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MAX9924U Evaluation Kit

Evaluates: MAX9924U/MAX9925

General Description

The MAX9924U evaluation kit (EV kit) is a fully assembled and tested PCB that contains a differential variable reluctance (VR) sensor interface circuit using a MAX9924U IC in a 10-pin µMAX® package. The single-channel interface circuit also features a differential amplifier for evaluating differential or single-ended VR sensor (magnetic pickup sensor) signal, and provides a fixed gain of 1V/V. Input power to the EV kit circuit can be supplied by a 4.5V to 5.5V DC source. The MAX9924U IC temperature range is -40°C to +125°C.

The MAX9924U EV kit circuit can be configured to demonstrate the MAX9924U IC's operation with internal adaptive peak threshold and zero-crossing detection modes. It can also interface to a microcontroller PWM signal for evaluating external thresholds. Additionally, a configurable on-board triangle-wave generator using a MAX9000 IC provides a 5Hz, 55Hz, 2.5kHz, or 24kHz triangle-wave signal if no external VR signal is available for evaluation.

Features

♦ **Demonstrates MAX9924U MODE A1, A2, B, and C Operation**

♦ **Evaluates Differential and Single-Ended Sensors (VR or Magnetic Pickup)**

♦ **Demonstrates Zero-Crossing and Adaptive Threshold Mechanism**

♦ **Includes Lowpass Sensor Input Filter**

♦ **On-Board 5Hz/24kHz Triangle-Wave Generator**

♦ **Evaluates MAX9925 (IC Replacement Required)**

♦ **Lead(Pb)-Free and RoHS Compliant**

♦ **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX9924UEVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	4.7µF ±20%, 25V X7R ceramic capacitor (1206) Murata GCM31CR71E475M
C2, C7, C8	3	0.1µF ±10%, 16V X7R ceramic capacitors (0603) Murata GCM188R71C104K
C3, C9	2	1µF ±10%, 16V X7R ceramic capacitors (0805) Murata GCM219R71C105K
C4, C10	2	0.1µF ±10%, 50V X7R ceramic capacitors (0805) Murata GCM21BR71H104K
C5	1	1000pF ±10%, 50V X7R ceramic capacitor (0805) Murata GCM216R71H102K
C6	1	220pF ±5%, 50V C0G ceramic capacitor (0603) Murata GCM1885C1H221J
JU1, JU3, JU7–JU10	6	2-pin headers

DESIGNATION	QTY	DESCRIPTION
JU2, JU5	2	3-pin headers
JU4	1	4-pin header
JU6	0	Not installed, 2-pin header, 0.1in centers
R1, R2, R9–R12, R20, R21	0	Not installed, resistors (0805) R1, R2, R9–R12 are open; R20, R21 are short (PC trace)
R3, R4	2	1kΩ ±1% resistors (0805)
R5–R8	4	4.99kΩ ±1% resistors (1206) Panasonic ERJ-8ENF4991V
R13	1	10kΩ ±1% resistor (0805)
R14	1	10kΩ ±5% resistor (0805)
R15	1	54.9kΩ ±1% resistor (0805)
R16	1	464kΩ ±1% resistor (0805)
R17	1	100kΩ ±1% resistor (0805)
R18	1	68.1kΩ ±1% resistor (0805)
R19	1	39.2kΩ ±1% resistor (0805)
TP1, TP2	2	PC mini test points, yellow

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_____Component List (continued)

DESIGNATION	QTY	DESCRIPTION
TP3, TP5	2	PC mini test points, red
TP4, TP6	2	PC test points, black
U1	1	VR sensor interface (10 µMAX) Maxim MAX9924UAUB+
U2	1	High-speed op amp comparator reference (8 SO) Maxim MAX9000ESA+
—	9	Shunts (JU1–JU5, JU7–JU10)
—	1	PCB: MAX9924U Evaluation Kit+

_____Component Suppliers

SUPPLIER	PHONE	WEBSITE
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Panasonic Corp.	800-344-2112	www.panasonic.com

Note: *Indicate that you are using the MAX9924U or MAX9925 when contacting these component suppliers.*

_____Quick Start

Required Equipment
Before beginning, the following equipment is needed:

- One 5V, 100mA power supply
- One voltmeter
- One oscilloscope

Procedure
The MAX9924U EV kit is fully assembled and tested. Follow the steps below to verify board operation. See Tables 1–4 for a description of the jumpers detailed in the procedure below. **Caution: Do not turn on the power supply until all connections are completed.**

1) Connect a voltmeter to TP3 (VCC/2) and TP4 (GND) test points.

2) Verify that a shunt is not installed across the pins of jumpers JU1 and JU3.

3) Verify that a shunt is installed across pins 1-2 of jumpers JU2, JU4, and JU5 (MODE A1 operation).

4) Verify that a shunt is installed across the pins of jumpers JU7 and JU10 and that no shunt is installed across jumpers JU8 and JU9 (on-board triangle-wave generator, 2.5kHz).

5) Connect the V_PULL PCB pad to the VCC pad to pull the COUT signal up to VCC.

6) Connect the 5V power supply to the VCC pad. Connect the power supply's ground to the GND pad.

7) Turn on the power supply and verify that the voltmeter reads approximately 2.5V.

8) Using an oscilloscope, measure the signal at the COUT and GND pads, which should be a 2.5kHz square waveform with amplitude of 5V.

9) The EV kit circuit is ready for further evaluation using a VR or magnetic pickup sensor. See the *Jumper Selection* section for configuring the EV kit circuit.

_Detailed Description of Hardware
The MAX9924U EV kit features a differential VR sensor interface circuit using a MAX9924U IC in a 10-pin µMAX surface-mount package. The EV kit's single-channel interface circuit evaluates signals from both differential and single-ended sensors. The interface circuit provides a fixed gain of 1V/V and evaluates sensor-signal amplitudes of 40mV$_{P-P}$ to 300V$_{P-P}$ with a frequency range of 5Hz to 25kHz. Power for the EV kit circuit can be supplied by a 4.5V to 5.5V DC source that provides at least 100mA.

The MAX9924U EV kit circuit can be configured to demonstrate the MAX9924U MODE A1, A2, B, or C operation. Resistors R3, R4 and capacitor C10 provide a VCC/2 source for evaluating MODE B or C. For MODE C operation, surface-mount resistor pads (R1, R2) are provided to configure the high- and low-threshold voltage. Refer to the *Mode Selection* section in the MAX9924/MAX9925 IC data sheet for additional information on the modes of operation. Lowpass sensor input filtering is provided by resistors R5, R6 on the SENSE+ input, and resistors R7, R8, and capacitor C5 on the SENSE- input. PCB pads provide access to the MAX9924U square-wave open-drain output signal at COUT.

Additionally, PCB pads are provided for interfacing with a user-supplied microcontroller PWM signal when evaluating MODE B of the MAX9924U, which enables the MAX9924U threshold voltage to be set externally. Resistor R13 and capacitor C4 provide a lowpass filter for the PWM input signal connected to the FILTER PCB pad. Refer to the *Adaptive Peak Threshold* section in the MAX9924/MAX9925 IC data sheet for additional information.

The MAX9924U EV kit provides a configurable on-board triangle-wave generator using a MAX9000 IC for evaluating the MAX9924U without a sensor. Capacitors C6, C7, resistors R15, R16, and jumpers JU8, JU9 con-

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figure the generator frequency. The generator can be configured for a 5Hz, 55Hz, 2.5kHz, or 24kHz triangle-wave signal. When configured to the 5Hz signal input mode, the EV kit circuit is used to demonstrate the MAX9924U internal watchdog timer's functionality.

The EV kit also features test points to ease evaluating the raw sensor input signals. Test point TP1 provides access to the SENSE+ signal after passing through resistors R5 and R6. TP2 provides access to the SENSE- signal after passing through resistors R7 and R8. Test point TP3 provides access to the VCC/2 voltage source, while TP4 provides access to GND.

Jumper Selection

The MAX9924U EV kit features several jumpers to reconfigure the interface circuit's mode of operation, sensor input type, and the triangle-wave generator frequency.

Sensor Signal Source (IN+, IN-)

The MAX9924U EV kit features jumpers to select the MAX9924U IC IN+ and IN- pin signal source, either the EV kit's triangle-wave generator (U2) or a user-supplied sensor signal. The sensor signal is applied to the EV kit's SENSE+ and SENSE- PCB pads. For proper operation, the typical sensor signal should have a $40mV_{P-P}$ to $300V_{P-P}$ and a frequency range of 5Hz to 25kHz. Table 1 lists the various jumper options for selecting the signal source.

Triangle-Wave Generator Frequency Selection and Enable

The MAX9924U EV kit features jumpers JU8 and JU9 to set the EV kit's triangle-wave generator frequency. The generator frequency is configurable to 5Hz, 55Hz, 2.5kHz, or 24kHz. Additionally, jumper JU6 is provided to disable the generator active IC (U2) and JU10 is used to disconnect the ramp generator signal from the MAX9924U IN+ pin. See Table 1 for configuring JU10. See Table 2 for the frequency selection options for jumpers JU8 and JU9. Table 3 lists jumper JU6 enable/disable options for U2.

Table 1. Sensor Source Configuration (JU7, JU10)

JU7	JU10	MAX9924U IN+ PIN	MAX9924U IN- PIN	SENSOR SOURCE
Installed	Installed	Connected to triangle-wave generator	Connected to VCC/2	EV kit triangle-wave generator*
Open	Open	Connected to SENSE+ PCB pad through resistors R5, R6	Connected to SENSE- PC pad through resistors R7, R8	External differential VR sensor
Installed	Open	Connected to SENSE+ PCB pad through resistors R5, R6	Connected to VCC/2	External single-ended VR sensor

*See Table 2 for configuring the triangle-wave generator frequency.

Table 2. Triangle-Wave Generator Frequency Configuration (JU8, JU9)

JU8	JU9	FREQUENCY
Installed	Open	5Hz
Installed	Installed	55Hz
Open	Open	2.5kHz
Open	Installed	24kHz

Table 3. Triangle-Wave Generator Enable Configuration (JU6)

JU6 PC TRACE SHORT	U2, PIN 8	GENERATOR OPERATION
Installed	Connected to VCC	Enabled
Cut open	Open	Disabled, not powered

Table 4. MODE A1, A2, B, and C Configuration (JU1–JU5, JU7)

MODE	JU1 (R1, R2)	JU2 (BIAS)	JU3 (ZERO_EN)	JU4 (EXT)	JU5 (INT_THRS)	JU7 (SENSOR)	MODE
A1	Open	1&2	Open	1-2	1-2	Installed*	A1
A2	Open	2&3	Installed	1-2	2-3	Installed*	A2
B	Open	1&2	Open	1-3	2-3	Installed*	B
C	Installed	1&2	Installed	1-4	2-3	Installed*	C

Open for a differential sensor or installed for singled-ended sensors or the triangle-wave generator.

MAX9924U MODE A1, A2, B, and C Operation

The MAX9924U EV kit features jumpers JU1–JU5 and JU7 to configure the VR sensor interface circuit mode of operation. The circuit can be configured for MODE A1, A2, B, or C operation. Table 4 lists the various jumper options for configuring the circuit.

MODE B Operation: Supply a digital PWM signal to the FILTER and GND pads. The signal must provide a 5V logic-high frequency in the range of 25kHz to 100kHz.

MODE C Operation: Threshold voltage resistors R1 and R2 must be selected using the following equation. Refer to the *Comparator* section and Figure 5 in the MAX9924/MAX9925 IC data sheet for additional information on selecting threshold voltages.

$$V_{TL} = [R2/(R1 + R2)] \times V_{BIAS}$$

$$V_{TH} = [R1/(R1 + R2 + R14)] \times (V\_PULL - V_{BIAS}) + V_{BIAS}$$

where R2 is typically in the range of 50kΩ to 500kΩ, R14 is 10kΩ, V_{BIAS} is the voltage at the MAX9924U BIAS pin, and V_PULL is the voltage connected to the V_PULL pad. Refer to the *Mode Selection* section in the MAX9924/MAX9925 IC data sheet for additional information on selecting a mode of operation and the *Comparator* section for additional information on selecting threshold voltages.

COUT and V_PULL

The MAX9924U open-drain comparator output is available at the COUT PCB pad. The V_PULL PCB pad is provided to pull up the COUT signal through R14 to the voltage connected to the V_PULL PCB pad. V_PULL accepts voltages from 0 to 5.5V.

Evaluating a MAX9925

The MAX9924U EV kit can also be used to evaluate the MAX9925 IC with externally set gain (IC replacement of U1 required). Contact the factory to request a free sample of the MAX9925. Cut open the shorting trace across R20 and R21 pads before populating the resistors on these pads. To set the gain to 1V/V, install 100kΩ resistors at R20 and R9 for the IN+ input and 100kΩ resistors at R21 and R10 for the IN- input. Test point TP5 is provided for probing the pin 3 signal of the MAX9925 IC during evaluation.
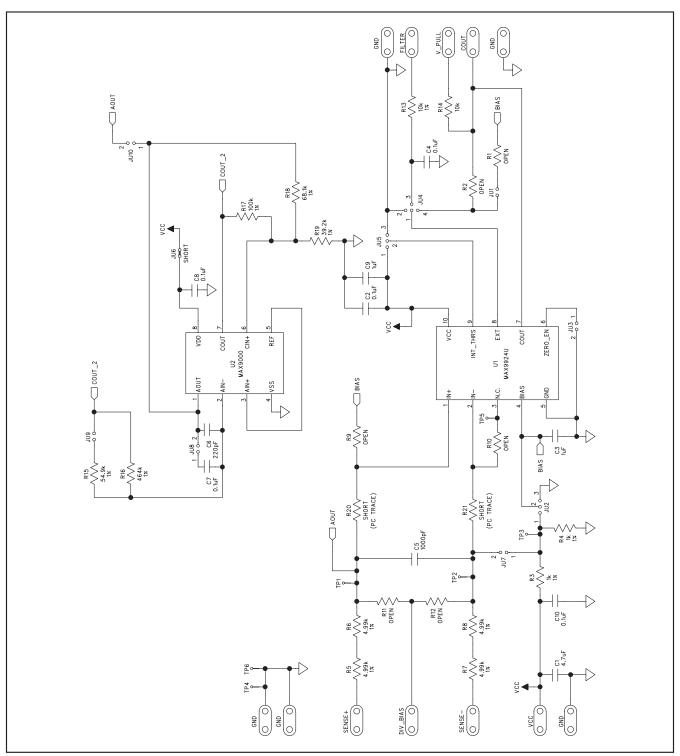
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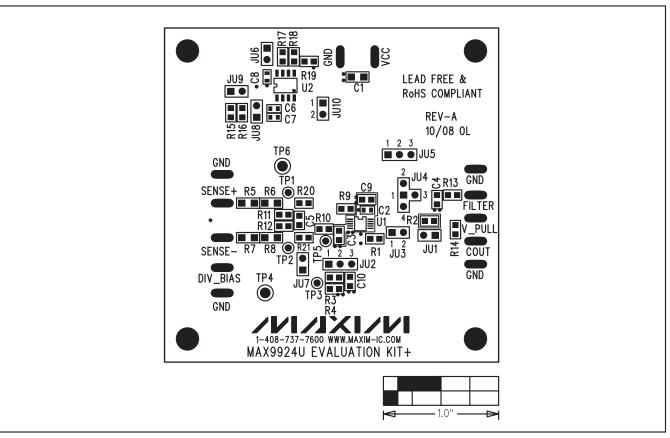
Figure 1. MAX9924U EV Kit Schematic

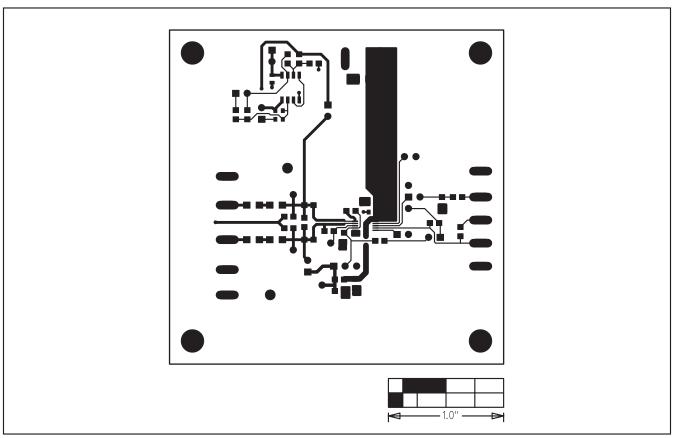Figure 2. MAX9924U EV Kit Component Placement Guide—Component Side

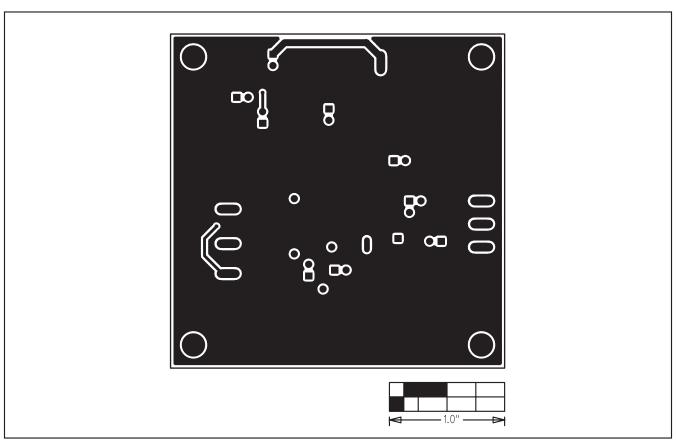Figure 3. MAX9924U EV Kit PCB Layout—Component Side

Evaluates: MAX9924U/MAX9925

Figure 4. MAX9924U EV Kit PCB Layout—Solder Side

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