STAR COOPERATION®

Your Partners in Excellence

FlexCard

FCBASE API Documentation

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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

Version	Date	Description
D1V0-F	06-Mar-2006	Initial release.
D1V1-F	02-Nov-2006	API functions added and updated. Multicard usage.
D1V2-F	02-May-2007	New API functions added and updated. PMC and XENOMAI usage.
D1V3-F	10-May-2007	Corrected description and changed Xenomai usage.
D1V4-F	21-Jun-2007	VxWorks API functions added.
D1V5-F	30-Aug-2007	PMC, VxWorks and Linux functions changed and added.
D1V6-F	02-Dec-2007	FlexCard Cyclone II (SE) support self startup/synchronization.
D1V7-F	28-Jan-2008	Support of CC Timer, API functions added and updated.
D1V8-F	25-Feb-2008	VxWorks chapter updated.
D1V9-F	11-Jul-2008	FlexCard Cyclone II (SE) support CAN. New API functions added.
D1V10-F	29-Oct-2008	FlexCard PMC/PCI support CAN. New FlexRay API functions added.
D1V11-F	27-Feb-2009	FlexCard PMC-II support and new API functions added.
D1V12-F	16-Apr-2009	Corrected description. Linux driver supports FlexCard PMC-II.
D1V13-F	10-Jul-2009	Xenomai driver supports FlexCard PMC-II. Windows driver is compatible to DMA Firmwares. Added extended message buffer configurations. Functions for FlexCard PMC-II firmware added.
D1V14-F	11-Dec-2009	Windows driver supports FlexCard USB-M. Redesigned API documentation. Added API functions for time stamp configuration.
D1V15-F	28-May-2010	Added CAN transmit FIFO feature.
D1V16-F	06-Oct-2010	Updated description.

Version	Date	Description
D1V17-F	19-May-2011	Updated VxWorks description.
D1V18-F	06-Jul-2012	Windows 64 bit release.
D1V19-F	12-Sep-2013	Linux S6V5 release.
D2V0-F	16-Nov-2015	Layout adapted to STAR COOPERATION. Replaced product names.
D2V1b-F	22-Jun-2016	Added CAN FD support. Updated Reference to Bosch ERay User Manual.
D2V2-F	25-Jan-2017	Update for Xenomai S6V5 release.
D2V3-F	10-Dec-2018	Linux 64 bit S6V6 release.

Related Hardware / Software Versions

Product	Reference No.	Version (Major and Minor)	Remarks
FlexCard Cyclone II Firmware	3-0009-0C04	S6V4	Current version
FlexCard Cyclone II SE Firmware	3-0009-0C05	S6V4	Current version
FlexCard PMC Firmware	3-0033-0B01	S6V4	Current version
FlexCard PMC-II Firmware Windows	3-0055-0C01	S6V6 (6.5.0.33)	Current version
FlexCard PMC-II Firmware Linux	3-0055-0C01	S6V5	Current version
FlexCard PMC-II Firmware Xenomai	3-0055-0C01	S6V5	Current version
FlexCard USB-M Firmware	3-0058-0B01	S6V4	Current version
FlexCard Cyclone II Hardware	3-0009-0A04	H1V1	Initial version
FlexCard Cyclone II SE Hardware	3-0009-0A05	H1V1	Initial version
FlexCard PMC Hardware	3-0033-0A01	H1V0	Initial version
FlexCard PMC-II Hardware	3-0055-0A01	H1V1	Initial version
FlexCard USB-M Hardware	3-0058-0A01	H1V2	Initial version

Related Software Versions (Windows)

Component	Reference No.	Version (Major and Minor)	Remarks
fcBase API	3-0009-0K03	S6V6	Current version supports : FlexCard Cyclone II (SE), FlexCard PMC (II), FlexCard USB-M
Device Driver	3-0009-0E05	S6V6	Current version

Related Software Versions (Linux)

Component	Reference No.	Version (Major and Minor)	Remarks
libflexcard API	3-0009-0U01	S6V6	New FlexCard Linux driver. Current version supports : FlexCard PMC-II
Kernel module	3-0009-0U01	S6V6	New FlexCard Linux driver. Current version

Related Software Versions (Xenomai)

Component	Reference No.	Version (Major and Minor)	Remarks
libfcBase API	3-0009-0V01	S6V5	Current version supports: FlexCard PMC (II)
Kernel module	3-0009-0V01	S6V5	Current version

Related Software Versions (VxWorks)

Component	Reference No.	Version (Major and Minor)	Remarks
FlexCard PMC Driver	3-0033-0D01	S2V1	Current version supports: FlexCard PMC

Related Documents

Document	Version (Major and Minor)	Ordering number
FlexCard Cyclone II SE Instructions for Use	D2V14	3-0009-0T01-D01
FlexCard PMC Instructions for Use	D1V11	3-0033-0P01-D01
FlexCard PMC-II Instructions for Use	D2V3	3-0055-0P01-D05
FlexCard USB-M Instructions for Use	D2V3	3-0058-0P01-D03
FlexCard Cyclone II SE Getting started	D1V6	3-0009-0S01-D02
FlexCard PMC-II Getting started	D2V1	3-0055-0P01-D07
FlexCard USB-M Getting started	D2V0	3-0058-0P01-D04
Release Notes FlexCard Windows	D1V8	3-0009-0S01-D13
Release Notes FlexCard Linux	D1V2	3-0009-0U01-D01
Release Notes FlexCard Xenomai	-	-

Contents

1 General

1.1 Intended use

This document describes the application programming interface of the FlexCard to build own software applications.

The FlexCard is designed, intended and authorized exclusively for

a) EU: laboratory applications

b) US: industrial test equipment

Any other use needs the prior express written consent of *STAR COOPERATION*.

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:

	**WARNING** Used to indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury.
	**CAUTION** Used to indicate a potentially hazardous situation which, if not avoided, could result in minor or moderate 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.
	**Information** Used to indicate information provided only for purposes of clarification, illustration, and general information.

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 fcBase API has to be handled as described herein.

Changes or modifications of the FlexCard fcBase API are not allowed for safety and warranty reasons!

STAR COOPERATION 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:

⚠ WARNING

- The FlexCard API can be used to interfere with networked electronic systems. It can be used to transmit messages via FlexRay or CAN busses.
- If transmitted messages are received by real electronic control units, e.g. within a test car, these messages could result in an unpredictable behavior or a failure of the electronic control unit. This may result in serious injury of persons or material damage!
- Only qualified and briefed persons are allowed to use the FlexCard API!
  Transmit only messages where the expected behavior of the receiver is known.

1.4 User Group

This documentation is written for software developers who are familiar with C/C++ programming language under the Windows™ operating systems and the FlexRay protocol specification.

Any person involved with installation, usage or maintenance of the FlexCard has to

- be a qualified technician
- strictly adhere to this guidance
- receive a briefing by an authorized person

1.5 Meaning of Text Styles

In this document *filenames*, `source code`, FlexRay Protocol Variable, **`functions`** and **`structs`** are marked with a different text format.

2 Product Description

2.1 FlexCard fcBase API at a glance

This document describes the application programming interface (API) *fcBase API* for the FlexCard. The API defines the basic functions and structures which are used to communicate with the FlexCard hardware, the FlexRay and CAN bus. With these functions the developer is able to integrate the FlexCard in a FlexRay cluster and CAN network.

The following figure illustrates a typical approach of accessing the FlexRay and CAN bus via the FlexCard:

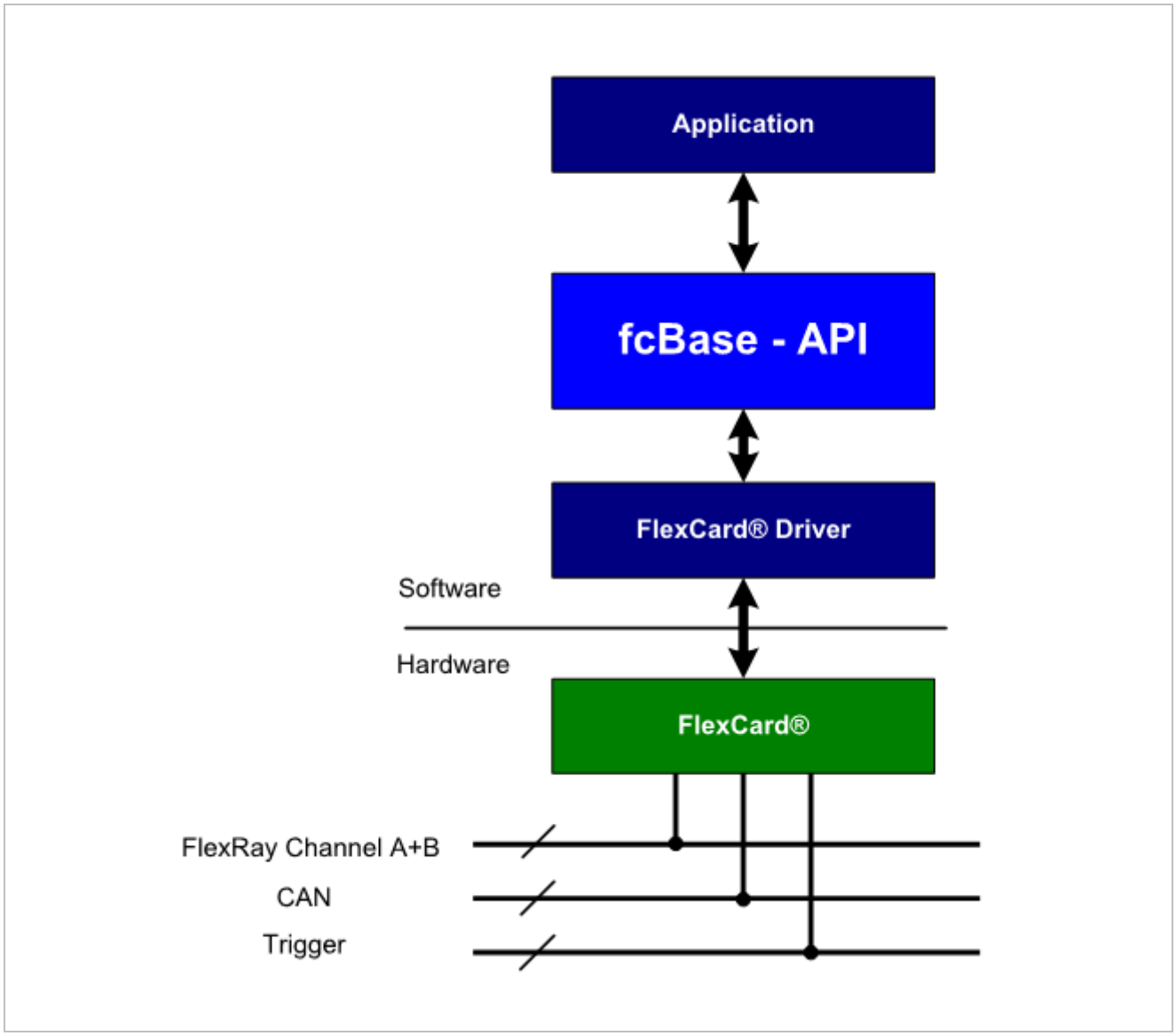


Figure 1: Overview of a typical FlexCard system with hardware and software

The *fcBase API* consists of the following groups of functions:

- **Error handling** → Functions to get detailed error information
- **Configuration** → Functions and structures to configure the available Communication Controller and the FlexCard hardware. For example, bus parameters, message buffers and the triggers may be configured.

- **Initialization** → Functions to enumerate the FlexCards in the system, to establish a connection to a FlexCard and to start and stop the monitoring of the FlexRay and CAN bus.
- **Transmit / Receive** → Functions to receive FlexRay and CAN frames or informational frames (e.g. Trigger information), or to transmit a FlexRay and CAN frame on a specific slot or id.
- **Event handling** → Functions to obtain event handles which are signalled if a specific time elapses, a wake-up pattern is detected or at the start of a new FlexRay cycle.

Additional there is a tracing module, which can only be accessed by the tracing control application. For further information refer to chapter 17 in this document.

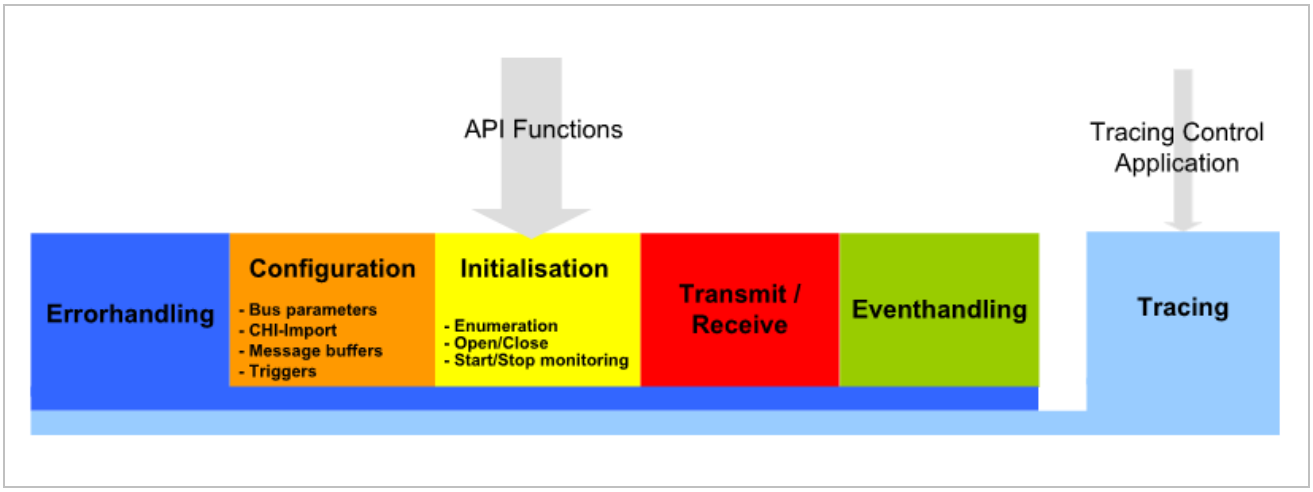


Figure 2: *fcBase API* groups

The FlexCard API uses a well-defined naming convention. Each function, structure or enumeration is prefixed with fc or fcb. The prefix fcb (fcBase) stands for a function, a structure or an enumeration which is only available in the fcBase API. Functions, structures or enumerations which are prefixed with fc are not limited to the fcBase API and could also be available in other FlexCard APIs.

Each function of this library (except some error handling functions) returns an error code. If the return value is equal to zero, no error occurred. A number greater than zero indicates an error. To get more information about it, use the error handling functions described in chapter 4.1.

Some functions will allocate memory for you. In such a case the **`fcFreeMemory`** function needs to be called to release this memory.

2.2 General Function Availability

There are some functional hardware and software differences between FlexCard products which demand additional functions or enumerations. The differences are listed in the table below:

Functions	FlexCard Cyclone II (SE)	FlexCard USB-M	FlexCard PMC	FlexCard PMC-II
`General FlexCard API Description`	Available			
`FlexRay API`	Available (depends on firmware configuration)			
`CAN API`	Available (depends on firmware configuration)			
`CAN FD API`	Not available			Available
`Trigger API`	2 trigger lines, unidirectional		2 trigger lines, configurable	

Functions	FlexCard Cyclone II (SE)	FlexCard USB-M	FlexCard PMC	FlexCard PMC-II
`Termination API`	Not available	Not available	Available	Available
`Self Synchronization API`	Available for versions with exactly 1 FlexRay Communication Controller.			
`Firmware API`	Not available	Available	Not available	Available

The functions are located in different header files, but all functions are provided by fcBase.dll (or libfcBase API under Linux/Xenomai). If the function you called is not supported on the selected hardware, the FlexCard API will return an error.

Following a list of the supported number of Communication Controllers per FlexCard device:

Functions	FlexCard Cyclone II (SE)	FlexCard USB-M	FlexCard PMC	FlexCard PMC-II
CC count	1 CC for FlexRay and 2 CCs for CAN-HS	1 CC for FlexRay and 2 CCs for CAN-HS, 1 CC for CAN-LS	2 CCs for FlexRay or 1 CC for FlexRay and 2 CCs for CAN-HS	Variable interface configurations for FlexRay and CAN max. 4 FlexRay CCs or max. 8 CAN-HS CCs with FlexTiny II possible.

The FlexCard features are only available with the correct firmware, driver and license.

2.3 Exceptions for Function Availability

This chapter lists the differences in the functional range compared to the general function availability (see chapter 2.2). Exceptions may also be found in the Operation System chapters.

2.3.1 FlexCard USB-M

The FlexCard USB-M driver doesn't support the following functions:

- `fcbSetEventHandleV2`
- `fcbSetReceiveBufferLevelNotification`
- `fcbSetTimer`
- `fcbFRSetTransceiverState`
- `fcbFRGetTransceiverState`
- `fcbFRSetCcTimerConfig`
- `fcbFRGetCcTimerConfig`
- `fcbFRCalculateMacrotickOffset`

2.4 API Changes From Previous Versions

2.4.1 From S1V0-F to S2V0-F

Change	Reason	Page	Remark
Definition of type fcQuad corrected	Portability	43	Downwardly compatible. Works with applications which are designed for S1V0-F.
Enumeration fcTransceiverState added	New feature	103	
Function fcbSetTransceiverState added	New feature	215	
Function fcbGetTransceiverState added	New feature	215	
Structure fcMsgBufCfgTx modified. New configuration options TxAcknowledgeShowNullFrames and TxAcknowledgeShowPayload added. TxAcknowledge packets work in all transmission modes.	Feature extended	113	Downwardly compatible. Works with applications which are designed for S1V0-F, if the reserved member of this structure was set to zero.
New member fcNoticiationTypeWakeup for enumeration fcNotifyType added for getting notification if one of the transceivers has detected a wakeup event.	Feature extended	65	Downwardly compatible. Works with applications which are designed for S1V0-F.
Function fcbNotificationPacket added	New feature	68	
Structure fcInfoPacket modified. Rate and offset correction information added.	Feature extended	69	Downwardly compatible. Works with applications which are designed for S1V0-F.
Structure fcFlexRayFrame modified. Timestamp information added.	Feature extended.	70	Downwardly compatible. Works with applications which are designed for S1V0-F.
Structure fcTxAcknowledgePacket modified. Additional information about the transmitted frame added.	Feature extended.	72	Downwardly compatible. Works with applications which are designed for S1V0-F.
Structure fcNotificationPacket added	New feature	78	
Structure fcPacket modified. fcNotificationPacket information added	Feature extended.	81	Downwardly compatible. Works with applications which are designed for S1V0-F.
Enumeration fcErrorPacketFlag extended.	Feature extended.	86	Downwardly compatible. Works with applications which are designed for S1V0-F.

2.4.2 From S2V0-F to S2V2-F

Change	Reason	Page	Remark
PMC functions added: fcbSetCCIndex, fcbGetCCIndex, fcbSetTermination, fcbGetTermination PMC Enumerations added: fcBusChannel, fcBusType	New features	176, 230	
Added new trigger functionality for FlexCard Cyclone II and FlexCard Cyclone SE. Triggers can be OR-ed now.	Feature extended	61	
Added Xenomai support function for event handling	New feature	190	

2.4.3 From S2V2-F to S3V0-F

Change	Reason	Page	Remark
Added Self synchronization for FlexCard Cyclone II (SE)	New features	156	Firmware-Version S3V0-F is needed

2.4.4 From S3V0-F to S4V0-F

Change	Reason	Page	Remark
Added CAN API for FlexCard Cyclone II (SE)	New features	135	Firmware-Version S4V0-F is needed
Added function fcbResetTimestamp.	New feature	63	
Added function fcbGetNumberCcs.	New feature	61	
Added function fcbSetContinueOnPacketOverflow.	New feature	62	
Added function fcbCalculateMacrotickOffset.	New feature	225	
Added function fcbGetCcTimerConfig.	New feature	224	
Added function fcbSetCcTimerConfig.	New feature	224	
Added function fcbCheckVersion	New feature	54	
New packets CAN packet and CAN error packet.	New feature	79, 81	
Extended enumeration fcPacketType	Feature extended	85	Downwardly compatible.
Extended enumeration fcCC	Feature extended	43	Downwardly compatible.
Extended enumeration fcTriggerConditionEx	Feature extended	169	Downwardly compatible.
Structure fcTriggerExInfoPacket modified. Reserved1 added	Feature extended	79	Downwardly compatible.
Structure fcCcTimerCfg added.	New feature	116	
Enumeration fcCyclePos added.	New feature	105	
Enumeration fcNotificationType modified. fcNotificationTypeCcTimer added.	Feature extended	65	Downwardly compatible.
Enumeration fcMemoryType modified. fcMemoryTypeInfoV2 added.	Feature extended	41	Downwardly compatible.
Structure fcInfoV2 added.	New feature	209	
Added function fcbGetEnumFlexCardsV2.	New feature	210	
Added function fcbReinitializeCcMessageBuffer	New feature	60	

Change	Reason	Page	Remark
Added function fcbReinitializeCcMessageBufferSelfSynchronization	New feature	167	
Added function fcbGetCurrentTimeStamp	New feature	63	

2.4.5 From S4V0-F to S4V2-F

Change	Reason	Page	Remark
CAN API is supported by FlexCard Cyclone II (SE) and FlexCard PMC/PCI.	New features	135	Firmware-Version S4V2-F is needed
Added additional Linux API.	New feature	184	
Xenomai: Added thread-safe function for event handling.	New feature	187	
Added new thread-safe FlexRay API for all supported devices.	New features	92	
Extended enumeration fcNotificationType.	Feature extended	65	Downwardly compatible.
Added thread-safe function for event handling.	New feature	66	
Structure fcFlexRayFrame modified. AsyncMode added.	Feature extended	70	Downwardly compatible.

2.4.6 From S4V2-F to S5V1-F

Change	Reason	Page	Remark
Structure fcMemoryType modified. fcMemoryTypeInfoHwSW added.	Feature extended	41	Downwardly compatible.
Enumeration fcFlexCardDeviceId modified. fcFlexCardPMCII added.	Feature extended	45	Downwardly compatible.
Structure fcVersionCC modified. IncorrectPhysicalLayer added.	Feature extended	47	Downwardly compatible.
Structure fcInfoHw added.	New feature	49	
Structure fcInfoSw added.	New feature	50	
Structure fcInfoHwSw added.	New feature	51	
Added function fcbGetEnumFlexCardsV3	New feature	52	
Added function fcbGetInfoFlexCard	New feature	56	
Added function fcbSetUserDefinedCardId	New feature	57	Firmware-Version S5V1-F is needed
Added function fcbGetUserDefinedCardId	New feature	57	Firmware-Version S5V1-F is needed
Added function fcbFRSetHardwareAcceptanceFilter	New feature	128	Firmware-Version S5V1-F is needed
Structure fcFlexRayFrame modified. FrameCRC added.	Feature extended	70	Downwardly compatible.
Structure fcTxAcknowledgePacket modified. ValidFrame, SyntaxError, ContentError added.	Feature extended	72	Downwardly compatible.
Structure fcCANMonitoringMode modified. fcCANMonitoringSilent, fcCANMonitoringActive, fcCANMonitoringPassive added.	Feature extended	138	Downwardly compatible.
Structure fcCANBufCfgTx modified. newData added.	Feature extended	144	Downwardly compatible.

Change	Reason	Page	Remark
Structure fcCANBufCfgRemoteTx modified. newData added.	Feature extended	145	Downwardly compatible.
Added FlexCard PMC-II description	New features	15	
Enumeration fcBusChannel modified. fcBusChannel5 to fcBusChannel8 added.	Feature extended	176	Downwardly compatible.

2.4.7 From S5V1-F to S6V1-F

Change	Reason	Page	Remark
Added typedef fcBool.	New feature	43	
Structure fcVersionCC modified. Ansi-C conformity.	Feature extended	47	Downwardly compatible.
Structure fcInfo modified. Ansi-C conformity.	Feature extended	209	Downwardly compatible.
Structure fcInfoV2 modified. Ansi-C conformity.	Feature extended	209	Downwardly compatible.
Structure fcInfoHwSw modified. Ansi-C conformity.	Feature extended	51	Downwardly compatible.
Structure fcPacket modified. Ansi-C conformity.	Feature extended	81	Downwardly compatible.
Enumeration fcNotificationType modified. fcNotificationTypeReceiveBufferLevel added.	Feature extended	65	Downwardly compatible.
Added function fcbSetReceiveBufferLevelNotification.	New feature	69	Firmware-Version S6V1-F is needed
Function fcbGetEnumFlexCardsV3 modified. Ansi-C conformity.	Feature extended	52	Downwardly compatible.
Function fcbMonitoringStart modified. Ansi-C conformity.	Feature extended	212	Downwardly compatible.
Function fcbTrigger modified. Ansi-C conformity.	Feature extended	230	Downwardly compatible.
Function fcbSetTimer modified. Ansi-C conformity.	Feature extended	67	Downwardly compatible.
Function fcbSetCcTimerConfig modified. Ansi-C conformity.	Feature extended	224	Downwardly compatible.
Function fcbSetContinueOnPacketOverflow modified. Ansi-C conformity.	Feature extended	62	Downwardly compatible.
Function fcbNotificationPacket modified. Ansi-C conformity.	Feature extended	68	Downwardly compatible.
Added enumerations fcFRMsgBufCfgMode.	New features	103	
Added function fcbFRSetMsgBufCfgMode.	New feature	123	
Added function fcbFRSetHardwareTransmitFilter.	New feature	129	Firmware-Version S6V1-F is needed
Function fcbFRMonitoringStart modified. Ansi-C conformity.	Feature extended	94	Downwardly compatible.
Function fcbFRSetCcTimerConfig modified. Ansi-C conformity.	Feature extended	130	Downwardly compatible.
Function fcbFRSetHardwareAcceptanceFilter modified. Ansi-C conformity.	Feature extended	128	Downwardly compatible.
Function fcbCANMonitoringStart modified. Ansi-C conformity.	Feature extended	139	Downwardly compatible.

Change	Reason	Page	Remark
Function fcbCANSetMessageBuffer modified. Ansi-C conformity.	Feature extended	149	Downwardly compatible.
Function fcbCANTransmit modified. Ansi-C conformity.	Feature extended	153	Downwardly compatible.
Added function fcbSetBusTerminationCc.	New features	176	
Added function fcbGetBusTerminationCc.	New features	177	
Function fcbSetBusTermination modified. Ansi-C conformity.	Feature extended	178	Downwardly compatible.
Function fcbGetBusTermination modified. Ansi-C conformity.	Feature extended	179	Downwardly compatible.
Structure fcInfoSw modified. LicensedForLabviewDriver added.	Feature extended	50	Downwardly compatible.
Structure fcFWInfo added.	New features	181	
Added function fcbFWGetImageInfo.	New features	181	Firmware-Version S6V1-F is needed
Added function fcbSetSelectImage.	New features	182	Firmware-Version S6V1-F is needed

2.4.8 From S6V1-F to S6V2-F

Change	Reason	Page	Remark
Enumeration fcTriggerConditionEx modified. fcTriggerOutOnTimeStampChanged added.	Feature extended	169	Downwardly compatible
Enumeration fcTriggerConditionPMC modified. fcTriggerPMCOutOnTimeStampChanged added.	Feature extended	171	Downwardly compatible
Enumeration fcTimeStampSourceMode added.	New features	59	
Enumeration fcFlexCardDeviceId modified.	Feature extended	45	Downwardly compatible.
Structure fcTimeStampCfg added.	New features	60	
Added function fcbConfigureFlexCardTimeStamp.	New features	64	Firmware-Version S6V2-F is needed
Added function fcbGetCurrentHighResTimeStamp.	New features	65	Firmware-Version S6V2-F is needed
Structure fcNumberCC modified. FlexRaySelfSync added.	Feature extended	47	Downwardly compatible
Structure fcVersionCC modified. FaultTolerantCAN added.	Feature extended	47	Downwardly compatible

2.4.9 From S6V2-F to S6V3-F

Change	Reason	Page	Remark
Structure fcCANTxFifoConfig added.	New features	148	
Added function fcbCANSetTxFifoConfiguration.	New features	151	Firmware-Version S6V3-F is needed
Added function fcbCANGetTxFifoConfiguration.	New features	152	Firmware-Version S6V3-F is needed
Added function fcbCANTxFifoReset.	New features	153	Firmware-Version S6V3-F is needed

Change	Reason	Page	Remark
Added function fcbCANTxFifoTransmit.	New features	155	Firmware-Version S6V3-F is needed

2.4.10 From S6V3-F to S6V4-F

No API change.

2.4.11 From S6V4-F to S6V5-F

No API change.

2.4.12 From S6V5-F to S6V6-F

Change	Reason	Page	Remark
Added enum fcCANFDFrameFormat, structure fcCANCcBitTime, structure fcCANFDCcConfig, structure fcCANFDTxFrame.	New features	158	
Enum fcTimeStampSourceMode extended.	Feature extended	59	Downwardly compatible
Added function fcbCANFDSetCcConfiguration, fcbCANFDTransmit.	New features	160	Firmware-Version S6V6-F (6.5.0.33) is needed
Added function fcbGetTinyInfo.	New features	58	Firmware-Version S6V6-F (6.5.0.33) is needed

2.5 Support

There is support available by *STAR COOPERATION* regarding software (device driver and API) and hardware. Before you submit a problem, ensure that you have the latest release of the software. The latest versions of the device driver and API are available from our support team or on our web site: http://www.star-cooperation.com/ee-solutions

If you encounter a problem, please send an email to support-ee@star-cooperation.com, including the following information:

- Description of your problem
- Detailed steps to reproduce the problem
- Version number of the device driver or loadable kernel module
- Version number of the DLL or shared object library
- Version number of the hardware
- Version number of the firmware
- Serial number of your FlexCard
- The application you are using
- Your computer system (manufacturer and type of PC, e.g. Dell Inspiron 7500)
- Your operating system (Windows 7, Linux, Xenomai, VxWorks)

- The cardbus or PCI adapter in your PC (e.g. Texas Instruments, …)
- If possible the CC configuration file or string or a CC parameter list

3 Getting Started

In this section the necessary steps for developing a FlexCard application with Windows operating systems are specified. First, the setup of the files and the integration in an Integrated Development Environment (IDE) is described. The next section provides a guideline with important steps to create an application. This includes the functions and structures which should normally be used. A more in depth view about the used functions can be found in chapter 4 et seq

3.1 Installation

For details about the installation process please refer to the installation section in [1]. After a successful installation of the developer package the following directory structure should exist:

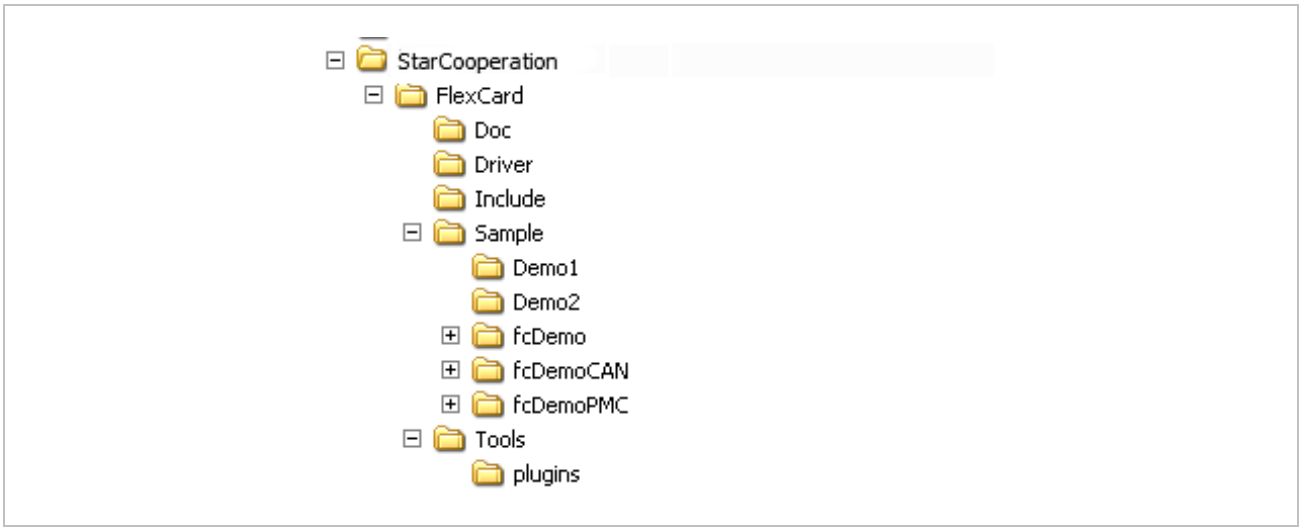


Figure 3: FlexCard directory structure

The directory *Doc* contains the documentation (Instructions for Use and Getting started guides) in PDF format. The API documentation is only present if during the installation the setup type Developer was selected.

The directory *Driver* contains the files for the manual installation of the device driver:

- *fce05xp.sys* (Device driver for the Windows™ XP and Vista operating system)

  fce057.sys (Device driver for the Windows™ 7 and later operating system)

  fce05.inf (Text file containing information which is needed for the installation of the device driver)
- *fcBase.dll* (fcBase Library. Exists as 32 bit and 64 bit version.)

  fcftbus.sys (Low-level driver component for FlexCard USB-M)

  fcFtd.dll (High-level driver component for FlexCard USB-M)

The previous directory is not required for developing user defined application, whereas the two following directories are a must-have for developers.

The directory *Include* contains the API definition, namely the *fcBase* header file:

- *fcBase.h*: The file includes the definition of the basic API functions.
- *fcBaseTypes.h*: The file contains the data types and enumerations (e.g. possible error codes) used by the basic functions.
- *fcBaseFlexRay.h*: This file contains definitions of functions specific for FlexRay.

- *fcBaseTypesFlexRay.h*: The data types and enumerations for the FlexRay functions are defined here.
- *fcBasePMC.h*: The file includes additional definitions of API functions which are to use with FlexCard PMC and FlexCard PMC-II only.
- *fcBaseTypesPMC.h*: The file (for the FlexCard PMC and FlexCard PMC-II only) contains additional data types and enumerations used in this library.
- *fcBaseCAN.h*: The file includes the definition of the API functions which are to be used with a CAN license only. Contains CAN/ CAN FD functionality.
- *fcBaseTypesCAN.h*: The file (for FlexCards with CAN license only) contains additional data types and enumerations for CAN/ CAN FD used in this library.
- *fcBase.lib*: Exported functions. Exists as 32 bit and 64 bit version.

The directory *Sample* contains the following directories:

- *Demo1*: Configuration files for a cluster composed of two FlexCards
- *Demo2*: Configuration files for a cluster composed of one FlexCard and two FlexNodes.
- *fcDemo:* Contains the source files for the demo application.
- *fcDemoCAN*: Contains the source files for the CAN demo application for a FlexCard.
- *fcDemoCANFD*: Contains the source files for the CAN FD demo application for a FlexCard.
- *fcDemoPMC:* Contains the source files for the demo application for a FlexCard PMC-II.

The directory *Tools* contains the following applications:

- *CANBaudrateCalculator.exe*: Application to calculate CAN CC configuration for fcBase CAN API.
- *fcDemo.exe:* The demo application for one FlexRay CC.
- *fcDemoCAN.exe*: The demo application for two CAN CCs.
- *fcDemoCANFD.exe*: The demo application for two CAN FD CCs.
- *fcDemoPMC.exe:* The demo application for two FlexRay CCs.
- *FlexAlyzerV2.exe*: FlexRay and CAN monitoring application for FlexCard products.
- *FlexUpdate.exe:* Firmware and license update application for FlexCard products.

	Information
	The windows installer will copy the *fcBase.dll* into your *<windows>\system32* directory. On Windows 64 bit, *fcBase.dll* 32 bit will be copied to *<windows>\SysWOW64*. If you do not use the windows installer, please check if the desired version of the DLL is loaded. A description of the DLL search order which is used by the Windows operating system can be found in [2].

3.2 Integration

There are different ways to integrate the fcBase DLL into your application depending on the development platform and language. Under Microsoft Visual Studio the integration is done via the property pages/project settings.

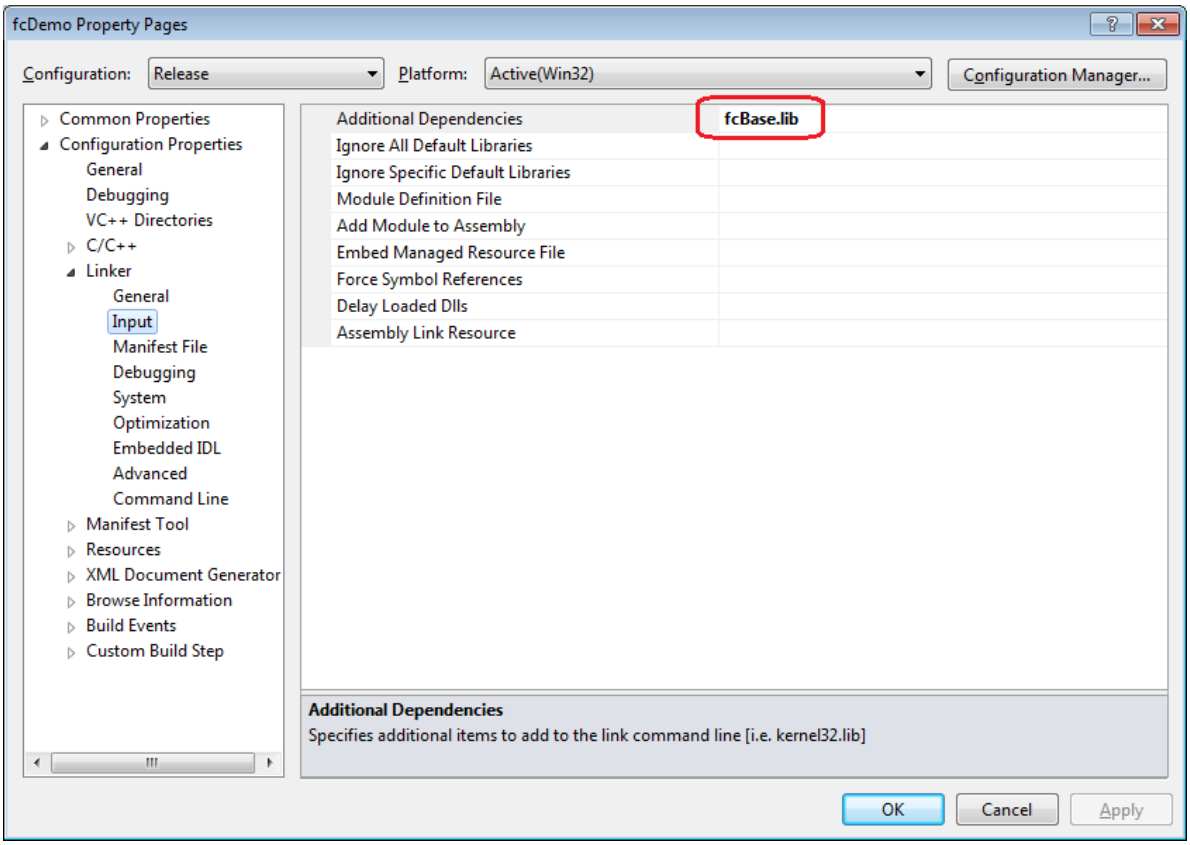


Figure 4: Integration under Microsoft Visual Studio 2010

Another alternative for Microsoft compiler users is to include the fcBase API via the Microsoft specific pre-processor command:

```
#pragma comment( lib , "fcBase.lib")
```

To complete the integration of the fcBase API into your user defined application, you have to add the files *fcBaseTypes.h*, *fcBaseTypesFlexRay.h*, *fcBase.h* and *fcBaseFlexRay.h*. The include order is important because the file *fcBase.h* uses definitions which are declared in *fcBaseTypes.h* and the file *fcBaseFlexRay.h* uses definitions which are declared in *fcBaseTypes.h* and *fcBaseTypeFlexRay.h*. For FlexCard PMC-II) usage please also include the files *fcBaseTypesPMC.h* and *fcBasePMC.h* in the right order. In case you want to access the CAN functionality of the FlexCard, the files *fcBaseTypesCAN.h* and *fcBaseCAN.h* should be also included.

```
#include "fcBaseTypes.h"
#include "fcBaseTypesFlexRay.h"
#include "fcBase.h"
#include "fcBaseFlexRay.h"

//Additional for PMC usage
#include "fcBaseTypesPMC.h"
#include "fcBasePMC.h"

//Additional for CAN usage
#include "fcBaseTypesCAN.h"
#include "fcBaseCAN.h"
```

The setup program sets the environment variable FLEXCARD_INC which directly points to the fcBase include directory. This variable can be used as shown in the figures below.

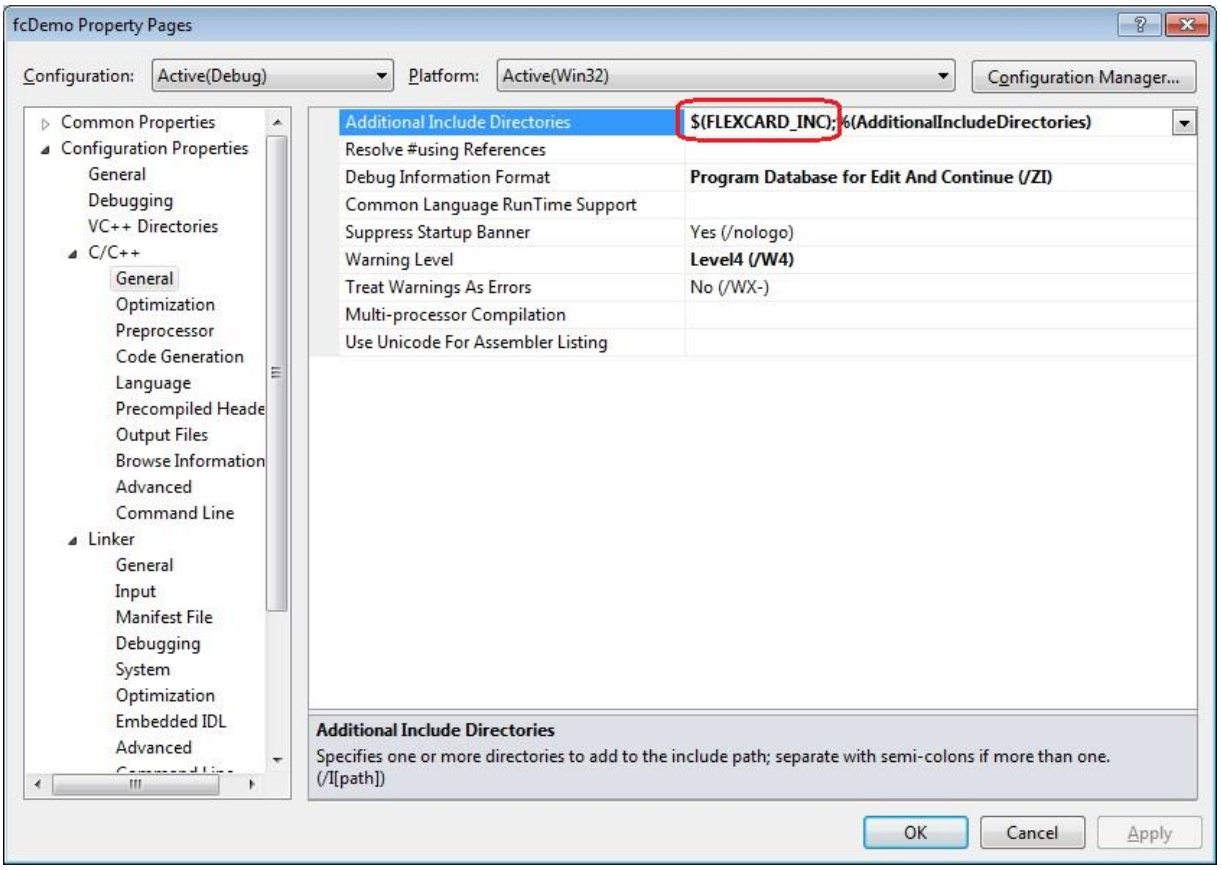


Figure 5: Using the variable FLEXCARD_INC under Microsoft Visual Studio 2010 (Compiler)

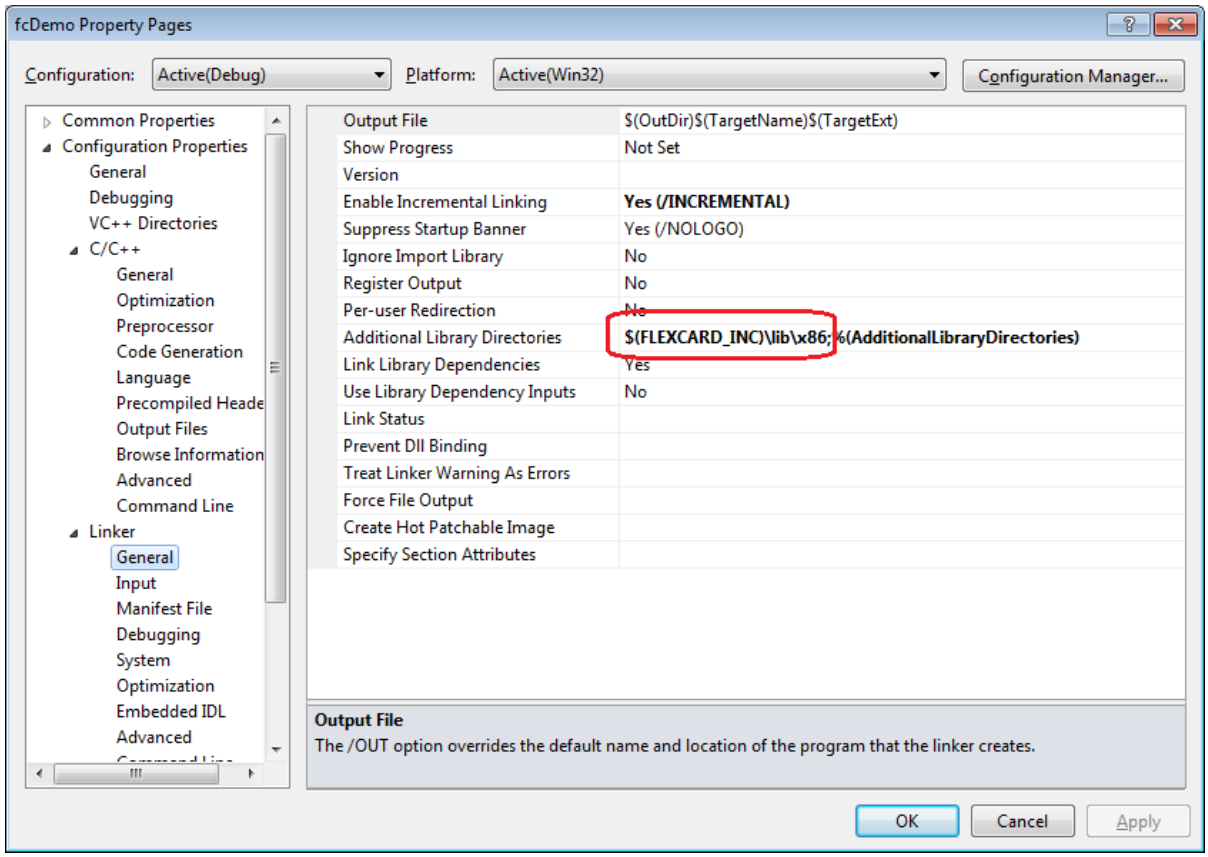


Figure 6: Using the variable FLEXCARD_INC under Microsoft Visual Studio 2010 (Linker)

	NOTICE
	Ensure you use the directory of the fcBase library and header files which corresponds to the loaded DLL. A description of the DLL search order which is used by the windows operating system can be found in [2].

3.2.1 Calling Convention

The dynamic link library for Windows was developed under Microsoft Visual Studio 2010 C++. The Microsoft C/C++ compiler supports several calling conventions (__cdecl, __stdcall, __fastcall, this, naked). To provide access to the *fcBase.dll* 32 bit for other languages (e.g. Visual Basic), the functions are declared with __stdcall calling convention (function arguments are pushed onto the stack from right to left, the callee cleans the stack). On *fcBase.dll* 64 bit the user does not have to specify a calling convention, because there is only one.

3.2.2 Loading the Dll

When you use the standard “inf” installation, you don’t have to append the *fcBase.dll* path to the Windows PATH environment variable. On a Windows 64 bit installation, loading *fcBase.dll* in a 64 bit application will load it from *<windows>\system32* and loading it in a 32 bit application will load it from *<windows>\SysWOW64.*

3.2.3 Multithreading

All functions, which are not declared as obsolete, of the fcBase library are thread-safe. If you are using the fcBase functions in the context of a multi-threaded program, the library ensures that only one thread is accessing the internal shared data at any given time.

3.3 Basic Workflow

This section will guide you through the necessary workflow for creating an application for the FlexCard. The following figure shows a typical workflow. For FlexRay refer to 5.1 Basic FlexRay Workflow, for CAN refer to 6.1 Basic CAN Workflow. The main functions and principles for building a user defined application are introduced in this chapter. Demo applications for the FlexRay/CAN usage (source code and binary) are installed with the FlexCard Windows Developer Setup.

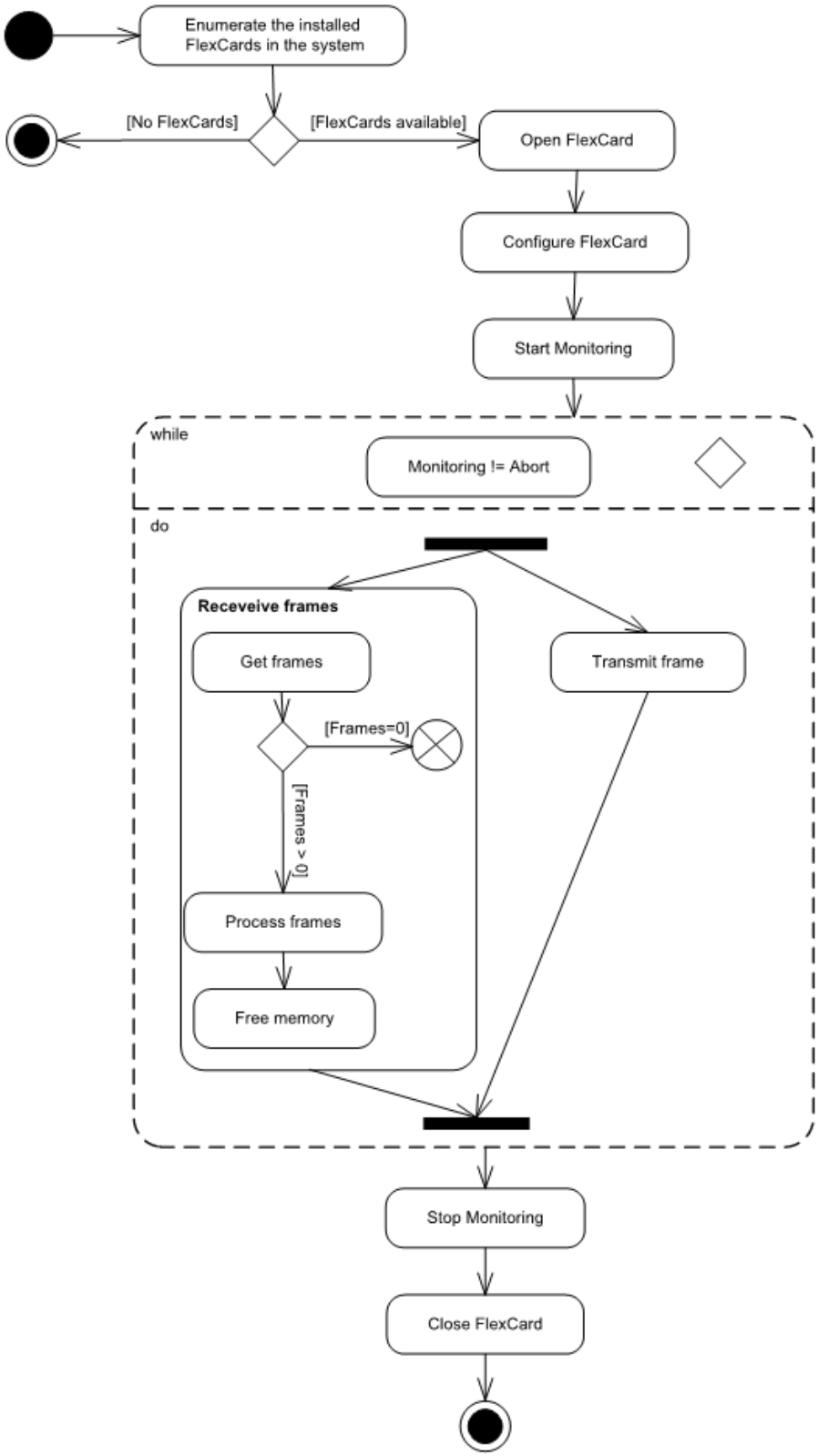


Figure 7: Typical FlexCard workflow

3.3.1 Setting Up the Project

For the development of the example project we will use Microsoft Visual Studio 2003 with the programming language C/C++ and the Microsoft Foundation Class (MFC). The Visual Studio project wizard will generate the framework for our MFC dialog based application (for more details, please refer to the documentation of Microsoft Visual Studio 2003).

As described in the chapter Integration, we must add the library and header files of the fcBase API. This can be done easily at the end of the file *stdafx.h*. Ensure your compiler and linker use the correct path to the fcBase header and library files.

```
// fcBase API
#pragma comment(lib,"fcBase.lib")
#include "fcBaseTypes.h"
#include "fcBase.h"

// additional for FlexCards with FlexRay
#include "fcBaseTypesFlexRay.h"
#include "fcBaseFlexRay.h"

// additional for FlexCards with CAN
#include "fcBaseTypesCAN.h"
#include "fcBaseCAN.h"

// additional for FlexCard PMC and FlexCard PMC-II
#include "fcBaseTypesPMC.h"
#include "fcBasePMC.h"

// own headers
```

3.3.2 Get the Installed FlexCards

Before we can open a connection to a FlexCard, we require a valid FlexCard identifier. This can be done with the function **`fcbGetEnumFlexCardsV3`** which returns a list of FlexCards found in the system. In the method `CselectFlexCardDlg::OnInitDialog()` in our example we call **`fcbGetEnumFlexCardsV3`** to fill the combo box with available FlexCards found in the system.

	Information
	The **`fcInfoHwSw`** structure contains valid FlexCard information only if the member `FlexCardId` is greater than 0. The `FlexCardId` is later used to open a connection to the FlexCard.

```
fcError e = fcbGetEnumFlexCardsV3(&m_pInfoHwSw, false);
if (0 == e)
{
      // Iterate through the list of flexcards
      fcInfoHwSw* pCurrent = m_pInfoHwSw;
      while (NULL != pCurrent)
      {
            // only if we got a valid flexcard identfier
            if ( 0 != pCurrent->FlexCardId )
            {
                  Cstring szItem;
                  szItem.Format("FlexCard #%d",pCurrent->InfoHardware.Serial);

                  // Add the string to the combo box
```

```
                    int nIndex = m_FlexCardComboBox.InsertString(0,szItem);
                    m_FlexCardComboBox.SetItemDataPtr(nIndex,pCurrent);
              }
              // get the next flexcard
              pCurrent = pCurrent->pNext;
       }
}
```

If the user selects one of the items in the combo box, we save the member FlexCardId from the structure **`fcInfoHwSw`** into the member variable `m_flexcardIdentifier` (see `CselectFlexCardDlg::UpdateVersionInformation`).

```
Int nCurrentSelection = m_FlexCardComboBox.GetCurSel();
if (-1 != nCurrentSelection)
{
       fcInfo* pCurrent =
              (fcInfo*)m_FlexCardComboBox.GetItemDataPtr(nCurrentSelection);

       // Save the flexcard identifier
       m_flexcardIdentifier = pCurrent->FlexCardId;
       ...
}
```

Once finished with the selection of a FlexCard, we have to free the memory which was allocated by the function **`fcbGetEnumFlexCardsV3`**.

```
CselectFlexCardDlg::~CselectFlexCardDlg()
{
       if (NULL != m_pInfo)
       {
              fcFreeMemory(fcMemoryTypeInfoHwSw,m_pInfo);
              m_pInfo = NULL;
       }
}
```

3.3.3 Open a Connection

After getting a valid FlexCard identifier, we use it to open a connection to the FlexCard. The function **`fcbOpen`** expects this identifier and returns a handle (to the previously selected FlexCard) which is later used in all other functions.

	Information
	The function **`fcbOpen`** resets all configuration settings. That means that all Communication Controller registers are set to their default value and the FlexRay message buffers are configured as FIFO buffer

```
...
m_hFlexCard = NULL;
fcError e = fcbOpen(&m_hFlexCard,dlg.FlexCardIdentifier());
...
```

3.3.4 FlexRay Configuration behavior FlexCard

To integrate the FlexCard into a FlexRay cluster it is essential to configure its Communication Controller registers. These registers describe global cluster parameters (e.g. gdStaticSlot), node parameters (e.g.

pMicroPerCycle) and Communication Controller specific settings. The global cluster parameters are identical for all nodes of a cluster, whereas the node parameters are set for each node individually.

The FlexRay CC configuration is possible via directly entering the bus parameters, or by passing a CHI-file. If one of the parameters is not correct, the integration of the FlexCard and/or the communication may fail. Therefore, it is recommended to use a tool which helps generate a valid FlexRay configuration for each node. FlexConfig Developer from STAR COOPERATION is such a tool. It exports the bus parameters as CHI-file.

In our example we use a CHI-compatible string to configure the FlexCard. As the function **`fcbFRSetCcConfigurationChi`** expects a string, we read and parse the configuration file into a string.

```
Std::string s;
std::ifstream file(szPath);
if (! File.is_open())
{
      // Print error message
      return;
}

char ch;
while (file.get(ch)) s += ch;
file.close();
```

This string is passed to the function **`fcbFRSetCcConfigurationChi`** which will configure the specified Communication Controller registers described in the chi file. Setting a configuration via this function will override the previous configuration of this CC.

```
fcCC eCC = fcCC1;
fcError e = fcbFRSetCcConfigurationChi(m_hFlexCard, eCC, s.c_str());
```

As we want to transmit messages on the FlexRay bus, we have to configure transmit buffers for the FlexCard. To configure such a buffer two options exist: Using the function **`fcbFRConfigureMessageBuffer`** or via the CHI configuration string. There is a significant difference between these two methods: While **`fcbFRConfigureMessageBuffer`** returns the index of the configured message buffer, **`fcbFRSetCcConfigurationChi`** does not. And considering that to transmit the content of a message buffer, the function **`fcbFRTransmit`** requires its index; we need a way to retrieve it. The following code performs this task for all configured transmit message buffers.

```
// Get all transmit message buffers
unsigned int bufferIdx = 1; // The first valid buffer is 1
while (true)
{
      fcMsgBufCfg cfg;
      fcCC eCC = fcCC1;

      // as long no error occurs we try to get each buffer
      fcError e = fcbFRGetMessageBuffer(m_hFlexCard,eCC,bufferIdx,&cfg);
      if (0 != e) break;

      // is this a tx buffer, then add it to our list
      if (fcMsgBufTx == cfg.Type)    Buffers[bufferIdx] = cfg;

      // next buffer index
      bufferIdx++;
}
```

The function **fcbFRConfigureMessageBuffer** is used to add a message buffer dynamically. This function checks the given message buffer settings and will report an error in the case of a mismatch with a global cluster parameter or a node specific parameter. The returned error informs the user about the mismatch. Before setting the members of a struct, initialize it to zero.

```
fcMsgBufCfg cfg;

memset(&cfg, 0, sizeof(fcMsgBufCfg)); // Initialize to zero
cfg.Type = fcMsgBufTx;
cfg.ChannelFilter = fcChannelA;
cfg.CycleCounterFilter = 0;
cfg.Tx.FrameId = 5;
cfg.Tx.TxAcknowledgeEnable = 1;
cfg.Tx.PayloadLength = 16;
cfg.Tx.PayloadLengthMax = 16;
cfg.Tx.PayloadPreambleIndicator = 0;
cfg.Tx.StartupFrameIndicator = 0;
cfg.Tx.SyncFrameIndicator = 0;
cfg.Tx.TransmissionMode = fcMsgBufTxSingleShot;
cfg.Tx.TxAcknowledgeShowNullFrames = 0;
cfg.Tx.TxAcknowledgeShowPayload = 0;

fcCC eCC=fcCC1;
unsigned int bufferIdx = 0;
fcError e = fcbFRConfigureMessageBuffer(m_hFlexCard,eCC,&bufferIdx,cfg);

if (0 != e)
{
      ShowErrorI;
}
```

Via the function **fcbFRReconfigureMessageBuffer** and with some restrictions the user can modify an existing message buffer.

3.3.5 Start and Stop a FlexRay Measurement

After having successfully configured the FlexCard, the monitoring can be started through the function **fcbFRMonitoringStart**. To use the FlexCard as a wake-up node, the flag `enableWakeup` has to be set to true (the FlexCard must have been previously configured with the correct wake-up settings). To use the FlexCard as a start-up node, the flag `enableColdstart` has to be set to true (one transmit buffer with both start-up and sync flags set must have been previously configured). In the case of the integration of a FlexCard into a running cluster, none of these two parameters has to be set. To be notified at the start of each cycle, the flag `enableCycleStartEvents` has to be set to true and the user has to provide an event object (used to signal when a new cycle starts) to the function **fcbSetEventHandleV2**.

```
// create the event handle which is signaled when a new cycle starts
const bool cyclestart = true;
fcCC eCC=fcCC1;

HANDLE hEvent = ::CreateEvent(NULL,FALSE,FALSE,NULL);

// inform the api that the event should be used when a new cycle starts
fcError e = fcbSetEventHandleV2(m_hFlexCard, eCC,
      hEvent, fcNotificationTypeCycleStarted);

// no coldstart and wake-up attempt have to be done
const bool coldstart = false;
const bool wakeup = false;
```

```
fcError e = fcbFRMonitoringStart(m_hFlexCard,eCC,fcMonitoringNormal,true,
            cyclestart,coldstart,wakeup);
```

After starting the monitoring, it is highly recommended to verify that the integration has succeeded. It can be determined either by receiving (via **fcbReceive**) a status packet with the flag `fcStatusStartupCompletedSuccessfully` set or by calling the function **fcbFRGetCcState** and checking that the return value is `fcStateNormalActive`.

Calling the function **fcbFRMonitoringStop** will stop the monitoring and set back the Communication Controller in its configuration state, `fcStateConfig`.

3.3.6 Receive FlexRay Frames

Once the monitoring started, the FlexCard begins to monitor the FlexRay bus. The received FlexRay frames and the FlexCard generated packets (Info frame, Error frame, etc.) can be fetched by the function **fcbReceive**. A call to this function will get all available packets from the FlexCard.

The code below uses the cycle start event to collect the received data of the previous cycles. If the event is signalled or if the timeout elapses, we get the available received packets (fcPacket) by calling the function **fcbReceive**. The timeout is used as a fallback if the FlexCard is not successfully integrated and no cycle start events could be generated. The FlexCard USB-M does not support events, so WAIT_TIMEOUT is signalled.

```
DWORD CdemoDlg::Thread()
{
      // … Code removed for listing …
      fcCC eCC=fcCC1;
      // create the event handle which is signaled when a new cycle starts

      hEvents[1] = ::CreateEvent(NULL,FALSE,FALSE,NULL);

      // inform the api that the event should be used when a new cycle starts
      fcError e = fcbSetEventHandleV2(m_hFlexCard,eCC,hEvents[1],
            fcNotificationTypeCycleStarted); // not for FlexCard USB-M

      // … Code removed for listing

      while (endlessLoop)
      {
            // Wait until an event is signaled or until timeout has elapsed
            DWORD dwResult = ::WaitForMultipleObjects(2,hEvents,false,
                  dwTimeOutMilliseconds);

            switch (dwResult)
            {
            case WAIT_OBJECT_0+1:  // Cycle start event
            case WAIT_TIMEOUT:     // or time is elasped
                  {
                        //Update our transmit buffers
                        AutomaticTransmit();

                        fcPacket* pPacket = NULL;
                        e = fcbReceive(m_hFlexCard, &pPacket);
                        if (0 == e)
                        {
                              ProcessPackets(pPacket);
                              e =   fcFreeMemory(fcMemoryTypePacket, pPacket);
                        }
                        else
                        {
```

```
                        // … Code removed for listing
                    }
                }
                break;

            // … Code removed for listing
        }
        // … Code removed for listing
}
```

The **fcbReceive** function returns the received data as a linked list of packets. The code below goes through the whole list and processes each packet.

```
Void CdemoDlg::ProcessPackets(fcPacket* pPackets)
{
        fcPacket* p = pPackets;
        while (NULL != p)
        {
            switch (p->Type)
            {
            case fcPacketTypeInfo:
                // … Code removed for listing
                break;
            case fcPacketTypeFlexRayFrame:
                // … Code removed for listing
                break;
            // … Code removed for listing
            default:

            };

            // get the next packet
            p = p->pNextPacket;
        }
}
```

	Information
	If an error packet with the flag *fcErrFlexcardOverflow* is received, the monitoring can not continue in case the FlexCard is set to stop if a packet overflow occurred (**fcbSetContinueOnPacketOverflow**). This error occurs if the application is too slow to receive and process the packets. In such a case it is necessary to stop the monitoring and start it again.

After processing the packets, the memory allocated by the packet list must be released.

```
ProcessPackets(pPacket);
e =    fcFreeMemory(fcMemoryTypePacket, pPacket);
```

3.3.7 Transmit FlexRay Frames

To transmit a frame on the FlexRay bus you need to have previously configured a transmit buffer and to know its index. The transmission is done by calling the **fcbFRTransmit** function.

```
fcCC eCC=fcCC1;
fcWord payload[fcPayloadMaximum];
payload[0] = 0x0001; // Update your payload data
```

```
fcError e = fcbFRTransmit(m_hFlexCard,eCC,bufferIdx,
            payload,payloadLength);
```

The transmit function expects the index of the Communication Controller, the index of the transmit buffer, the payload of the frame (the data) and the length of the payload section (the data length). The configured payload length (set during configuration of the transmit buffer) and the payload length to transmit (set during call to **`fcbFRTransmit`**) must match. It is recommended to check the error that is returned by the function.

3.3.8 Close a Connection

Once the measurement finished, closing the connection to the FlexCard is done by calling the function **`fcbClose`**.

3.4 Library compatibility

The Library offers a C interface to the application. For compatibility reasons, new features are added as new Library functions.

To make extensions to existing Library functions possible, it uses reserved fields in structs. When a new Library version introduces a new field, a reserved field is used for it. That way the size of the function parameter stays the same.

3.4.1 Library getter function

App old. Library old.	No problem.
App old. Library new (backwards compatibility).	App must ignore the reserved fields. E.g. the App must not binary compare two structs.
App new. Library old (upwards compatibility).	App should consider checking the library version.
App new. Library new.	No problem.

3.4.2 Library setter function

App old. Library old.	No problem.
App old. Library new (backwards compatibility).	App must zero the reserved fields.
App new. Library old (upwards compatibility).	App should consider checking the library version.
App new. Library new.	No problem.

4 General FlexCard API Description

This chapter describes the application programming interface in detail. Each section represents a group of operations dedicated to a common purpose (configuring, initializing, receiving...). For each group, the data definition (structures and enumerations) is first described, followed by the API functions illustrated with code samples.

For additional API description, which depends on the used operating system and/or used FlexCard device, please refer to the following major chapters.

Please note the following limitations of the FlexCard driver:

- The latency in transmit direction is influenced by the underlying operating system. Jitter is possible when the driver is interrupted by processes with a higher priority.
- If the PC lacks performance, it may lead to a buffer overflow in the receive path. In this case the measurement must be restarted.
- The FlexCard API does not support the loading of network databases directly.

4.1 Error Handling

Almost every function in this library returns with an error status number. The meaning of this status code can be retrieved with the following functions and enumerations. Additional to this status code it is possible to get hints about the error if you use the tool *fcTracerControl.exe*. For more information about the tracing tool please refer to Tracing.

	Information
	In a few situations you will not get a meaningful error text. This happens for example if the device driver reports an error to the API. In such a case only the error code ACTION_FAILED is returned. To get a more detailed error description it may be helpful to use the tracing module.

4.1.1 Type Definitions

4.1.1.1 fcError

This type provides information about an error. A zero value means no error occurred. To extract the detailed information about an error, use the functions **`fcGetErrorType`**, **`fcGetErrorText`** and **`fcGetErrorCode`**.

```
Typedef unsigned int fcError;
```

	Information
	fcError is not equivalent to fcErrorCode (see **fcErrorCode**)

4.1.2 Enumerations

4.1.2.1 fcErrorCode

This enumeration contains all error codes which are reported by the fcBase API. To extract the error code from a **fcError** use the **fcGetErrorCode** function. To get information for the error code, use the **fcGetErrorText** function. For detailed error description please refer to the Headerfile *fcBaseTypes.h*.

See Also

fcGetErrorCode, **fcGetErrorText**, **fcGetErrorType**

4.1.2.2 fcErrorType

This enumeration defines the type of error information. To get the `fcErrorType` from a **fcError**, use the **fcGetErrorType** function.

```
Typedef enum fcErrorType
{
      fcErrorTypeSuccess        = 0,
      fcErrorTypeInformation    = 1,
      fcErrorTypeWarning        = 2,
      fcErrorTypeError          = 3,
} fcErrorType;
```

Members

fcErrorTypeSuccess
: No error.

fcErrorTypeInformation
: The error should be treated as an information message. The function has succeeded but wants to give additional information.

fcErrorTypeWarning
: The error should be treated as a warning message. The function has succeeded but the input parameters are modified or not completely accepted.

fcErrorTypeError
: The error should be treated as an error message. The function has failed.

See Also

fcGetErrorType, **fcGetErrorText**, **fcGetErrorCode**

4.1.3 fcGetErrorCode

This function returns the error code for a given error. A zero value indicates no error occurred. The list of all error codes can be found in the **fcErrorCode** enumeration (see *fcBaseTypes.h*).

```
fcErrorCode fcGetErrorCode(
      fcError error
);
```

Parameters

error
: [IN] An error value of type `fcError`

Return values

Error code

See Also

fcErrorCode, **fcGetErrorType**, **fcGetErrorText**

4.1.4 fcGetErrorType

This function returns the error type for a given error. Please, refer to **fcErrorType** for more details.

```
fcErrorType fcGetErrorType(
      fcError error
);
```

Parameters

error

[IN] An error value of type `fcError`

Return values

Error type

See Also

fcErrorType, **fcGetErrorCode**, **fcGetErrorText**

Example

```
fcError e = fcbFRSetCcConfigurationChi(hFlexCard,eCC,pszChi);
if (0 != e)
{
      // oops, something went wrong
      fcErrorType etype = fcGetErrorTypeI;
      if (fcErrorTypeInformation == etype || fcErrorTypeWarning == etype)
      {
            // ok, the function succeeds, but the function wants to give us some
            // information
            PrintInfo(e);
      }
      else
      {
            PrintError(e);
      }
}
```

4.1.5 fcGetErrorText

This function returns the corresponding error text for a given error. To free the memory which was allocated by this function, please use the function **fcFreeMemory** with the type *fcMemoryTypeString* (see **fcMemoryType)**. Some text will be generated at runtime to provide a more detailed error description.

```
fcError fcGetErrorText(
      fcError error,
      char** szText
);
```

Parameters

error

[IN] An error value of type `fcError` for which an error text should be returned.

szText
[OUT] Address of a char pointer which holds the address for the generated error text.

Return values

If the function succeeds (return value is zero), the parameter `szText` contains the requested error text. If the function fails `szText` isn't valid. The fcErrorCode `NULL_PARAMETER` is returned if the *szText* parameter is a null pointer, `TEXT_NOT_DEFINIED` if no error text for the given error could be found, or `MEMORY_ALLOCATION_FAILED` to indicate that the memory allocation for the error text failed.

Example

```
fcError e = fcbOpen(&hFlexCard,flexcardId);
if (fcErrorTypeSuccess != fcGetErrorTypeI)
{
       char* szErrorText = NULL;
       if (0 == fcGetErrorText(e, &szErrorText))
       {
              // Print the error text and then free up the memory
              PrintErrorText(szErrorText);
              fcFreeMemory(fcMemoryTypeString, reinterpret_cast<void*>(szErrorText));
       }
}
```

See Also

fcFreeMemory, **fcGetErrorType**, **fcGetErrorCode**

4.2 Memory Handling

As the API allocates memory for you, it has to free up this memory. For this task the API provides the function **fcFreeMemory** which frees only the memory allocated by a function from the API. The reason why the API provides this mechanism is that your application may be linked to a different C/C++ run-time library than this library. Allocating memory in one module and freeing it in another one (with different run-time libraries) may fail or cause a run-time error. Another reason for this implementation is that the API can use its own memory management in order to reuse the memory blocks.

4.2.1 Enumerations

4.2.1.1 fcMemoryType

This enumeration defines the memory types needed to release the memory allocated by the functions **fcGetErrorText**, **fcbGetEnumFlexCards (Obsolete)**, **fcbGetEnumFlexCardsV2 (Obsolete)**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard** and **fcbReceive**.

```
Typedef enum fcMemoryType
{
       fcMemoryTypeString,
       fcMemoryTypeInfo,
       fcMemoryTypePacket,
       fcMemoryTypeInfoV2,
       fcMemoryTypeInfoHwSw,
} fcMemoryType;
```

Members

fcMemoryTypeString
Memory is of the type char[]

fcMemoryTypeInfo
Memory is of the type `fcInfo`

fcMemoryTypePacket
Memory is of the type fcPacket
fcMemoryTypeInfoV2
Memory is of the type fcInfoV2
fcMemoryTypeInfoHwSw
Memory is of the type fcInfoHwSw

See Also

fcFreeMemory, **fcGetErrorText**, **fcbGetEnumFlexCards (Obsolete)**, **fcbGetEnumFlexCardsV2 (Obsolete)**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard**, **fcbReceive**

4.2.2 fcFreeMemory

This function releases the memory allocated by one of the API functions **fcGetErrorText**, **fcbGetEnumFlexCards (Obsolete)**, **fcbGetEnumFlexCardsV2 (Obsolete)**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard** or **fcbReceive**. The allocated memory can be used as long as necessary. If the connection to the FlexCard is closed, all allocated memory blocks must be released with this function.

```
fcError fcFreeMemory(
       const fcMemoryType memoryType,
       void* p
);
```

Parameters

memoryType
Type of memory to be released.
P
Pointer to the memory to be released.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information. The **fcErrorCode** INVALID_PARAMETER is returned if the memoryType parameter wasn't correct, NULL_PARAMETER if the p parameter is a null pointer.

Example

```
fcError e = fcbOpen(&hFlexCard, flexcardId);
if (0 != e)
{
       char* szErrorText = NULL;
       if (0 == fcGetErrorText(e, &szErrorText))
       {
              // Print the error text and then free up the memory
              PrintErrorText(szErrorText);
              fcFreeMemory(fcMemoryTypeString, reinterpret_cast<void*>(szErrorText));
       }
}
```

See Also

fcMemoryType, **fcGetErrorText**, **fcbGetEnumFlexCards (Obsolete)**, **fcbGetEnumFlexCardsV2 (Obsolete)**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard**, **fcbReceive**

4.3 Initialization

The following section describes the data structures and features used for initialization.

4.3.1 Type Definitions

4.3.1.1 fcHandle

It defines a handle to a FlexCard object. A handle is returned by the function **fcbOpen** (assuming that a valid FlexCard identifier has been used).

```
Typedef void* fcHandle;
```

4.3.1.2 fcByte

Unsigned 8-bit value.

```
Typedef unsigned char fcByte;
```

4.3.1.3 fcWord

Unsigned 16-bit value.

```
Typedef unsigned short fcWord;
```

4.3.1.4 fcDword

Unsigned 32-bit value.

```
Typedef unsigned int fcDword;
```

4.3.1.5 fcQuad

Unsigned 64-bit value.

```
Typedef unsigned long long fcQuad;
```

4.3.1.6 fcBool

Boolean value.

```
Typedef unsigned char fcBool;
```

4.3.2 Enumerations

4.3.2.1 fcBusType

This enumeration defines the available FlexCard bus types.

```
Typedef enum fcBusType
{
       fcBusTypeFlexRay = 0,
       fcBusTypeCAN,
} fcBusType;
```

Members

fcBusTypeFlexRay
The FlexRay bus is selected.

fcBusTypeCAN
The CAN bus is selected.

See Also

fcVersionCC

4.3.2.2 fcCC

This enumeration defines the available FlexCard Communication Controller index depending on the communication bus type.

```
Typedef enum fcCC
{
       fcCC1 = 0x00,
       fcCC2 = 0x01,
       fcCC3 = 0x02,
       fcCC4 = 0x03,
       fcCC5 = 0x04,
       fcCC6 = 0x05,
       fcCC7 = 0x06,
       fcCC8 = 0x07,
} fcCC;
```

Members

fcCC1
: The Communication Controller 1 is selected.

fcCC2
: The Communication Controller 2 is selected.

fcCC3
: The Communication Controller 3 is selected.

fcCC4
: The Communication Controller 4 is selected.

fcCC5
: The Communication Controller 5 is selected.

fcCC6
: The Communication Controller 6 is selected.

fcCC7
: The Communication Controller 7 is selected.

fcCC8
: The Communication Controller 8 is selected.

4.3.2.3 fcCCType

This enumeration defines the Communication Controller types supported by the API. The parameter *CCType* of the structure **fcVersionCC**, which is returned by the functions **fcbGetEnumFlexCardsV3**, indicates the Communication Controller used by the FlexCard.

```
Typedef enum fcCCType
{
       Undefined = 0,
       FreeScale_FPGA,
       Bosch_E_Ray,
       Bosch_DCAN,
}fcCCType;
```

Members

Undefined
: Undefined Communication Controller.

FreeScale_FPGA
: Communication controller is a FreeScale FPGA

Bosch_E_Ray
: Communication controller is a Bosch E-Ray

Bosch_DCAN
: Communication controller is a Bosch DCAN

See Also

fcVersionCC, **fcbGetEnumFlexCardsV3**

Remarks

Current FlexCard hardware (FlexCard PMC (II), FlexCard Cyclone II (SE), FlexCard USB-M) supported by the latest driver versions integrate Bosch E-Ray and D-CAN Communication Controllers.

4.3.2.4 fcFlexCardDeviceId

This enumeration defines the different FlexCard types. The driver supports the FlexCard products except FlexCard PXI (aka FlexCard Cyclone II PXI).

```
Typedef enum fcFlexCardDeviceId
{
       fcNoDevice               = 0,
       fcFlexCardCycloneII      = 5,
       fcFlexCardCycloneIIPXI   = 6,
       fcFlexCardPMC            = 7,
       fcFlexCardCycloneIISE    = 8,
       fcFlexCardPMCII          = 9,
       fcFlexDevice_M_0P01      = 10,
       fcFlexXConMidgetBinderV1 = 10,
       fcFlexDevice_M_0P02      = 11,
       fcFlexXConMidgetBinderV2 = 11,
       fcFlexDevice_M_0R01      = 12,
       fcFlexXConMidgetLemo     = 12,
       fcFlexXConExpert         = 13,
       fcFlexCardUSB_M          = 14,
       fcFlexCardUSB            = 14,
} fcFlexCardDeviceId;
```

Members

fcNoDevice
: No FlexCard device was detected.

fcFlexCardCycloneII
: The device identifier of a FlexCard Cyclone II.

fcFlexCardCycloneIIPXI
: The device identifier of a FlexCard PXI.

fcFlexCardPMC
: The device identifier of a FlexCard PMC / PCI.

fcFlexCardCycloneIISE
: The device identifier of a FlexCard Cyclone II SE.

fcFlexCardPMCII
: The device identifier of a FlexCard PMC-II.

fcFlexDevice_M_0P01
: The device identifier of a FlexDevice-M with black case; Layout Version 1.1

fcFlexXConMidgetBinderV1
: The device identifier of a FlexXCon Midget Binder V1.

fcFlexDevice_M_0P02
: FlexDevice-M with grey case; Layout Version 2.x; Lemo connectors.

fcFlexXConMidgetBinderV2
: The device identifier of a FlexXCon Midget Binder V2.

fcFlexDevice_M_0R01
: The device identifier of a FlexDevice-M with grey case; Layout Version 2.x; Lemo connectors.

fcFlexXConMidgetLemo
: The device identifier of a FlexXCon Midget Lemo.

fcFlexXConExpert
: The device identifier of a FlexXCon Expert.

fcFlexCardUSB_M
: The device identifier of a FlexCard USB-M.

fcFlexCardUSB
The device identifier of a FlexCard USB.

See Also

fcInfoHw, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard**

4.3.2.5 fcTinyType

This enumeration defines the FlexCard FlexTiny types. The FlexTiny modules are small PCBs that contain physical layer components.

```
Typedef enum fcTinyType
{
       fcTinyTypeUnknown = 0,
       fcTinyTypeFlexRay,
       fcTinyTypeCAN,
       fcTinyTypeEthernet,
       fcTinyTypeRS232,
       fcTinyTypeCAN_LS,
       fcTinyTypeCAN_HS,
       fcTinyTypeLIN,
       fcTinyTypeK_Line,
       fcTinyTypeFlexRayIso,
       fcTinyTypeCAN_HS_Iso,
       fcTinyTypeCAN_LS_Iso,
       fcTinyTypeLIN_Iso,
       fcTinyTypeRS232_Iso,
       fcTinyTypeCAN_FD,
       fcTinyTypeCAN_FD_Iso,
       fcTinyTypeUSB,
       fcTinyTypeBroadR_Reach,
}fcTinyType;
```

Members

fcTinyTypeUnknown
fcTinyTypeFlexRay
fcTinyTypeCAN
fcTinyTypeEthernet
fcTinyTypeRS232
fcTinyTypeCAN_LS
fcTinyTypeCAN_HS
fcTinyTypeLIN
fcTinyTypeK_Line
fcTinyTypeFlexRayIso
fcTinyTypeCAN_HS_Iso
fcTinyTypeCAN_LS_Iso
fcTinyTypeLIN_Iso
fcTinyTypeRS232_Iso
fcTinyTypeCAN_FD
fcTinyTypeCAN_FD_Iso
fcTinyTypeUSB
fcTinyTypeBroadR_Reach

See Also

4.3.3 Structures

4.3.3.1 fcNumberCC

This structure provides information about the available number of Communication Controllers of the FlexCard hardware.

```
Typedef struct fcNumberCC
{
       fcByte FlexRay;
       fcByte CAN;
       fcByte LIN;
       fcByte MOST;
       fcByte FlexRaySelfSync;
       fcByte Reserved[3];
} fcNumberCC;
```

Members

FlexRay
: Number of FlexRay Communication Controllers.

CAN
: Number of CAN Communication Controllers.

LIN
: Number of LIN Communication Controllers. This parameter is currently not supported.

MOST
: Number of MOST Communication Controllers. This parameter is currently not supported.

FlexRaySelfSync
: Number of FlexRay self sync Communication Controllers.

Reserved
: Reserved for future use.

See Also

fcInfoHw, **fcbGetNumberCcs**, **fcbGetInfoFlexCard**

	Information
	This structure is initially supported by FlexCard API version S4V0-F. The parameter *FlexRaySelfSync* is initially supported by version S6V2-F.

4.3.3.2 fcVersionCC

This structure provides version information about the available FlexCard Communication Controllers.

```
Typedef struct fcVersionCC
{
       fcBusType BusType;
       fcCC CCIndex;
       fcCCType CCType;
       fcVersionNumber CCVersion;
       fcVersionNumber Protocol;
       struct fcVersionCC* pNext;
       fcDword IncorrectPhysicalLayer : 1;
       fcDword FaultTolerantCAN : 1;
       fcDword Reserved[2];
} fcVersionCC;
```

Members

BusType
: Communication controller bus type

CCIndex
: Communication controller identifier

CCType
: Communication controller type

CCVersion
: Communication controller version

Protocol
: Protocol version of the bus type

pNext
: Pointer to the next CC version. If the pointer is NULL, there are no more CC versions available.

IncorrectPhysicalLayer
: Physical layer module detection. A value <> 0 indicates a mismatch between Communication Controller type and physical layer module.

FaultTolerantCAN
: Low speed CAN bus detection. A value <> 0 indicates a fault tolerant CAN compatible physical layer module.

Reserved
: Reserved for future use

See Also

fcInfoHw

	Information
	This structure is initially supported by FlexCard API version S4V0-F. The parameter *IncorrectPhysicalLayer* is initially supported by version S5V1-F. The parameter *FaultTolerantCAN* is initially supported by version S6V2-F.

4.3.3.3 fcVersionNumber

This structure describes the version of a FlexCard component (hardware or software). The function **fcbGetEnumFlexCardsV3** returns the version numbers for the FlexCard components.

```
Typedef struct fcVersionNumber
{
       fcDword Major;
       fcDword Minor;
       fcDword Update;
       fcDword Release;
} fcVersionNumber;
```

Members

Major
: An increment indicates a modification which is not downwardly compatible

Minor
: An increment indicates a light-weight modification

Update
: Indicates an update (bug fix) for a minor version

Release
: 0 indicates a release version, greater than 0 indicates a test version

Remarks

Software version numbers are displayed as SmVn-r, with m = major number, n = minor number, r = release number. Released software is displayed with an “F” as release number. In binary values like this struct, the “F” is replaced with a zero. Example: S1V2-F may also be displayed as 1.2.0.0.

See Also

fcInfoHw, **fcInfoSw**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard**

4.3.3.4 fcInfoHw

This structure provides information about the hardware components of a FlexCard.

```
Typedef struct fcInfoHw
{
       fcQuad Serial;
       fcFlexCardDeviceId DeviceId;
       fcVersionNumber VersionFirmware;
       fcVersionNumber VersionHardware;
       fcNumberCC SupportedCCs;
       fcNumberCC LicensedCCs;
       fcNumberCC UseableCCs;
       fcVersionCC* pVersionCC;
       fcDword Reserved[8];
} fcInfoHw;
```

Members

Serial
: FlexCard serial number. A zero value indicates a non-valid FlexCard serial number.

DeviceId
: FlexCard Device ID

VersionFirmware
: Firmware (gateway software) version

VersionHardware
: FlexCard hardware version

SupportedCCs
: Possible FlexCard Communication Controller counts with the hardware.

LicensedCCs
: Licensed FlexCard Communication Controller counts with the hardware.

UseableCCs
: Useable FlexCard Communication Controller counts for the software.

pVersionCC
Pointer to version information about the useable Communication Controllers.
Reserved
Reserved for future use

See Also

fcInfoSw, **fcInfoHwSw**, **fcVersionCC**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard**

	Information
	This structure is initially supported by FlexCard API version S5V1-F.

4.3.3.5 fcInfoSw

This structure provides information about the software components of a FlexCard. For correct operation, the base driver, the device driver and the firmware should have the same major version number. An exception is the FlexCard USB-M, where the base driver and the device driver have completely different versions. Refer to the document FlexCard USB-M Instructions for Use to find out what versions should be installed. You may use the function **fcbCheckVersion** to ensure correct component versions.

```
Typedef struct fcInfoSw
{
       fcVersionNumber VersionBaseDll;
       fcVersionNumber VersionDeviceDriver;
       fcDword LicensedForLinuxDriver : 1;
       fcDword LicensedForWindowsDriver : 1;
       fcDword LicensedForXenomaiDriver : 1;
       fcDword LicensedForLabviewDriver : 1;
       fcDword Reserved[4];
} fcInfoSw;
```

Members

VersionBaseDll
DLL Base Version.
VersionDeviceDriver
Device driver version.
LicensedForLinuxDriver
Valid license for FlexCard Linux driver.
LicensedForWindowsDriver
Valid license for FlexCard Windows driver.
LicensedForXenomaiDriver
Valid license for FlexCard Xenomai driver.
LicensedForLabviewDriver
Valid license for FlexCard Labview driver.
Reserved
Reserved for future use.

See Also

fcInfoHw, **fcInfoHwSw**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard**

Information
This structure is initially supported by FlexCard API version S5V1-F. The parameter *LicensedForLabviewDriver* is initially supported by version S6V1-F.

4.3.3.6 fcInfoHwSw

This structure provides information about the components, the identifiers and the current device state of a FlexCard. If more than one FlexCard is detected on the system, the **fcbGetEnumFlexCardsV3** function returns a linked list of this structure; the function **fcbGetInfoFlexCard** function returns an item of this structure.

```
Typedef struct fcInfoHwSw
{
       fcDword FlexCardId;
       fcDword UserDefinedCardId;
       fcInfoSw InfoSoftware;
       fcInfoHw InfoHardware;
       fcDword Busy : 1;
       struct fcInfoHwSw* pNext;
       fcDword Reserved[2];
} fcInfoHwSw;
```

Members

FlexCardId
: Unique number used to identify a FlexCard. This id is required to open a connection to the FlexCard.

UserDefinedCardId
: User defined number used to identify a FlexCard. This id is not unique! A zero value indicates a non-valid or non-existing identifier.

InfoSoftware
: Information about software components of the FlexCard.

InfoHardware
: Information about hardware components of the FlexCard.

Busy
: The current device state. A value <> 0 indicates a connection to this FlexCard is already opened.

pNext
: Pointer to the next available FlexCard. If no other FlexCard exists, *pNext* is a null pointer.

Reserved
: Reserved for future use.

See Also

fcInfoHw, **fcInfoSw**, **fcbGetEnumFlexCardsV3**, **fcbGetInfoFlexCard**

Information
This structure is initially supported by FlexCard API version S5V1-F.

4.3.3.7 fcTinyInfo

This structure contains information about a FlexTiny.

```
Typedef struct fcTinyInfo
{
       fcTinyType TinyType;
       fcDword Reserved;
} fcTinyInfo;
```

Members

TinyType

The type of the FlexTiny.

Reserved

Reserved for future use.

See Also

	Information
	This structure is initially supported by FlexCard API version S6V6-F.

4.3.3.8 fcTinyInfoCollection

This structure contains information about all the FlexTiny modules that are mounted on a FlexCard.

```
Typedef struct fcTinyInfoCollection
{
       fcTinyInfo info[255];
} fcTinyInfoCollection;
```

Members

info

Information about the mounted FlexTiny modules.

See Also

	Information
	This structure is initially supported by FlexCard API version S6V6-F.

4.3.4 fcbGetEnumFlexCardsV3

This function returns a linked list of the installed FlexCards found on the system. To free the memory, which was allocated by this function, please use the function **`fcFreeMemory`** with type **`fcMemoryTypeInfoHwSw.`**

```
fcError fcbGetEnumFlexCardsV3(
       fcInfoHwSw** pInfoHwSw,
       fcBool getBusyDevices
)
```

Parameters

pInfoHwSw

[OUT] linked list of fcInfoHwSw objects

getBusyDevices

[IN] Show busy devices in linked list. Set this parameter to 0 to get a linked list of the unused FlexCards found on the system.

Return values

If the function succeeds, the return value is 0. If the function fails the content of *pInfoHwSw* is not valid. The error code NULL_PARAMETER is returned if *pInfoHwSw* parameter is a null pointer. If the memory allocation fails, the error code MEMORY_ALLOCATION_FAILED is returned.

Remarks

If the function succeeds, there will always be one valid fcInfoHwSw structure regardless if there is a FlexCard in the system or not. This functionality is given to provide version information about the DLL/library. The version information concerning the hardware is only valid if the identifier (***pInfoHwSw->FlexCardId***) is not 0.

	Information
	This function allocates memory for use. To prevent memory leaks, you have to free it up by calling the function **fcFreeMemory** with the type *fcMemoryTypeInfoHwSw*.

	Information
	Restriction: FlexCard USB-M devices are only enumerated by this function, if it's opened with the calling application. Devices opened in other applications are not returned in the linked list.

See Also

fcInfoHwSw

Example

```
//
// Get the installed FlexCards in the system and print the version numbers
//
fcInfoHwSw* pInfoHwSw = NULL;
fcError e = fcbGetEnumFlexCardsV3(&pInfoHwSw, true);
if (0 != e) return; // if it fails, return directly

fcInfoHwSw* pLoop = pInfoHwSw;
while (NULL != pLoop)
{
      // if FlexCard ID is equal to zero, we got NO FlexCard in the system
      bool bFlexCardAvailable = (0 != pLoop->FlexCardId);

      printf("\r\nFlexCard ID\t:  ");
      if (bFlexCardAvailable) printf("%d\r\n",pLoop->FlexCardId);
      else printf("not available\r\n");

      // if FlexCard isn't in use, we print out the version numbers
      if (bFlexCardAvailable && (0 == pLoop->Busy))
      {/*... print out the version numbers ...*/}
      else printf("FlexCard is in use\r\n");

      pLoop = pLoop->pNext; // get the next flexcard
}

// Don't forget to free the memory
fcFreeMemory(fcMemoryTypeInfoHwSw, pInfoHwSw);
```

	Information
	This function is initially supported by FlexCard API version S5V1-F.

4.3.5 fcbCheckVersion

This function checks the version combination of the installed FlexCard driver and firmware. On Windows the files *fcBase.DLL*, *fce05xp.SYS* / *fce052k.SYS and* and *FCFTBUS.sys* are checked. On Linux, *flexcard.ko* and *libfcBase.so* are checked. This function can only be called after **fcbOpen**. The major version number of the files must be identical when you want to use the FlexCard. An exception is the FlexCard USB-M: With this device, the major driver version may differ. Refer to the document FlexCard USB-M Instructions for Use to find out what versions should be installed.

```
fcError fcbCheckVersion(
      fcHandle hFlexCard
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

Return values

If the function succeeds, the return value is 0 and the opened FlexCard can be used with the SYS and DLL. If the return value is <> 0, use the functions described in the section Error Handling to get extended error information and the opened FlexCard cannot be used because of incompatible SYS and DLL versions.

Example

```
fcError e = fcbCheckVersion(hFlexCard);
if (0 != e)
{
     fcbClose(hFlexCard);
     // Error handling
}
```

	Information
	This function is initially supported by FlexCard API version S4V0-F.

4.3.6 fcbOpen

This function opens a connection to a specified FlexCard and returns a handle to this FlexCard. The function modifies some Communication Controller registers (e.g. set the Communication Controller in its configuration state, *fcStateConfig*) and all message buffers are configured as receive FIFO buffers with maximum payload length.

```
fcError fcbOpen(
      fcHandle* phFlexCard,
      fcDword flexCardId
)
```

Parameters

phFlexCard

[OUT] Handle to a specific FlexCard.

flexCardId

[IN] Number which indicates the FlexCard you want to use. This identifier is stored in **fcInfoHwSw** objects returned by the function **fcbGetEnumFlexCardsV3**. Only FlexCardId greater than zero are valid FlexCard identifier.

Return values

If the function succeeds, phFlexCard holds a valid FlexCard handle and the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

Use the functions **fcbGetEnumFlexCardsV3** to get a valid FlexCardId. The function **fcbClose** is used to close a connection previously opened with **fcbOpen**.

	Information
	If the FlexCard is closed and reopened, all previous (before closing) configuration settings are lost. After opening a connection, it is necessary to configure the FlexCard.

See Also

fcbGetEnumFlexCardsV3, **fcbClose**

Example

```
...
fcInfoHwSw* pInfoHwSw = NULL;
fcHandle hFlexCard = NULL;

if (0 == fcbGetEnumFlexCardsV3(&pInfoHwSw, true))
{
      // Open the flexcard using the first flexcard identifier
      fcError e = fcbOpen(&hFlexCard, pInfoHwSw ->FlexCardId);

      // always free the memory which was allocated by fcbGetEnumFlexCardsV3
      fcFreeMemory(fcMemoryTypeInfoHwSw, pInfoHwSw);
      if (0 != e) // handle isn't valid
            printErrorI;
}
...
```

4.3.7 fcbClose

This function closes the connection to a FlexCard.

```
fcError fcbClose(
      fcHandle hFlexCard
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

If a monitoring is active, this function will first stop the monitoring and then close the connection.

See Also

fcbGetEnumFlexCardsV3, **fcbOpen**

Example

```
fcError e = fcbClose(hFlexCard);
if (0 == e)
{
	// This handle isn't valid anymore
	hFlexCard = NULL;
}
```

4.3.8 fcbGetInfoFlexCard

This function returns an item of the structure **fcInfoHwSw**, which provides information about the components, the identifiers and the current device state of the opened FlexCard device. The pointer `pNext` in the struct `fcInfoHwSw` is empty. To free the memory which was allocated by this function, please use the function **fcFreeMemory** with type *fcMemoryTypeInfoHwSw*.

```
fcError fcbGetInfoFlexCard(
	fcHandle hFlexCard,
	fcInfoHwSw** pInfoHwSw
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

pInfoHwSw

[OUT] Hardware and software information of a FlexCard.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

	Information
	This function allocates memory for use. To prevent memory leaks, you have to free it up by calling the function **fcFreeMemory** with the type *fcMemoryTypeInfoHwSw*.

See Also

fcbGetEnumFlexCardsV3, **fcbOpen**, **fcInfoHwSw**

Example

```
...
fcInfoHwSw* pInfoHwSw = NULL;
fcError e = fcbGetInfoFlexCard(hFlexCard, &pInfoHwSw);
if (0 == e)
{
	// Check open device
	…

	// always free the memory which was allocated by fcbGetInfoFlexCard
	fcFreeMemory(fcMemoryTypeInfoHwSw, pInfoHwSw);
	if (0 != e) // handle isn't valid
		printErrorI;
}
...
```

	Information
	This function is initially supported by FlexCard API version S5V1-F.

4.3.9 fcbSetUserDefinedCardId

This function writes a persistent user ID to the FlexCard.

```
fcError fcbSetUserDefinedCardId (
      fcHandle hFlexCard,
      fcDword UserDefinedCardId
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

UserDefinedCardId

[IN] The ID that will be given to the FlexCard.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbGetUserDefinedCardId

Example

```
fcDword UserDefinedCardId = 0xef000001;
fcError e = fcbSetUserDefinedCardId (hFlexCard, UserDefinedCardId);
if (0 != e)
{
// error handling
}
```

	Information
	This function is initially supported by FlexCard API version S5V1-F.

4.3.10 fcbGetUserDefinedCardId

This function reads the persistent ID from the FlexCard.

```
fcError fcbGetUserDefinedCardId (
      fcHandle hFlexCard,
      fcDword* pUserDefinedCardId
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

UserDefinedCardId

[OUT] The user defined FlexCard ID.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbSetUserDefinedCardId

Example

```
fcDword UserDefinedCardId = 0x0;
fcError e = fcbGetUserDefinedCardId (hFlexCard, &UserDefinedCardId);
if (0 != e)
{
      // error handling
}
else
{
      printf("FlexCard UserID: 0x%X", UserDefinedCardId);
}
```

	Information
	This function is initially supported by FlexCard API version S5V1-F.

4.3.11 fcbGetTinyInfo

Gets information about the FlexTiny II modules mounted on the FlexCard.

```
fcError fcbGetTinyInfo (
      fcHandle hFlexCard,
      fcTinyInfoCollection* pTinyInfo,
      fcByte* pNumberOfTinySlots
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

pTinyInfo

[OUT] This struct contains the FlexTiny II information.

pNumberOfTinySlots

[OUT] The number of FlexTiny II slots that are available on the hardware. For FlexCard PMC-II this is always four.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcTinyInfoCollection

Example

```
fcTinyInfoCollection tinyCollection;
memset(&tinyCollection, 0, sizeof(tinyCollection));
fcByte numberOfTinySlots;
fcError error = fcbGetTinyInfo(handle, &tinyCollection, &numberOfTinySlots);
if (0 == error)
{
    for(int i = 0; i < numberOfTinySlots; i++)
    {
        printf("Tiny index: %u, type: %u\n", i, tinyCollection.info[i].TinyType);
    }
}
```

	Information
	This function is initially supported by FlexCard API version S6V6-F.

4.4 Configuration

4.4.1 Enumerations

4.4.1.1 fcTimeStampSourceMode

This enumeration defines the modes available for the time stamp clock source configuration of the FlexCard hardware.

```
Typedef enum fcTimeStampSourceMode
{
      fcTimeStampModeDefault = 0,
      fcTimeStampModeTriggerIn,
      fcTimeStampModeUserIo,
} fcTimeStampSourceMode;
```

Members

fcTimeStampModeDefault
: The internal FlexCard time stamp with a resolution of 1 µs is used.

fcTimeStampModeTriggerIn
: The trigger in line is used to generate the time stamp. Time stamp resolution depends on the frequency at the configured trigger line.

fcTimeStampModeUserIo
: The PMC UserIo lines on the FlexCard PMC-II are used to control the FlexCard timestamp. UserIo pin 63 is used to increment the timestamp and UserIo pin 64 is used to reset it.

See Also

fcTimeStampCfg

Information
This enumeration is initially supported by FlexCard API version S6V2-F.

4.4.2 Structures

4.4.2.1 fcTimeStampCfg

This structure defines the time stamp configuration of the FlexCard. Default configuration uses the internal FlexCard time stamp (1 µs resolution).

```
Typedef struct fcTimeStampCfg
{
       fcTimeStampSourceMode mode;
       fcDword Reserved1;
       union
       {
       fcDword TriggerLine;
       fcDword Reserved[2];
       } AdditionalCfg;
       fcDword Reserved2[4];
} fcTimeStampCfg;
```

Members

mode

Time stamp clock source mode

Reserved1

Reserved for future use

AdditionalCfg

- *TriggerLine*

  The trigger line number used for external time stamp generation. Only valid for PMC cards. Valid values range from 1 to 2.

- *Reserved*

  Reserved for architecture compatibility

Reserved2

Reserved for future use

See Also

fcTimeStampSourceMode

Information
This structure is initially supported by FlexCard API version S6V2-F.

4.4.3 fcbReinitializeCcMessageBuffer

This function re-initializes the message buffer configuration of the specified bus type and Communication Controller index. After calling this function the Communication Controller does not send old payload data. Re-initialization of message buffers is only allowed if the Communication Controller is in configuration state. Currently this function only supports the bus type *fcBusTypeFlexRay*.

```
fcError fcbReinitializeCcMessageBuffer(
       fcHandle hFlexCard,
       fcBusType BusType,
       fcCC CC
```

```
)
```

Paramaters

hFlexCard
[IN] Handle to a FlexCard

BusType
[IN] The bus type.

CC
[IN] Index of the Communication Controller.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Example

```
// FlexRay network running, FlexCard is sending data

// monitoring is stopped, e.g. because of user interaction
fcbFRMonitoringStop(hFlexCard,eCC);

fcError e = fcbReinitializeCcMessageBuffer(hFlexCard, fcBusTypeFlexRay, eCC);
if (0 == e)
{
      // error handling
}

// fcbReinitializeCcMessageBuffer ist not needed when calling
//    fcbFRSetCcConfiguration, fcbFRSetCcConfigurationChi or
//    fcbFRConfigureMessageBuffer before MonitoringStart

fcError e = fcbFRMonitoringStart(hFlexCard,eCC,fcMonitoringNormal,true,
                                 false,false,false);
if (0 == e)
{
      // error handling
}

// now the CC does not send data from the previous monitoring
```

	Information
	This function is initially supported by FlexCard API version S4V0-F.

4.4.4 fcbGetNumberCcs

This function reads the number of the various Communication Controllers which are available on the FlexCard.

```
fcError fcbGetNumberCcs(
      fcHandle hFlexCard,
      fcNumberCC* pNumberCC
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard.

pNumberCC

[OUT] Pointer to the structure of the available Communication Controller numbers.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Example

```
fcNumberCC numberCC;
fcError e = fcbGetNumberCcs(hFlexCard, &numberCC);
if (0 == e)
{
      printf("Communication controllers: FlexRay: %d, FlexRay SelfSync: %d, CAN: %d,
LIN:  %d,  MOST:  %d",  numberCC.FlexRay,  numberCC.FlexRaySelfSync,  numberCC.CAN,
numberCC.LIN, numberCC.MOST);
}
```

See Also

fcNumberCC

	Information
	This function is initially supported by FlexCard API version S4V0-F.

4.4.5 fcbSetContinueOnPacketOverflow

This function configures the packet overflow handling of the FlexCard. The FlexCards default 62ehavior is to stop the monitoring if a data overflow was detected. This is the case, when the application receives the data too slowly. This function can configure the FlexCard to continue with the monitoring when an amount of free RAM space is available again. An error packet fcErrFlexCardOverflow is generated in both cases.

```
fcError fcbSetContinueOnPacketOverflow(
      fcHandle hFlexCard,
      fcBool bContinue
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

bContinue

[IN] Set this flag to <> 0 to continue the monitoring in case of a packet buffer overflow being detected when RAM space is available again. Set to 0 to stop the monitoring.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Example

```
// Configure the FlexCard to continue on a data overflow
fcError e = fcbSetContinueOnPacketOverflow (hFlexCard, true);
if (0 == e)
{
      printf("FlexCard will continue receiving after a data overflow.");
}
```

	Information
	This function is initially supported by FlexCard API version S4V0-F.

4.4.6 fcbGetCurrentTimeStamp

This function returns the current time stamp of the FlexCard device and the correlated performance counter value of the operating system. The unit of the timestamp depends on the timestamp configuration. The default configuration is the internal clock with 1 MHz. The resolution of the 32-bit timestamp is in this case 1 µs. When an external clock with 1 MHz, 10 MHz or 100 MHz is used, the resolution is 1 µs, 100 ns or 10 ns.

```
fcError fcbGetCurrentTimeStamp(
      fcHandle hFlexCard,
      fcDword* pTimeStamp,
      fcQuad* pPerformanceCounter
)
```

Parameters

hFlexCard
: [IN] Handle to a FlexCard

pTimeStamp
: [OUT] Current time stamp

pPerformanceCounter
: [OUT] Correlated performance counter

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcQuad

	Information
	This function is initially supported by FlexCard API version S4V0-F.

4.4.7 fcbResetTimestamp

This function sets the FlexCard timestamp to 0.

```
fcError fcbResetTimestamp (
      fcHandle hFlexCard
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Example

```
fcError e = fcbResetTimestamp(hFlexCard);
if (0 == e)
{
      printf("Timestamp was reset.");
}
```

Information
This function is initially supported by FlexCard API version S4V0-F.

4.4.8 fcbConfigureFlexCardTimeStamp

This function configures the FlexCards time stamp. By default the FlexCard uses an internal clock (1 MHz) to generate a time stamp with 1 µs resolution. This function cannot be used with FlexCard Cyclone II (SE) devices.

```
fcError fcbConfigureFlexCardTimeStamp(
      fcHandle hFlexCard,
      fcTimeStampCfg cfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

cfg

[IN] The time stamp configuration

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcTimeStampSourceMode, **fcTimeStampCfg**

Remarks

This function isn't available for FlexCard Cyclone II (SE) cards.

Information
With external clock the FlexCards time stamp doesn't represent a real time. It's a clock counter value. All received packets (member TimeStamp) and the FlexCards time stamp itself (**fcbGetCurrentTimeStamp**, **fcbGetCurrentHighResTimeStamp**) must be translated to the expected time by the user application.

	Information
	This function is initially supported by FlexCard API version S6V2-F.

4.4.9 fcbGetCurrentHighResTimeStamp

This function returns the current high resolution time stamp of the FlexCard device and the correlated performance counter value of the operating system. The unit of the timestamp depends on the timestamp configuration. The default configuration is the internal clock with 1 MHz. The resolution of the 64-bit timestamp is in this case 1 µs. When an external clock with 1 MHz, 10 MHz or 100 MHz is used, the resolution is 1 µs, 100 ns or 10 ns.

```
fcError fcbGetCurrentHighResTimeStamp(
      fcHandle hFlexCard,
      fcQuad* pTimeStamp,
      fcQuad* pPerformanceCounter
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

pTimeStamp
[OUT] Current time stamp. For the resolution, see above.

pPerformanceCounter
[OUT] Correlated performance counter

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcQuad

	Information
	This function is initially supported by FlexCard API version S6V2-F.

4.5 Event

4.5.1 Enumerations

4.5.1.1 fcNotificationType

This enumeration defines different notification types. These types are used in the functions **fcbSetEventHandleV2**, **fcbSetEventHandleSemaphore** or **fcbWaitForEventV2** to specify on which kind of event the application has to be notified.

```
Typedef enum fcNotificationType
{
      fcNotificationTypeCycleStarted       = 1,
      fcNotificationTypeFRCycleStarted     = fcNotificationTypeCycleStarted,
      fcNotificationTypeTimer              = 2,
      fcNotificationTypeWakeup             = 3,
      fcNotificationTypeFRWakeup           = fcNotificationTypeWakeup,
      fcNotificationTypeCcTimer            = 12,
      fcNotificationTypeFRCcTimer          = fcNotificationTypeCcTimer,
      fcNotificationTypeSurpriseRemoval    = 13,
      fcNotificationTypeStandby            = 14,
      fcNotificationTypeReceiveBufferLevel = 15,
} fcNotifyType, fcNotificationType;
```

Members

fcNotificationTypeCycleStarted

fcNotificationTypeFRCycleStarted

Used to notify that a new cycle has started and that probably new data has been received.

fcNotificationTypeTimer

Used to notify that the timer interval has elapsed. This notification requires the internal timer of the FlexCard to be enabled (See **fcbSetTimer**).

fcNotificationTypeWakeup

fcNotificationTypeFRWakeup

Used to notify that one of the transceivers has received a wake-up event (only if one of the transceivers was in sleep mode).

fcNotificationTypeCcTimer

fcNotificationTypeFRCcTimer

Used to notify that the configured CC timer macrotick offset has elapsed. This notification requires the E-Ray CC Timer0 to be enabled (See **fcbFRSetCcTimerConfig**).

fcNotificationTypeSurpriseRemoval

fcNotificationTypeStandby

For internal use only.

fcNotificationTypeReceiveBufferLevel

Used to notify that the configured FlexCard receive buffer filling level has reached (See **fcbSetReceiveBufferLevelNotification**).

See Also

fcbFRMonitoringStart, **fcbSetEventHandleV2**, **fcbSetEventHandleSemaphore**, **fcbSetTimer**, **fcbFRSetCcTimerConfig**, **fcbWaitForEventV2**, **fcbSetReceiveBufferLevelNotification**

4.5.2 fcbSetEventHandleV2

This function registers an event handle for a specific notification type.

```
fcError fcbSetEventHandleV2(
      fcHandle hFlexCard,
      fcCC CC,
      fcHandle hEvent,
      fcNotificationType type
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

hEvent

[IN] Event handle to be registered to signal when a new cycle starts, a timer interval has elapsed or the FlexCard receive buffer reaches a specific filling level depending on the given *type*.

Type

[IN] The notification type for which the event must be registered.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcNotificationType

Example

```
// Create the event objects
HANDLE hCycleStartEvent = ::CreateEvent(NULL,FALSE,FALSE,NULL);
fcCC eCC = fcCC1;

// Register our event handles
fcbSetEventHandleV2(hFlexCard, eCC, hCycleStartEvent,
   fcNotificationTypeFRCycleStarted);

// ...
// Use the event objects
// ...
```

Information
This function is initially supported by FlexCard API version S4V2-F.

Information
This function is not supported by the *FlexCard USB-M*.

Information
Please don't use this function with the FlexCard Linux driver, because it's not async-signal safe. To avoid deadlocks with the API use the function **fcbSetEventHandleSemaphore** instead. On Xenomai, use the function **fcbWaitForEventV2**.

4.5.3 fcbSetTimer

This function enables or disables the internal FlexCard timer. To become notified when the timer interval has elapsed, an event of type *fcNotificationTypeTimer* has to be registered by the function **fcbSetEventHandleV2**, **fcbSetEventHandleSemaphore** or **fcbWaitForEventV2**.

```
fcError fcbSetTimer(
       fcHandle hFlexCard,
       fcBool enable,
       fcDword timerInterval
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

enable

[IN] Set to <> 0 to enable the timer and to 0 to disable it.

timerInterval

[IN] Specifies the timer period in µs

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcNotificationType, **fcbSetEventHandleV2**, **fcbSetEventHandleSemaphore**, **fcbWaitForEventV2**

Example

```
// Create the event objects
HANDLE hCycleStartEvent = ::CreateEvent(NULL,FALSE,FALSE,NULL);
HANDLE hTimerEvent = ::CreateEvent(NULL,FALSE,FALSE,NULL);
fcCC eCC = fcCC1;

// Register our event handles
fcbSetEventHandleV2(hFlexCard, eCC, hCycleStartEvent,
   fcNotificationTypeCycleStarted);
fcbSetEventHandleV2(hFlexCard, eCC, hTimerEvent, fcNotificationTypeTimer);

// Enable the timer (1ms Interval)
fcbSetTimer(hFlexCard,true,1000);

// ...
// Use the event objects
// ...
```

4.5.4 fcbNotificationPacket

This function generates a notification packet each time the configured timer timeout has elapsed. This timer can be enabled / disabled by this function and the timeout can be set. The notification packets are inserted in the stream and received through the function **fcbReceive**.

```
fcError fcbNotificationPacket(
      fcHandle hFlexCard,
      fcBool enable,
      fcDword timerInterval
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

enable

[IN] Set to <> 0 to enable the timer and to 0 to disable it.

timerInterval

[IN] Specifies the time-out interval, in microseconds. A packet is generated as soon as the time-out has elapsed. The timer interval must be greater than 50µs and smaller than 655350µs. The value must be rounded to 10µs units.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

	Information
	This function is initially supported by FlexCard API version S2V0-F.

4.5.5 fcbSetReceiveBufferLevelNotification

This function enables or disables the FlexCard receive buffer level notification. To become notified, when the receive buffer reaches the filling level, an event of type *fcNotificationTypeReceiveBufferLevel* has to be registered by one of the functions **fcbSetEventHandleV2**, **fcbSetEventHandleSemaphore** or **fcbWaitForEventV2**.

```
fcError fcbSetReceiveBufferLevelNotification(
      fcHandle hFlexCard,
      fcBool enable,
      fcDword percentage
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

enable

[IN] Set to 0 to disable the receive buffer level notification, a value <> 0 enables the notification.

Percentage

[IN] Specifies the percentage filling level of the FlexCard receive buffer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

	Information
	This function is initially supported by FlexCard API version S6V1-F.

4.6 Receive

4.6.1 Typedefinitions

4.6.1.1 fcInfoPacket

This structure describes an information packet. This packet type informs you about the start of a new cycle. All packets received between two consecutives info packets are part of the current cycle.

```
Typedef struct fcInfoPacket
{
    fcDword CurrentCycle;
    fcDword TimeStamp;
    fcDword RateCorrection : 12;
    fcDword OffsetCorrection : 19;
    fcDword ClockCorrectionFailedCounter : 4;
    fcDword PassiveToActiveCount : 5;
    fcCC    CC;
}fcInfoPacket;
```

Members

CurrentCycle

The current cycle (FlexRay Protocol Specification: vRF!Header!CycleCount)

Timestamp

The FlexCard timestamp (per default 1 µs resolution). The timestamp marks the point in time where the FlexCard detects the internal FlexRay cycle start interrupt. The event fcNotificationTypeFRCycleStarted does not have to be configured to receive the timestamp.RateCorrection

Rate correction value (two's complement). Indicates by how many microticks the node's cycle length should be changed.

OffsetCorrection

Offset correction value (two' complement). Indicates the number of microticks that are added to the offset correction segment of the network idle time.

ClockCorrectionFailedCounter

FlexRay Protocol Specification: vClockCorrectionFailed.

PassiveToActiveCount

FlexRay Protocol Specification: vAllowPassiveToActive

CC

The FlexCard CC which created this packet. This parameter will always be set to fcCC1 if only one FlexRay CC is available.

Remarks

A timestamp overflow occurs after approximately 4295 seconds.

See Also

fcPacket

4.6.1.2 fcFlexRayFrame

This structure is equivalent to the FlexRay frame described in the FlexRay specification [3].

```
Typedef struct fcFlexRayFrame
{
    fcDword ID : 11;
    fcDword STARTUP : 1;
    fcDword SYNC : 1;
    fcDword NF : 1;
    fcDword PP : 1;
    fcDword R : 1;
    fcDword PayloadLength : 7;
    fcDword CycleCount : 6;
    fcDword HeaderCRC : 11;
    fcWord* pData;

    fcChannel Channel;
    fcDword ValidFrame : 1;
    fcDword SyntaxError : 1;
    fcDword ContentError : 1;
    fcDword SlotBoundaryViolation : 1;
    fcDword AsyncMode : 1;
    fcDword FrameCRC : 24;

    fcDword TimeStamp;
    fcCC    CC;
} fcFlexRayFrame;
```

Members

ID

The frame id defines the slot in which the frame was transmitted.
(FlexRay Protocol Specification: vRF!Header!FrameID)

STARTUP

Indicates if the frame is a start-up frame (=1) or not (=0)
(FlexRay Protocol Specification: vRF!Header!SuFIndicator)

SYNC

Indicates if the frame is a sync frame (=1) or not (=0)
(FlexRay Protocol Specification: vRF!Header!SyFIndicator)

NF

Set to 0, the null frame indicator indicates that *pData* contains no valid data. Set to 1, it indicates that *pData* contains valid data.
(FlexRay Protocol Specification: vRF!Header!NFIndicator)

PP

The payload preamble indicator indicates whether or not an optional vector is contained within the payload segment of the frame transmitted. In the static segment, it indicates the presence of a network management vector at the beginning of the payload. In the dynamic segment it indicates the presence of a message id at the beginning of the payload, (FlexRay Protocol Specification: vRF!Header!PPIndicator).

R

Reserved Bit (FlexRay Protocol Specification: vRF!Header!Reserved)

PayloadLength

Defines the number of 16-bit words contained in *pData*
(FlexRay Protocol Specification: vRF!Header!Length)

CycleCount

The cycle in which the frame was received. (FlexRay Protocol Specification: vRF!Header!CycleCount)

HeaderCRC

The header CRC containing the cyclic redundancy check code is computed over the sync frame indicator, the start-up frame indicator, the frame id and the payload length.(FlexRay Protocol Specification: vRF!Header!HeaderCRC)

pData

The pointer to the payload data. The payload is given in 16-bit words.
(FlexRay Protocol Specification: vRF!Payload)

If Data0 is the first byte that was received and Data1 the second byte received, then the high byte (Bit 8 – 15) of payload[0] contains Data1, the low byte (Bit 0-7) of payload[0] contains Data0, etc.

Parameter `data`	`data[0]` (Word 0)		`data[1]` (Word 1)		...
	High byte	Low byte	High byte	Low byte	...
FlexRay payload segment	Data 1	Data 0	Data 3	Data 2	...

Channel

The channel (A or B) on which the frame was received.
(FlexRay Protocol Specification: vRF!Channel)

ValidFrame

If a valid frame was received, this parameter is set to 1 (FlexRay Protocol Specification: vSS!ValidFrameA or vSS!ValidFrameB depends on Channel - Table 9-2: Slot status interpretation)

SyntaxError

If a syntax error was observed, this parameter is set to 1 (frame is syntactically incorrect). (FlexRay Protocol Specification: vSS!SyntaxErrorA or vSS!SyntaxErrorB depends on Channel)

ContentError

If a content error was observed, this parameter is set to 1 (frame is semantically incorrect). (FlexRay Protocol Specification: vSS!ContentErrorA or vSS!ContentErrorB depends on Channel)

SlotBoundaryViolation

If a slot boundary violation was observed, this parameter is set to 1 (FlexRay Protocol Specification: vSS!BviolationA or vSS!BviolationB depends on Channel)

AsyncMode

If the packet was generated by the asynchronous debug mode, this parameter is set to 1.

FrameCRC

If the packet was generated by the asynchronous debug mode, the FrameCRC contains the cyclic redundancy check code is computed over complete frame. In synchronous monitoring mode, this parameter is not set.

TimeStamp

The FlexCard timestamp (per default 1 µs resolution). The timestamp marks the point in time where the FlexCard detects the transition from the ChannelIdle state to the FlexRay frame header of the received frame.

CC

The FlexCard CC which created this packet. This parameter will always be set to fcCC1 if only one FlexRay CC is available.

See Also

`fcPacket`, **`fcChannel`**

	Information
	The payload length is a multiple of 16-bit words. The payload data is also given in 16-bit words.

4.6.1.3 fcTxAcknowledgePacket

This structure provides information about a transmit acknowledge packet. Transmit acknowledge packets are used to inform the user when a frame is transmitted.

```
Typedef struct fcTxAcknowledgePacket
{
    fcDword BufferId;
    fcDword TimeStamp;
    fcDword CycleCount;

    fcDword ID : 11;
    fcDword STARTUP : 1;
    fcDword SYNC : 1;
    fcDword NF : 1;
    fcDword PP : 1;
    fcDword R : 1;
    fcDword PayloadLength : 7;
    fcDword ValidFrame : 1;
    fcDword SyntaxError : 1;
    fcDword ContentError : 1;
    fcDword HeaderCRC : 11;
    fcWord* pData;
    fcChannel Channel;
    fcCC CC;
} fcTxAcknowledgePacket;
```

Members

BufferId

The buffer id used to transmit the frame (equivalent to the buffer id returned by the function **fcbFRConfigureMessageBuffer**).

TimeStamp

The FlexCard timestamp (per default 1 µs resolution). The timestamp marks the point in time where the FlexCard detects the transition from the ChannelIdle state to the FlexRay frame header of the transmitted frame.

CycleCount

Indicates the cycle in which the frame was transmitted. (FlexRay Protocol Specification: vTF!Header!CycleCount)

ID

The frame id defines the slot in which the frame was transmitted.

STARTUP

Indicates if the frame was a start-up frame (=1) or not (=0)

SYNC

Indicates if the frame was a sync frame (=1) or not (=0)

NF

Set to 0, the null frame indicator indicates that *pData* contains no valid data. Set to 1, it indicates that *pData* contains valid data.

PP

The payload preamble indicator indicates whether or not an optional vector is contained within the payload segment of the frame transmitted. In the static segment, it indicates the presence of a network management vector at the beginning of the payload. In the dynamic segment it indicates the presence of a message id at the beginning of the payload.

R

Reserved Bit

PayloadLength

Defines the number of 16-bit words contain in *pData*

ValidFrame

If a valid frame was received, this parameter is set to 1 (FlexRay Protocol Specification: vSS!ValidFrameA or vSS!ValidFrameB depends on Channel - Table 9-2: Slot status interpretation)

SyntaxError

If a syntax error was observed, this parameter is set to 1 (frame is syntactically incorrect). (FlexRay Protocol Specification: vSS!SyntaxErrorA or vSS!SyntaxErrorB depends on Channel)

ContentError

If a content error was observed, this parameter is set to 1 (frame is semantically incorrect). (FlexRay Protocol Specification: vSS!ContentErrorA or vSS!ContentErrorB depends on Channel)

HeaderCRC

The header CRC contains the cyclic redundancy check code is computed over the sync frame indicator, the start-up frame indicator, the frame id and the payload length.

pData

The pointer to the payload data. The payload is given in 16-bit words.

If Data0 is the first byte that was transmitted and Data1 the second byte transmitted, then the high byte (Bit 8 – 15) of payload[0] contains Data1, the low byte (Bit 0-7) of payload[0] contains Data0, etc.

Parameter `data`	`data[0]` (Word 0)		`data[1]` (Word 1)		...
	High byte	Low byte	High byte	Low byte	...
FlexRay payload segment	Data 1	Data 0	Data 3	Data 2	...

Channel

The channel (A or B) on which the frame was transmitted.
(FlexRay Protocol Specification: vRF!Channel)

CC

The FlexCard CC which created this packet. This parameter will always be set to fcCC1 if only one FlexRay CC is available. This parameter will always be set to fcCC2 for used SelfSync feature packets.

See Also

`fcPacket`, **`fcChannel`**

4.6.1.4 fcErrPOCErrorModeChangedInfo

This structure provides additional information about the *`fcErrPOCErrorModeChanged`* error.

```
Typedef struct fcErrPOCErrorModeChangedInfo
{
    fcState State;
}fcErrPOCErrorModeChangedInfo;
```

Members

State

Contains the new POC error mode (HALT, NORMAL_ACTIVE or NORMAL_PASSIVE)

See Also

`fcErrorPacket`, **`fcState`**

4.6.1.5 fcErrSyncFramesInfo

This structure provides additional information about the *`fcErrSyncFramesBelowMinimum`* and *`fcErrSyncFrameOverflow`* errors.

```
Typedef struct fcErrSyncFramesInfo
{
    fcDword SyncFramesEvenA : 4;
    fcDword SyncFramesEvenB : 4;
    fcDword SyncFramesOddA : 4;
    fcDword SyncFramesOddB : 4;
}fcErrPOCErrorModeChangedInfo;
```

Members

SyncFramesEvenA

Valid sync frame received and transmitted on channel A in even communication cycles

SyncFramesEvenB
Valid sync frame received and transmitted on channel B in even communication cycles
SyncFramesOddA
Valid sync frame received and transmitted on channel A in odd communication cycles
SyncFramesOddB
Valid sync frame received and transmitted on channel B in odd communication cycles

See Also
fcErrorPacket

4.6.1.6 fcErrClockCorrectionFailureInfo

This structure provides additional information about the *fcErrClockCorrectionFailure* error.

```
Typedef struct fcErrClockCorrectionFailureInfo
{
    fcDword MissingRateCorrection : 1;
    fcDword RateCorrectionLimitReached : 1;

    fcDword OffsetCorrectionLimitReached : 1;
    fcDword MissingOffsetCorrection : 1;

    fcDword SyncFramesEvenA : 4;
    fcDword SyncFramesEvenB : 4;
    fcDword SyncFramesOddA : 4;
    fcDword SyncFramesOddB : 4;
}fcErrClockCorrectionFailureInfo;
```

Members
MissingRateCorrection
Is set to 1 if no rate correction can be performed because no pairs of even/odd sync frames were received.
RateCorrectionLimitReached
Is set to 1 if the maximum rate correction limit is reached.
OffsetCorrectionLimitReached
Is set to 1 if the maximum offset correction limit is reached.
MissingOffsetCorrection
Is set to 1 if no offset correction can be performed because no sync frames were received.
SyncFramesEvenA
Valid sync frame received and transmitted on channel A in even communication cycles
SyncFramesEvenB
Valid sync frame received and transmitted on channel B in even communication cycles
SyncFramesOddA
Valid sync frame received and transmitted on channel A in odd communication cycles
SyncFramesOddB
Valid sync frame received and transmitted on channel B in odd communication cycles

See Also
fcErrorPacket

4.6.1.7 fcErrSlotInfo

This structure provides additional information about the *fcErrSyntax*, *fcErrContent*, *fcErrSlotBoundaryViolation*, *fcErrTransmissionAcrossBoundary*, *fcErrLatestTransmitViolation* fcErrSyntaxSW, *fcErrSlotBoundaryViolationSW*, *fcErrTransmissionConflictSW*, *fcErrSyntaxNIT* and *fcErrSlotBoundaryViolationNIT* errors.

```
Typedef struct fcErrSlotInfo
{
    fcChannel Channel;
    fcDword SlotCount;
}fcErrSlotInfo;
```

Members

Channel
The channel on which the error was observed.

SlotCount
The approximate slot count when the error occurred.

See Also

fcErrorPacket

4.6.1.8 fcErrorPacket

This structure provides information about an error packet.

```
Typedef struct fcErrorPacket
{
    fcErrorPacketFlag Flag;
    fcDword TimeStamp;
    fcDword CycleCount;

    union
    {
        fcErrPOCErrorModeChangedInfo        ErrPOCErrorModeChangedInfo;
        fcErrSyncFramesInfo                 ErrSyncFramesInfo;
        fcErrSlotInfo                       ErrSlotInfo;
        fcErrClockCorrectionFailureInfo     ErrClockCorrectionFailureInfo;
    }AdditionalInfo;
    fcCC CC;

    fcDword Reserved;
}fcErrorPacket;
```

Members

Flag
Error type

TimeStamp
The FlexCard time stamp (per default 1 µs resolution). Indicates the time at which the packet was generated.

CycleCount
The cycle in which the error occurred.

AdditionalInfo

- *ErrPOCErrorModeChangedInfo*
  Additional information about the `fcErrPOCErrorModeChanged` error.
- *ErrSyncFramesInfo*
  Additional information about the `fcErrSyncFramesBelowMinimum`, `fcErrSyncFrameOverflow` errors
- *ErrSlotInfo*
  Additional information about the `fcErrSyntax`, `fcErrContent`, `fcErrSlotBoundaryViolation`, `fcErrTransmissionAcrossBoundary` and `fcErrLatestTransmitViolation` errors
- *ErrClockCorrectionFailureInfo*
  Additional information about the `fcErrClockCorrectionFailure` error.

CC
The FlexCard CC which created this packet. This parameter will always be set to fcCC1 if only one FlexRay CC is available.
Reserved
Reserved for future use.

See Also
fcPacket, **fcErrorPacketFlag**, **fcErrPOCErrorModeChangedInfo**, **fcErrSyncFramesInfo**, **fcErrSlotInfo**, **fcErrClockCorrectionFailureInfo**

4.6.1.9 fcStatusWakeupInfo

This structure provides additional information about the `cStatusWakeupStatus` status.

```
Typedef struct fcStatusWakeupInfo
{
    fcWakeupStatus WakeupStatus;
} fcStatusWakeupInfo;
```

Members
WakeupStatus
Current wake-up state.

See Also
fcStatusPacket, **fcWakeupStatus**

4.6.1.10 fcStatusPacket

This structure provides information about a status packet.

```
Typedef struct fcStatusPacket
{
    fcStatusPacketFlag Flag;
    fcDword TimeStamp;
    fcDword CycleCount;

    union
    {
         fcStatusWakeupInfo StatusWakeupInfo;
    }AdditionalInfo;
    fcCC    CC;
    fcDword Reserved[2];
}fcStatusPacket;
```

Members
Flag
Status type
TimeStamp
The FlexCard time stamp (per default 1 µs resolution). Indicates the time at which the packet was generated.
CycleCount
The cycle in which the status has changed.
AdditionalInfo
StatusWakeupInfo
Additional information about `fcStatusWakeupStatus` status
CC
The FlexCard CC which created this packet. This parameter will always be set to fcCC1 if only one FlexRay CC is available. This parameter will always be set to fcCC2 for used SelfSync feature packets.
Reserved
Reserved for future use.

See Also

fcPacket, **fcStatusPacketFlag**, **fcStatusWakeupInfo**

4.6.1.11 fcNMVectorPacket

This structure provides information about a network management vector. (FlexRay Protocol Specification V2.0: Section 4.3.1 NMVector)

```
typedef struct fcNMVectorPacket
{
    fcDword TimeStamp;
    fcDword CycleCount;
    fcDword NMVectorLength;
    fcByte NMVector[12];
    fcCC CC;
    fcDword Reserved;
} fcNMVectorPacket;
```

Members

TimeStamp

The FlexCard time stamp (per default 1 µs resolution). Indicates the time at which the packet was generated.

CycleCount

The cycle in which the network management vector was updated.

NMVectorLength

Length of network management vector in number of bytes. (FlexRay Protocol Specification: gNetworkManagementVectorLength)

NMVector

The data bytes of the network management vector.

CC

The FlexCard CC which created this packet. This parameter will always be set to fcCC1 if only one FlexRay CC is available.

Reserved

Reserved for future use.

See Also

fcPacket, **fcCC**

4.6.1.12 fcNotificationPacket

This structure provides information about a notification packet. A notification packet is generated each time the configured time out elapses. The generation of this packet can be controlled with the function **fcbNotificationPacket**.

```
Typedef struct fcNotificationPacket
{
    fcDword TimeStamp;
    fcDword SequenceCounter;
    fcDword Reserved;
} fcNotificationPacket;
```

Members

TimeStamp

The FlexCard time stamp (per default 1 µs resolution). Indicates the time at which the packet was generated.

SequenceCounter

This parameter is incremented each time a notification packet is generated.

Reserved

See Also

fcPacket, **fcbNotificationPacket**

	Information
	This packet type is initially supported by FlexCard API version S2V0-F.

4.6.1.13 fcTriggerExInfoPacket

This structure provides information about a trigger packet.

```
Typedef struct fcTriggerExInfoPacket
{
       fcDword Condition;
       fcDword TimeStamp;
       fcDword SequenceCount;
       fcDword Reserved1;
       fcQuad PerformanceCounter;
       fcDword Edge;
       fcDword TriggerLine;
       fcDword reserved[4];
} fcTriggerInfoPacket;
```

Members

Condition
: The fulfilled condition which has caused the trigger packet generation.

TimeStamp
: The FlexCard time stamp (per default 1 µs resolution). Indicates the time at which the packet was generated.

Reserved1
: Reserved for future use.

SequenceCount
: Sequence count for each signal.

PerformanceCounter
: Variable that receives the current performance-counter value. This value is only valid for the trigger condition `fcTriggerInOnSWTimer`.

Edge
: The edge on which the trigger was signalled.

TriggerLine
: The trigger line which detected a trigger signal. This value is only valid for triggers of FlexCard PMC and FlexCard PMC-II.

Reserved[4]
: Reserved for future use.

See Also

fcPacket

	Information
	This packet type is initially supported by FlexCard API version S2V2-F.

4.6.1.14 fcCANPacket

This structure provides information about a CAN packet.

```
Typedef struct fcCANPacket
{
      fcDword ID           : 29;
      fcDword ExtendedId   : 1;
      fcDword TimeStamp;
      fcDword BufferNumber : 8;
      fcDword DLC          : 4;
      fcDword Direction    : 1;
      fcDword RemoteFrame  : 1;
      fcDword MessageLost  : 1;
      fcDword Reserved;
      fcCC CC;
      fcByte Data[8];
}fcCANPacket;
```

Members

ID

The CAN message identifier which was received or transmitted.

ExtendedId

If this flag is 1 the CAN message is an extended frame. If set to 0 it is a standard frame.

TimeStamp

The CAN timestamp (per default 1 µs resolution). The timestamp marks the point in time where the FlexCard detects the Ack Slot of the frame.

BufferNumber

Indicates the corresponding buffer number for the CAN packet.

DLC

Indicates the data length (in bytes).

Direction

This flag depends on the parameter *RemoteFrame*. If *Direction* is 0 and *RemoteFrame* is 0, the CAN packet is a received data frame. If *Direction* is 1 and *RemoteFrame* is 0 the CAN packet is a transmit acknowledge frame generated by the FlexCard. If *RemoteFrame* is 1, see *RemoteFrame* for further description.

RemoteFrame

This flag depends on the parameter *Direction*. If *RemoteFrame* is 1 and *Direction* is 0, the CAN packet is a remote rx frame. If *RemoteFrame* is 1 and *Direction* is 1, the CAN packet is a remote tx frame. If *Direction* is 0, see *Direction* for further description.

MessageLost

If this flag is 1 the CAN Communication Controller has lost a message. If 0 no message has been lost. This flag is only valid with *Direction* = 0.

Reserved

Reserved for future use.

CC

The CAN Communication Controller on which the frame was received or transmitted.

Data

The received or transmitted data. All of the 8 data bytes can be read. The corresponding parameter *DLC* indicates the length of the valid values.

See Also

fcPacket

	Information
	This packet type is initially supported by FlexCard API version S4V0-F.

4.6.1.15 fcCANErrorPacket

This structure provides information about a CAN error packet.

```
Typedef struct fcCANErrorPacket
{
      fcCANErrorType Type;
      fcCANCcState State;
      fcDword TimeStamp;
      fcDword ReceiveErrorCounter;
      fcDword TransmitErrorCounter;
      fcCC CC;
      fcDword Reserved[2];
}fcCANErrorPacket;
```

Members

Type
: Error type

State
: Communication controller state

TimeStamp
: The FlexCard time stamp (per default 1 µs resolution). Indicates the time at which the packet was generated.

ReceiveErrorCounter
: Actual state of the Receive Error Counter. Valid values range from 0 to 127.

TransmitErrorCounter
: Actual state of the Transmit Error Counter. Values values range from 0 to 255.

CC
: The CC on which the packet was created.

Reserved[4]
: Reserved for future use.

See Also

fcPacket, **fcCANErrorType**, **fcCANCcState**

	Information
	This packet type is initially supported by FlexCard API version S4V0-F.

4.6.1.16 fcCANFDPacket

This structure provides information about a CAN FD packet.

```
Typedef struct fcCANFDPacket
{
      fcDword ID           :29;
      fcDword ExtendedId   :1;
      fcDword TimeStampLow;
      fcDword TimeStampHigh;
      fcDword BufferNumber :8;
      fcDword DLC          :4;
      fcDword Direction    :1;
      fcDword RemoteFrame  :1;
      fcDword MessageLost  :1;
      fcDword FdFormat  :1;
      fcDword BitRateSwitch  :1;
      fcDword ESI  :1;
      fcDword Reserved;
      fcCC CC;
      fcByte* pData;
} fcCANFDPacket;
```

Members

ID

The CAN message identifier which was received or transmitted.

ExtendedId

If this flag is 1 the CAN message is an extended frame. If set to 0 it is a standard frame.

TimeStampLow

The CAN timestamp low (per default 1 µs resolution). The timestamp marks the point in time where the FlexCard detects the Ack Slot of the frame.

TimeStampHigh

The CAN timestamp high (per default 1 µs resolution). The timestamp marks the point in time where the FlexCard detects the Ack Slot of the frame.

BufferNumber

Unused field.

DLC

Indicates the data length. It is coded with four bits according to the CAN/ CAN FD standard.

Direction

If Direction is 0 the CAN packet is a received data frame. If Direction is 1 the packet is a transmit acknowledge frame generated by the FlexCard.

RemoteFrame

Unused field.

MessageLost

Unused field.

FdFormat

If this flag is 1 the message has the CAN FD frame format.

BitRateSwitch

If this flag is 1 the message uses CAN FD bit rate switching. This bit is only valid when FdFormat is 1.

ESI

If ESI (Error state indicator) is 0, the transmitting node is in the error active state. That means the node is allowed to send error frames. If ESI is 1, the transmitting node is in the error passive state. This bit is only valid when FdFormat is 1.

Reserved

Reserved for future use.

CC

The CAN Communication Controller on which the frame was received or transmitted.

pData

The pointer to the payload data. The payload is given in byte. The corresponding parameter DLC indicates the length of the valid values.

See Also

fcPacket

	Information
	This packet type is initially supported by FlexCard API version S6V6-F.

4.6.1.17 fcCANFDErrorPacket

This structure provides information about a CAN FD error packet.

```
Typedef struct fcCANFDErrorPacket
{
       fcCANErrorType Type;
       fcCANCcState State;
       fcDword TimeStampLow;
       fcDword TimeStampHigh;
       fcDword ReceiveErrorCounter;
       fcDword TransmitErrorCounter;
       fcCC CC;
       fcDword Reserved[3];
}fcCANFDErrorPacket;
```

Members

Type
: Error type

State
: Current CAN CC state

TimeStampLow
: The FlexCard time stamp low (per default 1 µs resolution). Indicates the time at which the packet was generated.

TimeStampHigh
: The FlexCard time stamp high (per default 1 µs resolution). Indicates the time at which the packet was generated.

ReceiveErrorCounter
: Current state of the Receive Error Counter. Valid values range from 0 to 127.

TransmitErrorCounter
: Current state of the Transmit Error Counter. Values values range from 0 to 255.

CC
: The CC on which the packet was created.

Reserved[4]
: Reserved for future use.

See Also

fcPacket, **fcCANErrorType**, **fcCANCcState**

	Information
	This packet type is initially supported by FlexCard API version S6V6-F.

4.6.1.18 fcPacket

This structure provides information about a packet.

```
Typedef struct fcPacket
{
    fcPacketType Type;
    union
    {
        fcFlexRayFrame*         FlexRayFrame;
        fcInfoPacket*           InfoPacket;
        fcErrorPacket*          ErrorPacket;
        fcStatusPacket*         StatusPacket;
        fcTriggerInfoPacket*    TriggerPacket;
        fcTxAcknowledgePacket*  TxAcknowledgePacket;
        fcNMVectorPacket*       NMVectorPacket;
        fcNotificationPacket*   NotificationPacket;
        fcTriggerExInfoPacket*  TriggerExPacket;
        fcCANPacket*            CANPacket;
        fcCANErrorPacket*       CANErrorPacket;
        fcCANFDPacket*          CANFDPacket;
        fcCANFDErrorPacket*     CANFDErrorPacket;
    };
    struct fcPacket* pNextPacket;
}fcPacket;
```

Members

Type
: Type of packet.

FlexRayFrame
: Pointer to the packet data. The content depends on the type of packet.

InfoPacket
: Pointer to the packet data. The content depends on the type of packet.

ErrorPacket
: Pointer to the packet data. The content depends on the type of packet.

StatusPacket
: Pointer to the packet data. The content depends on the type of packet.

TriggerPacket
: Pointer to the packet data. The content depends on the type of packet.

TxAcknowledgePacket
: Pointer to the packet data. The content depends on the type of packet.

NMVectorPacket
: Pointer to the packet data. The content depends on the type of packet.

NotificationPacket
: Pointer to the packet data. The content depends on the type of packet.

TriggerExPacket
: Pointer to the packet data. The content depends on the type of packet.

CANPacket
: Pointer to the packet data. The content depends on the type of packet.

CANErrorPacket
: Pointer to the packet data. The content depends on the type of packet.

CANFDPacket
: Pointer to the packet data. The content depends on the type of packet.

CANFDErrorPacket
: Pointer to the packet data. The content depends on the type of packet.

pNextPacket
: Pointer to the next packet. If the pointer is NULL, there are no more packets available.

See Also

fcInfoPacket, **fcErrorPacket**, **fcStatusPacket**, **fcTriggerInfoPacket**, **fcTriggerExInfoPacket**, **fcNotificationPacket**, **fcFlexRayFrame**, **fcTxAcknowledgePacket**, **fcNMVectorPacket**, **fcCANPacket**, **fcCANErrorPacket**

4.6.2 Enumerations

4.6.2.1 fcPacketType

This enumeration contains the different packet types.

```
Typedef enum fcPacketType
{
      fcPacketTypeInfo           = 1,
      fcPacketTypeFlexRayFrame   = 2,
      fcPacketTypeError          = 3,
      fcPacketTypeStatus         = 4,
      fcPacketTypeTrigger        = 5,
      fcPacketTypeTxAcknowledge  = 6,
      fcPacketTypeNMVector       = 7,
      fcPacketTypeNotification   = 8,
      fcPacketTypeTriggerEx      = 9,
      fcPacketTypeCAN            = 10,
      fcPacketTypeCANError       = 11,
      fcPacketTypeCANFD          = 12,
      fcPacketTypeCANFDError     = 13,
}fcPacketType;
```

Members

fcPacketTypeInfo
: Frame is an info packet

fcPacketTypeFlexRayFrame
: Frame is a FlexRay frame

fcPacketTypeError
: Frame is an error packet

fcPacketTypeStatus
: Frame is a status packet

fcPacketTypeTrigger
: Frame is a trigger packet (obsolete)

fcPacketTypeTxAcknowledge
: Frame is a transmit acknowledge packet

fcPacketTypeNMVector
: Frame is a network management vector packet

fcPacketTypeNotification
: Frame is a notification packet

fcPacketTypeTriggerEx
: Frame is a trigger packet

fcPacketTypeCAN
: Frame is a CAN packet

fcPacketTypeCANError
: Frame is a CAN error packet

fcPacketTypeCANFD
: Frame is a CAN FD packet

fcPacketTypeCANFDError
: Frame is a CAN FD error packet

See Also

fcPacket, **fcInfoPacket**, **fcFlexRayFrame**, **fcTxAcknowledgePacket**, **fcErrorPacket**, **fcStatusPacket**, **fcTriggerInfoPacket**, **fcNMVectorPacket**, **fcNotificationPacket**, **fcTriggerExInfoPacket**, **fcCANPacket**, **fcCANErrorPacket**

4.6.2.2 fcErrorPacketFlag

This enumeration contains the different error types reported by an error packet.

```
Typedef enum fcErrorPacketFlag
{
    fcErrNone = 0,
    fcErrFlexcardOverflow,
    fcErrPOCErrorModeChanged,
    fcErrSyncFramesBelowMinimum,
    fcErrSyncFrameOverflow,
    fcErrClockCorrectionFailure,
    fcErrParityError,
    fcErrReceiveFIFOOverrun,
    fcErrEmptyFIFOAccess,
    fcErrIllegalInputBufferAccess,
    fcErrIllegalOutputbufferAccess,
    fcErrSyntax,
    fcErrContent,
    fcErrSlotBoundaryViolation,
    fcErrTransmissionAcrossBoundary,
    fcErrLatestTransmitViolation,
    fcErrSyntaxSW,
    fcErrSlotBoundaryViolationSW,
    fcErrTransmissionConflictSW,
    fcErrSyntaxNIT,
    fcErrSlotBoundaryViolationNIT,
} fcErrorPacketFlag;
```

Members

fcErrNone
: No error occurred

fcErrFlexcardOverflow
: FlexCard buffer overflow. This error occurs if the application was too slow to receive and process the packets. If the FlexCard is configured to stop the monitoring it is necessary to stop and start the monitoring again. Else the FlexCard continue the monitoring when an amount of free RAM space is available again. In such a case the FlexCard loses packets.

fcErrPOCErrorModeChanged
: Protocol Operation Control error. Additional information is described in the structure `fcErrPOCErrorModeChangedInfo`

fcErrSyncFramesBelowMinimum
: Additional information are described in the structure `fcErrSyncFramesInfo`

fcErrSyncFrameOverflow
: Additional information described in the structure `fcErrSyncFramesInfo`

fcErrClockCorrectionFailure
: Additional information are described in the structure `fcErrClockCorrectionFailureInfo`

fcErrParityError
: Internal E-Ray error. No additional information is available

fcErrReceiveFIFOOverrun
: No additional information exists for the internal FlexCard error (`fcErrorPacket.AdditionalInfo` is not valid)

fcErrEmptyFIFOAccess
: No additional information exists for the internal FlexCard error

fcErrIllegalInputBufferAccess
No additional information exists for the internal FlexCard error

fcErrIllegalOutputbufferAccess
No additional information exists for the internal FlexCard error

fcErrSyntax
A syntax error was observed (frame is syntactically incorrect). (FlexRay Protocol Specification: vSS!SyntaxErrorA or vSS!SyntaxErrorB depends on Channel) Additional information are described in the structure `fcErrSlotInfo`

fcErrContent
A content error was observed (frame is semantically incorrect). (FlexRay Protocol Specification: vSS!ContentErrorA or vSS!ContentErrorB depends on Channel) Additional information is described in the structure `fcErrSlotInfo`

fcErrSlotBoundaryViolation
A slot boundary violation was observed. (FlexRay Protocol Specification: vSS!BviolationA or vSS!BviolationB depends on Channel) Additional information is described in the structure `fcErrSlotInfo`

fcErrTransmissionAcrossBoundary
Additional information are described in the structure `fcErrSlotInfo`

fcErrLatestTransmitViolation
Additional information are described in the structure `fcErrSlotInfo`

fcErrSyntaxSW
Syntax error in symbol window was observed. Additional information are described in the structure `fcErrSlotInfo`.

fcErrSlotBoundaryViolationSW
Slot boundary violation in symbol window was observed. Additional information are described in the structure `fcErrSlotInfo`.

fcErrTransmissionConflictSW
Transmission conflict in symbol window was observed. Additional information are described in the structure `fcErrSlotInfo`.

fcErrSyntaxNIT
Syntax error in network idle time was observed. Additional information are described in the structure `fcErrSlotInfo`.

fcErrSlotBoundaryViolationNIT
Slot boundary violation in network idle time was observed. Additional information are described in the structure `fcErrSlotInfo`.

See Also

`fcErrorPacket`, `fcErrPOCErrorModeChangedInfo`, `fcErrSyncFramesInfo`, `fcErrClockCorrectionFailureInfo`, `fcErrSlotInfo`

4.6.2.3 fcStatusPacketFlag

Possible hardware status flags are reported by a status packet.

```
Typedef enum fcStatusPacketFlag
{
    fcStatusNone = 0,
    fcStatusWakeupStatus,
    fcStatusCollisionAvoidanceSymbol,
    fcStatusStartupCompletedSuccessfully,
    fcStatusWakeupPatternChannelA,
    fcStatusWakeupPatternChannelB,
    fcStatusMTSReceivedonChannelA,
    fcStatusMTSReceivedonChannelB,
} fcStatusPacketFlags;
```

Members

fcStatusNone
: No status change.

fcStatusWakeupStatus
: Wakeup status has changed

fcStatusCollisionAvoidanceSymbol
: Collision avoidance symbol was received

fcStatusStartupCompletedSuccessfully
: Start-up has been successfully completed

fcStatusWakeupPatternChannelA
: Wakeup pattern received on Channel A

fcStatusWakeupPatternChannelB
: Wakeup pattern received on Channel B

fcStatusMTSReceivedonChannelA
: Media Access Test Symbol received on Channel A

fcStatusMTSReceivedonChannelB
: Media Access Test Symbol received on Channel B

See Also

fcPacket, **fcStatusPacket**, **fcStatusWakeupInfo**

4.6.2.4 fcCANErrorType

This enumeration contains the different error types reported by a CAN error packet.

```
Typedef enum fcCANErrorType
{
      fcCANErrorNone = 0,
      fcCANErrorStuff,
      fcCANErrorForm,
      fcCANErrorAcknowledge,
      fcCANErrorBit1,
      fcCANErrorBit0,
      fcCANErrorCRC,
      fcCANErrorParity,
}fcCANErrorType;
```

Members

fcCANErrorNone
: No error occurred.

fcCANErrorStuff
: More than 5 equal bits in a sequence have occurred in a part of a received message where this is not allowed.

fcCANErrorForm
: A fixed format part of a received frame has the wrong format.

fcCANErrorAcknowledge
: The message the CAN Communication Controller transmitted was not acknowledged by another node.

fcCANErrorBit1
During the transmission of a message (with the exception of the arbitration field), the device wanted to send a recessive level (Bit of logical value 1), but the monitored bus value was dominant (Bit of logical value 0).

fcCANErrorBit0
During the transmission of a message, the device wanted to send a dominant level (data or identifier Bit logical value 0), but the monitored bus value was recessive (data or identifier Bit logical value 1).

fcCANErrorCRC
The CRC check sum was incorrect in the message received, the CRC received for an incoming message does not match with the calculated CRC for the received data.

fcCANErrorParity
The parity check mechanism has detected a parity error in the message RAM of the Communication Controller.

See Also

fcCANErrorPacket

	Information
	This enumeration is initially supported by FlexCard API version S4V0-F.

4.6.3 fcbReceive

This function reads all available packets from the FlexCard memory into a memory block allocated by the fcBase API. The frames are stored into a linked list. To free the memory allocated by this function, use the function **fcFreeMemory** with the type *fcMemoryTypePacket*.

```
fcError fcbReceive(
      fcHandle hFlexCard,
      fcPacket** pPacket
);
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

pPacket
[OUT] Address of the fcPacket object pointer. The memory for this structure and its content is allocated by the fcBase API. Packets are available if the return code is 0 and *pPacket* is not a null pointer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

	Information
	This function allocates memory. To prevent memory leaks the memory has to be released after having processed the packets.

Example

```
fcPacket* pPackets = NULL;
fcError e = fcbReceive(m_hFlexCard, &pPackets);
if (0 == e)
{
      fcPacket* pCurrentPacket = pPackets;
      while (NULL != pCurrentPacket)
      {
            switch (pCurrentPacket->Type)
            {
            case fcPacketTypeInfo:
                  printf("[fcPacketTypeInfo] TimeStamp: %f Cycle: %d\n",
                        (float)pCurrentPacket->InfoPacket->TimeStamp* 0.000001,
                        pCurrentPacket->InfoPacket->CurrentCycle);

            break;

            case fcPacketTypeFlexRayFrame:
            {
                  fcFlexRayFrame* pFrame = pCurrentPacket->FlexRayFrame;
                  printf("[fcPacketTypeFlexRayFrame] Cycle: %d ID: %d Channel:"
                        "%d PayloadLength: %d",  pFrame->CycleCount,
                        pFrame->ID,
                        pFrame->Channel,
                        pFrame->PayloadLength);

                  for (int i = 0; i < pFrame->PayloadLength; i++)
                  {
                        printf("%04X ", pFrame->pData[i]);
                  }

                  if (pFrame->PP) printf(" PP");
                  if (pFrame->NF) printf(" NF");
                  if (pFrame->SYNC) printf(" SYNC");
                  if (pFrame->STARTUP) printf(" STARTUP");
                  if (pFrame->SyntaxError) printf(" SyntaxError");
                  if (pFrame->ContentError) printf(" ContentError");
                  if (pFrame->ValidFrame) printf(" ValidFrame");
                  if (pFrame->SlotBoundaryViolation)
                        printf(" SlotBoundaryViolation");
                  if (pFrame->AsyncMode)
                        printf(" AsyncMode FrameCRC: 0x%06X", pFrame->FrameCRC);
                  printf("\n");
                  break;
            }
            case fcPacketTypeError:
                  printf("[fcPacketTypeError]\n");
                  break;

            case fcPacketTypeStatus:
                  printf("[fcPacketTypeStatus]\n");
                  break;

            case fcPacketTypeTrigger:
                  printf("[fcPacketTypeTrigger]\n");
                  break;

            case fcPacketTypeTxAcknowledge:
                  printf("[fcPacketTypeTxAcknowledge]\n");
                  break;

            case fcPacketTypeNMVector:
                  printf("[fcPacketTypeNMVector]\n");
                  break;
            }
```

```
            pCurrentPacket = pCurrentPacket->pNextPacket;
        }

        fcFreeMemory(fcMemoryTypePacket, pPackets);
}
```

5 FlexRay API

The following section describes the data structures and features used for FlexRay functionality. To use these functions the FlexCard must have a firmware with a FlexRay CC and the FlexCard must be licensed for FlexRay.

	Information
	All enumerations, structures and function in this chapter are initially supported by FlexCard API version S4V2-F.

5.1 Basic FlexRay Workflow

The following figure shows a typical FlexRay workflow. Refer to the chapter General Function Availability to find out what FlexCard supports what functions. The FlexCard Windows Developer Setup installs the example applications *fcDemo.exe*, *fcDemoPMC.exe* and their source code to the installation directory.

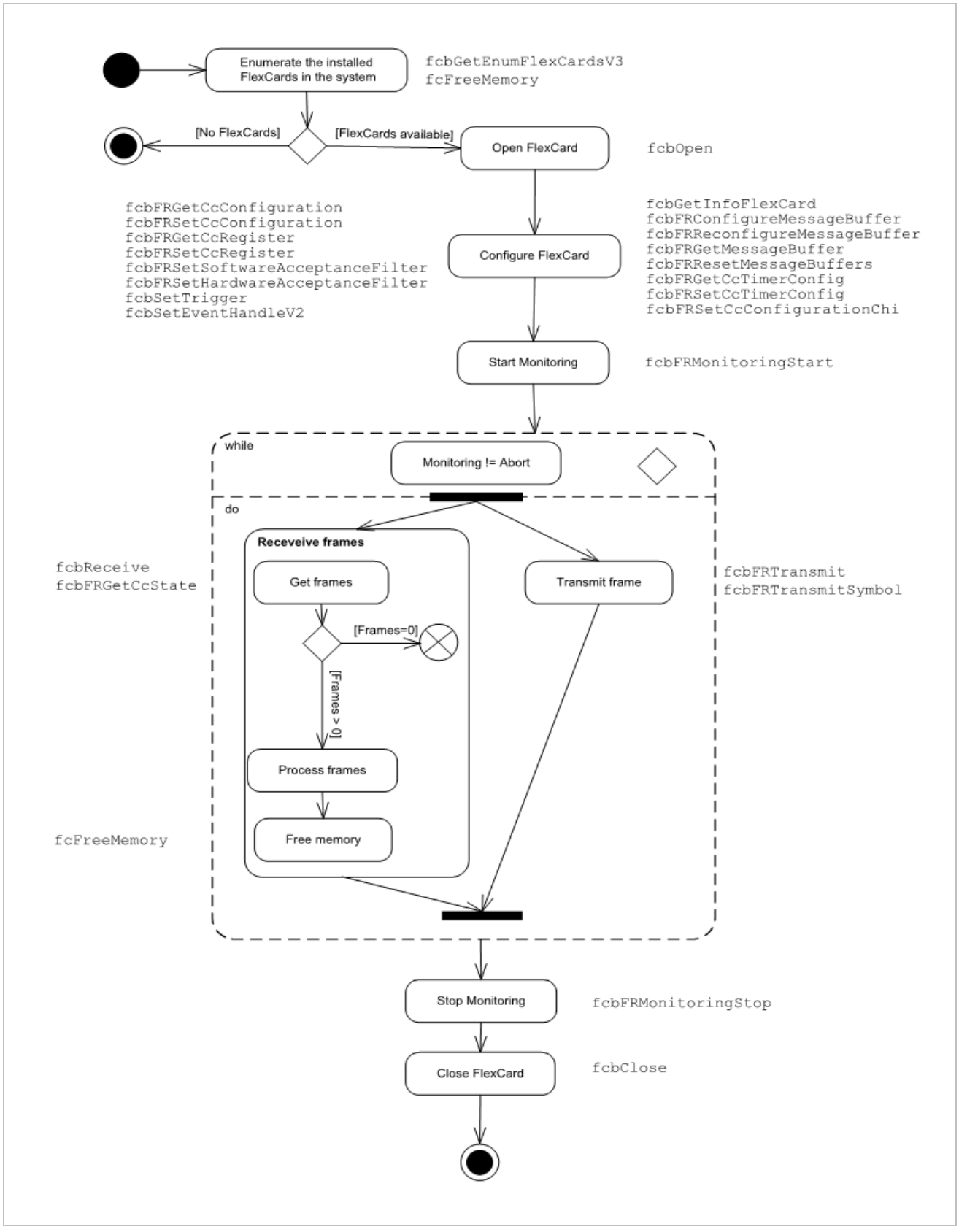


Figure 8: Typical FlexRay function workflow

The following table gives information about what message buffer functions may be called during monitoring.

Functionality	Action during monitoring
New configuration of a message buffer.	Not possible.
Read message buffer configuration.	Not possible. Application has to store the buffer information.
Reconfiguration of a static FlexRay ID (Reconfigure channel, id, payload length).	Only in extended mode (fcFRMsgBufCfgModeReconfigurationDuringMonitoring)
Reconfiguration of a static FlexRay Sync-ID.	Not possible due to limitations of the Communication Controller Bosch E-Ray.
Reconfiguration of a dynamic FlexRay ID (Reconfigure channel, id, payload length).	Possible.
Turning off/on a static FlexRay ID (Reconfigure to fcChannelNone).	Only in extended mode (fcFRMsgBufCfgModeReconfigurationDuringMonitoring)
Turning off/on a static FlexRay Sync ID (Reconfigure to fcChannelNone).	Not possible due to limitations of the Communication Controller Bosch E-Ray.
Turning off/on a dynamic FlexRay ID (Reconfigure to fcChannelNone).	Only in extended mode (fcFRMsgBufCfgModeReconfigurationDuringMonitoring)

5.2 Initialization

5.2.1 Enumerations

5.2.1.1 fcMonitoringModes

This enumeration defines the different modes available, used to monitor a FlexRay cluster.

```
Typedef enum fcMonitoringModes
{
       fcMonitoringNormal,
       fcMonitoringDebug,
       fcMonitoringDebugAsynchron,
       fcMonitoringDebugAsynchronBeforeStartup,
} fcMonitoringModes;
```

Members

fcMonitoringNormal

First, the FlexCard tries to synchronize itself with the cluster. Once the synchronization succeeds, the FlexCard enters in the NORMAL_ACTIVE state and is able to transmit and receive FlexRay frames, symbols and errors, as previously configured. The timestamp accuracy in this mode is +/-1 µs.

fcMonitoringDebug

This mode is provided by the E-Ray FlexRay core. The FlexCard does not try to synchronize itself with the cluster and is only able to receive FlexRay frames, symbols and errors from the FlexRay bus. This mode does not allow transmission; it is therefore not possible to perform a start-up or a wake-up. This mode is adapted for debugging purpose (e.g. start-up of a FlexRay network fails).

Note: To receive frames within this mode using an E-Ray version older than 1.3, you have to configure RX receive buffers. The FIFO receive buffers aren't working in this mode. With CC version 1.3 it's possible to receive frames wih FIFO receive buffers. You may call **`fcbGetInfoFlexCard`** and read the variable *`CCVersion`* to check the E-Ray version that is present on the FlexCard.

fcMonitoringDebugAsynchron

This debug operation mode of the FlexCard allows the reception of all frames without any message buffer (API configures FIFO buffers automatically) and controller configuration. The only parameter to be set is the baudrate (Register 0x0090: 10 Mbit/s: 0x00000000, 5 Mbit/s: 0x00004000, 2.5 Mbit/s: 0x00008000). This mode does not allow transmission. It is therefore not possible to perform a start-

up or a wake-up. This mode is adapted for debugging purpose (e.g. start-up of a FlexRay network fails or to monitor an unknown network). The timestamp accuracy in this mode is +/-2 µs. Incorrect data will be interpreted as received FlexRay frames (the Valid Frame Bit is not set for such frames).

fcMonitoringDebugAsynchronBeforeStartup

This mode combines the mode *fcMonitoringDebugAsynchron* and *fcMonitoringNormal*. The mode *fcMonitoringDebugAsynchronBeforeStartup* is used to receive all frames during start-up. Unlike *fcMonitoringDebug* this mode allows to send sync frames. After the start-up completed successfully, the FlexCard switchs directly to the mode *fcMonitoringNormal*.

See Also

fcbFRMonitoringStart

5.2.1.2 fcState

This enumeration defines the possible Communication Controller POC states (FlexRay Protocol Specification: vPOC!State). For more details about Communication Controller POC states, please refer to [3].

```
Typedef enum fcState
{
       fcStateUnknown,
       fcStateConfig,
       fcStateNormalActive,
       fcStateNormalPassive,
       fcStateHalt,
       fcStateReady,
       fcStateStartup,
       fcStateWakeup,
       fcStateMonitorMode,
} fcState;
```

Members

fcStateUnknown

Communication controller state is not known.

fcStateConfig

Communication controller is in CONFIG state.

fcStateNormalActive

Communication controller is in NORMAL_ACTIVE state.

fcStateNormalPassive

Communication controller is in NORMAL_PASSIVE state.

fcStateHalt

Communication controller is in HALT state.

fcStateReady

Communication controller is in READY state.

fcStateStartup

Communication controller is in STARTUP state.

fcStateWakeup

Communication controller is in WAKEUP state.

fcStateMonitorMode

Communication controller is in MONITORMODE state.

See Also

fcbFRGetCcState, **fcbFRMonitoringStart**

5.2.2 fcbFRMonitoringStart

This function is used to start the monitoring of a FlexRay bus. Once the user calls the function with *fcMonitoringNormal*, it changes the Communication Controller state from configuration state to normal active state if the cluster integration succeeds. The function returns immediately and does not wait for the Communication Controller to get synchronous. The current Communication Controller state can be read using the function **fcbFRGetCCState**. If the FlexCard is synchronized with the cluster the function **fcbFRGetCCState** will return the value *fcStateNormalActive*.

```
fcError fcbFRMonitoringStart(
      fcHandle hFlexCard,
      fcCC CC,
      fcMonitoringModes mode,
      fcBool restartTimestamps,
      fcBool enableCycleStartEvents
      fcBool enableColdstart,
      fcBool enableWakeup
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index

mode

[IN] The monitoring mode. Not every monitoring mode is supported by all Communication Controllers. See **fcMonitoringModes** for details.

restartTimestamps

[IN] Set this parameter to 0 to restart the measurement without resetting the FlexCard timestamp. Set it to <> 0 to start the measurement from the beginning. The timestamps have micro second resolution.

enableCycleStartEvents

[IN] Set this parameter to <> 0 to enable the cycle start events in order that at the beginning of every cycle the event *fcNotificationTypeFRCycleStarted* is signalled. On the *FlexCard USB-M*, this feature is not supported. **fcbFRMonitoringStart** does not return an error when this parameter is set, but no events are signalled.

enableColdstart

[IN] Set this parameter to <> 0 to allow the FlexCard to initialize the cluster communication, otherwise the coldstart inhibit mode is active. This feature can not be used in the monitoring modes *fcMonitoringDebug* and *fcMonitoringDebugAsynchron*.

enableWakeup

[IN] Set this parameter to <> 0 to transmit a wake-up pattern on the configured wake-up channel (FlexRay Protocol Specification: pWakeupChannel). A cluster wake-up must precede the communication start-up to ensure that all nodes in a cluster are awake. The minimum requirement for a cluster wake-up is that all bus drivers are supplied with power. This feature can not be used in the monitoring modes *fcMonitoringDebug* and *fcMonitoringDebugAsynchron*.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

After the monitoring with *fcMonitoringNormal* has started, the user should check if the integration in the cluster was successful: **fcbFRGetCCState** should return the state *fcStateNormalActive*.

	Information
	After the monitoring has successfully started, the receive process has to be started as soon as possible to avoid an overflow (error packet *fcErrFlexcardOverflow* is received). Once an overflow occurred, no more packets can be received. The monitoring has to be stopped and started again.

See Also

fcCC, **fcbFRMonitoringStop**, **fcbFRGetCcState**, **fcMonitoringModes**, **fcbSetEventHandleV2**, **fcbSetEventHandleSemaphore**

Example

```
// Precondition: valid flexcard handle exists and the flexcard is
// already configured.
fcCC eCC = fcCC1;
fcError e = fcbFRMonitoringStart(hFlexCard,eCC,fcMonitoringNormal,true,
                                 false,false,false);
if (0 == e)
{
      bool synchronized = false;
      bool timeout = false;
      DWORD maxTime = ::GetTickCount() + 2000;
      fcState currentState = fcStateUnknown;

      // Check if the FlexCard is synchronized
      do
      {
            fcbFRGetCcState(hFlexCard, eCC, &currentState);
            synchronized = (currentState == fcStateNormalActive);
            timeout            = ::GetTickCount() >= maxTime;

      } while ( ! synchronized && ! timeout);

      if (synchronized)
      {
            // Start your receive thread/routine
            //   ...
      }
      else
      {
            // if we timed out, we stop the monitoring
            fcbFRMonitoringStop(hFlexCard,eCC);
      }
}
else
{
      // error handling …
}
```

5.2.3 fcbFRMonitoringStop

This function stops the FlexRay bus measurement. The Communication Controller is set back in its configuration state.

```
fcError fcbFRMonitoringStop(
      fcHandle hFlexCard,
      fcCC CC
)
```

Parameters

hFlexCard

[IN] Handle to FlexCard

CC

[IN] Communication controller index

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcbFRMonitoringStart**

5.2.4 fcbFRGetCcState

This function returns the current Communication Controller POC state. For a description of possible states, refer to the enumeration **fcState**. This function should be used to check if the integration into a FlexRay cluster has succeeded.

```
fcError fcbFRGetCcState(
      fcHandle hFlexCard,
      fcCC CC,
      fcState* pState
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

pState

[OUT] Current Communication Controller state

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See

fcCC, **fcState**, **fcbFRMonitoringStart**, **fcbFRMonitoringStop**

Example

See example **fcbFRMonitoringStart**

5.2.5 fcbFRSetTransceiverState

This function sets the transceiver mode individually for each channel.

```
fcError fcbFRSetTransceiverState (
      fcHandle hFlexCard,
      fcCC CC,
      fcTransceiverState stateChA,
      fcTransceiverState stateChB
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

CC
[IN] Communication controller index

stateChA
[IN] The new transceiver state for channel A

stateChB
[IN] The new transceiver state for channel B

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

If one of the transceivers is in the sleep mode and the transceiver detects a wake-up event, the notification event *fcNotificationTypeFRWakeup* is fired once only. Note that the transceiver state stays the same after closing the FlexCard and opening it again. When the FlexCard is powered off and on again, the transceiver state is reset. This e.g. happens during the stand-by of the computer. When you want to make sure that the FlexCard is in its default state, set the transceiver state to normal before starting the monitoring.

See

fcCC, **fcTransceiverState**, **fcbFRMonitoringStart**, **fcbFRSetTransceiverState**

5.2.6 fcbFRGetTransceiverState

This function gets the transceiver state of a selected Communication Controller individually for each channel.

```
fcError fcbFRGetTransceiverState (
      fcHandle hFlexCard,
      fcCC CC,
      fcTransceiverState* pStateChA,
      fcTransceiverState* pStateChB
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

CC
[IN] Communication controller index

pStateChA
[OUT] The current transceiver state for channel A

pStateChB
[OUT] The current transceiver state for channel B

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

If one of the transceiver is in the sleep mode and the transceiver detects a wake-up event, the notification event *fcNotificationTypeFRWakeup* is fired once only. Note that the transceiver state stays the same after closing the FlexCard and opening it again. When the FlexCard is powered off and on again, the transceiver state is reset. This e.g. happens during the stand-by of the computer. When you want to make sure that the FlexCard is in its default state, set the transceiver state to normal before starting the monitoring.

See

fcCC, **fcTransceiverState**, **fcbFRMonitoringStart**, **fcbFRSetTransceiverState**

5.3 Configuration

This chapter describes the functions and data types used to configure both Communication Controller and hardware of a FlexCard. The configuration phase of a FlexCard is an essential part of its integration into a cluster and can not be skipped. Entering the bus parameters of an existent network is possible directly or by CHI-Import. If one of the FlexCard configuration settings does not match the cluster ones, the FlexCard may not be able to monitor the bus. Therefore, it is highly recommended to use a configuration tool for designing a new FlexRay network. FlexConfig Developer from *STAR COOPERATION* is such a tool that outputs a CHI file. It automatically validates and generates for each FlexRay parameter the corresponding register values of each node in a cluster. Manual configuration of the FlexCard is also a possibility but will be a complex, time-consuming and error-prone method due to the large number of E-Ray registers used for configuration.

As the FlexCard uses the receive FIFO functionality from the Communication Controller to monitor the FlexRay frames, the fcBase API has to ensure that enough FIFO message buffers are configured, that means that not all message buffers are available for the user. Modifying the FIFO message buffers settings may affect the ability to correctly monitor the FlexRay bus.

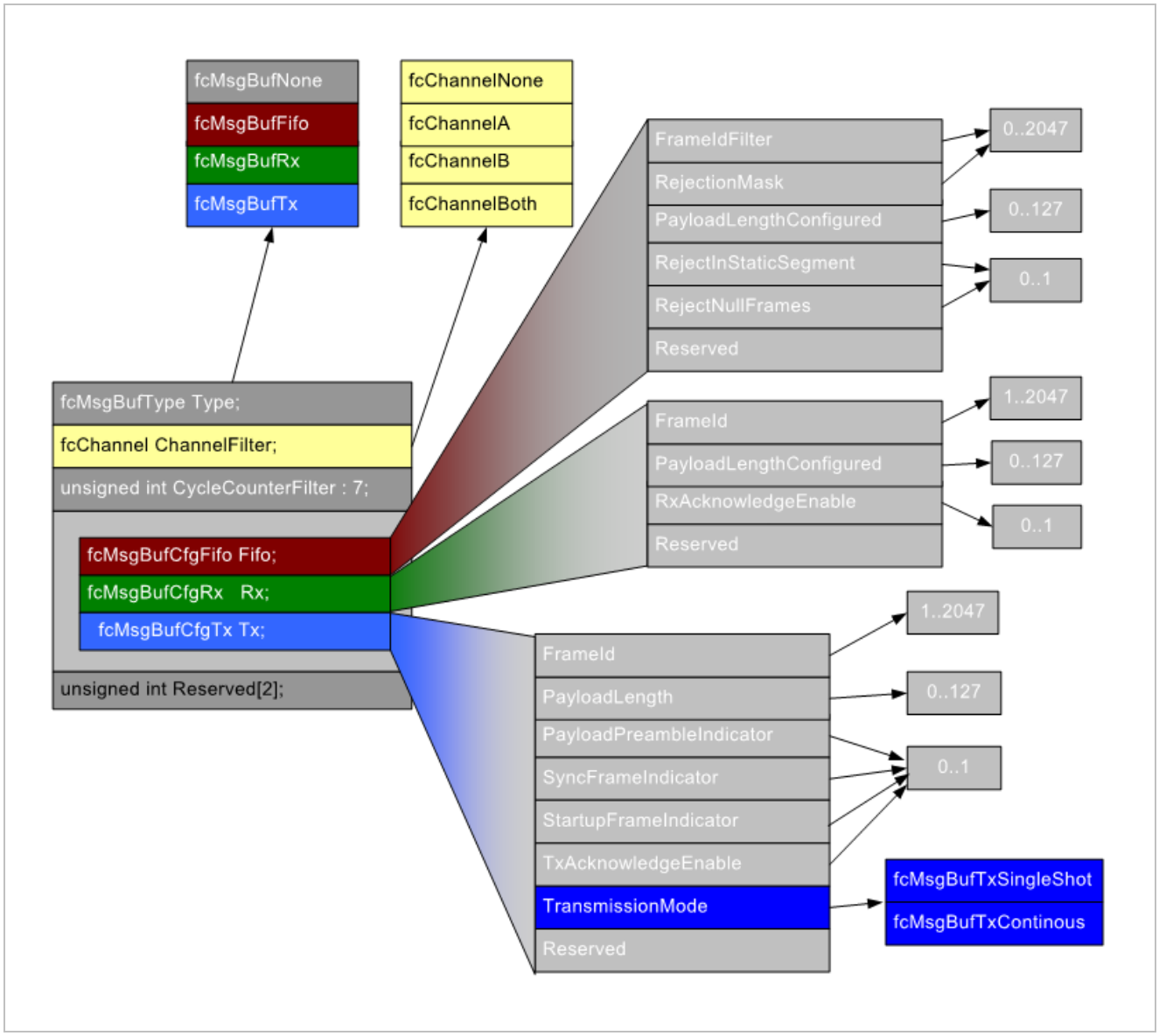


Figure 9: Overview fcbMsgBufCfg structure

The message buffer RAM is 2048 32 bit words in total. It contains a 16 byte administration data structure for each message buffer, the rest may be used for the payload. This leads to a possible maximum configuration for example of 30 message buffers with 254 byte payload, 56 message buffers with 128 byte payload, or 128 message buffers with 48 byte payload. For further information on configuration of the message RAM see [5] chapter 5.12.

5.3.1 Constants

5.3.1.1 fcPayloadMaximum

Maximum number of 2-byte payload data words

```
const fcByte fcPayloadMaximum = 127
```

5.3.2 Enumerations

5.3.2.1 fcChannel

This enumeration defines the available channel combination of the FlexCard.

```
Typedef enum fcChannel
{
       fcChannelNone = 0x00,
       fcChannelA    = 0x01,
       fcChannelB    = 0x02,
       fcChannelBoth = fcChannelA | fcChannelB,
} fcChannel;
```

Members

fcChannelNone
No FlexRay channel selected

fcChannelA
Only FlexRay channel A is selected

fcChannelB
Only FlexRay channel B is selected

fcChannelBoth
FlexRay channel A and B are selected

See Also

fcMsgBufCfg

5.3.2.2 fcWakeupStatus

This enumeration defines the possible Communication Controller wake-up states (FlexRay Protocol Specification: vPOC!WakeupStatus). For more details about Communication Controller wake-up states, please refer to [3].

```
Typedef enum fcWakeupStatus
{
       fcWakeupStatusUndefined = 0,
       fcWakeupStatusReceiveHeader,
       fcWakeupStatusReceiveWUP,
       fcWakeupStatusCollisionHeader,
       fcWakeupStatusCollisionWUP,
       fcWakeupStatusCollisionUnknown
       fcWakeupStatusTransmitted,
} fcWakeupStatus;
```

Members

fcWakeupStatusUndefined
FlexRay Protocol Specification: UNDEFINED

fcWakeupStatusReceiveHeader
FlexRay Protocol Specification: RECEIVE_HEADER

fcWakeupStatusReceiveWUP
FlexRay Protocol Specification: RECEIVE_WUP

fcWakeupStatusCollisionHeader
FlexRay Protocol Specification: COLLISION_HEADER

fcWakeupStatusCollisionWUP
FlexRay Protocol Specification: COLLISION_WUP

fcWakeupStatusCollisionUnknown
FlexRay Protocol Specification: COLLISION_UNKNOWN

fcWakeupStatusTransmitted
FlexRay Protocol Specification: TRANSMITTED

See Also

fcStatusWakeupInfo, **fcStatusPacket**

5.3.2.3 fcTransceiverState

This enumeration defines the different states of the FlexRay transceivers.

```
Typedef enum fcTransceiverState
{
       fcTransceiverNormal,
       fcTransceiverSleep,
} fcTransceiverState;
```

Members

fcTransceiverNormal
: Transceiver is in normal mode and is able to transmit and receive data via the FlexRay bus.

fcTransceiverSleep
: Transceiver is in low power mode and is not able to transmit and receive data, but is able to detect wake-up events on the bus. If a wake-up is detected the event `fcNotificationTypeFRWakeup` is fired.

See Also

fcbFRSetTransceiverState, **fcbFRGetTransceiverState**

	Information
	This enumeration is initially supported by FlexCard API version S2V0-F.

5.3.2.4 fcFRBaudRate

This enumeration defines the various baud rates on the FlexRay bus.

```
Typedef enum fcFRBaudRate
{
       fcFRBaudRateNone = 0,
       fcFRBaudRate2M5,
       fcFRBaudRate5M,
       fcFRBaudRate10M,
} fcFRBaudRate;
```

Members

fcFRBaudRateNone
: No baud rate defined

fcFRBaudRate2M5
: Defines the baud rate 2.5 Mbit/s

fcFRBaudRate5M
: Defines the baud rate 5 Mbit/s

fcFRBaudRate10M
: Defines the baud rate 10 Mbit/s

See Also

fcFRCcConfig

5.3.2.5 fcFRMsgBufCfgMode

This enumeration defines the available message buffer configuration modes with the FlexCard fcBase API. In normal mode the message buffer configuration is very strict and safe; in expert mode some special configurations are allowed. These message buffer configuration modes can be binary Ored.

```
Typedef enum fcFRMsgBufCfgMode
{
       fcFRMsgBufCfgModeNone = 0,
       fcFRMsgBufCfgModeNormal = fcFRMsgBufCfgModeNone,
       fcFRMsgBufCfgModeUnequalStaticPayloadLength = 1,
       fcFRMsgBufCfgModeReconfigurationDuringMonitoring = 2,
       fcFRMsgBufCfgModeCycleMultiplexInStartupSyncFrame = 4,
       fcFRMsgBufCfgModeAll = fcFRMsgBufCfgModeUnequalStaticPayloadLength |
                              fcFRMsgBufCfgModeReconfigurationDuringMonitoring |
                              fcFRMsgBufCfgModeCycleMultiplexInStartupSyncFrame,
       fcFRMsgBufCfgModeExpert = fcFRMsgBufCfgModeAll,
} fcFRMsgBufCfgMode;
```

Members

fcFRMsgBufCfgModeNone

fcFRMsgBufCfgModeNormal

Normal (safe) message buffer configuration mode.

fcFRMsgBufCfgModeUnequalStaticPayloadLength

Allows transmit message buffer configurations in static segment with PayloadLength between 0 and PayloadLengthMax. For further description see **fcMsgBufCfgTx** and **fcMsgBufCfgRx**.

fcFRMsgBufCfgModeReconfigurationDuringMonitoring

Allows extended reconfigurations of message buffers during monitoring. Is this mode set, message buffer transmission and reception can be configured with parameter *ChannelFilter* in normal active mode. For further description see **fcMsgBufCfg**.

fcFRMsgBufCfgModeCycleMultiplexInStartupSyncFrame

Allows extended configurations of start-up/sync message buffers. Is this mode set, cycle counter filtering for more than two start-up/sync message buffers is possible. A reconfiguration of start-up/sync isn't allowed while monitoring is active. For further description see **fcMsgBufCfg**.

fcFRMsgBufCfgModeAll

fcFRMsgBufCfgModeExpert

Expert (unsafe) message buffer configuration mode

See Also

fcbFRSetMsgBufCfgMode, **fcMsgBufCfg**, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**

	Information
	This enumeration is initially supported by FlexCard API version S6V1-F.

5.3.2.6 fcMsgBufType

For the transmission and reception of FlexRay frames the Communication Controller provides different types of message buffers. Each message buffer can be assigned with one of the following specific types.

```
Typedef enum fcMsgBufType
{
       fcMsgBufNone,
       fcMsgBufRx,
       fcMsgBufTx,
       fcMsgBufFifo,
} fcMsgBufType;
```

Members

fcMsgBufNone

The message buffer is not used.

fcMsgBufRx

The message buffer is used as a receive buffer (e.g. to analyse a specific frame).

fcMsgBufTx
: The message buffer is used as a transmit buffer (e.g. to transmit a message on a specific communication slot).

fcMsgBufFifo
: The message buffer is used as a receive FIFO buffer. In that case, it will receive frames from different communication slots.

	Information
	In certain cases, it is not possible to receive all frames with only receive message buffers. To ensure that all frames will be received, we recommend to configure some FIFO message buffers.

See Also

fcMsgBufCfg

5.3.2.7 fcMsgBufTxMode

This enumeration defines the different modes of transmission.

```
Typedef enum fcMsgBufTxMode
{
       fcMsgBufTxSingleShot,
       fcMsgBufTxContinous,
}fcMsgBufTxMode;
```

Members

fcMsgBufTxSingleShot
: Frame is transmitted once only if its corresponding message buffer content has been set and both frame id and cycle filter are matching. The function **fcbFRTransmit** sets the content of a given message buffer.

fcMsgBufTxContinous
: Frame is transmitted each time when both the frame id and cycle filter are matching, regardless if its corresponding message buffer content has been set or not.

See Also

fcMsgBufCfgTx

5.3.2.8 fcCyclePos

This enumeration defines various positions in a FlexRay cycle.

```
Typedef enum fcCyclePos
{
       fcCyclePosNotDefined = 0,

       fcCyclePosStaticSlot,
       fcCyclePosDynamicMiniSlot,

       fcCyclePosEndStaticSegment,
       fcCyclePosStartDynamicSegment,
       fcCyclePosEndDynamicSegment,
       fcCyclePosStartSymbolWindow,
       fcCyclePosEndSymbolWindow,
       fcCyclePosStartNetworkIdleTime,
} fcCyclePos;
```

Members

fcCyclePosNotDefined
No cycle position defined

fcCyclePosStaticSlot
Defines the start of a static slot

fcCyclePosDynamicMiniSlot
Defines the start of a dynamic mini slot

fcCyclePosEndStaticSegment
Defines the end of the static segment

fcCyclePosStartDynamicSegment
Defines the start of the dynamic segment

fcCyclePosEndDynamicSegment
Defines the end of the dynamic segment

fcCyclePosStartSymbolWindow
Defines the start of the symbol window

fcCyclePosEndSymbolWindow
Defines the end of the symbol window

fcCyclePosStartNetworkIdleTime
Defines the start of the network idle time

See Also

fcbFRCalculateMacrotickOffset

	Information
	This enumeration is initially supported by FlexCard API version S4V0-F.

5.3.3 Structures

5.3.3.1 fcFRCcConfig

This structure describes the configuration of the FlexRay Communication Controller. The struct contains the variables from the FlexRay specification. The FlexCard driver makes the conversion to/from the registers the FlexRay core E-Ray uses. For example, gListenNoise is not the same in the FlexRay specification compared to the E-Ray register.

The variable descriptions were extracted from [5] (Bosch E-Ray FlexRay IP-Module User's Manual).

```
Typedef struct fcFRCcConfig
{
       fcFRBaudRate BaudRate;
       fcDword gdActionPointOffset;
```

```
        fcDword gdCASRxLowMax;
        fcDword gdDynamicSlotIdlePhase;
        fcDword gdMinislot;
        fcDword gdMinislotActionPointOffset;
        fcDword gdNIT;
        fcDword gdStaticSlot;
        fcDword gdTSSTransmitter;
        fcDword gdWakeupSymbolRxIdle;
        fcDword gdWakeupSymbolRxLow;
        fcDword gdWakeupSymbolRxWindow;
        fcDword gdWakeupSymbolTxIdle;
        fcDword gdWakeupSymbolTxLow;
        fcDword gColdStartAttempts;
        fcDword gListenNoise;
        fcDword gMacroPerCycle;
        fcDword gMaxWithoutClockCorrectionFatal;
        fcDword gMaxWithoutClockCorrectionPassive;
        fcDword gNetworkManagementVectorLength;
        fcDword gNumberOfMinislots;
        fcDword gNumberOfStaticSlots;
        fcDword gOffsetCorrectionStart;
        fcDword gPayloadLengthStatic;
        fcDword gSyncNodeMax;
        fcDword pdAcceptedStartupRange;
        fcDword pdListenTimeout;
        fcDword pdMaxDrift;
        fcDword pAllowHaltDueToClock;
        fcDword pAllowPassiveToActive;
        fcChannel pChannelsMTS;
        fcChannel pChannels;
        fcDword pClusterDriftDamping;
        fcDword pDecodingCorrection;
        fcDword pDelayCompensationA;
        fcDword pDelayCompensationB;
        fcDword pExternOffsetCorrection;
        fcDword pExternRateCorrection;
        fcDword pKeySlotUsedForStartup; //NOT USED.
        fcDword pKeySlotUsedForSync; //NOT USED.
        fcDword pLatestTx;
        fcDword pMacroInitialOffsetA;
        fcDword pMacroInitialOffsetB;
        fcDword pMicroInitialOffsetA;
        fcDword pMicroInitialOffsetB;
        fcDword pMicroPerCycle;
        fcDword pOffsetCorrectionOut;
        fcDword pRateCorrectionOut;
        fcDword pSingleSlotEnabled;
        fcChannel pWakeupChannel;
        fcDword pWakeupPattern;
        fcDword vExternOffsetControl;
        fcDword vExternRateControl;

        fcDword Reserved[16];
} fcFRCcConfig;
```

Members

BaudRate

Configures the baud rate on the FlexRay bus.

gdActionPointOffset

Configures the action point offset in macroticks within static slots and symbol window. Must be identical in all nodes of a cluster. Valid values are 1 to 63 MT.

gdCASRxLowMax
: Configures the upper limit of the acceptance window for a collision avoidance symbol (CAS). Valid values are 67 to 99 bit times.

gdDynamicSlotIdlePhase
: The duration of the dynamic slot idle phase has to be greater or equal than the idle detection time. Must be identical in all nodes of a cluster. Valid values are 0 to 2 Minislot.

gdMinislot
: Configures the duration of a minislot in macroticks. The minislot length must be identical in all nodes of a cluster. Valid values are 2 to 63 MT.

gdMinislotActionPointOffset
: Configures the action point offset in macroticks within the minislots of the dynamic segment. Must be identical in all nodes of a cluster. Valid values are 1 to 31 MT.

gdNIT
: Configures the starting point of the Network Idle Time NIT at the end of the communication cycle expressed in terms of macroticks from the beginning of the cycle. The start of NIT is recognized if Macrotick = gMacroPerCycle – gdNIT -1 and the increment pulse of Macrotick is set. Must be identical in all nodes of a cluster. Valid values of "gMacroPerCycle – gdNIT -1" are 7 to 15997 MT. Therefore valid values for the parameter gdNIT are 2 to 805 MT.

gdStaticSlot
: Configures the duration of a static slot in macroticks. The static slot length must be identical in all nodes of a cluster. Valid values are 4 to 659 MT.

gdTSSTransmitter
: Configures the duration of the Transmission Start Sequence (TSS) in terms of bit times (1 bit time = 4 µT = 100ns@10Mbps). Must be identical in all nodes of a cluster. Valid values are 3 to 15 bit times.

gdWakeupSymbolRxIdle
: Configures the number of bit times used by the node to test the duration of the idle phase of the received wake-up symbol. Must be identical in all nodes of a cluster. Valid values are 14 to 59 bit times.

gdWakeupSymbolRxLow
: Configures the number of bit times used by the node to test the duration of the low phase of the received wake-up symbol. Must be identical in all nodes of a cluster. Valid values are 10 to 55 bit times.

gdWakeupSymbolRxWindow
: Configures the number of bit times used by the node to test the duration of the received wake-up pattern. Must be identical in all nodes of a cluster. Valid values are 76 to 301 bit times.

gdWakeupSymbolTxIdle
: Configures the number of bit times used by the node to transmit the idle phase of the wake-up symbol. Must be identical in all nodes of a cluster. Valid values are 45 to 180 bit times.

gdWakeupSymbolTxLow
: Configures the number of bit times used by the node to transmit the low phase of the wake-up symbol. Must be identical in all nodes of a cluster. Valid values are 15 to 60 bit times.

gColdStartAttempts
: Configures the maximum number of attempts that a cold starting node is permitted to try to start-up the network without receiving any valid response from another node. It can be modified in DEFAULT_CONFIG or CONFIG state only. Must be identical in all nodes of a cluster. Valid values are 2 to 31.

gListenNoise
: Configures the upper limit for start-up and wake-up listen timeout in the presence of noise expressed as a multiple of `pdListenTimeout`. The range for gListenNoise is 2 to 16.

gMacroPerCycle
: Configures the duration of one communication cycle in macroticks. The cycle length must be identical in all nodes of a cluster. Valid values are 10 to 16000 MT.

gMaxWithoutClockCorrectionFatal
: Defines the number of consecutive even/odd cycle pairs with missing clock correction terms that will cause a transition from NORMAL_ACTIVE or NORMAL_PASSIVE to HALT state. Must be identical in all nodes of a cluster. Valid values are 1 to 15 cycle pairs.

gMaxWithoutClockCorrectionPassive
: Defines the number of consecutive even/odd cycle pairs with missing clock correction terms that will cause a transition from NORMAL_ACTIVE to NORMAL_PASSIVE state. Must be identical in all nodes of a cluster. Valid values are 1 to 15 cycle pairs.

gNetworkManagementVectorLength
: Configures the length of the NM vector. The configured length must be identical in all nodes of a cluster. Valid values are 0 to 12 bytes.

gNumberOfMinislots
: Configures the number of minislots within the dynamic segment of a cycle. The number of minislots must be identical in all nodes of a cluster. Valid values are 0 to 7986.

gNumberOfStaticSlots
: Configures the number of static slots in a cycle. At least 2 coldstart nodes must be configured to start-up a FlexRay network. The number of static slots must be identical in all nodes of a cluster. Valid values are 2 to 1023.

gOffsetCorrectionStart
: Determines the start of the offset correction within the NIT phase, calculated from start of cycle. Must be identical in all nodes of a cluster. Valid values are 9 to 15999 MT.

gPayloadLengthStatic
: Configures the cluster-wide payload length for all frames sent in the static segment in double bytes. The payload length must be identical in all nodes of a cluster. Valid values are 0 to 127.

gSyncNodeMax
: Maximum number of frames within a cluster with sync frame indicator Bit SYN set to ’1’. Must be identical in all nodes of a cluster. Valid values are 2 to 15.

pdAcceptedStartupRange
: Number of microticks constituting the expanded range of measured deviation for start-up frames during integration. Valid values are 0 to 1875 µT.

pdListenTimeout
: Configures wake-up/start-up listen timeout in µT. The range for pdListenTimeout is 1284 to 1283846 µT.

pdMaxDrift
: Maximum drift offset between two nodes that operate with unsynchronized clocks over one communication cycle in µT. Valid values are 2 to 1923 µT.

pAllowHaltDueToClock
: Controls the transition to HALT state due to a clock synchronization error. Valid values are 0 to 1. If a clock sync error occurred the CC will enter HALT state or enter/remain in NORMAL_PASSIVE state.

pAllowPassiveToActive
: Defines the number of consecutive even/odd cycle pairs that must have valid clock correction terms before the CC is allowed to transit from NORMAL_PASSIVE to NORMAL_ACTIVE state. If set to zero the CC is not allowed to transit from NORMAL_PASSIVE to NORMAL_ACTIVE state. It can be modified in DEFAULT_CONFIG or CONFIG state only. Valid values are 0 to 31 even/odd cycle pairs.

pChannelsMTS
: Selects channels for MTS symbol transmission. The flag is reset by default and may be modified only in DEFAULT_CONFIG or CONFIG state.

pChannels
: Configures which channel the node is connected to.

pClusterDriftDamping
: Configures the cluster drift damping value used in clock synchronization to minimize accumulation of rounding errors. Valid values are 0 to 20 µT.

pDecodingCorrection
: Configures the decoding correction value used to determine the primary time reference point. Valid values are 14 to 143 µT.

pDelayCompensationA
: Used to compensate for reception delays on the indicated channel. This covers assumed propagation delay up to `cPropagationDelayMax` for microticks in the range of 0.0125 to 0.05µs. In practice, the minimum of the propagation delays of all sync nodes should be applied. Valid values are 0 to 200 µT.

pDelayCompensationB
: Used to compensate for reception delays on the indicated channel. This covers assumed propagation delay up to `cPropagationDelayMax` for microticks in the range of 0.0125 to 0.05µs. In practice, the minimum of the propagation delays of all sync nodes should be applied. Valid values are 0 to 200 µT.

pExternOffsetCorrection
: Holds the external offset correction value in microticks to be applied by the internal clock synchronization algorithm. The value is subtracted / added from / to the calculated offset correction value. The value is applied during NIT. May be modified in DEFAULT_CONFIG or CONFIG state only. Valid values are 0 to 7 µT.

pExternRateCorrection
: Holds the external rate correction value in microticks to be applied by the internal clock synchronization algorithm. The value is subtracted / added from / to the calculated rate correction value. The value is applied during NIT. May be modified in DEFAULT_CONFIG or CONFIG state only. Valid values are 0 to 7 µT.

pKeySlotUsedForStartup
: Defines whether the key slot is used to transmit start-up frames. The Bit can be modified in DEFAULT_CONFIG or CONFIG state only.
1 = Key slot used to transmit start-up frame, node is leading or following coldstarter
0 = No start-up frame transmission in key slot, node is non-coldstarter
Not used during configuration. Is set when configuring a message buffer.

pKeySlotUsedForSync
: Defines whether the key slot is used to transmit sync frames. The Bit can be modified in DEFAULT_CONFIG or CONFIG state only.
1 = Key slot used to transmit sync frame, node is sync node
0 = No sync frame transmission in key slot, node is neither sync nor coldstart node
Not used during configuration. Is set when configuring a message buffer.

pLatestTx
: Configures the maximum minislot value allowed before inhibiting frame transmission in the dynamic segment of the cycle. There is no transmission in dynamic segment if it is set to zero. Valid values are 0 to 7981 minislots.

pMacroInitialOffsetA
: Configures the number of macroticks between the static slot boundary and the subsequent macrotick boundary of the secondary time reference point based on the nominal macrotick duration. Must be identical in all nodes of a cluster. Valid values are 2 to 72 MT.

pMacroInitialOffsetB
: Configures the number of macroticks between the static slot boundary and the subsequent macrotick boundary of the secondary time reference point based on the nominal macrotick duration. Must be identical in all nodes of a cluster. Valid values are 2 to 72 MT.

pMicroInitialOffsetA
: Configures the number of microticks between the actual time reference point on channel A and the subsequent macrotick boundary of the secondary time reference point. The parameter depends on pDelayCompensationA and therefore has to be set for each channel independently. Valid values are 0 to 240 µT.

pMicroInitialOffsetB
: Configures the number of microticks between the actual time reference point on channel B and the subsequent macrotick boundary of the secondary time reference point. The parameter depends on pDelayCompensationB and therefore has to be set for each channel independently. Valid values are 0 to 240 µT.

pMicroPerCycle
: Configures the duration of the communication cycle in microticks. Valid values are 640 to 640000 µT.

pOffsetCorrectionOut
: Holds the maximum permitted offset correction value to be applied by the internal clock synchronization algorithm (absolute value). The CC checks only the internal offset correction value against the maximum offset correction value. Valid values are 5 to 15266 µT.

pRateCorrectionOut
: Holds the maximum permitted rate correction value to be applied by the internal clock synchronization algorithm. The CC checks only the internal rate correction value against the maximum rate correction value (absolute value). Valid values are 2 to 1923 µT.

pSingleSlotEnabled
: Selects the initial transmission slot mode. In SINGLE slot mode the CC may only transmit in the preconfigured key slot.
1 = SINGLE Slot Mode (default after hard reset)
0 = ALL Slot Mode.

pWakeupChannel
: With this Bit the Host selects the channel on which the CC sends the Wakeup pattern. The CC ignores any attempt to change the status of this Bit when not in DEFAULT_CONFIG or CONFIG state.
1 = Send wake-up pattern on channel B
0 = Send wake-up pattern on channel A

pWakeupPattern
: Configures the number of repetitions (sequences) of the Tx wake-up symbol. Valid values are 2 to 63.

vExternOffsetControl
: By setting this parameter the external offset correction is enabled as specified below. Should be modified only outside NIT.
00, 01 = No external offset correction
10 = External offset correction value subtracted from calculated offset correction value
11 = External offset correction value added to calculated offset correction value.

vExternRateControl
: By setting this parameter the external rate correction is enabled as specified below. Should be modified only outside NIT.
00, 01 = No external rate correction
10 = External rate correction value subtracted from calculated rate correction value
11 = External rate correction value added to calculated rate correction value.

Reserved[16]
: Reserved Dwords for possible later use.

See Also

fcbFRSetCcConfiguration, **fcbFRGetCcConfiguration**

5.3.3.2 fcMsgBufCfgFifo

This structure specifies the configuration of a FIFO buffer. The FIFO message buffers are used to receive FlexRay frames from different communication slots and allow therefore to receive more frames than message buffers exist.

```
Typedef struct fcMsgBufCfgFifo
{
      fcDword FrameIdFilter : 11;
      fcDword RejectionMask : 11;
      fcDword PayloadLengthConfigured : 7;
      fcDword RejectInStaticSegment : 1;
      fcDword RejectNullFrames : 1;
      fcDword Reserved;
}fcMsgBufCfgFifo;
```

Members

FrameIdFilter
: Defines the acceptance filter used for frame id rejection. A zero value means that no frame is rejected. It is recommended to use the extra acceptance and rejection filter functions and leave this parameter to zero.

RejectionMask
: Specifies the relevant bits used for rejection filtering. It is recommended to use the extra acceptance and rejection filter functions and leave this parameter to zero.

PayloadLengthConfigured
: Defines the maximum number of 2-byte payload words received.

RejectInStaticSegment
: Set this flag to 1 to reject all received static frames of the FIFO. A zero value deactivates the FIFO static segment rejection.

RejectNullFrames
: Set this flag to 1 to reject all received null frames of the FIFO. A zero value deactivates the FIFO null frame rejection.

Reserved
: Reserved for future use.

	Information
	Modifying the FIFO configuration may affect the ability to receive all frames (e.g. setting the *RejectInStaticSegment* flag to 1 will disable the FlexCard to monitor frames in the static segment). Configuring (**fcbFRConfigureMessageBuffer**) the FIFO is only possible when the Communication Controller is in its configuration state, *fcStateConfig*. A reconfiguration (**fcbFRReconfigureMessageBuffer**) is allowed for this buffer type. The FIFO can be accessed with buffer ID 1 (as long as buffer ID 1 was not reconfigured to a different buffer type by user).

See Also

fcMsgBufCfg

Example

```
// Configure fifo receive buffers
// -> Channels A+B, all frames (including null frames) on every cycles

fcMsgBufCfg cfg;
cfg.Type = fcMsgBufFifo;
cfg.ChannelFilter = fcChannelBoth;
cfg.CycleCounterFilter = 0;

cfg.Fifo.FrameIdFilter = 0;
cfg.Fifo.RejectionMask = 0;
cfg.Fifo.PayloadLengthConfigured = 127;
cfg.Fifo.RejectInStaticSegment = 0;
cfg.Fifo.RejectNullFrames = 0;

unsigned int bufferIdx = 0;
fcError e = fcbFRConfigureMessageBuffer(hFlexCard,fcCC1,&bufferIdx,cfg);
```

5.3.3.3 fcMsgBufCfgRx

This structure specifies the configuration of a receive message buffer. This buffer type should be used to analyse a specific communication slot (=frame id).

```
Typedef struct fcMsgBufCfgRx
{
       fcDword FrameId : 11;
       fcDword PayloadLengthConfigured : 7;
       fcDword PayloadLengthMax : 7;
       fcDword RxAcknowledgeEnable: 1;
       fcDword Reserved;
} fcMsgBufCfgRx;
```

Members

FrameId

Defines the slot (=frame id) to be received in this message buffer. With the function **fcbFRReconfigureMessageBuffer**, this parameter can be changed while monitoring is active.

PayloadLengthConfigured

Defines the number of 2-byte payload words to be received. This parameter can be changed while monitoring is active. To do so, call the function **fcbFRReconfigureMessageBuffer** and set this parameter with a value between 0 and *PayloadLengthMax*. The reconfiguration of this parameter for message buffers assigned to the static segment is only allowed with *fcFRMsgBufCfgModeUnequalStaticPayloadLength*.

PayloadLengthMax

Defines the maximum payload reserved for this buffer in the message ram. This E-Ray specific parameter sets the range for the payload reconfiguration. This parameter can not be changed while monitoring is active.

RxAcknowledgeEnable

This flag is obsolete and can be ignored.

Enables message buffer interrupt. This flag must be set to 1 to allow the function **fcbReceive** to get the received frame. This parameter can be changed while monitoring is active. To do so, call the function **fcbFRReconfigureMessageBuffer**.

Reserved

Reserved for future use.

See Also

fcMsgBufCfg

	Information
	FlexCards cannot receive null frames with receive message buffers. For receiving null frames a matched FIFO message buffer configuration is necessary.

5.3.3.4 fcMsgBufCfgTx

This structure specifies the configuration of a transmit message buffer. This buffer type is used to transmit a frame on a specific communication slot.

```
Typedef struct fcMsgBufCfgTx
{
      fcDword FrameId : 11;
      fcDword PayloadLength : 7;
      fcDword PayloadLengthMax : 7;
      fcDword PayloadPreambleIndicator : 1;
      fcDword SyncFrameIndicator : 1;
      fcDword StartupFrameIndicator : 1;
      fcDword TxAcknowledgeEnable: 1;
      fcMsgBufTxMode TransmissionMode;
      fcDword TxAcknowledgeShowNullFrames : 1;
      fcDword TxAcknowledgeShowPayload : 1;
      fcDword Reserved : 29;
} fcMsgBufCfgTx;
```

Members

FrameId

Defines the slot (=frame id) assigned to the transmit message buffer. With the function **fcbFRReconfigureMessageBuffer**, this parameter can be changed while monitoring is active.

PayloadLength

Defines the number of 2-byte payload words to be transmitted. This parameter can be changed while monitoring is active. To do so, call the function **fcbFRReconfigureMessageBuffer** and set this parameter with a value between 0 and *PayloadLengthMax*. The reconfiguration of this parameter for message buffers assigned to the static segment is only allowed with *fcFRMsgBufCfgModeUnequalStaticPayloadLength*.

PayloadLengthMax

Defines the maximum payload reserved for this buffer in the message ram. This E-Ray specific parameter sets the range for the payload reconfiguration. This parameter can not be changed while monitoring is active.

PayloadPreambleIndicator

This parameter is protocol specific. For more information, refer to FlexRay Protocol Specification. With the function **fcbFRReconfigureMessageBuffer**, this parameter can be changed while monitoring is active.

SyncFrameIndicator

Set this flag to 1 to indicate that the frame is a sync frame. This parameter can not be changed while monitoring is active.

StartupFrameIndicator

Set this flag to 1 to indicate that the frame is a start-up frame. This parameter can not be changed while monitoring is active.

TxAcknowledgeEnable

Set this flag to 1 to get an acknowledge packet (**fcTxAcknowledgePacket**) once a frame is transmitted (includes null frames). With the function **fcbFRReconfigureMessageBuffer**, this parameter can be changed while monitoring is active. This feature is only available on FlexCard based on E-Ray Communication Controller.

TransmissionMode

Type of transmission (refer to **fcMsgBufTxMode**). With the function **fcbFRReconfigureMessageBuffer**, this parameter can be changed while monitoring is active.

TxAcknowledgeShowNullFrames

Set this flag to 1 to get TxAcknowledge packet for transmitted null frames. This flag is only evaluated if the `TxAcknowledgeEnable` flag is set.

TxAcknowledgeShowPayload

Set this flag to 1 to get the payload of the transmitted frame. The payload length of generated TxAcknowledge packet will otherwise be set to zero. This flag is only evaluated if the `TxFrameEnable` flag is set.

Reserved

Reserved for future use

See Also

fcMsgBufCfg

5.3.3.5 fcMsgBufCfg

This structure describes the configuration of a message buffer.

```
Typedef struct fcMsgBufCfg
{
       fcMsgBufType Type;
       fcChannel ChannelFilter;
       fcDword CycleCounterFilter : 7;

       union
       {
              fcMsgBufCfgFifo Fifo;
              fcMsgBufCfgRx   Rx;
              fcMsgBufCfgTx   Tx;
       };

       fcDword Reserved[2];
} fcMsgBufCfg;
```

Members

Type

Defines the buffer type (FIFO, receive or transmit buffer)

ChannelFilter

Defines the channel(s) assigned to this buffer. With the function **fcbFRReconfigureMessageBuffer**, this parameter can only be changed while monitoring is active for receive and transmit buffer. For the configuration of a transmit buffer or a receive message buffer assigned to a dynamic frame *fcChannelBoth* isn't allowed. With *fcChannelNone* the buffer can be en- or disabled during an active monitoring. The reconfiguration of this parameter with *fcChannelNone* is only allowed with *fcFRMsgBufCfgModeReconfigurationDuringMonitoring*.

CycleCounterFilter

Defines the filter used by the message buffer for cycle counter filtering. A zero value means that no cycle counter filtering is used. The cycle counter filter is composed of two parameters. The first one determines the cycle repetition and the second one the offset (the first cycle). The cycle repetition must be given in the form of 2^x where x is a number between 0 and 6. The offset must be less than the cycle repetition value. The two values are added. With the function **fcbFRReconfigureMessageBuffer**, this parameter can only be changed while monitoring is active for receive and transmit buffer.

Fifo

FIFO buffer configuration

Rx

Receive buffer configuration

Tx

Transmit buffer configuration

Reserved

Reserved for future use

See Also

fcbFRConfigureMessageBuffer, **fcbFRReconfigureMessageBuffer**, **fcbFRGetMessageBuffer**, **fcMsgBufType**, **fcMsgBufCfgFifo**, **fcMsgBufCfgRx**, **fcMsgBufCfgTx**, **fcFRMsgBufCfgMode**

Example

```
// The following code configures a transmit buffer, which only transmits on cycles
6,14,22,30, …
```

```
fcMsgBufCfg cfg;
cfg.Type = fcMsgBufTx;
cfg.ChannelFilter = fcChannelA;


// Repetition: each 8 cycles
// Offset: 6 (First cycle will be cycle number 6)

cfg.CycleCounterFilter = 0x8 + 0x6;

cfg.Tx.FrameId = 61;
cfg.Tx.PayloadLength = 10;
cfg.Tx.PayloadLengthMax = 127;
cfg.Tx.PayloadPreambleIndicator = 0;
cfg.Tx.SyncFrameIndicator = 0;
cfg.Tx.StartupFrameIndicator = 0;
cfg.Tx.TxAcknowledgeEnable= 0;
cfg.Tx.TransmissionMode = fcMsgBufTxSingleShot;


unsigned int bufferIdx = 0;
fcError e = fcbFRConfigureMessageBuffer(hFlexCard,fcCC1,&bufferIdx,cfg);
```

```
// The following code configures 2 sync frame buffers with the same frame id // but
with different channelfilters. This way a different payload can be sent // on the sync
frame id on channel a and on channel b.

fcMsgBufCfg cfg;
cfg.Type = fcMsgBufTx;
//first message buffer on channel a
cfg.ChannelFilter = fcChannelA;
cfg.CycleCounterFilter = 0;
cfg.Tx.FrameId = 1;//this id has to be in the static range
cfg.Tx.PayloadLength = 16;//payload length in the static segment
cfg.Tx.PayloadLengthMax = 16;
cfg.Tx.PayloadPreambleIndicator = 0;
cfg.Tx.SyncFrameIndicator = 1;
cfg.Tx.StartupFrameIndicator = 1;
cfg.Tx.TxAcknowledgeEnable= 1;
cfg.Tx.TransmissionMode = fcMsgBufTxSingleShot;

unsigned int bufferIdx = 0;
fcError e = fcbFRConfigureMessageBuffer(hFlexCard,fcCC1,&bufferIdx,cfg);

//second message buffer on channel b
cfg.ChannelFilter = fcChannelB;
e = fcbFRConfigureMessageBuffer(hFlexCard,fcCC1,&bufferIdx,cfg);
```

5.3.3.6 fcCcTimerCfg

This structure describes the configuration of a Communication Controller timer.

```
Typedef struct fcCcTimerCfg
{
      fcDword ContinuousMode : 1;
      fcDword CycleCounterFilter : 7;
      fcDword MacrotickOffset : 14;
} fcCcTimerCfg;
```

Members

ContinuousMode

Defines the Communication Controller timer mode. Set to 1 for continuous mode or 0 for single-shot mode.

CycleCounterFilter

Defines the filter used by the CC timer for cycle counter filtering. A zero value means that no cycle counter filtering is used. The cycle counter filter is composed of two parameters. The first one determines the cycle repetition and the second one the offset (the first cycle). The cycle repetition must be given in the form of 2^x where x is a number between 0 and 6. The offset must be less than the cycle repetition value.

MacrotickOffset

Defines the macrotick offset from the beginning of the cycle when the CC timer interrupt has to occur. The CC timer interrupt occurs at this offset for each cycle of the cycle counter filter.

See Also

fcbFRSetCcTimerConfig, **fcbFRGetCcTimerConfig**, **fcbFRCalculateMacrotickOffset**

	Information
	This structure is initially supported by FlexCard API version S4V0-F.

5.3.4 fcbFRSetCcRegister

This function writes a value in a given register of the selected Communication Controller. Not every register can be written (e.g. the registers belonging to the message buffer configuration or some interrupt settings).

```
fcError fcbFRSetCcRegister(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword address,
      fcDword value
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

address

[IN] Address of the CC register to be written. Must be a multiple of 4 bytes, otherwise an error will be returned

value

[IN] The value to be written

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information. If the register can not be written the error code `REGISTER_NOT_WRITEABLE` is returned.

Remarks

For a register description, refer to the specification of the corresponding Communication Controller. Modifying one of the following registers will reset message buffers with their default settings (FIFO receive buffers). The user's message buffers configuration will not be valid anymore.

Bosch E-Ray: MHDC (0x0098) and GTUC7 (0x00B8).

On FlexCard driver version Windows S6V4-F or later, on E-Ray, the register GTUC11 (0x00C8) may be read/written when monitoring is not activated. After monitoring, it may be read/written, but for the write operation, only External Offset Correction Control and External Rate Correction Control may be changed. External Offset Correction and External Rate Correction may not be modified.

	Information
	Not all registers of a Communication Controller can be set. The base API will modify some parameters so that the operating of the FlexCard is guaranteed (e.g. interrupt settings). Access is denied to all registers which are used for message buffer configuration.

See Also

fcCC, **fcbFRGetCcRegister**

5.3.5 fcbFRGetCcRegister

This function reads and returns the content of a given register of the selected Communication Controller.

```
fcError fcbFRGetCcRegister(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword address,
      fcDword* pValue
)
```

Parameters

hFlexCard
: [IN] Handle to a FlexCard

CC
: [IN] Communication controller index

address
: [IN] Address of the CC register to be read. Must be a multiple of 4 bytes, otherwise an error will be returned

pValue
: [OUT] The content of the desired CC register.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information. If the register cannot be read the error code `REGISTER_NOT_READABLE` is returned.

Remarks

Not every register can be read. For a register description, refer to the specification of the corresponding Communication Controller.

See Also

fcCC, **fcbFRSetCcRegister**

Example

```
fcDword value = 0xFFFFFFFF;
fcDword address = 0x0B8;
fcCC eCC = fcCC1;

if (0 != address % 4) return; //address not a multiple of 4 bytes!

fcError e = fcbFRGetCcRegister(hFlexCard,eCC,address,&value);
if (0 == e)
{
      printf("Register 0x%X=0x%X", address, value);
}
```

5.3.6 fcbFRSetCcConfigurationChi

This function configures the selected Communication Controller of the FlexCard with a FlexConfig compatible configuration string (CHI File). The configuration string contains the global FlexRay parameter and/or the message buffer configuration. The payload data for transmit message buffers is not set by this function. Before the configuration of the Communication Controller starts, all message buffers are reset to their default settings (FIFO buffer).

```
fcError fcbFRSetCcConfigurationChi(
      fcHandle hFlexCard,
      fcCC CC,
      const char* szChi
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index

szChi

[IN] Pointer to null-terminated CHI content string (refer to the CHI string example section).
Please note: Do not use the CHI file name here, but the content of the CHI file as parameter value.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

	Information
	Internally, the function uses the **`fcbFRSetCcRegister`** function; therefore the same restrictions as for writing registers exist.

See Also

`fcCC`, **`fcbFRSetCcRegister`**

Example

See **`fcbFRSetCcConfigurationChi`**

5.3.7 fcbFRSetCcConfigurationCANdb

This function configures the FlexRay Communication Controller of the FlexCard with a CANdb compatible string. The configuration string contains the global FlexRay parameter and/or the message buffer

configuration. Before the configuration of the Communication Controller starts, all message buffers are reset to their default settings (FIFO buffer). Configuring the CAN CC with a CANdb file is not supported by the FlexCard driver.

```
fcError fcbFRSetCcConfigurationCANdb(
       fcHandle hFlexCard,
       fcCC CC,
       const char* szCanDb
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

szCanDb

[IN] Pointer to null-terminated CANdb string

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

This function is only available in the Windows FlexCard driver. The FlexCard Linux and Xenomai drivers don't support this function.

	Information
	Internally, the function uses the **`fcbFRSetCcRegister`** function; therefore the same restrictions as for writing a register exist.

5.3.8 fcbFRSetCcConfiguration

This function configures the FlexRay Communication Controller.

```
fcError fcbFRSetCcConfiguration(
       fcHandle hFlexCard,
       fcCC CC,
       fcFRCcConfig cfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index.

Cfg

[IN] The FlexRay Communication Controller configuration.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

`fcCC, fcFRCcConfig, fcbFRGetCcConfiguration`

Example

```
fcCC eCC = fcCC1;
fcFRCcConfig frCcConfigSet;
memset(&frCcConfigSet, 0, sizeof(fcFRCcConfig));

// SUCC1
frCcConfigSet.pKeySlotUsedForStartup = 0;
frCcConfigSet.pKeySlotUsedForSync = 0;
frCcConfigSet.gColdStartAttempts = 31;
frCcConfigSet.pAllowPassiveToActive = 0;
frCcConfigSet.pWakeupChannel = 0;
frCcConfigSet.pSingleSlotEnabled = 0;
frCcConfigSet.pAllowHaltDueToClock = 1;
frCcConfigSet.pChannelsMTS = fcChannelNone;
frCcConfigSet.pChannels = fcChannelBoth;

// SUCC2
frCcConfigSet.pdListenTimeout = 80242 ;
frCcConfigSet.gListenNoise = 2 ;

// SUCC3
frCcConfigSet.gMaxWithoutClockCorrectionPassive = 2;
frCcConfigSet.gMaxWithoutClockCorrectionFatal = 2;

// NEMC
frCcConfigSet.gNetworkManagementVectorLength = 0;

// PRTC1
frCcConfigSet.gdTSSTransmitter = 7;
frCcConfigSet.gdCASRxLowMax = 99;
frCcConfigSet.BaudRate = fcFRBaudRate10M;
frCcConfigSet.gdWakeupSymbolRxWindow = 301;
frCcConfigSet.pWakeupPattern = 2;

// PRTC2
frCcConfigSet.gdWakeupSymbolRxIdle = 59;
frCcConfigSet.gdWakeupSymbolRxLow = 54;
frCcConfigSet.gdWakeupSymbolTxIdle = 180;
frCcConfigSet.gdWakeupSymbolTxLow = 60;

// MHDC
frCcConfigSet.gPayloadLengthStatic = 4;
frCcConfigSet.pLatestTx = 0;

// GTUC1
frCcConfigSet.pMicroPerCycle = 40000;

// GTUC2
frCcConfigSet.gMacroPerCycle = 1000;
frCcConfigSet.gSyncNodeMax = 2;

// GTUC3
frCcConfigSet.pMicroInitialOffsetA = 0;
frCcConfigSet.pMicroInitialOffsetB = 0;
frCcConfigSet.pMacroInitialOffsetA = 2;
frCcConfigSet.pMacroInitialOffsetB = 2;

// GTUC4
frCcConfigSet.gdNIT = 40;
frCcConfigSet.gOffsetCorrectionStart = 991;

// GTUC5
frCcConfigSet.pDelayCompensationA = 0;
frCcConfigSet.pDelayCompensationB = 0;
```

```
frCcConfigSet.pClusterDriftDamping = 1;
frCcConfigSet.pDecodingCorrection = 40;

// GTUC6
frCcConfigSet.pdAcceptedStartupRange = 258;
frCcConfigSet.pdMaxDrift = 121;

// GTUC7
frCcConfigSet.gdStaticSlot = 22;
frCcConfigSet.gNumberOfStaticSlots = 43;

// GTUC8
frCcConfigSet.gdMinislot = 11;
frCcConfigSet.gNumberOfMinislots = 0;

// GTUC9
frCcConfigSet.gdActionPointOffset = 1;
frCcConfigSet.gdMinislotActionPointOffset = 5;
frCcConfigSet.gdDynamicSlotIdlePhase = 2;

// GTUC10
frCcConfigSet.pOffsetCorrectionOut = 81;
frCcConfigSet.pRateCorrectionOut = 121;

// GTUC11
frCcConfigSet.vExternOffsetControl = 0;
frCcConfigSet.vExternRateControl = 0;
frCcConfigSet.pExternOffsetCorrection = 0;
frCcConfigSet.pExternRateCorrection = 0;

// Configure the FlexRay CC
e = fcbFRSetCcConfiguration(hFlexCard, eCC, frCcConfigSet);
if (0 != e) {/* Error handling */};
```

5.3.9 fcbFRGetCcConfiguration

This function reads the FlexRay Communication Controller configuration.

```
fcError fcbFRGetCcConfiguration (
      fcHandle hFlexCard,
      fcCC CC,
      fcFRCcConfig* pCfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index.

pCfg

[OUT] Pointer to the configuration parameters of the FlexRay Communication Controller.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcFRCcConfig**, **fcbFRSetCcConfiguration**

Example

```
fcCC eCC = fcCC1;
fcFRCcConfig frCcConfigGet;

e = fcbFRGetCcConfiguration(hFlexCard, eCC, &frCcConfigGet);
if (0 != e) {/* Error handling */};
```

5.3.10 fcbFRSetMsgBufCfgMode

This function configures the fcBase APIs message buffer configuration handling for the FlexRay Communication Controllers. The message buffer configuration mode can be changed while monitoring is active.

```
fcError fcbFRSetMsgBufCfgMode(
      fcHandle hFlexCard,
      fcFRMsgBufCfgMode mode
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

Mode

[IN] The message buffer configuration mode.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcFRMsgBufCfgMode, **fcMsgBufCfg**, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**

	Information
	This function is initially supported by FlexCard API version S6V1-F.

5.3.11 fcbFRConfigureMessageBuffer

This function configures transmit, receive and FIFO message buffers of the selected Communication Controller. Configuring message buffers is only allowed if the Communication Controller is in its configuration state, `fcStateConfig`.

```
fcError fcbFRConfigureMessageBuffer(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword* pBufferId,
      fcMsgBufCfg cfg
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

pBufferId

[OUT] Message buffer identifier. If the configuration was successful the message buffer identifier is greater than 0. This identifier will be required to transmit the content of the buffer (in the case of a transmit buffer).

Cfg

[IN] Message buffer configuration parameters

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

Before configuring the message buffers, it is necessary to set up the global communication parameters (cluster parameters). Internally the FlexCard uses the FIFO buffers as receive buffers, therefore we recommend using FIFO message buffers as much as possible.

See Also

fcCC, **fcMsgBufCfg**, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**, **fcMsgBufCfgFifo**, **fcbFRSetMsgBufCfgMode**

Example

```
// The following code configures a transmit buffer,
// which only transmits on cycles 6,14,22,30, …

fcMsgBufCfg cfg;
memset(&cfg, 0, sizeof(fcMsgBufCfg));
cfg.Type = fcMsgBufTx;
cfg.ChannelFilter = fcChannelA;


// Repetition: each 8 cycles
// Offset: 6 (First cycle will be cycle number 6)

cfg.CycleCounterFilter = 0x8 + 0x6;

cfg.Tx.FrameId = 61;
cfg.Tx.PayloadLength = 10;
cfg.Tx.PayloadLengthMax = 127;
cfg.Tx.PayloadPreambleIndicator = 0;
cfg.Tx.SyncFrameIndicator = 0;
cfg.Tx.StartupFrameIndicator = 0;
cfg.Tx.TxAcknowledgeEnable= 0;
cfg.Tx.TransmissionMode = fcMsgBufTxSingleShot;

fcCC eCC = fcCC1;
unsigned int bufferIdx = 0;
fcError e = fcbFRConfigureMessageBuffer(hFlexCard,eCC,&bufferIdx,cfg);
```

5.3.12 fcbFRReconfigureMessageBuffer

This function reconfigures transmit, receive and FIFO message buffers of the selected Communication Controller. A reconfiguration is only allowed for message buffers which are already configured. This function is available in all states of the CC. Not all configuration settings can be modified in monitoring state. Refer to the documentation of the message buffer structures for further details.

```
fcError fcbFRReconfigureMessageBuffer(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword bufferId,
```

```
      fcMsgBufCfg cfg
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

CC
[IN] Communication controller index

bufferId
[IN] The identifier of the message buffer which should be reconfigured.

Cfg
[IN] Message buffer configuration parameters.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcMsgBufCfg**, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**, **fcMsgBufCfgFifo**, **fcbFRConfigureMessageBuffer**, **fcbFRGetMessageBuffer**, **fcbFRSetMsgBufCfgMode**

5.3.13 fcbFRGetMessageBuffer

This function reads a specific message buffer configuration.

```
fcError fcbFRGetMessageBuffer(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword bufferId,
      fcMsgBufCfg* pCfg
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

CC
[IN] Communication controller index

bufferId
[IN] The identifier of the message buffer to be read

pCfg
[OUT] The configuration parameters of the specified message buffer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcMsgBufCfg**, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**, **fcMsgBufCfgFifo**, **fcbFRConfigureMessageBuffer**

	Information
	The buffer with id 1 is always a FIFO message buffer.

Example

```
// Get all configured transmit message buffers of Communication Controller 1
fcCC eCC = fcCC1;
std::map<unsigned int, fcMsgBufCfg> Buffers;
unsigned int bufferIdx = 1; // The first valid buffer is 1
while (true)
{
	fcMsgBufCfg cfg;

	// as long no error occurs we try to get each buffer
	fcError e = fcbFRGetMessageBuffer(m_hFlexCard,eCC,bufferIdx,&cfg);
	if (0 != e) break;

	// is this a tx buffer, then add it to our list
	if (fcMsgBufTx == cfg.Type)    Buffers[bufferIdx] = cfg;

	// next buffer index
	bufferIdx++;
}
```

5.3.14 fcbFRResetMessageBuffers

This function resets the Communication Controller message buffers. After calling this function, all message buffers are configured as receive FIFO – with maximal payload (depends on the Communication Controller).

```
fcError fcbFRResetMessageBuffers(
	fcHandle hFlexCard,
	fcCC CC
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

5.3.15 fcbFRSetSoftwareAcceptanceFilter

This function configures the frame ids accepted by the device driver. Only the FlexRay ids which are in the filter list are forwarded to the user application, all other FlrexRay frames are rejected. One filter can be defined for both channels or two filters can be defined, one for Channel A and one for Channel B. See the configuration notice for further details. The filter behavior differs from the function **fcbFRSetHardwareAcceptanceFilter**.

```
fcError fcbFRSetSoftwareAcceptanceFilter(
      fcHandle hFlexCard,
      fcCC CC,
      fcChannel channel,
      fcDword* pData,
      fcDword size
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

channel

[IN] FlexCard channel(s) concerned by the filter

`pData`

[IN] Pointer to an `fcDword` array containing the ids accepted by the device driver. Each element (`fcDword`) contains one frame identifier.

fcDword	fcDword	fcDword	fcDword
ID x	ID y	ID z	…

`size`

[IN] Number of ids in the array.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Configuration notice

channel	pData	size	Behaviour
	NULL	0	Accept all IDs.
fcChannelBoth	ID 0		Accept all IDs.
fcChannelNone	ID x		Does nothing.
fcChannelA	ID 5		Accepts only ID 5 on Channel A, but allows all frames on Channel B (including ID 5) if there wasn't another filter for Channel B defined.
fcChannelA, fcChannelB	ID 5 ID 3		Accepts only ID 5 Channel A and ID 3 Channel B, rejects all other frames.

Example

```
// Configure the filter to get only
// - the frames from frame id 15 and 60 on CC 1, channel A
// - and the frame ids 1,2,3,6 on CC 1, channel B

fcDword idsChA[2] = {15,60};
fcDword idsChB[4] = {1,2,3,6};
fcCC eCC = fcCC1;

fcError e = fcbFRSetSoftwareAcceptanceFilter(hFlexCard,eCC,fcChannelA,idsChA,2);
//…
e = fcbFRSetSoftwareAcceptanceFilter(hFlexCard,eCC,fcChannelB,idsChB,4);
```

5.3.16 fcbFRSetHardwareAcceptanceFilter

This function configures the FlexRay frame ids accepted by the FlexCard firmware. Only the FlexRay ids which are in the filter list are forwarded to the device driver, all other FlexRay frames are rejected. See the configuration notice for further details. The filter behavior differs from the function **fcbFRSetSoftwareAcceptanceFilter**. When using this function, receiving frames is faster than using **fcbFRSetSoftwareAcceptanceFilter**.

```
fcError fcbFRSetHardwareAcceptanceFilter(
       fcHandle hFlexCard,
       fcCC CC,
       fcChannel channel,
       fcDword* pData,
       fcDword size,
       fcBool reset
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index.

Channel

[IN] FlexCard channel(s) concerned by the filter.

pData

[IN] Pointer to an `fcDword` array containing the ids accepted by the device driver. Each element (`fcDword`) contains one frame identifier.

fcDword	fcDword	fcDword	fcDword
ID x	ID y	ID z	...

size

[IN] Number of ids in the array.

Reset

[IN] Set to <> 0 to reset the filter, before configure a new filter. The hardware transmit filter and hardware acceptance filter of both channels are resetted, while the software acceptance filter is not touched. Set *reset* to 0 to add the frame identifier to the existing filter.

Configuration notice

channel	pData	size	Behaviour
	NULL	0	Accept all IDs.
fcChannelBoth	ID 0		Accept all IDs.
fcChannelNone	ID 0		Reject all IDs.
fcChannelNone	ID x		Reject ID x.
fcChannelA	ID 5		Accepts only ID 5 Channel A, rejects all other frames.
fcChannelA, fcChannelB	ID 5 ID 3		Accepts only ID 5 Channel A and ID 3 Channel B, rejects all other frames.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcChannel**, **fcbReceive**

5.3.17 fcbFRSetHardwareTransmitFilter

This function configures the FlexRay frame ids transmitted by the FlexCard firmware. Only the FlexRay ids which are in the transmission filter configuration list are enabled or disabled for transmission. See the configuration notice for further details.

```
fcError fcbFRSetHardwareTransmitFilter(
       fcHandle hFlexCard,
       fcCC CC,
       fcChannel channel,
       fcDword* pData,
       fcDword size,
       fcBool reject,
       fcBool reset
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index.

Channel

[IN] FlexCard channel(s) concerned by the transmission filter.

pData

[IN] Pointer to an `fcDword` array containing the ids which will be configured (en-/disabled). Each element (`fcDword`) contains one frame identifier.

fcDword	fcDword	fcDword	fcDword
ID x	ID y	ID z	...

size

[IN] Number of ids in the array.

Reject

[IN] Set this value to <> 0 to disable the transmission of the ids in the array. Set the value to 0 to enable the transmission.

Reset

[IN] Set this value to <> 0 to reset the transmission filter, before configuring a new filter. The hardware transmit filter and hardware acceptance filter of both channels are resetted, while the software acceptance filter is not touched. If *reset* is set to 0 the frame identifier is added to the existing transmission filter configuration.

Configuration notice

channel	pData	size	behaviour
	NULL	0	Accept all IDs.
fcChannelBoth	ID 0		Transmit or reject transmission of all IDs (depends on reject member).

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcChannel**, **fcbFRTransmit**

	Information
	This function is initially supported by FlexCard API version S6V1-F.

5.3.18 fcbFRSetCcTimerConfig

This function configures the Communication Controller timer interrupt. To get a notification when the Communication Controller timer interval elapsed, an event of type *fcNotificationTypeFRCcTimer* has to be registered by the function **fcbSetEventHandleV2**. Additionally the Communication Controller timer can be enabled / disabled by this function.

```
fcError fcbFRSetCcTimerConfig(
       fcHandle hFlexCard,
       fcCC CC,
       fcCcTimerCfg cfg,
       fcBool bEnable
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index

Cfg

[IN] The Communication Controller timer configuration.

bEnable

[IN] Set to <> 0 to enable the CC timer, and to 0 to disable it.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcbSetEventHandleV2**, **fcbSetEventHandleSemaphore**, **fcCcTimerCfg**, **fcbFRGetCcTimerConfig**

Example

See Example **fcbFRCalculateMacrotickOffset**

5.3.19 fcbFRGetCcTimerConfig

This function reads the Communication Controller timer configuration.

```
fcError fcbFRGetCcTimerConfig(
       fcHandle hFlexCard,
       fcCC CC,
       fcCcTimerCfg* pCfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication controller index

pCfg
[OUT] The configuration parameters of the CC timer.

Return values
If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also
fcCC, **fcCcTimerCfg**, **fcbFRSetCcTimerConfig**

Example
See Example **fcbFRCalculateMacrotickOffset**

5.3.20 fcbFRCalculateMacrotickOffset

This function calculates the macrotick offset for a specific cycle position in a FlexRay cycle.

```
fcError fcbFRCalculateMacrotickOffset(
       fcHandle hFlexCard,
       fcCC CC,
       fcCyclePos CyclePosition,
       fcDword SlotOrMiniSlotId,
       fcDword* pValue
)
```

Parameters
hFlexCard
[IN] Handle to a FlexCard.
CC
[IN] Communication controller index
CyclePosition
[IN] The cycle position of type **fcCyclePos**.
SlotOrMiniSlotId
[IN] This parameter is used for a cycle position of *fcCyclePosStaticSlot* and *fcCyclePosDynamicMiniSlot* to calculate the macrotick offset for a static slot or a dynamic mini slot id.
pValue
[OUT] The macrotick offset value.

Return values
If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also
fcCC, **fcCyclePos**, **fcCcTimerCfg**, **fcbFRSetCcTimerConfig**, **fcbFRGetCcTimerConfig**

Example
```
//
// Configure the CC 1 timer to get notified of the static slot id 9 start,
// Check the configuration and start the CC 1 timer
//
fcCC eCC = fcCC1 ;
fcCcTimerCfg ccTimerConfigSet, ccTimerConfigGet ;
memset(&ccTimerConfigSet, 0, sizeof(fcCcTimerCfg)) ;
memset(&ccTimerConfigGet, 0, sizeof(fcCcTimerCfg)) ;
```

```
ccTimerConfigSet.CycleCounterFilter = 1 ;
ccTimerConfigSet.ContinuousMode = 1 ;
ccTimerConfigSet.MacrotickOffset = 0 ;

// Calculate the macrotick offset for static slot id 9
fcDword dwMTOffset = 0;
fcDword dwSlotId = 9;
fcError e = fcbFRCalculateMacrotickOffset(hFlexCard, eCC,
      fcCyclePosStaticSlot, dwSlotId, &dwMTOffset);
if (0 != e) {/* Error handling */};
else ccTimerConfigSet.MacrotickOffset = dwMTOffset;

// Configure the CC 1 timer, but don't start
e = fcbFRSetCcTimerConfig(hFlexCard, eCC, ccTimerConfigSet, false) ;
if (0 != e) {/* Error handling */};

// Read the configuration
e = fcbFRGetCcTimerConfig(hFlexCard, eCC, &ccTimerConfigGet) ;
if (0 != e) {/* Error handling */};

// Check the configured timer
if (ccTimerConfigSet.CycleCounterFilter != ccTimerConfigGet.CycleCounterFilter
      || ccTimerConfigSet.ContinuousMode != ccTimerConfigGet.ContinuousMode
      || ccTimerConfigSet.MacrotickOffset != ccTimerConfigGet.MacrotickOffset)
      {return;}

// We passed the check, now start the CC timer with this config
e = fcbFRSetCcTimerConfig(hFlexCard, eCC, ccTimerConfigSet, true);
if (0 != e) {/* Error handling */};

// Wait for the CC 1 timer event ...
```

5.4 Transmit

5.4.1 Enumerations

5.4.1.1 fcSymbolType

This enumeration defines the supported communication symbols when the Communication Controller is in POC state NORMAL_ACTIVE. For more details about these symbols, please refer to the FlexRay Protocol Specification. To send a wake-up symbol (WUS) or collision avoidance symbol (CAS), refer to the function **fcbFRMonitoringStart**.

```
Typedef enum fcSymbolType
{
      fcMediaAccessTestSymbolType = 1,
} fcSymbolType;
```

Members

fcMediaAccessTestSymbolType
Media Access Test Symbol (MTS)

See Also

fcbFRTransmitSymbol

5.4.2 fcbFRTransmit

This function writes a data frame into a Communication Controller transmit buffer of the FlexCard. The function returns immediately and does not wait for the data frame to arrive on the bus. The frame should

normally be transmitted in the next cycle. In the static segment of the FlexRay cycle, frames are transmitted in the order of the time slot. Example: If the CC is in the current slot 15 and the user transmits the static frame ID 1 and shortly after that ID 30, the CC will transmit ID 30 before ID 1. If the transmit acknowledgment is activated, an acknowledge packet is generated as soon as the frame has been transmitted. This function should only be called when the FlexCard is in normal active state or when all message buffer configurations have been done. When the user transmits several times new data with the same buffer ID in a very short time periode, it may happen that data is overwritten that was not transmitted yet. If you experience that behavior, wait for the TxAck for the data you wanted to send.

```
fcError fcbFRTransmit(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword bufferId,
      fcWord * pPayload,
      fcByte payloadLength
);
```

Parameters

hFlexCard
: [IN] Handle to a FlexCard

CC
: [IN] Communication controller index

bufferId
: [IN] The id of the message buffer used for the transmission

pPayload
: The payload data to be transmitted

payloadLength
: The size of the payload data (number of 2-byte words)

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

The payload data has to be organized as follows: if Data0 is the first byte to transmit and Data1 the second byte to transmit, then the high byte (Bit 8 – 15) of payload[0] contains Data1, the low byte (Bit 0-7) of payload[0] contains Data0, etc.

Parameter `payload`	`payload[0]` (Word 0)		`payload[1]` (Word 1)		...
	High byte	Low byte	High byte	Low byte	...
FlexRay payload segment	Data 1	Data 0	Data 3	Data 2	...

Example

```
fcCC eCC = fcCC1;
fcWord payload[fcPayloadMaximum];
payload[0] = 0x0001; // Update your payload data

fcError e = fcbFRTransmit(m_hFlexCard,eCC,bufferIdx,payload,payloadLength);
```

5.4.3 fcbFRTransmitSymbol

This function transmits a symbol in the symbol window segment. It can only be called if the selected Communication Controller is in the POC state NORMAL_ACTIVE. For a list of available symbols to be transmitted, see the enumeration *fcSymbolType*.

```
fcError fcbFRTransmitSymbol(
      fcHandle hFlexCard,
```

```
      fcCC CC,
      fcSymbolType type
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] Communication controller index

type

[IN] Type of symbol to transmit

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

6 CAN API

The following section describes the data structures and features used for CAN functionality. To use these functions the FlexCard must have a firmware with a CAN CC and the FlexCard must be licensed for CAN.

	Information
	All enumerations, structures and function in this chapter are initially supported by FlexCard Windows API version S4V0-F and FlexCard Linux/Xenomai API version S4V2-F.

6.1 Basic CAN Workflow

The following figure shows a typical CAN workflow.

The CAN functions are supported for the CAN Communication Controller type Bosch D_CAN. The Enum function returns the struct fcInfoHwSw. Check the struct fcInfoHw.pVersionCC to see whether the firmware provides this CC type.

The CCs are counted in following order: First FlexRay, then CAN. CAN FD CCs count like CAN CCs.

For example if the firmware image has 2 FlexRay CC and 4 CAN CCs, the CCs are referred to like this:

- FlexRay fcCC1, fcCC2
- CAN fcCC1, fcCC2, fcCC3, fcCC4

Please note that the message buffers may be reconfiguered during monitoring, but the CAN configuration may only be changed when monitoring is not active.

The API for CAN-HS and CAN-LS buses is the same. CAN-HS baud rate is 40 Kbit/s to 1 Mbit/s. CAN-LS baud rate is 5 Kbit/s to 125 Kbit/s. The FlexCard installer includes the application “CANBaudRateCalculator” which calculates the bus parameters for a selected baud rate. Refer to the chapter General Function Availability to find out if the connected FlexCard device supports onboard CAN terminations. For CAN-LS the bus termination is integrated on the PCB.

There are several ways to transmit CAN data. Using message buffers either with the function **fcbCANTransmit** or with **fcbCANSetMessageBuffer** with *enableTxRequest* = true. The parameter *ignoreTxRqstLock* should be set to false, so that you notice when data was lost during transmitting or reconfiguring.

Check for the error code that is returned from **fcbCANTransmit** and **fcbCANSetMessageBuffer**. If it is *MSG_BUF_LOCKED_FOR_TRANSMISSION*, try again. This error appears permanently when the configuration is not right, so set a limit to the number of retries.

When you want to transmit data from the start, call **fcbCANSetMessageBuffer** with *enableTxRequest* = false and *newData* = true. After having called **fcbCANMonitoringStart**, use the function **fcbCANTransmit** with *transmitNewData* = false. Using the function **fcbCANSetMessageBuffer** with *enableTxRequest* = true is not recommended before the start-up, because the data is transmitted immediately after starting the CC. When you use two CAN CCs on the FlexCard, the second CC may not be started up and misses the ID you tried to send.

When you want to send new data during monitoring, use **fcbCANSetMessageBuffer** with *enableTxRequest* = true and *newData* = true.

With FlexCard API version S6V3-F and FlexCard firmware version S6V3-F on, it’s possible to transmit CAN data messages very easily. FlexCard version S6V3-F introduces a CAN transmit FIFO for every CAN Communication Controller. There are two new configurations (**fcbCANSetTxFifoConfiguration**, **fcbCANTxFifoReset**) and one new transmit function available (**fcbCANTxFifoTransmit**). With these

functions CAN data messages can be configured and transmitted without reconfiguration of the corresponding message buffer objects. A configurable hardware timer helps to transmit CAN data messages to a deliberate time slot, i.d. real-time behavior with non real-time capable operating systems are possible.

The FlexCard Windows Developer Setup installs the example application *fcDemoCAN.exe* and its source code to the installation directory.

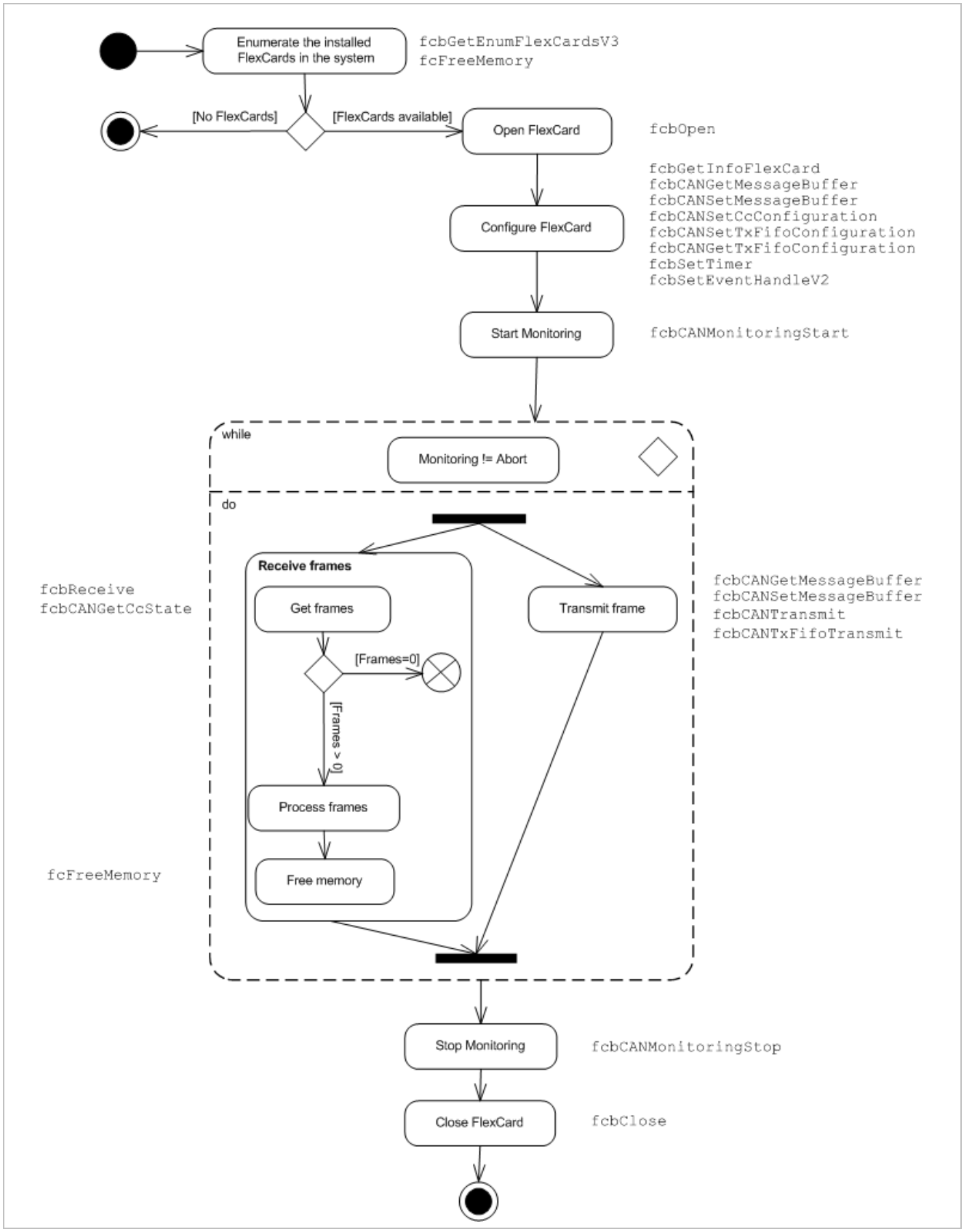


Figure 10: Typical CAN function workflow

6.2 Initialization

6.2.1 Enumerations

6.2.1.1 fcCANCcState

This enumeration defines the CAN Communication Controller states. For more details about CAN Communication Controller states, please refer to [6]/[7] (CAN Protocol Specification).

```
Typedef enum fcCANCcState
{
       fcCANCcStateUnknown = 0,
       fcCANCcStateConfig,
       fcCANCcStateNormalActive,
       fcCANCcStateWarning,
       fcCANCcStateErrorPassive,
       fcCANCcStateBusOff,
}fcCANCcState;
```

Members

fcCANCcStateUnknown
: Communication controller state is unknown.

fcCANCcStateConfig
: Communication controller is in configuration state.

fcCANCcStateNormalActive
: Communication controller is in normal active state.

fcCANCcStateWarning
: Communication controller is in error warning state. At least one of the error counters has reached the error warning limit of 96.

fcCANCcStateErrorPassive
: Communication controller is in error passive state. No CAN messages can be sent anymore except CAN passive errors.

fcCANCcStateBusOff
: Communication controller is in bus off state. No CAN messages can be sent anymore.

See Also

fcbCANGetCcState, **fcbCANMonitoringStart**

6.2.1.2 fcCANMonitoringMode

This enumeration defines the different modes available, used to monitor a CAN cluster.

```
Typedef enum fcCANMonitoringMode
{
       fcCANMonitoringNormal = 0,
       fcCANMonitoringActive = fcCANMonitoringNormal,
       fcCANMonitoringSilent = 1,
       fcCANMonitoringPassive = fcCANMonitoringSilent,
}fcCANMonitoringMode;
```

Members

fcCANMonitoringNormal

fcCANMonitoringActive
: The FlexCard will switch from configuration to normal active state as soon as possible. In normal active state CAN frames can be received and transmitted.

fcCANMonitoringSilent
fcCANMonitoringPassive
The FlexCard will switch from configuration to normal passive state as soon as possible. In normal passive state CAN frames can be received only.

See Also
fcbCANMonitoringStart

6.2.2 fcbCANMonitoringStart

This function is used to start the monitoring of a CAN bus. Once called, the function changes the Communication Controller state from configuration state to *fcCANCcStateNormalActive* if the start-up is successful. This state is entered if either mode *fcCANMonitoringNormal* or *fcCANMonitoringSilent* is used. The current Communication Controller state can be read using the function **fcbCANGetCcState**. The user should call **fcbCANGetCcState** after **fcbCANMonitoringStart** and check that the CC is in the state *fcCANCcStateNormalActive*.

```
fcError fcbCANMonitoringStart(
      fcHandle hFlexCard,
      fcCC CC,
      fcBool resetTimestamps,
      fcCANMonitoringMode mode
);
```

Parameters
hFlexCard
[IN] Handle to a FlexCard.
CC
[IN] Index of the CAN Communication Controller.
restartTimestamps
[IN] Set this parameter to 0 to restart the measurement without resetting the FlexCard timestamp. Set it to <> 0 to start the measurement from the beginning. The timestamps have micro second resolution.
Mode
[IN] The monitoring mode. See **fcCANMonitoringMode** for details which monitoring mode is supported.

Return values
If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks
After the monitoring has started, the user should check if the integration in the cluster was successful, **fcbCANGetCcState** should return the state *fcCANCcStateNormalActive*.

	Information
	After the monitoring has successfully started, the receive process has to be started as soon as possible to avoid an overflow (error packet *fcErrFlexcardOverflow* is received). Once an overflow occurred, no more packets can be received. The monitoring has to be stopped and started again.

See Also
fcbCANMonitoringStop, **fcbCANGetCcState**, **fcCANMonitoringMode**

Example

```
// Precondition: valid flexcard handle exists and the flexcard is
// already configured.

fcCC eCC = fcCC1;
fcError e = fcbCANMonitoringStart(hFlexCard,eCC,true,fcCANMonitoringNormal);
if (0 == e)
{
	bool active = false;
	bool timeout = false;
	DWORD maxTime = ::GetTickCount() + 2000;
	fcCANCcState state = fcCANCcStateUnknown;

	// Check if the FlexCard is in CAN normal active state
	do
	{
		fcbCANGetCcState(hFlexCard, eCC, &state);
		active= (state == fcCANCcStateNormalActive);
		timeout	= ::GetTickCount() >= maxTime;

	} while ( ! active && ! timeout);

	if (active)
	{
		// Start your receive thread/routine
		//   ...
	}
	else
	{
		// if we timed out, we stop the monitoring
		fcbCANMonitoringStop(hFlexCard);
	}
}
else
{
	// error handling …
}
```

6.2.3 fcbCANMonitoringStop

This function stops the CAN bus monitoring of the selected Communication Controller. The Communication Controller is set back in its configuration state. After calling this function and emptying the receive buffer with **fcbReceive**, no more messages from this Communication Controller are received. Additionally, if the user transmits messages after calling this function, they don't appear on the CAN bus.

```
fcError fcbCANMonitoringStop(
	fcHandle hFlexCard,
	fcCC CC
)
```

Parameters

hFlexCard

[IN] Handle to FlexCard.

CC

[IN] Index of the CAN Communication Controller.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbCANMonitoringStart

6.2.4 fcbCANGetCcState

This function returns the current CAN Communication Controller state. For a description of possible states, refer to the enumeration **fcCANCcState**.

```
fcError fcbCANGetCcState(
      fcHandle hFlexCard,
      fcCC CC,
      fcCANCcState* pState
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] Communication Controller index.

pState

[OUT] Current CAN Communication Controller state.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See

fcbCANMonitoringStart, **fcbCANMonitoringStop**, **fcCANCcState**

Example

For an example, see **fcbCANMonitoringStart**.

6.3 Configuration

6.3.1 Enumerations

6.3.1.1 fcCANBufCfgType

For the transmission and reception of CAN frames the Communication Controller provides different types of message buffers. There are 128 message buffers available. These buffers can be freely configured as rx or tx buffers. For sending and receiving error frames or for receiving trigger packets, no message buffer is needed. Each message buffer can be assigned with one of the following specific types.

```
Typedef enum fcCANBufCfgType
{
       fcCANBufCfgTypeNone = 0,
       fcCANBufCfgTypeCommon,
       fcCANBufCfgTypeRxAll,
       fcCANBufCfgTypeRx,
       fcCANBufCfgTypeTx,
       fcCANBufCfgTypeRemoteRx,
       fcCANBufCfgTypeRemoteTx,
}fcCANBufCfgType;
```

Members

fcCANBufCfgTypeNone
: The message buffer is not used. It can be used to reset a message buffer.

fcCANBufCfgTypeCommon
: The message buffer is reserved for internal use only. (No support.)

fcCANBufCfgTypeRxAll
: The message buffer is used for receiving all incoming CAN data and remote frames.

fcCANBufCfgTypeRx
: The message buffer is used as a receive buffer for either a specific message or a set of messages.

fcCANBufCfgTypeTx
: The message buffer is used as a transmit buffer for a specific CAN message ID.

fcCANBufCfgTypeRemoteRx
: The message buffer is used as a remote receive buffer. It is used for sending a remote request and receiving the according replying message.

fcCANBufCfgTypeRemoteTx
: The message buffer is used as a remote transmission buffer. It can be transmitted automatically when a remote request is received.

See Also

fcCANBufCfg

6.3.1.2 fcCANBufCfgRxAllCondition

This enumeration defines the acceptance conditions of an **fcCANBufCfgRxAll** buffer. The conditions may be binary Ored.

```
Typedef enum fcCANBufCfgRxAllCondition
{
       fcCANRxAllNone            = 0x0,
       fcCANRxAllIDStandard      = 0x1,
       fcCANRxAllIDExtended      = 0x2,
       fcCANRxAllFrameData       = 0x4,
       fcCANRxAllFrameRemote     = 0x8,
}fcCANBufCfgRxAllCondition;
```

Members

fcCANRxAllNone
: Accept no frames.

fcCANRxAllIDStandard
: Accept CAN frames with standard identifiers.

fcCANRxAllIDExtended
: Accept CAN frames with extended identifiers.

fcCANRxAllFrameData
: Accept all CAN data frames.

fcCANRxAllFrameRemote
: Accept all CAN remote frames.

See Also

fcCANBufCfgRxAll

6.3.2 Structures

6.3.2.1 fcCANBufCfgRxAll

This structure specifies a special CAN receive message buffer. This buffer type is used to receive all frames of the specified conditions.

```
Typedef struct fcCANBufCfgRxAll
{
       fcDword Condition;
       fcDword Reserved[2];
}fcCANBufCfgRxAll;
```

Members

Condition

The acceptance condition for this buffer, which can be OR-ed.
At least one id condition and one frame condition must be used to receive frames.

Reserved

Reserved for future use.

See Also

fcCANBufCfg, **fcCANBufCfgRxAllCondition**

6.3.2.2 fcCANBufCfgRx

This structure specifies the configuration of a CAN receive message buffer. This buffer type is used to receive a CAN message with a specific CAN ID only or a range of CAN IDs.

```
Typedef struct fcCANBufCfgRx
{
       fcDword ID;
       fcDword MaskID;
       fcDword enableIDExtended  :1;
       fcDword enableMask        :1;
       fcDword Reserved[2];
}fcCANBufCfgRx;
```

Members

ID

Defines the CAN identifier to be received in this message buffer.
Valid values for a standard CAN ID range from 0x0 – 0x7FF.
Valid values for an extended CAN ID range from 0x0 – 0x1FFFFFFF.

MaskID

The bit mask. The corresponding bits from the struct member ID are used for acceptance filtering. MaskID configures which bits will be checked during filtering. 1 means that the bit position of the ID will be checked, while 0 means that the bit position of the ID is not used for acceptance filtering. ID configures which value the bit position must contain so that the frame is received.
If MaskID is equal 0, all IDs will be accepted.

enableIDExtended

If set to 1 the message buffer is defined for extended CAN identifiers only. If set to 0 the message buffer is defined for standard CAN identifiers. It's not possible to receive both versions in one message buffer.

enableMask

Set this flag to 1 to enable the acceptance mask.

Reserved

Reserved for future use.

Configuration notice

Example: IDs 11 and 13 should be received.

ID 11 is in binary code: 1011

ID 13 is in binary code: 1101

Set the MaskID to 1001 (0x9) and the ID to one of the IDs that should be received, e.g. 13 (0xD). The filter is not perfect, that means that IDs 9 and 15 are received, too.

Further examples:

ID	MaskID	enableMask	Behaviour
0x1	0x1	1	Only odd frames are received (1,3,5,...)
0x3	0x3	1	Received: 3, 7,... Rejected: 1, 2, 4, 5, 9...
0x1	0xF	1	Received: 1, 17. Rejected: 9, 16,...
0x0	0x7F0	1	Received: ID < 16

See Also

fcCANBufCfg

6.3.2.3 fcCANBufCfgTx

This structure specifies the configuration of a CAN transmit message buffer. This buffer type is used to transmit a CAN message with a specific CAN ID only.

```
Typedef struct fcCANBufCfgTx
{
       fcDword ID;
       fcByte  Data[8];
       fcDword DLC : 4;
       fcDword enableIDExtended : 1;
       fcDword enableTxAcknowledge : 1;
       fcDword enableTxRequest : 1;
       fcDword newData : 1;
       fcDword Reserved[2];
}fcCANBufCfgTx;
```

Members

ID

Defines the CAN identifier to be transmitted in this message buffer.
Valid values for a standard CAN ID range from 0x0 – 0x7FF.
Valid values for an extended CAN ID range from 0x0 – 0x1FFFFFFF.

Data

Defines the data for transmission. All of the 8 data bytes can be set. The corresponding DLC parameter is used to define the number of bytes to transmit.

DLC

Defines the data length (in bytes) to be transmitted.

enableIDExtended

If set to 1 the message buffer is defined for extended CAN identifiers only. If set to 0 the message buffer is defined for standard CAN identifiers. It's not possible to transmit both versions in one message buffer.

enableTxAcknowledge

Set this flag to 1 to enable the transmit acknowledge. The FlexCard generates a CAN packet with a direction flag = 1 (Tx), if the data is transmitted successfully.

enableTxRequest
Set this flag to 1 to indicate that the message is requested to be sent as soon as the Communication Controller is in state 'normal active'.

newData
Set this flag to 1 to update the data of the message buffer. Set to 0 if no new data shall be updated.

Reserved
Reserved for future use

See Also

fcCANBufCfg, **fcCANPacket**

6.3.2.4 fcCANBufCfgRemoteRx

This structure specifies a CAN remote receive message buffer. This buffer type is used to send a CAN remote message to request a CAN message with the same CAN identifier. This will be received into the message buffer.

```
Typedef struct fcCANBufCfgRemoteRx
{
       fcDword ID;
       fcDword DLC                    :4;
       fcDword enableIDExtended       :1;
       fcDword enableTxAcknowledge    :1;
       fcDword enableTxRequest        :1;
       fcDword Reserved[2];
}fcCANBufCfgRemoteRx;
```

Members

ID
Defines the CAN identifier to be received in this message buffer.
Valid values for a standard CAN ID range from 0x0 – 0x7FF.
Valid values for an extended CAN ID range from 0x0 – 0x1FFFFFFF.

DLC
Defines the data length (in bytes) to be transmitted.

enableIDExtended
If set to 1 the message buffer is defined for extended CAN identifiers only. If set to 0 the message buffer is defined for standard CAN identifiers. It's not possible to receive both versions in one message buffer.

enableTxAcknowledge
Set this flag to 1 to enable the transmit acknowledge. The FlexCard generates a CAN packet (RemoteTx) if the data are transmitted successfully.

enableTxRequest
Set this flag to 1 to indicate that the message is requested to be sent as soon as the Communication Controller is in state 'normal active'.

Reserved
Reserved for future use.

See Also

fcCANBufCfg, **fcCANPacket**

6.3.2.5 fcCANBufCfgRemoteTx

This structure specifies a CAN remote transmit message buffer. This buffer type is used to transmit a CAN message when this ID is requested by a corresponding CAN remote frame.

```
Typedef struct fcCANBufCfgRemoteTx
{
       fcDword ID;
       fcByte  Data [8];
       fcDword DLC                 :4;
       fcDword enableIDExtended    :1;
       fcDword enableTxAcknowledge :1;
       fcDword enableTxRequest     :1;
       fcDword enableAutoResponse  :1;
       fcDword newData             :1;
       fcDword Reserved[2];
}fcCANBufCfgRemoteTx;
```

Members

ID

Defines the CAN identifier to be responded with the same id.
Valid values for a standard CAN ID range from 0x0 – 0x7FF.
Valid values for an extended CAN ID range from 0x0 – 0x1FFFFFFF.

Data

Defines the data for transmission. All of the 8 data bytes can be set. The corresponding DLC parameter is used to define the number of bytes to transmit.

DLC

Defines the data length (in bytes) to be transmitted.

enableIDExtended

If set to 1 the message buffer is defined for extended CAN identifiers only. If set to 0 the message buffer is defined for standard CAN identifiers. It's not possible to receive both versions in one message buffer.

enableTxAcknowledge

Set this flag to 1 to enable the transmit acknowledge. The FlexCard generates a CAN packet (RemoteTx) if the data are transmitted successfully and the parameter *enableAutoResponse* is set to 1 too.

enableTxRequest

Set this flag to 1 to indicate that the message is requested to be sent as soon as the Communication Controller is in state 'normal active'.

enableAutoResponse

Set this flag to 1 to enable the buffer to transmit a frame as soon as a corresponding CAN remote frame is received.

newData

Set this flag to 1 to update the data of the message buffer. Set to 0 if no new data shall be updated.

Reserved

Reserved for future use.

See Also

fcCANBufCfg, **fcCANPacket**

6.3.2.6 fcCANBufCfg

This structure describes the configuration of a CAN message buffer.

```
Typedef struct fcCANBufCfg
{
       fcCANBufCfgType Type;
       union
       {
              fcCANBufCfgCommon Common;
              fcCANBufCfgRxAll RxAll;
              fcCANBufCfgRx Rx;
              fcCANBufCfgTx Tx;
              fcCANBufCfgRemoteRx RemoteRx;
```

```
            fcCANBufCfgRemoteTx RemoteTx;
      };

}fcCANBufCfg;
```

Members

Type
: Defines the CAN message buffer type. Using type *fcCANBufCfgTypeNone* disables/resets the message buffer.

Common
: Used for internal purposes. (No support).

RxAll
: Receive all buffer configuration.

Rx
: Receive buffer configuration.

Tx
: Transmit buffer configuration.

RemoteRx
: Remote receive buffer configuration.

RemoteTx
: Remote transmit buffer configuration.

See Also

fcCANBufCfgType, **fcCANBufCfgRxAll**, **fcCANBufCfgRx**, **fcCANBufCfgTx**, **fcCANBufCfgRemoteRx**, **fcCANBufCfgRemoteTx**, **fcbCANSetMessageBuffer**, **fcbCANGetMessageBuffer**

6.3.2.7 fcCANCcConfig

This structure describes the configuration of a CAN Communication Controller. Within this function all message buffers will be reset.

```
Typedef struct fcCANCcConfig
{
      fcWord BaudRatePrescaler;
      fcWord SynchronizationJumpWidth;
      fcWord TimeSegment1;
      fcWord TimeSegment2;
      fcDword enableAutomaticRetransmission :1;
      fcDword Reserved[6];
} fcCANCcConfig;
```

Members

BaudRatePrescaler
: Defines the baud rate prescaler (BRP). Valid values are from 0 to 1023.

SynchronizationJumpWidth
: Defines the synchronization jump width (SJW). Valid values are from 0 to 3 and must not be larger than TSEG1 and TSEG2.

TimeSegment1
: Defines the time segment 1 (TSEG1). Valid values are from 0 to 15.

TimeSegment2
: Defines the time segment 2 (TSEG2). Valid values are from 0 to 7.

enableAutomaticRetransmission
: Set this flag to 1 to enable automatic retransmission. If the CAN Communication Controller has lost the arbitration or if an error occurred during the transmission, the message will be retransmitted as soon as the CAN bus is free again.

Reserved
: Reserved for future use.

See Also

fcbCANSetCcConfiguration

Remarks

The baud rate and the sample point calculation of the CAN Communication Controller depends on *BaudRatePrescaler*, *SynchronizationJumpWidth*, *TimeSegment1* and *TimeSegment2*.
Baud rate [baud] = 16 * 10^6 [Hz] / ((3 + TSEG1 + TSEG2) * (1 + BRP))
Sample point [%] = 100 * (2 + TSEG1) / (3 + TSEG1 + TSEG2)

The unit of the baud rate is either Hz or Bit/sec. 1 Hz equals 1 Bit/sec. 1 Kbit/sec equals 1000 Bit/sec.

The CAN specification defines the BitLength as follows:
BitLength = Sync_Seg + Prop_Seg+ Phase_Seg1 + Phase_Seg2 = 8-25 Tq (Timequantum)

D_CAN uses following definitions:
Tseg1 + 1 = Prop_Seg+ Phase_Seg1
Tseg2 + 1 = Phase_Seg2
1 = Sync_Seg
BitLength = 1 + Tseg1 + 1 + Tseg2 + 1 = 4-25 Tq

The fcBase API and CANBaudRateCalculator use the D_CAN definitions.

	Information
	*STAR COOPERATION* delivers a calculation tool “CANBaudRateCalculator”, which can be found in the FlexCard tools directory in the Windows program menu.

6.3.2.8 fcCANTxFifoConfig

This structure describes the configuration of the transmit FIFO feature for a CAN Communication Controller. With the transmit FIFO it’s possible to transmit CAN data messages without the configuration of several message buffer objects.

```
Typedef struct fcCANTxFifoConfig
{
      fcDword BufferNumber;
      fcDword TimerInterval;
      fcDword enableRetransmission : 1;
      fcDword enableTxAcknowledge : 1;
      fcDword Reserved[3];
} fcCANTxFifoConfig;
```

Members

BufferNumber

The number of the message buffer used for the transmission. This buffer number is reserved for CAN transmit FIFO only and should not be used with other available message buffer functions to avoid transmit disturbances. Valid values are from 0 to 128. Set to 0 to deactivate the FIFO.

TimerInterval

The transmit FIFO timer interval with microsecond resolution. Valid values are from 200 to 1048575. Timer interval depends on the configured CAN baud rate and will be adjusted to a minimum calculated value by the driver automatically.

enableRetransmission

Set this flag to 1 to enable automatic retransmission. If the transmit FIFO has lost the arbitration or if an error occurred during the transmission, the message will be retransmitted with the configured timer interval. With disabled flag, the transmit FIFO tries to transmit the CAN message once. In case of

arbitration lost or error occurrence the next message will be transmitted after the configured timer interval.

enableTxAcknowledge

Set this flag to 1 to enable transmit acknowledge for all transmitted CAN messages with this FIFO.

Reserved

Reserved for future use.

See Also

fcbCANSetTxFifoConfiguration, **fcbCANGetTxFifoConfiguration**, **fcbCANTxFifoTransmit**

Remarks

In case the transmission of any number of message buffers may be requested at the same time, they are transmitted subsequently according to their priority (The message buffer numbers are configurable from 1 up to 128, the lower the message number, the higher is the priority).

	Information
	This structure is initially supported by FlexCard API version S6V3-F.

6.3.3 fcbCANSetCcConfiguration

This function configures the CAN Communication Controller. This function cannot be called during monitoring. Before the configuration of the CAN CC starts, all CAN message buffers are reset.

```
fcError fcbCANSetCcConfiguration(
      fcHandle hFlexCard,
      fcCC CC,
      fcCANCcConfig cfg
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] CAN Communication Controller identifier.

Cfg

[IN] CAN Communication Controller configuration parameters.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbCANGetMessageBuffer, **fcCANCcConfig**

6.3.4 fcbCANSetMessageBuffer

This function configures the message buffers of the CAN Communication Controller. Configuring message buffers is allowed in all Communication Controller states.

```
fcError fcbCANSetMessageBuffer(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword bufferNumber,
```

```
      fcCANBufCfg cfg,
      fcBool ignoreTxRqstLock
);
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

CC
[IN] CAN Communication Controller identifier.

bufferNumber
[IN] Identifier of the message buffer to be configured.

Cfg
[IN] Message buffer configuration parameters.

ignoreTxRqstLock
Set this flag to <> 0 if you want to force a reconfiguration of this buffer although the previous message in this buffer was (probably) not transmitted yet.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCANBufCfg

6.3.5 fcbCANGetMessageBuffer

This function reads a specific CAN message buffer configuration.

```
fcError fcbCANGetMessageBuffer(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword bufferNumber,
      fcCANBufCfg* pCfg
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard.

CC
[IN] CAN Communication Controller identifier.

bufferNumber
[IN] Identifier of the message buffer to be read.

Cfg
[OUT] The configuration parameters of the specified message buffer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbCANSetMessageBuffer, fcCANBufCfg

Example

```
// Get all configured transmit message buffers
std::map<unsigned int, fcCANBufCfg > Buffers;
unsigned int bufferNr = 1; // The first valid buffer is 1
while (true)
{
	fcCANBufCfg cfg;

	// as long as no error occurs we try to get each buffer
	fcError e = fcbCANGetMessageBuffer (m_hFlexCard,fcCC1,bufferNr,&cfg);
	if (0 != e) break;

	// is this a tx buffer, then add it to our list
	if (fcCANBufCfgTypeTx == cfg.Type)
		Buffers[bufferNr] = cfg;

	// next buffer number
	bufferNr++;
}
```

6.3.6 fcbCANSetTxFifoConfiguration

This function configures the transmit FIFO feature for a CAN Communication Controller. With the transmit FIFO it is possible to transmit CAN data messages without the configuration of several message buffer objects. This function cannot be called during monitoring. The FlexCard driver corrects the transmit interval if the configured CAN baudrate is too low. After calling **fcbCANSetTxFifoConfiguration** call **fcbCANGetTxFifoConfiguration** to get the corrected transmit interval.

```
fcError fcbCANSetTxFifoConfiguration(
	fcHandle hFlexCard,
	fcCC CC,
	fcCANTxFifoConfig cfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] CAN Communication Controller identifier.

Cfg

[IN] CAN transmit FIFO configuration parameters.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCANTxFifoConfig, **fcbCANSetTxFifoConfiguration**, **fcbCANTxFifoTransmit**

Example

```
// Configure a transmit CAN FIFO with timer interval of 200 us
// and use with message buffer index 2 for a high priority transmission
fcCANTxFifoConfig FifoConfig;
memset(&FifoConfig, 0, sizeof(fcCANTxFifoConfig));
FifoConfig.BufferNumber = 2;
FifoConfig.TimerInterval = 200;
FifoConfig.enableRetransmission = 1;
FifoConfig.enableTxAcknowledge = 1;

fcError e = fcbCANSetTxFifoConfiguration(m_hFlexCard, fcCC1, FifoConfig);
if (0 != e) {/* Error handling */}
```

	Information
	This function is initially supported by FlexCard API version S6V3-F.

6.3.7 fcbCANGetTxFifoConfiguration

This function reads the transmit FIFO configuration parameters of a CAN Communication Controller. With the transmit FIFO it's possible to transmit CAN data messages without the configuration of several message buffer objects.

```
fcError fcbCANGetTxFifoConfiguration(
      fcHandle hFlexCard,
      fcCC CC,
      fcCANTxFifoConfig* pCfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] CAN Communication Controller identifier.

pCfg

[OUT] CAN transmit FIFO configuration parameters.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCANTxFifoConfig, **fcbCANSetTxFifoConfiguration**, **fcbCANTxFifoTransmit**

Example

```
// Read the configuration parameters of the transmit CAN FIFO
fcCANTxFifoConfig FifoConfig;
memset(&FifoConfig, 0, sizeof(fcCANTxFifoConfig));

fcError e = fcbCANGetTxFifoConfiguration(m_hFlexCard, fcCC1, &FifoConfig);
if (0 != e) {/* Error handling */}
```

	Information
	This function is initially supported by FlexCard API version S6V3-F.

6.3.8 fcbCANTxFifoReset

This function resets the CAN Communication Controller transmit FIFO buffer. CAN data messages in the FIFO are lost.

```
fcError fcbCANTxFifoReset(
      fcHandle hFlexCard,
      fcCC CC,
      fcBool bOnlyCurrent
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] CAN Communication Controller identifier.

bOnlyCurrent

[IN] Reset only the current CAN message that is scheduled for transmission by the CAN CC. The next CAN message is going to be scheduled for transmission. Current CAN data message is lost. Other queued CAN data messages in the FIFO aren't lost.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCANTxFifoConfig, **fcbCANTxFifoTransmit**

Example

```
// Reset the current CAN message, which blocks the schedule for next
// CAN messages in the transmit CAN FIFO
bool bResetOnlyCurrent = true;
fcError e = fcbCANTxFifoReset(m_hFlexCard, fcCC1, bResetOnlyCurrent);
if (0 != e) {/* Error handling */}
```

	Information
	This function is initially supported by FlexCard API version S6V3-F.

6.4 Transmit

6.4.1 fcbCANTransmit

This function writes the data bytes in a CAN Communication Controller transmit buffer of the FlexCard. The transmitted data bytes depend on the message buffer configuration. The function returns immediately and does not wait for the data frame to arrive on the bus. The CAN message should normally be transmitted as soon as possible. Example: If the CAN bus is full with high priority messages, and the user transmits a low

priority message, this function immediately returns successfully, but the message appears on the bus, only when it wins the arbitration.

In case the transmission of any number of message buffers may be requested at the same time, they are transmitted subsequently according to their priority (The message object numbers are configurable from 1 up to 128, the lower is the message number, the higher is the priority). If the transmit acknowledgment is activated, a CAN packet with a direction flag = 1 (Tx) is generated as soon as the message has been transmitted. This function should only be called when the FlexCard is in normal active state or when all message buffer configurations have been done.

The transmission may fail, if the buffer is already locked for transmission (**fcGetErrorCode** returns MSG_BUF_LOCKED_FOR_TRANSMISSION). In that case retry later or set the parameter *ignoreTxRqstLock* to true.

```
fcError fcbCANTransmit(
       fcHandle hFlexCard,
       fcCC CC,
       fcDword bufferNumber,
       fcByte data[8],
       fcBool transmitNewData,
       fcBool ignoreTxRqstLock
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] CAN Communication Controller identifier.

bufferNumber

[IN] The number of the message buffer used for the transmission.

Data

[IN] The data to be transmitted. The configured DLC in the message buffer determinates the size of bytes which will be copied in the transmit buffer.

transmitNewData

[IN] Set to <> 0 to update the data of the message buffer. Set to 0 if the previous data shall be sent again.

ignoreTxRqstLock

[IN] Set this value to <> 0 if you want to force a reconfiguration of this buffer although the previous message was not transmitted yet.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCANBufCfg, **fcbCANGetMessageBuffer**

Example

```
fcByte data[8];
for (int i=0; i<8; i++) data[i]=0xA;

// Transmit new data
fcError e = fcbCANTransmit(m_hFlexCard, fcCC1, bufferNumber, data, true, true);
if (0 != e) {/* Error handling */}
```

6.4.2 fcbCANTxFifoTransmit

This function writes a CAN data message into the CAN transmit FIFO buffer of the FlexCard. It holds maximum 512 messages. The function returns immediately and does not wait for the data frame to arrive on the bus. The message should normally be transmitted as soon as possible. This function should only be called when the CAN transmit FIFO is configured.

```
fcError fcbCANTxFifoTransmit(
      fcHandle hFlexCard,
      fcCC CC,
      fcDword id,
      fcBool bExt,
      fcByte* pData,
      fcDword dlc
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CC

[IN] CAN Communication Controller identifier.

Id

[IN] The CAN identifier. Valid values for a standard CAN ID range from 0x0 to 0x7FF. Valid values for an extended CAN ID range from 0x0 to 0x1FFFFFFF.

bExt

[IN] Set to <> 0 to transmit a CAN message with an extended identifier. Set to 0 to transmit a standard CAN message.

pData

[IN] The data to be transmitted.

Dlc

[IN] The size of bytes which will be copied in the FIFO.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbCANSetTxFifoConfiguration

Example

```
fcDword id = 0x789;
bool bExt = false;
const fcDword dlc = 8;
fcByte data[dlc];
for (int i=0; i<dlc; i++) data[i]=i;

// Put CAN message into the transmit FIFO for scheduling as soon as possible
fcError e = fcbCANTxFifoTransmit(m_hFlexCard, fcCC1, id, bExt, data, dlc);
if (0 != e)
{
      // Error handling
}
```

	Information
	This function is initially supported by FlexCard API version S6V3-F.

7 CAN FD API

The following section describes the data structures and features used for CAN FD functionality. To use these functions the FlexCard must have a firmware with a CAN FD CC and the FlexCard must be licensed for CAN.

	Information
	All enumerations, structures and functions in this chapter are initially supported by FlexCard Windows API version S6V6-F.

7.1 Basic CAN FD Workflow

The following figure shows a typical CAN FD workflow.

The CAN FD functions are supported for the CAN Communication Controller type Bosch M_CAN. The Enum function returns the struct fcInfoHwSw. Check the struct fcInfoHw.pVersionCC to see whether the firmware provides this CC type.

When you compare the CAN and CAN FD API functions, the functions fcbCANFDSetCcConfiguration and fcbCANFDTransmit were added for CAN FD. The functions fcbCANGetCcState and fcbCANMonitoringStart/Stop are used on the Bosch M_CAN.

The CCs are counted in following order: First FlexRay, then CAN. CAN FD CCs count like CAN CCs.

For example if the firmware image has 1 FlexRay CC and 4 CAN FD CCs, the CCs are referred to like this:

- FlexRay fcCC1
- CAN fcCC1, fcCC2, fcCC3, fcCC4

CAN-HS baud rate is 40 Kbit/s to 1 Mbit/s. The maximum CAN FD baud rate depends on the transceiver.

Refer to the chapter General Function Availability to find out if the connected FlexCard device supports onboard CAN terminations.

For transmitting CAN data use the function fcbCANFDTransmit. Check the error code to see whether the internal transmit buffer had enough space for the frame.

The FlexCard Windows Developer Setup installs the example application *fcDemoCANFD.exe* and its source code to the installation directory.

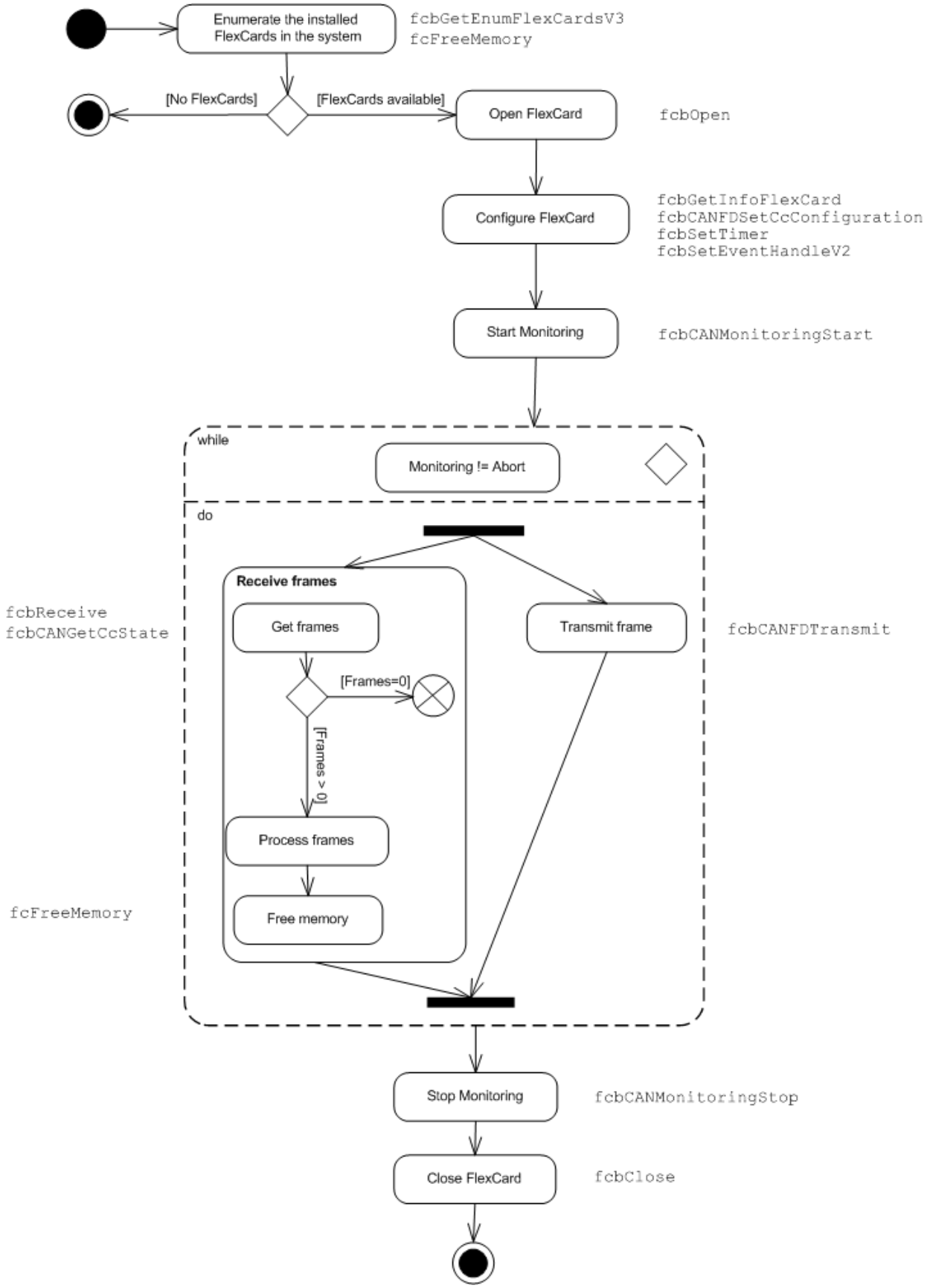


Figure 11: Typical CAN FD function workflow

7.2 CAN FD DLC

The CAN FD specification defines following four bit long DLCs (data length codes).

DLC (decimal)	Number of bytes
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	12
10	16
11	20
12	24
13	32
14	48
15	64

DLCs smaller and equal 8 are possible in a CAN network. DLCs smaller and equal 15 are possible in CAN FD networks.

7.3 Configuration

7.3.1 Enumerations

7.3.1.1 fcCANFDFrameFormat

This enumeration describes the CAN FD frame format.

```
Typedef enum fcCANFDFrameFormat
{
       fcCANFDFormatUnspecified = 0,
       fcCANFDFormatIso11898_1,
       fcCANFDFormatBoschSpecV1_0,
} fcCANFDFrameFormat;
```

Members

fcCANFDFormatUnspecified
: Unspecified CAN FD frame format.

fcCANFDFormatIso11898_1
: CAN FD frame format according to ISO 11898-1 (CAN/ CAN FD).

fcCANFDFormatBoschSpecV1_0
: CAN FD frame format according to CAN FD Bosch Specification 1.0.

See Also

fcbCANFDSetCcConfiguration

7.3.2 Structures

7.3.2.1 fcCANCcBitTime

This structure describes the configuration of a CAN/ CAN FD communication controller.

```
Typedef struct fcCANCcBitTime
{
       fcWord BaudRatePrescaler;
       fcWord SynchronizationJumpWidth;
       fcWord TimeSegment1;
       fcWord TimeSegment2;
       fcDword Reserved[4];
} fcCANCcBitTime;
```

Members

BaudRatePrescaler

Defines the baud rate prescaler (BRP).
Valid range for CAN: 1..512
Valid range for CAN FD: 1..32

SynchronizationJumpWidth

Defines the synchronization jump width (SJW).
Valid range for CAN: 1..128
Valid range for CAN FD: 1..16

TimeSegment1

Defines the time segment 1 (TSEG1).
This value is equal Prop_Seg + Phase_Seg1
from the specification.
Valid range for CAN: 2..256
Valid range for CAN FD: 1..32

TimeSegment2

Defines the time segment 2 (TSEG2).
This value is equal Phase_Seg2 from the specification.
Valid range for CAN: 1..128
Valid range for CAN FD: 1..16

Reserved

Reserved for future use.

See Also

fcbCANFDSetCcConfiguration

Remarks

The Sync_Seg from the specification is always 1. The information processing time from the specification is 0. The clock frequency is 20 MHz.

The baud rate and the sample point calculation by the CAN communication controller depends on BaudRatePrescaler, SynchronizationJumpWidth, TimeSegment1 and TimeSegment2.

Baud rate [baud] = 20 * 10^6 [Hz] / ((1 + TSEG1 + TSEG2) * BRP)

Sample point [%] = 100 * (1 + TSEG1) / (1 + TSEG1 + TSEG2)

7.3.2.2 fcCANFDCcConfig

This structure describes the configuration of a CAN FD Communication Controller.

```
Typedef struct fcCANFDCcConfig
{
       fcCANCcBitTime nominalBitTime;
       fcCANCcBitTime dataBitTime;
       fcCANFDFrameFormat frameFormat;
       fcDword enableAutomaticRetransmission :1;
       fcDword enableCANFDOperation    :1;
       fcDword enableCANFDBitRateSwitch      :1;
       fcDword Reserved[6];
} fcCANFDCcConfig;
```

Members

nominalBitTime

Please note: Nominal and data bit time have different ranges. Relevant for CAN and CAN FD.

dataBitTime

The data bit rate must be greater or equal the nominal bit rate. Relevant for CAN FD.

frameFormat

Please note: All communication partners in a CAN FD network must use the same frame format. Relevant for CAN FD.

enableAutomaticRetransmission

Set this flag to 1 to enable automatic retransmission. If the CAN communication controller has lost the arbitration or if an error occurred during the transmission, the message will be retransmitted as soon as the CAN bus is free again.
Relevant for CAN and CAN FD.

enableCANFDOperation

Enables CAN FD operation. When CAN FD is enabled, it is also possible to transmit normal CAN frames. This is decided while transmitting the frame.
Relevant for CAN and CAN FD.

enableCANFDBitRateSwitch

Specifies that it is possible to switch the bit rate for CAN FD frames.
Relevant for CAN FD.

Reserved

Reserved for future use.

See Also

fcbCANFDSetCcConfiguration

7.3.3 fcbCANFDSetCcConfiguration

This function configures the CAN FD Communication Controller. This function cannot be called during monitoring.

```
fcError fcbCANFDSetCcConfiguration(
       fcHandle hFlexCard,
       fcCC CC,
       fcCANFDCcConfig cfg
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CC

[IN] CAN Communication Controller identifier.

Cfg

[IN] CAN FD Communication Controller configuration parameters.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCANFDCcConfig

Example

```
fcCANFDCcConfig CcConfig;
memset(&CcConfig, 0, sizeof(fcCANFDCcConfig));

// 500 Kbit/s nominal
CcConfig.nominalBitTime.BaudRatePrescaler = 1;
CcConfig.nominalBitTime.SynchronizationJumpWidth = 1;
CcConfig.nominalBitTime.TimeSegment1 = 29;
CcConfig.nominalBitTime.TimeSegment2 = 10;

// 4 Mbit/s data
CcConfig.dataBitTime.BaudRatePrescaler = 1;
CcConfig.dataBitTime.SynchronizationJumpWidth = 1;
CcConfig.dataBitTime.TimeSegment1 = 2;
CcConfig.dataBitTime.TimeSegment2 = 2;

CcConfig.frameFormat = fcCANFDFormatIso11898_1;
CcConfig.enableAutomaticRetransmission = true;
CcConfig.enableCANFDOperation = true;
CcConfig.enableCANFDBitRateSwitch = true;

fcError e = fcbCANSetCcConfiguration(handle, fcCC1, CcConfig);
if (0 != e) {/* Error handling*/}
```

7.4 Transmit

7.4.1 Structures

7.4.1.1 fcCANFDTxFrame

This structure contains a CAN/ CAN FD frame that can be transmitted by a CAN FD communication controller.

```
Typedef struct fcCANFDTxFrame
{
       fcDword ID;
       fcDword DLC :4;
       fcByte data[64];
       fcBool enableIDExtended;
       fcBool enableTxAcknowledge;
       fcBool enableCanFdFormat;
       fcBool enableCanFdBitrateSwitch;
       fcDword reserved;
} fcCANFDTxFrame;
```

Members

ID

Defines the CAN identifier to be transmitted in this message buffer. Valid values for a standard CAN Id range from 0x0 to 0x7FF. Valid values for an extended CAN Id range from 0x0 to 0x1FFFFFFF.

DLC

Defines the data length to be transmitted. Note that the length is coded with four bits according to the CAN/ CAN FD standard.

Data

The payload data.

enableIDExtended
: If set to 1 the CAN identifier of the message is defined as extended. If set to 0 the CAN identifier is defined as standard.

enableTxAcknowledge
: When this bit is selected, the FlexCard generates a Tx acknowledge packet if the frame was transmitted correctly.

enableCanFdFormat
: Specifies whether the frame has a CAN format or a CAN FD format.

enableCanFdBitrateSwitch
: Specifies whether the frame uses bit rate switching. This is only relevant if enableCanFdFormat is configured.

Reserved
: Reserved for future use.

See Also
fcbCANFDTransmit

7.4.2 fcbCANFDTransmit

This function writes the data bytes in a CAN FD communication controller of the FlexCard. The function returns immediately and does not wait for the data frame to arrive on the bus. The message should normally be transmitted as soon as possible. The FlexCard internally uses a Tx FIFO which holds maximum 32 messages. The messages appear on the bus in the order in which they were transmitted by the user. If the transmit acknowledgment is activated, a CAN FD packet with a direction flag = 1 (Tx) is generated as soon as the message has been transmitted. This function should only be called when the FlexCard is in normal active state. If the internal Tx message fifo is full, the error TX_FIFO_FULL is returned and the message is not transmitted.

Sending CAN Remote frames via the function fcbCANFDTransmit is not supported.

```
fcError fcbCANFDTransmit(
      fcHandle hFlexCard,
      fcCC CC,
      const fcCANFDTxFrame* pFrame
);
```

Parameters

hFlexCard
: [IN] Handle to a FlexCard.

CC
: [IN] CAN Communication Controller identifier.

pFrame
: [IN] The frame that should be transmitted. This struct contains the payload data and configuration options.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCANFDTxFrame

Example

```
fcCANFDTxFrame frame1;
memset(&frame1, 0, sizeof(frame1));
frame1.DLC = 0xF; // this Dlc means 64 byte payload length
frame1.ID = 1;
frame1.enableIDExtended = false;
frame1.enableCanFdBitrateSwitch = true;
frame1.enableCanFdFormat = true;
frame1.enableTxAcknowledge = true;

fcError e = fcbCANFDTransmit(handle, fcCC1, &frame1);
fcErrorCode ec = fcGetErrorCode(e);
if (TX_FIFO_FULL == ec)
{
    // handle error. E.g. wait and retransmit.
}
else if(NONE != ec)
{
    // handle error
}
```

8 Self Synchronization API

The following section describes the data structures and features used for Self Sync functionality. To use these functions the FlexCard must have a firmware with exactly one FlexRay CC and the FlexCard must be licensed for FlexRay.

To also be able to test FlexRay nodes that don't take part actively in the synchronization process of a FlexRay network, the FlexCard provides the possibility to generate a second start-up/synchronization frame. Thus, the FlexCard synchronizes the FlexRay network independently. Self synchronization runs on the first Communication Controller.

	Information
	All enumerations, structures and functions in this chapter are initially supported for FlexCard Cyclone II (SE) devices by: ➢ FlexCard Windows API version S3V0-F. ➢ FlexCard Linux API version S2V0-F. ➢ FlexCard Xenomai API version S4V2-F.

	Information
	This additional API is also initially supported for: ➢ FlexCard PMC devices with only one FlexRay Communication Controller and the FlexCard API version S4V2-F. ➢ FlexCard PMC-II devices with only one FlexRay Communication Controller and the FlexCard API version S5V1-F. ➢ FlexCard USB-M devices with the FlexCard API version S6V2-F.

8.1 Configuration

8.1.1 fcbConfigureMessageBufferSelfSynchronization

This function configures up to 2 additional start-up/synchronization message buffers. Configuring message buffers is only allowed if the Communication Controller is in its configuration state, `fcStateConfig`. The message buffer needs to be defined as *`fcMsgBufCfgTx`*. The *`SyncFrameIndicator`* and *`StartupFrameIndicator`* need to be set, while *`CycleCounterFilter`* must be set to 0.

```
fcError fcbConfigureMessageBufferSelfSynchronization(
      fcHandle hFlexCard,
      fcDword* bufferId,
      fcMsgBufCfg cfg
)
```

Parameters

`hFlexCard`
[IN] Handle to a FlexCard

`bufferId`
[OUT] Message buffer identifier. If the configuration was successful the message buffer identifier is greater than 0. This identifier will be required to transmit the content of the buffer.

`Cfg`
[IN] Message buffer configuration parameters

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

Only one additional start-up/synchronization ID can be defined. Therefore maximum 2 additional message buffers can be configured: *fcChannelA* and *fcChannelB* or *fcChannelBoth*. Before configuring the message buffers, it is necessary to set up the global communication parameters (cluster parameters). Calling **fcbFRSetCcConfiguration**, **fcbFRSetCcConfigurationChi** or **fcbFRSetCcConfigurationCANdb** will reset the additional start-up/synchronization frames.

See Also

fcMsgBufCfg, **fcMsgBufCfgTx**, **fcbReconfigureMessageBufferSelfSynchronization**, **fcbGetCcMessageBufferSelfSynchronization**, **fcbResetCcMessageBuffersSelfSynchronization**, **fcbFRSetMsgBufCfgMode**

Example

```
// The following code configures a self start-up/synch transmit buffer
fcMsgBufCfg cfg;
memset(&cfg, 0, sizeof(fcMsgBufCfg));

cfg.Type = fcMsgBufTx;
cfg.ChannelFilter = fcChannelA;
cfg.CycleCounterFilter = 0x0;       // sync frames must appear in every cycle

cfg.Tx.FrameId = 3;                 // unused slotId of static segment
cfg.Tx.PayloadLength = 2;
cfg.Tx.PayloadLengthMax = 127;
cfg.Tx.PayloadPreambleIndicator = 0;
cfg.Tx.SyncFrameIndicator = 1;      // mandatory to be set to 1
cfg.Tx.StartupFrameIndicator = 1;   // mandatory to be set to 1
cfg.Tx.TxAcknowledgeEnable= 1;
cfg.Tx.TransmissionMode = fcMsgBufTxSingleShot;

unsigned int bufIdx = 0;
fcError e=fcbConfigureMessageBufferSelfSynchronization(hFlexCard,&bufIdx,cfg);
```

8.1.2 fcbReconfigureMessageBufferSelfSynchronization

This function reconfigures the additional transmit message buffers for self start-up/synchronization. A reconfiguration is only allowed for message buffers which are already configured and if the Communication Controller is in its configuration state, `fcStateConfig`. The message buffer needs to be defined for a start-up/synchronization transmit frame. Therefore it is mandatory to set the *SyncFrameIndicator* and *StartupFrameIndicator* to 1 and the *CycleCounterFilter* to 0.

```
fcError fcbReconfigureMessageBufferSelfSynchronization(
      fcHandle hFlexCard,
      fcDword bufferId,
      fcMsgBufCfg cfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

bufferId

[IN] The identifier of the message buffer which should be reconfigured.

Cfg
[IN] Message buffer configuration parameters.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcMsgBufCfg, **fcMsgBufCfgTx**, **fcbConfigureMessageBufferSelfSynchronizatio**, **fcbGetCcMessageBufferSelfSynchronization**, **fcbResetCcMessageBuffersSelfSynchronization**, **fcbFRSetMsgBufCfgMode**

8.1.3 fcbReinitializeCcMessageBufferSelfSynchronization

This function re-initializes the message buffer configuration of the self-start-up synchronization Communication Controller. After calling this function the Communication Controller does not send old payload data. Re-initialization of message buffers is only allowed if the Communication Controller is in configuration state.

```
fcError fcbReinitializeCcMessageBufferSelfSynchronization(
      fcHandle hFlexCard
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information

8.1.4 fcbGetCcMessageBufferSelfSynchronization

This function reads a specific message buffer configuration of the additional message buffers for self start-up/synchronization.

```
fcError fcbGetCcMessageBufferSelfSynchronization(
      fcHandle hFlexCard,
      fcDword bufferId,
      fcMsgBufCfg* cfg
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard
bufferId
[IN] The identifier of the additional start-up/sync message buffer to be read
cfg
[OUT] The configuration parameters of the specified message buffer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcMsgBufCfg, **fcMsgBufCfgTx**, **fcbConfigureMessageBufferSelfSynchronization**, **fcbReconfigureMessageBufferSelfSynchronization**, **fcbResetCcMessageBuffersSelfSynchronization**

Example

```
// Get all configured additional start-up/synchronization transmit
// message buffers
std::map<unsigned int, fcMsgBufCfg> Buffers;

// valid buffer indexes are only 1 and 2
for(unsigned int bufIdx = 1;bufIdx <=2; bufIdx++)
{
  fcMsgBufCfg cfg;

  // as long no error occurs we try to get each buffer
  fcError e=fcbGetCcMessageBufferSelfSynchronization(m_hFlexCard,bufIdx,&cfg);
  if (0 != e)
      continue;

  //and add it to our list
  Buffers[bufIdx] = cfg;
}
```

8.1.5 fcbResetCcMessageBuffersSelfSynchronization

This function resets the additional start-up/synchronization message buffers.

```
fcError fcbResetCcMessageBufferSelfSynchronization(
      fcHandle hFlexCard
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

8.2 Transmit

8.2.1 fcbTransmitSelfSynchronization

This function writes a data frame into a self start-up/synchronization transmit buffer of the FlexCard. The function returns immediately and does not wait for the data frame to arrive on the bus. The frame should normally be transmitted in the next cycle. If the transmit acknowledgment is activated, an acknowledge packet is generated as soon as the frame has been transmitted. This function should only be called when the FlexCard is in normal active state or when all message buffer configurations have been done. When the user transmits several times new data with the same buffer ID in a very short time periode, it may happen that data is overwritten that was not transmitted yet. If you experience that behavior, wait for the TxAck for the data you wanted to send.

```
fcError fcbTransmitSelfSynchronization(
      fcHandle hFlexCard,
      fcDword bufferId,
      fcWord payload[],
      fcByte payloadLength
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

bufferId

[IN] The id of the additional start-up/synchronization message buffer used for the transmission

payload

The payload data to be transmitted

payloadLength

The size of the payload data (number of 2-byte words)

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

The payload data has to be organized as follows: if Data0 is the first byte to transmit and Data1 the second byte to transmit, then the high byte (Bit 8 – 15) of payload[0] contains Data1, the low byte (Bit 0-7) of payload[0] contains Data0, etc.

Parameter `payload`	`payload[0]` (Word 0)		`payload[1]` (Word 1)		…
	High byte	Low byte	High byte	Low byte	…
FlexRay payload segment	Data 1	Data 0	Data 3	Data 2	…

Example

```
fcWord payload[fcPayloadMaximum];
payload[0] = 0x0001; // Update your payload data

fcError e = fcbTransmitSelfSynchronization(m_hFlexCard,bufferIdx,
            payload,payloadLength);
```

9 Trigger API

This chapter shows how to set up the two FlexCard trigger lines. FlexCard Cyclone II (SE) and FlexCard USB-M have 2 unidirectional triggers. One IN and one OUT line. Via the IN trigger line it has the ability to receive trigger events and forward them to the user application. The two trigger lines of the FlexCard PMC (II) may be configured as IN or OUT. To configure and activate this feature, use the following structures and functions. The trigger event data (trigger IN) is received as **`fcTriggerExInfoPacket`** or **`fcTriggerInfoPacket (Obsolete)`** with the **`fcbReceive`** function.

The OUT trigger level is depending on the FlexCard. Refer to the document Instructions for Use. It may be high or low active. The IN trigger does not detect the voltage level, but it detects either the rising or falling signal edge. This can be configured.

The following table lists the supported triggers during asynchronous and synchronous FlexRay monitoring.

Trigger	Supported in Asynch-Mode	Supported in Synch-Mode	Supported FlexCard
fcTriggerIn	OK	OK	FC Cyclone II (SE), FC USB-M
fcTriggerInOnSWPulse	OK	OK	FC Cyclone II (SE), FC USB-M
fcTriggerInOnSWTimer	OK	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnPulse	OK	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnTimeStampChanged	OK	OK	FC USB-M
fcTriggerOutOnCycle	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnSlotChX	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnSlotInCycleChX	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnCycleStart	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnErrorDetected	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnErrorX	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnStartupCompleted	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerOutOnStartDynamicSegment	-	OK	FC Cyclone II (SE), FC USB-M
fcTriggerPMCIn	OK	OK	FC PMC (II)
fcTriggerPMCOutOnPulse	OK	OK	FC PMC (II)
fcTriggerPMCOutOnTimeStampChanged	OK	OK	FC PMC (II)
fcTriggerPMCOutOnErrorDetected	-	OK	FC PMC (II)
fcTriggerPMCOutOnStartupCompleted	-	OK	FC PMC (II)
fcTriggerPMCOutOnCycleStart	-	OK	FC PMC (II)

	Information
	The IN trigger line of the FlexCard Cyclone II SE recognizes a trigger impuls only if it is longer than 50 us.

9.1 Enumerations

9.1.1 fcTriggerConditionEx

This enumeration defines the conditions available for a trigger configuration. It is used for the FlexCard Cyclone II (SE) and FlexCard USB-M. The conditions may be binary Ored.

```
Typedef enum fcTriggerConditionEx
{
       fcTriggerIn                              = 0x00000002,
       fcTriggerOutOnPulse                      = 0x00000004,
       fcTriggerInOnSWPulse                     = 0x00000008,
       fcTriggerInOnSWTimer                     = 0x00000010,
       fcTriggerOutOnCycle                      = 0x00000040,
       fcTriggerOutOnSlotChA                    = 0x00000080,
       fcTriggerOutOnSlotChB                    = 0x00000100,
       fcTriggerOutOnSlotInCycleChA             = 0x00000200,
       fcTriggerOutOnSlotInCycleChB             = 0x00000400,
       fcTriggerOutOnTimeStampChanged           = 0x00008000,
       fcTriggerOutOnCycleStart                 = 0x00010000,
       fcTriggerOutOnErrorDetected              = 0x00020000,
       fcTriggerOutOnStartupCompleted           = 0x00040000,
       fcTriggerOutOnStartDynamicSegment        = 0x00080000,
       fcTriggerOutOnErrorSFBM                  = 0x00100000,
       fcTriggerOutOnErrorSFO                   = 0x00200000,
       fcTriggerOutOnErrorCCF                   = 0x00400000,
       fcTriggerOutOnErrorSBVA                  = 0x00800000,
       fcTriggerOutOnErrorPERR                  = 0x01000000,
       fcTriggerOutOnErrorEDA                   = 0x02000000,
       fcTriggerOutOnErrorLTVA                  = 0x04000000,
       fcTriggerOutOnErrorTABA                  = 0x08000000,
       fcTriggerOutOnErrorEDB                   = 0x10000000,
       fcTriggerOutOnErrorLTVB                  = 0x20000000,
       fcTriggerOutOnErrorTABB                  = 0x40000000,
       fcTriggerOutOnErrorSBVB                  = 0x80000000,
}fcTriggerConditionEx;
```

Members

fcTriggerIn
: A trigger packet is generated as soon as the set edge (falling/rising) is detected on the input trigger line.

fcTriggerOutOnPulse
: A signal is generated on the output trigger line as soon as the condition is set to the driver.

fcTriggerInOnSWPulse
: A trigger packet is generated as soon as the trigger function is called.

fcTriggerInOnSWTimer
: A trigger packet is generated by a set time interval.

fcTriggerOutOnCycle
: A signal is generated on the output trigger line at each start of a set FlexRay cycle.

fcTriggerOutOnSlotChA
: A signal is generated on the output trigger line at each start of a set FlexRay slot on channel A.

fcTriggerOutOnSlotChB
: A signal is generated on the output trigger line at each start of a set FlexRay slot on channel B.

fcTriggerOutOnSlotInCycleChA
: A signal is generated on the output trigger line at each start of a set slot in a set FlexRay cycle on channel A.

fcTriggerOutOnSlotInCycleChB
: A signal is generated on the output trigger line at each start of a set slot in a set FlexRay cycle on channel B.

fcTriggerOutOnTimeStampChanged
: A signal is generated on the output trigger line at each change of the internal FlexCard time stamp.

fcTriggerOutOnCycleStart
: A signal is generated on the output trigger line at a FlexRay cycle start.

fcTriggerOutOnErrorDetected
: A signal is generated on the output trigger line at a detected FlexRay error.

fcTriggerOutOnStartupCompleted
: A signal is generated on the output trigger line at a completed FlexRay start-up.

fcTriggerOutOnStartDynamicSegment
: A signal is generated on the output trigger line at the start of the FlexRay dynamic segment.

fcTriggerOutOnErrorSFBM
: A signal is generated on the output trigger line at the FlexRay error SFBM (sync frame below minimum).

fcTriggerOutOnErrorSFO
: A signal is generated on the output trigger line at the FlexRay error SFO (sync frame overflow).

fcTriggerOutOnErrorCCF
: A signal is generated on the output trigger line at the FlexRay error CCF (clock correction failure).

fcTriggerOutOnErrorSBVA
: A signal is generated on the output trigger line at the FlexRay error SBVA (slot boundary violation channel A).

fcTriggerOutOnErrorPERR
: A signal is generated on the output trigger line at the FlexRay error PERR (parity error).

fcTriggerOutOnErrorEDA
: A signal is generated on the output trigger line at the FlexRay error EDA (error detected on channel A).

fcTriggerOutOnErrorLTVA
: A signal is generated on the output trigger line at the FlexRay error LTVA (latest transmit violation channel A).

fcTriggerOutOnErrorTABA
: A signal is generated on the output trigger line at the FlexRay error TABA (transmission across boundary channel A).

fcTriggerOutOnErrorEDB
: A signal is generated on the output trigger line at the FlexRay error EDB (error detected on channel B).

fcTriggerOutOnErrorLTVB
: A signal is generated on the output trigger line at the FlexRay error LTVB (latest transmit violation channel B).

fcTriggerOutOnErrorTABB
: A signal is generated on the output trigger line at the FlexRay error TABB (transmission across boundary channel B).

fcTriggerOutOnErrorSBVB
: A signal is generated on the output trigger line at the FlexRay error SBVB (slot boundary violation channel B).

See Also

fcbSetTrigger, **fcTriggerConfigurationEx**

Remarks

In the FlexRay monitoring mode DebugAsynchron only the conditions *fcTriggerIn*, *fcTriggerOutOnPulse*, *fcTriggerInOnSWTimer*, *fcTriggerInOnSWPulse* and *fcTriggerOutOnTimeStampChanged* can be used.

9.1.2 fcTriggerConditionPMC

This enumeration defines the conditions available for a trigger configuration of a FlexCard PMC (II). Please note that these conditions can not be OR-ed.

```
Typedef enum fcTriggerConditionPMC
{
       fcTriggerPMCNone = 0x00000000,
       fcTriggerPMCIn = 0x00000100,
       fcTriggerPMCOutOnPulse = 0x00001000,
       fcTriggerPMCOutOnTimeStampChanged = 0x00002000,
       fcTriggerPMCOutOnErrorDetected = 0x00010000,
       fcTriggerPMCOutOnStartupCompleted = 0x00020000,
       fcTriggerPMCOutOnCycleStart = 0x00100000,
} fcTriggerConditionPMC;
```

Members

fcTriggerPMCNone
: This value can be used instead of zero.

fcTriggerPMCIn
: A trigger packet is generated as soon as the set edge (falling/rising) is detected on the input trigger line.

fcTriggerPMCOutOnPulse
: A signal is generated on the output trigger line as soon as the condition is set to the driver.

fcTriggerPMCOutOnTimeStampChanged
: A signal is generated on the output trigger line if the internal FlexCard time stamp was changed.

fcTriggerPMCOutOnErrorDetected
: A signal is generated on the output trigger line at a detected FlexRay error.

fcTriggerPMCOutOnStartupCompleted
: A signal is generated on the output trigger line at a completed FlexRay start-up.

fcTriggerPMCOutOnCycleStart
: A signal is generated on the output trigger line at a FlexRay cycle start.

See Also

fcbSetTrigger, **fcTriggerConditionEx**

Remarks

In the FlexRay monitoring mode DebugAsynchron only the conditions *fcTriggerPMCNone*, *fcTriggerPMCIn*, *fcTriggerPMCOutOnPulse* and *fcTriggerPMCOutOnTimeStampChanged* can be used.

9.2 Structures

9.2.1 fcTriggerConfigurationEx

This structure configures the triggers of the FlexCard. Using the parameter *Condition* the trigger is enabled. For *Condition* the enumeration *fcTriggerConditionEx* is used for FlexCard Cyclone II (SE) and FlexCard USB-M. To set more than one trigger condition the conditions available in *fcTriggerConditionEx* must be binary OR-ed. Setting *Condition* to zero resets all triggers. In case you add additional trigger conditions, they have to be binary OR-ed with the former ones. Otherwise the previous settings will be reset.

When you use a FlexCard PMC or PMC II, use *fcTriggerConditionPMC* as *Condition*. The conditions **cannot be OR-ed**. If you do it nevertheless, none of the conditions are set and an error message is returned. Set the parameter *TriggerLineToConfigure* to either 1 or 2. Set the parameter *TriggerGeneratingCC* to the CC index you wish to use.

Some conditions need additional parameters:

The condition *fcTriggerIn* demands to set the parameter *onEdge*.

The condition *fcTriggerInOnSWTimer* demands to set the parameter *onTimePeriod*.

The condition *fcTriggerOutOnCycle* demands to set the parameter *onCycle*.

The condition *fcTriggerOutOnSlotChA* demands to set the parameter *onSlotChA*.

The condition *fcTriggerOutOnSlotChB* demands to set the parameter *onSlotChB*.

The condition *fcTriggerOutOnSlotInCycleChA* demands to set the parameters *onSlotChA* and *onCycle*.

The condition *fcTriggerOutOnSlotInCycleChB* demands to set the parameters *onSlotChB* and *onCycle*.

The PMC conditions *fcTriggerPMCOutOnErrorDetected*, *fcTriggerPMCOutOnCycleStart* and *fcTriggerPMCOutOnStartupCompleted* demand to set the parameter *TriggerGeneratingCC.*

```
Typedef struct fcTriggerConfigurationEx
{
       fcDword Condition;
       fcDword onEdge;

       // for Cyclone II (SE) / USB only
       fcDword onCycle;
       fcDword onSlotChA;
       fcDword onSlotChB;
       fcDword onTimePeriod;
       fcDword Reserved1[4];

       // for PMC (II) only:
       fcDword TriggerLineToConfigure;
       fcCC    TriggerGeneratingCC;
       fcDword Reserved2[4];
} fcTriggerConfigurationEx;
```

Members

Condition

This parameter can be set to zero to disable all trigger conditions. To configure the trigger, set the parameter to a value from *fcTriggerConditionEx* or *fcTriggerConditionPMC*.

onEdge

This parameter has to be set when the condition *fcTriggerIn* is chosen.
Valid values are 0 = falling edge and 1 = rising edge. Setting the trigger edge for output triggers is NOT supported.

onCycle

This parameter has to be set when at least one of the conditions *fcTriggerOutOnCycle*, *fcTriggerOutOnSlotInCycleChA* and *fcTriggerOutOnSlotInCycleChB* are chosen.
Valid values range from 0 to 63.

onSlotChA

This parameter has to be set when at least on of the conditions *fcTriggerOutOnSlotChA* or *fcTriggerOutOnSlotInCycleChA* are chosen.
Valid values range from 1 to 2047.

onSlotChB

This parameter has to be set when at least one of the conditions *fcTriggerOutOnSlotChB* or *fcTriggerOutOnSlotInCycleChB* are chosen.
Valid values range from 1 to 2047.

onTimePeriod

This parameter is only used in timer mode. The unit is millisecond. On Windows, the minimum granularity is 16 ms.

Reserved1[4]

Reserved Dwords for possible later use.

TriggerLineToConfigure
(PMC (II) only) This parameter sets the trigger line which should be configured.
Valid values range from 1 to 2.

TriggerGeneratingCC
(PMC (II) only) This parameter has to be set when a CC dependent trigger condition was set.
Valid values are *fcCC1* to *fcCC4*.

Reserved2[4]
(PMC (II) only) Reserved Dwords for possible later use.

See Also

fcbSetTrigger, **fcTriggerConditionEx**, **fcTriggerConditionPMC**

9.3 fcbSetTrigger

This function configures and starts/stops triggers. For further information, refer to the structure fcTriggerConfigurationEx.

```
fcError fcbSetTrigger(
      fcHandle hFlexCard,
      fcTriggerConfigurationEx cfg
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

cfg
[IN] The **trigger configuration**

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcTriggerConfigurationEx, **fcTriggerConditionEx**

Example for FlexCard Cyclone II (SE) or FlexCard USB-M

```
// Generate a pulse at the beginning of a detected FlexRay error and on
// FlexRay cycle 3
fcTriggerConfigurationEx triggerCfg;
memset(&triggerCfg, 0, sizeof(fcTriggerConfigurationEx));
triggerCfg.Condition = 0;
triggerCfg.Condition |= (fcDword)fcTriggerOutOnErrorDetected;
triggerCfg.Condition |= (fcDword)fcTriggerOutOnCycle;
triggerCfg.onCycle = 3;
// Generate a trigger packet all 1000 milliseconds
triggerCfg.Condition |= (fcDword)fcTriggerInOnSWTimer;
triggerCfg.onTimePeriod = 1000;

fcError e = fcbSetTrigger(hFlexCard,triggerCfg);
```

Example for FlexCard PMC (II)

```
// Generate a pulse on trigger line 1 when the Communication Controller 2
// completed its FlexRay start-up
fcTriggerConfigurationEx triggerCfg;
memset(&triggerCfg, 0, sizeof(fcTriggerConfigurationEx));
triggerCfg.Condition = fcTriggerPMCOutOnStartupCompleted;
triggerCfg.TriggerLineToConfigure = 1;
triggerCfg.TriggerGeneratingCC = fcCC2;

fcError e = fcbSetTrigger(hFlexCard,triggerCfg);

// Generate a trigger packet when a pulse on trigger line 2 is detected
triggerCfg.Condition = fcTriggerPMCIn;
triggerCfg.TriggerLineToConfigure = 2;

fcError e = fcbSetTrigger(hFlexCard,triggerCfg);
```

10 Termination API

This chapter shows how to configure the on-board termination of the FlexCard PMC and FlexCard PMC-II.

10.1 Enumerations

10.1.1 fcBusChannel

This enumeration defines the bus channels available on the card.

```
Typedef enum fcBusChannel
{
       fcBusChannel1 = 1,
       fcBusChannel2 = 2,
       fcBusChannel3 = 3,
       fcBusChannel4 = 4,
       fcBusChannel5 = 5,
       fcBusChannel6 = 6,
       fcBusChannel7 = 7,
       fcBusChannel8 = 8,
} fcBusChannel;
```

Members

fcBusChannel1
: Identifies bus channel 1.

fcBusChannel2
: Identifies bus channel 2.

fcBusChannel3
: Identifies bus channel 3.

fcBusChannel4
: Identifies bus channel 4.

fcBusChannel5
: Identifies bus channel 5.

fcBusChannel6
: Identifies bus channel 6.

fcBusChannel7
: Identifies bus channel 7.

fcBusChannel8
: Identifies bus channel 8.

See Also

fcbSetBusTerminationCc, **fcbGetBusTerminationCc**, **fcbSetBusTermination**, **fcbGetBusTermination**

10.2 fcbSetBusTerminationCc

This function sets the bus termination individually for each Communication Controller channel.

```
fcError fcbSetBusTerminationCc(
       fcHandle hFlexCard,
       fcBusType BusType,
       fcCC CC,
       fcChannel Channel
       fcBool bTermination
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

BusType
[IN] The bus type termination.

CC
[IN] Index of the bus type Communication Controller.

Channel
[IN] FlexRay channel(s) that shall be terminated. This parameter needs only to be set for *fcBusTypeFlexRay*.

bTermination
[IN] Set the value <> 0 to enable the bus termination. Set the value 0 to disable the bus termination.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbGetBusTerminationCc

	Information
	This function is initially supported by FlexCard API version S6V1-F.

10.3 fcbGetBusTerminationCc

This function reads the bus termination individually for each Communication Controller channel.

```
fcError fcbGetBusTerminationCc(
       fcHandle hFlexCard,
       fcBusType BusType,
       fcCC CC,
       fcChannel Channel
       fcBool* pbTermination
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

BusType
[IN] The bus type termination.

CC
[IN] Index of the bus type Communication Controller.

Channel
[IN] States the FlexRay channel(s) for which the termination status is read. This parameter needs only be set for *fcBusTypeFlexRay*.

pbTermination

[OUT] The current bus termination. The value 0 indicates a disabled termination. A value <> 0 indicates an enabled termination.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbSetBusTerminationCc

	Information
	This function is initially supported by FlexCard API version S6V1-F.

10.4 fcbSetBusTermination

This function sets the bus termination individually for each hardware bus channel.

```
fcError fcbSetBusTermination(
      fcHandle hFlexCard,
      fcBusChannel BusChannel,
      fcBusType BusType,
      fcBool bTermination
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

BusChannel

[IN] The bus channel describes the channel at which the termination should be switched on or off.

BusType

[IN] The bus type describes which bus protocol/transceiver is used for the channel. Different bus protocols/transceivers demand different bus terminations.

bTermination

[IN] This parameter enables or disables the bus termination

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbGetBusTermination

Example

```
fcBusChannel busChannel = fcBusChannel3;
fcBusType busType = fcBusTypeFlexRay;
bool bTerm = true; // enable termination

// set FlexRay termination on bus channel 3
fcError e = fcbSetBusTermination(m_hFlexCard,busChannel,busType,bTerm);
```

Remarks

The termination will not be switched off by the driver automatically if the application closes the device or the driver will be unloaded. So the bus will not be disturbed by termination loss in case the user application fails.

The bus channels for a FlexCard PMC (II) are named channel1 to channel 8 as shown in the figures below. Please note that the bus type (FlexRay or CAN) of channel 3 and 4 for a FlexCard PMC/PCI need to be set by dip switches as described in the FlexCard PMC (II) instructions for use.

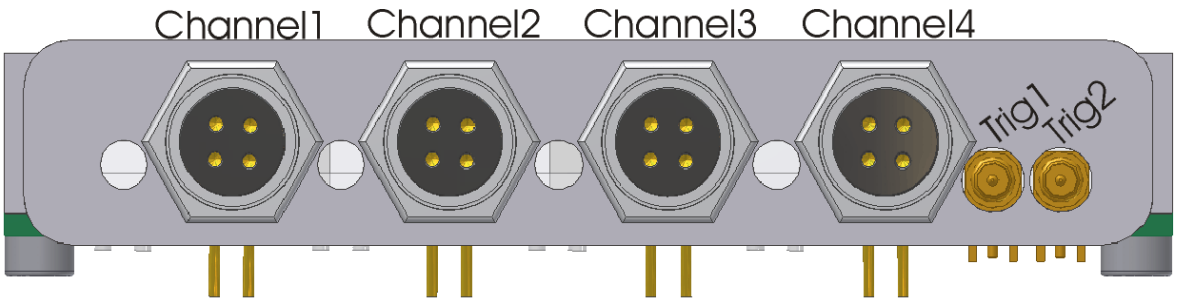


Figure 12: FlexCard PMC front panel

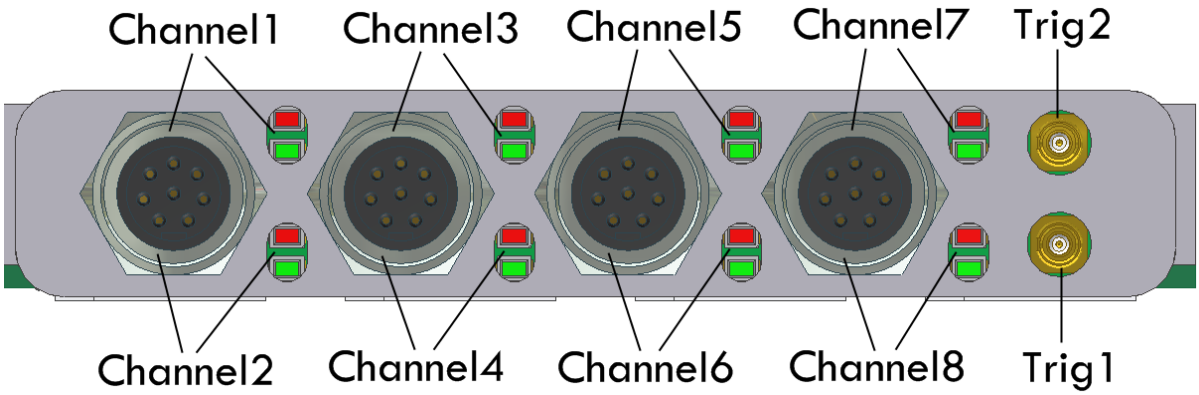


Figure 13: FlexCard PMC-II front panel

10.5 fcbGetBusTermination

This function reads the current bus termination individually for each hardware bus channel.

```
fcError fcbGetBusTermination(
      fcHandle hFlexCard,
      fcBusChannel BusChannel,
      fcBusType BusType,
      fcBool* pbTermination
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

BusChannel

[IN] The bus channel of the termination.

BusType

[IN] The bus type describes which bus termination type has be to be checked. Currently only FlexRay bus terminations are available.

pbTermination

[OUT] This parameter value describes whether the bus termination is enabled or disabled.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbSetBusTermination

11 Firmware API

This chapter shows how to get information about the firmware of a FlexCard and switch to another firmware slot. The functions only work on FlexCard PMC-II and FlexCard USB-M. The FlexCard USB-M offers 2 firmware slots while the FlexCard PMC-II offers 8.

11.1 Structures

11.1.1 fcFWInfo

This structure defines the information about one of the stored firmwares (user image) on the FlexCard PMC-II/USB-M. The information is read with **fcbFWGetImageInfo**.

```
Typedef struct fcFWInfo
{
       fcNumberCC NumberOfCCs;
       fcVersionNumber FwVersion;
       fcDword bIsActive : 1;
       fcDword Reserved[3];
} fcFWInfo;
```

Members

NumberOfCCs
Contains the number of available CCs that are supported by the firmware. Note that the CCs only work if they are licensed.

FwVersion
Contains the version number of the firmware.

bIsActive
Shows whether the stated firmware index is currently running on the FlexCard PMC-II.

Reserved
Data is reserved for future use.

See Also

fcbFWGetImageInfo, **fcNumberCC**, **fcVersionNumber**

	Information
	This function is initially supported by FlexCard API version S6V1-F.

11.2 fcbFWGetImageInfo

This function reads information about a firmware slot. If supported by the FlexCard, it has a number of firmware slots and each slot can hold a firmware (also called user image). A user image can be activated by **fcbFWSelectImage**. The firmware slot update or activation on a FlexCard PMC-II take effect after a complete shut down of the PC. On a FlexCard USB-M, the changes take effect after reconnecting it. Whether an image slot is active at the moment can be checked with the flag *bIsActive* in the struct **fcFWInfo**.

```
fcError fcbFWGetImageInfo (
      fcHandle hFlexCard,
      fcDword index,
      fcFWInfo* pFWInfo
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

index

[IN] The firmware slot whose information should be read.

pFWInfo

[OUT] Pointer to the image information struct.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcFWInfo, **fcbFWSelectImage**

	Information
	This function is initially supported by FlexCard API version S6V1-F.

11.3 fcbFWSelectImage

This function selects a firmware slot. If supported by the FlexCard, it has a number of firmware slots and each slot can hold a firmware (also called user image). The firmware slot update or activation on a FlexCard PMC-II takes effect after a complete shut down of the PC. On a FlexCard USB-M, the changes take effect after reconnecting it. Information about an image slot can be read with **fcbFWGetImageInfo**.

```
fcError fcbFWSelectImage(
      fcHandle hFlexCard,
      fcDword index
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

index

[IN] The firmware slot that should be activated.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbFWGetImageInfo

	Information
	This function is initially supported by FlexCard API version S6V1-F.

12 Additional Linux API

There are additional functions available in the FlexCard Linux driver.

	Information
	This chapter refers to the new FlexCard Linux driver! For the old FlexCard Linux driver (S5V3), please refer to the API Documentation for S5V3.

12.1 Integration

For a detailed description of the installation process, please refer to the text file *Read_Me.txt* which is included in the *tar.gz* archive.

To use the additional Linux API, please include the header file *fcBaseLinux.h* in your application.

After a successful installation please check the correct device initialization with cat /proc/flexcard.

12.2 Event

12.2.1 fcbSetEventHandleSemaphore

This function registers an event handle (as semaphore) for a specific notification type. *hEvent* must be an unnamed POSIX semaphore from type (sem_t).

```
fcError fcbSetEventHandleSemaphore(
      fcHandle hFlexCard,
      fcCC CC,
      fcHandle hEvent,
      fcNotificationType type
)
```

Parameters

hFlexCard
: [IN] Handle to a FlexCard

CC
: [IN] Communication controller index

hEvent
: [IN] Event handle to be registered to signal when a new cycle starts or a timer interval has elapsed depending on the given type.

Type
: [IN] The notification type for which the event has to be registered.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcNotificationType**

Remarks

The table below gives an overview of the **fcNotificationType** which are CC specific and which is not.

CC specific fcNotificationType	CC global fcNotificationType
fcNotificationTypeFRCycleStarted fcNotificationTypeFRWakeup fcNotificationTypeFRCcTimer	fcNotificationTypeTimer

13 Additional Xenomai API

There is a difference in the event handling between the FlexCard Xenomai driver and the other drivers for the FlexCard products. Instead of **`fcbSetEventHandleV2`** function, the **`fcbWaitForEventV2`** function should be used.

Please note that if the fcbOpen call took place in non-real-time context, fcbClose must be issued within non-real-time as well. Otherwise, the call to fcbClose will fail.

CAUTION

The FlexCard **Xenomai driver** version S6V5-F does **not** support the FlexCard Cyclone II (SE) officially.

Please don't use these cards with enabled device interrupts. This may lead to system freeze.

13.1 Integration

For a detailed description of the installation process, please refer to the text file *Read_Me.txt* which is included in the zip archive.

After a successful installation please check the correct device initialisation with 'cat/proc/xeno_flexcard'. All installed devices must be shown with versions and irq info. Please compare the irq info with used irqs (cat/proc/interrupts). Make sure no non real time device shares an irq with a FlexCard.

To use the additional Xenomai API, please include the header file *fcBaseXENOMAI.h* in your application.

13.2 Structures

13.2.1 fcFROffsetSynchronization

This structure describes the configuration of a FlexRay offset synchronization.

```
typedef struct fcFROffsetSynchronization
{
    fcBool activate;
    fcCC masterCc;
    fcCC slaveCc;
    fcBool relative;
    fcDword cycleOffset;
    fcDword macrotickOffset;
    fcBool resync;
    fcDword resyncMacrotickOffset;
    fcDword reserved[6];
} fcFROffsetSynchronization;
```

Members

activate
: Activate the firmware offset synchronization between a master and a slave FlexRay network.

masterCc
: The master CC to which the slave will be synchronized with a precise time delay. Currently must be fcCC1!

slaveCc
: The slave CC which follows the master with a precise time delay. Currently must be fcCC2!

relative
When the bit relative is activated, the firmware synchronizes the master and the slave CC but disregards the cycle number.

cycleOffset
The cycle offset value.

macrotickOffset
The macrotick offset value.

resync
When the bit resync is activated, the firmware stops to establish an offset synchronization after a certain amount of macroticks passed. This duration is defined with the variable resyncMacrotickOffset. The application has to call fcbFRMonitoringStop and then fcbFRMonitoringStart in order to retry the offset synchronization. This is useful when the target and actual value are far apart and the firmware would take very long to bring them together.

resyncMacrotickOffset
Value in macroticks in which the firmware tries to establish an offset synchronization.

Reserved[6]
Data is reserved for future use.

13.3 Event

13.3.1 fcbWaitForEventV2

This function makes a safe real time I/O-Control that blocks the user process in kernel-space, until an event of the given type occurs or the event does not appear within the specified amount of time. The driver's kernel interrupt service routine then unblocks and the program routine continues. You don't need to set a handle with **fcbSetEventHandle (Obsolete)** or **fcbSetEventHandleV2**.

```
fcError fcbWaitForEventV2(
       fcHandle hFlexCard,
       fcCC CC,
       fcNotificationType type,
       fcDword nTimeout
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

CC
[IN] Communication controller index

type
[IN] The notification type for which event has to be waited for.

nTimeout
[IN] The maximum amount of time in usec to wait for the event.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC, **fcNotificationType**

Remarks

The table below gives an overview of the **fcNotificationType** which are CC specific and which is not.

CC specific fcNotificationType	CC global fcNotificationType
fcNotificationTypeFRCycleStarted fcNotificationTypeFRWakeup fcNotificationTypeFRCcTimer	fcNotificationTypeTimer

13.4 Initialization

13.4.1 fcbFRSetOffsetSynchronization

This function synchronizes two FlexRay networks with a defined time delay. The master always comes first and the slave follows. This feature may be used to route frames from the master to the slave CC in the same FlexRay cycle number. Make sure that the time offset is big enough to route the frames. However, when you make the time offset too large, routing frames the other way (from the slave to the master) will lead to a bigger time offset. The user has to make a trade-off here.

The following figure shows a FlexRay offset synchronization with an in-cycle offset of half a cycle and a cycle offset of 0. This makes it possible to receive ID 3, manipulate the value and send it on the slave network in the same cycle number.

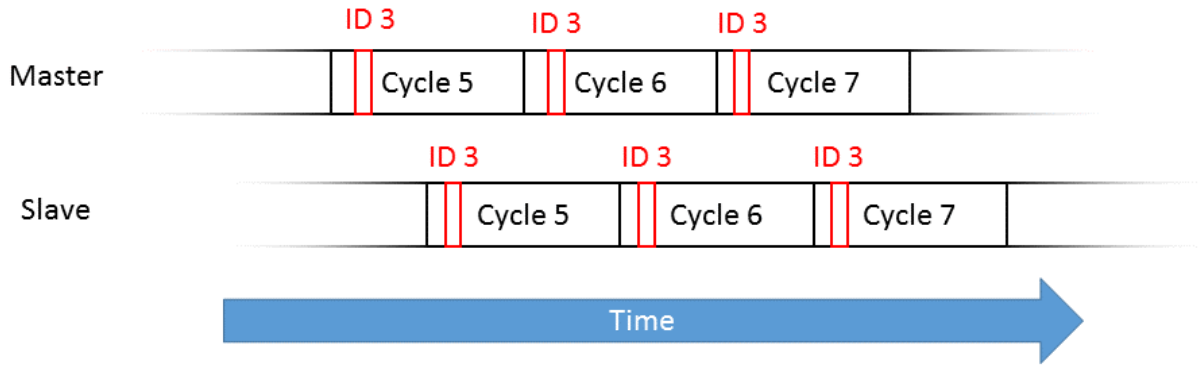


Figure 14: Example for a FlexRay offset synchronization

The user must set the parameters pExternOffsetCorrection and pExternRateCorrection via fcbFRSetCcConfigurationChi or fcbFRSetCcConfiguration. These parameters control how big an external offset correction is. Valid values for these parameters are 0 to 7 microticks.

vExternOffsetControl and vExternRateControl can have three values:

- 0 (no offset control)
- 2 (add the correction value)
- 3 (substract the correction value)

The user must set those values to 0. The FlexCard sets these values. This way it controls the time offset between the master and the slave.

pOffsetCorrectionOut and pRateCorrectionOut hold the maximum allowed offset correction values.

- pOffsetCorrectionOut: 5 to 15266 microticks
- pRateCorrectionOut: 2 to 1923 microticks

Those parameters should be set high enough.

Example: pExternOffsetCorrection is set to 7 microticks. When the defined time offset between the master and the slave is not reached yet, the FlexCard control adds 7 microticks offset each cycle.

Calling fcbFRSetOffsetSynchronization is only allowed when the CCs are not running. The offset synchronization is only possible if `fcMonitoringNormal` is used on both CCs and the slave CC sends a startup/sync frame.

When the offset synchronization is activated, the startup/sync frame from the slave CC should not come immediately after a different sync frame. E.g., when a communication partner uses frame Id 5 as sync frame, the slave CC should use frame Id 7 or higher with startup/sync bit.

Please note that a firmware with FlexRay offset synchronization is required.

```
fcError fcbFRSetOffsetSynchronization(
            fcHandle hFlexCard,
            fcFROffsetSynchronization offsetSync
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

offsetSync

[IN] Configures the offset synchronization.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Example

```
// precondition: valid flexcard handle exists

// add code here to call fcbFRSetCcConfiguration or
// fcbFRSetCcConfigurationChi for fcCC1 and fcCC2.

// add code here to configure the FlexRay message buffers

fcFROffsetSynchronization offsetSync;
memset(&offsetSync, 0, sizeof(offsetSync));

offsetSync.activate = 1;
offsetSync.masterCc = fcCC1;
offsetSync.slaveCc = fcCC2;
offsetSync.relative = 0;
offsetSync.cycleOffset = 3;
offsetSync.macrotickOffset = 20;
offsetSync.resync = 0;
offsetSync.resyncMacrotickOffset = 0;

// create a time offset so that the slave CC runs 3
// cycles and 20 macroticks later than the master CC.
fcError e = fcbFRSetOffsetSynchronization(hFlexCard, offsetSync);
if (0 == e)
{
      // add code here to start monitoring on fcCC1 and fcCC2
}
else
{
      // error handling …
}
```

13.5 Obsolete

13.5.1 fcbWaitForEvent (Obsolete)

	Information
	This function is obsolete. Please use **fcbWaitForEventV2** instead.

This function makes a safe real time I/O-Control that blocks the user process in kernel-space, until an event of the given type occurs or the event does not appear within the specified amount of time. The driver's kernel interrupt service routine then unblocks and the program routine continues. You don't need to set a handle with **fcbSetEventHandle (Obsolete)**.

```
fcError fcbWaitForEvent(
       fcHandle hFlexCard,
       fcNotificationType hEvent,
       fcDword nTimeout
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

hEvent

[IN] The notification type for which event has to be waited for.

nTimeout

[IN] The maximum amount of time in usec to wait for the event.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcNotificationType

Remarks

The table below gives an overview of the fcNotificationType which are CC specific and which is not. To use the CC specific fcNotificationType, the CC index has to be set.

CC specific fcNotificationType	CC global fcNotificationType
fcNotificationTypeCycleStarted fcNotificationTypeWakeup	fcNotificationTypeTimer

14 Additional VxWorks API

The VxWorks driver provides additional functionality for the FlexCard PMC. Please note that there are also some fcBase API functions and type definitions which were changed or are not supported by the VxWorks driver. The VxWorks driver only supports multiple CC indexes by using the function `fcbSetCcIndex`. The FRxxx functions are not supported.

To use the driver in a user application, the header files *fcPmcDrv.h*, *fcBaseTypesVxWorks.h* and *fcbBaseVxWorks.h* have to be included in that order.

14.1 Integration

For a detailed description of the installation process, please refer to the text file *Read_Me.txt* which is included in the zip archive.

	Information
	The FlexCard **VxWorks driver** version S1V2-F supports only the FlexCard PMC firmware version S1V2-F. The FlexCard **VxWorks driver** version S2V1-F supports only the FlexCard PMC firmware version S5V2-F with 2 FR 191ehavior191atio controllers. Other driver and 191ehavior version are not compatible.

14.1.1 fcDrvInit

This function initializes the FlexCard PMC VxWorks driver.

```
STATUS fcDrvInit()
```

Return values

If the function succeeds, the return value is (OK). If the value is (ERROR) the driver couldn't be initialized.

See Also

fcDrvExit

14.1.2 fcDrvExit

This function finalizes the FlexCard PMC VxWorks driver.

```
STATUS fcDrvExit()
```

Return values

If the function succeeds, the return value is (OK). If the value is (ERROR) the driver couldn't be finalized.

See Also

fcDrvInit

14.2 Restrictions / Changes

14.2.1 Not Supported Type Definitions

The VxWorks driver doesn't support the following type definitions:

fcFreeMemory
fcTriggerCondition (Obsolete)
fcTriggerType (Obsolete)
fcTriggerMode (Obsolete)
fcTriggerCfgHardware (Obsolete)
fcTriggerCfgSoftware (Obsolete)
fcTriggerCfg (Obsolete)
fcTriggerInfoPacket (Obsolete)
fcTriggerConditionEx

14.2.2 Changed Type Definitions

14.2.2.1 fcVersion

This structure provides version information about the FlexCard hardware and software components.

```
Typedef struct fcVersion
{
       fcVersionNumber    DeviceDriver;
       fcVersionNumber    Firmware;
       fcVersionNumber    Hardware;
       fcCCType           CCType;
       fcVersionNumber    CC;
       fcVersionNumber    BusGuardian;
       fcVersionNumber    Protocol;
       fcDword            Serial;
       fcFlexCardDeviceId DeviceId;
       fcDword            Reserved[3];
} fcVersion;
```

Members

DeviceDriver
Device driver version

Firmware
Firmware (gateway software) version

Hardware
FlexCard hardware version

CCType
Communication controller type

CC
Communication controller module version

BusGuardian
Bus Guardian version

Protocol
FlexRay Protocol version

Serial
FlexCard serial number. A zero value indicates a non-valid FlexCard serial number.

DeviceId
Device identifier to detect the FlexCard type (FlexCard Cyclone II, FlexCard Cyclone II SE or FlexCard PMC)

Reserved[3]
Reserved for internal purpose

See Also

fcInfo, fcbGetEnumFlexCards (Obsolete), fcFlexCardDeviceId

14.2.2.2 fcTriggerConfigurationEx

This structure is used for the configuration of a trigger. By using the parameter *Condition* several triggers can be enabled. The trigger conditions of the FlexCard PMC are defined in the enumeration **fcTriggerConditionPMC**. The **conditions cannot be combined (OR-ed)**. If it is done, none of the conditions will be set and an error message will be returned.

The conditions fcTriggerPMCOutOnErrorDetected, fcTriggerPMCOutOnCycleStart and fcTriggerPMCOutOnStartupCompleted demand to set the parameter *TriggerGeneratingCC*. Please note the FlexCard trigger lines are not hard defined as IN or OUT trigger lines. Therefore a valid value has always to be set for the parameter *TriggerLineToConfigure*.

```
Typedef struct fcTriggerConfigurationEx
{
       fcDword Condition;
       fcDword onEdge;
       fcDword TriggerLineToConfigure;
       fcCC    TriggerGeneratingCC;
       fcDword Reserved[4];
} fcTriggerConfigurationEx;
```

Members

Condition
: This parameter can either be set to 0 (fcTriggerPMCNone) to reset the trigger or to any condition available in fcTriggerConditionPMC.

onEdge
: This parameter has to be set when the condition fcTriggerPMCIn is chosen. Valid values are 0 = falling edge and 1 = rising edge.

TriggerLineToConfigure
: This parameter sets the trigger line which should be configured. Valid values range from 1 to 2.

TriggerGeneratingCC
: This parameter has to be set when a CC dependent trigger condition was set. Valid values range from fcCC1 to fcCC2.

Reserved[4]
: Reserved Dwords for possible later use.

See Also

fcbSetTrigger, **fcTriggerConditionPMC**

14.2.2.3 fcNotificationType

This enumeration defines different notification types. These types are used in the functions **fcbSetEventHandle**. and **fcbSetNotificationTypeCount** to specify on which kind of event the application has to be notified.

```
Typedef enum fcNotificationType
{
      fcNotificationTypeCycleStarted      = 1,
      fcNotificationTypeTimer             = 2,
      fcNotificationTypeWakeup            = 3,
      fcNotificationTypeRxCount           = 4,
      fcNotificationTypeTxCount           = 5,
      fcNotificationTypeInfoCount         = 6,
      fcNotificationTypeErrorCount        = 7,
      fcNotificationTypeStatusCount       = 8,
      fcNotificationTypeTriggerCount      = 9,
      fcNotificationTypeNMVCount          = 10,
      fcNotificationTypeNotificationCount = 11,
      fcNotificationTypeCcTimer           = 12,
} fcNotificationType;
```

Members

fcNotificationTypeCycleStarted
: Used to notify that a new cycle has started and that probably new data has been received.

fcNotificationTypeTimer
: Used to notify that the timer interval has elapsed. This notification requires the internal timer of the FlexCard to be enabled (See **fcbSetTimer**).

fcNotificationTypeWakeup
: Used to notify that one of the transceivers has received a wake-up event (only if one of the transceivers was in sleep mode).

fcNotificationTypeRxCount
: Used to notify that the configured amount of FlexRay frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeTxCount
: Used to notify that the configured amount of TxAcknowledge frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeInfoCount
: Used to notify that the configured amount of info frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeErrorCount
: Used to notify that the configured amount of error frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeStatusCount
: Used to notify that the configured amount of status frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeTriggerCount
: Used to notify that the configured amount of trigger frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeNMVCount
: Used to notify that the configured amount of network management vector frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeNotificationCount
: Used to notify that the configured amount of notification frames has been received. This notification can be configured (See **fcbSetNotificationTypeCount**).

fcNotificationTypeCcTimer
: Used to notify that the configured CC timer macrotick offset has elapsed.

See Also

fcbMonitoringStart, **fcbSetEventHandle**, **fcbSetNotificationTypeCount**, **fcbSetTimer**, **fcbSetCcTimerConfig (Obsolete)**

14.2.2.4 fcTriggerExInfoPacket

This structure provides information about a trigger packet.

```
Typedef struct fcTriggerExInfoPacket
{
       fcDword Condition;
       fcDword TimeStamp;
       fcDword SequenceCount;
       fcDword Edge;
       fcDword TriggerLine;
       fcDword Reserved[4];
} fcTriggerExInfoPacket;
```

Members

Condition
The fulfilled condition which has caused the trigger packet generation.

TimeStamp
The FlexCard time stamp (1 µs resolution). Indicates the time at which the packet was generated.

SequenceCount
Sequence count for each signal.

Edge
The edge on which the trigger was signalled.

TriggerLine
The trigger line which detected a trigger signal.

Reserved[4]
Reserved for future use.

See Also

fcPacket

14.2.2.5 fcPacketType

This enumeration contains the different packet types.

```
Typedef enum fcPacketType
{
       fcPacketTypeInfo          = 1,
       fcPacketTypeFlexRayFrame  = 2,
       fcPacketTypeError         = 3,
       fcPacketTypeStatus        = 4,
       fcPacketTypeTxAcknowledge = 6,
       fcPacketTypeNMVector      = 7,
       fcPacketTypeNotification  = 8,
       fcPacketTypeTriggerEx     = 9,
} fcPacketType;
```

Members

fcPacketTypeInfo
Frame is an info packet.

fcPacketTypeFlexRayFrame
Frame is a FlexRay frame.

fcPacketTypeError
Frame is an error packet.

fcPacketTypeStatus
Frame is a status packet.

fcPacketTypeTxAcknowledge
Frame is a transmit acknowledge packet.

fcPacketTypeNMVector
Frame is a network management vector packet.

fcPacketTypeNotification
Frame is a notification packet.
fcPacketTypeTriggerEx
Frame is a trigger packet.

See Also

fcPacket, **fcInfoPacket**, **fcFlexRayFrame**, **fcTxAcknowledgePacket**, **fcErrorPacket**, **fcStatusPacket**, **fcNMVectorPacket**, **fcNotificationPacket**, **fcTriggerExInfoPacket**

14.2.2.6 fcPacket

This structure provides information about a packet.

```
Typedef struct fcPacket
{
       fcPacketType Type;
       union
       {
              fcFlexRayFrame*         FlexRayFrame;
              fcInfoPacket*           InfoPacket;
              fcErrorPacket*          ErrorPacket;
              fcStatusPacket*         StatusPacket;
              fcTriggerExInfoPacket*  TriggerExPacket;
              fcTxAcknowledgePacket*  TxAcknowledgePacket;
              fcNMVectorPacket*       NMVectorPacket;
              fcNotificationPacket*   NotificationPacket;
       };
       fcPacket* pNextPacket;
} fcPacket;
```

Members

Type
Type of packet.
FlexRayFrame
Pointer to the packet data. The content depends on the type of packet.
InfoPacket
Pointer to the packet data. The content depends on the type of packet.
ErrorPacket
Pointer to the packet data. The content depends on the type of packet.
StatusPacket
Pointer to the packet data. The content depends on the type of packet.
TriggerExPacket
Pointer to the packet data. The content depends on the type of packet.
TxAcknowledgePacket
Pointer to the packet data. The content depends on the type of packet.
NMVectorPacket
Pointer to the packet data. The content depends on the type of packet.
NotificationPacket
Pointer to the packet data. The content depends on the type of packet.
pNextPacket
Pointer to the next packet. If the pointer is NULL, there are no more packets available.

See Also

fcPacketType, **fcInfoPacket**, **fcFlexRayFrame**, **fcTxAcknowledgePacket**, **fcErrorPacket**, **fcStatusPacket**, **fcNMVectorPacket**, **fcNotificationPacket**, **fcTriggerExInfoPacket**

14.2.2.7 fcState

This enumeration defines the possible Communication Controller POC states (FlexRay Protocol Specification: vPOC!State). For more details about Communication Controller POC states, please refer to [3].

```
Typedef enum fcState
{
       fcStateUnknown = 0,
       fcStateDefaultConfig,
       fcStateReady,
       fcStateNormalActive,
       fcStateNormalPassive,
       fcStateHalt,
       fcStateMonitorMode,
       fcStateConfig,

       fcStateWakeupStandby,
       fcStateWakeupListen,
       fcStateWakeupSend,
       fcStateWakeupDetect,

       fcStateStartupPrepare,
       fcStateColdstartListen,
       fcStateColdstartCollisionResolution,
       fcStateColdstartConsistencyCheck,
       fcStateColdstartGap,
       fcStateColdstartJoin,
       fcStateIntegrationColdstartCheck,
       fcStateIntegrationListen,
       fcStateIntegrationConsistencyCheck,
       fcStateInitializeSchedule,
       fcStateAbortStartup,
       fcStateStartupSuccess,
}fcState;
```

Members

fcStateUnknown
: Communication controller state is not known.

fcStateDefaultConfig
: Communication controller is in DEFAULT_CONFIG state.

fcStateReady
: Communication controller is in READY state.

fcStateNormalActive
: Communication controller is in NORMAL_ACTIVE state.

fcStateNormalPassive
: Communication controller is in NORMAL_PASSIVE state.

fcStateHalt
: Communication controller is in HALT state.

fcStateMonitorMode
: Communication controller is in MONITORMODE state

fcStateConfig
: Communication controller is in CONFIG state.

fcStateWakeupStandby
: Communication controller is in WAKEUP_STANDBY state.

fcStateWakeupListen
: Communication controller is in WAKEUP_LISTEN state.

fcStateWakeupSend
: Communication controller is in WAKEUP_SEND state.

fcStateWakeupDetect
: Communication controller is in WAKEUP_DETECT state.

fcStateStartupPrepare
: Communication controller is in STARTUP_PREPARE state.

fcStateColdstartListen
: Communication controller is in COLDSTART_LISTEN state.

fcStateColdstartCollisionResolution
: Communication controller is in COLDSTART_COLLISION_RESOLUTION state.

fcStateColdstartConsistencyCheck
: Communication controller is in COLDSTART_CONSISTENCY_CHECK state.

fcStateColdstartGap
: Communication controller is in COLDSTART_GAP state.

fcStateColdstartJoin
: Communication controller is in COLDSTART_JOIN state.

fcStateIntegrationColdstartCheck
: Communication controller is in INTEGRATION_COLDSTART_CHECK state.

fcStateIntegrationListen
: Communication controller is in INTEGRATION_LISTEN state.

fcStateIntegrationConsistencyCheck
: Communication controller is in INTEGRATION_CONSISTENCY_CHECK state.

fcStateInitializeSchedule
: Communication controller is in INITIALIZE_SCHEDULE state.

fcStateAbortStartup
: Communication controller is in ABORT_STARTUP state.

fcStateStartupSuccess
: Communication controller is in STARTUP_SUCCESS state.

See Also

fcbGetCcState, **fcbMonitoringStart**

14.2.2.8 fcFlexRayFrame

This structure is equivalent to the FlexRay frame described in the FlexRay specification [3].

```
Typedef struct fcFlexRayFrame
{
    fcDword ID : 11;
    fcDword STARTUP : 1;
    fcDword SYNC : 1;
    fcDword NF : 1;
    fcDword PP : 1;
    fcDword R : 1;
    fcDword PayloadLength : 7;
    fcDword CycleCount : 6;
    fcDword HeaderCRC : 11;
    fcWord* pData;

    fcChannel Channel;
    fcDword ValidFrame : 1;
    fcDword SyntaxError : 1;
    fcDword ContentError : 1;
    fcDword SlotBoundaryViolation : 1;
    fcDword AsyncMode : 1;
    fcDword FrameCRC : 24;

    fcDword TimeStamp;
    fcCC    CC;
} fcFlexRayFrame;
```

Members

ID

The frame id defines the slot in which the frame was transmitted.
(FlexRay Protocol Specification: vRF!Header!FrameID)

STARTUP

Indicates if the frame is a start-up frame (=1) or not (=0)
(FlexRay Protocol Specification: vRF!Header!SuFIndicator)

SYNC

Indicates if the frame is a sync frame (=1) or not (=0)
(FlexRay Protocol Specification: vRF!Header!SyFIndicator)

NF

Set to 0, the null frame indicator indicates that *pData* contains no valid data. Set to 1, it indicates that *pData* contains valid data.
(FlexRay Protocol Specification: vRF!Header!NFIndicator)

PP

The payload preamble indicator indicates whether or not an optional vector is contained within the payload segment of the frame transmitted. In the static segment, it indicates the presence of a network management vector at the beginning of the payload. In the dynamic segment it indicates the presence of a message id at the beginning of the payload, (FlexRay Protocol Specification: vRF!Header!PPIndicator).

R

Reserved Bit (FlexRay Protocol Specification: vRF!Header!Reserved)

PayloadLength

Defines the number of 16-bit words contained in *pData*
(FlexRay Protocol Specification: vRF!Header!Length)

CycleCount

The cycle in which the frame was received. (FlexRay Protocol Specification: vRF!Header!CycleCount)

HeaderCRC

The header CRC containing the cyclic redundancy check code is computed over the sync frame indicator, the start-up frame indicator, the frame id and the payload length.(FlexRay Protocol Specification: vRF!Header!HeaderCRC)

pData
The pointer to the payload data. The payload is given in 16-bit words.
(FlexRay Protocol Specification: vRF!Payload)

Channel
The channel (A or B) on which the frame was received.
(FlexRay Protocol Specification: vRF!Channel)

ValidFrame
If a valid frame was received, this parameter is set to 1 (FlexRay Protocol Specification: vSS!ValidFrameA or vSS!ValidFrameB depends on Channel - Table 9-2: Slot status interpretation)

SyntaxError
If a syntax error was observed, this parameter is set to 1 (frame is syntactically incorrect). (FlexRay Protocol Specification: vSS!SyntaxErrorA or vSS!SyntaxErrorB depends on Channel)

ContentError
If a content error was observed, this parameter is set to 1 (frame is semantically incorrect). (FlexRay Protocol Specification: vSS!ContentErrorA or vSS!ContentErrorB depends on Channel)

SlotBoundaryViolation
If a slot boundary violation was observed, this parameter is set to 1 (FlexRay Protocol Specification: vSS!BviolationA or vSS!BviolationB depends on Channel)

AsyncMode
If the packet was generated by the asynchronous debug mode, this parameter is set to 1.

FrameCRC
If the packet was generated by the asynchronous debug mode, the FrameCRC contains the cyclic redundancy check code is computed over complete frame. In synchronous monitoring mode, this parameter is not set.

TimeStamp
The FlexCard time stamp (1 µs resolution). The timestamp marks the begin of the reception of the frame.

CC
The FlexCard CC which created this packet.

	Information
	The payload length is a multiple of 16-bit words. The payload data is also given in 16-bit words.

	Information
	Members *AsyncMode* and *FrameCRC* are initially supported by FlexCard VxWorks driver S2V1-F.

14.2.2.9 fcTxAcknowledgePacket

This structure provides information about a transmit acknowledge packet. Transmit acknowledge packets are used to inform the user when a frame is transmitted.

```
Typedef struct fcTxAcknowledgePacket
{
    fcDword BufferId;
    fcDword TimeStamp;
    fcDword CycleCount;

    fcDword ID : 11;
    fcDword STARTUP : 1;
    fcDword SYNC : 1;
    fcDword NF : 1;
    fcDword PP : 1;
    fcDword R : 1;
    fcDword PayloadLength : 7;
    fcDword ValidFrame : 1;
    fcDword SyntaxError : 1;
    fcDword ContentError : 1;
    fcDword HeaderCRC : 11;
    fcWord* pData;
    fcChannel Channel;
    fcCC CC;
} fcTxAcknowledgePacket;
```

Members

BufferId

The buffer id used to transmit the frame (equivalent to the buffer id returned by the function **fcbFRConfigureMessageBuffer**).

TimeStamp

The FlexCard time stamp (1 µs resolution). The timestamp marks the beginning of the transmission of the frame.

CycleCount

Indicates the cycle in which the frame was transmitted. (FlexRay Protocol Specification: vTF!Header!CycleCount)

ID

The frame id defines the slot in which the frame was transmitted.

STARTUP

Indicates if the frame was a start-up frame (=1) or not (=0)

SYNC

Indicates if the frame was a sync frame (=1) or not (=0)

NF

Set to 0, the null frame indicator indicates that *pData* contains no valid data. Set to 1, it indicates that *pData* contains valid data.

PP

The payload preamble indicator indicates whether or not an optional vector is contained within the payload segment of the frame transmitted. In the static segment, it indicates the presence of a network management vector at the beginning of the payload. In the dynamic segment it indicates the presence of a message id at the beginning of the payload.

R

Reserved Bit

PayloadLength

Defines the number of 16-bit words contain in *pData*

ValidFrame

If a valid frame was received, this parameter is set to 1 (FlexRay Protocol Specification: vSS!ValidFrameA or vSS!ValidFrameB depends on Channel - Table 9-2: Slot status interpretation)

SyntaxError

If a syntax error was observed, this parameter is set to 1 (frame is syntactically incorrect). (FlexRay Protocol Specification: vSS!SyntaxErrorA or vSS!SyntaxErrorB depends on Channel)

ContentError
If a content error was observed, this parameter is set to 1 (frame is semantically incorrect). (FlexRay Protocol Specification: vSS!ContentErrorA or vSS!ContentErrorB depends on Channel)

HeaderCRC
The header CRC contains the cyclic redundancy check code is computed over the sync frame indicator, the start-up frame indicator, the frame id and the payload length.

pData
The pointer to the payload data. The payload is given in 16-bit words.

Channel
The channel (A or B) on which the frame was transmitted.
(FlexRay Protocol Specification: vRF!Channel)

CC
The FlexCard CC which created this packet.

	Information
	Members *ValidFrame*, *SyntaxError*, *ContentError* and *HeaderCRC* are initially supported by FlexCard VxWorks driver S2V1-F.

14.2.3 Not Supported Functions

The VxWorks driver doesn't support the following functions:

```
fcGetErrorText
fcFreeMemory
fcbCanDbCcConfiguration (Obsolete)
fcbTrigger (Obsolete)
fcbGetEnumFlexCardsV2 (Obsolete)
```

14.2.4 Changed Functions

14.2.4.1 fcbMonitoringStart

This function is used to start the monitoring of a FlexRay bus. Once called, the function changes the Communication Controller state from configuration state to normal active state (if the cluster integration succeeds). The current Communication Controller state can be read using the function **fcbGetCcState (Obsolete)**. If the FlexCard is synchronized with the cluster the function **fcbGetCcState (Obsolete)** will return the value *fcStateNormalActive*. Please note, that if an event for the event counter (for the several packet type) is registered with **fcbSetEventHandle**, this function activates the corresponding hardware interrupts and the application is notified if this event occurred.

```
fcError fcbMonitoringStart(
       fcHandle hFlexCard,
       fcMonitoringModes mode,
       bool restartTimestamps,
       bool enableCycleStartEvents
       bool enableColdstart,
       bool enableWakeup
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard.

Mode
[IN] The monitoring mode. See **fcMonitoringModes** for details.

restartTimestamps
[IN] Set this parameter to false to restart the measurement without resetting the FlexCard timestamp. Set it to true to start the measurement from the beginning. The timestamps have micro second resolution.

enableCycleStartEvents
[IN] Set this parameter to true to enable the cycle start events in order that at the beginning of every cycle the event `fcNotificationTypeCycleStarted` is signalled.

enableColdstart
[IN] Set this parameter to true to allow the FlexCard to initialize the cluster communication, otherwise the coldstart inhibit mode is active. This feature can not be used in the monitoring modes `fcMonitoringDebug` and `fcMonitoringDebugAsynchron`.

enableWakeup
[IN] Set this parameter to true to transmit a wake-up pattern to the configured wake-up channel (FlexRay Protocol Specification: pWakeupChannel). A cluster wake-up must precede the communication start-up to ensure that all nodes in a cluster are awake. The minimum requirement for a cluster wake-up is that all bus drivers are supplied with power. This feature can not be used in the monitoring modes `fcMonitoringDebug` and `fcMonitoringDebugAsynchron`.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

After the monitoring has started, the user should check if the integration in the cluster was successful: **`fcbGetCcState (Obsolete)`** should return the state `fcStateNormalActive`.

	Information
	After the monitoring has successfully started, the receive process has to be started as soon as possible to avoid an overflow (error packet `fcErrFlexcardOverflow` is received). Once an overflow occurred, no more packets can be received. The monitoring has to be stopped and started again.

See Also

`fcbMonitoringStop`, **`fcbGetCcState (Obsolete)`**, **`fcMonitoringModes`**, **`fcbSetEventHandle`**

14.2.4.2 fcbMonitoringStop

This function stops the FlexRay bus measurement. The Communication Controller is set back in its configuration state.

Please note, that if an event for the event counter (for the several packet types) is registered with **`fcbSetEventHandle`**, **`this function`** deactivates the corresponding hardware interrupts and the application is not notified if this event occurred.

```
fcError fcbMonitoringStop(
      fcHandle hFlexCard
)
```

Parameters

hFlexCard
[IN] Handle to FlexCard

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbMonitoringStart

14.2.4.3 fcbSetEventHandle

This function registers an event handle for a specific notification type. The event handling is based on binary semaphores.

```
fcError fcbSetEventHandle(
      fcHandle hFlexCard,
      fcHandle hEvent,
      fcNotificationType type
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

hEvent

[IN] Event handle to be registered. This value depends on the given *type*. Set this parameter to NULL to deregister the event handle for the given type.

Type

[IN] The notification type for which the event has to be registered.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcNotificationType

Example

See Example in **fcbSetNotificationTypeCount**

14.2.4.4 fcbReceive

This function reads all available packets from the FlexCard memory into a memory block allocated by the fcBase API during the initialization phase in **fcbOpen**. The frames are stored into a linked list. The memory allocated by this function is released by the **fcbClose** function. Please note, that every function call from **fcbReceive** overwrites the old frames in the memory block. The size of the memory block can be configured with **fcbSetReceiveMemorySize**.

```
fcError fcbReceive(
      fcHandle hFlexCard,
      fcPacket** pPacket
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

pPacket

[OUT] Address of the `fcPacket` object pointer. The memory for this structure and its content is allocated by the fcBase API. Packets are available if the return code is 0 and *pPacket* is not a null pointer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Example

```
fcPacket* pPackets = NULL;
fcError e = fcbReceive(m_hFlexCard, &pPackets);
if (0 == e)
{
      fcPacket* pCurrentPacket = pPacket;
      while (NULL != pCurrentPacket)
      {
            switch (pCurrentPacket->Type)
            {
            case fcPacketTypeInfo:
            {
                  fcInfoPacket* pFrame = pCurrentPacket->InfoPacket;
                  printf("[fcPacketTypeInfo] CC: %d TimeStamp: %f Cycle: %d",
                        pFrame->CC + 1,
                        (float) pFrame->TimeStamp * 0.000001,
                        pFrame->CurrentCycle);
                  printf(" Rate Correction: %d", pFrame->RateCorrection);
                  printf(" Offset Correction: %d", pFrame->OffsetCorrection);
                  printf(" Clock Correction Failed Counter: %d",
                        pFrame->ClockCorrectionFailedCounter);
                  printf(" Passive to Active Count: %d",
                        pFrame->PassiveToActiveCount);
                  printf("\n");
                  break;
            }

            case fcPacketTypeFlexRayFrame:
            {
                  fcFlexRayFrame* pFrame = pCurrentPacket->FlexRayFrame;
                  printf("[fcPacketTypeFlexRayFrame] CC: %d TimeStamp: %f "
                        "Cycle: %d ID: %d Channel: %d PayloadLength: %d",
                        pFrame->CC + 1,
                        (float) pFrame->TimeStamp * 0.000001,
                        pFrame->CycleCount,
                        pFrame->ID,
                        pFrame->Channel,
                        pFrame->PayloadLength);

                  for (int i = 0; i < pFrame->PayloadLength; i++)
                  {
                        printf(" %04X", pFrame->pData[i]);
                  }

                  if (pFrame->PP) printf(" PP");
                  if (pFrame->NF) printf(" NF");
                  if (pFrame->SYNC) printf(" SYNC");
                  if (pFrame->STARTUP) printf(" STARTUP");
                  if (pFrame->SyntaxError) printf(" SyntaxError");
                  if (pFrame->ContentError) printf(" ContentError");
                  if (pFrame->ValidFrame) printf(" ValidFrame");
                  if (pFrame->SlotBoundaryViolation)
                        printf(" SlotBoundaryViolation");
                  printf("\n");
                  break;
            }

            case fcPacketTypeError:
                  printf("[fcPacketTypeError]\n");
                  break;

            case fcPacketTypeStatus:
                  printf("[fcPacketTypeStatus]\n");
                  break;
```

```
            case fcPacketTypeTriggerEx:
                  printf("[fcPacketTypeTriggerEx]\n");
                  break;

            case fcPacketTypeTxAcknowledge:
                  printf("[fcPacketTypeTxAcknowledge]\n");
                  break;

            case fcPacketTypeNMVector:
                  printf("[fcPacketTypeNMVector]\n");
                  break;
            }

            pCurrentPacket = pCurrentPacket->pNextPacket;
      }
}
```

14.3 Configuration

14.3.1 fcbSetPacketGeneration

This function allows to dis- or enable the generation of a packet type. It is designed to reduce the amount of packets, which will be generated by the FlexCard.

```
fcError fcbSetPacketGeneration(
      fcHandle hFlexCard,
      fcPacketType type,
      bool bEnable
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

type

[IN] The packet type.

bEnable

[IN] Set to true to enable the generation and to false to disable it.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbReceive, **fcPacketType**

14.3.2 fcbSetReceiveMemorySize

This function allows configuring the size of memory, where **fcbReceive** will store all received frames. This function has to be called before you open a connection to the FlexCard. During the 206ehavior206ation phase (in **fcbOpen**) the amount of memory is dynamically allocated. Closing the connection (by **fcbClose**) releases the memory automatically.

```
fcError fcbSetReceiveMemorySize(
      fcDword size;
)
```

Parameters

size

[IN] The size of memory. The default value is 128 kB and it is recommended to set *size* in a range from 20 kB to 70 MB. Other values than the recommended values are ignored and *size* will be set to default.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbReceive, **fcbOpen**, **fcbClose**

14.4 Event

14.4.1 fcbSetNotificationTypeCount

This function allows configuring the event counter for the several packet types. *Count* represents the amount of packets (of a dedicated packet type) which need to be received to initiate an event of the chosen notification packet type.

```
fcError fcbSetNotificationTypeCount(
      fcHandle hFlexCard,
      fcNotificationType type,
      fcByte count
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

type

[IN] The notification type for which the configuration has to be used. The notification types *fcNotificationTypeCycleStarted*, *fcNotificationTypeWakeup*, *fcNotificationTypeTimer* and *fcNotificationTypeCcTimer* are not supported.

Count

[IN] The value represents the amount of packets (of a dedicated packet type) which need to be received to initiate an event of the chosen notification packet type. Valid values range from 1 to 255.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcNotificationType, **fcbSetEventHandle**, **fcbMonitoringStart**, **fcbMonitoringStop**

Example

```
fcPacket* pPackets = NULL;
SEM_ID semInfoCount = NULL;
semInfoCount = semBCreate(SEM_Q_FIFO, SEM_EMPTY);
assert (NULL != semInfoCount);

fcError e = fcbSetEventHandle(m_hFlexCard, (void *) semInfoCount, \
      fcNotificationTypeInfoCount);
if (0 == e)
{
      // Configure the Info packet event counter
      fcbSetNotificationTypeCount(m_hFlexCard,fcNotificationTypeInfoCount, 2);

      // Start monitoring and wait for the event forever
      fcbMonitoringStart(m_hFlexCard, fcMonitoringNormal, 1, 0, 0, 0);
      semTake(semInfoCount, WAIT_FOREVER);

      // Min. 2 Info packets can be received now
      e = fcbReceive(m_hFlexCard, &pPackets);
      if (0 == e)
      { /* Process packets */ }
}
```

15 Obsolete

15.1 fcInfo (Obsolete)

Information
This structure is obsolete. Please use **fcInfoHwSw** instead.

This structure provides information about the components and the identifier of a FlexCard. If more than one FlexCard is detected on the system, the **fcbGetEnumFlexCards (Obsolete)** function returns a linked list of this structure. If a connection to a FlexCard is already opened, this FlexCard does not appear in this list.

```
Typedef struct fcInfo
{
       fcDword FlexCardId;
       fcVersion Version;
       struct fcInfo* pNext;
} fcInfo;
```

Members

FlexCardId
Unique number used to identify a FlexCard. This id is required to open a connection to the FlexCard.

Version
Version information about hardware and software components of the FlexCard.

pNext
Pointer to the next available FlexCard. If no other FlexCard exists, `pNext` is a null pointer.

See Also

fcVersion (Obsolete), **fcbGetEnumFlexCards (Obsolete)**

15.2 fcInfoV2 (Obsolete)

Information
This structure is obsolete. Please use **fcInfoHwSw** instead.

This structure provides information about the components, the identifier and the current device state of a FlexCard. If more than one FlexCard is detected on the system, the **fcbGetEnumFlexCardsV2 (Obsolete)** function returns a linked list of this structure.

```
Typedef struct fcInfoV2
{
       fcDword FlexCardId;
       fcVersion Version;
       fcDword Busy;
       fcDword Reserved;
       struct fcInfoV2* pNext;
} fcInfoV2;
```

Members

FlexCardId
Unique number used to identify a FlexCard. This id is required to open a connection to the FlexCard.

Version
: Version information about hardware and software components of the FlexCard.

Busy
: The current device state. A value <> 0 indicates a connection to this FlexCard is already opened.

Reserved
: Reserved for future use.

pNext
: Pointer to the next available FlexCard. If no other FlexCard exists, `pNext` is a null pointer.

See Also

fcVersion (Obsolete), **fcbGetEnumFlexCardsV2 (Obsolete)**

15.3 fcVersion (Obsolete)

	Information
	This structure is obsolete. Please use **fcInfoHw** and **fcInfoSw** instead.

This structure provides version information about the FlexCard hardware and software components.

```
Typedef struct fcVersion
{
       fcVersionNumber BaseDll;
       fcVersionNumber DeviceDriver;
       fcVersionNumber Firmware;
       fcVersionNumber Hardware;
       fcCCType CCType;
       fcVersionNumber CC;
       fcVersionNumber BusGuardian;
       fcVersionNumber Protocol;
       fcDword Serial;
       fcFlexCardDeviceId DeviceId;
       fcVersionCC* pVersionCC;
       fcDword Reserved[2];
}fcVersion;
```

Members

BaseDll
: DLL Base Version

DeviceDriver
: Device driver version

Firmware
: Firmware (gateway software) version

Hardware
: FlexCard hardware version

CCType
: Communication controller type

CC
: Communication controller module version

BusGuardian
: Bus Guardian version

Protocol
: FlexRay Protocol version

Serial
: FlexCard serial number. A zero value indicates a non-valid FlexCard serial number.

DeviceId
Device identifier to detect the FlexCard type (FlexCard Cyclone II, FlexCard Cyclone II SE or FlexCard PMC).

pVersionCC
Pointer to version information about the available Communication Controllers.

Reserved
Reserved for internal purpose

See Also

fcFlexCardDeviceId, **fcInfo (Obsolete)**, **fcInfoV2 (Obsolete)**, **fcbGetEnumFlexCards (Obsolete)**, **fcbGetEnumFlexCardsV2 (Obsolete)**

15.4 fcbGetEnumFlexCards (Obsolete)

	Information
	This function is obsolete. Please use **fcbGetEnumFlexCardsV3** instead.

This function returns a linked list of the unused FlexCards found on the system. To free the memory, which was allocated by the function, please use the function **fcFreeMemory** with type *fcMemoryTypeInfo*.

```
fcError fcbGetEnumFlexCards(
      fcInfo** pInfo
)
```

Parameters

pInfo
[OUT] linked list of **fcInfo (Obsolete)** objects

Return values

If the function succeeds, the return value is 0. If the function fails the content of `pInfo` is not valid. The error code `NULL_PARAMETER` is returned if `pInfo` parameter is a null pointer. If the memory allocation fails, the error code `MEMORY_ALLOCATION_FAILED` is returned.

Remarks

If a connection to a FlexCard is already opened, this FlexCard does not appear in this list. If the function succeeds, there will always be one valid **fcInfo (Obsolete)** structure regardless if there is a FlexCard in the system or not. This functionality is given to provide version information about the DLL / library. The version information concerning the hardware is only valid if the identifier (***pInfo->FlexCardId***) is not 0.

	Information
	This function allocates memory for use. To prevent memory leaks you have to free it up by calling the function **fcFreeMemory** with the type *fcMemoryTypeInfo*. From FlexCard API version S2V0-F on it is possible to use four FlexCards in one PC. With FlexCard API versions up to S2V0-F it isn't possible to use two FlexCards in one PC at the same time. That means that only the first inserted FlexCard can be used. The second one doesn't appear in the list of available FlexCards. From FlexCard API version S6V1-F on it is possible to use eight FlexCards in one PC.

See Also

fcInfo (Obsolete),

15.5 fcbGetEnumFlexCardsV2 (Obsolete)

Information
This function is obsolete. Please use **fcbGetEnumFlexCardsV3** instead.

This function returns a linked list of the installed FlexCards found on the system. To free the memory, which was allocated by this function, please use the function **fcFreeMemory** with type *fcMemoryTypeInfoV2*.

```
fcError fcbGetEnumFlexCardsV2(
      fcInfoV2** pInfoV2
)
```

Parameters

pInfoV2

[OUT] linked list of **fcInfoV2 (Obsolete)** objects

Return values

If the function succeeds, the return value is 0. If the function fails the content of pInfoV2 is not valid. The error code NULL_PARAMETER is returned if pInfoV2 parameter is a null pointer. If the memory allocation fails, the error code MEMORY_ALLOCATION_FAILED is returned.

Remarks

If the function succeeds, there will always be one valid **fcInfoV2 (Obsolete)** structure regardless if there is a FlexCard in the system or not. This functionality is given to provide version information about the DLL / library. The version information concerning the hardware is only valid if the identifier (***pInfoV2->FlexCardId***) is not 0.

Information
This function allocates memory for use. To prevent memory leaks you have to free it up by calling the function **fcFreeMemory** with the type *fcMemoryTypeInfoV2*.

See Also

fcInfoV2 (Obsolete)

15.6 fcbMonitoringStart (Obsolete)

Information
This function is obsolete. Please use **fcbFRMonitoringStart** instead.

This function is used to start the monitoring of a FlexRay bus. Once called, the function changes the Communication Controller state from configuration state to normal active state (if the cluster integration succeeds). The current Communication Controller state can be read using the function **fcbGetCcState (Obsolete)**. If the FlexCard is synchronized with the cluster the function **fcbGetCcState (Obsolete)** will return the value *fcStateNormalActive*.

```
fcError fcbMonitoringStart(
      fcHandle hFlexCard,
      fcMonitoringModes mode,
      fcBool restartTimestamps,
```

```
      fcBool enableCycleStartEvents
      fcBool enableColdstart,
      fcBool enableWakeup
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

Mode

[IN] The monitoring mode. Not every monitoring mode is supported by all Communication Controllers. See **fcMonitoringModes** for details.

restartTimestamps

[IN] Set this parameter to 0 to restart the measurement without resetting the FlexCard timestamp. Set it to <> 0 to start the measurement from the beginning. The timestamps have micro second resolution.

enableCycleStartEvents

[IN] Set this parameter to <> 0 to enable the cycle start events in order that at the beginning of every cycle the event *fcNotificationTypeCycleStarted* is signalled.

enableColdstart

[IN] Set this parameter to <> 0 to allow the FlexCard to initialize the cluster communication, otherwise the coldstart inhibit mode is active. This feature can not be used in the monitoring modes `fcMonitoringDebug` and `fcMonitoringDebugAsynchron`.

enableWakeup

[IN] Set this parameter to <> 0 to transmit a wake-up pattern on the configured wake-up channel (FlexRay Protocol Specification: pWakeupChannel). A cluster wake-up must precede the communication start-up to ensure that all nodes in a cluster are awake. The minimum requirement for a cluster wake-up is that all bus drivers are supplied with power. This feature can not be used in the monitoring modes *fcMonitoringDebug* and *fcMonitoringDebugAsynchron*.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

After the monitoring has started, the user should check if the integration in the cluster was successful: **fcbGetCcState (Obsolete)** should return the state `fcStateNormalActive`.

	Information
	After the monitoring has successfully started, the receive process has to be started as soon as possible to avoid an overflow (error packet `fcErrFlexcardOverflow` is received). Once an overflow occurred, no more packets can be received. The monitoring has to be stopped and started again.

See Also

fcbMonitoringStop (Obsolete), **fcbGetCcState (Obsolete)**, **fcMonitoringModes**, **fcbSetEventHandle (Obsolete)**

15.7 fcbMonitoringStop (Obsolete)

Information
This function is obsolete. Please use **fcbFRMonitoringStop** instead.

This function stops the FlexRay bus measurement. The Communication Controller is set back in its configuration state.

```
fcError fcbMonitoringStop(
      fcHandle hFlexCard
)
```

Parameters

hFlexCard

[IN] Handle to FlexCard

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbMonitoringStart (Obsolete)

15.8 fcbGetCcState (Obsolete)

Information
This function is obsolete. Please use **fcbFRGetCcState** instead.

This function returns the current Communication Controller POC state. For a description of possible states, refer to the enumeration **fcState**. This function should be used to check if the integration into a FlexRay cluster has succeeded.

```
fcError fcbGetCcState(
      fcHandle hFlexCard,
      fcState* pState
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

pState

[OUT] Current Communication Controller state

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See

fcbMonitoringStart (Obsolete), **fcbMonitoringStop (Obsolete)**

15.9 fcbSetTransceiverState (Obsolete)

Information
This function is obsolete. Please use **fcbFRSetTransceiverState** instead.

This function sets the transceiver mode individually for each channel.

```
fcError fcbSetTransceiverState (
      fcHandle hFlexCard,
      fcTransceiverState stateChannelA,
      fcTransceiverState stateChannelB
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

stateChannelA
[IN] The new transceiver state for channel A

stateChannelB
[IN] The new transceiver state for channel B

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

If one of the transceivers is in the sleep mode and the transceiver detects a wake-up event, the notification event *fcNotificationTypeWakeup* is fired once only.

See

fcTransceiverState, **fcbMonitoringStart (Obsolete)**, **fcbGetTransceiverState (Obsolete)**

15.10 fcbGetTransceiverState (Obsolete)

Information
This function is obsolete. Please use **fcbFRGetTransceiverState** instead.

This function gets the transceiver state individually for each channel.

```
fcError fcbGetTransceiverState (
      fcHandle hFlexCard,
      fcTransceiverState* stateChannelA,
      fcTransceiverState* stateChannelB
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

stateChannelA
[OUT] The current transceiver state for channel A

stateChannelB
[OUT] The current transceiver state for channel B

Return values
If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks
If one of the transceiver is in the sleep mode and the transceiver detects a wake-up event, the notification event *fcNotificationTypeWakeup* is fired once only.

See
fcTransceiverState, fcbMonitoringStart (Obsolete), fcbSetTransceiverState (Obsolete)

15.11 fcbSetEventHandle (Obsolete)

Information
This function is obsolete. Please use **fcbSetEventHandleV2** or **fcbSetEventHandleSemaphore** instead.

This function registers an event handle for a specific notification type.

```
fcError fcbSetEventHandle(
      fcHandle hFlexCard,
      fcHandle hEvent,
      fcNotificationType type
)
```

Parameters
hFlexCard
[IN] Handle to a FlexCard
hEvent
[IN] Event handle to be registered to signal when a new cycle starts, a timer interval has elapsed or the FlexCard receive buffer reaches a specific filling level depending on the given *type*.
Type
[IN] The notification type for which the event has to be registered.

Return values
If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also
fcNotificationType

15.12 fcbTransmit (Obsolete)

Information
This function is obsolete. Please use **fcbFRTransmit** instead.

This function writes a data frame into a Communication Controller transmit buffer of the FlexCard. The frame should normally be transmitted in the next cycle. If the transmit acknowledgment is activated, an acknowledge packet is generated as soon as the frame has been transmitted. This function should only be called when the FlexCard is in normal active state or when all message buffer configurations have been done.

```
fcError fcbTransmit(
      fcHandle hFlexCard,
      fcDword bufferId,
      fcWord payload[],
      fcByte payloadLength
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

bufferId

[IN] The id of the message buffer used for the transmission

payload

The payload data to be transmitted

payloadLength

The size of the payload data (number of 2-byte words)

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.
The transmission may fail, if the buffer is currently in use (**fcGetErrorCode** returns `MSG_BUFFER_BUSY`). In that case retry later.

Remarks

The payload data has to be organized as follows: if Data0 is the first byte to transmit and Data1 the second byte to transmit, then the high byte (Bit 8 – 15) of payload[0] contains Data1, the low byte (Bit 0-7) of payload[0] contains Data0, etc.

Parameter `payload`	`payload[0]` (Word 0)		`payload[1]` (Word 1)		...
	High byte	Low byte	High byte	Low byte	...
FlexRay payload segment	Data 1	Data 0	Data 3	Data 2	...

15.13 fcbTransmitSymbol (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRTransmitSymbol** instead.

This function transmits a symbol in the symbol window segment. It can only be called if the Communication Controller is in the POC state NORMAL_ACTIVE. For a list of available symbols to be transmitted, see the enumeration fcSymbolType.

```
fcError fcbTransmitSymbol(
      fcHandle hFlexCard,
      fcSymbolType symbol
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

symbol
[IN] Type of symbol to transmit

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

15.14 fcbSetCcRegister (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRSetCcRegister** instead.

This function writes a value in a given register of the Communication Controller. Not every register can be written (e.g. the registers belonging to the message buffer configuration or some interrupt settings).

```
fcError fcbSetCcRegister(
      fcHandle hFlexCard,
      fcDword address,
      fcDword value
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

address
[IN] Address of the CC register to be written

value
[IN] The value to be written

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information. If the register can not be written the error code REGISTER_NOT_WRITEABLE is returned.

Remarks

For a register description, refer to the specification of the corresponding Communication Controller. Modifying one of the following registers will reset message buffers with their default settings (FIFO receive buffers). The user's message buffers configuration will not be valid anymore.
Bosch E-Ray: MHDC (0x0098) and GTUC7 (0x00B8)

	Information
	Not all registers of a Communication Controller can be set. The base API will modify some parameters so that the operation of the FlexCard is guaranteed (e.g. interrupt settings). Access is denied to all registers which are used for message buffer configuration.

See Also

fcbGetCcRegister (Obsolete)

15.15 fcbGetCcRegister (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRGetCcRegister** instead.

This function reads and returns the content of a given register of the Communication Controller.

```
fcError fcbGetCcRegister(
      fcHandle hFlexCard,
      fcDword  address,
      fcDword* pValue
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

address

[IN] Address of the CC register to be read.

pValue

[OUT] The content of the desired CC register.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information. If the register cannot be read the error code REGISTER_NOT_READABLE is returned.

Remarks

Not every register can be read. For a register description, refer to the specification of the corresponding Communication Controller.

See Also

fcbSetCcRegister (Obsolete)

15.16 fcbChiCcConfiguration (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRSetCcConfigurationChi** instead.

This function configures the Communication Controller of the FlexCard with a FlexConfig compatible configuration string (CHI File). The configuration string contains the global FlexRay parameter and/or the message buffer configuration. The payload data for transmit message buffers are not set by this function. Before the configuration of the Communication Controller starts, all message buffers are reset to their default settings (FIFO buffer).

```
fcError fcbChiCcConfiguration(
      fcHandle hFlexCard,
      const char* szChi
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

szChi

[IN] Pointer to null-terminated CHI content string (refer to the CHI string example section).
Please note: Do not use the CHI file name here, but the content of the CHI file as parameter value.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

	Information
	Internally, the function uses the function **fcbSetCcRegister (Obsolete)**; therefore the same restrictions as for writing registers exist.

See Also

fcbSetCcRegister (Obsolete)

15.17 fcbCanDbCcConfiguration (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRSetCcConfigurationCANdb** instead.

This function configures the Communication Controller of the FlexCard with a CANdb compatible string. The configuration string contains the global FlexRay parameter and/or the message buffer configuration. Before the configuration of the Communication Controller starts, all message buffers are reset to their default settings (FIFO buffer).

```
fcError fcbCanDbCcConfiguration(
      fcHandle hFlexCard,
      const char* szCanDb
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

szCanDb

[IN] Pointer to null-terminated CANdb string

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

This function is only available in the Windows FlexCard driver. The FlexCard Linux and Xenomai drivers don't support this function.

Information
Internally, the function uses the **fcbSetCcRegister (Obsolete)** function; therefore the same restrictions as for writing a register exist.

15.18 fcbConfigureMessageBuffer (Obsolete)

Information
This function is obsolete. Please use **fcbFRConfigureMessageBuffer** instead.

This function configures transmit, receive and FIFO message buffers of the Communication Controller. Configuring message buffers is only allowed if the Communication Controller is in its configuration state, *fcStateConfig*.

```
fcError fcbConfigureMessageBuffer(
      fcHandle hFlexCard,
      fcDword* bufferId,
      fcMsgBufCfg cfg
);
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

bufferId

[OUT] Message buffer identifier. If the configuration was successful the message buffer identifier is greater than 0. This identifier will be required to transmit the content of the buffer (in the case of a transmit buffer).

Cfg

[IN] Message buffer configuration parameters

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

Before configuring the message buffers, it is necessary to set up the global communication parameters (cluster parameters). Internally the FlexCard uses the FIFO buffers as receive buffers, therefore we recommend using FIFO message buffers as much as possible.

See Also

fcMsgBufCfg, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**, **fcMsgBufCfgFifo**

15.19 fcbReconfigureMessageBuffer (Obsolete)

Information
This function is obsolete. Please use **fcbFRReconfigureMessageBuffer** instead.

This function reconfigures transmit, receive and FIFO message buffers of the Communication Controller. A reconfiguration is only allowed for message buffers which are already configured. This function is available

in all states of the CC. Not all configuration settings can be modified in monitoring state. Refer to the documentation of the message buffer structures for further details.

```
fcError fcbReconfigureMessageBuffer(
       fcHandle hFlexCard,
       fcDword bufferId,
       fcMsgBufCfg cfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

bufferId

[IN] The identifier of the message buffer which should be reconfigured.

Cfg

[IN] Message buffer configuration parameters.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcMsgBufCfg, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**, **fcMsgBufCfgFifo**, **fcbConfigureMessageBuffer (Obsolete)**, **fcbGetCcMessageBuffer (Obsolete)**

15.20 fcbGetCcMessageBuffer (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRGetMessageBuffer** instead.

This function reads a specific message buffer configuration.

```
fcError fcbGetCcMessageBuffer(
       fcHandle hFlexCard,
       fcDword bufferId,
       fcMsgBufCfg* cfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

bufferId

[IN] The identifier of the message buffer to be read

cfg

[OUT] The configuration parameters of the specified message buffer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

Remarks

The buffer with id 1 is always a FIFO message buffer.

See Also

fcMsgBufCfg, **fcMsgBufCfgTx**, **fcMsgBufCfgRx**, **fcMsgBufCfgFifo**, **fcbConfigureMessageBuffer (Obsolete)**

15.21 fcbResetCcMessageBuffer (Obsolete)

Information
This function is obsolete. Please use **fcbFRResetMessageBuffers** instead.

This function resets the Communication Controller message buffers. After calling this function, all message buffers are configured as receive FIFO – with maximal payload (depends on the Communication Controller).

```
fcError fcbResetCcMessageBuffer(
      fcHandle hFlexCard
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

15.22 fcbFilter (Obsolete)

Information
This function is obsolete. Please use **fcbFRSetSoftwareAcceptanceFilter** or **fcbFRSetHardwareAcceptanceFilter** instead.

This function configures the frame ids accepted by the device driver. Only the ids which are in the filter list are forwarded to the user application, all other frames are rejected. To accept all frames set the parameters *pData* to NULL and nSize to zero or configure a single frame id of zero.

```
fcError fcbFilter(
      fcHandle hFlexCard,
      fcChannel channel,
      fcDword* pData,
      fcDword size
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

channel

[IN] FlexCard channel(s) concerned by the filter

pData

[IN] Pointer to a fcDword array containing the ids accepted by the device driver. Each element (fcDword) contains one frame identifier.

fcDword	fcDword
ID x	ID y

size
[IN] Number of ids in the array

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

15.23 fcbSetCcTimerConfig (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRSetCcTimerConfig** instead.

This function configures the Communication Controller timer interrupt. To get a notification when the Communication Controller timer interval elapsed, an event of type *fcNotificationTypeCcTimer* has to be registered by the function **fcbSetEventHandle (Obsolete)**. Additionally the Communication Controller timer can be enabled / disabled by this function.

```
fcError fcbSetCcTimerConfig(
      fcHandle hFlexCard,
      fcCcTimerCfg cfg,
      fcBool bEnable
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard.

Cfg
[IN] The Communication Controller timer configuration.

bEnable
[IN] Set to <> 0 to enable the CC timer, and to 0 to disable it.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbSetEventHandle (Obsolete), **fcCcTimerCfg**, **fcbGetCcTimerConfig (Obsolete)**

15.24 fcbGetCcTimerConfig (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRGetCcTimerConfig** instead.

This function reads the Communication Controller timer configuration.

```
fcError fcbGetCcTimerConfig(
      fcHandle hFlexCard,
      fcCcTimerCfg* pCfg
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

pCfg

[OUT] The configuration parameters of the CC timer.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCcTimerCfg, **fcbSetCcTimerConfig (Obsolete)**

15.25 fcbCalculateMacrotickOffset (Obsolete)

	Information
	This function is obsolete. Please use **fcbFRCalculateMacrotickOffset** instead.

This function calculates the macrotick offset for a specific cycle position in a FlexRay cycle.

```
fcError fcbCalculateMacrotickOffset(
      fcHandle hFlexCard,
      fcCyclePos CyclePosition,
      fcDword SlotOrMiniSlotId,
      fcDword* pValue
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard.

CyclePosition

[IN] The cycle position of type **fcCyclePos**.

SlotOrMiniSlotId

[IN] This parameter is used for a cycle position of *fcCyclePosStaticSlot* and *fcCyclePosDynamicMiniSlot* to calculate the macrotick offset for a static slot or a dynamic mini slot id.

pValue

[OUT] The macrotick offset value.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCyclePos, **fcCcTimerCfg**, **fcbSetCcTimerConfig (Obsolete)**

15.25.1 Trigger Configuration (Obsolete)

	Information
	This configuration is obsolete. Please see **`fcTriggerConfigurationEx`** instead.

If the FlexCard is equipped with a trigger interface, the FlexCard has the ability to receive trigger events and forward them to the user application. This feature allows e.g. a synchronization of different bus 226ehavior. To configure and activate this feature, use the following structures and functions. The trigger event data is received as **`fcTriggerInfoPacket (Obsolete)`** with the **`fcbReceive`** function.

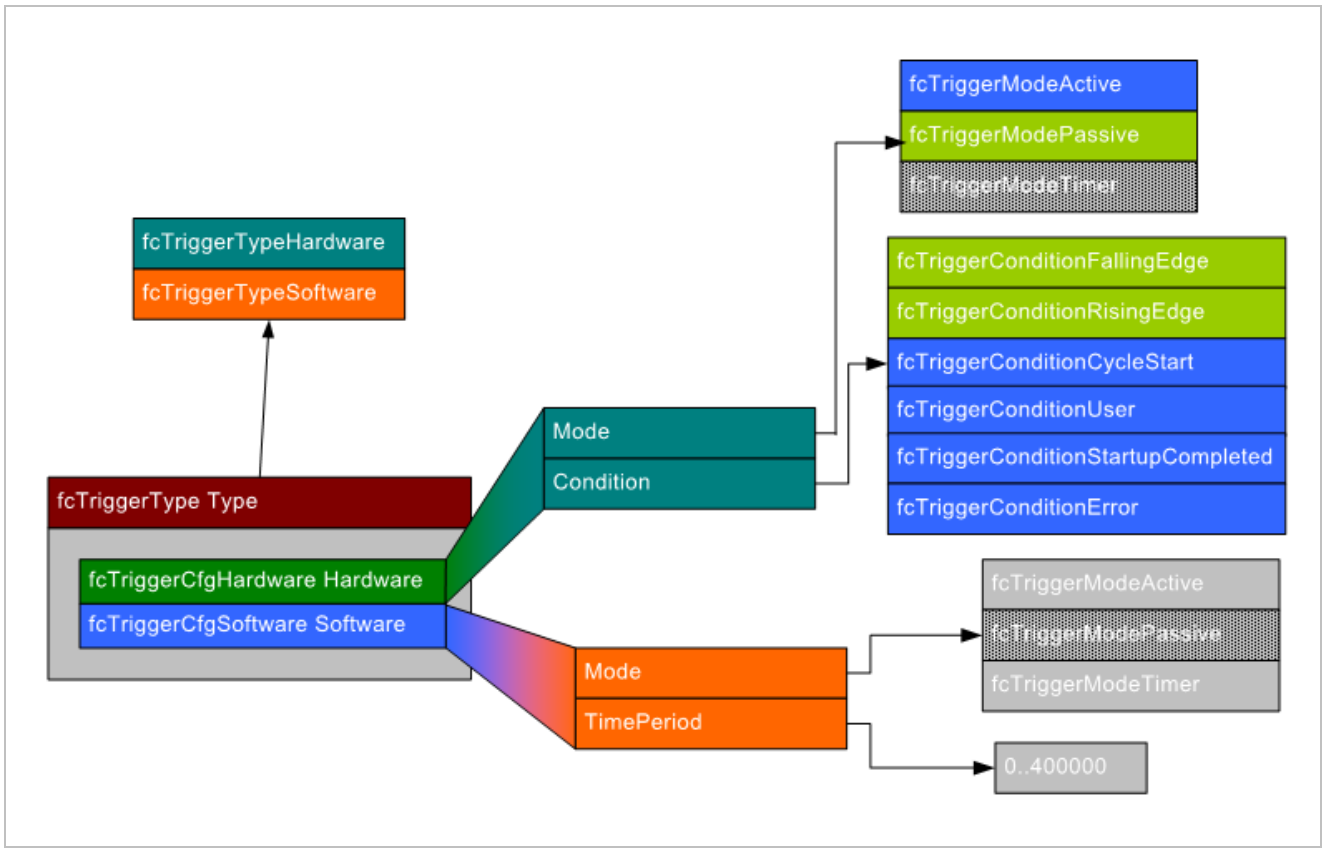


Figure 15: Overview obsolete structure fcbTriggerCfg

15.26 Typedefinitions (Obsolete)

15.26.1 fcTriggerCfgHardware (Obsolete)

This structure configures the hardware trigger. In the passive mode, the FlexCard waits for trigger events on its input line and generates a **`fcTriggerInfoPacket (Obsolete)`** object each time a trigger event is received. In this mode, the parameter *`Condition`* specifies on which condition the input signal will be recognized as a trigger event. In the active mode, the FlexCard generates a pulse on its output line when a trigger event is signalled. In this mode, the parameter *`Condition`* specifies on which condition a pulse will be generated by the FlexCard. For information about the pin assignment of the input and output line, refer to the user manual of the FlexCard.

```
Typedef struct fcTriggerCfgHardware
{
       fcTriggerMode Mode;
       fcTriggerCondition Condition;
}fcTriggerCfgHardware;
```

Members

Mode

Set the trigger mode (active or passive mode). The hardware trigger does not support the timer mode.

fcTriggerCondition

Depending on the mode, the following conditions can be used:

- Passive mode:
  - Falling edge (Trigger packet is generated on falling edge of the input signal)
  - Rising edge (Trigger packet is generated on rising edge of the input signal)
- Active mode:
  - Cycle start (A pulse is generated on the output line when a new cycle starts)
  - User (A pulse is generated on the output line when the user is calling the function fcbTrigger)
  - Error (A pulse is generated on the output line when an error occurred)
  - Start-up completed (A pulse is generated on the output line when the start-up was completed)

See Also

fcTriggerCfg (Obsolete), fcTriggerCondition (Obsolete), fcTriggerMode (Obsolete)

15.26.2 fcTriggerCfgSoftware (Obsolete)

This structure configures the software trigger. In active mode an **fcTriggerInfoPacket (Obsolete)** object is generated each time the function **fcbTrigger (Obsolete)** is called. In the timer mode an **fcTriggerInfoPacket (Obsolete)** object is generated every *TimePeriod* millisecond. A zero *TimePeriod* means that no **fcTriggerInfoPacket (Obsolete)** will be generated.

```
Typedef struct fcTriggerCfgSoftware
{
       fcTriggerMode Mode;
       fcDword  TimePeriod;
}fcTriggerCfgSoftware;
```

Members

Mode

Set the trigger mode (active or timer mode). The software trigger does not support the passive mode.

TimePeriod

This parameter is only used in timer mode. Every *TimePeriod* milliseconds (range: 0 – 400000) a trigger packet will be generated.

See Also

fcTriggerCfg (Obsolete), fcTriggerMode (Obsolete)

15.26.3 fcTriggerCfg (Obsolete)

This structure is used for the configuration of a trigger. Only one trigger at a time (hardware or software) can be used and the conditions cannot be combined.

```
Typedef struct fcTriggerCfg
{
    fcTriggerType Type;
    union
    {
        fcTriggerCfgHardware Hardware;
        fcTriggerCfgSoftware Software;
    };
}fcTriggerCfg;
```

Members

Type
Type of trigger (hardware or software)

Hardware
Configuration of hardware trigger

Software
Configuration of software trigger

See Also

fcTriggerType (Obsolete), fcTriggerCfgHardware (Obsolete), fcTriggerCfgSoftware (Obsolete), fcbTrigger (Obsolete)

15.26.4 fcTriggerInfoPacket (Obsolete)

This structure provides information about a trigger packet.

```
Typedef struct fcTriggerInfoPacket
{
    fcTriggerType Type;
    fcTriggerCondition Condition;
    fcDword TimeStamp;
    fcDword SequenceCount;
    fcQuad PerformanceCounter;

}fcTriggerInfoPacket;
```

Members

Type
Type of trigger info packet

Condition
The fulfilled condition which has caused the trigger packet generation

TimeStamp
The FlexCard time stamp (1 µs resolution). Indicates the time at which the packet was generated.

SequenceCount
Sequence count for each signal

PerformanceCounter
Variable that receives the current performance-counter value. This value is only valid for software triggers (*fcTriggerTypeSoftware*).

See Also

fcPacket, fcTriggerType (Obsolete), fcTriggerCondition (Obsolete)

15.27 Enumerations (Obsolete)

15.27.1 fcTriggerCondition (Obsolete)

This enumeration defines the conditions available for a trigger configuration.

```
Typedef enum fcTriggerCondition
{
      fcTriggerConditionFallingEdge         = 1,
      fcTriggerConditionRisingEdge          = 2,
      fcTriggerConditionCycleStart          = 3,
      fcTriggerConditionUser                = 4,
      fcTriggerConditionErrorDetected       = 5,
      fcTriggerConditionStartupCompleted    = 6,
      fcTriggerConditionTimer               = 7,
}fcTriggerEdge;
```

Members

fcTriggerConditionFallingEdge
: Passive mode condition: input trigger is detected on falling edge

fcTriggerConditionRisingEdge
: Passive mode condition: input trigger is detected on rising edge

fcTriggerConditionCycleStart
: *Active mode* condition*:* output trigger is set on start of a new FlexRay cycle

fcTriggerConditionUser
: Active mode condition: output trigger is set by the user

fcTriggerConditionErrorDetected
: Active mode condition: output trigger is set if an error was detected

fcTriggerConditionStartupCompleted
: Active mode condition: output trigger is set when the start-up was completed

fcTriggerConditionTimer
: Timer mode condition: Internal trigger is set by the software timer (neither input nor output trigger signal is used)

See Also

fcTriggerCfgHardware (Obsolete)

15.27.2 fcTriggerType (Obsolete)

This enumeration defines the different trigger types.

```
Typedef enum fcTriggerType
{
    fcTriggerTypeHardware   = 1,
    fcTriggerTypeSoftware   = 2,
} fcTriggerType;
```

Members

fcTriggerTypeHardware
: Hardware trigger

fcTriggerTypeSoftware
: Software trigger

See Also

fcTriggerCfg (Obsolete)

15.27.3 fcTriggerMode (Obsolete)

This enumeration defines the different trigger modes.

```
Typedef enum fcTriggerMode
{
    fcTriggerModeActive  = 1,
    fcTriggerModePassive = 2,
    fcTriggerModeTimer   = 3,
}fcTriggerMode;
```

Members

fcTriggerModeActive
Active mode: triggered by FlexCard or by user

fcTriggerModePassive
Passive mode: triggered by external hardware

fcTriggerModeTimer
Timer mode: triggered by software timer.

See Also

fcTriggerCfgHardware (Obsolete), fcTriggerCfgSoftware (Obsolete)

15.28 fcbTrigger (Obsolete)

This function configures and starts/stops a trigger. For further information, refer to the structures **fcTriggerCfgSoftware** and **fcTriggerCfgHardware**.

```
fcError fcbTrigger(
      fcHandle hFlexCard,
      fcBool enable,
      fcTriggerCfg cfg
)
```

Parameters

hFlexCard
[IN] Handle to a FlexCard

enable
[IN] Set to <> 0 to enable the trigger, and to 0 to disable it.

Cfg
[IN] The trigger configuration

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcTriggerCfg (Obsolete)

15.29 fcbSetCcIndex (Obsolete)

	Information
	This function is obsolete. Please use the functions in chapter 5 and 6 instead and specify the Communication Controller as parameter.

This function sets the FlexRay Communication Controller index. Following functions refer to the Communication Controller that was set. This function was only available on FlexCard PMC.

```
fcError fcbSetCcIndex (
      fcHandle hFlexCard,
      fcCC     CCIndex
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

CCIndex

[IN] The FlexRay Communication Controller to be set.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcCC

Remarks

The table below gives an overview of the functions which are CC specific.

CC specific functions	CC global functions
fcbMonitoringStart (Obsolete)	**fcGetErrorCode**
fcbMonitoringStop (Obsolete)	**fcGetErrorType**
fcbGetCcState (Obsolete)	**fcGetErrorText**
fcbSetTransceiverState (Obsolete)	**fcFreeMemory**
fcbGetTransceiverState (Obsolete)	**fcbGetEnumFlexCards (Obsolete)**
fcbSetCcRegister (Obsolete)	**fcbOpen**
fcbGetCcRegister (Obsolete)	**fcbClose**
fcbChiCcConfiguration (Obsolete)	**fcbSetTrigger**
fcbCanDbCcConfiguration (Obsolete)	**fcbSetTimer**
fcbConfigureMessageBuffer (Obsolete)	**fcbNotificationPacket**
fcbReconfigureMessageBuffer (Obsolete)	**fcbReceive**
fcbGetCcMessageBuffer (Obsolete)	**fcbSetBusTermination**
fcbResetCcMessageBuffer (Obsolete)	**fcbGetBusTermination**
fcbFilter (Obsolete)	**fcbGetEnumFlexCardsV2 (Obsolete)**
fcbSetEventHandle (Obsolete)	
fcbTransmit (Obsolete)	
fcbTransmitSymbol (Obsolete)	
fcbSetCcTimerConfig (Obsolete)	
fcbGetCcTimerConfig (Obsolete)	
fcbCalculateMacrotickOffset (Obsolete)	

15.30 fcbGetCcIndex (Obsolete)

Information

This function is obsolete. Please use the functions in chapter 5 and 6 instead and specify the Communication Controller as parameter.

This function reads the index of the set FlexRay Communication Controller. Communication controller dependent functions refer to this Communication Controller only. This function was only available on FlexCard PMC.

```
fcError fcbGetCcIndex (
      fcHandle hFlexCard,
      fcCC *   pCCIndex
)
```

Parameters

hFlexCard

[IN] Handle to a FlexCard

pCCIndex

[OUT] The FlexRay Communication Controller which is currently set.

Return values

If the function succeeds, the return value is 0. If the value is <> 0, use the functions described in the section Error Handling to get extended error information.

See Also

fcbSetCcIndex (Obsolete), **fcCC**

16 Power Management

Figure 16: System Standby Failed message box

On Windows 2000 and Windows XP stand-by and hibernation is prohibited by the FlexCard (except FlexCard USB-M) in order to provide a continuous monitoring of a bus and not to disturb a running network. The message box above is displayed. On Windows Vista and later however, drivers are not allowed to prohibit power saving functions so that energy costs can be reduced and battery duration is improved.

When the PC enters standby or hibernation, the current measurement is stopped automatically. After standby the handle to the driver is not valid anymore. On resume, developers should call **`fcbClose`**, **`fcbGetEnumFlexCardsV3`**, **`fcbOpen`** to initialize the FlexCard again.

Applications have the possibility to react to standby or resume with the Windows message `WM_POWERBROADCAST` containing the events `PBT_APMSUSPEND` and `PBT_APMRESUMESUSPEND`.

Developers should inform the user under Windows Vista and later that standby and hibernation stops the current monitoring. This may be done for example in the user manual or with a message window at the first start of the application. Users have the possibility to deactivate the automatic standby in the control panel.

Developers may consider deactivating idle recognition with the Windows command **`SetThreadExecutionState()`** to prohibit automatic stand-by. However, manual switching to stand-by can not be prevented under Windows Vista and later.

	Information
	Please note: Power Management is only supported under Microsoft Windows operating systems. Under Linux, please deactivate kernel power management options to avoid undefined behavior with the FlexCard Linux and Xenomai driver.

17 Tracing

17.1 Overview

The tracing module allows the user to get more information about the *fcBase.dll* (Windows only) activity (e.g. in the case of an error).

The tracing consists of three parts:

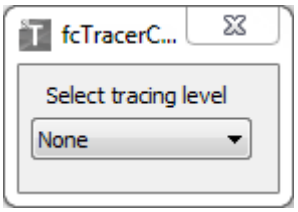
- The tracing module inside the fcBase dynamic link library. This module will send the trace messages to a debugger for displaying (using the windows function `OutputDebugString`).
- The tracing control application to choose the tracing level.
- A debug output viewer (e.g. DebugView from SysInternals) to view the trace messages. If you are debugging your own application, the messages appear normally in the debug output window of your IDE.

The followings tracing levels are available:

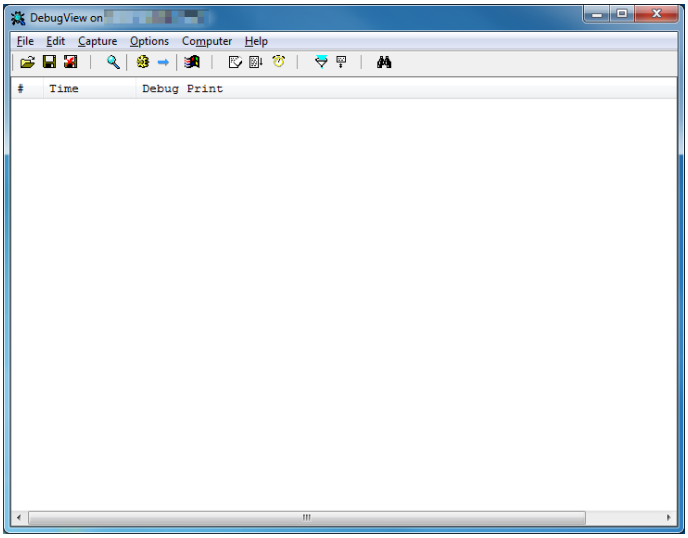
- Debug: all trace messages will be shown.
- Info: info and warning messages will be shown.
- Warn: only warning messages will be shown.
- Error: only error messages will be shown.
- Fatal: only fatal error message will be shown.
- None: tracing messages will not be generated.

To use the tracing the following steps are required:

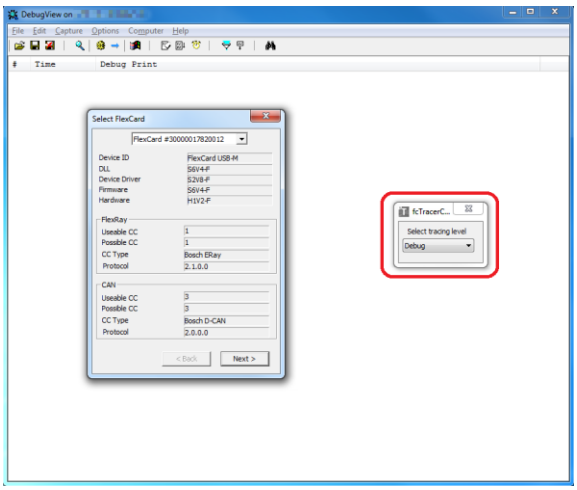
Step 1
Start the tracing control application (*fcTracerControl.exe*)



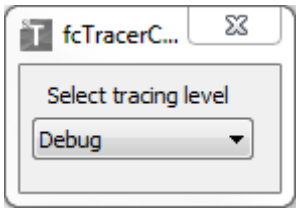
Step 2
Start the debug output viewer *(DebugView.exe)*



Step 3
Start your application. In our case we use the demo application *(fcDemo.exe)*. Now, the tracing level should be selectable.



Step 4
Activate the tracing by choosing a tracing level different of None (e.g. Debug). Use your application and view the trace messages.



17.2 Limitation

The tracing module inside the fcBase DLL will update the new tracing level only by calling the following functions:

```
fcbGetEnumFlexCards (Obsolete)
fcbGetEnumFlexCardsV2 (Obsolete)
fcbGetEnumFlexCardsV3
fcbOpen
fcbClose
```

That means a level modification by the tracing control application will only be passed to the tracing module inside the *fcBase.dll* if one of the above functions is called.

This limitation ensures that performance critical functions such as fcbReceive or fcbTransmit are not delayed.

18 Appendix

18.1 Bibliography

[1] FlexCard Cyclone II (SE) Instruction for Use (3-0009-0T01-D01)
[2] MSDN: Dynamic-Link Library Search Order
[3] FlexRay Protocol Specification V2.1 Rev. A
[4] FlexRay Electrical Physical Layer Specification V2.1 Rev. A
[5] Bosch E-Ray FlexRay IP-Module User's Manual
[6] CAN Specification 2.0 Part A (Base frame format)
[7] CAN Specification 2.0 Part B (Base and extended frame format)

18.2 Abbreviations

Abbreviations	Definition
API	Programming Interface
DLL	Dynamic Link Library
IDE	Integrated Development Environment
PDF	Portable Document Format
SYS	System device driver
MFC	Microsoft Foundation Class
CC	Communication controller
PMC	PCI Mezzazine Card
LKM	Loadable kernel module (for Linux OS)
LIB	Library (shared object file)
USB	Universal Serial Bus
PCB	Printed Circuit Board

18.3 Glossary

Term	Description
INF File	A text-based file containing information required by the system to install a device's software components
MFC	C++ Application framework for programming in Microsoft Windows
Qt	C++ Application framework for programming platform independent applications
Cluster	Network topology
CHI	File that configures a Communication Controller
CANdb	File that configures a Communication Controller

18.4 List of Figures

18.5 Index

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