Driver Manual

CIF Device Driver

Windows

V1.xxx ... V3.2xx

Hilscher Gesellschaft für Systemautomation mbH

www.hilscher.com

DOC030501DRV14EN | Revision 14 | English | 2013-02 | Released | Public

Table of Contents

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1 Introduction

1.1 About this Document

This manual describes the application programming interface (API) to our communication boards. The interface is designed to give the user an easy access to all the communication board functionality.

1.2 List of Revisions

Rev	Date	Version	Name	Chapter	Revision
12	2010-02-08	3.210	MT		Support for Vista (32/64Bit) / Windows 7 (32/64Bit) added - CIFNTDLL / CIF95DLL only available for Win9X and NT - Driver installation splitted into Win 9x/NT, Windows 2000/XP/Vista/7 32 Bit and Windows Vista/7 64 Bit Section *List of Error Numbers*: Hints integrated into *Table 20.*
13	2011-10-20	3.280	RM	5.1 5.2.1 7	New chapter *Windows Operating System Timing Behaviour* added - Information about Windows driver time issues added - Diagrams with access times added Content description of the DRVPRG directory updated. Information about functions with performance improvements added.
14	2013-02-27	3.290	RM	All	Support for Windows 8 (32/64 Bit) added.

Table 1: List of Revisions

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1.3 Operating Systems

- On **DOS** and **Windows 3.xx** systems, we are offering a C-function library or DLL (Windows 3.xx). There is no device driver used to get access to the communication boards.
- For **Windows 9x, Windows NT and Windows 2K/XP/Vista/7/8** we are using device drivers. These drivers are running in the kernel (Ring 0) of the operating system. The communication between the application and the driver is done by a DLL. This DLL can be statically or dynamically linked to the application.

1.4 Data Transfer

On the communication boards, we distinguish between two types of data transfer.

- The first one is the **message oriented data transfer** used by message oriented protocols.
- The second one is the data exchange with **process images** from I/O based protocols.

1.5 Terms for this Manual

Term	Description
DPM	DPM **D**ual-**P**ort **M**emory, this is the physical interface to all communication board (DPM is also used for PROFIBUS-**DP M**aster)
CIF	**C**ommunication **I**nter**F**ace
COM	**CO**mmunication **M**odule
HOST	Application on the PC or a similar device
DEVICE	Synonym for communication interfaces or communication modules
RCS	**R**eal-time **C**ommunicating **S**ystem, this is the name of the operating system that runs on the communication boards
DLL	**D**ynamic **L**ink **L**ibrary
WDM	**W**indows **D**river **M**odel

Table 2: Terms for this Manual

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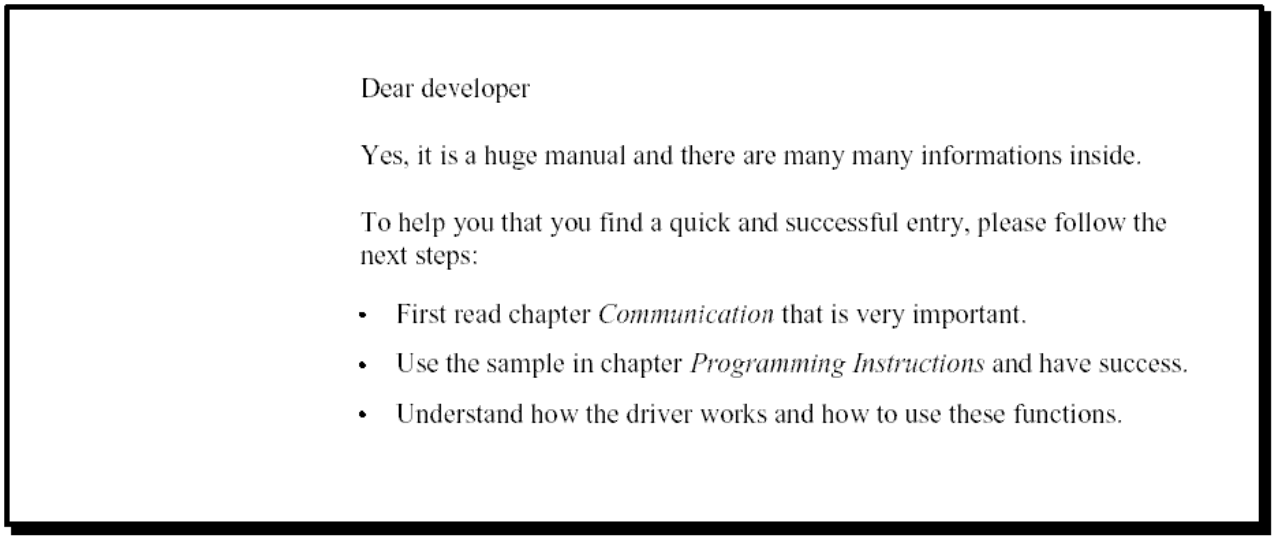
2 Getting Started

This section describes how to configure a CIF device and how to check a configuration which already exists on the CIF hardware against an application local configuration.

Usually a fieldbus configuration is created and checked by SyCon (**Sy**stem **Con**figurator). After creating a valid configuration SyCon is able to export the configuration into a database file (.DBM). This exported file can be used in the driver to run the automatic database checking and download (see *DevInitBoard()* function). By using this functionality, an application can always be sure the CIF card is correctly configured.



If an applications generates an own configuration (mostly SoftPLCs) it could be necessary to compared it against an actual CIF configuration. To enable a configuration check in such cases, the external C module CifConfiguration.c can be used. This module includes all necessary functions to read the actual configuration from the hardware and to compare it against an application local configuration.

Overview

- Chapter *Communication* includes general definitions and describes the fundamentals about data transfers between an application and the communication boards.
- The features of the driver for Dos and Windows 3.xx is described in chapter *DOS/Windows 3.xx Function Library.*
- Chapter *The Device Driver* describes an overview, the installation and configuration of the device driver for Windows 9x, Windows NT, Windows 2K/XP/Vista/7/8 and Windows CE.
- The important chapter *Programming Instructions* describes the basic functionality of using the device driver and presents an example.
- All functions of the device driver are explained in chapter *The Application Programming Interface*.
- Chapter *Error Numbers* lists a detail description of the error numbers
- Chapter *Development Environments* informs about the Microsoft and Borland development tools.

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3 Communication

3.1 About the User Interface

3.1.1 Message Interface and Process Data Image

There are two ways of data transfer between the HOST and the DEVICE:

- **Message oriented data transfer**
  Telegram oriented protocols like PROFIBUS-FMS the data transfer happens with messages, which will be send or received over two mailboxes in the dual-port memory. There is one mailbox for each direction (Send direction and receive direction). Normally, the data transfer will be controlled by events.
- **Process data image transfer**
  In fieldbus systems, which handle input and output data, like PROFIBUS-DP or InterBus-S, there is a data image of the process data inside the dual-port memory. Input data and output data have their own area and the data transfer normally happens cyclic.

3.1.2 The Protocol Dependent and Independent User Interface

The user interface via the dual-port memory of the communication interface and the communication module has two parts, a protocol dependent, and a protocol independent part.

The protocol independent part of the dual-port memory is the main part of the data between HOST and DEVICE.

The particular protocol dependent part are the parameters for initializing the protocol and the message structure for exchanging jobs between the HOST and the DEVICE. These jobs are called messages. The structure of a message has reached a high standard. This means that changing to another protocol is very simple.

The exactly composition of a message is described in the particular protocol manual. The difference between the various protocols are only the protocol parameters. The data model of the dual-port memory and the mechanism of message exchange are always the same.

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3.2 Interface Structure

The interface to the communication board is based on a dual-port memory. The following picture shows the various parts of the dual-port memory.

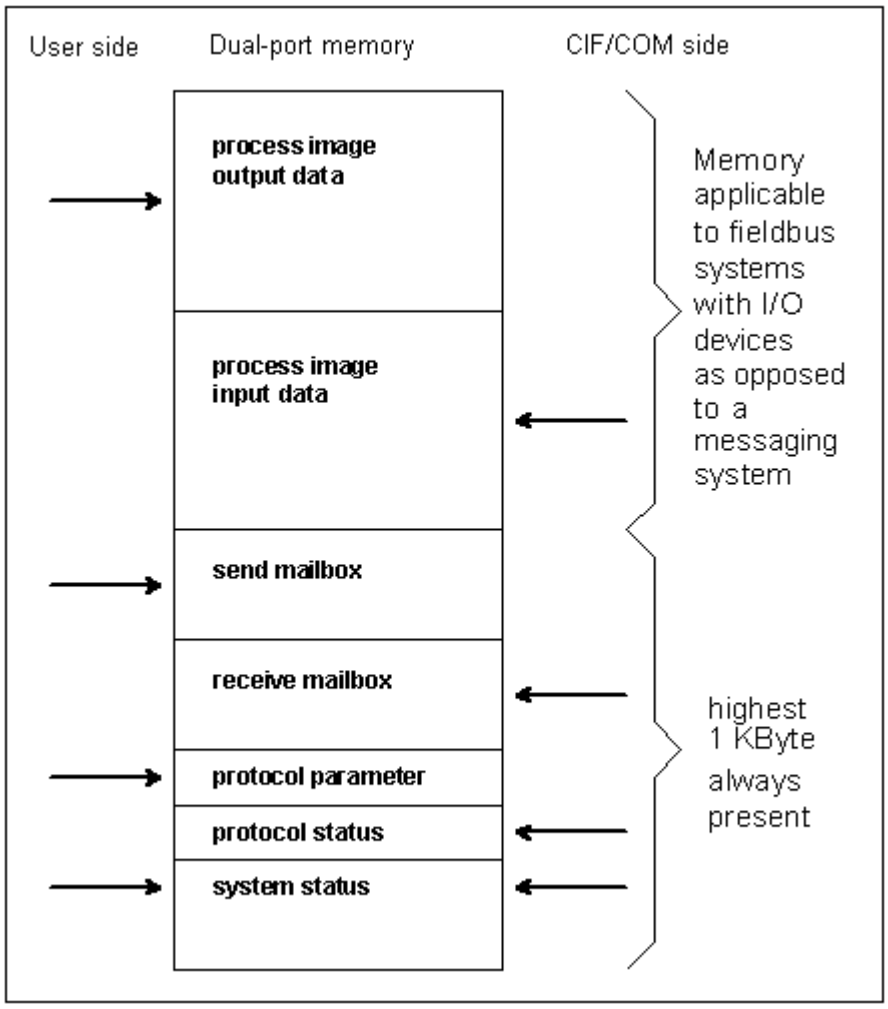

Figure 1: Interface Structure

One dual-port memory map for all CIFs/COMs and all protocols with

- Process image for input and output data
- Two mailboxes for message communication
- Parameter area for simple protocols (baudrate, data bits, parity ...)
- Protocol status information (telegram counter, last error, valid slaves...)
- System status (firmware name/version, CIF revision/serial number...)

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3.3 Message and Process Data Communication

3.3.1 Message Communication

A message is a unique data structure in which the user transmits or receives commands and data from the CIF or COM.

A message consists of an 8 byte message header, an 8 byte telegram header and up to 247 bytes of user data.

- **Message Header** Used from operating system for transportation of the message. It is defined in this manual and constant for the application.
- **Telegram Header** Defines the action for the protocol task
- **User data** Send/received data

Parameter	Type	Meaning	
Msg.Rx	byte	Number of Receiving Task	Message Header
Msg.Tx	byte	Number of Sending Task	
Msg.Ln	byte	Number of Data length	
Msg.Nr	byte	Number of Message for Identification	
Msg.A	byte	Number of Responses	
Msg.F	byte	Error Code	
Msg.B	byte	Number of Command	
Msg.E	byte	Completion	
Msg.DeviceAdr	byte	Communication Reference	Telegram Header
Msg.DataArea	byte	Data Block	
Msg.DataAdr	word	Object Index	
Msg.DataIdx	byte	Object Subindex	
Msg.DataCnt	byte	Data Quantity	
Msg.DataType	byte	Data Type	
Msg.Fnc	byte	Service	
Msg.D[0-246]	byte	User Data	Telegram User Data

Table 3: General structure of a message

The meaning of the telegram header is an example for PROFIBUS-FMS. For other protocols the structure is the same but, the parameters change as for example with Modbus Plus, from communication reference to slave address, object index to register address or service to function code.

The driver transfers a message independent from the protocol and works transparent. The message reproduces the telegram.

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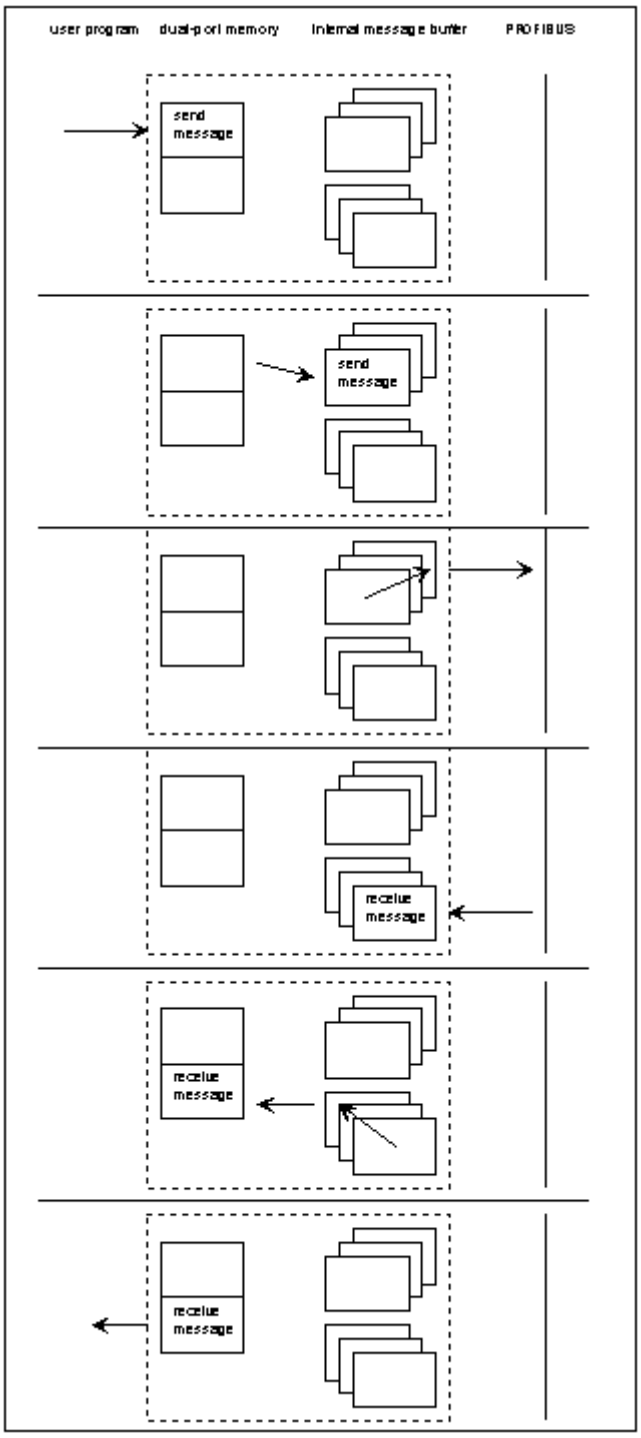
3.3.1.1 Sending (Putting) and Receiving (Getting) Messages



The user creates the send message and writes it in the send mailbox. This message is set to be send by the `DevPutMessage()` command.

The device takes out the message, puts it in an internal queue and signals this action to the HOST.

The queue is handled by the FIFO principle. If the message is on the first position, it will be decoded to generate the send telegram.

If the device receives the acknowledge telegram, it generates a receive message and puts it in the queue.

If the message is in the first position and the receive mailbox is empty, the message will be copied in the mailbox and set valid.

The user takes out the receive message, with the `DevGetMessage()` command, which sets the mailbox state to empty.

Figure 2: Sending (Putting) and Receiving (Getting) Messages

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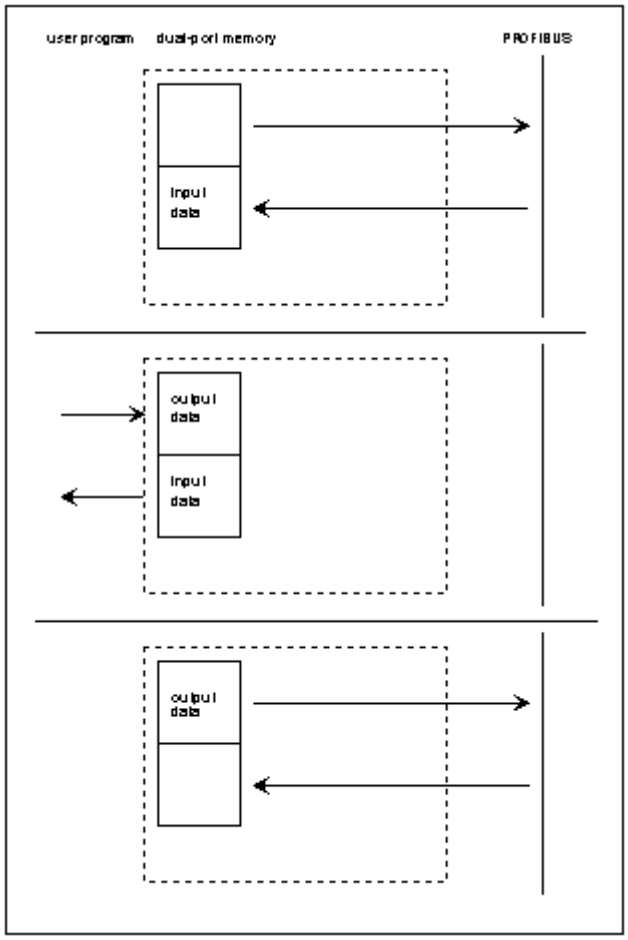
3.3.2 Communication with a Process Image

In fieldbus systems with IO devices like PROFIBUS-DP or InterBus-S there is a process image of the IO data available directly in the dual-port memory. The access is the same if the CIF or COM works as master or slave. Depending on the application the user can choose between several handshake modes, or if only byte consistence is required, the user can read and write without any synchronization.

3.3.2.1 Direct Data Transfer, DEVICE Controlled



The CIF/COM starts by itself a data exchange cycle if it is a master, or it receives a data exchange cycle if it is slave.

Now the user can read the new input data and write the output data in the dual-port memory.
This is done by the `DevExchangeIO()` function.

The CIF/COM starts the next data exchange cycle.

Figure 3: Direct Data Transfer, DEVICE Controlled

Typical application: Slave system, which must guarantee that the data from every master cycle must be given to the user program.

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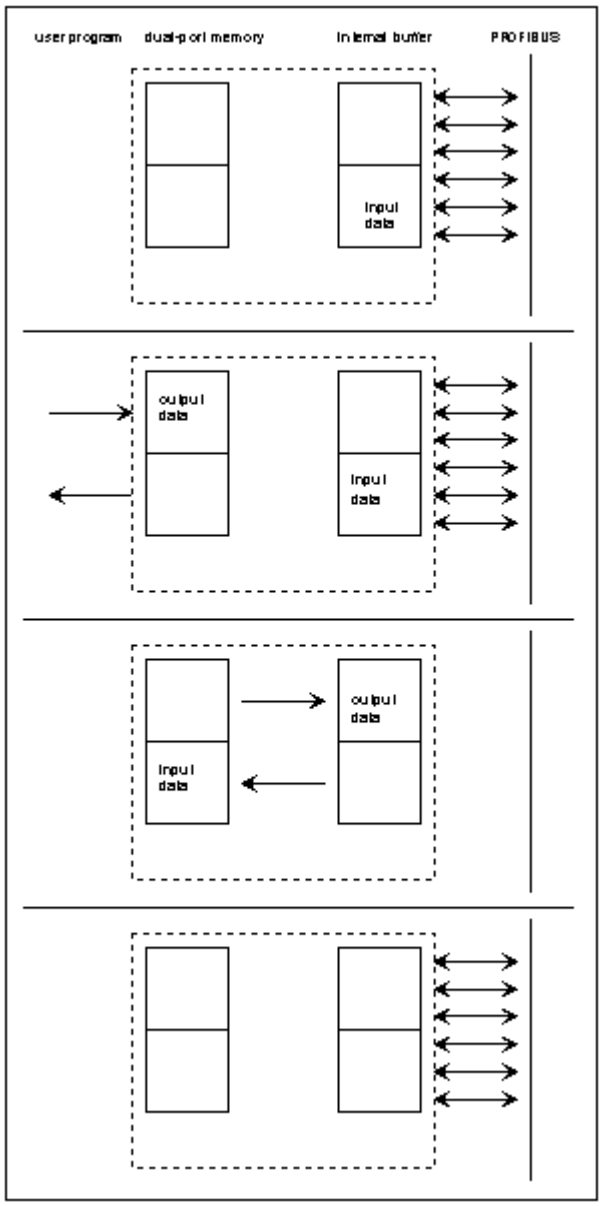
3.3.2.2 Buffered Data Transfer, DEVICE Controlled



CIF/COM makes cyclic data exchanges on the bus.

After each data exchange the CIF/COM checks, if the dual-port memory is available.

The user can read out the input data and write the new output data.
This is done by the `DevExchangeIO()` function.

If there was one data exchange on the bus in the meantime, the CIF/COM exchanges the data between the internal buffer and the dual-port memory.

Figure 4: Buffered Data Transfer, DEVICE Controlled

Typical application: Slave system, where the slave gets an interrupt with the next data exchange cycle.

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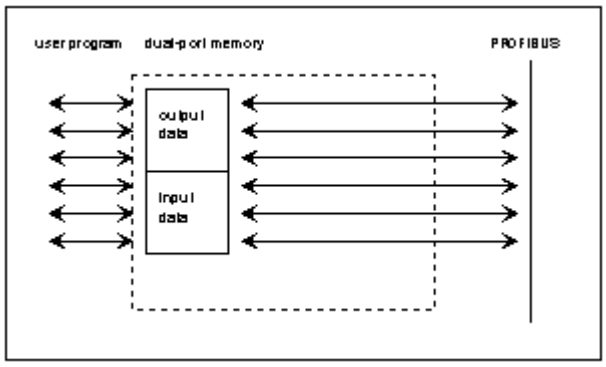
3.3.2.3 Uncontrolled Direct Data Transfer



The user reads and writes the process image, with the `DevExchangeIO()` function, at the same time like the CIF/COM.
The CIF/COM does cyclic data exchanges and after every exchange it makes an update of the process image.

Figure 5: Uncontrolled Direct Data Transfer

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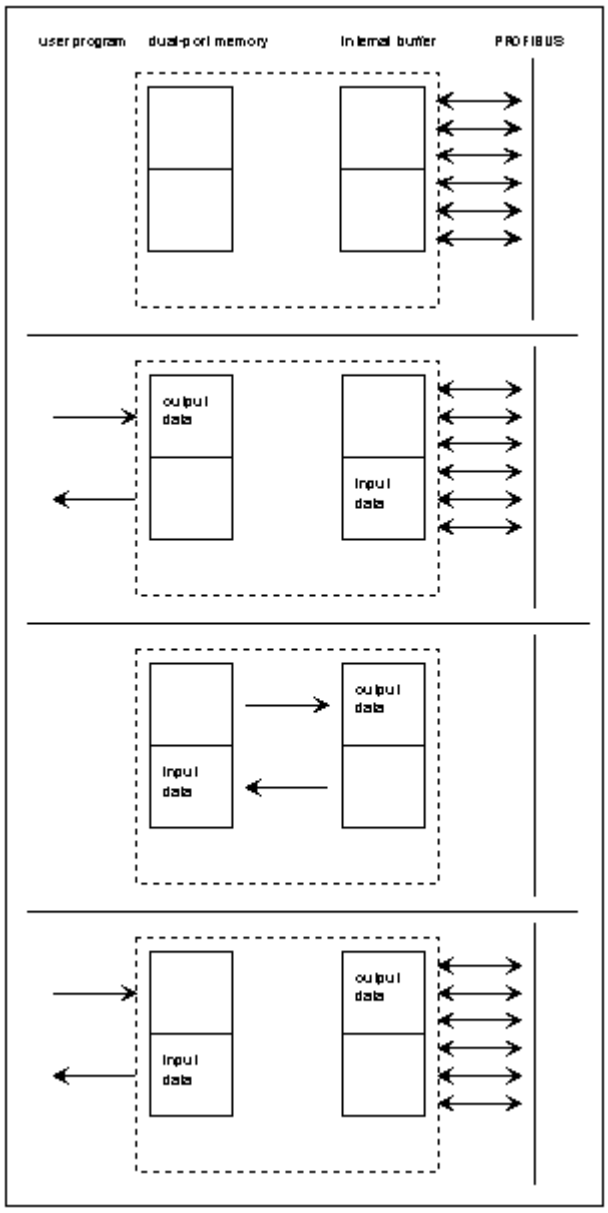
3.3.2.4 HOST Controlled, Buffered Data Transfer



Cyclic data exchange between internal buffer and PROFIBUS.

User reads last input data and writes new output data, with the `DevExchangeIO()` command.

Data exchange continues.

CIF stops data exchange, puts the output data in the internal buffer and the latest input data in the dual-port memory.

User reads input data and writes output data `DevExchangeIO()`.

Figure 6: HOST Controlled, Buffered Data Transfer

Typical application: Easiest handshake in master and slave systems with a guaranteed consistence of the complete process image.

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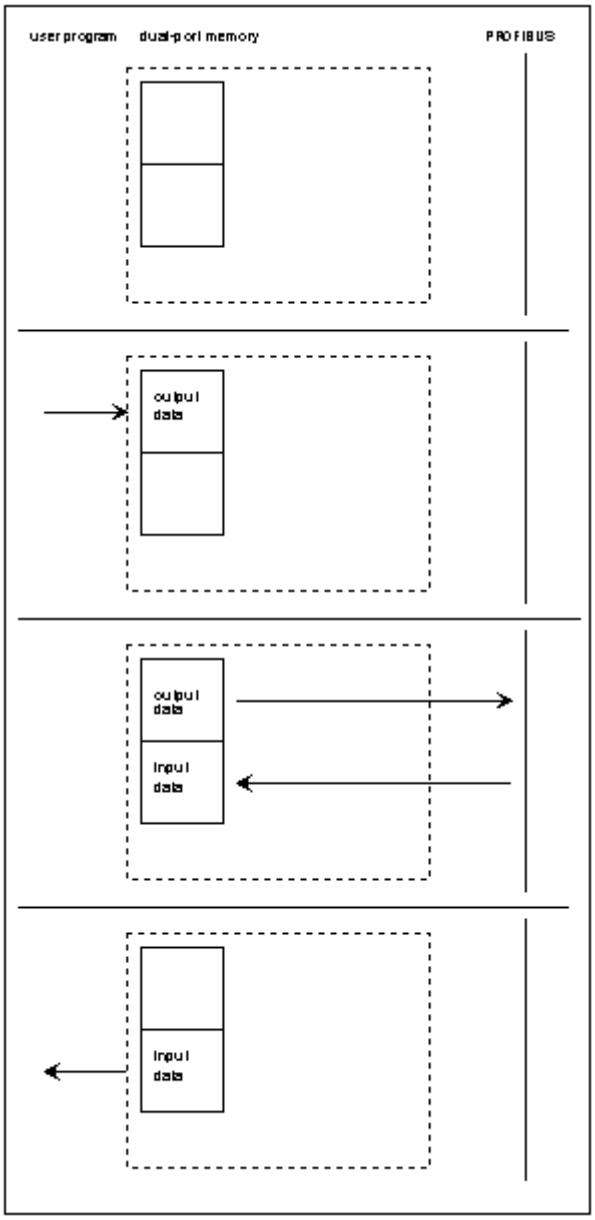
3.3.2.5 HOST Controlled, Direct Data Transfer



No data exchange.

User writes new output data, with the `DevExchangeIO()` command.

CIF/COM starts one data exchange with the output data from the dual-port memory and writes the new input data in the dual-port memory.

User reads new input data with the next `DevExchangeIO()` command.

Figure 7: HOST Controlled, Direct Data Transfer

Typical application:Master system with synchronous IO devices.

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3.3.3 Overview

The following table list the bus systems and protocols and shows which communication has to be used for the **(user) data transfer**.

I/O Communication	Message Communication	
	Read/Write	**Send/Receive**
PROFIBUS-DP Master	PROFIBUS-DPV1	-
PROFIBUS-DP Slave	PROFIBUS-DPV1	-
-	PROFIBUS-FMS	-
-	PROFIBUS-FDL FDL defined	PROFIBUS-FDL FDL transparent
InterBus Master (I/O)	InterBus Master (PCP)	-
InterBus Slave (I/O)	InterBus Slave (PCP)	-
CANopen Master (PDO)	CANopen Master (SDO)	-
CANopen Slave (PDO)	CANopen Slave (SDO)	-
DeviceNet Master (I/O)	DeviceNet Master (Explicit Messaging)	-
DeviceNet Slave (I/O)	DeviceNet Slave (Explicit Messaging)	-
ControlNet Slave (Scheduled Data)	ControlNet Slave (Unscheduled Data)	-
SDS Master	-	-
AS-Interface Master	-	-
-	-	3964R
-	RK512	-
-	ASCII (Master mode)	ASCII (Slave mode)
-	Modbus RTU	-
-	Modbus Plus	-
-	-	Modnet 1/N
-	-	Modnet 1/SFB

Table 4: Bus Systems/Protocols and Communication for Data Transfer

Note 1:

- For IO communication the driver function DevExchangeIO() is necessary.
- For message communication the driver function DevPutMessage() and DevGetMessage() are necessary.

Note 2:

- The list above documents the user data.
- The bus systems and the protocols also offer possibilities of diagnostic, parameter telegrams, control telegrams and more. These are not listed above.

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3.4 The Software Structure on the Communication Boards

The software is based on an extremely modular architecture. The protocol itself is a self-contained module which has no variables in common with any other software module apart from the operating system. It is therefore possible to implement the protocol with the same software module on all our boards, thus ensuring the greatest software quality.

The main parts of the firmware are the real-time operating system and the protocol task(s).

3.4.1 The Real-Time Operating System

The operating system can manage 7 tasks, and is optimized for real-time communications services. It provides the following functions:

- Distribution of computing time among the individual-tasks
- Task communication
- Memory management
- Provision of time functions
- Diagnostic and general management functions
- Transmit and receive functions

The computing time is evenly distributed by the operating system among all tasks ready to run. A task switch, i.e. switch over to the next task, takes place in cycles every millisecond.

If a task has to wait for an external event, e.g. for the receipt of data, it is no longer ready to run and a task switch is performed immediately.

The available computing time and the maximum possible sum baud rate make sure, that a less prior task is not completely blocked by a high priority task. Presumably the data through put is lower in this case.

Communication between the tasks takes place by messages. These are the areas of memory made available by the operating system into which the tasks write data. Transport of messages from one task to another and notification to a task that a message is there is handled by the operating system.

The operating system also manages the memory area for storage of the tasks and their stack. Individual tasks can be deleted or reloaded.

A task can wait for an event and the operating system will restart the task when the event has occurred, the time resolution is 1 millisecond.

The operating system can stop or start individual tasks and pass on certain jobs to them. The tasks thus make available data in the trace buffer which is managed by the operating system.

The operating system communicates with the HOST (PC or a similar device) via the dual-port memory interface. There is access to the individual-operating system functions and to the individual tasks via the communications system.

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3.4.2 The Protocol Task

The protocol task is responsible for transmission of the data in accordance with the protocol. The parameters it requires for this are taken from the dual-port memory or from the FLASH-memory.

A transmit job is always initiated with a message. This contains all the data to be transmitted. These are provided with any control characters and checksums required and then output by interrupt or DMA. At the same time, the corresponding monitoring periods are started. When the data has been transferred or an error has occurred, a corresponding acknowledgment is returned to the sender of the message.

Depending on the protocol, receive messages are restored after the transmission. Receiving is done by interrupt or DMA. If a message has been received without error, it is passed on by message to the PC via the dual-port memory interface.

I/O oriented protocol tasks work on the bus independently according to the given protocol specification. The data transfer is not done by a message, but is done by direct reading or writing to the send and receive data in the dual-port memory.

As the protocol task runs independently, a wide variety of protocols can be implemented on the CIF, PC/104 or COM by replacing this task. Different tasks can also be used for the two serial interfaces.

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4 DOS/Windows 3.xx Function Library

The DOS/Windows 3.xx function library includes all necessary functions to make an application working with a communication device. The interface is the same as used by the device drivers, so an upgrade to this driver will be very easy. On a DOS/Windows 3.xx system there is no interrupt handling of the communication boards available.

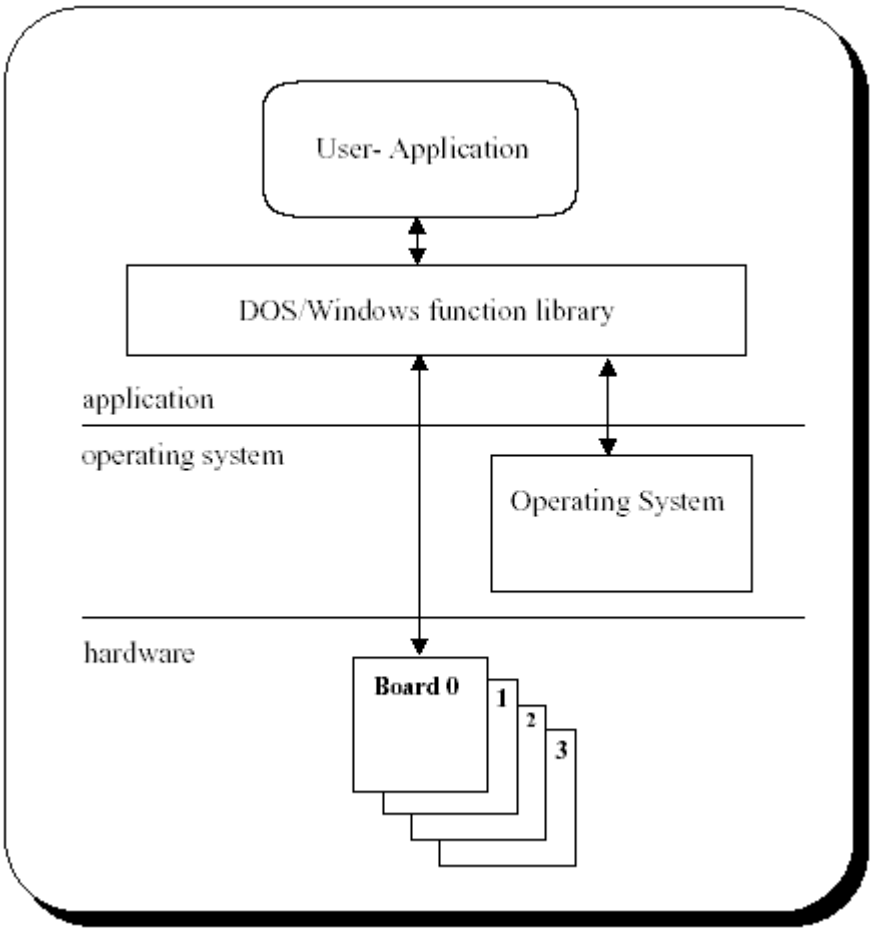

Figure 8: DOS/Windows 3.xx Function Library

Function overview

DOS/Windows 3.xx

- Handles up to four communication board
- Libraries are compiled in the LARGE-Memory model
- Available as a Windows 3.xx DLL
- ANSI C compatible source code available

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Some functions are only for compatibility with the device driver like `DevOpenDriver()`, `DevCloseDriver()` and `DevGetDriverInfo()`. These function do nothing when used in a Windows 3.xx environment.

The following development platforms are used:

DOS	Microsoft Visual C++, V 1.5x
WINDOWS	Microsoft Visual C++, V 1.5x

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4.1 Toolkit Contents

The whole DOS/Windows 3.xx source code and library files are located on our System Software CD, in the \DRVPRG\16Bit directory.

This directory contains a number of subdirectories.

Directory structure:

CD Path: DRVPRG		
Header	- DUALPORT.H definition of the communication interface dual port memory structure - RCS_USER.H definitions for the communication interface operating system (RCS) - Fieldbus specific header files	
CD Path: DRVPRG\16Bit		
Subdirectory	**Description**	**Description**
DLL	Windows 3.xx DLL (CifWinDl.DLL)	
LIB	Function library for DOS (CifDOS.lib) and Windows 3.xx (CifWin.lib)	Windows 3.xx DLL (CifWinDl.DLL)
PRG	Function library source code and header files	Windows 3.xx DLL (CifWinDl.DLL)
CD Path: DRVPRG\16Bit\Demo		
Subdirectory	**Description**	**Description**
C	Simple Message and IO data transfer source code example (Demo.c)	Simple Message and IO data transfer source code example (Demo.c)
ASi	Simple AS Interface IO-View example	Simple AS Interface IO-View example
CANOpen	Simple CANopen IO-View example	Simple CANopen IO-View example
CtrlNet	Simple ControlNet IO-View example	Simple ControlNet IO-View example
DevNet	Simple DeviceNet IO-View example	Simple DeviceNet IO-View example
InterBus	Simple InterBus IO-View example	Simple InterBus IO-View example
Profibus\IOVIEW	Simple PROFIBUS IO-View example	Simple PROFIBUS IO-View example
Profibus\FMS	Simple PROFIBUS FMS example	Simple PROFIBUS FMS example
SDS	Simple SDS IO-View example	Simple SDS IO-View example
VBasic30	Visual Basic 3.0 demo program including the definition file CIFDEF.BAS	Visual Basic 3.0 demo program including the definition file CIFDEF.BAS

Table 5: Toolkit – Directory Structure

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4.1.1 Toolkit File Description

The DOS library files

CIFDOS.LIB	Function library of the user interface

The Windows 3.xx files

CIFWINDL.DLL	Dynamic Link Library
CIFWINDL.LIB	DLL library file
CIFWIN.LIB	C-Function library

Common DOS and Windows 3.xx files

CIFUSER.H	Header file of the user interface
CIF_DPM.C	Function library source code
CIFWINDL.DEF	Function export definitions for the Windows 3.xx DLL
DPMI.C	Memory allocation functions for Windows 3.xx
DEMO.C	Source file of the demo program, demonstrates the use with a simple communication protocol.
DEMO.H	Include file of the demo program

Demo program

DOS_DEMO.EXE	Demo program for DOS (created from DEMO.C)
WIN_DEMO.EXE	Test program for Windows 3.xx (created from DEMO.C)

4.2 Using with DOS and Windows 3.xx

The difference between the Windows 3.xx and the DOS functions is the access to the DPM (dual ported RAM) of the communication board.

With DOS the access is a simple address which can be loaded to a pointer.

Windows 3.xx normally does not allow direct memory access. To get access, the DPMI (DOS Protected Mode Interface) of Windows 3.xx is used. The memory will be allocated in the function `DevInitBoard()` and released in the function `DevExitBoard()`.

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4.3 Using Visual Basic 3.0/4.0 (16 bit)

For Visual Basic 3.0/4.0 16 Bit we have created the file CIFDEF.BAS. This file includes all the necessary definitions to access a communication device by the 16 Bit windows DLL CIFWINDL.DLL.

4.4 Writing an own Driver or Library

To write an own driver or function library, we provide the dual port memory structures in the file DUALPORT.H and the general definitions RCS_USER.H for the operating system (RCS) which is running on the communication device.

4.5 Using the Source Code

Sometimes it is not possible to use the given libraries. Mainly by using real-time DOS environments or other operating systems like Linux, QNX or VxWorks. Therefore we providing the whole source code in the CIF_DPM.C file. This file is used to generate the libraries and DLLs for DOS and Windows. To determine the type of generation, the file includes three definitions (_WINDLL, DRV_WIN and DRV_DOS).

Definition	Description	
_WINDLL	Create a Windows 3.xx DLL - Define APIENTRY and EXPORT for the calling convention of DLL functions. - Generate a LibMain() function as the standard DLL entry point - Use the Windows 3.xx function GetTickCount() to read the system time.	
DRV_WIN	Used in conjunction with _WINDLL - Use Windows 3.xx DPMI (DOS protected mode) function to map the dual ported memory address of the hardware.	
DRV_DOS	Create a standard DOS library or object file - Use the given physical hardware address to access the dual ported memory. - Use ((clock()*1000L)/CLOCKS_PER_SEC) to calculate the actual system time.	Windows 3.xx DLL (CifWinDl.DLL)

Table 6: Using the Source Code

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5 The Device Driver

IMPORTANT NOTE: Windows® is not a deterministic real-time operating system. Any response times to specific hardware or driver functions can not be guaranteed and may differ between different versions of the Windows® operating systems. Furthermore, response times are also depending on the used host hardware, host performance, running services and installed software components.

5.1 Windows Operating System Timing Behaviour

Depending on the system layout and system load the processing speed of driver calls are more or less deterministic. Under specific circumstances the Windows operating will re-schedule running processes which could lead to very long function call durations (factor 10 to 100 higher than average time).

Researching this behavior shows a possible re-scheduling during transition of the driver function call from “User-Space” to “Kernel-Space” or during processing the IRP in kernel mode.

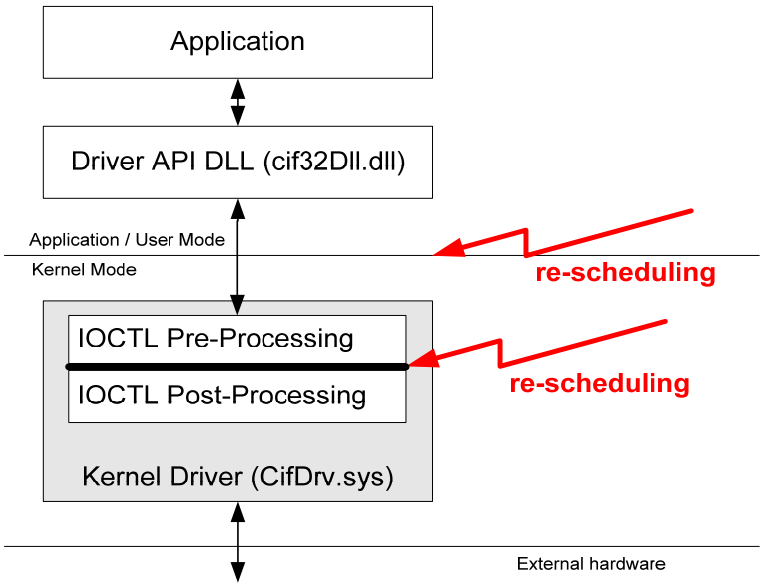

Figure 9: Cif Device Driver – System Architecture

At least, re-scheduling could appear at all stages during the call into the driver. A User-Space, important applications is able to increase its process and thread priority to achieve better performance and lower the impact of other running processes.

At driver level, some of the CIFX API functions, usually used during cyclic device handling, are executed directly at pre-processing stage to prevent re-scheduling.

Both measures are helpful in getting more deterministic function call durations, but there is no 100% guarantee of a deterministic program flow.

Note: Specially handled CIF API functions are marked in function overview table of chapter *The Application Programming Interface* on page 82.

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Access Time Measurements:

Test System	Windows 7 / 64Bit, Intel Core2Duo E6550 2,33 GHz 1 GB RAM
Process Priority	NORMAL_PRIORITY_CLASS
Thread Priority	THREAD_PRIORITY_TIME_CRITICAL
I/O - Cycles	100000, cycle time 1ms
CIFX Device	CIF50-PB (PBCombi V1.208 / Slave: CB-AB32 (2 Bytes In/Out))

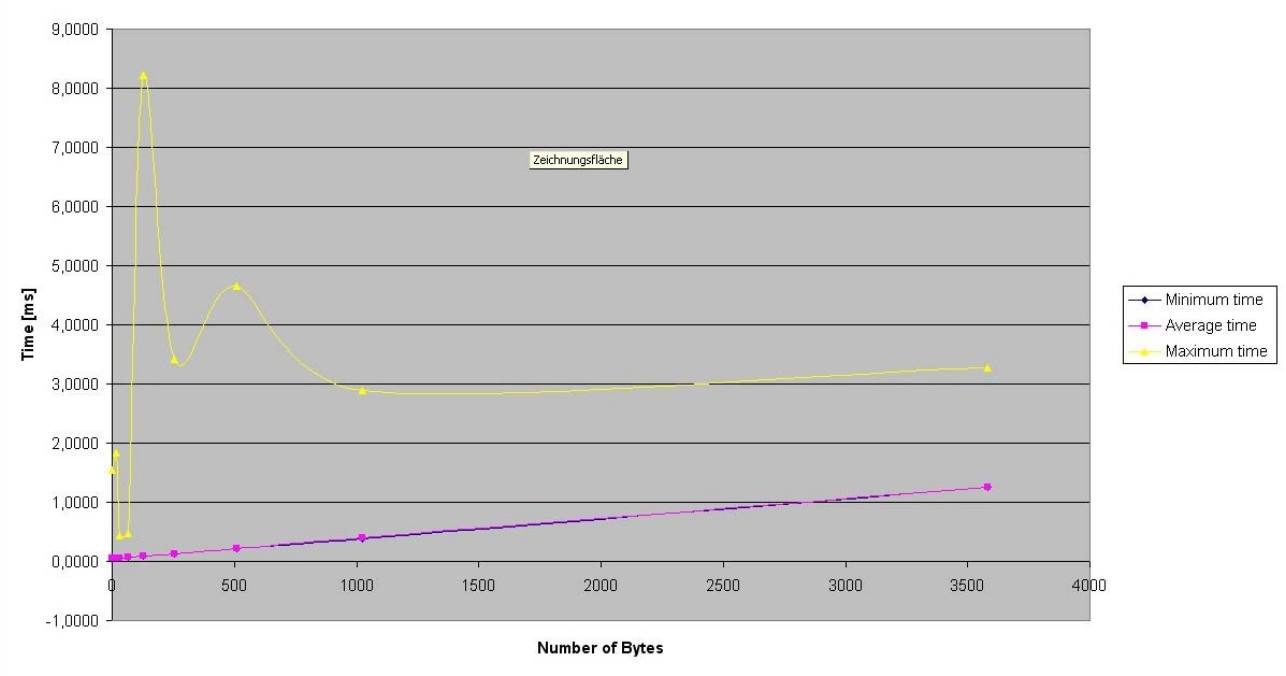

Figure 10: Windows 7 64 Bit with standard IOCTL Handling

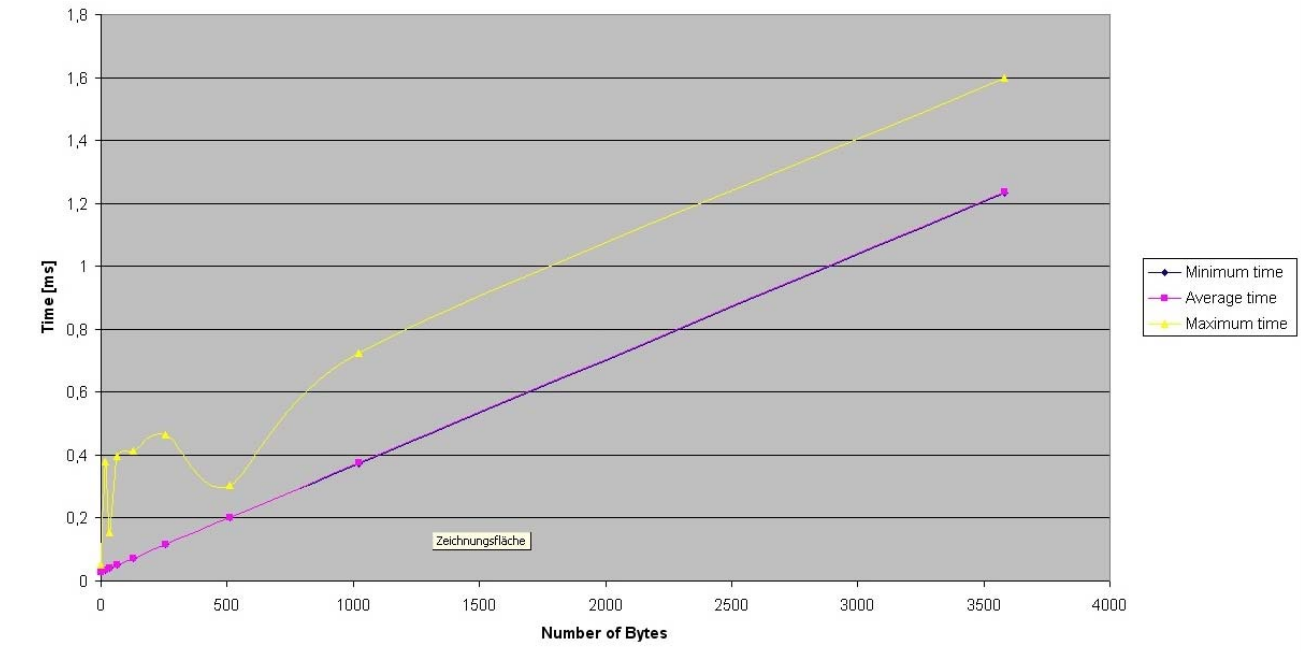

Figure 11: Windows 7 64 Bit with direct IOCTL Handling

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5.2 Windows 9x, Windows NT and Windows 2K/XP/Vista/7/8

The device drivers, also known as VxD (virtual device drivers) or WDM (Windows Driver Model), are running in the kernel of multitasking operating systems like Windows 9x, Windows NT, Windows 2K, XP, Vista, 7 and 8 and offers the best performance for drivers.

The following section describes the internal driver handling and new functions specially designed for some SoftPLC requirements.

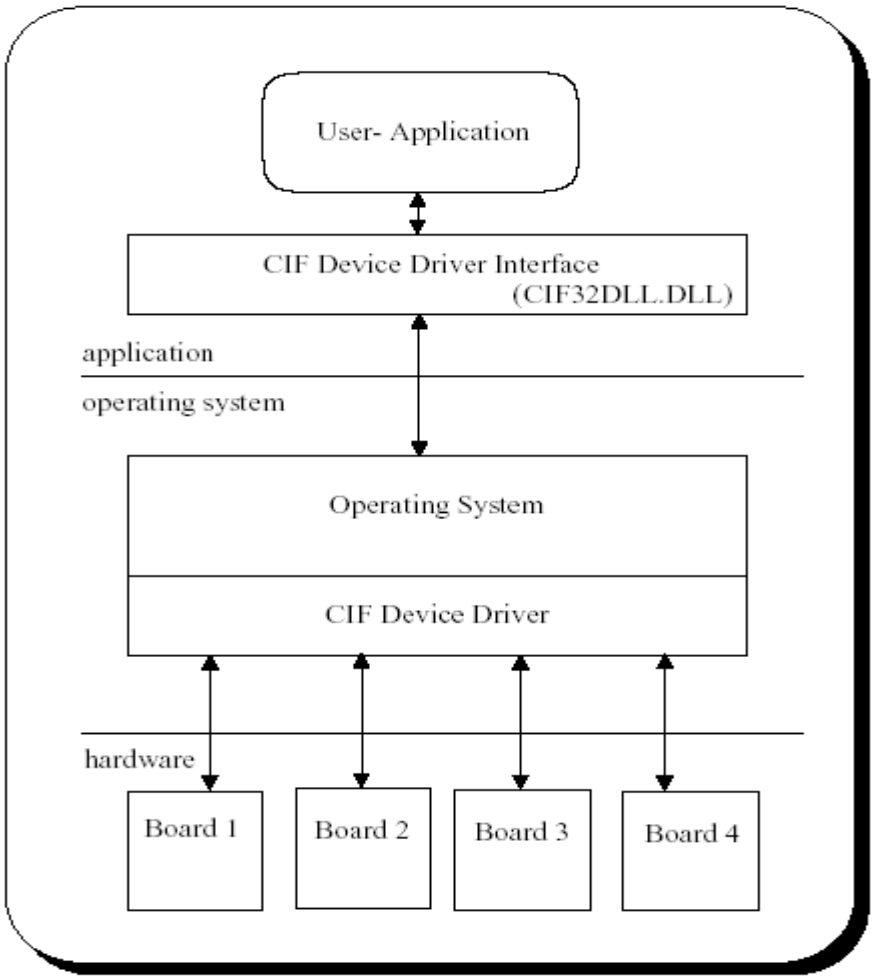

Figure 12: Windows 9x, Windows NT and Windows 2K/XP/Vista/7/8

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Function Overview:

- Handles one to four communication boards at once
- Interrupt and polling mode useable for each board (except PCMCIA)

The device drivers for Windows 9x, Windows NT and Windows 2K/XP/Vista/7/8 can handle up to four communication boards.

All boards can be run in interrupt or polling mode. If interrupt mode is configured for a board the device driver will install an interrupt service function for this board. The driver will install an own interrupt service function for each interrupt driven board. So the boards can be handled independently.

The difference between interrupt and poll mode is only the handling of application request during timeout situations. If an application has to wait for a function (e.g. `DevReset()`) so in interrupt mode the application will be blocked in the driver and the CPU is free to do other work. After the given timeout or at the end of the command, the application is released and does normal executing.

In poll mode the driver will run a **"while loop"**, waiting until the function has finished or the given timeout is reached. The user can also use the functions without timeout (timeout=0) and run the polling by itself.

It is possible to use independent processes for send message (`DevPutMessage()`), receive message (`DevGetMessage()`) and I/O data transfers (`DevExchangeIO()`). Each process will be blocked in the driver when necessary without blocking the other ones.
If threads are used and a function has to wait for a certain operation (timeout parameter unequal 0), the driver blocking mechanism will block each thread which is accessing the driver. This is by design, because all threads in a process are sharing the same driver handle (hidden in the driver API DLL).

A solution is to use timeout=0 in the driver functions and to check the return values if the function is processed without an error. For the message transfer functions (`DevPutMessage()` and `DevGetMessage()`), `DevGetMBXState()` can be used to check if the function can be e executed. immediately.

On each board only one receive (`DevGetMessage()`), one send (`DevPutMessage()`) and one IO-Exchange (`DevExchangeIO()`) command can be active at the same time, because there is no command queuing in the driver implemented. So if one command for the specific function is active, all further commands to the same function will be returned with an error. All other driver functions are reentrant and can be called at every time.

Notice: Switching between pooling mode and interrupt mode is supported by the driver setup program (DrvSetup)

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5.2.1 Contents for Windows 9x, NT and 2K/XP/Vista/7/8

Directory	Sub Directories	Description
DRVPRG	API \ 32Bit	Application Programming Interface, libraries and header files to access the 32 Bit driver interface DLL (the DLL is installed by the driver installation)
	API \ 64Bit	Application Programming Interface, libraries and header files to access the 64 Bit driver interface DLL (the DLL is installed by the driver installation)
	DEMO	C: Simple Message and IO data transfer source code example (Demo.c)
		MSG_DBG: Complete CIF device driver test program written in C++, created with Microsoft Visual C/C++ 6.0
		VBasic32: Visual basic demo program created with Microsoft Visual Basic 4.0 32 bit
	HEADER	C header files for the various fieldbus systems
	MANUALS	Device driver manual and all protocol interface manuals
	FMS_DEMO	Simple 32 bit console application to demonstrate a send and receive message for the PROFIBUS-FMS protocol

Table 7: Directory Structure

Windows 9x, Windows NT, Windows 2K/XP/Vista/7/8 API files:

CIF32DLL.DLL	Dynamic link library of the driver interface, created for use with Windows 9x, Windows NT and Window 2K/XP/Vista/7/8 (CIF95DLL.DLL/.LIB and CIFNTDLL.DLL/.LIB are only used for compatibility with older user applications and only available for Win9x and NT anymore)
CIF32DLL.LIB	Definition file containing the exported function of the CIF32DLL.DLL.
CIFUSER.H	Header file containing the CIF driver user interface definition.
STDINT.H	ISOC99 header file containing standard data type definitions

Device Driver files:

CIFDEV.VXD	CIF Device driver for Windows 9x
CIFDRV.SYS	CIF Device driver for Windows NT or Windows 2000/XP/Vista/7/8

Applications:

DrvSetup.EXE	CIF Device Driver Setup program for registry entries
Msg_dbg.EXE or DrvTest.EXE	CIF Device Driver Test program to run the various device driver functions

Development platform:

Windows 9x / NT4	Microsoft Visual C++, V 6.x
Windows 2K/XP/VISTA/7/8	Microsoft Visual C++, V 6.x or above

Attention: The CIF Device Driver DLL and the driver files are installed during the driver installation and not included in the development directories.

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5.2.2 Installation of the Device Driver

The device driver will be installed by an installation program. This will guide you to the installation process. The installation program will run the following steps:

- Creating the standard registry entries for the CIF Device Driver
- Copying the device driver and interface DLL files
- Copying the device driver setup and test program

5.2.2.1 Standard Registry Entries Windows 9x and Windows NT

Windows 9x registry path:
\HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\VxD

Windows NT registry path:
\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services

CIF Device Driver entry:

CIFDEV - PCISupport 0x00000000 // Enable PCI support
\ Board0
\ Board1
\ Board2
\ Board3

The default entries are:

```
Board0     - BUSType       0x00000000 // ISA, PCI, PCMCIA
           - DPMBase       0x000ca000 // physical dual port address
           - DPMSize       0x00000002 // DPM size in KBytes
           - IRQ           0x00000000 // interrupt of the board
           - PCIIntEnable       0x00000000 // PCI interrupt enabled
Board1     - BUSType       0x00000000 // not assigned
           - DPMBase       0x00000000
           - DPMSize       0x00000000
           - IRQ           0x00000000
           - PCIIntEnable       0x00000000
Board2     - BUSType       0x00000000 // not assigned
           - DPMBase       0x00000000
           - DPMSize       0x00000000
           - IRQ           0x00000000
           - PCIIntEnable       0x00000000
Board3     - BUSType       0x00000000 // not assigned
           - DPMBase       0x00000000
           - DPMSize       0x00000000
           - IRQ           0x00000000
           - PCIIntEnable       0x00000000
```

Note: All entries under the key CIFDEV which are not described here, are created automatically by the used operating system and should not be changed. To show the entries you can use the system program REGEDIT.EXE (located in the Windows 9x\system or Windows NT\system32 directory).

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5.2.2.2 Standard Registry Entries Windows 2K/XP/Vista/7/8

Windows 2K/XP/Vista/7/8 registry path:
\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services

CIF Device Driver entry:
CIFDEV - PCIIntEnable 0x00000000 // Enable PCI interrupt
\ Board0
\ Board1
\ Board2
\ Board3

The default entries are:

```
Board0      - DevActive         // Device avtive
Board1     - DevBUSType         // Bus type (1=ISA,4=PCI,5=PCMCIA)
Board2     - DevErrorDriver     // Driver error
Board3     - DevErrorRCS        // RCS error
           - DevIRQVector       // System IRQ vector
           - DevInfoDeviceNumber     // Device number
           - DevInfoSerialNumber     // Device serial number
           - DevInfoFirmwareName     // Firmware name
           - DevInfoFirmwareDate     // Firmware date
           - DPMBase       // Physical DPM address
           - DPMSize       // DPM size in bytes
           - IRQ           // IRQ
           - PCIError      // PCI error
           - PCIBurstLength     // PCI burst length  (n.c.)
           - PCIBusNumber       // PCI bus number    (n.c.)
           - PCISlotNumber // PCI slot number   (n.c.)
```

Note: All entries under the key CIFDEV which are not described here, are created automatically by the used operating system and should not be changed. To show the entries you can use the system program REGEDIT.EXE (Windows\system32 directory).

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5.2.2.3 Driver File Installation

Device Driver Files:

- Windows 9x The driver file CIFDEV.VXD is copied to %System Root%\System directory.
- Windows NT The driver file CIFDRV.SYS is copied to %System Root%\System32\drivers directory.
- Windows 2000 and later The driver file CIFDRV.SYS is copied to %System Root%\System32\drivers directory.

Device Driver Interface DLLs:

- Windows 9x The driver DLL CIF32DLL.DLL is copied to the %System Root%\System directory.
- Windows NT The driver DLL CIF32DLL.DLL is copied to the %System Root%\System32 directory.
- Windows 2000 and later The driver DLL CIF32DLL.DLL is copied to the %System Root%\System32 directory.

Device Driver Utilities:

- Installation path <System>\Program Files\CIF Device Driver
- DrvSetup Driver setup program
- MSG_DBG or DrvTest Driver test program
- INF files Hardware description for PnP OS installation

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5.2.2.4 Driver Utilities

The driver including a driver setup (DRVSETUP.EXE) and a driver test (MSG_DBG.EXE or DRVTEST:EXE) program. These files are also installed during the installation procedure. Therefore, the installation program creates a CIF Device Driver directory below the standard PROGRAM directory where the files are copied. Also a program folder CIF Device Driver is created.

For the PnP operating systems Windows 9x and Windows 2K/XP/Vista/7/8, additional directories are generated below the CIF Device Driver directory. These directories are holding the INF files which are necessary to install hardware.

5.2.2.5 Device Driver startup

Non PnP device drivers are loaded during system start. During the startup phase, the drivers are reading the configuration data about ISA, PCI and PCMCIA boards from the registry database of the operating system.

The drivers for Windows 2000 and later are fully Plug and Play aware and started as soon as a supported hardware is detected by the operating system.

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5.2.3 Configure the Windows 9x and Windows NT Driver

The user must configure the physical memory address, the size of the DPM and the interrupt number of each communication board.

All these information are written to the registry data base of the operating system. To get an easy access to this data the device driver gets its own setup program DRVSETUP.EXE. This program will help you to change the registry entries without using REGEDIT.EXE. It is also used during installation to configure the communication boards for the first time and it will be copied to your hard disk drive for further use. The program is able to determine the Windows platform and show this in the caption line of the program.

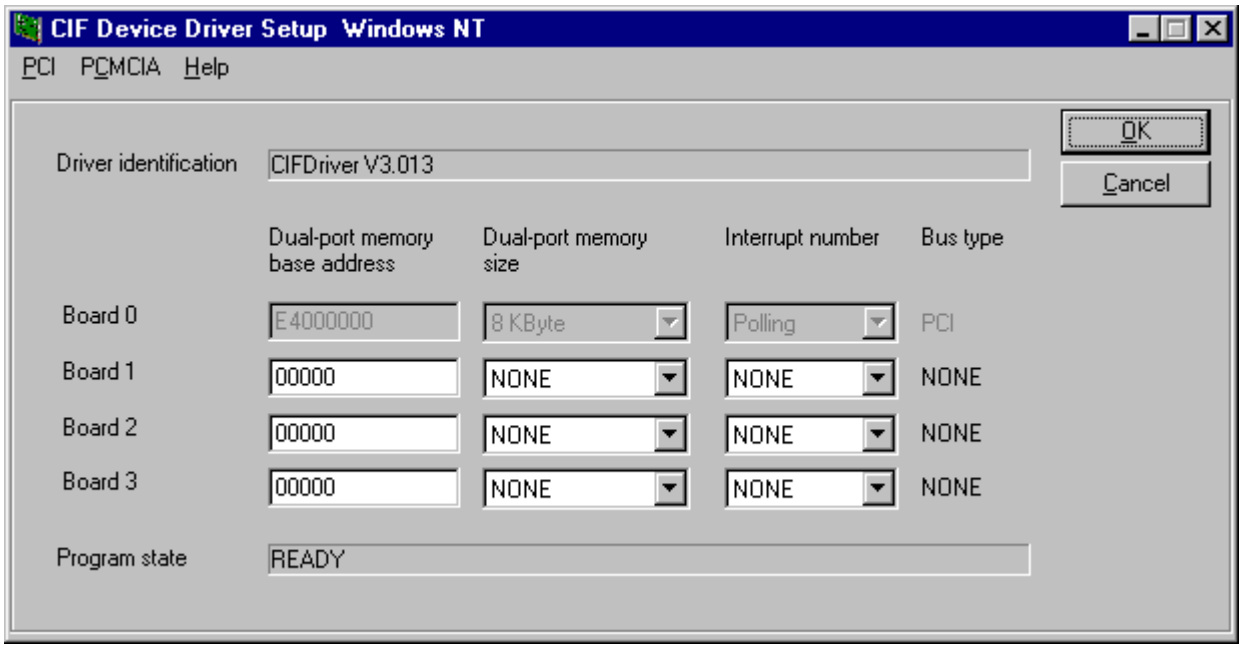

Figure 13: Configuration Window – Windows 9x and NT

Parameter	Description
DPM base address	Physical memory address of the device. A0000 to FF000 in 2 KBytes steps. (CA000, CA800, CB000.....)
DPM size	Physical dual port memory size given in Kbytes. If no entry is defined, the driver uses 2 KBytes as default. NONE = Board not configured 2 KByte = 4096 bytes 8 KByte = 8192 bytes
Interrupt number	Physical interrupt number. NONE = Board not configured POLLING = Driver does not use interrupts (3, 4, 5, 6, 7, 9, 10, 11, 12, 14, 15)

Table 8: Configuration Window – Windows 9x and NT

Notice: Compare the settings you made with the actual jumper settings of the communication board. Invalid entries in the registry, forces the driver to unload itself.

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5.2.4 Configure the Driver under Windows 2K and later

Windows 2K/XP/Vista/7/8 are Plug and Play operating systems. The device settings are done with the Device Manager. PnP devices like PCI and PCMCIA, will be recognized by the operating system, when they inserted in the PC. The Device Manager from Windows will ask for a INF file, which describes the hardware. These files can be found either on the System Software CD (directory Driver\Win_2K_XP_VISTA_7_8) or after running the driver setup program in the <Install Directory>\CIF Device Driver\Win2000_XP_VISTA_7_8.

ISA devices must be inserted manually by the use of the hardware Wizard. An INF file is also necessary and can be found at the above described places.

The driver setup program (DRVSETUP.EXE) for Windows 2K/XP/Vista/7/8 only gives the possibility to global enable or disable interrupt handling for all PCI boards. All other settings must be done by the use of the *Device Manager* and the *Hardware Wizard*.

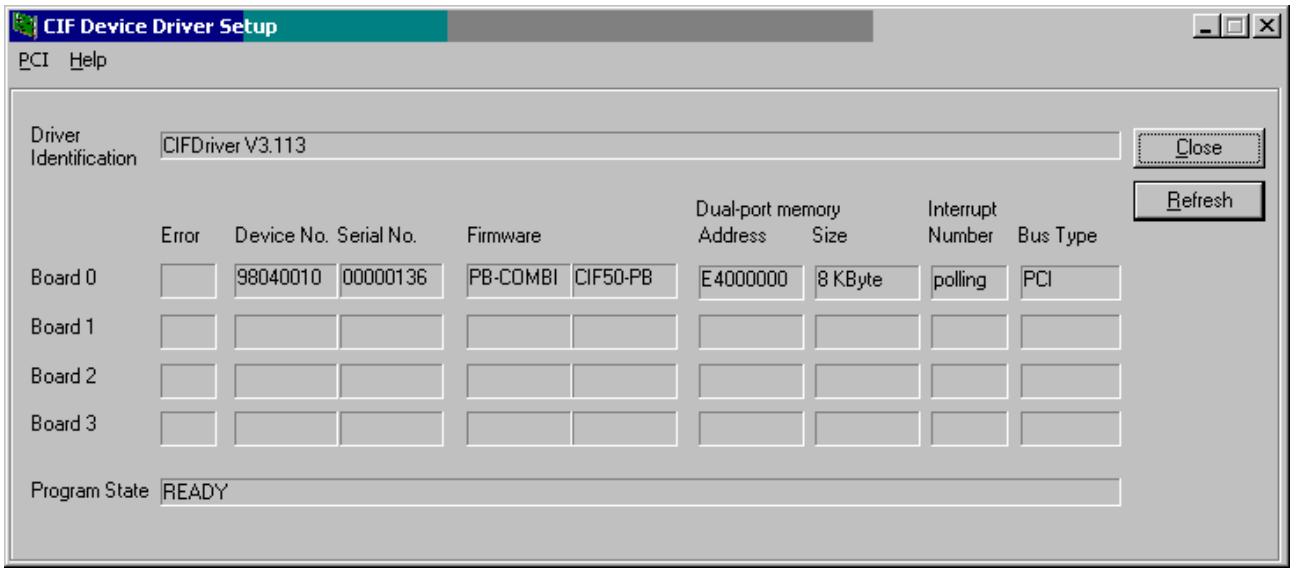

Figure 14: Configuration Window – Windows 2K and later

Notice: For ISA devices you have to make sure the hardware jumper setting corresponds to the software setting. Invalid or different settings can result in undefined system behavior.

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5.2.5 System Startup

Windows 9x and Windows NT:

On Windows 9x and Windows NT PCs, you have to restart the system to load the device driver. Each change to the setting of a device (ISA, PCI, PCMCIA) needs a system restart.

Windows 2000/XP/Vista/7/8:

Windows 2000/XP doesn't need a restart after driver installation. The driver will be automatically loaded if a device is installed.

A system restart is only necessary if either the PCI interrupt setting (polling/interrupt) or the settings of an ISA device is changed.

Startup Information:

- Windows 9x: The driver will show the following lines at system start: **CIF Device Driver Release V x.xxx** After the restart the driver is ready to work.
- Windows NT: Change to the <Control panel> and open <devices>, this should show "CIFDEV started system". You can check the correct installation of the driver by running NT diagnosis 'drivers'. After the restart the driver is ready to work
- Windows 2K/XP/Vista/7/8: Open <Control Panel><Administrative Tool><Computer Management><System Information><Software Environment> <Drivers>. The driver "CIFDEV" will be shown either running or stopped. It should be in the state running, if at least one device is installed. A second indication if the driver is installed and running is a CIF device without any errors in the Device Manager. Because only devices which are accepted by driver will be shown without any errors.

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5.3 Windows CE (up to 5.0)

On Windows CE we distinguish between three drivers to support PCMCIA, ISA and PCI boards. This is done to match the Windows CE specific conditions to the best.

The main difference is the startup procedure between the drivers. PCMCIA and PCI drivers are loaded automatically, by the operating system, using the PnP-ID of the PCMCIA/PCI board if the device is plugged into the system. ISA driver can be loaded at system start or at runtime by an application.

All drivers are loadable drivers which must not be included into the Windows CE kernel (binary).

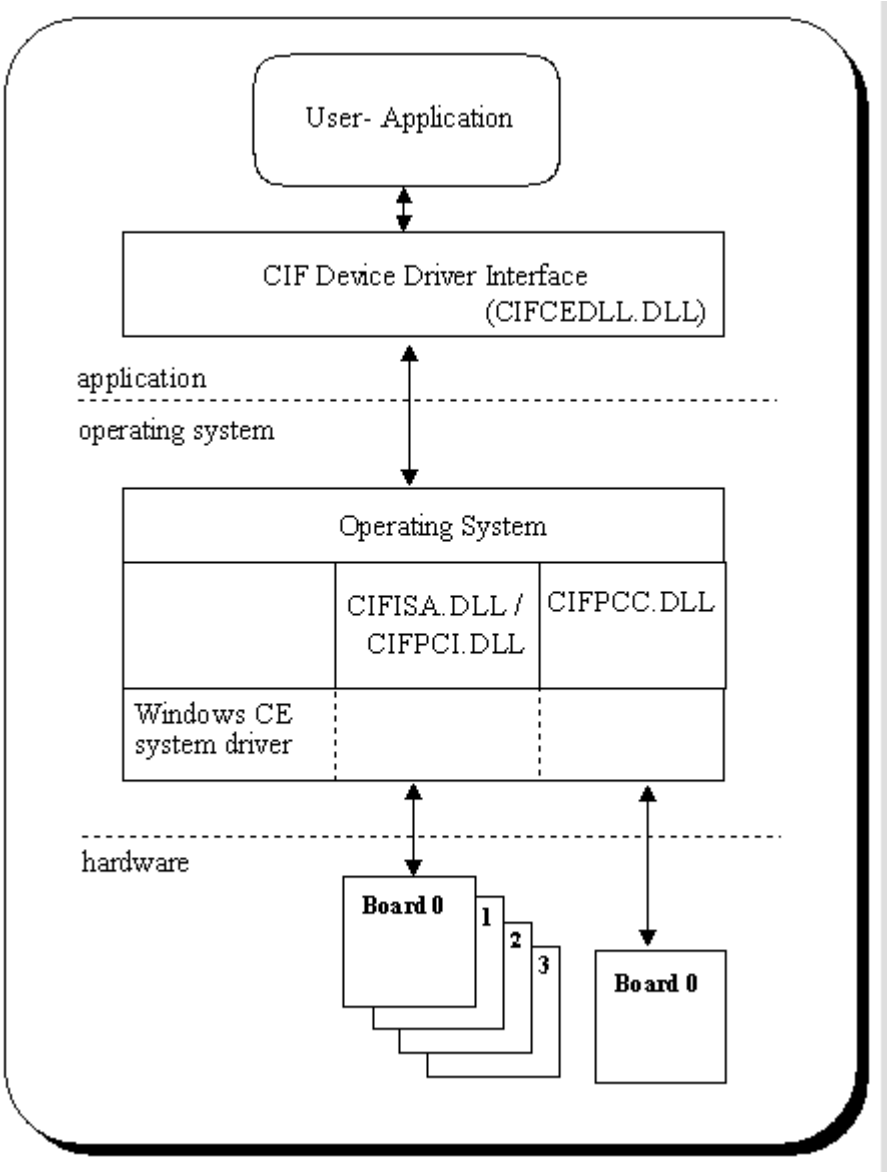

Figure 15: Windows CE

The Windows CE device driver interface corresponds to the Windows 9x/NT interface and all functions which are defined in this manual are also available on the CE system.

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Features:

- ISA driver handles up to four communication board
- PCI driver handles up to four communication board
- PCMCIA driver handles one communication board
- Loadable driver, which does not need to be included into the Windows CE kernel
- Complete source code for the drivers, interface DLL and programs

Limitations:

- No interrupt functionality included yet
- PCMCIA, ISA and PCI driver are not able to run at the same time

Development platform:

Windows CE 3.0	Embedded Visual Tools 3.0
Windows CE 4.0/5.0	Embedded Visual C/C++ 4.0

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5.3.1 General Information about Windows CE Drivers

Windows CE drivers are DLLs which must meet some special requirements. A driver must offer a specific interface to be accessible by the operating system. Windows CE uses a three letter prefix to distinguish between different drivers. The information about the driver prefix and the name of the driver file must be defined in the registry.

This information will be used by the operating system to call a driver.

Windows CE Driver Interface:

Following functions must be available in a the driver interface and will be called by the operating system:

- xxx_Init
- xxx _Deinit
- xxx _Open
- xxx _Close
- xxx _Read
- xxx _Write
- xxx _Seek
- xxx _PowerDown
- xxx _PowerUp
- xxx _IOControl

Where xxx is the driver prefix. The prefix for Hilscher drivers is CIF.

Function Description:

CIF_Init This function is called by the *Device Manager* to initialize a driver.

CIF_Deinit When the user stops using a device the *Device Manager* calls this function. The function frees all virtual memory that was allocated during the install step.

CIF_Open This function opens a device for reading and/or writing. An application indirectly invokes this function when it calls **CreateFile** to open a CIF device. The function creates a new device context information structure.

CIF_Close Is called when an application calls **CloseHandle(***hFile***)** to stop using a stream interface driver. It also removes an open context from the linked list and frees this context.

CIF_Read, CIF_Write, CIF_Seek (not supported)
Standard interface for ***ReadFile*** and ***WriteFile*** functions. This is not supported by the CIF driver.

Continued on next page

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CIF_PowerDown, CIF_PowerUp

Are used to manage power management events from the perating system. These functions have an empty body and are not used by CIF driver.

CIF_IOControl This function sends a command to a device when an application uses the **DeviceIOControl** function to specify an operation to be performed. All CIF functions are processed by **DeviceIOControl** function.

5.3.2 Contents for Windows CE

The Windows CE driver will be delivered in source code. This includes the drivers, the driver interface DLL (API DLL), test and demo programs and the development projects files for all parts. Also included are C header files with the driver function and protocol definitions for own applications and the protocol and driver manuals in PDF format.

The following table shows the contents of the \DRVPRG directory.

DEVDRV			
Directory	**Description**		
Manuals	Protocol and driver manuals in .PDF file format		
Headers	Protocol definition files		
CE5			
CEDRVx.xxx	**Directory**	**Subdirectory**	**Description**
	Application	CifTest	Driver test program (CIFTEST.EXE)
		DrvSetup	Driver setup program (DRVSETUP.EXE)
		IODemo	Simple I/O demo program (IODEMO.EXE)
		Common	Common files for the applications
	CifCEDll		Device driver interface DLL (CIFCEDLL.DLL)
	CifDrv	CifISA	Device driver for ISA boards (CIFISA.DLL)
		CifPCC	Device driver for PCMCIA boards (CIFPCC.DLL)
		CifPCI	Device driver for PCI boards (CIFPCI.DLL)
		Common	Common driver include files
	Include		Include directory for applications, holds the definition file CIFUSER.H

Table 9: Directory Structure

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5.3.2.1 Driver Files

The driver development directory contains several subdirectories for the different parts of the driver.

Directory	Subdirectory	Description
CifDrv	CifISA	Device driver for ISA boards (CIFISA.DLL)
	CifPCC	Device driver for PCMCIA boards (CIFPCC.DLL)
	CifPCI	Device driver for PCI boards (CIFPCI.DLL)
	Common	Common driver include files

Table 10: Driver Files

The Driver Directory:

Each driver is located in an own directory.

- CIFISA.c ISA driver main module
- CIFPCI.c PCI driver main module
- CIFPCC.c PCIMCIA driver main module

The Common Directory:

The common directory holds the files which are common to all drivers.

- CIFDEV.c CIF-Functions to access the dual port memory
- CIFFNC.c Device Driver IO control function
- CIFREG.c Registry functions for Windows CE

File Names after Compilation:

CIFISA.DLL CIF Device Driver supporting ISA boards

CIFPCI.DLL CIF Device Driver supporting PCI boards

CIFPCC.DLL CIF Device Driver supporting PCMCIA boards

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5.3.2.2 Application Interface Files

The application interface to the driver is a DLL (CIFCEDLL.DLL). The source of the DLL is located in the CifCEDLL directory. The DLL converts function calls from the CIF driver API into **DeviceIOControl** function calls to the driver**.**

Directory	Description
CifCEDll	Device driver interface DLL (CIFCEDLL.DLL)

Table 11: Application Interface Files

CifCEDLL Source Files:

- CifCEDLL.c User interface module
- CifDown.c Download functions for configuration and firmware download

File Names after Compilation:

CIFCEDLL.DLL CIF Device Driver application interface DLL (API)

5.3.2.3 Setup, Test and Demo program

Each of the programs has an own subdirectory. Common files for all applications are located in the common subdirectory.

The applications are dialog based programs and as far as possible, each dialog is based in an own source module. Module names comparing to the function they processes.

Directory	Subdirectory	Description
Application	CifTest	Driver test program (CIFTEST.EXE)
	DrvSetup	Driver setup program (DRVSETUP.EXE)
	IODemo	Simple I/O demo program (IODEMO.EXE)
	Common	Common files for the applications

Table 12: Setup, Test and Demo Files

Dependencies:

CifCEDLL.LIB CIF driver interface DLL

CIFUSER.H CIF driver interface definition file

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5.3.3 Compiling the Source Code

Note: All drivers and applications must be compiled before they can be used.

Microsoft has divided the development process for Windows CE systems into two parts. One part is the generation of a running hardware platform using the Windows CE operating system while the other part focuses the application development for an existing Windows CE system. Both parts are using different environments. Platforms are generated with the Microsoft Platformbuilder and the application development is based on the Microsoft Embedded Visual Tools.

There is one important dependency between the two parts. Application development requires information about the target system like used CPU, available system drivers, available system services and platform depending libraries and definition files. These information's are only available in the platform generation process. The only way to get the information into the application development process is a platform SDK (**S**oftware **D**evelopment **K**it) which must be generated by the Microsoft Platformbuilder.

Because of the above described development process, it is not possible to offer pre-compiled drivers and application for a specific Windows CE target system.

This chapter describes the steps to compile the source code.

- Install the Platform SDK for the target system
- Include the installed Platform SDK into the existing project
- Compile the driver, API, setup and test programs

5.3.3.1 Install the Platform SDK for the target system

Platform SDKs are generated by the Microsoft Platformbuilder and installable like a normal program. Make sure the Microsoft Embedded Visual Tools are already installed.

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5.3.3.2 Include the installed Platform SDK into an existing project

New installed Platform SDKs are not automatically included into existing projects. There are different ways to insert a new SDK into a project. Microsoft has described the procedure under Q266243.

The following point will give you an overview how to proceed:

1. Build a new project in the Microsoft Embedded Visual Tools. This enables the access to already installed SDKs. This procedure is **not preferred**, because you have to set all project dependencies according to the original project by yourself.
2. Extend the original project by inserting a DUMMY project (**preferred method)**. After inserting a dummy project it is possible to extend the existing project by the new settings from the dummy project.

- Add a dummy project with the necessary CPUs (hardware) to the existing project
- Select the dummy project and make it the active project
- Select the hardware you want to insert into the original project
- Open the configuration dialog from <Build->Configuration...>
- Now you see both projects, the original one and the new created one with their configurations where the original one does not have any assigned configuration.
- Select the original project and choose <ADD> and you are able to add the CPUs (Debug/Release) supported by the dummy project.
- Save the project
- At the end you can delete the dummy project

5.3.3.3 Compile the driver, API, Setup and Test programs

Each part has an own project file. After loading the project file the specific project can be compiled in debug or release version. Some of the projects using specific settings which will be shown in the following table.

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Specific Project Settings:

CIF Driver Interface DLL		
Project File	**Description**	**Settings**
CifCEDLL	CIF driver API	**Preprocessor definitions:** CIFCEDLL_EXPORTS **Additional include directories:** ..\CIfDRV\Common
CIF Device Driver		
Project File	**Description**	**Settings**
CifISA	ISA card driver	**Preprocessor definitions:** CIFISA_EXPORTS **Additional include directories:** ..\common
CifPCC	PCMCIA driver	**Preprocessor definitions:** CIFPCC_EXPORTS Used in CIFDEV.H to Includes PCMCIA specific files (TUPLE.H and CARDSERV.H) and data areas into structure DEV_INSTANCE. **Additional include directories:** ..\common **Object/library modules:** pcmcia.lib Windows CE library file for PCMCIA specific functions **Windows CE system header files:** tuple.h cardserv.h devload.h
CifPCI	PCI driver	**Preprocessor definitions:** CIFPCI_EXPORTS Used in CIFDEV.H to Includes PCI specific files (CIFPCI.H) and data areas into structure DEV_INSTANCE. **Additional include directories:** ..\common
CIF Driver Programs		
Project File	**Description**	**Settings**
DrvSetup	Driver setup program	**Additional include directories:** ..\common ..\..\include ..\..\CifDRV\common **Object/library modules:** CifCEDLL.lib Interface API LIB file (release/debug) CEDDK.lib Windows CE library file for operating system specific functions
MSG_DBG	CIF test program	**Additional include directories:** ..\common ..\..\include **Object/library modules:** CifCEDLL.lib Interface API LIB file (release/debug)
IODemo	I/O demo program	**Additional include directories:** ..\common ..\..\include **Object/library modules:** CifCEDLL.lib Interface API LIB file (release/debug)

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5.3.4 Installation of the Device Driver

To install the CIF Device Driver, the driver file, the interface DLL and the utility programs must be copied to the Windows CE target system.

Device Driver	The driver must be copied to the Windows CE system directory
Driver interface DLL	The interface DLL should also be placed into the Windows CE system directory, so it is reachable from all applications
Driver utilities	Can be placed in any user directory

Note: The executable programs are written by the use of the MFC and compiled with the option "Use MFC as a static Library", so it should not be necessary to have a MFC.DLL on the Windows CE target system. The debug version of the programs are compiled with the option "Use MFC in a Shared DLL". Therefore it is necessary to put the debug version of the MFC DLL on the target system.

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5.3.5 Configure the Device Driver

The standard configuration and the specific board configuration can be done by the DRVSETUP.EXE program. The program offers functions to create, show and change the hardware settings for the different drivers. It also generates the standard driver registry entries to allow the operating system to load the driver.

If a driver should be loaded from the system during start time, the registry settings and driver and the API file must be included in the system binary.

5.3.5.1 PCMCIA Initialization Process and Registry Entries

PCMCIA cards are Plug and Play aware and automatically detected by the operating system if they are plug into the system.

The operating system uses a registry entry to know which driver is responsible for the hardware. This entry must be placed into the following entry:

[HKEY_LOCAL_MACHINE][Drivers][PCMCIA]

The entry contains the manufacture, the card type and a checksum. This must compare to the information stored on the PCMCIA card. The only configuration value for the driver is the memory size (DPMSize) because this can't be detected. The memory start address can be taken from the Windows CE card services.

After mapping the memory window into system ram the driver also checks the accessibility of the memory and activates the hardware if the check successful.

Example for a PROFIBUS CIF60 card:

```
Hilscher_GmbH-CIF60_PB-CE0C          // Card identification
     Index:          1               // Dword
     Prefix:         "CIF"           // String
     DLL:            "CIFPCC.DLL"    // String
     DeviceType:     3               // Dword
     DPMSize:        8               // Dword
```

The card identification contains the manufacture, a device name and a checksum. The other entries are necessary to define which driver is responsible for this device. This driver will be started by the operating system if such a card is found.

The following boards are defined at the moment:

CIF60-PB	PROFIBUS DP and FMS	
CIF60-CAN	CAN open	(CIF60-COM)
	Device Net	(CIF60-DNM)
	SDS	(CIF60-SDSM)
CIF60-IBM	InterBus Master	

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Using of the Driver Setup Program:

Run the device driver setup program DRVSETUP.EXE to create the PCMCIA entries. Therefore you have to go to the menu point <Registry> <Create PCMCIA entries>. With the create button, all of the following entries will be created. To remove the entries use the delete button. There is no further configuration necessary.

PCMCIA registry entries:

```
HKEY_LOCAL_MACHINE:
     Drivers
          PCMCIA
               Hilscher_GmbH-CIF60_PB-CE0C
                    Index:          1               // Dword
                    Prefix:         "CIF"           // String
                    DLL:            "CIFPCC.DLL"    // String
                    DeviceType:     3               // Dword
                    DPMSize:        8               // Dword
          PCMCIA
               Hilscher_GmbH-CIF60_CAN-8E6F
                    Index:          1               // Dword
                    Prefix:         "CIF"           // String
                    DLL:            "CIFPCC.DLL"         // String
                    DeviceType:     3               // Dword
                    DPMSize:        8               // Dword
          PCMCIA
                    Hilscher_GmbH-CIF60_IBM-0761
                    Index:          1               // Dword
                    Prefix:         "CIF"           // String
                    DLL:            "CIFPCC.DLL"    // String
                    DeviceType:     3               // Dword
                    DPMSize:        8               // Dword
```


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5.3.5.2 ISA Initialization Process and Registry Entries

ISA cards are not Plug and Play aware. Therefore the information about installed ISA cards must be provided by the user and will be inserted into the registry. During *CIF_init()* the driver reads the configuration for “Board 0..3“ from the registry entry.

[HKEY_LOCAL_MACHINE][Drivers][BuiltIn][CIFDEV]

Configuration values are the memory size (DPMSize), the memory start address (DPMBase) and an interrupt number (IRQ) which is ignored. After checking the values the driver allocates the memory area and tries to access the hardware.

If the driver is able to read a valid hardware identification from the hardware, the card will be accepted and activated.

Using of the Driver Setup Program:

Run the device driver setup program DRVSETUP.EXE to create the default registry entries for ISA boards. Therefore, go to the menu point <Registry> <Create ISA entries> and use the create button to create the standard entries, shown below. Use the delete button to remove all ISA entries from the registry.

Afterwards, change to <ISA/PCI bus> <Board setup> to configure each ISA board independently.

Registry entries:

```
HKEY_LOCAL_MACHINE:
Drivers
     BuiltIn
          CIFDEV
               Index          1              // Dword
               Order          3              // Dword
               Prefix         "CIF"          // String
               DLL            "CIFISA.DLL"   // String
               DeviceType     0              // Dword
               PCISupport     0              // Dword

               Board0
                    BUSType         0         // Dword
                    DPMBase         000CA000  // Dword
                    DPMSize         2         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
               Board1
                    BUSType         0         // Dword
                    DPMBase         00000000  // Dword
                    DPMSize         0         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
               Board2
                    BUSType         0         // Dword
                    DPMBase         00000000  // Dword
                    DPMSize         0         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
               Board3
                    BUSType         0         // Dword
                    DPMBase         00000000  // Dword
                    DPMSize         0         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
```


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5.3.5.3 PCI Initialization Process and Registry Entries

PCI cards are also Plug and Play aware and detected by the operating system. This is done during the startup phase of Windows CE and the operating system also assigns the resources requested by the PCI hardware.

The PCI driver expects the hardware configuration information under the following registry key.

[HKEY_LOCAL_MACHINE][Drivers][BuiltIn][CIFDEV]

This entry will be created by the driver setup program DRVSETUP.EXE. The program scans the PCI hardware and if a Hilscher PCI hardware is found, it reads the resource values for the memory start address (DPMBase), the memory size (DPMSize) and the interrupt number (IRQ) from the hardware and creates the necessary entries.

Note: Microsoft does not recommend to scan the PCI hardware directly from a driver. That's why the scan function is placed into a separate program.

The driver reads the configuration information during CIF_init(), checks the values, allocates the memory area and tries to access the hardware. If the driver is able to read a valid hardware identification from the hardware, the card will be accepted and activated.

Using of the Driver Setup Program:

Run the device driver setup program DRVSETUP.EXE to create the default registry entries for PCI boards. Therefore, go to the menu point <Registry> <Create PCI entries> and use the create button to create the standard entries (shown below). Use the delete button to remove all PCI entries from the registry.

Note: The registry entries are only created if at least one PCI Hilscher card could be found in the system.

PCI cards are Plug and Play aware. You can check the card settings by changing to <ISA/PCI bus> <Board setup>. It is not possible to change neither the memory address nor the memory size.

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Registry entries:

```
HKEY_LOCAL_MACHINE:
Drivers
     BuiltIn
          CIFDEV
               Index          1              // Dword
               Order          3              // Dword
               Prefix         "CIF"          // String
               DLL            "CIFPCI.DLL"   // String
               DeviceType 0                  // Dword
               PCISupport 0                  // Dword

               Board0
                    BUSType         0        // Dword
                    DPMBase         00000000 // Dword
                    DPMSize         0        // Dword
                    IRQ             0        // Dword
                    PCIIntEnable    0        // Dword
               Board1
                    BUSType         0        // Dword
                    DPMBase         00000000 // Dword
                    DPMSize         0        // Dword
                    IRQ             0        // Dword
                    PCIIntEnable    0        // Dword
               Board2
                    BUSType         0        // Dword
                    DPMBase         00000000 // Dword
                    DPMSize         0        // Dword
                    IRQ             0        // Dword
                    PCIIntEnable    0        // Dword
               Board3
                    BUSType         0        // Dword
                    DPMBase         00000000 // Dword
                    DPMSize         0        // Dword
                    IRQ             0        // Dword
                    PCIIntEnable    0        // Dword
```


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5.3.6 Integration into a Windows CE Image

This is an example how to integrate the driver into a Windows CE image. The example shows the integration of the PCI driver.

5.3.6.1 Extend the Platform.reg file

Extend the Platform.reg file by the registry settings for the driver.

```
[HKEY_LOCAL_MACHINE\Drivers\BuiltIn\CIFDEV]
     "Index"         = dword:1
     "Prefix"        = "CIF"
     "Order"         = dword:3
     "Dll"           = "cifpci.dll"
     “DeviceType"    = dword:0
```

These entries defining the PCI device driver prefix “CIF” for the functions in the CIFPCI.DLL and the start index of the first device.

5.3.6.2 Extend ‘Module’ Section in the Project.bib File

cifpci.dll \[DestinationPath]\cifpci.dll NK SH

“*DestinationPath*” defines the path to the driver file.

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5.4 Windows CE 6.0

On Windows CE 6 we distinguish between two drivers to support PCMCIA, DPM (ISA/PCI) boards. This is done to match the Windows CE specific conditions to the best.

Note: The Windows CE 6.0 driver supports ISA and PCI cards in one driver (CIFDPM.DLL) and it is possible to use both type of cards at the same time.

The main difference is the startup procedure between the drivers. PCMCIA is loaded automatically, by the operating system, using the PnP-ID of the PCMCIA board if the device is plugged into the system. The DPM driver can be loaded at system start or at runtime by an application and will automatically handle PCI and configured ISA boards.

All drivers are loadable drivers which don't need to be included into the Windows CE kernel (binary).

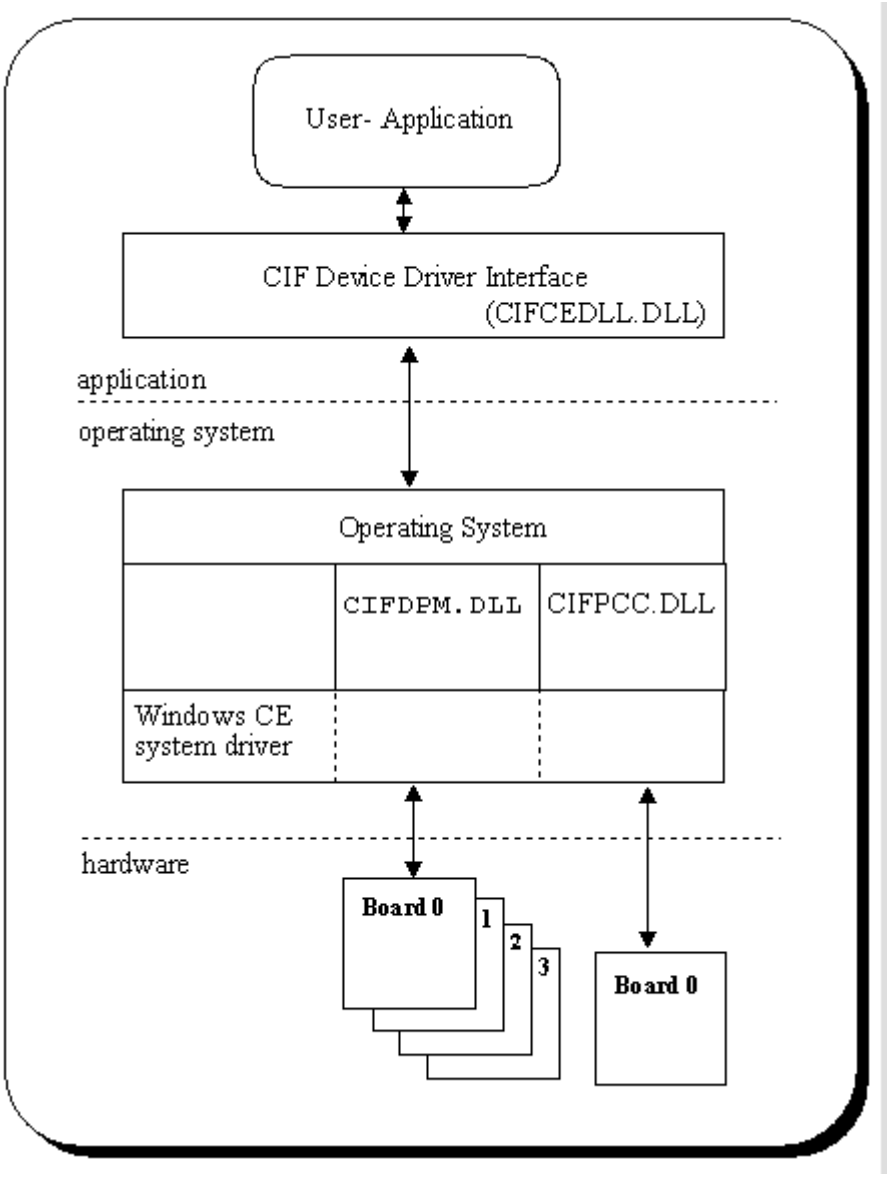

Figure 16: Windows CE 6.0

The Windows CE device driver interface corresponds to the Windows 9x/NT interface and all functions which are defined in this manual are also available on the CE system.

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Features:

- DPM driver handles up to four communication boards (ISA and PCI)
- ISA and PCI cards can be used at the same time
- PCI hardware detection now down in the driver
- PCMCIA driver handles only one communication board
- Loadable driver, which does not need to be included into the Windows CE kernel
- Complete source code for the drivers, interface DLL and programs

Limitations:

- No interrupt functionality included
- PCMCIA and DPM driver cannot be used at the same time

Development platform:

Windows CE	Microsoft Visual Studio 2005

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5.4.1 General Information about Windows CE Drivers

Windows CE drivers are DLLs which must meet some special requirements. A driver must offer a specific interface to be accessible by the operating system. Windows CE uses a three letter prefix to distinguish between different drivers. The information about the driver prefix and the name of the driver file must be defined in the registry.

This information will be used by the operating system to call a driver.

Windows CE Driver Interface:

Following functions must be available in a the driver interface and will be called by the operating system:

- xxx_Init
- xxx _Deinit
- xxx _Open
- xxx _Close
- xxx _Read
- xxx _Write
- xxx _Seek
- xxx _PowerDown
- xxx _PowerUp
- xxx _IOControl

Where xxx is the driver prefix. The prefix for Hilscher drivers is CIF.

Function Description:

CIF_Init This function is called by the *Device Manager* to initialize a driver.

CIF_Deinit When the user stops using a device the *Device Manager* calls this function. The function frees all virtual memory that was allocated during the install step.

CIF_Open This function opens a device for reading and/or writing. An application indirectly invokes this function when it calls **CreateFile** to open a CIF device.
The function creates a new device context information structure.

CIF_Close Is called when an application calls **CloseHandle(***hFile***)** to stop using a stream interface driver. It also removes an open context from the linked list and frees this context.

CIF_Read, CIF_Write, CIF_Seek (not supported)
Standard interface for ***ReadFile*** and ***WriteFile*** functions. This is not supported by the CIF driver.

Continued on next page

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CIF_PowerDown, CIF_PowerUp

Are used to manage power management events from the perating system. These functions have an empty body and are not used by CIF driver.

CIF_IOControl This function sends a command to a device when an application uses the **DeviceIOControl** function to specify an operation to be performed. All CIF functions are processed by **DeviceIOControl** function.

5.4.2 Contents for Windows CE

The Windows CE driver will be delivered in source code. This includes the drivers, the driver interface DLL (API DLL), test and demo programs and the development projects files for all parts. Also included are C header files with the driver function and protocol definitions for own applications and the protocol and driver manuals in PDF format.

The following table shows the contents of the \DRVPRG directory.

DEVDRV		
Directory	**Description**	
Manuals	Protocol and driver manuals in .PDF file format	
Headers	Protocol definition files	
CE6	Windows CE 6 directory	
	Subdirectory	**Description**
	CEDRVx.xxx	Platform Builder Project

Table 13: Directory Structure

Windows CE 6 Directory, Platform Builder:

Directory	**Description**	
PB	Platform Builder Project	
	Directory	**Description**
	CifCEDll	Device driver interface DLL (CIFCEDLL.DLL)
	CifDPM	Device driver for DPM boards (CIFDPM.DLL) This is the driver to use for ISA and PCI boards
	CifPCC	Device driver for PCMCIA boards (CIFPCC.DLL)
	Common	Common driver include files
	Include	Include directory for applications, holds the definition file CIFUSER.H

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Windows CE 6 Directory, Visual Studio 2005:

Directory	Description		
VS2005	Visual Studio 2005 Solution		
	Directory	**Subdirectory**	**Description**
	Application	AygShell	Neccessary for MFC applications if not included in SDK
		CifTest	Driver test program (CIFTEST.EXE)
		DrvSetup	Driver setup program (DRVSETUP.EXE)
		IODemo	Simple I/O demo program (IODEMO.EXE)
		Common	Common files for the applications
	CifCEDll		Device driver interface DLL (CIFCEDLL.DLL)
	CifDPM		Device driver for DPM boards (CIFDPM.DLL) This is the driver to use for ISA and PCI boards
	CifPCC		Device driver for PCMCIA boards (CIFPCC.DLL)
	Common		Common driver include files
	Include		Include directory for applications, holds the definition file CIFUSER.H
	DDK		Necessary DDK definition files

Table 14: Directory Structure

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5.4.2.1 Driver Files

The driver development directory contains several subdirectories for the different parts of the driver.

Directory	Description
CifDPM	Device driver for ISA/PCI boards (CIFDPM.DLL)
CifPCC	Device driver for PCMCIA boards (CIFPCC.DLL)
Common	Common driver include files

Table 15: Driver Files

The Driver Directory:

Each driver is located in an own directory.

- CIFDPM.c DPM driver main module
- CIFPCC.c PCIMCIA driver main module

The Common Directory:

The common directory holds the files which are common to all drivers.

- CIFDEV.c CIF-Functions to access the dual port memory
- CIFFNC.c Device Driver IO control function
- CIFREG.c Registry functions for Windows CE

File Names after Compilation:

CIFDPM.DLL CIF Device Driver supporting ISA/PCI boards

CIFPCC.DLL CIF Device Driver supporting PCMCIA boards

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5.4.2.2 Application Interface Files

The application interface to the driver is a DLL (CIFCEDLL.DLL). The source of the DLL is located in the CifCEDLL directory. The DLL converts function calls from the CIF driver API into **DeviceIOControl** function calls to the driver.

Directory	Description
CifCEDll	Device driver interface DLL (CIFCEDLL.DLL)

Table 16: Application Interface Files

CifCEDLL Source Files:

- CifCEDLL.c User interface module
- CifDown.c Download functions for configuration and firmware download

File Names after Compilation:

CIFCEDLL.DLL CIF Device Driver application interface DLL (API)

5.4.2.3 Setup, Test and Demo Program

Each of the programs has an own subdirectory. Common files for all applications are located in the common subdirectory.

The applications are dialog based programs and as far as possible, each dialog is based in an own source module. Module names comparing to the function they processes.

Directory	Subdirectory	Description
Application	AygShell	Neccessary for MFC applications if not included in SDK
	CifTest	Driver test program (CIFTEST.EXE)
	DrvSetup	Driver setup program (DRVSETUP.EXE)
	IODemo	Simple I/O demo program (IODEMO.EXE)
	Common	Common files for the applications

Table 17: Setup, Test and Demo Program Files

Dependencies:

CifCEDLL.LIB CIF driver interface DLL

CIFUSER.H CIF driver interface definition file

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5.4.3 Compiling the Source Code

Note: All drivers and applications must be compiled before they can be used.

Microsoft has divided the development process for Windows CE systems into two parts. One part is the generation of a running hardware platform using the Windows CE operating system while the other part focuses the application development for an existing Windows CE system. Both parts are using different environments. Platforms are generated with the Microsoft Platformbuilder and the application development is based on the Microsoft Visual Studio 2005.

The Driver either includes a project for use within Platform Builder to integrate the driver directly into your platform, or a solution to compile the driver for inclusion using non-volatile memory (e.g. Flashdisk).

The first method can only be used to build the driver and the API dll itself. It cannot be used to build the setup and test applications.

The second method needs a **S**oftware **D**evelopment **K**it (SDK) to be installed for the target device.

The following chapter describes the steps to compile the source using:

- Microsoft Platform Builder
- Microsoft Visual Studio 2005

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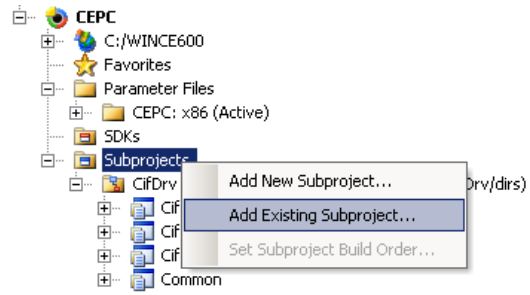
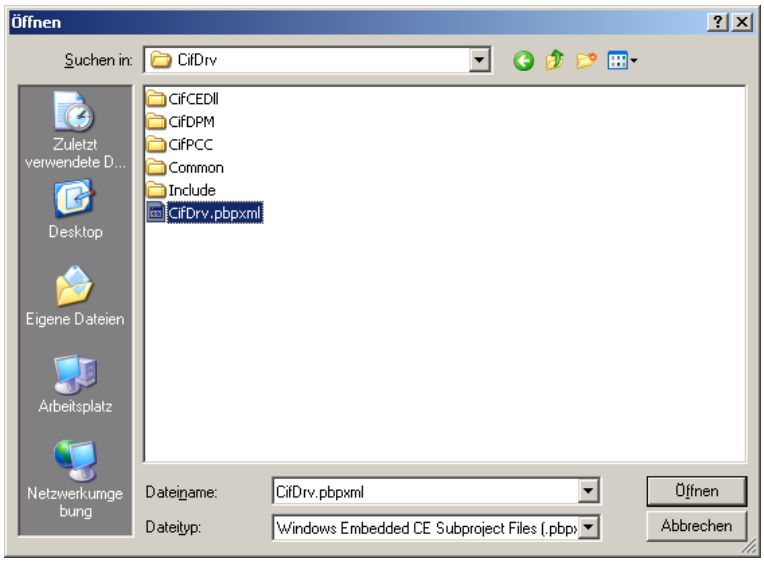
5.4.3.1 Compile using Platform Builder

The Platform Builder example will include all drivers into your Windows CE runtime image. To change the registry settings or the included files, you will need to edit *"CifDrv.reg"* and *"CifDrv.bib"* inside the project directory. The Platform Builder project does not include the Setup/Testapplications. These must be compiled using the Visual Studio 2005 project.

The following steps need to be done to build and integrate the driver into a runtime image:

- Add the project to your Platfom Builder solution





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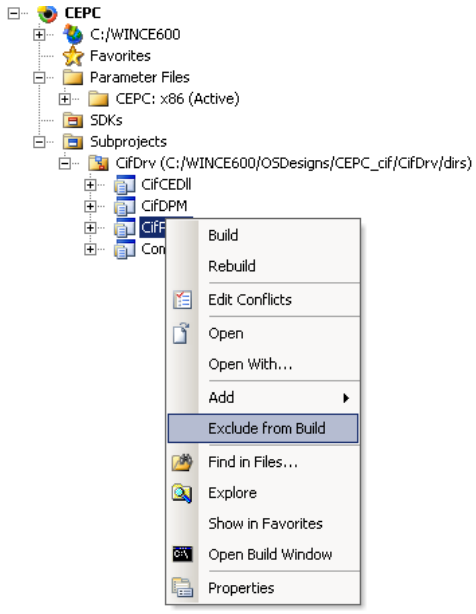
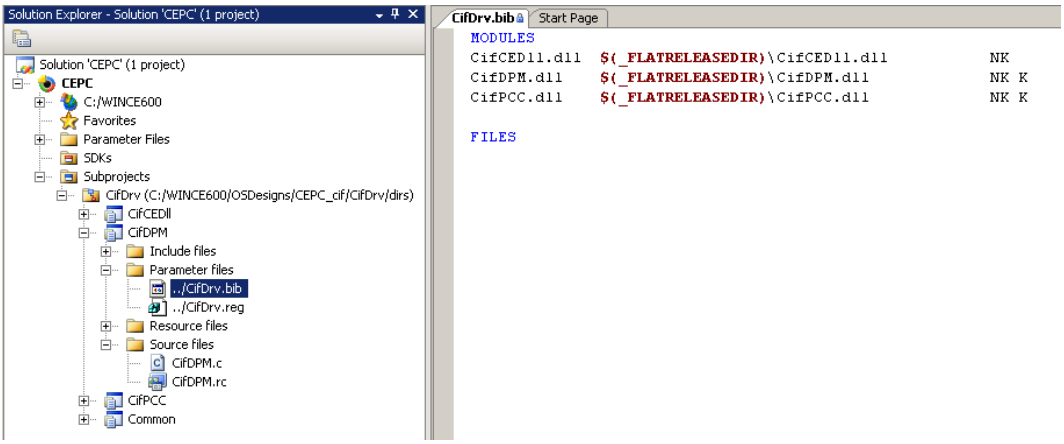
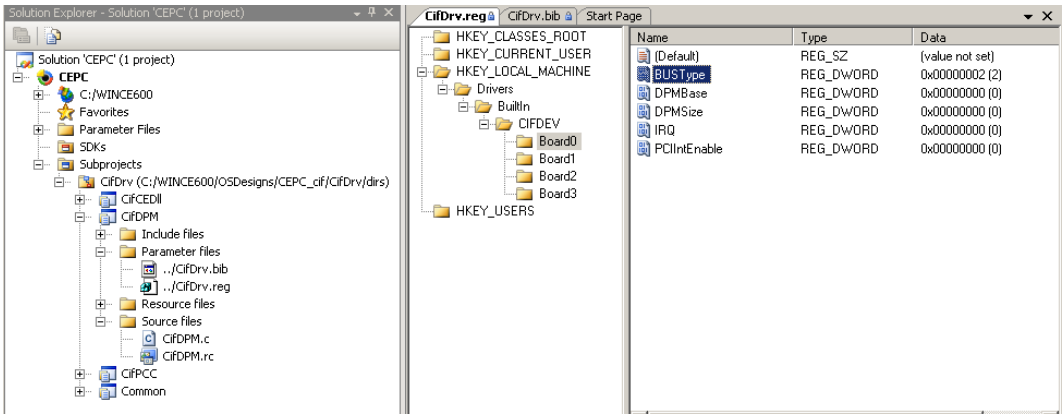
- Exclude all drivers you don't want to compile (e.g. CifPCC)



- Comment out unneeded files from "CifDrv.bib"



- Edit the default registry settings in "CifDrv.reg"



- Build your platform

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5.4.3.2 Compile using Microsoft Visual Studio 2005

The Visual Studio project includes the following components:

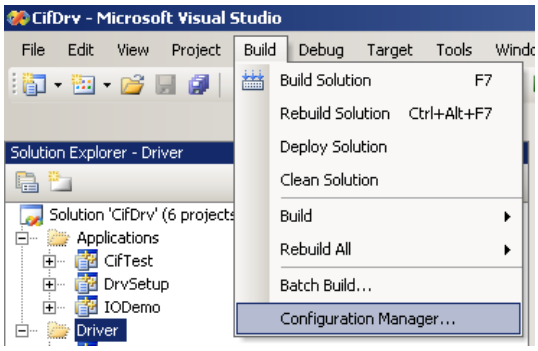
- CifDriver and API Dll
- Setup and Testapplications

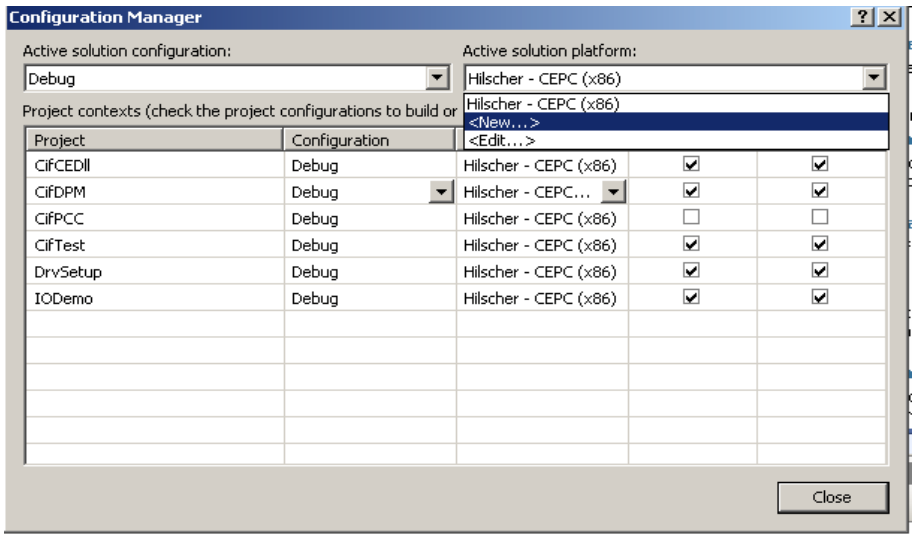
It needs to be setup to use the target platforms SDK. You will need to adjust the platform Configuration to be able to compile it.

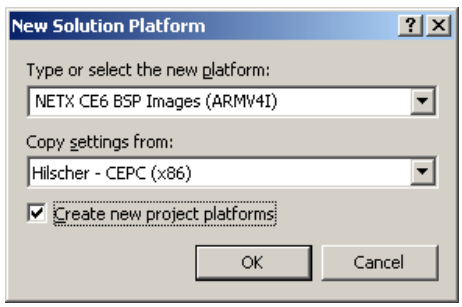
Note: If you want to build the PCMCIA driver you will need the *"pcc_pcm.lib"* from your platform, thus it is excluded from build per default.

The following steps need to be done to compile the solution:

- Add your target SDK to known configurations







- Rebuild the project

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5.4.4 Installation of the Device Driver

To install the CIF Device Driver, the driver file, the interface DLL and the utility programs must be copied to the Windows CE target system.

Device Driver	The driver must be copied to the Windows CE system directory
Driver interface DLL	The interface DLL should also be placed into the Windows CE system directory, so it is reachable from all applications
Driver utilities	Can be placed in any user directory

Note: The executable programs are use the MFC library and are compiled with the option "Use MFC as a static Library", so it should not be necessary to have a MFC.DLL on the Windows CE target system. The debug version of the programs is compiled with the option "Use MFC in a Shared DLL". Therefore it is necessary to put the debug version of the MFC DLL on the target system.

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5.4.5 Configure the Device Driver

The standard configuration and the specific board configuration can be done by the DRVSETUP.EXE program. The program offers functions to create, show and change the hardware settings for the different drivers. It also generates the standard driver registry entries to allow the operating system to load the driver.

If a driver should be loaded from the system during start time, the registry settings and driver and the API file must be included in the system binary.

5.4.5.1 PCMCIA Initialization Process and Registry Entries

PCMCIA cards are Plug and Play aware and automatically detected by the operating system if they are plugged into the system.

The operating system uses a registry entry to know which driver is responsible for the hardware. This entry must be placed into the following entry:

[HKEY_LOCAL_MACHINE][Drivers][PCMCIA]

The entry contains the manufacture, the card type and a checksum. This must compare to the information stored on the PCMCIA card. The only configuration value for the driver is the memory size (DPMSize) because this can't be detected. The memory start address can be taken from the Windows CE card services.

After mapping the memory window into system RAM the driver also checks the accessibility of the memory and activates the hardware if the check successful.

Example for a PROFIBUS CIF60 card:

```
Hilscher_GmbH-CIF60_PB-CE0C          // Card identification
     Index:          1               // Dword
     Prefix:         "CIF"           // String
     DLL:            "CIFPCC.DLL"    // String
     DeviceType:     3               // Dword
     DPMSize:        8               // Dword
```

The card identification contains the manufacture, a device name and a checksum. The other entries are necessary to define which driver is responsible for this device. This driver will be started by the operating system if such a card is found.

The following boards are defined at the moment:

CIF60-PB	PROFIBUS DP and FMS	
CIF60-CAN	CANopen	(CIF60-COM)
	Device Net	(CIF60-DNM)
	SDS	(CIF60-SDSM)
CIF60-IBM	InterBus Master	

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Using of the Driver Setup Program:

Run the device driver setup program DRVSETUP.EXE to create the PCMCIA entries. Therefore you have to go to the menu point <Registry> <Create PCMCIA entries>. With the create button, all of the following entries will be created. To remove the entries use the delete button. There is no further configuration necessary.

PCMCIA registry entries:

```
HKEY_LOCAL_MACHINE:
Drivers
     PCMCIA
          Hilscher_GmbH-CIF60_PB-CE0C
               Index:          1               // Dword
               Prefix:         "CIF"           // String
               DLL:            "CIFPCC.DLL"    // String
               DeviceType:     3               // Dword
               DPMSize:        8               // Dword
     PCMCIA
          Hilscher_GmbH-CIF60_CAN-8E6F
               Index:          1               // Dword
               Prefix:         "CIF"           // String
               DLL:            "CIFPCC.DLL"    // String
               DeviceType:     3               // Dword
               DPMSize:        8               // Dword
     PCMCIA
          Hilscher_GmbH-CIF60_IBM-0761
               Index:          1               // Dword
               Prefix:         "CIF"           // String
               DLL:            "CIFPCC.DLL"    // String
               DeviceType:     3               // Dword
               DPMSize:        8               // Dword
```


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5.4.5.2 DPM Initialization Process and Registry Entries

The DPM driver handles ISA and PCI cards. ISA cards are not Plug and Play aware, therefore the information about installed ISA cards must be provided by the user and will be inserted into the registry. During *CIF_init()* the driver reads the configuration for “Board 0..3“ from the registry entry.

[HKEY_LOCAL_MACHINE][Drivers][BuiltIn][CIFDEV]

Configuration values are the memory size (DPMSize), the memory start address (DPMBase), Bus type (BUSType) and an interrupt number (IRQ) which is ignored.

After checking the values the driver scans for PCI devices and uses all registry entries marked as BUSType=2 (PCI) to store the device information.

If the driver is able to read a valid hardware identification from the hardware, the card will be accepted and activated.

Using of the Driver Setup Program:

Run the device driver setup program DRVSETUP.EXE to create the proper registry settings using "Registry/Create Device Registry". To use PCI and ISA cards at the same time, configure the ISA boards (BUSType = 0) and set all other Entries to BUSType PCI (2).

Sample Registry entries (using Board 0 as ISA at 0xCA000 and Board1-3 as PCI devices being automatically enumerated):

```
HKEY_LOCAL_MACHINE:
Drivers
     BuiltIn
          CIFDEV
               Index          1              // Dword
               Order          3              // Dword
               Prefix         "CIF"          // String
               DLL            "CIFDPM.DLL"   // String
               DeviceType     0              // Dword
               PCISupport     0              // Dword

               Board0
                    BUSType         0         // Dword
                    DPMBase         000CA000  // Dword
                    DPMSize         2         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
               Board1
                    BUSType         2         // Dword
                    DPMBase         00000000  // Dword
                    DPMSize         0         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
               Board2
                    BUSType         2         // Dword
                    DPMBase         00000000  // Dword
                    DPMSize         0         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
               Board3
                    BUSType         2         // Dword
                    DPMBase         00000000  // Dword
                    DPMSize         0         // Dword
                    IRQ             0         // Dword
                    PCIIntEnable    0         // Dword
```


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5.4.5.3 Integration into a Windows CE Image

This is an example how to integrate the driver into a Windows CE image.

Note: When using the provided Platform Builder project you will need to edit *"CifDrv.reg"* and *"CifDrv.bib"* inside the projects directory.

5.4.5.4 Extend the Project.reg file

Extend the Platform.reg file by the registry settings for the driver.

```
[HKEY_LOCAL_MACHINE\Drivers\BuiltIn\CIFDEV]
     "Index"         = dword:1
     "Prefix"        = "CIF"
     "Order"         = dword:3
     "Dll"           = "cifdpm.dll"
     “DeviceType"    = dword:0
```

These entries define the device driver prefix “CIF” for the functions in the CIFDPM.DLL and the start index of the first device.

5.4.5.5 Extend ‘Module’ Section in the Project.bib File

cifcedll.dll \[DestinationPath]\cifcedll.dll NK

cifdpm.dll \[DestinationPath]\cifdpm.dll NK K

“*DestinationPath*” defines the path to the driver file.

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6 Programming Instructions

6.1 Include the Interface API in Your Application

For the user API there is only one include file CIFUSER.H which contains all the necessary information like structure, constant and prototype definitions. A complete function description is given in the chapter 'The Programming Interface'.

Link the device API-DLL (CIFWINDL.DLL, CIF32DLL.LIB) according to your operating system to your program. Make sure the device driver is installed.

For the support of the various protocols, each protocol has its own header file where all the protocol dependent definition are included (e.g. DPM_USER.H for the PROFIBUS-DP Master protocol). Furthermore, there exists an include file RCS_USER.H for the definitions of the operating system of the communication boards.

6.2 Open and Close the driver

Only three functions are needed to get a DEVICE to work:

Open a Driver

- Open the driver `DevOpenDriver()`, checks if a driver is installed
- Initialize your communication board `DevInitBoard()`, check if a specific board is available
- Set the application ready state `DevSetHostState(HOST_READY)`, signals the board an application

After these functions your application is able to start with the communication.

Close a Driver

- Clear the application ready state `DevSetHostState(HOST_NOT_READY)`, signals the board, no application running
- Close the board link DevExitBoard(), unlink from a board
- Close the device driver `DevCloseDriver()`, close a link to the device driver

After calling these functions all resources for the communication API is freed.

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6.3 Writing an Application

6.3.1 Determine Device Information

The interface API includes information functions, which gives an application the possibility to determine the installed DEVICEs, the actual driver version and the firmware name and version installed on the device.

We suggest to read out these information and make them accessible to the user. This information can be used by support inquiries to our hotline.

Important information:

- Driver version
- DEVICE type, model and serial number
- Firmware name and version

Read information about installed devices:

After opening the driver with DevOpenDriver(), the function DevGetBoardInfo() can be used to read the driver version and the installed devices.

```
void Demo (void)
{
  short      sRet;
  BOARD_INFO tBoardInfo;

  if ( (sRet = DevOpenDriver(0)) == DRV_NO_ERROR) {
    // Driver successfully opend, read board information
    if ( (sRet = DevGetBoardInfo( 0,
                                  sizeof ( tBoardInfo),
                                  tBoardInfo) != DRV_NO_ERROR) {
      // Function error
      printf( "DevGetBoardInfo      RetWert = %5d \n", sRet );
    } else {
      // Information successfully read, save for further use
      // Check out which boards are available
      for ( usIdx = 0; usIdx < MAX_DEV_BOARDS; usIdx++){
        if ( tBoardInfo.tBoard[usIdx].usAvailable == TRUE) {
          // Board is configured, try to init the board
          sRet = DevInitBoard( tBoardInfo.tBoard[usIdx].usBoardNumber,
                               NULL);    // for Windows 9x/NT
          if  ( sRet != DRV_NO_ERROR) {
            // Function error
            printf( "DevInitBoard      RetWert = %5d \n", sRet );
          } else {
            // DEVICE is available and ready.....
          }
        }
      }
    }
  }
}
```

Please refer to the function DevGetBoardInfo() for a description of the BOARD_INFO structure.

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Read information about a specific DEVICE:

After opening a specific DEVICE with `DevInitBoard()` a lot of information about a DEVICE can be read by the function `DevGetInfo()`.

```
void Demo (void)
{
  short         sRet;
  BOARD_INFO    tBoardInfo;
  FIRMWARE_INFO tFirmwareInfo;
  VERSION_INFO  tVersionInfo;
  DEVINFO       tDeviceInfo;

  if ( (sRet = DevOpenDriver(0)) == DRV_NO_ERROR) {
    // Driver successfully opend, read board information
    if ( (sRet =DevGetBoardInfo( 0,
                                 sizeof ( tBoardInfo),
                                 tBoardInfo) != DRV_NO_ERROR) {
      // Function error
      printf( "DevGetBoardInfo      RetWert = %5d \n", sRet );
    } else {
      // Information successfully read, open all existing boards
      for ( usIdx = 0; usIdx < MAX_DEV_BOARDS; usIdx++){
        if ( tBoardInfo.tBoard[usIdx].usAvailable == TRUE) {
          // Board is configured, try to init the board
          sRet = DevInitBoard( tBoardInfo.tBoard[usIdx].usBoardNumber,
                               NULL);    // for Windows 9x/NT
          if  ( sRet != DRV_NO_ERROR) {
            // Function error
            printf( "DevInitBoard      RetWert = %5d \n", sRet );
          } else {

            // DEVICE is available and ready.....

            // Read DEVICE specific information (VERSION_INFO)
            sRet = DevGetInfo( tBoardInfo.tBoard[usIdx].usBoardNumber,
                               GET_VERSION_INFO,
                               sizeof(tVersionInfo),
                               tVersionInfo);

            // Read DEVICE specific information (DEVICE_INFO)
            sRet = DevGetInfo( tBoardInfo.tBoard[usIdx].usBoardNumber,
                               GET_DEV_INFO,
                               sizeof(tDeviceInfo),
                               tDeviceInfo);

            // Read DEVICE specific information (FIRMWARE_INFO)
            sRet = DevGetInfo( tBoardInfo.tBoard[usIdx].usBoardNumber,
                               GET_FIRMWARE_INFO,
                               sizeof(tFirmwareInfo),
                               tFirmwareInfo);
          }
        }
      } /* end for */
    }
  }
}
```

Please refer to the `DevGetInfo()` function for a description of the different information structures.

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6.3.2 Message Based Application

On message based application you have to be aware that a DEVICE can only queue a fix number of messages (normally 20 to 128). Message queuing will be done in send and receive direction. This means, the HOST and the connected protocol will share all available messages. Each request or response from both sides will occupy a message until it is transfered to the other side.

If the amount of messages exceeds the given limit, no matter if the HOST or the protocol uses all the messages, the DEVICE is not longer able to create a response for a send or receive request.

This will happen until a message is freed by transferring it to the HOST or sending it over by the protocol. This will free a message, which can be used for another data transfer.

So an application should always be able to receive messages to prevent the DEVICE for overrunning by the use of messages.

After opening the device interface and setting the application ready state, the application must be able to process receive messages from the DEVICE.

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Example 1:

```
/*****************************************************************************
/*  Mainprogram
/*****************************************************************************
include "cifuser.h"
int main( void )
{
  short           sRet;
  MSG_STRUC       tReceiceMessage;
  MSG_STRUC       tSendMessage;
/* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
/* Open the driver */
if ( (sRet = DevOpenDriver(0)) != DRV_NO_ERROR)
{
  printf( "DevOpenDriver       RetWert = %5d \n", sRet );
/* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
/* Initialize board */
} else if ( (sRet = DevInitBoard (0,
                                  (void*) 0xCA000000 )) != DRV_NO_ERROR) {
  printf( "DevInitBoard        RetWert = %5d \n", sRet );

/* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
/* Signal board, application is running */
} else if ( (sRet = DevSetHostState( 0,
                                     HOST_READY,
                                     0L) != DRV_NO_ERROR) ) {
  printf( "DevSetHostState (HOST_READY) RetWert = %5d \n", sRet );
} else {
  while ( ...PROGRAM IS RUNNING....) {
// Application work........
// Try to read a message
sRet = DevGetMessage( 0,
                      &tReceiveMessage,
                      100L);   // Wait a maximum of 100 ms
if ( sRet == DRV_GET_TIMEOUT ) {
  // No message available
  // Try again..............
} else if ( sRet != DRV_NO_ERROR ) {
  // This is a function error
  // Process error ............
} else {
  // Message available
  // Process message ..........
}
// Try to send a message
// Create a message like described in the protocol manual
sRet = DevPutMessage( 0,
                      &tSendMessage,
                      100L);  // Wait a maximum of 100 ms
if ( sRet == DRV_PUT_TIMEOUT) {
  // Message could not be send
  // Mailbox full......
} else if ( sRet != DRV_NO_ERROR)  ) {
  // Error during send message
  // Process message error ........
}
   } /* end while*/
  // Close the application
  /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
    /* Signal board, application is not running */
    if ( (sRet = DevSetHostState(0,
                                 HOST_NOT_READY,
                                 0L)) != DRV_NO_ERROR) {
      printf( "DevSetHostState       RetWert = %5d \n", sRet );
    }
    /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
    /* Free board */
    if ( (sRet = DevExitBoard (0)) != DRV_NO_ERROR) {
```


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```
      printf( "DevExitBoard        RetWert = %5d \n", sRet );
    }
/* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
   /* Close driver */
   if ( (sRet = DevCloseDriver(0)) != DRV_NO_ERROR ) {
     printf( "DevCloseDriver      RetWert = %5d \n", sRet );
   }
  }
} /* end main*/
```

DevPutMessage() and DevGetMessage() uses a timeout value to force the driver to wait for the completion of the function, until the given timeout period is passed. This timeout should be used because the device needs also a period of time to get a message from the DPM or to write a message to the DPM. This period is normally very short (400 us up to 4 ms) but working in a while loop with timeout equal to zero and try to put a message in such a loop will result in a bad system response.

The given timeout from 100 ms is the maximum time the function will wait for completion It will return immediately if the function is done.

The application is responsible for the reiteration of messages which could not be send to the DEVICE.

How the device acts after power up or changes of the HOST ready state (e.g. shut down the bus or stop data transmission) is normally configurable by the protocol configuration.

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Another way to check if messages can be send or received is the use of the `DevGetMBXState()` function. This function is used to determine the actual state (DEVICE_MBX_FULL/EMPTY, HOST_MBX_FULL/EMPTY) of the HOST and DEVICE mailbox. This the preferred way for a polling application.

Example 2:

```
/*****************************************************************************
/*  Mainprogram
/*****************************************************************************
int main( void )
{
  unsigned short  usDevState, usHostState;
  short           sRet;
  MSG_STRUC       tReceiceMessage;
  MSG_STRUC       tSendMessage;

  // ..... see example 1

      // HOST and DEVICE mailbox state
      if ( (sRet = DevGetMBXState( 0,
                                   &usDeviceState,
                                   &usHostState)) != DEV_NO_ERROR) {
        printf( "DevGetMBXState   RetWert = %5d \n", sRet );
      } else {
        if ( usHostState == HOST_MBX_FULL) {
          // Read device message. message is available
          if ( (sRet = DevGetMessage( 0,
                                      &tReceiveMessage,
                                      0L)) != DRV_NO_ERROR) {
            printf( "DevGetMessage   RetWert = %5d \n", sRet );
          } else {
            // Process message ..........
          }
        }
        if ( usDeviceState == DEVICE_MBX_EMPTY) {
          // Send mailbox is empty
          if ( (sRet = DevPutMessage( 0,
                                      &tSendMessage,
                                      0L)) != DRV_NO_ERROR) {
            printf( "DevPutMessage   RetWert = %5d \n", sRet );
          }
        }
      }

  //....... see example 1
```

In this example, the application must create its own polling cycle an is responsible for freeing the processor for other applications.

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6.3.3 Process Data Image Based Application

Applications which working with process data images (IO protocols) are using the `DevExchangeIO(), DevExchangeIOErr() or DevExchangeIOEx()` function for the data transfer between the HOST and the DEVICE.

Attention: By using `DevExchangeIO()`it is not possible for master devices to recognize the fault of a specific bus device. Only global errors like whole bus disruptions or communication breaks to all configured device will be indicated by this function. To get specific device fault, the application must read the "TaskState-Field", where device specific data's are located. This must be done after each call to `DevExchangeIO()`.

Example 1:

```
/*****************************************************************************
/*  Mainprogram
/*****************************************************************************
include "cifuser.h"
int main( void )
{
  short           sRet;
  unsigned char   abIOSendData[512];
  unsigned char   abIOReceiveData[512];

  /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
  /* Open the driver */
  if ( (sRet = DevOpenDriver(0)) != DRV_NO_ERROR) {
    printf( "DevOpenDriver       RetWert = %5d \n", sRet );
  /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
  /* Initialize board */
  } else if ( (sRet = DevInitBoard (0,
                                    (void*) 0xCA000000 )) != DRV_NO_ERROR) {
    printf( "DevInitBoard        RetWert = %5d \n", sRet );
  /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
  /* Signal board, application is running */
  } else if ( (sRet = DevSetHostState( 0,
                                       HOST_READY,
                                       0L) != DRV_NO_ERROR) ) {
    printf( "DevSetHostState (HOST_READY) RetWert = %5d \n", sRet );
  } else {
while ( ...PROGRAM IS RUNNING....) {
       // Application work........

       // Insert datas to the send data buffer
       abIOSendData[0] = 11;
       abIOSendData[1] = 22;
       abIOSendData[2] = 33;

       if ( ( sRet = DevExchangeIO( 0,
                                    0,
                                    sizeof(abIOSendData),
                                    &abIOSendData[0],
                                    0,
                                    sizeof(abIOReceiveData),
                                    &abIOReceiveData[0],
                                    100L)) != DRV_NO_ERROR) {
          // Error during data exchange
            printf( "DevExchangeIO  RetWert = %5d \n", sRet );
       } else {
         // Input data are stored in the abIOReceiveData
           // Check for specific device errors (VERY IMPORTEND)
         if ( (sRet = DevGetTaskState(.......)) != DRV_NO_ERROR) {
             // Error by reading task state information
         } else {
           // Check if one of the bus devices are faulty
```


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```
          // Process input data.....
        }
      }
    } /* end while*/

    // Close the application
    /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
    /* Signal board, application is not running */
    if ( (sRet = DevSetHostState(0,
                                 HOST_NOT_READY,
                                 0L)) != DRV_NO_ERROR) {
      printf( "DevSetHostState       RetWert = %5d \n", sRet );
    }
    /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
    /* Free board */
    if ( (sRet = DevExitBoard (0)) != DRV_NO_ERROR) {
      printf( "DevExitBoard        RetWert = %5d \n", sRet );
    }
    /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
    /* Close driver */
    if ( (sRet = DevCloseDriver(0)) != DRV_NO_ERROR ) {
      printf( "DevCloseDriver      RetWert = %5d \n", sRet );
    }
    }
} /* end main*/
```

This example creates a send and a receive buffer. During the data exchange function call the data from the send buffer (abIOSendBuffer) are written to the DEVICE output process data area and the data from the input process data area are read to the receive buffer (abIOReceiveBuffer).

As data buffers, there are fixed data area from 512 bytes for input and 512 bytes for output data used. The real size of the process image can be determine by the `DevGetInfo(GET_DEV_INFO)` function. This function returns the DPM size of the DEVICE as a multiple of 1024 Bytes (e.g. 2).

process image size = ((bDpmSize * 1024) -1024) /2

From the whole size (2 * 1024 Byte) there must be subtract 1024 Byte, which is the length of the last Kbytes (always reserved for message transfer and protocol independent data). This gives a value of 1024 Bytes, which must be divided by two (the size of the input and output process image is always equal.

The synchronization mode for the exchange function (e.g. uncontrolled and so on) will be recognized by the `DevExchangeIO()` function and handled in the right manner.

Read out state information for all connected bus devices when using a master device, to find out if on of the bus devices has a malfunction. This is done by the use of `DevGetTaskState()`. The function must be called after each call to `DevExchangeIO()` to discover problems with particular devices (see also `DevExchangeIOErr()`).

The evaluation of the process data is up to the application. The exchange function only copies a data area (one byte up to the whole data area) from and to the device. Where the data for a particular device is located in the IO process image is defined by the system configuration.

It is also possible to read only one byte from the image. But be aware, depending on the synchronization mode (HOST Controlled, Buffered Data Transfer) , each data exchange by the HOST will result in a complete buffer exchange on the DEVICE. To prevent needless data transfers of unchanged data between the DPM and the internal data buffer of the DEVICE, we suggest to transfer as much data as possible with one `DevExchangeIO()` call to get the best system performance.

The DevExchangeIO() function can be used to send and receive process data in one call or in two calls. Where one call writes output data and the other on reads input data. To prevent one of the functions, set the corresponding size parameter equal to zero.

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6.4 The Demo Application

For all operating systems we have created small demo applications which shows the use of the drivers.

- The application for DOS/Windows 3.xx shows how to work with a simple ASCII protocol. The protocol definitions are located in the header file DEMO.H.
- For Windows 9x/NT we included our MSG_DBG program where the most of the functions are realized. Also the possibility to check the message transfer and to read and write process images are included.

6.4.1 C-Example

Example for DOS, Windows 3.xx, Windows 9x, Windows NT, Windows 200/XP:

The sample code demonstrate the initialization and the data transfer for a message an for process image exchange. This source code is available from the driver disk.

```
include <cifuser.h>
/*****************************************************************************
/*  Mainprogram
/*****************************************************************************
int main( void )
{
  unsigned short   usDevState, usHostState;
  short            sRet;
  MSG_STRUC        tMessage;
  unsigned char       tIOSendData[512];
  unsigned char       tIORecvData[512];

  /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
  /* Open the driver */
  if ( (sRet = DevOpenDriver(0)) != DRV_NO_ERROR) {
    printf( "DevOpenDriver       RetWert = %5d \n", sRet );
  /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
  /* Initialize board */
  } else if ( (sRet = DevInitBoard (0,
                                    (void*) 0xCA000000 )) != DRV_NO_ERROR) {
    printf( "DevInitBoard        RetWert = %5d \n", sRet );
  /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
  /* Signal board, application is running */
  } else if ( (sRet = DevSetHostState( 0,          /* DeviceNumber */
                                       HOST_READY, /* Mode */
                                       0L) != DRV_NO_ERROR) ) {
    printf( "DevSetHostState (HOST_READY) RetWert = %5d \n", sRet );
  } else {
    /*=================================================================
    /* Test Message transfer
    /*=================================================================
    /* Build a message */
    tMessage.rx         = 0x01;
    tMessage.tx         = 0x10;
    tMessage.ln         =   12;
    tMessage.nr         =    1;
    tMessage.a          =    0;
    tMessage.f          =    0;
    tMessage.b          =   17;
    tMessage.e          = 0x00;
    tMessage.daten[0]   =    1;
    tMessage.daten[1]   =    2;
    tMessage.daten[2]   =    3;
    tMessage.daten[3]   =    4;
    /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    /* Send a message */
    sRet = DevPutMessage ( 0,
                           (MSG_STRUC *)&tMessage,
```


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```
                          5000L );
    printf( "  DevPutMessage       RetWert = %5d \n", sRet );
    /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    /* Receive a message */
    sRet = DevGetMessage ( 0,
                          sizeof(tMessage),
                          (MSG_STRUC *)&tMessage,
                          20000L );
    printf( "  DevGetMessage       RetWert = %5d \n", sRet );
/*=====================================================================
/* Test for ExchangeIO
/*=====================================================================
/* Write test data to Send buffer */
tIOSendData.abSendData[0] = 0;
tIOSendData.abSendData[1] = 1;
tIOSendData.abSendData[2] = 2;
tIOSendData.abSendData[3] = 3;

/* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
/* Run ExchangeIO */
sRet = DevExchangeIO ( 0,
                       0,              /* usSendOffset    */
                       4,              /* usSendSize      */
                       &tIOSendData,   /* *pvSendData     */
                       0,              /* usReceiveOffset */
                       4,              /* usReceiveSize   */
                       &tIORecvData,   /* *pvReceiveData  */
                       100L );         /* ulTimeout       */
printf( "DevExchangeIO RetWert = %5d \n", sRet );
}

/*- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
/* Signal board, application is not running
if ( (sRet = DevSetHostState( 0,
                              HOST_NOT_READY,
                              0L) != DRV_NO_ERROR) ) {
  printf( "DevSetHostState (HOST_NOT_READY) RetWert = %5d \n", sRet );
}
/* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
/* Close communication */
sRet = DevExitBoard( 0 );
printf( "DevExitBoard        RetWert = %5d \n", sRet );
/* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
/* Close Driver */
sRet = DevCloseDriver(0);
printf( "DevCloseDriver      RetWert = %5d \n", sRet );

return 0;
}
```


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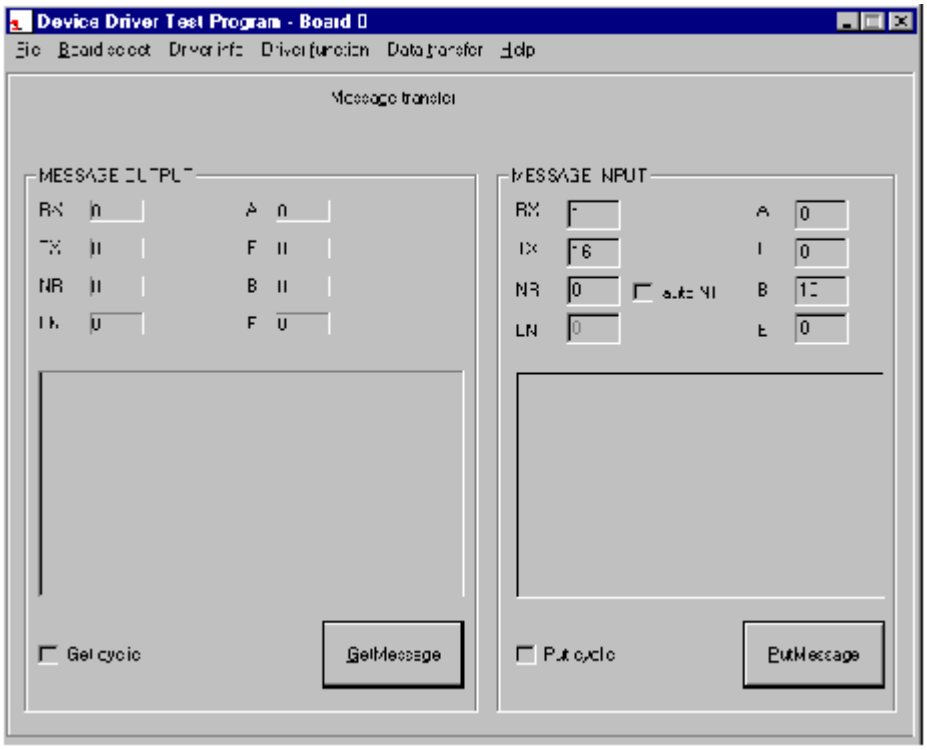
6.4.2 C++-Example

Example for Windows 9x, Windows NT and Windows 2000/XP:

This program named MSG_DBG.EXE (DrvTest.EXE) is a 32 bit program, written with Microsoft Visual C++ V 6.x, uses the MFC-Library for the application window and the CIF32DLL.DLL to get connection to the device driver.

The source code can be used for an example how to integrate our API to a C++ application. All function are saved in own source files. The whole program is a dialog based application with a menu line, from where the functions can be activated.



All function will be called from the MSG_DBGDlg.C (DrvTestDlg.C) module. Also the handling for the message monitor window and the data exchange windows are located in this file.

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7 The Application Programming Interface

All drivers are working with the same interface. The following functions are known by each driver:

Function Group	Function	Description	Info
Initialization	DevOpenDriver()	Links an application to the device driver	
	DevCloseDriver()	Closes a Link to the driver	
	DevInitBoard ()	Links an application to a board	
	DevExitBoard()	Closes a Link to a board	
Device control	DevReset()	Reset a board	
	DevSetHostState()	Sets/Clears the information bit for host is running	
	DevTriggerWatchDog()	Serves the watchdog function of a board	**X**
Message Data Transfer	DevPutMessage()	Transfer a message to the board	**X**
	DevGetMessage()	Reads a message from a board	**X**
	DevGetMBXState()	Read the actual mailbox state	**X**
IO Data Transfer	DevExchangeIO()	Put/Get IO data from/to a board	**X**
	DevExchangeIOEx()	Put/Get IO data from/to a COM module	**X**
	DevExchangeIOErr()	Put/Get IO data from/to a board including state information	**X**
	DevReadSendData()	Read back IO data from the send area	**X**
Protocol Information / Configuration	DevPutTaskParameter()	Writes the parameters for a communication task	
	DevGetTaskParameter()	Reads the parameters from a communication task	**X**
	DevGetTaskState()	Read all task states from a board	**X**
Device Information	DevGetBoardInfo()	Read global board information	
	DevGetInfo()	Reads the various information from a board	**X**
Other	DevReadWriteDPMRaw()	Read/write to/from the last Kbytes of a	**X**
System Function	DevDownload()	Firmware/Configuration download	

Table 18: The Application Programming Interface

(X) Marked functions are handled with higher priority under Windows Vista/7/8.

All definitions for data structures, function prototypes and definitions are located in the user interface header file CIFUSER.H.

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7.1 Differences of the Operating Systems

7.1.1 Function Parameters

Please notice, that the interface for all drivers are the same. But there are differences between the parameter which where used by the function library and the device drivers which also depends on the used operating system.

Driver	Operating System	Used Parameters	Unused parameters
Function library	DOS	*pDevAddress	usDevNumber = 0
	Windows 3.xx	*pDevAddress	usDevNumber = 0
Device driver	Windows 9x	usDevNumber (0..3)	*pvDevAddress
	Windows NT	usDevNumber (0..3)	*pvDevAddress
	Windows 2000/XP/Vista/7/8	usDevNumber (0..3)	*pvDevAddress

7.1.2 Timer Resolution

Operating System	Timer Resolution in Milliseconds
DOS	54,95 ms (18.2 ticks per second)
Windows 3.xx	54,95 ms (18.2 ticks per second)
Windows 9x	54,95 ms (18.2 ticks per second)
Windows NT	10 ms
Windows 2000/XP/Vista/7/8	10 ms
Windows CE	Platform dependent

Table 19: Timer Resolution

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7.2 DevOpenDriver()

Description:

If an application wants to communicate with a board, it must call this function first. This function checks if the device driver is available and opens a link to it. Once an link is opened, all other functions can be used. Call `DevCloseDriver()` to close the link.

```
short DevOpenDriver ( unsigned short usDevNumber);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Always 0

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.3 DevCloseDriver()

Description:

Close an open link to the device driver. An application has to call this function before it ends.

```
short DevCloseDriver ( unsigned short usDevNumber);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Always 0

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.4 DevGetBoardInfo()

Description:

With `DevGetBoardInfo()`, the user can read global information of all communication boards the device driver knows.

The users interface offers the user a data structure which describes the board information data. The function copies the number of data, given in the parameter `usSize`. This function can be used after `DevOpenDriver()` and before opening a specific DEVICE with the `DevInitBoard()` function.

```
short DevGetBoardInfo (   unsigned short       usDevNumber,
                          unsigned short       usSize,
                          void                 *pvData);
```

Parameter:

Type	Parameter	Description
unsigend short	UsDevNumber	Always 0
unsigned short	UsSize	Size of the users data buffer and length of data to be read
void *	PvData	Pointer to the users data buffer

Data structure:

```
typedef struct tagBOARD_INFO{
  unsigned char abDriverVersion[16];    // DRV version information
  struct {
    unsigned short  usBoardNumber;      // DRV board number
    unsigned short  usAvailable;        // DRV board is available
    unsigned long   ulPhysicalAddress;  // DRV physical DPM address
    unsigned short  usIrqNumber;        // DRV irq number
  } tBoard [MAX_DEV_BOARDS];
} BOARD_INFO;
```

Type	Parameter	Description
unsigned short	usNumber	Always 0
unsigned short	usAvailable	0 = board not available 1 = board available
unsigned long	ulPhysicalBoardAddress	Physical memory address
unsigned short	usIrqNumber	Number of the hardware interrupt 0 = polling mode 3,4,5,6,7,9,10,11,12,14,15 for interrupt

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.5 DevInitBoard()

Description:

After an application has opened a link to the device driver, it must call `DevInitBoard()` before it can start with the communication. `DevInitBoard()` tells the device driver that an application wants to work with a defined board. The device driver checks if the board is physical available, if the board works properly and setup up all the internal state flags for the addressed board.

The device driver works in the following order:

- Check if an communication board is known at the physical address, this is done by checking an name entry in the DPM of the board.
- Clearing the name entry in the boards DPM and write it back, to test if read and write access is possible.
- Check if the ready flag (RDY) of the boards operation system is set (1), which indicates proper board state.
- Check the boards watchdog function by reading the `HostWatchDog` number from the DPM and write it to the `DevWatchDog` cell of the DPM. The operating system has to read the number, increment it by one an write it back to the `HostWatchDog` cell.
- Check if the board is configured to run with this device driver. This function is only used by the device drivers.

Some operation systems (MSDOS, Windows 3.xx) need the physical address of the board. This address must be transmitted as a parameter. Please notice, that the physical board address and the passed address have to be the same!.

```
short DevInitBoard ( unsigned short  usDevNumber,
                     void            *pDevAddress);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
void	*pDevAddress	Pointer to the physical board address

Note: By using the Windows 9x, Windows NT or Windows 2000/XP- device driver, the physical address is needless, because the driver uses configured addresses. Set this to NULL.

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.6 DevExitBoard()

Description:

If an application wants to end communication it has to call `DevExitBoard()` for each board which has been opened by a previous call to `DevInitBoard()`. This function frees all internal driver structures and unlink itself from the communication board.

```
short DevExitBoard ( unsigned short  usDevNumber);
```

Parameter:

Type	Parameter	Description
unsigned short	UsDevNumber	Board number (0..3)

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.7 DevPutTaskParameter()

Description:

This function hands over parameter to a task. This is only possible, if the protocol picks up the parameters of the DPM.

The parameters in the DPM will only be taken over from the tasks with the next WARMSTART.

```
short DevPutTaskParameter (     unsigned short  usDevNumber,
                                unsigned short  usNumber,
                                unsigned short  usSize,
                                void            *pvData);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usNumber	Number of the parameter area (1..7)
unsigned short	usSize	Size of the parameter area and length of data to be put
void*	pvData	Pointer to the users task parameters

Please notice, that you have to put the parameters in a structure according to the protocol. The user has to build his own structure definition. The driver do not check the parameters but it checks the length of the parameter structure. If the length of the user data exceed the maximum length of the DPM area, the function call fails with an error. Invalid parameters will be reported by the protocol.

Data structure:

```
typedef struct tagTASKPARAM {
  unsigned char   abTaskParameter[64];
} TASKPARAM;
```

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.8 DevGetTaskParameter()

Description:

This function reads the task parameter area from a task.

```
short DevGetTaskParameter (     unsigned short  usDevNumber,
                                unsigned short  usNumber,
                                unsigned short  usSize,
                                void            *pvData);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usNumber	Task number (1,2)
unsigned short	usSize	Size of the users data buffer and length of data to be read
void*	pvData	Pointer to the users buffer

Please notice, that you get the parameters in a structure according to the protocol. The user has to build his own structure definition. The driver do not check the parameters but it checks the length of the parameter structure. If the length of the user data exceed the maximum length of the DPM area, the function call fails with an error.

Data structure:

```
typedef struct tagTASKPARAM {
  unsigned char   abTaskParameter[64];
} TASKPARAM;
```

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.9 DevReset()

Description:

This function provokes a reset on a communication board. The passed parameter `usMode` switches a coldstart or a warmstart.

The amount of the timeout `ulTimeout` depends on the used protocol and reset mode. A coldstart needs a longer time then a warmstart because there will be made a complete hardware check by the device operating system. Usually the time for a coldstart will be between 3 and 10 seconds, a warmstart needs between 2 and 8 seconds.

```
short DevReset (     unsigned  short usDevNumber,
                     unsigned  short usMode,
                     unsigned  long ulTimeout);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usMode	2 = COLDSTART, new initializing 3 = WARMSTART, initializing with parameters 4 = BOOTSTART, switches the board into bootstrap loader mode. COM modules uses this mode to store user parameters
unsigned long	ulTimeout	Timeout

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.10 DevSetHostState()

Description:

The `DevSetHostState()` function is used, to signal the communication board that a user application is running or not.

The utilization of the host state depends on the used communication protocol. Some of the message based and the I/O based protocols uses this state to signal a requesting station, no user application is running. I/O based protocol, such as InterBus S or PROFIBUS-DP, can use this state to shut down data transmission to other stations. On most of the protocols, the use of the host state can be configured. A detailed description can be found in the corresponding protocol manual.

```
short DevSetHostState (   unsigned short  usDevNumber,
                          unsigned short  usMode,
                          unsigned long   ulTimeout);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usMode	Function of the watchdog 0 = HOST_NOT_READY 1 = HOST_READY
unsigned long	ulTimeout	Timeout in milliseconds 0 = no timeout

The timeout parameter can be used by the user application to change the host state and wait until the communication state of the board has also changed. That means, if the host set HOST_READY and a timeout is configured, then the function returns, if the communication state of the board is ready. Otherwise a timeout occurs and the function returns with an error, which means, the board has not reached communication ready state. If the host set HOST_NOT_READY and a timeout is given, so the function will return, if the communication state of the board reaches not ready. If a timeout occurs, the communication state has not reached not ready and the function will return with an error. If no timeout is given, only the used host state will be written to the communication board. No further check will be done. The timeout period depends on the used bus system and varies between 100 ms up to several seconds.

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.11 Message Transfer Functions

Following functions are defined for message transfer:

- DevGetMBXState()
- DevPutMessage()
- DevGetMessage()

7.11.1 DevGetMBXState()

Description:

This function reads the actual state of the host and device mailbox of a communication board. You can use this function for writing applications to poll the device without waiting for device events.

```
short DevGetMBXState (     unsigned short  usDevNumber,
                           unsigned short  *pusDevMBXState,
                           unsigned short  *pusHostMBXState);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	*pusDevMBXState	Pointer to user buffer, to hold the device mailbox state 0 = DEVICE_MBX_EMPTY 1 = DEVICE_MBX_FULL
unsigned short	*pusHostMBXState	Pointer to user buffer, to hold the host mailbox state 0 = HOST_MBX_EMPTY 1 = HOST_MBX_FULL

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.11.2 DevPutMessage()

Description:

This function sends (transfers) a message to the communication board. The function copies the number of data, given in the length entry (msg.ln) of the message structure and the message header.

If no timeout (`ulTimeout` = 0) is used, the function returns immediately. The return code shows if the function was able to write the message to the device or not. If a timeout (`ulTimeout` != 0) is used and the send mailbox of the device is empty, the message is written to the mailbox and the function returns also immediately. If the mailbox is full, the function will wait until the mailbox is free. If this does not happen during the timeout duration, the function returns with an error code. How the timeout is realized depends on the mode the DEVICE is configured. Polling mode will run a loop in the driver while waiting the timeout duration. In interrupt mode the calling application will block to free the CPU for other work..

```
short DevPutMessage (     unsigned short  usDevNumber,
                          MSG_STRUC       *ptMessage,
                          unsigned long   ulTimeout);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
MSG_STRUC*	ptMessage	Pointer to the message data
unsigned long	ulTimeout	Timeout in milliseconds 0 = no timeout

The message have to be compatible to the message format and it must be consistent, according to the protocol. The structure of the standard message is located in the users interface header file.

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Message structure:

```
#pragma pack(1)
// max. length is 288 Bytes, max. message length is 255 + 8 Bytes
typedef struct tagMSG_STRUC {
  unsigned char   rx;                    // Receiver
  unsigned char   tx;                    // Transmitter
  unsigned char   ln;                    // Length
  unsigned char   nr;                    // Number
  unsigned char   a;                 // Answer
  unsigned char   f;                 // Fault
  unsigned char   b;                 // Command
  unsigned char   e;                 // Extension
  unsigned char   data[ 255];            // Data
      unsigned char   dummy[25];             // for compatibility with older
                                         // versions
} MSG_STRUC;
#pragma pack()
```

Notice: For more information about the message structure refer to the corresponding manual.

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.11.3 DevGetMessage()

Description:

This function reads a message out of the dual port memory (DPM) of a communication board and puts it into the data buffer that is given by the user. The function checks if the message fits in the users data buffer. This is done by comparing the parameter `usSize` with the length which is given in the message structure. If the message doesn't fit, the function will fail and returns an error.

If no timeout (`ulTimeout` = 0) is used, the function returns immediately. The return code shows if the function was able to read a message from the device or not. If a timeout (`ulTimeout` != 0) is used and a message is available, the function reads the message and returns also immediately. If no message is available, the function will wait until a message is available. If this does not happen during the timeout duration, the function returns with an error code.

How the timeout is realized depends on the mode the DEVICE is configured. Polling mode will run a loop in the driver while waiting the timeout duration. In interrupt mode the calling application will blocked to free the CPU for other work..

```
short DevGetMessage (     unsigned        short usDevNumber,
                          unsigned        short usSize,
                          MSG_STRUC       *ptMessage,
                          unsigned long   ulTimeout);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usSize	Size of the users data buffer (maximum length to be read)
MSG_STRUC*	ptMessage	Pointer to the users data area
unsigned long	ulTimeout	Timeout in milliseconds 0 = no timeout

Notice, the size of the user data buffer has to be large enough to hold all the data of a message. The maximum length of a message can be taken from the message structure in the users interface header file.

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Message structure:

```
#pragma pack(1)
// max. length is 288 Bytes, max. message length is 255 + 8 Bytes
typedef struct tagMSG_STRUC {
  unsigned char   rx;                    // Receiver
  unsigned char   tx;                    // Transmitter
  unsigned char   ln;                    // Length
  unsigned char   nr;                    // Number
  unsigned char   a;                 // Answer
  unsigned char   f;                 // Fault
  unsigned char   b;                 // Command
  unsigned char   e;                 // Extension
  unsigned char   data[ 255];            // Data
  unsigned char   dummy[25];             // for compatibility with older
                                     // versions
} MSG_STRUC;
#pragma pack()
```

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.12 DevGetTaskState()

Description:

This function reads one of the task state areas of a DEVICE. The data will be transferred into the user data buffer. The function copies the number of data, given in the parameter `usSize`.

```
short DevGetTaskState (   unsigned short  usDevNumber,
                          unsigned short  usNumber,
                          unsigned short  usSize,
                          void            *pvData);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usNumber	Number of the state area (1,2)
unsigned short	usSize	Size of the users data buffer (maximum length to be read)
void*	pvData	Pointer to the users data buffer

To handle the data, please use the structures given by the protocols.

Notice, the maximum size of the area given by the user can be taken from the task parameter structure in the users interface header file.

Data structures:

```
typedef struct tagTASKSTATE {
  unsigned char   abTaskState[64];
} TASKSTATE;
```

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.13 DevGetInfo()

Description:

This function reads the various information out of the DPM of a communication board and the driver internal state information for a board. The information that can be read are as followed:

- Driver state information GET_DRIVER_INFO
- Board version information GET_VERSION_INFO
- Board firmware information GET_FIRMWARE_INFO
- Task information area GET_TASK_INFO
- Board operation system information GET_RCS_INFO
- Device information area GET_DEV_INFO
- Device IO information GET_IO_INFO
- Device IO send data GET_IO_SEND_DATA

The function copies the number of data, given in the parameter `usSize`. The information areas which are located in DPM of a board are defined in the device documentation. For each area you can find a structure definition in the user interface header file.

```
short DevGetInfo (   unsigned short       usDevNumber,
                     unsigned short       usInfoArea,
                     unsigned short       usSize,
                     void                 *pvData);
```

Parameters:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usInfoArea	Defines which area to be read: 1 = GET_DRIVER_INFO 2 = GET_VERSION_INFO 3 = GET_FIRMWARE_INFO 4 = GET_TASK_INFO 5 = GET_RCS_INFO 6 = GET_DEV_INFO 7 = GET_IO_INFO 8 = GET_IO_SEND_DATA
unsigned short	usSize	Size of the user data buffer and Number of byte to read
void*	pvData	Pointer to the user data buffer

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Defined data structures:

```
// GETINFO information definitions
#define GET_DRIVER_INFO     1
// Internal driver state information structure
typedef struct tagDRIVERINFO{
  unsigned long ulOpenCnt;      // DevOpen() counter
  unsigned long ulCloseCnt;          // DevClose() counter (not used)
  unsigned long ulReadCnt;      // Number of DevGetMessage() commands
  unsigned long ulWriteCnt;          // Number of DevPutMessage() commands
  unsigned long ulIRQCnt;            // Number of board interrupts
  unsigned char bInitMsgFlag;        // Actual init state
  unsigned char bReadMsgFlag;        // Actual read mailbox state
  unsigned char bWriteMsgFlag;       // Actual write mailbox state
  unsigned char bLastFunction;       // Last driver function
  unsigned char bWriteState;         // Actual write command state
  unsigned char bReadState;          // Actual read command state
  unsigned char bHostFlags;          // Actual host flags
  unsigned char bMyDevFlags;         // Actual device flags
  unsigned char bExIOFlag;      // Actual IO flags
  unsigned long ulExIOCnt;      // DevExchangeIO() counter
} DRIVERINFO;

#define GET_VERSION_INFO    2
// Serial number and OS versions information
typedef struct tagVERSIONINFO {
  unsigned long   ulDate;            // Manufactor date        (BCD coded)
  unsigned long   ulDeviceNo;        // Device number          (BCD coded)
  unsigned long   ulSerialNo;        // Serial number          (BCD coded)
  unsigned long   ulReserved;        // reserved
  unsigned char   abPcOsName0[4];    // Operating system code 0     (ASCII)
  unsigned char   abPcOsName1[4];    // Operating system code 1     (ASCII)
  unsigned char   abPcOsName2[4];    // Operating system code 2     (ASCII)
  unsigned char   abOemIdentifier[4];     // OEM reserved          (ASCII)
} VERSIONINFO;

#define GET_FIRMWARE_INFO   3
// Device firmware information
typedef struct tagFIRMWAREINFO {
  unsigned char abFirmwareName[16];  // Firmware name          (ASCII)
  unsigned char abFirmwareVersion[16];// Firmware version      (ASCII)
} FIRMWAREINFO;

#define GET_TASK_INFO       4
// Device task information
typedef struct tagTASKINFO {
  struct  {
    unsigned char     abTaskName[8]; // Taskname               (ASCII)
    unsigned short usTaskVersion;    // Task version      (number)
    unsigned char  bTaskCondition;   // Actual task state
    unsigned char  abreserved[5];    // reserved
  } tTaskInfo [7];
} TASKINFO;
```


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```
#define GET_RCS_INFO        5
// Device operating system (RCS) information
typedef struct tagRCSINFO {
  unsigned short usRcsVersion;  // Device RCS version          (number)
  unsigned char  bRcsError;     // Operating system errors
  unsigned char  bHostWatchDog; // Host watchdog value
  unsigned char  bDevWatchDog;  // Device watchdog value
  unsigned char  bSegmentCount; // RCS segment free counter
  unsigned char  bDeviceAdress; // RCS device base address
  unsigned char  bDriverType;   // RCS driver type
} RCSINFO;

#define GET_DEV_INFO        6
// Device description
typedef struct tagDEVINFO {
  unsigned char  bDpmSize;      // Device DPM size (2,8..)(number)
  unsigned char  bDevType;      // Device type       (number)
  unsigned char  bDevModel;          // Device model           (number)
  unsigned char  abDevIdentifier[3]; // Device identification  (ASCII)
} DEVINFO;

#define GET_IO_INFO         7
// Device exchange IO information
typedef struct tagIOINFO {
  unsigned char   bComBit;      // Actual state of the COM bit (0,1)
  unsigned char   bIOExchangeMode;   // Actual data exchange mode   (0..5)
  unsigned long   ulIOExchangeCnt;   // Exchange IO counter
} IOINFO;
```

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.14 DevTriggerWatchdog()

Description:

The DevTriggerWatchdog() command can be used to check the device operating system for normal operation. The parameter function determines what action on the boards watchdog should be done (WATCHDOG_START, WATCHDOG_STOP).

The function reads the PcWatchDog cell and write it to the DevWatchDog cell of the DPM. Writing a number unequal to zero into the DevWatchDog cell of the DPM, the watchdog function of the board is activated. Since the watchdog is activated, the application must trigger the watchdog within the time which is defined in the protocols database.

The application must not generate a watchdog counter, because the operating system of the board increments the watchdog counter. This is done by giving an unequal number (1) in the PcWatchDog. The trigger function take this number and write it to the DevWatchDog cell. If the operating system reads a number unequal to zero from the DevWatchDog then it increments the number and write it back to the PcWatchDog cell. Every time the function is called, it returns the actual watchdog counter to the application. So, if the application reads the same counter value twice or more after the call to the trigger function, the board failed. To stop the watchdog, the function writes a 0 to the DevWatchDog cell. After this the boards operating system stops the watchdog checking.

```
short DevTriggerWatchDog (unsigned short usDevNumber,
                          unsigned short usFunction,
                          unsigned short *usDevWatchDog);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usFunction	Function of the watchdog 0 = WATCHDOG_STOP 1 = WATCHDOG_START
unsigned short*	usDevWatchDog	Pointer to a user buffer, where the watchdog counter value can be written to

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.15 Process Data Transfer Functions

Following functions are defined for process data transfer:

- **DevExchangeIO()**
  Is the standard function for the data transfer of process image data. Only general bus errors are detected by this function. To get error information about specific devices, the function DevGetTaskState() must be used after each call to DevExchangeIO() to read the task information field.
- **DevExchangeIOErr()**
  Is an extension of the DevExchangeIO() function. This function contains the COMSTATE structure as an parameter, where device specific data's will be transferred by each call to the function. No additional call of DevGetTaskState() are required.
- **DevExchangeIOEx()**
  This function is a special function to work with COM modules.
- **DevReadSendData()**
  This function can be used to read back the send process image from a device

Attention: By using DevExchangeIO()it is not possible for master devices to recognize the fault of a specific bus device. Only global errors like whole bus disruptions or communication breaks to all configured device will be indicated by this function. To get specific device fault, the application must read the "TaskState-Field", where device specific data's are located.

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7.15.1 DevExchangeIO()

Description:

The `DevExchangeIO()` function is used, to send I/O data to and receive I/O data from a communication board. This function is able to send and receive I/O data at once. If one of the size parameter is set to zero, no action will be taken for the corresponding function. This means, if `usSendSize` is set to zero, send data will not be written to the board. If `usReceiveSize` is set to zero, receive data will not be read from the board.

The user can wait until a complete action is done, by the use of `ulTimeout`. If an timeout occurs, the function will return with an error. If no timeout is given, the function will return immediately.

The function will automatically recognize the synchronization mode of the process data transfer and handle it in the defined way.

Attention: Only general bus errors are detected by this function. Use DevGetTaskState() after each call to DevExchangeIO() to read the task information field and to check device specific errors.

```
short DevExchangeIO (     unsigned short  usDevNumber,
                          unsigned short  usSendOffset,
                          unsigned short  usSendSize,
                          void            *pvSendData,
                          unsigned short  usReceiveOffset,
                          unsigned short  usReceiveSize,
                          void            *pvReceiveData,
                          unsigned long   ulTimeout);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usSendOffset	Byte offset in the send IO data area of the communication board
unsigned short	usSendSize	Length of the send IO data
void*	pvSendData	Pointer to the user send data buffer
unsigned short	usReceiveOffset	Byte offset in the receive IO data area of the communication board
unsigned short	usReceiveSize	Length of the send IO data
void*	pvReceiveData	Pointer to the user read data buffer
unsigned long	ulTimeout	Timeout in milliseconds 0 = no timeout

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.15.2 DevExchangeIOErr()

Description:

`DevExchangeIOErr()` is an extension of the `DevExchangeIO()` function. The handling for sending and receiving I/O data acts in the same way like in the `DevExchangeIO()` function.

Furthermore, the function has an additional parameter which holds state information according to the configured bus devices. This information is only available on master DEVICEs (PROFIBUS-DP master, InterBus-S master etc.).

Normally the DEVICE will set its communication ready bit (COM flag) if at least one of the configured bus devices is connected and running properly. If more modules are configured, the COM flag can not signal an error for a specific device. The COM flag is only able to indicate global failures like whole bus disruptions or communication breaks to all configured devices. In this case the state field information can be used to detect errors of a specific bus device.

Please check, if the DEVICE firmware of the master device supports the several modes of state field handling.

```
short DevExchangeIOErr(   unsigned short  usDevNumber,
                          unsigned short  usSendOffset,
                          unsigned short  usSendSize,
                          void            *pvSendData,
                          unsigned short  usReceiveOffset,
                          unsigned short  usReceiveSize,
                          void            *pvReceiveData,
                          COMSTATE        *ptState,
                          unsigned long   ulTimeout);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usSendOffset	Byte offset in the send IO data area of the communication board
unsigned short	usSendSize	Length of the send IO data
void*	pvSendData	Pointer to the user send data buffer
unsigned short	usReceiveOffset	Byte offset in the receive IO data area of the communication board
unsigned short	usReceiveSize	Length of the send IO data
void*	pvReceiveData	Pointer to the user read data buffer
COMSTATE	ptComState	Pointer to the user COMSTATE buffer
unsigned long	ulTimeout	Timeout in milliseconds 0 = no timeout

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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COMSTATE structure definition:

```
// Communication state field structure
typedef struct tagCOMSTATE {
  GLD16U      usMode;                // Actual mode
  GLD16U      usStateFlag;           // State flag
  GLD8U       abState[64];           // State area
} COMSTATE;
```

The COMSTATE structure can be transferred on each function call.

- usMode Defines the actual configured transfer mode of the state field
  0xFF = Not supported by the firmware
  3 = Cyclic transfer of the state field including the state error flag (usStateFlag)
  4 = Event driven transfer of the state field including the usStateFlag
- usStateFlag
  0 = No entries in the state field (abState[])
  1 = Entries in the state available
- abState[64] Buffer of the actual state field. Refer to the protocol interface manual for a description of the state buffer.

Example:

```
  // Read process image and state field information
  if ( (sRet = DevExchangeIOErr( usBoardNumber,
                                 0,
                                 0,
                                 NULL,
                                 usReadOffset,
                                 usReadSize,
                                 &abIOReadData[0],
                                 &tComState,
                                 100L)) == DRV_NO_ERROR) {
    // Check state field transfer mode
    switch ( tComState.usMode) {

      case STATE_MODE_3:
        // Check state field usStateFlag signals entrys
        if ( tComState.usStateFlag != 0) {
          // Show COM errors
        }
        break;

      case STATE_MODE_4:
        // Check state field usStateFlag signals new entrys
        if ( tComState.usStateFlag != 0) {
          // Show COM errors
        }
        break;

           default:
        // State mode unknown or not implemented
        // Read the task state field by yourself
        if ( (sRet = DevGetTaskState(....) ) != DRV_NO_ERROR) {
          // Error by reading the task state
        }
        break;

    } /* end switch */
  }
```


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7.15.3 DevExchangeIOEx()

Description:

The DevExchangeIOEx() function is created for the use with COM modules. It works in the same way like the DevExchangeIO() function, except the data transfer mode must be defined by the application.

COM modules are normally not able to signal the actual data transfer modes to the device driver, which means the driver can not decide how to act with the DPM. Therefore the DevExchangeIOEx() function gets a new parameter which tells the driver how to handle the DPM.

The configuration of the COM modules are done by writing WARMSTRART parameters to the board. During configuration, the user defines the IO data transfer mode. The configured mode must be given the DevExchangeIOEx() function to make sure the driver handles the DPM in the right manner.

```
short DevExchangeIOEx (   unsigned short  usDevNumber
                          unsigned short  usMode,
                          unsigned short  usSendOffset,
                          unsigned short  usSendSize,
                          void            *pvSendData,
                          unsigned short  usReceiveOffset,
                          unsigned short  usReceiveSize,
                          void            *pvReceiveData,
                          unsigned long   ulTimeout);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usMode	Data transfer mode (0..4)
unsigned short	usSendOffset	Byte offset in the send IO data area of the communication board
unsigned short	usSendSize	Length of the send IO data
void*	pvSendData	Pointer to the user send data buffer
unsigned short	usReceiveOffset	Byte offset in the receive IO data area of the communication board
unsigned short	usReceiveSize	Length of the send IO data
void*	pvReceiveData	Pointer to the user read data buffer
unsigned long	ulTimeout	Timeout in milliseconds 0 = no timeout

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.16 DevReadWriteDPMRaw()

Description:

The `DevReadWriteDPMRaw()` function can be used to read and write every byte in the last KByte of the DPM except the last two bytes. It is up to the user to protect important data in DPM against overwriting.

```
short DevReadWriteDPMRaw (unsigned short usDevNumber,
                          unsigned short usMode,
                          unsigned short usOffset,
                          unsigned short usSize,
                          void           *pvSendData);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usMode	1 = PARAMETER_READ 2 = PARAMETER_WRITE
unsigned short	usOffset	Byte offset in DPM of the communication board (0..1022)
unsigned short	usSize	Length of the send IO data to be read
void*	pvData	Pointer to the user data buffer

The definition structure definition RAWDATA can be used as a data buffer definition.

```
// Device raw data structure
typedef struct tagRAWDATA {
  unsigned char   abRawData[1022];        /* Definition of the last kByte
} RAWDATA;
```

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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7.17 DevDownload()

Description:

The `DevDownload()` function can be used to either load a firmware or configuration file to the hardware.

The whole data transfer will be executed in the download function. Therefore, the function loads the file into memory and transfers it from the memory to the hardware. The transfer function is running in a "loop", so no other activity during a download is possible.

Firmware files must have a correct file extension, which is check in the download function. Configuration files will be check by the operating system and rejected, if the database name is not known on the hardware.

```
short DevDownload(        unsigned short  usDevNumber,
                          unsigned short  usMode,
                          unsigned char   *pszFileName,
                          DWORD           *pdwBytes);
```

Parameter:

Type	Parameter	Description
unsigned short	usDevNumber	Board number (0..3)
unsigned short	usMode	1 = FIRMWARE_DOWNLOAD 2 = CONFIGURATION_DOWNLOAD
unsigned char*	pszFilename	Pointer to the filename with or without a complete path description. This must be a multibyte string zero terminated.
DWORD*	pdwBytes	Pointer to a dword value which receives the number of bytes transferred to the hardware

Return values:

Value	Description
DRV_NO_ERROR	0 = No error

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8 Error Numbers

8.1 List of Error Numbers

The column hint shows if there are additional information. If 'Yes' then see chapter *hints to error numbers*, which is the next chapter.

Value	Error Name	Description
0	DRV_NO_ERROR	no error
-1	DRV_BOARD_NOT_INITIALIZED	DRIVER Board not initialized The communication board is not initialized by the driver. No or wrong configuration found for the given board. - Check the driver configuration - Driver function used without calling DevOpenDriver() first
-2	DRV_INIT_STATE_ERROR	DRIVER Error in internal init state
-3	DRV_READ_STATE_ERROR	DRIVER Error in internal read state
-4	DRV_CMD_ACTIVE	DRIVER Command on this channel is active
-5	DRV_PARAMETER_UNKNOWN	DRIVER Unknown parameter in function occurred
-6	DRV_WRONG_DRIVER_VERSION	DRIVER Version is incompatible with DLL The device driver version does not corresponds to the driver DLL version. From version V1.200 the internal command structure between DLL and driver has changed. - Make sure to use the same version of the device driver and the driver DLL
-7	DRV_PCI_SET_CONFIG_MODE	DRIVER Error during PCI set run mode
-8	DRV_PCI_READ_DPM_LENGTH	DRIVER Could not read PCI dual port memory length
-9	DRV_PCI_SET_RUN_MODE	DRIVER Error during PCI set run mode
-10	DRV_DEV_DPM_ACCESS_ERROR	DEVICE Dual port ram not accessible (board not found) Dual ported RAM (DPM) not accessible / no hardware found. This error occurs, when the driver is not able to read or write to the DPM - Check the BIOS setting of the PC - Memory address conflict with other PC components, try another memory address - Check the driver configuration for this board - Check the jumper setting of the board
-11	DRV_DEV_NOT_READY	DEVICE Not ready (ready flag failed) Board is not ready. This is a general error, the board has a hardware malfunction.
-12	DRV_DEV_NOT_RUNNING	DEVICE Not running (running flag failed) At least one task is not initialized. The board is ready but not all tasks are running. - No data base is loaded into the device - Wrong parameter that causes that a task can't initialize. Use ComPro menu Online-task-version.
-13	DRV_DEV_WATCHDOG_FAILED	DEVICE Watchdog test failed
-14	DRV_DEV_OS_VERSION_ERROR	DEVICE Signals wrong OS version No license code found on the communication board. - Device has no license for the used operating system or customer software. - No firmware or no data base on the device loaded.
-15	DRV_DEV_SYSERR	DEVICE Error in dual port flags
-16	DRV_DEV_MAILBOX_FULL	DEVICE Send mailbox is full

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Value	Error Name	Description
-17	DRV_DEV_PUT_TIMEOUT	DEVICE PutMessage timeout No message could be send during the timeout period given in the `DevPutMessage()` function. - Using device interrupts Wrong or no interrupt selected. Check interrupt on the device and in driver registration. They have to be the same!. Interrupt already used by an other PC component. - Device internal segment buffer full `PutMessage()` function not possible, because all segments on the device are in use. This error occurs, when only `PutMessage()` is used but not `GetMessage()`. - HOST flag not set for the device No messages are taken by the device. Use DevSetHostState() to signal a board an application is available.
-18	DRV_DEV_GET_TIMEOUT	DEVICE GetMessage timeout No message received during the timeout period given in the DevGetMessage() function. - Using device interrupts Wrong or no interrupt selected. Check interrupt on the device and in driver registration. They have to be the same!. Interrupt already used by an other PC component. - The used protocol on the device needs longer than the timeout period given in the DevGetMessage() function
-19	DRV_DEV_GET_NO_MESSAGE	DEVICE No message available
-20	DRV_DEV_RESET_TIMEOUT	DEVICE RESET command timeout The device needs longer than the timeout period given in the DevReset() function - Using device interrupts This error occurs when for example interrupt 9 is set in the driver registration but no or a wrong interrupt is jumpered on the device (=device in pollmode). Interrupt already used by an other PC component. - The timeout period can differ between fieldbus protocols
-21	DRV_DEV_NO_COM_FLAG	DEVICE COM-flag not set The device can not reach communication state. - Device not connected to the fieldbus - No station found on the fieldbus - Wrong configuration on the device
-22	DRV_DEV_EXCHANGE_FAILED	DEVICE IO data exchange failed
-23	DRV_DEV_EXCHANGE_TIMEOUT	DEVICE IO data exchange timeout The device needs longer than the timeout period given in the DevExchangeIO() function. - Using device interrupts Wrong or no interrupt selected. Check interrupt on the device and in driver registration. They have to be the same!. Interrupt already used by an other PC component.
-24	DRV_DEV_COM_MODE_UNKNOWN	DEVICE IO data mode unknown
-25	DRV_DEV_FUNCTION_FAILED	DEVICE Function call failed
-26	DRV_DEV_DPMSIZE_MISMATCH	DEVICE DPM size differs from configuration
-27	DRV_DEV_STATE_MODE_UNKNOWN	DEVICE State mode unknown

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Value	Error Name	Description
-30	DRV_USR_OPEN_ERROR	USER Driver not opened (device driver not loaded) The device driver could not be opened. - Device driver not installed - Wrong parameters in the driver configuration If the driver finds invalid parameters for a communication board and no other boards with valid parameters are available, the driver will not be loaded. - Security Problems under Windows Vista/7/8. This can be checked by starting the application as administrator.
-31	DRV_USR_INIT_DRV_ERROR	USER Can't connect with device
-32	DRV_USR_NOT_INITIALIZED	USER Board not initialized (DevInitBoard not called)
-33	DRV_USR_COMM_ERR	USER IOCTRL function failed A driver function could not be called. This is an internal error between the device driver and the DLL. - Make sure to use a device driver and a DLL with the same version. - An incompatible old driver DLL is used.
-34	DRV_USR_DEV_NUMBER_INVALID	USER Parameter DeviceNumber invalid
-35	DRV_USR_INFO_AREA_INVALID	USER Parameter InfoArea unknown
-36	DRV_USR_NUMBER_INVALID	USER Parameter Number invalid
-37	DRV_USR_MODE_INVALID	USER Parameter Mode invalid
-38	DRV_USR_MSG_BUF_NULL_PTR	USER NULL pointer assignment
-39	DRV_USR_MSG_BUF_TOO_SHORT	USER Message buffer too short
-40	DRV_USR_SIZE_INVALID	USER Parameter Size invalid
-42	DRV_USR_SIZE_ZERO	USER Parameter Size with zero length
-43	DRV_USR_SIZE_TOO_LONG	USER Parameter Size too long
-44	DRV_USR_DEV_PTR_NULL	USER Device address null pointer
-45	DRV_USR_BUF_PTR_NULL	USER Pointer to buffer is a null pointer
-46	DRV_USR_SENDSIZE_TOO_LONG	USER Parameter SendSize too long
-47	DRV_USR_RECVSIZE_TOO_LONG	USER Parameter ReceiveSize too long
-48	DRV_USR_SENDBUF_PTR_NULL	USER Pointer to send buffer is a null pointer
-49	DRV_USR_RECVBUF_PTR_NULL	USER Pointer to receive buffer is a null pointer
-50	DRV_DMA_TIMEOUT_CH4	DMA read IO timeout
-51	DRV_DMA_TIMEOUT_CH5	DMA write IO timeout
-52	DRV_DMA_TIMEOUT_CH6	DMA PCI transfer timeout
-53	DRV_DMA_TIMEOUT_CH7	DMA download timeout
-54	DRV_DMA_INSUFF_RES_MEM	DMA Memory allocation error
-70	DRV_ERR_ERROR	DRIVER General error
-71	DRV_DMA_ERROR	DRIVER General DMA error
-72	DRV_BATT_ERROR	DRIVER Battery error
-73	DRV_PWF_ERROR	DRIVER Power failed error
-80	DRV_USR_DRIVER_UNKNOWN	USER driver unknown
-81	DRV_USR_DEVICE_NAME_INVALID	USER device name invalid
-82	DRV_USR_DEVICE_NAME_UKNOWN	USER device name unknown
-83	DRV_USR_DEVICE_FUNC_NOTIMPL	USER device function not implemented
-100	DRV_USR_FILE_OPEN_FAILED	USER file not opened
-101	DRV_USR_FILE_SIZE_ZERO	USER file size zero
-102	DRV_USR_FILE_NO_MEMORY	USER not enough memory to load file
-103	DRV_USR_FILE_READ_FAILED	USER file read failed

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Value	Error Name	Description
-104	DRV_USR_INVALID_FILETYPE	USER file type invalid
-105	DRV_USR_FILENAME_INVALID	USER file name not valid
-110	DRV_FW_FILE_OPEN_FAILED	USER firmware file not opened
-111	DRV_FW_FILE_SIZE_ZERO	USER firmware file size zero
-112	DRV_FW_FILE_NO_MEMORY	USER not enough memory to load firmware file
-113	DRV_FW_FILE_READ_FAILED	USER firmware file read failed
-114	DRV_FW_INVALID_FILETYPE	USER firmware file type invalid
-115	DRV_FW_FILENAME_INVALID	USER firmware file name not valid
-116	DRV_FW_DOWNLOAD_ERROR	USER firmware file download error
-117	DRV_FW_FILENAME_NOT_FOUND	USER firmware file not found in the internal table
-118	DRV_FW_BOOTLOADER_ACTIVE	USER firmware file BOOTLOADER active
-119	DRV_FW_NO_FILE_PATH	USER firmware file not file path
-120	DRV_CF_FILE_OPEN_FAILED	USER configuration file not opened
-121	DRV_CF_FILE_SIZE_ZERO	USER configuration file size zero
-122	DRV_CF_FILE_NO_MEMORY	USER not enough memory to load configuration file
-123	DRV_CF_FILE_READ_FAILED	USER configuration file read failed
-124	DRV_CF_INVALID_FILETYPE	USER configuration file type invalid
-125	DRV_CF_FILENAME_INVALID	USER configuration file name not valid
-126	DRV_CF_DOWNLOAD_ERROR	USER configuration file download error
-127	DRV_CF_FILE_NO_SEGMENT	USER no flash segment in the configuration file
-128	DRV_CF_DIFFERS_FROM_DBM	USER configuration file differs from database
-131	DRV_DBM_SIZE_ZERO	USER database size zero
-132	DRV_DBM_NO_MEMORY	USER not enough memory to upload database
-133	DRV_DBM_READ_FAILED	USER database read failed
-136	DRV_DBM_NO_FLASH_SEGMENT	USER database segment unknown
-150	DEV_CF_INVALID_DESCRIPT_VERSION	CONFIG version of the descript table invalid
-151	DEV_CF_INVALID_INPUT_OFFSET	CONFIG input offset is invalid
-152	DEV_CF_NO_INPUT_SIZE	CONFIG input size is 0
-153	DEV_CF_MISMATCH_INPUT_SIZE	CONFIG input size does not match configuration
-154	DEV_CF_INVALID_OUTPUT_OFFSET	CONFIG invalid output offset
-155	DEV_CF_NO_OUTPUT_SIZE	CONFIG output size is 0
-156	DEV_CF_MISMATCH_OUTPUT_SIZE	CONFIG output size does not match configuration
-157	DEV_CF_STN_NOT_CONFIGURED	CONFIG Station not configured
-158	DEV_CF_CANNOT_GET_STN_CONFIG	CONFIG cannot get the Station configuration
-159	DEV_CF_MODULE_DEF_MISSING	CONFIG Module definition is missing
-160	DEV_CF_MISMATCH_EMPTY_SLOT	CONFIG empty slot mismatch
-161	DEV_CF_MISMATCH_INPUT_OFFSET	CONFIG input offset mismatch
-162	DEV_CF_MISMATCH_OUTPUT_OFFSET	CONFIG output offset mismatch
-163	DEV_CF_MISMATCH_DATA_TYPE	CONFIG data type mismatch
-164	DEV_CF_MODULE_DEF_MISSING_NO_SI	CONFIG Module definition is missing,(no Slot/Idx)
>=1000	RCS_ERROR	Board operation system errors will be passed with this offset (e.g. error 1234 means RCS error 234). Only if a ready fault occurred during board initialization.

Table 20: Error Numbers of CIF Device Driver

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9 Development Environments

This chapter includes information about various development environments and tools. It is not possible for us to check our software with all tools from all companies, which offer such tools. As long as a tool can work with DLLs (Dynamic Link Libraries) it should be possible to integrate our API into applications created with such tools.

For the development of our software, we only using Microsoft development tools and we try to use only ANSI-C functionality's.

If you encounter problems to access our API (Libs and DLLs) from your application, there are some ways to solve this problems.

On the 16 bit platform DOS/Windows3.xx and a C software development tool from another manufacturer you should be able to recompile our software with your C development tools.

On the 32 bit platform Windows 9x, Windows NT and Windows 2000 you have several choices to access our API. In general you have to use our interface DLL (CIF32DLL.DLL) and there are two ways to accessing a 32 bit DLL by an application. The possible ways are described in the following chapter.

Binding of dynamic link libraries:

On the Windows platform, there are two ways to connect (bind) a DLL to an application.

The first one is static (early) binding of a DLL. This is done by linking the DLL definition file xxxxx.LIB to an application. As a result, the DLL will be loaded during the program startup sequence. If the DLL is not available, the program will be aborted with the error message "Could not found dynamic link library xxxxxx.DLL".

Some development tools are not able to use the definition files created by a Microsoft compiler. Therefore it is maybe possible to use the second way for binding a DLL to an application. This way is named dynamic (late) binding of a DLL. Dynamic binding is done by loading the DLL during program runtime. Therefor, the Windows API offers the function 'LoadLibrary()' and 'FreeLibrary()'.

'LoadLibrary()' will load the DLL into system memory and returns a handle to the given DLL. Only the file name of the DLL as an ASCII string is needed to do this. FreeLibrary() must be used to release the resources of an previously loaded DLL. The next step is to get the procedure address of the wanted DLL function. This can be done by the 'GetProcAddress()' function. This function takes the function name as an ASCII string. After reading the procedure address from the DLL, the function can be called from an application. Only a proper function declaration in the application is required to call this function.

The advantage by doing this is the following, an application can start without the existence of the DLL, because the application can determine when to load the DLL.

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Example of using dynamic Linking of DLLs

The following example will show you the modification in CIFUSER.H for the use with the Borland C-Builder V1.0.

Example: Modification for cifuser.h to call `DevOpenDriver()`

```
// ---------------------------------------------------------------------
// Header file
// Function prototype definition
extern "C" {
     typedef short APIENTRY (*FDevOpenDriver)(unsigned short usDevNumber)
     ..... etc.
}
// ---------------------------------------------------------------------

// ---------------------------------------------------------------------
// Source file
// Pointer definition
FDevOpenDriver      DevOpenDriver=NULL;
.....
..... etc.

// Macro for GetProcAddress function
#define DLLExport(DLL, Name) (Name=F##Name(GetProcAddress(hDLL,#Name)))
With this macro it is possible to easily export a function from a driver DLL.
// Application
hDLL=LoadLibrary( "CIFxxDLL");  // Get a handle to the driver DLL
DLLExport( hDLL, DevOpenDriver);     // Get a function procedure address
                           // by using the macro
// Or use the standard way to get the function address without a macro
DevOpenDriver = (FDevOpenDriver)GetProcAddress( hDLL, "DevOpenDriver");

// Call the driver function
sRet = DevOpenDriver( usDevNumber);
```

Make sure to check all return values and pointers from each function. Otherwise it is possible to get "general protection faults" when calling functions with unloaded pointers.

This will show you only one example how to use `LoadLibrary()` and `GetProcAddress()`. Please refer to the manuals of your development environment how to use dynamic binding of DLLs.

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9.1 Microsoft Software Development Tools

9.1.1 Visual Basic 3.0, 4.0 (16 bit)

It is possible to use the device driver with Visual Basic. Therefore we created a definition file CIFDEV.BAS. This file describes the function definitions and the data structures for the driver function.

9.1.2 Microsoft Visual Basic 4.0, 5.0 (32 bit)

32 bit Visual Basic uses another structure definition. This defines all elements of a structure as WORD aligned. This means each element of a data structure starts on an even memory address. If there is a BYTE followed by a WORD element, the structure will be extended by a dummy BYTE.

All data structures in the device driver DLL are BYTE aligned. There is no data extension for structures. Therefore not all of the driver defined data structures can be used in a Visual Basic application like defined in the CIFDEV.BAS file. But all structures can be read from the driver by using byte arrays.

At the moment, it is up to the user to convert the byte arrays into the driver data structures given in CIFDEV.BAS.

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9.2 Borland Software Development Tools

For the most of the Borland development tools, it is not possible to statically link DLLs created by the Microsoft C compiler. Furthermore some of the definitions in our CIFUSER.H file are also not known by the Borland tools

The following points will describe what to do if you encounter problems by using the CIFUSER.H file and by binding our DLL.

9.2.1 Borland C 5.0, Borland C-Builder V1.0

1. Convert the Microsoft DLL into a Borland DLL

Borland C offers a conversion program to convert Microsoft DLL into definition file which is excepted by the Borland C compiler.

The program is named "IMPLIB.EXE and is also able to convert our API-DLL into a Borland acceptable definition file (xxxx.LIB).

Please refer to the corresponding Borland manual how to use this tool.

Notice:	This program should be used from the Borland C 5.0 compiler or later and the version of "IMPLIB.EXE" should be equal or greater 2.0.140.1.

Example use of "IMPLIB.EXE" to convert the driver DLL to a Borland DLL

Usage: **IMPLIB** *NewBorland.lib* **CIF32DLL.DLL**

2. Definition for use of our functions with C++

```
#ifdef __cplusplus
  extern "C" {
#endif  /* _cplusplus */

#ifdef __cplusplus
}
#endif  /* _cplusplus */
```

Borland defines __cplusplus as _cplusplus with only one underline.

3. Prototype definition for DLL functions in CIFUSER.H

```
short APIENTRY DevOpenDriver        ( unsigned short usDevNumber);
```

APIENTRY is not known by Borland. APIENTRY is defined as __stdcall which describes the calling convention of the DLL function.

You can easily change the definition by including definition line on the top of the header file or outside of the header file which can look like:

```
#define APIENTRY
(This will define APIENTRY as nothing)
```


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9.2.2 Borland Delphi

Delphi is the graphical development environment from Borland and works with Pascal. Also with Borland Delphi, you have the choice to either static or dynamic binding of a DLL.

Notice: Make sure to use standard calling convention (__stdcall) when defining the driver functions.

1. Static binding

```
Function DevOpenDriver(usDevNumber: word): smallint; stdcall; external
'CIF32DLL.DLL';
Function DevInitBoard(usDevNumber: word; pDevAdress : pointer):smallint; stdcall;
external 'CIF32DLL.DLL';
Function DevCloseDriver(usDevNumber: word): smallint; stdcall; external'CIF32DLL.DLL';
Function DevExitBoard(usDevNumber: word): smallint; stdcall; external'CIF32DLL.DLL';
Function DevGetMessage(usDevNumber: word; size : word;var ptMessage : T_Msg_Struct;
time_out : longint): smallint; stdcall; external 'CIF32DLL.DLL';
Function DevPutMessage(usDevNumber: word;var ptMessage : T_Msg_Struct; time_out :
longint): smallint; stdcall; external 'CIF32DLL.DLL';
type
     T_Msg_Struct = record // packed
                rx   : byte;
                tx   : byte;
                ln   : byte;
                nr   : byte;
                a    : byte;
                f    : byte;
                b    : byte;
                e    : byte;
                data : array[1..255] of byte;
                dummy: array[1..25] of byte;
     end;
var
     Msg_Struct : T_Msg_Struct;
procedure Test;
var
     erg  : integer;
begin
     erg:= DevOpenDriver(0);
     erg:= DevInitBoard(0,NIL);
     erg:= DevPutMessage(0,Msg_Struct,100);
     erg:= DevGetMessage(0,sizeof(Msg_Struct),Msg_Struct,100);
     erg:= DevExitBoard(0);
     erg:= DevCloseDriver(0);
end;
```


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2. Dynamic binding

Create a type definition for the function you want to call from the API.

Example DevOpenDriver():

```
type tDevOpenDriver(usDevNumber: word): smallint; stdcall;
```

Load the DLL with LoadLibrary()/FreeLibrary() and read the procedure address from the function by the call to GetProcAddress();

Program example:

```
hHandle := LoadLibrary("CIF32DLL.DLL");
pt := GetProcAddress( hHandle, "DevOpenDriver");
(tDevOpenDriver)pt.(0);
.......
FreeLibrary( hHandle);
```

9.2.3 National Instruments CVI LabWindows 4.1

CVI Lab Windows supports the development of Microsoft C compatible programs. So the library file which comes with our API-DLL can be used directly. Only the definition **APIENTRY** in our CIFUSER.H file is not included in the Microsoft C development environment.

Include the following line into your source code before including the CIFUSER.H file:

```
#define APIENTRY __stdcall
```


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10 Appendix

10.1 List of Tables

10.2 List of Figures

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10.3 Contacts

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