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802.11b WLAN Transceiver Shrinks Circuit Board and Bill of Materials

This application note describes the features and performance of an IEEE 802.11b WLAN transceiver using Maxim's zero IF IC, the MAX2820. The MAX2820 output spectrum is shown to have adequate ACPR to meet the standard. A MAX2242 power amplifier is shown on an actual PC layout. This solution ofers small size and a reduced number of external components.

IEEE 802.11b wireless networks have become a key element of enterprise networks. They provide convenient access to network resources for workers carrying portable computers and handheld devices and for guests or temporary workers. They are finding wide application in public environments such as hotels, airports, and coffee shops. They also provide a cost-effective alternative to relocating physical Ethernet jacks in environments where facilities are moved or changed frequently.

To serve this fast-growing, emerging market, Maxim has developed a complete RF solution (RF transceiver and power amplifier) that meets the requirements of the IEEE 802.11b WLAN (wireless local area network) standard.

The MAX2820 and MAX2821 are single-chip zero-IF (intermediate frequency) transceivers designed for 802.11b (11Mbps) applications operating in the 2.4GHz to 2.5GHz ISM (industrial scientific medical) band. The transceivers are nearly identical, except the MAX2821 provides low-power shutdown and analog voltage reference output features and the MAX2820 does not. The transceivers include all the circuitry required to implement an 802.11b RF-to-baseband transceiver solution, providing a fully integrated receive path, transmit path, VCO, frequency synthesis, and baseband/control interface. To complete the radio front-end solution, only a 802.11b dedicated PA like the MAX2242, RF switch, RF BPF (band pass filter), and a small number of passive components are needed. The devices are suitable for the full range of 802.11b data rates (1Mbps, 2Mbps, 5.5Mbps, and 11Mbps) and also the higher-rate 22Mbps PBCC™(Packet Binary Convolutional Code) standard. The MAX2820 and MAX2821 are available in the very small 7mm x 7mm 48-lead QFN/thin QFN packages.

The MAX2820-MAX2242 chip set complements Maxim's capabilities in other wireless areas, including CDMA2000/WCDMA Chipsets, Multimode Transmitter ICs for GSM/GPRS and Enhanced Data rates for Global Evolution (EDGE), Zero IF Direct satellite receivers and transmitters.

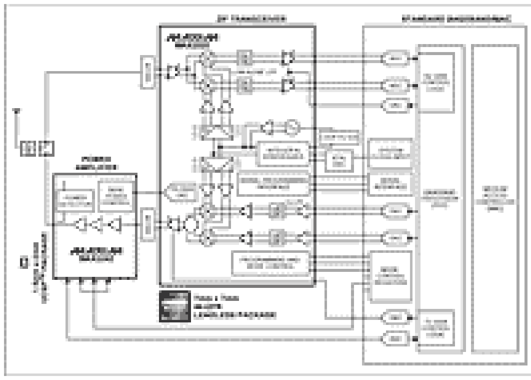

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Figure 1. Maxim's complete IEEE 802.11b solution

The MAX2820 Detailed Description

Maxim's RF BICMOS (Bipolar Complementary Metal Oxide Semiconductor) process allows this part to achieve low power consumption without sacrificing the high performance demanded by the end customer. Because these parts employ a Zero IF (ZIF) receiver and transmitter architecture, they are best suited to respond to the 802.11 market's continuing demand for reduced prices. The MAX2820 zero IF architecture attains the suppression of a transmit and receive IF SAW filter, saving cost and design space of an external SAW filter. The entire RF front end with the MAX2820 and a MAX2247 PA only needs four inductors, 33 capacitors , and four resistors. A MAX2820 802.11b solution, with a MAC/Baseband DSP included, is easily laid-out in a 20mm x 40mm form factor. (26.5mm x 12mm for the RF only).

The homodyne (zero IF) approach used in today's highest-performing solutions results in a typical receive sensitivity of -87dBm at 11 Mb/s(-97dBm RX Sensitivity at 1Mbps) with MAXIM's reference designs. This sensitivity is 2-3dB better than other homodyne solutions and 1-2dB better than other heterodyne solutions.

The SAW (surface acoustic wave) filter from a heterodyne transceiver might appear to provide an advantage in terms of power consumption, because passive filters seem to allow lower supply currents. One must not forget, however, that heterodyne architectures need a RF mixer with additional power gain to compensate for the SAW filter's insertion loss. Active filters integrated within the transceiver are attractive in that they allow a very low 4.5dB worst case noise figure for the whole receiver chain at a maximum gain condition (34dB at minimum gain condition). The on-chip receive low-pass filters provide the steep filtering necessary to attenuate the out-of-band (> 11MHz) interfering signals to sufficiently low levels to preserve receiver sensitivity. The MAX2820 receive-path gain is varied through an external voltage applied to the RX_AGC pin. The continuously variable gain-control range in the I and Q sections is typically 70dB. The differential 100Ω input impedance front end LNA (low noise amplifier) is easily matched using a 2:1 balun. The LNA also offers a 30dB gain step. In most applications, the LNA

Gain Select Logic Input is connected directly to a CMOS output of the baseband IC, which controls the LNA gain based on the detected signal amplitude.

When in the receive mode, the MAX2820 consumes just under 85mA of current with a 2.7V supply. The MAX2820 transmitter RF outputs are a high-impedance differential configuration, directly connected to the driver amplifier. The outputs are essentially open-collector with an on-chip inductor connected to V_{CC}. The power-amplifier driver outputs require external impedance matching and differential to single-ended conversion. The balanced 20Ω to single-ended 50Ω conversion is achieved through the use of a low cost off-chip balun transformer, available from Murata or Toko.

The transmit gain of the MAX2820 is controlled by an external voltage at the TX_GC in, offering a 30dB gain control range. At maximum gain, the power delivered at the balun transformer output is +2dBm for a 11Mbps data rate, with -37dBc first side lobe and -59dBc second side lobe rejection.

The MAX2820 on-chip transmit lowpass filters provide the filtering necessary to attenuate the unwanted higher-frequency spurious signal content that arises from DAC (digtal-to-analog converter) clock feed-through and sampling images. In addition, the filter provides additional attenuation of the second sidelobe of the signal's spectrum. The filter frequency response requires no user adjustment.

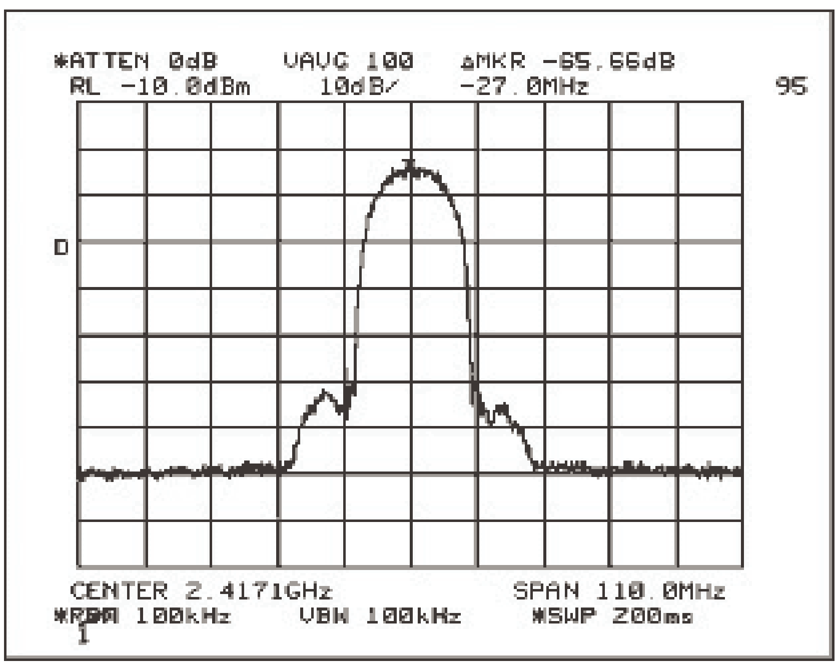

Figure 2. The MAX2820 transmitter output spectrum offers low adjacent channel power

In a zero-IF system, in order to achieve low LO leakage at the RF output, the DC offset of the TX baseband signal path must be reduced to as near zero as possible. Given that the amplifier stages, baseband filters, and TX DAC possess finite DC offset that is too large for the required

LO leakage specification, it is necessary to "null" the DC offset. The MAX2820 accomplish this through an on-chip calibration sequence. During this sequence, the net transmit base-band signal path offsets are sampled and canceled in the baseband amplifiers. This calibration occurs in the first ~2.2µs after TX_ON is taken high.

The MAX2820 Zero IF quadrature modulator needs approximately 75mA of current with a 2.7V supply for all the transmit functions active. The MAX2820 baseband interface is compatible with several baseband/MACs, giving the user the option of choosing one that is most appropriate for a specific application. Baseband inputs and outputs are differential and both requires a +1.2V common-mode voltage. They are designed to be DC-coupled to the I/Q inputs & outputs of the baseband IC.

The MAX2242 Power Amplifier Detailed Description

The MAX2242 low-voltage, three-stage linear PA (power amplifier), is a highly efficient linear amplifier which delivers the maximum allowable output power with high efficiency and greater margin to meet spectral mask requirements. The MAX2242 is optimized for 802.11b WLAN (wireless local area network) applications. The device, integrated with an adjustable bias control, power detector, and shutdown mode, is packaged in the tiny 3 x 4 chip-scale package (UCSP™), measuring only 1.5mm x 2mm. The MAX2242 features 28.5dB of power gain and delivers up to +22.5dBm of linear output power with single +3.3V supply. It achieves less than -33dBc first-side lobe suppression and less than -55dBc second-side lobe suppression under 802.11b modulation and has harmonic output (2f, 3f, 4f) rejection better than -40dBc without a harmonic trap. In addition, the device can be matched for optimum efficiency and performance at output power levels from +10dBm to +22.5dBm. Its also possesses a high +26.5dBm saturated output power.

The combination of the MAX2820 and the MAX2242 forms a complete chip set to implement IEEE 802.11b physical-layer solution (Figure 1). Both are in high volume production. The chip set is supported by several complete reference designs .

A complete stand-alone MAX2820 evaluation kit is also available (Figure 3), with schematic diagrams, lay-out drawings, and a Bill Of Material. The evaluation kits provide 50Ω SMA connectors for all RF and baseband inputs and outputs. Differential-to single-ended and single-ended to-differential line drivers are provided to convert the differential I/Q baseband inputs and outputs to single-ended.

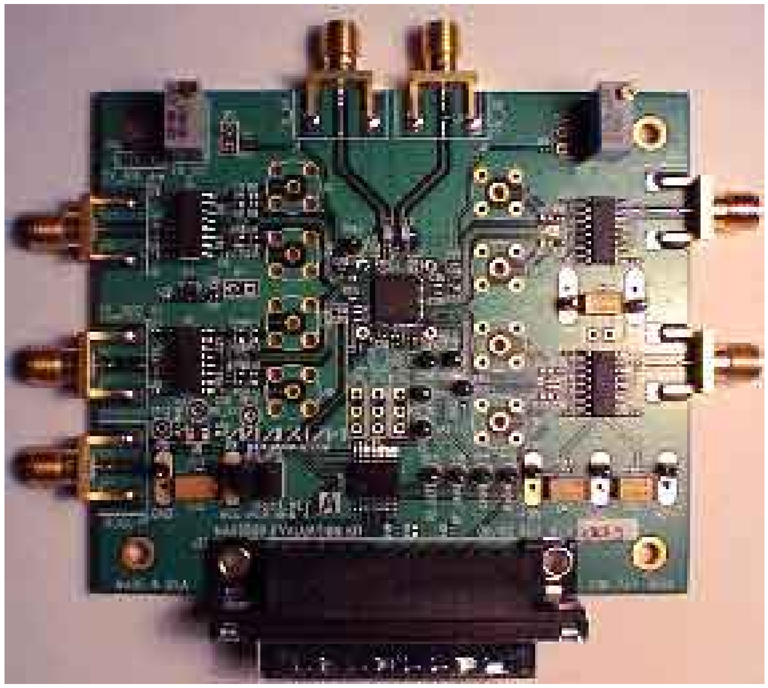

Figure 3. The MAX2820 stand-alone evaluation Kit

One common method for estimating the cost from a solution is the number of interconnect pins, passive components and layout vias needed to interconnect several packaged IC. (See Figure 4) The three-chip WLAN solution (including Baseband/Mac chip) from Maxim provides a small form factor, low passive-component count solution. The highly integrated and programmable transceiver supports a WLAN solution that features a high degree of flexibility at low cost.

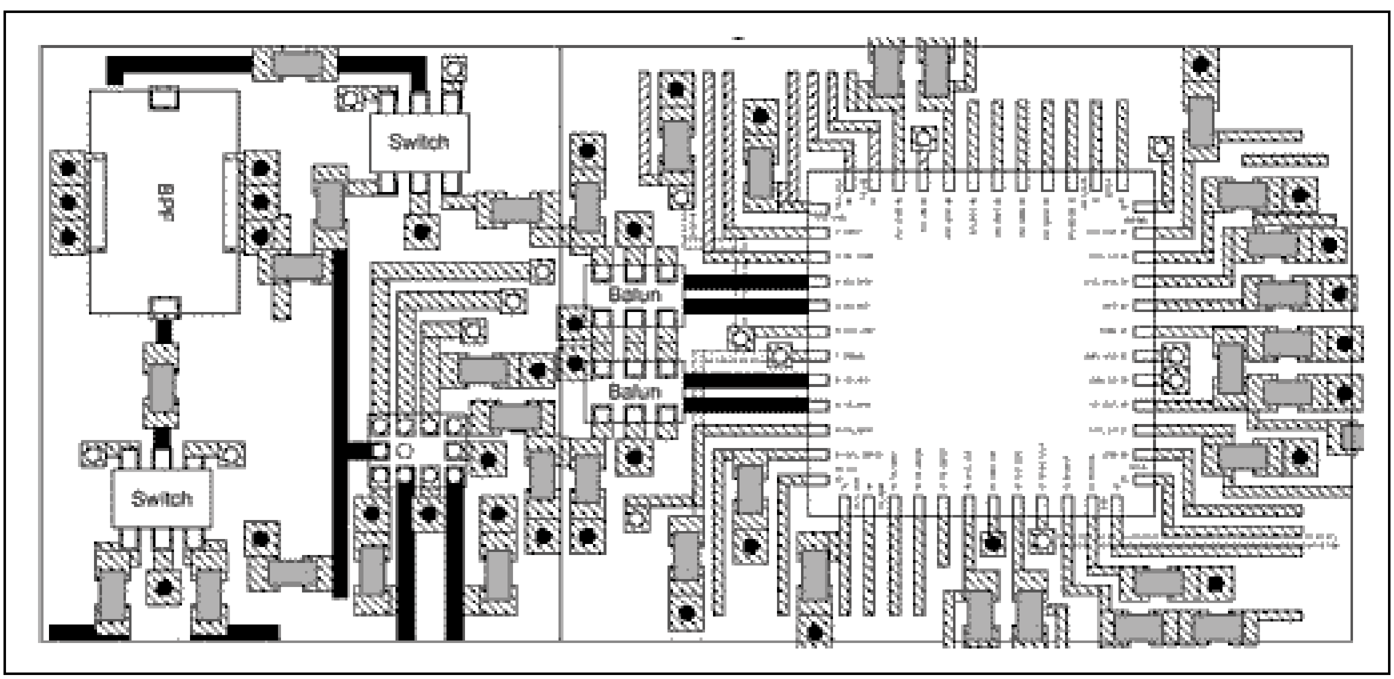

Figure 4. The MAX2820/MAX2242 radio interface approximate PCB layout (26.5mm x 12mm)

This highly integrated Maxim 2.4GHz WLAN chip-set solution offers outstanding performance for

CCK and PBCK modulation schemes, small size (see Figure 5) and is the lowest-cost solution available on the market.

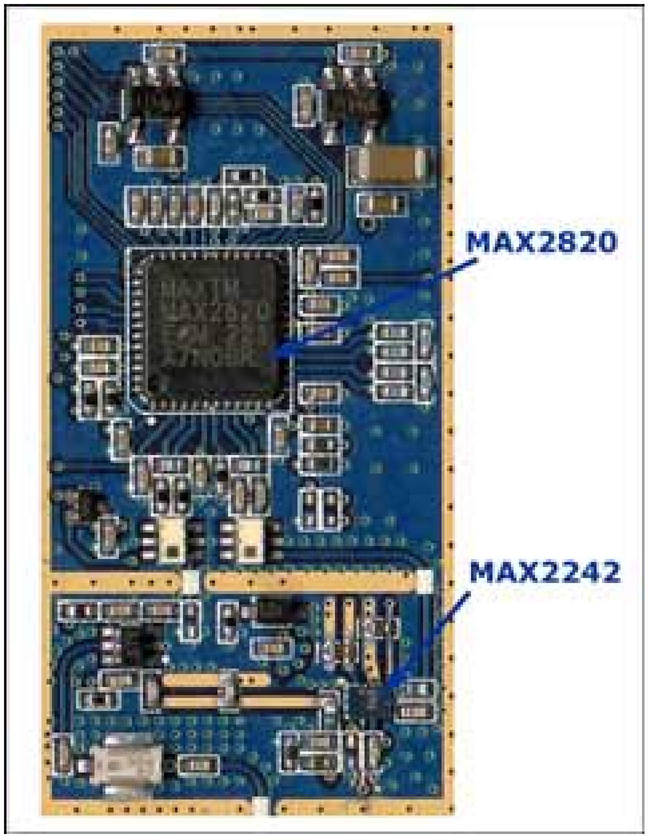

Figure 5. Small size 802.11 RF transceiver

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More Information

MAX2820: QuickView -- Full (PDF) Data Sheet -- Free Samples