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## APPLICATION NOTE 335

# Maxim Wireless/RF Power Amplifier Selector Guide

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*Abstract: An overview of Maxim's RF power amplifier (PA) products targeted towards cellular, PCS, 802.11a/b/g, cordless phone and Bluetooth applications. Table compares operating voltage, supply current, output power, package, power added efficiency, and features of Maxim PA ICs. Another table assists selection by market application.*

## Additional Information:

- [Wireless Product Line Page](#)
- [Quick View Data Sheet for the MAX2240](#)
- [Quick View Data Sheet for the MAX2264/MAX2265](#)
- [Quick View Data Sheet for the MAX2267/MAX2268/MAX2269](#)
- [Quick View Data Sheet for the MAX2320/MAX2321/MAX2322/MAX2324/MAX2326/MAX2327](#)
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- [Quick View Data Sheet for the MAX2601/MAX2602](#)
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[Click here for an overview of the wireless components used in a typical radio transceiver.](#)

Maxim's RF power amplifiers (PAs) address both linear-modulation formats, such as QAM and QPSK, and nonlinear modulation, such as FM and FSK. PAs designed for the TDMA markets have improved performance features like auto-ramping to reduce spectral splatter. Auto-ramping helps keep a steady  $V_{CC}$  and reduce VCO pulling. Automatic thermal protection is available to temporarily reduce output power yielding a very robust PA. PAs for the CDMA markets have been optimized to achieve the lowest current draw in the most probable operating output power levels for urban and suburban CDMA environments. CDMA PAs spend most of their time in the lower output power settings.

For 2.4GHz ISM applications such as 802.11b WLAN, Bluetooth, HomeRF, and cordless phones, Maxim provides low-cost, ultra-small power amplifiers in the ultra-chip scale package. These PAs feature analog or digital power control, closed-loop power control, dynamic bias control, integrated detector, and high efficiency performance.

These are some of the key advantages offered by silicon bipolar RF power amplifiers:

1. Lower cost, due to higher die yield and simple device fabrication (compared to Heterojunction devices)
2. Small solution size due to the ultra-chip scale package and minimal external components
3. No negative bias supply required, such as for many GaAs amplifiers
4. Robust device performance over temperature and load variations

## 5. Auto-ramping feature

The table below shows a sampling of our power amplifiers and their capabilities to date. Note that several of these PAs have been re-tuned to specific performance characteristics and at center frequencies other than as shown.

**Table 1. Selector Guide: A Sampling**

| Part    | V <sub>CC</sub> (V) | I <sub>CC</sub> (mA)            | Frequency (MHz) | P <sub>OUT</sub> (dBm) | Class | Package         | PAE (full) | PAE (derated)  | Features  |
|---------|---------------------|---------------------------------|-----------------|------------------------|-------|-----------------|------------|----------------|---|
| MAX2235 | 2.7 to 5.5          | 20 idle<br>610 full             | 800 to 1000     | +30.3                  | C     | 20-Pin TSSOP-EP | 47%        | 22%<br>+24dBm  | Analog Gain Control, Auto Power Ramp, Shutdown                        |
| MAX2430 | 3.0 to 5.5          | 52                              | 800 to 1000     | +21.4                  | AB    | 16-Pin SO/QSOP  | 24%        | NA             | Power Control, Shutdown, Drives MAX2601/02                            |
| MAX2601 | 2.7 to 5.5          | 450                             | DC to 1000      | +30.0                  | AB/C  | 8-Pin PSOPII    | 54%        | 18%<br>+20dBm  | Power Transistor  |
| MAX2602 | 2.7 to 5.5          | 450                             | DC to 1000      | +30.0                  | AB/C  | 8-Pin PSOPII    | 54%        | 18%<br>+20dBm  | Power Transistor with On-Chip Bias Diode, Power Ramp, Shutdown        |
| MAX2264 | 2.7 to 5.0          | 34 idle,<br>58 avg,<br>95 full  | 824 to 849      | +28.0                  | AB    | 16-Pin TSSOP-EP | 32%        | 12%<br>+16dBm  | IS-98 CDMA U.S., Internal Switch, Smallest, Most Economical Solution  |
| MAX2265 | 2.7 to 5.0          | 83 full                         | 824 to 849      | +28.0                  | AB    | 16-Pin TSSOP-EP | 37%        | 7%<br>+16dBm   | IS-98 CDMA U.S., TDMA PAE = 40% at +30dBm                             |
| MAX2266 | 2.7 to 5.0          | 34 idle,<br>52 avg,<br>100 full | 824 to 849      | +28.0                  | AB    | 16-Pin TSSOP-EP | 32%        | 17%<br>+16dBm  | IS-98 CDMA U.S., Off-Chip Switch, Lowest Current                      |
| MAX2267 | 2.7 to 4.5          | 34 idle,<br>56 avg,<br>95 full  | 887 to 925      | +27.0                  | AB    | 16-Pin TSSOP-EP | 28%        | 12%<br>+17dBm  | IS-98 CDMA Japan, Internal Switch, Smallest, Most Economical Solution |
| MAX2268 | 2.7 to 4.5          | 90 idle                         | 887 to 925      | +27.0                  | AB    | 16-Pin TSSOP-EP | 34%        | 7%<br>+13.6dBm | IS-98 CDMA Japan, PDC PAE = 41% at +29dBm                             |
| MAX2269 | 2.7 to 4.5          | 34 idle,<br>50 avg,             | 887 to 925      | +27.0                  | AB    | 16-Pin TSSOP-   | 29%        | 17%<br>+17dBm  | IS-98 CDMA Japan, Off-Chip Switch, Lowest                             |

|         |            | 100 full             |              |       |    | EP       |                        |              | Current   |
|---------|------------|----------------------|--------------|-------|----|----------|------------------------|--------------|---|
| MAX2240 | 2.7 to 5.0 | 65 idle<br>105 full  | 2400 to 2500 | +20   | AB | UCSP 3x3 | 30%                    | NA           | Bluetooth PA with Digital Power Control, Shutdown   |
| MAX2242 | 2.7 to 3.6 | 280 idle<br>300 full | 2400 to 2500 | +22.5 | AB | UCSP 3x4 | 17% Pin=-7dBm<br>315mA | 6.7% +13dBm  | +22.5dBm Output Power at -33dBc ACPR for 802.11b<br>28.5dB Power Gain<br>External Bias Control for Current Throttleback<br>On-Chip Power Detector<br>Output Power Tunable from +10dBm to +22dBm   |
| MAX2244 | 3.0 to 3.6 | 65 idle<br>172 full  | 2400 to 2500 | +22   | AB | UCSP 3x3 | 34.2%                  | NA           | Integrated Input Match<br>Internal Bandwidth-Limited Power Ramping<br>Power Control Range: 0.5V to 2.0V<br>Supply Current = 170mA at +22dBm   |
| MAX2245 | 3.0 to 3.6 | 65 idle<br>179 full  | 2400 to 2500 | +22   | AB | UCSP 3x3 | 29.2%                  | NA           | Integrated Input Match<br>Internal Bandwidth-Limited Power Ramping<br>Power Control Range: 0.9V to 2.0V<br>Supply Current = 170mA at +22dBm   |
| MAX2246 | 3.0 to 3.6 | 42 idle<br>118 full  | 2400 to 2500 | +20   | AB | UCSP 3x3 | 27.8%                  | NA           | Integrated Input Match<br>Internal Bandwidth-Limited Power Ramping<br>Power Control Range: 0.5V to 2.0V   |
| MAX2247 | 2.7 to 3.6 | 293 idle<br>390 full | 2400 to 2500 | +25   | AB | UCSP 3x4 | 24.5%                  | 21% +22.5dBm | High Linear Output Power: +25dBm with < -33dBc ACPR (1st side lobe) and < -55dBc ACPR (2nd side lobe) (802.11b)<br><b>+17dBm and 3%EVM (802.11g)</b><br>25% Efficiency with Linear Output Power<br>29dB Power Gain<br>On-Chip Power Detector<br>External Bias Control for |

|         |            |                       |              |                            |    |                       |                          |                 |   |
|---------|------------|-----------------------|--------------|----------------------------|----|-----------------------|--------------------------|-----------------|---|
|         |            |                       |              |                            |    |                       |                          |                 | Current Throttleback<br>On-Chip Input Matching<br>0.5µA Shutdown Mode   |
| MAX2251 | 2.8 to 4.5 | 205 idle<br>1029 full | 824 to 849   | +32.4 AMPS<br><br>+30 TDMA | AB | UCSP<br>3x4           | 51% AMPS<br><br>41% TDMA | 38% +30dBm AMPS | Gain: 28dB<br>Integrated Power Detector<br>Low-Power Shutdown Mode<br>PAE: 41% at +30dBm for TDMA<br>PAE: 51% at +32.4dBm for AMPS                      |
| MAX2840 | 2.7 to 3.6 | 120 idle<br>155 full  | 5150 to 5350 | +15                        | A  | 12-UCSP-<br>1.52x2.02 | 6%                       | NA              | High Linear Output Power<br>+15dBm at 5.25 GHz (802.11a), 22dB Power gain, On-chip Power detector, Simple input/output matching, <10uA Shutdown current |
| MAX2841 | 2.7 to 3.6 | 165 idle<br>260 full  | 5150 to 5350 | +18                        | A  | 12-UCSP-<br>1.52x2.02 | 7%                       | NA              | High Linear Output Power<br>+18dBm at 5.25 GHz (802.11a), 22dB Power gain, On-chip Power detector, Simple input/output matching, <10uA Shutdown current |

**Table 2. Selections by Market**

| Market               | Part               | Advantages  | Specs   |
|----------------------|--------------------|---|---|
| Cellular CDMA (U.S.) | MAX2265            | Low-cost, Simple Layout, Few External Components, High-peak Efficiency                                    | Efficiency = 37% (ACPR = -45)<br>Efficiency = 35% (ACPR = -48)                  |
|                      | MAX2264<br>MAX2266 | Low-cost, World's Lowest Talk Current   | Talk Current=55mA<br>16dBm Efficiency =12/18% (2264/66)<br>Peak Efficiency =32% |
|                      | MAX2251            | Small Size Ultra-chip Scale Package (2.06mm x 2.06mm), Integrated Power Detector, Low-power Shutdown Mode | Gain: 28dB<br>PAE: 41% at +30dBm for TDMA<br>PAE: 51% at +32.4dBm for AMPS      |
| CDMA (Japan)         | MAX2268            | Low-cost, Simple Layout, Few External Components, High-peak Efficiency                                    | Efficiency = 37% (ACPR = -45)<br>Efficiency = 35% (ACPR = -48)                  |
|                      | MAX2267<br>MAX2269 | Low-cost, World's Lowest Talk Current   | Talk Current=55mA<br>16dBm Efficiency =12/18% (2264/66 and ACPR=-45)            |

|                              |         |   |   |
|------------------------------|---------|---|---|
|                              |         |   | Peak Efficiency =33% (ACPR=-45)   |
| Cellular TDM                 | MAX2251 | Small Size Ultra-chip Scale Package (2.06mm x 2.06mm), Integrated Power Detector, Low-power Shutdown Mode | Gain: 28dB<br>PAE: 41% at +30dBm for TDMA   |
| PDC                          | MAX2265 | Low-cost, Simple Layout, Few External Components, High-peak Efficiency                                    | Efficiency=40% (ACPR=-28)<br>P <sub>OUT</sub> =30dBm  |
| AMPs                         | MAX2251 | Small Size Ultra-chip Scale Package (2.06mm x 2.06mm), Integrated Power Detector, Low-power Shutdown Mode | Efficiency=51%<br>P <sub>OUT</sub> =32.4dBm   |
|                              | MAX2265 | Low-cost, Simple Layout, Few External Components, High-peak Efficiency                                    | PAE: 48% at +31.5dBm Output Power for AMPS  |
| WLL                          | MAX2265 | Low-cost, Simple Layout, Few External Components, High-peak Efficiency                                    | Efficiency=37% (ACPR=-45)<br>Efficiency=35% (ACPR=-48)  |
| 900MHz ISM                   | MAX2235 | Analog Gain Control, Auto Power Ramp, Shutdown  | PAE: 47% at +30.3dBm Output Power   |
|                              | MAX2251 | Small Size Ultra-chip Scale Package (2.06mm x 2.06mm), Integrated Power Detector, Low-power Shutdown Mode | Gain: 28dB<br>PAE: 41% at +30dBm for TDMA<br>PAE: 51% at +32.4dBm for AMPS                    |
| Bluetooth HomeRF 2.4GHz DECT | MAX2240 | Small Size Ultra-chip Scale Package (1.56mm x 1.56mm), 2-bit Digital Power Control                        | +20dBm, Efficiency =30%   |
|                              | MAX2244 | Closed-loop Analog Power Control, Small Size Ultra-chip Scale Package (1.56mm x 1.56mm)                   | +22dBm, Efficiency = 34.2%<br>Power control range 0.5V to 2V                                  |
|                              | MAX2245 | Closed-loop Analog Power Control, Small Size Ultra-chip Scale Package (1.56mm x 1.56mm)                   | +22dBm, Efficiency = 29.2%<br>Power control range 0.9V to 2V                                  |
|                              | MAX2246 | Closed-loop Analog Power Control, Small Size Ultra-chip Scale Package (1.56mm x 1.56mm)                   | +20dBm, Efficiency = 27.8%<br>Power control range 0.5V to 2V                                  |
| Cellular TDMA/AMPS Dual Mode | MAX2251 | Small Size Ultra-chip Scale Package (2.06mm x 2.06mm), Integrated Power Detector, Low-power Shutdown Mode | Gain: 28dB<br>PAE: 41% at +30dBm for TDMA<br>PAE: 51% at +32.4dBm for AMPS                    |
| 802.11b WLAN                 | MAX2242 | Integrated Power Detector, Dynamic Bias Control, Output Power Tunable from +10dBm to +22dBm               | +22.5dBm Output Power at -33dBc ACPR for 802.11B<br>28.5dB Power Gain                         |
| 802.11b/g                    | MAX2247 | High linear output power, On-chip power detector, External DAC controllable Bias, On-chip input matching  | +25dBm Output Power for 802.11b, +17dBm output power at 3.0% EVM for 802.11g, 29dB Power Gain |

|         |         |   |   |
|---------|---------|---|---|
| 802.11a | MAX2840 | High linear output power, On-chip power detector, Simple Matching External DAC controllable Bias  | +15dBm Output Power at 3.9% EVN for 802.11a, 22dBm power gain |
|         | MAX2841 | High linear output power, On-chip power detector, Simple Matching External DAC controllable Bias, | +18dBm Output Power at 3.5% EVN for 802.11a, 22dBm power gain |

- [16-pin PQSOP Package Outline](#)
- [16/20-pin TSSOP-EP Package Outline](#)
- [16-pin SO/QSOP Package Outline](#)
- [8-pin PSOPII Package Outline](#)
- [9-pin UCSP Package Outline](#)
- [12-pin UCSP Package Outline](#)
- [25-pin UCSP Package Outline](#)

| Related Parts |   |                              |
|---------------|---|------------------------------|
| MAX2240       | 2.5GHz, +20dBm Power Amplifier IC in UCSP Package           |                              |
| MAX2251       | +2.8V, Single-Supply, Cellular-Band Linear Power Amplifier  |                              |
| MAX2264       | 2.7V, Single-Supply, Cellular-Band Linear Power Amplifiers  |                              |
| MAX2265       | 2.7V, Single-Supply, Cellular-Band Linear Power Amplifiers  | <a href="#">Free Samples</a> |
| MAX2267       | +2.7V, Single-Supply, Cellular-Band Linear Power Amplifiers |                              |
| MAX2268       | +2.7V, Single-Supply, Cellular-Band Linear Power Amplifiers |                              |
| MAX2269       | +2.7V, Single-Supply, Cellular-Band Linear Power Amplifiers |                              |
| MAX2322       | Adjustable, High-Linearity, SiGe, Dual-Band, LNA/Mixer ICs  |                              |
| MAX2430       | Low-Voltage Silicon RF Power-Amplifier Predriver            |                              |
| MAX2601       | 3.6V, 1W RF Power Transistors for 900MHz Applications       | <a href="#">Free Samples</a> |
| MAX2602       | 3.6V, 1W RF Power Transistors for 900MHz Applications       | <a href="#">Free Samples</a> |

#### More Information

For Technical Support: <http://www.maximintegrated.com/support>

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