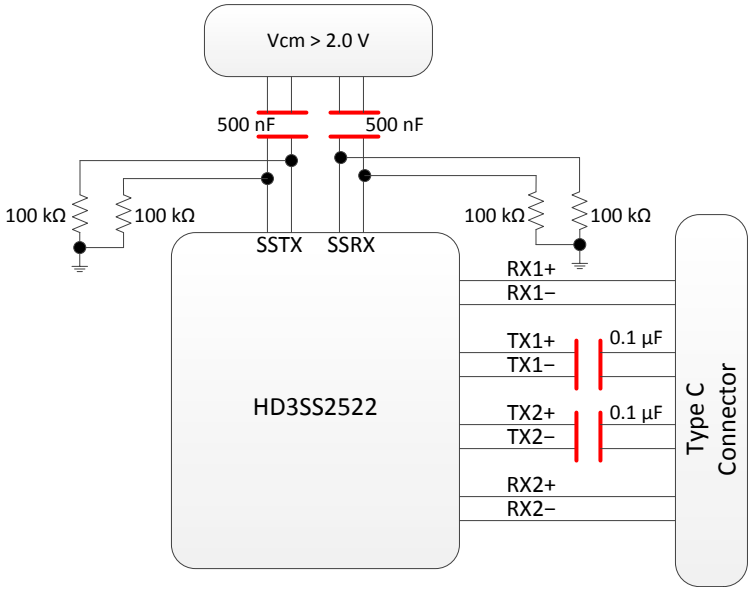


Figure 5. HD3SS2522 USB Host With SS USB Vcm > 2 V Example

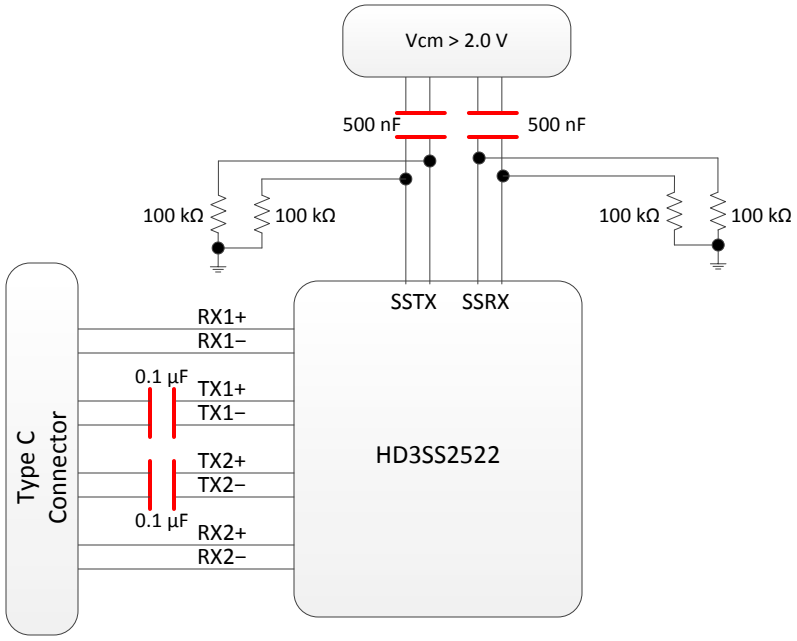


Figure 6. HD3SS2522 USB Upstream With SS USB Vcm > 2 V Example

5 References

1. *HD3SS2522 USB Type C SS MUX with DFP Controller* Datasheet (SLLSEM6)

6 EVM Schematics

The following pages contain schematics for the HD3SS2522 EVM.

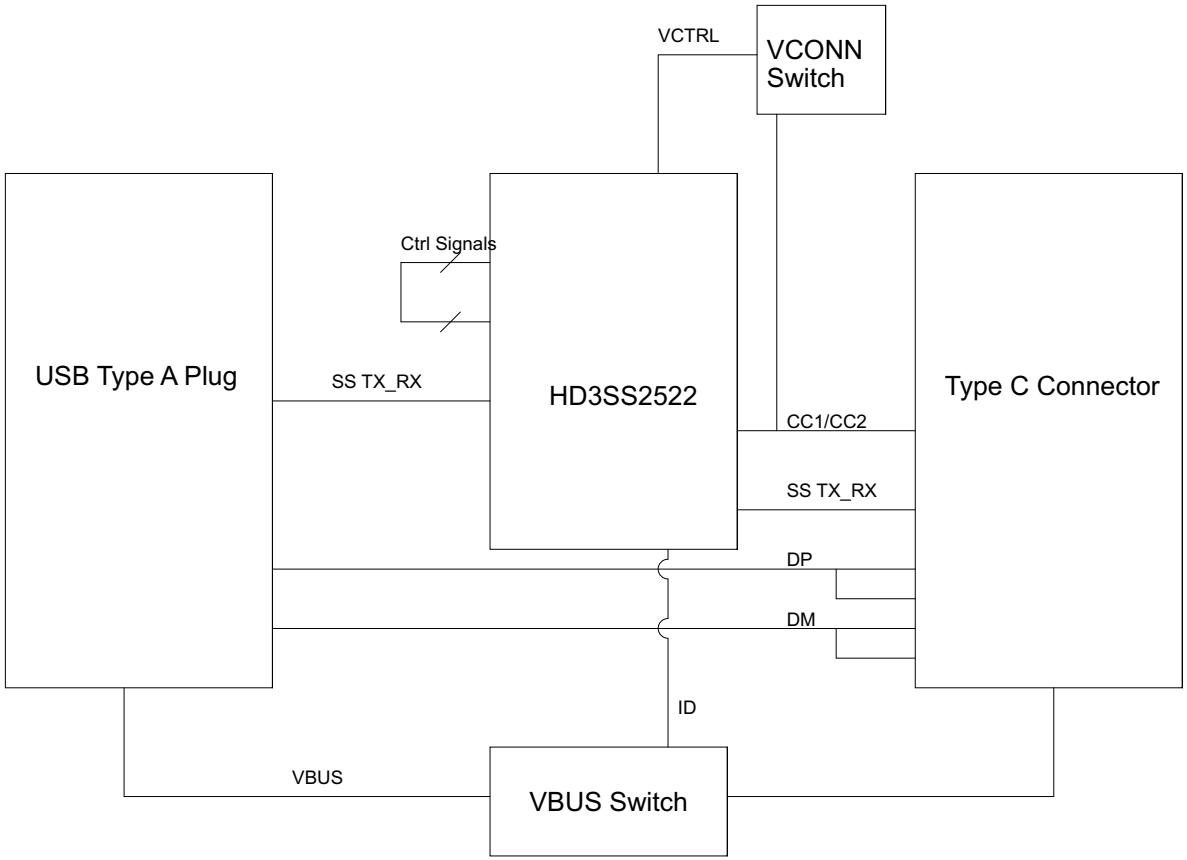


Figure 7. Schematic (Page 1 of 3)

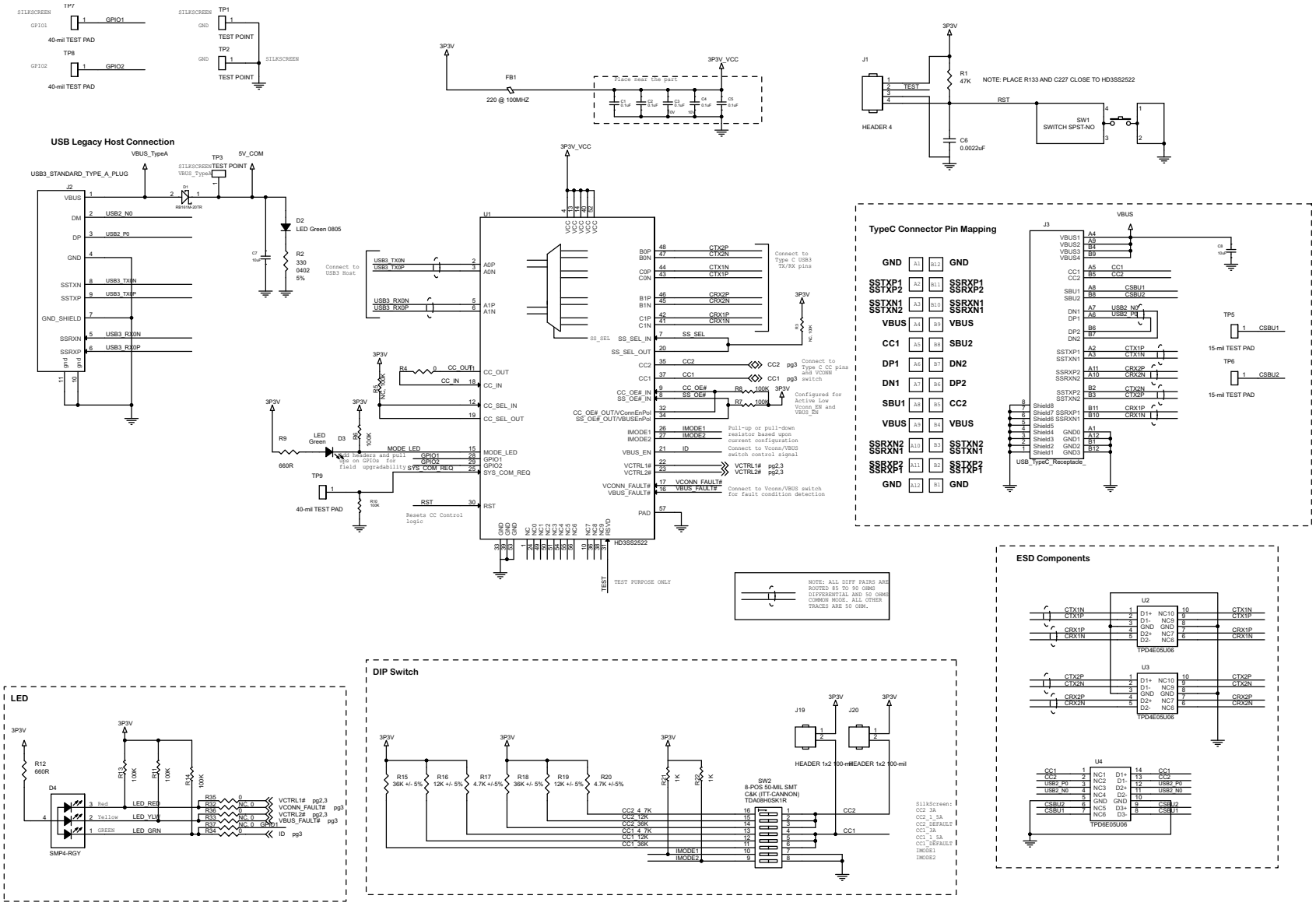


Figure 8. Schematic (Page 2 of 3)

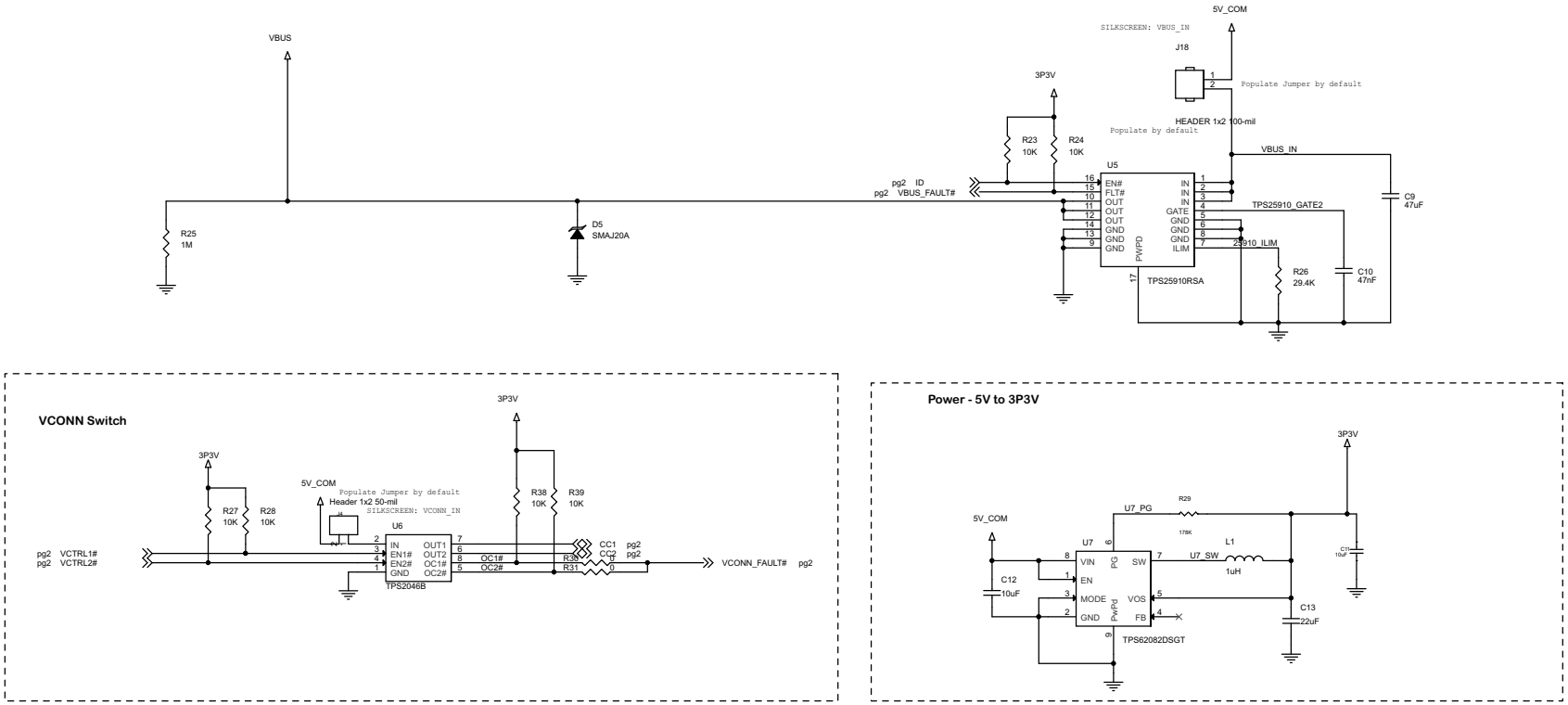


Figure 9. Schematic (Page 3 of 3)

7 Bill of Materials

Table 3 lists the HD3SS2522 bill of materials (BOM).

Table 3. HD3SS2522 Bill of Materials

Line #	QTY	Value	Designators	PKG/ Case	T.COEFF/ PWR	Volt Rated	Description	Manufacturer	MFG Part #	DigiKey Part#
1	1	2200pF	C6	0201	X7R	25V	Capacitors	Panasonic Electronic Components	ECJ-ZEB1E222K	PCC2386CT-ND
2	5	0.1µF	C1, C2, C3, C4, C5	0402	X7R	16V	Capacitors	TDK Corporation	C1005X7R1C104K	445-4952-1-ND
3	1	47000pF	C10	0402	X7R	25V	Capacitors	Murata Electronics North America	GRM155R71E473KA88D	490-3254-1-ND
4	2	10µF	C7, C8	0805	X7R	10V	Capacitors	Murata Electronics North America	GRM21BR71A106KE51L	490-3905-1-ND
5	2	10µF	C11, C12	0805	X7R	10V	Capacitors	Murata Electronics North America	GRM21BR71A106KE51L	490-3905-1-ND
6	1	22µF	C13	0805¥	X5R	6.3V	Capacitors	TDK Corporation	C2012X5R0J226M/1.25	445-1422-1-ND
7	1	47µF	C9	1206	X5R	10V	Capacitors	Taiyo Yuden	LMK316BJ476ML-T	587-1780-1-ND
28	6	0.0 (Zero Ohm)	R4, R30, R31, R34, R35, R36	0201	1/20W	50V	Resistors	Vishay Dale	CRCW02010000Z0ED	541-0.0AGCT-ND
29	2	1.00K	R21, R22	0201	1/20W		Resistors	Panasonic Electronic Components	ERJ-1GEF1001C	P1.00KABCT-ND
30	7	100K	R6, R7, R8, R10, R11, R13, R14	0201	1/20W	75V	Resistors	Venkel	CR0201-20W-1003FT	CR0201-20W-1003FT
31	1	47.0K	R1	0201	1/20W		Resistors	Panasonic Electronic Components	ERJ-1GEF4702C	P47.0KABCT-ND
32	1	665 ohm	R9	0201	1/20W		Resistors	Panasonic Electronic Components	ERJ-1GEF6650C	P665ABCT-ND
33	1	1.00M	R25	0402	1/16W		Resistors	Vishay Dale	CRCW04021M00FKED	541-1.00MLCT-ND
34	6	10.0K	R23, R24, R27, R28, R38, R39	0402	1/10W		Resistors	Panasonic Electronic Components	ERJ-2RKF1002	P10.0KLCT-ND
35	2	12.0K	R16, R19	0402	1/16W		Resistors	Yageo	RC0402FR-0712KL	311-12.0KLRCT-ND
36	1	178K	R29	0402	1/10W		Resistors	Panasonic Electronic Components	ERJ-2RKF1783X	P178KLCT-ND
37	1	29.4K	R26	0402	1/16W		Resistors	Stackpole	RMCF0402FT29K4	RMCF0402FT29K4CT-ND
38	1	330	R2	0402	±100ppm/°C	1/10W	Resistors	Panasonic Electronic Components	ERJ-2RKF3300X	P330LCT-ND
39	2	36.0K	R15, R18	0402	1/16W	50V	Resistors	Yageo	RC0402FR-0736KL	311-36.0KLRCT-ND
40	2	4.70K	R17, R20	0402	1/16W		Resistors	Vishay Dale	CRCW04024K70FKED	541-4.70KLCT-ND
41	1	665	R12	0402	1/16W	75V	Resistors	Venkel	CR0402-16W-6650FT	CR0402-16W-6650FT
8	1	TPD6E05U06RVZR	U4	14-UFDFN		14V	Circuit Protection	Texas Instruments	TPD6E05U06RVZR	TPD6E05U06RVZR-ND
16	1	220	FB1	0603	2A		Filters	Murata Electronics North America	BLM18EG221SN1D	490-3992-1-ND
19	1	1µH	L1	SMDV3.0X3.0X1.5mm	2.1A		Inductors_Coils_Chokes	Taiyo Yuden	NR3015T1R0N	587-1647-1-ND
25	1	LED - Green Clear	D2	0805	35mcd	2V	Optoelectronics	Lite-On Inc	LTST-C170KGKT	160-1414-1-ND
26	1	LED - Green Clear	D3	0805	35mcd	2V	Optoelectronics	Lite-On Inc	LTST-C170KGKT	160-1414-1-ND
27	1	Green, Red, Yellow	D4	4-PLCC	20mA	1.9V Green, 1.85V Red, 1.9V Yellow	Optoelectronics	Bivar Inc	SMP4-RGY	492-1226-1-ND
14	1	DIODE TVS	D5	SMA	400W	20V	Discrete Semiconductor Products	Littelfuse	SMAJ20A	SMAJ20ADICT-ND
15	1	Single - Schottky	D1	SOD-123F	1A	20V	Discrete Semiconductor Products	ROHM Semiconductor USA, LLC	RB161M-20TR	RB161M-20CT-ND
20	1	HD3SS2522	U1	56-WQFN			Integrated Circuits	Texas Instruments	HD3SS2522	
21	1	TPS2046B	U6	8-SOIC			Integrated Circuits	Texas Instruments	TPS2046B	
22	1	TPS62082DSGT	U7	8-WSON			Integrated Circuits	Texas Instruments	TPS62082DSGT	296-29647-1-ND

Table 3. HD3SS2522 Bill of Materials (continued)

Line #	QTY	Value	Designators	PKG/ Case	T.COEFF/ PWR	Volt Rated	Description	Manufacturer	MFG Part #	DigiKey Part#
23	1	TPS25910RSA	U5	QFN-16			Integrated Circuits	Texas Instruments	TPS25910RSA	TPS25910RSA
24	2	TPD4E05U06DQAR	U2, U3	SON-10			Integrated Circuits	Texas Instruments	TPD4E05U06DQA	
42	1	SPST-NO Off-Mom	SW1	3.00mm x 2.60mm	0.05A	32V	Switches	C&K Components	KMT211NG HF LFS	CKN9433CT-ND
43	1	8 SPST	SW2	8 pos	0.025A	24VDC	Switches	ITT Cannon	TDA08H0SK1	CKN1365-ND
44	3	TESTPOINT TERMINAL	TP1, TP2, TP3	.335"L			Test Equipment	Keystone Electronics	1035	1035K-ND
9	1	4 pos	J1	0.1			Connectors	TE Connectivity	5-104363-3	A32565-ND
10	3	1 X 2	J18, J19, J20	0.1"	High Temp		Connectors	Samtec Inc	HTSW-150-07-G-S	HTSW-150-07-G-S-ND
11	1	1 X 2	J4	1.27MM			Connectors	Sullins Connector Solutions	GRPB501VWVN-RC	S9014E-50-ND
12	1	USB-TYPE C	J3	SMT			Connectors	Foxconn	UT12113-11601-7H	
13	1	USB TYPE A 3.0 R/A	J2	SMT Edge mount			Connectors	Wurth Electronics Inc	692112030100	732-3157-ND
17	1	Closed Top- Shunt	Shunt	0.050"	High Temp		Hardware	Sullins Connector Solutions	NPB02SVAN-RC	S9345-ND
18	1	Shunt	Shunt	0.1" SP	High Temp		Hardware	Kobiconn	151-8000-E	151-8000-E
45	5	DNI	R3, R5, R32, R33, R37	DNI	DNI	DNI	Undefined Category	DNI	DNI	DNI
47	5	DNI	TP5, TP6, TP7, TP8, TP9	DNI	DNI	DNI	Undefined Category	DNI	DNI	DNI

Revision History

Changes from Original (February 2015) to A Revision	Page
• Added *AC Coupling Cap Placement Recommendation* section.	6
• Changed Figure 7 through Figure 9.	8

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

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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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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.

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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