

FlexCard PMC2 PXIe3 and PCIe3 Ethernet UserManual



NOTICE

ESD (Electro Static Discharge) sensitive product.

Refer to chapter 1.4 and follow the safety and handling instructions.

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			Page 2 of 25

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Any semiconductor devices have an inherent chance of failure. You have to protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over-current levels and other abnormal operating conditions. The safety and handling instructions in this document have to be followed strictly.

Revision History

Document number: 3-0094-0A01-D16

Version	Date	Description
D1V0-F	06-Oct-2021	First Release
D1V0a-F	15-Feb-2022	Added information about Jumbo frames (chapter troubleshooting)

Related Hardware / Software Versions

Product	Reference No.	Version	Remarks
FlexCard PMC-II hardware	3-0055-0A02	15	
FlexCard PXIe3 hardware	3-0094-0B01	50	
FlexCard PCIe3 hardware	3-0095-0B01	20	

3-0094-0A01-D16_FlexCard_PMC2_PXIe3_PCIe3_Ethernet_UserManual_D1V0a-F.docx

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Date created	2022-02-15	Date modified	2022-02-15	Page 3 of 25

Contents

1	General	6
1.1	Intended User Group	6
1.2	Intended Use	6
1.3	Used Pictograms	7
1.4	Safety and Handling Instructions	8
1.5	Meaning of Text Styles	9
2	Getting Started	10
2.1	Software Installation and Update	10
2.1.1	Preconditions	10
2.1.2	Installation	10
2.1.3	Uninstallation	13
2.2	Available Operating Modes	14
2.2.1	FlexCard PMC-II	14
2.2.2	FlexCard PXle3/PCIe3	14
2.3	Firmware Update	14
2.3.1	FlexCard PMC-II	14
2.3.2	FlexCard PXle3/PCIe3	14
2.4	License Update	14
2.5	Supported FlexTiny Modules	14
2.5.1	FlexCard PMC-II	15
2.5.2	FlexCard PXle3/PCIe3	15
2.6	Connector Pinout	15
2.6.1	FlexCard PMC-II	15
2.6.2	FlexCard PXle3/PCIe3	15
3	FlexCard PMC2/PXle3/PCIe3 Usages	16
3.1	FlexCard API	16
3.2	Network Adapter Settings	16
3.2.1	100BASE-T1 Master Setting	16
3.2.2	Speed Duplex Setting	16
3.3	Sc_WinPcap	17
3.3.1	Packet Timestamp	17
3.3.2	OID interface	18
3.3.3	Sc_basic_dump	18
3.3.4	Sc_sendpack	18
3.4	NDIS	18
3.5	Changing the MAC Address	19
4	Performance	20
4.1	Wireshark	20
4.2	Process Priority	20
4.3	sc_wpcap Kernel Buffer	20
4.4	sc_wpcap Read Timeout	20
4.5	sc_wpcap Packet Counters	20
4.6	Fceth/fcxeth Packet Counters	20
5	Troubleshooting	21
6	Ordering Information	22

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6.1	FlexCard PMC2/PXle3/PCIe3	22
6.2	Accessory Parts	22
6.3	Related Documents.....	22
7	Appendix.....	23
7.1	Appendix A: Guideline for handling ESD sensitive Products.....	23
7.2	Appendix B:	23
7.2.1	Acronyms and Abbreviations	23
7.2.2	List of Tables	24
7.2.3	List of Figures	24

3-0094-0A01-D16_FlexCard_PMC2_PXle3_PCIe3_Ethernet_UserManual_D1V0a-F.docx

Created by	STAR ELECTRONICS GmbH & Co. KG		
Date created	2022-02-15	Date modified	2022-02-15
			Page 5 of 25

1 General

1.1 Intended User Group

This product may only be used by expert technicians and/or engineers who are qualified and familiar with electronic components and systems.

Each person involved with setup or operation of the product must

- be a qualified technician or engineer
- strictly adhere to this manual
- receive a briefing by an authorized person

	NOTICE
	<p>If you are unsure of how to use the product as intended or have any questions about the use of the product, please discontinue use of the product immediately and contact the STAR ELECTRONICS GmbH & Co. KG Support.</p>

	⚠ WARNING
	<p>The product may only be used by expert technicians and/or engineers who are qualified and familiar with electronic components and systems!</p> <p>The use of the product by non-professionals is not permitted and strictly forbidden!</p>

1.2 Intended Use

The FlexCard PMC2/PXIe3/PCIe3 is a testing equipment. It was developed to test the communication behavior of automotive bus systems and Ethernet together with Electronics Control Units and sensors in a fully controlled testing and/or laboratory environment.

For this intended use, the FlexCard PMC2/PXIe3/PCIe3 offers the following options:

- Transmit and receive data (e.g. Use Case “Remaining Bus Simulation”).
- Exchange of data traffic between two or more bus systems (e.g. Use Case “Gateway”)
- Manipulation of data traffic (e.g. Use Case “Manipulation of signal values based on user configuration”)
- Recording of data traffic (e.g. Use Case “Logging”)

Any deviation from the intended use and/or installation in a testing vehicle is only permitted with specific **prior written approval** of STAR ELECTRONICS GmbH & Co. KG.

	 WARNING
	<p>The FlexCard PMC2/PXle3/PCle3 may be used to communicate with networked electronic systems. E.g. FlexRay, CAN or Ethernet.</p> <p>Any use of the product outside a fully controlled testing and/or laboratory environment may result in death or serious injury due to unpredictable behavior of a vehicle and/or potentially missing, deactivated, or malfunctioning safety devices on a vehicle!</p> <p>The user is responsible to ensure the safety of the entire system. This includes amongst other things a safety shutdown.</p>

	NOTICE
	<p>The device is not a calibrated measurement device. STAR ELECTRONICS GmbH & Co. KG accepts no liability whatsoever for the correctness of any measurement results.</p>

	 WARNING
	<p>The FlexCard PMC2/PXle3/PCle3 is NOT designed, intended, or authorized and may NOT be used for or in connection with the following purposes and/or devices:</p> <ul style="list-style-type: none"> - use as part of medical systems - life support applications - aviation, space, nuclear, or military applications - use in areas where combustible or explosive gas mixtures are likely to occur - any other purposes / devices deviating from the intended use of the product specified by STAR ELECTRONICS GmbH & Co. KG.

	 WARNING
	<p>The product may only be used by expert technicians and/or engineers who are qualified and familiar with electronic components and systems!</p> <p>The use of the product by non-professionals is not permitted and strictly forbidden!</p>

1.3 Used Pictograms

The meaning of used pictograms is shortly described below.

Follow the specific instructions in the document where these pictograms are placed.

	WARNING
	Used to indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	NOTICE
	Used to indicate a situation which may result in an operating failure. Damage of the product may occur, but there is no hazard of injury if not avoided.
	Reference
	References to other documents.

1.4 Safety and Handling Instructions

Please read the instructions for use carefully. To protect the device or the application against damage, or to avoid personal injury the FlexCard PMC2/PXle3/PCle3 has to be handled as described herein.

Changes or modifications of the FlexCard PMC2/PXle3/PCle3 is not allowed for safety and warranty reasons!

STAR ELECTRONICS GmbH & Co. KG is not liable for any damages arising from non-observance of the product information.

Follow the

- a) specific safety and handling instructions placed at dedicated document positions
- b) general safety and handling instructions below:

	NOTICE
	<p>To prevent damage to the FlexCard PMC2/PXle3/PCle3, or consequential damages: Use only adapter cables from STAR ELECTRONICS GmbH & Co. KG for connecting the FlexCard PMC2/PXle3/PCle3.</p> <p>High temperatures can damage the FlexCard PMC2/PXle3/PCle3. Keep the FlexCard PMC2/PXle3/PCle3 away from heaters, stoves, fireplaces, and other sources of heat.</p> <p>Do not expose the FlexCard PMC2/PXle3/PCle3 to rain or use it near water.</p> <p>Do not use the FlexCard PMC2/PXle3/PCle3 in areas of explosion hazard.</p>

	NOTICE
	<p>To prevent irreversible damages to the FlexCard PMC2/PXle3/PCle3: Avoid any direct current flow through the housing of the device or the shield of the Binder connectors!</p> <p>Do not connect any other signals to the interfaces as described in the chapter 6.2 Accessory Parts. Ensure that all signals are within the specified range.</p> <p>Attention: The warranty is lost if the device is damaged by not avoiding such current flow or connecting any signals which are out of range.</p>

NOTICE	
	<p style="text-align: center;">ESD (Electro Static Discharge) sensitive product</p> <p><i>STAR ELECTRONICS GmbH & Co. KG</i> products lacking protective enclosures are subject to damage by ESD.</p> <p>Take proper ESD precautions to avoid performance degradation or loss of functionality!</p> <p>Unpack, handle or operate these products only in environments where sufficient precautionary measures have been taken in respect to ESD hazards. A guideline is available in chapter 7.1.</p> <p>Only appropriately trained personnel (such as electricians, technicians and engineers) may handle and/or operate these products.</p>

1.5 Meaning of Text Styles

In this document *filenames* are marked with a different text format.

2 Getting Started

2.1 Software Installation and Update

2.1.1 Preconditions

	NOTICE
	<p>On all operating systems administrator access rights are required to install the device driver.</p>

The minimum system requirements for installing and running the FlexCard PMC2/PXle3/PCIe3 hardware and software are:

Microsoft Windows 10 64 bit with or without Secure Boot

- Computer/Processor: 2 GHz or faster AMD/Pentium-compatible processor
- 2 GB of RAM
- Display: VGA or higher-resolution monitor
- Peripheral keyboard and mouse or compatible pointing device
- FlexCard PMC-II: Free PMC/PCI slot.
- FlexCard PXle3: Free PXle peripheral slot.
- FlexCard PCIe3: Free PCIe slot (1 PCIe lane or more).
- Microsoft Visual C++ 2010 Redistributable Package (x86)
- Microsoft Visual C++ 2010 Redistributable Package (x64)

2.1.2 Installation

Please note that the following steps should be taken in the right order. If you update from a previous Version, please uninstall the old driver before you continue.

Step 1

Mount the FlexTiny modules onto the FlexCard. Mount the FlexCard hardware to the PC. Please note that the FlexCard hardware contains devices sensitive to electro-static discharge.

Step 2

Start the PC. Windows may show the “New Hardware Wizard” dialog one time or two times. Cancel these dialogs.

Step 3

Install FlexCard Setup (*FlexCard_Setup_xyz.msi*). In the device manager, under Multifunction devices, there should be an entry “FlexCard PMC II”, “FlexCard PXle3”, or “FlexCard PCIe3”.

Step 4

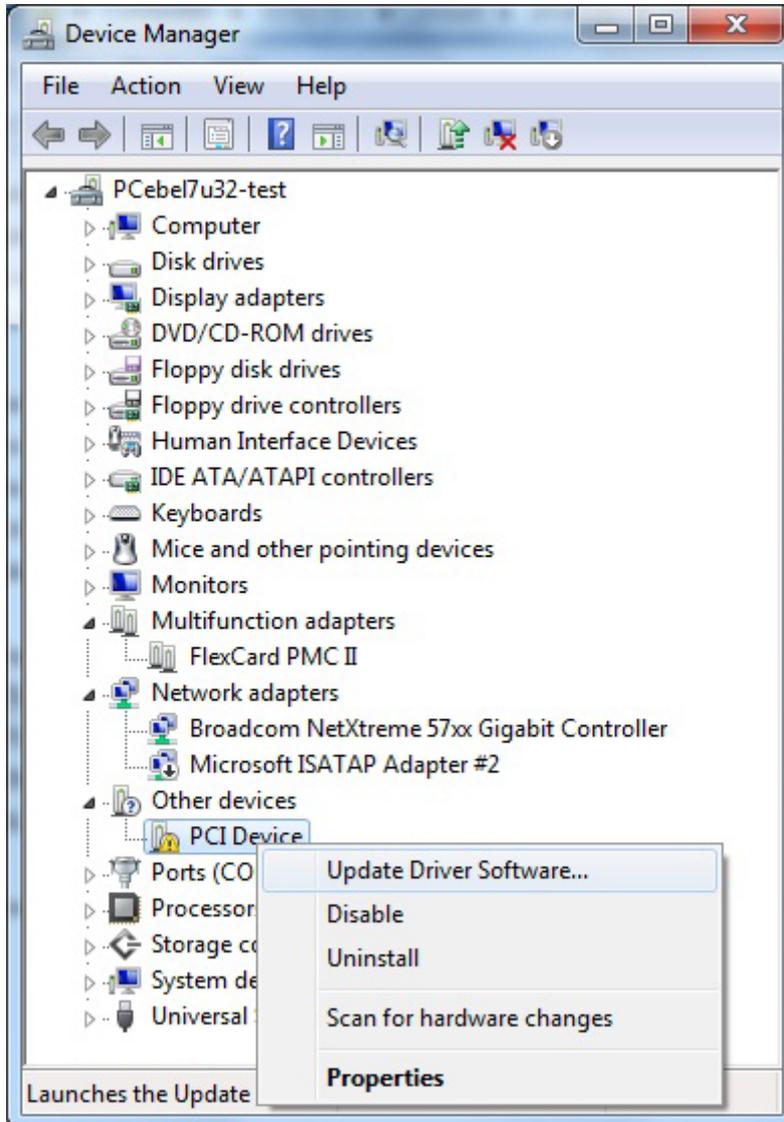


Figure 1: Other device in the device manager

In the device manager, right click on the unknown device.

Select “*Update Driver software...*”, click on “*Search for driver software on the PC*”, click on “*Browse*” and choose the directory where *.inf file is located. By default the drivers are installed into the following directory:

C:\Program Files\StarCooperation\FlexCard\bin\driver

Following table lists what device requires what driver. The column “Driver name” shows how the driver is displayed in the device manager under Multifunction adapters.

Device	Driver	Driver name	ProductId (hexadecimal)
FlexCard PMC-II	Fceth	FlexCardEth	0x11
FlexCard PXle3, FlexCard PCIe3	Fcxeth	FlexCardEthX	0x1A or 0x1B

Information	
	<p>In case there are multiple unknown devices, choose the one with “VendorId 1974”. VendorId and ProductId of the connected hardware can be found when you open the Properties in the device manager. Then select the tab Details and choose Hardware Ids. The table above shows what driver is required for what device.</p>

In the device manager, under network adapters, there should now be an entry with the driver name that is shown in the table above.

Step 5

Go to the control panel, network and internet, network and sharing center, manage network connections.

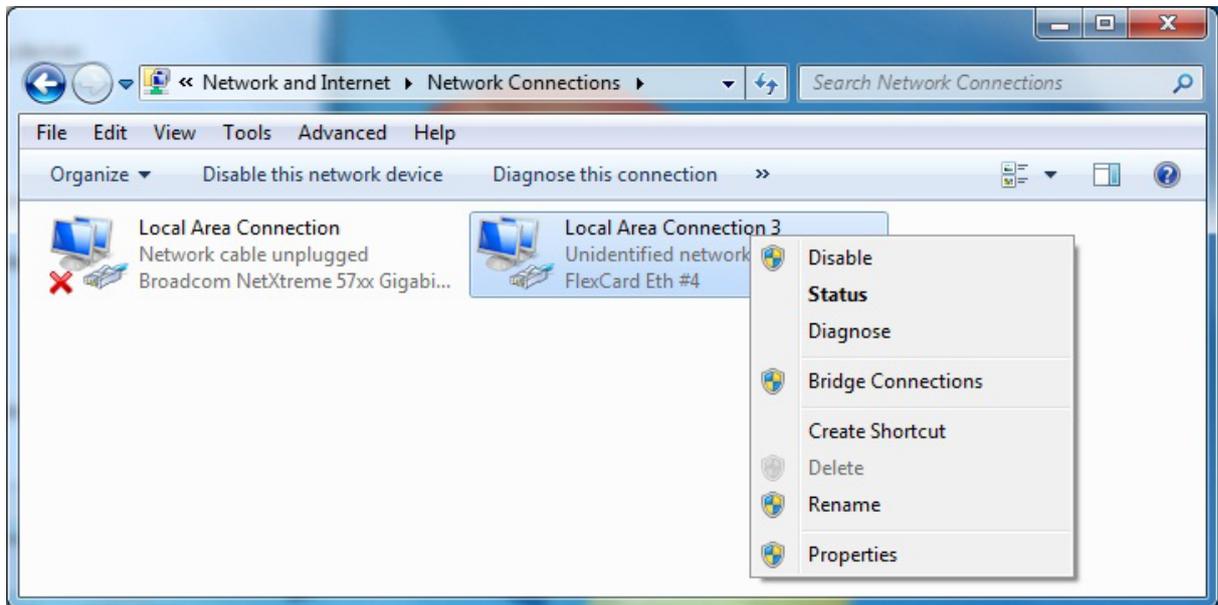


Figure 2: Network Connections window

Right-click on the FlexCard Ethernet device and select “properties”. Then select *Install -> Protocol -> Add*. Click on “Have disk”, select “Browse” and select the folder where *sc_npf.inf* is located. By default the driver is installed into the following directory:

C:\Program Files\StarCooperation\FlexCard\bin\driver\Sc_WinPcap

In the properties for the FlexCard Ethernet device there should now be an entry “STAR COOPERATION NetGroup Packet Filter”.

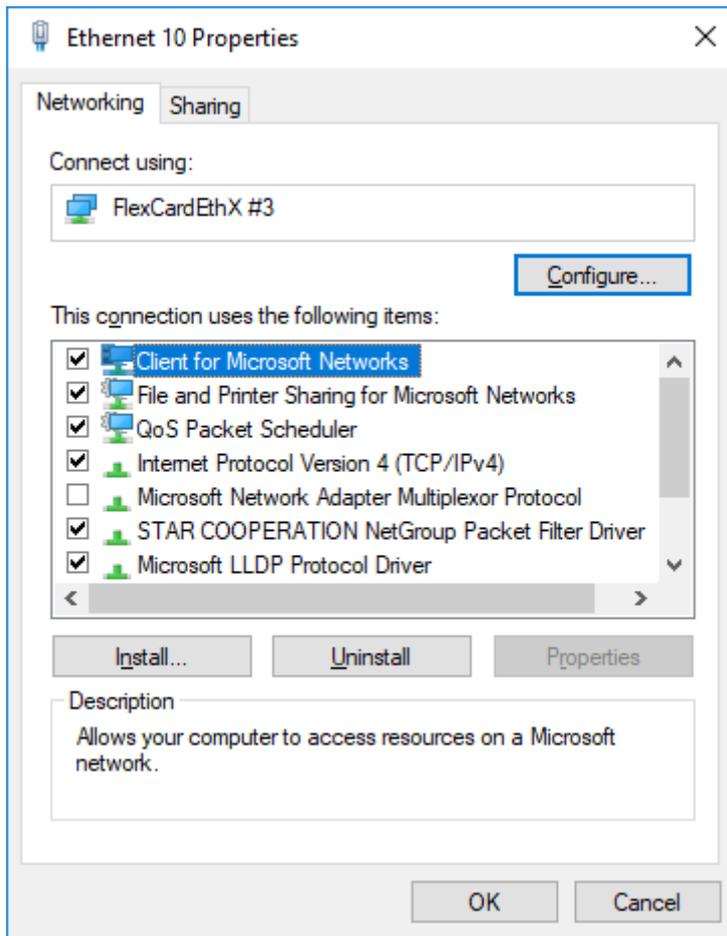


Figure 3: Network connection properties

	Information
	A restart is necessary so that the FlexCard Ethernet device is recognized by Sc_wpcap!

Now you can connect the Ethernet cable with the FlexCard. Refer to [1] and [3] for a picture of the front panel.

2.1.3 Uninstallation

Step 1

Connect the FlexCard hardware to your computer.

Step 2

Go to the control panel, network and internet, network and sharing center, manage network connections.

Right-click on the FlexCard Ethernet device and select “*properties*”. Select “STAR COOPERATION NetGroup Packet Filter” and click on “*Uninstall*”.

Step 3

Go to the Windows Device Manager, select Multifunction Devices. Right click on every FlexCard hardware and choose “*Uninstall*”. Activate the checkbox “*Delete driver software for this device*”.

Step 4

If necessary, uninstall the FlexCard Setup.

2.2 Available Operating Modes

2.2.1 FlexCard PMC-II

The FlexCard PMC-II has only one operating mode.

2.2.2 FlexCard PXIe3/PCIe3

The FlexCard PXIe3/PCIe3 have three operating modes. The FlexCard can only be used as Windows network card, when the operating mode is "*FlexCard Mode*".

	Reference
	<p>More information about the available operation modes of the FlexCard PXIe3/PCIe3 can be found in [1]. In this document it is also described how to switch the operating mode.</p>

2.3 Firmware Update

2.3.1 FlexCard PMC-II

In order to update the firmware, refer to the document [4].

2.3.2 FlexCard PXIe3/PCIe3

In order to update the firmware, refer to the document [5].

2.4 License Update

To update the FlexCard PMC2/PXIe3/PCIe3 with a new license file, refer to the document [4].

2.5 Supported FlexTiny Modules

Following FlexTiny modules are supported by the FlexCard. In case an unsupported FlexTiny module or no FlexTiny is mounted, the FlexCard Eth/ FlexCard EthX driver is displayed with a warning icon in the device manager. In this case, the FlexCard is not usable.

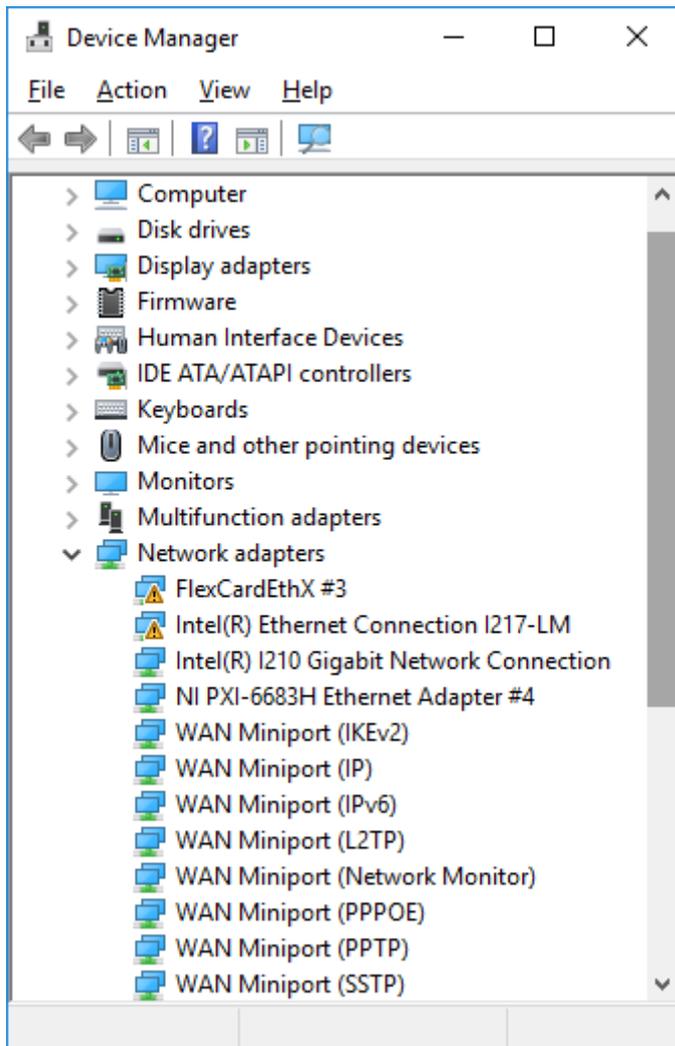


Figure 4: Device manager when the FlexCard has an invalid FlexTiny configuration

2.5.1 FlexCard PMC-II

- FlexTiny 2 Ethernet DP83640 (3-0056-0D01)

2.5.2 FlexCard PXIe3/PCIe3

- FlexTiny 3 ETH_BR (3-0088-2C02)

2.6 Connector Pinout

The pinout of the connectors can be found below.

2.6.1 FlexCard PMC-II

Refer to document [6].

2.6.2 FlexCard PXIe3/PCIe3

Refer to document [7].

3 FlexCard PMC2/PXle3/PCle3 Usages

3.1 FlexCard API

	Reference
	<p>The automotive networks FlexRay, CAN, CAN FD are controlled via FlexCard API.</p> <p>How to use the FlexCard API is described in the document “<i>API Documentation.pdf</i>” in the FlexCard installation folder.</p>

3.2 Network Adapter Settings

The network adapter settings are done via Windows device manager. Open network adapters, select the FlexCardEth or FlexCardEthX, right click on it, select Properties. Go to the tab “Advanced”.

3.2.1 100BASE-T1 Master Setting

The following figure shows the options for the 100BASE-T1 master setting. This setting is only relevant when the bus system is 100BASE-T1.

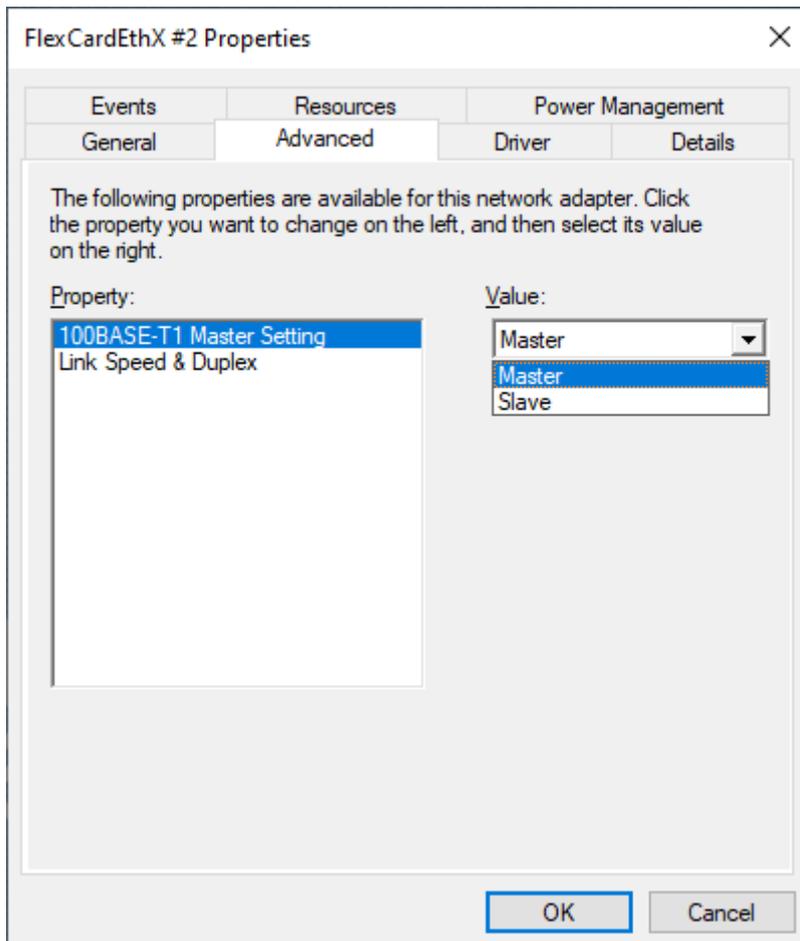


Figure 5: Device manager – advanced settings - master setting

3.2.2 Speed Duplex Setting

The following figure shows the options for the speed duplex setting. This setting is only relevant when the bus system is 100BASE-TX.

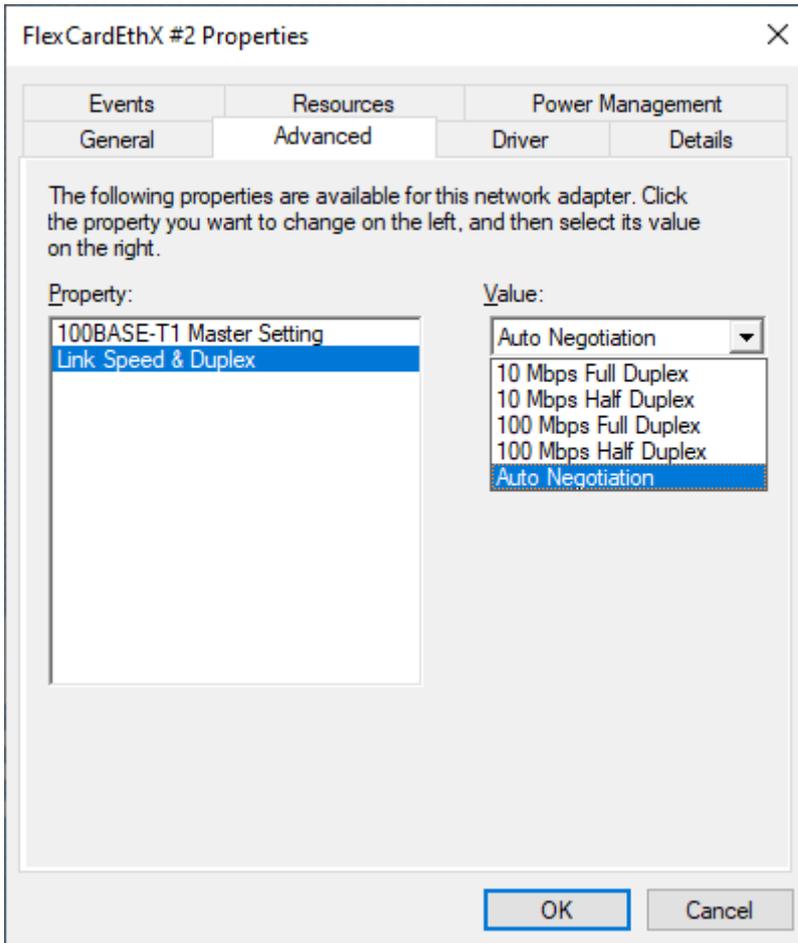


Figure 6: Device manager – advanced settings - speed duplex setting

3.3 Sc_WinPcap

Sc_WinPcap is used for raw Ethernet support including hardware timestamps for received packets. Only the *sc_wpcap.dll* has a documented interface. *sc_packet.dll* is not documented. The API of *sc_wpcap.dll* is identical to the API of *wpcap.dll*. Its documentation may be found at

<https://www.winpcap.org/docs/>

3.3.1 Packet Timestamp

The hardware timestamp is placed in the `timeval` variable in the `pcap_pkthdr struct`.

To calculate the timestamp in the same format as the FlexRay/CAN-packets, following conversion has to be performed:

```
unsigned long long timestamp = (((unsigned long long)header->ts.tv_sec)
    *1000*1000)+((unsigned long long)header->ts.tv_usec); //timestamp in usec
```

It is also possible to read the 64 bit timestamp from the hardware. To do that, call `fcGetCurrentHighResTimeStamp` from the `fcBase` API. It counts in units of 1 microsecond.

3.3.1.1 FlexCard PMC-II

The Ethernet packet timestamp uses the same timestamp as the HighResTimestamp, except that the Ethernet packet timestamp uses the lower 4 byte from the HighResTimestamp. It overflows after 4294967295 microseconds (4295 seconds).

3.3.1.2 FlexCard PXIe3/PCIe3

The Ethernet packet timestamp uses the same timebase as the packets returned by the fcBase API. Internally, the ethernet timestamp counts in units of nanoseconds and is 64 bits wide. It overflows after 213504 days. The timestamp is converted to the time_val format which limits the number of seconds that can be counted to $2^{32}-1 = 4294967295$.

	Information
	<p>The FlexCard ethernet only supports timestamps in rx direction (packets that were recieved by the FlexCard).</p> <p>Packets in tx direction have the field header->ts set to the system time.</p>

3.3.2 OID interface

sc_packet.dll may be used to request OIDs via following function:

```
BOOLEAN PacketRequest(LPADAPTER AdapterObject, BOOLEAN Set, PPACKET_OID_DATA OidData)
```

See also the example application “Ebel_Test_RCV_CRC_ERROR” which is contained in the software package.

3.3.3 Sc_basic_dump

The example *sc_basic_dump* shows how to receive ethernet packets via *sc_winpcap*. It is a console application. It displays the packets that were received or transmitted via the FlexCard. The timestamp is also displayed for each packet.

3.3.4 Sc_sendpack

The example *sc_sendpack* shows how to send packets via *sc_winpcap*. It is a console application. It sends a single packet with ethertype 0x0C 0x0D.

3.4 NDIS

The FlexCard is recognized as a normal Ethernet card. It works together with the standard Windows protocols like the TCP/IP-Stack. NDIS specifies an interface that can be used for example to set the promiscuous mode or read the Ethernet statistics from the FlexCard. With OIDs (Object Identifier) it is possible to get or set properties from a Network interface card. Only network protocol drivers and *sc_packet.dll* can send OID requests to the FlexCard Ethernet card.

Example 1:

The `OID_GEN_STATISTICS` is used to read statistic information from a NIC. The request contains the address of the NIC and the answer contains a filled `NDIS_STATISTICS_INFO` structure.

```
Typedef struct NDIS_STATISTICS_INFO {
    NDIS_OBJECT_HEADER Header;
    ULONG SupportedStatistics;
    ULONG64 ifInDiscards;
    ULONG64 ifInErrors;
    ULONG64 ifHCInOctets;
    ULONG64 ifHCInUcastPkts;
    ULONG64 ifHCInMulticastPkts;
    ULONG64 ifHCInBroadcastPkts;
    ULONG64 ifHCOutOctets;
    ULONG64 ifHCOutUcastPkts;
    ULONG64 ifHCOutMulticastPkts;
    ULONG64 ifHCOutBroadcastPkts;
    ULONG64 ifOutErrors;
    ULONG64 ifOutDiscards;
    ULONG64 ifHCInUcastOctets;
    ULONG64 ifHCInMulticastOctets;
```

```

ULONG64 ifHCInBroadcastOctets;
ULONG64 ifHCOutUcastOctets;
ULONG64 ifHCOutMulticastOctets;
ULONG64 ifHCOutBroadcastOctets;
} NDIS_STATISTICS_INFO, *PNDIS_STATISTICS_INFO;
    
```

Example 2:

The `OID_GEN_RCV_CRC_ERROR` is used to read the number of packets with an FCS error. NDIS returns a DWORD (4 byte) with the counter.

3.5 Changing the MAC Address

The physical MAC address is stored in the FlexTiny module. It may be replaced by a software MAC address via Windows registry. This procedure is described below:

Start the registry editor with `regedit.exe`.

Navigate to following key:

`HKLM\System\CurrentControlSet\Control\Class{4d36e972-e325-11ce-bfc1-08002be10318}\`

The subkeys exist in the form of `0001, 0002, 0003, ...`

Select the subkey of the FlexCardEth/FlexCardEthX driver. This key must contain the key `DriverDesc` that contains the value "FlexCardEth" or "FlexCardEthX".

Open the string value "NetworkAddress". Enter the MAC address without a separator between the bytes. E.g.: "70B3D53BF3B2".

The change takes effect after performing one of the following actions:

- Deactivate and activate the driver
- Reboot the PC

Information	
	To use the physical MAC address from the device, set the value "NetworkAddress" to "FFFFFFFFFFFF".

After re-installing the driver, the MAC address is reset to the physical address.

4 Performance

4.1 Wireshark

Wireshark is not appropriate for logging high data rates. See this site:

<http://packetlife.net/blog/2011/mar/9/long-term-traffic-capture-wireshark/>

“A reader recently asked for my opinion on building a server to be dedicated to network traffic capturing with Wireshark. While Wireshark is an excellent packet analysis application, its graphical interface is quite demanding on system resources (memory in particular) and is intended for use only in low-throughput environments or offline packet analysis (where packets are read from a file on disk).”

Therefore, it is recommended to use a console based logging application.

4.2 Process Priority

You may set the priority of the logging application to “Above Normal” or “High” so that sc_wpcap gets more CPU time. This will improve the performance of the FlexCard Ethernet driver.

4.3 sc_wpcap Kernel Buffer

The standard configuration of *sc_wpcap.dll* is not appropriate for high data rates. By default, it uses a 1 MB kernel buffer.

Use following function to set the size of the sc_wpcap kernel buffer:

```
int pcap_setbuff (pcap_t *p, int dim)
```

Recommended is at least 4 MB, better more. However, you should not allocate very large chunks because kernel memory is a limited resource.

4.4 sc_wpcap Read Timeout

For very high requirements on data integrity, use following function with `to_ms = -1`:

```
pcap_t* pcap_open_live (
    const char * device,
    int snaplen,
    int promisc,
    int to_ms,
    char * ebuf
)
```

This eliminates the read timeout and can lead to a CPU core being completely busy.

4.5 sc_wpcap Packet Counters

Use following function to read the packet counters:

```
int pcap_stats (
    pcap_t * p,
    struct pcap_stat * ps
)
```

`ps->ps_drop` contains the number of packets dropped due to insufficient performance.

4.6 Fceth/fcxeth Packet Counters

Use **OID_GEN_STATISTICS** to read the number of packets dropped by the miniport driver due to insufficient performance. The next table shows the relevant variables inside the struct **NDIS_STATISTICS_INFO**.

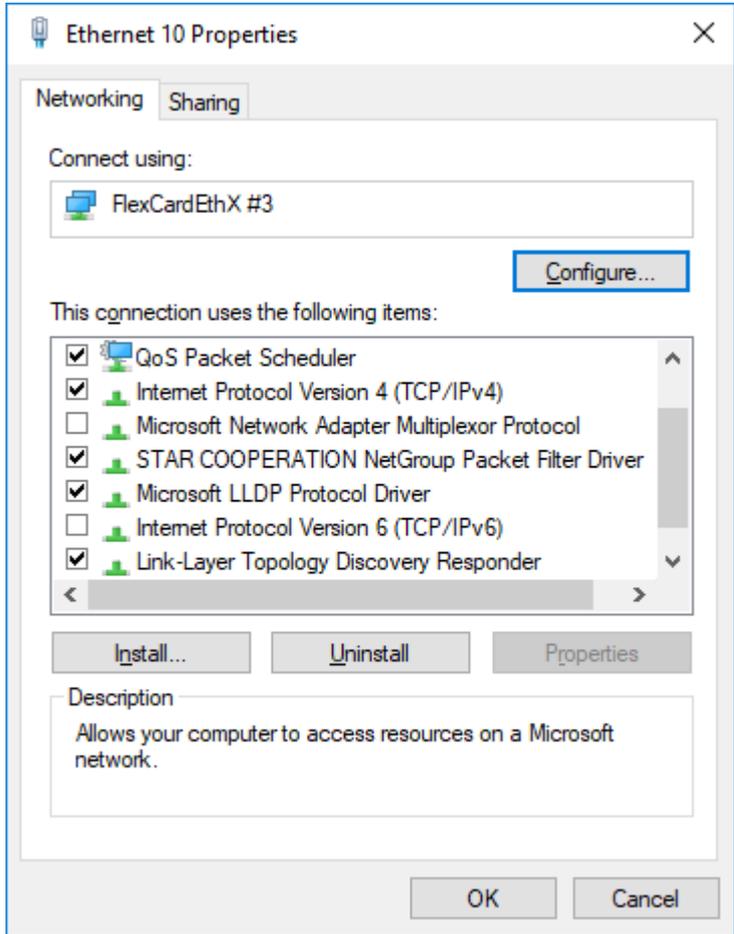
ULONG64	ifInDiscards
ULONG64	ifInErrors
ULONG64	ifOutDiscards
ULONG64	ifOutErrors

5 Troubleshooting

This chapter contains some frequently asked questions about the FlexCard PMC2/PXle3/PCle3 Ethernet.

1	Issue	fcResetTimestamp is called but the timestamp of the Ethernet packets from <code>sc_wpcap</code> show no timestamp reset.
	Solution	Probably the application links against the standard <code>wpcap</code> which uses the system time as timestamp.

2	Issue	<code>Sc_wincap</code> shows packets with unexpected timestamps
	Solution	Rx packets (packets that are sent from a testpartner to the FlexCard) and Tx packets (packets that are sent from the FlexCard) have different time basis. See chapter 3.2.1.

3	Issue	Various connection problems appear. The connection problems might be caused by IPv6. Deactivate it in the network properties:
	Solution	

4	Issue	Unexpected behavior occurs when the FlexCard is connected to a network with “Jumbo frames” (OSI layer 2 ethernet frames with payload length > 1518 byte calculated with the vlan tag and without the ethernet fcs).
	Solution	The FlexCard does not support sending/receiving “Jumbo frames”.

6 Ordering Information

6.1 FlexCard PMC2/PXle3/PCle3

Product	Description	Ordering number
FlexCard PMC-II	FlexCard PMC-II hardware	3-V0550A01
FlexCard PXle3	FlexCard PXle3 hardware	3-V0940A01
FlexCard PCle3	FlexCard PCle3 hardware	3-V0950A01

6.2 Accessory Parts

Product	Description	Ordering number
Any accessory part		Contact <i>STAR ELECTRONICS GmbH & Co. KG</i>

6.3 Related Documents

Document	Description	Ordering number
[1] Instructions for Use FlexCard PXle3/PCle3	Instructions for Use FlexCard PXle3/PCle3	3-0094-0A01-D10
[2] Instructions for Use FlexTiny3	Instructions for Use FlexTiny3	3-0088-0Z01-D01
[3] Instructions for Use FlexCard PMC-II	Instructions for Use FlexCard PMC-II	3-0055-0P01-D05
[4] FlexUpdate User Manual	FlexUpdate User Manual. It describes the License Update for FlexCards and FlexDevices. It also contains information how to update the firmware of FlexCard USB-M and FlexCard PMC-II.	3-0038-0C01-D03
[5] Firmware Update	Guide on how to update the firmware for FlexDevices and FlexCard PXle3/PCle3.	3-0016-1K01-D23
[6] FlexCard PMC-II Pin Assigment Ethernet BRR	FlexCard PMC-II Pin Assigment Ethernet BRR	3-0055-0P01-D11
[7] Instructions for Use FlexTiny3	Instructions for Use FlexTiny3	3-0088-0Z01-D01

7 Appendix

7.1 Appendix A: Guideline for handling ESD sensitive Products

- Any tester, equipment, or tool used at any production step or for any manipulation of semi-conductor devices must have its shield connected to ground.
- The product itself and the carrier system of the product respectively must be placed on a conductive table top or covered by an antistatic surface (superficial resistivity equal to or higher than $0.5 \text{ M}\Omega/\text{cm}^2$), grounded through a ground cable (conductive cable from protected equipment to ground isolated through a $1 \text{ M}\Omega$ resistor placed in series).
- All manipulation of finished goods has to be made at such a grounded worktable.
- The worktable must be free of all non-antistatic objects.
- An antistatic floor covering grounded through a conductive ground cable (with serial resistor between $0.9 \text{ M}\Omega$ and $1.5 \text{ M}\Omega$) should be used.
- It is recommended that you wear an antistatic wrist or ankle strap, connected to the antistatic floor covering or to the grounded equipment.
- If no antistatic wrist or ankle strap is worn, touch the surface of the grounded worktable before each manipulation of the ESD sensitive product.
- It is recommended that antistatic gloves or finger coats be worn.
- It is recommended that nylon clothing be avoided while performing any manipulation of parts.

7.2 Appendix B:

7.2.1 Acronyms and Abbreviations

Item	Definition
BP	Bus plus
BM	Bus minus
CAN	Controller Area Network
EMC	Electromagnetic Compatibility
ESD	Electro-Static Discharge
FR	FlexRay
ETH	Ethernet
BRR	BroadR-Reach
NC	Not Connected

Table 1: Acronyms and abbreviations

7.2.2 List of Tables

Table 1: Acronyms and abbreviations.....23

7.2.3 List of Figures

Figure 1: Other device in the device manager 11
Figure 2: Network Connections window 12
Figure 3: Network connection properties 13
Figure 4: Device manager when the FlexCard has an invalid FlexTiny configuration 15
Figure 5: Device manager – advanced settings - master setting 16
Figure 6: Device manager – advanced settings - speed duplex setting..... 17

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			Page 24 of 25

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