

# **WinDriver V5 User's Guide**

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## WinDriver Overview

*In this Chapter you will explore the uses of WinDriver, and learn the basic steps of creating your driver.*

[Introduction to WinDriver](#)

[Background](#)

[WinDriver Advantages](#)

[WinDriver Feature List](#)

[WinDriver Architecture](#)

[What Platforms does WinDriver Support?](#)

[Can I Try WinDriver Before I Buy?](#)

[Limitations of the different evaluation versions](#)

[How do I develop my Driver with WinDriver? \(Overview\)](#)

[What Does the WinDriver Toolkit Include?](#)

[Can I distribute the driver created with WinDriver?](#)

[Device Driver Overview](#)

[Matching the right tool for your driver](#)

## WinDriver USB Overview

*This chapter explores the basic characteristics of the USB bus and introduces WinDriver USB features and architecture.*

[Introduction to USB](#)

[Feature List](#)

[USB Components](#)

[Data Flow in USB Devices](#)

[USB Data Exchange](#)

[USB Data Transfer Types](#)

[USB Configuration](#)

[WinDriver USB](#)

[WinDriver USB Architecture](#)

[What drivers can I write with WinDriver USB?](#)

## Installation and Setup

*This chapter takes you through the WinDriver installation process, and shows you how to check that your WinDriver is properly installed. The last section discusses the uninstallation procedure.*

[Systems Requirements](#)

[Installing WinDriver](#)

[Upgrading Your Installation](#)

[Checking Your Installation](#)

[Uninstalling WinDriver](#)

## The DriverWizard

[An Overview](#)

[DriverWizard Walkthrough](#)

[DriverWizard Notes](#)

[Remote WinDriver](#)

## Creating Your Driver

*This chapter takes you through the WinDriver driver development cycle.*

**IMPORTANT NOTE:** If your card's PCI bridge is either a PLX, Altera, PLDA, Galileo, QuickLogic, AMCC or V3, then WinDriver's special chip-set APIs dramatically shorten your development time. If this is the case, read the following overview, and jump straight to the chapter discussing this or refer to the electronic reference manual.

[Using the DriverWizard to Build a Device Driver](#)

[Writing the Device Driver without the DriverWizard](#)

[Win CE - Testing on CE](#)

[Using the Help Files](#)

## **Debugging**

*Debugging your hardware access application code should be approached in the manner described in the following sections*

User Mode Debugging  
DebugMonitor



## WinDriver Function Reference

The WinDriver API is available from the user mode and the Kernel Plugin to WinDriver users, and from the kernel mode for KernelDriver users.

Use this Chapter as a quick reference to the WinDriver functions. The definition of the structures used in the following functions may be found in the 'WinDriver Structure Reference' [[WinDriver Structure Reference](#)].

**NOTE:** If you are a registered user, you need to read the file `register.txt` under `windriver/redist/register` or `kerneldriver/redist/register` to understand the process of enabling your driver to work with the registered version.

[WD\\_Open\(\)](#)

[WD\\_Close\(\)](#)

[WD\\_Version\(\)](#)

[WD\\_PciScanCards\(\)](#)

[WD\\_PciGetCardInfo\(\)](#)

[WD\\_PciConfigDump\(\)](#)

[WD\\_PcmciaScanCards\(\)](#)

[WD\\_PcmciaGetCardInfo\(\)](#)

[WD\\_PcmciaConfigDump\(\)](#)

[WD\\_IsapnpScanCards\(\)](#)

[WD\\_IsapnpGetCardInfo\(\)](#)

[WD\\_IsapnpConfigDump\(\)](#)

[WD\\_CardRegister\(\)](#)

[WD\\_CardUnregister\(\)](#)

[WD\\_Transfer\(\)](#)

[WD\\_MultiTransfer\(\)](#)

[WD\\_IntEnable\(\)](#)

[WD\\_IntDisable\(\)](#)

[WD\\_IntWait\(\)](#)

[WD\\_IntCount\(\)](#)

[WD\\_DMALock\(\)](#)

[WD\\_DMAUnlock\(\)](#)

[WD\\_Sleep\(\)](#)

[WD\\_UsbScanDevice\(\)](#)

[WD\\_UsbGetConfiguration\(\)](#)

[WD\\_UsbDeviceRegister\(\)](#)

[WD\\_UsbDeviceUnregister\(\)](#)

[WD\\_UsbTransfer\(\)](#)

[WD\\_UsbResetPipe\(\)](#)

[InterruptThreadEnable\(\)](#)

[InterruptThreadDisable\(\)](#)

## WinDriver Structure Reference

The WinDriver API is available from the user mode and the Kernel Plugin to WinDriver users, and from the kernel mode for KernelDriver users. Use this Chapter as a reference to the structures used by the WinDriver API.

WD\_TRANSFER

WD\_DMA

WD\_DMA\_PAGE

WD\_INTERRUPT

WD\_VERSION

WD\_CARD\_REGISTER

WD\_CARD

WD\_ITEMS

WD\_SLEEP

WD\_PCI\_SLOT

WD\_PCI\_ID

WD\_PCI\_SCAN\_CARDS

WD\_PCI\_CARD\_INFO

WD\_PCI\_CONFIG\_DUMP

WD\_ISAPNP\_CARD\_ID

WD\_ISAPNP\_CARD

WD\_ISAPNP\_SCAN\_CARDS

WD\_ISAPNP\_CARD\_INFO

WD\_ISAPNP\_CONFIG\_DUMP

WD\_PCMCIA\_SLOT

WD\_PCMCIA\_ID

WD\_PCMCIA\_SCAN\_CARDS

WD\_PCMCIA\_CARD\_INFO

WD\_PCMCIA\_CONFIG\_DUMP

WD\_USB\_ID

WD\_USB\_PIPE\_INFO

WD\_USB\_CONFIG\_DESC

WD\_USB\_INTERFACE\_DESC

WD\_USB\_ENDPOINT\_DESC

WD\_USB\_INTERFACE

WD\_USB\_CONFIGURATION

WD\_USB\_HUB\_GENERAL\_INFO

WD\_USB\_DEVICE\_GENERAL\_INFO

WD\_USB\_DEVICE\_INFO

WD\_USB\_SCAN\_DEVICES

WD\_USB\_TRANSFER

WD\_USB\_DEVICE\_REGISTER

WD\_USB\_RESET\_PIPE

## Creating Your Driver Using Jungo's PLX9050 API

*This chapter takes you through the driver development process for the PLX9050 PCI bridge -- Read this chapter only if you are using the PLX9050 PCI bridge.*

[Overview of the Development Process for the PLX9050 Using WinDriver's PLX9050 API](#)

[What is the PLX9050 Diagnostics?](#)

[Using PLX9050 Diagnostics](#)

[Creating the driver project without using the P50\\_DIAG as the skeletal driver code](#)

[WinDriver's PLX9050 API Function Reference](#)

[PLX 9050 API Structure Reference](#)

[Trouble-Shooting](#)

## Creating Your Device Driver Using Jungo's PLX9060 / PLX9080 API

*This chapter takes you through the driver development process for the PLX9060 or PLX9080 PCI bridge - Read this chapter only if you are using the PLX9060 or PLX9080 PCI bridge.*

[Overview of the Development Process for the PLX9060 / PLX9080 Using WinDriver's PLX9060 API](#)

[What is PLX9060 Diagnostics?](#)

[Using PLX9060 Diagnostics](#)

[Creating the Driver Project without using the P60\\_DIAG as the Skeletal Driver Code](#)

[WinDriver's PLX 9060/9080 API Function Reference](#)

[PLX 9060 API Structure Reference](#)

[Trouble-Shooting](#)

## Creating Your Device Driver Using Jungo's AMCC S5933 API

*This chapter takes you through the driver development process for the AMCC S5933 PCI bridge - Read this chapter only if you are using the AMCC S5933 PCI bridge.*

[Overview of the Development Process for the AMCC S5933 Using WinDriver's AMCC API](#)

[What is AMCC Diagnostics?](#)

[Using the AMCC Diagnostics](#)

[Creating the Driver Project without using the AMCCDIAG as the Skeletal Driver Code](#)

[Sample Code](#)

[WinDriver's AMCC S5933 API Function Reference](#)

[AMCC S5933 API Structure Reference](#)

[Trouble-Shooting](#)

## Creating Your Driver Using Jungo's V3 PBC API

*This chapter takes you through the driver development process for the V3 PBC PCI bridge -- Read this chapter only if you are using the V3 PBC PCI bridge.*

[Overview of the Development Process for the V3 PBC using WinDriver's V3 PBC API](#)

[What is V3 PBC Diagnostics?](#)

[Using the V3 PBC Diagnostics](#)

[Creating the Driver Project without using the PBC\\_DIAG as the Skeletal Driver Code](#)

[Sample Code](#)

[WinDriver's V3 PBC API Function Reference](#)

[PCI Configuration Registers Definitions](#)

[Trouble-Shooting](#)

## WinDriver Implementation Issues

*This chapter contains instructions for performing operations that DriverWizard cannot automate. If you are using a PCI chip set from PLX, Galileo, Altera, AMCC, or V3 you do not have to read this chapter.*

WinDriver includes custom APIs built especially for these PCI chip-set vendors. These APIs save you the need to learn both the PCI internals and the chip-set's data sheets. Using these specific APIs a DMA function is as simple as calling a function (i.e. **P9054\_DMAOpen()**, **P9054\_DMAStart()** and so on... ).

[Performing DMA](#)

[Handling Interrupts](#)

[USB Control Transfers](#)

[Performing Control Transfers with WinDriver](#)

## Improving Performance

[Improving performance of your device driver - Overview](#)

[Performance improvement checklist](#)

[Improving the performance of your User Mode driver](#)



## Kernel PlugIn

*This chapter provides you with a brief description of the "Kernel PlugIn" feature of WinDriver.*

Background

Do I need to write a Kernel PlugIn?

What kind of Performance can I expect

Overview of the development process

## **WinDriver Kernel PlugIn Architecture**

*This chapter explains the architectural details of the "Kernel PlugIn" feature of WinDriver.*

[Introduction](#)

[WinDriver Kernel and Kernel Plugin Interaction](#)

[Kernel Plugin Components](#)

[Kernel PlugIn Event Sequence](#)

## Kernel PlugIn - How it works

*This chapter takes you through the development cycle of a Kernel PlugIn. It assumes that you have already written and debugged your entire driver code in the User Mode, and have encountered a performance problem.*

[Minimal Requirements for creating a Kernel PlugIn](#)

[Directory structure and sample for the WinDriver Kernel PlugIn](#)

[Kernel PlugIn implementation](#)

[KPTest -- A sample Kernel PlugIn Driver](#)

[Handling Interrupts in the Kernel PlugIn](#)

[Message passing](#)

## Writing a Kernel PlugIn

The Kernel PlugIn directory (`\windriver\kerplug`) contains a sample Kernel PlugIn driver called `KP_Test`. The sample demonstrates communication between your application (`KPTest.EXE`) and your Kernel PlugIn (`KPTest.VXD` or `KPTest.SYS`).

The easiest way to write a Kernel PlugIn driver is to use this example as the skeletal code for your driver.

The following is a step by step guide to creating your kernel driver. The ***KPTest*** sample code will be used to demonstrate the different stages:

[Determining whether a Kernel PlugIn is needed](#)

[Preparing the User Mode source code](#)

[Creating a new Kernel PlugIn Project](#)

[Creating a handle to the WinDriver Kernel PlugIn](#)

[Interrupt Handling in the Kernel PlugIn](#)

[I/O handling in the Kernel PlugIn](#)

[Compiling your Kernel PlugIn Driver](#)

[Installing your Kernel PlugIn Driver](#)

## Kernel PlugIn Function reference

[User Mode functions](#)

[Kernel functions](#)

## Kernel PlugIn structure reference

User Mode structures

Kernel Mode structures

## Developing in Visual Basic and Delphi

*The entire WinDriver API can be used when developing drivers in Visual Basic and Delphi.*

### **Using DriverWizard**

DriverWizard can be used to diagnose your hardware and verify that it is working properly before you start coding. DriverWizard's automatic source code generator generates code in C and Delphi only. Automatic generation of code in Visual Basic will be supported in later versions of WinDriver.

To create your driver code in C and Delphi, please refer to the "DriverWizard" [The DriverWizard](#) chapter.

### **Samples**

Samples for drivers written using the WinDriver API in Delphi or Visual Basic can be found in :

1. \windriver\delphi\samples
2. \windriver\vb\samples

Use these samples as a starting point for your own driver.

### **Kernel PlugIn**

Delphi and Visual Basic cannot be used to create a Kernel PlugIn. Developers using WinDriver with Delphi or VB in User Mode, must use C when writing their Kernel PlugIn.

### **Creating your Driver**

The method of development in Visual Basic is the same as the method in C except for the automatic code generation feature of DriverWizard.

Your work process should be as follows:

- Use DriverWizard to easily diagnose your hardware and verify that it is working properly.
  - Write your driver code in the User Mode using the WinDriver API. For details and explanations please see Section [Writing the Device Driver without the DriverWizard](#) that explains how to write the device driver without the DriverWizard.
  - The files to be included when developing in VB are:
    1. windrvr.cls
    2. windrvr\_usb.cls
- The files to be included when developing in Delphi are:
  1. windrvr.pas
  2. windrvr\_usb.pas

- You may find it useful to use the WinDriver samples to get to know the WinDriver API and as your skeletal driver code.



## Trouble-Shooting

*To determine and verify the cause of your driver problems Open the DebugMonitor and set your desired trace level. This will help narrow down your debugging process and lead you in the right direction.*

WD\_Open() (or xxx\_Open()) fails.

WD\_CardRegister() fails

Can't open USB device using the DriverWizard

Can't get interfaces for USB devices.

PCI Card has no resources when using the DriverWizard

Computer hangs on interrupt

## Dynamically loading your driver

Windows NT/2000 and 95/98/ME

Linux

Solaris

## Distributing your Driver

*Read this chapter in the final stages of driver development. This chapter guides you in creating your driver package for distribution.*

[Get a valid license for your WinDriver](#)

[Windows 95/98/ME and NT/2000](#)

[Creating a .INF file](#)

[Windows CE](#)

[Linux](#)

[Solaris](#)

[VxWorks](#)

## PC-Based Development Platform Parallel Port Cable Info

To use the parallel port shell utility (Ppsh) to transfer a Windows CE image from your development workstation to a PC-based hardware development platform, a custom parallel cable is required. This cable requires a DB-25 male connector at both ends, with pins mapped as follows:

- 1 - 10
  - 2 - Same
  - 3 - Same
  - 4 - Same
  - 5 - Same
  - 6 - Same
  - 7 - Same
  - 8 - Same
  - 9 - Same
  - 10 - 1
  - 11 - 14
  - 12 - 16
  - 13 - 17
  - 14 - 11
  - 15 - Not connected on either ends
  - 16 - 12
  - 17 - 13
  - 18 - Same
- 19 - Same
  - 20 - Same
  - 21 - Same
  - 22 - Same
  - 23 - Same
  - 24 - Same

- 25 - Same

To order this cable, please contact:

Redmond Cable

15331 NE 90th Street

Redmond, WA 98052

**Telephone:** (425) 882-2009

**Fax:** (425) 883-1430

**Part Number:** 64355913

## **Limitations on demo versions**

### **Windows 95/98/ME and NT/2000**

- A DEMO MESSAGE will appear at every first use of WinDriver in each session.
- WinDriver will function for only 30 days after the original installation.

### **Windows CE**

- A DEMO MESSAGE will appear at every first use of WinDriver in each session.
- The WinDriver CE Kernel (windrvr.dll) will operate for no more than 30 minutes at a time.
- WinDriver CE emulation on Windows NT will stop working after 30 days.

### **Linux**

- The Linux Kernel will work for no more than 30 minutes at a time.

### **Solaris**

- The Solaris Kernel will work for no more than 30 minutes at a time.

### **VxWorks**

- The VxWorks Kernel will work for no more than 30 minutes at a time.

### **DRIVERWIZARD GUI**

- An evaluation dialog pops up whenever you attempt to interact with the hardware.

## Version history list

### New in Version 2.02

- Header files can now be compiled under Borland C/C++ compiler.
- Anonymous unions were changed in structures WD\_TRANSFER and WD\_CARD.

### New in Version 2.10

- For memory mapped cards, changed item dwUserAddr to dwTransAddr.
- Use dwTransAddr when calling WD\_Transfer().
- Added dwUserDirectAddr for direct memory transfers without calling WD\_Transfer().
- dwUserDirectAddr NOT YET IMPLEMENTED.

### New in Version 2.11

- For PCI cards: Structure used for calls to WD\_PciScanCards() was changed.
- Use pciScan.searchId.dwVendorId and pciScan.searchId.VendorId and the same for dwDeviceId.

### New in Version 2.12

- For memory mapped cards: you can now directly access the memory region, without calling WD\_Transfer().
- The pointer to the memory region is returned in dwUserDirectAddr by WD\_CardRegister().
- DMA transfers: DMA contiguous buffer allocation by WinDriver is available by setting dwOptions = DMA\_KERNEL\_BUFFER\_ALLOC, when calling WD\_DMALock().
- The linear address of the buffer allocated will be returned in pUserAddr, and the physical address in Page[0].
- The buffer is available till WD\_DMAUnlock() is called.

### New in Version 3.0

- Added DriverWizard to the package. DriverWizard enables the programmer to 'talk' and 'listen' to his card via a windows user-interface. DriverWizard then creates the source code for the driver.
- DMA option DMA\_LARGE\_BUFFER added for locking regions larger than 1MB.
- Removed limitation of 20 concurrent DMA buffers in use.

### **New in Version 3.01**

- Support for Win98/ME and Windows 2000

### **New in Version 3.02**

- Minor improvements in DriverWizard
  - Supports Windows NT checked build

### **New in Version 3.03**

- Enhanced support for Multi-CPU Multi-PCI bus
  - Corrected the interrupt count value returned by WD\_IntWait().

### **New in Version 4.0**

- WinDriver Kernel PlugIn - allows running parts of the driver code from the Kernel Mode.
  - Sleep function - For accessing slow hardware.
  - ISA Plug and Play support.
  - Debug monitor - Allows tracking of errors, warnings and trace messages from the WinDriver's kernel module.
    - Dynamic driver loader - WinDriver enables the driver created to be loaded and unloaded without rebooting the machine.
    - Enhanced source code generation for interrupts - DriverWizard creates full interrupt source code.
- PLX 9050 library enhancements - EEPROM read/write support functions and Enhanced interrupt handling.

### **New in Version 4.1**

- New support for Linux, and Windows CE.
  - Support for ISA PnP cards.
  - Support for PCMCIA cards in Windows CE.
  - Graphical KernelTracer introduced.
  - Robust support for Delphi and VB (Visual Basic). More Delphi and VB samples.
  - New support for the PLX 9054 and 9080 chipsets. Support includes EEPROM access and bus master DMA implementation.



- Support for Galileo GT64 chipsets.
- Includes The Enhanced DriverWizard.
  - Automatic Vendor and Device detection.
  - Automatic handling and code generation for Level sensitive interrupts.
  - Wizard allows multiple concurrent register and memory dialogs.
  - Improved GUI.

#### **New in Version 4.14**

- ISA PnP support
  - Wizard can generate Kernel Code, supported by KernelDriver.
  - Wizard generates Borland CBuilder Ver 3 and Ver 4 make files.
  - PLX 9052 support.
  - PLX 9054 and 9080 added DMA function enabling non-busy wait for DMA to complete.
  - Added WD\_VB\_GetAddress() for VB to get an address of a variable.
  - Overcome Windows NT inability to map addresses at the end of physical memory (???-0xffffffff)
- Fixed 9054 and 9080 EEPROM access and corrected register names.
  - WD\_VERSION structure correction in Delphi.
  - Fixed interrupt handling in Windows CE.
  - Fixed WD\_PciGetCardInfo() on Windows 98 / ME.
  - Fixed Wizard Halting after interrupt is disabled.

#### **New in Version 4.20**

- Wizard now also generates driver code in Delphi.
  - Enhanced support for Altera PCI cores.
  - Automatic generation of INF file for windows 95/98/ME.
  - Wizard generates makefiles simultaneously for all operating systems and IDEs chosen by the user.
  - All samples include makefiles for all supported IDEs.
  - Debug Monitor is now integrated into the Wizard environment.

- GUI enhancements in the Driver Wizard.
- The default when adding new ISA interrupts in Wizard is now sharable interrupts.
  - Contiguous DMA also for Linux 2.2 (only 2.0 was supported previously).
  - Fixed Scatter / Gather DMA in Windows 98/ME.
  - Unix make files: Fixed DOS slashes.

### **New in Version 4.30**

- USB support in WinDriver.
  - Wizard enables programmers to detect their USB devices and select the desired configuration.
  - Wizard enables USB hardware testing (read, write and listen to pipes).
  - Wizard generates USB driver source code in C\C++ or Delphi.
  - Wizard generates .INF file for USB devices for Windows 98/ME/2000 (as well as for PCI devices).
  - WinDriver's Kernel PlugIn supports all WinDriver USB APIs.
- WinDriver's Kernel PlugIn supports also Solaris and Linux, assures optimal performance for all supported operating systems and full code compatibility among all supported operating systems.
  - In version 4.3 WinDriver and KernelDriver are integrated into one driver development suite.
  - KernelDriver now also supports Windows 95/98/ME (VxD. Drivers).
  - KernelDriver now also supports Linux.
  - USB support in KernelDriver API is available now also in C in KernelDriver for Windows NT/2000 (previously only in C++).
- GUI enhancements: Registers can now be defined as auto-read.
  - Wizard includes pre-defined resources for parallel port which enable quick access to the port.
  - Fixed: WD\_DMAUnlock() with KERNEL\_BUFFER\_ALLOC on Windows NT and Linux.
  - WD\_IntWait(): Can now terminate applications waiting on IntWait without locking machine.

### **New in version 4.31**

- USB support: Improved performance of bulk transfer and isochronous transfer.
  - Major improvements in handling interrupts in Visual Basic.
  - Interrupt handling sample in Visual Basic is now available.
  - New graphical sample in Visual Basic for accessing the parallel port.
  - VxD files generated with KernelDriver or with 'WinDriver Kernel PlugIn' now communicate with windrvr.sys on Windows 98/ME.
  - Fix: interrupt handling on Windows 98/ME, WindowsNT/2000 (bug only in V4.30).
- Fix: WD\_DMAUnlock() on Windows 98/ME, WindowsNT/2000 (bug only in V4.30).
  - Fix: error message when installing USB INF file on Windows 2000.

#### **New in version 4.32**

- Name change: The company name has been changed from KRFTech to Jungo.
  - New feature: supports USB devices with multiple interfaces.
  - Major improvement in WinDriver for Solaris: The PCI scan is now performed faster, and we eliminated abnormally long scan times on AXi boards.
  - Improvement in WinDriver USB: Isoch transfer auto adjust are better capable of overcoming failures in transfers.
  - Improvement in WinDriver USB: Supports multiple interfaces.
- Fix: On Windows 95/98/ME, non-sharable edge-triggered interrupts were in some cases received only once.
  - Fix: On WinNT/98/ME (SYS) and Solaris, resources were not released on abnormal termination.
  - Fix: WinDriver USB would display a message "duplicate object name" after installation.
  - Fix: In WinDriver USB, A Device can now be stopped.
  - Fix: In WinDriver USB, No more report error in short USB transfers and transfer of size 0.
- Fix: In WinDriver for Linux, Installation fixes on Linux 2.0.kernel.
  - Fix: In Wizard, Saving INF file without an extension can now be done without causing problems.
  - Fix: In WinDriver for Solaris, Interrupts are now acknowledged by default which prevents sys log overflow and lock ups.

- Fix: In KernelDriver, WinNT samples and the generated code can now be compiled currently using the build utility.

### **New in Version 4.33**

- New feature: On WinNT enabled access to additional PCI devices that are not accessible by Windows.
  - New feature: On Windows2000 added support to service pack 1.
  - New feature: On Windows2000 added the capability to generate Windows 2000 INF file for PCI devices. INF file and PnP service is required for PCI cards on Windows2000.
  - New feature: In WinDriver for Solaris(Sparc), added support for Ultra 220, Ultra 450, CP1500 and CP1400.
- New feature: In WinDriver for Solaris, enabled abnormal application termination.
  - Fix: In WinDriver and KernelDriver, fixed the crash that occurred when WD\_DMAUnlock() was called from Kernel PlugIn and KernelDriver.
  - Fix: In WinDriver USB, WD\_USB\_MAX\_DEVICE\_NUMBER changed from 20 to 127. This requires programs to be recompiled.
  - Fix: On Windows eliminated crashes that resulted from the Delphi code for PCI interrupts that was generated by the wizard.
- Fix: On Windows2000 corrected computation of interrupt slot number.
  - Fixed Interrupt related bugs that caused system hang.
  - Fix: On Windows2000 fixed crashes that occurred when USB user write buffer is declared as const void \* in user mode code.
  - Fix: In WinDriver for Linux, fixed Kernel PlugIn for registered version.
  - Fix: In WinDriver for Linux, fixed compilation warning about undeclared function int close(int).
- Fix: In WinDriver for Linux, removed extra license check which broke the registered version of KernelPlugIn.
  - Fix: In WinDriver for Solaris, fixed memory leak in abnormal application termination.
  - Fix: In WinDriver for Solaris, fixed crash on WD\_KernelPlugInOpen().
  - Fix: In WinDriver for Solaris(Sparc), shortened scan of PCI bus from 40 seconds to 1-2 seconds.
  - Fix: In WinDriver for Solaris(Sparc), fixed PCI interrupt handling for shared PCI interrupts and cards behind PCI bridges.

### **New in Version 4.34**

- Fix: Eliminated application crashes when listening repeatedly (listen/stop listening/listen) to ISA interrupts on Windows 95/98. For example, through the Wizard.
- Fix: Corrected shared interrupt acknowledgment when WinDriver user mode program is forcibly terminated.
- Enhancement: Windows 98, Kernel PlugIn user mode sample program - Added a new comment to usermode.c advising users not to use long file names.
- Fix: Corrected Windows 95/98 and NT kernel plugin libraries that gave linkage errors on 4.33.
- Fix: The file windrvr\_ce\_emu.lib was missing from the 4.33 package.
- Fix : Fixed crashes on Solaris 8 that occurred when calling WD\_CardRegister()

### **New in Version 5.0**

- New feature: Added a Graphical User Interface (GUI) to WinDriver for Linux and WinDriver for Solaris.
- New feature: A Remote Access feature is incorporated into the WinDriver Wizard. Remote Host capability is currently supported on Windows NT/2000, Linux and Solaris. Remote Target capability is supported on Windows 95/98/ME/NT/2000/CE, VxWorks, Solaris and Linux.
- New feature: The evaluation timeout per session on Linux/Solaris/VxWorks/WinCE is increased to 30 minutes.
- New feature: The electronic documentation (PDF) now has thumbnails, bookmarks, and cross-reference hyperlinks in the references sections. HLP (WinHelp) files have cross reference hyperlinks. CHM format documentation is included with Windows versions; HTML format documentation is included with Unix versions.
- Fix: For DriverWizard, several fixes have been incorporated in the file saving process and in reading from the registry.
- Fix: The INF files generated by DriverWizard under Windows 2000 now comply with MS recommendations for Windows 2000.

- Enhancement: DriverWizard Wizard for Windows allows choosing between WinDriver and KernelDriver help files when invoked.
  
- Fix: KernelDriver USB generates C and C++ SYS files for Windows 2000.

## Purchasing WinDriver

Choose the WinDriver product that suits your needs:

- Choose '**WinDriver**' for NT/2000 or 95/98 support.
  - Choose '**WinDriver Bundle**' for Windows NT/2000 and 95/98 support (no re-writing or re-compiling needed).
  - Choose '**WinDriver CE**' for Windows CE support.
  - Choose '**WinDriver Linux**' for Linux support.
  - Choose '**WinDriver ToolBox**' to receive all the above operating systems support in one package. The driver you develop will run under all supported environments.

in the order form found in '**Start | WinDriver | Order Form**' on your Windows start menu, and send it back to Jungo via email/fax/mail (see details below).

Your WinDriver package will be sent to you via Fedex / Postal mail. The WinDriver license string will be emailed to you immediately.

### E - M A I L

**Support:** support@jungo.com

**Sales:** sales@jungo.com

**Services:** services@jungo.com

### P H O N E / F A X

**Phone:**

**USA (Toll-Free):** 1-877-514-0537

**Worldwide:** +972-9-8859365

**Fax:**

**USA (Toll-Free):** 1-877-514-0538

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**W E B:**

Jungo <http://www.jungo.com>

### P O S T A L A D D R E S S

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Netanya 42504,

ISRAEL

## Distributing your driver - legal issues

*WinDriver is licensed per-seat. The WinDriver license allows one developer on a single computer to develop an unlimited number of device drivers, and to freely distribute the created driver without royalties, as outlined in the license agreement below.*

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## Introduction to WinDriver

WinDriver is a device driver development toolkit that dramatically simplifies the very difficult task of developing a device driver. The driver you develop using WinDriver is source code compatible between all supported operating systems (WinDriver currently supports Windows 95/98/ME/NT/2000/CE, Linux, Solaris, VxWorks and OS/2.). It is binary compatible between Windows 95, 98, ME, NT and 2000. Bus architecture support includes PCI/PCMCIA/ ISA/ISA PnP/EISA/CompactPCI and USB. WinDriver provides a complete solution for creating high performance drivers, which handle interrupts and I/O at optimal rates.

Don't let the size of this manual fool you -- WinDriver makes developing device drivers an easy task that takes hours instead of months. Most developers will find that reading this chapter and glancing through the DriverWizard and function reference chapters is all they need to successfully write their driver.

The major part of this manual deals with the features that WinDriver offers to the advanced user.

WinDriver supports all PCI bridges, from all vendors. Enhanced support is offered for the **PLX / Altera / Galileo / QuickLogic / PLDA / AMCC** and **V3** PCI chips. A special chapter is dedicated to developers of PCI card drivers who are using PCI chips from these vendors. The last several chapters of this manual explain how to tune your driver code to achieve optimal performance. The "Kernel PlugIn" feature of WinDriver is explained there. This feature allows the developer to write and debug the entire device driver in the User Mode, and later 'drop' performance critical parts of it into the Kernel Mode. Therefore, the driver achieves optimal Kernel Mode performance, with User Mode ease of use.

Please check Jungo's web site at <http://www.jungo.com> for the latest news about WinDriver and other driver development tools that Jungo offers.

Good luck with your project!

## Background

In protected operating systems (such as Windows, Linux, Solaris and OS/2), a programmer cannot access hardware directly from the application level (the "User Mode") where development work is usually done. Hardware access is allowed only from within the operating system itself (the "Kernel Mode" or "Ring 0"), by software modules called "Device Drivers". In order to access a custom hardware device from the application level, a programmer must do the following:

1. Learn the internals of the operating system he is working on (95/98/ME/NT / CE / Linux / Solaris... )
2. Learn how to write a device driver.
3. Learn new tools for developing/debugging in the Kernel Mode (DDK, ETK, DDI/DKI )
4. Write the Kernel Mode device driver that does the basic hardware input / output.
5. Write the application in the User Mode, which accesses the hardware through the device driver written in the Kernel Mode.
6. Repeat the first four steps for each new operating system on which the code should run.

## WinDriver Advantages

*Easy development* - WinDriver enables Windows programmers to create **PCI/PCMCIA/ISA/ISA PnP/EISA/CompactPCI and USB** based device drivers in an extremely short time. WinDriver allows you to create your driver in the "User Mode" in the familiar environment - using MSDEV, Visual C/C++, Borland Delphi, Borland C++, Visual Basic, GCC or any other 32-bit compiler. WinDriver eliminates the need for you to be familiar with the operating system internals, kernel programming or with the DDK,ETK,DDI/DKI or have any device driver knowledge.

*Cross Platform* - The driver created with WinDriver will run on **Windows 95/ 98/ME/NT/2000/CE, Linux, Solaris, VxWorks and OS/2**, - i.e. write once - run on any of these platforms.

*Friendly Wizards* - DriverWizard (included) is a **graphical** diagnostics tool that lets you write to, and read from the hardware, before writing a single line of code. With a few clicks of the mouse, the hardware is diagnosed - memory ranges are read, registers are toggled and interrupts are checked. Once the device is operating to your satisfaction, DriverWizard creates the skeletal driver source code, giving access functions to all the resources on the hardware.

*Kernel Mode Performance* - WinDriver's API is optimized for performance. For drivers that need kernel mode performance, WinDriver offers the "Kernel PlugIn". This powerful feature enables you to create and debug your code in the user mode, and run the performance critical parts of your code, (such as the interrupt handler, or access to I/O mapped memory ranges), in kernel mode, thereby achieving kernel mode performance (zero performance degradation).

This unique feature allows the developer to run the user mode code in the OS kernel without having to learn how the kernel works. When working with Windows CE or VxWorks, there is no need to use the Kernel PlugIn since Windows CE and VxWorks have no separation between user mode and kernel mode. This enables you to achieve optimal performance from the user mode code.

### How fast can WinDriver go?

Using the WinDriver Kernel PlugIn you can expect the same throughput of a custom Kernel Driver. You are confined only by your operating system and hardware limitations. A ballpark figure of the throughput you can reach using the Kernel PlugIn would be about 100,000 interrupts per second.

User Mode ease - Kernel Mode performance!

To conclude -- using WinDriver, all a developer has to do to create an application that accesses the custom hardware is:

1. Start DriverWizard and detect the hardware and its resources.
2. Automatically generate the device driver code from within DriverWizard.
3. Call the generated functions from the User Mode application.

The new hardware access application now runs on all Windows platforms (including CE), on Linux, on Solaris, on VxWorks and on OS/2 (just recompile).

## WinDriver Feature List

- Easy User Mode driver development.
  - Kernel PlugIn for high performance drivers.
  - Friendly DriverWizard allows hardware diagnostics without writing a single line of code.
  - DriverWizard automatically generates the driver code for the project in C\C++ or Delphi (Pascal).
  - Supports any PCI/PCMCIA/ISA/ISA PnP/EISA/CompactPCI and USB device regardless of manufacturer.
  - Enhanced support for the PLX 9030/9050/9052/9054/9060/9080/IOP 480, Altera, Galileo, QuickLogic, PLDA, V3 and AMCC PCI bridges, thereby hiding the PCI bridge details from the developer.
- Applications are binary compatible across Windows 95,98,ME,NT and 2000.
  - Applications are source code compatible across Windows 95, 98, ME, NT, 2000, CE, Linux, Solaris, VxWorks and OS/2.
  - WinDriver can be used with common development environments including MSDEV, Visual C/C++, Borland Delphi, Borland C++, Visual Basic, GCC or any other 32 compiler.
  - No DDK, ETK, DDI or any system-level programming knowledge is required.
- Detailed examples in C, Delphi and Visual Basic are included.
  - Supports I/O, DMA, Interrupt handling and access to memory mapped cards.
  - Supports multiple CPU and multiple PCI-bus platforms.
  - Includes Dynamic Driver Loader.
  - Comprehensive documentation and help files.
  - Four months of free technical support.
  - No run time fees or royalties.

### Notes

1. PCMCIA is only supported in the Windows CE version.



## WinDriver Architecture

### WinDriver Architecture

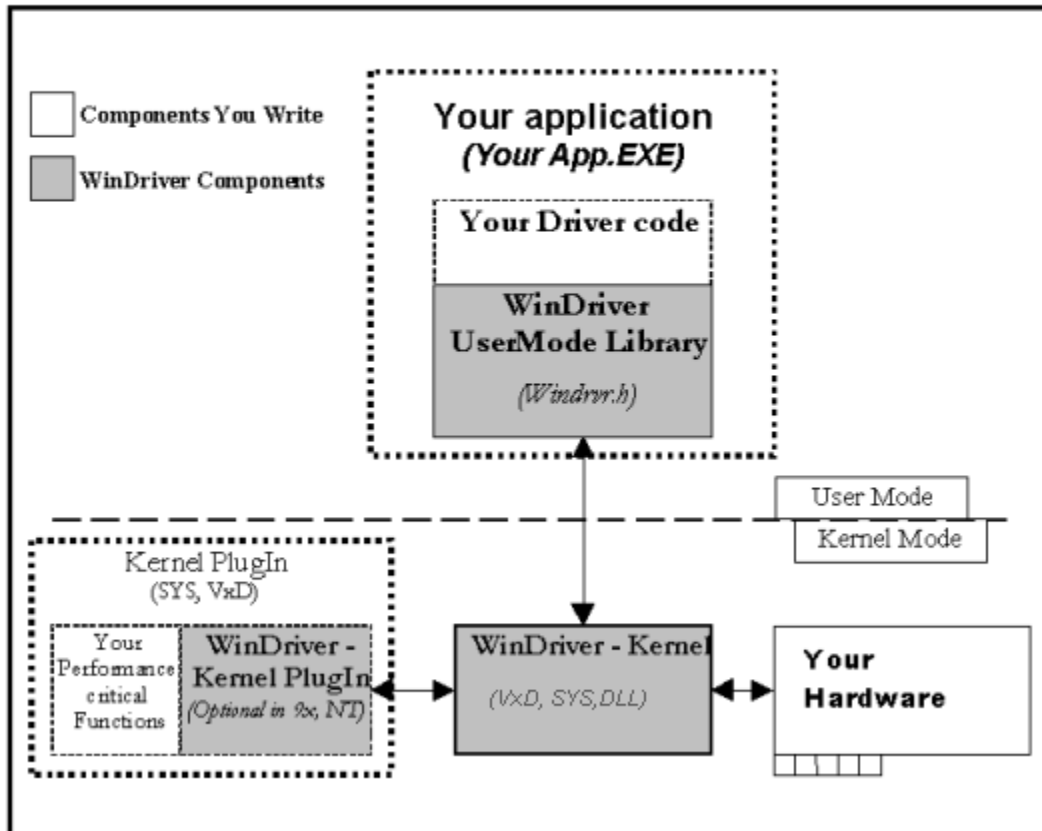


Figure 1.1: WinDriver Architecture

For hardware access, your application calls one of the WinDriver functions from the WinDriver User Mode library (`windrvr.h`). The User Mode library calls the WinDriver Kernel, which accesses the hardware for you, through the native calls of the operating system.

WinDriver's design minimizes performance hits on your code, even though it is running in the User Mode. However, some hardware drivers need performance, which cannot be achieved from the User Mode. This is where WinDriver's edge sharpens - after easily creating and debugging your code in the User Mode, you may 'drop' the performance critical modules of your code (such as a hardware interrupt handler) into the WinDriver Kernel PlugIn without changing a single line of it. Now, WinDriver Kernel calls this module from the Kernel Mode, thereby achieving maximal performance. This allows you to program and debug in the User Mode, and still achieve kernel performance where needed. In **Windows CE and VxWorks** there is no separation between User Mode and Kernel Mode, therefore you may achieve optimal performance directly from the user mode, eliminating the need to use the Kernel PlugIn in this OS.

## **What Platforms does WinDriver Support?**

WinDriver supports Windows 95/98/ME/NT/2000/CE, Solaris, VxWorks, OS/2 and Linux. The same source code will run on all supported platforms. The same executable you write will operate on Windows 95, 98, ME, NT and 2000. Even if your code is meant only for one of these operating systems, using WinDriver will give you the flexibility of moving your driver to the other operating system without changing your code.

## **Can I Try WinDriver Before I Buy?**

Yes! Evaluation versions of WinDriver for all supported operating systems and buses are available at the Jungo web site at <http://www.jungo.com/dnload.html>

## Limitations of the different evaluation versions

All the evaluation versions of WinDriver are full featured. No functions are limited or crippled in any way. The following is a list of the differences between the evaluation versions and the registered ones:

- At first use of the driver, an 'unregistered' message appears.
  - A dialog box with a message stating that an evaluation version is being run , is popped up on every interaction with the hardware.
  - In the Linux, Solaris, VxWorks and CE versions - The driver is operational for 30 minutes after which it has to be restarted.
  - The Windows evaluation version expires 30 days from the date of installation.

## **How do I develop my Driver with WinDriver? (Overview)**

[On Windows 95, 98, ME, NT and 2000](#)

[On Windows CE](#)

[On Linux and Solaris](#)

[On Embedded Operating Systems](#)

## What Does the WinDriver Toolkit Include?

- The WinDriver CD.
  - A printed version of this manual.
  - Four months of free technical support (Phone - Fax - Email).
  - The WinDriver CE license enables you to run your CE driver code on your NT machine via the CE emulation.
  - The WinDriver Linux and Solaris licenses enable you to use DriverWizard on your Windows machine to diagnose your hardware and automatically generate your driver skeletal code. You may then compile and run the code created on your Linux/ Solaris machine. The code will not run on your Windows machine without WinDriver for Windows licensing.

The following modules are included in your WinDriver toolkit:

WinDriver Modules

Utilities

WinDriver's SPECIFIC CHIP-SET SUPPORT

Samples

## Can I distribute the driver created with WinDriver?

Yes. WinDriver is purchased as a development toolkit, and any device driver created using WinDriver may be distributed royalty free in as many copies as you wish. See the license agreement (`\\windriver\docs\license.txt`) for more details.

## Device Driver Overview

The following is an overview of the common types of device driver architectures:

Monolithic Drivers

Windows 95/98/ME Drivers

NT Driver Model

Unix Device Drivers

Linux Device Drivers

Solaris Device Drivers



## Matching the right tool for your driver

Jungo offers two driver development products lines: WinDriver and KernelDriver. WinDriver is a tool designed for monolithic type user mode drivers. WinDriver enables you to access your hardware directly from within your Win32 application, without writing a kernel mode device driver. Using WinDriver you can either access your hardware directly from your application (in user mode) or write a DLL that you can call from many different applications.

WinDriver also provides a complete solution for high performance drivers. Using WinDriver's **Kernel Plugin**, you can 'drop' your user mode code into the kernel and reach full kernel mode performance.

A driver created with WinDriver runs on **Windows 95, 98, ME, NT, 2000, CE, Linux, Solaris, VxWorks and OS/2**. Typically, a developer without any previous driver knowledge can get a driver running in a matter of a few hours (compared to several weeks with a kernel mode driver).

There are situations that require drivers to be running in the kernel mode. Network drivers under Linux and Windows for example, almost always need to reside in the kernel. In addition under Windows NT, for layered or miniport drivers, kernel programming is necessary. To simplify this difficult task, Jungo provides "KernelDriver" - a tool kit for writing kernel mode drivers for Windows platforms (95/98/ME/NT/2000) and Linux. In addition, KernelDriver has special support for NT/2000 - a C++ toolkit that provides classes that encapsulate thousands of lines of kernel code, enabling you to focus on your driver's added-value functionality, instead of your OS internals.

## Introduction to USB

USB, short for *Universal Serial Bus*, is a new industry-standard extension to the PC architecture, for attaching peripherals to the computer. The Universal Serial Bus was originally developed in 1995 by leading PC and telecommunication industry companies, such as Intel, Compaq, Microsoft and NEC. The motivation for the development of USB, was fueled because of several considerations. Among them are the needs for an inexpensive and widespread connectivity solution for peripherals in general and for the "Computer Telephony Integration" in particular, the need for an easy to use and flexible method of reconfiguring the PC and a solution for adding a large number of external peripherals.

The USB interface meets the needs stated above. A single USB port can be used to connect up to 127 peripheral devices. USB also supports Plug-and-Play installation and hot swapping. USB 1.1 supports both isochronous and asynchronous data transfers and has dual-speed data transfer; 1.5Mbps (Megabit per second) for low-speed USB devices and 12Mbps for high-speed USB devices (much faster than the original serial port). Cables connecting the device to the PC can be up to five meters (16.4 feet) long. USB includes built-in power distribution for low power devices, and can provide limited power (maximum: 500mA of current) to devices attached on the bus.

Because of these benefits, USB is enjoying broad market acceptance today.

The next generation (USB2.0) supports a faster signalling rate of 480 Mb/S that is 40 times faster than USB 1.1. USB2.0 is fully forward and backward compatible with USB1.1 and uses the existing cables and connectors.

USB2.0 supports a connection for higher bandwidth, higher functionality PC peripherals. In addition, it has the capability to handle more simultaneously running peripherals.

USB2.0 will benefit many applications like Interactive Gaming, Broadband Internet Access, Desktop and Web Publishing, Internet Services and Conferencing.

## Feature List

- External connection; easy to use for the end user.
- Self-identifying peripherals, automatic mapping of function to driver, and configuration.
- Dynamically attachable and re-configurable peripherals.
- Suitable for device bandwidths ranging from a few Kb/s to several Mb/s.
- Supports isochronous as well as asynchronous transfer types over the same set of wires.
- Supports simultaneous operation of many devices (multiple connections).
- Supports up to 127 devices.
- Guaranteed bandwidth and low latencies; appropriate for telephony, audio, etc. (Isochronous transfer may use almost entire bus bandwidth).
- Flexibility: Supports a wide range of packet sizes and a wide range of data rates.
- Robustness: Error handling mechanism built into protocol, dynamic insertion and removal of devices identified in user observed real-time.
- Synergy with PC industry.
- Optimized for integration in peripheral and host hardware.

- Low-cost implementation, therefore suitable for development of low-cost peripherals.
- Low-cost cables and connectors.
- Uses commodity technologies.
- Built in power management and distribution.

## **USB Components**

*USB Host:* The USB host computer is where the USB host controller is installed, and where the client software / device driver runs. The USB host controller is the interface between the host and the USB peripherals. The host is responsible for detecting attachment and removals of USB devices, managing the control and data flow between the host and the devices, providing power to attached devices and more.

*USB Hub:* A USB device that enables connecting additional USB devices to a single USB port on the USB host. Hubs on the back plane of the hosts are called root hubs. Other hubs are external hubs.

*USB Function:* The USB device that is able to transmit or receive data or control information over the bus, and provides a function. Compound devices provide multiple functions on the USB bus.

## Data Flow in USB Devices

During the operation of the USB device, data flows between the client software and the device. The data is moved between memory buffers of the software on the host and the device, using pipes, which end in endpoints on the device side.

An endpoint is a uniquely identifiable entity on the USB device, which is the source or the terminus of the data that flows from or to the device. Each USB device, logical or physical, has a collection of independent endpoints. Endpoint attributes are their bus access frequency, their bandwidth requirement, their endpoint number, their error handling mechanism, the maximum packet size that the endpoint can transmit or receive, their transfer type and their direction (into the device / out of the device).

Pipes are logical components, representing associations between an endpoint on the USB device and software on the host. The data is moved to and from the device 'through' a pipe. A pipe can be of two modes: stream pipe and message pipe, according to the type of data transfer used in that pipe. Pipes, sending data in interrupt, bulk or isochronous types are stream pipes, while control transfer type is supported by the message pipes. The different USB transfer types are discussed below:

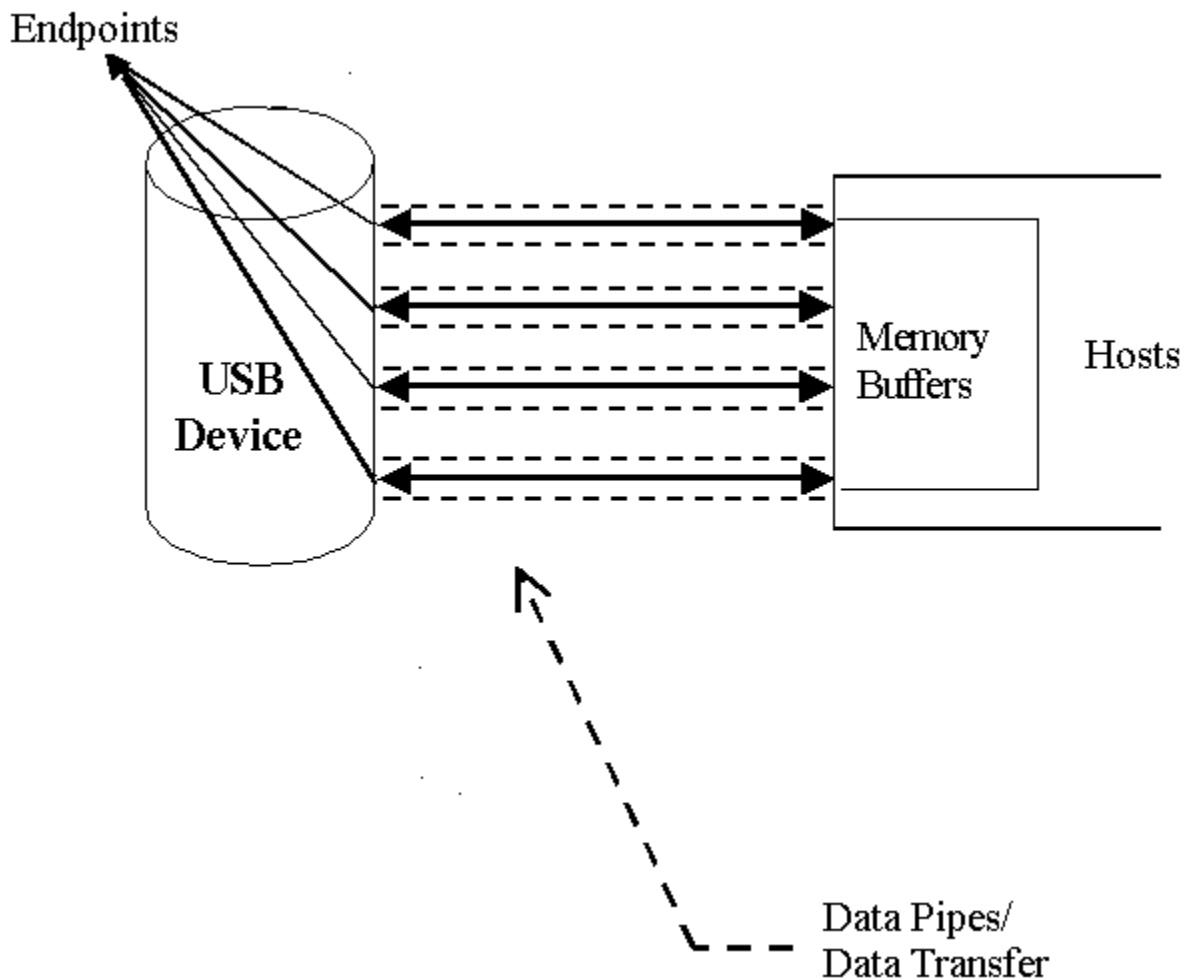


Figure 2.1: USB Endpoints



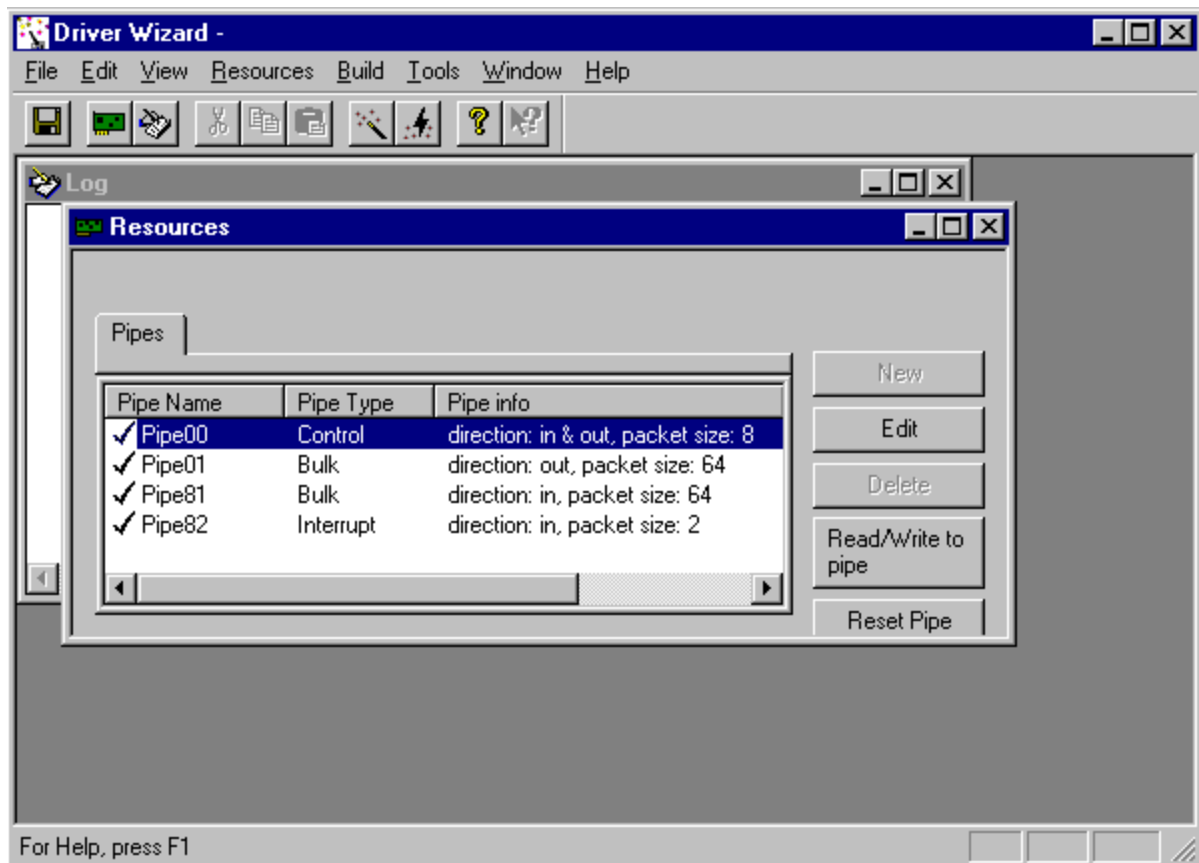
## USB Data Exchange

The USB standard supports two kinds of data exchange between the host and the device: functional data exchange and control exchange.

- Functional data exchange is used to move data to and from the device. There are three types of data transfers: Bulk transfers, Interrupt transfers and Isochronous transfers.
- Control exchange is used to configure a device when it is first attached and can also be used for other device-specific purposes, including control of other pipes on the device. The control exchange is transferred via the control pipe (Pipe 00). The control transfer consists of a setup stage (in which a setup packet is sent from the host to the device), an optional data stage and a status stage.

More information on how to implement the control transfer by sending Setup Packets can be found in Chapter [WinDriver Implementation Issues](#) that deals with WinDriver Implementation Issues.

The screen shot below shows a USB device with one bi-directional control and three functional data transfer pipes/endpoints:





**Figure 2.2: USB Pipes**

## USB Data Transfer Types

The USB device (function) communicates with the host by transferring data through a pipe between a memory buffer on the host and an endpoint on the device. USB provides different transfer types, that best suit the service required by the device and by the software. The transfer type of a specific endpoint is determined in the endpoint descriptor.

There are four different types of data transfer within the USB specification:

*Control Transfer:* Control transfer is mainly intended to support configuration, command and status operations between the software on the host and the device. Each USB device has at least one control pipe (default pipe), which provides access to the configuration, status and control information. The control pipe is a bi-directional pipe. Control transfer is bursty, non-periodic communication. Control transfer has a robust error detection, recovery and retransmission mechanism and retries are made with no involvement of the driver. Control transfer is used by low speed and high-speed devices.

*Isochronous Transfer:* A type usually used for time dependent information, such as multimedia streams and telephony. The transfer is periodic and continuous. The isochronous pipe is uni-directional and a certain endpoint can either transmit or receive information. For bi-directional isochronous communication there's a need to use two isochronous pipes, one in each direction. USB guarantees the isochronous transfer access to the USB bandwidth (that is it reserves the required amount of bytes of the USB frame) with bounded latency and guarantees the data transfer rate through the pipe unless there is less data transmitted. Up to 90% of the USB frame can be allocated to periodic transfers (isochronous and interrupt transfers). If, during configuration, there is no sufficient bus time available for the requester isochronous pipe, the configuration is not established. Since time is more important than correctness in these types of transfers, no retries are made in case of error in the data transfer, though the data receiver can determine the error that occurred on the bus. Isochronous transfer can be used only by high-speed devices.

*Interrupt Transfer:* Interrupt transfer is intended for devices that send and receive small amounts of data, in low frequency or in an asynchronous time frame. An interrupt transfer type guarantees a maximum service period and a retry of delivery to be attempted in the next period, in case of an error on the bus. The interrupt pipe, like the isochronous pipe, is uni-directional. The bus access time period (1-255ms for high-speed devices and 10-255ms for low-speed devices) is specified by the endpoint of the interrupt pipe. Although the host and the device can count only on the time period indicated by the endpoint, the system can provide a shorter period up to 1 ms.

*Bulk Transfer:* Bulk transfer is non-periodic, large packet, bursty communication. Bulk transfer typically supports devices that transfer large amounts of non-time sensitive data, and that can use any available bandwidth, such as printers and scanners. Bulk transfer allows access to the bus on availability basis, guarantees the data transfer but not the latency and provides error-check mechanism with retries attempts. If part of the USB bandwidth is not being used for other transfers, the system will use it for bulk transfer. Like previous stream pipes (isochronous and interrupt) the bulk pipe is also uni-directional. Bulk transfer can only be used by high-speed devices.

## USB Configuration

Before the USB function (or functions in a compound device) can be operated, the device must be configured. The host does the configuring, by acquiring the configuration information from the USB device. USB devices report their attributes by descriptors. A descriptor is the defined structure and format in which the data is transferred. A complete description of the USB descriptors can be found in Chapter 9 of the USB Specification (See <http://www.usb.org> for the full specification).

It is best to view the USB descriptors as a hierarchic structure of four levels:

- The Device level
  
- The Configuration level
  
- The Interface level (this level may include an optional sub-level called alternate settings)
  
- The Endpoint level.

There is only one device descriptor for each USB device. Each device has one or more configurations, that have one or more interfaces, and each interface has zero or more endpoints.

*Device Level:* At the top level is the 'device descriptor', that includes general information about the USB device, that is global information for all of the device configurations. The device descriptor describes, among other things, the device class (USB devices are divided into device classes, such as HID devices, hubs, locator devices etc.), subclass, protocol code, Vendor ID, Device ID and more. Each USB device has one device descriptor.

*Configuration Level:* A USB device has one or more configuration descriptors, which describe the number of interfaces grouped in each configuration and power attributes of the configuration (such as self-powered, remote wakeup, maximum power consumption and more). At a given time, only one configuration is loaded. An example of different configurations of the same device may be an ISDN adapter, where one configuration presents it with a single interface of 128KB/s and a second configuration with two interfaces of 64KB/s.

*Interface Level:* The interface is a related set of endpoints that present a specific functionality or feature of the device. Each interface may operate independently. The interface descriptor describes the number of the interface, number of endpoints used by this interface, and the interface specific class, subclass and protocol values when the interface operates independently. In addition, an interface may have alternate settings. The alternate settings allow the endpoints or their characteristics to be varied after the device is configured.

*Endpoint Level:* The lowest level is the endpoint descriptor that provides the host with information regarding the data transfer type of the endpoint and the bandwidth of each endpoint (the maximum packet size of the specific endpoint). For isochronous endpoints, this value is used to reserve the bus time required for the data transfer. Other attributes of the endpoints are their bus access frequency, their endpoint number, their error handling mechanism, and their direction.

Seems complicated? Not at all! WinDriver automates the USB configuration process. The included DriverWizard and USB diagnostics application, scan the USB bus, detect all USB devices and their

different configurations, interfaces, settings and endpoints, and enables the developer to pick the desired configuration before starting driver development.

WinDriver identifies the endpoint transfer type as determined in the endpoint descriptor. The driver created with WinDriver contains all configuration information acquired at this early stage.

## WinDriver USB

WinDriver USB enables developers to quickly develop high performance drivers for USB based devices, without having to learn the USB specifications or the OS internals. Using WinDriver USB, developers can create USB drivers without having to use the DDK (Microsoft Driver Development Kit), and without having to be familiar with Microsoft's WDM (Win32 Driver Module).

The driver code developed with WinDriver USB is binary compatible between Windows 2000, Windows ME and Windows 98.

The source code will be code-compatible among all other operating systems, supported by WinDriver USB. For up to date information regarding operating systems currently supported by WinDriver USB, please check Jungo's web site at

<http://www.jungo.com>

WinDriver USB encapsulates the USB specification and architecture, letting you focus on your application logic. WinDriver USB features DriverWizard, with which you can detect your hardware, configure it and test it before writing a single line of code. DriverWizard will lead you through the configuration procedure first, enable you to choose the desirable configuration, interface and alternate setting through a friendly graphical user interface. After detecting and configuring your USB device, you can then test it, listen to pipes, write and read packets and ensure that all your hardware resources function as expected. WinDriver USB is a generic tool kit, which supports all USB devices, from all vendors and with all types of configurations.

After your hardware is diagnosed, DriverWizard automatically generates your device driver source code in C or in Delphi. WinDriver USB provides user-mode APIs to your hardware, which you can call from within your application. The WinDriver USB API is specific for your USB device and includes USB unique operations such as reset-pipe and reset-device. Along with the device API, WinDriver USB creates a diagnostics application, which just needs to be compiled and run. You can use this application as your skeletal driver to jump-start your development cycle. If you are a VB programmer, you will find all WinDriver USB API supported for you also in VB, giving you everything you need to develop your driver in VB.

DriverWizard also automates the creation of a .INF file where needed. The .INF file is a text file used by the Plug-&-Play mechanisms of Windows 95/98/ME and Windows 2000 to load the driver for the newly installed hardware or to replace an existing driver. The .INF file includes all necessary information about the device(s) and the files to be installed. .INF files are required for hardware that identify themselves, such as USB and PCI. In some cases, the .INF file of your specific device is included in the .INF files that are shipped with the operating system. In other cases, you will need to create a .INF file for your device. WinDriver automates this process for you. More information on how to create your own .INF file with DriverWizard can be found in Chapter [The DriverWizard](#) that explains the DriverWizard. Installation instructions of .INF files can be found in Chapter [Distributing your Driver](#) that illustrates how to distribute your driver.

Using WinDriver USB, all development is done in the user mode, using familiar development and debugging tools and your favorite compiler (such as MSDEV, Visual C/C++, Borland Delphi, Borland C++, Visual Basic).

WinDriver USB API is designed to give you optimized performance. In cases where native kernel mode performance is needed, use WinDriver USB's unique 'KernelPlugIn' feature (included). This powerful feature enables you to write and debug your code in the user mode, and then simply 'drop' it into the Kernel PlugIn for kernel mode execution. This unique architecture enables you to achieve maximum performance with user mode ease of use.

All other WinDriver USB features can be found in the WinDriver feature list in Chapter [WinDriver USB Overview](#) that covers the USB features of WinDriver.

## WinDriver USB Architecture

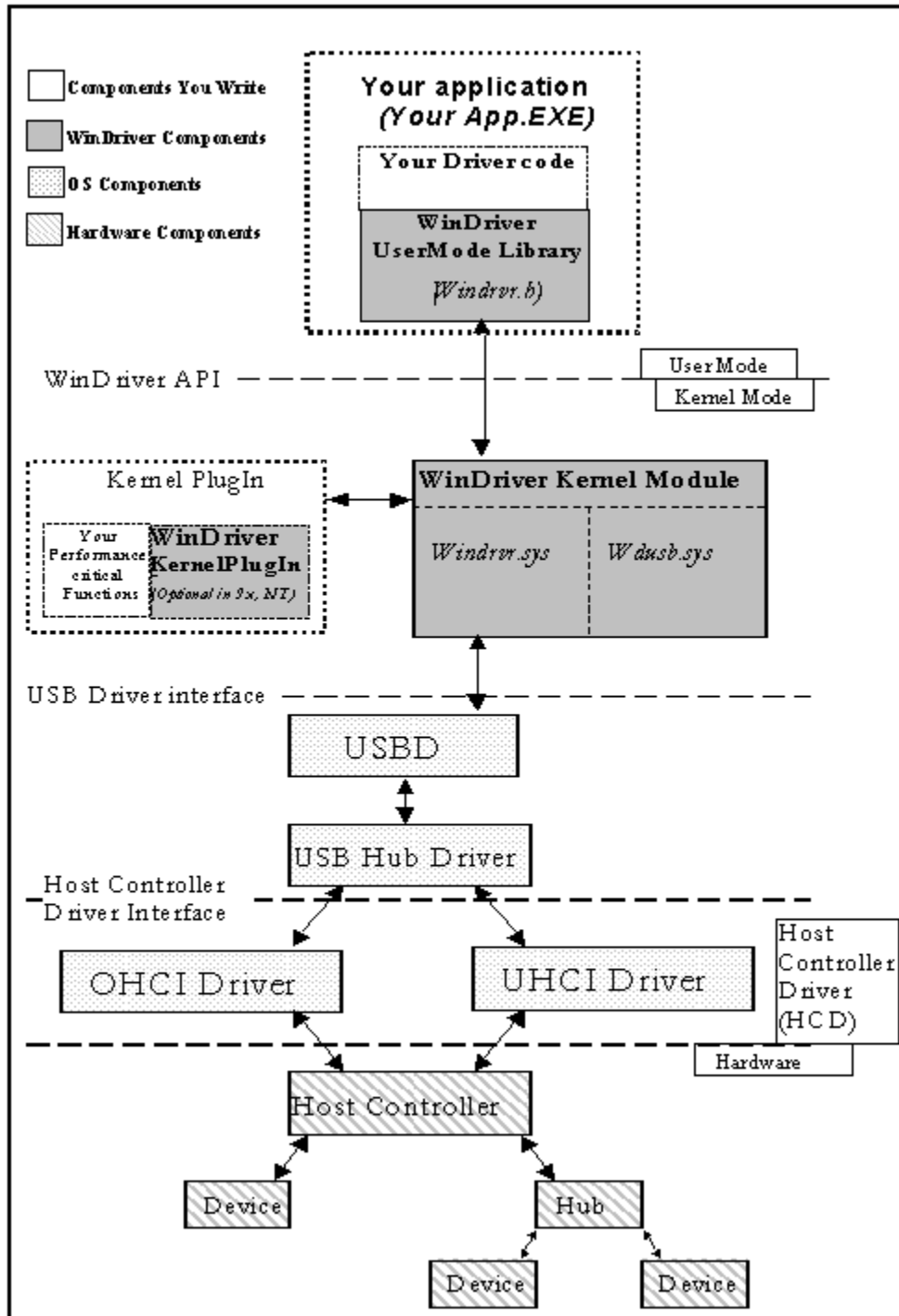


Figure 2.3: WinDriver USB Architecture

**NOTE:** Any occurrence of wdbus in the above figure should be read as wdpnp. As of version 5.0 the file wdbus.sys has been changed to wdpnp.sys and supports PCI, PCMCIA and USB devices.

To access your hardware, your application calls the required WinDriver USB API function from the WinDriver User Mode Library (windrvr.h). The User Mode Library calls the WinDriver Kernel Module. The WinDriver Kernel Module is comprised of windrvr.sys and wdpnp.sys. The WinDriver Kernel Module accesses your USB device resources through the native operating system calls.

There are two layers responsible to abstract the USB device to the USB device driver:

The upper one is the USB Driver layer (including the USB Driver (USB D) and USB Hub Driver) and the lower one is the host controller driver layer (HCD). The division of duties between the HCD and USB D is not defined, and is operating system dependent. Both HCD and USB D are software interfaces and components of the operating system, where the HCD layer represents a lower level of abstraction.

The HCD is the software layer that provides an abstraction of the host controller hardware while the USB D provides an abstraction of the USB device and the data transfer between the host software and the function of the USB device.

The USB D communicates with its clients (the specific device driver for example) through the USB Driver Interface USBDI. At the lower level, the USB D and USB Hub Driver implement the hardware access and data transfer by communicating with the HCD using the Host Controller Driver Interface **HCDI**.

The USB Hub Driver is responsible for identifying addition and removal of devices from a particular hub. Once the Hub Driver receives a signal that a device was attached or detached, it uses additional host software and the USB D to recognize and configure the device. The software implementing the configuration can include the hub driver, the device driver and other software.

WinDriver USB abstracts the configuration procedure and hardware access described above for the developer. With WinDriver USB API, developers can do all the hardware-related operations without having to master the lower levels of implementing these activities.

## **What drivers can I write with WinDriver USB?**

Almost all monolithic drivers (drivers that need to access specific USB devices), can be written with WinDriver USB. In cases where a "standard" driver needs to be written (e.g. NDIS driver, SCSI driver, Display driver, USB to Serial port drivers, USB layered drivers, etc.), use KernelDriver USB (also from Jungo).

For quicker development time, select WinDriver USB over KernelDriver USB wherever possible.



## **Systems Requirements**

[For Windows 95 / 98 / ME](#)

[For Windows NT/2000](#)

[For Windows CE](#)

[For Linux](#)

[For Solaris](#)

[For VxWorks](#)

## Installing WinDriver

The WinDriver CD contains all versions of WinDriver for all the different operating systems. The CD's root directory contains the Windows 95/98/ME and NT/2000 version. This will automatically begin when you insert the CD into your CD drive. The other versions of WinDriver are located in subdirectories i.e. \ **Linux**, \ **Wince** and so on.

[Installing WinDriver for Windows 95,98,ME,NT and 2000](#)

[Installing WinDriver CE](#)

[Testing Your Applications on the X86 HPC Emulator](#)

[Installing WinDriver for Linux](#)

[Installing DriverWizard on your Windows machine](#)

[Installing WinDriver for Solaris](#)

[Installing DriverBuilder for VxWorks](#)

## Upgrading Your Installation

To upgrade to a new version of WinDriver, follow the steps outlined in Section [Installing WinDriver for Windows 95,98,ME,NT and 2000](#) that illustrates the process of installing WinDriver for Windows 95/98/ME/NT/2000. You can either choose to overwrite the existing installation or install to a separate directory.

After installation, start DriverWizard and enter the new license string, if you have received one. This completes the upgrade of WinDriver.

To upgrade your source code, navigate to the RegisterWinDriver() function call in your source code, and pass the new license string as a parameter to this function. For more information on RegisterWinDriver(), please refer to the file **register.txt** in the directory **WinDriver\redist\register**.

The procedure for upgrading your installation on other operating systems is the same as the one described above. Please check the respective installation sections for installation details.

## Checking Your Installation

[On your Windows machine](#)

[On your Windows CE machine](#)

[On your Linux machine](#)

[On your Solaris machine](#)

[On VxWorks](#)

## Uninstalling WinDriver

If for some reason you wish to uninstall either the evaluation or registered version of WinDriver, please refer to this section.

[Uninstalling Windriver from Windows \(95/98/ME/NT/2000\)](#)

[Uninstalling Windriver from Linux](#)

[Uninstalling WinDriver from Solaris](#)

[Uninstalling DriverBuilder for Vxworks](#)

## An Overview

DriverWizard (included in the WinDriver toolkit) is a Windows-based diagnostics tool that lets you write to and read from the hardware, before writing a single line of code. The hardware is diagnosed through a Windows interface - memory ranges are read, registers are toggled and interrupts are checked.

Once the card is operating to your satisfaction, DriverWizard creates the skeletal driver source code, creating functions accessing all your hardware resources (where 'status register' is a register you have defined on your hardware).

If you are developing a driver for a PLX based card, it is recommended to read the chapter that explains WinDriver's enhanced support for specific PCI chipsets, before starting your driver development (**Note:** this chapter does not appear in the HLP format documentation). You can use DriverWizard to diagnose your hardware. You should use DriverWizard to generate an INF file for your card for Windows operating systems. You should avoid using DriverWizard to generate code for your PLX card because DriverWizard generates generic code and you will have to modify the code before it can be useful. We supply complete source code libraries and sample applications tailored for various PLX chipsets in the package.

DriverWizard is an excellent tool for two major phases in your HW / Driver development:

1. *Hardware diagnostics:* After the hardware has been built, insert the hardware into the PCI/PCMCIA/ISA/ISA PnP/EISA/CompactPCI bus or attach your new USB device to the USB port in your machine, and use DriverWizard to check that the hardware is performing as expected.
2. *Code generation:* Once you are ready to build your code, let DriverWizard generate your driver code for you.

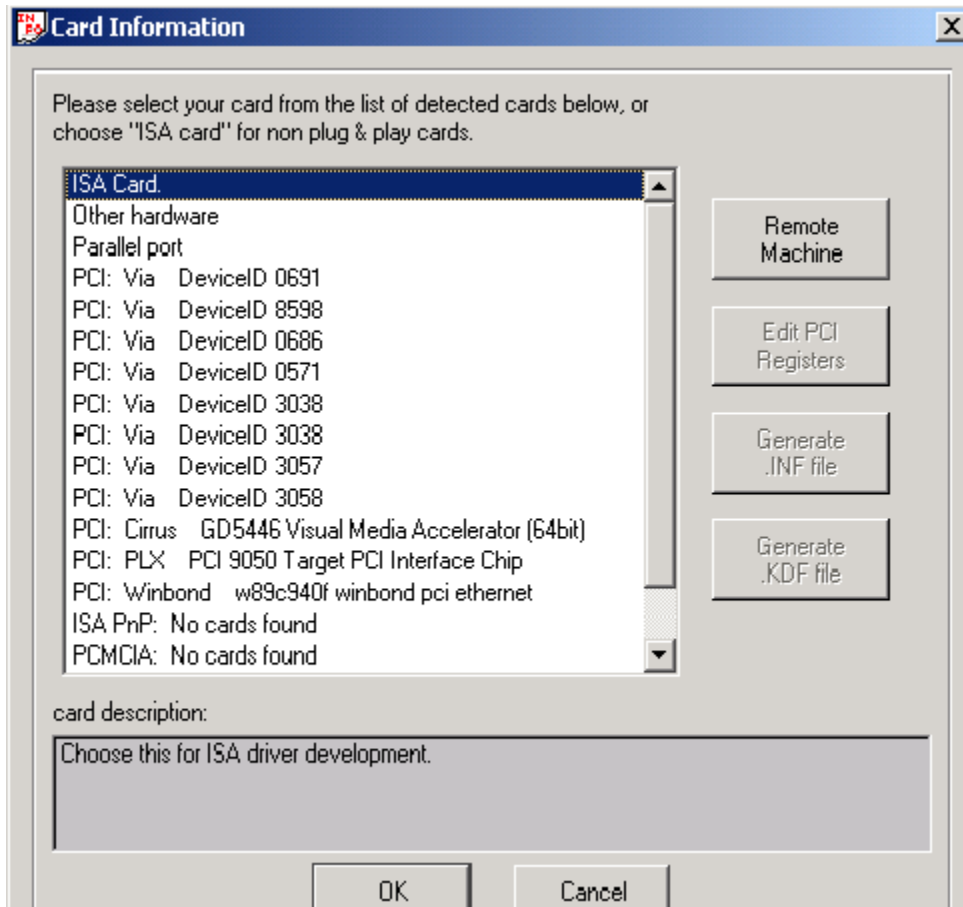
The code generated by DriverWizard is composed of the following elements:

- *Library functions* for accessing each element of your device's resources (Memory ranges, I/O ranges, registers and interrupts).
- *A 32 bit diagnostics program*, in console mode with which you can diagnose your device. This application utilizes the special library functions, (described above), which were created for your device by DriverWizard. Use this diagnostics program as your skeletal device driver.
- *A project workspace* that you can use to automatically load all the above project information and files into your development environment. In WinDriver Linux and WinDriver Solaris, DriverWizard generates the makefile for the relevant operating system.

## DriverWizard Walkthrough

Following are the five steps in using DriverWizard:

1. Insert your card in your hardware bus (PCI/PCMCIA/ ISA/ISA PnP/EISA/CompactPCI) or attach your USB device to the USB port in your machine.
  
2. Run DriverWizard.
  - Click *Start* | *WinDriver* | *DriverWizard* from the start menu or double click the DriverWizard icon on your desktop.
  
  - The start-up dialog will appear. Click your mouse to start DriverWizard. If you are using an evaluation copy of WinDriver, you will be notified of the time left for your evaluation period.
  
  - Choose your PnP device from the list of devices detected by DriverWizard or configure it manually (for non PnP cards like ISA).



**Figure 4.1: Selection of PnP Device**

- In some cases, DriverWizard will notify you of the need to generate an INF file, in order to continue your hardware diagnostics. (If after pressing the OK button, no message popped up then move to the next step).

To generate an INF file simply press the '*Generate .INF file*' button in the 'Card information' screen and save the generated .INF file (the default name given to the file by DriverWizard is 'my\_device.inf').

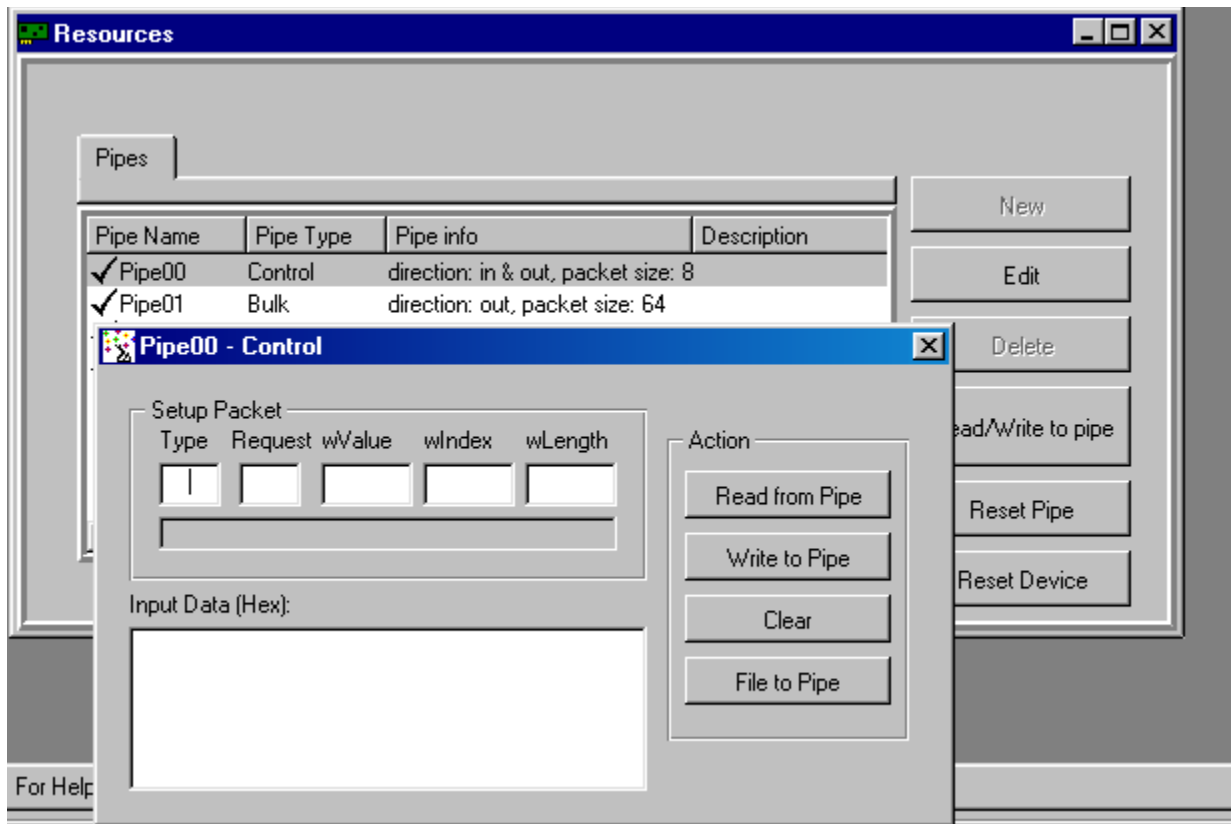
To install the .INF file follow the instruction displayed by DriverWizard or refer to Section [Creating a .INF file](#) that explains how to create an INF file.

#### **Why should I create an INF file?**

1. To stop the 'new hardware wizard' of the Windows operating system from popping up after boot.



2. In some cases the OS doesn't initialize the PCI configuration registers in Win98/ME and Windows 2000 without an INF file. In such cases, you will not be able to diagnose your hardware with DriverWizard until after creating the INF file.
  3. In some cases the OS doesn't assign physical address to USB devices without an INF file. In these cases you will not be able to diagnose your USB device with DriverWizard until after creating the INF file.
  4. To load the new driver created for the card / device. Creating an INF file is required whenever developing a new driver for the hardware.
  5. To replace the existing driver with a new one.
3. Configure your USB device (developers working with PCI/PCMCIA/ISA/ISA PnP/EISA/CompactPCI cards should skip this step):
- Choose the desired configuration\interface\settings from the list.(Note: DriverWizard reads all the supported devices interface and alternate settings and displays them. For USB devices with only one interface configured, DriverWizard automatically selects the detected interface and therefore the 'interface selection' screen will not be displayed).

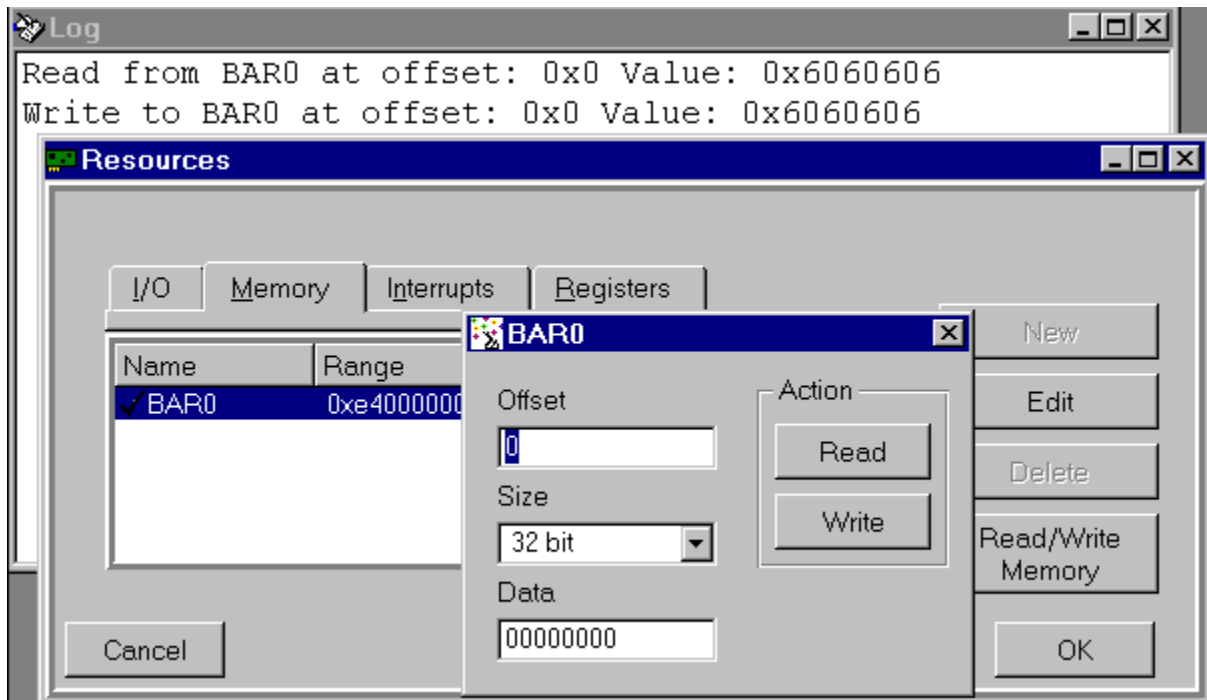


**Figure 4.2: USB Device Configuration**

#### 4. Diagnose your device

- Test your card's I/O, memory ranges, registers and interrupts.
- Test the USB device's pipes.
- All of your activity will be logged on DriverWizard Logger, so that you may later analyze your testing.
- Make sure your card is performing as expected.

#### **A PCI diagnostic screen**



**Figure 4.3: A PCI Diagnostics Screen**

- For USB testing: DriverWizard shows the pipe detected according to the selected configuration.

In order to perform data transfers follow the steps given below:

- Select the desired pipe.
- For control pipe (a bi-directional pipe) - press 'read/write to pipe'. A new dialog will pop up where you enter a setup packet and for a 'writing operation' you also input data. The setup packet should be 8 bytes long (little endian) and should conform to the USB specification parameters (bmRequestType, bRequest, wValue, wIndex, wLength).  
*More detailed information on how to implement the control transfer and how to send Setup packets can be found under Chapter [WinDriver Implementation Issues](#) that explains the WinDriver Implementation Issues*
- For input pipe (moves data from device to the host) - click 'listen to pipe'. To successfully accomplish this operation with devices other than HID, first you need to

verify that the device sends data to the host. If no data is being sent, after 'listening' for a short period of time DriverWizard will notify you 'Transfer failed').

- To stop reading click 'stop listen to pipe'.
- For output pipe (host to device) - press 'write to pipe'. A new dialog will pop up asking you to enter the data to write. DriverWizard Logger will contain the outcome of the operation.

### A USB diagnostics screen

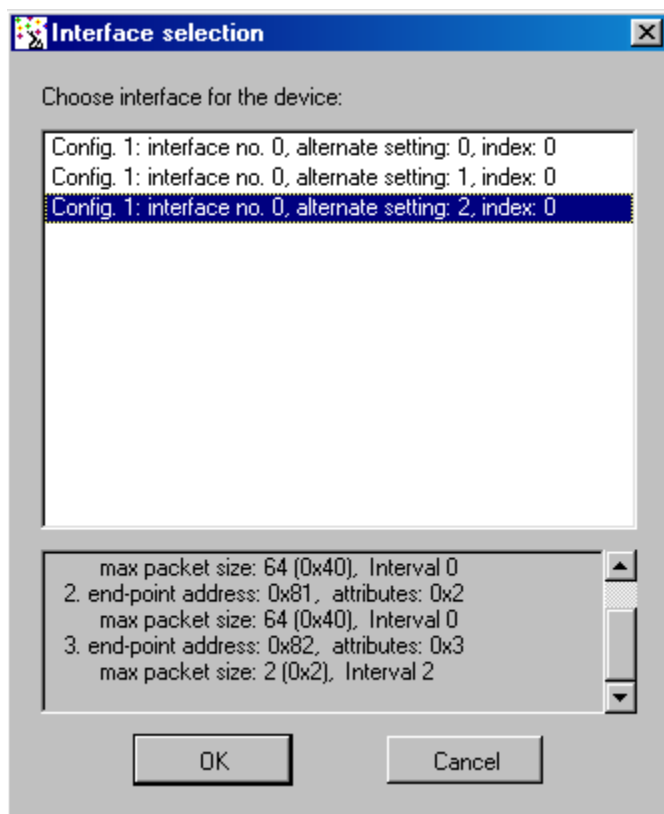


Figure 4.4: USB Diagnostics Screen

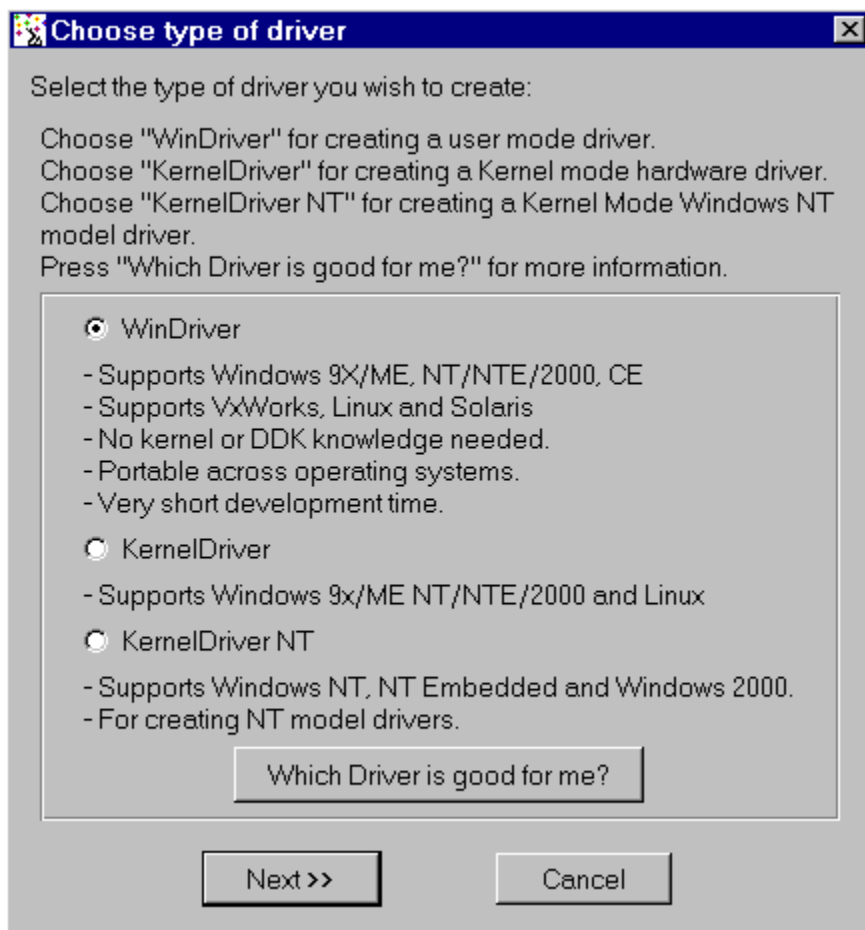
5. Generate the skeletal driver code.

- Choose the '**Generate Code**' option from the **Build** menu.

■

**Figure 4.5: Generate Code Option**

Select the **WinDriver** option from the 'Choose type of driver' screen. Selecting the KernelDriver option will generate kernel source code designed for full kernel mode drivers. See the KernelDriver documentation or the Jungo <http://www.jungo.com> site url for more details (**Note:** this screen appears only when both WinDriver and KernelDriver are installed on your machine.)



**Figure 4.6: Select Driver Type**

From the following screen, choose the language in which the code will be generated , and choose your desired development environment for the various operating systems.

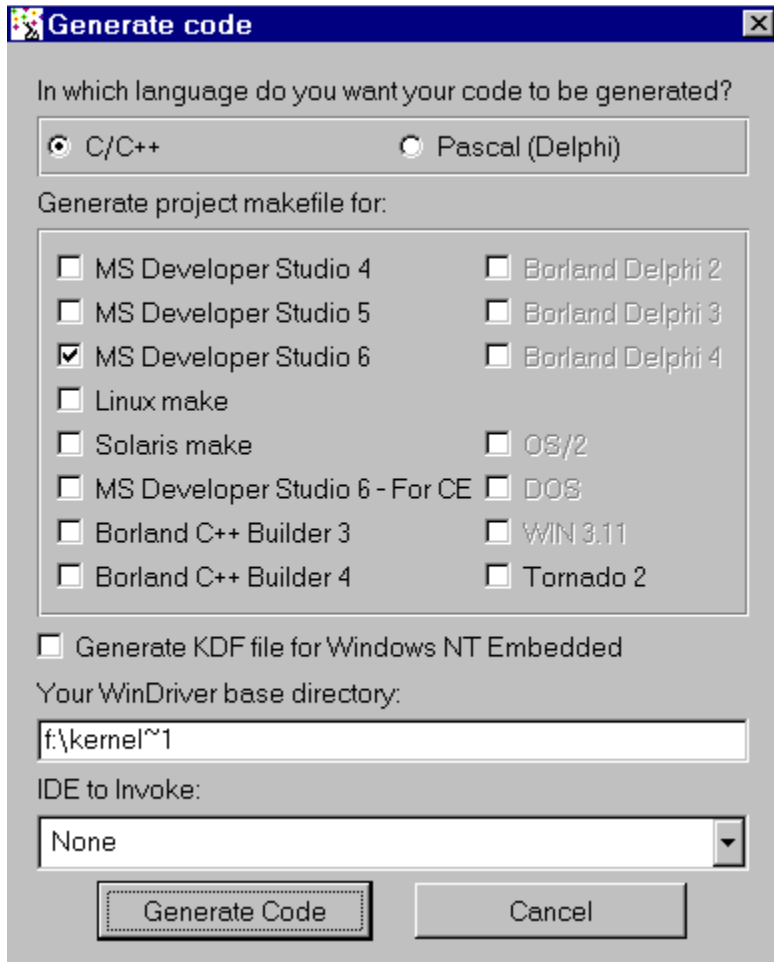


Figure 4.7: Options for Generating Code

- Click the **Generate Code** button at the bottom of the screen.
6. Compile and run the generated code.
- Use this code as a starting point for your device driver. Modify where needed to perform your driver's specific functionality.
  - The source code DriverWizard creates can be compiled with any 32-bit compiler, and will run on ALL supported platforms (95, 98, ME, NT, 2000, CE, Linux, Solaris, VxWorks and OS/2) without

needing modification.

## **DriverWizard Notes**

[Sharing a Resource](#)

[Disabling a Resource](#)

[DriverWizard Logger](#)

[Automatic Code Generation](#)



## Remote WinDriver

Remote WinDriver enables driver developers and hardware engineers to develop PCI/PCMCIA/ISA/ISA PnP/EISA/CompactPCI and USB based device drivers on any remote target including embedded systems. Remote WinDriver accesses the hardware on the remote target system from a host machine, tests it and generates a driver for it.

Remote WinDriver consists of two components:

1. The client component which is integrated into DriverWizard.
2. The server component (WinDriver Remote Agent) which runs on the target system and communicates with one or more clients over the TCP/IP network.

Remote WinDriver clients are available on Windows, Linux and Solaris. In version 5.0, server components are supplied for Windows(95/98/ME/NT/2000/CE), Linux, Solaris and VxWorks.

[How does it work?](#)

[Using Remote WinDriver \(For all Windows OSes\)](#)

[Using Remote WinDriver \(For Windows CE\)](#)

[Using Remote WinDriver \(For Linux and Solaris\)](#)

[Using Remote WinDriver \(For VxWorks\)](#)

## Using the DriverWizard to Build a Device Driver

- Use DriverWizard to diagnose your card. Read / Write to the IO / Memory ranges / registers that your card supports and to the pipes of your USB device. Check that your device operates as expected.
- Use DriverWizard to generate skeletal code for your device in C, C++ or in Delphi. (See Chapter [The DriverWizard](#) for details about DriverWizard).
- If you are using one of the supported chip sets (PLX / AMCC / V3 / Altera / Galileo) as your PCI bridge -- it is recommended that you use the **p9030\_diag.exe | p9054\_diag.exe | p9050\_diag.exe | p9080\_diag.exe | p9060\_diag.exe | iop480\_diag.exe | p480\_diag.exe | gt64\_diag.exe | amccdiag.exe | pbc\_diag.exe** (respectively) as your skeletal driver code. These executables are applications that access all the registers and memory ranges through the respective bridge. Their full WinDriver source code is included.(See the respective chip-set chapters for more details on using the diagnostics applications).  
**NOTE:** WinDriver PLX 9050 library is fully compatible with PLX 9052. Therefore, use the files in plx/9050 directory for the PLX 9052 chip.
- Use any 32-bit compiler (such as MSDEV, Visual C/C++, Borland Delphi, Borland C++, Visual Basic, GCC) to generate the skeletal driver you need.
- For Linux and Solaris use gcc to build your code.
- That is all you need to create your User Mode driver. If you discover that better performance is needed, see Chapter [Improving Performance](#) for details on performance improvement. That chapter suggests some performance enhancements you can make in your User Mode driver, and instructs you on how to move parts of your code to the WinDriver Kernel PlugIn. This will eliminate any performance problem.

See Chapter [WinDriver Function Reference](#) that details the function reference for WinDriver , Chapter [WinDriver Structure Reference](#) that details the structure reference for WinDriver and Chapter [WinDriver Implementation Issues](#) that explains the WinDriver Implementation Issues for more details.

## Writing the Device Driver without the DriverWizard

- It is recommended to use DriverWizard to generate the skeletal driver you need. If you choose to write your driver directly without using DriverWizard, proceed according to the steps outlined below, or choose a sample that most closely resembles what your driver should do, and modify it.

1. Copy the file **windrvr.h** to your source code directory.

2. Add these lines to the source code:

```
#include <windows.h>
#include <winioctl.h>
#include "windrvr.h"
```

1. Call **WD\_Open()** at the beginning of your program to get a handle for WinDriver.
2. Call **WD\_Version()** to make sure that the WinDriver version installed is up to date.
3. For PCI cards: call **WD\_PciScanCards()** to get a list of the PCI cards installed. Choose your card and call **WD\_PciGetCardInfo()**
4. For ISA Plug and Play (PnP) cards: call **WD\_IsapnpScanCards()** to get a list of the ISA PnP cards installed. Choose your card and call **WD\_IsapnpGetCardInfo()**.
5. For ISA (non PnP) cards: fill in your card information (IO, memory & interrupts) in the **WD\_CARD** structure.
6. For PCMCIA Cards: call **WD\_PcmciaScanCards()** to get a list of the PCMCIA cards installed. Choose your card and call **WD\_PcmciaGetCardInfo()**.

**Note:** *WD\_PcmciaGetCardInfo()* inserts an *ITEM\_BUS* item as the first element of the *WD\_ITEMS*

array of the *WD\_CARD* structure that it returns. This item must be present for PCMCIA card configuration to work correctly. If you are filling up the *WD\_CARD* structure yourself without the help of *WD\_PcmciaGetCardInfo()*, then you must set up this item yourself and it must be the first entry in the *WD\_ITEMS* array.

1. For USB devices call **WD\_UsbScanDevice()** to get the unique ID of your device.
2. For USB devices an optional step is to call **WD\_UsbGetConfiguration()** to learn about your device configurations and interfaces.
3. Call **WD\_CardRegister()**. For USB devices call **WD\_UsbDeviceRegister()** instead, to open a handle to your device with the desired configuration.
4. Now you can use **WD\_Transfer()** to perform IO and memory transfers or operate your USB device by calling **WD\_UsbTransfer()**.
5. For PCI/PCMCIA/ISA/ISA PnP/EISA/CompactPCI cards: If the card uses interrupts call **WD\_IntEnable()**. Now you can wait for interrupts using **WD\_IntWait()**.
6. To finish call **WD\_CardUnregister()** or **WD\_USBDeviceUnregister()** for your USB device, and at the end call **WD\_Close()**.

## Win CE - Testing on CE

### Emulation

WinDriver is currently the only tool that enables you to test your driver code with your hardware on your NT machine under the CE emulation environment. This can dramatically shorten your development time by eliminating the need to work via a serial cable each time you want to see how your driver code operates your hardware.

If your NT host development workstation already has the target hardware plugged in, you can use the X86 HPC software emulator to test your driver. You need to generate the code as usual using DriverWizard, or from scratch as described earlier in this chapter. When compiling the code, select the target platform as X86em from the VisualC++ WCE Configuration Toolbar. You will need to link the import library **windriver\redist\register\x86emu\windrvr\_ce\_emu.lib** with your application program objects.

## Using the Help Files

You may use the help files supplied to you with the WinDriver toolkit. Use these files by pressing '**Start**' on your task bar, and choosing '**Programs | WinDriver | WinDriver Help**' from there.

## User Mode Debugging

- Since WinDriver is accessed from User Mode, it is recommended you first debug your code using your standard debugging software.
  
- Use 'Set Debug On' and 'Set Debug Off' to toggle WinDriver runtime debugging. This will check the validity of the addresses sent to the register commands in run-time, and report errors.
  
- Use DriverWizard to check values of memory and registers in the debugging process.
  
- When developing for windows CE - If you are using the WinDbg debugger from Microsoft to connect to your target platform using a serial (COM1) port, you can use the DEBUGMSG macro inside your user-mode driver code to send printf style debugging output to the debugger window. Refer to the following files or directories for more information. (The ETK documentation also includes detailed documentation on using WinDbg for user mode or driver debugging ).

1. **WINCE210\PUBLIC\COMMON\DDK\INC\DBGPRINT.H**

2. **\WINCE210\PUBLIC\COMMON\OAK\DEMOS\DBGSAMP1**

## **DebugMonitor**

DebugMonitor is a powerful graphical and console mode tool for monitoring all activities handled by the WinDriver Kernel (*windrvr.sys* / *windrvr.vxd* / *windrvr.dll* / *windrvr.o* / *wdpnp.sys*). Using this tool you can monitor how each command sent to the kernel is executed.

[Using DebugMonitor](#)



## WD\_Open()

Open a WinDriver device and return a handle to the device. WD\_Open must be called before any other WinDriver functions can be used.

**NOTE:** If you are a registered user, you need to read the file `register.txt` under `windriver/redist/register` or `kerneldriver/redist/register` to understand the process of enabling your driver to work with the registered version.

### Prototype

```
HANDLE WD_Open();
```

### Return Value

INVALID\_HANDLE\_VALUE if device could not be opened, otherwise returns the handle.

### Example

```
HANDLE hWD;
```

```
hWD = WD_Open();  
if (hWD==INVALID_HANDLE_VALUE)  
{  
    printf ("Cannot open WinDriver device\n");  
}
```

## **WD\_Close()**

Closes the WinDriver device. This must be called when finished using the driver.

### **Prototype**

```
void WD_Close(HANDLE hWD);
```

### **Parameters**

hWD - handle of driver from WD\_Open()

### **Example**

```
WD_Close (hWD);
```

## WD\_Version()

Returns the version of WinDriver that is currently running.

### Prototype

```
void WD_Version( HANDLE hWD, WD_VERSION *pVer);
```

**Parameters**(WD\_VERSION elements)

- **dwVer** - returns WinDriver's version.
- **cVer** - returns a string of the driver's version.

### Example

```
WD_VERSION ver;  
  
BZERO(ver);  
WD_Version (hWD, &ver);  
printf("%s\n", ver.cVer);  
if (ver.dwVer <WD_VER)  
{  
    printf ("error incorrect WinDriver version \n");  
}
```

## WD\_PciScanCards()

Scan the PCI bus for cards installed.

### Prototype

```
void WD_PciScanCards( HANDLE hWD, WD_PCI_SCAN_CARDS *pPciScan);
```

**Parameters**(WD\_PCI\_SCAN\_CARDS elements)

- **searchId.dwVendorId** - PCI Vendor ID to detect. If 0, then detect cards from all vendors.
  - **searchId.dwDeviceId** - PCI Device ID to detect. If 0, then detect all devices.
  - **dwCards** - returns the number of cards detected.
  - **cardSlot[]** - list of the PCI slots (dwBus, dwSlot and dwFunction) where matching cards were detected.
  - **cardId[]** - list of the corresponding PCI IDs (dwVendorId and dwDeviceId) where matching cards were detected.

### Example

```
WD_PCI_SCAN_CARDS pciScan;
DWORD cards_found;
WD_PCI_SLOT pciSlot;

BZERO(pciScan);
pciScan.searchId.dwVendorId = 0x12bc;
pciScan.searchId.dwDeviceId = 0x1;
WD_PciScanCards (hWD, &pciScan);
if (pciScan.dwCards>0) // Found at least one card
{
    pciSlot = pciScan.cardSlot[0];
}
else
{
    printf ("No matching PCI cards found\n");
}
```

## WD\_PciGetCardInfo()

Get PCI card information: interrupts, I/O & memory.

### Prototype

```
BOOL WD_PciGetCardInfo(HANDLE hWD, WD_PCI_CARD_INFO *pPciCard);
```

**Parameters**(WD\_PCI\_CARD\_INFO elements)

- **pciSlot**- the slot of the card needed, from **WD\_PciScanCards()**[WD\_PciScanCards()].
- **Card**- returns the card information.

### Example

```
WD_PCI_CARD_INFO pciCardInfo;
WD_CARD Card;

BZERO(pciCardInfo);
pciCardInfo.pciSlot = pciSlot;
WD_PciGetCardInfo (hWD, &pciCardInfo);
if (pciCardInfo.Card.dwItems!=0)
{
    Card = pciCardInfo.Card;
}
else
{
    printf ("Failed fetching PCI card information\n");
}
```

## WD\_PciConfigDump()

Read / Write the PCI configuration registers.

### Prototype

```
void WD_PciConfigDump( HANDLE hWD, WD_PCI_CONFIG_DUMP *pConfig);
```

**Parameters**(WD\_PCI\_CONFIG\_DUMP elements)

- **pciSlot**- PCI bus, slot and function number
  - **pBuffer**- buffer for read/write
  - **dwOffset**- offset in PCI configuration space to read/write from
  - **dwBytes**- bytes to read/write from/to buffer, returns the number of bytes read/wrote
  - **flsRead**- if TRUE, then read PCI config. If FALSE, then write PCI config
  - **dwResult**- returns:

**PCI\_ACCESS\_OK** - if read/write ok

**PCI\_ACCESS\_ERROR** - if error

**PCI\_BAD\_BUS** - if bus doesn't exist

**PCI\_BAD\_SLOT** - if slot and function don't exist

### Example

```
WD_PCI_CONFIG_DUMP pciConfig;  
WORD aBuffer[2];  
  
BZERO(pciConfig);  
pciConfig.pciSlot.dwBus = 0;  
pciConfig.pciSlot.dwSlot = 3;  
pciConfig.pciSlot.dwFunction = 0;  
pciConfig.pBuffer = aBuffer;  
pciConfig.dwOffset = 0;  
pciConfig.dwBytes = sizeof(aBuffer);  
pciConfig.flIsRead = TRUE;  
  
WD_PciConfigDump( hWD, &pciConfig);  
if (pciConfig.dwResult!=PCI_ACCESS_OK)
```

```
{  
    printf ("No PCI card in Bus 0 Slot 3\n");  
}  
else  
{  
    printf ("Card in Bus 0 Slot 3 has VendorID %x DeviceID %x" ,  
           aBuffer[0], aBuffer[1]);  
}
```

## WD\_PcmciaScanCards()

Scans the PCMCIA bus for PCMCIA cards installed.

### Prototype

```
BOOL WD_PcmciaScanCards(HANDLE hWD, WD_PCMCIA_SCAN_CARDS
                        *pBuf);
```

**Parameters**(WD\_PCMCIA\_SCAN\_CARDS elements)

- **SearchId.cManufacturer** - PCMCIA Card manufacturer name string
  - **SearchId.cProductName** - PCMCIA Card product name string
  - **dwCards** - returns the number of cards detected
  - **CardSlot[]**- list of the PCMCIA slots (uSocket,uFunction ) where matching cards were detected
  - **CardId[]**- list of the corresponding PCMCIA IDs (cVersion, cManufacturer, cProductName, CheckSum) where matching cards were detected.

### Example

```
WD_PCMCIA_SCAN_CARDS pcmciaScan;
DWORD cards_found;
WD_PCMCIA_CARD pcmciaCard;

BZERO(pcmciaScan);
// Kingston DATAFLASH ATA Flash Card }
strcpy (pcmciaScan.searchId.cManufacturer, "Kingston Technology");
strcpy (pcmciaScan.searchId.cProductName, "DataFlash");

WD_PcmciaScanCards (hWD, &pcmciaScan);

if (pcmciaScan.dwCards > 0) // Found at least one card
{
    pcmciaCard = pcmciaScan.Card[0];
}
else
{
    printf ("No matching PCMCIA cards found");
}
```



## WD\_PcmciaGetCardInfo()

Get PCMCIA card information: interrupts, I/O & memory.

### Prototype

```
BOOL WD_PcmciaGetCardInfo(HANDLE hWD, WD_PCMCIA_CARD_INFO pPcmciaCard);
```

**Parameters**(WD\_PCMCIA\_CARD\_INFO elements)

- **pcmciaSlot** - the slot/function information of the card needed, from **WD\_PcmciaScanCards()** [[WD\\_PcmciaScanCards\(\)](#)].
- **Card** - returns the card information.

### Example

```
WD_PCMCIA_CARD_INFO pcmciaCardInfo;
WD_CARD Card;

BZERO(pcmciaCardInfo);

// get this from WD_PcmciaScanCards()

pcmciaCardInfo.pcmciaSlot = pcmciaSlot;

WD_PcmciaGetCardInfo (hWD, &pcmciaCardInfo);

if (pcmciaCardInfo.Card.dwItems!=0)
{
    Card = pcmciaCardInfo.Card;
}
else
{
    printf ("Failed fetching PCMCIA card information\n");
}
```

## **WD\_PcmciaConfigDump()**

Read/ Write the PCMCIA configuration registers.

### **Prototype**

```
void WD_PcmciaConfigDump( HANDLE hWD, WD_PCMCIA_CONFIG_DUMP *pConfig);
```

**Parameters**(WD\_PCMCIA\_CONFIG\_DUMP elements)

- **pcmciaSlot** - Slot descriptor of PCMCIA card
  - **pBuffer** - buffer for read/write
  - **dwOffset** - offset in pcmcia configuration space to read/write from
  - **dwBytes** - bytes to read/write from/to buffer, returns the number of bytes read/wrote
  - **flsRead** - if 1, then read pci config. If 0, then write pci config
  - **dwResult** - PCMCIA\_ACCESS\_RESULT

## WD\_IsapnpScanCards()

Scan the ISA bus for ISA Plug and Play cards installed.

### Prototype

```
void WD_IsapnpScanCards( HANDLE hWD, WD_ISAPNP_SCAN_CARDS *pIsapnpScan);
```

**Parameters**(WD\_ISAPNP\_SCAN\_CARDS elements)

- **searchId.cVendor**- ISA PnP Vendor ID. This identifies the vendor and card type. If cVendor[0] is 0, then this will search for all Vendor IDs.
- **searchId.dwSerial**-ISA PnP serial device number. If zero, then search for all serial numbers.
- **dwCards**- returns the number of cards detected.
- **Card[]**- list of the cards detected.

### Example

```
WD_ISAPNP_SCAN_CARDS isapnpScan;  
DWORD cards_found;  
WD_ISAPNP_CARD isapnpCard;  
  
BZERO(isapnpScan);  
// CTL009e - Sound Blaster ISA PnP card  
strcpy (isapnpScan.searchId.cVendorId, "CTL009e");  
isapnpScan.searchId.dwSerial = 0;  
WD_IsapnpScanCards (hWD, &isapnpScan);  
if (isapnpScan.dwCards>0) // Found at least one card  
{  
    isapnpCard = isapnpScan.Card[0];  
}  
else  
{  
    printf ("No matching ISA PnP cards found\n");  
}
```

## WD\_IsapnpGetCardInfo()

Get ISA Plug and Play card information: interrupts, I/O & memory.

### Prototype

```
BOOL WD_IsapnpGetCardInfo(HANDLE hWD, WD_ISAPNP_CARD_INFO *plsapnpCard);
```

**Parameters**(WD\_ISAPNP\_CARD\_INFO elements)

- **CardId** - the card ID needed, from **WD\_IsapnpScanCards()** [WD\_IsapnpScanCards()].
  - **dwLogicalDevice** - if ISA card device is multi-function, then this is the number of the logical device to use, otherwise set it to zero.
  - **cLogicalDeviceId** - returns ASCII code of logical device ID found.
  - **dwCompatibleDevices** - returns the number of compatible device IDs in CompatibleDevice array.
- **CompatibleDevice[]**- returns an array of compatible device IDs
  - **clident** - returns the ASCII device identification string
  - **Card** - returns the card information

### Example

```
WD_ISAPNP_CARD_INFO isapnpCardInfo;
WD_CARD Card;

BZERO(isapnpCardInfo);
// from WD_IsapnpScanCard():
isapnpCardInfo.CardId = isapnpCard;
isapnpCardInfo.dwLogicalDevice = 0;
WD_IsapnpGetCardInfo (hWD, &isapnpCardInfo);
if (isapnpCardInfo.Card.dwItems!=0)
{
    Card = isapnpCardInfo.Card;
}
else
{
    printf ("Failed fetching ISA PnP card information\n");
}
```

## WD\_IsapnpConfigDump()

Read / Write the ISA PnP configuration registers.

### Prototype

```
void WD_IsapnpConfigDump( HANDLE hWD, WD_ISAPNP_CONFIG_DUMP *pConfig);
```

**Parameters**(WD\_ISAPNP\_CONFIG\_DUMP elements)

- **CardId** - the card ID needed, from **WD\_IsapnpScanCards()** [WD\_IsapnpScanCards()]
- **dwOffset** - offset in ISA PnP configuration space to read/write from
- **flsRead** - if TRUE, then read config. If FALSE, then write config
- **bData** - the data to read or write
- **dwResult** - returns:

**ISAPNP\_ACCESS\_OK** - if read/write ok

**ISAPNP\_ACCESS\_ERROR** - if error

**ISAPNP\_BAD\_ID** - if card does not exist

### Example

```
WD_ISAPNP_CONFIG_DUMP isapnpConfig;

BZERO(isapnpConfig);
// from WD_IsapnpScanCard():
isapnpConfig.CardId = isapnpCard;
isapnpConfig.dwOffset = 0;
isapnpConfig.fIsRead = TRUE;
WD_IsapnpConfigDump( hWD, &isapnpConfig);
if (isapnpConfig.dwResult!=ISAPNP_ACCESS_OK)
{
    printf ("No ISA PnP card specified slot\n");
}
else
{
    printf ("ISA PnP config in offset 0 =%x",
            isapnpConfig.bData);
}
}
```



## WD\_CardRegister()

Register card - install interrupts & map card memory. For USB devices, see WD\_UsbDeviceRegister. Must be called in order to use interrupts and perform I/O & memory transfers to card.

### Prototype

```
void WD_CardRegister(HANDLE hWD, WD_CARD_REGISTER *pCardReg);
```

**Parameters**(WD\_CARD\_REGISTER elements)

- **Card** - information of card to register (interrupts, I/O & memory)
  - **Card.dwItems** - number of items in Card.Item array.
  - **Card.Item[]**- items of card. Each item can be an I/O range, Memory range or an Interrupt.
  - **Card.Item[i].item**- can be ITEM\_INTERRUPT, ITEM\_MEMORY or ITEM\_IO
  - **Card.Item[i].fNotSharable** - normally should be TRUE, in order that two applications will not attempt to access the same hardware at the same time

### FOR AN I/O RANGE ITEM

- **Card.Item[i].I.IO.dwAddr** - first address of I/O range.
- **Card.Item[i].I.IO.dwBytes**- length of range in bytes.

### FOR A MEMORY RANGE ITEM

**Card.Item[i].I.Mem.dwPhysicalAddr**- first address of physical memory range.

**Card.Item[i].I.Mem.dwBytes** - length of range in bytes.

**Card.Item[i].I.Mem.dwTransAddr** - returns the base address to use for memory transfers with WD\_Transfer() .

**Card.Item[i].I.Mem.dwUserDirectAddr**- returns the base address to use for memory transfers directly by user.

### FOR AN INTERRUPT ITEM

- **Card.Item[i].I.Int.dwInterrupt** - interrupt IRQ to install.
  - **Card.Item[i].I.Int.dwOptions** - usually 0. For level sensitive interrupts use INTERRUPT\_LEVEL\_SENSITIVE.
  - **Card.Item[i].I.Int.hInterrupt** -returns an interrupt handle to use with WD\_IntEnable().
  - **fCheckLockOnly** -should be set to FALSE to register the card. In order to just check whether a card can be registered (i.e.: not used by someone else), it should be TRUE.
- **hCard** - returns the handle of the card, or 0 if card cannot be registered. If the *fCheckLockOnly* flag is set to TRUE, then hCard will return 1 if the card can be registered, or 0 if not.

### Example

```
WD_CARD Card;
```

```
WD_CARD_REGISTER cardReg;

// the info for Card comes from WD_PciGetCardInfo()
// for PCI cards.
//For ISA cards the information has to be set by the user
//(IO/memory address & interrupt number).
BZERO(cardReg);
cardReg.Card = Card;
cardReg.fCheckLockOnly = FALSE;
WD_CardRegister (hWD, &cardReg);
if (cardReg.hCard==0)
    printf ("could not lock device - already in use\n");
```



## **WD\_CardUnregister()**

Un-register a card, and free its resources. For USB devices see `WD_UsbDeviceUnregister()`.

### **Prototype**

```
void WD_CardUnregister(HANDLE hWD, WD_CARD_REGISTER *pCardReg);
```

**Parameters**(WD\_CARD\_REGISTER elements)

hCard - handle of card to un-register.

### **Example**

```
WD_CardUnregister (hWD, &cardReg);
```

## WD\_Transfer()

Execute a read/write instruction to I/O port or memory. For USB devices, see `WD_UsbTransfer()`

### Prototype

```
void WD_Transfer(HANDLE hWD, WD_TRANSFER *pTrns);
```

**Parameters**(WD\_TRANSFER elements)

- **cmdTrans** - command of operation: <dir><p>\_<string><size>:
  - **dir** - R for read, W for write
  - **p** - P for port, M for memory
  - **string** - S for string, none for single transfer
  - **size** - BYTE, WORD or DWORD
  - **dwPort**- Port address for I/O, or User address for memory transfer. User address for a memory mapped card is returned by **WD\_CardRegister()**[WD\_CardRegister()], in the Card structure.

### FOR SINGLE TRANSFER

- **Data.Byte** for Byte read/write.
- **Data.Word** for Word read/write.
- **Data.Dword** for DWord read/write.

### FOR STRING TRANSFER

- **dwBytes** - number of bytes to transfer.
  - **fAutoinc** - If TRUE then I/O or memory address should be incremented for transfer. If FALSE, then all data is transferred to the same port address.
  - **dwOptions** - should be 0.
  - **Data.pBuffer** - the buffer with the data to transfer to/from.

### Example

```
WD_TRANSFER Trns;
BYTE read_data;

BZERO(Trns);
Trns.cmdTrans = RP_BYTE; // Read Port BYTE
Trns.dwPort = 0x210;
WD_Transfer(hWD, &Trns);
read_data = Trns.Data.Byte;
```



## WD\_MultiTransfer()

Perform multiple I/O & memory transfers.

### Prototype

```
void WD_MultiTransfer(HANDLE hWD, WD_TRANSFER *pTransArray, DWORD dwNumTransfers);
```

### Parameters

- **pTransArray** - array of transfer commands, same as in WD\_Transfer()[\[WD\\_Transfer\(\)\]](#)
- **dwNumTransfers** - number of commands in array

### Example

```
WD_TRANSFER Trns[4];
DWORD dwResult;
char *cData = "Message to send\n";

BZERO(Trns);
Trns[0].cmdTrans = WP_WORD; // Write Port Word
Trns[0].dwPort = 0x1e0;
Trns[0].Data.Word = 0x1023;

Trns[1].cmdTrans = WP_WORD;
Trns[1].dwPort = 0x1e0;
Trns[1].Data.Word = 0x1022;

Trns[2].cmdTrans = WP_SBYTE; // Write Port String Byte
Trns[2].dwPort = 0x1f0;
Trns[2].dwBytes = strlen(cData);
Trns[2].fAutoinc = FALSE;
Trns[2].dwOptions = 0;
Trns[2].Data.pBuffer = cData;

Trns[3].cmdTrans = RP_DWORD; // Read Port DWord
Trns[3].dwPort = 0x1e4;

WD_MultiTransfer(hWD, Trns, 4);
dwResult = Trns[3].Data.Dword;
```

## WD\_IntEnable()

Enable interrupt processing.

**Note:** The easiest way to handle interrupts with WinDriver is by defining the Interrupt in DriverWizard, and letting DriverWizard generate the code for you. (In Plug-n-Play cards, DriverWizard will auto-detect the interrupts for you).

### Prototype

```
void WD_IntEnable( HANDLE hWD, WD_INTERRUPT *pInterrupt);
```

**Parameters**(WD\_INTERRUPT elements)

- **hInterrupt** - handle of interrupt to enable. The handle is returned by **WD\_CardRegister()** [[WD\\_CardRegister\(\)](#)], in the Card structure.
  - **Cmd** - an array of transfer commands to perform on hardware interrupt. These commands are needed for level sensitive interrupts, to lower the interrupt level. Otherwise, after WinDriver finishes dealing with the interrupt, another interrupt will immediately occur. If no commands are needed, this should be NULL. The commands are the same as in **WD\_Transfer()** [[WD\\_Transfer\(\)](#)].
- **dwCmds** - number of transfer commands in Cmd array.
  - **dwOptions** - should be 0. If transfer commands are used for the interrupt installed, set the value to INTERRUPT\_CMD\_COPY to copy back the transfer to user-mode from the WinDriver kernel.
  - **kpCall** - kernel plugin call
  - **fEnableOk** - returns TRUE if enable succeeded.

### Example

```
WD_INTERRUPT Intrp;
WD_CARD_REGISTER cardReg;

BZERO(cardReg);
cardReg.Card.dwItems = 1;
cardReg.Card.Item[0].item = ITEM_INTERRUPT;
cardReg.Card.Item[0].fNotSharable = TRUE;
cardReg.Card.Item[0].I.Int.dwInterrupt = 10; // IRQ 10
// INTERRUPT_LEVEL_SENSITIVE - set to level sensitive
// interrupts, otherwise should be 0.
// ISA cards usually are edge sensitive, and PCI cards
// usually are level sensitive.
cardReg.Card.Item[0].I.Int.dwOptions =
    INTERRUPT_LEVEL_SENSITIVE;
cardReg.fCheckLockOnly = FALSE;
WD_CardRegister(hWD, &cardReg);
```

```
if (cardReg.hCard==0)
    printf("could not lock device - already in use\n");
else
{
    BZERO(Intrp);
    Intrp.hInterrupt =
        cardReg.Card.Item[0].I.Int.hInterrupt;
    Intrp.Cmd = NULL;
    Intrp.dwCmds = 0;
    Intrp.dwOptions = 0;
    WD_IntEnable(hWD, &Intrp);
}
if (!Intrp.fEnableOk)
    printf("failed enabling interrupt\n");
}
```

## **WD\_IntDisable()**

Disable interrupt processing.

### **Prototype**

```
void WD_IntDisable( HANDLE hWD, WD_INTERRUPT *pInterrupt);
```

**Parameters**(WD\_INTERRUPT elements)

hInterrupt - handle of interrupt to disable.

### **Example**

```
WD_IntDisable(hWD, &Intrp);
```

## WD\_IntWait()

Wait for an interrupt.

### Prototype

```
void WD_IntWait( HANDLE hWD, WD_INTERRUPT *pInterrupt);
```

**Parameters**(WD\_INTERRUPT elements)

- **hInterrupt** - handle of interrupt to wait for.
  - **fStopped** - returns TRUE if interrupt was disabled while waiting.
  - **dwCounter** - returns the number of interrupts processed.
  - **dwLost** - returns the number of interrupts not yet dealt with.
  - **Cmd** - if commands are set on interrupt should point to commands array, otherwise should be NULL.

### Example

```
for (;;)
{
    WD_IntWait (hWD, &Intrp);
    if (Intrp.fStopped)
        break;

    ProcessInterrupt (Intrp.dwCounter);
}
```



## WD\_IntCount()

Count the number of interrupts from the time WD\_IntEnabled was called.

### Prototype

```
void WD_IntCount( HANDLE hWD, WD_INTERRUPT *pInterrupt);
```

**Parameters**(WD\_INTERRUPT elements)

- **hInterrupt** - handle of interrupt to count.
  - **dwCounter** - returns the number of interrupts processed.
  - **dwLost** - returns the number of interrupts not yet dealt with.
  - **Cmd** - if commands are set on, interrupt should point to commands array, otherwise should be NULL.

### Example

```
DWORD dwNumInterrupts;
```

```
WD_IntCount (hWD, &Intrp);
```

```
dwNumInterrupts = Intrp.dwCounter;
```

## WD\_DMALock()

Lock a linear memory region, and return a list of the corresponding physical addresses.

### Prototype

```
void WD_DMALock( HANDLE hWD, WD_DMA *pDma);
```

### Parameters(WD\_DMA elements)

- **pUserAddr** - user base address of region needed to be locked for DMA transfer.
  - **dwBytes** - number of bytes to lock.
  - **dwOptions** - normally 0.
- 1. Set to **DMA\_KERNEL\_BUFFER\_ALLOC** so WinDriver will allocate a contiguous buffer. When this option is set, the user address of the buffer will be returned in **pUserAddr**. Use this option if your device does not support scatter/gather transfers.
- 2. Set to **DMA\_LARGE\_BUFFER** for locking down regions larger than 1MB (See 'Implementing DMA' for more details).
- **Page[]**- returns an array listing the physical addresses of the locked memory ranges. Program the card's DMA to transfer data to these addresses.
  - **Page[i].pPhysicalAddr** - physical address of page i.
  - **Page[i].dwBytes** - length in bytes of page i.
  - **dwPages** - returns the number of pages in Page array.
  - **hDma** - returns the handle for DMA buffer.

### Example 1

User buffer DMA (scatter gather locking)

```
WD_DMA Dma;  
PVOID pBuffer = malloc (20000);  
  
BZERO(Dma);  
Dma.dwBytes = 20000;  
Dma.pUserAddr = pBuffer;  
Dma.dwOptions = 0;  
WD_DMALock (hWD, &Dma);  
// on return Dma.Page has the list of physical addresses  
if (Dma.hDma==0)  
    printf ("Could not lock down buffer\n");
```

## Example 2

The following code shows kernel buffer DMA

```
BZERO(Dma)
Dma.dwBytes =20 * 4096; //(20 pages)
Dma.dwOptions=DMA_KERNEL_BUFFER_ALLOC;
{
WD_DMALock (hWD, &Dma);
// on return Dma.Page has the list of physical addresses
if (Dma.hDma==0)
printf("Failed allocating kernel buffer for DMA\n");
```

## **WD\_DMAUnlock()**

Unlock a DMA buffer.

### **Prototype**

```
void WD_DMAUnlock( HANDLE hWD, WD_DMA *pDma);
```

**Parameters**(WD\_DMA elements)

hDma - handle for DMA buffer to unlock.

### **Example**

```
WD_DMAUnlock (hWD, &Dma);
```

## WD\_Sleep()

Delay execution for a specific amount of time. This function is used when accessing slow hardware.

### Prototype

```
void WD_Sleep( HANDLE hWD, WD_SLEEP *pSleep);
```

### Parameters(WD\_Sleep elements)

- **dwMicroSeconds**- time, in microseconds, to sleep.
- **dwOptions** - should be zero.

### Example

```
WD_SLEEP sleep;
```

```
BZERO (sleep);
```

```
sleep.dwMicroSeconds = 1000; // Sleep for 1 millisecond
```

```
sleep.dwOptions = 0;
```

```
WD_Sleep (hWD, &sleep);
```

## WD\_UsbScanDevice()

Scan the USB tree for installed devices.

### Prototype

```
void WD_UsbScanDevice(Handle hWD, WD_USB_SCAN_DEVICES *pScan);
```

**Parameters**(WD\_USB\_SCAN\_DEVICES elements):

- **searchId.dwVendorId** - USB Vendor ID to detect. If 0, then detect devices from all vendors.
  - **searchId.dwProductId** - USB Product ID to detect. If 0, then detect all products from the selected vendor.
  - **dwDevices** - returns the number of devices detected.
  - **uniqueId[]** - list of unique USB ID's where matching devices were detected.
  - **deviceGeneralInfo[]** - general information (device address, number of configurations.....) about the devices.

### Example

```
WD_USB_SCAN_DEVICES scan;
DWORD uniqueId;

BZERO(scan);
scan.searchId.dwVendorId = 0x553;
scan.searchId.dwProductId = 0x2;
WD_UsbScanDevice(hWD, &scan);
if (scan.dwDevices > 0) // Found atleast one card
{
    uniqueId = scan.uniqueId[0];
}
else
{
    printf("No matching USB devices found\n");
}
```

## WD\_UsbGetConfiguration()

Get information about a USB device.

### Prototype

```
void WD_UsbGet Configuration(HANDLE hWD, WD_USB_CONFIGURATION *pConfig);
```

### Parameters(WD\_USB\_CONFIGURATION elements)

- **uniqueId** - the unique ID of the device as received from WD\_UsbScan Device()
- **dwConfigurationIndex** - the index of the configuration to get (zero based). The number of configurations are received from **WD\_UsbScanDevice()**[WD\_UsbScanDevice()] in the deviceGeneralInfo
- **configuration** - configuration general data - (value, attributes...)
- **dwInterfaceAlternatives** - how many interfaces (and alternate interfaces) are on the device.
- **Interface[]** - list of interface descriptions (number of endpoints, class, sub class, protocol...)

### Example

```
WD_USB_CONFIGURATION config;  
  
BZERO(config);  
config.uniqueId=2;  
config.dwConfigurationIndex=0;  
WD_UsbGetConfiguration(hWD, &config);  
printf("found %d interfaces\n",  
       config.dwInterfaceAlternatives);
```

## WD\_UsbDeviceRegister()

Register the selected interface of the device. (This tells the hardware which interface to work with).  
Must be called in order to perform data transfers on the pipes.

### Prototype

```
void WD_UsbDeviceRegister(HANDLE hWD, WD_USB_DEVICE_REGISTER *pDevice);
```

### Parameters (WD\_USB\_DEVICE\_REGISTER elements)

- **uniqueId** - the unique deviceID as received from **WD\_UsbScanDevice()** [WD\_UsbScanDevice()]
  - **dwConfigurationIndex** - the index of the configuration to register (zero based). The number of configurations are received from **WD\_UsbScanDevice()** [WD\_UsbScanDevice()] in the deviceGeneralInfo
  - **dwInterfaceNum** - interface number to register as received from **WD\_UsbGetConfiguration()** [WD\_UsbGetConfiguration()]
- **hDevice** - the handle of the device returned
  - **Device** - the returned device description (number of pipes and their description)
  - **dwOptions** - should be zero
  - **cName[]** - name of card
  - **cDescription[]** - description

### Example

```
WD_USB_DEVICE_REGISTER device;  
  
BZERO(device);  
device.uniqueId = 2;  
device.dwConfigurationIndex = 0;  
device.dwInterfaceNum = 1;  
device.dwInterfaceAlternative = 1;  
WD_DeviceRegister(hWD, &device);  
if(!device.{hDevice})  
    printf("error - could not register device\n");  
else  
    printf("device has %d pipes\n", device.Device.dwPipes);
```



## **WD\_UsbDeviceUnregister()**

Un-register the device.

### **Prototype**

```
void WD_UsbDeviceUnregister(HANDLE hWD, WD_USB_DEVICE_REGISTER  
                           *pDevice);
```

### **Parameters(WD\_USB\_DEVICE\_REGISTER elements)**

**hDevice** - the handle of the device to un-register

### **Example**

```
WD_UsbDeviceUnregister(hWD, &Device);
```

## WD\_UsbTransfer()

Perform Read / Write data transfers from / to the device using it's pipes.

### Prototype

```
void WD_UsbTransfer(HANDLE hWD, WD_USB_TRANSFER *pTrans);
```

### Parameters(WD\_USB\_TRANSFER elements)

- **hDevice** - handle of the USB device as received from **WD\_UsbDeviceRegister()**  
[WD\_UsbDeviceRegister()]
- **dwPipe** - pipe number of the device
- **fRead** - perform Read or Write
- **dwOptions** - can be USB\_TRANSFER\_HALT to halt the previous transfer on the same pipe
- **pBuffer** - pointer to buffer to read/write
- **dwBytes** - size of the buffer
  
- **dwTimeout** - timeout for the transfer in milliseconds. 0 →No timeout
- **dwBytesTransferred** - returns the number of bytes actually read / written.
- **SetupPacket[8]** - 8 bytes setup packet for control pipe transfer
- **fOK** - return true if transfer is successful

### Example

```
WD_USB_TRANSFER trans;

BZERO(trans);
trans.hDevice = hDevice;
trans.dwPipe = 0x81;
trans.fRead = TRUE;
trans.pBuffer = malloc(100);
trans.dwBytes = 100;
WD_UsbTransfer(hWD, &trans);
if (!fOK)
    printf("Error on Transfer\n");
else
    printf("Transferred %d bytes from %d\n",
          trans.dwBytesTransferred,trans.dwBytes);
```



## WD\_UsbResetPipe()

Reset the pipe to its default state (resets the state machine of the firmware's pipe to its initial state)

### Prototype

```
void WD_UsbResetPipe(HANDLE hWD, WD_USB_RESET_PIPE *pReset);
```

### Parameters(WD\_USB\_RESET\_PIPE elements)

- **hDevice** - handle of the USB Device
- **dwPipe** - The pipe number to reset

### Example

```
WD_USB_RESET_PIPE reset;  
  
BZERO(reset);  
reset.hDevice = hDevice;  
reset.dwPipe = 0x81;  
WD_UsbResetPipe(hWD, &reset);
```

## InterruptThreadEnable()

Convenience function for setting up interrupt handling. This function is implemented as a static function in the header file *windrivr\_int\_thread.h* found under **windriver/include**

### Prototype

```
BOOL InterruptThreadEnable(HANDLE *phThread, HANDLE hWD, WD_INTERRUPT *pInt,  
    HANDLER_FUNC func, PVOID pData)
```

### Parameters

- **phThread** - returns the handle of the spawned interrupt thread. This should be passed to `InterruptThreadDisable` when shutting down the interrupt handling
- **hWD** - the handle to WinDriver as returned by `WD_Open()`[\[WD\\_Open\(\)\]](#)
- **pInt** - the pointer to an initialized `WD_INTERRUPT`[\[WD\\_INTERRUPT\]](#) structure describing the interrupt to connect to.
- **func** - the interrupt handling function. This function will be called once at every interrupt occurrence. `HANDLER_FUNC` is defined in *windrivr\_int\_thread.h*
- **pData** - this pointer is passed to the interrupt handling function as an argument.

### Example

```
VOID interrupt_handler (PVOID pData)  
{  
    WD_INTERRUPT * pIntrp = (WD_INTERRUPT *) pData;  
    // do your interrupt routine here  
    printf ("Got interrupt %d\n", pIntrp->dwCounter);  
}  
  
.....  
main()  
{  
    WD_CARD_REGISTER cardReg;  
    WD_INTERRUPT Intrp;  
    HANDLE hWD, thread_handle;
```

```

...
hWD = WD_Open();
BZERO(cardReg);
cardReg.Card.dwItems = 1;
cardReg.Card.Item[0].item = ITEM_INTERRUPT;
cardReg.Card.Item[0].fNotSharable = TRUE;
cardReg.Card.Item[0].I.Int.dwInterrupt = MY_IRQ;
cardReg.Card.Item[0].I.Int.dwOptions = 0;
...
WD_CardRegister (hWD, &cardReg);
...
PVOID pData = NULL;
BZERO(Intrp);
Intrp.hInterrupt = cardReg.Card.Item[0].I.Int.hInterrupt;
Intrp.Cmd = NULL;
Intrp.dwCmds = 0;
Intrp.dwOptions = 0;
printf ("starting interrupt thread\n");
pData = &Intrp;
if (!InterruptThreadEnable(&thread_handle, hWD, &Intrp,
    interrupt_handler, pData))
    {
        printf ("failed enabling interrupt\n");
    }
else
    {
        printf ("Press Enter to uninstall interrupt\n");
        fgets(line, sizeof(line), stdin);
        // this calls WD_IntDisable()
        InterruptThreadDisable(thread_handle);
    }
WD_CardUnregister(hWD, &cardReg);
....
}

```

## InterruptThreadDisable()

Convenience function for shutting down interrupt handling. This function is implemented as a static function in the header file *windrvr\_int\_thread.h* found under **windriver/include**

### Prototype

```
VOID InterruptThreadDisable(HANDLE hThread)
```

### Parameters

- **hThread** - The handle of the spawned interrupt thread which was created by `InterruptThreadEnable`

### Example

```
main()
{
    ....
    if (!InterruptThreadEnable(&thread_handle, hWD, &Intrp,
        interrupt_handler, pData))
    {
        printf ("failed enabling interrupt\n");
    }
    else
    {
        printf ("Press Enter to uninstall interrupt\n");
        fgets(line, sizeof(line), stdin);
        // this calls WD_IntDisable()
        InterruptThreadDisable(thread_handle);
    }
    WD_CardUnregister(hWD, &cardReg);
    ....
}
```

## WD\_TRANSFER

This structure defines a single transfer operation to be performed by WinDriver.

Used by **WD\_Transfer()** [[WD\\_Transfer\(\)](#)], **WD\_MultiTransfer()** [[WD\\_MultiTransfer\(\)](#)], **WD\_IntEnable()** [[WD\\_IntEnable\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	cmdTrans	Transfer command WD_TRANSFER_CMD
DWORD	dwPort	i/o port for transfer or user mem address
DWORD	dwBytes	Number of bytes for string trans
DWORD	fAutoinc	transfer from one port/address o incremental range of addresses
DWORD	dwOptions	must be 0
Union	Data	the data for transfer
UCHAR	Data.Byte	Use for byte transfer
USHORT	Data.Word	Use for word transfer
DWORD	Data.Dword	Use for dword transfer
PVOID	Data.pBuffer	Use for string transfer



## WD\_DMA

Contains information about a DMA buffer. Used by **WD\_DMALock()** [[WD\\_DMALock\(\)](#)] and **WD\_DMAUnlock()** [[WD\\_DMAUnlock\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	hDma	Handle of DMA buffer
PVOID	pUserAddr	Beginning of buffer
DWORD	dwBytes	Size of buffer
DWORD	dwOptions	Allocation options: Bit masked flags '0' for no option, or: DMA_KERNEL_BUFFER_ALLOCATE DMA_KBUF_BELOW_16M DMA_LARGE_BUFFER
DWORD	dwPages	Number of pages in the buffer
WD_DMA_PAGE [ <a href="#">WD_DMA_PAGE</a> ]	Page [ <a href="#">WD_DMA_PAGES</a> ]	Array of pages in the buffer

## WD\_DMA\_PAGE

### MEMBERS:

#### TYPE

PVOID  
DWORD

#### NAME

pPhysicalAddr  
dwBytes

#### DESCRIPTION

physical address of page  
size of page

## WD\_INTERRUPT

Used to describe an interrupt

Used by **WD\_IntEnable()** [[WD\\_IntEnable\(\)](#)], **WD\_IntDisable()** [[WD\\_IntDisable\(\)](#)], **WD\_IntWait()** [[WD\\_IntWait\(\)](#)], **WD\_IntCount()** [[WD\\_IntCount\(\)](#)], **InterruptThreadEnable()** [[InterruptThreadEnable\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	hInterrupt	handle of interrupt
DWORD	dwOptions	interrupt options: Bit masked flags (0 for no option, or: INTERRUPT_LEVEL_SENSITIVE (level sensitive interrupts) or INTERRUPT_CMD_COPY (choose when you need the WinDriver kernel to copy the actions of the read command has done to acknowledge the interrupt back to the user mode)
<b>WD_TRANSFER</b> [ <a href="#">WD_TRANSFER</a> ]	*Cmd	Pointer to commands to perform interrupt
DWORD	dwCmds	number of commands
WD_KERNEL_PLUGIN_CALL	kpCall	kernel plugin call
DWORD	fEnableOk	'1' if WD_IntEnable() succeeded
DWORD	dwCounter	number of interrupts received
DWORD	dwLost	number of interrupts not yet dealt with
DWORD	fStopped	was interrupt disabled during wait

## WD\_VERSION

Describes version of WinDriver in use. Used by **WD\_Version()** [[WD\\_Version\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	dwVer	version
CHAR	cVer[100]	string of version

## WD\_CARD\_REGISTER

Holds a handle to a registered card.

Used by **WD\_CardRegister()** [[WD\\_CardRegister\(\)](#)], **WD\_CardUnregister()** [[WD\\_CardUnregister\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
WD_CARD	Card	card to register
DWORD	fCheckLock Only	only check if card is lockable, re hCard=1 if OK
DWORD	hCard	handle of card

## WD\_CARD

Describes the card's resources.

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	dwItems	Number of items in card
<b>WD_ITEMS</b> <u>[WD_ITEMS]</u>	Item [WD_CARD_ITEMS]	Array of items[0...dwItems-1]

## WD\_ITEMS

Defines each item (resource) in a card.

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	item	ITEM_TYPE
DWORD	fNotSharable	If TRUE, item may not be share
union	I	Item specific information
struct	I.Mem	ITEM_MEMORY
DWORD	I.Mem.dw PhysicalAddr	Physical address on card
DWORD	I.Mem.dwBytes	Address range
DWORD	I.Mem.dwTrans Addr	Returns the address to pass on commands
DWORD	I.Mem.dwUser DirectAddr	Returns the address for direct u read/write
DWORD	dwCpuPhysical Addr	returns the CPU physical address
struct	I.IO	ITEM I/O
DWORD	I.IO.dwAddr	Beginning of I/O address
DWORD	I.IO.dwBytes	I/O range
struct	I.Int	ITEM INTERRUPT
DWORD	I.Int.dwInterrupt	Number of the interrupt to instal
DWORD	I.Int.dwOptions	interrupt options:INTERRUPT_LEVEL_S
DWORD	I.Int.hInterrupt	Returns the handle of the interr installed

## WD\_SLEEP

Defines a sleep command.

Used by **WD\_Sleep()** [[WD\\_Sleep\(\)](#)].

### MEMBERS:

#### TYPE

DWORD

DWORD

#### NAME

dwMicro Seconds

dwOptions

#### DESCRIPTION

Sleep time in micro seconds - 1.  
of a second.  
should be zero



## WD\_PCI\_SLOT

Defines a physical location of a PCI card.

### MEMBERS:

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
DWORD	dwBus	PCI physical bus number of card
DWORD	dwSlot	PCI physical slot number of card
DWORD	dwFunction	PCI function on card

## WD\_PCI\_ID

Defines the identity of a PCI card.

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	dwVendorId	The PCI Vendor ID of the card.
DWORD	dwDeviceId	The PCI Device ID of the card.

## WD\_PCI\_SCAN\_CARDS

Receives information on cards detected on the PCI bus.

Used by **WD\_PciScanCards()** [WD\_PciScanCards()].

### MEMBERS:

TYPE	NAME	DESCRIPTION
WD_PCI_ID	searchId	If searchId.dwVendorId==0, then scan all vendor IDs. If searchId.dwDeviceId==0, then scan all device IDs.
DWORD	dwCards	Number of cards found
<b>WD_PCI_ID</b> [ <u>WD_PCI_ID</u> ]	cardId [ <u>WD_PCI_CARDS</u> ]	VendorID & DeviceID of cards found
<b>WD_PCI_SLOT</b> [ <u>WD_PCI_SLOT</u> ]	cardSlot [ <u>WD_PCI_CARDS</u> ]	PCI slot info of cards found

## WD\_PCI\_CARD\_INFO

Describes a PCI card's resources detected.

Used by **WD\_PciGetCardInfo()** [[WD\\_PciGetCardInfo\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_PCI_SLOT</b> [ <a href="#">WD_PCI_SLOT</a> ]	pciSlot	PCI slot
<b>WD_CARD</b> [ <a href="#">WD_CARD</a> ]	Card	get card parameters for PCI slot

## WD\_PCI\_CONFIG\_DUMP

Defines a read / write command to the PCI configuration registers of a PCI card.

Used by **WD\_PciConfigDump()** [[WD\\_PciConfigDump\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_PCI_SLOT</b> [ <a href="#">WD_PCI_SLOT</a> ]	pciSlot	PCI bus,slot and function number
PVOID	pBuffer	buffer for read/write
DWORD	dwOffset	offset in PCI configuration space
DWORD	dwBytes	read/write from bytes to read/write from/to buffer
DWORD	flsRead	the number of bytes read/written
DWORD	dwResult	FALSE - write PCI config TRUE config 0 - PCI_ACCESS_OK - read/w PCI_ACCESS_ERROR - error 2 PCI_BAD_BUS - bus does not e only) 3 - PCI_BAD_SLOT - slot does not exist (read only)

## WD\_ISAPNP\_CARD\_ID

Identifies a specific ISA Plug and Play card on the ISA bus.

### MEMBERS:

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
CHAR	cVendor [8]	Vendor ID
DWORD	dwSerial	Serial number of card

## WD\_ISAPNP\_CARD

Information on an ISA Plug and Play card.

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_ISAPNP_CARD_ID</b>	cardId	Vendor ID and serial number of
<u>WD_ISAPNP_CARD_ID</u>		
DWORD	dwLogicalDevices	Number of logical devices on the
BYTE	bPnPVersionMajor	ISA PnP version major
BYTE	bPnPVersionMinor	ISA PnP version minor
BYTE	bVendorVersionMajor	Vendor version major
BYTE	bVendorVersionMinor	Vendor version minor
WD_ISAPNP_ANSI	clIdent	Device identifier

## WD\_ISAPNP\_SCAN\_CARDS

Used to receive information on cards detected on the ISA PnP bus.

Used by **WD\_IsapnpScanCards()** [[WD\\_IsapnpScanCards\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_ISAPNP_CARD_ID</b> [ <a href="#">WD_ISAPNP_CARD_ID</a> ]	searchId	If searchId.cVendorId[0]==0, the vendor IDs. If searchId.dwSerial scan all serial numbers.
DWORD <b>WD_ISAPNP_CARD</b> [ <a href="#">WD_ISAPNP_CARD</a> ]	dwCards Card [ <a href="#">WD_ISAPNP_CARDS</a> ]	Number of cards found cards found



## WD\_ISAPNP\_CARD\_INFO

Describes an ISA PnP card device's resources detected.

Used by **WD\_IsapnpGetCardInfo()** [[WD\\_IsapnpGetCardInfo\(\)](#)]

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_ISAPNP_CARD_ID</b> [ <a href="#">WD_ISAPNP_CARD_ID</a> ] DWORD	cardId  dwLogicalDevice	Vendor ID and serial number of which information is required Number of the logical device for information is requested
WD_ISAPNP_COMP_ID DWORD WD_ISAPNP_COMP_ID	logicalDeviceId[8] dwCompatibleDevices CompatibleDevice [ <a href="#">WD_ISAPNP_COMPATIBLE_IDS</a> ]	ascii of logical device id found Number of compatible devices f Compatible device IDs
WD_ISAPNP_ANSI <b>WD_CARD</b> [ <a href="#">WD_CARD</a> ]	cldent Card	Identity of device The card resource information

## WD\_ISAPNP\_CONFIG\_DUMP

Defines a read / write command to the ISA PnP configuration registers of an ISA PnP card.

Used by **WD\_IsapnpConfigDump()** [[WD\\_IsapnpConfigDump\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_ISAPNP_CARD_ID</b> <u>[WD_ISAPNP_CARD_ID]</u>	cardId	VendorID and serial number of card
DWORD	dwOffset	offset in ISA PnP configuration space read/write from
DWORD	flsRead	if 1, then read ISA PnP configuration write ISA PnP configuration
BYTE	bData	result data of byte read/write
DWORD	dwResult	ISAPNP_ACCESS_RESULT

## WD\_PCMCIA\_SLOT

Defines a physical location of a PCMCIA card.

### MEMBERS:

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
BYTE	uSocket	Specifies the socket number (first function is 0)
BYTE	uFunction	Specifies the function number (first function is 0)

## WD\_PCMCIA\_ID

Defines the identity of a PCMCIA card.

### MEMBERS:

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
CHAR	cVersion[WD_PCMCIA_VERSION_LEN]	The Card's PCMCIA version
CHAR	cManufacturer[WD_PCMCIA_MANUFACTURER_LEN]	Manufacturer name
CHAR	cProductName[WD_PCMCIA_PRODUCT_NAME_LEN]	Product name
USHORT	cChecksum	Card's CRC checksum value

## WD\_PCMCIA\_SCAN\_CARDS

Receives information on cards detected on the PCMCIA bus.

Used by **WD\_PcmciaScanCards()** [[WD\\_PcmciaScanCards\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_PCMCIA_ID</b> [ <a href="#">WD_PCMCIA_ID</a> ]	searchId	if strlen(searchId.cManufacturer) > 0, scan all Manufacturers. if strlen(searchId.cProductName) > 0, scan all product names.
DWORD <b>WD_PCMCIA_ID</b> [ <a href="#">WD_PCMCIA_ID</a> ]	dwCards cardId[ <a href="#">WD_PCMCIA_CARDS</a> ]	Number of cards found Manufacturer Name, Product Name, Version and CRC Info of card found
<b>WD_PCMCIA_SLOT</b> [ <a href="#">WD_PCMCIA_SLOT</a> ]	cardSlot[ <a href="#">WD_PCMCIA_CARDS</a> ]	PCMCIA slot/function info of card

## WD\_PCMCIA\_CARD\_INFO

Describes a PCMCIA card's resources detected.

Used by **WD\_PcmciaGetCardInfo()** [[WD\\_PcmciaGetCardInfo\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_PCMCIA_SLOT</b> [ <a href="#">WD_PCMCIA_SLOT</a> ]	pcmciaSlot	PCMCIA slot information
<b>WD_CARD</b> [ <a href="#">WD_CARD</a> ]	Card	get card parameters for PCMCIA

## WD\_PCMCIA\_CONFIG\_DUMP

Defines a read / write command to the PCMCIA configuration registers of a PCMCIA card.

Used by **WD\_PcmciaConfigDump()** [[WD\\_PciConfigDump\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<b>WD_PCMCIA_SLOT</b> <u>[WD_PCMCIA_SLOT]</u>	pcmciaSlot	Slot descriptor of PCMCIA card
PVOID	pBuffer	buffer for read/write
DWORD	dwOffset	offset in <b>pcmcia</b> PnP configuration from which to read/write
DWORD	dwBytes	bytes to read from or write to buffer
DWORD	flsRead	Returns the number of bytes read if 1, then read pci config if 0, the config
DWORD	dwResult	PCMCIA_ACCESS_RESULT

## WD\_USB\_ID

Defines the identity of the USB device.

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	dwVendorId	Vendor ID of the USB device
DWORD	dwProductId	product ID of the USB device



## WD\_USB\_PIPE\_INFO

Information about a pipe.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	dwNumber	The number of the pipe (Pipe 0 is the default pipe)
DWORD	dwMaximum PacketSize	the maximum packet size of interrupt transfers on the pipe
DWORD	type	Control, Isochronous, Bulk or Interrupt
DWORD	direction	In=1, out=2 or in&out=3
DWORD	dwInterval	Intervals of data transfer in ms (0 for Interrupt pipes)

## WD\_USB\_CONFIG\_DESC

Describes a configuration.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	dwNumInter faces	the configuration number
DWORD	dwValue	the device value
DWORD	dwAttributes	the device attributes
DWORD	Maxpower	the device MaxPower

## WD\_USB\_INTERFACE\_DESC

Describes an interface.

### MEMBERS

#### TYPE

DWORD  
DWORD  
DWORD  
DWORD  
DWORD  
DWORD  
DWORD

#### NAME

dwNumber  
dwAlternate Setting  
dwNumEnd points  
dwClass  
dwSubClass  
dwProtocol  
dwIndex

#### DESCRIPTION

the interface number  
the interface alternate value  
the number of endpoints in the i  
the interface class  
the interface sub class  
the interface protocol  
the index of the interface

## WD\_USB\_ENDPOINT\_DESC

Describes an endpoint.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	dwEndpoint Address	end point address
DWORD	dwAttributes	end point attributes
DWORD	dwMaxPacket Size	maximum packet size
DWORD	dwInterval	interval in milli-seconds

## WD\_USB\_INTERFACE

Holds interface data.

### MEMBERS

TYPE	NAME	DESCRIPTION
<b>WD-USB-INTER FACE-DESC</b> <u>[WD_USB_INTERFACE_DESC]</u>	Interface	the interface description
<b>WD-USB-END POINT-DESC</b> <u>[WD_USB_ENDPOINT_DESC]</u>	Endpoints[]	list of the interface endpoints

## WD\_USB\_CONFIGURATION

Holds configuration data.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	uniqueId	the unique ID of the device
DWORD	dwConfiguration Index	the Configuration Index
<b>WD-USB-CONFIG- DESC</b> <u>[WD_USB_CONFIG_DESC]</u>	configuration	the configuration description
DWORD	dwInterfaceAl ternatives	number of interfaces and their a
<b>WD-USB-INTER FACE</b> <u>[WD_USB_INTERFACE]</u>	Interface[]	list of configuration interfaces

## WD\_USB\_HUB\_GENERAL\_INFO

Holds hub information (if the selected device is a hub).

### MEMBERS

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
DWORD	fBusPowered	is bus powered or self powered
DWORD	dwPorts	number of ports on this hub
DWORD	dwCharacter istics	hub characteristics
DWORD	dwPowerOn ToPowerGood	port power on till power good in
DWORD	dwHubControl Current	max current in mA

## WD\_USB\_DEVICE\_GENERAL\_INFO

General information about the device.

### MEMBERS

TYPE	NAME	DESCRIPTION
WD_USB_ID [WD_USB_ID] DWORD	deviceId	the vendor ID and product ID of
	dwHubNum	the number of the hub to which is attached
DWORD	dwPortNum	the number of the port on the hu the device is attached
DWORD	fHub	is the device itself a hub?
DWORD	fFullSpeed	full speed or low speed device?
DWORD	dwConfigurations Num	how many configurations does t have?
DWORD	deviceAddress	the physical address of the devi
WD_USB_HUB_GENERAL_INFO [WD_USB_HUB_GENERAL_INFO]	hubInfo	contains information about the c the device is a Hub



## WD\_USB\_DEVICE\_INFO

Holds device pipes information.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	dwPipes	number of pipes
WD-USB- PIPE-INFO	Pipe[]	the list of pipes information
<u>[WD_USB_PIPE_INFO]</u>		

## WD\_USB\_SCAN\_DEVICES

Define a scan command.

### MEMBERS

TYPE	NAME	DESCRIPTION
WD_USB_ID [WD_USB_ID]	searchId	if dwvendorId ==0, then scan all IDs. if dwProductId ==0, then scan products.
DWORD	dwDevices	Number of devices found
DWORD	uniqueId[]	a list of the uniqueIDs to identify devices
WD_USB_DEVICE_GENERAL_INFO [WD_USB_DEVICE_GENERAL_INFO]	deviceGeneral Info[]	list of general information about devices found

## WD\_USB\_TRANSFER

Defines a transfer command.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	hDevice	handle of USB device to read from / write to
DWORD	dwPipe	pipe number on device
DWORD	fRead	read or write
DWORD	dwOptions	can be USB_TRANSFER_HALT or USB_TRANSFER_WAIT; the previous transfer on the same pipe
DWORD	pBuffer	pointer to buffer to read / write
DWORD	dwBytes	the size of the buffer
DWORD	dwTimeout	transfer timeout(milliseconds) 0: no timeout
DWORD	dwBytes Transferred	returns the number of bytes actually written
BYTE	SetupPacket[8]	setup packet for control pipe transfer
DWORD	fOK	return TRUE if the transfer is successful

## WD\_USB\_DEVICE\_REGISTER

Define a device registration command.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	uniqueId	the unique ID of the device
DWORD	dwConfiguration Index	the index of the configuration to
DWORD	dwInterfaceNum	interface to register
Dword	dwInterfaceAl ternate	alternate number of the interface
		register
DWORD	hDevice	handle of the device
WD_USB_DEVICE_INFO	Device	description of the device
<u>WD_USB_DEVICE_INFO</u>		
DWORD	dwOptions	should be zero
CHAR	cName[32]	name of card
CHAR	cDescription [100]	description

## WD\_USB\_RESET\_PIPE

Defines a reset pipe command.

### MEMBERS

TYPE	NAME	DESCRIPTION
DWORD	hDevice	handle of the device
DWORD	dwPipe	number of the pipe to reset

## Overview of the Development Process for the PLX9050 Using WinDriver's PLX9050 API

1. Run the PLX9050 diagnostics (P50\_DIAG.EXE) to diagnose your card.
2. Use the P50\_DIAGs source code as your skeletal device driver.
3. Modify the P50\_DIAGs code to suit your application. Use the PLX9050 function reference to add your own code.
4. If the User Mode driver you have created in the above steps contains some parts which in which performance must be enhanced (an interrupt handler for example), please see Section [Kernel PlugIn](#). There, you learn how to move parts of your source code to the WinDriver Kernel PlugIn, thereby eliminating any calling overhead, and achieving maximal performance.

## What is the PLX9050 Diagnostics?

PLX9050 Diagnostics is a ready-to-run sample diagnostics application for PLX9050. The diagnostics program accesses the hardware via WinDrivers PLX9050 API (P50LIB.C). It is written as a console mode application, and not as a GUI application, to simplify the understanding of the source code of the diagnostics program. This will help you learn how to properly use the PLX9050 API.

This application can be used as your skeletal device driver. If your driver is not a console mode application, just remove the printf() calls from the code (you may replace them with MessageBox() if you wish). Besides P50\_DIAG.C being an example of using the PLX9050 API, it is also a useful diagnostics utility.

## Using PLX9050 Diagnostics

[Introduction](#)

[Main Menu Options](#)



## Creating the driver project without using the P50\_DIAG as the skeletal driver code

- Add P50LIB.C to your project or your make file.
- Include p50lib.h in your driver source code.

**NOTE:** In your \windrvr\plx\9050\p50\_diag folder, you will find the source code for P50\_DIAG.EXE. Double click the mdp file (which contains the project environment used to compile this code) in this directory to start your MSDEV with the proper settings for a project. You may use this as your skeletal code.

- Call P9050\_Open() at beginning of your code to get a handle to your card.
- After locating your card, you may read / write to memory, enable / disable interrupts, and more, using any of these functions:

1. P9050\_IsAddrSpaceActive()
2. P9050\_ReadReg ()
3. P9050\_WriteReg ()
4. P9050\_ReadSpaceBlock()
5. P9050\_WriteSpaceBlock()
6. P9050\_ReadSpaceByte()
7. P9050\_ReadSpaceWord()

8. P9050\_ReadSpaceDWord()

9. P9050\_WriteSpaceByte()

10. P9050\_WriteSpaceWord()

11. P9050\_WriteSpaceDWord()

12. P9050\_ReadBlock()

13. P9050\_WriteBlock()

14. P9050\_ReadByte()

15. P9050\_ReadWord()

16. P9050\_ReadDWord()

17. P9050\_WriteByte()

18. P9050\_WriteWord()

19. P9050\_WriteDWord()

20. P9050\_IntIsEnabled()

21. P9050\_IntEnable()

22. P9050\_IntDisable()

23. P9050\_EEPROMReadWord()

24. P9050\_EEPROMWriteWord()

25. P9050\_ReadPCIReg()

26. P9050\_WritePCIReg()

- Call P9050\_Close() before end of code.

**NOTES:**

1. Using one of the sample drivers included with WinDriver as your skeletal code may shorten the development process. (see Section Sample Code that illustrates the sample code.)
2. After development of the driver is through, follow the Re-Distribution procedure.

Sample

## WinDriver's PLX9050 API Function Reference

Use this section as a quick reference to the WinDrivers PLX 9050 API functions. This reference may also be found in the WinDriver Help files. Advanced users may find more functionality in the WinDrivers API. All the functions outlined in the FunctionReference are implemented in the \windrvr\plx\9050\lib\p50lib.c file. The definition of the structures used in the following functions may be found in the PLX 9050 structure reference.

P9050\_CountCards()

P9050\_Open()

P9050\_Close()

P9050\_IsAddrSpaceActive()

P9050\_ReadReg(), P9050\_WriteReg()

P9050\_ReadSpaceByte(), P9050\_ReadSpaceWord(), P9050\_ReadSpaceDWord()

P9050\_WriteSpaceByte(), P9050\_WriteSpaceWord(), P9050\_WriteSpaceDWord()

P9050\_ReadSpaceBlock(), P9050\_WriteSpaceBlock()

P9050\_ReadByte(), P9050\_ReadWord(), P9050\_ReadDWord()

P9050\_WriteByte(), P9050\_WriteWord(), P9050\_WriteDWord()

P9050\_ReadBlock(), P9050\_WriteBlock()

P9050\_IntIsEnabled()

P9050\_IntEnable()

P9050\_IntDisable()

P9050\_EEPROMReadWord(), P9050\_EEPROMWriteWord()

P9050\_ReadPCIReg(), P9050\_WritePCIReg()

## **PLX 9050 API Structure Reference**

These structures are used only in conjunction with the PLX API.

PLX Register Definitions

P9050\_MODE

P9050\_ADDR

P9050\_INT\_RESULT

## Trouble-Shooting

P9050\_Open() fails

## Overview of the Development Process for the PLX9060 / PLX9080 Using WinDriver's PLX9060 API

1. Run the PLX9060 diagnostics (P60\_DIAG.EXE) to diagnose your card.
2. Use the P60\_DIAGs source code as your skeletal device driver.
3. Modify the P60\_DIAGs code to suite your application. Use the PLX9060 function reference to add your own code.
4. If the User Mode driver you have created in the above steps contains some parts for which the performance must be enhanced (an interrupt handler for example), see Section [Kernel PlugIn](#). It shows you how to move parts of your source code to WinDriver's Kernel PlugIn.

## What is PLX9060 Diagnostics?

PLX9060 Diagnostics is a ready-to-run sample diagnostics application for PLX9060. The diagnostics program accesses the hardware via WinDrivers PLX 9060/9080 API (P60LIB.C). It is written as a console mode application, and not as a GUI application, to simplify the understanding of the source code of the diagnostics program. This will help you learn how to properly use the PLX 9060/9080 API.

This application can be used as your skeletal device driver. If your driver is not a console mode application, just remove the printf() calls from the code (you may replace them with MessageBox() if you wish). Besides P60\_DIAG.C being an example of using the PLX 9060/9080 API, it is also a useful diagnostics utility.



## Using PLX9060 Diagnostics

[Introduction](#)

[Main Menu Options](#)

## Creating the Driver Project without using the P60\_DIAG as the Skeletal Driver Code

- Add P60LIB.C to your project or your make file.
- Include p60lib.h in your driver source code.

**NOTE:** In your \windrvr\plx\9060\p60\_diag folder, you will find the source code for P60\_DIAG.EXE. Double click the mdp file (which contains the project environment used to compile this code) in this directory to start your MSDEV with the proper settings for a project. You may use this as your skeletal code.

- Call P9060\_Open() at beginning of your code to get a handle to your card.
- After locating your card, you may read / write to memory, enable / disable interrupts, and more, using any of these functions:

1. P9060\_IsAddrSpaceActive()
2. P9060\_ReadReg()
3. P9060\_WriteReg()
4. P9060\_ReadSpaceBlock()
5. P9060\_WriteSpaceBlock()
6. P9060\_ReadSpaceByte()
7. P9060\_ReadSpaceWord()
8. P9060\_ReadSpaceDWord()
9. P9060\_WriteSpaceByte()
10. P9060\_WriteSpaceWord()
11. P9060\_WriteSpaceDWord()
12. P9060\_ReadBlock()
13. P9060\_WriteBlock()

14. P9060\_ReadByte()
15. P9060\_ReadWord()
16. P9060\_ReadDWord()
17. P9060\_WriteByte()
18. P9060\_WriteWord()
19. P9060\_WriteDWord()
20. P9060\_IntIsEnabled()
21. P9060\_IntEnable()
22. P9060\_IntDisable()
23. P9060\_ReadPCIReg()
24. P9060\_WritePCIReg()

- Call P9060\_Close() before end of code.

**NOTES:**

1. Using one of the sample drivers included with WinDriver as your skeletal code may shorten the development process.
2. After development of the driver is through, follow the Re-Distribution procedure.

Sample Code

## WinDriver's PLX 9060/9080 API Function Reference

Use this appendix as a quick reference to the WinDrivers PLX 9060/9080 functions. This reference may also be found in the WinDriver Help files. Advanced users may find more functionality in the WinDriver API.

All the functions outlined in FunctionReference are implemented in the \windrvr\plx\9060\lib\p60lib.c file. The definition of the structures used in the following functions may be found in the PLX 9060 / 9080 structure reference.

P9060\_CountCards()

P9060\_Open()

P9060\_Close()

P9060\_IsAddrSpaceActive()

P9060\_ReadReg(), P9060\_WriteReg()

P9060\_ReadSpaceByte(), P9060\_ReadSpaceWord(), P9060\_ReadSpaceDWord()

P9060\_WriteSpaceByte(), P9060\_WriteSpaceWord(), P9060\_WriteSpaceDWord()

P9060\_ReadSpaceBlock(), P9060\_WriteSpaceBlock()

P9060\_ReadByte(), P9060\_ReadWord(), P9060\_ReadDWord()

P9060\_WriteByte(), P9060\_WriteWord(), P9060\_WriteDWord()

P9060\_ReadBlock(), P9060\_WriteBlock()

P9060\_IntIsEnabled()

P9060\_IntEnable()

P9060\_IntDisable()

P9060\_ReadPCIReg(), P9060\_WritePCIReg()

## **PLX 9060 API Structure Reference**

These structures are used only in conjunction with the PLX API.

PLX Register Definitions

P9060\_MODE

P9060\_INT\_RESULT

## Trouble-Shooting

P9060\_Open() fails.

## Overview of the Development Process for the AMCC S5933 Using WinDriver's AMCC API

1. Run the AMCC-S5933 diagnostics (AMCCDIAG.EXE) to diagnose your card.
2. Use the AMCCDIAGs source code as your skeletal device driver.
3. Modify the AMCCDIAGs code to suite your application. Use the AMCC S5933 function reference to add your own code.
4. If the User Mode driver you have created in the above steps contains some parts which in which the performance must be enhanced (an interrupt handler for example), see Section [Kernel PlugIn](#) . It will show you how to move parts of your source code to the WinDriver Kernel PlugIn.

## What is AMCC Diagnostics?

AMCC Diagnostics is a ready-to-run sample diagnostics application for AMCC S5933. The diagnostics program accesses the hardware via WinDriver's AMCC API (AMCCLIB.C). It is written as a console mode application, and not as a GUI application, to simplify the understanding of the source code of the diagnostics program. This will help you learn how to properly use the AMCC API.

This application can be used as your skeletal device driver. If your driver is not a console mode application, just remove the printf() calls from the code (you may replace them with MessageBox() if you wish). Besides AMCCDIAG.C being an example of using the AMCC API, it is also a useful diagnostics utility.



## Using the AMCC Diagnostics

[Introduction](#)

[Main Menu Options](#)

## Creating the Driver Project without using the AMCCDIAG as the Skeletal Driver Code

- Add AMCCLIB.C to your project or your make file.
- Include amcclib.h in your driver source code.

**NOTE:** In your \windrvr\amcc\amccdiag folder, you will find the source code for AMCCDIAG.EXE. Double click the mdp file (which contains the project environment used to compile this code) in this directory to start your MSDEV with the proper settings for a project. You may use this as your code.

- Call AMCC\_Open() at beginning of your code to get a handle to your card.
- After locating your card, you may read / write to memory, enable / disable interrupts, and more, using any of these functions:

1. AMCC\_IsAddrSpaceActive()
2. AMCC\_ReadReg ()
3. AMCC\_WriteReg ()
4. AMCC\_ReadByte()
5. AMCC\_ReadWord()
6. AMCC\_ReadDWord()
7. AMCC\_WriteByte()
8. AMCC\_WriteWord()
9. AMCC\_WriteDWord()
10. AMCC\_ReadSpaceBlock()
11. AMCC\_WriteSpaceBlock()
12. AMCC\_IntIsEnabled()
13. AMCC\_IntEnable()

14. AMCC\_IntDisable()

15. AMCC\_ReadPCIReg()

16. AMCC\_WritePCIReg()

17. AMCC\_DMAOpen()

18. AMCC\_DMAClose()

19. AMCC\_DMAStart()

20. AMCC\_DMAIsDone()

- Call AMCC\_Close() before end of code.

**NOTES:**

1. Using one of the sample drivers included with WinDriver as your skeletal code may shorten the development process. (see Section [Sample Code](#) that illustrates the sample code).
2. After development of the driver is through, follow the Re-Distribution procedure.

## Sample Code

Sample uses of WinDriver and WinDriver for AMCC are supplied with the WinDriver toolkit. You may find the WinDriver samples under \windrvr\samples, and the WinDriver for AMCC samples under \windrvr\AMCC.

Each directory contains a files.txt file which describes the various samples included. Each sample is located in its own directory. For your convenience, we have supplied an mdp file alongside of each .c file, so that users of Microsoft's developer studio may double-click the mdp file and have the whole environment ready for compilation. (Users of different win32 compilers need to include the \*.c files in their standalone console project, and include the AMCCLIB in their project) You may learn to use the WinDriver for AMCC API by looking at amcclib.c which is found in \windrvr\amcc\amccdiag.c . amccdiag.c is the source code of the AMCC diagnostics program found under Start \Programs \ WinDriver.

## WinDriver's AMCC S5933 API Function Reference

Use this appendix as a quick reference to the WinDrivers AMCC S5933 functions. This reference may also be found in the WinDriver Help files. Advanced users may find more functionality in the WinDrivers API. All of the functions outlined in FunctionReference are implemented in the \windrvr\amcc\lib\amcclib.c file. The definition of the structures used in the following functions may be found in the AMCC S5933 structure reference.

AMCC\_CountCards()

AMCC\_Open()

AMCC\_Close()

AMCC\_IsAddrSpaceActive()

AMCC\_ReadRegByte(),AMCC\_ReadRegWord(),AMCC\_ReadRegDWord()

AMCC\_WriteRegByte(),AMCC\_WriteRegWord(),AMCC\_WriteRegDWord()

AMCC\_ReadByte(),AMCC\_ReadWord(),AMCC\_ReadDWord()

AMCC\_WriteByte(),AMCC\_WriteWord(),AMCC\_WriteDWord()

AMCC\_ReadSpaceBlock(),AMCC\_WriteSpaceBlock()

AMCC\_IntIsEnabled()

AMCC\_IntEnable()

AMCC\_IntDisable()

AMCC\_ReadPCIReg(),AMCC\_WritePCIReg()

## **AMCC S5933 API Structure Reference**

PCI Configuration Registers Definitions

AMCC\_ADDR

AMCC\_INT\_RESULT

## Trouble-Shooting

AMCC\_Open() fails.

## Overview of the Development Process for the V3 PBC using WinDriver's V3 PBC API

1. Run the V3-PBC diagnostics (PBC\_DIAG.EXE) to diagnose your card.
2. Use the PBC\_DIAGs source code as your skeletal device driver.
3. Modify the PBC\_DIAGs code to suit your application. Use the V3 PBC function reference to add your own code.
4. If the User Mode driver you have created in the above steps contains some parts which in which the performance must be enhanced (an interrupt handler for example), see Chapter [Kernel Plugin](#). It shows you how to move parts of your source code to the WinDriver Kernel Plugin.



## What is V3 PBC Diagnostics?

V3 PBC Diagnostics is a ready-to-run sample diagnostics application for V3 PBC. The diagnostics program accesses the hardware via WinDriver's V3 PBC API (PBCLIB.C). It is written as a console mode application, and not as a GUI application, to simplify the understanding of the source code of the diagnostics program. This will help you learn how to properly use the V3 PBC API.

This application can be used as your skeletal device driver. If your driver is not a console mode application, just remove the printf() calls from the code (you may replace them with MessageBox() if you wish). Besides PBC\_DIAG.C being an example of using the V3 PBC API, it is also a useful diagnostics utility.

## Using the V3 PBC Diagnostics

[Introduction](#)

[Main Menu Options](#)

## Creating the Driver Project without using the PBC\_DIAG as the Skeletal Driver Code

- Add PBCLIB.C to your project or your make file.
- Include pbclib.h in your driver source code.

**NOTE:** In your `\windrvr\V3\pbc_diag` folder, you will find the source code for `PBC_DIAG.EXE`. Double click the `mdp` file (which contains the project environment used to compile this code) in this directory to start your MSDEV with the proper settings for a project. You may use this as your skeletal code.

- Call `V3PBC_Open()` at beginning of your code to get a handle to your card.
  - After locating your card, you may read / write to memory, enable / disable interrupts, and more, using any of these functions:

1. `V3PBC_IsAddrSpaceActive()`
2. `V3PBC_GetRevision()`
3. `V3PBC_ReadRegByte ()`
4. `V3PBC_ReadRegWord ()`
5. `V3PBC_ReadRegDWord ()`
6. `V3PBC_WriteRegByte ()`
7. `V3PBC_WriteRegWord ()`
8. `V3PBC_WriteRegDWord ()`
9. `V3PBC_ReadSpaceBlock()`
10. `V3PBC_WriteSpaceBlock()`
11. `V3PBC_ReadSpaceByte()`
12. `V3PBC_ReadSpaceWord()`
13. `V3PBC_ReadSpaceDWord()`

14. V3PBC\_WriteSpaceByte()
15. V3PBC\_WriteSpaceWord()
16. V3PBC\_WriteSpaceDWord()
17. V3PBC\_ReadBlock()
18. V3PBC\_WriteBlock()
19. V3PBC\_ReadByte()
20. V3PBC\_ReadWord()
21. V3PBC\_ReadDWord()
22. V3PBC\_WriteByte()
23. V3PBC\_WriteWord()
24. V3PBC\_WriteDWord()
25. V3PBC\_IntIsEnabled()
26. V3PBC\_IntEnable()
27. V3PBC\_IntDisable()
28. V3PBC\_DMAOpen()
29. V3PBC\_DMAClose()
30. V3PBC\_DMAStart()
31. V3PBC\_DMAIsDone()
32. V3PBC\_EEPROMInit()
33. V3PBC\_EEPROMRead()

**34.** V3PBC\_EEPROMWrite()

**35.** V3PBC\_ReadPCIReg()

**36.** V3PBC\_WritePCIReg()

- Call V3PBC\_Close() before end of code.

**NOTES:**

1. Using one of the sample drivers included with WinDriver as your skeletal code may shorten the development process. (See Section Sample Code that illustrates the sample code).
2. After development of the driver is through, follow the Re-Distribution procedure.

## Sample Code

Sample uses of WinDriver and WinDriver for V3 are supplied with the WinDriver toolkit. You may find the WinDriver samples under `\windrvr\samples`, and the WinDriver for V3 samples under `\windrvr\V3`.

Each directory contains a `files.txt` file which describes the various samples included. Each sample is located in its own directory. For your convenience, we have supplied an `mdp` file alongside each `.c` file, so that users of Microsoft's developer studio may double-click the `mdp` file and have the whole environment ready for compilation. (Users of different win32 compilers need to include the `.c` files in their standalone console project, and include the `PBCLIB` in their project) You may learn to use the WinDriver for V3 API by looking at `pbclib.c` which is found in `\windrvr\V3\pbclib.c`. `pbclib.c` is the source code of the V3 PBC diagnostics program found under `Start\Programs\WinDriver`.

## WinDriver's V3 PBC API Function Reference

Use this appendix as a quick reference to the WinDrivers V3 PBC functions. This reference may also be found in the WinDriver Help files. Advanced users may find more functionality in the WinDriver API. All the functions outlined in FunctionReference are implemented in the \windrvr\v3\lib\pbclib.c file. The definition of the structures used in the following functions may be found in the V3 PBC structure reference.

V3PBC\_CountCards()

V3PBC\_Open()

V3PBC\_Close()

V3PBC\_IsAddrSpaceActive()

V3PBC\_GetRevision()

V3PBC\_ReadRegByte(), V3PBC\_ReadRegWord(), V3PBC\_ReadRegDWord()

V3PBC\_WriteRegByte(), V3PBC\_WriteRegWord(), V3PBC\_WriteRegDWord()

V3PBC\_ReadSpaceByte(), V3PBC\_WriteSpaceByte(), V3PBC\_ReadSpaceWord(),

V3PBC\_WriteSpaceWord(), V3PBC\_ReadSpaceDWord(), V3PBC\_WriteSpaceDWord()

V3PBC\_ReadSpaceBlock(), V3PBC\_WriteSpaceBlock()

V3PBC\_ReadBlock(), V3PBC\_WriteBlock()

V3PBC\_ReadByte(), V3PBC\_ReadWord(), V3PBC\_WriteByte(), V3PBC\_ReadDWord(),

V3PBC\_WriteWord(), V3PBC\_ReadDWord(), V3PBC\_WriteDWord()

V3PBC\_IntIsEnabled()

V3PBC\_IntEnable()

V3PBC\_IntDisable()

V3PBC\_ReadPCIReg(), V3PBC\_WritePCIReg()

V3PBC\_DMAOpen()

V3PBC\_DMAClose()

V3PBC\_DMAStart()

V3PBC\_DMAIsDone()

V3PBC\_PulseLocalReset()

V3PBC\_EEPROMInit()

V3PBC\_EEPROMWrite()

V3PBC\_EEPROMRead()

## PCI Configuration Registers Definitions

Use for V3PBC\_ReadReg() & V3PBC\_WriteReg() functions.

1. V3PBC\_PCI\_VENDOR = 0x00
2. V3PBC\_PCI\_DEVICE = 0x02
3. V3PBC\_PCI\_CMD = 0x04
4. V3PBC\_PCI\_STAT = 0x06
5. V3PBC\_PCI\_CC\_REV = 0x08
6. V3PBC\_PCI\_HDR\_CFG = 0x0c
7. V3PBC\_PCI\_IO\_BASE = 0x10
8. V3PBC\_PCI\_BASE0 = 0x14
9. V3PBC\_PCI\_BASE1 = 0x18
10. V3PBC\_PCI\_SUB\_VENDOR = 0x2c
11. V3PBC\_PCI\_SUB\_ID = 0x2e
12. V3PBC\_PCI\_ROM = 0x30
13. V3PBC\_PCI\_BPARM = 0x3c
14. V3PBC\_PCI\_MAP0 = 0x40
15. V3PBC\_PCI\_MAP1 = 0x44
16. V3PBC\_INT\_STAT = 0x48
17. V3PBC\_INT\_CFG = 0x4c
18. V3PBC\_LB\_BASE0 = 0x54



19. V3PBC\_LB\_BASE1 = 0x58
20. V3PBC\_LB\_MAP0 = 0x5e
21. V3PBC\_LB\_MAP1 = 0x62
22. V3PBC\_LB\_IO\_BASE = 0x6e
23. V3PBC\_FIFO\_CFG = 0x70
24. V3PBC\_FIFO\_PRIORITY = 0x72
25. V3PBC\_FIFO\_STAT = 0x74
26. V3PBC\_LB\_ISTAT = 0x76
27. V3PBC\_LB\_IMASK = 0x77
28. V3PBC\_SYSTEM = 0x78
29. V3PBC\_LB\_CFG = 0x7a
30. V3PBC\_DMA\_PCI\_ADDR0 = 0x80
31. V3PBC\_DMA\_LOCAL\_ADDR0 = 0x84
32. V3PBC\_DMA\_LENGTH0 = 0x88 // mask off upper 8 bits
33. V3PBC\_DMA\_CSR0 = 0x8b
34. V3PBC\_DMA\_CTLB\_ADR0 = 0x8c
35. V3PBC\_DMA\_PCI\_ADDR1 = 0x90
36. V3PBC\_DMA\_LOCAL\_ADDR1 = 0x94
37. V3PBC\_DMA\_LENGTH1 = 0x98 // mask off upper 8 bits
38. V3PBC\_DMA\_CSR1 = 0x9b

**39.** V3PBC\_DMA\_CTLB\_ADR1 = 0x9c

V3PBC\_ADDR

V3PBC\_INT\_RESULT

## Trouble-Shooting

V3PBC\_Open() fails

## Performing DMA

If you are not using a PCI chip which has enhanced support WinDriver (currently - PLX, Galileo, Altera, V3 or AMCC) these few pages will guide you through the steps of performing DMA via WinDriver's API.

There are basically two methods to perform DMA - **Contiguous Buffer DMA** and **Scatter/Gather DMA**. Scatter/Gather DMA is much more efficient than contiguous DMA. This feature allows the PCI device to copy memory blocks from different addresses. This means that the transfer can be done directly to/from the user's buffer - that is contiguous in Virtual memory, but fragmented in the Physical memory. If your PCI device does not support Scatter/Gather, you will need to allocate a physically contiguous memory block, perform the DMA transfer to there, and then copy the data to your own buffer.

The programming of DMA is specific for different PCI devices. Normally, you need to program your PCI device with the Local address (on your PCI device), the Host address (the physical memory address on your PC), the transfer count (size of block to transfer), and then set the register that initiates the transfer.

[Scatter/Gather DMA](#)

[Contiguous Buffer DMA](#)

## Handling Interrupts

Interrupts can easily be handled via DriverWizard. It is recommended that you use DriverWizard to generate the interrupt code for you, by defining (or auto-detecting) your hardware's interrupts, and generating code. Use this section to understand the code DriverWizard generates for you or to write your own Interrupt handler.

[General - Handling an Interrupt](#)

[Simplified interrupt handling using \*windrvr\\_int\\_thread.h\*](#)

[ISA / EISA and PCI interrupts](#)

[Interrupts in Windows CE](#)

[PCMCIA interrupts in Windows CE](#)

## **USB Control Transfers**

[USB Data Exchange](#)

[More about the Control Transfer](#)

[The Setup Packet](#)

[USB Setup Packet Format](#)

[Standard device requests codes](#)

[Setup Packet example](#)

## Performing Control Transfers with WinDriver

WinDriver allows you to easily send and receive control transfers on Pipe00, while using DriverWizard to test your device and within WinDriver API.

[Control Transfers with DriverWizard](#)

[Control Transfers with WinDriver API](#)

## Improving performance of your device driver - Overview

Once your User Mode driver has been written and debugged, you might find that certain modules in your code do not operate fast enough (for example - an interrupt handler or accessing IO mapped regions). If this is the case, try to improve the performance by any one of the two ways suggested in this chapter.

1. Improve the performance of your User Mode driver.
2. Move the performance critical parts of your code into WinDriver's **Kernel PlugIn**.

that the Kernel PlugIn is not implemented under Windows CE and VxWorks since in these OSes there is no separation between kernel mode and user mode. As such, top performance can be achieved without using the Kernel PlugIn.

Use the checklist below to determine how the performance should be improved in your driver.



## Performance improvement checklist

The following "Checklist" will help you determine how to improve the performance of your driver:

1. Create your driver in the User Mode as explained in the previous Chapters of this manual.
2. Compile and debug your driver in the User Mode.
3. When working in the User Mode, performance may take a back-seat. Check if you have performance problems. If you do not have any performance problems, you have finished your driver development.

### ***If you do have performance problems:***

Identify which part of the code the performance problem is at. Classify and solve the problem according to the table that follows:

	<b>Problem</b>	<b>Solution</b>
#1	ISA Card - Accessing an IO mapped range on the card	-Try to convert multiple calls to WD_Transfer() to one call to WD_MultiTransfer() (See the 'Improving Performance - Accessing IO mapped regions' section later in this Chapter). -If this does not solve the problem, handle the IO at Kernel Mode, by writing a Kernel PlugIn. (See the Kernel PlugIn related chapters for details)
#2	PCI Card - Accessing an IO mapped range on the card	First, try to change the card from IO mapped to memory mapped by setting bit 0 of the address space PCI configuration register to 0 and then try the solutions for problem #3. You will need to re-program the EPROM to initialize BAR0/1/2/3 registers with different values. -If possible, try the solutions suggested for problem #1. -If this does not solve the problem, handle the IO at Kernel Mode by writing a Kernel PlugIn. (See the Kernel PlugIn related chapters for details)
#3	Accessing a memory mapped range on the card	-Try to access memory without using WD_Transfer() by using direct access to memory mapped regions (See the 'Improving Performance -using direct access to memory mapped regions' section later in this Chapter). -If this does not solve the problem, then there is a hardware design problem. You will be able to increase performance by using any software design method, or

#4

Interrupt latency. (Missing interrupts,  
Receiving interrupts too late)

writing a Kernel PlugIn, or even  
a full kernel driver.

You need to handle the interrupts  
Kernel Mode, by writing a kernel  
(See the Kernel PlugIn related c  
details)

#5

USB devices: Slow transfer rate

To increase the transfer rate tr  
increase the packet size by ch  
different device configuration. If  
need to do many small transfe  
Kernel-Plugin can be used.

## Improving the performance of your User Mode driver

As a general rule, transfers to memory mapped regions are faster than transfers to I/O mapped regions. The reason is that WinDriver enables the user to directly access the memory mapped regions, without calling the **WD\_Transfer()** function.

Using direct access to memory mapped regions

Accessing IO mapped regions

## Background

There are some distinct advantages with creating your driver in User Mode.

- No knowledge of the kernel is necessary
  - No knowledge of the MS DDK or kernel debuggers is required
  - Easy development / debugging using standard development / debugging tools.

However, this imposes a fair amount of function call overhead from the Kernel to the User mode and then performance may not be acceptable. In such cases, the Kernel PlugIn feature allows critical section of the driver code to be moved to the kernel while keeping most of the code intact. Using WinDriver's Kernel PlugIn feature, your driver will operate without any degradation in performance.

The advantages of writing a Kernel PlugIn driver over a Kernel Mode driver are:

1. All the driver code is written and debugged in User Mode.
2. The code segments that are moved to the Kernel Mode remain essentially the same and therefore no Kernel debugging is needed.
3. The parts of the code that will run in the kernel through the Kernel PlugIn are platform independent and therefore will run on all platforms supported by WinDriver. A standard kernel mode driver will run only on the platform it was written for.

Using WinDriver's Kernel PlugIn feature, your driver will operate without any degradation.

## Do I need to write a Kernel PlugIn?

Not every performance problem requires you to write a Kernel PlugIn. Some performance problems can be solved in the User Mode driver, by better utilization of the features that WinDriver provides.

Chapter [Improving Performance](#) guides you in solving your performance issues. This chapter contains a table to help you determine solutions for your driver's performance problems. In some cases a quick User Mode solution is provided, and in other cases, a Kernel Mode PlugIn must be written.

## **What kind of Performance can I expect**

Since you can write your own interrupt handler in the kernel with the WinDriver Kernel PlugIn, you can expect to handle about 100,000 interrupts per sec without missing any one of them.

## **Overview of the development process**

Using the WinDriver Kernel PlugIn, the developer first develops and debugs the driver in the User Mode with the standard WinDriver tools. After identifying the performance critical parts of the code (such as the interrupt handler, access to I/O mapped memory ranges, or slow data transfer rate through the USB pipes, etc.), the developer can 'drop' these parts of code into WinDriver's Kernel PlugIn ( which runs in the Kernel Mode) thereby eliminating calling overhead. This unique feature allows the developer to start with quick and easy development in the User Mode, and progress to performance oriented code only where needed. This unique architecture saves time, and allows absolutely zero performance degradation.

## Introduction

A driver written in the User Mode uses WinDriver's functions(WD\_XXX functions) for device access. If a certain function in the User Mode needs to achieve kernel performance (the interrupt handler for example), that function is moved to the WinDriver KernelPlugIn. The code will still work "as is" since WinDriver exposes its WD\_XXX interface to the Kernel PlugIn as well.

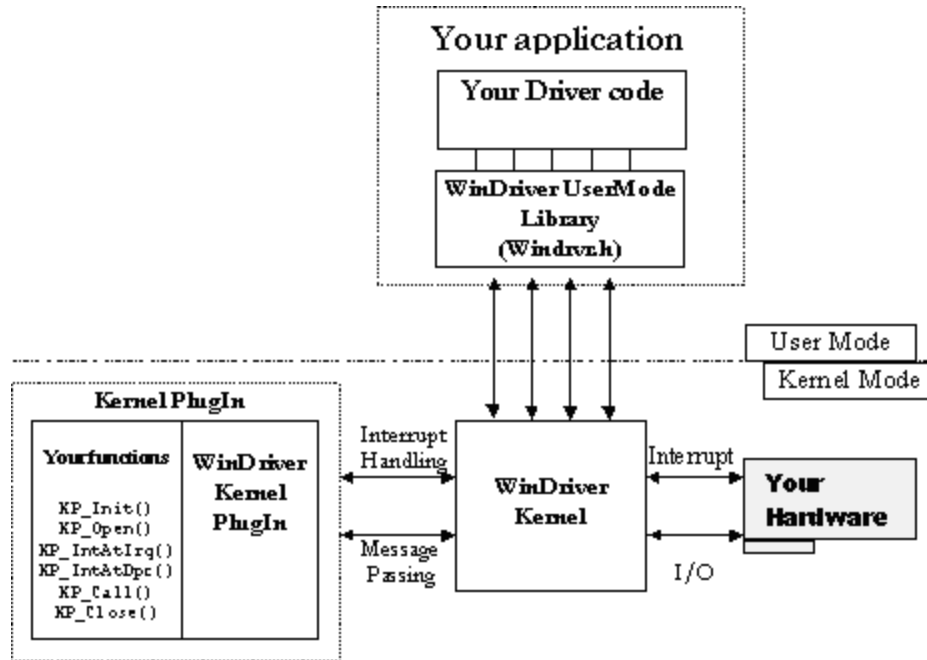


Figure 16.1: KernelPlugIn Architecture



## WinDriver Kernel and Kernel Plugin Interaction

There are two types of interaction between the WinDriver Kernel and the WinDriver Kernel Plugin. They are:

1. **Interrupt handling:** When WinDriver receives an interrupt, it will activate the interrupt handler in the User Mode by default. However, if the interrupt was set to be handled by the WinDriver Kernel Plugin, then once WinDriver receives the interrupt, it is processed by the interrupt function in the Kernel. This is the same code that you wrote and debugged in the User Mode interrupt handler before.
2. **Message passing:** To execute functions in the Kernel Mode (such as I/O processing functions), the user mode driver simply passes a "message" to the WinDriver Kernel Plugin. This message is mapped to a specific function, which is then executed in the kernel. This function contains the same code as it did when it was written and debugged in the User Mode.

## Kernel Plugin Components

At the end of your Kernel PlugIn development cycle, you have the following elements to your driver:

1. Your User Mode driver - written with the WD\_XXX functions.
2. The WinDriver Kernel - Windrvr.sys or Windrvr.vxd and wdpnp.sys for USB drivers.
3. Your Kernel PlugIn - <Your Driver Name>.sys or <Your Driver Name>.vxd - this is the driver that contains the functionality that you have chosen to bring down to the Kernel level.

## Kernel PlugIn Event Sequence

The following is a typical event sequence that covers all the functions that you can implement in your Kernel PlugIn(KP):

Event / Callback	Remarks
<p><b>Event:</b> Windows loads your Kernel PlugIn driver <b>KP Call-back:</b> Your KP_Init() Kernel PlugIn function is called</p>	<p>At boot time, or by dynamic loading, or as instructed by the registry. KP_Init() informs WinDriver of the name of your KP_Open() routine. WinDriver will call this routine when the applicaton wishes to open your driver (when it calls WD_KernelPlugInOpen())</p>
<p><b>Event:</b> Your app(User Mode driver) calls WD_KernelPlugInOpen() <b>KP Call-back:</b> Your KP_Open() routine is called</p>	<p>In your KP_Open() function, you inform WinDriver of the names of all the call-back functions that you have implemented in your KP driver, and initiate the KP driver if needed.</p>
<b>Event / Callback</b>	<b>Remarks</b>
<p><b>Event:</b> Your app calls WD_KernelPlugInCall()</p>	<p>Your app calls WD_KernelPlugInCall() to run code in the Kernel Mode(in the KP driver). The app passes a message to the KP driver. The KP driver will select the function to execute according to the message sent.</p>
<p><b>KP Call-back:</b> Your KP_Call() routine is called.</p>	<p>Executes code according to the message passed to it from the User Mode.</p>
<p><b>Event:</b> Your hardware creates an interrupt <b>KP Call-back:</b> Your KP_IntAtIrql() routine is called. (If the KP interrupts are enabled</p>	<p>KP_IntAtIrql() runs at a high priority, and therefore should do only the basic interrupt handling(such as lowering the HW interrupt signal). If more interrupt processing is needed, it is deferred to the KP_IntAtDpc() function. If your KP_IntAtIrql() function returns a value greater than 0, your KP_IntAtDpc() function is called.</p>
<b>Event / Callback</b>	<b>Remarks</b>
<p><b>Event:</b> KP_IntAtIrql() function returns a value greater than 0 <b>KP Call-back:</b> KP_IntAtDpc() is called</p>	<p>Needs interrupt code to be processed as a deferred procedure call in the kernel Processes the rest of the interrupt code, but at a lower priority than KP_IntAtIrql</p>
<p><b>Event:</b> KP_IntAtDpc() returns a value greater than 0</p>	<p>Needs interrupt code to be processed in the User Mode as well</p>

**KP\_Call-back:** WD\_Intwait() returns.

Execution resumes at your User Mode interrupt handler.

## Minimal Requirements for creating a Kernel PlugIn

- To compile the **Kernel Mode** driver you need the VC compiler (cl.exe, rc.exe and link.exe and nmake.exe).
  - To create a **Win 95/98/ME driver (VXD)** you do not need the Win 95/98/ME DDK.
  - To create a **WinNT driver (SYS)** you need the WinNT DDK, for the following file: ntoskrnl.lib.
  - To compile the Kernel Mode driver on Linux and Solaris, you need gcc, gmake or make.

**NOTE:** Windows NT/2000 require SYS files for Kernel PlugIn. Windows 95/98/ME need VXD files. SYS files cannot be used on Windows 98/ME as Kernel PlugIn in Version 5.0 and below.

**NT DDK can be downloaded (Free) at <http://www.microsoft.com/hwdev/ddk/ddk40.htm>.**

## Directory structure and sample for the WinDriver Kernel PlugIn

**\windriver\kerplug\lib** - includes the files needed to link your Kernel PlugIn

**\windriver\kerplug\kptest** - contains a sample minimal Kernel PlugIn driver.

The sample implements a passing data function to / from the kernel driver and a kernel mode interrupt handler.

The data exchange function gets the version of the WinDriver kernel module and passes it to the user level. This sample can be a base to implement I/O calls with the Kernel PlugIn.

The interrupt handler implements an interrupt counter. The interrupt handler counts five interrupts and notifies the user mode only on one out of every five incoming interrupts.(more details can be found in `windriver\kerplug\kptest\files.txt`).

KPTest\_com.h contains common definitions such as messages, between the Kernel PlugIn and the User-mode.

**\windriver\kerplug\kptest\usermode** - User-mode component of the driver

**\windriver\kerplug\kptest\kermode** - Kernel PlugIn driver

## Kernel PlugIn implementation

Before you begin

Write your KP\_INIT() function

Write your KP\_OPEN() function

Write the remaining PlugIn call-backs

## **KPTest -- A sample Kernel PlugIn Driver**

The KPTest directory (*WinDriver\kerplug\KPTest*) contains a sample minimal Kernel PlugIn driver which you can compile and execute. Use this sample as your skeletal Kernel PlugIn driver.

This sample builds ***KPTest.VXD*** and ***KPTest.SYS***, and ***KPTest.EXE***. The sample demonstrates communication between your application (***KPTest.EXE***) and your Kernel PlugIn (***KPTest.VXD*** or ***KPTest.SYS***).

The KPTest sample in this directory, is a Kernel PlugIn which implements a "Get Version" function, to demonstrate passing data (messages) to/from the Kernel PlugIn. It also implements an interrupt handler in the kernel. This Kernel PlugIn is called by the User Mode driver called KPTest.EXE.

**NOTE:** To check that you are ready to build a Kernel PlugIn driver, it is recommended to build and run this project first, before continuing to write your own Kernel PlugIn.



## Handling Interrupts in the Kernel PlugIn

Interrupts will be handled by the Kernel PlugIn, if a Kernel PlugIn handle was passed to *WD\_IntEnable()* by the User Mode application when it enabled the interrupt. When WinDriver receives a hardware interrupt, it calls the *KP\_IntAtIrql()* (if Kernel PlugIn interrupts are enabled). In the KPTest sample, the interrupt handler running in the Kernel PlugIn counts 5 interrupts, and notifies the user-mode only of one out of each 5 incoming interrupts. This means that *WD\_IntWait()* (in the user-mode) will return only on one out of 5 incoming interrupts.

Interrupt handling in user mode (without Kernel PlugIn)

Interrupt handling in the Kernel (with the Kernel PlugIn)

## Message passing

The WinDriver architecture enables calling a Kernel Mode function from the User Mode by passing a message through the ***WD\_KernelPluginCall()*** function. The messages are defined by the developer in a header file that is common to both the User Mode and Kernel Mode Plugin parts of the driver. This header file is called KPxxx\_COM.H by convention -- the corresponding header file in the KPTest sample is called KPTest\_COM.H. Upon receiving the message, WinDriver Kernel Plugin executes the KP\_Call function which maps a function to this message.

In the KPTest sample, the GetVersion function is a simple function which returns an arbitrary integer and string (which simulates your KPTest's version). This function will be called by the Kernel Plugin, whenever the Kernel Plugin receives a 'GetVersion' message from the ***KPTest.EXE***. You can see the definition of the message KPTEST\_MSG\_VERSION in the header file KPTEST\_COM.H

The KPTest.EXE sends the message using the ***WD\_Kernel PluginCall()*** function.

## Determining whether a Kernel PlugIn is needed

1. The Kernel PlugIn should be used only after your driver code has been written and debugged in the User Mode. This way, all of the logical problems of creating a device driver are solved in the User Mode, where development and debugging are much easier.
2. Determine whether a Kernel PlugIn should be written by consulting chapter Improving Performance that explains how to improve the performance of your driver.

## Preparing the User Mode source code

1. Isolate the function or functions that you need to move into the Kernel PlugIn.
2. Remove any platform specific code from the function. Use only the WinDriver functions which may be used from the kernel as well (See details later on in this chapter).
3. Compile and debug your driver in the User Mode again, to see that your code still works after these changes are made.

## Creating a new Kernel PlugIn Project

1. Make a copy of the **KPTest** directory. For example, to create a new project called **MyDrv**, copy `\WinDriver\kerplug\KPTest` to `\WinDriver\kerplug\MyDrv`.
2. Change all instances of **KPTest** in all the files in your new directory to **MyDrv**. (You may use the 'find in files' option in MSDEV for this).
3. Change all occurrences of **KPTest** in file names to **MyDrv**.

## Creating a handle to the WinDriver Kernel Plugin

In your original User Mode source code, call ***WD\_Kernel PlugInOpen()*** at the beginning of your code, and ***WD\_KernelPlug InClose()*** before terminating.

## Interrupt Handling in the Kernel PlugIn

1. When calling ***WD\_IntEnable()***, give the handle to the Kernel PlugIn that you received from opening the Kernel PlugIn
2. Move the source code in the User Mode interrupt handler to the Kernel PlugIn, by moving some of it to ***KP\_IntAtIrql()*** and some of it to ***KP\_IntAtDpc()*** (See Section Handling Interrupts in the Kernel PlugIn for an explanation on handling interrupts in the kernel).

## I/O handling in the Kernel PlugIn

1. Move your I/O handling code from the User Mode to `KP_Call()`.
2. To call this code in the kernel from the User Mode, use `WD_KernelPlugInCall()`, with the Kernel PlugIn handle, and a message for each of the different functionalities you need. For each functionality, create a different message.
3. Define these messages in the file `KPTest_Com.H`, which is a common header file, between the kernel-mode and the user-mode. This file should have the message definitions (IDs) and data structures used to communicate between the kernel-mode and user-mode.



## Compiling your Kernel PlugIn Driver

Run compile.bat to compile and link your KP driver.

- **On Windows platforms:** Run COMPILE.BAT in KERMODE directory. This will create two files: MyDrv.SYS and MyDrv.VXD (in this example, run windriver\kerplug\MyDrv\kermode\compile.bat).
- **On Linux Platforms:** Run the "make" command in the kermode/LINUX directory.
- **On Solaris Platform:** Run the "make" command in the kermode/SOLARIS directory.

## Installing your Kernel PlugIn Driver

Copy the relevant file to your drivers directory.

*On Win32 Platforms:*

- **Win95:** Copy the MyDrv.VXD driver that was created to the `c:\win95\system\mmm32` directory.
- **WinNT:** Copy the MyDrv.SYS driver that was created to the `c:\winnt\system32\drivers` directory.
- **Win98:** You can either copy the created VXD driver to the `c:\win98\system\mmm32` directory or copy the created SYS driver to the `c:\win98\system32\drivers` directory.

Register / Load your driver: The Kernel PlugIn driver is dynamically loadable, and therefore you need not re-boot in order to run your driver.

On all Win32 platforms, you need to run WDREG.EXE to install the driver:

(In the following instructions, NAME stands for your Kernel PlugIn driver name).

*On Win95 and WinNT:*

Run `c:\WinDriver\util\WDREG -name NAME install` (in this example run `WDREG -name mydrv install`) to register and load your driver. For further instructions see chapter [Dynamically loading your driver](#) that explains how to dynamically load your driver .

*On Win98*

To install the SYS file, run `c:\WinDriver\util\WDREG -name NAME install`(in this example run `WDREG -name mydrv install`).

To install the VXD file (note the -vxd flag), run `c:\WinDriver\util\WDREG -vxd -name NAME install`

*On Linux*

1. Copy the driver created to the modules directory: For example: `kptest/LINUX# cp kptest_module.o/lib/modules/misc/`
2. Insert the module into the kernel: For example: `kptest/LINUX#/sbin/insmod kptest_module.o`

*On Solaris*

1. Copy the driver created to the drivers directory: For example: `kptest/SOLARIS# cp kptest/kernel/drv`
2. Install the driver: For example: `kptest/SOLARIS# add_drv kptest`

## User Mode functions

The following functions are the User Mode functions which initiate the Kernel PlugIn's operation, and activate its call-backs.

WD\_KernelPlugInOpen()

WD\_KernelPlugInClose()

WD\_KernelPlugInCall()

WD\_IntEnable()

## Kernel functions

The following functions are call-back functions which you will implement in your Kernel PlugIn driver, and which will be called when their 'calling' event occurs. For example, `KP_Init()` is the call-back function which is called when the driver is loaded. Any code that you want to execute upon loading should be in this function.

In `KP_Init()`, the name of your driver is given, and its call-backs. From then on, all of the call-backs which you implement in the kernel will contain your driver's name. For example, if your driver's name is `MyDriver`, then your `KP_Open` call-back may be called `MyDriver_Open()`. It is the convention of this reference guide to mark these functions as `KP_` functions - i.e. the 'Open' function will be written here as `KP_Open()`, where the `KP` replaces your driver's name.

`KP_Init()`

`KP_Open()`

`KP_Close()`

`KP_Call()`

`KP_IntEnable()`

`KP_IntDisable()`

`KP_IntAtIrql()`

`KP_IntAtDpc()`

## **User Mode structures**

WD\_KERNEL\_PLUGIN

WD\_INTERRUPT

WD\_KERNEL\_PLUGIN\_CALL

## Kernel Mode structures

KP\_INIT

KP\_OPEN\_CALL

## WD\_Open() (or xxx\_Open()) fails.

The following may cause WD\_Open() to fail:

- **Cause:** WinDriver's kernel is not loaded.  
**Action:** Run 'WDREG.EXE install' (in the *windriver\util* directory). This will let Windows know how to add WinDriver to the list of device drivers loaded on boot. Also, copy WINDRVR.SYS (for WinNT/2000/98/ME) or WINDRVR.VXD (for Win95/98/ME) to the device drivers directory. A detailed explanation can be found in Chapter Distributing your Driver that explains how to distribute your driver.
  
- **Cause:** The 30 day evaluation license is over.  
**Action:** WinDriver will inform you that your evaluation license is over. Please contact Jungo : [sales@jungo.com](mailto:sales@jungo.com) to purchase WinDriver.
  
- **Cause (for PnP cards only):** The VendorID / DeviceID requested in **xxx\_Open()** do not match that of the board. (In licensed versions).  
**Action:** Run *Your\_card\_name\_DIAG.EXE*, (generated by DriverWizard or from the PLX /Galileo /V3 /Altera /AMCC directories), and choose scan-pci bus to check the correct VendorID / DeviceID of your hardware.
  
- **Cause:** The device is not installed or configured correctly.  
**Action:** Run *Your\_Card\_Name\_DIAG.EXE* and choose PCI scan. Check that your device returns all the resources needed.
  
- **Cause:** Your device is in use by another application.  
**Action:** Close all other applications that might be using your device.

## **WD\_CardRegister() fails**

WD\_CardRegister fails if one of the resources defined in the card cannot be locked.

First, check out what resource (out of all the card's resources) cannot be locked.

Activate the KernelTracer and set the trace mode to trace. This will output all warning and error debug messages. Now, run your application and you will get a printout of the resource that failed.

After finding out the resource that cannot be locked, check out the following:

Is the resource in use by another application? In order for several resource lock requests to the same I/O, Memory or interrupt to succeed, both applications must enable sharing of the resource. This is done by setting `fNonSharable = FALSE` for every item that can be shared.



## **Can't open USB device using the DriverWizard**

When a driver already exists in Windows for your device, you must create an .INF file (DriverWizard automates this process) and install it. For exact instructions, see the sections explaining how to create and install .INF files.

## **Can't get interfaces for USB devices.**

In some operating systems (such as Windows 98), when there is no driver installed for your USB device (Symptom - In DriverWizard's "Card Information" screen, the device's physical address is 0x0.), you must create an .inf file (DriverWizard automates this process) and install it. For exact instructions, see the sections explaining how to create and install .INF file.

## **PCI Card has no resources when using the DriverWizard**

In some operating systems (such as Windows 98), when there is no device driver for a new device, the operating system does not allocate resources to the device.

The symptom - When trying to open the card in DriverWizard's "Card Information" screen, a message pops-up notifying that no resources were found on card. In addition, card configuration registers, such as memory 'BAR' are zeroed. When this happens, you need to create and install an INF file for the new card. For exact instructions, see Chapters [The DriverWizard](#) and [Distributing your Driver](#) that explain how to create and install a .INF file.

## Computer hangs on interrupt

This can occur with level-sensitive interrupt handlers. PCI cards interrupts are usually level sensitive.

Level sensitive interrupts are generated as long as the physical interrupt signal is high. If the interrupt signal is not lowered by the end of the interrupt handling by the kernel, the Windows OS will call the WinDriver kernel interrupt handler again - This will cause the PC to hang!

Acknowledging a level sensitive interrupt is hardware specific. Acknowledging an interrupt means lowering the interrupt level generated by the card. Normally, writing to a register on the PCI card can terminate the interrupt, and lower the interrupt level.

When calling **WD\_IntEnable()** it is possible to give the WinDriver kernel interrupt handler a list of transfer commands (IO and memory read/write commands) to perform upon interrupt, at the kernel level - before **WD\_IntWait()** returns.

These commands can be used to write to the needed register to lower the interrupt level, thereby 're-setting' the interrupt.

Before calling **WD\_IntEnable()**, prepare two transfer command structures (to read the interrupt status and then write the status to lower the level).

```
WD_TRANSFER trans[1];

BZERO (trans);

trans[0].cmdTrans = WP_DWORD; // Write Port Dword

// address of IO port to write to

trans[0].dwPort = dwAddr;

// the data to write to the IO port

trans[0].Data.Dword = 0;

Intrp.dwCmds = 1;

Intrp.Cmd = trans;

Intrp.dwOptions = INTERRUPT_LEVEL_SENSITIVE;

WD_IntEnable(hWD, &Intrp);
```

This will tell WinDriver's kernel to Write to the register at **dwAddr** value of '0', upon an interrupt.

The user-mode interrupt handler is the thread waiting on **WD\_IntWait()** - this is your code. Here you only do your normal stuff to handle the interrupt. You do not need to clear the interrupt level since this is already done by the WinDriver kernel , with the transfer command you gave **WD\_IntEnable()**.

### **WD\_DMALock() fails to allocate buffer**

The efficient method for memory transfer is scatter/gather DMA. If your hardware does not support scatter/gather, you will need to allocate a DMA buffer using **WD\_DMALock()**.

WD\_DMALock() fails when the Windows OS has run out of contiguous physical memory.

When calling WD\_DMALock() with dwOptions = DMA\_KERNEL\_BUFFER\_ALLOC, WinDriver requests the Windows OS for a physical contiguous memory block.

On WinNT you can allocate a few hundred kilobytes by default. If you want to allocate a few megabytes, you will have to reserve memory for it, by setting the following value in the registry:

#### **On Windows NT:**

Run REGEDIT.EXE, and access the following key:

HKEY\_LOCAL\_MACHINE\SYSTEM\CurrentControlSet\Control \SessionManager \MemoryManagement

Increment the value of NonPagesPoolSize.

This change will take place only after re-boot.

#### **On Windows 95:**

Win95 does not support contiguous buffer reservation, therefore, the earlier you allocate the buffer, the larger the block you can allocate.

## **Windows NT/2000 and 95/98/ME**

[Dynamic loading - background](#)

[Why do you need a dynamically loadable driver?](#)

[Dynamically loading and unloading your driver](#)

[Dynamically loading your Kernel PlugIn](#)

## Linux

To dynamically load WinDriver on Linux, execute:

```
> /sbin/insmod -f /lib/modules/misc/windrvr.o
```

To dynamically unload WinDriver, execute:

```
> /sbin/rmmod windrvr
```

In addition, you can use the **wdreg** script under Linux to install (load) windrvr.o

## Solaris

To dynamically load WinDriver on Solaris, execute:

```
> /usr/sbin/add_drv -m "* 0666 root sys" windrvr
```

To dynamically unload WinDriver, execute:

```
> /usr/sbin/rem_drv windrvr
```

In addition, you can use the **wdreg** script under Solaris to install (load) windrvr.o



## Get a valid license for your WinDriver

To purchase your WinDriver license, fill in your order form found in `\windriver\docs\order.txt`, and fax or email it to Jungo (you can find the full details on the order form itself).

Alternatively, you can order WinDriver on-line. See Jungo's WEB site <http://www.jungo.com> for more details.

When you receive the registered string, you should follow the instructions found under `\windriver\redist\register.txt` to enable your driver to work with the registered version of the WinDriver kernel. This applies for all OS'es.

## Windows 95/98/ME and NT/2000

1. Copy VxD or SYS files to the target computer.

In the driver installation script you create, you must copy the following files to the target computer (the system on which you want to install your driver):

- **For Windows NT/2000/98/ME:** Copy WINDRVR.SYS file to WINNT\SYSTEM32\DRIVERS
- **For Windows 95:** Copy WINDRVR.VXD file to \WIN95\SYSTEM\MM32  
**NOTE:** WINDRVR.SYS can be used on 98/ME. Due to the limitations of 98/ME, it cannot be loaded dynamically but requires a reboot. If a reboot is not acceptable to you, then use WINDRVR.VXD instead.

### USB developers:

- On Windows 2000: Copy Windrvr.sys and wdpnp.sys to WINNT\SYSTEM32\DRIVERS
- On Windows 98/ME: Copy Windrvr.sys and wdpnp.sys to WINDOWS\SYSTEM32\DRIVERS

### If you have created a Kernel Plugin

- Copy your Kernel Plugin driver ( [Your driver name].VXD or [Your driver name].SYS ) to the relevant directory.

2. Add WinDriver to the list of Device Drivers Windows loads on boot.

This is done by calling **WDREG install**. You can add the WDREG source code (found in \windriver\samples\wdreg\wdreg.cpp) to your own installation code, in order to install WinDriver programmatically. The utility WDREG.EXE is found in the UTIL subdirectory under the WinDriver installation.

For Windows 98/ME, **WDREG.EXE install** installs WINDRVR.SYS and requires a reboot. For a reboot free installation on Windows 98/ME, please install WINDRVR.VXD instead and use the command **WDREG -vxd install** to install it.

If you have created a WinDriver Kernel Plugin as well, call "**WDREG.EXE -name [Your driver name] install**". You can add the 'WDREG' source code (found in \windriver\samples\wdreg\wdreg.cpp) to your own installation code, in order to install a kernel plugin.

**NOTE:** When distributing your driver, take care to see that you DO NOT overwrite a newer version of **windrvr.sys** in the **windows\system32\drivers** directory or **windrvr.vxd** in the **windows\system\vm32** directory with an older version of the file. You should configure your Install Shield installation program (if you are using Install Shield) or your .INF file such that the installer automatically compares the timestamp on these two files and DOES NOT overwrite a newer version with an older one.

## Creating a .INF file

Device information (INF) files are text files, that provide information used by the "Plug and Play" mechanism in Windows ME/95/98/2000 to install software that supports a given hardware device. INF files are required for hardware that identifies itself, such as USB and PCI. The INF file includes all necessary information about the device(s) and the files to be installed. When hardware manufactures introduce new products, they must create INF files to explicitly define the resources and files required for each class of device.

In some cases, the .INF file of your specific device is included in the .INF files supplied with the operating system. In other cases, you will need to create a .INF file for your device. DriverWizard can generate an INF specific for your Card/device. The INF is used to tell the OS that the selected device is now handled by WinDriver.

Why should I create an INF file?

How do I install an INF file when no driver exists?

How do I replace an existing driver using the INF file?

## Windows CE

### Copy WinDriver Kernel DLL file to the target computer

In the driver installation script you create, you must copy the following files to the target computer (the one you will install your driver on):

#### For Windows CE hand-held computer installations:

Copy **WINDRVR.DLL** file to **\\WINDOWS** on your target Windows CE computer.

#### For Windows CE PC:

Copy **WINDRVR.DLL** %\_FLATRELEASEDIR% and use **MAKEIMG.EXE** to build a new Windows CE kernel **NK.BIN**. You should modify **PLATFORM.REG** and **PLATFORM.BIB** appropriately before doing this by appending the contents of the supplied files **PROJECT\_WD.REG** and **PROJECT\_WD.BIB** respectively. This process is similar to the process of installing WinDriver CE on a CE PC /ETK installation as described in INSTALLATION AND SETUP.

### Add WinDriver to the list of Device Drivers Windows CE loads on boot

For Windows CE hand-held computer installations, please modify the registry according to the entries documented in the file **PROJECT\_WD.REG**. This can be done using the Windows CE Pocket Registry Editor on the hand-held CE computer or by using the Remote CE Registry Editor Tool supplied with the Windows CE Platform SDK. You will need to have Windows CE Services installed on your Windows NT Host System to use the Remote CE Registry Editor Tool. For Windows CE PC/ETK, the required registry entries are made by appending the contents of the file **PROJECT\_WD.REG** to the Windows CE ETK configuration file **PROJECT.REG** before building the Windows CE image using **MAKEIMG.EXE**. If you wish to make the WinDriver kernel file a permanent part of the Windows CE kernel **NK.BIN**, you should append the contents of the file **PROJECT\_WD.BIB** to the Windows CE ETK configuration file **PROJECT.BIB** as well.

## Linux

The Linux kernel is continuously under development, and kernel data structures are subject to frequent change. To support such a dynamic development environment and still have kernel stability, the Linux kernel developers decided that kernel modules must be compiled with the identical header files that the kernel itself was compiled with. They enforce this by *#include*'ing a version number into the kernel header files that is checked against the version number encoded into the kernel. This forces Linux driver developers to facilitate recompilation of their driver based on the target system's kernel version.

[WinDriver Kernel Module](#)

[Your User Mode Driver](#)

[Kernel Plugin Modules](#)

[Installation script](#)

## Solaris

For Solaris, you need to supply the following items to enable the client to enable target installation of your driver:

- **WinDriver kernel module:** The files windrvr and windrvr.cnf implement the WinDriver kernel module.
- **User mode driver:** The source code or the binaries of your user mode driver.
- **Kernel plugin module:** If you used a kernel plugin module, you should supply the relevant files, for example, mykp and mykp.cnf

[Installation script](#)

## VxWorks

For VxWorks, you need to supply the following items to enable the client to enable target installation of your driver:

- **WinDriver Kernel:** The file `windrvr.o` implements the WinDriver kernel module.
  
- **Your Driver:** The source code or the binaries of your driver, say `your_drv.out`

The client that you provide these modules to, would want to incorporate all these files into the VxWorks embedded image. There are two steps involved here:

1. `windrvr.o` and `your_drv.out` has to be built into the VxWorks image.  
In the Tornado II Project's build specification for the VxWorks image, specify `windrvr.o` and `your_drv.out` as `EXTRA_MODULES` under the `MACROS` tab, and copy these files under the appropriate target directory tree. Rebuild the project and these files are now included in the image and it should work.
  
2. During startup, the `drvrlnit()` routine should be called to initialize `windrvr.o`. Your driver's startup routine may also need to be called.  
You have to use the file `usrApplnit.c` found under the Tornado II project directory and insert code to call `drvrlnit()` -- which is WinDriver's initialization routine -- and your driver applications startup routine. Of course, this means you need to rebuild the VxWorks image.





## On Windows 95, 98, ME, NT and 2000

1. Start DriverWizard (See the Chapter detailing DriverWizard [The DriverWizard](#) for details). Diagnose your card, and let DriverWizard generate skeletal code for you. The code generated by DriverWizard is a diagnostics program, containing functions that read and write to any resource detected or defined (including custom defined registers), and enables your card's interrupts and listens to them. Modify the code generated by DriverWizard, to suit your particular application needs.
2. Run and debug your driver in the User Mode.
3. If your code contains performance critical sections, improve their performance by referring to Chapter [Improving Performance](#) . This Chapter provides a checklist of tune-ups you can make in your code, and shows you how to take the performance critical sections and move them to the "Kernel Plugin".

## On Windows CE

1. Plug your hardware into your NT machine.
2. Install the CE ETK on NT.
3. Diagnose your hardware via DriverWizard and then let it generate your driver's skeletal code. Modify this code using Visual C++ to meet your specific needs. Test and debug your code and hardware from the CE emulation running on the NT machine.
4. If you cannot plug your hardware into your NT machine, you may still use DriverWizard by manually entering all your resources into it. Let DriverWizard generate your code and then test it on your hardware using serial connection. After verifying that the generated code works properly, modify it to meet your specific needs. You may also use (or combine) any of the sample files for your driver's skeletal code.
5. If your code contains performance critical sections, improve their performance by referring to the Chapter [Improving Performance](#).

## On Linux and Solaris

From version 5.0 and onwards, WinDriver offers a GUI DriverWizard that facilitates Driver Development on Linux and Solaris. Use the GUI DriverWizard for Linux and Solaris in the same way as you use the one on Windows and then generate Linux and Solaris code.

If you are using WinDriver 4.x and below, and you do not use the Linux or Solaris X11 GUI, you may consider Windows as your initial development platform. It is recommended to start the development process on your Windows machine, using DriverWizard in the same way as described above.

If you do not have a Windows machine, you may use the sample files included with WinDriver as skeletons for your driver and change them using the WinDriver API.

## On Embedded Operating Systems

For embedded operating systems, like Windows CE or VxWorks, you can use the new Remote WinDriver feature. Just run DriverWizard on a supported Host platform and you can detect and diagnose your hardware on the remote embedded target using the new Remote WinDriver option.

**Note:** Cross-endian network communication support is not yet provided and therefore both the host and the target machine must have the same endian scheme when using Remote WinDriver. For example, when detecting and diagnosing hardware on a Motorola PPC target architecture, you can use a Sparc machine as a compatible host since both Motorola and Sparc use the same endian scheme.

## WinDriver Modules

- WinDriver Version 5 - (***windriverinclude***) - The general-purpose hardware access toolkit. The important files here are:
  1. **windrivr.h**: The WinDriver API, data structures and constants are defined in this header file.
  2. **windrivr\_int\_thread.h**: This is a convenience header file, that contains wrapper functions to simplify interrupt handling.
  
- DriverWizard (accessible through **Start Menu | Programs | WinDriver | DriverWizard**) - The graphical tool that diagnoses your hardware and lets you easily code your driver.
  
- Graphical Debugger (accessible through **Start Menu | Programs | WinDriver | Monitor Debug Messages**) - A graphical debugging tool which collects debugging information on your driver as it runs. On Linux, Solaris, WinCE and VxWorks, you may use the console version of this program. Starting from version 5.00, the graphical version of the debugger is available on Linux and Solaris also.
  
- WinDriver distribution package (***windriverredist***) - The files needed to be included in the driver you distribute to your customers.
  - WinDriver Version 5 electronic manual - (accessible through **Start Menu | Programs | windriver**) - Full WinDriver manual, in pdf (Adobe Acrobat) format, hyperlinked Windows HELP (HLP) format and CHM format for Windows users, and in HTML for Unix users.
  - WinDriver Kernel PlugIn (***windriverkerplug***) - The files and samples needed to create a Kernel PlugIn for WinDriver.

## Utilities

- **PCI\_SCAN.EXE** (*\\windriver\util\pci\_scan.exe*) - A utility for getting a list of the PCI cards installed and the resources allocated for each one of them.
- **PCI\_DUMP.EXE** (*\\windriver\util\pci\_dump.exe*) - A utility for getting a dump of all the PCI configuration registers of the PCI cards installed.
- **PCMCIA\_SCAN.EXE** (*\\windriver\util\pcmcia\_scan.exe*) - A utility for getting a list of the PCMCIA cards installed and the resources allocated for each one of them.  
**NOTE:**PCMCIA\_SCAN.EXE is found only in the WinDriver CE version.

- **USB\_DIAG.EXE** (*\\windriver\util\usb\_diag.exe*) - A utility for getting a list of the USB devices installed, the resources allocated for each one of them, and for accessing the USB devices.

### The CE version includes:

- **\\REDIST\... \X86EMU\WINDRVR\_CE\_EMU.DLL**: The DLL that communicates with the WinDriver kernel for the X86 HPC emulation mode of Windows CE.
- **\\REDIST\... \X86EMU\WINDRVR\_CE\_EMU.LIB**: The import library for linking with WinDriver applications that are compiled for the X86 HPC emulation mode of Windows CE.

## WinDriver's SPECIFIC CHIP-SET SUPPORT

These are APIs that support the major PCI bridge chip-sets, for even faster code development.

- WinDriver PLX APIs (for the 9030, 9050, 9052, 9054 and 9060/9080 PCI bridges) - **windriver\plx\9050** and **\9054**, **\9060**, **\9080** respectively.
- WinDriver Galileo APIs (for the Galileo GT64 PCI bridges) - **windriver\galileo\gt64**
- WinDriver AMCC APIs (for the AMCC S5933 PCI bridges) - **windriver\amcc**
- WinDriver ALTERA (for Altera PCI cores) - **windriver\altera**
- WinDriver V3 APIs (for the V3 PCI bridges) - **windriver\v3**

Each of these directories includes the following subdirectories:

- **\lib** - the special chip set API for the PLX/AMCC/V3/ALTERA chip set, written using the WinDriver API.
- **\xxx\_diag** - a sample diagnostics application, which was written using the special library functions available for these chip sets. This application may be compiled and executed as-is (xxx\_diag i.e. p9054\_diag.c for the PLX 9054 chip).



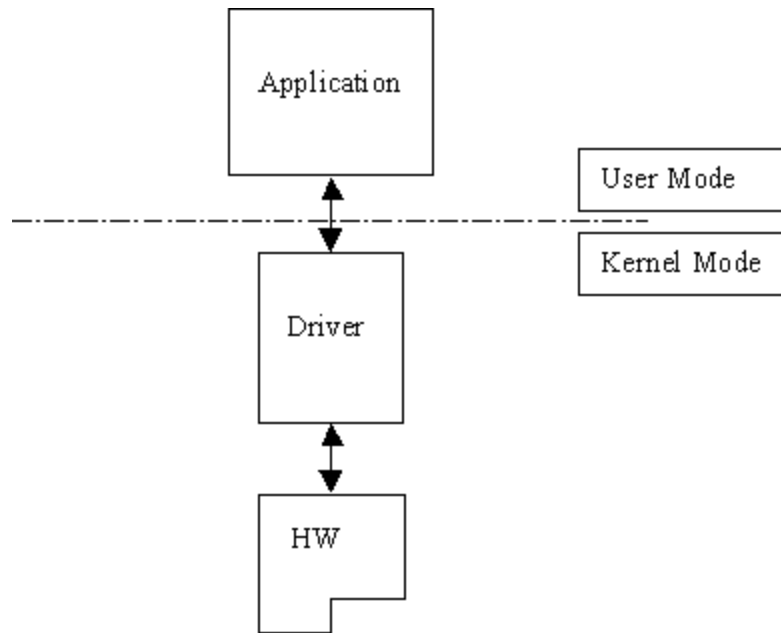
## Samples

Here you will find the source code for the utilities listed above, along with other samples which show how various driver tasks are performed. Find the sample which is closest to the driver you need. Use it to jump-start your driver development process.

- WinDriver samples - (***windriver\samples***) - Samples which demonstrate different common drivers.
  - WinDriver for PLX | GALILEO | AMCC | V3 samples - (***lp9054\_diag lp9080\_diag*** etc.) - Source code of the diagnostics applications for the specific chipsets that WinDriver supports.

## Monolithic Drivers

These are the device drivers that are primarily used to drive custom hardware. A monolithic driver is accessed by one or more user applications, and directly drives a hardware device. The driver communicates with the application through I/O control commands - (IOCTLs), and drives the hardware through calling the different DDK, ETK, DDI/DKI functions.



**Figure 1.2: Monolithic Drivers**

Monolithic drivers are encountered under all operating systems including all Windows platforms (95/98/ME, NT/2000, CE), all Unix platforms (Linux, VxWorks and Solaris), and others like OS/2.

## **Windows 95/98/ME Drivers**

We use the term Windows drivers to mean VxD drivers that run on the related family of OS's, Windows 95, Windows 98 and Windows ME. These drivers do not work on Windows NT. Windows drivers are typically monolithic in nature. They provide direct access to hardware and privileged operating system functions. These drivers are called VxD drivers. Windows drivers can be stacked or layered in any fashion. However, the driver structure itself does not impose any layering.

## **NT Driver Model**

Besides monolithic drivers, Windows NT defines other kinds of drivers that are generally unique to Windows NT, but subsets or minor variations of which, are supported on other Windows operating systems like Windows 95/98/ME and WinCE. These are discussed below.

Layered Drivers

Miniport Drivers

## Unix Device Drivers

In the classic Unix driver model, devices belong to three categories, character (char) devices, block devices and network devices. Drivers that implement these devices are correspondingly known as char drivers, block drivers or network drivers. Under Unix, drivers are code units that are linked into the kernel, and run in privileged kernel mode. Generally, driver code runs on behalf of the user mode application. Access to Unix drivers from user mode applications is provided via the filesystem. In other words, devices appear to the applications as special device files that can be opened.

The three classes of devices are:

**Character** Character (*char*) devices can be accessed as files, and are implemented by char drivers. These drivers usually implement the *open*, *close*, *read*, *write* and *ioctl* system calls. The console and the serial port are examples of devices that are implemented by char drivers. Applications access char devices through files known as device nodes such as */dev/console* or */dev/ttyS0*.

**Block** Block devices are also accessed as files, and are implemented by block drivers. Block devices are generally used to represent hardware on which you can implement a file system. Typically, block devices are accessed by multiples of a block of data at a time. Block sizes are typically 512 bytes or 1 Kilobyte (1024 bytes). Block drivers interface with the kernel through a similar interface as a char driver. The device node for a block device shows differently in the filesystem listing.

**Network** Network interfaces are used to perform network transactions between applications residing on a network. A network interface may work through a hardware device or sometimes be implemented completely in software, like the loopback interface. User applications perform network transactions through interfaces to the kernel network subsystem (usually exposed as API such as sockets and pipes). Network interfaces send and receive network packets on behalf of user applications, without regard to how each individual transaction maps to actual packets being transmitted.

Network interfaces don't easily fit into the block or char philosophy. Hence, they are not visible as device nodes in the filesystem. They are represented by system-wide unique logical names such as *eth0*. Clearly, network interfaces are not accessed via the *open/read/write ...* system calls. Instead they are accessed through network API such as sockets, pipes, RPC etc.

## Linux Device Drivers

Linux device drivers are based on the classic Unix device driver model. In addition, Linux introduces some of its own characteristics.

Under Linux, block devices can also be accessed like a character device, but has an additional block oriented interface which is invisible to the user or application.

Traditionally, under Unix, device drivers had to be linked with the kernel, and the system had to be brought down and restarted after installing a new driver. Linux introduced the concept of a dynamically loadable driver called a *module*. Linux modules can be loaded or removed dynamically without requiring the system to be shut down. All Linux drivers can be written so that they are statically linked, or in modular form, which makes them dynamically loadable. This makes Linux memory usage very efficient because modules can be written to probe for their own hardware and unload themselves if they cannot find the hardware they are looking for.

## **Solaris Device Drivers**

Solaris device drivers are also based on the classic Unix device driver model. Like Linux, Solaris drivers may either be statically linked with the kernel, or may be dynamically loaded and removed, from the kernel.

## **For Windows 95 / 98 / ME**

1. An x86 processor
2. Any 32-bit development environment supporting C, VB or Delphi.



## **For Windows NT/2000**

1. An x86 processor.
2. Any 32-bit development environment supporting C, VB or Delphi.

## For Windows CE

1. Windows NT Workstation 4.0 host development platform
2. Microsoft Developer Studio 97 including:
  - Microsoft Visual C++ V5.0 or higher
  - Windows CE Platform SDK

**If you are using a commercial Windows CE hand-held Computer like the HP Jornada or the Sharp Mobilon, you will need the following items in addition to the ones mentioned above:**

- Your hand-held computer.
- Serial PC link cable for communication via Windows CE Services (This cable is normally custom manufactured and supplied by the manufacturer of the hand-held computer. Do not attempt to use different cables for this purpose.)

**If you are using an X86 PC or a commercial target board like the Hitachi ODO, you will need the following items in addition:**

- Your target platform.
- The Windows CE Embedded Toolkit for Visual C++ (ETK) V2.10, or Platform Builder V2.11 and above. IF you have the ETK V2.0, you should upgrade to 2.1 via the ETK 2.1 Enhancement Pack and upgrade your installation before installing WinDriver CE.
- A serial null modem cable for debugging. A null modem cable can be purchased from a computer hardware store and wired by hand using a soldering iron.
  - A custom parallel port cable for downloading the OS image and dynamic loading of WinDriver CE. Please see Appendix [PC-Based Development Platform Parallel Port Cable Info](#) of this manual for the pin-out details of the Parallel Port Cable.

This procedure is explained in detail in the online documentation of the Windows CE ETK and Platform Builder.

## For Linux

1. An x86 processor
2. Any 32-bit development environment supporting C (such as GCC).

## **For Solaris**

1. An x86 processor
2. Any 32-bit development environment supporting C (such as GCC).

## For VxWorks

1. Windows NT Workstation 4.0 host platform development
2. Tornado II IDE
3. Selected Target Platform: This should be running a processor that has a BSP (Board Support Package) compatible with the list of CPU/BSP combinations supported by DriverBuilder.  
For an up-to-date list, see the URL below:  
<http://www.jungo.com/db-vxworks.html#platforms>

For information on BSP compatibility, please contact your nearest Wind River Systems support representative.

## Installing WinDriver for Windows 95,98,ME,NT and 2000

1. Insert the WinDriver CD into your CD-ROM drive. (When installing WinDriver by downloading it from Jungo's web site instead of using the WinDriver CD, double click the downloaded WinDriver file (**WDxxx.exe**) in your download directory, and go to step 3).
2. Wait a few seconds until the installation program starts automatically. If for some reason it does not start automatically, double-click the file "**Wdxxx.exe**" (where "xxx" is the version number) and click the "Install WinDriver" button.
3. Read the license text carefully, and click 'YES' if you accept its terms.
4. The evaluation package installer proceeds to copy all the files and may prompt you to reboot your system.

### **The following steps are For Registered Users only:**

5. Choose 'Install registered version' when prompted for the version to install.
6. In the "Setup type" screen, choose one of the following:
  - *Typical* - To install all WinDriver modules. (Generic WinDriver toolkit + specific chip set APIs).
  - *Minimal* - To install only the generic WinDriver toolkit.
  - *Custom* - To choose which modules of WinDriver to install. You may choose which APIs will be installed.
7. You will now be prompted for an 8-digit password to continue the installation. Type in the password you received when purchasing WinDriver. Take care when entering the password. The installation will fail if the wrong password is written here. Note that the password is case

sensitive.

8. After completing the set-up, please reboot your computer.
  
9. Activate DriverWizard from *Start | Programs | WinDriver | DriverWizard*. Select the **Register WinDriver** option from the File menu and insert your license string there.
  
10. To activate source code you have developed in the evaluation version, simply follow the instructions in *windriver\redist\register\register.txt*.



## **Installing WinDriver CE**

[Installing WinDriver CE for a hand held PC](#)  
[Using WinDriver CE with ETK/Platform Builder](#)

## Testing Your Applications on the X86 HPC Emulator

Emulation on Windows NT

## Installing WinDriver for Linux

Since WinDriver installation installs the kernel module `windrvr.o`, WinDriver should be installed by the system administrator logged in as root, or with root privileges.

- Insert the WinDriver CD into your Linux machine CD drive or copy the downloaded file to your preferred directory (eg. `/home/username/`).
  
- Change directory to preferred installation root directory, say **`/usr/local`** (`cd /usr/local/`)
  
- Extract the file **`WDxxxLN.tgz`** (where xxx is the version number) (`/usr/local> tar xvzf /mnt/cdrom/LINUX/WDxxxLN.tgz`) From a CD: (`/usr/local> tar xvzf /mnt/cdrom/LINUX/WDxxxLN.tgz`)  
From a downloaded file: (`/usr/local> tar xvzf /home/username /WDxxxLN.tgz`)
  
- Change directory to WinDriver (this directory gets created by tar) (`/usr/local> cd WinDriver/`)  
**Note:** In V5.0, this directory gets created by tar, but in versions preceding 5.0, the WinDriver directory does not get created by the extraction. Therefore with older versions like 4.33, first create a directory ( say WinDriver) before proceeding with the installation. (`>mkdir /usr/local/WinDriver`)
  
- Install WinDriver (`/usr/local/WinDriver> make install`)
  
- Create a symbolic link so that you can easily launch the GUI DriverWizard (`/usr/local/WinDriver>ln -s /usr/local/WinDriver/wizard/wdwizard /usr/bin/wdwizard`).
  
- Change the read and execute permissions on the file `wdwizard` so that ordinary users can access this program
  
- Change the user and group ids and give read/write permissions to the device file `/dev/windrvr` depending on how you wish to allow users to access hardware through the device.
  
- Start accessing your hardware and generate your skeletal code!

### The following steps are for Registered Users only

1. Change directory to **/windriver/redist/register/** (`/usr/local/WinDriver> cd redist/register`)
2. Extract the file `wdxxxreg.zip` using the password you have received with the WinDriver package (`/usr/local/WinDriver/redist/register> ../../util/unzip WDxxxREG.ZIP`)
3. Change directory to **windriver/redist/** (`/usr/local/WinDriver/redist/register/>cd ..`)
4. Remove the evaluation module if previously installed (`/usr/local/WinDriver/redist/> /sbin/rmmod windrvr`)
5. Clean the evaluation version module directory (`/usr/local/WinDriver/redist/> make clean`)
6. Install registered version (`/usr/local/WinDriver/redist/> make install IS_REGISTERED=1`)  
Once you activate DriverWizard you will be prompted for the license string you have received when purchasing the registered version.
7. To activate source code you have developed in the evaluation version, simply follow the instructions in `WinDriver/redist/register/register.txt`.

### Restricting hardware access on Linux

## **Installing DriverWizard on your Windows machine**

- 1.** Insert the WinDriver CD into your Windows machine CD drive.
- 2.** Follow steps 2-9 of the Windows installation instructions (above).

## Installing WinDriver for Solaris

Since WinDriver installation installs the kernel module `windrvr.o`, it should be installed by the system administrator logged in as root, or with root privileges.

1. Insert your CD into your Solaris machine CD drive or copy the downloaded file to your preferred directory (eg. `/home/username/`).
2. Change directory to preferred installation root directory, say **/usr/local**: (`cd /usr/local/`)
3. Copy the file `WDxxxSLS.tgz` (Sparc) or `WDxxxSL.tgz` (Intel) to the current directory (here xxx stands for the version number, for example 500): (`/usr/local/> cp /home/username /WDxxxSL.tgz`  
`./`)  
**Note:** When installing WinDriver for Solaris x86 use `WDxxxSL.tgz` instead of `WDxxxSLS.tgz`.
4. Extract the file (`/usr/local/> gunzip -c WDxxxSLS.tgz | tar -xvf WDxxxSLS.tar`)
5. Change directory to WinDriver (**Note:** In V5.0 this directory gets created by tar but in versions preceding 5.0, the WinDriver directory does not get created by the extraction. Therefore with older versions like 4.3, first create a directory (say WinDriver) before proceeding with the installation.)
6. Install WinDriver for Solaris (`/usr/local/WinDriver>./ install_windrvr`)
7. Create a symbolic link so that you can easily launch the GUI DriverWizard (`/usr/local/WinDriver>ln -s /usr/local/WinDriver/wizard/wdwizard /usr/bin/wdwizard`).
8. Change the read and execute permissions on the file `wdwizard` so that ordinary users can access this program
9. Change the user and group ids and give read/write permissions to the device file `/dev/windrvr` depending on how you wish to allow users to access hardware through the device.

**The following steps are for Registered Users only:**

- Change directory to **WinDriver/redist/register/**: (*/usr/local/WinDriver> cd redist/register*)
  - Extract the file found in **WDxxxREG.ZIP** and enter the 8 digit password you have received with the WinDriver package: (*/usr/local/WinDriver/redist/register> unzip WDxxxREG.ZIP*)
  
- Remove the evaluation kernel with the command */usr/sbin/rem\_drv windrvr*
  
- Replace the evaluation WinDriver kernel (windrvr) with the registered version you have extracted above: (*cp WinDriver/redist/register/windrvr /kernel/drv*)
  
- Install the registered module by running the command */usr/sbin/add\_drv -m "0666 root sys" windrvr*

**Note:** after extracting the registered kernel in step 2 you can modify the install\_windrvr (used to install the evaluation kernel) script in top dir (WinDriver) to install the registered kernel. For this you need to perform the following change: Open the file install\_windrvr and look for the following line: (*util/wdreg redist/eval/windrvr util/windrvr.conf*)  
change it to: (*util/wdreg redist/register/windrvr util/windrvr.conf*)
  
- To create symbolic links from the /dev dir to the actual nodes in the /devices dir, run the command */usr/sbin/devlinks*
  
- To activate source code you have developed in the evaluation version, simply follow the instructions in *WinDriver/redist/register/register.txt*

[Restricting hardware access on Solaris](#)  
[Solaris Platform Specific Issues](#)

## Installing DriverBuilder for VxWorks

The following describes the installation of DriverBuilder for VxWorks. DriverBuilder development environment works with Tornado 2 for Windows only (on x86 platform). Drivers generated using version 5.0 of DriverBuilder will run on Intel x86 BSPs (pc486, pcPentium and pcPentiumPro), PPC 821/860 with MBX821/860 and PPC 750 (IBM PPC 604) with MCP750. For an up-to-date list, see the URL below: <http://www.jungo.com/db-vxworks.html#platforms>

To install DriverBuilder:

1. Download DriverBuilder for VxWorks
2. Change drive to the preferred root drive for DriverBuilder, for example "c:\"
3. Unpack the file you downloaded - for example: "unzip -d DB500VX.zip c:\". The extraction creates a directory called DriverBuilder under which all the DriverBuilder installation files can be found.(this feature was added in version 5.00. If you are working on a previous version,please create a directory for DriverBuilder,for example: "c:\cd\_vxworks" and unpack the file to it: "unzip -d DBxxxVX.zip c:\db\_vxworks").
4. Create a shortcut on your desktop to DriverWizard found under C:\DriverBuilder\wizard\wdwizard.exe so that you can easily launch the GUI DriverWizard

**Note:** The WinDriver samples for VxWorks have the .out extension. For example, *pci\_diag.out*. To invoke these programs, use Windsh to load them, and execute the routine xxx\_main. For example:

*wddebug.out* : *wddebug\_main*

*pci\_diag.out* : *pci\_diag\_main*



## On your Windows machine

Start DriverWizard by choosing '*Programs | WinDriver | DriverWizard*' from the **Start** menu.

### Registered Users

- Make sure that your WinDriver license is installed (see Section [Installing WinDriver](#) that explains how to install WinDriver). If you are an evaluation version user, you do not need to install a license.
  
- **For PCI cards** - Insert your card into the PCI bus, and check that DriverWizard detects it.
  
- **For ISA cards** - Insert your card into the ISA bus, configure DriverWizard with your card's resources and try to read / write to the card using DriverWizard.

## On your Windows CE machine

- Start DriverWizard on your NT machine by choosing *Programs | WinDriver | DriverWizard* from the start menu.
- Make sure that your WinDriver license is installed (see Section [Installing WinDriver](#) for WinDriver installation details). If you are an evaluation version user, you do not need to install a license.
- For PCI cards - Insert your card into the PCI bus, and check that DriverWizard detects it.
- For ISA cards - Insert your card into the ISA bus, Configure DriverWizard with your card's resources and try to read / write to the card using DriverWizard.
- Activate Visual C++ for CE and load one of the WinDriver samples (e.g. `\windriver\samples\speaker\speaker.dsw`)
- Select the target platform as X86em from the VisualC++ WCE Configuration Toolbar.
- Compile and run the speaker sample. The NT speaker should be activated from within the CE emulation environment.

## On your Linux machine

- Run the pre-compiled speaker sample found in `WinDriver/samples/speaker/LINUX/speaker`
- If the sample program works, then you have installed WinDriver for Linux properly.

## On your Solaris machine

- Run the precompiled speaker sample found in `WinDriver/samples/speaker/Solaris/speaker`
- If the sample program works, then you have installed WinDriver for Solaris properly (this program only works under X86). For Sparc Solaris you can run the GUI DriverWizard to check the installation.

## On VxWorks

1. In x86 only: Make sure MMU is set to basic support ("hardware/memory/MMU/MMU Mode"). DriverBuilder for "no MMU" support will be available shortly.

2. Load DriverBuilder: download the object file  
(DriverBuilder \redist\eva\intelx86\PENTIUM\windrvr.o).

3. Initialize DriverBuilder: from the WindShell:

```
=> drvInit()
```

```
function returned (return value = 0)
```

```
=>
```

4. Run a sample driver: load C:\DriverBuilder\samples\pci\_diag\PENTIUM\pci\_diag.out  
from the WindShell:

```
=> pci_diag_main()
```

now you can scan the PCI bus, open cards and 'talk' to them.

## Uninstalling Windriver from Windows (95/98/ME/NT/2000)

1. Uninstall the Windriver service using the command **windriver\util\wdreg remove**
  
2. Use the "Add/Remove Programs" applet from the Control Panel, select Windriver, and click on the "Remove" button.
  
3. Delete the following files if they exist:
  - Windows NT/2000: Windrvr.sys and wdpnp.sys from Winnt\system32\drivers
  
  - Windows 98: Windrvr.sys and wdpnp.sys from Windows\system32\drivers
  
  - Windows 95/98/ME: windrvr.vxd from Windows\System\Vmm32

## Uninstalling Windriver from Linux

**NOTE: You must be logged in as root to do the uninstallation.**

1. Uninstall the Windriver service
  - Do a `/sbin/lsmmod` to check if the WinDriver module is in use by any application or by other modules
  - Make sure that no programs are using WinDriver
  - if any application or module is using WinDriver, close all applications and do a `/sbin/rmmod` to remove any module using WinDriver
  - Run the command `"/sbin/rmmod windrvr"`
  - `rm -rf /dev/windrvr` (Remove the old device node in the `/dev` directory)
  - Remove the file `.windriver.rc` in the `/etc` directory.  
Run the command `rm -rf /etc/.windriver.rc` to do this.
  - Remove the file `.windriver.rc` in `$HOME`.  
Run the command `rm -rf $HOME/.windriver.rc` to do this.
2. If you created a symbolic link to DriverWizard, delete the link using the command `"rm -f /usr/bin/wdwizard"`
3. Delete the Windriver installation directory. Use the command `"rm -rf /usr/local/WinDriver"`

## Uninstalling WinDriver from Solaris

1. Uninstall the WinDriver service
  - You must be root to do the uninstallation
  - Make sure no programs are using WinDriver
  - If any applications or modules are using WinDriver, then close them and do a `/usr/sbin/rem_drv` to remove any modules using WinDriver
  - Run the command `"/usr/bin/rem_drv windrvr"` to unload the kernel module
  - Run the command `"rm -rf /kernel/drv/windrvr /kernel/drv/windrvr.conf"` to clean up the old device node.
  - Remove the file `.windriver.rc` in the `/etc` directory.  
Run the command `rm -rf /etc/.windriver.rc` to do this.
  - Remove the file `.windriver.rc` in `$HOME`.  
Run the command `rm -rf $HOME/.windriver.rc` to do this.
2. If you created a symbolic link to DriverWizard, delete the link using the command `"rm -f /usr/bin/wdwizard"`
3. Delete the WinDriver installation directory. Use the command `"rm -rf /usr/local/WinDriver"`





## Uninstalling DriverBuilder for Vxworks

1. Delete the DriverBuilder installation directory (for example C:\DriverBuilder) using Windows Explorer
2. If you created any shortcuts to DriverWizard on your desktop, delete the shortcut.

## Sharing a Resource

When two or more drivers want to share the same resource, you must define that resource as 'shared'.

To define a resource as shared:

1. Select the resource.
2. 'Right click' the resource.
3. Select '**Share**' from the menu.

(Note: The default for a newly defined interrupt is 'shared'. If you wish to define it as an unshared interrupt, follow steps 1-2 and select '**Unshared**' from the menu in step 3).

## Disabling a Resource

During your diagnostics, you may wish to disable a resource, so that DriverWizard will ignore it, and not create code for it.

### To disable a resource

1. Select the resource.
2. 'Right - click' on the resource name.
3. Choose '**Disable**' from the menu.

## **DriverWizard Logger**

DriverWizard Logger is the blank window that opens up along with the device resources dialog when opening a new project. The logger keeps track of all your input / output in the diagnostics stage, so that the developer may analyze his device's physical performance at a later time. It is possible to save the log for future reference. When saving the project, your log is saved as well. Each log is associated with one project.

## Automatic Code Generation

After you have finished diagnosing your device and have ensured that it runs according to your specifications, you are ready to write your driver.

### Step One - Generating your code.

Choose **Generate Code** from the **Build** menu. DriverWizard will generate the source code for your driver, and place it along with the project file (xxx.wdp where xxx is your project name). The files are saved in a directory the DriverWizard creates for every development environment and operating system chosen in the 'Generate Code' screen.

In the source code directory you now have a new '**xxxlib.h**' file which states the interface for the new functions that DriverWizard created for you, and the source of these functions '**xxxlib.c**', where your device specific API is implemented. In addition, you will find the sample main() function in the file '**xxxdiag.c**'.

The code generated by DriverWizard is composed of the following elements and files ('xxx' your project name):

1. Library functions for accessing each element of your card's resources (Memory ranges, I/O ranges, registers, interrupts and the USB pipes).  
**xxx\_lib.c** Here you can find the implementation of your hardware specific API, (found in xxx\_lib.h), using the regular WinDriver API.  
**xxx\_lib.h** This is the header file of the diagnostics program. Here you can find all your hardware specific API created by DriverWizard. You should include this file in your source code to use this API.
2. A general PCI utility library.  
**A diagnostics program**, which is a console application with which you can diagnose your card. This application utilizes the special library functions, which were created for your device by DriverWizard. Use this diagnostics program as your skeletal device driver.  
**pci\_diag\_lib.c** This is the source code of the diagnostics program DriverWizard creates.
3. A list of all files created can be found at **xxx\_files.txt**.

After creating your code, compile it with your favorite Win32 compiler, and see it work!

Change the function main() of the program so that the functionality fits your needs.

### Step 2 - Compiling the generated code

#### For Windows 95, 98, ME, NT, 2000 and CE (Using MSDEV)

For Windows platforms, DriverWizard generates the project files (for MSDEV 4, 5 and 6 ,C Builder and Delphi 2, 3, 4). After code generation, the chosen IDE (Integrated development environment) will be launched automatically. You can immediately compile and run the generated code.

#### For Linux and Solaris

DriverWizard creates a makefile for your project.

Compile the source code using the makefile generated by DriverWizard.

Use GCC to build your code.

### **For Other OSs or IDEs**

Create a new project in your IDE (Integrated development environment).

Include the source files created by DriverWizard into your project.

Compile and run the project.

The project contains a working example of the custom functions that DriverWizard created for you. Use this example to create the functionality you want.

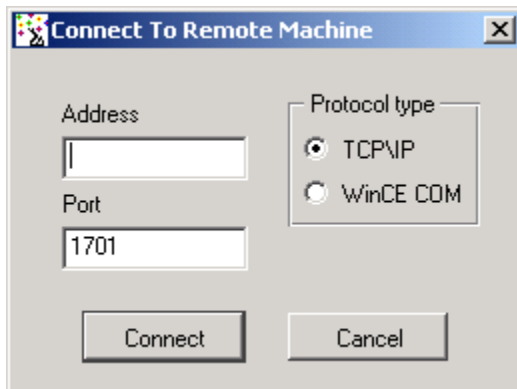
## **How does it work?**

Remote WinDriver utilizes a TCP/IP connection to communicate between the host development system and a target development system to which the hardware is plugged. On the remote target machine, WinDriver Remote Agent is installed together with the WinDriver Kernel Module, and permits access to the hardware directly from the user level in the local host development machine.



## Using Remote WinDriver (For all Windows OSes)

- Install Remote WinDriver Agent (wdremote\_gui.exe) on the remote machine (target). This file is in the directory WinDriver\util
- Run DriverWizard (wdwizard.exe) on the local machine. DriverWizard is in the directory WinDriver\wizard
- Open a new project from DriverWizard
- Click on the "Remote Machine" button in the Card Information screen
- The following screen is then displayed:



**Figure 4.8: Remote WinDriver on all Windows OS**

- Enter the IP address of the remote machine (on which wdremote\_gui.exe runs)
- Select the protocol type as TCP/IP

- Enter the Port number to listen to in the Port text box. The default port number is 1701
  
- DriverWizard will scan the buses of the remote machine and display the Plug and Play cards plugged into the remote machine.
  
- Select your hardware and click on the OK button
  
- Test and diagnose your hardware on the remote machine and generate the driver code as with any other WinDriver product. For more information refer to Chapters [The DriverWizard](#) and [Creating Your Driver](#). These illustrate the process of developing a device driver.

**Notes:** By default, wdremote\_gui.exe listens to the TCP port number 1701 for incoming remote connections. If this port number is already used on your system, you can change the port number to a different one that you know is unused. If you do so, then on the host-side, you need to specify the same port number when you attempt to connect using DriverWizard.

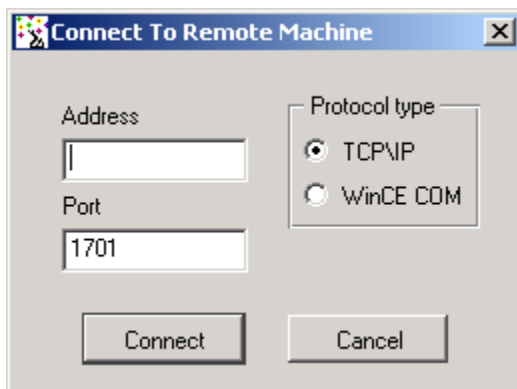
There are two ways of running this program wdremote\_gui.exe:

1. Just run it from the command prompt as wdremote\_gui.exe
  
2. Launch the program from Programs | WinDriver | WinDriver Remote Server

## Using Remote WinDriver (For Windows CE)

Remote WinDriver configuration for Windows CE is different from other OSes. The following steps explain the Remote WinDriver Setup and use for Win CE.

1. Copy wdremote.dll (in \WinDriver\util) to the windows directory of your hand-held PC. If your WinCE target is a normal PC, then copy wdremote.dll to the release directory of WinCE in your NT workstation
2. Establish a serial PC link between the host and the target using Microsoft Active Sync
3. Run DriverWizard on the NT workstation
4. Open a new project
5. DriverWizard will display all the hardware components in the local machine
6. Click the "Remote Machine" button
7. The following screen is then displayed:



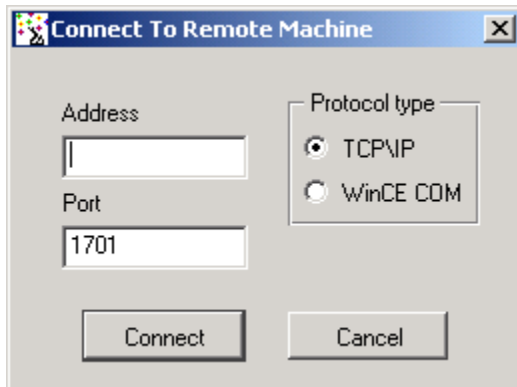
**Figure 4.9: Remote WinDriver on Windows CE**

8. Select the Protocol Type as Wince COM
  
9. Click the Connect button
  
10. After a few seconds, the hardware in the Remote Machine is displayed. If you are using an eval version , then as soon as the remote connection is established, a screen pops-up in the target machine informing you that the WinDriver kernel will work only for 30 mins. After you click OK in this screen, DriverWizard will display the list of devices on the target platform.  
In the eval versions, the remote agent in the CE machine will stop working after 10 mins.
  
11. Select your hardware and click OK
  
12. Test, diagnose and generate code for your driver as with any other WinDriver product.

For more information, refer to Chapters [The DriverWizard](#) and [Creating Your Driver](#) that illustrate the process of developing a device driver.

## Using Remote WinDriver (For Linux and Solaris)

- On the Target machine(contains the hardware for which you are writing the driver), do the following:
  1. Change your directory to WinDriver/util
  2. Start the wdremote server utility by running the command **wdremote**  
**NOTE:** The options for the wdremote are the TCP/IP port number you wish use to communicate with the client. The default port number is 1701.
  
- On the Client machine, do the following:
  1. Start the wizard in the directory WinDriver/wizard
  2. Open a new project
  3. Click on the "Remote Machine" button  
The following screen is then displayed:



**Figure 4.10: Remote WinDriver on Linux**

4. Enter the IP address of the machine which is running the wdremote server (your target machine)

5. Enter the TCP/IP port number you wish to use to communicate with the server. The default port number is 1701

**Note:** Use the same port number you used to start your server.

6. Click OK

**NOTE:** This takes a while, so please wait for a while for the wizard to display the information of all the cards on your target machine

7. Test and diagnose your hardware on the remote machine and generate the driver code.

**Note:** wdremote is a command line program that takes one option - the TCP port number to listen on. If no option is given, the port number defaults to 1701.

Just run this program as wdremote from the command line. Call this program from /etc/rc.d/rc.local/ to have it started automatically at boot time.

## Using Remote WinDriver (For VxWorks)

- Run Remote WinDriver Agent (*wdremote.out*) on the remote machine (target). This file is in the directory `DriverBuilder\util<CPU>`, where `<CPU>` stands for the BSP you are using. For example, `DriverBuilder\util\Pentium\wdremote.out`. You need to use the **Tornado II IDE** utility *Windsh* to load this program and launch it, by using the entry point *wdremote\_main*
- Run DriverWizard (*wdwizard*) on the local machine (Windows, Linux or Solaris). DriverWizard is in the directory `WinDriver\wizard` or `DriverBuilder\wizard`.
- Open a new project from DriverWizard
- Click on the "Remote Machine" button in the Card Information screen
- Enter the IP address of the remote machine (on which *wdremote\_main* runs)
- Select the protocol type as TCP/IP
- Enter the Port number to listen to in the Port text box. The default port number is 1701
- DriverWizard scans the buses of the remote machine and display the Plug and Play cards plugged into the remote machine.
- Select your hardware and click on the OK button
- Test and diagnose your hardware on the remote machine and generate the driver code.

For more information, refer to Chapters [The DriverWizard](#) and [Creating Your Driver](#) that illustrate the process of developing a device driver.

## Using DebugMonitor

DebugMonitor has two modes **Graphic** and **Console** mode. The following is an explanation on how to operate DebugMonitor in both modes.

[DebugMonitor Graphical Mode](#)

[DebugMonitor - Console Mode](#)

[DebugMonitor on Linux and Solaris](#)

[DebugMonitor on Windows CE](#)

[DebugMonitor on VxWorks](#)



## Introduction

The PLX9050 Diagnostics (P50\_DIAG.EXE) accesses the hardware using WinDriver. Therefore WinDriver must be installed before being able to run P50\_DIAG. Once WinDriver is running, you may run P50\_DIAG.

Click 'Start / Programs / WinDriver / PLX 9050 Diagnostics'. The application will first try to locate the card, with the default VendorID and DeviceID assigned by PLX (VendorID = 0x10b5, DeviceID = 0x9050). If such a card is found you will get a message "PLX 9050 card found". If you have programmed your EEPROM to load a different VendorID/DeviceID, then at the main menu you will have to choose your card (option 'Locate/Choose PLX 9050 board' in main menu).

## Main Menu Options

*Scan PCI bus:* Displays all the cards present on the PCI bus and their resources. (IO ranges, Memory ranges, Interrupts, VendorID/DeviceID). This information may be used to choose the card you need to access.

*Locate/Choose PLX 9050 board:* Chooses the active card that the diagnostics application will use. You are asked to enter the VendorID/DeviceID of the card you want to access. In case there are several cards with the same VendorID/DeviceID, you will be asked to choose one of them.

*PCI configuration registers:* This option is available only after choosing an active card. A list of the PCI configuration registers and their READ value are displayed. These are general registers, common to all PCI cards. In order to WRITE to a register, enter its number, and then the value to write to it.

*PLX 9050 local registers:* This option is available only after choosing an active card. A list of the PLX9050 registers and their READ value are displayed. In order to WRITE to a PLX9050 register, enter the register number, and then enter the value to write to it.

*Access memory ranges on the board:* This option is available only after choosing an active card. Use this option carefully. Accessing memory ranges, accesses the local bus on your card -- If you access an invalid local address, or if you have any problem with your card (such as a problem with the IRDY signal), the CPU may hang.

To access a local region, first toggle the active mode between BYTE/WORD/DWORD, to fit the hardware you are accessing. The PLX9050 has four memory ranges to access a local region. There is no difference between them, therefore you need not change the active memory range.

- To READ from a local address, choose 'Read from board'. You will be asked for local address to read from.
  
- To WRITE from a local address, choose 'Write from board'. You will be asked for local address to write to, and the data to write. Both in board READ and WRITE, the address you give will also be used to set the base address register.  
LASxBA register is set with the base address, and LASxBRD register is set with the mode (BYTE/WORD/DWORD as chosen as active mode).

## Sample

Code Sample uses of WinDriver and WinDriver for PLX are supplied with the WinDriver toolkit. You may find the WinDriver samples under `\windrvr\samples`, and the WinDriver for PLX samples under `\windrvr\plx`.

Each directory contains a `files.txt` file which describes the various samples included. Each sample is located in its own directory. For your convenience, we have supplied an `mdp` file alongside each `.c` file, so that users of Microsoft's Developer Studio may double-click the `mdp` file and have the whole environment ready for compilation. (Users of different win32 compilers need to include the `.c` files in their standalone console project, and include the `p50_lib` in their project) You may learn to use the WinDriver for PLX API by looking at `P50_diag.c` which is found in `\windrvr\plx\P50_diag.c`. `P50_diag.c` is the source code of the PLX 9050 diagnostics program found under `Start \ Programs \ WinDriver`.

## **P9050\_CountCards()**

Returns the number of cards on the PCI bus that have the given VendorID and DeviceID. This value can then be used when calling P9050\_Open, to choose which board to open. Normally, only one board is in the bus and this function will return 1.

### **Prototype**

```
DWORD P9050_CountCards(DWORD dwVendorID, DWORD dwDeviceID);
```

### **Parameters**

1. dwVendorID - Vendor ID of your PLX 9050 card. If 0, detects cards from all vendors.
2. dwDeviceID - Device ID of your PLX 9050 card. If 0, detects all devices.

### **Return Value**

Returns the number of matching PCI cards found.

### **Example**

```
nCards = P9050_CountCards( 0x10b5, 0x9050 );
```

## P9050\_Open()

Used to open a handle to the PLX 9050 card. If several 9050 cards are installed, the specific card to open may be specified by using P9050\_CountCards before using P9050\_Open, and calling open with a specific card number (See prototype below) If open is successful function returns TRUE, and a handle to the PLX card.

### Prototype

```
BOOL P9050_Open ( P9050HANDLE *phPlx, DWORD dwVendorID, DWORD dwDeviceID, WORD nCardNum, DWORD options );
```

### Parameters

1. dwVendorID, dwDeviceID - DeviceID / VendorID of the board to access.
2. nCardNum - If there are a few cards with the given VendorID and DeviceID, this will choose what one of them to open. This number should be from 0 (the first board) up to the value returned by P9050\_CountCards() minus one. Most programs that do not need to handle multiple boards, can set nCardNum to 0.
3. options - options regarding the board opened. If P9050\_OPEN\_USE\_INT, then the board must have an interrupt, and the interrupt will be installed. If P9050\_OPEN\_FIX\_BIT7, then a workaround will be applied on the errata on some PLX chips regarding BIT7 of BAR0.

### Return Value

TRUE if OK.

### Example

```
if (!P9050_Open( &hPlx, 0x10b5, 0x9050, 0, P9050_OPEN_USE_INT ))  
{  
  
    printf("Error opening device\n");  
}
```

## **P9050\_Close()**

Closes the WinDriver device. Must be called after finished using the driver.

### **Prototype**

```
void P9050_Close( P9050HANDLE hPlx );
```

### **Parameters**

hPlx - handle to the PLX card to close.

### **Return Value**

none

### **Example**

```
P9050_Close(hPlx);
```

## **P9050\_IsAddrSpaceActive()**

Checks if the specified address space is enabled. The enabled address spaces are determined by the EEPROM, which at boot time sets the PLX's memory ranges requests. Use this function after calling P9050\_Open() to make sure that the address space(s) that your driver is going to use are enabled.

### **Prototype**

```
BOOL P9050_IsAddrSpaceActive(P9050HANDLE hPlx, P9050_ADDR addrSpace);
```

### **Parameters**

1. hPlx - PLX card handle
2. addrSpace - Can be P9050\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM.

### **Return Value**

TRUE if address space is enabled

### **Example**

```
if ( !P9050_IsAddrSpaceActive(hPlx, P9050_ADDR_SPACE2) )  
  
{  
  
    printf ("Address space2 is not active!\n");  
  
}
```

## **P9050\_ReadReg(), P9050\_WriteReg()**

Reads or writes to or from a specified register on the board.

### **Prototype**

```
DWORD P9050_ReadReg (P9050HANDLE hPlx, DWORD dwReg);
```

```
void P9050_WriteReg (P9050HANDLE hPlx, DWORD dwReg, DWORD dwData);
```

### **Parameters**

1. hPlx - PLX card handle.
2. dwReg - offset of register to read or write. The constant values of registers are already defined in P50LIB.H, for example: P9050\_LAS0RR is the offset of LAS0RR register.
3. dwData - data to write to register. (for P9050\_WriteReg() only).

### **Return Value**

Data read from register (for P9050\_ReadReg() only).



## **P9050\_ReadSpaceByte(), P9050\_ReadSpaceWord(), P9050\_ReadSpaceDWord()**

Reads a byte / word / dword from address space on board.

### **Prototype**

1. BYTE P9050\_ReadSpaceByte (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwOffset);
2. WORD P9050\_ReadSpaceWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwOffset);
3. DWORD P9050\_ReadSpaceDWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwOffset);

### **Parameters**

1. hPlx - PLX card handle.
2. addrSpace - Can be P9050\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM.  
Choose the address space to access.
3. dwOffset - offset in the address space to read from.

### **Return Value**

Data read from the board.

## **P9050\_WriteSpaceByte(), P9050\_WriteSpaceWord(), P9050\_WriteSpaceDWord()**

Writes a byte / word / dword to address space on board.

### **Prototype**

1. void P9050\_WriteSpaceByte (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwOffset, BYTE data);
2. void P9050\_WriteSpaceWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwOffset, WORD data);
3. void P9050\_WriteSpaceDWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwOffset, DWORD data);

### **Parameters**

1. hPlx - PLX card handle.
2. addrSpace - Can be P9050\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM. Choose the address space to access.
3. dwOffset - offset in the address space to write to.

### **Return Value**

None

## **P9050\_ReadSpaceBlock(), P9050\_WriteSpaceBlock()**

Reads or writes a block to or from an address space on the board.

### **Prototype**

1. void P9050\_ReadSpaceBlock (P9050HANDLE hPlx, DWORD dwOffset, PVOID buf, DWORD dwBytes, P9050\_ADDR addrSpace, P9050\_MODE mode);
2. void P9050\_WriteSpaceBlock (P9050HANDLE hPlx, DWORD dwOffset, PVOID buf, DWORD dwBytes, P9050\_ADDR addrSpace, P9050\_MODE mode);

### **Parameters**

1. hPlx - PLX card handle.
2. dwOffset - offset in the address space to read from or write to.
3. buf - a caller given buffer, into which data is read from or written to.
4. dwBytes - size to read in bytes
5. addrSpace - Can be P9050\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM.  
Choose the address space to access.
6. mode - access mode: P9050\_MODE\_BYTE/WORD/DWORD.

### **Return Value**

None

## **P9050\_ReadByte(),P9050\_ReadWord()P9050\_ReadDWord()**

Reads a byte / word / dword from memory on board.

### **Prototype**

1. BYTE P9050\_ReadByte (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwLocalAddr);
2. WORD P9050\_ReadWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwLocalAddr);
3. DWORD P9050\_ReadDWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwLocalAddr);

### **Parameters**

1. hPlx - PLX card handle.
2. addrSpace - Can be P9050\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM. Chooses the address space used to access the local address. If accesses to card are not done from two threads simultaneously (this is the normal case), then all accesses can use the same address space.
3. dwLocalAddr - local address on board to read from.

### **Return Value**

Data read from board.

## **P9050\_WriteByte(),P9050\_WriteWord(),P9050\_WriteDWord()**

Writes a byte / word / dword to memory on board.

### **Prototype**

1. void P9050\_WriteByte (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwLocalAddr, BYTE data);
2. void P9050\_WriteWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwLocalAddr, WORD data);
3. void P9050\_WriteDWord (P9050HANDLE hPlx, P9050\_ADDR addrSpace, DWORD dwLocalAddr, DWORD data);

### **Parameters**

1. hPlx - PLX card handle.
2. addrSpace - Can be P9050\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM. Chooses the address space used to access the local address. If accesses to card are not done from two threads simultaneously (this is the normal case), then all accesses can use the same address space.
3. dwLocalAddr - local address on board to write to.
4. data - data to write to board.

### **Return Value**

None

## **P9050\_ReadBlock(),P9050\_WriteBlock()**

Reads or writes a block of memory to or from the board.

### **Prototype**

1. void P9050\_ReadBlock (P9050HANDLE hPlx, DWORD dwLocalAddr, PVOID buf, DWORD dwBytes, P9050\_ADDR addrSpace, P9050\_MODE mode);
2. void P9050\_WriteBlock (P9050HANDLE hPlx, DWORD dwLocalAddr, PVOID buf, DWORD dwBytes, P9050\_ADDR addrSpace, P9050\_MODE mode);

### **Parameters**

1. hPlx - PLX card handle.
2. dwLocalAddr - local address on board to read from or write to.
3. buf - a caller given buffer, into which data is read from or written to.
4. dwBytes - size to read in bytes.
5. addrSpace - Can be P9050\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM. Chooses the address space used to access the local address. If accesses to card are not done from two threads simultaneously (this is the normal case), then all accesses can use the same address space.
6. mode - local address access mode: P9050\_MODE\_BYTE/WORD/DWORD.

### **Return Value**

None

## **P9050\_IntIsEnabled()**

Checks whether interrupts are enabled or not.

### **Prototype**

```
BOOL P9050_IntIsEnabled(P9050HANDLE hPlx);
```

### **Parameters**

hPlx - PLX card handle.

### **Return Value**

TRUE if interrupts are already enabled (i.e. if P9050\_IntEnable() was called).

## **P9050\_IntEnable()**

Enable interrupt processing.

**IMPORTANT NOTE:** *The PLX 9050 uses level sensitive interrupts, therefore you must edit the implementation of this function (found in \windrvr\plx\lib\9050\p50lib.c) to fit your specific hardware. The comments in the function will instruct you where your changes must be inserted. See more about this in the 'WinDriver'manual, in the section regarding PCI interrupts implementation.*

### **Prototype**

```
BOOL P9050_IntEnable(P9050HANDLE hPlx, P9050_INT_HANDLER funcIntHandler);
```

### **Parameters**

1. hPlx - PLX card handle.
2. FuncIntHandler - callback interrupt handler. Upon each incoming interrupt, this function will be called.

### **Return Value**

TRUE if successful.



## **P9050\_IntDisable()**

Disable interrupt processing.

### **Prototype**

```
void P9050_IntDisable(P9050HANDLE hPlx);
```

### **Parameters**

hPlx - PLX card handle.

### **Return Value**

None

## **P9050\_EEPROMReadWord(), P9050\_EEPROMWriteWord()**

Read from or write to the serial EEPROM.

### **Prototype**

1. `BOOL P9050_EEPROMReadWord (P9050HANDLE hPlx, DWORD dwAddr, PWORD pwData);`
2. `BOOL P9050_EEPROMWriteWord (P9050HANDLE hPlx, DWORD dwAddr, WORD wData);`

### **Parameters**

1. `hPlx` - PLX card handle.
2. `dwAddr` - address to read or write, ranges 0-0x3f.
3. `pwData` - pointer to data to read (P9050\_EEPROMReadWord() only).
4. `wData` - data to write (P9050\_EEPROMWriteWord() only).

### **Return Value**

TRUE if successful.

## **P9050\_ReadPCIReg(),P9050\_WritePCIReg()**

Read from or write to the PCI configuration registers.

### **Prototype**

1. `DWORD P9050_ReadPCIReg (P9050HANDLE hPlx, DWORD dwReg);`
2. `void P9050_WritePCIReg (P9050HANDLE hPlx, DWORD dwReg, DWORD dwData);`

### **Parameters**

1. `hPlx` - PLX card handle.
2. `dwReg` - offset of PCI configuration register to read or write.
3. `dwData` - data to write (P9050\_WritePCIReg() only).

### **Return Value**

Data read from configuration register (for P9050\_ReadPCIReg only).

## PLX Register Definitions

Use these definitions for accessing the PLX 9050 specific registers.

Use when calling P9050\_ReadReg() and P9050\_WriteReg().

1. P9050\_LAS0RR = 0x00
2. P9050\_LAS1RR = 0x04
3. P9050\_LAS2RR = 0x08
4. P9050\_LAS3RR = 0x0c
5. P9050\_EROMRR = 0x10
6. P9050\_LAS0BA = 0x14
7. P9050\_LAS1BA = 0x18
8. P9050\_LAS2BA = 0x1c
9. P9050\_LAS3BA = 0x20
10. P9050\_EROMBA = 0x24
11. P9050\_LAS0BRD = 0x28
12. P9050\_LAS1BRD = 0x2c

13. P9050\_LAS2BRD = 0x30

14. P9050\_LAS3BRD = 0x34

15. P9050\_EROMBRD = 0x38

16. P9050\_CS0BASE = 0x3c

17. P9050\_CS1BASE = 0x40

18. P9050\_CS2BASE = 0x44

19. P9050\_CS3BASE = 0x48

20. P9050\_INTCSR = 0x4c

21. P9050\_CNTRL = 0x50

## **P9050\_MODE**

Used for P9050\_ReadBlock() and P9050\_WriteBlock

1. P9050\_MODE\_BYTE = 0
2. P9050\_MODE\_WORD = 1
3. P9050\_MODE\_DWORD = 2

## **P9050\_ADDR**

Used for P9050\_ReadBlock() and P9050\_WriteBlock().

1. P9050\_ADDR\_SPACE0 = 1
2. P9050\_ADDR\_SPACE1 = 2
3. P9050\_ADDR\_SPACE2 = 3
4. P9050\_ADDR\_SPACE3 = 4
5. P9050\_ADDR\_EPROM = 5

## P9050\_INT\_RESULT

Used for the interrupt handler callback, given to P9050\_IntEnable() to receive information on the interrupt.

### Members

TYPE	NAME	DESCRIPTION
DWORD	dwCounter	number of interrupts received
DWORD	dwLost	number of interrupts not yet dealt with
BOOL	fStopped	true if interrupt was disabled during interrupt
DWORD	dwIntStatusReg	value of status register when interrupt occurred



## **P9050\_Open() fails**

The following may cause P9050\_Open() to fail:

*Cause:* WinDriver's kernel is not loaded.

*Action:* Run WDREG.EXE install (in the \windrvr\util directory). This will let Windows know how to add WinDriver to the list of device drivers loaded on boot. Also, copy WINDRVR.SYS (for WinNT) or WINDRVR.VXD (for Win95) to the device drivers directory.

*Cause:* The 30 day evaluation license is over.

*Action:* In this case, WinDriver will inform you that your evaluation license is over, in a message box. Please contact sales@jungo.com to purchase WinDriver.

*Cause:* The VendorID / DeviceID requested in P9050\_Open() do not match that of the board. (In licensed versions).

*Action:* Run P50\_DIAG.EXE and choose scan-pci bus to check the correct VendorID / DeviceID of your hardware.

*Cause:* The PLX device is not installed or configured correctly.

*Action:* Run P50\_DIAG.EXE (found in your \windrvr\util directory), and choose PCI scan. Check that your PLX device returns all the resources needed.

*Cause:* Your PLX device is in use by another application.

*Action:* Close all other applications that might be using the PLX device.

## Introduction

The PLX9060 Diagnostics (P60\_DIAG.EXE) accesses the hardware using WinDriver. Therefore, WinDriver must be installed before being able to run P60\_DIAG. Once WinDriver is running, you may run P60\_DIAG.

Click 'Start / Programs / WinDriver / PLX 9060 Diagnostics'. The application will first try to locate the card, with the default VendorID and DeviceID assigned by PLX (VendorID = 0x10b5, DeviceID = 0x9060). If such a card is found you will get a message "PLX 9060 card found". If you have programmed your EEPROM to load a different VendorID/DeviceID, then at the main menu you will have to choose your card (option 'Locate/Choose PLX 9060 board' in main menu).

## Main Menu Options

*Scan PCI bus:* Displays all the cards present on the PCI bus and their resources. (IO ranges, Memory ranges, Interrupts, VendorID/DeviceID). This information may be used to choose the card you need to access.

*Locate/Choose PLX 9060 board:* Chooses the active card that the diagnostics application will use. You are asked to enter the VendorID/DeviceID of the card you want to access. In case there are several cards with the same VendorID/DeviceID, you will be asked to choose one of them.

*PCI configuration registers:* This option is available only after choosing an active card. A list of the PCI configuration registers and their READ value are displayed. These are general registers, common to all PCI cards.

In order to WRITE to a register, enter its number, and then the value to write to it.

*PLX 9060 local registers:* This option is available only after choosing an active card. A list of the PLX9060 registers and their READ value are displayed. In order to WRITE to a PLX9060 register, enter the register number, and then enter the value to write to it.

*Access memory ranges on the board:* This option is available only after choosing an active card. Use this option carefully. Accessing memory ranges, accesses the local bus on your card. If you access an invalid local address, or if you have any problem with your card (such as a problem with the IRDY signal), the CPU may hang. To access a local region, first toggle active mode between BYTE/WORD/DWORD, to fit the hardware you are accessing.

- To READ from a local address, choose 'Read from board'. You will be asked for local address to read from.
- To WRITE from a local address, choose 'Write from board'. You will be asked for local address to write to, and the data to write.
- Both in board READ and WRITE, the address you give will also be used to set the base address register. REMAP\_PTOL\_0 register is set with the base address, and REGION\_DESC register is set with the mode (BYTE/WORD/DWORD as chosen as active mode).

## Sample Code

Sample uses of WinDriver and WinDriver for PLX are supplied with the WinDriver toolkit. You may find the WinDriver samples under `\windrvr\samples`, and the WinDriver for PLX samples under `\windrvr\plx`.

Each directory contains a `files.txt` file which describes the various samples included. Each sample is located in its own directory. For your convenience, we have supplied an `mdp` file alongside each `.c` file, so that users of Microsoft's developer studio may double-click the `mdp` file and have the whole environment ready for compilation. (Users of different win32 compilers need to include the `.c` files in their standalone console project, and include the `p60_lib` in their project) You may learn to use the WinDriver for PLX API by looking at `P60_diag.c` which is found in `\windrvr\plx\P60_diag.c`. `P60_diag.c` is the source code of the PLX 9060 diagnostics program found under `Start \ Programs \ WinDriver`.

## **P9060\_CountCards()**

Returns the number of cards on the PCI bus that have the given VendorID and DeviceID. This value can then be used when calling P9060\_Open, to choose which board to open. Normally, only one board is in the bus and this function will return 1.

### **Prototype**

DWORD P9060\_CountCards(DWORD dwVendorID, DWORD dwDeviceID);

### **Parameters**

1. dwVendorID - Vendor ID of your PLX 9060/9080 card. If 0, detects cards from all vendors.
2. dwDeviceID - Device ID of your PLX 9060/9080 card. If 0, detects all devices.

### **Return Value**

Returns the number of matching PCI cards found.

### **Example**

```
nCards = P9060_CountCards( 0x10b5, 0x9060 );
```

## **P9060\_Open()**

Used to open a handle to the PLX 9060 card. If several 9060 cards are installed, the specific card to open may be specified by using P9060\_CountCards before using P9060\_Open, and calling open with a specific card number (See prototype below). If open is successful, the function returns TRUE, and a handle to the PLX card.

### **Prototype**

```
BOOL P9060_Open ( P9060HANDLE *phPlx, DWORD dwVendorID, DWORD dwDeviceID, WORD nCardNum, DWORD options );
```

### **Parameters**

dwVendorID, dwDeviceID - DeviceID / VendorID of the board to access.

nCardNum - If there are a few cards with the given VendorID and DeviceID, this will choose what one of them to open. This number should be from 0 (the first board) up to the value returned by P9060\_CountCards() minus one. Most programs that do not need to handle multiple boards, can set nCardNum to 0.

options - options regarding the board opened. If P9060\_OPEN\_USE\_INT, then the board must have an interrupt, and the interrupt will be installed.

### **Return Value**

TRUE if OK.

### **Example**

```
if (!P9060_Open( &hPlx, 0x10b5, 0x9060, 0, P9060_OPEN_USE_INT ))
```

```
{
```

```
    printf("Error opening device\n");
```

```
}
```

## **P9060\_Close()**

Closes the WinDriver device. Must be called after finished using the driver.

### **Prototype**

```
void P9060_Close( P9060HANDLE hPlx );
```

### **Parameters**

hPlx - handle to the PLX card to close.

### **Return Value**

None

### **Example**

```
P9060_Close(hPlx);
```

## **P9060\_IsAddrSpaceActive()**

Checks if the specified address space is enabled. The enabled address spaces are determined by the EEPROM, which at boot time sets the PLX's memory ranges requests. Use this function after calling P9060\_Open() to make sure that the address space(s) that your driver is going to use are enabled.

### **Prototype**

```
BOOL P9060_IsAddrSpaceActive(P9060HANDLE hPlx, P9060_ADDR addrSpace);
```

### **Parameters**

1. hPlx - PLX card handle.
2. addrSpace - Can be P9060\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM.

### **Return Value**

TRUE if address space is enabled.

### **Example**

```
if ( !P9060_IsAddrSpaceActive(hPlx, P9060_ADDR_SPACE2) )  
  
{  
  
    printf ("Address space2 is not active!\n");  
  
}
```



## **P9060\_ReadReg(), P9060\_WriteReg()**

Reads or writes to or from a specified register on the board.

### **Prototype**

1. `DWORD P9060_ReadReg (P9060HANDLE hPlx, DWORD dwReg);`
2. `void P9060_WriteReg (P9060HANDLE hPlx, DWORD dwReg, DWORD dwData);`

### **Parameters**

1. `hPlx` - PLX card handle.
2. `dwReg` - offset of register to read or write. The constant values of registers are already defined in `P60LIB.H`, for example: `P9060_DOORBELL_PTOL` is the offset of `DOORBELL_PTOL` register.
3. `dwData` - data to write to register. (for `P9060_WriteReg()` only).

### **Return Value**

Data read from register (for `P9060_ReadReg()` only).

## **P9060\_ReadSpaceByte() ,P9060\_ReadSpaceWord() , P9060\_ReadSpaceDWord()**

Reads a byte / word / dword from address space on board.

### **Prototype**

1. BYTE P9060\_ReadSpaceByte (P9060HANDLE hPlx, P9060\_ADDR addrSpace, DWORD dwOffset);
2. WORD P9060\_ReadSpaceWord (P9060HANDLE hPlx, P9060\_ADDR addrSpace, DWORD dwOffset);
3. DWORD P9060\_ReadSpaceDWord (P9060HANDLE hPlx, P9060\_ADDR addrSpace, DWORD dwOffset);

### **Parameters**

1. hPlx - PLX card handle.
2. addrSpace - Can be P9060\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM.  
Chooses the address space to access.
3. dwOffset - offset in address space to read from.

### **Return Value**

Data read from board.

## **P9060\_WriteSpaceByte(),P9060\_WriteSpaceWord(), P9060\_WriteSpaceDWord()**

Writes a byte / word / dword to address space on board.

### **Prototype**

1. void P9060\_WriteSpaceByte (P9060HANDLE hPlx, P9060\_ADDR addrSpace, DWORD dwOffset, BYTE data);
2. void P9060\_WriteSpaceWord (P9060HANDLE hPlx, P9060\_ADDR addrSpace, DWORD dwOffset, WORD data);
3. void P9060\_WriteSpaceDWord (P9060HANDLE hPlx, P9060\_ADDR addrSpace, DWORD dwOffset, DWORD data);

### **Parameters**

1. hPlx - PLX card handle.
2. addrSpace - Can be P9060\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM. Chooses the address space to access.
3. dwOffset - offset in address space to write to.
4. data - data to write to board

### **Return Value**

None

## **P9060\_ReadSpaceBlock() ,P9060\_WriteSpaceBlock()**

Reads or writes a block to or from an address space on the board.

### **Prototype**

1. void P9060\_ReadSpaceBlock (P9060HANDLE hPlx, DWORD dwOffset, PVOID buf, DWORD dwBytes, P9060\_ADDR addrSpace, P9060\_MODE mode);
2. void P9060\_WriteSpaceBlock (P9060HANDLE hPlx, DWORD dwOffset, PVOID buf, DWORD dwBytes, P9060\_ADDR addrSpace, P9060\_MODE mode);

### **Parameters**

1. hPlx - PLX card handle.
2. dwOffset - offset in address space to read from or write to.
3. buf - a caller given buffer, into which data is read or written.
4. dwBytes - size to read in bytes
5. addrSpace - Can be P9060\_ADDR\_SPACE0 / SPACE1 / SPACE2 / SPACE3 / EPROM. Chooses the address space to access.
6. mode - access mode: P9060\_MODE\_BYTE/WORD/DWORD.

Return Value

**None**

## **P9060\_ReadByte(),P9060\_ReadWord(),P9060\_ReadDWord()**

Reads a byte / word / dword from memory on board.

### **Prototype**

1. BYTE P9060\_ReadByte (P9060HANDLE hPlx, DWORD dwLocalAddr);
2. WORD P9060\_ReadWord (P9060HANDLE hPlx, DWORD dwLocalAddr);
3. DWORD P9060\_ReadDWord (P9060HANDLE hPlx, DWORD dwLocalAddr);

### **Parameters**

1. hPlx - PLX card handle.
2. dwLocalAddr - local address on board to write to.

### **Return Value**

Data read from board.

## **P9060\_WriteByte(), P9060\_WriteWord(), P9060\_WriteDWord()**

Writes a byte / word / dword to memory on board.

### **Prototype**

1. void P9060\_WriteByte (P9060HANDLE hPlx, DWORD dwLocalAddr, BYTE data);
2. void P9060\_WriteWord (P9060HANDLE hPlx, DWORD dwLocalAddr, WORD data);
3. void P9060\_WriteDWord (P9060HANDLE hPlx, DWORD dwLocalAddr, DWORD data);

### **Parameters**

1. hPlx - PLX card handle.
2. dwLocalAddr - local address on board to write to.
3. data - data to write to board

### **Return Value**

None

## **P9060\_ReadBlock(),P9060\_WriteBlock()**

Reads or writes a block of memory to or from the board.

### **Prototype**

1. void P9060\_ReadBlock (P9060HANDLE hPlx, DWORD dwLocalAddr, PVOID buf, DWORD dwBytes, P9060\_MODE mode);
2. void P9060\_WriteBlock (P9060HANDLE hPlx, DWORD dwLocalAddr, PVOID buf, DWORD dwBytes, P9060\_MODE mode);

### **Parameters**

1. hPlx - PLX card handle.
2. dwLocalAddr - local address on board to read from or write to.
3. buf - a caller given buffer, into which data is read or written.
4. dwBytes - size to read in bytes.
5. mode - local address access mode: P9060\_MODE\_BYTE/WORD/DWORD.

### **Return Value**

None

## **P9060\_IntIsEnabled()**

Check whether interrupts are enabled or not.

### **Prototype**

```
BOOL P9060_IntIsEnabled(P9060HANDLE hPlx);
```

### **Parameters**

hPlx - PLX card handle.

### **Return Value**

TRUE if interrupts are already enabled (i.e. if P9060\_IntEnable() was called).



## **P9060\_IntEnable()**

Enable interrupt processing.

**IMPORTANT NOTE:** *The PLX 9060 uses level sensitive interrupts, therefore you must edit the implementation of this function (found in \windrvr\plx\9060\lib\p60lib.c) to fit your specific hardware. The comments in the function will instruct you where your changes must be inserted. See more about this in the 'WinDriver' manual, in the section regarding PCI interrupts implementation.*

### **Prototype**

```
BOOL P9060_IntEnable(P9060HANDLE hPlx, P9060_INT_HANDLER funcIntHandler);
```

### **Parameters**

1. hPlx - PLX card handle.
2. FuncIntHandler - callback interrupt handler. Upon each incoming interrupt, this function will be called.

### **Return Value**

TRUE if successful.

## **P9060\_IntDisable()**

Disable interrupt processing.

### **Prototype**

```
void P9060_IntDisable(P9060HANDLE hPlx);
```

### **Parameters**

hPlx - PLX card handle.

### **Return Value**

None

## **P9060\_ReadPCIReg(),P9060\_WritePCIReg()**

Read from or write to the PCI configuration registers.

### **Prototype**

1. `DWORD P9060_ReadPCIReg (P9060HANDLE hPlx, DWORD dwReg);`
2. `void P9060_WritePCIReg (P9060HANDLE hPlx, DWORD dwReg, DWORD dwData);`

### **Parameters**

1. `hPlx` - PLX card handle.
2. `dwReg` - offset of PCI configuration register to read or write.
3. `dwData` - data to write (P9060\_WritePCIReg() only).

### **Return Value**

Data read from configuration register (for P9060\_ReadPCIReg only).

## PLX Register Definitions

Use these definitions for accessing the PLX 9060 specific registers.

Use when calling P9060\_ReadReg() and P9060\_WriteReg().

1. P9060\_RANGE\_PTOL\_0 = 0x00
2. P9060\_REMAP\_PTOL\_0 = 0x04
3. P9060\_RANGE\_PTOL\_EPROM = 0x10
4. P9060\_REMAP\_PTOL\_EPROM = 0x14
5. P9060\_REGION\_DESC = 0x18
6. P9060\_MAILBOX\_0 = 0x40
7. P9060\_MAILBOX\_1 = 0x44
8. P9060\_MAILBOX\_2 = 0x48
9. P9060\_MAILBOX\_3 = 0x4c
10. P9060\_MAILBOX\_4 = 0x50
11. P9060\_MAILBOX\_5 = 0x54
12. P9060\_MAILBOX\_6 = 0x58
13. P9060\_MAILBOX\_7 = 0x5c
14. P9060\_DOORBELL\_PTOL = 0x60
15. P9060\_DOORBELL\_LTOP = 0x64
16. P9060\_INT\_STATUS = 0x68
17. P9060\_MISC\_CONTROL = 0x6c

## **P9060\_MODE**

Used for P9060\_ReadBlock() and P9060\_WriteBlock.

1. P9060\_MODE\_BYTE = 0
2. P9060\_MODE\_WORD = 1
3. P9060\_MODE\_DWORD = 2

## P9060\_INT\_RESULT

Used for the interrupt handler callback, given to P9060\_IntEnable() to receive information on the interrupt.

### Members

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
DWORD	dwCounter	number of interrupts received
DWORD	dwLost	number of interrupts not yet dealt with
BOOL	fStopped	true if interrupt was disabled during interrupt
DWORD	dwIntStatusReg	value of status register when interrupt occurred

## **P9060\_Open() fails.**

The following may cause P9060\_Open() to fail:

*Cause:* WinDriver's kernel is not loaded.

*Action:* Run WDREG.EXE install (in the \windrvr\util directory). This will let Windows know how to add WinDriver to the list of device drivers loaded on boot. Also, copy WINDRV.RSYS (for WinNT) or WINDRV.RVXD (for Win95) to the device drivers directory.

*Cause:* The 30 day evaluation license is over.

*Action:* In this case, the WinDriver will inform you that your evaluation license is over, in a message box. Please contact sales@jungo.com to purchase WinDriver.

*Cause:* The VendorID / DeviceID requested in P9060\_Open() do not match that of the board. (In licensed versions).

*Action:* Run P60\_DIAG.EXE and choose scan-pci bus to check the correct VendorID / DeviceID of your hardware.

*Cause:* The PLX device is not installed or configured correctly.

*Action:* Run P60\_DIAG.EXE (found in your \windrvr\util directory), and choose PCI scan. Check that your PLX device returns all the resources needed.

*Cause:* Your PLX device is in use by another application.

*Action:* Close all other applications that might be using the PLX device.

## Introduction

The AMCC Diagnostics (AMCCDIAG.EXE) accesses the hardware using WinDriver, therefore WinDriver must be installed and running before being able to run AMCCDIAG. Once WinDriver is running, you may run AMCCDIAG.

Click 'Start / Programs / WinDriver / AMCC Diagnostics'. The application will first try to locate the card, with the default VendorID and DeviceID assigned by AMCC. If such a card is found you will get a message "AMCC card found". If you have programmed your EEPROM to load a different VendorID/DeviceID, then at the main menu you will have to choose your card (option 'Locate/Choose AMCC board' in main menu).



## Main Menu Options

*Scan PCI bus:* Displays all the cards present on the PCI bus and their resources. (IO ranges, Memory ranges, Interrupts, VendorID/DeviceID).

This information may be used to choose the card you need to access.

*Locate/Choose AMCC board:* Chooses the active card that the diagnostics application will use. You are asked to enter the VendorID/DeviceID of the card you want to access. In case there are several cards with the same VendorID/DeviceID, you will be asked to choose one of them.

*PCI configuration registers:* This option is available only after choosing an active card. A list of the PCI configuration registers and their READ value are displayed. These are general registers, common to all PCI cards.

In order to WRITE to a register, enter its number, and then the value to write to it.

*AMCC S5933 local registers:* This option is available only after choosing an active card. A list of the AMCC S5933 registers and their READ value are displayed. In order to WRITE to a S5933 register, enter the register number, and then enter the value to write to it.

*Access memory spaces on the board:* This option is available only after choosing an active card. This option assumes that the configuration EEPROM has initialised the address spaces. To choose the address range, toggle the active memory space mode. To access the location as BYTE / WORD / DWORD toggle the active mode option.

- To READ the location, choose Read from board. You will be asked for an offset into the space to read from.
  
- To WRITE to location, choose Write to board. You will for an offset into the space and the data to write.

## **AMCC\_CountCards()**

Counts number of cards in the PCI bus whose VendorID / DeviceID is the same as the VendorID / DeviceID given as parameters.

### **Prototype**

DWORD AMCC\_CountCards (DWORD dwVendorID, DWORD dwDeviceID);

### **Parameters**

1. dwVendorID - Vendor ID of your AMCC 5933 card. If 0, detects cards from all vendors.
2. dwDeviceID - Device ID of your AMCC 5933 card. If 0, detects all devices.

### **Return value**

Returns the number of matching PCI cards found.

## **AMCC\_Open()**

Opens a handle to a AMCC card. The handle will be used in future calls to the card.

### **Prototype**

```
BOOL AMCC_Open (AMCCHANDLE *phAMCC, DWORD dwVendorID, DWORD dwDeviceID, DWORD nCardNum, DWORD dwOptions);
```

### **Parameters**

1. dwVendorId - PCI Vendor ID of card to open. If 0, detects cards from all vendors.
2. dwDeviceId - PCI Device ID of card to open. If 0, detects all devices.
3. nCardNum - If there are a few cards with the given VendorID and DeviceID, this will choose which one of them to open. This number should be from 0 (the first board) up to the value returned by AMCC\_CountCards() minus one. Most programs that do not need to handle multi-boards, can set nCardNum to 0.
4. dwOptions - 0 if no interrupts needed, or AMCC\_OPEN\_USE\_INT for use of interrupts in session. You may use wildcards in the DeviceID / VendorID settings to detect a number of cards, and loop on AMCC\_Open() while incrementing nCardNum, to open all cards detected.

### **Return value**

Returns TRUE if open card succeeds.

## **AMCC\_Close()**

Must be called when ending session. Frees handle to card.

### **Prototype**

```
void AMCC_Close (AMCCHANDLE hAmcc);
```

### **Parameters**

hAmcc - Handle to the AMCC S5933 card obtained with AMCC\_Open.

## **AMCC\_IsAddrSpaceActive()**

Returns TRUE if addrSpace exists on card.

### **Prototype**

```
BOOL AMCC_IsAddrSpaceActive(AMCCHANDLE hAmcc, AMCC_ADDR addrSpace);
```

### **Parameters**

1. hAmcc - AMCC card handle.
2. addrSpace - The address space to be checked.

### **Return value**

Returns TRUE if address space is active.

## **AMCC\_ReadRegByte(),AMCC\_ReadRegWord(), AMCC\_ReadRegDWord()**

These functions read a Byte/Word/DWord from a register.

### **Prototypes**

1. BYTE AMCC\_ReadRegByte (AMCCHANDLE hAmcc, DWORD dwReg);
2. WORD AMCC\_ReadRegWord (AMCCHANDLE hAmcc, DWORD dwReg);
3. DWORD AMCC\_ReadRegDWord (AMCCHANDLE hAmcc, DWORD dwReg);

### **Parameters**

1. hAmcc - AMCC card handle.
2. dwReg - offset of register to read.

### **Return value**

Data read from register.

## **AMCC\_WriteRegByte(),AMCC\_WriteRegWord(), AMCC\_WriteRegDWord()**

These functions write a Byte/Word/DWord to a register.

### **Prototypes**

1. void AMCC\_WriteRegByte (AMCCHANDLE hAmcc, DWORD dwReg, BYTE bData);
2. void AMCC\_WriteRegWord (AMCCHANDLE hAmcc, DWORD dwReg, WORD wData);
3. void AMCC\_WriteRegDWord (AMCCHANDLE hAmcc, DWORD dwReg, DWORD dwData);

### **Parameters**

1. hAmcc - AMCC card handle.
2. data - the data to write to the register.

### **Return value**

None

## **AMCC\_ReadByte(), AMCC\_ReadWord(), AMCC\_ReadDWord()**

These functions read a Byte/Word/DWord from an address space on the card.

### **Prototype**

1. BYTE AMCC\_ReadByte (AMCCHANDLE hAmcc, AMCC\_ADDR addrSpace, DWORD dwOffset);
2. WORD AMCC\_ReadWord (AMCCHANDLE hAmcc, AMCC\_ADDR addrSpace, DWORD dwOffset);
3. DWORD AMCC\_ReadDWord (AMCCHANDLE hAmcc, AMCC\_ADDR addrSpace, DWORD dwOffset);

### **Parameters**

1. hAmcc - AMCC card handle.
2. addrSpace - Address space on card to read to / write from.
3. dwOffset - offset of address to read to / write from, in the address space

### **Return value**

Data read from card.



## **AMCC\_WriteByte(),AMCC\_WriteWord(),AMCC\_WriteDWord()**

These functions write a Byte/Word/DWord to an address space on the card.

### **Prototype**

1. void AMCC\_WriteByte (AMCCHANDLE hAmcc, AMCC\_ADDR addrSpace, DWORD dwOffset, BYTE data);
2. void AMCC\_WriteWord (AMCCHANDLE hAmcc, AMCC\_ADDR addrSpace, DWORD dwOffset, WORD data);
3. void AMCC\_WriteDWord (AMCCHANDLE hAmcc, AMCC\_ADDR addrSpace, DWORD dwOffset, DWORD data);

### **Parameters**

1. hAmcc - AMCC card handle.
2. addrSpace - Address space on card to read to / write from
3. dwOffset - offset of address to read to / write from, in the address space
4. data - the data to write.

### **Return value**

None

## **AMCC\_ReadSpaceBlock(), AMCC\_WriteSpaceBlock()**

Read / Write a block of data from card to buffer.

### **Prototype**

1. void AMCC\_ReadSpaceBlock (AMCCHANDLE hAmcc, DWORD dwOffset, PVOID buf, DWORD dwBytes, AMCC\_ADDR addrSpace);
2. void AMCC\_WriteSpaceBlock (AMCCHANDLE hAmcc, DWORD dwOffset, PVOID buf, DWORD dwBytes, AMCC\_ADDR addrSpace);

### **Parameters**

1. hAmcc - AMCC card handle.
2. buf - buffer to read data into / from
3. addrSpace - Address space on card to read from / write to
4. dwLocalAddr - offset of address to read from / write to, in the address space
5. dwBytes - number of bytes to read / write

## **AMCC\_IntIsEnabled()**

Check whether interrupts are enabled or not.

### **Prototype**

```
BOOL AMCC_IntIsEnabled(AMCCHANDLE hAmcc);
```

### **Parameters**

hAmcc - AMCC card handle.

### **Return Value**

TRUE if interrupts are already enabled (AMCC\_IntEnable() was called).

## **AMCC\_IntEnable()**

Enable interrupt handler routines.

*IMPORTANT NOTE:* The AMCC S5933 uses level sensitive interrupts, therefore you must edit the implementation of this function (found in \windrvr\amcc\lib\amcclib.c) to fit your specific hardware. The comments in the function will instruct you where your changes must be inserted. See more about this in the 'WinDriver' manual, in the section regarding PCI interrupts implementation.

### **Prototype**

```
BOOL AMCC_IntEnable(AMCCHANDLE hAmcc, AMCC_INT_HANDLER funcIntHandler);
```

### **Parameters**

1. hAmcc - AMCC card handle.
2. FuncIntHandler - callback interrupt handler. For each incoming interrupt, this function will be called.

### **Return value**

Returns TRUE if interrupt enable succeeds.

## **AMCC\_IntDisable()**

Disable interrupt handler routines.

### **Prototype**

```
void AMCC_IntDisable(AMCCHANDLE hAmcc);
```

### **Parameters**

hAmcc - AMCC card handle.

## **AMCC\_ReadPCIReg(), AMCC\_WritePCIReg()**

Read from or write to the PCI configuration registers.

### **Prototype**

1. `DWORD AMCC_ReadPCIReg (AMCCHANDLE hAmcc, DWORD dwReg);`
2. `void AMCC_WritePCIReg (AMCCHANDLE hAmcc, DWORD dwReg, DWORD dwData);`

### **Parameters**

1. `hAmcc` - AMCC card handle.
2. `dwReg` - offset of PCI configuration register to read or write.
3. `dwData` - data to write (`AMCC_WritePCIReg()` only).

### **Return Value**

Data read from configuration register (for `AMCC_ReadPCIReg` only).

## PCI Configuration Registers Definitions

Use for AMCC\_ReadReg() and AMCC\_WriteReg() functions.

1. OMB1\_ADDR = 0x00
2. OMB2\_ADDR = 0x04
3. OMB3\_ADDR = 0x08
4. OMB4\_ADDR = 0x0c
5. IMB1\_ADDR = 0x10
6. IMB2\_ADDR = 0x14
7. IMB3\_ADDR = 0x18
8. IMB4\_ADDR = 0x1c
9. FIFO\_ADDR = 0x20
10. MWAR\_ADDR = 0x24
11. MWTC\_ADDR = 0x28
12. MRAR\_ADDR = 0x2c
13. MRTC\_ADDR = 0x30
14. MBEF\_ADDR = 0x34
15. INTCSR\_ADDR = 0x38
16. BMCSR\_ADDR = 0x3c

## **AMCC\_ADDR**

Used to choose the address space on the card.

1. AMCC\_ADDR\_REG = 0
2. AMCC\_ADDR\_SPACE0 = 1
3. AMCC\_ADDR\_SPACE1 = 2
4. AMCC\_ADDR\_SPACE2 = 3
5. AMCC\_ADDR\_SPACE3 = 4



## AMCC\_INT\_RESULT

Used for the interrupt handler callback, given to AMCC\_IntEnable() to receive information on the interrupt.

### Members

TYPE	NAME	DESCRIPTION
DWORD	dwCounter	number of interrupts received
DWORD	dwLost	number of interrupts not yet dealt with
BOOL	fStopped	was interrupt disabled during wait
DWORD	dwIntStatusReg	value of status register when interrupt occurred

## **AMCC\_Open() fails.**

The following may cause AMCC\_Open() to fail:

*Cause:* WinDriver's kernel is not loaded.

*Action:* Run WDREG.EXE install (in the \windrvr\util directory). This will let Windows know how to add WinDriver to the list of device drivers loaded on boot. Also, copy WINDRV.RSYS (for WinNT) or WINDRV.RVXD (for Win95) to the device drivers directory.

*Cause:* The 30 day evaluation license is over.

*Action:* In this case, the WinDriver will inform you that your evaluation license is over, in a message box. Please contact sales@jungo.com to purchase WinDriver.

*Cause:* The VendorID / DeviceID requested in AMCC\_Open() do not match that of the board. (In licensed versions).

*Action:* Run AMCCDIAG.EXE and choose scan-pci bus to check the correct VendorID / DeviceID of your hardware.

*Cause:* The AMCC device is not installed or configured correctly.

*Action:* Run AMCCDIAG.EXE (found in your \windrvr\util directory), and choose PCI scan. Check that your AMCC device returns all the resources needed.

*Cause:* Your AMCC device is in use by another application.

*Action:* Close all other applications that might be using the AMCC device.

## Introduction

The V3 PBC Diagnostics (PBC\_DIAG.EXE) accesses the hardware using WinDriver, therefore WinDriver must be installed before being able to run PBC\_DIAG. Once WinDriver is running, you may run PBC\_DIAG.

Click 'Start / Programs / WinDriver / V3 PBC Diagnostics'. The application will first try to locate the card, with the default VendorID and DeviceID assigned by V3 PBC. If such a card is found you will get a message "V3 PBC card found". If you have programmed your EEPROM to load a different VendorID/DeviceID, then at the main menu you will have to choose your card (option 'Locate/Choose V3 PBC board' in main menu).

## Main Menu Options

**Scan PCI bus:** Displays all the cards present on the PCI bus and their resources. (IO ranges, Memory ranges, Interrupts, VendorID/DeviceID). This information may be used to choose the card you need to access.

**Locate/Choose V3 PBC board:** Chooses the active card that the diagnostics application will use. You are asked to enter the VendorID/DeviceID of the card you want to access. In case there are several cards with the same VendorID/DeviceID, you will be asked to choose one of them.

**PCI configuration registers:** This option is available only after choosing an active card. A list of the PCI configuration registers and their READ value are displayed. These are general registers, common to all PCI cards.

In order to WRITE to a register, enter its number, and then the value to write to it.

**V3 PBC local registers:** This option is available only after choosing an active card. A list of the V3 PBC registers and their READ value are displayed. In order to WRITE to a V3 PBC register, enter the register number, and then enter the value to write to it.

**Access local memory ranges on the board:** This option is available only after choosing an active card. This option assumes that the configuration EEPROM has initialised the Configuration Register, Aperture zero and one space to valid local address regions. Use this option carefully. Accessing memory ranges, accesses the local bus on your card. If you access an invalid local address, or if you have any problem with your card (such as a problem with the IRDY signal), the CPU may hang. To access a local region, first toggle active mode between BYTE/WORD/DWORD, to fit the hardware you are accessing. The V3 PBC has two memory ranges to access a local region. There is no difference between them, therefore you need not change the active memory range.

- To READ from a local address, choose 'Read from board'. You will be asked for local address to read from.
- To WRITE from a local address, choose 'Write from board'. You will be asked for local address to write to, and the data to write.
- Both in board READ and WRITE, the address you give will also be used to set the base address register. PCI\_MAP0 register is set with the base address.

**Access memory spaces on the board:** This option is available only after choosing an active card. This option assumes that the configuration EEPROM has initialised the Configuration Register, Aperture zero and one space to valid local address regions. To access Configuration, Aperture zero or one space, toggle the active memory space mode. To access the location as BYTE / WORD / DWORD, toggle the active mode option.

- To READ the location, choose Read from board. You will be asked for an offset into the space to read from.
- To WRITE to location, choose Write to board. You will for an offset into the space and the data to write.

**Access EEPROM device:** This option provides basic read/write access to the serial configuration EEPROM. is available only after choosing an active card. This option assumes that the configuration EEPROM has initialised the Configuration Register, Aperture zero and one space to valid local. To read an EEPROM location, choose Read a byte from serial EEPROM. You will be asked for the address of the location to read from. To write an EEPROM location, choose Write a byte to serial EEPROM. You

will be asked for the address and the data to write.

***Pulse Local Reset:*** This option provides a way to reset the local processor, from the host. To RESET the local host processor, choose Enter reset duration in milliseconds. You will be asked for the time in milliseconds.

**Note:** Resolution of delay time is based on PC timer tick, or approximately 55 milliseconds.

## **V3PBC\_CountCards()**

Counts number of cards in the PCI bus whos VendorID / DeviceID is the same as the VendorID / DeviceID given as parameters.

### **Prototype**

DWORD V3PBC\_CountCards (DWORD dwVendorID, DWORD dwDeviceID);

### **Parameters**

1. dwVendorID - Vendor ID of your V3 PBC card. If 0, detects cards from all vendors.
2. dwDeviceID - Device ID of your V3 PBC card. If 0, detects all devices.

### **Return value**

Returns the number of matching PCI cards found.

## V3PBC\_Open()

Opens a handle to a V3PBC card. The handle will be used in future calls to the card.

### Prototype

```
BOOL V3PBC_Open (V3PBCHANDLE *phV3, DWORD dwVendorID, DWORD dwDeviceID, DWORD nCardNum, DWORD dwOptions);
```

### Parameters

1. dwVendorId - PCI Vendor ID of card to open. If 0, detects cards from all vendors.
2. dwDeviceId - PCI Device ID of card to open. If 0, detects all devices.
3. nCardNum - If there are a few cards with the given VendorID and DeviceID, this will choose what one of them to open. This number should be from 0 (the first board) up to the value returned by V3PBC\_CountCards() minus one. Most programs that do not need to handle multi-boards, can set nCardNum to 0.
4. dwOptions - 0 if no interrupts needed, or V3PBC\_OPEN\_USE\_INT for use of interrupts in session. You may use wildcards in the DeviceID / VendorID settings to detect a number of cards, and loop on V3PBC\_Open() while incrementing nCardNum, to open all cards detected.

### Return value

Returns TRUE if open card succeeds.

## **V3PBC\_Close()**

Must be called when ending session. Frees handle to card.

### **Prototype**

```
void V3PBC_Close (V3PBCHANDLE hV3);
```

### **Parameters**

hV3 - Handle to the V3 card obtained with V3PBC\_Open.



## **V3PBC\_IsAddrSpaceActive()**

Returns TRUE if addrSpace exists on card.

### **Prototype**

```
BOOL V3PBC_IsAddrSpaceActive(V3PBCHANDLE hV3, V3PBC_ADDR addrSpace);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. addrSpace - The address space to be checked.

### **Return value**

Returns TRUE if address space is active.

## **V3PBC\_GetRevision()**

Returns the V3 PBC silicon revision (equates defined in V3PBC\_REV).

### **Prototype**

```
DWORD V3PBC_GetRevision(V3PBCHANDLE hV3);
```

### **Parameters**

hV3 - V3 PBC card handle.

### **Return value**

Returns the silicon revision.

## **V3PBC\_ReadRegByte(), V3PBC\_ReadRegWord(), V3PBC\_ReadRegDWord()**

These functions read a Byte/Word/DWord from a register.

### **Prototypes**

1. BYTE V3PBC\_ReadRegByte (V3PBCHANDLE hV3, DWORD dwReg);
2. WORD V3PBC\_ReadRegWord (V3PBCHANDLE hV3, DWORD dwReg);
3. DWORD V3PBC\_ReadRegDWord (V3PBCHANDLE hV3, DWORD dwReg);

### **Parameters**

1. hV3 - V3 PBC card handle.
2. dwReg - offset of register to read.

### **Return value**

Data read from register.

## **V3PBC\_WriteRegByte(), V3PBC\_WriteRegWord(), V3PBC\_WriteRegDWord()**

These functions write a Byte/Word/DWord to a register.

### **Prototypes**

1. void V3PBC\_WriteRegByte (V3PBCHANDLE hV3, DWORD dwReg, BYTE bData);
2. void V3PBC\_WriteRegWord (V3PBCHANDLE hV3, DWORD dwReg, WORD wData);
3. void V3PBC\_WriteRegDWord (V3PBCHANDLE hV3, DWORD dwReg, DWORD dwData);

### **Parameters**

1. hV3 - V3 PBC card handle.
2. dwReg - offset of register to read.
3. data - the data to write.

### **Return value**

None

## **V3PBC\_ReadSpaceByte(), V3PBC\_WriteSpaceByte(), V3PBC\_ReadSpaceWord(), V3PBC\_WriteSpaceWord(), V3PBC\_ReadSpaceDWord(), V3PBC\_WriteSpaceDWord()**

These functions Read/Write a Byte/Word/DWord to/from an address space on the card.

### **Prototype**

1. `BYTE V3PBC_ReadSpaceByte (V3PBCHANDLE hV3, V3PBC_ADDR addrSpace, DWORD dwOffset);`
2. `void V3PBC_WriteSpaceByte (V3PBCHANDLE hV3, V3PBC_ADDR addrSpace, DWORD dwOffset, BYTE data);`
3. `WORD V3PBC_ReadSpaceWord (V3PBCHANDLE hV3, V3PBC_ADDR addrSpace, DWORD dwOffset);`
4. `void V3PBC_WriteSpaceWord (V3PBCHANDLE hV3, V3PBC_ADDR addrSpace, DWORD dwOffset, WORD data);`
5. `DWORD V3PBC_ReadSpaceDWord (V3PBCHANDLE hV3, V3PBC_ADDR addrSpace, DWORD dwOffset);`
6. `void V3PBC_WriteSpaceDWord (V3PBCHANDLE hV3, V3PBC_ADDR addrSpace, DWORD dwOffset, DWORD data);`

### **Parameters**

1. `hV3` - V3 PBC card handle.
2. `addrSpace` - Address space on card to read to / write from
3. `dwOffset` - offset of address to read to / write from, in the address space
4. `data` - the data to write.

### **Return value**

For read functions, the return value is the data read.

## **V3PBC\_ReadSpaceBlock(), V3PBC\_WriteSpaceBlock()**

Read / Write a block of data from card to buffer.

### **Prototype**

1. void V3PBC\_ReadSpaceBlock (V3PBCHANDLE hV3, DWORD dwOffset, PVOID buf, DWORD dwBytes, V3PBC\_ADDR addrSpace);
2. void V3PBC\_WriteSpaceBlock (V3PBCHANDLE hV3, DWORD dwOffset, PVOID buf, DWORD dwBytes, V3PBC\_ADDR addrSpace);

### **Parameters**

1. hV3 - V3 PBC card handle.
2. buf - buffer to write/read data into / from
3. addrSpace - Address space on card to read from / write to
4. dwLocalAddr - offset of address to read from / write to, in the address space
5. dwBytes - number of bytes to read / write

## **V3PBC\_ReadBlock(), V3PBC\_WriteBlock()**

Reads or writes a block of data from card to or from a buffer.

### **Prototype**

1. void V3PBC\_ReadBlock (V3PBCHANDLE hV3, DWORD dwLocalAddr, PVOID buf, DWORD dwBytes, V3PBC\_ADDR addrSpace);
2. void V3PBC\_WriteBlock (V3PBCHANDLE hV3, DWORD dwLocalAddr, PVOID buf, DWORD dwBytes, V3PBC\_ADDR addrSpace);

### **Parameters**

1. hV3 - V3 PBC card handle.
2. buf - buffer to read or write data into.
3. addrSpace - Address space on card to read or write.
4. dwLocalAddr - offset of address to read or write, in the address space
5. dwBytes - number of bytes to read.

**V3PBC\_ReadByte(), V3PBC\_ReadByte(), V3PBC\_WriteByte(),  
V3PBC\_ReadWord(), V3PBC\_WriteWord(), V3PBC\_ReadDWord(),  
V3PBC\_WriteDWord()**

These functions Read/Write a Byte/Word/DWord to/from a local address on the card.

**Prototypes**

1. BYTE V3PBC\_ReadByte (V3PBCHANDLE hV3, DWORD dwLocalAddr);
2. void V3PBC\_WriteByte (V3PBCHANDLE hV3, DWORD dwLocalAddr, BYTE data);
3. WORD V3PBC\_ReadWord (V3PBCHANDLE hV3, DWORD dwLocalAddr);
4. void V3PBC\_WriteWord (V3PBCHANDLE hV3, DWORD dwLocalAddr, WORD data);
5. DWORD V3PBC\_ReadDWord (V3PBCHANDLE hV3, DWORD dwLocalAddr);
6. void V3PBC\_WriteDWord (V3PBCHANDLE hV3, DWORD dwLocalAddr, DWORD data);

**Parameters**

1. hV3 - V3 PBC card handle.
2. dwLocalAddr - local address to read to / write from.
3. data - the data to write.

**Return value**

For read functions, the return value is the data read.



## **V3PBC\_IntIsEnabled()**

Check whether interrupts are enabled or not.

### **Prototype**

```
BOOL V3PBC_IntIsEnabled(V3PBCHANDLE hV3);
```

### **Parameters**

hV3 - V3 PBC card handle.

### **Return Value**

TRUE if interrupts are already enabled (V3PBC\_IntEnable() was called).

## V3PBC\_IntEnable()

Enable interrupt handler routines.

**IMPORTANT NOTE:** *The V3 PBC uses level sensitive interrupts, therefore you must edit the implementation of this function (found in \windrvr\v3\lib\pbclib.c) to fit your specific hardware. The comments in the function will instruct you where your changes must be inserted. See more about this in the 'WinDriver' manual, in the section regarding PCI interrupts implementation.*

### Prototype

```
BOOL V3PBC_IntEnable(V3PBCHANDLE hV3, V3PBC_INT_HANDLER funcIntHandler);
```

### Parameters

1. hV3 - V3 PBC card handle.
2. FuncIntHandler - callback interrupt handler. For each incoming interrupt, this function will be called.

### Return value

Returns TRUE if interrupt enable succeeds.

## **V3PBC\_IntDisable()**

Disable interrupt handler routines.

### **Prototype**

```
void V3PBC_IntDisable(V3PBCHANDLE hV3);
```

### **Parameters**

hV3 - V3 PBC card handle.

## **V3PBC\_ReadPCIReg(), V3PBC\_WritePCIReg()**

Read from or write to the PCI configuration registers.

### **Prototype**

1. `DWORD V3PBC_ReadPCIReg (V3PBCHANDLE hV3, DWORD dwReg);`
2. `void V3PBC_WritePCIReg (V3PBCHANDLE hV3, DWORD dwReg, DWORD dwData);`

### **Parameters**

1. `hV3` - V3 PBC card handle.
2. `dwReg` - offset of PCI configuration register to read or write.
3. `dwData` - data to write (`V3PBC_WritePCIReg()` only).

### **Return Value**

Data read from configuration register (for `V3PBC_ReadPCIReg` only).

## **V3PBC\_DMAOpen()**

Initialises the WD\_DMA structure (see windrvr.h) and allocates a contiguous buffer.

### **Prototype**

```
BOOL V3PBC_DMAOpen(V3PBCHANDLE hV3, WD_DMA *pDMA, DWORD dwBytes);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. pDMA - Pointer to a DMA structure that will be used during the DMA.
3. dwBytes - Size of buffer to allocate.

### **Return value**

Returns TRUE if DMA buffer allocation succeeds.

## **V3PBC\_DMAClose()**

Frees the DMA handle, and frees the allocated contiguous buffer.

### **Prototype**

```
void V3PBC_DMAClose(V3PBHANDLE hV3, WD_DMA *pDMA);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. pDMA - pointer to the DMA buffer to release.

## **V3PBC\_DMAStart()**

Start DMA to/from card.

### **Prototype**

```
BOOL V3PBC_DMAStart(V3PBCHANDLE hV3, V3PBC_DMA_CHANNEL dmaChannel, WD_DMA  
*pDMA, BOOL fRead, BOOL fBlocking, DWORD dwBytes, DWORD dwOffset, DWORD dwLocalAddr);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. dmaChannel - the channel to use for DMA transfer. Can be V3PBC\_DMA\_0 or V3PBC\_DMA\_1.
3. pDMA - initialised with V3PBC\_DMAOpen
4. fRead - TRUE: read from card to buffer. FALSE: write from buffer to card
5. fBlocking - TRUE: wait until DMA is done
6. dwBytes - number of bytes to transfer (must be a multiple of 4)
7. dwOffset - offset in DMA buffer to read to / write from.
8. dwLocalAddr - local address on card to write to / read from

### **Return value**

Returns TRUE if DMA transfer succeeds.

## **V3PBC\_DMAIsDone()**

Used to test if DMA is done. (Use when V3PBC\_DMAStart was called with fBlocking == FALSE).

### **Prototype**

```
BOOL V3PBC_DMAIsDone(V3PBCHANDLE hV3, V3_DMA_CHANNEL dmaChannel);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. dmaChannel - the channel to test. Can be V3PBC\_DMA\_0 or V3PBC\_DMA\_1.

### **Return value**

Returns TRUE if DMA transfer is completed.



## **V3PBC\_PulseLocalReset()**

Sends a reset signal to the card, for a period of 'wDelay' milliseconds.

### **Prototype**

```
void V3PBC_PulseLocalReset(V3PBCHANDLE hV3, WORD wDelay);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. wDelay - Number of milliseconds to hold the reset down.

## **V3PBC\_EEPROMInit()**

Initialises I2C bus. Call this function once before calling V3PBC\_EEPROMWrite() and V3PBC\_EEPROMRead().

### **Prototype**

```
void V3PBC_EEPROMInit(V3PBHANDLE hV3);
```

### **Parameters**

hV3 - V3 PBC card handle.

## **V3PBC\_EEPROMWrite()**

Programs one byte to the EEPROM.

### **Prototype**

```
BOOL V3PBC_EEPROMWrite(V3PBCHANDLE hV3, BYTE bSlaveAddr, BYTE bAddr, BYTE bData);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. bSlaveAddr - slave device to use
3. bAddr - address to write to
4. bData - data to write

### **Return value**

Returns TRUE if EEPROM write succeeds.

## **V3PBC\_EEPROMRead()**

Reads one byte from the EEPROM.

### **Prototype**

```
BOOL V3PBC_EEPROMRead(V3PBCHANDLE hV3, BYTE bSlaveAddr, BYTE bAddr, BYTE *bData);
```

### **Parameters**

1. hV3 - V3 PBC card handle.
2. bSlaveAddr - slave device to use.
3. bAddr - address to read from
4. bData - data read.

### **Return value**

Returns TRUE if EEPROM read succeeds.

## V3PBC\_ADDR

Used to choose the address space on the card.

1. V3PBC\_ADDR\_IO\_BASE = 0
2. V3PBC\_ADDR\_BASE0 = 1
3. V3PBC\_ADDR\_BASE1 = 2
4. V3PBC\_ADDR\_ROM = 3

## V3PBC\_INT\_RESULT

Used for the interrupt handler callback, given to V3PBC\_IntEnable() to receive information on the interrupt.

### Members

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
DWORD	dwCounter	number of interrupts received
DWORD	dwLost	number of interrupts not yet dealt with
BOOL	fStopped	was interrupt disabled during wait ?
DWORD	dwIntStatusReg	value of status register when interrupt occurred

## V3PBC\_Open() fails

The following may cause V3PBC\_Open() to fail:

**Cause:** WinDriver's kernel is not loaded.

**Action:** Run WDREG.EXE install (in the \windrvr\util directory). This will let Windows know how to add WinDriver to the list of device drivers loaded on boot. Also, copy WINDRVR.SYS (for WinNT) or WINDRVR.VXD (for Win95) to the device drivers directory.

**Cause:** The 30 day evaluation license is over.

**Action:** In this case, the WinDriver will inform you that your evaluation license is over, in a message box. Please contact sales@jungo.com to purchase WinDriver.

**Cause:** The VendorID / DeviceID requested in V3PBC\_Open() do not match that of the board. (In licensed versions).

**Action:** Run PBC\_DIAG.EXE and choose scan-pci bus to check the correct VendorID / DeviceID of your hardware.

**Cause:** The V3 device is not installed or configured correctly.

**Action:** Run PBC\_DIAG.EXE (found in your \windrvr\util directory), and choose PCI scan. Check that your V3 device returns all the resources needed.

**Cause:** Your V3 device is in use by another application.

**Action:** Close all other applications that might be using the V3 device.

## Scatter/Gather DMA

Following is an outline of a DMA transfer routine for PCI devices that support Scatter/Gather DMA. More detailed examples can be found at:

- `\windriver\plx\9054\lib\p9054_lib.c`
  - `\windriver\plx\9080\lib\p9080_lib.c`
  - `\windriver\galileo\gt64\lib\gt64_lib.c`

**Note for Linux developers:** Due to Linux's own limitations WinDriver does not yet support Scatter Gather DMA on this OS. This feature will be added to the Linux version of WinDriver as soon as the Linux kernel includes support for Scatter Gather DMA operations.

### Sample DMA implementation:

```
BOOL DMA_routine(void *startAddress, DWORD transferCount,
    BOOL fDirection)
{
    WD_DMA dma;

    int i;

    BZERO (dma);

    dma.pUserAddr = startAddress;

    dma.dwBytes = transferCount;

    dma.dwOptions = 0;

    // lock region in memory
    WD_DMALock(hWD, &dma);
    if (dma.hDma==0)
        return FALSE;
    for(i=0;i!=dma.dwPages;i++)
    {
        // Program the registers for each page of the transfer
        My_DMA_Program_Page(dma.Page[i].pPhysicalAddr,
            dma.Page[i].dwBytes, fDir);
    }
    // write to the register that initiates the DMA transfer
```



```
My_DMA_Initiate();  
    // read register that tells when the DMA is done  
while(!My_DMA_Done());  
WD_DMAUnlock(hWD, &dma);  
return TRUE;  
  
}
```

***You should implement:***

- **My\_DMA\_Program\_Page()** - Set the registers on your device that are part of the chained list of transfer addresses.
  - **My\_DMA\_Initiate()** - Set the start bit on your PCI device to initiate the DMA
  - **My\_DMA\_Done()** - Read the 'Transfer Ended' bit on your PCI device

Scatter/Gather DMA for buffers larger than 1MB

## Contiguous Buffer DMA

More detailed examples can be found at:

- `windriver\v3\lib\pbclib.c`
- `windriver\amcc\lib\amcclib.c`

### ***A read sequence (from the card to the mother-board's memory):***

```
{
    WD_DMA dma;
    BZERO (dma);
    // allocate the DMA buffer (100000 bytes)
    dma.pUserAddr = NULL;
    dma.dwBytes = 10000;
    dma.dwOptions = DMA_KERNEL_BUFFER_ALLOC;
    WD_DMA Lock(hWD, &dma);
    if (dma.hDma==0)
        return FALSE;
    // transfer data from the card to the buffer
    My_Program_DMA_Transfer(dma.Page[0].pPhysicalAddr,
    // Wait for transfer to end
    while(!My_Dma_Done());
    // now the data is the buffer, and can be used
    UseDataReadFromCard(dma.pUserAddr);
    // release the buffer
    WD_DMAUnlock(hWD, &dma);
}
```

### ***A Write Sequence (from the mother-board's memory to the card):***

```
{

    WD_DMA dma;

    BZERO (dma);

    //allocate the DMA buffer (100000 bytes)

    dma.pUserAddr = NULL;

    dma.dwBytes = 10000;
```

```
dma.dwOptions = DMA_KERNEL_BUFFER_ALLOC;

WD_DMA Lock(hWD, &dma);

if (dma.hDma==0)

    return FALSE;

// prepare data into buffer

PrepareDataInBuffer(dma.pUserAddr);

// transfer data from the buffer to the card

My_Program_DMA_Transfer(dma.Page[0].pPhysicalAddr,
    LocalAddr);

// Wait for transfer to end

while(!My_Dma_Done());

// release the buffer

WD_DMAUnlock(hWD, &dma);

}
```

## General - Handling an Interrupt

- A thread that will handle incoming interrupts needs to be created.
  - The interrupt handler thread will run an infinite loop that waits for an interrupt to occur.
  - When an interrupt occurs, the driver's interrupt handler code is called.
  - When an interrupt handler code returns, the wait loop continues.

The **WD\_IntWait()** function, puts the thread to sleep until an interrupt occurs. There is no CPU consumption while waiting for an interrupt. Once an interrupt occurs, it is first handled by the WinDriver kernel, then the **WD\_IntWait()** wakes up the interrupt handler thread and returns.

Since your interrupt thread runs in user-mode, you may call any Windows API function, including File handling and GDI functions.

***Simple interrupt handler routine, for edge-triggered interrupts (normally ISA/EISA cards):***

```
// interrupt structure

WD_INTERRUPT Intrp;

DWORD WINAPI wait_interrupt (PVOID pData)

{

    printf ("Waiting for interrupt");
    for (;;)

    {

        WD_IntWait (hWD, &Intrp);
        if (Intrp.fStopped)

            break; // WD_IntDisable called by parent
        // call your interrupt routine here
        printf ("Got interrupt %d\n", Intrp.dwCounter);

    }
    return 0;
}

void Install_interrupt ()
{
```

```
BZERO(Intrp);
// put interrupt handle returned by WD_CardRegister
Intrp.hInterrupt = cardReg.Card.Item[0].I.Int.hInterrupt;
// no kernel transfer commands to do upon interrupt
Intrp.Cmd = NULL;
Intrp.dwCmds = 0;
// no special interrupt options
Intrp.dwOptions = 0;
WD_IntEnable(hWD, &Intrp);
if (!Intrp.fEnableOk)
{
    printf ("Failed enabling interrupt\n");
    return;
}

printf ("starting interrupt thread\n");

thread_handle = CreateThread (0, 0x1000,
    wait_interrupt, NULL, 0, &thread_id);

// call your driver code here

WD_IntDisable (hWD, &Intrp);
WaitForSingleObject(thread_handle, INFINITE);

}
```

## Simplified interrupt handling using *windrvr\_int\_thread.h*

From Version 4.3 onwards, a new header file *windrvr\_int\_thread.h* simplifies the code you need to write to handle interrupts. In this header file -- found under **windriver/include**, we provide the convenience functions `InterruptThreadEnable` [[InterruptThreadEnable\(\)](#)] and `InterruptThreadDisable` [[InterruptThreadDisable\(\)](#)]. These functions are implemented as static functions in the header file *windrvr\_int\_thread.h*. Please study the code in the header file to understand how this operates. We may rewrite the code from Section [General - Handling an Interrupt](#) as follows. This code was extracted from the sample program *int\_io.c* which can be found under **windriver/samples/int\_io**. Please refer to this file for the full listing.

```
// interrupt handler routine. you can use pData to pass
// information from InterruptThreadEnable()
VOID interrupt_handler (PVOID pData)
{
    WD_INTERRUPT * pIntrp = (WD_INTERRUPT *) pData;
    // do your interrupt routine here
    printf ("Got interrupt %d\n", pIntrp->dwCounter);
}

...

int main()
{
    HANDLE hWD;
    WD_CARD_REGISTER cardReg;
    // interrupt structure
    WD_INTERRUPT Intrp;
    HANDLE thread_handle;

    ...
    hWD = WD_Open();
    BZERO(cardReg);
    cardReg.Card.dwItems = 1;
    cardReg.Card.Item[0].item = ITEM_INTERRUPT;
    cardReg.Card.Item[0].fNotSharable = TRUE;
    cardReg.Card.Item[0].I.Int.dwInterrupt = MY_IRQ;
    cardReg.Card.Item[0].I.Int.dwOptions = 0;
    ...
    WD_CardRegister (hWD, &cardReg);
    ...
    PVOID pData = NULL;
```

```

BZERO(Intrp);
Intrp.hInterrupt = cardReg.Card.Item[0].I.Int.hInterrupt;
Intrp.Cmd = NULL;
Intrp.dwCmds = 0;
Intrp.dwOptions = 0;
printf ("starting interrupt thread\n");
// this calls WD_IntEnable() and creates an interrupt
// handler thread which calls the function
// interrupt_handler with the pointer pData as a parameter

pData = &Intrp;
...
if (!InterruptThreadEnable(&thread_handle, hWD, &Intrp,
    interrupt_handler, pData))
    {
        printf ("failed enabling interrupt\n");
    }
else
    {
        // call your driver code here
        printf ("Press Enter to uninstall interrupt\n");
        fgets(line, sizeof(line), stdin);

        // this calls WD_IntDisable()
        InterruptThreadDisable(thread_handle);
    }
WD_CardUnregister(hWD, &cardReg);
....
}

```

In the above code, the function *interrupt\_handler* serves as our "interrupt handler", getting invoked once for every interrupt that occurs. In the simplified code for setting up the interrupt handling, we call `InterruptThreadEnable[InterruptThreadEnable()]` spawn a thread that calls the function *interrupt\_handler* -- a pointer to this function is passed as the fourth parameter to `InterruptThreadEnable` -- each time an interrupt occurs, passing into this function, the data *pData* specified by the fifth parameter.

## ISA / EISA and PCI interrupts

Generally, ISA/EISA interrupts are edge triggered, as opposed to PCI interrupts that are level sensitive. This difference has many implications on writing the interrupt handler routine.

**Edge triggered** interrupts are generated once, when the physical interrupt signal goes from low to high. Therefore, exactly one interrupt is generated. This makes the Windows OS to call the WinDriver kernel interrupt handler, that released the thread waiting on the **WD\_IntWait()** function. There is no special action that needs to take place in order to acknowledge this interrupt.

**Level sensitive interrupts** are generated as long as the physical interrupt signal is high. If the interrupt signal is not lowered by the end of the interrupt handling by the kernel, the Windows OS will call the WinDriver kernel interrupt handler again - This will cause the PC to hang!

To prevent this situation from happening, the interrupt must be acknowledged by the WinDriver kernel interrupt handler. Explanation on acknowledging level-sensitive interrupts can be found under Section [Computer hangs on interrupt](#) that explains how to deal with the problem of the computer hanging on interrupt.

### ***Transfer commands at kernel-level (acknowledging the interrupt)***

Usually, interrupt handlers for PCI cards (level sensitive interrupt handlers) need to perform transfer commands at the kernel to lower the interrupt level (acknowledge the interrupt).

To pass transfer commands to be performed in the WinDriver kernel interrupt handler, before **WD\_IntWait()** returns, you must prepare an array of commands (**WD\_Transfer** structure), and pass it to the **WD\_IntEnable()**function.

```
WD_TRANSFER trans[2];
BZERO(trans);
trans[0].cmdTrans = RP_DWORD; // Read Port Dword
// address of IO port to write to
trans[0].dwPort = dwAddr;
trans[1].cmdTrans = WP_DWORD; // Write Port Dword
// address of IO port to write to
trans[1].dwPort = dwAddr;
// the data to write to the IO port
trans[1].Data.Dword = 0;
Intrp.dwCmds = 2;
Intrp.Cmd = trans;
Intrp.dwOptions =
    INTERRUPT_LEVEL_SENSITIVE | INTERRUPT_COPY_CMD;
WD_IntEnable(hWD, &Intrp);
```

This sample performs a DWORD read command from the IO address dwAddr, then it writes to the same IO port a value of '0'.

The INTERRUPT\_COPY\_CMD option is used to retrieve the value read by the first transfer command, before the write command is issued. This is useful when you need to read the value of a register, and then write to it to lower the interrupt level. If you try to read this register after WD\_IntWait() returns, it will already be '0' because the write transfer command was issued at kernel level.

```
DWORD WINAPI wait_interrupt (PVOID pData)
```



```

{
printf ("Waiting for interrupt");
for (;;)
{
WD_TRANSFER trans[2];
Intrp.dwCmds = 2;
Intrp.Cmd = trans;
WD_IntWait (hWD, &Intrp);
if (Intrp.fStopped)

break; // WD_IntDisable called by parent
        // call your interrupt routine here

printf (
        "Got interrupt %d. Value of register read %x\n",
        Intrp.dwCounter, trans[0].Data.Dword);
}
return 0;
}

```

If you study the implementation of the interrupt handling in *windrivr\_int\_thread.h*, you see that code similar to the above is used there.

## Interrupts in Windows CE

Windows CE uses a logical interrupt scheme rather than the physical interrupt number. It maintains an internal kernel table that maps the physical IRQ number to the logical IRQ number. Device drivers are generally expected to get the logical interrupt number after having ascertained the physical interrupt.

This is handled internally by WinDriver so programmers using WinDriver need not worry about this issue. However, the X86 CEPC builds provided with the ETK do not provide interrupt mappings for certain reserved interrupts including the following:

- **IRQ0**: Timer Interrupt
  - **IRQ2**: Cascade interrupt for the second PIC
  - **IRQ6**: The floppy controller.
  - **IRQ7**: LPT1 because the PPSH does not use interrupts
  - **IRQ9**
  - **IRQ13**: The numeric coprocessor

attempt to initialize and use any of these interrupts will fail. In case you wish to use any of these interrupts - (e.g.: you do not want to use the PPSH and you want to reclaim the parallel port for some other purpose) - you should modify the file CFWPC.C that is found in the directory `%_TARGETPLATROOT%\KERNEL\HAL` to include code as shown below that sets up a value for the interrupt 7 in the interrupt mapping table.

```
SETUP_INTERRUPT_MAP(SYSINTR_FIRMWARE+7, 7);
```

Supposing you have a PCI card in your X86 CEPC and the BIOS assigned IRQ9 to it. Since WinCE does not map this interrupt by default, you will not be able to receive interrupts from this card. In this case, you will need to insert a similar entry for IRQ 9.

```
SETUP_INTERRUPT_MAP(SYSINTR_FIRMWARE+9, 9);
```

You will then need to rebuild the Windows CE image NK.BIN and download the new executable onto your target platform.

For non-X86 machines like the hand-held PCs from HP and Sharp, the developer should use the logical interrupt ID which can be in the platform specific header file NKINTR.H

A complete discussion of this procedure is outside the scope of this manual. Please refer to the ETK or Platform Builder documentation for more details.

## PCMCIA interrupts in Windows CE

Windows CE handles PCMCIA interrupts differently than PCI and ISA/EISA interrupts. WinDriver handles the setting up of the PCMCIA interrupt internally by calling the Card Services API so this process is transparent to the developer.

The **WD\_PcmciaGetCardInfo()** function automatically sets up the interrupt items and registers the interrupt.

## USB Data Exchange

The USB standard supports two kinds of data exchange between the host and the device: functional data exchange and control exchange.

- Functional data exchange is used to move data to and from the device. There are three types of data transfers: Bulk transfers, Interrupt transfers and Isochronous transfers.
- Control exchange is used to configure a device when it is first attached, getting common configuration data, and can be also used for other device-specific purposes, including control of other pipes on the device. The control exchange is transferred via the control pipe (Pipe 00).

The control transfer consists of a setup stage (in which a setup packet is sent from the host to the device), an optional data stage and a status stage.

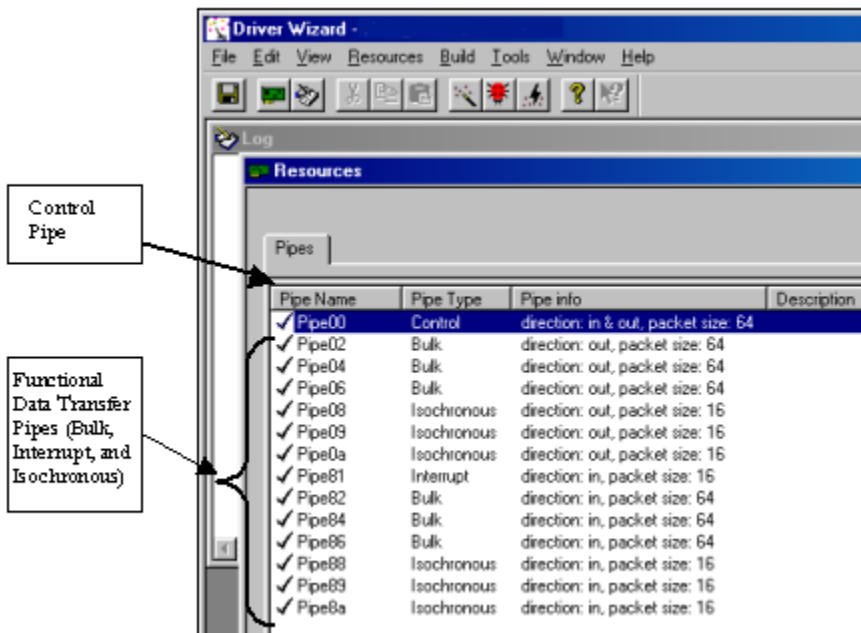


Figure 13.1: USB Data Exchange

## More about the Control Transfer

The control transaction always begins with a setup stage. Then, it is followed by zero or more control data transactions (data stage) that carry the specific information for the requested operation, and finally, a Status transaction completes the control transfer by returning the status to the host.

During the setup stage, a SETUP Packet is used to transmit information to the control endpoint of the device. The Setup Packet consists of eight bytes, and its format is specified in the USB specification.

A control transfer can be a read transaction or a write transaction. In a read transaction, the Setup Packet indicates the characteristics and amount of data to be read from the device. In a write transaction, the Setup Packet contains the command sent (written) to the device and the number of control Data bytes, associated with this transaction, that are sent to the device in the data stage.

The following figure shows the sequence of read and write transactions (the figure is taken from the USB specification). 'In' means the data flows from the device to the host. 'Out' means the data flows from the host to the device.

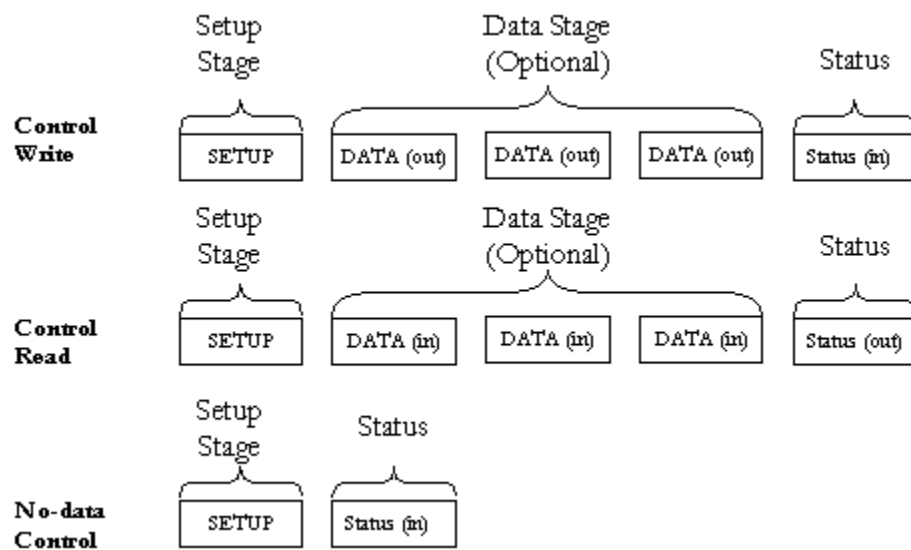


Figure 13.2: USB Read and Write

## The Setup Packet

The Setup Packets (combined with the control data stage and the status stage) are used to configure and send commands to the device. Chapter 9 of the USB specification defines standard device requests. USB requests such as these are sent from the host to the device, using Setup Packets. The USB device is required to respond properly to these requests. In addition, each vendor may define device-specific Setup Packets, to perform device specific operations. The standard Setup Packets (standard USB device requests) are detailed below. The vendor's device-specific Setup Packets are detailed in the vendor's specific data book for each USB device.

## USB Setup Packet Format

The table below shows the format of the USB setup packet. (For further information please refer to the USB specification at <http://www.usb.org>.)

Byte	Field	Description
0	bmRequest Type	Bit 7: Request direction (0=Host - out, 1=Device to host - in) Bits 5..6: Request type (0=standard, 2=vendor, 3=reserved) Bits 0..4 (0=device, 1=interface, 2=endpoint, 3=other)
1	bRequest	The actual request (see next table)
2	wValueL	A word-size value that varies according to the request (for example in the CLEAR_FEATURE request, the value is used to select the feature, in the GET_DESCRIPTOR request, the value indicates the descriptor type, in the SET_ADDRESS request, the value contains the device address)
3	wValueH	The upper byte of the Value word
4	wIndexL	A word size value that varies according to the request. The index is generally used to specify an endpoint or an interface
5	wIndexH	The upper byte of the Index word
6	wLengthL	Word size value, indicates the number of bytes to be transferred if there is more than one stage.
7	wLengthH	The upper byte of the Length word

## Standard device requests codes

<b>bRequest</b>	<b>Value</b>
GET_STATUS	0
CLEAR_FEATURE	1
Reserved for future use	2
SET_FEATURE	3
Reserved for future use	4
SET_ADDRESS	5
GET_DESCRIPTOR	6
SET_DESCRIPTOR	7
GET_CONFIGURATION	8
SET_CONFIGURATION	9
GET_INTERFACE	10
SET_INTERFACE	11
SYNCH_FRAME	12



## Setup Packet example

This is an example of a standard USB device request to illustrate the Setup Packet format and its different fields. The Setup packet is in Hex format.

The following Setup Packet is a 'Control Read' transaction that retrieves the 'Device descriptor' from the USB device. The 'Device descriptor' includes information such as USB standard revision, the vendor ID and the device product ID.

### GET\_DESCRIPTOR (device) Setup Packet

80	06	00
----	----	----

### Setup Packet meaning:

Byte	Field	Value
0	BmRequest Type	80
1	bRequest	06
2	wValueL	00
3	wValueH	01
4	wIndexL	00
5	wIndexH	00
6	wLengthL	12
7	wLengthH	00

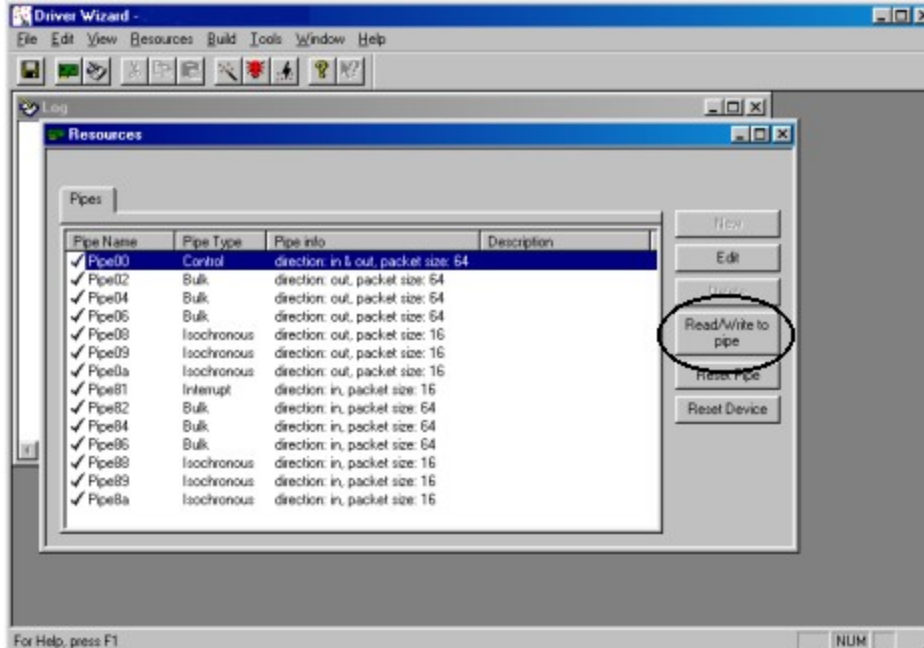
In response, the device sends the 'Device Descriptor' data. For example, this is a 'Device Descriptor' of 'Cypress EZ-USB Integrated Circuit':

<b>Byte No.</b>	0	1	2	3
<b>Content</b>	12	01	00	01
<b>Byte No.</b>	11		12	
<b>Content</b>	00		01	

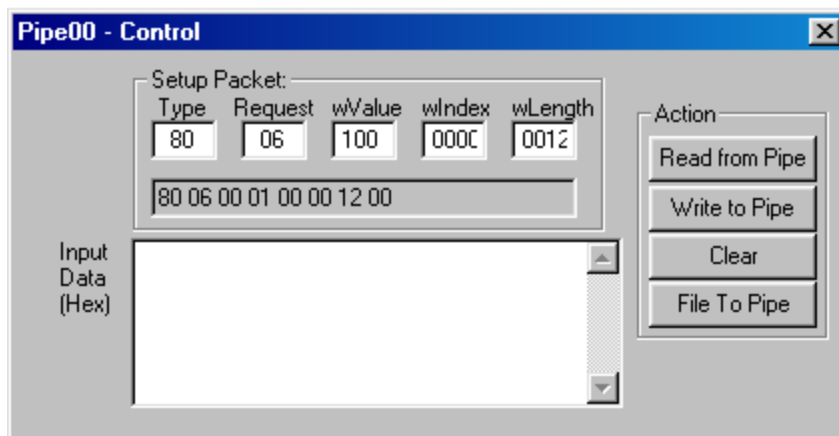
As defined in the USB specification, byte 0 indicates the length of the descriptor, bytes 2..3 contains the USB specification release number, byte 7 is the maximum packet size for endpoint 00, bytes 8..9 are the Vendor ID, bytes 10..11 are the Product ID, etc.

## Control Transfers with DriverWizard

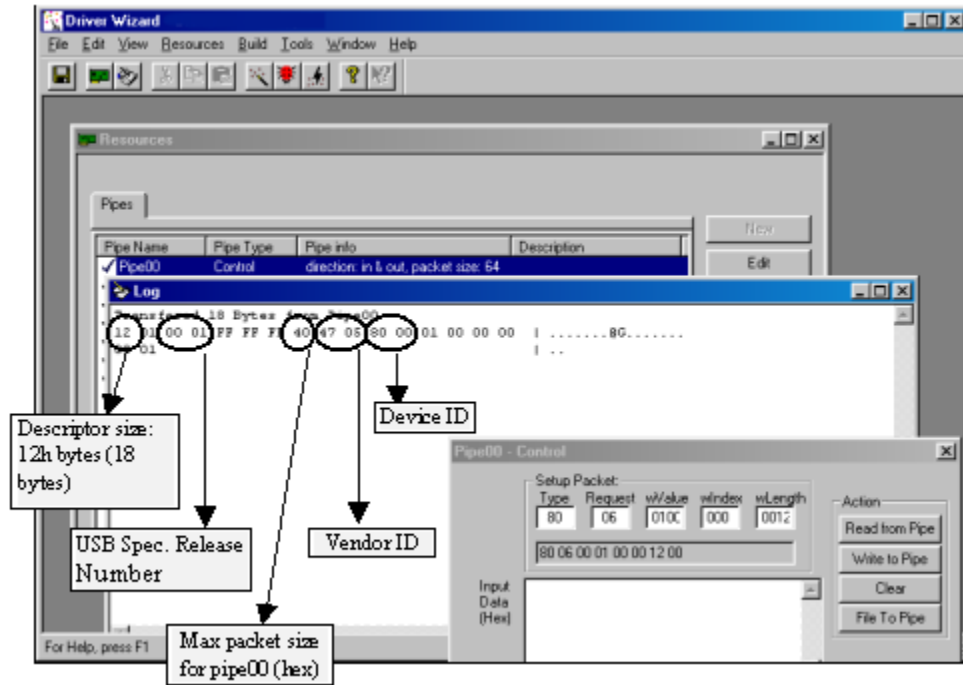
1. Choose Pipe00 and click on 'Read/Write to pipe'



2. Enter the required Setup Packet. For a 'Write' transaction that includes a data stage, enter the data in the 'Input Data' field. Click 'Read from Pipe' or 'Write to Pipe' according to the required transaction.



- The 'Device Descriptor' data retrieved from the device can be seen in DriverWizard log screen:  
(See the following image)



## Control Transfers with WinDriver API

To perform a read or write transaction on the control pipe, you can either use the API generated by DriverWizard for your hardware, or directly call WinDriver WD\_UsbTransfer function within your application.

DriverWizard generates the functions below (the functions can be found in the MyDevice\_lib.c source file). Fill the setup packet in the BYTE SetupPacket[8] array (an element in the WD\_USB\_TRANSFER structure) and call these functions to send setup packets on Pipe00 and to retrieve control and status data from the device:

```
DWORD MY_DEVICE_ReadPipe00(MY_DEVICE_HANDLE hMY_DEVICE,
    PVOID pBuffer, DWORD dwSize, CHAR setupPacket[8])
{
    WD_USB_TRANSFER transfer;
    DWORD i;
    BZERO(transfer);
    transfer.dwPipe = 0x00;
    transfer.dwBytes = dwSize;
    transfer.fRead = TRUE;
    for (i=0; i<8; i++)
        transfer.SetupPacket[i] = setupPacket[i];
    transfer.pBuffer = pBuffer;
    transfer.hDevice = hMY_DEVICE->hDevice;
    WD_UsbTransfer(hMY_DEVICE->hWD, &transfer);
    if (transfer.FOK)
        return transfer.dwBytesTransferred;
    return 0xffffffff;
}
```

```
DWORD MY_DEVICE_WritePipe00(MY_DEVICE_HANDLE hMY_DEVICE,
    PVOID pBuffer, DWORD dwSize, CHAR setupPacket[8])

    WD_USB_TRANSFER transfer;
    DWORD i;
    BZERO(transfer);
    transfer.dwPipe = 0x00;
    transfer.dwBytes = dwSize;
    for (i=0; i<8; i++)
        transfer.SetupPacket[i] = setupPacket[i];
    transfer.pBuffer = pBuffer;
```

```
transfer.hDevice = hMY_DEVICE->hDevice;
WD_UsbTransfer(hMY_DEVICE->hWD, &transfer);
if (transfer.fOK)
    return transfer.dwBytesTransferred;
return 0xffffffff;
```

For further information regarding WD\_UsbTransfer, please refer to Chapter [WinDriver Function Reference](#) that illustrates the function reference for WinDriver in the WinDriver Manual.

## Using direct access to memory mapped regions

After registering a memory mapped region, via **WD\_CardRegister()**, two results are returned: **dwTransAddr** and **dwUserDirectAddr**.

**dwTransAddr** should be used as a base address when calling **WD\_Transfer()** to read or write to the memory region. A more efficient way to perform memory transfers would be to use **dwUserDirectAddr** directly as a pointer, and access with it the memory mapped range. This method enables you to read/write data to your memory-mapped region without any function calls overhead (i.e. Zero performance degradation).

## Accessing IO mapped regions

The only way to transfer data on IO mapped regions is by calling **WD\_Transfer()** function. If a large buffer needs to be transferred, the String (Block) Transfer commands can be used. For example: **RP\_SBYTE** - **ReadPort String Byte** command will transfer a buffer of Bytes to the IO port. In such a case the function calling overhead is negligible compared to the block transfer time.

In a case where many short transfers are called, the function calling overhead may increase to an extent of overall performance degradation. This may happen if you need to call **WD\_Transfer()** more than 20,000 calls per second.

An example for such a case could be: A block of 1MB of data needs to be transferred Word by Word, where in each word that is transferred, first the LOW byte is transferred to IO port 0x300, then the HIGH byte is transferred to IO port 0x301.

Normally this would mean calling **WD\_Transfer()** 1 million times - Byte 0 to port 0x300, Byte 1 to port 0x301, Byte 2 to port 0x300 Byte 3 to port 0x301 etc (**WP\_BYTE** - Write Port Byte).

A quick way to save 50% of the function call overhead would be to call **WD\_Transfer()** with a **WP\_SBYTE** (Write Port String Byte), with two bytes at a time. First call would transfer Byte0 and Byte1 to ports 0x300 and 0x301,

Second call would transfer Byte2 and Byte3 to ports 0x300 and 0x301 etc. This way, **WD\_Transfer()** will only be called 500,000 times to transfer the block.

The third method would be by preparing an array of 1000 **WD\_TRANSFER** commands. Each command in the array will have a **WP\_SBYTE** command that transfers two bytes at a time. Then you call **WD\_MultiTransfer()** with a pointer to the array of **WD\_TRANSFER** commands. In one call to **WD\_MultiTransfer()** - 2000 bytes of data will be transferred. To transfer the 1MB of data you will need only 500 calls to **WD\_Transfer()**. This is 0.5% of the original calls to **WD\_Transfer()**. The trade off in this case is the memory that is used to set-up the 1000 **WD\_TRANSFER** commands.

## Before you begin

The following functions are call-back functions which you will implement in your Kernel PlugIn driver, and which will be called when their 'calling' event occurs. For example, `KP_Init()` is the call-back function which is called when the driver is loaded. Any code that you want to execute upon loading should be in this function.

In `KP_Init()`, the name of your driver is given. From then on, all of the call-backs which you implement in the kernel will contain your driver's name. For example, if your driver's name is `MyDriver`, then your 'Open' call-back will be called `MyDriver_Open()`. It is the convention of this reference guide to mark these functions as `KP_` functions - i.e. the 'Open' function will be written here as `KP_Open()`, where the `KP` replaces your driver's name.



## Write your KP\_INIT() function

In your kernel driver you should implement the following function:

```
BOOL __cdecl KP_Init(KP_INIT *kplnit);
```

where **KP\_INIT** is the following structure:

```
typedef struct {  
    DWORD dwVerWD;           // Version of library WD_KP.LIB  
    CHAR cDriverName[9];     // driver name, up to 8 chars.  
    KP_FUNC_OPEN funcOpen;   // The KP_Open function  
} KP_INIT;
```

This function is called once, when the driver is loaded. The kplnit structure should be filled out with the **KP\_Open** function and the name of your Kernel PlugIn. (see example in KPTest.c). Note that the name that you choose for your KP driver (by setting it in the kplnit structure), should be the same name as the driver you are creating.

For example, if you are creating a driver called **ABC.VXD** or **ABC.SYS**, then you should pass the name ABC in the kplnit structure.

### **From the KPTest Sample:**

```
BOOL __cdecl KP_Init(KP_INIT *kpInit)  
{  
    // check if the version of WD_KP.LIB is the same version  
    // as WINDRVR.H and WD_KP.H  
  
    if (kpInit->dwVerWD!=WD_VER)  
    {  
        // you need to re-compile your kernel plugin with  
        // the compatible version of WD_KP.LIB, WINDRVR.H  
        // and WD_KP.H!  
        return FALSE;  
    }  
  
    kpInit->funcOpen = KPTest_Open;  
    strcpy (kpInit->cDriverName, "KPTest");  
    return TRUE;  
}
```

## Write your KP\_OPEN() function

In your Kernel PlugIn file, implement the KP\_Open() function, where KP is the name of your KP driver (copied to kplnit->cDriverName in the KP\_Init() function).

```
BOOL __cdecl KP_Open(KP_OPEN_CALL *kpOpenCall, HANDLE hWD, PVOID pOpenData, PVOID *ppDrvContext);
```

This call-back is called when the User Mode application calls the **WD\_KernelPlugInOpen()** function.

In the KP\_Open() function, define the call-backs that you wish to implement in the Kernel PlugIn.

Following is a list of the call-backs which can be implemented:

Call-back Name	Functionality
KP_Close() <u>[KP_Close()]</u>	Called when the User Mode application calls the WD_KernelPlugInClose() <u>[WD_KernelPlugInClose()]</u> Function
KP_Call() <u>[KP_Call()]</u>	Called when the User Mode application calls the WD_KernelPlugInCall() <u>[WD_KernelPlugInCall()]</u> function. This function is a message handler for your utility functions.
KP_IntEnable() <u>[KP_IntEnable()]</u>	Called when the User Mode application calls the WD_IntEnable() <u>[WD_IntEnable()]</u> function. This function should contain any initialization needed for your Kernel PlugIn interrupt handling
KP_IntDisable() <u>[KP_IntDisable()]</u>	Called when the User Mode application calls the WD_IntDisable() <u>[WD_IntDisable()]</u> function. This function should free any memory which was allocated in the KP_IntEnable() <u>[KP_IntEnable()]</u> callback.
KP_IntAtIrql() <u>[KP_IntAtIrql()]</u>	Called when WinDriver receives an interrupt. This is the function that will handle your interrupt in the Kernel Mode.
KP_IntAtDpc() <u>[KP_IntAtDpc()]</u>	Called if the KP_IntAtIrql() <u>[KP_IntAtIrql()]</u> callback has requested deferred handling of the interrupt (by returning with a value of TRUE).

These handlers will later be called when the user-mode program opens a KP driver (**WD\_KernelPlugInOpen()**, **WD\_Kernel PlugInClose()**), sends a message (**WD\_KernelPlugInCall()**), or installs an interrupt where hKernelPlugIn passed to **WD\_IntEnable()** is of a Kernel PlugIn driver opened with WD\_KernelPlugInOpen().

### From the KPTTest Sample:

```
BOOL __cdecl KPTTest_Open(KP_OPEN_CALL *kpOpenCall,  
                          PVOID pOpenData, PVOID *ppDrvContext)  
{  
    kpOpenCall->funcClose = KPTTest_Close;  
    kpOpenCall->funcCall = KPTTest_Call;  
    kpOpenCall->funcIntEnable = KPTTest_IntEnable;
```

```
kpOpenCall->funcIntDisable = KPTest_IntDisable;  
kpOpenCall->funcIntAtIrql = KPTest_IntAtIrql;  
kpOpenCall->funcIntAtDpc = KPTest_IntAtDpc;  
*ppDrvContext = NULL; // you can allocate memory here  
return TRUE;  
}
```

## **Write the remaining Plugin call-backs**

Add your specific code inside the call backs routines.

## Interrupt handling in user mode (without Kernel PlugIn)

If the Kernel PlugIn interrupt handle is NOT enabled, then each incoming interrupt will cause *WD\_IntWait()* to return. See drawing below:

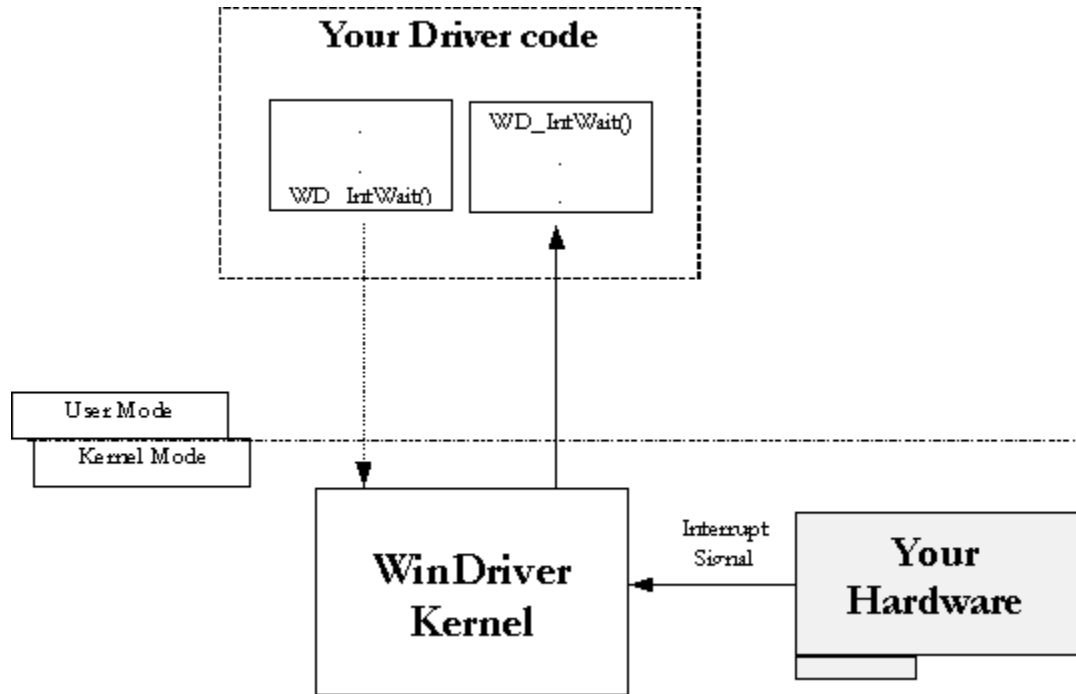


Figure 17.1: Interrupt Handling without Kernel PlugIn

## Interrupt handling in the Kernel (with the Kernel PlugIn)

To instruct the interrupts to be handled by the Kernel PlugIn, the Kernel PlugIn handle must be given as a parameter to the `WD_IntEnable()` function. This enables the Kernel PlugIn interrupt handler.

If the Kernel PlugIn interrupt handler is enabled, then `KP_IntAtIrql()` will be called on each incoming interrupt. The code in the `KP_IntAtIrql()` function is executed at IRQL. While this code is running, the system is halted (i.e. there will be no context switch and no lower priority interrupts will be handled). The code in the `KP_IntAtIrql()` function is limited to the following restrictions:

- You may only access non pageable memory.
  - You may only call the following functions:
    1. `WD_Transfer()`
    2. Specific DDK functions which are allowed to be called from an IRQL.
- You may not call `malloc()`, `free()`, or any `WD_xxx` command (other than `WD_Transfer()`).

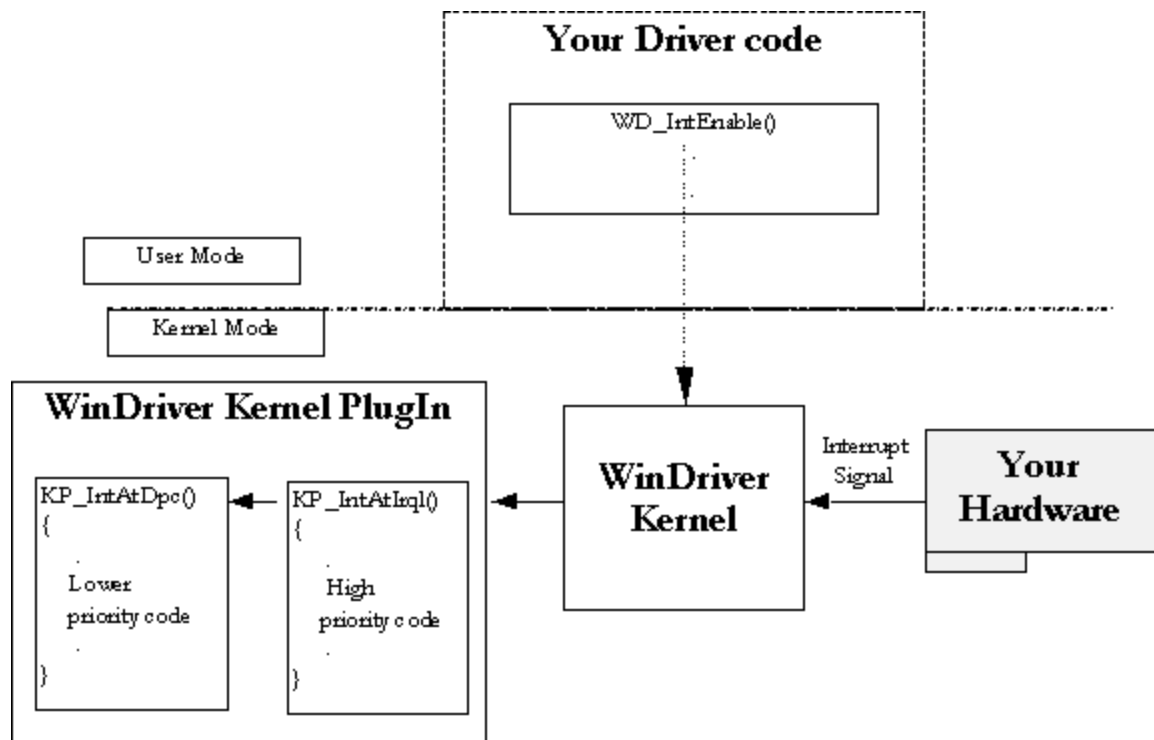


Figure 17.2: Interrupt Handling with the Kernel PlugIn

Therefore, the code in *KP\_IntAtIrql()* should be kept to a minimum, while the rest of the code that you want to run in the interrupt handler should be written in the *KP\_IntAtDpc()*, which is called after IRQL finishes. The code in *KP\_IntAtDpc()* is not limited by the above restrictions.

## WD\_KernelPlugInOpen()

This function is used to obtain a valid handle for the Kernel PlugIn.

### PROTOTYPE

```
void WD_KernelPlugInOpen(HANDLE hWD, WD_KERNEL_PLUGIN *pKernelPlugIn);
```

### PARAMETERS

(WD\_KERNEL\_PLUGIN elements)

**hKernelPlugIn** - returns the handle of the Kernel PlugIn.

**pcDriverName** - name of Kernel PlugIn to load, up to 8 chars

**pcDriverPath** - file name of Kernel PlugIn to load. If NULL the driver will be searched in the windows system directory with the name in pcDriverName.

**pOpenData** - pointer to data that will be passed to KP\_Open() callback in the Kernel PlugIn.

### RETURN VALUE

None

### EXAMPLE

```
// Handle to the KernelPlugIn

WD_KERNEL_PLUGIN kernelPlugIn;

BZERO (kernelPlugIn); // Tells WinDriver which driver to open

kernelPlugIn.pcDriverName = "KPTTEST"; // Opens KPTTEST.SYS/VXD

WD_KernelPlugInOpen(hWD, &kernelPlugIn);

if (!kernelPlugIn.hKernelPlugIn)
{
    printf ("There was an error loading driver: %s\n",
           kernelPlugIn.pcDriverName);
    return ;
}

printf("Kernel PlugIn opened\n");
```



## **WD\_KernelPlugInClose()**

Closes the WinDriver Kernel PlugIn handle obtained from ***WD\_KernelPlugInOpen()***.

### **PROTOTYPE**

```
void WD_KernelPlugInClose(HANDLE hWD,WD_KERNEL_PLUGIN *pKernelPlugIn);
```

### **PARAMETERS**

(WD\_KERNEL\_PLUGIN elements)

**hKernelPlugIn** - handle of the Kernel PlugIn to close.

### **RETURN VALUE**

**None**

### **EXAMPLE**

```
WD_KernelPlugInClose(hWD, &kernelPlugIn);
```

## WD\_KernelPlugInCall()

Calls a routine in the Kernel PlugIn to be executed.

Calling the **WD\_KernelPlugInCall()** function in the User Mode, calls your **KP\_Call()** callback function in the Kernel Mode. Your **KP\_Call()** function in the Kernel PlugIn will decide what routine to execute according to the message passed to it in the **WD\_KERNEL\_PLUGIN\_CALL** structure.

### PROTOTYPE

```
void WD_KernelPlugInCall( HANDLE hWD, WD_KERNEL_PLUGIN_CALL *pKernelPlugInCall);
```

### PARAMETERS

(WD\_KERNEL\_PLUGIN\_CALL elements)

**hKernelPlugIn** - handle of the Kernel PlugIn.

**dwMessage** - message ID to pass to KP\_Call() callback.

**pData** - pointer to data to pass to KP\_Call() callback.

**dwResult** - value set by KP\_Call() callback.

### RETURN VALUE

None

### EXAMPLE

```
WD_KERNEL_PLUGIN_CALL kpCall;

BZERO (kpCall);    // Prepare the kpCall structure
//from WD_KernelPlugInOpen()
kpCall.hKernelPlugIn = hKernelPlugIn;
// The message to pass to KP_Call(). This will determine
// the action performed in the kernel.
kpCall.dwMessage = MY_DRV_MSG_VERSION;

kpCall.pData = &mydrvVer;    // The data to pass to the call.
WD_KernelPlugInCall(hWD, &kpCall);
```

## WD\_IntEnable()

If the handle passed to this function is of a Kernel PlugIn, then that Kernel PlugIn will handle all the interrupts.

In this case, upon receiving the interrupt, your Kernel Mode KP\_IntAtIrql() function will execute. If this function returns a value greater than 0, then your deferred procedure call, KP\_IntAtDpc() , will be called.

### PROTOTYPE

```
void WD_IntEnable(HANDLE hWD,WD_INTERRUPT *pInterrupt);
```

### PARAMETERS

(WD\_INTERRUPT elements)

textbfkpCall- information on Kernel PlugIn to install as interrupt handler.

textbfkpCall.hKernelPlugIn- handle of Kernel PlugIn. if zero, then no Kernel PlugIn interrupt handler is installed.

textbfkpCall.dwMessage- message ID to pass to KP\_IntEnable() callback.

textbfkpCall.pData- pointer to data to pass to KP\_IntEnable() callback.

textbfkpCall.dwResult- value set by KP\_IntEnable() callback.

For information about all other parameters of WD\_IntEnable(), see the documentation of *WD\_IntEnable()* in Chapter [WinDriver Function Reference](#) explaining the WinDriver functions.

### RETURN VALUE

None

### EXAMPLE

```
WD_INTERRUPT Intrp;

BZERO(Intrp); // from WD_CardRegister()

Intrp.hInterrupt = hInterrupt;

Intrp.Cmd = NULL;

Intrp.dwCmds = 0;

Intrp.dwOptions = 0; // from WD_KernelPlugInOpen()

Intrp.kpCall.hKernelPlugIn = hKernelPlugIn;

WD_IntEnable(hWD, &Intrp);

if (!Intrp.fEnableOk)
    printf ("failed enabling interrupt\n");
```



## KP\_Init()

You must define the KP\_Init() function in your code in order to link the Kernel PlugIn driver to the WinDriver.

KP\_Init() is called when the driver is loaded. Any code that you want to execute upon loading should be in this function.

### PROTOTYPE

```
BOOL __cdecl KP_Init(KP_INIT *kpInit);
```

### PARAMETERS

**kpInit** - structure to fill in the address of the KP\_Open() callback function.

### RETURN VALUE

TRUE if successful. If FALSE, then the Kernel PlugIn driver will be unloaded.

### EXAMPLE

```
BOOL __cdecl KP_Init(KP_INIT *kpInit)
{
    // check if the version of WD_KP.LIB is the same version as
    //WINDRVR.H and WD_KP.H
    if (kpInit->dwVerWD!=WD_VER)
    {

        // you need to re-compile your kernel plugin
        //with the compatible version
        // of WD_KP.LIB,
        // WINDRVR.H and WD_KP.H!
        return FALSE;
    }

    kpInit->funcOpen = KP_Open;
    strcpy (kpInit->cDriverName, "KPTEST"); // until 8 chars
    return TRUE;
}
```

## KP\_Open()

Called when WD\_KernelPlugInOpen() is called from the User Mode. The pDrvContext returned will be passed to rest of the functions.

### PROTOTYPE

```
BOOL __cdecl KP_Open(KP_OPEN_CALL *kpOpenCall, HANDLE hWD, PVOID pOpenData, PVOID *ppDrvContext);
```

### PARAMETERS

**kpOpenCall**- structure to fill in the addresses of the KP\_xxxx() callback functions

**hWD**- handle of WinDriver that WD\_KernelPlugInOpen() was called with.

**pOpenData**- pointer to data, passed from user-mode.

**ppDrvContext**- pointer to driver context data with which KP\_Close(), KP\_Call() and KP\_IntEnable() functions will be called. Use this to keep driver specific information.

### RETURN VALUE

TRUE if successful. If FALSE, then the call to WD\_KernelPlugInOpen() from user-mode will fail.

### EXAMPLE

```
BOOL __cdecl KP_Open(KP_OPEN_CALL *kpOpenCall, HANDLE hWD,
                    PVOID pOpenData, PVOID *ppDrvContext)
{
    kpOpenCall->funcClose = KP_Close;
    kpOpenCall->funcCall = KP_Call;
    kpOpenCall->funcIntEnable = KP_IntEnable;
    kpOpenCall->funcIntDisable = KP_IntDisable;
    kpOpenCall->funcIntAtIrql = KP_IntAtIrql;
    kpOpenCall->funcIntAtDpc = KP_IntAtDpc;
    *ppDrvContext = NULL; // you can allocate memory here
    return TRUE;
}
```

## **KP\_Close()**

Called when WD\_KernelPlugInClose() is called from the User Mode.

### **PROTOTYPE**

```
void __cdecl KP_Close(PVOID pDrvContext);
```

### **PARAMETERS**

**pDrvContext** - driver context data that was set by KP\_Open().

### **RETURN VALUE**

None

### **EXAMPLE**

```
void __cdecl KP_Close(PVOID pDrvContext)
{
    // you can free the memory allocated for pDrvContext here
}
```

## KP\_Call()

Called when the User Mode application calls the WD\_Kernel PlugInCall() function. This function is a message handler for your utility functions.

### PROTOTYPE

```
void __cdecl KP_Call(PVOID pDrvContext, WD_KERNEL_PLUGIN_CALL *kpCall, BOOL  
    fIsKernelMode);
```

### PARAMETERS

**pDrvContext** - driver context data that was set by KP\_Open().

**kpCall** - structure with information from WD\_Kernel PlugInCall().

**kpCall.dwMessage** - message ID passed from WD\_Kernel PlugInCall().

**kpCall.pData** - pointer to data passed from WD\_Kernel PlugInCall().

**kpCall.dwResult** - value to return to WD\_Kernel PlugInCall().

**fIsKernelMode** - this parameter is passed by the Windriver kernel.

### RETURN VALUE

None

### EXAMPLE

```
void __cdecl KP_Call(PVOID pDrvContext,  
    WD_KERNEL_PLUGIN_CALL *kpCall, BOOL fIsKernelMode)  
{  
    kpCall->dwResult = MY_DRV_OK;  
    switch ( kpCall->dwMessage )  
    {  
        // in this sample we implement a GetVersion message  
        case MY_DRV_MSG_VERSION:  
        {  
            MY_DRV_VERSION *ver = (MY_DRV_VERSION *)  
                kpCall->pData;  
            COPY_TO_USER_OR_KERNEL(&ver->dwVer, &dwVer,  
                sizeof(DWORD), fIsKernelMode);  
            COPY_TO_USER_OR_KERNEL(ver->cVer, "My Driver V1.00",  
                sizeof("My Driver V1.00")+1, fIsKernelMode);  
            kpCall->dwResult = MY_DRV_OK;  
        }  
    }  
}
```



```
    }  
    break;  
    // you can implement other messages here  
    default:  
        kpCall->dwResult = MY_DRV_NO_IMPL_MESSAGE;  
    }  
}
```

## NOTES

The **flsKernelMode** parameter is passed by the Windriver kernel to the KP\_Call routine. The user need not do anything about this parameter. But notice how this parameter is passed to the macro COPY\_TO\_USER\_OR\_KERNEL -- this is required for the macro to function correctly. You may see the implementation of the macro COPY\_TO\_USER\_OR\_KERNEL in the header file **kpstdlib.h**, found under the directory *WinDriver\Include* of your WinDriver installation.

## KP\_IntEnable()

Called when WD\_IntEnable() is called from the User Mode, with a Kernel PlugIn handler specified. The pIntContext will be passed to the rest of the functions that handle interrupts.

This function should contain any initialization needed for your Kernel PlugIn interrupt handling.

### PROTOTYPE

```
BOOL __cdecl KP_IntEnable (PVOID pDrvContext, WD_KERNEL_PLUGIN_CALL *kpCall, PVOID *ppIntContext);
```

### PARAMETERS

**pDrvContext**- driver context data that was set by KP\_Open().

**kpCall**- structure with information from WD\_IntEnable().

**kpCall.dwMessage**- message ID passed from WD\_IntEnable().

**kpCall.pData**- pointer to data passed from WD\_IntEnable().

**kpCall.dwResult**- value to return to WD\_IntEnable().

**ppIntContext**- pointer to interrupt context data that KP\_Int Disable(), KP\_IntAtIrql() and KP\_IntAtDpc() functions will be called with. Use this to keep interrupt specific information.

### RETURN VALUE

Returns TRUE if enable is successful.

### EXAMPLE

```
BOOL __cdecl KP_IntEnable (PVOID pDrvContext,
    WD_KERNEL_PLUGIN_CALL *kpCall, PVOID *ppIntContext)
{
    // you can allocate memory specific for each interrupt
    //in ppIntContext

    *ppIntContext = NULL;

    return TRUE;
}
```

## **KP\_IntDisable()**

Called when the User Mode application calls the `WD_IntDisable()` function. This function should free any memory which was allocated in the `KP_IntEnable()`.

### **PROTOTYPE**

```
void __cdecl KP_IntDisable(PVOID pIntContext);
```

### **PARAMETERS**

**pIntContext** - interrupt context data that was set by `KP_Enable()`.

**RETURN VALUE** None

### **EXAMPLE**

```
void __cdecl KP_IntDisable(PVOID pIntContext)
{

    // you can free the interrupt specific
    //memory in pIntContext here

}
```

## KP\_IntAtIrql()

This is the function which will run at IRQL if the Kernel PlugIn handle is passed when enabling interrupts.

Code running at IRQL will only be interrupted by higher priority interrupts.

Code running at IRQL is limited by the following restrictions:

1. You may only access non-pageable memory.
2. You may only call the following functions: WD\_Transfer(), specific DDK functions which are allowed to be called from an IRQL.
3. You may not call malloc(), free(), or any WD\_xxx command (other than WD\_Transfer()).

The code performed at IRQL should be minimal (e.g. only the code which acknowledges the interrupt), since it is operating at a high priority. The rest of your code should be written at KP\_AtDpc(), in which the above restrictions do not apply.

### PROTOTYPE

```
BOOL __cdecl KP_IntAtIrql(PVOID pIntContext, BOOL *pfIsMyInterrupt);
```

### PARAMETERS

**pIntContext**- interrupt context data that was set by KP\_Int Enable().

**pfIsMyInterrupt**- set this to TRUE, if the interrupt belongs to this driver, or FALSE if not. If you are not sure, it is safest to return FALSE.

### RETURN VALUE

Returns TRUE if DPC function is needed for execution.

### EXAMPLE

```
static DWORD G_dwInterruptCount = 0;

BOOL __cdecl KP_IntAtIrql(PVOID pIntContext, BOOL *pfIsMyInterrupt)
{
    // you should check your hardware here to see
    //if the interrupt belongs to you.
    // if in doubt, return FALSE (this is the safest)
    *pfIsMyInterrupt = TRUE;
    // in this example we will schedule a DPC
    //once in every 5 interrupts
    G_dwInterruptCount ++;
    if ((G_dwInterruptCount % 5) == 0 )
        return TRUE;
    return FALSE;
}
```



## KP\_IntAtDpc()

This is the Deferred Procedure Call which is executed only if the KP\_IntAtIrql() function returned true. Most of your interrupt handler should be written at DPC.

- If KP\_IntAtDpc() returns with a value of 1 or more, WD\_IntWait() returns. i.e., if you do not want the User Mode interrupt handler to execute, then the KP\_IntAtDpc() function should return 0.
- If KP\_IntAtDpc() returns with a value which is larger than 1, this means that some interrupts have been 'lost' (i.e. were not processed by the User Mode). In this case, dwLost will contain the number of interrupts that were lost.

### PROTOTYPE

```
DWORD __cdecl KP_IntAtDpc(PVOID pIntContext, DWORD dwCount);
```

### PARAMETERS

**pIntContext**- interrupt context data that was set by KP\_Enable().

**dwCount**- the number of times KP\_IntAtIrql() returned TRUE. If dwCount is 1, then only KP\_IntAtIrql() only requested once a DPC. If the value is greater, then KP\_IntAtIrql() has already requested a DPC a few times, but the interval was too short, therefore KP\_IntAtDpc() was not called for each one of them.

### RETURN VALUE

Returns the number of times to notify user-mode (i.e. return from WD\_IntWait()).

### EXAMPLE

```
DWORD __cdecl KP_IntAtDpc(PVOID pIntContext, DWORD dwCount)
{

    // return WD_IntWait as many times as KP_IntAtIrql
    // scheduled KP_IntAtDpc()

    return dwCount;

}
```

## WD\_KERNEL\_PLUGIN

Defines a Kernel PlugIn open command.

Used by `WD_KernelPlugInOpen()` [`WD_KernelPlugInOpen()`] and `WD_KernelPlugInClose()` [`WD_KernelPlugInClose()`].

### MEMBERS:

<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
DWORD	<code>hKernelPlug In</code>	Handle to Kernel PlugIn
<b>TYPE</b>	<b>NAME</b>	<b>DESCRIPTION</b>
PCHAR	<code>pcDriverName</code>	Name of Kernel PlugIn driver. Should be no longer than 8 letters. Should include the VXD or SYS extension.
PCHAR	<code>pcDriverPath</code>	The directory and file name in which to look for the KP driver. If NULL, the driver will be searched for in the windows system directory, under the name supplied in <code>pcDriverName</code> , with <code>.VXD</code> added for Windows-95, or <code>.SYS</code> for Windows-NT.
PVOID	<code>pOpenData</code>	Data to pass to <code>KP_Open()</code> call to open Kernel PlugIn.

## WD\_INTERRUPT

Used to describe an interrupt.

Used by the following functions: [WD\\_IntEnable\(\)](#)[[WD\\_IntEnable\(\)](#)], [WD\\_IntDisable\(\)](#)[[WD\\_IntDisable\(\)](#)], [WD\\_IntWait\(\)](#)[[WD\\_IntWait\(\)](#)], [WD\\_IntCount\(\)](#)[[WD\\_IntCount\(\)](#)].

### MEMBERS:

TYPE	NAME	DESCRIPTION
<a href="#">WD_KERNEL_PLUGIN_CALL</a> <a href="#">WD_KERNEL_PLUGIN_CALL</a>	kpCall	The kpCall structure contains the handle to the Kernel PlugIn and other information which should be passed to the Kernel PlugIn mode interrupt handler when installed. If the handle is zero, then interrupt handler is installed without a Kernel PlugIn handler.

For information about all other members of WD\_INTERRUPT, see the documentation of this structure in Chapter [WinDriver Structure Reference](#) that explains the WinDriver structures.



## WD\_KERNEL\_PLUGIN\_CALL

Contains information about the Kernel PlugIn, which will be used when calling a utility Kernel PlugIn function or when installing an interrupt.

Used by `WD_KernelPlugInCall()`[\[WD\\_KernelPlugInCall\(\)\]](#) and `WD_IntEnable()`[\[WD\\_IntEnable\(\)\]](#).

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	hKernelPlugIn	handle to Kernel PlugIn.
DWORD	dwMessage	message ID to pass to Kernel PlugIn callback
PVOID	pData	pointer to data to pass to Kernel PlugIn callback.
DWORD	dwResult	value set by Kernel PlugIn callback to return back to User Mode.

## KP\_INIT

The KP\_INIT structure is used by your KP\_Init()[KP\_Init()] function in the Kernel PlugIn. Its primary use is for notifying WinDriver what the name of the driver will be, and which Kernel Mode function to call when the application calls WD\_KernelPlugInOpen()[WD\_KernelPlugInOpen()].

### MEMBERS:

TYPE	NAME	DESCRIPTION
DWORD	dwVerWD	Version of WinDriver library WD
CHAR	cDriver Name[9]	The device driver name, upto 8
KP_FUNC_OPEN	funcOpen	The KP_Open() Kernel Mode fu which WinDriver should call whe application calls WD_KernelPlu

## KP\_OPEN\_CALL

This is the structure through which the Kernel PlugIn defines the names of the call-backs which it implements. It is used in the KP\_Open() Kernel PlugIn function.

A kernel PlugIn may implement 6 different call-back functions:

**funcClose** - Called when application is done with this instance of the driver.

**funcCall** - Called when the application calls the WD\_Kernel PlugInCall function. This function is the 'general purpose' function. In it, implement any functions which should run in the Kernel Mode, (besides the Interrupt handler which is a special case). The funcCall will determine which function to execute according to the message passed to it.

**funcIntEnable** - Called when application calls the WD\_Kernel PlugInIntEnable(). This call-back function should initiate any activity which needs to be done when enabling an interrupt.

**funcIntDisable** - The cleanup function which is called when the application calls WD\_KernelPlugInIntDisable().

**funcIntAtIrql** - This is the Kernel Mode interrupt handler. This call-back function is called when the WinDriver processes the interrupt which is assigned to this Kernel PlugIn. If this function returns a value greater than 0, then funcIntAtDpc is called as a Deferred procedure call.

**funcIntAtDpc** - Most of your interrupt handler code should be written in this call-back. It is called as a Deferred procedure call, if the funcIntAtIrql returns a value greater than 0.

TYPE	NAME	DESCRIPTION
KP_FUNC_CLOSE	funcClose	Name of your KP_Close() function in kernel.
KP_FUNC_CALL	funcCall	Name of your KP_Call() function in kernel.
KP_FUNC_INT_ENABLE	funcIntEnable	Name of your KP_IntEnable() function in the kernel.
KP_FUNC_INT_DISABLE	funcIntDisable	Name of your KP_IntDisable() function in the kernel.
KP_FUNC_INT_AT_IRQL	funcIntAtIrql	Name of your KP_IntAtIrql() function in kernel.
KP_FUNC_INT_AT_DPC	FuncIntAtDpc	Name of your KP_IntAtDpc() function in the kernel.

## **Dynamic loading - background**

When adding a new driver to the Windows operating system, you must re-boot the system, for the Windows to load your new driver into the system. Dynamic loading enables you to install a new driver to your operating system, without needing to re-boot. WinDriver is a dynamically loadable driver, and provides you with the utility needed to dynamically load the driver you create. You may dynamically load your driver whether you have created a User Mode or a Kernel Mode driver.

## **Why do you need a dynamically loadable driver?**

A dynamically loadable driver enables your customers to start your application immediately after installing it, without the need to re-boot.

## Dynamically loading and unloading your driver

The utility you use to dynamically load and unload your driver is called WDREG.EXE, and is found in `\windriver\util\WDREG.EXE`.

**USAGE:** WDREG [-vxd ] [-name <driver name>] [-file <driver file name>]  
[[CREATE] [START] [STOP] [DELETE] [INSTALL] [REMOVE]]

WDREG.EXE has 4 basic operations:

1. **CREATE** - Instructs the Windows to load your driver next time it boots, by adding your driver to the registry.
2. **START** - Dynamically loads your driver into memory for use. On Windows NT/2000, you must first 'CREATE' your driver before 'START'ing it.
3. **STOP** - Dynamically unloads your driver from memory.
4. **DELETE** - Removes your driver from the registry , so that it does not load on next boot.

For example, to reload WinDriver use:

**WDREG STOP START**

WDREG.EXE has 2 'shortcut' operations for your convenience:

**INSTALL** - Creates and starts your driver (same as using WDREG CREATE START).

**REMOVE** - Unloads your driver from memory, and removes it from the registry so that it does not load on next boot (same as using WDREG STOP DELETE).

You may dynamically load your driver via command line or from within your application as follows:

### **Dynamically loading your driver via command line:**

From the command line, type **WDREG INSTALL**. This loads the driver into memory, and instructs Windows to load your driver on the next boot.

### **Dynamically loading your driver in your installation application:**

Add the WDREG source code to your installation application.

The full source code for WDREG is found in `\windriver\samples\wdreg\`

For Linux and Solaris, use the command **wdreg <driver name>** to load and unload your driver. The parameters are the same as that of the Windows version.

## Dynamically loading your Kernel PlugIn

If you have used WinDriver to develop a Kernel PlugIn, you must dynamically load your Kernel PlugIn as well as the WinDriver.

To Dynamically load / unload your Kernel PlugIn driver ([Your driver name].VXD / [Your driver name].SYS):

Use the WDREG command as described above, with the addition of the "- name" flag, after which you must add the name of your Kernel PlugIn driver.

For example, to load your Kernel PlugIn driver called KPTest.VXD or KPTest.SYS, use:

**WDREG -name KPTest install**

(You should not add the .VXD or .SYS extension to your driver name).

WDREG allows you to install your driver in the registry under a different name than the physical file name.

**USAGE: WDREG -name [Your new driver name]-file [Your original driver name] install**

For example, typing the following:

**WDREG -name "Kernel PlugIn Test" -file KPTest install**

Installs the KPTest.VXD or KPTest.SYS driver under a different name.

## Why should I create an INF file?

1. To stop the 'new hardware wizard' of the Windows operating system from popping up after boot.
2. In some cases the OS doesn't initialize the PCI configuration registers in Win98/ME without an INF file.
3. In some cases the OS doesn't assign physical address to USB devices without an INF file.
4. To load the new driver created for the card / device. Creating an INF file is required whenever developing a new driver for the hardware.
5. To replace the existing driver with a new one.



## How do I install an INF file when no driver exists?

1. When no driver exists for your hardware, use DriverWizard to generate an INF file for your card / device (the INF file includes your device **VID/PID** and loads **WDPNP.SYS** as your device driver).
2. Save the file under **C:\temp\mydevice.INF** (or any other name or location you choose). For instructions on how to generate the INF file, see Chapter [The DriverWizard](#) that explains the DriverWizard .
3. Go to: **Start | Settings | Control Panel | System**.
4. Use the operating system 'Add new hardware' wizard to add and register the .INF file created with WinDriver. In the relevant screen enter the path of the new .INF file created with WinDriver.

## How do I replace an existing driver using the INF file?

Windows 2000

Windows 95/98/ME

## WinDriver Kernel Module

Since Windrvr.o is a kernel module, it requires recompilation for every kernel version that it must be loaded on. To facilitate this, we supply the following components to insulate the windriver kernel module from the Linux kernel:

- **windrvr.a:** This is the compiled object code for the windriver kernel module
- **linux\_wrappers.c/h:** These are the wrapper library source code that binds the windriver kernel module to the Linux kernel.

You need to distribute these components along with your driver source code or object code. We suggest that you adapt our makefile from the windriver/redist directory to compile and insert the module windrvr.o into the kernel. Note that this makefile calls the wdreg utility shell script that we supply under windriver/util. You should understand how this works and adapt it for your own needs.

## **Your User Mode Driver**

Since the user mode driver does not have to be matched against the kernel version number, you are free to distribute it as binary code (in case you wish to protect your source code from unauthorized copying), or as source code.

## **Kernel Plugin Modules**

Since the kernel plugin module is a kernel module, it also needs to be matched against the active kernel's version number. This means recompilation for the target system. It is advisable to supply the kernel plugin module source code to clients so that they may recompile it. You may also use the same makefile, to build and insert any kernel plugin modules that you distribute with Linux, that you use to recompile and install the WinDriver kernel module.

## **Installation script**

We suggest that you supply an installation shell script that copies your driver executables to the correct places (perhaps `/usr/local/bin`), then invoke `make` or `gmake` to build and install the windriver kernel module and any kernel plugin modules.

## **Installation script**

We suggest that you supply an installation shell script that copies your driver executables to the correct places (perhaps `/usr/local/bin`), then install the windriver kernel and any kernel plugin modules. You may adapt the utility scripts `wdreg` and `install_windrvr`, that we supply under the directory `windriver/util` for your purpose.





## Layered Drivers

Layered drivers are device drivers that are part of a "stack" of device drivers, that together process an I/O request. An example of a layered driver is a driver that intercepts calls to the disk, and encrypts / decrypts all data being written / read from the disk. In this example, a driver would be hooked on to the top of the existing driver and would only do the encryption / decryption.

Layered drivers are sometimes also known as filter drivers. These are also supported on Windows 95/98/ME.

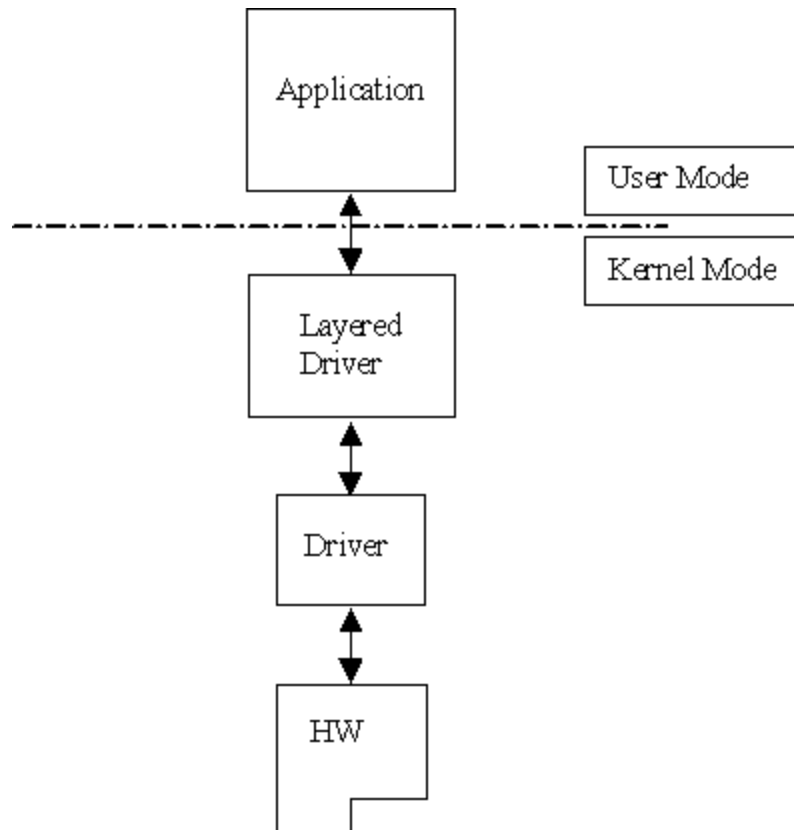
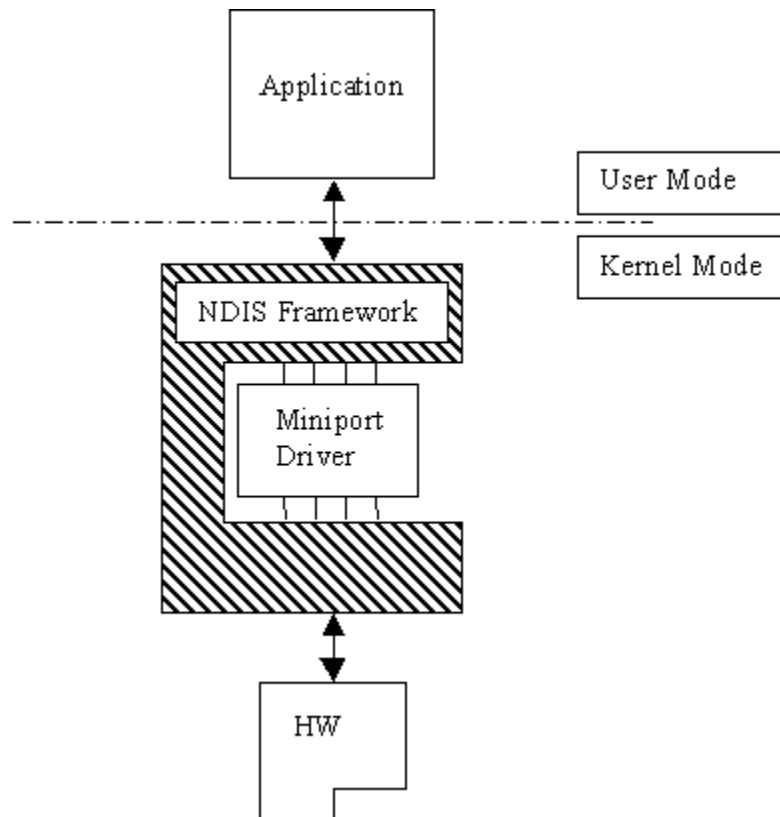


Figure 1.3: Layered Drivers

## Miniport Drivers

There are classes of device drivers in which much of the code has to do with the functionality of the device, and not with the device's inner workings.



**Figure 1.4: Miniport Drivers**

Windows NT/2000, for instance, provides several driver classes (called "ports") that handle the common functionality of their class. It is then up to the user to add only the functionality that has to do with the inner workings of the specific hardware.

An example of Miniport drivers is the "NDIS" miniport driver. The NDIS miniport framework is used to create network drivers that hook up to NT's communication stacks, and are therefore accessible by the common communication calls from within applications. The Windows NT kernel provides drivers for the different communication stacks, and other code that is common to communication cards. Due to the NDIS framework, the network card developer does not have to write all of this code, the developer must only write the code that is specific to the network card that he is developing.

## Installing WinDriver CE for a hand held PC

Insert the WinDriver CD into your NT machine CD drive.

Exit from the auto installation and double click the "**Cd\_setup.exe**" file from the *Wince* directory inside the CD. This will copy all needed WinDriver files to your development platform (NT).

Copy the WinDriver CE kernel file  
*\windriver\redist\register\TARGET\_CPU\windrvr.dll*)  
to the *WINDOWS* subdirectory of your HPC.

Use the Windows CE Remote Registry Editor tool(*ceragedt.exe*) or the Pocket Registry Editor(*pregedt.exe*) on your HPC to modify your registry so that the WinDriver CE kernel is loaded appropriately. The file

*\windriver\samples\wince\_install\PROJECT\_WD.REG*  
contains the appropriate changes to be made.

Restart your HPC. The WinDriver CE kernel will be automatically loaded. You will have to do a warm RESET rather than just Suspend/Resume. You should look for a button labelled RESET on your HPC. On the HP 3xx/6xx series, this button can be found under the reserve battery cover.

Compile and run the sample programs (see Section [Checking Your Installation](#) that describes how to check your installation) to make sure that WinDriver CE is loaded and is functioning correctly.

## Using WinDriver CE with ETK/Platform Builder

- It is highly recommended that you read the ETK documentation and understand the Windows CE and device driver integration procedure before you perform the following installation procedure:
- Open an ETK Build Command Window using the **MAXALL** project on your NT development platform.
- Copy the WinDriver CE kernel file (`\windriver\redist\register\TARGET_CPU\windrvr.dll`) to the `_%FLATRELEASEDIR%` subdirectory on your development platform.  
This environment variable is set by the WinCE ETK and may be `D:\WINCE210\RELEASE` for example.
- Append the contents of the file `PROJECT_WD.REG` to the file `\windriver\samples\wince_install\PROJECT_WD.REG` in the `_%FLATRELEASEDIR%` subdirectory.
- Append the contents of the file `\windriver\samples\wince_install\PROJECT_WD.BIB` to the file `PROJECT.BIB` in the `_%FLATRELEASEDIR%` subdirectory. This step is only necessary if you want the WinDriver CE kernel file (`WINDRVR.DLL`) to be part of the WinCE image (`NK.BIN`) permanently. This would be the case if you were transferring the file to your target platform using a floppy disk. If you prefer to have the file `WINDRVR.DLL` loaded on demand via the `CESH/PPSH` services, you need not carry out this step until you build a permanent kernel.
- Use the WinCE ETK tool `MAKEIMG.EXE` to generate a new WinCE kernel called `NK.BIN`. Transfer this kernel to the target platform using the `PPSH/CESH` service or via a floppy disk.
- Restart your target CE platform. The WinDriver CE kernel will be automatically loaded.
- Compile and run the sample programs (see Section [Checking Your Installation](#) that describes how to check your installation) to make sure that WinDriver CE is loaded and is functioning correctly.

## Emulation on Windows NT

1. Repeat step 1-2 in the first CE installation set of instructions.
2. Select the X86EMU target and then compile and run one of the sample programs to make sure that it works correctly.

## Restricting hardware access on Linux

**CAUTION:** Since `/dev/windrvr` gives direct hardware access to user programs, it may compromise kernel stability on multi-user Linux systems. Please restrict access to DriverWizard and the device file `/dev/windrvr` to trusted users.

For security reasons the Windriver installation script does not automatically perform the steps of changing the permissions on `/dev/windrvr` and the DriverWizard executable (`wdwizard`).

## Restricting hardware access on Solaris

**CAUTION:** Since `/dev/windrvr` gives direct hardware access to user programs, it may compromise kernel stability on multi-user Solaris systems. Please restrict to trusted users, access to DriverWizard and the device file `/dev/windrvr`.

For security reasons the Windriver installation script does not automatically perform the steps of changing the permissions on `/dev/windrvr` and the DriverWizard executable (`wdwizard`).

## Solaris Platform Specific Issues

WinDriver for Solaris supports version 2.6, 7.0 and 8.0 on Intel X86 and Sparc. The same WinDriver based hardware access code will run on both platforms after recompilation.

WinDriver does not support Solaris 7 64 bit kernel. To switch from a 64 bit kernel to a 32 bit kernel follow these simple steps:

1. Reboot the computer (as super user)-#reboot
2. When the computer resets, Break into the boot prompt by pressing **STOP+A**.
3. At the prompt enter the following: (*boot kernel/unix*)
4. To make the 32 bit kernel to be the default one, enter the following at the boot prompt: (*setenv boot-file kernel/unix*)



## DebugMonitor Graphical Mode

Applicable for Windows 95, 98, ME, NT, 2000. You may also use DebugMonitor to debug your CE driver code running on CE emulation on Windows NT. For Linux, Solaris, VxWorks and CE targets use the console mode DebugMonitor.

- Start DebugMonitor from the **Start | Programs | WinDriver | MonitorDebugMessages** menu.

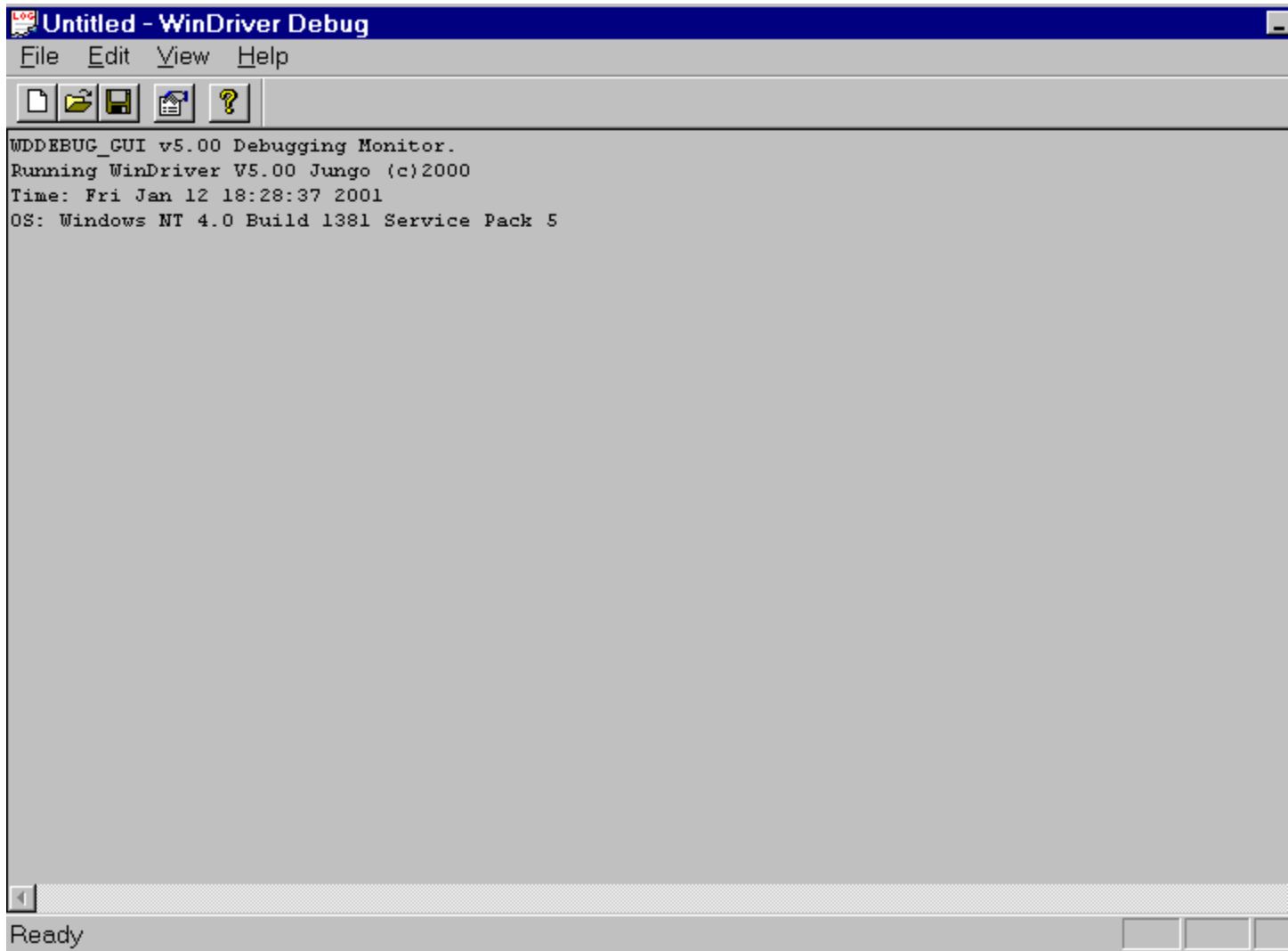


Figure 6.1: Start DebugMonitor

- Activate and set the trace level you are interested in from the **View | Debug Options** menu or using the change status button.



**Figure 6.2: Set Trace Options**

**Status** - Set trace on or off.

**Section** - Choose what part of the WinDriver API you are interested to monitor. If you are developing a PCI card and experiencing problems with your interrupt handler you should check the Int box and the PCI box.

Checking more options than necessary could amount to overflow of information making it harder for you to locate your problem. USB developers, should choose the USB box.

The **Ker\_drv** option is for KernelDriver users, monitoring communication between their custom Kernel mode drivers (developed using KernelDriver) and the WinDriver kernel.

**Level** - Choose the level of messages you are interested to see for the resources defined. *Error* is the lowest level of trace, resulting with minimum output to the screen. Trace is the highest level of tracing displaying every operation the WinDriver Kernel performs.

Once you have defined what you want to trace and on what level just press **OK** to close the "Modify status" window, activate your program, (Step by step or in one run), and watch the monitor screen for error or any unexpected messages.

## DebugMonitor - Console Mode

This tool is available in all operating systems supported including Linux. To use it run "**wddebug**" in the *WinDriver\util* directory with the appropriate switches. For a list of switches available with the DebugMonitor in console mode just type "**wddebug**" and a help screen appears, describing all the different options for this command.

To see activity logged with the DebugMonitor simply type "**wddebug dump**".

## DebugMonitor on Linux and Solaris

On Linux and Solaris, DebugMonitor is only available in console mode. Its usage is therefore as described in Section [DebugMonitor - Console Mode](#). However, you can also start it from DriverWizard GUI using the menu selection *Tools | Debug Monitor*. This starts up separate Xterm window with the command line version of *wdebug* running inside it.

## **DebugMonitor on Windows CE**

On Windows CE, DebugMonitor is only available in console mode. Its usage is therefore as described in Section [DebugMonitor - Console Mode](#). You first need to start a Windows CE command window (CMD.EXE) on the Windows CE target computer and then run the program WDDEBUG.EXE inside this shell.

## DebugMonitor on VxWorks

On VxWorks, DebugMonitor is only available in console mode. Its usage is therefore as described in Section [DebugMonitor - Console Mode](#). However, because of the special syntax of the Tornado WindShell, we show a sample session with Tornado II IDE below, where we first load the debug monitor, then set the options and then run it to capture information.

```
-> ld < wddebug.out
Loading wddebug.out |
value = 10893848 = 0xa63a18
-> wdddebug

-> wddebug_main "on", "trace", "all"
Debug level (4) TRACE, Debug sections (0xffffffff) ALL ,
Buffer size 16384
value = 0 = 0x0
-> wddebug_main "dump"
WDDEBUG v5.00 Debugging Monitor.
Running DriverBuilder V5.00 Jungo (c) 2001 evaluation copy
Time: THU JAN 01 01:06:56 2001
OS: VxWorks
Press CTRL-BREAK to exit
```

Please note the following:

- The DebugMonitor object binary module is called wddebug.out.
- The main program entry point is called wddebug\_main
- The arguments are enclosed in double quotations, and seperated by commas. This syntax is required by *WindShell*

## Scatter/Gather DMA for buffers larger than 1MB

The **WD\_DMA** structure holds a list of 256 pages. The x86 CPU uses 4K page size, so 256 pages can hold  $256 * 4K = 1MB$ . Since the first and last page might not start (or end) on a 4096 byte boundary, 256 pages can hold 1MB - 8K.

If you need to lock down a buffer larger than 1MB, that needs more than 256 pages, you will need the **DMA\_LARGE\_BUFFER** option.

```
BOOL DMA_Large_routine(void *startAddress, DWORD transferCount,
    BOOL fDirection)
{
    DWORD dwPagesNeeded = transferCount / 4096 + 2;
    WD_DMA *dma=calloc
        (sizeof(WD_DMA)+sizeof(WD_DMA_PAGE)*dwPagesNeeded,1);
    dma->pUserAddr = startAddress;
    dma->dwBytes = transferCount;
    dma->dwOptions = DMA_LARGE_BUFFER;
    dma->dwPages = dwPagesNeeded;
    // lock region in memory
    WD_DMA Lock(hWD, &dma);
    // the rest is the same as in the DMA_routine()
    // free the WD_DMA structure allocated
    free (dma);
}
```

## Windows 2000

1. Use DriverWizard to generate an INF file for your card / device (the INF file includes your device VID/PID and loads WDPNP.SYS as your device driver).
2. Save the file under C:\temp\mydevice.INF (or any other name or location you choose). For instructions on how to generate the INF file, see Chapter [The DriverWizard](#) that explains the DriverWizard.
3. Go to: **Start | Settings | Control Panel |System**.
4. Click the '**Device Manager**' option in the "**Hardware**" tab.
5. Now select the **View Devices by connection** option.
6. For PCI cards, navigate to **Standard PC | PCI bus |<your\_card>**.
7. For USB devices: navigate to **Standard PC | PCI bus |PCI to USB Universal Host Controller | USB Root Hub |<the current driver for the device>**.
8. Select **Action | Properties**.
9. Click the '**Update Driver**' button in the "**Driver**" tab.
10. In DriverWizard: click on the '**Next**' button.
11. Select "**Search for a suitable driver for my device**" option by clicking on the appropriate radio button.
12. Click the "**Next**" button
13. Check the "**only Specify a location**" check-box
14. Click the "**Next**" button
15. Enter the path: **c:\temp\<your .INF file>**in the input box that is displayed.
16. Click the "**OK**" button
17. Click the "**Next**" button



18. Click the "**Finish**" button

19. Reboot

## Windows 95/98/ME

1. Use DriverWizard to generate an INF file for your card / device (the INF file includes your device VID/PID and loads WDPNP.SYS as your device driver).
2. Save the file under C:\temp\mydevice.INF (or any other name or location you choose). For instructions on how to generate the INF file, see Chapter [The DriverWizard](#) that explains the DriverWizard.
3. Go to: **Start | Settings | Control Panel |System**.
4. Now select the **View Devices by connection** option.
5. For PCI cards, navigate to **Standard PC | PCI bus |<your\_card>**.
6. For USB devices: navigate to **Standard PC | PCI bus |PCI to USB Universal Host Controller | USB Root Hub |<the current driver for the device>**.
7. Select **Properties**.
8. Click the '**Update Driver**' button in the "**Driver**" tab.
9. Click the "**Next**" button
10. Check the "**only Specify a location**" check-box
11. Click the "**Next**" button
12. Enter the path: **c:\temp\<your .INF file>**in the input box that is displayed.
13. Click the "**OK**" button
14. Click the "**Next**" button
15. Click the "**Finish**" button
16. Reboot





