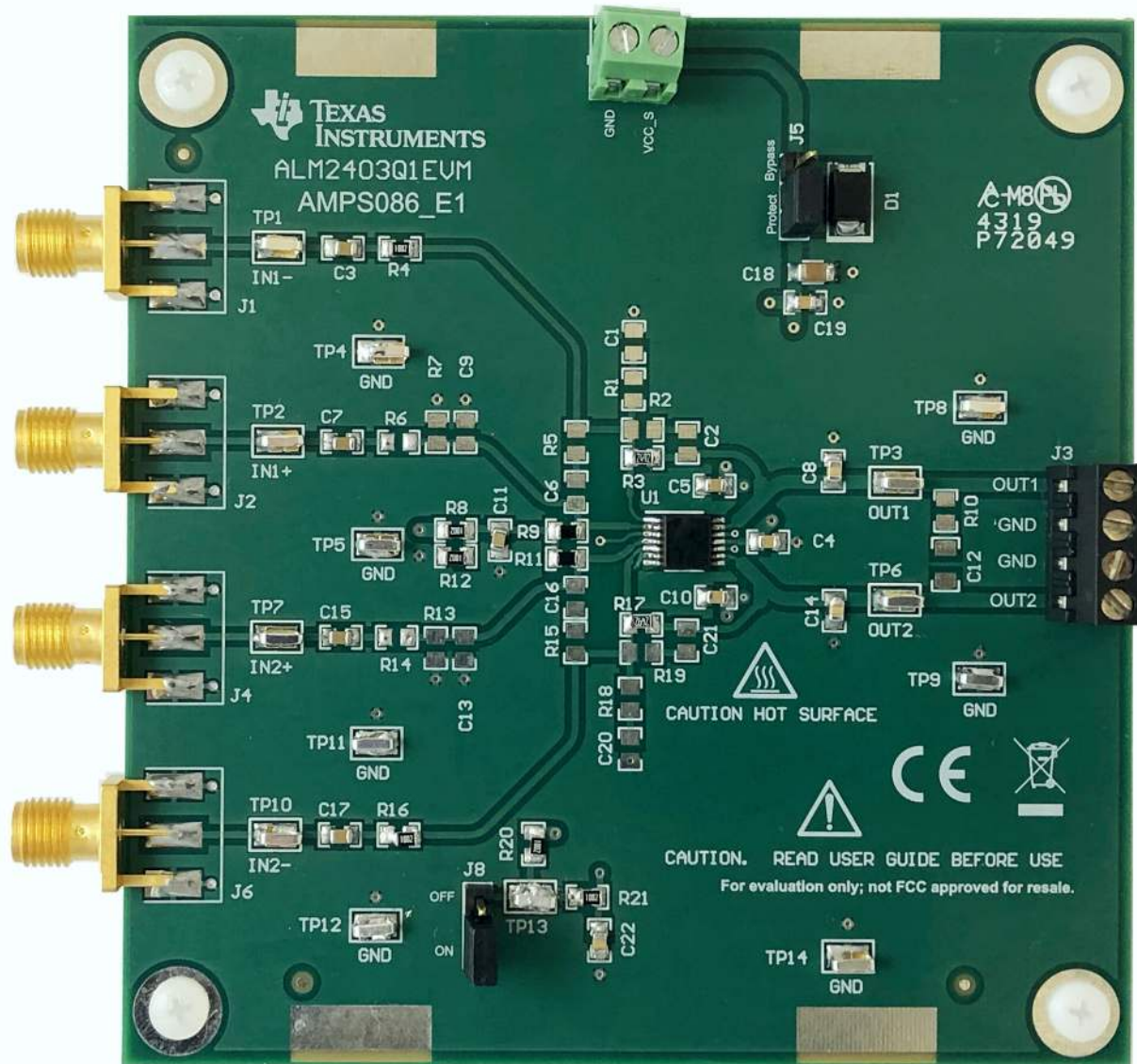


# ALM2403-Q1 Evaluation Module



## ABSTRACT



This user's guide contains information and support documentation for the ALM2403-Q1 evaluation module (EVM). Included are the circuit description, jumper settings, required connections, printed circuit board (PCB) layout, schematic, and bill of materials of the ALM2403Q1EVM. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the ALM2403Q1EVM.

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## 1 Overview

The ALM2403-Q1 is an automotive-grade, high-voltage, high-current, dual operational amplifier (op amp) with wide bandwidth and thermal protection from Texas Instruments. For a full list of electrical characteristics for the ALM2403-Q1, see the [ALM2403-Q1 24-V, High Current, Wide-Bandwidth, Dual Operational Amplifier data sheet](#).

### 1.1 Related Documentation

The following document provides information regarding Texas Instruments integrated circuits used in the assembly of the ALM2403Q1EVM. This user's guide is available from the TI website under literature number SBOU236. 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 website at <http://www.ti.com/>, 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.

**Table 1-1. Related Documentation**

Device	Literature Number
<a href="#">ALM2403-Q1</a>	<a href="#">SBOS928</a>

### 1.2 Electrostatic Discharge Caution

Many of the components on the ALM2403Q1EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

### 1.3 Hot Surface Warning

**WARNING**

Device may become hot under high-current conditions. Take care when handling the EVM.

## 2 EVM Circuit Description

This EVM provides access to the features, and measure the performance, of the ALM2403-Q1. By default, the ALM2403Q1EVM has both amplifiers configured in the inverting configuration with a gain of  $-2.5$  V/V. A simplified schematic of the ALM2403Q1EVM is displayed in Figure 2-1. For a full schematic of the ALM2403EVM, see Figure 7-1.

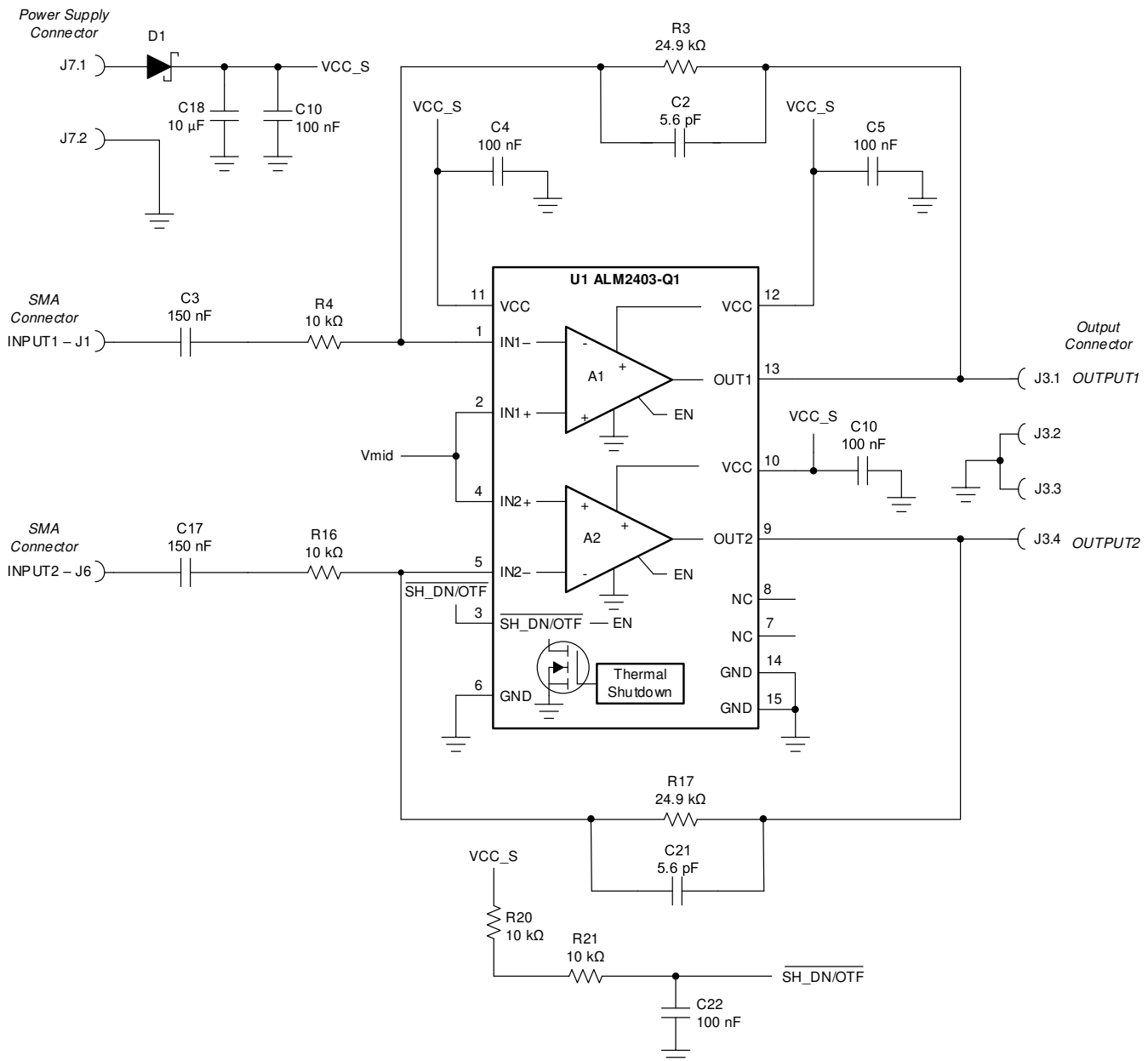


Figure 2-1. ALM2403Q1EVM Simplified Schematic

### 3 Jumper Settings

Figure 3-1 details the default jumper settings of the ALM2403Q1EVM. Table 3-1 explains the configuration for these jumpers.

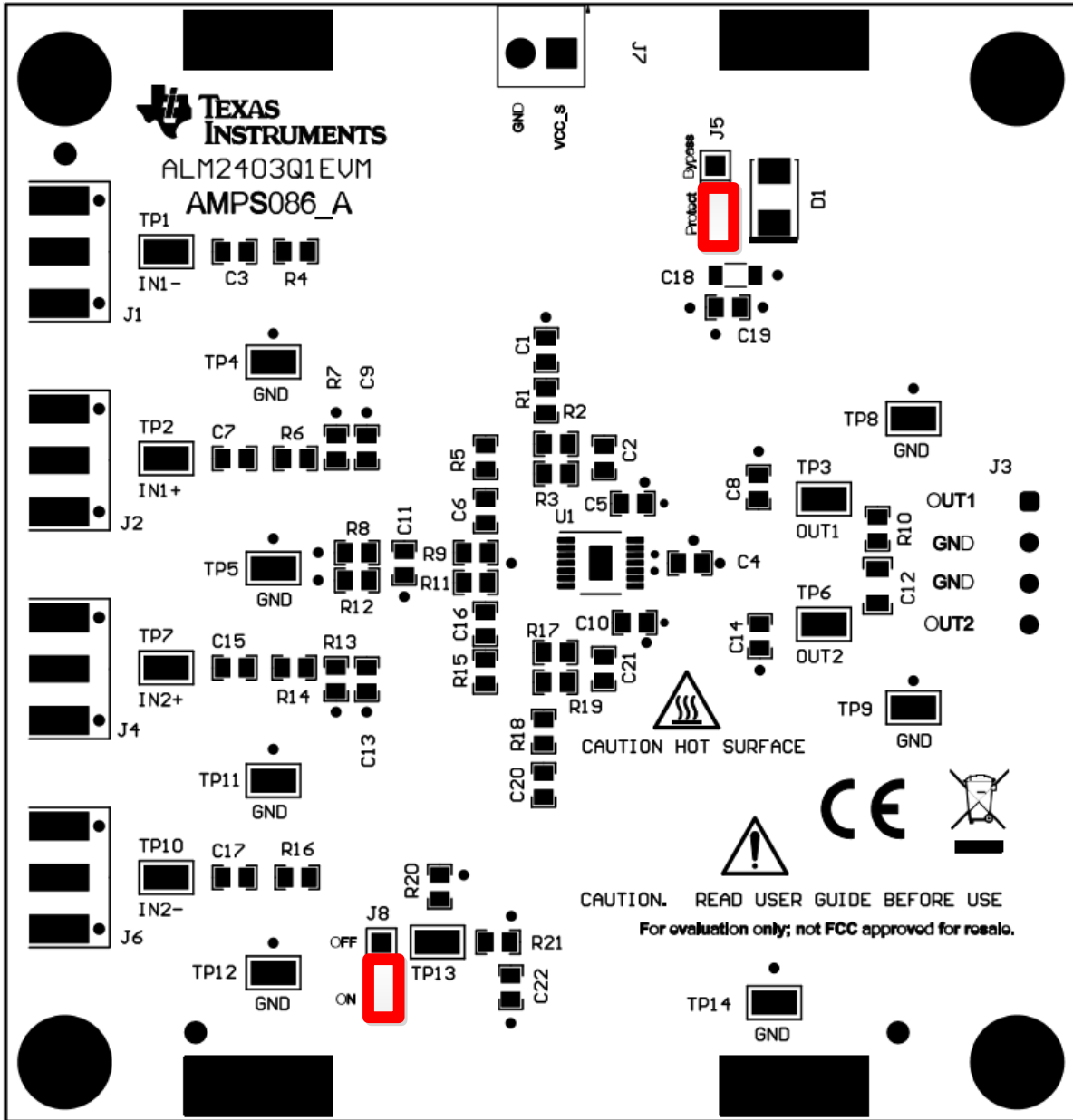


Figure 3-1. ALM2403Q1EVM Default Jumper Settings

Table 3-1. Default Jumper Configuration

Jumper	Function	Default Position	Description
J5	VCC_S reverse polarity protection	Shunt 2-3	Shunt 2-3: Schottky diode blocks VCC-S supply reverse current Shunt 1-2 bypasses VCC_S Schottky diode protection
J8	SH_DN / OTF	Shunt 2-3	Overtemperature flag or shutdown: Shunt 2-3 turns on amplifiers; pin works as overtemperature flag Shunt 1-2 shuts down amplifiers

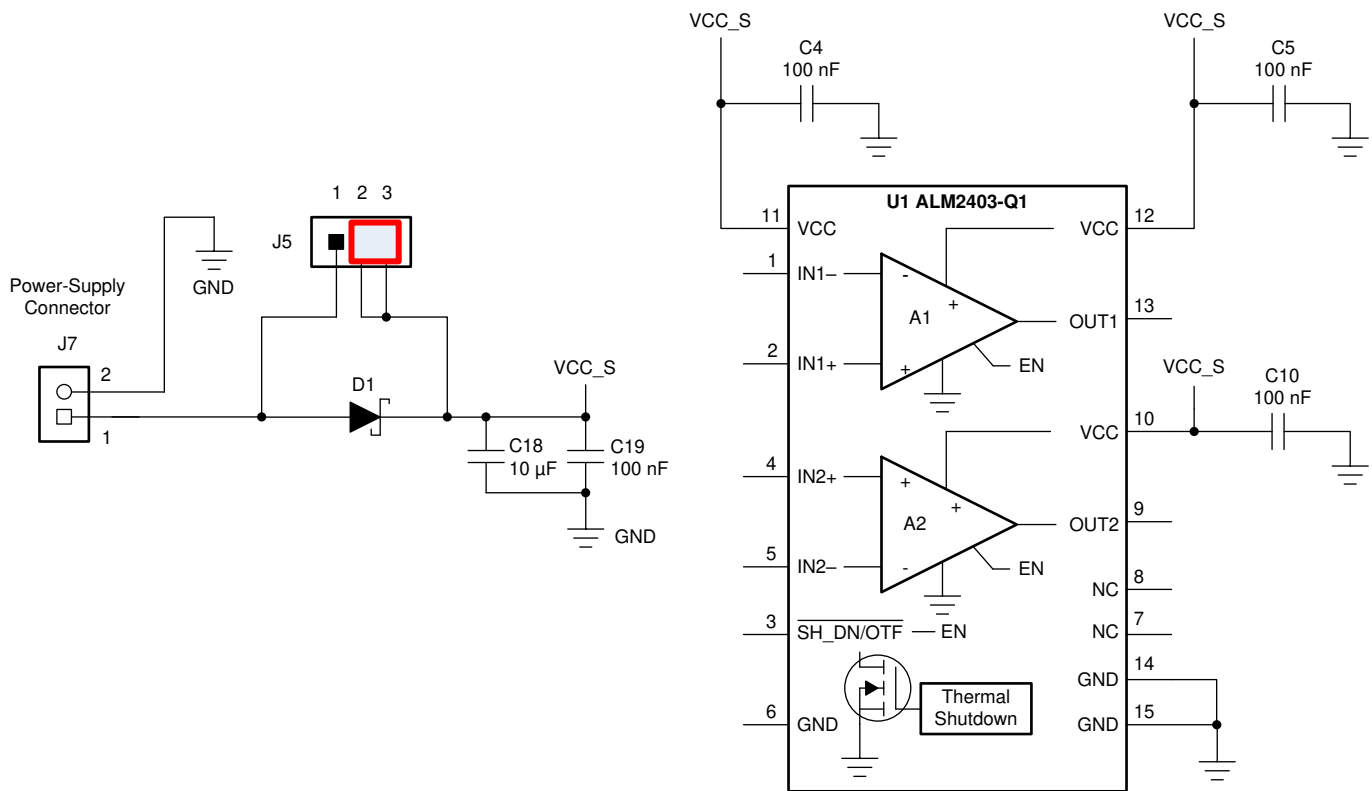
## 4 Power-Supply Connections

The power-supply connections for the ALM2403Q1EVM are provided through connector J7 at the top of the EVM. Table 4-1 summarizes the pin definition for supply connector J7, and the allowed voltage range for each supply connection.

**Table 4-1. ALM2403Q1EVM Supply-Range Specifications**

Pin Number	Supply Connection	Voltage Range
J7.1	Input stage supply (VCC)	5 V to 24 V
J7.2	Ground	0 V

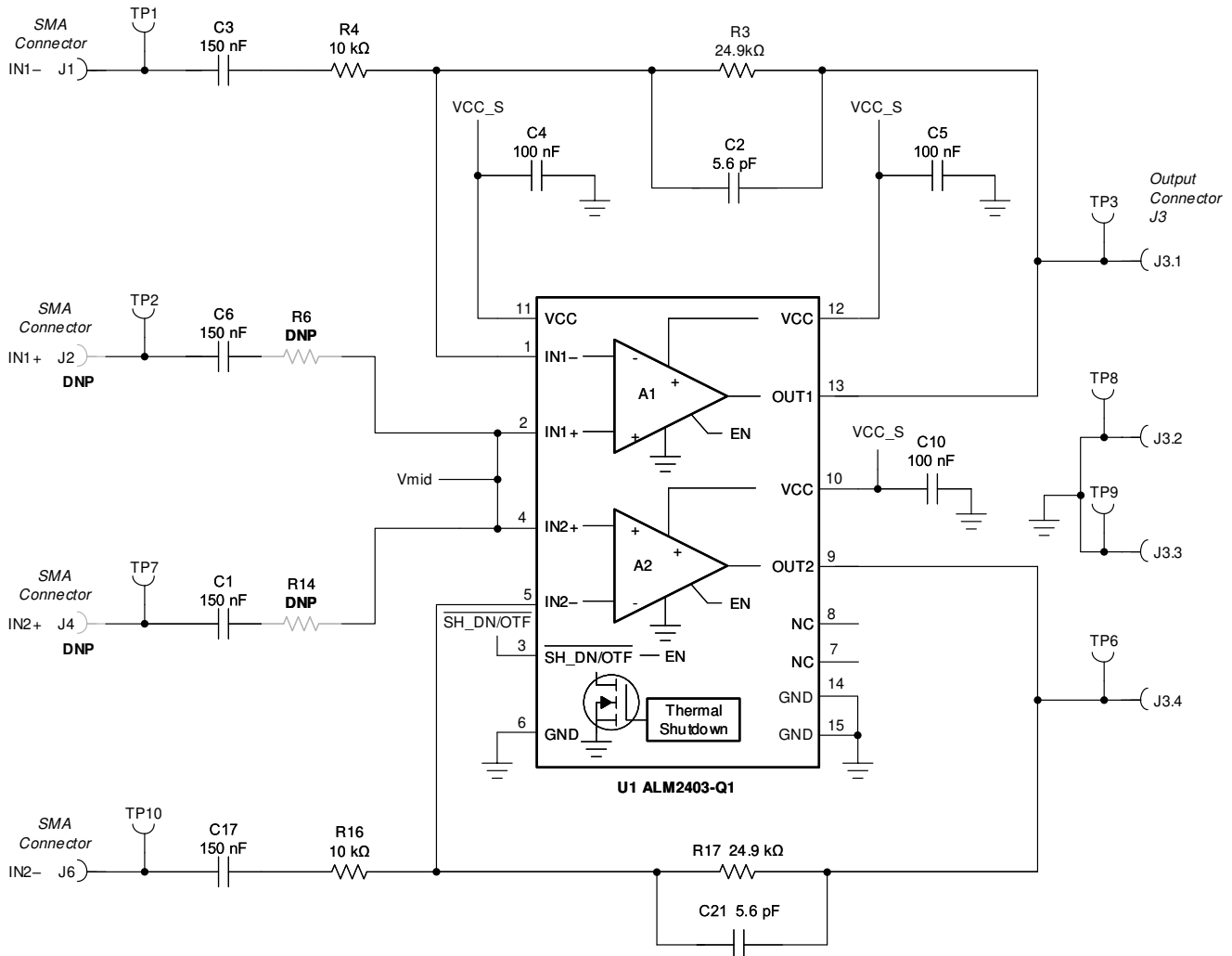
The ALM2403Q1 is configured to use a single supply connected through J7.1 (VCC) and J7.2 (GND). By default, jumper J5 is set to shunt pins 2-3 placing a Schottky diode (D1) in series with the power supply connection. The Schottky diode blocks any reverse current into the VCC\_S supply during a fault condition when the output of the amplifier is shorted to a higher potential than the VCC\_S supply. Place J5 to shunt pins 1-2 to bypass the optional diode (D1). Figure 4-1 shows the ALM2403Q1EVM voltage supply connections.



**Figure 4-1. ALM2403Q1EVM Voltage Supply Connections**

## 5 Input and Output Connections

Input signal connections for the ALM2403Q1EVM are provided through the use of the SMA connectors and test points located at the left of the EVM. The dual output-amplifier connections are provided through connector J3 and test points located at the right side of the EVM. A simplified diagram of the ALM2403Q1EVM input and output connections is displayed in Figure 5-1.



Note: SMA connectors J2 and J4 are not populated. Resistors R6 and R14 are not populated.

**Figure 5-1. ALM2403Q1EVM Input and Output Connections**

Table 5-1 summarizes the input and output connectors and corresponding test points.

**Table 5-1. ALM2403Q1EVM Input and Output Connections**

Connector Designator	Signal	Comment	Test Point
J1	IN1-	SMA	TP1
J2	IN1+	SMA (not populated)	TP2
J4	IN2+	SMA (not populated)	TP7
J6	IN2-	SMA	TP10
J3.1	OUT1	Screw terminal	TP3
J3.2	GND	Screw terminal	TP8
J3.3	GND	Screw terminal	TP9
J3.4	OUT2	Screw terminal	TP6

## 6 Modifications

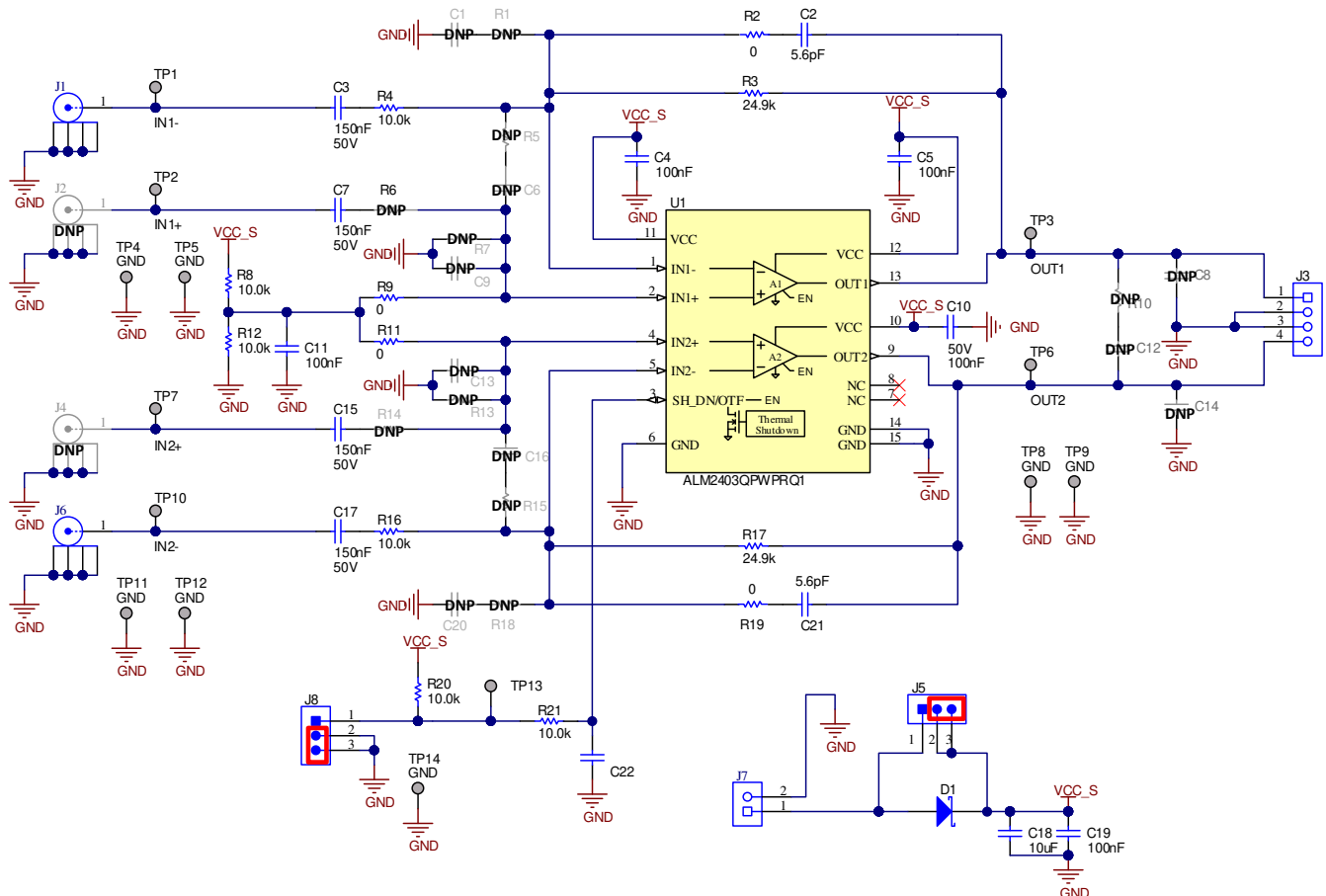
By default, the ALM2403Q1EVM is populated with both amplifiers set to the inverting configuration. However, for flexibility, the PCB layout has additional unpopulated passive component footprints, and additional input connections. These additional component footprints in the layout allow the user to change the ALM2403Q1 circuit to other common configurations, such as the buffer and noninverting amplifier configurations. For a full schematic of the ALM2403Q1EVM, see [Figure 7-1](#).

## 7 Schematic, PCB Layout, and Bill of Materials

This section contains the schematic, bill of materials, and references for the ALM2403Q1EVM.

### 7.1 Schematic

[Figure 7-1](#) illustrates the EVM schematic.



Note: DNP components are not populated.

**Figure 7-1. ALM2403Q1EVM Schematic**

### 7.2 PCB Layout

The ALM2403Q1EVM is a four-layer PCB design. [Figure 7-2](#) to [Figure 7-6](#) show the PCB layer illustrations. The top layer consists of all signal path traces, and is poured with a solid ground plane. A symmetrical board layout is used on amplifier 1 and amplifier 2 to keep good performance matching. Decoupling capacitors C4, C5, and C10 are positioned on the top layer as close as possible to the power supply pins of the device. The second internal layer is a dedicated solid GND plane. Independent vias are placed at the ground connection of every component to provide a low-impedance path to ground. The third internal layer and the bottom layer route the power-supply connections.



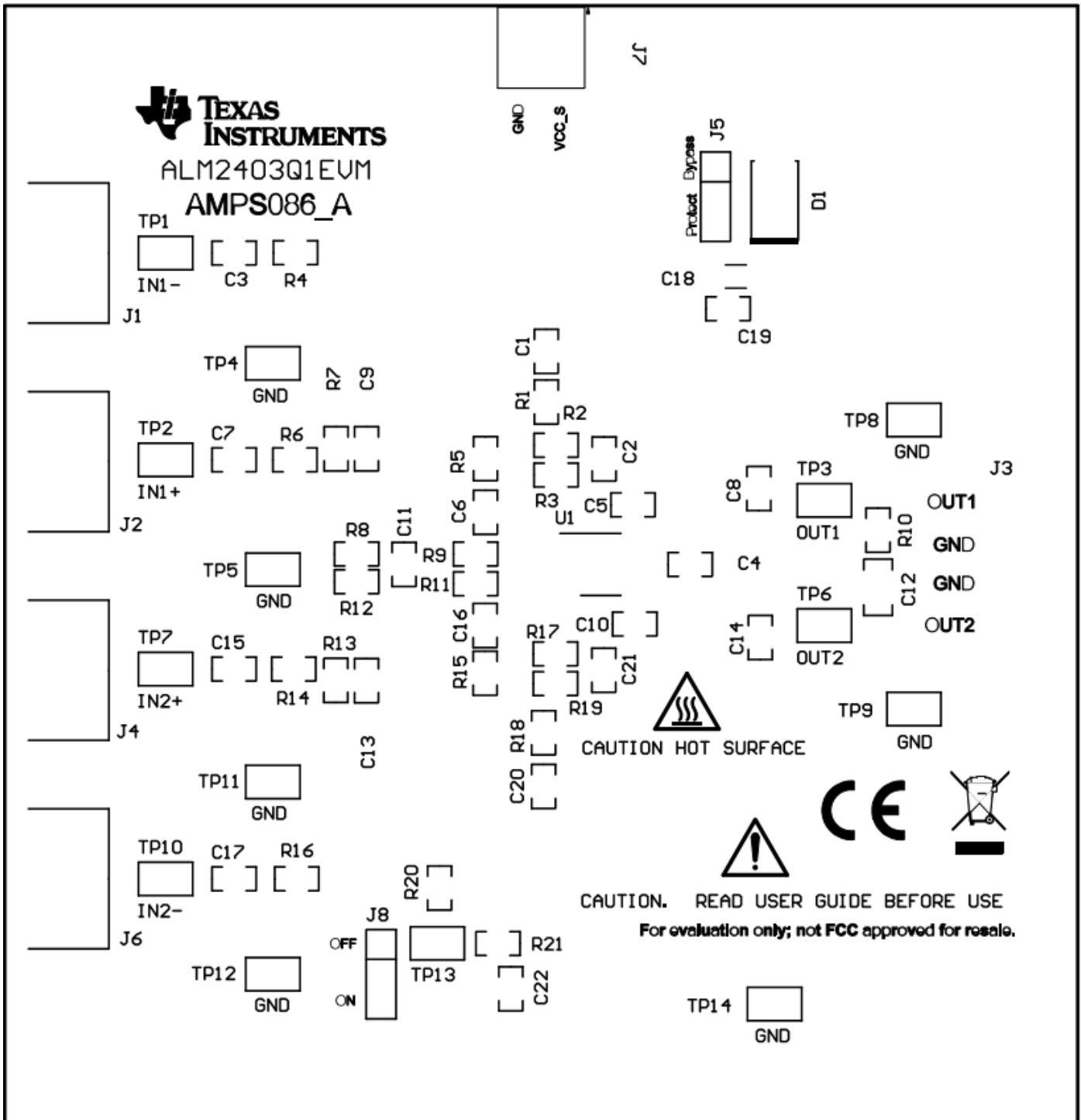


Figure 7-2. Top Overlay PCB Layout

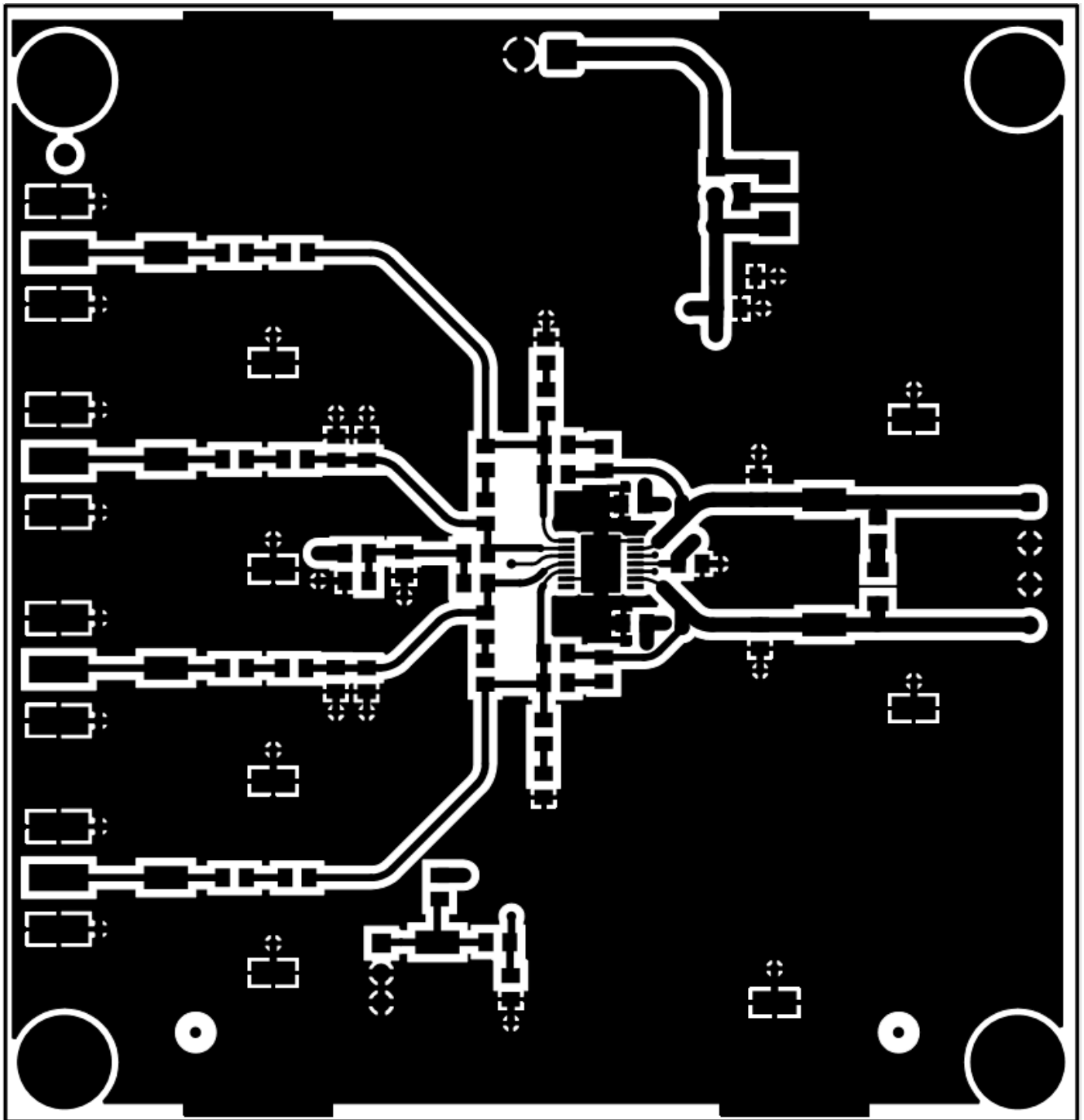


Figure 7-3. Top Layer PCB Layout



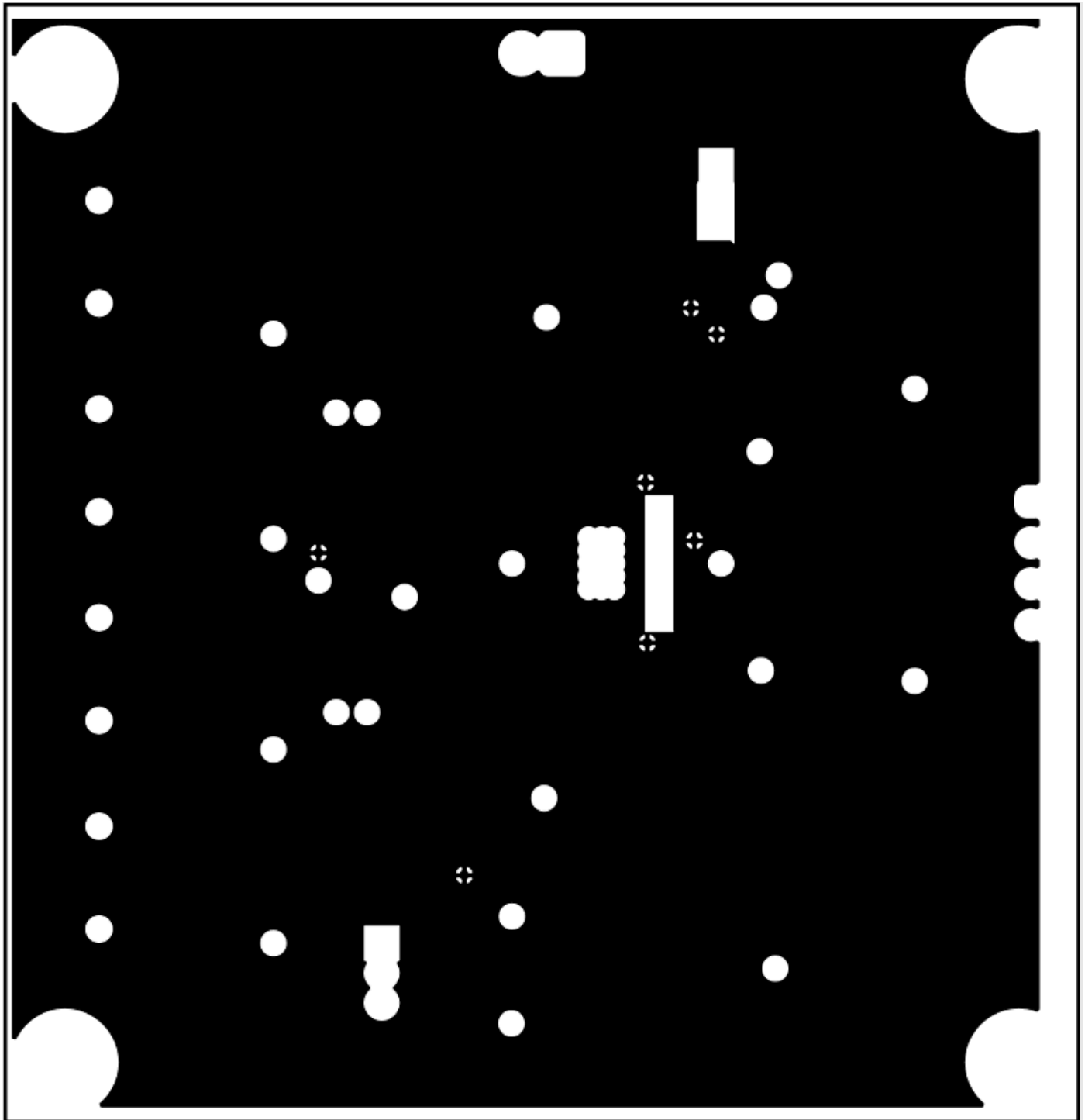


Figure 7-5. Power Layer PCB Layout

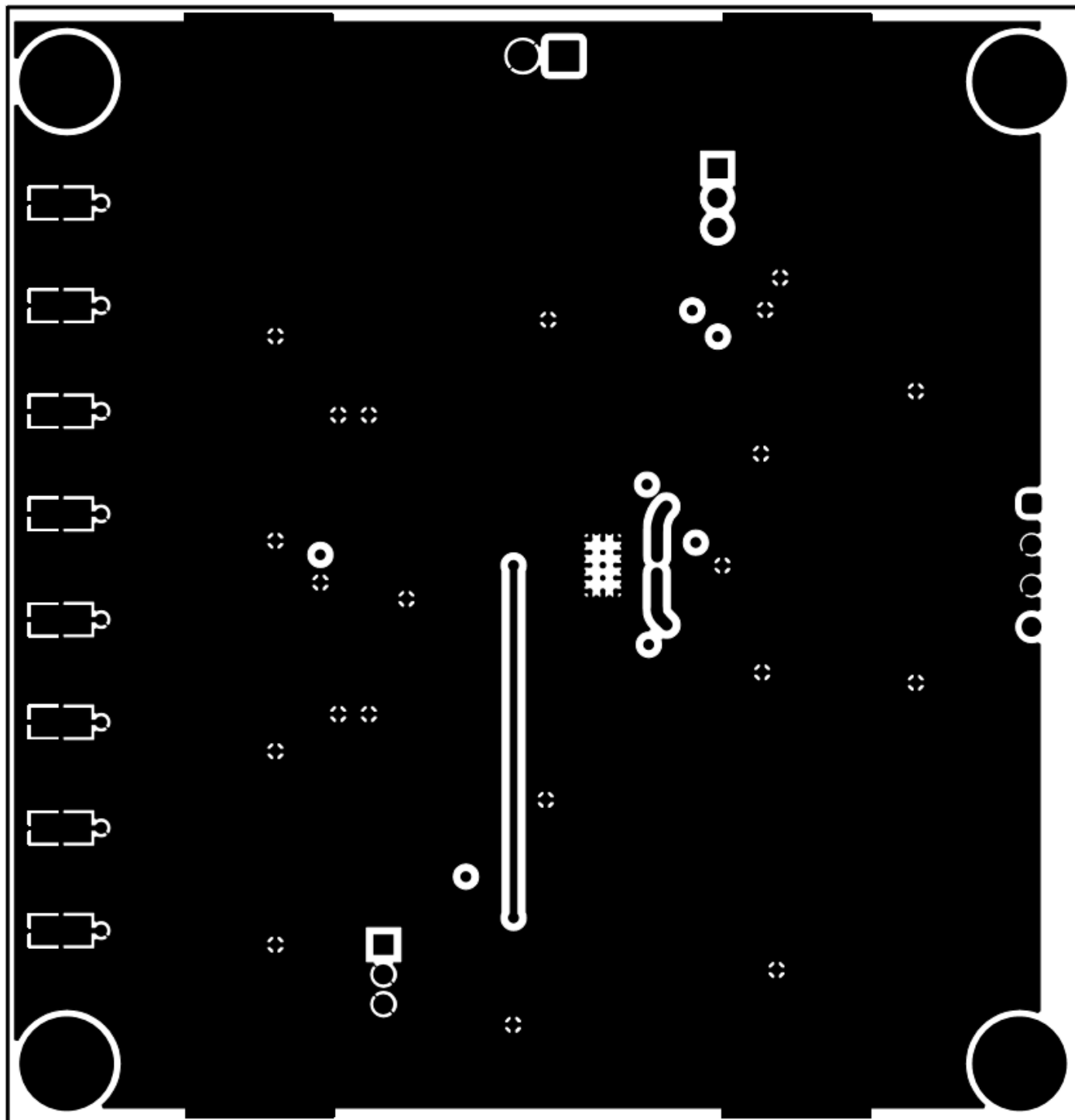


Figure 7-6. Bottom Layer PCB Layout

## 7.3 Bill of Materials

Table 7-1 lists the ALM2403Q1EVM bill of materials (BOM).

**Table 7-1. ALM2403Q1EVM Bill of Materials**

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		AMPS086	Any
C3, C7, C15, C17	4	0.15uF	CAP, CERM, 0.15 uF, 50 V, +/- 10%, X7R, 0805	0805	C0805C154K5RACTU	Kemet
C2, C21	2	5.6pF	CAP, CERM, 5.6 pF, 50 V, +/- 5%, C0G/NP0, 0805	0805	08055A5R6CAT2A	AVX
C4, C5, C10, C11, C19	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0805	0805	08055C104KAT2A	AVX
C22	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0805	0805	08055C103KAT2A	AVX
C18	1	10uF	CAP, CERM, 10 uF, 35 V, +/- 10%, X7R, 1206	1206	'C3216X7R1V106K160AC	TDK
D1	1	40V	Diode, Schottky, 40 V, 2 A, SMB	SMB	MBRS2040LT3G	ON Semiconductor
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, J6	2		Connector, End launch SMA, 50 ohm, SMT	End Launch SMA	142-0701-801	Cinch Connectivity
J3	1		Terminal Block, 3.5mm, 4x1, Tin, TH	Terminal Block, 3.5mm, 4x1, TH	0393570004	Molex
J5, J8	2		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
J7	1		Terminal Block, 3.5mm, 2x1, Tin, TH	Terminal Block, 3.5mm, 2x1, TH	ED555/2DS	On_shore Technology
R3, R17	2	24.9k	RES, 24.9 k, 0.5%, 0.1 W, 0805	0805	RR1220P-2492-D-M	Susumu Co Ltd
R4, R8, R12, R16, R20, R21	6	10.0k	RES, 10.0 k, 0.5%, 0.125 W, 0805	0805	RT0805DRE0710KL	Yageo America
R2, R9, R11, R19	4	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6GEY0R00V	Panasonic
SH-J1, SH-J2	2	1x2	Shunt, 100mil, Flash Gold, Black	Closed Top 100mil Shunt	SPC02SYAN	Sullins Connector Solutions
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14	14		Test Point, Miniature, SMT	Test Point, Miniature, SMT	5019	Keystone
U1	1		24-V, High-Current, Wide-Bandwidth, Dual Operational Amplifier, PWP0014H (HTSSOP-14)	PWP0014H	ALM2403QPWPRQ1	Texas Instruments
C1, C6, C8, C9, C13, C14, C16, C20	0	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0805	0805	08055C103KAT2A	AVX
C12	0	0.22uF	CAP, CERM, 0.22 uF, 50 V, +/- 5%, X7R, 1206	1206	C1206C224J5RACTU	Kemet
J2, J4	0		Connector, End launch SMA, 50 ohm, SMT	End Launch SMA	142-0701-801	Cinch Connectivity
R1, R5, R7, R10, R13, R15, R18	0	24.9k	RES, 24.9 k, 0.5%, 0.1 W, 0805	0805	RR1220P-2492-D-M	Susumu Co Ltd
R6, R14	0	10.0k	RES, 10.0 k, 0.5%, 0.125 W, 0805	0805	RT0805DRE0710KL	Yageo America

## 8 Revision History

<b>Changes from Revision * (February 2020) to Revision A (March 2021)</b>	<b>Page</b>
• Added C2 (5.6 pF) and C21 (5.6 pF) to Figure 2-1, <i>ALM2403Q1EVM Simplified Schematic</i> .....	<a href="#">4</a>
• Added C2 (5.6 pF) and C21 (5.6 pF) to Figure 5-1, <i>ALM2403Q1EVM Input and Output Connections</i> .....	<a href="#">7</a>
• Changed Figure 7-1, <i>ALM2403Q1EVM Schematic</i> to show C2 (5.6 pF), R2 (0 $\Omega$ ) C21 (5.6 pF), and R19 (0 $\Omega$ ) as populated components.....	<a href="#">8</a>
• Changed BOM table to show C2, C21, R2, and R19 as populated.....	<a href="#">14</a>

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