

Embedded **CANopen**[®] Software



Version: 1.1
Editor: Dr. M. Merkel
Date: 2015-05-13
Doc. No: WP112-0005

**Software solutions available from
IXXAT Automation GmbH**

White Paper

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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 20 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 Manager Software. These product lines will be discussed individually in the following chapters.

2 CANopen Protocol Software

The CANopen Protocol Software (see Figure 1) is available as either Slave or Master package. The Slave package implements all CANopen slave mechanisms specified in CiA 301 V4.2 and includes LSS slave functionality according to CiA 305 V2.2. Support for start-up capable devices according to CiA 302 V4.1 is available as add-on module.

The Master package enhances this feature list with basic CANopen master functionality, including support for the NMT startup and NMT slave assignment objects according to the most recent versions of CiA 302. Master related application functionality such as handling the network boot-up has to be coded in the user application. In general the Master package is targeted at the implementation of master devices in a network with a static system topology. Included with the Master package is LSS master functionality including support for LSS Fastscan. Complete flying master functionality according to CiA 302-2 is available as optional add-on.

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 other events. Existing applications can be easily integrated with the CANopen Protocol Software.

All variants of the IXXAT CANopen Protocol Software include support for the CiA 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 with CANopenRT a version of the CANopen Protocol Software specifically tailored for the use in either real-time or mainstream operating system environments (see Figure 2). In the CANopenRT framework, the CANopen protocol stack runs separated from the actual user application embedded in independent threads. The application interfaces to the CANopen processes via services defined in a CANopen Real-Time Module (CRT). CRT module and application process use an operating system independent abstraction of mailboxes, 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 maps the operating system specific CAN driver API to the generic CAN interface as expected by the protocol stack.

The typical application domains for CANopenRT are complex devices where control and regulation tasks have to be executed concurrently to the handling of the CANopen protocol itself.

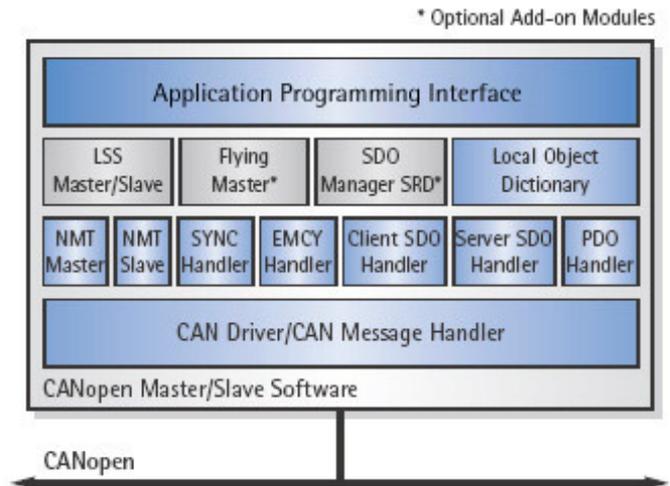


Figure 1: Basic software structure of the CANopen Slave and Slave and Master packages

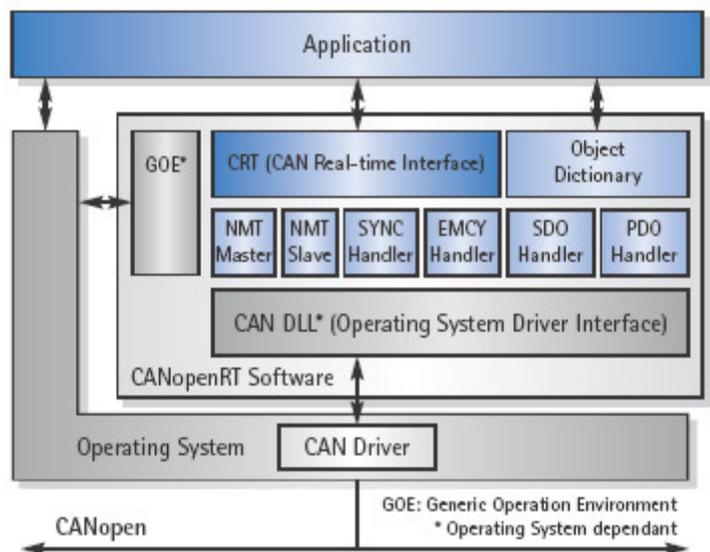


Figure 2: Elements of the CANopenRT software

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

Function	Slave	Master
Supported number of server SDOs	127	127
Supported number of client SDOs	-	127
Supported number of PDOs (Tx/Rx)	512	512
Dynamic PDO mapping	✓	✓
SYNC object	C	P/C
EMERGENCY object	P	P/C
TIME STAMP object	C	P/C
NMT functionality	S	M/S
Node guarding, heartbeat	✓	✓
CAN-ID configuration according to Predefined Connection Set	✓	✓
CAN-ID configuration via SDOs	✓	✓
NMT startup object (1F80 _h) according to CiA 302-2	✓	✓
NMT slave assignment object (1F81 _h) according to CiA 302-2	-	✓
Status display according to CiA 303-3	✓	✓
Flying Master according to CiA 302	S (optional)	M/S (optional)
LSS services according to CiA 305	S	M/S

3 CANopen 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 kinds of applications IXXAT offers the CANopen Manager Software. This package differs from the CANopen Master package described in the previous chapter by adding CANopen manager functionality as specified in CiA 302. Supported features are:

- Standardized NMT start-up procedure
- Network management (configured via object dictionary entries 1F80_h NMT startup and 1F81_h NMT slave assignment)
- Request NMT (object 1F82_h Request NMT)
- Configuration manager (configured via objects 1F22_h Concise DCF, 1F26_h Expected configuration date, and 1F27_h Expected configuration time)
- Request configuration (Object 1F25_h Configure slave)
- Verify configuration (Object 1020_h Verify configuration)

In addition to the services specified in CiA 302 the CANopen Manager Software offers an auto-configuration mode that allows automatically scanning and configuring slave devices connected to the CANopen network.

The CANopen Manager Software allows the user to implement both master and slave devices. The active 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, and a diagnostics and command interface (see Figure 3), the latter being subdivided into three distinct components. The general command interface controls the functionality of CANopen manager. The general SDO command interface permits to access local, and if in master mode also remote object dictionary entries. Due to its structure, the command interface supports IEC 61131-3 functional modules as previously specified in CiA 405 (now moved to CiA 314). Via the diagnostics and error interface the status of all CANopen devices including the CANopen 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 CANopen Manager Software complies with CiA 302-4.

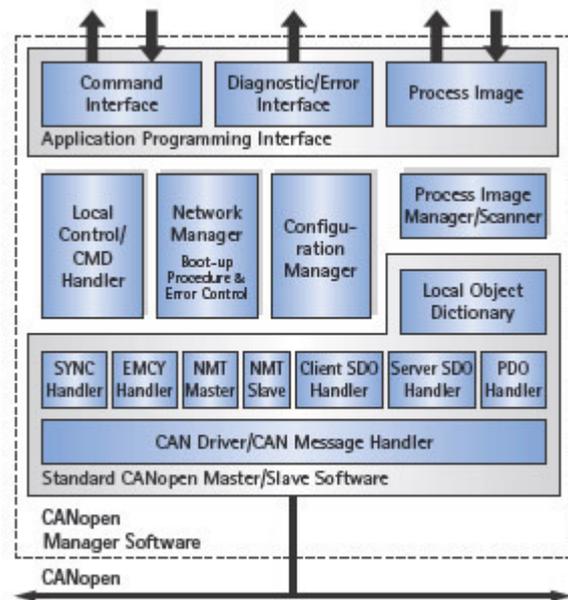


Figure 3: Software structure of the CANopen Manager Software

4 Software Validation

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 an 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.

5 Availability

IXXAT embedded CANopen software solutions are largely independent of the underlying processor architecture. Hardware dependencies related to the CAN controller are completely encapsulated in the corresponding driver modules. For certain combinations of micro and CAN controllers (please refer to <http://www.ixxat.com>) 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.

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.

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