PGA281EVM

This user's guide describes the characteristics, operation, and use of the evaluation module (EVM) for the PGA281. This document also includes the schematic, printed circuit board (PCB) layout, and a bill of materials (BOM). Throughout this document the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the PGA281EVM.

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1 Introduction

1.1 PGA281

The PGA281 is a high-precision instrumentation amplifier with pin-programmable gain, attenuation, and error detection. The PGA281 offers low offset voltage, near zero drift, and very low 1/f noise for high-resolution, precision measurement. The high supply voltage and excellent common-mode rejection comply with the requirements for universal industrial signal front-ends.

1.2 PGA281EVM

The PGA281EVM provides basic functional evaluation of the PGA281, along with the following features:

- Onboard power management circuitry generates all required power-supply rails from one split-supply input
- DIP switch allows easy setting of pin-programmable gain
- Error flag LED provides visual feedback of any detected error condition
- Easy access to pertinent nodes with test points, BNC connectors, and banana jacks
- Component footprints allow multiple filtering configurations

A picture of the PGA281EVM is shown in Figure 1.

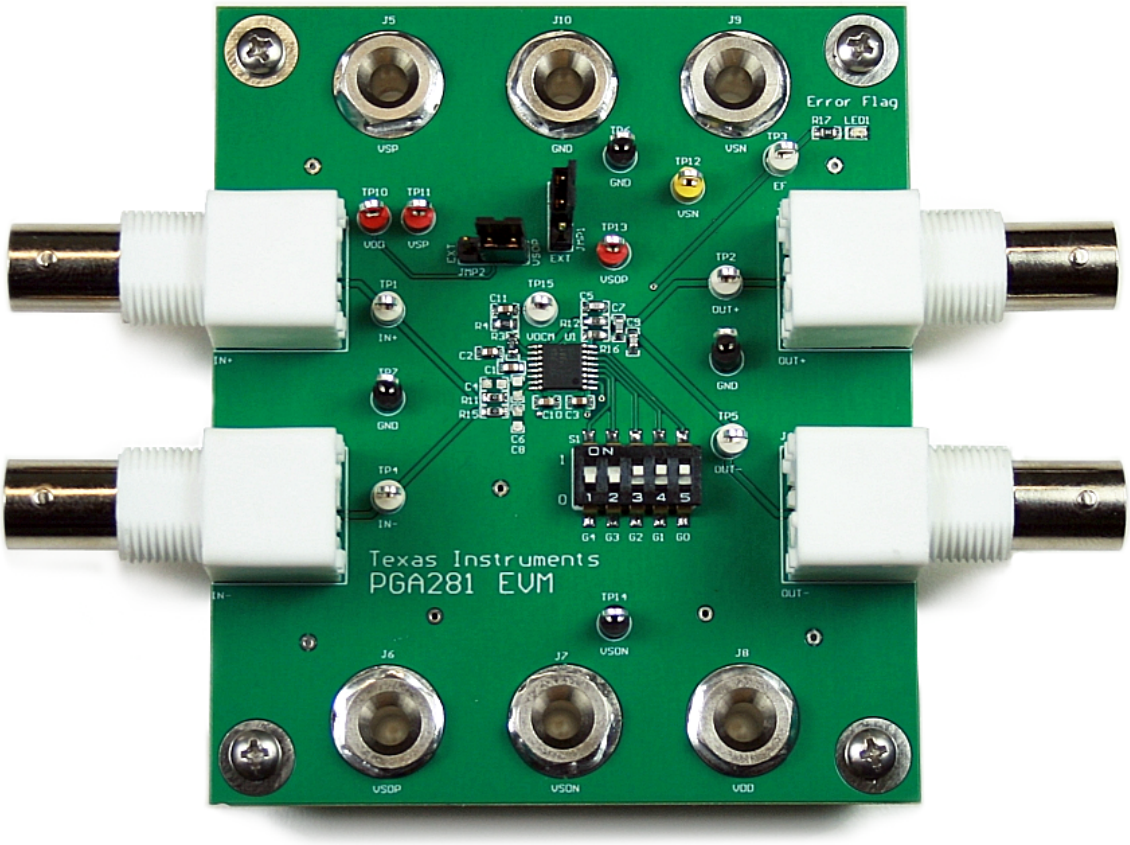


Figure 1. PGA281EVM

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2 PGA281EVM Hardware

This section discusses the PGA281EVM hardware schematics and PCB layout.

2.1 Schematic

The schematic of the PGA281EVM is shown in Figure 2.

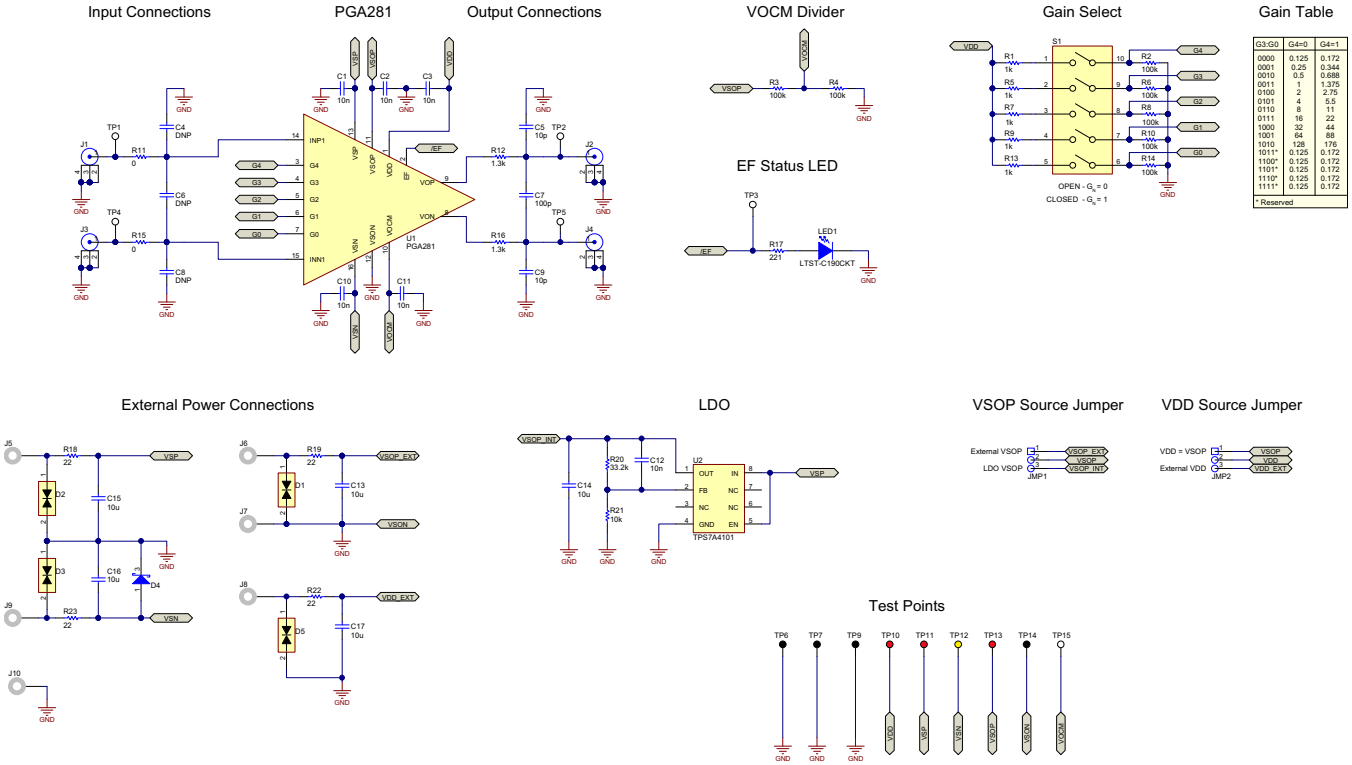


Figure 2. PGA281EVM Schematic

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2.2 Jumper Settings

The PGA281EVM jumper settings are given in Table 1. The default settings are shown in Figure 3.

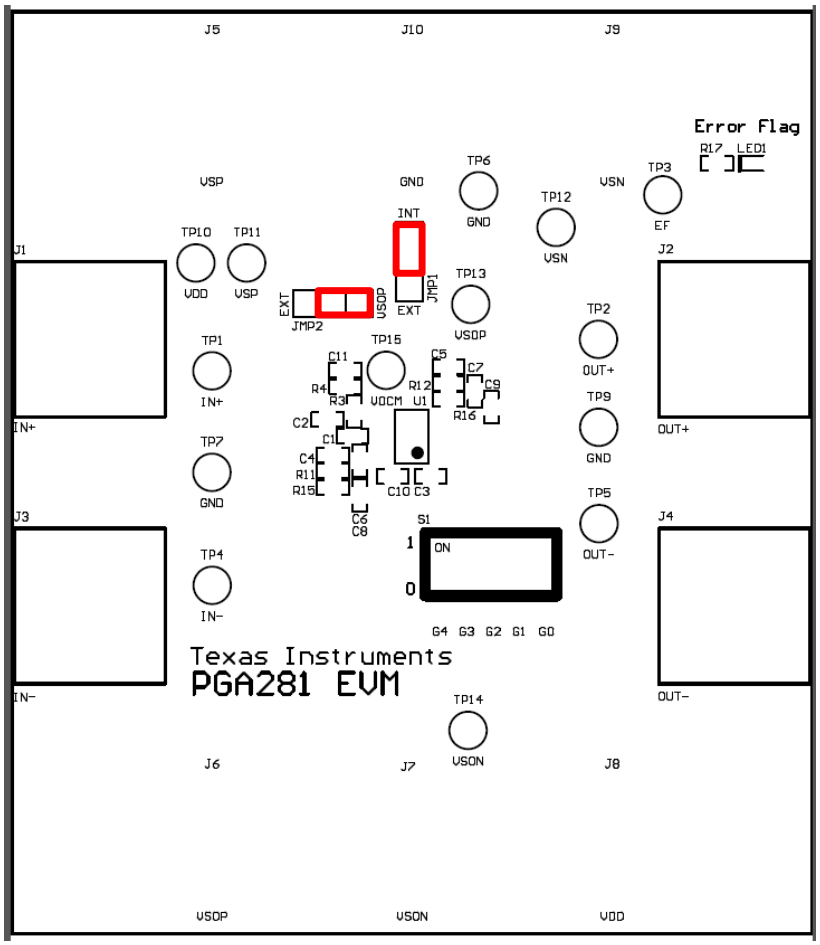


Figure 3. PGA281EVM Default Jumper Settings

Table 1. PGA281EVM Jumper Settings

Jumper	Position	Function
JMP1	INT (default)	VSOP provided by onboard low dropout (LDO) regulator
	EXT	VSOP provided externally at J6
JMP2	VSOP (default)	VDD connected to VSOP
	EXT	VDD provided externally at J8

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2.3 Power Supply Connections

Power is applied through banana connectors J5, J6, J7, J8, J9, and J10. The PGA281 requires three supply voltages: the high-voltage analog input stage supply, the low-voltage analog output stage supply, and the digital supply.

2.3.1 Analog Input Stage Power (VSP, VSN)

Power for the analog input stage is applied at J5 (VSP), J10 (GND), and J9 (VSN). The specified range for these supplies is given in Table 2.

Table 2. Analog Input Stage Power

Name	Minimum	Maximum	Description
VSP	+5 V	+18 V	Positive supply for analog input stage
GND	0 V	0 V	Ground reference voltage for analog input stage
VSN	–5 V	–18 V	Negative supply voltage for analog input stage

2.3.2 Analog Output Stage Power (VSOP, VSON)

Power for the analog output stage is applied at J6 (VSOP) and J7 (VSON). The specified range for these supplies is given in Table 3. On the PGA281EVM, VSON is always connected to GND.

Table 3. Analog Output Stage Power

NAME	MINIMUM	Maximum	Description
VSOP	+2.7 V	+5.5 V	Positive supply for analog output stage
VSON	0 V	0 V	Negative voltage/ground reference for analog output stage

2.3.3 Digital Logic Power (VDD)

Power for the digital core is applied at J8 (VDD). The specified range for VDD is the same as VSOP (+2.7 V to +5.5 V). VSON is used as the digital core ground reference.

2.3.4 Onboard LDO Regulator

The PGA281EVM contains an onboard LDO regulator (U2) that is used to generate VSOP and VDD from VSP. This configuration greatly simplifies the power connections to the PGA281EVM, because then only VSP, VSN, and GND must be provided. The LDO regulator output voltage can be adjusted by replacing resistor R20. When using the LDO regulator in this manner, set jumpers JMP1 and JMP2 to INT and VSOP, respectively.

Table 4. LDO Adjustable Output Voltages

R20 Resistance	Output Voltage
33.2 kΩ	5 V
18.2 kΩ	3.3 V

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2.4 Input/Output Connections

The PGA281 is a differential input, differential output amplifier. The input signal is applied at BNC connectors J1 (IN+) and J3 (IN–), while the output signal is measured at BNC connectors J2 (OUT+) and J4 (OUT–).

2.5 VOCM

VOCM controls the output stage common-mode voltage. On the PGA281EVM, a resistive voltage divider created by R3 and R4 sets VOCM equal to (VSOP/2).

2.6 Gain Select

Switch S1 controls the PGA281 gain. Each switch channel sets the logic level at the corresponding gain set pin. When the switch channel is on (up position), G_N = 1. When the switch channel is off (down position), G_N = 0. See Table 5 for all possible gain settings.

Table 5. PGA281 Gain Settings

G3:G0	G4 = 0	G4 = 1
0000	0.125	0.172
0001	0.25	0.344
0010	0.5	0.688
0011	1	1.375
0100	2	2.75
0101	4	5.5
0110	8	11
0111	16	22
1000	32	44
1001	64	88
1010	128	176
1011*	0.125	0.172
1100*	0.125	0.172
1101*	0.125	0.172
1110*	0.125	0.172
1111*	0.125	0.172

2.7 Error Flag

The PGA281 contains circuitry that monitors the integrity of the analog signal at several of the internal nodes. When signal conditions are outside the linear range, the error flag pin goes active (sets to V_{DD}). In an error condition, LED1 on the PGA281EVM turns on.

Error conditions include:

- Input common-mode range exceeded
- Input clamp active
- Input stage at supply rail
- Input-stage current limit exceeded
- Output stage at supply rail
- Output-stage current limit exceeded

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2.8 PGA281EVM PCB Layout

Figure 4, Figure 5, Figure 6, and Figure 7 depict the four layers of the PGA281EVM PCB layout.

NOTE: Board layouts are not to scale. These figures are intended to show how the board is laid out; they are not intended to be used for manufacturing PGA281EVM PCBs.

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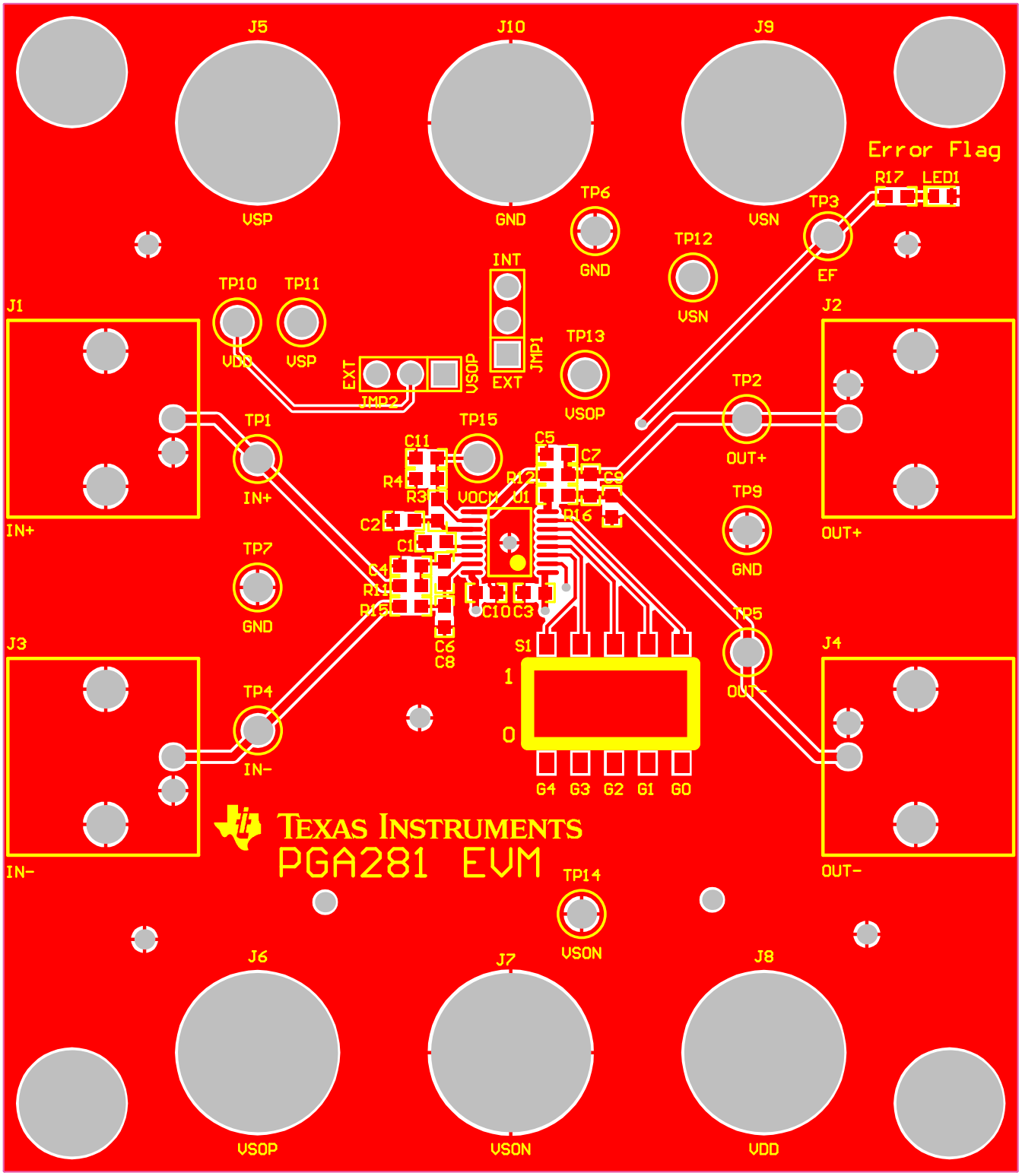


Figure 4. Top Layer (Signal and Ground)

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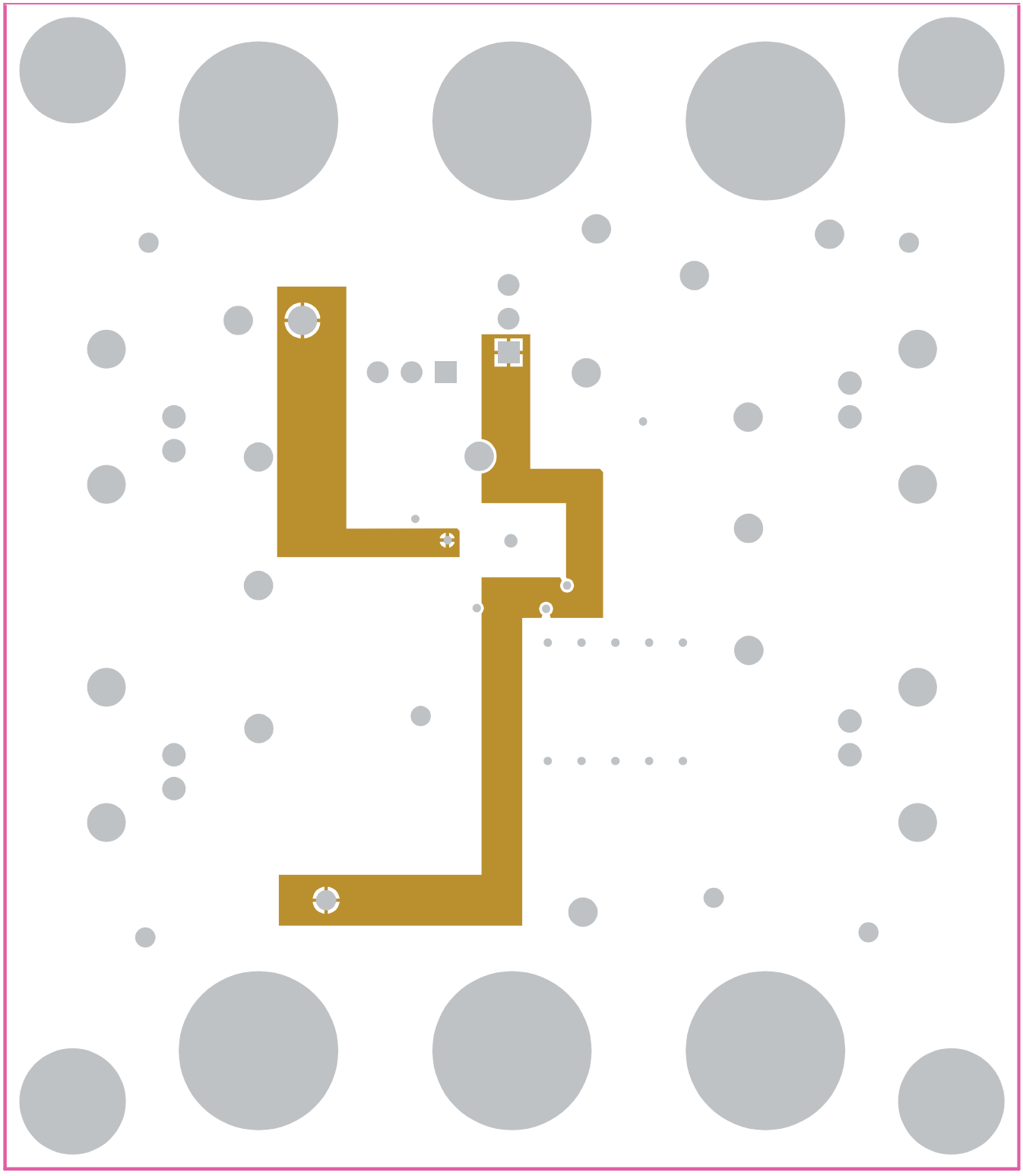


Figure 5. Layer 2 (Power)

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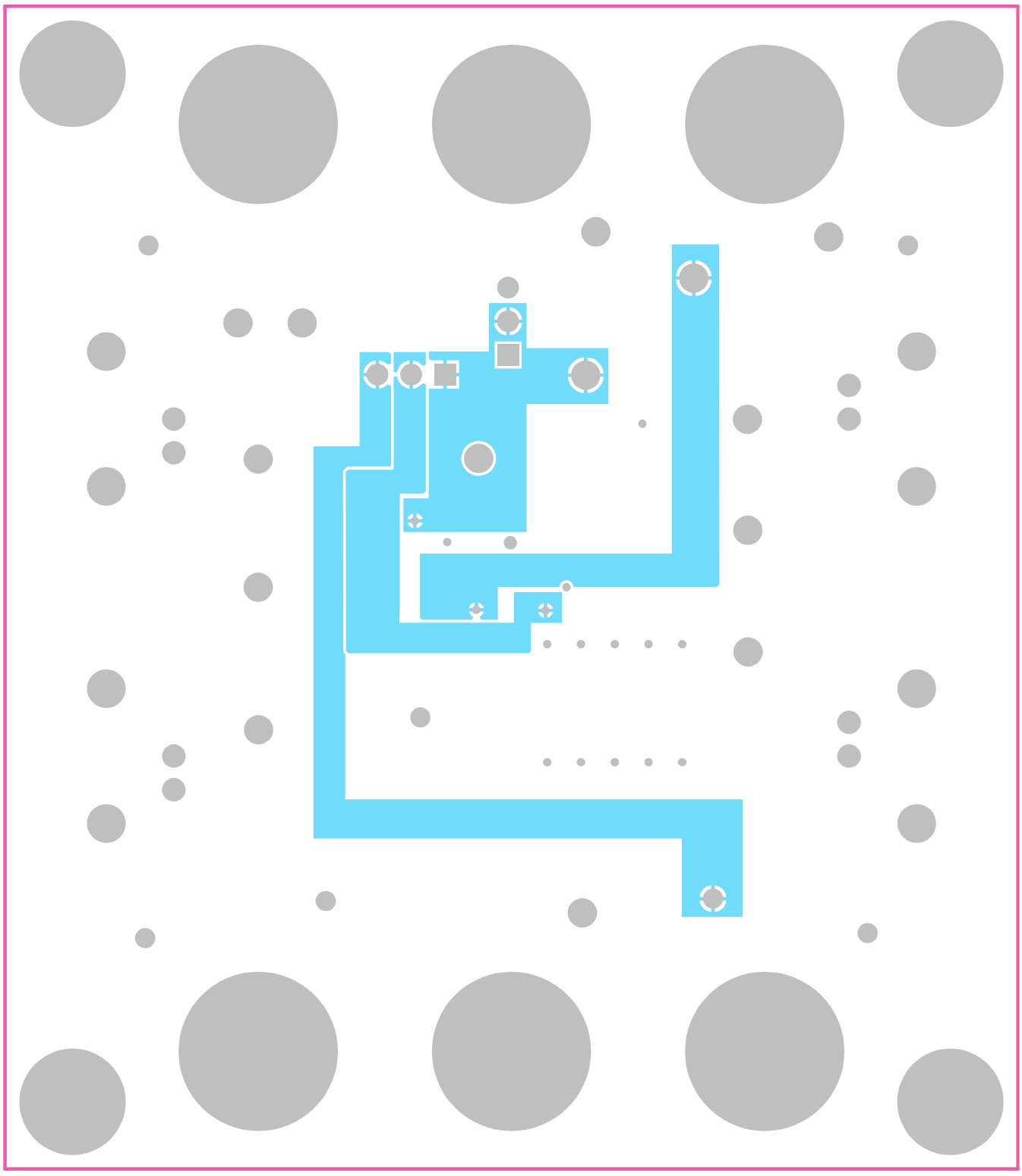


Figure 6. Layer 3 (Power)

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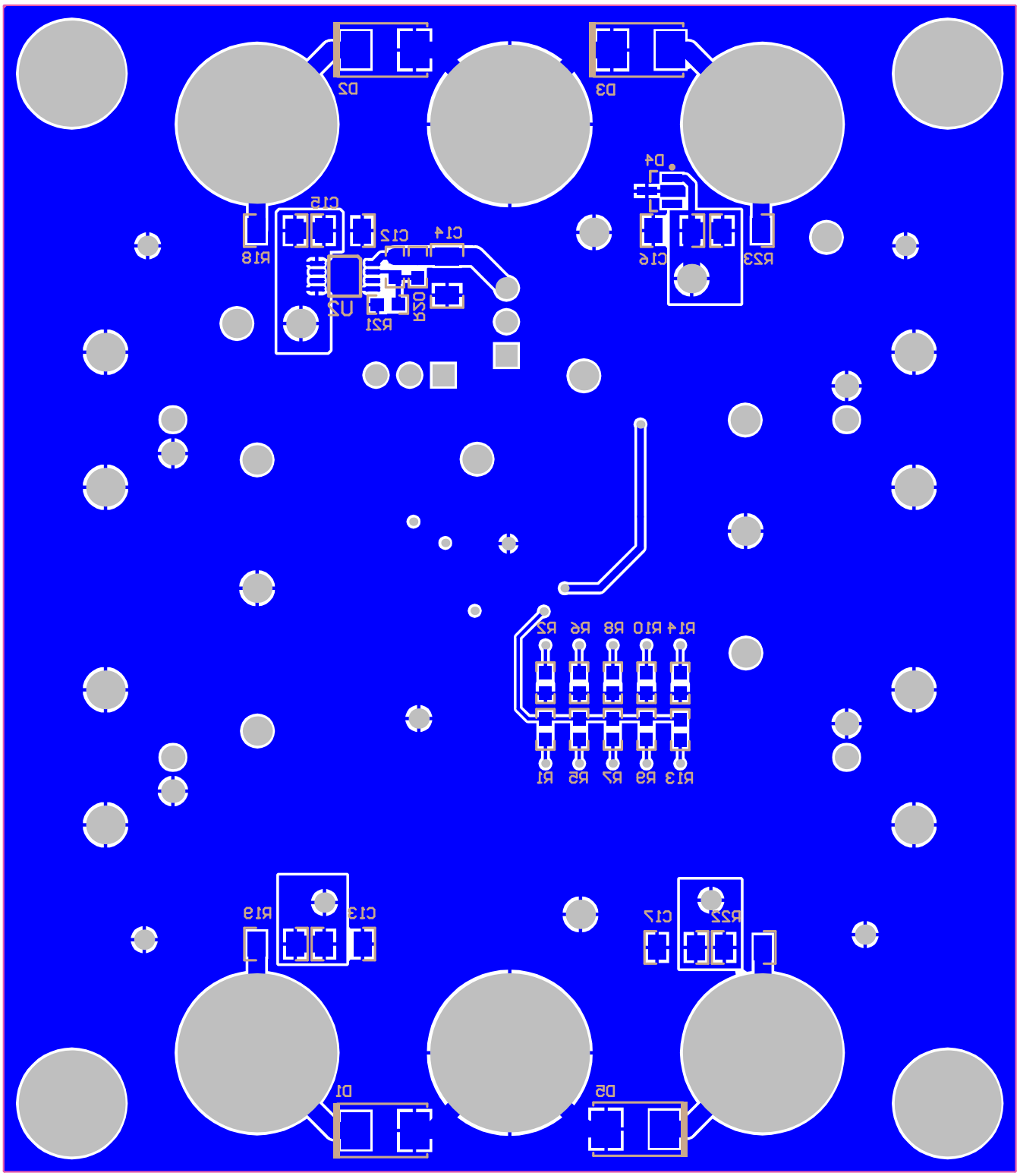


Figure 7. Bottom Layer (Power and Ground)

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3 Bill of Materials

Table 6 gives the bill of materials (BOM) used for the PGA281EVM. It also lists examples of optional components.

Table 6. PGA281EVM Bill of Materials

Count	RefDes	Value	Description	Part Number	Manufacturer
1	U1	N/A	PGA281, TSSOP-16	PGA281	Texas Instruments
1	U2	N/A	TPS7A4101, MSOP-8	TPS7A4101	Texas Instruments
5	C1-C3, C10, C11	10 nF	CAP CER 10000PF 25V 10% X7R 0603	C1608X7R1E103K080AA	TDK Corporation
2	C5, C9	10 pF	CAP CER 10PF 50V NP0 0603	C1608C0G1H100D080AA	TDK Corporation
1	C7	100 pF	CAP CER 100PF 50V 5% NP0 0603	C1608C0G1H101J080AA	TDK Corporation
1	C12	10 nF	CAP CER 10000PF 25V 5% NP0 0603	C1608C0G1E103J080AA	TDK Corporation
5	C13-C17	10 µF	CAP CER 10UF 25V 10% X7R 1206	C3216X7R1E106K160AB	TDK Corporation
2	D1, D5	N/A	TVS 6.0 VOLT 600 WATT BI-DIR SMB	SMBJ6.0CA	Littelfuse Inc
2	D2, D3	N/A	TVS 24 VOLT 600 WATT BI-DIR SMB	SMBJ24CA	Littelfuse Inc
1	D4	N/A	DIODE SCHOTTKY 30V 200MA SOT23	BAT54-V-GS08	Vishay Semiconductor
1	LED1	N/A	LED RED CLEAR 0603 SMD	LTST-C190CKT	Lite-On Inc
5	R1, R5, R7, R9, R13	1 kΩ	RES 1K OHM 1/10W 1% 0603 SMD	RMCF0603FT1K00	Stackpole Electronics Inc
7	R2-R4, R6, R8, R10, R14	100 kΩ	RES 100K OHM 1/10W 1% 0603 SMD	RMCF0603FT100K	Stackpole Electronics Inc
2	R11, R15	0 Ω	RES 0.0 OHM 1/10W JUMP 0603 SMD	ERJ-3GEY0R00V	Panasonic Electronic Components
2	R12, R16	1.3 kΩ	RES 1.3K OHM 1/16W .5% 0603 SMD	RR08P1.3KDCT-ND	Susumu
1	R17	221 Ω	RES 221 OHM 1/10W 1% 0603 SMD	RMCF0603FT221R	Stackpole Electronics Inc
4	R18-R19, R22-R23	22 Ω	RES 22 OHM 1/4W 5% 1206 SMD	RMCF1206JT22R0	Stackpole Electronics Inc
1	R20	33.2 kΩ	RES 33.2K OHM 1/10W .1% 0603 SMD	ERA-3AEB3322V	Panasonic Electronic Components
1	R21	10 kΩ	RES 10.0K OHM 1/10W .1% 0603 SMD	RG1608P-103-B-T5	Susumu
1	Q1	N/A	SWITCH DIP 5POS TOP ACT GULLEAD	A6S-5104-H	Omron Electronics Inc
6	TP1-TP5, TP15	N/A	TEST POINT WHITE	5012	Keystone Electronics
5	TP6-TP9, TP14	N/A	TEST POINT BLACK	5011	Keystone Electronics
3	TP10, TP11, TP13	N/A	TEST POINT RED	5010	Keystone Electronics
1	TP12	N/A	TEST POINT YELLOW	5014	Keystone Electronics
6	J5-J10	N/A	CONN JACK BANANA UNINS PANEL MOUNT	108-0740-001	Emerson Network Power
4	J1-J4	N/A	CONN SOCKET BNC R/A 75 OHM PCB	1-1478032-0	TE Connectivity
2	JMP1, JMP2	N/A	CONN HEADER .100 SNGL 3POS	TSW-103-07-G-S	Samtec
4	Screws	N/A	SCREW MACHINE PHILLIPS 4-40X3/8	PMS 440 0038 PH	B&F Fastener Supply
4	Standoffs	N/A	STANDOFF HEX 4-40THR ALUM .500"L	2203	Keystone Electronics
Not Installed	C4, C6, C8	N/A	Capacitor, 0603	N/A	N/A

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4 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments' integrated circuits and support tools for the PGA281EVM. This user's guide is available from the TI web site under literature number ***SBOU130***. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the TI web site, or call the Texas Instruments' Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Related Documentation

Document	Literature Number
PGA281 Product Data Sheet	SBOS664

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

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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