TPS65257 High Current, Synchronous Step Down Three Buck Switcher Evaluation Module with 1USB Switch and Push Button Controller

This document presents the information required to power the TPS65257 PMIC as well as the support documentation including schematic and bill of materials.

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1 Background and EVM Limitations

The TPS65257 PMIC is designed to provide 3A, 2A, and 2 A continuous outputs with an operational range of 4.5 to 16V and a externally set switching frequency ranging from 300kHz to 2.2MHz, with automatic PFM/PWM operation . When the PMIC is not fully loaded, buck1 can be loaded to 3.5A and buck 2 and 3 to 2.5A. The device also features two USB distribution switches.

As there are many possible options to set the converters, table 1 presents the performance specification summary for the EVM.

Table 1. Input Voltage and Output Current Summary

Evaluation Module	Test Conditions	Output Current Range
TPS65257EVM	Vin = 4.5 V to 15 V Fsw = 500 KHz	Buck1, 1.2 V, 3A Buck2, 1.8 V, 3A Buck3, 3.3 V, 3A (25°C ambient)

This evaluation module is designed to provide access to the features of the TPS65257. Some modifications can be made to this module to test performance at different input and output voltages, current and frequency operation. Please contact TI Field Applications Group for advice on these matters.

2 Power-up Procedure

1. 1. Define which converters are to be enabled or disabled by connecting jumpers to JP3, JP11 and JP20 accordingly, or to wiring external drive signals to the ENx headers.
2. If PGOOD signal is required connect JP27 or wire the PGOOD pin to a pull-up supply.
3. Define the strategy to enable the USB switch, either with A jumper or external drive signals to the USBEN pin.
4. If USBx_nFAULT signal is required connect J35 jumpers or wire the alarms pin to a pull-up supply.
5. Connect loads to the output connectors.
6. Apply a DC voltage to header J3. Polarity is marked on the silk-screen. No output will be enabled.
7. Press push button S5. Converters will start according to the setting on JP3, JP11 and JP20. Check the outputs.
8. Once operating the converters can be enabled/disabled by applying the correct setting for the JP3, JP11, and JP20 headers
9. To power off all the rails, press push button S5 again. You can monitor the INT pin being asserted and the rails power down 1s afterwards.
10. To power the USB switches apply a DC voltage to JP4 and JP5. Enable the switches with JP5 and JP34. Check the outputs.

3 TPS65258EVM Schematic

The resistor and capacitor values have been chosen according to the guidelines presented on the TPS65257 spec that will be available at

http://focus.ti.com/docs/prod/folders/print/TPS65257.html

Note that for the purpose of gains-phase measurements R14, R17 and R37 (zero ohm on the EVM) need to be replaced by suitable low value resistors as per the network analyzer setup required. Test points connections are provided on either end of the resistors to allow for easy measurement. Also note that

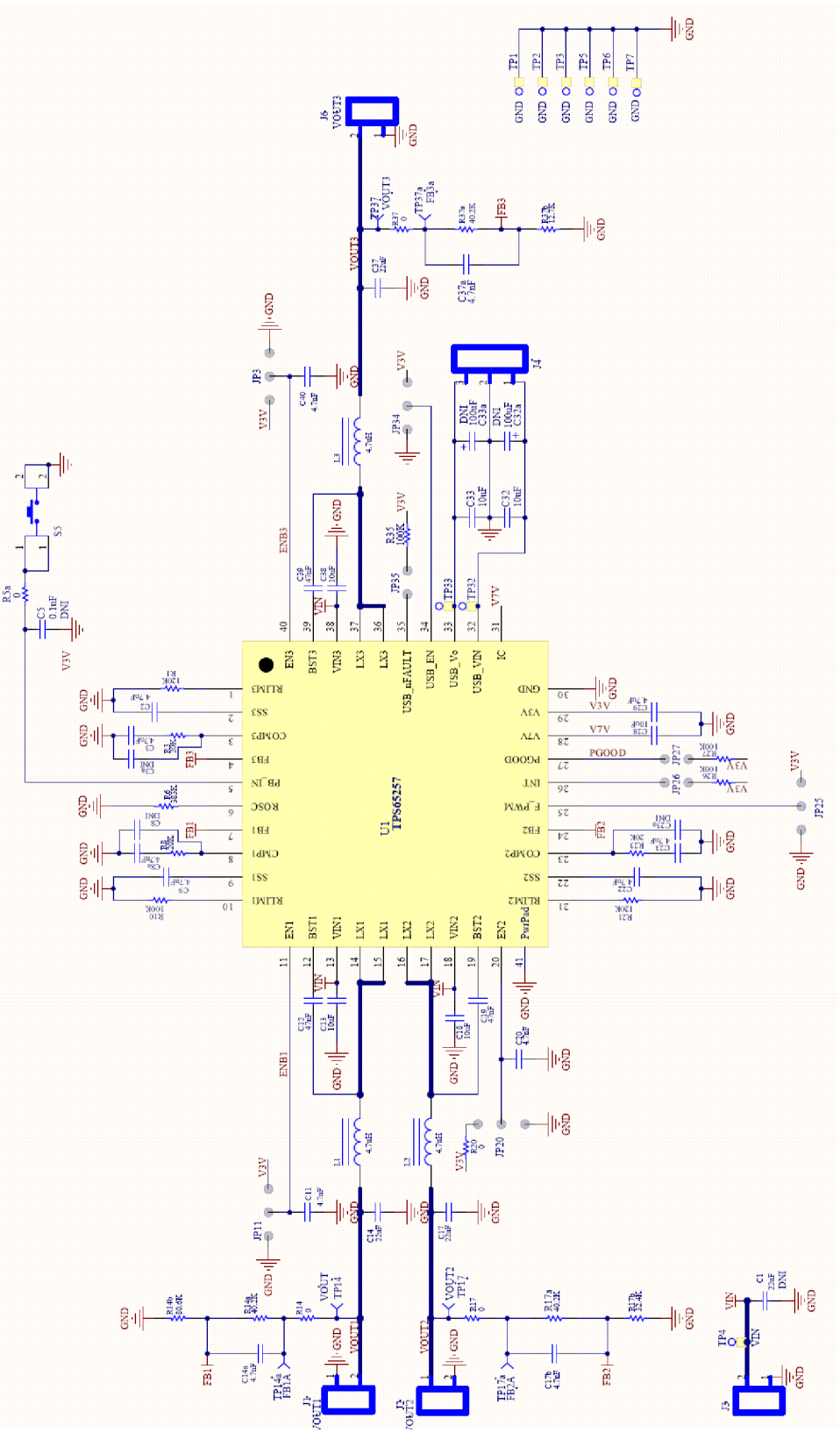


Figure 1. TPS65258EVM Schematic

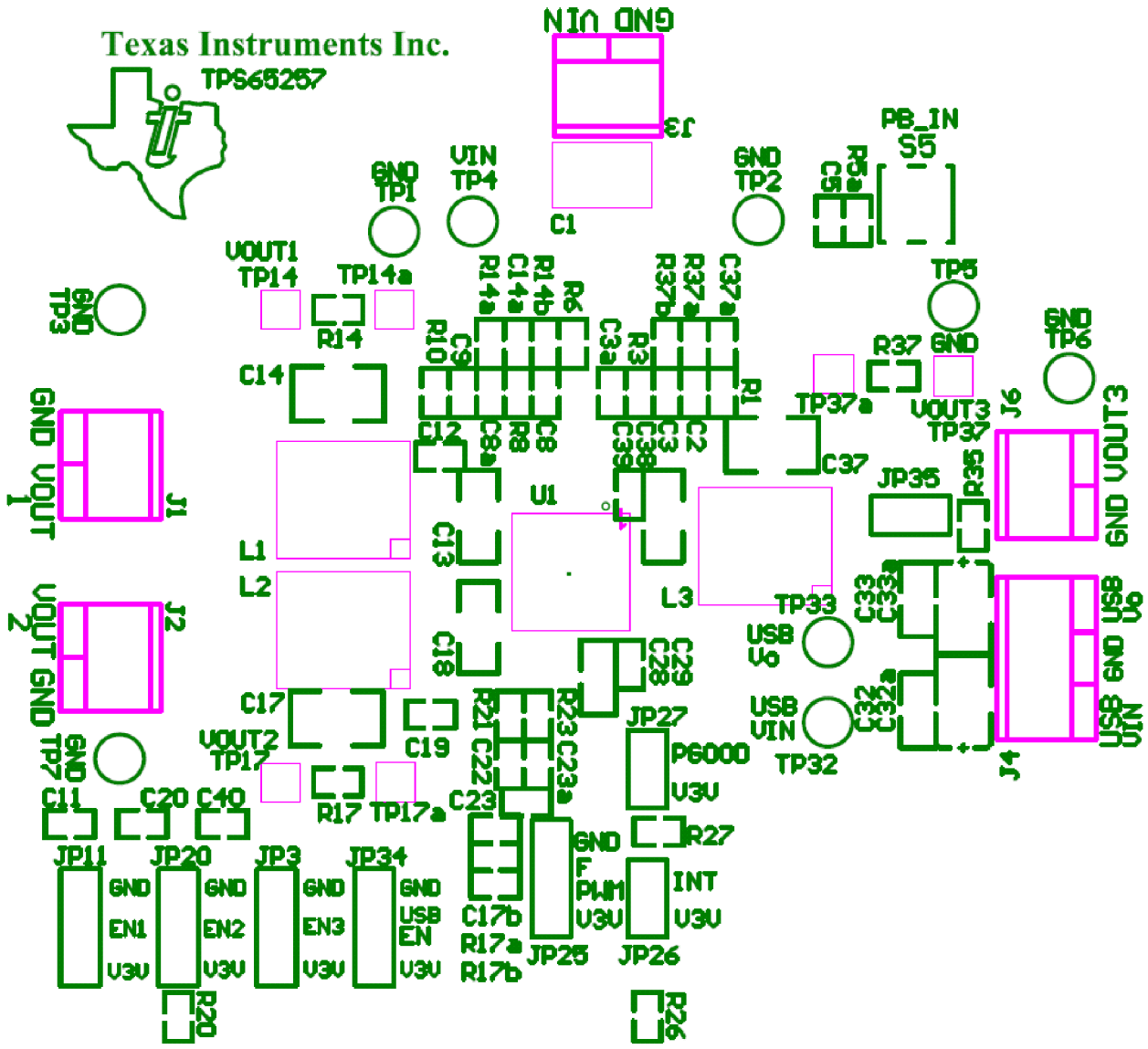


Figure 2. Composite Layer

4 EVM Layout

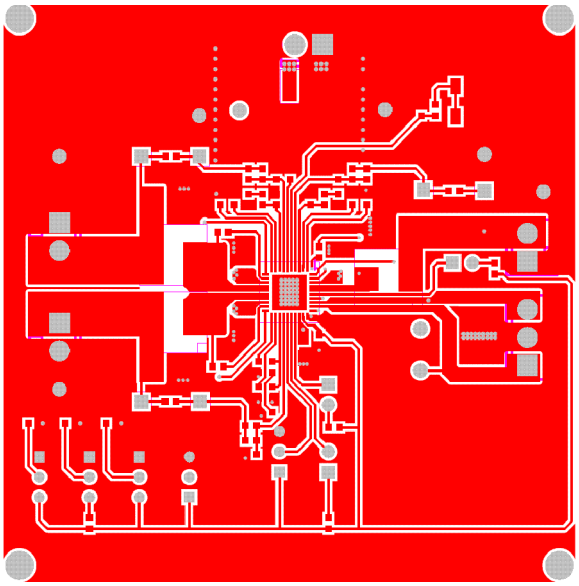


Figure 3. Top Layer

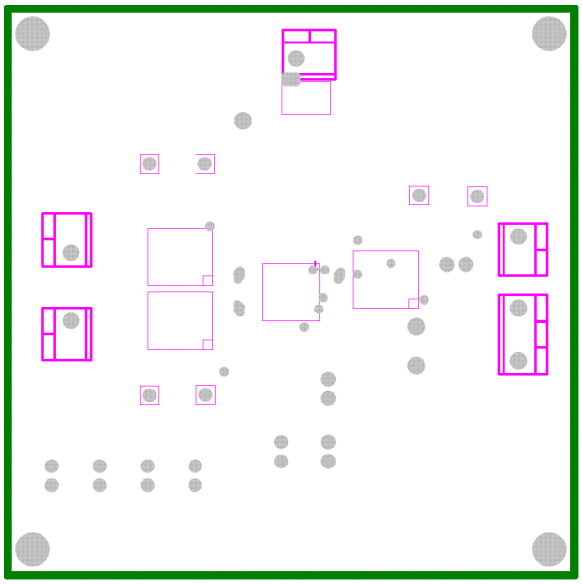


Figure 4. Middle Layer (2nd), Solid Cu Ground

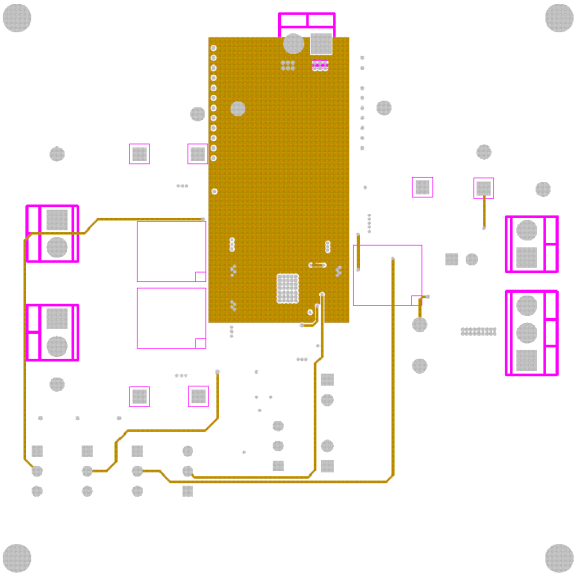


Figure 5. Middle (3rd) Layer

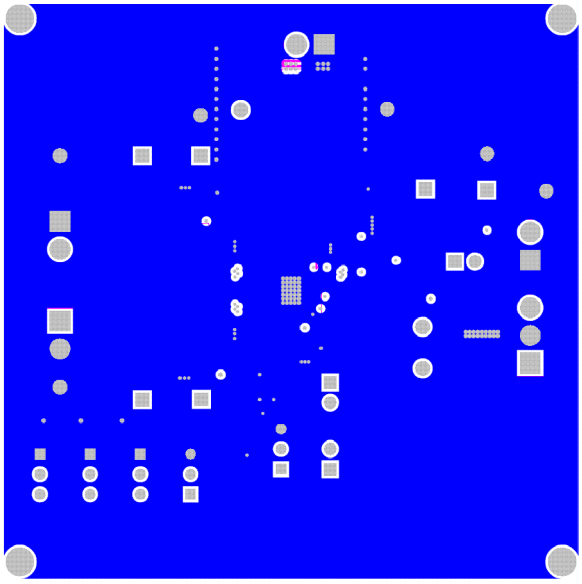
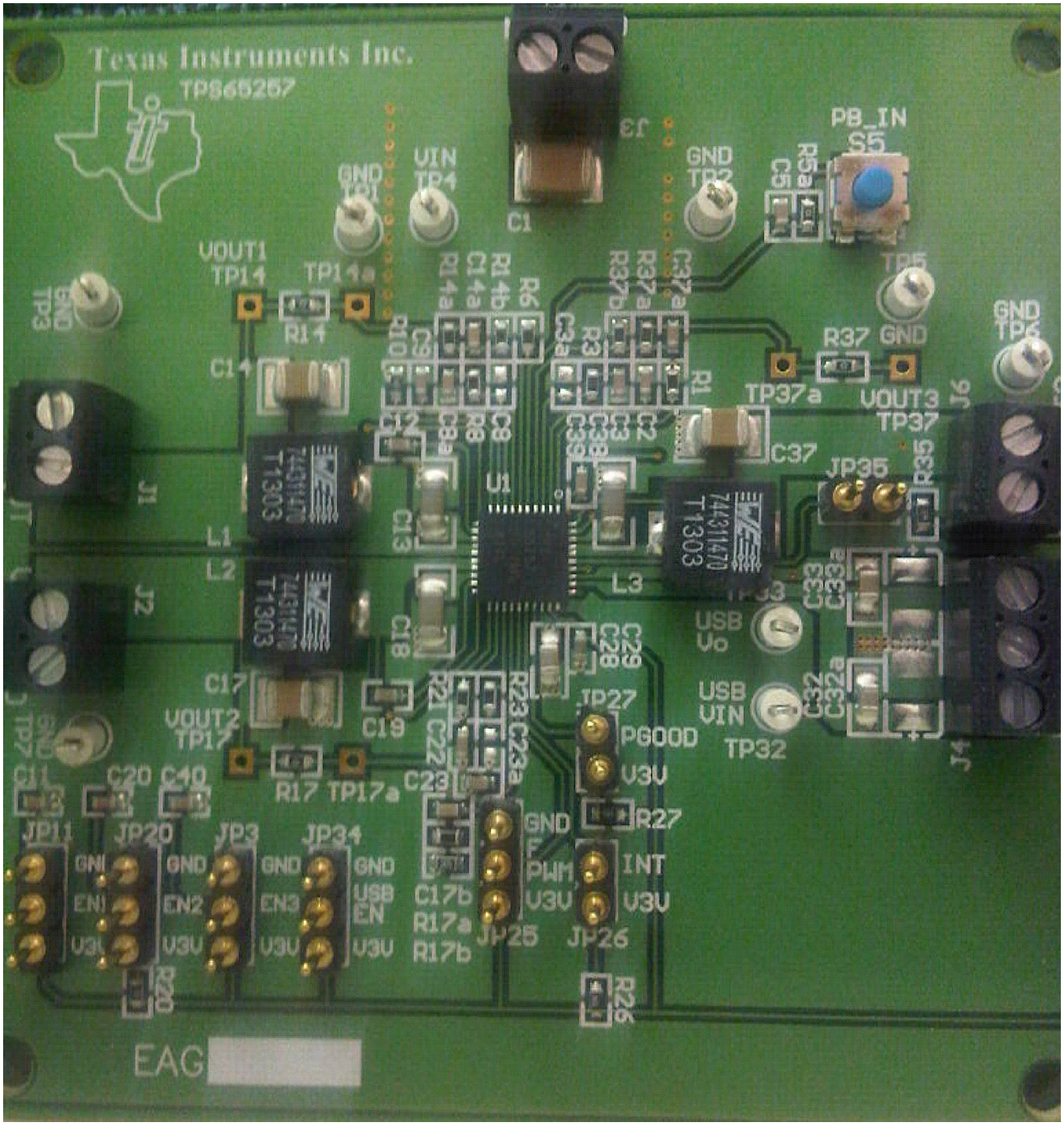


Figure 6. Bottom Layer

5 Bench Test Setup Conditons

Headers description and jumper placement.



5.1 Headers Description

Header Number	Function	LOC	Placement	Comment
JP11	BUCK1 enable (EN1)	SW	For immediate start-up fit jumper to V3V For sequencing do not fit jumper To disable converter fit jumper to GND	Fit according to test requirement
JP20	BUCK2 enable (EN2)	SW	For immediate start-up fit jumper to V3V For sequencing do not fit jumper To disable converter fit jumper to GND	Fit according to test requirement
JP3	BUCK3 enable (EN3)	SW	For immediate start-up fit jumper to V3V For sequencing do not fit jumper To disable converter fit jumper to GND	Fit according to test requirement
JP25	Forced PWM (F_PWM)	S	For forced PWM operation fit jumper to V3V For automatic PFM/PWM operation fit jumper to GND	**Do not leave this header open. Use a jumper to set either forced PWM mode or automatic PFM/PWM mode**
JP34	USB1 enable (USB1EN)	SW	For automatic start-up fit jumper to V3V To disable SWITCH fit jumper to GND	Fit according to test requirement
JP35	USB1_nFAULT	E	USB1 fault indicator pulled to 3V3	Fit according to test requirement
JP26	INT	S	Interruption fault indicator pulled to 3V3	Fit according to test requirement
JP27	PGOOD	S	PGOOD indicated pulled to 3V3	Fit according to test requirement

5.2 Test Points and Placement

Buck converter outputs are white and have a label for easy location. Close to any of these test points there are black ground test points to allow for DVM measurement or to use a metal exposed scope probe to reduce common mode noise measurements. All test points are described in the following table:

Test Point	Name	Signal	COLOR	Comment
TP1	GND	GND	White	
TP2	GND	GND	White	
TP3	GND	GND	White	
TP4	Vin	Vin	Black	
TP5	GND	GND	White	
TP6	GND	GND	White	
TP7	GND	GND	White	
TP14	Vout1	Output voltage Buck1	Not fitted	
TP14a		Injection Point gain-phase measurement buck1	Not fitted	Normally not used
TP17	Vout1	Output voltage Buck2	Not fitted	
TP17a		Injection Point gain-phase measurement buck2	Not fitted	Normally not used
TP37	Vout1	Output voltage Buck3	Not fitted	
TP37a		Injection Point gain-phase measurement buck3	Not fitted	Normally not used
TP32	USB1_Vin	USB1 switch input	Black	
TP33	USB1_Vo	USB1 switch output	Black	

Table 2. Bill of Materials[(1)]

Count	RefDes	Value	Description	Size
1	C1	22 µF	CAP CERAMIC 22UF 25V X5R 1210	1812
12	C2, C3, C8a, C9, C11, C14a, C17b, C20, C22, C23, C37a, C40	4.7 nF	CAP 4700PF 50V CERAMIC X7R 0603	0603
3	C3a, C8, C23a	DNI		0603
3	C12, C19, C39	47 nF	CAP 47000PF 25V CERM X7R 0603	0603
1	C5	DNI	CAP 100nF 25V CERM X7R 0603	0603
3	C13, C18	10 µF	CAP CERAMIC 10UF 25V X5R 1206	1206
2	C38 C14,	47 µF	CAP CERAMIC 22UF 25V X5R 1210	1210
1	C17, C37	22 µF	CAP CERAMIC 22UF 25V X5R 1210	1210
3	C28, C32, C33	10 µF	CAP CER 10UF 10V X7R 0805	0805
1	C29	4.7 µF	CAP CER 4.7UF 10V X5R 0603	0603
4	C32a, C33a	100 µF	CAPACITOR TANT 100UF 10V 20% SMD	CAP_POL_1210
1	J1,'J2,'J3,'J6	ED55/2DS	TERMINAL BLOCK 3.5MM 2POS PCB	TB_2X3.5MM
2	J4, J5	ED55/3DS	TERMINAL BLOCK 3.5MM 2POS PCB	TB_3X3.5MM
6	JP3, JP5, JP11, JP20, JP25, JP34		CONN HEADER 50POS .100" SGL GOLD	JMP0.3
3	JP26, JP27, JP35		CONN HEADER 50POS .100" SGL GOLD	JMP0.2
3	L1, L2, L3	4.7 µH	Magnetic-Core Inductor	IND_RLF7030
2	R1, R21	120 K	RES 120K OHM 1/10W 5% 0603 SMD	0603
1	R2	10 K	RES 10K OHM 1/10W 5% 0603 SMD	0603
3	R3, R8, R23	20 K	RES 20K OHM 1/10W 5% 0603 SMD	0603
1	R6	383 K	RES 383K OHM 1/10W 1% 0603 SMD	0603
4	R10, R26, R27, R35	100 K	RES 100K OHM 1/10W 5% 0603 SMD	0603
5	R14, R17, R20, R37, R5a	0	RES 0.0 OHM 1/10W 5% 0603 SMD	0603
3	R14a, R17a, R37a	40.2 K	RES 40.2K OHM 1/10W 1% 0603 SMD	0603
1	R14b	80.6 K	RES 80.6K OHM 1/10W 1% 0603 SMD	0603
1	R17b	32.4 K	RES 32.4K OHM 1/10W 1% 0603 SMD	0603
1	R37b	12.7 K	RES 12.7K OHM 1/10W 1% 0603 SMD	0603
1	S5		SEALED MINIATURE KEY SWITCHES, SURFACE MOUNT" J " TERMINALS	7914J
6	TP1, TP2, TP3, TP5, TP6, TP7		TEST POINT 0.052	Glass Beaded Test Point
1	TP4		TEST POINT 0.052	Glass Beaded Test Point
1	TP14	STD	TP-032	Test Point, O.032 Hole
1	TP14a	STD	TP-032	Test Point, O.032 Hole
1	TP17	STD	TP-032	Test Point, O.032 Hole
1	TP17a	STD	TP-032	Test Point, O.032 Hole
4	TP30, TP31, TP32, TP33		TEST POINT 0.052	Glass Beaded Test Point
1	TP37	STD	TP-032	Test Point, O.032 Hole
1	TP37a	STD	TP-032	Test Point, O.032 Hole
1	U1		QFN-40	TPS65258

(1) Items with gray backgrounds are optional/not needed for a reference design.

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of xx V to xx V and the output voltage range of xx V to xx V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 55°C. The EVM is designed to operate properly with certain components above 60°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

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