TPS54362B EVM User's Guide

1 Introduction

The Texas Instruments TPS54362BEVM evaluation module (EVM) helps designers evaluate the operation and performance of the TPS54362B-Q1 switch-mode power-supply buck regulator. The device is configurable and can be configured to switch from 200 kHz up to 2.2 MHz. This EVM is optimized for EMI performance. For the EMI test results, see the application report *Passing CISPR25 Radiated Emissions Using TPS54362B-Q1*, SLVA661.

Table 1. Device and Package Configurations

CONVERTER	IC	PACKAGE
U1	TPS54362BQPWPQ1	PWP-20

Table 2. Input and Output Summary

EVM	INPUT VOLTAGE RANGE	DEFAULT OUTPUT SETTING
TPS54362BEVM	V_I = 3.6 V to 40 V	5 V at currents up to 3 A

1.1 Performance Summary

The TPS54362BEVM is optimized to meet the CISPR25 EMC standard for automotive components. TPS54362BEVM was tested at $V_{(BAT)}$ = 12 V an output voltage of 5 V at 2 A. The layout is designed to reduce emissions to levels deemed acceptable by the previously mentioned standard.

The switching frequency is externally set at a nominal 500 KHz. The compensation components are external to the integrated circuit (IC) and have been selected to optimize the transient performance of the device. An external divider allows for an adjustable output voltage.

Table 3 lists a summary of the TPS54362BEVM performance specifications. Specifications are given for an input voltage of V_I = 12 V and an output voltage of 5 V, unless otherwise specified. The TPS54362BEVM is designed and tested for V_I = 6 V to 48 V. The ambient temperature is 25°C for all measurements, unless otherwise noted.

Table 3. TPS54362BEVM Performance Specification Summary

SPECIFICATION	TEST CONDITION	MIN	TYP	MAX	UNIT
VIN operating voltage range		6	12	48	V
Output voltage set-point			5		V
Output current range	V_I = 7 V to 48 V	0		3	A
Operating frequency			500		kHz

2 Setup

This section describes the jumpers and connectors on the EVM as well and how to properly connect, set up, and use the TPS54362BEVM.

2.1 Input-Output Connector Description

J1 – Input — This jumper is the power input terminal for the converter. The terminal block provides a power ($V_{(BAT)}$) and ground (GND) connection to allow the user to attach the EVM to a cable harness.

J2 – Output — This jumper is the regulated output voltage for the converter. The terminal block provides a power (V_O) and ground (GND) connection to allow the user to attach the EVM to a cable harness.

J3 – Sync — This jumper is the input terminal for an optional external input clock to the converter. The external clock can be used to synchronize the switching frequency for multiple devices. The external clock frequency, if used, must meet the guideline as shown in Equation 1.

$$f_S < f_{(EXT)} < 2 \times f_S \quad (1)$$

where

- f_S is the switching frequency

JP1 – LPM — This jumper is the jumper used to enable Low Power Mode. The jumper allows LPM to be enabled or disabled. The “disabled with protection diode” selection should be used if the output voltage is programmed for voltages greater than 5 V. The external Zener will prevent over voltage damage to the LPM input.

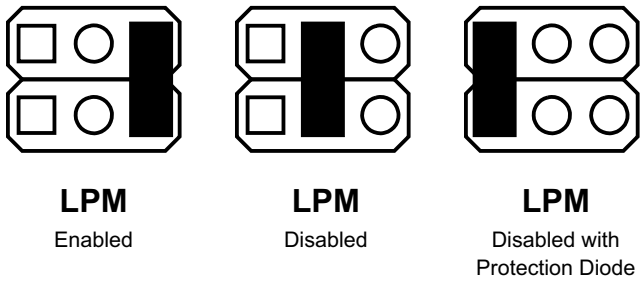


Figure 1. LPM Jumper Settings

JP2 – Enable—The converter is enabled when the EN pin is high and is disabled when the EN pin is low. The jumper placement allows the converter to be enabled or disabled.

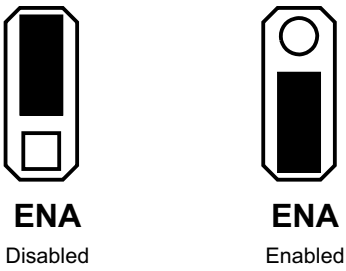


Figure 2. Enable Jumper Settings

JP3 – Slew Rate — This jumper sets the slew rate for the switch pin. The device slew rate should be set between 15 ns and 200 ns. Slower slew rates can improve EMI performance, but increase switching losses. Jumper resistors allow the slew rate to be set to four set points. The user can set a specific slew rate by changing one of the slew rate set resistors, either R8, R9, or R10.

NOTE: The slew rate should be set to 1 V, 1.2 ns if the EVM is configured for a 2-MHz switching frequency.

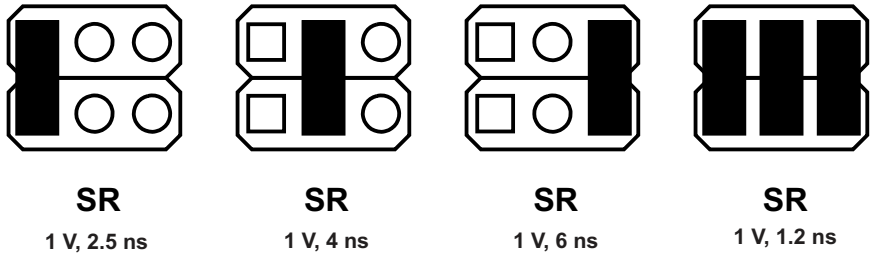


Figure 3. Slew-Rate Jumper Settings

JP4 – Delay — This jumper sets the delay time to assert the RST pin low after the supply exceeds the programmed VREG_RST voltage. The delay can be programmed in the range of 7 ms to 200 ms. Jumper capacitors allow the reset delay to be set to four set points. The user can set a specific delay time by changing one of the delay capacitors, either C13, C14, or C15. The RST signal can be monitored on the RST test point.

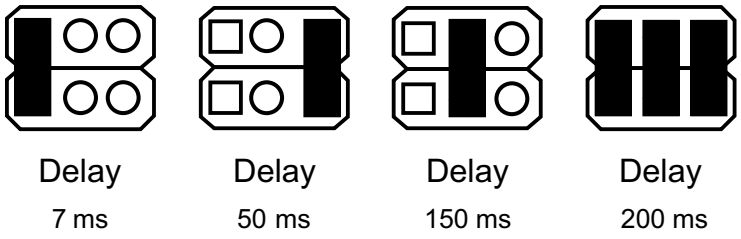


Figure 4. Reset Delay-Time Jumper Settings

2.2 Setup

The input voltage range for the converter is 3.6 V to 48 V. If the input voltage is lower than 5 V (default setting) the output voltage will track the input voltage within the drop out proportional to the load current and the internal FET on resistance.

2.3 Operation

For proper operation of the TPS54362B-Q1 device, JP1, JP2, JP3, and JP4 should be properly configured. The following lists the recommended setting which uses shorting blocks:

- JP1 to enabled
- JP2 to enabled
- JP3 to 1 V, 2.5 ns
- JP4 to 200 ms

  In this configuration, the device powers up when power is applied.

Setting the R6 and R7 resistors to transition the EN input low as the supply voltage drops implements undervoltage lockout. Use Equation 2 to set the values for R6 and R7.

$$V_{dis} = ENTHRES \times (1 + R6 / R7)$$

where

- ENTHRES is around 1 V (2)

Resistor R7 is not populated on this EVM to reduce the quiescent supply current if this feature is not required.

3 Board Layout

Figure 5, Figure 6, Figure 7, Figure 8, and Figure 9 show the board layout for the TPS54362BEVM PWB. The EVM offers resistors, capacitors, and jumpers to program the switch-pin slew rate and regulator turn-on delay. Jumpers are also provided to enable the device and to enable the low power-mode option. The TPS54362B-Q1 converter offers high efficiency, but dissipates power. The PowerPAD™ package offers an exposed thermal pad to enhance thermal performance. This pad must be soldered to the copper landing on the PCB for optimal performance. The PCB provides 2-oz copper planes on the top and bottom to dissipate heat.

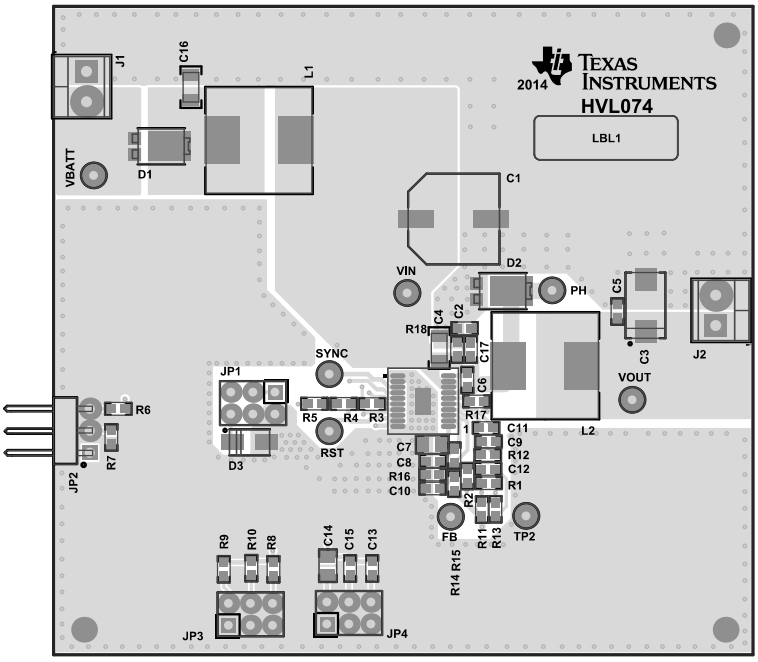


Figure 5. Top Assembly Layer

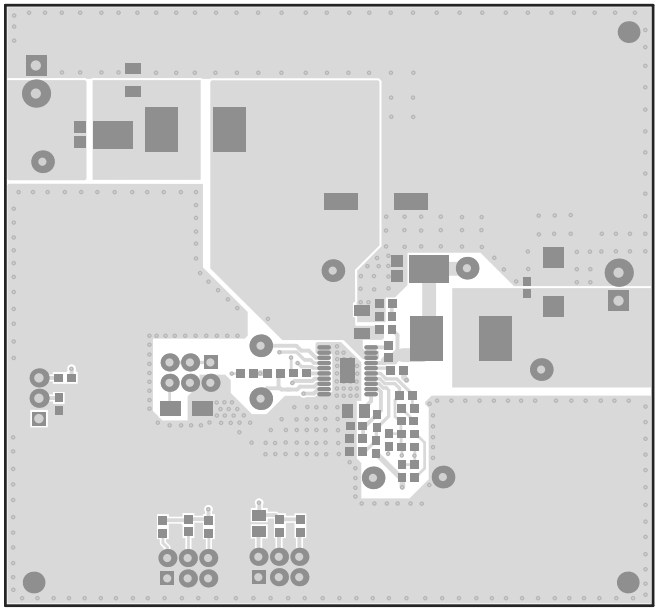


Figure 6. Top Layer Routing

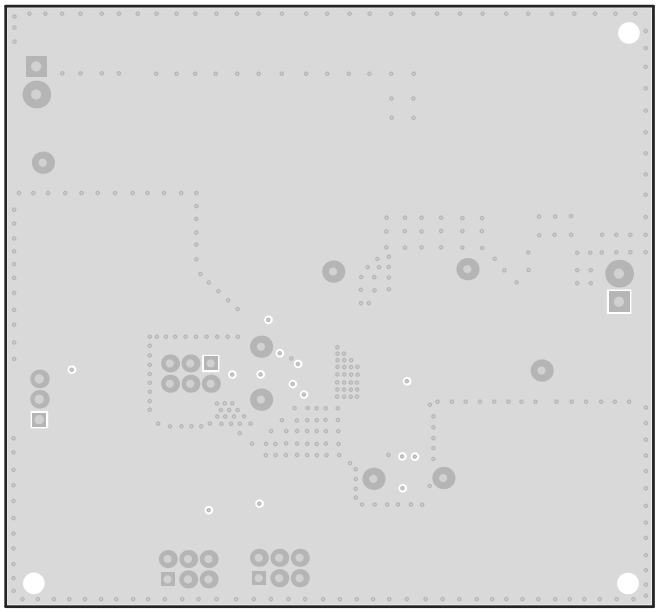


Figure 7. Inner Layer 2 (Ground Plane)

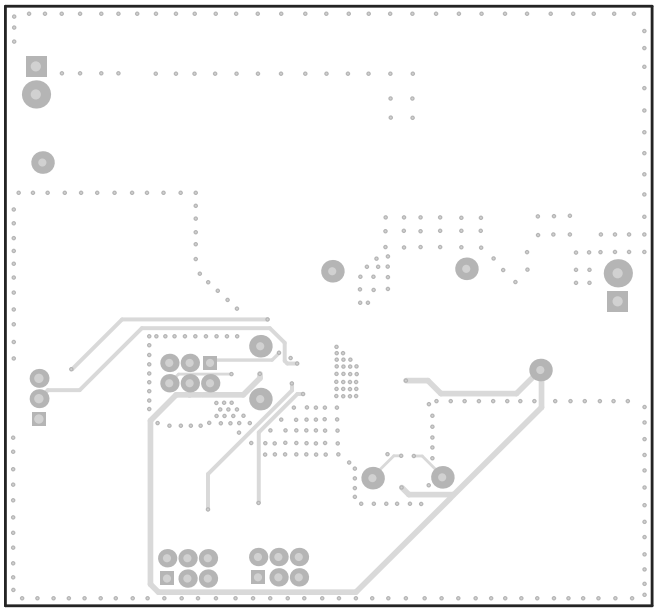


Figure 8. Inner Layer 3 Routing

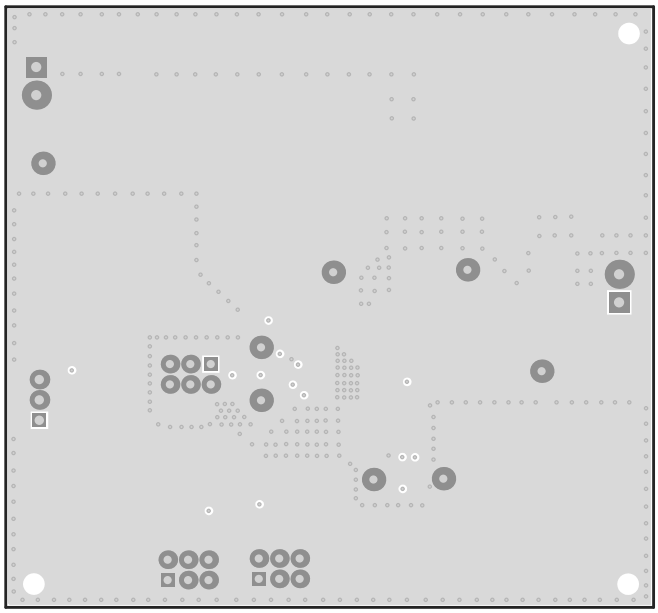
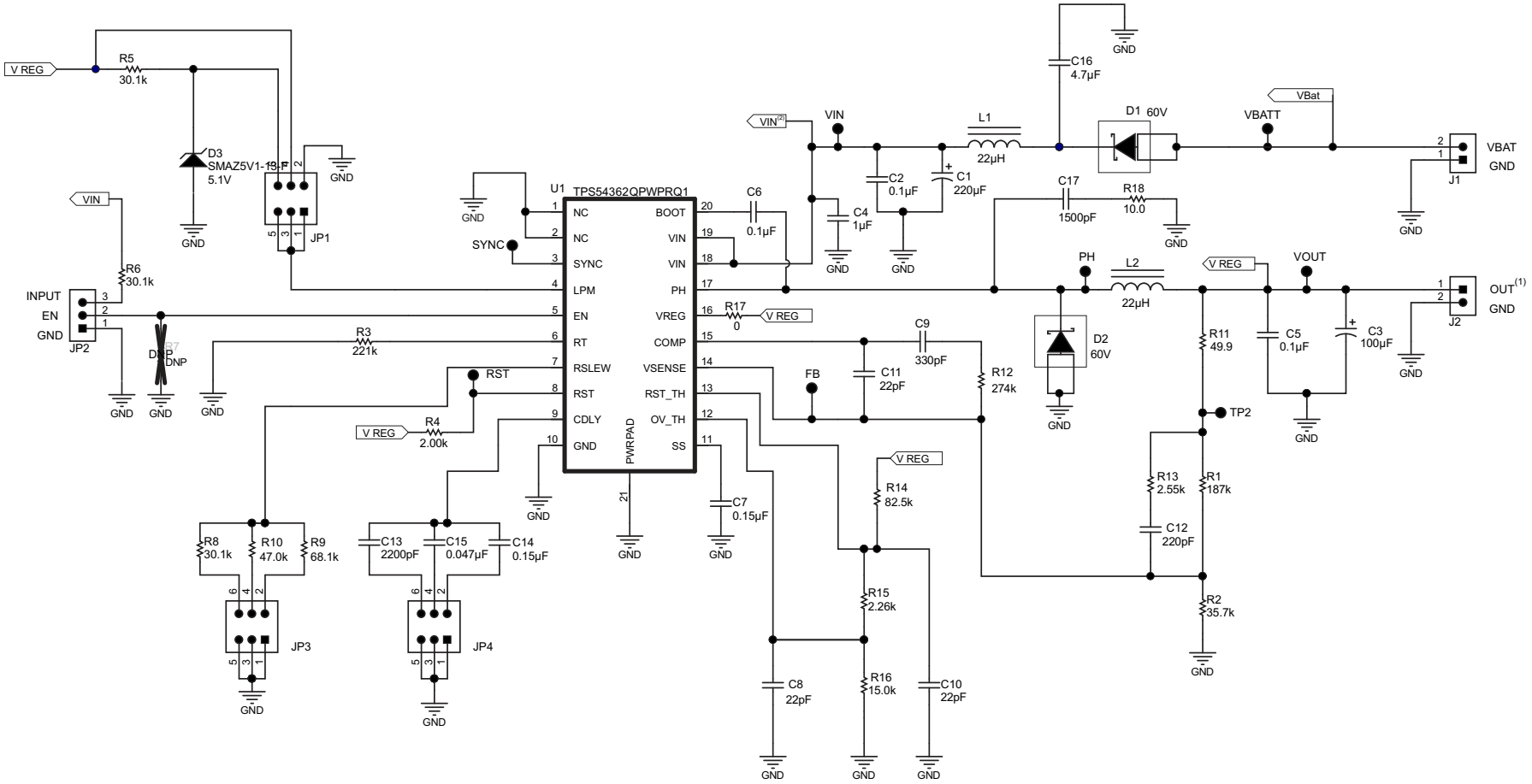


Figure 9. Bottom Layer (Ground Plane)

4 Schematic and Bill of Materials

4.1 Schematic



(1) Output voltage = 5 V, load current = 3 A maximum

(2) Input voltage up to 48 V

Figure 10. Schematic

4.2 Bill of Materials

Table 4. TPS54362BEVM Bill of Materials for a 500-kHz Configuration

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER	ALTERNATE PART NUMBER	ALTERNATE MANUFACTURER
!PCB	1		Printed Circuit Board		TPS54362BEVM	Any	-	-
C1	1	220 µF	Capacitor, AL, 220 µF, 50 V, ±20%, 0.18 Ω, SMD	SMT Radial G	EEE-FK1H221P	Panasonic		
C2, C5, C6	3	0.1 µF	Capacitor, ceramic, 0.1 µF, 50 V, ±10%, X7R, 0603	0603	GRM188R71H104KA93D	MuRata		
C3	1	100 µF	Capacitor, TA, 100 µF, 16 V, ±20%, 0.06 Ω, SMD	7343-31	TPSD107M016R0060	AVX		
C4	1	1 µF	Capacitor, ceramic, 1 µF, 50 V, ±10%, X7R, 1206	1206	GRM31MR71H105KA88L	MuRata		
C7, C14	2	0.15 µF	Capacitor, ceramic, 0.15 µF, 25 V, ±10%, X7R, 0805	0805	08053C154KAT2A	AVX		
C8, C10, C11	3	22 pF	Capacitor, ceramic, 22 pF, 50 V, ±5%, C0G/NP0, 0603	0603	06035A220JAT2A	AVX		
C9	1	330 pF	Capacitor, ceramic, 330 pF, 50 V, ±5%, C0G/NP0, 0603	0603	C0603C331J5GACTU	Kemet		
C12	1	220 pF	Capacitor, ceramic, 220 pF, 50 V, ±5%, C0G/NP0, 0603	0603	C1608C0G1H221J	TDK		
C13	1	2200 pF	Capacitor, ceramic, 2200 pF, 50 V, ±5%, C0G/NP0, 0603	0603	GRM1885C1H222JA01D	MuRata		
C15	1	0.047 µF	Capacitor, ceramic, 0.047 µF, 50 V, ±10%, X7R, 0603	0603	C1608X7R1H473K	TDK		
C16	1	4.7 µF	Capacitor, ceramic, 4.7 µF, 50 V, ±10%, X7R, 1206	1206	GRM31CR71H475KA12L	MuRata		
C17	1	1500 pF	Capacitor, ceramic, 1500 pF, 50 V, ±10%, X7R, 0603	0603	GRM188R71H152KA01D	MuRata		
D1, D2	2	60 V	Diode, Schottky, 60 V, 3 A, PowerDI5	PowerDI5	PDS360-13	Diodes Inc.		
D3	1	5.1 V	Diode, Zener, 5.1 V, 1 W, SMA	SMA	SMAZ5V1-13-F	Diodes Inc.		
FB, PH, RST, SYNC, TP2, VBATT, VIN, VOUT	8	Red	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone		
J1, J2	2		Terminal Block, 6 A, 3.5 mm Pitch, 2-Pos, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology		
JP1, JP3, JP4	3		Header, 100 mil, 3 × 2, Tin, TH	3x2 Header	PEC03DAAN	Sullins Connector Solutions		
JP2	1		Header, male, 3 × 1, 100 mil, RA, TH	Header, 3x1, RA	PEC03SBAN	Sullins Connector Solutions		
L1, L2	2	22 µH	Inductor, Shielded Drum Core, Ferrite, 22 µH, 4 A, 0.04 Ω, SMD	MSS1278T	MSS1278T-223MLB	Coilcraft		

Table 4. TPS54362BEVM Bill of Materials for a 500-kHz Configuration (continued)

DESIGNATOR	QUANTITY	VALUE	DESCRIPTION	PACKAGE REFERENCE	PART NUMBER	MANUFACTURER	ALTERNATE PART NUMBER	ALTERNATE MANUFACTURER
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650"H x 0.200"W	THT-14-423-10	Brady	-	-
R1	1	187 kΩ	Resistor, 187 kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-07187KL	Yageo America		
R2	1	35.7 kΩ	Resistor, 35.7 kΩ, 1%, 0.1 W, 0603	0603	CRCW060335K7FKEA	Vishay-Dale		
R3	1	221 kΩ	Resistor, 221 kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-07221KL	Yageo America		
R4	1	2 kΩ	Resistor, 2.00 kΩ, 1%, 0.1 W, 0603	0603	CRCW06032K00FKEA	Vishay-Dale		
R5, R6, R8	3	30.1 kΩ	Resistor, 30.1 kΩ, 1%, 0.1 W, 0603	0603	CRCW060330K1FKEA	Vishay-Dale		
R9	1	68.1 kΩ	Resistor, 68.1 kΩ, 1%, 0.1 W, 0603	0603	CRCW060368K1FKEA	Vishay-Dale		
R10	1	47 kΩ	Resistor, 47 kΩ, 1%, 0.1 W, 0603	0603	RC0603FR-0747KL	Yageo America		
R11	1	49.9 Ω	Resistor, 49.9 Ω, 1%, 0.1 W, 0603	0603	CRCW060349R9FKEA	Vishay-Dale		
R12	1	274 kΩ	Resistor, 274 kΩ, 1%, 0.1 W, 0603	0603	CRCW0603274KFKEA	Vishay-Dale		
R13	1	2.55 kΩ	Resistor, 2.55 kΩ, 1%, 0.1 W, 0603	0603	CRCW06032K55FKEA	Vishay-Dale		
R14	1	82.5 kΩ	Resistor, 82.5 kΩ, 1%, 0.1 W, 0603	0603	CRCW060382K5FKEA	Vishay-Dale		
R15	1	2.26 kΩ	Resistor, 2.26 kΩ, 1%, 0.1 W, 0603	0603	CRCW06032K26FKEA	Vishay-Dale		
R16	1	15 kΩ	Resistor, 15.0 kΩ, 1%, 0.1 W, 0603	0603	CRCW060315K0FKEA	Vishay-Dale		
R17	1	0 Ω	Resistor, 0 Ω, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale		
R18	1	10 Ω	Resistor, 10 Ω, 1%, 0.1 W, 0603	0603	RC0603FR-0710RL	Yageo America		
SH-JP1A, SH-JP1B, SH-JP1C, SH-JP2, SH-JP3A, SH-JP3B, SH-JP3C, SH-JP4A, SH-JP4B, SH-JP4C	10	1 × 2	Shunt, 100 mil, Gold plated, Black	Shunt	969102-0000-DA	3M	SNT-100-BK-G	Samtec
U1	1	TPS54362BQPWPRQ1	IC, 3 A, 60 V step down DC/DC converter with low I_Q	PWP20	TPS54362BQPWPRQ1	TI		None
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
R7	0	0	Resistor, 0 Ω, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale		

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General Statement for EVMs including a radio

User Power/Frequency Use Obligations: For EVMs including a radio, the radio included in such EVMs is intended for development and/or professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability in such EVMs and their development application(s) must comply with local laws governing radio spectrum allocation and power limits for such EVMs. 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 TI unless user has obtained appropriate experimental and/or development licenses from local regulatory authorities, which is the sole responsibility of the user, including its acceptable authorization.

U.S. Federal Communications Commission Compliance

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 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 its 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.

Industry Canada Compliance (English)

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.

Canada Industry Canada Compliance (French)

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.

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Important Notice for Users of EVMs Considered "Radio Frequency Products" in Japan

EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If user uses EVMs in Japan, user is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after user obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after user obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless user gives the same notice above to the transferee. Please note that if user does not follow the instructions above, user will be subject to penalties of Radio Law of Japan.

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