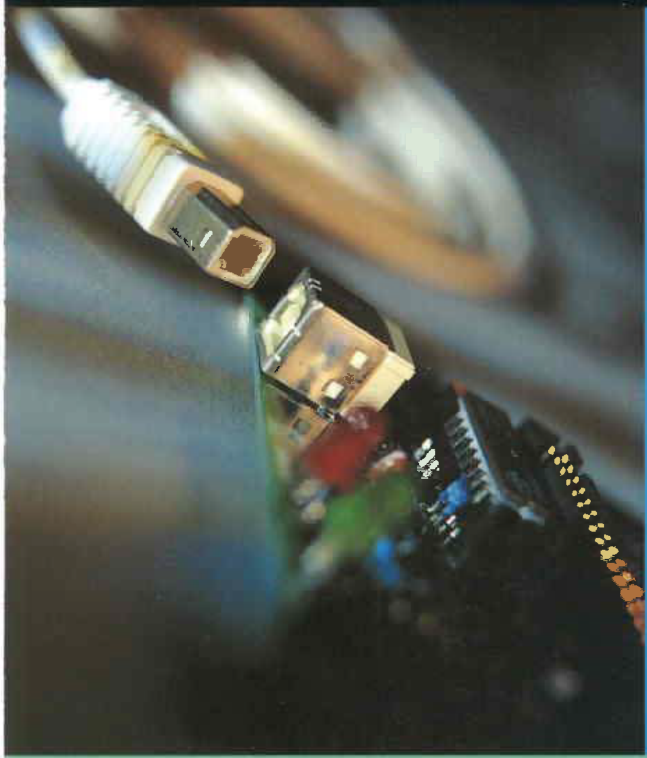
Includes USB 2.0

USB COMPLETE

SECOND EDITION



Everything You Need to Develop Custom USB Peripherals

With firmware tips & host code in Visual Basic and Visual C++

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USB Complete

Everything You Need to Develop Custom USB Peripherals

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later. And some things are repeated because they're important and relevant in more than one place.

The information in these chapters is dense. If you don't have a background in USB, you won't absorb it all in one reading. You should, however, get a feel for how USB works, and will know where to look later when you need to check the details.

The ultimate authority on the USB interface is the specification published by its sponsoring members. The specification document, titled not surprisingly, *Universal Serial Bus Specification*, is available on the USB Implementers Forum's website (*www.usb.org*). However, by design, the specification omits information and tips that are unique to any operating system or controller chip. This type of information is essential when you're designing a product for the real world, so I've included it.

Transfer Basics

You can divide USB communications into two categories, depending on whether they're used in configuring and setting up the device or in the applications that carry out the device's purpose. In configuration communications, the host learns about the device and prepares it for exchanging data. Most of these communications take place when the host enumerates the device on power up or attachment. Application communications occur when the host exchanges data for use with applications. These are the communications that perform the functions the device is designed for. For example, for a keyboard, the application communications are the sending of keypress data to the host to tell an application to display a character.

Configuration Communications

During enumeration, the device's firmware responds to a series of standard requests from the host. The device must identify each request, return requested information, and take other actions specified by the requests.

On PCs, Windows performs the enumeration, so there's no user programming involved. However, to complete the enumeration, Windows must have two files available: an INF file that identifies the filename and location of the device's driver, and the device driver itself. If the files are available and the firmware is in order, the enumeration process is invisible to users.

Depending on the device and how it will be used, the device driver may be one that's included with Windows or one provided by the product vendor. The INF file is a text file that you can usually adapt if needed from an example provided by the driver's provider. Chapter 11 has more details about device drivers and INF files.

Application Communications

After the host has exchanged enumeration information with the device and a device driver has been assigned and loaded, the application communications can be fairly straightforward. At the host, applications can use standard Windows API functions to read and write to the device. At the device, transferring data typically requires placing data to send in the USB controller's transmit buffer, reading received data from the receive buffer, and on completing a transfer, ensuring that the device is ready for the next transfer. Most devices also require additional firmware support for handling errors and other events.

Each data transfer on the bus uses one of four transfer types: control, interrupt, bulk, or isochronous. Each has a format and protocol suited for particular uses.

Managing Data on the Bus

USB's two signal lines carry data to and from all of the devices on the bus. The wires form a single transmission path that all of the devices must share. (As explained later in this chapter, a cable segment between a 1.x device and a 2.0 hub on a high-speed bus is an exception, but even here, all data shares the path between the hub and host.) Unlike RS-232, which has a TX line to carry data in one direction and an RX line for the other direction, USB's pair of wires carries a single differential signal, with the directions taking turns.

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