

TS5USBC402 Evaluation Module

This user's guide describes how to use and configure the TS5USBC402EVM, along with recommendations for system hardware implementation. These recommendations are only guidelines and it is the responsibility of the designer to consider all system characteristics and requirements. Engineers should see the [data sheet](#) for technical details, such as device operation, terminal description, and so on.

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1 Introduction

The TS5USBC40x device is a bidirectional, low-power, dual port, high-speed, USB 2.0, analog switch with integrated protection for Type-C systems. The device is configured as a dual 2:1 or 1:2 switch and is optimized for handling the USB 2.0 D $\pm$ lines in a Type-C system.

The TS5USBC402EVM is a printed-circuit board (PCB) created to help customers evaluate the TS5USBC40x device for Type-C applications.

1.1 Features

The major components of the EVM follow:

- TS5USBC402 board
- Standard Type-C connector (receptacle)
- Standard USB Type-A connector (receptacle)
- DC power regulators

1.2 Applications

- Mobile phones
- Tablets
- PCs/Notebooks
- Devices using a USB type-C or μ USB connector

1.3 Description

Figure 1 shows the TS5USBC402EVM.

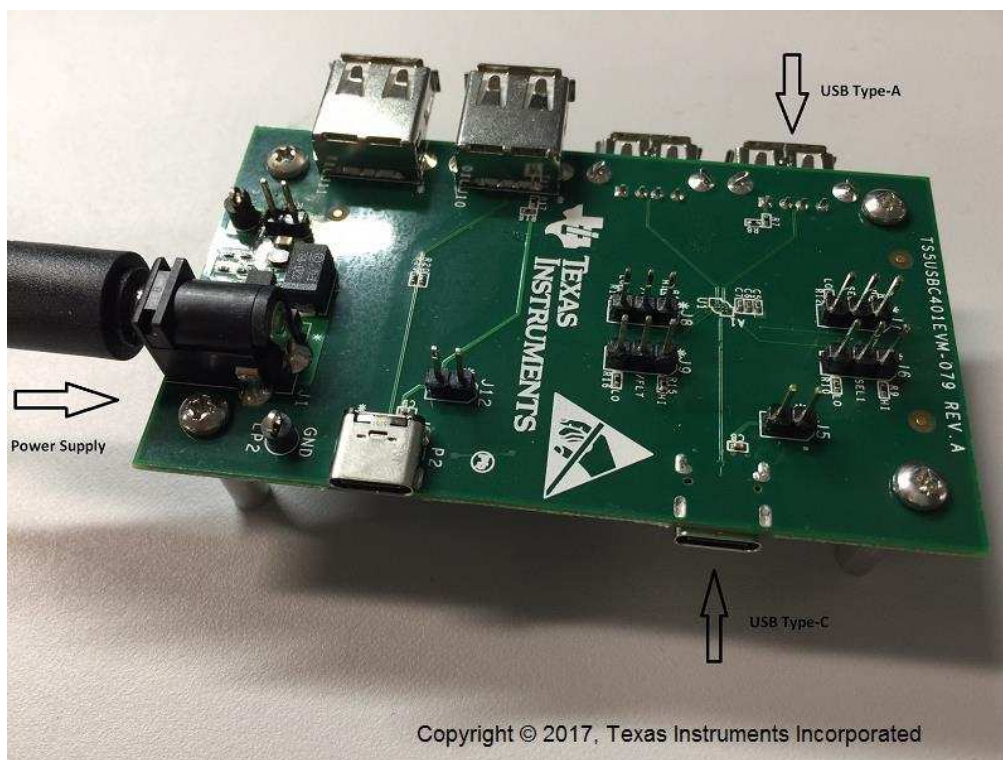
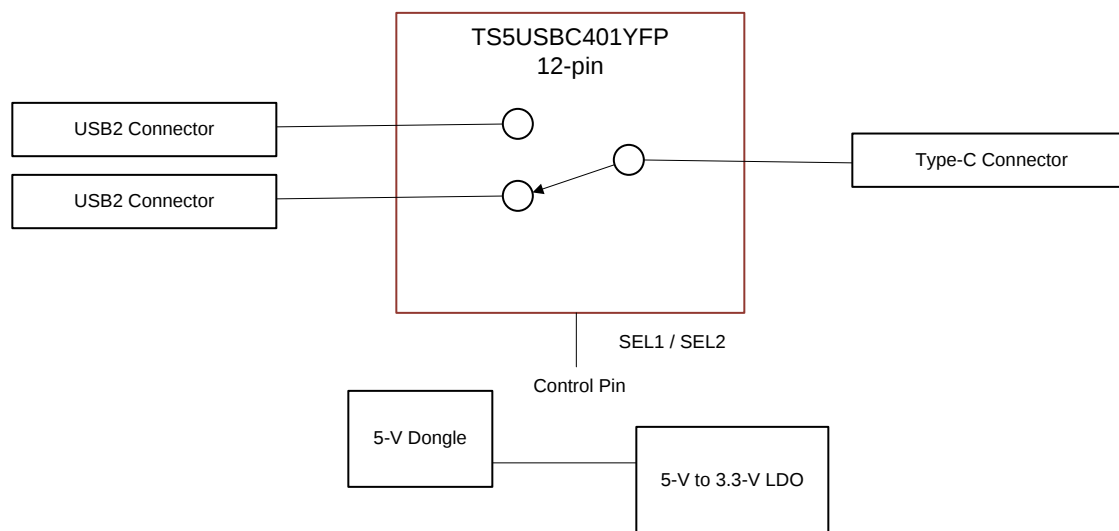


Figure 1. TS5USBC402EVM

1.3.1 Hardware Description

Figure 2 shows the TS5USBC402EVM block diagram.



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Figure 2. TS5USBC402EVM Block Diagram

- USB connectors for TS5USBC40X ports – EVM has a Type-C connector (P1) and two Type-A USB receptacles (J3 and J4).
- Enable – Device is enabled when /OE pin is low.
- Power – DC power jack (J1) to accept a 5-V, wall power adapter is provided on the EVM. The DC power jack (CUI Inc. PJ-202AH) has an inner diameter of 2.1 mm and an outer diameter of 5.5 mm. The tip of the +5-V power supply must be positive. A +5-V power supply of at least 1.5 amps that meets the previously mentioned requirements can be used to power the TS5USBC400EVM. Power is provided to the EVM when J2 is connected.

CAUTION

Do not plug in a power source higher than the configured voltage (5 V).

- Jumper configuration – Jumpers are provided to operate the EVM in different configurations (see [Table 1](#)).

Table 1. Jumpers Setting

DIP Software No.	Signal Name	Description	Default Configuration
J8	/OE	Output enable (active low)	Low
J9	/FLT	Fault indicator output pin (active low)	
J6	SEL1	Switch select	See Table 2
J7	SEL2	Switch select	See Table 2
J2		JP 1-2 for 5-V wall power supply	JP 1-2
		NC to use external power supply	
J5		For V _{BUS} output	

Table 2 lists the function table.

Table 2. Function Table

IOE	SEL1	SEL2	D+ Connection	D- Connection
H	X	X	High-Z	High-Z
L	L	L	D– to D1–	D+ to D1+
L	L	H	D– to D2–	D+ to D2+
L	H	L	D– to D1–	D+ to D1+
L	H	H	D– to D2–	D+ to D2+

2 Test Setup

To get started using the TS5USBC402EVM, follow these steps:

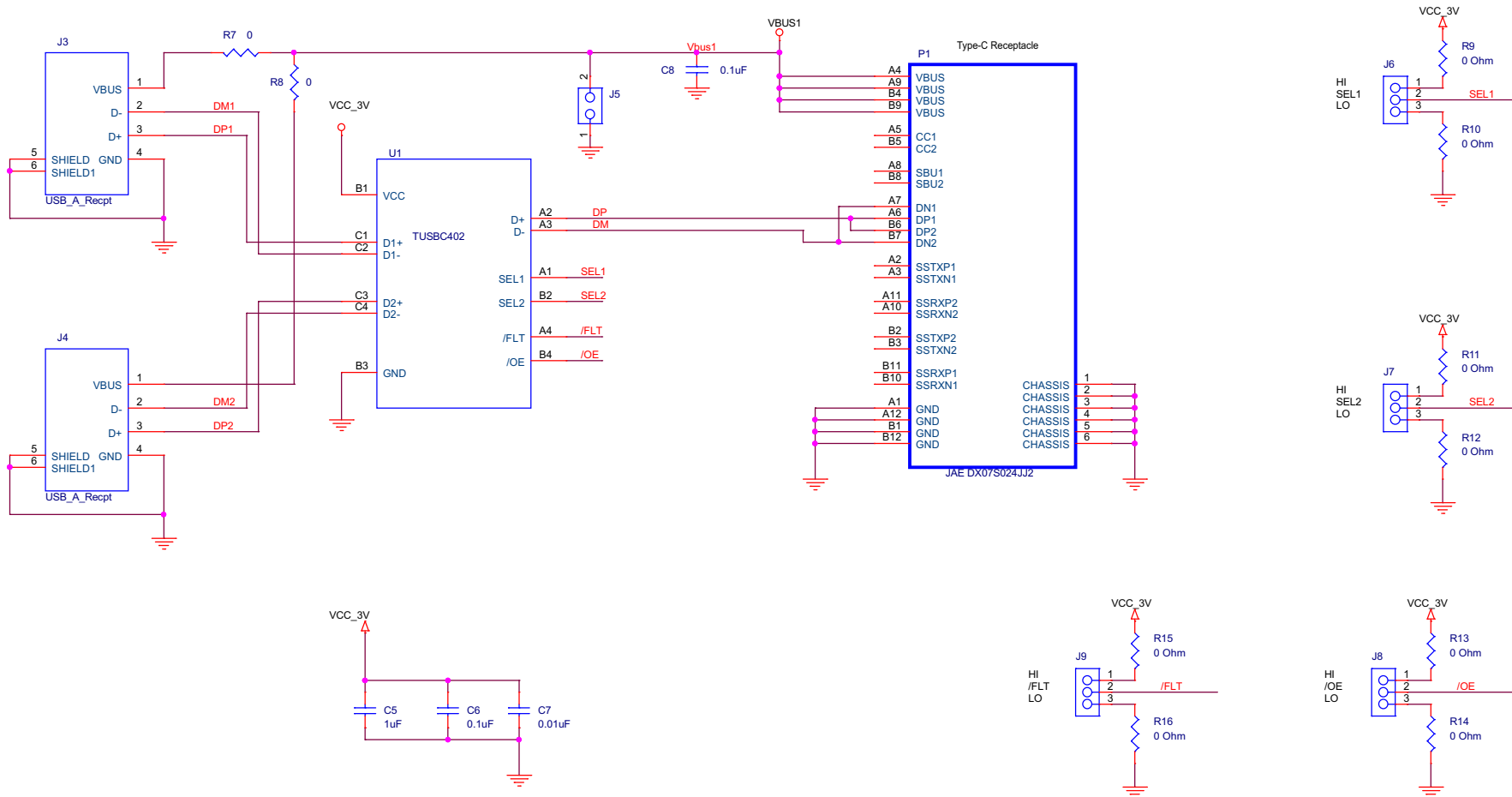
1. Apply 5-V power to the EVM.
2. Plug in a Type-C cable to the P2 connector, and any USB2 Type-A connector of a computer or laptop at P1.
3. Plug in a USB2 flash drive to J3 or J4, based on the SEL1/SEL2 status.

The USB2 flash drive then shows up on the computer.

3 Schematic and Bill of Materials

Figure 3 shows the schematic for the TS5USBC402EVM.

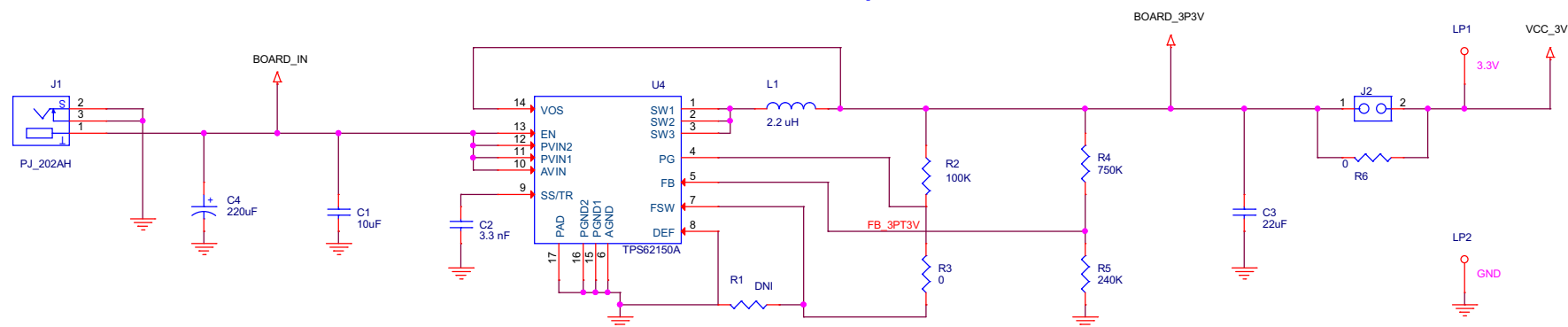
3.1 Schematic



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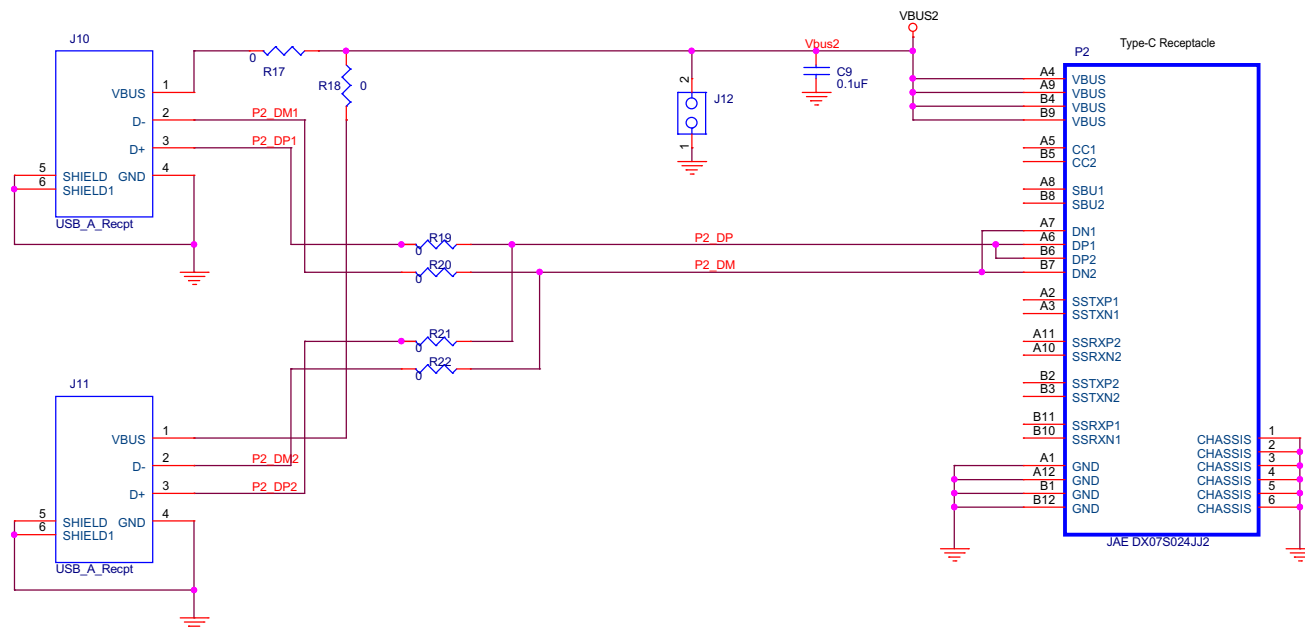
Figure 3. TS5USBC402EVM Schematic

3.3V BUCK REGULATOR - 4V to 17V input



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Figure 4. Buck Regulator



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Figure 5. USB Type-C Receptable

3.2 Bill of Materials

Table 3 lists the BOM for the TS5USBC402EVM.

Table 3. Bill of Materials

Item Number	Quantity	Part Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint	Description
1	1	C1	10 μ F	C0805C106K8PACTU	KEMET	C0805	10 μ F, $\pm$ 10%, 10-V, ceramic capacitor, X5R 0805 (2012 metric)
2	1	C2	3300 pF	GRM155R71H332KA01D	Murata	C0402	3300 pF, $\pm$ 10%, 50-V, ceramic capacitor, X7R 0402 (1005 metric)
3	1	C3	22 μ F	CL21A226MQCLQNC	Samsung	C0805	22 μ F, $\pm$ 20%, 6.3-V, ceramic capacitor, X5R 0805 (2012 metric)

Table 3. Bill of Materials (continued)

Item Number	Quantity	Part Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint	Description
4	1	C4	220 μ F	T491D227M006AT	KEMET	TANT_7343-31	220 μ F, $\pm$ 20%, molded tantalum capacitors, 6.3-V, 2917 (7343 metric) 700 m Ω
5	1	C5	1 μ F	JMK105BJ105KV-F	Taiyo Yuden	C0402	1 μ F, $\pm$ 10%, 6.3-V, ceramic capacitor, X5R 0402 (1005 metric)
6	1	C6	0.1 μ F	0402ZD104KAT2A	AVX	C0402	0.1 μ F, $\pm$ 10%, 10-V, ceramic capacitor, X5R 0402 (1005 metric)
7	1	C7	10000 pF	GRM155R71H103KA88D	Murata	C0402	10000 pF $\pm$ 10%, 50-V, ceramic capacitor, X7R 0402 (1005 Metric)
8	1	C8	0.1 μ F	0402ZD104KAT2A	AVX	C0402	0.1 μ F, $\pm$ 10%, 10-V, ceramic capacitor, X5R 0402 (1005 metric)
9	1	C9	0.1 μ F	0402ZD104KAT2A	AVX	C0402	0.1 μ F, $\pm$ 10%, 10-V ceramic capacitor, X5R 0402 (1005 metric)
10	1	J1	PJ_202AH	PJ-202AH	CUI Inc	PJ-202AH	Power-barrel, connector jack 2.00 mm ID (0.079"), 5.50-mm, OD (0.217") through hole, right angle
11	1	J2	HDR 2 $\times$ 1 M .1	M20-9990246	Harwin Inc	HDR_THVT_1x2_100	Two positions header, cuttable connector 0.100" (2.54 mm) through hole tin
12	1	J3	USB_A_Recept	61400416021	Würth Electronics	USB-A_THRT_61400416021	USB - A USB 2.0 receptacle connector 4 position through hole, right angle
13	1	J4	USB_A_Recept	61400416021	Würth Electronics	USB-A_THRT_61400416021	USB - A USB 2.0 receptacle connector 4 position through hole, right angle
14	1	J5	HDR 2 $\times$ 1 M .1	M20-9990246	Harwin Inc	HDR_THVT_1x2_100	Two positions header, cuttable connector 0.100" (2.54 mm) through hole tin
15	1	J6	HDR 3 $\times$ 1 M .1	61300311121	Würth Electronics	HDR_THVT_1x3_100	Three positions header connector 0.100" (2.54 mm) through hole gold
16	1	J7	HDR 3 $\times$ 1 M .1	61300311121	Würth Electronics	HDR_THVT_1x3_100	Three positions header connector 0.100" (2.54 mm) through hole gold
17	1	J8	HDR 3 $\times$ 1 M .1	61300311121	Würth Electronics	HDR_THVT_1x3_100	Three positions header connector 0.100" (2.54 mm) through hole gold

Table 3. Bill of Materials (continued)

Item Number	Quantity	Part Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint	Description
18	1	J9	HDR3 × 1 M .1	61300311121	Würth Electronics	HDR_THVT_1x3_10 0	Three positions header connector 0.100" (2.54 mm) through hole gold
19	1	J10	USB_A_Re cpt	61400416021	Würth Electronics	USB- A_THRT_61400416 021	USB - A USB 2.0 receptacle connector 4 position through hole, right angle
20	1	J11	USB_A_Re cpt	61400416021	Würth Electronics	USB- A_THRT_61400416 021	USB - A USB 2.0 receptacle connector 4 position through hole, right angle
21	1	J12	HDR 2 × 1 M .1	M20-9990246	Harwin Inc	HDR_THVT_1x2_10 0	Two positions header, cuttable connector 0.100" (2.54 mm) through hole tin
22	1	L1	2.2 µH	SRN2512-2R2M	Bourns Inc	IND_1008	2.2 µH, semi-shielded, wirewound Inductor, 2.3 A, 102 mΩ max 1008 (2520 metric)
23	1	LP1	LP	5005	Keystone Electronics	TP_THVT_5005- 5009	Red PC test point, compact phosphor bronze, silver plating 0.063" (1.60 mm) hole diameter mounting type
24	1	LP2	LP	5006	Keystone Electronics	TP_THVT_5005- 5009	Black PC test point, compact phosphor bronze, silver plating 0.063" (1.60 mm) hole diameter mounting type
25	1	P1	JAE DX07S024 JJ2	DX07S024JJ2R1300	JAE Electronics	USB- C_SMRT_DX07S02 4JJ2	USB - C USB 3.1 (USB 3.1 Generation 2, Superspeed+) receptacle connector 24 position surface mount
26	1	P2	JAE DX07S024 JJ2	DX07S024JJ2R1300	JAE Electronics	USB- C_SMRT_DX07S02 4JJ2	USB - C USB 3.1 (USB 3.1 Generation 2, Superspeed+) receptacle connector 24 position surface mount
27	1	R1	DNI			R0402	
28	1	R2	100 K	RC0402FR-07100KL	Yageo	R0402	100 kΩ ±1% 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
29	1	R3	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
30	1	R4	750 K	RC0402FR-07750KL	Yageo	R0402	750k Ω ±1% 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film

Table 3. Bill of Materials (continued)

Item Number	Quantity	Part Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint	Description
31	1	R5	240 K	RC0402JR-07240KL	Yageo	R0402	240k Ω $\pm$ 5% 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
32	1	R6	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
33	1	R7	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
34	1	R8	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
35	1	R9	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
36	1	R10	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
37	1	R11	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
38	1	R12	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
39	1	R13	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
40	1	R14	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
41	1	R15	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
42	1	R16	0 Ω	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
43	1	R17	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
44	1	R18	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film

Table 3. Bill of Materials (continued)

Item Number	Quantity	Part Reference	Value	Manufacturer Part Number	Manufacturer	PCB Footprint	Description
45	1	R19	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
46	1	R20	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
47	1	R21	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
48	1	R22	0	RC0402JR-070RL	Yageo	R0402	0.0 Ω jumper 0.063W, 1/16W chip resistor 0402 (1005 metric) moisture resistant thick film
49	1	U1	TUSBC402	TS5USBC402YFPR	Texas Instruments	SKT_TI-12G40	
50	1	U4	TPS62150 A	TPS62150ARGTR	Texas Instruments	RGT_QFN-16	3 to 17-V, 1 A, 3-MHz step-down converter with DCS-control in 3x3 QFN package

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 semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms 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.

- 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.

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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:*

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