

# MAXIM

## MAX2402 Evaluation Kit

Evaluates: MAX2402

### General Description

The MAX2402 evaluation kit (EV kit) simplifies evaluation of the MAX2402 transmitter. The EV kit enables the testing of all MAX2402 functions with no additional support circuitry and with minimal equipment.

### Features

- ◆ Low-Cost, Flexible Transmitter
- ◆ More than 100mW of Output Power
- ◆ Operates from 800MHz to 1000MHz
- ◆ Single +5V Supply
- ◆ Easy Testing of All MAX2402 Features

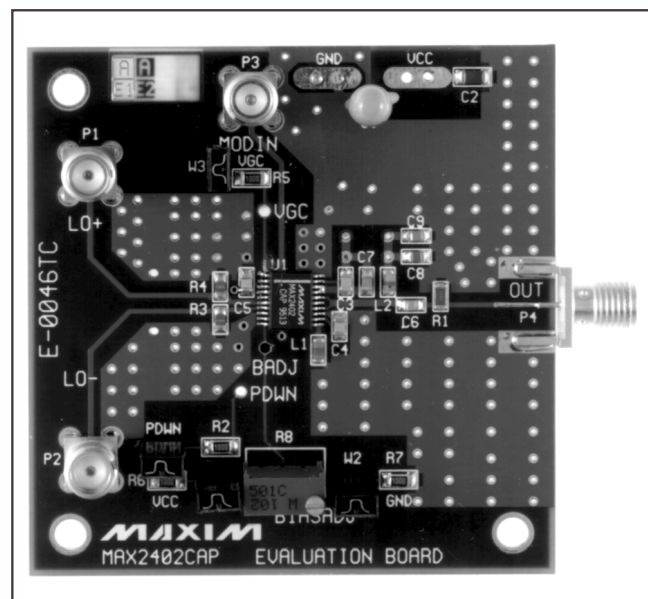
### Component List

| DESIGNATION      | QTY | DESCRIPTION                                    |
|------------------|-----|--|
| C1               | 1   | 10 $\mu$ F, 25V, 10%, tantalum capacitor       |
| C2               | 1   | 0.1 $\mu$ F, 50V, 10% ceramic capacitor        |
| C3, C4, C5       | 3   | 39pF, 50V, 5% ceramic capacitors               |
| C6               | 1   | 150pF, 50V, 5% ceramic capacitor               |
| C7, C9, C12      | 2   | 0.01 $\mu$ F, 50V, 10% ceramic capacitors      |
| C8               | 1   | 100pF, 50V, 5% ceramic capacitor               |
| C10              | 1   | 220pF  |
| L1               | 1   | 27nH, 20% inductor<br>Coilcraft 0805CS-270XMBC |
| L2               | 1   | 47nH, 20% inductor<br>Coilcraft 0805CS-470XMBC |
| LO+, LO-MOD, OUT | 4   | Female SMA connectors                          |
| R1               | 1   | 121 $\Omega$ , 1% resistor                     |
| R2, R5           | 2   | 100 $\Omega$ , 5% resistors                    |
| R3, R4           | 2   | 49.9 $\Omega$ , 1% resistors                   |
| R6, R7           | 2   | 51 $\Omega$ , 5% resistors                     |
| R8               | 1   | 1k $\Omega$ , multi-turn potentiometer         |
| U1               | 1   | MAX2402EAP                                     |
| W1-W4            | 4   | 2-pin headers                                  |
| None             | 4   | 2-pin shunts                                   |

### Ordering Information

| PART            | TEMP. RANGE    | BOARD TYPE    |
|-----------------|----------------|---------------|
| MAX2402EVKIT-SO | -40°C to +85°C | Surface Mount |

### EV Kit



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## Quick Start

The MAX2402 EV kit is fully assembled and factory tested. **Do not turn on the power until all connections are made.**

### Test Equipment Required

- Signal source, sine-wave generator with range up to 1000MHz (example: HP8656B)
- Signal source, function generator with range up to 10MHz
- Spectrum analyzer with range up to 4GHz (example: TEK2755AP)
- Power supply capable of 5V, 300mA output with current limit

### Connections and Signal Conditions

- 1) Verify that all shunts are across jumpers W1–W4.
- 2) The LO port can be driven single-ended or differentially. For single-ended drive, connect an SMA cable from the 1000MHz signal source to the LO+ SMA input on the EV kit. For differential drive, install a 220pF ceramic capacitor (not provided) at site C11. Using SMA cables, connect the signal source to the LO+ and LO- inputs through a balun with sufficient bandwidth.

The EV kit was designed for single-ended or differential LO drive. In your final layout, capacitors C10 and C11 are not required. For single-ended LO drive applications, ground the unused LO port as close to the package as possible. For differential drive applications, connect LO lines directly to LO port pins. Coupling capacitors are not required, as the LO ports are internally AC coupled.

- 3) Connect an SMA cable from the spectrum analyzer to the OUT SMA on the EV kit.
- 4) Connect the power supply to the appropriate VCC and GND terminals on the EV kit.
- 5) Place a shorting termination on the MOD SMA connector to put the mixer in a fully on position.
- 6) Set LO power to 0dBm and frequency to 900MHz on the signal source. Do not apply a signal to the DUT yet, if you have control of this function.
- 7) Set the spectrum analyzer's dynamic range for a top limit of 30dBm, and set the frequency range for an appropriate setting to view the output.
- 8) Set the power supply to 5.0V and set the current limit to 300mA. Apply power.

## Analysis

- 1) R1 is a 121 $\Omega$  surface-mount resistor on the EV kit which is parallel with the 50 $\Omega$  termination of the spectrum analyzer. This sets the load of the power amplifier at 35 $\Omega$ , which is a close match to the power amplifier's output impedance. As a result, the spectrum analyzer will display an output power level which is 1.5dB below the actual transmitted power. As long as this resistor is on the EV kit, 1.5dB must be added to any displayed power levels to get accurate information.

R1 can be removed, if desired, with about a 0.7dB reduction in transmitted power due to the load mismatch. The output power (with 1.5dB added to the displayed power) should be at least 20dBm. (Note: Before signal is applied to the LO port there may be a parasitic oscillation on the EV board. This is caused by parasitic feedback from the power-amplifier output to the LO port and cable. When signal is applied to the LO port, this oscillation will abate.)

- 2) The output power can be observed for the 800MHz to 1000MHz LO input range and over the prescribed input power levels. (Near 800MHz, it may be necessary to adjust BADI to higher than 2.5V to maintain stability.)
- 3) To observe the effects of the VGC voltage on output power, connect an adjustable supply to the VGC test point on the EV kit and remove the VGC jumper (W3). This supply can now be adjusted and the output power can be observed as a function of VGC voltage. The VGC range is 0V to VCC. The output power should be at a minimum when VGC is adjusted below 0.8V. The output power should be at a maximum when VGC is adjusted above (VCC - 0.5V).
- 4) The BADI pin is used to control the bias level of the final stages of the PA. The adjustment range on BADI is 0V to VCC, with 0V representing the greatest bias current and 5V the least. More bias current will result in more output power, less efficiency, and less distortion. The intended configuration for this pin is a single resistor pull-up or pull-down to VCC or GND, respectively. The value of this resistor will determine the bias voltage at the BADI pin. See Table 1 in the MAX2402 data sheet for a guide to resistor use at the BADI input.

The MAX2402 BADI input is self biasing to about VCC/2 and can be left open. At low BADI voltage settings and lower frequencies within the 800MHz to 1000MHz range, the power-supply current may increase unacceptably or the circuit may oscillate.

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At these lower frequencies, more than 20dBm of power can easily be obtained with BADJ set at 3V or above (see the *BADJ Input* section of the MAX2402 data sheet).

Removing the VCC jumper (W1) on the EV kit will connect BADJ to GND, while removing the GND jumper (W2) will connect BADJ to VCC. Removing both will cause BADJ to rely on its internal bias.

- 5) The MAX2402  $\overline{\text{SHDN}}$  pin connects to VCC through a jumper and 100 $\Omega$ . To test the shutdown function, ensure that either W1 or W2 is removed, which will prevent current draw through R6, R7, and R8. When the  $\overline{\text{SHDN}}$  jumper is removed and the  $\overline{\text{SHDN}}$  test point is grounded, the supply current should drop below 1 $\mu$ A.
- 6) The modulated spectrum can be examined on the spectrum analyzer by removing the shorting termination and supplying a modulation signal to the SMA MOD input. The MOD input is linear from approximately 1.5V to 3.5V, and has a bandwidth of DC to 25MHz. The MOD input is self-biasing to approximately VCC/2. Any offset at the MOD input from a symmetric signal around the self-bias voltage will act as an offset and cause less than optimal carrier rejection. Capacitive coupling into the MOD input will eliminate this situation and result in optimum carrier rejection. The MOD input will act as an attenuator if it is left open.

## Adjustments and Control

### VGC

The VGC jumper (W3) shorts the VGC input of the MAX2402 to VCC. The VGC test point can be used to manipulate the gain control voltage. The VGC jumper (W3) should be removed before trying to control this VGC voltage. It connects to VCC when in place.

### SHDN

The  $\overline{\text{SHDN}}$  jumper (W4) shorts the  $\overline{\text{SHDN}}$  input to VCC to keep the part in normal operating condition. The  $\overline{\text{SHDN}}$  test point can be used with a controlling voltage to power down the MAX2402. The  $\overline{\text{SHDN}}$  jumper (W4) should be removed when adjusting the voltage on the test pin. It connects to VCC when in place.

### BADJ

The two bias adjust jumpers connect either end of the 1k $\Omega$  potentiometer to VCC and GND through 50 $\Omega$  resistors. The wiper on the potentiometer has been factory adjusted to provide 2.5V to the BADJ input on the MAX2402. The BADJ test point is for monitoring the BADJ voltage. The BADJ jumpers (W1, W2) connect R8 to VCC and GND, respectively. BADJ voltage is altered by adjusting the R8 potentiometer.

### Layout Considerations

The evaluation board can serve as a guide for board layout. C3, C4, and C5 should be small surface-mount capacitors, placed directly from each VCC pin to the adjacent ground. Place them as close to the MAX2402 as possible, and make connections directly to the pins (not through vias or long traces). C6, C7, and C8 should also be surface mount. C7 should be next to C3. C8 and C9 should be located at the VCC terminal of choke L2. If the LO is driven single-ended, ground the unused LO port. If a single resistor is used to bias BADJ, it may be necessary to AC couple BADJ to ground with a low-value capacitor, since the high-impedance at the BADJ node may be sensitive to circuit noise. Although the evaluation board uses four layers, it is possible to use two.

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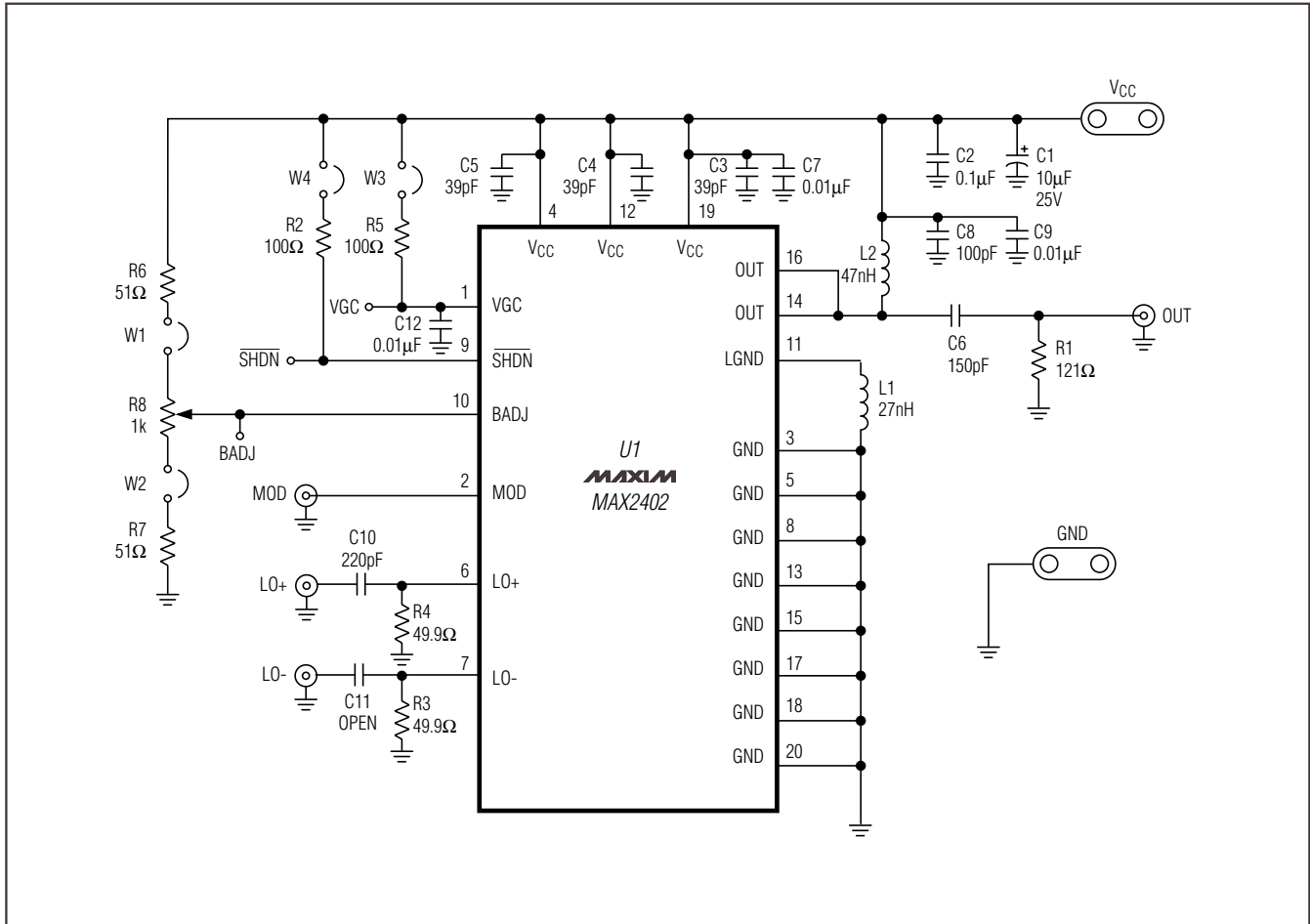


Figure 1. MAX2402 EV Kit Schematic

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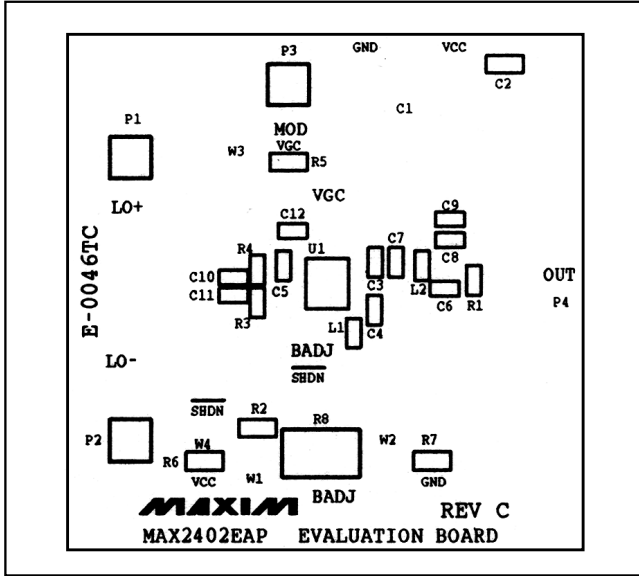


Figure 2. MAX2402 EV Kit Component Placement Guide—Component Side

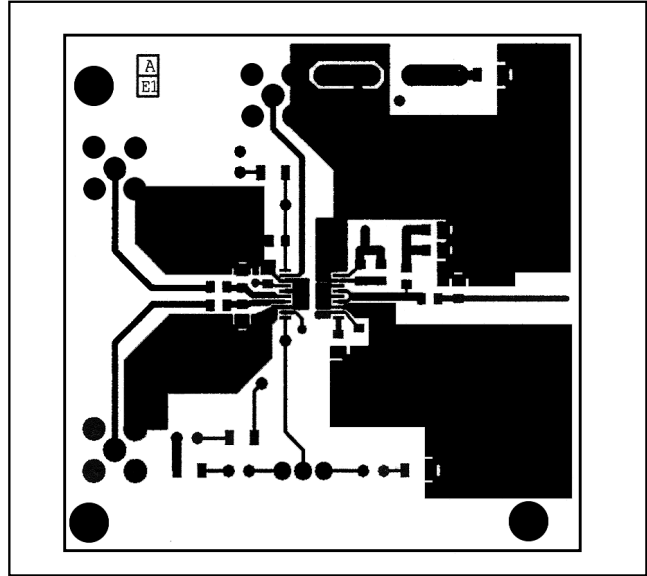


Figure 3. MAX2402 EV Kit PC Board Layout—Component Side

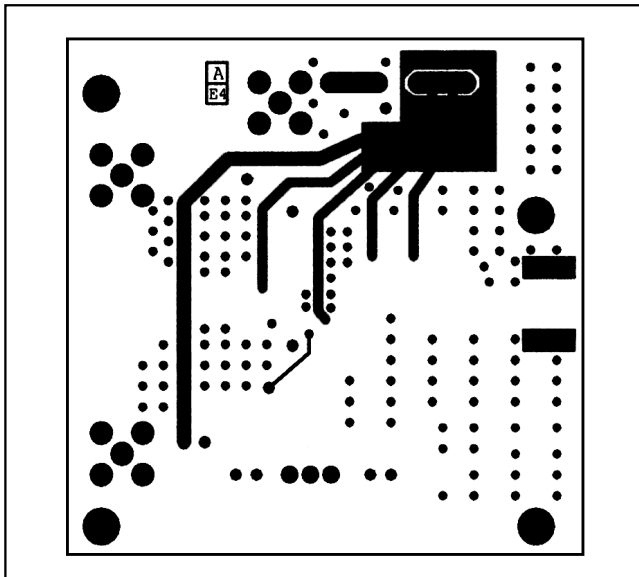


Figure 4. MAX2402 EV Kit PC Board Layout—Solder Side

Note: Ground layers 2 and 3 not shown.

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