



acontis technologies GmbH

SOFTWARE

EC-Master

EtherCAT® Master Stack Class B

Version 3.2

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1 Introduction

1.1 What is EtherCAT?

EtherCAT® (Ethernet for Control Automation Technology) is a high-performance Ethernet Fieldbus technology that provides a reliable, efficient, and cost-effective communication solution for a wide variety of industrial automation applications. Originally developed as an open technology by Beckhoff Automation in 2003, and subsequently turned over to an independent organization known as the EtherCAT Technology Group, EtherCAT has since become one of the most widely used industrial Ethernet protocols in the world.

See also:

A comprehensive introduction to EtherCAT technology can be found at <https://www.acontis.com/en/what-is-ethercat-communication-protocol.html>.

1.2 The EC-Master - Features

Feature ID: Unique identification used in ETG.1500 EtherCAT Master Classes

Feature name	Short description	EC-Master Class A	EC-Master Class B	Feature ID
Basic Features				
Service Commands	Support of all commands	✓	✓	101
IRQ field in datagram	Use IRQ information from Slave in datagram header	✓	✓	102
Slaves with Device Emulation	Support Slaves with and without application controller	✓	✓	103
EtherCAT State Machine	Support of ESM special behavior	✓	✓	104
Error Handling	Checking of network or slave errors, e.g. Working Counter	✓	✓	105
VLAN	Support VLAN Tagging	✓	²	106
EtherCAT Frame Types	Support EtherCAT Frames	✓	✓	107
UDP Frame Types	Support UDP Frames	¹	?	108
Process Data Exchange				
Cyclic PDO	Cyclic process data exchange	✓	✓	201
Multiple Tasks	Different cycle tasks Multiple update rates for PDO	✓	✓	202

continues on next page

Table 1 – continued from previous page

Feature name	Short description	EC-Master Class A	EC-Master Class B	Feature ID
Frame repetition	Send cyclic frames multiple times to increase immunity	?	?	203
Network Configuration				
Online scanning	Network configuration functionality included in EtherCAT Master	✓	✓	301
Reading ENI	Network Configuration taken from ENI file	✓	✓	301
Compare Network configuration	Compare configured and existing network configuration during boot-up	✓	✓	302
Explicit Device identification	Identification used for Hot Connect and prevention against cable swapping	✓	✓	303
Station Alias Addressing	Support configured station alias in slave, i.e. enable 2nd Address and use it	✓	✓	304
Access to EEPROM	Support routines to access EEPROM via ESC register	✓	✓	305
Mailbox Support				
Support Mailbox	Main functionality for mailbox transfer	✓	✓	401
Mailbox Resilient Layer	Support underlying resilient layer	✓	✓	402
Multiple Mailbox channels		✓	✓	403
Mailbox polling	Polling Mailbox state in slaves	✓	✓	404
CAN application layer over EtherCAT (CoE)				
SDO Up/Download	Normal and expedited transfer	✓	✓	501
Segmented Transfer	Segmented transfer	✓	✓	502
Complete Access	Transfer the entire object (with all subindices) at once	✓	✓	503
SDO Info service	Services to read object dictionary	✓	✓	504
Emergency Message	Receive Emergency messages	✓	✓	505

continues on next page

Table 1 – continued from previous page

Feature name	Short description	EC-Master Class A	EC-Master Class B	Feature ID
PDO in CoE	PDO services transmitted via CoE	?	?	506
EoE				
EoE protocol	Services for tunneling Ethernet frames. includes all specified EoE services	✓	✓	601
Virtual Switch	Virtual Switch functionality	✓	✓	602
EoE Endpoint to Operation Systems	Interface to the Operation System on top of the EoE layer	FP	?	603
FoE				
FoE Protocol	Support FoE Protocol	✓	✓	701
Firmware Up-/Download	Password, File-Name should be given by the application	✓	✓	702
Boot State	Support Boot-State for Firmware Up/Download	✓	✓	703
SoE				
SoE Protocol	Support SoE Services	✓	✓	801
AoE				
AoE Protocol	Support AoE Protocol	✓	✓	901
VoE				
VoE Protocol	External Connectivity supported	✓	✓	1001
Synchronization with Distributed Clock (DC)				
DC support	Support of Distributed Clocks	✓	?	1101
Continuous Propagation Delay compensation	Continuous Calculation of the propagation delay	✓	?	1102
Sync window monitoring	Continuous monitoring of the Synchronization difference in the slaves	✓	?	1103
Slave-to-Slave Communication				

continues on next page

Table 1 – continued from previous page

Feature name	Short description	EC-Master Class A	EC-Master Class B	Feature ID
via Master	Information is given in ENI file or can be part of any other network configuration. Copying of the data can be handled by master stack or master's application	✓	✓	1201
Master information				
Master Object Dictionary		FP	?	1301

² : According to ETG.1500 Master Classes not mandatory for Class B¹ : According to ETG.1500 Master Classes not mandatory for Class A

1.3 Protected version

The EC-Master software can be delivered in 3 different versions:

Protected

Binary with MAC protection

Unrestricted

Binary without MAC protection

Source

Source code

The protected version will automatically stop after about 1 hour of continuous operation. In order to remove this restriction a valid runtime license key is required. The runtime license protection is based on the MAC address of the Ethernet controller used for the EtherCAT protocol. With a valid License Key the protected version of EC-Master will automatically become an unrestricted version.

1.3.1 Licensing procedure for Development Licenses

1. Installation of EC-Master protected version
2. Determine the MAC Address by calling `emGetSrcMacAddress()` or from a sticker applied on the hardware near the Ethernet controller
3. Send an Email with the subject “**Development License Key Request, Commission your commission number**” with the MAC address to sales@acontis.com
4. Acontis will create the license keys and return them in a License Key Text File (CSV format).

```
Number;MAC Address;License Key
1;00-00-5A-11-77-FE;DA1099F2-15C249E9-54327FBC
2;64-31-50-80-20-4E;1B7C1F86-D08E40A8-4F96F2BA
3;2C-F0-5D-03-CB-2B;10005078-DFD9A2C3-5FD4B1CD-35041597-F8094AA4-6C7CCE7E
```

5. Activate the License Key by calling `emSetLicenseKey()` with the license key that corresponds to the MAC address on the hardware and check the return code. The license key is 26 or 53 characters long.

```
dwRes = emSetLicenseKey(0, "DA1099F2-15C249E9-54327FBC");
```

1.3.2 Licensing procedure for Runtime Licenses

1. Installation of EC-Master protected version
2. Determine the MAC Address by calling `emGetSrcMacAddress()` or from a sticker applied on the hardware near the Ethernet controller
3. Provide the MAC Addresses and numbers from previously ordered and unused runtime license stickers in a text file to acontis as described in the example below. Please use a separate line for each runtime license sticker number and MAC Address.

```
S/N; MAC Address
100-105-1-1/1603310001;00-00-5A-11-77-FE
100-105-1-1/1603310002;64-31-50-80-20-4E
100-105-1-1/1603310003;2C-F0-5D-03-CB-2B
```

4. Send an Email with the subject “**Runtime License Key Request, Commission your commission number**” with the MAC address to sales@acontis.com
5. Acontis will create the license keys and return them in a License Key Text File.

```
Number;MAC Address;License Key  
1;00-00-5A-11-77-FE;DA1099F2-15C249E9-54327FBC  
2;64-31-50-80-20-4E;1B7C1F86-D08E40A8-4F96F2BA  
3;2C-F0-5D-03-CB-2B;10005078-DFD9A2C3-5FD4B1CD-35041597-F8094AA4-6C7CCE7E
```

6. Activate the License Key by calling `emSetLicenseKey()` with the license key that corresponds to the MAC address on the hardware and check the return code.

```
dwRes = emSetLicenseKey(0, "DA1099F2-15C249E9-54327FBC");
```

1.4 License

1.4.1 EC-Master license

According to EC-Master Software License Agreement (SLA).

1.4.2 Free Open Source Software contained in EC-Master

Expat XML parser license

```
Copyright (c) 1998, 1999, 2000 Thai Open Source Software Center Ltd  
and Clark Cooper  
Copyright (c) 2001, 2002, 2003, 2004, 2005, 2006 Expat maintainers.
```

```
Permission is hereby granted, free of charge, to any person obtaining  
a copy of this software and associated documentation files (the  
"Software"), to deal in the Software without restriction, including  
without limitation the rights to use, copy, modify, merge, publish,  
distribute, sublicense, and/or sell copies of the Software, and to  
permit persons to whom the Software is furnished to do so, subject to  
the following conditions:
```

```
The above copyright notice and this permission notice shall be included  
in all copies or substantial portions of the Software.
```

```
THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND,  
EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF  
MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT.  
IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY  
CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT,  
TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE  
SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
```

1.4.3 Free Open Source Software supported by EC-Master

The following components are not part of EC-Master, but relate to it:

acontis atemsys Linux kernel module

The acontis atemsys is licensed under the GPL:

```
Copyright (c) 2009 - 2020 acontis technologies GmbH, Ravensburg, Germany  
All rights reserved.
```

```
This program is free software; you can redistribute it and/or modify it  
under the terms of the GNU General Public License as published by the  
Free Software Foundation; either version 2 of the License, or (at your  
option) any later version.
```

WinPCap

The WinPCap library is supported, but not shipped with the EC-Master.

Npcap

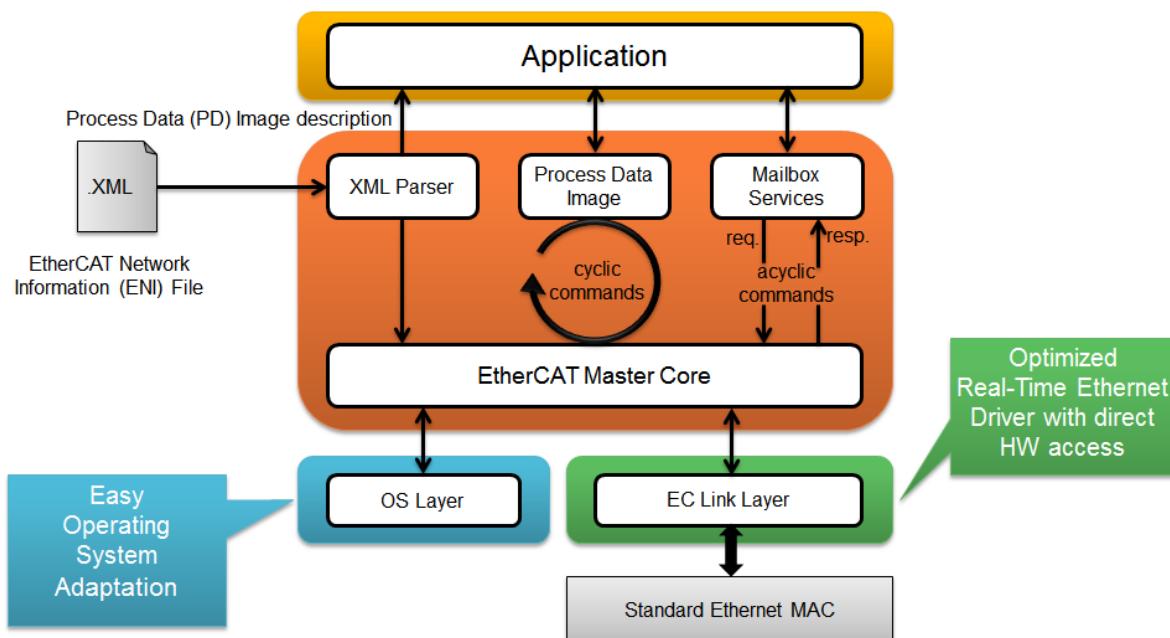
The Npcap library is supported, but not shipped with the EC-Master.

2 Getting Started

2.1 EC-Master Architecture

The EC-Master EtherCAT Master Stack is implemented in C++ and can be easily ported to any embedded OS platforms using an appropriate C++ compiler. The API interfaces are C language interfaces, thus the master can be used in ANSI-C as well as in C++ environments.

The Master Stack is divided into modules, see diagram and descriptions below:



- EtherCAT Master Core: In the core module cyclic (process data update) and acyclic (mailbox) EtherCAT commands are sent and received. Among others there exist some state machines to handle for example the mailbox protocols.
- Configuration Layer: The EtherCAT master is configured using a XML file whose format is fixed in the EtherCAT specification ETG.2100. EC-Master contains an OS independent XML parser.
- Ethernet Link Layer: This layer exchanges Ethernet frames between the master and the slave devices. If hard real-time requirements exist, this layer has to be optimized for the network adapter card in use.
- OS Layer: All OS dependent system calls are encapsulated in a small OS layer. Most functions are that easy that they can be implemented using simple C macros.

2.2 EtherCAT Network Configuration (ENI)

The EtherCAT master has to know about the EtherCAT bus topology and the cyclic/acyclic frames to exchange with the slaves. This configuration is determined in a configuration file which has to be available in the EtherCAT Network Information Format (ENI). This format is completely independent from EtherCAT slave vendors, from EtherCAT master vendors and from EtherCAT configuration tools. Thus interoperability between those vendors is guaranteed.

Additionally some static configuration parameters have to be defined like the identification of the network adapter card to use, the priority of the EtherCAT master timer task etc.

2.3 Operating system configuration

The main task is to setup the operating system to support the appropriate network adapter for EtherCAT usage and for some systems real-time configuration may be needed.

The operating system-specific settings and configurations are described in *Platform and Operating Systems (OS)*.

2.4 Running EcMasterDemo

The EcMasterDemo is available “out of the box” for different operating systems. It is an EC-Master example application that handles the following tasks:

- Showing basic EtherCAT communication
- Master stack initialization into OPERATIONAL state
- Process Data operations for e.g. Beckhoff EL2004, EL1004 and EL4132
- Periodic diagnosis task
- Periodic Job Task in polling mode
- Logging

Start the EcMasterDemo from the command line to put the EtherCAT network into operation. At least a Link Layer must be specified.

```
> EcMasterDemo -winpcap 192.168.157.2 1 -f eni.xml -t 0 -v 3
```

See also:

- *Example application* for detailed explanation

2.4.1 Command line parameters

```
EcMasterDemo <LinkLayer> [-f ENI-FileName] [-t time] [-b cycle time] [-a affinity] [-v level] [-perf [level]] [-log prefix [msg cnt]] [-lic key] [-oem key] [-maxbusslaves cnt] [-flash address] [-sp [port]] [-rec [prefix [frame cnt]]]
```

The parameters are as follows:

-f <configFileName>

Path to ENI file

-t <time>

Running duration in msec. When the time expires the demo application exits completely.

<time>

Time in msec, 0 = forever (default = 120000)

-b <cycle time>

Specifies the bus cycle time. Defaults to 1000 µs (1 ms).

<cycle time>

Bus cycle time in µsec

-a <affinity>

The CPU affinity specifies which CPU the demo application ought to use.

<affinity>

0 = first CPU, 1 = second, ...

-v <level>

The verbosity level specifies how much console output messages will be generated by the demo application. A high verbosity level leads to more messages.

<level>

Verbosity level: 0=off (default), 1..n=more messages

-perf [<level>]

Enable max. and average time measurement in μ s for all EtherCAT jobs (e.g. ProcessAllRxFrames).

<level>

Depending on level the performance histogram can be activated as well.

-log <prefix> [<msg cnt>]

Use given file name prefix for log files.

<prefix>**<msg cnt>**

Messages count for log buffer allocation

-lic <key>

Use License key.

<key>

26 characters long license key.

-oem <key>

Use OEM key

<key>

64 bit OEM key.

-maxbusslaves <cnt>

Set max number of slaves

-flash <address>

Flash outputs

<address>

0=all, >0 = slave station address

-sp [<port>]

If platform has support for IP Sockets, this command-line option enables the Remote API Server to be started. The Remote API Server is going to listen on TCP Port 6000 (or port parameter if given) and is available for connecting Remote API Clients.

<port>

RAS server port

-rec [<prefix> [<frame cnt>]]

Packet capture file recording

<prefix>

File name prefix

<frame cnt>

Frame count for log buffer allocation

Link Layer

Using one of the following demo application Link Layer options, the EC-Master will dynamically load the network driver for the specified network adapter card and use the appropriate network driver to access the Ethernet adapter for EtherCAT®. `ShowSyntaxLinkLayer()` in `Common/EcSelectLinkLayer.cpp` is called automatically if the Demo application is started without parameters and lists the possibilities.

Note: Not all link layers are available on all operating systems or architectures. A detailed view in the form of a matrix can be found in the [developer center](#).

-alteratse <instance> <mode>

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1= Polling mode

-antaios
Device instance fixed to 2

Mode fixed to 1 = Polling mode

-bcmgenet <instance> <mode>

Hardware: Broadcom BcmGenet

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1 = Polling mode

-ccat <instance> <mode>

Hardware: Beckhoff CCAT

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1= Polling mode

-cpsw <instance> <mode> <portpriority> <masterflag> <refboard>

Hardware: TI CPSW

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode, 1 = Polling mode

<portpriority>
Low priority (0) or high priority (1)

<masterflag>

(m) Master (Initialize Switch), (s) Slave

<RefBoard>

bone | am3359-icev2 | am437x-idk | am572x-idk | 387X_evm | custom | osdriver

If custom:

```
<CpswType>
    am33XX | am437X | am57X | am387X

<PhyAddress>
    0 ... 31

<PhyInterface>
    rmii | gmii | rgmii | osdriver

<NotUseDmaBuffers>
    0 = FALSE | 1 = TRUE
```

-dw3504 <instance> <mode> <RefBoard>

Hardware: Synopsys DesignWare 3504-0 Universal 10/100/1000 Ethernet MAC (DW3504)

```
<instance>
    Device instance 1 = first, 2 = second, ...

<mode>
    0 = Interrupt mode | 1 = Polling mode

<RefBoard>
    Reference Board: intel_atom | lces1 | rd55up06 | r12ccpu | rzn1 | socrates | stm32mp157a-
    dk1 | custom
```

If custom:

```
<DW3504Type>
    intel_atom | cycloneV | lces1 | stm32mp157a-dk1

<PhyInterface>
    fixed | mii | rmii | gmii | sgmii | rgmii | osdriver

<PhyAddress>
    0 ... 31 (don't use if osdriver)
```

-eg20t <instance> <mode>

Hardware: Intel EG20T Gigabit Ethernet Controller

```
<instance>
    Device instance 1 = first, 2 = second, ...

<mode>
    0 = Interrupt mode | 1 = Polling mode
```

-emac <instance> <mode> <refboard>

Hardware: Xilinx LogiCORE IP XPS EMAC

```
<instance>
    Device instance 1 = first, 2 = second, ...

<mode>
    0 = Interrupt mode | 1 = Polling mode

<RefBoard>
    MC2002E | custom
```

If custom:

```
<RegisterBase>
    Register base address as hex value

<RegisterLength>
    Register length as hex value

<NotUseDmaBuffers>
    0 = FALSE | 1 = TRUE

-fsletsec <instance> <mode> <refboard>
```

Hardware: Freescale TSEC / eTSEC V1 / eTSEC V2 (VeTSEC)

```
<instance>
    Device instance 1 = first, 2 = second, ...

<mode>
    0 = Interrupt mode | 1 = Polling mode

<RefBoard>
    p2020rdb | twrp1025 | istmpc8548 | xj_epu20c | twrls1021a | tqmls_ls102xa | custom
```

If custom:

```
<PhyAddress>
    0 ... 31

<RxIrq>
    Default depending on ETSEC type

<NotUseDmaBuffers>
    0 = FALSE | 1 = TRUE

-fs1fec <instance> <mode> <refboard>
```

Hardware: Freescale FEC/ENET

```
<instance>
    Device instance 1 = first, 2 = second, ...

<mode>
    0 = Interrupt mode | 1 = Polling mode

<RefBoard>
    mars | sabrelite | sabresd | imx28evk | topaz | imxceetul2 | mimxrt1064-evk |
    imx93evk | custom
```

If custom:

```
<FecType>
    imx25 | imx28 | imx53 | imx6 | vf6 | imx7 | imx8 | imx8m | imxrt1064 | imx9

<PhyInterface>
    fixed | mii | rmii | rmii50Mhz | gmii | sgmii | rgmii | osdriver

<PhyAddress>
    0 ... 31, default 0 (don't use if osdriver)
```

Optional:

```
<nopinmuxing>
    no pin muxing

<nomacaddr>
    don't read MAC address
```

-gem <instance> <mode> <refboard>

Hardware: Xilinx Zynq-7000/Ultrascale (GEM)

<instance>
Device instance for GEM, 1 = GEM0, ...

<mode>
0 = Interrupt mode | 1 = Polling mode

<RefBoard>
zc702 | zedboard | microzed | zcu102 | zcu104 | KR260 | custom

If custom:

<PhyAddress>
0 ... 31

<PhyConnectionMode>
MIO (0) or EMIO (1)

<UseGmiiToRgmii>
Use Xilinx GmiiToRgmii converter TRUE (1) or FALSE (0)

<GmiiToRgmiiPort>
GmiiToRgmii converter PHY address 0 ... 31

<GemType>
zynq7000 or ultrascale

Optional:

<PhyInterface>
osdriver

<ClkDivType_K26>
Clock divisor

<Pnopinmuxing>
Don't use pin muxing

-i8254x <instance> <mode>

Hardware: Intel Pro/1000 network adapter card

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1 = Polling mode

-i8255x <instance> <mode>

Hardware: Intel Pro/100 network adapter card

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1 = Polling mode

-

icss <instance> <mode> <masterflag> <refboard> [<PhyInterface> <PhyAddress>] [<NoPhyReset> cleTime TtsSendOffset]

Hardware: Texas Instruments Board with PRUSS

<instance>
ICSS Port (100 Mbit/s) 1 ... 4

<mode>
0 = Interrupt mode | 1 = Polling mode

<MasterFlag>
(m) Master (Initialize board, mdio, both phy) or (s) Slave

<RefBoard>
am572x-idk | am571x-idk | am3359-icev2 | am574x

Optional:

<PhyInterface>
mii | osdriver

<PhyAddress>
0 ... 31 (only for mii)

Optional:

<NoPhyReset>
NoPhyReset

Optional:

<TtsEnable>
tts

<TtsCycleTime>
TTS cycle time (usec)

<TtsSendOffset>
TTS cyclic frame send offset from cycle start (usec)

-icssg <instance> <mode> <masterflag> <refboard>

Hardware: Texas Instruments AARCH64 Board with Gigabit PRUSS

<instance>
ICSSG Port 1 ... 6

<mode>
0 = Interrupt mode | 1 = Polling mode

<MasterFlag>
(m) Master (Initialize board, mdio, both phy) or (s) Slave

<RefBoard>
am654x-idk

-19218i <instance> <mode>

Hardware: SMSC LAN9218i/LAN9221

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1 = Polling mode

-lan743x <instance> <mode>

Hardware: Microchip LAN743x

<instance>
Device instance 1 = first, 2 = second, ...
<mode>
1= Polling mode

-ndis <IpAddress> <mode>

Hardware: Hardware independent, only available for Windows.

<IpAddress>
IP address of network adapter card, e.g. 192.168.157.2 or 0.0.0.0 if name given
<mode>
0 = Interrupt mode | 1 = Polling mode

Optional:

--name
Adapter name. Service name from HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\NetworkCards
<DisablePromiscuousMode>
Disable promiscuous mode
<DisableForceBroadcast>

-multiplier <instance> <mode> [--type <type>] --port <port> --link <link parms>

Hardware: Beckhoff CUxxxx Ethernet-Port-Multiplier

<instance>
Device instance 1 = first, 2 = second, ...
<mode>
0 = Interrupt mode | 1 = Polling mode, for now only polling mode is supported
<port>
used CU2508 downlink port 0 = X1, 1 = X2, ...
<link parms>
link parms of network adapter connected to the uplink port e.g. -intelgb ...

Optional:

<type>
cu2508 = CU2508 Ethernet-Port-Multiplier

-r6040 <instance> <mode>

Hardware: RDC R6040

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
1 = Polling mode

-rin32m3 <instance> <mode>

Hardware: Renesas R-IN32M3-EC

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
1 = Polling mode

-rtl8139 <instance> <mode>

Hardware: Realtek RTL8139

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1 = Polling mode

-rtl8169 <instance> <mode>

Hardware: Realtek RTL8168 / RTL8169 / RTL8111

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
0 = Interrupt mode | 1 = Polling mode

-rztl <instance>

Hardware: Renesas RZ/T1

<instance>
Device instance 1 = Port 0 | 2 = Port 1

-sheth <instance> <mode> <RefBoard>

Hardware: Renesas RZG1 or Armadillo-800 EVA

<instance>
Device instance 1 = first, 2 = second, ...

<mode>
1 = Polling mode

<RefBoard>
rzg1e | a800eva

-snarf <adapterName>

Hardware: Hardware independent, only available for VxWorks

<adapterName>
Adapter name, e.g. fei0

-sockraw <device>

Hardware: Hardware independent, only available for Linux.

<device>
Network device, e.g. eth1

Optional:

<mode>
0 = Interrupt mode | 1 = Polling mode

--nommaprx
Disable PACKET_MMAP for receive

-stm32eth <instance> <mode>

Hardware: STM32H7 Ethernet

<instance>
Device instance 1=first, 2=second, ...

<mode>
1 = Polling mode

-winpcap <ipAddress> <mode>

Hardware: Hardware independent, only available for Windows.

<ipAddress>
IP address of network adapter card, e.g. 192.168.157.2

<mode>
0 = Interrupt mode | 1 = Polling mode

2.5 Compiling the EcMasterDemo

The following main rules can be used to generate the example applications for all operating systems.

- <OS> is a placeholder for the operating system used.
- <ARCH> for the architecture. If different architectures are supported.

2.5.1 EtherCAT Master Software Development Kit (SDK)

The EtherCAT master development kit is needed to write applications based on the master stack. The master stack is shipped as a library which is linked together with the application.

The following components are supplied together with an SDK:

<InstallPath>/Bin
<InstallPath>/Doc
<InstallPath>/SDK
<InstallPath>/SDK/INC
<InstallPath>/SDK/LIB
<InstallPath>/SDK/FILES
<InstallPath>/Sources/Common

/Bin

Executables containing the master stack

/Doc

Documentation

/Examples

One or more example applications using a predefined EtherCAT-configuration. It is easily adaptable to different configurations using an appropriate EtherCAT configuration XML file.

/SDK

EtherCAT Software Development Kit containing libraries and header files to build C/C++-applications.

/SDK/INC:

Header files to be included with the application

/SDK/LIB:

Libraries to be linked with the application

/SDK/FILES:

Additional files for platform integration (e.g. Windows CE registry files)

/sources/Common:

Shared .cpp-files

2.5.2 Include search path

The header files are located in the following directories:

```
<InstallPath>/SDK/INC  
<InstallPath>/SDK/INC/<OS>/<ARCH>  
<InstallPath>/Sources/Common
```

2.5.3 Libraries

The libraries located in the following directories:

```
<InstallPath>/SDK/LIB/<OS>/<ARCH>
```

3 Software Integration

3.1 Network Timing

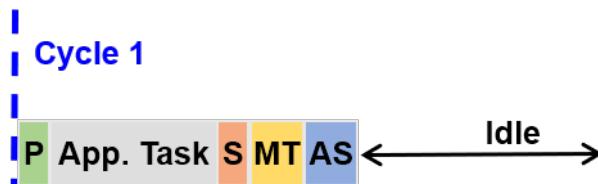
Interaction between application and EtherCAT network

EC-Master has no internal tasks, the operation is fully controlled by the user's application. The benefits of this design are:

- No synchronization issues between application and EC-Master
- Consistent process data without using any locks
- Various network timings driven by the application possible
- Cyclic part may run within Interrupt Service Routine (ISR)
- Easy to integrate

From the application perspective, EC-Master behaves like a driver that is controlled by the `emExecJob()` function with additional parameters, so-called `EC_T_USER_JOB`.

Typical sequence of `EC_T_USER_JOB` for `emExecJob()` to be called cyclically by the application:



Refresh Inputs

`EC_T_USER_JOB::eUsrJob_ProcessAllRxFrames`: Process all received frames



Write Outputs

`EC_T_USER_JOB::eUsrJob_SendAllCycFrames`: Send cyclic frames to update process output data.



Administration

`EC_T_USER_JOB::eUsrJob_MasterTimer`: Trigger master and slave state machines.



Send acyclic datagrams/commands

`EC_T_USER_JOB::eUsrJob_SendAcycFrames`: Transmit pending acyclic frame(s).

When a process data update is initiated by calling `emExecJob(eUsrJob_ProcessAllRxFrames)` new input data are read from the received frames and copied into the process data image. After the function returns the application can process the inputs, calculate the outputs and update the values in the process image. With calling `emExecJob(eUsrJob_SendAllCycFrames)` the output data are read from the process data image and stored in Ethernet/EtherCAT frames prior to sending them to the Link Layer. When this call returns all output process data values are stored in Ethernet/EtherCAT frames which are then processed by the network controller.

If only one single thread is both writing into the process data image and calling `emExecJob(eUsrJob_SendAllCycFrames)` no further output process data synchronization is necessary. The application is responsible to (cyclically) calling the function `emExecJob()` with the appropriate parameters.

EtherCAT frames are divided into two categories:

1. Cyclic frames

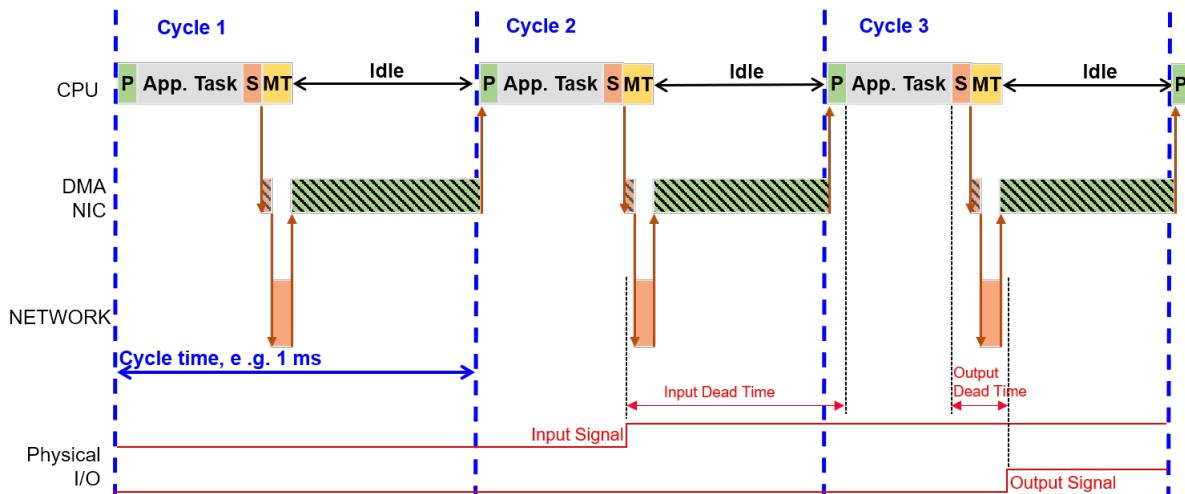
- Contain process output and input data
- Distributed Clocks (DC): Contain datagram to distribute network time
- Typically sent by master in every cycle
- Defined by the configuration tool (which data to read and to write)

2. Acyclic frames

- Asynchronous, event triggered communication
- Mailbox communication (CoE, FoE, EoE)
- Status requests (e. g. read slave state information)
- Raw EtherCAT datagrams requested by application

3.1.1 Standard Timing: Short output dead time

Cyclic frames



Application has to perform:

```
/* Job P: Process data are saved in the process data image */
emExecJob(dwInstanceId, eUsrJob_ProcessAllRxFrames, &oJobParms);

/* App. Task */

/* Job S: Send updated process data.
   Outputs are updated in slaves and input data is collected to be present for the
   next cycle.
   The process data image is saved during eUsrJob_ProcessAllRxFrames */
emExecJob(dwInstanceId, eUsrJob_SendAllCycFrames, EC_NULL);

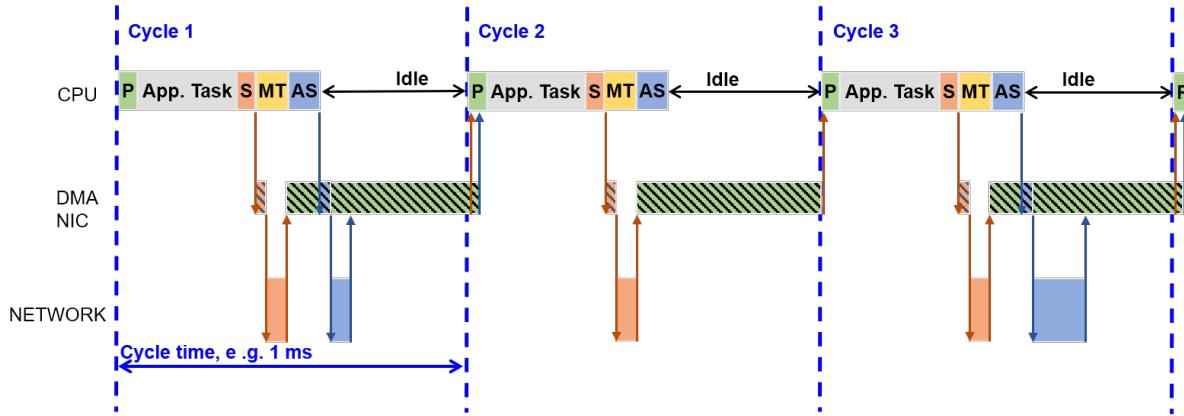
/* Job MT: Trigger master state machines.
```

(continues on next page)

(continued from previous page)

*Required to perform any status changes or internal administration tasks */*
`emExecJob(dwInstanceId, eUsrJob_MasterTimer, EC_NULL);`

Cyclic and acyclic frames



Application has to perform:

```

/* Job P: Process data are saved in the process data image */
emExecJob(dwInstanceId, eUsrJob_ProcessAllRxFrames, &oJobParms);

/* App. Task */

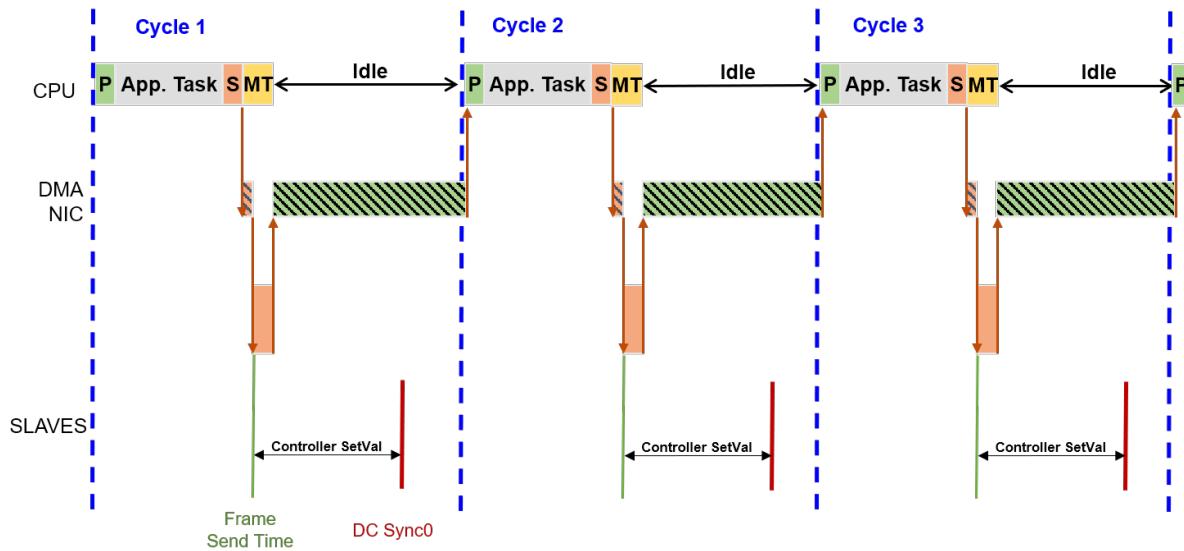
/* Job S: Send updated process data.
Outputs are updated in slaves and input data is collected to be present for the
→next cycle.
The process data image is saved during eUsrJob_ProcessAllRxFrames */
emExecJob(dwInstanceId, eUsrJob_SendAllCycFrames, EC_NULL);

/* Job MT: Trigger master state machines.
Required to perform any status changes or internal administration tasks */
emExecJob(dwInstanceId, eUsrJob_MasterTimer, EC_NULL);

/* Job AS: Transmission of the acyclic commands from the queue.
These may have been queued by the application or by the internal administration
→task (eUsrJob_MasterTimer) */
emExecJob(dwInstanceId, eUsrJob_SendAcycFrames, EC_NULL);

```

Cyclic frames with DC



Application has to perform:

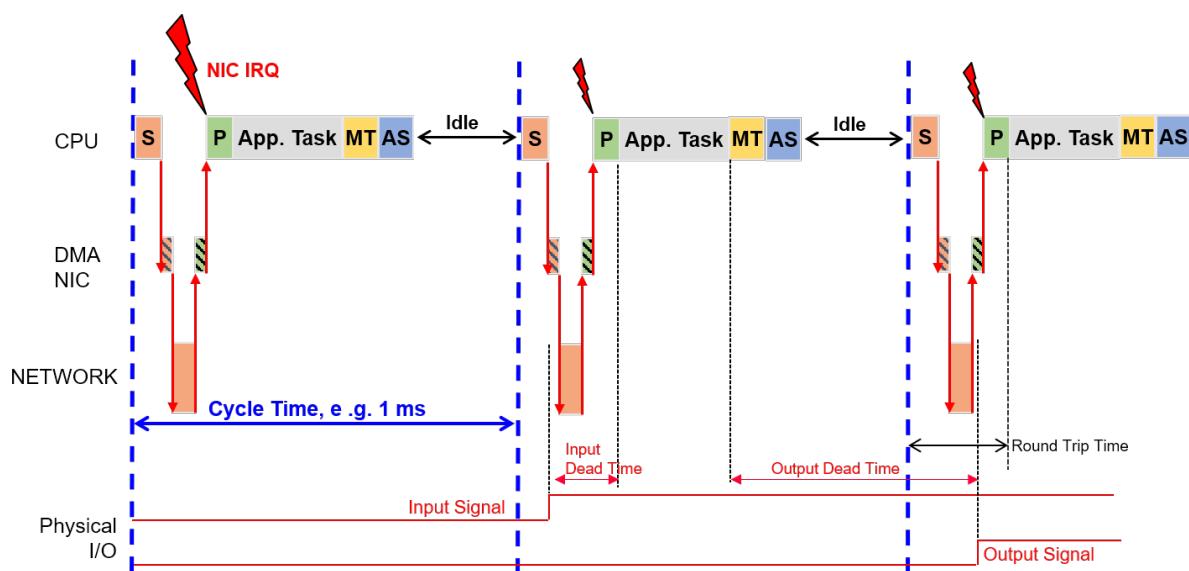
```
/* Job P: Process data are saved in the process data image */
emExecJob(dwInstanceId, eUsrJob_ProcessAllRxFrames, &oJobParms);

/* App. Task */

/* Job S: Send updated process data.
   Outputs are updated in slaves and input data is collected to be present for the
   next cycle.
   The process data image is saved during eUsrJob_ProcessAllRxFrames */
emExecJob(dwInstanceId, eUsrJob_SendAllCycFrames, EC_NULL);

/* Job MT: Trigger master state machines.
   Required to perform any status changes or internal administration tasks */
emExecJob(dwInstanceId, eUsrJob_MasterTimer, EC_NULL);
```

3.1.2 Alternative Timing: Short Input dead time



Application has to perform during startup:

```
emInitMaster(dwInstanceId, &oInitMasterParms);

/* create event for "cyclic frame received" and register RX callback function */
{
    EC_T_CYCFRAME_RX_CBDESC oCycFrameRxCallbackDesc;

    S_pvCycFrameReceivedEvent = OsCreateEvent();

    /* setup callback function which is called after RX */
    OsMemset(&oCycFrameRxCallbackDesc, 0, sizeof(EC_T_CYCFRAME_RX_CBDESC));
    oCycFrameRxCallbackDesc.pfnCallback = CycFrameReceivedCallback;
    oCycFrameRxCallbackDesc.pCallbackContext = S_pvCycFrameReceivedEvent;

    emIoCtl(dwInstanceId, EC_IOCTL_REGISTER_CYCFRAME_RX_CB, &oCycFrameRxCallbackDesc,
    ↪ sizeof(EC_T_CYCFRAME_RX_CBDESC), EC_NULL, 0, EC_NULL);
}

/* create cyclic process data Thread */
S_pvtJobThread = OsCreateThread((EC_T_CHAR*) "EcMasterJobTask", EcMasterJobTask,
    ↪ CpuSet,
    JOBS_THREAD_PRIO, JOBS_THREAD_STACKSIZE, (EC_T_VOID*) pAppContext);
```

Application has to perform inside job task:

```
/* Job S: Send updated process data.
   Outputs are updated in slaves and input data is collected to be present for the
   ↪ current cycle.
   The process data image is saved after receiving the response frame within the
   ↪ interrupt service thread */
emExecJob(dwInstanceId, eUsrJob_SendAllCycFrames, EC_NULL);

/* wait until cyclic frame is received */
OsWaitForEvent(S_pvCycFrameReceivedEvent, dwCycleTime);

/* App. Task */

/* Job MT: Trigger master state machines.
   Required to perform any status changes or internal administration tasks */
emExecJob(dwInstanceId, eUsrJob_MasterTimer, EC_NULL);

/* Job AS: Transmission of the acyclic commands from the queue.
   These may have been queued by the application or by the internal administration
   ↪ task (eUsrJob_MasterTimer) */
emExecJob(dwInstanceId, eUsrJob_SendAcycFrames, EC_NULL);
```

For closer details find an example project Examples/EcMasterDemoSyncSm

3.2 Example application

The example application EcMasterDemo will handle the following tasks:

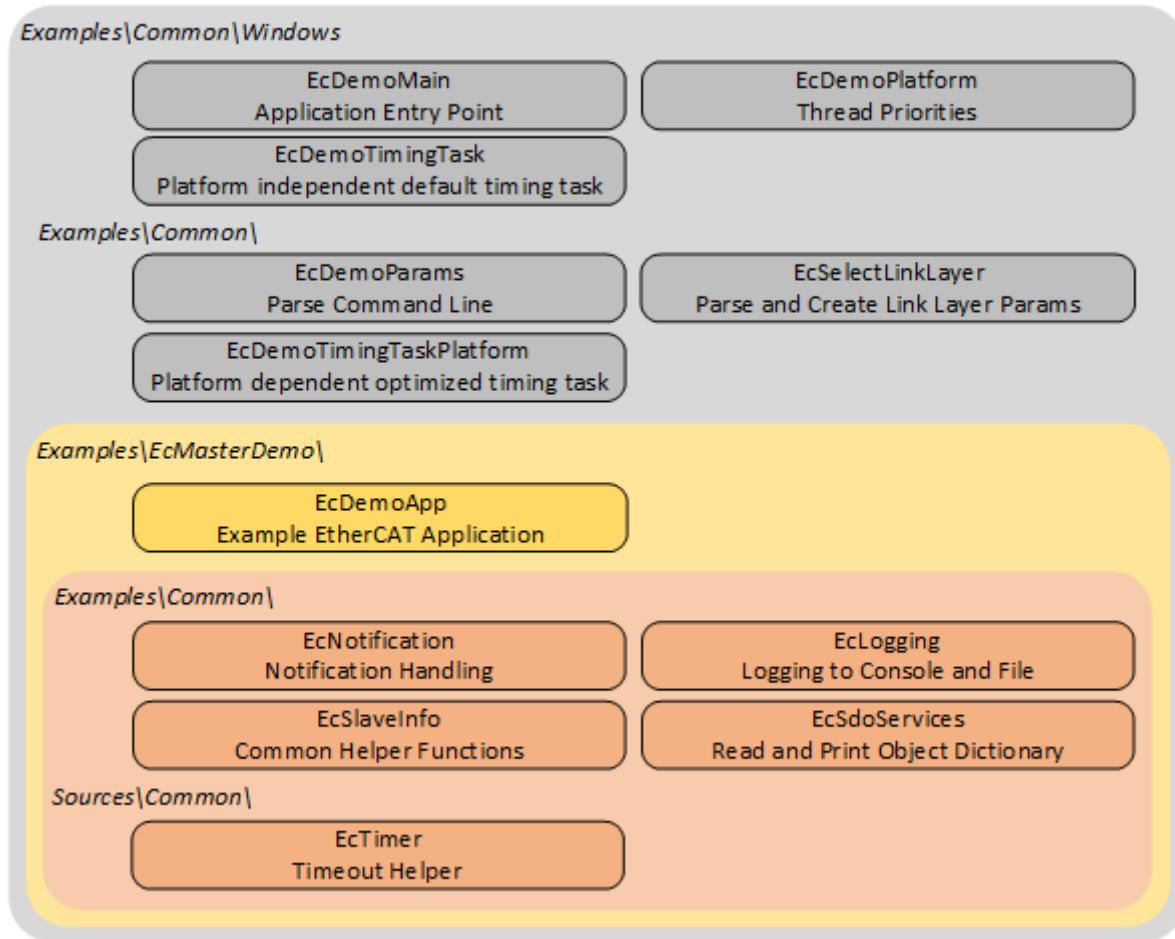
- Showing basic EtherCAT communication
- Master stack initialization
- Start (set all slaves into OPERATIONAL state)
- “Out of the box” solution for different operating systems, see *Platform and Operating Systems (OS)*
- Thread with periodic tasks and application thread already implemented

- The output messages of the demo application will be printed on the console as well as in some files.
The following log files will be created:

- ecmaster0.log all messages
- error0.log application error messages (logged via LogError function)

3.2.1 File reference

The EC-Master Demo application consists of the following files:



EcDemoMain.cpp

Entry point for the different operating systems

EcDemoPlatform.h

Operating system specific settings (taskpriorities, timer settings)

EcDemoTimingTask.h/.cpp

Operating system independent default timing task implementation (base class)

EcDemoTimingTaskPlatform.h/.cpp

Operating system dependent performance increasing overrides of EcDemoTimingTask

EcDemoApp.cpp

Initialize, start and terminate the EtherCAT master

EcDemoApp.h

Application specific settings for EcDemoApp

EcDemoParms .cpp

Parsing of command line parameters

EcDemoParms .h

Basic configuration structs and parameters (EtherCAT master parameter)

EcSelectLinkLayer .cpp

Common Functions which abstract the command line parsing into Link Layer parameters

EcNotification .cpp

Slave monitoring and error detection (function `emNotify()`)

EcSdoServices .cpp

CoE object dictionary example

EcSlaveInfo .cpp

Slave information services (bus scan, slave properties, getting information of slaves connected to the EtherCAT bus)

EcLogging .cpp

Message logging functions

EcTimer .cpp

Start and monitor timeouts

3.2.2 Master lifecycle

This chapter provides a brief overview of starting and stopping the EC-Master. Basically the operation of the EC-Master is wrapped between the functions:

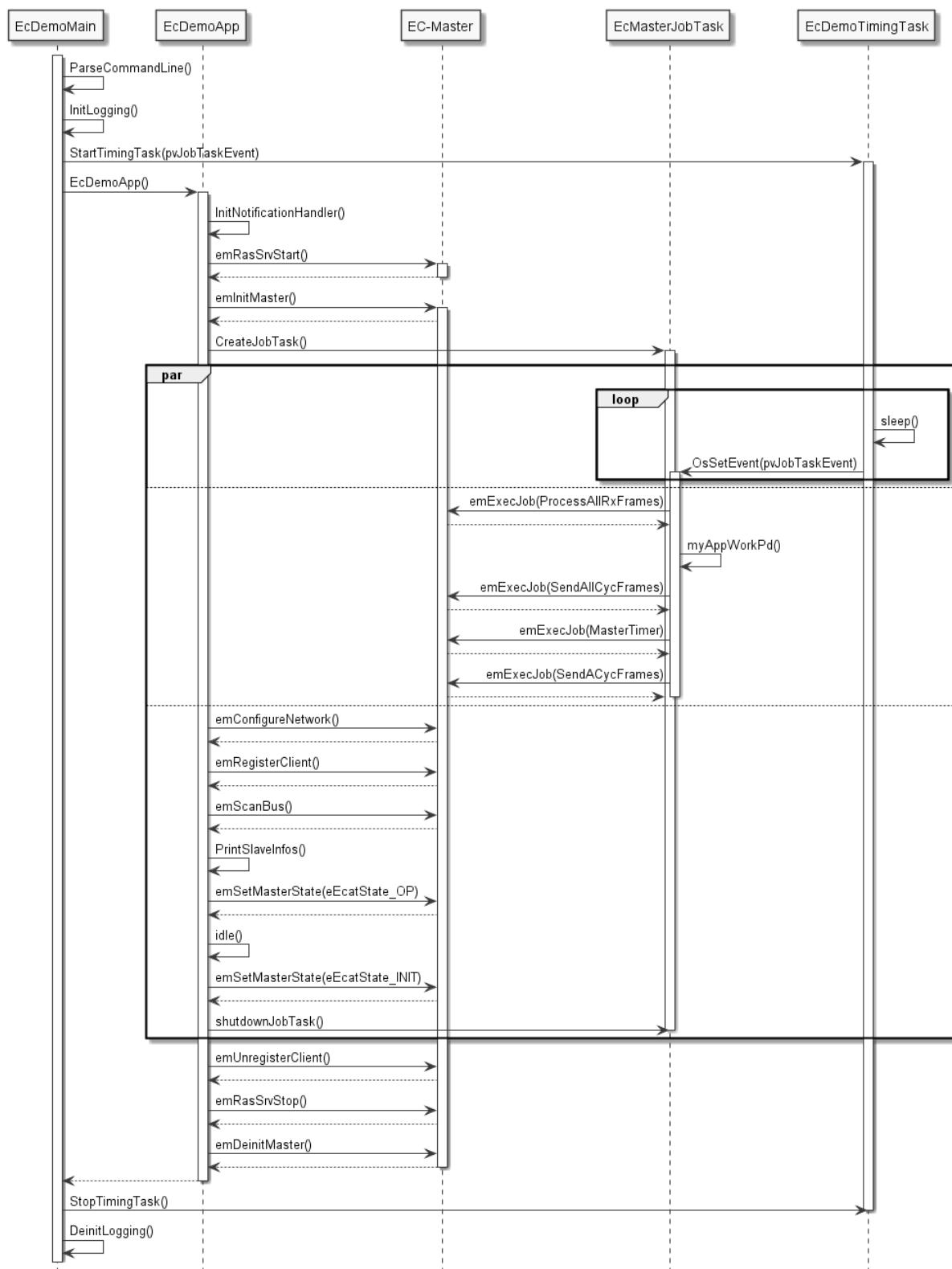
- `emInitMaster()`
- `emSetMasterState()`

and

- `emDeinitMaster()`

The EC-Master is made ready for operation and started with the first two functions mentioned. During this preparation, a thread is set up and started that handles all the cyclic tasks of the EC-Master. The last function stops the EC-Master and clears the memory.

An overview of the complete life cycle as a sequence diagram:



A more detailed description of the functions:

EcDemoMain()

A wrapper to start the demo from the respective operating system. In addition to initializing the operating system, parsing command line parameters, and initializing logging, it also starts the timing task.

EcDemoApp()

Demo application. The function takes care of starting and stopping the master and all related tasks. In between, the function runs idle, while all relevant work is done by the EcMasterJobTask().

EcMasterJobTask()

Thread that does the necessary periodic work. Very important here is myAp-pWorkPd() between `EC_T_USER_JOB::eUsrJob_ProcessAllRxFrames` and `EC_T_USER_JOB::eUsrJob_SendAllCycFrames`. Application-specific manipulations of the process image, which must be synchronous with the bus cycle, can be carried out here.

EcDemoTimingTask()

Timing Thread. This thread sets the timing event that triggers the EcMasterJobTask for the next cycle.

emInitMaster()

EC-Master API function: Prepare the master for operation and set operational parameters, e.g. used Link Layer, buffer sizes, maximum number of slaves,

emConfigureNetwork()

EC-Master API function: Loads the configuration from the ENI (XML file).

emRegisterClient()

EC-Master API function: Register the application as a client at the EC-Master to receive event notifications.

emSetMasterState()

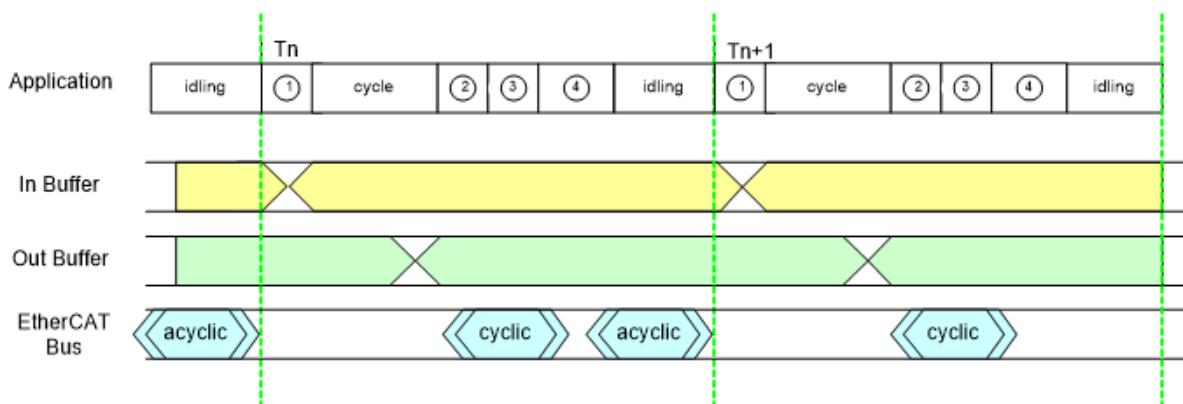
EC-Master API function: Startup the EtherCAT master and switch the bus to the different states from INIT to OPERATIONAL.

emDeinitMaster()

EC-Master API function: Clean up.

3.2.3 Synchronization

This chapter puts the tasks or functions, which run in the “tEcJobTask()”, into relation with timing and communication on the EtherCAT bus. See Picture.

**Application**

Shown are the tasks/jobs (1) through (4) which must be done by the application every single cycle. The details of the individual tasks are described below. When the application is done with the jobs, it waits for the next cycle. (period between (4) and (1)).

In buffer

Shown are the contents of the input section of the process image. The contents are not valid while the EtherCAT master updates the data (1).

Out buffer

Shown are the contents of the output section of the process image. The contents are not valid while the application updates the data (1).

EtherCAT bus

Shown are the timing positions, when the EtherCAT master does cyclic and acyclic communication on the

EtherCAT bus. Besides the timing position of the start for the cyclic frames, the shown positions may vary, depending on the number of frames.

In the “EcDemoApp()” application the tasks/jobs (1) through (4) shown in the picture are managed and scheduled by the “tEcJobTask()”. Here a more detailed description:

Job 1

The job `EC_T_USER_JOB::eUsrJob_ProcessAllRxFrames` works on the frames and data received with previous bus activity. This includes cyclic as well as acyclic frames. The received frames are analyzed for new input data and the local process image is updated. During this process the input data section of the process image is invalid.

cycle In the current `myAppWorkpd()`: Call `ELxxxx()` slave functions. This is the spot where a user defined application can manipulate the process image. The application has updated input information (from Job 1 above), can do calculations and manipulation, and write new data to the output section of the process image.

Job 2

This function triggers the transmission of all cyclic frames on the EtherCAT bus.

Job 3

The job `EC_T_USER_JOB::eUsrJob_MasterTimer` has administrative character and are basically necessary to run the timeout timers. There is no interaction with the process image during these calls nor does this call trigger any bus traffic. It is not necessary to run this function with every bus cycle, especially on systems with short cycle times < 1 msec. But it is recommended to run this function with a 1 msec period.

Job 4

With the job `EC_T_USER_JOB::eUsrJob_SendAcycFrames` call, the acyclic frames are scheduled for transmission.

idling

Currently implemented as waiting for the next cycle (triggered by the timing event).

3.2.4 Event notification

The EtherCAT master provides event notification for a great number of events. These events are for example:

- Bus state change
- Link state change
- Working counter errors
- ...

Any thread can register for these events to be notified. This is achieved by calling the API function

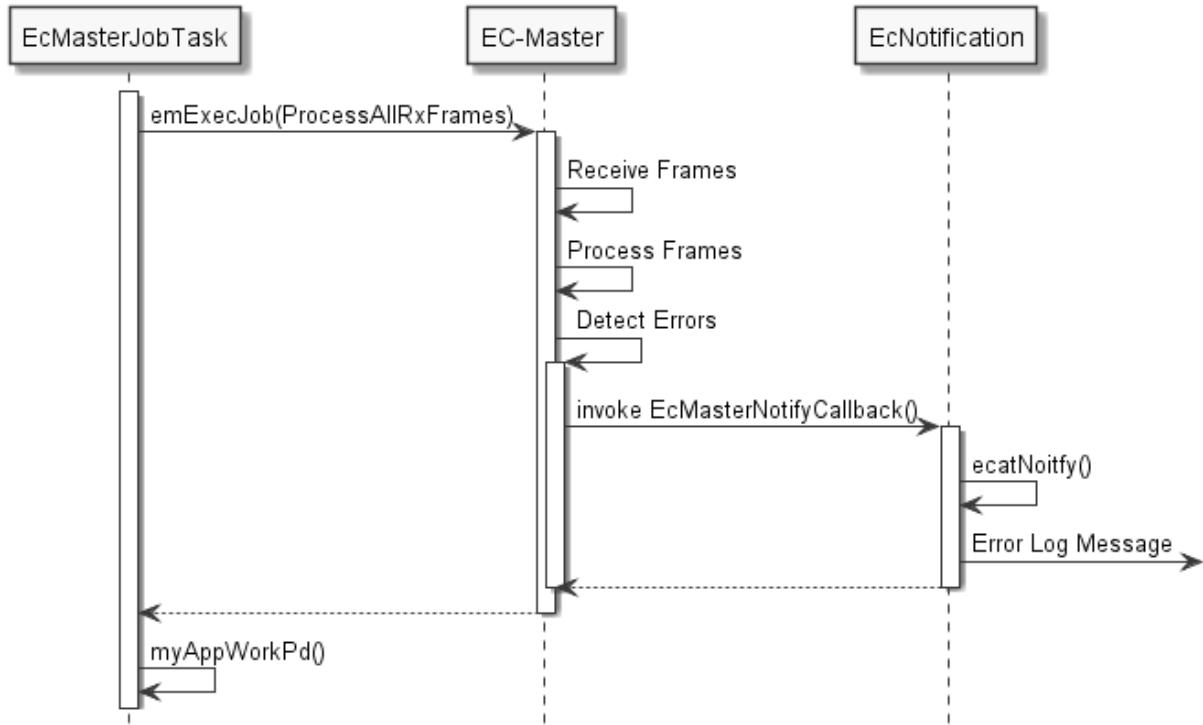
`EC_T_DWORD emRegisterClient(EC_T_DWORD dwInstanceID, EC_PF_NOTIFY pfnNotify, EC_T_VOID *pCallerData, EC_T_REGISTERRESULTS *pRegResults)`

In case of the EcMasterDemo the class `CEmNotification` is provided. It implements the complete framework to catch and handle the EC-Master notifications. The class is instantiated once and registered at the EC-Master with the call `emRegisterClient()` shown above. The class implements the method `ecatNotify()` as major entry point (or callback function) for events.

There are two different ways events can be handled. The method of handling an event is primarily determined by the time required to handle the event and the processing context in which the event is to be handled. The methods are described below.

Direct notification handling

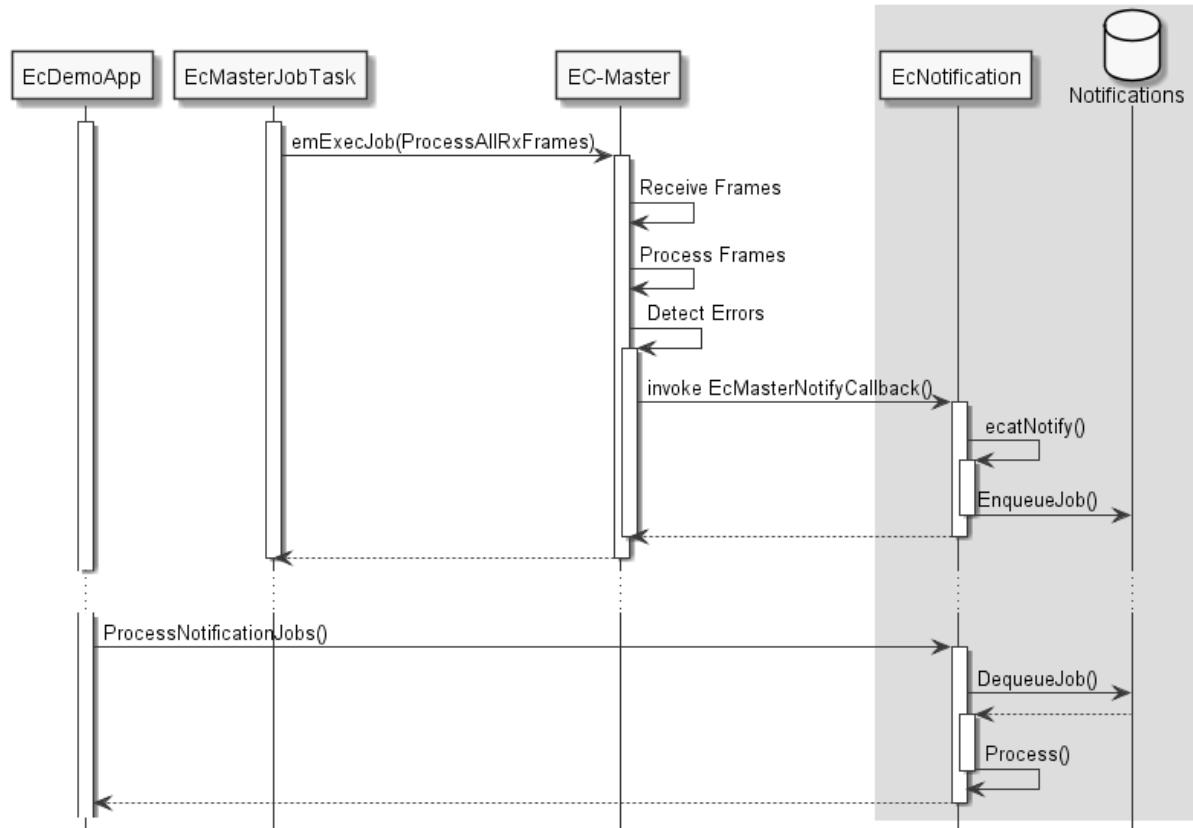
Smaller events can be handled directly in the context in which they are detected. A possible example of such an event is the detection of a false work counter (WKC). The procedure is as follows:



The event handling is reduced to simply issuing a log message, which is not time critical. The event is handled directly within the context of the `emExecJob()` (`eUsrJob_ProcessAllRxFrames`) function.

Postponed notification handling

Events that require more time-consuming processing cannot be handled directly in the context in which they are detected. The handling or processing of the event must be postponed. This is accomplished through a queue, which is also readily implemented using the `CEmNotification` class. The procedure is as follows:



By calling periodically `CEmNotification::ProcessNotificationJobs()`, the application checks and handles all queued notifications.

Important: The call of `CEmNotification::ProcessNotificationJobs()` shall NOT be executed in the `EcMasterJobTask()`. As the CPU time consumption may be high, this would have a high impact to the real-time behavior of the cyclic operation.

3.2.5 Logging

The `EcMasterDemo` examples demonstrate how log messages can be processed by the application, see `Examples/Common/EcLogging.cpp`. The messages processed by `EcLogging.cpp` are of different types, e.g. EC-Master log messages, application messages, DCM messages and are logged to the console and/or files. Identical messages are skipped automatically by default.

Note: With some operating systems, logging in files is deactivated, e.g. because a file system is not available.

Parameters

The verbosity of the EcMasterDemo is specified as a `-v` command line parameter. It is used to determine the log level of the application, see `EcDemoMain.cpp`. For performance reasons the EC-Master automatically filters log messages according to `EC_T_LOG_PARMS::dwLogLevel`. `EcLogging.cpp` has various parameters beside the log level, like Roll Over setting, log task prio and affinity, log buffer size, etc. See `EcMasterDemo` for reference.

Configure EC-Master logging

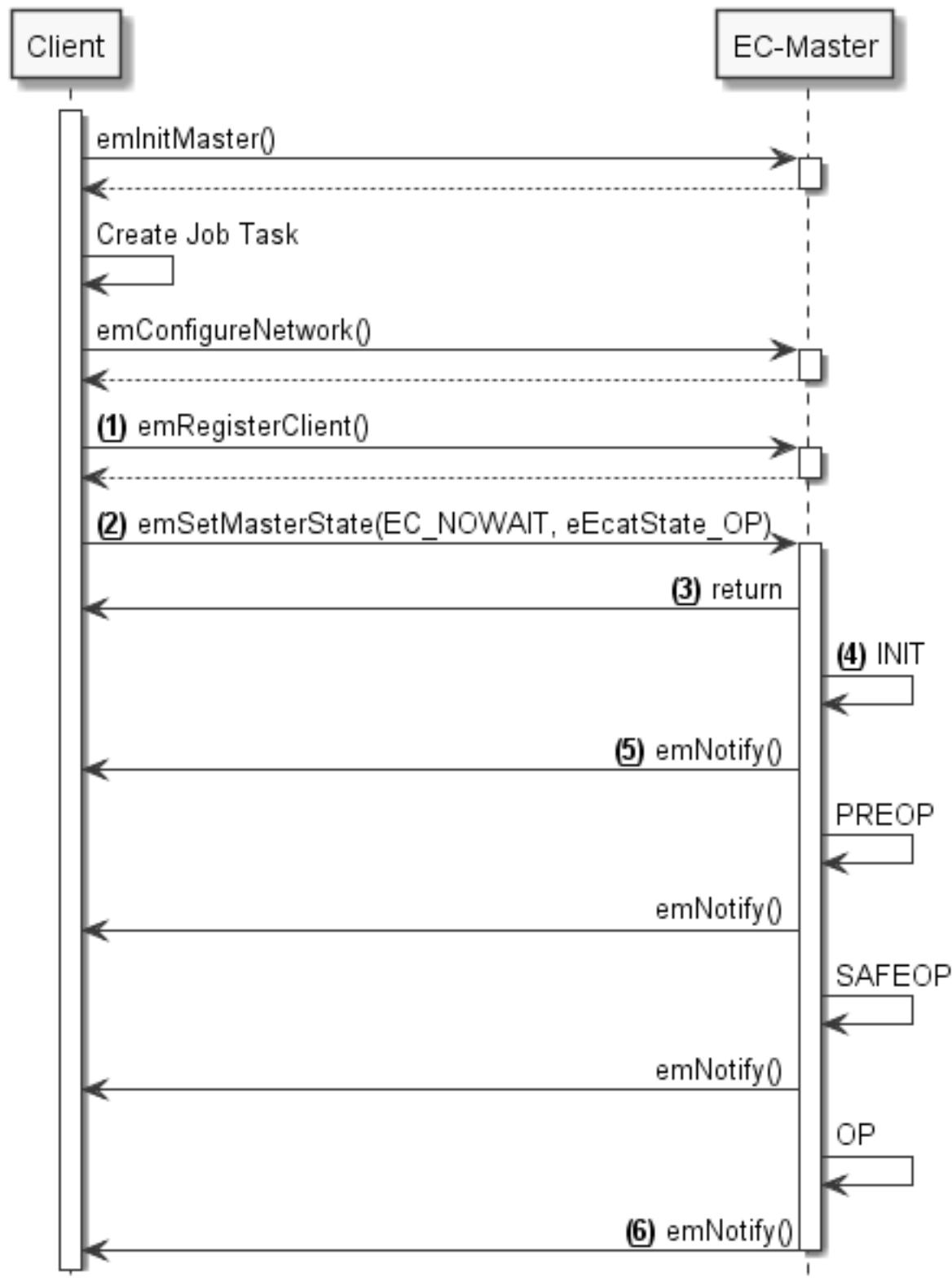
The EC-Master logging is configured on initialization, see `EC_T_INIT_MASTER_PARMS::LogParms` in `em-InitMaster()`. The application can provide customized log message handlers of type `EC_PF_LOGMSGHK` if the default handler in `EcLogging.cpp` does not fulfill the application's needs.

Note: The callback is typically called from the EcMasterJobTask's context and should return as fast as possible.

3.3 Master startup

The master stack has to be initialized once when the application is starting. After this one-time initialization one or more clients may register with the master. Finally, after all clients are registered the master can be started. Starting the master means that all slaves will be set into the operational state. Every time the state of the master has changed the clients are notified about this state-change.

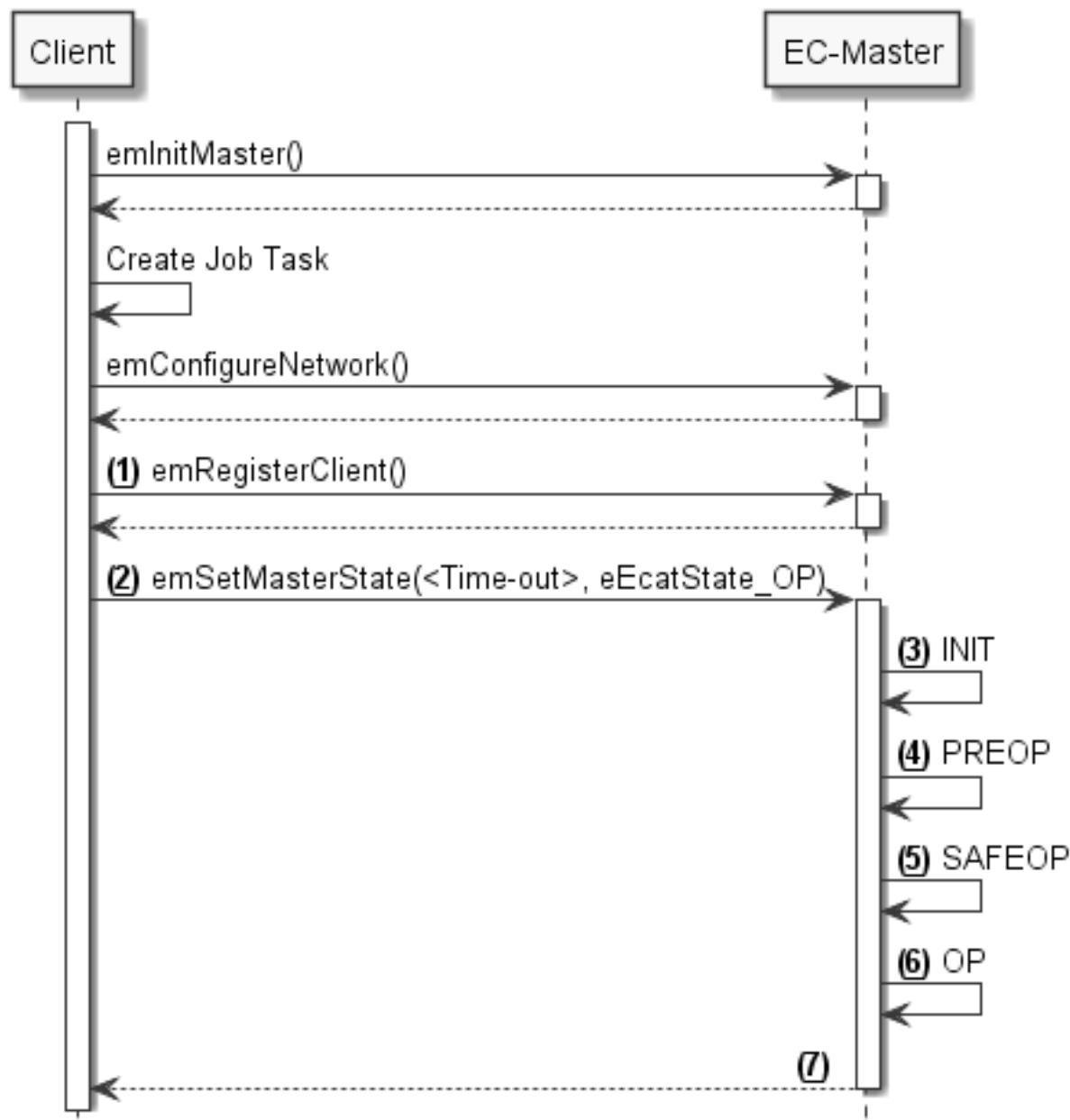
3.3.1 Asynchronous (deferred) startup



- Client calls `emInitMaster()` (...)
- Client creates Job Task. See *Master lifecycle*
- Client calls `emConfigureNetwork()` (...)

- Client calls `emRegisterClient ()` (...) (See “1”)
- Client calls `emSetMasterState ()` (...) with a timeout parameter `EC_NOWAIT` (See “2”)
- Function `emSetMasterState ()` (...) returns immediately (`EC_NOWAIT`) (See “3”)
- Inside `emSetMasterState ()` (...) the master startup procedure will be initiated (See “4”)
- The master initializes all slaves until all slaves reach OPERATIONAL state
- After every state change the client will be notified (See “5”)
- After reaching the OPERATIONAL state the system is ready (See “6”)

3.3.2 Synchronous startup



- Client calls `emInitMaster ()` (...)
- Client creates Job Task. See *Master lifecycle*

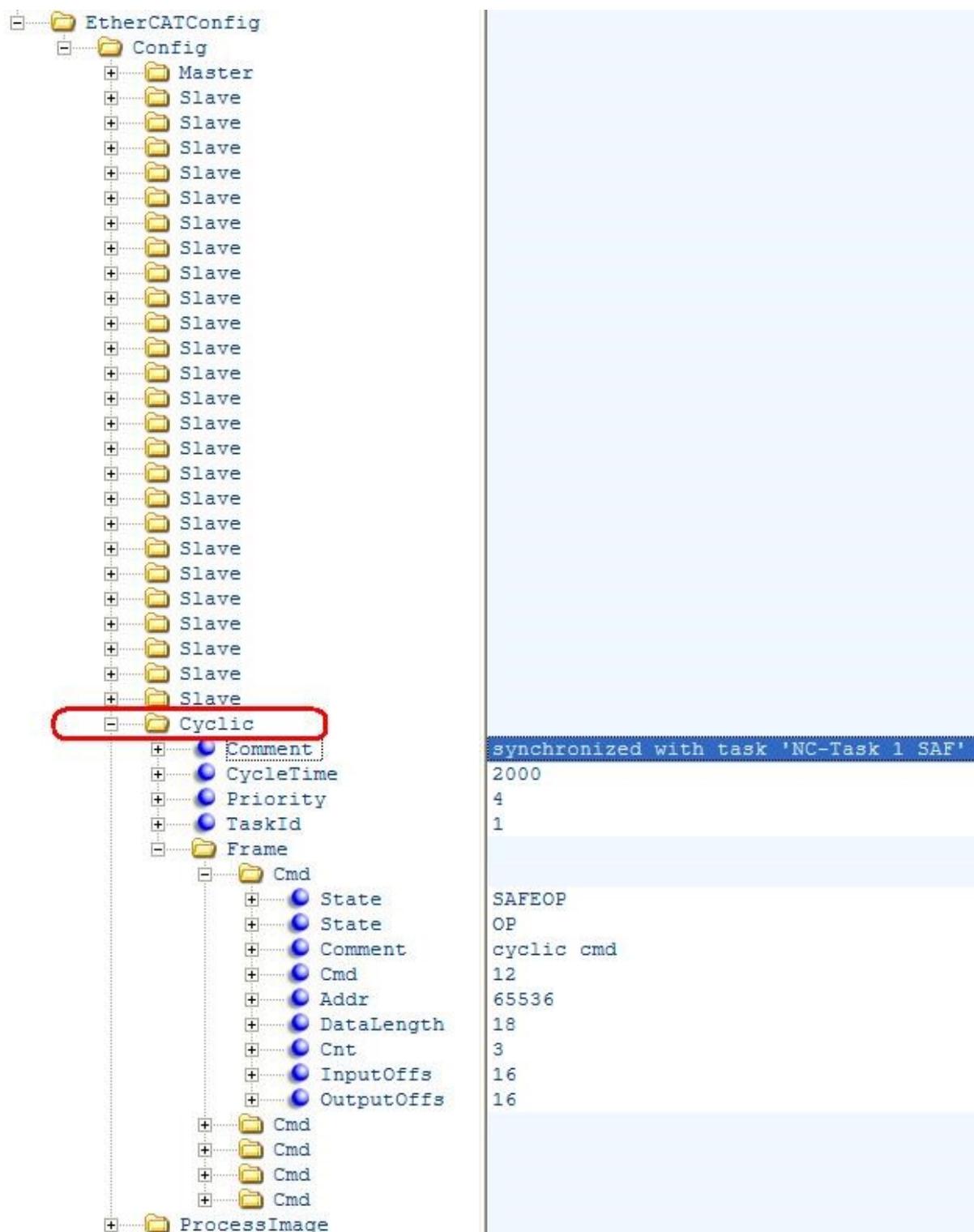
- Client calls `emConfigureNetwork()` (...)
- Client calls `emRegisterClient()` (...) (See “1”)
- Client calls `emSetMasterState()` (...) with an appropriate timeout value (See “2”)
- Inside `emSetMasterState()` (...) the master startup procedure will be initiated (See “3”)
- The client is blocked until the whole startup has finished(See “7”)
- The master initializes all slaves until all slaves reach OPERATIONAL state(See “3-6”)
- After reaching the OPERATIONAL state the system is ready (See “6”)
- `emSetMasterState()` (...) returns(See “7”)

3.4 EtherCAT Network Configuration ENI

For reading new input data values and writing new output data values (process data update) the EtherCAT configuration file contains one or multiple “Cyclic” entries. These entries contain one or multiple frames (so-called cyclic frames) to be sent cyclically by the master. Inside the cyclic frames there are one or multiple EtherCAT datagrams containing logical read/write commands for reading and writing process data values.

3.4.1 Single cyclic entry configuration

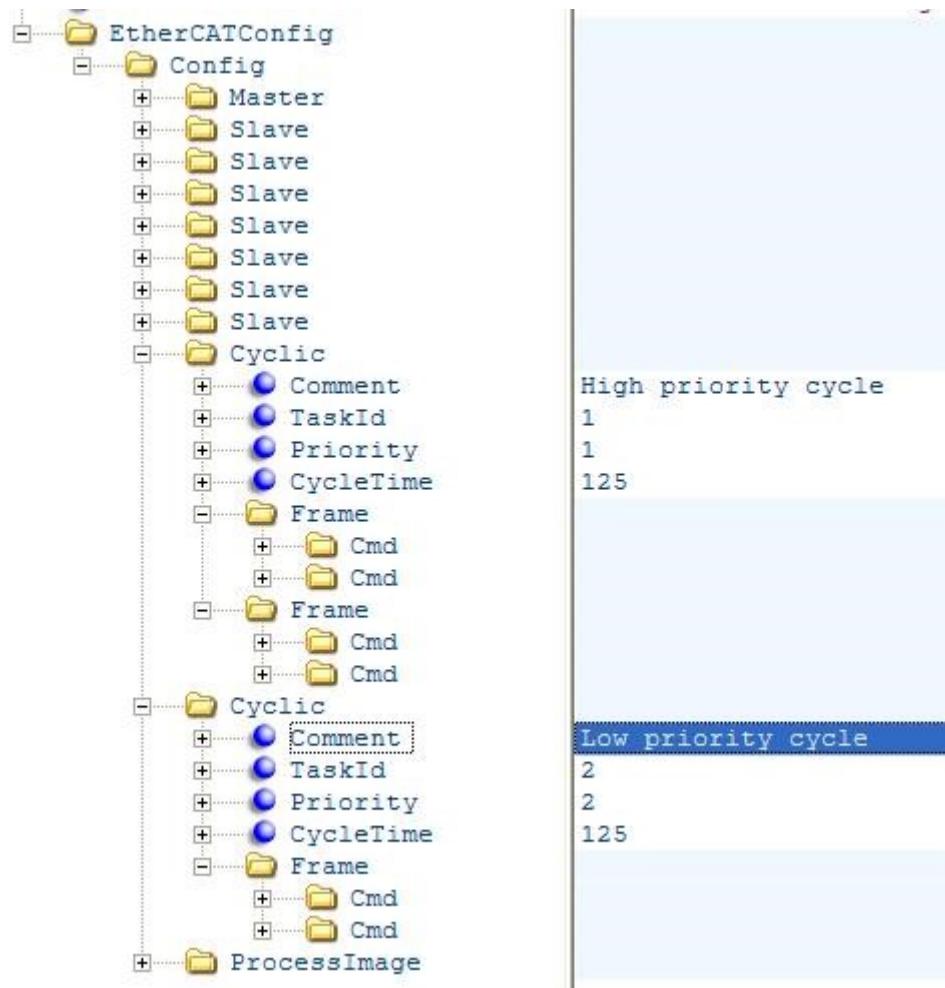
In the simplest case, there is only a single cyclic entry with one or more cyclic frames.



All process data synchronization modes support this configuration variant.

3.4.2 Multiple cyclic entries configuration

For more complex scenarios it is possible to configure the system using multiple cyclic entries with one or more cyclic frames for each cyclic entry.



The application has to use the `EC_T_USER_JOB::eUsrJob_SendCycFramesByTaskId` job call to the master to send the appropriate cyclic frame.

See also:

`emExecJob()`

3.4.3 Copy Information for Slave-to-Slave communication

It is possible to configure the system to copy input variables to output variables within EC-Master. The copy info declarations of the corresponding received cyclic frame are processed in `emExecJob(eUsrJob_ProcessAllRxFrames)`.

The exchange of process data takes two communication cycles. The duration is necessary if cable redundancy is used or if the WKC of INPUT needs to be checked before changing OUTPUT.

The copy info declarations are located at /EtherCATConfig/Config/Cyclic/Frame/Cmd/CopyInfos in the ENI file.

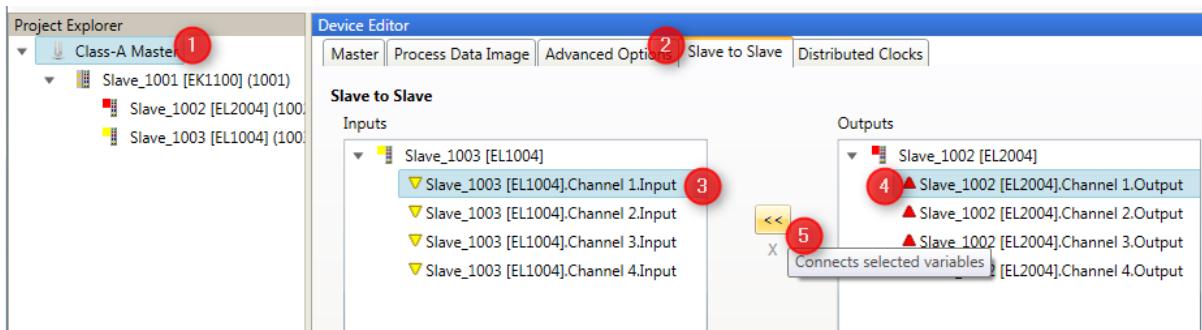
See also:

- *Cyclic cmd WKC validation*

- CopyInfoType in ETG.2100

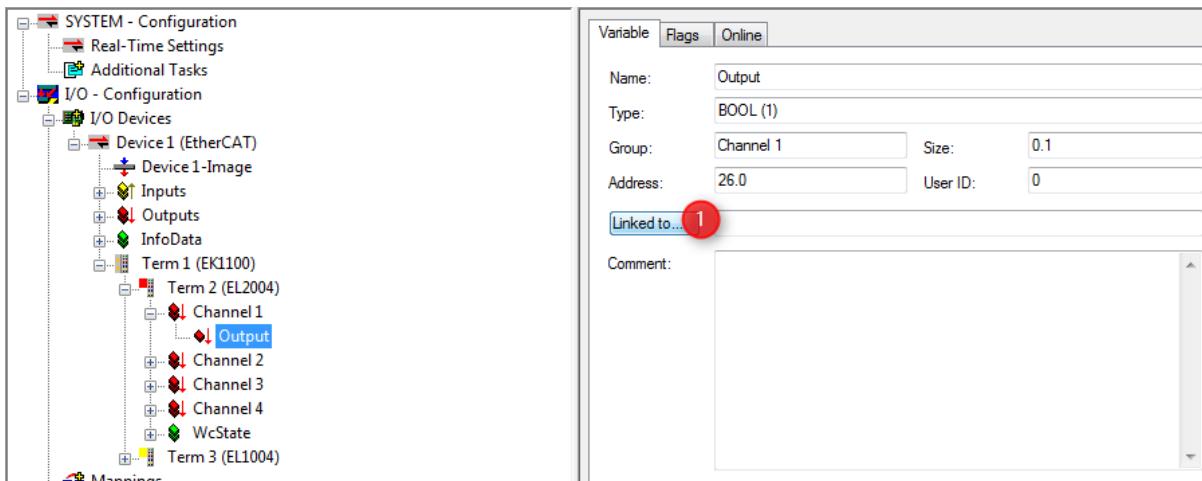
Configuration with EC-Engineer

1. In the “Slave to Slave” tab of the Master select Input and Output Variable and connect them:

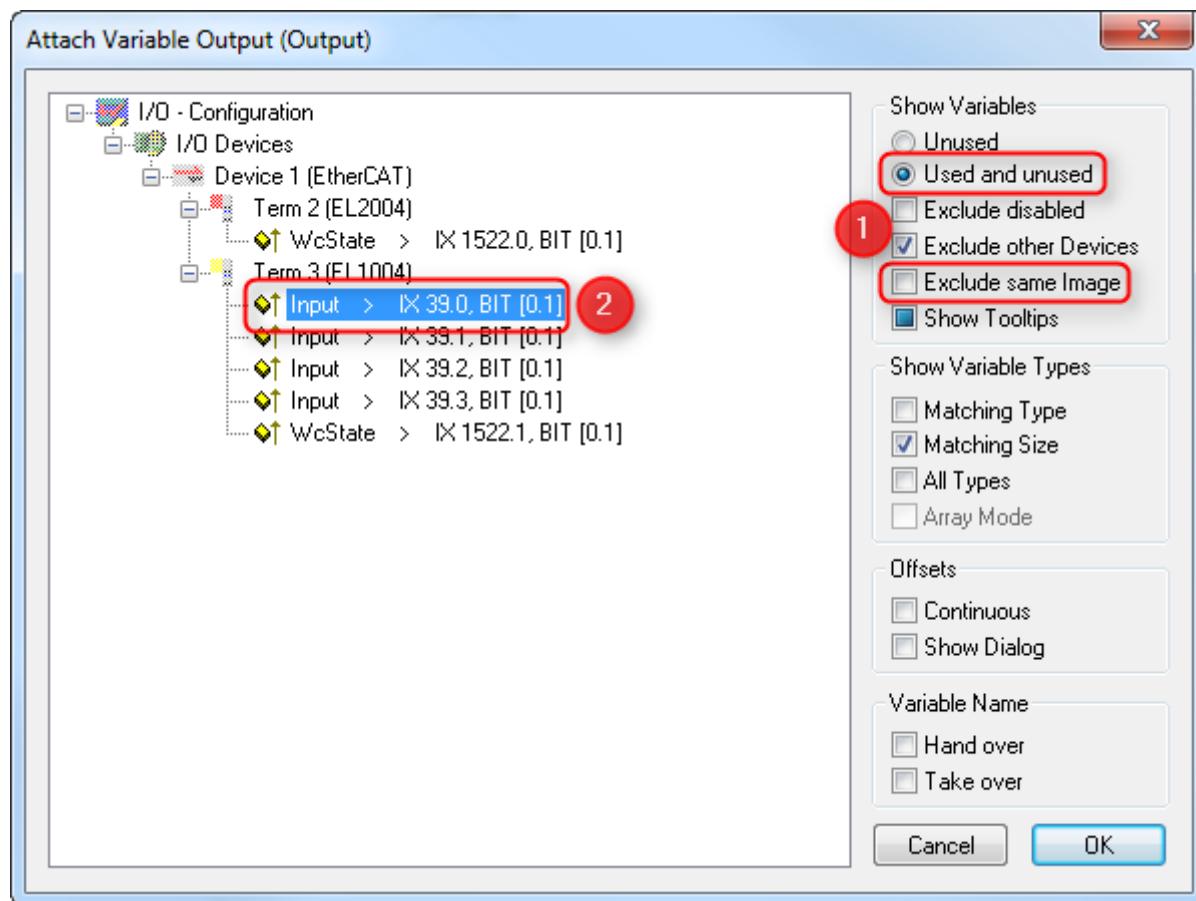


Configuration with ET9000

1. Select “Linked to...” from the Output Variable:



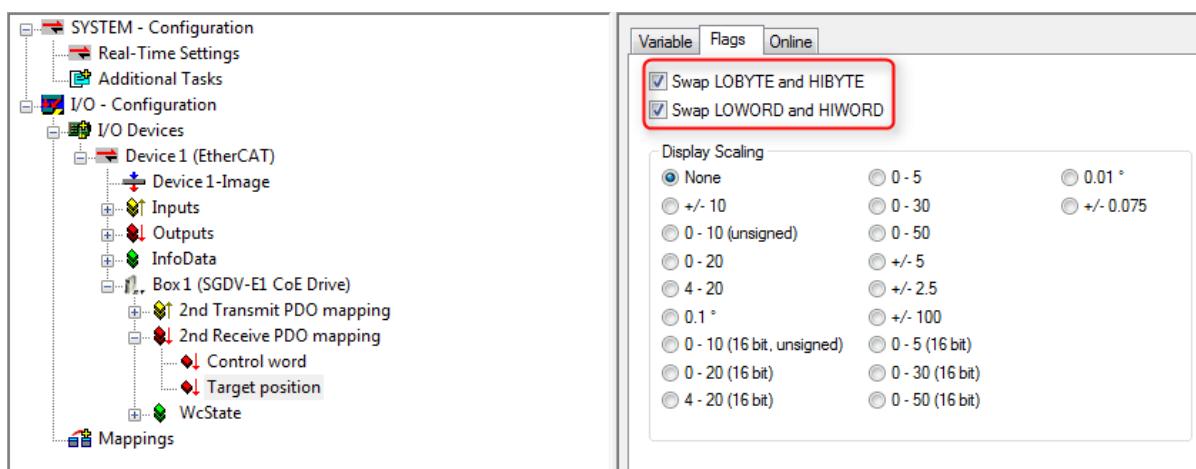
2. Select Input Variable to be attached to the Output Variable:



Hint: Copy info declaration processing is independent of WKC values, but updating the INPUT source depends on successful Cyclic cmd WKC validation.

3.4.4 Swap variables' bytes according to ENI

The following screenshot (ET9000) shows how to configure variables to be swapped by the EC-Master:



Hint: The EC-Master does not distinguish between WORD or BYTE swapping. Setting any PDO swap flag instructs

the EC-Master to swap the PDO variable.

The swap declarations are located at `DataType`'s attribute `SwapData` of `RxPdo` or `TxPdo`, e.g. `/EtherCATConfig/Config/Slave/ProcessData/RxPdo/Entry/DataTypes` in the ENI file.

3.5 Process Data Access

The process data, exchanged between the EtherCAT master and the slaves in every cycle, are stored in the process data image. There are two separate memory areas, one for the input data and another one for the output data. The base addresses of these areas are provided by calling the functions `emGetProcessImageInputPtr()` and `emGetProcessImageOutputPtr()`. The size of the process data input image is defined in the ENI file under `EtherCATConfig/Config/ProcessImage/Inputs/ByteSize` and `EtherCATConfig/Config/ProcessImage/Outputs/ByteSize` and is returned by `emRegisterClient()` at `EC_T_REGISTERRESULTS::dwPDOOutSize` and `EC_T_REGISTERRESULTS::dwPDInSize`.

3.5.1 Process Data Access Functions

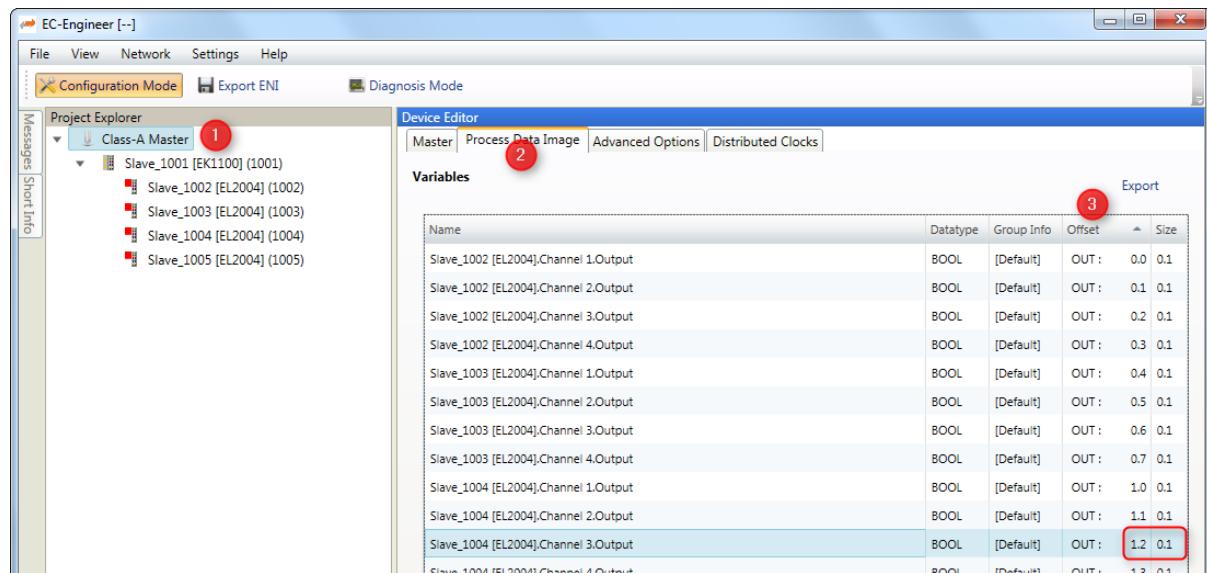
Process data variables that are packed as array of bits are bit aligned and not byte aligned in process data. See `EC_COPYBITS` for how to copy data areas with bit offsets that are not byte aligned. Getting and setting bits that are bit aligned and not byte aligned should be done using `EC_SETBITS` and `EC_GETBITS`. Accessing complete `EC_T_BYTE`, `EC_T_WORD`, `EC_T_DWORD`, `EC_T_QWORD` can be accessed more efficiently using the appropriate macros according to the following table.

Note: These functions do not initiate any transmission on the line. Process data is typically transmitted as little endian and must therefore be swapped on big endian systems such as PPC in order to be correctly interpreted, see e.g. `EC_SET_FRM_WORD`, `EC_GET_FRM_WORD`.

Variable Type	Bit Size	EC Type	Macro
INTEGER8, UNSIGNED8, BIT8	8	EC_T_BYTE	N/A
INTEGER16, UNSIGNED16	16	EC_T_WORD	<code>EC_SET_FRM_WORD</code> , <code>EC_GET_FRM_WORD</code>
INTEGER32, UNSIGNED32, REAL32	32	EC_T_DWORD	<code>EC_SET_FRM_DWORD</code> , <code>EC_GET_FRM_DWORD</code>
INTEGER64, UNSIGNED64, REAL64	64	EC_T_UINT64	<code>EC_SET_FRM_QWORD</code> , <code>EC_GET_FRM_QWORD</code>
BOOLEAN, BIT1...BIT7	1	EC_T_BOOL	<code>EC_SETBITS</code> , <code>EC_GETBITS</code>

3.5.2 Process variables' offset and size

The following screenshot shows variables' offset and size within the Process Data Image:



Accessing the process data of a specific slave always works by adding an offset to the base address.

There are different ways possible to get this offset. All offsets are given as bit offsets! The offset values will not change until a new configuration is provided (s.a. [emNotify - EC_NOTIFY_CLIENTREGISTRATION_DROPPED](#)) therefore it is sufficient to load them once right after [emConfigureNetwork\(\)](#), it is not needed every cycle.

3.5.3 Process variable access via hard coded offsets

The offset value is determined from the EtherCAT configuration tool. It is not recommended to use fixed values as the offsets will change as slaves are added/removed from the configuration.

As shown in the screenshot above, “Slave_1004 [EL2004].Channel 3.Output” is at offset 1.2 with size 0.1 in the example.

The numbering is Byte.Bit so the offset in the example is Byte 1, Bit 2, Bit offset:

$$8 * 1 + 2 = 10$$

Bit size

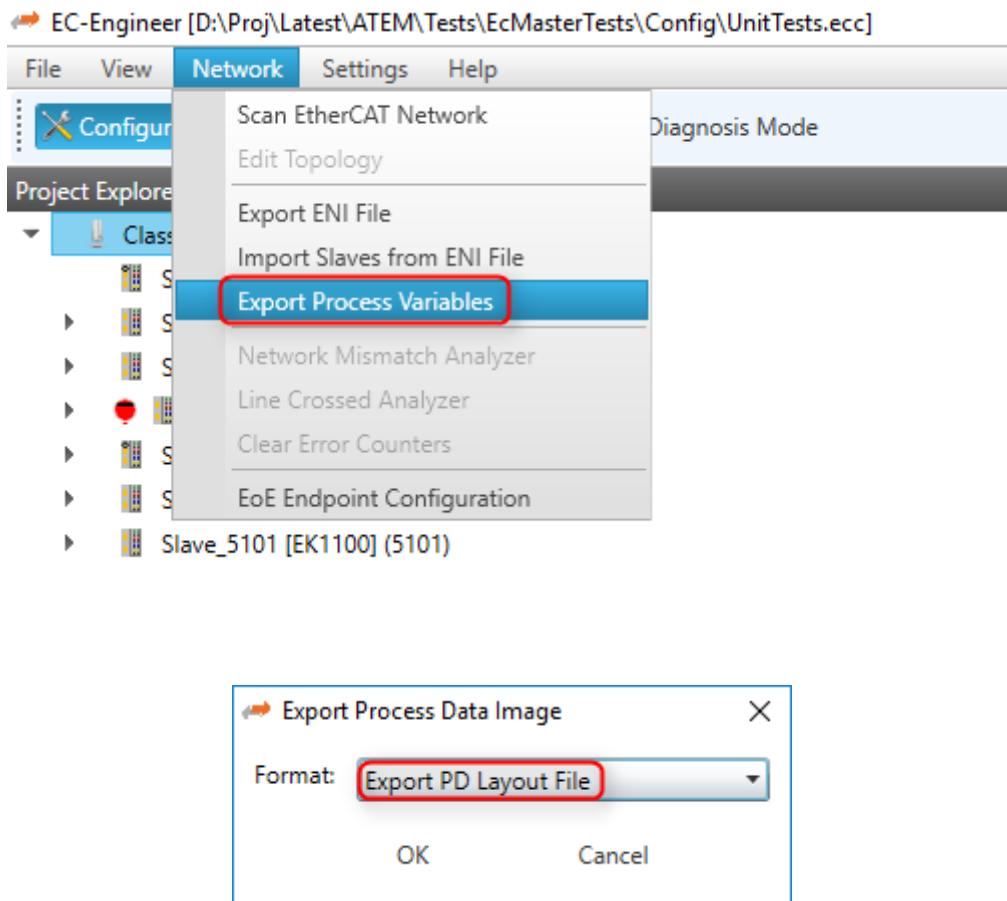
$$0 * 8 + 1 = 1$$

```
EC_T_BYTE* pbyPdOut      = emGetProcessImageOutputPtr(dwInstanceId);
EC_T_BYTE  byNewValue     = 0x01;
EC_T_DWORD dwBitOffset   = 10;
EC_T_DWORD dwBitSize     = 1;

/* set variable in process data */
EC_SETBITS(pbyPdOut, &byNewValue, dwBitOffset, dwBitSize);
```

3.5.4 Process variable access via generated PD Layout

The EC-Engineer can export the process variables to a PD-Layout C-Header via the menu item *Network > Export Process Variables* as shown in the following screenshots:



This will generate a header file containing the slaves' variables as follows:

```
#include EC_PACKED_INCLUDESTART(1)
#define PDLAYOUT_OUT_OFFSET_SLAVE_2002 22
typedef struct _T_PDLAYOUT_OUT_SLAVE_2002
{
    EC_T_SWORD    swChannel_1_Output; // Slave_2002 [EL4132].Channel 1.Output ...
    EC_T_SWORD    swChannel_2_Output; // Slave_2002 [EL4132].Channel 2.Output ...
} EC_PACKED(1) T_PDLAYOUT_OUT_SLAVE_2002;
#include EC_PACKED_INCLUDESTOP
```

Example how a value can be set:

```
EC_T_BYTE* pbyPdOut = emGetProcessImageOutputPtr(dwInstanceId);
T_PDLAYOUT_OUT_SLAVE_2002* pPdOutSlave2002 = (T_PDLAYOUT_OUT_SLAVE_2002*) (pbyPdOut_
↪+ PDLAYOUT_OUT_OFFSET_SLAVE_2002);

EC_SET_FRM_WORD (&pPdOutSlave2002->swChannel_1_Output, 42);
```

3.5.5 Process variable access dynamically from ENI

emGetCfgSlaveInfo

The slave offsets can be determined dynamically with the function `emGetCfgSlaveInfo()`. The offsets are stored in `EC_T_CFG_SLAVE_INFO::dwPdOffsIn` and `EC_T_CFG_SLAVE_INFO::dwPdOffsOut`.

Example of how “Slave_1004 [EL2004].Channel 3.Output” can be set:

```
EC_T_CFG_SLAVE_INFO SlaveInfo;
emGetCfgSlaveInfo(dwInstanceId, EC_TRUE, 1004, &SlaveInfo);

EC_T_BYTE* pbyPdOut      = emGetProcessImageOutputPtr(dwInstanceId);
EC_T_BYTE byNewValue     = 0x01;
EC_T_DWORD dwBitOffset   = SlaveInfo.dwPdOffsOut + 2;
EC_T_DWORD dwBitSize     = 1;

/* set variable in process data */
EC_SETBITS(pbyPdOut, &byNewValue, dwBitOffset, dwBitSize);
```

emGetSlaveOutpVarInfo

All variables of a specific slave can be determined dynamically with the functions `emGetSlaveInpVarInfoEx()` or `emGetSlaveOutpVarInfoEx()`. The offset is stored in `EC_T_PROCESS_VAR_INFO_EX::nBitOffs`. Each input or output has a unique variable name. All variables names are stored in the ENI file under EtherCATConfig/Config/ProcessImage/[Inputs|Outputs]/Variable.

Example of how “Slave_1004 [EL2004].Channel 3.Output” can be set:

```
EC_T_WORD wNumSlaveVars = 0;
EC_T_WORD wNumVarsRead = 0;
EC_T_PROCESS_VAR_INFO_EX* aProcVarInfo = EC_NULL;

/* get number of output variables */
dwRes = emGetSlaveOutpVarInfoNumOf(dwInstanceId, EC_TRUE, 1004, &wNumSlaveVars);

/* allocate buffer for the variable info structs */
aProcVarInfo = (EC_T_PROCESS_VAR_INFO_EX*)OsMalloc(sizeof(EC_T_PROCESS_VAR_INFO_EX) * wNumSlaveVars);
OsMemset(aProcVarInfo, 0, sizeof(EC_T_PROCESS_VAR_INFO_EX) * wNumSlaveVars);

/* read all variables of the slave at once */
dwRes = emGetSlaveOutpVarInfoEx(dwInstanceId, EC_TRUE, 1004, wNumSlaveVars, aProcVarInfo, &wNumVarsRead);

EC_T_BYTE* pbyPdOut = emGetProcessImageOutputPtr(dwInstanceId);
EC_T_BYTE byNewValue = 0x01;

/* set variable in process data */
EC_SETBITS(pbyPdOut, &byNewValue, aProcVarInfo[0].nBitOffs, aProcVarInfo[0].nBitSize);
```

emFindOutpVarByName

The variable offsets can be determined dynamically with the functions `emFindInpVarByNameEx()` or `emFindOutpVarByNameEx()`. The offset is stored in `EC_T_PROCESS_VAR_INFO_EX::nBitOffs`. Each input or output has a unique variable name. All variables names are stored in the ENI file under EtherCATConfig/Config/ProcessImage/[Inputs|Outputs]/Variable.

Example of how “Slave_1004 [EL2004].Channel 3.Output” can be set:

```
EC_T_PROCESS_VAR_INFO_EX ProcVarInfo;
emFindOutpVarByNameEx(dwInstanceId, "Slave_1004 [EL2004].Channel 3.Output", &
    ProcVarInfo);

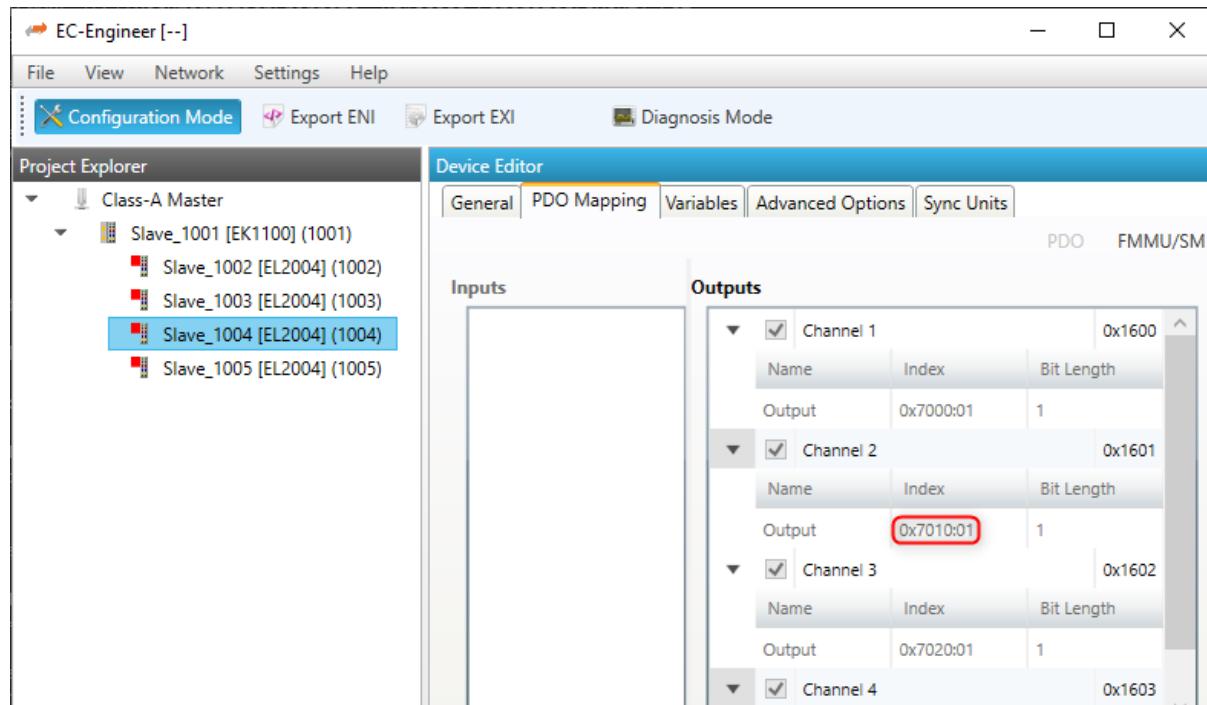
EC_T_BYTE* pbyPdOut = emGetProcessImageOutputPtr(dwInstanceId);
EC_T_BYTE byNewValue = 0x01;

/* set variable in process data */
EC_SETBITS(pbyPdOut, &byNewValue, ProcVarInfo.nBitOffs, ProcVarInfo.nBitSize);
```

emGetSlaveOutpVarByObjectEx

The variable offsets can be determined dynamically using the object index and subindex with the functions `emGetSlaveInpVarByObjectEx()` or `emGetSlaveOutpVarByObjectEx()`.

The object index and subindex can be get with the EC-Engineer:



Example of how `Slave_1004 [EL2004].Channel 3.Output` can be set:

```
EC_T_PROCESS_VAR_INFO_EX ProcVarInfo;
dwRes = emGetSlaveOutpVarByObjectEx(dwInstanceId, EC_TRUE, 1004, 0x7010, 0x01, &
    ProcVarInfo);

EC_T_BYTE* pbyPdOut = emGetProcessImageOutputPtr(dwInstanceId);
EC_T_BYTE byNewValue = 0x01;
```

(continues on next page)

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```
/* set variable in process data */
EC_SETBITS(pbyPdOut, &byNewValue, ProcVarInfo.nBitOffs, ProcVarInfo.nBitSize);
```

3.6 Process Data Memory

All mapped process data objects of the slaves are copied by the master into a process data memory image. New input values received from the slaves are written to the input process data image. New output values to be sent to the slaves are read from the output process data image.

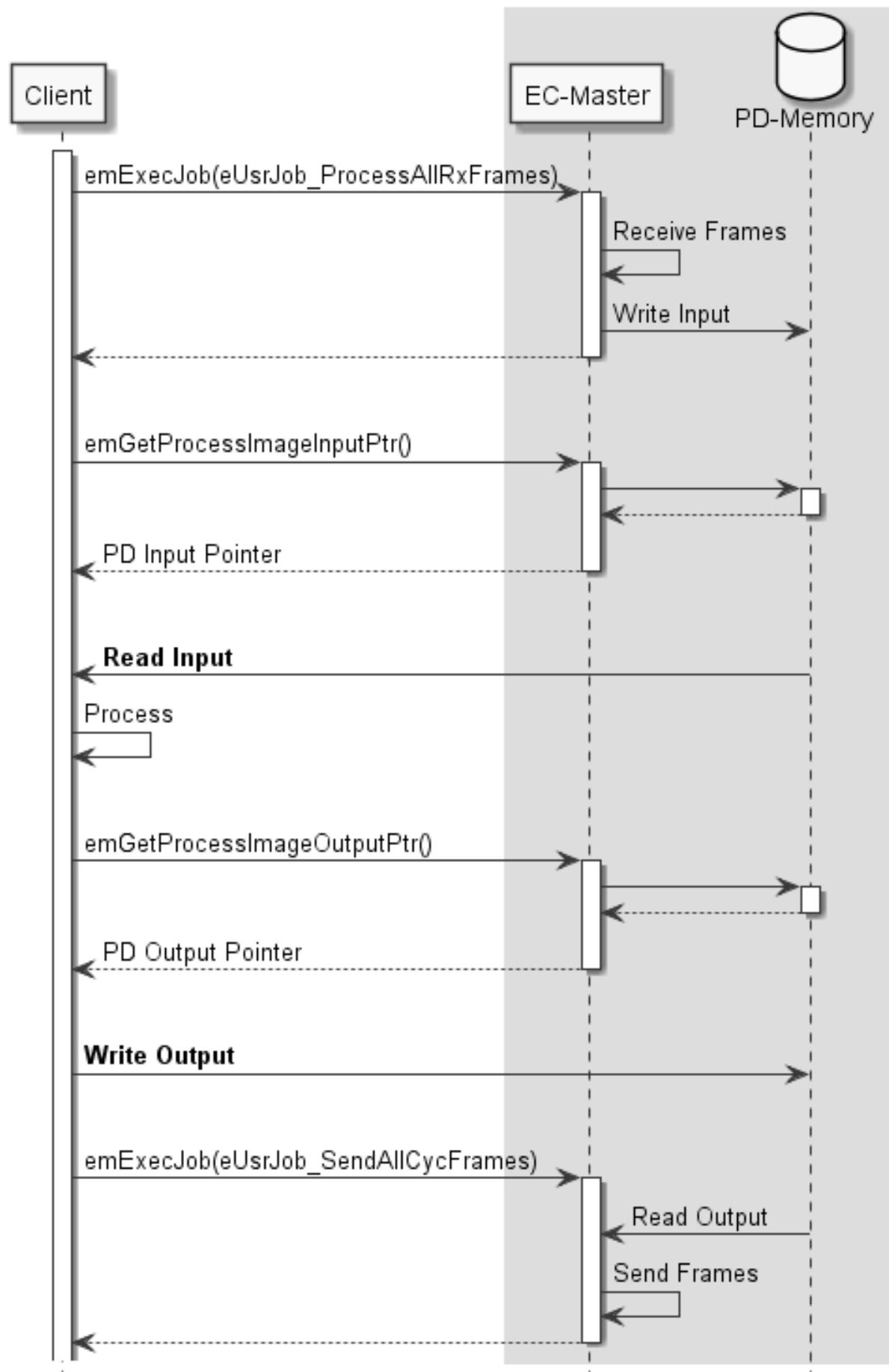
The EC-Master uses two separate buffers where process data input values and process data output values are stored. The buffers used may either be always the same (fixed buffers) or be changed on every process data transfer cycle (dynamic buffers).

The EC-Master has different options for how the process data memory is provided.

1. EC-Master provides process data memory (fixed buffers)
2. User application registers an external memory provider with fixed buffers
3. User application registers an external memory provider with dynamic buffers

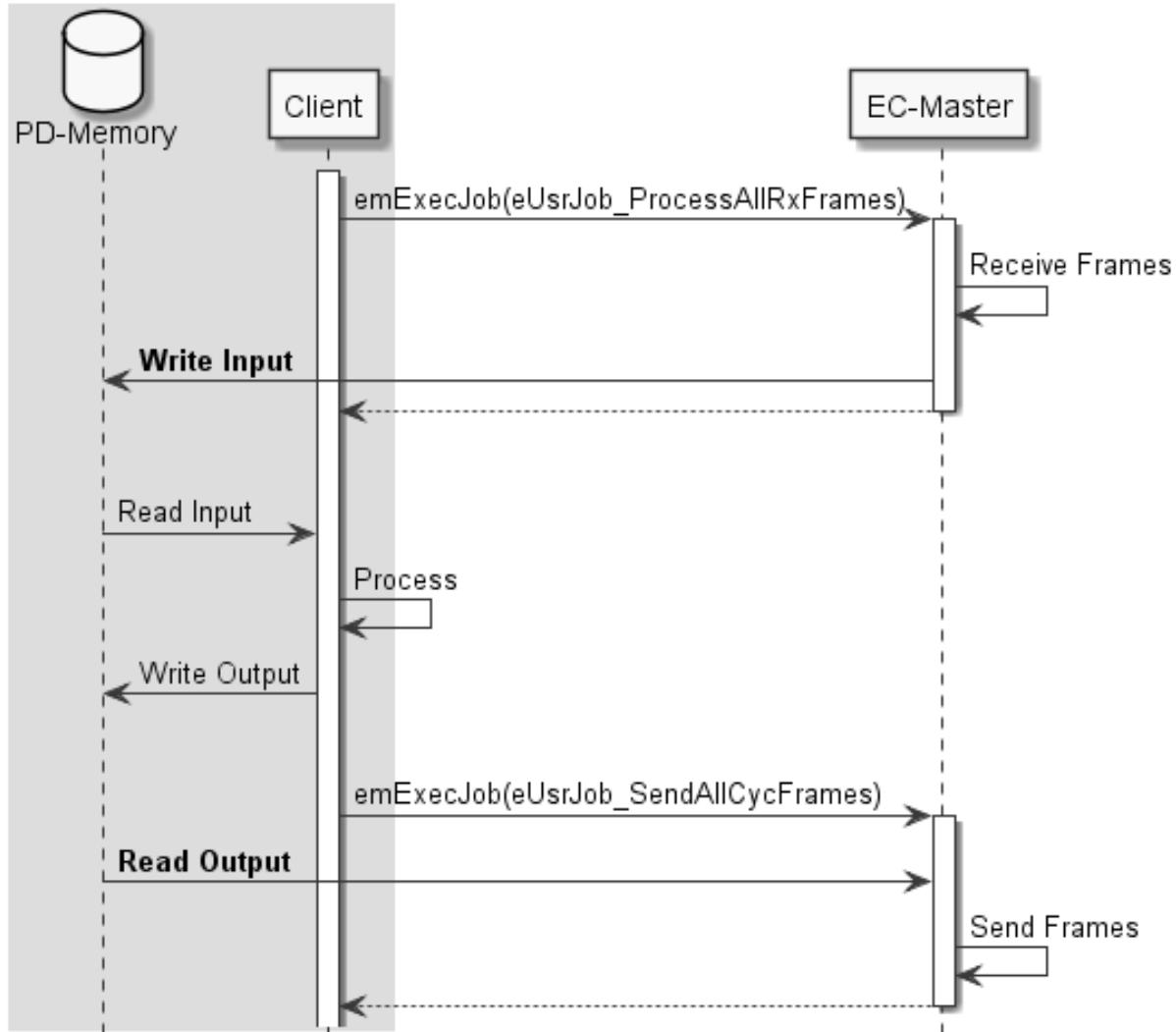
3.6.1 EC-Master as process data memory provider

If the application does not register a memory provider, the EC-Master internally allocates the required memory needed to store input and output process data values during `emConfigureNetwork()`. The EC-Master always uses the same buffers for reading/writing process data.



3.6.2 Application as process data memory provider with fixed buffers

The application may register a memory provider with [emIoControl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER](#) in case the master shall use externally allocated memory to store input and output process data values.



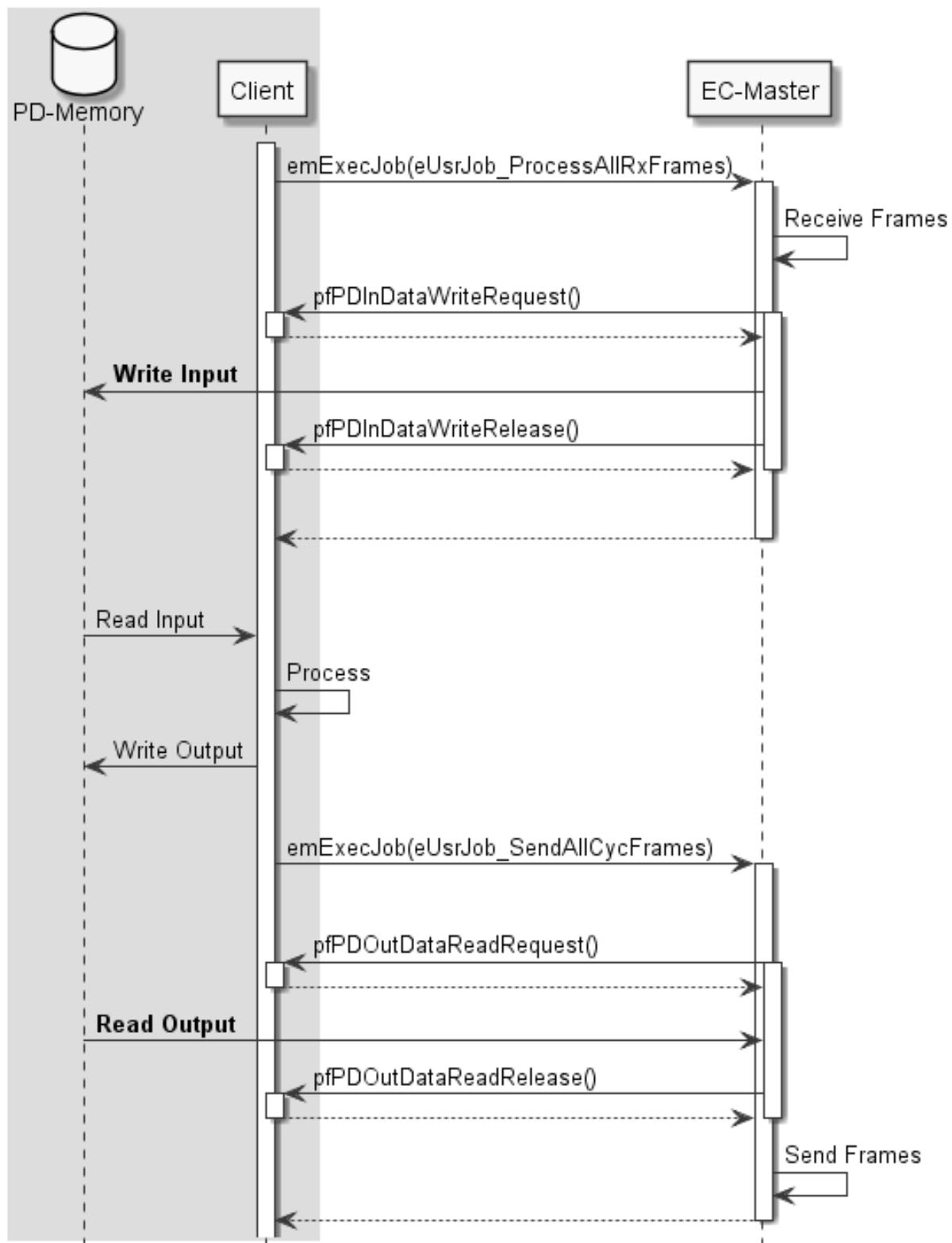
The memory provider may optionally supply callback functions to synchronize memory access between the client and the EC-Master.

Receiving new input process data:

- `EC_T_MEMPROV_DESC::pfPDIInDataWriteRequest`
- `EC_T_MEMPROV_DESC::pfPDIInDataWriteRelease`

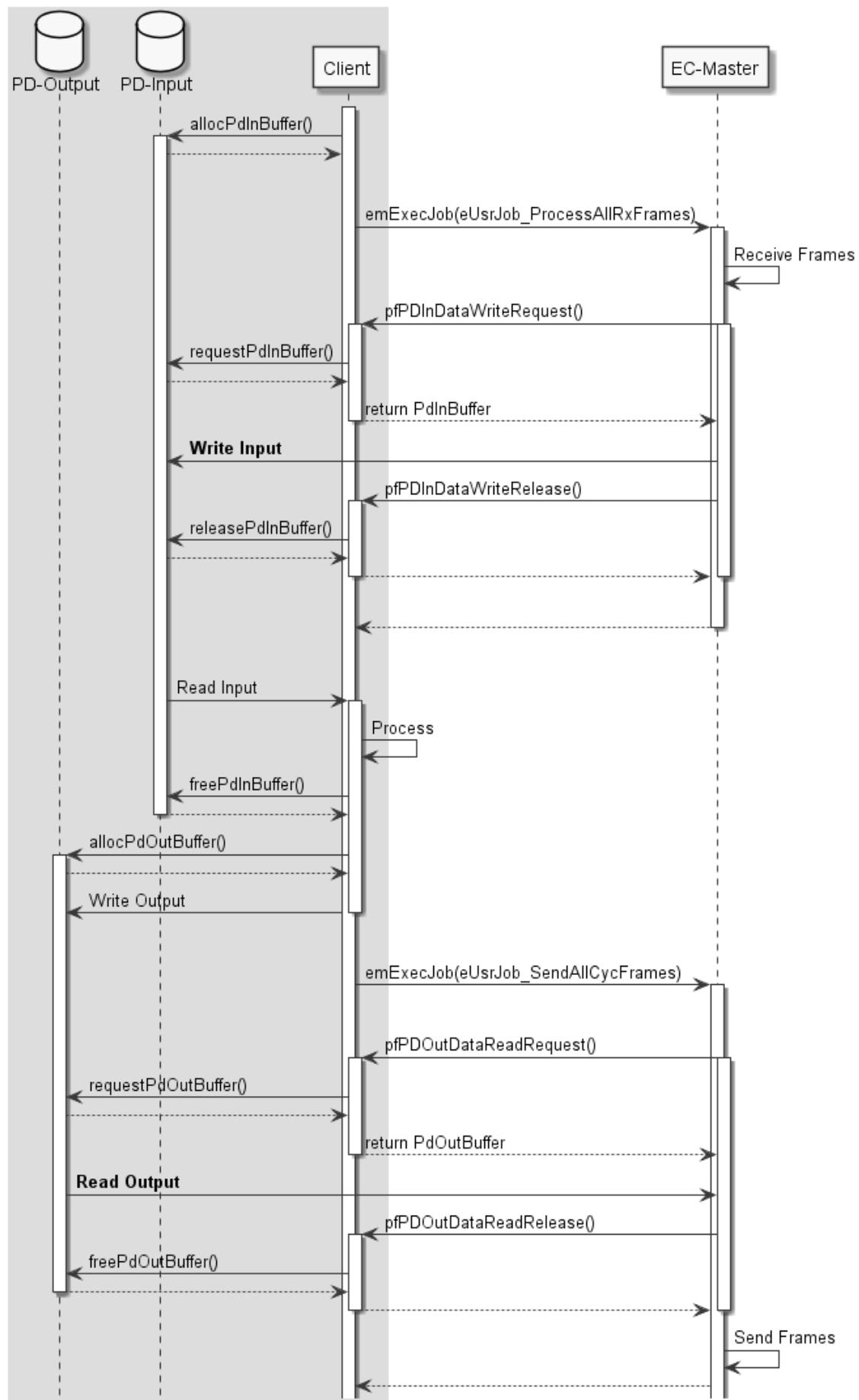
Sending new output process data:

- `EC_T_MEMPROV_DESC::pfPDOOutDataReadRequest`
- `EC_T_MEMPROV_DESC::pfPDOOutDataReadRelease`



3.6.3 Application as process data memory provider with dynamic buffers

The application registers an external memory provider without fixed buffers via *emIoControl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER* with the parameters *EC_T_MEMPROV_DESC::pbyPDInData* and *EC_T_MEMPROV_DESC::pbyPDOOutData* set to EC_NULL. In this case, the EC-Master requests via the callback functions the buffer addresses cyclically when reading or writing process data. This mode can be used to implement dynamic buffering mechanisms between the application and the EC-Master, e.g. double buffering, triple buffering.



3.7 Error detection and diagnosis

The EC-Master API generally return `EC_E_NOERROR` or an error code.

One of the parameters that the client must set when registering with the EC-Master is a generic notification callback function (`emNotify()`). If an error is detected, the master calls this function.

The EC-Master log messages are enabled if `EC_T_LOG_PARMS` is configured as described in `emInitMaster()`.

3.7.1 Cyclic cmd WKC validation

New input values received from the slaves will be written into the input process data memory only if the WKC of the corresponding datagram is not 0 and not greater than the configured WKC value.

See also:

`emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR`

3.7.2 WKC State in Diagnosis Image

Each cyclic Process Data cmd has its own WKC State bit in the diagnosis image. The state is updated on frame receiving, frame loss detection or link disconnection. All process data variables within a datagram have the same WKC State value. The WKC State bit is set to 1 if the WKC value is not as expected or 0. In case of MSU if all the commands related to the MSU return WKC 0, the WKC State will be set to 1.

The WKC State offset within the Diagnosis Image is available at `EC_T_CFG_SLAVE_INFO` and `EC_T_PROCESS_VAR_INFO_EX`, `EC_T_MSU_INFO` see `emGetDiagnosisImagePtr()`, `emGetCfgSlaveInfo()`, `emGetSlaveInpVarInfoEx()`, `emGetSlaveOutpVarInfoEx()`, `emGetMasterSyncUnitInfo()`.

The application can check the WKC State of a variable e.g. as follows:

```
EC_T_CFG_SLAVE_INFO oSlaveInfo;
EC_T_BYTE* pbyDiagnosisImage = emGetDiagnosisImagePtr();
EC_T_BYTE byWkcState = 1;

if (EC_NULL != pbyDiagnosisImage)
{
    if (EC_NOERROR == emGetCfgSlaveInfo(EC_TRUE, 2302, &oSlaveInfo))
    {
        EC_GETBITS(pbyDiagnosisImage, &byWkcState, oSlaveInfo.wWkcStateDiagOffsOut[0],
        ← 1);
    }
}

if (1 == byWkcState)
{
    /* ... error ... */
}
```

See also:

[Cyclic cmd WKC validation](#)

Behavior in case of automatically adjusted expected WKC value

Optionally, the expected WKC value can be automatically adjusted according the state and the presence of the slaves. See [emIoControl - EC_IOCTL_SET_AUTO_ADJUST_CYCCMD_WKC_ENABLED](#). The WKC State bits change synchronized to the corresponding notification, e.g. on link disconnection all slaves disappear and the behavior is as follows:

- All WKC State bits are set to 1 as missing data is not expected.
- The Master notifies the application about the link disconnection and the slaves' disappearing
- All WKC State bits are set to 0 as it is now expected to have no process data if all slaves are absent.

See also:

- [emNotify - EC_NOTIFY_ETH_LINK_NOT_CONNECTED](#)
- [emNotify - EC_NOTIFY_SLAVE_PRESENCE](#)

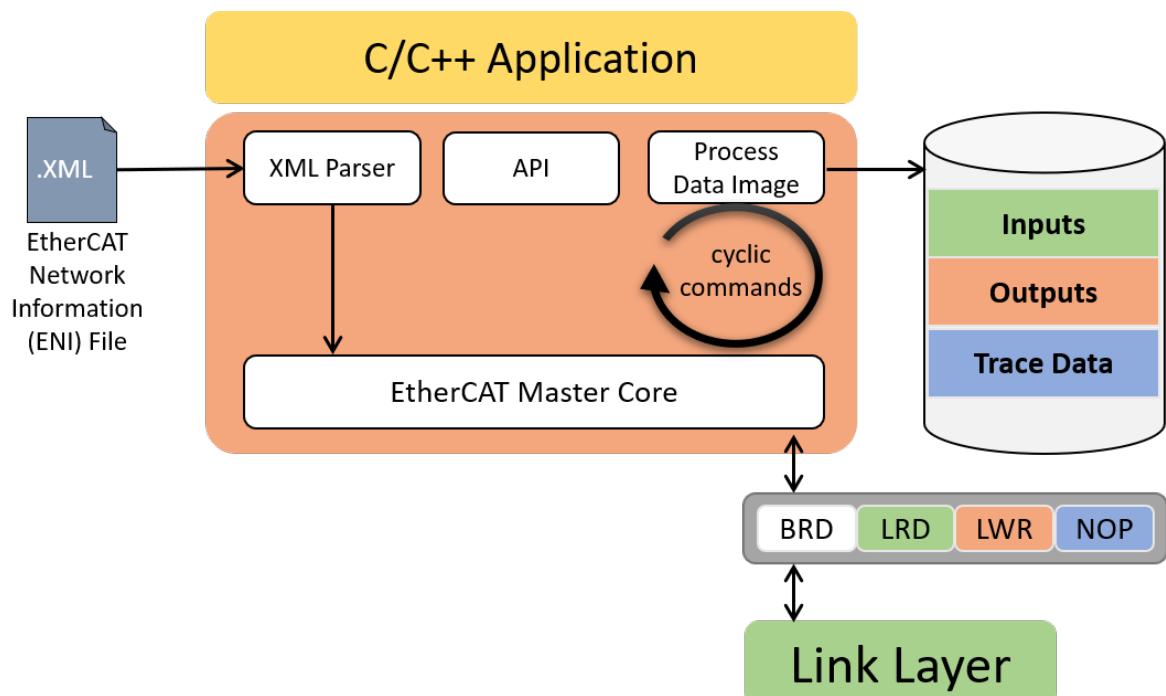
3.7.3 Master Sync Units

Figure out the MSU offsets by calling the function [emGetMasterSyncUnitInfo\(\)](#), as described in [emGetMasterSyncUnitInfo\(\)](#).

3.8 Trace Data

Trace Data allows applications to trace data in real time on the network. To ensure real-time transmission, it is implemented as part of the cyclic process data. They are placed behind the slave output data in the output area of the process data image of the EtherCAT application. The trace data area can be configured either via the ENI with the help of the EC-Engineer or without changing the ENI using the API [emTraceDataConfig\(\)](#).

Trace Data can be captured with a network monitoring tool like Wireshark.



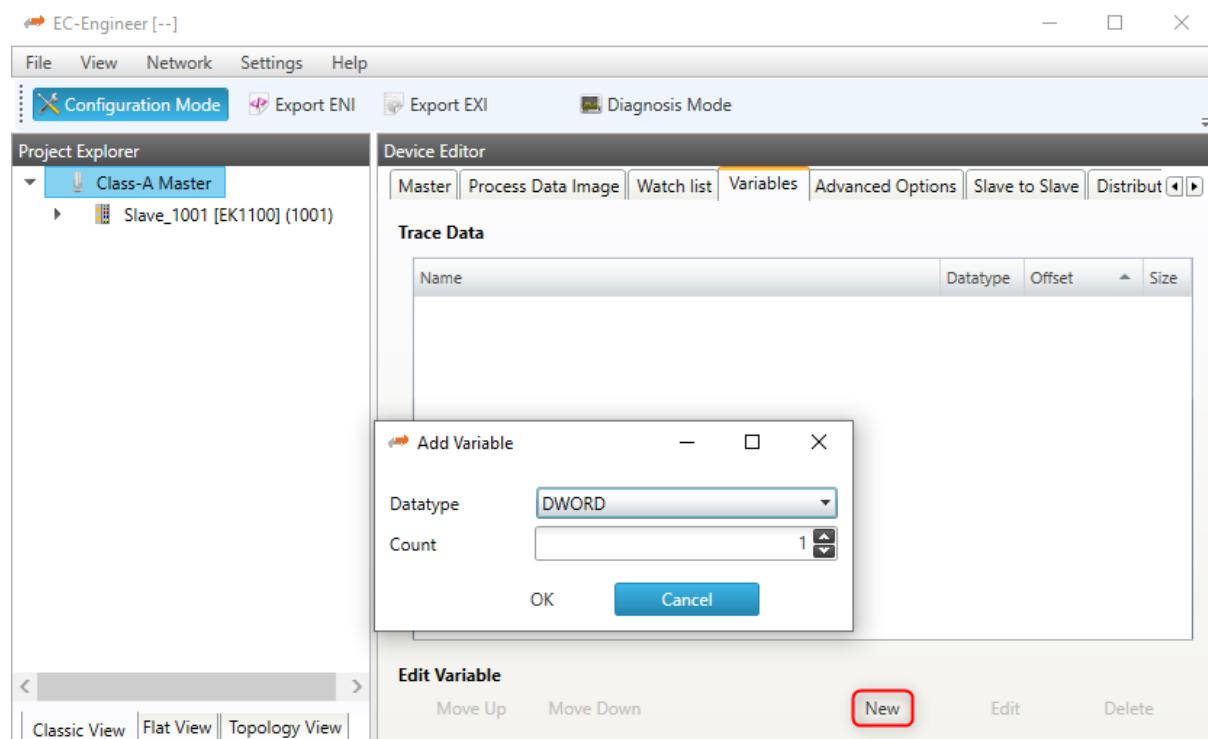
To transfer the data, an additional NOP cmd is appended to the end of the cyclic EtherCAT frame. The NOP cmd has ADP 0 and ADO 0x4154. The EC-Master automatically fills the data area of the NOP Cmd with the current

trace data when sending cyclic frames. Since the trace data are transferred to the network as NOP Cmd, they are not evaluated by any ESC. Therefore, the WKC of the trace data remains 0 and the application cannot validate the data.

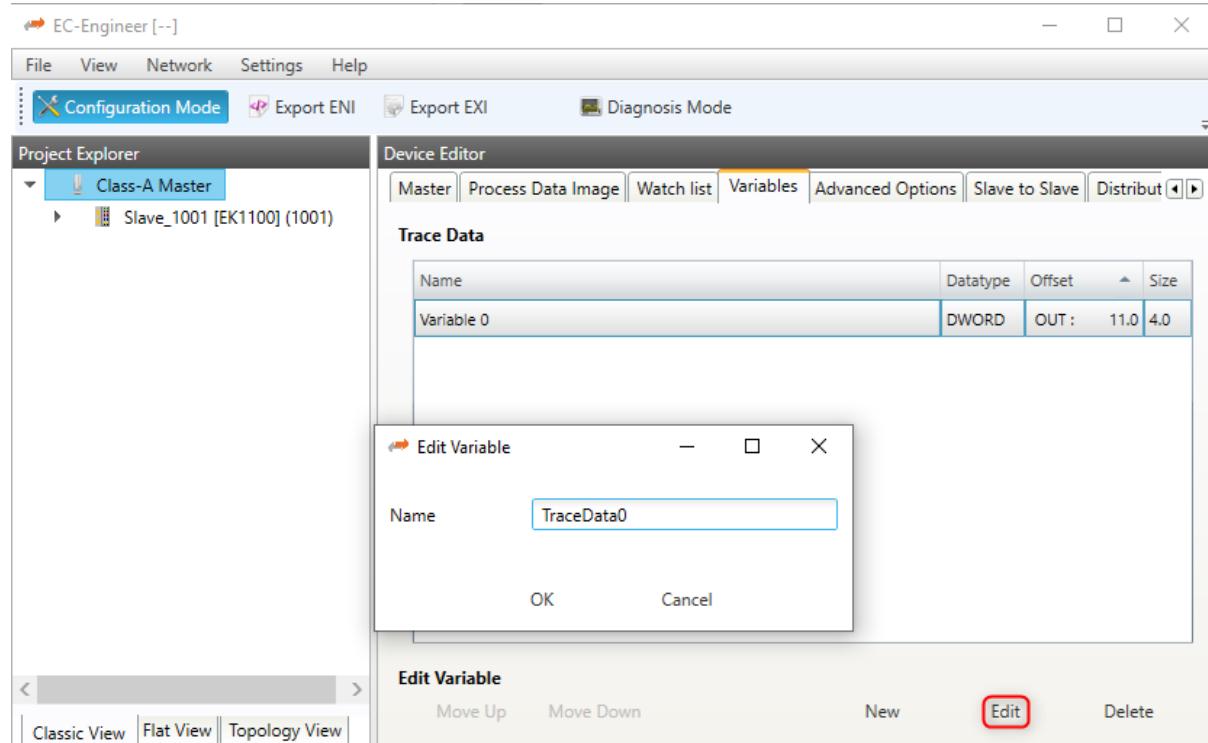
3.8.1 Trace Data configuration via EC-Engineer

The easiest and most comfortable way to create trace data variables is with the help of the EC-Engineer. The necessary NOP cmd and the process data variables are automatically created and exported to the ENI. The process variables can be accessed as usual using the `emFindOutpVarByNameEx()` function.

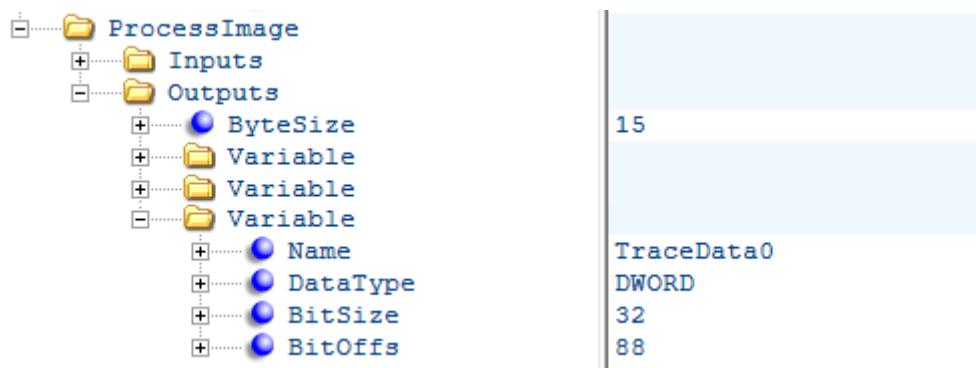
Trace data variables of any size and number can be created in the Variables tab of the EC-Engineer:



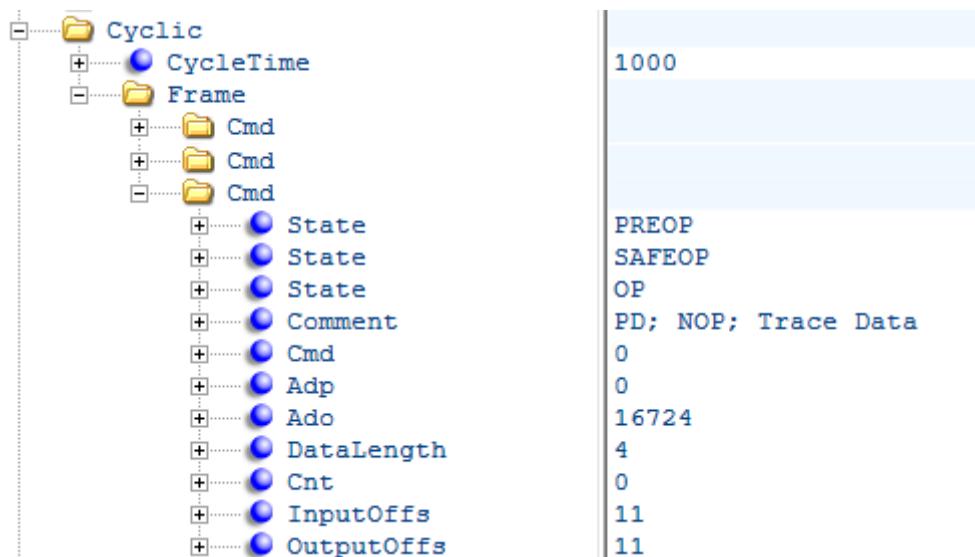
The automatically created variable names can also be edited:



The generated process variables can be found in the exported ENI file:



As well as the NOP cmd:



3.8.2 Trace Data configuration via API

The application can configure the trace data size using the `emTraceDataConfig()` API. The trace data configuration must take place between the initialization of the EC-Master (`emInitMaster()`) and the configuration of the network (`emConfigureNetwork()`). During `emConfigureNetwork()` the EC-Master tries to expand the process image output area by the trace data buffer and generates the corresponding NOP cmd.

Access to the trace data buffer is via an offset to the process data output image. The offset can be determined via the API `emTraceDataGetInfo()`.

Configuration of the trace data buffer:

```
//emInitMaster();

emTraceDataConfig(dwInstanceId, sizeof(EC_T_DWORD));

//emConfigureNetwork;
```

Access to the trace data buffer:

```
EC_T_TRACE_DATA_INFO oTraceDataInfo;
emTraceDataGetInfo(dwInstanceId, &oTraceDataInfo);

EC_SET_FRM_DWORD(oTraceDataInfo.pbyData + oTraceDataInfo.dwOffset, 0x11223344);
```

Warning:

- Trace data, encapsulated in an additional EtherCAT Cmd, must fit in the first cyclic frame.
- Trace data is not available for the fixed cyclic frame layout
`EC_T_CYCFRAME_LAYOUT::eCycFrameLayout_FIXED`.

3.9 EtherCAT Master Stack Source Code

In a source code delivery the master stack sources are divided into 4 parts:

- SDK Header files
- Link layer files (multiple Link Layers may be shipped)
- Link OS layer files (only valid for the Link Layers)
- Master stack files (configuration, core and interface layer)
- OS layer files (only valid for the master stack)

The master stack can be ported to several different operating systems and CPU architectures with different compilers and development environments. Typically no supported build environment files like IDE projects are shipped with the source code.

To build the master stack the appropriate build environment for the target operating system has to be used. If an integrated development environment (IDE) exists (Visual Studio, Eclipse, etc.) several projects containing all necessary files are needed to build the artefacts. If no integrated development environment is available makefiles and dependency rules may have to be created which contain the necessary master stack source and header files.

3.9.1 Components

For most platforms three separate independent binaries will have to be generated:

1. Link Layer Binary (e.g. a downloadable object module in VxWorks or a DLL in Windows). The Link Layer binary will be dynamically bound to the application at runtime. (currently not for On Time RTOS-32 which uses static libraries)
2. Master Stack Library
3. Remote API Server Library

Link Layer Binaries

The following files have to be included into an IDE project or makefile:

- Link layer files. Only one single Link Layer must be selected even if multiple Link Layers are shipped. For each Link Layer a separate binary has to be created.
- Link OS layer files
- Windows: a dynamic link library (.dll) has to be created. The name of the DLL has to be emllXxxx.dll where Xxxx shall be replaced by the Link Layer type (e.g. emlliI8255x.dll for the I8255x Link Layer).
- VxWorks: a downloadable kernel module (.out) has to be created. The name of the module has to be emllXxxx.out where Xxxx shall be replaced by the Link Layer type (e.g. emlliI8255x.out for the I8255x Link Layer). sysLoSalAdd.c should be included in BSP if needed and should not be compiled within the Link Layer binary
- Linux/QNX: a shared object library (.so) has to be created.
- RTX a RTX dynamic link library (.rtdll) has to be created. The name of the DLL has to be emllXxxx.dll where Xxxx shall be replaced by the Link Layer type (e.g. emlliI8255x.dll for the I8255x Link Layer).
- INtime: a shared library (.rsl) has to be created. The name of the RSL has to be emllXxxx.rsl where Xxxx shall be replaced by the Link Layer type (e.g. emlliI8255x.rsl for the I8255x Link Layer).

Master Stack Binaries

The following files have to be included into an IDE project or makefile:

- Master stack files
- OS layer files
- For all platforms a static library has to be created. This library will have to be linked together with the application.

Remote API Server Binaries

The following files have to be included into an IDE project or makefile:

- Remote API server files.
- For all platforms a static library has to be created. This library will have to be linked together with the application.

See also:

Platform and Operating Systems (OS) for required tool chain settings

3.9.2 Excluding features

It is possible to reduce the footprint of the master library and improve its execution performance by compiling less features.

EXCLUDE_EOE_ENDPOINT

FP-EoE-Endpoint

EXCLUDE_HOTCONNECT

FP-Hot-Connect

EXCLUDE_JUNCTION_REDUNDANCY

FP-Cable-Redundancy

EXCLUDE_MASTER_OBD

FP-Master-Object-Dictionary

EXCLUDE_RED_DEVICE

FP-Cable-Redundancy

EXCLUDE_SPLITTED_FRAME_PROCESSING

FP-Splitted-Frame-Processing

EXCLUDE_DC_SUPPORT

Class-A

The following defines and their impact are described below:

EXCLUDE_ADS_ADAPTER

```
emAdsAdapterStart()  
emAdsAdapterStop()
```

EXCLUDE_AOE_SUPPORT

```
emAoeGetSlaveNetId()  
emAoeRead()  
emAoeReadReq()  
emAoeWrite()
```

```
emAoeWriteReq()
emAoeReadWrite()
emAoeWriteControl()
```

EXCLUDE_BAD_CONNECTIONS

```
emBadConnectionsDetect()
```

EXCLUDE_CONFIG_EXTEND

```
EC_T_CFG_SLAVE_INFO::bExtended
emConfigExtend()
```

EXCLUDE_DCX

DCM DCX mode

EXCLUDE_EEPROM_SUPPORT

```
emReadSlaveEEProm()
emReadSlaveEEPromReq()
emWriteSlaveEEProm()
emWriteSlaveEEPromReq()
emReloadSlaveEEProm()
emReloadSlaveEEPromReq()
emAssignSlaveEEProm()
emAssignSlaveEEPromReq()
emActiveSlaveEEProm()
emActiveSlaveEEPromReq()
```

EXCLUDE_EOE_DEFERRED_SWITCHING

```
EC_T_USER_JOB::eUsrJob_SwitchEoeFrames
```

EXCLUDE_EOE_ENDPOINT

```
emEoeRegisterEndpoint()
```

EXCLUDE_EXECJOB_REENTRANCY_SUPPORT

EXCLUDE_FOE_SUPPORT

```
emFoeFileUpload()
emFoeUploadReq()
emFoeFileDownload()
emFoeDownloadReq()
emFoeSegmentedUploadReq()
emFoeSegmentedDownloadReq()
```

EXCLUDE_FORCE_PROCESSDATA

```
emForceProcessDataBits()
emReleaseProcessDataBits()
emReleaseAllProcessDataBits()
```

EXCLUDE_FRAME_LOGGING

emLogFrameEnable()

EXCLUDE_FRAME_LOSS_SIMULATION

emIoControl - EC_IOCTL_SET_FRAME LOSS SIMULATION

emIoControl - EC_IOCTL_SET_RXFRAME LOSS SIMULATION

emIoControl - EC_IOCTL_SET_TXFRAME LOSS SIMULATION

EXCLUDE_GEN_OP_ENI

emConfigExtend()

EXCLUDE_INTERFACE_LOCK

No API protection against InitMaster/DeinitMaster

EXCLUDE_LINE_CROSSED_DETECTION

No line crossed detection

EXCLUDE_LOG_MESSAGES

No Log messages generated

EXCLUDE_MAILBOX_STATISTICS

EC_T_MASTER_INFO::MailboxStatistics

EXCLUDE_MASTER_OBD

EC_T_MASTER_INFO::BusDiagnosisInfo

EXCLUDE_MASTERSYNCUNITS

EC_T_CFG_SLAVE_INFO::awMasterSyncUnitIn

emGetMasterSyncUnitInfoNumOf()

emGetMasterSyncUnitInfo()

EXCLUDE_MEMORY_PROVIDER

emIoControl - EC_IOCTL_REGISTER_PDMMEMORYPROVIDER

EXCLUDE_MULTIPLE_CYC_ENTRIES

emIoControl - EC_IOCTL_GET_CYCLIC_CONFIG_INFO

EC_T_USER_JOB::eUsrJob_ProcessRxFramesByTaskId

EC_T_USER_JOB::eUsrJob_SendCycFramesByTaskId

EXCLUDE_PORT_OPERATION

emBlockNode()

emOpenBlockedPorts()

emSetSlavePortState()

EXCLUDE_RAWMBX_SUPPORT

emClntSendRawMbx()

EXCLUDE_RED_DEVICE

EC_T_MASTER_INFO::RedundancyDiagnosisInfo

EXCLUDE_RESCUE_SCAN

emRescueScan()

EXCLUDE_S2SMBX_SUPPORT

EC_T_INIT_MASTER_PARMS::dwMaxS2SMBxSize

EC_T_INIT_MASTER_PARMS::dwMaxQueuedS2SMBxTfer

EXCLUDE_SLAVE_HANDLING

EC_T_CFG_SLAVE_INFO::bDisabled

EC_T_CFG_SLAVE_INFO::bDisconnected

emSetSlaveDisabled()

emSetSlavesDisabled()

emSetSlaveDisconnected()

emSetSlavesDisconnected()

EXCLUDE_SLAVE_IDENTIFICATION

/EtherCATConfig/Config/Slave/Info/Identification

EC_T_CFG_SLAVE_INFO::wIdentifyAdo

emReadSlaveIdentification()

EXCLUDE_SLAVE_STATISTICS

emGetSlaveStatistics()

emClearSlaveStatistics()

EXCLUDE_SOE_SUPPORT

emSoeRead()

emSoeReadReq()

emSoeWrite()

emSoeWriteReq()

emSoeAbortProcCmd()

EXCLUDE_SPLITTED_FRAME_PROCESSING

EC_IOCTL_SET_SPLITTED_FRAME_PROCESSING_ENABLED

EC_T_USER_JOB::eUsrJob_ProcessRxFramesByTaskId

EXCLUDE_TEXT

ecatGetText()

ecatGetNotifyText()

EXCLUDE_TRACE_DATA

EXCLUDE_TRACE_DATA_VARINFO

```
emTraceDataConfig()  
emTraceDataGetInfo()
```

EXCLUDE_VARREAD

```
EC_T_CFG_SLAVE_INFO::wNumProcessVarsInp  
EC_T_CFG_SLAVE_INFO::wNumProcessVarsOutp  
emGetSlaveInpVarInfoNumOf()  
emGetSlaveOutpVarInfoNumOf()  
emGetSlaveInpVarInfo()  
emGetSlaveInpVarInfoEx()  
emGetSlaveOutpVarInfo()  
emGetSlaveOutpVarInfoEx()  
emGetSlaveOutpVarByObjectEx()  
emGetSlaveInpVarByObjectEx()  
emFindOutpVarByName()  
emFindOutpVarByNameEx()  
emFindInpVarByName()  
emFindInpVarByNameEx()
```

EXCLUDE_VOE_SUPPORT

```
emVoeRead()  
emVoeWrite()  
emVoeWriteReq()
```

EXCLUDE_WKCSTATE

```
EC_T_CFG_SLAVE_INFO::wWkcStateDiagOffsIn  
EC_T_CFG_SLAVE_INFO::wWkcStateDiagOffsOut  
emGetDiagnosisImagePtr()
```

4 Platform and Operating Systems (OS)

4.1 CMSIS-RTOS for STM32

4.1.1 Setting up and running EcMasterDemo in Keil µVision IDE

1. Prerequisites

- Keil µVision 5 IDE
- STM32H747I-DISCO board
- EtherCAT devices

2. Connect the STM32H747I-DISCO development board to the PC according to user manual.
3. Connect EtherCAT devices to the board.
4. **Create ENI file for EtherCAT configuration.**

xxd.exe is capable of converting ENI files to a C file as array, e.g.

```
C:  
> xxd.exe -i eni.xml ENI.c
```

Replace ENI.c file with generated one. File should be manually modified to look like:

```
unsigned char MasterENI_xml_data[] = {  
...  
};  
unsigned int MasterENI_xml_data_size = ???;
```

5. Start Keil µVision IDE and set the EcMasterDemoApp project as active.
6. If needed, change debug project settings.
7. Build and run EcMasterDemoApp.

See also:

Running EcMasterDemo

4.1.2 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for CMSIS-RTOS (STM32).

Extra include paths

```
<InstallPath>/SDK/INC/CMSIS-RTOS  
<InstallPath>/Examples/Common/CMSIS-RTOS_STM32
```

Extra source paths

```
<InstallPath>/Examples/Common/CMSIS-RTOS  
<InstallPath>/Sources/OsLayer/CMSIS-RTOS
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/CMSIS-RTOS/STM32H7
```

Extra libraries

```
EcMaster.lib  
em11Stm32Eth.lib  
EcMasterDemo.lib
```

4.1.3 Setting up and running EcMasterDemo in STM32CubeIDE for STM32H747I-DISCO

1. Prerequisites

- STM32CubeIDE V1.5.0
- EC-Master V3.1
- **CMSIS-RTOS sources package.** Use git https://github.com/ARM-software/CMSIS_5.git or download from https://github.com/ARM-software/CMSIS_5/archive/develop.zip.

Note: Alternative *ARM CMSIS Drivers for external devices* contains CMSIS-RTOS sources as well.

- *ARM CMSIS Drivers for external devices* from <https://www.keil.com/dd2/pack/> (for CMSIS PHY driver sources)
- *STMicroelectronics STM32H7 Series Device Support and Examples* from <https://www.keil.com/dd2/pack/> (for CMSIS MAC driver sources)

2. Environment variables

In order to be able to build and run demo application the following environment variables (either system or project variables) has to be defined:

- **CMSIS_LOC**, has to be set to the CMSIS package location, i.e. C:/CMSIS_5-5.7.0
- **FW_LOC**, points to the firmware folder in STM32Cube repository, i.e. <PATH_TO_STM32CUBE_REPOSITORY>/STM32Cube_FW_H7_V1.8.0
- **PATH variable must contain the following paths (needed for tool chain):**

```
C:/ST/STM32CubeIDE_1.5.0/STM32CubeIDE/plugins/com.st.stm32cube.ide.  
↳mcu.externaltools.gnu-tools-for-stm32.7-2018-q2-update.win32_1.5.  
↳0.202011040924/tools/bin  
C:/ST/STM32CubeIDE_1.5.0/STM32CubeIDE/plugins/com.st.stm32cube.ide.  
↳mcu.externaltools.make.win32_1.5.0.202011040924/tools/bin
```

- **PACKS_LOC**, points to the packs location, where *ARM CMSIS Drivers for external devices* and *STMicroelectronics STM32H7 Series Device Support and Examples* were installed, i.e. C:/Users/<USER_NAME>/AppData/Local/Arm

3. Build EcMasterDemo

- Build the EcMasterDemo project

- Create EtherCAT network configuration
- Build the EcMasterDemo_STM32H747I-DISCO project for CM7 CPU

4. Run on a STM32H747I-DISCO board

- Connect the board to PC using CN2 connector. This connection will be used for powering the board and for debugging as well.
- Connect EtherCAT cable to the Ethernet interface on the board and the EtherCAT slave(s).
- Power on EtherCAT slave(s).
- Using your favorite terminal application (i.e. Teraterm) connect to the serial port of STM32H747I-DISCO. Usually it is called *STMicroelectronics STLink Virtual COM Port*. Ensure it has the following settings: 115200, 8, N, 1.
- Create a debug or run configuration, select *STM32 Cortex-M C/C++ Application* as template. For this configuration select *SWD* in *GDB Server Command Line Options*.

Note: in order to let the application run with different command line parameter please change `szCommandLine` declared in `app_main.c`

4.2 eCos

4.2.1 Setting up and running EcMasterDemo

1. Build the eCos kernel with the parameters associated to the application

As a starting point there is a eCos configuration file (.ecc) file located at `SDK/LIB/eCos/x86/`.

eCos is unable to get command line parameters for `main()`. The parameters for the application are build in the kernel via the configuration tool (Arguments to `main`).

Configuration	
Global build options	
Redboot HAL options	
Intel 82544 ethernet driver	v3_0
PC board ethernet driver	v3_0
eCos HAL	v3_0
I/O sub-system	v3_0
Infrastructure	v3_0
eCos kernel	v3_0
Dynamic memory allocation	v3_0
ISO C and POSIX infrastructure	v3_0
ISO C library	v3_0
ISO C library internationalization functions	v3_0
ISO C library setjmp/longjmp functions	v3_0
ISO C library signal functions	v3_0
ISO environment startup/termination	v3_0
Arguments to main()	{(char *)"name", (char *)"-v", (char *)"2", (char *)"-trx", (char *)"i8254x", (char *)"1 ", (char *)"1", (char *)NULL}
Startup context for main()	
main()'s default thread stack size	8192
Include atexit() function	<input checked="" type="checkbox"/>
Make exit() call fflush()	<input checked="" type="checkbox"/>
_exit() stops all threads	<input type="checkbox"/>
Default environment	{ NULL }
Invoke default static constructors	<input checked="" type="checkbox"/>
ISO environment startup/termination build option	
ISO C library standard input/output functions	v3_0
ISO C library general utility functions	v3_0
ISO C library string functions	v3_0
ISO C library date and time functions	v3_0
Math library	v3_0
Wallclock device	v3_0
Common error code support	v3_0
Disk device drivers	v3_0
Block cache and access library	v3_0
FAT filesystem	v3_0
POSIX File IO compatibility layer	v3_0
Linux compatibility layer	v3_0

To use an other example with different parameters, the kernel has to be rebuild.

For the EcMasterDemo example following line has to be passed to the application via the configuration tool:

```
{
    (char *) "name", (char *) "-f", (char *) "perf.xml",
    (char *) " -intelgbe", (char *) "1", (char *) "1", (char *) "-v",
    (char *) "3", (char *) "-t", (char *) "60000", (char *) "-perf", (char *)NULL
}
```

2. Compile EcMasterDemo

As a starting point there is the Eclipse project for EcMasterDemo for eCos located at Workspace/eCos/EcMasterDemo. The following macro in Sources/OsLayer/eCos/EcOs.cpp loads the ENI file from disk:

```
"MTAB_ENTRY(fat, "/", "fatfs", "/dev/idedisk1/1", 0)"
```

3. Copy the ENI file to target

eCos supports only the 8.3 file format. Adjust the ENI file name and the command line in the configuration tool accordingly.

4. Configure Grub to load the application

Adjust the Grub menu file:

```
title eCos EcMasterDemo
kernel (hd0,0) /EcMasterDemo
boot
```

5. Load and start the EcMasterDemo with Grub

6. Verify that the EcMasterDemo is running successfully

The EcMasterDemo takes some seconds to start. The following message is sent to the serial port on startup finished:

```
$ [ 3593.654951] Master state changed from <SAFEOP> to <OP>
```

See also:

[Running EcMasterDemo](#)

4.2.2 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for eCos.

Extra include paths

```
<InstallPath>/SDK/INC/eCos  
<InstallPath>/Examples/Common/eCos
```

Extra source paths

```
<InstallPath>/Examples/Common/eCos  
<InstallPath>/Sources/OsLayer/eCos/EcOs.cpp
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/eCos
```

Extra libraries

```
libEcMaster.a  
libem11IntelGbe.a  
libtarget.a
```

4.3 tenAsys INtime

Optimized Link Layers are available for INtime. If using INtime with Windows running in parallel on the same host the network adapter card has to be assigned to INtime. The network adapters should be passed to INtime using the “INtime Device Manager”. Please refer to the INtime user manual for this.

Search locations for Optimized Link Layers can be adjusted using the PATH environment variable

4.3.1 Setting up and running EcMasterDemo

The file EcMasterDemo.rta has to be executed. The full path and file name of the configuration file has to be given as a command line parameter as well as the appropriate Link Layer. To start the application from the command prompt, enter following commands:

```
> nodemgr start NodeA  
> sleep 5  
> piperta.exe -node NodeA -stderr EcMasterDemo.rta -intelgbe 1 1 -f eni.xml
```

See also:

[Running EcMasterDemo](#)

4.3.2 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for INTIME.

Extra include paths

```
<InstallPath>\SDK\INC\INTime  
<InstallPath>\Examples\Common\INTime
```

Extra source paths

```
<InstallPath>\Examples\Common\INTime  
<InstallPath>\Sources\OsLayer\INTime
```

Extra library paths to the main EtherCAT components

```
<InstallPath>\SDK\LIB\INTime
```

4.4 Linux

4.4.1 OS optimizations

Linux itself is not real-time capable, so it is recommended to use it with the additional *PREEMPT_RT* patch.

The power management can disrupt cyclical processing, it is advisable to disable the *CPUIDLE sub-system* and *CPUFREQ sub-system*. The sub-systems can be disabled by changing the kernel command line parameters in the boot loader. On x86, x86_64 systems this is usually *grub*, on embedded devices with ARM, ARM64 is usually *u-boot*. It is also possible to build a custom kernel without these sub-systems.

Running a EC-Master application on a dedicated CPU core that is isolated from the Linux scheduler (*ISOLCPUS*) can provide additional stability.

CPUIDLE sub-system

Check if CPUFREQ sub-system is enabled:

```
$ ls /sys/devices/system/cpu/
```

If *cpuidle* appears in the list, it is enabled.

Disable CPUIDLE via the kernel command-line in grub:

```
linux /boot/vmlinuz-4.19.0-16-rt-amd64 cpuidle.off=1
```

CPUFREQ sub-system

Check if CPUFREQ sub-system is enabled:

```
$ ls /sys/devices/system/cpu/
```

If cpufreq appears in the list, it is enabled.

Disable CPUFREQ sub-system via the kernel command-line grub:

```
linux /boot/vmlinuz-4.19.0-16-rt-amd64 cpufreq.off=1
```

If CPUFREQ is not to be deactivated, the governor should be set to performance.

The currently active governor can be determined as follows:

```
$ cat /sys/devices/system/cpu/cpu*/cpufreq/scaling_governor
```

The available governors with:

```
$ cat /sys/devices/system/cpu/cpu*/cpufreq/scaling_available_governors
```

To change governor use:

```
$ echo performance > /sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
```

ISOLCPUS

Isolate CPU core number 4 of a quad-core processor via the kernel command-line grub:

```
linux /boot/vmlinuz-4.19.0-16-rt-amd64 isolcpus=3
```

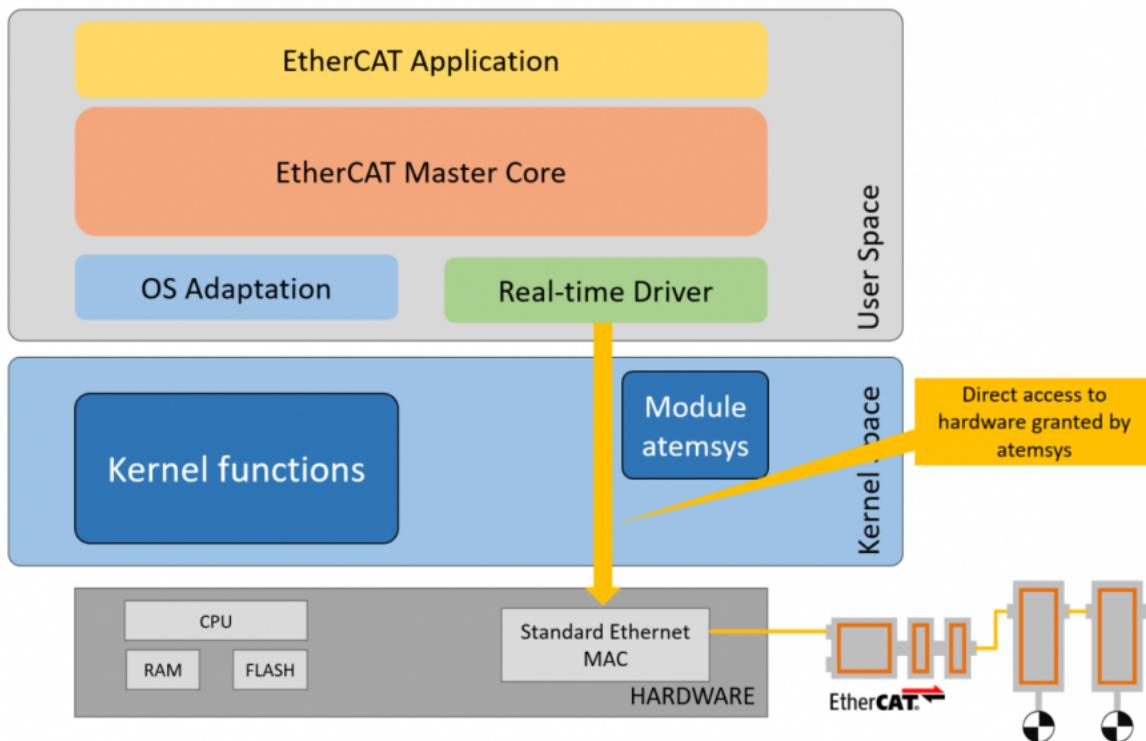
Running EcMasterDemo on the isolated CPU core by setting the CPU affinity -a:

```
$ ./EcMasterDemo -a 3
```

4.4.2 atemsy kernel module

To use Optimized Link Layers under Linux, the atemsy kernel module must be compiled and loaded. atemsy grants direct access to hardware to improve the performance.

All necessary scripts, source code and a detailed description of the installation can be found on <https://github.com/acontis/atemsy>. A ready-to-use Yocto recipe is also available on <https://github.com/acontis/meta-acontis>



atemsys as Device Tree Ethernet Driver

atemsys can also be used as a device tree driver to avoid certain conflicts between the link layer and the Linux kernel, e.g. power management, shared MDIO bus, etc..

A detailed guide on how to customize the device tree accordingly can also be found on <https://github.com/acontis/atemsys>. Example device tree modifications for different link layers/SoC can be found in <https://github.com/acontis/atemsys/wiki>.

Note: This is the preferred solution on all embedded devices with device tree support.

atemsys and PHY OS Driver

To use the PHY OS Driver, the acontis kernel module atemsys has to be included in the kernel device tree as an official driver for the Ethernet controller and doesn't require any additional configuration at the application level. As a result atemsys can interact with Linux drivers.

4.4.3 Unbind Link Layer instance

Link Layer instances used by optimized Link Layers may not be bound by kernel drivers modules! Unbind can be done by unloading the kernel driver module, via the unbind interface of the driver or by modifying the device tree.

Unbind from kernel driver

The following command unbinds an instance without unloading the kernel driver module:

PCI

```
$ echo "<Instance-ID>" > /sys/bus/pci/drivers/<driver-name>/unbind
```

Example:

```
$ echo "0000:00:19.0" > /sys/bus/pci/drivers/e1000e/unbind
```

This call requires the PCI bus, device, function codes (in the above example it is 0000:00:19.0). The codes can be found using Linux commands like, for example:

```
$ ls /sys/bus/pci/drivers/e1000e
```

SOC

```
$ echo "<Instance-ID>" > /sys/bus/platform/drivers/<driver-name>/unbind
```

Example:

```
$ echo "2188000.ethernet" > /sys/bus/platform/drivers/fec/unbind
```

Unload kernel driver

Not all drivers allow unbinding of network adapters. If unbinding is not supported the corresponding Linux kernel driver must not be loaded.

The following command lists the loaded kernel modules that may conflict with optimized Link Layers:

```
$ lsmod | egrep "<module-name>"
```

Example:

```
$ lsmod | egrep "e1000|e1000e|igb"
```

PCI/PCIe: The command *lspci -v* shows which driver is assigned to which network card, e.g.:

```
$ lspci -v
```

```
...
11:0a.0 Ethernet controller: Intel Corporation 82541PI Gigabit Ethernet Controller
    ↳(rev 05)
...
Kernel driver in use: e1000e
```

Modules can be prevented from loading with the following commands:

```
$ echo blacklist <module-name> | sudo tee -a /etc/modprobe.d/blacklist.conf
$ update-initramfs -k all -u
$ sudo reboot
```

The following table shows the kernel modules related to the Optimized Link Layers:

Chip	Link Layer Name	Kernel driver(s)	Remarks
Broadcom Genet	emllBcmGenet	genet	Unbind not supported
Beckhoff CCAT	emllCCAT	ec_bhf	
CPSW	emllCPSW	ti_cpsw	
DesignWare 3504	emllDW3504	stmmac	
	emllEG20T		
Freescale TSEC/eTSEC v1/2	emllETSEC	gianfar_driver	
Freescale FEC and ENET controller	emllFslFec	fec, fec_ptp	
Xilinx Zynq-7000/Ultrascale	emllGEM		
Intel Pro/1000	emlliI8254x	igb, e1000, e1000e	
Intel Pro/1000	emlliIntelGbe	igb, e1000, e1000e	
Intel Pro/100	emlliI8255x	e100	
ICSS	emlliICSS	prueth,pruss	Unbind not supported
RDC R6040	emlliR6040		
Realtek RTL8139	emlliRTL8139	8139too, 8139cp	
Realtek RTL8169 / RTL8111 / RTL8168	emlliRTL8169	r8169	Unbind not supported
SuperH	emllSHEth	sh_eth	Unbind not supported
Generic	emllSockRaw		

4.4.4 Docker

It is possible to operate EC-Master within a Docker container with realtime priority. The atemsys kernel module should be installed on the host in order to operate the container with the lowest possible capabilities and privileges.

The following additional settings, permissions for `docker run` are required:

Add atemsys device to container

```
--device=/dev/atemsys:/dev/atemsys
```

Allow max realtime priority

```
--ulimit rtprio=99
```

Add capability to set priority and lock memory

```
--cap-add=sys_nice  
--cap-add=ipc_lock
```

Publish RAS server port 6000

```
-p 6000:6000
```

4.4.5 Setting up and running EcMasterDemo

1. Unbind Link Layer instance, e.g.

```
$ echo 0000:00:19.0 > /sys/bus/pci/drivers/e1000e/unbind
```

2. Load atemsys kernel module

```
$ insmod atemsys.ko
```

3. Copy files from EC-Master package /bin and a eni.xml to directory e.g. /tmp.

4. Adjust *LD_LIBRARY_PATH* search locations for Optimized Link Layers if necessary, e.g.

```
$ export LD_LIBRARY_PATH=/tmp:$LD_LIBRARY_PATH
```

5. Run EcMasterDemo

```
$ cd /tmp
$ ./EcMasterDemo -f eni.xml -intelgbe 1 1 -perf
```

See also:

[Running EcMasterDemo](#)

Run in Docker container

1. Unbind Link Layer instance and load atemsys on the host.

2. Create a directory on the host (e.g. ~/docker) and copy files from EC-Master package /bin and eni.xml into this directory.

3. Start bash console in container

```
$ sudo docker run -it      --name atem_container
← --device=/dev/atemsys:/dev/atemsys      --ulimit rtprio=99
← --cap-add=sys_nice --cap-add=ipc_lock      -v ~/docker:/home/docker
← -p 6000:6000      ubuntu bash
```

Command line arguments:

- **-it** Allocate a pseudo-TTY and run container
- **--name atem_container** Container name
- **--device=/dev/atemsys:/dev/atemsys** Add *atemsys* device to container
- **--ulimit rtprio=99** Allow max realtime priority
- **--cap-add=sys_nice** Add Linux capability to set priority
- **--cap-add=ipc_lock** Add Linux capability to lock memory
- **-v ~/docker:/home/docker** Mount previously create directory to container
- **-p 6000:6000** Publish RAS server port *6000*
- **ubuntu bash** Use Docker image *ubuntu* and start bash

4. Run EcMasterDemo in container

```
# cd /home/docker
# export LD_LIBRARY_PATH=.
# ./EcMasterDemo -f eni.xml -intelgbe 2 1 -perf
```

4.4.6 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for Linux

Possible ARCHs (see ATECAT_ARCHSTR in `SDK/INC/Linux/EcOsPlatform.h`):

- armv4t-eabi
- armv6-vfp-eabihf
- aarch64
- x64 (aka amd64)
- x86 (aka i686)
- PPC

***armv4t-eabi* and *armv6-vfp-eabihf* are incompatible with each other. A potentially *armv6-vfp-eabihf* compatible system returns success on**

```
$ readelf -A /proc/self/exe | grep Tag_ABI_VFP_args
```

Extra include paths

```
<InstallPath>/SDK/INC/Linux
<InstallPath>/Examples/Common/Linux
```

Extra source paths

```
<InstallPath>/Examples/Common/Linux
<InstallPath>/Sources/OsLayer/Linux
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/Linux/<Arch>
```

Extra libraries (in this order)

```
EcMasterRasServer EcMaster pthread dl rt
```

4.5 QNX Neutrino

4.5.1 Thread priority

QNX supports a total of 256 scheduling priority levels. A non-root thread can set its priority to a level from 1 to 63 (the highest priority).

Using priorities higher than 63 is only possible if the allowed priority range is changed for non-root processes:

```
$ procnto -P priority
```

For more information's about changing the priority range refer to the QNX documentation.

Attention: Don't changing the priority range leads to bad timing performance!

4.5.2 Unbind Link Layer instance

The network interface must be unloaded if it is used by an operating system driver. Depending on the QNX version, a corresponding command must be executed in the QNX Shell or the QNX Build Script.

QNX >= 6.5

```
ifconfig en1 destroy
```

QNX >= 7.1

```
umount /dev/io-sock/devs-em.so/em1
```

4.5.3 IOMMU/SMMU support

For systems that have to use an IOMMU/SMMU for security reasons, it is possible to create predefined typed memory region that is used by the Link Layer. The definition has to be done in the QNX BSP build file and the name must match following pattern:
smm_LinkLayerName - InstanceNumber(32Bit Hex)

Example: Link Layer eml1I8254x with instance number 1

```
smm_eml1I8254x-0x00000001
```

A separate typed memory region must be defined for each Link Layer instance. The typed memory is automatically used by the Link Layer if it matches the pattern, otherwise the default memory is used.

4.5.4 Setting up and running EcMasterDemo

1. QNX Neutrino OS configuration

In order to get real-time priority (e.g. 250), see [Thread priority](#) and also set JOBS_PRIORITY. The applications needs root privileges to increase the priority above 63.

2. Unbind Link Layer instance, e.g.

```
$ ifconfig en1 destroy
```

3. Copy files from EC-Master package /bin and eni.xml to directory, e.g. /tmp.

4. Adjust LD_LIBRARY_PATH search locations for Optimized Link Layers if necessary, e.g.

```
$ export LD_LIBRARY_PATH=/tmp:$LD_LIBRARY_PATH
```

5. Run EcMasterDemo

```
$ cd /tmp
$ ./EcMasterDemo -f eni.xml -intelgbe 1 1 -perf
```

See also:

[Running EcMasterDemo](#)

4.5.5 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for QNX Neutrino.

Extra include paths

```
<InstallPath>/SDK/INC/QNX
<InstallPath>/Examples/Common/QNX
```

Extra source paths

```
<InstallPath>/Examples/Common/QNX
<InstallPath>/Sources/OsLayer/QNX
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/QNX/<Arch>
```

Extra libraries (in this order)

```
EcMasterRasServer EcMaster socket
```

4.6 Renesas

4.6.1 R-IN32M3

1. Prerequisites

Hardware:

- R-IN32M3-EC Evaluation Board,
- adviceLUNA Emulator

Software:

- microVIEW-PLUS debugger,
- GNU compiler (Sourcery G++ Lite for ARM EABI)

2. Verify TCP/IP evaluation sample from Renesas works fine.

3. Download from official Renesas site following files:

- r-in32m3_tcpip_evaluation.zip
- r-in32m3_samplesoft.zip.

4. Create ENI file for EtherCAT configuration.

xxd.exe is capable of converting ENI files to a C file as array, e.g.

```
C:
> xxd.exe -i eni.xml ENI.c
```

Replace ENI.c file with generated one. File should be manually modified to look like:

```
unsigned char MasterENI_xml_data[] = {
...
};

unsigned int MasterENI_xml_data_size = ???;
```

5. Import project **Workspace/RIN32M3/EcMasterDemo** into Eclipse IDE.
Hardcoded parameters for the demo can be changed using DEMO_PARAMETERS definition.
6. Upload **Workspace/RIN32M3/EcMasterDemo/Release/EcMasterDemo.bin** with debugger and run

See also:

Running EcMasterDemo

4.6.2 R-IN32M4

1. **Prerequisites**

Hardware:

- SBEV-RIN32M4CL3 Evaluation Board

Software:

- IAR Workbench 9.10.1,
- “R-IN32M4 series R-IN32M4-CL3 Driver/Middleware Release Note - Sample Code” package

2. Build EcMasterDemo

1. Install “R-IN32M4 series R-IN32M4-CL3 Driver/Middleware Release Note - Sample Code” and set the path the environment variable *MIDDLEWARE_LOC* to the same folder.
2. Start IAR Workbench and import EcMasterDemo project into workspace
3. **Create ENI file for EtherCAT configuration.**

xxd.exe is capable of converting ENI files to a C file as array, e.g.

```
C:
> xxd.exe -i eni.xml MasterENI.c
```

Replace MasterENI.c file with generated one. File should be manually modified to look like:

```
unsigned char MasterENI_xml_data[] = {
...
};

unsigned int MasterENI_xml_data_size = ???;
```

4. Import project **Workspace/RIN32M3/EcMasterDemo** into project.
5. Build the project and upload it to the board

See also:

Running EcMasterDemo

1. Troubleshooting

If after upload a program into serial FLASH the application has been trapped in HardFault_Handler_rom() reset the board with reset button.

4.7 IntervalZero RTX

EC-Master is available for the RTX versions listed below:

RTX version	EC-Master version
RTX 2012	V2.9.x.x
RTX 2016	V2.9.x.x
RTX64 2014	V2.9.x.x
RTX64 3.x	V3.1.x.x
RTX64 4.x	V3.1.x.x

4.7.1 Unbind Link Layer instance

To use Optimized Link Layers under RTX, the network adapter should be assigned to RTX as described in the RTX user manual. The NIC driver should not use the network adapter for TCP/IP and therefore the network adapter may not be configured in RtxTcpIp.ini.

4.7.2 Setting up and running EcMasterDemo

The file EcMasterDemo.rtss has to be executed. The full path to the ENI file has to be given as a command line parameter as well as the appropriate Link Layer.

```
> RTSSrun EcMasterDemo.rtss -i8255x 1 1 -f C:/eni.xml -t 60000
```

See also:

[Running EcMasterDemo](#)

4.7.3 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for RTX.

Extra include paths

```
<InstallPath>/SDK/INC/RTX
<InstallPath>/Examples/Common/RTX
```

Extra source paths

```
<InstallPath>/Examples/Common/RTX
<InstallPath>/Sources/OsLayer/RTX
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/RTX64 (RTX64 4.x)
<InstallPath>/SDK/LIB/RTX64_30 (RTX64 3.x)
```

4.8 TI-RTOS

4.8.1 Setting up and running EcMasterDemo

Prerequisites, basic settings:

TI SDK RTOS v4.02 for AM335x/AM437x/AM57x

Make sure your Code Composer Studio uses correct versions of SYS/BIOS, XDCtools and PDK. For TI SDK 4.02 corresponding versions are:

- XDCtools: 3.50.3_33_core
- PDK 1.0.9
- SYS/BIOS 6.52.0.12

Ensure environment variable PDK_INSTALL_PATH is pointing to the installed root directory of SDK. Eg: For AM572x demo project, PDK_INSTALL_PATH=C:/ti/pdk_am57xx_1_0_9/packages

TI SDK RTOS for AM654x

At lease Version 9 of the Code Composer Studio is needed and together with the Ti Processor SDK-rtos for am65xxevm Version 07.01.00.14 this lead to the packages:

- XDCtools: 3.61.3_29_core
- PDK 7.1.0.55
- SYS/BIOS 6.83.0.18

Ensure environment variable PDK_INSTALL_PATH is pointing to the installed root directory of SDK. For AM654x demo project, PDK_INSTALL_PATH=C:/ti/pdk_am65xx_07_01_00_55/packages

How to create the demo applications

1. Create ENI file for EtherCAT configuration.

xxd.exe is capable of converting ENI files to a C file as array, e.g. “xxd.exe -i eni.xml ENI.c”. Replace MasterENI.c file with the generated one

2. On TI RTOS the EcMasterDemo can run with either CPSW or ICSS link layer.

Eg: AM572x with ICSS link layer

Workspace/TI-RTOS_AM57x in Code Composer Studio and import all projects from this directory:

- EcMaster
- emllICSS
- EcMasterDemoICSS or
- EcMasterDemoDcICSS

Hardcoded parameters for the demo can be changed using DEMO_PARAMETERS definition.

How to run the EC-Master demo applications

- The compiled .out application files of the demo can be uploaded to the device via JTAG debugger from Code Composer Studio Debugger.
- The SD Card bootable demo binary is generated as an APP file from post build script calling pdkAppImage-Create.bat from the PSDK package.

How to run the EC-Master motion demo application

1. **Create an appropriate ENI file as en EcMasterDemo with the xxd.exe tool**
The DC configuration has to be done appropriately, please see the EtherCAT general documentation and EC-Master manuals for details
2. **Create an appropriate motion demo configuration file and copy it into the config directory of the project**
See example in Examples/EcMasterDemoMotion/Config/DemoConfig.xml See additional info in: Examples/EcMasterDemoMotion/readme.txt
3. Convert DemoConfig.xml to C file DemoConfig.c as array.
4. Build the Project and download it to target Processor.
5. The demo logging is done over UART.

See also:

[Running EcMasterDemo](#)

4.8.2 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for TI-RTOS.

Extra include paths

```
<InstallPath>/SDK/INC/TI-RTOS  
<InstallPath>/Examples/Common/TI-RTOS
```

Extra source paths

```
<InstallPath>/Examples/Common/TI-RTOS  
<InstallPath>/Sources/OsLayer/TI-RTOS
```

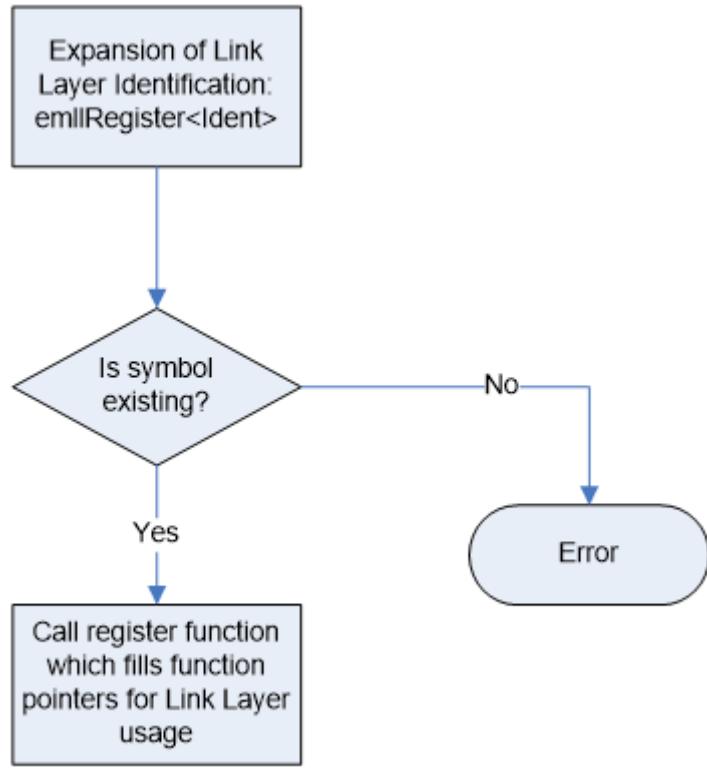
Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/TI-RTOS
```

4.9 Windriver VxWorks

Optimized Link Layers for VxWorks are available. If none of the optimized Link Layers can be used, the SNARF Link Layer must be selected.

The identification of the Link Layer is done like this:



4.9.1 VxWorks native

The BSP has to be prepared to support Optimized Link Layers:

1. To use an optimized Link Layer the adapter memory has to be mapped into VxWorks memory space (VxWorks 5.x only). I.e. for the Intel Pro/100 Link Layer this can be achieved by setting the INCLUDE_FEI_END macro in the BSP configuration file config.h.
2. To avoid conflicts with the VxWorks network driver which normally will be loaded when INCLUDE_FEI_END is set the file configNet.h has to be adjusted in a way that the network driver is not loaded. The network driver entry has to be removed from the endDevTbl[]:

```

END_TBL_ENTRY endDevTbl [] =
{
    :       :       :
    :       :       :
    :       :       :
/*
#ifndef INCLUDE_FEI_END
    { 0, FEI82557_LOAD_FUNC, FEI82557_LOAD_STRING, FEI82557_BUFF_LOAN,
      NULL, FALSE},
#endif /* INCLUDE_FEI_END */
*/
    :       :       :
    :       :       :
  
```

Warning: Do not call `muxDevUnload()` for a device managed by a VxBus driver. VxBus drivers expect to call `muxDevUnload()` themselves in their `{vxbDrvUnlink}()` methods, and instability may result if `muxDevUnload()` is called for a VxBus network device instance by other code.

See also:

The VxWorks Device Driver Developer's Guide for more information about unloading VxBus network devices

4.9.2 SNARF Link Layer

The SNARF Link Layer is only needed if none of the optimized Link Layers can be used. The appropriate network adapter drivers have to be added to the VxWorks image.

4.9.3 Setting up and running EcMasterDemo

1. VxWorks OS configuration

See sections above.

2. Determine the network interface

Using the command line option the network interface card and Link Layer to be used in the example application can be determined.

3. Connection of the EtherCAT slaves

The slaves have to be connected with the VxWorks system using an Ethernet switch or a patch cable. Local IT infrastructure should not be mixed with EtherCAT modules at the same switch as the EC-Master will send many broadcast packets! EtherCAT requires a 100Mbit/s connection. If the VxWorks network adapter card does not support this speed an 100Mbit/s (!) Ethernet switch has to be used.

4. Download a Link Layer module

The Link Layer library (e.g. `em11IntelGbe.out`) which contains hardware support for the corresponding NIC must be downloaded. By default the Link Layers `em11SnarfGpp` are contained with the binary delivery.

5. Download the example application

The target has to be started and a target-server connection will have to be established. After this the example application can be downloaded into the target.

6. Set up a FTP server connection on host

The demo application needs to load a XML file (`eni.xml`) for the configuration of the master. This file can be accessed using a FTP server. The screen shot below show, how to configure the FTP server. The directory contents can be checked via FTP using the `ls` command. The file `eni.xml` will have to be accessed using the default directory.

7. Check for exclusive hardware access

Be sure that the network adapter instance dedicated to EtherCAT is not controlled by a VxWorks driver, this can be verified using:

```
-> muxShow
```

If it is needed, first unload the driver using: (e.g. first instance of the Intel Pro/100):

```
-> muxDevUnload "fei", 1
```

(e.g. second instance of the Intel Pro/1000):

```
-> muxDevUnload "gei", 2
```

(e.g. first instance of the Realtek 8139):

```
-> muxDevUnload "rtl", 1
```

(e.g. first instance of the Realtek 8169):

```
-> muxDevUnload "rtg", 1  
(e.g. first instance of the FEC on Freescale iMX platform):  
-> muxDevUnload "motfec", 1  
(e.g. first instance of the ETSEC on Freescale PPC platform):  
-> muxDevUnload "motetsec", 1
```

8. Run the example application

The downloadable module `EcMasterDemo.out` has to be executed. The configuration file `eni.xml` will be used and thus has to be accessible in the current working directory. The appropriate Link Layer and network adapter card have to be selected. If the log files shall be written the global variable `bLogFileEnb` has to be set to 1 prior to starting the demo.

Loading and running the demo:

```
-> ld<EcMasterDemo.out  
-> sp EcMasterAppMain, "-intelgbe 1 1 -f eni.xml"
```

Example:

```

172.17.7.148 - PuTTYtel

-> ld<em1i18254x.out
value = 78468256 = 0x4ad54a0
-> ld<EcMasterDemo.out
value = 78582152 = 0x4af1188 = G_dwLinkOsUnLockCounter + 0x3dc
-> sp atemDemo, "-f EL9800.xml -i8254x 1 1 -v 2"
Task spawned: id = 0x4af1bac, name = t1
value = 78584748 = 0x4af1bac = G_dwLinkOsUnLockCounter + 0xe00
-> Full command line: -f EL9800.xml -i8254x 1 1 -v 2

tEcTimingTask: bus cycle time: 1000 us (using Sleep)
Run demo now!

=====
Initialize EtherCAT Master
=====
EtherCAT Master V2.6.1 Build 99 Copyright acontis technologies GmbH
Evaluation Version, stop sending ethernet frames after 480 minutes!
Evaluation Version, number of slaves supported = 12!
Evaluation starts now ...
Bus scan successful - 1 slaves found

*****
Number : 0
Vendor : Beckhoff (Product Management), ID 2
Product : EL9820, Code: 0x4570862
Revision: 0x1f4008e Serial Number: 0
ESC Type: Beckhoff ET1100 (0x11) Revision=0 Build=2
Bus AutoInc Address: 0 (0x0)
Bus Station Address: 1001 (0x3e9)
Bus Alias Address : 4103 (0x1007)
Config Station Address: 1001 (0x3e9)
PD OUT Byte.Bit offset: 0.0 Size: 32 bits
Port 0: Connected Port 1: Not_Conn. Port 2: Not_Conn. Port 3: Not_Conn.

=====
Start EtherCAT Master
=====
Master state changed from <UNKNOWN> to <INIT>
Master state changed from <INIT> to <PREOP>
Master state changed from <PREOP> to <SAFEOP>
Master state changed from <SAFEOP> to <OP>

```

See also:

Running EcMasterDemo

4.9.4 OS Compiler settings

Besides the general settings from *Compiling the EcMasterDemo* the following settings are necessary to build the example application for VxWorks.

Extra include paths

```
<InstallPath>/SDK/INC/VxWorks
<InstallPath>/Examples/Common/VxWorks
```

Extra source paths

```
<InstallPath>/Examples/Common/VxWorks
<InstallPath>/Sources/OsLayer/VxWorks
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/VxWorks/<ARCH>
```

VxWorks V6.1 .. V6.4: In case the SNARF Link Layer shall be used and ifconfig() is available -D IFCON-FIG_SUPPORT has to be set.

GNU/PowerPC: -mlongcall compiler option may be needed to avoid relocation offset errors when downloading .out files.

4.10 Microsoft Windows

4.10.1 EcMasterDemo - Microsoft Windows

1. Install EC-Master

Run setup.exe from EC-Master package, which will guide you through the installation process.

2. Determine the network interface

For example the option -winpcap 192.168.1.1 1 will be using the network adapter card with the IP address 192.168.1.1.

3. Connect EtherCAT modules

Any EtherCAT module can be directly connected to the target system. EtherCAT requires a 100 Mbit/s connection. If the Ethernet adapter card does not support this speed, an Ethernet switch must be used.

Warning: The local IT infrastructure should not be mixed with EtherCAT modules on the same Ethernet adapter. The EC-Master sends many broadcast packets!

4. Run the example application

Execute <InstallPath>/Bin/Windows/<Arch>/EcMasterDemo.exe. At least a Link Layer option has to be given.

```
C:
> EcMasterDemo -winpcap 192.168.1.1 1 -f D:/eni.xml
```

```
C:\Windows\system32\cmd.exe - EcMasterDemo.exe -winpcap 192.168.1.1 1 -f D:/eni.xml
D:\temp\EC-Master-Windows-x86_64Bit\Bin\Windows\x64\EcMasterDemo.exe -winpcap 192.168.1.1 1 -f D:/eni.xml
000000005: EcMasterDemo V3.1.1.02 (Unrestricted) for Windows_x64 Copyright acontis technologies GmbH @ 2021
000000005: Full command line: -winpcap 192.168.1.1 1 -f "D:/eni.xml"
000000006: EC-Master V3.1.1.02 (Unrestricted) for Windows_x64 Copyright acontis technologies GmbH @ 2021
000000414: EtherCAT network adapter MAC: 68-05-CA-3D-03-E7
000000508: Bus scan successful - 6 slaves found
000000519: Master state changed from <UNKNOWN> to <INIT>
000000575: Master state changed from <INIT> to <PREOP>
000000618: Master state changed from <PREOP> to <SAFEOP>
000000639: Master state changed from <SAFEOP> to <OP>
000000640: EcMasterDemo will stop in 600s...
```

See also:

[Running EcMasterDemo](#) for a detailed description of the demo application.

4.10.2 EcMasterDemoDotNet (.NET) - Microsoft Windows

1. Open the Workspace

Please find the solution including the C#-project for VS2005 at `Workspace/WindowsVS2005/EcMasterDemoDotNet/EcMasterDemoDotNet.sln`

2. Compile the application

3. Copy DLLs in the executables folder

To run the `EcMasterDemoDotNet.exe`, copy `EcMaster.dll`, `EcMasterDotNet.dll` and `emllPcap.dll` from `Bin/Windows/x86` to the executables folder

4. Run/Debug `EcMasterDemoDotNet.exe`

4.10.3 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for Windows.

Extra include paths

```
<InstallPath>/SDK/INC/Windows  
<InstallPath>/Examples/Common/Windows
```

Extra source paths

```
<InstallPath>/Examples/Common/Windows  
<InstallPath>/Sources/OsLayer/Windows
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/Windows
```

4.10.4 OS optimizations

Power Options

- Set *Hard disk* ▶ *Turn off hard disk after* ▶ *Setting to Never*
- Set *PCI Express* ▶ *Link State Power Management* ▶ *Setting to Off*

Performance Options

- Select *Visual Effects* ▶ *Adjust for best performance*

See also:

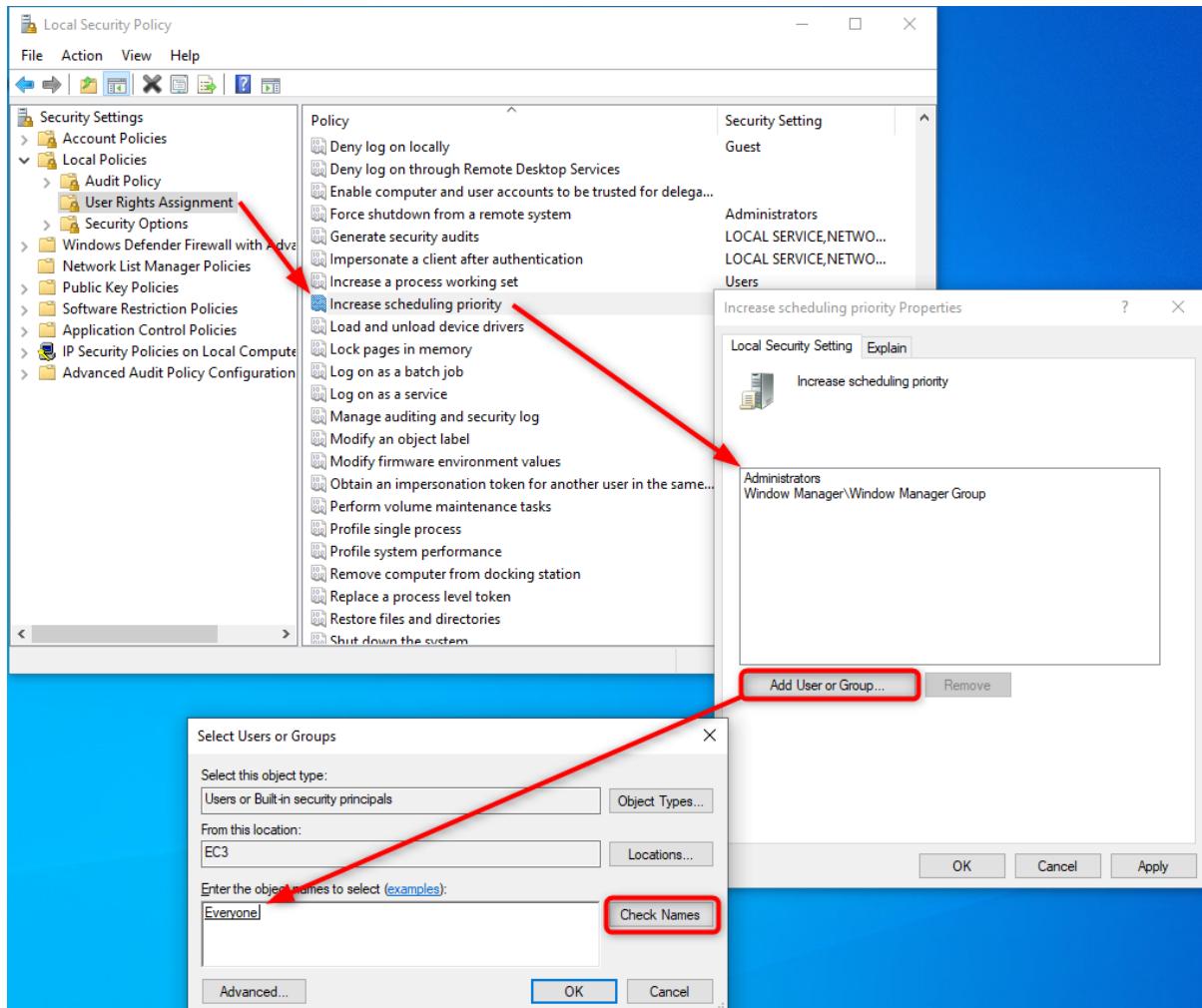
[Windows 10 Real-time Optimization](#) in the acontis developer center

Enable Realtime Priority Class

In order to comply with the timing as best as possible, it is necessary that the application / EcMasterDemo runs with realtime priority. By default, an application on Windows can not be run with real-time priority. To allow this the Increase scheduling priority user rights policy setting must be set. Also, the application must be run as an administrator.

Increase scheduling priority setting

Local Security Policy ▶ User Rights Assignment ▶ Increase scheduling priority ▶ Add User or Group ... ▶ Everyone



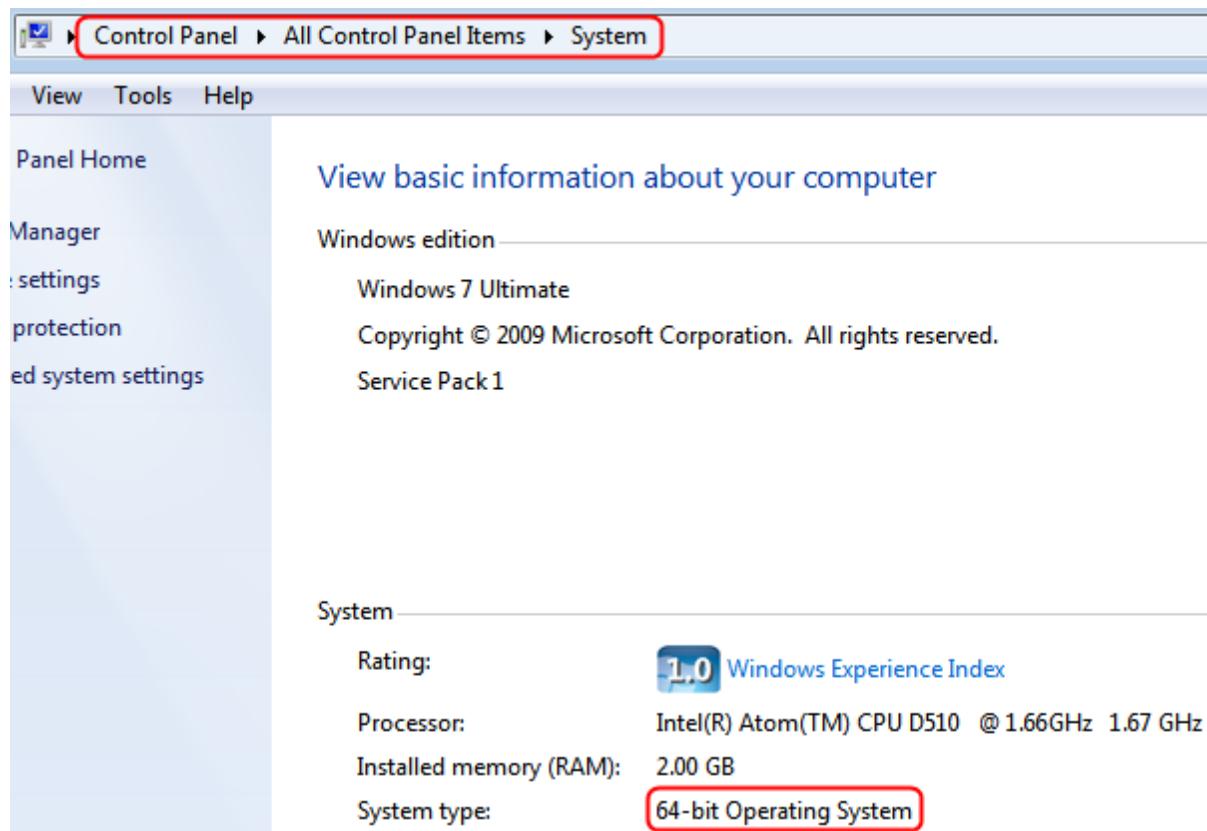
4.10.5 EcatDrv for Kernel Timer

Due to the non-real-time behavior of Windows, it is not possible to get accurate timing when using the standard timer API. The EcatDrv implements an Kernel Timer that is accurate enough to get DCM in sync. The EcatDrv does not guarantee response to the cycle's deadline.

Prerequisites of the EcatDrv

Microsoft Windows: 32 bit or 64 bit?

On Windows the System Properties dialog contains the information about the PC's architecture. The System type states if it is a 64-bit Operating System or 32-Bit.



Disable CPU Power Management Driver

To prevent influences from the Intel-PPM-driver, the driver can be disabled. The registry file “intelppmOFF.reg” to disable the Intel-PPM-driver can be merged into the registry and is located in the Files/Windows-folder of the EC-Master installation directory, e.g. C:/Program Files/acontis_technologies/EC-Master/Files/Windows. Merging “intelppmON.reg” would enable it again.

Disable Local APIC usage of Windows

To make sure that there is no collision between Windows and the EcatDrv, disable the use of the Local APIC timer for Windows. This can be done by changing the boot configuration with the following command in the Windows console as an administrator:

```
$ bcdedit.exe /set current useplatformtick yes
```

No Local APIC support since Windows 10

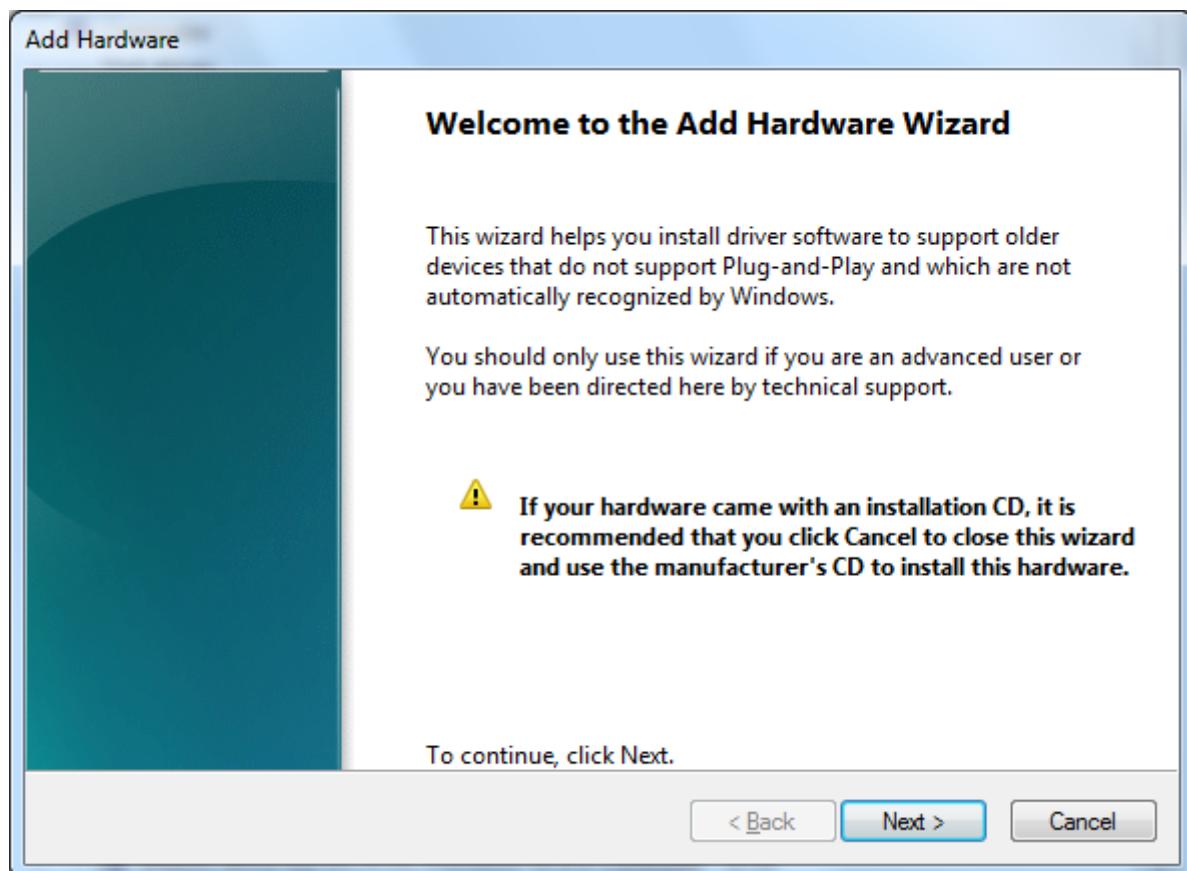
Since Windows 10, direct access to the local APIC timer is no longer allowed and can cause an blue screen of death (BSOD). In this case the EcatDrv can use the Windows Kernel Timer as clock source. The EC-Master stack automatically uses the EcatDrv if this driver is installed and activated on the Windows system. If not the standard timer API is used.

Installing and configuring the EcatDrv on Windows

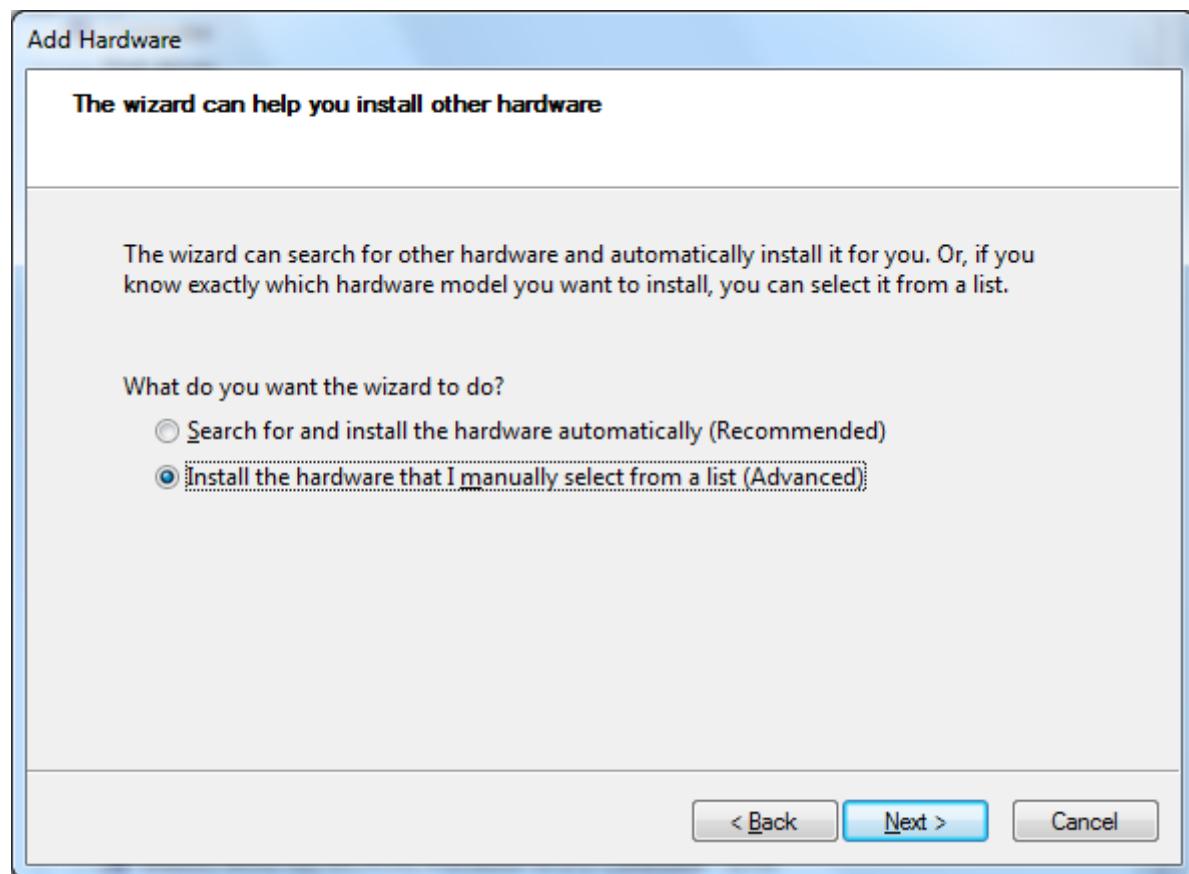
1. Start the “Add Hardware Wizard” and click “Next”



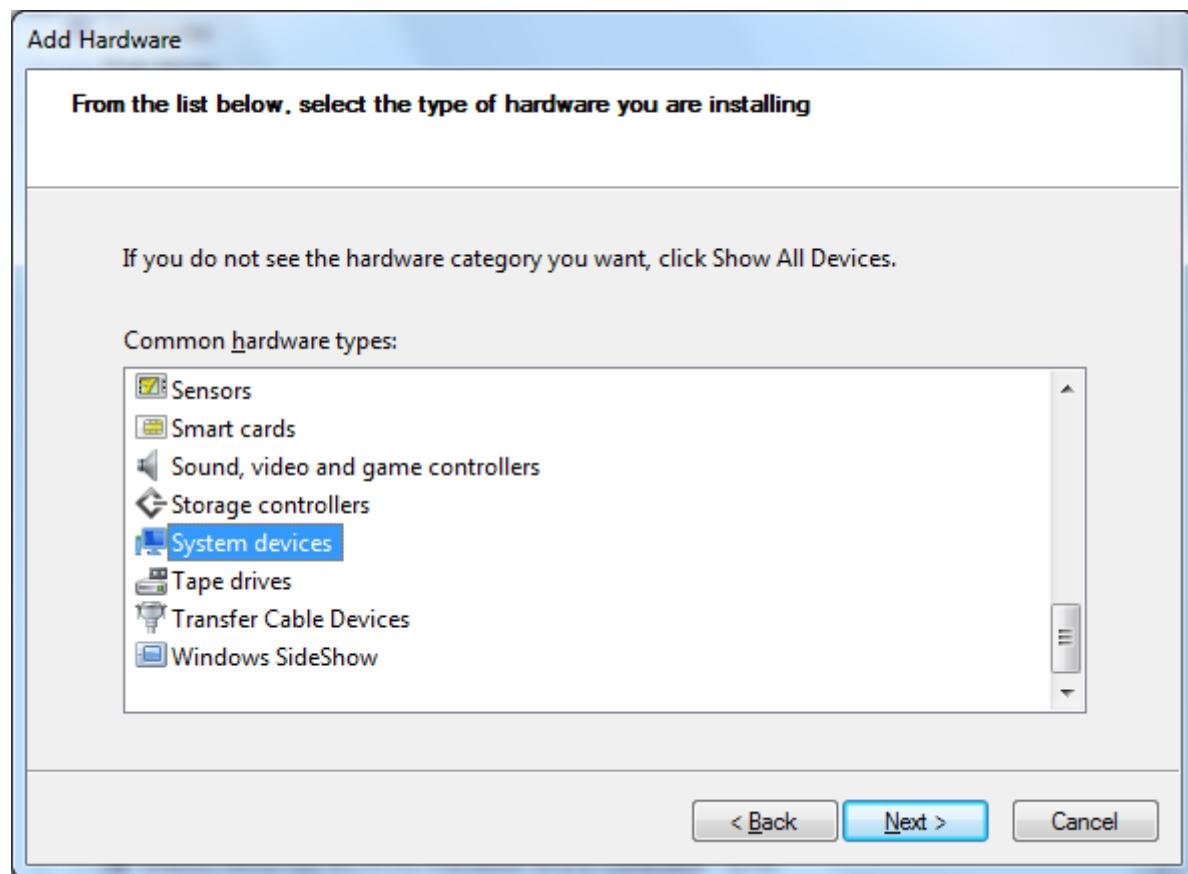
The Add Hardware Wizard shows up:



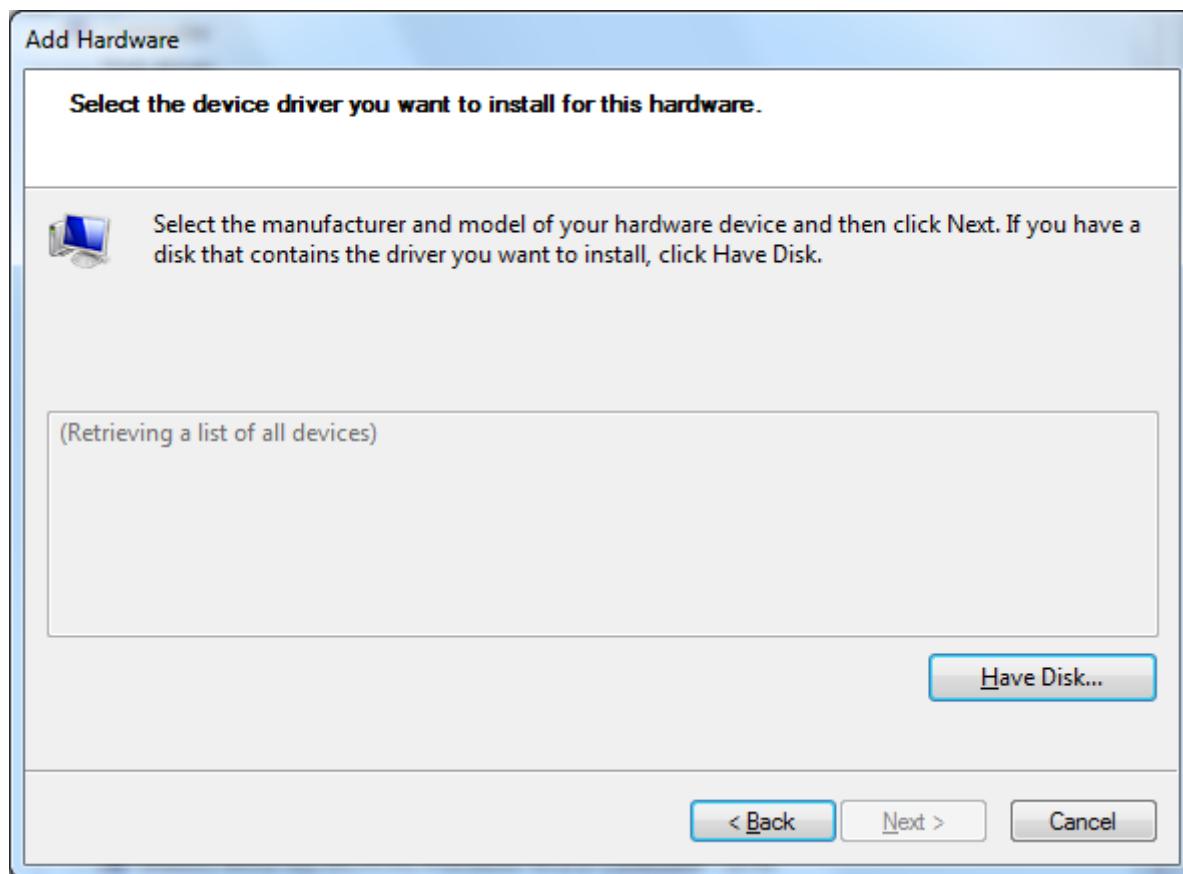
2. Select “Install the hardware...” and proceed



3. Select “System devices” and proceed



4. Click to “Have Disk...” and proceed

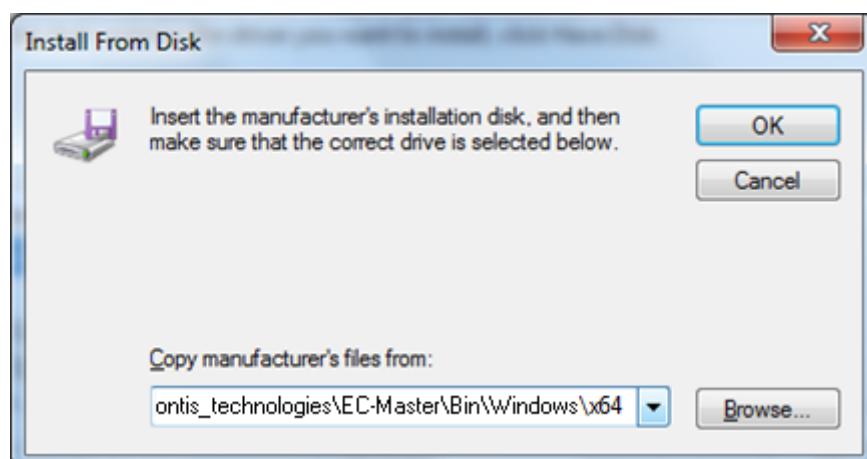


5. Enter the directory to the correct driver version (32 bit or 64 bit)

The default folder if not changed when installing the EC-Master is under C:/Program Files/acontis_technologies/EC-Master/Bin/Windows.

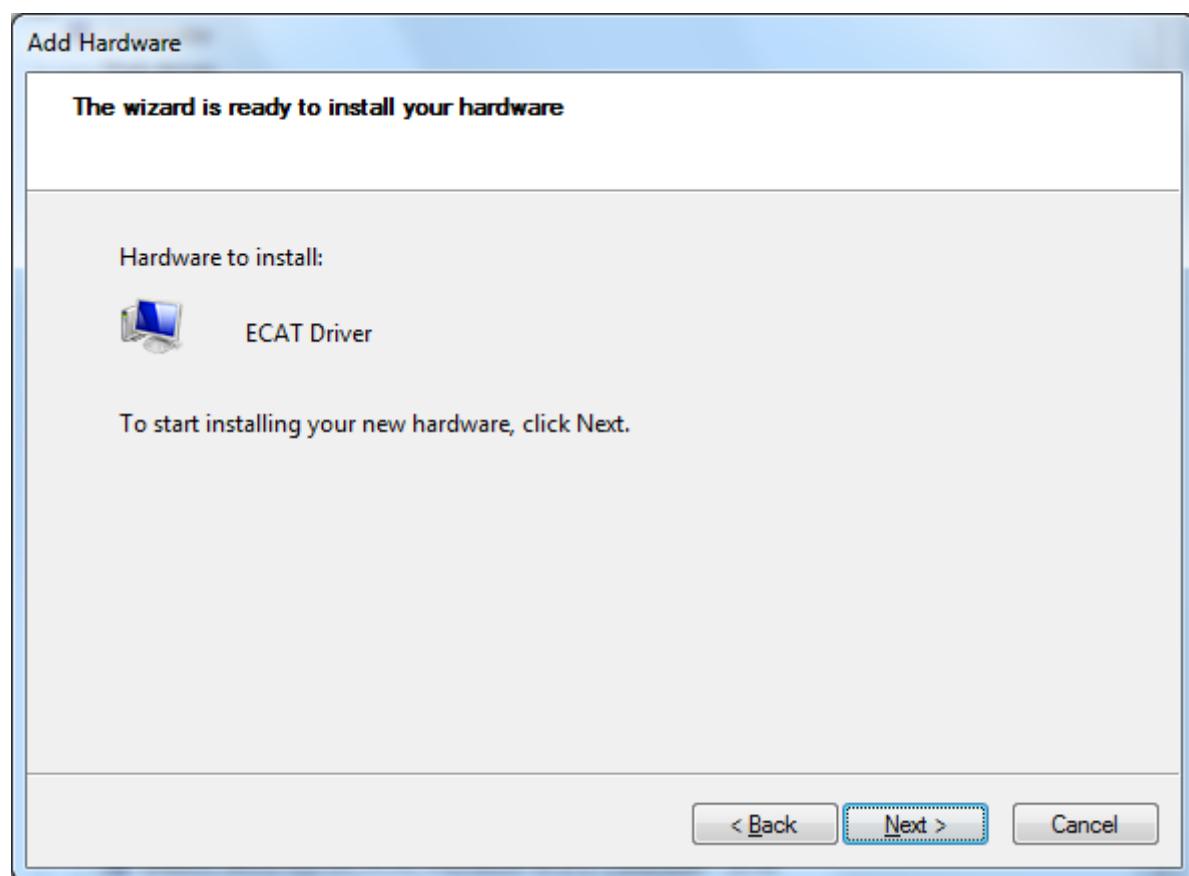
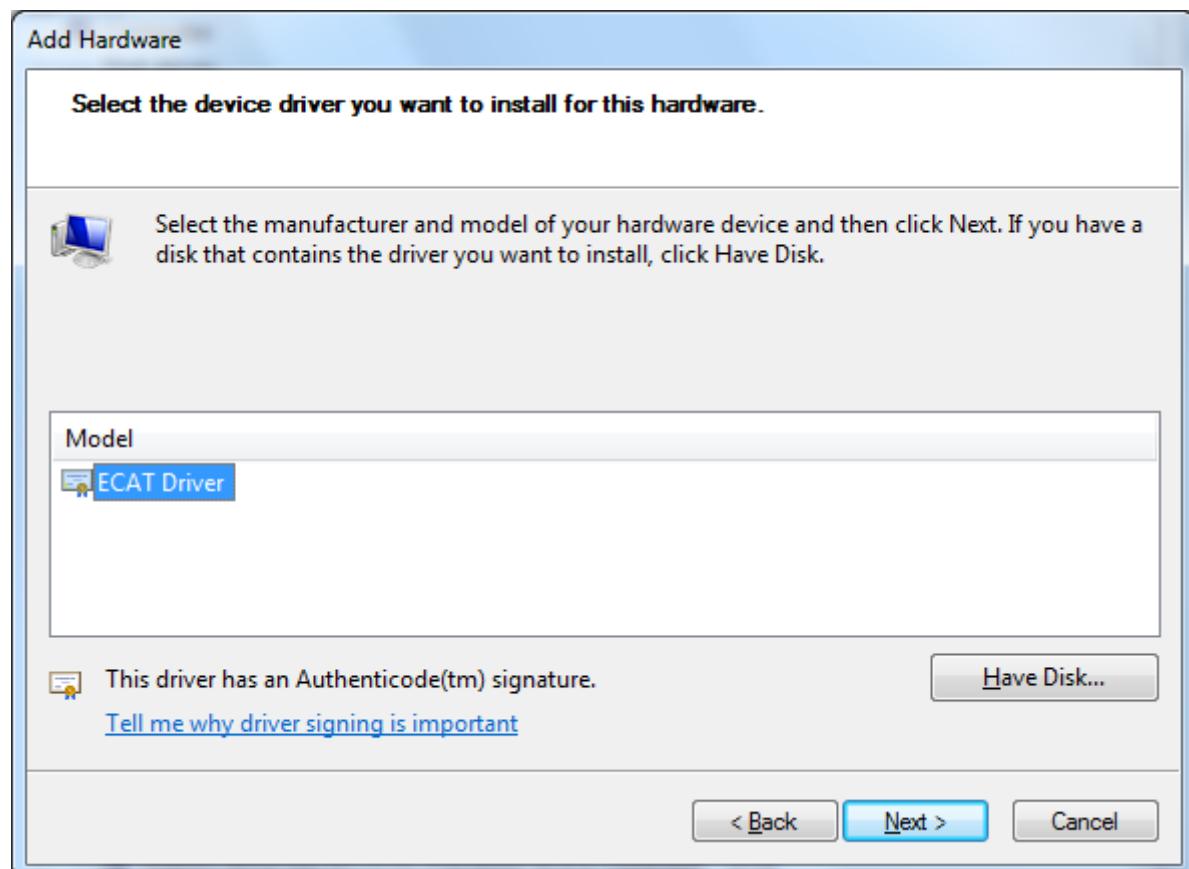
Attention: There are two different drivers available: 32 bit and 64 bit. The subfolder x86 contains the 32 bit driver files. The subfolder x64 contains the 64 bit driver files.

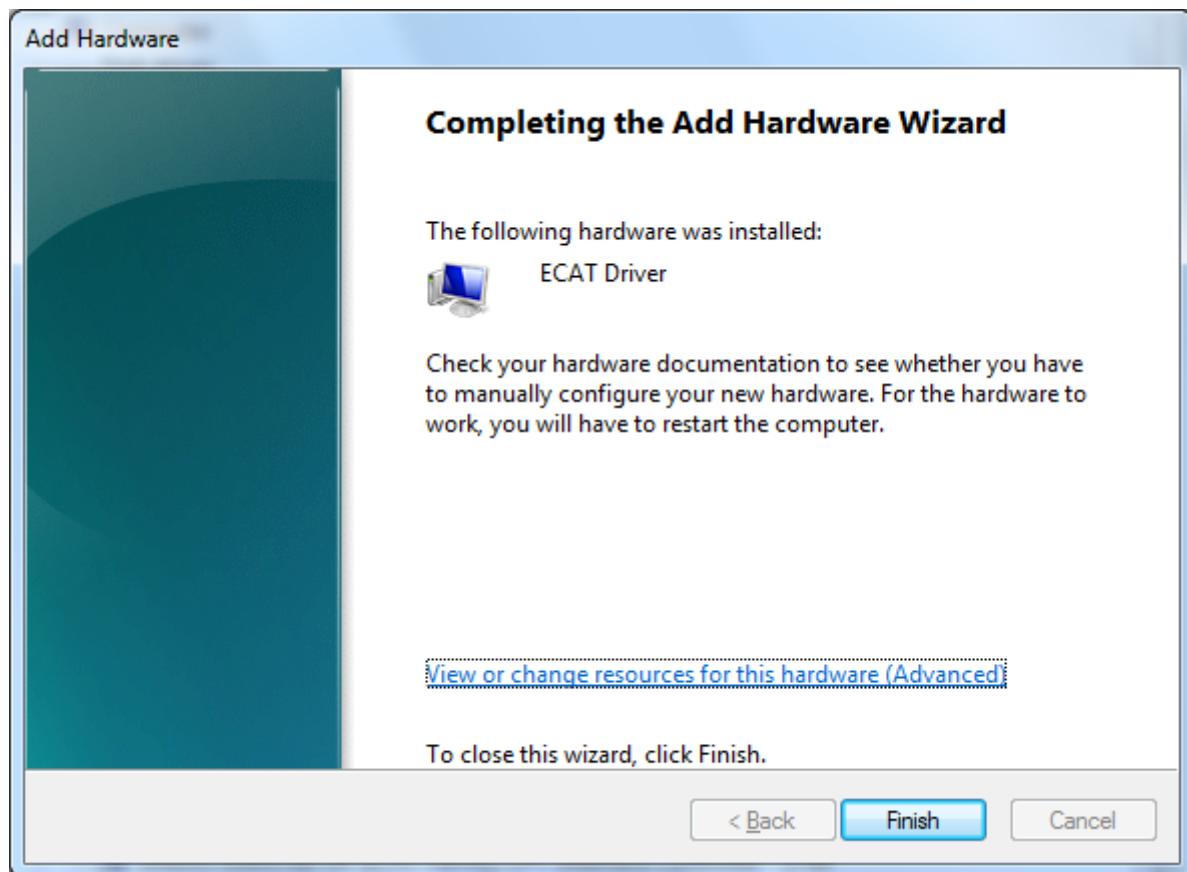
Enter the correct directory at the input box:



Press OK to proceed.

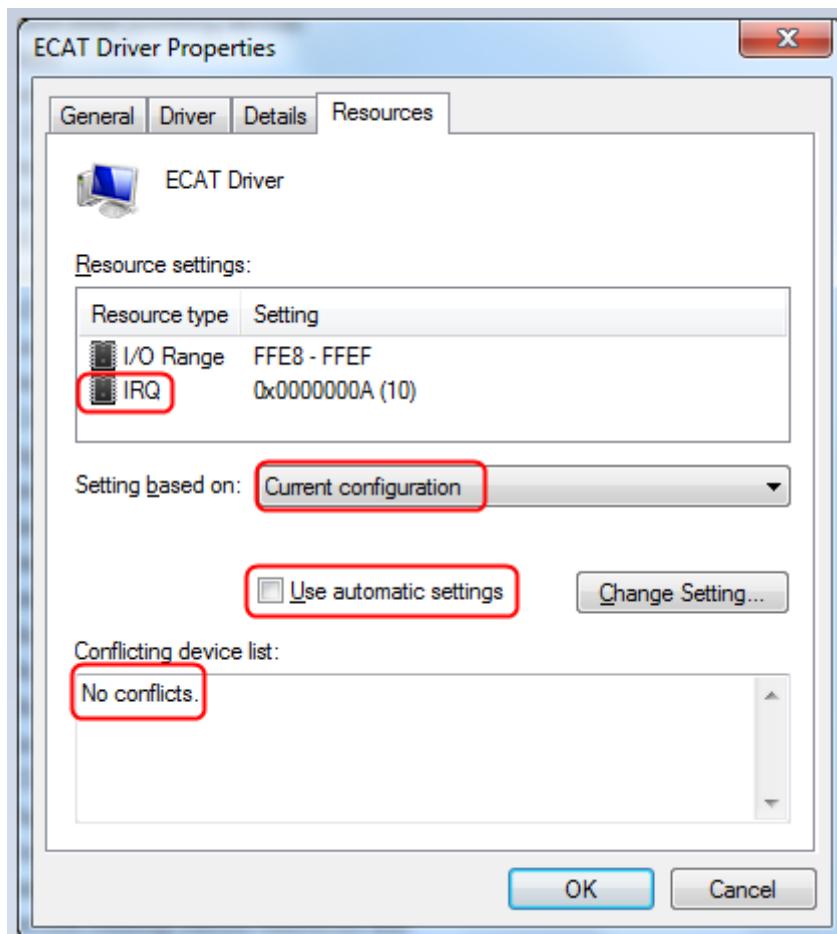
6. Choose the EcatDrv and click "Next" and confirm the installation



7. Continue on any warning about unsigned driver**8. Configure the driver for local APIC usage**

Attention: This is not required for Windows 10 !

- Open the Device Manager and open the properties of the EcatDrv
- Uncheck “Use automatic settings”
- Change “Current Configuration” to “Basic configuration 0001”
- Double-click the “IRQ”-label and adjust the Interrupt Request Value until “No conflicts” is shown.



9. Press “OK” to close and apply the settings

Confirm the manual settings

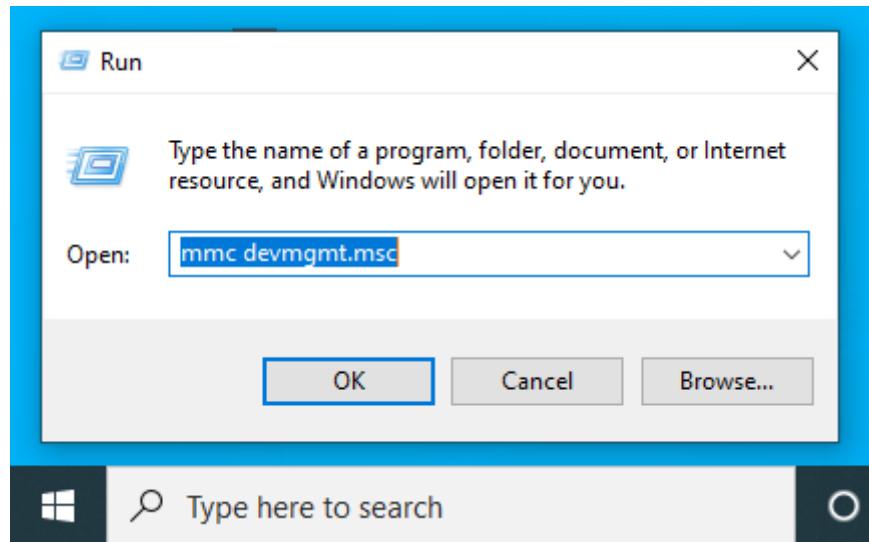
10. Restart the PC

4.10.6 EcatDrv for Optimized Link Layer

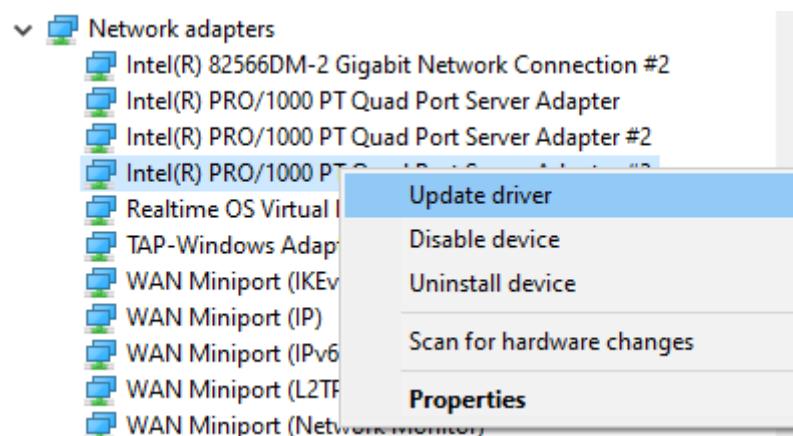
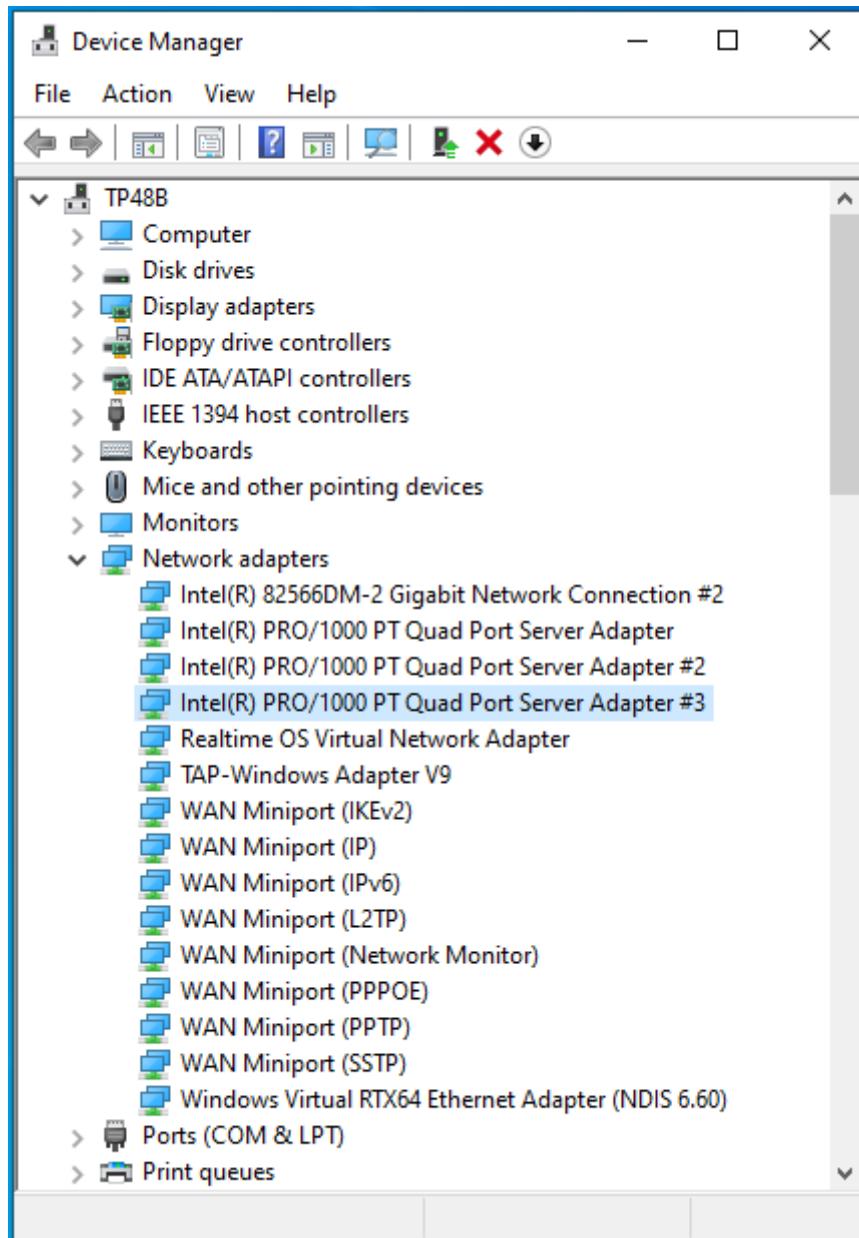
As alternative to the NDIS based or Pcap based Link Layer, an optional Real-time Link Layer on Windows can be installed. The Link Layer replaces the original Windows driver and also requires an extra license.

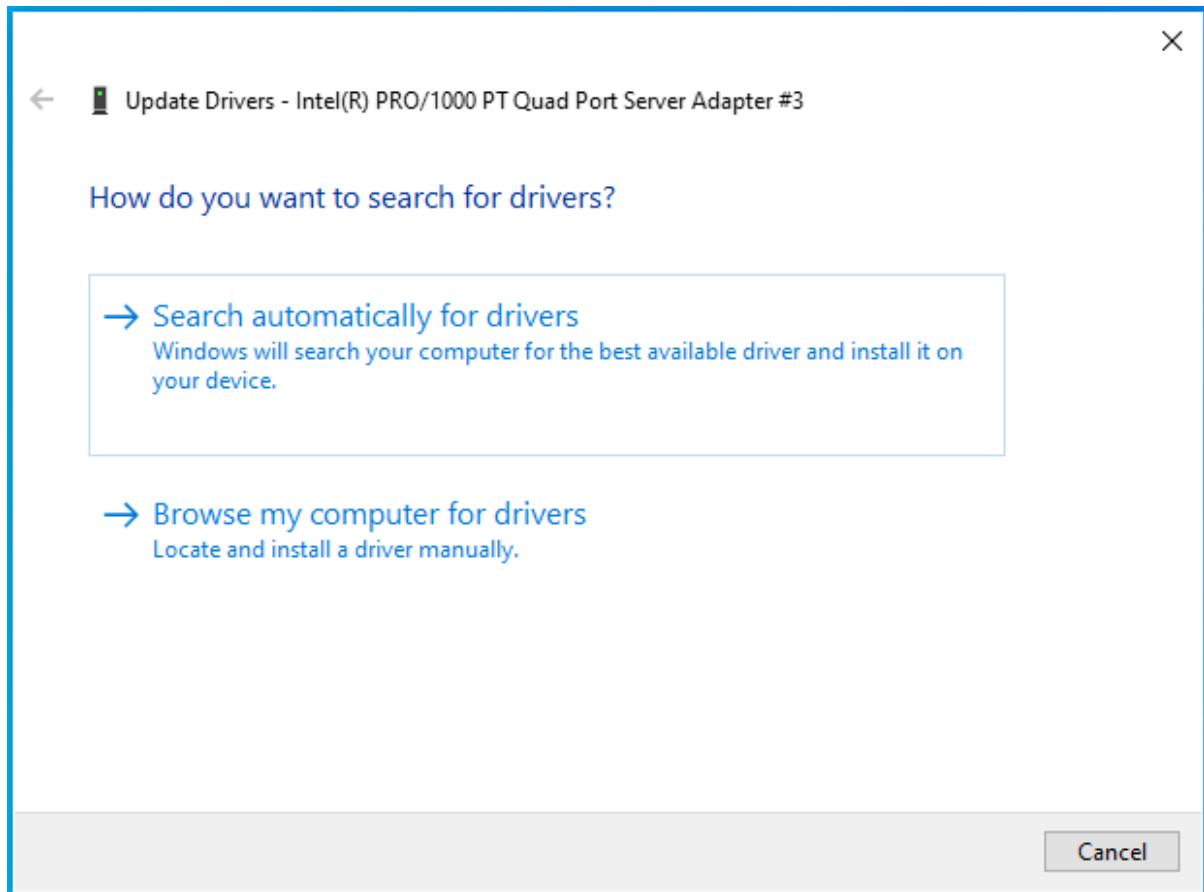
To use the optimized Link Layers under Windows, it is necessary to install the EcatDrv driver included in the optimized Link Layer delivery:

1. Start the “Device Manager”

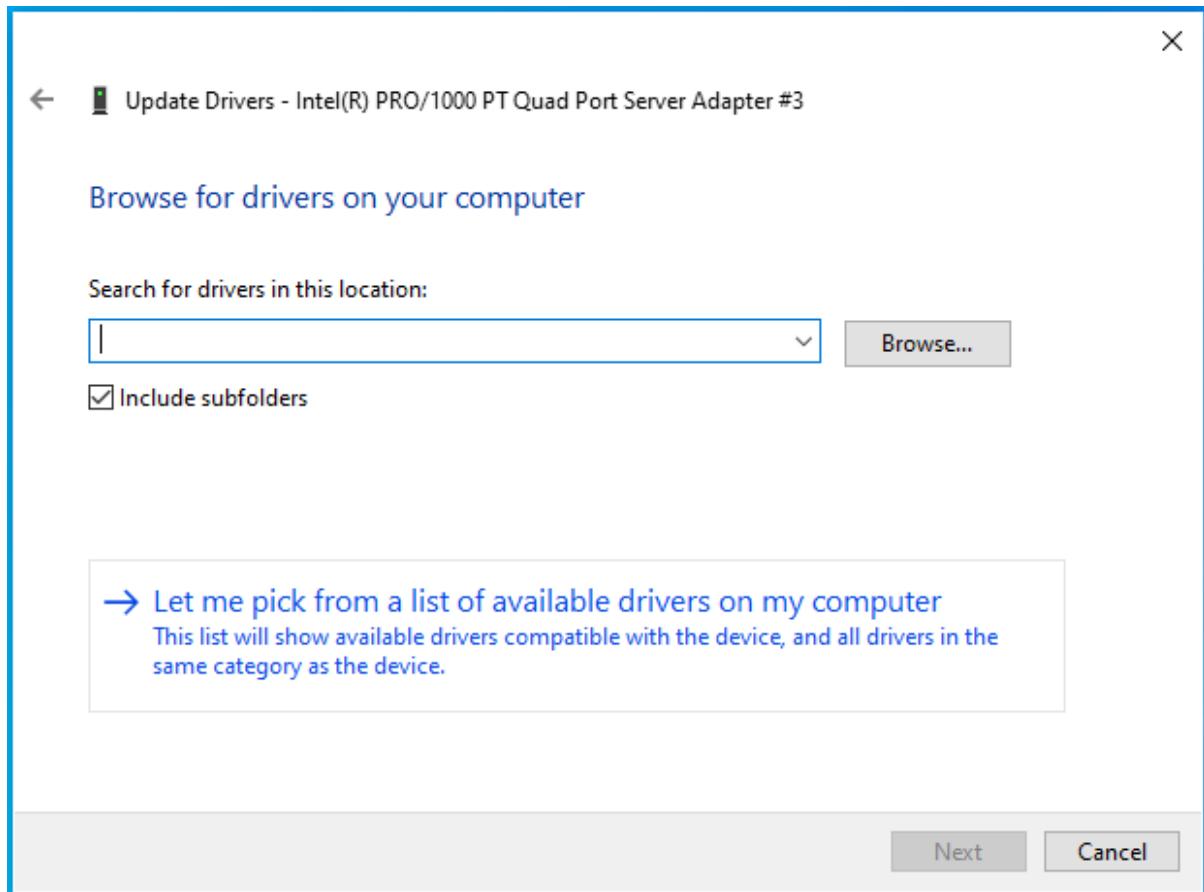


2. Assign EcatDrv to the network adapter

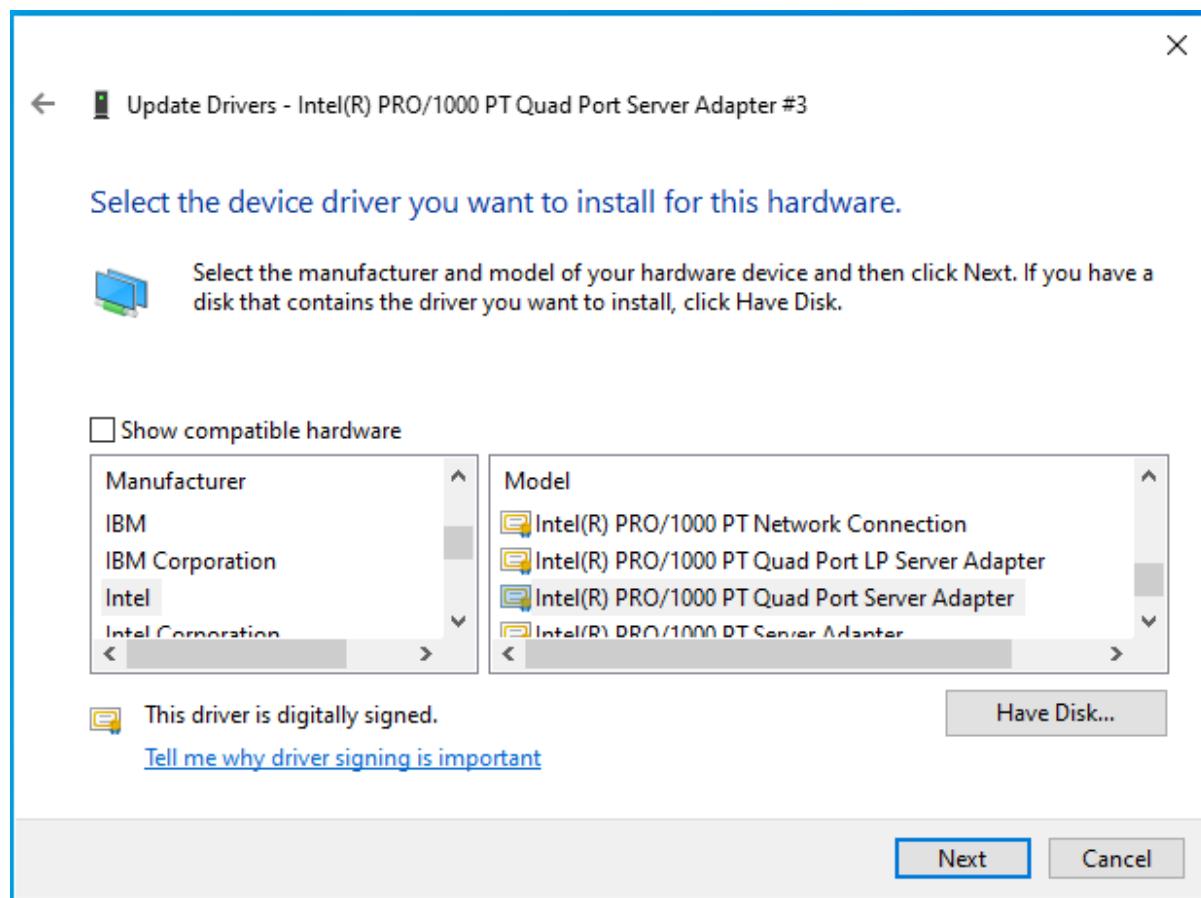




Click on “Browse my computer for driver”



Click on “Let me pick...”

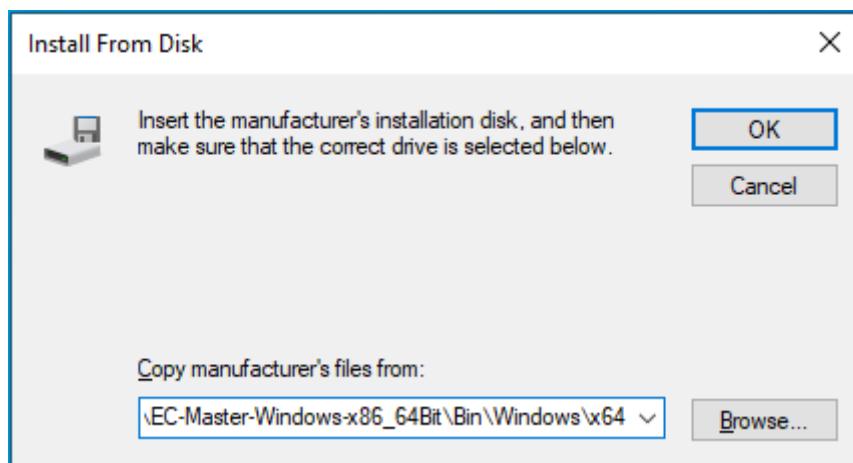


Click on “Have Disk...”

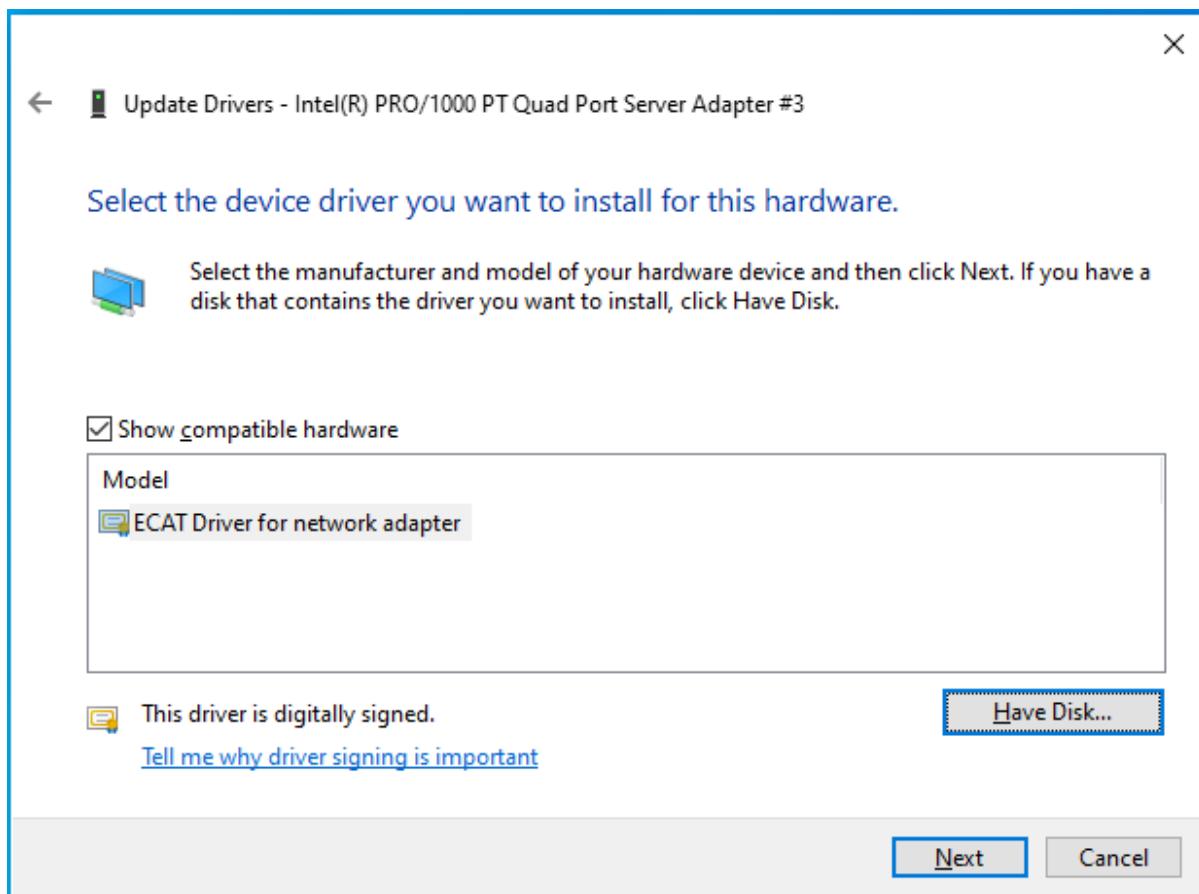
3. Enter the directory of EcatDrv

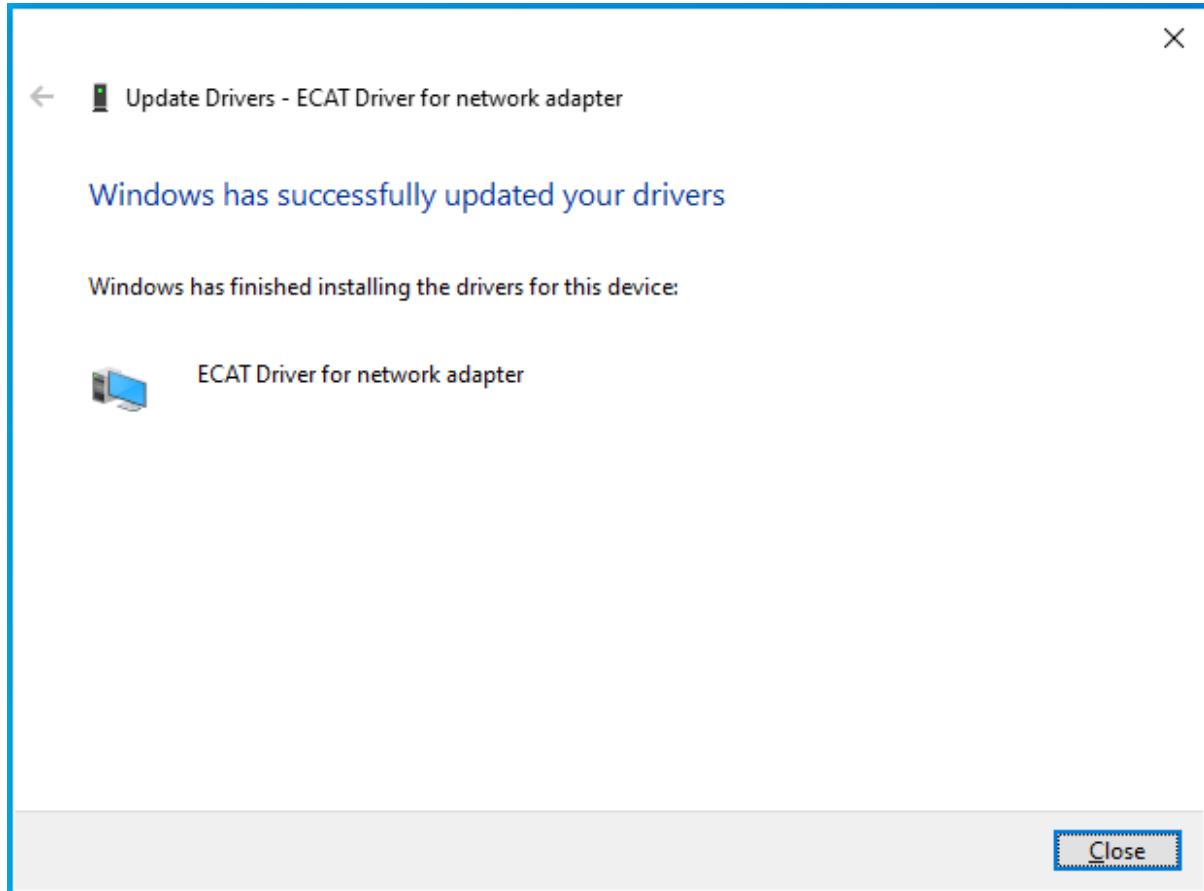
The default folder if not changed when installing the EC-Master is under C : /Program Files/acontis_technologies/EC-Master/Bin/Windows.

Attention: Two different versions are available: 32 bit (subfolder **x86**) and 64 bit (subfolder **x64**).



Enter the correct directory at the input box and press OK to proceed.

4. Choose the EcatDrv and click “Next” and confirm the installation

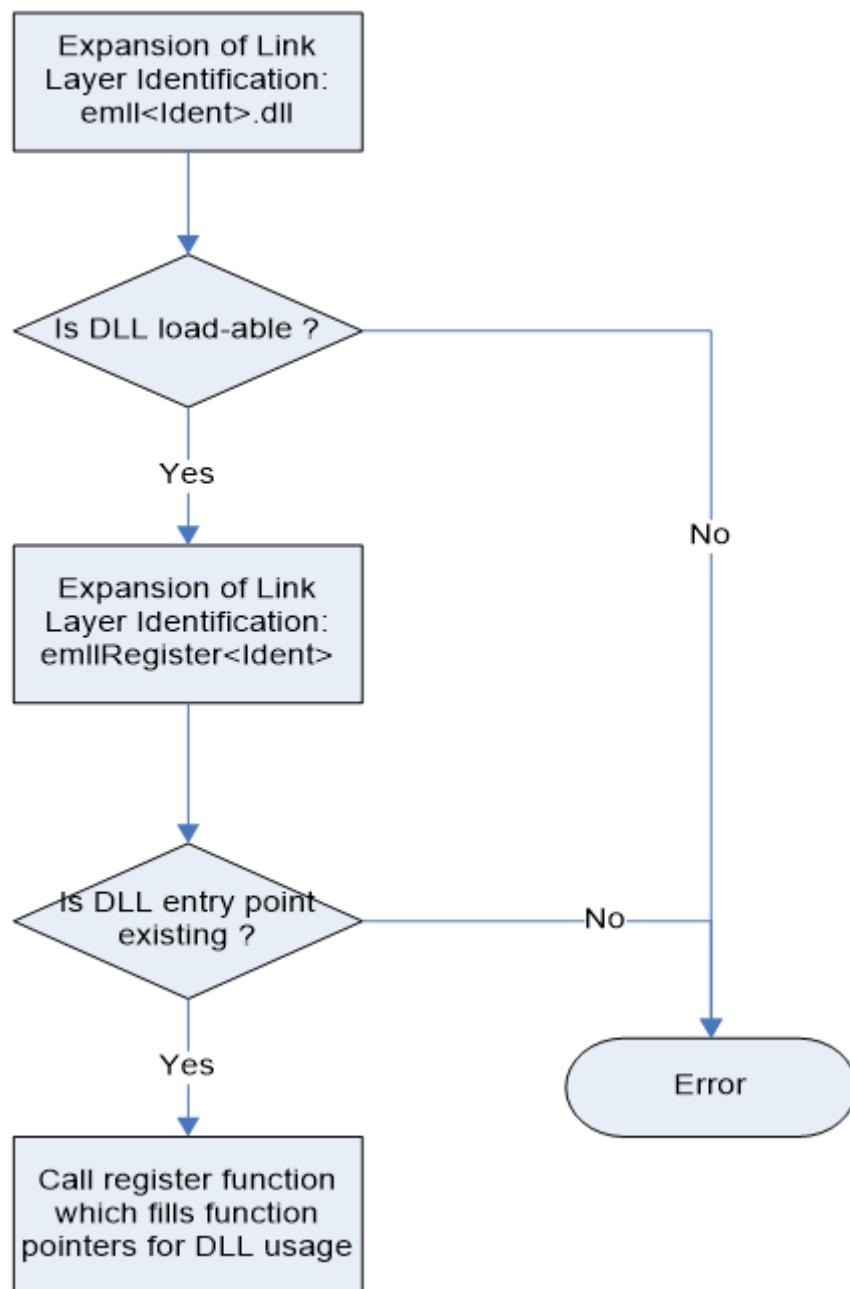


Optionally modify search location for Optimized Link Layers

Search locations for Optimized Link Layers can be adjusted using the PATH environment variable.

4.11 Microsoft Windows CE

4.11.1 Identification of the Link Layer



The Link Layer module DLL has to be locatable within the applications DLL search path (local or Windows directory). If it is not, an error is given.

4.11.2 KUKA CeWin

For KUKA CeWin (Windows CE runs in parallel with Windows on the same host) the network adapter card to be used has to be assigned to Windows CE. It is also possible in CeWin to load the NDISUIO filter driver dynamically.

An example how to include the EtherCAT Master using a Realtek RTL8139 Network Interface Card can be found in the directory /SDK/FILES/Ndisuio/CeWin (CeWin version 3.3.1):

- Windows INF-File to assign the Realtek NIC to the RTOS (WindowsCE): RTOS_RTL8139.inf
- WinCE image file for Windows CE 4.2 with RTL8139 support: /3.3.1/WINCE420/RTL8139.zip
- WinCE image file for Windows CE 5.0 with RTL8139 support: /3.3.1/WINCE500/RTL8139.zip
- Windows CE configuration for the Realtek-NIC: RTL8139.config
- Dynamic start of the NDISUIO-filter driver AtNdisUio.dll via network share: AtNdisUio.config

Note: Due to a bug in Windows CE Version 5.0 a workaround is needed to load a DLL (e.g. the NDISUIO driver AtNdisUio.dll) from a network share. This can be done by including the following configuration file into cewin.config:

- /SDK/FILES/Ndisuio/CeWin/CE5_DllLoadFix.config

To create a new Windows CE image which includes the NDISUIO based Link Layer the following files have to be included in the Windows CE OS-image:

- /SDK/BIN/NDISUIO/x86/AtNdisUio.dll
- /SDK/BIN/NDISUIO/x86/EcMaster.dll
- /SDK/BIN/NDISUIO/x86/emllNdisUio.dll

This is done by use of the files:

- [...]/SDK/FILES/EcMaster.bib
- [...]/SDK/FILES/Ndisuio/AtNdisUio.bib

The registry entries which have to be added can be taken from:

- [...]/SDK/FILES/Ndisuio/AtNdisUio.reg

The appropriate network adapter card (e.g. the Realtek 8139 adapter card) has to be taken from the Windows CE catalog to include it in the Windows CE image.

If using KUKA CeWin (Windows CE runs in parallel with Windows on the same host) the network adapter card has to be assigned to Windows CE. An example how to include the EtherCAT Master using the optimized Intel PRO/100 Network Interface Card can be found in the directory [...]/SDK/FILES/I8255x/CeWin (version 3.3.1):

- Windows INF-File to assign the PRO/100 NIC to the RTOS (WindowsCE): RTOS_I8255x.inf
- Windows CE configuration for the PRO/100-NIC: I8255x.config

Note:

1. **Due to a bug in Windows CE Version 5.0 a workaround is needed to load a DLL (e.g. for dynamically loading the EtherCAT stack EcMaster.dll) from a network share. This can be done by including the following configuration file into cewin.config:**
[...]/SDK/FILES/Ndisuio/CeWin/CE5_DllLoadFix.config
2. The images shipped with CeWin can be used together with the Intel PRO/100 optimized Link Layer

For example to create a new Windows CE image which includes the optimized PRO/100 Link Layer the following files have to be included in the Windows CE OS-image:

- [...]/BIN/WinCE500/I8255x/x86/EcMaster.dll

- [...] /BIN/WinCE500/I8255x/CPU/emlliI8255x.dll

This is done by use of the file:

- [...] /SDK/FILES/EcMaster.bib

The registry entries which have to be added can be taken from:

- [...] /SDK/FILES/I8255x/I8255x.reg

4.11.3 Windows CE 5.0

To be able to use the optimized Link Layers the following files have to be included to the Windows CE OS-image:
Here the proceedings for Intel PRO/100

- [...] /BIN/WinCE500/X86/EcMaster.dll
- [...] /Bin/WinCE500/X86/emlliI8255x.dll

This is done by use of the files:

- [...] /SDK/FILES/EcMaster.bib

The registry entries which have to be added can be taken from:

- [...] /SDK/FILES/I8255x/I8255x.reg

Same procedure and settings may be applied for the other optimized Link Layer; i.e. use IntelGbe instead of I8255x.
Search locations for Optimized Link Layers can be adjusted using the PATH environment variable.

4.11.4 Windows CE 6.0

To be able to use the optimized Link Layers the following files have to be included to the Windows CE OS-image:
Here the proceedings for Intel PRO/100

- [...] /BIN/WinCE600/EcMaster.dll
- [...] /BIN/WinCE600/emlliI8255x.dll
- [...] /SDK/FILES/I8255x/WinCE600/VirtualDrv.dll

This is done by use of the files:

- [...] /SDK/FILES/EcMaster.bib
- [...] /SDK/FILES/I8255x/WinCE600/VirtDrv600.bib (merge into platform.bib)

The registry entries which have to be added can be taken from:

- [...] /SDK/FILES/I8255x/I8255x.reg

Same procedure and settings may be applied for the other optimized Link Layer; i.e. use IntelGbe instead of I8255x.
Search locations for Optimized Link Layers can be adjusted using the PATH environment variable.

4.11.5 Windows CE 2013

To be able to use the optimized Link Layers the following files have to be included to the Windows CE OS-image:
Here the proceedings for Intel PRO/100

- [...] /BIN/ARM/WinCE800/EcMaster.dll
- [...] /BIN/ARM/WinCE800/emlliI8255x.dll
- [...] /BIN/ARM/WinCE800/VirtualDrv.dll

This is done by use of the files:

- [...] /SDK/FILES/EcMaster.bib

The registry entries which have to be added can be taken from:

- [...]SDK/FILES/I8255x/WinCE800/I8255x.reg

Same procedure and settings may be applied for the other optimized Link Layer; i.e. use IntelGbe instead of I8255x. Search locations for Optimized Link Layers can be adjusted using the PATH environment variable. For built-in chips like FslFec the VirtualDrv.reg is used. Then rebuild is necessary.

4.11.6 Setting up and running EcMasterDemo

1. Windows CE configuration

See the section Operating system configuration for how to prepare the operating system

2. Determine the network interface

Using the command line option the network interface card and Link Layer to be used in the example application can be determined. For example the option -i8255x 1 1 will dynamically load the optimized Intel Pro/100 Link Layer (the first PCI device instance) and operate in polling mode.

3. Connection of the EtherCAT modules

The Evaluation board has to be connected with the target system using an Ethernet switch or a patch cable. Local IT infrastructure should not be mixed with EtherCAT modules at the same switch as the EC-Master will send many broadcast packets! EtherCAT requires a 100Mbit/s connection. If the network adapter card does not support this speed an Ethernet switch has to be used.

4. Copy the corresponding LinkLayer module from Bin/WINCE<version>/<arch>:

emllIntelGbe.dll (Intel Pro/1000)

emlliI8255x.dll (Intel Pro/100)

emlliRTL8169.dll (Realtek RTL8169/8168/8111)

emlliRTL8139.dll (Realtek RTL8139)

5. Copy the EC-Master dynamic libraries to the Windows CE target system:

EcMaster.dll (Master core library)

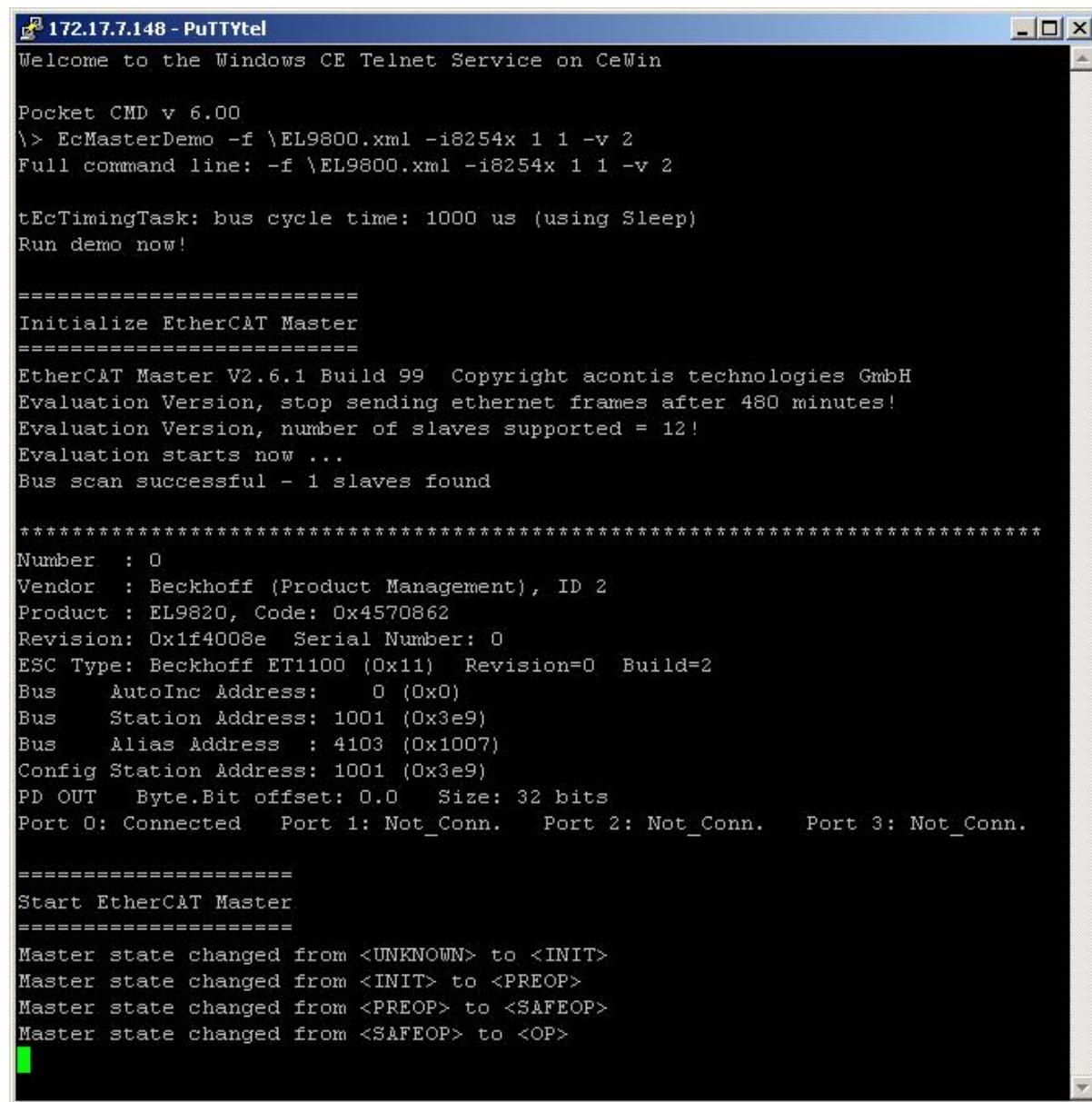
EcMasterRasServer.dll (Remote access service library if needed)

6. Copy one of the demo applications (EcMasterDemo, EcMasterDemoSyncSm, ...) from the EC-Master package to the Windows CE target system.

7. Run the example application

The file EcMasterDemo.exe has to be executed. The full path and file name of the configuration file has to be given as a command line parameter as well as the appropriate Link Layer. Example (starting the application on a network share via telnet):

```
> EcMasterDemo "-f ENI.xml -rtl8169 1 1"
```



The screenshot shows a PuTTY terminal window with the title "172.17.7.148 - PuTTYtel". The window displays the output of the EcMasterDemo application running on a Windows CE system. The output includes:

```
Welcome to the Windows CE Telnet Service on CeWin  
Pocket CMD v 6.00  
\> EcMasterDemo -f \EL9800.xml -i8254x 1 1 -v 2  
Full command line: -f \EL9800.xml -i8254x 1 1 -v 2  
  
tEcTimingTask: bus cycle time: 1000 us (using Sleep)  
Run demo now!  
  
=====  
Initialize EtherCAT Master  
=====  
EtherCAT Master V2.6.1 Build 99 Copyright acontis technologies GmbH  
Evaluation Version, stop sending ethernet frames after 480 minutes!  
Evaluation Version, number of slaves supported = 12!  
Evaluation starts now ...  
Bus scan successful - 1 slaves found  
  
*****  
Number : 0  
Vendor : Beckhoff (Product Management), ID 2  
Product : EL9820, Code: 0x4570862  
Revision: 0x1f4008e Serial Number: 0  
ESC Type: Beckhoff ET1100 (0x11) Revision=0 Build=2  
Bus AutoInc Address: 0 (0x0)  
Bus Station Address: 1001 (0x3e9)  
Bus Alias Address : 4103 (0x1007)  
Config Station Address: 1001 (0x3e9)  
PD OUT Byte.Bit offset: 0.0 Size: 32 bits  
Port 0: Connected Port 1: Not_Conn. Port 2: Not_Conn. Port 3: Not_Conn.  
  
=====  
Start EtherCAT Master  
=====  
Master state changed from <UNKNOWN> to <INIT>  
Master state changed from <INIT> to <PREOP>  
Master state changed from <PREOP> to <SAFEOP>  
Master state changed from <SAFEOP> to <OP>
```

See also:

[Running EcMasterDemo](#)

4.11.7 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for Windows.

Extra include paths

```
<InstallPath>/SDK/INC/WinCE  
<InstallPath>/Examples/Common/WinCE
```

Extra source paths

```
<InstallPath>/Examples/Common/WinCE  
<InstallPath>/Sources/OsLayer/WinCE
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/WinCE
```

Extra libraries (in this order)

```
coredll.lib corelibc.lib EcMaster.lib EcMasterRasServer.lib
```

Preprocessor definitions

```
CEWIN if running on acontis EC-WinCE.
```

- Don't "Treat wchar_t as Built-in Type"

Entry Point:

```
mainWCRTStartup
```

4.12 Xenomai

The system must be setup first the same way as for EC-Master for Linux, especially installation of the atemsys module and optimized Link Layer usage preparation.

See also:

Chapter [Linux](#)

The binaries are built using the following versions:

- **armv6-vfp-eabihf:**
 - Xenomai 2.6.3, tested on Linux Kernel 3.8.13-xenomai-2.6.4
- **x64:**
 - Xenomai 3.0.2, tested on Linux Kernel 3.18.20 (Cobalt)
- **x86:**
 - Xenomai 2.6.2.1, tested on Linux Kernel 3.5.7
 - Xenomai 3.0.2, tested on Linux Kernel 3.18.20 (Cobalt) and 3.10.32-rt31 (Mercury)

4.12.1 Setting up and running EcMasterDemo

1. Prepare system

Prepare the system to run EcMasterDemo on Linux as described in chapter [Linux](#)

2. Compile EcMasterDemo

As a starting point there is the Eclipse project for EcMasterDemo for Xenomai located at Workspace/Xenomai/EcMasterDemo. Ensure OPERATING_SYSTEM, ARCH, CFLAGS, LD FLAGS, LD_LIBRARY_PATH are set accordingly (export ARCH=x86, ...) when compiling using Eclipse!

3. Run using GDB

Provide search path for Xenomai libraries and prevent GDB to stop execution on SIGXCPU:

```
$ export LD_LIBRARY_PATH=../../Bin/Xenomai/x86:/usr/xenomai/lib:.
$ gdb --args ./EcMasterDemo -intelgbe 2 1 -f eni.xml -v 3
$ [...]
$ (gdb) handle SIGXCPU nostop noprint nopass
$ (gdb) run
```

See also:

[Running EcMasterDemo](#)

4.12.2 OS compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for Xenomai.

Extra include paths

```
<InstallPath>/SDK/INC/Xenomai
<InstallPath>/Examples/Common/Xenomai
```

Extra source paths

```
<InstallPath>/Examples/Common/Xenomai
<InstallPath>/Sources/OsLayer/Xenomai
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/Xenomai
```

Extra libraries (in this order)

- Xenomai 2:

```
EcMasterRasServer EcMaster pthread dl rt native xenomai
```

- Xenomai 3:

```
EcMasterRasServer EcMaster pthread dl rt
```

xeno-config --cflags and xeno-config --ldflags of the Xenomai installation return the needed CFLAGS and LDFLAGS. If further information is needed, please refer to <http://xenomai.org/>.

4.13 Zephyr

4.13.1 Setting up and running EcMasterDemo

1. Prerequisites

- Up Squared board
- Docker

2. Clone the Zephyr repository and checkout the sha: d489765be4e57ca0d836d391dbda23284ac09e7f

```
git clone https://github.com/zephyrproject-rtos/zephyr
cd zephyr
git checkout d489765be4e57ca0d836d391dbda23284ac09e7f
```

3. Download the latest Docker container of the build environment

```
docker pull zephyrprojectrtos/zephyr-build:latest
```

4. Start the Docker Container (On Windows make sure to use absolute paths with forward slashes)

```
docker run -ti -v <ZEPHYR_REPO_PATH>:/workdir -v
          <EC_MASTER_BASE_PATH>:/Master zephyrprojectrtos/zephyr-build:latest
```

5. Inside the Container change the directory

```
/Master/Workspace/Zephyr/EcMasterDemo
```

6. Build the EcMasterDemo

```
mkdir build && cd build
cmake .. -DBOARD=up_squared -DRELEASE_MODE=Release
make install
```

7. The stripped project file can be found in

```
<EC_MASTER_BASE_PATH>/Bin/Zephyr/x64/Release/EcMasterDemo.strip
```

8. To run the demo place the stripped project file on the Up Squared board and connect to the serial console on UART 1. After booting into the Application it will prompt for command line arguments on the serial console.

See also:

Running EcMasterDemo

4.13.2 OS Compiler settings

Besides the general settings from [Compiling the EcMasterDemo](#) the following settings are necessary to build the example application for Zephyr.

Extra include paths

```
<InstallPath>/SDK/INC/Zephyr
<InstallPath>/Examples/Common/Zephyr
```

Extra source paths

```
<InstallPath>/Examples/Common/Zephyr
<InstallPath>/Sources/OsLayer/Zephyr
```

Extra library paths to the main EtherCAT components

```
<InstallPath>/SDK/LIB/Zephyr
```

4.14 FreeRTOS

4.14.1 Setting up and running EcMasterDemo on Xilinx Zynq UltraScale+ (ZCU104) and Xilinx Zynq-7000 (ZC702 Evaluation Kit)

Install Xilinx SDK 2018.2

How to create the demo applications for Xilinx Zynq

1. Create ENI file for EtherCAT configuration.

`xxd.exe` is capable of converting ENI files to a C file as array, e.g.

```
xxd.exe -i eni.xml ENI.c
```

Replace ENI.c file with generated one.

2. Create a BSP project

Based on the delivered hardware project, replace the settings file with the one from the package:

```
.. /<BSP name>/<core name>/libsrv/freertos10_xilinx_v1_1/src/FreeRTOSConfig.h
```

For the new BSP project, just use the same BSP name and core as in the package.

How to run the EC-Master demo applications on Xilinx Zynq

Via USB debugger

Load the application with *Debug Configuration* ▶ *Xilinx C/C++ application (System Debugger)* to the chosen core.

Via SD card

By creating a `BOOT.bin` file, e.g.:

```
bootgen -w on -image .. /EcMasterDemo_ZCU104_cortexa53.bif -arch zynqmp -o
→ BOOT.bin
```

Maybe adjust the boot setting switches on the board

4.14.2 Setting up and running EcMasterDemo on Ti AM64x EVM for R5 Core

Install MCU-PLUS-SDK-AM64X 08.01.00.36

Code Composer Studio 11.1 or newer

How to create the demo applications for Ti AM64x

1. Create ENI file for EtherCAT configuration.

xxd.exe is capable of converting ENI files to a C file as array, e.g.

```
xxd.exe -i eni.xml ENI.c
```

Replace ENI.c file with generated one.

2. rebuild BSP for the correct performance measurement

Change: timcu_plus_sdk_am64x_08_01_00_36sourcekernelfreertosconfigam64xr5fFreeRTOSConfig.h

```
#define configUSE_IDLE_HOOK (0)
```

or:

timcu_plus_sdk_am64x_08_01_00_36sourcekernelfreertosportableTI_ARM_CLANGARM_CR5Fport.c

```
vApplicationIdleHook() replace "wfi" with "nop"
```

How to run the EC-Master demo applications on Ti AM64x

Follow getting started guide to flash the UART loader into the internal memory.

Load the application with *Debug Configuration ▶ Code ComposerStudio - Device Debugging* and the Target Configuration to the R5F_0 core.

4.15 PC / BIOS

A real-time behavior of a PC system may be optimized by changing various BIOS settings. As there are no real standards the following, settings may or may not exist on your BIOS.

Disable

- *Legacy USB Support*
- *Hyper-Threading*
- *Intel C-STATE*
- *Intel SpeedStep*

See also:

[Adjust BIOS Settings](#) in the acontis developer center

5 Link Layer

The EtherCAT master stack currently supports a variety of different Link Layer modules, each of which contained in a single library file, which is loaded by the core library dynamically. The EtherCAT master stack shipment consist of a master core library (e.g. EcMaster.dll for Windows, libEcMaster.a for Linux) and one (or more) libraries each containing support for one specific Link Layer module. Which library actually is loaded, is depending on the Link Layer parameters at runtime.

The principle of the Link Layer selection is that the Link Layer name (Link Layer identification) is used to determine the location and name of a registration function called by the EtherCAT master and registers function pointers that allow access to the Link Layer functional entries.

The EtherCAT Link Layer will be initialized using a Link Layer specific configuration parameter set. A pointer to this parameter set is part of the master's initialization settings when calling the function `emInitMaster()`

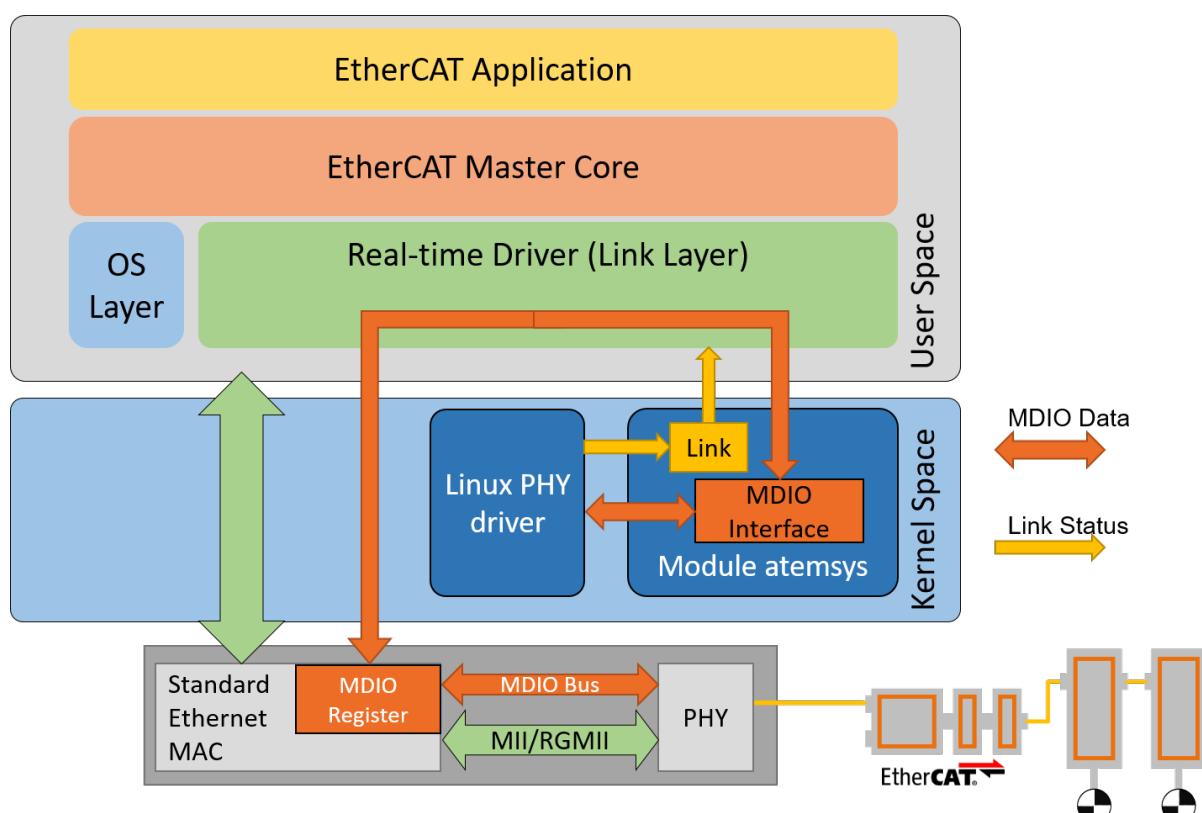
The EtherCAT master supports two Link Layer operating modes. If the Link Layer operates in interrupt mode all received Ethernet frames will be processed immediately in the context of the Link Layer receiver task. When using the polling mode the EtherCAT master will call the Link Layer receiver polling function prior to processing received frames.

Optimized Link Layer drivers

Optimized means operating directly on the network device's register set instead of using the operating system's native driver.

Optimized Link Layer drivers and PHY OS Driver

Some operating systems, e.g. Linux and Xenomai, provide drivers for most common Ethernet controllers and their related physical transceivers (PHY). The manufacturer specific PHY circuits can be handled by a dedicated driver. Using the PHY OS Driver interface it is possible to use the manufacturer's dedicated PHY driver without modification of the acontis optimized Link Layer driver. Depending on the hardware architecture, an additional module from acontis, e.g. atemsys for Linux, grants access to the MDIO bus to the OS drivers, or request MDIO operations from the OS drivers.



Note: Link Layer modules not listed here may be available if purchased additionally. Not all Link Layer modules support interrupt mode.

5.1 Link Layer initialization

The different Link Layer modules are selected and parameterized by a Link Layer specific structure. Each Link Layer specific structure start with a common `EC_T_LINK_PARMS` structure, followed by some Link Layer specific members. The common link parameter structure is passed to `EC_T_INIT_MASTER_PARMS::pLinkParms` with the call of `emInitMaster()` like in the following example:

```

/* identify Link Layer in the common struture */
oLinkParmsSockRaw.linkParms.dwSignature = EC_LINK_PARMS_SIGNATURE_SOCKRAW;
oLinkParmsSockRaw.linkParms.dwSize = sizeof(EC_T_LINK_PARMS_SOCKRAW);
OsStrncpy(&oLinkParmsSockRaw.linkParms.szDriverIdent, EC_LINK_PARMS_IDENT_SOCKRAW,
          EC_DRIVER_IDENT_MAXLEN);

/* specific Link Layer parameters should be set here */

/* pass Link Layer parameters */
oInitMasterParms.dwSignature = ATECAT_SIGNATURE;
oInitMasterParms.dwSize = sizeof(EC_T_INIT_MASTER_PARMS);
oInitMasterParms.pLinkParms = &oLinkParmsSockRaw.linkParms;

/* more parameters should be set here */

/* initialize master */
emInitMaster(dwInstanceId, &oInitMasterParms);

```

struct `EC_T_LINK_PARMS`

Public Members

`EC_T_DWORD dwSignature`

[in] Signature of the adapter specific structure containing the `EC_T_LINK_PARMS` structure

`EC_T_DWORD dwSize`

[in] Size of the adapter specific structure containing the `EC_T_LINK_PARMS` structure

`EC_T_LOG_PARMS LogParms`

[in] Logging parameters

`EC_T_CHAR szDriverIdent[EC_DRIVER_IDENT_NAMESIZE]`

[in] Name of Link Layer module (driver identification) for Link Layer Selection

`EC_T_DWORD dwInstance`

[in] Instance of the adapter. if `EC_LINKUNIT_PCILOCATION` is set: contains PCI address

`EC_T_LINKMODE eLinkMode`

[in] Mode of operation

`EC_T_CPUSET cpuIstCpuAffinityMask`

[in] Interrupt service thread CPU affinity mask

EC_T_DWORD dwIstPriority

[in] Task priority of the interrupt service task (not used in polling mode)

EC_T_DWORD dwIstStackSize

[in] Task stack size

EC_T_DWORD dwLinkSpeed

[in] 10, 100, 1000 Mbit\`s

***EC_T_LINKLAYER_TIMINGTASK* oLinkLayerTimingTask**

[in] LinkLayer timimg task parameters

EC_T_CHAR szLoadPath[EC_DRIVER_PATH_MAXLEN]

[in] path from which the libraries should be loaded

struct **EC_T_LINKLAYER_TIMINGTASK**

Public Members**EC_T_LINKLAYER_TIMING eLinkLayerTiming**

[in] LinkLayer timing task mode

EC_T_DWORD dwCycleTimeUsec

[in] Cycle time between 2 pfnStartCycle calls in us. Will be set by the master stack for the linklayer.

EC_T_LINK_STARTCYCLE_CALLBACK pfnStartCycle

[in] Callback function called cyclically according dwCycleTimeUsec

EC_T_VOID *pvStartCycleContext

[in] Context passed to each pfnStartCycle call

EC_T_DWORD dwTtsSendOffsetUsec

[in] Time between pfnStartCycle call and TTS frame transmission

EC_T_UINT64 nSystemTime

[in] System

enum **EC_T_PHYINTERFACE**

Values:

enumerator ePHY_UNDEFINED

undefined

enumerator ePHY_FIXED_LINK

No PHY access at all

enumerator ePHY_MII

MII 10 / 100 MBit

enumerator ePHY_RMII

Reduced MII, 10 / 100 MBit

enumerator **ePHY_GMII**
Gigabit MII, 10, 100, 1000 MBit

enumerator **ePHY_SGMII**
Serial (SERDES) Gigabit MII, 10, 100, 1000 MBit

enumerator **ePHY_RGMII**
Reduced Gigabit MII, 10, 100, 1000 MBit

enumerator **ePHY_OSDRIVER**
Get interface type from OS

enumerator **ePHY_RMII_50MHZ**
ePHY_RMII with 50 MHz clock mode

5.1.1 Link Layer instance selection via PCI location

For some operating systems it is possible to address the Link Layer instance using its PCI address as an alternative. To do this, EC_LINKUNIT_PCILOCATION (0x01000000) and the PCI location must be set as *EC_T_LINK_PARMS::dwInstance*.

On Linux the PCI address can be shown using e.g.:

```
$ lspci | grep Ethernet
$ 00:19.0 Ethernet controller: Intel Corporation Ethernet Connection I217-LM (rev 04)
$ 04:00.0 Ethernet controller: Intel Corporation 82574L Gigabit Network Connection
$ 05:00.0 Ethernet controller: Intel Corporation 82574L Gigabit Network Connection
```

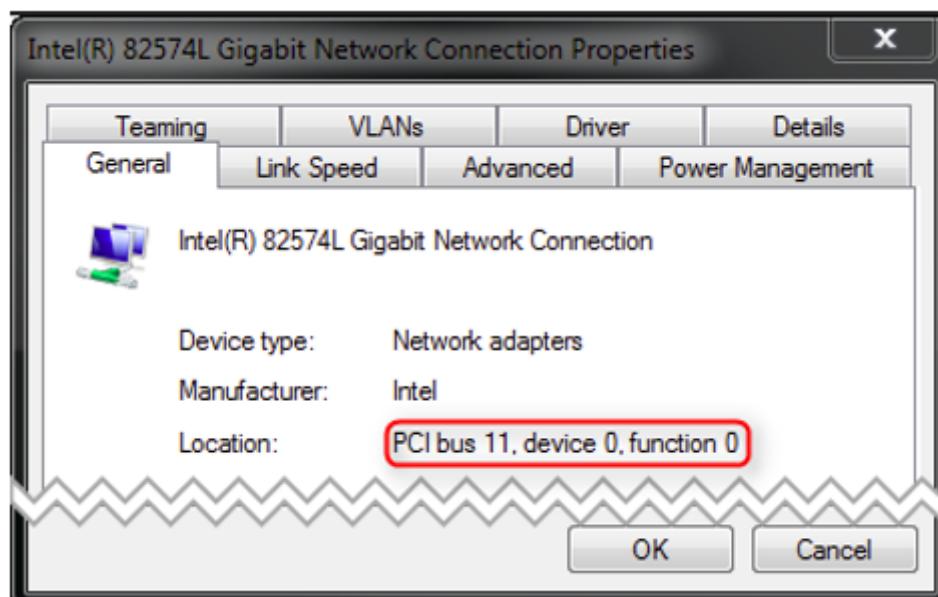
The format of *EC_T_LINK_PARMS::dwInstance* using PCI bus address is:

0x01bbddff

- *bb* Bus Number
- *dd* Device Number
- *ff* Function Number

```
EC_T_LINK_PARMS::dwInstance = 0x01001900; // "0000:00:19.0"
```

On Windows the integer value displayed in properties dialog must be converted to HEX. E.g the number from the following dialog (*PCI bus 11, device 0, function 0*) corresponds to *0x010B0000* (bus *0xB*).



5.2 Intel Pro/1000 - emIII8254x

This Link Layer is deprecated since V3.2.0.0. The parameters to the Intel Pro/1000 Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLinei8254x()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_I8254X
```

Public Members

EC_T_LINK_PARMS linkParms

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_I8254X`

EC_T_WORD wRxBufferCnt

Receive buffer count, 0: default to 96

EC_T_WORD wRxBufferSize

Receive buffer size for a single Ethernet frame. 0: buffer optimized for standard Ethernet frame.

EC_T_WORD wTxBufferCnt

Transmit buffer count, 0: default to 96

EC_T_WORD wTxBufferSize

Transmit buffer size for a single Ethernet frame. 0: buffer optimized for standard Ethernet frame.

EC_T_BOOL bDisableLocks

Disable locks

EC_T_DWORD dwAutoNegTimeout

Timeout [ms] for auto negotiation

EC_T_BOOL bNotUseDmaBuffers

Use buffers from DMA (`EC_FALSE`) or from heap for receive. AllocSend is not supported, when

EC_TRUE.

NICs equipped with 82577, 82579 or 82567 may need HardCodedPhySettings. This must be set after `emInitMaster()`, before using the NIC, e.g.:

```
dwRes = emInitMaster(&oInitParms);
if (dwRes != EC_E_NOERROR)
{
    dwRetVal = dwRes;
    LogError("ERROR EtherCAT-Master! %s (0x%08X)", emGetText(dwRes), dwRes);
    goto Exit;
}

{
    EC_T_IOCTLPARMS oIoCtlParms = {0};
    oIoCtlParms.pbyInBuf          = (EC_T_BYTE*) EC_NULL + 0x20103;
    oIoCtlParms.dwInBufSize       = sizeof(EC_T_DWORD);
    emIoControl(EC_IOCTL_LINKLAYER_MAIN + EC_LINKIOCTL_FORCELINKMODE, &
    oIoCtlParms);
    OsSleep(1000);
}
```

5.2.1 Supported PCI devices

Intel PRO-1000 PCI specific definitions (VendorId, DeviceId)

- **PCI_DEVICE_I82540EM_DESKTOP**
(0x8086, 0x100E)
- **PCI_DEVICE_I82545EM_COPPER** (0x8086, 0x100F)
- **PCI_DEVICE_I82546EB_COPPER_DUAL**
(0x8086, 0x1010)
- **PCI_DEVICE_I82541EI_COPPER** (0x8086, 0x1013)
- **PCI_DEVICE_I82547GI_COPPER** (0x8086, 0x1019)
- **PCI_DEVICE_I82545GM_COPPER**
(0x8086, 0x1026)
- **PCI_DEVICE_I82566MM** (0x8086, 0x1049)
- **PCI_DEVICE_I82566DM** (0x8086, 0x104A)
- **PCI_DEVICE_I82566MC** (0x8086, 0x104D)
- **PCI_DEVICE_N1E5132_SERVER** (0x8086, 0x105E)
- **PCI_DEVICE_I82547EI** (0x8086, 0x1075)
- **PCI_DEVICE_I82541GI_COPPER** (0x8086, 0x1076)
- **PCI_DEVICE_I82541GI_MOBILE** (0x8086, 0x1077)
- **PCI_DEVICE_I82541ER** (0x8086, 0x1078)
- **PCI_DEVICE_I82546GB_COPPER_DUAL**
(0x8086, 0x1079)
- **PCI_DEVICE_I82541PI_DESKTOP** (0x8086, 0x107C)
- **PCI_DEVICE_I82572EI** (0x8086, 0x107D)
- **PCI_DEVICE_I82573E** (0x8086, 0x108B)
- **PCI_DEVICE_I82573** (0x8086, 0x108C)
- **PCI_DEVICE_I82573L** (0x8086, 0x109A)
- **PCI_DEVICE_I82571GB_QUAD** (0x8086, 0x10A4)
- **PCI_DEVICE_I82575_ZOAR** (0x8086, 0x10A7)
- **PCI_DEVICE_I82572GI** (0x8086, 0x10B9)
- **PCI_DEVICE_I82571GB_QUAD_2** (0x8086, 0x10BC)
- **PCI_DEVICE_I82566L** (0x8086, 0x10BD)
- **PCI_DEVICE_I82576** (0x8086, 0x10C9)
- **PCI_DEVICE_I82567V** (0x8086, 0x10CE)
- **PCI_DEVICE_I82574L** (0x8086, 0x10D3)
- **PCI_DEVICE_I82567LM3** (0x8086, 0x10DE)
- **PCI_DEVICE_I82577LM** (0x8086, 0x10EA)
- **PCI_DEVICE_I82577LC** (0x8086, 0x10EB)
- **PCI_DEVICE_I82578DM** (0x8086, 0x10EF)
- **PCI_DEVICE_I82578DC** (0x8086, 0x10F0)
- **PCI_DEVICE_I82567LM** (0x8086, 0x10F5)
- **PCI_DEVICE_I82567V3** (0x8086, 0x1501)
- **PCI_DEVICE_I82579LM** (0x8086, 0x1502)
- **PCI_DEVICE_I82579V** (0x8086, 0x1503)
- **PCI_DEVICE_I82576NS** (0x8086, 0x150A)
- **PCI_DEVICE_I82583V** (0x8086, 0x150C)
- **PCI_DEVICE_I82580_QUAD** (0x8086, 0x150E)
- **PCI_DEVICE_I350** (0x8086, 0x1521)
- **PCI_DEVICE_I82576_ET2** (0x8086, 0x1526)
- **PCI_DEVICE_I82580_QUAD_FIBRE**
(0x8086, 0x1527)
- **PCI_DEVICE_I210AT** (0x8086, 0x1531)
- **PCI_DEVICE_I210AT_2** (0x8086, 0x1532)
- **PCI_DEVICE_I210_COPPER** (0x8086, 0x1533)
- **PCI_DEVICE_I210IT** (0x8086, 0x1535)
- **PCI_DEVICE_I210_SERDES** (0x8086, 0x1537)
- **PCI_DEVICE_I211AT** (0x8086, 0x1539)
- **PCI_DEVICE_I210_COPPER_FLASHLESS**

- (0x8086, 0x157B)
- **PCI_DEVICE_I210_BACKPLANE** (0x8086, 0x157C)
- **PCI_DEVICE_I217LM** (0x8086, 0x153A)
- **PCI_DEVICE_I217V** (0x8086, 0x153B)
- **PCI_DEVICE_I218LM** (0x8086, 0x155A)
- **PCI_DEVICE_I218V** (0x8086, 0x1559)
- **PCI_DEVICE_I218LM_2** (0x8086, 0x15A0)
- **PCI_DEVICE_I218V_2** (0x8086, 0x15A1)
- **PCI_DEVICE_I218LM_3** (0x8086, 0x15A2)
- **PCI_DEVICE_I218V_3** (0x8086, 0x15A3)
- **PCI_DEVICE_I219LM** (0x8086, 0x156F)
- **PCI_DEVICE_I219LM_2** (0x8086, 0x15B7)
- **PCI_DEVICE_I219LM_3** (0x8086, 0x15B9)
- **PCI_DEVICE_I219LM_4** (0x8086, 0x15D7)
- **PCI_DEVICE_I219LM_5** (0x8086, 0x15E3)
- **PCI_DEVICE_I219LM_6** (0x8086, 0x15BD)
- **PCI_DEVICE_I219LM_7** (0x8086, 0x15BB)
- **PCI_DEVICE_I219LM_8** (0x8086, 0x15DF)
- **PCI_DEVICE_I219LM_9** (0x8086, 0x15E1)
- **PCI_DEVICE_I219V** (0x8086, 0x1570)
- **PCI_DEVICE_I219V_2** (0x8086, 0x15B8)
- **PCI_DEVICE_I219V_4** (0x8086, 0x15D8)
- **PCI_DEVICE_I219V_5** (0x8086, 0x15D6)
- **PCI_DEVICE_I219V_6** (0x8086, 0x15BE)
- **PCI_DEVICE_I219V_7** (0x8086, 0x15BC)
- **PCI_DEVICE_I219V_8** (0x8086, 0x15E0)
- **PCI_DEVICE_I219V_9** (0x8086, 0x15E2)
- **PCI_DEVICE_I219LM_10** (0x8086, 0x0D4E)
- **PCI_DEVICE_I219V_10** (0x8086, 0x0D4F)
- **PCI_DEVICE_I219LM_11** (0x8086, 0x0D4C)
- **PCI_DEVICE_I219V_11** (0x8086, 0x0D4D)
- **PCI_DEVICE_I219LM_12** (0x8086, 0x0D53)
- **PCI_DEVICE_I219V_12** (0x8086, 0x0D55)
- **PCI_DEVICE_I219LM_13** (0x8086, 0x15FB)
- **PCI_DEVICE_I219V_13** (0x8086, 0x15FC)
- **PCI_DEVICE_I219LM_14** (0x8086, 0x15F9)
- **PCI_DEVICE_I219V_14** (0x8086, 0x15FA)
- **PCI_DEVICE_I219LM_15** (0x8086, 0x15F4)
- **PCI_DEVICE_I219V_15** (0x8086, 0x15F5)
- **PCI_DEVICE_I219LM_16** (0x8086, 0x1A1E)
- **PCI_DEVICE_I219V_16** (0x8086, 0x1A1F)
- **PCI_DEVICE_I219LM_17** (0x8086, 0x1A1C)
- **PCI_DEVICE_I219V_17** (0x8086, 0x1A1D)
- **PCI_DEVICE_I225LM** (0x8086, 0x15F2)
- **PCI_DEVICE_I225V** (0x8086, 0x15F3)
- **PCI_DEVICE_I225I** (0x8086, 0x15F8)
- **PCI_DEVICE_I225K** (0x8086, 0x3100)
- **PCI_DEVICE_I225K_2** (0x8086, 0x3101)
- **PCI_DEVICE_I225LMVP** (0x8086, 0x5502)
- **PCI_DEVICE_I225IT** (0x8086, 0x0D9F)
- **PCI_DEVICE_I226LM** (0x8086, 0x125B)
- **PCI_DEVICE_I226V** (0x8086, 0x125C)
- **PCI_DEVICE_I226IT** (0x8086, 0x125D)

5.3 Intel Pro/1000 - emlllIntelGbe

The parameters to the Intel Pro/1000 Link Layer are setup-specific. The function “CreateLinkParmsFromCmdLineIntelGbe” in EcSelectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_INTELGBE
```

Public Members

EC_T_LINK_PARMS **linkParms**

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_INTELGBE

EC_T_WORD wRxBufferCnt

Receive buffer count, 0: default to 96

EC_T_WORD wRxBufferSize

Receive buffer size for a single Ethernet frame. 0: buffer optimized for standard Ethernet frame.

EC_T_WORD wTxBufferCnt

Transmit buffer count, 0: default to 96

EC_T_WORD wTxBufferSize

Transmit buffer size for a single Ethernet frame. 0: buffer optimized for standard Ethernet frame.

EC_T_BOOL bDisableLocks

Disable locks

EC_T_DWORD dwAutoNegTimeout

Timeout [ms] for auto negotiation

EC_T_BOOL bNotUseDmaBuffers

EC_TRUE: copy buffer before processing (default), EC_FALSE: Use buffers from DMA

NICs equipped with 82577, 82579 or 82567 may need HardCodedPhySettings. This must be set after `emInitMaster()`, before using the NIC, e.g.:

```
dwRes = emInitMaster(&oInitParms);
if (dwRes != EC_E_NOERROR)
{
    dwRetVal = dwRes;
    LogError("ERROR EtherCAT-Master! %s (0x%x)", emGetText(dwRes), dwRes);
    goto Exit;
}
{
    EC_T_IOCTLPARMS oIoCtlParms = {0};
    oIoCtlParms.pbyInBuf      = (EC_T_BYTE*) EC_NULL + 0x20103;
    oIoCtlParms.dwInBufSize   = sizeof(EC_T_DWORD);
    emIoControl(EC_IOCTL_LINKLAYER_MAIN + EC_LINKIOCTL_FORCELINKMODE, &
    ↪oIoCtlParms);
    OsSleep(1000);
}
```

5.4 Intel Pro/100 - emIII8255x

The parameters to the Intel Pro/100 Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineI8255x()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_I8255X
```

Public Members

`EC_T_LINK_PARMS linkParms`Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_I8255X`

```
#include "EcLink.h"
EC_T_LINK_PARMS_I8255X oLinkParmsAdapter;

OsMemset(&oLinkParmsAdapter, 0, sizeof(EC_T_LINK_PARMS_I8255X));
oLinkParmsAdapter.linkParms.dwSignature = EC_LINK_PARMS_SIGNATURE_I8255X;
oLinkParmsAdapter.linkParms.dwSize     = sizeof(EC_T_LINK_PARMS_I8255X);
OsStrncpy(oLinkParmsAdapter.linkParms.szDriverIdent,
          EC_LINK_PARMS_IDENT_I8255X, MAX_DRIVER_IDENT_LEN - 1);
oLinkParmsAdapter.linkParms.dwInstance = 1;
oLinkParmsAdapter.linkParms.eLinkMode  = EcLinkMode_POLLING;
oLinkParmsAdapter.linkParms.dwIstPriority = dwIstPriority;
```

5.4.1 Supported PCI devices

Intel PRO-100 PCI specific definitions (VendorId, DeviceId)

- **PCI_DEVICE_I82801DB** (0x8086, 0x103a)
- **PCI_DEVICE_I8255X** (0x8086, 0x1229)
- **PCI_DEVICE_I8255X_ER** (0x8086, 0x1209)
- **PCI_DEVICE_I8255X_VE** (0x8086, 0x1050)
- **PCI_DEVICE_I82562_VM** (0x8086, 0x1039)
- **PCI_DEVICE_I82559_ER** (0x8086, 0x2449)
- **PCI_DEVICE_I8255X_VE2** (0x8086, 0x27DC)
- **PCI_DEVICE_I82551_QM** (0x8086, 0x1059)
- **PCI_DEVICE_I8255X_VE3** (0x8086, 0x1092)

5.5 Broadcom BcmGenet - emlIBcmGenet

The parameters to the BcmGenet Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineBcmGenet()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_BCMGENET
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_BCMGENET`

`EC_T_BCMGENET_TYPE eSocType`

Broadcomm processor type

`EC_T_BOOL bNotUseDmaBuffers`

`EC_TRUE`: copy buffer before processing (default), `EC_FALSE`: Use buffers from DMA

enum `EC_T_BCMGENET_TYPE`

Values:

enumerator `eBCMGENET_BCM2711`

MAC on BCM2711 SoC

5.6 Broadcom BcmNetXtreme - emlIBcmNetXtreme

The parameters to the BcmNetXtreme Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineBcmNetXtreme()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_BCMNETXTREME
```

Public Members***EC_T_LINK_PARMS* linkParms**

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_BCMNETXTREME

***EC_T_DWORD* dwRxBuffers**

Receive buffer count. Must be a power of 2, maximum 1024

***EC_T_DWORD* dwTxBuffers**

Transmit buffer count. Must be a power of 2, maximum 1024

5.7 Beckhoff CCAT - emIICCAT

The parameters to the CCAT Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineCCAT()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance. Because the link status cannot be read quickly from a register of the adapter, it will not be automatically refreshed like by the other Link Layers.

```
struct EC_T_LINK_PARMS_CCAT
```

Public Members***EC_T_LINK_PARMS* linkParms**

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_CCAT

***EC_T_CCAT_TYPE* eCcatType**

CCAT connection type

***EC_T_UINT64* qwCcatBase**

Physical address of register block, only for eCCAT_EIM

***EC_T_DWORD* dwCcatSize**

Size of register block, only for eCCAT_EIM

***EC_T_DWORD* dwRxBufferCnt**

Receive buffer count, only for eCCAT_EIM

***EC_T_DWORD* dwTxBufferCnt**

Transmit buffer count, only for eCCAT_EIM

```
enum EC_T_CCAT_TYPE
```

Values:

enumerator *eCCAT_PCI*

CCAT connected to PCI bus

enumerator *eCCAT_EIM*

CCAT connected via EIM. Used in ARM systems, no DMA

5.7.1 Supported PCI devices

Beckhoff CCAT PCI specific definitions (VendorId, DeviceId)

- **PCI_DEVICE_CCAT** (0x15EC, 0x2600)

5.8 CMSIS-RTOS STM32Eth - emlICmsisEth

The parameters to the STM32Eth Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineStm32Eth()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_STM32ETH
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_STM32ETH`

`EC_T_DWORD dwRxBuffersCnt`

Receive buffer count

`EC_T_DWORD dwRxBufferLen`

Receive buffer size for a single Ethernet frame.

`EC_T_DWORD dwTxBuffersCnt`

Transmit buffer count

5.9 Texas Instruments CPSW - emlICPSW

The parameters to the CPSW Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineCPSW()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_CPSW
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_CPSW`

`EC_T_CPSW_TYPE eCpswType`

CPSW type

`EC_T_DWORD dwPhyAddr`

PHY address

`EC_T_DWORD dwPortPrio`

0 (lowest), 1 (highest)

`EC_T_BOOL bMaster`

`EC_TRUE`: Initialize MAC

EC_T_BOOL bPhyRestartAutoNegotiation
EC_TRUE: Restart auto negotiation on initialization

EC_T_PHYINTERFACE ePhyInterface
PHY connection type

EC_T_DWORD dwRxInterrupt
Receive interrupt number (IRQ)

EC_T_BOOL bNotUseDmaBuffers
Use buffers from DMA (EC_FALSE) or from heap for receive. AllocSend is not supported, when EC_TRUE

enum **EC_T_CPSW_TYPE**
Values:

enumerator **eCPSW_AM33XX**
TI AM33xx (e.g. Beaglebone)

enumerator **eCPSW_AM387X**
TI DM814x/AM387x (e.g. Mistral/TI 814X/387X BASE EVM)

enumerator **eCPSW_AM437X**
TI AM437x

enumerator **eCPSW_AM57X**
TI AM57x

5.9.1 CPSW usage under Linux

Due to lacking unbind-feature of the CPSW driver, the target's Kernel must not load the CPSW driver when starting. If the CPSW was built as a module, it can be renamed or removed to ensure, it never gets loaded. If it was compiled into the Kernel, the Kernel needs to be recompiled without it.

It is possible to use one CPSW port for Linux kernel (TCP/IP) and another CPSW port for EC-Master. To do this, the CPSW kernel driver must be patched.

Currently following Linux versions are supported:

- linux-4.1.6 from TI Linux SDK 2.0
- linux-4.4.4-rt11 from Lenze
- linux-3.10.93-rt101 from Canon

Note: A patch for other Linux versions can also be created on request.

The patch needs:

- Linux kernel with enabled CPSW driver.
- Patch applied to Linux kernel.
- EC_ETHERNET_PORT defined according to target in csw.c and davinci_mdio.c files.
- Kernel must be rebuilt and installed

After that Linux will have only 1 Ethernet device, another can be used by EC-Master.

Note: EtherCAT ports should be used as “slave” since “master” is the Linux driver.

5.10 DW3504 - emIIDW3504

The parameters to the Synopsys DesignWare 3504-0 Universal 10/100/1000 Ethernet MAC (DW3504) Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineDW3504()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_DW3504
```

Public Members

EC_T_LINK_PARMS **linkParms**

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_DW3504`

EC_T_DWORD dwPhyAddr
PHY address

EC_T_DWORD dwRegisterBasePhys
Physical base address of register block (8k)

EC_T_DW3504_TYPE eDW3504Type
System on Chip type

EC_T_PHYINTERFACE ePhyInterface
PHY connection type

EC_T_BOOL bNotUseDmaBuffers
Use buffers from DMA (`EC_FALSE`) or from heap for receive. AllocSend is not supported, when `EC_TRUE`

EC_T_DWORD dwTxDmaDesCnt
Transmit DMA descriptor buffer count. Must be a power of 2, maximum 256

EC_T_DWORD dwRxDmaDesCnt
Receive DMA descriptor buffer count. Must be a power of 2, maximum 256

EC_T_BOOL bNotUseCacheSync
Default use of CacheSync `EC_FALSE`, Don't call CacheSync on older systems `EC_TRUE`

EC_T_BOOL bUsePhyLib
Use PhyLib instead of Legacy PHY handling for `eDW3504_CycloneV`, `eDW3504_LCES1` or `eDW3504_RZN1`, for all others the PhyLib is mandatory

enum **EC_T_DW3504_TYPE**
Values:

enumerator **eDW3504_CycloneV**
MAC on Cyclone V SoC

enumerator **eDW3504_LCES1**
MAC on LCES1 SoC

enumerator **eDW3504_RZN1**
MAC on Renesas RZN1

enumerator **eDW3504_STM32MP15x**
MAC on STM32MP15x

enumerator **eDW3504_ATOM**
MAC on Atom 6000

enumerator **eDW3504_STM32MP13x**
MAC on STM32MP13x

enumerator **eDW3504_RK3328**
MAC on Rockchip 3328 Rock64

enumerator **eDW3504_RK3399**
MAC on Rockchip 3399 Orange Pi 4

enumerator **eDW3504_RK3588S**
MAC on Rockchip 3588s Orange Pi 5

enumerator **eDW3504_RK3568**
MAC on Rockchip 3568 Radxa Rock3 a

5.10.1 Supported PCI devices

Synopsis DW3504 PCI specific definitions (VendorId, DeviceId)

- **PCI_DEVICE_INTEL_ELKHART_LAKE_RGMII_1**
(0x8086, 0x4BA1)
PCI_DEVICE_INTEL_ELKHART_LAKE_RGMII_3
(0x8086, 0x4BB0)
- **PCI_DEVICE_INTEL_ELKHART_LAKE_RGMII_2**
(0x8086, 0x4BA0)
PCI_DEVICE_INTEL_ELKHART_LAKE_SGMII_4
(0x8086, 0x4B30)
- **PCI_DEVICE_INTEL_ELKHART_LAKE_SGMII_1**
(0x8086, 0x4B32)
PCI_DEVICE_INTEL_ELKHART_LAKE_SGMII_5
(0x8086, 0x4BA2)
- **PCI_DEVICE_INTEL_ELKHART_LAKE_SGMII_2**
(0x8086, 0x4BB1)
PCI_DEVICE_INTEL_ELKHART_LAKE_SGMII_6
(0x8086, 0x4BB2)
- **PCI_DEVICE_INTEL_ELKHART_LAKE_SGMII_3**

5.11 Freescale TSEC / eTSEC - emIETSEC

The parameters to the ETSEC Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineETSEC()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_ETSEC
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_ETSEC`

`EC_T_DWORD dwRegisterBase`

Physical base address of register block (4k)

`EC_T_DWORD dwLocalMdioBase`

Physical base address of local MDIO register block (4k). For the eTSEC V1 or TSEC this is the same as `dwRegisterBase`, for the eTSEC V2 it's not.

`EC_T_DWORD dwPhyMdioBase`

Physical base address of MDIO register block (4k). This is the MDIO base of the (e)TSEC where the PHY (MII bus) is physically connected to (MII interface is shared by (e)TSEC's).

`EC_T_DWORD dwPhyAddr`

PHY address on MII bus. `ETSEC_FIXED_LINK` if fixed link configuration

`EC_T_DWORD dwTbiPhyAddr`

Address of internal TBI PHY. Any address from [0..31] can be used here, but the address shouldn't collide with any external PHY connected to the external MII bus

`EC_T_DWORD dwFixedLinkVal`

Only evaluated if `dwPhyAddr == FIXED_LINK`. Set to one of the `ETSEC_LINKFLAG_*` macros. I.e. `ETSEC_LINKFLAG_1000baseT_Full`

`EC_T_BYT& abyStationAddress[6]`

MAC address

`EC_T_VOID *oMiiBusMtx`

This mutex protect the access to the (shared) MII bus. Set to 0 if mutex shouldn't be used. The MII bus is shared between eTSEC instances. So this mutex should be created once and assigned here for all Linklayer instances

`EC_T_DWORD dwRxInterrupt`

Receive interrupt number (IRQ)

`EC_T_BOOL bNotUseDmaBuffers`

`EC_TRUE`: copy buffer before processing, `EC_FALSE`: Use buffers from DMA (default)

`EC_T_ETSEC_TYPE eETSECType`

System on Chip type

`EC_T_BOOL bMaster`

Full control over the MAC and need to initialize MAC and the connections to the PHYs

enum **EC_T_ETSEC_TYPE**

Values:

enumerator **eETSEC_P2020RDB**

MAC on Freescale P2020

enumerator **eETSEC_TWRP1025**

MAC on Freescale TWRP1025

enumerator **eETSEC_ISTMPC8548**

MAC on Freescale ISTMPC8548

enumerator **eETSEC_XJ_EPU20C**

MAC on Freescale XJ EPU20C

enumerator **eETSEC_TWRLS1021A**

MAC on Freescale TWRLS1021A

enumerator **eETSEC_TQMLS_LS102XA**

MAC on Freescale TQMLS LS102XA

5.11.1 ETSEC supported MAC's

- TSEC (not tested): Legacy hardware. Should be supported, because eTSEC is compatible to TSEC if the enhanced functionality is not used.
- eTSEC v1 (tested): This chip is used for QorIQ (i.e. P2020E) and PowerQUICC devices (i.e. MPC8548). It has 4k of IO memory.
- eETSEC v2, also called vETSEC, v read as “virtualization” (tested): This chip is used for newer QorIQ devices (i.e. P1020). It has 12k of IO memory (4k MDIO, 4k Register group0, 4k Register group1)

5.11.2 Shared MII bus

The driver will access the Ethernet PHY for the following reasons:

- Check for link (or timeout), if the driver instance is opened.
- Configure MAC according to the auto-negotiated PHY speed (mandatory).
- Check link (and reconfigure MAC) during cyclic run. Therefore `EC_LINKIOCTL_UPDATE_LINKSTATUS` should not be called explicitly in parallel!

Note: The external PHYs are connected physically to the MII bus of the first eTSEC (and/or eTSEC3, depending on SoC type). From SoC reference manuals: “14.5.3.6.6 MII Management Configuration Register (MIIMCFG) ... Note that MII management hardware is shared by all eTSECs. Thus, only through the MIIM registers of eTSEC1 can external PHYs be accessed and configured.”

That means that the acontis TSEC / eTSEC driver will also mmap the register set of the corresponding eTSEC. The following initialization parameters are used to specify the MII settings:

1. Memory map of eTSEC which will manage the MII bus (connection of external PHY's):

```
poDrvSpecificParam->dwPhyMdioBase = dwCcsrbar + 0x24000;
```

1. Dummy address assigned to internal TBI PHY. Use any address (from 0 .. 31) which will not collide with any of the physical PHY's addresses:

```
poDrvSpecificParam->dwTbiPhyAddr = 16;
```

5.11.3 Locking

The optional lock is acquired each time the MDIO register (specified by poDrvSpecificParam->dwPhyMdioBase) are accessed:

```
poDrvSpecificParam->oMiiBusMtx = EC_NULL;

/* implement locking by using return value of LinkOsCreateLock(eLockType_DEFAULT);
 * */


```

5.11.4 Link check

The driver's API function EcLinkGetStatus (pfEcLinkGetStatus) is called by the cyclic thread of the EtherCAT master stack. On eTSEC the link status can't be obtained directly by reading eTSEC registers without access to the MII bus (Use mutex, poll for completion). Accessing the bus would violate timing constraints and is therefore not possible.

The following IOCTL updates the link status and accesses the PHY. The IOCTL is blocking and may therefore be not called from the JobTask's context. I.e. use:

```
dwRes = emIoControl(( EC_IOCTL_LINKLAYER | EC_LINKIOCTL_UPDATE_LINKSTATUS), EC_
    →NULL);
```

EcLinkGetStatus always returns the last known link status.

5.11.5 Fixed Link

PHY access can be effectively disable at all to avoid concurrent access if link speed and mode as define to be fixed. This functionality is mainly provided for L2-Switch-IC's like Vertesse VSC7385 which haven't any PHY and are attached to the eTSEC MAC with fixed speed and mode.

The driver's open function will not wait until the link is up on EC-Master start up. Auto-negotiation of following PHY's are not affected by this parameter and still active. There is no forced link and no PHY access at all.

Parameters for fixed link:

```
pETSECParam->dwPhyAddr      = ETSEC_FIXED_LINK;
pETSECParam->dwFixedLinkVal = ETSEC_LINKFLAG_1000baseT_Full | ETSEC_LINKFLAG_
    →LINKOK;
```

5.12 Freescale FslFec - emlIFslFec

The parameters to the FslFec Link Layer are setup-specific. The function CreateLinkParmsFromCmdLineF-slfec() in EcSelectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_FSLFEC
```

Public Members***EC_T_LINK_PARMS* linkParms**

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_FSLFEC

EC_T_DWORD dwRxBuffers

Receive buffer count

EC_T_DWORD dwTxBuffers

Transmit buffer count

***EC_T_FEC_TYPE* eFecType**

System on Chip type

***EC_T_PHYINTERFACE* ePhyInterface**

PHY interface type

EC_T_BOOL bUseDmaBuffers

Use buffers from DMA (EC_TRUE) or from heap for receive and AllocSend not supported (EC_FALSE)

EC_T_DWORD dwPhyAddr

PHY Address

EC_T_BOOL bNoPinMuxing

No clock configuration and pin muxing

EC_T_BOOL bDontReadMacAddr

Read of MAC address disabled

EC_T_DWORD dwRxInterrupt

Receive interrupt number (IRQ)

enum EC_T_FEC_TYPE

Values:

enumerator eFEC_IMX25

MAC on Freescale i.MX25 (ARM9; ARMv5)

enumerator eFEC_IMX28

MAC on Freescale i.MX28 (ARM9; ARMv5)

enumerator eFEC_IMX53

MAC on Freescale i.MX53 (ARM Cortex-A8; ARMv7-a)

enumerator eFEC_IMX6

MAC on Freescale i.MX6 (ARM Cortex-A9 Single/Dual/Quad; ARMv7-a)

enumerator eFEC_VF6

MAC on Freescale VYBRID VF6xx (ARM Cortex-A5 + Cortex-M4)

enumerator eFEC_IMX7

MAC on Freescale i.MX7 (ARM Cortex-A9 Single/Dual/Quad; ARMv7-a)

enumerator eFEC_IMX8

MAC on Freescale i.MX8 (ARM Cortex-A72/A53 Single/Dual/Quad; ARMv8-a)

enumerator **eFEC_IMX8M**

MAC on Freescale i.MX8M (ARM Cortex-A53 Single/Dual/Quad; ARMv8-a)

enumerator **eFEC_IMXRT1064**

MAC on NXP i.MX RT 1064 (ARM Cortex-M7)

enumerator **eFEC_IMX9**

MAC on NXP i.MX93 (ARM Cortex-A55/M33 Single/Dual)

5.13 Xilinx Zynq-7000/Ultrascale (GEM) - emIIGEM

The parameters to the GEM Link Layer are setup-specific. The function CreateLinkParmsFromCmdLineGEM() in EcSelectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_GEM
```

Public Members

EC_T_LINK_PARMS linkParms

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_GEM

EC_T_GEM_RXSOURCE eRxSource

Source of RX clock, control and data signals

EC_T_DWORD dwPhyAddr

PHY address

EC_T_DWORD dwRxInterrupt

Receive interrupt number (IRQ)

EC_T_BOOL bUseDmaBuffers

Use buffers from DMA (EC_TRUE) or from heap for receive. AllocSend is not supported, when EC_FALSE.

EC_T_BOOL bNoPhyAccess

EC_FALSE: Link layer should initialize PHY and read link status (connected/disconnected). EC_TRUE: Client is responsible of PHY initialization and clock initialization

EC_T_BOOL bUseGmiiToRgmiiConv

Use XILINX GMIITORGMII Converter (EC_TRUE)

EC_T_DWORD dwConvPhyAddr

PHY address used to communicate with converter. In Linux doc it named “reg”

EC_T_DWORD dwTxDmaDesCnt

Transmit DMA descriptor buffer count. Must be a power of 2, maximum 256

EC_T_DWORD dwRxDmaDesCnt

Receive DMA descriptor buffer count. Must be a power of 2, maximum 256

EC_T_GEM_TYPE eGemType

System on Chip type

EC_T_PHYINTERFACE ePhyInterface

PHY connection type

EC_T_BOOL bNoPinMuxing

No clock configuration and pin muxing

EC_T_GEM_CLK_DIV_TYPE eClkDivType

Change Ref Clock settings

EC_T_BOOL bNotUseCacheSync

Default use of CacheSync EC_FALSE, Don't call CacheSync on older systems EC_TRUE

enum *EC_T_GEM_RXSOURCE*

Values:

enumerator *eGemRxSource_MIO*

MIO as source for RX clock, control and data signals

enumerator *eGemRxSource_EMIO*

EMIO as source for RX clock, control and data signals

enum *EC_T_GEM_TYPE*

Values:

enumerator *eGemType_Zynq7000*

Xilinx Zynq 7000

enumerator *eGemType_ZynqUltrascale*

Xilinx Zynq Ultrascale

5.14 Texas Instruments ICSS - emIIICSS

The parameters to the ICSS Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLine-ICSS()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

struct *EC_T_LINK_PARMS_ICSS*

Public Members

EC_T_LINK_PARMS linkParms

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_ICSS`

EC_T_LINK_ICSS_BOARD eBoardType

TI System on Chip board type

EC_T_BOOL bMaster

Initialize whole PRUSS subsystem, not only port. This flag is always required when link layer is used on single ICSS port. This flag is also required, when link layer is used in “Redundancy mode” und two ICSS ports are used. In this case, first port should be master, and second port should be slave

EC_T_BOOL bNoMacAddr

EC_TRUE: No MAC address registers access

EC_T_DWORD dwPhyAddr
PHY address

EC_T_PHYINTERFACE ePhyInterface
PHY connection type

EC_T_BOOL bNoPhyReset
No hardware reset of the PHY

EC_T_BOOL bUseAllSendQueues
Use the additional 3 queues with lower priority to send more frames per cycle

EC_T_BOOL bLegacyFirmware
For am57xx use legacy ICSS firmware from pdk_am57xx_1_0_6, instead of pdk_am57xx_1_0_17 with patch for Rx error issue, see https://e2e.ti.com/support/processors-group/processors/f/processors-forum/1022410/am5746-rx_error_offset-conditions/3788558#3788558

enum **EC_T_LINK_ICSS_BOARD**
Values:

enumerator **EcLinkIcssBoard_Unsupported**

enumerator **EcLinkIcssBoard_am572x**
TI AM572x

enumerator **EcLinkIcssBoard_am571x**
TI AM571x

enumerator **EcLinkIcssBoard_am3359**
TI AM3359

enumerator **EcLinkIcssBoard_am572x_emerson**
TI AM572x on Emerson board

enumerator **EcLinkIcssBoard_am574x**
TI AM574x

5.14.1 TTS Feature

PRU ICSS Link Layer can optionally use Time-Triggered Send feature http://processors.wiki.ti.com/index.php/ICSS_EMAC_LLD_developers_guide#Time_Triggered_Send

To test it, you need to build a demo application with INCLUDE_TTS macro. Additionally, you need to set bTts flag and configure other tts parameters in **EC_T_LINK_PARMS_ICSS** structure. Please note, we have already TTS Demo applications for some of the operating systems (for ex. Linux and TI RTOS).

dwTtsSendTimeUsec time is determined experimentally. It depends to how long your own real project prepares cyclic and acyclic frames to be sent in the current cycle.

Main purpose of the TTS feature is to reduce jitter to 40 ns (nanoseconds). To measure jitter accurately you need to have special software and hardware. For example:

- Old version of Wire Shark, ex. 1.8.4
- Dissect plugin for Wire Shark (this plugin is available only for this version of WireShark)
- ET2000 device to insert accurate timestamps with nanoseconds resolution.

Details can be found here: <https://infosys.beckhoff.com/index.php?content=..../content/1031/et2000/1309654283.html&id=>

5.14.2 TI AM335x ICEV2

After the two 100 MBit ports have been deactivated, there are no longer any Ethernet ports that can be used for TCP/IP. The board cannot work in mixed mode, i.e. there is no CPSW+ICSS support. It is also necessary to configure the board to start in ICSS rather than CPSW mode. Set both jumpers on the board to ICSS mode.

See also:

http://processors.wiki.ti.com/index.php/AM335x_Industrial_Communication_Engine_EVM_Rev2_1_HW_User_Guide

5.14.3 TI AM57xx IDK

After the four 100 MBit ports of the ICSS have been deactivated, the other two 1 GBit ports (CPSW) remain active and can be used for other purposes (e.g. TCP / IP).

5.14.4 AM5728 IDK and AM5718 IDK boards and Technical Limitations

The main difference between these two boards is number of available ICSS ports. AM5728 IDK supports only two 100 Mbit ports: port 3 and 4. It is a technical limitation of this board. On AM5718 IDK all four 100 Mbit ports are available for EtherCAT purposes.

Another limitation: PRUICSS link layer can use maximum 2 ports together (in redundancy mode) and these two ports should correspond to the same PRUSS. I.e. Port 3 and 4 OR Port 1 and 2, but not Port 1 and 4, Port 1 and 3 and etc. This technical limitation exists, because PRU firmware for PRU0 and PRU1 uses the same memory areas of OCMC Memory. In future, this limitation can be removed.

5.15 Texas Instruments ICSSG - emIIICSSG on AM654x

The parameters to the ICSSG Link Layer are setup-specific. The function `CreateLinkParmsFromCommandLine-ICSSG()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_ICSSG
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_ICSSG`

`EC_T_LINK_ICSSG_BOARD eBoardType`

TI System on Chip board type

`EC_T_BOOL bMaster`

Initialize whole PRUSS subsystem, not only port. This flag is always required when link layer is used on single ICSSG port. This flag is also required, when link layer is used in “Redundancy mode” and two ICSSG ports are used. In this case, first port should be master, and second port should be slave

enum `EC_T_LINK_ICSSG_BOARD`

Values:

```
enumerator EcLinkIcssgBoard_Unsupported
enumerator EcLinkIcssgBoard_am654x
    TI AM654x
```

5.15.1 TI AM654x IDK

Support for ICSSG on AM654x is currently limited to TI AM654x IDK/EVK with TI RTOS/Sysbios in polling mode.

5.16 Microchip LAN743x - emllan743x

The parameters to the LAN743x Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineLAN743x()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_LAN743X
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_LAN743X`

`EC_T_BOOL bNotUseDmaBuffers`

`EC_TRUE`: copy buffer before processing, `EC_FALSE`: Use buffers from DMA (default)

`EC_T_DWORD dwRxBuffers`

Receive buffer count. Must be a power of 2, maximum 1024

`EC_T_DWORD dwTxBuffers`

Transmit buffer count. Must be a power of 2, maximum 1024

5.16.1 Supported PCI devices

Microchip LAN743x PCI specific definitions (VendorId, DeviceId)

- `PCI_DEVICE_LAN743X` (0x1055, 0x7430)

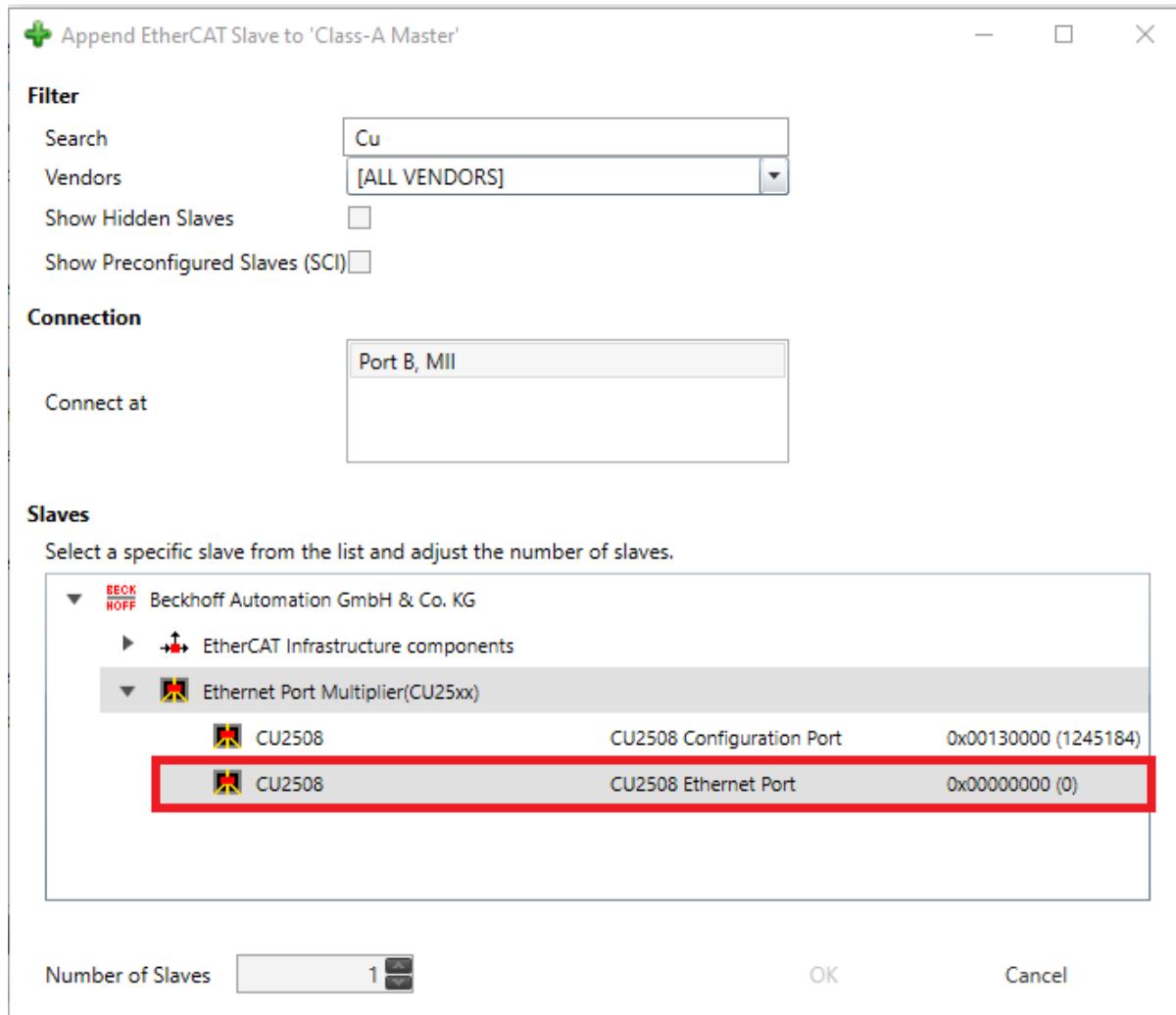
5.17 Beckhoff CUxxxx Multiplier - emlMultiplier

The parameters to the Multiplier Link Layer are setup-specific. The function “`CreateLinkParmsFromCmdLineMultiplier`” in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

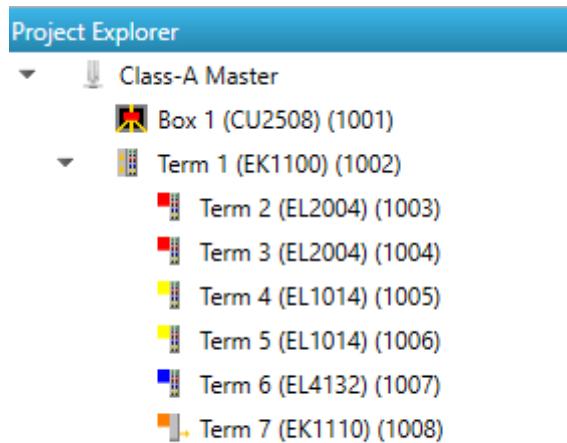
5.17.1 Configuration with EC-Engineer

This configuration is valid for one downlink port. For each used CUxxxx multiplier downlink port, a new configuration should be arranged.

- Start EC-Engineer in Offline Configuration modus.
- Add the CU2508 Ethernet Port as your first slave.



- Append the slaves that you are going to connect to the port.



```
struct EC_T_LINK_PARMS_MULTIPLIER
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_MULTIPLIER

`EC_T_MULTIPLIER_TYPE eMultiplierType`

Type of the Multiplier Ethernet port

`EC_T_DWORD dwPort`

Used CU2508 downlink port

`EC_T_LINK_PARMS *pHwLinkParms`

Link parameters of network adapter connected to the uplink of the Multiplier

enum **`EC_T_MULTIPLIER_TYPE`**

Values:

enumerator **`eMultiplier_Cu2508`**

Beckhoff CU2508 port multiplier

5.18 Windows NDIS - emlNdis

As default EC-Master for Windows contains emlNdis.dll to use a native Windows driver for EtherCAT.

The acontis ECAT Protocol Driver is needed to use the NDIS Link Layer and can be installed from Bin/Windows/x64/EcatNdisSetup-x86_64Bit.msi or Bin/Windows/x86/EcatNdisSetup-x86_32Bit.msi respectively depend on the Windows Operating System Type of 64 Bit or 32 Bit.

IPv4 must be installed for the network adapter as the NDIS Link Layer uses the IP address to identify the network adapter.

The parameters to the NDIS Link Layer are setup-specific. The function CreateLinkParmsFromCmdLnINENDIS() in EcSelectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_NDIS
```

Public Members

EC_T_LINK_PARMS linkParms

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_NDIS

EC_T_CHAR szAdapterName[EC_NDIS_ADAPTER_NAME_SIZE]

ServiceName of network adapter, see HKLM\SOFTWARE\Microsoft\Windows NT\CurrentVersion\NetworkCards in registry (zero terminated)

EC_T_BYTE abyIpAddress[4]

IP address of network adapter

EC_T_BOOL bDisablePromiscuousMode

Disable adapter promiscuous mode

EC_T_BOOL bDisableForceBroadcast

Don't change target MAC address to FF:FF:FF:FF:FF:FF

In case of problems while using the Link layer, it is advised to set the windows registry entry DontSetPromiscuousMode of the ECAT NDIS Protocol driver. This option is available since V3.1.3.02 of the driver. This can be done through the following steps:

- Install ECAT NDIS Protocol driver (V3.1.3.02 or newer version)
- Open the registry editor
- Switch to Computer\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Ecatndis, or just look for Ecatndis in the editor
- Create a new DWORD entry named DontSetPromiscuousMode
- Set the value of DontSetPromiscuousMode to 1
- Close the registry editor and restart your computer

5.19 Windows WinPcap - emIIpcap

A Link Layer based on the WinPcap library is shipped with the EtherCAT master stack. This Link Layer is implemented using a network filter driver that enables the software to send and receive raw Ethernet frames. Using this Link Layer any Windows standard network drivers can be used. The Windows network adapter card has to be assigned a unique IP address (private IP address range). This IP address is used by the EtherCAT WinPcap Link Layer driver to select the appropriate adapter.

It is recommended to use a separate network adapter to connect EtherCAT devices. If the main network adapter is used for both EtherCAT devices and the local area network there may be a main impact on the local area network operation. The network adapter card used by EtherCAT has to be set to a fixed private IP address, e.g. 192.168.x.y.

The parameters to the WinPcap Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineWinPcap()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_WINPCAP
```

Public Members

EC_T_LINK_PARMS linkParms

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_WINPCAP

EC_T_BYTE abyIpAddress[4]

IP address

EC_T_CHAR szAdapterId[MAX_LEN_WINPCAP_ADAPTER_ID]

Adapter ID, format: {XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX}

EC_T_BOOL bFilterInput

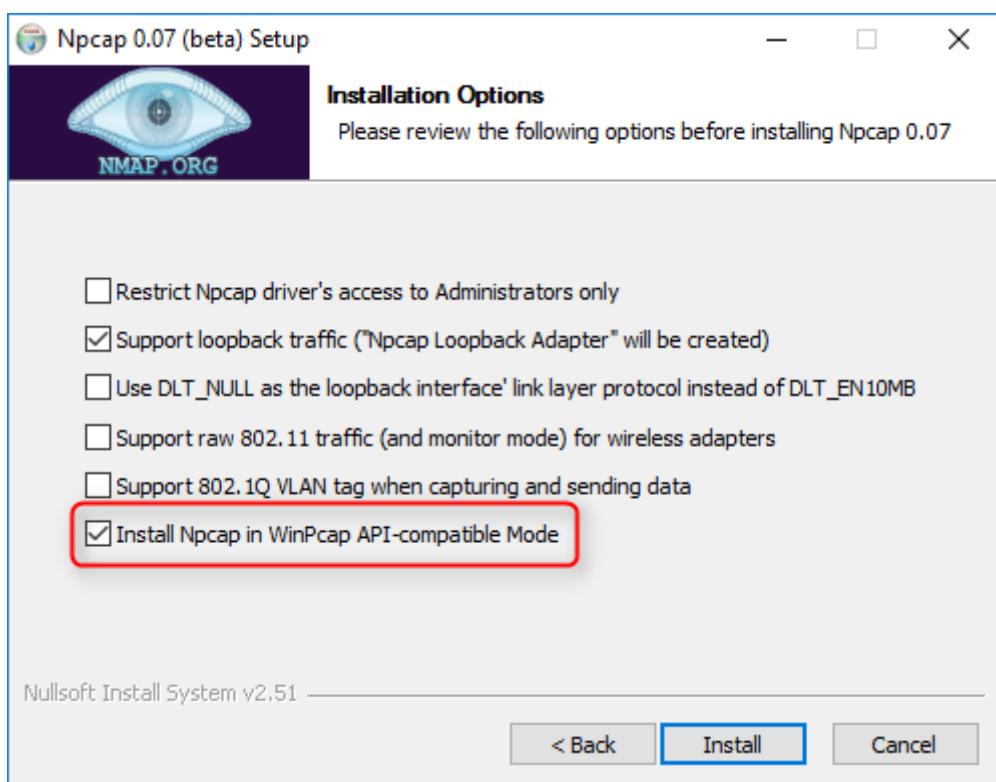
Filter input if EC_TRUE. This is needed on some system if the winpcap library notify the sent frames to the network adapter

5.19.1 WinPcap, Npcap support

At least WinPcap version 4.1.2 or Npcap 0.07 r17 must be used.

WinPcap version 4.1.2 is the preferred library. The EC-Master installer installs WinPcap by default.

If using Npcap 0.07 r17, the WinPcap API-compatible mode must be chosen:



5.20 RDC R6040 - emlIR6040

The parameters to the RDC R6040 Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineR6040()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_R6040
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_R6040`

`EC_T_DWORD dwTxDmaDesCnt`

Transmit DMA descriptor buffer count. Must be a power of 2, maximum 256

`EC_T_DWORD dwRxDmaDesCnt`

Receive DMA descriptor buffer count. Must be a power of 2, maximum 256

5.20.1 Supported PCI devices

RDC R6040 PCI specific definitions (VendorId, DeviceId)

- `PCI_DEVICE_R6040` (0x17F3, 0x6040)

5.21 Realtek RTL8169 - emlIRTL8169

The parameters to the Realtek RTL8169 Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineRTL8169()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_RTL8169
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_RTL8169`

`EC_T_BOOL bNotUseDmaBuffers`

`EC_TRUE`: copy buffer before processing, `EC_FALSE`: Use buffers from DMA (default)

`EC_T_BOOL bAckErrInIrq`

Acknowledge errors in interrupt handler

`EC_T_DWORD dwRxBuffers`

Receive buffer count. Must be a power of 2, maximum 1024

`EC_T_DWORD dwTxBuffers`

Transmit buffer count. Must be a power of 2, maximum 1024

EC_T_BOOL bNoPhyAccess

Don't use MDIO to set up the PHY

5.21.1 RTL8169 usage under Linux

Because the Linux Kernel module de-initializes the PHY on unloading, Linux must be prevented from loading the r8169 module on startup.

5.21.2 Supported PCI devices

RealTek RTL8169 PCI specific definitions (VendorId, DeviceId)

- **PCI_DEVICE_RTL8169** (0x10EC, 0x8169)
- **PCI_DEVICE_RTL8168** (0x10EC/0x19EC, 0x8168)
- **PCI_DEVICE_RTL8169_SC** (0x10EC, 0x8167)
- **PCI_DEVICE_DLINK_RTL8169** (0x1186, 0x4300)
- **PCI_DEVICE_RTL8103** (0x10EC, 0x8136)
- **PCI_DEVICE_KILLER_E2600** (0x10EC, 0x2600)
- **PCI_DEVICE_RTL8125** (0x10EC, 0x8125)
- **PCI_DEVICE_RTL8161** (0x10EC, 0x8161)

5.22 Renesas RZ/T1 - emlIRZT1

The parameters to the Renesas RZ/T1 Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineRZT1()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_RZT1
```

Public Members

`EC_T_LINK_PARMS linkParms`

Common link parameters. Signature must be set to `EC_LINK_PARMS_SIGNATURE_RZT1`

5.23 Renesas SHEth - emlISHEth

The parameters to the Renesas SuperH Ethernet Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineSHEth()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_SHETH
```

Public Members***EC_T_LINK_PARMS* *linkParms***

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_SHETH

EC_T_SHETH_TYPE* *eType

System on Chip type

EC_T_BYTE* *abyStationAddress[6]

MAC address

EC_T_DWORD* *dwBaseAddr

Physical address of register block

EC_T_BYTE* *byPhyAddr

PHY address

EC_T_BOOL* *bNotUseDmaBuffers

EC_TRUE: copy buffer before processing, EC_FALSE: Use buffers from DMA (default)

EC_T_DWORD* *dwTxDmaDesCnt

Transmit DMA descriptor buffer count. Must be a power of 2, maximum 256

EC_T_DWORD* *dwRxDmaDesCnt

Receive DMA descriptor buffer count. Must be a power of 2, maximum 256

enum ***EC_T_SHETH_TYPE***

Values:

enumerator ***eSHeth_R8A777X***

Renesas R8A777X

enumerator ***eSHeth_R8A779X***

Renesas R8A779X

enumerator ***eSHeth_SH7724***

Renesas SH7724

enumerator ***eSHeth_SH7757***

Renesas SH7757

enumerator ***eSHeth_SH7757_GIGA***

Renesas SH7757_GIGA

enumerator ***eSHeth_SH7734***

Renesas SH7734

enumerator ***eSHeth_SH7763***

Renesas SH7763

enumerator ***eSHeth_R8A7740***

Renesas R8A7740

enumerator ***eSHeth_R7S72100***

Renesas R7S72100

enumerator **eSHEth_SH7619**
Renesas SH7619

enumerator **eSHEth_SH771X**
Renesas SH771X

enumerator **eSHEth_R8A77400**
Renesas R8A77400

enumerator **eSHEth_R8A77435**
Renesas R8A77435

enumerator **eSHEth_R8A77430**
Renesas R8A77430

enumerator **eSHEth_R8A77450**
Renesas R8A77450

5.23.1 SHEth link status update

On some targets like *Armadillo A800 eva* the link status can't be obtained directly by reading MAC PHY status register without access to the MII bus. Accessing the bus would violate timing constraints and is therefore not possible.

The following IOCTL updates the link status and accesses the PHY. The IOCTL is blocking and may therefore be not called from the JobTask's context.

```
dwRes = emIoControl((EC_IOCTL_LINKLAYER | EC_LINKIOCTL_UPDATE_LINKSTATUS), EC_
    ↪NULL);
```

`ecLinkGetStatus()` always retuns the last known link status.

5.23.2 SHEth usage under Linux

Due to lacking unbind-feature of the SuperH driver, the target's Kernel must not load the SuperH driver when starting. If the SuperH was built as a module, it can be renamed to ensure, it never gets loaded. If it was compiled into the Kernel, the Kernel needs to be recompiled without it.

5.24 VxWorks SNARF - emlISNARF

Using the EtherCAT master stack's SNARF Link Layer it is possible to use any of the standard network drivers shipped with VxWorks. In VxWorks every network adapter is identified using a short string and a unit number in case of multiple identical network adapters. The unit numbers start with a value of 0. For example the string for the Intel Pro/100 network adapter driver is "fei". The first unit is identified using the string "fei0":

The network adapter driver has to be loaded prior to initialize the EtherCAT master stack.

Using the SNARF Link Layer has some disadvantages. As the VxWorks network layering is involved in this architecture, the drivers are usually not optimized for realtime behavior the needed CPU time is often too high to reach cycle times less than 300 to 500 microseconds. Additionally there is an impact if in parallel to EtherCAT traffic the VxWorks application needs to use a second network card for transferring TCP/IP data. The single tNetTask is shared by all network drivers. Using a dedicated EtherCAT driver these disadvantages can be overcome.

The parameters to the SNARF Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineSNARF()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_SNARF
```

Public Members

EC_T_LINK_PARMS linkParams

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_SNARF

EC_T_CHAR szAdapterName[EC_SNARF_ADAPTER_NAME_SIZE]

SNARF adapter name (zero terminated)

EC_T_DWORD dwRxBuffers

Receive buffer count, only used in RTP context, 0: default to 20

```
#include "EcLink.h"
EC_T_LINK_PARMS_SNARF oLinkParmsAdapter;

OsMemset(&oLinkParmsAdapter, 0, sizeof(EC_T_LINK_PARMS_SNARF));
oLinkParmsAdapter.linkParams.dwSignature = EC_LINK_PARMS_SIGNATURE_SNARF;
oLinkParmsAdapter.linkParams.dwSize      = sizeof(EC_T_LINK_PARMS_SNARF);
OsStrncpy(oLinkParmsAdapter.linkParams.szDriverIdent,
          EC_LINK_PARMS_IDENT_SNARF, MAX_DRIVER_IDENT_LEN - 1);
OsStrncpy(oLinkParmsAdapter.szAdapterName, "fei0", MAX_DRIVER_IDENT_LEN - 1);
```

5.25 Linux SockRaw - emlISockRaw

The SockRaw Link Layer is always part of the EC-Master for Linux package. It does not need the atemsys driver and uses already established Ethernet adapters, e.g. eth0, eth1, etc. It is strongly recommended to use a separate network adapter to connect EtherCAT devices. If the main network adapter is used for both EtherCAT devices and the local area network there may be a main impact on the local area network operation.

Note: The SockRaw cannot be used for real time applications and may need cycle time of 4 ms or higher. Root privileges are required.

To run the application without root privileges, set the Linux capability ‘cap_net_raw’ to the application.

```
$ sudo setcap 'cap_net_raw+pe' ./EcMasterDemo
```

To run python scripts without root privileges, create a python environment and set the Linux capability ‘cap_net_raw’ to the python interpreter.

```
$ cd Bin/Linux
$ python3 -m venv --copies PyEnv/
$ source PyEnv/bin/activate
$ sudo setcap 'cap_net_raw+pe' PyEnv/bin/python3
```

The parameters to the SockRaw Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineSockRaw()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_SOCKRAW
```

Public Members***EC_T_LINK_PARMS linkParms***

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_SOCKRAW

EC_T_CHAR szAdapterName[EC_SOCKRAW_ADAPTER_NAME_SIZE]

Native ETH device name, e.g. "eth0" (zero terminated)

EC_T_BOOL bDisableForceBroadcast

Don't change target MAC address to FF:FF:FF:FF:FF:FF

EC_T_BOOL bReplacePaddingWithNopCmd

Prevent adding Ethernet padding to work-around EtherCAT corruption bugs from native Linux driver(s).

EC_T_BOOL bUsePacketMmapRx

Use PACKET_MMAP PACKET_RX_RING for receive

EC_T_BOOL bSetCoalescingParms

Set Coalescing parameters to enhance the link layer performance

5.26 Texas Instruments ICSSG via Ti FreeRTOS Enet LLD - emll-TiEnetIcssg on AM64x

The parameters to the TiEnetIcssg Link Layer are setup-specific. The function `CreateLinkParmsFromCmdLineTiEnetIcssg()` in `EcSelectLinkLayer.cpp` demonstrates how to initialize the Link Layer instance.

```
struct EC_T_LINK_PARMS_TIENETICSSG
```

Public Members***EC_T_LINK_PARMS linkParms***

Common link parameters. Signature must be set to EC_LINK_PARMS_SIGNATURE_TIENETICSSG

EC_T_BOOL bMaster

EC_TRUE: Initialize MAC

5.26.1 TI AM64x EVM

Support for ICSSG/TiEnetIcssg on AM64x is currently limited to TI AM64x EVM with FreeRTOS in polling mode. Working with MCU Plus SDK AM64x 08.01.00.36.

6 Application programming interface, reference

Function prototypes, definitions etc. of the API can be found in the header file EcMaster.h which is the main header file to include when using EC-Master.

6.1 Generic API return status values

Most of the functions and also some notifications will return an error status value to indicate whether a function was successfully executed or not. Some of the return status values have a generic meaning unspecific to the called API function.

<code>EC_E_NOERROR</code>	The function was successfully executed
<code>EC_E_NOTSUPPORTED</code>	Unsupported feature or functionality
<code>EC_E_BUSY</code>	The master currently is busy and the function has to be re-tried at a later time
<code>EC_E_NOMEMORY</code>	Not enough memory or frame buffer resources available
<code>EC_E_INVALIDPARAM</code>	Invalid or inconsistent parameters
<code>EC_E_TIMEOUT</code>	Timeout error
<code>EC_E_SLAVE_ERROR</code>	A slave error was detected

See also:

- *emNotify - EC_NOTIFY_STATUS_SLAVE_ERROR*
- *emNotify - EC_NOTIFY_SLAVE_ERROR_STATUS_INFO*

<code>EC_E_INVALID_SLAVE</code>	The slave is not in the requested state to execute the operation (e.g. when initiating a mailbox transfer the slave must be at least in PREOP state)
<code>EC_E_SLAVE_NOT_ADDR</code>	The slave does not respond to its station address (e.g. when requesting its AL_STATUS value). The slave may be removed from the bus or powered-off
<code>EC_E_LINK_DISCONNECTED</code>	Link cable not connected.
<code>EC_E_MASTERCORE_INACCESSIBLE</code>	Mastercore inaccessible. This result code usually means a remote connected server / EtherCAT Master does not respond anymore

The `EC_E_BUSY` return status value indicates that a previously requested operation is still in progress. For example if the master is requested to enter the OPERATIONAL state the next request from the API will return this status value unless the OPERATIONAL state is entered.

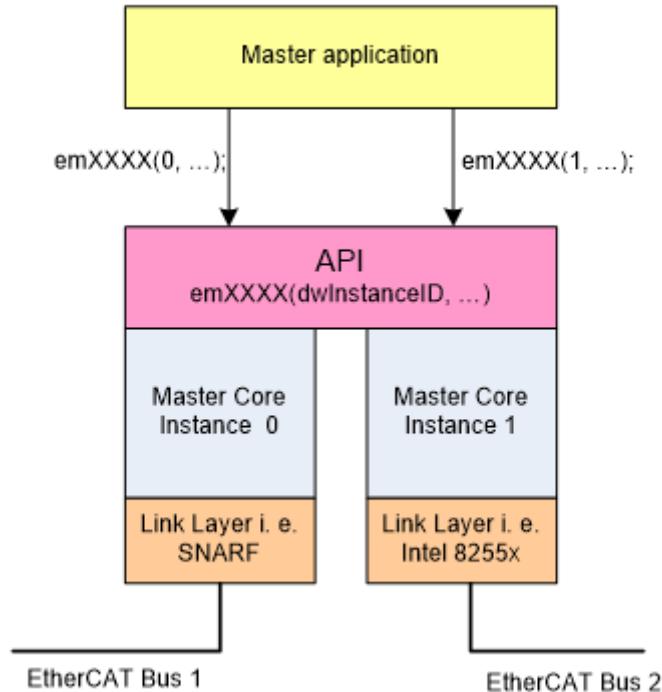
6.2 Multiple EtherCAT Bus Support

6.2.1 Licensing

Multiple EtherCAT Bus support is included within the Class B and Class A master stack. For each bus a separate runtime license is required. A single runtime allows the usage of the multi instance functions only with an instance identifier of 0.

6.2.2 Overview

The acontis EtherCAT master allows controlling more than one EtherCAT bus within one application process. For this use case the master core is instantiated several times by using the multi instance API functions inside the application. Each API function is available as a single instance version (prefix `ecat`, e.g. `ecatInitMaster()`) and a multi instance version (prefix `em`, e.g. `emInitMaster()`). The first parameter of all multi instance functions `emXXX()` is the instance identifier. The single instance functions `ecatXXX()` will use the first master core instance with the identifier 0. The maximum number of supported instances is 12 (MAX_NUMOF_MASTER_INSTANCES).



6.2.3 Example application

The application EcMasterDemoMulti demonstrates a client application which handles two master instances with the following configuration (el9800.xml):

- Master instance 0: One Beckhoff EtherCAT Evaluation Board EL9800
- Master instance 1: One Beckhoff EtherCAT Evaluation Board EL9800

Parameters for this application:

```
$ -winpcap 192.168.1.32 1 -f el9800.xml @ -winpcap 192.168.2.32 1 -f el9800.xml
```

6.3 General functions

6.3.1 emInitMaster

static EC_T_DWORD **ecatInitMaster** (*EC_T_INIT_MASTER_PARMS* *pParms)

```
EC_T_DWORD emInitMaster (
    EC_T_DWORD dwInstanceID,
    EC_T_INIT_MASTER_PARMS *pParms
)
```

Initialize EC-Master.

This function has to be called prior to calling any other function of EC-Master.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pParms** – [in] Pointer to parameter definitions

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master is already initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or pParms is EC_NULL or contains some values out of range
- *EC_E_SIGNATURE_MISMATCH* if *EC_T_INIT_MASTER_PARMS.dwSignature* mismatch
- *EC_E_NOTFOUND* if the link layer cannot be found
- *EC_E_FEATURE_DISABLED* if a configured feature is not included in the license key
- *EC_E_NOTSUPPORTED* if a configured feature is not supported (e.g not compiled in the library)
- *EC_E_LOCK_CREATE_FAILED* if some lock (e.g mutex) cannot be created
- *EC_E_NOMEMORY* if some memory cannot be allocated

struct **EC_T_INIT_MASTER_PARMS**

Public Members

EC_T_DWORD dwSignature
[in] set to ATECAT_SIGNATURE

EC_T_DWORD dwSize
[in] set to sizeof(EC_T_INIT_MASTER_PARMS)

***EC_T_LOG_PARMS* LogParms**
[in] Logging parameters

struct _EC_T_OS_PARMS *pOsParms
[in] OS layer parameters

```

struct _EC_T_LINK_PARMS *pLinkParms
[in] Link layer parameters

struct _EC_T_LINK_PARMS *pLinkParmsRed
[in] Link layer parameters for red device (cable redundancy)

EC_T_DWORD dwBusCycleTimeUsec
[in] [usec] bus cycle time in microseconds

EC_T_DWORD dwMaxBussSlaves
[in] maximum pre-allocated bus slave objects

EC_T_DWORD dwMaxAcycFramesQueued
[in] maximum queued acyclic frames

EC_T_DWORD dwAdditionalEoEEndpoints
[in] additional EoE endpoints

EC_T_DWORD dwMaxAcycBytesPerCycle
[in] maximum bytes sent during eUsrJob_SendAcycFrames per cycle

EC_T_DWORD dwMaxAcycFramesPerCycle
[in] maximum frames sent during eUsrJob_SendAcycFrames per cycle

EC_T_DWORD dwMaxAcycCmdsPerCycle
[in] maximum commands sent during eUsrJob_SendAcycFrames per cycle

EC_T_DWORD dwMaxSlavesProcessedPerCycle
[in] maximum slave-related state machine calls per cycle

EC_T_DWORD dwEcatCmdMaxRetries
[in] maximum retries to send pending ethercat command frames

EC_T_DWORD dwEcatCmdTimeout
[in] timeout to send pending ethercat command frames

EC_T_BOOL bVLANenable
[in] E=enable (1/0)

EC_T_WORD wVLANId
[in] I=VLAN Id (12Bit)

EC_T_BYTExbyVLANPrio
[in] P=Prio (3Bit)

EC_T_MASTER_RED_PARMS MasterRedParms
[in] Master Redundancy parameters

EC_T_DWORD dwMaxS2SMbxSize
[in] Size of the queued S2S mailbox in bytes

EC_T_DWORD dwMaxQueuedS2SMbxTfer
[in] S2S Fifo number of entries

```

EC_T_WORD wMaxSlavesProcessedPerBusScanStep
 [in] maximum slave-related calls per cycle during bus scans

EC_T_BOOL bApiLockByApp
 [in] lock pending API against emDeinitMaster(). EC_FALSE (default): locked internally. EC_TRUE: application is responsible for locking.

EC_T_PERF_MEAS_INTERNAL_PARMS PerfMeasInternalParms
 [in] Internal performance measurement parameters

struct **EC_T_OS_PARMS**

Public Members

EC_T_DWORD dwSignature
 [in] Set to EC_OS_PARMS_SIGNATURE

EC_T_DWORD dwSize
 [in] Set to sizeof(EC_T_OS_PARMS)

struct **_EC_T_LOG_PARMS *pLogParms**
 [in] Pointer to logging parameters

EC_PF_SYSTIME pfSystemTimeGet
 [in] Function to get host time in nanoseconds since 1st January 2000. Used as time base for DC Initialization.

EC_T_DWORD dwSupportedFeatures
 [in/out] reserved

EC_PF_QUERY_MSEC_COUNT pfSystemQueryMsecCount
 [in] Function to get system's msec count

struct **EC_T_LOG_PARMS**

Public Members

EC_T_DWORD dwLogLevel
 [in] Log level. See EC_LOG_LEVEL_...

EC_PF_LOGMSGHK pfLogMsg
 [in] Log callback function called on every message

struct **_EC_T_LOG_CONTEXT *pLogContext**
 [in] Log context to be passed to log callback

EC_LOG_LEVEL... The following log levels are defined:

EC_LOG_LEVEL_SILENT

EC_LOG_LEVEL_ANY

EC_LOG_LEVEL_CRITICAL

```
EC_LOG_LEVEL_ERROR
EC_LOG_LEVEL_WARNING
EC_LOG_LEVEL_INFO
EC_LOG_LEVEL_INFO_API
EC_LOG_LEVEL_VERBOSE
EC_LOG_LEVEL_VERBOSE_ACYC
EC_LOG_LEVEL_VERBOSE_CYC
EC_LOG_LEVEL_UNDEFINED
```

typedef EC_T_DWORD (***EC_PF_LOGMSGHK**)(struct _EC_T_LOG_CONTEXT *pContext, EC_T_DWORD dwLogMsgSeverity, const EC_T_CHAR *szFormat, ...)

Parameters

- **pContext** – [in] Context pointer. This pointer is used as parameter when the callback function is called
- **dwLogMsgSeverity** – [in] Log message severity, EC_LOG_LEVEL_...
- **szFormat** – [in] String that contains the text to be written. It can optionally contain embedded format specifiers that are replaced by the values specified in subsequent additional arguments and formatted as requested.

Returns

EC_E_NOERROR or error code

Log messages are passed from the EC-Master to the callback given at *EC_T_LOG_PARMS::pfLogMsg*. EcLogging.cpp demonstrates how messages can be handled by the application. For performance reasons the EC-Master automatically filters log messages according to *EC_T_LOG_PARMS::dwLogLevel*. E.g. messages of severity *EC_LOG_LEVEL_WARNING* are not passed to the application if *EC_T_LOG_PARMS::dwLogLevel* is set to *EC_LOG_LEVEL_ERROR*.

The application can provide customized log message handlers of type *EC_PF_LOGMSHK* if the default handler in EcLogging.cpp does not fulfill the application's needs. Note: The callback is typically called from the Job Task's context and should return as fast as possible.

struct **EC_T_PERF_MEAS_INTERNAL_PARMS**

Public Members

EC_T_BOOL bEnabled

[in] enable/disable internal performance counters.

EC_T_PERF_MEAS_COUNTER_PARMS CounterParms

[in] Timer function settings. When not provided OsMeasGetCounterTicks is used

EC_T_PERF_MEAS_HISTOGRAM_PARMS HistogramParms

[in] Histogram settings. When not provided the histogram is disabled.

struct **EC_T_PERF_MEAS_COUNTER_PARMS**

Public Members

EC_PF_PERF_MEAS_GETCOUNTERTICKS **pfGetCounterTicks**
 [in] Function returning the current counter ticks

EC_T_VOID ***pvGetCounterTicksContext**
 [in] Context passed into GetCounterTicks

EC_T_UINT64 **qwFrequency**
 [in] Frequency in Hz used by the timer in GetCounterTicks

typedef EC_T_UINT64 (***EC_PF_PERF_MEAS_GETCOUNTERTICKS**)(EC_T_VOID *pvContext)

Parameters

pvContext [in] – Context pointer

struct **EC_T_PERF_MEAS_HISTOGRAM_PARMS**

Public Members

EC_T_DWORD **dwBinCount**
 [in] amount of bins to use for the histogram.

EC_T_UINT64 **qwMinTicks**
 [in] results below qwMinTicks are stored in the first bin

EC_T_UINT64 **qwMaxTicks**
 [in] results above qwMaxTicks are stored in the last bin

6.3.2 emDeinitMaster

static EC_T_DWORD **ecatDeinitMaster** (EC_T_VOID)

EC_T_DWORD **emDeinitMaster** (EC_T_DWORD dwInstanceID)
 Deinitialize EC-Master.

Waits for pending API calls if emInitMaster() was called with *EC_T_INIT_MASTER_PARMS::bApiLockByApp* = EC_FALSE (default).

Returns

EC_E_NOERROR or error code

6.3.3 emGetMasterParms

```
static EC_T_DWORD ecatGetMasterParms (
    EC_T_INIT_MASTER_PARMS *pParms,
    EC_T_DWORD dwParmsBufSize
)
EC_T_DWORD emGetMasterParms (
    EC_T_DWORD dwInstanceID,
    EC_T_INIT_MASTER_PARMS *pParms,
    EC_T_DWORD dwParmsBufSize
)
) Get current Master initialization parameters.
```

If the given buffer is larger than the actual size of structure `EC_T_INIT_MASTER_PARMS`, the parameters of `EC_T_INIT_MASTER_PARMS.pOsParms`, `EC_T_INIT_MASTER_PARMS.pLinkParms` and `EC_T_INIT_MASTER_PARMS.pLinkParmsRed` are appended.

Parameters

- `dwInstanceID` – [in] Instance ID (Multiple EtherCAT Network Support)
- `pParms` – [out] Buffer to store Master parameters
- `dwParmsBufSize` – [in] Size of Master parameters buffer

Returns

- `EC_E_NOERROR` if successful
- `EC_E_INVALIDSTATE` if master isn't initialized
- `EC_E_INVALIDPARAM` if dwInstanceID is out of range or the output pointer is EC_NULL or dwParmsBufSize is too small

Example

```
/* Read all master init parameters, including OS, Main- and Red-Link parameters */
EC_T_BYTE abyBuffer[sizeof(EC_T_INIT_MASTER_PARMS) + sizeof(EC_T_OS_PARMS) + 512 /
    ↪ * LinkLayer parameters *];
EC_T_INIT_MASTER_PARMS* pParms = (EC_T_INIT_MASTER_PARMS*)abyBuffer;

dwRes = emGetMasterParms(dwInstanceId, pParms, sizeof(abyBuffer));
```

See also:

`emInitMaster()`

6.3.4 emSetMasterParms

static EC_T_DWORD `ecatSetMasterParms` (`EC_T_INIT_MASTER_PARMS` *`pParms`)

```
EC_T_DWORD emSetMasterParms (
    EC_T_DWORD dwInstanceId,
    EC_T_INIT_MASTER_PARMS *pParms
)
```

Change Master initialization parameters.

Currently the following parameters cannot be changed:

- `EC_T_INIT_MASTER_PARMS.pOsParms`
- `EC_T_INIT_MASTER_PARMS.pLinkParms`
- `EC_T_INIT_MASTER_PARMS.pLinkParmsRed`
- `EC_T_INIT_MASTER_PARMS.dwMaxBusSlaves`
- `EC_T_INIT_MASTER_PARMS.dwMaxAcycFramesQueued`
- `EC_T_INIT_MASTER_PARMS.dwAdditionalEoEEndpoints`
- `EC_T_INIT_MASTER_PARMS.bVLANEnable`
- `EC_T_INIT_MASTER_PARMS.wVLANId`
- `EC_T_INIT_MASTER_PARMS.byVLANPrio`

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pParams** – [in] New Master parameters

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized

See also:

emInitMaster()

6.3.5 emScanBus

static EC_T_DWORD **ecatScanBus** (EC_T_DWORD dwTimeout)

EC_T_DWORD **emScanBus** (EC_T_DWORD dwInstanceID, EC_T_DWORD dwTimeout)

Scans all connected slaves.

Scans all connected slaves connected to EC-Master. If a configuration has been loaded, a validation between the configuration and the connected slaves is done. This function should not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range
- *EC_E_LINK_DISCONNECTED* if link is disconnected
- *EC_E_TIMEOUT* if dwTimeout elapsed during the API call
- *EC_E_BUSCONFIG_MISMATCH* if the slaves found are not matching the configured ones
- *EC_E_LINE_CROSSED* if a line crossed (cabling wrong) condition has been detected
- *EC_E_REDLINEBREAK* if cable redundancy is configured and a line break condition has been detected
- *EC_E_JUNCTION_RED_LINE_BREAK* if junction redundancy is configured and a line break condition has been detected
- *EC_E_MAX_BUS_SLAVES_EXCEEDED* if the amount of slaves found exceeds *EC_T_INIT_MASTER_PARMS.dwMaxBusSlaves*
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive
- *EC_E_ADS_IS_RUNNING* if ADS server is running

See also:

- *EtherCAT Bus Scan*

6.3.6 emRescueScan

```
static EC_T_DWORD ecatRescueScan (EC_T_DWORD dwTimeout)
EC_T_DWORD emRescueScan (EC_T_DWORD dwInstanceID, EC_T_DWORD dwTimeout)
    Recovers the bus from permanent frame loss situations.
```

Scans all connected slaves. Closes and open ports on the network to rule out slaves which permanently discard frames. The Master notifies every slave port which permanently discard frames with EC_NOTIFY_FRAMELOSS_AFTER_SLAVE. Due to port opening and closing the scanning time is increased about 2 seconds per slave. The Master will not automatically re-open this port. The application can force to open the port again. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwTimeout** – [in] Timeout [ms]

Returns

EC_E_NOERROR or error code

See also:

- *emSetSlavePortState()*
- *emNotify - EC_NOTIFY_FRAMELOSS_AFTER_SLAVE*

6.3.7 emConfigureNetwork

```
static EC_T_DWORD ecatConfigureNetwork (
    EC_T_CNF_TYPE eCnfType,
    EC_T_PBYTE pbyCnfData,
    EC_T_DWORD dwCnfDataLen
)
EC_T_DWORD emConfigureNetwork (
    EC_T_DWORD dwInstanceID,
    EC_T_CNF_TYPE eCnfType,
    EC_T_PBYTE pbyCnfData,
    EC_T_DWORD dwCnfDataLen
)
```

Configure the Master.

This function must be called after the master has been initialized. Among others the EtherCAT topology defined in the given XML configuration file will be stored internally. Analyzing the network including mailbox communication can be done without specifying an ENI file using eCnfType_GenPreopENI.

Note: A client must not be registered prior to calling this function. Existing client registrations will be dropped.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **eCnfType** – [in] Type of configuration data provided
- **pbyCnfData** – [in] Filename / configuration data, or EC_NULL if eCnfType is eCnfType_GenPreopENI

- **dwCnfDataLen** – [in] Length of configuration data in byte, or zero if eCnfType is eCnfType_GenPreopENI

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized or eCnfType is eCnfType_GenPreopENI or eCnfType_GenOpENI and link is disconnected
- **EC_E_INVALIDPARAM** if dwInstanceID is out of range or pParms is EC_NULL contains some values out of range
- **EC_E_LINK_DISCONNECTED** if link is disconnected
- **EC_E_FEATURE_DISABLED** if a configured feature is not included in the license key
- **EC_E_NOTSUPPORTED** if a configured feature is not supported (e.g. not compiled in the library)
- **EC_E_CFGFILENOTFOUND** if the ENI file cannot be found
- **EC_E_WRONG_FORMAT** if some format error have been detected in the ENI
- **EC_E_OEM_SIGNATURE_MISMATCH** if the OEM signature in the ENI file doesn't match the used OEM key
- **EC_E_ENI_ENCRYPTION_WRONG_VERSION** if the ENI encryption version is not supported (e.g. the library is too old)
- **EC_E_ENI_ENCRYPTED** if the ENI is encrypted and no OEM key has been set
- **EC_E_XML_CYCCMDS_MISSING** if the ENI doesn't contain cyclic commands
- **EC_E_XML_ALSTATUS_READ_MISSING** if the ENI doesn't contain any read AL status command
- **EC_E_XML_CYCCMDS_SIZEMISMATCH** if the size of the cyclic commands in the ENI mismatch
- **EC_E_XML_INVALID_INP_OFFSET** if some input offset in the ENI are invalid
- **EC_E_XML_INVALID_OUT_OFFSET** if some output offset in the ENI are invalid
- **EC_E_XML_INVALID_CMD_WITH_RED** if the ENI contains LRW commands and cable redundancy is configured
- **EC_E_XML_PREV_PORT_MISSING** if some previous port information are missing in the ENI
- **EC_E_XML_DC_CYCCMDS_MISSING** if the DC related cyclic commands are missing in the ENI
- **EC_E_XML_AOE_NETID_INVALID** if the ENI contains some invalid NetID

enum **EC_T_CNF_TYPE**

Values:

enumerator **eCnfType_Unknown**

enumerator **eCnfType_Filename**

pbyCnfData: ENI filename to read

enumerator **eCnfType_Data**

pbyCnfData: ENI data

enumerator **eCnfType_Datadiag**
 pbyCnfData: ENI data for diagnosis

enumerator **eCnfType_GenPreopENI**
 Generate ENI based on bus-scan result to get into PREOP state

enumerator **eCnfType_GenPreopENIWithCRC**
 same as eCnfType_GenPreopENI with CRC protection

enumerator **eCnfType_GenOpENI**
 Generate ENI based on bus-scan result to get into OP state

enumerator **eCnfType_None**
 Reset configuration

enumerator **eCnfType_ConfigData**
 pbyCnfData: Binary structured configuration

enumerator **eCnfType_GenOpENINoStrings**
 Generate ENI based on bus-scan result to get into OP state , does not read strings from EEPROM

Depending on this enum pbyCnfData is interpreted differently. This function may not be called from within the JobTask's context.

6.3.8 emConfigGet

```
static EC_T_DWORD ecatConfigGet (
    EC_T_BYTEx **ppbyCnfData,
    EC_T_DWORDx *pdwCnfDataLen
)
EC_T_DWORD emConfigGet (
    EC_T_DWORD dwInstanceID,
    EC_T_BYTEx **ppbyCnfData,
    EC_T_DWORDx *pdwCnfDataLen
)
Get the master configuration.
```

This function returns the result of ENI parsing in binary format. This data can be stored at a different location (e.g. read only flash). Later on, the Master can be configured without ENI using the type EC_T_CNF_TYPE::eCnfType_ConfigData.

Note: The binary format is not version independent and the data becomes invalid, when used with a different version. The returned pointer is valid as long as the Master is initialized and no other configuration was loaded.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **ppbyCnfData** – [out] Configuration data
- **pdwCnfDataLen** – [out] Length of configuration data in byte

Returns

EC_E_NOERROR or error code

See also:

emConfigureNetwork ()

6.3.9 emConfigExtend

Warning: Before using this function, please check if the following patents has to be taken into consideration for your application and use case: **JP5212509:ADDRESS SETTING METHOD IN NETWORK SYSTEM**

```
static EC_T_DWORD ecatConfigExtend (
    EC_T_BOOL bResetConfig,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emConfigExtend (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bResetConfig,
    EC_T_DWORD dwTimeout
)
```

Extends the existing network configuration.

This function extends the existing configuration described in the ENI to allow mailbox communication with unexpected slaves. After this function was called, unexpected slaves can reach PREOP state. After the configuration was extended, disconnecting any slave will generate a bus mismatch, because all the slaves are part of the configuration. Recalling this function with bResetConfig set to EC_FALSE will extend the configuration again by any new connected unexpected slaves. The previous extension is not deleted. Calling the function with bResetConfig set to EC_TRUE, reset all the previous extensions.

Note: This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bResetConfig** – [in] EC_TRUE: Extended configuration will be removed
- **dwTimeout** – [in] Timeout [ms]

Returns

EC_E_NOERROR or error code

6.3.10 emRegisterClient

```
static EC_T_DWORD ecatRegisterClient (
    EC_PF_NOTIFY pfnNotify,
    EC_T_VOID *pCallerData,
    EC_T_REGISTERRESULTS *pRegResults
)
EC_T_DWORD emRegisterClient (
    EC_T_DWORD dwInstanceID,
    EC_PF_NOTIFY pfnNotify,
    EC_T_VOID *pCallerData,
    EC_T_REGISTERRESULTS *pRegResults
)
Registers a client on the EC-Master.
```

It must be called after configuration, otherwise the registration handle is lost. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pfnNotify** – [in] Notification callback function. This function will be called every time a state change occurs, an error occurs or a mailbox transfer terminates.
- **pCallerData** – [in] Pointer to a caller data area which will be passed to the client on every notification callback.
- **pRegResults** – [out] Registration results, a pointer to a structure of type *EC_T_REGISTERRESULTS*.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or the output pointer is EC_NULL
- *EC_E_NOMEMORY* if some memory cannot be allocated

`typedef EC_T_DWORD (*EC_PF_NOTIFY)(EC_T_DWORD dwCode, EC_T_NOTIFYPARAMS *pParms)`

Parameters

- **dwCode** – [in] Notification code.
- **pParms** – [in] Notification code depending data.

`struct EC_T_REGISTERRESULTS`

Public Members

`EC_T_DWORD dwClnId`
[out] Client ID

`EC_T_BYTE *pbyPDIn`
[out] Pointer to process data input memory

`EC_T_DWORD dwPDIInSize`
[out] Size of process data input memory (in bytes)

`EC_T_BYTE *pbyPDOOut`
[out] Pointer to process data output memory

`EC_T_DWORD dwPDOOutSize`
[out] Size of process data output memory (in bytes)

6.3.11 emUnregisterClient

```
static EC_T_DWORD ecatUnregisterClient (EC_T_DWORD dwClntId)
EC_T_DWORD emUnregisterClient (EC_T_DWORD dwInstanceID, EC_T_DWORD dwClntId)
    Unregister a client from the EtherCAT master.
```

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClntId** – [in] Client ID determined when registering with the master.

Returns

EC_E_NOERROR or error code

6.3.12 emGetSrcMacAddress

```
static EC_T_DWORD ecatGetSrcMacAddress (ETHERNET_ADDRESS *pMacSrc)
```

```
EC_T_DWORD emGetSrcMacAddress (
    EC_T_DWORD dwInstanceID,
    ETHERNET_ADDRESS *pMacSrc
)
```

) Gets the source MAC address.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMacSrc** – [out] 6-byte buffer to write source MAC address to.

Returns

EC_E_NOERROR or error code

See also:

EC_T_INIT_MASTER_PARMS::*pLinkParms*

6.3.13 emSetMasterState

```
static EC_T_DWORD ecatSetMasterState (EC_T_DWORD dwTimeout, EC_T_STATE eReqState)
```

```
EC_T_DWORD emSetMasterState (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwTimeout,
    EC_T_STATE eReqState
)
```

) Set the EtherCAT master (and all slaves) into the requested state.

If the function is called with *EC_NOWAIT*, the client may wait for reaching the requested state using the notification callback (*EC_NOTIFY_STATECHANGED*).

Master by default will just change to a higher state, if all slaves have reached the requested state. It may happen that some slaves are in higher state at network than Master, e.g.:

- Master and all slaves are in PREOP
- Application requests SAFEOP

- Master starts transition for all slaves
- Some slaves changed to SAFEOP, but some fail and therefore stay in PREOP
- Master state stays in PREOP, function returns with error

The application can request SAFEOP again to re-request state of previously failed slaves. Transition to lower state: The master changes to lower state, even if one slave is not able to follow. This function may not be called from within the JobTask's context with dwTimeout other than EC_NOWAIT.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwTimeout** – [in] Timeout [ms] This function will block until the requested state is reached or the timeout elapsed. If the timeout value is set to EC_NOWAIT the function will return immediately.
- **eReqState** – [in] Requested System state

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or the output pointer is EC_NULL
- *EC_E_TIMEOUT* if dwTimeout elapsed during the API call
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive
- *EC_E_ADS_IS_RUNNING* if ADS server is running

enum **EC_T_STATE**

Values:

enumerator **eEcatState_UNKNOWN**

Unknown state

enumerator **eEcatState_INIT**

EtherCAT state INIT

enumerator **eEcatState_PREOP**

EtherCAT state PREOP (pre-operational)

enumerator **eEcatState_SAFEOP**

EtherCAT state SAFEOP (safe operational)

enumerator **eEcatState_OP**

EtherCAT state OP (operational)

enumerator **eEcatState_BOOTSTRAP**

EtherCAT state BOOTSTRAP

See also:

emIoControl - EC_IOCTL_ALL_SLAVES_MUST_REACH_MASTER_STATE

6.3.14 emGetMasterState

```
static EC_T_STATE ecatGetMasterState (EC_T_VOID)
EC_T_STATE emGetMasterState (EC_T_DWORD dwInstanceID)
```

Get the EtherCAT master current state.

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

EtherCAT master state

6.3.15 emGetMasterStateEx

```
static EC_T_DWORD ecatGetMasterStateEx (
    EC_T_WORD *pwCurrState,
    EC_T_WORD *pwReqState
)
EC_T_DWORD emGetMasterStateEx (
    EC_T_DWORD dwInstanceID,
    EC_T_WORD *pwCurrState,
    EC_T_WORD *pwReqState
)
```

Get the EtherCAT master current and requested state. Possible return values for current and requested state:

- *DEVICE_STATE_UNKNOWN*
- *DEVICE_STATE_INIT*
- *DEVICE_STATE_PREOP*
- *DEVICE_STATE_SAFEOP*
- *DEVICE_STATE_OP*

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pwCurrState** – [out] Current master state.
- **pwReqState** – [out] Requested master state

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or the output pointers are EC_NULL

6.3.16 emStart

```
static EC_T_DWORD ecatStart (EC_T_DWORD dwTimeout)
EC_T_DWORD emStart (EC_T_DWORD dwInstanceID, EC_T_DWORD dwTimeout)
The EtherCAT master and all slaves will be set into the OPERATIONAL state.
```

Deprecated:

Use emSetMasterState() instead

Note: If the function is called with EC_NOWAIT, the client may wait for reaching the OPERATIONAL state using the notification callback (EC_NOTIFY_STATECHANGED). This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwTimeout** – [in] Timeout [ms] This function will block until the OPERATIONAL state is reached or the timeout elapsed. If the timeout value is set to EC_NOWAIT the function will return immediately.

Returns

EC_E_NOERROR or error code

6.3.17 emStop

```
static EC_T_DWORD ecatStop (EC_T_DWORD dwTimeout)
EC_T_DWORD emStop (EC_T_DWORD dwInstanceID, EC_T_DWORD dwTimeout)
The EtherCAT master and all slaves will be set back into the INIT state.
```

Deprecated:

Use emSetMasterState() instead

Note: If the function is called with EC_NOWAIT, the client may wait for reaching the INIT state using the notification callback (ECAT_NOTIFY_STATECHANGE). This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwTimeout** – [in] Timeout [ms] This function will block until the INIT state is reached or the timeout elapsed. If the timeout value is set to EC_NOWAIT the function will return immediately.

Returns

EC_E_NOERROR or error code

6.3.18 emExecJob

```
static EC_T_DWORD ecatExecJob (
    EC_T_USER_JOB eUserJob,
    EC_T_USER_JOB_PARMS *pUserJobParms
)
EC_T_DWORD emExecJob (
    EC_T_DWORD dwInstanceID,
    EC_T_USER_JOB eUserJob,
    EC_T_USER_JOB_PARMS *pUserJobParms
)
```

Execute or initiate the requested master job.

To achieve maximum speed, this function is implemented non re-entrant. It is highly recommended that only one single task is calling all required jobs to run the stack. If multiple tasks are calling this function, the calls have to be synchronized externally. Calling it in a context that doesn't support operating system calls can lead to unpredictable behavior.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **eUserJob** – [in] user requested job
- **pUserJobParms** – [in] optional user job parameters

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized
- **EC_E_INVALIDPARAM** if dwInstanceID is out of range or the output pointer is EC_NULL
- **EC_E_LINK_DISCONNECTED** if the link is disconnected
- **EC_E_FEATURE_DISABLED** for eUsrJob_SwitchEoeFrames if EC_IOCTL_SET_EOE_DEFERRED_SWITCHING_ENABLED hasn't be called before
- **EC_E_ADS_IS_RUNNING** if ADS server is running

Brief job overview:

```
enum EC_T_USER_JOB
Values:
enumerator eUsrJob_Undefined
enumerator eUsrJob_ProcessAllRxFrames
enumerator eUsrJob_SendAllCycFrames
enumerator eUsrJob_MasterTimer
enumerator eUsrJob_SendAcycFrames
enumerator eUsrJob_SendCycFramesByTaskId
enumerator eUsrJob_MasterTimerMinimal
enumerator eUsrJob_ProcessRxFramesByTaskId
enumerator eUsrJob_ProcessAcycRxFrames
enumerator eUsrJob_SwitchEoeFrames
```

```

enumerator eUsrJob_StartTask
enumerator eUsrJob_StopTask
enumerator eUsrJob_StampSendAllCycFrames
enumerator eUsrJob_StampSendCycFramesByTaskId
enumerator eUsrJob_SimulatorTimer
enumerator eUsrJob_MonitorTimer

union EC_T_USER_JOB_PARMS

```

Public Members

```

EC_T_BOOL bAllCycFramesProcessed
EC_T_DWORD dwNumFramesSent
EC_T_DWORD dwTaskIdToSend
struct EC_T_USER_JOB_PARMS::_SEND_CYCFRAME_BY_TASKID SendCycFramesByTaskId
struct EC_T_USER_JOB_PARMS::_PROCESS_RXFRAME_BY_TASKID ProcessRxFramesByTaskId
struct EC_T_USER_JOB_PARMS::_SWITCH_EOE_FRAMES SwitchEoeFrames
struct EC_T_USER_JOB_PARMS::_START_TASK StartTask
struct EC_T_USER_JOB_PARMS::_STOP_TASK StopTask
struct _PROCESS_RXFRAME_BY_TASKID

```

Public Members

```

EC_T_BOOL bCycFramesProcessed
EC_T_DWORD dwTaskId
struct _SEND_CYCFRAME_BY_TASKID

```

Public Members

```

EC_T_DWORD dwTaskId
struct _START_TASK

```

Public Members

```

EC_T_DWORD dwTaskId
struct _STOP_TASK

```

Public Members

```
EC_T_DWORD dwTaskId
struct _SWITCH_EOE_FRAMES
```

Public Members

```
EC_T_DWORD dwMaxPortsToProcess
EC_T_DWORD dwNumFramesProcessed
```

Detailed job description:

1. [*eUsrJob_ProcessAllRxFrames*](#)

When the Link Layer operates in polling mode this call will process all currently received frames, when the Link Layer operates in interrupt mode all received frames are processed immediately and this call just returns with nothing done.

pUserJobParms->bAllCycFramesProcessed

This flag is set to a value of EC_TRUE it indicates that all previously initiated cyclic frames ([*eUsrJob_SendAllCycFrames*](#)) are received and processed within this call. Not used if pUserJobParms set to EC_NULL.

Return: EC_E_NOERROR if successful, error code in case of failures.

2. [*eUsrJob_SendAllCycFrames*](#)

Send all cyclic frames. New values will be written to the EtherCAT slave's outputs and new input values will be received. If the Link Layer operates in interrupt mode, the process data input values will be updated immediately after receiving the frames. If the Link Layer operates in polling mode, the next call to [*emExecJob\(\)*](#) with the [*eUsrJob_ProcessAllRxFrames*](#) job will check for received frames and update the process data input values.

pUserJobParms->dwNumFramesSent

Indicates number of frames send within this call. Not used if pUserJobParms set to EC_NULL.

Return: EC_E_NOERROR if successful, error code in case of failures.

In case not all previously initiated cyclic frames are processed when calling this function an error notification will be generated ([*emNotify - EC_NOTIFY_FRAME_RESPONSE_ERROR*](#)).

3. [*eUsrJob_SendAcycFrames*](#)

Acyclic EtherCAT datagrams stored in the acyclic frame buffer FIFO will be sent when executing this call.

pUserJobParms->dwNumFramesSent

Indicates number of frames send within this call. Not used if pUserJobParms set to EC_NULL.

Return: EC_E_NOERROR if successful, error code in case of failures.

4. [*eUsrJob_MasterTimer*](#)

To trigger the master and slave state machines as well as the mailbox handling this call has to be executed cyclically. The master cycle time is determined by the period between calling [*emExecJob\(\)*](#) ([*eUsrJob_MasterTimer*](#)). The state-machines are handling the EtherCAT state change transfers.

Return: EC_E_NOERROR if successful, error code in case of failures.

5. [*eUsrJob_SendCycFramesByTaskId*](#)

Send cyclic frames related to a specific task id. If more than one cyclic entries are configured this user

job can be used to send the appropriate cyclic frames. All frames stored in cyclic entries with the given task id will be sent.

See also:

Multiple cyclic entries configuration

pUserJobParms->SendCycFramesByTaskId.dwTaskId

Task id.

Return: EC_E_NOERROR if successful, error code in case of failures. If not all previously initiated cyclic frames for the same task are already processed when calling this function an error will be generated (*emNotify - EC_NOTIFY_FRAME_RESPONSE_ERROR*).

6. **eUsrJob_ProcessRxFramesByTaskId**

eUsrJob_ProcessAcycRxFrames

See also:

Feature-Pack Split Frame Processing

7. **eUsrJob_SwitchEoeFrames**

This job must be called if *emIoControl - EC_IOCTL_SET_EOE_DEFERRED_SWITCHING_ENABLED* has been called before. It can be called in parallel to Send / Process jobs in a lower prioritized task

pUserJobParms->SwitchEoeFrames.dwMaxPortsToProcess
--

Indicates number of ports to be processed within this call. If zero, all ports will be processed.

pUserJobParms->SwitchEoeFrames.dwNumFramesProcessed

Returns number of frames processed within this call.

Return: EC_E_NOERROR if successful

8. **eUsrJob_StartTask**

Inform EC-Master that the current task is started. Specify pUserJobParms.StartTask.dwTaskId or pass pUserJobParms set to EC_NULL for task ID 0.

9. **eUsrJob_StopTask**

Inform EC-Master that the current task is stopped. Specify pUserJobParms.StopTask.dwTaskId or pass pUserJobParms set to EC_NULL for task ID 0.

6.3.19 emGetVersion

```
static EC_T_DWORD ecatGetVersion(
    EC_T_DWORD *pdwVersion,
    EC_T_DWORD *pdwVersionType
)
EC_T_DWORD emGetVersion (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD *pdwVersion,
    EC_T_DWORD *pdwVersionType
)
```

Gets the version number as a 32-bit value.

Parameters

- **dwInstanceId** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pdwVersion** – [out] Pointer to EC_T_DWORD to carry out version number

- **pdwVersionType** – [out] Pointer to EC_T_DWORD to carry out version type

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or the output pointer is EC_NULL

6.3.20 emSetLicenseKey

static EC_T_DWORD **ecatSetLicenseKey** (const EC_T_CHAR *pszLicenseKey)

```
EC_T_DWORD emSetLicenseKey (
    EC_T_DWORD dwInstanceID,
    const EC_T_CHAR *pszLicenseKey
)
```

Sets the license key for the protected version of EC-Master.

Must be called after initialization and before configuration. This function may not be called if a non protected version is used.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pszLicenseKey** – [in] License key as zero terminated string with 26 characters.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range
- *EC_E_INVALIDSIZE* the format of the license key is wrong. The correct length is 26 characters
- *EC_E_LICENSE_MISSING* the license key doesn't match to the MAC Address

Example

```
dwRes = emSetLicenseKey(dwInstanceId, "DA1099F2-15C249E9-54327FBC");
```

See also:

- *emInitMaster()*
- *emConfigureNetwork()*

6.3.21 emSetOemKey

static EC_T_DWORD **ecatSetOemKey** (EC_T_UINT64 qwOemKey)

static EC_T_DWORD **emSetOemKey** (EC_T_DWORD dwInstanceId, EC_T_UINT64 qwOemKey)

Provide OEM Key needed for OEM Masters to parse ENI files and provide access via RAS. Must be called after initialization and before configuration.

Parameters

- **dwInstanceId** – [in] Instance ID (Multiple EtherCAT Network Support)
- **qwOemKey** – [in] 64 bit OEM key

Example

```
dwRes = emSetOemKey(dwInstanceId, 0x1234567812345678);
```

See also:

- *emInitMaster()*
- *emConfigureNetwork()*

6.3.22 emIoControl

static EC_T_DWORD **ecatIoControl** (EC_T_DWORD dwCode, *EC_T_IOCTLPARMS* *pParms)

```
EC_T_DWORD emIoControl (
    EC_T_DWORD dwInstanceId,
    EC_T_DWORD dwCode,
    EC_T_IOCTLPARMS *pParms
)
```

A generic control interface between the application, the EC-Master and its Link Layers.

Parameters

- **dwInstanceId** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwCode** – [in] Control code
- **pParms** – [in/out] Control code depending parameters

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceId is out of range, the input pointer is EC_NULL or contains EC_NULL pointer
- *EC_E_NOMEMORY* if some memory cannot be allocated
- *EC_E_ADS_IS_RUNNING* if ADS server is running

```
struct EC_T_IOCTLPARMS
```

Public Members

EC_T_BYTE *pbyInBuf

[in] Pointer to control input parameter.

EC_T_DWORD dwInBufSize

[in] Size of the input buffer provided at pbyInBuf in bytes

EC_T_BYTE *pbyOutBuf

[out] Pointer to control output buffer where the results will be copied into

EC_T_DWORD dwOutBufSize

[in] Size of the output buffer provided at pbyOutBuf in bytes

EC_T_DWORD *pdwNumOutData

[out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer

6.3.23 emIoControl - EC_IOCTL_GET_PDMEMORYSIZE

Queries the master for the necessary size the process data image has got. This information may be used to provide process data image storage from outside the master core. This IOCTL is to be called after `emConfigureNetwork()` and before `emStart()`.

emIoControl - EC_IOCTL_GET_PDMEMORYSIZE

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Pointer to memory where the memory size information will be stored (type: EC_T_MEMREQ_DESC).
- dwOutBufSize: [in] Size of the output buffer in bytes.
- pdwNumOutData: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

struct **EC_T_MEMREQ_DESC**

6.3.24 emIoControl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER

This function call registers an external memory provider to the EtherCAT master, this memory will be used to store process data. If no memory provider is registered the master will internally allocate the necessary amount of memory. The function `emIoControl - EC_IOCTL_GET_PDMEMORYSIZE` should be executed to determine the amount of memory the master needs to store process data values. The external memory provider may additionally supply some hooks to give the master a possibility to synchronize memory access with the application. The memory provider has to be registered after calling `emConfigureNetwork()` but prior to registering any client. Every client that registers with the master (`emRegisterClient()`) will get back the memory pointers to PDOOut/PDIn data registered within this call.

emIoControl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER

Parameter

- pbyInBuf: [in] Memory provider (*EC_T_MEMPROV_DESC*)
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

`EC_E_NOERROR` or error code

struct **EC_T_MEMPROV_DESC**

Public Members**`EC_T_PVOID pContext`**

Context pointer. This pointer is used every time when one of the callback functions (e.g. `pfPDOOutReadRequest`) is called

`EC_T_PBYTE pbyPDOOutData`

Pointer to the fixed output process data buffer (values transferred from the master to the slaves). A value of EC_NULL may be given in case the pointer will be provided later when function *EC_T_MEMPROV_DESC.pfPDOOutDataReadRequest* is called

`EC_T_DWORD dwPDOOutDataLength`

Length of the output process data buffer

`EC_T_PBYTE pbyPDInData`

Pointer to the fixed input process data buffer (values transferred from the slaves to the master). A value of EC_NULL may be given in case the pointer will be provided later when function *EC_T_MEMPROV_DESC.pfPDInDataWriteRequest* is called

`EC_T_DWORD dwPDInDataLength`

Length of the output process data buffer

`EC_T_PFMEMREQ pfPDOOutDataReadRequest`

This function will be called cyclically within the process data transfer cycle prior to read data from the output process data buffer. If EC_NULL is set, the fixed buffer *EC_T_MEMPROV_DESC.pbyPDOOutData* is used.

`EC_T_PFMEMREL pfPDOOutDataReadRelease`

This function will be called cyclically within the process data transfer cycle after all data were read from the output process data buffer.

`EC_T_PFMEMREQ pfPDOOutDataWriteRequest`

This function will be called cyclically within the process data transfer cycle prior to write new data into the output process data buffer. If EC_NULL is set, the fixed buffer *EC_T_MEMPROV_DESC.pbyPDOOutData* is used.

`EC_T_PFMEMREL pfPDOOutDataWriteRelease`

This function will be called cyclically within the process data transfer cycle after all data were written into the output process data buffer.

EC_T_PFMEMREQ* *pfPDIInDataWriteRequest

This function will be called cyclically within the process data transfer cycle prior to write new data into the input process data buffer. If EC_NULL is set, the fixed buffer *EC_T_MEMPROV_DESC.pbyPDInData* is used.

EC_T_PFMEMREL* *pfPDIInDataWriteRelease

This function will be called cyclically within the process data transfer cycle after all data were written into the input process data buffer.

EC_T_PBYTE* *pbyMasterRedPDOOutData

Pointer to the MasterRed output process data buffer (ACTIVE to INACTIVE)

EC_T_DWORD* *dwMasterRedPDOOutDataLength

Length of the MasterRed output process data buffer

EC_T_PBYTE* *pbyMasterRedPDInData

Pointer to the default input process data buffer (INACTIVE to ACTIVE)

EC_T_DWORD* *dwMasterRedPDInDataLength

Length of the input process data buffer

EC_T_PFMEMREQ* *pfMasterRedPDOOutReadRequest

This function will be called within the process data transfer cycle prior to read data.

EC_T_PFMEMREL* *pfMasterRedPDOOutReadRelease

This function will be called after all data was read from output process data buffer.

EC_T_PFMEMREQ* *pfMasterRedPDOOutWriteRequest

This function will be called within the process data transfer cycle prior to read data.

EC_T_PFMEMREL* *pfMasterRedPDOOutWriteRelease

This function will be called after all data was read from output process data buffer.

EC_T_PFMEMREQ* *pfMasterRedPDInWriteRequest

This function will be called within the process data transfer cycle prior to write data.

EC_T_PFMEMREL* *pfMasterRedPDInWriteRelease

This function will be called after all data was written to input process data buffer.

EC_T_PFMEMREQ* *pfMasterRedPDInReadRequest

This function will be called within the process data transfer cycle prior to write data.

EC_T_PFMEMREL* *pfMasterRedPDInReadRelease

This function will be called after all data was written to input process data buffer.

```
typedef EC_T_VOID (*EC_T_PFMEMREQ)(EC_T_PVOID pvContext, EC_T_DWORD dwTaskId,
EC_T_PBYTE *ppbyPDData)
```

Parameters

- ***pvContext*** – [in] Context pointer. This pointer is used as parameter when the callback function is called
- ***dwTaskId*** – [in] Task id of cyclic data transfer. If TASKID_COMPLETE_PD is given, the function must return a complete output process data buffer which contains valid data for all cyclic tasks.

- **ppbyPDDData** – [out] Pointer to the process data buffer to be used. If set to EC_NULL, the corresponding fixed buffer from [EC_T_MEMPROV_DESC](#) is used. The provided buffer size must correspond to the caller context.

typedef EC_T_VOID (*[**EC_T_PFMEMREL**](#))(EC_T_PVOID pvContext, EC_T_DWORD dwTaskId)

Parameters

- **pvContext** – [in] Context pointer. This pointer is used as parameter when the callback function is called
- **dwTaskId** – [in] Task id of cyclic data transfer.

See also:

- [emIoControl - EC_IOCTL_GET_PDMEMORYSIZE](#)
- [emConfigureNetwork \(\)](#)
- [emRegisterClient \(\)](#)
- Feature Pack “Master Redundancy”

6.3.25 emIoControl - EC_IOCTL_REGISTER_CYCFRAME_RX_CB

This function call registers an callback function which is called after the cyclic frame is received. Typically this is used when the Link Layer operates interrupt mode to get an event when the new input data (cyclic frame) is available. The callback function has to be registered after calling [emInitMaster \(\)](#) before starting the job task.

emIoControl - EC_IOCTL_REGISTER_CYCFRAME_RX_CB

Parameter

- pbyInBuf: [in] Cyclic frame received callback descriptor (EC_T_CYCFRAME_RX_CBDESC)
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

struct **EC_T_CYCFRAME_RX_CBDESC**

Public Members

EC_T VOID *pCallbackContext

[in] Context pointer. This pointer is used as parameter every time when the callback function is called

[EC_PF_CYCFRAME_RECV](#) pfnCallback

[in] This function will be called after the cyclic frame is received, if there is more than one cyclic frame after the last frame. The application has to assure that these functions will not block.

typedef EC_T_VOID (*[**EC_PF_CYCFRAME_RECV**](#))(EC_T_DWORD dwTaskId, EC_T_VOID *pvContext)

Parameters

- **dwTaskId** – [in] Task id of the received cyclic frame.
- **pvContext** – [in] Context pointer. This pointer is used as parameter every time when the callback function is called.

6.3.26 emIoControl - EC_IOCTL_ISLINK_CONNECTED

Determine whether link between the EtherCAT master and the first slave is connected.

emIoControl - EC_IOCTL_ISLINK_CONNECTED**Parameter**

- **pbyInBuf**: [in] Should be set to EC_NULL
- **dwInBufSize**: [in] Should be set to 0
- **pbyOutBuf**: [out] Pointer to EC_T_DWORD. If value is EC_TRUE link is connected, if EC_FALSE it is not.
- **dwOutBufSize**: [in] Size of the output buffer in bytes.
- **pdwNumOutData**: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

With Redundancy support enabled, EC_FALSE is only set if main and redundancy link are down.

6.3.27 emIoControl - EC_IOCTL_GET_LINKLAYER_MODE

This call allows the application to determine whether the LinkLayer is currently running in polling or in interrupt mode.

emIoControl - EC_IOCTL_GET_LINKLAYER_MODE**Parameter**

- **pbyInBuf**: [in] Should be set to EC_NULL
- **dwInBufSize**: [in] Should be set to 0
- **pbyOutBuf**: [out] Pointer to struct EC_T_LINKLAYER_MODE_DESC
- **dwOutBufSize**: [in] Size of the output buffer in bytes.
- **pdwNumOutData**: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

struct **EC_T_LINKLAYER_MODE_DESC**

Public Members

EC_T_LINKMODE eLinkMode
 [out] Operation mode of main interface

EC_T_LINKMODE eLinkModeRed
 [out] Operation mode of redundancy interface

6.3.28 emIoControl - EC_IOCTL_GET_CYCLIC_CONFIG_INFO

Determine cyclic configuration details from ENI configuration file. It can be called only after calling ecatConfigureNetwork() or emConfigureNetwork()

emIoControl - EC_IOCTL_GET_CYCLIC_CONFIG_INFO

Parameter

- pbyInBuf: [in] Pointer to dwCycEntryIndex: cyclic entry index for which to get information
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Pointer to EC_T_CYC_CONFIG_DESC data type
- dwOutBufSize: [in] Size of the output buffer provided at pbyOutBuf in bytes.
- pdwNumOutData: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

struct **EC_T_CYC_CONFIG_DESC**

Public Members

EC_T_DWORD dwNumCycEntries
 [out] Total number of cyclic entries

EC_T_DWORD dwTaskId
 [out] Task id of selected cyclic entry

EC_T_DWORD dwPriority
 [out] Priority of selected cyclic entry

EC_T_DWORD dwCycleTime
 [out] Cycle time of selected cyclic entry

6.3.29 emIoControl - EC_IOCTL_IS_SLAVETOSLAVE_COMM_CONFIGURED

Determine if any slave to slave communication is configured.

emIoControl - EC_IOCTL_IS_SLAVETOSLAVE_COMM_CONFIGURED

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Pointer to EC_T_DWORD. If value is EC_TRUE slave to slave communication is configured, if EC_FALSE it is not.
- dwOutBufSize: [in] Size of the output buffer in bytes.
- pdwNumOutData: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

6.3.30 emIoControl - EC_LINKIOCTL...

The generic control interface provides access to the main network adapter when adding EC_IOCTL_LINKLAYER_MAIN to the EC_LINKIOCTL parameter at dwCode.

```
EC_T_DWORD dwCode = (EC_IOCTL_LINKLAYER_MAIN | EC_LINKIOCTL_GET_ETHERNET_ADDRESS);
```

6.3.31 emIoControl - EC_LINKIOCTL_GET_ETHERNET_ADDRESS

Provides MAC addresses of main or red line.

emIoControl - EC_LINKIOCTL_GET_ETHERNET_ADDRESS

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Pointer to MAC address buffer (6 bytes).
- dwOutBufSize: [in] Size of the output buffer in bytes (at least 6).
- pdwNumOutData: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

6.3.32 emIoControl - EC_LINKIOCTL_GET_SPEED

emIoControl - EC_LINKIOCTL_GET_SPEED

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Pointer to EC_T_DWORD. Set by Link Layer driver to 10/100/1000.
- dwOutBufSize: [in] Size of the output buffer in bytes.
- pdwNumOutData: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

6.3.33 emIoControl - EC_IOCTL_SET_CYCFRAME_LAYOUT

Set the cyclic frames layout.

emIoControl - EC_IOCTL_SET_CYCFRAME_LAYOUT

Parameter

- pbyInBuf: [in] Pointer to a EC_T_CYCFRAME_LAYOUT value containing the cyclic frame layout.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

enum **EC_T_CYCFRAME_LAYOUT**

Values:

enumerator **eCycFrameLayout_STANDARD**

Layout according ENI with command add/reordering, no relationship to PD

enumerator **eCycFrameLayout_DYNAMIC**

Layout is dynamically modified to send as less as possible cyclic frames and commands

enumerator **eCycFrameLayout_FIXED**

Layout strictly match ENI, frame buffers and PD area overlapped

enumerator **eCycFrameLayout_IN_DMA**

Layout strictly match ENI, frame buffers and PD area overlapped, frame buffers in DMA

6.3.34 emIoControl - EC_IOCTL_SET_MASTER_DEFAULT_TIMEOUTS

Set master default timeouts.

emIoControl - EC_IOCTL_SET_MASTER_DEFAULT_TIMEOUTS

Parameter

- pbyInBuf: [in] Pointer to EC_T_MASTERDEFAULTTIMEOUTS_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

struct **EC_T_MASTERDEFAULTTIMEOUTS_DESC**

Public Members

EC_T_DWORD dwMasterStateChange

Default state change timeout [ms], applied if emSetMasterState called with EC_NOWAIT.

EC_T_DWORD dwInitCmdRetry

Timeout [ms] between retry sending an init-command.

EC_T_DWORD dwMbxCmd

Timeout [ms] between retry sending an mailbox command

EC_T_DWORD dwMbxPolling

Mailbox polling cycle [ms]

EC_T_DWORD dwDcmInSync

Timeout [ms] to wait for DCM InSync in state change PREOP to SAFEOP

EC_T_WORD wInitCmd

Timeout [ms] to InitCmds if not specified in ENI

EC_T_DWORD dwSlaveIdentification

Timeout [ms] to wait for the reading of the slave identification

Setting a value of this descriptor to zero resets the default timeout value to the initial value.

See also:

- *emSetMasterState()*

6.3.35 emIoControl - EC_IOCTL_SET_COPYINFO_IN_SENDCYCFRAMES

Set copy info processed in either SendCycFrames or in ProcessAllRxFrames.

emIoControl - EC_IOCTL_SET_COPYINFO_IN_SENDCYCFRAMES

Parameter

- pbyInBuf: [in] Pointer to EC_T_BOOL. EC_TRUE: SendCycFrames, EC_FALSE: ProcessAll-RxFrames
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Default: Set by ProcessAllRxFrames.

6.3.36 emIoControl - EC_IOCTL_SET_BUS_CYCLE_TIME

Set bus cycle time in usec master parameter without calling `emInitMaster()` again.

emIoControl - EC_IOCTL_SET_BUS_CYCLE_TIME

Parameter

- pbyInBuf: [in] Pointer to value of EC_T_DWORD. Value may not be 0!
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Implicitly recalculates Order Timeout and `EC_T_INIT_MASTER_PARMS::dwEcatCmdTimeout`.

6.3.37 emIoControl - EC_IOCTL_ADDITIONAL_VARIABLES_FOR_SPECIFIC_DATA_TYPES

Enable or disable additional variables for specific data types. Default: Enabled.

emIoControl - EC_IOCTL_ADDITIONAL_VARIABLES_FOR_SPECIFIC_DATA_TYPES

Parameter

- pbyInBuf: [in] Pointer to value of EC_T_BOOL. EC_TRUE: enable, EC_FALSE: disable.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0

- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Additional variables are added to the process image for the following data types:

- FSOE_4096
- FSOE_4098
- FSOE_4099
- FB Info 1
- FB Info 3

6.3.38 emIoControl - EC_IOCTL_SLV_ALIAS_ENABLE

Enables slave alias addressing for all slaves.

emIoControl - EC_IOCTL_SLV_ALIAS_ENABLE**Parameter**

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Important: All slaves need to have the correct alias address set! If in doubt, don't use this IOCTL.

6.3.39 emIoControl - EC_IOCTL_SET_IGNORE_INPUTS_ON_WKC_ERROR

Set ignore inputs on WKC error

emIoControl - EC_IOCTL_SET_IGNORE_INPUTS_ON_WKC_ERROR**Parameter**

- pbyInBuf: [in] Pointer to value of EC_T_BOOL. EC_TRUE: inputs are ignored on WKC error.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Calling this IOCTL with EC_TRUE as parameter will ignore the inputs data of cyclic commands on WKC error. The default behavior will copy the input data if WKC is non zero and below the expected value. If WKC is not matching the expected value a notification *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR* is generated and the application must consider this status for the current cycle.

6.3.40 emIoControl - EC_IOCTL_SET_ZERO_INPUTS_ON_WKC_ERROR

Set zero inputs on WKC error

emIoControl - EC_IOCTL_SET_ZERO_INPUTS_ON_WKC_ERROR

Parameter

- pbyInBuf: [in] Pointer to value of EC_T_BOOL. EC_TRUE: inputs are set to zero on WKC error.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Calling this IOCTL with EC_TRUE as parameter will set the inputs data of cyclic commands to zero on WKC error. The default behavior will copy the input data if WKC is non zero and below the expected value. If WKC is not matching the expected value a notification *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR* is generated and the application must consider this status for the current cycle.

6.3.41 emIoControl - EC_IOCTL_SET_ZERO_INPUTS_ON_WKC_ZERO

Set zero inputs on WKC is zero

emIoControl - EC_IOCTL_SET_ZERO_INPUTS_ON_WKC_ZERO

Parameter

- pbyInBuf: [in] Pointer to value of EC_T_BOOL. EC_TRUE: inputs are set to zero on WKC is zero.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Calling this IOCTL with EC_TRUE as parameter will ignore the inputs data of cyclic commands on WKC error. At default behavior it will ignore the input data if WKC is zero, and keep the previous state.

6.3.42 emIoControl - EC_IOCTL_SET_GENENI_ASSIGN_EEPROM_BACK_TO_EM

Enable or disable creation of “assign EEPROM back to EM” InitCmd if ENI generated based on bus-scan result.

emIoControl - EC_IOCTL_SET_GENENI_ASSIGN_EEPROM_BACK_TO_EM

Parameter

- pbyInBuf: [in] Pointer to value of EC_T_BOOL. EC_TRUE: generate InitCmd.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

The ENI’s “assign EEPROM back to EM” InitCmd depends on the attribute “AssignToPdi” of the EEPROM tag in the slave’s description within the ESI file. Because this attribute is not reflected in the SII in the slave’s EEPROM, the Master cannot know its value and inserts for legacy reasons the InitCmd if not disabled using this IOCTL.

6.3.43 emIoControl - EC_IOCTL_SET_EOE_DEFERRED_SWITCHING_ENABLED

Enable or disable deferred EoE switching

emIoControl - EC_IOCTL_SET_EOE_DEFERRED_SWITCHING_ENABLED

Parameter

- pbyInBuf: [in] Pointer to value of EC_T_BOOL. EC_TRUE: Deferred EoE switching enabled.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Enabling deferred EoE switching reduces the CPU load of JOB_ProcessAllRxFrames in case of EoE communication. *eUsrJob_SwitchEoeFrames* has to be called explicitly to switch the received EoE frames between the EoE slaves and EoE end point(s).

6.3.44 emIoControl - EC_IOCTL_SET_MAILBOX_POLLING_CYCLES

This call changes the mailbox polling cycles.

emIoControl - EC_IOCTL_SET_MAILBOX_POLLING_CYCLES

Parameter

- pbyInBuf: [in] Pointer to struct EC_T_SET_MAILBOX_POLLING_CYCLES_DESC

- dwInBufSize: [in] Size of the input buffer in bytes. E.g. sizeof(EC_T_SET_MAILBOX_POLLING_CYCLES_DESC)
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

struct **EC_T_SET_MAILBOX_POLLING_CYCLES_DESC****Public Members**EC_T_DWORD **dwSlaveId**
[in] Slave IdEC_T_WORD **wCycles**
[in] Number of cycles between polling [ms]**6.3.45 emIoControl - EC_IOCTL_SET_MASTER_MAX_STATE**

This call sets maximal master state. `emSetMasterState()` returns with `EC_E_INVALIDSTATE` if the requested master state exceeds the maximal master state.

emIoControl - EC_IOCTL_SET_MASTER_MAX_STATE**Parameter**

- pbyInBuf: [in] Pointer to value of EC_T_STATE
- dwInBufSize: [in] Size of the input buffer in bytes. E.g. sizeof(EC_T_STATE)
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

See also:enum `EC_T_STATE`**6.3.46 emIoControl - EC_IOCTL_ACTIVATE_VOE_RECV_FIFO**

This call activates the VoE receive FIFO and sets its size.

emIoControl - EC_IOCTL_ACTIVATE_VOE_RECV_FIFO**Parameter**

- pbyInBuf: [in] Pointer to value of EC_T_WORD, size of the FIFO, use 0 to set it to the original size.

- dwInBufSize: [in] Size of the input buffer in bytes. E.g. sizeof(EC_T_WORD)
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return*EC_E_NOERROR or error code*

6.4 Process Data Access

6.4.1 emGetProcessData

```
static EC_T_DWORD ecatGetProcessData (
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwOffset,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwLength,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emGetProcessData (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwOffset,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout
)
    Retrieve Process data synchronized.
```

If process data are required outside the cyclic master job task (which is calling ecatExecJob), direct access to the process data is not recommended as data consistency cannot be guaranteed. A call to this function will send a data read request to the master stack and then check every millisecond whether new data are provided. The master stack will provide new data after calling ecatExecJob(eUsrJob_MasterTimer) within the job task. This function is usually only called remotely (using the Remote API).

Note: This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bOutputData** – [in] EC_TRUE: read output data, EC_FALSE: read input data.
- **dwOffset** – [in] Byte offset in Process data to read from.
- **pbyData** – [out] Buffer receiving transferred data
- **dwDataLen** – [in] Buffer length [bytes]
- **dwTimeout** – [in] Timeout [ms]

Returns

EC_E_NOERROR or error code

6.4.2 emGetProcessDataBits

```
static EC_T_DWORD ecatGetProcessDataBits (
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_BYTE *pbyDataDst,
    EC_T_DWORD dwBitLengthDst,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emGetProcessDataBits (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataBitLen,
    EC_T_DWORD dwTimeout
)
```

) Reads a specific number of bits from the process image to the given buffer with a bit offset (synchronized).

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bOutputData** – [in] EC_TRUE: read output data, EC_FALSE: write input data.
- **dwBitOffsetPd** – [in] Bit offset in Process data image.
- **pbyData** – [out] Buffer receiving transferred data
- **dwDataBitLen** – [in] Buffer length [bit]
- **dwTimeout** – [in] Timeout [ms] The timeout value must not be set to EC_NOWAIT.

Returns

EC_E_NOERROR or error code

See also:

emGetProcessData ()

6.4.3 emSetProcessData

```
static EC_T_DWORD ecatSetProcessData (
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwOffset,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwLength,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emSetProcessData (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwOffset,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout
)
```

) Write Process data synchronized.

If process data shall be set outside the cyclic master job task (which is calling ecatExecJob), direct access to the process data is not recommended as data consistency cannot be guaranteed. A call to this function will send a data write request to the master stack and then check every millisecond whether new data is written. The master stack will copy the data after calling ecatExecJob(eUsrJob_MasterTimer) within the job task. This function is usually only called remotely (using the Remote API).

Note: This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bOutputData** – [in] EC_TRUE: write output data, EC_FALSE: write input data.
- **dwOffset** – [in] Byte offset in Process data to write to.
- **pbyData** – [in] Buffer containing transferred data
- **dwDataLen** – [in] Buffer length [bytes]
- **dwTimeout** – [in] Timeout [ms]

Returns

EC_E_NOERROR or error code

6.4.4 emSetProcessDataBits

```
static EC_T_DWORD ecatSetProcessDataBits (
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_BYTE *pbyDataSrc,
    EC_T_DWORD dwBitLengthSrc,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emSetProcessDataBits (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataBitLen,
    EC_T_DWORD dwTimeout
)
```

Writes a specific number of bits from a given buffer to the process image with a bit offset (synchronized).

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bOutputData** – [in] EC_TRUE: write output data, EC_FALSE: write input data.
- **dwBitOffsetPd** – [in] Bit offset in Process data image.
- **pbyData** – [in] Buffer containing transferred data
- **dwDataBitLen** – [in] Buffer length [bit]
- **dwTimeout** – [in] Timeout [ms] The timeout value must not be set to EC_NOWAIT.

Returns*EC_E_NOERROR* or error code**See also:***emSetProcessData ()*

6.4.5 emForceProcessDataBits

```
static EC_T_DWORD ecatForceProcessDataBits (
    EC_T_DWORD dwClientId,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_WORD wBitLength,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emForceProcessDataBits (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_WORD wDataBitLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwTimeout
)
```

Force a specific number of bits from a given buffer to the process image with a bit offset.

All output data set by this API are overwriting the values set by the application. All input data set by this API are overwriting the values read from the slaves. Forcing will be terminated by calling the corresponding functions. This function may not be called from within the JobTask's context.

Parameters

- **`dwInstanceID`** – [in] Instance ID (Multiple EtherCAT Network Support)
- **`dwClientId`** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **`bOutputData`** – [in] EC_TRUE: write output data, EC_FALSE: write input data.
- **`dwBitOffsetPd`** – [in] Bit offset in Process data image
- **`wDataBitLen`** – [in] Buffer length [bit]
- **`pbyData`** – [in] Buffer containing transferred data
- **`dwTimeout`** – [in] Timeout [ms] The timeout value must not be set to EC_NOWAIT.

Returns*EC_E_NOERROR* or error code**See also:**

- *emSetProcessData ()*
- *emReleaseProcessDataBits ()*
- *emReleaseAllProcessDataBits ()*

6.4.6 emReleaseProcessDataBits

```
static EC_T_DWORD ecatReleaseProcessDataBits (
    EC_T_DWORD dwClientId,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_WORD wBitLength,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReleaseProcessDataBits (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_BOOL bOutputData,
    EC_T_DWORD dwBitOffsetPd,
    EC_T_WORD wBitLength,
    EC_T_DWORD dwTimeout
)

```

Release previously forced process data.

- Forced output: Value set by application become valid again. Because forced process data bits are written directly into the process output image, the application has to update the process image with the required value, otherwise the forced value is still valid.
- Forced input: Value read from the slaves become valid again.

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **bOutputData** – [in] EC_TRUE: write output data, EC_FALSE: write input data
- **dwBitOffsetPd** – [in] Bit offset in Process data image
- **wBitLength** – [in] Number of bits that shall be written to the process image.
- **dwTimeout** – [in] Timeout [ms] The timeout value must not be set to EC_NOWAIT.

Returns

EC_E_NOERROR or error code

See also:

- [emSetProcessData\(\)](#)
- [emForceProcessDataBits\(\)](#)

6.4.7 emReleaseAllProcessDataBits

```
static EC_T_DWORD ecatReleaseAllProcessDataBits (
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReleaseAllProcessDataBits (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTimeout
)
    Release all previously forced process data for a dedicated client.
```

- Forced output: Value set by application become valid again. Because forced process data bits are written directly into the process output image, the application has to update the process image with the required value, otherwise the forced value is still valid.
- Forced input: Value read from the slaves become valid again.

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **dwTimeout** – [in] Timeout [ms] The timeout value must not be set to EC_NOWAIT.

Returns

EC_E_NOERROR or error code

See also:

- [emSetProcessData \(\)](#)
- [emForceProcessDataBits \(\)](#)

6.4.8 emGetProcessImageInputPtr

```
static EC_T_BYT* ecatGetProcessImageInputPtr (EC_T_VOID)
EC_T_BYT* emGetProcessImageInputPtr (EC_T_DWORD dwInstanceID)
    Gets the process data input image pointer.
```

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

Process data input image pointer

See also:

- [emConfigureNetwork \(\)](#)
- [emIoControl - EC_IOCTL_GET_PDMMEMORYSIZE](#)
- [emIoControl - EC_IOCTL_REGISTER_PDMMEMORYPROVIDER](#)
- [emExecJob \(\)](#) (`eUsrJob_ProcessAllRxFrames`) in case of Polling Mode

6.4.9 emGetProcessImageOutputPtr

```
static EC_T_BYTEecatGetProcessImageOutputPtr (EC_T_VOID)
EC_T_BYTEemGetProcessImageOutputPtr (EC_T_DWORD dwInstanceID)
    Gets the process data output image pointer.
```

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

Process data output image pointer

See also:

- *emConfigureNetwork ()*
- *emIoControl - EC_IOCTL_GET_PDMEMORYSIZE*
- *emIoControl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER*
- *emExecJob ()* (*eUsrJob_SendAllCycFrames*)

6.4.10 emGetDiagnosisImagePtr

```
static EC_T_BYTEecatGetDiagnosisImagePtr (EC_T_VOID)
EC_T_BYTEemGetDiagnosisImagePtr (EC_T_DWORD dwInstanceID)
    Gets the diagnosis image pointer.
```

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

Diagnosis image pointer

6.4.11 emGetDiagnosisImageSize

```
static EC_T_DWORD ecatGetDiagnosisImageSize (EC_T_VOID)
EC_T_DWORD emGetDiagnosisImageSize (EC_T_DWORD dwInstanceID)
    Gets the diagnosis image size.
```

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

Diagnosis image size

6.4.12 emGetSlaveInpVarInfoNumOf

```
static EC_T_DWORD ecatGetSlaveInpVarInfoNumOf (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD *pwSlaveInpVarInfoNumOf
)
```

```
EC_T_DWORD emGetSlaveInpVarInfoNumOf (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD *pwSlaveInpVarInfoNumOf
)
```

) Gets the number of input variables of a specific slave.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **pwSlaveInpVarInfoNumOf** – [out] Number of found process variable entries

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or the output pointer is EC_NULL
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found

See also:

- *emGetSlaveInpVarInfo()*
- *emGetSlaveInpVarInfoEx()*

6.4.13 emGetSlaveInpVarInfo

```
static EC_T_DWORD ecatGetSlaveInpVarInfo (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO *pSlaveProcVarInfoEntries,
    EC_T_WORD *pwReadEntries
)
```

```
EC_T_DWORD emGetSlaveInpVarInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO *pSlaveProcVarInfoEntries,
    EC_T_WORD *pwReadEntries
)
```

) Gets the process variable information entries of an specific slave.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing

- **wNumOfVarsToRead** – [in] Number process variable entries that have been stored in pSlaveProcVarInfoEntries
- **pSlaveProcVarInfoEntries** – [out] The read process variable information entries
- **pwReadEntries** – [out] The number of read process variable information entries

Returns*EC_E_NOERROR* or error codestruct **EC_T_PROCESS_VAR_INFO****Public Members**

EC_T_CHAR szName[MAX_PROCESS_VAR_NAME_LEN]
 [out] Name of the found process variable

EC_T_WORD wDataType
 [out] Data type of the found process variable (according to ETG.1000, section 5). See also EcCommon.h,
 DEFTYPE_BOOLEAN

EC_T_WORD wFixedAddr
 [out] Station address of the slave that is owner of this variable

EC_T_INT nBitSize
 [out] Size in bit of the found process variable

EC_T_INT nBitOffs
 [out] Bit offset in the process data image

EC_T_BOOL bIsInputData
 [out] Determines whether the found process variable is an input variable or an output variable

MAX_PROCESS_VAR_NAME_LEN

Maximum length of a process variable name: 71 characters

6.4.14 emGetSlaveInpVarInfoEx

```
static EC_T_DWORD ecatGetSlaveInpVarInfoEx (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO_EX *pSlaveProcVarInfoEntries,
    EC_T_WORD *pwReadEntries
)
EC_T_DWORD emGetSlaveInpVarInfoEx (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO_EX *pSlaveProcVarInfoEntriesEx,
    EC_T_WORD *pwReadEntries
)
Gets the input process variable extended information entries of a specific slave.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wNumOfVarsToRead** – [in] Number process variable entries that have been stored in pSlaveProcVarInfoEntries
- **pSlaveProcVarInfoEntriesEx** – [out] The read process variable extended information entries
- **pwReadEntries** – [out] The number of read process variable information entries

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or the output pointer is EC_NULL
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found

struct **EC_T_PROCESS_VAR_INFO_EX**

Public Members

EC_T_CHAR szName[MAX_PROCESS_VAR_NAME_LEN_EX]
 [out] Name of the found process variable

EC_T_WORD wDataType
 [out] Data type of the found process variable (according to ETG.1000, section 5). See also EcCommon.h, DEFTYPE_BOOLEAN

EC_T_WORD wFixedAddr
 [out] Station address of the slave that is owner of this variable

EC_T_INT nBitSize
 [out] Size in bit of the found process variable

EC_T_INT nBitOffs
 [out] Bit offset in the process data image

EC_T_BOOL bIsInputData
 [out] Determines whether the found process variable is an input variable or an output variable

EC_T_WORD wIndex
 [out] Object index

EC_T_WORD wSubIndex
 [out] Object sub index

EC_T_WORD wPdoIndex
 [out] Index of PDO (process data object)

EC_T_WORD wWkcStateDiagOffs

[out] Bit offset in the diagnostic image (emGetDiagnosisImagePtr)

EC_T_WORD wMasterSyncUnit

[out] Master Sync Unit (ENI: RxPdo[1..4]@Su, TxPdo[1..4]@Su)

EC_T_CYC_COPY_INFO CopyInfo

[out] Copy Info if applied to the variable

MAX_PROCESS_VAR_NAME_LEN_EX

Maximum length of a extended process variable name: 127 characters

6.4.15 emGetSlaveOutpVarInfoNumOf

```
static EC_T_DWORD ecatGetSlaveOutpVarInfoNumOf (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD *pwSlaveOutpVarInfoNumOf
)
EC_T_DWORD emGetSlaveOutpVarInfoNumOf (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD *pwSlaveOutpVarInfoNumOf
)
```

Gets the number of output variables of a specific slave.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **pwSlaveOutpVarInfoNumOf** – [out] Number of found process variables

Returns

EC_E_NOERROR or error code

See also:

- [emGetSlaveOutpVarInfo\(\)](#)
- [emGetSlaveOutpVarInfoEx\(\)](#)

6.4.16 emGetSlaveOutpVarInfo

```
static EC_T_DWORD ecatGetSlaveOutpVarInfo (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO *pSlaveProcVarInfoEntries,
    EC_T_WORD *pwReadEntries
)
```

```
EC_T_DWORD emGetSlaveOutpVarInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO *pSlaveProcVarInfoEntries,
    EC_T_WORD *pwReadEntries
)
```

) Gets the output process variable information entries of a specific slave.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wNumOfVarsToRead** – [in] Number of found process variable entries
- **pSlaveProcVarInfoEntries** – [out] The read process variable information entries
- **pwReadEntries** – [out] The number of read process variable information entries

Returns

EC_E_NOERROR or error code

See also:

EC_T_PROCESS_VAR_INFO

6.4.17 emGetSlaveOutpVarInfoEx

```
static EC_T_DWORD ecatGetSlaveOutpVarInfoEx (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO_EX *pSlaveProcVarInfoEntries,
    EC_T_WORD *pwReadEntries
)
```

```
EC_T_DWORD emGetSlaveOutpVarInfoEx (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO_EX *pSlaveProcVarInfoEntriesEx,
    EC_T_WORD *pwReadEntries
)
```

) Gets the output process variable extended information entries of a specific slave.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wNumOfVarsToRead** – [in] Number of process variable information entries

- **pSlaveProcVarInfoEntriesEx** – [out] The read process extended variable entries
- **pwReadEntries** – [out] The number of read process variable information entries

Returns*EC_E_NOERROR* or error code**See also:***EC_T_PROCESS_VAR_INFO_EX***6.4.18 emGetSlaveInpVarByObjectEx**

```
static EC_T_DWORD ecatGetSlaveInpVarByObjectEx (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wIndex,
    EC_T_WORD wSubIndex,
    EC_T_PROCESS_VAR_INFO_EX *pProcessVarInfoEntry
)
EC_T_DWORD emGetSlaveInpVarByObjectEx (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wIndex,
    EC_T_WORD wSubIndex,
    EC_T_PROCESS_VAR_INFO_EX *pProcessVarInfoEntry
)
Gets the input process variable extended information entry by object index, subindex of a specific slave.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wIndex** – [in] Object index
- **wSubIndex** – [in] Object sub index
- **pProcessVarInfoEntry** – [out] Process variable extended information entry

Returns*EC_E_NOERROR* or error code**See also:***EC_T_PROCESS_VAR_INFO_EX*

6.4.19 emGetSlaveOutpVarByObjectEx

```
static EC_T_DWORD ecatGetSlaveOutpVarByObjectEx (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wIndex,
    EC_T_WORD wSubIndex,
    EC_T_PROCESS_VAR_INFO_EX *pProcessVarInfoEntry
)
EC_T_DWORD emGetSlaveOutpVarByObjectEx (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wIndex,
    EC_T_WORD wSubIndex,
    EC_T_PROCESS_VAR_INFO_EX *pProcessVarInfoEntry
)
```

) Gets the input process variable extended information entry by object index, subindex of a specific slave.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wIndex** – [in] Object index
- **wSubIndex** – [in] Object sub index
- **pProcessVarInfoEntry** – [out] Process variable extended information entry

Returns

EC_E_NOERROR or error code

See also:

EC_T_PROCESS_VAR_INFO_EX

6.4.20 emFindInpVarByName

```
static EC_T_DWORD ecatFindInpVarByName (
    const EC_T_CHAR *szVariableName,
    EC_T_PROCESS_VAR_INFO *pProcessVarInfoEntry
)
EC_T_DWORD emFindInpVarByName (
    EC_T_DWORD dwInstanceID,
    const EC_T_CHAR *szVariableName,
    EC_T_PROCESS_VAR_INFO *pProcessVarInfoEntry
)
```

) Finds an input process variable information entry by the variable name.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **szVariableName** – [in] Variable name
- **pProcessVarInfoEntry** – [out] Process variable information entry

Returns*EC_E_NOERROR* or error code**See also:***EC_T_PROCESS_VAR_INFO***6.4.21 emFindInpVarByNameEx**

```
static EC_T_DWORD ecatFindInpVarByNameEx (
    const EC_T_CHAR *szVariableName,
    EC_T_PROCESS_VAR_INFO_EX *pProcessVarInfoEntry
)
EC_T_DWORD emFindInpVarByNameEx (
    EC_T_DWORD dwInstanceID,
    const EC_T_CHAR *szVariableName,
    EC_T_PROCESS_VAR_INFO_EX *pProcessVarInfoEntry
)
```

Finds an input process variable extended information entry by the variable name.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **szVariableName** – [in] Variable name
- **pProcessVarInfoEntry** – [out] Process variable extended information entry

Returns*EC_E_NOERROR* or error code**See also:***EC_T_PROCESS_VAR_INFO_EX***6.4.22 emFindOutpVarByName**

```
static EC_T_DWORD ecatFindOutpVarByName (
    const EC_T_CHAR *szVariableName,
    EC_T_PROCESS_VAR_INFO *pProcessVarInfoEntry
)
EC_T_DWORD emFindOutpVarByName (
    EC_T_DWORD dwInstanceID,
    const EC_T_CHAR *szVariableName,
    EC_T_PROCESS_VAR_INFO *pProcessVarInfoEntry
)
```

Finds an output process variable information entry by the variable name.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **szVariableName** – [in] Variable name
- **pProcessVarInfoEntry** – [out] Process variable information entry

Returns*EC_E_NOERROR* or error code

See also:[EC_T_PROCESS_VAR_INFO](#)

6.4.23 emFindOutpVarByNameEx

```
static EC_T_DWORD ecatFindOutpVarByNameEx (
    const EC_T_CHAR *szVariableName,
    EC\_T\_PROCESS\_VAR\_INFO\_EX *pProcessVarInfoEntry
)
EC_T_DWORD emFindOutpVarByNameEx (
    EC_T_DWORD dwInstanceID,
    const EC_T_CHAR *szVariableName,
    EC\_T\_PROCESS\_VAR\_INFO\_EX *pProcessVarInfoEntry
)
```

Finds an output process variable extended information entry by the variable name.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **szVariableName** – [in] Variable name
- **pProcessVarInfoEntry** – [out] Process variable extended information entry

Returns[EC_E_NOERROR](#) or error code**See also:**[EC_T_PROCESS_VAR_INFO_EX](#)

6.4.24 emTraceDataConfig

```
static EC_T_DWORD ecatTraceDataConfig (EC_T_WORD wTraceDataSize)
```

```
EC_T_DWORD emTraceDataConfig (
    EC_T_DWORD dwInstanceID,
    EC_T_WORD wTraceDataSize
)
```

Configures a trace data buffer and enables it for transmission.

Must be called after initialization and before configuration.

Note: If wTraceDataSize is too large, configuration will fail with return code [EC_E_XML_CYCCMDS_SIZEISMATCH](#).

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **wTraceDataSize** – [in] Size of Trace Data in bytes

Returns

- [EC_E_NOERROR](#) if successful
- [EC_E_INVALIDSTATE](#) if master isn't initialized

- *EC_E_INVALIDPARM* if dwInstanceID is out of range
- *EC_E_NOTSUPPORTED* if eCycFrameLayout_FIXED is configured

6.4.25 emTraceDataGetInfo

static EC_T_DWORD **ecatTraceDataGetInfo** (*EC_T_TRACE_DATA_INFO* *pTraceDataInfo)

```
EC_T_DWORD emTraceDataGetInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_TRACE_DATA_INFO *pTraceDataInfo
)
```

) Get information about the offset and size of trace data.

The trace data buffer is locate in *EC_T_TRACE_DATA_INFO.pbyData* at the byte offset *EC_T_TRACE_DATA_INFO.dwOffset*.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pTraceDataInfo** – [out] Information about trace data

Returns

EC_E_NOERROR or error code

struct **EC_T_TRACE_DATA_INFO**

Public Members

EC_T_BYTE *pbyData
[out] Process data output buffer, containing trace data

EC_T_DWORD dwOffset
[out] Trace data offset in bytes

EC_T_WORD wSize
[out] Trace data size in bytes

6.4.26 EC_COPYBITS

EC_COPYBITS (pbyDst, nDstBitOffs, pbySrc, nSrcBitOffs, nBitSize)

Copies a block of bits from a source buffer to a destination buffer.

Note: The memory buffers must be allocated before. The buffers must be big enough to hold the block starting at the given offsets! The buffers are not checked for overrun.

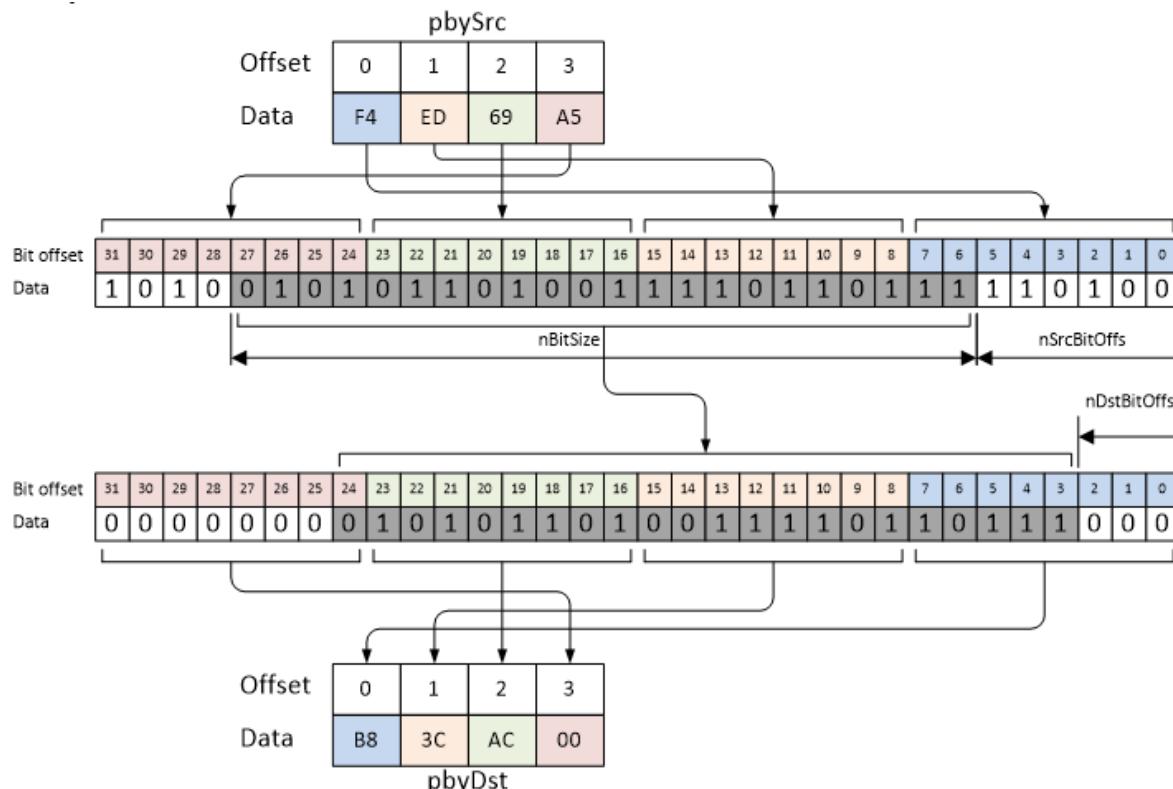
Parameters

- **pbyDst** – [out] Destination buffer
- **nDstBitOffs** – [in] Bit offset within destination buffer
- **pbySrc** – [in] Source buffer

- **nSrcBitOffs** – [in] Bit offset within source buffer
- **nBitSize** – [in] Block size in bits

See also:

- [EC_SETBITS](#)
- [EC_GETBITS](#)



```
EC_T_BYTE pbySrc[] = {0xF4, 0xED, 0x69, 0xA5};
EC_T_BYTE pbyDst[] = {0x00, 0x00, 0x00, 0x00};
EC_COPYBITS(pbyDst, 3, pbySrc, 6, 22);

/* pbyDst now contains 0xB8 0x3C 0xAC 0x00 */
```

6.4.27 EC_GET_FRM_WORD

EC_GET_FRM_WORD (ptr)

Reads a value of type EC_T_WORD (16 bit) at given pointer. The value is swapped on big endian systems.

Parameters

- **ptr** – [in] Source buffer

Returns

EC_T_WORD value (16 bit) from buffer.

```
EC_T_BYTE byFrame[] = {0x01, 0xF4, 0xDD, 0x85, 0x03, 0x00, 0x60, 0xC1, 0x00};
EC_T_WORD wResult = 0;

wResult = EC_GET_FRM_WORD(byFrame);
```

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```
/* wResult is 0xF401 on little endian systems */

wResult = EC_GET_FRM_WORD(byFrame + 5);
/* wResult is 0x6000 on little endian systems */

wResult = EC_GET_FRM_WORD(byFrame + 2);
/* wResult is 0x85DD on little endian systems */
```

6.4.28 EC_GET_FRM_DWORD

EC_GET_FRM_DWORD (ptr)

Reads a value of type EC_T_DWORD (32 bit) at given pointer. The value is swapped on big endian systems.

Parameters

- **ptr** – [in] Source buffer

Returns

EC_T_DWORD value (32 bit) from buffer.

```
EC_T_BYTE byFrame[] = {0x01, 0xF4, 0xDD, 0x85, 0x03, 0x00, 0x60, 0xC1, 0x00};
EC_T_DWORD dwResult = 0;

dwResult = EC_GET_FRM_DWORD(byFrame);
/* dwResult is 0x85DDF401 on little endian systems */

dwResult = EC_GET_FRM_DWORD(byFrame + 5);
/* dwResult is 0x00C16000 on little endian systems */

dwResult = EC_GET_FRM_DWORD(byFrame + 2);
/* dwResult is 0x000385DD on little endian systems */
```

6.4.29 EC_GET_FRM_QWORD

EC_GET_FRM_QWORD (ptr)

Reads a value of type EC_T_QWORD (64 bit) at given pointer. The value is swapped on big endian systems.

Parameters

- **ptr** – [in] Source buffer

Returns

EC_T_QWORD value (64 bit) from buffer.

```
EC_T_BYTE byFrame[] = {0x01, 0xF4, 0xDD, 0x85, 0x03, 0x00, 0x60, 0xC1, 0x00};
EC_T_UINT64 ui64Result = 0;

ui64Result = EC_GET_FRM_QWORD(byFrame + 1);
/* wResult is 0x00C16000385DDF4 on little endian systems */
```

6.4.30 EC_SET_FRM_WORD

EC_SET_FRM_WORD (ptr, w)

Writes a value of type EC_T_WORD (16 bit) at given pointer. The value is swapped on big endian systems.

Parameters

- **ptr** – [in] Destination buffer
- **w** – [in] 16 bit value

```
EC_T_BYTE byFrame[32];

/* Initialize the frame buffer */
OsMemset(byFrame, 0xFF, 32);

EC_SET_FRM_WORD (byFrame + 1, 0x1234);
/* byFrame = FF 34 12 FF FF FF ... */
```

6.4.31 EC_SET_FRM_DWORD

EC_SET_FRM_DWORD (ptr, dw)

Writes a value of type EC_T_DWORD (32 bit) at given pointer. The value is swapped on big endian systems.

Parameters

- **ptr** – [in] Destination buffer
- **dw** – [in] 32 bit value

```
EC_T_BYTE byFrame[32];

/* Initialize the frame buffer */
OsMemset(byFrame, 0xFF, 32);

EC_SET_FRM_DWORD (byFrame + 1, 0x12345678);
/* byFrame = FF 78 56 34 12 FF ... */
```

6.4.32 EC_SET_FRM_QWORD

EC_SET_FRM_QWORD (ptr, qw)

Writes a value of type EC_T_QWORD (64 bit) at given pointer. The value is swapped on big endian systems.

Parameters

- **ptr** – [in] Destination buffer
- **qw** – [in] 64 bit value

```
EC_T_BYTE byFrame[32];

/* Initialize the frame buffer */
OsMemset(byFrame, 0xFF, 32);

EC_SET_FRM_QWORD (byFrame + 1, 0xFEDCBA9876543210);
/* byFrame = FF 10 32 54 76 98 BA DC FE FF FF ... */
```

6.4.33 EC_GETBITS

EC_GETBITS (pbySrcBuf, pbyDstData, nSrcBitOffs, nBitSize)

Reads a given number of bits from source buffer starting at given bit offset to destination buffer.

Note: This function should be only used to get bit-aligned data. For byte-aligned data the corresponding functions should be used.

Parameters

- **pbySrcBuf** – [in] Source buffer to be copied
- **pbyDstData** – [out] Destination buffer where data is copied to
- **nSrcBitOffs** – [in] Source bit offset where data is copied from
- **nBitSize** – [in] Bit count to be copied

See also:

- [*EC_GET_FRM_WORD*](#)
- [*EC_GET_FRM_DWORD*](#)
- [*EC_GET_FRM_QWORD*](#)

6.4.34 EC_SETBITS

EC_SETBITS (pbyDstBuf, pbySrcData, nDstBitOffs, nBitSize)

Writes a given number of bits from source data starting at first bit to destination buffer at given bit offset.

Note: This function should be only used to set bit-aligned data. For byte-aligned data the corresponding functions should be used.

Parameters

- **pbyDstBuf** – [out] Destination buffer where data is copied to
- **pbySrcData** – [in] Source buffer to be copied, starting with first bit
- **nDstBitOffs** – [in] Destination bit offset where data is copied to
- **nBitSize** – [in] Bit count to be copied

See also:

- [*EC_SET_FRM_WORD*](#)
- [*EC_SET_FRM_DWORD*](#)
- [*EC_SET_FRM_QWORD*](#)

6.5 Generic notification interface

One of the parameters the client has to set when registering with the EtherCAT master is a generic notification callback function (`emNotify()`). The master calls this function every time a event (for example an error event) occurs about which the client has to be informed.

Within this callback function the client must not call any active EtherCAT functions which finally would lead to send EtherCAT commands (e.g. initiation of mailbox transfers, starting/stopping the master, sending raw commands). In such cases the behavior is undefined.

This callback function is usually called in the context of the EtherCAT master timer thread or the EtherCAT Link Layer receiver thread. It may also be called within the context of a user thread (when calling an EtherCAT master function). To avoid dead-lock situations the notification callback handler may not use mutex semaphores.

As the whole EtherCAT operation is blocked while calling this function the error handling must not use much CPU time or even call operating system functions that may block. Usually the error handling will be done in a separate application thread.

6.5.1 Notification callback: `emNotify`

When a client registers with the EtherCAT master the client has to determine a generic notification callback function. The master calls this function every time an event (for example an error event or operational state change event) occurs about which the client has to be informed. Within this callback function the client must not call any active EtherCAT functions which finally would lead to send EtherCAT commands (e.g. initiation of mailbox transfers, starting/stopping the master, sending raw commands). In such cases the behavior is undefined. Only EtherCAT functions which are explicitly marked to be callable within `emNotify()` may be called.

A further important rule exists due to the fact that this callback function is usually called in the context of the EtherCAT master timer thread. As the whole EtherCAT operation is blocked while calling this function the notification handler must not use much CPU time or even call operating system functions that may block. Time consuming operations should be executed in separate application threads.

```
typedef EC_T_DWORD (*EC_PF_NOTIFY)(EC_T_DWORD dwCode, EC_T_NOTIFYPARMS *pParms)
```

```
struct EC_T_NOTIFYPARMS
```

Public Members

`EC_T_VOID *pCallerData`

[in] Client depending caller data parameter. This pointer is one of the parameters when the client registers

`EC_T_BYTE *pbyInBuf`

[in] Notification input parameters

`EC_T_DWORD dwInBufSize`

[in] Size of input buffer in byte

`EC_T_BYTE *pbyOutBuf`

[out] Notification output (result)

`EC_T_DWORD dwOutBufSize`

[in] Size of output buffer in byte

`EC_T_DWORD *pdwNumOutData`

[out] Amount of bytes written to the output buffer

6.5.2 emNotify - EC_NOTIFY_STATECHANGED

Notification about a change in the master's operational state. This notification is enabled by default.

emNotify - EC_NOTIFY_STATECHANGED

Parameter

- pbyInBuf: [in] Pointer to data of type EC_T_STATECHANGE which contains the old and the new master operational state.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct **EC_T_STATECHANGE**

Public Members

EC_T_STATE oldState
old operational state

EC_T_STATE newState
new operational state

See also:

[emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED](#) for how to control the deactivation

6.5.3 emNotify - EC_NOTIFY_XXXX

Notification about an error.

emNotify - EC_NOTIFY_XXXX

Parameter

- pbyInBuf: [in] Pointer to data of type EC_T_ERROR_NOTIFICATION_DESC.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

See also:

[Diagnosis, error detection, error notifications](#)

6.5.4 Feature Pack Master Redundancy Notifications

See also:

Feature Pack “Master Redundancy”

6.5.5 emNotifyApp

By calling this function the generic notification callback function setup by `emRegisterClient()` is called for all clients including RAS.

```
static EC_T_DWORD ecatNotifyApp(EC_T_DWORD dwCode, EC_T_NOTIFYPARMS *pParms)
```

```
EC_T_DWORD emNotifyApp (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwCode,
    EC_T_NOTIFYPARMS *pParms
)
```

) Calls the notification callback functions of all registered clients.

Note: EC_E_ERROR and EC_E_INVALIDPARM from registered clients' callback functions are ignored.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwCode** – [in] Application specific notification code. dwCode must be <= EC_NOTIFY_APP_MAX_CODE. The callback functions get “EC_NOTIFY_APP | dwCode” as parameter.
- **pParms** – [in] Parameter to all callback functions. Note: Output parameters are not transferred from RAS client to RAS server.

Returns

`EC_E_ERROR` or first error code different from EC_E_ERROR and EC_E_INVALIDPARM of registered clients' callback functions

The maximum value for dwCode is defined by EC_NOTIFY_APP_MAX_CODE

6.5.6 emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED

The following notifications can be enabled or disabled.

- *emNotify* - `EC_NOTIFY_SLAVE_STATECHANGED` (default Off)
- *emNotify* - `EC_NOTIFY_SLAVES_STATECHANGED` (default Off)
- *emNotify* - `EC_NOTIFY_SLAVE_UNEXPECTED_STATE` (default On)
- *emNotify* - `EC_NOTIFY_SLAVES_UNEXPECTED_STATE` (default Off)
- *emNotify* - `EC_NOTIFY_SLAVE_PRESENCE` (default On)
- *emNotify* - `EC_NOTIFY_SLAVES_PRESENCE` (default Off)
- *emNotify* - `EC_NOTIFY_SLAVE_ERROR_STATUS_INFO` (default On)
- *emNotify* - `EC_NOTIFY_SLAVES_ERROR_STATUS` (default Off)
- *emNotify* - `EC_NOTIFY_NOT_ALL_DEVICES_OPERATIONAL` (default On)
- *emNotify* - `EC_NOTIFY_CYCCMD_WKC_ERROR` (default On)

- *emNotify* - ***EC_NOTIFY_SB_MISMATCH*** (default On)
- *emNotify* - ***EC_NOTIFY_SB_STATUS*** (default On)
- *emNotify* - ***EC_NOTIFY_STATUS_SLAVE_ERROR*** (default On)
- *emNotify* - ***EC_NOTIFY_FRAME_RESPONSE_ERROR*** (default On)
- *emNotify* - ***EC_NOTIFY_HC_TOPOCHGDONE*** (default On)
- *emNotify* - ***EC_NOTIFY_STATECHANGED*** (default On)
- *emNotify* - ***EC_NOTIFY_COE_INIT_CMD*** (default Off)
- ***EC_NOTIFY_JUNCTION_RED_CHANGE*** (default Off)
- *emNotify* - ***EC_NOTIFY_ALL_DEVICES_OPERATIONAL*** (default Off)
- ***EC_NOTIFY_DC_STATUS*** (default On)
- ***EC_NOTIFY_DC_SLV_SYNC*** (default On)
- ***EC_NOTIFY_DCM_SYNC*** (default On)
- *emNotify* - ***EC_NOTIFY_SLAVE_INITCMD_RESPONSE_ERROR*** (default On)
- ***EC_NOTIFY_REF_CLOCK_PRESENCE*** (default Off)
- ***EC_NOTIFY_DCX_SYNC*** (default On)
- ***EC_NOTIFY_HC_DETECTADDGROUPS*** (default On)
- *emNotify* - ***EC_NOTIFY_FRAMELOSS_AFTER_SLAVE*** (default On)
- *emNotify* - ***EC_NOTIFY_ETH_LINK_NOT_CONNECTED*** (default On)
- *emNotify* - ***EC_NOTIFY_S2SMBX_ERROR*** (default On)
- *emNotify* - ***EC_NOTIFY_SLAVE_INITCMD_WKC_ERROR*** (default On)
- *emNotify* - ***EC_NOTIFY_BAD_CONNECTION*** (default On)

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED

Parameter

- pbyInBuf: [in] pointer to **EC_T_SET_NOTIFICATION_ENABLED_PARMS**.
- dwInBufSize: [in] size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to **EC_NULL**
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to **EC_NULL**

Return

EC_E_NOERROR or error code

struct **EC_T_SET_NOTIFICATION_ENABLED_PARMS**

Public Members

EC_T_DWORD dwClientId
 [in] Client ID, 0: Master

EC_T_DWORD dwCode
 [in] Notification code or EC_ALL_NOTIFICATIONS

EC_T_DWORD dwEnabled
 [in] Enable, disable or reset to default notification. See EC_NOTIFICATION_flags

Notifications are given to clients if enabled for dwClientId = 0 AND corresponding dwClientId.

6.5.7 emIoControl - EC_IOCTL_GET_NOTIFICATION_ENABLED

The enabled state of notifications can be retrieved using *emIoControl - EC_IOCTL_GET_NOTIFICATION_ENABLED*.

emIoControl - EC_IOCTL_GET_NOTIFICATION_ENABLED

Parameter

- pbyInBuf: [in] pointer to EC_T_GET_NOTIFICATION_ENABLED_PARMS.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Pointer to EC_T_BOOL to carry out current enable set.
- dwOutBufSize: [in] Size of the output buffer provided at pbyOutBuf in bytes.
- pdwNumOutData: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

struct **EC_T_GET_NOTIFICATION_ENABLED_PARMS**

Public Members

EC_T_DWORD dwClientId
 [in] Client ID, 0: Master

EC_T_DWORD dwCode
 [in] Notification code

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED

6.6 Slave control and status functions

6.6.1 emGetNumConfiguredSlaves

```
static EC_T_DWORD ecatGetNumConfiguredSlaves (EC_T_VOID)
EC_T_DWORD emGetNumConfiguredSlaves (EC_T_DWORD dwInstanceID)
    Returns number of slaves which are configured in the ENI.
```

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

Number of slaves

6.6.2 emGetNumConnectedSlaves

```
static EC_T_DWORD ecatGetNumConnectedSlaves (EC_T_VOID)
EC_T_DWORD emGetNumConnectedSlaves (EC_T_DWORD dwInstanceID)
    Get amount of currently connected slaves.
```

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

Number of connected slaves

6.6.3 emGetSlaveId

```
static EC_T_DWORD ecatGetSlaveId (EC_T_WORD wStationAddress)
EC_T_DWORD emGetSlaveId (EC_T_DWORD dwInstanceID, EC_T_WORD wStationAddress)
    Determines the slave ID using the slave station address.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **wStationAddress** – [in] Station address of the slave

Returns

Slave ID or INVALID_SLAVE_ID if the slave could not be found or stack is not initialized

6.6.4 emGetSlaveIdAtPosition

```
static EC_T_DWORD ecatGetSlaveIdAtPosition (EC_T_WORD wAutoIncAddress)
```

```
EC_T_DWORD emGetSlaveIdAtPosition (
    EC_T_DWORD dwInstanceID,
    EC_T_WORD wAutoIncAddress
)
```

Determines the slave ID using the slave auto increment address.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **wAutoIncAddress** – [in] Auto increment address of the slave

Returns

Slave ID or INVALID_SLAVE_ID if no slave matching wAutoIncAddress can be found

6.6.5 emSetSlaveState

```
static EC_T_DWORD ecatSetSlaveState (
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wNewReqDevState,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emSetSlaveState (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wNewReqDevState,
    EC_T_DWORD dwTimeout
)
```

Set a specified slave into the requested state.

The requested state shall not be higher than the overall operational state. DEVICE_STATE_BOOTSTRAP can only be requested if the slave's state is INIT. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **wNewReqDevState** – [in] Requested state
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized or denies the requested state, see comments below
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or BOOTSTRAP was requested for a slave that does not support it
- *EC_E_NOTFOUND* if no slave matching dwSlaveId can be found
- *EC_E_TIMEOUT* if dwTimeout elapsed during the API call
- *EC_E_BUSY* if the master cannot execute the request at this time, the function has to be called at a later time
- *EC_E_NOTREADY* if the working counter was not set when requesting the slave's state (slave may not be connected or did not respond)
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

DEVICE_STATE_UNKNOWN

Slave in unknown state

DEVICE_STATE_INIT

Slave in INIT state

DEVICE_STATE_PREOP
Slave in PREOP state

DEVICE_STATE_BOOTSTRAP
Slave in BOOTSTRAP state

DEVICE_STATE_SAFEOP
Slave in SAFEOP state

DEVICE_STATE_OP
Slave in OP state

DEVICE_STATE_ERROR
Slave in error state

See also:

[emGetSlaveId\(\)](#)

6.6.6 emGetSlaveState

```
static EC_T_DWORD ecatGetSlaveState (
    EC_T_DWORD dwSlaveId,
    EC_T_WORD *pwCurrDevState,
    EC_T_WORD *pwReqDevState
)
EC_T_DWORD emGetSlaveState (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD *pwCurrDevState,
    EC_T_WORD *pwReqDevState
)
    Get the slave state.
```

The slave state is always read automatically from the AL_STATUS register whenever necessary. It is not forced by calling this function. This function may be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **pwCurrDevState** – [out] Current slave state.
- **pwReqDevState** – [out] Requested slave state

Returns

- [*EC_E_NOERROR*](#) if successful.
- [*EC_E_INVALIDSTATE*](#) if master isn't initialized
- [*EC_E_INVALIDPARAM*](#) if dwInstanceID is out of range or the output pointers are `EC_NULL`
- [*EC_E_SLAVE_NOT_PRESENT*](#) if slave not present.
- [*EC_E_NOTFOUND*](#) if no slave matching dwSlaveId can be found

See also:

- `emGetSlaveId()`
- `emSetSlaveState()`

6.6.7 emIsSlavePresent

This function may be called from within the JobTask. Since Slave Id is a parameter, valid response only can be retrieved after calling `emConfigureNetwork()`.

```
static EC_T_DWORD ecatIsSlavePresent (
    EC_T_DWORD dwSlaveId,
    EC_T_BOOL *pbPresence
)
EC_T_DWORD emIsSlavePresent (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_BOOL *pbPresence
)
```

Returns whether a specific slave is currently connected to the Bus.

This function may be called from within the JobTask.

Parameters

- `dwInstanceID` – [in] Instance ID (Multiple EtherCAT Network Support)
- `dwSlaveId` – [in] Slave ID
- `pbPresence` – [out] EC_TRUE if slave is currently connected to the bus, EC_FALSE if not.

Returns

- `EC_E_NOERROR` if successful
- `EC_E_INVALIDSTATE` if master isn't initialized
- `EC_E_INVALIDPARM` if dwInstanceID is out of range
- `EC_E_NOTFOUND` if no slave matching dwSlaveId can be found

See also:

`emGetSlaveId()`

6.6.8 emGetSlaveProp

```
static EC_T_BOOL ecatGetSlaveProp (
    EC_T_DWORD dwSlaveId,
    EC_T_SLAVE_PROP *pSlaveProp
)
EC_T_BOOL emGetSlaveProp (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_SLAVE_PROP *pSlaveProp
)
```

Determines the properties of the slave device.

Deprecated:

Use `emGetCfgSlaveInfo` instead

Parameters

- **`dwInstanceID`** – [in] Instance ID (Multiple EtherCAT Network Support)
- **`dwSlaveId`** – [in] Slave ID
- **`pSlaveProp`** – [out] Slave properties

Returns

`EC_TRUE` if the slave exists, `EC_FALSE` if no slave matching `dwSlaveId` can be found

See also:

[`emGetSlaveId\(\)`](#)

6.6.9 `emSlaveSerializeMbxTfers`

static EC_T_DWORD **`ecatSlaveSerializeMbxTfers`** (EC_T_DWORD dwSlaveId)

```
EC_T_DWORD emSlaveSerializeMbxTfers (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId
)
```

Serializes all mailbox transfers to the specified slave.

The parallel (overlapped) usage of more than one protocol (CoE, EoE, FoE, etc.) will be disabled. By default parallel mailbox transfers are enabled.

Parameters

- **`dwInstanceID`** – [in] Instance ID (Multiple EtherCAT Network Support)
- **`dwSlaveId`** – [in] Slave ID

Returns

- [`EC_E_NOERROR`](#) if successful
- [`EC_E_INVALIDSTATE`](#) if master isn't initialized
- [`EC_E_INVALIDPARM`](#) if `dwInstanceID` is out of range
- [`EC_E_NOTFOUND`](#) if no slave matching `dwSlaveId` can be found
- [`EC_E_NO_MBX_SUPPORT`](#) if slave does not support mailbox transfers

See also:

[`emGetSlaveId\(\)`](#)

6.6.10 emSlaveParallelMbxTfers

static EC_T_DWORD **ecatSlaveParallelMbxTfers** (EC_T_DWORD dwSlaveId)

```
EC_T_DWORD emSlaveParallelMbxTfers (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId
)
```

Re-enable the parallel mailbox transfers to the specified slave.

Allows parallel (overlapped) usage of more than one protocol (CoE, EoE, FoE, etc.). By default parallel mailbox transfers are enabled.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range
- *EC_E_NOTFOUND* if no slave matching dwSlaveId can be found
- *EC_E_NO_MBX_SUPPORT* if slave does not support mailbox transfers

See also:

[emGetSlaveId \(\)](#)

6.6.11 emIoControl - EC_IOCTL_SET_MBX_RETRYACCESS_PERIOD

Sets the mailbox retry access period in milliseconds for a specific slave. If a slave rejects a mailbox access because of a busy state, the master restarts mailbox access after that period of time.

emIoControl - EC_IOCTL_SET_MBX_RETRYACCESS_PERIOD

Parameter

- pbyInBuf: [in] Pointer to a size 6 byte array. The first 4 bytes must contain the slave id (EC_T_DWORD), the last 2 bytes the new retry access period in milliseconds(EC_T_WORD).
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

By default, the retry access period is set to 25 milliseconds.

6.6.12 emNotify - EC_NOTIFY_SLAVE_STATECHANGED

This notification is given, when a slave changed its EtherCAT state. This notification is disabled by default.

emNotify - EC_NOTIFY_SLAVE_STATECHANGED

Parameter

- pbyInBuf: [in] Pointer to EC_T_SLAVE_STATECHANGED_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

```
struct EC_T_SLAVE_STATECHANGED_NTFY_DESC
```

Public Members

EC_T_SLAVE_PROP **SlaveProp**
Slave properties

EC_T_STATE **newState**
New slave state

See also:

[emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED](#) for how to control the activation

6.6.13 emNotify - EC_NOTIFY_SLAVES_STATECHANGED

Collects [emNotify - EC_NOTIFY_SLAVE_STATECHANGED](#)

This notification is disabled by default.

See also:

[emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED](#) for how to control the activation

emNotify - EC_NOTIFY_SLAVES_STATECHANGED

Parameter

- pbyInBuf: [in] Pointer to EC_T_SLAVES_STATECHANGED_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

```
struct EC_T_SLAVES_STATECHANGED_NTFY_DESC_ENTRY
```

Public Members

EC_T_WORD wStationAddress
Slave station address

EC_T_BYTEx byState
New slave state

6.6.14 emWriteSlaveRegister

```
static EC_T_DWORD ecatWriteSlaveRegister (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emWriteSlaveRegister (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen,
    EC_T_DWORD dwTimeout
)
```

Writes data into the ESC memory of a specified slave.

This function may not be called from within the JobTask's context

Warning: Changing contents of ESC registers may lead to unpredictable behavior of the slaves and/or the master.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wRegisterOffset** – [in] Register offset, e.g. use 0x0120 to write to the AL Control register.
- **pbyData** – [in] Buffer containing transferred data
- **wLen** – [in] Number of bytes to send
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized

- *EC_E_INVALIDPARM* if dwInstanceID is out of range or the command is not supported or the timeout value is set to EC_NOWAIT
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found
- *EC_E_TIMEOUT* if dwTimeout elapsed during the API call
- *EC_E_BUSY* another transfer request is already pending or the master or the corresponding slave is currently changing its operational state
- *EC_E_NOTREADY* if the working counter was not set when sending the command (slave may not be connected or did not respond)
- *EC_E_INVALIDSIZE* if the size of the complete command does not fit into a single Ethernet frame. The maximum amount of data to transfer must not exceed 1486 bytes

6.6.15 emWriteSlaveRegisterReq

```
static EC_T_DWORD ecatWriteSlaveRegisterReq (
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
EC_T_DWORD emWriteSlaveRegisterReq (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
```

) Requests a data write transfer into the ESC memory of a specified slave and returns immediately.

A notification EC_NOTIFY_SLAVE_REGISTER_TRANSFER is given on completion. This function may be called from within the JobTask's context.

Warning: Changing contents of ESC registers may lead to unpredictable behavior of the slaves and/or the master.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **dwTferId** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within *EC_T_SLAVEREGISTER_TRANSFER_NTFY_DESC*
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address

- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wRegisterOffset** – [in] Register offset. I.e. use 0x0120 to write to the AL Control register
- **pbyData** – [in] Buffer containing transferred data
- **wLen** – [in] Number of bytes to send

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or the command is not supported or the timeout value is set to EC_NOWAIT
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found
- *EC_E_INVALIDSIZE* if the size of the complete command does not fit into a single Ethernet frame. The maximum amount of data to transfer must not exceed 1486 bytes

See also:

emNotify - EC_NOTIFY_SLAVE_REGISTER_TRANSFER

6.6.16 emReadSlaveRegister

```
static EC_T_DWORD ecatReadSlaveRegister (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReadSlaveRegister (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen,
    EC_T_DWORD dwTimeout
)
```

Reads data from the ESC memory of a specified slave.

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wRegisterOffset** – [in] Register offset. I.e. use 0x0130 to read the AL Status register.

- **pbyData** – [out] Buffer receiving transferred data
- **wLen** – [in] Number of bytes to receive
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or the command is not supported or the timeout value is set to EC_NOWAIT
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found
- *EC_E_TIMEOUT* if dwTimeout elapsed during the API call
- *EC_E_BUSY* another transfer request is already pending or the master or the corresponding slave is currently changing its operational state
- *EC_E_NOTREADY* if the working counter was not set when sending the command (slave may not be connected or did not respond)
- *EC_E_INVALIDSIZE* if the size of the complete command does not fit into a single Ethernet frame. The maximum amount of data to transfer must not exceed 1486 bytes

6.6.17 emReadSlaveRegisterReq

```
static EC_T_DWORD ecatReadSlaveRegisterReq (
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
EC_T_DWORD emReadSlaveRegisterReq (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wRegisterOffset,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
```

) Requests data read transfer from the ESC memory of a specified slave and returns immediately.

A notification *EC_NOTIFY_SLAVE_REGISTER_TRANSFER* is given on completion. This function may be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).

- **dwTransferId** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within [EC_T_SLAVEREGISTER_TRANSFER_NTFY_DESC](#)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wRegisterOffset** – [in] Register offset, e.g. use 0x0130 to read the AL Status register.
- **pbyData** – [out] Buffer receiving transferred data
- **wLen** – [in] Number of bytes to receive

Returns

- [EC_E_NOERROR](#) if successful.
- [EC_E_INVALIDSTATE](#) if master isn't initialized
- [EC_E_INVALIDPARAM](#) if dwInstanceID is out of range or the command is not supported or the timeout value is set to EC_NOWAIT
- [EC_E_SLAVE_NOT_PRESENT](#) if slave not present.
- [EC_E_NOTFOUND](#) if no slave matching bFixedAddressing / wSlaveAddress can be found
- [EC_E_INVALIDSIZE](#) if the size of the complete command does not fit into a single Ethernet frame. The maximum amount of data to transfer must not exceed 1486 bytes.

See also:

[emNotify - EC_NOTIFY_SLAVE_REGISTER_TRANSFER](#)

6.6.18 emNotify - EC_NOTIFY_SLAVE_REGISTER_TRANSFER

This notification is given, when a slave register transfer is completed.

[emNotify - EC_NOTIFY_SLAVE_REGISTER_TRANSFER](#)

Parameter

- pbyInBuf: [in] Pointer to [EC_T_SLAVEREGISTER_TRANSFER_NTFY_DESC](#)
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct [EC_T_SLAVEREGISTER_TRANSFER_NTFY_DESC](#)

Public Members

EC_T_DWORD dwTferId

Transfer ID. For every new slave register transfer a unique ID has to be assigned. This ID can be used after completion to identify the transfer

EC_T_DWORD dwResult

Result of Slave register transfer

EC_T_BOOL bRead

EC_TRUE: Read register, EC_FALSE: Write register transfer

EC_T_WORD wFixedAddr

Station address of slave

EC_T_WORD wRegisterOffset

Register offset

EC_T_WORD wLen

Length of slave register transfer

EC_T_BYT *pbyData

Pointer to the data read

EC_T_WORD wWkc

Received working counter

6.6.19 emReadSlaveEEPROM

```
static EC_T_DWORD ecatReadSlaveEEPROM (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPROMStartOffset,
    EC_T_WORD *pwReadData,
    EC_T_DWORD dwReadLen,
    EC_T_DWORD *pdwNumOutData,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReadSlaveEEPROM (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPROMStartOffset,
    EC_T_WORD *pwReadData,
    EC_T_DWORD dwReadLen,
    EC_T_DWORD *pdwNumOutData,
    EC_T_DWORD dwTimeout
)
```

Read EEPROM data from slave.

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)

- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wEEPROMStartOffset** – [in] Word address to start EEPROM read from
- **pwReadData** – [in] Pointer to EC_T_WORD array to carry the read data
- **dwReadLen** – [in] Size of the EC_T_WORD array provided at pwReadData (in EC_T_WORDS)
- **pdwNumOutData** – [out] Pointer to EC_T_DWORD carrying actually read data (in EC_T_WORDS) after completion
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Returns*EC_E_NOERROR* or error code

6.6.20 emReadSlaveEEPROMReq

```
static EC_T_DWORD ecatReadSlaveEEPROMReq (
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPROMStartOffset,
    EC_T_WORD *pwReadData,
    EC_T_DWORD dwReadLen,
    EC_T_DWORD *pdwNumOutData,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReadSlaveEEPROMReq (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPROMStartOffset,
    EC_T_WORD *pwReadData,
    EC_T_DWORD dwReadLen,
    EC_T_DWORD *pdwNumOutData,
    EC_T_DWORD dwTimeout
)
```

Requests a EEPROM data read operation from slave and returns immediately.

A EC_NOTIFY_EEPROM_OPERATION is given on completion or timeout. This function may be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **dwTferId** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within *EC_T_EEPROM_OPERATION_NTFY_DESC*

- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wEEPROMStartOffset** – [in] Word address to start EEPROM read from
- **pwReadData** – [out] Pointer to EC_T_WORD array to carry the read data, must be valid until the operation complete
- **dwReadLen** – [in] Size of the EC_T_WORD array provided at pwReadData (in EC_T_WORDS)
- **pdwNumOutData** – [out] Pointer to EC_T_DWORD carrying actually read data (in EC_T_WORDS) after completion
- **dwTimeout** – [in] Timeout [ms]

Returns*EC_E_NOERROR* or error code**See also:***emNotify - EC_NOTIFY_EEPROM_OPERATION***6.6.21 emWriteSlaveEEPROM**

```
static EC_T_DWORD ecatWriteSlaveEEPROM (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPROMStartOffset,
    EC_T_WORD *pwWriteData,
    EC_T_DWORD dwWriteLen,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emWriteSlaveEEPROM (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPROMStartOffset,
    EC_T_WORD *pwWriteData,
    EC_T_DWORD dwWriteLen,
    EC_T_DWORD dwTimeout
)
    Write EEPROM data to slave.
```

The EEPROM's CRC is updated automatically. *emResetSlaveController()* is needed to reload the alias address in register 0x12. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wEEPROMStartOffset** – [in] Word address to start EEPROM Write from
- **pwWriteData** – [in] Pointer to WORD array carrying the write data
- **dwWriteLen** – [in] Size of Write Data WORD array (in WORDS)

- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Returns*EC_E_NOERROR* or error code**See also:**`emResetSlaveController()`

6.6.22 emWriteSlaveEEPromReq

```
static EC_T_DWORD ecatWriteSlaveEEPromReq(
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPromStartOffset,
    EC_T_WORD *pwWriteData,
    EC_T_DWORD dwWriteLen,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emWriteSlaveEEPromReq(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wEEPromStartOffset,
    EC_T_WORD *pwWriteData,
    EC_T_DWORD dwWriteLen,
    EC_T_DWORD dwTimeout
)
```

) Requests a EEPROM data write operation from slave and returns immediately.

The EEPROM's CRC is updated automatically. A reset of the slave controller is needed to reload the alias address in register 0x12. A *EC_NOTIFY_EEPROM_OPERATION* is given on completion or timeout. This function may be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **dwTferId** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within *EC_T_EEPROM_OPERATION_NTFY_DESC*
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wEEPromStartOffset** – [in] Word address to start EEPROM Write from.
- **pwWriteData** – [in] Pointer to WORD array carrying the write data, must be valid until operation complete
- **dwWriteLen** – [in] Size of Write Data WORD array (in WORDS)
- **dwTimeout** – [in] Timeout [ms]

Returns*EC_E_NOERROR* or error code**See also:**

- *emResetSlaveController()*
- *emNotify - EC_NOTIFY EEPROM_OPERATION*

6.6.23 emAssignSlaveEEProm

```
static EC_T_DWORD ecatAssignSlaveEEProm (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bSlavePDIAccessEnable,
    EC_T_BOOL bForceAssign,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emAssignSlaveEEProm (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bSlavePDIAccessEnable,
    EC_T_BOOL bForceAssign,
    EC_T_DWORD dwTimeout
)
    Set EEPROM Assignment to PDI or EtherCAT Master.
```

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **bSlavePDIAccessEnable** – [in] EC_TRUE: EEPROM assigned to slave PDI application, EC_FALSE: EEPROM assigned to EC-Master
- **bForceAssign** – [in] Force Assignment of EEPROM (only for ECat Master Assignment)
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Returns*EC_E_NOERROR* or error code

6.6.24 emAssignSlaveEEPromReq

```
static EC_T_DWORD ecatAssignSlaveEEPromReq (
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bSlavePDIAccessEnable,
    EC_T_BOOL bForceAssign,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emAssignSlaveEEPromReq (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bSlavePDIAccessEnable,
    EC_T_BOOL bForceAssign,
    EC_T_DWORD dwTimeout
)
```

Requests EEPROM Assignment to PDI or EtherCAT Master operation and return immediately.

`EC_NOTIFY_EEPROM_OPERATION` is given on completion or timeout. This function may be called from within the JobTask's context.

Parameters

- **`dwInstanceID`** – [in] Instance ID (Multiple EtherCAT Network Support)
- **`dwClientId`** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **`dwTferId`** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within [`EC_T_EEPROM_OPERATION_NTFY_DESC`](#)
- **`bFixedAddressing`** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **`wSlaveAddress`** – [in] Slave address according bFixedAddressing
- **`bSlavePDIAccessEnable`** – [in] EC_TRUE: EEPROM assigned to slave PDI application, EC_FALSE: EEPROM assigned to EC-Master
- **`bForceAssign`** – [in] Force Assignment of EEPROM (only for ECat Master Assignment)
- **`dwTimeout`** – [in] Timeout [ms]

Returns

[`EC_E_NOERROR`](#) or error code

See also:

`emNotify` - [`EC_NOTIFY_EEPROM_OPERATION`](#)

6.6.25 emActiveSlaveEEPROM

```
static EC_T_DWORD ecatActiveSlaveEEPROM (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL *pbSlavePDIAccessActive,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emActiveSlaveEEPROM (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL *pbSlavePDIAccessActive,
    EC_T_DWORD dwTimeout
)
Check whether EEPROM is marked access active by Slave PDI application.
```

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **pbSlavePDIAccessActive** – [out] Pointer to Boolean value: EC_TRUE: EEPROM active by PDI application, EC_FALSE: EEPROM not active
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. The timeout value must not be set to EC_NOWAIT

Returns

EC_E_NOERROR or error code

6.6.26 emActiveSlaveEEPROMReq

```
static EC_T_DWORD ecatActiveSlaveEEPROMReq (
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL *pbSlavePDIAccessActive,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emActiveSlaveEEPROMReq (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL *pbSlavePDIAccessActive,
    EC_T_DWORD dwTimeout
)
Requests EEPROM is marked access active by Slave PDI application check and returns immediately.
```

A EC_NOTIFY_EEPROM_OPERATION is given on completion or timeout. This function may be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **dwTransferId** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within *EC_T_EEPROM_OPERATION_NTFY_DESC*
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **pbSlavePDIAccessActive** – [out] Pointer to Boolean value: EC_TRUE: EEPROM active by PDI application, EC_FALSE: EEPROM not active. Must be valid until operation complete
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Returns

EC_E_NOERROR or error code

See also:

emNotify - EC_NOTIFY_EEPROM_OPERATION

6.6.27 emReloadSlaveEEProm

```
static EC_T_DWORD ecatReloadSlaveEEProm (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReloadSlaveEEProm (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwTimeout
)
```

Causes a slave to reload its EEPROM values to ESC registers.

Alias address at 0x12 is not reloaded through this command, this is prevented by the slave hardware. The slave controller must be reset to reload the alias address. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. The timeout value must not be set to EC_NOWAIT

Returns*EC_E_NOERROR* or error code**See also:***emResetSlaveController()***6.6.28 emReloadSlaveEEPROMReq**

```
static EC_T_DWORD ecatReloadSlaveEEPROMReq (
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReloadSlaveEEPROMReq (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwTimeout
)
```

Request a slave to reload its EEPROM values to ESC registers, and returns immediately.

Alias address at 0x12 is not reloaded through this command, this is prevented by the slave hardware. The slave controller must be reset to reload the alias address. A *EC_NOTIFY_EEPROM_OPERATION* is given on completion or timeout. This function may be called from within the JobTask's context.

Parameters

- **`dwInstanceID`** – [in] Instance ID (Multiple EtherCAT Network Support)
- **`dwClientId`** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **`dwTferId`** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within *EC_T_EEPROM_OPERATION_NTFY_DESC*
- **`bFixedAddressing`** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **`wSlaveAddress`** – [in] Slave address according bFixedAddressing
- **`dwTimeout`** – [in] Timeout [ms]

Returns*EC_E_NOERROR* or error code**See also:**

- *emNotify - EC_NOTIFY_EEPROM_OPERATION*
- *emResetSlaveController()*

6.6.29 emNotify - EC_NOTIFY_EEPROM_OPERATION

This notification is given, when a slave EEPROM operation is completed.

emNotify - EC_NOTIFY_EEPROM_OPERATION

Parameter

- pbyInBuf: [in] Pointer to EC_T_EEPROM_OPERATION_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

```
struct EC_T_EEPROM_OPERATION_NTFY_DESC
```

Public Members

EC_T_DWORD dwTransferId

Transfer ID. For every new EEPROM operation a unique ID has to be assigned. This ID can be used after completion to identify the transfer

EC_T_EEPROM_OPERATION_TYPE eType

Type of EEPROM operation

EC_T_DWORD dwResult

Result of EEPROM operation

EC_T_SLAVE_PROP SlaveProp

Slave properties

```
union _EC_T_EEPROM_OPERATION_NTFY_DESC_RESULT
```

```
struct _EC_T_EEPROM_OPERATION_NTFY_DESC_RESULT_ACTIVE
```

Public Members

EC_T_BOOL bSlavePDIAccessActive

EC_TRUE: EEPROM active by PDI application, EC_FALSE: EEPROM not active

```
struct _EC_T_EEPROM_OPERATION_NTFY_DESC_RESULT_READ
```

Public Members**EC_T_WORD wEEPROMStartOffset**

Start address of EEPROM operation. Given by API

EC_T_WORD *pwData

Pointer to WORD array contains the data. Given by API

EC_T_DWORD dwReadLen

Number of Words to be read. Given by API

EC_T_DWORD dwNumOutData

Number of Words actually read from EEPROM

struct **_EC_T_EEPROM_OPERATION_NTFY_DESC_RESULT_WRITE****Public Members****EC_T_WORD wEEPROMStartOffset**

Start address of EEPROM operation. Given by API

EC_T_WORD *pwData

Pointer to WORD array contains the data. Given by API

EC_T_DWORD dwWriteLen

Number of Words to be written. Given by API

enum **EC_T_EEPROM_OPERATION_TYPE***Values:*enumerator **eEEPROMOp_Unknown**

Unknown EEPROM operation, only for internal use

enumerator **eEEPROMOp_Assign**

Assign slave EEPROM operation, used by emAssignSlaveEEPROMReq

enumerator **eEEPROMOp_Active**

Active slave EEPROM operation, used by emActiveSlaveEEPROMReq

enumerator **eEEPROMOp_Read**

Read slave EEPROM operation, used by emReadSlaveEEPROMReq

enumerator **eEEPROMOp_Write**

Write slave EEPROM operation, used by emWriteSlaveEEPROMReq

enumerator **eEEPROMOp_Reload**

Reload slave EEPROM operation, used by emReloadSlaveEEPROMReq

enumerator **eEEPROMOp_Reset**

Reset slave EEPROM operation, used by emResetSlaveController

6.6.30 emResetSlaveController

```
static EC_T_DWORD ecatResetSlaveController (
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emResetSlaveController (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwTimeout
)
Reset EtherCAT slave controller (ESC)
```

A special sequence of three independent and consecutive frames/commands is sent to the slave (reset register ECAT 0x0040 or PDI 0x0041), after which the slave resets. If that fails, the reset sequence is repeated until it succeeds or the timeout expires. The ESC must support resetting and the slave state should be INIT when calling this function. The number of acyclic frames per cycle *EC_T_INIT_MASTER_PARMS.dwMaxAcycFramesPerCycle* must be at least 3, otherwise an error is returned. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. The timeout value must not be set to EC_NOWAIT

Returns

- *EC_E_NOERROR* or error code
- *EC_E_NOTSUPPORTED* if *EC_T_INIT_MASTER_PARMS.dwMaxAcycFramesPerCycle* is less than 3
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

6.6.31 emIoControl - EC_IOCTL_ALL_SLAVES_MUST_REACH_MASTER_STATE

Specifies if all the slaves must reach the requested master state.

emIoControl - EC_IOCTL_ALL_SLAVES_MUST_REACH_MASTER_STATE

Parameter

- pbyInBuf: [in] Pointer to EC_T_BOOL variable. If set to EC_TRUE all slaves must reach the master requested state, if set to EC_FALSE the master can reach the requested state even if some slaves are missing or cannot reach the requested state.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.

- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return*EC_E_NOERROR* or error code

Missing mandatory slaves will be signalized by *emNotify - EC_NOTIFY_SLAVE_PRESENCE*. Slaves who cannot reach the requested master state will be signalized by *emNotify - EC_NOTIFY_SLAVE_UNEXPECTED_STATE*. *emNotify - EC_NOTIFY_NOT_ALL_DEVICES_OPERATIONAL* will not be generated anymore if this IOCTL is called with EC_FALSE, *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR* will be still generated.

6.6.32 emGetCfgSlaveInfo

```
static EC_T_DWORD ecatGetCfgSlaveInfo (
    EC_T_BOOL bStationAddress,
    EC_T_WORD wSlaveAddress,
    EC_T_CFG_SLAVE_INFO *pSlaveInfo
)
EC_T_DWORD emGetCfgSlaveInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_CFG_SLAVE_INFO *pSlaveInfo
)
```

Return information about a configured slave from the ENI file.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **pSlaveInfo** – [out] Information about the slave.

Returns*EC_E_NOERROR* or error code

struct **EC_T_CFG_SLAVE_INFO**

Public Members**EC_T_DWORD dwSlaveId**

[out] The slave's ID to bind bus slave and config slave information

EC_T_CHAR abyDeviceName[ECAT_DEVICE_NAME_SIZE]

[out] The slave's configured name (80 Byte) (from ENI file)

EC_T_DWORD dwHCGroupIdx

[out] Index of the hot connect group, 0 for mandatory

EC_T_BOOL bIsPresent

[out] Slave is currently present on bus

EC_T_BOOL bIsHCGroupPresent

[out] Slave's hot connect group is currently present on bus

EC_T_DWORD dwVendorId

[out] Vendor identification (from ENI file)

EC_T_DWORD dwProductCode

[out] Product code (from ENI file)

EC_T_DWORD dwRevisionNumber

[out] Revision number (from ENI file)

EC_T_DWORD dwSerialNumber

[out] Serial number (from ENI file)

EC_T_WORD wStationAddress

[out] The slave's station address (from ENI file)

EC_T_WORD wAutoIncAddress

[out] The slave's auto increment address (from ENI file)

EC_T_DWORD dwPdOffsIn

[out] Process input data bit offset (from ENI file)

EC_T_DWORD dwPdSizeIn

[out] Process input data bit size (from ENI file)

EC_T_DWORD dwPdOffsOut

[out] Process output data bit offset (from ENI file)

EC_T_DWORD dwPdSizeOut

[out] Process output data bit size (from ENI file)

EC_T_DWORD dwPdOffsIn2

[out] 2nd sync unit process input data bit offset (from ENI file)

EC_T_DWORD dwPdSizeIn2

[out] 2nd sync unit process input data bit size (from ENI file)

EC_T_DWORD dwPdOffsOut2

[out] 2nd sync unit process output data bit offset (from ENI file)

EC_T_DWORD dwPdSizeOut2

[out] 2nd sync unit process output data bit size (from ENI file)

EC_T_DWORD dwPdOffsIn3

[out] 3rd sync unit process input data bit offset (from ENI file)

EC_T_DWORD dwPdSizeIn3

[out] 3rd sync unit process input data bit size (from ENI file)

EC_T_DWORD dwPdOffsOut3

[out] 3rd sync unit process output data bit offset (from ENI file)

EC_T_DWORD dwPdSizeOut3

[out] 3rd sync unit process output data bit size (from ENI file)

EC_T_DWORD dwPdOffsetIn4

[out] 4th sync unit process input data bit offset (from ENI file)

EC_T_DWORD dwPdSizeIn4

[out] 4th sync unit process input data bit size (from ENI file)

EC_T_DWORD dwPdOffsetOut4

[out] 4th sync unit process output data bit offset (from ENI file)

EC_T_DWORD dwPdSizeOut4

[out] 4th sync unit process output data bit size (from ENI file)

EC_T_DWORD dwMbxSupportedProtocols

[out] Mailbox protocols supported by the slave (from ENI file). Combination of *Supported mailbox protocols* flags

EC_T_DWORD dwMbxOutSize

[out] Mailbox output byte size (from ENI file)

EC_T_DWORD dwMbxInSize

[out] Mailbox input byte size (from ENI file)

EC_T_DWORD dwMbxOutSize2

[out] Bootstrap mailbox output byte size (from ENI file)

EC_T_DWORD dwMbxInSize2

[out] Bootstrap mailbox input byte size (from ENI file)

EC_T_BOOL bDcSupport

[out] Slave supports DC (from ENI file)

EC_T_WORD wNumProcessVarsInp

[out] Number of input process data variables (from ENI file)

EC_T_WORD wNumProcessVarsOutp

[out] Number of output process data variables (from ENI file)

EC_T_WORD wPrevStationAddress

[out] Station address of the previous slave (from ENI file)

EC_T_WORD wPrevPort

[out] Connected port of the previous slave (from ENI file)

EC_T_WORD wIdentifyAdo

[out] ADO used for identification command (from ENI file)

EC_T_WORD wIdentifyData

[out] Identification value to be validated (from ENI file)

EC_T_BYTEx byPortDescriptor

[out] Port descriptor (ESC register 0x0007) (from ENI file)

EC_T_WORD wWkcStateDiagOffsIn[EC_CFG_SLAVE_PD_SECTIONS]

[out] Offset of WkcState bit in diagnosis image (ENI: ProcessData/Recv[1..4]/BitStart) WkcState bit values: 0 = Data Valid, 1 = Data invalid

EC_T_WORD wWkcStateDiagOffsOut[EC_CFG_SLAVE_PD_SECTIONS]

[out] Offset of WkcState bit in diagnosis image (ENI: ProcessData/Send[1..4]/BitStart) WkcState bit values: 0 = Data Valid, 1 = Data invalid

EC_T_WORD awMasterSyncUnitIn[EC_CFG_SLAVE_PD_SECTIONS]

[out] Sync Unit (ENI: ProcessData/TxPdo[1..4]@Su)

EC_T_WORD awMasterSyncUnitOut[EC_CFG_SLAVE_PD_SECTIONS]

[out] Sync Unit (ENI: ProcessData/RxPdo[1..4]@Su)

EC_T_BOOL bDisabled

[out] Slave disabled by API (emSetSlaveDisabled / emSetSlavesDisabled).

EC_T_BOOL bDisconnected

[out] Slave disconnected by API (emSetSlaveDisconnected / emSetSlavesDisconnected).

EC_T_BOOL bExtended

[out] Slave generated by emConfigExtend

EC_T_BOOL bDcReferenceClock

[out] Slave is reference clock (from ENI file)

EC_T_BOOL bDcPotentialRefClock

[out] Slave can be used as a reference clock (from ENI file)

EC_T_DWORD dwDcCycleTime0

[out] Cycle time of Sync0 event in ns (from ENI file)

EC_T_DWORD dwDcCycleTime1

[out] Calculated value dwDcCycleTime1 [ns] = Cycle time of Sync1 event - Cycle time of Sync0 event + Shift time of Sync0 event (from ENI file)

EC_T_INT nDcShiftTime

[out] Shift time of Sync0 event in ns (from ENI file)

Supported mailbox protocols flags

group **EC_MBX_PROTOCOLS**

Defines

EC_MBX_PROTOCOL_AOE

EC_MBX_PROTOCOL_EOE

EC_MBX_PROTOCOL_COE

EC_MBX_PROTOCOL_FOE

EC_MBX_PROTOCOL_SOE

EC_MBX_PROTOCOL_VOE

6.6.33 emGetCfgSlaveEoeInfo

```
static EC_T_DWORD ecatGetCfgSlaveEoeInfo (
    EC_T_BOOL bStationAddress,
    EC_T_WORD wSlaveAddress,
    EC_T_CFG_SLAVE_EOE_INFO *pSlaveEoeInfo
)
EC_T_DWORD emGetCfgSlaveEoeInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_CFG_SLAVE_EOE_INFO *pSlaveEoeInfo
)
```

) Return EoE information about a configured slave from the ENI file.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **pSlaveEoeInfo** – [out] Information about the slave

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized
- **EC_E_INVALIDPARAM** if dwInstanceID is out of range
- **EC_E_NOTFOUND** if no slave matching bFixedAddressing / wSlaveAddress can be found
- **EC_E_NO_MBX_SUPPORT** if the slave does not support mailbox communication
- **EC_E_NO_EOE_SUPPORT** if the slave supports mailbox communication, but not EoE

struct **EC_T_CFG_SLAVE_EOE_INFO**

Public Members

EC_T_DWORD dwSlaveId
[out] Slave ID

EC_T_BOOL bMacAddr
[out] Indicates whether the MAC address could be read and is valid

EC_T_BYTE abyMacAddr[6]
[out] MAC address

EC_T_BOOL bIpAddr
[out] Indicates whether the IP address could be read and is valid

EC_T_IPADDR oIpAddr
[out] IP address

EC_T_BOOL bSubnetMask

[out] Indicates whether the subnet mask could be read and is valid

***EC_T_IPADDR* oSubnetMask**

[out] Subnet mask

EC_T_BOOL bDefaultGateway

[out] Indicates whether the default gateway could be read and is valid

***EC_T_IPADDR* oDefaultGateway**

[out] Default gateway

EC_T_BOOL bDnsServer

[out] Indicates whether the DNS server could be read and is valid

***EC_T_IPADDR* oDnsServer**

[out] DNS server

EC_T_BOOL bDnsName

[out] Indicates whether the DNS name could be read and is valid

EC_T_CHAR szDnsName[32]

[out] DNS name

6.6.34 emGetBusSlaveInfo

```
static EC_T_DWORD ecatGetBusSlaveInfo (
    EC_T_BOOL bStationAddress,
    EC_T_WORD wSlaveAddress,
    EC_T_BUS_SLAVE_INFO *pSlaveInfo
)
EC_T_DWORD emGetBusSlaveInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BUS_SLAVE_INFO *pSlaveInfo
)
```

Return information about a slave connected to the EtherCAT bus.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **pSlaveInfo** – [out] Information from the slave.

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized
- **EC_E_INVALIDPARAM** if dwInstanceID is out of range

- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found

struct **EC_T_BUS_SLAVE_INFO**

Public Members

EC_T_DWORD dwSlaveId

[out] The slave's ID to bind bus slave and config slave information

EC_T_DWORD adwPortSlaveIds[ESC_PORT_COUNT]

[out] The slave's ID of the slaves connected to ports. See *Port slave ID's*

EC_T_WORD wPortState

[out] Port link state. Format: wwww xxxx yyyy zzzz (each nibble : port 3210)

wwww : Signal detected 1=yes, 0=no

xxxx : Loop closed 1=yes, 0=no

yyyy : Link established 1=yes, 0=no

zzzz : Slave connected 1=yes, 0=no (zzzz = logical result of w,x,y)

EC_T_WORD wAutoIncAddress

[out] The slave's auto increment address

EC_T_BOOL bDcSupport

[out] Slave supports DC (Bus Topology Scan)

EC_T_BOOL bDc64Support

[out] Slave supports 64 Bit DC (Bus Topology Scan)

EC_T_DWORD dwVendorId

[out] Vendor Identification stored in the EEPROM at offset 0x0008

EC_T_DWORD dwProductCode

[out] Product Code stored in the EEPROM at offset 0x000A

EC_T_DWORD dwRevisionNumber

[out] Revision number stored in the EEPROM at offset 0x000C

EC_T_DWORD dwSerialNumber

[out] Serial number stored in the EEPROM at offset 0x000E

EC_T_BYTExbyESCType

[out] Type of ESC (Value of slave ESC register 0x0000)

EC_T_BYTExbyESCRevision

[out] Revision number of ESC (Value of slave ESC register 0x0001)

EC_T_WORD wESCBuild

[out] Build number of ESC (Value of slave ESC register 0x0002)

EC_T_BYTExbyPortDescriptor

[out] Port descriptor (Value of slave ESC register 0x0007)

EC_T_WORD wFeaturesSupported

[out] Features supported (Value of slave ESC register 0x0008)

EC_T_WORD wStationAddress

[out] The slave's station address (Value of slave ESC register 0x0010)

EC_T_WORD wAliasAddress

[out] The slave's alias address (Value of slave ESC register 0x0012)

EC_T_WORD wAlStatus

[out] AL status (Value of slave ESC register 0x0130)

EC_T_WORD wAlStatusCode

[out] AL status code. (Value of slave ESC register 0x0134 during last error acknowledge). This value is reset after a slave state change

EC_T_DWORD dwSystemTimeDifference

[out] System time difference. (Value of slave ESC register 0x092C)

EC_T_WORD wMbxSupportedProtocols

[out] Supported Mailbox Protocols stored in the EEPROM at offset 0x001C

EC_T_WORD wDlStatus

[out] DL status (Value of slave ESC register 0x0110)

EC_T_WORD wPrevPort

[out] Connected port of the previous slave

EC_T_WORD wIdentifyData

[out] Last read identification value see *EC_T_CFG_SLAVE_INFO.wIdentifyAdo*

EC_T_BOOL bLineCrossed

[out] Line crossed was detected at this slave

EC_T_DWORD dwSlaveDelay

[out] Delay behind slave [ns]. This value is only valid if a DC configuration is used

EC_T_DWORD dwPropagDelay

[out] Propagation delay [ns]. ESC register 0x0928, This value is only valid if a DC configuration is used

EC_T_BOOL bIsRefClock

[out] Slave is reference clock

EC_T_BOOL bIsDeviceEmulation

[out] Slave without Firmware. ESC register 0x0141, enabled by EEPROM offset 0x0000.8.

EC_T_WORD wLineCrossedFlags

[out] Combination of *Line crossed flags*

EC_T_DWORD dwCyclicWkcErrorCnt

[out] Counter for Cyclic WC Error

EC_T_DWORD dwSlaveAbsentCnt

[out] Counter for Absent/Not Present Slaves

EC_T_DWORD dwUnexpectedStateCnt
 [out] Counter for Abnormal State Change

Port Slave ID's

group EC_SLAVE_IDS

Defines

```
MASTER_SLAVE_ID
SIMULATOR_SLAVE_ID
MASTER_RED_SLAVE_ID
EL9010_SLAVE_ID
FRAMELOSS_SLAVE_ID
JUNCTION_RED_FLAG
EC_LINECROSSED_flags
```

group EC_LINECROSSED_FLAGS

Defines

```
EC_LINECROSSED_NOT_CONNECTED_PORTA
EC_LINECROSSED_UNEXPECTED_INPUT_PORT
EC_LINECROSSED_UNEXPECTED_JUNCTION_RED
EC_LINECROSSED_UNRESOLVED_PORT_CONNECTION
EC_LINECROSSED_HIDDEN_SLAVE_CONNECTED
EC_LINECROSSED_PHYSIC_MISMATCH
EC_LINECROSSED_INVALID_PORT_CONNECTION
```

6.6.35 emReadSlaveIdentification

```
static EC_T_DWORD ecatReadSlaveIdentification(
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wAdo,
    EC_T_WORD *pwValue,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReadSlaveIdentification(
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wAdo,
    EC_T_WORD *pwValue,
    EC_T_DWORD dwTimeout
)
    Read identification value from slave.
```

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wAdo** – [in] ADO used for identification command
- **pwValue** – [out] Pointer to Word value containing the Identification value
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or the command is not supported or the timeout value is set to EC_NOWAIT
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found
- *EC_E_TIMEOUT* if dwTimeout elapsed during the API call
- *EC_E_BUSY* another transfer request is already pending or the master or the corresponding slave is currently changing its operational state
- *EC_E_NOTREADY* if the working counter was not set when sending the command (slave may not be connected or did not respond)
- *EC_E_ADO_NOT_SUPPORTED* if the slave does not support requesting ID mechanism
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

6.6.36 emReadSlaveIdentificationReq

```
static EC_T_DWORD ecatReadSlaveIdentificationReq(
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wAdo,
    EC_T_WORD *pwValue,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emReadSlaveIdentificationReq(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_WORD wAdo,
    EC_T_WORD *pwValue,
    EC_T_DWORD dwTimeout
)
```

Request the identification value from a slave and returns immediately.

A notification EC_NOTIFY_SLAVE_IDENTIFICATION is given on completion or timeout. This function may be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **dwTferId** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within *EC_T_SLAVE_IDENTIFICATION_NTFY_DESC*
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **wAdo** – [in] ADO used for identification command
- **pwValue** – [out] Pointer to Word value containing the Identification value, must be valid until the request complete.
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or the command is not supported or the timeout value is set to EC_NOWAIT
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found
- *EC_E_ADO_NOT_SUPPORTED* if the slave does not support requesting ID mechanism

See also:

[emNotify - EC_NOTIFY_SLAVE_IDENTIFICATION](#)

6.6.37 emNotify - EC_NOTIFY_SLAVE_IDENTIFICATION

This notification is given, when the read slave identification request is completed.

emNotify - EC_NOTIFY_SLAVE_IDENTIFICATION

Parameter

- pbyInBuf: [in] Pointer to EC_T_SLAVE_IDENTIFICATION_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct **EC_T_SLAVE_IDENTIFICATION_NTFY_DESC**

Public Members**EC_T_DWORD dwTransferId**

Transfer ID. For every new port operation a unique ID has to be assigned. This ID can be used after completion to identify the transfer

EC_T_DWORD dwResult

Result of request

***EC_T_SLAVE_PROP* SlaveProp**

Slave properties

EC_T_WORD wAdo

Slave address offset used for identification. Given by API

EC_T_WORD wValue

Slave identification value. Given by API

6.6.38 emIoControl - EC_IOCTL_SET_AUTO_ACK_AL_STATUS_ERROR_ENABLED

Specifies if slave errors must be automatically acknowledged

emIoControl - EC_IOCTL_SET_AUTO_ACK_AL_STATUS_ERROR_ENABLED**Parameter**

- pbyInBuf: [in] Pointer to EC_T_BOOL variable. If set to EC_TRUE slave errors must be automatically acknowledged, if set to EC_FALSE the application must acknowledge slave errors explicitly
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

The pending slave error will be acknowledged during the next `emSetSlaveState()` call.

6.6.39 emIoControl - EC_IOCTL_SET_AUTO_ADJUST_CYCCMD_WKC_ENABLED

Specifies if the cyclic commands expected WKC must be automatically adjusted according the state and the presence of the slaves.

emIoControl - EC_IOCTL_SET_AUTO_ADJUST_CYCCMD_WKC_ENABLED**Parameter**

- pbyInBuf: [in] Pointer to EC_T_BOOL variable. If set to EC_TRUE cyclic commands expected WKC must be automatically adjusted, if set to EC_FALSE the cyclic commands expected WKC stay unchanged
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.

- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return*EC_E_NOERROR or error code*

If TRUE, the notification *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR* is only generated if a slave doesn't increment the WKC although it should. AUTO_ADJUST_CYCCMD_WKC is disabled by default.

See also:

- *Cyclic cmd WKC validation*
- *WKC State in Diagnosis Image*

6.6.40 emSetSlaveDisabled

Before using this function, please check if the following patents has to be taken into consideration for your application and use case:

- JP2014146077: CONTROL DEVICE AND OPERATION METHOD FOR CONTROL DEVICE
- JP2014146070: CONTROL DEVICE, CONTROL METHOD, AND PROGRAM
- JP2014120884: INFORMATION PROCESSING APPARATUS, INFORMATION ROCESSING PROGRAM, AND INFORMATION PROCESSING METHOD

```
static EC_T_DWORD ecatSetSlaveDisabled(
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bDisabled
)
EC_T_DWORD emSetSlaveDisabled(
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bDisabled
)
```

Enable or disable a specific slave.

The EtherCAT state of disabled slaves can not be set higher than PREOP. If the state is higher than PREOP at the time this function is called. The state will be automatically change to PREOP. The information about the last requested state is lost and is set to PREOP too.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **bDisabled** – [in] EC_TRUE: Disable slave, EC_FALSE: Enable slave

Returns*EC_E_NOERROR or error code*

6.6.41 emSetSlaveDisconnected

Before using this function, please check if the following patents has to be taken into consideration for your application and use case:

- JP2014146077: CONTROL DEVICE AND OPERATION METHOD FOR CONTROL DEVICE
- JP2014146070: CONTROL DEVICE, CONTROL METHOD, AND PROGRAM
- JP2014120884: INFORMATION PROCESSING APPARATUS, INFORMATION ROCESSING PROGRAM, AND INFORMATION PROCESSING METHOD

```
static EC_T_DWORD ecatSetSlaveDisconnected(
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bDisconnected
)
EC_T_DWORD emSetSlaveDisconnected (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_BOOL bDisconnected
)
Mark specific slave for connection or disconnection.
```

The EtherCAT state of disconnected slaves can not be set higher than INIT. If the state is higher than INIT at the time this function is called, the state will be automatically change to INIT. The information about the last requested state is lost and is set to INIT too.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **bDisconnected** – [in] EC_TRUE: Mark slave for disconnection, EC_FALSE: Mark slave for (re-)connection

Returns

EC_E_NOERROR or error code

6.6.42 emSetSlavesDisconnected

Before using this function, please check if the following patents has to be taken into consideration for your application and use case:

- JP2014146077: CONTROL DEVICE AND OPERATION METHOD FOR CONTROL DEVICE
- JP2014146070: CONTROL DEVICE, CONTROL METHOD, AND PROGRAM
- JP2014120884: INFORMATION PROCESSING APPARATUS, INFORMATION ROCESSING PROGRAM, AND INFORMATION PROCESSING METHOD

```
static EC_T_DWORD ecatSetSlavesDisconnected(
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_SLAVE_SELECTION eSlaveSelection,
    EC_T_BOOL bDisconnected
)
```

```
EC_T_DWORD emSetSlavesDisconnected(
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_SLAVE_SELECTION eSlaveSelection,
    EC_T_BOOL bDisconnected
)
Mark a specific group of slaves for connection or disconnection.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **eSlaveSelection** – [in] Slave selection criteria
- **bDisconnected** – [in] EC_TRUE: mark slaves for disconnection, EC_FALSE: mark slaves for connection

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range
- *EC_E_NOTFOUND* if no slave matching bFixedAddressing / wSlaveAddress can be found

See also:

emSetSlaveDisconnected()

6.6.43 emGetSlavePortState

```
static EC_T_DWORD ecatGetSlavePortState(
    EC_T_DWORD dwSlaveId,
    EC_T_WORD *pwPortState
)
EC_T_DWORD emGetSlavePortState(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD *pwPortState
)
```

Returns the state of the slave ports.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **pwPortState** – [out] Slave port state.

Format: wwww xxxx yyyy zzzz (each nibble : port 3210)

wwww : Signal detected 1=yes, 0=no

xxxx : Loop closed 1=yes, 0=no

yyyy : Link established 1=yes, 0=no
 zzzz : Slave connected 1=yes, 0=no (zzzz = logical result of w,x,y)

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or the output pointer is EC_NULL
- *EC_E_NOTFOUND* if no slave matching dwSlaveId can be found

See also:

`emGetSlaveId()`

6.6.44 emSetSlavePortState

```
static EC_T_DWORD ecatSetSlavePortState (
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wPort,
    EC_T_BOOL bClose,
    EC_T_BOOL bForce,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emSetSlavePortState (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wPort,
    EC_T_BOOL bClose,
    EC_T_BOOL bForce,
    EC_T_DWORD dwTimeout
)
Open or close slave port.
```

This function allows to open or close a specific slave port in different ways. It also can be used to re-open ports closed by a rescue scan.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **wPort** – [in] Port to open or close. Can be ESC_PORT_A, ESC_PORT_B, ESC_PORT_C, ESC_PORT_D
- **bClose** – [in] EC_TRUE: close port, EC_FALSE: open port
- **bForce** – [in] EC_TRUE: port will be closed or open, EC_FALSE: port will be set in AutoClose mode
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range

- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching dwSlaveId can be found
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

See also:

- *emRescueScan()*
- *emGetSlaveId()*

6.6.45 emSetSlavePortStateReq

```
static EC_T_DWORD ecatSetSlavePortStateReq(
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wPort,
    EC_T_BOOL bClose,
    EC_T_BOOL bForce,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emSetSlavePortStateReq(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClientId,
    EC_T_DWORD dwTferId,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wPort,
    EC_T_BOOL bClose,
    EC_T_BOOL bForce,
    EC_T_DWORD dwTimeout
)
```

Requests Open or close slave port operation and returns immediately.

A *EC_T_PORT_OPERATION_NTFY_DESC* is given on completion. This function can be called to re-open ports closed by a rescue scan.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClientId** – [in] Client ID returned by RegisterClient (0 if all registered clients shall be notified).
- **dwTferId** – [in] Transfer ID. The application can set this ID to identify the transfer. It will be passed back to the application within *EC_T_PORT_OPERATION_NTFY_DESC*
- **dwSlaveId** – [in] Slave ID
- **wPort** – [in] Port to open or close. Can be ESC_PORT_A, ESC_PORT_B, ESC_PORT_C, ESC_PORT_D
- **bClose** – [in] EC_TRUE: close port, EC_FALSE: open port
- **bForce** – [in] EC_TRUE: port will be closed or open, EC_FALSE: port will be set in AutoClose mode
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching dwSlaveId can be found

See also:

- *emNotify* - **EC_T_PORT_OPERATION_NTFY_DESC**
- *emRescueScan()*
- *emGetSlaveId()*

6.6.46 emNotify - EC_T_PORT_OPERATION_NTFY_DESC

This notification is given, when the port operation request is completed.

emNotify - EC_T_PORT_OPERATION_NTFY_DESC

Parameter

- pbyInBuf: [in] Pointer to **EC_T_PORT_OPERATION_NTFY_DESC**
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to **EC_NULL**
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to **EC_NULL**

struct **EC_T_PORT_OPERATION_NTFY_DESC**

Public Members**EC_T_DWORD dwTransferId**

Transfer ID. For every new port operation a unique ID has to be assigned. This ID can be used after completion to identify the transfer

EC_T_DWORD dwResult

Result of request

EC_T_SLAVE_PROP SlaveProp

Slave properties

EC_T_WORD wPortStateOld

Old state of the slave ports

EC_T_WORD wPortStateNew

New state of the slave ports

See also:

- *emGetSlavePortState()*

6.6.47 emIoControl - EC_IOCTL_SET_NEW_BUSSLAVES_TO_INIT

Force state change to INIT for all new slaves in network after detection.

emIoControl - EC_IOCTL_SET_NEW_BUSSLAVES_TO_INIT

Parameter

- pbyInBuf: [in] Pointer to EC_T_BOOL. EC_TRUE: Force state change, EC_FALSE: No state change.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Default: No state change after detection

6.7 Diagnosis, error detection, error notifications

In case of errors on the bus or in one or multiple slaves the EtherCAT master stack will notify the application about such an event. The master automatically detects unexpected slaves states by evaluating the AL Status event interrupt. If the interrupt is set, the master reads the state of each slave and compares it to the expected (required) state. In case of a state mismatch the master generates the notification *emNotify - EC_NOTIFY_SLAVE_UNEXPECTED_STATE*. The application will then have to enter an error handling procedure.

The error notifications can be separated into two classes:

1. Slave unrelated errors
2. Slave related errors

A slave related error notification will also contain the information about which slave has generated an error. If for example a slave could not be set into the requested state the application will get the *emNotify - EC_NOTIFY_SLAVE_INITCMD_RESPONSE_ERROR* error notification including slave related information. A slave unrelated error does not contain this information even if one specific slave caused the error. For example if one or multiple slaves are powered off the working counter of the cyclic commands would be wrong. In that case the *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR* error notification will be generated.

Example Error Scenario

Slave is powered off or disconnected while bus is operational

If the master is operational it cyclically sends EtherCAT commands to read and write the slave's process data. It expects the working counter to be incremented to the appropriate value. If one slave is powered off the master will generate the *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR* to indicate such an event. Also the master detects a DL status event and performs a bus scan as reaction on this. For the not reachable slaves (powered off or disconnected) the master generates the notification *emNotify - EC_NOTIFY_SLAVE_PRESENCE*.

A possible error recovery scenario would be to stay operational and in parallel wait until the slave is powered on again. The next step would be to determine the slave's state and set it operational again:

Master calls *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR*

- Application gets informed
- WKC State in Diagnosis Image changes

See also:

WKC State in Diagnosis Image

Use cases**1. Slave is disconnected or powered off:**

- Master detects a DL status event interrupt and performs a bus scan.
- Master calls *emNotify - EC_NOTIFY_SLAVE_PRESENCE*
- Application gets informed and could set the whole master into a lower state, e.g. *eEcat-State_INIT*

2. Slave state is not OPERATIONAL anymore

- Master calls *emNotify - EC_NOTIFY_SLAVE_UNEXPECTED_STATE*
- Application gets informed and could either set the whole master into lower state (e.g. *eEcat-State_PREOP*), or calls *emSetSlaveState()* to repair the failed slave.

3. Slave is re-connected or powered on:

- Master detects a DL status event interrupt and performs a bus scan.
- Master calls *emNotify - EC_NOTIFY_SLAVE_PRESENCE*.
- Application could wait until all slaves are re-connected by calling the functions *emGetNumConnectedSlaves()* and *emGetNumConfiguredSlaves()*.
- After all slaves are re-connected the application could either set the whole master to *eEcat-State_INIT* and afterwards to *:cpp:enumerator:`eEcatState_OP`*, or the application uses *emSetSlaveState()* to repair only the failed slaves.

6.7.1 **emEthDbgMsg**

```
static EC_T_DWORD ecatEthDbgMsg (
    EC_T_BYT byEthTypeByte0,
    EC_T_BYT byEthTypeByte1,
    EC_T_CHAR *szMsg
)
EC_T_DWORD emEthDbgMsg (
    EC_T_DWORD dwInstanceID,
    EC_T_BYT byEthTypeByte0,
    EC_T_BYT byEthTypeByte1,
    EC_T_CHAR *szMsg
)
Send a debug message to the EtherCAT Link Layer.
```

This feature can be used for debugging purposes.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **byEthTypeByte0** – [in] Ethernet type byte 0
- **byEthTypeByte1** – [in] Ethernet type byte 1
- **szMsg** – [in] Message to send to link layer

Returns*EC_E_NOERROR* or error code

6.7.2 emIoControl - EC_IOCTL_GET_SLVSTATISTICS

Get Slave's statistics counter. Counters are collected on a regularly base (default: off) and show errors on Ethernet Layer.

emIoControl - EC_IOCTL_GET_SLVSTATISTICS

Parameter

- *pbyInBuf*: [in] Pointer to a EC_T_DWORD type variable containing the slave id.
- *dwInBufSize*: [in] Size of the input buffer provided at *pbyInBuf* in bytes.
- *pbyOutBuf*: [out] Pointer to struct EC_T_SLVSTATISTICS_DESC
- *dwOutBufSize*: [in] Size of the output buffer provided at *pbyOutBuf* in bytes.
- *pdwNumOutData*: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return*EC_E_NOERROR* or error code

```
struct EC_T_SLVSTATISTICS_DESC
```

Public Members

EC_T_BYTExabyInvalidFrameCnt[ESC_PORT_COUNT]
 [out] Invalid Frame Counters per Slave Port

EC_T_BYTExabyRxErrorCnt[ESC_PORT_COUNT]
 [out] RX Error Counters per Slave Port

EC_T_BYTExabyFwdRxErrorCnt[ESC_PORT_COUNT]
 [out] Forwarded RX Error Counters per Slave Port

EC_T_BYTExbyProcessingUnitErrorCnt
 [out] Processing Unit Error Counter

EC_T_BYTExbyPdiErrorCnt
 [out] PDI Error Counter

EC_T_WORD wAlStatusCode
 [out] AL Status Code

EC_T_BYTExabyLostLinkCnt[ESC_PORT_COUNT]
 [out] Lost Link Counters per Slave Port

EC_T_UINT64 qwReadTime
 [out] Timestamp of the last read [ns]

EC_T_UINT64 qwChangeTime
 [out] Timestamp of the last counter change [ns]

See also:

- *emIoControl - EC_IOCTL_SET_SLVSTAT_PERIOD*
- *emIoControl - EC_IOCTL_CLR_SLVSTATISTICS*

6.7.3 emGetSlaveStatistics

```
static EC_T_DWORD ecatGetSlaveStatistics (
    EC_T_DWORD dwSlaveId,
    EC_T_SLVSTATISTICS_DESC *pSlaveStatisticsDesc
)
EC_T_DWORD emGetSlaveStatistics (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_SLVSTATISTICS_DESC *pSlaveStatisticsDesc
)
) Get Slave's statistics counter.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave id
- **pSlaveStatisticsDesc** – [out] Pointer to structure *EC_T_SLVSTATISTICS_DESC*

Returns*EC_E_NOERROR* or error code**See also:**

- *emIoControl - EC_IOCTL_GET_SLVSTATISTICS*
- *emGetSlaveId()*

6.7.4 emIoControl - EC_IOCTL_CLR_SLVSTATISTICS

Clear all error registers in all slaves

emIoControl - EC_IOCTL_CLR_SLVSTATISTICS**Parameter**

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return*EC_E_NOERROR* or error code

6.7.5 emClearSlaveStatistics

```
static EC_T_DWORD ecatClearSlaveStatistics (EC_T_DWORD dwSlaveId)
```

```
EC_T_DWORD emClearSlaveStatistics (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId
)
```

) Clears all error registers of a slave.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave Id, INVALID_SLAVE_ID clears all slaves

Returns

EC_E_NOERROR or error code

See also:

emGetSlaveId ()

6.7.6 emIoControl - EC_IOCTL_GET_SLVSTAT_PERIOD

Get Slave Statistics collection period. Period of 0: automatic slave statistics collection disabled.

emIoControl - EC_IOCTL_GET_SLVSTAT_PERIOD

Parameter

- **pbyInBuf**: [in] Should be set to EC_NULL
- **dwInBufSize**: [in] Should be set to 0
- **pbyOutBuf**: [out] Pointer to a EC_T_DWORD type variable containing the slave statistics collection period [ms] to get.
- **dwOutBufSize**: [in] Size of the output buffer provided at pbyOutBuf in bytes.
- **pdwNumOutData**: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

6.7.7 emIoControl - EC_IOCTL_SET_SLVSTAT_PERIOD

Update Slave Statistics collection period. It implicitly forces an immediate collection of slave statistics if performed successfully.

A Period of 0 disables automatic slave statistics collection, otherwise it set the time between the read sequences.

emIoControl - EC_IOCTL_SET_SLVSTAT_PERIOD

Parameter

- **pbyInBuf**: [in] pointer to a EC_T_DWORD type variable containing the slave statistics collection period [ms] to set.
- **dwInBufSize**: [in] Size of the input buffer provided at pbyInBuf in bytes.

- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

6.7.8 emIoControl - EC_IOCTL_FORCE_SLVSTAT_COLLECTION

Sends datagrams to collect slave statistics counters.

emIoControl - EC_IOCTL_FORCE_SLVSTAT_COLLECTION**Parameter**

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

6.7.9 emIoControl - EC_IOCTL_CLEAR_MASTER_INFO_COUNTERS

Reset Master Info Counters according to given bit masks

emIoControl - EC_IOCTL_CLEAR_MASTER_INFO_COUNTERS**Parameter**

- pbyInBuf: [in] Pointer to value of EC_T_CLEAR_MASTER_INFO_COUNTERS_PARMS.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

```
struct EC_T_CLEAR_MASTER_INFO_COUNTERS_PARMS
```

Public Members**EC_T_DWORD dwClearBusDiagnosisCounters**

[in] Bit 0..7: Clear corresponding Counter ID:

- Bit 0: Clear all Counters
- Bit 1: Clear Tx Frame Counter
- Bit 2: Clear Rx Frame Counter
- Bit 3: Clear Lost Frame Counter
- Bit 4: Clear Cyclic Frame Counter
- Bit 5: Clear Cyclic Datagram Counter
- Bit 6: Clear Acyclic Frame Counter
- Bit 7: Clear Acyclic DataGram Counter
- Bit 8: Clear Cyclic Lost Frame Counter
- Bit 9: Clear Acyclic Lost Frame Counter

EC_T_UINT64 qwMailboxStatisticsClearCounters

[in] Bit 0..56: Clear corresponding Counter ID.

- Bit 0..7: Clear AoE statistics
 - Bit 0: Total Read Transfer Count
 - Bit 1: Read Transfer Count Last Second
 - Bit 2: Total Bytes Read
 - Bit 3: Bytes Read Last Second
 - Bit 4: Total Write Transfer Count
 - Bit 5: Write Transfer Count Last Second
 - Bit 6: Total Bytes Write
 - Bit 7: Bytes Write Last Second
- Bit 8..15: Clear CoE statistics (same ordering as Bit 0..7, AoE)
- Bit 16..23: Clear EoE statistics (same ordering as Bit 0..7, AoE)
- Bit 24..31: Clear FoE statistics (same ordering as Bit 0..7, AoE)
- Bit 32..39: Clear SoE statistics (same ordering as Bit 0..7, AoE)
- Bit 40..47: Clear VoE statistics (same ordering as Bit 0..7, AoE)
- Bit 48..55: Clear RawMbx statistics (same ordering as Bit 0..7, AoE)

```
qwMailboxStatisticsClearCounters = 0x0000000100; //Clear CoE Total Read Transfer
                                         ↳Count.
```

6.7.10 emIoControl - EC_IOCTL_SET_FRAME_RESPONSE_ERROR_NOTIFY_MASK

Sets a bit mask to enable or disable the generation of specific error notifications of frame response errors. The application then can decide to suppress those error messages. By default all errors, expect `EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_NON_ECAT_FRAME` are enabled (the notification mask is set to `EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_DEFAULT`).

`emIoControl - EC_IOCTL_SET_FRAME_RESPONSE_ERROR_NOTIFY_MASK`

Parameter

- `pbyInBuf`: [in] pointer to a `EC_T_DWORD` type value containing the new error mask.
- `dwInBufSize`: [in] Size of the input buffer provided at `pbyInBuf` in bytes.
- `pbyOutBuf`: [out] Should be set to `EC_NULL`
- `dwOutBufSize`: [in] Should be set to 0
- `pdwNumOutData`: [out] Should be set to `EC_NULL`

Return

`EC_E_NOERROR` or error code

The following frame response error notification mask values exist:

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_UNDEFINED`
Mask for `eRspErr_UNDEFINED` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_NO_RESPONSE`
Mask for `eRspErr_NO_RESPONSE` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_WRONG_IDX`
Mask for `eRspErr_WRONG_IDX` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_UNEXPECTED`
Mask for `eRspErr_UNEXPECTED` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_FRAME_RETRY`
Mask for `eRspErr_FRAME_RETRY` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_RETRY_FAIL`
Mask for `eRspErr_RETRY_FAIL` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_FOREIGN_SRC_MAC`
Mask for `eRspErr_FOREIGN_SRC_MAC` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_NON_ECAT_FRAME`
Mask for `eRspErr_NON_ECAT_FRAME` notifications

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_ALL`
Mask for all notifications enabled except `eRspErr_NON_ECAT_FRAME`

`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_DEFAULT`
Mask for all frame response error notifications

See also:

emNotify - EC_NOTIFY_FRAME_RESPONSE_ERROR

6.7.11 emIoControl - EC_IOCTL_SET_FRAME_LOSS_SIMULATION

This IO Control is introduced for testing and debugging purposes. It enables an application to simulate the loss of EtherCAT frames on both transmit and receive bus direction.

Important: Do not activate this on shipped releases. Frameloss has significant influence on performance and reliability of the application!

emIoControl - EC_IOCTL_SET_FRAME_LOSS_SIMULATION

Parameter

- pbyInBuf: [in] Array of four EC_T_DWORDs (arrDword)
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

The parameters configurable are :

- **arrDword [0] -> dwNumGoodFramesAfterStart**
Number of good frames before frame loss simulation starts
- **arrDword [1] -> dwFrameLossLikelihoodPpm**
Random loss simulation: frame loss likelihood (ppm)
- **arrDword [2] -> dwFixedLossNumGoodFrames**
Fixed loss simulation: number of good frames before frame loss
- **arrDword [3] -> dwFixedLossNumLostFrames**
Fixed loss simulation: number of lost frames after processing the good ones

6.7.12 emIoControl - EC_IOCTL_SET_RXFRAME_LOSS_SIMULATION

Same as [emIoControl - EC_IOCTL_SET_FRAME_LOSS_SIMULATION](#) but only enables receive direction frame losses.

emIoControl - EC_IOCTL_SET_RXFRAME_LOSS_SIMULATION

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

6.7.13 emIoControl - EC_IOCTL_SET_TXFRAME_LOSS_SIMULATION

Same as [emIoControl - EC_IOCTL_SET_FRAME_LOSS_SIMULATION](#) but only enables transmit direction frame losses.

emIoControl - EC_IOCTL_SET_TXFRAME_LOSS_SIMULATION

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

6.7.14 Error notifications - general information

For each error an error ID (error code) will be defined. This error ID will be used as the notification code when `emNotify()` is called. In addition to this notification code the second parameter given to `emNotify()` contains a pointer to an error notification descriptor of type [EC_T_ERROR_NOTIFICATION_DESC](#). This error notification descriptor contains detailed information about the error.

struct **EC_T_ERROR_NOTIFICATION_DESC**

Public Members

EC_T_DWORD dwNotifyErrorCode
 Error ID (same value as the notification code)

EC_T_CHAR achErrorInfo[MAX_ERRINFO_STRLEN]
 Additional error string (may be empty)

union **_EC_T_ERROR_NOTIFICATION_PARM**

Public Members

EC_T_WKCERR_DESC WkcErrDesc
 WKC error descriptor

EC_T_FRAME_RSPERR_DESC FrameRspErrDesc
 Frame response error descriptor

EC_T_INITCMD_ERR_DESC InitCmdErrDesc
 Master/Slave init command error descriptor

EC_T_SLAVE_ERROR_INFO_DESC SlaveErrInfoDesc
 Slave Error Info Descriptor

EC_T_SLAVES_ERROR_DESC **SlavesErrDesc**
 Slaves Error Descriptor

EC_T_MBOX_SDO_ABORT_DESC **SdoAbortDesc**
 SDO Abort

EC_T_RED_CHANGE_DESC **RedChangeDesc**
 Redundancy Descriptor

EC_T_MBOX_FOE_ABORT_DESC **FoeErrorDesc**
 FoE error code and string

EC_T_MBXRXCV_INVALID_DATA_DESC **MbxRcvInvalidDataDesc**
 Invalid mailbox data received descriptor

EC_T_PDIWATCHDOG_DESC **PdiWatchdogDesc**
 PDI watchdog expired

EC_T_SLAVE_NOTSUPPORTED_DESC **SlaveNotSupportedDesc**
 Slave not supported

EC_T_SLAVE_UNEXPECTED_STATE_DESC **SlaveUnexpectedStateDesc**
 Slave in unexpected state

EC_T_SLAVES_UNEXPECTED_STATE_DESC **SlavesUnexpectedStateDesc**
 Slaves in unexpected state

EC_T_EEPROM_CHECKSUM_ERROR_DESC **EEPROMChecksumErrorDesc**
 EEPROM checksum error

EC_T_JUNCTION_RED_CHANGE_DESC **JunctionRedChangeDesc**
 Junction redundancy change descriptor

EC_T_FRAMELOSS_AFTER_SLAVE_NTFY_DESC **FrameLossAfterSlaveDesc**
 Frameloss after Slave descriptor

EC_T_S2SMBX_ERROR_DESC **S2SMBxErrorDesc**
 S2S Mailbox Error descriptor

EC_T_BAD_CONNECTION_NTFY_DESC **BadConnectionDesc**
 Bad connection descriptor

EC_T_COMMUNICATION_TIMEOUT_NTFY_DESC **CommunicationTimeoutDesc**
 Communication timeout descriptor

EC_T_TAP_LINK_STATUS_NTFY_DESC **TapLinkStatusDesc**
 Tap link status

If the pointer to this descriptor exists (is not set to `EC_NULL`) the detailed error information (e.g. information about the slave) is stored in the appropriate structure of a union. These error information structures are described in the following sections.

The EtherCAT master will call `emNotify()` every time an error is detected. In some cases this will lead to calling this function in every EtherCAT cycle (e.g. if there is no physical connection to the slaves). Using the control interface `emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED` it is possible to determine which errors shall be signalled and which not.

6.7.15 emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR

To update the process data some EtherCAT commands will be sent cyclically by the master. These commands will address one or multiple slaves. These EtherCAT commands contain a working counter which has to be incremented by each slave that is addressed. The working counter will be checked after the EtherCAT command is received by the master. If the expected working counter will not match to the working counter of the received command the error *emNotify - EC_NOTIFY_CYCCMD_WKC_ERROR* will be indicated. The working counter value expected by the master is determined by the EtherCAT configuration (XML) file for each cyclic EtherCAT command (section Config/Cyclic/Frame/Cmd/Cnt). Detailed error information is stored in structure *EC_T_WKCERR_DESC* of *EC_T_ERROR_NOTIFICATION_DESC*.

This notification is enabled by default.

```
struct EC_T_WKCERR_DESC
```

Public Members

EC_T_SLAVE_PROP SlaveProp

Slave properties, content is undefined in case of cyclic WKC_ERROR

EC_T_BYTExbyCmd

EtherCAT command type

EC_T_DWORD dwAddr

Logical address or physical address (ADP/ADO)

EC_T_WORD wWkcSet

Working counter set value

EC_T_WORD wWkcAct

Working counter actual value

```
struct EC_T_SLAVE_PROP
```

Public Members

EC_T_WORD wStationAddress

Configured station address or INVALID_FIXED_ADDR

EC_T_WORD wAutoIncAddr

Configured auto increment address or INVALID_AUTO_INC_ADDR

EC_T_CHAR achName[MAX_STD_STRLEN]

Configured name of the slave device (NULL terminated string)

See also:

- *emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED* for how to control the deactivation.
- *Cyclic cmd WKC validation*
- *WKC State in Diagnosis Image*
- *emIoControl - EC_IOCTL_SET_AUTO_ADJUST_CYCCMD_WKC_ENABLED*

6.7.16 emNotify - EC_NOTIFY_MASTER_INITCMD_WKC_ERROR

This error will be indicated in case of a working counter mismatch when sending master init commands. The working counter value expected by the master is determined by the EtherCAT configuration (XML) file for each master init command (section Config/Master/InitCmds/InitCmd/Cnt). In case there is no “Cnt” entry in the XML file for this init command there will be no working counter verification. The working counter has to be incremented by all slaves which have to process this init command.

Detailed error information is stored in structure [*EC_T_WKCERR_DESC*](#) of [*EC_T_ERROR_NOTIFICATION_DESC*](#).

6.7.17 emNotify - EC_NOTIFY_SLAVE_INITCMD_WKC_ERROR

This error will be indicated in case of a working counter mismatch when sending slave init commands. The working counter value expected by the master is determined by the EtherCAT configuration (XML) file for each slave init command (section Config/Slave/InitCmds/InitCmd/Cnt). In case there is no “Cnt” entry in the XML file for this init command there will be no working counter verification.

Detailed error information is stored in structure [*EC_T_WKCERR_DESC*](#) of [*EC_T_ERROR_NOTIFICATION_DESC*](#). The structure member SlaveProp contains information about the corresponding slave device.

6.7.18 emNotify - EC_NOTIFY_FOE_MBSLAVE_ERROR

This error will be indicated in case a slave notifies an error over FoE.

6.7.19 emNotify - EC_NOTIFY_EOE_MBXSND_WKC_ERROR

This error will be indicated in case the working counter of a EoE mailbox write command was not set to the expected value of 1.

Detailed error information is stored in structure [*EC_T_WKCERR_DESC*](#) of [*EC_T_ERROR_NOTIFICATION_DESC*](#). The structure member SlaveProp contains information about the corresponding slave device.

6.7.20 emNotify - EC_NOTIFY_COE_MBXSND_WKC_ERROR

This error will be indicated in case the working counter of a CoE mailbox write command was not set to the expected value of 1.

Detailed error information is stored in structure [*EC_T_WKCERR_DESC*](#) of [*EC_T_ERROR_NOTIFICATION_DESC*](#). The structure member SlaveProp contains information about the corresponding slave device.

6.7.21 emNotify - EC_NOTIFY_FOE_MBXSND_WKC_ERROR

This error will be indicated in case the working counter of a FoE mailbox write command was not set to the expected value of 1.

6.7.22 emNotify - EC_NOTIFY_VOE_MBXSND_WKC_ERROR

This error will be indicated in case the working counter of a VoE mailbox write command was not set to the expected value of 1.

Detailed error information is stored in structure [EC_T_WKCERR_DESC](#) of [EC_T_ERROR_NOTIFICATION_DESC](#). The structure member SlaveProp contains information about the corresponding slave device.

6.7.23 emNotify - EC_NOTIFY_S2SMBX_ERROR

This error will be indicated in case a Slave-To-Slave mailbox transfer fails.

See also:

[EC_E_S2SMBX_NOT_CONFIGURED](#)

6.7.24 emNotify - EC_NOTIFY_FRAME_RESPONSE_ERROR

This error will be indicated if the actually received Ethernet frame does not match to the frame expected or if a expected frame was not received.

This notification is enabled by default.

See also:

[emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED](#) for how to control the deactivation.

Missing response (timeout, [eRspErr_NO_RESPONSE](#)/ [eRspErr_FRAME_RETRY](#)) acyclic frames: Acyclic Ethernet frames are internally queued by the master and sent to the slaves at a later time (usually after sending cyclic frames). The master will monitor the time between queueing such a frame and receiving the result. If a maximum time is exceeded then this error will be indicated. This maximum time will be determined by the parameter dwEcatCmdTimeout when the master is initialized

See also:

[emInitMaster \(\)](#)

The master will retry sending the frame if the master configuration parameter dwEcatCmdMaxRetries is set to a value greater than 1. In case of a retry the [eRspErr_FRAME_RETRY](#) error is signalled, if the number of retries has elapsed the [eRspErr_NO_RESPONSE](#) error is signalled.

Possible reasons:

1. **the frame was not received at all (due to bus problems)**

In this case the achErrorInfo member of the error notification descriptor will contain the string "L".

2. **the frame was sent too late by the master due to a improper configuration.**

In this case the achErrorInfo member of the error notification descriptor will contain the string "T".

To avoid this error the configuration may be changed as follows:

-> higher value for master configuration parameter dwMaxAcycCmdsPerCycle -> shorter master timer cycle, i.e. shorter period between two calls to

`emExecJob (eUsrJob_MasterTimer)`

-> higher timeout value (master configuration parameter dwEcatCmdTimeout)

If the frame was sent too late by the master (due to improper configuration values) it will also be received too late and the master then signals an [eRspErr_WRONG_IDX](#) or [eRspErr_UNEXPECTED](#) error (as the master then doesn't expect to receive this frame).

Missing response (timeout, [eRspErr_NO_RESPONSE](#)) cyclic frames:

A response to all cyclic frames must occur until the next cycle starts. If the first cyclic frame is sent the master checks whether all cyclic frames of the last cycle were received. If there is one frame missing this error is indicated.

Possible reasons:

1. the frame was not received (due to bus problems)
2. **too many or too long acyclic frames are sent in between sending cyclic frames by the master due to a improper configuration, to avoid these error notifications the configuration may be changed as follows:**

- lower value for master configuration parameter dwMaxAcycCmdsPerCycle
- higher cyclic timer period, i.e. less calls to `emExecJob()` (`eUsrJob_SendAllCycFrames`)

3. non-deterministic sending of acyclic frames.

Sending acyclic frames by calling `emExecJob()` (`eUsrJob_SendAcycFrames`) have to be properly scheduled with sending cyclic frames by calling `emExecJob()` (`eUsrJob_SendAllCycFrames`).

Using the control interface `emIoControl - EC_IOCTL_SET_FRAME_RESPONSE_ERROR_NOTIFY_MASK` it is possible to determine which response errors shall be signalled and which not.

Detailed error information is stored in structure `EC_T_FRAME_RSPERR_DESC` of `EC_T_ERROR_NOTIFICATION_DESC`.

```
struct EC_T_FRAME_RSPERR_DESC
```

Public Members

`EC_T_BOOL bIsCyclicFrame`

Indicates whether the lost frame was a cyclic frame

`EC_T_FRAME_RSPERR_TYPE EErrorType`

Frame response error type

`EC_T_BYTExEcCmdHeaderIdxSet`

Expected IDX value, this value is valid only for acyclic frames in case EErrorType is not equal to eRspErr_UNEXPECTED

`EC_T_BYTExEcCmdHeaderIdxAct`

Actually received IDX value, this value is only valid for acyclic frames in case of EErrorType is equal to: eRspErr_WRONG_IDX and eRspErr_UNEXPECTED

`EC_T_WORD wCycFrameNum`

Number of the lost cyclic frame from the ENI

`EC_T_DWORD dwTaskId`

Cyclic Task Id from the ENI. Only valid if bIsCyclicFrame is set

enum `EC_T_FRAME_RSPERR_TYPE`

Values:

enumerator `eRspErr_UNDEFINED`

undefined

enumerator `eRspErr_NO_RESPONSE`

No Ethernet frame received (timeout, frame loss)

enumerator **eRspErr_WRONG_IDX**
Wrong IDX value in acyclic frame

enumerator **eRspErr_UNEXPECTED**
Unexpected frame was received

enumerator **eRspErr_FRAME_RETRY**
Ethernet frame will be re-sent (timeout, frame loss)

enumerator **eRspErr_RETRY_FAIL**
all retry mechanism fails to re-sent acyclic frames

enumerator **eRspErr_FOREIGN_SRC_MAC**
Frame with MAC from other Master received

enumerator **eRspErr_NON_ECAT_FRAME**
Non EtherCAT frame received

enumerator **eRspErr_CRC**
Ethernet frame with CRC error received

6.7.25 emNotify - EC_NOTIFY_SLAVE_INITCMD_RESPONSE_ERROR

This error code will be indicated if a slave does not respond appropriately while sending slave init commands. The slave init commands are defined in the EtherCAT configuration (XML) file (Config/Slave/InitCmds/InitCmd). A timeout value for these commands may also be defined in the configuration file (Config/Slave/InitCmds/InitCmd/Timeout). If there is no timeout value defined here the frame response is expected within one single cycle.

This notification is enabled by default.

Detailed error information is stored in structure *EC_T_INITCMD_ERR_DESC* of *EC_T_ERROR_NOTIFICATION_DESC*.

```
struct EC_T_INITCMD_ERR_DESC
```

Public Members

EC_T_SLAVE_PROP **SlaveProp**
Slave properties

EC_T_CHAR **achStateChangeName**[MAX_SHORT_STRLEN]
State change description when the error occurred

EC_T_INITCMD_ERR_TYPE **EErrorType**
Init command error type

EC_T_CHAR **szComment**[MAX_STD_STRLEN]
Comment (ENI)

enum **EC_T_INITCMD_ERR_TYPE**
Values:

enumerator **eInitCmdErr_NO_ERROR**
No error

enumerator **eInitCmdErr_NO_RESPONSE**
No Ethernet frame received (timeout)

enumerator **eInitCmdErr_VALIDATION_ERR**
Validation error (invalid slave command response)

enumerator **eInitCmdErr_FAILED**
Init commands failed (state could not be reached)

enumerator **eInitCmdErr_NOT_PRESENT**
Slave not present on the bus

enumerator **eInitCmdErr_ALSTATUS_ERROR**
Error in AL Status Register

enumerator **eInitCmdErr_MBXSLAVE_ERROR**
Error at Mailbox Init Command

enumerator **eInitCmdErr_PDI_WATCHDOG**
PDI watchdog has been detected

See also:

[emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED](#) for how to control the deactivation

6.7.26 emNotify - EC_NOTIFY_MBSLAVE_INITCMD_TIMEOUT

This error is identical to error code [emNotify - EC_NOTIFY_SLAVE_INITCMD_RESPONSE_ERROR](#) but it will be indicated in case of timeouts when processing mailbox init commands.

The timeout value used for CoE mailbox slaves is defined in the EtherCAT configuration (XML) file (Config/Slave/Mailbox/CoE/InitCmds/InitCmd/Timeout). In case this value is set to 0 a fixed timeout value of 500 msec will be used by the EtherCAT master. The timeout value used for EoE mailbox slaves will be set fixed to a value of 5000 msec.

6.7.27 emNotify - EC_NOTIFY_MASTER_INITCMD_RESPONSE_ERROR

This error code will be indicated if a missing or wrong command response was detected while sending master init commands. The master init commands are defined in the EtherCAT configuration (XML) file (Config/Master/InitCmds/InitCmd). A timeout value for these commands may also be defined in the configuration file (Config/Master/InitCmds/InitCmd/Timeout). If there is no timeout value defined here the frame response is expected within one single cycle.

Detailed error information is stored in structure [*EC_T_INITCMD_ERR_DESC*](#) of [*EC_T_ERROR_NOTIFICATION_DESC*](#).

6.7.28 emNotify - EC_NOTIFY_NOT_ALL_DEVICES_OPERATIONAL

When processing cyclic frames the EtherCAT master checks whether all slaves are still in OPERATIONAL state. If at least one slave device is not OPERATIONAL this error will be indicated.

6.7.29 emNotify - EC_NOTIFY_ALL_DEVICES_OPERATIONAL

When processing cyclic frames the EtherCAT master checks whether all slaves are still in OPERATIONAL state. This will be notified after *emNotify - EC_NOTIFY_NOT_ALL_DEVICES_OPERATIONAL* and all the slaves are back in OPERATIONAL state.

6.7.30 emNotify - EC_NOTIFY_STATUS_SLAVE_ERROR

When processing cyclic frames the EtherCAT master checks if at least one slave has the ERROR bit in the AL-STATUS register set. In that case this error will be indicated. The master will then automatically determine detailed error information of the slave(s) indicating an error and acknowledge the error status. The application will get a *emNotify - EC_NOTIFY_SLAVE_ERROR_STATUS_INFO* notification for each such slave. Usually those slaves will enter safe-operational state in this case. It is the application's response how to further handle such error cases.

This notification is enabled by default.

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation

6.7.31 emNotify - EC_NOTIFY_SLAVE_ERROR_STATUS_INFO

Every time the master detects a slave error, the Error bit on the specific slave is cleared and this error code will be signalled to the application. Detailed error information is stored in structure *EC_T_SLAVE_ERROR_INFO_DESC* of *EC_T_ERROR_NOTIFICATION_DESC*. This notification is enabled by default.

struct **EC_T_SLAVE_ERROR_INFO_DESC**

Public Members

EC_T_SLAVE_PROP SlaveProp
Slave properties

EC_T_WORD wStatus
Slave Status (AL Status)

EC_T_WORD wStatusCode
Error status code (AL STATUS CODE)

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation

6.7.32 emNotify - EC_NOTIFY_SLAVES_ERROR_STATUS

This notification collects notifications of type *emNotify - EC_NOTIFY_SLAVE_ERROR_STATUS_INFO*. Notification is given on either collection full or master state changed whatever comes first.

This notification is disabled by default.

```
struct EC_T_SLAVES_ERROR_DESC
```

Public Members

EC_T_WORD wCount

Number of slave errors

EC_T_SLAVES_ERROR_DESC_ENTRY **SlaveError**[MAX_SLAVES_ERROR_NTFY_ENTRIES]

Slave error descriptions

```
struct EC_T_SLAVES_ERROR_DESC_ENTRY
```

Public Members

EC_T_WORD wStationAddress

Slave station address

EC_T_WORD wStatus

Slave status (AL Status)

EC_T_WORD wStatusCode

Slave status code (AL Control Status)

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the activation

6.7.33 emNotify - EC_NOTIFY_SLAVE_UNEXPECTED_STATE

This error is signalized every time a slave changes into an unexpected state. Detailed error information is stored in structure *EC_T_SLAVE_UNEXPECTED_STATE_DESC* of *EC_T_ERROR_NOTIFICATION_DESC*. This notification is enabled by default.

```
struct EC_T_SLAVE_UNEXPECTED_STATE_DESC
```

Public Members

EC_T_SLAVE_PROP **SlaveProp**

Slave properties

EC_T_STATE **curState**

Current state

EC_T_STATE **expState**

Expected state

See also:

[emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED](#) for how to control the deactivation

6.7.34 emNotify - EC_NOTIFY_SLAVES_UNEXPECTED_STATE

This notification collects notifications of type *emNotify - EC_NOTIFY_SLAVE_UNEXPECTED_STATE*. Notification is given on either collection full or master state changed whatever comes first. This notification is disabled by default.

```
struct EC_T_SLAVES_UNEXPECTED_STATE_DESC
```

Public Members

EC_T_WORD wCount

Number of unexpected slave state changes

EC_T_SLAVES_UNEXPECTED_STATE_DESC_ENTRY

```
SlaveStates[MAX_SLAVES_UNEXPECTED_STATE_NTFY_ENTRIES]
```

Slave state change descriptions

```
struct EC_T_SLAVES_UNEXPECTED_STATE_DESC_ENTRY
```

Public Members

EC_T_WORD wStationAddress

Slave station address

EC_T_STATE curState

Current state

EC_T_STATE expState

Expected state

See also:

[emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED](#) for how to control the activation

6.7.35 emNotify - EC_NOTIFY_ETH_LINK_NOT_CONNECTED

This notification will be indicated if the Ethernet link is disconnected. This error is never indicated if the Link Layer does not support detection of a missing link cable.

In case of permanent frame loss no slaves can be found although the slaves are connected. This does not affect link connection detection therefore this notification will be not indicated on permanent frame loss.

6.7.36 emNotify - EC_NOTIFY_ETH_LINK_CONNECTED

This notification will be indicated if the Ethernet link is reconnected after a disconnect. This notification is never indicated if the Link Layer does not support detection of a missing link cable.

6.7.37 emNotify - EC_NOTIFY_CLIENTREGISTRATION_DROPPED

This notification will be indicated if the client registration was dropped because `emConfigureNetwork()` was called by another thread. The notification has the following parameter:

```
EC_T_DWORD dwDeinitForConfiguration; /* 0 = terminating Master, 1 = restarting
                                         ↳Master */
```

6.7.38 emNotify - EC_NOTIFY_EEPROM_CHECKSUM_ERROR

This error is signalized every time a EEPROM checksum error is detected.

Detailed error information is stored in structure `EC_T_EEPROM_CHECKSUM_ERROR_DESC` of `EC_T_ERROR_NOTIFICATION_DESC`.

```
struct EC_T_EEPROM_CHECKSUM_ERROR_DESC
```

Public Members

`EC_T_SLAVE_PROP SlaveProp`
Slave properties

6.7.39 emNotify - EC_NOTIFY_PDIWATCHDOG

This error is signalized every time a PDI watchdog error is detected. Detailed error information is stored in structure `EC_T_PDIWATCHDOG_DESC` of `EC_T_ERROR_NOTIFICATION_DESC`.

```
struct EC_T_PDIWATCHDOG_DESC
```

Public Members

`EC_T_SLAVE_PROP SlaveProp`
Slave properties

6.7.40 ecatGetText

```
const EC_T_CHAR *ecatGetText(EC_T_DWORD dwTextId)
```

6.7.41 emLogFrameEnable

```
static EC_T_DWORD ecatLogFrameEnable (
    EC_T_PFLGLOGFRAME_CB pvLogFrameCallBack,
    EC_T_VOID *pvContext
)
EC_T_DWORD emLogFrameEnable (
    EC_T_DWORD dwInstanceID,
    EC_T_PFLGLOGFRAME_CB pvLogFrameCallBack,
    EC_T_VOID *pvContext
)
```

Setup a callback function to log the EtherCAT network traffic.

The callback function is called by the cyclic task. Therefore the code inside the callback has to be fast and non-blocking. The callback parameter dwLogFlags can be used as a filter to log just specific frames. The master discards the frame if the callback function modifies the Ethernet frame type at byte offset 12.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pvLogFrameCallBack** – [in] Pointer to frame logging callback function
- **pvContext** – [in] Pointer to function specific context

Returns

EC_E_NOERROR or error code

typedef EC_T_VOID (***EC_T_PFLGLOGFRAME_CB**)(EC_T_VOID *pvContext, EC_T_DWORD dwLogFlags, EC_T_DWORD dwFrameSize, EC_T_BYTEx *pbyFrame)

Note: The master discards the frame if the callback function modifies the Ethernet frame type at byte offset 12.

Parameters

- **pvContext** – [in] Context pointer. This pointer is used as parameter when the callback function is called
- **dwLogFlags** – [in] Frame logging flags, EC_LOG_FRAME_FLAG_...
- **dwFrameSize** – [in] Size of frame in bytes
- **pbyFrame** – [in] Pointer to frame data

EC_LOG_FRAME_FLAG_MASTERSTATE_MASK

Bit 0 to 15: Master state mask

EC_LOG_FRAME_FLAG_ACYC_FRAME

Bit 16 (0x00010000): 0=cyclic frame, 1=acyclic frame

EC_LOG_FRAME_FLAG_DBG_FRAME

Bit 17 (0x00020000): 0=EtherCAT frame, 1=debug frame

EC_LOG_FRAME_FLAG_RED_FRAME

Bit 18 (0x00040000): 0=main frame, 1=red frame

EC_LOG_FRAME_FLAG_RX_FRAME

Bit 19 (0x00080000): 0=TX frame, 1=RX frame

EC_LOG_FRAME_FLAG_MASTER_RED_FRAME

Bit 20 (0x00100000): 0=slave frame, 1=MasterMaster frame

```
/**************************************************************************
 ** \brief Handler to log frames.
 *
 *   CAUTION: Called by cyclic task!!! Do not consume too much CPU time!!!
 */
EC_T_VOID LogFrameHandler(EC_T_VOID* pvContext, EC_T_DWORD dwLogFlags, EC_T_DWORD_
dwFrameSize, EC_T_BYTE* pbyFrame)
{
    EC_T_STATE eMasterState;

    /* get master state */
    eMasterState = (EC_T_STATE) (dwLogFlags & EC_LOG_FRAME_FLAG_MASTERSTATE_MASK);

    /* skip tx frame */
    if ((S_dwLogFrameLevel == 3) && !(dwLogFlags & EC_LOG_FRAME_FLAG_RX_FRAME))
        return;

    /* skip cyclic frame */
    if ((S_dwLogFrameLevel == 2) && !(dwLogFlags & EC_LOG_FRAME_FLAG_ACYC_FRAME))
        return;

    /* skip red frame */
    if (dwLogFlags & EC_LOG_FRAME_FLAG_RED_FRAME)
        return;

    /* do something with pbyFrame ... */
}
```

6.7.42 emLogFrameDisable

static EC_T_DWORD **ecatLogFrameDisable** (EC_T_VOID)

EC_T_DWORD emLogFrameDisable (EC_T_DWORD dwInstanceID)

Disable the frame logging callback.

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

EC_E_NOERROR or error code

6.7.43 emGetMasterInfo

static EC_T_DWORD **ecatGetMasterInfo** (**EC_T_MASTER_INFO** *pMasterInfo)

EC_T_DWORD emGetMasterInfo (

 EC_T_DWORD dwInstanceID,
 EC_T_MASTER_INFO *pMasterInfo

)
Get generic information about the Master.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMasterInfo** – [out] Master information

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or pParms is NULL or contains values out of range
- *EC_E_ADS_IS_RUNNING* if ADS server is running

struct **EC_T_MASTER_INFO**

Public Members

EC_T_DWORD dwMasterVersion
Master version

EC_T_BUS_DIAGNOSIS_INFO **BusDiagnosisInfo**
Bus diagnostics

EC_T_MAILBOX_STATISTICS **MailboxStatistics**
Mailbox statistics

EC_T_REDUNDANCY_DIAGNOSIS_INFO RedundancyDiagnosisInfo
Redundancy diagnosis info

EC_T_DWORD dwMasterStateSummary
Master state summary

EC_T_DWORD dwMasterVersionType
Master version type

struct **EC_T_BUS_DIAGNOSIS_INFO**

Public Members

EC_T_DWORD dwCRC32ConfigChecksum
CRC32 checksum of the loaded configuration

EC_T_DWORD dwNumSlavesFound
Number of slaves connected

EC_T_DWORD dwNumDCSlavesFound
Number of slaves with DC enabled connected

EC_T_DWORD dwNumCfgSlaves
Number of slaves in ENI

EC_T_DWORD dwNumMbxSlaves
Number of slaves in ENI with mailbox support

EC_T_DWORD dwTXFrames
Number of frames sent

EC_T_DWORD dwRXFrames
Number of frames received

EC_T_DWORD dwLostFrames
Number of lost frames

EC_T_DWORD dwCyclicFrames
Number of cyclic frames sent

EC_T_DWORD dwCyclicDatagrams
Number of cyclic datagrams / EtherCAT commands sent

EC_T_DWORD dwAcyclicFrames
Number of acyclic frames sent

EC_T_DWORD dwAcyclicDatagrams
Number of acyclic datagrams / EtherCAT commands sent

EC_T_DWORD dwClearCounters
Clear frame / datagram counter bit field

EC_T_DWORD dwCyclicLostFrames
Number of cyclic lost frames

EC_T_DWORD dwAcyclicLostFrames
Number of acyclic lost frames

struct **EC_T_MAILBOX_STATISTICS**

Public Members

EC_T_STATISTIC_TRANSFER_DUPLEX Aoe
AoE mailbox transfer statistics

EC_T_STATISTIC_TRANSFER_DUPLEX Coe
CoE mailbox transfer statistics

EC_T_STATISTIC_TRANSFER_DUPLEX Eoe
EoE mailbox transfer statistics

EC_T_STATISTIC_TRANSFER_DUPLEX Foe
FoE mailbox transfer statistics

EC_T_STATISTIC_TRANSFER_DUPLEX Soe
SoE mailbox transfer statistics

EC_T_STATISTIC_TRANSFER_DUPLEX Voe
VoE mailbox transfer statistics

EC_T_STATISTIC_TRANSFER_DUPLEX RawMbx
Raw mailbox transfer statistics

```
struct EC_T_STATISTIC_TRANSFER_DUPLEX
```

Public Members

EC_T_STATISTIC_TRANSFER Read
Number of read transfers

EC_T_STATISTIC_TRANSFER Write
Number of write transfers

```
struct EC_T_STATISTIC_TRANSFER
```

Public Members

EC_T_STATISTIC Cnt
Number of transfers

EC_T_STATISTIC Bytes
Number of bytes transferred

```
struct EC_T_STATISTIC
```

Public Members

EC_T_DWORD dwTotal
Total

EC_T_DWORD dwLast
Last

6.7.44 emGetMemoryUsage

```
static EC_T_DWORD ecatGetMemoryUsage (
    EC_T_DWORD *pdwCurrentUsage,
    EC_T_DWORD *pdwMaxUsage
)
EC_T_DWORD emGetMemoryUsage (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD *pdwCurrentUsage,
    EC_T_DWORD *pdwMaxUsage
)
```

Returns information about memory usage.

All calls to malloc/free and new/delete are monitored.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pdwCurrentUsage** – [out] Current memory usage in Bytes at the time where this function is called
- **pdwMaxUsage** – [out] Maximum memory usage in Bytes since initialization at the time where this function is called

Returns

EC_E_NOERROR or error code

6.7.45 emGetMasterDump

```
static EC_T_DWORD ecatGetMasterDump (
    EC_T_BYTE *pbyBuffer,
    EC_T_DWORD dwBufferSize,
    EC_T_DWORD *pdwDumpSize
)
EC_T_DWORD emGetMasterDump (
    EC_T_DWORD dwInstanceID,
    EC_T_BYTE *pbyBuffer,
    EC_T_DWORD dwBufferSize,
    EC_T_DWORD *pdwDumpSize
)
```

The dump contains relevant information about the master and slave status.

The dump is only intended for internal troubleshooting at acontis. Amongst others it contains the following descriptors:

- *EC_T_INIT_MASTER_PARMS*
- *EC_T_BUS_DIAGNOSIS_INFO*
- *EC_T_MAILBOX_STATISTICS*
- *EC_T_CFG_SLAVE_INFO*
- *EC_T_BUS_SLAVE_INFO*
- *EC_T_SLVSTATISTICS_DESC*

The buffer is written until all relevant data have been dumped or buffer size has been exceeded.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pbyBuffer** – [in] Preallocated buffer to dump log data
- **dwBufferSize** – [in] Size of preallocated buffer
- **pdwDumpSize** – [out] Size of master dump

Returns

- *EC_E_NOERROR*
- *EC_E_NOMEMORY* if buffer too small

6.7.46 emGetMasterSyncUnitInfoNumOf

```
static EC_T_DWORD ecatGetMasterSyncUnitInfoNumOf (EC_T_VOID)
EC_T_DWORD emGetMasterSyncUnitInfoNumOf (EC_T_DWORD dwInstanceID)
    Get number of Master Sync Units info entries.
```

Parameters

dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

Returns

Number of Master Sync Units info entries

6.7.47 emGetMasterSyncUnitInfo

```
static EC_T_DWORD ecatGetMasterSyncUnitInfo (
    EC_T_WORD wMsuId,
    EC_T_MSU_INFO *pMsuInfo
)
EC_T_DWORD emGetMasterSyncUnitInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_WORD wMsuId,
    EC_T_MSU_INFO *pMsuInfo
)
    Get information about specific Master Sync Unit.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **wMsuId** – [in] Master Sync Unit to get the information from
- **pMsuInfo** – [out] Pointer to an *EC_T_MSU_INFO* structure receiving the Master Sync Unit information

Returns

EC_E_NOERROR or error code

MSU_ID_ALL_INFO_ENTRIES retrieves the information from all master sync units at once. The application must ensure that *pMsuInfo* is capable for all entries.

struct *EC_T_MSU_INFO*

Public Members

EC_T_WORD wMsuId
[out] master sync unit ID

EC_T_DWORD dwBitOffsetIn
[out] input bit offset of master sync unit in process data image

EC_T_DWORD dwBitSizeIn
[out] input bit size of master sync unit

EC_T_DWORD dwBitOffsetOut
[out] output bit offset of master sync unit in process data image

EC_T_DWORD dwBitSizeOut
 [out] output bit size of master sync unit

EC_T_WORD wWkcStateDiagOffsIn
 [out] Offset of WkcState bit in diagnosis image WkcState bit values: 0 = Data Valid, 1 = Data invalid

EC_T_WORD wWkcStateDiagOffsOut
 [out] Offset of WkcState bit in diagnosis image WkcState bit values: 0 = Data Valid, 1 = Data invalid

EC_T_DWORD adwReserved[16]
 reserved

See also:

emGetMasterSyncUnitInfoNumOf()

6.7.48 emBadConnectionsDetect

```
static EC_T_DWORD ecatBadConnectionsDetect (
    EC_T_BOOL bRefreshSlaveStatistics,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emBadConnectionsDetect (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bRefreshSlaveStatistics,
    EC_T_DWORD dwTimeout
)
```

Detects bad connections.

Analyzes the slave ESC error counters:

- Invalid Frame Counter (0x0300),
- RX Error Counter (0x0301),
- Lost Link Counter (0x0310),

whether there is a problem in the area PHY - connector - cable - connector - PHY. If one of the above error counters shows a value not equal to zero, an EC_NOTIFY_BAD_CONNECTION is generated, which contains the exact position of the faulty connection. It is recommended to call emBadConnectionsReset() on startup of EC-Master to ensure that all error counters of all slaves are in a defined state.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bRefreshSlaveStatistics** – [in] EC_TRUE: refresh ESC error counters, EC_FALSE: process current ESC error counters
- **dwTimeout** – [in] Timeout [ms] May not be EC_NOWAIT!

Returns

EC_E_NOERROR or error code

See also:

emBadConnectionsReset()

6.7.49 emBadConnectionsReset

```
static EC_T_DWORD ecatBadConnectionsReset (EC_T_VOID)
static EC_T_DWORD emBadConnectionsReset (EC_T_DWORD dwInstanceID)
    Clears all error counters (0x0300 - 0x0313) of all slaves.
```

Parameters

- dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)

6.7.50 emNotify - EC_NOTIFY_BAD_CONNECTION

This error is signalized every time a bad connection is detected within the call of *emBadConnectionsDetect()*. It contains the exact location of the bad connection between two slaves. This notification is enabled by default.

```
struct EC_T_BAD_CONNECTION_NTFY_DESC
```

Public Members

EC_T_SLAVE_PROP **SlavePropParent**
slave properties of parent slave

EC_T_WORD **wPortAtParent**
port at parent slave

EC_T_SLAVE_PROP **SlavePropChild**
slave properties of child slave

EC_T_WORD **wPortAtChild**
port at child slave

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation

6.7.51 emSelfTestScan

```
static EC_T_DWORD ecatSelfTestScan (EC_T_SELFTESTSCAN_PARMS *pParms)
```

```
EC_T_DWORD emSelfTestScan (
    EC_T_DWORD dwInstanceID,
    EC_T_SELFTESTSCAN_PARMS *pParms
)
    Self test scan.
```

Send a burst of numerous frames and analyze the slave connections. After deactivating the job task, frames will be sent as fast as the LinkLayer can send them. The size of the frames increases and decreases between the defined limits. Dependent on the parameters the BadConnectionsDetect API will analyze the slave connections.

Parameters

- dwInstanceID – [in] Instance ID (Multiple EtherCAT Network Support)
- pParms – [in] Self-test scan parameters

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or pParms is NULL or contains values out of range
- *EC_E_BAD_CONNECTION* if bad connection was detected
- *EC_E_FRAME_LOST* if frame(s) lost during self-test
- *EC_E_NOTSUPPORTED* if not in polling mode
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

struct **EC_T_SELFTESTSCAN_PARMS**

Public Members

EC_T_DWORD dwSize

[in] Set to sizeof(EC_T_SELFTESTSCAN_PARMS)

EC_T_DWORD dwTimeout

[in] Timeout [ms], 0 or EC_NOWAIT defaults to 500ms

EC_T_DWORD dwFrameCount

[in] Total number of frames sent during the self-test. Default value is 1500. A value of 0 let the current setting unmodified.

EC_T_DWORD dwFrameSizeMin

[in] Min frame size [bytes]. Default value is 60. A value of 0 let the current setting unmodified.

EC_T_DWORD dwFrameSizeMax

[in] Max frame size [bytes]. Default value is 1514. A value of 0 let the current setting unmodified.

EC_T_DWORD dwFrameSizeStep

[in] Size [bytes] by which the frame increases or decreases continuously during the self-test. Default value is 1. A value of 0 let the current setting unmodified.

EC_T_BOOL bDetectBadConnections

[in] Execute the bad connection detection after self-test

EC_T_UINT64 qwFrameRoundtripTimeAvg

[out] Roundtrip time average [us]. Time taken from sending to receiving the frame (master application level).

EC_T_UINT64 qwFrameRoundtripTimeMin

[out] Roundtrip time minimum [us]. Time taken from sending to receiving the frame (master application level).

EC_T_UINT64 qwFrameRoundtripTimeMax

[out] Roundtrip time maximum [us]. Time taken from sending to receiving the frame (master application level).

See also:

emBadConnectionsDetect ()

6.8 Performance Measurement

The acontis EC-Master software has a built-in performance measurement capability. This can be used to measure the execution times of the job functions that are called within the cyclic part of the application, as well as application specific functions. These executions times can be recorded both in form of overall statistics (min/avg/max) and in form of histograms.

6.8.1 Enabling performance measurements

Performance measurements need to be enabled inside the master init parms.

```
/* enable performance measurements */
oInitParms.PerfMeasInternalParms.bEnabled = EC_TRUE;

/* initialize the master */
dwRes = ecatInitMaster(&oInitParms);
```

See also:

[EC_T_PERF_MEAS_INTERNAL_PARMS](#)

6.8.2 Retrieving overall performance statistics (min/avg/max)

Performance measurements in the example application can be activated using the command line parameter (-perf). It enables performance measurements and performance histograms as well. The resulting measurement values are recorded every few seconds to the log file, and printed to the console in the following format:

PerfMsmt	'JOB_ProcessAllRxFrames'	(min/avg/max)	[usec]	: 12.5/ 15.9/ 25.6
PerfMsmt	'JOB_SendAllCycFrames'	(min/avg/max)	[usec]	: 3.6/ 5.7/ 14.8
PerfMsmt	'JOB_MasterTimer'	(min/avg/max)	[usec]	: 2.1/ 3.7/ 8.2
PerfMsmt	'JOB_SendAcycFrames'	(min/avg/max)	[usec]	: 0.3/ 0.6/ 2.6
PerfMsmt	'Cycle Time'	(min/avg/max)	[usec]	: 918.4/ 999.6/1067.9
PerfMsmt	'myAppWorkPd'	(min/avg/max)	[usec]	: 0.1/ 0.4/ 0.8
PerfMsmt	'JOB_Total'	(min/avg/max)	[usec]	: 19.0/ 25.9/ 39.2

In an application these values can be retrieved using the *emPerfMeasGet*/*emPerfMeasAppGet* APIs. These APIs require the index of a measurement point. Note that the index of a particular measurement point is implementation defined and not the same in all versions. It should therefore be detected at runtime using *emPerfMeasGetInfo*. The following example shows how measurements for *JOB_ProcessAllRxFrames* can be retrieved:

```
EC_T_DWORD dwProcessAllRxFramesIdx = 0;
EC_T_DWORD dwMeasNum = 0;
dwRes = ecatPerfMeasGetNumOf(&dwMeasNum);

/* find index of perf measurement */
for (EC_T_DWORD i = 0; i < dwMeasNum; ++i)
{
    EC_T_PERF_MEAS_INFO PerfMeasInfo;
    dwRes = ecatPerfMeasGetInfo(i, &PerfMeasInfo, 1);

    if (0 == OsStrncmp("JOB_ProcessAllRxFrames", PerfMeasInfo.szName, OsStrlen(
        "JOB_ProcessAllRxFrames") + 1))
    {
        dwProcessAllRxFramesIdx = i;
        break;
    }
}
```

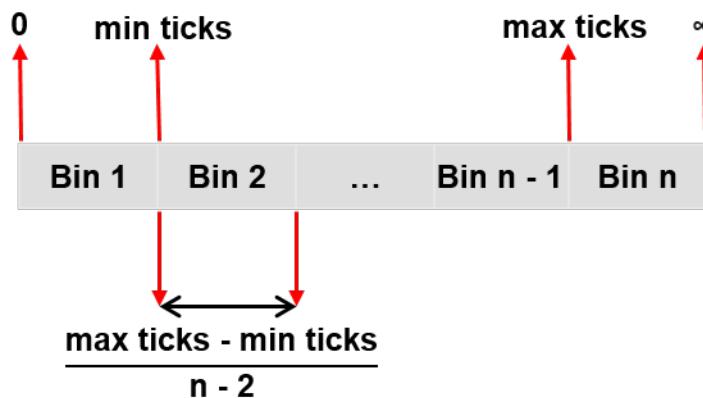
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```
/* retrieve values */
EC_T_PERF_MEAS_VAL PerfMeasVal;
dwRes = ecatPerfMeasGetRaw(dwProcessAllRxFramesIdx, &PerfMeasVal, EC_NULL, 1);
```

6.8.3 Recording performance histograms

In addition to the overall statistics described above it is possible to create a histogram of all results of a particular benchmark. The histogram has the following format:



```
/* enabling histograms */
EC_T_PERF_MEAS_COUNTER_PARMS* pHistParms = EC_NULL;
pHistParms = &oInitParms.PerfMeasInternalParms.HistogramParms;
/* amount of bins to use for the histogram */
pHistParms->dwBinCount = 1000;
/* range of the histograms.
 * - results below qwMinTicks are stored in the first bin
 * - results above qwMaxTicks are stored in the last bin
 *
 * a good starting point is the range 0 <-> 2 * the amount of ticks per cycle
 */
pHistParms->qwMinTicks = 0;
pHistParms->qwMaxTicks = 2 * qwTicksPerCycle;

/* initialize the master */
dwRes = ecatInitMaster(&oInitParms);
```

See also:

EC_T_PERF_MEAS_HISTOGRAM_PARMS

Similar to the overall statistics it is possible to retrieve the histograms using *emPerfMeasGetRaw*:

```
/* retrieve values */
EC_T_PERF_MEAS_HISTOGRAM PerfMeasHist;
PerfMeasHist.aBins = (EC_T_DWORD*)OsMalloc(dwBinCount * sizeof(EC_T_DWORD));
PerfMeasHist.dwBinCount = dwBinCount;
dwRes = ecatPerfMeasGetRaw(dwProcessAllRxFramesIdx, EC_NULL, &PerfMeasHist, 1);
```

6.8.4 Special benchmark types

In addition to the normal benchmarks as described above, there are some special benchmark types which are flagged in `EC_T_PERF_MEAS_INFO`.

`EC_T_PERF_MEAS_FLAG_OFFSET`

distance benchmarks are used to measure the time between the cycle start and the benchmark start. This can be helpful when visualizing the benchmarks inside a cycle

`EC_T_PERF_MEAS_FLAG_LONG_TIMER`

Changes the default of qwMinTicks/qwMaxTicks selected when passing qwMinTicks=qwMinTicks=0 from 0
– cycle time to 0.5 * cycle time – 1.5 * cycle time

6.8.5 Application benchmarks

In addition to the internal benchmarks it is possible to create application specific benchmarks using the *emPerfMeasApp* API.

```
static EC_T_PERF_MEAS_INFO_PARMS S_aPerfMeasInfos[] =
{
    {"myBench", 0}
};

#define APPL_PERF_MEAS_NUM      (sizeof(S_aPerfMeasInfos) / sizeof(S_
→aPerfMeasInfos[0]))
#define PERF_myBench            0

EC_T_PERF_MEAS_APP_PARMS oPerfMeasAppParms;
OsMemset(&oPerfMeasAppParms, 0, sizeof(EC_T_PERF_MEAS_APP_PARMS));
oPerfMeasAppParms.dwNumMeas = APPL_PERF_MEAS_NUM;
oPerfMeasAppParms.aPerfMeasInfos = S_aPerfMeasInfos;

dwRes = ecatPerfMeasAppCreate( &oPerfMeasAppParms, EC_NULL);

ecatPerfMeasAppStart(EC_NULL, PERF_myBench);
/* benchmarked work */
ecatPerfMeasAppEnd(EC_NULL, PERF_myBench);
```

6.8.6 API

`emPerfMeasAppCreate`

```
static EC_T_DWORD ecatPerfMeasAppCreate (
    EC_T_PERF_MEAS_APP_PARMS *pPerfMeasAppParms,
    EC_T_VOID **ppvPerfMeas
)
EC_T_DWORD emPerfMeasAppCreate (
    EC_T_DWORD dwInstanceID,
    EC_T_PERF_MEAS_APP_PARMS *pPerfMeasAppParms,
    EC_T_VOID **ppvPerfMeas
)
```

Create PerfMeas object and bind it to the master instance.

This API can be called multiple times to create PerfMeas objects. The performance counters in each of the objects can be accessed in the following two ways:

- by passing the PerfMeas object and the index of the performance measurement. The index ranges from [0-pPerfMeasAppParms->dwNumAppMeas]

- by passing EC_NULL instead of a PerfMeas object and an index. In this case the index works across all PerfMeas objects bound to the master instance.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pPerfMeasAppParms** – [in] Pointer to parameter definitions
- **ppvPerfMeas** – [out] Created PerfMeas object.

Returns

EC_E_NOERROR or an error code

struct **EC_T_PERF_MEAS_APP_PARMS**

Public Members

EC_T_DWORD dwNumMeas

[in] Number of performance counters to create

EC_T_PERF_MEAS_INFO_PARMS *aPerfMeasInfos

[in] PerfMeasInfos associated with the corresponding benchmark

EC_T_PERF_MEAS_COUNTER_PARMS CounterParms

[in] Timer function settings. When not provided OsMeasGetCounterTicks is used

EC_T_PERF_MEAS_HISTOGRAM_PARMS HistogramParms

[in] Histogram settings. When not provided the histogram is disabled.

emPerfMeasAppDelete

static EC_T_DWORD **ecatPerfMeasAppDelete** (EC_T_VOID *pvPerfMeas)

EC_T_DWORD emPerfMeasAppDelete (

EC_T_DWORD dwInstanceID,
 EC_T_VOID *pvPerfMeas

)

Delete application performance measurement and unbind it from the master instance.

Objects which are not deleted using PerfMeasAppDelete are automatically deleted when calling DeinitMaster.

Note: This invalidates the global index used when passing EC_NULL into the other PerfMeasApp functions

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pvPerfMeas** – [in] PerfMeas object to delete

Returns

EC_E_NOERROR or an error code

emPerfMeasAppStart

```
static EC_T_DWORD ecatPerfMeasAppStart (
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex
)
EC_T_DWORD emPerfMeasAppStart (
    EC_T_DWORD dwInstanceID,
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex
)
) Start application performance measurement.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pvPerfMeas** – [in] PerfMeas object or EC_NULL to use continuous index
- **dwIndex** – [in] Index of the performance measurement

Returns*EC_E_NOERROR* or an error code**emPerfMeasAppEnd**

```
static EC_T_DWORD ecatPerfMeasAppEnd (EC_T_VOID *pvPerfMeas, EC_T_DWORD dwIndex)

EC_T_DWORD emPerfMeasAppEnd (
    EC_T_DWORD dwInstanceID,
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex
)
) Stop application performance measurement.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pvPerfMeas** – [in] PerfMeas object or EC_NULL to use continuous index
- **dwIndex** – [in] Index of the performance measurement

Returns*EC_E_NOERROR* or an error code**emPerfMeasAppReset**

```
static EC_T_DWORD ecatPerfMeasAppReset (
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex
)
EC_T_DWORD emPerfMeasAppReset (
    EC_T_DWORD dwInstanceID,
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex
)
) Reset application performance measurement.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pvPerfMeas** – [in] PerfMeas object or EC_NULL to use continuous index
- **dwIndex** – [in] Index of the performance measurement, use EC_PERF_MEAS_ALL to reset all

Returns*EC_E_NOERROR* or an error code**emPerfMeasAppGetNumOf**

```
static EC_T_DWORD ecatPerfMeasAppGetNumOf (
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD *pdwNumOf
)
EC_T_DWORD emPerfMeasAppGetNumOf (
    EC_T_DWORD dwInstanceID,
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD *pdwNumOf
)
    Reset number of application performance measurement.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pvPerfMeas** – [in] PerfMeas object or EC_NULL to get the number of performance measurements in all PerfMeas objects
- **pdwNumOf** – [out] Number of performance measurements

Returns*EC_E_NOERROR* or an error code**emPerfMeasAppGetInfo**

```
static EC_T_DWORD ecatPerfMeasAppGetInfo (
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_INFO *pPerfMeasInfo,
    EC_T_DWORD dwPerfMeasNumOf
)
EC_T_DWORD emPerfMeasAppGetInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_INFO *pPerfMeasInfo,
    EC_T_DWORD dwPerfMeasNumOf
)
    Get general info about one/all application performance measurement.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)

- **pvPerfMeas** – [in] PerfMeas object or EC_NULL to use continuous index
- **dwIndex** – [in] Index of the performance measurement information, use EC_PERF_MEAS_ALL to get all
- **pPerfMeasInfo** – [out] Pointer to a buffer receiving one/all performance measurement information
- **dwPerfMeasNumOf** – [in] Number of elements allocated in pPerfMeasInfo

Returns*EC_E_NOERROR* or an error codestruct **EC_T_PERF_MEAS_INFO****Public Members**EC_T_CHAR **szName**[MAX_STD_STRLEN]
Name of the benchmarkEC_T_UINT64 **qwFrequency**
Frequency in Hz used by the timer*EC_T_USER_JOB* **eUserJob**
UserJob associated with the benchmarkEC_T_DWORD **dwBinCountHistogram**
length of Histogram BinsEC_T_DWORD **dwFlags**
Flags associated with the benchmark (See EC_T_PERF_MEAS_FLAG...)**emPerfMeasAppGetRaw**

```
static EC_T_DWORD ecatPerfMeasAppGetRaw (
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_VAL *pPerfMeasVal,
    EC_T_PERF_MEAS_HISTOGRAM *pPerfMeasHistogram,
    EC_T_DWORD dwPerfMeasNumOf
)
EC_T_DWORD emPerfMeasAppGetRaw (
    EC_T_DWORD dwInstanceID,
    EC_T_VOID *pvPerfMeas,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_VAL *pPerfMeasVal,
    EC_T_PERF_MEAS_HISTOGRAM *pPerfMeasHistogram,
    EC_T_DWORD dwPerfMeasNumOf
)
) Get raw data of one/all application performance measurement.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pvPerfMeas** – [in] PerfMeas object or EC_NULL to use continuous index

- **dwIndex** – [in] Index of the performance measurement, use EC_PERF_MEAS_ALL to get all
- **pPerfMeasVal** – [out] Pointer to a buffer receiving one/all performance measurement values or EC_NULL
- **pPerfMeasHistogram** – [out] Pointer to a buffer receiving one/all performance measurement histograms or EC_NULL
- **dwPerfMeasNumOf** – [in] Number of elements allocated in pPerfMeasVal and pPerfMeasHistogram

Returns*EC_E_NOERROR* or an error codestruct **EC_T_PERF_MEAS_VAL****Public Members**EC_T_UINT64 **qwCurrTicks**
[ticks]EC_T_UINT64 **qwMinTicks**
[ticks]EC_T_UINT64 **qwMaxTicks**
[ticks]EC_T_UINT64 **qwAvgTicks**
[ticks]struct **EC_T_PERF_MEAS_HISTOGRAM****Public Members**EC_T_DWORD ***aBins**

Histogram Bins:

The first bin is used for times below dwMinTicks. The last bin is used for times equal and above dwMaxTicks. All other times are stored in dwBinCount – 2 bins of equal size.

With e.g. dwBinCount = 202

qwMinTicks corresponding to 500us

qwMaxTicks corresponding to 1500us

aBins[0]: (-inf, 500us) corresponds to -inf < x < 500us

aBins[1]: [500us, 505us) corresponds to 500us <= x < 505us

aBins[2]: [505us, 510us) corresponds to 505us <= x < 510us

...

aBins[199]: [1490us, 1495us) corresponds to 1490us <= x < 1495us

aBins[200]: [1495us, 1500us) corresponds to 1495us <= x < 1500us

aBins[201]: [1500us, inf+) corresponds to 1500us <= x < inf+

EC_T_DWORD dwBinCount
length of aBins

EC_T_UINT64 qwMinTicks
results below qwMinTicks are stored in the first bin

EC_T_UINT64 qwMaxTicks
results above qwMaxTicks are stored in the last bin

emPerfMeasResetByTaskId

```
static EC_T_DWORD ecatPerfMeasResetByTaskId(
    EC_T_DWORD dwTaskId,
    EC_T_DWORD dwIndex
)
EC_T_DWORD emPerfMeasResetByTaskId(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwTaskId,
    EC_T_DWORD dwIndex
)
    Reset internal performance measurement.
```

Parameters

- **dwInstanceID** – [in] Master Instance ID
- **dwTaskId** – [in] Task Job ID
- **dwIndex** – [in] Index of the performance measurement, use EC_PERF_MEAS_ALL to reset all

Returns

EC_E_NOERROR or an error code

emPerfMeasGetNumOfByTaskId

```
static EC_T_DWORD ecatPerfMeasGetNumOfByTaskId(
    EC_T_DWORD dwTaskId,
    EC_T_DWORD *pdwNumOf
)
EC_T_DWORD emPerfMeasGetNumOfByTaskId(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwTaskId,
    EC_T_DWORD *pdwNumOf
)
    Reset number of internal performance measurement.
```

Parameters

- **dwInstanceID** – [in] Master Instance ID
- **dwTaskId** – [in] Task Job ID
- **pdwNumOf** – [out] Number of performance measurements

Returns

EC_E_NOERROR or an error code

emPerfMeasGetInfoByTaskId

```
static EC_T_DWORD ecatPerfMeasGetInfoByTaskId(
    EC_T_DWORD dwTaskId,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_INFO *pPerfMeasInfo,
    EC_T_DWORD dwPerfMeasNumOf
)
EC_T_DWORD emPerfMeasGetInfoByTaskId(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwTaskId,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_INFO *pPerfMeasInfo,
    EC_T_DWORD dwPerfMeasNumOf
)
) Get general info about one/all internal performance measurement.
```

Parameters

- **dwInstanceID** – [in] Master Instance ID
- **dwTaskId** – [in] Task Job ID
- **dwIndex** – [in] Index of the performance measurement, use EC_PERF_MEAS_ALL to get all
- **pPerfMeasInfo** – [out] Pointer to a buffer receiving one/all performance measurement infos
- **dwPerfMeasNumOf** – [in] Number of elements allocated in pPerfMeasInfo

Returns

EC_E_NOERROR or an error code

emPerfMeasGetRawByTaskId

```
static EC_T_DWORD ecatPerfMeasGetRawByTaskId(
    EC_T_DWORD dwTaskId,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_VAL *pPerfMeasVal,
    EC_T_PERF_MEAS_HISTOGRAM *pPerfMeasHistogram,
    EC_T_DWORD dwPerfMeasNumOf
)
EC_T_DWORD emPerfMeasGetRawByTaskId(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwTaskId,
    EC_T_DWORD dwIndex,
    EC_T_PERF_MEAS_VAL *pPerfMeasVal,
    EC_T_PERF_MEAS_HISTOGRAM *pPerfMeasHistogram,
    EC_T_DWORD dwPerfMeasNumOf
)
) Get raw data of one/all application performance measurement.
```

Parameters

- **dwInstanceID** – [in] Master Instance ID
- **dwTaskId** – [in] Task Job ID

- **dwIndex** – [in] Index of the performance measurement, use EC_PERF_MEAS_ALL to get all
- **pPerfMeasVal** – [out] Pointer to a buffer receiving one/all performance measurement values or EC_NULL
- **pPerfMeasHistogram** – [out] Pointer to a buffer receiving one/all performance measurement histograms or EC_NULL
- **dwPerfMeasNumOf** – [in] Number of elements allocated in pPerfMeasVal and pPerfMeasHistogram

Returns*EC_E_NOERROR* or an error code

6.9 EtherCAT Mailbox Transfer

To be able to initiate a mailbox transfer the client has to create a mailbox transfer object first. This mailbox transfer object also contains the memory where the data to be transferred is stored. The one client that initiated the mailbox transfer will be notified about a mailbox transfer completion by the `emNotify()` callback function.

To be able to identify the transfer which was completed the client has to assign a unique transfer identifier for each mailbox transfer. The mailbox transfer object can only be used for one single mailbox transfer. If multiple transfers shall be initiated in parallel the client has to create one transfer object for each. The transfer object can be re-used after mailbox transfer completion.

Typical mailbox transfer sequence:

1. **Create a transfer object (for example a SDO download transfer object).**

```
MbxTferDesc.dwMaxDataLen = 10

MbxTferDesc.pbyMbxTferDescData=(EC_T_PBYTE)OsMalloc(MbxTferDesc.
    ↳dwMaxDataLen)

pMbxTfer = emMbxTferCreate(&MbxTferDesc)
    state of the transfer object = Idle
```

2. **Copy the data to be transferred to the slave into the transfer object, determine the transfer ID, store the client ID in the object and initiate the transfer (e.g. a SDO download). A transfer may only be initiated if the state of the transfer object is Idle.**

```
OsMemcpy (pMbxTfer->pbyMbxTferData, "0123456789", 10);

pMbxTfer->dwTferId = 1;

pMbxTfer->dwClntId = dwClntId;

pMbxTfer->dwDataLen=10;

dwResult = emCoeSdoDownloadReq(pMbxTfer, dwSlaveId, wObIndex, ...);
    state of the transfer object = Pend or TferReqError
```

The state will then be set to Pend to indicate that this mailbox transfer object currently is in use and the transfer is not completed. If the mailbox transfer cannot be initiated the master will set the object into the state TferReqError - in such cases the client is responsible to set the state back into Idle.

3. **If the mailbox transfer is completed the notification callback function of the corresponding client (`emNotify()`) will be called with a pointer to the mailbox transfer object. The state of the**

transfer object is set to TferDone prior to calling emNotify().

```
if( dwResult != EC_E_NOERROR ) { ... }

emNotify( EC_NOTIFY_MBOXRCV, pParms )
    state of the transfer object = TferDone
```

4. In case of errors the appropriate error handling has to be executed. Application must set the transfer object state to Idle.

```
if( pMbxTfer->dwErrorCode != EC_E_NOERROR ) { ... }
    In emNotify: application may set transfer object state to Idle
```

5. Delete the transfer object. Alternatively this object can be used for the next transfer.

```
emMbxTferDelete(pMbxTfer);
```

6.9.1 Mailbox transfer object states

The following states exist for a mailbox transfer object:

enum **EC_T_MBXTFER_STATUS**
Values:

enumerator **eMbxTferStatus_Idle**
 Mailbox transfer object not in use

enumerator **eMbxTferStatus_Pend**
 Mailbox transfer in process

enumerator **eMbxTferStatus_TferDone**
 Mailbox transfer completed

enumerator **eMbxTferStatus_TferReqError**
 Mailbox transfer request error

enumerator **eMbxTferStatus_TferWaitingForContinue**
 Mailbox transfer waiting for continue, object owned by application

A mailbox transfer will be processed by the master independently from the client's timeout setting. Some types of mailbox transfers can be cancelled by the client, e.g. if the client's timeout elapsed.

After completion of the mailbox transfer (with timeout and the client may finally set the transfer object into the state **EC_T_MBXTFER_STATUS::eMbxTferStatus_Idle**. New mailbox transfers can only be requested if the object is in the state **EC_T_MBXTFER_STATUS::eMbxTferStatus_Idle**.

See also:

[emMbxTferAbort\(\)](#)

6.9.2 emMbxTferCreate

static ***EC_T_MBXTFER*** ****ecatMbxTferCreate*** (***EC_T_MBXTFER_DESC*** ****pMbxTferDesc***)

```
EC_T_MBXTFER *emMbxTferCreate (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER_DESC *pMbxTferDesc
)
```

Creates a mailbox transfer object.

While a mailbox transfer is in process the related transfer object and the corresponding memory may not be accessed. After a mailbox transfer completion the object may be used for the next transfer. The mailbox transfer object has to be deleted by calling ***ecatMbxTferDelete*** if it is not needed any more.

Parameters

- ***dwInstanceID*** – [in] Instance ID (Multiple EtherCAT Network Support)
- ***pMbxTferDesc*** – [in] Pointer to the mailbox transfer descriptor. Determines details of the mailbox transfer.

Returns

- Pointer to the created mailbox transfer object if successful
- ***EC_NULL*** on error (No memory left)

struct ***EC_T_MBXTFER_DESC***

Public Members

EC_T_DWORD dwMaxDataLen

Maximum amount of data bytes that shall be transferred using this object. A mailbox transfer type without data transfer will ignore this parameter

EC_T_BYT* pbyMbxTferDescData

Pointer to byte stream carrying in and out data of mailbox content

struct ***EC_T_MBXTFER***

Public Members

EC_T_DWORD dwClnId

[] Client ID

EC_T_MBXTFER_DESC MbxTferDesc

[out] Mailbox transfer descriptor. All elements of ***pMbxTferDesc*** will be stored here

EC_T_MBXTFER_TYPE eMbxTferType

[] This type information is written to the Mailbox Transfer Object by the last call to a mailbox command function. It may be used as an information, and is required to fan out consecutive notifications. This value is only valid until next mailbox relevant API call, where this value may be overwritten

EC_T_DWORD dwDataLen

[] Amount of data bytes for the next mailbox transfer. If the mailbox transfer does not transfer data from

or to the slave this parameter will be ignored. This element has to be set to an appropriate value every time prior to initiate a new request. When the transfer is completed (emNotify) this value will contain the amount of data that was actually transferred

EC_T_BYT_E *pbyMbxTferData

[in/out] Pointer to data. In case of a download transfer the client has to store the data in this location. In case of an upload transfer this element points to the received data. Access to data that was uploaded from a slave is only valid within the notification function because the buffer will be re-used by the master “this data has to be copied into a separate buffer in case it has to be used later by the client

EC_T_MBXTFER_STATUS eTferStatus

[out] Transfer state. After a new transfer object is created the state will be set to eMbxTferStatus_Idle

EC_T_DWORD dwErrorCode

[out] Error code of a mailbox transfer that was terminated with error

EC_T_DWORD dwTferId

[] Transfer ID. For every new mailbox transfer a unique ID has to be assigned. This ID can be used after mailbox transfer completion to identify the transfer

EC_T_MBX_DATA MbxData

[] Mailbox data. This element contains mailbox transfer data, e.g. the CoE object dictionary list.

enum **EC_T_MBXTFER_TYPE**

Values:

enumerator **eMbxTferType_COE_SDO_DOWNLOAD**
CoE SDO download

enumerator **eMbxTferType_COE_SDO_UPLOAD**
CoE SDO upload

enumerator **eMbxTferType_COE_GETODLIST**
CoE Get object dictionary list

enumerator **eMbxTferType_COE_GETOBDESC**
CoE Get object description

enumerator **eMbxTferType_COE_GETENTRYDESC**
CoE Get object entry description

enumerator **eMbxTferType_COE_EMERGENCY**
CoE emergency request

enumerator **eMbxTferType_COE_RX_PDO**
CoE RxPDO

enumerator **eMbxTferType_FOE_FILE_UPLOAD**
FoE upload

enumerator **eMbxTferType_FOE_FILE_DOWNLOAD**
FoE download

enumerator **eMbxTferType_SOE_READREQUEST**
SoE read request

enumerator **eMbxTferType_SOE_READRESPONSE**
SoE read response

enumerator **eMbxTferType_SOE_WRITEREQUEST**
SoE write request

enumerator **eMbxTferType_SOE_WRITERESPONSE**
SoE write response

enumerator **eMbxTferType_SOE_NOTIFICATION**
SoE notification

enumerator **eMbxTferType_SOE_EMERGENCY**
SoE emergency

enumerator **eMbxTferType_VOE_MBX_READ**
VoE read

enumerator **eMbxTferType_VOE_MBX_WRITE**
VoE write

enumerator **eMbxTferType_AOE_READ**
AoE read

enumerator **eMbxTferType_AOE_WRITE**
AoE write

enumerator **eMbxTferType_AOE_READWRITE**
AoE read/write

enumerator **eMbxTferType_AOE_WRITECONTROL**
AoE write control

enumerator **eMbxTferType_RAWMBX**
Raw mbx

enumerator **eMbxTferType_FOE_SEG_DOWNLOAD**
FoE segmented download

enumerator **eMbxTferType_FOE_SEG_UPLOAD**
FoE segmented upload

enumerator **eMbxTferType_S2SMBX**
S2S mbx

enumerator **eMbxTferType_FOE_UPLOAD_REQ**
FoE upload request

enumerator **eMbxTferType_FOE_DOWNLOAD_REQ**
FoE download request

union **EC_T_MBX_DATA**

Public Members

EC_T_AOE_CMD_RESPONSE **AoE_Response**
AoE

EC_T_MBX_DATA_COE **CoE**
CoE

EC_T_COE_ODLIST **CoE_ODList**
CoE Object Dictionary list

EC_T_COE_OBDESC **CoE_ObDesc**
CoE object description

EC_T_COE_ENTRYDESC **CoE_EntryDesc**
CoE entry description

EC_T_COE_EMERGENCY **CoE_Emergency**
CoE emergency data

EC_T_MBX_DATA_COE_INITCMD **CoE_InitCmd**
CoE InitCmd

EC_T_MBX_DATA_FOE **FoE**
FoE

EC_T_MBX_DATA_FOE_REQ **FoE_Request**
FoE request

EC_T_MBX_DATA_SOE **SoE**
SoE

EC_T_SOE_NOTIFICATION **SoE_Notification**
SoE notification request

EC_T_SOE_EMERGENCY **SoE_Emergency**
SoE emergency request

See also:

EC-Master Class A about AoE, FoE and VoE mailbox protocols.

6.9.3 emMbxTferAbort

static EC_T_DWORD **ecatMbxTferAbort** (*EC_T_MBXTFER* *pMbxTfer)

EC_T_DWORD **emMbxTferAbort** (EC_T_DWORD dwInstanceID, *EC_T_MBXTFER* *pMbxTfer)
Abort a running mailbox transfer.

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object created with emMbxTferCreate

Returns*EC_E_NOERROR* if successful

Currently only supported for FoE Transfer, CoE Download and CoE Upload.

6.9.4 emMbxTferDelete

```
static EC_T_VOID ecatMbxTferDelete (EC_T_MBXTFER *pMbxTfer)
EC_T_VOID emMbxTferDelete (EC_T_DWORD dwInstanceID, EC_T_MBXTFER *pMbxTfer)
    Deletes a mailbox transfer object.
```

A transfer object may only be deleted if it is in the Idle state.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object created with emMbxTferCreate

Returns*EC_E_NOERROR* or error code**6.9.5 emNotify - EC_NOTIFY_MBOXRCV**

Indicates a mailbox transfer completion.

emNotify - EC_NOTIFY_MBOXRCV**Parameter**

- **pbyInBuf**: [in] Pointer to a structure of type EC_T_MBXTFER, contains the corresponding mailbox transfer object.
- **dwInBufSize**: [in] Size of the transfer object provided at pbyInBuf in bytes.
- **pbyOutBuf**: [out] Should be set to EC_NULL
- **dwOutBufSize**: [in] Should be set to 0
- **pdwNumOutData**: [out] Should be set to EC_NULL

The element *EC_T_MBXTFER::dwClntId* contains the corresponding ID of the client that is notified, the corresponding transfer ID can be found in *EC_T_MBXTFER::dwTferId*. The transfer result is stored in *EC_T_MBXTFER::dwErrorCode*.

On error *EC_T_MBXTFER::eTferStatus* is *eMbxTferStatus_TferReqError*, on success *eMbxTferStatus_TferDone*. In order to reuse the transfer object the application must set it back to *eMbxTferStatus_Idle*.

The *EC_T_MBXTFER::eMbxTferType* element determines the mailbox transfer type (e.g. *eMbxTferType_COE_SDO_DOWNLOAD* for a completion of a CoE SDO download transfer).

6.10 Automation Device Specification over EtherCAT (AoE)

The AoE protocol is used to access the Object dictionary of slave devices of underlying field-buses, e.g. for a CAN application protocol Slave connected to a EtherCAT-CANopen gateway device. It is also used in relation with the EtherCAT Automation Protocol (EAP).

Reference:

- ETG.1020 -> AoE

Current limitations

- Fragmented AoE access is not yet implemented

6.10.1 emAoeGetSlaveNetId

```
static EC_T_DWORD ecatAoeGetSlaveNetId (
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poAoeNetId
)
EC_T_DWORD emAoeGetSlaveNetId (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poAoeNetId
)
    Retrieve the NetID of a specific EtherCAT device.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **poAoeNetId** – [out] AoE NetID of the corresponding slave

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized
- **EC_E_INVALIDPARAM** if dwInstanceID is out of range, the input pointer is EC_NULL or contains EC_NULL pointer, or dwTimeout is EC_NOWAIT
- **EC_E_SLAVE_NOT_PRESENT** if slave not present
- **EC_E_NOTFOUND** if no slave matching dwSlaveId can be found
- **EC_E_NO_MBX_SUPPORT** if slave has no mailbox support
- **EC_E_ADS_IS_RUNNING** if ADS server is running

```
struct EC_T_AOE_NETID
```

Public Members

EC_T_BYTE aby[6]
AoE net id

See also:

emGetSlaveId()

6.10.2 emAoeRead

```
static EC_T_DWORD ecatAoeRead (
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwDataOutLen,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emAoeRead (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwDataOutLen,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
Execute a AoE mailbox read request to an EtherCAT slave device.
```

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **poTargetNetId** – [in] Target NetID.
- **wTargetPort** – [in] Target port.
- **dwIndexGroup** – [in] AoE read command index group.
- **dwIndexOffset** – [in] AoE read command index offset
- **dwDataLen** – [in] Buffer length [bytes]
- **pbyData** – [out] Buffer receiving transferred data
- **pdwDataOutLen** – [out] Number of bytes read from the target device

- **pdwErrorCode** – [out] AoE response error code
- **pdwCmdResult** – [out] AoE read command result code
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time.

Returns

- *EC_E_NOERROR*
- *EC_E_AOE_VENDOR_SPECIFIC*: will be returned in case the AoE device has responded with an user defined error code
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

See also:

- *emAoeReadReq()*
- *emGetSlaveId()*

6.10.3 emAoeReadReq

```
static EC_T_DWORD ecatAoeReadReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emAoeReadReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwTimeout
)
Execute a non-blocking AoE mailbox read request to an EtherCAT slave device.

If the functions returns EC_E_AOE_DEVICE_XXXX (well known device errors) or
EC_E_AOE_VENDOR_SPECIFIC the original ADS error can be retrieved from the mailbox transfer object at EC_T_MBXTFER.MbxData.AoE_Response. A unique transfer ID must be written into
EC_T_MBXTFER.dwTferId.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **poTargetNetId** – [in] Target NetID.
- **wTargetPort** – [in] Target port.
- **dwIndexGroup** – [in] AoE read command index group

- **dwIndexOffset** – [in] AoE read command index offset
- **dwTimeout** – [in] Timeout [ms]

Returns

- *EC_E_NOERROR*
- *EC_E_AOE_VENDOR_SPECIFIC*: will be returned in case the AoE device has responded with an user defined error code
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

struct **EC_T_AOE_CMD_RESPONSE**

Public Members

EC_T_DWORD dwErrorCode
AoE response error code

EC_T_DWORD dwCmdResult
AoE command result code

See also:

[emGetSlaveId \(\)](#)

6.10.4 emNotify - eMbxTferType_AOE_READ

emNotify - eMbxTferType_AOE_READ

Parameter

- pbyInBuf: [in] pMbxTfer - Pointer to a structure of type EC_T_MBXTFER, this structure contains the used mailbox transfer object. This mailbox transfer object also contains AoE device error codes in case of an AoE access error.
- dwInBufSize: [in] Size of the transfer object.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

See also:

[emAoeReadReq \(\)](#)

6.10.5 emAoeWrite

```
static EC_T_DWORD ecatAoeWrite (
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emAoeWrite (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
```

Execute a AoE mailbox write request to an EtherCAT slave device.

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **poTargetNetId** – [in] Target NetID.
- **wTargetPort** – [in] Target port.
- **dwIndexGroup** – [in] AoE write command index group.
- **dwIndexOffset** – [in] AoE write command index offset
- **dwDataLen** – [in] Buffer length [bytes]
- **pbyData** – [in] Buffer containing transferred data
- **pdwErrorCode** – [out] Pointer to AoE response error code.
- **pdwCmdResult** – [out] Pointer to AoE write command result code.
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time.

Returns

- ***EC_E_NOERROR***
- ***EC_E_AOE_VENDOR_SPECIFIC***: will be returned in case the AoE device has responded with an user defined error code
- ***EC_E_MASTER_RED_STATE_INACTIVE*** if Master Redundancy is configured and master is inactive

See also:

- [emAoeWriteReq\(\)](#)
- [emGetSlaveId\(\)](#)

6.10.6 emAoeWriteReq

```
static EC_T_DWORD ecatAoeWriteReq(
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emAoeWriteReq(
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwTimeout
)
```

Execute a non-blocking AoE mailbox write request to an EtherCAT slave device.

If the functions returns EC_E_AOE_DEVICE_XXXX (well known device errors) or EC_E_AOE_VENDOR_SPECIFIC the original ADS error can be retrieved from the mailbox transfer object at EC_T_MBXTFER.MbxData.AoE_Response. A unique transfer ID must be written into [EC_T_MBXTFER.dwTferId](#).

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **poTargetNetId** – [in] Target NetID.
- **wTargetPort** – [in] Target port.
- **dwIndexGroup** – [in] AoE write command index group.
- **dwIndexOffset** – [in] AoE write command index offset
- **dwTimeout** – [in] Timeout [ms]

Returns

- [EC_E_NOERROR](#)
- [EC_E_AOE_VENDOR_SPECIFIC](#): will be returned in case the AoE device has responded with an user defined error code
- [EC_E_MASTER_RED_STATE_INACTIVE](#) if Master Redundancy is configured and master is inactive

See also:`emGetSlaveId()`

6.10.7 emNotify - eMbxTferType_AOE_WRITE

emNotify - eMbxTferType_AOE_WRITE

Parameter

- `pbyInBuf`: [in] `pMbxTfer` - Pointer to a structure of type `EC_T_MBXTFER`, this structure contains the used mailbox transfer object. This mailbox transfer object also contains AoE device error codes in case of an AoE access error.
- `dwInBufSize`: [in] Size of the transfer object.
- `pbyOutBuf`: [out] Should be set to `EC_NULL`
- `dwOutBufSize`: [in] Should be set to 0
- `pdwNumOutData`: [out] Should be set to `EC_NULL`

See also:`emAoeWriteReq()`

6.10.8 emAoeReadWrite

```
static EC_T_DWORD ecatAoeReadWrite (
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwReadDataLen,
    EC_T_DWORD dwWriteDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwDataOutLen,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emAoeReadWrite (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_DWORD dwIndexGroup,
    EC_T_DWORD dwIndexOffset,
    EC_T_DWORD dwReadDataLen,
    EC_T_DWORD dwWriteDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwDataOutLen,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
    Execute a AoE mailbox read/write request to an EtherCAT slave device.
```

Parameters

- **`dwInstanceID`** – [in] Instance ID (Multiple EtherCAT Network Support)
- **`dwSlaveId`** – [in] Slave ID
- **`poTargetNetId`** – [in] Target NetID.
- **`wTargetPort`** – [in] Target port.
- **`dwIndexGroup`** – [in] AoE read/write command index group.
- **`dwIndexOffset`** – [in] AoE read/write command index offset
- **`dwReadDataLen`** – [in] Number of bytes to read from the target device.
- **`dwWriteDataLen`** – [in] Number of bytes to read from the target device.
- **`pbyData`** – [in, out] Buffer containing and receiving transferred data
- **`pdwDataOutLen`** – [out] Number of bytes read from the target device
- **`pdwErrorCode`** – [out] Pointer to AoE response error code.
- **`pdwCmdResult`** – [out] Pointer to AoE write command result code.
- **`dwTimeout`** – [in] Timeout [ms] The function will block at most for this time.
EC_NOWAIT is not valid.

Returns

- **`EC_E_NOERROR`**
- **`EC_E_AOE_VENDOR_SPECIFIC`**: will be returned in case the AoE device has responded with an user defined error code
- **`EC_E_MASTER_RED_STATE_INACTIVE`** if Master Redundancy is configured and master is inactive

See also:

[emGetSlaveId \(\)](#)

6.10.9 emAoeWriteControl

```
static EC_T_DWORD ecatAoeWriteControl (
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_WORD wAoEState,
    EC_T_WORD wDeviceState,
    EC_T_DWORD dwDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
```

```
EC_T_DWORD emAoeWriteControl (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_AOE_NETID *poTargetNetId,
    EC_T_WORD wTargetPort,
    EC_T_WORD wAoEState,
    EC_T_WORD wDeviceState,
    EC_T_DWORD dwDataLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD *pdwErrorCode,
    EC_T_DWORD *pdwCmdResult,
    EC_T_DWORD dwTimeout
)
```

) Execute a AoE mailbox write control request to an EtherCAT slave device.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **poTargetNetId** – [in] Target NetID. The Target NetID of a AoE slave device can be retrieved by ecatAoeGetSlaveNetId()..
- **wTargetPort** – [in] Target port.
- **wAoEState** – [in] AoE state
- **wDeviceState** – [in] Device specific state
- **dwDataLen** – [in] Buffer length [bytes]
- **pbyData** – [in] Buffer containing transferred data
- **pdwErrorCode** – [out] Pointer to AoE response error code.
- **pdwCmdResult** – [out] Pointer to AoE write command result code.
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. EC_NOWAIT is not valid.

Returns

- **EC_E_NOERROR**
- **EC_E_AOE_VENDOR_SPECIFIC**: will be returned in case the AoE device has responded with an user defined error code
- **EC_E_MASTER_RED_STATE_INACTIVE** if Master Redundancy is configured and master is inactive

See also:

[emGetSlaveId\(\)](#)

6.10.10 emConvertEcErrorToAdsError

`EC_T_DWORD ecatConvertEcErrorToAdsError (EC_T_DWORD dwErrorCode)`

```
EC_T_DWORD emConvertEcErrorToAdsError (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwErrorCode
)
    Convert master error code to AoE error code.
```

Returns

AoE error code

6.11 CAN application protocol over EtherCAT (CoE)

6.11.1 emCoeSdoDownload

```
static EC_T_DWORD ecatCoeSdoDownload (
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYT byObSubIndex,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
EC_T_DWORD emCoeSdoDownload (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYT byObSubIndex,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
    Execute a CoE SDO download to an EtherCAT slave device.
```

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **wObIndex** – [in] Object index.
- **byObSubIndex** – [in] Object sub index. 0 or 1 if Complete Access.
- **pbyData** – [in] Buffer containing transferred data
- **dwDataLen** – [in] Buffer length [bytes]
- **dwTimeout** – [in] Timeout [ms]
- **dwFlags** – [in] Mailbox Flags. Bit 0: set if Complete Access (EC_MAILBOX_FLAG_SDO_COMPLETE).

Returns

EC_E_NOERROR or error code

See also:

emGetSlaveId()

6.11.2 emCoeSdoDownloadReq

```
static EC_T_DWORD ecatCoeSdoDownloadReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYTE byObSubIndex,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
EC_T_DWORD emCoeSdoDownloadReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYTE byObSubIndex,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
```

Initiates a CoE SDO download to an EtherCAT slave device and returns immediately.

The length of the data to be downloaded must be set in *EC_T_MBXTFER.dwDataLen*. A unique transfer ID must be written into *EC_T_MBXTFER.dwTferId*. *EC_NOTIFY_MBOXRCV* is given on completion.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **wObIndex** – [in] Object index
- **byObSubIndex** – [in] Object sub index. 0 or 1 if Complete Access.
- **dwTimeout** – [in] Timeout [ms]
- **dwFlags** – [in] Mailbox Flags. Bit 0: set if Complete Access (*EC_MAILBOX_FLAG_SDO_COMPLETE*).

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range, the input pointer is EC_NULL or contains EC_NULL pointer, or dwTimeout is EC_NOWAIT
- *EC_E_NOMEMORY* if the mailbox protocol queue of the slave is full
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching dwSlaveId can be found
- *EC_E_NO_MBX_SUPPORT* if slave has no mailbox support

- *EC_E_INVALID_SLAVE_STATE* if slave is in an invalid state for mailbox transfer
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive
- *EC_E_AMS_IS_RUNNING* if AMS server is running

See also:

- *emNotify - eMbxTferType_COE_SDO_DOWNLOAD*
- *emMbxTferCreate()*
- *emGetSlaveId()*

6.11.3 emNotify - eMbxTferType_COE_SDO_DOWNLOAD

SDO download transfer completion.

emNotify - eMbxTferType_COE_SDO_DOWNLOAD

Parameter

- pbyInBuf: [in] Pointer to a structure of type EC_T_MBXTFER, this structure contains the corresponding mailbox transfer object.
- dwInBufSize: [in] Size of the transfer object pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

The corresponding transfer ID can be found in *EC_T_MBXTFER::dwTferId*. The transfer result is stored in *EC_T_MBXTFER::dwErrorCode*.

The request parameters stored in element *EC_T_MBX_DATA::CoE* of type *EC_T_MBX_DATA_COE* are part of *EC_T_MBXTFER::MbxData* and may have to be buffered by the client. Access to the memory area *EC_T_MBXTFER::MbxData* outside of the notification caller context is illegal and the results are undefined.

```
struct EC_T_MBX_DATA_COE
```

Public Members

EC_T_WORD wStationAddress

Station address of the slave

EC_T_WORD wIndex

Object index

EC_T_BYTE bSubIndex

Object subindex

EC_T_BOOL bCompleteAccess

Complete access

6.11.4 emCoeSdoUpload

```
static EC_T_DWORD ecatCoeSdoUpload (
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYT byObSubIndex,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
EC_T_DWORD emCoeSdoUpload (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYT byObSubIndex,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
)
```

Execute a CoE SDO upload from an EtherCAT slave device to the master.

This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **wObIndex** – [in] Object index.
- **byObSubIndex** – [in] Object sub index. 0 or 1 if Complete Access.
- **pbyData** – [out] Buffer receiving transferred data
- **dwDataLen** – [in] Buffer length [bytes]
- **pdwOutDataLen** – [out] Length of received data [byte]
- **dwTimeout** – [in] Timeout [ms]
- **dwFlags** – [in] Mailbox Flags. Bit 0: set if Complete Access (EC_MAILBOX_FLAG_SDO_COMPLETE).

Returns

EC_E_NOERROR or error code

See also:

[emGetSlaveId\(\)](#)

6.11.5 emCoeSdoUploadReq

```
static EC_T_DWORD ecatCoeSdoUploadReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYTE byObSubIndex,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
EC_T_DWORD emCoeSdoUploadReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYTE byObSubIndex,
    EC_T_DWORD dwTimeout,
    EC_T_DWORD dwFlags
)
```

Initiates a CoE SDO upload from an EtherCAT slave device to the master and returns immediately.

The length of the data to be uploaded must be set in *EC_T_MBXTFER.dwDataLen*. A unique transfer ID must be written into *EC_T_MBXTFER.dwTferId*. EC_NOTIFY_MBOXRCV is given on completion.

Parameters

- **`dwInstanceID`** – [in] Instance ID (Multiple EtherCAT Network Support)
- **`pMbxTfer`** – [in] Mailbox transfer object created with emMbxTferCreate
- **`dwSlaveId`** – [in] Slave ID
- **`wObIndex`** – [in] Object index
- **`byObSubIndex`** – [in] Object sub index. 0 or 1 if Complete Access.
- **`dwTimeout`** – [in] Timeout [ms]
- **`dwFlags`** – [in] Mailbox Flags. Bit 0: set if Complete Access (EC_MAILBOX_FLAG_SDO_COMPLETE).

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range, the input pointer is EC_NULL or contains EC_NULL pointer, or dwTimeout is EC_NOWAIT
- *EC_E_NOMEMORY* if the mailbox protocol queue of the slave is full
- *EC_E_SLAVE_NOT_PRESENT* if slave not present
- *EC_E_NOTFOUND* if no slave matching dwSlaveId can be found
- *EC_E_NO_MBX_SUPPORT* if slave has no mailbox support
- *EC_E_INVALID_SLAVE_STATE* if slave is in an invalid state for mailbox transfer
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive
- *EC_E_ADS_IS_RUNNING* if ADS server is running

Example

The following code demonstrates how to upload a CoE object from a slave using the non-blocking API `emCoeSdoUploadReq()`.

In this example the mailbox transfer object state is polled. `emNotify - EC_NOTIFY_MBOXRCV` can be used as alternative to polling.

```
EC_T_DWORD CoeSdoUploadReqExample()
{
    EC_T_DWORD dwRetVal = EC_E_ERROR;
    EC_T_DWORD dwRes = EC_E_ERROR;

    /* needed only for notifications, see
     - ecatRegisterClient(...)
     - pApplicationContext->pNotificationHandler->GetClientID() */
    EC_T_DWORD dwClientId = 0;

    /* slave with station address 2002 used for CoE SDO upload */
    EC_T_DWORD dwSlaveId = ecatGetSlaveId(2002);

    EC_T_MBXTFER* pMbxTferObject = EC_NULL;
    EC_T_BYTE abyObjectDataBuffer[] = { 0, 0, 0, 0 };
    EC_T_MBXTFER_DESC oObjectDataTferDesc;
    OsMemset(&oObjectDataTferDesc, 0, sizeof(EC_T_MBXTFER_DESC));

    /* create mailbox transfer object */
    oObjectDataTferDesc.pbyMbxTferDescData = abyObjectDataBuffer;
    oObjectDataTferDesc.dwMaxDataLen = sizeof(abyObjectDataBuffer);
    pMbxTferObject = ecatMbxTferCreate(&oObjectDataTferDesc);
    if (EC_NULL == pMbxTferObject)
    {
        dwRes = EC_E_NOMEMORY;
        dwRetVal = dwRes;
        goto Exit;
    }

    /* create mailbox transfer object */
    pMbxTferObject->dwClntId = dwClientId;
    pMbxTferObject->dwTferId = 1; /* assigned by application. should be unique for
→each object */

    /* request upload of object index 0x1018, subindex 1, timeout 5s, no complete
→access */
    dwRes = ecatCoeSdoUploadReq(pMbxTferObject, dwSlaveId, 0x1018, 1, 5000, 0);
    if (EC_E_NOERROR != dwRes)
    {
        dwRetVal = dwRes;
        goto Exit;
    }

    /* wait for transfer finished */
    while (eMbxTferStatus_Pend == pMbxTferObject->eTferStatus)
    {
        OsSleep(10);

        /* transfer can be canceled using ecatMbxTferAbort(...) if it takes too
→long */
    }

    /* check transfer result */
    dwRes = pMbxTferObject->dwErrorCode;
    if (EC_E_NOERROR != dwRes)
```

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```

{
    dwRetVal = dwRes;
    goto Exit;
}

dwRetVal = EC_E_NOERROR;
Exit:
    if (EC_NULL != pMbxTferObject)
    {
        pMbxTferObject->eTferStatus = eMbxTferStatus_Idle;
        ecatMbxTferDelete(pMbxTferObject);
    }

    return dwRetVal;
}

```

See also:

- [emNotify - eMbxTferType_COE_SDO_UPLOAD](#)
- [emMbxTferCreate\(\)](#)
- [emGetSlaveId\(\)](#)

6.11.6 emNotify - eMbxTferType_COE_SDO_UPLOAD

SDO upload transfer completion.

emNotify - eMbxTferType_COE_SDO_UPLOAD

Parameter

- pbyInBuf: [in] Pointer to a structure of type EC_T_MBXTFER, contains the corresponding mailbox transfer object.
- dwInBufSize: [in] Size of the transfer object in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

The corresponding transfer ID can be found in [EC_T_MBXTFER::dwTferId](#). The transfer result is stored in [EC_T_MBXTFER::dwErrorCode](#).

The request parameters stored in element [EC_T_MBX_DATA::CoE](#) of type [EC_T_MBX_DATA_COE](#) are part of [EC_T_MBXTFER::MbxData](#). The SDO data stored in [EC_T_MBXTFER::pbyMbxTferData](#) may have to be buffered by the client. Access to the memory area referenced by [EC_T_MBXTFER::pbyMbxTferData](#) outside of the notification caller context is illegal and the results are undefined.

6.11.7 emCoeGetODListReq

```
static EC_T_DWORD ecatCoeGetODListReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_COE_ODLIST_TYPE eListType,
    EC_T_DWORD dwTimeout
)
```

```
EC_T_DWORD emCoeGetODListReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_COE_ODLIST_TYPE eListType,
    EC_T_DWORD dwTimeout
)
```

) Gets a list of object IDs that are available in a slave.

A unique transfer ID must be written into *EC_T_MBXTFER.dwTferId*. EC_NOTIFY_MBOXRCV is given on completion. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer
- **dwSlaveId** – [in] Slave ID
- **eListType** – [in] which object types shall be transferred
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. If the timeout value is set to EC_NOWAIT the function will return immediately.

Returns

EC_E_NOERROR or error code

enum **EC_T_COE_ODLIST_TYPE**

Values:

enumerator **eODListType_Lengths**
Lengths of each list type

enumerator **eODListType_ALL**
List contains all objects

enumerator **eODListType_RxPdoMap**
List with PDO mappable objects

enumerator **eODListType_TxPdoMap**
List with objects that can be changed

enumerator **eODListType_StoredFRep1**
Only stored for a device replacement objects

enumerator **eODListType_StartupParm**
Only startup parameter objects

See also:

- *emNotify - eMbxTferType_COE_GETODLIST*

- `emMbxTferCreate()`
- `emGetSlaveId()`

6.11.8 emNotify - eMbxTferType_COE_GETODLIST

Object dictionary list upload transfer completion.

emNotify - eMbxTferType_COE_GETODLIST

Parameter

- `pbyInBuf`: [in] Pointer to a structure of type `EC_T_MBXTFER`, contains the corresponding mailbox transfer object.
- `dwInBufSize`: [in] Size of the transfer object in bytes.
- `pbyOutBuf`: [out] Should be set to `EC_NULL`
- `dwOutBufSize`: [in] Should be set to 0
- `pdwNumOutData`: [out] Should be set to `EC_NULL`

The corresponding transfer ID can be found in `EC_T_MBXTFER::dwTferId`. The transfer result is stored in `EC_T_MBXTFER::dwErrorCode`.

The object list stored in element `EC_T_MBX_DATA::CoE_ODList` of type `EC_T_COE_ODLIST` is part of `EC_T_MBXTFER::MbxData` and may have to be buffered by the client. Access to the memory area `EC_T_MBXTFER::MbxData` outside of the notification caller context is illegal and the results are undefined.

struct `EC_T_COE_ODLIST`

Public Members

`EC_T_COE_ODLIST_TYPE eOdListType`
list type

`EC_T_WORD wLen`
amount of object IDs

`EC_T_WORD wStationAddress`
Station address of the slave

`EC_T_WORD *pwOdList`
array containing object IDs

6.11.9 emCoeGetObjectDescReq

```
static EC_T_DWORD ecatCoeGetObjectDescReq(
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_DWORD dwTimeout
)
```

```
EC_T_DWORD emCoeGetObjectDescReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_DWORD dwTimeout
)
```

Determines the description of a specific object.

A unique transfer ID must be written into *EC_T_MBXTFER.dwTferId*. EC_NOTIFY_MBOXRCV is given on completion. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **wObIndex** – [in] Object index
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. If the timeout value is set to EC_NOWAIT the function will return immediately.

Returns

EC_E_NOERROR or error code

See also:

- *emNotify - eMbxTferType_COE_GETOBDESC*
- *emMbxTferCreate ()*
- *emGetSlaveId ()*

6.11.10 emNotify - eMbxTferType_COE_GETOBDESC

Completion of a SDO information service transfer to get a object description.

emNotify - eMbxTferType_COE_GETOBDESC

Parameter

- **pbyInBuf**: [in] Pointer to a structure of type EC_T_MBXTFER, contains the corresponding mailbox transfer object.
- **dwInBufSize**: [in] Size of the transfer object in bytes.
- **pbyOutBuf**: [out] Should be set to EC_NULL
- **dwOutBufSize**: [in] Should be set to 0
- **pdwNumOutData**: [out] Should be set to EC_NULL

The corresponding transfer ID can be found in *EC_T_MBXTFER::dwTferId*. The transfer result is stored in *EC_T_MBXTFER::dwErrorCode*.

The object description stored in element *EC_T_MBX_DATA::CoE_ObDesc* of type *EC_T_COE_OBDESC* is part of *EC_T_MBXTFER::MbxData* and may have to be buffered by the client. Access to the memory area *EC_T_MBXTFER::MbxData* outside of the notification caller context is illegal and the results are undefined.

```
struct EC_T_COE_OBDESC
```

Public Members

EC_T_WORD wObIndex

Index in the object dictionary

EC_T_WORD wDataType

Data type of the object

EC_T_BYTEx byObjCode

Object code, see Table 62, ETG.1000 section 6

EC_T_BYTEx byObjCategory

Object category

EC_T_BYTEx byMaxNumSubIndex

Maximum sub index number

EC_T_WORD wObNameLen

Length of the object name

EC_T_WORD wStationAddress

Station address of the slave

EC_T_CHAR *pchObName

Object name (not NULL terminated!)

See also:

A more detailed description of the values for data type, object code etc. can be found in the EtherCAT specification ETG.1000, section 5.

6.11.11 emCoeGetEntryDescReq

```
static EC_T_DWORD ecatCoeGetEntryDescReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYTEx byObSubIndex,
    EC_T_BYTEx byValueInfo,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emCoeGetEntryDescReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_BYTEx byObSubIndex,
    EC_T_BYTEx byValueInfo,
    EC_T_DWORD dwTimeout
)
```

Determines the description of a specific object entry.

A unique transfer ID must be written into **EC_T_MBXTFER.dwTferId**. EC_NOTIFY_MBOXRCV is given on completion. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **wObIndex** – [in] Object index
- **byObSubIndex** – [in] Object sub-index
- **byValueInfo** – [in] The value info bit mask includes which elements shall be in the response. See *Value info flags* for available values.
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time. If the timeout value is set to EC_NOWAIT the function will return immediately

Returns*EC_E_NOERROR* or error code**Value info flags***group EC_COE_ENTRY_VALUEINFO*

EtherCat CoE entry description value information bit definitions.

Defines**EC_COE_ENTRY_ObjAccess**

Object access

EC_COE_ENTRY_ObjCategory

Object category

EC_COE_ENTRY_PdoMapping

PDO mapping

EC_COE_ENTRY_UnitType

Unit type

EC_COE_ENTRY_DefaultValue

Default value

EC_COE_ENTRY_MinValue

Minimum value

EC_COE_ENTRY_MaxValue

Maximum value

See also:

- *emNotify - eMbxTferType_COE_GETENTRYDESC*
- *emMbxTferCreate ()*
- *emGetSlaveId ()*

6.11.12 emNotify - eMbxTferType_COE_GETENTRYDESC

Completion of a SDO information service transfer to get a object entry description.

emNotify - eMbxTferType_COE_GETENTRYDESC

Parameter

- pbyInBuf: [in] Pointer to a structure of type EC_T_MBXTFER, contains the corresponding mailbox transfer object.
- dwInBufSize: [in] Size of the transfer object in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

The corresponding transfer ID can be found in `EC_T_MBXTFER::dwTransferId`. The transfer result is stored in `EC_T_MBXTFER::dwErrorCode`.

The object entry description stored in element `EC_T_MBX_DATA::CoE_EntryDesc` of type `EC_T_COE_ENTRYDESC` is part of `EC_T_MBXTFER::MbxData` and may have to be buffered by the client. Access to the memory area `EC_T_MBXTFER::MbxData` outside of the notification caller context is illegal and the results are undefined.

```
struct EC_T_COE_ENTRYDESC
```

Public Members

EC_T_WORD wObIndex

Index in the object dictionary

EC_T_BYTEx byObSubIndex

Sub index in the object dictionary

EC_T_BYTEx byValueInfo

Bit mask which information is included in pbyData. See *Value info flags*

EC_T_WORD wDataType

Object data type according to ETG.1000

EC_T_WORD wBitLen

Object size (number of bits)

EC_T_BYTEx byObAccess

Access rights. See *Object access flags*

EC_T_BOOL bRxPdoMapping

Object is mappable in a RxPDO

EC_T_BOOL bTxPdoMapping

Object is mappable in a TxPDO

EC_T_BOOL bObCanBeUsedForBackup

Object can be used for backup

EC_T_BOOL bObjCanBeUsedForSettings
Object can be used for settings

EC_T_WORD wStationAddress
Station address of the slave

EC_T_WORD wDataLen
Size of the remaining object data

EC_T_BYTE *pbyData
Remaining object data: dwUnitType, pbyDefaultValue, pbyMinValue, pbyMaxValue, pbyDescription
(see ETG.1000.5 and ETG.1000.6)

Object access flags

group **EC_COE_ENTRY_OBJACCESS**
EtherCat CoE entry access bit definitions.

Defines

EC_COE_ENTRY_Access_R_PREOP
Read access in Pre-Operational state

EC_COE_ENTRY_Access_R_SAFEOP
Read access in Safe-Operational state

EC_COE_ENTRY_Access_R_OP
Read access in Operational state

EC_COE_ENTRY_Access_W_PREOP
Write access in Pre-Operational state

EC_COE_ENTRY_Access_W_SAFEOP
Write access in Safe-Operational state

EC_COE_ENTRY_Access_W_OP
Write access in Operational state

See also:

- A example for the evaluation of [*EC_T_COE_ENTRYDESC::pbyData*](#) comes with EcMasterDemo.
- A more detailed description of the values can be found in the EtherCAT specification ETG.1000, section 5 and 6.

6.11.13 emCoeProfileGetChannelInfo

```
static EC_T_DWORD ecatCoeProfileGetChannelInfo (
    EC_T_BOOL bStationAddress,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwChannel,
    EC_T_PROFILE_CHANNEL_INFO *pInfo
)
EC_T_DWORD emCoeProfileGetChannelInfo (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL bFixedAddressing,
    EC_T_WORD wSlaveAddress,
    EC_T_DWORD dwChannel,
    EC_T_PROFILE_CHANNEL_INFO *pInfo
)
) Return information about a configured CoE profile channel from the ENI file.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **bFixedAddressing** – [in] EC_TRUE: use station address, EC_FALSE: use AutoInc address
- **wSlaveAddress** – [in] Slave address according bFixedAddressing
- **dwChannel** – [in] Channel
- **pInfo** – [out] Channel info

Returns

EC_E_NOERROR or error code

struct **EC_T_PROFILE_CHANNEL_INFO**

Public Members

EC_T_WORD wProfileNo
[out] ProfileNo: “low word of CoE object 0x1000”

EC_T_WORD wAddInfo
[out] AddInfo : “high word of CoE object 0x1000”

EC_T_CHAR szDisplayName[ECAT_DEVICE_NAMESIZE]
[out] Display name

6.11.14 emNotify - EC_NOTIFY_COE_INIT_CMD

Indicates a COE mailbox transfer completion during slave state transition. This notification is disabled by default.

emNotify - EC_NOTIFY_COE_INIT_CMD

Parameter

- **pbyInBuf**: [in] Pointer to a structure of type **EC_T_MBXTFER**, contains the corresponding mailbox transfer object.

- dwInBufSize: [in] Size of the transfer object provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

The `EC_T_MBX_DATA::CoE_InitCmd` element of type `EC_T_MBX_DATA_COE_INITCMD` is part of `EC_T_MBXTFER::MbxData` and may have to be buffered by the client. Access to the memory area `EC_T_MBXTFER::MbxData` outside of the notification caller context is illegal and the results are undefined.

struct `EC_T_MBX_DATA_COE_INITCMD`

Public Members

`EC_T_SLAVE_PROP SlaveProp`

Slave properties

`EC_T_DWORD dwHandle`

Handle passed by EC_IOCTL_ADD_COE_INITCMD, otherwise zero

`EC_T_WORD wTransition`

Transition, e.g. ECAT_INITCMD_I_P

`EC_T_CHAR szComment[MAX_STD_STRLEN]`

Comment (ENI)

`EC_T_DWORD dwErrorCode`

InitCmd result

`EC_T_BOOL bFixed`

Fixed flag (ENI)

`EC_T_BYTE byCcs`

Client command specifier (read or write access)

`EC_T_BOOL bCompleteAccess`

Complete access

`EC_T_WORD wIndex`

Object Index

`EC_T_BYTE bySubIndex`

Object SubIndex

`EC_T_DWORD dwDataLen`

InitCmd data length

`EC_T_BYTE *pbyData`

InitCmd data

See also:

`emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED`

6.11.15 CoE Emergency (emNotify - eMbxTferType_COE_EMERGENCY)

Indication of a CoE emergency request. A *emNotify - EC_NOTIFY_MBOXRCV* is given with *EC_T_MBXTFER::eMbxTferType = EC_T_MBXTFER_TYPE::eMbxTferType_COE_EMERGENCY*.

emNotify - eMbxTferType_COE_EMERGENCY

Parameter

- pbyInBuf: [in] Pointer to a structure of type *EC_T_MBXTFER*, contains the corresponding mailbox transfer object.
- dwInBufSize: [in] Size of the transfer object in bytes.
- pbyOutBuf: [out] Should be set to *EC_NULL*
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to *EC_NULL*

In case of an emergency notification all registered clients will get this notification. The corresponding mailbox transfer object will be created inside the EtherCAT master. The content in *EC_T_MBXTFER::dwTferId* is undefined as it is not needed by the client and the master. The transfer result is stored in *EC_T_MBXTFER::dwErrorCode*.

The emergency data stored in element *EC_T_MBX_DATA::CoE_Emergency* of type *EC_T_COE_EMERGENCY* is part of *EC_T_MBXTFER::MbxData* and may have to be buffered by the client. Access to the memory area *EC_T_MBXTFER::MbxData* outside of the notification caller context is illegal and the results are undefined.

```
struct EC_T_COE_EMERGENCY
```

Public Members

EC_T_WORD wErrorCode

Error code according to EtherCAT specification

EC_T_BYTE byErrorRegister

Error register

EC_T_BYTE abyData[EC_COE_EMERGENCY_DATASIZE]

Error data

EC_T_WORD wStationAddress

Slave node address of the faulty slave

See also:

A more detailed description of the values can be found in the EtherCAT specification ETG.1000, section 5.

6.11.16 CoE Abort (emNotify - EC_NOTIFY_MBSLAVE_COE_SDO_ABORT)

The application can abort asynchronous CoE Uploads and Downloads. The slave may abort CoE Uploads and Downloads which is indicated at the return code of `emCoeSdoUpload()`, This notification is given if an SDO transfer aborts while sending init commands.

emNotify - EC_NOTIFY_MBSLAVE_COE_SDO_ABORT

Parameter

- `pbyInBuf`: [in] Pointer to a structure of type `EC_T_MBXTFER`, contains the corresponding mailbox transfer object.
- `dwInBufSize`: [in] Size of the transfer object in bytes.
- `pbyOutBuf`: [out] Should be set to `EC_NULL`
- `dwOutBufSize`: [in] Should be set to 0
- `pdwNumOutData`: [out] Should be set to `EC_NULL`

Detailed error information is stored in structure `EC_T_MBOX_SDO_ABORT_DESC` of the union element `SdoAbort-Desc`.

```
struct EC_T_MBOX_SDO_ABORT_DESC
```

Public Members

`EC_T_SLAVE_PROP SlaveProp`
Slave properties

`EC_T_DWORD dwErrorCode`
Error code

`EC_T_WORD wObjIndex`
SDO object index

`EC_T_BYTE bySubIndex`
SDO object sub index

See also:

`emMbxTferAbort()`

6.11.17 emConvertEcErrorToCoeError

```
EC_T_DWORD ecatConvertEcErrorToCoeError(EC_T_DWORD dwErrorCode)
```

```
EC_T_DWORD emConvertEcErrorToCoeError(  
    EC_T_DWORD dwInstanceID,  
    EC_T_DWORD dwErrorCode  
)
```

Convert master error code to CoE error code.

Returns

CoE error code according to the following specifications:

- CoE Abort Codes defined in ETG.1000.6 V1.0.4, Table 41: SDO Abort Codes

- Additional codes defined in ETG.1020, V1.2.0, Table 21: CoE Abort Codes (extension)

6.12 File access over EtherCAT (FoE)

The File access over EtherCAT (FoE) mailbox command specifies a standard way to download a firmware or any other files from a client to a server or to upload a firmware or any other files from a server to a client.

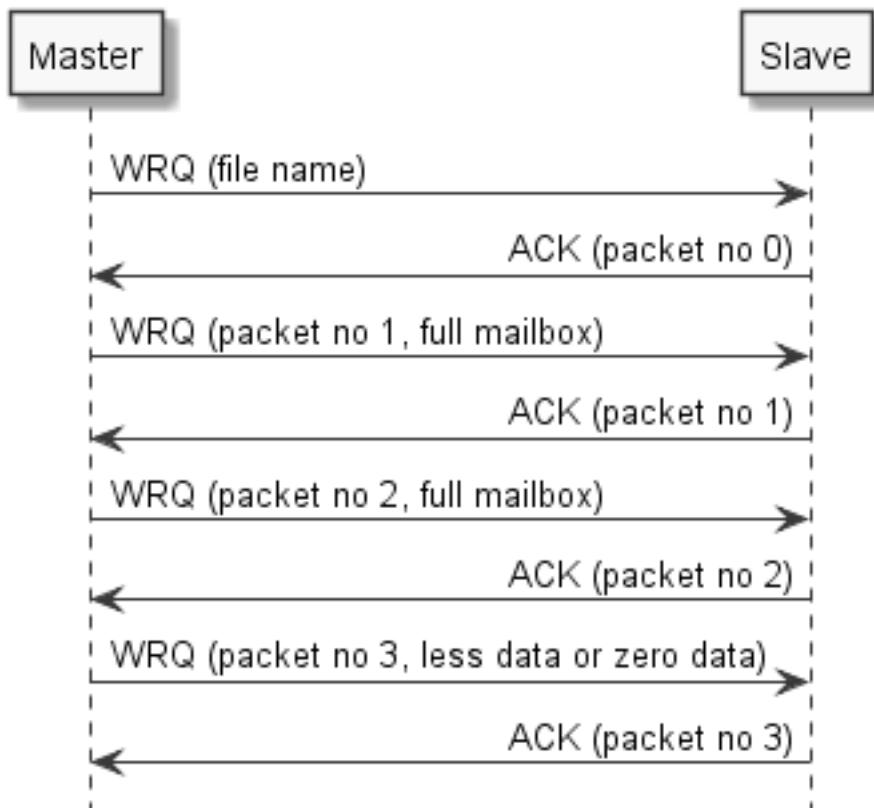
Reference:

- ETG.1000.5 and ETG.1000.6

6.12.1 Specification

FoE file download

Regular download



Segmented download

In case of segmented download the EC-Master raises emNotify - EC_NOTIFY_MBOXRCV in [EC-Master Class B](#) documentation to request more data from the application after each ACK from the slave. The notification handler may not block the EC-Master, e.g. due to reading from or writing to the file system, therefore applications typically do not handle EC_NOTIFY_MBOXRCV within the JobTask context. The segments are transferred using the slave's mailbox, so the maximum size of a segment is known from the configuration. The segment's size can be calculated as follows:

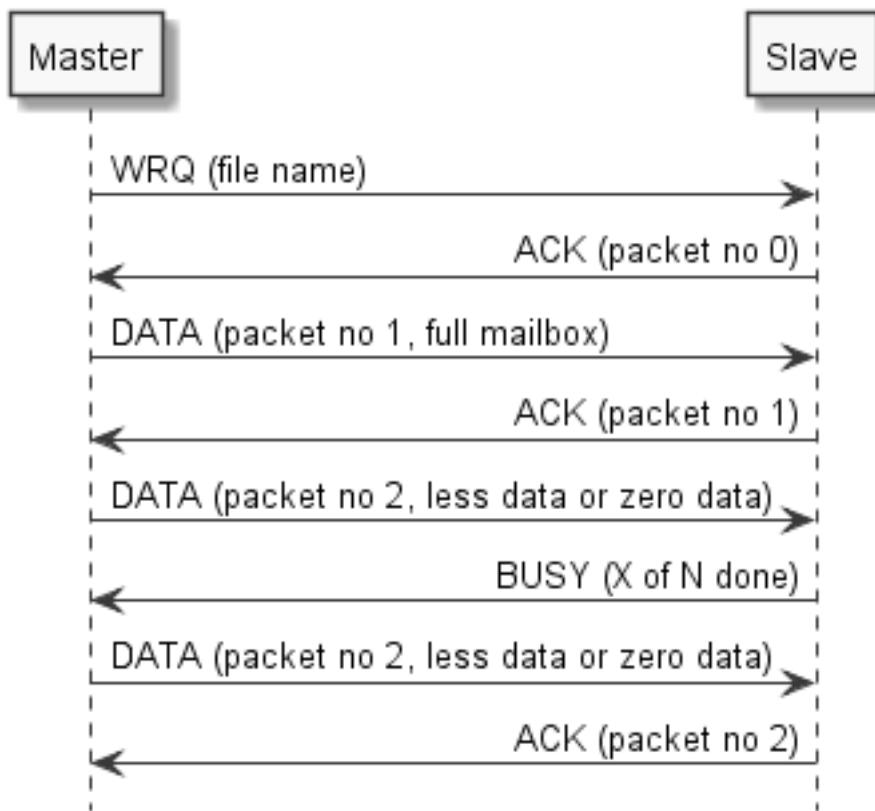
segment size = mailbox size - 12 (protocol overhead)

See also:

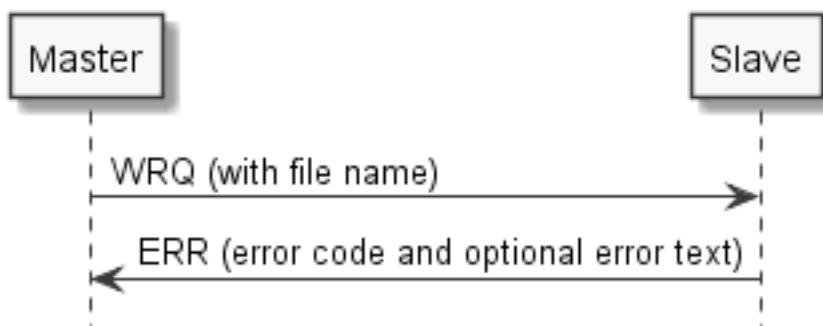
- `EC_T_CFG_SLAVE_INFO::dwMbxOutSize(emGetCfgSlaveInfo())`
- `EC_T_CFG_SLAVE_INFO::dwMbxOutSize2(emGetCfgSlaveInfo())`

- `EC_T_CFG_SLAVE_INFO::dwMbxInSize(emGetCfgSlaveInfo())`
- `EC_T_CFG_SLAVE_INFO::dwMbxInSize2(emGetCfgSlaveInfo())`

Download with busy



Download with error

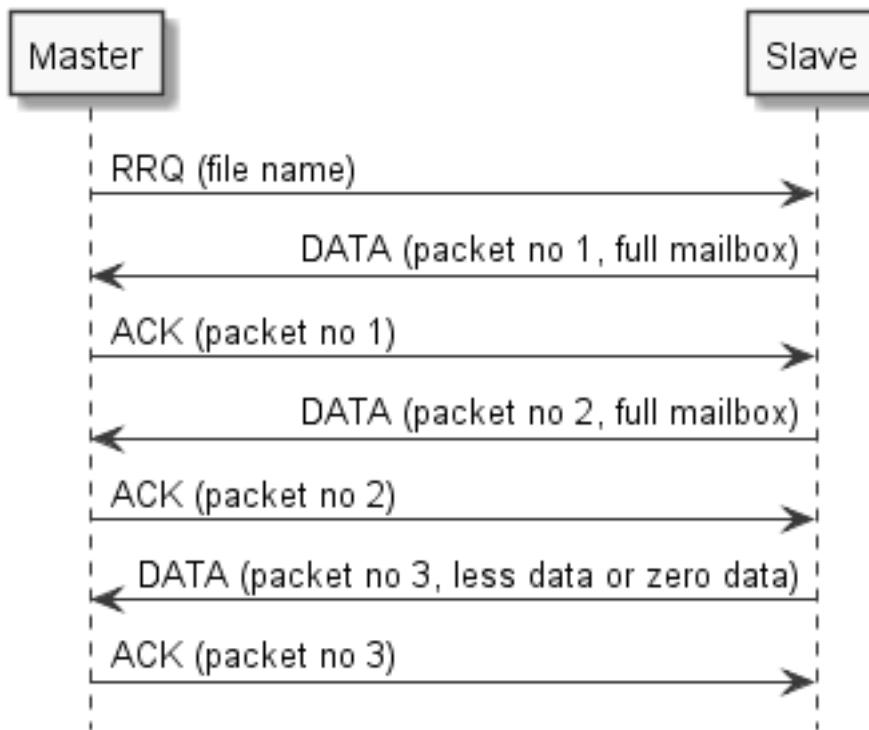


FoE file upload

The names of available files and their size are slave specific and cannot be retrieved using FoE. It is possible to upload the complete file in segments without the need to know the file size.

The segments are transferred using the slave's mailbox, so the maximum size of a segment is known from the configuration.

Regular upload



Boot State

For the download of firmware the BOOT state in the EtherCAT state machine is defined. In bootstrap mode only FoE Download is possible. A special Mailbox size can be supported by the slave for the Boot state (ETG.2000). This is part of the Init-Commands in the network configuration.

See also:

- [EC_T_CFG_SLAVE_INFO::dwMbxOutSize2\(emGetCfgSlaveInfo\(\)\)](#)
- [EC_T_CFG_SLAVE_INFO::dwMbxInSize2\(emGetCfgSlaveInfo\(\)\)](#)

6.12.2 emFoeFileDownload

```

static EC_T_DWORD ecatFoeFileDownload(
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emFoeFileDownload(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)

```

Execute a FoE File download to an EtherCAT slave device.

This function is used to download a complete file. The function returns after the download has been successfully completed or an error has occurred. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **achFileName** – [in] File name of slave file to write
- **dwFileNameLen** – [in] Length of slave file name in bytes
- **pbyData** – [in] Buffer containing transferred data
- **dwDataLen** – [in] Buffer length [bytes]
- **dwPassword** – [in] slave password
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or maximum file name length of 64 bytes (MAX_FILE_NAME_SIZE) exceeded
- *EC_E_FOE_ERRCODE_NOTINBOOTSTRAP* if slave in BOOTSTRAP and filename not accepted by slave
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

See also:

[emGetSlaveId\(\)](#)

The following example demonstrates how to download files from the Master to the Slave using FoE.

FoE Download Example

This example code shows how to download a file from a buffer at the master to a slave, e.g. in order to update the firmware.

```

EC_T_DWORD dwRetVal = EC_E_ERROR;
EC_T_DWORD dwRes = EC_E_ERROR;

EC_T_WORD wSlaveAddress = MY_FOE_SLAVE_ADDRESS /* e.g. 1001 */;
EC_T_DWORD dwSlaveId = ecatGetSlaveId(wSlaveAddress);

FILE* pfLocalFile = EC_NULL;

EC_T_BYTE* pbyBuffer = EC_NULL;
EC_T_DWORD dwBufferSize = 0;

/* read file to buffer */
pfLocalFile = OsFopen(MY_FOE_TRANSFER_LOCAL_FILENAME, "rb");
if (EC_NULL == pfLocalFile)
{
    dwRetVal = EC_E_OPENFAILED;
    goto Exit;
}
dwBufferSize = OsGetFileSize(pfLocalFile);

```

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```

pbyBuffer = (EC_T_BYTE*)OsMalloc(dwBufferSize);
if (EC_NULL == pbyBuffer)
{
    dwRetVal = EC_E_NOMEMORY;
    goto Exit;
}
dwRes = (EC_T_DWORD)OsFread(pbyBuffer, 1, dwBufferSize, pfLocalFile);
if (dwRes != dwBufferSize)
{
    dwRetVal = EC_E_ERROR;
    goto Exit;
}

/* download buffer to slave */
dwRes = ecatFoeFileDownload(dwSlaveId, MY_FOE_TRANSFER_SLAVE_FILENAME,
    (EC_T_DWORD)OsStrlen(MY_FOE_TRANSFER_SLAVE_FILENAME),
    pbyBuffer, dwBufferSize, 0, 600000 /* 10 minutes */);
if (EC_E_NOERROR != dwRes)
{
    dwRetVal = dwRes;
    goto Exit;
}

dwRetVal = EC_E_NOERROR;
Exit:
/* free resources */
if (EC_NULL != pfLocalFile)
{
    OsFclose(pfLocalFile);
}
SafeOsFree(pbyBuffer);

```

6.12.3 emFoeFileUpload

```

static EC_T_DWORD ecatFoeFileUpload(
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emFoeFileUpload(
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
Execute a FoE File upload from an EtherCAT slave device.

```

This function is used to upload a complete file. The function returns after the upload has been successfully completed or an error has occurred. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **achFileName** – [in] File name of slave file to read.
- **dwFileNameLen** – [in] Length of slave file name in bytes.
- **pbyData** – [out] Buffer receiving transferred data
- **dwDataLen** – [in] Buffer length [bytes]
- **pdwOutDataLen** – [out] Length of received data [byte]
- **dwPassword** – [in] slave password
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or maximum file name length of 64 bytes (MAX_FILE_NAME_SIZE) exceeded
- *EC_E_TIMEOUT* if dwTimeout elapsed during the API call
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

See also:

`emGetSlaveId()`

6.12.4 emFoeDownloadReq

```
static EC_T_DWORD ecatFoeDownloadReq(
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emFoeDownloadReq(
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
Initiates an FoE File download to an EtherCAT slave device.
```

This function is used to download a complete file and returns immediately. After the download has been successfully completed or an error has occurred, EC_NOTIFY_MBOXRCV is raised. The progress of the file transfer is also notified with EC_NOTIFY_MBOXRCV.

Deprecated:

EC_NOWAIT as a timeout is still accepted for reasons of compatibility and sets the timeout to 10 seconds

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **achFileName** – [in] File name of slave file to write.
- **dwFileNameLen** – [in] Length of slave file name in bytes.
- **dwPassword** – [in] slave password
- **dwTimeout** – [in] Timeout [ms]

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized
- **EC_E_INVALIDPARAM** if dwInstanceID is out of range or maximum file name length of 64 bytes (MAX_FILE_NAME_SIZE) exceeded
- **EC_E_MASTER_RED_STATE_INACTIVE** if Master Redundancy is configured and master is inactive

See also:

[emGetSlaveId\(\)](#)

6.12.5 emFoeSegmentedDownloadReq

```
static EC_T_DWORD ecatFoeSegmentedDownloadReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *szFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwFileSize,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emFoeSegmentedDownloadReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *szFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwFileSize,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
```

Initiates or continues a segmented FoE File download to an EtherCAT slave device.

This function is used to download a file chunk-by-chunk and returns immediately. An EC_NOTIFY_MBOXRCV is raised to request the next chunk from the application or to provide information about the progress and the change in the transfer status.

The slave may have a different mailbox size for BOOTSTRAP than for PREOP, SAFEOP, OP. See [EC_T_CFG_SLAVE_INFO.dwMbxInSize2](#). The maximum chunk size is the slave's mailbox size - 12 bytes overhead for EtherCAT's FoE protocol. The mailbox transfer object's buffer must be at least as big as the chunks to be transferred.

Deprecated:

EC_NOWAIT as a timeout is still accepted for reasons of compatibility and sets the timeout to 10 seconds

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Pointer to the corresponding mailbox transfer object.
EC_T_MBXTFER.pbyMbxTferData: next chunk, *EC_T_MBXTFER.dwDataLen*: next chunk size.
- **dwSlaveId** – [in] Slave ID
- **szFileName** – [in] File name of slave file to write. Only evaluated when initiating the request.
- **dwFileNameLen** – [in] Length of slave file name in bytes
- **dwFileSize** – [in] Complete file size (mandatory). Used also for progress information. Only evaluated when initiating the request.
- **dwPassword** – [in] Slave password. Only evaluated when initiating the request.
- **dwTimeout** – [in] Timeout [ms] specify the overall timeout of the FoE transfer. Only evaluated when initiating the request.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARM* if dwInstanceID is out of range or maximum file name length of 64 bytes (MAX_FILE_NAME_SIZE) exceeded
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

See also:

- [*EC_T_CFG_SLAVE_INFO::dwMbxOutSize\(emGetCfgSlaveInfo\(\)\)*](#)
- [*EC_T_CFG_SLAVE_INFO::dwMbxOutSize2\(emGetCfgSlaveInfo\(\)\)*](#)
- [*emGetSlaveId\(\)*](#)

6.12.6 emFoeUploadReq

```
static EC_T_DWORD ecatFoeUploadReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emFoeUploadReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *achFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
```

Initiates an FoE File upload from an EtherCAT slave device.

This function is used to upload a complete file and returns immediately. After the upload has been successfully completed or an error has occurred, EC_NOTIFY_MBOXRCV is raised. The progress of the file transfer is also notified with EC_NOTIFY_MBOXRCV.

Deprecated:

EC_NOWAIT as a timeout is still accepted for reasons of compatibility and sets the timeout to 10 seconds

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **achFileName** – [in] File name of slave file to read.
- **dwFileNameLen** – [in] Length of slave file name in bytes.
- **dwPassword** – [in] slave password
- **dwTimeout** – [in] Timeout [ms]

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized
- **EC_E_INVALIDPARM** if dwInstanceID is out of range or maximum file name length of 64 bytes (MAX_FILE_NAME_SIZE) exceeded
- **EC_E_MASTER_RED_STATE_INACTIVE** if Master Redundancy is configured and master is inactive

See also:

[emGetSlaveId \(\)](#)

6.12.7 emFoeSegmentedUploadReq

```
static EC_T_DWORD ecatFoeSegmentedUploadReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *szFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwFileSize,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emFoeSegmentedUploadReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    const EC_T_CHAR *szFileName,
    EC_T_DWORD dwFileNameLen,
    EC_T_DWORD dwFileSize,
    EC_T_DWORD dwPassword,
    EC_T_DWORD dwTimeout
)
```

Initiates or continues a segmented FoE File upload from an EtherCAT slave device.

This function is used to upload a file chunk-by-chunk and returns immediately. An EC_NOTIFY_MBOXRCV is raised to provide the next chunk to the application or to get information about the progress and the change in the transfer status.

The slave may have a different mailbox size for BOOTSTRAP than for PREOP, SAFEOP, OP. See [EC_T_CFG_SLAVE_INFO.dwMbxInSize2](#). The maximum chunk size is the slave's mailbox size - 12 bytes overhead for EtherCAT's FoE protocol. The mailbox transfer object's buffer must be at least as big as the chunks to be transferred.

Deprecated:

EC_NOWAIT as a timeout is still accepted for reasons of compatibility and sets the timeout to 10 seconds

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Pointer to the corresponding mailbox transfer object.
EC_T_MBXTFER.pbyMbxTferData: next chunk, *EC_T_MBXTFER.dwDataLen*: next chunk size.
- **dwSlaveId** – [in] Slave ID
- **szFileName** – [in] File name of slave file to write. Only evaluated when initiating the request.
- **dwFileNameLen** – [in] Length of slave file name in bytes.
- **dwFileSize** – [in] Used only for progress information.
- **dwPassword** – [in] Slave password. Only evaluated when initiating the request.
- **dwTimeout** – [in] Timeout [ms] specify the overall timeout of the FoE transfer. Only evaluated when initiating the request.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or maximum file name length of 64 bytes (*MAX_FILE_NAME_SIZE*) exceeded
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

See also:

- *EC_T_CFG_SLAVE_INFO::dwMbxInSize(emGetCfgSlaveInfo())*
- *emGetSlaveId()*

The following example demonstrates how to upload a file in segments:

FoE Segmented Upload Example

The following code demonstrates how to receive FoE from the slave with address MY_FOE_SLAVE_ADDRESS and store it in a file. The data uploaded from MY_FOE_TRANSFER_SLAVE_FILENAME of the slave is stored in a file with filename MY_FOE_TRANSFER_LOCAL_FILENAME in this example.

The example code can be placed after the corresponding *emSetMasterState()*-call in EcDemoApp.cpp:

```

EC_T_DWORD dwRetVal = EC_E_ERROR;
EC_T_DWORD dwRes = EC_E_ERROR;

EC_T_WORD wSlaveAddress = MY_FOE_SLAVE_ADDRESS /* e.g. 1001 */;
EC_T_DWORD dwSlaveId = ecatGetSlaveId(wSlaveAddress);

EC_T_CFG_SLAVE_INFO oCfgSlaveInfo;

FILE* pfLocalFile = EC_NULL;
EC_T_DWORD dwFileSize = 0;

EC_T_MBXTFER_DESC oMbxTferDesc;
EC_T_MBXTFER* pMbxTfer = EC_NULL;
EC_T_BYTE* pbyBuffer = EC_NULL;
EC_T_DWORD dwBufferSize = 0;

OsMemset(&oCfgSlaveInfo, 0, sizeof(EC_T_CFG_SLAVE_INFO));
OsMemset(&oMbxTferDesc, 0, sizeof(EC_T_MBXTFER_DESC));

/* get max. FoE segment size */
dwRes = ecatGetCfgSlaveInfo(EC_TRUE, wSlaveAddress, &oCfgSlaveInfo);
if (EC_E_NOERROR != dwRes)
{
    dwRetVal = dwRes;
    goto Exit;
}
/* mailbox contains mailbox header, FoE header and payload for buffer */
dwBufferSize = oCfgSlaveInfo.dwMbxInSize - ETHERCAT_MAX_FOE_MBOX_HDR_LEN;

/* allocate segment buffer */
pbyBuffer = (EC_T_BYTE*)OsMalloc(dwBufferSize);
if (EC_NULL == pbyBuffer)
{
    dwRetVal = EC_E_NOMEMORY;
    goto Exit;
}
oMbxTferDesc.pbyMbxTferDescData = pbyBuffer;
oMbxTferDesc.dwMaxDataLen = dwBufferSize;
pMbxTfer = ecatMbxTferCreate(&oMbxTferDesc);

```

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```

if (EC_NULL == pMbxTfer)
{
    dwRetVal = EC_E_NOMEMORY;
    goto Exit;
}
pMbxTfer->dwTferId = 0x12345678; /* uniq ID from application */

/* open local file */
pfLocalFile = OsFopen(MY_FOE_TRANSFER_LOCAL_FILENAME /* e.g. (EC_T_CHAR*) "MyFile.dat" */, "wb");
if (EC_NULL == pfLocalFile)
{
    dwRetVal = EC_E_OPENFAILED;
    goto Exit;
}

/* start upload */
dwRes = ecatFoeSegmentedUploadReq(pMbxTfer, dwSlaveId,
    MY_FOE_TRANSFER_SLAVE_FILENAME /* e.g. (EC_T_CHAR*) "MyFile.dat" */, (EC_T_
DWORD)OsStrlen(MY_FOE_TRANSFER_SLAVE_FILENAME),
    0xffffffff /* unknown file size */, 0, MBX_TIMEOUT /* e.g. 5000 */);
if (EC_E_NOERROR != dwRes)
{
    dwRetVal = dwRes;
    goto Exit;
}

/* upload file writing segments to disk */
while ((eMbxTferStatus_Pend == pMbxTfer->eTferStatus)
    || (eMbxTferStatus_TferWaitingForContinue == pMbxTfer->eTferStatus))
{
    /* wait for master received data from slave */
    if (eMbxTferStatus_TferWaitingForContinue == pMbxTfer->eTferStatus)
    {
        /* write segment */
        OsFwrite(pMbxTfer->pbyMbxTferData, pMbxTfer->dwDataLen, 1,_
→pfLocalFile);
        dwFileSize = dwFileSize + pMbxTfer->dwDataLen;

        /* acknowledge segment so master can receive the next segment */
        dwRes = ecatFoeSegmentedUploadReq(pMbxTfer, 0, EC_NULL, 0, 0, 0, 0);
        if (EC_E_NOERROR != dwRes)
        {
            dwRetVal = dwRes;
            goto Exit;
        }
    }
    OsSleep(10);
}
if (eMbxTferStatus_TferReqError == pMbxTfer->eTferStatus)
{
    dwRetVal = pMbxTfer->dwErrorCode;
    goto Exit;
}

/* transfer done */
if (eMbxTferStatus_TferDone == pMbxTfer->eTferStatus)
{
    dwRetVal = pMbxTfer->dwErrorCode; /* e.g. EC_E_NOERROR */
    pMbxTfer->eTferStatus = eMbxTferStatus_Idle;
}

```

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```
Exit:
    /* free resources */
    if (EC_NULL != pfLocalFile)
    {
        OsFclose(pfLocalFile);
    }
    if (EC_NULL != pMbxTfer)
    {
        if (eMbxTferStatus_Pend == pMbxTfer->eTferStatus)
        {
            CEcTimer oTimeout (MBX_TIMEOUT);
            ecatMbxTferAbort(pMbxTfer);
            while ((eMbxTferStatus_Pend == pMbxTfer->eTferStatus) && !oTimeout.
→IsElapsed())
            {
                OsSleep(100);
            }
        }
        ecatMbxTferDelete(pMbxTfer);
    }
    SafeOsFree(pbyBuffer);
```

6.12.8 emConvertEcErrorToFoeError

EC_T_DWORD **ecatConvertEcErrorToFoeError** (EC_T_DWORD dwErrorCode)

```
EC_T_DWORD emConvertEcErrorToFoeError (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwErrorCode
)
```

Convert master error code to FoE error code.

Returns

FoE error code according to ETG1000.6 Table 92 - Error codes of FoE

6.12.9 emNotify - EC_NOTIFY_FOE_MBXSND_WKC_ERROR

This error will be indicated in case the working counter of a FoE mailbox write command was not set to the expected value of 1. Detailed error information is stored in structure *EC_T_WKCERR_DESC* of the union element WkcErrDesc.

struct *EC_T_WKCERR_DESC*

```
EC_T_SLAVE_PROP SlaveProp
EC_T_BYTEx byCmd
EC_T_DWORD dwAddr
EC_T_WORD wWkcSet
EC_T_WORD wWkcAct
```

6.12.10 emNotify - EC_NOTIFY_FOE_MBSLAVE_ERROR

This error will be indicated in case a FoE mailbox slave send an error message. Detailed error information is stored in structure `EC_T_MBOX_FOE_ABORT_DESC` of the union element FoeErrorDesc.

```
struct EC_T_MBOX_FOE_ABORT_DESC
```

Public Members

`EC_T_SLAVE_PROP SlaveProp`
Slave properties

`EC_T_DWORD dwErrorCode`
Error code

`EC_T_CHAR achErrorString[MAX_STD_STRLEN]`
FoE error string

6.12.11 Extending EC_T_MBX_DATA

FoE transfer data, e.g. progress information in notification.

```
struct EC_T_MBX_DATA_FOE
```

Public Members

`EC_T_DWORD dwTransferredBytes`
[out] amount of transferred bytes

`EC_T_DWORD dwRequestedBytes`
[out] amount of bytes to be provided by application

`EC_T_DWORD dwBusyDone`
[out] If slave is busy: 0 ... dwBusyEntire

`EC_T_DWORD dwBusyEntire`
[out] If dwBusyEntire > 0: Slave is busy

`EC_T_CHAR szBusyComment[EC_FOE_BUSY_COMMENT_SIZE]`
[out] Busy Comment from slave

`EC_T_DWORD dwFileSize`
[out] File size

`EC_T_WORD wStationAddress`
[out] Station address of the slave

6.13 Servo Drive Profil according to IEC61491 over EtherCAT (SoE)

The SoE Service Channel (SSC) is equivalent to the IEC61491 Service Channel used for non-cyclic data exchange. The SSC uses the EtherCAT mailbox mechanism. It allows accessing IDNs and their elements.

For extended informations about SoE see the IEC IEC61800-7-300 document 22G185eFDIS.

Following services are available:

- **Write IDN:**

With `emSoeWrite()` the data and elements of an IDN which are writeable can be written.

- **Read IDN:**

With `emSoeRead()` the data and elements of an IDN can be read.

- **Procedure command Execution:**

With `emSoeWrite()` also procedure commands can be started. Procedure commands are special IDNs, which invokes fixed functional processes. When proceeding is finished, a notification will be received. To abort a running command execution `emSoeAbortProcCmd()` has to be called.

- **Notification:**

In case of an notification all registered clients will get this notification. A notification will be received when proceeding of a command has finished. To register a client `emRegisterClient()` must be called.

- **Emergency:**

The main purpose of this service is to provide additional information about the slave for debugging and maintenance. In case of an emergency, all registered clients will get notified. To register a client `emRegisterClient()` must be called.

Abbreviations:

- **IDN:**

identification number: Designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data.

- **SoE:**

IEC 61491 Servo drive profile over EtherCAT (SoE)

- **SSC:**

SoE Service Channel (non-cyclic data exchange)

6.13.1 SoE ElementFlags

With the ElementFlags each element of an IDN can be addressed. The ElementFlags indicating which elements of an IDN are read or written. The ElementFlags indicating which data will be transmitted in the SoE data buffer.

SOE_BM_ELEMENTFLAG_DATATSTATE

Shall be set in case of Notify SoE Service Channel Command Execution

SOE_BM_ELEMENTFLAG_NAME

Name of operation data. The name consist of 64 octets maximum

SOE_BM_ELEMENTFLAG_ATTRIBUTE

Attribute of operation data. The attribute contain all information which is needed to display operation data intelligibly

SOE_BM_ELEMENTFLAG_UNIT

Unit of operation data

SOE_BM_ELEMENTFLAG_MIN

The IDN minimum input value shall be the smallest numerical value for the operation data which the slave is able to process

SOE_BM_ELEMENTFLAG_MAX

The IDN maximum input value shall be the largest numerical value for the operation data which the slave is able to process

SOE_BM_ELEMENTFLAG_VALUE

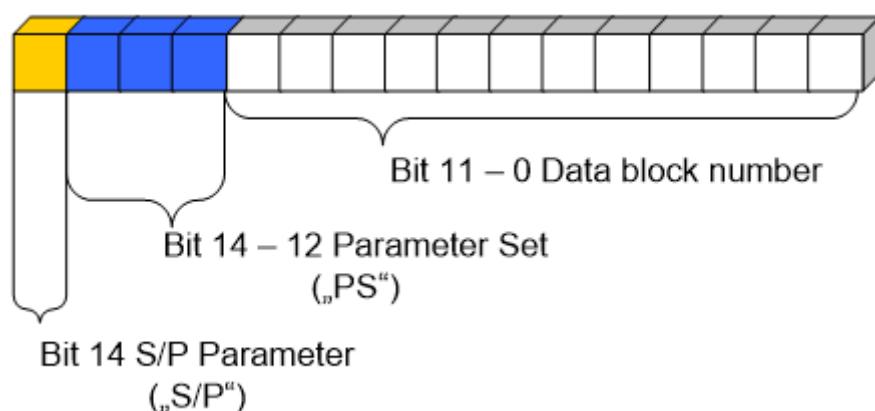
Operation data

SOE_BM_ELEMENTFLAG_DEFAULT

The IDN default value

6.13.2 SoE IDN coding

The parameter addressing area consist of 4096 different standard IDNs, each with 8 parameter sets and 4096 manufacturer specific IDNs, each with 8 parameter sets.



The Control unit cycle time (TNcyc) which is an standard IDN S-0-0001 equates to wIDN = 0x1 The first manufacturer specific IDN P-0-0001 equates to wIDN = 0x8001

6.13.3 emSoeWrite

```
static EC_T_DWORD ecatSoeWrite (
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIDN,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout
)
```

```
EC_T_DWORD emSoeWrite (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIdn,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout
)
```

Execute a SoE SSC Write service which download data to an EtherCAT slave device.

The function returns after timeout expired or download is completed successfully (Write response is received). It can also perform a SoE SSC Procedure Command. After a procedure command has started, the slave generates a normal SSC Write Response, and the function returns. If the data to be sent with the write service exceeds the mailbox size, the data will be sent fragmented. The fragmented write operation consists of several Write SSC Fragment Services. Therefore the selected Timeout should be increasing with the count of fragments. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **byDriveNo** – [in] Drive number to address inside slave device
- **pbyElementFlags** – [in/out] SoE ElementFlags. Flag indicating elements to address
- **wIdn** – [in] IDN of the object to address
- **pbyData** – [in] Buffer containing transferred data
- **dwDataLen** – [in] Buffer length [byte]
- **dwTimeout** – [in] Timeout [ms]

Returns

EC_E_NOERROR or error code

See also:

emGetSlaveId()

6.13.4 emSoeWriteReq

Requests an SoE SSC Write and returns immediately.

```
static EC_T_DWORD ecatSoeWriteReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIDN,
    EC_T_DWORD dwTimeout
)
```

```
EC_T_DWORD emSoeWriteReq(
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIdn,
    EC_T_DWORD dwTimeout
)
```

) Requests an SoE SCC Write and returns immediately.

This function may be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **byDriveNo** – [in] Drive number to address inside slave device
- **pbyElementFlags** – [in/out] SoE ElementFlags. Flag indicating elements to address
- **wIdn** – [in] IDN of the object to address
- **dwTimeout** – [in] Timeout [ms]

Returns

EC_E_NOERROR or error code

See also:

- [emSoeWrite\(\)](#)
- [emGetSlaveId\(\)](#)

6.13.5 emSoeRead

```
static EC_T_DWORD ecatSoeRead(
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIDN,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwTimeout
)
```

```
EC_T_DWORD emSoeRead (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIdn,
    EC_T_BYT *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwTimeout
)
```

) Execute a SoE SCC Read service which upload data from an EtherCAT SoE slave device.

The received data can consist of several fragments. The reserved data buffer (`pbyData`) must have space for all received data segments and the selected Timeout should be increasing with the count of fragments.

Parameters

- `dwInstanceID` – [in] Instance ID (Multiple EtherCAT Network Support)
- `dwSlaveId` – [in] Slave ID
- `byDriveNo` – [in] Drive number to address inside slave device
- `pbyElementFlags` – [in/out] SoE ElementFlags. Flag indicating elements to address
- `wIdn` – [in] IDN of the object to address
- `pbyData` – [out] Buffer receiving transferred data
- `dwDataLen` – [in] Buffer length [byte]
- `pdwOutDataLen` – [out] Length of received data [byte]
- `dwTimeout` – [in] Timeout [ms]

Returns

`EC_E_NOERROR` or error code

See also:

`emGetSlaveId()`

6.13.6 emSoeReadReq

```
static EC_T_DWORD ecatSoeReadReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIdn,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emSoeReadReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIdn,
    EC_T_DWORD dwTimeout
)
```

Requests an SoE SSC Read and returns immediately.

This function may be called from within the JobTask's context.

Parameters

- `dwInstanceID` – [in] Instance ID (Multiple EtherCAT Network Support)
- `pMbxTfer` – [in] Mailbox transfer object
- `dwSlaveId` – [in] Slave ID
- `byDriveNo` – [in] Drive number to address inside slave device
- `pbyElementFlags` – [in/out] SoE ElementFlags. Flag indicating elements to address

- **wIdn** – [in] IDN of the object to address
- **dwTimeout** – [in] Timeout [ms] Must not be set to EC_NOWAIT

Returns*EC_E_NOERROR* or error code**See also:**

- [emSoeRead\(\)](#)
- [emGetSlaveId\(\)](#)

6.13.7 emSoeAbortProcCmd

```
static EC_T_DWORD ecatSoeAbortProcCmd (
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIDN,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emSoeAbortProcCmd (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_BYT byDriveNo,
    EC_T_BYT *pbyElementFlags,
    EC_T_WORD wIdn,
    EC_T_DWORD dwTimeout
)
Abort SSC Procedure Command sequence.
```

A Procedure Command take up some time. After a procedure command has started, the slave generates a normal SSC Write Response. The end of a procedure command is indicated by the Notify SSC Command Execution Service.

Note: This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **byDriveNo** – [in] Drive number to address inside slave device
- **pbyElementFlags** – [in/out] SoE ElementFlags. Flag indicating elements to address
- **wIdn** – [in] IDN of the object to address
- **dwTimeout** – [in] Timeout [ms]

Returns*EC_E_NOERROR* or error code**See also:**[emGetSlaveId\(\)](#)

6.13.8 emConvertEcErrorToSoeError

`EC_T_DWORD ecatConvertEcErrorToSoeError (EC_T_DWORD dwErrorCode)`

```
EC_T_DWORD emConvertEcErrorToSoeError (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwErrorCode
)
    Convert master error code to SoE error code.
```

Returns

SoE error code

6.13.9 emNotify - EC_NOTIFY_SOE_MBXSND_WKC_ERROR

This error will be indicated in case the working counter of a SoE mailbox write command was not set to the expected value of 1. Detailed error information is stored in structure `EC_T_WKCERR_DESC` of `EC_T_ERROR_NOTIFICATION_DESC`.

6.13.10 emNotify - EC_NOTIFY_SOE_WRITE_ERROR

This error will be indicated in case SoE mailbox write command responded with an error. Detailed error information is stored in structure `EC_T_INITCMD_ERR_DESC` of `EC_T_ERROR_NOTIFICATION_DESC`.

6.14 Vendor specific protocol over EtherCAT (VoE)

VoE is for vendor specific protocols. With VoE the vendor has access to a raw EtherCAT mailbox without a specific header or specific protocol mechanism.

6.14.1 emVoeWrite

```
static EC_T_DWORD ecatVoeWrite (
    EC_T_DWORD dwSlaveId,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emVoeWrite (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD dwTimeout
)
    Execute a VoE mailbox write to an EtherCAT slave device.
```

This function blocks until the VoE write has been successfully completed or an error has occurred.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **pbyData** – [in] Buffer containing transferred data

- **dwDataLen** – [in] Buffer length [bytes] The maximum data length including 6 bytes for the mailbox header is given at [*EC_T_CFG_SLAVE_INFO.dwMbxOutSize*](#)
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time.

Returns[*EC_E_NOERROR*](#) or error code**See also:**

- [*emGetCfgSlaveInfo\(\)*](#)
- [*emGetSlaveId\(\)*](#)

6.14.2 emVoeWriteReq

```
static EC_T_DWORD ecatVoeWriteReq (
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emVoeWriteReq (
    EC_T_DWORD dwInstanceID,
    EC_T_MBXTFER *pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_DWORD dwTimeout
)
```

Initiates a VoE mailbox write to an EtherCAT slave device.

The amount of data bytes to write has to be stored in [*EC_T_MBXTFER.dwDataLen*](#). The maximum data length including 6 bytes for the mailbox header is given at [*EC_T_CFG_SLAVE_INFO.dwMbxOutSize*](#). A unique transfer ID must be written into [*EC_T_MBXTFER.dwTferId*](#).

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pMbxTfer** – [in] Mailbox transfer object
- **dwSlaveId** – [in] Slave ID
- **dwTimeout** – [in] Timeout [ms], EC_NOWAIT returns the function immediately

Returns[*EC_E_NOERROR*](#) or error code**See also:**

[*emGetSlaveId\(\)*](#)

6.14.3 emVoeRead

```
static EC_T_DWORD ecatVoeRead (
    EC_T_DWORD dwSlaveId,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwTimeout
)
```

```
EC_T_DWORD emVoeRead (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwSlaveId,
    EC_T_BYTE *pbyData,
    EC_T_DWORD dwDataLen,
    EC_T_DWORD *pdwOutDataLen,
    EC_T_DWORD dwTimeout
)
```

) Retrieves VoE mailbox, that was sent by an EtherCAT slave device.

If a VoE mailbox was already received, further received VoE mailboxes will be discarded as long as this function was not called. The received data includes the Mailbox header of type [ETHERCAT_MBOX_HEADER](#) followed by the VoE payload.

This function blocks until the VoE data has been successfully received or an error has occurred.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwSlaveId** – [in] Slave ID
- **pbyData** – [out] Buffer receiving transferred data
- **dwDataLen** – [in] Buffer length [byte]
- **pdwOutDataLen** – [out] Length of received data [byte]
- **dwTimeout** – [in] Timeout [ms] The function will block at most for this time.
EC_NOWAIT returns the function immediately

Returns

- [EC_E_NOERROR](#) if the VoE slave has provided some VoE data
- [EC_E_INVALIDSTATE](#) if master isn't initialized
- [EC_E_INVALIDPARM](#) if dwInstanceID is out of range
- [EC_E_TIMEOUT](#) if dwTimeout elapsed during the API call
- [EC_E_VOE_NO_MBX_RECEIVED](#) no VoE data received
- [EC_E_MASTER_RED_STATE_INACTIVE](#) if Master Redundancy is configured and master is inactive

struct [ETHERCAT_MBOX_HEADER](#)

Public Members

EC_T_WORD **wLength**

Following bytes (payload length)

EC_T_WORD **wAddress**

Station address of destination (READ) or source (WRITE). 0 == Master (ETHERCAT_MBOX_MASTER_ADDRESS)

EC_T_BYT**e** **byChnPri**

Channel, Priority

EC_T_BYTExTypCntRsvd
wMbxType, Counter, Rsvd

See also:

emGetSlaveId()

6.14.4 emNotify - eMbxTferType_VOE_READ

The corresponding Slave ID can be found in pMbxTfer->dwTferId. The MBX data stored in pMbxTfer->pbyMbxTferData may have to be buffered by the client. After emNotify returns the pointer and thus the data is invalid. Access to the memory area pointed to by pMbxTfer->pbyMbxTferData after returning from emNotify is illegal and the results are undefined.

emNotify - eMbxTferType_VOE_READ

Parameter

- pbyInBuf: [in] pMbxTfer - Pointer to a structure of type EC_T_MBXTFER, this structure contains the used mailbox transfer object . To retrieve this VoE mailbox data emVoeRead has to be called.
- dwInBufSize: [in] Size of the transfer object.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

6.14.5 emNotify - eMbxTferType_VOE_WRITE

VoE mailbox was successfully written to the VoE slave. The corresponding transfer ID can be found in pMbxTfer->dwTferId. The transfer result is stored in pMbxTfer->dwErrorCode.

emNotify - eMbxTferType_VOE_WRITE

Parameter

- pbyInBuf: [in] pMbxTfer - Pointer to a structure of type EC_T_MBXTFER, this structure contains the corresponding mailbox transfer object.
- dwInBufSize: [in] Size of the transfer object.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

6.15 Raw command transfer

6.15.1 emTferSingleRawCmd

```
static EC_T_DWORD ecatTferSingleRawCmd (
    EC_T_BYTE byCmd,
    EC_T_DWORD dwMemoryAddress,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emTferSingleRawCmd (
    EC_T_DWORD dwInstanceID,
    EC_T_BYTE byCmd,
    EC_T_DWORD dwMemoryAddress,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen,
    EC_T_DWORD dwTimeout
)
```

Transfers a single raw EtherCAT command to one or multiple slaves and waits for the result.

Using this function it is possible exchange arbitrary data between the master and the slaves. When the master receives the response to the queued frame it raises EC_NOTIFY_RAWCMD_DONE to all clients. This function blocks until the command is completely processed. In case of read commands the slave data will be written back into the given memory area. If a timeout occurs (e.g. due to a bad line quality) the corresponding frame will be sent again. The timeout value and retry counter can be set using the master configuration parameters dwEcatCmdTimeout and dwEcatCmdMaxRetries. The call will return in any case (without waiting for the number of retries specified in dwEcatCmdMaxRetries) if the time determined with the dwTimeout parameter elapsed. Caveat: Using auto increment addressing (APRD, APWR, APRW) may lead to unexpected results in case the selected slave does not increment the working counter. In such cases the EtherCAT command would be handled by the slave directly behind the selected one. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **byCmd** – [in] EtherCAT command type. EC_CMD_TYPE_...
- **dwMemoryAddress** – [in] Slave memory address, depending on the command to be sent this is either a physical or logical address.
- **pbyData** – [in, out] Buffer containing or receiving transferred data
- **wLen** – [in] Number of bytes to transfer
- **dwTimeout** – [in] Timeout [ms]

Returns

- **EC_E_NOERROR** if successful
- **EC_E_INVALIDSTATE** if master isn't initialized
- **EC_E_INVALIDPARM** if dwInstanceID is out of range or the command is not supported or the timeout value is set to EC_NOWAIT
- **EC_E_TIMEOUT** if dwTimeout elapsed during the API call
- **EC_E_BUSY** another transfer request is already pending or the master or the corresponding slave is currently changing its operational state

- *EC_E_NOTREADY* if the working counter was not set when sending the command (slave may not be connected or did not respond)
- *EC_E_INVALIDSIZE* if the size of the complete command does not fit into a single Ethernet frame. The maximum amount of data to transfer must not exceed 1486 bytes
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

The following EtherCAT commands are supported:

- eRawCmd_AP RD Auto Increment Physical Read (avoid to use, see below)
- eRawCmd_AP WR Auto Increment Physical Write (avoid to use, see below)
- eRawCmd_AP RW Auto Increment Physical Read/Write (avoid to use, see below)
- eRawCmd_F PRD Fixed addressed Physical Read
- eRawCmd_F PWR Fixed addressed Physical Write
- eRawCmd_F PRW Fixed addressed Physical Read/Write
- eRawCmd_BR D Broadcast (wire or'ed) Read
- eRawCmd_B WR Broadcast Write
- eRawCmd_BR W Broadcast Read/Write
- eRawCmd_L RD Logical Read
- eRawCmd_L WR Logical Write
- eRawCmd_L RW Logical Read/Write
- eRawCmd_A RMW Auto Increment Physical Read, multiple Write

6.15.2 emCIntSendRawMbx

```
static EC_T_DWORD ecatCIntSendRawMbx (
    EC_T_DWORD dwClntId,
    EC_T_BYT E *pbyMbxCmd,
    EC_T_DWORD dwMbxCmdLen,
    EC_T_DWORD dwTimeout
)
EC_T_DWORD emCIntSendRawMbx (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClntId,
    EC_T_BYT E *pbyMbxCmd,
    EC_T_DWORD dwMbxCmdLen,
    EC_T_DWORD dwTimeout
)
Send a raw mailbox command.
```

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClntId** – [in] Client ID
- **pbyMbxCmd** – [in] Buffer containing the raw mailbox command starting with mailbox header
- **dwMbxCmdLen** – [in] Length of pbyMbxCmd buffer
- **dwTimeout** – [in] Timeout [ms]

Returns

- EC_E_NOERROR* or error code

6.15.3 emClntQueueRawCmd

```
static EC_T_DWORD ecatClntQueueRawCmd (
    EC_T_DWORD dwClntId,
    EC_T_WORD wInvokeId,
    EC_T_BYTE byCmd,
    EC_T_DWORD dwMemoryAddress,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
EC_T_DWORD emClntQueueRawCmd (
    EC_T_DWORD dwInstanceID,
    EC_T_DWORD dwClntId,
    EC_T_WORD wInvokeId,
    EC_T_BYTE byCmd,
    EC_T_DWORD dwMemoryAddress,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
```

) Transfers a raw EtherCAT command to one or multiple slaves.

Using this function it is possible to exchange data between the master and the slaves. When the response to the queued frame is received, the notification *EC_NOTIFY_RAWCMD_DONE* is given for the appropriate client. This function queues a single EtherCAT command. Queued raw commands will be sent after sending cyclic process data values. If a timeout occurs the corresponding frame will be sent again, the timeout value and retry counter can be set using the master configuration parameters *EC_T_INIT_MASTER_PARMS.dwEcatCmdTimeout* and *EC_T_INIT_MASTER_PARMS.dwEcatCmdMaxRetries*.

Using auto increment addressing (APRD, APWR, APRW) may lead to unexpected results in case the selected slave does not increment the working counter. In such cases the EtherCAT command would be handled by the slave directly behind the selected one. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **dwClntId** – [in] Client ID to be notified (0 if all registered clients shall be notified).
- **wInvokeId** – [in] Invoke ID to reassign the results to the sent CMD
- **byCmd** – [in] EtherCAT command
- **dwMemoryAddress** – [in] Slave memory address, depending on the command to be sent this is either a physical or logical address
- **pbyData** – [in, out] Buffer containing or receiving transferred data. In case a read-only command is queued (e.g. APRD) this pointer should be set to a value of *EC_NULL*.
- **wLen** – [in] Number of bytes to transfer.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range or the command is not supported

- *EC_E_BUSY* if the master or the corresponding slave is currently changing its operational state
- *EC_E_INVALIDSIZE* if the size of the complete command does not fit into a single Ethernet frame. The maximum amount of data to transfer must not exceed 1486 bytes

The following EtherCAT commands are supported:

enum **EC_T_RAWCMD**

Values:

enumerator **eRawCmd_APRD**

Auto-Increment physical read

enumerator **eRawCmd_APWR**

Auto-Increment physical write

enumerator **eRawCmd_APRW**

Auto-Increment physical read/write

enumerator **eRawCmd_BRD**

Broadcast (wire-or'ed) read

enumerator **eRawCmd_BWR**

Broadcast write

enumerator **eRawCmd_BRW**

Broadcast read/write

enumerator **eRawCmd_LRD**

Logical read

enumerator **eRawCmd_LWR**

Logical write

enumerator **eRawCmd_LRW**

Logical read/write

enumerator **eRawCmd_ARMW**

Auto-increment physical read, multiple write

enumerator **eRawCmd_FPRD**

Fixed address physical read

enumerator **eRawCmd_FPWR**

Fixed address physical write

enumerator **eRawCmd_FPRW**

Fixed address physical read/write

6.15.4 emQueueRawCmd

```
static EC_T_DWORD ecatQueueRawCmd (
    EC_T_WORD wInvokeId,
    EC_T_BYTE byCmd,
    EC_T_DWORD dwMemoryAddress,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
EC_T_DWORD emQueueRawCmd (
    EC_T_DWORD dwInstanceID,
    EC_T_WORD wInvokeId,
    EC_T_BYTE byCmd,
    EC_T_DWORD dwMemoryAddress,
    EC_T_BYTE *pbyData,
    EC_T_WORD wLen
)
```

Transfers a raw EtherCAT command to one or multiple slaves.

All registered clients will be notified. This function may not be called from within the JobTask's context.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **wInvokeId** – [in] Invoke ID to reassign the results to the sent CMD
- **byCmd** – [in] EtherCAT command
- **dwMemoryAddress** – [in] Slave memory address, depending on the command to be sent this is either a physical or logical address.
- **pbyData** – [in, out] Buffer containing or receiving transferred data In case a read-only command is queued (e.g. APRD) this pointer should be set to a value of EC_NULL
- **wLen** – [in] Number of bytes to transfer.

Returns

EC_E_NOERROR or error code

See also:

[emCIntQueueRawCmd \(\)](#)

6.15.5 emNotify - EC_NOTIFY_RAWCMD_DONE

This notification is given when the response to an [emTransferSingleRawCmd \(\)](#) or [emCIntQueueRawCmd \(\)](#) is received.

emNotify - EC_NOTIFY_RAWCMD_DONE

Parameter

- pbyInBuf: [in] Pointer to EC_T_RAWCMDRESPONSE_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

```
struct EC_T_RAWCMDRESPONSE_NTFY_DESC
```

Public Members

EC_T_DWORD dwInvokeId

[in] Invoke Id from callee. Only lower 16 bits are relevant

EC_T_DWORD dwResult

[in] EC_E_NOERROR on success, error code otherwise

EC_T_DWORD dwWkc

[in] Received working counter

EC_T_DWORD dwCmdIdx

[in] Command Index Field

EC_T_DWORD dwAddr

[in] Address Field

EC_T_DWORD dwLength

[in] Length of data portion (11 relevant bits)

EC_T_BYT* pbyData

[in] Pointer to data portion within a PDU. The callback function has to store the data into application memory, the data pointer will be invalid after returning from the callback

6.16 EtherCAT Bus Scan

The acontis EtherCAT Master stack supports scanning the EtherCAT Bus to determine which devices are available. If a configuration was provided the connected slaves are validated against the given ENI.

See also:

[emScanBus \(\)](#)

6.16.1 emIoControl - EC_IOCTL_SB_ENABLE

Enables Busscan support.

emIoControl - EC_IOCTL_SB_ENABLE

Parameter

- pbyInBuf: [in] Pointer to Timeout Parameter Value in MSec (EC_T_DWORD). Timeout Parameter is used for timeout during Bus Topology determination.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

The Scanbus support is enabled by default.

6.16.2 emIoControl - EC_IOCTL_SB_RESTART

This call will restart the bus scanning cycle. On completion the Notification *emNotify - EC_NOTIFY_SB_STATUS* is given.

emIoControl - EC_IOCTL_SB_RESTART

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

The timeout value given by *emIoControl - EC_IOCTL_SB_ENABLE* will be used. This function may be called prior to running *emConfigureNetwork ()*. In such a case a first bus scan will be executed before master configuration. This feature may be used to dynamically create or adjust the XML configuration file. When issuing this IoControl, the application has to take care *emExecJob ()* is called cyclically to trigger master state machines, timers, send acyc and receive frames accordingly.

6.16.3 emIoControl - EC_IOCTL_SB_STATUS_GET

This call will get the status of the last bus scan.

emIoControl - EC_IOCTL_SB_STATUS_GET

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Pointer to EC_T_SB_STATUS_NTFY_DESC.
- dwOutBufSize: [in] Size of the output buffer in bytes.
- pdwNumOutData: [out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Return

EC_E_NOERROR or error code

See also:

emNotify - EC_NOTIFY_SB_STATUS

6.16.4 emIoControl - EC_IOCTL_SB_SET_TOPOLOGY_CHANGED_DELAY

This call will set the topology changed delay value. The master will wait this duration in msec to react on appearing links in topology. The default value is 1000 ms.

emIoControl - EC_IOCTL_SB_SET_TOPOLOGY_CHANGED_DELAY

Parameter

- pbyInBuf: [in] Pointer to EC_T_DWORD containing the delay information in msec
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

6.16.5 emIoControl - EC_IOCTL_SB_SET_TOPOLOGY_CHANGED_DELAYS

This call will set the topology changed delay values individually. The master will wait individual durations in msec (0 msec: disabled) for slave ports, main link and red link to react on appearing links in topology. The default value is 1000 ms.

emIoControl - EC_IOCTL_SB_SET_TOPOLOGY_CHANGED_DELAYS

Parameter

- pbyInBuf: [in] Pointer to EC_T_TOPOLOGY_CHANGED_DELAYS containing the delay information in msec
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

struct **EC_T_TOPOLOGY_CHANGED_DELAYS**

Public Members

EC_T_DWORD dwSlavePort

[in] Delay before opening slave port after link connection detected

EC_T_DWORD dwMainLine

[in] Delay before sending frames at main line after link connection detected

EC_T_DWORD dwRedLine

[in] Delay before sending frames at red line after link connection detected

EC_T_DWORD adwReserved[5]
reserved

6.16.6 emIoControl - EC_IOCTL_SB_SET_ERROR_ON_CROSSED_LINES

This call will enable or disable bus mismatch if IN and OUT connectors are swapped. If enabled the swapped IN and OUT connectors will lead to bus mismatch. By default swapped IN and OUT connectors will lead to bus mismatch.

emIoControl - EC_IOCTL_SB_SET_ERROR_ON_CROSSED_LINES

Parameter

- pbyInBuf: [in] Pointer to EC_T_BOOL variable. If set to EC_TRUE swapped IN and OUT connectors will lead to bus mismatch, if set to EC_FALSE swapped IN and OUT connectors are tolerated.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

6.16.7 emIoControl - EC_IOCTL_SB_SET_ERROR_ON_LINEBREAK

This call will enable or disable bus mismatch if a line is broken in a redundant network. If enabled, line breaks in cable or junction redundant networks will lead to bus mismatch.

emIoControl - EC_IOCTL_SB_SET_ERROR_ON_LINEBREAK

Parameter

- pbyInBuf: [in] Pointer to EC_T_BOOL. EC_TRUE: Return error code, EC_FALSE: Return no error.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

Default: No error on line break.

Error codes:

- EC_E_REDLINEBREAK: Line break in a cable redundant network.
- EC_E_JUNCTION_RED_LINE_BREAK: Line break in a junction redundant network.

6.16.8 emIoControl - EC_IOCTL_SB_SET_TOPOLOGY_CHANGE_AUTO_MODE

Warning: This documentation is preliminary and is subject to change

This call will enable or disable the automatical topology change mode. By default the automatical mode is enabled.

emIoControl - EC_IOCTL_SB_SET_TOPOLOGY_CHANGE_AUTO_MODE

Parameter

- pbyInBuf: [in] Pointer to EC_T_BOOL variable. If set to EC_TRUE the automatical mode is enabled.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

In automatical mode, new slaves will be discovered automatically. In manual mode, after new slaves have been connected, a *emNotify - EC_NOTIFY_HC_TOPOCHGDONE* notification will be given without opening the ports of the slaves on bus. When the application is able to handle the new slaves, it should call *emIoControl - EC_IOCTL_SB_ACCEPT_TOPOLOGY_CHANGE*

6.16.9 emIoControl - EC_IOCTL_SB_ACCEPT_TOPOLOGY_CHANGE

Warning: This documentation is preliminary and is subject to change

This call will trigger a scan bus. On completion the Notification *emNotify - EC_NOTIFY_SB_STATUS* is given.

emIoControl - EC_IOCTL_SB_ACCEPT_TOPOLOGY_CHANGE

Parameter

- pbyInBuf: [in] Should be set to EC_NULL
- dwInBufSize: [in] Should be set to 0
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

EC_E_NOERROR or error code

This function may be called after a *emNotify - EC_NOTIFY_HC_TOPOCHGDONE* notification was given if the automatical topology change mode was previously disabled using *emIoControl - EC_IOCTL_SB_SET_TOPOLOGY_CHANGE_AUTO_MODE*. During this scan bus the ports of the slaves will be (re)open and new slaves can be detected. The timeout value given by *emIoControl - EC_IOCTL_SB_ENABLE* will be used. When issuing this IoControl, the application has to take care *emExecJob()* is called cyclically to trigger master state machines, timers, send acyc and receive frames accordingly.

6.16.10 emNotify - EC_NOTIFY_SB_STATUS

Scan bus status notification.

This notification is enabled by default.

emNotify - EC_NOTIFY_SB_STATUS

Parameter

- pbyInBuf: [in] Pointer to EC_T_SB_STATUS_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct **EC_T_SB_STATUS_NTFY_DESC**

Public Members

EC_T_DWORD dwresultCode

[in] EC_E_NOERROR: success EC_E_NOTREADY: no bus scan executed
EC_E_BUSCONFIG_MISMATCH: bus configuration mismatch Result of scanbus

EC_T_DWORD dwSlaveCount

[in] number of slaves connected to the bus

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation

6.16.11 emNotify - EC_NOTIFY_SB_MISMATCH

This notification will be initiated if scan bus detects mismatch of connected slaves and configuration, due to unexpected slaves or missing mandatory slaves.

emNotify - EC_NOTIFY_SB_MISMATCH

Parameter

- pbyInBuf: [in] Pointer to EC_T_SB_MISMATCH_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

This notification is enabled by default. In case of permanent frame loss no slaves can be found although the slaves are connected.

struct **EC_T_SB_MISMATCH_DESC**

Public Members

EC_T_WORD wPrevFixedAddress
[in] Previous slave station address

EC_T_WORD wPrevPort
[in] Previous slave station address

EC_T_WORD wPrevAIncAddress
[in] Previous slave auto-increment address

EC_T_WORD wBusAIncAddress
[in] Unexpected slave (bus) auto-inc address

EC_T_DWORD dwBusVendorId
[in] Unexpected slave (bus) vendor ID

EC_T_DWORD dwBusProdCode
[in] Unexpected slave (bus) product code

EC_T_DWORD dwBusRevisionNo
[in] Unexpected slave (bus) revision number

EC_T_DWORD dwBusSerialNo
[in] Unexpected slave (bus) serial number

EC_T_WORD wBusFixedAddress
[in] Unexpected slave (bus) station address

EC_T_BOOL bIdentificationError
[in] Identification command sent to slave but failed

EC_T_WORD wIdentificationAdo
[in] Identification register

EC_T_WORD wIdentificationVal
[in] last identification value read from slave according to the last used identification method

EC_T_WORD wIdentificationValExpected
[in] Identification expected value

EC_T_WORD wCfgFixedAddress
[in] Missing slave (config) station Address

EC_T_WORD wCfgAIncAddress
[in] Missing slave (config) Auto-Increment Address

EC_T_DWORD dwCfgVendorId
[in] Missing slave (config) Vendor ID

EC_T_DWORD dwCfgProdCode
[in] Missing slave (config) Product code

EC_T_DWORD dwCfgRevisionNo
[in] Missing slave (config) Revision Number

EC_T_DWORD dwCfgSerialNo
 [in] Missing slave (config) Serial Number

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation

6.16.12 emNotify - EC_NOTIFY_SB_DUPLICATE_HC_NODE

Scan bus mismatch was detected while scan because of a duplicated slave(s). An application get this notification if the there are two slaves on the network with the same product code, vendor ID and identification value (alias address or switch id).

emNotify - EC_NOTIFY_SB_DUPLICATE_HC_NODE

Parameter

- pbyInBuf: [in] Pointer to EC_T_SB_MISMATCH_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

The members of *EC_T_SB_MISMATCH_DESC* have the following meaning:

- *EC_T_SB_MISMATCH_DESC::wCfgFixedAddress* Duplicated slave (config) station Address
- *EC_T_SB_MISMATCH_DESC::wCfgAIncAddress* Duplicated slave (config) Auto-Increment Address.
- *EC_T_SB_MISMATCH_DESC::dwCfgVendorId* Duplicated slave (config) Vendor ID
- *EC_T_SB_MISMATCH_DESC::dwCfgProdCode* Duplicated slave (config) Product code
- *EC_T_SB_MISMATCH_DESC::dwCfgRevisionNo* Duplicated slave (config) Revision Number
- *EC_T_SB_MISMATCH_DESC::dwCfgSerialNo* Duplicated slave (config) Serial Number

6.16.13 emNotify - EC_NOTIFY_SLAVE_PRESENCE

This notification is given, if slave appears or disappears from the network.

This notification is enabled by default.

emNotify - EC_NOTIFY_SLAVE_PRESENCE

Parameter

- pbyInBuf: [in] Pointer to EC_T_SLAVE_PRESENCE_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Disconnecting the slave from the network, powering it off or a bad connection can produce this notification.

struct **EC_T_SLAVE_PRESENCE_NTFY_DESC**

Public Members

EC_T_WORD wStationAddress
Slave station address

EC_T_BYTE bPresent
EC_TRUE: present , EC_FALSE: absent

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation

6.16.14 emNotify - EC_NOTIFY_SLAVES_PRESENCE

This notification collects notifications of the type *emNotify - EC_NOTIFY_SLAVE_PRESENCE*. Notification is given either upon completion or when master status is changed, whichever comes first. Disconnecting slaves from the network, turning them off, or having a bad connection can lead to this notification.

This notification is disabled by default.

emNotify - EC_NOTIFY_SLAVES_PRESENCE**Parameter**

- pbyInBuf: [in] Pointer to EC_T_SLAVES_PRESENCE_NTFY_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct **EC_T_SLAVES_PRESENCE_NTFY_DESC**

Public Members

EC_T_WORD wCount
Number of slave presence notifications

EC_T_SLAVE_PRESENCE_NTFY_DESC
SlavePresence[MAX_SLAVES_PRESENCE_NTFY_ENTRIES]
slave presence descriptions

See also:

emIoControl - EC_IOCTL_SET_NOTIFICATION_ENABLED

6.16.15 emNotify - EC_NOTIFY_LINE_CROSSED

Cable swapping detected. All slaves' port 0 must lead to Master.

emNotify - EC_NOTIFY_LINE_CROSSED

Parameter

- pbyInBuf: [in] Pointer to EC_T_LINE_CROSSED_DESC
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct **EC_T_LINE_CROSSED_DESC**

Public Members

EC_T_SLAVE_PROP SlaveProp
slave properties

EC_T_WORD wInputPort
port where frame was received

6.16.16 emNotify - EC_NOTIFY_SLAVE_NOTSUPPORTED

Is currently generated during Bus Scan if [emConfigureNetwork\(\)](#) (GenOp/Preop) and a wrong category type is detected in the EEPROM. This notification should only print a log message or be ignored (Master print log message itself).

emNotify - EC_NOTIFY_SLAVE_NOTSUPPORTED

Parameter

- pbyInBuf: [in] Pointer to EC_T_ERROR_NOTIFICATION_DESC containing EC_T_SLAVE_NOTSUPPORTED_DESC.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct **EC_T_SLAVE_NOTSUPPORTED_DESC**

Public Members

EC_T_SLAVE_PROP SlaveProp
Slave properties

6.16.17 emNotify - EC_NOTIFY_FRAMELOSS_AFTER_SLAVE

Is currently generated and automatically handled during *emRescueScan()* if opening port destroys communication (frameloss). This notification should only print a log message or be ignored.

emNotify - EC_NOTIFY_FRAMELOSS_AFTER_SLAVE**Parameter**

- pbyInBuf: [in] Pointer to EC_T_ERROR_NOTIFICATION_DESC containing EC_T_FRAMELOSS_AFTER_SLAVE_NTFY_DESC.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

```
struct EC_T_FRAMELOSS_AFTER_SLAVE_NTFY_DESC
```

Public Members

EC_T_SLAVE_PROP SlaveProp
slave properties

EC_T_WORD wPort
port

6.16.18 emNotify - Bus Scan notifications for Feature Packs

The notifications EC_NOTIFY_RED_LINEBRK, EC_NOTIFY_RED_LINEFIXED belong to the Feature Pack Redundancy. The notifications EC_NOTIFY_HC_DETECTADDGROUPS, EC_NOTIFY_HC_PROBEALLGROUPS belong to the Feature Pack Hot Connect.

6.16.19 emIoControl - EC_IOCTL_SB_NOTIFY_UNEXPECTED_BUS_SLAVES

Specifies if unexpected bus slaves must be notified as bus mismatch.

emIoControl - EC_IOCTL_SB_NOTIFY_UNEXPECTED_BUS_SLAVES**Parameter**

- pbyInBuf: [in] Pointer to EC_T_BOOL variable. If set to EC_TRUE unexpected bus slaves on the network will be notified by EC_NOTIFY_SB_MISMATCH.
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL

- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

`EC_E_NOERROR` or error code

6.16.20 emIsTopologyChangeDetected

```
static EC_T_DWORD ecatIsTopologyChangeDetected (
    EC_T_BOOL *pbTopologyChangeDetected
)
EC_T_DWORD emIsTopologyChangeDetected (
    EC_T_DWORD dwInstanceID,
    EC_T_BOOL *pbTopologyChangeDetected
)
```

Returns whether topology change detected.

Parameters

- **dwInstanceID** – [in] Instance ID (Multiple EtherCAT Network Support)
- **pbTopologyChangeDetected** – [out] Pointer to EC_T_BOOL value: EC_TRUE if Topology Change Detected, EC_FALSE if not.

Returns

- *EC_E_NOERROR* if successful
- *EC_E_INVALIDSTATE* if master isn't initialized
- *EC_E_INVALIDPARAM* if dwInstanceID is out of range
- *EC_E_MASTER_RED_STATE_INACTIVE* if Master Redundancy is configured and master is inactive

6.16.21 emNotify - EC_NOTIFY_HC_TOPOCHGDONE

This notification is raised when topology change has completely processed.

emNotify - EC_NOTIFY_HC_TOPOCHGDONE

Parameter

- pbyInBuf: [in] Pointer to EC_T_DWORD (EC_E_NOERROR on success, Error code otherwise)
- dwInBufSize: [in] sizeof(EC_T_DWORD).
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

The notification is raised when the slaves have been detected and DC initialized.

6.16.22 emIoControl - EC_IOCTL_SB_SET_NO_DC_SLAVES_AFTER_JUNCTION

Declares that no DC slaves are located after junction

emIoControl - EC_IOCTL_SB_SET_NO_DC_SLAVES_AFTER_JUNCTION

Parameter

- pbyInBuf: [in] Pointer to EC_T_BOOL variable. If set to EC_TRUE the hidden slave detection and the junction redundancy specific propagation delay measurement are not executed
- dwInBufSize: [in] Size of the input buffer provided at pbyInBuf in bytes.
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

Return

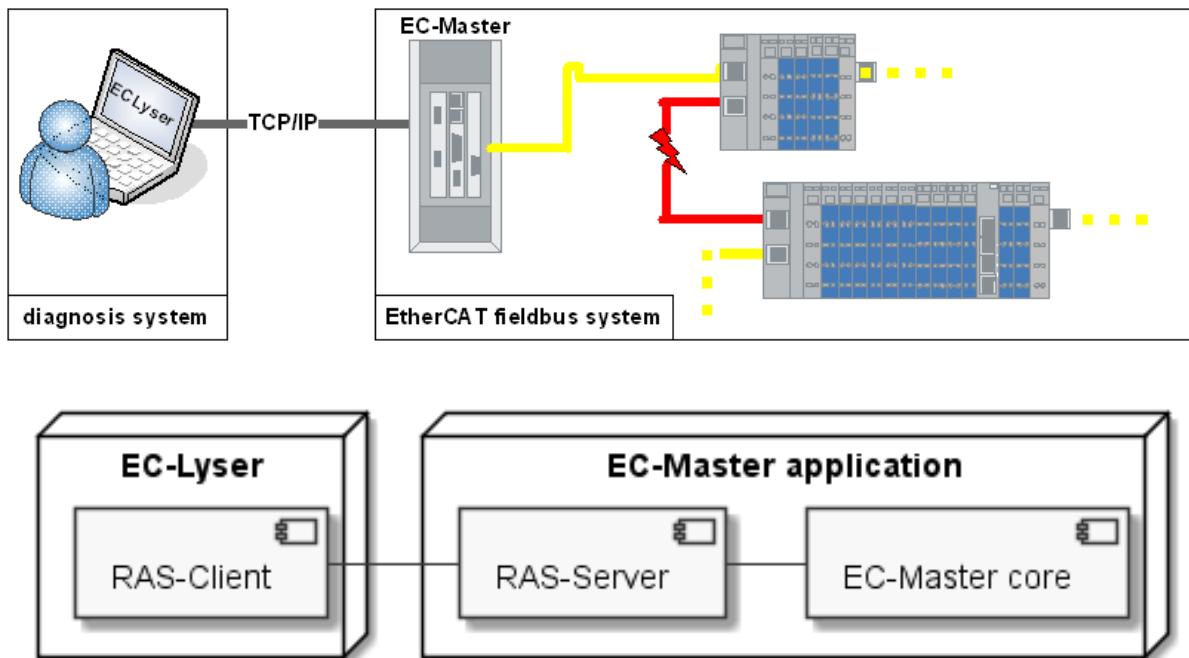
EC_E_NOERROR or error code

Calling this IOCTL if DC slaves are located in or after a junction redundancy segment will generate an undefined behavior.

7 RAS-Server for EC-Lyser and EC-Engineer

7.1 Integration Requirements

To use the diagnosis tool EC-Lyser with a customer application, some modifications have to be done during integration of the EC-Master. The task is to integrate and start the Remote API Server system within the custom application, which provides a socket based uplink, which later on is connected by the EC-Lyser.



An example on how to integrate the Remote API Server within the application is given with the example application EcMasterDemo, which in case is pre-configured to listen for EC-Lyser on TCP Port 6000 when command line parameter `EcMasterDemo -sp` is given.

To clarify the steps, which are needed within a custom application, a developer may use the following pseudo-code segment as a point of start. The Remote API Server library `EcMasterRasServer.lib` (or respectively `EcMasterRasServer.a`) must be linked.

7.2 Application programming interface, reference

7.2.1 emRasSrvStart

```
EC_T_DWORD EC_NAMESPACE::emRasSrvStart (
    ECMASTER_RAS_T_SRVPARMS *pParms,
    EC_T_PVOID *ppHandle
)
```

Initializes and starts remote API Server Instance.

Parameters

- **pParms** – [in] Server start-up parameters
- **ppHandle** – [out] Handle to opened instance, used for ctrl access

Returns

EC_E_NOERROR or error code

struct **ECMASTERRAS_T_SRVPARMS****Public Members****EC_T_DWORD dwSignature**

[in] Set to ECMASTERRASSERVER_SIGNATURE

EC_T_DWORD dwSize

[in] Set to sizeof(ECMASTERRAS_T_SRVPARMS)

***EC_T_LOG_PARMs* LogParms**

[in] Logging parameters

***EC_T_IPADDR* oAddr**

[in] Remote Access Server (RAS) listen IP address

EC_T_WORD wPort

[in] Remote Access Server (RAS) listen port

EC_T_WORD wMaxClientCnt

[in] Max. clients in parallel (0: unlimited)

EC_T_DWORD dwCycleTime

[in] Cycle Time of RAS Network access (acceptor, worker)

EC_T_DWORD dwCommunicationTimeout

[in] timeout before automatically closing connection

EC_T_CPUSET oAcceptorThreadCpuAffinityMask

[in] Acceptor Thread CPU affinity mask

EC_T_DWORD dwAcceptorThreadPrio

[in] Acceptor Thread Priority

EC_T_DWORD dwAcceptorThreadStackSize

[in] Acceptor Thread Stack Size

EC_T_CPUSET oClientWorkerThreadCpuAffinityMask

[in] Client Worker Thread CPU affinity mask

EC_T_DWORD dwClientWorkerThreadPrio

[in] Client Worker Thread Priority

EC_T_DWORD dwClientWorkerThreadStackSize

[in] Client Worker Thread Stack Size

EC_T_DWORD dwMaxQueuedNotificationCnt

[in] Amount of concurrently queue able Notifications

EC_T_DWORD dwMaxParallelMbxTferCnt

[in] Amount of concurrent active mailbox transfers

EC_PF_NOTIFY pfnRasNotify

[in] Function pointer called to notify error and status information generated by Remote API Layer

EC_T_VOID *pvRasNotifyCtxt

[in] Notification context returned while calling pfNotification

EC_T_DWORD dwCycErrInterval

[in] Interval which allows cyclic Notifications

union **EC_T_IPADDR**

Public Members**EC_T_INNER_IPADDR sAddr**

IPv4 address (endianness independent)

EC_T_DWORD dwAddr

Reserved, use EC_T_IPADDR::sAddr.by instead. OS-Layer socket API calls (SOCK-ADDR_IN::sin_addr)

struct **EC_T_INNER_IPADDR**

Public Members**EC_T_BYTE by[4]**

IPv4 address (endianness independent)

7.2.2 emRasSrvStop

```
EC_T_DWORD EC_NAMESPACE::emRasSrvStop(
    EC_T_PVOID pvHandle,
    EC_T_DWORD dwTimeout
)
```

Stop and de-initialize remote API Server Instance.

Parameters

- **pvHandle** – [in] Handle to previously started Server
- **dwTimeout** – [in] Timeout [ms] used to shut down all spawned threads, it's multiplied internally by the amount of threads spawned.

Returns

EC_E_NOERROR or error code

7.2.3 emRasNotify - xxx

Callback function called by Remote API Server in case of state changes or error situations.

```
typedef EC_T_DWORD (*EC_PF_NOTIFY)(EC_T_DWORD dwCode, EC_T_NOTIFYPARMS *pParms)
```

7.2.4 emRasNotify - ECMASTERRAS_NOTIFY_CONNECTION

Notification about a change in the Remote API's state.

emRasNotify - ECMASTERRAS_T_CONNOTIFYDESC

Parameter

- pbyInBuf: [in] Pointer to data of type ECMASTERRAS_T_CONNOTIFYDESC
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

```
struct ECMASTERRAS_T_CONNOTIFYDESC
```

Public Members

EC_T_DWORD dwCause

[in] Cause of state connection state change

EC_T_DWORD dwCookie

[in] Unique identification cookie of connection instance.

7.2.5 emRasNotify - ECMASTERRAS_NOTIFY_REGISTER

Notification about a connected application registered a client to the master stack.

emRasNotify - ECMASTERRAS_NOTIFY_REGISTER

Parameter

- pbyInBuf: [in] Pointer to data of type ECMASTERRAS_T_REGNOTIFYDESC
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

```
struct ECMASTERRAS_T_REGNOTIFYDESC
```

Public Members**EC_T_DWORD dwCookie**

[in] Unique identification cookie of connection instance

EC_T_DWORD dwResult

[in] Result of registration request

EC_T_DWORD dwInstanceId

[in] Master Instance client registered to

EC_T_DWORD dwClientId

[in] Client ID of registered client

7.2.6 emRasNotify - ECMASTERRAS_NOTIFY_UNREGISTER

Notification about a connected application un-registered a client from the master stack.

emRasNotify - ECMASTERRAS_NOTIFY_UNREGISTER**Parameter**

- pbyInBuf: [in] Pointer to data of type ECMASTERRAS_T_REGNOTIFYDESC
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

See also:

[ECMASTERRAS_T_REGNOTIFYDESC](#)

7.2.7 emRasNotify - ECMASTERRAS_NOTIFY_MARSHALERROR

Notification about an error during marshalling in Remote API Server connection layer.

emRasNotify - ECMASTERRAS_NOTIFY_MARSHALERRORDESC**Parameter**

- pbyInBuf: [in] Pointer to data of type ECMASTERRAS_T_MARSHALERRORDESC
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

struct **ECMASTERRAS_T_MARSHALERRORDESC**

Public Members**EC_T_DWORD dwCookie**

[in] Unique identification cookie of connection instance

EC_T_DWORD dwCause

[in] Cause of the command marshalling error

EC_T_DWORD dwLenStatCmd

[in] Length faulty command

EC_T_DWORD dwCommandCode

[in] Command code of faulty command

7.2.8 emRasNotify - ECMASTERRAS_NOTIFY_ACKERROR

Notification about an error during creation of ack / nack packet.

emRasNotify - ECMASTERRAS_NOTIFY_ACKERROR**Parameter**

- pbyInBuf: [in] Pointer to EC_T_DWORD containing error code
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

7.2.9 emRasNotify - ECMASTERRAS_NOTIFY_NONOTIFYMEMORY

Notification given, when no empty buffers for notifications are available in pre-allocated notification store. This points to a configuration error.

emRasNotify - ECMASTERRAS_NOTIFY_NONOTIFYMEMORY**Parameter**

- pbyInBuf: [in] Pointer to EC_T_DWORD containing unique identification cookie of connection instance
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

7.2.10 emRasNotify - ECMASTERRAS_NOTIFY_STDNOTIFYMEMORYSMALL

Notification given, when buffersize for standard notifications available in pre-allocated notification store are too small to carry a specific notification. This points to a configuration error.

emRasNotify - ECMASTERRAS_NOTIFY_STDNOTIFYMEMORYSMALL

Parameter

- pbyInBuf: [in] Pointer to EC_T_DWORD containing unique identification cookie of connection instance
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

7.2.11 emRasNotify - ECMASTERRAS_NOTIFY_MBXNOTIFYMEMORYSMALL

Notification given, when buffersize for Mailbox notifications available in pre-allocated notification store are too small to carry a specific notification. This points to a configuration error. This is a serious error. If this error is given, Mailbox Transfer objects may have been become out of sync and therefore no more valid usable. Mailbox notifications should be dimensioned correctly see emRasSrvStart ()

emRasNotify - ECMASTERRAS_NOTIFY_MBXNOTIFYMEMORYSMALL

Parameter

- pbyInBuf: [in] Pointer to EC_T_DWORD containing unique identification cookie of connection instance
- dwInBufSize: [in] Size of the input buffer in bytes
- pbyOutBuf: [out] Should be set to EC_NULL
- dwOutBufSize: [in] Should be set to 0
- pdwNumOutData: [out] Should be set to EC_NULL

8 Error Codes

8.1 Groups

No.	Group	Abbr.	Description
1	Application Error	APP	Error within application, running the master E.g. API function call with invalid parameters
2	EtherCAT network information file problem	ENI	Master configuration XML file mismatches slave configuration on bus E.g. Bus Topology Scan cannot detect all slaves configured within network information file
3	Master parameter configuration	CFG	Master configuration parameters erroneous E.g. mailbox command queue not large enough
4	Bus/Slave Error	SLV	Slave error E.g. Working Counter Error
5	Link Layer	LLA	Link Layer error (network interface driver) E.g. Intel Pro/1000 NIC could not be found
6	Remote API	RAS	Remote API error E.g. connection to Remote API server is not possible from client
7	Internal software error	ISW	Master internal error E.g. Master state machine in undefined state
8	DC Master Sync	DCM	DC slave and host time synchronization
9	Pass-Through-Server	PTS	Initialisation/De-Initialisation errors
10	System Setup	SYS	Errors from Operating System or obviously due to System Setup

8.2 Generic Error Codes

EC_E_NOERROR

0x00000000: No Error

EC_E_ERROR

0x98110000: Unspecific Error

EMRAS_E_ERROR

0x98110180: Unspecific RAS Error

EC_E_NOTSUPPORTED

0x98110001: APP: Feature not supported (e.g. function or property not available)

EC_E_INVALIDINDEX

0x98110002: APP: Invalid index (e.g. CoE: invalid SDO index)

EC_E_INVALIDOFFSET

0x98110003: ISW: Invalid offset (e.g. invalid offset while accessing Process Data Image)

EC_E_CANCEL

0x98110004: APP: Cancel (e.g. master should abort current mailbox transfer)

EC_E_INVALIDSIZE

0x98110005: APP: Invalid size

EC_E_INVALIDDATA

0x98110006: ISW: Invalid data (multiple error sources)

EC_E_NOTREADY

0x98110007: ISW: Not ready (multiple error sources)

EC_E_BUSY

0x98110008: APP: Busy (e.g. stack is busy currently and not available to process the API request. The function may be called again later)

EC_E_ACYC_FRM_FREEQ_EMPTY

0x98110009: ISW: Cannot queue acyclic EtherCAT command (Acyclic command queue is full. Possible solution: Increase of configuration value dwMaxQueuedEthFrames)

EC_E_NOMEMORY

0x9811000A: CFG: No memory left (e.g. memory full / fragmented))

EC_E_INVALIDPARAM

0x9811000B: APP: Invalid parameter (e.g. API function called with erroneous parameter set)

EC_E_NOTFOUND

0x9811000C: APP: Not found (e.g. Network Information File ENI not found or API called with invalid slave ID)

EC_E_DUPLICATE

0x9811000D: ISW: Duplicated fixed address detected (handled internally)

EC_E_INVALIDSTATE

0x9811000E: ISW: Invalid state (master not initialized or not configured)

EC_E_TIMER_LIST_FULL

0x9811000F: ISW: Cannot add slave to timer list (slave timer list full)

EC_E_TIMEOUT

0x98110010: Timeout

EC_E_OPENFAILED

0x98110011: ISW: Open failed

EC_E_SENDFAILED

0x98110012: LLA: Frame send failed

EC_E_INSERTMAILBOX

0x98110013: CFG: Insert Mailbox error (internal limit MAX_QUEUED_COE_CMDS: 20)

EC_E_INVALIDCMD

0x98110014: ISW: Invalid Command (Unknown mailbox command code)

EC_E_UNKNOWN_MBX_PROTOCOL

0x98110015: ISW: Unknown Mailbox Protocol Command (Unknown Mailbox protocol or mailbox command with unknown protocol association)

EC_E_ACCESSDENIED

0x98110016: ISW: Access Denied (e.g. master internal software error)

EC_E_IDENTIFICATIONFAILED

0x98110017: ENI: Identification failed (e.g. identification command failed)

EC_E_LOCK_CREATE_FAILED

0x98110018: SYS: Create lock failed (e.g. OsCreateLockTyped failed)

EC_E_PRODKEY_INVALID

0x9811001A: CFG: Product Key Invalid (e.g. application using protected version of the stack, which stops operation after the evaluation time limit reached if a license is not provided)

EC_E_WRONG_FORMAT

0x9811001B: ENI: Wrong configuration format (e.g. Network information file empty or malformed)

EC_E_FEATURE_DISABLED

0x9811001C: APP: Feature disabled (e.g. Application tried to perform a missing or disabled API function)

EC_E_SHADOW_MEMORY

0x9811001D: Shadow memory requested in wrong mode

EC_E_BUSCONFIG_MISMATCH

0x9811001E: ENI: Bus configuration mismatch (e.g. Network information file and currently connected bus topology does not match)

EC_E_CONFIGDATAREAD

0x9811001F: ENI: Error reading configuration file (e.g. Network information file could not be read)

EC_E_ENI_NO_SAFEOP_OP_SUPPORT

0x98110020: Configuration doesn't support SAFEOP and OP requested state

EC_E_XML_CYCCMDS_MISSING

0x98110021: ENI: Cyclic commands are missing (e.g. Network information file does not contain cyclic commands)

EC_E_XML_ALSTATUS_READ_MISSING

0x98110022: ENI: AL_STATUS register read missing in XML file for at least one state (e.g. Read of AL Status register is missing in cyclic part of given network information file)

EC_E_MCSM_FATAL_ERROR

0x98110023: ISW: Fatal internal McSm (master control state machine is in an undefined state)

EC_E_SLAVE_ERROR

0x98110024: SLV: Slave error (e.g. A slave error was detected. See also EC_NOTIFY_STATUS_SLAVE_ERROR and EC_NOTIFY_SLAVE_ERROR_STATUS_INFO)

EC_E_FRAME_LOST

0x98110025: SLV: Frame lost, IDX mismatch (EtherCAT frame(s) lost on bus, means the response was not received. In case this error shows frequently a problem with the wiring could be the cause)

EC_E_CMD_MISSING

0x98110026: SLV: At least one EtherCAT command is missing in the received frame (e.g. received EtherCAT frame incomplete)

EC_E_CYCCMD_WKC_ERROR

0x98110027: Cyclic command WKC error

EC_E_INVALID_DCL_MODE

0x98110028: APP: IOCTL EC_IOCTL_DC_LATCH_REQ_LTIMVALS invalid in DCL auto read mode (this function cannot be used if DC Latching is running in mode “Auto Read”)

EC_E_AI_ADDRESS

0x98110029: SLV: Auto increment address increment mismatch (e.g. Network information file and bus topology doesn't match any more. Error shows only, if a already recognized slave isn't present any more)

EC_E_INVALID_SLAVE_STATE

0x9811002A: APP: Slave in invalid state, e.g. not in OP (API not callable in this state) (mailbox commands are not allowed in current slave state)

EC_E_SLAVE_NOT_ADDRESSABLE

0x9811002B: SLV: Station address lost (or slave missing) - FPRD to AL_STATUS failed (e.g. Slave had a power cycle)

EC_E_CYC_CMDS_OVERFLOW

0x9811002C: ENI: Too many cyclic commands in XML configuration file (e.g. [EC_T_INIT_MASTER_PARMS.dwMaxAcycFramesQueued](#) too small)

EC_E_LINK_DISCONNECTED

0x9811002D: SLV: Ethernet link cable disconnected (e.g. EtherCAT bus segment not connected to network interface)

EC_E_MASTERCORE_INACCESSIBLE

0x9811002E: RAS: Master core not accessible (e.g. Connection to remote server was terminated or master instance has been stopped on remote side)

EC_E_COE_MBXSND_WKC_ERROR

0x9811002F: SLV: CoE mailbox send: working counter (e.g. CoE mailbox couldn't be read on slave, slave didn't read out mailbox since last write)

EC_E_COE_MBXRCV_WKC_ERROR

0x98110030: SLV: CoE mailbox receive: working counter (e.g. CoE mailbox couldn't be read from slave)

EC_E_NO_MBX_SUPPORT

0x98110031: APP: No mailbox support (e.g. Slave does not support mailbox access)

EC_E_NO_COE_SUPPORT

0x98110032: ENI: CoE protocol not supported (e.g. Configuration error or slave information file doesn't match slave firmware)

EC_E_NO_EOE_SUPPORT

0x98110033: ENI: EoE protocol not supported (e.g. Configuration error or slave information file doesn't match slave firmware)

EC_E_NO_FOE_SUPPORT

0x98110034: ENI: FoE protocol not supported (e.g. Configuration error or slave information file doesn't match slave firmware)

EC_E_NO_SOE_SUPPORT

0x98110035: ENI: SoE protocol not supported (e.g. Configuration error or slave information file doesn't match slave firmware)

EC_E_NO_VOE_SUPPORT

0x98110036: ENI: VoE protocol not supported (e.g. Configuration error or slave information file doesn't match slave firmware)

EC_E_EVAL_VIOLATION

0x98110037: ENI: Configuration violates Evaluation limits (obsolete)

EC_E_EVAL_EXPIRED

0x98110038: CFG: Evaluation Time limit reached (e.g. License not provided and evaluation period (1 hour) of protected version exceeded)

EC_E_LICENSE_MISSING

0x98110039: License key invalid or missing

EC_E_CFGFILENOTFOUND

0x98110070: CFG: Master configuration not found (e.g. path to master configuration file (XML) was wrong or the file is not available)

EC_E_EEPROMREADERROR

0x98110071: SLV: Command error while EEPROM upload (read slave EEPROM)

EC_E_EEPROMWRITEERROR

0x98110072: SLV: Command error while EEPROM download (write slave EEPROM)

EC_E_XML_CYCCMDS_SIZEISMATCH

0x98110073: ENI: Cyclic command wrong size (too long) (size in master configuration file (XML) does not match size of process data)

EC_E_XML_INVALID_INP_OFF

0x98110074: ENI: Invalid input offset in cyclic command, please check InputOffs

EC_E_XML_INVALID_OUT_OFF

0x98110075: ENI: Invalid output offset in cyclic command, please check OutputOffs

EC_E_PORTCLOSE

0x98110076: Port close failed

EC_E_PORTOPEN

0x98110077: Port open failed

EC_E_SLAVE_NOT_PRESENT

0x9811010E: APP / SLV: command not executed (slave not present on bus) (e.g. slave disappeared or was never present)

EC_E_EEPROMRELOADERROR

0x98110110: Command error while EEPROM reload

EC_E_SLAVECTRLRESETERROR

0x98110111: Command error while Reset Slave Controller

EC_E_SYSDRIVERMISSING

0x98110112: SYS: Cannot open system driver (e.g. system driver was not loaded)

EC_E_BUSCONFIG_TOPOCHANGE

0x9811011E: Bus configuration not detected, Topology changed (e.g. Topology changed while scanning bus)

EC_E_EOE_MBX_WKC_ERROR

0x9811011F: EoE: Mailbox receive: working counter

EC_E_FOE_MBX_WKC_ERROR

0x98110120: FoE: Mailbox receive: working counter

EC_E_SOE_MBX_WKC_ERROR

0x98110121: SoE: mailbox receive: working counter

EC_E_AOE_MBX_WKC_ERROR

0x98110122: AoE: Mailbox receive: working counter

EC_E_VOE_MBX_WKC_ERROR

0x98110123: SLV: VoE mailbox send: working counter (VoE mailbox couldn't be written)

EC_E_EEPROMASSIGNERROR

0x98110124: SLV: EEPROM assignment failed

EC_E_MBX_ERROR_TYPE

0x98110125: SLV: Unknown mailbox error code received in mailbox

EC_E_REDLINEBREAK

0x98110126: SLV: Redundancy line break (e.g. cable break between slaves or between master and first slave)

EC_E_XML_INVALID_CMD_WITH_RED

0x98110127: ENI: Invalid EtherCAT command in cyclic frame with redundancy (e.g. BRW commands are not allowed with redundancy)

EC_E_XML_PREV_PORT_MISSING

0x98110128: ENI: <PreviousPort>-tag is missing (e.g. if the auto increment address is not the first slave on the bus we check if a previous port tag OR a hot connect tag is available)

EC_E_XML_DC_CYCCMDS_MISSING

0x98110129: DC enabled and DC cyclic commands missing (e.g. access to 0x0900)

EC_E_DLSTATUS_IRO_TOPOCHANGED

0x98110130: SLV: Data link (DL) status interrupt because of changed topology (automatically handled by master)

EC_E_PTS_IS_NOT_RUNNING

0x98110131: PTS: Pass Through Server is not running (Pass-Through-Server was tried to be enabled/disabled or stopped without being started)

EC_E_PTS_IS_RUNNING

0x98110132: PTS: Pass Through Server is running (obsolete, replaced by EC_E_ADS_IS_RUNNING)

EC_E_ADS_IS_RUNNING

0x98110132: PTS: ADS adapter (Pass Through Server) is running (API call conflicts with ADS state (running))

EC_E_PTS_THREAD_CREATE_FAILED

0x98110133: PTS: Could not start the Pass Through Server

EC_E_PTS_SOCK_BIND_FAILED

0x98110134: PTS: The Pass Through Server could not bind the IP address with a socket (e.g. Possibly because the IPaddress (and Port) is already in use or the IP-address does not exist)

EC_E PTS NOT ENABLED

0x98110135: PTS: The Pass Through Server is running but not enabled

EC_E PTS_LL_MODE_NOT_SUPPORTED

0x98110136: PTS: The Link Layer mode is not supported by the Pass Through Server (e.g. The Master is running in interrupt mode but the Pass-Through-Server only supports polling mode)

EC_E VOE_NO_MBX RECEIVED

0x98110137: SLV: No VoE mailbox received yet from specific slave

EC_E DC_REF_CLOCK_SYNC_OUT_UNIT_DISABLED

0x98110138: DC (time loop control) unit of reference clock disabled

EC_E DC_REF_CLOCK_NOT_FOUND

0x98110139: SLV: Reference clock not found! May happen if reference clock is removed from network.

EC_E MBX_CMD_WKC_ERROR

0x9811013B: SLV: Mailbox command working counter error (e.g. Mailbox init command Retry Count exceeded)

EC_E NO_AOE_SUPPORT

0x9811013C: APP / SLV: AoE: Protocol not supported (e.g. Application calls AoE-API although not implemented at slave)

EC_E AOE_INV_RESPONSE_SIZE

0x9811013D: AoE: Invalid AoE response received

EC_E AOE_ERROR

0x9811013E: AoE: Common AoE device error

EC_E AOE_SRVNOTSUPP

0x9811013F: AoE: Service not supported by server

EC_E AOE_INVALIDGRP

0x98110140: AoE: Invalid index group

EC_E AOE_INVALIDOFFSET

0x98110141: AoE: Invalid index offset

EC_E AOE_INVALIDACCESS

0x98110142: AoE: Reading/writing not permitted

EC_E AOE_INVALIDSIZE

0x98110143: AoE: Parameter size not correct

EC_E AOE_INVALIDDATA

0x98110144: AoE: Invalid parameter value(s)

EC_E AOE_NOTREADY

0x98110145: AoE: Device not in a ready state

EC_E AOE_BUSY

0x98110146: AoE: Device busy

EC_E_AOE_INVALIDCONTEXT

0x98110147: AoE: Invalid context

EC_E_AOE_NOMEMORY

0x98110148: AoE: Out of memory

EC_E_AOE_INVALIDPARM

0x98110149: AoE: Invalid parameter value(s)

EC_E_AOE_NOTFOUND

0x9811014A: AoE: Not found

EC_E_AOE_SYNTAX

0x9811014B: AoE: Syntax error in command or file

EC_E_AOE_INCOMPATIBLE

0x9811014C: AoE: Objects do not match

EC_E_AOE_EXISTS

0x9811014D: AoE: Object already exists

EC_E_AOE_SYMBOLNOTFOUND

0x9811014E: AoE: Symbol not found

EC_E_AOE_SYMBOLVERSIONINVALID

0x9811014F: AoE: Symbol version invalid

EC_E_AOE_INVALIDSTATE

0x98110150: AoE: Server in invalid state

EC_E_AOE_TRANSMODENOTSUPP

0x98110151: AoE: AdsTransMode not supported

EC_E_AOE_NOTIFYHNDINVALID

0x98110152: AoE: Notification handle invalid

EC_E_AOE_CLIENTUNKNOWN

0x98110153: AoE: Notification client not registered

EC_E_AOE_NOMOREHDLS

0x98110154: AoE: No more notification handles

EC_E_AOE_INVALIDWATCHSIZE

0x98110155: AoE: Size for watch too big

EC_E_AOE_NOTINIT

0x98110156: AoE: Device not initialized

EC_E_AOE_TIMEOUT

0x98110157: AoE: Device has a timeout

EC_E_AOE_NOINTERFACE

0x98110158: AoE: Query interface failed

EC_E_AOE_INVALIDINTERFACE

0x98110159: AoE: Wrong interface required

EC_E_AOE_INVALIDCLSID

0x9811015A: AoE: Class ID invalid

EC_E_AOE_INVALIDOBJID

0x9811015B: AoE: Object ID invalid

EC_E_AOE_PENDING

0x9811015C: AoE: Request pending

EC_E_AOE_ABORTED

0x9811015D: AoE: Request aborted

EC_E_AOE_WARNING

0x9811015E: AoE: Signal warning

EC_E_AOE_INVALIDARRAYIDX

0x9811015F: AoE: Invalid array index

EC_E_AOE_SYMBOLNOTACTIVE

0x98110160: AoE: Symbol not active -> release handle and try again

EC_E_AOE_ACCESSDENIED

0x98110161: AoE: Access denied

EC_E_AOE_INTERNAL

0x98110162: AoE: Internal error

EC_E_AOE_TARGET_PORT_NOT_FOUND

0x98110163: AoE: Target port not found

EC_E_AOE_TARGET_MACHINE_NOT_FOUND

0x98110164: AoE: Target machine not found

EC_E_AOE_UNKNOWN_CMD_ID

0x98110165: AoE: Unknown command ID

EC_E_AOE_PORT_NOT_CONNECTED

0x98110166: AoE: Port not connected

EC_E_AOE_INVALID_AMS_LENGTH

0x98110167: AoE: Invalid AMS length

EC_E_AOE_INVALID_AMS_ID

0x98110168: AoE: invalid AMS Net ID

EC_E_AOE_PORT_DISABLED

0x98110169: AoE: Port disabled

EC_E_AOE_PORT_CONNECTED

0x9811016A: AoE: Port already connected

EC_E_AOE_INVALID_AMS_PORT

0x9811016B: AoE: Invalid AMS port

EC_E_AOE_NO_MEMORY

0x9811016C: AoE: No memory

EC_E_AOE_VENDOR_SPECIFIC

0x9811016D: AoE: Vendor specific AoE device error

EC_E_XML_AOE_NETID_INVALID

0x9811016E: ENI: AoE: Invalid NetID (e.g. Error from Configuration Tool)

EC_E_MAX_BUS_SLAVES_EXCEEDED

0x9811016F: CFG: Error: Maximum number of bus slave has been exceeded (The maximum number of preallocated bus slave objects are to small. The maximum number can be adjusted by the master initialization parameter EC_T_INITMASTERPARMS.dwMaxBusSlaves)

EC_E_MBXERR_SYNTAX

0x98110170: SLV: Mailbox error: Syntax of 6 octet Mailbox header is wrong (Slave error mailbox return value: 0x01)

EC_E_MBXERR_UNSUPPORTEDPROTOCOL

0x98110171: SLV: Mailbox error: The Mailbox protocol is not supported (Slave error mailbox return value: 0x02)

EC_E_MBXERR_INVALIDCHANNEL

0x98110172: SLV: Mailbox error: Field contains wrong value (Slave error mailbox return value: 0x03)

EC_E_MBXERR_SERVICENOTSUPPORTED

0x98110173: SLV: Mailbox error: The mailbox protocol header of the mailbox protocol is wrong (Slave error mailbox return value: 0x04)

EC_E_MBXERR_INVALIDHEADER

0x98110174: SLV: Mailbox error: The mailbox protocol header of the mailbox protocol is wrong (Slave error mailbox return value: 0x05)

EC_E_MBXERR_SIZETOOSHORT

0x98110175: SLV: Mailbox error: Length of received mailbox data is too short (Slave error mailbox return value: 0x06)

EC_E_MBXERR_NOMOREMEMORY

0x98110176: SLV: Mailbox error: Mailbox protocol can not be processed because of limited resources (Slave error mailbox return value: 0x07)

EC_E_MBXERR_INVALIDSIZE

0x98110177: SLV: Mailbox error: The length of data is inconsistent (Slave error mailbox return value: 0x08)

EC_E_DC_SLAVES_BEFORE_REF_CLOCK

0x98110178: ENI: Slaves with DC configured present on bus before reference clock (e.g. The first DC Slave was not configured as potential reference clock)

EC_E_DATA_TYPE_CONVERSION_FAILED

0x98110179: Data type conversion failed

EC_E_LINE_CROSSED

0x9811017B: Line crossed (cabling wrong)

EC_E_LINE_CROSSED_SLAVE_INFO

0x9811017C: Line crossed at slave (obsolete)

EC_E_ADO_NOT_SUPPORTED

0x9811017E: SLV: ADO for slave identification not supported (e.g. Request ID mechanism (ADO 0x134) not supported by slave)

EC_E_FRAMELOSS_AFTER_SLAVE

0x9811017F: Frameloss after Slave (opening port destroys communication)

EC_E_OEM_SIGNATURE_MISMATCH

0x98130008: ENI, OEM: Manufacturer signature mismatch

EC_E_ENI_ENCRYPTION_WRONG_VERSION

0x98130009: ENI, OEM: ENI encryption algorithm version not supported

EC_E_ENI_ENCRYPTED

0x9813000A: OEM: Loading encrypted ENI needs OEM key

EC_E_OEM_KEY_MISMATCH

0x9813000B: RAS, APP: OEM key mismatch

EC_E_OEM_KEY_MISSING

0x9813000C: APP: OEM key access needs OEM key set (e.g. Application must call esSetOemKey (HiL) or set EC_T_LINK_PARMS_SIMULATOR::qwOemKey (SiL))

EC_E_S2SMBX_NOT_CONFIGURED

0x98130020: S2S: Not Configured

EC_E_S2SMBX_NO_MEMORY

0x98130021: S2S: No Memory

EC_E_S2SMBX_NO_DESCRIPTOR

0x98130022: S2S: No Descriptor

EC_E_S2SMBX_DEST_SLAVE_NOT_FOUND

0x98130023: S2S: Destination Slave not found

EC_E_MASTER_RED_STATE_INACTIVE

0x98130024: APP: Master Redundancy State is INACTIVE (e.g. API not allowed in current Master Redundancy State)

EC_E_MASTER_RED_STATE_ACTIVE

0x98130025: APP: Master Redundancy State is ACTIVE (e.g. API not allowed in current Master Redundancy State)

EC_E_JUNCTION_RED_LINE_BREAK

0x98130026: Junction redundancy line break

EC_E_VALIDATION_ERROR

0x98130027: Validation error (validation data mismatch)

EC_E_TIMEOUT_WAITING_FOR_DC

0x98130028: Timeout waiting for DC

EC_E_TIMEOUT_WAITING_FOR_DCM

0x98130029: Timeout waiting for DCM

EC_E_SIGNATURE_MISMATCH

0x98130030: Signature mismatch

EC_E_PDIWATCHDOG

0x98130031: PDI watchdog expired

EC_E_BAD_CONNECTION

0x98130032: Bad connection

EC_E_XML_INCONSISTENT

0x98130033: ENI: Inconsistent content

8.3 DCM Error Codes

DCM_E_ERROR

0x981201C0: Unspecific DCM Error

DCM_E_NOTINITIALIZED

0x981201C1: Not initialized

DCM_E_MAX_CTL_ERROR_EXCEED

0x981201C2: DCM controller - synchronization out of limit

DCM_E_NOMEMORY

0x981201C3: Not enough memory

DCM_E_INVALID_HWLAYER

0x981201C4: Hardware layer - (BSP) invalid

DCM_E_TIMER MODIFY ERROR

0x981201C5: Hardware layer - error modifying timer

DCM_E_TIMER NOT RUNNING

0x981201C6: Hardware layer - timer not running

DCM_E_WRONG_CPU

0x981201C7: Hardware layer - function called on wrong CPU

DCM_E_INVALID_SYNC_PERIOD

0x981201C8: Invalid DC sync period length (invalid clock master?)

DCM_E_INVALID_SETVAL

0x981201C9: DCM controller SetVal to small

DCM_E_DRIFT_TO_HIGH

0x981201CA: DCM controller - Drift between local timer and ref clock to high

DCM_E_BUS_CYCLE_WRONG

0x981201CB: DCM controller - Bus cycle time (dwBusCycleTimeUsec) doesn't match real cycle

DCX_E_NO_EXT_CLOCK

0x981201CC: DCX controller - No external synchronization clock found

DCM_E_INVALID_DATA

0x981201CD: DCM controller - Invalid data

8.4 ADS over EtherCAT (AoE) Error Codes

EC_E_AOE_NO_RTIME

0x9813000D: AoE: No Rtime

EC_E_AOE_LOCKED_MEMORY

0x9813000E: AoE: Allocation locked memory

EC_E_AOE_MAILBOX

0x9813000F: AoE: Insert mailbox error

EC_E_AOE_WRONG_HMSG

0x98130010: AoE: Wrong receive HMSG

EC_E_AOE_BAD_TASK_ID

0x98130011: AoE: Bad task ID

EC_E_AOE_NO_IO

0x98130012: AoE: No IO

EC_E_AOE_UNKNOWN_AMS_COMMAND

0x98130013: AoE: Unknown ADS command

EC_E_AOE_WIN32

0x98130014: AoE: Win 32 error

EC_E_AOE_LOW_INSTALL_LEVEL

0x98130015: AoE: Low installation level

EC_E_AOE_NO_DEBUG

0x98130016: AoE: No debug available

EC_E_AOE_AMS_SYNC_WIN32

0x98130017: AoE: Sync Win 32 error

EC_E_AOE_AMS_SYNC_TIMEOUT

0x98130018: AoE: Sync Timeout

EC_E_AOE_AMS_SYNC_AMS

0x98130019: AoE: Sync AMS error

EC_E_AOE_AMS_SYNC_NO_INDEX_MAP

0x9813001A: AoE: Sync no index map

EC_E_AOE_TCP_SEND

0x9813001B: AoE: TCP send error

EC_E_AOE_HOST_UNREACHABLE

0x9813001C: AoE: Host unreachable

EC_E_AOE_INVALIDAMSFRAGMENT

0x9813001D: AoE: Invalid AMS fragment

EC_E_AOE_NO_LOCKED_MEMORY

0x9813001E: AoE: No allocation locked memory

EC_E_AOE_MAILBOX_FULL

0x9813001F: AoE: Mailbox full

8.5 CAN application protocol over EtherCAT (CoE) SDO Error Codes

EC_E_SDO_ABORTCODE_TOGGLE

0x98110040: SLV: SDO: Toggle bit not alternated (CoE abort code 0x05030000 of slave)

EC_E_SDO_ABORTCODE_TIMEOUT

0x98110041: SLV: SDO: Protocol timed out (CoE abort code 0x05040000 of slave)

EC_E_SDO_ABORTCODE_CCS_SCS

0x98110042: SLV: SDO: Client/server command specifier not valid or unknown (CoE abort code 0x05040001 of slave)

EC_E_SDO_ABORTCODE_BLK_SIZE

0x98110043: SLV: SDO: Invalid block size (block mode only) (CoE abort code 0x05040002 of slave)

EC_E_SDO_ABORTCODE_SEQNO

0x98110044: SLV: SDO: Invalid sequence number (block mode only) (CoE abort code 0x05040003 of slave)

EC_E_SDO_ABORTCODE_CRC

0x98110045: SLV: SDO: CRC error (block mode only) (CoE abort code 0x05040004 of slave)

EC_E_SDO_ABORTCODE_MEMORY

0x98110046: SLV: SDO: Out of memory (CoE abort code 0x05040005 of slave)

EC_E_SDO_ABORTCODE_ACCESS

0x98110047: SLV: SDO: Unsupported access to an object (CoE abort code 0x06010000 of slave)

EC_E_SDO_ABORTCODE_WRITEONLY

0x98110048: SLV: SDO: Attempt to read a write only object (CoE abort code 0x06010001 of slave)

EC_E_SDO_ABORTCODE_READONLY

0x98110049: SLV: SDO: Attempt to write a read only object (CoE abort code 0x06010002 of slave)

EC_E_SDO_ABORTCODE_INDEX

0x9811004A: SLV: SDO: Object does not exist in the object dictionary (CoE abort code 0x06020000 of slave)

EC_E_SDO_ABORTCODE_PDO_MAP

0x9811004B: SLV: SDO: Object cannot be mapped to the PDO (CoE abort code 0x06040041 of slave)

EC_E_SDO_ABORTCODE_PDO_LEN

0x9811004C: SLV: SDO: The number and length of the objects to be mapped would exceed PDO length (CoE abort code 0x06040042 of slave)

EC_E_SDO_ABORTCODE_P_INCOMP

0x9811004D: SLV: SDO: General parameter incompatibility reason (CoE abort code 0x06040043 of slave)

EC_E_SDO_ABORTCODE_I_INCOMP

0x9811004E: SLV: SDO: General internal incompatibility in the device (CoE abort code 0x06040047 of slave)

EC_E_SDO_ABORTCODE_HARDWARE

0x9811004F: SLV: SDO: Access failed due to an hardware error (CoE abort code 0x06060000 of slave)

EC_E_SDO_ABORTCODE_DATA_LENGTH_NOT_MATCH

0x98110050: SLV: SDO: Data type does not match, length of service parameter does not match (CoE abort code 0x06070010 of slave)

EC_E_SDO_ABORTCODE_DATA_LENGTH_TOO_HIGH

0x98110051: SLV: SDO: Data type does not match, length of service parameter too high (CoE abort code 0x06070012 of slave)

EC_E_SDO_ABORTCODE_DATA_LENGTH_TOO_LOW

0x98110052: SLV: SDO: Data type does not match, length of service parameter too low (CoE abort code 0x06070013 of slave)

EC_E_SDO_ABORTCODE_OFFSET

0x98110053: SLV: SDO: Sub-index does not exist (CoE abort code 0x06090011 of slave)

EC_E_SDO_ABORTCODE_VALUE_RANGE

0x98110054: SLV: SDO: Value range of parameter exceeded (only for write access) (CoE abort code 0x06090030 of slave)

EC_E_SDO_ABORTCODE_VALUE_TOO_HIGH

0x98110055: SLV: SDO: Value of parameter written too high (CoE abort code 0x06090031 of slave)

EC_E_SDO_ABORTCODE_VALUE_TOO_LOW

0x98110056: SLV: SDO: Value of parameter written too low (CoE abort code 0x06090032 of slave)

EC_E_SDO_ABORTCODE_MINMAX

0x98110057: SLV: SDO: Maximum value is less than minimum value (CoE abort code 0x06090036 of slave)

EC_E_SDO_ABORTCODE_GENERAL

0x98110058: SLV: SDO: General error (CoE abort code 0x08000000 of slave)

EC_E_SDO_ABORTCODE_TRANSFER

0x98110059: SLV: SDO: Data cannot be transferred or stored to the application (CoE abort code 0x08000020 of slave)

EC_E_SDO_ABORTCODE_TRANSFER_LOCAL_CONTROL

0x9811005A: SLV: SDO: Data cannot be transferred or stored to the application because of local control (CoE abort code 0x08000021 of slave)

EC_E_SDO_ABORTCODE_TRANSFER_DEVICE_STATE

0x9811005B: SLV: SDO: Data cannot be transferred or stored to the application because of the present device state (CoE abort code 0x08000022 of slave)

EC_E_SDO_ABORTCODE_DICTIONARY

0x9811005C: SLV: SDO: Object dictionary dynamic generation fails or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of an file error) (CoE abort code 0x08000023 of slave)

EC_E_SDO_ABORTCODE_UNKNOWN

0x9811005D: SLV: SDO: Unknown code (Unknown CoE abort code of slave)

EC_E_SDO_ABORTCODE_MODULE_ID_LIST_NOT_MATCH

0x9811005E: Detected Module Ident List (0xF030) and Configured Module Ident list (0xF050) does not match

EC_E_SDO_ABORTCODE_SI_NOT_WRITTEN

0x98130004: SLV: SDO: Sub Index cannot be written, SI0 must be 0 for write access (CoE abort code 0x06010003 of slave)

EC_E_SDO_ABORTCODE_CA_TYPE_MISM

0x98130005: SLV: SDO: Complete access not supported for objects of variable length such as ENUM object types (CoE abort code 0x06010004 of slave)

EC_E_SDO_ABORTCODE_OBJ_TOO_BIG

0x98130006: SLV: SDO: Object length exceeds mailbox size (CoE abort code 0x06010005 of slave)

EC_E_SDO_ABORTCODE_PDO_MAPPED

0x98130007: SLV: SDO: Object mapped to RxPDO, SDO Download blocked (CoE abort code 0x06010006 of slave)

8.6 File Transfer over EtherCAT (FoE) Error Codes

EC_E_FOE_ERRCODE_NOTDEFINED

0x98110060: SLV: ERROR FoE: not defined (FoE Error Code 0 (0x8000) of slave)

EC_E_FOE_ERRCODE_NOTFOUND

0x98110061: SLV: ERROR FoE: not found (FoE Error Code 1 (0x8001) of slave)

EC_E_FOE_ERRCODE_ACCESS

0x98110062: SLV: ERROR FoE: access denied (FoE Error Code 2 (0x8002) of slave)

EC_E_FOE_ERRCODE_DISKFULL

0x98110063: SLV: ERROR FoE: disk full (FoE Error Code 3 (0x8003) of slave)

EC_E_FOE_ERRCODE_ILLEGAL

0x98110064: SLV: ERROR FoE: illegal (FoE Error Code 4 (0x8004) of slave)

EC_E_FOE_ERRCODE_PACKENO

0x98110065: SLV: ERROR FoE: packet number wrong (FoE Error Code 5 (0x8005) of slave)

EC_E_FOE_ERRCODE_EXISTS

0x98110066: SLV: ERROR FoE: already exists (FoE Error Code 6 (0x8006) of slave)

EC_E_FOE_ERRCODE_NOUSER

0x98110067: SLV: ERROR FoE: no user (FoE Error Code 7 (0x8007) of slave)

EC_E_FOE_ERRCODE_BOOTSTRAPONLY

0x98110068: SLV: ERROR FoE: bootstrap only (FoE Error Code 8 (0x8008) of slave)

EC_E_FOE_ERRCODE_NOTINBOOTSTRAP

0x98110069: SLV: ERROR FoE: Downloaded file name is not valid in Bootstrap state (FoE Error Code 9 (0x8009) of slave)

EC_E_FOE_ERRCODE_INVALIDPASSWORD

0x9811006A: SLV: ERROR FoE: no rights (FoE Error Code 10 (0x800A) of slave)

EC_E_FOE_ERRCODE_PROGERROR

0x9811006B: SLV: ERROR FoE: program error (FoE Error Code 11 (0x800B) of slave)

EC_E_FOE_ERRCODE_INVALID_CHECKSUM

0x9811006C: FoE: Wrong checksum

EC_E_FOE_ERRCODE_INVALID_FIRMWARE

0x9811006D: SLV: ERROR FoE: Firmware does not fit for Hardware (FoE Error Code 13 (0x800D) of slave)

EC_E_FOE_ERRCODE_NO_FILE

0x9811006F: SLV: ERROR FoE: No file to read (FoE Error Code 15 (0x800F) of slave)

EC_E_NO_FOE_SUPPORT_BS

0x9811010F: APP: ERROR FoE: Protocol not supported in boot strap (e.g. Application requested FoE in Bootstrap although slave does not support this)

EC_E_FOE_ERRCODE_MAX_FILE_SIZE

0x9811017A: APP: ERROR FoE: File is bigger than max file size (e.g. Slave returned more data than the

buffer provided by application can store.)

EC_E_FOE_ERRCODE_FILE_HEAD_MISSING

0x98130001: SLV: ERROR FoE: File header does not exist (FoE Error Code 16 (0x8010) of slave)

EC_E_FOE_ERRCODE_FLASH_PROBLEM

0x98130002: SLV: ERROR FoE: Flash problem (FoE Error Code 17 (0x8011) of slave)

EC_E_FOE_ERRCODE_FILE_INCOMPATIBLE

0x98130003: SLV: ERROR FoE: File incompatible (FoE Error Code 18 (0x8012) of slave)

8.7 Servo Drive Profil over EtherCAT (SoE) Error Codes

EC_E_SOE_ERRORCODE_INVALID_ACCESS

0x98110078: ERROR SoE: Invalid access to element 0

EC_E_SOE_ERRORCODE_NOT_EXIST

0x98110079: ERROR SoE: Does not exist

EC_E_SOE_ERRORCODE_INVL_ACC_ELEM1

0x9811007A: ERROR SoE: Invalid access to element 1

EC_E_SOE_ERRORCODE_NAME_NOT_EXIST

0x9811007B: ERROR SoE: Name does not exist

EC_E_SOE_ERRORCODE_NAME_UNDERSIZE

0x9811007C: ERROR SoE: Name undersize in transmission

EC_E_SOE_ERRORCODE_NAME_OVERSIZE

0x9811007D: ERROR SoE: Name oversize in transmission

EC_E_SOE_ERRORCODE_NAME_UNCHANGE

0x9811007E: ERROR SoE: Name unchangeable

EC_E_SOE_ERRORCODE_NAME_WR_PROT

0x9811007F: ERROR SoE: Name currently write-protected

EC_E_SOE_ERRORCODE_UNDERS_TRANS

0x98110080: ERROR SoE: Attribute undersize in transmission

EC_E_SOE_ERRORCODE_OVERS_TRANS

0x98110081: ERROR SoE: Attribute oversize in transmission

EC_E_SOE_ERRORCODE_ATTR_UNCHANGE

0x98110082: ERROR SoE: Attribute unchangeable

EC_E_SOE_ERRORCODE_ATTR_WR_PROT

0x98110083: ERROR SoE: Attribute currently write-protected

EC_E_SOE_ERRORCODE_UNIT_NOT_EXIST

0x98110084: ERROR SoE: Unit does not exist

EC_E_SOE_ERRORCODE_UNIT_UNDERSIZE

0x98110085: ERROR SoE: Unit undersize in transmission

EC_E_SOE_ERRORCODE_UNIT_OVERSIZE

0x98110086: ERROR SoE: Unit oversize in transmission

EC_E_SOE_ERRORCODE_UNIT_UNCHANGE

0x98110087: ERROR SoE: Unit unchangeable

EC_E_SOE_ERRORCODE_UNIT_WR_PROT

0x98110088: ERROR SoE: Unit currently write-protected

EC_E_SOE_ERRORCODE_MIN_NOT_EXIST

0x98110089: ERROR SoE: Minimum input value does not exist

EC_E_SOE_ERRORCODE_MIN_UNDERSIZE

0x9811008A: ERROR SoE: Minimum input value undersize in transmission

EC_E_SOE_ERRORCODE_MIN_OVERSIZE

0x9811008B: ERROR SoE: Minimum input value oversize in transmission

EC_E_SOE_ERRORCODE_MIN_UNCHANGE

0x9811008C: ERROR SoE: Minimum input value unchangeable

EC_E_SOE_ERRORCODE_MIN_WR_PROT

0x9811008D: ERROR SoE: Minimum input value currently write-protected

EC_E_SOE_ERRORCODE_MAX_NOT_EXIST

0x9811008E: ERROR SoE: Maximum input value does not exist

EC_E_SOE_ERRORCODE_MAX_UNDERSIZE

0x9811008F: ERROR SoE: Maximum input value undersize in transmission

EC_E_SOE_ERRORCODE_MAX_OVERSIZE

0x98110090: ERROR SoE: Maximum input value oversize in transmission

EC_E_SOE_ERRORCODE_MAX_UNCHANGE

0x98110091: ERROR SoE: Maximum input value unchangeable

EC_E_SOE_ERRORCODE_MAX_WR_PROT

0x98110092: ERROR SoE: Maximum input value currently write-protected

EC_E_SOE_ERRORCODE_DATA_NOT_EXIST

0x98110093: ERROR SoE: Data item does not exist

EC_E_SOE_ERRORCODE_DATA_UNDERSIZE

0x98110094: ERROR SoE: Data item undersize in transmission

EC_E_SOE_ERRORCODE_DATA_OVERSIZE

0x98110095: ERROR SoE: Data item oversize in transmission

EC_E_SOE_ERRORCODE_DATA_UNCHANGE

0x98110096: ERROR SoE: Data item unchangeable

EC_E_SOE_ERRORCODE_DATA_WR_PROT

0x98110097: ERROR SoE: Data item currently write-protected

EC_E_SOE_ERRORCODE_DATA_MIN_LIMIT

0x98110098: ERROR SoE: Data item less than minimum input value limit

EC_E_SOE_ERRORCODE_DATA_MAX_LIMIT

0x98110099: ERROR SoE: Data item exceeds maximum input value limit

EC_E_SOE_ERRORCODE_DATA_INCOR

0x9811009A: ERROR SoE: Data item incorrect

EC_E_SOE_ERRORCODE_PASWD_PROT

0x9811009B: ERROR SoE: Data item protected by password

EC_E_SOE_ERRORCODE_TEMP_UNCHANGE

0x9811009C: ERROR SoE: Data item temporary unchangeable (in AT or MDT)

EC_E_SOE_ERRORCODE_INVL_INDIRECT

0x9811009D: ERROR SoE: Invalid indirect

EC_E_SOE_ERRORCODE_TEMP_UNCHANGE1

0x9811009E: ERROR SoE: Data item temporary unchangeable (parameter or opmode)

EC_E_SOE_ERRORCODE_ALREADY_ACTIVE

0x9811009F: ERROR SoE: Command already active

EC_E_SOE_ERRORCODE_NOT_INTERRUPT

0x98110100: ERROR SoE: Command not interruptible

EC_E_SOE_ERRORCODE_CMD_NOT_AVAIL

0x98110101: ERROR SoE: Command not available (in this phase)

EC_E_SOE_ERRORCODE_CMD_NOT_AVAIL1

0x98110102: ERROR SoE: Command not available (invalid parameter)

EC_E_SOE_ERRORCODE_DRIVE_NO

0x98110103: ERROR SoE: Response drive number not identical with requested drive number

EC_E_SOE_ERRORCODE_IDN

0x98110104: ERROR SoE: Response IDN not identical with requested IDN

EC_E_SOE_ERRORCODE_FRAGMENT_LOST

0x98110105: ERROR SoE: At least one fragment lost

EC_E_SOE_ERRORCODE_BUFFER_FULL

0x98110106: ERROR SoE: RX buffer full (EtherCAT call with to small data-buffer)

EC_E_SOE_ERRORCODE_NO_DATA

0x98110107: ERROR SoE: No data state

EC_E_SOE_ERRORCODE_NO_DEFAULT_VALUE

0x98110108: ERROR SoE: No default value

EC_E_SOE_ERRORCODE_DEFAULT_LONG

0x98110109: ERROR SoE: Default value transmission too long

EC_E_SOE_ERRORCODE_DEFAULT_WP

0x9811010A: ERROR SoE: Default value cannot be changed, read only

EC_E_SOE_ERRORCODE_INVL_DRIVE_NO

0x9811010B: ERROR SoE: Invalid drive number

EC_E_SOE_ERRORCODE_GENERAL_ERROR

0x9811010C: ERROR SoE: General error

EC_E_SOE_ERRCODE_NO_ELEM_ADR

0x9811010D: ERROR SoE: No element addressed

8.8 Remote API Error Codes

EC_E_SOCKET_DISCONNECTED

0x9811017D: RAS: Socket disconnected (e.g. IP connection terminated or lost)

EMRAS_E_INVALIDCOOKIE

0x98110181: RAS: Invalid Cookie (e.g. obsolete)

EMRAS_E_MULSRVDISMULCON

0x98110183: RAS: Connect 2nd server denied because Multi Server support is disabled (obsolete)

EMRAS_E_LOGONCANCELLED

0x98110184: RAS: Logon canceled (Server-side connection reject while opening a client connection.)

EMRAS_E_INVALIDVERSION

0x98110186: RAS: Invalid Version (Connection reject because of using mismatching protocol versions on client and server side)

EMRAS_E_INVALIDACCESSCONFIG

0x98110187: RAS: Access configuration is invalid (e.g. SPoC access configuration invalid)

EMRAS_E_ACCESSLESS

0x98110188: RAS: No access to this call at this access level (e.g. a higher SPoC access level is needed to use the called Remote API function)

EMRAS_E_INVALIDDATA RECEIVED

0x98110189: RAS: Invalid data received (communication corrupted)

EMRAS_EVT_SERVERSTOPPED

0x98110191: RAS: Server stopped (e.g. connection dropped because of Remote API Server stop)

EMRAS_EVT_WDEXPIRED

0x98110192: RAS: Watchdog expired (e.g. connection dropped because of missing keep-alive messages)

EMRAS_EVT_RECONEXPIRED

0x98110193: RAS: Reconnect expired (obsolete)

EMRAS_EVT_CLIENTLOGON

0x98110194: RAS Server: Client logged on

EMRAS_EVT_RECONNECT

0x98110195: RAS: obsolete

EMRAS_EVT_SOCKCHANGE

0x98110196: RAS: Socket exchanged after reconnect (obsolete)

EMRAS_EVT_CLNTDISC

0x98110197: RAS: Client disconnect

EMRAS_E_ACCESS_NOT_FOUND

0x98110198: RAS: Access not configured for this call (e.g. SPoC access configuration missing)