General Description

The MAX40023 evaluation kit (EV kit) provides a proven design to evaluate the MAX40023 low-noise, low-power, low-bias-current operational amplifier in a 6-pin wafer-level package (WLP). The EV kit circuit is preconfigured as noninverting amplifiers, but can be adapted to other topologies by changing a few components.

The EV kit comes with a MAX40023ANT+ installed.

Features

- Accommodates Multiple Op Amp Configurations
- Component Pads Allow for Sallen-Key Filter
- Accommodates Easy-to-Use Components
- Proven PCB Layout
- Fully Assembled and Tested

Quick Start

Required Equipment

- MAX40023 EV kit
- +1.6 to +3.6V, 10mA DC power supply
- Precision voltage source
- Digital multimeter

Procedure

The EV kit is fully assembled and tested. Follow the steps below to verify board operation:

1) Verify that all jumpers (JU1–JU4) are in their default positions, as shown in Table 1.
2) Set the power supply to +1.8V. Connect the positive terminal of the power supply to V_{DD} and the negative terminal to GND.
3) Connect the positive terminal of the precision voltage source to INP. Connect the negative terminal of the precision voltage source to GND. INM is already connected to GND through jumper JU1.
4) Connect the DMM to monitor the voltage on OUT. With the 10kΩ feedback resistors and 1kΩ series resistors, the gain of the noninverting amplifier is +11V/V.
5) Turn on the power supply.
6) Apply 100mV from the precision voltage sources. Observe the output at OUT on the DMM that reads approximately +1.1V.

***Ordering Information** appears at end of data sheet.*

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EV Kit Photo

Detailed Description of Hardware

The MAX40023 EV kit provides a proven layout for the MAX40023 low-power op amp. The device is a single-supply op amp that is ideal for sensor interfaces, loop-powered systems, and various types of medical and data-acquisition instruments.

The default configuration for the device in the EV kit is in a noninverting configuration.

Op-Amp Configurations

The device is a single-supply op amp that is ideal for differential sensing, noninverting amplification, buffering, and filtering. A few common configurations are shown in the next few sections.

The following sections explain how to configure the op amp.

Noninverting Configuration

The EV kit comes preconfigured as a noninverting amplifier. The gain is set by the ratio of R5 and R1. The EV kit comes preconfigured for a gain of +11V/V. The output voltage for the noninverting configuration is given by the equation below:

$$V_{OUT} = \left(1 + \frac{R5}{R1}\right)\left[V_{INP} \pm V_{OS}\right]$$

Inverting Configuration

To configure the EV kit as an inverting amplifier, remove the shunt on jumper JU1 and install a shunt on jumper JU2 and feed an input signal on the INAM PCB pad.

Differential Amplifier

To configure the EV kit as a differential amplifier, replace R1–R3 and R5 with appropriate resistors. When R1 = R2 and R3 = R5, the CMRR of the differential amplifier is determined by the matching of the resistor ratios R1/R2 and R3/R5.

$$V_{OUT} = GAIN(V_{INP} - V_{INM})$$

where:

$$GAIN = \frac{R5}{R1} = \frac{R3}{R2}$$

Sallen-Key Configuration

The Sallen-Key topology is ideal for filtering sensor signals with a second-order filter and acting as a buffer. Schematic complexity is reduced by combining the filter and buffer operations. The EV kit can be configured in a Sallen-Key topology by replacing and populating a few components. The Sallen-Key topology can be configured as a unity-gain buffer by replacing R5 with a 0Ω resistor and removing resistor R1. The signal is noninverting and applied to INAP. The filter component pads are R2-R3 and R7-R8, where some have to be populated with resistors and others with capacitors.

Lowpass Sallen-Key Filter: To configure the Sallen-Key as a lowpass filter, remove the shunt from jumper JU1, populate the R2 and R8 pads with resistors, and populate the R3 and R7 pads with capacitors. The corner frequency and Q are then given by:

$$f_C = \frac{1}{2\pi\sqrt{R_{R2}R_{R8}C_{R3}C_{R7}}}$$

$$Q = \frac{\sqrt{R_{R2}R_{R8}C_{R3}C_{R7}}}{C_{R3}(R_{R2} + R_{R8})}$$

Highpass Sallen-Key Filter: To configure the Sallen-Key as a highpass filter, remove the shunt from jumper JU1, populate the R3 and R7 pads with resistors, and populate the R2 and R8 pads with capacitors. The corner frequency and Q are then given by:

$$f_C = \frac{1}{2\pi\sqrt{R_{R3}R_{R7}C_{R2}C_{R8}}}$$

$$Q = \frac{\sqrt{R_{R3}R_{R7}C_{R2}C_{R8}}}{R_{R7}(C_{R2} + C_{R8})}$$

Bandpass Sallen-Key Filter: To configure the Sallen-Key as a bandpass filter, remove the shunt from jumper JU1, replace R8, populate the R3 and R7 pads with resistors, and populate the C8 and R2 pads with capacitors. The corner frequency and Q are then given by:

$$f_C = \frac{1}{2\pi}\sqrt{\frac{R_{R7} + R_{R8}}{C_{C8}C_{R2}R_{R8}R_{R3}R_{R7}}}$$

$$Q = \frac{\sqrt{(R_{R7} + R_{R8})C_{C8}C_{R2}R_{R8}R_{R3}R_{R7}}}{R_{R7}R_{R8}(C_{C8} + C_{R2}) + R_{R3}C_{R2}(R_{R7} - \frac{R_{R5}}{R_{R1}}R_{R8})}$$

Transimpedance Amplifier (TIA)

To configure the EV kit as a TIA, place a shunt on jumper JU2 and replace R1 with 0Ω resistors. The output voltage of the TIA is the input current multiplied by the feedback resistor:

$$V_{OUT} = -(I_{IN} + I_{BIAS}) \times R_{R5} \pm V_{OS}$$

where:

I_{IN} is the input current source applied at the INP test point

I_{BIAS} is the input bias current

V_{OS} is the input offset voltage of the op amp

Use a capacitor and 0Ω resistor at location R4 or R10 (and C8, if applicable) to stabilize the op amp by rolling off high-frequency gain due to a large cable capacitance.

Capacitive Loads

Some applications require driving large capacitive loads. The EV kit provides C8 and R6 pads for an optional capacitive-load driving circuit. C8 simulates the capacitive load while R6 acts as an isolation resistor to improve the op amp's stability at higher capacitive loads. To improve the stability of the amplifier in such cases, replace R6 with a suitable resistor value to improve amplifier phase margin

Table 1. Jumper Descriptions (JU1–JU3)

JUMPER	SHUNT POSITION	DESCRIPTION
JU1	Pin 1	Disconnects INM from GND
	1-2*	Connects IN- to GND through R1 for noninverting configuration
JU2	Pin 1*	Disconnects INAP from GND
	1-2	Connects IN+ to GND through R2
JU3	1-2*	Connects $\overline{SHDN}$ to V_{DD} to place device into normal operation
	2-3	Connects $\overline{SHDN}$ to GND to place device into shutdown operation
JU4	1-2*	Connect VSS to GND
	1	Disconnect VSS to GND

**Default position.*

Ordering Information

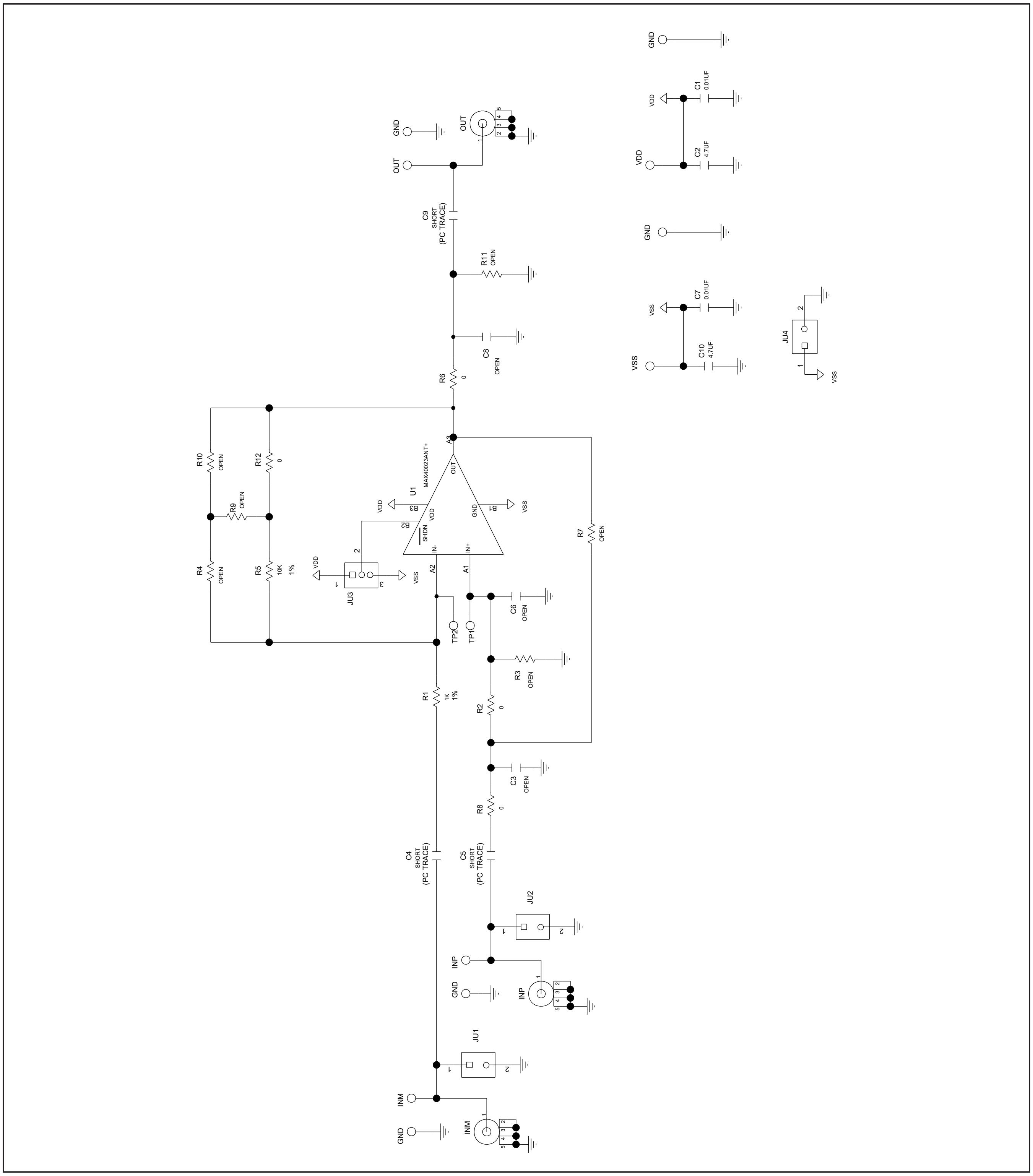
PART	TYPE
MAX40023EVKIT#	EV Kit

#Denotes RoHS compliance.

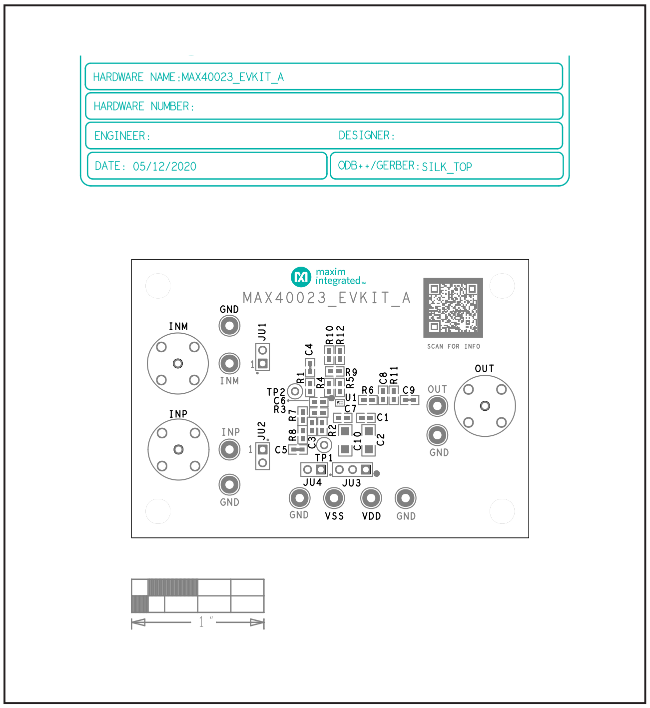
MAX40023 EV Bill of Materials

ITEM	QTY	REF DES	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
1	2	C1, C7	C0603X7R500103JNP; C0603C103J5RAC	VENKEL LTD;KEMET	0.01UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 0.01UF; 50V; TOL=5%; MODEL=X7R; TG=-55 DEGC TO +125 DEGC; TC=+/
2	2	C2, C10	GRM31CR71H475KA12; GRJ31CR71H475KE11; GXM31CR71H475KA10; UMK316AB7475KL	MURATA;MURATA;MURATA; TAIYO YUDEN	4.7UF	CAPACITOR; SMT (1206); CERAMIC CHIP; 4.7UF; 50V; TOL=10%; MODEL=; TG=-55 DEGC TO +125 DEGC; TC=X7R
3	5	GND, TP0_GND, TP4_GND-TP6_GND	5011	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH; RECOMMENDED FOR BOARD THICKNESS=0.062IN; NOT FOR COLD TEST
4	3	JU1, JU2, JU4	PCC02SAAN	SULLINS	PCC02SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 2PINS; -65 DEGC TO +125 DEGC
5	1	JU3	PCC03SAAN	SULLINS	PCC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 3PINS; -65 DEGC TO +125 DEGC
6	1	R1	CRCW06031K00FK; ERJ-3EKF1001	VISHAY DALE;PANASONIC	1K	RESISTOR; 0603; 1K; 1%; 100PPM; 0.10W; THICK FILM
7	4	R2, R6, R8, R12	RC1608J000CS; CR0603-J/-000ELF; RC0603JR-070RL	SAMSUNG ELECTRONICS; BOURNS;YAGEO PH	0	RESISTOR; 0603; 0 OHM; 5%; JUMPER; 0.10W; THICK FILM
8	1	R5	CRCW060310K0FK; ERJ-3EKF1002	VISHAY DALE;PANASONIC	10K	RESISTOR; 0603; 10K; 1%; 100PPM; 0.10W; THICK FILM
9	4	S1-S4	S1100-B;SX1100-B; STC02SYAN	KYCON;KYCON;SULLINS ELECTRONICS CORP.	SX1100-B	TEST POINT; JUMPER; STR; TOTAL LENGTH=0.24IN; BLACK; INSULATION=PBT;PHOSPHOR BRONZE CONTACT=GOLD PLATED
10	2	TP1, TP2	5000	KEYSTONE	N/A	TEST POINT; PIN DIA=0.1IN; TOTAL LENGTH=0.3IN; BOARD HOLE=0.04IN; RED; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH; RECOMMENDED FOR BOARD THICKNESS=0.062IN; NOT FOR COLD TEST
11	3	TP_INM, TP_INP, TP_OUT	5012	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; WHITE; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH; RECOMMENDED FOR BOARD THICKNESS=0.062IN; NOT FOR COLD TEST
12	1	U1	MAX40023ANT+	MAXIM	MAX40023ANT+	EVKIT PART - IC; MAX40023ANT+; PACKAGE OUTLINE: 21-100491; PACKAGE CODE: N60S1+1; WLP6
13	2	VDD, VSS	5010	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; RED; PHOSPHOR BRONZE WIRE SIL; NOT FOR COLD TEST

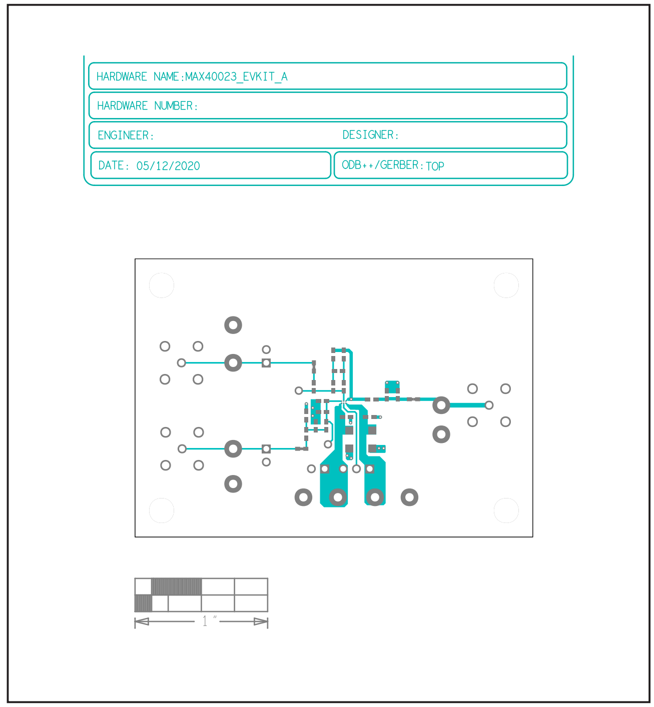
MAX40023 EV Schematic



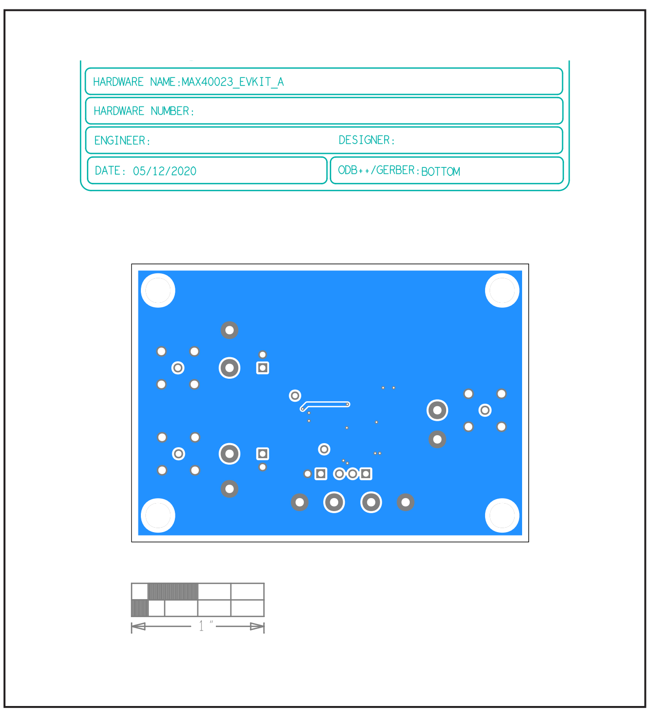
MAX40023 EV PCB Layout



MAX40023 EV Kit PCB Layout—Silk Top



MAX40023 EV Kit PCB Layout—Top



MAX40023 EV Kit PCB Layout—Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/21	Initial release	—

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