

Software

Software solutions available from
IXXAT Automation GmbH

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1 Introduction

IXXAT Automation GmbH has been involved in the specification and development of higher layer CAN based protocols for more than 10 years. Besides other standardization related activities IXXAT has provided essential contributions to the specification of the CANopen standards. As a founding member of CAN in Automation (CiA), an international users' and manufacturers' organization, IXXAT is actively collaborating with all important technical working groups. Drawing on this unique experience IXXAT is in the position to offer CANopen products that meet all requirements of current and future applications in the field of industrial and embedded system solutions.

Embedded CANopen software solutions from IXXAT Automation GmbH are characterized by offering extensive functionality compliant to the most recent CANopen specifications, their extensive configuration and scaling capabilities, and their high efficiency combined with minimum resource requirements. Due to their highly modular structure they can be easily adapted to alternate micro and CAN controllers.

The IXXAT embedded CANopen software solutions are targeted at two main application areas:

- Simple CANopen applications like for example sensor and actuator units, drives, MMI units etc. that require CANopen Slave functionality and possibly support for limited network management and coordination tasks (NMT Master, SYNC Producer).
- Highly configurable CANopen Managers like programmable logic controllers (PLC) or intelligent PC interface solutions that require full network and configuration management capabilities tightly integrated with the CANopen protocol stack.

Serving these distinct application domains, IXXAT Automation GmbH offers two main product lines, the CANopen Protocol Software and the CANopen Master/Manager Software. These product lines will be discussed individually in the following chapters.

Complementing the embedded software solutions described in this paper, IXXAT offers CANopen software for maritime applications which is described in a separate publication.

2 CANopen Protocol Software

The CANopen Protocol Software (see Figure 1) is available as either Slave or Master/Slave package. The Slave package implements all CANopen Slave mechanisms specified in CiA DS-301 V4.02. LSS functionality according to CiA DSP-305 V1.1 and support for Startup-capable Devices according to CiA DSP-302 V3.2 are available as add-on modules. The two versions Slave S and Slave D differ only in their support for dynamic PDO-Mapping.

The Master/Slave package enhances this feature list with basic CANopen Master functionality, as well as support for NMT Startup-Object and Slave Assignment List according to CiA DSP-302 V3.2. Master related application functionality like for example handling the network boot-up has to be coded in the user application. The Master/Slave package is in general suited for the implementation of master devices in a network with a static system structure. Various add-on modules are available for LSS Master or Slave services according to CiA DSP-305 V1.1, and Flying Master as well as SDO Manager functionality according to CiA DSP-302 V3.2.

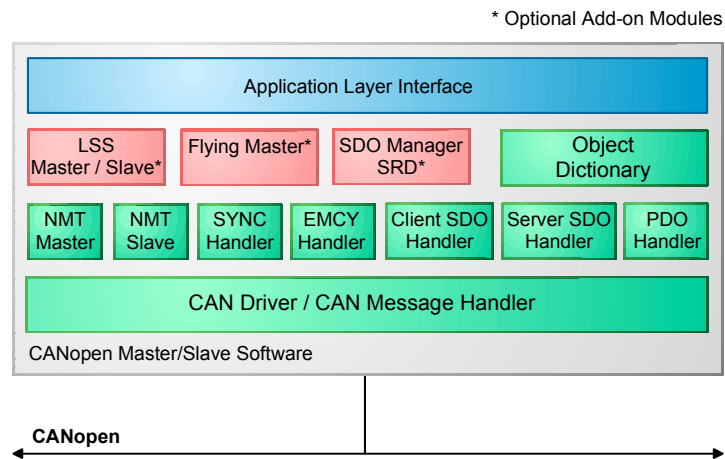


Figure 1: Basic software structure of the CANopen Slave and Master/Slave packages

All versions of the IXXAT CANopen Protocol Software feature a modular architecture permitting that only required CANopen functionality is compiled into the executable code. Internally the software is based on an object dictionary data structure with pointers to application variables and functions, CANopen functions responsible for the execution of CANopen services requested by the application, and application call-back functions for the notification of the application about received data or occurred events. Existing applications can be easily integrated with the CANopen Protocol Software.

As of Version 4.10, all flavours of the IXXAT CANopen Protocol Software include support for the CiA DR 303-3 Indicator Specification. A detailed comparison of the functionality supported by the different versions of the CANopen Protocol Software can be found in Table 1.

In addition to the standard protocol software IXXAT offers CANopenRT (see Figure 2), a version of the CANopen Protocol Software specifically tailored for the use in either Real-Time or mainstream operating system environments. In the CANopenRT framework, the CANopen protocol stack runs separated from the actual user application embedded in an independent process. The application interfaces to the CANopen process via services defined in a CANopen Real-Time Module (CRT). CRT Module and application process use an operating system independent representation of mail-boxes, semaphores and tasks to communicate with the operating system environment. This approach permits multiple application tasks to access one common CANopen protocol stack. The CANopen process interfaces via a generic wrapper library that

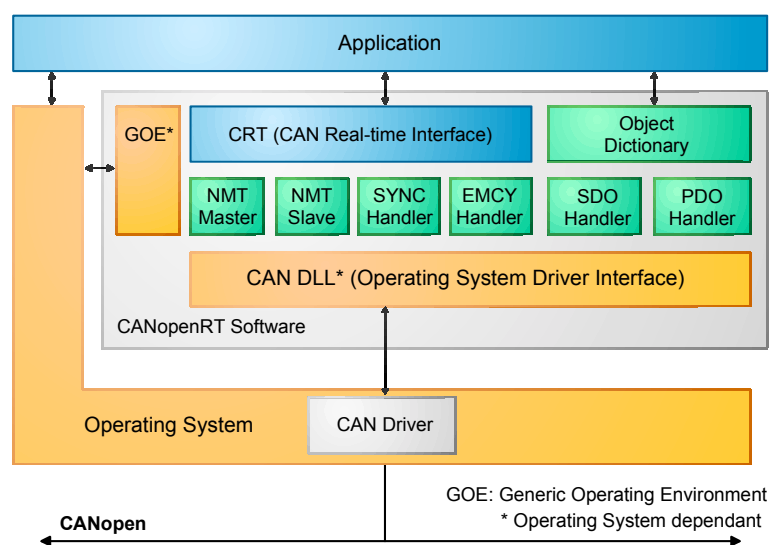


Figure 2: Elements of the CANopenRT software

maps the operating system specific driver API to the generic interface as expected by the protocol stack. Typical applications of CANopenRT can be seen in CAN devices in which complex control and regulation tasks have to be executed concurrently to the handling of the CANopen protocol itself.

Table 1: CANopen Protocol Software
 Functionality overview of versions Slave S, Slave D and Master/Slave
 P: Producer; C: Consumer; M: Master; S: Slave

Functionality	Slave S	Slave D	Master/Slave
Maximum Number of Server-SDOs	128	128	128
Maximum Number of Client-SDOs	-	-	128
Maximum Number of PDOs (Tx/Rx)	256	256	256
Dynamic PDO Mapping	-	✓	✓
SYNC Object	C	C	P/C
EMERGENCY Object	P	P	P/C
TIME STAMP Object	C	C	P/C
NMT-Functionality	S	S	M/S
Node Guarding/Heartbeat	✓	✓	✓
ID-Configuration according to Predefined Connection Set	✓	✓	✓
ID-Configuration via SDOs	✓	✓	✓
NMT Start-up-Object (Object 1F80H) according to CiA DSP 302	✓	✓	✓
Slave-Assignment-List (Object 1F81H) according to CiA DSP 302	-	-	✓
Indicator/LED according to CiA DR 303-3	✓	✓	✓
Flying Master according to CiA DSP 302	S optional	S optional	M/S optional
Layer Setting Services according to CiA DSP 305	S optional	S optional	M/S optional
SDO Manager according to DSP 302	SRD optional	SRD optional	SDM optional

3 CANopen Master/Manager Software

In complex CANopen systems with a possibly dynamic network topology the CANopen Master must implement a much higher degree of local intelligence. Typical scenarios include CANopen interfaces for PCs and PLCs. For these kind of applications IXXAT Automation GmbH offers the CANopen Master/Manager Software. This package differs from the Master/Slave Software described in the previous chapter by adding CANopen Manager functionality as specified in CiA DSP 302 V3.2. Supported are:

- Standardized Boot-Up Procedure.
- Network Management (configured via Object Dictionary entries 1F80H *NMTStartup* and 1F81H *SlaveAssignment*).
- Request NMT-Object (Object 1F82H *RequestNMT*).
- Configuration Manager (configured via Objects 1F22H *Concise DCF*, 1F26H, 1F27H *ExpectedConfigurationDate* and *ExpectedConfigurationTime*).
- Request Configuration (Object 1F25H *ConfigureSlave*).
- Verify Configuration (Object 1020H *Verify Configuration*).

In addition to the services specified in CiA DSP 302 the Master/Manager Software offers an auto-configuration mode that allows to automatically scan and configure slave devices connected to the CANopen network.

The Master/Manager Software allows the user to implement both master and slave devices. The actual mode is selected via an entry in the local Object Dictionary. The application and the CANopen protocol run in logically separate functional units. They are connected via the process image, a diagnostics and a command interface (see Figure 3), the latter being subdivided into three distinct components. The general command interface controls the functionality of Master/Manager. The general SDO command interface permits to access local, and if in master mode also remote Object Dictionary entries. The application specific SDO interface implements a link between local Object Dictionary entries in the Manufacturer- and Device Profile-specific range. Due to its structure, the command interface supports IEC 61131-3 functional modules as specified in CiA DS 405. Via the diagnostics and error interface the status of all CANopen devices including the Master/Manager and its internal state machine is reported to the application process. Finally the Process Image establishes the interface between the actual process data and the application. The addressing scheme implemented in the Process Image of the IXXAT Master/Manager software complies with CiA DS 405.

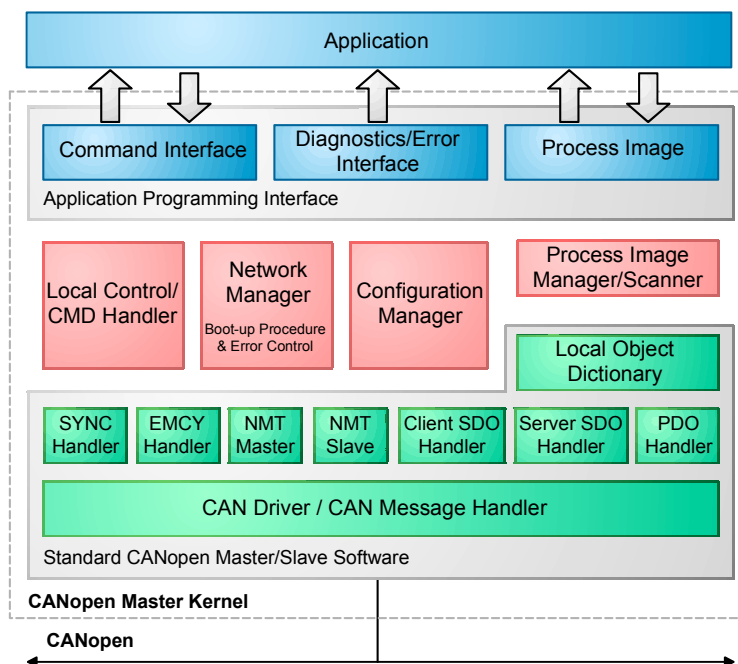


Figure 3: Software structure of the Master/Manager software

In order to achieve the highest possible quality, IXXAT embedded software solutions are constantly improved and extensively tested to comply with the most recent CANopen specifications. IXXAT actively pursues a ISO9001 based quality management system including constant code reviews and regression tests. Both static and dynamic software tests at all levels of the code generation process assure that software discrepancies are detected already in the early stages of the development process. Pending final release the software is subjected to the official CiA CANopen Conformance test.

4 Software Validation

On request the IXXAT internal test tools can be made available and adapted to serve as building blocks for customer specific product validation suites.

5 Availability

IXXAT embedded CANopen software solutions are largely independent of the underlying processor architecture. Hardware dependencies related to for example the CAN controller are completely encapsulated in the corresponding driver modules. For certain combinations of micro and CAN controllers (see Table 2) IXXAT provides ready-to-use reference implementations, which are delivered with project files that are already adapted to commonly available evaluation platforms. The list of available target platforms is constantly enhanced. Adaptations to other micro and CAN controllers can be performed with minimum effort either by the customer or on request by IXXAT Automation GmbH.

Table 2: Availability of reference implementations – Combinations of micro-, CAN controller and development environment

Micro Controller	CAN Controller	Development Tool Chain
80x51	Philips SJA1000	Keil C51
80x51	Intel i82527	Keil C51
Infineon C165	Philips SJA1000	Keil C166
Infineon C165	Intel i82527	Keil C166
Infineon C165	Intel i82527	Tasking C166/ST10
Intel 80x86	Philips SJA1000	Borland C
Intel 80x86	Intel i82527	Borland C
Atmel T89C51CC01	internal	Keil C51
Fujitsu MB90F543	internal	Fujitsu Softune
Infineon C167CR	internal	Keil C166
Infineon C167CR	internal	Tasking C166/ST10
Infineon XC16x	internal	Keil C166
Microchip PIC18F458	internal	MPLAB C18
Microchip PIC18F6680	internal	MPLAB C18
Mitsubishi M16C (C62-6N)	internal	Tasking M16C
Texas Instruments TMS320F28xx	internal	C24x/C28x Code Composer Studio IDE

6 Support and Services

IXXAT Automation GmbH is one of the leading suppliers of CANopen communication technologies. Since many years IXXAT products are in use worldwide in the field of automation technology, machine and plant construction, medical technology, and in military, maritime and automotive applications. IXXAT supports its customers with consulting services and technical training, as early as in the phase of product and system definition, as well as with prototyping of individual components up to the delivery of fully developed and tested products. Specific adaptations of IXXAT products according to customer requirements can be realized on request.

7 Contact Information

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For a list of international distributors please consult the IXXAT web page under:

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