



acontis technologies GmbH

SOFTWARE

EC-Master

EtherCAT® Master Stack Class B

Version 3.0

Edition: 2018-11-06

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1 Introduction

1.1 What is EtherCAT?

EtherCAT is an IEEE802.3 Ethernet based fieldbus system. EtherCAT defines a new standard in communication speed and is due to its flexible topology and simple configuration to handle like a conventional Fieldbus. The implementation of EtherCAT is inexpensive to implement which allows the system to use fieldbus technology in applications which had to omit fieldbus use in the past. EtherCAT is an open technology which is standardized within the IEC (International Electrotechnical Commission). The system itself is supported and powered by the EtherCAT Technology Group, which is an international community of users and vendors where more than 3100 members already joined including acontis technologies GmbH.

Fieldbusses are proved and established in automation and most applications depend on them. The use of PC based control systems in a reasonable way was only made possible by the introduction of fieldbus technology. Since the control CPU's speed is increasing rapidly (especially with IPC's), the conventional fieldbus systems are moreover become the bottle neck and limit the reachable performance of the control systems. Additionally the control topology becomes multi layered with some subsided cyclic systems:

- the control task himself
- the fieldbus system
- and propably some local extension busses in the I/O system
- or simply the local firmware cycle in the peripheral device

Because of this latency times are generated which are typically a multiple of 3 or 5 of the control cycle time, which is not a satisfying solution in most applications. On top of the fieldbus systems, to interconnect control systems, ethernet is state of the art for a long time. The use of Ethernet to control drives or I/O systems is pretty new and was reserved for the conventional fieldbus systems in the past. In this focus the propability to carry small data, hard real time possibilities and of course low costs are the primary requirements. EtherCAT fulfills those requirements and brings internet technologies to the level of I/O communication.

1.2 EtherCAT protocol

The EtherCAT protocol is optimized for process data transfer and is transported directly within the Ethernet frame thanks to a special Ethertype. It may consist of several EtherCAT telegrams, each serving a particular memory area of the logical process image which can address up to 4 gigabytes in size. The data sequence is independent of the physical order of the Ethernet terminals in the network; addressing can be in any order. Broadcast, Multicast and communication between slaves are possible. Direct Ethernet frame transfer is used in cases where maximum performance is required and the EtherCAT components are operated in the same subnet as the controller.

However, EtherCAT applications are not limited to a single subnet: EtherCAT UDP packages the EtherCAT protocol into UDP/IP datagrams. This enables any control with Ethernet protocol stack to address EtherCAT systems. Even communication across routers into other subnets is possible. In this variant, system performance obviously depends on the real-time characteristics of the control and its Ethernet protocol implementation. The response times of the EtherCAT network itself are hardly restricted at all: the UDP datagram only has to be unpacked in the first station.

In addition to data exchange according to the master/slave principle, EtherCAT is also very suitable for communication between controllers (master/master). Freely addressable network variables for process data and a variety of services for parameterization, diagnosis, programming and remote control cover a wide range of requirements. The data interfaces for master/slave and master/master communication are identical. For slave to slave communication, two mechanisms are available. Upstream devices can communicate to downstream devices within the same cycle and thus extremely fast. Since this method is topology dependent, it is particularly suitable for slave to slave communication relationships given by machine design - e.g. in printing or packaging applications. For freely configurable slave to slave communication, the second mechanism applies: the data is relayed by the master. Here two cycles are needed, but due to the extraordinary performance of EtherCAT this is still faster than any other approach.

EtherCAT only uses standard frames according to IEEE802.3 - the frames are not shortened. EtherCAT frames can thus be sent from any Ethernet MAC, and standard tools (e.g. monitor) can be used.

1.3 EC-Master – Features

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

*1: According to ETG.1500 Master Classes not mandatory for Class A

*2: According to ETG.1500 Master Classes not mandatory for Class B

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)	-- (*2)	108
Process Data Exchange				
Cyclic PDO	Cyclic process data exchange	✓	✓	201
Multiple Tasks	Different cycle tasks Multiple update rates for PDO	✓	✓	202
Frame repetition	Send cyclic frames multiple times to increase immunity	-- (*1)	-- (*2)	203
Network Configuration				
Online scanning	Network configuration functionality included in EtherCAT Master	✓	✓	301
Reading ENI	Network Configuration taken from ENI file			
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

Feature name	Short description	EC-Master Class A	EC-Master Class B	Feature ID
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 sub-indices) at once	✓	✓	503
SDO Info service	Services to read object dictionary	✓	✓	504
Emergency Message	Receive Emergency messages	✓	✓	505
PDO in CoE	PDO services transmitted via CoE	-- (*1)	-- (*2)	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	-- (*2)	603
FoE				
FoE Protocol	Support FoE Protocol	✓	-- (*2)	701
Firmware Up-/Download	Password, FileName should be given by the application	✓	-- (*2)	702
Boot State	Support Boot-State for Firmware Up/Download	✓	-- (*2)	703
SoE				
SoE Services	Support SoE Services	✓	✓	801
AoE				
AoE Protocol	Support AoE Protocol	✓	-- (*2)	901
VoE				
VoE Protocol	External Connectivity supported	✓	-- (*2)	1001
Synchronization with Distributed Clock (DC)				
DC support	Support of Distributed Clock	✓	-- (*2)	1101
Continuous Propagation Delay compensation	Continuous Calculation of the propagation delay	V 2.4.2	-- (*2)	1102
Sync window monitoring	Continuous monitoring of the Synchronization difference in the slaves	✓	-- (*2)	1103
Slave-to-Slave Communication				
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	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	FP	-- (*2)	1301

1.4 Restrictions of the protected version

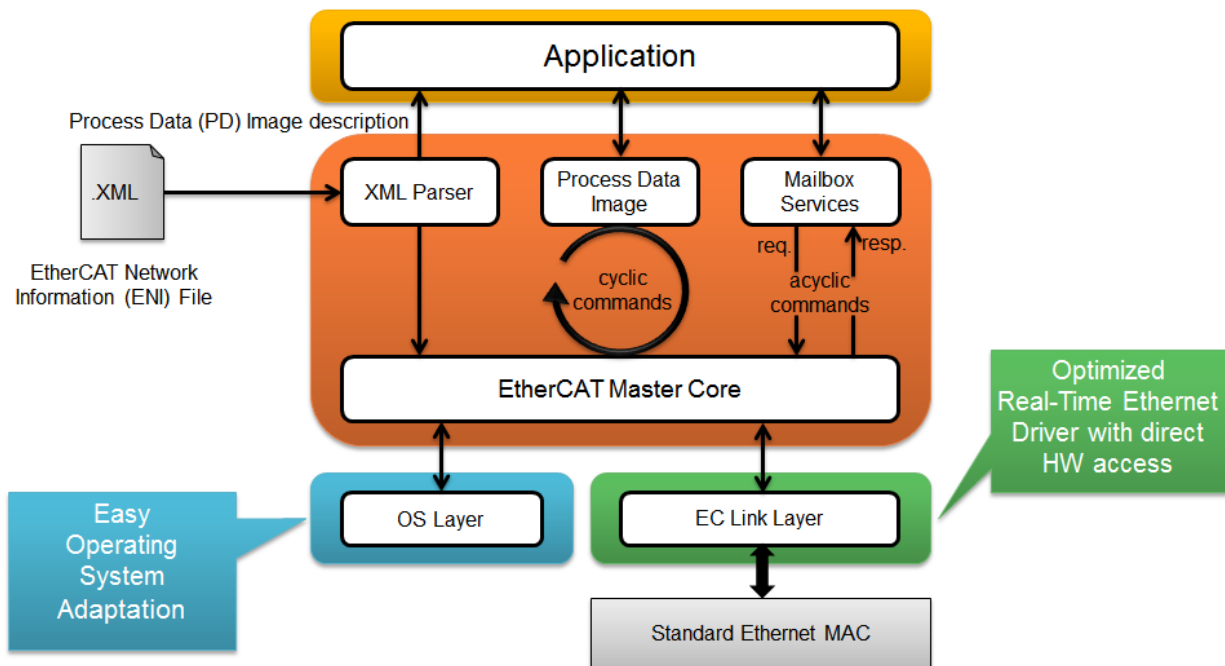
An unlicensed version stops sending ethernet frames after 1 hour (evaluation period expired). Afterwards timeout errors will occur. See 4.3.28 `ecatSetLicenseKey`.

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 inter-operability 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

This chapter is about preparing the operating system for usage with the EC-Master stack. 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. Only network adapters which support at least 100 MBit are supported. First the Link Layer drivers must be chosen as for some, the Operating system must be configured with special steps.

2.3.1 Link Layer selection

2.3.1.1 General

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 CE, EcMaster.a for VxWorks) and one (or more) libraries each containing support for one specific Link Layer module (type of hardware card). Which library actually is loaded, is depending on the Link Layer parameters at runtime.

The principle of Link Layer selection is that the name of the Link Layer (Link Layer Identification) is used to determine the location and name of a registration function, which is called by the EtherCAT master and registers function pointers which 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 `ecatInitMaster()`.

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.

2.3.1.2 Optimized Link Layer drivers

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

Please check in chapter 0 “
” if the optimized Link Layer is available for the target operating system.

The supported network controllers are listed in chapter 6, “Supported network controllers”.

Link Layer modules not listed there may be available if purchased additionally.

2.3.1.3 Freescale TSEC / eTSEC

The following MAC's are supported:

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)

2.3.1.3.1 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 autonegotiated 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;
```

2. 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;
```

2.3.1.3.2 Locking

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

1. poDrvSpecificParam->oMiiBusMtx = EC_NULL;
/* implement locking by using return value of LinkOsCreateLock(eLockType_DEFAULT); */

2.3.1.3.3 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 = ecatIoControl((EC_IOCTL_LINKLAYER | EC_LINK_IOCTL_UPDATE_LINKSTATUS), EC_NULL);
```

EcLinkGetStatus() always returns the last known link status.

2.3.1.3.4 Fixed Link

PHY access can be effectively disabled at all to avoid concurrent access if link speed and mode as defined to be fixed. This functionality is mainly provided for L2-Switch-ICs 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 PHYs are not affected by this parameter and still active. There is no forced link and no PHY access at all.

Parameters for fixed link:

```
pETSECParm->dwPhyAddr      = ETSEC_FIXED_LINK;  
pETSECParm->dwFixedLinkVal = ETSEC_LINKFLAG_1000baseT_Full | ETSEC_LINKFLAG_LINKOK;
```

2.3.1.3.5 Build instructions

Linux and VxWorks (PowerPC only) are supported. The GNU GCC compiler is needed to compile.

The following files need to be compiled:

- EcDeviceETSEC.cpp
- LinkOsLayer.cpp (platform-dependent)

2.3.2 DOS GO32-V2

The EC-Master library for DOS 32-bit (GO32) is designed to be used under DPML extension only, a virtual-memory-disabling DPML server like `CWSDPM0.exe` has to be used.

It is recommended to set the `CONFIG.SYS` as following:

```
DEVICE=C:\DOS\HIMEM.SYS
DOS=HIGH
FILES=30
```

2.3.3 Greenhills INTEGRITY

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

1. Copy the file `<InstallPath>\SDK\Files\INTEGRITY\ethercat.c` to `<INTEGRITYPath>\modules\acontis\ethercat.c`
2. Open the project `<INTEGRITYPath>\pcx86\default.gpj` according to the used BSP
3. Add `<INTEGRITYPath>\modules\acontis\ethercat.c` to `libbsp.gpj`
4. Recompile the library
5. Recompile kernel space project

2.3.4 IntervalZero RTX

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`**.

2.3.5 Linux

2.3.5.1 Kernel parameters

Because power management may disturb cyclic processing, it is advisable to set Kernel parameter `"cpuidle.off=1"`.

2.3.5.2 Atemsyz for Optimized Link Layers

To use Optimized Link Layers under Linux, the `atemsyz` Kernel module must be compiled and loaded.

Compile the `atemsyz` Kernel module for Linux `>= 2.6.18` (see `atemsyz.c`) if running EC-Master **natively**:

```
cd Sources/LinkOsLayer/Linux/atemsyz
make modules
```

Cross-compile the `atemsyz` Kernel module if running EC-Master on a **target**:

```
export ARCH=<...>
export CROSS_COMPILE=<...>
cd Sources/atemsyz
make modules KERNELDIR=<path to target kernel dir>
```

Load the `atemsyz` module:

```
sudo insmod Sources/LinkOsLayer/Linux/atemsyz/atemsyz.ko
```

2.3.5.3 Show loaded modules

The following command lists the loaded Kernel modules that may conflict with Optimized Link Layers:

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

E.g.:

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

PCI/PCIe: The command "lspci" 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)
...
```

2.3.5.4 Unbind Link Layer instance

Link Layer instances used by Optimized Link Layers may not be bound by Kernel drivers modules!

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

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

E.g.:

```
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
```

Some optimized Link Layers support PCI bus, device, function codes as instance ID.

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

Modules can be prevented from loading on Ubuntu 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
Beckhoff CCAT	emIIICCAT	ec_bhf	
CPSW	emIICPSW	ti_cpsw	Unbind not supported, see below!
DesignWare 3504	emIIDW3504	stmmac	
	emIIEG20T		
Freescall TSEC/eTSEC v1/2	emIIETSEC	gianfar_driver	
Freescall FEC and ENET controller	emIIFsIFec	fec, fec_ptp	
Xilinx Zynq-7000	emIIGEM		Unbind not supported, see below!
Intel Pro/1000	emIII8254x	igb, e1000, e1000e	
Intel Pro/100	emIII8255x	e100	
ICSS	emIIICSS	prueth,pruss	Unbind not supported, see below!
RDC R6040	emIIR6040		

Chip	Link Layer Name	Kernel driver (s)	Remarks
Realtek RTL8139	emlIRTL8139	8139too, 8139cp	
Realtek RTL8169 / RTL8111 / RTL8168	emlIRTL8169	r8169	De-initializes PHY, see below!
SuperH	emlISHEth	sh_eth	Unbind not supported, see below!
Generic	emlISockRaw		

2.3.5.5 Optionally modify search location for Optimized Link Layers

Search locations for Optimized Link Layers can be adjusted using `LD_LIBRARY_PATH`.

2.3.5.6 Configuring acontis atemsys for Yocto Linux

In order to install atemsys recipe please do following steps:

1. Add atemsys files to subfolder 'recipes-kernel' in the active layer

```
cd <layer_folder_path>
mkdir -p recipes-kernel/atemsys/files
cp -r /opt/EC-Master/Sources/LinkOsLayer/Linux/atemsys recipes-kernel/
cd recipes-kernel/atemsys
mv atemsys.c atemsys.h Makefile files/
```

2. Add 'atemsys' to the image, for this add the following line to the '<poky_root_folder>/build/conf/local.conf' file

```
MACHINE_ESSENTIAL_EXTRA_RDEPENDS += "kernel-module-atemsys"
```

3. Build image

2.3.5.7 CPSW

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 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. For this goal kernel should be patched with one of the file located at `SDK/FILES/CPSW/Linux`. 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

The patch needs:

- Linux kernel with enabled CPSW driver.
- Patch applied to Linux kernel.
- `EC_ETHERNET_PORT` defined according to target in `cpsw.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 that EtherCAT ports should be used as "slave" since "master" is the Linux driver.

2.3.5.8 ICSS

PRU ICSS LinkLayer for EC-Master achieves real-time performance and for this purpose it uses direct access to the board hardware. Because of that the link layer does not use linux drivers, so these drivers should be disabled in system (because they lock hardware resources and do not allow to access them from the Link Layer).

This Link Layer tested on TI RT Linux 4.9.59 and TI Processor SDK 4.02.

To create SD Card with this version of Linux download card image am335x-evm-linux-rt-04.02.00.09.img.zip or am57xx-evm-linux-rt-04.02.00.09.img.zip from TI site. To read more

http://processors.wiki.ti.com/index.php/Processor_SDK_RTOS_Creating_a_SD_Card_with_Windows

TI AM57xx IDK: please note, after the four 100Mbit Ports have been disabled in linux, other two 1Gb ports (CPSW) remain active and can be used for other purposes (ex.tcp/ip).

TI AM335x ICEV2: after the both 100Mbit Ports have been disabled in linux, there are no more ethernet ports that can be used for tcp/ip. Please note, the board cannot work in mixed mode, i.e. there is no CPSW+ICSS support. It is also needed to correctly configure board to boot up linux in ICSS and not in CPSW mode. Set both jumpers on the board to the ICSS mode. Read

http://processors.wiki.ti.com/index.php/AM335x_Industrial_Communication_Engine_EVM_Rev2_1_HW_Use_r_Guide

Please note, here we show the quick way how to make the link layer working. In your real world environment is is recommended to create own variant of the Device Tree.

2.3.5.8.1 Step 1. Disabling PRU drivers

In the following SDK subdirectory you find all device tree source files (.dts) and compiled versions (.dtb):
/board-support/linux-rt-4.9.59+gitAUTOINC+273202a0d3-g273202a0d3/arch/arm/boot/dts

Normally, board is booted up from am572x-idk.dtb/am335x-icev2.dtb, but TI has already prepared am572x-idk-pru-excl-uo.dtb/am335x-icev2-pru-excl-uo.dtb that better fits our needs. It already excludes most of the PRUSS drivers and we need just to make some little modifications to make it working.

As we mentioned before, here is a quick and easy way to disable necessary drivers, that should be used only for demonstration purposes, but is is not best one. For your real world system it is better to make a copy of the am572x-idk-pru-excl-uo.dts/am335x-icev2-pru-excl-uo.dts file and then add it to the makefile script to build always your own .dtb file.

AM57xx

In our example we should edit am572x-pru-uo.dtsi file and add to the end the following:

```
// acontis changes

&pruss_soc_bus1 {
    status = "disabled";
};

&pruss2_eth {
    compatible = "acontis,device";
    status="disabled";

    interrupt-parent = <&crossbar_mpu>;

    interrupts = <GIC_SPI 188 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 189 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 198 IRQ_TYPE_LEVEL_HIGH>,
                <GIC_SPI 199 IRQ_TYPE_LEVEL_HIGH>;
};
```

Please note, if you do not need to use an TTS Feature, your could skip all interrupt* parts here and only keep status=disabled for both sections for the sake of simplicity. These interrupts* strings instruct linux to forward TTS interrupts from PRUSS via CrossbarIRQ controller to GIC. On other OS, PRUICSS Link Layer configures crossbar directly, but on linux it is the preferred way.

Please also note, that on AM571x board there are two ETH sections (on AM572x only port 3 and port 4 can be used for ethernet), so, if you have this board, you will need to disable pruss1_eth additionally in the dts file.

AM335x

In our example we should edit am335x-pru-uo.dtsi file and add to the end the following:

```
// acontis changes
```

```
&gpio2 {
    status = "disabled";
};

&gpio3 {
    status = "disabled";
    compatible = "acontis,device";

    interrupt-parent = <&intc>;
    interrupts = <22>, <23>;
};

&gpio0 {
    pinctrl-0 = <&pruss_mdio_default>;
    pinctrl-names = "default";
    status = "okay";
};

&gpio1 {
    pinctrl-0 = <&pruss_eth_default>;
    pinctrl-names = "default";
    status = "okay";
};
```

In short words, these sections disable gpio2 and gpio3 controllers, which are needed for pruicss link layer. Additionally, it tells linux to configure PinMux for MDIO and MAC. We reuse gpio0 and gpio1, because they do not have own pinctrl items. Additionally, we change the compatible string in disabled gpio3 section to acontis,devcie, so our atemsys driver can find this section and get correct TTS IRQ.

2.3.5.8.2 Step 2. Compiling DTS->DTB

To compile device tree go to SDK directory and execute command "make linux-dtbs".

2.3.5.8.3 Step 3. Replace device tree on board

On the development machine in the dts folder, mentioned earlier, you will find your compiled device tree in the file am335x-icev2-pru-excl-uo.dtb/am572x-idk-pru-excl-uo.dtb.

Connect your SD Card with Linux RT to a card reader (on linux, not windows) and copy the dtb file to the /boot directory.

Next step is to use linux **ln** command to make link on our compiled device tree.

```
am335x: am335x-icev2.dtb->am335x-icev2-pru-excl-uo.dtb
am57xx: am572x-idk.dtb->am572x-idk-pru-excl-uo.dtb
```

Next, try to boot up your board. If everything has been done correctly, you will not see pruss/prueth drivers.

Our lsmod shows on AM335x:

Module	Size	Used by
pvrsvkm	403455	0
ti_am335x_adc	6864	0

sha512_generic	9967	0	
sha512_arm	12252	0	
sha256_generic	10178	0	
sha1_generic	2864	0	
sha1_arm_neon	6261	0	
sha1_arm	3862	1	sha1_arm_neon
md5	2219	0	
des_generic	17608	0	
cbc	2388	0	
xfrm_user	22147	2	
xfrm4_tunnel	2040	0	
ipcomp	2257	0	
xfrm_ipcomp	4225	1	ipcomp
esp4	6363	0	
ah4	5627	0	
af_key	26992	0	
xfrm_algo	6970	5	xfrm_user, esp4, ah4, af_key, xfrm_ipcomp
bluetooth	338029	2	
wkup_m3_rproc	3670	1	
pm33xx	4348	0	
omap_aes_driver	19021	0	
wkup_m3_ipc	8141	1	pm33xx
crypto_engine	6466	1	omap_aes_driver
remoteproc	28840	2	wkup_m3_rproc, wkup_m3_ipc
omap_sham	21671	0	
ti_emif_sram	5406	1	pm33xx
gpio_tpic2810	2639	0	
gpio_pca953x	11032	4	
gpio_pisotr	2972	0	
omap_wdt	4719	0	
rtc_omap	9341	1	
ti_am335x_tscadc	5853	1	ti_am335x_adc
gpio_decoder	2387	0	
input_polldev	4488	1	gpio_decoder
sch_fq_codel	9039	1	
uio_module_drv	7349	0	
uio	9158	1	uio_module_drv
cryptodev	38385	1	

Our lsmod shows on AM572x:

Module	Size	Used by
bc_example	7282	0
xhci_plat_hcd	6119	0
xhci_hcd	108686	1 xhci_plat_hcd
usbcore	200983	2 xhci_plat_hcd, xhci_hcd
rpmsg_proto	6847	0
dwc3	71210	0
udc_core	19470	1 dwc3
usb_common	4737	3 udc_core, usbcore, dwc3
sha512_generic	9967	0
sha512_arm	12252	0
sha256_generic	10178	0
sha1_generic	2864	0
sha1_arm_neon	6261	0
sha1_arm	3862	1 sha1_arm_neon
md5	2219	0
cbc	2388	0
xfrm_user	23037	2
rpmsg_rpc	20236	0
xfrm4_tunnel	2040	0
ipcomp	2473	0
xfrm_ipcomp	4613	1 ipcomp
esp4	6465	0
ah4	5665	0
af_key	28293	0
xfrm_algo	6970	5 xfrm_user, esp4, ah4, af_key, xfrm_ipcomp
bluetooth	338165	2
snd_soc_omap_hdmi_audio	4823	0
c_can_platform	6638	0

c_can	9654	1	c_can_platform
pvrsvrkm	409493	1	bc_example
can_dev	13163	1	c_can
omap_sham	21607	0	
omap_aes_driver	19085	0	
pruss_soc_bus	3751	0	
omap_wdt	4719	0	
ahci_platform	3474	0	
libahci_platform	7311	1	ahci_platform
libahci	28751	2	ahci_platform, libahci_platform
ti_vip	41361	0	
libata	205714	3	ahci_platform, libahci_platform, libahci
scsi_mod	132177	1	libata
ti_vpe	19048	0	
ti_sc	24305	2	ti_vpe, ti_vip
ti_csc	2351	2	ti_vpe, ti_vip
ti_vpdma	15264	2	ti_vpe, ti_vip
dwc3_omap	4737	0	
rtc_omap	9341	0	
extcon_palmas	5464	0	
extcon_core	16711	3	dwc3_omap, extcon_palmas, dwc3
rtc_palmas	5125	0	
gpio_pisotr	3036	0	
ov2659	9490	0	
omap_des	11176	0	
des_generic	17608	1	omap_des
gpio_tpic2810	2639	0	
crypto_engine	6530	2	omap_des, omap_aes_driver
omap_remoteproc	12147	0	
virtio_rpmsg_bus	9932	2	rpmsg_rpc, rpmsg_proto
rpmsg_core	7252	3	rpmsg_rpc, rpmsg_proto, virtio_rpmsg_bus
remoteproc	29238	3	rpmsg_rpc, omap_remoteproc, rpmsg_proto
sch_fq_codel	9039	3	
uio_module_drv	7579	0	
uio	9174	1	uio_module_drv
gdbserverproxy	4769	0	
cryptodev	37885	1	
cmemk	35523	2	

2.3.5.8.4 Compiling Atems Driver

PRUICSS LinkLayer for Ec-Master works in user mode, but accesses hardware registers, memory and etc. To access hardware, it needs a helper in kernel space. For this purpose we have created "atemsys" driver.

This driver cannot be shipped in binary form, because it should use exactly the same kernel headers that OS on board has. So, we need to build the driver.

Source code of the driver is located in the Ec-Master directory in /Sources/LinkOsLayer/Linux/atemsys

Please create a build script in this directory.

"build_am5728_rtlinux_sdk4_02.sh"

```
source /home/user/ti/ti-processor-sdk-linux-rt-am57xx-evm-04.02.00.09/linux-devkit/environment-setup
export CROSS_COMPILE=/home/user/ti/ti-processor-sdk-linux-rt-am57xx-evm-04.02.00.09/linux-
devkit/sysroots/x86_64-arago-linux/usr/bin/arm-linux-gnueabi-
export ARCH=arm
export KERNELDIR=/home/user/ti/ti-processor-sdk-linux-rt-am57xx-evm-04.02.00.09/board-support/linux-rt-
4.9.59+gitAUTOINC+273202a0d3-g273202a0d3
make clean
make
```

"build_am3359_rtlinux_sdk4_02.sh"

```
source /home/user/ti_rtos/ti-processor-sdk-linux-rt-am335x-evm-04.02.00.09/linux-devkit/environment-setup
export CROSS_COMPILE=/home/user/ti_rtos/ti-processor-sdk-linux-rt-am335x-evm-04.02.00.09/linux-
devkit/sysroots/x86_64-arago-linux/usr/bin/arm-linux-gnueabi-
export ARCH=arm
```

```
export KERNELDIR=/home/user/ti_rtos/ti-processor-sdk-linux-rt-am335x-evm-04.02.00.09/board-
support/linux-rt-4.9.59+gitAUTOINC+273202a0d3-g273202a0d3
make
```

make it as executable and run. If all directories are correct and if you have kernel headers (they are built when SDK is built) the built driver should be found in this directory "atemsys.ko".

This driver should be copied to the sd card to the /home/user directory and then always loaded by command "insmod atemsys.ko" before using EcMaster Demo app.

2.3.5.9 Freescale TSEC / eTSEC

The driver is compiled as dynamic library "libemlTSEC.so" to be loadable by the EC-Master.
The following compiler flags are set:

-te500v2: Generate optimized code for the PPC e500v2 core.

2.3.5.10 Realtek RTL8169 / RTL8111 / RTL8168

Because the Linux Kernel module de-initializes the PHY on unloading Linux must be prevented from loading the r8169 module on startup, see above.

2.3.5.11 Xilinx Zynq-7000 (GEM) EtherCAT driver

Due to lacking unbind-feature of the GEM driver, the target's Kernel must be patched to not bind the adapter on startup. Therefore the board's Kernel SDK is needed.

The patch is located at `SDK/FILES/GEM/Linux/xilinx_emacps.c.patch`. The patch can be applied using the command "patch -p1 < /opt/EC-Master/SDK/FILES/GEM/Linux/xilinx_emacps.c.patch" in the target's Kernel development dir and rebuild the Kernel and its modules.

A correctly patched system shows "xemacps at 0x... disabled (Used for EtherCAT!)" with given address in the kernel logs.

2.3.5.12 SockRaw Link Layer

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. **The SockRaw cannot be used for real time applications and may need cycle time of 4 ms or higher.**

2.3.5.13 SuperH

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.

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.

I.e. use:

```
dwRes = ecatIoControl((EC_IOCTL_LINKLAYER | EC_LINK_IOCTL_UPDATE_LINKSTATUS), EC_NULL);
```

EcLinkGetStatus() always returns the last known link status.

2.3.6 Microsoft Windows

2.3.6.1 Windows WinPcap based Link Layer

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.

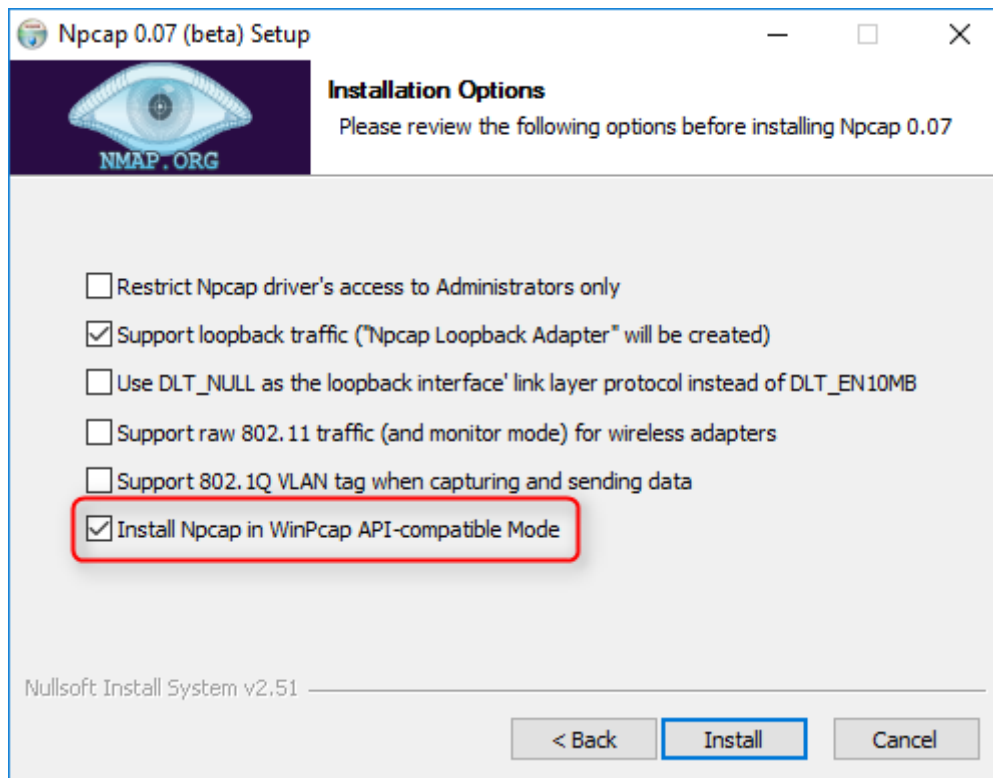
It is recommended to use a separate network adapter to connect EtherCAT devices. If the main network adapter is used for both EtherCAT devices and the local area network there may be a main impact on the local area network operation.

The network adapter card used by EtherCAT has to be set to a fixed private IP address, e.g. 192.168.x.y.

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.**

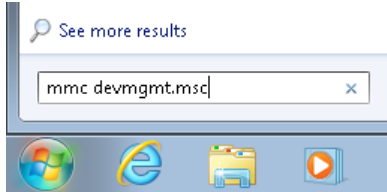
If using Npcap 0.07 r17, the WinPcap API-compatible mode must be chosen:



2.3.6.2 EcatDrv for Optimized Link Layers

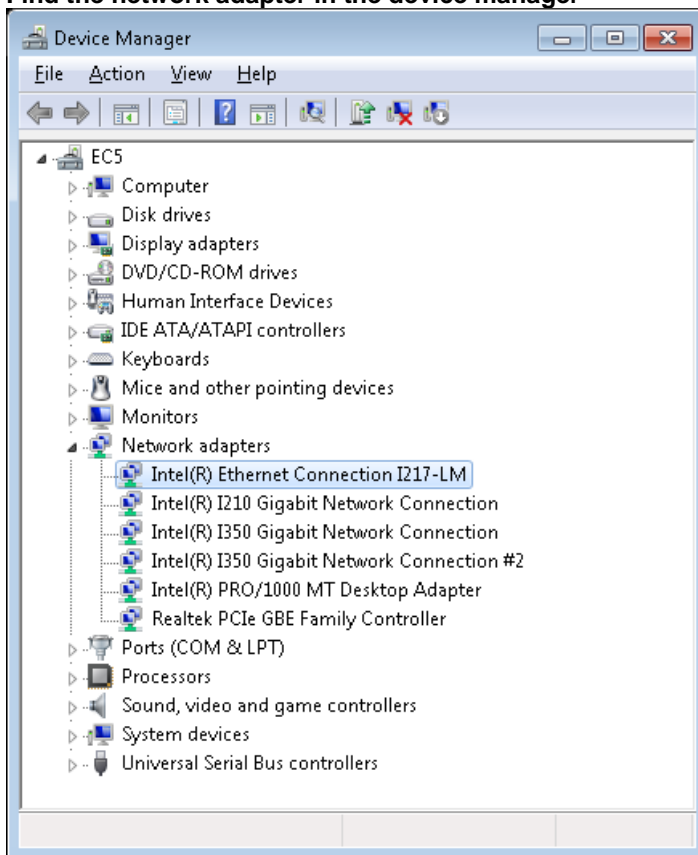
To use the optimized Link Layers under Windows, it is necessary to install the EcatDrv driver included in the optimized Link Layer delivery:

Step 1: Start the “Device Manager”

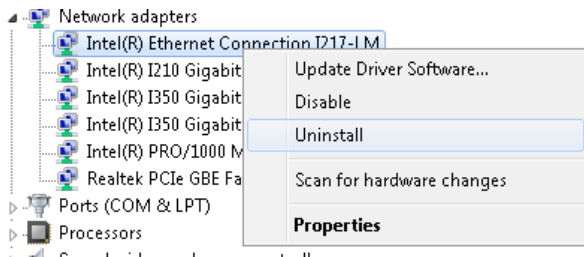


Step 2: Disable the windows driver of the network adapter that should be assigned to the ECAT driver

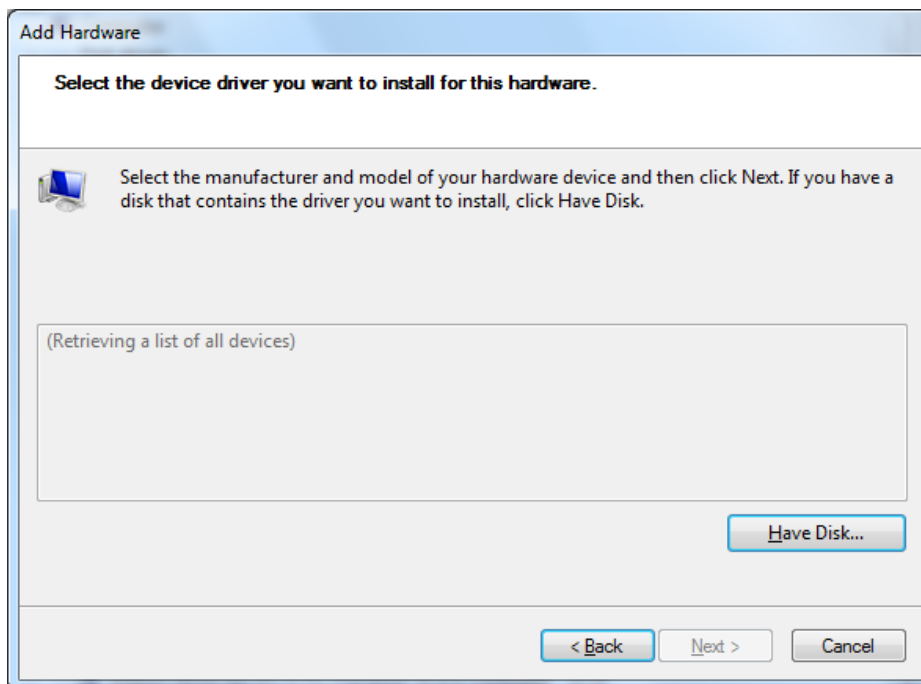
Find the network adapter in the device manager



Look in C:\Windows\Inf for .inf files containing the name of the adapter as displayed in the device manager. Rename the .inf files to .bak and delete the associated .pnf files.

Step 3: Delete network adapter from the device manager

Restart the system.

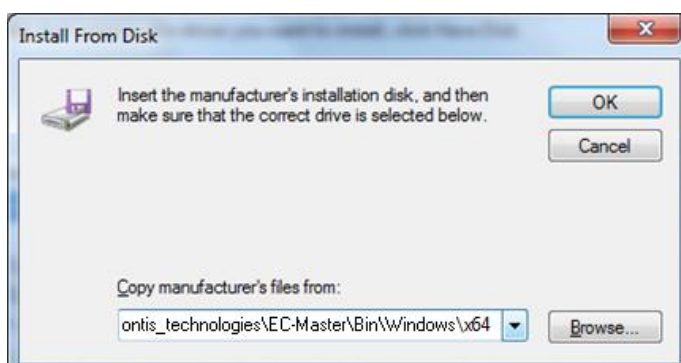
Step 4: Assign the ECAT driver to the network adapter**Step 5: Enter the directory to the correct driver version (32 bit or 64 bit)**

The default folder if not changed when installing the EC-Master is beneath "C:\Program Files\aconis_technologies\EC-Master\Bin\Windows".

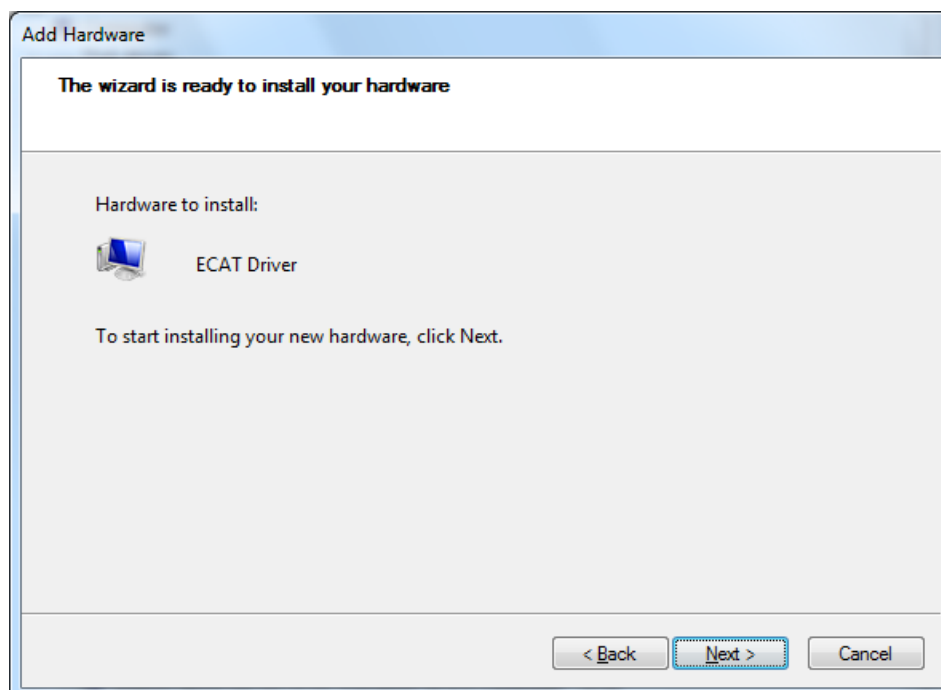
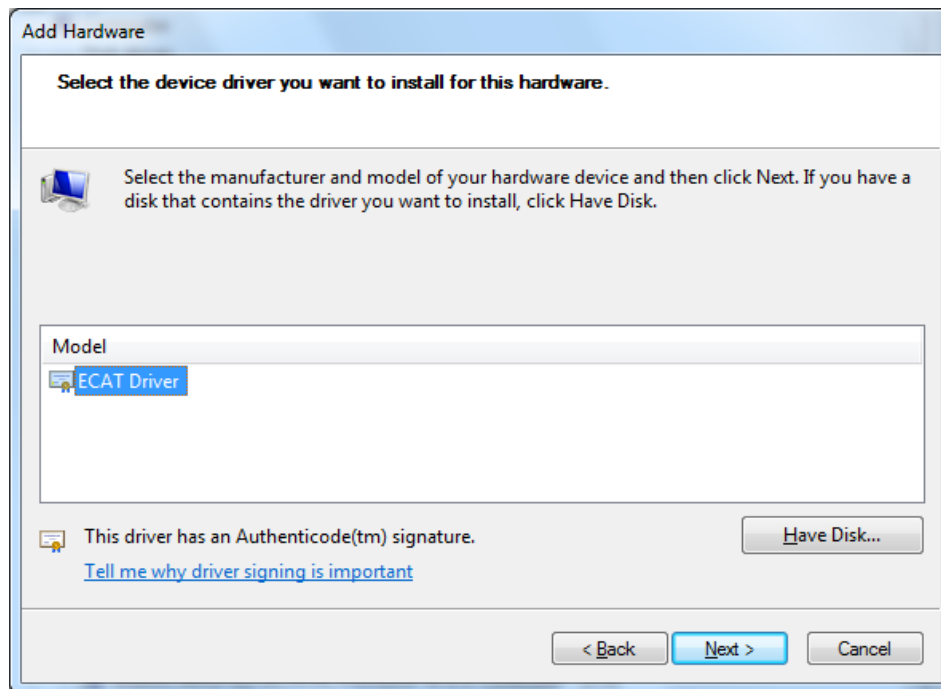


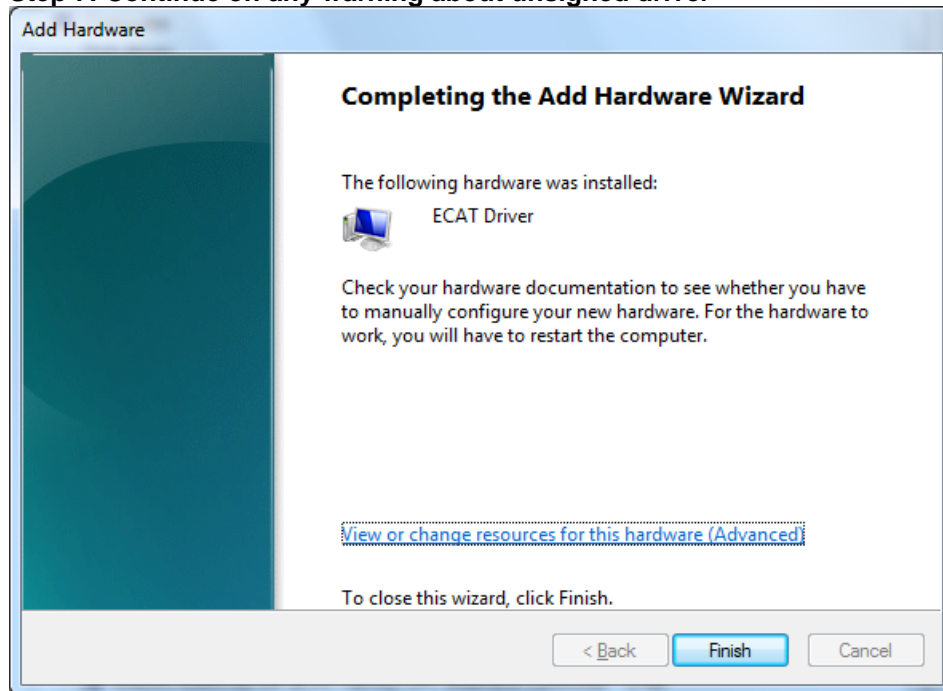
There are two different drivers available: 32 bit (subfolder **x86**) and 64 bit (subfolder **x64**).

Enter the correct directory at the input box:



Press OK to proceed.

Step 6: Chose the ECAT Driver and click “Next” and confirm the installation

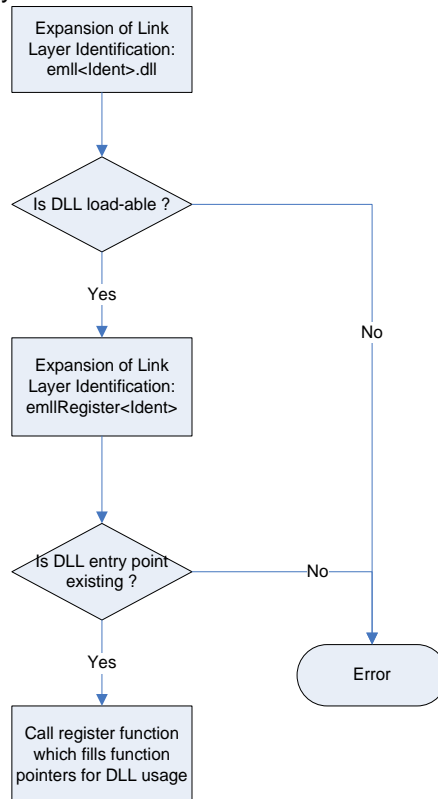
Step 7: Continue on any warning about unsigned driver**Optionally modify search location for Optimized Link Layers**

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

2.3.7 Microsoft Windows CE

2.3.7.1.1 Windows and WinCE

The identification of the Link Layer is done like this:



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.

2.3.7.2 NdisUio Link Layer

To be able to use the NDISUIO based Link Layer the following files have to be included to the Windows CE OS-image:

```
[...]\BIN\WinCE500\NDISUIO\CPU\AtNdisUio.dll
[...]\BIN\WinCE500\NDISUIO\CPU\EcMaster.dll
[...]\BIN\WinCE500\NDISUIO\CPU\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
```

2.3.7.3 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\emlNdisUio.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.

2.3.7.4 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\emlI8255x.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 I8254x instead of I8255x.

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

2.3.7.5 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\emlI8255x.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.600.reg

Same procedure and settings may be applied for the other optimized Link Layer; i.e. use I8254x instead of I8255x.

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

2.3.7.6 KUKA CeWin

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

Note1: 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

Note2: 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\emlI8255x.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

2.3.8 QNX Neutrino

2.3.8.1 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 with the `procnto -P` option:

```
procnto -P priority
```

For more informations about changing the priority range refer to the QNX documentation.

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

2.3.8.2 Optimized Link Layers

The network interface card and Link Layer to be used for the demo application can be set via command line. For example the option `-i8255x` will dynamically load the Link Layer for the Intel Pro/100 interface. The corresponding network interface must be unloaded if in use by a driver using the `umount` (QNX 6.3) or `ifconfig` (QNX 6.5) command in the QNX shell. For example `umount /dev/io-net/en1` or `ifconfig en1 destroy` unloads the driver for the interface `en1`.

The Link Layer drivers for QNX are "so" files (shared object files).

Search locations for Optimized Link Layers can be adjusted using `_CS_LIBPATH`.

2.3.9 RTAI

Step 1: Load required RTAI Kernel modules

Example:

```
> insmod /usr/realtime/modules/rtai_hal.ko
> insmod /usr/realtime/modules/rtai_sched.ko
> insmod /usr/realtime/modules/rtai_shm.ko
```

Step 2: Make sure that the native Linux driver for the EtherCAT network card is not loaded

Note: SockRaw cannot be used with RTAI.

See 2.4.1.5 "Linux" for how to unload drivers that may use network adapter.

2.3.10 RTEMS

Build the RTEMS operating system with least following configuration parameters:

```
--target=i386-rtems4.11 --enable-rtemsbsp=pc386 --enable-cxx
```

2.3.11 T-Kernel / eT-Kernel

2.3.11.1 T-Engine T-Kernel

2.3.11.1.1 Optimized Link Layers

Optimized Link Layers are available for T-Kernel.

The driver for the EtherCAT adapter may **not be loaded** by T-Kernel in order to use the optimized Link Layers.

2.3.11.1.2 System Timer

For T-Kernel the default interval of the system timer interrupt ("time tick") is 10 ms. The EtherCAT Master Stack needs a system timer interrupt of 1 ms.

Changing the "time tick" interval:

The period of the system timer interrupt ("time tick" interval) is defined by the "TTimerPeriod" entry of the "SYSCONF" file.

It can be changed by the "sysconf" command as follows:

```
[/SYS]% sysconf TTimerPeriod      # check current value
+0: TTimerPeriod 10               # timer interrupt interval (in milliseconds)

[/SYS]% sysconf TTimerPeriod 1    # change value to 1 ms
+0: TTimerPeriod 1

[/SYS]% exit                      # exit CLI
[IMS]% exit -1                    # system reboot
```

Please note that the changed value becomes valid after system reboot.

2.3.11.2 eT-Kernel

The Operating system doesn't touch anything at the MAC or the Buses while booting. So the initialization has to be done by the linklayer or the user application.

The eTSEC has a flag to specify if the initialization is done by the user application or the linklayer.

For the fslFEC the initialization function has to be called before starting the Master application.

2.3.12 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.

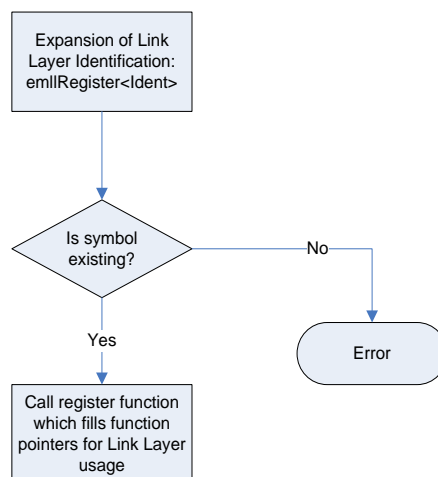
Search locations for Optimized Link Layers can be adjusted using the PATH environment variable.

2.3.13 Windriver VxWorks

Optimized Link Layers for VxWorks are available.

If none of the optimized Link Layers can be used, the SNARF or EtherLib Link Layer must be selected (see below).

The identification of the Link Layer is done like this:



2.3.13.1 SysLoSal

If the network adapter is not mapped in the MMU table until the AT-EtherCAT Masterstack is started (e.g. by vxBus or a driver), the BSP extension can be used to realize the mapping.

To use the LinkLayer in interrupt mode, the BSP extension is required and must be included:

1. Copy the file <InstallPath>\SDK\Files\VxWorks\sysLoSalAdd.c to the BSP directory
2. Right before function sysHwInit in sysLib.c insert this line:
#include "sysLoSalAdd.c"
3. Register the driver in function sysHwInit in sysLib.c:

Not relevant for VxBus or native VxWorks network driver!

Within the function sysHwInit locate the call:

```
pciConfigForeachFunc (0, TRUE, (PCI_FOREACH_FUNC) sysNetPciInit, NULL);
```

Right after the next line (#endif /* INCLUDE_NETWORK */) insert one of the following call:


```
SLOSAL_sysInitGEI(); /* Intel Pro1000 */
SLOSAL_sysInitFEI(); /* Intel Pro100 */
SLOSAL_sysInitRTL8139(); /* Realtek RTL8139 */
SLOSAL_sysInitRTL8169(); /* Realtek RTL8169/RTL8168/RTL8111 */
```

4. Rebuild the kernel image

5. Download to Target

The Link Layer module has to be downloaded before the master stack is started. If the register function is not found in the global symbol table of VxWorks an error is given.

2.3.13.2 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 [] =
{
    :      :      :
    :      :      :
    :      :      :
/*
#ifdef 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 the *VxWorks Device Driver Developer's Guide* for more information about unloading VxBus network devices.

2.3.13.3 KUKA VxWin

If using **KUKA VxWin** (Windows runs on top of VxWorks) the network adapter card used for EtherCAT has to be assigned to VxWorks. On APIC systems the interrupt used by the network card has to be activated for VxWorks (configuration file interrupt.config, a detailed description can be found in the VxWin manual).

I.e. for the optimized Intel Pro/100 Link Layer the following VxWin support files are located in

...\SDK\FILES\I8255X\VXWIN (VxWin version 3.1.1):

- Windows INF file to assign a Intel Pro/100 network adapter card to VxWorks: RTOS_I82557.inf
- VxWorks 6.3 image file which maps Intel Pro/100 PCI memory into VxWorks space:
V3.1.1\VxWorks63\VxWorks63_OPT_PRO100.zip (two files, one with ELF file format to be used by the target server and a second binary file for the VxWin uploader).

The VxWin board support package has to be adjusted prior to using this Link Layer:

- 1) I.e. to use the optimized PRO/100 Link Layer the adapter memory has to be mapped into VxWorks memory space. 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 [] =
{
    :      :      :
    :      :      :
    :      :      :
/*
#ifdef INCLUDE_FEI_END
    {0, FEI82557_LOAD_FUNC, FEI82557_LOAD_STRING, FEI82557_BUFF_LOAN,
     NULL, FALSE},
#endif /* INCLUDE_FEI_END */
*/
    :      :      :
    :      :      :
```

2.3.13.4 Freescale TSEC / eTSEC

2.3.13.4.1 Build instructions for VxWorks

There is no support for the WindRiver DIAB compiler. In order to use this driver in VxWorks BSP's which are DIAB compiled, this driver should be compiled as C-Code (not C++).

The driver should be compiled with the standard WindRiver Workbench settings for a "Downloadable Kernel Module" project with module name "emlETSEC.out". Recommended compiler flags:

Debug Build:

-DDEBUG

Debug and Release Build:

-xc -std=c99 -DVXWORKS -DNO_PCI_SUPPORT -mspe=no

-xc: Generate C Code, ignore file extension.
 -std=c99: Allows use of "/" as comment.
 -DVXWORKS Hint for the Os-Layer.
 -DNO_PCI_SUPPORT Don't reference pciLib in VxWorks's Os-Layer.
 -mspe=no Forbid generation of code which accesses the SPE unit.
 EC-Master VxWorks tasks are started without VX_FP_TASK or
 VX_SPE_TASK flags. Without this option "SPE Unavailable Exception" may be raised.

2.3.13.4.2 VxWorks driver interactions

There may be concurrent accesses by the VxWorks and our driver if the "motetsec" VxWorks driver is configured into the BSP. Due to 3.1.1, this may also happen if the VxWorks driver is disabled (i.e. muxDevUnload() for the specified interface).

The mutex handle, specified by poDrvSpecificParam->oMiiBusMtx can be used to synchronize the concurrent accesses to the MDIO registers. Note that this handle must be created by LinkOsCreateLock(). The LinkOsLock() and LinkOsUnlock() calls in EcDeviceETSEC.cpp can also be changed, so that a native VxWorks mutex handle (SEM_ID) can be used instead.

Pseudo code for getting the device mutex (see vxbEtsecEnd.c):

```
VXB_DEVICE_ID miiDev = vxbInstByNameFind ("motetsec", 0);
ETSEC_DRV_CTRL *pDrvCtrl = miiDev->pDrvCtrl;
semTake(pDrvCtrl->etsecDevSem);
...
semGive(pDrvCtrl->etsecDevSem);
```

There may also be a VxWorks task running (miiBusMonitor), which periodically checks the link status of attached PHY's. It is recommended to disable this task in order to avoid potential link problems.

2.3.13.5 SNARF / EtherLib Link Layer

The SNARF or EtherLib Link Layer is only needed if none of the optimized Link Layers can be used (see above).

The appropriate network adapter drivers have to be added to the VxWorks image. The demo requires the VxWorks image to support the Intel Pro/100 network card – FEI device and the Intel Pro/1000 network card – GEI device. The macros `INCLUDE_FEI_END` and `INCLUDE_GEI8254X_END` or respectively `INCLUDE_..._VXB_END` have to be set in the BSP configuration file `config.h`.

If using **KUKA VxWin** (Windows runs on top of VxWorks) the network adapter card used for EtherCAT has to be assigned to VxWorks. On APIC systems the interrupt used by the network card has to be activated for VxWorks (configuration file `interrupt.config`, a detailed description can be found in the VxWin manual).

The following VxWin support files are located in `...\SDK\FILES\SNARF\VXWIN` (VxWin version 3.1.1):

- Windows INF file to assign a Intel Pro/100 network adapter card to VxWorks: `RTOS_I82557.inf`
- VxWorks 6.1 image file containing Intel Pro/100 driver:
`V3.1.1\VxWorks61\VxWorks61_SNARF_PRO100.zip` (two files, one with ELF file format to be used by the target server and a second binary file for the VxWin uploader).

2.3.14 Xenomai

The system must be setup first the same way as for EC-Master for Linux, see chapter 2.3.5 “Linux”, especially installation of the `atemsys` module and optimized Link Layer usage preparation.

The binaries are built using the following versions:

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

2.3.15 SylxOS

The used ethernet port instance should be unbind from the OS otherwise the proper operation can't be guaranteed.

The LinkLayer is available as a shared library `"libemllI8254x.so"`.
 At the I8254x LinkLayer the interrupt mode is currently not supported.

2.4 Running EcMasterDemo

The EcMasterDemo 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 to `ecmaster0.log`, `error0.log`

See chapter 3.1 “Application framework and example application” for detailed explanation.

The EcMasterDemo is available “out of the box” for different operating systems. The operating system must be prepared for running EC-Master applications, see 2.3, “Operating system configuration”.

2.4.1 Setting up and running the demo

2.4.1.1 DOS GO32-V2

Step 1: Operating system configuration

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

Step 2: Starting EcMasterDemo

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. The DPDI server CSWDPRO.exe has to be present in system either in the same folder as EcMasterDemo.exe or has to be accessible over PATH environment variable.

Example

```
EcMasterDemo.exe -f c:\test.xml -r6040 1 1 -t 60000
```

2.4.1.2 eCos

Step 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	
Make exit() call fflush()	
_exit() stops all threads	
Default environment	{ NULL }
Invoke default static constructors	
ISO environment startup/termination build options	
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 *)"-i8254x",(char *)"1",(char *)"1",(char *)"-v",
(char *)"3",(char *)"-t",(char *)"60000",(char *)"-perf",(char *)NULL}}
```

Step 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)"

Step 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.

Step 4: Configure Grub to load the application

Adjust the Grub menu file:

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

Step 5: Load and start the EcMasterDemo with Grub

Step 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>
```

2.4.1.3 IntervalZero RTX

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.

Example:

```
RTSSrun EcMasterDemo.rtss -f c:\test.xml-i8255x 1 1 -t 60000
```

2.4.1.4 INtime

Step 1: Operating system configuration

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

Step 2: Starting 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 -wait 40 -node NodeA -stderr EcMasterDemo.rta -i8254x 1 1 -t 3000 -b 4000 -perf -f test.xml
```

2.4.1.5 Linux

Step 1: Operating system configuration

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

Step 2: Starting EcMasterDemo

```
cd /opt/EC-Master-Linux/Bin/Linux/x86
./EcMasterDemo -f MasterENI.xml -i8254x 2 1 -perf
```


2.4.1.6 Microsoft Windows (EcMasterDemo)

Step 1: Windows configuration

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

Step 2: Determine the network interface

Using the command line option the network interface card used by the example application can be determined. For example the option `-winpcap 192.168.110.11` will be using the network adapter card with the IP address 192.168.110.11.

Step 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.

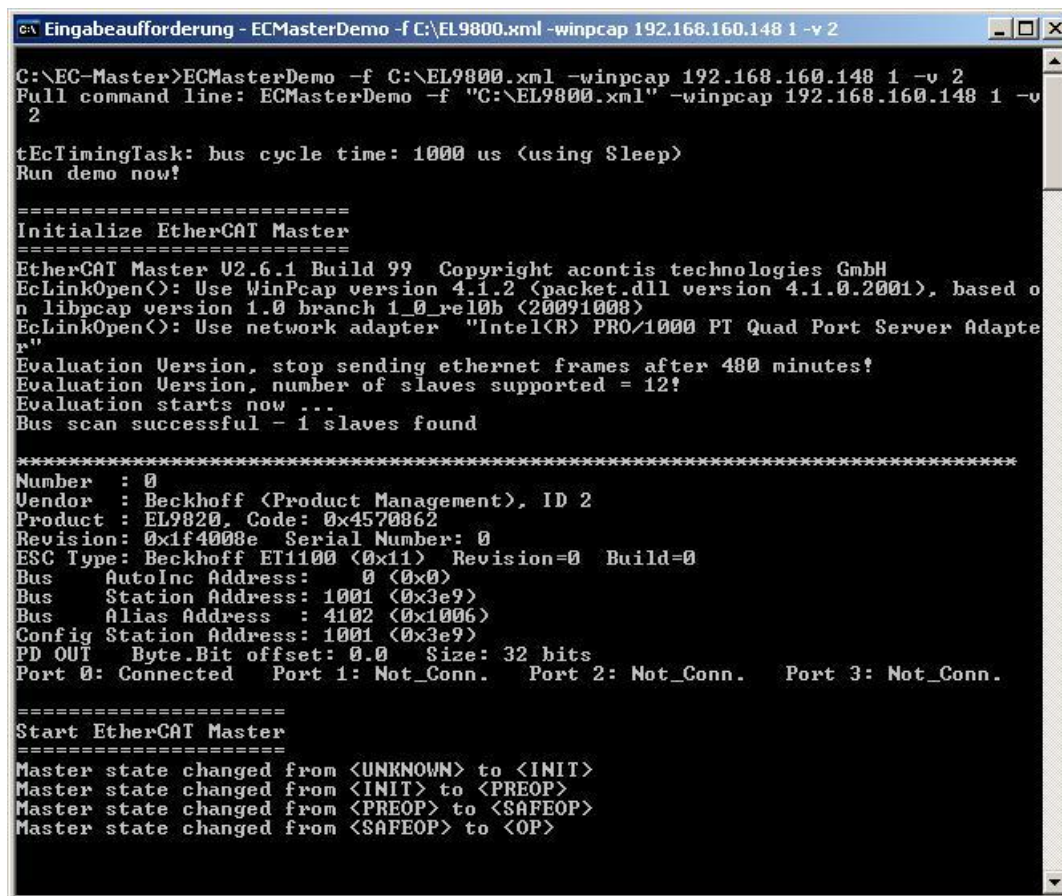
Step 4: Copy all of the example application files into one directory

The application `EcMasterDemo.exe` together with the master stack DLL `EcMaster.dll`, the link-layer DLL `emllPcap.dll` and the configuration XML file (for example the file `el9800.xml`) have to be copied into one directory.

Step 5: Run the example application

The file `EcMasterDemo.exe` has to be executed. The file name of the configuration file has to be given as a command line parameter as well as the appropriate Link Layer settings.

Example (starting the application with command line parameter `-f C:\EL9800.xml -winpcap 192.168.160.148 1 -v 2`):



```

C:\EC-Master>EcMasterDemo -f C:\EL9800.xml -winpcap 192.168.160.148 1 -v 2
Full command line: EcMasterDemo -f "C:\EL9800.xml" -winpcap 192.168.160.148 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
EcLinkOpen(): Use WinPcap version 4.1.2 (packet.dll version 4.1.0.2001), based on
n libpcap version 1.0 branch 1_0_rel0b (20091008)
EcLinkOpen(): Use network adapter "Intel(R) PRO/1000 PT Quad Port Server Adapter"
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=0
Bus AutoInc Address: 0 (0x0)
Bus Station Address: 1001 (0x3e9)
Bus Alias Address : 4102 (0x1006)
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>
  
```

2.4.1.7 Microsoft Windows (EcMasterDemoDotNet, .NET)

Step 1: Open the Workspace

Please find the solution including the C#-project for VS2005 at
Workspace\Windows\VS2005\EcMasterDemoDotNet\EcMasterDemoDotNet.sln

Step 2: Compile the application

Step 3: Copy DLLs in the executable's folder

To run the EcMasterDemoDotNet.exe, copy EcMaster.dll, EcMasterDotNet.dll and emllPcap.dll from
Bin\Windows\x86 to the executable's folder

Step 4: Run/Debug EcMasterDemoDotNet.exe

2.4.1.8 Microsoft Windows CE

Step 1: Windows CE configuration

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

Step 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.

Step 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.

Step 4: Copy the example application to target

The target has to be started and the application EcMasterDemo.exe together with the master stack DLL EcMaster.dll and the configuration XML file (for example the file el9800.xml) has to be copied onto the target.

Step 5: 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):

```

172.17.7.148 - PuTTYtel
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>

```

2.4.1.9 QNX Neutrino

Step 1: QNX Neutrino OS configuration

See 2.3.8 “QNX Neutrino” for how to prepare the operating system.

In order to get real-time priority (e.g. 250), see 2.3.8.1 “Thread priority” and also set `JOBS_PRIORITY`. The applications needs root privileges to increase the priority above 63.

Step 2: Determine the network interface

The network interface card and Link Layer to be used for the demo application can be set via command line. For example the option `-i8255x` will dynamically load the Link Layer for the Intel Pro/100 interface. The corresponding network interface driver maybe needs to be un-mounted using the `umount` command in the QNX shell. For example the command `umount /dev/io-net/en1` unloads the driver for the interface `en1`.

Step 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.

Step 4: Copy the example application to target

The QNX target has to be started and the application `EcMasterDemo` and the configuration XML file (for example the file `el9800.xml`) has to be copied onto the target.

Step 5: Copy the Link Layer files (shared object files) to target

The Link Layer library (e.g. emll8255x.so) which contains hardware support for the corresponding NIC must be downloaded. The Link Layer library should be located in /lib/dll or any other location that is specified by the _CS_LIBPATH configuration-string.

Step 6: Run the example application

The EcMasterDemo.exe and the libraries have to be executable. 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:

```
./EcMasterDemo -f /tmp/test.xml -i8255x 1 1 -t 60000
```

2.4.1.10 Renesas R-IN32M3

2.4.1.10.1 Prerequisites, basic settings:

- Hardware:
 - o R-IN32M3-EC Evaluation Board,
 - o adviceLUNA Emulator
- Software:
 - o microVIEW-PLUS debugger,
 - o GNU compiler (Sourcery G++ Lite for ARM EABI)
- Verify TCP/IP evaluation sample from Renesas works fine. Please download from official Renesas site following files: r-in32m3_tcpip_evaluation.zip and r-in32m3_samplesoft.zip.

2.4.1.10.2 How to create the demo applications

- 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. File should be manually modified to look like:


```
unsigned char MasterENI_xml_data[] = {
    ...
};
unsigned int MasterENI_xml_data_size = ???;
```
- Import project Workspace\RIN32M3\EcMasterDemo into Eclipse IDE.
- Hardcoded parameters for the demo can be changed using DEMO_PARAMETERS definition. See "ECMasterDemo Command line options" for details.

2.4.1.10.3 How to run the EC-Master demo application

- Upload Workspace\RIN32M3\EcMasterDemo\Release\EcMasterDemo.bin with debugger and run

2.4.1.11 Renesas RG/G1e

2.4.1.11.1 Prerequisites, basic settings:

- Hardware:
 - o RZ/G1E Starter Kit board,
 - o J-Link PRO emulator
- Software:
 - o SEGGER J-Link debugger,
 - o GNU compiler (gcc-arm-none-eabi-4_8-2013q4-20131204-win32.exe)

2.4.1.11.2 How to create the demo applications

- 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. File should be manually modified to look like:


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

```
unsigned int MasterENI_xml_data_size = ???;
```

- In command line window change folder to Workspace\RZGNoOS\EcMasterDemo. Run make.
- Hardcoded parameters for the demo can be changed using DEMO_PARAMETERS definition. DEMO_PARAMETERS is hardcoded for 20 seconds demo duration.

2.4.1.11.3 How to run the EC-Master demo application

Refer to "RZ/G1E NonOS-PF User's Manual" as binary file Release/EcMasterDemo

2.4.1.12 RTAI

Step 1: Load required RTAI Kernel modules

Example:

```
> insmod /usr/realtime/modules/rtai_hal.ko
> insmod /usr/realtime/modules/rtai_sched.ko
> insmod /usr/realtime/modules/rtai_shm.ko
```

Step 2: Make sure that the native Linux driver for the EtherCAT network card is not loaded

Note: SockRaw cannot be used with RTAI.

See 2.4.1.5 "Linux" for how to unload drivers that may use network adapter.

Step 3: Copy the ENI file to target

The location of the ENI file is /opt/EC-Master-RTAI/Examples/EcMasterDemoDc/RTAI/MasterENI.xml .

Step 4: Create the EcMasterDemoDc RTAI Kernel module

```
> cd /opt/EC-Master-RTAI/Examples/EcMasterDemoDc/RTAI
> make -f Kbuild
```

Step 5: Load the EcMasterDemoDc RTAI Kernel module

```
> insmod KcCMasterDemoDc.ko
```

Step 6: Verify that the EcMasterDemoDc RTAI Kernel module is loaded successfully

Give the EcMasterDemoDc RTAI module some seconds to start.

dmesg shows that the EC-Master has successfully started:

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

2.4.1.13 RTEMS

Step 1: Operating system configuration

Build the RTEMS operating system with least following configuration parameters:

```
--target=i386-rtems4.11 --enable-rtemsbsp=pc386 --enable-cxx
```

Step 2: Compile EcMasterDemo

To configure ENI file and logging, see function `rtemsMountFilesystems()`.

Step 3: Starting the demo

Boot the file EcMasterDemo.exe. 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

```
EcMasterDemo.exe -f /mnt/hda1/eni.xml -t 60000 -i8254x 1 1
```

2.4.1.14 TI RTOS/SYSBIOS

2.4.1.14.1 Prerequisites, basic settings:

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

Make sure your CCS 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

2.4.1.14.2 How to create the demo applications

- 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
- On TI RTOS the EcMasterDemo can run with either CPSW or ICSS link layer.
Eg: AM572x with ICSS link layer
Workspace\SYSBIOS_AM57x in CCS Studio and import all projects from this directory:
 - EcMaster
 - emIIICSS
 - EcMasterDemoICSS
 - EcMasterDemoDciCSS

Eg: AM572x with CPSW link layer

Workspace\SYSBIOS_AM57x in CCS Studio and import all projects from this directory:

- EcMaster
- emIICPSW
- EcMasterDemoCPSW
- Hardcoded parameters for the demo can be changed using DEMO_PARAMETERS definition. See "ECMasterDemo Command line options" for details.

2.4.1.14.3 How to run the EC-Master demo application

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

2.4.1.14.4 How to run the EC-Master motion demo application

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

2.4.1.15 Windriver VxWorks

Step 1: VxWorks OS configuration

See section VxWorks, SNARF Link Layer or KUKA VxWin, SNARF Link Layer for how to prepare the operating system.

Step 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.

Step 3: Connection of the EtherCAT slaves

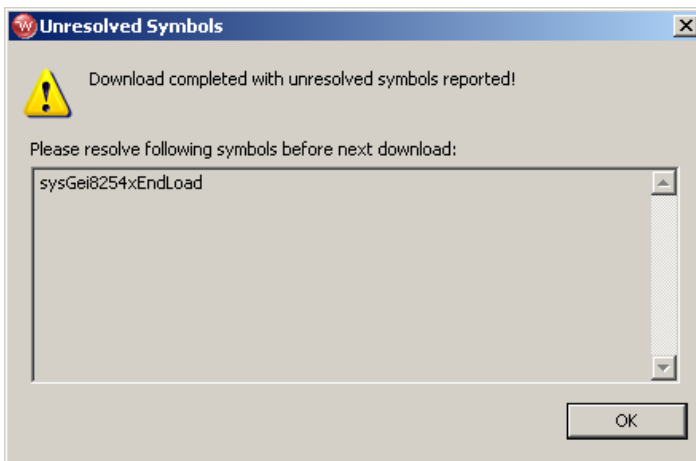
The slaves have to be connected with the VxWorks system using an Ethernet switch or a patch cable. Local IT infrastructure should not be mixed with EtherCAT modules at the same switch as the EC-Master will send many broadcast packets!

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.

Step 4: 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.

There may be unresolved symbols in case of a missing Link Layer. For example if the Intel Pro/1000 network driver is not included into the image the following dialog will be shown:



Message may be safely ignored if using the PRO/100 Link Layer.

Step 5: Download a Link Layer module

The Link Layer library (e.g. emll8255x.out) which contains hardware support for the corresponding NIC must be downloaded.

By default the Link Layers emllSnarfGpp / emllSnarfPid are contained with the binary delivery.

Step 6: Set up a FTP server connection on host

The demo application needs to load a XML file (MasterENI.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 MasterENI.xml will have to be accessed using the default directory.

Step 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

Step 8: Run the example application

The downloadable module EcMasterDemo.out has to be executed. The configuration file EL9800.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 atemDemo, "-f EL9800.xml -i8254x 1 1 -v 2"
```

Example:



```
172.17.7.148 - PuTTYtel
-> ld<emlli8254x.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>
```


2.4.1.16 Xenomai

Step 1: Prepare system

Prepare the system to run EcMasterDemo on Linux as described in chapter 2.4.1.5, "Linux".

Step 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, LDFLAGS, LD_LIBRARY_PATH are set accordingly (export ARCH=x86, ...) when compiling using Eclipse!

Step 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 -I8254x 2 1 -f eni.xml -v 3
[...]
(gdb) handle SIGXCPU nostop noprint nopass
(gdb) run
```

2.4.1.17 SylixOS

Step 1: Prepare system

- Setup your x64 operation system, unbind the wanted Ethernet port.
- Connect the SylixOS PC to the host PC via Ethernet and test the connection via FTP and TELNET

Step 2: Compile EcMasterDemo

- Install the RealEvo-IDE
- Start and open the Workspace
- Add the Base-Project "AT_SylixOSBase_x64", ensure the chosen Toolchain and CPU Type as 64bit (called "x86-64"), and build it
- Add the EcMasterDemo-Project, ensure the variable SYLIXOS_BASE_PATH in the "config.mk" is set to the Base-Project and build it
(All configurations in the EcMasterDemo Project have to be done in the make files!)

Step 3: Run using GDB

- Add the SylixOS PC as device. Open Properties of the EcMasterDemo project. Go to "SylixOS Project" -> "Device Setting", open "New Device", add a new Device with the IP address of the SylixOS PC
- Open the "Debug Configuration", create a new "SylixOS Remote Application" and enter the Argument Settings "-i8254x 1 1 -f "eni.xml" -t 10000 -auxclk 500" (If you chose the wrong instance of the Ethernet port you could kill your Debug connection. "-i8254x <Instance> 1")
- Copy the shared libraries of the EcMaster and the LinkLayer to the "/lib/" folder on the SylixOS PC or the folder of the EcMasterDemo /app/EcMasterDemo/ ("EcMaster.so" and "emllI8254x.so")
And copy your ENI-file to the folder of the EcMasterDemo on the SylixOS PC
- Start debugging

2.4.1.18 eT-Kernel

Step 1: Prepare system

- Install eBinder and all necessary packages like the BSP (Boards Support Package)
- Connect the JTAG-Debugger to the Board and to you PC and PC via USB to the Board
- Follow the instruction of the Getting Started Document of the BSP
- Test both debug connections

Step 2: Compile EcMasterDemo

- Create a new project for the Board, with your JTAG Debugger, UART as Debug Port Package, select the packages "LSF Subsystem", "eSOL make Framework" and "RealtimeProfiler", and use default configurations
- Set the SMP configurations in the SYSCONF file as mentioned in the Getting Started Document and define the unchached memory for DMA
 - Configuration->Product Configuration->Parts->eT-Kernel Multi ...->T-Kernel , enable the checkbox for "allocate memory for unchached area",
 - type in the "start address of unchached area" and
 - the for "size of unchached area"
 - in the SYSCONF file set the RealMemEnd parameter to the start address.
- Run the script Script->eT-Kernel Multi-Core Edition-> Build eT-Kernel libraries
- right click on DEBUG and choose build
- right click on "all" and click on Add->Build Reference->Files... , Choose the EcMasterDemo.bld file at Workspace->eT-Kernel->EcMasterDemo
- restart eBinder to ensure everything is saved

Step 3: Adjust ENI and set Parameters

- Demo Parameters are located in AtemDemoConfig.h

```
#elif (defined EC_VERSION_ETKERNEL)
```

```
  :
```

```
  #define DEMO_PARAMETERS          "-b 2000 -fsletsec 1 1 -v 3 -t 30000" // or -fslfec
  #else
```

- Create ENI file for EtherCAT configuration.
- Convert eni file to the C file with array. You can use xxd.exe (Juergen Weigert) with parameters: xxd.exe -i eni.xml ENI.c or some other tool which converts binary file to the C array. Replace ENI.c file with the generated one. File should be manually modified to look like:

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

Step 3: Start EcMasterDemo

- Script -> Program Loading Shell Scripts -> Load Resident Unit
- the new Window click on the GO button, open the VTTY tab and right click on it and set to active
- right click on EcMasterDemo.a choose "load" (this will take a while)
- for the execution you have two choices

1. For Debugging

- Open "Contexts"
- Create ... (a Task) With the function EcMasterDemo() and a stacksize of 0x4000
- The Attache the Task
- In the new window you can step through the code

2. for simple Execution

- type "EcMasterDemo();" in the shell

Handle lost log prints:

- the VTTY assigns the prints to the printing task and if the logging task is not attached (has its debug window open) the prints can get lost
- to prevent this we can turn the Logging Task off (with the define EXCLUDE_LOGGING_TASK) so the prints are saved (it's limited) and printed in the end in the main window.

2.4.2 Command line parameters

EcMasterDemo <Link Layer> [-f configFileName] [-t time] [-b time] [-v level] [-a affinity] [-perf] [-auxclk period] [-sp [port]]

e.g. EcMasterDemo -winpcap 192.168.157.2 1 -f MasterENI.xml -t 0 -v 3

The parameters are as follows:

- **-f <configFileName>**
Path to ENI file. **Note:** On Windows CE absolute file paths are needed.
- **-t <time>**
<time>: Time in msec, 0 = forever (default = 120000)
Running duration in msec. When the time expires the demo application exits completely.
- **-b <cycle time>**
<cycle time>: Bus cycle time in μsec
Specifies the bus cycle time. Defaults to 1000 μs (1ms).
- **-v <level>**
<level>: Verbosity level: 0=off (default), 1..n=more messages
The verbosity level specifies how much console output messages will be generated by the demo application. A high verbosity level leads to more messages.
- **-a <affinity>**
<affinity>: 0 = first CPU, 1 = second, ...
The CPU affinity specifies which CPU the demo application ought to use.
- **-perf**
Enable max. and average time measurement in μs for all EtherCAT jobs (e.g. ProcessAllRxFrames) .
- **-auxclk <period>**
<period>: Clock period in μs (if supported by Operating System).
- **-sp [port]**
If platform has support for IP Sockets, this commandline option enables the Remote API Server to be started with the EcMasterDemo. 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.
This option is included for attaching the EC-Lyser Application to the running master.
- **-log prefix**
Use given file name prefix for log files.

2.4.2.1 Link Layer

Using one of the following Link Layer options, the demo application will dynamically load the network driver for the specified network adapter card (e.g. `-i8254x 1 1` for the Intel Pro/1000 network card). The EtherCAT master then will use the appropriate network driver to access the Ethernet adapter.

- **`-i8254x <instance> <mode>`**
 <instance>: Device instance 1=first, 2=second
 <mode>: Mode 0 = Interrupt mode, 1= Polling mode
 Hardware: Intel Pro/1000 network adapter card
- **`-i8255x <instance> <mode>`**
 <instance>: Device instance 1=first, 2=second
 <mode>: Mode 0 = Interrupt mode, 1= Polling mode
 Hardware: Intel Pro/100 network adapter card
- **`-rtl8139 <instance> <mode>`**
 <instance>: Device instance 1=first, 2=second
 <mode>: Mode 0 = Interrupt mode, 1= Polling mode
 Hardware: Realtek RTL8139
- **`-rtl8169 <instance> <mode>`**
 <instance>: Device instance 1=first, 2=second
 <mode>: Mode 0 = Interrupt mode, 1= Polling mode
 Hardware: Realtek RTL8168 / RTL8169 / RTL8111
- **`-winpcap <ipAddress> <mode>`**
 <ipAddress>: IP address of network adapter card, e.g. 192.168.157.2
 <mode>: Mode 0 = Interrupt mode, 1= Polling mode
 Hardware: Hardware independent.
- **`-snarf <adapterName>`**
 <adapterName>: Adapter name, e.g. fei0
 Hardware: Hardware independent
 This parameter is only available for VxWorks
- **`-etherlib <adapterName>`**
 <adapterName>: Adapter name, e.g. fei0
 Hardware: Hardware independent
 This parameter is only available for VxWorks (5.4-5.5GPP)
- **`-hnx <instance>`**
 <instance>: Device instance (0=first), e.g. 0
 Hardware: Hilscher NetX XPEC Builtin PHY raw driver
- **`-sockraw <device>`**
 <device>: Network device, e.g. eth1
 Hardware: Hardware independent
 This parameter is only available for Linux.
- **`-hnx`**
 Hardware: Hilscher NetX XPEC Builtin PHY raw driver
- **`-ndisuio`** (Windows CE only)
 Using this option the example application will dynamically load the NDISUIO driver for the specified network adapter card (e.g. `-ndisuio PCI\RTL81391`). The EtherCAT master then will use NDISUIO to access the Ethernet adapter.

- **-fslfec <instance> <mode>**
Hardware: Freescale FEC/ENET
<Instance>: Device instance 1=first, 2=second
<Mode>: Mode 0 = Interrupt mode, 1= Polling mode
<RefBoard> custom or mars or sabrelite or imx28evk or topaz
if custom
<FecType> imx25 or imx28 or imx53 or imx6
<PhyInterface> fixed or mii or rmii or gmii or sgmii or rgmii
- **-ccat <instance> <mode>**
<instance>: Device instance 1=first, 2=second
<mode>: Mode 0 = Interrupt mode, 1= Polling mode
Hardware: Beckhoff CCAT
- **-gem <instance> <mode>**
Hardware: Xilinx Zynq-7000 (GEM)
<instance>: Device instance 1=first, 2=second
<mode>: Mode 0 = Interrupt mode, 1= Polling mode
<PhyAddr>: Optional parameter: PHY address (0..31)
<PhyConMode>: Optional parameter: PHY connection mode MIO (0) or EMIO (1)
<UseGmiiToRgmii>: Optional parameter: Use Xilinx GmiiToRgmii converter true (1) or false (0)
<GmiiToRgmiiPort>: Optional parameter: GmiiToRgmii converter PHY address 0 .. 31
- **-icss <instance> <mode> <masterflag> <refboard> [tts tts_config_time]**
Hardware: Texas Instruments Board with PRUSS
<instance>: ICSS Port (100 Mbit) 1..4
<mode>: Mode 0 = Interrupt mode, 1= Polling mode
<masterflag>: (m) Master (Initialize board, mdio, both phy), (s) Slave
<refboard>: am572x-idk | am571x-idk | am3359
[tts tts_config_time] OPTIONAL - activate TTS mode, tts_conf_time: 50 .. 1000 EtherCAT Master config time (usec)
- **-rin32m3**
Hardware: Renesas R-IN32M3-EC
- **-dw3504 <instance> <mode> <PhyAddress>**
Hardware: Synopsys DesignWare 3504-0 Universal 10/100/1000 Ethernet MAC (DW3504)
<instance>: Device instance 1=first, 2=second
<mode>: Mode 0 = Interrupt mode, 1= Polling mode
<phyaddress>: 0 .. 31
- **-r6040 <instance> <mode>**
Hardware: RDC R6040
<instance>: Device instance 1=first, 2=second
<mode>: Mode 0 = Interrupt mode (currently not supported), 1= Polling mode
- **-sheth <instance> <mode> <RefBoard>**
Hardware: Renesas RZG1 or Armadillo-800 EVA
<instance>: Device instance 1=first, 2=second
<mode>: Mode 0 = Interrupt mode (currently not supported), 1= Polling mode
<RefBoard> rzg1e or a800eva

2.5 Compiling the EcMasterDemo

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:

- Documentation (...\Doc)
- EtherCAT Software Development Kit (...SDK) containing libraries and header files to build C/C++-applications.
 - ...Bin: Executables containing the master stack
 - ...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
- One or multiple example applications (...Examples) using a predefined EtherCAT-configuration. It is easily adaptable to different configurations using an appropriate EtherCAT configuration XML file.

2.5.2 General

For all operating systems the same principal rules to generate the example applications can be used.

2.5.2.1 Include search path

The header files are located in the following two directories:

- a) <InstallPath>\SDK\INC\<OS>\<ARCH> (where <OS> is a placeholder for the operating system and <ARCH> for the architecture if different architectures are supported)
- b) <InstallPath>\SDK\INC
- c) <InstallPath>\Sources\Common

2.5.2.2 Preprocessor macro

The demo applications are the same for all operating systems. The appropriate pre-processor macro has to be set for the operating system, see also chapter 2.5.3 “OS Compiler settings” below.

2.5.2.3 Libraries

The libraries located in <InstallPath>\SDK\LIB\<OS>\<ARCH> have to be added (<OS> is a placeholder for the operating system used and <ARCH> for the architecture if different architectures are supported).

2.5.3 OS Compiler settings

2.5.3.1 DOS GO32-V2

The following settings are necessary to build the example application for DOS GO32-V2.

- Extra include paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/SDK/INC/GO32-V2
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
 - <InstallPath>/Workspace/GO32-V2/GO32-V2_common/include
- Extra source paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/Sources/Common/EcTimer.cpp
- Extra library paths to the main EtherCAT components:
 - <InstallPath>/SDK/LIB/GO32-V2

Extra libraries

libEcMaster.a libemllR6040.a

2.5.3.1.1 How to create the demo applications

- The DJGPP toolchain has to be installed and configured.
- Start the RHIDE IDE and open the project EcMasterDemo.gpr
- Build the project: menu "Compile" -> "Build all"
- Alternatively the project can be build from the command line like the following:

```
make -f EcMasterDemo.mak
```

Important! To run the demo application it is necessary to quit the RHIDE IDE and start the application as written above from command line.

2.5.3.2 eCos

The following settings are necessary to build the example application for eCos.

- Extra include paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/SDK/INC/eCos
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
- Extra source paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/Sources/Common/EcTimer.cpp
 - <InstallPath>/Sources/OsLayer/eCos/EcOs.cpp
- Extra library paths to the main EtherCAT components:
 - <InstallPath>/SDK/LIB/eCos/x86
- Extra libraries:
 - libEcMaster.a libemllI8254x.a libtarget.a

2.5.3.3 Greenhills INTEGRITY

The following settings are necessary to build the example application for INTEGRITY.

- Extra include paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/SDK/INC/INTEGRITY
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
- Extra source paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/Sources/Common/EcTimer.cpp
- Extra library paths to the main EtherCAT components:
 - <InstallPath>/SDK/LIB/INTEGRITY/x86
- Extra libraries (in this order)
 - AtemRasSrv EcMaster

2.5.3.4 Linux

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-eabi, x64 (aka amd64), x86 (aka i686), PPC (with "-te500v2")

armv4t-eabi and armv6-vfp-eabi are incompatible with each other. A potentially armv6-vfp-eabi-compatible system returns success on "readelf -A /proc/self/exe | grep Tag_ABI_VFP_args". If "readelf" isn't available on the target, the matching ARM version can be figured out by trying to run EcMasterDemo.

- Extra include paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/SDK/INC/Linux
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
- Extra source paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/Sources/Common/EcTimer.cpp
- Extra library paths to the main EtherCAT components (replace "x86" according to ARCH):
 - <InstallPath>/SDK/LIB/Linux/x86
- Extra libraries (in this order)
 - AtemRasSrv EcMaster pthread dl rt

Xilinx Zynq-7000 needs extra CFLAGS "-mcpu=cortex-a9 -march=armv7-a".

2.5.3.5 Microsoft Windows CE

The following settings are necessary to build the example application (e.g. *Win32 Smart Device Project Console Application*) for Windows CE:

- Preprocessor definitions:
 - CEWIN if running on acontis EC-WinCE.
- Include path:
 - <InstallPath>/SDK/INC/WinCE
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
- Don't "Treat wchar_t as Built-in Type"

- Library path of the main EtherCAT components:
`<InstallPath>/SDK/LIB/WINCE<Version>/<Arch>`
- Libraries:
`"coredll.lib", "corelibc.lib", "EcMaster.lib" and "AtemRasSrv.lib"`
- Entry Point:
`mainWCRTStartup`

2.5.3.6 Microsoft Windows

The following settings are necessary to build the example application for Windows:

- Library path of the main EtherCAT components:
`<InstallPath>/SDK/LIB/Windows/<Arch>`
- Include path:
`<InstallPath>/SDK/INC/Windows`
`<InstallPath>/SDK/INC`
`<InstallPath>/Sources/Common`

2.5.3.7 QNX Neutrino

The following settings are necessary to build the example application for QNX Neutrino.

- **Extra include paths:**
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/SDK/INC/QNX6
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
- **Extra source paths:**
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/Sources/Common/EcTimer.cpp
- **Extra library paths to the main EtherCAT components:**
 - <InstallPath>/SDK/LIB/QNX6/x86

Extra libraries

AtemRasSrv EcMaster socket

2.5.3.8 RTEMS

The following settings are necessary to build the example application for RTEMS.

- **Extra include paths:**
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/SDK/INC/RTEMS
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
- **Extra source paths:**
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/Sources/Common/EcTimer.cpp
- **Extra library paths to the main EtherCAT components (replace “x86” according to ARCH):**
 - <InstallPath>/SDK/LIB/RTEMS/x86
- **Extra libraries (in this order)**
 - libEcMaster.a libemllI8254x.a libemllRTL8169.a libemllCCAT.a

2.5.3.9 Windriver VxWorks

The following settings are necessary to build the example application for VxWorks:

- Library path of the main EtherCAT components (general purpose platform):
`<InstallPath>/SDK/LIB/VxWorks<Version>/<Arch>`
- Include paths:
 - I`<InstallPath>/SDK/INC/VxWorks`
 - I`<InstallPath>/SDK/INC`
 - I`<InstallPath>/Sources/Common`

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

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

2.5.3.10 Xenomai

The following settings are necessary to build the example application for Xenomai (Linux).

- Extra include paths:
 - `<InstallPath>/Examples/EcMasterDemo`
 - `<InstallPath>/SDK/INC/Xenomai`
 - `<InstallPath>/SDK/INC`
 - `<InstallPath>/Sources/Common`
- Extra source paths:
 - `<InstallPath>/Examples/EcMasterDemo`
 - `<InstallPath>/Sources/Common/EcTimer.cpp`
 - `<InstallPath>/Sources/Sources/OsLayer/Xenomai/EcOs.cpp`
- Extra library paths to the main EtherCAT components:
 - `<InstallPath>/SDK/LIB/Xenomai/x86`
- Extra libraries (in this order)
 - o Xenomai 2:
`AtemRasSrv EcMaster pthread dl rt native xenomai`
 - o Xenomai 3:
`AtemRasSrv 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/>.

2.5.3.11 SylixOS

The following settings are necessary to build the example application for SylixOS.

- Extra include paths:
 - `<InstallPath>/Examples/EcMasterDemo`
 - `<InstallPath>/SDK/INC/SylixOS`
 - `<InstallPath>/SDK/INC`
 - `<InstallPath>/Sources/Common`
- Extra source paths:
 - `<InstallPath>/Examples/EcMasterDemo`
 - `<InstallPath>/Sources/Common/EcTimer.cpp`
 - `<InstallPath>/Sources/Sources/OsLayer/SylixOS/EcOs.cpp`
- Extra library paths to the main EtherCAT components:
 - `<InstallPath>/SDK/LIB/SylixOS/x64`
- Extra libraries

- o libEcMaster.so
- o libemllI8254x.so

2.5.3.12 eTKernel

The following settings are necessary to build the example application for eTKernel.

- Extra include paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/SDK/INC/TKernel
 - <InstallPath>/SDK/INC
 - <InstallPath>/Sources/Common
- Extra source paths:
 - <InstallPath>/Examples/EcMasterDemo
 - <InstallPath>/Sources/Common/EcTimer.cpp
- Extra library paths to the main EtherCAT components:
 - <InstallPath>/SDK/LIB/eT-Kernel/armv7/
- Extra libraries
 - o libEcMaster.a
 - o the link layer for example libemllETSEC.a

2.5.4 Link Layer selection and initialization

The different Link Layer modules are selected and parametered by a common structure (shared by all Link Layers) and a Link Layer specific structure, pointed to by an element within the common structure. This parameter set is given to the EtherCAT master stack with the call of `ecatInitMaster`.

2.5.4.1 ecatInitMaster

Initializes the EtherCAT master stack.

```
EC_T_DWORD ecatInitMaster(
    EC_T_INIT_MASTER_PARMS* pParms
);
```

Parameters

pParms

[in] Pointer to parameter definitions

Return

EC_E_NOERROR or error code

Comment

The EtherCAT master stack will be initialized by calling this function. This function has to be called prior to calling any other functions of the EtherCAT master.

```
typedef struct _EC_T_INIT_MASTER_PARMS{
    :           :           :           :
    :           :           :           :
    :           :           :           :
    :           :           :           :
    EC_T_LINK_PARMS* pLinkParms;
    :           :           :           :
    :           :           :           :
} EC_T_INIT_MASTER_PARMS;
```

Description

pLinkParms

- [in] Pointer to the common Link Layer parameters. This parameter set will be used by the master to load the appropriate Link Layer dynamically if present and contains the Link Layer specific parameter set (see below).

EC_T_LINK_PARMS

EtherCAT Link Layer common parameters.

```
typedef struct _EC_T_LINK_PARMS
```

```
{
    EC_T_DWORD      dwSignature
    EC_T_DWORD      dwSize;
    EC_T_CHAR       szDriverIdent[MAX_DRIVER_IDENT_LEN];
    EC_T_DWORD      dwInstance
    EC_T_LINKMODE    eLinkMode;
    EC_T_DWORD      dwIstPriority
} EC_T_LINK_PARMS;
```

Description

dwSignature

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

dwSize

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

szDriverIdent

- [in] Name of Link Layer module (driver identification) this name is used for Link Layer Selection

dwInstance

- [in] Instance of the adapter

eLinkMode

- [in] Mode of operation: EcLinkMode_POLLING or EcLinkMode_INTERRUPT

dwIstPriority

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

2.5.4.2 Link Layer specific parameter set

The Link Layer specific parameter set extends the common Link Layer parameters, which is described here.

Multi-Platform Link Layers may be available for several different operating systems. The initialization is widely generic.

2.5.4.2.1 CPSW EtherCAT driver

The parameters to the CPSW Link Layer are setup-specific.

The function "CreateLinkParmsFromCmdLineCPSW" in selectLinkLayer.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.

To refresh the link status, EC_LINKIOCTL_UPDATE_LINKSTATUS should be called from another task:

```
for (;;)
{
    ecIoControl(EC_IOCTL_LINKLAYER_MAIN + EC_LINKIOCTL_UPDATE_LINKSTATUS, EC_NULL);
    OsSleep(1000);
}
```

2.5.4.2.2 DW3504 EtherCAT driver

The parameters to the Synopsys DesignWare 3504-0 Universal 10/100/1000 Ethernet MAC (DW3504) Link Layer are setup-specific.

The function "CreateLinkParmsFromCmdLineDW3504" in selectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
typedef struct _EC_T_LINK_PARMS_DW3504
```

```
{
    EC_T_LINK_PARMS    linkParms;
```

```
    EC_T_DWORD    dwPhyAddr;  
    EC_T_DWORD    dwRegisterBasePhys  
} EC_T_LINK_PARMS_DW3504;
```

Description

linkParms

Common parameters

dwPhyAddr

[in] PHY address (0 .. 31) on MII bus

dwRegisterBasePhys

[in] Physical base address of register block (8k)

2.5.4.2.3 ICSS EtherCAT driver

The function “CreateLinkParmsFromCmdLineICSS” in selectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
typedef struct _EC_T_LINK_PARMS_ICSS
{
    EC_T_LINK_PARMS    linkParms;
    EC_T_BYTE          abyMac[6];
    EC_T_LINK_ICSS_BOARD eBoardType;
    EC_T_BOOL          bMaster;
    EC_T_BOOL          bTts;
    EC_T_DWORD          wTtsCycleTimeUsec;
    EC_T_DWORD          dwTtsSendTimeUsec;
    EC_T_LINK_ICSS_TTS_CALLBACK pfnTtsStartCycle;
    EC_T_VOID*          pvTtsStartCycleContext;
} EC_T_LINK_PARMS_ICSS;
```

Description

linkParms

Common parameters

abyMac

MAC station address

eBoardType

TI AM board id: EcLinkIcssBoard_am572x, EcLinkIcssBoard_am571x, EcLinkIcssBoard_am3359

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” and two ICSS ports are used. In this case, first port should be master, and second port should be slave.

bTts

Use Time-Triggered Send.

dwTtsCycleTimeUsec

Cycle time between two pfnTtsStartCycle calls. This value is your cycle time. In TTS mode board generates interrupt to begin each cycle.

dwTtsSendTimeUsec

Time between pfnTtsStartCycle call and frame transmission. In terms of TI it means the “configuration time”. During this period cyclic and acyclic frames are prepared and added to send queues of PRU firmware. Once this configuration time expired, firmware starts transmission of cyclic frames and achieves jitter of 40 ns.

pfnTtsStartCycle

Callback function called cyclically according dwTtsCycleTimeUsec. PRU firmware generates interrupt for begin of each cycle, link layer is notified and calls this callback function. The function is called from a separate thread, also there are no restrictions for ISR functions. This callback function is normally used to set internal synchronization event/mutex in application code, which is then received by a separate application thread and this thread starts preparation of cyclic/acyclic frames.

pvTtsStartCycleContext

Context passed to each pfnTtsStartCycle call. Normally, it is a pointer to an internal structure, that contains mutex/event object.

2.5.4.2.4 TTS Feature

PRU ICSS Link Layer for Ec-Master 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=>

2.5.4.2.5 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.

2.5.4.2.6 FreeScale FEC EtherCAT driver

/ Link parameters */*

typedef struct _EC_T_LINK_PARMS_FSLFEC

```
{
    EC_T_DWORD          dwType;
    EC_T_DWORD          dwUnit;
    EC_T_DWORD          dwLstPriority;
    PF_DOINT_HDL        pfDoIntHandling;
    EC_T_DWORD          dwRxBuffers;
    EC_T_DWORD          dwTxBuffers;
    PF_emIIISRCallback  pflsrCallback;
    EC_T_PVOID          pvlsrCBContext;

    EC_T_FEC_TYPE        eFecType;
    EC_T_PHY_INTERFACE  ePhylInterface;
} EC_T_LINK_PARMS_FSLFEC;
```

Description

dwType

Validation pattern. The value EC_LINK_TYPE_FSLFEC has to be assigned to this parameter.

dwUnit

Network adapter instance, first is identified with 1. The second with 2 etc.

dwLstPriority

Obsolete.

eLinkMode

Obsolete.

pfDoIntHandling

Obsolete.

dwRxBuffers

Amount of allocated receive buffers in queue.

dwTxBuffers

Amount of allocated transmit buffers in queue (each of which 1536 bytes of size).

eFecType

eFEC_IMX25 or
eFEC_IMX28 or
eFEC_IMX53 or
eFEC_IMX6

ePhylInterface

ePHY_FIXED_LINK or
ePHY_MII or
ePHY_RMII or
ePHY_GMII or
ePHY_SGMII or

ePHY_RGMII

Comment

The demo applications support out of the box some reference boards where the combinations eFecType/ePhyInterface are already defined.

2.5.4.2.7 FreeScale TSEC/eTSEC EtherCAT driver

The parameters to the ETSEC Link Layer are much more setup-specific than e.g. the Intel Pro/1000. The function "CreateLinkParmsFromCmdLineETSEC" in selectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
typedef struct _EC_T_LINK_PARMS_ETSEC
{
    EC_T_LINK_PARMS    linkParms;
    EC_T_DWORD          dwRegisterBase;
    EC_T_DWORD          dwLocalMdioBase;
    EC_T_DWORD          dwPhyMdioBase;
    EC_T_DWORD          dwPhyAddr;
    EC_T_DWORD          dwTbiPhyAddr;
    EC_T_DWORD          dwFixedLinkVal;
    EC_T_BYTE           abyStationAddress[6];
    EC_T_BYTE           byReserved[2];
    EC_T_VOID*          oMiiBusMtx;
    EC_T_DWORD          dwRxInterrupt;
    EC_T_BOOL           bNotUseDmaBuffers;
    EC_T_ETSEC_TYPE     eETSECType;
    EC_T_BOOL           bMaster;
} EC_T_LINK_PARMS_ETSEC;
```

Description

linkParms

Common parameters

eETSECType

[in] ETSEC chip type

dwRegisterBase

[in] Physical base address of register block (4k)

dwLocalMdioBase

[in] 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.

dwPhyMdioBase

[in] 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.

dwPhyAddr

[in] PHY address on MII bus. ETSEC_FIXED_LINK (0xFFFFFFFF) if fixed link configuration.

dwTbiPhyAddr

[in] 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.

dwFixedLinkVal

[in] Only evaluated if dwPhyAddr == ETSEC_FIXED_LINK. Set to ETSEC_LINKFLAG_100baseT_Full or ETSEC_LINKFLAG_LINKOK.

abyStationAddress

[in] MAC station address

oMiiBusMtx

[in] 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 Link Layer instances.

bMaster

[in] Full control over the MAC and need to initialize

dwRxInterrupt

[in] Receive interrupt number (IRQ)

bNotUseDmaBuffers

[in] Use buffers from DMA (EC_FALSE) or from heap for receive. AllocSend is not supported, when EC_TRUE.

2.5.4.2.8 Intel Pro/100 EtherCAT driver emIII8255x

```
typedef struct _EC_T_LINK_PARMS_I8255X
{
    EC_T_LINK_PARMS linkParms;
} EC_T_LINK_PARMS_I8255X;
```

Description

linkParms
Common parameters

Comment

```
#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;
```

For some operating systems it is possible to alternatively address the emIII8255x using its PCI address. See chapter 2.5.4.2.9, "Intel Pro/1000 EtherCAT driver emIII8254x" for an example of how to specify the PCI address.

2.5.4.2.9 Intel Pro/1000 EtherCAT driver emIII8254x

```
typedef struct _EC_T_LINK_PARMS_I8254x
{
    EC_T_LINK_PARMS linkParms;
    EC_T_WORD wRxBufferCnt;
    EC_T_WORD wRxBufferSize;
    EC_T_WORD wTxBufferCnt;
    EC_T_WORD wTxBufferSize;
    EC_T_BOOL bDisableLocks
} EC_T_LINK_PARMS_I8254x;
```

Description

linkParms
Common parameters
wRxBufferCnt
Amount of allocated receive buffers in queue.
wRxBufferSize
Size of allocated receive buffers in queue.
wTxBufferCnt
Amount of allocated transmit buffers in queue.
wTxBufferSize
Size of allocated transmit buffers in queue.
bDisableLocks
False: Thread-safe, True: Increase performance, but not thread-safe.

Comment

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

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

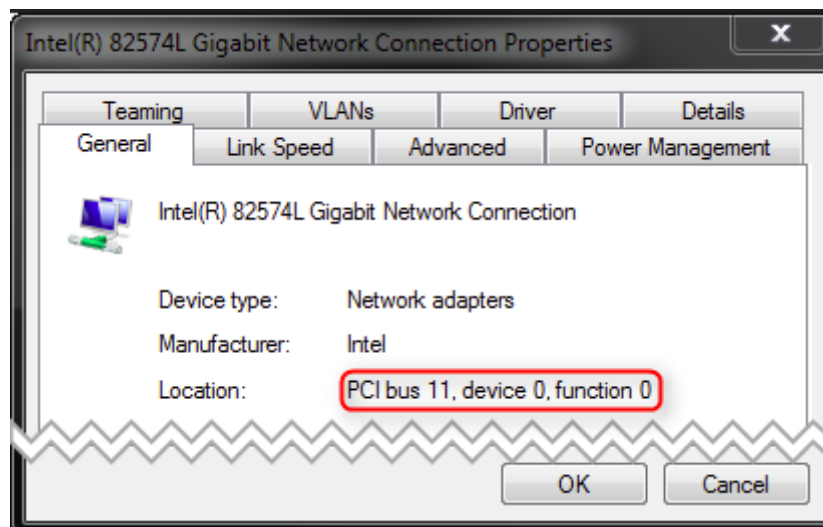
For some operating systems it is possible to alternatively address the emll8254x using its PCI address by adding EC_LINKUNIT_PCILLOCATION (0x01000000) and the PCI location as dwInstance.

On Linux the PCI address of the emll8254x can be shown using "lspci | grep Ethernet", e.g.:

```
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 dwInstanceId using PCI bus address is "0x01bbddff" with "bb" Bus Number, "dd" Device Number, "ff" Function Number. E.g. "0000:00:19.0" is dwInstanceId 0x01001900.

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 0x0B).



2.5.4.2.10 RDC R6040 EtherCAT driver emlR6040

```
typedef struct _EC_T_LINK_PARMS_R6040
{
    EC_T_LINK_PARMS linkParms;
} EC_T_LINK_PARMS_R6040;
```

Description

linkParms
Common parameters

Comment

```
#include "EcLink.h"
EC_T_LINK_PARMS_R6040 oLinkParmsAdapter;

OsMemset(&oLinkParmsAdapter, 0, sizeof(EC_T_LINK_PARMS_R6040));
oLinkParmsAdapter.linkParms.dwSignature = EC_LINK_PARMS_SIGNATURE_R6040;
oLinkParmsAdapter.linkParms.dwSize = sizeof(EC_T_LINK_PARMS_R6040);
OsStrncpy(oLinkParmsAdapter.linkParms.szDriverIdent,
    EC_LINK_PARMS_IDENT_R6040, MAX_DRIVER_IDENT_LEN - 1);
oLinkParmsAdapter.linkParms.dwInstance = 1;
oLinkParmsAdapter.linkParms.eLinkMode = EcLinkMode_POLLING;
oLinkParmsAdapter.linkParms.dwIstPriority = 0; /* not used */
```

2.5.4.2.11 Renesas SHEth Link Layer

The parameters to the SHEth Link Layer are setup-specific.[in] Super H Ethernet controller type
dwBaseAddr

2.5.4.2.12 VxWorks SNARF Link Layer

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":

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

OsMemset(&oLinkParmsAdapter, 0, sizeof(EC_T_LINK_PARMS_SNARF));
oLinkParmsAdapter.linkParms.dwSignature = EC_LINK_PARMS_SIGNATURE_SNARF;
oLinkParmsAdapter.linkParms.dwSize = sizeof(EC_T_LINK_PARMS_SNARF);
OsStrncpy(oLinkParmsAdapter.linkParms.szDriverIdent,
    EC_LINK_PARMS_IDENT_SNARF, MAX_DRIVER_IDENT_LEN - 1);
OsStrncpy(oLinkParmsAdapter.szAdapterName, "fei0", MAX_DRIVER_IDENT_LEN - 1);
```

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.

2.5.4.2.13 Windows CE NDISUIO Link Layer

A NDISUIO like Link Layer is shipped with the EtherCAT master stack. This Link Layer is based on a network filter driver that enables the software on top to send and receive raw Ethernet frames. Using this Link Layer any Windows CE standard network drivers can be used.

A PCI network adapter in Windows CE usually is identified using its registry instance key. The format for the instance key is PCI\CCCCn where CCCC is the name for the device and n is the instance number. The device name for a Realtek 8139 network adapter is RTL8139 and thus the first instance of this adapter gets the instance key PCI\RTL81391.

The ECAT Link Layer driver AtNdisUio.dll has to be installed first. This driver may either be statically loaded using appropriate registry keys or dynamically on behalf of the application.

The following registry keys are required to install this driver:

```
[HKEY_LOCAL_MACHINE\Drivers\BuiltIn\ECAT]
    "Prefix"="ECT"
    "Dll"= "AtNdisuio.dll"
    "Index"=dword:1
    "Order"=dword:3
```

The following steps show how to load and check for the driver:

```
#define NDISUIO_DEVNAME    TEXT("ECT1:")
#define NDISUIO_DRIVERKEY TEXT("Drivers\\BuiltIn\\ECAT")
HANDLE hNdisUioDevice     = EC_NULL;
HANDLE hNdisUioDriver     = EC_NULL;
/* check if NDISUIO driver started */
hNdisUioDevice = CreateFile( NDISUIO_DEVNAME,
                             GENERIC_READ | GENERIC_WRITE, 0, 0,
                             OPEN_EXISTING, 0, 0);

/* try to load driver if not already loaded */
if (hNdisUioDevice == EC_NULL)
{
    hNdisUioDriver = ActivateDeviceEx(NDISUIO_DRIVERKEY, 0, 0, 0);
}
/* check if driver is available */
if ((hNdisUioDevice == EC_NULL) && (hNdisUioDriver == EC_NULL))
{
    LogError("No NDISUIO ECAT driver available!!!\n");
}
else if (hNdisUioDevice != EC_NULL)
{
    /* close handle, it was just for the check */
    CloseHandle(hNdisUioDevice);
    hNdisUioDevice = EC_NULL;
}
}
```

The parameters for the NDISUIO EtherCAT Link Layer are set using a specific descriptor. The pvLinkParams value is a pointer to this descriptor:

```
#include "EcLink.h"
EC_T_LINK_PARMS_NDISUIO oLinkParamsAdapter;

OsMemset(&oLinkParamsAdapter, 0, sizeof(EC_T_LINK_PARMS_NDISUIO));
oLinkParamsAdapter.linkParams.dwSignature = EC_LINK_PARMS_SIGNATURE_NDISUIO;
oLinkParamsAdapter.linkParams.dwSize     = sizeof(EC_T_LINK_PARMS_NDISUIO);
OsStrncpy(oLinkParamsAdapter.linkParams.szDriverIdent,
          EC_LINK_PARMS_IDENT_NDISUIO, MAX_DRIVER_IDENT_LEN - 1);
OsStrncpy(oLinkParamsAdapter.szAdapterName, TEXT("\\PCI\\RTL81391"),
          MAX_LEN_NDISUIO_ADAPTER_NAME - 1);
```

```
typedef struct _EC_T_LINK_PARMS_NDISUIO
```

```
{
    EC_T_LINK_PARMS    linkParams;
    EC_T_WCHAR          szNetworkAdapterName[MAX_LEN_NDISUIO_ADAPTER_NAME];
}
```

```
} EC_T_LINK_PARMS_NDISUIO;
```

Description

linkParms

Common parameters

szNetworkAdapterName

Registry instance key for the network adapter.

Using the NDISUIO Link Layer has some major disadvantages. As the Windows CE network layering is involved in this architecture, the drivers are usually not optimized for realtime behavior and the needed CPU time is often too high to reach reasonable cycle times. Additionally there is an major impact concerning deterministic behaviour if in parallel to EtherCAT traffic the Windows CE applications need to use a second network card for transferring TCP/IP data.

Using a dedicated EtherCAT driver these disadvantages can be overcome.

2.5.4.2.14 Windows WinPcap based Link Layer

The parameter for the WinPcap EtherCAT Link Layer is just a pointer to the IP address string of the network adapter to use.

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

OsMemset(&oLinkParmsAdapter, 0, sizeof(EC_T_LINK_PARMS_WINPCAP));
oLinkParmsAdapter.linkParms.dwSignature = EC_LINK_PARMS_SIGNATURE_WINPCAP;
oLinkParmsAdapter.linkParms.dwSize = sizeof(EC_T_LINK_PARMS_WINPCAP);
OsStrncpy(oLinkParmsAdapter.linkParms.szDriverIdent,
          EC_LINK_PARMS_IDENT_WINPCAP, MAX_DRIVER_IDENT_LEN - 1);
oLinkParmsAdapter.abvIpAddress[0] = 192;
oLinkParmsAdapter.abvIpAddress[1] = 168;
oLinkParmsAdapter.abvIpAddress[2] = 149;
oLinkParmsAdapter.abvIpAddress[3] = 150;
```

At least WinPcap version 4.1.2 must be used.

2.5.4.2.15 Xilinx Zynq-7000 (GEM) EtherCAT driver

The parameters to the GEM Link Layer are setup-specific.

The function "CreateLinkParmsFromCmdLineGEM" in selectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
typedef struct _EC_T_LINK_PARMS_GEM
```

```
{
    EC_T_LINK_PARMS    linkParms;
    EC_T_GEM_RXSOURCE  eRxSource
    EC_T_DWORD          dwPhyAddr;
    EC_T_DWORD          dwRxInterrupt;
    EC_T_BOOL           bUseDmaBuffers;
    EC_T_BOOL           bNoPhyAccess;
    EC_T_BOOL           bUseGmiiToRgmiiConv;
    EC_T_DWORD          dwConvPhyAddr;
} EC_T_LINK_PARMS_GEM;
```

Description

linkParms

Common parameters

eRxSource

[in] Source of Rx clock, control and data signals: eGemRxSource_MIO or eGemRxSource_EMIO

dwPhyAddr

[in] PHY address (0 .. 31) on MII bus

dwRxInterrupt

[in] Receive interrupt number (IRQ) (not used in polling mode)

bUseDmaBuffers

[in] Use buffers from DMA (EC_TRUE) or from heap for receive. AllocSend is not supported, when EC_FALSE.

bNoPhyAccess

[in] When EC_FALSE, Link layer should initialize PHY and read link status (connected/disconnected).
When EC_TRUE, than client is responsible of PHY initialization and clock initialization

bUseGmiiToRgmiiConv

[in] Use XILINX GMIITORGMI Converter (EC_TRUE) or not.

dwConvPhyAddr

[in] PHY address used to communicate with converter. In Linux doc it named "reg"

2.5.4.2.16 SuperH EtherCAT driver

The parameters to the Renesas SuperH Ethernet MAC Link Layer are setup-specific.

The function "CreateLinkParmsFromCmdLineSHETH" in selectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
typedef struct _EC_T_LINK_PARMES_SHETH
{
    EC_T_LINK_PARMES    linkParms;
    EC_T_SHETH_TYPE     eType;
    EC_T_BYTE           abyStationAddress[6];
    EC_T_DWORD          dwBaseAddr;
    EC_T_BYTE           byPhyAddr;

    EC_T_BOOL           bNotUseDmaBuffers;
} EC_T_LINK_PARMES_SHETH;
```

Description

linkParms

Common parameters

eType

[in] SuperH controller type, as for now supported are eSHETH_R8A7740, eSHETH_R8A77430 and eSHETH_R8A77450

abyStationAddress

[in] MAC station address

dwBasePhys

[in] Physical base address of register block

dwPhyAddr

[in] PHY address (0 .. 31) on MII bus

bNotUseDmaBuffers

[in] Use buffers from DMA (EC_FALSE) or from heap for receive. AllocSend is not supported, when EC_TRUE.

2.5.4.2.17 Xilinx Zynq-7000 EMAC EtherCAT driver

The parameters to the EMAC Ethernet MAC Link Layer are setup-specific.

The function "CreateLinkParmsFromCmdLineEMAC" in selectLinkLayer.cpp demonstrates how to initialize the Link Layer instance.

```
typedef struct _EC_T_LINK_PARMES_EMAC
{
    EC_T_LINK_PARMES linkParms;

    EC_T_DWORD        dwRegisterBase;
    EC_T_DWORD        dwPhyAddr;
    EC_T_DWORD        dwRxInterrupt;
    EC_T_DWORD        dwRegisterLength;
    EC_T_BOOL         bNotUseDmaBuffers;
} EC_T_LINK_PARMES_EMAC
```

Description

linkParms

Common parameters

dwRegisterBase

[in] Physical base address of register block
 dwPhyAddr
 [in] PHY address (0 .. 31) on MII bus
 dwRxInterrupt
 [in] Receive interrupt number (IRQ)
 bNotUseDmaBuffers
 [in] Use buffers from DMA (EC_FALSE) or from heap for receive. AllocSend is not supported, when EC_TRUE.

2.5.4.2.18 UDP EtherCAT driver

The function "CreateLinkParmsFromCmdLineUdp" in selectLinkLayer.cpp demonstrates how to initialize the Link Layer instance. For now this Link Layer is not fully supported.

```
typedef struct _EC_T_LINK_PARMS_UDP
{
    EC_T_LINK_PARMS    linkParms;
    EC_T_CHAR          szAdapterName[MAX_LEN_UDP_ADAPTER_NAME];
    EC_T_BYTE          abyIpAddress[4];
    EC_T_WORD          wPort;
} EC_T_LINK_PARMS_UDP
```

Description

linkParms
 Common parameters
 szAdapterName
 [in] Adapter name
 abyIpAddress
 [in] Adapter IP address
 wPort
 [in] Port number

3 Software Integration

3.1 Application framework and example application

3.1.1 Overview

The example application EcMasterDemo will handle the following tasks:

- Showing basic EtherCAT communication
 - Master stack initialization
 - Start (set all slaves into OPERATIONAL state)
 - Working with the EL9800 EtherCAT evaluation kit, EL2004, EL1004 and EL4132
 - ``Out of the box`` solution for different operating systems:
 - Windows
 - Windows CE
 - RTOS-32
 - VxWorks
 - Linux
 - QNX
 - RTX
 - INtime
 - T-Kernel
 - ...
 - Example implementation for polled mode operation
 - 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:
 - error0.log application error messages (logged via LogError function)
 - ecmaster0.log all messages
- Note: for VxWorks these log files are splitted to avoid memory resource problems when using the netdrv driver (FTP filesystem). After a specified number of messages the old file will be closed and thus written to the hard disk and a new file will be created. The file name convention is file.x.log, e.g. app.0.log for the first application log file and app.1.log for the second.

3.1.2 File reference

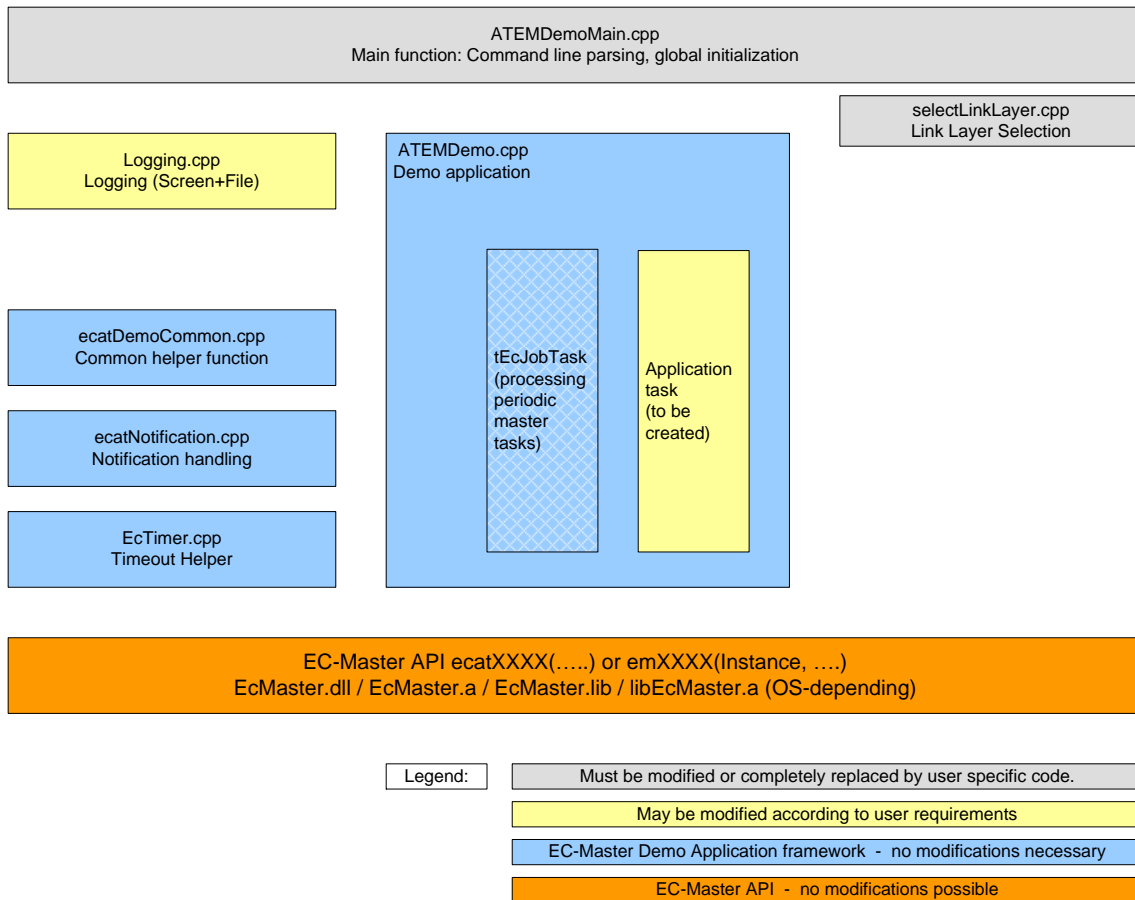
The EC-Master Demo application consists of the following files:

ATEMDemoMain.cpp	Entrypoint for the different operating systems and parsing of command line parameters
ATEMDemo.cpp	Initialize, start and terminate the EtherCAT master (function ATEMDemo())
ATEMDemoConfig.h	Contains basic static configuration parameters (task priorities, timer settings, EtherCAT master parameter)
selectLinkLayer.cpp	Common Functions which abstract the command line parsing into Link Layer parameters
ecatNotification.cpp	Slave monitoring and error detection (function ecatNotify())
ecatDemoCommon.cpp	Class with generic helper functions; e.g. trigger bus scan, getting information of slaves connected to the EtherCAT bus, CoE object dictionary example.
SlaveInfo.h	Slave information services (bus scan, slave properties)
Logging.cpp	Message logging functions

EcTimer.cpp

Start and monitor timeouts

The following picture gives an overview of delivered files and their responsibility.



Picture 1: Files overview

3.1.3 Master lifecycle

This chapter gives brief information about the starting and stopping of the EC-Master.

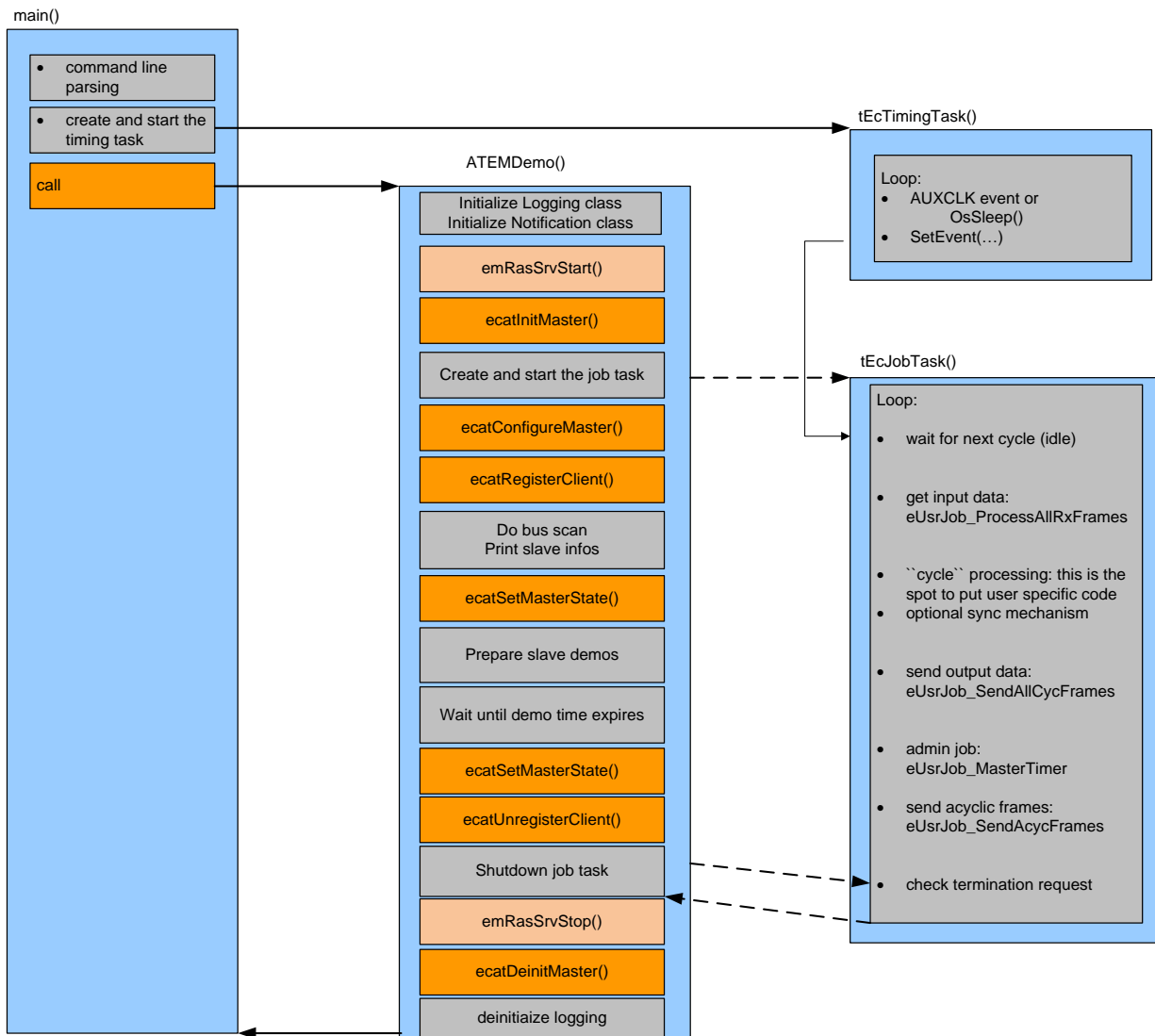
Basically the operation of the EtherCAT master is wrapped between the functions

- `ecatInitMaster()`
 - `ecatSetMasterState(<StateChangeTimeout>, eEcatState_OP)`
- and
- `ecatStop()`
 - `ecatDeinitMaster()`

With the former two functions the master is prepared for operation and started. Also during this preparation there is a thread set up and started, which does all the cyclic duties of the master.

With the later two functions, the master is stopped and memory is cleaned up.

An overview of the complete lifecycle is given in Picture.



Picture 2: Demo application lifecycle

Here a somewhat closer description of the functions:

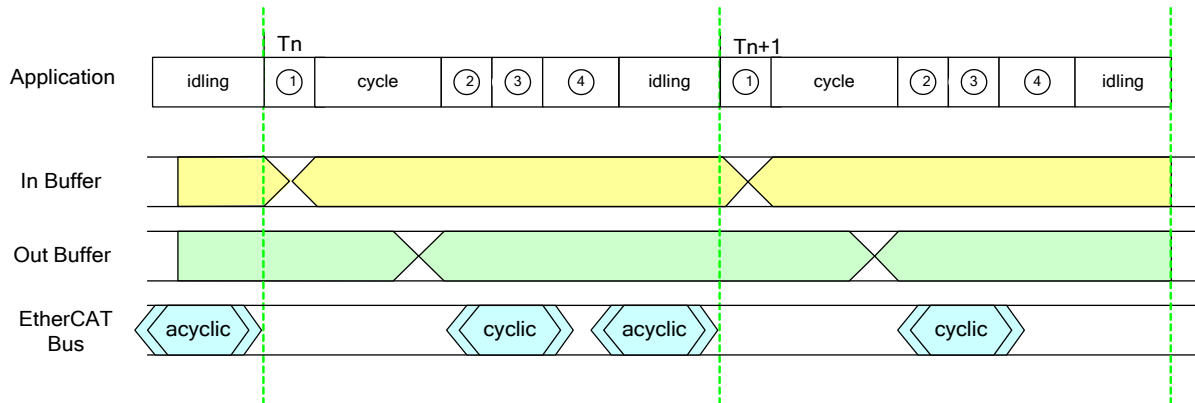
<code>main()</code>	Simply the wrapper to start the demo; probably dependant on the operating system. Implement command line parsing for individual parameter setting here.
<code>ATEMDemo()</code>	Demo application. The function takes care for starting and stopping the master and all related tasks. In between there is a spot where the function does nothing (idling). During this idling all relevant work is done by the <code>tEcJobTask()</code> , described below.

<code>atemDemoInit()</code>	<p>Prepare the master for operation and create the application threads. In case of the demo this is the <code>tEcJobTask()</code>. More threads can be created if required by the user application.</p> <p>Not shown is the creation of an instance of the <code>CEmNotification</code> class, which will be explained later.</p>
<code>atemDemoDeInit()</code>	Stop all application threads.
<code>tEcJobTask()</code>	<p>Thread which does the necessary, periodic work.</p> <p>Very important here is the spot between the calls to <code>eUsrJob_ProcessAllRxFrames</code> and to <code>eUsrJob_SendAllCycFrames</code>. In the chapter 3.1.4 this spot is referenced as <code>cycle</code>. Application specific manipulation of the process image, which must be synchronous with the bus cycle, can be put in <code>myAppWorkPd</code>.</p>
<code>tEcTimingTask()</code>	<p>Timing Thread.</p> <p>This thread sets the timing event that triggers the <code>tEcJobTask</code> for the next cycle.</p>
<code>ecatSetMasterState()</code>	EC-Master API function: Startup the EtherCAT master and switch the bus to the different states from INIT to OPERATIONAL.
<code>ecatStop()</code>	EC-Master API function: Stop master operation. The master quits sending packets.
<code>ecatInitMaster()</code>	EC-Master API function: Prepare the master for operation and set operational parameters, e.g. used Link Layer, buffer sizes, maximum number of slaves, ...
<code>ecatDeinitMaster()</code>	EC-Master API function: Clean up.
<code>ecatConfigureMaster()</code>	EC-Master API function: Tell master about its XML file configuration.

Remark: During cyclic operation, which is the desired OPERATIONAL state of an EtherCAT system, the main work is done in the `tEcJobTask()`. The originating process, in case of the demo this is `ATEMDemo()`, is doing nothing (idling).

3.1.4 Synchronisation

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



Picture 3: Synchronisation

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 ``ATEMDemo()`` 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 ``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 analysed 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 ATEMDemo(): 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 ``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 ``eUsrJob_SendAcycFrames`` call, the acyclic frames are scheduled for transmission.

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

3.1.5 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
- ...
- many more

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

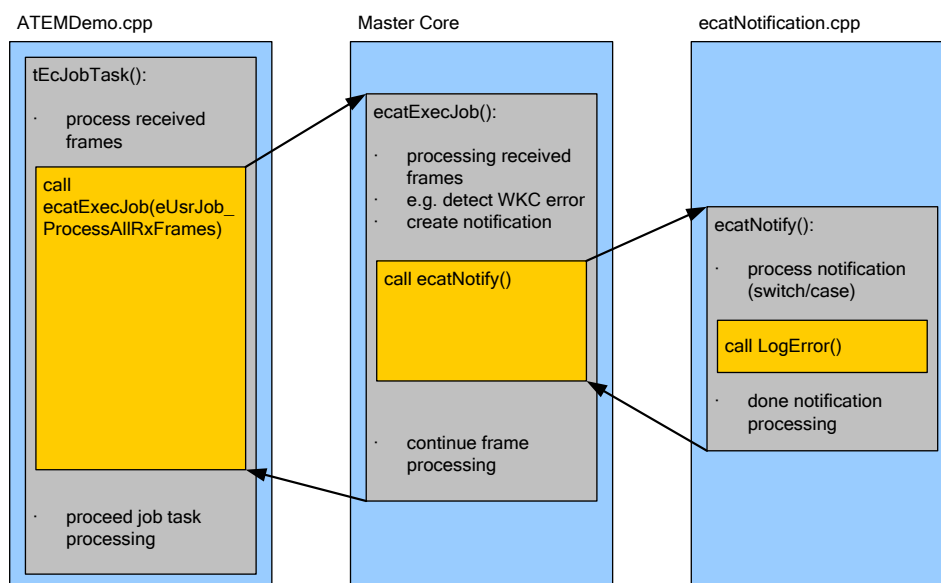
```
ecatRegisterClient()
```

In case of the EcMasterDemo the class ``CEmNotification`` is provided. It implements the complete framework to catch and handle the EtherCAT stack's notifications. The class is instantiated once and attached to the EtherCAT master with the ``ecatRegisterClient()`` call shown above. The class implements the method ``ecatNotify()`` as major entry point (or callback function) for events.

There exist three different ways how events can be handled. The method to handle an event is mainly determined by the time required to handle the event and the processing context in which the event shall be handled. The methods are described below.

3.1.5.1 Direct

Minor events can be handled directly within the context where they are detected. One possible example for such an event is the detection of a wrong working counter (WKC). See Picture for the example.

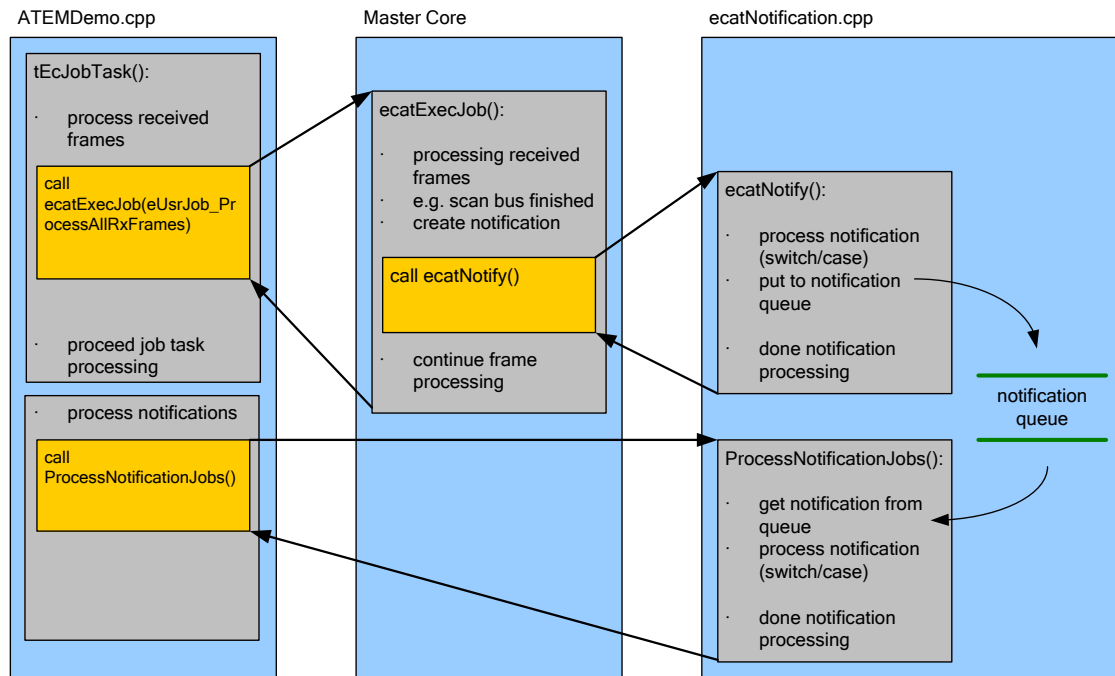


Picture 4: Direct event handling

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

3.1.5.2 Queue

Events which require more time consuming processing can not be handled directly in the context where they are detected. Handling or processing of the event must be postponed. This is achieved by a queue, which is also readily implemented with the ``CEmNotification`` class. Picture shows an example for this behavior.



Picture 5: Postponed (or queued) event handling

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

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

3.1.6 Logging

The Example programs cpp demonstrates how messages can be processed by the application, see `Examples\EcMasterDemo\Logging.cpp`.

The messages handled by `Logging.cpp` are of different type, e.g. Master Log Messages, Application Messages, DCM Messages and are logged to console and/or to files. Note: logging to files is disabled by default for some OS. Because e.g. a file system must be added explicitly. Setting `bLogFileEnb` to 1 enables file logging.

Identical messages are skipped automatically by default.

3.1.6.1 Parameters

The verbosity of the demo given as console parameter `"-v"` is used to determine the log level of the application, see "set application log level" in `ATEMDemoMain.cpp`.

For performance reasons the EC-Master automatically filters log messages according to `EC_T_INIT_MASTER_PARMS::LogParms.dwLogLevel`.

CatEmLogging has various parameters beside the log level, like Roll Over setting, log task prio and affinity, log buffer size, etc. See `InitLogging` in `Logging.h`, `ATEMDemoMain.cpp` for reference.

3.1.6.2 Configuring EC-Master logging

The EC-Master logging is configured on initialization, see the structure documentation of `EC_T_INIT_MASTER_PARMS::LogParms` in chapter 4.3.1, `ecatInitMaster`.

The application can provide customized log message handlers of type `EC_PF_LOGMSGHK` if the default handler in `Logging.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.

3.1.6.3 Operating System specific hints

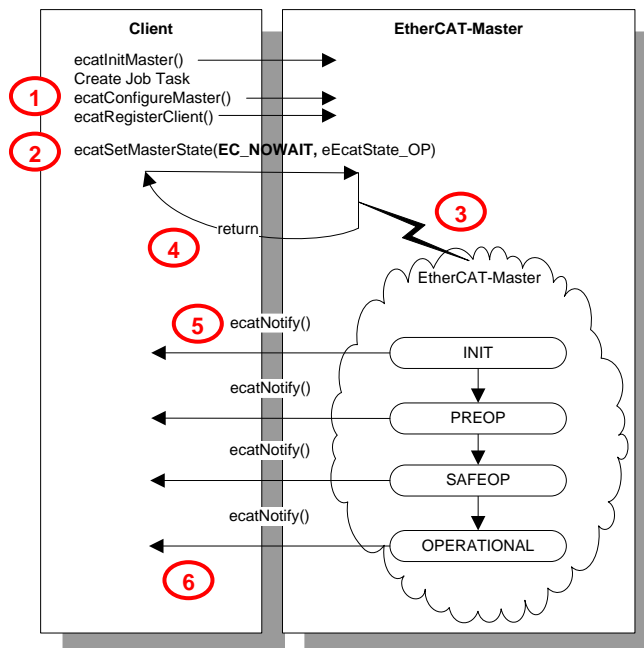
In case the VxWorks netDrv driver is used (e.g. when accessing the PC hard disk via FTP) the content of these files is stored in memory. These files will be closed only when the application terminates or when the specified number of messages to be stored in a single file is exceeded. There are no means to limit the amount of memory needed for those files. The amount of messages to be stored in the log file may lead to out of memory and thus may lead the system to crash.

3.2 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.

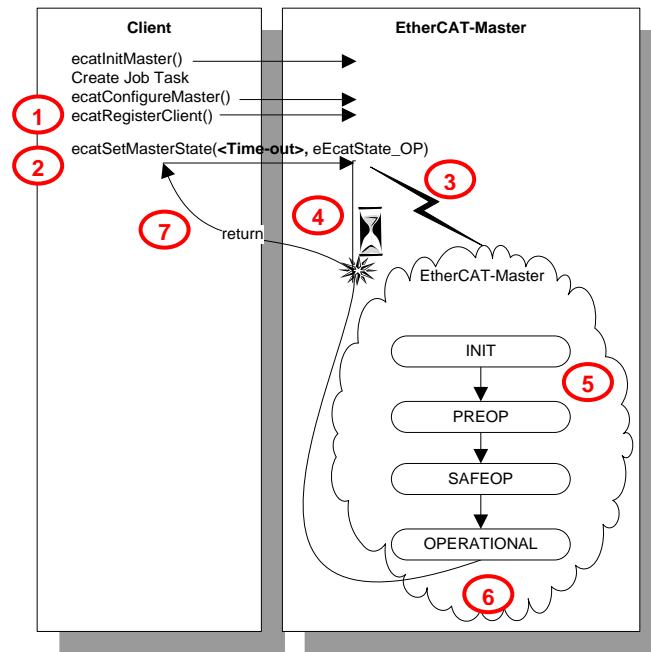
Starting the master means that all slaves will be set into the operational state. Every time the state of the master has changed the clients are notified about this state-change.

Asynchronous (deferred) startup



- Client calls `ecatInitMaster(...)`
- Client creates Job Task. See 3.1.3, "Master lifecycle".
- Client calls `ecatConfigureMaster(...)`
- Client calls `ecatRegisterClient(...)` (See "1")
- Client calls `ecatSetMasterState(...)` with a timeout parameter `EC_NOWAIT` (See "2")
- Inside `ecatSetMasterState(...)` the master startup procedure will be initiated (See "3")
- Function `ecatSetMasterState(...)` returns immediately (`EC_NOWAIT`) (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")

Synchronous startup



- Client calls `ecatInitMaster(...)`
- Client creates Job Task. See 3.1.3, "Master lifecycle".
- Client calls `ecatConfigureMaster(...)`
- Client calls `ecatRegisterClient(...)` (See "1")
- Client calls `ecatSetMasterState(...)` with an appropriate timeout value (see "2")
- Inside `ecatSetMasterState(...)` the master startup procedure will be initiated (see "3")
- The client is blocked until the whole startup has finished (see "4")
- The master initializes all slaves until all slaves reach OPERATIONAL state (see "5")
- After reaching the OPERATIONAL state the system is ready (see "6")
- `ecatSetMasterState(...)` returns (see "7")

3.3 Process data update and synchronization

The EtherCAT master's main task is to exchange process data objects between the client and the EtherCAT slaves. All mapped process data objects of the slaves will be copied by the master into a process data memory area.

New input values received from the slaves will be written into the input process data memory.

New output values which shall be sent to the slaves will be read from the output process data memory.

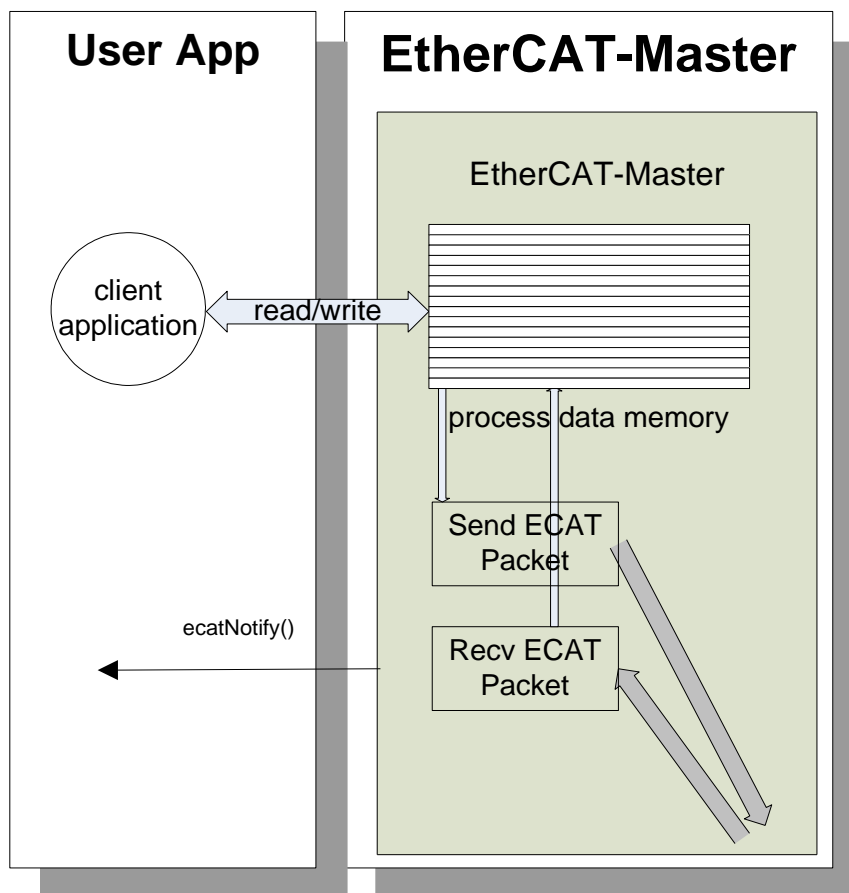
When the client registers with the master the client gets a pointer to those process data memory areas.

The EtherCAT master has two different options how process data memory is allocated (provided).

- A) The master itself is the memory provider (default case)
- B) The application serves as the memory provider

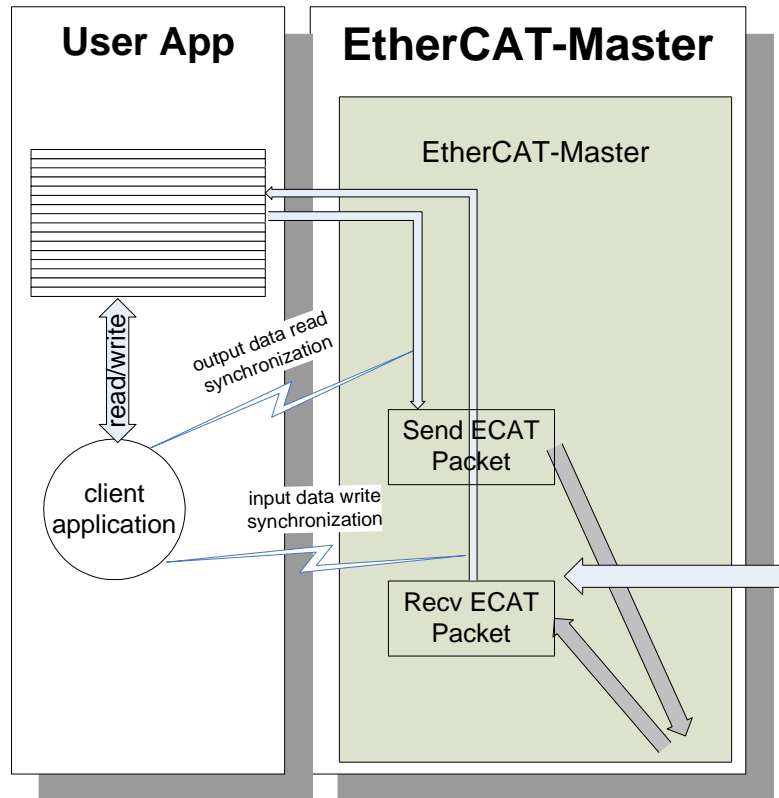
3.3.1 EtherCAT master as process data memory provider

If the application does not register a memory provider then the master will internally allocate the necessary memory needed to store input and output process data values.



3.3.2 User application as process data memory provider

The application may register a memory provider in case the master shall use externally allocated memory to store input and output process data values. See 4.3.32 “ecatIoControl – EC_IOCTL_REGISTER_PDMEMORYPROVIDER”.



The memory provider may optionally supply callback functions to synchronize memory access between the clients and the master.

In this case the master's sequence of receiving new input process data values is as follows:

- new process data is received, data is internally located in the Ethernet frame buffer
- master requests write access to the input process data memory (callback function pfPDInDataWriteRequest)
- master copies input data into process data memory
- master releases write access (callback function pfPDInDataWriteRelease)

The master's sequence of sending new output process data values is as follows:

- Application: new process data is stored in the output process data memory buffer
- Master requests read access to the output process data memory (callback function pfPDOOutDataReadRequest)
- Master copies output data into the Ethernet frame
- Master releases read access (callback function pfPDOOutDataReadRelease)
- new output process data will be sent to the slaves

3.3.3 Process data memory provider: fixed and dynamic buffers

The EtherCAT 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).

Case 1: EtherCAT master provides process data memory (fixed buffers)

If the application does not call `ecatIoctl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER` the master is used as process data memory provider. The memory will then be allocated once when the master is configured (`ecatConfigureMaster`). The master will always use the same buffers to read/write process data.

Case 2: User application registers an external memory provider with fixed buffers

When the application calls `ecatIoctl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER` it can determine the address where the process data buffers are located. These fixed buffers will be used by the EtherCAT master to store process data.

Case 3: User application registers an external memory provider without fixed buffers

The application calls `ecatIoctl - EC_IOCTL_REGISTER_PDMEMORYPROVIDER` with setting the fixed buffer address values to `EC_NULL`. In this case the EtherCAT master will request the buffer addresses cyclically when process data are read or written (callback functions). This mode may be used to implement dynamic buffering mechanisms between the application and the EtherCAT master (double buffering, triple buffering).

3.3.4 Process data synchronization

The master operation is fully controlled by the user's application. Thus the user application is responsible for synchronization of the process data between the EtherCAT master stack and the application itself.

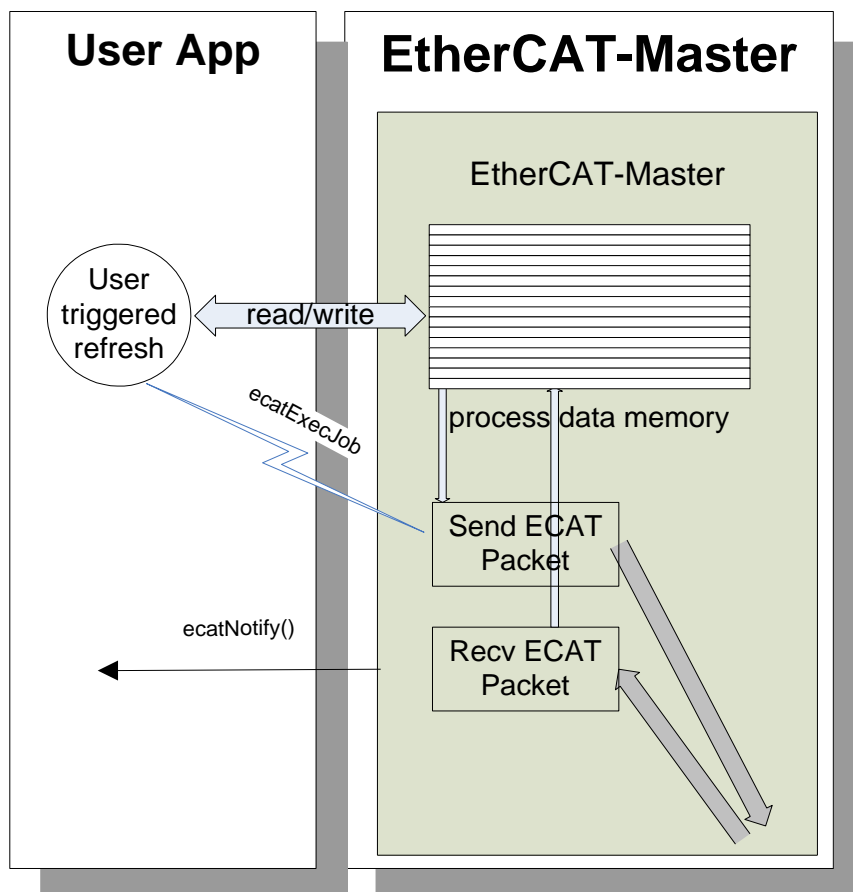
To update the process data in the slaves, one registered client task initiates the update by calling the function [ecatExecJob](#) (see 4.3.16) with the `eUsrcJob_SendAllCycFrames` parameter.

Using the same function with appropriate parameters a very flexible operation of the whole system can be achieved (see below).

When a process data update is initiated by calling `ecatExecJob(eUsrcJob_SendAllCycFrames)` new output data are read from the process data output area 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 output area and calling `ecatExecJob(eUsrcJob_SendAllCycFrames)` no further output process data synchronization is necessary.

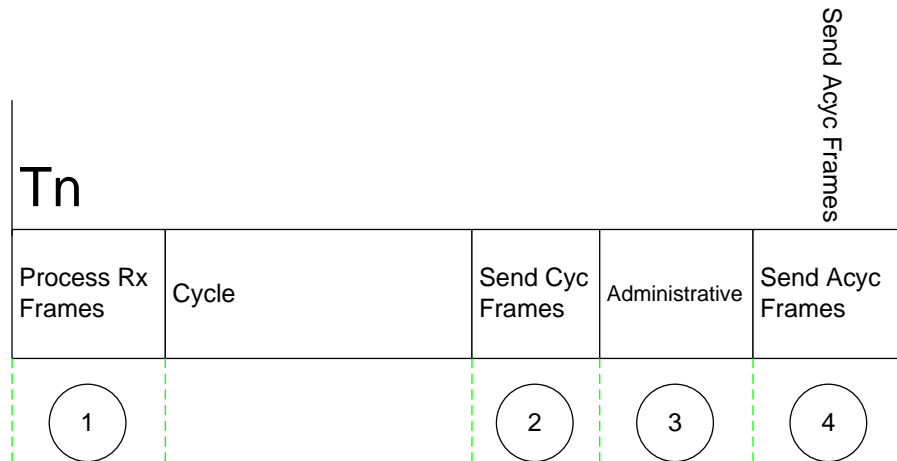
The application is responsible to (cyclically) calling the function `ecatExecJob` with the appropriate parameters.

Note: By using the callback functions when registering an external memory provider it is possible to synchronize process data memory access between the application and the master. This may be necessary for example in a multi-threading environment.



The master operates in a single mode called User Controlled Mode. This mode can be used in all applications, it is optimized for systems which require a tightly coupled timing, e.g. PLC with MCFB (Motion Control Function Blocks) or position control realized by the control application instead of a drive control (intelligent drive). The (user) application has to initiate each step necessary to update process data as well as for the master's internal management.

The timing of the necessary jobs within one cycle is described in the following diagram.

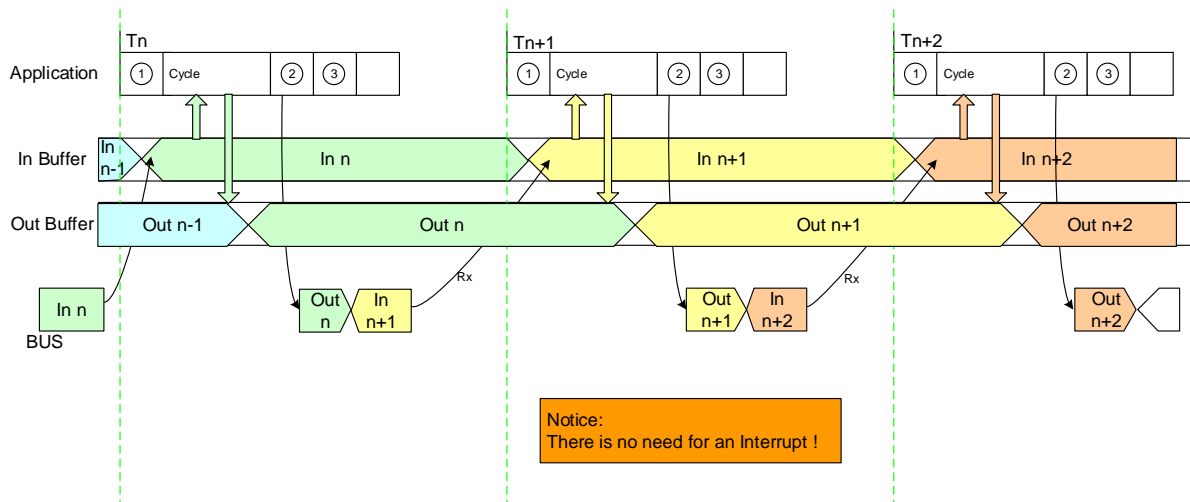


Steps the application (PLC) has to call:

- 1 – eUsrcJob_ProcessAllRxFrames
Link layer in polling mode: process all received frames (e.g. read new input process data).
- 2 – eUsrcJob_SendAllCycFrames
Send cyclic frames to update process output data.
- 3 – eUsrcJob_MasterTimer
Trigger the lower level master and slave state machines.
This job has to be called cyclically. The master cycle time is determined by the period between calling ecatExecJob(eUsrcJob_MasterTimer).
- 4 – eUsrcJob_SendAcycFrames
Transmit pending acyclic frame(s).

Note: When the Link Layer is running in interrupt mode processing of received frames is done immediately after the frame is received.

3.3.4.1 Cyclic frames – Link layer in polling mode



Application has to perform:

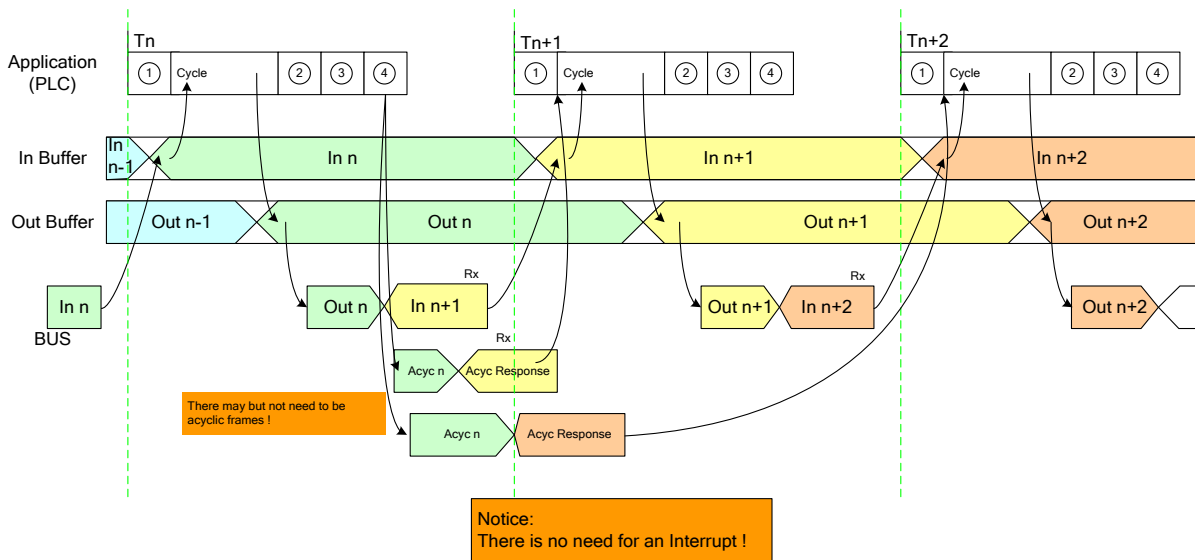
```

/* Job 1: incoming process data is stored to Process data image.
*/
ecatExecJob( eUsrJob_ProcessAllRxFrames, &bPrevCycProcessed );
...
/* do process data cycle */
...
/* Job 2: send out actualized process data. Outputs are actualized in slaves, and input
data is collected to be present for next cycle. Storage to process data image is done
while eUsrJob_ProcessAllRxFrames
*/
ecatExecJob( eUsrJob_SendAllCycFrames, EC_NULL );

/* Job 3: trigger master state machines, which are necessary to perform any status change
or master internal administration tasks
*/
ecatExecJob( eUsrJob_MasterTimer, EC_NULL );

```


3.3.4.2 Cyclic and acyclic frames – Link layer in polling mode



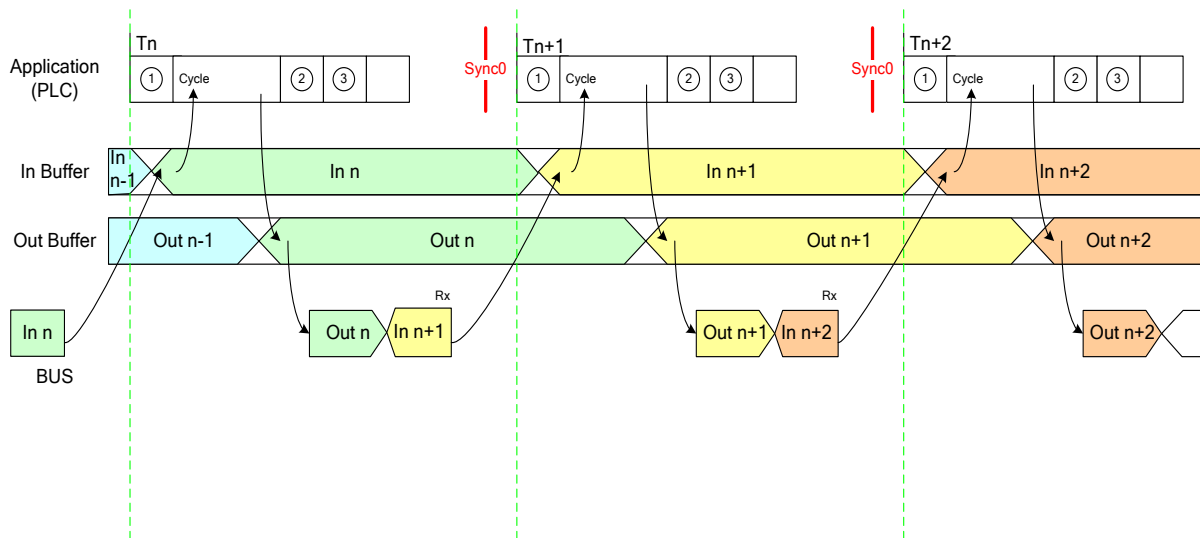
Application has to perform:

```
/* Job 1: incoming process data is stored to Process data image. */
ecatExecJob( eUsrJob_ProcessAllRxFrames, &bPrevCycProcessed );
...
/* do process data cycle */
...
/* Job 2: send out actualized process data. Outputs are actualized in slaves, and input
data is collected to be present for next cycle. Storage to process data image is done
while eUsrJob_ProcessAllRxFrames
*/
ecatExecJob( eUsrJob_SendAllCycFrames, EC_NULL );

/* Job 3: trigger master state machines, which are necessary to perform any status change
or master internal administration tasks
*/
ecatExecJob( eUsrJob_MasterTimer, EC_NULL );

/* Job 4: transmit queued acyclic commands, which in case can be enqueued through user
application or master administrative tasks. Responses are retrieved by issuing
eUsrJob_ProcessAllRxFrames.
*/
ecatExecJob( eUsrJob_SendAcycFrames, EC_NULL );
```

3.3.4.3 Cyclic frames with DC – Link layer in polling mode



Application has to perform:

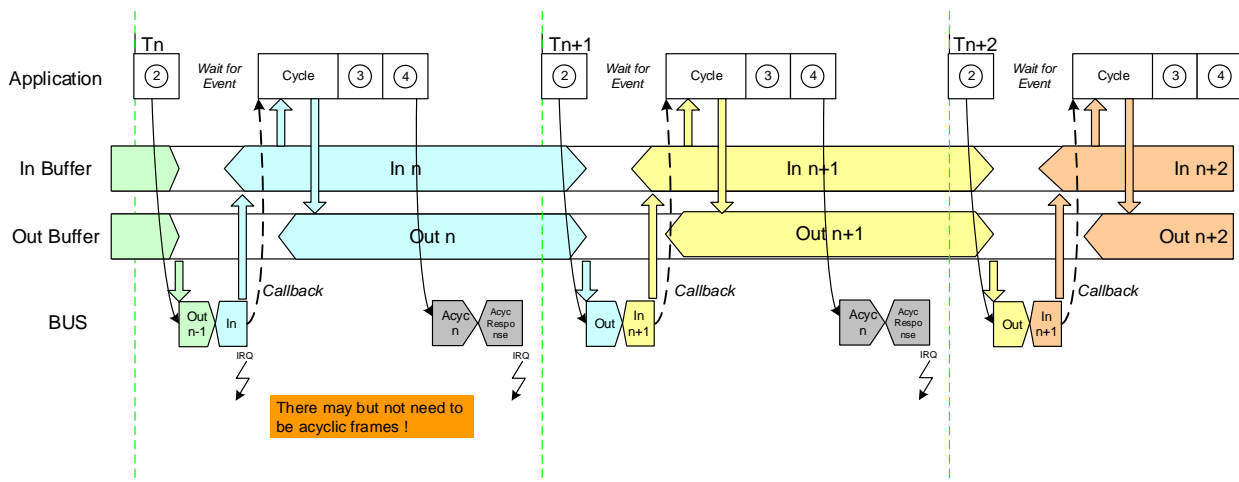
```

/* Job 1: incoming process data is stored to Process data image. */
ecatExecJob( eUsrJob_ProcessAllRxFrames, &bPrevCycProcessed );
...
/* do process data cycle */
...
/* Job 2: send out actualized process data. Outputs are actualized in slaves, and input
data is collected to be present for next cycle. Storage to process data image is done
while eUsrJob_ProcessAllRxFrames
*/
ecatExecJob( eUsrJob_SendAllCycFrames, EC_NULL );

/* Job 3: trigger master state machines, which are necessary to perform any status change
or master internal administration tasks
*/
ecatExecJob( eUsrJob_MasterTimer, EC_NULL );

```

3.3.4.4 Cyclic and acyclic frames – Link layer in interrupt mode



Application has to perform during startup:

```
dwRes = ecatInitMaster(&oInitParms);

/* setup callback function which is called after RX */
dwRes = ecatIoControl(EC_IOCTL_REGISTER_CYCFRAME_RX_CB, &oIoCtlParms);

/* create cyclic process data Thread */
S_pvtJobThread = OsCreateThread( "tEcJobTask", tEcJobTask, JOBS_PRIORITY,
PROCDATA_THREAD_STACKSIZE, (EC_T_VOID*)&S_DemoThreadParam);

dwRes = ecatConfigureMaster(eCnfType_Filename, szCfgFile, OsStrlen(szCfgFile));
```

Application has to perform inside job task:

```
/* Job 2: send out process data. Outputs are actualized in slaves, and input data is
collected to be present for current cycle. Storage to process data image is done after
reception of response frame within the interrupt service thread */
ecatExecJob( eUsrJob_SendAllCycFrames, EC_NULL );

/* wait until cyclic frame is received */
OsWaitForEvent(S_pvCycFrameRxEvent, CYCLE_TIME)

/* do process data cycle */
/*-----*/

/* Job 3: trigger master state machines, which are necessary to perform any status change
or master internal administration tasks
*/
ecatExecJob( eUsrJob_MasterTimer, EC_NULL );

/* Job 4: transmit queued acyclic commands, which in case can be enqueued through user
application or master administrative tasks.*/
ecatExecJob( eUsrJob_SendAcycFrames, EC_NULL );
```

For closer details find an example project <EcMasterDemoSyncSm> in the folder *Examples*

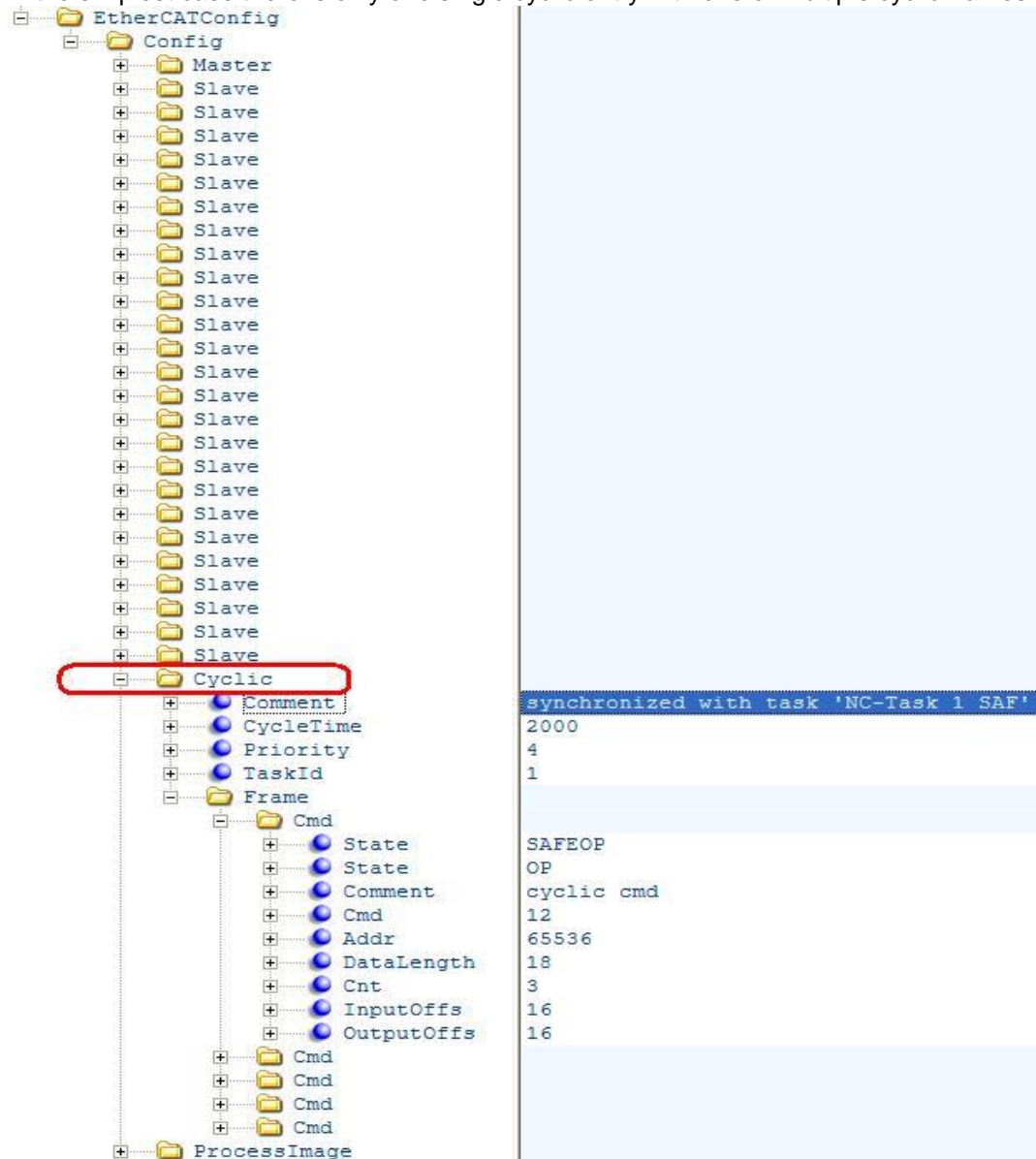
3.3.5 Single or multiple cyclic entries in ENI file

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.

3.3.5.1 Configuration variant 1: single cyclic entry

In the simplest case there is only one single cyclic entry with one or multiple cyclic frames.



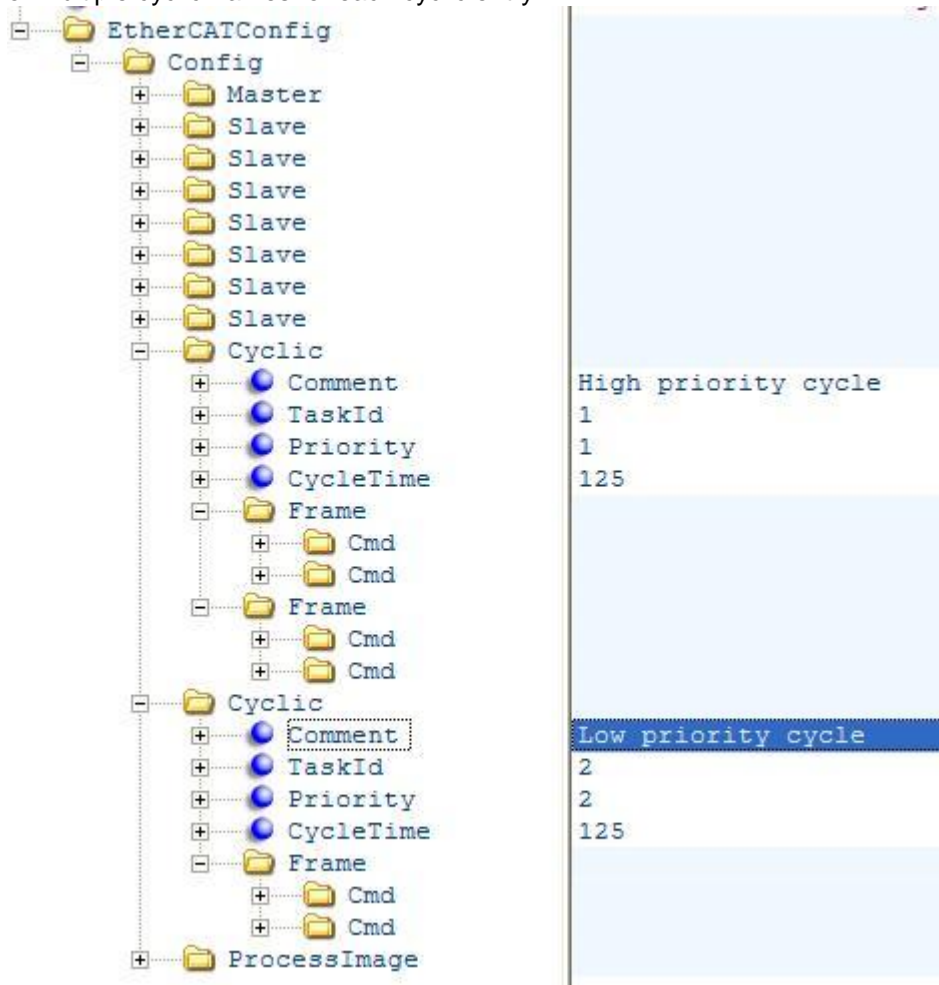
The screenshot shows the configuration tree on the left and the corresponding ENI file content on the right. The 'Cyclic' entry is highlighted with a red box.

Configuration Element	Value
Comment	synchronized with task 'NC-Task 1 SAF'
CycleTime	2000
Priority	4
TaskId	1
Frame	
Cmd	
State	SAFEOP
State	OP
Comment	cyclic cmd
Cmd	12
Addr	65536
DataLength	18
Cnt	3
InputOffs	16
OutputOffs	16
Cmd	
Cmd	
Cmd	
Cmd	
ProcessImage	

All process data synchronization modes support this configuration variant. See 3.3.4 “Process data synchronization”.

3.3.5.2 Configuration variant 2: multiple cyclic entries

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



The application has to use the `eUsrJob_SendCycFramesByTaskId` job call to the master to send the appropriate cyclic frame. See 4.3.16 “`ecatExecJob`”.

3.3.6 Copy Information for Slave-to-Slave communication

It is possible to configure the system to copy Input Variables to Output Variables within the Master Stack instead of Slave-to-Slave communication via LRW.

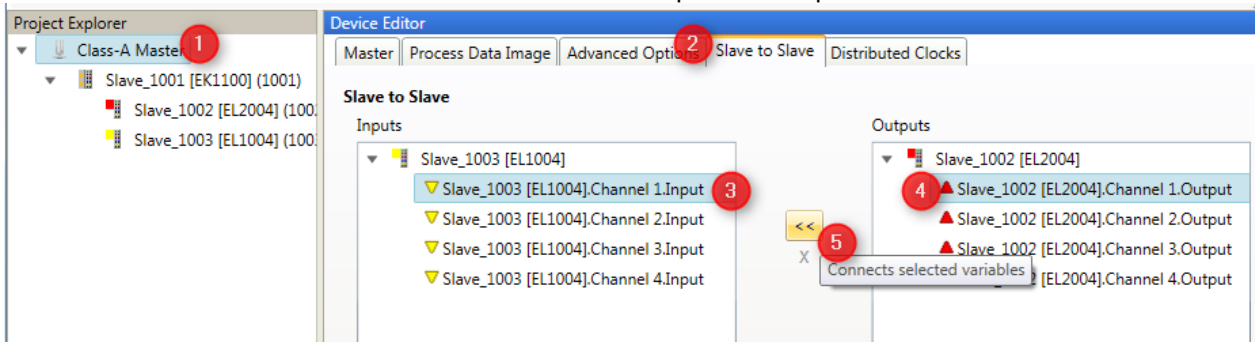
The copy info declarations of the corresponding received cyclic frame are processed on cyclic frame processing in `ecatExecJob(eUsrJob_ProcessAllRxFrames, ...)`.

It takes two communication cycles to exchange the process data, but it is needed e.g. if applying cable redundancy or if WKC of INPUT must be checked before changing OUTPUT, see 3.3.8 “Cyclic cmd WKC validation”.

The copy info declarations are located at `/EtherCATConfig/Config/Cyclic/Frame/Cmd/CopyInfos` in the ENI file, see 9.15 “CopyInfosType” in ETG.2100.

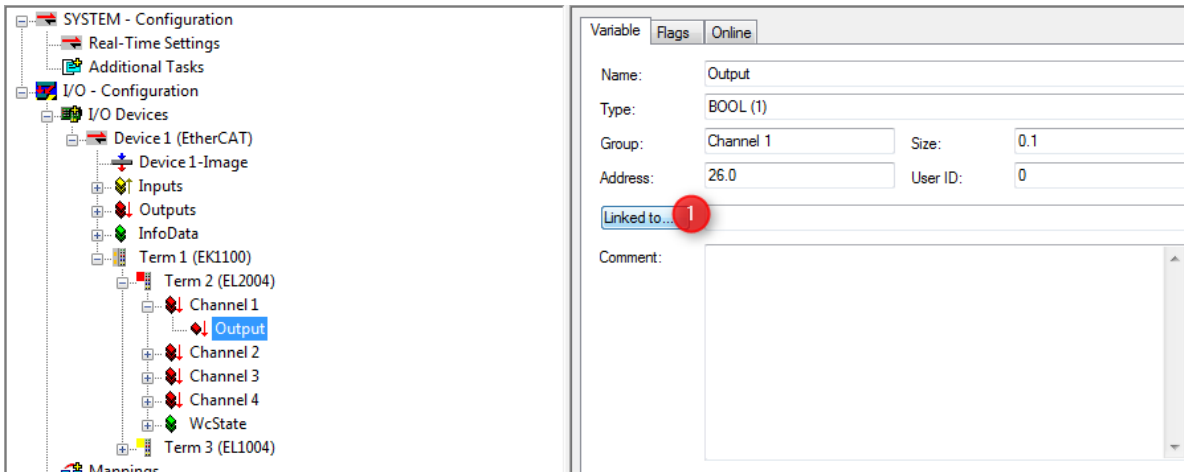
Configuration with EC-Engineer

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

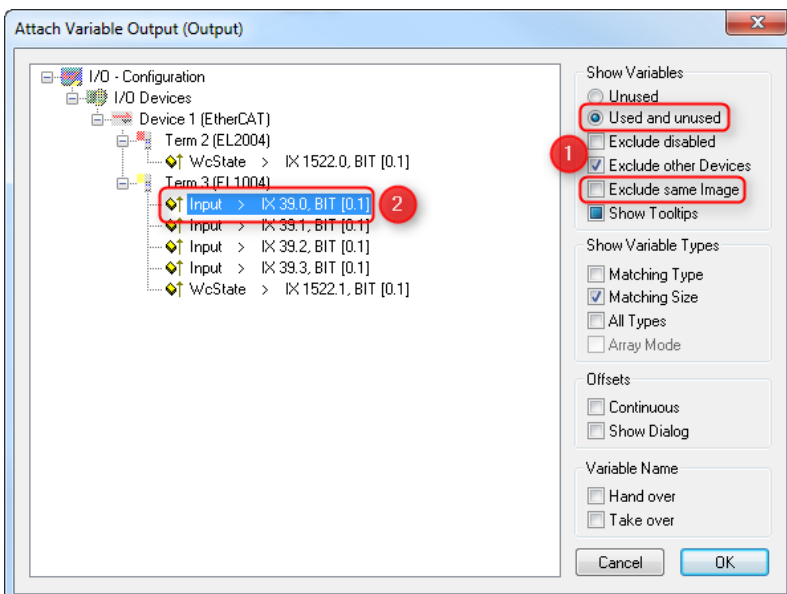


Configuration with ET9000

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



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

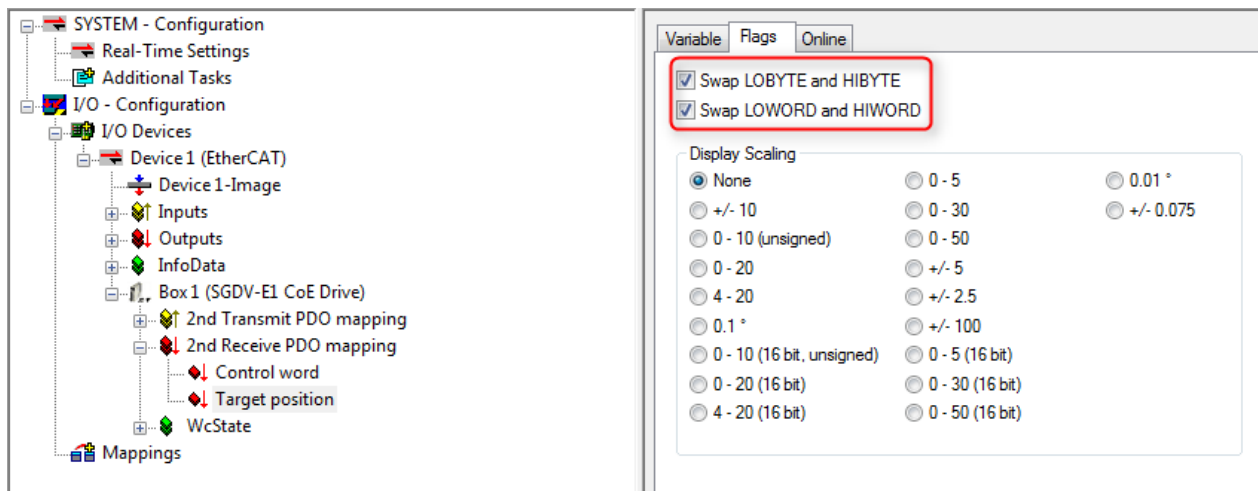


Hint

Copy info declaration processing is independent of WKC values, but updating the INPUT source depends on successful *Cyclic cmd WKC validation*, see 3.3.8 “Cyclic cmd WKC validation”.

3.3.7 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/DataType in the ENI file.

3.3.8 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 `EC_NOTIFY_CYCCMD_WKC_ERROR`.

3.3.9 WKC State in Diagnosis Image

Each cyclic Process Data cmd has its own WKC state in the diagnosis image. The state is updated on frame receiving. 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 `ecatGetDiagnosisImagePtr()`, `ecatGetCfgSlaveInfo()`, `ecatGetSlaveInpVarInfoEx()`, `ecatGetSlaveOutpVarInfoEx()`, `ecatGetMasterSyncUnitInfo()`.

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

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

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

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

}

3.4 Accessing process data in the application

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 [ecatGetProcessImageInputPtr\(\)](#) and [ecatGetProcessImageOutputPtr\(\)](#). 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”. See 4.3.21 “[ecatGetProcessImageInputPtr\(\)](#)” and 4.3.22 “[ecatGetProcessImageOutputPtr\(\)](#)”.

3.4.1 Process Data Access Functions selection

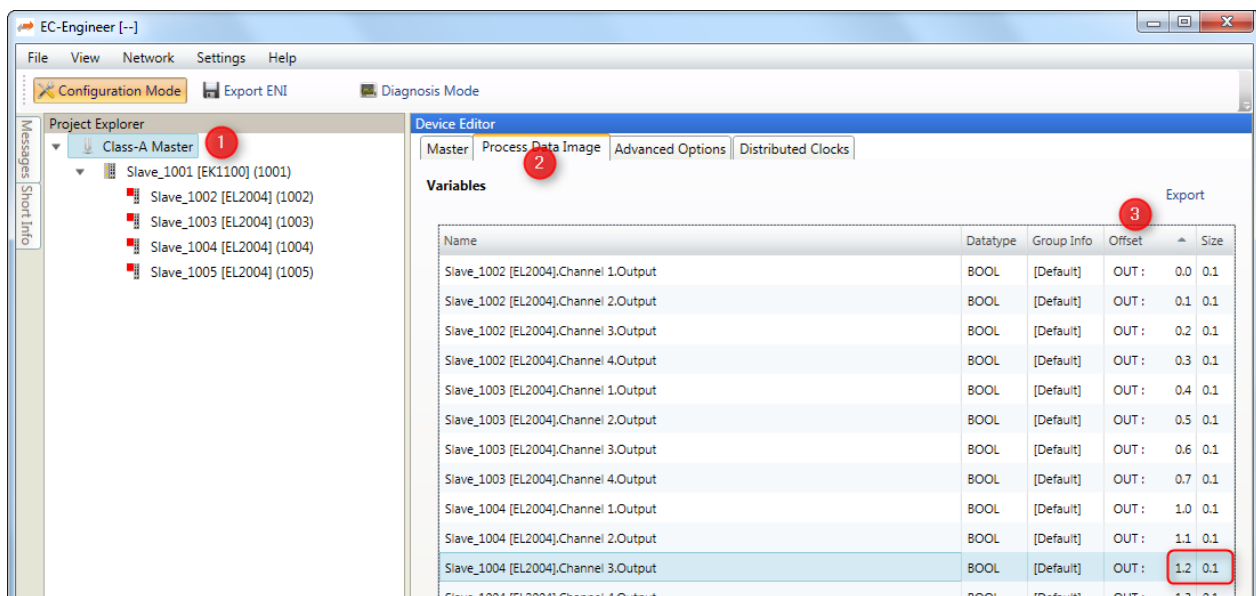
Process data variables that are packed as array of bits are bit aligned and not byte aligned in process data. See 4.4.1 “EC_COPYBITS” for how to copy data areas with bit offsets that are not byte aligned. Getting and setting bits that are bit aligned and not byte aligned should be done using EC_SETBITS 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 that these function do not initiate any transfer on wire. Typically process data is transferred as little endian on wire and therefore must be swapped on big endian systems like PPC to be correctly interpreted, see hints in table below.

Variable type	Bit size	Macro	Chapter	Hint
EC_T_BYTE	8	N/A		Bytes are byte-aligned and can be directly addressed at pbyBuffer[BitOffset/8]
EC_T_WORD	16	EC_SET_FRM_WORD, EC_GET_FRM_WORD	4.4.2	Contains swap for big endian systems.
EC_T_DWORD	32	EC_SET_FRM_DWORD, EC_GET_FRM_DWORD	4.4.3	Contains swap for big endian systems.
EC_T_QWORD	64	EC_SET_FRM_QWORD, EC_GET_FRM_QWORD	4.4.4	Contains swap for big endian systems.
Bit	1	EC_SETBITS / EC_GETBITS	4.4.8	

3.4.2 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. EC_NOTIFY_CLIENTREGISTRATION_DROPPED) therefore it is sufficient to load them once right after `ecatConfigureMaster`, it is not needed every cycle.

3.4.2.1 Manually hard coded offsets (compiled in application)

The offset value is figured out from the EtherCAT configuration tool. It's not recommended to use fixed values because the offsets changes in case of adding/removing slaves to/from the configuration.

As listed in the screenshot above "Slave_1004 [EL2004].Channel 3.Output" in the example is at offset 1.2 with size 0.1. The numbering is Byte.Bit so the offset in the example is Byte 1, Bit 2 means bit offset $8 \cdot 1 + 2 = 10$ and size is $0 \cdot 8 + 1 = 1$.

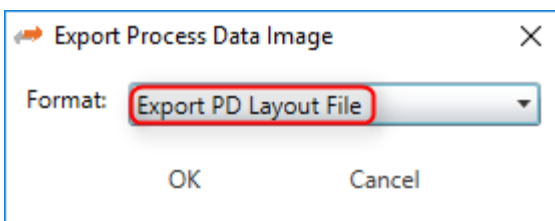
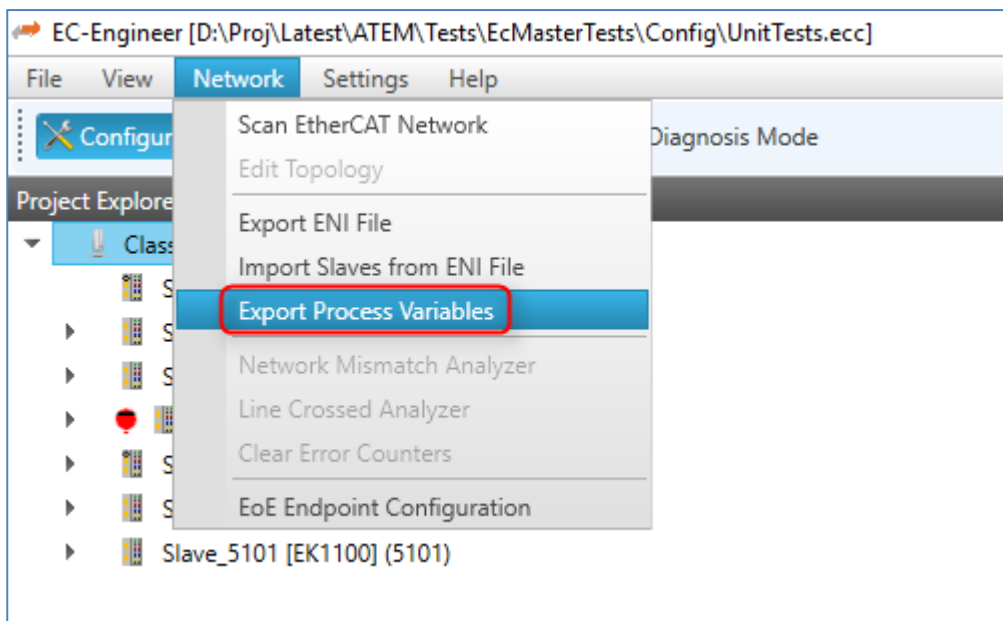
Sample code:

```
EC_T_BYTE byNewValue = 0x01;

/* set variable in process data */
EC_SETBITS(ecatGetProcessImageOutputPtr(), &byNewValue, /*offset*/10, /*size*/1);
```

3.4.2.2 Generated PD Layout (compiled in application)

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



This will generate a header file containing the slaves' variables like this:

```
[...]
#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 for changing values in e.g. myAppWorkPd:

```
EC_T_WORD wVal = 123;
EC_SET_FRM_WORD(&((T_PDLAYOUT_OUT_SLAVE_2002*)(pbyPDOut +
    PDLAYOUT_OUT_OFFSET_SLAVE_2002))->swChannel_1_Output, wVal);
```

3.4.2.3 Slave / variable offset from configuration

ecatGetCfgSlaveInfo

Figure out the slave offsets dynamically by calling the function `ecatGetCfgSlaveInfo()`:

The offsets are stored in `EC_T_CFG_SLAVE_INFO.dwPdOffsIn` and

`EC_T_CFG_SLAVE_INFO.dwPdOffsOut`.

E.g. setting "Slave_1004 [EL2004].Channel 3.Output" according to the screenshot above is like:

```
EC_T_BYTE byNewValue = 0x01;

EC_T_CFG_SLAVE_INFO SlaveInfo;
dwRes = ecatGetCfgSlaveInfo(EC_TRUE, 1004, &SlaveInfo);

/* set variable in process data */
EC_SETBITS(ecatGetProcessImageOutputPtr(), &byNewValue, SlaveInfo.dwPdOffsOut +
/*variable off*/2, /*variable size*/1);
```

ecatFindInpVarByName

Figure out the variable offset by calling the function `ecatFindInpVarByName()` or [ecatFindOutpVarByName\(\)](#):

The offset is stored in `EC_T_PROCESS_VAR_INFO.nBitOffs`. Each input or output has a unique variable

name. All variables names are stored in the ENI file under

"EtherCATConfig/Config/ProcessImage/Inputs/Variable".

E.g. setting "Slave_1004 [EL2004].Channel 3.Output" according to the screenshot above is like:

```
EC_T_BYTE byNewValue = 0x01;

EC_T_PROCESS_VAR_INFO VarInfo;
dwRes = ecatFindOutpVarByName("Slave_1004 [EL2004].Channel 3.Output", &VarInfo)

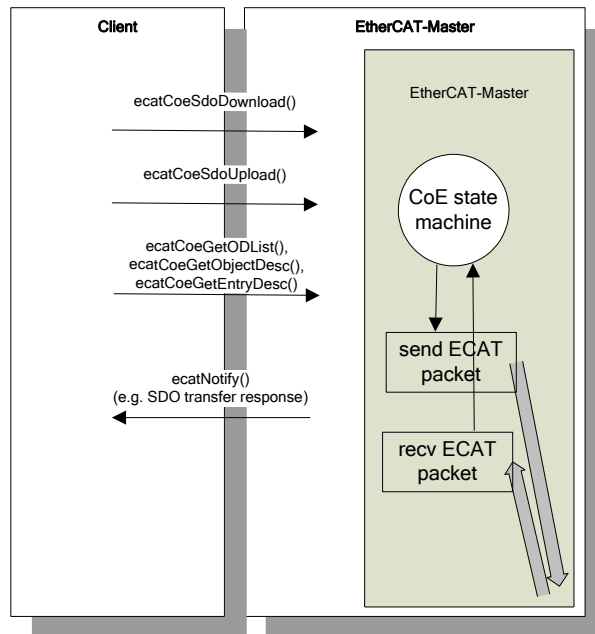
/* set variable in process data */
EC_SETBITS(ecatGetProcessImageOutputPtr(), &byNewValue, VarInfo.nBitOffs,
VarInfo.nBitSize);
```

ecatGetMasterSyncUnitInfo

Figure out the MSU offsets by calling the function `ecatGetMasterSyncUnitInfo()`, as described in chapter 4.7.57, "ecatGetMasterSyncUnitInfo".

3.5 CanOpen over EtherCAT transfers (CoE)

The EtherCAT client may use these services for example to access the object dictionary of a CoE slave.



The following services are supported:

- SDO download: SDO data transfer from the controller to a slave
- SDO upload: SDO data transfer from a slave to the controller
- SDO information service: read SDO object properties (object dictionary) from a slave
- Emergency Request

The CoE mailbox transfer is controlled by the master timer (application needs to call `ecatExecJob(eUshrJob_MasterTimer)` cyclically).

The client will be notified about a complete mailbox transfer using the generic `ecatNotify()` callback function.

3.6 Error detection and diagnosis

The EC-Master API generally return `EC_E_NOERROR` or an error code, see chapter 5, Error Codes.

One of the parameters the client has to set when registering with the EtherCAT master is a generic notification callback function (`ecatNotify`). In case an error is detected the master will call this function.

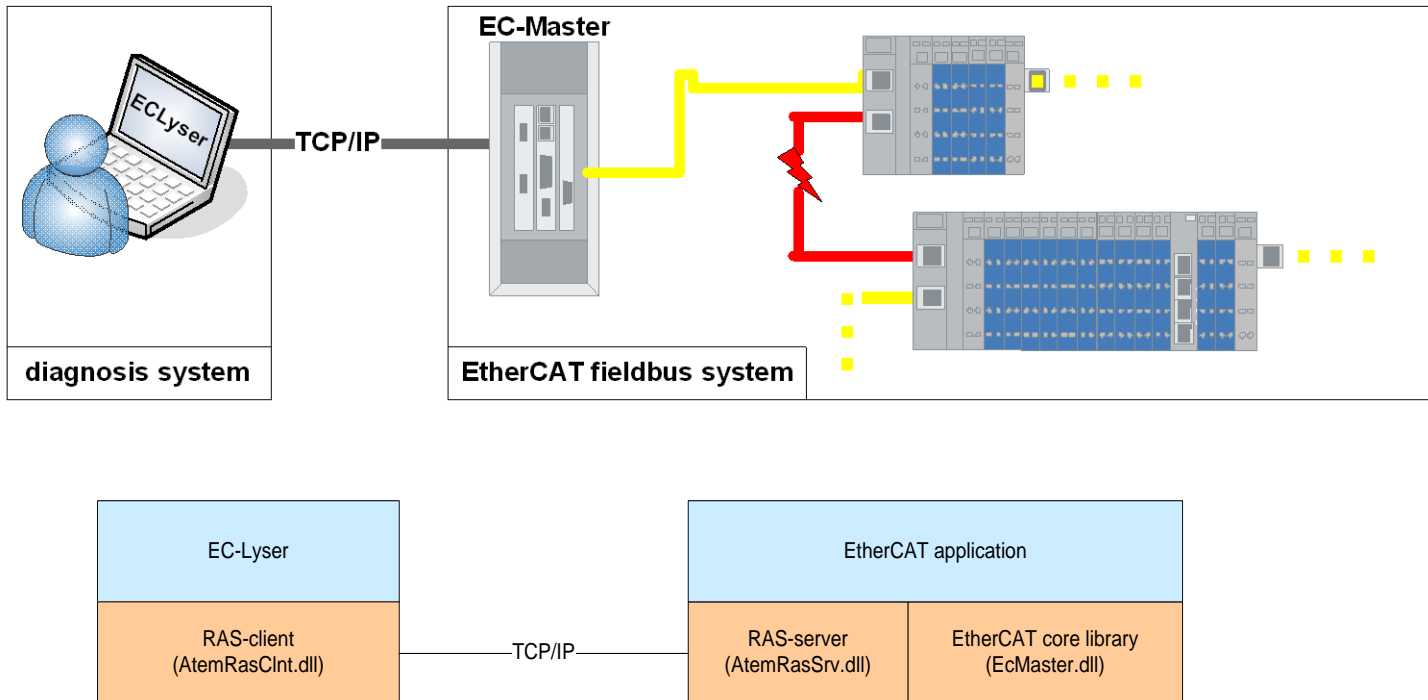
The EC-Master logs messages if `pfLogMsgCallBack` is given as described in chapter 4.3.1 `ecatInitMaster`.

Note: Logging is typically from JobTask context so the handler should queue the messages and process in a low priority task. See logging in `EcMasterDemo` and chapter 3.1.5.2.

3.7 RAS-Server for EC-Lyser and EC-Engineer

3.7.1 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 preconfigured to listen for EC-Lyser on TCP Port 6000 when commandline parameter “-sp” is given (→ [Further command line parameters](#)).

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 “AtemRasSrv.lib” (or respectively “AtemRasSrv.a”) must be linked.

3.7.2 Pseudo Code

```
#include <AtEmRasSrv.h>

/* custom Remote API Notification handler, example in EcMasterDemo (ecatNotification.cpp) */
EC_T_DWORD emRasNotify(
    EC_T_DWORD dwCode,      /**< [in]   Notification code identifier */
    EC_T_NOTIFYPARMS* pParms /**< [in]   Notification data portion */
)
{
    /* custom notification handler */
    ...
}

/* initialization function, creating master instance */
void InitFunction(void)
{
    ATEMRAS_T_SRVPARMS oRemoteApiConfig = {0};
    EC_T_VOID hRemApiHandle;
    /* INADDR_ANY */
    oRemoteApiConfig.oAddr.dwAddr = 0;
    /*< default is port 6000 > */
    oRemoteApiConfig.wPort = wServerPort;
    /*< default is 20 msec */
    oRemoteApiConfig.dwCycleTime = REMOTE_CYCLE_TIME;
    /*< default is 10000 msec */
    oRemoteApiConfig.dwWDTOLimit = (REMOTE_WD_TO_LIMIT/REMOTE_CYCLE_TIME);
    /* Reconnect Timeout after 600*100msec = 60secs + 10secs */
    oRemoteApiConfig.dwReConTOLimit = 60000;
    oRemoteApiConfig.dwMasterPrio = ECAT_MAIN_THREAD_PRIO;
    oRemoteApiConfig.dwClientPrio = ECAT_MAIN_THREAD_PRIO;
    /* Notification context, if required*/
    oRemoteApiConfig.pvNotifCtxt = pNotification;
    /* Notification function for emras Layer */
    oRemoteApiConfig.pfNotification = emRasNotify;
    /* memory for concurrent notifications */
    oRemoteApiConfig.dwConcNotifyAmount = 100;
    /* memory for concurrent mailbox notifications */
    oRemoteApiConfig.dwMbxNotifyAmount = 50;
    /* 2K user space for Mailbox Notifications */
    oRemoteApiConfig.dwMbxUsrNotifySize = 2000;
    /* span between to consecutive cyclic notifications of same type */
    oRemoteApiConfig.dwCycErrInterval = 500;

    /* start remote API server */
    emRasSrvStart(oRemoteApiConfig, &hRemApiHandle);

    /* init master, configure master, setup application */
    emInitMaster(...);

    ...

    ...

    /* end of custom application */
    emStop(...);

    /* stop remote API server */
    emRasSrvStop(hRemApiHandle, 2000)

    emDeinitMaster(...);
}
```

3.7.3 Required API Calls

3.7.3.1 emRasSrvStart

Initializes and start remote API Server Instance.

```
EC_T_DWORD emRasSrvStart (
    ATEMRAS_T_SRVPARMS  oParms,
    EC_T_PVOID*          ppHandle
);
```

Parameters

oParms

[in] Parameter definitions

ppHandle

[out] Server Instance handle

Return

EC_E_NOERROR or error code

Comment

The Remote API Server will be initialized and started by calling this function.

ATEMRAS_T_SRVPARMS

Remote API Server initialization parameters.

```
typedef struct _ATEMRAS_T_SRVPARMS{
    ATEMRAS_T_IPADDR    oAddr;
    EC_T_WORD            wPort;
    EC_T_DWORD           dwCycleTime;
    EC_T_DWORD           dwWDTOLimit;
    EC_T_DWORD           dwReConTOLimit;
    EC_T_DWORD           dwMasterPrio;
    EC_T_DWORD           dwClientPrio;
    EC_T_DWORD           dwConcNotifyAmount;
    EC_T_DWORD           dwMbxNotifyAmount;
    EC_T_DWORD           dwMbxUsrNotifySize;
    EC_T_PVOID           pvNotifCtxt;
    EC_PF_NOTIFY         pfNotification;
    EC_T_DWORD           dwCycErrInterval;
} ATEMRAS_T_SRVPARMS;
```

This function may not be called from within the JobTask's context.

Description

- oAddr
 - [in] IP Address to bind Remote API Server to (DWORD or 4Byte Array).
- wPort
 - [in] TCP Port to bind Remote API Server to.
- dwCycleTime
 - [in] Time in milliseconds which determines the timeout value of a poll cycle which either accepts a new connection or, if connection established, reads commands from the socket Interface. This is the maximum timeout data is processed asynchronous when ready for read.
- dwWDTOLimit
 - [in] Amount of cycles (determined by dwCycleTime) before connection enters wdexpired state.
- dwReConLimit
 - [in] Amount of cycles (determined by dwCycleTime) after connection is in wdexpired state before connection is completely disconnected and resources allocated from master stack are freed.
- dwMasterPrio
 - [in] Priority of connection acceptor thread.
- dwClientPrio
 - [in] Priority of command receiver thread in an established connection state.
- dwConcNotifyAmount
 - [in] Amount of concurrently queueable Notifications (not Mailboxes).
- dwMbxNotifyAmount
 - [in] Amount of pre-allocated notification memory buffers used for mailbox notifications. The application can handle up to this amount of mailboxes simultaneously. For security reasons the actual used amount of mailboxes shall be slightly lower than dwMbxNotifyAmount.
- dwMbxUsrNotifySize
 - [in] User definable amount of bytes each mailbox notification buffer is enlarged off. This value should be at least the size of the largest transferred / used mailbox object.
- pvNotifCtxt
 - [in] Buffer to user defined data, which is passed to each call of Remote API Server Notification function.
- pfNotification
 - [in] Pointer to function which is called to notify change of state or errors.
- dwCycErrInterval
 - [in] Shortest amount of time in msec in between two cyclic error messages of the same kind are transferred to a remote client.

3.7.3.2 emRasSrvStop

Stop and de-initialize remote API Server Instance.

```
EC_T_DWORD emRasSrvStop(  
    EC_T_PVOID pvHandle,  
    EC_T_DWORD dwTimeout  
);
```

Parameters

pvHandle

[in] Handle retrieved from [emRasSrvStart](#)

dwTimeout

[in] Timeout used to shut down all spawned threads. This timeout value is in msec and multiplied internally by the amount of threads spawned.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

3.7.3.3 emrasNotify - xxx

Callback function called by Remote API Server in case of State changes or error situations.

```
EC_T_DWORD emrasNotify(
    EC_T_DWORD      dwCode,
    EC_T_NOTIFYPARMS* pParms
);
```

Parameters

dwCode

[in] Notification code

pParms

[in] Notification code depending data

Return

EC_E_NOERROR or error code

Comment

EC_T_NOTIFYPARMS

Data structure filled with detailed information about the according notification.

```
typedef struct _EC_T_NOTIFYPARMS{
    EC_T_VOID*      pCallerData;
    EC_T_BYTE*      pbyInBuf;
    EC_T_DWORD      dwInBufSize;
    EC_T_BYTE*      pbyOutBuf;
    EC_T_DWORD      dwOutBufSize;
    EC_T_DWORD*      pdwNumOutData;
} EC_T_NOTIFYPARMS;
```

Description

pCallerData

[in] Client depending caller data parameter. This pointer is one of the parameters when the client registers with the master.

pbyInBuf

[in] Notification input parameters

dwInBufSize

[in] Size of the input buffer in bytes

pbyOutBuf

[out] Notification output (result)

dwOutBufSize

[in] Size of the output buffer in bytes

pdwNumOutData

[out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

3.7.3.4 emrasNotify – ATEMRAS_NOTIFY_CONNECTION

Notification about a change in the Remote API's state.

Parameters

pbyInBuf
[in] Pointer to data of type ATEMRAS_T_CONNOTIFYDESC
dwInBufSize
[in] Size of the input buffer in bytes
pbyOutBuf
[] Set to EC_NULL.
dwOutBufSize
[] Set to 0.
pdwNumOutData
[] Set to EC_NULL.

Comment

ATEMRAS_T_CONNOTIFYDESC

Data structure containing the new Remote API state and the cause of state change.

```
typedef struct _ATEMRAS_T_CONNOTIFYDESC{
    EC_T_DWORD      dwCause;
    EC_T_DWORD      dwCookie;
} ATEMRAS_T_CONNOTIFYDESC;
```

Description

dwCause
[in] Cause of state connection state change which is one of:
EC_E_NOERROR : new logon
EMRAS_E_LOGONCANCELLED: error during logon
EMRAS_EVT_RECONNECT: resume of former connection
EMRAS_EVT_RECONEXPIRED: re-connect failed due to long term
timeout
EMRAS_EVT_SERVERSTOPPED: RAS Server shutdown, re-connects
impossible
EC_E_INVALIDSTATE: if accepted socket object is invalid
dwCookie
[in] Unique identification cookie of connection instance.

3.7.3.5 emrasNotify – ATEMRAS_NOTIFY_REGISTER

Notification about a connected application registered a client to the master stack.

Parameters

pbyInBuf
[in] Pointer to data of type ATEMRAS_T_REGNOTIFYDESC
dwInBufSize
[in] Size of the input buffer in bytes
pbyOutBuf
[] Set to EC_NULL.
dwOutBufSize
[] Set to 0.
pdwNumOutData
[] Set to EC_NULL.

Comment

ATEMRAS_T_REGNOTIFYDESC

```
typedef struct _ATEMRAS_T_REGNOTIFYDESC{  
    EC_T_DWORD    dwCookie;  
    EC_T_DWORD    dwResult;  
    EC_T_DWORD    dwInstancelId;  
    EC_T_DWORD    dwClientId;  
} ATEMRAS_T_REGNOTIFYDESC;
```

Description

dwCookie
[in] Unique identification cookie of connection instance
dwResult
[in] Result of registration request
dwInstancelId
[in] Master Instance client registered to
dwClientId
[in] Client ID of registered client

3.7.3.6 emrasNotify – ATEMRAS_NOTIFY_UNREGISTER

Notification about a connected application un-registered a client from the master stack.

Parameters

pbyInBuf
[in] Pointer to data of type ATEMRAS_T_REGNOTIFYDESC
dwInBufSize
[in] Size of the input buffer in bytes
pbyOutBuf
[] Set to EC_NULL.
dwOutBufSize
[] Set to 0.
pdwNumOutData
[] Set to EC_NULL.

Comment

ATEMRAS_T_REGNOTIFYDESC

```
typedef struct _ATEMRAS_T_REGNOTIFYDESC{  
    EC_T_DWORD    dwCookie;  
    EC_T_DWORD    dwResult;  
    EC_T_DWORD    dwInstancelId;  
    EC_T_DWORD    dwClientId;  
} ATEMRAS_T_REGNOTIFYDESC;
```

Description

dwCookie
[in] Unique identification cookie of connection instance.
dwResult
[in] Result of un - registration request.
dwInstancelId
[in] Master Instance client un - registered from.
dwClientId
[in] Client ID of un - registered client.

3.7.3.7 emrasNotify – ATEMRAS_NOTIFY_MARSHALERROR

Notification about an error during marshalling in Remote API Server connection layer.

Parameters

pbyInBuf
[in] Pointer to data of type ATEMRAS_T_MARSHALERRORDESC
dwInBufSize
[in] Size of the input buffer in bytes
pbyOutBuf
[] Set to EC_NULL.
dwOutBufSize
[] Set to 0.
pdwNumOutData
[] Set to EC_NULL.

Comment

ATEMRAS_T_MARSHALERRORDESC

```
typedef struct _ATEMRAS_T_MARSHALERRORDESC{
    EC_T_DWORD    dwCookie;
    EC_T_DWORD    dwCause;
    EC_T_DWORD    dwLenStatCmd;
    EC_T_DWORD    dwCommandCode;
} ATEMRAS_T_MARSHALERRORDESC;
```

Description

dwCookie
[in] Unique identification cookie of connection instance
dwCause
[in] Error code
dwLenStaCmd
[in] Length of faulty command
dwCommandCode
[in] Command code of faulty command

3.7.3.8 emrasNotify – ATEMRAS_NOTIFY_ACKERROR

Notification about an error during creation of ack / nack packet.

Parameters

pbyInBuf
[in] Pointer to EC_T_DWORD containing error code
dwInBufSize
[in] Size of the input buffer in bytes
pbyOutBuf
[] Set to EC_NULL.
dwOutBufSize
[] Set to 0.
pdwNumOutData
[] Set to EC_NULL.

Comment

–

3.7.3.9 emrasNotify – ATEMRAS_NOTIFY_NONOTIFYMEMORY

Notification given, when no empty buffers for notifications are available in pre-allocated notification store. This points to a configuration error.

Parameters

pbyInBuf
[in] Pointer to EC_T_DWORD containing unique identification cookie of connection instance

dwInBufSize
[in] Size of the input buffer in bytes

pbyOutBuf
[] Set to EC_NULL.

dwOutBufSize
[] Set to 0.

pdwNumOutData
[] Set to EC_NULL.

Comment

—

3.7.3.10 emrasNotify – ATEMRAS_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.

Parameters

pbyInBuf
[in] Pointer to EC_T_DWORD containing unique identification cookie of connection instance

dwInBufSize
[in] Size of the input buffer in bytes

pbyOutBuf
[] Set to EC_NULL.

dwOutBufSize
[] Set to 0.

pdwNumOutData
[] Set to EC_NULL.

Comment

—

3.7.3.11 emrasNotify – ATEMRAS_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.

Parameters

pbyInBuf

[in] Pointer to EC_T_DWORD containing unique identification cookie of connection instance

dwInBufSize

[in] Size of the input buffer in bytes

pbyOutBuf

[] Set to EC_NULL.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to EC_NULL.

Comment

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](#).

3.8 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.

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

- a) 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 and T-Kernel these use static libraries)
- b) Master Stack Library
- c) 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. emlll8255x.dll for the l8255x 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. emlll8255x.out for the l8255x 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. emlll8255x.dll for the l8255x 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. emlll8255x.rsl for the l8255x 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 chapter 2.5.3 “OS Compiler settings” for required toolchain settings

4 Application programming interface, reference

Function prototypes, definitions etc. of the API can be found in the header file `AtEthercat.h` which is the main header file to include when using EC-Master.

4.1 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_INVALIDPARM</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 <code>EC_NOTIFY_STATUS_SLAVE_ERROR</code> and <code>EC_NOTIFY_SLAVE_ERROR_STATUS_INFO</code>
<code>EC_E_INVALID_SLAVE_STATE</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_ADDRESSABLE</code>	The slave does not respond to its station address (e.g. when requesting its <code>AL_STATUS</code> 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>	Master core 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.

4.2 Multiple EtherCAT Bus Support

4.2.1 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.

4.2.2 Overview

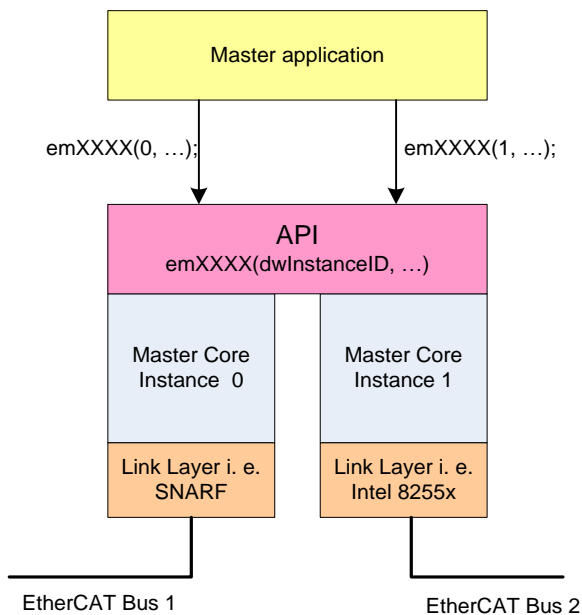
The acontis EtherCAT master allows controlling more than one EtherCAT bus within one application process. For this use case the master core is instantiated several times by using the multi instance API functions inside the application.

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`).



4.2.3 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
```

4.3 General functions

4.3.1 *ecatInitMaster*

Initializes the EtherCAT master stack.

```
EC_T_DWORD ecatInitMaster(
    EC_T_INIT_MASTER_PARMS* pParms
);
```

Parameters

pParms
[in] Pointer to parameter definitions

Return

EC_E_NOERROR or error code, e.g.:

EC_E_NOTFOUND if Link Layer configured at **pLinkParms** can't be found or is not usable.

Comment

The EtherCAT master stack will be initialized by calling this function. This function has to be called prior to calling any other functions of the EtherCAT master.

This function may not be called from within the JobTask's context.

EC_T_INIT_MASTER_PARMS

```
typedef struct _EC_T_INIT_MASTER_PARMS
{
    EC_T_DWORD    dwSignature;
    EC_T_DWORD    dwSize;

    EC_T_OS_PARMS* pOsParms;
    EC_T_LINK_PARMS* pLinkParms;
    EC_T_LINK_PARMS* pLinkParmsRed;
    EC_T_DWORD    dwBusCycleTimeUsec;

    /* memory */
    EC_T_DWORD    dwMaxBusSlaves;
    EC_T_DWORD    dwMaxAcycFramesQueued;
    EC_T_DWORD    dwAdditionalEoEEndpoints;

    /* bus load */
    EC_T_DWORD    dwMaxAcycBytesPerCycle;

    /* CPU load */
    EC_T_DWORD    dwMaxAcycFramesPerCycle;
    EC_T_DWORD    dwMaxSentQueuedFramesPerCycle;
    EC_T_DWORD    dwMaxSlavesProcessedPerCycle;

    /* retry and timeouts */
    EC_T_DWORD    dwEcatCmdMaxRetries;
    EC_T_DWORD    dwEcatCmdTimeout;

    /* VLAN */
    EC_T_BOOL     bVLANEnable;
    EC_T_WORD     wVLANId;
    EC_T_BYTE     byVLANPrio;

    /* logging */
    EC_T_LOG_PARMS LogParms;

    /* master redundancy */
    EC_T_MASTER_RED_PARMS MasterRedParms;

    /* slave to slave mailbox communication */
    EC_T_DWORD    dwMaxS2SMbxSize;
```

```

    EC_T_DWORD dwMaxQueuedS2SMbxTfer;

    EC_T_DWORD dwReserved[2];
} EC_T_INIT_MASTER_PARMS;

```

dwSignature
[in] Signature of the structure. The value ATECAT_SIGNATURE (defined in the header file AtEthercat.h) has to be assigned to this parameter.

dwSize
[in] Size of the structure. The value sizeof(EC_T_INIT_MASTER_PARMS) has to be assigned to this parameter.

pOsParms
[in] Pointer to the OS layer parameter structure EC_T_OS_PARMS. This parameter will be given to the OS layer initialization function *OsInit*.

pLinkParms
[in] Pointer to the Link Layer parameters (e.g. to determine which network adapter to use). The parameters are highly depending on the network adapter used by the Link Layer. More information can be found in chapter Link Layer selection and initialization.

pLinkParmsRed
[in] Pointer to the Link Layer parameters for second network interface used for redundancy support. Set to EC_NULL if redundancy should not be used

dwBusCycleTimeUsec
[in] Bus cycle time in microseconds

dwMaxBusSlaves
[in] The maximum number of master internal pre-allocated bus slave objects. If there are more slaves connected to the bus then pre-allocated the error code of the bus scan notification (see EC_NOTIFY_SB_STATUS) is set to EC_E_MAX_BUS_SLAVES_EXCEEDED.

dwMaxAcycFramesQueued
[in] Maximum number of queued acyclic frames. If the application (e.g. when calling mailbox services) or the master (e.g. when polling mailbox slaves) wants to send acyclic EtherCAT commands these commands are internally queued first. This value is internally limited to 127.

dwAdditionalEoEEndpoints
[in] Extend the virtual switch to this number of additional EoE endpoints. The default number of ports is equal to the number of EoE slaves and one EoE endpoint. Setting this value to 1 permit to register 2 EoE endpoints.

dwMaxAcycBytesPerCycle
[in] Maximum number of bytes sent during eUsrJob_SendAcycFrames. Using this parameter, the application can restrict the acyclic communication bandwidth.

dwMaxAcycFramesPerCycle
[in] This parameter determines (if set to a value greater than 0) the maximum number of acyclic frames that are sent during eUsrJob_SendAcycFrames. Using this parameter the application can reduce the CPU load related to frame processing or limits the frame usage if the linklayer has restricted resources.

dwMaxAcycCmdsPerCycle
[in] Maximum number of EtherCAT commands sent during eUsrJob_SendAcycFrames. Using this parameter the application can reduce the CPU load related to command processing.

dwMaxSlavesProcessedPerCycle
[in] Maximum slave-related state machine calls per cycle. Using this parameter the application can reduce the CPU load related to slave processing in eUsrJob_MasterTimer

dwEcatCmdMaxRetries
[in] Maximum number of retries in case of timeouts when waiting for pending queued EtherCAT commands.

dwEcatCmdTimeout
[in] Queued (acyclic) EtherCAT command receive timeout (milliseconds). If not set (equal=0), the default value is calculated by $\text{dwBusCycleTimeUsec}/1000 * 20$. In a well balanced system all queued (acyclic) frames can be sent and will be received and processed within one master cycle. The number of acyclic frames that are sent within one master cycle can be limited by the parameter

dwMaxSentQueuedFramesPerCycle (see below). In such cases it may actually take multiple master cycles until the acyclic frame will be sent. The master verifies if the time between queuing a frame and receiving the frame does not exceed this timeout value set in dwEcatCmdTimeout. The timeout value must therefore be higher than the time needed for one master cycle. The master cycle time is determined by the period between calling ecatExecJob(eUsrJob_MasterTimer)

bVLANEnable

[in] Set to EC_TRUE to activate VLAN support. VLAN support is not included within the standard EtherCAT master license agreement, thus the VLAN support has to be separately licensed. To activate VLAN support, the EC-Master Stack has to be compiled with the option VLAN_FRAME_SUPPORT set within the File EcType.h.

wVLANId

[in] 12Bit VLANId

byVLANPrio

[in] 3Bit VLAN priority

dwLogLevel

[in] Verbosity level. See EC_LOG_LEVEL_... below.

pfLogMsgCallBack

[in] Optional call-back function invoked by the Master to log messages.

bLogToLinkLayer

[in] Enable logging to EtherCAT network adapter.

MasterRedParms

[in] Master redundancy parameters (needs Feature Pack Master Redundancy)

dwMaxS2SMbxSize

[in] Size of the queued slave to slave mailbox in bytes. It must be at least the size of the biggest configured mailbox of a slave supporting slave to slave mailbox communication.

dwMaxQueuedS2SMbxTfer

[in] Maximum number of queued slave to slave mailbox request.

EC_T_OS_PARMS

```
typedef struct _EC_T_OS_PARMS {
    EC_T_DWORD          dwSignature;
    EC_T_DWORD          dwSize;
    EC_PF_SYSTIME       pfSystemTimeGet;
    EC_T_DWORD          dwSupportedFeatures;
    EC_PF_QUERY_MSEC_COUNT pfSystemQueryMsecCount;
    EC_PF_HW_TIMER_GET_INPUT_FREQUENCY pfHwTimerGetInputFrequency;
    EC_PF_HW_TIMER_MODIFY_INITIAL_COUNT pfHwTimerModifyInitialCount;
} EC_T_OS_PARMS;
```

```
typedef EC_T_DWORD (*EC_PF_SYSTIME)(EC_T_UINT64* pqwSystemTime);
```

```
typedef EC_T_DWORD (*EC_PF_QUERY_MSEC_COUNT)(EC_T_VOID);
```

```
typedef EC_T_DWORD (*EC_PF_HW_TIMER_GET_INPUT_FREQUENCY)(EC_T_DWORD* pdwFreq);
```

```
typedef EC_T_DWORD (*EC_PF_HW_TIMER_MODIFY_INITIAL_COUNT)(EC_T_INT nAdjPermil);
```

dwSignature

[in] Set to EC_OS_PARMS_SIGNATURE (see EcOs.h)

dwSize

[in] Set to sizeof(EC_T_OS_PARMS)

pfSystemTimeGet

[in] Function to get host time in nanoseconds since 1st January 2000. Used as time base for DC Initialization

dwSupportedFeatures

[in/out] Reserved

pfSystemQueryMsecCount

[in] Function to get host time in nanoseconds since 1st January 2000. Used as time base for DC Initialization

pfHwTimerGetInputFrequency

[in] Function to get input frequency of HW timer. This function is needed by some DCM modes described in the Class A Manual

pfHwTimerModifyInitialCount

[in] Function to modify initial count of HW timer. This function is needed by some DCM modes described in the Class A Manual

EC_T_LOG_PARMS

```
typedef struct _EC_T_OS_PARMS {
    EC_T_DWORD          dwLogLevel;
    EC_PF_LOGMSGHK      pfLogMsg
    _EC_T_LOG_CONTEXT*  pLogContext
} EC_T_OS_PARMS;
```

```
typedef EC_T_DWORD(*EC_PF_LOGMSGHK)(struct _EC_T_LOG_CONTEXT* pContext,
EC_T_DWORD dwLogLevel, const EC_T_CHAR* szFormat, ...);
```

dwLogLevel
[in] Log level (EC_LOG_LEVEL_...) to use by master stack for logging

pfLogMsg
[in] Log callback function called by the master stack for logging

pLogContext
[in] Context to be passed to pfLogMsg

EC_LOG_LEVEL_...

The following log levels are defined:

```
EC_LOG_LEVEL_CRITICAL    1
EC_LOG_LEVEL_ERROR       2
EC_LOG_LEVEL_WARNING     3
EC_LOG_LEVEL_INFO        4
EC_LOG_LEVEL_VERBOSE     5
EC_LOG_LEVEL_VERBOSE_CYC 6
```

Log messages are passed from the EC-Master to the callback given at LogParms.pfLogMsg.

Logging.cpp demonstrates how messages can be handled by the application.

For performance reasons the EC-Master automatically filters log messages according to LogParms.dwLogLevel. E.g. messages of severity EC_LOG_LEVEL_WARNING are not passed to the application if LogParms.dwLogLevel is set to EC_LOG_LEVEL_ERROR.

The application can provide customized log message handlers of type EC_PF_LOGMSGHK if the default handler in Logging.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.

4.3.2 ecatDeinitMaster

Terminates the EtherCAT master and releases all resources.

```
EC_T_DWORD ecatDeinitMaster(
    EC_T_VOID
);
```

Parameters

—

Return

EC_E_NOERROR or error code

Comment

Stops the EtherCAT master task and releases all resources.

This function may not be called from within the JobTask's context.

4.3.3 *ecatGetMasterParms*

Gets current Master Init Parameters provided by *ecatInitMaster* or *ecatSetMasterParms*.

```
EC_T_DWORD ecatGetMasterParms(  
    EC_T_INIT_MASTER_PARMS* pParms,  
    EC_T_DWORD dwParmsBufSize  
);
```

Parameters

pParms

[out] Pointer to parameter definitions

dwParmsBufSize

[in] Size of buffer *pParms* points to.

Return

EC_E_NOERROR or error code, e.g.:

EC_E_INVALIDPARAM if *pParms* is not usable.

Comment

Also fills OS parms, Main Link parms, Red Link parms if buffer at *pParms* is big enough according to *dwParmsBufSize*.

4.3.4 *ecatSetMasterParms*

Change Init Parameters provided by *ecatInitMaster*.

```
EC_T_DWORD ecatSetMasterParms(
    EC_T_INIT_MASTER_PARMS* pParms
);
```

Parameters

pParms
[in] Pointer to parameter definitions

Return

EC_E_NOERROR or error code, e.g.:

EC_E_INVALIDPARAM if *pParms* is not usable or a un-changeable parameter was modified, see below.

Comment

Currently OS parms, Main Link parms, Red Link parms, *dwMaxBusSlaves*, *dwMaxQueuedEthFrames*, *dwAdditionalEoEEndpoints*, *bVLANEnable*, *wVLANId*, *byVLANPrio* cannot be changed.

4.3.5 *ecatScanBus*

Scans all connected slaves.

```
EC_T_DWORD ecatScanBus (
    EC_T_DWORD dwTimeout
);
```

Parameters

dwTimeout
[in] Order timeout [ms]

Return

EC_E_NOERROR or error code

Comment

Does not close ports. This function should not be called from within the *JobTask*'s context.

4.3.6 *ecatRescueScan*

Scans all connected slaves including closing ports.

```
EC_T_DWORD ecatRescueScan (
    EC_T_DWORD dwTimeout
);
```

Parameters

dwTimeout
[in] Order timeout [ms]. May not be *EC_NOWAIT*!

Return

EC_E_NOERROR or *EC_E_FRAMELOSS_AFTER_SLAVE* if frameloss after slave detected or error code.

Comment

Closes and open ports on network to rule out slaves which permanently discard frames. Due to port opening and closing the scanning time is increased about 2 seconds per slave.

The Master notifies every slave port which permanently discard frames with *ecatNotify* – *EC_NOTIFY_FRAMELOSS_AFTER_SLAVE*.

The Master will not automatically re-open this port. The application can force to open the port again using *ecatSetSlavePortState*.

This function may not be called from within the *JobTask*'s context.

4.3.7 *ecatConfigureMaster*

Configure the Master.

```
EC_T_DWORD ecatConfigureMaster(
    EC_T_CNF_TYPE      eCnfType,
    EC_T_PBYTE         pbyCnfData,
    EC_T_DWORD         dwCnfDataLen
);
```

Parameters

eCnfType

[in] Enum 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*

Return

EC_E_NOERROR or error code

Comment

This function has to be called after *ecatInitMaster* and prior to calling *ecatStart*. Among others the EtherCAT topology defined in the given XML configuration file will be stored internally.

Analyzing the network including Mailbox communication like CoE can be done without given ENI file using *eCnfType_GenPreopENI*. This is mainly used for configuration tools to get information about the slaves in order to create the ENI file used for *ecatConfigureMaster(...)*.

Remark: All client registrations (see *ecatRegisterClient()*) are dropped during *ecatConfigureMaster()*. Dropped clients registration may be re-registered directly after calling *ecatConfigureMaster()*.

```
typedef enum _EC_T_CNF_TYPE{
    eCnfType_Filename,      /* pbyCnfData: ENI filename to read */
    eCnfType_Data,          /* pbyCnfData: ENI data */
    eCnfType_Datadiag,      /* pbyCnfData: ENI data for diagnosis */
    eCnfType_GenPreopENI,   /* generate ENI based on bus-scan result to get into preop state */
    eCnfType_GenPreopENIWithCRC, /* same as eCnfType_GenPreopENI with CRC protection */
    eCnfType_GenOpENI,      /* generate ENI based on bus-scan result to get into op state */
    eCnfType_None,          /* Reset configuration */
    eCnfType_ConfigData,    /* pbyCnfData: Binary structured configuration */
} EC_T_CNF_TYPE;
```

Depending on this enum *pbyCnfData* is interpreted differently.

This function may not be called from within the *JobTask*'s context.

4.3.8 *ecatConfigExtend*

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.

The following patent may have to be taken into account:

- JP5212509: ADDRESS SETTING METHOD IN NETWORK SYSTEM

```
EC_T_DWORD ecatConfigExtend(  
    EC_T_BOOL  
    EC_T_DWORD  
    bResetConfig,  
    dwTimeout  
);
```

Parameters

bResetConfig

[in] If EC_TRUE extended configuration will be removed.

dwTimeout

[in] Timeout in milliseconds. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code.

Comment

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. This function may not be called from within the JobTask's context.

4.3.9 *ecatRegisterClient*

Register a client with the EtherCAT Master. It must not be called prior to `ecatConfigureMaster` otherwise the registration handle is lost. This function replaces the `ecatIoControl – EC_IOCTL_REGISTERCLIENT`.

```
EC_T_DWORD ecatRegisterClient(
    EC_PF_NOTIFY
    EC_T_VOID*
    EC_T_REGISTERRESULTS*
);
pfnNotify,
pCallerData,
pRegResults
```

Parameters

pfnNotify

[in] Client's notification callback function. This function will be called by the master every time a state change occurs, an error occurs or a mailbox transfer terminates. See section 4.5.1 for more information.

pCallerData

[in] Pointer to a caller data area which will be returned back by the master to the client on every notification callback. This value will not be interpreted by the master.

pRegResults

[out] Registration results, a pointer to a structure of type `EC_T_REGISTERRESULTS`.

Return

`EC_E_NOERROR` or error code

Comment

EC_PF_NOTIFY

Client's notification callback function.

```
typedef EC_T_DWORD(*EC_PF_NOTIFY)(EC_T_DWORD dwCode, EC_T_NOTIFYPARMS* pParms);
```

EC_T_REGISTERRESULTS

Contain the registration results.

```
typedef struct _EC_T_REGISTERRESULTS{
    EC_T_DWORD      dwClientId;
    EC_T_BYTE *     pbyPDIn;
    EC_T_DWORD      dwPDInSize;
    EC_T_BYTE *     pbyPDOOut;
    EC_T_DWORD      dwPDOOutSize;
} EC_T_REGISTERRESULTS;
```

Description

`dwClientId`

[out] Client ID

`pbyPDIn`

[out] Pointer to process data input memory

`dwPDInSize`

[out] Size of process data input memory (in bytes)

`pbyPDOOut`

[out] Pointer to process data output memory

`dwPDOOutSize`

[out] Size of process data output memory (in bytes)

In the XML configuration file the data offsets into the process data memory will be determined (Config/Cyclic/Frame/Command/InputOffsets respectively OutputOffsets). Usually I/O data starts at an offset of 0x10. This function may not be called from within the JobTask's context.

4.3.10 *ecatUnregisterClient*

Unregister a client from the EtherCAT master. This function replaces the `ecatIoControl – EC_IOCTL_UNREGISTERCLIENT`.

```
EC_T_DWORD ecatUnregisterClient(  
    EC_T_DWORD    dwClientId  
);
```

Parameters

dwClientId
[in] Client ID determined when registering with the master.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.3.11 *ecatGetSrcMacAddress*

Gets the source MAC address.

```
EC_T_DWORD ecatGetSrcMacAddress(  
    ETHERNET_ADDRESS* pSrcMacAddress  
);
```

Parameters

pSrcMacAddress
[out] 6-byte buffer to write source MAC address to.

Return

EC_E_NOERROR or error code

Comment

Refers to adapter from `EC_T_INIT_MASTER_PARMS.pLinkParms` at 4.3.1 "ecatInitMaster".

4.3.12 ecatSetMasterState

The EtherCAT master (and all slaves) will be set into the requested state.

```
EC_T_DWORD ecatSetMasterState(
    EC_T_DWORD    dwTimeout,
    EC_T_STATE    eReqState
);
```

Parameters

dwTimeout

[in] Timeout in msec. 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 State.

eEcatState_INIT	Master state Init
eEcatState_PREOP	Master state pre-operational
eEcatState_SAFEOP	Master state safe operational
eEcatState_OP	Master state operational (if called first, same as ecatStart)

Return

EC_E_NOERROR or error code. If the last requested state was not reached, EC_E_BUSY will be returned and the request has to be repeated at a later time.

Comment

If the function is called with EC_NOWAIT, the client may wait for reaching the requested state using the notification callback (EC_NOTIFY_STATECHANGED).

See also EC_IOCTL_ALL_SLAVES_MUST_REACH_MASTER_STATE.

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 using ecatSetMasterState()
- Master starts transition for all slaves
- Some slaves **changed to SAFEOP**, but some fail and therefore **stay in PREOP**
- Master state stays in PREOP, ecatSetMasterState() 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..

4.3.13 ecatGetMasterState

The current master state is returned.

```
EC_T_STATE ecatGetMasterState(EC_T_VOID);
```

Parameters

-

Return

Current master state (*eEcatState_UNKNOWN*, *eEcatState_INIT*, *eEcatState_PREOP*, *eEcatState_SAFEOP* or *eEcatState_OP*).

Comment

-

4.3.14 *ecatStart*

The EtherCAT master (and all slaves) will be set into the OPERATIONAL state.

```
EC_T_DWORD ecatStart(  
    EC_T_DWORD    dwTimeout  
);
```

Parameters

dwTimeout

[in] Timeout in msec. 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.

Return

EC_E_NOERROR or error code

Comment

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.

4.3.15 *ecatStop*

The EtherCAT master and all slaves will be set back into the INIT state.

```
EC_T_DWORD ecatStop(  
    EC_T_DWORD    dwTimeout  
);
```

Parameters

dwTimeout

[in] Timeout in msec. 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.

Return

EC_E_NOERROR or error code. If the last requested state was not reached, EC_E_BUSY will be returned and the request has to be repeated at a later time.

Comment

If the function is called with EC_NOWAIT, the client may wait for reaching the INIT state using the notification callback (**ECAT_NOTIFY_STATECHANGE**).

Caveat: in multithreading systems *ecatStop()* must be executed only after after all other EtherCAT operations (e.g. mailbox transfers) on all slaves are completely terminated.

This function may not be called from within the JobTask's context.

4.3.16 ecatExecJob

Execute or initiate the requested master job.

```
EC_T_DWORD ecatExecJob(
    EC_T_USER_JOB      eUserJob,
    EC_T_USER_JOB_PARMS* pUserJobParms
);
```

Parameters

eUserJob

[in] Requested job.

pUserJobParms

[in] Additional job specific parameter. This parameter is reserved if not otherwise specified below.

Return

EC_E_NOERROR or error code, depending on the requested job (see below).

EC_BUSY will be returned in case one of the requests eUsrJob_ProcessAllRxFrames, eUsrJob_SendAllCycFrames, eUsrJob_SendCycFramesByTaskId or eUsrJob_SendAcycFrames would be executed concurrently.

EC_BUSY will be returned in case one of the requests eUsrJob_MasterTimer would be executed concurrently.

Important note:

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 ecatExecJob(), the calls have to be synchronized externally.

Calling ecatExecJob() in a context that doesn't support operating system calls can lead to unpredictable behavior.

Comment

EC_T_USER_JOB_PARMS

Contain the job specific parameters.

```
typedef union _EC_T_USER_JOB_PARMS
{
    EC_T_BOOL      bAllCycFramesProcessed;
    EC_T_DWORD     dwNumFramesSent;
    EC_T_DWORD     dwTaskIdToSend;
    struct
    {
        EC_T_BOOL      bCycFramesProcessed;
        EC_T_DWORD     dwTaskId;
    } ProcessRxFramesByTaskId;
    struct
    {
        EC_T_DWORD     dwMaxPortsToProcess;
        EC_T_DWORD     dwNumFramesProcessed;
    } SwitchEoeFrames;
} EC_T_USER_JOB_PARMS;
```

The following EUserJob requests are currently defined:

a) 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.

- b) **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 `ecatExecJob` 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 (`EC_NOTIFY_FRAME_RESPONSE_ERROR`).
- c) **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.
- d) **eUsrJob_RunMcSm**
 This job is obsolete.
- e) **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 `ecatExecJob(eUsrJob_MasterTimer)`. The state-machines are handling the EtherCAT state change transfers.
Return:
`EC_E_NOERROR` if successful, error code in case of failures.
- f) **eUsrJob_SendCycFramesByTaskId**
 Send cyclic frames related to a specific task id. If more than one cyclic entries are configured (see Configuration variant 2: multiple cyclic entries) 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.
pUserJobParms->dwTaskIdToSend:
 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 (`EC_NOTIFY_FRAME_RESPONSE_ERROR`).
- g) **eUsrJob_StampSendAllCycFrames**
 same as b) but the transmitted frame is timestamped for Distributed Clocks, if a callback is registered and an ARMW is contained. (Deprecated)
- h) **eUsrJob_StampSendCycFramesByTaskId**
 same as f) but the transmitted frame is timestamped for Distributed Clocks, if a callback is registered and an ARMW is contained. (Deprecated)
- i) **eUsrJob_MasterTimerMinimal**
 Reserved.
- j) **eUsrJob_ProcessRxFramesByTaskId**
eUsrJob_ProcessAcycRxFrames
 See Feature Pack "Splitted Frame Processing".
- k) **eUsrJob_SwitchEoeFrames**
 This job must be called if `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

4.3.17 *ecatGetProcessData*

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(eUusrJob_ MasterTimer)* within the job task. This function is usually only called remotely (using the Remote API).

This function must not be called from within the job task (dead lock!).

```
EC_T_DWORD ecatGetProcessData(
    EC_T_BOOL      bOutputData,
    EC_T_DWORD     dwOffset,
    EC_T_BYTE*     pbyData,
    EC_T_DWORD     dwLength,
    EC_T_DWORD     dwTimeout);
```

Parameters

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 to hold read data.

dwLength

[in] Size of *pbyData* Buffer and length of data to read.

dwTimeout

[in] Timeout in msec.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.3.18 *ecatSetProcessData*

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(eUusrJob_ MasterTimer)* within the job task. This function is usually only called remotely (using the Remote API).

This function must not be called from within the job task (dead lock!).

```
EC_T_DWORD ecatSetProcessData(
    EC_T_BOOL      bOutputData,
    EC_T_DWORD     dwOffset,
    EC_T_BYTE*     pbyData,
    EC_T_DWORD     dwLength,
    EC_T_DWORD     dwTimeout);
```

Parameters

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 to hold write data.

dwLength

[in] Size of *pbyData* Buffer and length of data to write.

dwTimeout
[in] Timeout in msec.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.3.19 *ecatSetProcessDataBits*

Writes a specific number of bits from a given buffer to the process image with a bit offset (synchronized). This function is handled in the same way as function *ecatSetProcessData* and must not be called from within the job task (dead lock).

```
EC_T_DWORD ecatSetProcessDataBits(
    EC_T_BOOL      bOutputData,
    EC_T_DWORD     dwBitOffsetPd,
    EC_T_BYTE*     pbyDataSrc,
    EC_T_DWORD     dwBitLengthSrc,
    EC_T_DWORD     dwTimeout);
```

Parameters

bOutputData
[in] EC_TRUE: write output data, EC_FALSE: write input data.

dwBitOffsetPd
[in] Bit offset in Process data image.

pbyDataSrc
[in] Data that shall be written to the process image

dwBitLengthSrc
[in] Number of bits that shall be written to the process image

dwTimeout
[in] Timeout in msec. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.3.20 *ecatGetProcessDataBits*

Reads a specific number of bits from the process image to the given buffer with a bit offset (synchronized). This function is handled in the same way as function *ecatGetProcessData* and must not be called from the job task (dead lock).

```
EC_T_DWORD ecatGetProcessDataBits(
    EC_T_BOOL      bOutputData,
    EC_T_DWORD     dwBitOffsetPd,
    EC_T_BYTE*     pbyDataDst,
    EC_T_DWORD     dwBitLengthDst,
    EC_T_DWORD     dwTimeout);
```

Parameters

bOutputData
[in] EC_TRUE: write output data, EC_FALSE: write input data.

dwBitOffsetPd
[in] Bit offset in Process data image.

pbyDataDst
[out] Data buffer for the read data

dwBitLengthDst

[in] Number of bits that shall be read from the process image
dwTimeout
 [in] Timeout in msec. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.3.21 *ecatGetProcessImageInputPtr*

Gets the process data input image pointer

EC_T_BYTE* *ecatGetProcessDataInputPtr*(EC_T_VOID);

Return

The process data input image pointer or EC_NULL

4.3.22 *ecatGetProcessImageOutputPtr*

Gets the process data output image pointer

EC_T_BYTE* *ecatGetProcessDataOutputPtr*(EC_T_VOID);

Return

The process data output image pointer or EC_NULL

4.3.23 *ecatGetDiagnosisImagePtr*

Gets the diagnosis image pointer

EC_T_BYTE* *ecatGetDiagnosisImagePtr*(EC_T_VOID);

Return

The diagnosis image pointer or EC_NULL

4.3.24 *ecatForceProcessDataBits*

Forces 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 [ecatReleaseProcessDataBits\(\)](#) or [ecatReleaseAllProcessDataBits\(\)](#).

This function is handled in the same way as function *ecatSetProcessData* and must not be called from within the job task (dead lock).

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*);

Parameters

dwClientId

[in] Client ID determined when registering with the master.

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.
pbyData
 [in] Data that shall be written to the process image.
dwTimeout
 [in] Timeout in msec. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.3.25 *ecatReleaseProcessDataBits*

Release previously forced process data.

For a forced output: Value set by application become valid again. Because [ecatForceProcessDataBits\(\)](#) writes 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.

For a forced input: Value read from the slaves become valid again.

This function is handled in the same way as function *ecatSetProcessData* and must not be called from within the job task (dead lock).

```
EC_T_DWORD ecatReleaseProcessDataBits (
    EC_T_DWORD      dwClientId,
    EC_T_BOOL       bOutputData,
    EC_T_DWORD      dwBitOffsetPd,
    EC_T_WORD       wBitLength,
    EC_T_DWORD      dwTimeout);
```

Parameters

dwClientId
 [in] Client ID determined when registering with the master.
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 in msec. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.3.26 *ecatReleaseAllProcessDataBits*

Release all previously forced process data for a dedicated client.

For a forced output: Value set by application become valid again. Because [ecatForceProcessDataBits\(\)](#) writes 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.

For a forced input: Value read from the slaves become valid again.

This function is handled in the same way as function `ecatSetProcessData` and must not be called from within the job task (dead lock).

```
EC_T_DWORD ecatReleaseAllProcessDataBits (
    EC_T_DWORD      dwClientId,
    EC_T_DWORD      dwTimeout);
```

Parameters

dwClientId

[in] Client ID determined when registering with the master.

dwTimeout

[in] Timeout in msec. The timeout value must not be set to `EC_NOWAIT`.

Return

`EC_E_NOERROR` or error code

Comment

This function may not be called from within the `JobTask`'s context.

4.3.27 *ecatGetVersion*

Gets the EC-Master's version as `EC_T_DWORD`.

```
EC_T_DWORD ecatGetVersion(EC_T_DWORD* pdwVersion);
```

Parameters

pdwVersion

[out] Pointer to `EC_T_DWORD` to carry out EC-Master's version.

Return

`EC_E_NOERROR` or error code

4.3.28 *ecatSetLicenseKey*

Sets the license key for the protected version.

```
EC_T_DWORD ecatSetLicenseKey(EC_T_CHAR* szKey);
```

Parameters

szKey

[in] License key as zero terminated string with 26 characters.

Return

`EC_E_NOERROR` or error code

Comment

Must be called after `ecatInitMaster()` and before `ecatConfigureMaster()`.

Example:

```
dwRes = ecatSetLicenseKey("DA1099F2-15C249E9-54327FBC");
```

4.3.29 *ecatSetOemKey*

Provide OEM Key needed for OEM Masters to parse ENI files and provide access via RAS.

EC_T_DWORD *ecatSetOemKey*(**EC_T_UINT64** *qwOemKey*);

Parameters

qwOemKey
[in] 64 bit OEM key.

Return

EC_E_NOERROR or error code

Comment

Must be called after *ecatInitMaster()* and before *ecatConfigureMaster()*.

Example:

```
dwRes = ecatSetOemKey(0x1234567812345678);
```


4.3.30 *ecatloControl*

With `ecatloControl()` a generic control interface exists between the application and the EC-Master and its Link Layers.

```
EC_T_DWORD ecatloControl(
    EC_T_DWORD      dwCode,
    EC_T_IOCTLPARMS* pParms
);
```

Parameters

dwCode

[in] Control code

pParms

[in] Control code depending parameters

Return

EC_E_NOERROR or error code

Comment

EC_T_IOCTLPARMS

Control parameters, the content is depending on the control code.

```
typedef struct _EC_T_IOCTLPARMS{
    EC_T_BYTE*      pbyInBuf;
    EC_T_DWORD      dwInBufSize;
    EC_T_BYTE*      pbyOutBuf;
    EC_T_DWORD      dwOutBufSize;
    EC_T_DWORD *    pdwNumOutData;
} EC_T_IOCTLPARMS;
```

Description

pbyInBuf

[in] Pointer to control input parameter.

dwInBufSize

[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf

[out] Pointer to control output buffer where the results will be copied into.

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.

4.3.31 *ecatIoControl* – *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 *ecatConfigureMaster* and before *ecatStart*.

Parameters

pbyInBuf
[] Should be set to *EC_NULL*.

dwInBufSize
[] 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.

Comment

EC_T_MEMREQ_DESC

Structure containing the necessary memory sizes in bytes.

```
typedef struct _EC_T_MEMREQ_DESC{
    EC_T_DWORD    dwPDOOutSize,
    EC_T_DWORD    dwPDInSize
} EC_T_MEMREQ_DESC;
```

4.3.32 *ecatIoControl* – *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 *ecatIoControl* - *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 *ecatConfigureMaster()* but prior to registering any client and prior to calling *ecatStart()*. Every client that registers with the master (*ecatRegisterClient()*) will get back the memory pointers to PDOOut/PDIn data registered within this call.

Parameters

pbyInBuf
[in] Memory provider (*EC_T_MEMPROV_DESC*)

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Should be set to *EC_NULL*.

dwOutBufSize
[] Should be set to 0.

pdwNumOutData
[] Should be set to *EC_NULL*.

Return

EC_E_NOERROR or error code.

EC_E_INVALIDSIZE: length of data buffer too small.

EC_T_MEMPROV_DESC

Descriptor of the memory provider.

```
typedef struct _EC_T_MEMPROV_DESC{
    EC_T_PVOID          pvContext;

    EC_T_PBYTE          pbyPDOutData;
    EC_T_DWORD          dwPDOutDataLength;
    EC_T_PBYTE          pbyPDInData;
    EC_T_DWORD          dwPDInDataLength;

    EC_T_PFMEMREQ       pfPDOutDataReadRequest;
    EC_T_PFMEMREL       pfPDOutDataReadRelease;
    EC_T_PFMEMREQ       pfPDInDataWriteRequest;
    EC_T_PFMEMREL       pfPDInDataWriteRelease;

    /* See Feature Pack "Master Redundancy" */
    EC_T_PBYTE          pbyMasterRedPDOutData;
    EC_T_DWORD          dwMasterRedPDOutDataLength;
    EC_T_PBYTE          pbyMasterRedPDInData;
    EC_T_DWORD          dwMasterRedPDInDataLength;
} EC_T_MEMPROV_DESC;

typedef EC_T_VOID (*EC_T_PFMEMREQ)( EC_T_PVOID pvContext,
                                     EC_T_DWORD dwTaskId,
                                     EC_T_BYTE** ppbyPDData);
typedef EC_T_VOID (*EC_T_PFMEMREL)( EC_T_PVOID pvContext, EC_T_DWORD dwTaskId);
```

Description

pvContext

- [in] Context pointer. This pointer is used every time when one of the callback functions (e.g. pfPDOutDataReadRequest) is called.

Fixed buffers:

pbyPDOutData

- [in] 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 pfPDOutDataReadRequest() is called.

dwPDOutDataLength

- [in] Length of the output process data buffer. The function ecatIoControl - EC_IOCTL_GET_PDMEMORYSIZE should be executed to determine the appropriate size.

pbyPDInData

- [in] 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 pfPDInDataWriteRequest() is called.

dwPDInDataLength

- [in] Length of the output process data buffer. The function ecatIoControl - EC_IOCTL_GET_PDMEMORYSIZE should be executed to determine the appropriate size.

Callback functions:

These functions will be called by the master within the cyclic process data transfer. The application has to assure that these functions will not block.

```
EC_T_VOID pfPDOOutReadRequest( EC_T_PVOID pvContext,
                               EC_T_DWORD dwTaskId,
                               EC_T_BYTE** ppbyPDOOutData)
```

- [in] This function will be called by the master cyclically within the process data transfer cycle prior to read data from the output process data buffer. If pfPDOOutReadRequest is set to EC_NULL the fixed buffer pointer pbyPDOOutData will be used.

Parameters:

pvContext

- [in] Context pointer, see above.

dwTaskId

- [in] Task id of cyclic data transfer. If dwTaskId == TASKID_COMPLETE_PD the function must return a complete output process data buffer which contains valid data for all cyclic tasks.

ppbyPDOOutData

- [out] Pointer to the output process data buffer to be used. If the function returns EC_NULL the master will use the fixed buffer pointer pbyPDOOutData. The provided buffer size must be at least dwPDOOutDataLength bytes.

```
EC_T_VOID pfPDOOutReadRelease(EC_T_PVOID pvContext, EC_T_DWORD dwTaskId)
```

- [in] This function will be called by the master cyclically within the process data transfer cycle after all data were read from the output process data buffer.

Parameters:

pvContext

- [in] Context pointer, see above.

dwTaskId

- [in] Task id of cyclic data transfer.

```
EC_T_VOID pfPDInWriteRequest( EC_T_PVOID pvContext,
                              EC_T_DWORD dwTaskId,
                              EC_T_BYTE** ppbyPDInData)
```

- [in] This function will be called by the master cyclically within the process data transfer cycle prior to write new data into the input process data buffer. If pfPDInWriteRequest is set to EC_NULL the fixed buffer pointer pbyPDInData will be used.

Parameters:

pvContext

- [in] Context pointer, see above.

dwTaskId

- [in] Task id of cyclic data transfer. If dwTaskId == TASKID_COMPLETE_PD the function must return a complete input process data buffer which contains valid data for all tasks.

ppbyPDInData

- [out] Pointer to the input process data buffer to be used. If the function returns EC_NULL the master will use the fixed buffer pointer pbyPDInData. The provided buffer size must be at least dwPDInDataLength bytes.

```
EC_T_VOID pfPDInWriteRelease(EC_T_PVOID pvContext, EC_T_DWORD dwTaskId)
```

- [in] This function will be called by the master cyclically within the process data transfer cycle after all data were written into the input process data buffer.

Parameters:

pvContext

- [in] Context pointer, see above.

dwTaskId

- [in] Task id of cyclic data transfer.

4.3.33 *ecatIoControl* – *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 *ecatInitMaster()* before starting the job task.

Parameters

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

[] Should be set to *EC_NULL*.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to *EC_NULL*.

Return

EC_E_NOERROR or error code.

EC_E_INVALIDSIZE: length of data buffer too small.

EC_T_CYCFRAME_RX_CBDESC

Descriptor of the cyclic frame received callback.

```
typedef struct _EC_T_CYCFRAME_RX_CBDESC {
    EC_T_VOID*          pCallbackContext;
    EC_PF_CYCFRAME_RECV pfnCallback;
} EC_T_CYCFRAME_RX_CBDESC;
```

```
typedef EC_T_VOID (*EC_PF_CYCFRAME_RECV)(EC_T_DWORD, EC_T_VOID*);
```

Description

pvCallbackContext

[in] Context pointer. This pointer is used as parameter every time when the callback function is called.

EC_T_VOID pfnCallback(EC_T_DWORD dwTaskId, EC_T_VOID pvCallbackContext)*

[in] This function will be called by the master after the cyclic frame is received. (if more than one cyclic frame after the last frame). The application has to assure that these functions will not block. Typically a event is given to wakeup the job task to continue.

Parameters:

dwTaskId

[out] Task id of the received cyclic frame.

pvCallbackContext

[in] Context pointer, see above.

4.3.34 *ecatIoControl* – *EC_IOCTL_ISLINK_CONNECTED*

Determine whether link between the EtherCAT master and the first slave is connected.

Parameters

pbyInBuf
[] Should be set to EC_NULL.

dwInBufSize
[] 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.

Comment

With Redundancy support enabled, EC_FALSE is only set if main and redundancy link are down.

4.3.35 *ecatIoControl* – *EC_IOCTL_GET_LINKLAYER_MODE*

This call allows the application to determine whether the LinkLayer is currently running in polling or in interrupt mode.

Parameters

pbyInBuf
[] Should be set to EC_NULL.

dwInBufSize
[] 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.

Comment

EC_T_LINKLAYER_MODE_DESC

```
typedef struct _EC_T_LINKLAYER_MODE_DESC{
    EC_T_LINKMODE      eLinkMode;
    EC_T_LINKMODE      eLinkModeRed;
} EC_T_LINKLAYER_MODE_DESC;
```

Description

eLinkMode

[in] Operation mode of currently used Link Layer, which maybe one of *EcLinkMode_INTERRUPT* or *EcLinkMode_POLLING*.

eLinkModeRed

[in] Operation mode of currently used Redundancy Interface. If no redundant interface is used *EcLinkMode_UNDEFINED* is returned.

4.3.36 *ecatIoControl – EC_IOCTL_GET_CYCLIC_CONFIG_INFO*

Determine cyclic configuration details from ENI configuration file.

Parameters

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.

Comment

EC_T_CYC_CONFIG_DESC

Cyclic configuration descriptor.

```
typedef struct _EC_T_CYC_CONFIG_DESC {
    EC_T_DWORD    dwNumCycEntries; /* total number of cyclic entries */
    EC_T_DWORD    dwTaskId;        /* task id of selected cyclic entry */
    EC_T_DWORD    dwPriority;       /* priority of selected cyclic entry */
    EC_T_DWORD    dwCycleTime;     /* cycle time of selected cyclic entry */
} EC_T_CYC_CONFIG_DESC;
```

4.3.37 *ecatIoControl – EC_IOCTL_IS_SLAVETOSLAVE_COMM_CONFIGURED*

Determine if any slave to slave communication is configured.

Parameters

pbyInBuf
[] Should be set to *EC_NULL*.

dwInBufSize
[] 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.

4.3.38 *ecatIoControl* – *EC_LINKIOCTL_...*

The generic control interface *ecatIoControl()* provides access to the main network adapter when adding *EC_IOCTL_LINKLAYER_MAIN* to the *EC_LINKIOCTL_...* parameter at *dwCode*. *EC_IOCTL_LINKLAYER_RED* specifies the redundant network adapter.

Parameters

pbyInBuf, *dwInBufSize*, *pbyOutBuf*, *dwOutBufSize*, *pdwNumOutData* are specific to the *EC_LINKIOCTL_...*

4.3.39 *ecatIoControl* – *EC_LINKIOCTL_GET_ETHERNET_ADDRESS*

Provides MAC addresses of main or red line.

Parameters

pbyInBuf

[] Should be set to *EC_NULL*.

dwInBufSize

[] 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.

4.3.40 *ecatIoControl* – *EC_LINKIOCTL_GET_SPEED*

Returns actual speed of main or red line in MBits at *pbyOutBuf*.

Parameters

pbyInBuf

[] Should be set to *EC_NULL*.

dwInBufSize

[] 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.

4.3.41 *ecatIoControl* – *EC_IOCTL_SET_CYCFRAME_LAYOUT*

Set the cyclic frames layout.

Parameters

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

[] Should be set to *EC_NULL*.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to *EC_NULL*.

EC_T_CYCFRAME_LAYOUT

Cyclic configuration descriptor.

typedef enum _EC_T_CYCFRAME_LAYOUT

```

{
    eCycFrameLayout_STANDARD,
    /* Layout according ENI with command add/reordering, no relationship to PD */

    eCycFrameLayout_DYNAMIC,
    /* Layout is dynamically modified to send as less as possible cyclic frames and commands */

    eCycFrameLayout_FIXED,
    /* Layout strictly match ENI, frame buffers and PD area overlapped */

    eCycFrameLayout_IN_DMA,
    /* Layout strictly match ENI, frame buffers and PD area overlapped, frame buffers in DMA */
} EC_T_CYCFRAME_LAYOUT;

```

4.3.42 *ecatIoControl* – **EC_IOCTL_SET_MASTER_DEFAULT_TIMEOUTS**

Set master default timeouts in milliseconds.

Parameters

pbyInBuf
 [in] Pointer to EC_T_MASTERDEFAULTTIMEOUTS_DESC

dwInBufSize
 [in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
 [] Should be set to EC_NULL.

dwOutBufSize
 [] Should be set to 0.

pdwNumOutData
 [] Should be set to EC_NULL.

Comment**EC_T_MASTERDEFAULTTIMEOUTS_DESC**

Master default timeouts descriptor.

typedef struct _EC_T_MASTERDEFAULTTIMEOUTS_DESC

```

{
    EC_T_DWORD    dwMasterStateChange;
    EC_T_DWORD    dwInitCmdRetry;
    EC_T_DWORD    dwMbxCmd;
    EC_T_DWORD    dwMbxPolling;
    EC_T_DWORD    dwDcmlnSync;
    EC_T_DWORD    dwReserved[11];
} EC_T_MASTERDEFAULTTIMEOUTS_DESC;

```

Description

dwMasterStateChange
 Default state change timeout, applied if *emSetMasterState* called with *EC_NOWAIT*.

dwInitCmdRetry
 Timeout between retry sending an init-command.

dwMbxCmd
 Timeout between retry sending an mailbox command.

dwMbxPolling
 Mailbox polling cycle.

dwDcmlnSync
 Timeout to wait for DCM InSync in state change PREOP to SAFEOP.

Setting a value of this descriptor to zero resets the default timeout value to the initial value.

4.3.43 *ecatIoControl* – ***EC_IOCTL_SET_COPYINFO_IN_SENDCYCFRAMES***

Set copy info processed in either *SendCycFrames* or in *ProcessAllRxFrames*.

Parameters

pbyInBuf
[in] Pointer to EC_T_BOOL. EC_TRUE: *SendCycFrames*, EC_FALSE: *ProcessAllRxFrames*
dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
[] Should be set to EC_NULL.
dwOutBufSize
[] Should be set to 0.
pdwNumOutData
[] Should be set to EC_NULL.

Comment

Default: Set by *ProcessAllRxFrames*.

4.3.44 *ecatIoControl* – ***EC_IOCTL_SET_BUS_CYCLE_TIME***

Set bus cycle time in usec master parameter without calling *ecatInitMaster* again.

Parameters

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
[] Should be set to EC_NULL.
dwOutBufSize
[] Should be set to 0.
pdwNumOutData
[] Should be set to EC_NULL.

Comment

Implicitly recalculates Order Timeout and EcatCmdTimeout.

4.3.45 *ecatIoControl* –

EC_IOCTL_ADDITIONAL_VARIABLES_FOR_SPECIFIC_DATA_TYPES

Enable or disable additional variables for specific data types. *Default:* Enabled.

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

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

4.3.46 *ecatIoControl* – ***EC_IOCTL_SLV_ALIAS_ENABLE***

Enables slave alias addressing for all slaves.

Parameters

pbyInBuf

[in] Should be set to EC_NULL.

dwInBufSize

[in] Should be set to 0.

pbyOutBuf

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

Caution: All slaves need to have the correct alias address set! If in doubt, don't use this IOCTL.

4.3.47 *ecatIoControl* – *EC_IOCTL_SET_IGNORE_INPUTS_ON_WKC_ERROR*

Set ignore inputs on WKC error

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

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 EC_NOTIFY_CYCCMD_WKC_ERROR is generated and the application must consider this status for the current cycle.

4.3.48 *ecatIoControl* – *EC_IOCTL_SET_ZERO_INPUTS_ON_WKC_ERROR*

Set zero inputs on WKC error

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

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 EC_NOTIFY_CYCCMD_WKC_ERROR is generated and the application must consider this status for the current cycle.

4.3.49 *ecatIoControl* – *EC_IOCTL_SET_ZERO_INPUTS_ON_WKC_ZERO*

Set zero inputs on WKC is zero

Parameters

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
[] Should be set to EC_NULL.
dwOutBufSize
[] Should be set to 0.
pdwNumOutData
[] Should be set to EC_NULL.

Comment

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.

4.3.50 *ecatIoControl* – *EC_IOCTL_SET_GENENI_ASSIGN_EEPROM_BACK_TO_ECAT*

Enable or disable creation of “assign EEPROM back to ECAT” InitCmd if ENI generated based on bus-scan result.

Parameters

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
[] Should be set to EC_NULL.
dwOutBufSize
[] Should be set to 0.
pdwNumOutData
[] Should be set to EC_NULL.

Comment

The ENI’s “assign EEPROM back to ECAT” 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.

4.3.51 *ecatIoControl* – *EC_IOCTL_SET_EOE_DEFERRED_SWITCHING_ENABLED*

Enable or disable deferred EoE switching

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

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).

4.3.52 *ecatIoControl* – *EC_IOCTL_SET_MAILBOX_POLLING_CYCLES*

This call changes the mailbox polling cycles.

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

```
typedef struct _EC_T_SET_MAILBOX_POLLING_CYCLES_DESC
{
    EC_T_DWORD dwSlaveld;
    EC_T_WORD wCycles;
}EC_T_SET_MAILBOX_POLLING_CYCLES_DESC;
```

Description

dwSlaveld	[in]	Slave Id
wCycles	[in]	Number of cycles between polling in msec

4.4 Process Data Access Functions

4.4.1 EC_COPYBITS

Copies a block of bits from a source buffer to a destination buffer.

EC_COPYBITS(pbyDst, nDstBitOffs, pbySrc, nSrcBitOffs, nBitSize)

Parameters

<i>pbyDst</i>	[out]	destination buffer
<i>nDstBitOffs</i>	[in]	bit offset within destination buffer
<i>pbySrc</i>	[in]	source buffer
<i>nSrcBitOffs</i>	[in]	bit offset in source buffer
<i>nBitSize</i>	[in]	block size in bits

Return

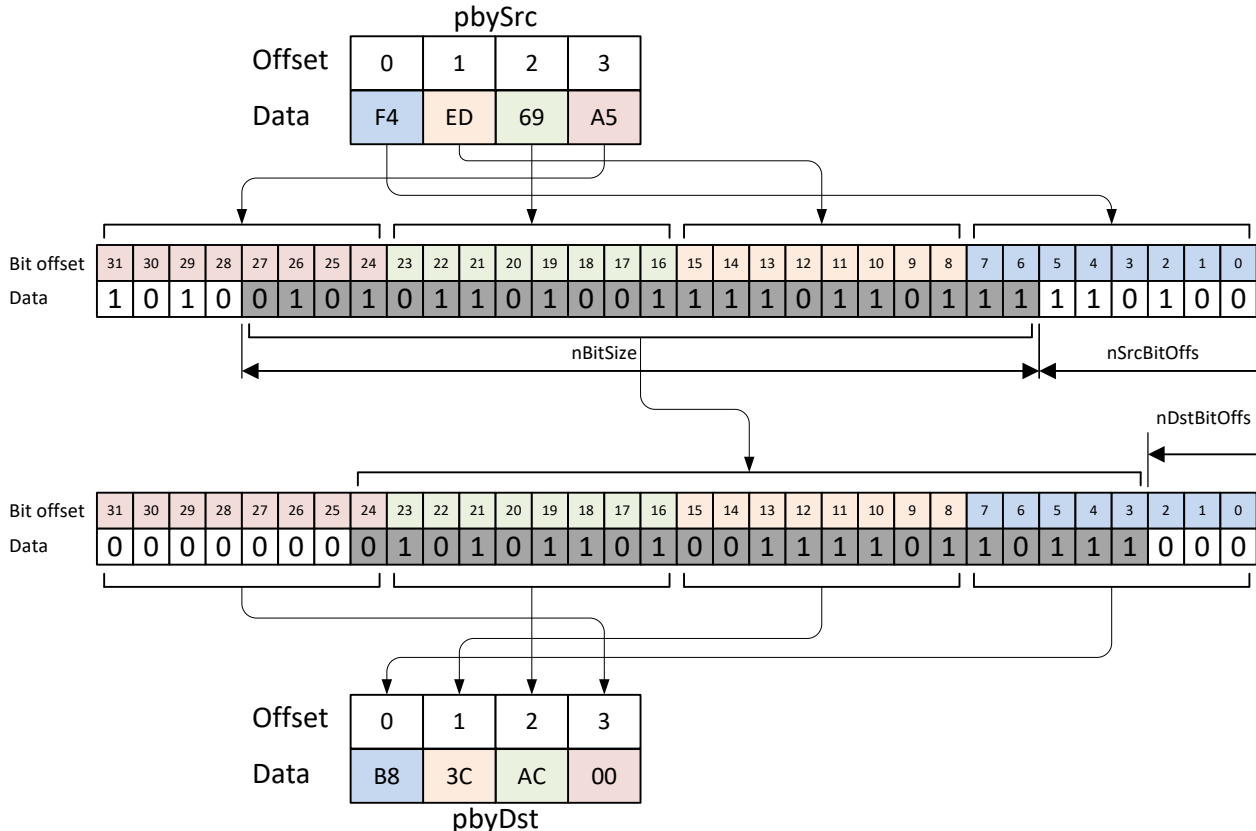
-

Comment

The memory buffers must be allocated before. **Important:** The buffers must be big enough to hold the block starting at the given offsets! The buffers are not checked for overrun.

See 4.4.8 EC_SETBITS and 4.4.9 EC_GETBITS.

Example



```
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 */
```

4.4.2 EC_GET_FRM_WORD

Returns a value of type “EC_T_WORD” (16 bits) at given pointer. The value is swapped on PPC systems.

EC_GET_FRM_WORD(ptr)

Parameters

ptr
[in] source buffer

Return

EC_T_WORD value (16 bits) from buffer pointed by *ptr*.

Comment

The pointer has to point to a EC_T_WORD value (2 bytes).

Examples

```
EC_T_BYTE byFrame[] = {0x01, 0xF4, 0xDD, 0x85, 0x03, 0x00, 0x60, 0xC1, 0x00};
EC_T_WORD wResult = 0;
```

```
wResult = EC_GET_FRM_WORD(byFrame);
/* 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 */
```

4.4.3 EC_GET_FRM_DWORD

Returns a value of type “EC_T_DWORD” (32 bits) at given pointer. The value is swapped on PPC systems.

EC_GET_FRM_DWORD(ptr)

Parameters

ptr
[in] source buffer

Return

EC_T_DWORD value (32 bits) from buffer pointed by *ptr*.

Comment

The pointer has to point to a EC_T_DWORD value (4 bytes).

Examples

```
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 */
```

4.4.4 EC_GET_FRM_QWORD

Returns a value of type “EC_T_QWORD” (64 bits) at given pointer. The value is swapped on PPC systems.

EC_GET_FRM_QWORD(ptr)

Parameters

ptr
[in] source buffer

Return

EC_T_QWORD value (64 bits) from buffer pointed by *ptr*.

Comment

The pointer has to point to a EC_T_QWORD value (8 bytes).

Examples

```
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 0x00C160000385DDF4 on little endian systems */
```

4.4.5 EC_SET_FRM_WORD

Writes a value of type “EC_T_WORD” (16 bits) at given pointer. The value is swapped on PPC systems.

EC_SET_FRM_WORD(ptr,w)

Parameters

ptr
[in] destination buffer
w
[in] value of type “EC_T_WORD”

Return

-

Comment

The pointer has to point to a buffer to hold at least EC_T_WORD (2 bytes).

Examples

```
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 ... */
```

4.4.6 EC_SET_FRM_DWORD

Writes a value of type “EC_T_DWORD” (32 bits) at given pointer. The value is swapped on PPC systems.

EC_SET_FRM_DWORD(ptr,dw)

Parameters

<i>ptr</i>	[in]	destination buffer
<i>dw</i>	[in]	value of type “EC_T_DWORD”

Return

-

Comment

The pointer has to point to a buffer to hold at least EC_T_DWORD (4 bytes).

Examples

```
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 ... */
```

4.4.7 EC_SET_FRM_QWORD

Writes a value of type “EC_T_QWORD” (64 bits) at given pointer. The value is swapped on PPC systems.

EC_SET_FRM_QWORD(ptr,qw)

Parameters

<i>ptr</i>	[in]	destination buffer
<i>qw</i>	[in]	value of type “EC_T_QWORD”

Return

-

Comment

The pointer has to point to a buffer to hold at least EC_T_QWORD (8 bytes).

Examples

```
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 ... */
```

4.4.8 EC_SETBITS

Copies *nBitSize* bits from *pbySrcData* starting at first bit to *pbyDstBuf* starting at *nDstBitOffs*.

EC_SETBITS(*pbyDstBuf*, *pbySrcData*, *nDstBitOffs*, *nBitSize*)

Parameters

pbyDstBuf
[out] destination where data is copied to (write!)
pbySrcData
[in] source data to be copied (read), starting with first bit
nDstBitOffs
[in] skipped bits at *pbyDstBuf*
nBitSize
[in] bit count to be copied
)

Comment

This function should be used to get bit aligned data, not byte aligned data as the byte aligned Process Data Functions are faster. See e.g. 4.4.2 EC_GET_FRM_WORD.

4.4.9 EC_GETBITS

Copies *nBitSize* bits from *pbySrcBuf* starting at *nSrcBitOffs* to *pbyDstData* starting at first bit.

EC_GETBITS(*pbySrcBuf*, *pbyDstData*, *nSrcBitOffs*, *nBitSize*)

Parameters

pbySrcBuf,
[in] source where data is copied from (read)
pbyDstData
[out] destination where data is copied to (write!), starting with first bit
nSrcBitOffs
[in] skipped bits at *pbySrcBuf*
nBitSize
[in] bit count to be copied

Comment

This function should be used to get bit aligned data, not byte aligned data as the byte aligned Process Data Functions are faster. See e.g. 4.4.2 EC_GET_FRM_WORD.

4.5 Generic notification interface

One of the parameters the client has to set when registering with the EtherCAT master is a generic notification callback function (*ecatNotify*). The master calls this function every time a event (for example an error event) occurs about which the client has to be informed (see also section 4.5.1).

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.

4.5.1 Notification callback: *ecatNotify*

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 *ecatNotify()* 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.

```
EC_T_DWORD ecatNotify(
    EC_T_DWORD      dwCode,
    EC_T_NOTIFYPARMS* pParms
);
```

Parameters

dwCode
[in] Notification code

pParms
[in] Notification code depending data

Return

EC_E_NOERROR or error code

Comment

EC_T_NOTIFYPARMS

Data structure filled with detailed information about the according notification.

```
typedef struct _EC_T_NOTIFYPARMS{
    EC_T_VOID*      pCallerData;
    EC_T_BYTE*      pbyInBuf;
    EC_T_DWORD      dwInBufSize;
    EC_T_BYTE*      pbyOutBuf;
    EC_T_DWORD      dwOutBufSize;
    EC_T_DWORD*      pdwNumOutData;
} EC_T_NOTIFYPARMS;
```

Description

pCallerData
[in] Client depending caller data parameter. This pointer is one of the parameters when the client registers with the master.

pbyInBuf
[in] Notification input parameters.

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[out] Notification output (result).

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.

4.5.2 *ecatNotify* – **EC_NOTIFY_STATECHANGED**

Notification about a change in the master's operational state.

This notification is enabled by default. See `EC_IOCTL_SET_NOTIFICATION_ENABLED` for how to control the deactivation.

Parameters

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
 [] Set to `EC_NULL`.

dwOutBufSize
 [] Set to 0.

pdwNumOutData
 [] Set to `EC_NULL`.

Comment

EC_T_STATECHANGE

Data structure containing the old and the new EtherCAT master operational state.

```
typedef struct _EC_T_STATECHANGE{
    EC_T_STATE      oldState; /* old operational state */
    EC_T_STATE      newState; /* new operational state */
} EC_T_STATECHANGE;
```

4.5.3 *ecatNotify* – **EC_NOTIFY_XXXX (error notification)**

Notification about an error. See 4.7 “Diagnosis, error detection, error notifications” for more information.

Parameters

pbyInBuf
 [in] Pointer to data of type `EC_T_ERROR_NOTIFICATION_DESC`.
 A detailed description of all error notifications and the corresponding data can be found in 4.7 “Diagnosis, error detection, error notifications”.

dwInBufSize
 [in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
 [] Set to `EC_NULL`.

dwOutBufSize
 [] Set to 0.

pdwNumOutData
 [] Set to `EC_NULL`.

4.5.4 *ecatNotify* – **EC_NOTIFY_MBOXRCV (mailbox notification)**

Indicates a mailbox transfer completion.

The notification `EC_NOTIFY_MBOXRCV_INVALID_DATA` is obsolete and not generated any more.

See section 4.8.5 for more information.

4.5.5 Feature Pack Master Redundancy Notifications

See Feature Pack “Master Redundancy” about EC_NOTIFY_MASTER_RED_STATECHANGED and EC_NOTIFY_MASTER_RED_FOREIGN_SRC_MAC.

4.5.6 *ecatNotifyApp*

By calling this function the generic notification callback function setup by `ecatRegisterClient()` is called.

```
EC_T_DWORD ecatNotifyApp(  
    EC_T_DWORD      dwCode,  
    EC_T_NOTIFYPARMS* pParms  
);
```

Parameters

dwCode

[in] Application specific notification code

pParms

[in] Parameters for application notification.

Return

EC_E_NOERROR or error code

Comment

The maximum value for *dwCode* is defined by EC_NOTIFY_APP_MAX_CODE.

4.5.7 *ecatIoControl* – *EC_IOCTL_SET_NOTIFICATION_ENABLED*

The following notifications can be enabled or disabled using *EC_IOCTL_SET_NOTIFICATION_ENABLED*

- *EC_NOTIFY_SLAVE_STATECHANGED* (default *Off*)
- *EC_NOTIFY_SLAVES_STATECHANGED* (default *Off*)
- *EC_NOTIFY_SLAVE_UNEXPECTED_STATE* (default *On*)
- *EC_NOTIFY_SLAVES_UNEXPECTED_STATE* (default *Off*)
- *EC_NOTIFY_SLAVE_PRESENCE* (default *On*)
- *EC_NOTIFY_SLAVES_PRESENCE* (default *Off*)
- *EC_NOTIFY_SLAVE_ERROR_STATUS_INFO* (default *On*)
- *EC_NOTIFY_SLAVES_ERROR_STATUS* (default *Off*)
- *EC_NOTIFY_NOT_ALL_DEVICES_OPERATIONAL* (default *On*)
- *EC_NOTIFY_CYCCMD_WKC_ERROR* (default *On*)
- *EC_NOTIFY_SB_MISMATCH* (default *On*)
- *EC_NOTIFY_SB_STATUS* (default *On*)
- *EC_NOTIFY_STATUS_SLAVE_ERROR* (default *On*)
- *EC_NOTIFY_FRAME_RESPONSE_ERROR* (default *On*)
- *EC_NOTIFY_HC_TOPOCHGDONE* (default *On*)
- *EC_NOTIFY_STATECHANGED* (default *On*)
- *EC_NOTIFY_COE_INIT_CMD* (default *Off*)
- *EC_NOTIFY_JUNCTION_RED_CHANGE* (default *Off*)
- *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*)
- *EC_NOTIFY_SLAVE_INITCMD_RESPONSE_ERROR* (default *On*)
- *EC_NOTIFY_REFCLOCK_PRESENCE* (default *Off*)

Parameters

pbyInBuf
[in] pointer to *EC_T_SET_NOTIFICATION_ENABLED_PARMS*.

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Should be set to *EC_NULL*.

dwOutBufSize
[] Should be set to 0.

pdwNumOutData
[] Should be set to *EC_NULL*.

Comment

```
typedef struct _EC_T_SET_NOTIFICATION_ENABLED_PARMS
{
    EC_T_DWORD    dwClientId;    /*< Client ID, 0: Master */
    EC_T_DWORD    dwCode;        /*< Notification code */
    EC_T_DWORD    dwEnabled;     /*< EC_NOTIFICATION_DISABLED, ..._ENABLED, ..._DEFAULT */
} EC_T_SET_NOTIFICATION_ENABLED_PARMS;
```

Notifications are given to clients if enabled for *dwClientId* = 0 AND corresponding *dwClientId*.

4.5.8 *ecatIoControl* – *EC_IOCTL_GET_NOTIFICATION_ENABLED*

The enabled state of notifications can be retrieved using *EC_IOCTL_GET_NOTIFICATION_ENABLED*. See *EC_IOCTL_SET_NOTIFICATION_ENABLED* for the list of supported notifications.

Parameters

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.

Comment

```
typedef struct _EC_T_GET_NOTIFICATION_ENABLED_PARMS
{
    EC_T_DWORD    dwClientId;    /*< Client ID, 0: Master */
    EC_T_DWORD    dwCode;        /*< Notification code */
} EC_T_GET_NOTIFICATION_ENABLED_PARMS;
```

4.6 Slave control and status functions

4.6.1 *ecatGetNumConfiguredSlaves*

Returns amount of slaves which are configured in the XML configuration file.

```
EC_T_DWORD ecatGetNumConfiguredSlaves (  
    EC_T_VOID  
);
```

Parameters

—

Return

Amount of slaves which are configured in the XML configuration file.

4.6.2 *ecatGetNumConnectedSlaves*

Returns amount of currently connected slaves.

```
EC_T_DWORD ecatGetNumConnectedSlaves (  
    EC_T_VOID  
);
```

Parameters

—

Return

Amount of currently connected slaves.

4.6.3 *ecatGetSlaveld*

Determines the slave ID using the slave station address.

```
EC_T_DWORD ecatGetSlaveld (  
    EC_T_WORD wStationAddress  
);
```

Parameters

wStationAddress

[in] The slave's station address.

Return

Slave ID (INVALID_SLAVE_ID in case the slave does not exist)

4.6.4 *ecatGetSlaveIdAtPosition*

Determines the slave ID using the slave auto increment address.

```
EC_T_DWORD ecatGetSlaveIdAtPosition (
    EC_T_WORD wAutoIncAddress
);
```

Parameters

wAutoIncAddress

[in] The slave's auto increment address.

Return

Slave ID (INVALID_SLAVE_ID in case the slave does not exist)

4.6.5 *ecatGetSlaveState*

Get the slave's state.

```
EC_T_DWORD ecatGetSlaveState(
    EC_T_DWORD    dwSlaveId,
    EC_T_WORD*    pwCurrDevState,
    EC_T_WORD*    pwReqDevState
);
```

Parameters

dwSlaveId

[in] Slave ID

pwCurrDevState

[out] Current operating state

pwReqDevState

[out] Set value of the operating state

Return

EC_E_NOERROR on success.

EC_E_SLAVE_NOT_PRESENT if the slave is not present on bus.

EC_E_NOTFOUND if the slave with ID *dwSlaveId* does not exist in the XML file.

Error code otherwise.

Comment

The following state definitions (bit mask) exist: *DEVICE_STATE_INIT*, *DEVICE_STATE_PREOP*, *DEVICE_STATE_BOOTSTRAP*, *DEVICE_STATE_SAFEOP*, *DEVICE_STATE_OP* and *DEVICE_STATE_ERROR*.

If the state is not known the value *DEVICE_STATE_UNKNOWN* will be returned.

Important hint

It is also allowed to use this function inside the notification callback routine. The EC-Master reads the *AL_STATUS* register whenever needed automatically, disregarding if "ecatGetSlaveState" was called.

4.6.6 *ecatSetSlaveState*

Set a specified slave into the requested state.

```
EC_T_DWORD ecatSetSlaveState(  
    EC_T_DWORD    dwSlaveld,  
    EC_T_WORD     wNewReqDevState,  
    EC_T_DWORD    dwTimeout  
);
```

Parameters

dwSlaveld

[in] Slave ID

wNewReqDevState

[in] Requested state

dwTimeout

[in] Timeout in ms until the state should have been reached. Maybe set to EC_NOWAIT.

Return

EC_E_NOERROR if successful.

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_NOTFOUND if the slave with ID *dwSlaveld* does not exist.

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_TIMEOUT if the slave did not enter the requested state in time.

EC_E_INVALIDSTATE if the master denies the requested state, see comments below.

EC_E_INVALIDPARAM if BOOTSTRAP was requested for a slave that does not support it.

Comment

The following state definitions exist: *DEVICE_STATE_INIT*, *DEVICE_STATE_PREOP*, *DEVICE_STATE_BOOTSTRAP*, *DEVICE_STATE_SAFEOP* and *DEVICE_STATE_OP*.

The requested state shall not be higher than the Master's operational state, e.g. the EC-Master denies requests to *DEVICE_STATE_SAFEOP* while the Master's operational state is *PREOP*.

DEVICE_STATE_BOOTSTRAP can only be requested if the slave's state is *INIT*.

Caveat: in multithreading systems *ecatSetSlaveState()* must be executed only after all other EtherCAT operations (e.g. mailbox transfers) on this slave are completely terminated.

This function may not be called from within the *JobTask*'s context.

4.6.7 *ecatIsSlavePresent*

Returns whether a specific slave is currently connected to the Bus. This function may be called from within the JobTask. Since Slave Id is a parameter, valid response only can be retrieved after calling [ecatConfigureMaster](#).

```
EC_T_DWORD ecatIsSlavePresent (  
    EC_T_DWORD      dwSlaveId,  
    EC_T_BOOL *      pbPresence  
);
```

Parameters

dwSlaveId

[in] Slave ID.

pbPresence

[out] Pointer to Bool value: EC_TRUE if slave is currently connected to the bus, EC_FALSE if not.

Return

EC_E_NOERROR if successful.

EC_E_INVALIDSTATE if the master is not initialized.

EC_E_NOTFOUND if the slave with ID *dwSlaveId* does not exist or no ENI File was loaded.

Comment

-

4.6.8 ecatGetSlaveProp

Determines the properties of the slave device.

```
EC_T_BOOL ecatGetSlaveProp(
    EC_T_DWORD      dwSlaveld,
    EC_T_SLAVE_PROP* pSlaveProp
);
```

Parameters

dwSlaveld

[in] Slave ID.

pSlaveProp

[out] Slave properties.

```
typedef struct _EC_T_SLAVE_PROP{
    EC_T_WORD  wStationAddress; /* station address or INVALID_FIXED_ADDR */
    EC_T_WORD  wAutoIncAddr;   /* auto increment address or
                                INVALID_AUTO_INC_ADDR*/
    EC_T_CHAR  achName[];      /* name of the slave device
                                (NULL terminated string) */
} EC_T_SLAVE_PROP;
```

Return

EC_TRUE if the slave with ID *dwSlaveld* exists, *EC_FALSE* if this slave does not exist.

Comment

—

4.6.9 ecatGetSlavePortState

Returns the state of the slave ports.

```
EC_T_DWORD ecatGetSlavePortState(
    EC_T_DWORD      dwSlaveld,
    EC_T_WORD*      pwPortState
);
```

Parameters

dwSlaveld

[in] Slave ID.

pwPortState

[out] Slave port state.

Format: *www* *xxx* *yyy* *zzz*
 (each nibble : port 3210)
www : Signal detected 1=yes, 0=no
xxx : Loop closed 1=yes, 0=no
yyy : Link established 1=yes, 0=no
zzz : Slave connected 1=yes, 0=no
 (zzzz = logical result of w,x,y)
 (Bus Topology Scan)

Return

EC_E_NOERROR if successful.

EC_E_INVALIDSTATE if master is not initialized

EC_E_NOTFOUND if the slave with ID *dwSlaveld* does not exist.

Comment

—

4.6.10 *ecatSlaveSerializeMbxTfers*

All mailbox transfers to the specified slave are serialized. The parallel (overlapped) usage of more than one protocol (CoE, EoE, FoE, etc.) is blocked by the master.

```
EC_T_DWORD ecatSlaveSerializeMbxTfers (  
    EC_T_DWORD    dwSlaveId,  
);
```

Parameters

dwSlaveId
[in] Slave ID

Return

EC_E_NOERROR if successful.
EC_E_INVALIDPARAM if master is not initialized
EC_E_NOTFOUND if the slave with ID *dwSlaveId* does not exist.
EC_E_NO_MBX_SUPPORT if slave does not support mailbox transfers

Comment

By default parallel mailbox transfers are enabled.

4.6.11 *ecatSlaveParallelMbxTfers*

Reenable the parallel (overlapped) usage of more than one protocol (CoE, EoE, FoE, etc.).

```
EC_T_DWORD ecatSlaveParallelMbxTfers (  
    EC_T_DWORD    dwSlaveId,  
);
```

Parameters

dwSlaveId
[in] Slave ID

Return

EC_E_NOERROR if successful.
EC_E_INVALIDPARAM if master is not initialized
EC_E_NOTFOUND if the slave with ID *dwSlaveId* does not exist.
EC_E_NO_MBX_SUPPORT if slave does not support mailbox transfers

Comment

By default parallel mailbox transfers are enabled.

4.6.1 *ecatIoctlSetMbxRetryAccessPeriod*

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.

Parameters

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
[] Should be set to EC_NULL.

dwOutBufSize
[] Should be set to 0.

pdwNumOutData
[] Should be set to EC_NULL.

Comment

By default, the retry access period is set to 25 milliseconds.

4.6.2 *ecatGetSlaveInpVarInfoNumOf*

Gets the number of input variables of a specific slave. This function mainly will be used in connection with *ecatGetSlaveInpVarInfo*.

```
EC_T_DWORD ecatGetSlaveInpVarInfoNumOf(
    EC_T_BOOL      bFixedAddressing,
    EC_T_WORD      wSlaveAddress,
    EC_T_WORD*     pwSlaveInpVarInfoNumOf );
```

Parameters

bFixedAddressing
[in] *EC_TRUE*: Use station address, *EC_FALSE*: use AutoInc address

wSlaveAddress
[in] Slave address

pwSlaveInpVarInfoNumOf
[out] Number of found process variables

Return

EC_E_NOERROR or error code

4.6.3 *ecatGetSlaveOutpVarInfoNumOf*

Gets the number of output variables of a specific slave. This function mainly will be used in connection with *ecatGetSlaveOutpVarInfo*.

```
EC_T_DWORD ecatGetSlaveOutpVarInfoNumOf(
    EC_T_BOOL      bFixedAddressing,
    EC_T_WORD      wSlaveAddress,
    EC_T_WORD*     pwSlaveOutpVarInfoNumOf );
```

Parameters

bFixedAddressing
[in] *EC_TRUE*: Use station address, *EC_FALSE*: use AutoInc address

wSlaveAddress
[in] Slave address

pwSlaveInpVarInfoNumOf
[out] Number of found process variable

Return

EC_E_NOERROR or error code

4.6.4 *ecatGetSlaveInpVarInfo*

Gets the input process variable information entries of a specific slave.

```
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);
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address

wSlaveAddress

[in] Slave address

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

Return

EC_E_NOERROR or error code

Comment

–

EC_T_PROCESS_VAR_INFO

```
typedef struct _EC_T_PROCESS_VAR_INFO
{
    EC_T_CHAR      szName[MAX_PROCESS_VAR_NAME_LEN];
    EC_T_WORD      wDataType;
    EC_T_INT       nBitSize;
    EC_T_INT       nBitOffs;
    EC_T_WORD      wFixedAddr;
    EC_T_BOOL      blsInputData;
} EC_T_PROCESS_VAR_INFO, *EC_PT_PROCESS_VAR_INFO;
```

Description

szName

[out] Name of the found process variable

wDataType

[out] Data type of the found process variable (according to ETG.1000, section 5). See also EcCommon.h, DEFTYPE_BOOLEAN,

nBitSize

[out] Size in bit of the found process variable

nBitOffs

[out] Bit offset in the process data image

wFixedAddr

[out] Station address of the slave that is owner of this variable

blsInputData

[out] Determines whether the found process variable is an input variable or an output variable

4.6.5 ecatGetSlaveInpVarInfoEx

Gets the input process variable extended information entries of a specific slave.

```
EC_T_DWORD ecatGetSlaveInpVarInfoEx(
    EC_T_BOOL      bFixedAddressing,
    EC_T_WORD      wSlaveAddress,
    EC_T_WORD      wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO_EX* pSlaveProcVarInfoEntriesEx,
    EC_T_WORD*      pwReadEntries);
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address

wSlaveAddress

[in] Slave address

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

Return

EC_E_NOERROR or error code

Comment

```
typedef struct _EC_T_PROCESS_VAR_INFO_EX {
    EC_T_CHAR      szName[MAX_PROCESS_VAR_NAME_LEN_EX];
    EC_T_WORD      wDataType;
    EC_T_INT       nBitSize;
    EC_T_INT       nBitOffs;
    EC_T_WORD      wFixedAddr;
    EC_T_BOOL      blsInputData;
    EC_T_WORD      wIndex;
    EC_T_WORD      wSubIndex;
    EC_T_WORD      wPdoIndex;
    EC_T_WORD      wWkcStateDiagOffs;
    EC_T_WORD      wMasterSyncUnit;
    EC_T_WORD      wRes1;
    EC_T_DWORD     dwRes2;
} EC_T_PROCESS_VAR_INFO_EX, *EC_PT_PROCESS_VAR_INFO_EX;
```

Description

szName

[out] Name of the found process variable

wDataType

[out] Data type of the found process variable

nBitSize

[out] Size in bit of the found process variable

nBitOffs

[out] Bit offset in the process data image

wFixedAddr

[out] Station address of the slave that is owner of this variable

blsInputData

[out] Determines whether the found process variable is an input or an output variable

wIndex

[out] Object index

wSubIndex

[out] Object sub index

wPdoIndex

[out] Index of PDO (process data object)

wWkcStateDiagOffs

[out] Bit offset in the diagnostic image (ecatGetDiagnosisImagePtr())

wMasterSyncUnit

[out] Master Sync Unit (ENI: RxPdo[1..4]@Su, TxPdo[1..4]@Su)

4.6.6 ecatGetSlaveOutpVarInfo

Gets the output process variable information entries of a specific slave.

```
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) ;
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address

wSlaveAddress

[in] Slave address

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

Return

EC_E_NOERROR or error code

Comment

See EC_T_PROCESS_VAR_INFO.

4.6.7 ecatGetSlaveOutpVarInfoEx

Gets the output process variable extended information entries of a specific slave.

```
EC_T_DWORD ecatGetSlaveOutpVarInfoEx(
    EC_T_BOOL          bFixedAddressing,
    EC_T_WORD          wSlaveAddress,
    EC_T_WORD          wNumOfVarsToRead,
    EC_T_PROCESS_VAR_INFO_EX* pSlaveProcVarInfoEntriesEx,
    EC_T_WORD*         pwReadEntries) ;
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address

wSlaveAddress

[in] Slave address

wNumOfVarsToRead

[in] Number of found process variable entries

pSlaveProcVarInfoEntriesEx

[out] The read process variable extended information entries

pwReadEntries

[out] The number of read process variable information entries

Return

EC_E_NOERROR or error code

Comment

See EC_T_PROCESS_VAR_INFO_EX.

4.6.8 *ecatFindInpVarByName*

Finds an input process variable information entry by the variable name.

```
EC_T_DWORD ecatFindInpVarByName(  
    EC_T_CHAR*          szVariableName,  
    EC_T_PROCESS_VAR_INFO* pProcessVarInfoEntry);
```

Parameters

szVariableName
[in] Variable name
pProcessVarInfoEntry
[out] Process variable information entry

Return

EC_E_NOERROR or error code

Comment

See *EC_T_PROCESS_VAR_INFO*.

4.6.9 *ecatFindInpVarByNameEx*

Finds an input process variable extended information entry by the variable name.

```
EC_T_DWORD ecatFindInpVarByName(  
    EC_T_CHAR*          szVariableName,  
    EC_T_PROCESS_VAR_INFO_EX* pProcessVarInfoEntryEx);
```

Parameters

szVariableName
[in] Variable name
pProcessVarInfoEntryEx
[out] Process variable extended information entry

Return

EC_E_NOERROR or error code

Comment

See *EC_T_PROCESS_VAR_INFO_EX*.

4.6.10 *ecatFindOutpVarByName*

Finds an output process variable information entry by the variable name.

```
EC_T_DWORD ecatFindOutpVarByName(  
    EC_T_CHAR*          szVariableName,  
    EC_T_PROCESS_VAR_INFO* pProcessVarInfoEntry);
```

Parameters

szVariableName

[in] Variable name

pProcessVarInfoEntry

[out] Process variable information entry

Return

EC_E_NOERROR or error code

Comment

See *EC_T_PROCESS_VAR_INFO*.

4.6.11 *ecatFindOutpVarByNameEx*

Finds an output process variable extended information entry by the variable name.

```
EC_T_DWORD ecatFindOutpVarByNameEx(  
    EC_T_CHAR*          szVariableName,  
    EC_T_PROCESS_VAR_INFO_EX* pProcessVarInfoEntryEx);
```

Parameters

szVariableName

[in] Variable name

pProcessVarInfoEntryEx

[out] Process variable extended information entry

Return

EC_E_NOERROR or error code

Comment

See *EC_T_PROCESS_VAR_INFO_EX*.

4.6.12 *ecatNotify* – **EC_NOTIFY_SLAVE_STATECHANGED**

This notification is given, when a slave changed its EtherCAT state.

This notification is disabled by default. See `EC_IOCTL_SET_NOTIFICATION_ENABLED` for how to control the activation.

Parameters

pbyInBuf
 [in] Pointer to `EC_T_SLAVE_STATECHANGED_NOTIFY_DESC`
dwInBufSize
 [in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
 [] Is set to `EC_NULL`.
dwOutBufSize
 [] Is set to 0.
pdwNumOutData
 [] Is set to `EC_NULL`.

Comment

```
typedef struct _EC_T_SLAVE_STATECHANGED_NOTIFY_DESC
{
    EC_T_SLAVE_PROP SlaveProp;    /*< slave properties. See EC_NOTIFY_CYCCMD_WKC_ERROR */
    EC_T_STATE      newState;     /*< new state */
} EC_T_SLAVE_STATECHANGED_NOTIFY_DESC;
```

4.6.13 *ecatNotify* – **EC_NOTIFY_SLAVES_STATECHANGED**

Collects EC_NOTIFY_SLAVE_STATECHANGED.

This notification is disabled by default. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the activation.

Parameters

pbyInBuf
[in] Pointer to EC_T_SLAVES_STATECHANGED_NTFY_DESC
dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
[] Is set to EC_NULL.
dwOutBufSize
[] Is set to 0.
pdwNumOutData
[] Is set to EC_NULL.

Comment

```
typedef struct _EC_T_SLAVES_STATECHANGED_NTFY_DESC_ENTRY
{
    EC_T_WORD  wStationAddress;
    EC_T_STATE eState;
} EC_T_SLAVES_STATECHANGED_NTFY_DESC_ENTRY;
typedef struct _EC_T_SLAVES_STATECHANGED_NTFY_DESC
{
    EC_T_WORD  wCount;
    EC_T_WORD  wRes;
    EC_T_SLAVES_STATECHANGED_NTFY_DESC_ENTRY
SlaveStates[MAX_SLAVES_STATECHANGED_NTFY_ENTRIES];
} EC_T_SLAVES_STATECHANGED_NTFY_DESC;
```

Description

wCount
[in] Contained EC_NOTIFY_SLAVE_STATECHANGED count.
wRes
[in] 0 (reserved)
SlavePresence
[in] Array of EC_T_SLAVE_PRESENCE_NTFY_DESC.
SlavePresence[...].wStationAddress
[in] Entry's station address.
SlavePresence[...].eState
[in] Entry's new state.

4.6.14 *ecatWriteSlaveRegister*

Writes data into the ESC memory of a specified slave.

WARNING: Changing contents of ESC registers may lead to unpredictable behavior of the slaves and/or the master.

```
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,
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: used station address, EC_FALSE: use Auto Increment address.

wSlaveAddress

[in] Address of slave (Station or Auto Increment depending on *bFixedAddressing*)

wRegisterOffset

[in] Register offset. I.e. use 0x0120 to write to the AL Control register.

pbyData

[in] Pointer to the data to send.

wLen

[in] Number of bytes to send.

dwTimeout

[in] Timeout in msec.

Return

EC_E_NOERROR if successful.

EC_E_SLAVE_NOT_PRESENT if slave not present.

EC_E_BUSY another transfer request is already pending.

EC_E_NOTFOUND if the slave with the given address does not exist.

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_TIMEOUT if the slave did not respond to the command.

EC_E_BUSY if the master or the corresponding slave is currently changing its operational state .

EC_E_INVALIDPARM if the command is not supported or the timeout value is set to EC_NOWAIT.

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.

Comment

This function may not be called from within the JobTask's context.

4.6.15 *ecatWriteSlaveRegisterReq*

Requests a data write transfer into the ESC memory of a specified slave and returns immediately.

WARNING: Changing contents of ESC registers may lead to unpredictable behavior of the slaves and/or the master.

```
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
);
```

Parameters

dwClientId
[in] ID of the client to be notified (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_NOTIFY_DESC

bFixedAddressing
[in] EC_TRUE: used station address, EC_FALSE: use Auto Increment address.

wSlaveAddress
[in] Address of slave (Station or Auto Increment depending on *bFixedAddressing*)

wRegisterOffset
[in] Register offset. I.e. use 0x0120 to write to the AL Control register.

pbyData
[in] Pointer to the data to send.

wLen
[in] Number of bytes to send.

Return

EC_E_NOERROR if successful.
EC_E_SLAVE_NOT_PRESENT if slave not present.
EC_E_NOTFOUND if the slave with the given address does not exist.
EC_E_INVALIDPARAM if the command is not supported or the timeout value is set to EC_NOWAIT.
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.

Comment

This function may be called from within the JobTask's context.
 A 4.6.18 *ecatNotify* – EC_NOTIFY_SLAVE_REGISTER_TRANSFER is given on completion, see below.

4.6.16 *ecatReadSlaveRegister*

Reads data from the ESC memory of a specified slave.

```
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,
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: used station address, EC_FALSE: use Auto Increment address.

wSlaveAddress

[in] Address of slave (Station or Auto Increment depending on *bFixedAddressing*)

wRegisterOffset

[in] Register offset. I.e. use 0x0130 to read the AL Status register.

pbyData

[out] Pointer to the receive buffer.

wLen

[in] Number of bytes to receive.

dwTimeout

[in] Timeout in msec.

Return

EC_E_NOERROR if successful.

EC_E_SLAVE_NOT_PRESENT if slave not present.

EC_E_BUSY another transfer request is already pending.

EC_E_NOTFOUND if the slave with the given address does not exist.

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_TIMEOUT if the slave did not respond to the command.

EC_E_BUSY if the master or the corresponding slave is currently changing its operational state .

EC_E_INVALIDPARAM if the command is not supported or the timeout value is set to EC_NOWAIT.

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.

Comment

This function may not be called from within the JobTask's context.

4.6.17 *ecatReadSlaveRegisterReq*

Requests data read transfer from the ESC memory of a specified slave and returns immediately.

```
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,
);
```

Parameters

dwClientId

[in] ID of the client to be notified (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_NOTIFY_DESC

bFixedAddressing

[in] EC_TRUE: used station address, EC_FALSE: use Auto Increment address.

wSlaveAddress

[in] Address of slave (Station or Auto Increment depending on *bFixedAddressing*)

wRegisterOffset

[in] Register offset. I.e. use 0x0130 to read the AL Status register.

pbyData

[out] Pointer to the receive buffer, must be valid until the transfer is complete.

wLen

[in] Number of bytes to receive.

Return

EC_E_NOERROR if successful.

EC_E_SLAVE_NOT_PRESENT if slave not present.

EC_E_NOTFOUND if the slave with the given address does not exist.

EC_E_INVALIDPARAM if the command is not supported or the timeout value is set to EC_NOWAIT.

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.

Comment

This function may be called from within the JobTask's context.

A 4.6.18 *ecatNotify* – EC_NOTIFY_SLAVE_REGISTER_TRANSFER is given on completion, see above.

4.6.18 *ecatNotify* – EC_NOTIFY_SLAVE_REGISTER_TRANSFER

This notification is given, when a slave register transfer is completed.

Parameters

pbyInBuf
 [in] Pointer to EC_T_SLAVEREGISTER_TRANSFER_NOTIFY_DESC
dwInBufSize
 [in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
 [] Is set to EC_NULL.
dwOutBufSize
 [] Is set to 0.
pdwNumOutData
 [] Is set to EC_NULL.

Comment

```
typedef struct _EC_T_SLAVEREGISTER_TRANSFER_NOTIFY_DESC {
    EC_T_DWORD    dwTferId;
    EC_T_DWORD    dwResult;
    EC_T_BOOL     bRead;
    EC_T_WORD     wFixedAddr;
    EC_T_WORD     wRegisterOffset;
    EC_T_WORD     wLen;
    EC_T_VOID*    pvData;
} EC_T_SLAVEREGISTER_TRANSFER_NOTIFY_DESC;
```

Description

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.

dwResult
 Result of Slave register transfer.

bRead
 EC_TRUE: Read register, EC_FALSE: Write register transfer.

wFixedAddr
 Station address of slave.

wRegisterOffset
 Register offset.

wLen
 Length of slave register transfer.

pvData
 Pointer to the data read

4.6.19 *ecatReadSlaveEEPROM*

Read EEPROM data from slave.

```
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
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

wEEPROMStartOffset

[in] Word address to start EEPROM read from.

pwReadData

[out] 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 in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.6.20 *ecatReadSlaveEEPROMReq*

Requests a EEPROM data read operation from slave and returns immediately.

```
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
);
```

Parameters

dwClientId

[in] ID of the client to be notified (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_NOTIFY_DESC

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *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 in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may be called from within the JobTask's context.

A 4.6.29 *ecatNotify* – EC_NOTIFY_EEPROM_OPERATION is given on completion, see below.

4.6.21 *ecatWriteSlaveEEPROM*

Write EEPROM data to slave.

```
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
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

wEEPROMStartOffset

[in] Word address to start EEPROM Write from.

pwWriteData

[in] Pointer to WORD array carrying the write data.

dwWriteLen

[in] Sizeof Write Data WORD array (in WORDS)

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

The EEPROM's CRC is updated automatically.

ecatResetSlaveController() is needed to reload the alias address in register 0x12.

This function may not be called from within the JobTask's context.

4.6.22 *ecatWriteSlaveEEPROMReq*

Requests a EEPROM data read operation from slave and returns immediately.

```
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
);
```

Parameters

dwClientId

[in] ID of the client to be notified (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_NOTIFY_DESC

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *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 in milliseconds. The function will block at most for this time.

Return

EC_E_NOERROR or error code

Comment

The EEPROM's CRC is updated automatically.

ecatResetSlaveController() is needed to reload the alias address in register 0x12.

This function may be called from within the JobTask's context.

A 4.6.29 *ecatNotify* – EC_NOTIFY_EEPROM_OPERATION is given on completion, see below.

4.6.23 *ecatAssignSlaveEEPROM*

Set EEPROM Assignment to PDI or EtherCAT Master.

```
EC_T_DWORD ecatAssignSlaveEEPROM (
    EC_T_BOOL      bFixedAddressing,
    EC_T_WORD      wSlaveAddress,
    EC_T_BOOL      bSlavePDIAccessEnable,
    EC_T_BOOL      bForceAssign,
    EC_T_DWORD     dwTimeout
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

bSlavePDIAccessEnable

[in] EC_TRUE: EEPROM assigned to slave PDI application,
EC_FALSE: EEPROM assigned to Ecat Master

bForceAssign

[in] Force Assignment of EEPROM (only for Ecat Master Assignment)

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.6.24 *ecatAssignSlaveEEPROMReq*

Requests EEPROM Assignment to PDI or EtherCAT Master operation and return immediately.

```
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
);
```

Parameters

dwClientId

[in] ID of the client to be notified (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_NOTIFY_DESC

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

bSlavePDIAccessEnable

[in] EC_TRUE: EEPROM assigned to slave PDI application,
EC_FALSE: EEPROM assigned to Ecat Master

bForceAssign

[in] Force Assignment of EEPROM (only for Ecat Master Assignment)

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time.

Return

EC_E_NOERROR or error code

Comment

This function may be called from within the JobTask's context.

A 4.6.29 *ecatNotify* – *EC_NOTIFY_EEPROM_OPERATION* is given on completion.

4.6.25 *ecatActiveSlaveEEPROM*

Check whether EEPROM is marked access active by Slave PDI application.

```
EC_T_DWORD ecatActiveSlaveEEPROM(
    EC_T_BOOL      bFixedAddressing,
    EC_T_WORD      wSlaveAddress,
    EC_T_BOOL*     pbSlavePDIAccessActive,
    EC_T_DWORD     dwTimeout
);
```

Parameters

bFixedAddressing

[in] *EC_TRUE*: use station addressing, *EC_FALSE*: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

pbSlavePDIAccessActive

[out] Pointer to Boolean value: *EC_TRUE*: EEPROM active by PDI application, *EC_FALSE*: EEPROM not active

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. The timeout value must not be set to *EC_NOWAIT*.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.6.26 *ecatActiveSlaveEEPROMReq*

Requests EEPROM is marked access active by Slave PDI application check and returns immediately.

```
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
);
```

Parameters*dwClientId*

[in] ID of the client to be notified (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_NOTIFY_DESC

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *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 in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may be called from within the JobTask's context.

A 4.6.29 ecatNotify – EC_NOTIFY_EEPROM_OPERATION is given on completion.

4.6.27 *ecatReloadSlaveEEPROM*

Causes a slave to reload its EEPROM values to ESC registers.

Attention: Alias address at 0x12 is not reloaded through this command. This is prevented by the slave hardware. To reload the alias address issue `ecatResetSlaveController()`.

```
EC_T_DWORD ecatReloadSlaveEEPROM(
    EC_T_BOOL      bFixedAddressing,
    EC_T_WORD      wSlaveAddress,
    EC_T_DWORD      dwTimeout
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.6.28 *ecatReloadSlaveEEPROMReq*

Request a slave to reload its EEPROM values to ESC registers, and returns immediately.

Attention: Alias address at 0x12 is not reloaded through this command. This is prevented by the slave hardware. To reload the alias address issue `ecatResetSlaveController()`.

```
EC_T_DWORD ecatReloadSlaveEEPROMReq(
    EC_T_DWORD      dwClientId,
    EC_T_DWORD      dwTferId,
    EC_T_BOOL      bFixedAddressing,
    EC_T_WORD      wSlaveAddress,
    EC_T_DWORD      dwTimeout
);
```

Parameters

dwClientId

[in] ID of the client to be notified (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_NOTIFY_DESC

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

This function may be called from within the JobTask's context.

A 4.6.29 `ecatNotify` – EC_NOTIFY_EEPROM_OPERATION is given on completion, see below.

4.6.29 ecatNotify – EC_NOTIFY_EEPROM_OPERATION

This notification is given, when a slave EEPROM operation is completed.

Parameters

pbyInBuf
[in] Pointer to EC_T_EEPROM_OPERATION_NOTIFY_DESC

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Is set to EC_NULL.

dwOutBufSize
[] Is set to 0.

pdwNumOutData
[] Is set to EC_NULL.

Comment

```
typedef struct _ EC_T_EEPROM_OPERATION_NOTIFY_DESC {
    EC_T_DWORD          dwTferId;
    EC_T_EEPROM_OPERATION_TYPE  eType;
    EC_T_DWORD          dwResult;
    EC_T_SLAVE_PROP     SlaveProp;

    union {

        struct {
            EC_T_WORD          wEEPROMStartOffset;
            EC_T_WORD*         pwData;
            EC_T_DWORD          dwReadLen;
            EC_T_DWORD          dwNumOutData;
        } Read;

        struct {
            EC_T_WORD          wEEPROMStartOffset;
            EC_T_WORD*         pwData;
            EC_T_DWORD          dwWriteLen;
        } Write;

        struct {
            EC_T_BOOL          bSlavePDIAccessActive;
        } Active;

        struct {
            EC_T_DWORD          dwReserved;
        } Assign;

        struct {
            EC_T_DWORD          dwReserved;
        } Reload;
    } uResult;
} EC_T_EEPROM_OPERATION_NOTIFY_DESC;
```

Description

<i>dwTferId</i>	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.
<i>eType</i>	Type of EEPROM operation, see below.
<i>dwResult</i>	Result of EEPROM operation.
<i>SlaveProp</i>	Slave properties.
<i>wEEPRomStartOffset</i>	Start address of EEPRom operation. Given by API.
<i>pwData</i>	Pointer to WORD array contains the data. Given by API.
<i>dwReadLen</i>	Number of Words to be read. Given by API.
<i>dwNumOutData</i>	Number of Words actually read from EEPRom.
<i>dwWriteLen</i>	Number of Words to be written. Given by API.
<i>bSlavePDIAccessActive</i>	EC_TRUE: EEPROM active by PDI application, EC_FALSE: EEPROM not active.

```
typedef enum _EC_T_EEPROM_OPERATION_TYPE {
    eEEPRomOp_Unknown    = 0,
    eEEPRomOp_Assign     = 1,
    eEEPRomOp_Active     = 2,
    eEEPRomOp_Read       = 3,
    eEEPRomOp_Write      = 4,
    eEEPRomOp_Reload     = 5,
} EC_T_EEPROM_OPERATION_TYPE;
```

Description

<i>eEEPRomOp_Unknown</i>	Unknown EEPROM operation, only for internal use.
<i>eEEPRomOp_Assign</i>	Assign slave EEPROM operation, used by <code>ecatAssignSlaveEEPRomReq</code> .
<i>eEEPRomOp_Active</i>	Active slave EEPROM operation, used by <code>ecatActiveSlaveEEPRomReq</code>
<i>eEEPRomOp_Read</i>	Read slave EEPRom operation, used by <code>ecatReadSlaveEEPRomReq</code> .
<i>eEEPRomOp_Write</i>	Read slave EEPRom operation, used by <code>ecatWriteSlaveEEPRomReq</code>
<i>eEEPRomOp_Reload</i>	Read slave EEPRom operation, used by <code>ecatWriteSlaveEEPRomReq</code>

4.6.30 *ecatResetSlaveController*

Resets a ESC (e.g., ET1100, ET1200, and IP Core) if it is capable of issuing a hardware reset. A special sequence of three independent and consecutive frames/commands has to be sent do the slave (Reset register ECAT 0x0040 or PDI 0x0041). Afterwards, the slave is reset.

```
EC_T_DWORD ecatResetSlaveController(  
    EC_T_BOOL      bFixedAddressing,  
    EC_T_WORD      wSlaveAddress,  
    EC_T_DWORD     dwTimeout  
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: use station addressing, EC_FALSE: use auto increment addressing

wSlaveAddress

[in] Slave Address, station or auto increment address depending on *bFixedAddressing*

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. The timeout value must not be set to EC_NOWAIT.

Return

EC_E_NOERROR or error code

Comment

Check that the ESC supports resetting. The EC-Master should be in INIT when issuing this API call. Set EC_T_INITMASTERPARMS.dwMaxSentQueuedFramesPerCycle >= 3.

This function may not be called from within the JobTask's context.

4.6.31 *ecatIoctlControl* –

EC_IOCTL_ALL_SLAVES_MUST_REACH_MASTER_STATE

Specifies if all the slaves must reach the requested master state.

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

Missing mandatory slaves will be signalized by **EC_NOTIFY_SLAVE_PRESENCE**. Slaves who cannot reach the requested master state will be signalized by **EC_NOTIFY_SLAVE_UNEXPECTED_STATE**.

EC_NOTIFY_NOT_ALL_DEVICES_OPERATIONAL will not be generated anymore if this ioctl is called with EC_FALSE, **EC_NOTIFY_CYCCMD_WKC_ERROR** will be still generated.

4.6.32 *ecatGetCfgSlaveInfo*

Return information about a configured slave from the ENI file

```
EC_T_DWORD ecatGetCfgSlaveInfo(
    EC_T_BOOL          bStationAddress,
    EC_T_WORD          wSlaveAddress,
    EC_T_CFG_SLAVE_INFO* pSlaveInfo
);
```

Parameters

bStationAddress

[in] EC_TRUE: used station address, EC_FALSE: use auto increment address

wSlaveAddress

[in] Address of slave (Station or auto increment depending on *bStationAddress*)

pSlaveInfo

[out] Information from the slave.

Return

EC_E_NOERROR if successful.

EC_E_NOTFOUND if the slave with the given address does not exist.

Comment

Size of EC_T_CFG_SLAVE_INFO content is subject to be extended.

EC_CFG_SLAVE_PD_SECTIONS = 4


```

typedef struct _EC_T_CFG_SLAVE_INFO{
    EC_T_DWORD    dwSlaveId;
    EC_T_CHAR     abyDeviceName[ECAT_DEVICE_NAMESIZE];
    EC_T_DWORD    dwHCGroupIdx;
    EC_T_BOOL     blsPresent;
    EC_T_BOOL     blsHCGroupPresent;
    EC_T_DWORD    dwVendorId;
    EC_T_DWORD    dwProductCode;
    EC_T_DWORD    dwRevisionNumber;
    EC_T_DWORD    dwSerialNumber;
    EC_T_WORD     wStationAddress;
    EC_T_WORD     wAutoIncAddress;
    EC_T_DWORD    dwPdOffsIn;
    EC_T_DWORD    dwPdSizeIn;
    EC_T_DWORD    dwPdOffsOut;
    EC_T_DWORD    dwPdSizeOut;
    EC_T_DWORD    dwPdOffsIn2;
    EC_T_DWORD    dwPdSizeIn2;
    EC_T_DWORD    dwPdOffsOut2;
    EC_T_DWORD    dwPdSizeOut2;
    EC_T_DWORD    dwPdOffsIn3;
    EC_T_DWORD    dwPdSizeIn3;
    EC_T_DWORD    dwPdOffsOut3;
    EC_T_DWORD    dwPdSizeOut3;
    EC_T_DWORD    dwPdOffsIn4;
    EC_T_DWORD    dwPdSizeIn4;
    EC_T_DWORD    dwPdOffsOut4;
    EC_T_DWORD    dwPdSizeOut4;
    EC_T_DWORD    dwMbxSupportedProtocols;
    EC_T_DWORD    dwMbxOutSize;
    EC_T_DWORD    dwMbxInSize;
    EC_T_DWORD    dwMbxOutSize2;
    EC_T_DWORD    dwMbxInSize2;
    EC_T_BOOL     bDcSupport;
    EC_T_WORD     wNumProcessVarsInp;
    EC_T_WORD     wNumProcessVarsOutp;
    EC_T_WORD     wPrevStationAddress;
    EC_T_WORD     wPrevPort;
    EC_T_WORD     wIdentifyAdo;
    EC_T_WORD     wIdentifyData;
    EC_T_BYTE     byPortDescriptor;
    EC_T_BYTE     abyReserved[3];
    EC_T_WORD     wWkcStateDiagOffsIn[EC_CFG_SLAVE_PD_SECTIONS];
    EC_T_WORD     wWkcStateDiagOffsOut[EC_CFG_SLAVE_PD_SECTIONS];
    EC_T_WORD     awMasterSyncUnitIn[EC_CFG_SLAVE_PD_SECTIONS];
    EC_T_WORD     awMasterSyncUnitOut[EC_CFG_SLAVE_PD_SECTIONS];
    EC_T_BOOL     bDisabled;
    EC_T_BOOL     bDisconnected;
    EC_T_BOOL     bExtended;
    EC_T_DWORD    adwReserved[13];
} EC_T_CFG_SLAVE_INFO;

```

Description

dwSlaveId
 [out] The slave's ID to bind bus slave and config slave information
 abyDeviceName[80]
 [out] The slave's configured name (80 Byte) (from ENI file)
 dwHCGroupIdx
 [out] Index of the hot connect group, 0 for mandatory
 blsPresent
 [out] Slave is currently present on bus
 blsHCGroupPresent
 [out] Slave's hot connect group is currently present on bus
 dwVendorId
 [out] Vendor identification (from ENI file)
 dwProductCode
 [out] Product code (from ENI file)
 dwRevisionNumber
 [out] Revision number (from ENI file)
 dwSerialNumber
 [out] Serial number (from ENI file)
 wStationAddress
 [out] The slave's station address (from ENI file)
 wAutoIncAddress
 [out] The slave's auto increment address (from ENI file)
 dwPdOffsIn
 [out] Process input data offset (in Bits) (from ENI file)
 dwPdSizeIn
 [out] Process input data data (in Bits) (from ENI file)
 dwPdOffsOut
 [out] Process output data offset (in Bits) (from ENI file)
 dwPdSizeOut
 [out] Process output data size (in Bits) (from ENI file)
 dwPdOffsIn2
 [out] 2nd sync unit process input data offset (in Bits) (from ENI file)
 dwPdSizeIn2
 [out] 2nd sync unit process input data size (in Bits) (from ENI file)
 dwPdOffsOut2
 [out] 2nd sync unit process output data offset (in Bits) (from ENI file)
 dwPdSizeOut2
 [out] 2nd sync unit process output data size (in Bits) (from ENI file)
 dwPdOffsIn3
 [out] 3rd sync unit process input data offset (in Bits) (from ENI file)
 dwPdSizeIn3
 [out] 3rd sync unit process input data size (in Bits) (from ENI file)
 dwPdOffsOut3
 [out] 3rd sync unit process output data offset (in Bits) (from ENI file)
 dwPdSizeOut3
 [out] 3rd sync unit process output data size (in Bits) (from ENI file)
 dwPdOffsIn4
 [out] 4th sync unit process input data offset (in Bits) (from ENI file)
 dwPdSizeIn4
 [out] 4th sync unit process input data size (in Bits) (from ENI file)
 dwPdOffsOut4
 [out] 4th sync unit process output data offset (in Bits) (from ENI file)
 dwPdSizeOut4
 [out] 4th sync unit process output data size (in Bits) (from ENI file)
 dwMbxSupportedProtocols
 [out] Mailbox protocol supported by the slave (from ENI file)
 dwMbxOutSize
 [out] Mailbox output size (in Bytes) (from ENI file)
 dwMbxInSize

[out] Mailbox input size (in Bytes) (from ENI file)
dwMbxOutSize2
[out] Bootstrap mailbox output size (in Bytes) (from ENI file)
dwMbxInSize2
[out] Bootstrap mailbox input size (in Bytes) (from ENI file)
bDcSupport
[out] Slave supports DC (from ENI file)
wNumProcessVarsInp
[out] Number of input process data variables (from ENI file)
wNumProcessVarsOutp
[out] Number of output process data variables (from ENI file)
wPrevStationAddress
[out] Station address of the previous slave (from ENI file)
wPrevPort
[out] Connected port of the previous slave (from ENI file)
wIdentifyAdo
[out] ADO used for identification command (from ENI file)
wIdentifyData
[out] Identification value to be validated (from ENI file)
byPortDescriptor
[out] Port descriptor (ESC register 0x0007) (from ENI file)
wWkcStateDiagOffsIn
[out] Offset of WkcState bit in diagnosis image (ENI: ProcessData/Recv[1..4]/BitStart)
WkcState bit values: 0 = Data Valid, 1 = Data invalid
wWkcStateDiagOffsOut
[out] Offset of WkcState bit in diagnosis image (ENI: ProcessData/Send[1..4]/BitStart)
WkcState bit values: 0 = Data Valid, 1 = Data invalid
awMasterSyncUnitIn
[out] Sync Unit (ENI: ProcessData/TxPdo[1..4]@Su)
awMasterSyncUnitOut
[out] Sync Unit (ENI: ProcessData/RxPdo[1..4]@Su)
bDisabled
[out] Slave disabled by API (ecatSetSlaveDisabled / ecatSetSlavesDisabled).
bDisconnected
[out] Slave disconnected by API (ecatSetSlaveDisconnected / ecatSetSlavesDisconnected).
bExtended
[out] Slave generated by ecatConfigExtend()

4.6.33 ecatGetBusSlaveInfo

Return information about a slave connected to the EtherCAT bus

```
EC_T_DWORD ecatGetBusSlaveInfo(
    EC_T_BOOL      bStationAddress,
    EC_T_WORD      wSlaveAddress,
    EC_T_BUS_SLAVE_INFO* pSlaveInfo
);
```

Parameters

bStationAddress

[in] EC_TRUE: used station address, EC_FALSE: use auto increment address

wSlaveAddress

[in] Address of slave (Station or auto increment depending on *bStationAddress*)

pSlaveInfo

[out] Information from the slave.

Return

EC_E_NOERROR if successful.

EC_E_NOTFOUND if the slave with the given address does not exist.

Comment

Size of EC_T_BUS_SLAVE_INFO content is subject to be extended.

```
typedef struct _EC_T_BUS_SLAVE_INFO{
    EC_T_DWORD      dwSlaveld;
    EC_T_DWORD      adwPortSlavelds[4];
    EC_T_WORD       wPortState;
    EC_T_WORD       wAutoIncAddress;
    EC_T_BOOL       bDcSupport;
    EC_T_BOOL       bDc64Support;
    EC_T_DWORD      dwVendorId;
    EC_T_DWORD      dwProductCode;
    EC_T_DWORD      dwRevisionNumber;
    EC_T_DWORD      dwSerialNumber;
    EC_T_BYTE       byESCType;
    EC_T_BYTE       byESCRevision;
    EC_T_WORD       wESCBuild;
    EC_T_BYTE       byPortDescriptor;
    EC_T_BYTE       byReserved;
    EC_T_WORD       wFeaturesSupported;
    EC_T_WORD       wStationAddress;
    EC_T_WORD       wAliasAddress;
    EC_T_WORD       wAIStatus;
    EC_T_WORD       wAIStatusCode;
    EC_T_DWORD      dwSystemTimeDifference;
    EC_T_WORD       wMbxSupportedProtocols;
    EC_T_WORD       wDIStatus;
    EC_T_WORD       wPrevPort;
    EC_T_WORD       wIdentifyData;
    EC_T_BOOL       bLineCrossed;
    EC_T_DWORD      dwSlaveDelay;
    EC_T_DWORD      dwPropagDelay;
    EC_T_BOOL       bIsRefClock;
    EC_T_BOOL       bIsDeviceEmulation;
    EC_T_DWORD      adwReserved[3];
} EC_T_BUS_SLAVE_INFO;
```

Description

dwSlaveId

[out] The slave's ID to bind bus slave and config slave information

adwPortSlaveIds

[out] The slave's ID of the slaves connected to ports, including MASTER_SLAVE_ID, MASTER_RED_SLAVE_ID, EL9010_SLAVE_ID, FRAMELOSS_SLAVE_ID or JUNCTION_RED_FLAG.

wPortState

[out] Port link state. Format: wwwwww xxxx yyyy zzzz
(each nibble : port 3210)
wwwwww : 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)
(Bus Topology Scan)

wAutoIncAddress

[out] The slave's auto increment address

bDcSupport

[out] Slave supports DC.
(Bus Topology Scan)

bDc64Support

[out] Slave supports 64Bit DC.
(Bus Topology Scan)

dwVendorId

[out] Vendor Identification stored in the E²PROM at offset 0x0008

dwProductCode

[out] Product Code stored in the E²PROM at offset 0x000A

dwRevisionNumber

[out] Revision number stored in the E²PROM at offset 0x000C

dwSerialNumber

[out] Serial number stored in the E²PROM at offset 0x000E

byESCType

[out] Type of ESC (Value of slave ESC register 0x0000)

byESCRevision

[out] Revision number of ESC (Value of slave ESC register 0x0001)

wESCBuild

[out] Build number of ESC (Value of slave ESC register 0x0002)

byPortDescriptor

[out] Port descriptor (Value of slave ESC register 0x0007)

wFeaturesSupported

[out] Features supported (Value of slave ESC register 0x0008)

wStationAddress

[out] The slave's station address (Value of slave ESC register 0x0010)

wAliasAddress

[out] The slave's alias address (Value of slave ESC register 0x0012)

wAlStatus

[out] AL status (Value of slave ESC register 0x0130)

wAlStatusCode

[out] AL status code. (Value of slave ESC register 0x0134 during last error acknowledge).
This value is reset after a slave state change

dwSystemTimeDifference

[out] System time difference. (Value of slave ESC register 0x092C)

wMbxSupportedProtocols

[out] Supported Mailbox Protocols stored in the E²PROM at offset 0x001C

wDIStatus

[out] DL status (Value of slave ESC register 0x0110)

wPrevPort

[out] Connected port of the previous slave

wIdentifyData

[out] Last read identification value see EC_T_CFG_SLAVE_INFO.wIdentifyAdo
 bLineCrossed
 [out] Line crossed was detected at this slave
 dwSlaveDelay
 [out] Delay behind slave in ns. This value is only valid if a DC configuration is used
 dwPropagDelay
 [out] Propagation delay in ns. ESC register 0x0928, This value is only valid if a DC configuration is used
 bIsRefClock
 [out] Slave is reference clock
 bIsDeviceEmulation
 [out] Slave without Firmware. ESC register 0x0141, enabled by EEPROM offset 0x0000.8.

wMbxSupportedProtocols is 0 after calling `ecatConfigureMaster`, use `EC_T_CFG_SLAVE_INFO.dwMbxSupportedProtocols` from `ecatGetCfgSlaveInfo` instead.

4.6.34 *ecatReadSlaveIdentification*

Read identification value from slave.

```
EC_T_DWORD ecatReadSlaveIdentification(
    EC_T_BOOL      bStationAddress,
    EC_T_WORD      wSlaveAddress,
    EC_T_WORD      wAdo,
    EC_T_WORD*     pwValue,
    EC_T_DWORD     dwTimeout
);
```

Parameters

bStationAddress
 [in] EC_TRUE: used station address, EC_FALSE: use auto increment address
wSlaveAddress
 [in] Address of slave (Station or auto increment depending on *bStationAddress*)
wAdo
 [in] ADO used for identification command
pwValue
 [out] Pointer to Word value containing the Identification value.
dwTimeout
 [in] Timeout in milliseconds. The function will block at most for this time.

Return

EC_E_NOERROR if successful.
EC_E_SLAVE_NOT_PRESENT if slave not present.
EC_E_BUSY another transfer request is already pending.
EC_E_NOTFOUND if the slave with the given address does not exist.
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_TIMEOUT if the slave did not respond to the command.
EC_E_BUSY if the master or the corresponding slave is currently changing its operational state .
EC_E_INVALIDPARAM if the command is not supported or the timeout value is set to EC_NOWAIT.
EC_E_ADO_NOT_SUPPORTED if the slave does not support requesting ID mechanism.

Comment

This function may not be called from within the JobTask's context.

4.6.35 *ecatReadSlaveIdentificationReq*

Request the identification value from a slave and returns immediately.

```
EC_T_DWORD ecatReadSlaveIdentification(
    EC_T_DWORD      dwClientId,
    EC_T_DWORD      dwTferId,
    EC_T_BOOL       bStationAddress,
    EC_T_WORD       wSlaveAddress,
    EC_T_WORD       wAdo,
    EC_T_WORD*      pwValue,
    EC_T_DWORD      dwTimeout
);
```

Parameters

dwClientId

[in] ID of the client to be notified (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_NOTIFY_DESC

bStationAddress

[in] EC_TRUE: used station address, EC_FALSE: use auto increment address

wSlaveAddress

[in] Address of slave (Station or auto increment depending on bStationAddress)

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 in milliseconds. The function will block at most for this time.

Return

EC_E_NOERROR if successful.

EC_E_SLAVE_NOT_PRESENT if slave not present.

EC_E_NOTFOUND if the slave with the given address does not exist.

EC_E_INVALIDPARAM if the command is not supported or the timeout value is set to EC_NOWAIT.

EC_E_ADO_NOT_SUPPORTED if the slave does not support requesting ID mechanism.

Comment

This function may be called from within the JobTask's context.

A 4.6.36 *ecatNotify* – EC_NOTIFY_SLAVE_IDENTIFICATION is given on completion.

4.6.36 *ecatNotify* – *EC_NOTIFY_SLAVE_IDENTIFICATION*

This notification is given, when the read slave identification request is completed.

Parameters

pbyInBuf
 [in] Pointer to *EC_T_SLAVE_IDENTIFICATION_NTFY_DESC*
dwInBufSize
 [in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
 [] Is set to *EC_NULL*.
dwOutBufSize
 [] Is set to 0.
pdwNumOutData
 [] Is set to *EC_NULL*.

Comment

```
typedef struct _EC_T_SLAVE_IDENTIFICATION_NTFY_DESC {
    EC_T_DWORD      dwTferId;
    EC_T_DWORD      dwResult;
    EC_T_SLAVE_PROP SlaveProp;
    EC_T_WORD       wAdo;
    EC_T_WORD       wValue;
} EC_T_SLAVE_IDENTIFICATION_NTFY_DESC;
```

Description

dwTferId
 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.

dwResult
 Result of request.

SlaveProp
 Slave properties.

wAdo
 Slave address offset used for identification. Given by API.

wValue
 Slave identification value. Given by API.

4.6.37 *ecatIoControl* – ***EC_IOCTL_SET_AUTO_ACK_AL_STATUS_ERROR_ENABLED***

Specifies if slave errors must be automatically acknowledged

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

The pending slave error will be acknowledged during the next **ecatSetSlaveState()** call.

4.6.38 *ecatIoControl* – ***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.

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

If TRUE, the notification **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 3.3.8 "Cyclic cmd WKC validation" and 3.3.9 "WKC State in Diagnosis Image".

4.6.39 *ecatSetSlaveDisabled*

Enable or disable a specific slave

The following patents may have to be taken into account:

- JP2014146077:CONTROL DEVICE AND OPERATION METHOD FOR CONTROL DEVICE
- JP2014146070:CONTROL DEVICE, CONTROL METHOD, AND PROGRAM
- JP2014120884:INFORMATION PROCESSING APPARATUS, INFORMATION PROCESSING PROGRAM, AND INFORMATION PROCESSING METHOD

```
EC_T_DWORD ecatSetSlaveDisabled (  
    EC_T_BOOL  
    EC_T_WORD  
    EC_T_BOOL  
    bFixedAddressing,  
    wSlaveAddress  
    bDisabled  
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address

wSlaveAddress

[in] Slave address

bDisabled

[in] Disable or enable slave

Return

EC_E_NOERROR or error code

Comment

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.

4.6.40 *ecatSetSlavesDisabled*

Enable or disable a specific group of slaves

The following patents may have to be taken into account:

- JP2014146077: CONTROL DEVICE AND OPERATION METHOD FOR CONTROL DEVICE
- JP2014146070: CONTROL DEVICE, CONTROL METHOD, AND PROGRAM
- JP2014120884: INFORMATION PROCESSING APPARATUS, INFORMATION PROCESSING PROGRAM, AND INFORMATION PROCESSING METHOD

```
EC_T_DWORD ecatSetSlavesDisabled(
    EC_T_BOOL          bFixedAddressing,
    EC_T_WORD          wSlaveAddress,
    EC_T_SLAVE_SELECTION eSlaveSelection,
    EC_T_BOOL          bDisabled
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address.

wSlaveAddress

[in] Slave address.

eSlaveSelection

[in] Slave selection criteria, (see below).

bDisabled

[in] EC_TRUE: Disable slaves, EC_FALSE: Enable slaves.

Return

EC_E_NOERROR or error code

Comment

```
typedef enum _EC_T_SLAVE_SELECTION {
    eSlaveSelectionSingle,
    eSlaveSelectionTopoFollowers,
    eSlaveSelectionMasterSyncUnit
}
```

eSlaveSelectionSingle

[in] Select only one slave.

eSlaveSelectionTopoFollowers

[in] Select slave and his topological followers.

eSlaveSelectionMasterSyncUnit

[in] Select all slaves with the same Master Sync Units.

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.

4.6.41 *ecatSetSlaveDisconnected*

Mark specific slave for connection or disconnection

The following patents may have to be taken into account:

- 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

```
EC_T_DWORD ecatSetSlaveDisconnected(
    EC_T_BOOL          bFixedAddressing,
    EC_T_WORD          wSlaveAddress
    EC_T_BOOL          bDisconnected
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address

wSlaveAddress

[in] Slave address

bDisconnected

[in] Mark specific slave for connection or disconnection

Return

EC_E_NOERROR or error code

Comment

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.

4.6.42 *ecatSetSlavesDisconnected*

Mark a specific group of slaves for connection or disconnection

The following patents may have to be taken into account:

- 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

```
EC_T_DWORD ecatSetSlavesDisconnected(
    EC_T_BOOL          bFixedAddressing,
    EC_T_WORD          wSlaveAddress,
    EC_T_SLAVE_SELECTION eSlaveSelection,
    EC_T_BOOL          bDisconnected
);
```

Parameters

bFixedAddressing

[in] EC_TRUE: Use station address, EC_FALSE: use AutoInc address.

wSlaveAddress

[in] Slave address.

eSlaveSelection

[in] Slave selection criteria, (see 4.6.40 *ecatSetSlavesDisabled*).

bDisconnected

[in] Mark specific slaves for connection or disconnection.

Return

EC_E_NOERROR or error code

Comment

See 4.6.41 *ecatSetSlaveDisconnected*.

4.6.43 *ecatSetSlavePortState*

Open or close slave port

```
EC_T_DWORD ecatSetSlavePortState(  
    EC_T_DWORD    dwSlaveId,  
    EC_T_WORD     wPort,  
    EC_T_BOOL     bClose,  
    EC_T_BOOL     bForce,  
    EC_T_DWORD    dwTimeout  
);
```

Parameters

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] Order timeout [ms]

Return

EC_E_NOERROR on success.

EC_E_SLAVE_NOT_PRESENT if slave not present.

EC_E_NOTFOUND if the slave with ID *dwSlaveId* does not exist.

Error code otherwise.

Comment

This function can be called to re-open ports closed by *ecatRescueScan*.

4.6.44 *ecatSetSlavePortStateReq*

Requests Open or close slave port operation and returns immediately.

```
EC_T_DWORD ecatSetSlavePortState(
    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
);
```

Parameters

dwClientId

[in] ID of the client to be notified (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_NOTIFY_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] Order timeout [ms]

Return

EC_E_NOERROR on success.

EC_E_SLAVE_NOT_PRESENT if slave not present.

EC_E_NOTFOUND if the slave with ID dwSlaveId does not exist.

Error code otherwise.

Comment

This function can be called to re-open ports closed by ecatRescueScan.

A 4.6.45 ecatNotify – EC_T_PORT_OPERATION_NOTIFY_DESC is given on completion.

4.6.45 ecatNotify – EC_T_PORT_OPERATION_NTFY_DESC

This notification is given, when the port operation request is completed.

Parameters

pbyInBuf
[in] Pointer to EC_T_PORT_OPERATION_NTFY_DESC

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Is set to EC_NULL.

dwOutBufSize
[] Is set to 0.

pdwNumOutData
[] Is set to EC_NULL.

Comment

```
typedef struct EC_T_PORT_OPERATION_NTFY_DESC {
    EC_T_DWORD      dwTferId;
    EC_T_DWORD      dwResult;
    EC_T_SLAVE_PROP SlaveProp;
    EC_T_WORD       wPortStateOld;
    EC_T_WORD       wPortStateNew;
} EC_T_PORT_OPERATION_NTFY_DESC;
```

Description

dwTferId
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.

dwResult
Result of request.

SlaveProp
Slave properties.

wPortStateOld
State of the slave ports old see ecatGetSlavePortState().

wPortStateNew
State of the slave ports new see ecatGetSlavePortState()

4.6.46 ecatIoControl – EC_IOCTL_SET_NEW_BUSSLAVES_TO_INIT

Force state change to INIT for all new slaves in network after detection.

Parameters

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
[] Should be set to EC_NULL.

dwOutBufSize
[] Should be set to 0.

pdwNumOutData
[] Should be set to EC_NULL.

Comment

Default: No state change after detection

4.7 Diagnosis, error detection, error notifications

4.7.1 Introduction

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 `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:

- a) Slave unrelated errors
- b) 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 `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 `EC_NOTIFY_CYCCMD_WKC_ERROR` error notification will be generated.

4.7.2 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 `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 `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:

- a) Master calls `ecatNotify(EC_NOTIFY_CYCCMD_WKC_ERROR)`
 → application gets informed
 → WKC State in Diagnosis Image changes (see 3.3.9 "WKC State in Diagnosis Image".)
- b) Use case: Slave is disconnected or powered off:
 Master detects a DL status event interrupt and performs a bus scan.
 Master calls `ecatNotify(EC_NOTIFY_SLAVE_PRESENCE)`
 → application gets informed and could set the whole master into a lower state, e. g. `eEcatState_INIT`
- c) Use case: Slave state is not OPERATIONAL anymore
 Master calls `ecatNotify(EC_NOTIFY_SLAVE_UNEXPECTED_STATE)`
 → application gets informed and could either set the whole master into lower state (e. g. `eEcatState_PREOP`), or calls `ecatSetSlaveState(...,DEVICE_STATE_OP)` to repair the failed slave.
- d) Use case: Slave is re-connected or powered on:
 Master detects a DL status event interrupt and performs a bus scan.
 Master calls `ecatNotify(EC_NOTIFY_SLAVE_PRESENCE)`

Application could wait until all slaves are re-connected by calling the functions `ecatGetNumConnectedSlaves()` and `ecatGetNumConfiguredSlaves()`.

After all slaves are re-connected the application could either set the whole master to `eEcatState_INIT` and afterwards to `eEcatState_OP`, or the application uses `ecatSetSlaveState()` to repair only the failed slaves.

4.7.3 *ecatEthDbgMsg*

Send a debug message to the EtherCAT Link Layer. This feature can be used for debugging purposes. This function replaced the “ecatIoControl – EC_IOCTL_LINKLAYER_DBG_MSG”.

```
EC_T_DWORD ecatEthDbgMsg(  
    EC_T_BYTE    byEthTypeByte0,  
    EC_T_BYTE    byEthTypeByte1,  
    EC_T_CHAR*   szMsg  
);
```

Parameters

byEthTypeByte0

[in] Ethernet type byte 0.

byEthTypeByte1

[in] Ethernet type byte 1.

szMsg

[in] Message to send to Link Layer.

Return

EC_E_NOERROR if successful.

4.7.4 *ecatIoControl* – *EC_IOCTL_GET_SLVSTATISTICS*

Get Slave's statistics counter.

Counters are collected on a regularly base (default: off) and show errors on Ethernet Layer.

Parameters

pbInBuf

[in] Pointer to a EC_T_DWORD type variable containing the slave id.

dwInBufSize

[in] Size of the input buffer provided at *pbInBuf* in bytes.

pbOutBuf

[out] Pointer to struct EC_T_SLVSTATISTICS_DESC

dwOutBufSize

[in] Size of the output buffer provided at *pbOutBuf* in bytes.

pdwNumOutData

[out] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Comment

EC_T_SLVSTATISTICS_DESC

typedef struct _EC_T_SLVSTATISTICS_DESC

```
{
    EC_T_WORD          wRxErrorCounter[4];
    EC_T_BYTE          byFwdRxErrorCounter[4];
    EC_T_BYTE          byEcatProcUnitErrorCounter;
    EC_T_BYTE          byPDIErrorCounter;
    EC_T_WORD          wAlStatusCode;
    EC_T_BYTE          byLostLinkCounter[4];
} EC_T_SLVSTATISTICS_DESC;
```

Description

wRxErrorCounter[4]

[out] RX Error Counters per Slave Port

byFwdRxErrorCounter[4];

[out] Forwarded RX Error Counters per Slave Port

byEcatProcUnitErrorCounter

[out] EtherCAT Processing unit error counter

byPDIErrorCounter;

[out] PDI Error counter

wAlStatusCode;

[out] AL status code

byLostLinkCounter[4];

[out] Lost Link Counter per Slave Port

See also EC_IOCTL_SET_SLVSTAT_PERIOD and EC_IOCTL_CLR_SLVSTATISTICS.

4.7.5 ecatGetSlaveStatistics

Get Slave's statistics counter. See EC_IOCTL_GET_SLVSTATISTICS

```
EC_T_DWORD ecatGetSlaveStatistics(
    EC_T_DWORD          dwSlaveId,
    EC_T_SLVSTATISTICS_DESC* pSlaveStatisticsDesc
    dwSlaveId
    [in] Slave Id.
    pSlaveStatisticsDesc
    [out] Pointer to struct EC_T_SLVSTATISTICS_DESC
```

EC_E_NOERROR if successful.

4.7.6 ecatIoControl – EC_IOCTL_CLR_SLVSTATISTICS

Clear all error registers in all slaves

Parameters

```
pbyInBuf
    [] Should be set to EC_NULL.
    dwInBufSize
    [] Should be set to 0.
    pbyOutBuf
    [] Should be set to EC_NULL.
    dwOutBufSize
    [] Should be set to 0.
    pdwNumOutData
    [] Should be set to EC_NULL.
```

4.7.7 ecatClearSlaveStatistics

Clears all error registers of a slave.

```
EC_T_DWORD ecatClearSlaveStatistics(
    EC_T_DWORD          dwSlaveId,
);
dwSlaveId
    [in] Slave Id, INVALID_SLAVE_ID clears all slaves
```

EC_E_NOERROR if successful.

4.7.8 *ecatIoControl* – *EC_IOCTL_GET_SLVSTAT_PERIOD*

Get Slave Statistics collection period.

Parameters

pbyInBuf

[in] Should be set to EC_NULL.

dwInBufSize

[in] Should be set to 0.

pbyOutBuf

[] Pointer to a EC_T_DWORD type variable containing the slave statistics collection period [ms] to get.

dwOutBufSize

[] Size of the output buffer provided at *pbyOutBuf* in bytes.

pdwNumOutData

[] Pointer to EC_T_DWORD. Amount of bytes written to the output buffer.

Comment

Period of 0: automatic slave statistics collection disabled.

4.7.9 *ecatIoControl* – *EC_IOCTL_SET_SLVSTAT_PERIOD*

Update Slave Statistics collection period.

It implicitly forces an immediate collection of slave statistics if performed successful.

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

A Period of 0 disables automatic slave statistics collection.

4.7.10 *ecatIoControl* – *EC_IOCTL_FORCE_SLVSTAT_COLLECTION*

Sends datagrams to collect slave statistics counters.

Parameters

pbyInBuf

[] Should be set to EC_NULL.

dwInBufSize

[] Should be set to 0.

pbyOutBuf

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

4.7.11 *ecatIoControl* – *EC_IOCTL_CLEAR_MASTER_INFO_COUNTERS*

Reset Master Info Counters according to given bit masks.

Parameters

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
[] Should be set to *EC_NULL*.
dwOutBufSize
[] Should be set to 0.
pdwNumOutData
[] Should be set to *EC_NULL*.

Comment

```
typedef struct _EC_T_CLEAR_MASTER_INFO_COUNTERS_PARMS
{
    EC_T_DWORD      dwClearBusDiagnosisCounters;
    EC_T_UINT64     qwMailboxStatisticsClearCounters;
} EC_T_CLEAR_MASTER_INFO_COUNTERS_PARMS;
```

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

qwMailboxStatisticsClearCounters
[in] Bit 0...56: Clear corresponding Counter ID.

Bit 0...7: Clear AoE statistics:

Bit 0: AoE Total Read Transfer Count	Bit 4: AoE Total Write Transfer Count
Bit 1: AoE Read Transfer Count Last Second	Bit 5: AoE Write Transfer Count Last Second
Bit 2: AoE Total Bytes Read	Bit 6: AoE Total Bytes Write
Bit 3: AoE Bytes Read Last Second	Bit 7: AoE 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)

Example

E.g. *qwMailboxStatisticsClearCounters* = 0x0000000100: Clear CoE Total Read Transfer Count.

4.7.12 *ecatIoControl* –

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, except `EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_NON_ECAT_FRAME` are enabled (the notification mask is set to `EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_DEFAULT`).

Parameters

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

[] Should be set to `EC_NULL`.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to `EC_NULL`.

The following frame response error notification mask values exist:

- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_NO_RESPONSE`**
→ mask for notifications with error type `eRspErr_NO_RESPONSE`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_WRONG_IDX`**
→ mask for notifications with error type `eRspErr_WRONG_IDX`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_UNEXPECTED`**
→ mask for notifications with error type `eRspErr_UNEXPECTED`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_FRAME_RETRY`**
→ mask for notifications with error type `eRspErr_FRAME_RETRY`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_RETRY_FAIL`**
→ mask for notifications with error type `eRspErr_RETRY_FAIL`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_FOREIGN_SRC_MAC`**
→ mask for notifications with error type `eRspErr_FOREIGN_SRC_MAC`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_NON_ECAT_FRAME`**
→ mask for notifications with error type `eRspErr_NON_ECAT_FRAME`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_DEFAULT`**
→ mask for all notifications enabled except error type `eRspErr_NON_ECAT_FRAME`
- **`EC_FRAME_RESPONSE_ERROR_NOTIFY_MASK_ALL`**
→ mask for all frame response error notifications

Comment

See also section 4.7.25 `EC_NOTIFY_FRAME_RESPONSE_ERROR`.

4.7.13 *ecatIoControl* – *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.

Attention: Do not activate this on shipped releases. Frameloss has significant influence on performance and reliability of the application!

Parameters

pbyInBuf
 [in] Array of four EC_T_DWORDS (arrDword), see below.
dwInBufSize
 [in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
 [] Should be set to EC_NULL.
dwOutBufSize
 [] Should be set to 0.
pdwNumOutData
 [] Should be set to EC_NULL.

Comment

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

4.7.14 *ecatIoControl* – *EC_IOCTL_SET_RXFRAME_LOSS_SIMULATION*

Same as [ecatIoControl – EC_IOCTL_SET_FRAME_LOSS_SIMULATION](#) but only enables receive direction frame losses.

4.7.15 *ecatIoControl* – *EC_IOCTL_SET_TXFRAME_LOSS_SIMULATION*

Same as [ecatIoControl – EC_IOCTL_SET_FRAME_LOSS_SIMULATION](#) but only enables transmit direction frame losses.

4.7.16 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 `ecatNotify` is called. In addition to this notification code the second parameter given to `ecatNotify` 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.

```
typedef struct _EC_T_ERROR_NOTIFICATION_DESC{
    EC_T_DWORD      dwNotifyErrorCode;    /* error ID (same value as the notification code) */
    EC_T_CHAR       achErrorInfo[];       /* additional error string (may be empty) */
    union {
        EC_T_WKCERR_DESC    WkcErrDesc    /* detailed error information, see below */
        EC_T_XXXXX          Xxxxxx        /* detailed error information, see below */
        : : : : :
        : : : : :
    }
} EC_T_ERROR_NOTIFICATION_DESC;
```

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 `ecatNotify` 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 `ecatIoControl – EC_IOCTL_SET_NOTIFICATION_ENABLED` it is possible to determine which errors shall be signalled and which not.

4.7.17 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 `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 the union element `WkcErrDesc`:

This notification is enabled by default. See `EC_IOCTL_SET_NOTIFICATION_ENABLED` for how to control the deactivation.

```
typedef struct _EC_T_WKCERR_DESC{
    EC_T_SLAVE_PROP SlaveProp;           /* slave properties, content not used (undefined) in case of cyclic
                                           WKC_ERROR */
    EC_T_BYTE        byCmd;               /* EtherCAT command where this error occurred */
    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 */
} EC_T_WKCERR_DESC;

typedef struct _EC_T_SLAVE_PROP{
    EC_T_WORD         wStationAddress;     /* station address */
    EC_T_WORD         wAutoIncAddr;        /* auto increment address */
    EC_T_CHAR         achName[];          /* name of the slave device (NULL terminated string) */
} EC_T_SLAVE_PROP;
```

Comment

See 3.3.8 “Cyclic cmd WKC validation” and 3.3.9 “WKC State in Diagnosis Image”.

See 4.6.38 “`ecatIoControl – EC_IOCTL_SET_AUTO_ADJUST_CYCCMD_WKC_ENABLED`”.

4.7.18 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 the union element WkcErrDesc.

4.7.19 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 the union element WkcErrDesc. The structure member SlaveProp contains information about the corresponding slave device:

4.7.20 EC_NOTIFY_FOE_MBSLAVE_ERROR

This error will be indicated in case a slave notifies an error over FoE. See EC-Master Class A Manual.

4.7.21 EC_NOTIFY_EOE_MBXSEND_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 the union element WkcErrDesc. The structure member SlaveProp contains information about the corresponding slave device.

4.7.22 EC_NOTIFY_COE_MBXSEND_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 the union element WkcErrDesc. The structure member SlaveProp contains information about the corresponding slave device.

4.7.23 EC_NOTIFY_FOE_MBXSEND_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. See EC-Master Class A Manual.

4.7.24 EC_NOTIFY_VOE_MBXSEND_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 the union element WkcErrDesc. The structure member SlaveProp contains information about the corresponding slave device.

4.7.25 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 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 section 4.3.1).

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:

- a) 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"*.
- b) 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 `dwMaxSentQueuedFramesPerCycle`
 - shorter master timer cycle, i.e. shorter period between two calls to `ecatExecJob(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:

- a) the frame was not received (due to bus problems)
- b) 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 `dwMaxSentQueuedFramesPerCycle`
 - higher cyclic timer period, i.e. less calls to `ecatExecJob(eUsrJob_SendAllCycFrames)`
- c) non-deterministic sending of acyclic frames.
Sending acyclic frames by calling `ecatExecJob(eUsrJob_SendAcycFrames)` have to be properly scheduled with sending cyclic frames by calling `ecatExecJob(eUsrJob_SendAllCycFrames)`.

Using the control interface `ecatIoControl` –

`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 the union element `FrameRspErrDesc`:

```
typedef struct _EC_T_FRAME_RSPERR_DESC{
    EC_T_BOOL    blsCyclicFrame; /* EC_TRUE if the frame contains cyclic commands */
    EC_T_FRAME_RSPERR_TYPE
        EErrorType; /* Error type, see below */
    EC_T_BYTE    byEcCmdHeaderIdxSet; /* Expected IDX value, this value is valid only for acyclic
        frames in case EErrorType is not equal to
        eRspErr_UNEXPECTED */
    EC_T_BYTE    byEcCmdHeaderIdxAct; /* Actually received IDX value, this value is only valid for
        acyclic frames in case of EErrorType is equal to:
        - eRspErr_WRONG_IDX
        - eRspErr_UNEXPECTED */
} EC_T_FRAME_RSPERR_DESC;

typedef enum _EC_T_FRAME_RSPERR_TYPE{
    eRspErr_NO_RESPONSE /* No Ethernet frame received (timeout, frame loss) */
    eRspErr_WRONG_IDX /* Wrong IDX value in acyclic frame */
    eRspErr_UNEXPECTED /* Unexpected frame was received */
    eRspErr_FRAME_RETRY /* Ethernet frame will be re-sent (timeout, frame loss) */
    eRspErr_RETRY_FAIL /* all retry mechanism fails to re-sent acyclic frames */
    eRspErr_FOREIGN_SRC_MAC /* Frame with MAC from other Master received. */
    eRspErr_NON_EC_CAT_FRAME /* Non EtherCAT frame received */
} EC_T_FRAME_RSPERR_TYPE;
```

4.7.26 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. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation.

Detailed error information is stored in structure EC_T_INITCMD_ERR_DESC of the union element InitCmdErrDesc:

```
typedef struct _EC_T_INITCMD_ERR_DESC{
    EC_T_SLAVE_PROP SlaveProp; /* Slave properties */
    EC_T_INITCMD_ERR_TYPE
        EErrorType; /* Error type, see below */
    EC_T_CHAR    achStateChangeName[]; /* State change description when the error occurred */
    EC_T_CHAR    szComment[]; /* < comment (ENI) */
} EC_T_INITCMD_ERR_DESC;

typedef enum _EC_T_INITCMD_ERR_TYPE{
    eInitCmdErr_NO_RESPONSE /* No Ethernet frame received (timeout) */
    eInitCmdErr_VALIDATION_ERR /* Validation error (invalid slave command response) */
    eInitCmdErr_FAILED /* Init commands failed (state could not be reached) */
} EC_T_INITCMD_ERR_TYPE;
```

4.7.27 EC_NOTIFY_MBSLAVE_INITCMD_TIMEOUT

This error is identical to error code 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.

4.7.28 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 the union element InitCmdErrDesc.

4.7.29 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.

4.7.30 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 EC_NOTIFY_NOT_ALL_DEVICES_OPERATIONAL and all the slaves are back in OPERATIONAL state.

4.7.31 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 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 EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation.

4.7.32 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 the union element SlaveErrInfoDesc.

This notification is enabled by default. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation.

```
typedef struct _EC_T_SLAVE_ERROR_INFO_DESC{
    EC_T_SLAVE_PROP SlaveProp;          /* Slave properties, see above */
    EC_T_WORD   wStatus;                /* Slave status (AL STATUS) */
    EC_T_WORD   wStatusCode;           /* Slave status code (AL STATUS CODE) */
} EC_T_SLAVE_ERROR_INFO_DESC;
```

4.7.33 EC_NOTIFY_SLAVES_ERROR_STATUS

This notification collects notifications of type 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. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the activation.

```
typedef struct _EC_T_SLAVES_ERROR_DESC
{
    EC_T_WORD wCount;
    EC_T_WORD wRes;
    EC_T_SLAVES_ERROR_DESC_ENTRY SlaveError[MAX_SLAVES_ERROR_NTFY_ENTRIES];
} EC_T_SLAVES_ERROR_DESC;
```

4.7.34 EC_NOTIFY_SLAVE_UNEXPECTED_STATE

This error is signaled every time a slave changes into an unexpected state.

Detailed error information is stored in structure EC_T_SLAVE_UNEXPECTED_STATE_DESC of the union element SlaveUnexpectedStateDesc.

This notification is enabled by default. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation.

```
typedef struct _EC_T_SLAVE_UNEXPECTED_STATE_DESC{
    EC_T_SLAVE_PROP SlaveProp;          /* Slave properties, see above */
    EC_T_STATE curState;                 /* Current state */
    EC_T_STATE expState;                 /* Expected state */
} EC_T_SLAVE_UNEXPECTED_STATE_DESC;
```

4.7.35 EC_NOTIFY_SLAVES_UNEXPECTED_STATE

This notification collects notifications of type 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. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the activation.

```
typedef struct _EC_T_SLAVES_UNEXPECTED_STATE_DESC_ENTRY
{
    EC_T_WORD wStationAddress;
    EC_T_STATE curState;
    EC_T_STATE expState;
} EC_T_SLAVES_UNEXPECTED_STATE_DESC_ENTRY;
typedef struct _EC_T_SLAVES_UNEXPECTED_STATE_DESC
{
    EC_T_WORD wCount;
    EC_T_WORD wRes;
    EC_T_SLAVES_UNEXPECTED_STATE_DESC_ENTRY
    SlaveStates[MAX_SLAVES_UNEXPECTED_STATE_NOTIFY_ENTRIES];
} EC_T_SLAVES_UNEXPECTED_STATE_DESC;
```

4.7.36 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.

4.7.37 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.

4.7.38 EC_NOTIFY_SLAVE_NOT_ADDRESSABLE

If the master cannot get the slave device state using its station address (if the working counter is not incremented) this error will be generated.

This may happen if the slave was removed from the bus or powered off during normal operation. Detailed error information is stored in structure EC_T_WKCERR_DESC of the union element WkcErrDesc. The structure member SlaveProp contains information about the corresponding slave device.

4.7.39 EC_NOTIFY_CLIENTREGISTRATION_DROPPED

This notification will be indicated if the client registration was dropped because ecatConfigureMaster was called by another thread. The notification has the following parameter:

```
EC_T_DWORD dwDeinitForConfiguration; /* 0 = terminating Master, 1 = restarting Master */
```

4.7.40 EC_NOTIFY_EEPROM_CHECKSUM_ERROR

This error is signaled every time a EEPROM checksum error is detected.

Detailed error information is stored in structure EC_T_EEPROM_CHECKSUM_ERROR_DESC of the union element EEPROMChecksumErrorDesc.

```
typedef struct _EC_T_EEPROM_CHECKSUM_ERROR_DESC{  
    EC_T_SLAVE_PROP SlaveProp;          /* Slave properties */  
} EC_T_EEPROM_CHECKSUM_ERROR_DESC;
```

4.7.41 EC_NOTIFY_PDIWATCHDOG

This error is signaled every time a PDI watchdog error is detected.

Detailed error information is stored in structure EC_T_PDIWATCHDOG_DESC of the union element PdiWatchdogDesc.

```
typedef struct _EC_T_PDIWATCHDOG_DESC {  
    EC_T_SLAVE_PROP SlaveProp;          /* Slave properties */  
} EC_T_PDIWATCHDOG_DESC;
```

4.7.42 *ecatGetText*

Return text tokens by ID from master stack.

```
EC_T_CHAR* ecatGetText(EC_T_WORD wTextId);
```

Parameters

wTextId
[in] Text enumeration ID

Return

Master stack stored text. To find the subordinate texts see source code in file EcError.h.

4.7.43 *ecatPerfMeasInit*

Initialize performance measurement.

```
EC_T_VOID ecatPerfMeasInit(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc,
    EC_T_UINT64          dwIFreqSet,
    EC_T_DWORD           dwNumMeas,
    EC_T_FNMESSAGE       pfnMessage
);
```

Parameters

pTscMeasDesc
[in,out] measurement descriptor
dwIFreqSet
[in] TSC frequency, 0: auto-calibrate
dwNumMeas
[in] number of elements to be allocated in in *pTscMeasDesc*->*aTscTime*
pfnMessage
[in] Reserved. Set to EC_NULL.

Comment

This function may not be called from within the JobTask's context.

4.7.44 *ecatPerfMeasDeinit*

De-initialize performance measurement.

```
EC_T_VOID ecatPerfMeasDeinit(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc
);
```

Parameters

pTscMeasDesc
[in,out] measurement descriptor

4.7.45 *ecatPerfMeasEnable*

Enable performance measurement.

```
EC_T_VOID ecatPerfMeasEnable(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc
);
```

Parameters

pTscMeasDesc
[in,out] measurement descript

4.7.46 ecatPerfMeasDisable

Disable performance measurement.

```
EC_T_VOID ecatPerfMeasDisable(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc
);
```

Parameters

pTscMeasDesc
[in,out] measurement descriptor

Return

-

4.7.47 ecatPerfMeasStart

Start measurement.

```
EC_T_VOID ecatPerfMeasStart(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc,
    EC_T_DWORD          dwIndex
);
```

Parameters

pTscMeasDesc
[in,out] measurement descriptor
dwIndex
[in] measurement index

Return

-

4.7.48 ecatPerfMeasEnd

Stop measurement.

```
EC_T_TSC_TIME* ecatPerfMeasEnd(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc,
    EC_T_DWORD          dwIndex
);
```

```
typedef struct _EC_T_TSC_TIME{
    EC_T_UINT64  qwStart;    /* start time */
    EC_T_UINT64  qwEnd;      /* end time */
    EC_T_DWORD   dwCurr;     /* [1/10 usec] */
    EC_T_DWORD   dwMin;      /* [1/10 usec] */
    EC_T_DWORD   dwMax;      /* [1/10 usec] */
    EC_T_DWORD   dwAvg;      /* [1/100 usec] */
    EC_T_BOOL    bMeasReset; /* EC_TRUE if measurement values shall be reset */
    EC_T_INT     nIntLevel;  /* for interrupt lockout handling */
} EC_T_TSC_TIME;
```

Parameters

pTscMeasDesc
[in,out] measurement descriptor
dwIndex
[in] measurement index

Return

Pointer to corresponding time descriptor.

4.7.49 *ecatPerfMeasReset*

Request measurement reset. Reset is done within `ecatPerfMeasEnd()`.

```
EC_T_VOID ecatPerfMeasReset(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc,
    EC_T_DWORD          dwIndex
);
```

Parameters

pTscMeasDesc
[in,out] measurement descriptor

dwIndex
[in] measurement index, 0xFFFFFFFF: all indexes

Return

-

4.7.50 *ecatPerfMeasShow*

Log current performance measurement values using `OsDbgMsg`.

```
EC_T_VOID ecatPerfMeasShow(
    EC_T_TSC_MEAS_DESC* pTscMeasDesc,
    EC_T_DWORD          dwIndex,
    EC_T_CHAR**         aszMeasCaption
);
```

Parameters

pTscMeasDesc
[in] measurement descriptor

dwIndex
[in] measurement index, 0xFFFFFFFF: all indexes

aszMeasCaption
[in] captions as array of zero terminated strings.

Return

-

4.7.51 *ecatPerfMeasSetIrqCtlEnabled*

By default, `ecatPerfMeasStart` disables interrupts and `ecatPerfMeasEnd` enables interrupts in order to protect against external events to influence the measurement.

This behavior can be disabled by calling `ecatPerfMeasSetIrqCtlEnabled(EC_FALSE)`.

```
EC_T_VOID ecatPerfMeasSetIrqCtlEnabled(
    EC_T_BOOL          bEnabled
);
```

Parameters

bEnabled
[in] EC_TRUE: IRQ control by `ecatPerfMeasStart`/`ecatPerfMeasEnd` enabled. EC_FALSE: disabled.

Return

-

4.7.52 *ecatLogFrameEnable*

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.

```
EC_T_DWORD ecatLogFrameEnable(
    EC_T_PFLOGFRAME_CB  pvLogFrameCallBack,
    EC_T_VOID*          pvContext
);
```

Parameters

pvLogFrameCallBack

[in] Pointer to frame logging callback function

pvContext

[in] Pointer to function specific context

Return

EC_E_NOERROR if successful.

```
typedef EC_T_VOID (*EC_T_PFLOGFRAME_CB)(EC_T_VOID* pvContext, EC_T_DWORD dwLogFlags,
    EC_T_DWORD dwFrameSize, EC_T_BYTE* pbyFrame);
```

Description

pvContext

[in] Context pointer. This pointer is used as parameter when the callback function is called.

dwLogFlags

[in] Flags (defined in *AtEtherCAT.h*) containing the master state and other information.

dwFrameSize

[in] Size of frame in bytes.

pbyFrame

[in] Pointer to frame data.

Example

```
/* ***** */
/** \brief Handler to log frames.
 *
 * CAUTION: Called by cyclic task!!! Do not consume to much CPU time!!!
 * \return Status value.
 */
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;

    /* is this a red frame? */
    if (dwLogFlags & EC_LOG_FRAME_FLAG_RED_FRAME)
    {
    }

    return;
}
```

4.7.53 *ecatLogFrameDisable*

Disable the frame logging callback.

```
EC_T_DWORD ecatLogFrameDisable(EC_T_VOID);
```

Return

EC_E_NOERROR if successful.

4.7.54 *ecatGetMasterInfo*

Get generic information on the Master Instance.

```
EC_T_DWORD ecatGetMasterInfo(EC_T_MASTER_INFO* pMasterInfo);
```

Parameters

pMasterInfo

[out] Pointer to *EC_T_MASTER_INFO* to carry master info.

Return

EC_E_NOERROR if successful.

```
typedef struct _EC_T_BUS_DIAGNOSIS_INFO {
    EC_T_DWORD dwCRC32ConfigChecksum;
    EC_T_DWORD dwNumSlavesFound;
    EC_T_DWORD dwNumDCSlavesFound;
    EC_T_DWORD dwNumCfgSlaves;
    EC_T_DWORD dwNumMbxSlaves;
    EC_T_DWORD dwTXFrames;
    EC_T_DWORD dwRXFrames;
    EC_T_DWORD dwLostFrames;

    EC_T_DWORD dwCyclicFrames;
    EC_T_DWORD dwCyclicDatagrams;
    EC_T_DWORD dwAcyclicFrames;
    EC_T_DWORD dwAcyclicDatagrams;
    EC_T_DWORD dwClearCounters;
} EC_T_BUS_DIAGNOSIS_INFO;

typedef struct _EC_T_STATISTIC {
    EC_T_DWORD dwTotal;
    EC_T_DWORD dwLast;
} EC_T_STATISTIC;

typedef struct _EC_T_STATISTIC_TRANSFER {
    EC_T_STATISTIC Cnt;
    EC_T_STATISTIC Bytes;
} EC_T_STATISTIC_TRANSFER;

typedef struct _EC_T_STATISTIC_TRANSFER_DUPLEX {
    EC_T_STATISTIC_TRANSFER Read;
    EC_T_STATISTIC_TRANSFER Write;
} EC_T_STATISTIC_TRANSFER_DUPLEX;
```

```
typedef struct _EC_T_MAILBOX_STATISTICS {
    EC_T_STATISTIC_TRANSFER_DUPLEX Aoe;
    EC_T_STATISTIC_TRANSFER_DUPLEX Coe;
    EC_T_STATISTIC_TRANSFER_DUPLEX Eoe;
    EC_T_STATISTIC_TRANSFER_DUPLEX Foe;
    EC_T_STATISTIC_TRANSFER_DUPLEX Soe;
    EC_T_STATISTIC_TRANSFER_DUPLEX Voe;
    EC_T_STATISTIC_TRANSFER_DUPLEX RawMbx;
    EC_T_STATISTIC_TRANSFER_DUPLEX aRes; /* reserved */
} EC_T_MAILBOX_STATISTICS;

typedef struct _EC_T_MASTER_INFO {
    EC_T_DWORD dwMasterVersion;
    EC_T_BUS_DIAGNOSIS_INFO BusDiagnosisInfo;
    EC_T_MAILBOX_STATISTICS MailboxStatistics;
} EC_T_MASTER_INFO;
```

4.7.55 *ecatGetMemoryUsage*

Returns information about memory usage

```
EC_T_DWORD ecatGetMemoryUsage(
    EC_T_DWORD*   pdwCurrentUsage,
    EC_T_DWORD*   pdwMaxUsage
);
```

Parameters

pdwCurrentUsage

[out] Current memory usage in Bytes at the time where this function is called

pdwMaxUsage

[out] Maximum memory usage in Bytes since first call to `ecatInitMaster()` at the time where this function is called

Return

EC_E_NOERROR or error code

Comment

Calls to `malloc/free` and `new/delete` are monitored within the Ec-Master stack.

4.7.56 *ecatGetMasterSyncUnitInfoNumOf*

Get number of Master Sync Units info entries.

EC_T_DWORD *ecatGetMasterSyncUnitInfoNumOf*(**EC_T_VOID**)

Return

Number of master sync units info entries.

4.7.57 *ecatGetMasterSyncUnitInfo*

Get information about specific Master Sync Unit.

EC_T_DWORD *ecatGetMasterSyncUnitInfo*(
EC_T_WORD **wMsuld**,
EC_T_MSU_INFO* **pMsulInfo**
);

Parameters

wMsuld

[in] Master Sync Unit to get the information from.

pMsulInfo

[out] Pointer to an **EC_T_MSU_INFO** structure receiving the Master Sync Unit information.

Return

EC_E_NOERROR or error code

Comment

MSU_ID_ALL_INFO_ENTRIES retrieves the information from all master sync units at once. The application must ensure that *pMsulInfo* is capable for all entries, see *ecatGetMasterSyncUnitInfoNumOf*.

```
typedef struct _EC_T_MSU_INFO {
    EC_T_WORD      wMsuld;
    EC_T_DWORD     dwBitOffsIn;
    EC_T_DWORD     dwBitSizeIn;
    EC_T_DWORD     dwBitOffsOut;
    EC_T_DWORD     dwBitSizeOut;
    EC_T_WORD      wWkcStateDiagOffsIn;
    EC_T_WORD      wWkcStateDiagOffsOut;
    EC_T_DWORD     adwReserved[16];
} EC_T_MSU_INFO;
```

Description

wMsuld

[out] Id of master sync unit.

dwBitOffsIn

[out] input bit offset of master sync unit in process data image.

dwBitSizeIn

[out] input bit size of master sync unit.

dwBitOffsOut

[out] output bit offset of master sync unit in process data image.

dwBitSizeOut

[out] output bit size of master sync unit.

wWkcStateDiagOffsIn

[out] Offset of WkcState bit in diagnosis image
WkcState bit values: 0 = Data Valid, 1 = Data invalid

wWkcStateDiagOffsOut

[out] Offset of WkcState bit in diagnosis image
WkcState bit values: 0 = Data Valid, 1 = Data invalid

4.8 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 *ecatNotify* 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.) MbxTferDesc.dwMaxDataLen = 10
- 2.) MbxTferDesc.pbyMbxTferDescData=(EC_T_PBYTE)OsMalloc(MbxTferDesc.dwMaxDataLen)
- 3.) pMbxTfer = ecatMbxTferCreate(&MbxTferDesc)
→ state of the transfer object = Idle
- 4.) OsMemcpy(pMbxTfer->pbyMbxTferData, „0123456789“, 10)
- 5.) pMbxTfer->dwTferId = 1;
- 6.) pMbxTfer->dwCIntId = dwCIntId;
- 7.) pMbxTfer->dwDataLen=10;
- 8.) dwResult = ecatCoeSdoDownloadReq(pMbxTfer, dwSlaveId, wObIndex, ...)
→ state of the transfer object = Pend or TferReqError
- 9.) if(dwResult != EC_E_NOERROR) { ... }
- 10.) ecatNotify(EC_NOTIFY_MBOXRCV, pParms)
→ state of the transfer object = TferDone
- 11.) if(pMbxTfer->dwErrorCode != EC_E_NOERROR) { ... }
→ In ecatNotify: application may set transfer object state to Idle
- 12.) ecatMbxTferDelete(pMbxTfer)

Steps 1 to 3: create a transfer object (for example a SDO download transfer object).

Steps 4 to 8: 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.

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.

Steps 9 to 10: If the mailbox transfer is completed the notification callback function of the corresponding client (*ecatNotify*) will be called with a pointer to the mailbox transfer object. The state of the transfer object is set to TferDone prior to calling *ecatNotify*.

Step 11: In case of errors the appropriate error handling has to be executed. Application must set the transfer object state to Idle.

Step 12: Delete the transfer object. Alternatively this object can be used for the next transfer.

4.8.1 Mailbox transfer object states

The following states exist for a mailbox transfer object:

eMbxTferStatus_Idle

The object is not in use and can be used for a new mailbox transfer. The object is owned by the application.

eMbxTferStatus_Pend

The object is currently used by the EtherCAT master and the transfer is not completed. The client may not access the transfer object (except for reading the object's state).

The client's notification function (ecatNotify) will be called for progress information by the master in this state for some types of mailbox transfers. The object is owned by the EtherCAT master.

eMbxTferStatus_TferWaitingForContinue

The EtherCAT master awaits more data from the application or provided data or information that must be acknowledged by the application. The object is currently owned by application.

eMbxTferStatus_TferDone

A mailbox transfer was completed (with or without error). The client's notification function (ecatNotify) will be called by the master after setting the transfer object into this state. The object is owned by the application.

eMbxTferStatus_TferReqError

The master was not able to initiate a mailbox transfer. After some kind of error handling the client has to set the object state back to eMbxTferStatus_Idle. The object is owned by the application.

Comment

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, see 4.8.3 "ecatMbxTferAbort".

After completion of the mailbox transfer (with timeout and the client may finally set the transfer object into the state eMbxTferStatus_Idle.

New mailbox transfers can only be requested if the object is in the state eMbxTferStatus_Idle.

4.8.2 *ecatMbxTferCreate*

Creates a mailbox transfer object.

```
EC_T_MBXTFER* ecatMbxTferCreate (
    EC_T_MBXTFER_DESC* pMbxTferDesc
);
```

Parameters

pMbxTferDesc

[in] Pointer to the mailbox transfer descriptor. Determines details of the mailbox transfer.

Return

Pointer to the mailbox transfer object. This object is needed when a mailbox transfer shall be initiated. In case of an error the value *EC_NULL* will be returned.

Comment

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.

EC_T_MBXTFER_DESC

Mailbox transfer descriptor; the content determines which kind of mailbox transfer the object is related to and the maximum amount of data that can be transferred using the object.

```
typedef struct _EC_T_MBXTFER_DESC {
    EC_T_DWORD          dwMaxDataLen;
    EC_T_BYTE*          pbyMbxTferDescData;
} EC_T_MBXTFER_DESC;
```

Description

dwMaxDataLen

[in] Maximum amount of data bytes that shall be transferred using this object. A mailbox transfer type without data transfer will ignore this parameter.

pbyMbxTferDescData

[in] Pointer to byte stream carrying in and out data of mailbox content.

EC_T_MBXTFER

Mailbox transfer object.

```
typedef struct _EC_T_MBXTFER {
    EC_T_DWORD          dwCIntId;
    EC_T_MBXTFER_DESC   MbxTferDesc;
    EC_T_MBXTFER_TYPE    eMbxTferType;
    EC_T_DWORD          dwDataLen;
    EC_T_BYTE*          pbyMbxTferData;
    EC_T_MBXTFER_STATUS eTferStatus;
    EC_T_DWORD          dwErrorCode;
    EC_T_DWORD          dwTferId;
    EC_T_MBX_DATA        MbxData;
} EC_T_MBXTFER;
```


Description

dwCIntId

[] Client ID.

MbxTferDesc

[out] Mailbox transfer descriptor. All elements of *pMbxTferDesc* will be stored here.

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.

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 (ecatNotify) this value will contain the amount of data that was actually transferred.

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.

eTferStatus

[out] Transfer state. After a new transfer object is created the state will be set to eMbxTferStatus_Idle.

dwErrorCode

[out] Error code of a mailbox transfer that was terminated with error.

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.

MbxData

[] Mailbox data. This element contains mailbox transfer data, e.g. the CoE object dictionary list.

EC_T_MBXTFER_TYPE

Enumeration containing mailbox transfer types.

```

typedef enum _EC_T_MBXTFER_TYPE {
    eMbxTferType_COE_SDO_DOWNLOAD,      /* CoE SDO Download */
    eMbxTferType_COE_SDO_UPLOAD,         /* CoE SDO Upload */
    eMbxTferType_COE_GETODLIST,          /* CoE Get Object Dictionary */
    eMbxTferType_COE_GETOBJDESC,         /* CoE Get Object Description */
    eMbxTferType_COE_GETENTRYDESC,       /* CoE Get Object Entry Description */
    eMbxTferType_COE_EMERGENCY,          /* CoE Emergency Request */
    eMbxTferType_FOE_FILE_UPLOAD,        /* FoE Upload */
    eMbxTferType_FOE_FILE_DOWNLOAD,      /* FoE Download */
    eMbxTferType_FOE_SEG_DOWNLOAD,       /* FoE Segmented Download */
    eMbxTferType_FOE_SEG_UPLOAD,         /* FoE Segmented Upload */
    eMbxTferType_VOE_MBX_READ,           /* VoE read */
    eMbxTferType_VOE_MBX_WRITE,          /* VoE write */
    eMbxTferType_SOE_READREQUEST,        /* SoE read request */
    eMbxTferType_SOE_READRESPONSE,      /* SoE read response */
    eMbxTferType_SOE_WRITEREQUEST,       /* SoE write request */
    eMbxTferType_SOE_WRITERESPONSE,     /* SoE write response */
    eMbxTferType_SOE_NOTIFICATION,       /* SoE notification */
    eMbxTferType_SOE_EMERGENCY,          /* SoE emergency */
    eMbxTferType_AOE_READ,               /* AoE read */
    eMbxTferType_AOE_WRITE,              /* AoE write */
    eMbxTferType_AOE_READWRITE,          /* AoE read/write */
    eMbxTferType_AOE_WRITECONTROL,       /* AoE write control */
    eMbxTferType_RAWMBX                  /* Raw Mbx */
} EC_T_MBXTFER_TYPE;

```

EC_T_MBXTFER_STATUS

Enumeration containing mailbox status values.

```
enum _EC_T_MBXTFER_STATUS:
    eMbxTferStatus_Idle = 0,           /* Mailbox transfer object not in use */
    eMbxTferStatus_Pend = 1,          /* Mailbox transfer in process */
    eMbxTferStatus_TferDone = 2,      /* Mailbox transfer completed */
    eMbxTferStatus_TferReqError = 3,  /* Mailbox transfer request error */

    /* Transfer waiting for continue, object owned by application */
    eMbxTferStatus_TferWaitingForContinue = 4,
```

EC_T_MBX_DATA

Mailbox data in notifications.

```
typedef union _EC_T_MBX_DATA {
    EC_T_AOE_CMD_RESPONSE    AoE_Response; /* AoE, Class A */
    EC_T_MBX_DATA_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, Class A */
    EC_T_MBX_DATA_SOE        SoE;
    EC_T_SOE_NOTIFICATION    SoE_Notification; /* SoE notification request */
    EC_T_SOE_EMERGENCY       SoE_Emergency; /* SoE emergency request */
} EC_T_MBX_DATA;
```

4.8.3 ecatMbxTferAbort

Abort a running mailbox transfer.

```
EC_T_DWORD ecatMbxTferAbort (
    EC_T_MBXTFER* pMbxTfer
);
```

Parameters

pMbxTfer
[in] Pointer to the transfer object.

Return

EC_E_NOERROR if successful.

Comment

Currently only supported for FoE Transfer, CoE Download and CoE Upload.
This function may not be called from within the JobTask's context.

4.8.4 ecatMbxTferDelete

Deletes a mailbox transfer object. A transfer object may only be deleted if it is in the Idle state.

```
EC_T_VOID ecatMbxTferDelete (
    EC_T_MBXTFER* pMbxTfer
);
```

Parameters

pMbxTfer
[in] Pointer to the transfer object.

Comment

This function should not be called from within the JobTask's context.

4.8.5 *ecatNotify* – *EC_NOTIFY_MBOXRCV*

Indicates a mailbox transfer completion.

Parameters

pbyInBuf

[in] *pMbxTfer* – 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

[] Set to *EC_NULL*.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to *EC_NULL*.

Comment

The element *pMbxTfer->dwClntId* contains the corresponding ID of the client that is notified.

The element *pMbxTfer->dwTferId* contains the corresponding transfer ID.

The transfer result is stored in *pMbxTfer->dwErrorCode*.

pMbxTfer->eTferStatus is *eMbxTferStatus_TferReqError* on error and *eMbxTferStatus_TferDone* on success. **In order to reuse the transfer object the application must set it back to *eMbxTferStatus_Idle*.**

The *pMbxTfer->eMbxTferType* element determines the mailbox transfer type (e.g. *eMbxTferType_COE_SDO_DOWNLOAD* for a completion of a CoE SDO download transfer).

4.8.6 *ecatNotify* – *EC_NOTIFY_COE_INIT_CMD*

Indicates a COE mailbox transfer completion during slave state transition.

Parameters

pbyInBuf

[in] *pMbxTfer* – 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

[] Set to *EC_NULL*.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to *EC_NULL*.

Comment

The *pMbxTfer->MbxData.Coe_InitCmd* element of type *EC_T_MBX_DATA_COE_INITCMD* gives further information.

This init command as to be enable using ***EC_IOCTL_SET_NOTIFICATION_ENABLED***.

MAX_STD_STRLen = 80

typedef struct _EC_T_MBX_DATA_COE_INITCMD

```
{
    EC_T_SLAVE_PROP SlaveProp;
    EC_T_DWORD dwHandle;
    EC_T_WORD wTransition;
    EC_T_CHAR szComment[MAX_STD_STRLen];
    EC_T_DWORD dwErrorCode;
    EC_T_BOOL bFixed;
    EC_T_BYTE byCcs;
    EC_T_BOOL bCompleteAccess;
    EC_T_WORD wIndex;
    EC_T_BYTE bySubIndex;
    EC_T_DWORD dwDataLen;
    EC_T_BYTE* pbyData;
} EC_T_MBX_DATA_COE_INITCMD;
```

SlaveProp

[out] Slave properties

dwHandle

[out] Handle passed by EC_IOCTL_ADD_COE_INITCMD, otherwise zero

wTransition

[out] Transition, e.g. ECAT_INITCMD_I_P

dwErrorCode

[out] InitCmd result

bFixed

[out] Fixed flag (ENI)

byCcs

[out] Client command specifier (read or write access)

bCompleteAccess

[out] Complete access

wIndex

[out] Object Index

bySubIndex

[out] Object SubIndex

dwDataLen

[out] InitCmd data length

pbyData

[out] InitCmd data

4.9 CanOpen over EtherCAT

4.9.1 *ecatCoeSdoDownload*

Performs a CoE SDO download to an EtherCAT slave device.

```
EC_T_DWORD ecatCoeSdoDownload(  
    EC_T_DWORD dwSlaveId,  
    EC_T_WORD wObIndex,  
    EC_T_BYTE byObSubIndex,  
    EC_T_BYTE* pbyData,  
    EC_T_DWORD dwDataLen,  
    EC_T_DWORD dwTimeout,  
    EC_T_DWORD dwFlags  
);
```

Parameters

dwSlaveId
[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

wObIndex
[in] Object index.

byObSubIndex
[in] Object sub index. 0 or 1 if Complete Access.

pbyData
[in] Data to be transferred.

dwDataLen
[in] Data size of *pbyData*

dwTimeout
[in] Timeout in milliseconds. The function will block at most for this time.

dwFlags
[in] Mailbox Flags. Bit 0: set if Complete Access (EC_MAILBOX_FLAG_SDO_COMPLETE).

Return

EC_E_NOERROR or error code, e.g.:
EC_E_SDO_ABORTCODE_INDEX if *wObIndex*, *byObSubIndex* invalid.

Comment

This function may not be called from within the JobTask's context.

4.9.2 *ecatCoeSdoDownloadReq*

Initiates a CoE SDO download to an EtherCAT slave device and returns immediately.

```
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
);
```

Parameters

pMbxTfer

[in] Pointer to the corresponding mailbox transfer object created with *ecatMbxTferCreate*. The SDO data to write have to be stored at *pMbxTfer->pbyMbxTferData*.

dwSlaveId

[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

wObIndex

[in] Object index.

byObSubIndex

[in] Object sub index. 0 or 1 if Complete Access.

dwTimeout

[in] Timeout in milliseconds.

dwFlags

[in] Mailbox Flags. Bit 0: set if Complete Access (*EC_MAILBOX_FLAG_SDO_COMPLETE*).

Return

EC_E_NOERROR or error code

Comment

The amount of data bytes to write has to be stored in *pMbxTfer->dwDataLen*. A unique transfer ID must be written into *pMbxTfer->dwTferId*. A [ecatNotify – EC_NOTIFY_MBOXRCV](#) is given on completion, see below.

The request parameters are part of the notification at *pMbxTfer->MbxData.CoE*, see below.

EC_T_MBX_DATA_COE (*pMbxTfer->MbxData.CoE*)

List containing object Ids available in the slave

```
typedef struct _EC_T_MBX_DATA_COE {
    EC_T_WORD    wStationAddress;
    EC_T_WORD    wIndex;          /*< object index */
    EC_T_BYTE    bySubIndex;      /*< object subindex */
    EC_T_BOOL    bCompleteAccess; /*< complete access */
} EC_T_MBX_DATA_COE;
```

4.9.3 *ecatNotify – eMbxTferType_COE_SDO_DOWNLOAD*

SDO download transfer completion.

Parameters

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 *pbyInBuf* in bytes.

pbyOutBuf

[] Set to *EC_NULL*.

dwOutBufSize

[] Set to 0.

pdwNumOutData
[] Set to EC_NULL.

Comment

The corresponding transfer ID can be found in pMbxTfer->dwTferId. The transfer result is stored in pMbxTfer->dwErrorCode.

4.9.4 *ecatCoeSdoUpload*

Performs a CoE SDO upload from an EtherCAT slave device to the master.

```
EC_T_DWORD ecatCoeSdoUpload(  
    EC_T_DWORD dwSlaveld,  
    EC_T_WORD wObIndex,  
    EC_T_BYTE byObSubIndex,  
    EC_T_BYTE* pbyData,  
    EC_T_DWORD dwDataLen,  
    EC_T_DWORD* pdwOutDataLen,  
    EC_T_DWORD dwTimeout,  
    EC_T_DWORD dwFlags  
);
```

Parameters

dwSlaveld
[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

wObIndex
[in] Object index.

byObSubIndex
[in] Object sub index. 0 or 1 if Complete Access.

pbyData
[out] Data buffer to upload data to.

dwDataLen
[in] Size of data buffer carried in *pbyData*

pdwOutDataLen
[out] Pointer returning size of data uploaded from slave.

dwTimeout
[in] Timeout in milliseconds. The function will block at most for this time.

dwFlags
[in] Mailbox Flags. Bit 0: set if Complete Access (EC_MAILBOX_FLAG_SDO_COMPLETE).

Return

EC_E_NOERROR or error code, e.g.:
EC_E_SDO_ABORTCODE_INDEX if *wObIndex*, *byObSubIndex* invalid.

Comment

This function may not be called from within the JobTask's context.

4.9.5 *ecatCoeSdoUploadReq*

Initiates a CoE SDO upload from an EtherCAT slave device to the master and returns immediately.

```
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
);
```

Parameters

pMbxTfer
[in] Pointer to the corresponding mailbox transfer object created with *ecatMbxTferCreate*

dwSlaveId
[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

wObIndex
[in] Object index

byObSubIndex
[in] Object sub index. 0 or 1 if Complete Access.

dwTimeout
[in] Timeout in milliseconds.

dwFlags
[in] Mailbox Flags. Bit 0: set if Complete Access (EC_MAILBOX_FLAG_SDO_COMPLETE).

Return

EC_E_NOERROR or error code

Comment

The amount of data bytes to read has to be stored in *pMbxTfer->dwDataLen*. A unique transfer ID must be written into *pMbxTfer->dwTferId*. A [ecatNotify – EC_NOTIFY_MBOXRCV](#) is given on completion, see below.

The request parameters are part of the notification at *pMbxTfer->MbxData.CoE*, see 4.9.2 - *ecatCoeSdoDownloadReq*.

4.9.6 *ecatNotify – eMbxTferType_COE_SDO_UPLOAD*

SDO upload transfer completion.

Parameters

pbyInBuf
[in] *pMbxTfer* – Pointer to a structure of type *EC_T_MBXTFER*, this structure contains the corresponding mailbox transfer object. The SDO data are stored in *pMbxTfer->pbyMbxTferData*.

dwInBufSize
[in] Size of the transfer object in bytes.

pbyOutBuf
[] Set to *EC_NULL*.

dwOutBufSize
[] Set to 0.

pdwNumOutData
[] Set to *EC_NULL*.

Comment

The corresponding transfer ID can be found in *pMbxTfer->dwTferId*. The transfer result is stored in *pMbxTfer->dwErrorCode*. The SDO data stored in *pMbxTfer->pbyMbxTferData* may have to be buffered by the client. After *ecatNotify* returns the pointer and thus the data is invalid. Access to the memory area pointed to by *pMbxTfer->pbyMbxTferData* after returning from *ecatNotify* is illegal and the results are undefined.

4.9.7 *ecatCoeGetODList*

Gets a list of object IDs that are available in a slave.

```
EC_T_DWORD ecatGetODList (
    EC_T_MBXTFER* pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_COE_ODLIST_TYPE eListType,
    EC_T_DWORD dwTimeout,
);
```

Parameters

pMbxTfer

[in] Pointer to the corresponding mailbox transfer object.

dwSlaveId

[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

eListType

[in] Object list type.

eODListType_Lengths: Lengths of each list type

eODListType_ALL: Get all objects

eODListType_RxPdoMap: Get PDO mappable objects

eODListType_TxPdoMap: Get objects that can be changed

eODListType_StoredFRepl: Get objects that are stored for a device replacement

eODListType_StartupParm: Get objects that can be used as startup parameter

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. If the timeout value is set to EC_NOWAIT the function will return immediately.

Return

EC_E_NOERROR or error code

Comment

A unique transfer ID must be written into *pMbxTfer->dwTferId*. A [ecatNotify – EC_NOTIFY_MBOXRCV](#) is given when new data arrives, see below.

This function may not be called from within the JobTask's context.

4.9.8 *ecatNotify – eMbxTferType_COE_GETODLIST*

Object dictionary list upload transfer completion.

Parameters

pbyInBuf

[in] *pMbxTfer* – Pointer to a structure of type EC_T_MBXTFER, this structure contains the corresponding mailbox transfer object.

The object list is stored in *pMbxTfer->MbxData.Coe_ODList*.

dwInBufSize

[in] Size of the transfer object in bytes.

pbyOutBuf

[] Set to EC_NULL.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to EC_NULL.

Comment

The corresponding transfer ID can be found in *pMbxTfer->dwTferId*. The transfer result is stored in *pMbxTfer->dwErrorCode*. The object list stored in *pMbxTfer->MbxData.Coe_ODList* may have to be buffered by the client. After *ecatNotify* returns the pointer and thus the data is invalid. Access to this element after returning from *ecatNotify* is invalid and the results are undefined.

EC_T_COE_ODLIST (pMbxTfer->MbxData.CoE_ODList)

List containing object IDs available in the slave

```
typedef struct _EC_T_COE_ODLIST {
    EC_T_COE_ODLIST_TYPE eOdListType; /* list type */
    EC_T_WORD wLen; /* amount of object IDs */
    EC_T_WORD* pwOdList; /* array containing object IDs */
} EC_T_COE_ODLIST;
```

EC_T_COE_ODLIST_TYPE

List type enumeration.

```
typedef enum _EC_T_COE_ODLIST_TYPE {
    eODListType_Lengths = 0, /* < lengths of each list type */
    eODListType_ALL = 1, /* list contains all objects */
    eODListType_RxPdoMap = 2, /* list with PDO mappable objects */
    eODListType_TxPdoMap = 3, /* list with objects that can be changed */
    eODListType_StoredFRepl = 4, /* only stored for a device replacement objects */
    eODListType_StartupParm = 5, /* only startup parameter objects */
} EC_T_COE_ODLIST_TYPE;
```

4.9.9 *ecatCoeGetObjectDesc*

Determines the description of a specific object.

```
EC_T_DWORD ecatGetObjectDesc (
    EC_T_MBXTFER* pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObIndex,
    EC_T_DWORD dwTimeout,
);
```

Parameters*pMbxTfer*

[in] Pointer to the corresponding mailbox transfer object.

dwSlaveId[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.*wObIndex*

[in] Object index.

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. If the timeout value is set to EC_NOWAIT the function will return immediately.

Return

EC_E_NOERROR or error code

Comment

A unique transfer ID must be written into pMbxTfer->dwTferId. A [ecatNotify – EC_NOTIFY_MBOXRCV](#) is given when new data arrives, see below.

This function may not be called from within the JobTask's context.

4.9.10 ecatNotify – eMbxTferType_COE_GETOBDESC

Completion of a SDO information service transfer to get a object description.

Parameters

pbyInBuf

[in] pMbxTfer – Pointer to a structure of type EC_T_MBXTFER, this structure contains the corresponding mailbox transfer object.

The object description is stored in pMbxTfer->MbxData.CoE_ObDesc.

dwInBufSize

[in] Size of the transfer object in bytes.

pbyOutBuf

[] Set to EC_NULL.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to EC_NULL.

Comment

The corresponding transfer ID can be found in pMbxTfer->dwTferId. The transfer result is stored in pMbxTfer->dwErrorCode. The object description stored in pMbxTfer->MbxData.CoE_ObDesc may have to be buffered by the client. After ecatNotify returns the pointer and thus the data is invalid. Access to this element after returning from ecatNotify is invalid and the results are undefined.

EC_T_COE_OBDESC (pMbxTfer->MbxData.CoE_ObDesc)

Object description. A more detailed description of the values for data type, object code etc. can be found in the EtherCAT specification ETG.1000, section 5. See also EcCommon.h, DEFTYPE_BOOLEAN,

```
typedef struct _EC_T_COE_OBDESC {
```

EC_T_WORD	wObIndex;	/* Index in the object dictionary */
EC_T_WORD	wDataType;	/* Data type of the object */
EC_T_BYTE	byObjCode;	/* Object code, see Table 62, ETG.1000 section 6 */
EC_T_BYTE	byObjCategory;	/* Object category */
EC_T_BYTE	byMaxNumSubIndex;	/* Maximum sub index number /
EC_T_WORD	wObNameLen;	/* Length of the object name */
EC_T_CHAR*	pchObName;	/* Object name (not NULL terminated!) */

```
} EC_T_COE_OBDESC;
```

4.9.11 *ecatCoeGetEntryDesc*

Determines the description of a specific object entry.

```
EC_T_DWORD ecatCoeGetEntryDesc (
    EC_T_MBXTFER* pMbxTfer,
    EC_T_DWORD dwSlaveId,
    EC_T_WORD wObjIndex,
    EC_T_BYTE byObjSubIndex,
    EC_T_BYTE byValueInfo,
    EC_T_DWORD dwTimeout,
);
```

Parameters

pMbxTfer

[in] Pointer to the corresponding mailbox transfer object.

dwSlaveId

[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

wObjIndex

[in] Object index.

byObjSubIndex

[in] Object sub index.

byValueInfo

[in] Bit mask to define which information to determine. The bit values are defined as follows:

EC_COE_ENTRY_ObjAccess	→ Object access rights
EC_COE_ENTRY_ObjCategory	→ Object category
EC_COE_ENTRY_PdoMapping	→ Information if the object is PDO mappable
EC_COE_ENTRY_UnitType	→ Unit
EC_COE_ENTRY_DefaultValue	→ Default value
EC_COE_ENTRY_MinValue	→ Minimum value
EC_COE_ENTRY_MaxValue	→ Maximum value

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time. If the timeout value is set to EC_NOWAIT the function will return immediately.

Return

EC_E_NOERROR or error code

Comment

A unique transfer ID must be written into *pMbxTfer->dwTferId*. A [ecatNotify – EC_NOTIFY_MBOXRCV](#) is given when new data arrives, see below.

This function may not be called from within the JobTask's context.

4.9.12 ecatNotify – eMbxTferType_COE_GETENTRYDESC

Completion of a SDO information service transfer to get a object entry description.

Parameters

pbyInBuf

[in] pMbxTfer – Pointer to a structure of type EC_T_MBXTFER, this structure contains the corresponding mailbox transfer object.

The object description is stored in pMbxTfer->MbxData.CoE_EntryDesc.

dwInBufSize

[in] Size of the transfer object in bytes.

pbyOutBuf

[] Set to EC_NULL.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to EC_NULL.

Comment

The corresponding transfer ID can be found in pMbxTfer->dwTferId. The transfer result is stored in pMbxTfer->dwErrorCode. The object entry description stored in pMbxTfer->MbxData.CoE_EntryDesc may have to be buffered by the client. After ecatNotify returns the pointer and thus the data is invalid. Access to this element after returning from ecatNotify is invalid and the results are undefined.

EC_T_COE_ENTRYDESC (pMbxTfer->MbxData.CoE_EntryDesc)

Object entry description. A more detailed description of the values can be found in the EtherCAT specification ETG.1000, section 5.

```
typedef struct _EC_T_COE_ENTRYDESC {
    EC_T_WORD    wObIndex;           /* Index in the object dictionary */
    EC_T_BYTE    byObSubIndex;       /* Sub index in the object dictionary */
    EC_T_BYTE    byValueInfo;        /* Bit mask to define which information is
                                     available */
    EC_T_WORD    wDataType;           /* Object data type according to ETG.1000 */
    EC_T_WORD    wBitLen;             /* Object size (number of bits) */
    EC_T_BYTE    byObAccess;          /* Access rights */
    EC_T_BOOL    bRxPdoMapping;       /* Is the object PDO-mappable? */
    EC_T_BOOL    bTxPdoMapping;       /* Can the PDO be changed */
    EC_T_BOOL    bObCanBeUsedForBackup; /* Parameter may be back upped */
    EC_T_BOOL    bObCanBeUsedForSettings; /* Parameter may be used for Settings */
    EC_T_WORD    wReserved;           /* Unit */
    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) */
} EC_T_COE_ENTRYDESC;
```

See szUnitType, szDefaultValue, szMinValue, szMaxValue, szDescription in CoeReadObjectDictionary in ecatDemoCommon.cpp as an example for evaluating EC_T_COE_ENTRYDESC.pbyData.

4.9.13 CoE Emergency (*ecatNotify – eMbxTferType_COE_EMERGENCY*)

Indication of a CoE emergency request. A [ecatNotify – EC NOTIFY MBOXRCV](#) is given with pMbxTfer->eMbxTferType = eMbxTferType_COE_EMERGENCY.

Parameters

pbyInBuf

[in] pMbxTfer – Pointer to a structure of type EC_T_MBXTFER, this structure contains the corresponding mailbox transfer object.

The emergency request is stored in pMbxTfer->MbxData.CoE_Emergency.

dwInBufSize

[in] Size of the transfer object in bytes.

pbyOutBuf

[] Set to EC_NULL.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to EC_NULL.

Comment

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 pMbxTfer->dwTferId is undefined as it is not needed by the client and the master. The transfer result is stored in pMbxTfer->dwErrorCode.

The emergency data stored in pMbxTfer->MbxData.CoE_Emergency may have to be buffered by the client. After ecatNotify returns the pointer and thus the data is invalid. Access to this element after returning from ecatNotify is invalid and the results are undefined.

EC_T_COE_EMERGENCY (pMbxTfer->MbxData.CoE_Emergency)

Emergency description. A more detailed description of the values can be found in the EtherCAT specification ETG.1000, section 5.

```
typedef struct _EC_T_COE_ENTRYDESC {
    EC_T_WORD    wErrorCode;      /* Error code according to EtherCAT specification */
    EC_T_BYTE    byErrorRegister; /* Error register */
    EC_T_BYTE    abyData[5];      /* Error data */
    EC_T_WORD    wStationAddress; /* Slave node address of the faulty slave */
} EC_T_COE_EMERGENCY;
```

4.9.14 CoE Abort (ecatNotify – EC_NOTIFY_MBSLAVE_COE_SDO_ABORT)

The application can abort asynchronous CoE Uploads and Downloads, see ecatMbxTferAbort.

The slave may abort CoE Uploads and Downloads which is indicated at the return code of ecatCoeSdoUpload, ...

The notification EC_NOTIFY_MBSLAVE_COE_SDO_ABORT is raised if an SDO transfer aborts while sending init commands.

Detailed error information is stored in structure EC_T_MBOX_SDO_ABORT_DESC of the union element SdoAbortDesc.

```
typedef struct _EC_T_MBOX_SDO_ABORT_DESC
{
    EC_T_SLAVE_PROP SlaveProp;           /*< slave properties */
    EC_T_DWORD      dwErrorCode;         /*< error code EC_E_ */
    EC_T_WORD       wObjIndex;           /*< SDO object index */
    EC_T_BYTE       bySubIndex;          /*< SDO object sub index */
} EC_T_MBOX_SDO_ABORT_DESC;
```

4.10 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 `ecatSoeWrite` the data and elements of an IDN which are writeable can be written.

Read IDN:

With `ecatSoeRead` the data and elements of an IDN can be read.

Procedure command Execution:

With `ecatSoeWrite` 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 `ecatSoeAbortProcCmd` 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 `ecatRegisterClient` 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 `ecatRegisterClient` 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 **S**ervo Profile **o**ver **E**therCAT

SSC:

SoE Service Channel (non-cyclic data exchange)

4.10.1 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

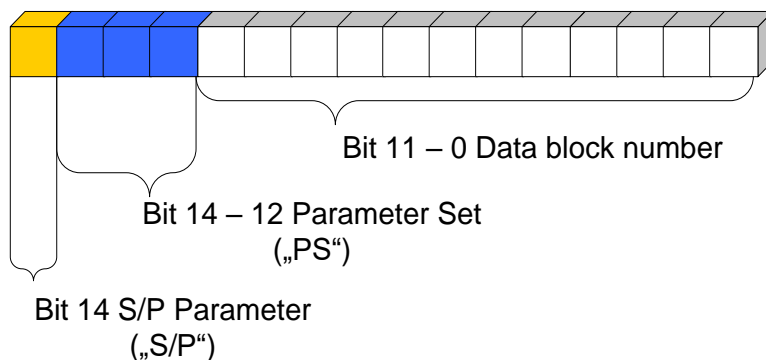
Operation data.

SOE_BM_ELEMENTFLAG_DEFAULT

The IDN default value.

4.10.2 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 (TN_{cyc}) which is an standard IDN **S-0-0001** equates to **wIDN = 0x1**

The first manufacturer specific IDN **P-0-0001** equates to **wIDN = 0x8001**

4.10.3 *ecatSoeWrite*

Performs an SoE SSC Write service which download data to an EtherCAT slave device. The function returns after *dwTimeout* in msec are expired or download is completed successfully (Write response is received). *ecatSoeWrite* 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.

```
EC_T_DWORD ecatSoeWrite(
    EC_T_DWORD    dwSlaveld,
    EC_T_BYTE     byDriveNo,
    EC_T_BYTE *   pbyElementFlags,
    EC_T_WORD     wIDN,
    EC_T_BYTE*    pbyData,
    EC_T_DWORD    dwDataLen,
    EC_T_DWORD    dwTimeout
);
```

Parameters

dwSlaveld

[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

byDriveNo

[in] Number of the drive inside the slave device that is addressed.

pbyElementFlags

[in/out] ElementFlag for each element of an IDN indicating which elements of the object are written. For more informations see 4.10.1 SoE ElementFlags.

wIDN

[in] IDN (see 4.10.2 SoE IDN) of the object which is addressed in the slave device.

pbyData

[in] Data buffer include the data of the element to be written.

dwDataLen

[in] Data Buffer length in bytes.

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time.

Return

EC_E_NOERROR or error code

Comment

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.

4.10.4 *ecatSoeWriteReq*

Requests an SoE SSC Write and returns immediately. See also *ecatSoeWrite*.

```
EC_T_DWORD ecatSoeWriteReq(
    EC_T_MBXTFER* pMbxTfer,
    EC_T_DWORD    dwSlaveld,
    EC_T_BYTE     byDriveNo,
    EC_T_BYTE *   pbyElementFlags,
    EC_T_WORD     wIDN,
    EC_T_DWORD    dwTimeout
);
```

Parameters

pMbxTfer

[in] Handle to the Mailbox Transfer Object. See chapter 4.8 "The other parameters are according to *ecatSoeWrite*."

Comment

This function may be called from within the JobTask's context. See also *ecatSoeWrite*.

4.10.5 *ecatSoeRead*

Performs an SoE SCC Read service which upload data from an EtherCAT SoE slave device. The function returns after *dwTimeout* in msec are expired or upload is completed successfully (Read response is received). The received data can consist of several fragments. The reserved data buffer (*pbyData*) must have space for all received data segments.

```
EC_T_DWORD ecatSoeRead(
    EC_T_DWORD    dwSlaveId,
    EC_T_BYTE     byDriveNo,
    EC_T_BYTE*    pbyElementFlags,
    EC_T_WORD     wIDN,
    EC_T_BYTE*    pbyData,
    EC_T_DWORD    dwDataLen,
    EC_T_DWORD*   pdwOutDataLen,
    EC_T_DWORD    dwTimeout
);
```

Parameters

dwSlaveId
[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used.

byDriveNo
[in] Number of the drive inside the slave device that is addressed.

pbyElementFlags
[in/out] ElementFlag for each element of an IDN indicating which elements of the object are read. For more informations see 4.10.1 SoE ElementFlags.

wIDN
[in] IDN (see 4.10.2 SoE IDN) of the object which is addressed in the slave device.

pbyData
[out] Data buffer to store uploaded file to.

dwDataLen
[in] Data Buffer length in bytes.

pdwOutDataLen
[out] Pointer returning size of data uploaded from slave.

dwTimeout
[in] Timeout in milliseconds. The function will block at most for this time.

Return

EC_E_NOERROR or error code

Comment

If the data to be read with the read service exceeds the mailbox size, the received data will be fragmented. The fragmented read operation consists of several Read SSC Fragment Services. Therefore the selected Timeout should be increasing with the count of fragments.

4.10.6 *ecatSoeReadReq*

Requests an SoE SSC Read and returns immediately. See also *ecatSoeRead*.

```
EC_T_DWORD ecatSoeReadReq(
    EC_T_MBXTFER*  pMbxTfer
    EC_T_DWORD      dwSlaveld,
    EC_T_BYTE       byDriveNo,
    EC_T_BYTE*      pbyElementFlags,
    EC_T_WORD       wIDN,
    EC_T_DWORD      dwTimeout
);
```

Parameters

pMbxTfer

[in] Handle to the Mailbox Transfer Object. See chapter 4.8 "The other parameters are according to *ecatSoeRead*."

Comment

This function may be called from within the JobTask's context. See also *ecatSoeRead*.

4.10.7 *ecatSoeAbortProcCmd*

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. To abort a procedure command earlier *ecatSoeAbortProcCmd* can be called.

```
EC_T_DWORD ecatSoeAbortProcCmd(
    EC_T_DWORD      dwSlaveld,
    EC_T_BYTE       byDriveNo,
    EC_T_BYTE*      pbyElementFlags,
    EC_T_WORD       wIDN,
    EC_T_DWORD      dwTimeout,
);
```

Parameters

dwSlaveld

[in] EtherCAT slave ID. To determine the slave ID the function *ecatGetSlaveId* has to be used. Should be the same as in the request.

byDriveNumber

[in] Number of the drive inside the slave device that is addressed. Should be the same as in the request.

pbyElementFlags

[in/out] ElementFlag for each element of an IDN indicating which elements of the object are written. Should be the same as in the request. For more informations see 4.10.1 SoE ElementFlags.

wIDN

[in] IDN (see 4.10.2 SoE IDN) of the object which is addressed in the slave device. Should be the same as in the request.

dwTimeout

[in] Timeout in milliseconds. The function will block at most for this time.

Return

EC_E_NOERROR or error code

Comment

This function may not be called from within the JobTask's context.

4.10.8 Error notifications

Following error notifications are defined for SoE.

4.10.8.1 EC_NOTIFY_SOE_MBXSEND_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 the union element WkcErrDesc. The structure member SlaveProp contains information about the corresponding slave device.

4.10.8.2 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 the union element InitCmdErrDesc:

4.11 Vendor specific protocol over EtherCAT (VoE)

The mailbox protocol VoE is part of the Class A user manual.

4.12 Automation Device Specification over EtherCAT (AoE)

The mailbox protocol AoE is part of the Class A user manual.

4.13 File access over EtherCAT (FoE)

The mailbox protocol FoE is part of the Class A user manual.

4.14 Raw command transfer

4.14.1 *ecatTferSingleRawCmd*

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 command may be called after ecatConfigureMaster and the master is in a stable state (no pending transition), if master is not stable, EC_E_BUSY is returned. If this command is called before ecatConfigureMaster, no slave objects do exist within the master, which prevents the master from sending data.

```
EC_T_DWORD ecatTferSingleRawCmd (
    EC_T_DWORD    dwSlaveld,
    EC_T_BYTE     byCmd,
    EC_T_DWORD    dwMemoryAddress,
    EC_T_BYTE*    pbyData,
    EC_T_WORD     wLen,
    EC_T_DWORD    dwTimeout,
);
```

Parameters

dwSlaveld

[in] Slave ID (ecatGetSlaveld(0) in case of broadcast commands).

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] Pointer to the data to transfer (read and/or write).

wLen

[in] Number of bytes to transfer.

dwTimeout

[in] Timeout in msec.

Return

EC_E_NOERROR if successful.

EC_E_BUSY another transfer request is already pending.

EC_E_NOTFOUND if the slave with ID *dwSlaveId* does not exist.

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_TIMEOUT if the slave did not respond to the command.

EC_E_BUSY if the master or the corresponding slave is currently changing its operational state .

EC_E_INVALIDPARM if the command is not supported or the timeout value is set to *EC_NOWAIT*.

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.

Comment

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 (*pvData*).

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.

The following EtherCAT commands are supported:

- *eRawCmd_APRD* Auto Increment Physical Read (avoid to use, see below!)
- *eRawCmd_APWR* Auto Increment Physical Write (avoid to use, see below!)
- *eRawCmd_APRW* Auto Increment Physical Read/Write (avoid to use, see below!)
- *eRawCmd_FPRD* Fixed addressed Physical Read
- *eRawCmd_FPWR* Fixed addressed Physical Write
- *eRawCmd_FPRW* Fixed addressed Physical Read/Write
- *eRawCmd_BRD* Broadcast (wire or'ed) Read
- *eRawCmd_BWR* Broadcast Write
- *eRawCmd_BRW* Broadcast Read/Write
- *eRawCmd_LRD* Logical Read
- *eRawCmd_LWR* Logical Write
- *eRawCmd_LRW* Logical Read/Write
- *eRawCmd_ARMW* Auto Increment Physical Read, multiple Write

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.

4.14.2 *ecatCIntQueueRawCmd*

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 command may be called after `ecatConfigureMaster` and the master is in a stable state (no pending transition), if master is not stable, `EC_E_BUSY` is returned. If this command is called before `ecatConfigureMaster`, no slave objects do exist within the master, which prevents the master from sending data.

```
EC_T_DWORD ecatCIntQueueRawCmd (
    EC_T_DWORD    dwCIntId,
    EC_T_DWORD    dwSlaveId,
    EC_T_WORD     wInvokeld,
    EC_T_BYTE     byCmd,
    EC_T_DWORD    dwMemoryAddress,
    EC_T_BYTE*    pbyData,
    EC_T_WORD     wLen
);
```

Parameters

dwCIntId

[in] ID of the client to be notified (0 if all registered clients shall be notified).

dwSlaveId

[in] Slave ID (the master ID which is returned by `ecatGetSlaveId(0)` shall be used for broadcast commands like `eRawCmd_BRD`).

wInvokeld

[in] Invoke ID to reassign the results to the sent cmd.

byCmd

[in] EtherCAT command, see below

dwMemoryAddress

[in] Slave memory address, depending on the command to be sent this is either a physical or logical address.

pbyData

[in] Pointer to the data to transfer (read and/or read/write). 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.

Return

`EC_E_NOERROR` if successful.

`EC_E_NOTFOUND` if the slave with ID `dwSlaveId` does not exist.

`EC_E_BUSY` if the master or the corresponding slave is currently changing its operational state.

`EC_E_INVALIDPARM` if the command is not supported.

`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.

Comment

This function queues a single EtherCAT command. Queued raw commands will be sent after sending cyclic process data values.

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 following EtherCAT commands are supported:

- `eRawCmd_APRD` Auto Increment Physical Read (avoid to use, see below!)
- `eRawCmd_APWR` Auto Increment Physical Write (avoid to use, see below!)
- `eRawCmd_APRW` Auto Increment Physical Read/Write (avoid to use, see below!)
- `eRawCmd_FPRD` Fixed addressed Physical Read
- `eRawCmd_FPWR` Fixed addressed Physical Write
- `eRawCmd_FPRW` Fixed addressed Physical Read/Write
- `eRawCmd_BRD` Broadcast (wire or'ed) Read
- `eRawCmd_BWR` Broadcast Write
- `eRawCmd_BRW` Broadcast Read/Write
- `eRawCmd_LRD` Logical Read
- `eRawCmd_LWR` Logical Write
- `eRawCmd_LRW` Logical Read/Write
- `eRawCmd_ARMW` Auto Increment Physical Read, multiple Write

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.

4.14.3 *ecatQueueRawCmd*

This function is identical to `ecatCIntQueueRawCmd` except that the notification function of all registered clients will be called.

```
EC_T_DWORD ecatQueueRawCmd (
    EC_T_DWORD    dwSlaveld,
    EC_T_WORD     wInvokeld,
    EC_T_BYTE     byCmd,
    EC_T_DWORD     dwMemoryAddress,
    EC_T_BYTE*    pbyData,
    EC_T_WORD     wLen
);
```

For more information, see chapter 4.14.2

This function may not be called from within the JobTask's context.

4.14.4 ecatNotify – EC_NOTIFY_RAWCMD_DONE

This notification is given when the response to an ecatQueueRawCmd is received.

Parameters

pbyInBuf
[in] Pointer to EC_T_RAWCMDRESPONSE_NTIFY_DESC

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Set to EC_NULL.

dwOutBufSize
[] Set to 0.

pdwNumOutData
[] Set to EC_NULL.

Comment

EC_T_RAWCMDRESPONSE_NTIFY_DESC

```
typedef struct _EC_T_RAWCMDRESPONSE_NTIFY_DESC{
    EC_T_DWORD      dwInvokeld;
    EC_T_DWORD      dwResult;
    EC_T_DWORD      dwWkc;
    EC_T_DWORD      dwCmdIdx;
    EC_T_DWORD      dwAddr;
    EC_T_DWORD      dwLength;
    EC_T_BYTE*      pbyData;
} EC_T_RAWCMDRESPONSE_NTIFY_DESC;
```

Description

dwInvokeld
[in] Invoke Id from callee (ecatQueueRawCmd). Only lower 16 bits are relevant.

dwResult
[in] EC_E_NOERROR on success, error code otherwise

dwWkc
[in] Received working counter

dwCmdIdx
[in] Command Index Field
Format:

0000	0000	0000	0000	iiii	iiii	cccc	cccc	
rrrr	rrrr	rrrr	rrrr	....	....	....	....	Reserved
....	....	....	....	....	....	cccc	cccc	Command
....	....	....	....	iiii	iiii	....	....	Index

dwAddr
[in] Address Field
Format:

0000	0000	0000	0000	pppp	pppp	pppp	pppp	
....	....	....	....	pppp	pppp	pppp	pppp	ADP/Slave address
0000	0000	0000	0000	....	....	....	....	ADO/Offset

dwLength
[in] Length of data portion (11 relevant bits)

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.

4.15 Distributed Clocks (DC)

Distributed Clocks is part of the Class A user manual.

4.16 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 4.3.5 `ecatScanBus`.

4.16.1 `ecatIoctl` – `EC_IOCTL_SB_ENABLE`

Enables Busscan support.

Parameters

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

[] Should be set to `EC_NULL`.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to `EC_NULL`.

Comment

The Scanbus support is enabled by default.

4.16.2 `ecatIoctl` – `EC_IOCTL_SB_RESTART`

This call will restart the bus scanning cycle. On completion the Notification `EC_NOTIFY_SB_STATUS` is given.

Parameters

–

Comment

The timeout value given by `EC_IOCTL_SB_ENABLE` will be used.

This function may be called prior to running `ecatConfigureMaster()`. 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 `ecatExecJob` is called cyclically to trigger master state machines, timers, send acyc and receive frames accordingly.

4.16.3 *ecatIoControl* – *EC_IOCTL_SB_STATUS_GET*

This call will get the status of the last bus scan.

Parameters

pbyInBuf
[] Should be set to EC_NULL.

dwInBufSize
[] Should be set to 0.

pbyOutBuf
[out] Pointer to EC_T_SB_STATUS_NOTIFY_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.

Comment

Description see 4.16.13 “ecatNotify – EC_NOTIFY_SB_STATUS”.

4.16.4 *ecatIoControl* – *EC_IOCTL_SB_SET_BUSCNF_VERIFY_PROP*

This call will determine whether a single slave property will be used to verify the bus configuration. The scan bus verifies the vendor id and product code of the slave device if it is not disabled using the IO-Control “EC_IOCTL_SB_SET_BUSCNF_VERIFY_PROP”. The ENI file may contain other EEPROM checks like Revision or Serial Number realized using init commands, they are not part of the scan bus.

Parameters

pbyInBuf
[in] Pointer to EC_T_SCANBUS_PROP_DESC

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Should be set to EC_NULL.

dwOutBufSize
[] Should be set to 0.

pdwNumOutData
[] Should be set to EC_NULL.

Comment

```
typedef struct _EC_T_SCANBUS_PROP_DESC
{
    EC_T_eEEPENTRY eEEPROMEntry;
    EC_T_DWORD dwVerify;
} EC_T_SCANBUS_PROP_DESC;
```

Description

eEEPROMEntry
[in] E²PROM entry (slave property) to add.

dwVerify
[in] if set to EC_TRUE the actual slave property (stored in the E²PROM) will be compared with the appropriate value in the XML configuration file.

EC_T_eEEPENTRY

```
typedef enum _EC_T_eEEPENTRY{
    eEEP_VendorId      = 0x0008, /* Checked by scan bus */
    eEEP_ProductCode   = 0x000A, /* Checked by scan bus */
    eEEP_RevisionNumber = 0x000C, /* Checked by init command */
    eEEP_SerialNumber   = 0x000E, /* Checked by init command */
} EC_T_eEEPENTRY;
```

4.16.5 *ecatIoControl* – *EC_IOCTL_SB_BUSCNF_GETSLAVE_INFO*

This call will return the basic slave info determined in the last bus scan. It may be called after retrieving the *EC_NOTIFY_SB_STATUS* notification.

Attention: The serial number and the revision number will not be read by default (0 will be returned). Please use the IO-Control *EC_IOCTL_SB_SET_BUSCNF_VERIFY_PROP* to activate the reading from the Slave EEPROM.

Parameters

pbyInBuf

[in] Pointer to auto-increment address of the slave (*EC_T_WORD*).

dwInBufSize

[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf

[out] Pointer to slave description (*EC_T_SB_SLAVEINFO_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.

Comment

EC_T_SB_SLAVEINFO_DESC

```
typedef struct _EC_T_SB_SLAVEINFO_DESC{
    EC_T_DWORD      dwScanBusStatus;
    EC_T_DWORD      dwVendorId;
    EC_T_DWORD      dwProductCode;
    EC_T_DWORD      dwRevisionNumber;
    EC_T_DWORD      dwSerialNumber;
} EC_T_SB_SLAVEINFO_DESC;
```

Description

dwScanBusStatus

[out] Scan bus status (determined in the latest scan bus)
See 4.16.13 “*ecatNotify* – *EC_NOTIFY_SB_STATUS*”.

dwVendorId

[out] Vendor Identification stored in the E²PROM at offset 0x0008

dwProductCode

[out] Product Code stored in the E²PROM at offset 0x000A

dwRevisionNumber

[out] Revision number stored in the E²PROM at offset 0x000C (Not read by default!)

dwSerialNumber

[out] Serial number stored in the E²PROM at offset 0x000E (Not read by default!)

4.16.6 *ecatIoControl* – *EC_IOCTL_SB_BUSCNF_GETSLAVE_INFO_EEP*

This call will return extended slave info determined in the last bus scan. It may be called after retrieving the *EC_NOTIFY_SB_STATUS* notification.

Parameters

pbyInBuf

[in] Pointer to *EC_T_SB_SLAVEINFO_EEP_REQ_DESC*.

dwInBufSize

[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf

[out] Pointer to slave description (*EC_T_SB_SLAVEINFO_EEP_RES_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.

Comment

EC_T_SB_SLAVEINFO_EEP_REQ_DESC

```
typedef struct _EC_T_SB_SLAVEINFO_EEP_REQ_DESC{
    EC_T_eSBSlaveInfoType    eSbSlaveInfoType;
    EC_T_WORD                wAutoIncAddress;
    EC_T_eEEPENTRY           eEEPROMEntry;
} EC_T_SB_SLAVEINFO_EEP_REQ_DESC;
```

Description

eSbSlaveInfoType

[in] Selection whether to use Auto-Increment address of Bus or XML Configuration

wAutoIncAddress

[in] Auto-Increment address of the slave

eEEPROMEntry

[in] E²PROM entry to read (only valid if entry was selected by *ecatIoControl* – *EC_IOCTL_SB_SET_BUSCNF_VERIFY_PROP*).

EC_T_eSBSlaveInfoType

```
typedef enum _EC_T_eSBSlaveInfoType{
    sbsit_unknown          = 0,
    sbsit_bustopology       = 1,      /* info from bus */
    sbsit_configuration     = 2,      /* info from XML configuration */
} EC_T_eSBSlaveInfoType;
```

Return

EC_E_NOERROR if successful.

EC_E_NOTFOUND if there is no scan bus result to the requested Auto-Increment address available.

EC_T_SB_SLAVEINFO_EEP_RES_DESC

```
typedef struct _EC_T_SB_SLAVEINFO_RES_DESC{  
    EC_T_DWORD          dwScanBusStatus;  
    EC_T_eEEPENTRY      eEEPROMEntry;  
    EC_T_DWORD          dwEEPROMValue;  
} EC_T_SB_SLAVEINFO_EEP_RES_DESC;
```

Description

dwScanBusStatus

[out] Scan bus status (determined in the latest scan bus)
See 4.16.13 “ecatNotify – EC_NOTIFY_SB_STATUS”.

eEEPROMEntry

[out] Select E²PROM Entry description from Request

dwEEPROMValue

[out] E²PROM entry value

4.16.7 *ecatIoControl* – *EC_IOCTL_SB_BUSCNF_GETSLAVE_INFO_EX*

This call will return extended slave info determined in the last bus scan. It may be called after retrieving the *EC_NOTIFY_SB_STATUS* notification.

Parameters

pbyInBuf

[in] Pointer to *EC_T_SB_SLAVEINFO_REQ_DESC*.

dwInBufSize

[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf

[out] Pointer to slave description (*EC_T_SB_SLAVEINFO_RES_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.

Comment

```
typedef struct _EC_T_SB_SLAVEINFO_REQ_DESC
{
    EC_T_eINFOENTRY eInfoEntry;
    EC_T_WORD      wAutoIncAddress;
} EC_T_SB_SLAVEINFO_REQ_DESC;
```

Description

wAutoIncAddress

[in] Auto-Increment address of the slave

eInfoEntry

[in] Info Entry to read

EC_T_SB_SLAVEINFO_RES_DESC

```
typedef struct _EC_T_SB_SLAVEINFO_RES_DESC{
    EC_T_eINFOENTRY    eInfoEntry;
    EC_T_PBYTE         pbyInfo;
    EC_T_DWORD         dwInfoLength;
} EC_T_SB_SLAVEINFO_RES_DESC;
```

Description

eInfoEntry

[out] Info entry read

pbyInfo

[out] Pointer to Info (-1 if no info found in XML file)

dwInfoLength

[in, out] Length of Info Field (buffer, actually read length)

EC_T_eINFOENTRY

```
typedef enum _EC_T_eINFOENTRY{
    eie_unknown                /** nothing / invalid */
    eie_pdoffs_in              /** config: get processdata offset of Input data (in Bits) */
    eie_pdsizes_in             /** config: get processdata size of Input data (in Bits) */
    eie_pdoffs_out             /** config: get processdata offset of Output data (in Bits) */
    eie_pdsizes_out            /** config: get processdata size of Output data (in Bits) */
    eie_pdoffs_in2             /** config: get PD offset of Input data (section 2)(in Bits) */
    eie_pdsizes_in2            /** config: get PD size of Input data (section 2)(in Bits) */
    eie_pdoffs_out2            /** config: get PD offset of Output data (section 2)(in Bits) */
    eie_pdsizes_out2           /** config: get PD size of Output data (section 2)(in Bits) */
    eie_pdoffs_in3             /** config: get PD offset of Input data (section 3)(in Bits) */
    eie_pdsizes_in3            /** config: get PD size of Input data (section 3)(in Bits) */
    eie_pdoffs_out3            /** config: get PD offset of Output data (section 3)(in Bits) */
    eie_pdsizes_out3           /** config: get PD size of Output data (section 3)(in Bits) */
    eie_pdoffs_in4             /** config: get PD offset of Input data (section 4)(in Bits) */
    eie_pdsizes_in4            /** config: get PD size of Input data (section 4)(in Bits) */
    eie_pdoffs_out4            /** config: get PD offset of Output data (section 4)(in Bits) */
    eie_pdsizes_out4           /** config: get PD size of Output data (section 4)(in Bits) */
    eie_phys_address           /** bus: get slave phys Address */
    eie_portstate              /** bus: get port link state (DL_STATUS,
                                needed e.g. for topology detection) */
    eie_dcsupport              /** bus: does slave support DC */
    eie_dc64support            /** bus: does slave support 64 Bit DC */
    eie_alias_address          /** bus: get slave alias Address */
    eie_cfgphy_address         /** config: get slave phys Address from config file */
    eie_device_name            /** get slave name from configuration */
    eie_ismailbox_slave        /** get whether slave support mailboxes */
    eie_mbx_outsize            /** get out mailbox 1 size */
    eie_mbx_insize             /** get in mailbox 1 size */
    eie_mbx_outsize2           /** get out mailbox 2 size */
    eie_mbx_insize2            /** get in mailbox 2 size */
    eie_isoptional             /** is slave optional */
    eie_ispresent              /** is slave present on bus */
    eie_escype                 /** Type of ESC controller */
} EC_T_eINFOENTRY;
```

Brief description of individual request:

eInfoEntry	Type	Coding	Description
eie_pdoffs_in	EC_T_DWORD	Offset in Bit	Process data offset for Input data
eie_pdsiz_in	EC_T_DWORD	Size in Bit	Process data size of Input data
eie_pdoffs_out	EC_T_DWORD	Offset in Bit	Process data offset for Output data
eie_pdsiz_out	EC_T_DWORD	Size in Bit	Process data size of Output data
eie_pdoffs_in2	EC_T_DWORD	Offset in Bit	PD offset for Input data (section 2)
eie_pdsiz_in2	EC_T_DWORD	Size in Bit	PD size of Input data (section 2)
eie_pdoffs_out2	EC_T_DWORD	Offset in Bit	PD offset for Output data (section 2)
eie_pdsiz_out2	EC_T_DWORD	Size in Bit	PD size of Output data (section 2)
eie_pdoffs_in3	EC_T_DWORD	Offset in Bit	PD offset for Input data (section 3)
eie_pdsiz_in3	EC_T_DWORD	Size in Bit	PD size of Input data (section 3)
eie_pdoffs_out3	EC_T_DWORD	Offset in Bit	PD offset for Output data (section 3)
eie_pdsiz_out3	EC_T_DWORD	Size in Bit	PD size of Output data (section 3)
eie_pdoffs_in4	EC_T_DWORD	Offset in Bit	PD offset for Input data (section 4)
eie_pdsiz_in4	EC_T_DWORD	Size in Bit	PD size of Input data (section 4)
eie_pdoffs_out4	EC_T_DWORD	Offset in Bit	PD offset for Output data (section 4)
eie_pdsiz_out4	EC_T_DWORD	Size in Bit	PD size of Output data (section 4)
eie_phys_address	EC_T_WORD	Address	Slave Address (effective address)
eie_portstate	EC_T_WORD	www xxxx yyyy zzzz	Portstate: each nibble : port 3210 www : 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)
eie_dcsupport	EC_T_BOOL	BOOL	EC_TRUE if slave supports DC
eie_dc64support	EC_T_BOOL	BOOL	EC_TRUE if slave supports 64 Bit DC
eie_alias_address	EC_T_WORD	Address	Slave Alias Address
eie_cfgphy_address	EC_T_WORD	Address	Slave Station Address (Configured)
eie_device_name	EC_T_CHAR[80]	Name	Name of Device from XML Configuration
eie_ismailbox_slave	EC_T_BOOL	BOOL	EC_TRUE if slave supports mailboxes
eie_mbx_outsize	EC_T_DWORD	DWORD	Size of out mailbox (0 if no mailbox slave)
eie_mbx_outsize2	EC_T_DWORD	DWORD	Size of boot out mailbox (0 if no mailbox slave)
eie_mbx_insize	EC_T_DWORD	DWORD	Size of in mailbox (0 if no mailbox slave)
eie_mbx_insize2	EC_T_DWORD	DWORD	Size of boot in mailbox (0 if no mailbox slave)
eie_isoptional	EC_T_BOOL	BOOL	EC_TRUE if slave is optional
eie_ispresent	EC_T_BOOL	BOOL	EC_TRUE if slave is present on bus
eie_escype	EC_T_BYTE	BYTE	Type of ESC controller 0x01: ESC10 0x02: ESC20 0x04: IP Core 0x11: ET1100 0x12: ET1200
eie_unknown	-	-	Error / unknown request id (shall not be used as input to IOCTL)

Example values for topology detection (values are binary):

- zzzz = 0001 only port 0 (IN port) is connected, no slave behind this device (device is at the end of a bus line)
- zzzz = 0011 ports 0 and 1 are connected, one slave behind this device (device is in the middle of a bus line)
- zzzz = 0111 ports 0, 1 and 2 are connected, two slaves behind this device (Y-device, e.g. EK1100 bus coupler with E-Bus line connected behind and a second slave or bus line connected to the OUT port of the EK1100)

4.16.8 *ecatIoControl* –

EC_IOCTL_SB_SET_TOPOLOGY_CHANGED_DELAY

This call will set the topology changed delay value. This is time the master will wait to react on the topology change in msec. The default value is 1s.

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

4.16.9 *ecatIoControl* –

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.

Parameters

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

[] Should be set to EC_NULL.

dwOutBufSize

[] Should be set to 0.

pdwNumOutData

[] Should be set to EC_NULL.

Comment

-

4.16.10 *ecatIoControl* – **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.

Parameters

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
[] Should be set to EC_NULL.
dwOutBufSize
[] Should be set to 0.
pdwNumOutData
[] Should be set to EC_NULL.

Comment

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.

4.16.11 *ecatIoControl* – **EC_IOCTL_SB_SET_TOPOLOGY_CHANGE_AUTO_MODE**

[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.

Parameters

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
[] Should be set to EC_NULL.
dwOutBufSize
[] Should be set to 0.
pdwNumOutData
[] Should be set to EC_NULL.

Comment

In automatical mode, new slaves will be discovered automatically. In manual mode, after new slaves have been connected, a **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

EC_IOCTL_SB_ACCEPT_TOPOLOGY_CHANGE

4.16.12 *ecatIoControl* – **EC_IOCTL_SB_ACCEPT_TOPOLOGY_CHANGE**

[This documentation is preliminary and is subject to change]

This call will trigger a scan bus. On completion the Notification **EC_NOTIFY_SB_STATUS** is given.

Parameters

–

Comment

This function may be called after a **EC_NOTIFY_HC_TOPOCHGDONE** notification was given if the automatical topology change mode was previously disabled using

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 **EC_IOCTL_SB_ENABLE** will be used. When issuing this IoControl, the application has to take care *ecatExecJob* is called cyclically to trigger master state machines, timers, send acyc and receive frames accordingly.

4.16.13 *ecatNotify* – **EC_NOTIFY_SB_STATUS**

Scan bus status notification.

This notification is enabled by default. See **EC_IOCTL_SET_NOTIFICATION_ENABLED** for how to control the deactivation.

Parameters

pbyInBuf

[in] Pointer to **EC_T_SB_STATUS_NTFY_DESC**

dwInBufSize

[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf

[] Set to **EC_NULL**.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to **EC_NULL**.

Comment

EC_T_SB_STATUS_NTFY_DESC

```
typedef struct _EC_T_SB_STATUS_NTFY_DESC{
    EC_T_DWORD      dwResultCode;
    EC_T_DWORD      dwSlaveCount;
} EC_T_SB_STATUS_NTFY_DESC;
```

Description

dwResultCode

[in] **EC_E_NOERROR**: success
EC_E_NOTREADY: no bus scan executed
EC_E_BUSCONFIG_MISMATCH: bus configuration mismatch

dwSlaveCount

[in] number of slaves connected to the bus

4.16.14 *ecatNotify* - 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.

Parameters

pbyInBuf
[in] Pointer to EC_T_SB_MISMATCH_DESC

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Set to EC_NULL.

dwOutBufSize
[] Set to 0.

pdwNumOutData
[] Set to EC_NULL.

Comment

This notification is enabled by default. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation.

In case of permanent frame loss no slaves can be found although the slaves are connected.

```
typedef struct _EC_T_SB_MISMATCH_DESC
{
    EC_T_WORD      wPrevFixedAddress;
    EC_T_WORD      wPrevPort;
    EC_T_WORD      wPrevAlncAddress;
    EC_T_WORD      wBusAlncAddress;
    EC_T_DWORD     dwBusVendorId;
    EC_T_DWORD     dwBusProdCode;
    EC_T_DWORD     dwBusRevisionNo;
    EC_T_DWORD     dwBusSerialNo;
    EC_T_WORD      wBusFixedAddress;
    EC_T_WORD      wIdentificationVal;
    EC_T_WORD      wCfgFixedAddress;
    EC_T_WORD      wCfgAlncAddress;
    EC_T_DWORD     dwCfgVendorId;
    EC_T_DWORD     dwCfgProdCode;
    EC_T_DWORD     dwCfgRevisionNo;
    EC_T_DWORD     dwCfgSerialNo;
    EC_T_BOOL      bIdentValidationError;
    EC_T_WORD      oldentCmdHdr[5]; /*
    EC_T_DWORD     dwCmdData; */
    EC_T_DWORD     dwCmdVMask;
    EC_T_DWORD     dwCmdVData;
} EC_T_SB_MISMATCH_DESC;
```

Description

wPrevFixedAddress
[in] Previous slave station address

wPrevPort
[in] Previous slave port

wPrevAlncAddress
[in] Previous slave auto-increment address

wBusAlncAddress;
[in] Unexpected slave (bus) auto-inc address

dwBusVendorId;
[in] Unexpected slave (bus) vendor ID

dwBusProdCode;
[in] Unexpected slave (bus) product code

dwBusRevisionNo;
[in] Unexpected slave (bus) revision number

`dwBusSerialNo;`
 [in] Unexpected slave (bus) serial number

`wBusFixedAddress;`
 [in] Unexpected slave (bus) station address

`wIdentificationVal;`
 [in] last identification value read from slave according to the last used identification method

`wCfgFixedAddress`
 [in] Missing slave (config) station Address

`wCfgAlncAddress;`
 [in] Missing slave (config) Auto-Increment Address.

`dwCfgVendorId;`
 [in] Missing slave (config) Vendor ID

`dwCfgProdCode;`
 [in] Missing slave (config) Product code

`dwCfgRevisionNo;`
 [in] Missing slave (config) Revision Number

`dwCfgSerialNo;`
 [in] Missing slave (config) Serial Number

`blIdentValidationError;`
 [in] Hotconnect Identification command sent to slave but failed

`oldentCmdHdr[5];`
 [in] Last HotConnect Identification command header (if `blIdentValidationError`)

`dwCmdData;`
 [in] First DWORD of Data portion of last identification command

`dwCmdVMask;`
 [in] First DWORD of Validation mask of last identification command

`dwCmdVData;`
 [in] First DWORD of Validation data of last identification command

4.16.15 *ecatNotify* – **EC_NOTIFY_SB_DUPLICATE_HC_NODE**

Scan bus mismatch was detected while scan because of a duplicate hot connect group.

An application get this notification if there are two hot connect groups on the bus with the same product code, vendor ID and identification value (alias address or switch id).

Parameters

pbyInBuf
[in] Pointer to EC_T_SB_MISMATCH_DESC

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Set to EC_NULL.

dwOutBufSize
[] Set to 0.

pdwNumOutData
[] Set to EC_NULL.

See section 4.16.14 (EC_T_SB_MISMATCH_DESC)

4.16.16 *ecatNotify* – **EC_NOTIFY_SLAVE_PRESENCE**

This notification is given, if slave appears or disappears from the network.

This notification is enabled by default. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the deactivation.

Parameters

pbyInBuf
[in] Pointer to EC_T_SLAVE_PRESENCE_NTFY_DESC

dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.

pbyOutBuf
[] Set to EC_NULL.

dwOutBufSize
[] Set to 0.

pdwNumOutData
[] Set to EC_NULL.

Comment

Disconnecting the slave from the network, powering it off or a bad connection can produce this notification.

```
typedef struct _EC_T_SLAVE_PRESENCE_NTFY_DESC
{
    EC_T_WORD      wStationAddress;
    EC_T_BOOL      bPresent;
} EC_T_SLAVE_PRESENCE_NTFY_DESC;
```

Description

wStationAddress
[in] Slave station address

bPresent
[in] 0: absent 1: present

4.16.17 *ecatNotify* – EC_NOTIFY_SLAVES_PRESENCE

This notification collects notifications of type EC_NOTIFY_SLAVE_PRESENCE.

Notification is given on either collection full or master state changed whatever comes first.

This notification is disabled by default. See EC_IOCTL_SET_NOTIFICATION_ENABLED for how to control the activation.

Parameters

pbyInBuf
[in] Pointer to EC_T_SLAVES_PRESENCE_NTFY_DESC
dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
[] Set to EC_NULL.
dwOutBufSize
[] Set to 0.
pdwNumOutData
[] Set to EC_NULL.

Comment

Disconnecting slaves from the network, powering them off or a bad connection can produce this notification.

```
typedef struct _EC_T_SLAVES_PRESENCE_NTFY_DESC
{
    EC_T_WORD      wCount;
    EC_T_WORD      wRes;
    EC_T_SLAVE_PRESENCE_NTFY_DESC SlavePresence[MAX_SLAVES_PRESENCE_NTFY_ENTRIES];
} EC_T_SLAVES_PRESENCE_NTFY_DESC;
```

Description

wCount
[in] Contained EC_NOTIFY_SLAVE_PRESENCE count.
wRes
[in] 0 (reserved)
SlavePresence
[in] Array of EC_T_SLAVE_PRESENCE_NTFY_DESC, see EC_NOTIFY_SLAVE_PRESENCE.

4.16.18 *ecatNotify* – EC_NOTIFY_LINE_CROSSED

Cable swapping detected. All slaves' port 0 must lead to Master.

Parameters

pbyInBuf
[in] Pointer to EC_T_LINE_CROSSED_DESC
dwInBufSize
[in] Size of the input buffer provided at *pbyInBuf* in bytes.
pbyOutBuf
[] Set to EC_NULL.
dwOutBufSize
[] Set to 0.
pdwNumOutData
[] Set to EC_NULL.

```
typedef struct _EC_T_LINE_CROSSED_DESC
{
    EC_T_SLAVE_PROP SlaveProp; /*< slave properties */
    EC_T_WORD      wInputPort; /*< port where frame was received */
} EC_T_LINE_CROSSED_DESC;
```

4.16.19 *ecatNotify* – **EC_NOTIFY_SLAVE_NOTSUPPORTED**

Is currently generated during Bus Scan if *ecatConfigureMaster*(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).

Parameters

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

[] Set to EC_NULL.

dwOutBufSize

[] Set to 0.

pdwNumOutData

[] Set to EC_NULL.

```
typedef struct _EC_T_SLAVE_NOTSUPPORTED_DESC
```

```
{
```

```
    EC_T_SLAVE_PROP    SlaveProp;    /*< slave properties of the not supported slave */
```

```
} EC_T_SLAVE_NOTSUPPORTED_DESC;
```

4.16.20 *ecatNotify* – **EC_NOTIFY_FRAMELOSS_AFTER_SLAVE**

Is currently generated and automatically handled during *ecatRescueScan* if opening port destroys communication (frameloss). This notification should only print a log message or be ignored.

Parameters

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
 [] Set to EC_NULL.
dwOutBufSize
 [] Set to 0.
pdwNumOutData
 [] Set to EC_NULL.

```
typedef struct _EC_T_FRAMELOSS_AFTER_SLAVE_NTFY_DESC
{
    /* Location of frameloss */
    EC_T_SLAVE_PROP    SlaveProp; /*< slave properties */
    EC_T_WORD          wPort;     /*< port */
} EC_T_FRAMELOSS_AFTER_SLAVE_NTFY_DESC;
```

4.16.21 *ecatNotify* – **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.

4.16.22 *ecatIoControl* – **EC_IOCTL_SB_NOTIFY_UNEXPECTED_BUS_SLAVES**

Specifies if unexpected bus slaves must be notified as bus mismatch.

Parameters

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
 [] Should be set to EC_NULL.
dwOutBufSize
 [] Should be set to 0.
pdwNumOutData
 [] Should be set to EC_NULL.

4.16.23 *ecatIsTopologyChangeDetected*

Returns whether topology change detected.

```
EC_T_DWORD ecatIsTopologyChangeDetected (  
    EC_T_BOOL *          pbTopologyChangeDetected  
);
```

Parameters

pbTopologyChangeDetected

[out] Pointer to Bool value: EC_TRUE if Topology Change Detected, EC_FALSE if not.

Return

EC_E_NOERROR if successful.

EC_E_INVALIDSTATE if the master is not initialized.

Comment

-

4.16.24 *ecatNotify - EC_NOTIFY_HC_TOPOCHGDONE*

This notification is raised when topology change has completely processed.

Parameters

pbyInBuf

[in] Pointer to EC_T_DWORD (EC_E_NOERROR on success, Error code otherwise)

dwInBufSize

[in] sizeof(EC_T_DWORD).

pbyOutBuf

[] Set to EC_NULL (not used).

dwOutBufSize

[] Set to 0 (not used).

pdwNumOutData

[] Set to EC_NULL (not used).

Comment

The notification is raised when the slaves have been detected and DC initialized.

5 Error Codes

5.1 Groups

Nr.	Group	Abbreviation	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

5.2 Codes

5.2.1 Generic Error Codes

Code / Define	Text	Group	Possible error cause
0x00000000 EC_E_NOERROR	No Error	n. a.	Function call successful.
0x98110001 EC_E_NOTSUPPORTED	Feature not supported	APP	Function or property not available
0x98110002 EC_E_INVALIDINDEX	Invalid Index	APP	CoE: invalid SDO index.
0x98110003 EC_E_INVALIDOFFSET	Invalid Offset	ISW	Invalid offset, while accessing Process Data Image
0x98110004 EC_E_CANCEL	Cancel	APP	master should abort current mbx transfer
0x98110005 EC_E_INVALIDSIZE	Invalid Size	APP	Invalid size - while accessing Process Data Image - while storing data
0x98110006 EC_E_INVALIDDATA	Invalid Data	ISW	Multiple error sources
0x98110007 EC_E_NOTREADY	Not ready	ISW	Multiple error sources
0x98110008 EC_E_BUSY	Busy	APP	Stack is busy currently and not available to process the API request. The function may be called again later.
0x98110009 EC_E_ACYC_FRM_FREEQ_EMPTY	Cannot queue acyclic ecat command	ISW	Acyclic command queue is full. Possible solution: Increase of configuration value <i>dwMaxQueuedEthFrames</i>
0x9811000A EC_E_NOMEMORY	No Memory left	CFG	Not enough allocatable memory available (memory full / corrupted).
0x9811000B EC_E_INVALIDPARM	Invalid Parameter	APP	API function called with erroneous parameter set.
0x9811000C EC_E_NOTFOUND	Not Found	APP	Network Information File not found or API called with invalid SlaveID.
0x9811000D EC_E_DUPLICATE	Duplicated fixed address detected	ISW	Internally handled.
0x9811000E EC_E_INVALIDSTATE	Invalid State	ISW	Multiple error sources, e.g. Master is not initialized or not configured.

Code / Define	Text	Group	Possible error cause
0x9811000F EC_E_TIMER_LIST_FULL	Cannot add slave to timer list	ISW	Slave timer list full.
0x98110010 EC_E_TIMEOUT	Timeout		Multiple error sources.
0x98110011 EC_E_OPENFAILED	Open Failed	ISW	Multiple error sources. See e.g. Optimized Link Layer description (Operating system configuration and instance configuration).
0x98110012 EC_E_SENDFAILED	Send Failed	LLA	Transmit of frame failed.
0x98110013 EC_E_INSERTMAILBOX	Insert Mailbox error	CFG	Mailbox command couldn't be stored to internal command queue. Internal limit <code>MAX_QUEUED_COE_CMDS: 20</code> .
0x98110014 EC_E_INVALIDCMD	Invalid Command	ISW	Unknown mailbox command code.
0x98110015 EC_E_UNKNOWN_MBX_PROTOCOL	Unknown Mailbox Protocol Command	ISW	Unknown Mailbox protocol or mailbox command with unknown protocol association.
0x98110016 EC_E_ACCESSDENIED	Access Denied	ISW	Master internal software error:
0x98110017 EC_E_IDENTIFICATIONFAILED	Identification failed	ENI	Identification command failed
0x98110018 EC_E_LOCK_CREATE_FAILED	Create lock failed	SYS	OsCreateLockTyped failed
0x9811001A EC_E_PRODKEY_INVALID	Product Key Invalid	CFG	Application is using protected version of stack, which stops operation after 60 minutes if license not provided.
0x9811001B EC_E_WRONG_FORMAT	Wrong configuration format	ENI	Network information file is empty or malformed.
0x9811001C EC_E_FEATURE_DISABLED	Feature disabled	APP	Application tried to perform a missing or disabled API function.
0x9811001E EC_E_BUSCONFIG_MISMATCH	Bus Config Mismatch	ENI	Network information file and currently connected bus topology does not match.
0x9811001F EC_E_CONFIGDATAREAD	Error reading config file	ENI	Network information file could not be read.
0x98110021 EC_E_XML_CYCCMDS_MISSING	Cyclic commands are missing	ENI	Network information file does not contain cyclic commands.
0x98110022 EC_E_XML_ALSTATUS_READ_MISSING	AL_STATUS register read missing in XML file for at least one state	ENI	Read of AL Status register is missing in cyclic part of given network information file.

Code / Define	Text	Group	Possible error cause
0x98110023 EC_E_MCSM_FATAL_ERROR	Fatal internal McSm	ISW	Master control state machine is in an undefined state.
0x98110024 EC_E_SLAVE_ERROR	Slave error	SLV	A slave error was detected. See also EC_NOTIFY_STATUS_SLAVE_ERROR and EC_NOTIFY_SLAVE_ERROR_STATUS_INFO
0x98110025 EC_E_FRAME_LOST	Frame lost, IDX mismatch	SLV	An EtherCAT frame was lost on bus segment, means the response was not received. In case this error shows frequently a problem with the wiring could be the cause.
0x98110026 EC_E_CMD_MISSING	At least one EtherCAT command is missing in the received frame	SLV	Received EtherCAT frame incomplete.
0x98110028 EC_E_INVALID_DCL_MODE	IOCTL EC_IOCTL_DC_LATCH_REQ_LTIMV ALS invalid in DCL auto read mode	APP	This function cannot be used if DC Latching is running in mode „Auto Read“.
0x98110029 EC_E_AI_ADDRESS	Auto increment address increment mismatch	SLV	Network information file and bus topology doesn't match any more. Error shows only, if a already recognized slave isn't present any more.
0x9811002A EC_E_INVALID_SLAVE_STATE	Slave in invalid state, e.g. not in OP (API not callable in this state)	APP	Mailbox commands are not allowed in current slave state.
0x9811002B EC_E_SLAVE_NOT_ADDRESSABLE	Station address lost (or slave missing) - FPRD to AL_STATUS failed	SLV	Slave had a powercycle.
0x9811002C EC_E_CYC_CMDS_OVERFLOW	Too many cyclic commands in XML configuration file	ENI	Error while creating network information file within configuration utility.
0x9811002D EC_E_LINK_DISCONNECTED	Ethernet link cable disconnected	SLV	EtherCAT bus segment not connected to network interface.
0x9811002E EC_E_MASTERCORE_INACCESSIBLE	Master core not accessible	RAS	Connection to remote server was terminated or master instance has been stopped on remote side.
0x9811002F EC_E_COE_MBXSEND_WKC_ERROR	COE mbox send: working counter	SLV	CoE mailbox couldn't be read on slave, slave didn't read out mailbox since last write.
0x98110030 EC_E_COE_MBXRCV_WKC_ERROR	COE mbox receive: working counter	SLV	CoE Mailbox couldn't be read from slave.
0x98110031 EC_E_NO_MBX_SUPPORT	No mailbox support	APP	Slave does not support mailbox access.
0x98110032 EC_E_NO_COE_SUPPORT	CoE protocol not supported	ENI	Configuration error or slave information file doesn't match slave firmware.
0x98110033 EC_E_NO_EOE_SUPPORT	EoE protocol not supported	ENI	Configuration error or slave information file doesn't match slave firmware.

Code / Define	Text	Group	Possible error cause
0x98110034 EC_E_NO_FOE_SUPPORT	FoE protocol not supported	ENI	Configuration error or slave information file doesn't match slave firmware.
0x98110035 EC_E_NO_SOE_SUPPORT	SoE protocol not supported	ENI	Configuration error or slave information file doesn't match slave firmware.
0x98110036 EC_E_NO_VOE_SUPPORT	VoE protocol not supported	ENI	Configuration error or slave information file doesn't match slave firmware.
0x98110037 EC_E_EVAL_VIOLATION	Configuration violates Evaluation limits	ENI	Obsolete
0x98110038 EC_E_EVAL_EXPIRED	Evaluation Time limit reached	CFG	Licence not provided and evaluation period (1 hour) of protected version exceeded.
0x98110070 EC_E_CFGFILENOTFOUND	Master configuration not found	CFG	The path to the master configuration file (XML) was wrong or the file is not available.
0x98110071 EC_E_EEPROMREADERROR	Command error while EEPROM upload	SLV	Could not read from slave EEPROM.
0x98110072 EC_E_EEPROMWRITEERROR	Command error while EEPROM download	SLV	Could not write to slave EEPROM.
0x98110073 EC_E_XML_CYCCMDS_SIZEMISMATCH	Cyclic command wrong size (too long)	ENI	Error while creating a new cyclic command. The size which was defined in the master configuration xml does not match to the size of the process data.
0x98110075 EC_E_XML_INVALID_OUT_OFF	Invalid output offset in cyc cmd, please check OutputOffs	ENI	Obsolete
0x98110076 EC_E_PORTCLOSE	Port Close failed		
0x98110077 EC_E_PORTOPEN	Port Open failed		
0x9811010e EC_E_SLAVE_NOT_PRESENT	Command not executed (slave not present on bus)	APP / SLV	Slave disappeared or was never present.
0x98110110 EC_E_EEPROMRELOADERROR	Command error while EEPROM reload		
0x98110111 EC_E_SLAVECTRLRESETERROR	Command error while Reset Slave Controller		
0x98110112 EC_E_SYSDRIVERMISSING	Cannot open system driver	SYS	System driver was not loaded.
0x9811011E EC_E_BUSCONFIG_TOPOCHANGE	Bus configuration not detected, Topology changed		Topology changed while scanning bus

Code / Define	Text	Group	Possible error cause
0x98110123 EC_E_VOE_MBX_WKC_ERROR	VoE mailbox send: working counter	SLV	VoE mailbox couldn't be written.
0x98110124 EC_E_EEPROMASSIGNERROR	EEPROM assignment failed	SLV	Assignment of the EEPROM to the slave went wrong.
0x98110125 EC_E_MBX_ERROR_TYPE	Error mailbox received	SLV	Unknown mailbox error code received in mailbox
0x98110126 EC_E_REDLINEBREAK	Redundancy line break	SLV	Cable break between slaves or between master and first slave
0x98110127 EC_E_XML_INVALID_CMD_WITH_RED	Invalid EtherCAT cmd in cyclic frame with redundancy	ENI	BRW commands are not allowed with redundancy. LRW commands with an expected WKC>3 are not allowed with redundancy (Workaround: Use LRD/LWR instead of LRW)
0x98110128 EC_E_XML_PREV_PORT_MISSING	<PreviousPort>-tag is missing	ENI	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
0x98110129 EC_E_XML_DC_CYCCMDS_MISSING	DC is enabled and DC cyclic commands are missing (e.g. access to 0x900)	ENI	Error in Configuration Tool.
0x98110130 EC_E_DLSTATUS_IRQ_TOPOCHANGE D	Data link (DL) status interrupt because of changed topology	SLV	Handled inside the master
0x98110131 EC_E_PTS_IS_NOT_RUNNING	Pass Through Server is not running	PTS	The Pass-Through-Server was tried to be enabled/disabled or stopped without being started.
0x98110132 EC_E_PTS_IS_RUNNING	Pass Through Server is running	PTS	Obsolete. Replaced by EC_E_ADS_IS_RUNNING
0x98110132 EC_E_ADS_IS_RUNNING	ADS adapter (Pass Through Server) is running	PTS	API call conflicts with ADS state (running).
0x98110133 EC_E_PTS_THREAD_CREATE_FAILED	Could not start the Pass Through Server	PTS	The Pass-Through-Server could not be started.
0x98110134 EC_E_PTS_SOCKET_BIND_FAILED	The Pass Through Server could not bind the IP address with a socket	PTS	Possibly because the IPaddress (and Port) is already in use or the IP-address does not exist.
0x98110135 EC_E_PTS_NOT_ENABLED	The Pass Through Server is running but not enabled	PTS	-
0x98110136 EC_E_PTS_LL_MODE_NOT_SUPPORTED	The Link Layer mode is not supported by the Pass Through Server	PTS	The Master is running in interrupt mode but the Pass-Through-Server only supports polling mode.

Code / Define	Text	Group	Possible error cause
0x98110137 EC_E_VOE_NO_MBX_RECEIVED	No VoE mailbox received	SLV	The master has not yet received a VoE mailbox from a specific slave.
0x98110138 EC_E_DC_REF_CLOCK_SYNC_OUT_UNIT_DISABLED	SYNC out unit of reference clock is disabled	ENI	Slave is selected as Reference clock in ENI file, but slave doesn't have a SYNC unit. Possible a ESI file bug.
0x98110139 EC_E_DC_REF_CLOCK_NOT_FOUND	Reference clock not found!	SLV	May happen if reference clock is removed from network.
0x9811013B EC_E_MBX_CMD_WKC_ERROR	Mailbox command working counter error	SLV	Mbx Init Cmd Retry Count exceeded.
0x9811013C EC_E_NO_AOE_SUPPORT	AoE: Protocol not supported	APP / SLV	Application calls AoE-API although not implemented at slave.
0x9811016E EC_E_XML_AOE_NETID_INVALID	AoE: Invalid NetID	ENI	Error from Configuration Tool.
0x9811016F EC_E_MAX_BUS_SLAVES_EXCEEDED	Error: Maximum number of bus slave has been exceeded	CFG	The maximum number of pre-allocated bus slave objects are too small. The maximum number can be adjusted by the master initialization parameter <code>EC_T_INITMASTERPARMS.dwMaxBusSlaves</code> .
0x98110170 EC_E_MBXERR_SYNTAX	Mailbox error: Syntax of 6 octet Mailbox header is wrong	SLV	Slave error mailbox return value: 0x01
0x98110171 EC_E_MBXERR_UNSUPPORTEDPROTOCOL	Mailbox error: The Mailbox protocol is not supported	SLV	Slave error mailbox return value: 0x02
0x98110172 EC_E_MBXERR_INVALIDCHANNEL	Mailbox error: Field contains wrong value	SLV	Slave error mailbox return value: 0x03
0x98110173 EC_E_MBXERR_SERVICENOTSUPPORTED	Mailbox error: The mailbox protocol header of the mailbox protocol is wrong	SLV	Slave error mailbox return value: 0x04
0x98110174 EC_E_MBXERR_INVALIDHEADER	Mailbox error: The mailbox protocol header of the mailbox protocol is wrong	SLV	Slave error mailbox return value: 0x05
0x98110175 EC_E_MBXERR_SIZE_TOO_SHORT	Mailbox error: Length of received mailbox data is too short	SLV	Slave error mailbox return value: 0x06
0x98110176 EC_E_MBXERR_NOMOREMEMORY	Mailbox error: Mailbox protocol can not be processed because of limited resources	SLV	Slave error mailbox return value: 0x07
0x98110177 EC_E_MBXERR_INVALIDSIZE	Mailbox error: The length of data is inconsistent	SLV	Slave error mailbox return value: 0x08

Code / Define	Text	Group	Possible error cause
0x98110178 EC_E_DC_SLAVES_BEFORE_REF_CLOCK	Slaves with DC configured present on bus before reference clock	ENI	The first DC Slave was not configured as potential reference clock.
0x9811017B EC_E_LINE_CROSSED	Line crossed		Cabling wrong.
0x9811017C EC_E_LINE_CROSSED_SLAVE_INFO	Line crossed at slave ...		Obsolete
0x9811017E EC_E_ADO_NOT_SUPPORTED	ADO for slave identification not supported	SLV	Request ID mechanism (ADO 0x134) not supported by slave
0x9811017F EC_E_FRAMELOSS_AFTER_SLAVE	Frame loss after Slave		Opening port destroys communication (frame loss).
0x98130008 EC_E_OEM_SIGNATURE_MISMATCH	Manufacturer signature mismatch	ENI, OEM	
0x98130009 EC_E_ENI_ENCRYPTION_WRONG_VERSION	ENI encryption algorithm version not supported	ENI, OEM	
0x9813000A EC_E_ENI_ENCRYPTED	Loading encrypted ENI needs OEM key	OEM	
0x9813000B EC_E_OEM_KEY_MISMATCH	OEM key mismatch	RAS, OEM	
0x9813000C EC_E_OEM_KEY_MISSING	OEM key access needs OEM key set	APP	Application must call ecatSetOemKey
0x98130020 EC_E_S2SMBX_NOT_CONFIGURED	S2S: Not Configured		
0x98130021 EC_E_S2SMBX_NO_MEMORY	S2S: No Memory		
0x98130022 EC_E_S2SMBX_NO_DESCRIPTOR	S2S: No Descriptor		
0x98130023 EC_E_S2SMBX_DEST_SLAVE_NOT_FOUND	S2S: Destination Slave not found		
0x98130024 EC_E_MASTER_RED_STATE_INACTIVE	Master Redundancy State is INACTIVE	APP	API not allowed in current Master Redundancy State.
0x98130025 EC_E_MASTER_RED_STATE_ACTIVE	Master Redundancy State is ACTIVE	APP	API not allowed in current Master Redundancy State.

Code / Define	Text	Group	Possible error cause
0x98130026 EC_E_JUNCTION_RED_LINE_BREAK	Junction redundancy line break		
0x98130027 EC_E_VALIDATION_ERROR	Validation error (validation data mismatch)		
0x98130028 EC_E_TIMEOUT_WAITING_FOR_DC	Timeout waiting for DC		
0x98130030 EC_E_SIGNATURE_MISMATCH	Signature mismatch		

5.2.2 DCM (Class A) Error Codes

0x981201C1 DCM_E_NOTINITIALIZED	Init function not called or not successful	DCM	Obsolete
0x981201C2 DCM_E_MAX_CTL_ERROR_EXCEED	Controller error - synchronisation out of limit		
0x981201C3 DCM_E_NOMEMORY	Not enough memory		Obsolete
0x981201C4 DCM_E_INVALID_HWLAYER	Hardware layer - (BSP) invalid		Obsolete
0x981201C5 DCM_E_TIMER_MODIFY_ERROR	Hardware layer - error modifying timer		Obsolete
0x981201C6 DCM_E_TIMER_NOT_RUNNING	Hardware layer - timer not running		Obsolete
0x981201C7 DCM_E_WRONG_CPU	Hardware layer - function called on wrong CPU		Obsolete
0x981201C8 DCM_E_INVALID_SYNC_PERIOD	Invalid DC sync period length (invalid clock master?)		Obsolete
0x981201C9 DCM_E_INVALID_SETVAL	DCM Controller SetVal to small		Obsolete
0x981201CA DCM_E_DRIFT_TO_HIGH	DCM Controller - Drift between local timer and ref clock to high		
0x981201CB DCM_E_BUS_CYCLE_WRONG	DCM Controller - Bus cycle time (dwBusCycleTimeUsec) doesn't match real cycle		
0x98130029 EC_E_TIMEOUT_WAITING_FOR_DCM	Timeout waiting for DCM		

5.2.3 ADS over EtherCAT (AoE) Error Codes

Code / Define	Text	Group	Possible error cause
0x9813000D EC_E_AOE_NO_RUNTIME	AoE: No Rtime		
0x9813000E EC_E_AOE_LOCKED_MEMORY	AoE: Allocation locked memory		
0x9813000F EC_E_AOE_MAILBOX	AoE: Insert mailbox error		
0x98130010 EC_E_AOE_WRONG_HMSG	AoE: Wrong receive HMSG		
0x98130011 EC_E_AOE_BAD_TASK_ID	AoE: Bad task ID		
0x98130012 EC_E_AOE_NO_IO	AoE: No IO		
0x98130013 EC_E_AOE_UNKNOWN_AMS_COMMAND	AoE: Unknown ADS command		
0x98130014 EC_E_AOE_WIN32	AoE: Win 32 error		
0x98130015 EC_E_AOE_LOW_INSTALL_LEVEL	AoE: Low installation level		
0x98130016 EC_E_AOE_NO_DEBUG	AoE: No debug available		
0x98130017 EC_E_AOE_AMS_SYNC_WIN32	AoE: Sync Win 32 error		
0x98130018 EC_E_AOE_AMS_SYNC_TIMEOUT	AoE: Sync Timeout		
0x98130019 EC_E_AOE_AMS_SYNC_AMS	AoE: Sync AMS error		
0x9813001A EC_E_AOE_AMS_SYNC_NO_INDEX_MAP	AoE: Sync no index map		
0x9813001B EC_E_AOE_TCP_SEND	AoE: TCP send error		

Code / Define	Text	Group	Possible error cause
0x9813001C EC_E_AOE_HOST_UNREACHABLE	AoE: Host unreachable		
0x9813001D EC_E_AOE_INVALIDAMSFRAGMENT	AoE: Invalid AMS fragment		
0x9813001E EC_E_AOE_NO_LOCKED_MEMORY	AoE: No allocation locked memory		
0x9813001F EC_E_AOE_MAILBOX_FULL	AoE: Mailbox full		

5.2.4 CANOpen over EtherCAT (CoE) SDO Error Codes

Code / Define	Text	Group	Possible error cause
0x98110040 EC_E_SDO_ABORTCODE_TOGGLE	SDO: Toggle bit not alternated	SLV	CoE abort code 0x05030000 of slave
0x98110041 EC_E_SDO_ABORTCODE_TIMEOUT	SDO: Protocol timed out	SLV	CoE abort code 0x05040000 of slave
0x98110042 EC_E_SDO_ABORTCODE_CCS_SCS	SDO: Client/server command specifier not valid or unknown	SLV	CoE abort code 0x05040001 of slave
0x98110043 EC_E_SDO_ABORTCODE_BLK_SIZE	SDO: Invalid block size (block mode only)	SLV	CoE abort code 0x05040002 of slave
0x98110044 EC_E_SDO_ABORTCODE_SEQNO	SDO: Invalid sequence number (block mode only)	SLV	CoE abort code 0x05040003 of slave
0x98110045 EC_E_SDO_ABORTCODE_CRC	SDO: CRC error (block mode only)	SLV	CoE abort code 0x05040004 of slave
0x98110046 EC_E_SDO_ABORTCODE_MEMORY	SDO: Out of memory	SLV	CoE abort code 0x05040005 of slave
0x98110047 EC_E_SDO_ABORTCODE_ACCESS	SDO: Unsupported access to an object	SLV	CoE abort code 0x06010000 of slave
0x98110048 EC_E_SDO_ABORTCODE_WRITEONLY	SDO: Attempt to read a write only object	SLV	CoE abort code 0x06010001 of slave
0x98110049 EC_E_SDO_ABORTCODE_READONLY	SDO: Attempt to write a read only object	SLV	CoE abort code 0x06010002 of slave
0x98130004	SDO: Sub Index cannot be written, SIO	SLV	CoE abort code 0x06010003 of slave

Code / Define	Text	Group	Possible error cause
EC_E_SDO_ABORTCODE_SI_NOT_WRITTEN	must be 0 for write access		
0x98130005 EC_E_SDO_ABORTCODE_CA_TYPE_MISM	SDO: Complete access not supported for objects of cvariable length suach as ENUM object types	SLV	CoE abort code 0x06010004 of slave
0x98130006 EC_E_SDO_ABORTCODE_OBJ_TOO_BIG	SDO: Object length exceeds mailbox size	SLV	CoE abort code 0x06010005 of slave
0x98130007 EC_E_SDO_ABORTCODE_PDO_MAPPED	SDO: Object mapped to RxPDO, SDO Download blocked	SLV	CoE abort code 0x06010006 of slave
0x9811004A EC_E_SDO_ABORTCODE_INDEX	SDO: Object does not exist in the object dictionary	SLV	CoE abort code 0x06020000 of slave
0x9811004B EC_E_SDO_ABORTCODE_PDO_MAP	SDO: Object cannot be mapped to the PDO	SLV	CoE abort code 0x06040041 of slave
0x9811004C EC_E_SDO_ABORTCODE_PDO_LEN	SDO: The number and length of the objects to be mapped would exceed PDO length	SLV	CoE abort code 0x06040042 of slave
0x9811004D EC_E_SDO_ABORTCODE_P_INCOMP	SDO: General parameter incompatibility reason	SLV	CoE abort code 0x06040043 of slave
0x9811004E EC_E_SDO_ABORTCODE_I_INCOMP	SDO: General internal incompatibility in the device	SLV	CoE abort code 0x06040047 of slave
0x9811004F EC_E_SDO_ABORTCODE_HARDWARE	SDO: Access failed due to an hardware error	SLV	CoE abort code 0x06060000 of slave
0x98110050 EC_E_SDO_ABORTCODE_DATA_SIZE	SDO: Data type does not match, length of service parameter does not match	SLV	CoE abort code 0x06070010 of slave
0x98110051 EC_E_SDO_ABORTCODE_DATA_SIZE1	SDO: Data type does not match, length of service parameter too high	SLV	CoE abort code 0x06070012 of slave
0x98110052 EC_E_SDO_ABORTCODE_DATA_SIZE2	SDO: Data type does not match, length of service parameter too low	SLV	CoE abort code 0x06070013 of slave
0x98110053	SDO: Sub-index does not exist	SLV	CoE abort code 0x06090011 of slave

Code / Define	Text	Group	Possible error cause
EC_E_SDO_ABORTCODE_OFFSET			
0x98110054 EC_E_SDO_ABORTCODE_DATA_RANGE	SDO: Value range of parameter exceeded (only for write access)	SLV	CoE abort code 0x06090030 of slave
0x98110055 EC_E_SDO_ABORTCODE_DATA_RANGE1	SDO: Value of parameter written too high	SLV	CoE abort code 0x06090031 of slave
0x98110056 EC_E_SDO_ABORTCODE_DATA_RANGE2	SDO: Value of parameter written too low	SLV	CoE abort code 0x06090032 of slave
0x9811005E EC_E_SDO_ABORTCODE_MODULE_ID_LIST_NOT_MATCH	SDO: Detected Module Ident List (0xF030) and Configured Module Ident list (0xF050) does not match	SLV	CoE abort code 0x06090033 of slave
0x98110057 EC_E_SDO_ABORTCODE_MINMAX	SDO: Maximum value is less than minimum value	SLV	CoE abort code 0x06090036 of slave
0x98110058 EC_E_SDO_ABORTCODE_GENERAL	SDO: General error	SLV	CoE abort code 0x08000000 of slave
0x98110059 EC_E_SDO_ABORTCODE_TRANSFER	SDO: Data cannot be transferred or stored to the application	SLV	CoE abort code 0x08000020 of slave
0x9811005A EC_E_SDO_ABORTCODE_TRANSFER1	SDO: Data cannot be transferred or stored to the application because of local control	SLV	CoE abort code 0x08000021 of slave
0x9811005B EC_E_SDO_ABORTCODE_TRANSFER2	SDO: Data cannot be transferred or stored to the application because of the present device state	SLV	CoE abort code 0x08000022 of slave
0x9811005C EC_E_SDO_ABORTCODE_DICTIONARY	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)	SLV	CoE abort code 0x08000023 of slave
0x9811005D EC_E_SDO_ABORTCODE_UNKNOWN	SDO: Unknown code	SLV	Unknown CoE abort code of slave

5.2.5 File Transfer over EtherCAT (FoE) Error Codes

Code / Define	Text	Group	Possible error cause
0x98110060 EC_E_FOE_ERRCODE_NOTDEFINED	ERROR FoE: not defined	SLV	FoE Error Code 0 (0x8000) of slave
0x98110061 EC_E_FOE_ERRCODE_NOTFOUND	ERROR FoE: not found	SLV	FoE Error Code 1 (0x8001) of slave
0x98110062 EC_E_FOE_ERRCODE_ACCESS	ERROR FoE: access denied	SLV	FoE Error Code 2 (0x8002) of slave
0x98110063 EC_E_FOE_ERRCODE_DISKFULL	ERROR FoE: disk full	SLV	FoE Error Code 3 (0x8003) of slave
0x98110064 EC_E_FOE_ERRCODE_ILLEGAL	ERROR FoE: illegal	SLV	FoE Error Code 4 (0x8004) of slave
0x98110065 EC_E_FOE_ERRCODE_PACKENO	ERROR FoE: packet number wrong	SLV	FoE Error Code 5 (0x8005) of slave
0x98110066 EC_E_FOE_ERRCODE_EXISTS	ERROR FoE: already exists	SLV	FoE Error Code 6 (0x8006) of slave
0x98110067 EC_E_FOE_ERRCODE_NOUSER	ERROR FoE: no user	SLV	FoE Error Code 7 (0x8007) of slave
0x98110068 EC_E_FOE_ERRCODE_BOOTSTRAP ONLY	ERROR FoE: bootstrap only	SLV	FoE Error Code 8 (0x8008) of slave
0x98110069 EC_E_FOE_ERRCODE_NOTINBOOT STRAP	ERROR FoE: Downloaded file name is not valid in Bootstrap state	SLV	FoE Error Code 9 (0x8009) of slave
0x9811006A EC_E_FOE_ERRCODE_INVALIDPAS SWORD	ERROR FoE: no rights	SLV	FoE Error Code 10 (0x800A) of slave
0x9811006B EC_E_FOE_ERRCODE_PROGERRO R	ERROR FoE: program error	SLV	FoE Error Code 11 (0x800B) of slave
0x9811006C EC_E_FOE_ERRCODE_INVALID_CH ECKSUM	ERROR FoE: Wrong checksum	SLV	FoE Error Code 12 (0x800C) of slave
0x9811006D EC_E_FOE_ERRCODE_INVALID_FIR MWARE	ERROR FoE: Firmware does not fit for Hardware	SLV	FoE Error Code 13 (0x800D) of slave

Code / Define	Text	Group	Possible error cause
			FoE Error Code 14 (0x800E) reserved
0x9811006F EC_E_FOE_ERRCODE_NO_FILE	ERROR FoE: No file to read	SLV	FoE Error Code 15 (0x800F) of slave
0x98130001 EC_E_FOE_ERRCODE_FILE_HEAD_MISSING	ERROR FoE: File header does not exist	SLV	FoE Error Code 16 (0x8010) of slave
0x98130002 EC_E_FOE_ERRCODE_FLASH_PROBLEM	ERROR FoE: Flash problem	SLV	FoE Error Code 17 (0x8011) of slave
0x98130003 EC_E_FOE_ERRCODE_FILE_INCOMPATIBLE	ERROR FoE: File incompatible	SLV	FoE Error Code 18 (0x8012) of slave
0x9811010F EC_E_NO_FOE_SUPPORT_BS	ERROR FoE: Protocol not supported in bootstrap	APP	Application requested FoE in Bootstrap although slave does not support this.
0x9811017A EC_E_FOE_ERRCODE_MAX_FILE_SIZE	ERROR FoE: File is bigger than max file size	APP	Slave returned more data than the buffer provided by application can store.

5.2.6 Servo Drive Profil over EtherCAT (SoE) Error Codes

Code / Define	Text	Group	Possible error cause
0x98110078 EC_E_SOE_ERRORCODE_INVALID_ACCESS	ERROR SoE: Invalid access to element 0		
0x98110079 EC_E_SOE_ERRORCODE_NOT_EXIST	ERROR SoE: Does not exist		
0x9811007A EC_E_SOE_ERRORCODE_INVL_ACC_ELEM1	ERROR SoE: Invalid access to element 1		
0x9811007B EC_E_SOE_ERRORCODE_NAME_NOT_EXIST	ERROR SoE: Name does not exist		
0x9811007C EC_E_SOE_ERRORCODE_NAME_UNDERSIZE	ERROR SoE: Name undersize in transmission		
0x9811007D EC_E_SOE_ERRORCODE_NAME_OVERSIZE	ERROR SoE: Name oversize in transmission		
0x9811007E EC_E_SOE_ERRORCODE_NAME_UNCHANGE	ERROR SoE: Name unchangeable		
0x9811007F EC_E_SOE_ERRORCODE_NAME_WRITE_PROT	ERROR SoE: Name currently write-protected		
0x98110080 EC_E_SOE_ERRORCODE_ATTR_UNDERSIZE	ERROR SoE: Attribute undersize in transmission		
0x98110081 EC_E_SOE_ERRORCODE_ATTR_OVERSIZE	ERROR SoE: Attribute oversize in transmission		
0x98110082 EC_E_SOE_ERRORCODE_ATTR_UNCHANGE	ERROR SoE: Attribute unchangeable		

Code / Define	Text	Group	Possible error cause
0x98110083 EC_E_SOE_ERRORCODE_ATTR_WR_PROT	ERROR SoE: Attribute currently write-protected		
0x98110084 EC_E_SOE_ERRORCODE_UNIT_NO_T_EXIST	ERROR SoE: Unit does not exist		
0x98110085 EC_E_SOE_ERRORCODE_UNIT_UNDERSIZE	ERROR SoE: Unit undersize in transmission		
0x98110086 EC_E_SOE_ERRORCODE_UNIT_OVERSIZE	ERROR SoE: Unit oversize in transmission		
0x98110087 EC_E_SOE_ERRORCODE_UNIT_UNCHANGE	ERROR SoE: Unit unchangeable		
0x98110088 EC_E_SOE_ERRORCODE_UNIT_WR_PROT	ERROR SoE: Unit currently write-protected		
0x98110089 EC_E_SOE_ERRORCODE_MIN_NOT_EXIST	ERROR SoE: Minimum input value does not exist		
0x9811008A EC_E_SOE_ERRORCODE_MIN_UNDERSIZE	ERROR SoE: Minimum input value undersize in transmission		
0x9811008B EC_E_SOE_ERRORCODE_MIN_OVERSIZE	ERROR SoE: Minimum input value oversize in transmission		
0x9811008C EC_E_SOE_ERRORCODE_MIN_UNCHANGE	ERROR SoE: Minimum input value unchangeable		
0x9811008D EC_E_SOE_ERRORCODE_MIN_WR_PROT	ERROR SoE: Minimum input value currently write-protected		
0x9811008E EC_E_SOE_ERRORCODE_MAX_NOT_EXIST	ERROR SoE: Maximum input value does not exist		

Code / Define	Text	Group	Possible error cause
0x9811008F EC_E_SOE_ERRORCODE_MAX_UNDE RSIZE	ERROR SoE: Maximum input value undersize in transmission		
0x98110090 EC_E_SOE_ERRORCODE_MAX_OVE RSIZE	ERROR SoE: Maximum input value oversize in transmission		
0x98110091 EC_E_SOE_ERRORCODE_MAX_UNC HANGE	ERROR SoE: Maximum input value unchangeable		
0x98110092 EC_E_SOE_ERRORCODE_MAX_WR_ PROT	ERROR SoE: Maximum input value currently write-protected		
0x98110093 EC_E_SOE_ERRORCODE_DATA_NO T_EXIST	ERROR SoE: Data item does not exist		
0x98110094 EC_E_SOE_ERRORCODE_DATA_UN DESIZE	ERROR SoE: Data item undersize in transmission		
0x98110095 EC_E_SOE_ERRORCODE_DATA_OV ERSIZE	ERROR SoE: Data item oversize in transmission		
0x98110096 EC_E_SOE_ERRORCODE_DATA_UN CHANGE	ERROR SoE: Data item unchangeable		
0x98110097 EC_E_SOE_ERRORCODE_DATA_WR_ PROT	ERROR SoE: Data item currently write-protected		
0x98110098 EC_E_SOE_ERRORCODE_DATA_MI N_LIMIT	ERROR SoE: Data item less than minimum input value limit		
0x98110099 EC_E_SOE_ERRORCODE_DATA_MA X_LIMIT	ERROR SoE: Data item exceeds maximum input value limit		
0x9811009A EC_E_SOE_ERRORCODE_DATA_INC OR	ERROR SoE: Data item incorrect		

Code / Define	Text	Group	Possible error cause
0x9811009B EC_E_SOE_ERRORCODE_PASWD_P ROT	ERROR SoE: Data item protected by password		
0x9811009C EC_E_SOE_ERRORCODE_TEMP_UN CHANGE	ERROR SoE: Data item temporary unchangeable (in AT or MDT)		
0x9811009D EC_E_SOE_ERRORCODE_INVL_INDI RECT	ERROR SoE: Invalid indirect		
0x9811009E EC_E_SOE_ERRORCODE_TEMP_UN CHANGE1	ERROR SoE: Data item temporary unchangeable (parameter or opmode)		
0x9811009F EC_E_SOE_ERRORCODE_ALREADY _ACTIVE	ERROR SoE: Command already active		
0x98110100 EC_E_SOE_ERRORCODE_NOT_INTE RRUPT	ERROR SoE: Command not interruptable		
0x98110101 EC_E_SOE_ERRORCODE_CMD_NOT _AVAIL	ERROR SoE: Command not available (in this phase)		
0x98110102 EC_E_SOE_ERRORCODE_CMD_NOT _AVAIL1	ERROR SoE: Command not available (invalid parameter)		
0x98110103 EC_E_SOE_ERRORCODE_DRIVE_N O	ERROR SoE: Response drive number not identical with requested drive number		
0x98110104 EC_E_SOE_ERRORCODE_IDN	ERROR SoE: Response IDN not identical with requested IDN		
0x98110105 EC_E_SOE_ERRORCODE_FRAGME NT_LOST	ERROR SoE: At least one fragment lost		
0x98110106 EC_E_SOE_ERRORCODE_BUFFER_ FULL	ERROR SoE: RX buffer full (ecat call with to small data-buffer)		

Code / Define	Text	Group	Possible error cause
0x98110107 EC_E_SOE_ERRORCODE_NO_DATA	ERROR SoE: No data state		
0x98110108 EC_E_SOE_ERRORCODE_NO_DEFAULT_VALUE	ERROR SoE: No default value		
0x98110109 EC_E_SOE_ERRORCODE_DEFAULT_LONG	ERROR SoE: Default value transmission too long		
0x9811010A EC_E_SOE_ERRORCODE_DEFAULT_WP	ERROR SoE: Default value cannot be changed, read only		
0x9811010B EC_E_SOE_ERRORCODE_INVALID_DRIVE_NO	ERROR SoE: Invalid drive number		
0x9811010C EC_E_SOE_ERRORCODE_GENERAL_ERROR	ERROR SoE: General error		
0x9811010D EC_E_SOE_ERRORCODE_NO_ELEMENT_ADDRESS	ERROR SoE: No element addressed		

5.2.7 Remote API Error Codes

Code / Define	Text	Group	Possible error cause
0x9811017D EC_E_SOCKET_DISCONNECTED	Socket disconnected	RAS	IP connection died.
0x98110181 EMRAS_E_INVALIDCOOKIE	Invalid Cookie	RAS	Reconnect with old connection cookie failed. Reconnect is performed implicit with new session cookie. Client registrations a mailbox objects have to be recreated.
0x98110183 EMRAS_E_MULSRVDISMULCON	Connect 2nd server denied because Multi Server support is disabled	RAS	Connection attempt to additional remote API server rejected because an existing connection was established without using multi connection API.
0x98110184 EMRAS_E_LOGONCANCELLED	Logon canceled	RAS	Serverside connection reject while opening a client connection.
0x98110186 EMRAS_E_INVALIDVERSION	Invalid Version	RAS	Connection reject because of using mismatching protocol versions on client and server side.
0x98110187 EMRAS_E_INVALIDACCESSCONFIG	Access configuration is invalid	RAS	The SPoC access configuration is invalid.
0x98110188 EMRAS_E_ACCESSLESS	No access to this call at this accesslevel	RAS	A higher SPoC accesslevel is needed to use the called Remote API function.
0x98110189 EMRAS_E_INVALIDDATARECEIVED	Invalid data received	RAS	The communication as been corrupted
0x98110191 EMRAS_EVT_SERVERSTOPPED	Server stopped	RAS	Closer description if connection dropped because of Remote API Server stop using local API call to stop Remote API server.
0x98110192 EMRAS_EVT_WDEXPIRED	Watchdog expired	RAS	Closer description on server side when connection is dropped because of missing keep-alive messages. Session is still reconnectable.
0x98110193 EMRAS_EVT_RECONEXPIRED	Reconnect expired	RAS	Client tries to reconnect old session after disconnect and server has cleaned session already. A reconnect requires to re-register client thread registrations and created mailbox objects have to be re-created.
0x98110194 EMRAS_EVT_CLIENTLOGON	Client logged on	RAS	Serverside notification if a new client establishes a connection.
0x98110195 EMRAS_EVT_RECONNECT	Client reconnect	RAS	Serverside notification if a client tries to reconnect to an existing session successfully.
0x98110196	Socket exchanged after Reconnect	RAS	Closer description on a connection change, if newly

Code / Define	Text	Group	Possible error cause
EMRAS_EVT_SOCKCHANGE			spawned client socket is transferred to an existing session on a reconnection attempt (only serverside)
0x98110197 EMRAS_EVT_CLNTDISC	Client disconnect	RAS	The remote client was disconnected from server.
0x98110198 EMRAS_E_ACCESS_NOT_FOUND	Access not configured for this call	RAS	The SPoC access configuration is missing.

6 Supported network controllers

Link Layer Name	Controller / Device ID	Windows 7, 8, 10	Linux	WinCE	VxWorks	On Time RTOS-32	T-Kernel	QNX	RTX	INtime	NoOS	TI SYS/BIOS
emllPcap	OS driver	x86										
emllSnarf	OS driver	-			x86, x64, ARM, PPC							
emllSockRaw	OS driver		x86, x64, ARM, PPC									
emll8255x Intel Pro/100	82551QM / 0x1059 82555VE2 / 0x27DC 82557 / 0x1229 82557ER / 0x1209 82559ER / 0x2449 82562 / 0x1039 82801DB / 0x103A 82801EB / 0x1050 Pro/100/M / 0x1229 Pro/100/S / 0x1229 Pro/100/VE / 0x1092	-	x86	x86	x86 PPC	x86	x86	X86	x86	x86	-	
emll8254x Intel Pro/1000	82540EM / 0x100E 82541EI / 0x1013 82541ER / 0x1078 82541GI / 0x1076 82541GI / 0x1077 82541PI / 0x107C 82545GM / 0x1026 82546EB / 0x1010 82546GB / 0x1079 82547EI / 0x1075 82547GI / 0x1019 82566DM / 0x104A 82566L / 0x10BD 82566MC / 0x104D 82567V / 0x10CE 82567V / 0x1501 82567LM / 0x10DE 82567LM / 0x10F5 82571GB / 0x10A4 82571GB / 0x10BC	x86 x64	x86 x64	x86	x86 x64 ARM	x86	x86	x86	x86 x64	x86	-	

Link Layer Name	Controller / Device ID	Windows 7, 8, 10	Linux	WinCE	VxWorks	On Time RTOS-32	T-Kernel	QNX	RTX	INtime	NoOS	TI SYS/BIOS
	82572GI / 0x10B9 82572PI / 0x107D 82573 / 0x108C 82573E / 0x108B 82573L / 0x109A 82574(L) / 0x10D3 82575 / 0x10A7 82577LM/0x10EA 82577LC / 0x10EB 82576 / 0x10C9 82576 ET2 / 0x1526 82576SN / 0x150A 82578DM / 0x10EF 82578DC / 0x10F0 82579LM / 0x1502 82579V / 0x1503 82580 / 0x150E 82580 QF / 0x1527 82583V / 0x150C N1E5132 / 0x105E I350 / 0x1521 I210 / 0x1533 I210 CFL / 0x157B I211AT / 0x1539 I217LM / 0x153A I217V / 0x153B I218LM / 0x155A I218V / 0x1559 I218V / 0x15A1 I218V / 0x15A3 I219LM / 0x156F I219LM / 0x15B7 I219LM / 0x15D7 I219LM / 0x15E3 I219LM / 0x15B9 I219V / 0x1570 I219V / 0x15B8 I219V / 0x15D8 I219V / 0x15D6											
emII L9218i SMSC LAN9218i	L9218i	-		ARM STR9	-	-	-			-	-	
emII RTL8139	8139D / 0x8139	-	x86	x86	x86	x86	x86	x86	X86	-	-	

Link Layer Name	Controller / Device ID	Windows 7, 8, 10	Linux	WinCE	VxWorks	On Time RTOS-32	T-Kernel	QNX	RTX	INtime	NoOS	TI SYS/BIOS
Realtek	8139D / 0x1300				ARM							
emlIRTL8169 Realtek Gigabit	RTL8110 / 0x8169 RTL8111 / 0x8168 RTL8168 / 0x8168 RTL8169 / 0x8169 RTL8169SC/0x8167 RTL8169 / 0x4300 RTL8103 / 0x8136	x86 X64	x86 x64 ARM	x86	x86 x64 ARM	x86		x86	x86 x64	x86	-	
emlICPSW	Texas Instruments AM33xx, AM43xx, AM57xx		ARM	ARM	ARM			ARM				ARM
emlIETSEC	Freescall TSEC/eTSEC controller eTSEC v1 and v2 LS1021A		ARM PPC		ARM, PPC			ARM				
emlIFslFec	Freescall FEC and ENET controller		ARM	ARM								
emlISHEth	R8A77430, R8A77450, R8A7740	-	ARM	-	-	-			-	-	ARM	
emlICCAT	Beckhoff CCAT	x86 x64	x86	X86	x86 x64	x86		x86		x86		
emlIEG20T	Intel EG20T / 0x8802		x86									
emlIDW3504	Altera Cyclone V		ARM					ARM				
emlIGEM	Xilinx Zync		ARM		ARM			ARM				
emlICSS	Texas Instruments AM33xx, AM57xx		ARM									ARM