General Description

The MAX9647 evaluation kit (EV kit) provides a proven design to evaluate the MAX9647 single comparator. The EV kit circuit can be easily configured by installing shunts and changing a few components to support multiple configurations for comparator applications such as logic-level translation and relaxation oscillator. The EV kit provides 0603 component PCB pads for ease of evaluation. The EV kit operates from a +1.8V to +5.5V VDD supply.

The EV kit comes with a MAX9647AUK+ installed. Contact the factory for samples of the pin-compatible MAX9648AUK+.

Features

- Accommodates Multiple Configurations for the Comparator
- Accommodates Easy-to-Use Components
- Proven PCB Layout
- Fully Assembled and Tested

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

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	0.1µF ±10%, 16V X7R ceramic capacitor (0603) Murata GCM188R71C104K
C2	1	4.7µF ±10%, 16V X7R ceramic capacitor (0805) Murata GRM21BR71C475K
C3	0	Not installed, ceramic capacitor (0603)
JU1	1	2-pin header
IN+, IN-, OUT, VDD, VPULL	5	Red test points
R1–R3, R5	0	Not installed, resistors (0603)
R4	1	100kΩ ±5% resistor (0603)
VSS	3	Black multipurpose test points
U1	1	Comparator (5 SOT23) Maxim MAX9647AUK+
—	1	Shunt
—	1	PCB: MAX9647 EVKIT

Component Supplier

SUPPLIER	PHONE	WEBSITE
Murata Americas	800-241-6574	www.murataamericas.com

Note: *Indicate that you are using the MAX9647 when contacting this component supplier.*

Quick Start

Required Equipment

- MAX9647 EV kit
- Three adjustable 0 to +5V DC power supplies
- Oscilloscope

Procedure

The EV kit is fully assembled and tested. Follow the steps below to verify board operation. **Caution: Do not turn on the power supplies until all connections are completed.**

1) Verify that a shunt is installed on jumper JU1.
2) Set the first DC power supply to +3.3V and connect the positive terminal to VDD and the negative terminal to the GND PCB pads.
3) Set the second DC power supply to +1.5V and connect the positive terminal to IN+ and the negative terminal to the GND PCB pads.
4) Set the third DC power supply to +1.0V and connect the positive terminal to IN- and the negative terminal to the GND PCB pads.
5) Connect the oscilloscope's channel to the OUT PCB pad on the EV kit.
6) Enable all three power supplies.
7) Verify that the OUT signal is logic-high (3.3V).
8) Increase the third DC power supply to +2.0V.
9) Verify that the OUT signal is logic-low (0V).

Detailed Description of Hardware

The MAX9647 EV kit is a fully assembled and tested PCB that evaluates the MAX9647 comparator. The EV kit requires a +1.8V to +5.5V input supply voltage at VDD for normal operation.

The EV kit is configurable for different applications such as logic-level translation and relaxation oscillator by installing appropriate components on the PCB.

Comparator Application Circuits

Logic-Level Translation

Jumper JU1 is available to change the logic level of the comparator's output. Install a shunt on JU1 to set VDD as the comparator output logic level. Remove the shunt from JU1 and apply the desired voltage at the VPULL test point to set the comparator output logic level independent of the supply voltage. Note that the OUT pins on the comparator have an absolute maximum of (VSS - 0.3) to +6V. See Table 1 for proper jumper JU1 configuration.

Relaxation Oscillator

The device can be configured to operate as a simple relaxation oscillator (Figure 2), as follows:

1) Add a suitable resistor and capacitor at the R3 and C3 PCB pads, respectively.
2) The trip thresholds are set by applying suitable external hysteresis using R1, R2, and R5 PCB pads.

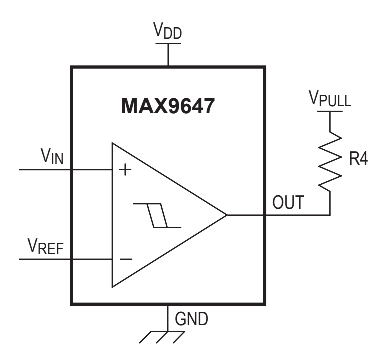

Figure 1. Logic-Level Translator Circuit

Table 1. OUTA Logic Level (JU1)

SHUNT POSITION	OUT_ PIN	LOGIC-HIGH VOLTAGE
Installed*	Pulled up to VDD through resistor R4	VDD
Not installed	Pulled up to VPULL through resistor R4	External voltage applied at the VPULL test point

**Default position.*

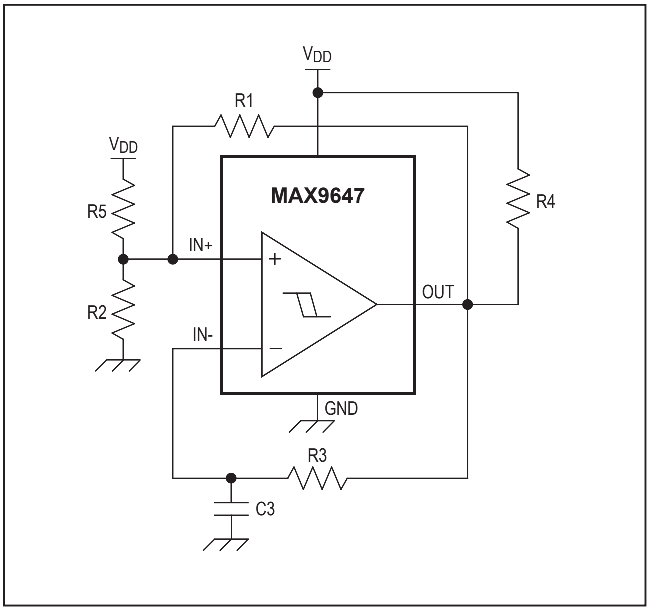

Figure 2. Relaxation Oscillator Circuit

Use the following equations to determine the optimum component values:

The selection of R3 should be much larger than R4 (R4 << R3). If R4 and R3 are in comparable ranges, the V_{OH} can drastically change, which eventually changes the trip points and hence the desired oscillating frequency.

Assuming R1 = 78.7kΩ; R2 = R5 = 40.2kΩ; C3 = 10nF; R3 = 100kΩ; R4 = 1kΩ; $V_{PULL\_UP} = V_{DD}$ = 5V.

Then:

$$R_P = R5 \parallel R2 \text{ and } V_P = \frac{V_{DD} \times R2}{R5 + R2}$$

$$V_{T\_RISE} = V_P \frac{(R1) + (R4)}{(R1 + R4 + R_P)} + V_{DD} \frac{(R_P)}{(R1 + R4 + R_P)} = 3.003\text{ V}$$

$$V_{T\_FALL} = V_P \frac{(R1)}{(R_P + R1)} + V_{OL} \frac{(R_p)}{(R_P + R1)} = 2.01\text{ V}$$

V_{T_RISE} and V_{T_FALL} values also vary with V_{DD} used.

Using the basic time-domain equation for charging and discharging the respective comparator RC circuit, the comparator oscillator frequency can be calculated using the following equation:

During Charging Phase:

$$V_{C(t1)} = V_{DD} + (V_{T\_FALL} - V_{DD})e^{-t1/\tau}$$

where t1 is the time required for the capacitor to charge to $V_{C(t1)} = V_{T\_RISE}$.

During Discharging Phase:

$$V_{C(t2)} = V_{OL} + (V_{T\_RISE} - V_{OL})e^{-t2/\tau}$$

where t2 is the time required for the capacitor to charge to $V_{C(t2)} = V_{T\_FALL}$.

Hence, for the above-mentioned case of component values:

$$t_{RISE} = R3 \times C3 \ln\left[\frac{(V_{DD} - V_{T\_FALL})}{(V_{DD} - V_{T\_RISE})}\right] \text{ and}$$

$$t_{FALL} = R3 \times C3 \ln\left[\frac{(V_{T\_RISE} - V_{OL})}{(V_{T\_FALL} - V_{OL})}\right]$$

$$t_1 = \tau \ln(\frac{3}{2}) \text{ and } t_2 = \tau \ln(\frac{3}{2}); \tau = R3 \times C3 = 1 \times 10^{-3}$$

Ideally, because t1 = t2. The output square waveform has 50% duty cycle; however, because V_{OH} and V_{OL} are subject to changes, the waveform becomes asymmetric.

Hence the total time would be:

$$T = t1 + t2$$

or

$$f_{OSC} = \left(\frac{1}{R3C3 \ln\left[\frac{(V_{DD} - V_{T\_FALL})}{(V_{DD} - V_{T\_RISE})}\right] + R3C3 \ln\left[\frac{(V_{T\_RISE} - V_{OL})}{(V_{T\_FALL} - V_{OL})}\right]} \right)$$

$$= \frac{1}{(436 + 364)\mu s} = 1.25\text{kHz}$$

Component Selection:

Choice of R4 (pullup resistor) should be within 500Ω to few kΩ because R4 affects the time constant, V_{OH}, V_{T_RISE} of the circuit. This eventually changes the frequency of oscillation.

Also ensure that $R_{PULL-UP}$ is small compared to the feedback resistors and particularly to R3. This way, it does not limit the current in that part of the circuit, but when R4 and R3 are in comparable ranges, the charging phase can take a longer period of time to charge the capacitor, which ultimately affects the oscillating frequency and also makes the duty cycle asymmetrical.

Other characteristics such as the offset voltage, the input bias current, propagation delay, and temperature also have an effect on the trip points and oscillation frequency.

For instance, when C3 = 100pF and R3 = 10kΩ, the capacitance used is in the vicinity of the input capacitance of the comparator (~3.5pF). The effective equivalent capacitance would be 103.5pF and produce a 3.5% error in the time constant. The board capacitance is not included in this case, which includes more errors. Also, the duty cycle is asymmetrical because of R3 being 10 times that of R4.

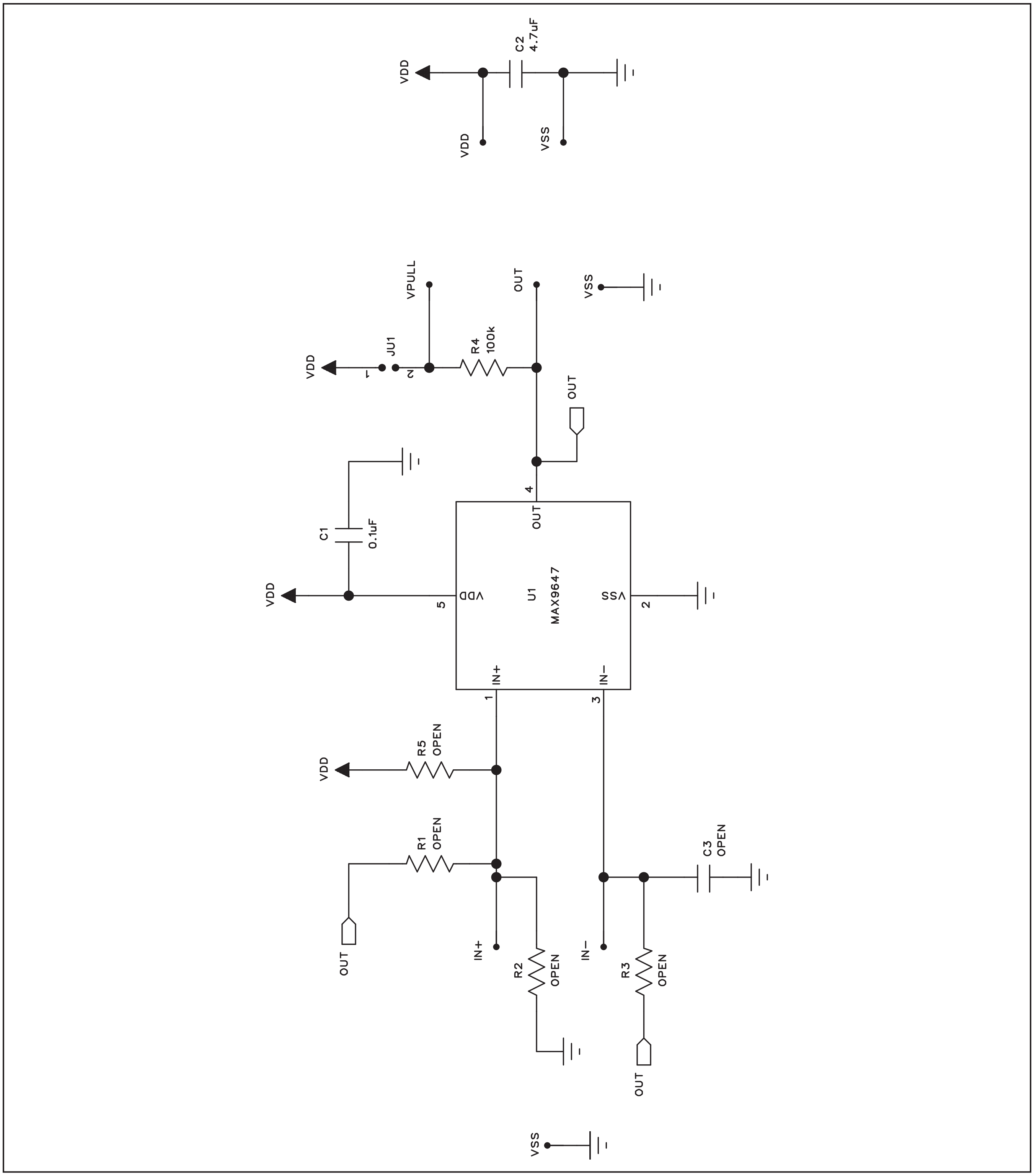

Figure 3. MAX9647 EV Kit Schematic

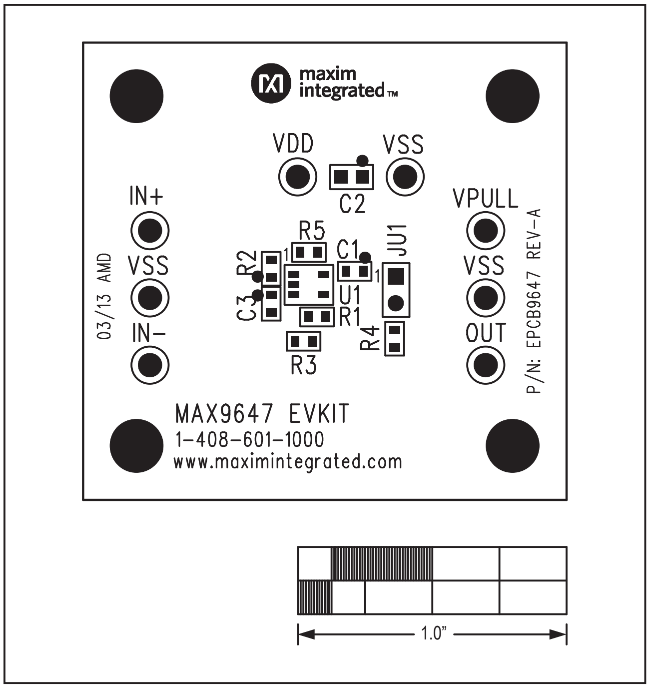

Figure 4. MAX9647 EV Kit Component Placement Guide—Component Side

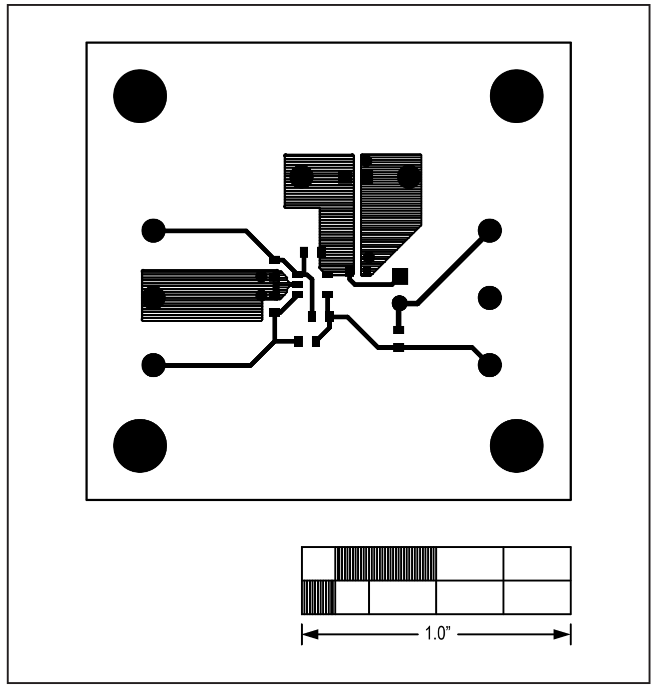

Figure 5. MAX9647 EV Kit PCB Layout—Component Side

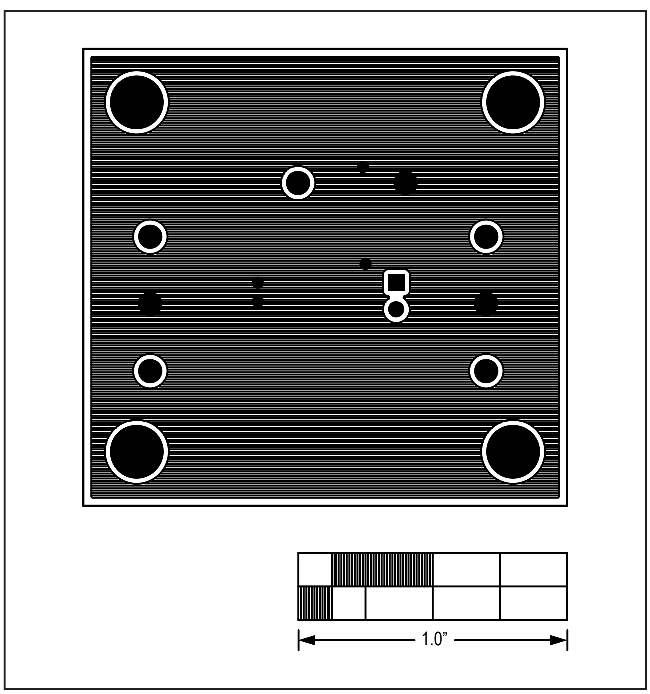

Figure 6. MAX9647 EV Kit PCB Layout—Solder Side

Ordering Information

PART	TYPE
MAX9647EVKIT#	EV Kit

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	5/13	Initial release	—

