

### **General Description**

The MAX2700/MAX2701 evaluation kits (EV kits) simplify evaluation of the MAX2700/MAX2701 direct downconverter receivers. These kits allow evaluation of the devices' low-noise amplifier (LNA), I/Q demodulator, and variable gain amplifiers (VGAs). Figure 1 shows the MAX2700/MAX2701 EV kits schematic. The EV kits provide  $50\Omega$  SMA connectors for all RF input and output signals, and BNC connectors for all baseband input and output signals.

#### Features

- Easy Evaluation of MAX2700/MAX2701
- ♦ +2.7V to +3.3V Single-Supply Operation
- ♦ RF Ports Matched to 1960MHz (MAX2700)
- ♦ RF Ports Matched to 2400MHz (MAX2701)
- ♦ SMA Connectors for All RF Signal Ports
- **♦ BNC Connectors for All Baseband Signal Ports**
- ♦ Low-Power Shutdown Mode

### **Ordering Information**

| PART         | TEMP.RANGE     | IC PACKAGE |
|--------------|----------------|------------|
| MAX2700EVKIT | -40°C to +85°C | 48 TQFP-EP |
| MAX2701EVKIT | -40°C to +85°C | 48 TQFP-EP |

### **MAX2700 Component List**

| DESIGNATION   | QTY | DESCRIPTION  |
|---|-----|--|
| C1, C17, C18, C19,<br>C21, C22, C23,<br>C30, C31, C32,<br>C36, C37, C38 | 13  | 0.1µF 10% ceramic capacitors<br>(0603)<br>Murata GRM39X7R104K016A  |
| C2, C10, C11, C25,<br>C43, C46  | 6   | 68pF 5% ceramic capacitors<br>(0402)<br>Murata GRM36COG680J050A    |
| C3, C6, C7, C45   | 4   | 1000pF 10% ceramic<br>capacitors (0402)<br>Murata GRM36X7R102K050A |
| C4, C50   | 2   | 2.0pF ±0.1pF ceramic capacitors Murata GRM36COG020B050A            |
| C5  | 1   | 0Ω resistor (0603)   |
| C8, C14, C33  | 3   | 100pF 5% ceramic capacitors<br>(0402)<br>Murata GRM36COG101J050A   |
| C9, C16, C34  | 3   | 0.01µF 10% ceramic capacitors<br>(0402)<br>Murata GRM36X7R103K016A |
| C12, C26, C27,<br>C40   | 4   | 22pF 5% ceramic capacitors<br>(0402)<br>Murata GRM36COG220J050A    |

| DESIGNATION                                   | QTY | DESCRIPTION   |
|---|-----|---|
| C13, C41, C42,<br>C47, C48                    | 5   | Not installed   |
| C15, C20, C35,<br>C39                         | 4   | 0.056µF 10% ceramic<br>capacitors (0603)<br>Murata GRM39X7R563K016A |
| C24, C29                                      | 2   | 0.56µF 10% ceramic capacitors<br>(0805)<br>Murata GRM40X7R564K016A  |
| C28   | 1   | Not installed   |
| C44   | 1   | 10μF tantalum capacitor ±10%<br>16V min<br>AVX TAJC106K016          |
| C49   | 1   | 5pF ±0.1pF ceramic capacitor<br>(0402)<br>Murata GRM36COG050B050A   |
| R1, R12, R15, R26,<br>R32, R40, R45           | 7   | 0Ω resistors (0805)   |
| R2, R5, R6, R11                               | 4   | 100Ω ±5% resistors (0402)   |
| R3, R4, R7, R8, R9,<br>R10                    | 6   | 0Ω resistors (0402)   |
| R13, R14, R19,<br>R20, R33, R34,<br>R38, R39, | 8   | 1kΩ ±5% resistors (0402)  |

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## MAX2700 Component List (continued)

| DESIGNATION                                  | QTY | DESCRIPTION   |
|--|-----|---|
| R16, R22, R30,<br>R36                        | 4   | 1.1kΩ ±5% resistors (0402)                                  |
| R17, R21, R31,<br>R37                        | 4   | 3.6kΩ ±5% resistors (0402)                                  |
| R18, R23, R29,<br>R35                        | 4   | 820Ω ±5% resistors (0402)                                   |
| R24, R25, R27,<br>R28, R41, R42,<br>R43, R44 | 8   | 51Ω ±5% resistors (0402)                                    |
| T1   | 1   | Balun transformer<br>Murata LDB15C500A1900                  |
| Z1   | 1   | 4.7nH inductor<br>Toko LL1608-FH4N7J                        |
| Z4   | 1   | 6pF ±0.1pF ceramic capacitor (0402) Murata GRM36COG060B050A |
| L2   | 1   | Not installed   |
| L3   | 1   | 1.5nH inductor<br>Toko LL1608-FH1N5S                        |
| L4   | 1   | 5.6nH inductor<br>Toko LL1005-FH5N6S                        |

| DESIGNATION      | QTY | DESCRIPTION   |
|------------------|-----|---|
| L5, L6           | 2   | 3.9nH inductors<br>Toko LL1608-FH3N9J   |
| L7               | 1   | 0Ω resistor (0603)  |
| U1               | 1   | MAX2700ECM 48-pin TQFP-EP NOTE: U1 has an exposed paddle which needs to be solder-attached to the circuit board to ensure proper functionality of the part. |
| J3, J6, J12, J18 | 4   | SMA PC-mount connectors<br>Johnson 142-0701-201 or<br>Digi-Key J500-ND  |
| J7–J11, J13–J17  | 10  | BNC connectors<br>A/D Electronics 580-002-00  |
| VCC, GND         | 2   | Test points, Digi-Key 5000K-ND  |
| J1, TP1          | 2   | 1x2 headers (0.1in centers)<br>Digi-Key S1012-36-ND   |
| J2, J4, J5       | 3   | 1x3 headers (0.1in centers)<br>Digi-Key S1012-36-ND   |
| J2, J4, J5       | 3   | Shunts, Digi-Key S9000-ND   |
| _                | 1   | MAX2700/2701 evaluation kit circuit board, rev. E   |

## MAX2701 Component List

| DESIGNATION  | QTY | DESCRIPTION  |
|--|-----|--|
| C1, C17, C18,C19,<br>C21, C22, C23,<br>C30, C31, C32,<br>C36, C37, C38 | 13  | 0.1µF 10% ceramic capacitors<br>(0603)<br>Murata GRM39X7R104K016A  |
| C2, C10, C11, C25,<br>C43, C46   | 6   | 68pF 5% ceramic capacitors<br>(0402)<br>Murata GRM36COG680J050A    |
| C3, C6, C7, C45  | 4   | 1000pF 10% ceramic<br>capacitors (0402)<br>Murata GRM36X7R102K050A |
| C4, C50  | 2   | 1.5pF ±0.1pF ceramic capacitors Murata GRM36COG1R5B050A            |
| C5   | 1   | 10pF ±0.1pF ceramic capacitor<br>(0603)<br>Murata GRM39COG100B050A |

| DESIGNATION           | QTY | DESCRIPTION   |
|-----------------------|-----|---|
| C8, C14, C33          | 3   | 100pF 5% ceramic capacitors<br>(0402)<br>Murata GRM36COG101J050A    |
| C9, C16, C34          | 3   | 0.01µF 10% ceramic capacitors<br>(0402)<br>Murata GRM36X7R103K016A  |
| C12, C26, C27,<br>C40 | 4   | 22pF 5% ceramic capacitors<br>(0402)<br>Murata GRM36COG220J050A     |
| C13                   | 1   | 2pF ±0.1pF ceramic capacitor<br>(0402)<br>Murata GRM36COG020B050A   |
| C15, C20, C35,<br>C39 | 4   | 0.056µF 10% ceramic<br>capacitors (0603)<br>Murata GRM39X7R563K016A |

## MAX2701 Component List (continued)

| DESIGNATION                                  | QTY | DESCRIPTION   |
|--|-----|---|
| C24, C29                                     | 2   | 0.56μF 10% ceramic capacitors<br>(0805)<br>Murata GRM40X7R564K016A  |
| C28, C41, C42,<br>C47, C48                   | 5   | Not installed   |
| C44  | 1   | 10µF tantalum capacitor ±10%<br>16V min<br>AVX TAJC106K016          |
| C49  | 1   | 3pF ±0.1pF ceramic capacitor (0402)<br>Murata GRM36COG030B050A      |
| R1, R12, R15,<br>R26, R32, R40,<br>R45       | 7   | 0Ω resistors (0805)   |
| R2, R5, R6, R11                              | 4   | 100Ω ±5% resistors (0402)   |
| R3, R4, R7, R8,<br>R9, R10                   | 6   | 0Ω resistors (0402)   |
| R13, R14, R19,<br>R20, R33, R34,<br>R38, R39 | 8   | 1kΩ 5% resistors (0402)   |
| R16, R22, R30,<br>R36                        | 4   | 1.1kΩ ±5% resistors (0402)  |
| R17, R21, R31,<br>R37                        | 4   | 3.6kΩ ±5% resistors (0402)  |
| R18, R23, R29,<br>R35                        | 4   | 820Ω ±5% resistors (0402)   |
| R24, R25, R27,<br>R28, R41, R42,<br>R43, R44 | 8   | 51Ω ±5% resistors (0402)  |
| T1   | 1   | Balun transformer<br>Murata LDB15C500A2400                          |
| Z1   | 1   | 0.5pF ±0.1pF ceramic<br>capacitor (0603)<br>Murata GRM39COG0R5B050A |
| Z4   | 1   | 1nH inductor<br>Toko LL1005-FH1N0S                                  |
| L2   | 1   | Not installed   |
| L3, L5, L6                                   | 3   | 2.7nH inductors<br>Toko LL1608-FH2N7S                               |

| DESIGNATION        | QTY | DESCRIPTION   |
|--------------------|-----|---|
| L4                 | 1   | 5.6nH inductor<br>Toko LL1005-FH5N6S  |
| L7                 | 1   | $0\Omega$ resistor (0603)   |
| U1                 | 1   | MAX2701ECM 48-pin TQFP-EP NOTE: U1 has an exposed paddle which needs to be solder-attached to the circuit board to ensure proper functionality of the part. |
| J3, J6, J12, J18   | 4   | SMA PC-mount connectors<br>Johnson 142-0701-201 or<br>Digi-Key J500-ND  |
| J7–J11,<br>J13–J17 | 10  | BNC connectors<br>A/D Electronics 580-002-00  |
| VCC, GND           | 2   | Test points, Digi-Key 5000K-ND  |
| J1, TP1            | 2   | 1×2 headers (0.1in centers)<br>Digi-Key S1012-36-ND   |
| J2, J4, J5         | 3   | 1×3 headers (0.1in centers)<br>Digi-Key S1012-36-ND   |
| J2, J4, J5         | 3   | Shunts, Digi-Key S9000-ND   |
| _                  | 1   | MAX2700/MAX2701 evaluation kit circuit board, rev. E  |

## **Component Suppliers**

| SUPPLIER  | PHONE        | FAX          |
|-----------|--------------|--------------|
| AVX       | 803-946-0690 | 803-626-3123 |
| EFJohnson | 402-474-4800 | 402-474-4858 |
| Kamaya    | 219-489-1533 | 219-489-2261 |
| Murata    | 949-852-2001 | 949-852-2002 |
| Toko      | 708-297-0070 | 708-699-1194 |

**Note:** Please indicate that you are using the MAX2700 or MAX2701 when contacting these component suppliers.

**Table 1. Recommended Test Equipment** 

| EQUIPMENT                             | DESCRIPTION   |  |
|---------------------------------------|---|--|
| RF Signal Generators (2)              | HP 8648C or equivalent, capable of delivering -50dBm to -10dBm of output power from 900MHz to 2500MHz |  |
| Dual-Channel<br>Oscilloscope          | For viewing the demodulator outputs   |  |
| Power Supply                          | Capable of providing at least 200mA at +2.7V to +3.3V   |  |
| Additional Variable<br>Voltage Source | For external control of VGA function  |  |
| Spectrum Analyzer                     | HP 8561E or equivalent, covering MAX2700/MAX2701 operating frequency range                            |  |
| Cables (50Ω)                          | (2) $50\Omega$ cables with SMA connectors   |  |
| Cables with BNC<br>Connectors         | (2) BNC cables to check baseband signals  |  |
| Ammeter (optional)                    | For measuring supply current  |  |
| Noise Figure Meter<br>(optional)      | HP 8970B or equivalent, for measuring the noise figure of the LNA and I/Q demodulator                 |  |
| Network Analyzer                      | HP 8753D or equivalent, for measuring return loss and gain simultaneously                             |  |

#### Quick Start

The MAX2700/MAX2701 EV kits are fully assembled and factory tested. Follow the instructions in the *Connections and Setup* section for proper device evaluation.

#### **Connections and Setup**

This section provides a step-by-step guide to setting up the MAX2700/MAX2701 EV kits and testing all three major functional blocks: LNA, I/Q demodulator, and VGAs. **Do not turn on the DC power or RF signal generators until all connections are made.** 

#### Low-Noise Amplifier

- 1) Set the SHDN jumper on the EV kit to V<sub>CC</sub> (HI). This enables the device to operate in the normal mode.
- Set the GAIN\_SET jumper on the EV kit to V<sub>CC</sub> (HI). This enables the LNA to operate in high-gain mode.

- 3) Set the X2EN jumper on the EV kit to GND (LOW). This enables the VCO doubler.
- 4) Connect a DC supply preset to +3V (through an ammeter, if desired) to the EV kit's V<sub>CC</sub> and GND terminals. Do not turn on the supply.
- 5) Perform a full two-port calibration on a network analyzer at a -30dBm power level.
- Connect port 1 and port 2 of network analyzer to LNAIN and LNAOUT, respectively.
- Turn on the DC supply. The supply current should read approximately 165mA for MAX2700 (167mA for MAX2701) if using an ammeter.
- 8) The network analyzer display should indicate a typical gain of 16.5dB for MAX2700 at 1960MHz (15.5dB for MAX2701at 2400Mhz) after accounting for board losses.
- The input and output board losses for MAX2700 are 0.25dB and 0.3dB, respectively. The input and output board losses for MAX2701 are 0.3dB and 0.35dB, respectively.
- 10) Set the GAIN\_SET jumper on the EV kit to GND (LOW). This enables the LNA's low-gain-mode operation. Measurements on the network analyzer should indicate a typical gain of -1.75dB for MAX2700 (-2.5dB for MAX2701) after accounting for board losses.
- 11) Connect the SHDN jumper to GND (LOW) to activate the shutdown mode. The supply current should drop to less than 100μA.

#### I/Q Demodulator

- 1) Turn off the DC supply.
- Remove the network analyzer from the LNAIN and LNAOUT connections. The DC supply connections needed for testing the downconverter mixer are the same as in the LNA section.
- Set jumper J2 (X2\_EN) to GND (LOW) to enable the LO doubler circuit.
- 4) Connect an RF signal generator (with output disabled) to the LO SMA connector. Set the frequency to 980MHz for MAX2700 (1200MHz for MAX2701) and the output power to -10dBm. This is the LO signal.
- 5) Connect another RF signal generator to the RFIN SMA connector (with output disabled). Set the frequency to 1961MHz for MAX2700 (2401MHz for MAX2701) and the output power to -25dBm. This is the RF input signal.

- 6) Connect the oscilloscope to the MIX\_I (for I channel signal) BNC connector. Set the oscilloscope to high-impedance input mode.
- 7) Turn on the DC supply. Enable the LO signal generator and RF input signal generator outputs.
- 8) Measure the peak-to-peak amplitude of the 1MHz IF signal on the oscilloscope with a high-impedance probe (V<sub>OUTp-p</sub>). Voltage gain can be calculated by the following formula:

Voltage Gain = 20 log[(( $V_{OUTp-p}$ ) / (2 ×  $\sqrt{2}$ )) /  $V_{IN}$  (RMS)]

 $V_{IN} (RMS) = SQRT(50 \times 10^{-3} \times 10^{Pin(dBm)/10})$ 

Voltage Gain should be nominally 19.3dB for MAX2700 (18.1dB for MAX2701).

**Note:** Compensate  $P_{IN}$  for input balun loss (1.25dB) and input board loss (0.3dB) and  $V_{OUT}$  p-p for the voltage divider network at the mixer output.

To check the Q-channel performance of the I/Q demodulator, connect the oscilloscope to MIXQ and repeat the measurements from step 7 of the I/Q Demodulator section.

#### Variable Gain Amplifiers

- Remove the RF signal generators and oscilloscope from RFIN, LO, and MIXI connections. The DC supply connections needed for testing the VGAs are the same as in the LNA section. Turn off the DC supply while making connections.
- Connect a variable voltage source, preset to +1.25V, to the VGC input of the EV kit. Do not turn on the supply.
- 3) Connect an RF signal generator to the BNC connector of input IIN1+ (using appropriate connector adapters). Do not turn on the generator's output. Set the generator for a output frequency of 1MHz at a -40dBm power level.
- 4) Connect the oscilloscope to the IOUT1 (for I channel signal) BNC connector. Set the oscilloscope to high-impedance-input mode.
- 5) Turn on the DC supply and the voltage source connected to the VGC input.
- 6) Measure the peak-to-peak output voltage of the 1MHz signal on the oscilloscope (V<sub>OUTp-p</sub>), and compute the voltage gain using the equation in the I/Q demodulator section. The voltage gain should be nominally 20dB between IIN1+ (J16) and IOU1 (J15).

- 7) Connect a jumper across J1.
- Perform a similar measurement between IIN2+ (J14) and IOUT2 (J13); voltage gain should be 30dB nominal between IIN2+ and IOUT2.

**Note:** Compensate P<sub>IN</sub> for the input network loss and V<sub>OUTp-p</sub> for the voltage divider network at the amplifier output.

9) The corresponding VGAs in the Q channel (between QIN1+ and QOUT1 and between QIN2+ and QOUT2) can be tested in the same way.

#### **Checking Noise Figure**

Noise-figure measurements are sensitive to board and lab setup losses and parasitics. There are many techniques and precautions for measuring a low-noise figure. Detailed explanation of these items goes beyond the scope of this document. For more information on how to perform this level of noise-figure measurement, refer to the noise-figure meter operating manual, as well as to Hewlett Packard application note #57-2, Noise Figure Measurement Accuracy.

#### **PC Board Layout Considerations**

The MAX2700/MAX2701 EV kits can serve as board layout guides. Keep PC board trace lengths as short as possible to minimize parasitics. Keep decoupling capacitors close to the device, with a low inductance via connection to the ground plane.

#### Modifying the EV Kit

The MAX2700/MAX2701 EV kits have been optimized for operation at 1960MHz and 2400MHz, respectively. The MAX2700/MAX2701 EV kits can be configured to operate in the 1800MHz to 2100MHz band and the 2100MHz to 2500MHz band, respectively. Use the device parameters listed in the MAX2700/MAX2701 data sheet to determine the proper input and output matching components at other frequencies.

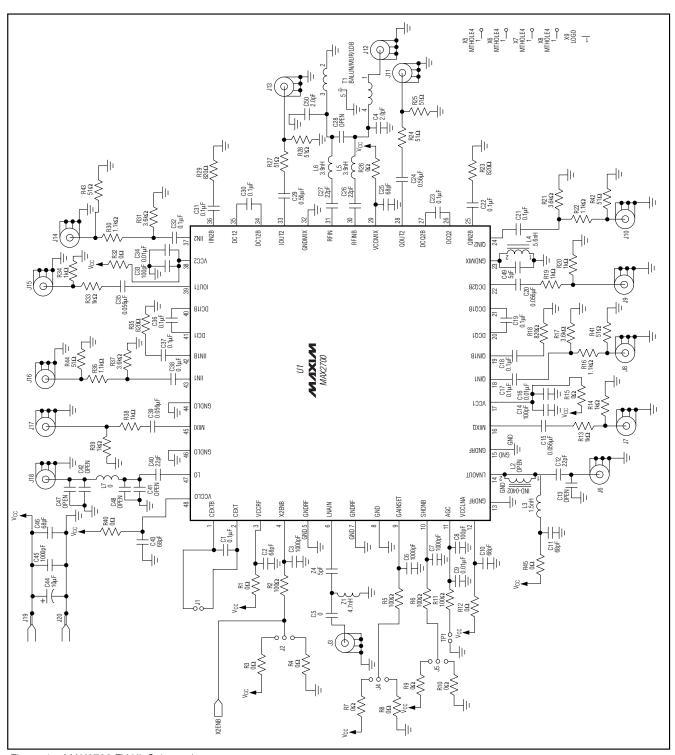


Figure 1a. MAX2700 EV Kit Schematic

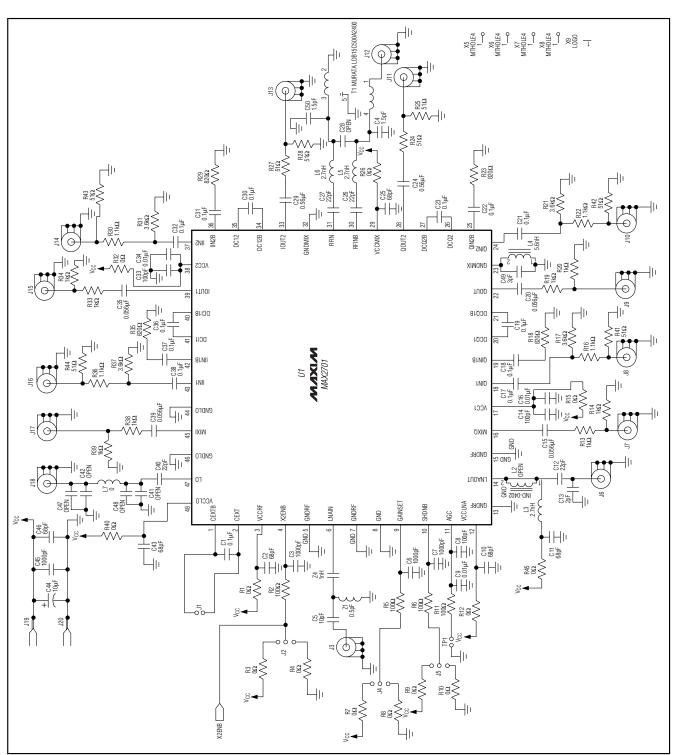


Figure 1b. MAX2701 EV Kit Schematic

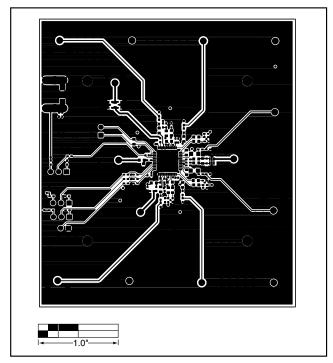


Figure 2. MAX2700/MAX2701 EV Kits PC Board Layout—Component Side

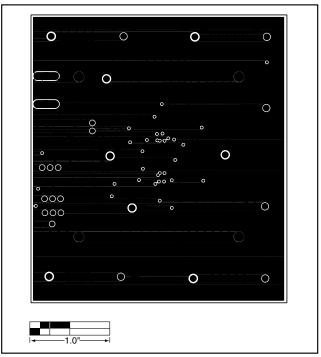


Figure 3. MAX2700/MAX2701 EV Kits PC Board Layout— Ground Plane

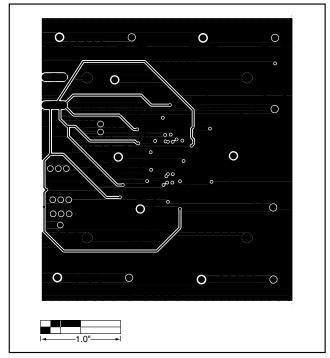


Figure 4. MAX2700/MAX2701 EV Kits PC Board Layout—Power Plane

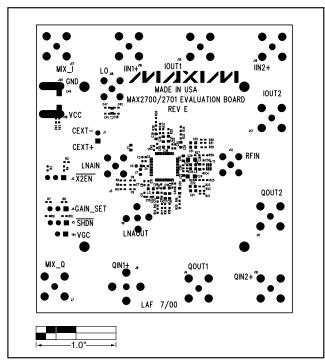


Figure 5. MAX2700/MAX2701 EV Kits Component Placement Guide—Top Silkscreen

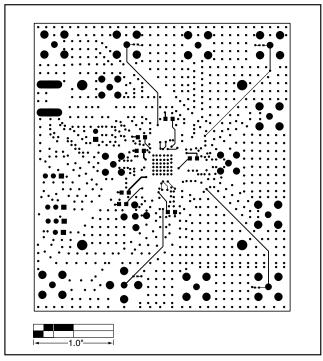


Figure 6. MAX2700/MAX2701 EV Kits PC Board Layout—Solder Side

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