User's Guide
SLVUBV7–May 2020

TPS25846-Q1 Evaluation Module

This user's guide describes the TPS25846-Q1 evaluation module (TPS25846Q1EVM-117). This document contains the EVM schematics, EVM configuration, bill of materials (BOM), board layout drawing, and assembly drawing.

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Trademarks

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1 Introduction

The TPS25846Q1EVM-117 is an evaluation module (EVM) for TI's TPS25846-Q1 USB BC1.2 5-V, 3.5-A output, 36-V input synchronous buck with cable compensation. The EVM operates over a range from 6 V to 36 V and provides USB type A connectors to evaluate USB BC1.2 and USB2.0 data communication functions. The value of cable compensation, current limit, and switching frequency can be adjusted by resistors on the EVM.

1.1 Features

The following features are available on this EVM:

- 6-V to 36-V input range, 3.5-A continuous output current buck converter
- Forced PWM operation with spread-spectrum dithering
- Fully AEC-Q100 qualified
- ±8% Current sense accuracy (I_{OUT} > 1.5 A) for precision cable droop compensation
- USB battery charging specification Rev. 1.2 compliant
- D+ and D– Short-to-VBAT, and VBUS protection
- User-programmable VBUS current limit

1.2 Applications

The EVM is used in the following applications:

- Automotive: Infotainment, USB hubs, aftermarket USB chargers

2 Test Setup and Results

Figure 1 shows the EVM board. Connect J1 to the 13.5-V power supply. Connect USB Type-A device to J3 connector.

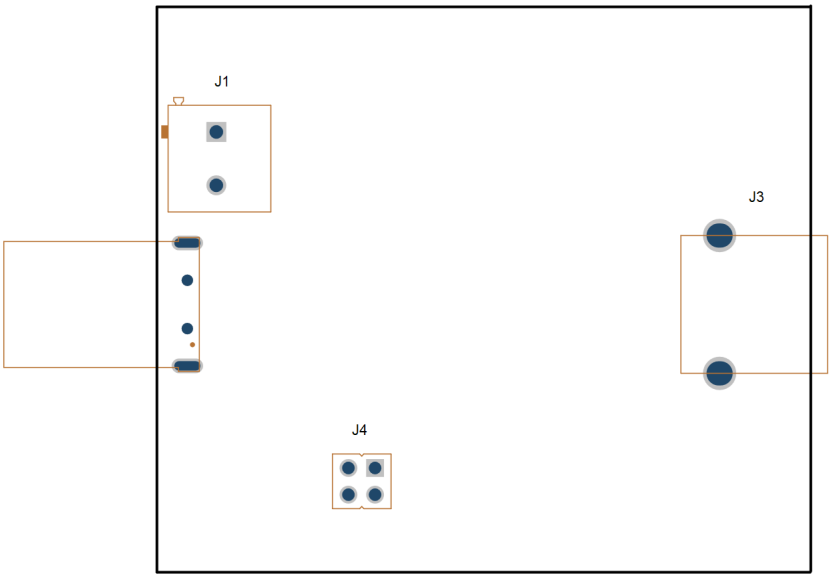

Figure 1. EVM Setup for Charging USB Type-A Device

2.1 Physical Access

Table 1 lists the TPS25846Q1EVM-117 connector functionality, Table 2 describes the jumper configuration, Table 3 shows LED labels and description, and Table 4 describes the test point availability.

Table 1. Connectors

Connector	Component Type	Description
J1	Terminal block	Power input connector for TPS25846-Q1. Connect to a 6-V to 36-V power supply.
J2	USB Type-A connector, plug	Upstream facing USB 2.0 Type A connector. Connect to the USB 2.0 host for data pass through to J7. The power pin of this connector is float.
J3	USB Type-A connector, receptacle	Downstream facing USB Type-A connector. Connect to the USB Type-A slave for data pass through from J2 and BC1.2 identification.

Table 2. Jumpers

Jumper	Label	Description
J4	CTRL1	Install shunt to select CTRL1 as LOW. Remove shunt to select CTRL1 as HIGH.
	CTRL2	Install shunt to select CTRL2 as LOW. Remove shunt to select CTRL2 as HIGH.

Table 3. LED

LED	Label	Description
D2	FAULT	FAULT signal LED. Turn on when FAULT asserts.

Table 4. Test Points

Test Point	Label	Description
TP1	VCC	VCC pin test point via R1
TP2	CSN(VOUT)	CSN pin test point and DC/DC output test point
TP3	CSP	Test point of CSP pin
TP4	VIN	VIN pin test point
TP5	EN	EN pin test point or external EN input
TP6	RT	RT pin test point or external clock input
TP7	VBUS	USB Type-A VBUS test point
TP8, TP9,TP10,TP11	GND	Power ground test point
TP12	FLT	FAULT pin test point

3 Board Layout

Figure 2 and Figure 3 show the top and bottom assembly. Figure 4 to Figure 7 show the layout of the EVM.

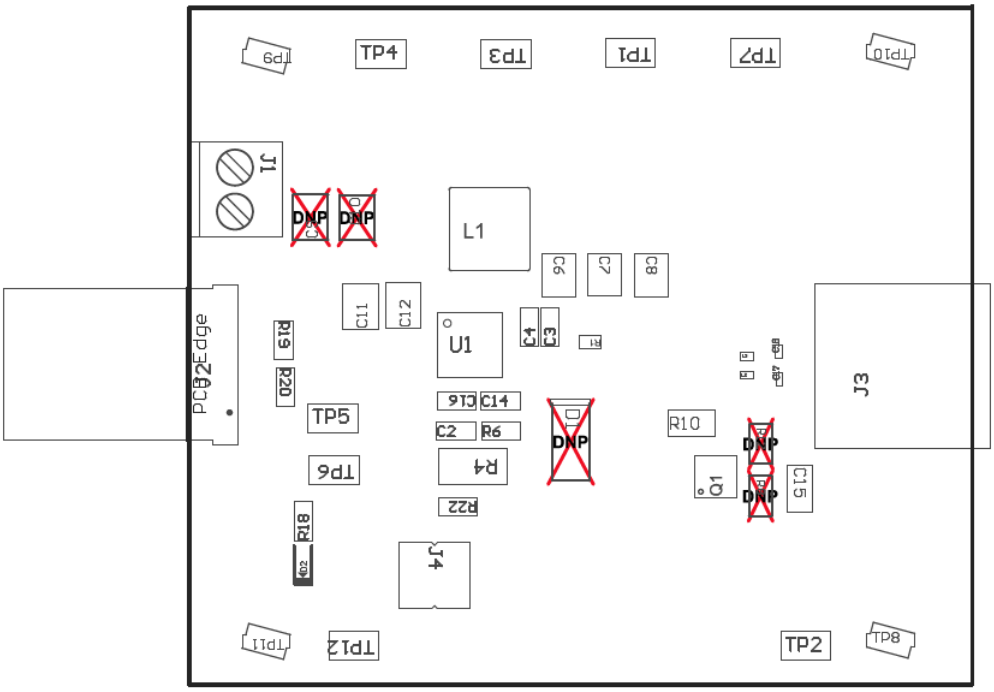

Figure 2. Top Side Assembly

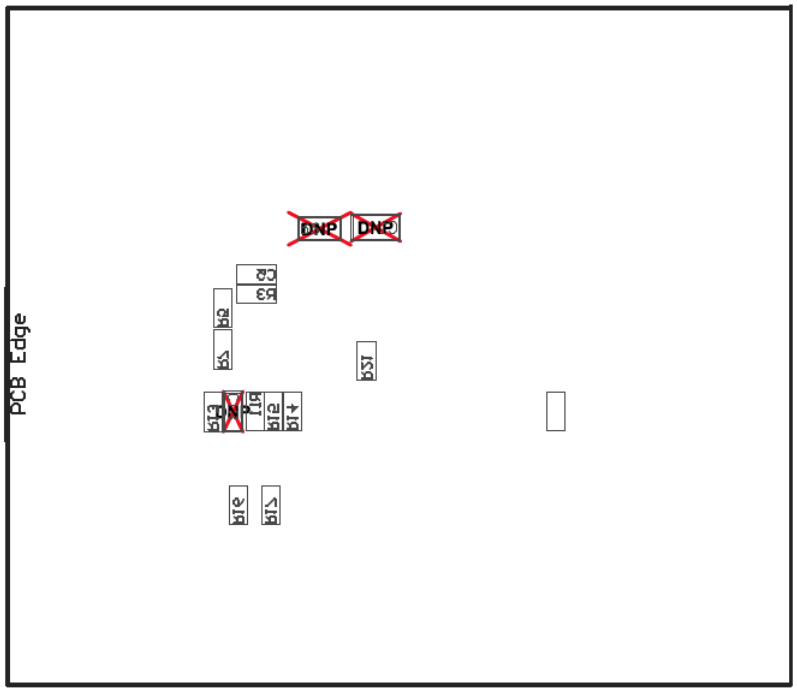

Figure 3. Bottom Side Assembly

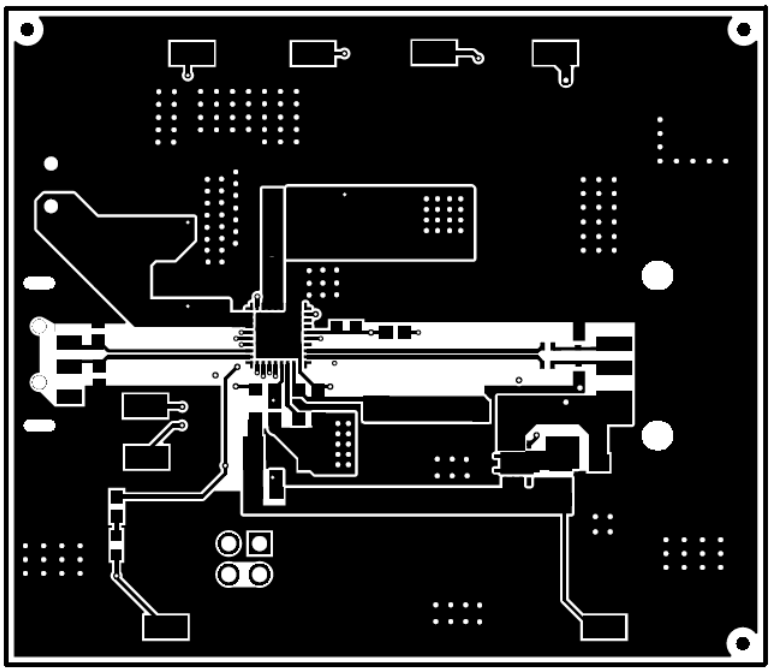

Figure 4. Top Layer Layout

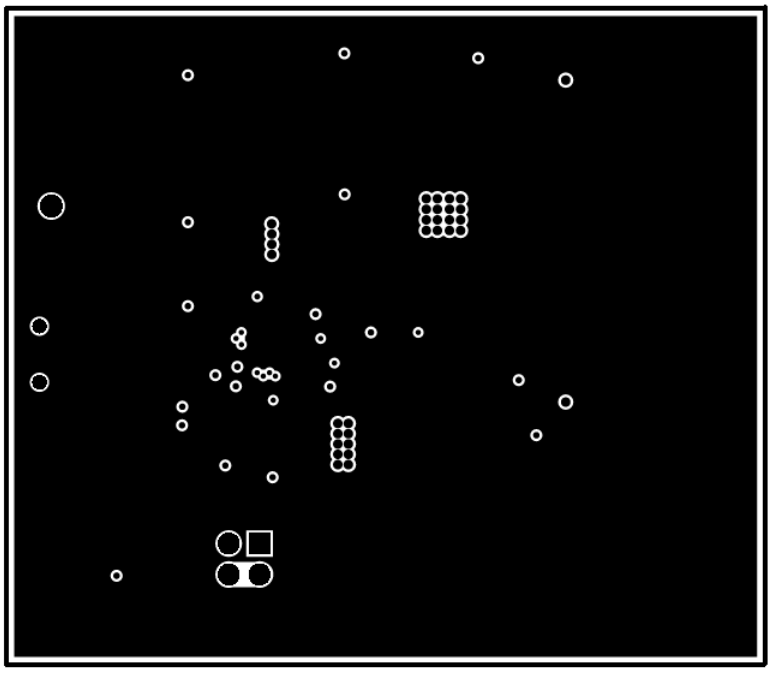

Figure 5. Middle Layer 1 Layout

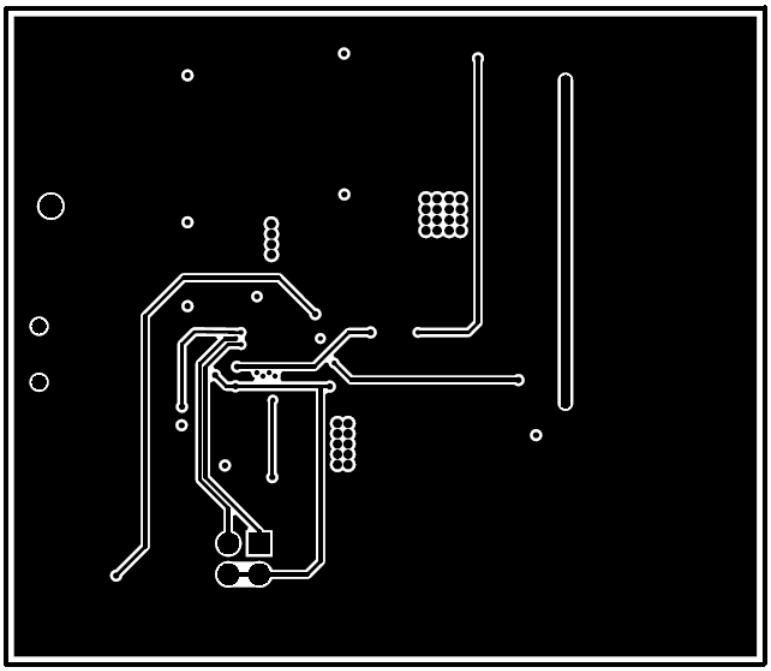

Figure 6. Middle Layer 2 Layout

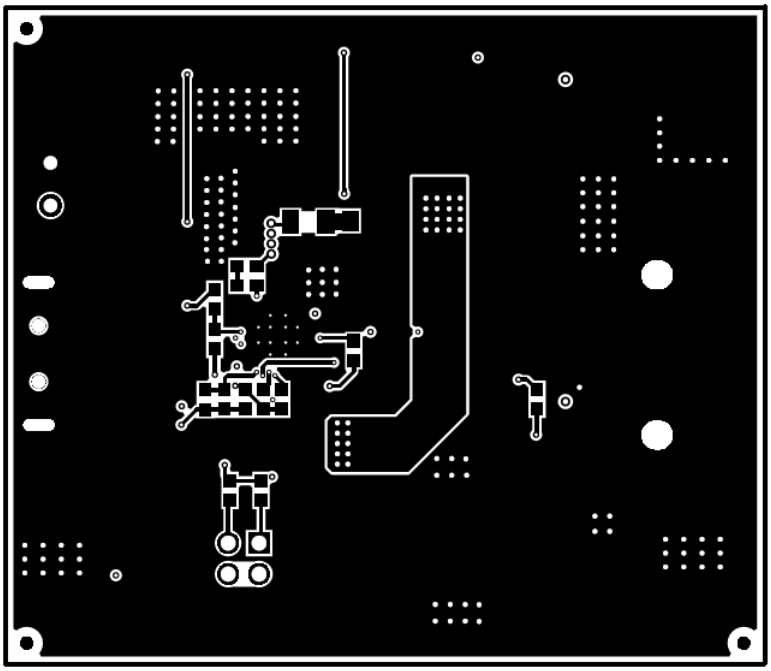

Figure 7. Bottom Layer Layout

4 Schematic and Bill of Materials

4.1 Schematic

Figure 8 illustrates the EVM schematic.

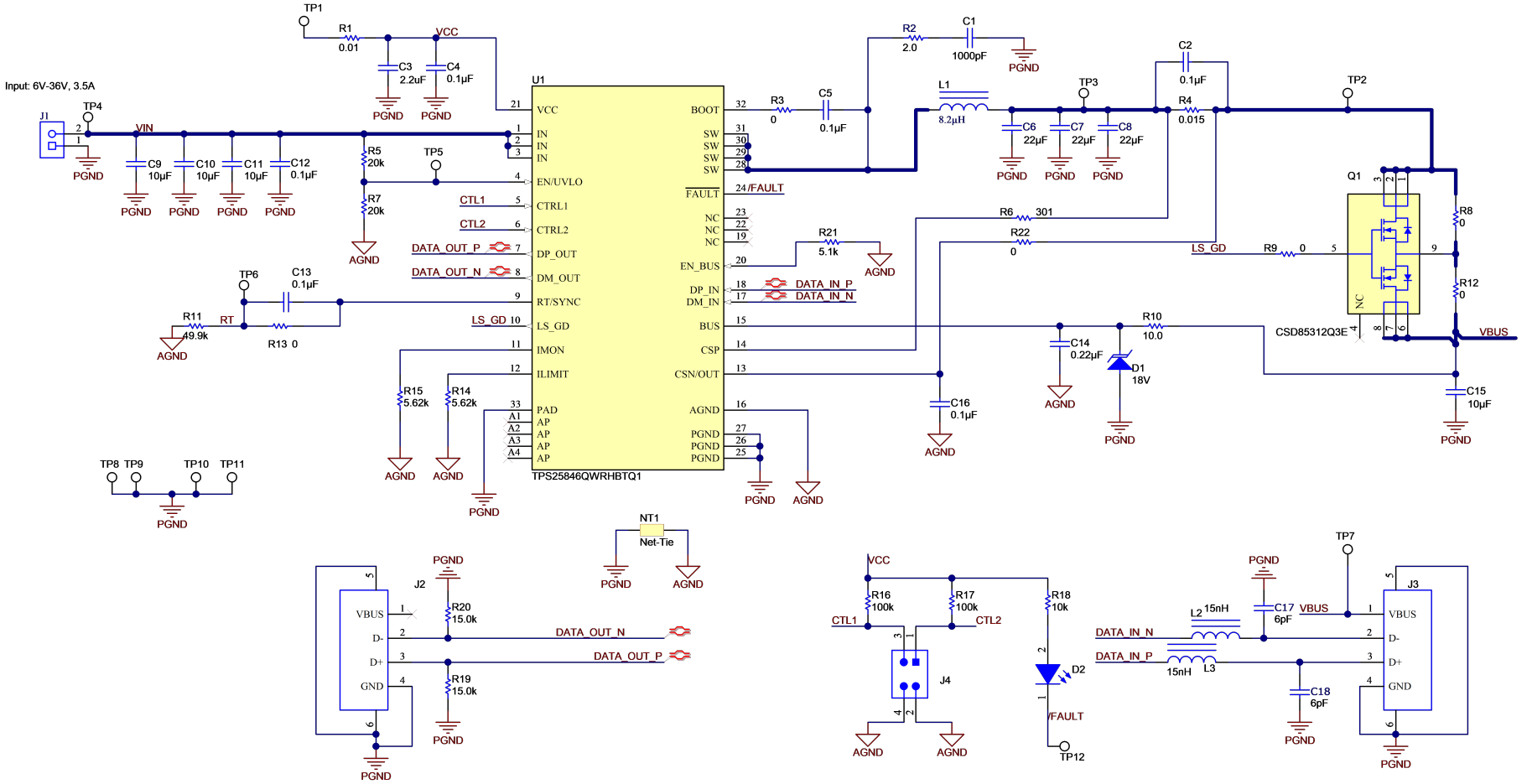

Figure 8. TPS25846Q1EVM-117 Schematic

4.2 Bill of Materials

Table 5 shows the EVM bill of materials.

Table 5. Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board	PSIL117		Any
C2, C4, C5, C16	4	0.1uF	CAP, CERM, 0.1 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	C0603C104K5RACAUTO	Kemet
C3	1	2.2uF	CAP, CERM, 2.2 uF, 16 V, ±20%, X5R, 0603	0603	885012106018	Wurth Elektronik
C6, C7, C8	3	22uF	CAP, CERM, 22 µF, 25 V, ±10%, X7R, 1210	1210	CL32B226KAJNFNE	Samsung Electro-Mechanics
C11	1	10uF	CAP, CERM, 10 µF, 50 V, ±20%, X7R, AEC-Q200 Grade 1, 1210	1210	UMJ325KB7106MMHP	Taiyo Yuden
C12	1	0.1uF	CAP, CERM, 0.1 µF, 50 V, ±5%, C0G/NP0, 1210	1210	C3225C0G1H104J250AA	TDK
C14	1	0.22uF	CAP, CERM, 0.22 µF, 16 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	CL10B224KO8VPNC	Samsung
C15	1	10uF	CAP, CERM, 10 µF, 16 V, ±10%, X6S, 0805	0805	GRM21BC81C106KA73L	MuRata
C17,C18	2	6pF	6pF ±0.5pF 50V Ceramic Capacitor C0G,NP0 0402 (1005 Metric)	0402	'GCM1555C1H6R0DA16J	MuRata
D2	1	Super Red	LED, Super Red, SMD	LED_0603	150060SS75000	Wurth Elektronik
J1	1		Terminal Block, 5.08 mm, 2x1, TH	2POS Terminal Block	1715721	Phoenix Contact
J2	1		Connector, Plug, USB Type A, R/A, Top Mount SMT	USB 2.0, SMT Plug, 18.65x4.5x12mm	931	Keystone
J3	1		Connector, Receptacle, USB TYPE A, R/A, Top Mount SMT	USB TYPE A CONNECTOR RECEPTACLE 4POS SMD	896-43-004-00-000000	Mill-Max
J4	1		Header, 2.54mm, 2x2, Gold, TH	Header, 2.54mm, 2x2, TH	PBC02DAAN	Sullins Connector Solutions
L1	1	8.2uH	'Inductor, Shielded, Hyperflux, 8.2 µH, 5.3 A, 0.0253 ohm, SMD	8.8x8.3mm	'74439346082	Wurth Elektronik
L2,L3	2	15nH	'LQG15WZ15NG02D	0402	'LQG15WZ15NG02D	'MuRata
Q1	1	20V	MOSFET, 2-CH, N-CH, 20 V, 12 A, DPA0008A (VSON-8)	DPA0008A	CSD85312Q3E	Texas Instruments
R1	1	0.01	RES, 0.01, 1%, 0.1 W, 0603	0603	WSL0603R0100FEA	Vishay-Dale
R3, R9, R13	3	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc
R4	1	0.015	RES, 0.015, 1%, 0.5 W, 2010	2010	WSL2010R0150FEA	Vishay-Dale
R5, R7	2	20k	RES, 20 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060320K0JNEA	Vishay-Dale
R6	1	301	RES, 301, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603301RFKEA	Vishay-Dale
R10	1	10.0	RES, 10.0, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW080510R0FKEA	Vishay-Dale
R11	1	49.9k	RES, 49.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060349K9FKEA	Vishay-Dale
R14, R15	2	5.62k	RES, 5.62 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06035K62FKEA	Vishay-Dale
R16, R17	2	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R18	1	10k	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0JNEA	Vishay-Dale
R19, R20	2	15k	RES, 15.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060315K0FKEA	Vishay-Dale
R21	1	5.1k	RES, 5.1 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06035K10JNEA	Vishay-Dale
SH-J1	1		Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black	60900213421	Wurth Elektronik

Table 5. Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP12	8		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
TP8, TP9, TP10, TP11	4		Test Point, Compact, SMT	Testpoint_Keystone_Compact	50156	Keystone
U1	1		USB Type-A BC1.2 5-V 3.5-A Output, 36-V Input Synchronous Buck With Cable Compensation, RHB0032R (VQFN-32)	RHB0032R	TPS25846QWRHBTQ1	Texas Instruments
C1	0	1000pF	CAP, CERM, 1000 pF, 100 V, ±10%, X7R, 0805	0805	C0805C102K1RACTU	Kemet
C9, C10	0	10uF	CAP, CERM, 10 µF, 50 V, ±20%, X7R, AEC-Q200 Grade 1, 1210	1210	UMJ325KB7106MMHP	Taiyo Yuden
C13	0	0.1uF	CAP, CERM, 0.1 µF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 0603	0603	C0603C104K5RACAUTO	Kemet
D1	0	18V	Diode, TVS, Uni, 18 V, 29.2 Vc, 400 W, 13.7 A, AEC-Q101, SMA	SMA	SZ1SMA18AT3G	Littelfuse
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R2	0	2.0	RES, 2.0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW12062R00JNEA	Vishay-Dale
R8, R12	0	0	RES, 0, 1%, 0.5 W, 1206	1206	5108	Keystone

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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 DEGREDATION 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/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 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:*

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.

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