802.11b WLAN transceiver shrinks circuit board and bill of materials

IEEE 802.11b wireless networks have become a key element of enterprise networks. To serve this fast-growing, emerging market, Maxim 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.

Wireless networks provide convenient access to network resources for workers carrying portable computers and handheld devices, and for guests or temporary workers. Those networks 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.

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 that the MAX2821 provides low-power shutdown and analog-voltage reference-output, while the MAX2820 does not. The transceivers include all 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 an 802.11b dedicated PA like the MAX2242, an RF switch, an RF BPF (bandpass 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 from Texas Instruments. The MAX2820 and MAX2821 are available in the very small, 7mm x 7mm, 48-pin QFN/thin QFN packages.

The MAX2820-MAX2242 chipset complements Maxim's capabilities in other wireless areas, including cdma2000/W-CDMA chipsets, multimode transmitter ICs for GSM/GPRS, and enhanced data rates for global evolution (EDGE), zero-IF (ZIF) direct satellite receivers and transmitters.

PBCC is a trademark of Texas Instruments Incorporated.

The ZIF transceiver

The homodyne (ZIF) approach used in today's highest performing solutions results in a typical receive sensitivity of -87dBm at 11Mbps (-97dBm Rx sensitivity at 1Mbps) with Maxim's reference designs. This sensitivity is 2dB to 3dB better than other homodyne solutions and 1dB to 2dB better than other heterodyne solutions.

The surface acoustic wave (SAW) filter from a heterodyne transceiver might appear to provide an advantage in power consumption, because passive filters seem to allow lower supply currents. One must not forget, however, that heterodyne architectures need an RF mixer with additional power gain to compensate for the SAW filter's insertion loss. Active filters integrated within the transceiver are attractive as 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 necessary steep filtering that attenuates the out-of-band (>11MHz) interfering signals to sufficiently low levels, thus preserving receiver sensitivity.

Maxim's RF BiCMOS™ (Bipolar Complementary Metal Oxide Semiconductor) process allows the MAX2820 to achieve low power consumption without sacrificing the high performance demanded by the end customer. Because this part employs a ZIF receiver and transmitter architecture, it is best suited to respond to the 802.11b market's continuing demand for reduced prices. The MAX2820's ZIF architecture attains the suppression of a transmit-and-receive IF SAW filter, saving the cost and design space of an external SAW filter. The entire RF front end with the MAX2820 and a MAX2247 PA only needs 4 inductors, 33 capacitors, and 4 resistors. A MAX2820 802.11b solution, with MAC/baseband DSP included, is easily laid out in a 20mm x 40mm form factor (26.5mm x 12mm for the RF only).

The MAX2820 receive-path gain is varied through an external voltage applied to the RX_AGC pin. The continuous 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.

BiCMOS is a trademark of Maxim Integrated Products, Inc.

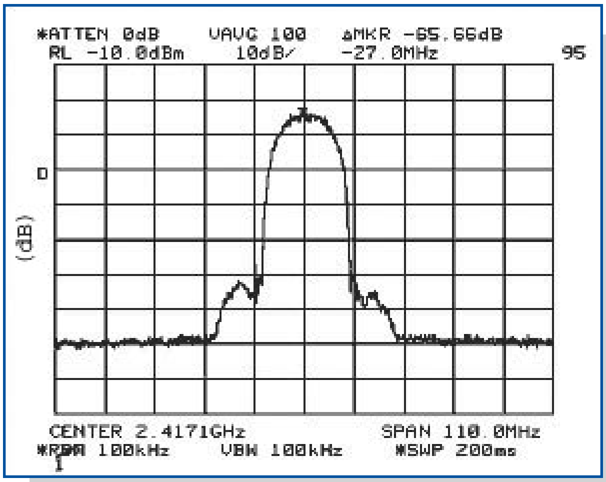

Figure 1. The MAX2820 transmitter output spectrum offers low adjacent-channel power.

When in the receive mode, the MAX2820 consumes just under 85mA of current with a 2.7V supply. The MAX2820 transmitter RF outputs have 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 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 input, offering a 30dB gain-control range. At maximum gain, the power delivered at the balun transformer output is +2dBm for an 11Mbps data rate, with -37dBc first side-lobe and -59dBc second side-lobe rejection (**Figure 1**).

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

To achieve low LO leakage at the RF output in a ZIF system, the DC offset of the Tx baseband signal path must be reduced as near to zero as possible. As the amplifier stages, baseband filters, and TX DAC possess a finite DC offset too large for the required LO leakage specification, it is necessary to null the DC offset. The MAX2820 accomplishes this through an on-chip calibration sequence. During this sequence, the net-transmit baseband-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 ZIF quadrature modulator needs approximately 75mA of current with a 2.7V supply for all the active transmit functions. The MAX2820 baseband interface is compatible with several baseband/MACs, giving the user the option of choosing the one most appropriate for a specific application. Baseband inputs and outputs are differential and both require a +1.2V common-mode voltage. They are designed to be DC-coupled to the I/Q inputs and outputs of the baseband IC.

The MAX2242 power amplifier

The MAX2242 low-voltage, three-stage linear power amplifier (PA) is a highly efficient linear amplifier that 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. Integrated with an adjustable bias control, power detector, and shutdown mode, this device 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 a single +3.3V supply. It achieves less than -33dBc of first side-lobe suppression and less than -55dBc of second side-lobe suppression under 802.11b modulation. It 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. It also possesses high +26.5dBm saturated output power.

The combination of the MAX2820 and the MAX2242 forms a complete chipset to implement an IEEE 802.11b physical-layer solution (**Figure 2**). Both ICs are in high-volume production. The chipset is supported by several complete reference designs.

A complete stand-alone MAX2820 evaluation kit is also available (**Figure 3**) with a schematic, lay-out diagrams, and a bill of materials (BOM). The evaluation kit provides 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.

UCSP is a trademark of Maxim Integrated Products, Inc.

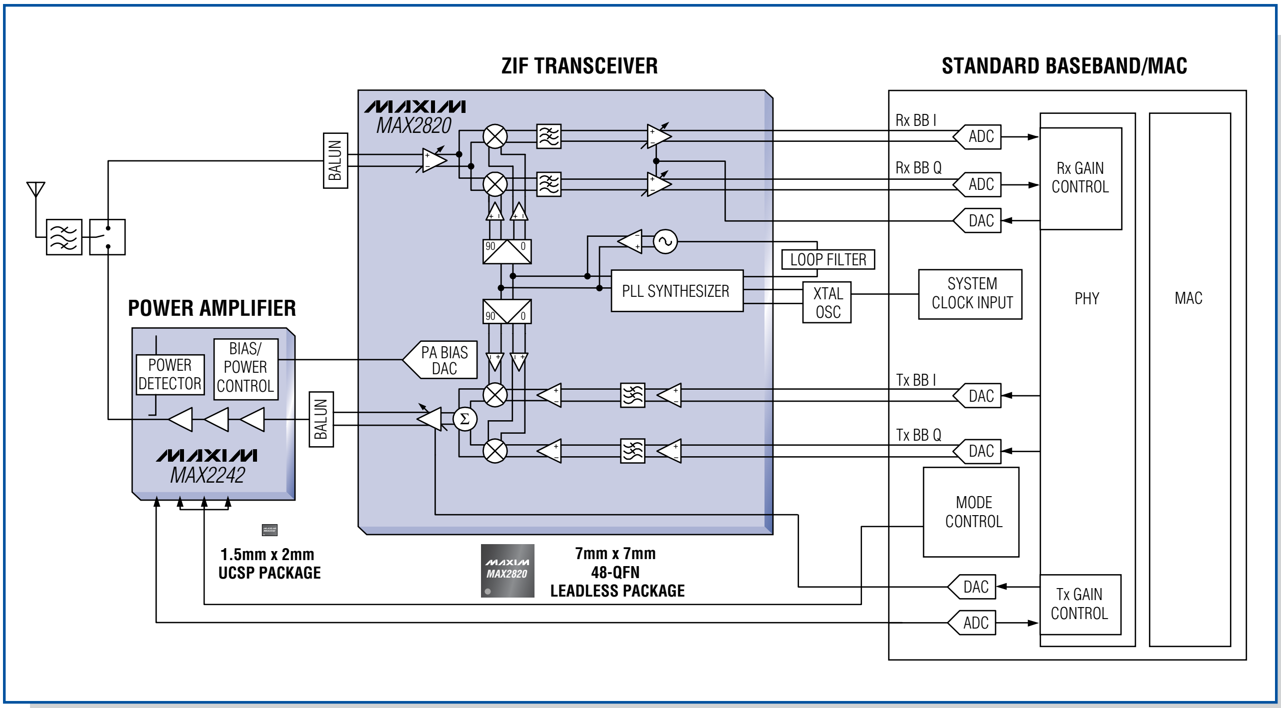

Figure 2. Maxim's complete IEEE 802.11b solution includes the MAX2820 single-chip ZIF transceiver and the MAX2242 linear power amplifier.

Conclusion

A common method for estimating the cost of a solution is by determining the number of interconnect pins, passive components, and layout vias needed to integrate several packaged ICs (**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 programmable transceiver supports a WLAN solution with a high degree of flexibility at a low cost.

This highly integrated, 802.11b, 2.4GHz WLAN chipset solution offers outstanding performance for CCK and PBCK modulation schemes. It is small (**Figure 5**), is the lowest cost solution available on the market, and offers an easy +20dBm output power at the antenna. This chipset is available now in high-volume production for access and client applications, and has been designed in for a number of enterprise and consumer products available in the marketplace today. Part of this chipset, the MAX2822, was recently introduced. As a client-dedicated, second-generation chip, it contains a +17dBm-output, power-integrated power amplifier. While maintaining a high level of performance, it offers a significant reduction in the power consumption, size, and BOM cost when compared to competitors' alternatives.

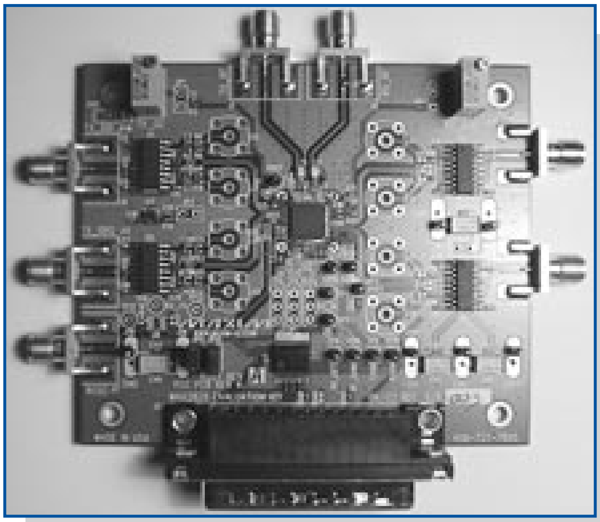

Figure 3. The MAX2820 stand-alone evaluation kit includes 50Ω SMA connectors, schematics, layout diagrams, and a BOM.

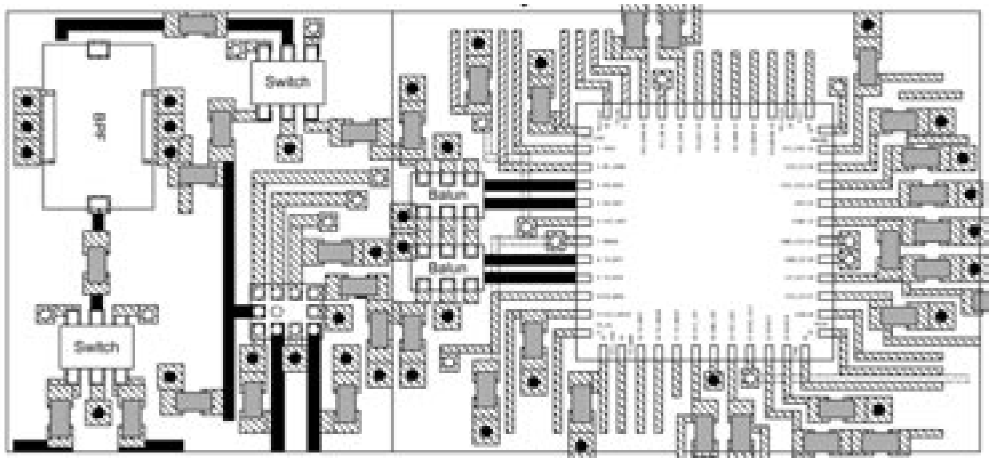

Figure 4. This diagram of the MAX2820/MAX2242 radio interface shows approximate PCB layout (26.5mm x 12mm) and low passive-component count.

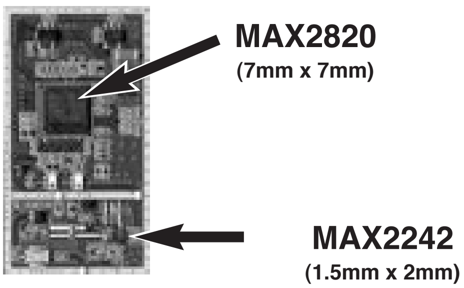

Figure 5. This small 802.11 RF transceiver offers excellent performance for CCK- and PBCK-modulation schemes.