

# MAXIM

## MAX3507 Evaluation Kit

### General Description

The MAX3507 evaluation kit (EV kit) simplifies evaluation of the MAX3507 CATV upstream amplifier. Each kit includes a data interface that can be programmed through the parallel port of a standard PC. Software (Windows® 95/98 compatible) is included to facilitate this function. This software allows programming of all available features through a simple user interface.

Access to the device input and output is provided through 50Ω SMA connectors. The input is matched to 50Ω. The output circuit includes a minimum-loss pad that presents a 75Ω load to the output transformer when using 50Ω test equipment.

### Features

- ◆ +5V Single-Supply Operation
- ◆ Output Level Range Up to +64dBmV (QPSK)
- ◆ Gain Programmable in 0.5dB Steps
- ◆ Transmit Disable Mode
- ◆ Shutdown Mode
- ◆ Control Software Included
- ◆ Fully Assembled and Tested Surface-Mount Board

### Ordering Information

PART	TEMP. RANGE	IC PACKAGE
MAX3507EVKIT	-40°C to +85°C	28 QFN

### Component List

DESIGNATION	QTY	DESCRIPTION
B3–B6	4	Murata BLM21A601RPT
C1, C2, C5, C8–C11	7	0.1μF ±10% ceramic capacitors (0603) Murata GRM39X7R104K016A
C3, C4	2	1000pF ±10% ceramic capacitors (0603) Murata GRM39X7R102K050A
C6, C12–C17	7	Leave site open
C7	1	10μF ±10% 16V min tantalum capacitor AVX TAJC106K016
IN1, IN2	2	Test points Digi-Key 5000K-ND
J1	1	SMA connector (PC-mount) EF Johnson 142-0701-201 or Digi-Key J500-ND
J2	1	DB25 connector, right angle, female Digi-Key A2102-ND or AMP 745783-4
J3	1	SMA connector (edge-mount) EF Johnson 142-0701-801 or Digi-Key J502-ND
JU1–JU7	7	1 × 3 pin headers (0.1in centers) Digi-Key S1012-36-ND

DESIGNATION	QTY	DESCRIPTION
JU1–JU7	7	Shunts Digi-Key S9000-ND
L1	1	0Ω resistor (0805)
L2–L5	4	0Ω resistors (0603)
R1–R4, R6–R13, R18–R20	15	Leave site open
R5	1	43.2Ω ±1% resistor (0805)
R14, R15	2	100kΩ ±5% resistors (0603)
R16	1	49.9Ω ±1% resistor (0603)
R21	1	86.6Ω ±1% resistor (0805)
R24	1	0Ω ±1% resistor (0603)
T1	1	Transformer 1:1 M/A-COM ETC1-1T
T2	1	Transformer 2:1 voltage ratio Toko 458PT-1087
U1	1	MAX3507EGI 28-pin QFN
None	1	MAX3507 EV kit circuit board, Rev 2
None	1	MAX3507 data sheet
None	1	MAX3507 EV kit data sheet

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## Component Suppliers

SUPPLIER	PHONE	FAX	WEBSITE
AVX	843-448-9411	843-448-1943	www.avxcorp.com
Digi-Key	800-344-4539	218-681-3380	www.digikey.com
EF Johnson	800-328-3911	507-835-6969	www.efjohnson.com
M/A-COM	978-442-5000	978-442-4178	www.macom.com
Murata	800-831-9172	814-238-0490	www.murata.com
Toko	800-745-8656	708-699-1194	www.tokoam.com

### Quick Start

The MAX3507 EV kit is fully assembled and factory tested. Follow the instructions in the *Connections and Setup* section. Note that the output circuit includes a minimum-loss pad that is used to bring the output impedance up to 75Ω. This must be accounted for in all measurements (see *Output Circuit* section). Also note, the input balun is supplied to allow differential input drive from a single-ended source. A balun is not required in the application.

### Test Equipment Required

- DC supply capable of delivering +5.5V and 400mA of continuous current
- HP 8648 (or equivalent) signal source capable of generating 40dBmV up to 200MHz
- HP 8561E (or equivalent) spectrum analyzer with a minimum 200MHz frequency range
- Two digital multimeters (DMMs) to monitor  $V_{CC}$  and  $I_{CC}$ , if desired
- IBM PC or compatible with Windows 95/98 installed
- Male-to-male 25-pin parallel cable, wired straight through
- 0 to +5V pulse generator for transient measurement

- Low-noise amplifier with 40dB gain from 5MHz to 100MHz for noise measurement
- Oscilloscope with 200MHz bandwidth
- Network analyzer, such as the HP 8753D. (May be used to measure gain vs. frequency)

### Connections and Setup

- 1) Connect the power supply (preset to +5V) to the pins labeled +5V and GND on the circuit board. Connect the 50Ω signal source to INPUT (preset the signal source for -13dBm (+34dBmV across a 50Ω load)), and terminate OUTPUT with a 50Ω spectrum analyzer. If using a signal source with a source impedance other than 50Ω, or if a different input impedance is required, be sure to replace R1 with the appropriate value resistor.
- 2) Connect the 25-pin male-to-male cable between the parallel (printer) port of the PC and the 25-pin female connector on the EV kit board.
- 3) See Table 1 for board jumper settings. Set all jumpers to PC port control, unless otherwise stated.
- 4) Turn on the power supply. Turn on the PC and the test equipment.
- 5) Run the software program.

**Table 1. Jumper Setting Functions**

JUMPER	FUNCTION	SHORT PIN1 TO PIN2	SHORT PIN2 TO PIN3
JU1	Set the method of control of $\overline{SHDN}$	PC port control	Manual control through JU2
JU2	Set the manual control state of $\overline{SHDN}$	Logic 1 state ( $V_{CC}$ )	Logic 0 state (GND)
JU3	Set the method of control of TXEN	PC port control	Manual control through JU4
JU4	Set the manual control state of TXEN	Logic 1 state ( $V_{CC}$ )	Logic 0 state (GND)
JU5	$\overline{CS}$ input	PC port control	N/A
JU6	SDA input	PC port control	N/A
JU7	SCLK input	PC port control	N/A

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## Detailed Description

### Using the Software

The MAX3507 uses a serial data interface (SDI) to set gain. Some method of communicating with the SDI is required to use the MAX3507 EV kit. A microprocessor, pattern generator, or PC can be used for this function. Software and supporting documentation for programming the part through the parallel port of a PC can be found at [www.maxim-ic.com/TechSupport/other.htm](http://www.maxim-ic.com/TechSupport/other.htm).

The valid gain code ranges from 0 to 127 (decimal). The nominal change in gain is 0.5dB per gain code. Gain codes are set exclusively by programming the SDI. Refer to the MAX3507 data sheet for details.

### High Power and Low Noise

High-power (HP) mode and low-noise (LN) mode may only be controlled through the PC interface. Manual control of the jumpers for the EV kit's board is not possible. For DOCSIS applications, HP mode should be used for output levels above 42dBmV. This corresponds to gain code 79. LN mode should be used below this output level. This corresponds to gain code 109. A transition from HP mode, gain code 79, to LN mode, gain code 107, results in a -1dB step.

### Shutdown and Transmit Enable

JU1 through JU4 determine how the shutdown and transmit enable features are controlled. Pin 2 of JU1 and JU3 is connected directly to the device. If an external source (such as a modulator chip or microprocessor) is used to control these features, make the connection to pin 2 of JU1 and JU3. Pads are provided on the bottom side of the board (R18 and R19, respectively) for placement of termination resistors, if needed.

If manual control of shutdown and transmit enable is desired, shunt pins 2 and 3 of JU1 and JU3. This allows  $\overline{\text{SHDN}}$  and TXEN to be controlled by JU2 and JU4, respectively. JU2 and JU4 are used to place either  $V_{CC}$  or ground at  $\overline{\text{SHDN}}$  or TXEN. Pin 3 of JU2 and JU4 is ground, and pin 1 is  $V_{CC}$ .

To control the  $\overline{\text{SHDN}}$  and TXEN features through the supplied software, shunt pins 1 and 2 of JU1 and JU3.

### Manual Control of Serial Data Interface (SDI)

If using a source other than a PC to bit bang the SDI of the MAX3507 EV kit (such as a digital pattern generator or microprocessor), shunt pins 2 and 3 of jumpers JU5, JU6, and JU7. Access to the SDI is available through these jumpers. Termination pads are provided (R2, R3,

and R4). Solder an appropriate resistor to these pads, if desired. Refer to the MAX3507 data sheet for a description of the serial data interface.

To control the SDI by using the supplied software, shunt pins 1 and 2 of JU5, JU6, and JU7 together.

### Input Circuit

The input circuit of the MAX3507 EV kit is configured with a 1:1 balun, terminated in 50 $\Omega$  (T1). This allows the input to be driven with single-ended 50 $\Omega$  test equipment. The balun is used to generate a differential signal, as rated performance is specified with a differential input drive.

If the MAX3507 itself is to be driven single ended, the input balun must be removed and the undriven input connected to ground through a 0.1 $\mu\text{F}$  blocking capacitor.

### Output Circuit

The MAX3507 has differential outputs. This architecture aids in suppressing second-order distortion (harmonics). To convert to a single-ended output, a 4:1 transformer (T2) is used. Since most test equipment is supplied with a 50 $\Omega$  input impedance, a minimum-loss pad is provided on the output of the transformer to increase the load impedance to a nominal 75 $\Omega$ . This places the proper load on the device, but also reduces the measured output voltage level by 7.5dB. It is essential to consider this when making any measurements with the EV kit; 7.5dB must be added to all measurements of voltage gain and output voltage level (including noise) to arrive at the correct value for a 75 $\Omega$  system.

Use 75 $\Omega$  test equipment, if available, and take the following steps:

- 1) Remove the 50 $\Omega$  output SMA connector and replace it with a 75 $\Omega$  connector.
- 2) Remove R5 and replace it with a 0 $\Omega$  resistor or some other type of shunt.
- 3) Remove R21.
- 4) Be sure to use a 75 $\Omega$  cable.

### Analysis

#### Harmonic Distortion

Set the signal source for 20MHz and -13dBm. Verify that the second and third harmonics generated by the source are suppressed by at least 60dBc. Filters are usually required to achieve these harmonic levels.

Connect a spectrum analyzer to OUTPUT. Set the center frequency to 40MHz and the span to 50MHz or more. Adjust the reference level so that the fundamen-

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tal (20MHz tone) is within 10dB to 20dB of the reference level. If the fundamental is less than 10dB below the reference level, the harmonic distortion of the spectrum analyzer may prevent accurate measurement of the distortion. If necessary, use the manual attenuation setting to ensure at least 20dB of input attenuation.

Set the gain code to 125, D7 = 1 (approximately 30dB of gain). Measure the level of the fundamental, second, and third harmonics on the spectrum analyzer. These readings have units of dBm. To convert from dBm to dBmV in a 50Ω system, use the following equation:

$$X(\text{dBmV}) = Y(\text{dBm}) + 47\text{dB (50}\Omega \text{ system)}$$

Add 7.5dB to this value to account for the attenuation of the minimum-loss pad in dBmV. The gain can now be calculated in dB, and the harmonic distortion can be calculated in dBc. The harmonic distortion should be approximately 55dBc.

### Switching Transients

To measure the transmit enable and transmit disable transients, the TXEN pin is driven from an external source. No input signal is applied, and the output is viewed on an oscilloscope. Connect OUTPUT to the oscilloscope's 50Ω input. Set the scope's time base to 5μs/div and the vertical scale to 5mV/div.

Set the pulse generator as follows:

- Amplitude: 5V
- Duty Cycle: 50%
- Rise/Fall Time: 100ns
- Pulse Width: 25μs
- Offset: 2.5V

Take care not to drive the MAX3507 TXEN pin below zero or above +5V. Turn on the power supply. Remove the shunt from jumper JU3 (TXEN), and connect the output of the pulse generator to pin 2 of this jumper. Trigger the oscilloscope from the pulse generator using a convenient method.

Set the gain code to 119, D7 = 1.

A rising- and falling-edge transient should appear on the scope's CRT. The amplitude of this transient should be less than 40mVp-p. Multiply the value of the measured transient by 2.37 to account for the presence of the minimum-loss pad. The gain may now be changed to show the output transient's dependence on gain.

### Output Noise

To measure output noise, a spectrum analyzer is used. A postamplifier with less than 10dB noise figure and greater than 40dB gain within the band of interest is needed.

With the power supply off, place a 50Ω termination on the input of the EV kit. Turn on the power supply to the MAX3507 EV kit. Using the software, set the device to transmit mode with a gain code of 119, D7 = 1. Connect the output of the postamplifier to the spectrum analyzer and the input to OUTPUT on the EV kit. Set the spectrum analyzer as follows:

- Center Frequency: 35MHz
- Span: 60MHz
- Reference: -50dBm
- Scale: 10dB/div
- IF Bandwidth: 1kHz
- Power up the postamplifier

If the spectrum analyzer being used has a noise marker function, enable it. Otherwise, be sure to divide the measured power by 10log (RBW). Move this marker to 42MHz. Read the value of the noise density from the spectrum analyzer. This noise value is a combination of the output noise of the MAX3507, the gain of the post-amplifier, and the noise figure of the postamplifier. With the specified noise figure of 10dB, the noise contribution of the postamplifier may be ignored. The minimum-loss pad reduces the actual measured value by 7.5dB. Use the following equation to arrive at the MAX3507's output noise in a 160kHz bandwidth:

$$V_{\text{NOISE}} = P_{\text{NOISE}} + 47\text{dB} + 7.5\text{dB} + 10 \times \log(160,000) - G_{\text{AMP}}$$

where:

$V_{\text{NOISE}}$  = MAX3507 output noise in dBmV measured in a 160kHz bandwidth

$P_{\text{NOISE}}$  = Noise density in dBm/Hz read from the spectrum analyzer

$G_{\text{AMP}}$  = Gain of the postamplifier in dB

### Layout Considerations

The MAX3507 evaluation board can serve as a guide for your board layout. Particular attention should be paid to thermal design and to the output network.

The output circuit that connects OUT- and OUT+ (pins 18 and 19) to the output transformer (T2) should be as symmetrical as possible to reduce second-order distortion. In addition, the capacitance of this path should be kept low to minimize gain roll-off at high frequencies.

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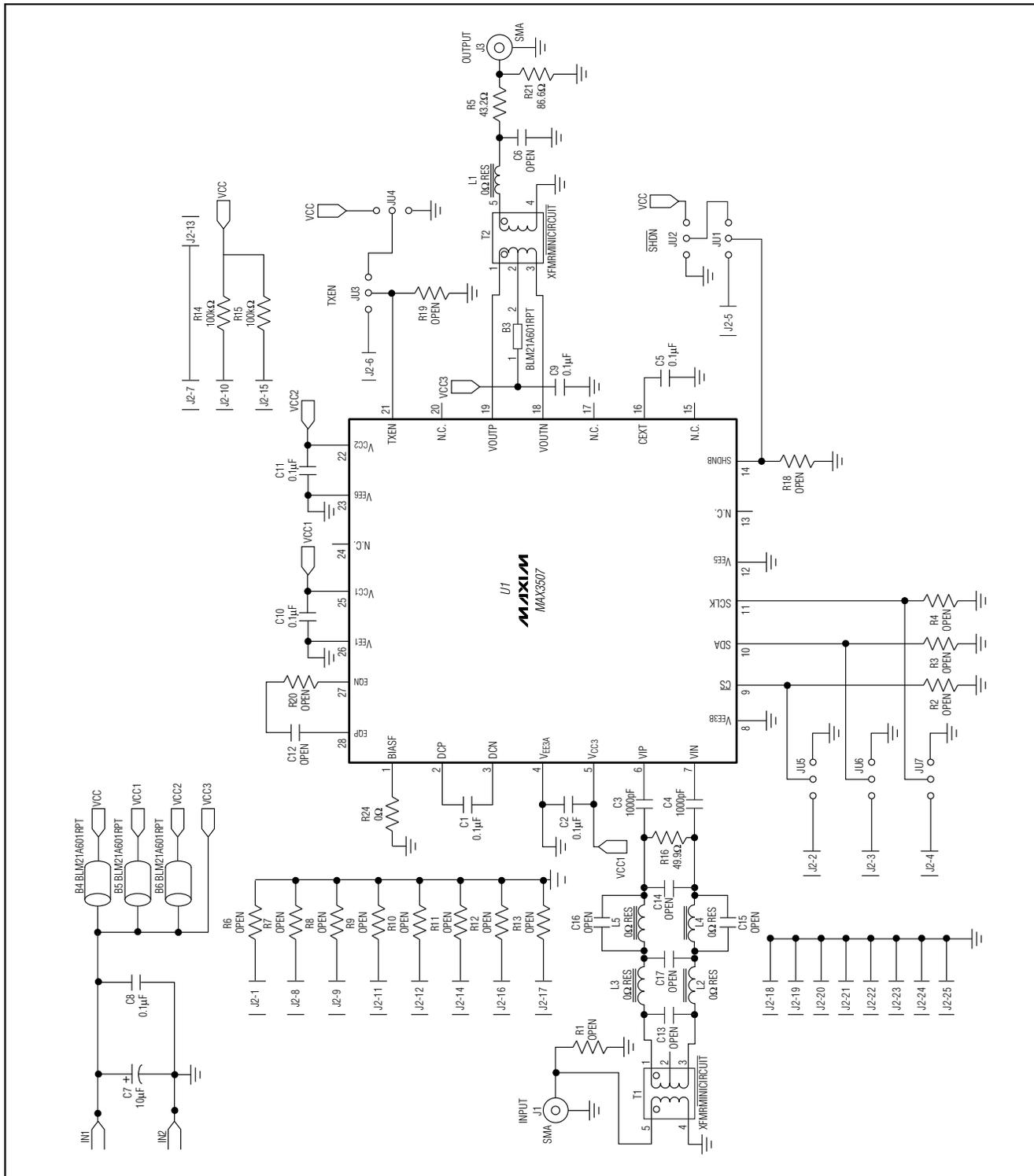


Figure 1. MAX3507 EV Kit Schematic

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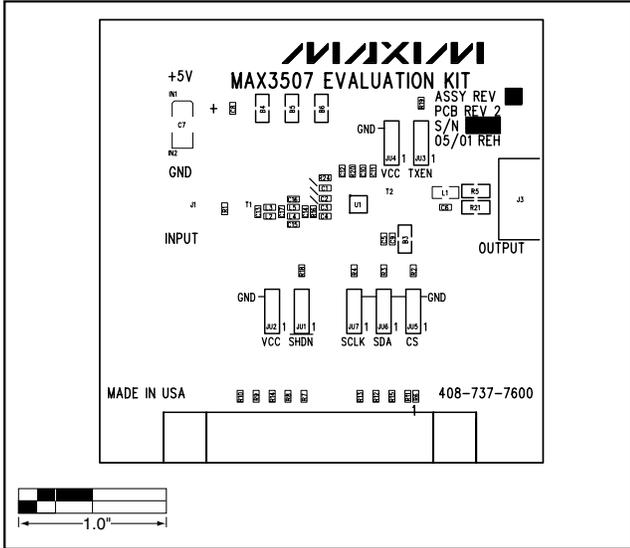


Figure 2. MAX3507 EV Kit Component Placement Guide—Component Side

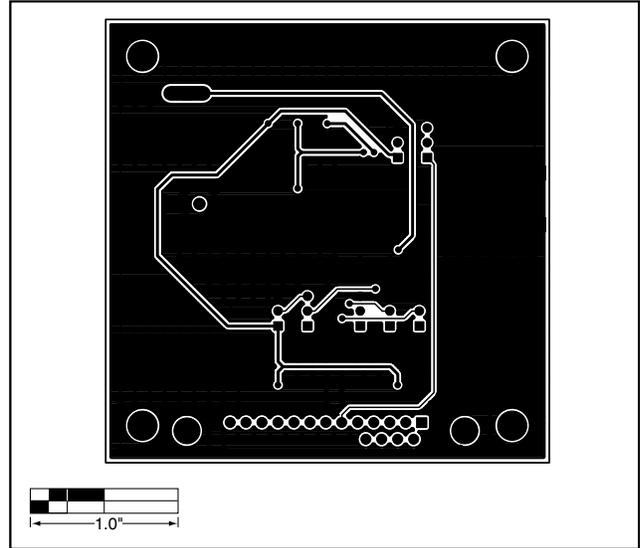


Figure 3. MAX3507 EV Kit PC Board Layout—Solder Side

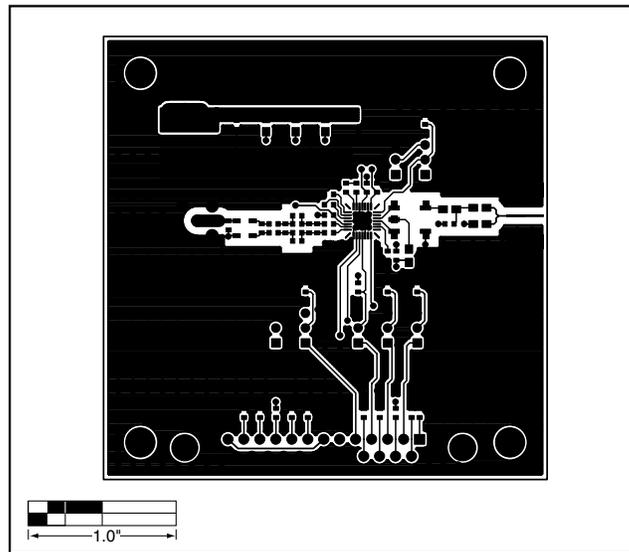


Figure 4. MAX3507 EV Kit PC Board Layout—Component Side

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