General Layout Guidelines for RF and Mixed-Signal PCBs

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Abstract: This application note provides guidelines and suggestions for RF printed-circuit board (PCB) design and layout, including some discussion of mixed-signal applications. The material provides "best practices" guidance, and should be used in conjunction with all other design and manufacturing guidelines that may apply to particular components, PCB manufacturers, and material sets as applicable.

This application note applies to all of Maxim's wireless products. For more information, please select a wireless or RF product.

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Introduction

This application note provides guidelines and suggestions for RF printed-circuit board (PCB) design and layout, including some discussion of mixed-signal applications, such as digital, analog, and RF components on the same PCB. The material is arranged by topic areas and provides "best practices" guidance. It should be used in conjunction with all other design and manufacturing guidelines that may apply to particular components, PCB manufacturers, and material sets as applicable.

RF Transmission Lines

Many of Maxim's RF components require controlled impedance transmission lines that will transport RF power to (or from) IC pins on the PCB. These transmission lines can be implemented on a exterior layer (top or bottom), or buried in an internal layer. Guidelines for these transmission lines include discussions relating to the microstrip, suspended stripline, coplanar waveguide (grounded), and characteristic impedance. It also describes transmission line bends and corner compensation, and layer changes for transmission lines.

Microstrip

This type of transmission line consists of fixed-width metal routing (the conductor), along with a solid unbroken ground plane located directly underneath (on the adjacent layer). For example, a microstrip on Layer 1 (top metal) requires a solid ground plane on Layer 2 (Figure 1). The width of the routing, the thickness of the dielectric layer, and the type of dielectric determine the characteristic impedance (typically 50Ω or 75Ω).
Suspended Stripline

This line consists of a fixed-width routing on an inner layer, with solid ground planes above and below the center conductor. The conductor can be located midway between the ground planes (Figure 2), or it can be offset (Figure 3). This is the appropriate method for RF routing on inner layers.

Coplanar Waveguide (Grounded)

A coplanar waveguide provides for better isolation between nearby RF lines, as well as other signal lines (end view). This medium consists of a center conductor with ground planes on either side and below (Figure 4).
Via "fences" are recommended on both sides of a coplanar waveguide, as shown in Figure 5. This top view provides an example of a row of ground vias on each top metal ground plane on either side of the center conductor. Return currents induced on the top layer are shorted to the underlying ground layer.

Figure 5. Via fences are recommended on both sides of a coplanar waveguide.

**Characteristic Impedance**

There are several calculators available to properly set the signal conductor line width to achieve the target impedance. However, caution should be used when entering the dielectric constant of the layers. The outer laminated layers of typical PCBs often contain less glass content than the core of the board, and consequently the dielectric constant is lower. For example, FR4 core is generally given as $\varepsilon_R = 4.2$, whereas the outer laminate (prepreg) layers are typically $\varepsilon_R = 3.8$. Examples given below for reference only, metal thickness assumed for 1oz copper (1.4 mils, 0.036mm).

<table>
<thead>
<tr>
<th>Media</th>
<th>Dielectric Layer Thickness in mils (mm)</th>
<th>Center Conductor in mils (mm)</th>
<th>Gap</th>
<th>Characteristic Impedance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microstrip</td>
<td>Prepreg (3.8)</td>
<td>6 (0.152)</td>
<td>11.5 (0.292)</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 (0.254)</td>
<td>20 (0.508)</td>
<td></td>
</tr>
<tr>
<td>Diff. Pair</td>
<td>Prepreg (3.8)</td>
<td>6 (0.152)</td>
<td>25 (0.635)</td>
<td>6 (0.152)</td>
</tr>
<tr>
<td>Stripline</td>
<td>FR4 (4.5)</td>
<td>12 (0.305)</td>
<td>3.7 (0.094)</td>
<td>N/A</td>
</tr>
<tr>
<td>Offset</td>
<td>Prepreg (3.9)</td>
<td>6 (0.152) upper,</td>
<td>4.8 (0.122)</td>
<td>N/A</td>
</tr>
<tr>
<td>Stripline</td>
<td></td>
<td>10 (0.254) lower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coplanar</td>
<td>Prepreg (3.8)</td>
<td>6 (0.152)</td>
<td>14 (0.35)</td>
<td>20 (0.50)</td>
</tr>
<tr>
<td>WG</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Transmission Line Bends and Corner Compensation**

When transmission lines are required to bend (change direction) due to routing constraints, use a bend radius that is at least 3 times the center conductor width. In other words:

\[
\text{Bend Radius} \geq 3 \times (\text{Line Width}).
\]

This will minimize any characteristic impedance changes moving through the bend.

In cases where a gradually curved bend is not possible, the transmission line can undergo a right-angle bend (noncurved). See Figure 6. However, this must be compensated to reduce the impedance discontinuity caused by the local increase in effective line width going through the bend. A standard compensation method is the angled miter, as illustrated below. The optimum microstrip right-angle miter is given by the formula of Douville and James:

\[
M = 100 \frac{x}{d} \% = \left( \frac{52 + 65e^{-27w_{20h}}}{20h} \right) \%
\]

Where $M$ is the fraction (%) of the miter compared to the unmitered bend. This formula is independent of the dielectric constant, and is subject to the constraint that $w/h \geq 0.25$. 

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Similar methods can be employed for other transmission lines. If there is any uncertainty as to the correct compensation, the bend should be modeled using an electromagnetic simulator if the design requires high-performance transmission lines.

![Figure 6. When a curved bend is not possible, the transmission line can undergo a right-angle bend.](image)

**Layer Changes for Transmission Lines**

When layout constraints required that a transmission line move to a different layer, it is recommended that at least two via holes be used for each transition to minimize the via inductance loading. A pair of vias will effectively cut the transition inductance by 50%, and the largest diameter via should be utilized that is compatible with the transmission line width. For example, on a 15-mil microstrip line, a via diameter (finished plated diameter) of 15 mils to 18 mils would be used. If space does not permit the use of larger vias, then three transition vias of smaller diameter should be used.

**Signal Line Isolation**

Care must be taken to prevent unintended coupling between signal lines. Some examples of potential coupling and preventative measures:

- **RF Transmission Lines**: Lines should be kept as far apart as possible, and should not be routed in close proximity for extended distances. Coupling between parallel microstrip lines will increase with decreasing separation and increasing parallel routing distance. Lines that cross on separate layers should have a ground plane keeping them apart. Signal lines that will carry high power levels should be kept away from all other lines whenever possible. The grounded coplanar waveguide provides for excellent isolation between lines. It is impractical to achieve isolation better than approximately -45dB between RF lines on small PCBs.

- **High-Speed Digital Signal Lines**: These lines should be routed separately on a different layer than the RF signal lines, to prevent coupling. Digital noise (from clocks, PLLs, etc.) can couple onto RF signal lines, and these can be modulated onto RF carriers. Alternatively, in some cases digital noise can be up/down-converted.

- **VCC/Power Lines**: These should be routed on a dedicated layer. Adequate decoupling/bypass capacitors should be provided at the main VCC distribution node, as well as at VCC branches. The choice of the bypass capacitances must be made based on the overall frequency response of the RF IC, and the expected frequency distribution nature of any digital noise from clocks and PLLs. These lines should also be separated from any RF lines that will transmit large amounts of RF power.

**Ground Planes**

The recommended practice is to use a solid (continuous) ground plane on Layer 2, assuming Layer 1 is used for the RF components and transmission lines. For striplines and offset striplines, ground planes above and below the center conductor are required. These planes must not be shared or assigned to signal or power nets, but must be uniquely allocated to ground. Partial ground planes on a layer, sometimes required by design constraints, must underlie all RF components and transmission lines. Ground planes must not be broken under transmission line routing.

Ground vias between layers should be added liberally throughout the RF portion of the PCB. This helps prevent accrual of parasitic ground inductance due to ground-current return paths. The vias also help to prevent cross-coupling from RF and other signal lines across the PCB.
Special Consideration on Bias and Ground Layers

The layers assigned to system bias (DC supply) and ground must be considered in terms of the return current for the components. The general guidance is to not have signals routed on layers between the bias layer and the ground layer.

![Figure 7. Incorrect layer assignment: there are signal layers between the bias layer and ground-current return path on ground layer. Bias line noise can be coupled to the signal layers.](image)

![Figure 8. Better layer assignment: there are no signal layers between the bias and ground current layers.](image)

Power (Bias) Routing and Supply Decoupling

A common practice is to use a "star" configuration for the power-supply routes, if a component has several supply connections (Figure 9). A larger decoupling capacitor (tens of µFds) is mounted at the "root" of the star, and smaller capacitors at each of the star branches. The value of these latter capacitors depends on the operating frequency range of the RF IC, and their specific functionality (i.e., interstage vs. main supply decoupling). An example is shown below.
Figure 9. If a component has several supply connections, the power-supply routes can be arranged in a star configuration.

The "star" configuration avoids long ground return paths that would result if all the pins connected to the same bias net were connected in series. A long ground return path would cause a parasitic inductance that could lead to unintended feedback loops. The key consideration with supply decoupling is that the DC supply connections must be electrically defined as AC ground.

Selection of Decoupling or Bypass Capacitors

Real capacitors have limited effective frequency ranges due to their self-resonant frequency (SRF). The SRF is available from the manufacturer, but sometimes must be characterized by direct measurement. Above the SRF, the capacitor is inductive, and therefore will not perform the decoupling or bypass function. When broadband decoupling is required, standard practice is to use several capacitors of increasing size (capacitance), all connected in parallel. The smaller value capacitors normally have higher SRFs (for example, a 0.2pF value in a 0402 SMT package with an SRF = 14GHz), while the larger values have lower SRFs (for example, a 2pF value in the same package with an SRF = 4GHz). A typical arrangement is depicted in Table 2.

Table 2. Useful Frequency Ranges of Capacitors

<table>
<thead>
<tr>
<th>Component</th>
<th>Capacitance</th>
<th>Package</th>
<th>SRF</th>
<th>Useful Frequency Range*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra-High Range</td>
<td>20pF</td>
<td>0402</td>
<td>2.5GHz</td>
<td>800MHz to 2.5GHz</td>
</tr>
<tr>
<td>Very High Range</td>
<td>100pF</td>
<td>0402</td>
<td>800MHz</td>
<td>250MHz to 800MHz</td>
</tr>
<tr>
<td>High Range</td>
<td>1000pF</td>
<td>0402</td>
<td>250MHz</td>
<td>50MHz to 250MHz</td>
</tr>
<tr>
<td>Midrange</td>
<td>1μF</td>
<td>0402</td>
<td>60MHz</td>
<td>100kHz to 600kHz</td>
</tr>
<tr>
<td>Low Range</td>
<td>10μF</td>
<td>0603</td>
<td>600kHz</td>
<td>10kHz to 600kHz</td>
</tr>
</tbody>
</table>
Bypass Capacitor Layout Considerations

Since the supply lines must be AC ground, it is important to minimize the parasitic inductance added to the AC ground return path. These parasitic inductances can be caused by layout or component orientation choices, such as the orientation of a decoupling capacitor's ground. There are two basic methods, shown in Figure 10 and Figure 11.

Figure 10. This configuration presents the smallest total footprint for the bypass capacitor and related vias.

In this configuration, the vias connecting the VCC pad on the top layer to the inner power plane (layer) potentially impede the AC ground current return, forcing a longer return path with resulting higher parasitic inductance. Any AC current flowing into the VCC pin passes through the bypass capacitor to its ground side before returning on the inner ground layer. This configuration presents the smallest total footprint for the bypass capacitor and related vias.

Figure 11. This configuration requires more PCB area.

In this alternate configuration, the AC ground return paths are not blocked by the power-plane vias. Generally this configuration requires somewhat more PCB area.

Grounding of Shunt-Connected Components

For shunt-connected (grounded) components (such as power-supply decoupling capacitors), the recommended practice is to use at least two grounding vias for each component (Figure 12). This reduces the effect of via parasitic inductance. Via ground "islands" can be used for groups of shunt-connected components.
Figure 12. Using at least two grounding vias for each component reduces the effect of via parasitic inductance.

IC Ground Plane ("Paddle")

Most ICs require a solid ground plane on the component layer (top or bottom of PCB) directly underneath the component. This ground plane will carry DC and RF return currents through the PCB to the assigned ground plane. The secondary function of this component "ground paddle" is to provide a thermal heatsink, so the paddle should include the maximum number of thru vias that are allowed by the PCB design rules. The example below shows a 5 × 5 array of via holes embedded in the central ground plane (on the component layer) directly under the RF IC (Figure 13). The maximum number of vias that can be accommodated by other layout considerations should be used. These vias are ideally thru- vias (i.e., penetrate all the way through the PCB), and must be plated. If possible, the vias should be filled with thermally conductive paste to enhance the heatsink (the paste is applied after via plating and prior to final board plating).

Figure 13. A 5 × 5 array of via holes embedded in the central ground plane directly under the RF IC.

Please see our Wireless and RF Products page for more information.

Related Parts

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS1870</td>
<td>LDMOS RF Power-Amplifier Bias Controller</td>
<td>Free</td>
</tr>
<tr>
<td>DS4026</td>
<td>10MHz to 51.84MHz TCXO</td>
<td>Free</td>
</tr>
<tr>
<td>MAX12000</td>
<td>1575MHz GPS Front-End Amplifier</td>
<td>Free</td>
</tr>
<tr>
<td>MAX12005</td>
<td>Satellite IF Switch</td>
<td>Free</td>
</tr>
<tr>
<td>MAX1385</td>
<td>Dual RF LDMOS Bias Controllers with I²C/SPI Interface</td>
<td>Free</td>
</tr>
<tr>
<td>MAX1386</td>
<td>Dual RF LDMOS Bias Controllers with I²C/SPI Interface</td>
<td>Free</td>
</tr>
<tr>
<td>MAX1470</td>
<td>315MHz Low-Power, +3V Superheterodyne Receiver</td>
<td>Free</td>
</tr>
<tr>
<td>MAX1471</td>
<td>315MHz/434MHz Low-Power, 3V/5V ASK/FSK Superheterodyne Receiver</td>
<td>Free</td>
</tr>
<tr>
<td>MAX1472</td>
<td>300MHz to 450MHz Low-Power, Crystal-Based ASK Transmitter</td>
<td>Free</td>
</tr>
<tr>
<td>MAX1473</td>
<td>315MHz/433MHz ASK Superheterodyne Receiver with Extended Dynamic Range</td>
<td>Free</td>
</tr>
<tr>
<td>MAX1479</td>
<td>300MHz to 450MHz Low-Power, Crystal-Based +10dBm ASK/FSK Transmitter</td>
<td>Free</td>
</tr>
<tr>
<td>MAX19692</td>
<td>12-Bit, 2.3Gsps Multi-Nyquist DAC</td>
<td>Free</td>
</tr>
<tr>
<td>MAX19790</td>
<td>250MHz to 4000MHz Dual, Analog Voltage Variable Attenuator</td>
<td>Free</td>
</tr>
<tr>
<td>MAX19985</td>
<td>Dual, SiGe, High-Linearity, High-Gain, 700MHz to 1000MHz Downconversion Mixer with LO Buffer/Switch</td>
<td>Free</td>
</tr>
<tr>
<td>MAX19985A</td>
<td>Dual, SiGe, High-Linearity, High-Gain, 700MHz to 1000MHz Downconversion Mixer with LO Buffer/Switch</td>
<td>Free</td>
</tr>
<tr>
<td>MAX19993</td>
<td>Dual, SiGe, High-Linearity, 1200MHz to 1700MHz Downconversion Mixer with LO Buffer/Switch</td>
<td>Free</td>
</tr>
<tr>
<td>MAX19993A</td>
<td>Dual, SiGe, High-Linearity, 1200MHz to 2000MHz Downconversion Mixer with LO Buffer/Switch</td>
<td>Free</td>
</tr>
</tbody>
</table>
MAX19994  LO Buffer/Switch
Dual, SiGe, High-Linearity, 1200MHz to 1700MHz Downconversion Mixer with
LO Buffer/Switch

MAX19994A  LO Buffer/Switch
Dual, SiGe, High-Linearity, 1200MHz to 2000MHz Downconversion Mixer with
LO Buffer/Switch

MAX19995  LO Buffer/Switch
Dual, SiGe, High-Linearity, 1700MHz to 2200MHz Downconversion Mixer with
LO Buffer/Switch

MAX19995A  LO Buffer/Switch
Dual, SiGe, High-Linearity, 1700MHz to 2200MHz Downconversion Mixer with
LO Buffer/Switch

MAX19996  LO Buffer/Switch
SiGe, High-Linearity, High-Gain, 2000MHz to 3000MHz Downconversion Mixer
with LO Buffer

MAX19996A  LO Buffer/Switch
SiGe, High-Linearity, 2000MHz to 3900MHz Downconversion Mixer with LO
Buffer

MAX19997A  LO Buffer/Switch
Dual, SiGe High-Linearity, High-Gain, 1800MHz to 2900MHz Downconversion
Mixer with LO Buffer/Switch

MAX19998  LO Buffer/Switch
SiGe, High-Linearity, 2300MHz to 4000MHz Downconversion Mixer with LO
Buffer

MAX19998A  LO Buffer/Switch
SiGe, High-Linearity, High-Gain, 3200MHz to 3900MHz Downconversion Mixer
with LO Buffer/Switch

MAX19999  LO Buffer/Switch
Dual, SiGe High-Linearity, 3000MHz to 4000MHz Downconversion Mixer with
LO Buffer

MAX2009  Adjustable RF Predistorter
1200MHz to 2500MHz Adjustable RF Predistorter

MAX2010  Adjustable RF Predistorter
500MHz to 1100MHz Adjustable RF Predistorter

MAX2014  Logarithmic Detector/Controller
50MHz to 1000MHz, 75dB Logarithmic Detector/Controller

MAX2015  Logarithmic Detector/Controller
0.1GHz to 3GHz, 75dB Logarithmic Detector/Controller

MAX2016  Logarithmic Detector/Controller for Power, Gain, and VSWR Measurements
LF-to-2.5GHz Dual Logarithmic Detector/Controller

MAX2021  Quadrature Modulator/Demodulator
High-Dynamic-Range, Direct Up-/Downconversion, 750MHz to 1200MHz

MAX2022  Quadrature Modulator/Demodulator
High-Dynamic-Range, Direct Upconversion 1500MHz to 2500MHz

MAX2023  Quadrature Modulator/Demodulator
High-Dynamic-Range, Direct Up-/Downconversion 1500MHz to 2300MHz

MAX2027  IF Digitally Controlled Variable-Gain Amplifier

MAX2029  Upconversion/Downconversion Mixer with LO Buffer/Switch
High-Linearity, 815MHz to 1000MHz Upconversion/Downconversion Mixer with
LO Buffer/Switch

MAX2030  Upconversion/Downconversion Mixer with LO Buffer/Switch
Dual, SiGe, High-Linearity, 700MHz to 1000MHz Up/Downconversion Mixer
with LO Buffer/Switch

MAX2030A  Upconversion/Downconversion Mixer with LO Buffer/Switch
Dual, SiGe, High-Linearity, 700MHz to 1000MHz Up/Downconversion Mixer
with LO Buffer/Switch

MAX2031  Upconversion/Downconversion Mixer with LO Buffer/Switch
High-Linearity, 650MHz to 1000MHz Upconversion/Downconversion Mixer with
LO Buffer/Switch

MAX2032  Upconversion/Downconversion Mixer with LO Buffer/Switch
High-Linearity, 650MHz to 1000MHz Upconversion/Downconversion Mixer with
LO Buffer/Switch

MAX2039  Upconversion/Downconversion Mixer with LO Buffer/Switch
High-Linearity, 1700MHz to 2200MHz Upconversion/Downconversion Mixer with
LO Buffer/Switch

MAX2040  Upconversion/Downconversion Mixer with LO Buffer/Switch
Dual, SiGe, High-Linearity, 1700MHz to 2200MHz Up/Downconversion Mixer
with LO Buffer/Switch

MAX2040A  Upconversion/Downconversion Mixer with LO Buffer/Switch
Dual, SiGe, High-Linearity, 1700MHz to 3000MHz Up/Downconversion Mixer
with LO Buffer/Switch

MAX2041  Upconversion/Downconversion Mixer with LO Buffer/Switch
High-Linearity, 1700MHz to 3000MHz Upconversion/Downconversion Mixer with
LO Buffer/Switch

MAX2042  Upconversion/Downconversion Mixer with LO Buffer
SiGe High-Linearity, 2000MHz to 3000MHz Upconversion/Downconversion
Mixer with LO Buffer

MAX2042A  Upconversion/Downconversion Mixer with LO Buffer
SiGe, High-Linearity, 1600MHz to 3900MHz Upconversion/Downconversion
Mixer with LO Buffer

MAX2043  Upconversion/Downconversion Mixer with LO Buffer
1700MHz to 3000MHz High-Linearity, Low LO Leakage Base-Station Rx/Tx
Mixer

MAX2044  Upconversion/Downconversion Mixer with LO Buffer
SiGe, High-Linearity, 2300MHz to 4000MHz Upconversion/Downconversion
Mixer with LO Buffer
MAX2044A  SiGe, High-Linearity, 3000MHz to 4000MHz Upconversion/Downconversion Mixer with LO Buffer

MAX2045  High-Gain Vector Multipliers  -- Free Samples
MAX2046  High-Gain Vector Multipliers  -- Free Samples
MAX2047  High-Gain Vector Multipliers  -- Free Samples
MAX2051  SiGe, High-Linearity, 850MHz to 1550MHz Up/Downconversion Mixer with LO Buffer  -- Free Samples

MAX2055  Digitally Controlled, Variable-Gain, Differential ADC Driver/Amplifier

MAX2056  800MHz to 1000MHz Variable-Gain Amplifier with Analog Gain Control  -- Free Samples
MAX2057  1300MHz to 2700MHz Variable-Gain Amplifier with Analog Gain Control  -- Free Samples
MAX2058  700MHz to 1200MHz High-Linearity, SPI-Controlled DVGA with Integrated Loopback Mixer  -- Free Samples
MAX2059  1700MHz to 2200MHz, High-Linearity, SPI-Controlled DVGA with Integrated Loopback Mixer  -- Free Samples

MAX2062  Dual 50MHz to 1000MHz High-Linearity, Serial/Parallel-Controlled Analog/Digital VGA  -- Free Samples
MAX2063  Dual 50MHz to 1000MHz High-Linearity, Serial/Parallel-Controlled Digital VGA  -- Free Samples
MAX2064  50MHz to 1000MHz, High-Linearity, Serial/Analog-Controlled VGA  -- Free Samples
MAX2065  50MHz to 1000MHz High-Linearity, Serial/Parallel-Controlled Analog/Digital VGA  -- Free Samples

MAX2066  50MHz to 1000MHz High-Linearity, Serial/Parallel-Controlled Digital VGA  -- Free Samples
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MAX2112  Complete, Direct-Conversion Tuner for DVB-S2 Applications  -- Free Samples
MAX2114  DBS Direct Downconverter

MAX2117  Complete, Direct-Conversion Tuner for MMDS Applications  -- Free Samples
MAX2120  Complete, Direct-Conversion Tuner for DVB-S and Free-to-Air Applications  -- Free Samples
MAX2121  Complete Direct-Conversion L-Band Tuner  -- Free Samples
MAX2135A  ISDB-T/DVB-T Diversity Tuner  -- Free Samples
MAX2136  ISDB-T/DVB-T Low-IF Tuner  -- Free Samples
MAX2140  Complete SDARS Receiver  -- Free Samples
MAX2141  Low-Power XM Satellite Radio Receiver  -- Free Samples
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MAX2160  ISDB-T Single-Segment Low-IF Tuners  -- Free Samples
MAX2160EBG  ISDB-T Single-Segment Low-IF Tuners  -- Free Samples
MAX2161  ISDB-T 1- and 3-Segment Low-IF Tuners  -- Free Samples
MAX2161S  ISDB-T 1- and 3-Segment Low-IF Tuners  -- Free Samples
MAX2162  ISDB-T 1- and 3-Segment Low-IF Tuners  -- Free Samples
MAX2162S  ISDB-T 1- and 3-Segment Low-IF Tuners  -- Free Samples
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MAX2170  Direct-Conversion to Low-IF Tuners for Digital Audio Broadcast  -- Free Samples
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MAX2180  AM/FM Car Antenna Low-Noise Amplifier  -- Free Samples
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MAX2207  RF Power Detectors in UCSP  -- Free Samples
MAX2208  RF Power Detectors in UCSP  -- Free Samples
MAX2209  RF Power Detector  -- Free Samples
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MAX2233  900MHz ISM-Band, 250mW Power Amplifiers with Analog or Digital Gain Control  -- Free Samples
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MAX2240  2.5GHz, +20dBm Power Amplifier IC in UCSP Package
MAX2242  2.4GHz to 2.5GHz Linear Power Amplifier
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MAX2670  GPS/GNSS Front-End Amplifier
MAX2671  400MHz to 2.5GHz Upconverters  -- Free Samples
MAX2672  400MHz to 2.5GHz Upconverters  -- Free Samples
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MAX2688  GPS/GNSS Low-Noise Amplifiers
MAX2689  GPS/GNSS Low-Noise Amplifier
MAX2690  Low-Noise, 2.5GHz Downconverter Mixer  -- Free Samples
MAX2691  GPS/GNSS Low-Noise Amplifier for L2 Band
MAX2692  WLAN/WiMax Low-Noise Amplifiers
MAX2693  GPS/GNSS Low-Noise Amplifier
MAX2694  GPS/GNSS Low-Noise Amplifiers
MAX2695  WLAN/WiMax Low-Noise Amplifiers
MAX2696  Integrated GPS Receiver and Synthesizer
MAX2697  Single-Chip Global Positioning System Front-End Downconverter  -- Free Samples
MAX2698  2.4GHz Monolithic Voltage-Controlled Oscillators  -- Free Samples
MAX2699  2.4GHz Monolithic Voltage-Controlled Oscillator for Automotive
MAX2701  2.4GHz Monolithic Voltage-Controlled Oscillators  -- Free Samples
MAX2702  2.4GHz Monolithic Voltage-Controlled Oscillators  -- Free Samples
MAX2703  Universal GPS Receiver  -- Free Samples
MAX2704  Universal GPS Receiver  -- Free Samples
MAX2705  Single-/Dual-Band 802.11a/b/g World-Band Transceiver ICs  -- Free Samples
MAX2706  Single-/Dual-Band 802.11a/b/g World-Band Transceiver ICs
MAX2707  2.4GHz to 2.5GHz 802.11g/b RF Transceiver with PA and Rx/Tx/Diversity Switch
MAX2708  2.4GHz to 2.5GHz, 802.11g RF Transceivers with Integrated PA  -- Free Samples
MAX2709  2.4GHz to 2.5GHz, 802.11g RF Transceivers with Integrated PA
MAX2710  2.3GHz to 2.7GHz Wireless Broadband RF Transceiver  -- Free Samples
MAX2711  2.3GHz to 2.7GHz Wireless Broadband RF Transceiver
MAX2712  2.3GHz to 2.7GHz MIMO Wireless Broadband RF Transceiver  -- Free Samples
MAX2713  2.3GHz to 2.7GHz MIMO Wireless Broadband RF Transceiver
MAX2714  3.3GHz to 3.9GHz MIMO Wireless Broadband RF Transceiver  -- Free Samples
MAX2715  3.3GHz to 3.9GHz MIMO Wireless Broadband RF Transceiver
MAX2716  5GHz, 4-Channel MIMO Transmitter  -- Free Samples
MAX2717  5GHz, 5-Channel MIMO Receiver  -- Free Samples
MAX2718  5GHz Receiver  -- Free Samples
MAX2719  5GHz Receiver  -- Free Samples
MAX2720  200mW Single-Chip Transmitter ICs for 868MHz/915MHz ISM Bands  -- Free Samples
MAX2721  200mW Single-Chip Transmitter ICs for 868MHz/915MHz ISM Bands
MAX2722  200mW Single-Chip Transmitter ICs for 868MHz/915MHz ISM Bands
MAX2723  200mW Single-Chip Transmitter ICs for 868MHz/915MHz ISM Bands
MAX2724  200mW Single-Chip Transmitter ICs for 868MHz/915MHz ISM Bands  -- Free Samples
MAX2725  200mW Single-Chip Transmitter ICs for 868MHz/915MHz ISM Bands
MAX2726  10kHz to 490kHz OFDM-Based Power Line Communications Modem  -- Free Samples
MAX2727  DOCSIS 3.0 Upstream Amplifier  -- Free Samples
MAX2728  Low-Noise, High-Linearity Broadband Amplifier  -- Free Samples
MAX2729  Complete Single-Conversion Television Tuner  -- Free Samples
MAX2730  Complete Single-Conversion Television Tuner  -- Free Samples
MAX2731  Multiband Analog and Digital Television Tuner  -- Free Samples
MAX2732  Multiband Digital Television Tuner  -- Free Samples
| MAX9994 | SiGe High-Linearity, 1400MHz to 2200MHz Downconversion Mixer with LO Buffer/Switch | -- Free Samples |
| MAX9995 | Dual, SiGe, High-Linearity, 1700MHz to 2700MHz Downconversion Mixer with LO Buffer/Switch | -- Free Samples |
| MAX9995A | Dual, SiGe, High-Linearity, 1700MHz to 2200MHz Downconversion Mixer with LO Buffer/Switch | -- Free Samples |
| MAX9996 | SiGe High-Linearity, 1700MHz to 2200MHz Downconversion Mixer with LO Buffer/Switch | -- Free Samples |

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