**General Description**

The MAX2130 broadband, low-distortion, low-noise, two-output amplifier performs preamp, loop-out, and buffer functions in TV tuner applications. The device integrates functions typically achieved with discrete components into the space-saving 8-pin µMAX-EP package. The MAX2130 provides a gain of +15dB with a noise figure less than 3.2dB over the 44MHz to 878MHz frequency range. The MAX2130 features an externally adjustable bias control, set with a single resistor, that allows the user to meet minimum linearity requirements while reducing current consumption. The device operates from a +5V single supply and only requires 93mA of supply current when nominally biased.

**Applications**

- DVB-T Digital Broadcast Receivers
- Digital/Terrestrial TV Tuners
- Set-Top Boxes
- Cable Modems
- Analog TV Tuners

**Features**

- +5V Single-Supply Operation
- 44MHz to 878MHz Operating Frequency Range
- Guaranteed 7.4dB (min) Input Return Loss Over Frequency Range
- LNA Performance at ICC = 93mA (RBias = 15kΩ)
  - 15dB Gain
  - 2.8dB Noise Figure
  - +17.5dBm Input IP3
  - +27dBm Input IP2
  - +2.7dBm Input 1dB Compression Point
- Loop-Out Amplifier Performance at ICC = 93mA (RBias = 15kΩ)
  - 8.7dB Gain
  - 4.2dB Noise Figure
  - +17dBm Input IP3
  - +29dBm Input IP2
  - -0.5dBm Input 1dB Compression Point
- Programmable Linearity vs. Supply Current

**Ordering Information**

<table>
<thead>
<tr>
<th>PART</th>
<th>TEMP RANGE</th>
<th>PIN-PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX2130EUA</td>
<td>-40°C to +85°C</td>
<td>8 µMAX-EP*</td>
</tr>
</tbody>
</table>

*Exposed paddle

**Typical Application Circuit**

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim’s website at www.maxim-ic.com.
**Broadband, Two-Output, Low-Noise Amplifier for TV Tuner Applications**

**ABSOLUTE MAXIMUM RATINGS**

- Vcc to GND: -0.3V to +6V
- BIAS, OUT2 to GND: -0.3 to (Vcc + 0.3V)
- IN Input Power: +15dBm
- OUT1 to GND: -0.3V to +6V
- OUT2 Short-Circuit Duration: Continuous

Continuous Power Dissipation (TA = +70°C) 8-Pin µMAX-EP (derate 15.4mW/°C above +70°C) 1.2W

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**DC ELECTRICAL CHARACTERISTICS**

(Vcc = +4.75V to +5.25V, TA = -40°C to +85°C, RBIAS = 15kΩ ±1%; no input signals applied. Typical values are at Vcc = +5V, TA = +25°C, unless otherwise noted.)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td></td>
<td>4.75</td>
<td>5.25</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>TA = +25°C</td>
<td>93</td>
<td>104</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>RBias = 30kΩ</td>
<td>49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bias = unconnected</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**AC ELECTRICAL CHARACTERISTICS**

(MAX2130 EV kit, Vcc = +4.75V to +5.25V, RBias = 15kΩ ±1%, fIN = 500MHz, ZO = 75Ω. Typical values are at Vcc = +5V, TA = +25°C, unless otherwise noted.) (Note 1)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW-NOISE AMPLIFIER (LNA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Frequency Range</td>
<td></td>
<td>44</td>
<td>878</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>Gain</td>
<td>(Note 2)</td>
<td>13.4</td>
<td>15</td>
<td>16.6</td>
<td>dB</td>
</tr>
<tr>
<td>Gain Flatness</td>
<td>TA = -40°C to +85°C</td>
<td>0.8</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure</td>
<td></td>
<td>2.8</td>
<td>3.2</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Input 1dB Compression Point</td>
<td></td>
<td>2.7</td>
<td></td>
<td>2.1</td>
<td>dBm</td>
</tr>
<tr>
<td>Input Third-Order Intercept Point</td>
<td></td>
<td>17.5</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input Second-Order Intercept Point</td>
<td></td>
<td>27</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>IN Return Loss</td>
<td>(Notes 2, 6)</td>
<td>7.4</td>
<td>8.6</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>OUT1 Return Loss</td>
<td>fIN = 44MHz to 878MHz</td>
<td>8.7</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Maximum Load for Stable Operation</td>
<td></td>
<td>Any load</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OUT1 to IN Isolation</td>
<td>(Note 2)</td>
<td>18</td>
<td>21</td>
<td></td>
<td>dB</td>
</tr>
</tbody>
</table>
**AC ELECTRICAL CHARACTERISTICS (continued)**

(MAX2130 EV kit, \( V_{CC} = +4.75V \) to +5.25V, \( R_{BIAS} = 15k\Omega \pm 1\% \), \( f_{IN} = 500MHz \), \( Z_O = 75\Omega \). Typical values are at \( V_{CC} = +5V \), \( T_A = +25^\circ C \), unless otherwise noted.) (Note 1)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Frequency Range</td>
<td>(Note 2)</td>
<td>44</td>
<td>878</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>(Note 2)</td>
<td>7.1</td>
<td>8.7</td>
<td>10.2</td>
<td>dB</td>
</tr>
<tr>
<td>Noise Figure</td>
<td></td>
<td>4.2</td>
<td>4.6</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>Input 1dB Compression Point</td>
<td>( V_{CC} = +3.5V ) (Note 3)</td>
<td>-0.5</td>
<td>-3.7</td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input Third-Order Intercept Point</td>
<td>(Note 4)</td>
<td></td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Input Second-Order Intercept Point</td>
<td>(Note 5)</td>
<td></td>
<td>29</td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>OUT2 Return Loss</td>
<td>( f_{IN} = 44MHz ) to 878MHz</td>
<td></td>
<td></td>
<td>16.6</td>
<td>dB</td>
</tr>
<tr>
<td>Maximum Load for Stable Operation</td>
<td></td>
<td></td>
<td></td>
<td>Any load</td>
<td></td>
</tr>
<tr>
<td>OUT2 to IN Isolation</td>
<td>(Note 2)</td>
<td></td>
<td></td>
<td>24.5</td>
<td>27</td>
</tr>
<tr>
<td>OUT2 to OUT1 Isolation</td>
<td>(Note 2)</td>
<td></td>
<td></td>
<td>11.0</td>
<td>12.5</td>
</tr>
</tbody>
</table>

**Note 1:** Specifications are guaranteed by design and characterization, except for gain which is production tested.

**Note 2:** Specifications are guaranteed over the operating frequency range.

**Note 3:** Operation possible with \( V_{CC} = +3.5V \). See Typical Operating Characteristics.

**Note 4:** Two tones at 500MHz and 506MHz, -20dBm per tone.

**Note 5:** Two tones at 500MHz and 550MHz, -20dBm per tone.

**Note 6:** Output load has worst-case 6dB return loss.
Typical Operating Characteristics (continued)

(MAX2130 EV kit, VCC = +5V, RBias = 15kΩ ±1%, TA = +25°C, unless otherwise noted.)

Gain vs. Frequency

Loop-Out Amplifier

LNA Noise Figure vs. Frequency

Noise Figure vs. RBias

Input P1dB vs. RBias

Input IP2 vs. Temperature

Input IP2 vs. RBias
Broadband, Two-Output, Low-Noise Amplifier for TV Tuner Applications

Typical Operating Characteristics (continued)

(MAX2130 EV kit, \(V_{CC} = +5\) V, \(R_{BIAS} = 15\, \Omega \pm 1\%, T_A = +25^\circ C\), unless otherwise noted.)

[Graphs showing input IP3 vs. temperature, input IP3 vs. RBIAS for loop-out amplifier and LNA, isolation vs. frequency, return loss vs. frequency for each port.]
**Detailed Description**

The MAX2130 is a broadband, high-gain, low-distortion low-noise amplifier (LNA) with two outputs intended for operation over the 44MHz to 878MHz frequency range. The device operates from a +5V supply and features externally adjustable bias control circuitry that allows minimum linearity requirements to be met while reducing current consumption.

**Input**

The IN port is a broadband 75Ω input that provides a guaranteed minimum input return loss of 7.4dB (allowing for 2:1 VSWR at output) across the 44MHz to 878MHz frequency range. AC-couple the IN port with a 0.1µF DC-blocking capacitor.

**Outputs**

The OUT1 port is a broadband, 75Ω, open-collector output for the LNA. It requires a pullup inductor to VCC for proper biasing, as well as a 0.1µF DC-blocking capacitor. See the Applications Information section for proper inductor selection.

The OUT2 port is a broadband, 75Ω output for the loop-out amplifier. The loop-out amplifier is internally biased and does not require a pullup inductor. AC-couple the OUT2 port with a 0.1µF DC-blocking capacitor.

**Bias Circuitry**

The linearity and supply current for both amplifiers are externally programmable with a single resistor, R_{BIAS}, from BIAS to GND. A nominal resistor value of 15kΩ sets an input IP3 of +17.5dBm, an input IP2 of +27dBm, and a supply current of 93mA. Decrease the resistor value to improve linearity at the cost of increased supply current. Increase the resistor value to decrease supply current and degrade linearity. Use resistor values greater than 10kΩ. Gain is not significantly affected by the R_{BIAS} value.

**Applications Information**

**Inductor Selection**

The OUT1 port of the LNA requires a pull-up inductor to VCC for proper biasing. The exact value of the inductor is not important as long as it has broadband impedance >150Ω (<500Ω) at 10MHz across the 44MHz to 878MHz frequency band. Table 1 is a list of recommended inductors.

**Table 1. OUT1 Pullup Inductor Recommended Components**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLM11A221S</td>
<td>Murata</td>
</tr>
<tr>
<td>BLM11A471SG</td>
<td>Murata</td>
</tr>
<tr>
<td>BLM10A221SG</td>
<td>Murata</td>
</tr>
<tr>
<td>BLM21A331SG</td>
<td>Murata</td>
</tr>
</tbody>
</table>
**Dynamic Linearity Adjustment**

The LNA and loop-out amplifier linearity can be dynamically adjusted by varying the amount of current sourced by the BIAS port. The BIAS port is internally biased to 1.2V. A resistor, \( R_{BIAS} \), connected from BIAS to ground sets the bias current. An additional resistor, \( R_{ADJ} \), placed from the BIAS port to an external voltage source, such as a digital-to-analog converter (DAC), varies the current sourced by the BIAS port. Choosing \( R_{ADJ} = R_{BIAS} = 20k\Omega \) and varying the voltage of the DAC from ground to 2.4V effectively varies the resistance seen from the BIAS port from 10k\Omega to an open circuit. See Typical Application Circuit.

The DAC output voltage, \( V_{ADJ} \), required to set an equivalent resistance to ground, \( R_{EQ} \), seen by the BIAS port, can be calculated with the following equation:

\[
V_{ADJ} = 2.4V - \frac{R_{BIAS} \times V_{BIAS}}{R_{EQ}}
\]

where \( R_{ADJ} = R_{BIAS} \), \( V_{BIAS} = 1.2V \), \( R_{EQ} \geq 10k\Omega \).

**Power-Supply Bypassing**

Proper voltage-supply bypassing is essential for high-frequency circuit stability. Bypass the VCC pin with a 1000pF capacitor in parallel with a 47pF capacitor, located as close to the VCC pin as possible. Refer to the MAX2130 EV kit for additional information.
Broadband, Two-Output, Low-Noise Amplifier for TV Tuner Applications

Package Information

Notes:
1. DRE DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006`).
3. CONTROLLING DIMENSION MILLIMETERS.
4. MEETS JEDEC MO-187.
5. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".
6. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
7. COPLANARITY SHALL NOT EXCEED 0.01MM.

-DRAWING NOT TO SCALE-

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.