

TUSB8044AEVM User's guide

TI's TUSB8044AEVM evaluation module (EVM) is a functional board design that implements both a USB 3.0 hub and a USB 2.0 hub. The EVM can support both USB SuperSpeed (SS) and USB 2.0 high-speed (HS), full-speed (FS), or low-speed (LS) operation on its USB ports. The EVM enumerates a *Billboard* device on a virtual downstream port for USB Type-C™ applications with alternate mode support. It has an I²C Master controllable through an HID-compliant device enumerated on a virtual downstream port. This EVM is intended for use in evaluating system compatibility, developing optional EEPROM firmware, and validating interoperability. This EVM also acts as a hardware reference design for any implementation of the TUSB8044.

Contents

1	Introduction	2
2	Hardware Overview.....	3
3	Hardware Setup.....	5
Appendix A	TUSB8044AEVM REV D EVM Bill of Materials	7
Appendix B	TUSB8044AEVM REV D EVM Schematics	9

List of Figures

1	TUSB8044AEVM Top Layer Layout	2
2	TUSB8044AEVM REV D EVM Top Layer Layout.....	9
3	USB Port Connections.....	10
4	Power	11

List of Tables

1	Switch Definitions	5
2	TUSB8044A QFN Lab EVM Bill Of Materials: Texas Instruments, CCI and ICP	7

Trademarks

Microsoft, Windows are registered trademarks of Microsoft Corporation.
 USB Type-C is a trademark of USB Implementer's Forum.
 All other trademarks are the property of their respective owners.

1 Introduction

Upon request, layout files for the EVM can be provided to illustrate techniques used to route the differential pairs, use of split power planes, placement of filters and other critical components, and methods used to achieve length matching of critical signals.

NOTE: The EVM accommodates various lab test components; actual production implementations can be much smaller.

Figure 1 illustrates the *TUSB8044AEVM* top layer layout.

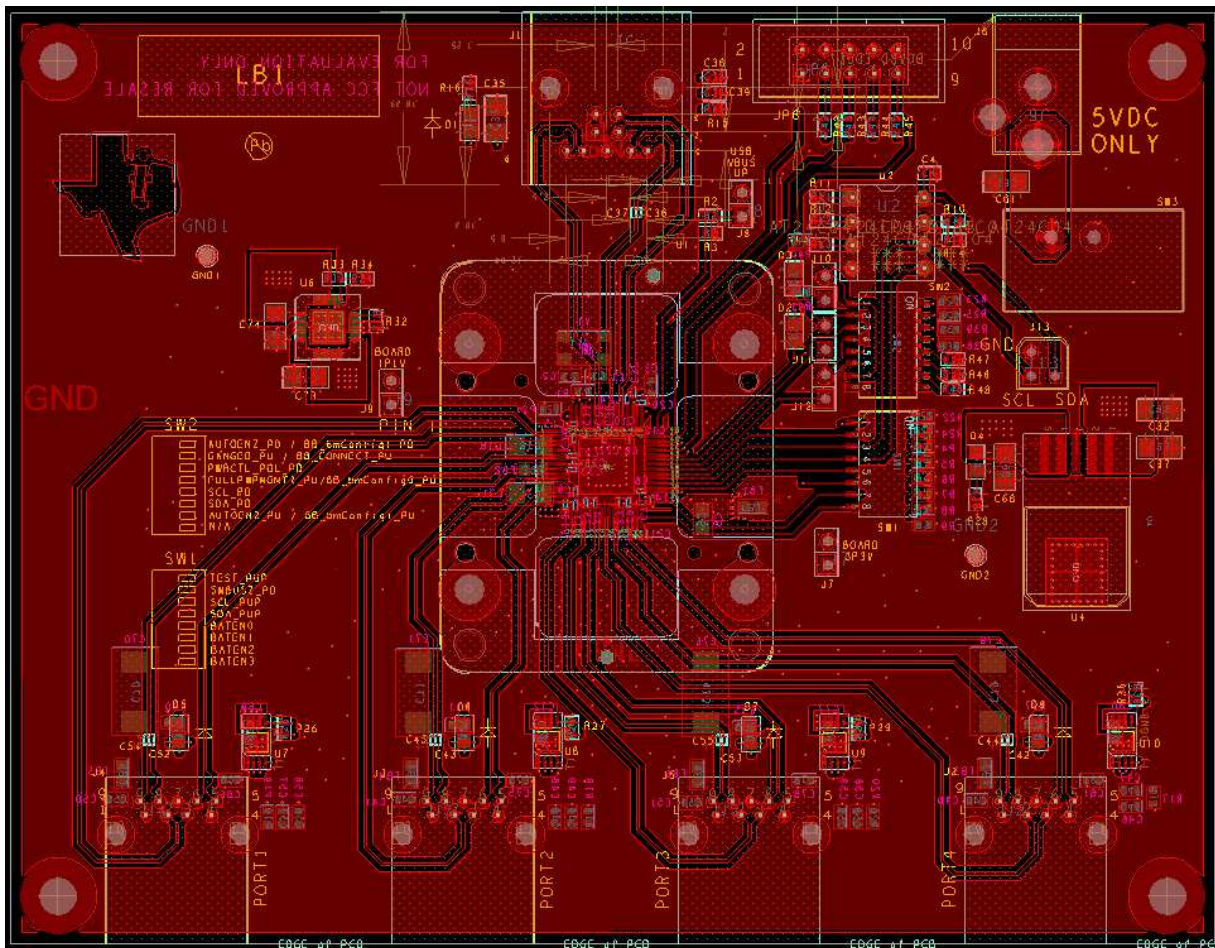


Figure 1. TUSB8044AEVM Top Layer Layout

2 Hardware Overview

The TUSB8044AEVM board hardware can be divided into the following functional areas:

2.1 TUSB8044AEVM

The TUSB8044A on the TUSB8044A EVM (U1 on the schematic) operates as a functional interconnect between an upstream connection to a USB host or hub and up to four directly connected downstream devices or hubs. More devices and hubs can be supported if arranged in tiers. The TUSB8044A is capable of supporting operation at USB SuperSpeed (SS), high speed (HS), full speed (FS), or low speed (LS). In general, the speed of the upstream connection of the TUSB8044AEVM limits the downstream connections to that speed (SS, HS, and FS), or lower.

The TUSB8044A enumerates a *Billboard* device on a virtual downstream port for USB Type-C applications with alternate mode support. It also has an *FC Master* controllable through an HID compliant device enumerated on a virtual downstream port.

The TUSB8044A requires a 24-MHz low-ESR crystal, Y1, with a 1-M Ω feedback resistor. The crystal must be in fundamental mode with a load capacitance of 12 to 24 pF and a frequency stability rating of ± 100 PPM or better. To ensure a proper startup oscillation condition, TI recommends a maximum crystal equivalent series resistance (ESR) of 50 Ω .

The TUSB8044A can also use an oscillator or other clock source. When using an external clock source such as an oscillator, the reference clock must have ± 100 PPM (or better) frequency stability and have less than 50-ps absolute peak-to-peak jitter (or less) than 25-ps peak-to-peak jitter after applying the USB 3.0 jitter transfer function.

2.2 USB Port Connectors

The TUSB8044A EVM is equipped with five standard 9-pin USB 3.0 port connectors. One of these five connectors, J1, is a Type B connector designed to interface with an upstream USB host or hub. The remaining connectors, J2, J3, J4, and J5, are Type A connectors for connection to downstream devices or hubs. Standard size connectors were used on the EVM design, but USB micro connectors can be used, if desired.

The USB ports can be attached through a standard USB cable to any USB 3.0 or legacy USB host, hub, or device. The TUSB8044A will automatically connect to any upstream USB 3.0 host or hub at both SS and HS. Using a legacy USB cable between the TUSB8044A EVM and a USB 3.0 host or hub forces it to HS operation. The same is true if a legacy USB cable is used between the TUSB8044A EVM and a downstream SS-capable device; operation will be limited to USB 2.0 HS.

2.3 USB Port Connector – Power

VBUS is received from the upstream host or hub on J1. The TUSB8044A is configured as a self-powered hub, so there is not any significant current draw by the EVM from VBUS. The TUSB8044A does monitor the VBUS input after filtering through a resistor divider network of a 90.9-k Ω , 1% resistor, R2, and a 10-k Ω , 1% resistor, R3. VBUS cannot be directly connected to the TUSB8044A device. A bulk capacitor of at least 1 μ F is required on the upstream port VBUS input to comply with the USB specification. The TUSB8044AEVM uses a 10- μ F capacitor, C35.

VBUS, sourced by the 5-V wall power input, J6, is provided to the downstream port connectors. The USB 3.0 specification limits the current consumption of a USB 3.0 device to 900 mA at 5 V. The current limiting parameter of the TPS2001C devices, U7, U8, U9, and U10, is 2 A to avoid any spurious overcurrent events due to bus-powered HDD spin-up power fluctuations or unnecessary limiting during USB charging. A production implementation could place stricter limits on this power consumption. An overcurrent event on any of the downstream port connectors will be reported to the TUSB8044A through the OVERCURxZ inputs.

2.4 USB Port Connector – Noise Filtering

Each downstream VBUS output has a 150- μ F bulk capacitor (C70, C71, C76, C79) as recommended by the TPS2001C data manual ([SLVSAU6](#)) to prevent in-rush current events on the downstream devices. In addition, there are ferrite beads and small capacitors on the VBUS lines to reduce noise and address ESD and EMI concerns.

The TUSB8044AEVM also implements optional isolation using two small noise-filtering capacitors and a 1-M Ω resistor between the earth ground of each connector and the digital ground of the EVM; this is not a requirement, but must be used if ground isolation is desired.

NOTE: Note that the series capacitors implemented on the SS TX pairs are incorporated to satisfy the USB 3.0 requirement that differential links be AC coupled on the transmit pair.

2.5 Optional Serial EEPROM

Each TUSB8044AEVM is equipped with an onboard EEPROM or socket placeholder, U2. A small I²C EEPROM can be installed to set the configuration registers as defined in the TUSB8044A data manual ([SLLSEW5](#)). In its default setting, the EVM does not have an EEPROM installed and instead uses the configuration inputs to determine any optional settings of the TUSB8044.

The EEPROM interface defaults to programmable (not write-protected) so that any installed contents on the EEPROM may be modified to test various settings. If an EEPROM data change is required, the values may be changed using the register access methods outlined in the TUSB8044A data sheet. In addition, a Microsoft® Windows® based EEPROM utility is available upon request.

2.6 Power

The TUSB8044A EVM operates from the power provided by a 5-V wall power adapter, J6, not bus power supplied by a USB host. TI recommends to use a wall power adapter that is capable of sourcing 2 to 3 A because the hub must be able to source significant power on its downstream ports (900 mA per port).

The TUSB8044A EVM uses a single-channel LDO voltage regulator to drop 5 V to 3.3 V. The TPS7A4533, U4, is a 1.5-A output linear regulator ([SLVS720](#)). The 1.1-V core voltage required by the TUSB8044A is sourced by the 3.3-V rail to reduce unnecessary heat dissipation. The TPS74801, U6, is a 1.5-A output single channel LDO linear regulator ([SBVS074](#)). Both regulators require few external passive components and are appropriately rated for heat dissipation.

2.7 Hub Configuration

The TUSB8044AEVM can be configured by setting several inputs to the TUSB8044A that are sampled at power-on reset or using an optional serial EEPROM or SMBUS host. A production implementation without EEPROM or SMBUS could either rely on the default internal pullup or pulldown resistor for each configuration input or override it with an external pullup or pulldown resistor. The settings can be modified using SW1 and SW2 on the EVM. Descriptions of the possible configuration changes are included in [Section 3.1](#).

2.8 Optional Circuitry

The TUSB8044A EVM design implements a variety of LEDs, none of which are required by the USB specification. They are provided to make testing and debugging easier.

- D1 – indicates that the upstream USB port power is on
- D4 – indicates that 3.3 V is being applied to the TUSB8044A EVM
- D5 – indicates downstream USB port 1 power is on
- D6 – indicates downstream USB port 2 power is on
- D7 – indicates downstream USB port 3 power is on
- D8 – indicates downstream USB port 4 power is on

The switches (SW1, SW2, and SW3) and headers (J7, J8, J9, JP6) present on the TUSB8044A EVM are intended only for lab evaluation and are not required for production designs.

3 Hardware Setup

3.1 Configuration Switch

The TI TUSB8044AEVM has a set of switches to facilitate configuration changes. TI does not recommend changing these switch settings without a complete understanding of the result. Configuration inputs are only read by the TUSB8044A during power-on reset, changing the switch settings while the EVM is powered on will have no effect. For additional information, refer to the EVM schematic in [Appendix B](#).

The switch definitions are shown in [Table 1](#).

Table 1. Switch Definitions

Switch	Standard	Definition
SW1_1	Off	TEST_TRSTz Switch The TUSB8044A has an internal pulldown on this terminal. If the switch is set to the ON position, the terminal is pulled high and test mode is enabled. This is a production test mode only.
SW1_2	Off	SMBUSz Switch The TUSB8044A has an internal pullup on this terminal, so I ² C interface mode is enabled by default. If the switch is set to the ON position, the terminal is pulled low and SMBUS mode is enabled.
SW1_3	Off	SCL_SMBCLK Switch The TUSB8044A has an internal pulldown on this terminal, so the serial EEPROM or SMBUS interface is disabled. If the switch is set to the ON position, a pullup resistor is connected to the serial clock terminal to indicate that an I ² C EEPROM may be attached (along with a pullup resistor on SDA).
SW1_4	Off	SDA_SMBDAT Switch The TUSB8044A has an internal pulldown on this terminal, so the serial EEPROM or SMBUS interface is disabled. If the switch is set to the ON position, a pullup resistor is connected to the serial clock terminal to indicate that an I ² C EEPROM may be attached (along with a pullup resistor on SCL).
SW1_5	Off	PWRON1_BATEN1 Switch The TUSB8044A has an internal pulldown on this terminal, so USB battery charging mode on Port 1 is disabled by default. If the switch is set to the ON position, the terminal is pulled high and battery charging is enabled on downstream port 1.
SW1_6	Off	PWRON2_BATEN2 Switch The TUSB8044A has an internal pulldown on this terminal, so USB battery charging mode on Port 2 is disabled by default. If the switch is set to the ON position, the terminal is pulled high and battery charging is enabled on downstream port 2.
SW1_7	Off	PWRON3_BATEN3 Switch The TUSB8044A has an internal pulldown on this terminal, so USB battery charging mode on Port 3 is disabled by default. If the switch is set to the ON position, the terminal is pulled high and battery charging is enabled on downstream port 3.
SW1_8	Off	PWRON4_BATEN4 Switch The TUSB8044A has an internal pulldown on this terminal, so USB battery charging mode on Port 4 is disabled by default. If the switch is set to the ON position, the terminal is pulled high and battery charging is enabled on downstream port 4.
SW2_1, SW2_7	Off	AUTOENZ_PD/BB_bmConfig1_PD Switch When configured for I ² C mode, this pin along with BBbmConfigured0 directly controls the bmConfigured field in the <i>Billboard Capability</i> descriptor. If SMBus is selected, then bmConfigured[1] field is determined by a register. If SMBus is selected, the sampled value of this pin will set or clear the autoEnz bit in the <i>Battery Charging Support Register</i> . SMBus master can at a later time override the register. If SMBus is selected and stsOutputEn bit is set, this pin will function as a HS_SUSPEND (upstream HS suspend indicator). When enabled, a value of 1 indicates the connection is suspended.
SW2_2	Off	GANGED_HS_UP/BB_CONNECT Switch When configured for I ² C mode, this pin functions as <i>Billboard Enable</i> . When high, the billboard device is enabled and presented to system. When low, the billboard device is disabled. If SMBus is selected, then <i>Billboard Enable</i> is controlled by a register. If SMBus is selected and stsOutputEn bit is set, this pin will function as a HS_UP (upstream HS connection indicator). When enabled, a value of 1 indicates the upstream port is connected to a HS USB-capable port. If SMBus is selected, the value of the pin is sampled at the de-assertion of reset to set the power switch and overcurrent detection mode as follows: 0 = Individual port power control supported. 1 = Ganged port power control supported. SMBus master can at a later time override the register.
SW2_3	Off	PWRCTL_POL Switch The TUSB8044A has an internal pullup on this terminal, so port power control polarity defaults to active high. If the switch is set to the ON position, the terminal is pulled low and the port power control polarity changes to active low.
SW2_4	Off	FULLPWRMGMTZ_SS_UP/BB_bmConfig0 Switch When configured for I ² C mode, this pin along with BBbmConfigured1 directly controls the bmConfigured field in the <i>Billboard Capability</i> descriptor. If SMBus is selected, then bmConfigured[0] field is determined by a register. If SMBus is selected and battery charging is enabled on any port, the sampled state of this pin will set or clear the FullAutoEn bit in the <i>Device Configuration Register 3</i> . SMBus master can at a later time override the register. If SMBus is selected and battery charging is disabled, then the value of the pin is sampled at the de-assertion of reset to set the power switch control: SMBus master can override this function at a later time. 0 = Power Switching and over current inputs supported. 1 = Power Switch and over current inputs not supported. If SMBus is selected and stsOutputEn bit is set, this pin will function as an SS_UP (upstream SS connection indicator). When enabled, a value of '1' indicates the upstream port is connected to a SuperSpeed USB capable port.

Table 1. Switch Definitions (continued)

Switch	Standard	Definition
SW2_5	Off	SCL_SMBCLK PD Switch The TUSB8044A has an internal pulldown on this terminal, so the serial EEPROM or SMBUS interface is disabled. If the switch is set to the ON position, an external pulldown resistor is connected to the serial clock terminal for test purposes.
SW2_6	Off	SDA_SMBDAT PD Switch The TUSB8044A has an internal pulldown on this terminal, so the serial EEPROM or SMBUS interface is disabled. If the switch is set to the ON position, an external pulldown resistor is connected to the serial clock terminal for test purposes.

3.2 EVM Installation

To install the EVM, perform the following steps:

1. Attach a 5-V, 3-A wall power source to J6.
2. Turn on switch SW3, LED D4 must be lit.
3. Attach a USB cable between J3 and a USB host. LEDs D1, D5, D6, D7 and D8 must be lit.

3.3 Troubleshooting

Case 1: Device function or functions are “banged out” in Device Manager.

- Make sure that the latest updates are installed for the operating system.
- Make sure that the latest drivers are installed for the host controller.

Case 2: The EVM does not work at all.

- Verify that all switches are in their default state and the EVM is powered on with a 5-V source with adequate current to support any bus-powered devices (3 A+).
- If installed, remove the serial EEPROM from the EEPROM socket. The EVM does not require an EEPROM to operate.
- Make sure shunts are installed on J7, J8, and J9.
- In the case where a 12-V power supply has been attached to the EVM, the fault is non-recoverable.

TUSB8044AEVM REV D EVM Bill of Materials

This appendix contains the TUSB8044AEVM REV D EVM BOM.

Table 2. TUSB8044A QFN Lab EVM Bill Of Materials: Texas Instruments, CCI and ICP

Item	Qty	Reference	Part	Manufacturer	Part Number	Pkg	Description
1	1	C5	1uF	Murata	GRM219R61A105KA01D	805	1µF ±10% 10V Ceramic Capacitor X5R 0805 (2012 Metric)
2	1	C3	1uF	Samsung	CL05B105KQ5NQNC	402	CAP CER 1UF 6.3V 10% X7R 0402
3	5	C39,C47,C49,C57,C59	0.001uF	TDK	C1005X7R1H102K	402	CAP CER 1000PF 50V X7R 10% 0402
4	9	C6,C9,C12,C15,C19,C22,C25,C28,C32,	0.001uF	TDK	C0603X7R1E102K030BA	201	CAP CER 1000PF 25V 10% X7R 0201
5	9	C7,C10,C13,C16,C20,C23,C26,C29,C33	0.01uF	Yageo	CC0201KRX7R7BB103	201	CAP CER 10000PF 16V 10% X7R 0201
6	18	C4,C38,C40,C41,C46,C48,C50,C51,C56,C58,C66,C69,C72,C75,C77,C78,C80,C81	0.1uF	Yageo	CC0402KRX5R6BB104	402	CAP CERAMIC .1UF 10V X5R 0402
7	19	C8,C11,C14,C17,C21,C24,C27,C30,C34,C36,C37,C42,C43,C44,C45,C52,C53,C54,C55	0.1uF	TDK	C0603X5R0J104M	201	CAP CER .10UF 6.3V X5R 0201
8	2	C1,C2	18pF	AVX	04025A180JAT2A	402	CAP CERM 18PF 5% 50V NP0 0402
9	9	C18,C31,C35,C61,C67,C68,C73,C74,C82	10uF	Murata Electronics	GRM31CR61C106KA88L	1206	CAPACITOR CERM 10UF 16V 10% SMD
10	4	C70,C71,C76,C79	150uF	Kemet	T495D157K010ATE100 (Tantalum)	7343	CAP TANT 150UF 10V 10% LOESR SMD
11	0	R10,R32,R42,R43,R44,R45	NOPOP			402	
12	6	D1,D4,D5,D6,D7,D8	LED Green 0805	Lite On	LTST-C171GKT	805	LED GREEN CLEAR THIN 0805 SMD
13	0	D2,D3	LED Green 0805 - NOPOP	Lite On	LTST-C171GKT	805	LED GREEN CLEAR THIN 0805 SMD
14	5	FB1,FB3,FB4,FB5,FB6	220 @ 100MHZ Ferrite Bead	Murata	BLM18PG221SN1D	603	FERRITE CHIP 220 OHM 1400MA 0603
15	2	SW1,SW2	8-POS 50-MIL SMT	C&K Components	SD08H0SBR		SWITCH DIP SPST SEALED 8POS SMD
16	1	J1	USB3_TYPEB_C ONNECTOR	Amphenol	GSB321131HR	9_RA_TH_B	CONN RCPT USB 3.0 TYPE B R/A 9PS
17	4	J2,J3,J4,J5	USB3_TYPEA_C ONNECTOR	Amphenol	GSB311131HR	9_RA_TH_A	CONN RCPT USB 3.0 TYPE A R/A 9PS
18	1	J6	2.1mm x 5.5mm DC Power Jack	CUI Inc.	PJ-202AH	2.1mm x 5.5mm	CONN PWR JACK 2.1X5.5MM HIGH CUR
19	6	R1,R15,R17,R18,R19,R20	1M	Rohm Semiconductor	MCR01MZPJ105	402	RES 1.0M OHM 1/16W 5% 0402 SMD
20	1	R2	90.9K 1%	Rohm Semiconductor	MCR01MZPF9092	402	RES 90.9K OHM 1/16W 1% 0402 SMD
21	4	R26,R27,R29,R36	10K	Rohm Semiconductor	MCR01MZPJ103	402	RES 10K OHM 1/16W 5% 0402 SMD
22	1	R3	10K 1%	Rohm Semiconductor	MCR01MZPF1002	402	RES 10K OHM 1/16W 1% 0402 SMD
23	4	R6,R7,R8,R9	4.7K	Rohm Semiconductor	MCR01MZPJ472	402	RES 4.7K OHM 1/16W 5% 0402 SMD

Table 2. TUSB8044A QFN Lab EVM Bill Of Materials: Texas Instruments, CCI and ICP (continued)

Item	Qty	Reference	Part	Manufacturer	Part Number	Pkg	Description
24	15	R4,R5,R11,R12,R13,R14,R22,R23,R24,R25,R38,R39,R46, R47, R48	1K	Rohm Semiconductor	MCR01MZPJ102	402	RES 1.0K OHM 1/16W 5% 0402 SMD
25	8	R16,R28,R30,R31,R35,R37, R40,R41	330	Rohm Semiconductor	MCR01MZPJ331	402	RES 330 OHM 1/16W 5% 0402 SMD
26	1	R33	1.87K	Vishay / Dale	CRCW04021K87FKED	402	RES 1.87K OHM 1/16W 1% 0402 SMD
27	1	R34	4.99K	Vishay / Dale	CRCW04024K99FKED	402	RES 4.99K OHM 1/16W 1% 0402 SMD
28	1	R21	9.53K 1%	Rohm Semiconductor	MCR01MRTF9531	402	RES 9.53K OHM 1/16W 1% 0402 SMD
29	1	U1	TUSB8044A - USB 3.0 Hub	Texas Instruments	TUSB8044AEVM	64QFN	
30	1	U2	AT24C04 I ² C EEPROM	Assmann WSW Components	A 08-LC-TR	8DIP	CONN IC DIP SOCKET 8POS TIN
31	4	U7,U8,U9,U10	TPS2001C	Texas Instruments	TPS2001CDGN	8DGN	IC PWR SW USB 2.87A 1CH 8MSOP
32	1	U4	TPS7A4533 - 3.3V Voltage Regulator	Texas Instruments	TPS7A4533KTT	DDPAK-5	IC REG LDO 3.3V 1.5A 5-DDPAK
33	1	U6	TPS74801RGW - 1.1V Voltage Regulator	Texas Instruments	TPS74801RGW	20VQFN	IC REG LDO ADJ 1.5A 20VQFN
34	1	Y1	ECS-24MHZ Crystal	ECS	ECS-240-20-30B-TR	5.0mm x 3.2mm	CRYSTAL 24.000 MHZ 20PF SMD
35	4		PCB Standoff	Keystone Electronics	2203		HEX STANDOFF 4-40 ALUMINUM 1/2"
36	4		Screw	Keystone Electronics	9900		MACHINE SCREW PAN PHILLIPS 4-40
37	1	FB2	0 ohm	Yageo	RC0603JR-070RL	603	RES 0.0 OHM 1/10W 0603 SMD
38	0	JP6	Conn 2x5 shroud - NO POP	3M	2510-6003UB	HDR5X2 M 0.1" TH	
39	6	J7,J8,J9,J10,J11,J12	Header 1x2	3M	961102-6404-AR	HDR2X1 M 0.1" TH	CONN HEADER VERT SGL 2POS GOLD
40	1	J13	Header 3PIN	3M	961102-6404-AR	HDR2X1 M 0.1" TH	CONN HEADER VERT SGL 2POS GOLD
41	1	SW3	Power Switch - L101011MS02Q	C&K Components	L101011MS02Q	SPST	
42	0	GND1, GND2	NOPOP				
43	1	LB1	sticker	3M	695-WHITE-2"X36YD		add text: TUSB8044AEVM INT077-001 REV A
44	6	Shunt	Shunt	3M	969102-0000-DA		Place shunts on: J7,J8,J9,J10,J11,J12
45	1	PCB BOARDS	TUSB8044AEVM		INT077-001		TUSB8044AEVM PCBBOARD

TUSB8044AEM REV D EVM Schematics

Figure 2 through Figure 4 the TUSB8044AEM REV D EVM schematics.

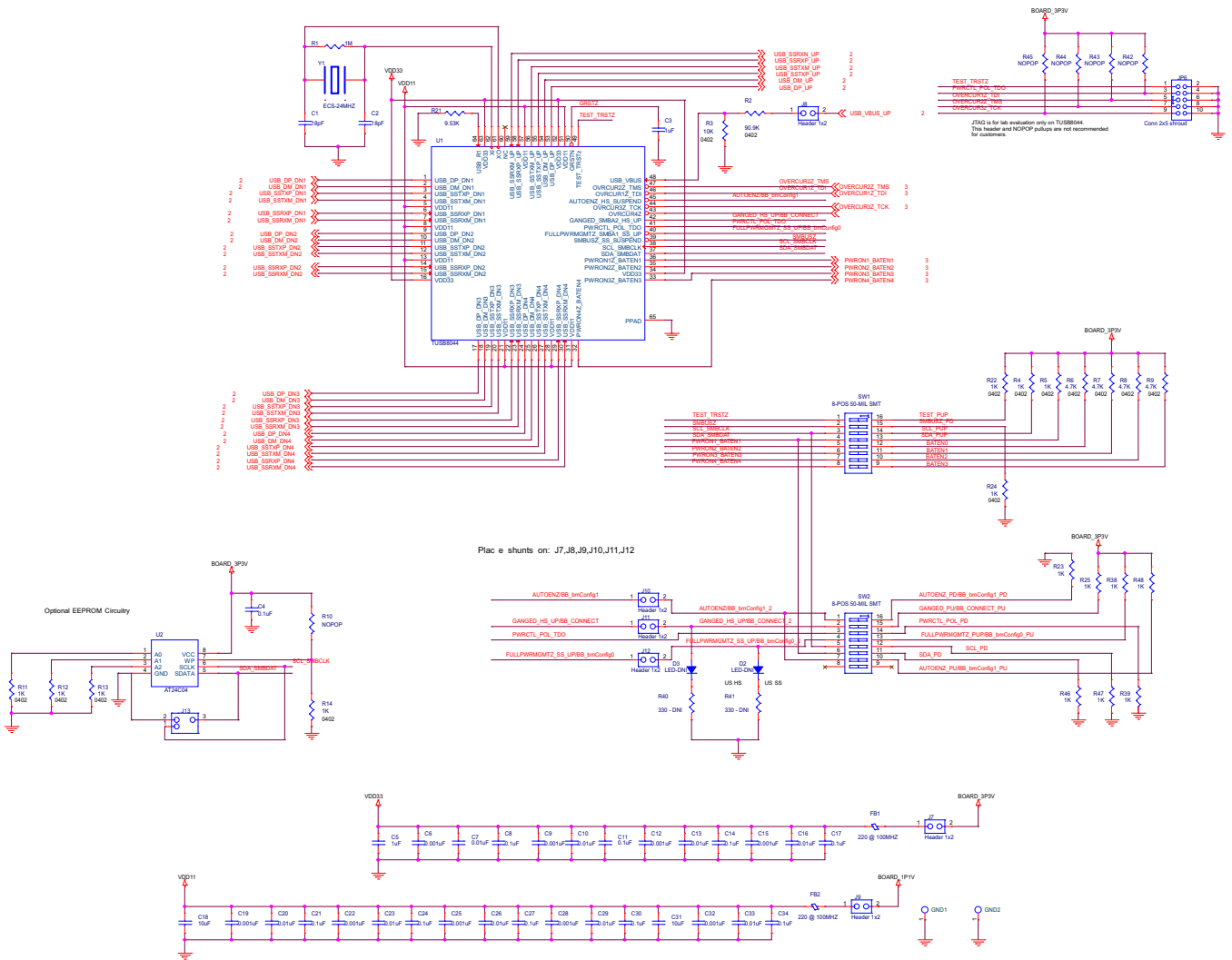
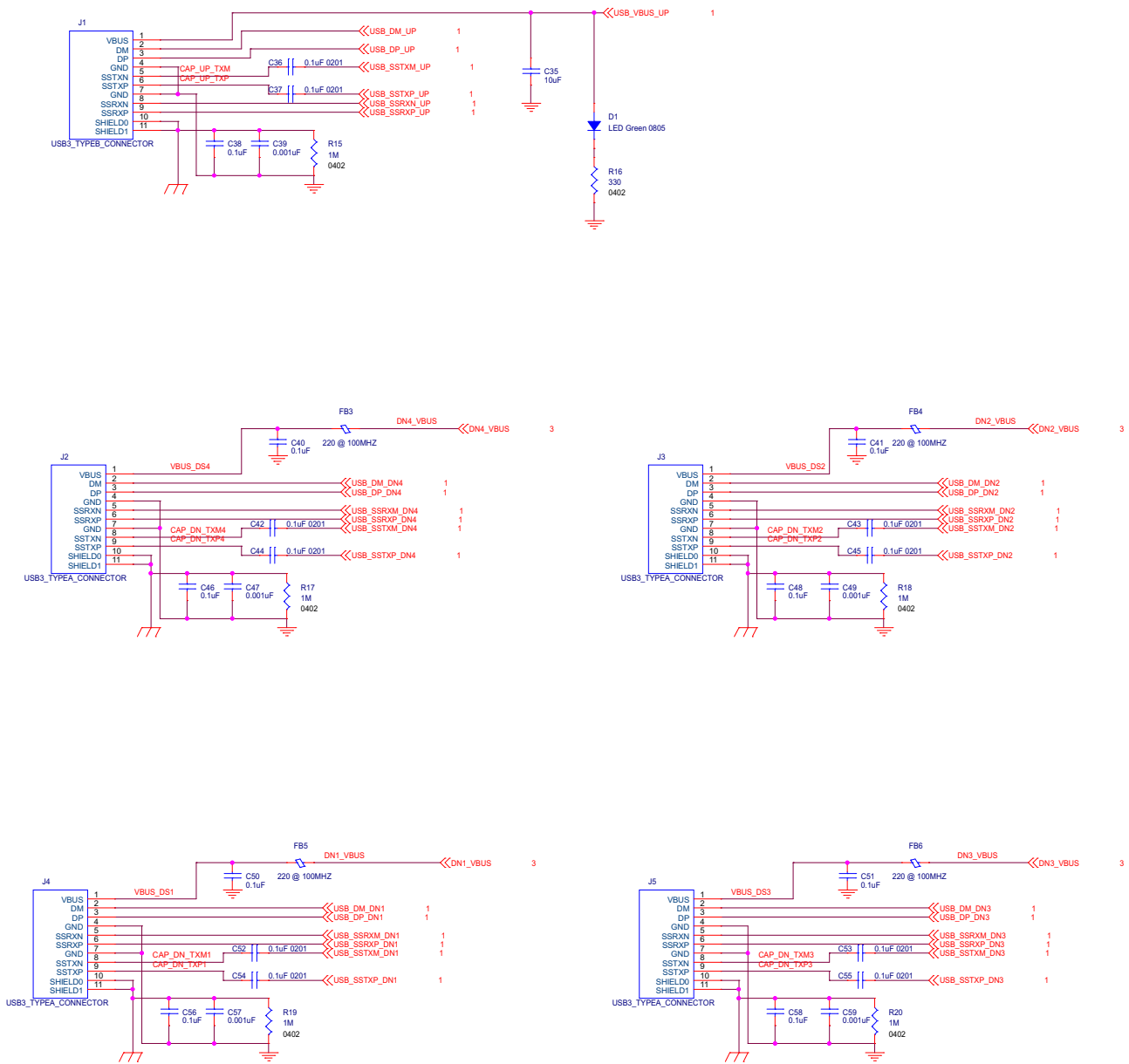
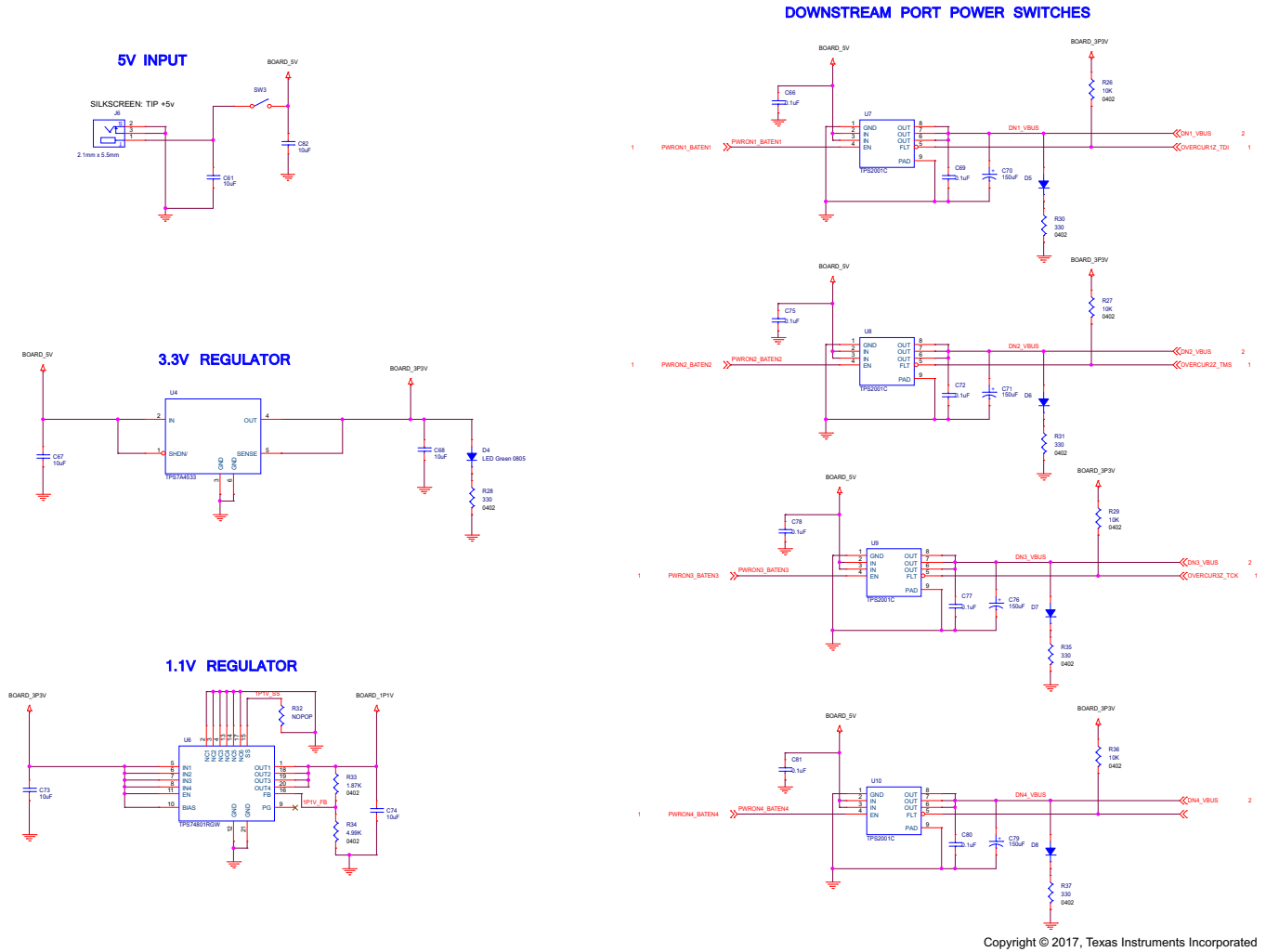


Figure 2. TUSB8044AEM REV D EVM Top Layer Layout



Copyright © 2017, Texas Instruments Incorporated

Figure 3. USB Port Connections



Copyright © 2017, Texas Instruments Incorporated

Figure 4. Power

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 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 semiconductor 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 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 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 a nonconforming EVM if (a) the nonconformity was 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, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, 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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: 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 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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 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

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 to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・インスツルメンツ株式会社
東京都新宿区西新宿 6 丁目 2 4 番 1 号
西新宿三井ビル

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

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

-
- 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.
 6. *Disclaimers:*
 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

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

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated