



# MAX038 Evaluation Kit

Evaluates: MAX038

## General Description

The MAX038 evaluation kit (EV kit) is a high-frequency function generator capable of producing accurate triangle/sawtooth, sine, and square/pulse waveforms up to 10MHz, using the supplied components. Output frequency and duty cycle are easily adjusted with on-board potentiometers. Removable jumpers select sine, square, or triangle waveforms, or fix the duty cycle at 50%. The output is buffered with a MAX442 amplifier capable of driving a 50Ω coaxial cable. The MAX038 EV kit is fully assembled and tested.

## Ordering Information

| PART            | TEMP. RANGE  | BOARD TYPE   |
|-----------------|--------------|--------------|
| MAX038EVKIT-DIP | 0°C to +70°C | Through-Hole |

## EV Kit



## Features

- ◆ 325kHz to 10MHz Operation
- ◆ Adjustable Duty Cycle
- ◆ 2.5V Reference Output
- ◆ TTL-Compatible SYNC Output
- ◆ Fully Assembled and Tested

## Component List

| DESIGNATION                       | QTY | DESCRIPTION         |
|-----------------------------------|-----|---------------------|
| U1                                | 1   | MAX038CPP           |
| U2                                | 1   | MAX442CPA           |
| C1                                | 1   | 82pF capacitor      |
| C2, C3, C5, C7, C9, C10, C11, C12 | 8   | 0.1μF capacitors    |
| C4, C6, C8                        | 3   | 4.7μF capacitors    |
| R1, R2                            | 2   | 20kΩ potentiometers |
| R3                                | 1   | 50kΩ potentiometer  |
| R4, R5                            | 2   | 10kΩ, 5% resistors  |
| R6                                | 1   | 51Ω, 5% resistor    |
| R7, R8                            | 2   | 270Ω, 5% resistors  |
| R9, R10, R11                      | 3   | 0Ω resistors        |
| R12                               | 1   | 3.3kΩ, 5% resistor  |
| JU1, JU2, JU5                     | 3   | 2-pin headers       |
| JU3, JU4                          | 2   | 3-pin headers       |
| None                              | 5   | Shunts              |
| J1                                | 1   | BNC jack            |

## Quick Start

The MAX038 EV kit is a fully assembled and tested board. Follow these steps to verify board operation. **Do not turn on the power supply until all connections are completed.**

- 1) Connect a +5V supply to the pad marked +5V. Connect a -5V supply to the pad marked -5V. Connect ground(s) to the GND pad.
- 2) Connect an oscilloscope to the BNC jack marked OUTPUT through a terminated 50Ω cable. The MAX038 output prior to the amplifier stage may also be monitored using an oscilloscope probe at the OUT pad.
- 3) Place the shunt across pins 2 and 3 of JU4 for 50% duty cycle. Place the shunt across pins 1 and 2 of



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JU3 to allow the frequency to be adjusted. Verify that there is a shunt on JU5.

- 4) Verify the shunts on JU1 and JU2 for a square-wave output. Refer to Table 1 for alternate waveform selections.
- 5) Apply power and verify the output waveform.

## Detailed Description

### Waveform Selection

To select the desired output waveform, place shunts across JU1 and JU2 in the combinations shown in Table 1. These jumpers set address pins A0 and A1 to TTL/CMOS-logic levels. External control may be initiated by connecting an external source to the A0 and A1 pads and removing the shunts on JU1 and JU2. Note that there are 10k $\Omega$  pull-up resistors to +5V on the A0 and A1 address lines.

**Table 1. Waveform Jumper Select**

| JU1        | JU2   | OUTPUT WAVEFORM |
|------------|-------|-----------------|
| Don't Care | Open  | Sine Wave       |
| Open       | Short | Triangle Wave   |
| Short      | Short | Square Wave     |

**Table 2. Frequency and Duty-Cycle Jumper Select**

| JUMPER | SHUNT LOCATION | MAX038 OUTPUT         |
|--------|----------------|-----------------------|
| JU3    | 1 & 2          | Adjustable Frequency  |
|        | 2 & 3          | Pre-Set Frequency*    |
| JU4    | 1 & 2          | Adjustable Duty Cycle |
|        | 2 & 3          | Fixed 50% Duty Cycle  |

\* Note: Frequency pre-set by oscillator capacitor (C1) and input current (position of R3) as specified by formula [1].

### Output Frequency

The output frequency is controlled by the oscillator capacitor (C1), the current injected into the IIN pin, and the voltage on the FADJ pin. The EV kit allows independent adjustment of both input current (R3) and FADJ voltage (R2). Refer to the *Detailed Description* section of the MAX038 data sheet for additional theory of operation.

### Input Current Control

The current injected into the IIN pin acts as the primary frequency-adjustment control. The R3 potentiometer varies the current to the MAX038's IIN pin. The input current can be easily monitored by removing the JU5 shunt and placing a current meter across the JU5 pins. The components supplied on the EV kit will allow an input current range of 50 $\mu$ A to 725 $\mu$ A. With the VADJ pin grounded, the fundamental output frequency ( $F_o$ ) is as follows:

$$F_o \text{ (MHz)} = I_{IN}(\mu\text{A}) \div \text{COSC (pF)} \quad [1]$$

where:  $I_{IN}$  = current injected into IIN

$$= V_{REF} \div (R3 + R12)$$

$$= 2.5\text{V} \div (0\text{k}\Omega \text{ to } 50\text{k}\Omega + 3.3\text{k}\Omega)$$

COSC = external oscillator capacitor (C1)

To use an external input current, connect the external current source to the IIN pad and remove the JU5 shunt completely. Note that there is a 3.3k $\Omega$  resistor in series with the device IIN pin.

### FADJ Control

Varying the FADJ voltage will also vary the output frequency. With a shunt across pins 1 and 2 of JU3, the R2 potentiometer will vary the voltage applied to the FADJ pin. With the JU3 shunt on pins 2 and 3, the FADJ pin is grounded. Grounding the FADJ pin sets the output to the fundamental output frequency ( $F_o$ ), as given by equation [1].

To use an external FADJ voltage, connect the external source to the FADJ pad and remove the JU3 shunt completely. Limit the external FADJ voltage to  $\pm 2.4\text{V}$ .

### Duty-Cycle Control

The voltage on the DADJ pin controls the duty cycle of the output waveform. With the JU4 shunt on pins 1 and 2, the R1 potentiometer will vary the voltage applied to the DADJ pin, thus varying the duty cycle 15% to 85%. With the JU4 shunt on pins 2 and 3, the DADJ pin is grounded. Grounding the DADJ pin fixes the duty cycle at 50%.

To use an external DADJ voltage, connect the external voltage source to the DADJ pad and remove the JU4 shunt completely. Limit the external DADJ voltage to  $\pm 2.3\text{V}$ .

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## Output Buffer

The MAX038 output amplitude is fixed at  $2V_{p-p}$ . The MAX038 output is capable of driving a capacitive load up to 90pF. The MAX442 amplifier buffers the MAX038 output to a  $50\Omega$  coaxial cable. The MAX442 is set at a gain of  $2V/V$ , so that the output amplitude remains  $1V/V$  after the  $50\Omega$  back termination. The EV kit's OUT pad provides access to the output of the MAX038 prior to the MAX442 buffer stage. The MAX442 output connects to the BNC connector through a  $50\Omega$  resistor to back terminate a  $50\Omega$  coaxial cable. When a terminated  $50\Omega$  cable is connected, this resistor forms a voltage divider with the load impedance, which attenuates the signal by one-half. The MAX442 is operated with a  $2V/V$  closed-loop gain to provide unity gain at the  $50\Omega$  cable's output.

The MAX442 is actually a 2-channel amplifier. A built-in multiplexer allows either of two input signals to be selected. TTL-level address pin A0 selects either IN0 or IN1. The MAX038 output is connected to MAX442 input IN0. IN1 is unused and connected to ground; it may be used by cutting the JU7 trace, thus disconnecting IN1 from ground. Likewise, the MAX442 address pin A0 can be disconnected from ground by cutting the JU8 trace. Pull up A0 to +5V to select IN1. See the MAX442 data sheet for additional operation details.

## Reference Voltage

The MAX038 includes a 2.5V bandgap reference capable of sourcing 4mA and sinking  $100\mu A$ . Access to the reference voltage is provided at the REF pad. The reference voltage is primarily used to provide stable current to IIN and to bias DADJ and FADJ.

## Extending the Output Frequency Range

The components supplied with the EV kit allow an output frequency range of 325kHz to 10MHz. The frequency range is controlled primarily by the oscillator capacitor (C1) and the input current, which is a function of the reference voltage and potentiometer R3. The resulting frequency range can be shifted up or down depending on the value of C1. Refer to the Output Frequency vs. Input Current graph which appears in the *Typical Operating Characteristics* of the MAX038 data sheet.

The upper end of the range can be extended by reducing C1. The lower end of the range can be reduced by increasing the value of C1. Take care when selecting alternate capacitors if stable operation over temperature is desired. Ceramic capacitors with low temperature coefficients give the best results. Refer to the *Selecting Resistors and Capacitors* section of the MAX038 data sheet for further details.

## Sync Output and Phase-Detector Input

Refer to the *SYNC Output* and *Phase Detector* sections of the MAX038 data sheet for details of circuit synchronization. Access to the Phase Detector Input (PDI) and SYNC is provided at pads PDI and SYNC.

High-speed transient currents in DGND and DV+ can cause a switching spike in the output waveform at the zero-crossing point. A lowpass output filter, as shown in Figure 3 of the MAX038 data sheet, may be used to greatly reduce the spike. Complete LC filter assemblies (S3LP series) are available from Coilcraft (phone: 708-639-6400). If the SYNC output is not required, disabling the SYNC circuit will eliminate the switching spike. Cut the trace between the DV+ and +5V pads to disable the SYNC output.



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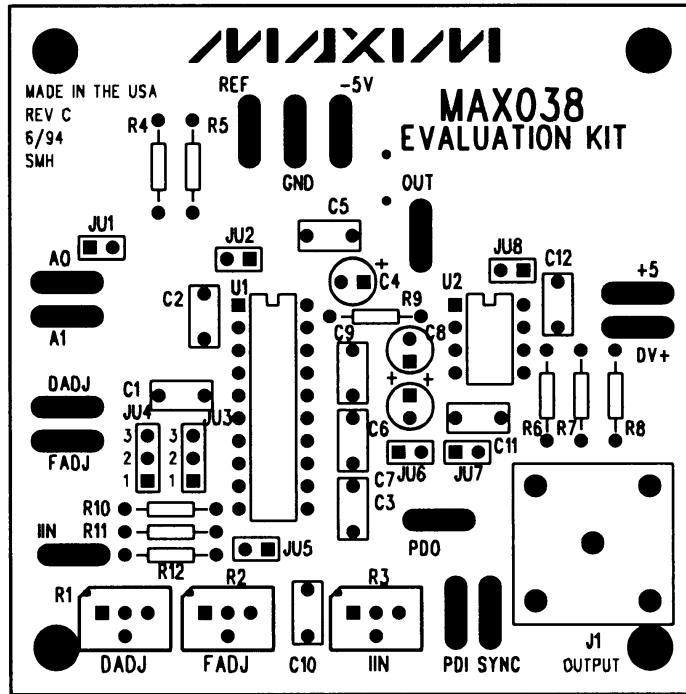


Figure 2. MAX038 EV Kit Component Placement Guide—Component Side

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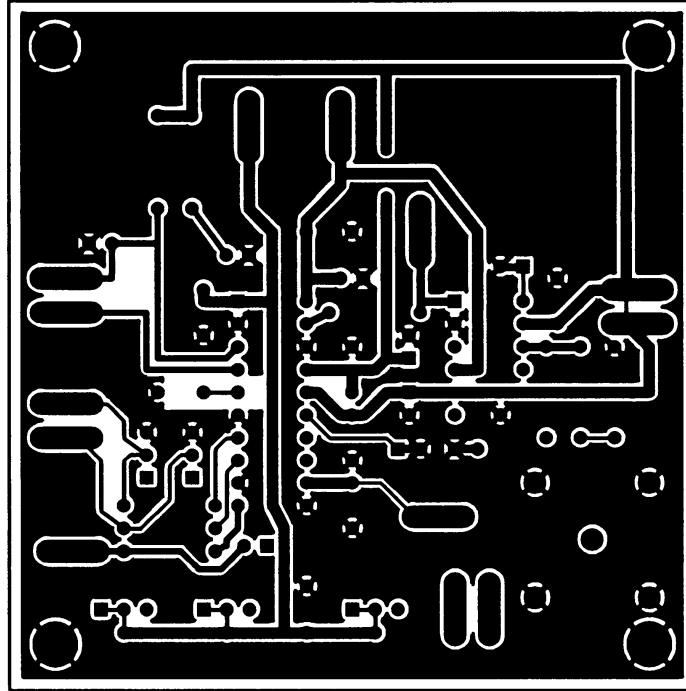


Figure 3. MAX038 EV Kit PC Board Layout—Component Side

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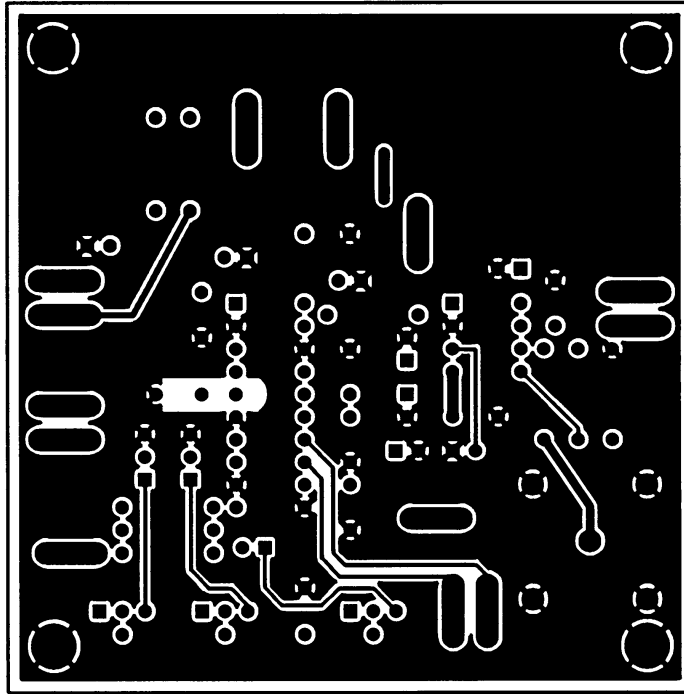


Figure 4. MAX038 EV Kit PC Board Layout—Solder Side

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## NOTES

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