

Wireless USB Uses Ultra Wideband (UWB) for High Data Rate

By Gary Breed
Editorial Director

A consortium of high-profile companies is supporting standards and product development for wireless USB port interconnections

On May 24, 2005, the Wireless USB Promoter Group announced that its Wireless USB specification had been completed. With a standard in place,

the final development of wireless USB components is well underway and consumer products are expected to appear as early as the 2005 Christmas shopping season.

Wireless USB Organizations

There are three groups involved in the development of wireless USB:

The Wireless USB Promoter Group—This group consists of Agere Systems, Hewlett Packard, Intel, Microsoft, NEC, Philips Semiconductors and Samsung. Now that they have developed the Wireless USB specification, their role is to encourage companies to adopt the specification in component and equipment development.

USB Implementers Forum, Inc. [1]—The USB-IF is the governing body established to oversee the Wireless USB specification. This non-profit organization promotes the new specification, providing a logo and compliance program for USB products.

WiMedia Alliance [2]—This group is the developer and promoter of a multiband orthogonal frequency-division multiplexing (MB-OFDM) radio platform for UWB. This transmission method is part of the Wireless USB specification. Early this year, the group merged with the MultiBand OFDM Alliance Special Interest Group (MBOA-SIG), the originator of this UWB transmission method. WiMedia's board includes Alereon, Hewlett

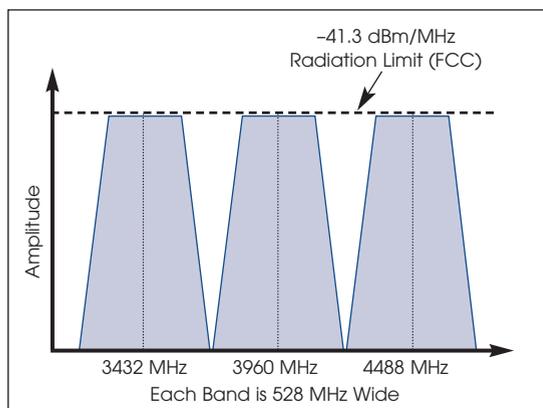


Figure 1 · Wireless USB uses Band Group 1 within the UWB spectrum approved by the FCC. Additional UWB Band Groups, which lie above these frequencies, may be used in the future.

Packard, Intel, Kodak, Microsoft, Nokia, Philips, Samsung Electronics, Sony, STMicroelectronics, Staccato Communications, Texas Instruments and Wisair.

Inside the Specification

The Wireless USB specification [3] defines a short-range (approximately 10-meter range) wireless replacement for the present wired USB interface. With a data rate of 480 Mb/s at 3 meters, the wireless system is essentially the same as USB 2.0. At 10 meters, the data rate is estimated to be 110 Mb/s, subject to local conditions that affect transmission.

The UWB radio portion of the specification uses the spectrum approved by the FCC in 2002 that includes three 528 MHz wide channels centered at 3.432, 3.960 and 4.488 GHz (Figure 1). The FCC limit (indoor) for UWB

emissions is -41.3 dBm/MHz.

The architecture of Wireless USB is a classic hub-and-spoke, where the host (the user's PC) communicates directly with up to 127 USB devices. Communications with each device is scheduled to simplify the management of communications with multiple devices.

The physical layer (PHY)—the radio portion and its interfaces—is defined by the MB-OFDM specification [4]. The PHY supports data rates of 53.3, 106.7 and 200 Mb/s (required) and 80, 160, 320, 400 and 480 Mb/s (optional). Wireless USB hosts must support the same data rates for both transmit and receive.

The PHY defines all hardware interfaces, such as the types of connectors and pin function assignments, as well as the radio functions, including modulation type, frequencies of operation, power control, and other characteristics that must be part of the baseband-TX-propagation-RX-baseband chain.

A typical OFDM transmit chain is shown in Figure 2. Note that, as a time-domain based transmission method, UWB uses inverse-FFT in the transmitter and FFT in the receiver. These processes have the additional benefit of easily handling narrowband interference—either

received or transmitted. Using FFT techniques, a single-frequency can be eliminated (“notched”) with minimal effect on the transmission quality.

Wireless USB Radio Design

Most of the Wireless USB radio will be incorporated into a single CMOS integrated circuit. While this will reduce an engineer's time for radio design, significant issues still must be addressed, related to UWB's wide bandwidth and operation at microwave frequencies.

The bandwidth, along with the time domain nature of the UWB signal, requires careful board layout. Even with a reference design from the IC manufacturer, there are a number of subtle layout factors that can be overlooked, especially by engineers who may be more familiar with digital design than microwave circuits.

Ideally, circuit board traces will be impedance-matched to the devices, maintaining that impedance with consistent manufacturing tolerances and proper microwave layout. Balanced circuits are often used for applications like this, so it is essential to maintain consistent spacing of the traces and symmetry with respect to the surrounding circuitry.

Bias resistors and test points are

often connected to signal traces. Designers must scrupulously avoid creating stubs. For example, bias or sampling resistors should connect directly to the trace without using a “tee” junction that introduces a major discontinuity in the signal transmission path.

Also, the underlying ground plane should be continuous, since it is part of the transmission line. Gaps and slots in the ground plane beneath the traces introduce resonances and impedance “bumps” that can greatly affect the integrity of the signal.

Finally, areas around connectors or the antenna attachment point are potential trouble spots, since the mechanical transition can also result in electrical discontinuity. A common problem is separating parallel conductors, creating an open space or “loop.” Like other discontinuities, these loops can cause reflections, radiation or changes in frequency response of the circuit. Maintain conductor sizes and spacing up to the connection point, as close as possible.

Summary

Wireless USB is an excellent fit for UWB technology—short range, high data rate and low cost. But its wide bandwidth and operation at microwave frequencies requires knowledgeable design for its implementation.

References

1. USB Implementers Forum, Inc. information is available at www.usb.org.
2. WiMedia Alliance information is available at www.wimedia.org.
3. The Wireless USB specification, errata and additional information can be downloaded at www.usb.org/wusb.
4. Multiband OFDM Physical Layer Specification (Revision 1.0), January 14, 2005, WiMedia Alliance.
5. Dave Leeper, Intel Corp., “Overview of MB-OFDM,” WiMedia Alliance, 2005.

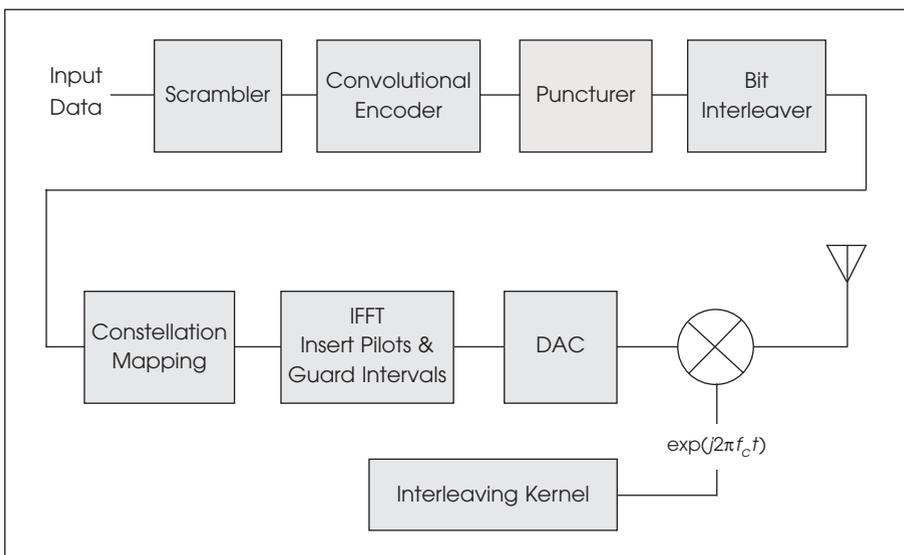


Figure 2 · A typical UWB MB-OFDM transmit chain for Wireless USB (5).