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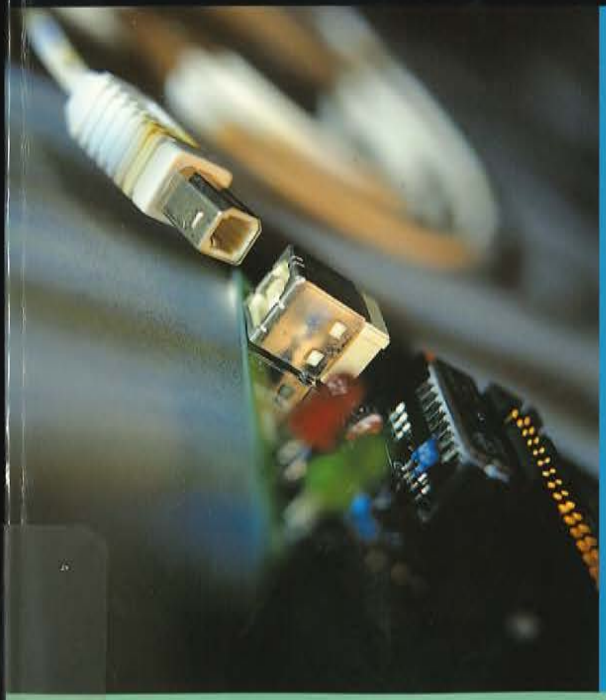

Everything You Need to Develop Custom USB Peripherals

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

IAN AXELSON

USB Complete

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Inside USB Transfers

To design and program a USB device, you need to know a certain amount about the inner workings of the interface. This is true even though the hardware and system software handle many of the details automatically.

This and the next three chapters are a tutorial on how USB transfers data. This chapter has essentials that apply to all transfers. The following chapters cover the four transfer types supported by USB, the enumeration process, and the standard requests used in control transfers.

You don't need to know every bit of this information to get a project up and running, but I've found that understanding something about how the transfers work helps in deciding which transfer types to use, in writing the firmware for the controller chip, and in tracking down the inevitable bugs that show up when you try out your circuits and code.

The USB interface is complicated, and much of what you need to know is interwoven with everything else. This makes it hard to know where to start. In general, I begin with the big picture and work down to the details. Unavoidably, some of the things I refer to aren't explained in detail until

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

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