


# FLEXCARD PMC/PCI INSTRUCTIONS FOR USE



	<table><tr><th data-bbox="435 217 1417 275">NOTICE</th></tr><tr><td data-bbox="435 275 1417 349">ESD (Electro Static Discharge) sensitive product. Refer to chapter 1.3 and follow the safety and handling instructions.</td></tr></table>	NOTICE	ESD (Electro Static Discharge) sensitive product. Refer to chapter 1.3 and follow the safety and handling instructions.
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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.

## EC CONFORMITY

The *FlexCard PMC/PCI* complies with the essential requirements of the following applicable European Community Directive(s) including current amendments, and carries the CE marking accordingly:

- 2004/108/EG      EMC Directive

The following standard(s) have been used to assess the product:

- EN 55022:1998 + A1:2001 + A2:2003 (Emission characteristics for information technology devices)
- EN 55024:1998 + A1:2000 + A2:2003 + Corrigendum 04:2003 + Corrigendum 07:2003 (Immunity characteristics for information technology devices)

The *FlexCard PMC/PCI* is designed, intended, and authorized for industrial use only. Using the product in domestic environment may lead to electromagnetic disturbances.

## REVISION HISTORY

Version	Date	Description
D1V0-F	30.04.2007	Initial version
D1V1-F	15.05.2007	Uninstallation process added.
D1V2-F	29.08.2007	Firmware update section updated.
D1V3-F	18.07.2008	Scope of delivery, EC confirmation and FW update section changed.
D1V4-F	29.10.2008	Firmware update description changed. License update description added. Interface description for CAN bus added. New accessory parts added. Reordered the table of DIP-switches. Linux chapters added.
D1V5-F	27.02.2009	Changed trouble shooting chapter and corrected CAN CC specification. Updated to Eberspächer Electronics
D1V6-F	10.07.2009	Updated description.
D1V7-F	30.07.2009	Added user card id chapter.
D1V8-F	11.12.2009	Updates for driver version S6V2-F.
D1V9-F	28.05.2010	Updates for driver version S6V3-F. Added black list of PMC adapters.

## RELATED HARDWARE / SOFTWARE VERSIONS

Product	Reference No.	Version	Remarks
FlexCard PMC Hardware	3-0033-0A01	H1V0-F	<i>FlexCard PMC/PCI</i> with two trigger connectors and four bus channel connectors
fcBase API (Windows)	3-0009-0K03	S6V3-F	API to build your own application
fcBase API (Linux)	3-0009-0U01	S5V1-F	API to build your own application
fcBase API (Xenomai)	3-0009-0V01	S5V1-F	API to build your own application
Caromee	3-0051-0P01	S1V4F-F	Analyzing software that can be easily extended and supports the FlexCard product family.

Further related hardware and software can be found in chapter Scope of supply.

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# 1 GENERAL

## 1.1 INTENDED USE

The *FlexCard PMC/PCI* is a PCI Mezzanine Card for use in 32bit/33MHz capable PMC carriers which are available for several host system architectures.

FlexCard PMC/PCI is a bus communication instrument which is mainly intended to be used with the time-triggered FlexRay bus system. Two FlexRay Communication Controllers can be realized in one device, according to four FlexRay Channels. Additionally, two FlexRay channels can be replaced by two CAN HS bus systems via software. The physical layers for these interfaces are already integrated on the board.

Only the herein described accessory parts are allowed to be used together with the *FlexCard PMC/PCI*.

The FlexCard PMC/PCI is designed, intended, and authorized exclusively for

- a) EU: laboratory applications
- b) US: industrial test equipment

Any other use without the prior written consent of *Eberspächer Electronics* is prohibited.

The *FlexCard PMC/PCI* is NOT designed, intended, or authorized for





- 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,
- other applications in which a mistake or malfunction may result in death, personal injury, or severe physical damage.






The product described in this document is an industrial device, i.e. is designed, intended, or authorized for professional use. It is not designed, intended, or authorized for home applications or consumers.

## 1.2 USED PICTOGRAMS

The meaning of used pictograms is shortly described below.

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

	 <b>WARNING</b>
	Used to indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	 <b>CAUTION</b>
	Used to indicate a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.

	<b>NOTICE</b> 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.
	<b>NOTICE</b> Used to indicate an electrostatic discharge sensitive product. The product is subject to damage by ESD, if no precautions are taken.
	<b>Information</b> Used to indicate information provided only for purposes of clarification, illustration, and general information.
	<b>Reference</b> References another document.
	Product marking which shows the compliance of the product with the European Waste Electrical and Electronic Equipment Directive 2002/96/EC.

### 1.3 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 PMC/PCI* has to be handled as described herein.

Changes or modifications of the *FlexCard PMC/PCI* are not allowed for safety and warranty reasons!


*Eberspächer Electronics* is not liable for any damages arising from non-observance of the product information.


Follow the


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


	<b>⚠ WARNING</b> MAINS VOLTAGE UP TO 110 / 230 VAC AT THE COMPUTER CHASSIS  ELECTRICAL SHOCK HAZARD!  TO PREVENT DEATH, PERSONAL INJURY OR DAMAGE: DISCONNECT THE POWER CABLE OF THE COMPUTER BEFORE OPENING THE CHASSIS.
---	---



	<b>⚠ CAUTION</b>
	<p>TO PREVENT PERSONAL INJURY, TO PREVENT DAMAGE TO THE <i>FlexCard PMC/PCI</i> OR TO PREVENT CONSEQUENTIAL DAMAGES:</p> <ul style="list-style-type: none"> <li>➤ PLEASE OBSERVE THE ESD-PROTECTION INSTRUCTIONS BEFORE GETTING IN CONTACT WITH THE CONNECTORS. OTHERWISE THE <i>FLEXCARD PMC/PCI</i> MAY GET DAMAGED. SEE APPENDIX A: GUIDELINE FOR HANDLING ESD SENSITIVE PRODUCTS.</li> <li>➤ DO NOT CONNECT ANY OTHER SIGNALS TO THE INTERFACES AS DESCRIBED IN THE CHAPTER INTERFACES AND CONNECTORS.</li> <li>➤ ENSURE THAT ALL SIGNALS ARE WITHIN THE SPECIFIED RANGE.</li> <li>➤ IT IS RECOMMENDED TO ONLY USE PRODUCTS FROM EBERSPÄCHER ELECTRONICS LISTED IN CHAPTER 8.2 ACCESSORY PARTS TO ENSURE PROPER FUNCTION!</li> <li>➤ HIGH TEMPERATURES CAN DAMAGE THE <i>FLEXCARD PMC/PCI</i>. KEEP THE <i>FLEXCARD PMC/PCI</i> AWAY FROM HEATERS, STOVES, FIREPLACES AND OTHER SOURCES OF HEAT.</li> <li>➤ DO NOT EXPOSE THE <i>FLEXCARD PMC/PCI</i> TO RAIN OR USE IT NEAR WATER.</li> </ul> <p><b>Do not use the <i>FlexCard PMC/PCI</i> in areas of explosion hazard.</b></p>

	<b>NOTICE</b>
	<p>The <i>FlexCard PMC/PCI</i> may not work correctly or communication problems may occur if:</p> <ul style="list-style-type: none"> <li>➤ The <i>FlexCard PMC/PCI</i> is used in existing passive networks, i.e. when changing the topology structure.</li> <li>➤ The coded 4-pole FlexRay connectors are inserted wrong (i.e. due to forced insertion).</li> <li>➤ The bus termination of the <i>FlexCard PMC/PCI</i> is not adapted to the connected bus topology.</li> <li>➤ The bus termination resistors are configured for the wrong bus type. <ul style="list-style-type: none"> <li>➤ The <i>FlexCard PMC/PCI</i> is configured wrong.</li> </ul> </li> </ul>

	<b>NOTICE</b>
	<p>By sending messages over the <i>FlexCard PMC/PCI</i> to an automotive bus system it is possible to trigger actions resulting in malfunction and/or damage.</p> <p>The <i>FlexCard PMC/PCI</i> must be used by expert technicians familiar with the corresponding systems.</p>

	<b>NOTICE</b>
	<p style="text-align: center;"><b>ESD (Electro Static Discharge) sensitive product</b></p> <p style="text-align: center;"><i>Eberspächer Electronics</i> products lacking protective enclosures are subject to damage by ESD.</p> <p style="text-align: center;">Take proper ESD precautions to avoid performance degradation or loss of functionality!</p> <p style="text-align: center;">Unpack, handle or operate these products only in environments where sufficient precautionary measures have been taken in respect to ESD hazards.</p> <p style="text-align: center;">A guideline is available in chapter 9.1.</p> <p style="text-align: center;">Only appropriately trained personnel (such as electricians, technicians and engineers) may handle and/or operate these products.</p>

## 1.4 USER GROUP

This document is written for expert technicians who are familiar with electronic components and systems.

Each person involved with assembly, line-up, operation, maintenance, or disposal of the *FlexCard PMC/PCI* has to

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

## 1.5 MEANING OF TEXT STYLES

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

## 2 PRODUCT DESCRIPTION

### 2.1 FLEXCARD PMC/PCI AT A GLANCE


The *FlexCard PMC/PCI* is a flexible multi-bus instrument for monitoring, testing, simulation and basic gateway applications. It is intended to be used with the FlexRay and CAN bus systems. Several features like switchable bus terminations, two trigger lines as well as the easily updateable firmware are integrated on the device.

The *FlexCard PMC/PCI* can be inserted in a 32bit/33MHz capable chassis or carrier module. Such carrier modules are available for several platforms like PCI, CompactPCI, or PXI.

Four bus channels are provided on the front panel of the *FlexCard PMC/PCI*. Channels 3 and 4 can be configured for CAN or FlexRay by using the respective firmware. The firmware update process is described in Chapter 4.4 of this document. Additionally, if the firmware image with one FlexRay CC is used, the *FlexCard PMC/PCI* supports Self-Synchronization through a second sync frame.


#### FEATURES


- 32bit/33MHz **PCI Mezzanine Card** device
- 2 FlexRay Communication Controller (resulting in 4 Channels)
- Support of up to 2 CAN High Speed channels
- Firmware updateable

	Information
	Each FlexRay Communication Controller needs a pair of channels.

For each channel one LED indicator is provided on the front panel. The LEDs can light in two colors, signaling different states of the bus channels.

Up to API- and FW-Version S5V2-F, all incoming data is temporarily stored into the 2MB onboard buffer of the device. 1MB is used for data buffering, 1MB for internal processes. From API- and FW-Version S6V1-F, all incoming data is transferred over DMA from the device to the system RAM and temporarily stored into a 2MB receive buffer. From API- and FW-Version S6V3-F, all incoming data is temporarily stored into the 2 MB onboard buffer of the device, too. This prevents data losses and flexible data collection cycles become possible. Transmit data will be written directly into the Communication Controller in order to ensure a maximum of performance.

	Reference
	Further information about how to program applications for the <i>FlexCard PMC/PCI</i> can be found in the <i>FlexCard API Documentation</i> .

	Information
	<p>The currently supported FlexRay Communication Controller type on the <i>FlexCard PMC/PCI</i> is:</p> <ul style="list-style-type: none"> <li>➤ BOSCH E-Ray FlexRay IP-Module, Release 1.3 (Referring to the FlexRay protocol specification v2.1a)</li> </ul> <p>The currently supported CAN Communication Controller type on the <i>FlexCard PMC/PCI</i> is:</p> <ul style="list-style-type: none"> <li>➤ BOSCH D_CAN CAN IP-Module Release 1.0 (Referring to the CAN protocol specification v2.0 part A, B)</li> </ul>
	Other versions are not supported up to now. Please contact <i>Eberspächer Electronics</i> if other versions need to be supported.
	<p>Two FlexCard firmwares are available for <i>FlexCard PMC/PCI</i>. One supports two FlexRay cores with two channels per core. The second supports one FlexRay core and two CAN cores. The firmwares can be exchanged using the update tool <i>FlexUpdate.exe</i>.</p>

### Applications

- Usage with Eberspächer Electronics *Caromee* (Demo available)
- Usage with Eberspächer Electronics *FlexAnalyzerV2* (See chapter 2.2 Scope of supply)
- Further commercial applications will support *FlexCard PMC/PCI* soon
- Usage with customer specific software. The FlexCard driver has a C-API, see [1].

## 2.2 SCOPE OF SUPPLY


The *FlexCard PMC/PCI* is delivered with

Product	Reference No.	Version	Remarks
<i>FlexCard PMC/PCI</i> Hardware	3-0033-0P01	H1V0-F	PMC/PCI card with FlexRay Physical Layers and 2 CAN-HS Physical Layers
<i>FlexCard PMC/PCI</i> Firmware	3-0033-0B01	S6V3-F and S5V1-F	The Firmware supports 2 configurations: - 2 FlexRay CCs - 1 FlexRay CC and 2 CAN CCs
<i>FlexCard PMC/PCI</i> cables	3-0034-1I02	H1V1-F	4-pole fixable connector to SubD9
<i>FlexCard</i> SYS	3-0009-0E04	S6V3-F	Required low level driver for the <i>FlexCard</i> .
<i>FlexCard</i> DLL	3-0009-0K03	S6V3-F	Required high level driver for the <i>FlexCard</i> .
<i>FlexCard</i> Linux driver	3-0009-0U01	S5V1-F	Linux driver for the <i>FlexCard</i> .
<i>FlexCard</i> Xenomai driver	3-0009-0V01	S5V1-F	Xenomai driver for the <i>FlexCard</i> .
<i>FlexAnalyzerV2</i>	3-0038-0B01	S1V4-F	<i>FlexCard</i> monitoring tool. Supports FlexRay/CAN monitoring and sending data, triggers, filters and data logging.
Instructions for Use	3-0033-0P01-D01	D1V9-F	This document.
API Documentation	3-0009-0S01-D03	D1V15-F	API programming manual as PDF file.
Getting Started Manual	3-0055-0P01-D07	D1V2-F	Example how to build a small FlexRay/CAN-communication.

Product	Reference No.	Version	Remarks
Demo	-	S1V6-F	Demo explaining the programming of the <i>FlexCard</i> .
DemoPMC	-	S1V5-F	Demo explaining the programming of the <i>FlexCard</i> with multiple FlexRay CCs.
DemoCAN	-	S1V5-F	Console application explaining the communication over CAN.
CanBaudRateCalculator	-	S1V7-F	Helps with the calculation of CAN bus parameters.
FlexUpdate	-	S1V8-F	Tool for updating firmware and licenses.
Tracer Control	-	S1V2-F	Activates debug information.

A list of available accessory parts can be found in chapter 8.2.

## 2.3 UPDATES

	Information
	<p>Updates regarding the Windows driver and firmware are possible via web-downloads from <i>Eberspächer Electronics</i> homepage.</p> <p>The firmware on the <i>FlexCard PMC/PCI</i> can be updated with an appropriate software tool, see chapter 4.3.2.</p>

## 3 TECHNICAL DATA

### 3.1 ELECTRICAL CHARACTERISTICS

The necessary power is directly provided by the PMC interface. The connected voltages are 3.3V, 5V and 12V. -12V is not needed for the *FlexCard PMC/PCI* and therefore unconnected.

Supply voltage	+3.3VDC	+5VDC	+12V
Supply current (typical)	250mA	-	-
Supply current (maximum)	400mA	350mA	5mA

Table 1: Electrical characteristics of the *FlexCard PMC/PCI*

### 3.2 PHYSICAL CHARACTERISTICS

CPU of FlexCard PMC/PCI	Altera Cyclone II EP2C70
Bus Interfaces	4 bus channels provided on the front panel
Bus Drivers	FlexRay: 4x NXP TJA1080N1D Transceivers CAN: 2x SN65HVD231 CAN HS Transceivers
Bus Termination	One relay per channel for switching the bus terminating resistors. Resistor values selectable for CAN (120Ω) and FlexRay (90Ω)
Bus state LEDs	One bicolor LED-indicator per channel
Synchronization Interfaces on the front panel	2 TTL trigger connectors provided on the front panel
Dimensions L x W x H without connectors approx.	149 x 74 x 21 mm

Table 2: Physical characteristics of the *FlexCard PMC/PCI*

### 3.3 ENVIRONMENTAL CONDITIONS

Temperature	<b>Operating:</b> 0 to +60°C <b>Storage:</b> -40 to +70°C
Relative Humidity	<b>Operating:</b> 10% to 90% rH, non-condensing <b>Storage:</b> 10% to 90% rH, non-condensing

Table 3: Environmental conditions for the *FlexCard PMC/PCI*

### 3.4 BLOCK DIAGRAM

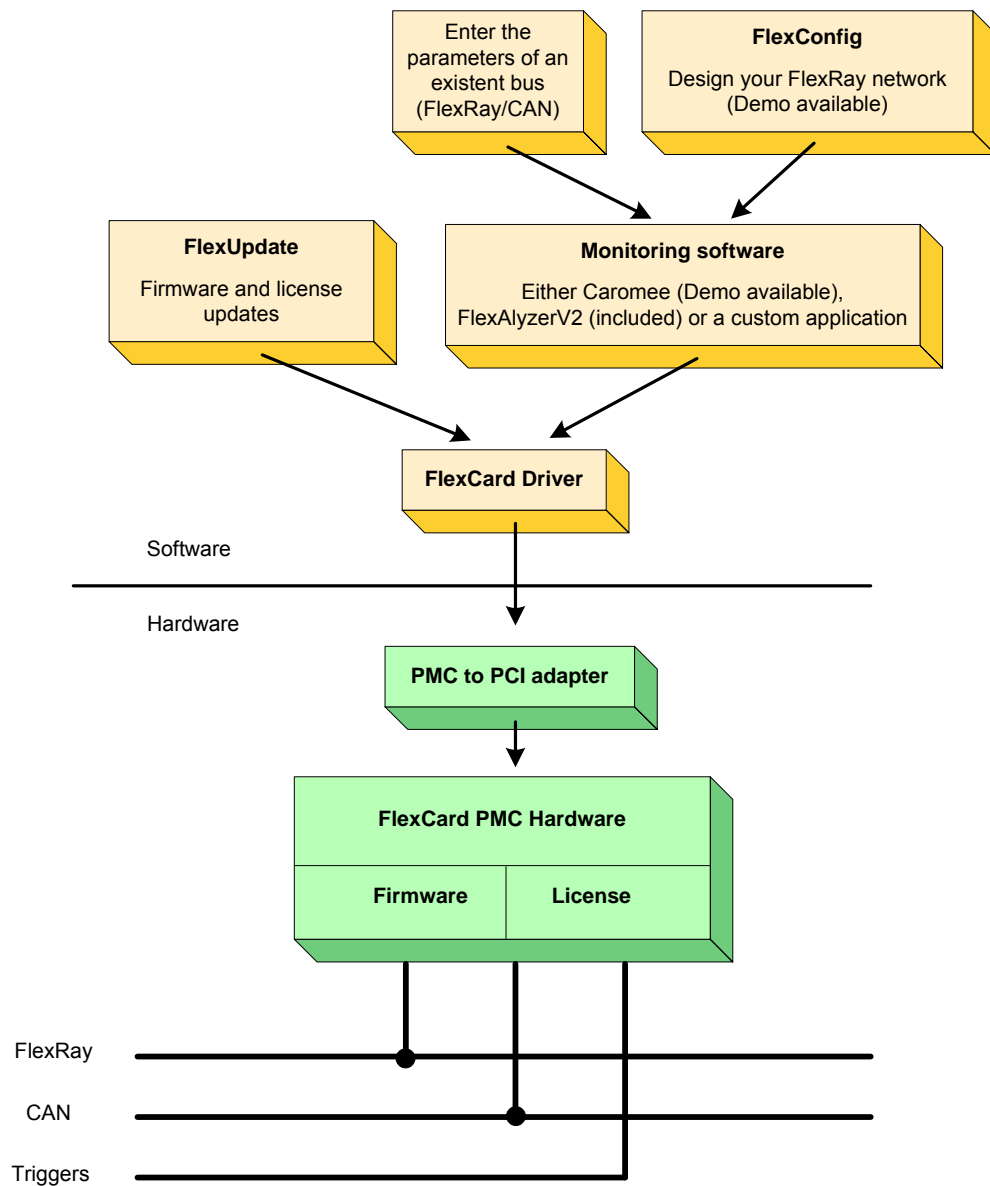




Figure 1: The *FlexCard PMC/PCI* in a functional environment

	Reference
	Further information about the usage of <i>FlexAnalyzerV2</i> , <i>Caromee</i> and <i>FlexConfig</i> can be found in [3], [4], [5].

### 3.5 INTERFACES AND CONNECTORS

Read and follow these instructions when connecting and using the *FlexCard PMC/PCI*:

	NOTICE
	<ul style="list-style-type: none"> <li>➤ Ensure that all signal lines connected to the <i>FlexCard PMC/PCI</i> are in the allowed range. <ul style="list-style-type: none"> <li>➤ Be sure to connect all cables as described in this manual.</li> </ul> </li> <li>➤ It is recommended to only use cables from <i>Eberspächer Electronics</i>. See Chapter 8.2 Accessory parts.</li> <li>➤ The cables for the bus channels should always be fixated by screwing the plug into the jack.</li> <li>➤ Ensure to grasp the plug and not the cable when disconnecting the <i>FlexCard PMC/PCI</i>.</li> </ul>

### 3.5.1 PMC INTERFACE

The *FlexCard PMC/PCI* can be driven with both 3.3V and 5V PCI-buses, because of its 5V tolerant components. The *FlexCard PMC/PCI* is running on 32 Bit PCI.

### 3.5.2 BUS INTERFACES ON THE FRONT PANEL

On the front panel, four Binder series 711 jacks are provided for the bus connections.

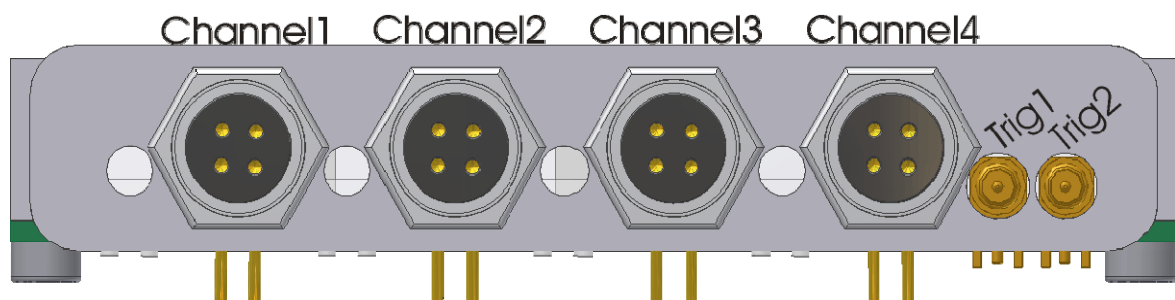


Figure 2: Front panel

The bus connectors “channel1” and “channel2” represent the connections for FlexRay communication controller 1, channel A and B. The bus system type of bus connectors “channel3” and “channel4” can be chosen by DIP-switches which are described in chapter 4.2.3.1.

For both bus types (FlexRay and CAN), the same pin assignment and the same cables are used.

The pin assignment of the *FlexCard PMC/PCI* connectors is shown in Figure 3 and Figure 4 and is listed in Table 4.



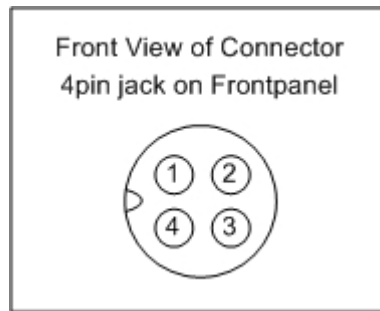


Figure 3: Front panel jack pin assignment, front view of the 4 pin Binder 711 female connector

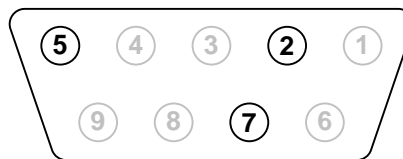


Figure 4: SubD9 pin assignment, front view

Binder series 711 Pin number	SubD9 Pin number	FlexRay	CAN
1	5	Shield	Shield
2	2	BM	Bus_low
3	7	BP	Bus_high
4	3	GND	GND

Table 4: FlexCard PMC/PCI Binder connector assignment

Maximum voltage input on FlexRay BP/BM: 60V

Minimum voltage input on FlexRay BP/BM: -60V

Maximum voltage input on CAN high/low: 16V

Minimum voltage input on CAN high/low: -4V

NOTICE	
	Use only the standard <i>FlexCard PMC/PCI</i> adapter cables from <i>Eberspächer Electronics</i> included in delivery for connecting the <i>FlexCard PMC/PCI</i> to the desired bus system.


### 3.5.3 BIDIRECTIONAL TRIGGER CONNECTORS ON THE FRONT PANEL


For synchronization purposes, the *FlexCard PMC/PCI* provides two 5V tolerant TTL-compatible trigger connectors (Trig1 and Trig2, see Figure 2) on the front panel. The device has the ability to receive and generate trigger events on both trigger connectors. This feature allows e.g. a synchronization of different bus analyzing hardware. Physically, the triggers are MMCX-male-connector for coax-cables. The electrical characteristic of this output is described in Table 5.

Parameter	Min	Typ	Max	Unit
Input High Voltage	2.4	-	5	V
Input High Current	4	-	12	mA
Input Low Voltage	-	-	0.4	V
Output High Voltage	3.0	3.3	3.5	V
Output High Current	-	4	6	mA
Output Low Voltage	0	0.1	0.4	V

Table 5: Electrical characteristic of trigger connections

Both trigger connectors can freely be configured by software to act as input or as output. The input trigger can be programmed to work with rising or falling edges, while the output trigger of the *FlexCard PMC* is always low-active.

	Reference
	Detailed information about how the trigger events are used with the <i>FlexCard PMC/PCI</i> can be found in the <i>FlexCard API Documentation</i> .

	Information
	To connect the trigger output to a BNC-connector, the trigger line cable can be ordered at <i>Eberspächer Electronics</i> , see chapter 8.2 Accessory parts.

### 3.5.4 LED INDICATORS ON THE FRONT PANEL

Each channel on the front panel has one LED indicator for signaling different channel states. The LEDs can light in two different colors: Red and green. The LED states are explained in Table 6.

Signaling	Used bus	Description
Permanent red lighting of all LEDs	FlexRay or CAN	Signals a buffer overflow on the internal RAM.
Red flashing	FlexRay	Signals an error in the FlexRay communication controller (e.g. clock correction errors).
Red and green lighting at the same time	FlexRay	FlexRay communication controller is not synchronized, but connected to an actively working network. Bus traffic is detected. This LED combination is active when monitoring in asynchronous mode. The intensity of the LEDs is dependent on the traffic on the bus.
	CAN	Bus traffic is detected. The intensity of the LEDs is dependent on the traffic on the bus.
Green lighting	FlexRay	FlexRay communication controller is synchronized. The intensity of the LED is dependent on the traffic on the bus.
Green flashing	FlexRay	Signals the FlexRay communication controller is in a startup path (that means that the FlexRay communication controller is ready for synchronization). This can be seen when monitoring in normal mode and the FlexRay configuration is incorrect or no cable connected.

Table 6: Description of indicating LEDs


## 4 GETTING STARTED

### 4.1 LICENSES

*Eberspächer Electronics* licenses the usage of the *FlexCard PMC/PCI* on Linux, Xenomai and with the LabVIEW driver. Please contact Eberspächer Electronics if you want to obtain a license file and refer to chapter 4.5 on how to update the *FlexCard PMC/PCI*.

### 4.2 HARDWARE INSTALLATION AND MAINTENANCE


#### 4.2.1 INSTALLATION OF THE FLEXCARD PMC/PCI DRIVER SOFTWARE

	<p style="text-align: center;"><b>Information</b></p> <p>The device should be connected before the software driver is installed. Then refer to chapter 4.3, where the software installation process is described.</p>
--	---

#### 4.2.2 INSTALLING AND CONNECTING THE FLEXCARD PMC/PCI

This chapter describes, how the *FlexCard PMC/PCI* is installed into a PMC system or a PCI system via an adapter board and how the cables are connected to the front panel.

##### 4.2.2.1 INSTALLING THE DEVICE INTO A PMC OR PCI SYSTEM


	<p style="text-align: center;"><b>NOTICE</b></p> <p>Be aware that the <i>FlexCard PMC/PCI</i> is a electrostatic discharge sensitive device. Please refer to Appendix A: Guideline for handling ESD sensitive products. Do not touch the components on the board or the pin connectors.</p>
---	---

The following steps shall be performed in order to install the device to your system:

1. Turn your host system off. Make sure that the host system is still plugged in so that it remains grounded during the installation procedure.
2. Ensure that you fulfill the EMC conformity and safety requirements.
3. Insertion and removal of *FlexCard PMC/PCI* should be done with care.
4. Insert the *FlexCard PMC/PCI* into a free module slot of your host / carrier module.
5. Fixate the *FlexCard PMC/PCI* with the screws to the host / carrier module

##### 4.2.2.2 CONNECTING THE CABLES

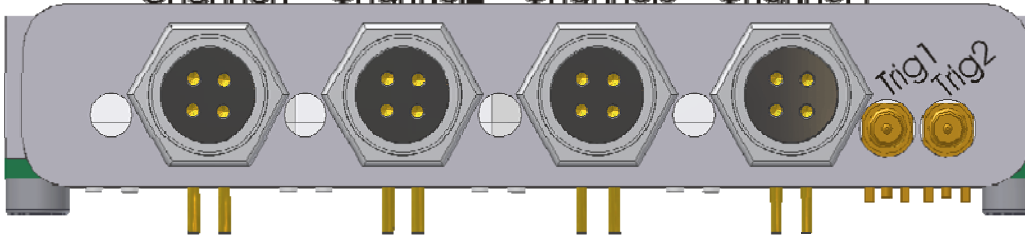
Read and follow these instructions when connecting and using your *FlexCard PMC/PCI*.



**⚠ CAUTION**

- Use only the 4 pole cables, which are delivered from *Eberspächer Electronics*, to connect the *FlexCard PMC/PCI* bus channels to your bus system.

Channel1 Channel2 Channel3 Channel4



- The connectors are coded. Do not try to insert them with force.
- Ensure that all signal lines connected to the *FlexCard PMC/PCI* are in the allowed range.
- The cables for the bus channels should always be fixated by screwing the plug into the jack.

### 4.2.3 CHANGING THE BUS DRIVER CONFIGURATION

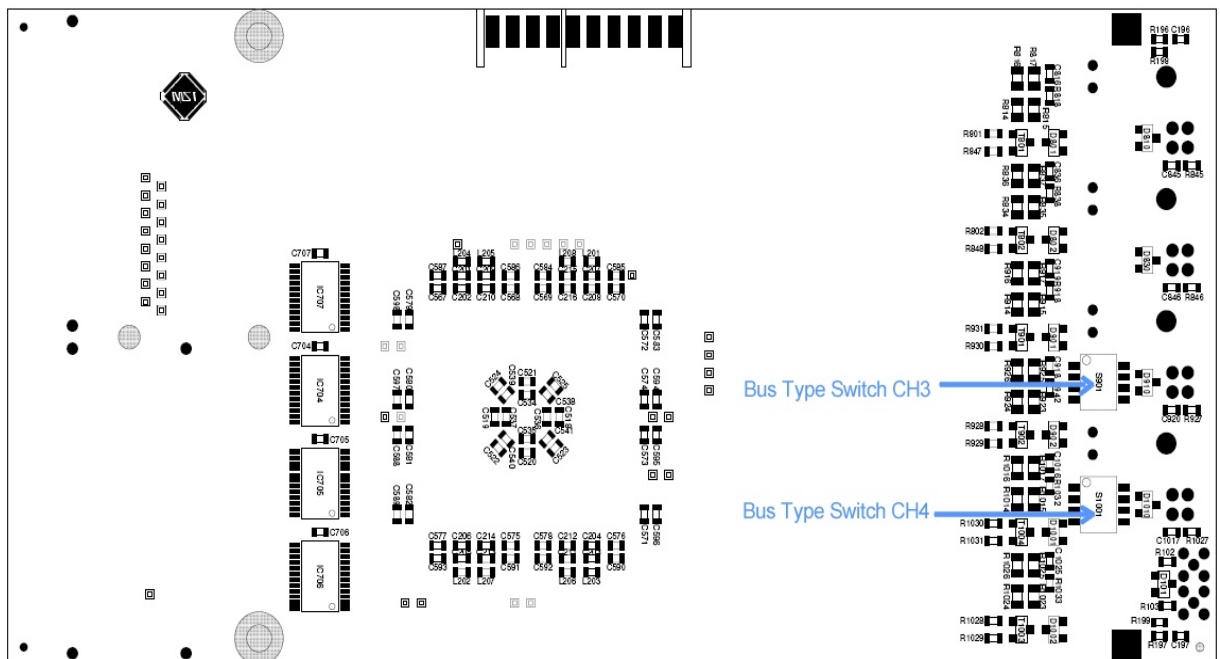


Figure 5: *FlexCard PMC/PCI* bottom view

One of the device's key features is the flexible support of FlexRay and CAN bus systems. This chapter describes how the *FlexCard PMC/PCI* can be modified to work with CAN bus systems beside FlexRay. In Figure 5, the involved parts of the *FlexCard PMC/PCI* board are shown.

#### 4.2.3.1 CUSTOMIZE THE CHANNEL USAGE OF CHANNEL 3 AND 4

Channel 3 and 4 of the *FlexCard PMC/PCI* can be used with different bus systems (FlexRay and CAN-HS). To choose the type of bus system which has to be used on these connectors, some initial steps have to be performed:

- **Firmware:** the firmware has to support the type of bus system. If the current version does not support the bus system, the firmware has to be updated.
- **Physical layer selection:** The correct physical layer has to be selected for the specific channel connector. This is done via the DIP-switches S901 and S1001 (see Figure 5).

	S901				S1001			
	SW1	SW2	SW3	SW4	SW1	SW2	SW3	SW4
<b>FlexRay on channel 3</b>	Off	On	Off	On	X	X	X	X
<b>CAN on channel 3</b>	On	Off	On	Off	X	X	X	X
<b>FlexRay on channel 4</b>	X	X	X	X	Off	On	Off	On
<b>CAN on channel 4</b>	X	X	X	X	On	Off	On	Off

Table 7: DIP-switches for channel configuration

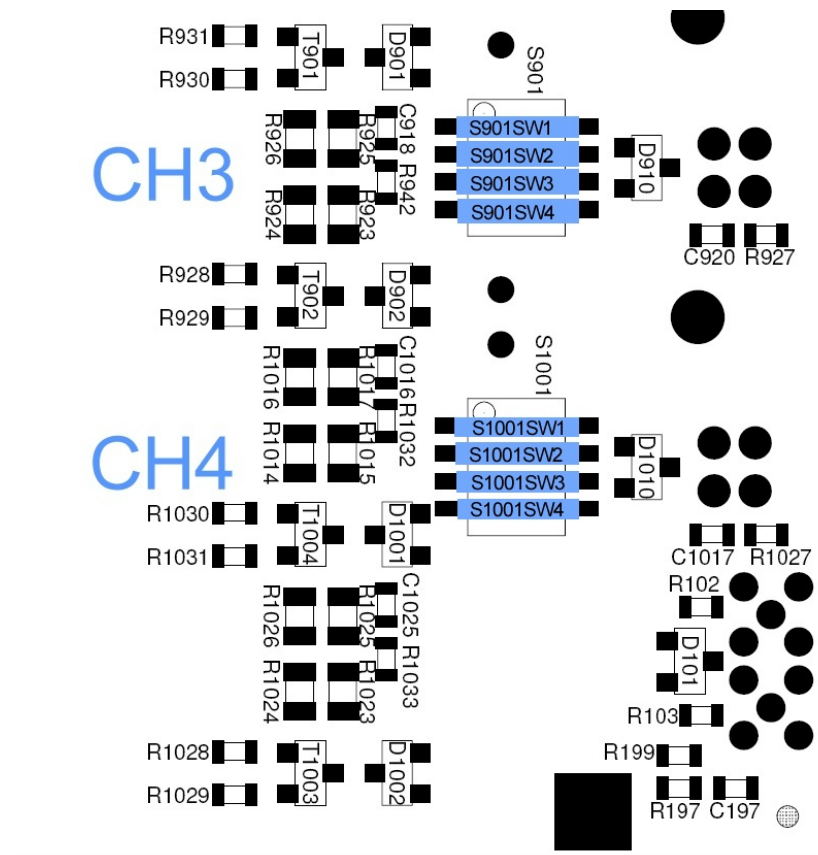



Figure 6: DIP-switches for channel configuration

#### 4.2.3.2 CUSTOMIZE THE BUS DRIVER TERMINATING RESISTOR VALUE

For each bus channel, a bus termination can be switched on or off via relays, so that different bus topologies are supported for FlexRay and CAN-HS bus. FlexRay needs terminating resistor values of 90Ω, whereas CAN-HS requires values of 120Ω. The settings for the bus termination can be done via software. Therefore please read the *FlexCard API Documentation* how the termination can be adapted to the specific needs.

## 4.3 SOFTWARE INSTALLATION AND UPDATE

### 4.3.1 PRECONDITIONS

	Information
	On all operating systems administrator access rights are required to install the device driver.

The minimum system requirements for installing and running the *FlexCard PMC/PCI* hardware and software are:

Microsoft Windows 2000 with Service Pack 4 or higher

- Computer/processor: 1 GHz or faster AMD/Pentium-compatible processor
- Memory: 256 MB of RAM
- Display: VGA or higher-resolution monitor
- Peripheral keyboard and mouse or compatible pointing device
- PCI-slot for FlexCard PCI, PMC-module slot for FlexCard PMC

Microsoft Windows XP (32 bit)

- Computer/processor: 1 GHz or faster AMD/Pentium-compatible processor
- Memory: 256 MB of RAM
- Display: VGA or higher-resolution monitor
- Peripheral keyboard and mouse or compatible pointing device
- PCI-slot for FlexCard PCI, PMC-module slot for FlexCard PMC

Microsoft Windows Vista (32 bit)

- Computer/Processor: 1.5 GHz or faster AMD/Pentium-compatible processor
- Memory: 1GB of RAM
- Display: VGA or higher-resolution monitor
- Peripheral keyboard and mouse or compatible pointing device
- PCI-slot for FlexCard PCI, PMC-module slot for FlexCard PMC

Microsoft Windows 7 (32 bit)

- Computer/Processor: 1.5 GHz or faster AMD/Pentium-compatible processor
- Memory: 1 GB of RAM
- Display: VGA or higher-resolution monitor
- Peripheral keyboard and mouse or compatible pointing device
- Free PMC-, PCI- or PCIe-slot

LabVIEW 8.6 or later

- Computer/Processor: 2 GHz or faster AMD/Pentium-compatible processor
- Memory: 512 MB of RAM
- Display: VGA or higher-resolution monitor
- Peripheral keyboard and mouse or compatible pointing device
- Free PMC-, PCI- or PCIe-slot

## Linux (with/without Xenomai)

- Computer/Processor: 1 GHz or faster AMD/Pentium-compatible processor
- Memory: 256 MB of RAM
- Display: VGA or higher-resolution monitor
- Peripheral keyboard and mouse or compatible pointing device
- PCI-slot for FlexCard PCI, PMC-module slot for FlexCard PMC
- Supported Linux kernel version: 2.6.16 to 2.6.29
- Optional supported Xenomai version: 2.4

## VxWorks 5.4

- Computer/processor: 1 GHz or faster AMD/Pentium-compatible processor
- Memory 256 MB of RAM
- Peripheral keyboard and mouse or compatible pointing device
- PCI-slot for FlexCard PCI, PMC-module slot for FlexCard PMC

For the PCI adapter, we recommend to use the following:

- TPCI270 PCI-to-PMC adapter from TEWS

The following table shows a list of tested adapters which do not work correctly with the *FlexCard PMC/PCI*. All other components are not tested and *Eberspächer Electronics* is not able to guarantee the compatibility with the *FlexCard PMC/PCI*. Devices which are not listed in this table might not work correctly. Please use the recommended adapters.

- ramix CP236
- NAT NPCI-PMC

## 4.3.2 INSTALLATION ON MICROSOFT WINDOWS OPERATING SYSTEMS

To install the *FlexCard PMC/PCI* device driver and dynamic link library, please follow the steps below. Before you install the *FlexCard PMC/PCI*, uninstall the old version first (Refer to chapter 4.3.3).

### Step 1

Insert the *FlexCard PMC/PCI* hardware in the PCI - slot. Switch the power on and boot your computer. Windows will show this dialog.

As the device driver will not be installed using the "New Hardware Wizard", click on the "Cancel" button to abort the wizard.

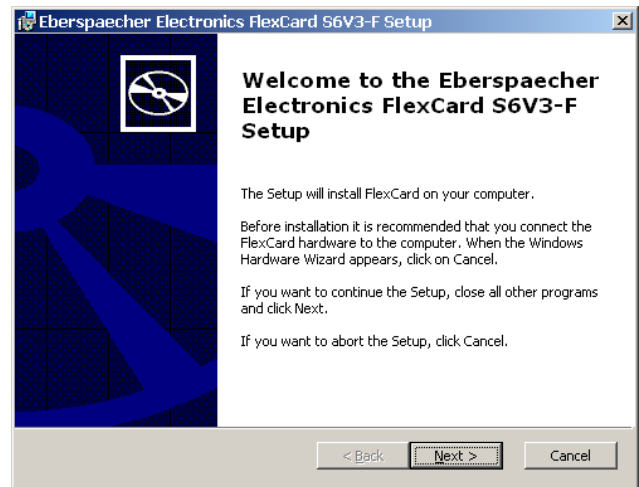


## Step 2 (a)

To start the installation, double click the file *FlexCard\_Setup\_SxVy-F.exe*. The installation wizard will start immediately and guide you through the installation.

Click on the “Next” button.

**Note:** On a Windows 2000 system, make sure that you have the Windows Installer 2.0 installed.



## Step 2 (b)

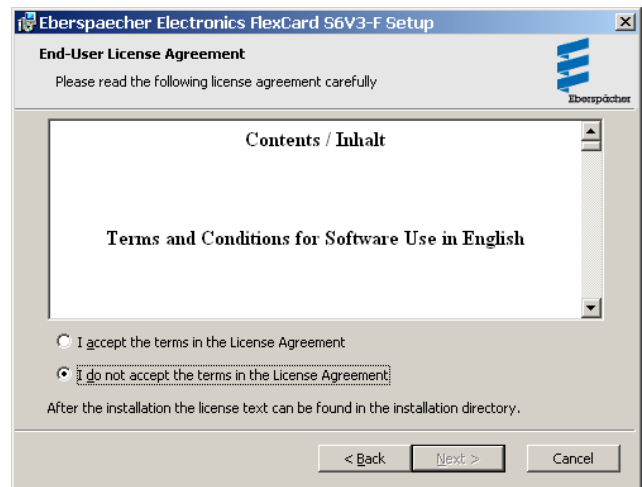
If you installed a *FlexCard* driver package before, the setup will return this error message. For installing the new driver you have to **remove** the previous package first.

Follow the instructions in chapter 4.3.3. **Restart** your computer and go to **Step 1** again.



## Step 3

Read the license agreement and if you accept the agreement, click “I accept the terms...” and the “Next” button to continue the installation. Otherwise click “Cancel” to abort the installation.





## Step 4

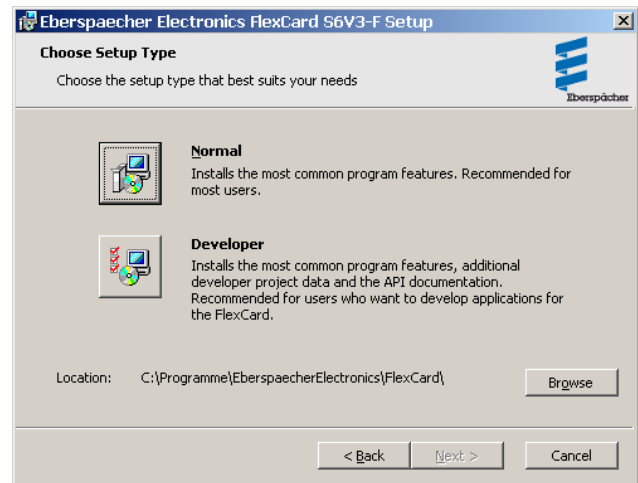
Select the installation folder for the *FlexCard* files.

There are two setup types:

- **Normal** setup for using *FlexCard PMC/PCI* with commercial applications.
- **Developer** setup for developing applications for the *FlexCard PMC/PCI*. This will install the C header files and libraries you need, to access the API in your own applications. Also the *FlexCard* API Documentation is installed.

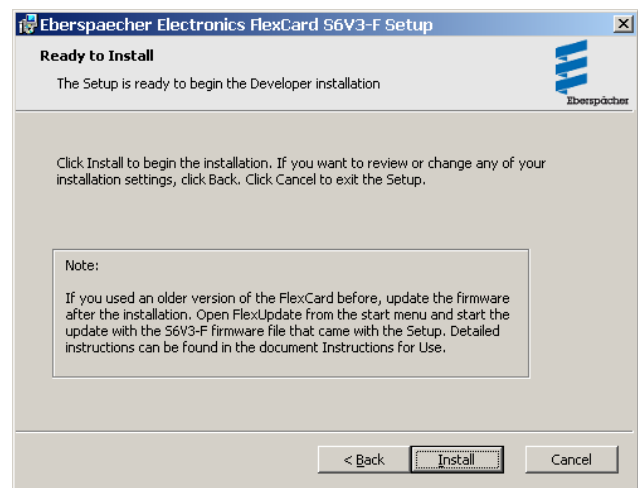
Choose your setup type by clicking the corresponding icon.

**Note:** The device driver and dynamic link library will be installed to the Windows system directory.



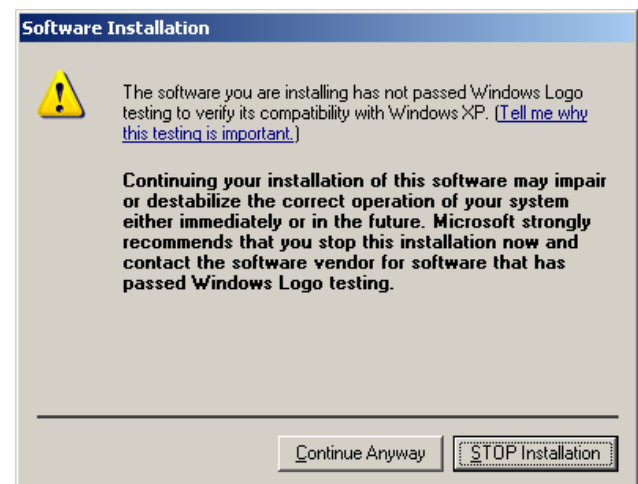
## Step 5

Click "*Install*" to start the installation.



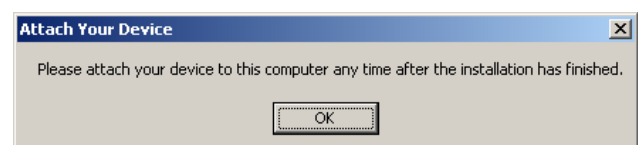
## Step 6

On a Windows system the following warning dialog may appear, as the *FlexCard* device driver is not certificated by the Microsoft Hardware Quality Labs. Click on "*Continue anyway*" to proceed with the installation.



## Step 7

A dialog box appears. Click on "*OK*".



**Step 8**

Click "*Finish*" to complete the installation.

**Step 9**

After the installation of the device driver you will find the *FlexCard PMC/PCI* entry in the *Device Manager* in the folder *Multifunction adapters*.

**Information**

It is recommended to install the *FlexCard PMC/PCI* Windows driver via setup.exe and not via INF-file. In case the installation via INF-file is necessary, always install it from the hard drive and not from USB stick or network drive.

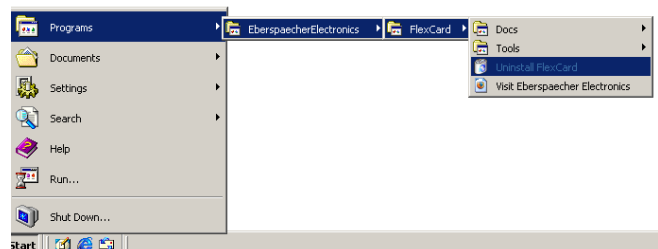
**4.3.3 UNINSTALLATION ON MICROSOFT WINDOWS OPERATING SYSTEMS****Uninstall alternative 1**

You can remove the installed *FlexCard* driver package by calling the shortcut in Windows start menu:

**Start->Programs->EberspächerElectronics  
->FlexCard->Uninstall FlexCard.**

Or:

**Start->Programs->TZM->FlexCard  
->Uninstall FlexCard.**



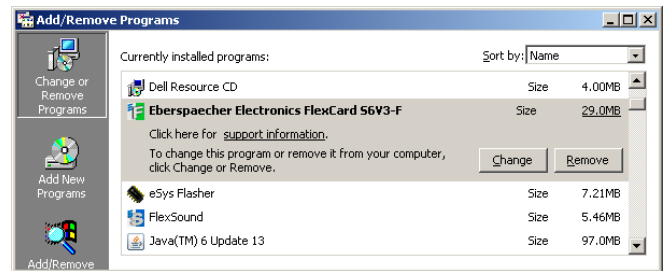
**Uninstall alternative 2**

Another possibility to uninstall the previous *FlexCard* driver package is provided in the Windows Control Panel:

**Start->Settings->Control Panel**

**->Add/Remove Programs**

Click "Remove" to uninstall the package.



#### 4.3.4 INSTALLATION ON LINUX OPERATING SYSTEMS

To install the *FlexCard PMC/PCI* Linux or Xenomai driver software, please refer to the *Read\_Me.txt* file, which can be found in the delivered *FlexCard.zip* file. Before you install the *FlexCard PMC/PCI*, uninstall the old version first.

#### 4.3.5 UNINSTALLATION ON LINUX OPERATING SYSTEMS

To uninstall the *FlexCard PMC/PCI* Linux or Xenomai driver, open a terminal and type in the following with super user rights:

```
>> flexcard_stop
```

For Debian based systems use

```
>> dpkg -r libfcBase
```

For Redhat based systems use

```
>> rpm -e libfcBase
```

### 4.4 FIRMWARE UPDATE

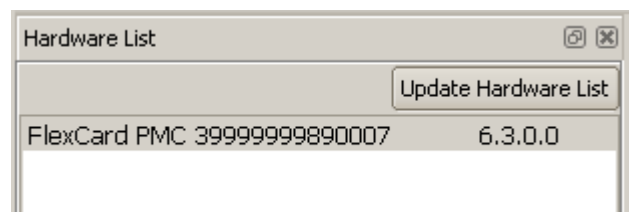
In order to update the firmware of a *FlexCard PMC/PCI*, it is necessary to follow these steps strictly.


**Step 1**

Start the update software *FlexUpdate* included in the *FlexCard PMC/PCI* install package.

In this window, you can check the current hardware and software version of installed *FlexCard* components.

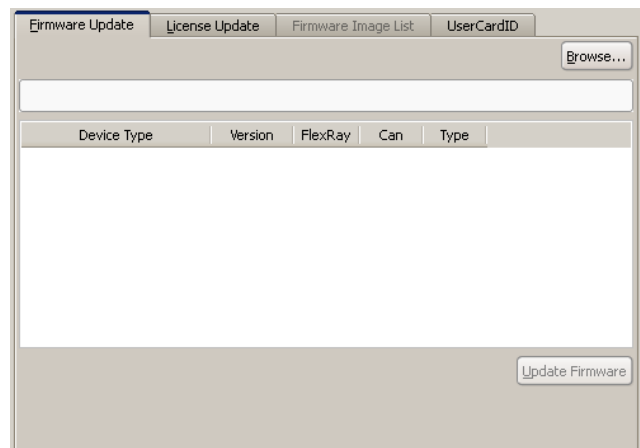
Select the *FlexCard PMC/PCI* whose firmware you want to update from the Hardware List.



Information																																														
 <p>The upper right shows details about the selected hardware.</p> <p>The column "Possible" lists the number of CCs in the firmware. The column "Useable" displays the CCs that are available in the firmware and licensed.</p>	<table border="1"> <tr> <td colspan="2">FlexCard PMC</td> <td>FlexRay</td> <td>Useable</td> <td>Possible</td> </tr> <tr> <td>Serial</td> <td>S39999999890007</td> <td>CC count</td> <td>2</td> <td>2</td> </tr> <tr> <td colspan="2">Versions:</td> <td>CC type</td> <td colspan="2">Bosch Eray</td> </tr> <tr> <td>Firmware</td> <td>6.3.0.0</td> <td>Protocol</td> <td colspan="2">2.1.0.0</td> </tr> <tr> <td>Hardware</td> <td>1.0.0.0</td> <td>BusGuardian</td> <td colspan="2">---</td> </tr> <tr> <td>BaseDLL</td> <td>6.3.0.0</td> <td>CAN</td> <td>Useable</td> <td>Possible</td> </tr> <tr> <td>DeviceDriver</td> <td>6.3.0.0</td> <td>CC count</td> <td>0</td> <td>0</td> </tr> <tr> <td>UserCardID (hex)</td> <td>1</td> <td>CC type</td> <td colspan="2">Bosch D-CAN</td> </tr> <tr> <td></td> <td></td> <td>Protocol</td> <td colspan="2">---</td> </tr> </table>	FlexCard PMC		FlexRay	Useable	Possible	Serial	S39999999890007	CC count	2	2	Versions:		CC type	Bosch Eray		Firmware	6.3.0.0	Protocol	2.1.0.0		Hardware	1.0.0.0	BusGuardian	---		BaseDLL	6.3.0.0	CAN	Useable	Possible	DeviceDriver	6.3.0.0	CC count	0	0	UserCardID (hex)	1	CC type	Bosch D-CAN				Protocol	---	
	FlexCard PMC		FlexRay	Useable	Possible																																									
Serial	S39999999890007	CC count	2	2																																										
Versions:		CC type	Bosch Eray																																											
Firmware	6.3.0.0	Protocol	2.1.0.0																																											
Hardware	1.0.0.0	BusGuardian	---																																											
BaseDLL	6.3.0.0	CAN	Useable	Possible																																										
DeviceDriver	6.3.0.0	CC count	0	0																																										
UserCardID (hex)	1	CC type	Bosch D-CAN																																											
		Protocol	---																																											

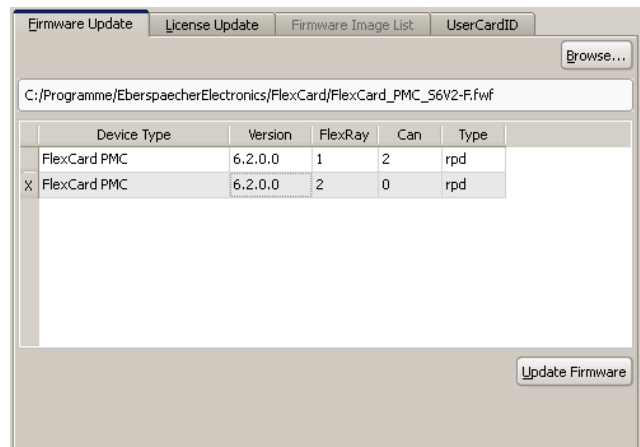
**Step 2**

Open the "Firmware Update" tab and click "Browse" button to select a firmware container file (\*.fwf).

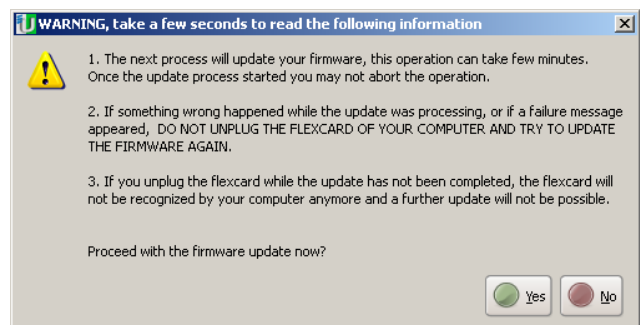
**Step 3**

The firmware files contained in the firmware container are displayed.

Select the firmware you like to write to the *FlexCard PMC/PCI* and click the "Update Firmware" button.

**Step 4**

Read attentively the warning messages before starting the update process. The process is composed of three phases: **Reset**, **Write** and **Check**.



**NOTICE**

Once started, the update process must not be interrupted!

**If it happens, neither unplug the *FlexCard PMC/PCI* nor restart the computer!**

Otherwise the *FlexCard PMC/PCI* is not functional any more and has to be shipped to *Eberspächer Electronics* for reprogramming.

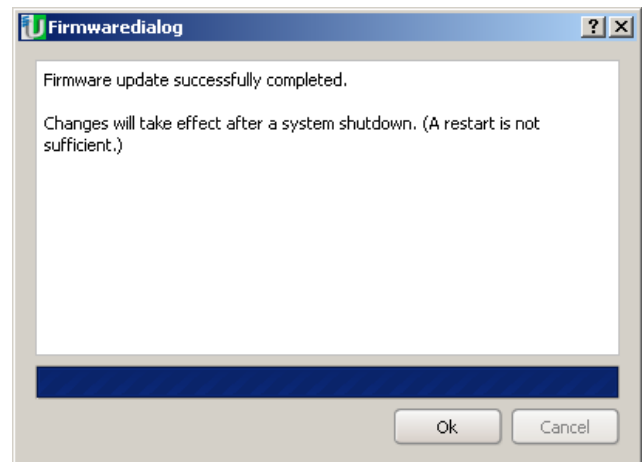
Try to update the firmware again until the whole update has been successfully completed.

**Step 5**

Once the message “**Firmware update successfully completed.**” appears, close the Firmware-update software and shutdown. **A restart is not sufficient!**

After a firmware update stand-by is prevented by the *FlexCard PMC/PCI* until the next start of the computer.

**If any problems occur when updating the *FlexCard PMC/PCI* firmware, please try again without reinserting the *FlexCard PMC/PCI*!**



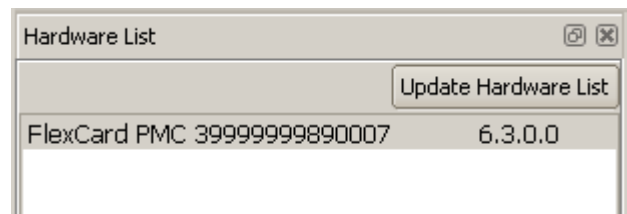
## 4.5 LICENSE UPDATE

To update the *FlexCard PMC/PCI* with a new license file you need to follow these steps:

**Step 1**

Insert the *FlexCard PMC/PCI* hardware in the PCI-Slot and start the update software *FlexUpdate* included in the *FlexCard PMC/PCI* install package. In this window, you can check the current hardware and software version of *FlexCard PMC/PCI* components installed.

Select the *FlexCard PMC/PCI* you want to update from the Hardware List.



	Information			
	FlexCard PMC		FlexRay	
<p>The upper right shows details about the selected hardware and its currently available features.</p> <p>The column “Possible” lists the number of CCs in the firmware. The column “Useable” displays the CCs that are available for the application.</p>	Serial	539999999890007	CC count	2
	Versions:		CC type	Bosch Eray
	Firmware	6.3.0.0	Protocol	2.1.0.0
	Hardware	1.0.0.0	BusGuardian	---
	BaseDLL	6.3.0.0	CAN	Useable
	DeviceDriver	6.3.0.0	CC count	0
	UserCardID (hex)	1	CC type	Bosch D-CAN
			Protocol	---

**Step 2**

Open the “License Update” tab. On the left side the currently licensed features are displayed.

Click the “Load from file” button to select a license file (\*.lic).

**Step 3**

Once you choose the file, the text on the right side will inform you about the state of the file. The number of licensed FlexRay and CAN CCs and the licenses for the LabVIEW, Linux, Windows and Xenomai FlexCard driver are displayed.

If the text “license file ok” appears, you can use “Write License” to apply the license to the hardware.

If not, you need to choose another license file.

**Step 4**

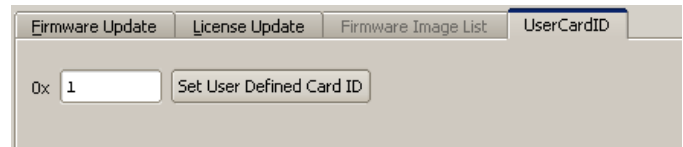
After the license was written, the current licenses on the *FlexCard PMC/PCI* are displayed on the left side.

## 4.6 USERCARDID

### Step 1

The UserCardID stays the same even after a computer restart. The purpose is to differentiate between several FlexCards.

Open the UserCardID tab. Enter the new ID and click on the button “*Set User Defined Card ID*”.



### Step 2

An entry in the message log states whether the action was successful. The ID is updated in the info list.

FlexCard PMC		FlexRay		Useable	Possible
Serial	539999999890007	CC count	2	2	
Versions:		CC type	Bosch Eray		
Firmware	6.3.0.0	Protocol	2.1.0.0		
Hardware	1.0.0.0	BusGuardian	---		
BaseDLL	6.3.0.0	CAN	Useable	Possible	
DeviceDriver	6.3.0.0	CC count	0	0	
UserCardID (hex)	1	CC type	Bosch D-CAN		
		Protocol	---		

# 5 CONFIGURATION AND OPERATION

Operation of the *FlexCard PMC/PCI* is described in the user manual of your software vendor. For a description of *Caromee*, refer to [5]. All operation modes as well as information about the programming of a *FlexCard* application are described in the *FlexCard* API Documentation [1].

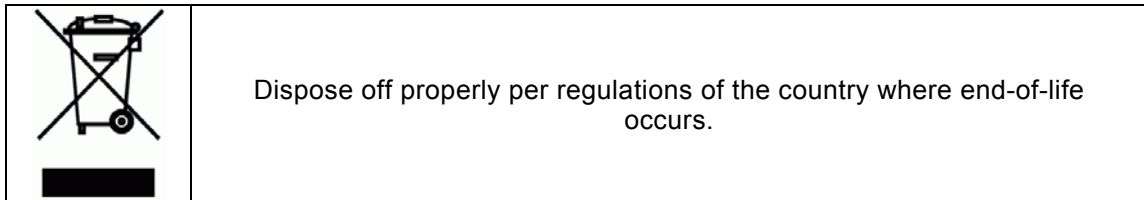


### 6 SHIPPING, MAINTENANCE AND DISPOSAL

Keep the package in which the *FlexCard PMC/PCI* was shipped. Store and transport the *FlexCard PMC/PCI* in the ESD foil bag.

Store and transport the *FlexCard PMC/PCI* in a cool, dry, dark environment. Don't store or transport it near sources of magnetic fields.

Void warranty if tried to manipulate/repair the *FlexCard PMC/PCI*. Please contact *Eberspächer Electronics* for maintenance.



## 7 TROUBLESHOOTING

This chapter contains some frequently asked questions about the *FlexCard PMC/PCI*.

1	Effect	The <i>FlexCard PMC/PCI</i> is not recognized. On Windows, the <i>FlexCard PMC/PCI</i> is not displayed under "Multifunction adapters" in the device manager or it is displayed with a warning symbol in the device manager.
	Cause	<i>FlexCard PMC/PCI</i> is not correctly plugged in. The drivers (respective the INF-file), required by the system to recognize the <i>FlexCard PMC/PCI</i> , are not installed properly.
	Solution	Check if the <i>FlexCard PMC/PCI</i> is inserted correctly. Reinstall the driver for the <i>FlexCard PMC/PCI</i> or update the firmware. Check whether the DLL, SYS and firmware are compatible. The major version numbers must be identical. Use the <i>FlexCard API</i> function "fcbCheckVersion" to test whether DLL, SYS and firmware match. See " <i>FlexCard API Documentation</i> ".

2	Effect	No FlexRay frames are received. The <i>FlexCard PMC/PCI</i> could not synchronize with the FlexRay bus (LED is green flashing).
	Cause	Wrong configuration of the communication controller → the hardware could not synchronize on the FlexRay bus Wrong firmware of the <i>FlexCard PMC/PCI</i> (wrong bus systems chosen). Buses are not correctly terminated. The cable of FlexRay channel A is inserted in plug B and/or vice versa. The wrong physical layer is selected via the DIP-switches.
	Solution	Check all parameters in the configuration; be sure to use the same configuration as the other FlexRay nodes Ensure that you chose the correct firmware which fits to your needs (regarding FlexRay connections). Terminate your bus systems correctly, for example using the onboard termination. Insert the cables to the correct connectors of the <i>FlexCard</i> . Ensure that the correct physical layer is selected via the DIP-switches. Refer to chapter 4.2.3.1.

3	Effect	No FlexRay frames are received. The <i>FlexCard PMC/PCI</i> is synchronized with the FlexRay bus (LED is green lighting).
	Cause	Maybe a filter is activated.
	Solution	Deactivate the message filter and channel filter in the software.

4	Effect	No CAN frames are received.
	Cause	Wrong configuration of the communication controller Wrong firmware of the <i>FlexCard PMC/PCI</i> (wrong bus systems chosen). Bus is not correctly terminated. Maybe a filter is activated. The wrong physical layer is selected via the DIP-switches.
	Solution	Check the CAN bus parameters on the <i>FlexCard PMC/PCI</i> . Ensure that you chose the correct firmware which fits to your needs (regarding CAN connections). Terminate your bus systems correctly, for example using the onboard termination. Deactivate the message filter and channel filter in the software. Ensure that the correct physical layer is selected via the DIP-switches. Refer to chapter 4.2.3.1.

5	Effect	The <i>FlexCard API</i> returns with the error "The CC index is not valid".
	Cause	Maybe the license is missing or the wrong firmware is on the FlexCard.
	Solution	Open FlexUpdate and check whether license and firmware are Ok. If the license is missing, please contact Eberspächer Electronics to obtain a license for the bus interfaces.

6	Effect	The <i>FlexCard API</i> returns with the error "Invalid hardware license".
	Cause	The license for the LabVIEW, Linux and Xenomai driver of the <i>FlexCard PMC/PCI</i> is missing.
	Solution	Please contact <i>Eberspächer Electronics</i> to obtain a license.

7	Effect	All LEDs of the <i>FlexCard PMC/PCI</i> glow red, no messages can be received.
	Cause	The buffer on the <i>FlexCard PMC/PCI</i> is full. The data on the <i>FlexCard PMC/PCI</i> is collected too slowly by the software.
	Solution	Use a faster PC or filter messages to reduce the workload.

8	Effect	If you start a FlexCard application an error message appears that says <i>fcbase.dll</i> is missing.
	Cause	The FlexCard driver was not installed properly.
	Solution	If the FlexCard setup was not installed yet, follow the instructions in this document on how to install the FlexCard. If the FlexCard setup is already installed: Insert the FlexCard. When the Windows Hardware Wizard appears, select that you don't want to look online on the Windows Update homepage for the software. Then, select that the software should be installed automatically. The problem should be solved now.

## 8 ORDERING INFORMATION

### 8.1 FLEXCARD PMC/PCI

Product	Description	Ordering number
FlexCard PMC/PCI	The FlexCard PMC/PCI is equipped with 4 FlexRay physical layer chips TJA1080 (with different development steps) from NXP per default. Furthermore 2 CAN-HS physical layer chips are also equipped.	3-0033-0P01 (PMC) 3-0033-0Q01 (PCI)

### 8.2 ACCESSORY PARTS

Product	Description	Ordering number
FlexCard PXI cable, 1.5m length, black	Bus adapter cable between FlexCard PMC/PCI and Sub-D-connector female.	3-0034-1I02
FCX FCL cable, 1.5m length, black	Bus adapter cable between FlexCard PMC/PCI and Sub-D-connector male.	3-0034-1C02
FC Trigger in cable, 1m	Trigger cable for FlexCard trigger connector to Binder 3-pole.	3-0034-0G01
FC Trigger cable BNC, 1m	Trigger cable for FlexCard trigger connector to BNC-plug.	3-0034-0H01
PMC-to-PCI-adapter	Passive adapter to use a FlexCard PMC/PCI in a standard PC environment.	3-0033-0C01
FlexRay Termination	SubD9 gender changer that terminates one FlexRay interface on the pins used by the FlexCard.	3-0034-0I01
Customer specific parts		Please contact <i>Eberspächer Electronics</i>

### 8.3 RELATED DOCUMENTS

Document	Description	Ordering number
[1] API Documentation	Describes how to write own applications for the <i>FlexCard</i> family.	3-0009-0S01-D03
[2] Declaration of Conformity of FlexCard PMC	Declaration that the <i>FlexCard PMC/PCI</i> complies with European Community Directive(s) and carries the CE marking accordingly.	3-0033-0P01-D03
[3] <i>FlexCard PMC/PMC II</i> Getting Started	Describes how to use the demo application contained in the Windows <i>FlexCard</i> Installer.	3-0055-0P01-D07

Document	Description	Ordering number
[4] <i>FlexAnalyzerV2</i> Instructions for Use	Explains how to use the monitoring software that is contained in the Windows <i>FlexCard</i> Installer.	3-0038-0B01-D01
[5] <i>FlexConfig</i> User Manual	Manual for the configuration software for FlexRay networks. <i>FlexConfig</i> generates the CHI configuration files used by the <i>FlexCard</i> , <i>FlexXCon</i> and <i>FlexEntry</i> .	3-0016-0C01-D06
[6] <i>Caromee</i> User Manual	Analyzing software that can be easily extended and supports the FlexCard product family.	3-0051-0P01-D03

## 9 APPENDIX

### 9.1 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  $0.9$  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.

### 9.2 APPENDIX B:

#### 9.2.1 ACRONYMS AND ABBREVIATIONS

Item	Definition
BD	Bus driver
BG	Bus guardian
BP	Bus plus
BM	Bus minus
CAN	Controller Area Network
CC	Communication Controller
DLL	Dynamic Linked Library
DMA	Direct Memory Access
ECU	Electronic Control Unit
EMC	Electromagnetic Compatibility
ESD	Electro Static Discharge
FR	FlexRay
FW	Firmware
HW	Hardware

Item	Definition
LED	Light Emitting Diode
NC	Not Connected
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PL	Physical Layer
PMC	PCI Mezzanine Card
PXI	PCI eXtension for Instrumentation
SYS	System (Windows low level driver extension)

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