

# USB COMPLETE



*Everything You  
Need to Develop  
Custom USB  
Peripherals*

No custom drivers needed—use  
the Win32 API and Visual Basic

AXELSON



# USB Complete

**Everything You Need  
to Develop Custom USB Peripherals**

**Jan Axelson**

Lakeview Research  
Madison, WI 53704

*Jianjian Song*

copyright 1999 by Jan Axelson. All rights reserved.  
Published by Lakeview Research  
Cover by Rattray Design. Cover Photo by Bill Bilsley Photography.

Lakeview Research	Phone: 608-241-5824
2209 Winnebago St.	Fax: 608-241-5848
Madison, WI 53704	Email: <a href="mailto:info@lvr.com">info@lvr.com</a>
USA	Web: <a href="http://www.lvr.com">http://www.lvr.com</a>

14 13 12 11 10 9 8 7 6 5 4 3 2

Products and services named in this book are trademarks or registered trademarks of their respective companies. In all instances where Lakeview Research is aware of a trademark claim, the product name appears in initial capital letters, in all capital letters, or in accordance with the vendor's capitalization preference. Readers should contact the appropriate companies for complete information on trademarks and trademark registrations. All trademarks and registered trademarks in this book are the property of their respective holders.

No part of this book, except the programs and program listings, may be reproduced in any form, or stored in a database or retrieval system, or transmitted or distributed in any form, by any means, electronic, mechanical photocopying, recording, or otherwise, without the prior written permission of Lakeview Research or the author, except as permitted by the Copyright Act of 1976. The programs and program listings, or any portion of these, may be stored and executed in a computer system and may be incorporated into computer programs developed by the reader.

The information, computer programs, schematic diagrams, documentation, and other material in this book and the accompanying diskette are provided "as is," without warranty of any kind, expressed or implied, including without limitation any warranty concerning the accuracy, adequacy, or completeness of the material or the results obtained from using the material. *Neither the publisher nor the author shall be responsible for any claims attributable to errors, omissions, or other inaccuracies in the material in this book and the accompanying disc. In no event shall the publisher or author be liable for direct, indirect, special, incidental, or consequential damages in connection with, or arising out of, the construction, performance, or other use of the materials contained herein.*

ISBN 0-9650819-3-1

Manufactured in the United States of America

# 3

## Inside USB Transfers

In order 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 the 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.

USB is complicated, and much of what you need to know is intertwined with everything else. This makes it hard to know where to start. In general, I try to begin with the big picture and work down to the details. Unavoidably, some of the things I refer to won't be 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.

You don't need to know every bit of this information in order 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 will occur when you try out your circuits and code.

The ultimate authority on the USB interface is the specification published by its sponsoring members. The specification document, *Universal Serial Bus Specification*, is available on the USB Implementers Forum's website. However, by design, the specification omits information and tips that are unique to any operating system or controller chip, and this type of information is essential when you're designing a product for the real world.

## Transfer Basics

You can divide USB communications into two types, depending on whether they're used in initial configuration or in applications. 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 applications on the host exchange data with an enumerated device. These are the communications that carry out the device's purpose. 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 or perform other actions.

### 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 the 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

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.