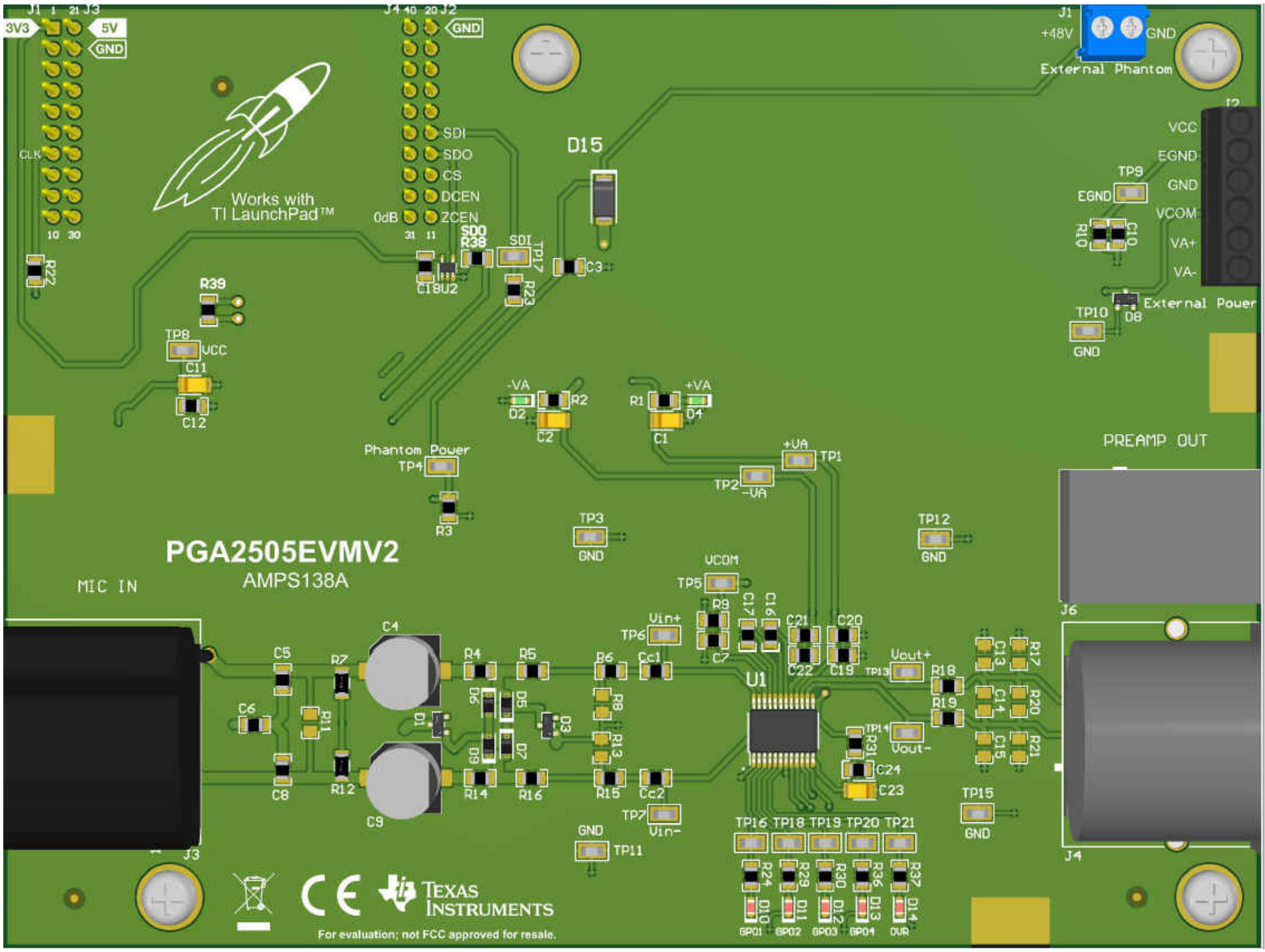
User's Guide

PGA2505EVMV2 Evaluation Module

ABSTRACT



This user's guide describes the characteristics, operation, and use of the PGA2505EVMV2, a refreshed evaluation module (EVM) compatible with the PGA2505 on a modern operating system. This document includes the schematic, printed circuit board (PCB) layout, and bill of materials (BOM). Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the universal PGA2505EVMV2.

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Trademarks

MSP430™ is a trademark of Texas Instruments.
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1 Product Overview

The PGA2505 is a digitally-controlled, microphone preamplifier integrated circuit designed for amplifying the output of dynamic and condenser microphones and driving high-performance audio analog-to-digital converters (ADCs). Figure 1-1 shows a functional block diagram of the PGA2505.

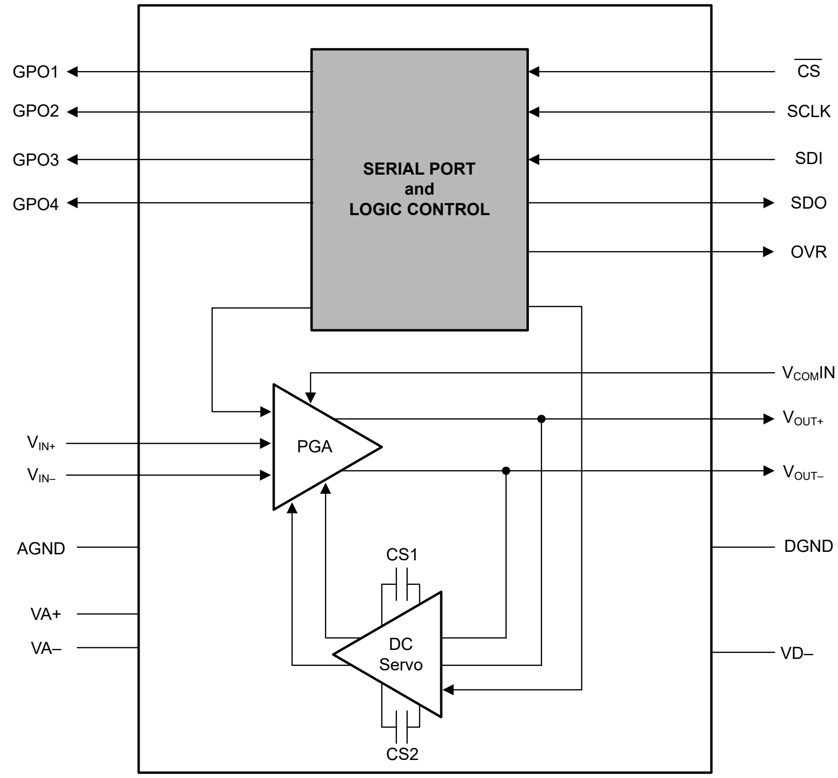

Figure 1-1. PGA2505 Functional Block Diagram

The analog input to the preamplifier is provided differentially at the VIN+ and VIN− inputs (pins 24 and 23, respectively). The programmable gain amplifier can be programmed to either pass through the signal at unity gain, or apply 9 dB to 60 dB of gain to the input signal. The gain of the amplifier is adjustable over the full 9-dB to 60-dB range in 3-dB steps. The differential output of the PGA2505 is made available at VOUT+ and VOUT− (pins 15 and 14, respectively). Gain is controlled using a MSP430F5529 microcontroller and PGA2505EVMV2 graphical user interface (GUI), which can be accessed here. The microcontroller and GUI are used to program the PGA2505 gain and support functions, as shown in Figure 1-2.

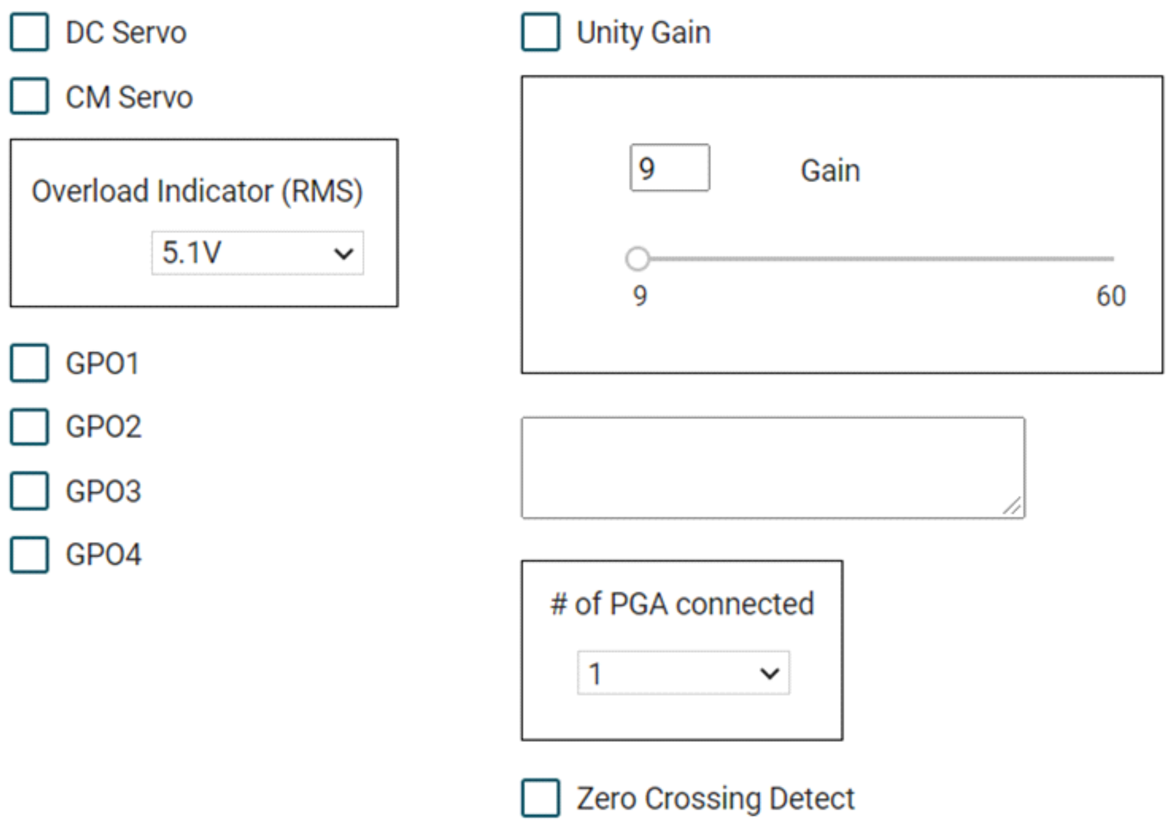

Figure 1-2. PGA2505EVMV2 GUI

A 16-bit control word is utilized to program these functions; see Figure 1-3.

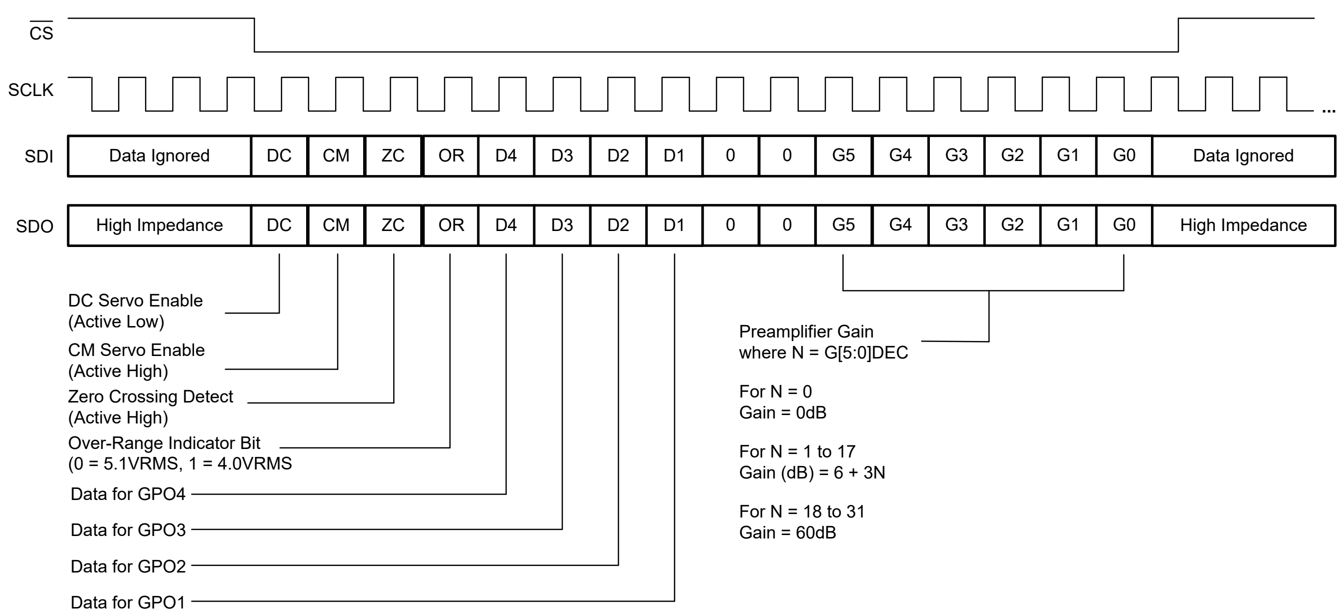

Figure 1-3. PGA2505 16-Bit Control

The differential analog output of the PGA2505 is constantly monitored by a dc servo amplifier loop. The purpose of the servo loop is to minimize the dc offset voltage present at the analog outputs by feeding back an error signal to the input stage of the programmable gain amplifier. The error signal is then used to correct the offset.

The dc servo may be enabled by checking the *DC Servo* checkbox in the GUI. To disable this function, leave the *DC Servo* checkbox in the GUI unchecked.

Two external capacitors are required for the dc servo function, with one capacitor connected between CS11 (pin 21) and CS12 (pin 20), and the second capacitor connected between CS21 (pin 19) and CS22 (pin 18). Capacitor values up to 4.7 μF may be used. However, larger-value capacitors result in longer settling times for the dc servo loop. A value of 1 μF is recommended for use in most microphone preamplifier applications.

The PGA2505 includes a common-mode servo function. This function is enabled and disabled using the CM bit in the serial control word, as shown in Figure 1-3, or by checking the *CM Servo* checkbox in the GUI. When enabled, the servo provides common-mode negative feedback at the input differential pair, resulting in very low common-mode input impedance. The differential input impedance is not affected by this feedback. This function is useful when the source is floating, or has a high common-mode output impedance. In this case, the only connection between the source and the ground is through the PGA2505 preamplifier input resistance.

In this case, input common-mode parasitic current is determined by high output impedance of the source, not by input impedance of the amplifier. Therefore, input common-mode interference is reduced by lowering the common-mode input impedance while not increasing the input common-mode current. Increasing common-mode current degrades common-mode rejection. Using the common-mode servo, overall common-mode rejection is improved by suppressing low and medium frequency common-mode interference.

The common-mode servo function is designed to operate with a total common mode input capacitance (including the microphone cable capacitance) of up to 10 nF. Beyond this limit, stable servo operation is not ensured.

The common-mode voltage control input, VCOMIN (pin 22), allows the PGA2505 output and input to be dc biased to a common-mode voltage between 0 V and 2.5 V. The VCOMIN pin allows for a dc-coupled interface between the PGA2505 preamplifier output and the inputs of common, single-supply, audio analog-to-digital converters (ADCs).

The PGA2505 may be forced to unity. Check the *Unity Gain* checkbox in the GUI to activate this function.

The zero-crossing control input is provided for enabling and disabling the internal zero-crossing detector function. Forcing the zero-crossing input high enables the function, check the *Zero Crossing Detect* checkbox in the GUI to activate this function. Zero-crossing detection is used to force gain changes on zero crossings of the analog input signal. This limits the glitch energy associated with the switched gain network, thereby minimizing audible artifacts at the preamplifier output. Zero-crossing detection can add some delay when performing gain changes (up to 16 ms maximum for a detector timeout event). Therefore, there may be cases where the function must be discabled. Forcing the zero cross detect input low (unchecking the checkbox in the GUI) disables zero-crossing detection, with gain changes occurring immediately when programmed.

An overflow indicator output, OVR, is provided at pin 6. The OVR pin is an active high, CMOS-logic-level output. The overflow output is forced high when the preamplifier output voltage exceeds one of two preset thresholds. The threshold is programmed through the GUI using the *Overload Indicator (RMS)* drop-down menu. When the *Overload Indicator (RMS)* option is set to *5.1V* RMS differential, that is approximately −1 dB less than the specified output voltage range. When the *Overload Indicator (RMS)* option is set to *4.0V* RMS differential, that is approximately −3 dB less than the specified output voltage range.

The PGA2505 includes four general-purpose, programmable digital outputs, GPO1 through GPO4 (pins 2 through 5, respectively), that are controlled using the GUI checkboxes. All four pins are CMOS-logic-level outputs. These pins may be used to control relay drivers or switches used for external preamplifier functions, including input pads, filtering, polarity reversal, or phantom power.

2 Features

The PGA2505EVMV2 provides a convenient platform for evaluating the performance and features of the PGA2505 product. Key EVM features include the following:

- Accepts either XLR or TRS balanced input connections
- Configurable front-end circuit options for prototyping pads and filters
- XLR and TRS balanced output with flexible output loading options
- LED indicators for GPOs and the over range output
- Common-mode voltage input (VCOMIN) pin
- Includes applications software that is compatible with personal computers that include a built-in USB port
- Requires +5-V and −5-V analog supplies, as well as a +5-V digital supply
  - Leave the +5-V digital supply (VCC) unconnected if using the MSP-EXP430F5529LP

3 Getting Started

This section provides information regarding PGA2505EVMV2 handling and unpacking, as well as the absolute operating conditions.

3.1 Electrostatic Discharge Caution

CAUTION

Many of the components on the PGA2505EVMV2 are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM. Failure to observe ESD handling procedures may result in damage to the EVM components.

3.2 Unpacking the EVM

In addition to the PGA2505EVMV2 evaluation module board, order and unpack the MSP-EXP430F5529LP, MSP430F5529 USB LaunchPad development kit. Plug in the MSP430™ microcontroller on top of the PGA2505EVMV2, as shown in Figure 3-1.

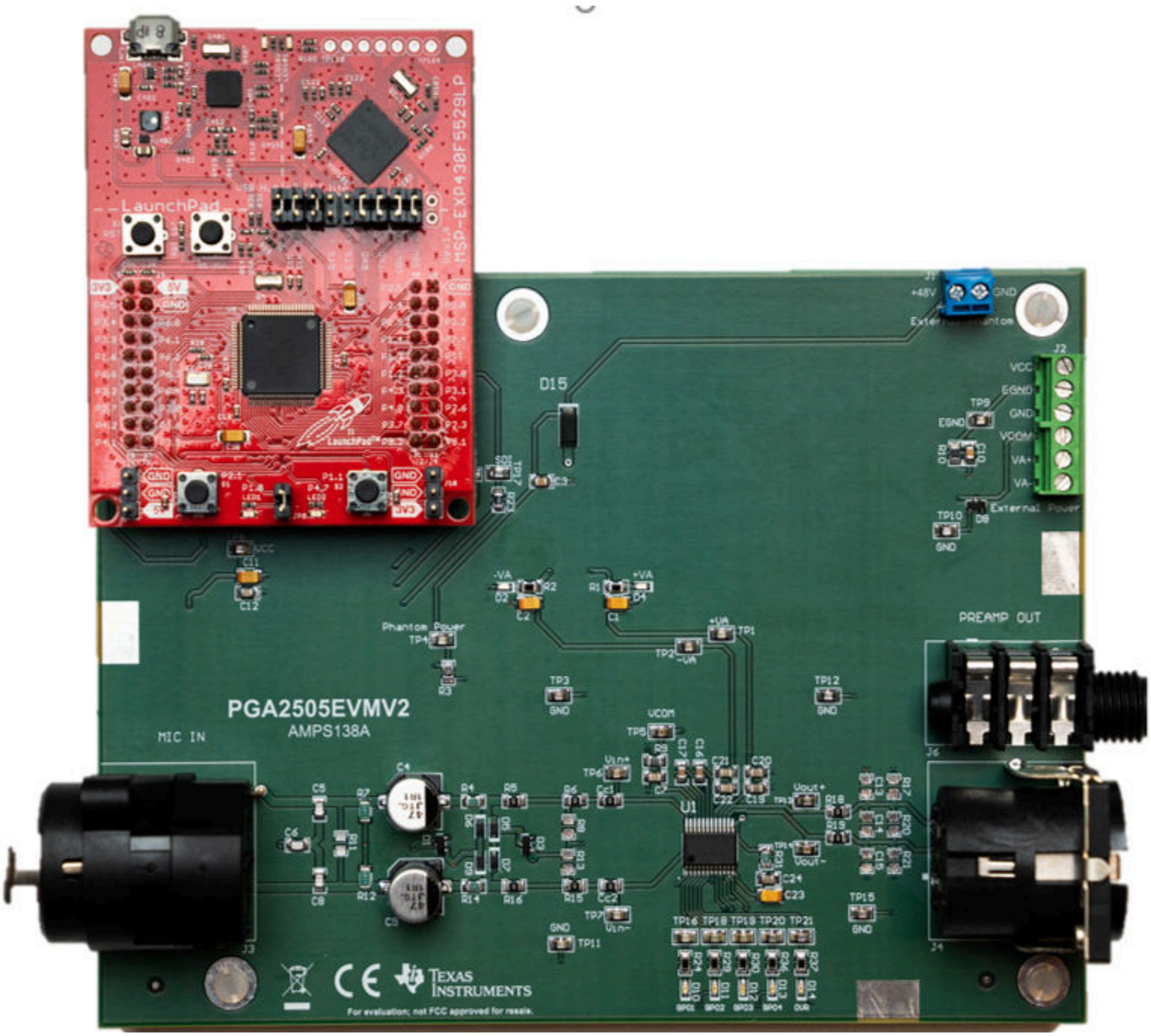

Figure 3-1. PGA2505EVMV2 With MSP430™ Microcontroller Connected

3.3 Absolute Maximum Operating Conditions

Be aware of the absolute maximum operating conditions for the evaluation module. Table 3-1 summarizes the critical data points.

CAUTION
Exceeding absolute maximum operating conditions may cause damage to the device.

Table 3-1. PGA2505EVMV2 Absolute Maximum Ratings

Description		Rating
Power-supply voltages	VA+	+5.5 VDC maximum
	VA–	–5.5 VDC maximum
	VCOM	–0.3 VDC minimum to (VA+) +0.3 VDC maximum
	VCC	+5.5 VDC maximum
	Phantom power	+50 VDC maximum
Microphone input (J3), XLR, or TRS maximum input voltage, differential		20 V_{PP} (or 7 V RMS) maximum
Preamplifier output (J6) maximum output voltage, differential		17.5 VPP (or 6.2 V RMS) maximum

4 Setup Guide

This section provides descriptions of the hardware components that make up the PGA2505EVMV2. In addition, configuration information for power supplies, analog input and output connections, switches, and jumpers are provided.

4.1 Analog and Digital Power Supplies

All analog and digital power supplies are connected through terminal block J2, as shown in Figure 4-1. Recommended power-supply connections are as follows:

- +VA and –VA are +5 V and –5 V, respectively
- Connect EGND to earth or chassis ground of the power supply
- Connect GND to common ground
- Leave VCC unconnected if using the MSP-EXP430F5529LP

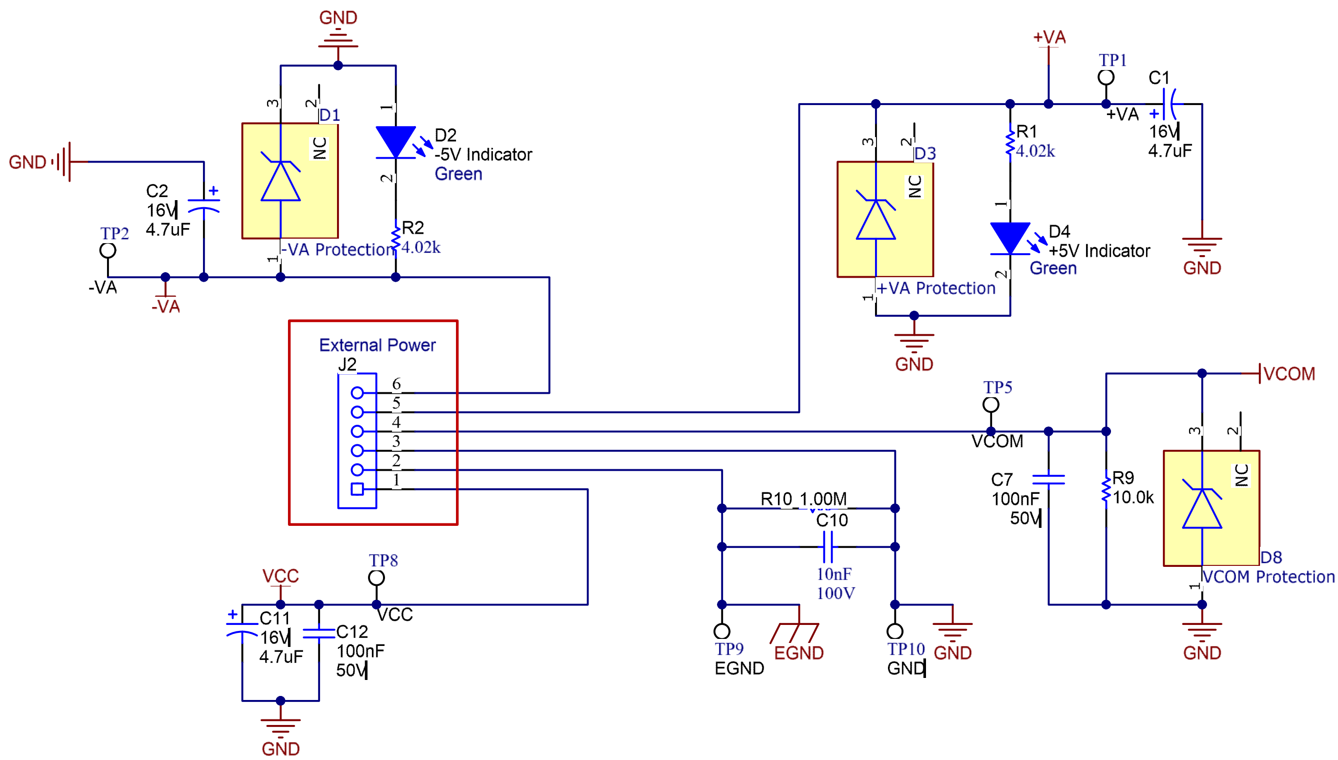

Figure 4-1. Power Terminal Block J2 Schematic

The PGA2505EVMV2 requires two analog supplies and one digital power supply. The analog supplies are VA+ and VA−, respectively. VA+ is typically set to +5.0 VDC, while VA− is typically set to −5.0 VDC. The analog supplies power the PGA2505 microphone preamplifier integrated circuit. The digital power supply, VCC, is unconnected if using the MSP-EXP430F5529LP.

An optional third analog power supply may be used for the PGA2505 common-mode dc voltage input, VCOMIN (pin 22). VCOMIN allows the PGA2505 output and input to be dc biased to a common-mode voltage between 0 V and 2.5 V, and is connected through terminal block J2. The common-mode voltage biases both the output and input terminals of the PGA2505, with the output pins biased to the VCOMIN voltage level and the input pins biased to approximately VCOMIN − 0.65 V.

The GND terminal of connector J2 serves as the common ground connection for both the analog and digital sections of the PGA2505EVMV2. Connect the EGND (earth ground) terminal to the earth or chassis ground of the power supply. The common ground (GND) and earth ground (EGND) are connected to one another using a 0.1-µF capacitor (C10).

4.2 Microphone Input

Dynamic and condenser microphones or audio test equipment are connected to the PGA2505EVMV2 input through combo connector J3. The combo connector combines both a 3-pin female XLR and a 1/4-inch TRS jack for connecting to microphones and test signal sources. Both the XLR and TRS jacks are wired for a balanced input. Figure 4-2 illustrates the combo connector pin configuration for the PGA2505EVMV2.

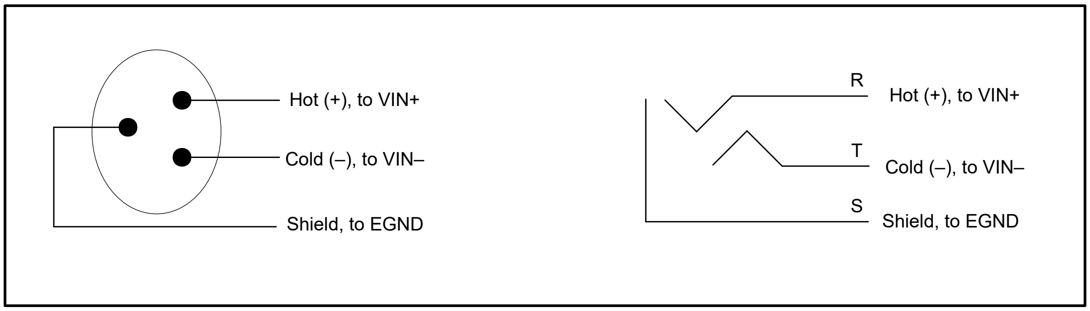

Figure 4-2. Microphone Input Connector Configuration

4.3 Phantom Power Connections

The PGA2505EVMV2 supports connection of a phantom power source across the inputs of the preamplifier using terminal block J1. The voltage source is connected to the hot (+) and cold (−) sides of the preamplifier input through 6.81-kΩ resistors. Phantom power may be operated at voltages up to 50 VDC.

Phantom power is required for condenser microphones. When using a condenser microphone requiring a phantom power source, short pins 1 and 2 of jumper JMP1, and leave pins 3 and 4 open.

CAUTION

Be aware that when using a phantom power source, connect the microphone and cable before turning on phantom power. Make sure to turn off phantom power before disconnecting the microphone or cable. Making or breaking the input connection with 48 V may cause large transient spikes that could damage the PGA2505 or anything connected to the output.

In addition, When using a dynamic microphone, short pins 3 and 4 of jumper J3, and leave pins 1 and 2 open.

4.4 DC Blocking Capacitors

Capacitors C4 and C9 are used as dc blocking capacitors. They provide ac coupling to the microphone input, as well as block the phantom voltage from reaching the PGA2505 input terminals when using a condenser microphone. The blocking capacitors are selected to not degrade the dynamic performance of the PGA2505. The capacitors shown in the bill of materials (see Table 6-1) are installed by default at the factory. If using an alternative capacitor, use components rated for 50 V minimum, with 63 V or greater recommended for long-term reliability.

4.5 Protection Network

Resistors R4 and R14, along with Schottky diodes D5, D6, D7 and D9, provide input protection for the PGA2505 preamplifier when using phantom power, or when the input voltage exceeds the VA+ or VA− power supplies by more than 350 mV (the approximate turn-on voltage of the Schottky diodes).

A common fault condition is for either the hot (+) or cold (−) input of the preamplifier to be shorted to ground. With phantom voltage applied, this causes the blocking capacitors to discharge, with a large surge current presented at the PGA2505 input pins. Without the protection network, the PGA2505 can be permanently damaged by the surge current, which can reach several amperes in peak magnitude.

The Schottky diodes are forced into conduction during this fault condition, steering most of the charge away from the PGA2505 device and towards the power supplies. The series resistors can be set to a value that helps limit the input current; however, take care to avoid adding too much resistance because the added noise can degrade the overall performance of the preamplifier. The Schottky diodes add a nonlinear capacitance to the input circuit, which can result in additional distortion. However, with the relatively small input voltage swing present when the preamplifier is set to gains between 9 dB and 60 dB, the effect on the THD+N of the PGA2505 is small or negligible. For unity-gain applications, where the voltage swing may become large enough in magnitude to transition over a greater portion of the diodes nonlinear capacitance, the THD+N ratio may degrade by as much as 3 dB from the published typical performance specifications.

4.6 Configurable Input Circuitry

The configurable portion of the input circuit includes R5, R6, R8, R13, R15, R16, Cc1, and Cc2. These components support prototyping of additional circuitry, such as pads and filters. During assembly at the factory, resistors R8 and R13 are not installed, while R5, R6, R15, R16, Cc1, and Cc2 are replaced by 0-Ω shunt resistors.

4.7 Configurable Output Circuitry and Preamp Output Connector

The configurable portion of the output circuit includes R17, R18, R19, R20, R21, C13, C14, and C15. These components support prototyping of additional circuitry, such as pads and filters, as well as emulation of various loading conditions. During assembly at the factory, resistors R18 and R19 are replaced by 0-Ω shunt resistors. Resistors R17, R20, and R21, as well as capacitors C13 through C15, are not installed. The differential preamplifier output is provided at J4, a 3-pin male XLR connector, or at J6, a 1/4-inch TRS connector.

5 Software Operation

This section provides instructions for using the PGA2505EVMV2 application software and using the software to control the PGA2505 gain and support functions.

5.1 Applications Software Overview

The applications software supplied with the PGA2505EVMV2 allows the user to control the board using an online GUI, found here. All programmable functions are supported.

5.2 Using the GUI

The following steps describe how to connect the EVM boards to a computer:

1. Connect the MSP-EXP430F5529LP to the PGA2505EVMV2 board.
2. Connect the micro USB end of the provided USB cable into the MSP430 board, and the other end of the USB cable into an open USB port on the computer.
3. Launch the GUI to automatically flash the microcontroller and adjust all programmable functions. Successful flash can be visually confirmed by the GPO LEDs flashing in sequence.
4. Manually set the COM port in the GUI composer to the COM port titled *Microsoft* after the successful flash by clicking *File* → *Options* → *Serial Port*.

When successfully connected to the microcontroller through the serial COM port, the MSP430 acknowledges successful GUI control actions by printing to the textbox shown in Figure 5-1.

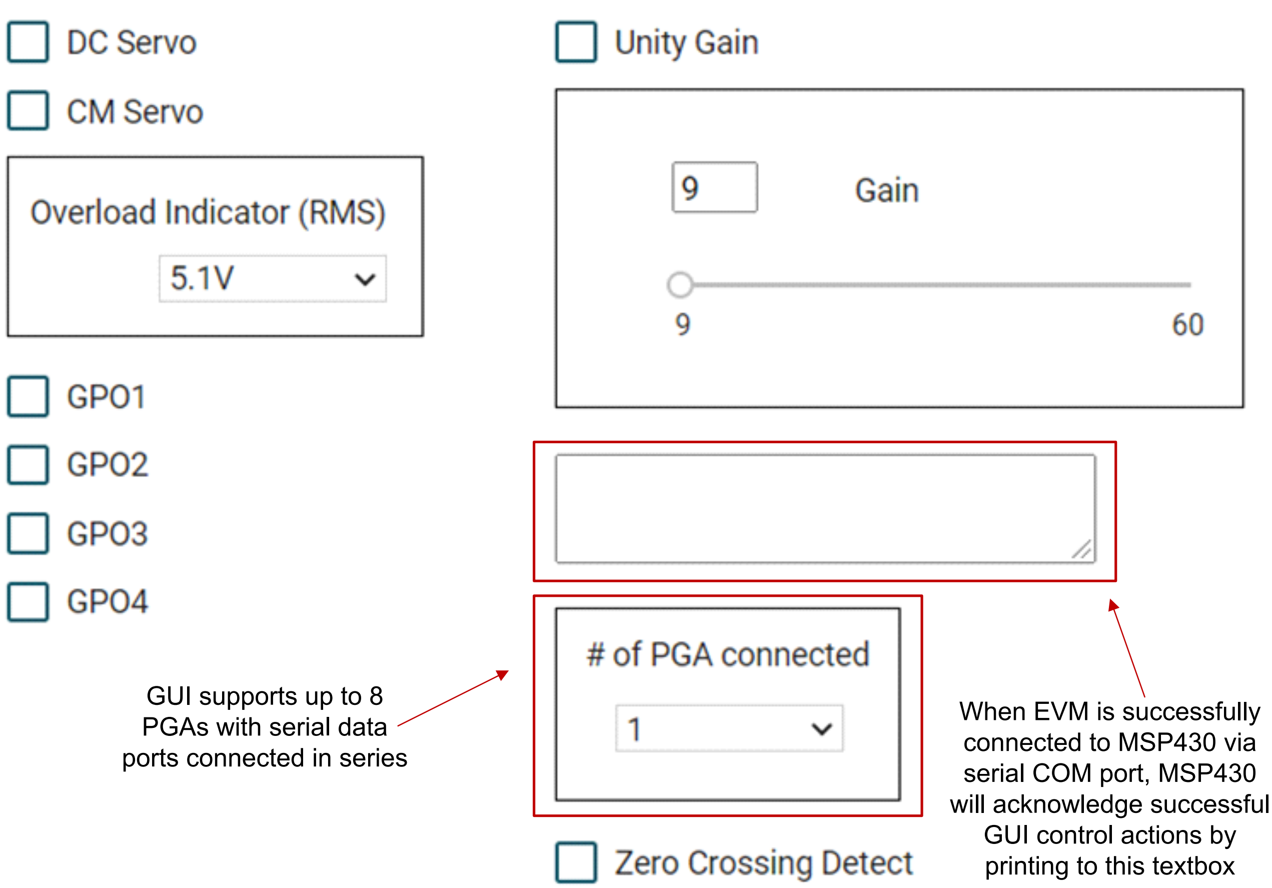

Figure 5-1. PGA2505EVMV2 GUI With Programmable Functions

6 Schematic, PCB Layout, and Bill of Materials

This section provides the electrical schematic and physical PCB layout information for the PGA2505EVMV2. The bill of materials is included for component reference.

6.1 Schematic

The complete electrical schematic for the PGA2505EVMV2 is shown in Figure 6-1. See the bill of materials in Table 6-1 for descriptions of components shown in the schematic.

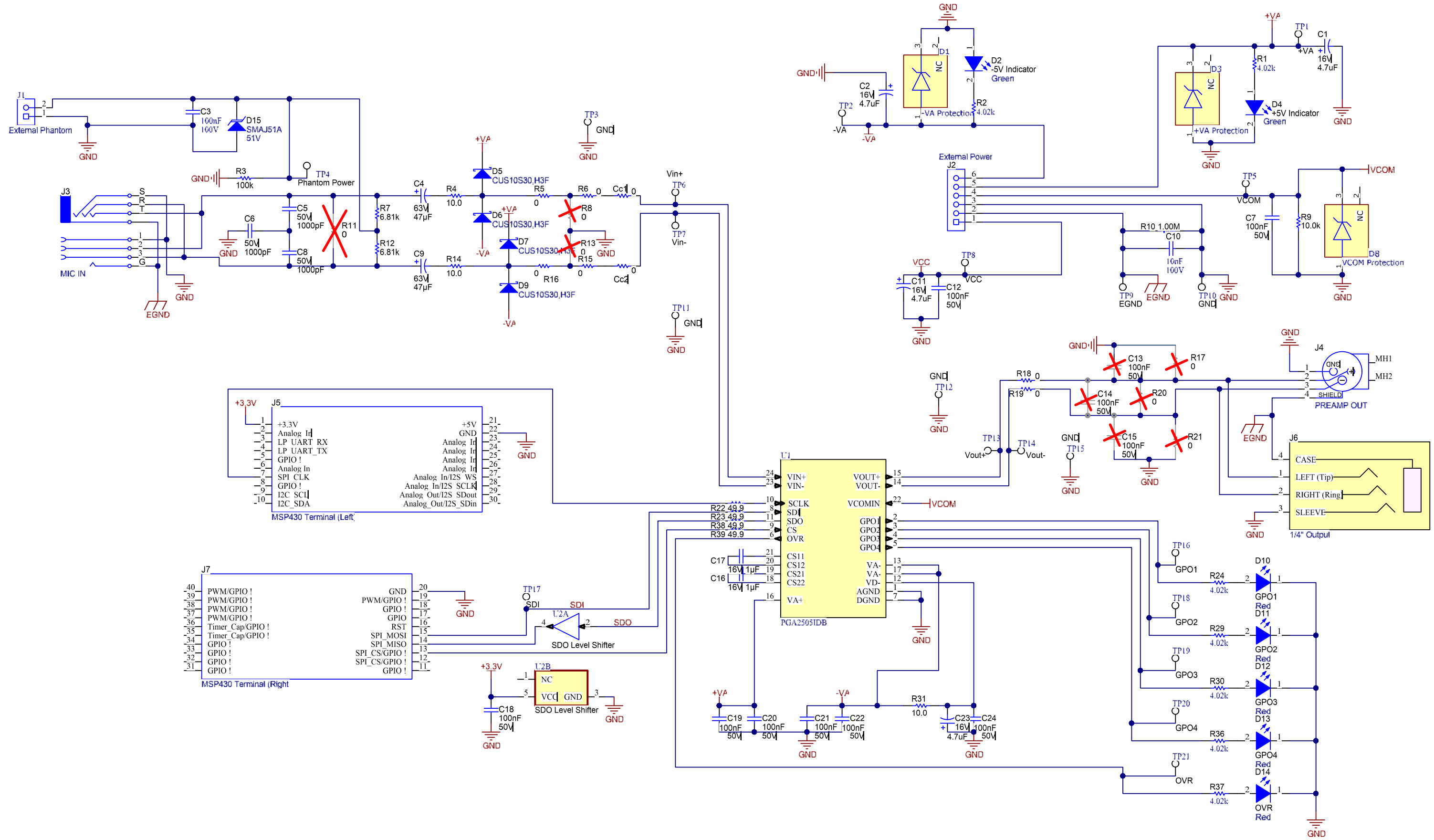

Figure 6-1. PGA2505EVMV2 Schematic

6.2 PCB Layout

The PGA2505EVMV2 is a four-layer printed circuit board using both through-hole and surface-mount components.

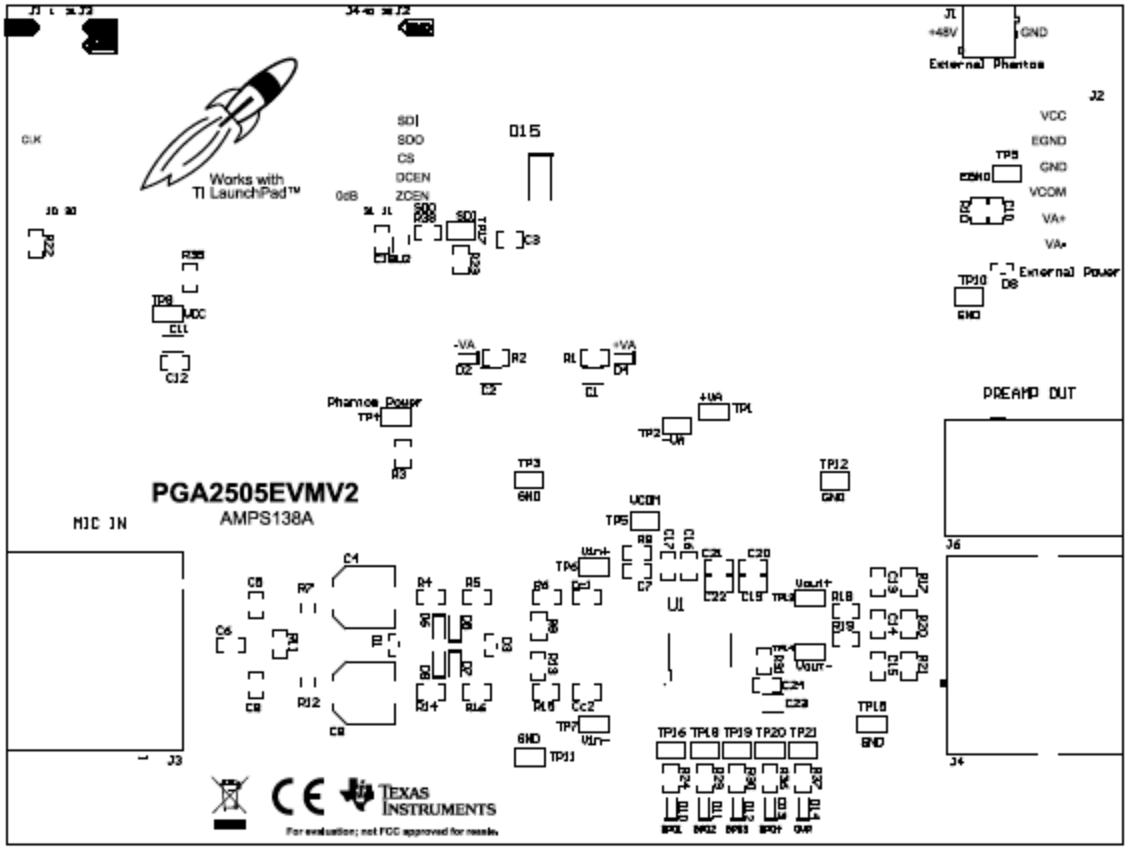

Figure 6-2. PGA2505EVMV2 Top Overlay

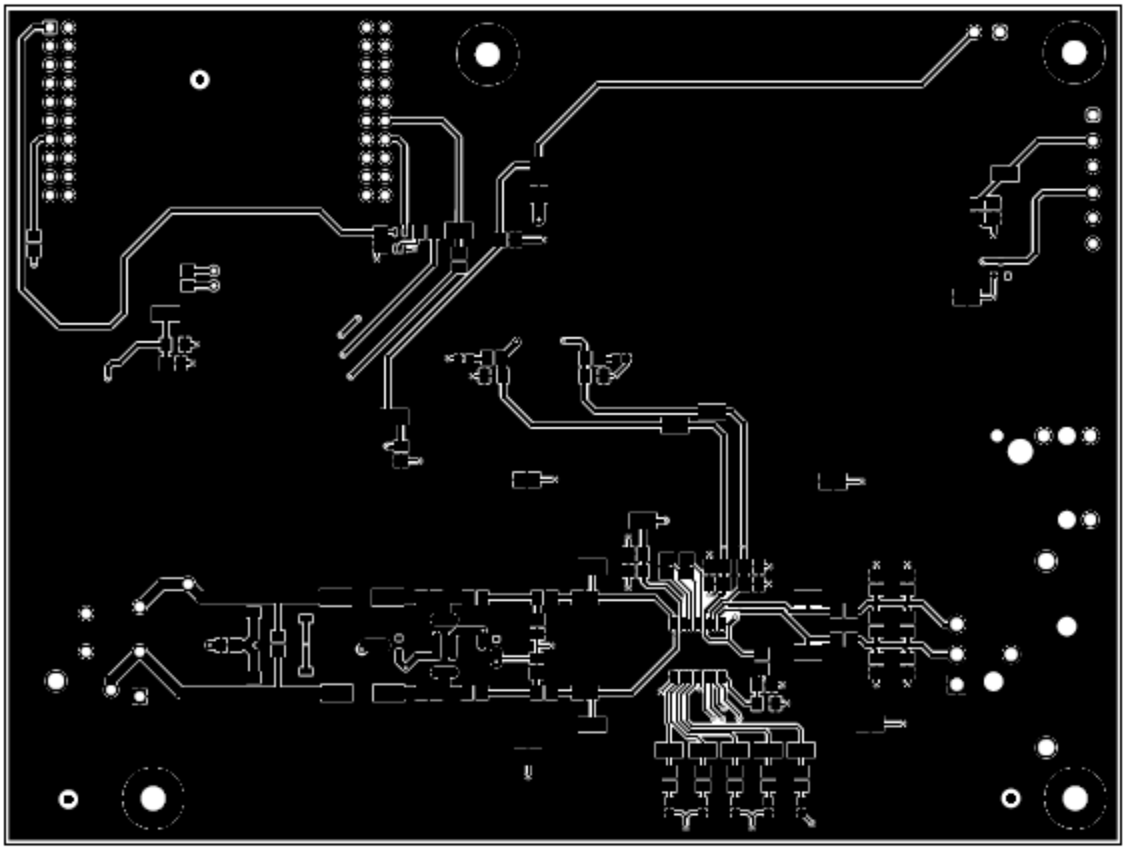

Figure 6-3. PGA2505EVMV2 Top Layer

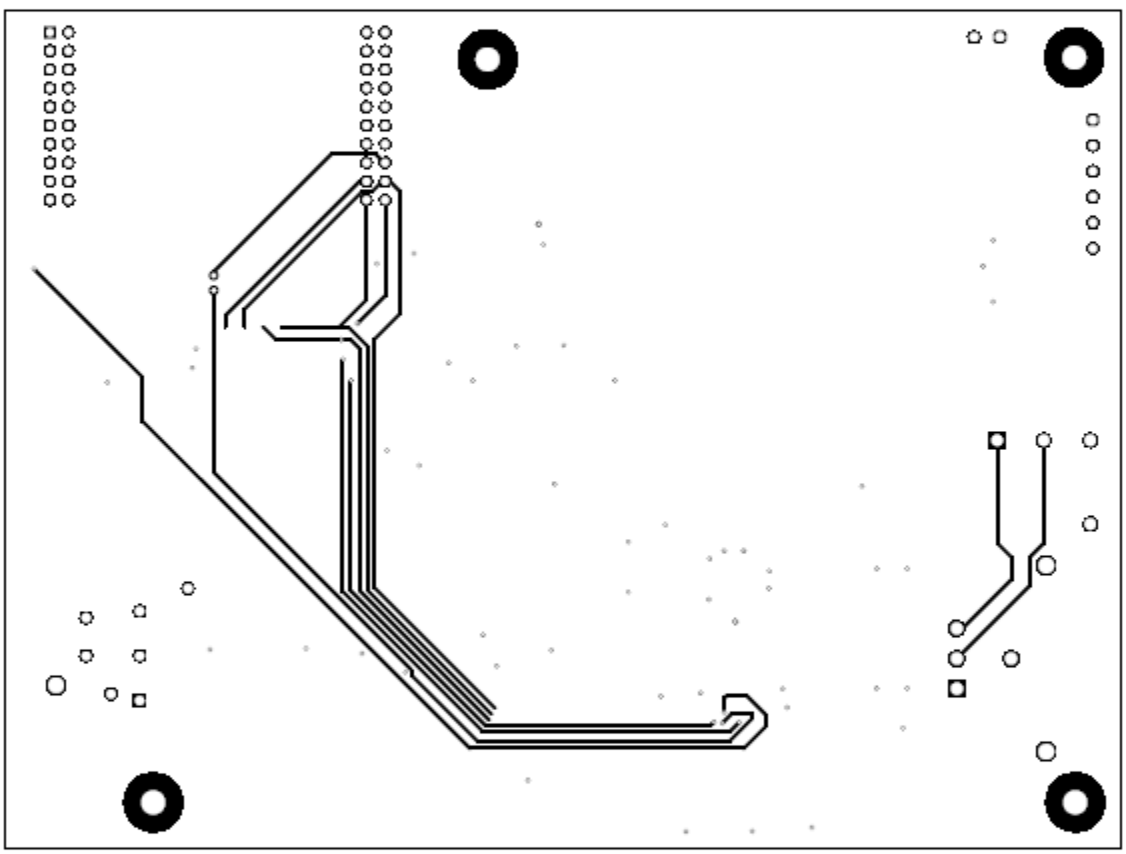

Figure 6-4. PGA2505EVMV2 Bottom Layer

6.3 Bill of Materials

Table 6-1 lists the complete bill of materials for the PGA2505EVMV2. Data for each component is available from the corresponding manufacturer's web site.

Table 6-1. PGA2505EVMV2 BOM

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		AMPS138	Any
C1, C2, C11, C23	4	4.7uF	CAP, TA, 4.7 uF, 16 V, +/- 10%, 4 ohm, SMD	3216-18	TAJA475K016RNJ	AVX
C3	1	0.1uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, 0805	0805	C0805C104K1RACTU	Kemet
C4, C9	2	47uF	CAP, AL, 47 µF, 63 V, +/- 20%, 1 ohm, AEC-Q200 Grade 1, SMD	D8xL10.2mm	EEETG1J470UP	Panasonic
C5, C6, C8	3	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0805	0805	C0805C102J5GACTU	Kemet
C7, C12, C18, C19, C20, C21, C22, C24	8	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0805	0805	C0805C104K5RACTU	Kemet
C10	1	0.01uF	CAP, CERM, 0.01 uF, 100 V, +/- 10%, X7R, 0805	0805	08051C103KAT2A	AVX
C16, C17	2	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0805	0805	C0805C105K4RACTU	Kemet
Cc1, Cc2, R5, R6, R15, R16, R18, R19	8	0	RES, 0, 0%, W, AEC-Q200 Grade 0, 0805	0805	PMR10EZPJ000	Rohm
D1, D3, D8	3		Zener Diode 5.6V 250mW ±4% Surface Mount TO-236AB	SOT23-3	PLVA656A,215	Nexperia
D2, D4	2	Green	LED, Green, SMD	LED_0603	LTST-C191TGKT	Lite-On
D5, D6, D7, D9	4	20V	Diode, Schottky, 20 V, 1 A, SOD-323	SOD-323	CUS10S30,H3F	Toshiba
D10, D11, D12, D13, D14	5	Red	LED, Red, SMD	LED_0603	150060RS75000	Wurth Elektronik
D15	1	51V	Diode, TVS, Uni, 51 V, 82.4 Vc, 400 W, 4.9 A, SMA	SMA	SMAJ51A	Littelfuse
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1	1		Terminal Block, 3.5mm, 2x1, Tin, TH	Terminal Block, 3.5mm, 2x1, TH	1776275-2	TE Connectivity
J2	1		Terminal Block, 3.5mm, 6x1, Tin, TH	Terminal Block, 3.5mm, 6x1, TH	0393570006	Molex
J3	1		XLR Receptacle and 1/4" Phone Jack, 8-Pin, TH	TH, 8-Leads, Body 27x37mm	NCJ6FI-H	Neutrik

Table 6-1. PGA2505EVMV2 BOM (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
J4	1		Receptacle, Male, 3 Position, R/A, TH	Receptacle, Male, 3 Position, R/A, TH	PQG3MRA112	Switchcraft
J5, J7	2		Receptacle, 2.54mm, 10x2, Tin, TH	10x2 Receptacle	SSQ-110-03-T-D	Samtec
J6	1			Phone Jack, 1/4 inch, TH	NRJ3HF-1	Neutrik
R1, R2, R24, R29, R30, R36, R37	7	4.02k	RES, 4.02 k, 0.1%, 0.125 W, 0805	0805	RG2012P-4021-B-T5	Susumu Co Ltd
R3	1	100k	RES, 100 k, 0.1%, 0.125 W, 0805	0805	RG2012P-104-B-T5	Susumu Co Ltd
R4, R14, R31	3	10.0	RES, 10.0, 0.1%, 0.2 W, AEC-Q200 Grade 0, 0805	0805	PATT0805E10R0BGT1	Vishay Thin Film
R7, R12	2		6.81 kOhms ±0.1% 0.4W, 2/5W Chip Resistor 1206 (3216 Metric) Anti-Sulfur, Automotive AEC-Q200, Moisture Resistant Thin Film	1206	TNPW12066K81BEEN	Vishay Dale
R9	1	10.0k	RES, 10.0 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD0710KL	Yageo America
R10	1	1.00Meg	RES, 1.00 M, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW08051M00FKEA	Vishay-Dale
R22, R23, R38, R39	4	49.9	RES, 49.9, 0.1%, 0.125 W, 0805	0805	RT0805BRD0749R9L	Yageo America
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21	21		Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
U1	1		Gain Range: 0 dB, and 9 dB to 60 dB, in 3 dB Steps, -40 to 85 degC, 24-pin SOP (DB24), Green (RoHS & no Sb/Br)	DB0024A	PGA2505IDB	Texas Instruments
U2	1		Single Power Supply BUFFER Logic Level Shifter (no enable), DCK0005A (SOT-SC70-5)	DCK0005A	SDO Level Shifter	Texas Instruments
C13, C14, C15	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0805	0805	C0805C104K5RACTU	Kemet
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R8, R11, R13, R17, R20, R21	0	0	RES, 0, 0%, W, AEC-Q200 Grade 0, 0805	0805	PMR10EZPJ000	Rohm