KPA EtherCAT Master

KPA EtherCAT Master (Master) is a comprehensive product for industrial automation specialists who intend to add high-speed communication capabilities to their applications and solutions. This software stack was ported to various real-time operating systems and hardware platforms, and its unique features facilitate better integration and performance increase.

Key Features

- Versatile functionality exceeding EtherCAT Technology Group (ETG) standard classes
- Available for numerous OS platforms, RTOS and OS-less systems
- Optimized for Xilinx, Intel FPGA (Altera) and others
- Master Redundancy for exceptional fault tolerance
- Autoconfigurator including bus scan and automatic bus configuring
- Experienced team of support engineers ready to help with integration

Master Classes

Master can be delivered as a standard or customized feature package subject to customer's demands. Two standard packages are available in accordance with ETG.1500 requirements: Class A (Standard package) and Class B (Basic package). Besides, for the most demanding customers, koenig-pa offers an additional type of package - Premium, which already includes several advanced extensions. And Full package, which includes all existing extensions and the ability to use the functionality developed in the future at no additional payment.

Name	Basic	Standard	Premium	Full[1]
Core functionality	✓	✓	✓	✓
Process Data Exchange	✓	✓	✓	✓
Network Configuration	✓	✓	✓	✓
Event handler	✓	✓	✓	✓
PI Snapshot	✓	✓	✓	✓
PI Logger	✓	✓	✓	✓
Mailbox support				
CoE	✓	✓	✓	✓
FoE	✓	✓	✓	✓
EoE	–	✓	✓	✓
SoE	–	✓	✓	✓
AoE	–	✓	✓	✓
VoE	–	✓	✓	✓

Name	Basic	Standard	Premium	Full[1]
Distributed Clock (DC)				
Time distribution (Slaves synchronization)	✓	✓	✓	✓
Synchronization of Master with Slaves	–	✓	✓	✓
Continuous Propagation Delay compensation	–	✓	✓	✓
Sync window monitoring	–	✓	✓	✓
Slave-to-Slave Communication	✓	✓	✓	✓
FSoE	–	✓	✓	✓
Feature Packs				
Cable Redundancy	–	*	✓	✓
Hot Connect	*	*	✓	✓
Mailbox Gateway	–	*	✓	✓
Frame Logger and Data Logger	–	–	✓	✓
Explicit Device Identification	–	*	✓	✓
Extensions				
External Synchronization	–	*	*	✓
CAN DBC driver	–	*	*	✓
COM port emulator	–	*	*	✓
Multimaster	–	*	*	✓
Autoconfigurator	*	*	*	✓
Master Redundancy[2]	–	*	*	✓
Hardware Timed Send	*	*	*	✓
Hardware Send Scheduler	*	*	*	✓
Options				
Optimized drivers and HW Extensions	–	*	*	*
RPC Client	–	*	*	*
Python Interface Library	–	*	*	*

"✓" - included in the delivery set
"*" - may be included in the delivery set
"–" - not included in the delivery set
Full[1]- this class includes all existing functionality at the time of a purchase, as well as all the functionality that will be developed in the future.
Master Redundancy[2]- requires the Hardware Timed Send extension to be included in Master license.

Master Versions

Depending on Master version different extensions are available. All versions of the product are supported during the whole period of their use.

Name	Master 1.x	Master 2.x
Feature Packs		
Cable Redundancy	*	*
Hot Connect	*	*
Mailbox Gateway	*	*
Frame Logger	*	*
Data Logger	*	*
Explicit Device Identification	*	*
Extensions		
Access Rights	*	–
External Synchronization	*	*
CAN DBC driver	*	*
COM port emulator	*	*
Multimaster	*	*
Autoconfigurator	–	*
Master Redundancy	–	*
Hardware Timed Send	–	*
Hardware Send Scheduler	–	*
Options		
Optimized drivers		
RtE1000	*	–
TI AM335x BBB	*	–
Realtek RTL8111H	–	*
HW Extensions		
Zynq IP Cores	*	*
TI AM57x PRU Including Send Scheduller	–	*
RPC Client	*	*
Python Interface Library	–	*

"*" - may be included in the delivery set
"–" - not included in the delivery set

Core functionality

- Hard real-time capable in respective environments
- Single-threaded configuration for low-end systems
- Scalable, multi-threaded, multi-tasking configuration for high-end systems
- Asynchronous API and event-driven model for immediate reaction and effective system resources usage
- Multiple Process image clients for any number of PI clients with different rights and isolated internal buffer
- Extended Process Image for additional customization

Feature Packs and Extensions

Feature Packs (in terms of ETG) and Extensions are advanced functional options that can be purchased separately and added to Standard or Premium Classes of KPA EtherCAT Master. Besides ETG Feature Packs we provide the KPA Extensions to extend KPA EtherCAT Master functionality. Currently, the following functional options are available:

- Cable Redundancy (ETG Feature Pack)
- Hot Connect (ETG Feature Pack)
- Mailbox Gateway (ETG Feature Pack)
- External Synchronization (ETG Feature Pack)
- Frame Logger
- Data Logger
- Explicit Device Identification
- CAN DBC driver
- COM port emulator
- Autoconfigurator
- Master Redundancy
- Multimaster
- Hardware Timed Send
- Hardware Send Scheduler

Cable Redundancy

EtherCAT system in Cable Redundancy mode can maintain the communication in case of a cable break or node failure. Therefore, we use a ring topology, which is normally operated in both directions.

Cable Redundancy mode is single-error tolerant, i.e. normal communication with the slaves will continue if the cable is interrupted in one place. When the communication is restored, the original communication direction is restored as well. If the communication is interrupted in more than one place, all connections have to be restored for normal communication.

To implement Cable redundancy feature, only a second Ethernet adapter is required on a target System.

Hot Connect

Hot Connect function allows user to connect additional devices flexibly. They can be optionally removed from or added to the data traffic before the start or during operation of the system. Such actions will not cause the damage of the overall functionality. This is called "flexible topology" or Hot Connect.

Mailbox Gateway

TCP/UDP Mailbox Gateway feature allows extra configuring a device by using a vendor's tool through the KPA EtherCAT Master without extra Ethernet connection or any other connection types.

For configuring the device vendors offer special tools requiring a separate Ethernet connection to the device. With connecting the tool to one NIC (network interface card) of master, user can configure the device via EtherCAT remotely. Master's internal routing of the Ethernet connection from the tool to the drive saves an extra wire and time.

External Synchronization

In an EtherCAT system the distributed clocks concept (DC) is used for synchronization of local clocks in the EtherCAT components. Further information can be found in the separate documentation.

Measurement of one signal at one point in time can be evaluated based on another signal at the same point in time, and thus, these acquisitions need some type of synchronization scheme.

Along with local synchronization of a few production lines with the same source can also be implemented in the boundaries of one production line.

Explicit Device Identification

EtherCAT technology allows slave addressing in different ways depending on device's possibility and user's needs. The use of EtherCAT Device identification is to identify an EtherCAT slave explicitly. This is necessary for the following use cases: Hot Connect applications, prevention against cable swapping.
Also, the Device Identification value can be used optionally for unique addressing.
For slaves supporting the Safety functionality Device Identification is mandatory even if one Safety slave is on the bus.

Three different mechanisms for setting the Device ID are used according to the specification ETG.1020 Protocol Enhancements: Requesting ID, Direct ID, Configured station alias. Explicit device identification is a modern way of the device identification. In most cases it is much more faster than identification via EEPROM Alias.

For details, please, refer to Master documentation.

Frame Logger

With the Frame Logger it is possible to get time information on EtherCAT packets: duration of packet assembling, time of received frame parsing, time of setting frame to queue for sending, etc.

Data Logger

With the Data Logger it is possible to get general information on EtherCAT packets: e.g. what data were sent, when, whether there were missed (unprocessed) frames, etc. Generally, data logging procedure may be represented as getting Wireshark trace in KPA-specific format.

CAN DBC driver

CAN DBC driver converts information to a view specified at the DBC level, what allows user to apply them. It is intended for operating with CAN Gateways produced by BECKHOFF EL6751 (CAN DBC Driver) or KPA EtherCAT4CAN Gateway (4CAN DBC Driver).

COM port emulator

KPA offers an easy way of data exchange with devices with serial interface (RS232/RS422/RS485) when there is no a Serial COM port on the target PC. For example, to communicate with a QR-scanner, or various sensors to measure pressure/ temperature / humidity and so on.

The serial interface terminal is used as a normal Windows COM interface. Using this in conjunction with the KPA Virtual Serial COM driver and the KPA EtherCAT Master allows a user to communicate with a serial device from their Windows application through a Virtual COM port. Master transmits data got from the serial interface terminal to the application and back.

Multimaster

Multimaster functionality allows user to control several EtherCAT buses from the same target system simultaneously. Master API gives an opportunity to create several master instances inside one process (or several processes). Each master instance has its own handle, so resources such as network interfaces and timers are used without conflicts and there is no confusion when using API calls.

Autoconfigurator

Master provides a possibility to configure the bus on the fly. The Autoconfigurator module allows the user application to select slave's configuration (uESI) that will be applied. Then the module generates Master configuration file (ENI) with applied uESI. Further, this ENI will be used at Master work. The Autoconfigurator functionality may be used to switch between different configurations of the slave, e.g. position control of the drive and velocity control, or to switch between bus configurations with different number of slaves. Also, Autoconfigurator functionality can be integrated to the OPC UA /WebSocket communication.

Master Redundancy

Several EtherCAT Masters can co-exist in a network segment, providing backup for seamless EtherCAT operation during possible Master failures. It significantly increases reliability and fault tolerance while reducing downtime.

Master Redundancy requires the Hardware Timed Send feature to be included in Master license.

Hardware Timed Send

The feature "Hardware Timed Send" enables the cyclic frame to be sent exactly at the beginning of the Master cycle without any delays. The hardware timed send function can only be activated if the target system has a hardware timer. With hardware-controlled sending enabled, the Master prepares the frames in advance before starting the cycle and transfers them to a hardware module (HW module) on the target. Therefore, when the cycle starts, the HW module just sends the prepared frames without delay.

The function "Timed send emulation" makes it possible to imitate the timed send functionality, when the target system does not include a hardware timer.

Hardware Send Scheduler

The feature "Hardware send scheduler" allows to reduce the Master load by sending background data on the side of FPGA implemented scheduler. Using this feature leads to the benefits:

- increase of Master performance by decreasing EtherCAT frame preparation time;
- allows to achieve smaller cycle period;
- up to 100% bus utilization.

Options

Options are also advanced functional option that can be purchased separately and added to any Class of KPA EtherCAT Master. Unlike the features, the extensions are not included in any Master class by default and can be added upon request.

- Optimized drivers and HW Extensions
- RPC Client
- Python Interface Library

Optimized drivers and HW Extensions

We provide optimised drivers for certain boards such as BeagleBone Black, MYIR, Xilinx Zynq® ZedBoard and UltraScale+, SALUTE-EL24OM1 etc. Drivers for other boards are available upon request.

Also, available IP Cores for Xilinx and for Intel FPGA (Altera) FPGAs, PRUss co-program for Texas Instrument Sitara CPUs (AM47x and AM57x) which allows to increase productivity and data processing efficiency. Implementation for AM6x is available upon request.

RPC Client

With the RPC Client extension, we provide the ability to connect to Master remotely through the RPC Server which is included in Master. This approach allows to control Master and monitoring its state. It can be implemented to read slave EEPROMs, get Master variables, create charts/diagrams.

Python Interface Library

This extension allows to communicate with Master via RPC Server (included into Master package by default). With RPC Server, it is possible to use Python application to configure or diagnose Master. Python applications are useful to visualize some processes, to create charts/diagrams or for online configuring (the Autoconfigurator feature).

Custom Development

koenig-pa offers specific software development for customers who require additional support for integrating EtherCAT capabilities into their applications or solutions. Our company has extensive experience in fieldbuses, embedded systems, real-time operating environments, industrial automation solutions for various fields of application.

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