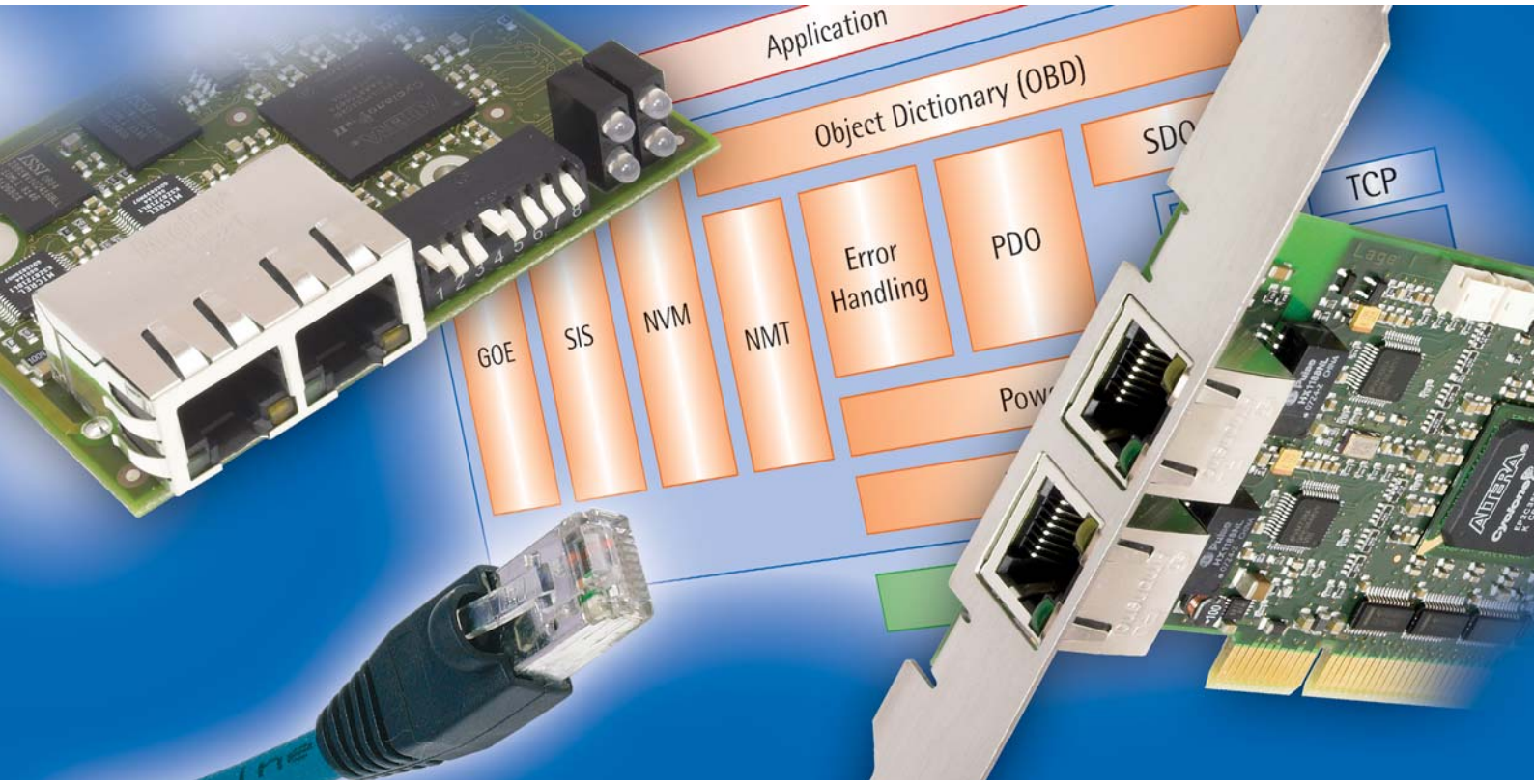
IXXAT



ETHERNET POWERLINK

PC-Interfaces
Integration Modules
Protocol Stacks
Gateways
Development Services

IXXAT · Leibnizstr. 15 · 88250 Weingarten
Tel.: +49-(0)7 51/5 61 46-0 · Fax: +49-(0)7 51/5 61 46-29
Internet: www.ixxat.de · E-mail: info@ixxat.de

IXXAT Inc. · 120 Bedford Center Road · Bedford, NH 03110
Phone: 603-471-0800 · Fax: 603-471-0880
Internet: www.ixxat.com · E-mail: sales@ixxat.com

POWERLINK meets the highest real-time demands of industrial automation, medical, transportation, power generation and many other applications. In addition to microsecond precision, POWERLINK features a common application layer protocol according to CANopen, which ensures plug-and-play interoperability among devices from multiple vendors.

IXXAT offers a complete range of POWERLINK solutions for component manufacturers, system integrators and machine builders.

Real-time industrial Ethernet with POWERLINK

Managing and Controlled Nodes
A POWERLINK system always consists of one Managing Node (MN), such as a PLC, and up to 239 Controlled Nodes (CN), typically I/Os, drives, encoders, sensors, etc. By controlling the bus access, the MN acts as a bus arbitrator that actively avoids collisions on the physical media. A simple request/response protocol exchanged between the MN and the CNs insures real time deterministic behavior of the bus.

Guaranteed real-time
POWERLINK guarantees time-deterministic data transfer by insuring that only one node at any given time has access to the network.

The POWERLINK cycle is divided into an isochronous and an asynchronous period. The MN sends a "start of cycle" message that signals all nodes on the bus the start of a new transmission cycle. During the isochronous period, all nodes transmit their cyclic process data, called PDO (Process Data Objects) when requested by the MN. The following asynchronous period is used for transmitting service data parameters, called SDO (Service Data Objects), or standard IP traffic like web-server accesses or FTP.

Domain separation
Although POWERLINK is using completely standard Ethernet controllers, transceivers, cables and IP protocols, POWERLINK systems always operate in an exclusive real-time domain, which is isolated from legacy Ethernet systems through a POWERLINK router.

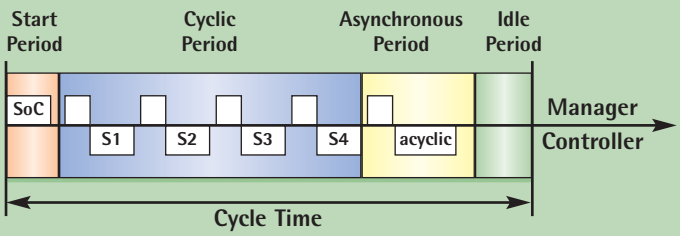
Scaleable performance
Depending on the system requirements for the exchange of cyclic data, a POWERLINK cycle is typically between 200 µs and 1 ms. Of course slower cycles with periods of up to several hundred milliseconds are also possible.

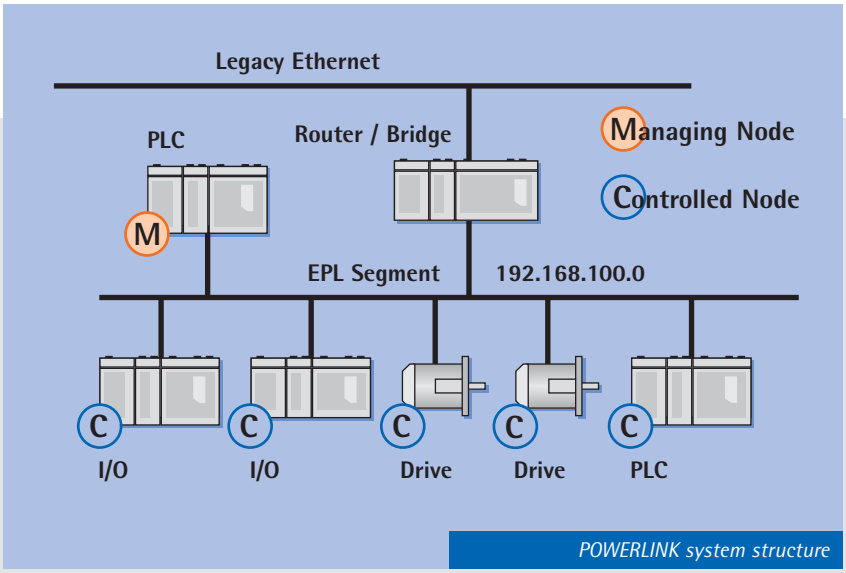
Microsecond precision
The "start of cycle" package is the time reference of all nodes on the bus. The MN broadcasts this timing information with a precision of less than 1 µs, which is used by all controlled nodes to synchronize their application processes.

Producer-Consumer type of data transmission
Since process data is always broadcasted to all other nodes, an overhead-free distribution of data is given. Therefore an efficient, direct data exchange between controlled nodes is provided.

Inside a POWERLINK node
Any microcontroller with an internal or external Ethernet MAC is capable

POWERLINK cycle





POWERLINK system structure

of becoming a POWERLINK node. Both, MN as well as CN functionality may be implemented in form of a software protocol stack which takes advantage of standard Ethernet MACs.
In order to function as a MN, the MN POWERLINK protocol stack is controlling the POWERLINK cycle and requesting the CNs to send their synchronous and asynchronous data. In order to function as a CN, the CN POWERLINK protocol stack is responding to requests of the MN and is receiving data from the other CNs or the MN.

Application Layer Interface
POWERLINK includes an application layer protocol that employs a device model and device profiles that insure plug-and-play interoperability among devices from multiple vendors in virtually any system configuration.
The POWERLINK communication mechanisms and device profiles are fully compliant with the well-adopted CANopen standard.

Similar to CANopen, functions, parameters and data of a device are specified by the entries of an Object Dictionary which can be accessed by different standardized protocols. POWERLINK devices are classified and described by pre-defined device profiles, according to the CANopen standard. Therefore, system users, device users and manufacturers already familiar with CANopen significantly benefit from this when migrating to POWERLINK as an Ethernet-based technology.

IXXAT POWERLINK products

IXXAT provides a complete range of POWERLINK products and services including protocol stacks, communication modules and interfaces, configuration tools and prototype development services.

POWERLINK Protocol Software

IXXAT's POWERLINK protocol software is considered to be the reference protocol stack in the market since all the products of the main players are using this stack. The IXXAT POWERLINK protocol software incorporates all the mandatory and most of the optional features of the latest POWERLINK specification.
The IXXAT protocol software allows a seamless integration of POWERLINK into embedded systems.

The protocol software is available in form of source code in a generic version for "Controlled-Nodes" and "Managing- Nodes". Due to its modular structure, the software is easily scalable according to the required performance. Already available are specifically adapted version for different target systems and platforms. Although it is possible to use IXXAT's POWERLINK protocol software with an operating system, it is not necessary.

Incorporation of POWERLINK's hard real-time tasks into specific hardware platforms
The POWERLINK protocol software is divided into several layers. The lower layer driver (LLD) represents a hardware abstraction layer and is responsible for the real-time behavior of a POWERLINK device. This layer has to be adapted to the specific features of the hardware platform such as the Ethernet controller, the Interrupt system and if necessary, the operating system.

Object dictionary and programming interface
The Object Dictionary represents the interface between the application process and the bus communication. Each Object Dictionary entry can be directly referenced to a variable in the application. Process Data Objects (PDOs) and Service Data Objects (SDOs) access these application variables directly.
User-specific call-back functions can be linked to every application object that enables an event-controlled notification of the application. This mechanism provides a direct and application-specific reaction on received data.

Process (PDO) and Service Data Objects (SDO)
According to CANopen, POWERLINK provides two communication princi-

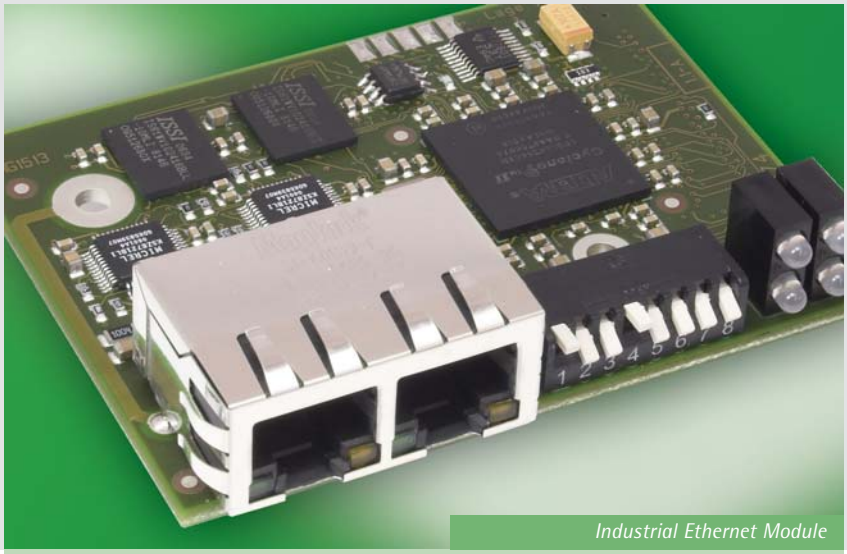
ples to address the requirements of industrial communication systems: The exchange of cyclically transferred, real-time-critical process data by means of "Process Data Objects" (PDOs) and the non-time critical access to Object Dictionary entries by means of "Service Data Objects" (SDOs).
Mapping of application data into PDOs can be configured statically or dynamically. Dynamic PDO mapping is used in situations in which the operation modes of a device have to be changed during run-time.
The transfer of SDOs is a fully confirmed service used for Object Dictionary read/write access such as the exchange of configuration data or for control of device functions. The SDO protocol also supports the transfer of large amount of data such as downloading of device code.

Since the SDO protocol can also be embedded into a UDP/IP frame, a POWERLINK node can communicate directly with a generic Ethernet device such as a PC.

Multi-channel support
The POWERLINK protocol software supports the implementation of several independent POWERLINK interfaces into a single device. MN or CN functionality can be configured separately with independent Object Dictionaries for each channel. This feature is extremely useful for example when a device must serve as a gateway between different POWERLINK segments in which the one device is acting as a CN and the other device as a MN.

Operating system support
Since the POWERLINK protocol software can be used with or without an operating system, the software provides its own scheduler which ensures optimal allocation of the available processing time to the various stack functions. When using an operating system, the POWERLINK protocol software is executed as one task. Only basic operating system functions such as semaphores and tasks are required. These functions are encapsulated by an abstraction layer called GOE (Generic Operating Environment). Therefore adaptation of the stack to specific operation system can be easily done.

Reference platform
The POWERLINK protocol software has been developed for embedded systems using "C" based development environments and is provided as reference implementation for the Freescale ColdFire 523x platform. Due to the strict ANSI-C coding, the software can be ported to almost any target system
The POWERLINK protocol software can be used with almost any TCP/IP stack, which usually comes with the operating system. Alternatively, TCP/IP stacks from alternate vendors can be used.



Industrial Ethernet Module

POWERLINKsafety Protocol Software

The trend for implementation of safety-critical systems continues to change from discrete cabling towards the use of already available standard communication systems. With the POWERLINKsafety protocol software the exchange of safety-related data over a non-safety network like POWERLINK is possible up to SIL-3.
IXXAT has developed the POWERLINKsafety protocol software for B&R as a pre-certified component that is shipped as C source code. The software can be run with or without an operating system. Based on hardware and software abstraction layers, the POWERLINKsafety protocol software can be easily adapted do different platforms and compilers. IXXAT offers development services for the POWERLINKsafety hardware and software integration. Reference portations to Intel Xscale (IXP420) and Atmel ARM7 (AT91SAM7S64) for GNU C-Compiler are available.

Industrial Ethernet Module

FPGA-based embedded "single-chip" solution for POWERLINK Controlled Nodes

The POWERLINK version of the Industrial Ethernet Module has been specifically designed to add POWERLINK capability to devices such as drives, I/O modules or encoders without significantly influencing the system's performance. On the Industrial Ethernet Module a FPGA with the integrated Altera NIOS II processor core and external RAM executes a fully-featured CN protocol stack.

The Industrial Ethernet module can be used as piggy-back board or can be designed into custom-specific board layouts. The generic approach

POWERLINK / CANopen Gateway

of the module´s API allows simple migration to other Ethernet-based field buses like EtherNet/IP, PROFINET I/O, EtherCAT or SERCOS III that can be run on the Industrial Ethernet Module as well.

The FPGA employs an Ethernet MAC and a 2-port HUB, which is connected to two RJ45 jacks. The module provides fast response times (< 2 µs) and POWERLINK cycle times down to 400 µs.

Simple I/O applications can be completely implemented on the FPGA processor core together with the POWERLINK CN protocol stack. For more complex applications which are executed on an extra host MCU, the Industrial Ethernet Module provides a parallel 16/32 address/data bus interface or a serial interface via SPI. Other custom-specific host-interfaces can be integrated within the FPGA as well. The data exchange is processed in the external RAM of the FPGA, which functions as shared memory between the FPGA processor core and host MCU.
For evaluation purposes a base board is available that provides power supply and host MCU connectivity. Additional it is possible to directly connect Phytec or Spectrum Digital processor modules.

A major advantage of the Industrial Ethernet Module is its ability to integrate the complete POWERLINK CN functionality without affecting the performance of the host MCU. Additionally a very easy POWERLINK CN connectivity can be provided based on already existing device hardware and application software, originally designed for lower performance field busses like CANopen, DeviceNet or Profibus.

POWERLINK/ CANopen Gateway

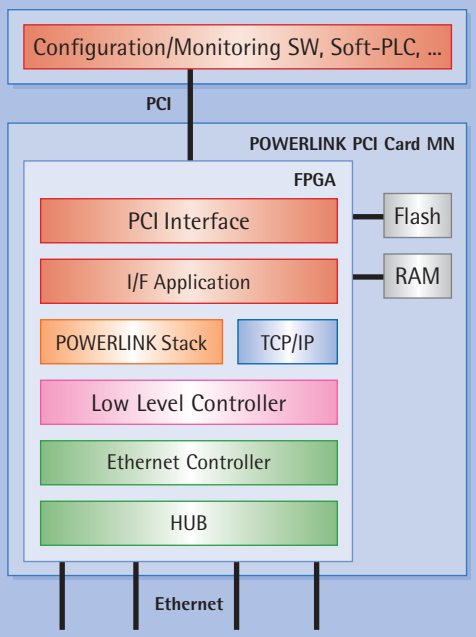
Because of the similarity of CANopen and POWERLINK, the extension or integration of CANopen systems within POWERLINK systems is easily achievable. Existing CANopen systems can be extended by POWERLINK in many ways by means of of special POWERLINK/CANopen-Gateways. In this way, for example, several CANopen segments can be linked via a POWERLINK network with each other over large distances. In addition, central data logging can be carried out across several CANopen subsegments due to the high bandwidth of the POWERLINK network.

The IXXAT POWERLINK/CANopen-Gateway offers a simple way of combining CANopen and POWERLINK networks. From the point of view of the POWERLINK network, the gateway provides full access to the input and output data of the CANopen network acting as a standard POWERLINK Controlled Node. On the CANopen side, the Gateway can be configured either as a CANopen master or slave. Synchronization of the CANopen network by the very precise POWERLINK SoC message is also possible.

POWERLINK PC Interface Board

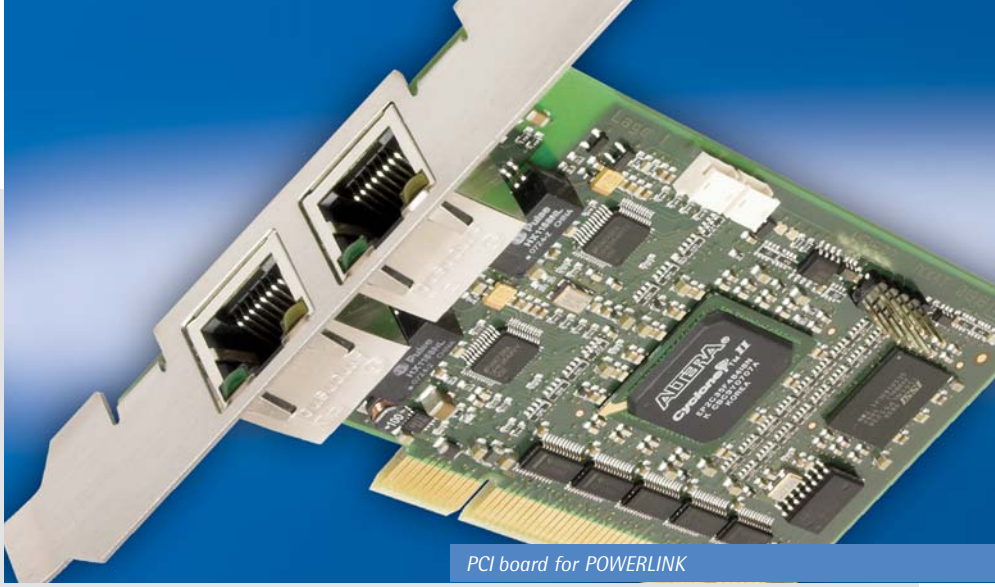
With the increasing use of industrial PCs, PCI-based fieldbus adapters have become very popular. Since most of the industrial PC architectures are not capable to address the needs of real-time buses, such as POWERLINK, the use of specific interface cards becomes necessary to isolate the PC from the real-time events on the bus. The IXXAT POWERLINK PCI board features complete POWERLINK functionality and can be operated as managing node (MN) or as controlled node (CN). The host application accesses the POWERLINK interface board through an application-programmer`s interface (API), which has access to the POWERLINK network via a command/status and a data interface. Input and output variables are represented in form of process images. The API for Windows 2000/XP supports multi-channel as well as the multi-board operation. This means that several POWERLINK PCI cards can be used in one PC through one or more host applications. The synchronization of the PCI cards is enabled by an extra

Structure of the PC interface board for POWERLINK



sync line, which makes it possible to implement a hardware synchronization between several POWERLINK PCI cards in one PC.
The POWERLINK PC interface is able to perform POWERLINK cycles down to 200 µs with a SoC jitter of less than 50 ns and to support networks with up to 240 nodes.

The integrated 2-port Hub connects the two RJ45 connectors of the PCI card and simplifies cabling.



PCI board for POWERLINK

High Performance POWERLINK FPGA IP

For custom-specific design-ins of Managing Nodes a POWERLINK FPGA IP is also available from IXXAT. Based on this solution, cost efficient and high-performance full-featured MN solutions can be developed in very short time.
Integrated on a single Altera FPGA the complete functionality of a POWERLINK MN is available in form of a FPGA IP core. This core comprises an Ethernet MAC, Hub, POWERLINK MN stack as well as the Altera NIOS II CPU. The FPGA Core provides sufficient power to run POWERLINK cycles down to 200 µs or to control networks with up to 240 nodes.
The IXXAT POWERLINK FPGA IP provides very fast Ethernet response times (< 2 µs) which allow the most efficient use of the Ethernet bandwidth. The ultra precise SoC transmission (Jitter < 50 ns) is another crucial feature of this solution.

It is possible to use the IXXAT POWERLINK FPGA IP also for custom-specific MN Design-In solutions. Due to the high degree of flexibility offered by the FPGA, the IXXAT POWERLINK FPGA IP can be easily adapted to the customers needs.

POWERLINK Network Configuration Tool

The IXXAT POWERLINK ConfigurationStudio enables the user to customize and generate the configuration data for POWERLINK and CANopen networks and supports the system integrator during system configuration.

Besides the assembly of the network components by selecting the devices from a device catalogue, the tool allows the definition of parameter values, the linking of input and output data as well as the definition of network variables of IEC61131 conformal devices.

The PDO mapping is calculated automatically based on the defined linking of input and output data. Furthermore all timing parameters for the MN and the CNs are calculated automatically. The configuration data (concised-DCF), which is used by the MN for downloading the configuration data to the devices during system boot-up is also generated by the tool.
The POWERLINK ConfigurationStudio is available as stand-alone version or as module for integration into OEM tools. Besides XML based device description files (XDD/XDC) also CANopen EDS/DCF file format is supported.

Seminars

IXXAT offers a 2-day seminar on POWERLINK, which helps the participants to evaluate the potential of POWERLINK. The seminar illustrates various approaches for implementing POWERLINK in an automation device. It is intended in particular for developers and system designers who want a solid introduction into this technology. The seminar is offered at IXXAT or in-house in English or German language.

Services

Beside the POWERLINK products, IXXAT offers a range of development and consulting services like:
- Customized Hardware and Software development
- Code Introduction
- Application consulting
- Software integration services
- Development of complete POWERLINK turn-key solutions

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