TPS62230EVM-370 User's Guide

This user's guide describes the characteristics, operation, and use of the TPS62230EVM-370 evaluation module (EVM). This EVM demonstrates three individual configurations of the Texas Instruments TPS62230 3-MHz, synchronous step-down converter capable of supplying up to 500 mA of output current. This user's guide includes setup instructions, a schematic diagram, a bill of materials, and printed-circuit board layout drawings for the evaluation module.

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1 Introduction

The Texas Instruments TPS62230EVM-370 evaluation module helps designers evaluate the operation and performance of the TPS62230 family of devices. These devices are high-efficiency, ultra-small size, buck converters that switch at 3 MHz.

The EVM contains three independent dc/dc converters. Table 1 lists the default output voltages of the converters.

Table 1. Device and Output Voltage Configurations

Converter	Integrated Circuit	Output Voltage
U11	TPS62230DRY	2.5 V
U21	TPS62231DRY	1.8 V
U31	TPS62232DRY	1.2 V

See the data sheet (SLVS941) for the various fixed output voltage options available in the TPS62230 device family.

2 Setup

This section describes the jumpers and connectors on the EVM and how to properly connect, set up, and use the TPS62230EVM-370.

2.1 Input/Output Connector Descriptions

2.1.1 J11 , J21, and J31 – VIN

This is the positive input connection to the corresponding converter. Twist the leads to the input supply, and keep as short as possible to minimize EMI transmission.

2.1.2 J13 , J23, and J33 – GND

This is the return connection for the input power supply for the corresponding converter.

2.1.3 J12, J22, and J32 – Input Sense

This connection provides monitoring for input voltage using independent traces to the input capacitor.

2.1.4 J14, J24, and J34 – VOUT

This is the positive connection from the output of the corresponding buck power supply.

2.1.5 J16 , J26, and J36 – GND

This is the negative connection from the output of the corresponding buck power supply.

2.1.6 J15, J25, and J35 – Output Sense

This connection provides monitoring for output voltage using independent traces to the output capacitor.

2.1.7 JP11, JP21, JP31 – ENABLE

This jumper enables or disables the converter through the IC EN pin. Connect the shorting jumper from the center (EN) pin to either the ON or OFF position. Never leave EN floating.

2.1.8 JP12, JP22, and JP32 – Mode

This jumper is used to select the operating mode of the converter. The converter operates in a fixed-frequency, low-noise, PWM mode when a jumper is used to short the MODE pin to the ON pin. Shorting the MODE pin and OFF pin together allows the controller to use the power-saving (PFM) mode for high efficiency at low output currents.

2.2 Converter Configurations

All converters are designed to use an input voltage between 2.05 V and 6 V. But the input voltage must be higher than the output voltage in order to maintain voltage regulation, and U11 requires 2.5-V minimum input. Connect the input voltage power supply and output according to Table 2.

Table 2. Input and Output Connections

Converter No.	Output Voltage	Signal	Connection
U11	2.5 Vdc Fixed	Positive Input Voltage	J11
		Input Voltage Return	J13
		Positive Output Voltage	J14
		Output Voltage Return	J16
U21	1.8 Vdc Fixed	Positive Input Voltage	J21
		Input Voltage Return	J23
		Positive Output Voltage	J24
		Output Voltage Return	J26
U31	1.2 Vdc Fixed	Positive Input Voltage	J31
		Input Voltage Return	J33
		Positive Output Voltage	J34
		Output Voltage Return	J36

2.3 Operation

The ENABLE jumper and the MODE jumper must be configured for proper operation of the converter.

For ENABLE, the converter enable uses a shorting block to set the JPX1 header to the desired configurations. Each converter has its own header: JP11 for U11, JP21 for U21, and JP31 for U31. The converters are shut down when the EN pin is pulled low; this is the ENABLE-to-OFF connection. The converters are in operate mode when the EN pin is pulled high; this is the ENABLE-to-ON connection. Do not leave the EN pin floating.

The MODE header, JPX2, controls the device power-save mode option. This mode changes the operation at light loads; it has no impact at mid-to-high loads . The device can operate in the low-noise, fixed-frequency PWM mode or high-efficiency, power-saving PFM mode at low power. Each converter has its own mode header: JP12 for U11, JP22 for U21, and JP32 for U31. The converters are in PWM mode when the MODE pin is pulled high; this is the MODE-to-ON connection. The converters operate in PFM mode when the MODE pin is pulled low; this is the MODE-to-OFF connection. Do not leave the MODE pin floating.

2.4 Test Results

See the Typical Characteristics section of the TPS62230 data sheet. This EVM uses the same inductors and similar capacitors as those used for characterization in the data sheet. Performance is consistent with that shown in the data sheet.

3 Board Layout

This section provides the TPS62230EVM-370 board layout and illustrations.

Board layout is critical for all high-frequency, switch-mode power supplies. Figure 1, Figure 2, and Figure 3 show the board layout for the TPS62230EVM-370 printed-circuit board. The nodes with high-switching frequencies and currents are kept as short as possible to minimize trace inductance. High-impedance inputs to the TPS62230, such as the Vout pin, have traces that are shielded by ground traces and planes. Careful attention has been given to the routing of high-frequency current loops, and a single-point grounding scheme is used. See the data sheet for specific layout guidelines. Input and output capacitors must be kept as close as possible to the device. A large bulk input capacitor (C13, C23, and C33) is provided to compensate for impedance in long input leads.

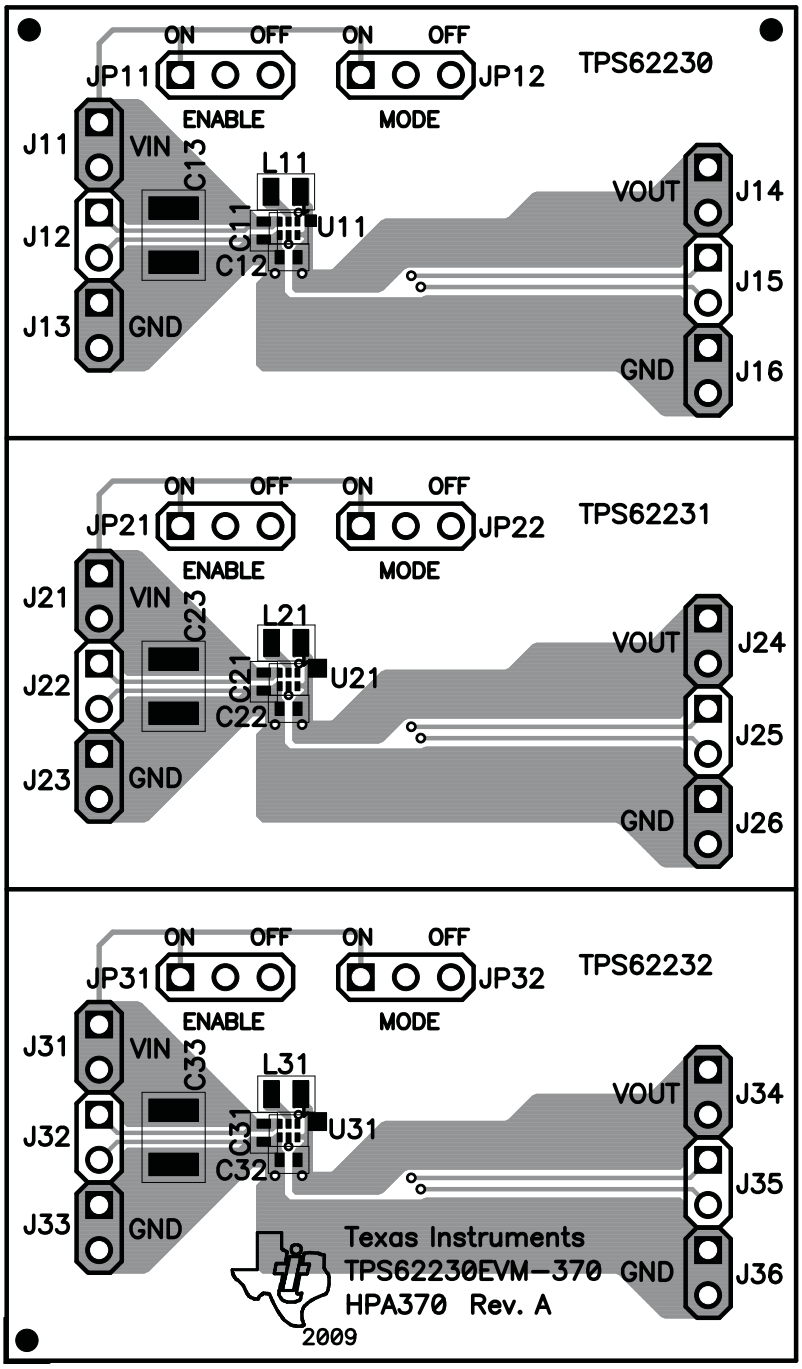

Figure 1. Assembly Layer

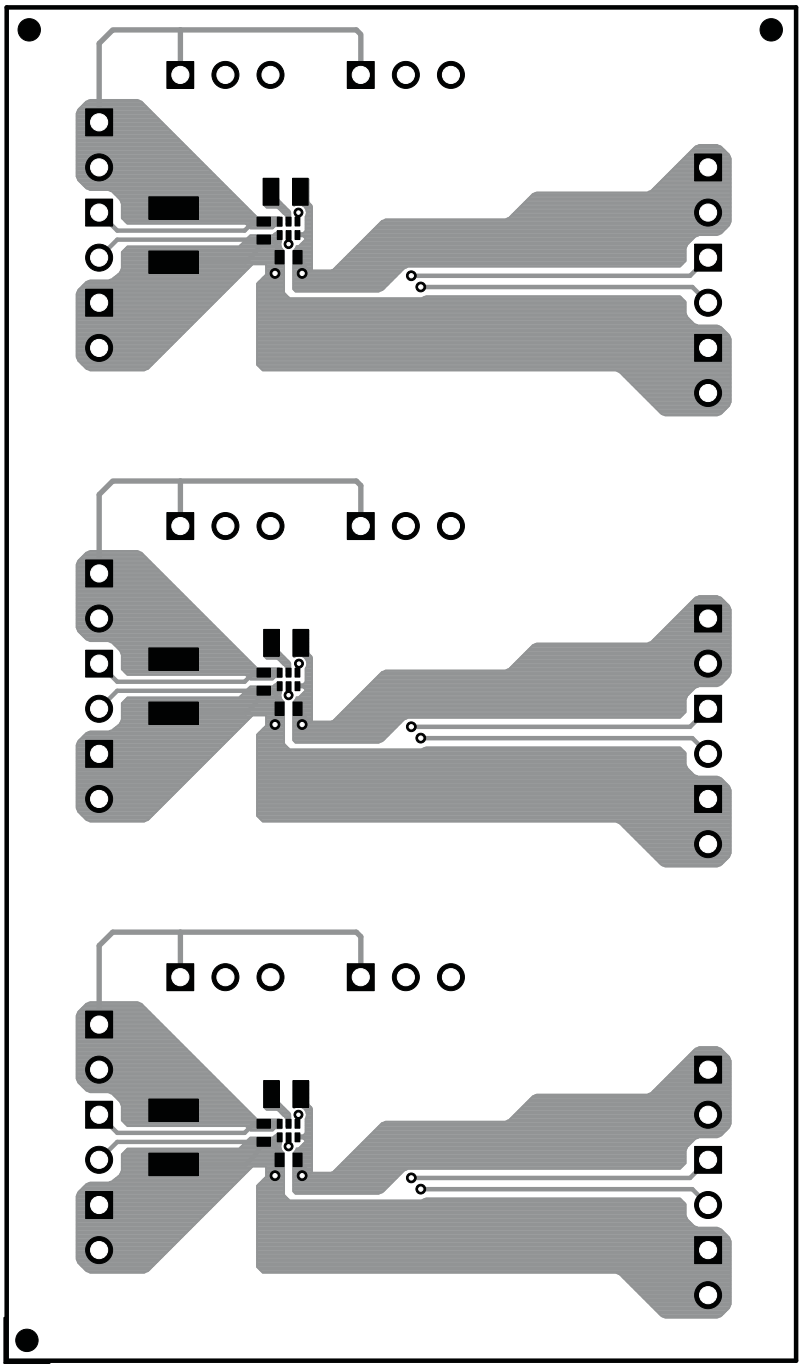

Figure 2. Top Layer Routing

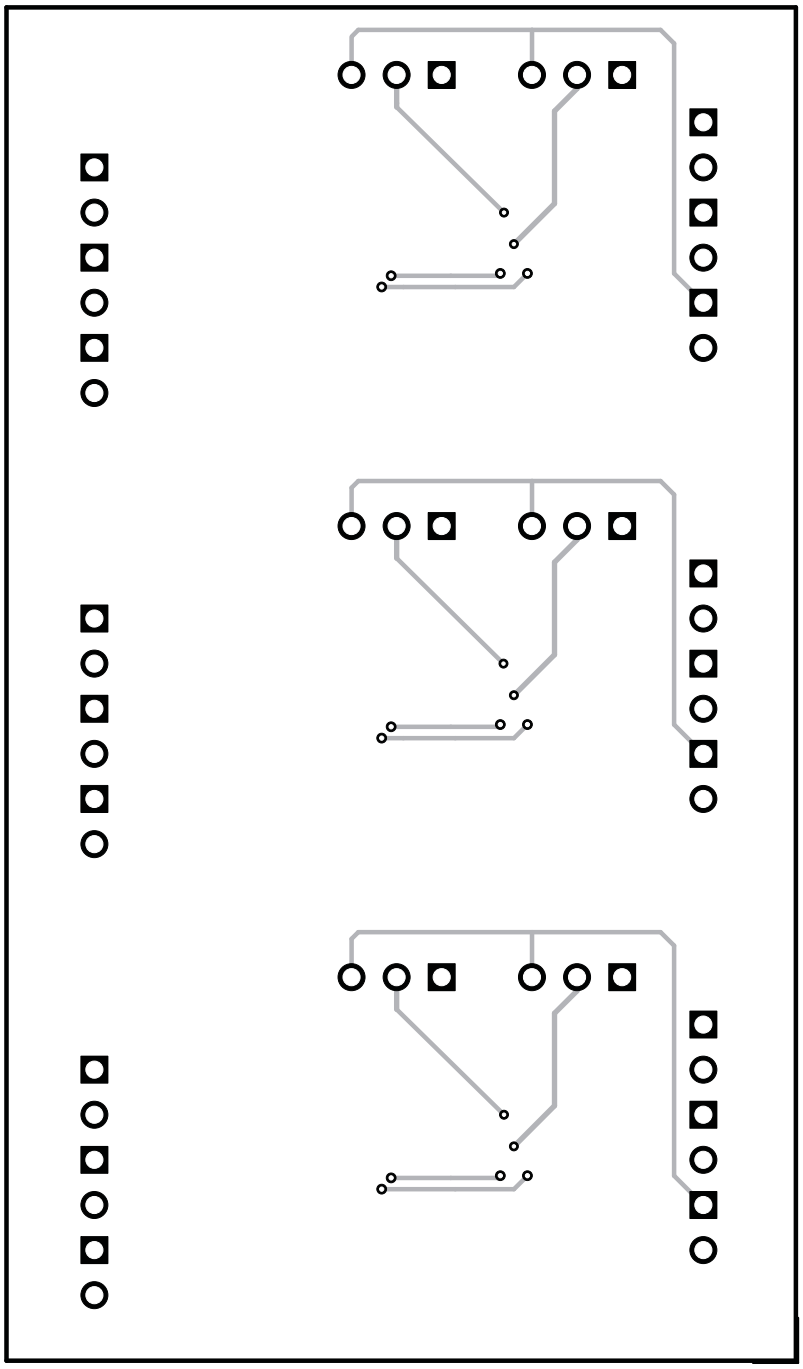

Figure 3. Bottom Layer Routing

4 Schematic and Bill of Materials

This section provides the TPS62230EVM-370 schematic and bill of materials.

4.1 Schematic

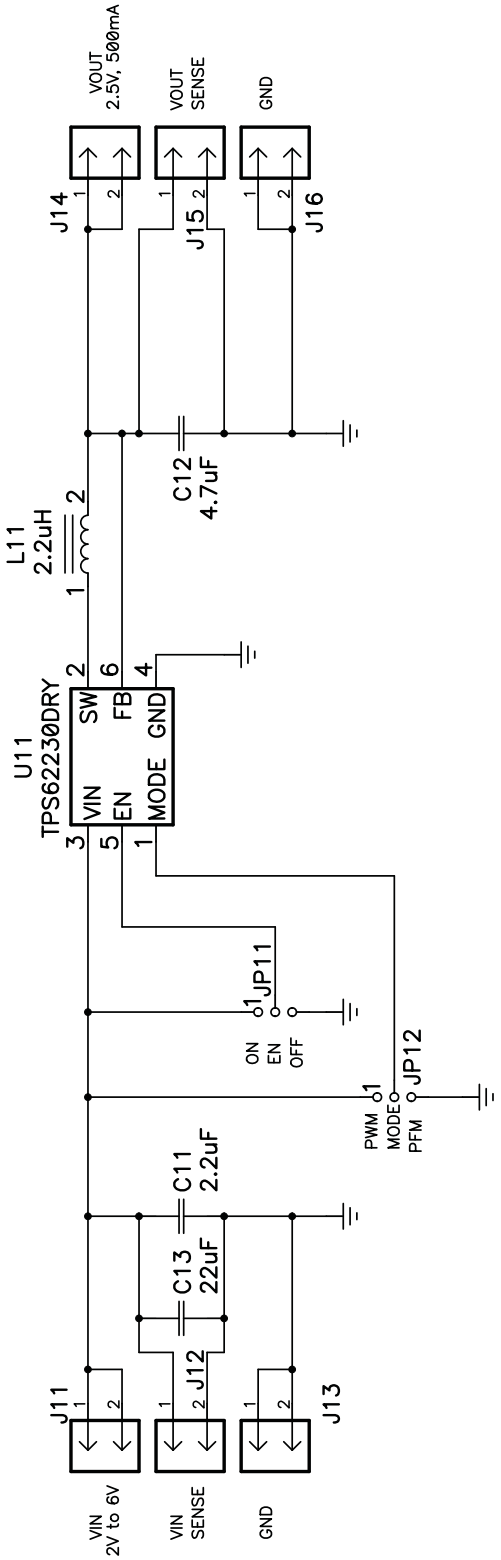

Figure 4. TPS62230EVM-370 Schematic, U11 Section

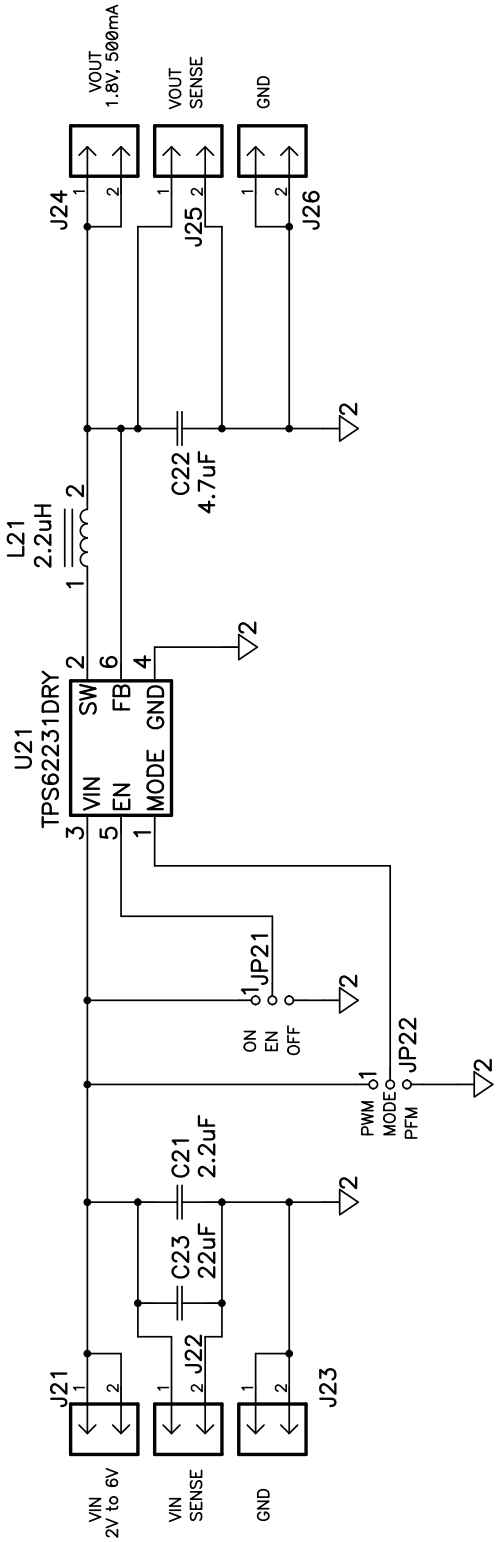

Figure 5. TPS62230EVM-370 Schematic, U21 Section

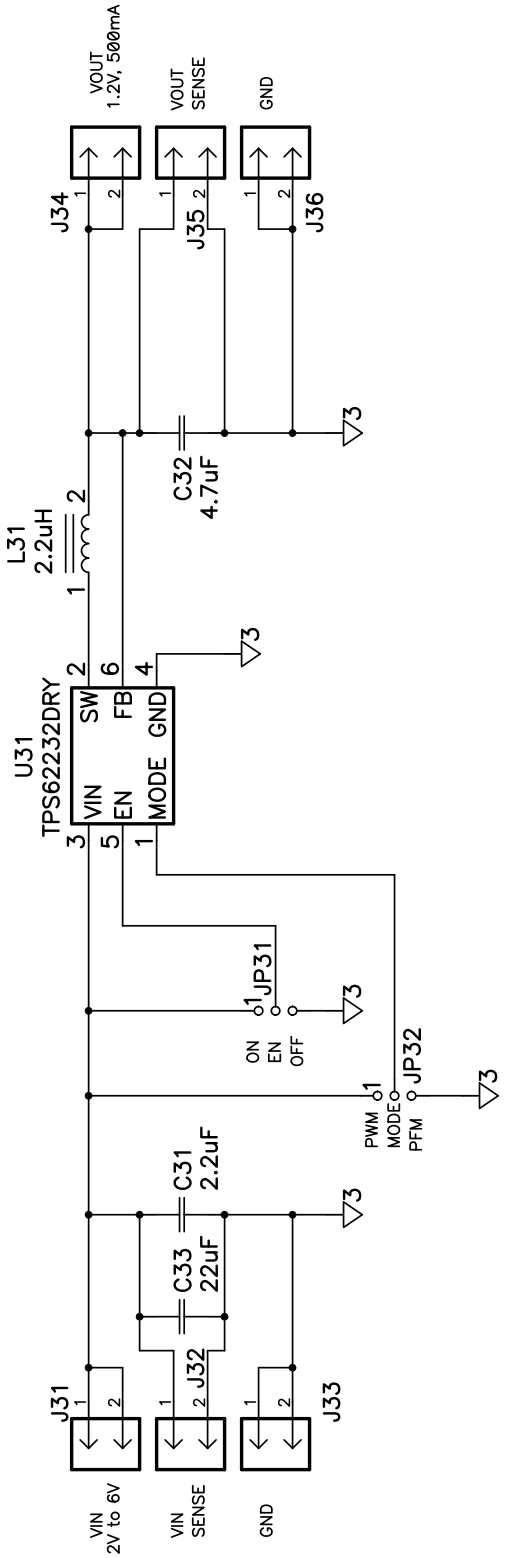

Figure 6. TPS62230EVM-370 Schematic, U31 Section

4.2 Bill of Materials

Table 3. TPS62230EVM-370 Bill of Materials

COUNT	RefDes	Value	Description	Size	Part Number	MFR
3	C11,C21,C31	2.2µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0402	CL05A225MQ5NNNC	Samsung
3	C12,C22,C32	4.7µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0402	CL05A475MQ5NRNC	Samsung
3	C13, C23, C33	22µF	Capacitor, Ceramic, 10V, X5R, 20%	1210	Std	Vishay
18	J11, J12, J13, J14, J15, J16, J21, J22, J23, J24, J25, J26, J31, J32, J33, J34, J35, J36	PEC02SAAN	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
6	JP11, JP12, JP21, JP22, JP31, JP32	PEC03SAAN	Header, 3 pin, 100mil spacing	0.100 x 3	PEC03AAN	Sullins
3	L11,L21,L31	2.2µH	Inductor, SMT, 0.7A, 230-milliohm	0805	MIPSZ20120D2R2	FDK
1	U11	TPS62230DRY	IC, 3MHz Ultra Small Step Down Converter, 2.5 V	QFN	TPS62230DRY	TI
1	U21	TPS62231DRY	IC, 3MHz Ultra Small Step Down Converter, 1.8 V	QFN	TPS62231DRY	TI
1	U31	TPS62232DRY	IC, 3MHz Ultra Small Step Down Converter, 1.2 V	QFN	TPS62232DRY	TI
6	--		Shunt, 100-mil, Black	0.100	929950-00	3M
1			PCB	1.75x3.0x0.062"	HPA370	Any

5 Related Documentation From Texas Instruments

TPS62230, TPS62231, TPS62232, 3 MHz Ultra Small Step Down Converter in 1x1.5 SON Package data sheet (SLVS941)

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This evaluation board/kit 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 customer 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 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments 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.

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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 25°C. The EVM is designed to operate properly with certain components above 25°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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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.

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.

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