compatible with you

CAN 300 PRO

CAN Communication Module for S7-300
CANopen® Master, CAN Layer 2 or SAE J1939

700-600-CAN12

Manual

Edition 3 / 06.07.2009 / HW30 & FW1.08 and higher

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Note:

We have checked the content of this manual for conformity with the hardware and software described. Nevertheless, because deviations cannot be ruled out, we cannot accept any liability for complete conformity. The data in this manual are checked regularly. The latest version of the manual can be downloaded from the internet at any time at www.helmholz.com.

Our customers are important to us. We are always interested in ideas for improvement and suggestions.

Revision history of this document:

Edition	Date	Revision
1	11.03.2009	1st version
2		minor corrections
3	02.07.2009	Behavior of the power LED in the CANopen® Master mode Correction of the calling parameter of the FCs Addition of the CANopen® Tools of the CANParam v4.10

Contents

1 Safety Information

Please observe the safety information given for your own and other people's safety. The safety information indicates possible hazards and provides information about how you can avoid hazardous situations.

The following symbols are used in this manual.

Caution, indicates hazards and sources of error

Gives information

Hazard, general or specific

*Danger of **electric shock***

1.1 General

The CAN 300 PRO module is only used as part of a complete system.

The operator of a machine system is responsible for observing all safety and accident prevention regulations applicable to the application in question.

During configuration, safety and accident prevention rules specific to the application must be observed.

Emergency OFF facilities according to EN 60204 / IEC 204 must remain active in all modes of the machine system. The system must not enter an undefined restart.

Faults occurring in the machine system that can cause damage to property or injury to persons must be prevented by additional external equipment. Such equipment must also ensure entry into a safe state in the event of a fault. Such equipment includes electromechanical safety buttons, mechanical interlocks, etc. (see EN 954-1, risk assessment).

Never execute or initiate safety-related functions using the operator terminal.

1.2 Restriction of access

Only authorized persons must have access to the modules!

The modules are open equipment and must only be installed in electrical equipment rooms, cabinets, or housings. Access to the electrical equipment rooms, barriers, or housings must only be possible using a tool or key and only permitted to personnel having received instruction or authorization. See also Section 2.

1.3 Information for the user

This manual is addressed to anyone wishing to configure or install the CAN 300 PRO module.

It is intended for use as a programming manual and reference work by the configuring engineer. It provides the installing technician with all the necessary data.

The CAN 300 PRO module is exclusively for use in a S7-300 programmable controller from Siemens. For that reason, the configuring engineer, user, and installing technician must observe the standards, safety and accident prevention rules applicable in the particular application. The operator of the automation system is responsible for observing these rules.

1.4 Use as intended

The CAN 300 module must only be used as a communication system as described in the manual.

1.5 Avoiding use not as intended!

Safety-related functions must not be controlled using the CAN 300 PRO module alone.

2 Installation and Mounting

The CAN 300 PRO module must be installed according to VDE 0100 IEC 364. Because it is an “OPEN type” module, you must install it in a (switching) cabinet. Ambient temperature: 0 °C – 60 °C.

Before you start installation work, all system components must be disconnected from their power source.

*Danger of **electric shock**!*

During installation, application-specific safety and accident prevention rules must be observed.

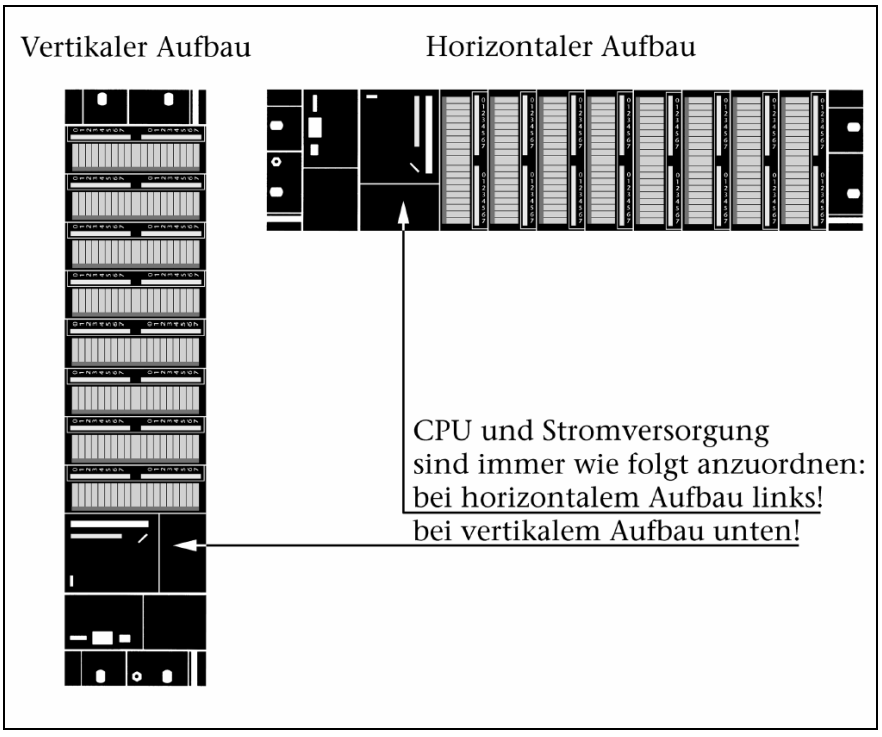
2.1 Vertical and horizontal mounting

The modules can be mounted either vertically or horizontally.

Permissible ambient temperature:

for vertical mounting: from 0 to 40 °C

for horizontal mounting: from 0 to 60 °C



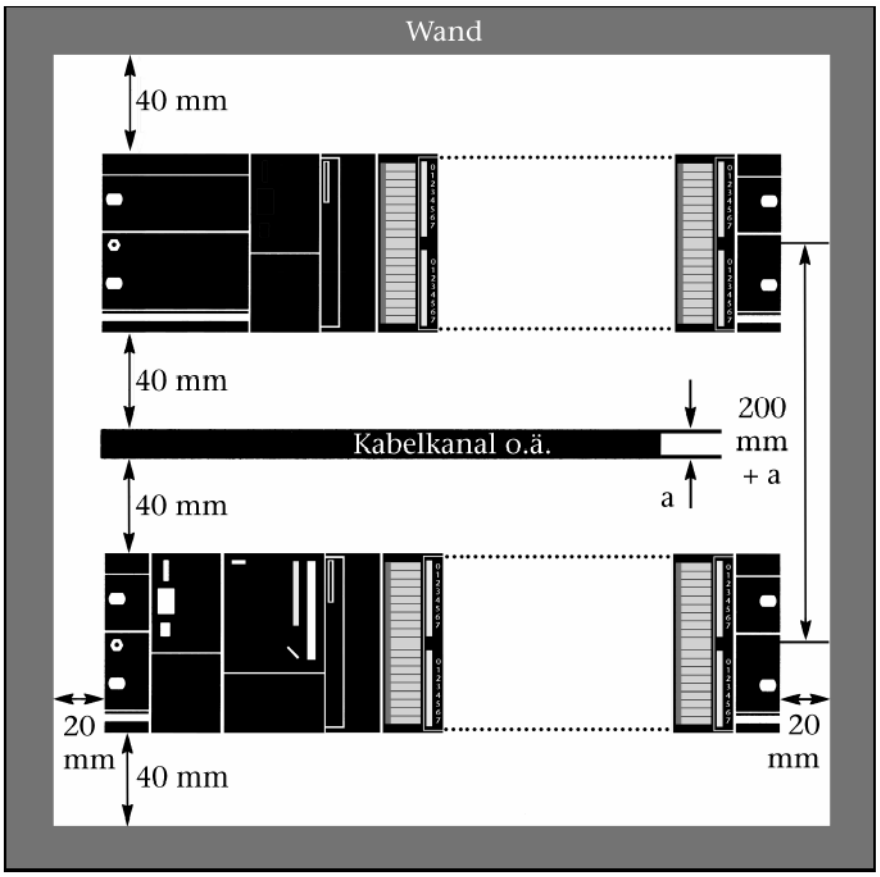
2.2 Minimum clearance

Minimum clearances must be observed because

- it ensures cooling of the CAN 300 PRO modules
- it provides space to insert and remove modules
- it provides space to route cables
- it increases the mounting height of the module rack to 185 mm, although the minimum spacing of 40 mm must still be observed

The following diagram shows the minimum spacing between the module racks and between these and any adjacent cabinet walls, equipment, cable ducts, etc. for S7-300s mounted in several module racks.

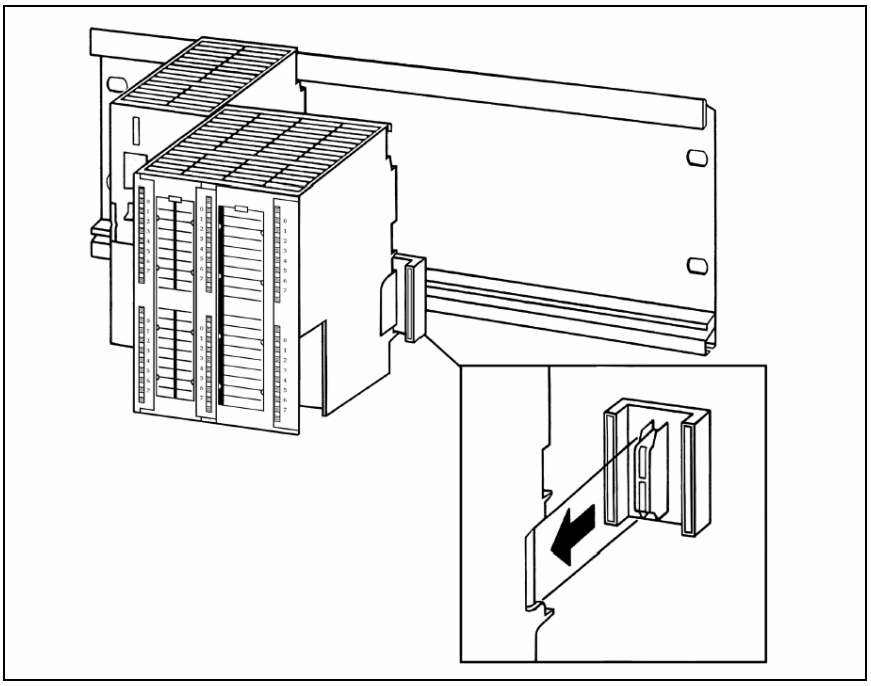
Non-observance of the minimum distances can destroy the module at high ambient temperatures!



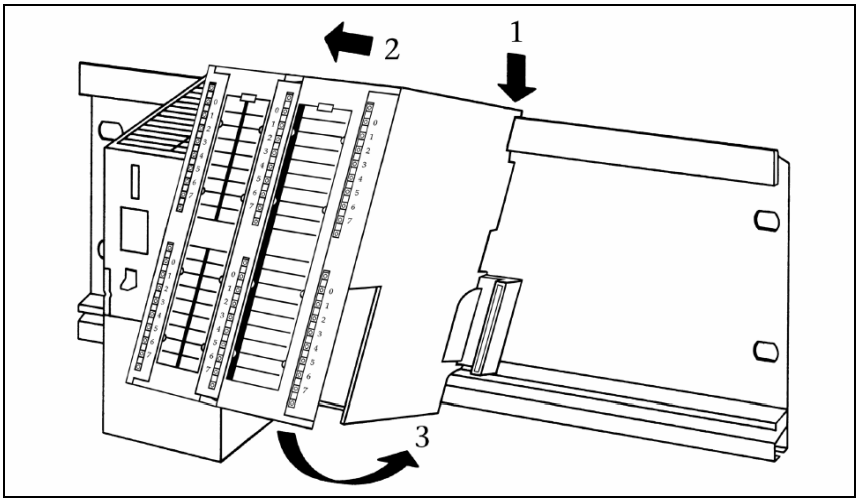
2.3 Mounting of the module on the DIN rail

A bus connector is included with each signal module but not with the CPU. When connecting the bus connector, always start with the CPU.

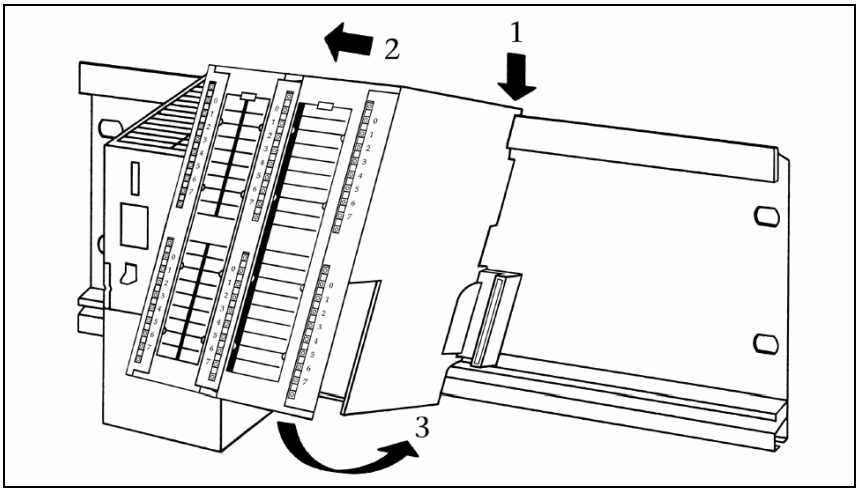
Take the bus connector off the last module and insert it into the CPU. Do not plug a bus connector into the last module of the tier.



Hook on the modules (1), slide them up to the left module, and click them downward (3).



Screw the modules on with a torque of 0.8 to 1.1 Nm.



3 System Overview

3.1 CAN bus

The CAN bus (Control Area Network) is an international and open field bus standard for applications in building, production, and process automation.

The comprehensive error detection measures make the CAN bus currently the most reliable bus system with a residual error probability of less than 4.7×10^{-11}.

3.2 CAN cabling

A CAN bus cable requires at least 3 conductors: CAN High, CAN Low, and CAN Ground. Only a bus topology is permitted. At both ends of the CAN bus cable, a terminating resistor of 120 ohms must be connected between CAN High and CAN Low. The CAN 300 PRO module does not have an integrated terminating resistor.

No terminating resistor is integrated into the CAN 300 PRO module.

The maximum cable lengths primarily depend on the baudrate used.

Bit rate	Bus length	Bit time
1 Mbps	30 m	1 µsec.
800 Kbps	50 m	1.25 µsec.
500 Kbps	100 m	2 µsec.
250 Kbps	250 m	4 µsec.
125 Kbps	500 m	8 µsec.
20 Kbps	2,500 m	50 µsec.
10 Kbps	5,000 m	100 µsec.

The cable lengths stated are for guidance only. The maximum cable length also depends on the number of connected stations and the type of cable.

More precise information is available in the document "CANopen® Recommendation DR 303-1" that is provided on the CD of the software package.

Check for correct cabling in the debug dialog box of the CANParam (see also Section 6.7).

3.3 Application and function description

The CAN 300 PRO module from System Helmholz GmbH allows you to connect any CAN stations to the programmable controller. The module is plugged into the backplane bus of the programmable controller. It can be used both in the central controller and in the expansion rack (e.g. with the IM360, 361, 365). Use of the CAN 300 PRO is also possible in an ET200M (with IM153), but this drastically reduces the performance.

The CAN 300 PRO module must be parameterized as a communication module in the hardware configurator and takes up 16 bytes in the analog process image. Data is exchanged with the PLC via the backplane bus.

Data handling blocks that enable simple handling of CAN communication are contained in the separately available software package. Data handling blocks are available both for simple layer 2 communication, SAE J1939, and for CANopen® master communication. Data handling software for use of the CAN 300 PRO module as a CANopen® slave is available on request.

The scope of supply of the software package also includes the Windows parameterization tool “CANParam V4” for setting the CAN bus communication parameters and for creating CANopen® Master projects.

The CAN 300 PRO module supports both CAN 2.0A (11 bits) and CAN 2.0B (29 bits) frames as a high-speed node according to ISO 11898-2 with a freely selectable baudrate of 10Kbps to 1Mbps.

The CAN 300 PRO module contains the power management functions "Power On," "Stop>>Run," and "Run>>Stop." Behind each of the three functions, it is possible to use a simple macro language to configure a CAN bus response with up to 100 frames per script that is executed automatically by the module when the event occurs.

In a multi-level acceptance mask it is possible to prefilter the IDs relevant to the programmable controller. Only those CAN frames are accepted that are required, which off-loads the cycle of the programmable controller.

16 freely settable timers are available in the CAN 300 PRO module. Each timer can trigger a freely programmable CAN frame. That way, it is easy to implement the synchronous protocols in common use in drive and servo systems using the CAN 300 PRO module.

It is also possible to have the data sent via the CAN bus only in a time window. The data to be transmitted are transferred non-cyclically by the programmable controller and transmitted from the CAN 300 PRO module after the parameterized time has elapsed.

3.4 Connections

The CAN 300 PRO module has behind the hinged front cover a 9-way SubD connector for the CAN bus and an USB connector for configuration and diagnostics.

Pin assignment:

Pin	SUBD connector CAN
1	-
2	CAN Low
3	CAN GND
4	-
5	-
6	-
7	CAN High
8	-
9	-

A 24V power supply is not applied to the CAN bus connector.

3.5 LED displays

The LEDs on the front of the module inform you about its operating state.

LED "SF" (orange):

System error: shows a project that has an error or a memory card with an error or that is too small.

LED "BF" (red):

This LED indicates a CAN error. A CAN error has occurred if the error counter is not zero, the CAN status is not "OK," or a CAN FIFO overflow has occurred. You can obtain further information in debug mode of the CANParam software (see also Section 6.7).

LED "RX" (green):

CAN bus reception active: Indicates correct reception of a CAN frame.

LED "TX" (orange):

CAN bus transmission active: Indicates correct transmission of a CAN frame.

LED "CPU" (orange):

Data transmission to the PLC active: Indicates transmission of a frame or command on the backplane bus (between the S7-CPU and the module).

LED "ON" (green):

Indicates that the module is correctly supplied with power and that the operating system is running.

A blinking LED shows the master state is not “operational” in the CANopen® master mode.

3.6 DIP switch

The 10-fold DIP switch on the front of the housing is for setting the CAN baudrate and for defining the node address (Bit-filter) to use the module as a CANopen slave.

Address	2^6	*+ 64*
	2^5	*+ 32*
	2^4	*+ 16*
	2^3	*+ 8*
	2^2	*+ 4*
	2^1	*+ 2*
	2^0	*+ 1*
Baud	2^2	*+ 4*
	2^1	*+ 2*
	2^0	*+ 1*

Baudrates:

0	*1*	*2*	*3*	*4*	*5*	*6*	*7*
10K	*50K*	*100K*	*125K*	*250K*	*500K*	*800K*	*1M*

3.7 Project memory card MMC

The CAN 300 PRO module stores the project in an internal memory (256 KByte). As an option, the project can be stored on an MMC. With the MMC, the valid project can be transferred onto the new module when the module is replaced.

If an MMC is in the slot of the module, this is also copied to the MMC when the project is transferred to the module.

If a faulty or too small MMC is plugged into the CAN 300 PRO module, the SF-LED lights up.

The MMC must have a memory capacity of at least 256Kbyte.

Micro Memory Card, 256Kbyte 700-953-8LH11

3.8 Items supplied

CAN 300 PRO module, bus connector, USB cable

3.9 Accessories

CAN CD with parameterization software “CANParam,” “Layer 2”, “CANopen®” and “SAE J1939” data handling blocks 800-600-1AA11

Manual, German/English 900-600-CAN01

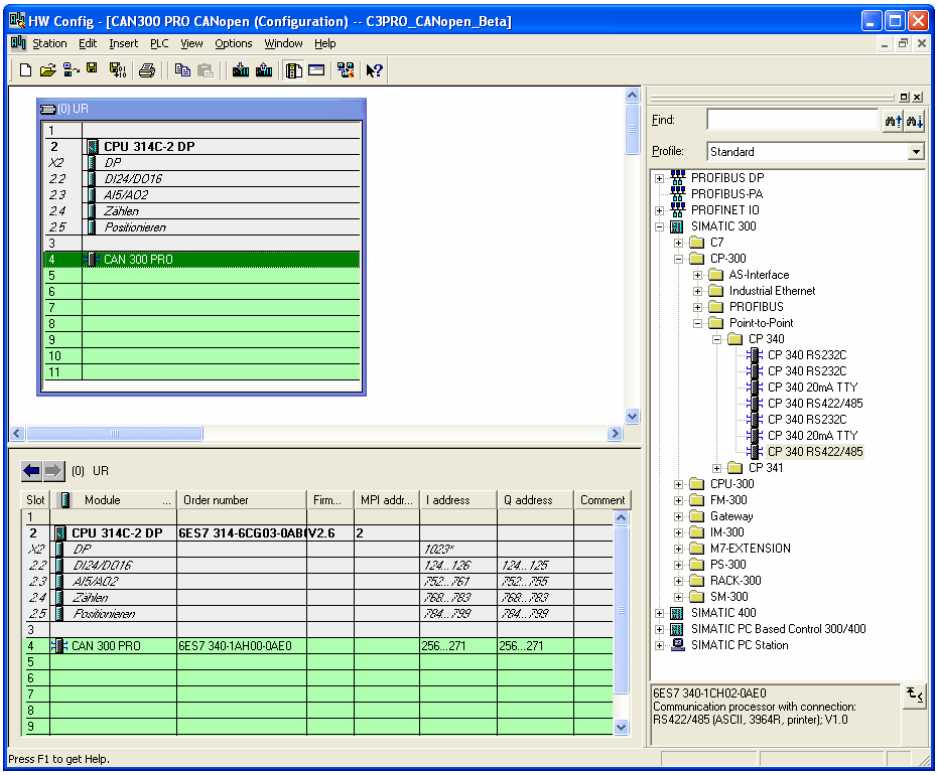
CAN bus plug connector 700-690-0BA12

CAN bus plug connector with cable connector 700-690-0BB12

CAN bus plug connector with axial cable outlet 700-690-0CA11

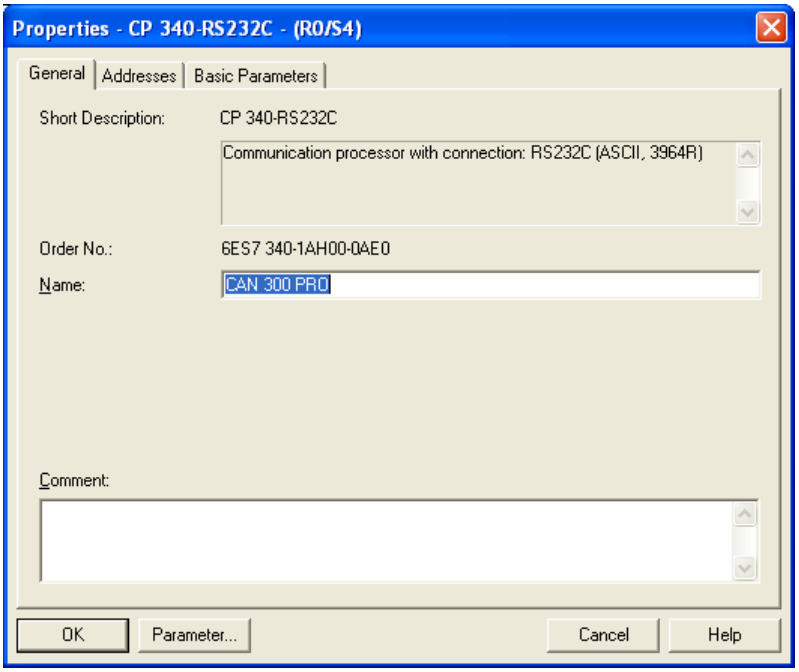
4 Configuration in the PLC

The CAN 300 PRO module is configured as the CP 340 communication module in the programming software of the PLC.



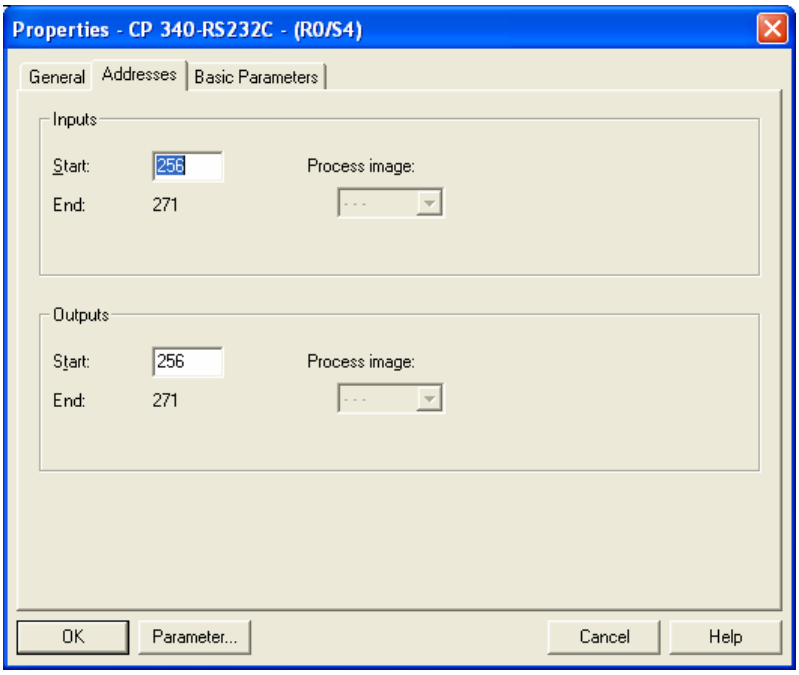
The module can be used wherever a CP module is allowed, i.e. also in the expansion unit after an interface module.

When the CAN 300 PRO module is used in an ET200M system, noticeably poorer performance must be expected.



*The I/O addresses should **not** be in the cyclic process image!*

In parameterization of the module, only the range of I/O addresses is relevant. All other settings have no effect on the module.



Only the input image is used in the data handling blocks; the output image has no relevance to the function.

Accesses to the input image can only be performed with the I/O direct access commands: L PEB, L PEW, L PED.

For CPU 318 the IO-addresses must never address in cyclic memory area.

5 Process image in the PLC

The CAN 300 PRO module occupies 16 bytes in the input and output process image. The content of the output process image is not used.

The content of the input process image can be used for information purposes by the user in the application.

Byte	Function
0	Module status generally, CAN group error display
1	CAN controller status (register of the CAN controller)
2	FIFO status bits (send & receive)
3	CAN controller: TX error counter
4	CAN controller: RX error counter
5	CANopen®: Master status
6	CANopen®: Assignment of the SDO request mailboxes
7	CANopen®: Number of nodes in operational
8	Node ID on use of the bit filter or of the master
9	*reserved*
10	*reserved*
11…15	used internally

Accesses to the input image can only be performed with the I/O direct access commands: L PIB, L PIW, L PID.

Bytes 5, 6, and 7 are only assigned data that can be evaluated in the CANopen® Master mode.

5.1 Byte 0: Module status

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
CAN controller group error	Module is CAN 300 PRO						Module parameterized and running

Bit 0: The CAN 300 PRO module has processed the configuration and is ready for operation.

Bit 1: The Bit is always 1 to indicate a CAN 300 PRO module is plugged.

Bit 7: Group error bit for errors on the CAN controller, more precise information about the cause of error can be found in byte 1.

5.2 Byte 1: Error status (EFLG) of the CAN controller

RX1OVR	RX0OVR	TXBO	TXEP	RXEP	TXWAR	RXWAR	EWARN
bit 7							bit 0

bit 7 **RX1OVR**: Receive Buffer 1 Overflow Flag
- Set when a valid message is received for RXB1 and CANINTF.RX1IF = 1
- Must be reset by MCU

bit 6 **RX0OVR**: Receive Buffer 0 Overflow Flag
- Set when a valid message is received for RXB0 and CANINTF.RX0IF = 1
- Must be reset by MCU

bit 5 **TXBO**: Bus-Off Error Flag
- Bit set when TEC reaches 255
- Reset after a successful bus recovery sequence

bit 4 **TXEP**: Transmit Error-Passive Flag
- Set when TEC is equal to or greater than 128
- Reset when TEC is less than 128

bit 3 **RXEP**: Receive Error-Passive Flag
- Set when REC is equal to or greater than 128
- Reset when REC is less than 128

bit 2 **TXWAR**: Transmit Error Warning Flag
- Set when TEC is equal to or greater than 96
- Reset when TEC is less than 96

bit 1 **RXWAR**: Receive Error Warning Flag
- Set when REC is equal to or greater than 96
- Reset when REC is less than 96

bit 0 **EWARN**: Error Warning Flag
- Set when TEC or REC is equal to or greater than 96 (TXWAR or RXWAR = 1)
- Reset when both REC and TEC are less than 96

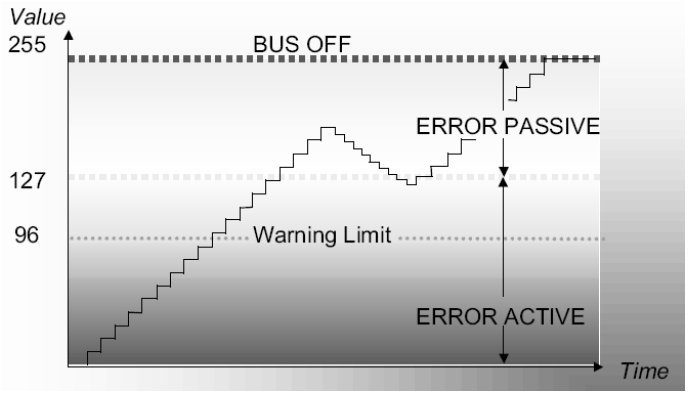
5.3 Byte 2: FIFO status bits

Bit 7	Bit 6	Bit 5	Bit 4
Send-FIFO (high) half full	Send-FIFO (high or low) overflow	Send-FIFO (low) half full	Send-FIFOs (high & low) completely empty

Bit 3	Bit 2	Bit 1	Bit 0
Receive-FIFO (high) half full	Receive-FIFO (high or low) overflow	Receive-FIFO (low) half full	Receive-FIFOs (high & low) completely empty

5.4 Byte 3/4: CAN controller Tx/Rx error counter

The error counter is incremented on every CAN frame transmitted or received with an error. If a CAN frame has been correctly transmitted, the error counter is decremented again. If the counter is greater than 96, the CAN controller goes into “warning” mode (see 5.2). If the error counter exceeds 127, the CAN controller goes into “error passive.”



5.5 Byte 5: CANopen® master status

This byte indicates the current state of the CANopen® master state machine.

Values up to 20 indicate that the master is still starting up or is in the initialization phase of the CANopen® slaves. Values greater than 21 indicate that the master is in cyclic operation.

5.6 Byte 6: Assignment SDO requests (CANopen® Master)

The CAN 300 PRO module can process in CANopen® Master mode up to 8 SDO requests at the same time, with 4 request channels being used internally. This byte provides information about the number of currently running SDO requests, both internal requests and those started by the PLC.

Note: The CANopen® Master data handling software can currently only manage one request at a time. This byte is intended for later more complex application.

5.7 Byte 7: Nodes in Operational (CANopen® Master)

This byte indicates the number of slaves already parameterized by the master and started.

5.8 Byte 8: Active node ID

This byte indicates in layer 2 mode, the active node ID of the bit filter (see Section 6.3.4) or, in CANopen® mode, the node ID of the master.

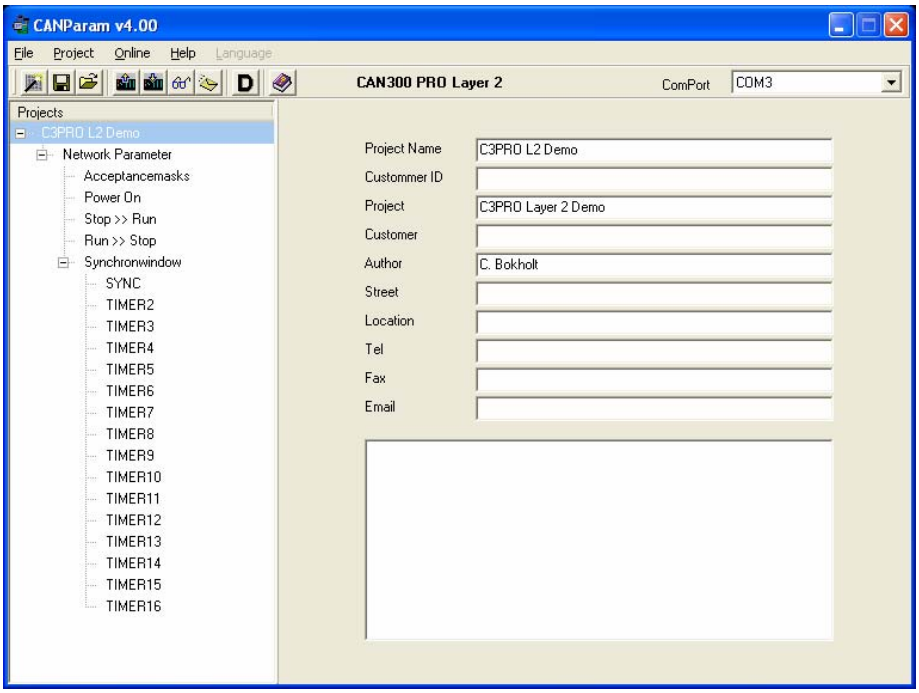
If no bit filter is used in layer 2, the value 0xFF will be in this byte.

6 Configuration of the module

6.1 Overview

The CAN 300 PRO module is configured on the PC with the "CANParam V4" software. This software is supplied together with the data handling blocks or can be downloaded from www.helmholz.com.

It is executable on each Windows 2000/XP computer.



The configuration of a module can be stored in a project file on the PC.

You can use a normal commercial type USB cable to link the PC to the CAN 300 PRO module.

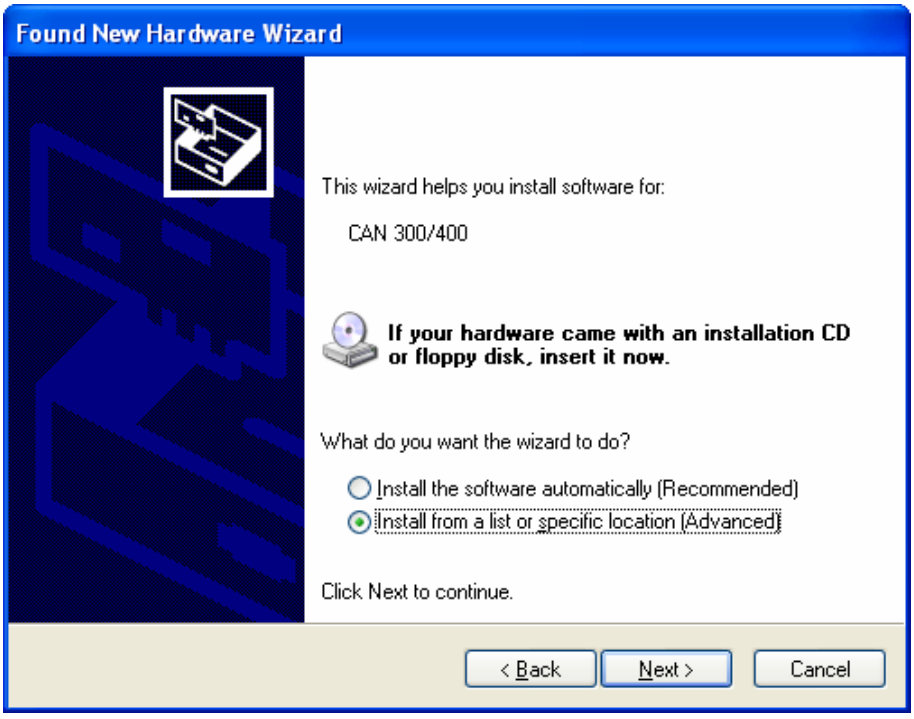
6.2 Installation of the USB interface driver

If this is the first time a CAN 300 PRO module is being connected to the PC, the operating system will try to install a suitable USB driver. This driver provides the interface between the USB interface and the operating system (Windows).

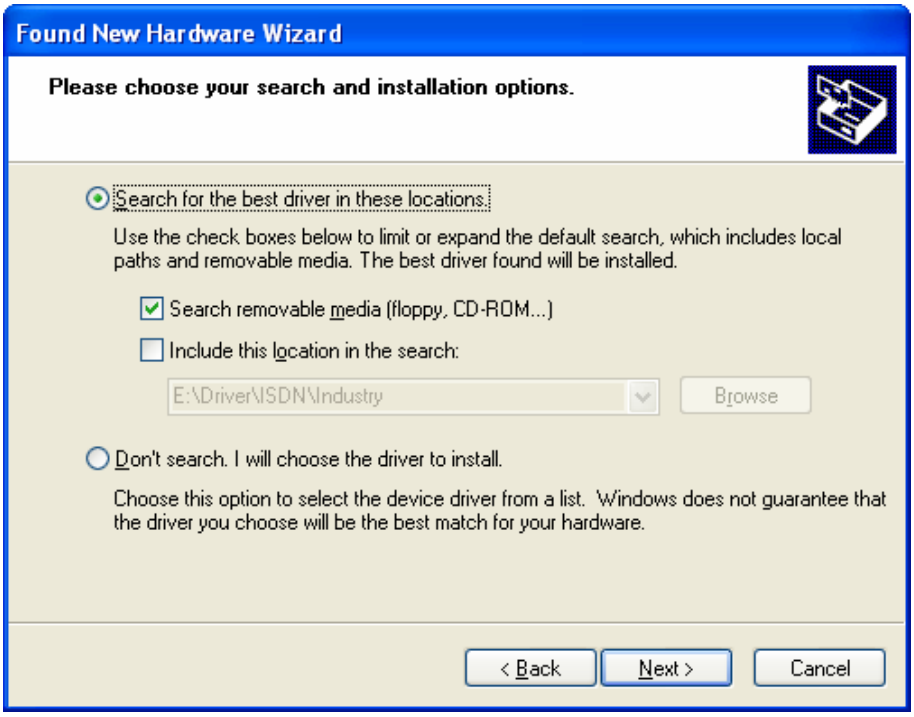
This initialization can take some time and goes through the following steps:

- The operating system starts an installation wizard that performs the installation, which is largely automatic. In the first step, you must enter whether the driver is to be searched for online or locally.

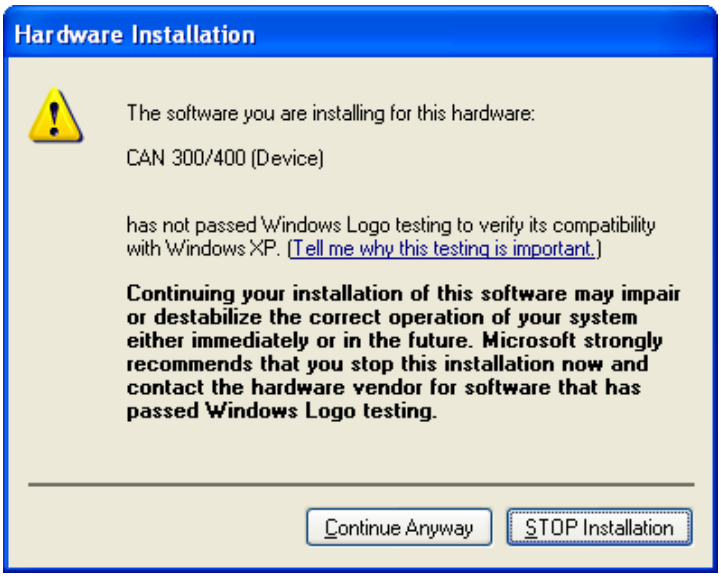
- To be able to specify the search path for the driver (generally the CD supplied), it is necessary to make the following setting and confirm it with *"Next."*



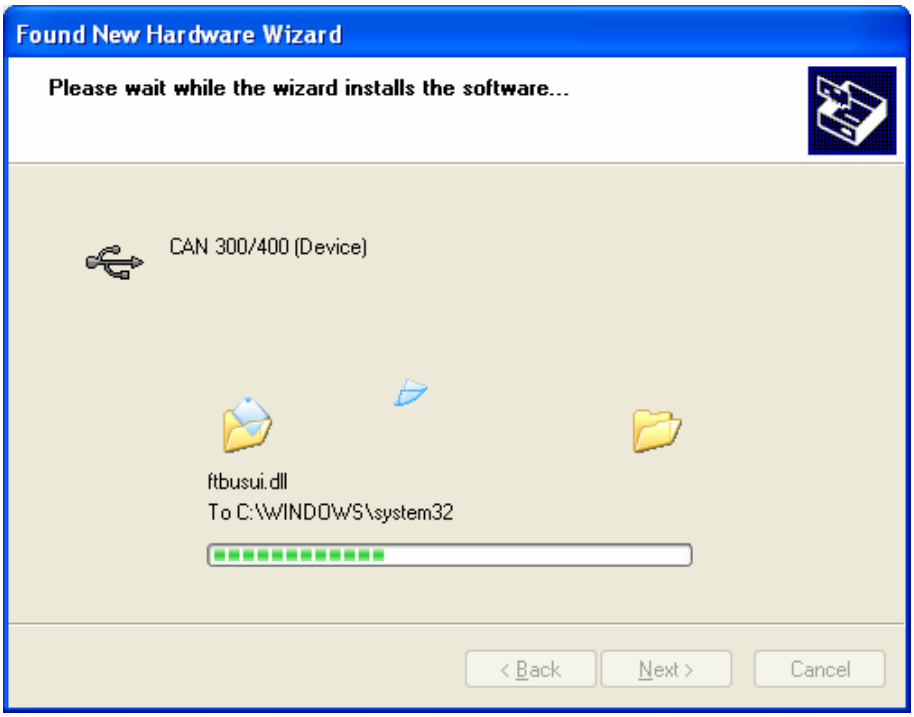
- The next step is a prompt to specify the location of the driver. It is generally enough to set a checkmark next to *"Search removable media..."* and then to click the *"Next"* button.



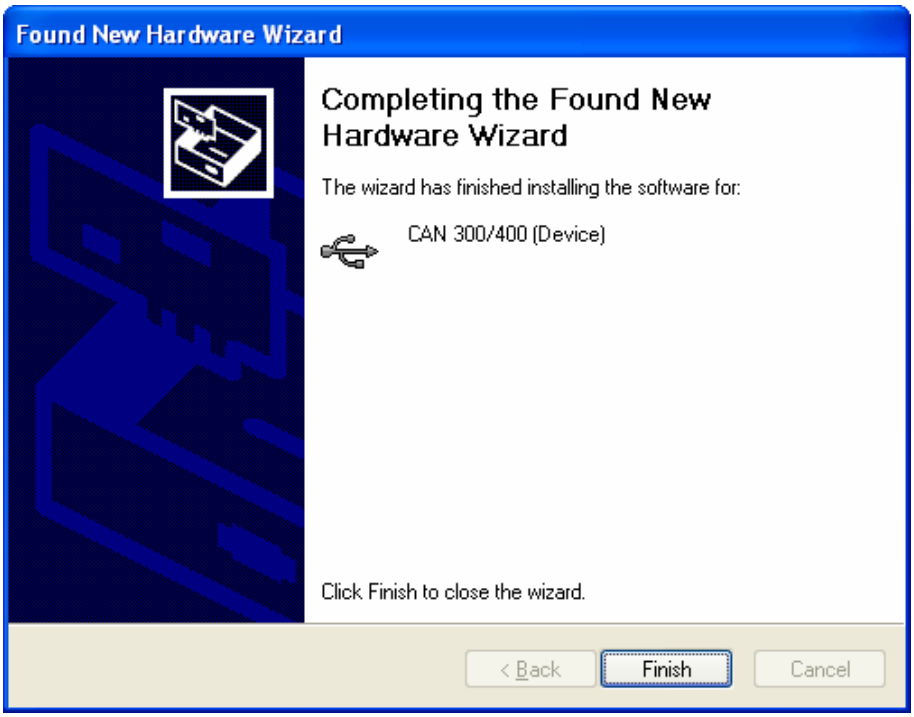
- If the CAN CD is in a local drive, the search for the driver now begins.
- If the driver is found, a WindowsXP logo compatibility query appears.



- Confirm with the button "*Continue installation.*" The driver is then installed.

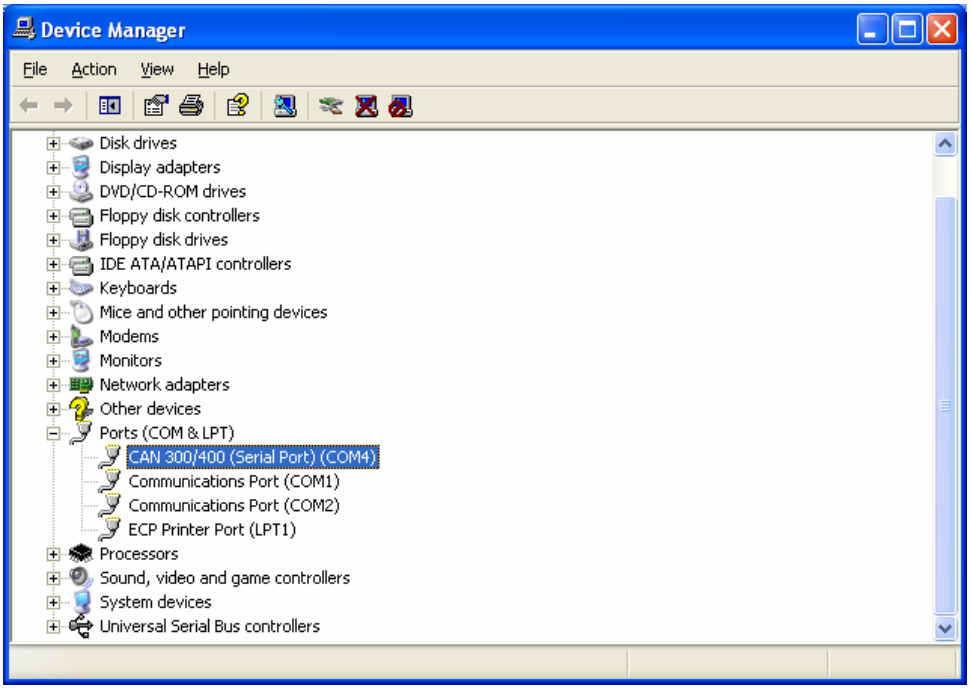


- After successful installation, the operation is completed by clicking the "*Finish*" button.



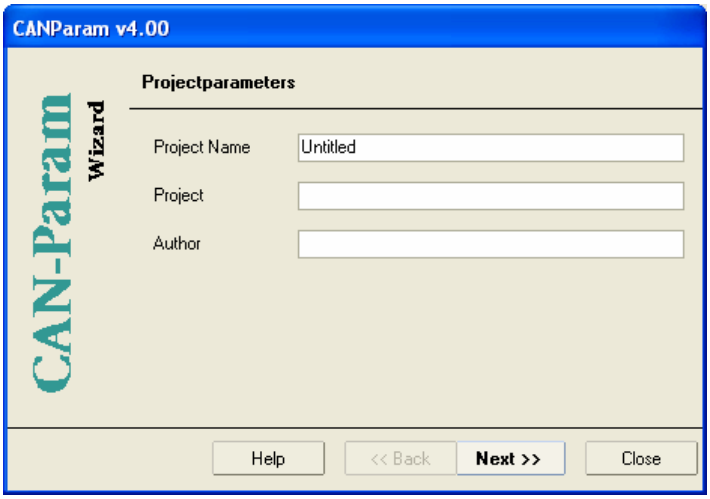
- The operating system starts the installation wizard a second time to install the virtual COM port driver, too. The installation routine is identical to the procedure described above.

A new COM port has now been added in the device manager. This COM port must be selected in the CANParam software to be able to communicate with the CAN 300 PRO module.

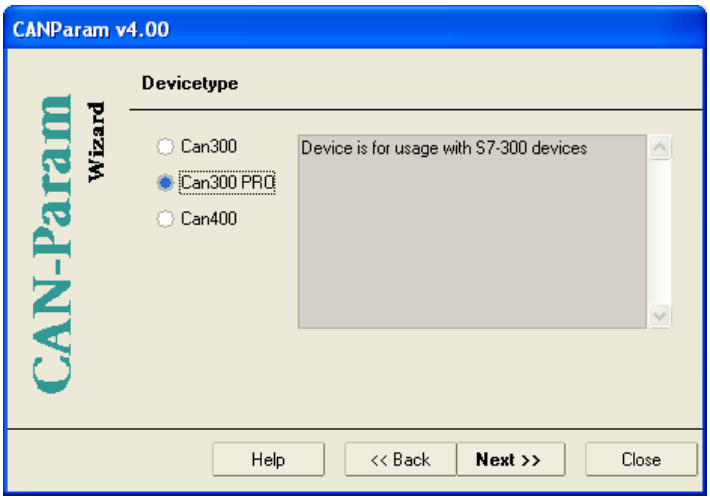


6.3 Creation of a layer 2 project

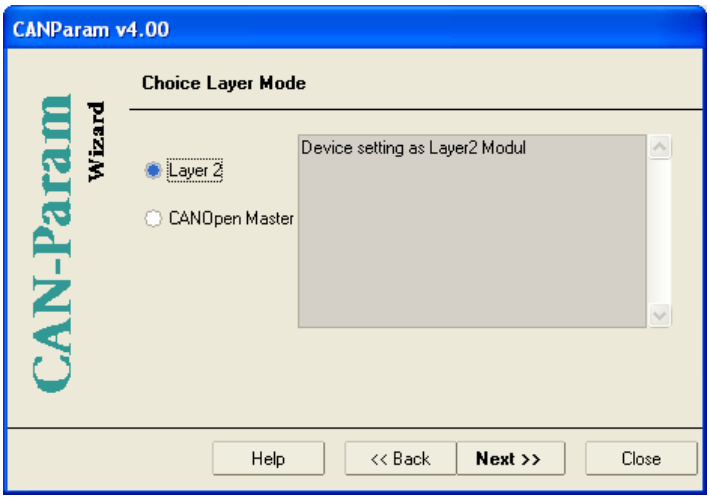
A new project can be created via the “Project / Create project / New project” function or with the project wizard.

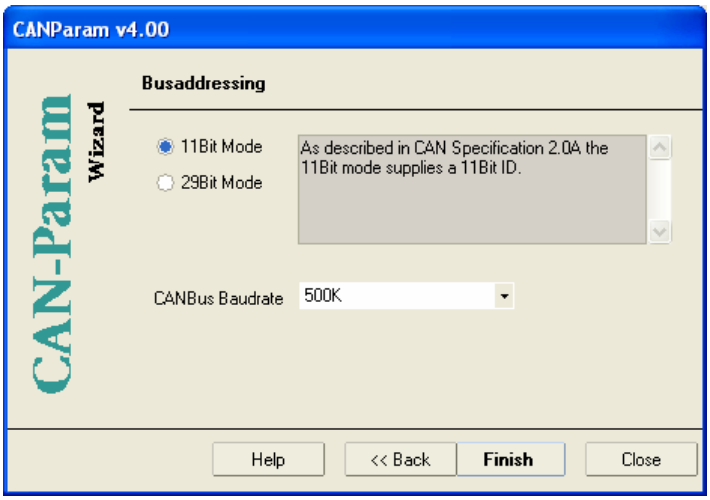


The project wizard guides you through the most important settings to obtain a new and complete project.



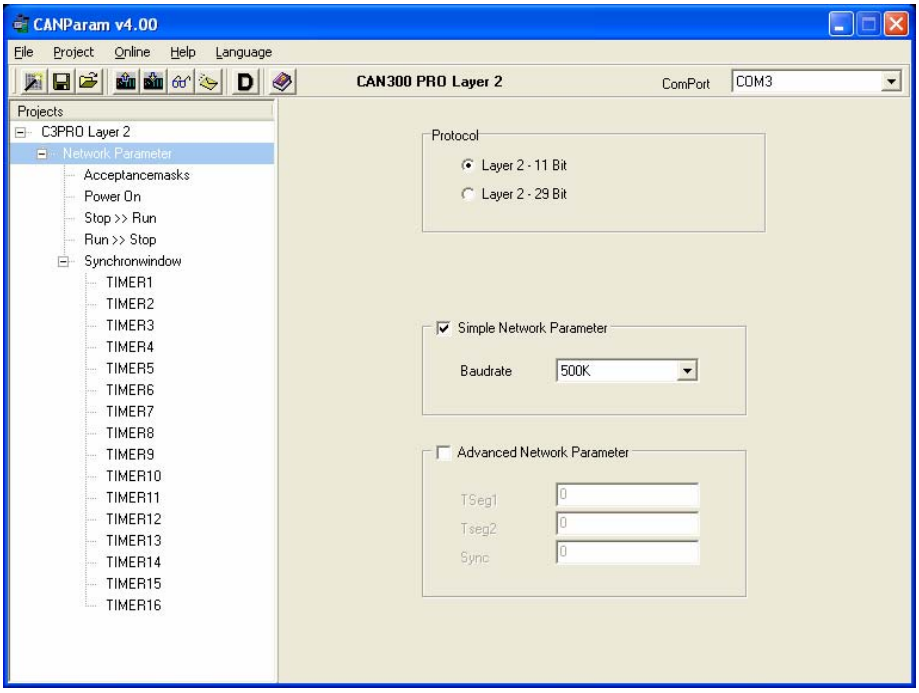
Für die Erstellung von CANopen® Master Projekten lesen Sie bitte Kapitel 6.4.





6.3.1 Setting the CAN bus baudrate

The CAN baudrate can be selected in the range 10kbps to 1Mbps.



For special applications, you can define the bit time of transmission directly. For a precise description of the bit timing see CAN Specification 2.0 Part B, Section 10 onward.

As an alternative, the baudrate can be set using the DIP switch.

6.3.2 Setting the transmission mode type

Mixed operation with 11-bit and 29-bit identifiers is not possible!

The CAN 300 PRO module supports both the protocol format CAN 2.0A (11 bits) and CAN 2.0 B (29 bits).

For use of the SAE J1939 data handling blocks, a CAN 2.0B (29 bits) must always be selected.

6.3.3 Mask filter

16 mask filters (acceptance masks) are available in the CAN 300 PRO module. Using these masks you can enable or block various frame IDs for receiving.

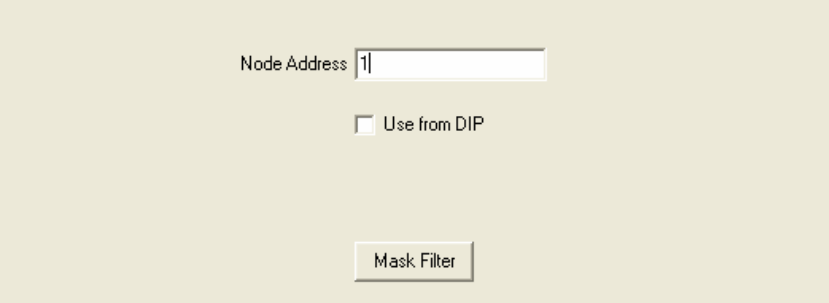
The default setting of the acceptance mask (0h to 7FFh) is to allow receipt of all frames.

With the “highprior” option, it is possible to deal with CAN frames with priority. Frames that are received with the IDs set there will be passed to the S7 as the next frame bypassing the normal receive buffer.

6.3.4 Bit filter

As an alternative to the acceptance masks, the CAN frames received can also be filtered according to a node ID.

The node ID is used, for example, in CANopen® networks to identify CANopen® slaves.



If the CAN 300 PRO is to be used as a slave station, filtering for all CAN frames for this station can be defined via the node ID setting. The node ID is stored in the lower 7 bits of the CAN ID.

In addition to the CAN frames with the defined node ID, all frames with node ID 0 are let through: COB-ID 0x0, 0x80, 0x100, 0x180, 0x200, …

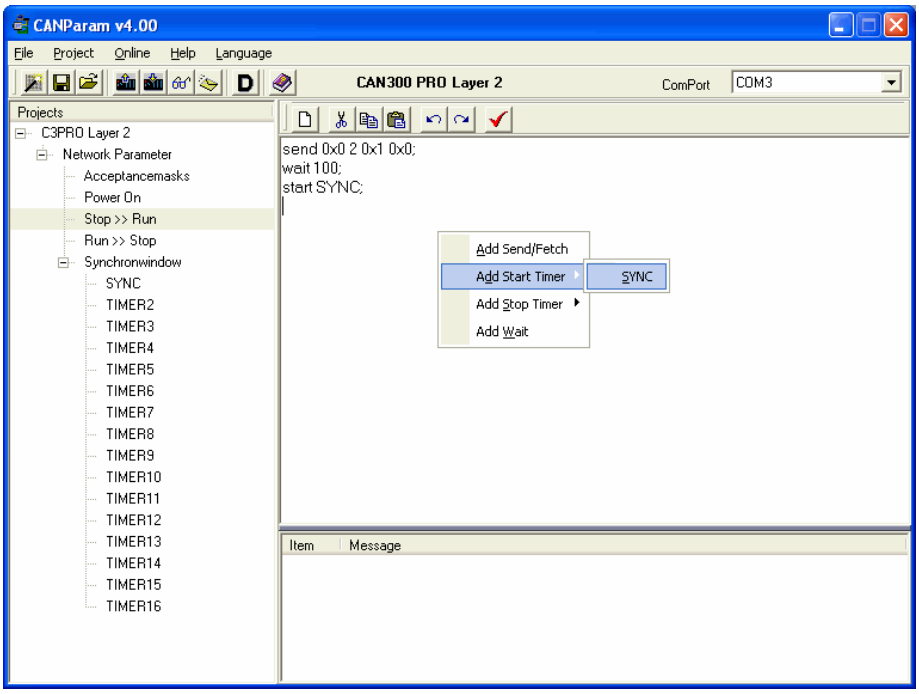
The node ID can either be defined permanently in the project, or set on the module via the DIP switch.

6.3.5 Script events

The CAN 300 PRO module can transmit freely programmable CAN frames (layer 2) for the PLC events "Power ON," "Stop >> Run," and "Run >> Stop," and start and stop timers.

The following commands are available:

Send	Transmit frame (Structure ID, length, data byte 1, data byte 2, etc.)
Fetch	Transmit frame with RTR bit 1
Start	Start Timer X
Stop	Stop Timer X
Wait	Wait X (1..65535) ms
//	Comment line



100 lines per script can be created with the CAN 300 PRO module.

6.3.6 Timer

16 timers are available for time-dependent events in the CAN 300 PRO module. Each timer can transmit any CAN frame.

An alias can be assigned to each timer. This name can then be used in the scripts of the PLC events.

The time *Repetition* states the repeat interval for the timer, the *phase* the starting point within the interval.

For the timer *Repetition*, times from 1 msec to 65535 msec can be set in steps of 1 msec. For the *phase* 0 msec to 1 msec before the repetition time.

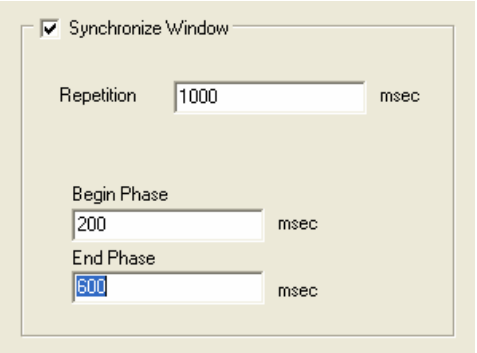
If the option “to the PLC” is selected, the frame is transmitted simultaneously on the CAN bus and to the PLC. With this option, the PLC can be synchronized on a CAN frame.

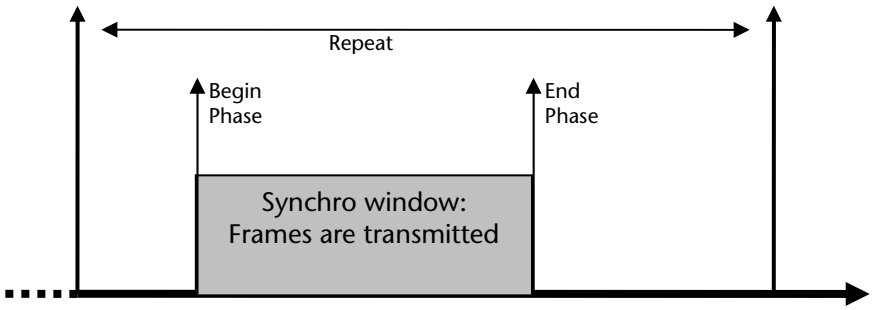
6.3.7 Synchronous window

If you are using the synchronous timer (setting "synchronous queue"), the frame transmitted asynchronously by the FC110 "CANSEND" are transmitted within a time window. "Repeat" indicates the repeat rate, "Begin phase" & "End phase" defines the transmit window within the repeat time.

The frames to be transmitted are only transmitted within the time window between "Begin phase" & "End phase."

This makes time on the bus outside the synchronous window for communication by other stations.



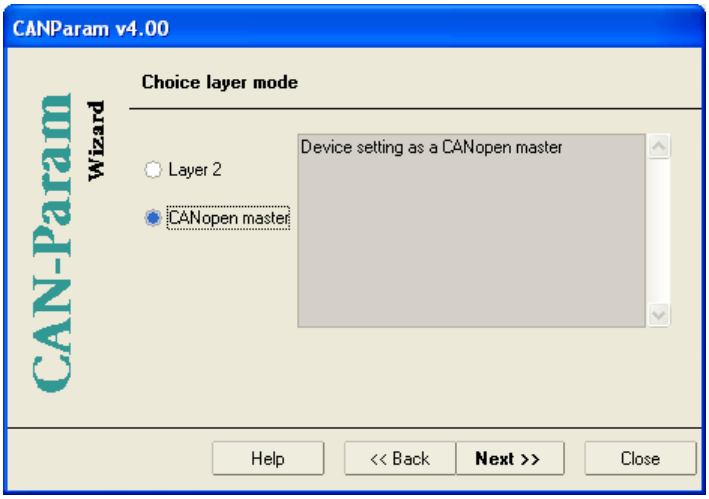


To use the synchronous window, both Timer1 & 2 must be started directly one after the other in a script!

Timer 1 "SYNCBEGIN" and Timer 2 "SYNCEND" are used internally, if the synchronous window is used. However, this must be started by the user, e.g. in a script. For the synchronous window to function correctly, these two timers must be started in succession.

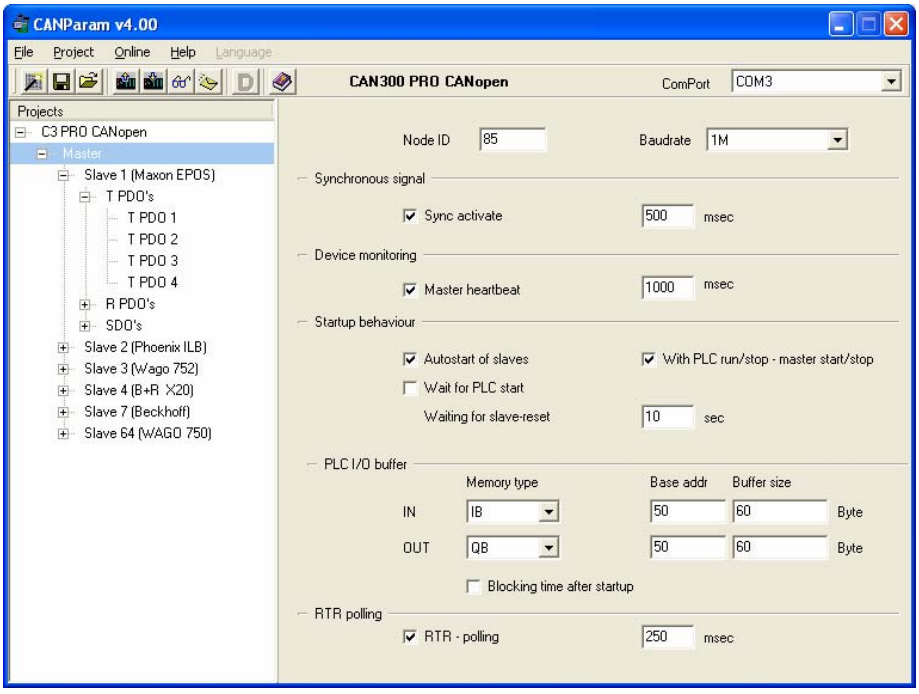
6.4 Creation of a CANopen® project

For applications with CANopen® stations, the CAN 300 PRO module can be parameterized as a CANopen® Master.



The CANopen® Master in the CAN 300 PRO module works independently of the PLC.

6.4.1 Settings of the master



Node ID: The master requires a node ID for broadcasting the master heartbeat. The node ID can be defined in the range 0…127.

Baudrate: Definition of the CAN bus baudrate (10Kbaud .. 1Mbaud)

Sync activate: The master can broadcast a SYNC frame (ID: 0x80) in fixed timebase.

Device monitoring "master heartbeat": The master broadcasts a heartbeat frame in the parameterized timebase (ID: 700 + Node ID of the master).

Startup behavior "Autostart of the slave": Slaves that fail during operation and the recover are automatically re-initialized and included in cyclic operation again.

Startup behavior "With PLC Run/Stop – Master Start/Stop": The master starts and stops if the PLC is started or stopped.

Startup behavior "Wait for PLC start": The master initializes the slaves and waits for the release command from the PLC (Sec. 7.7.4) before it goes into cyclic operation.

Startup behavior "Wait for slave reset": The master transmits on restart an NMT reset to all slaves. Some slaves require a fairly long time to complete the reset and register on the master again (bootup). The maximum waiting time can be defined here.

Note: Some CANopen devices require up to 10 seconds or longer before they register on the bus after a reset. The slave wait time should not be set too short on initial start-up.

PLC I/O buffer "IN": Buffer for receiving PDOs

PLC I/O buffer "OUT": Buffer for transmitting PDOs

The buffer size has to fit with the PLC programming to assure correct data transferbetween PLC and CAN 300 PRO module.

The information about memory type and base address is to alleviate the mapping of the PDOs between PLC an module.

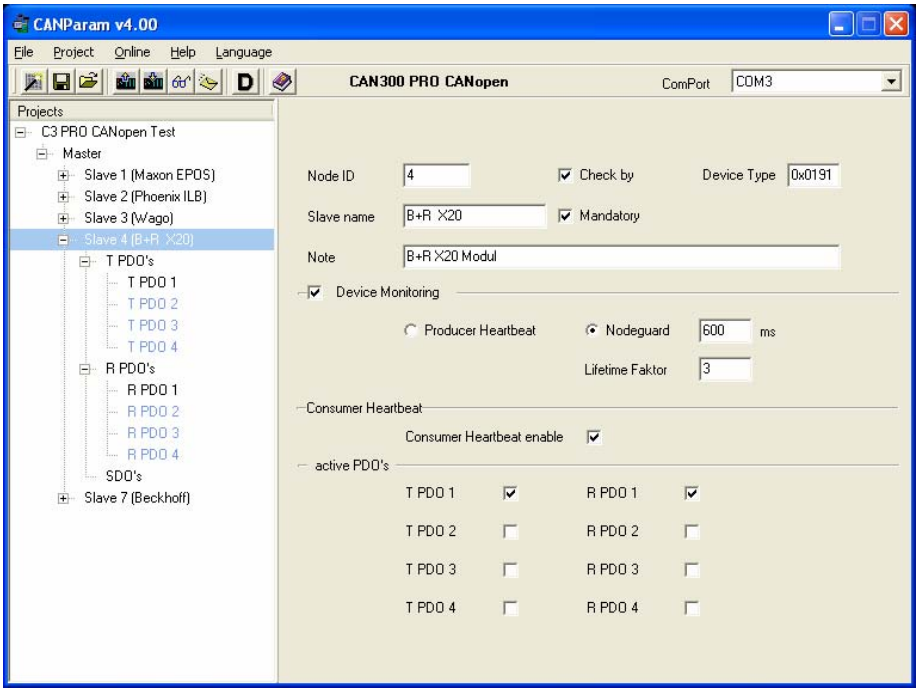
A detailed explanation of the PLC Buffer concept can be found in chapter 6.4.5.

PLC I/O buffer "Blocking time after start-up": Definition of the waiting time after start-up of the master until the first data are transmitted to the PLC.

RTR Polling: Definition of the timebase in which PDOs are to be queried via RTR frames.

6.4.2 Creating a slave

With operation of the right mouse button in the project tree, it is possible to create a new slave.



Node ID: Node ID of the slave

Check device type: With this option, the master checks during start-up whether the slave had the specified device type on the stated node number. For this purpose, the SDO 1000 is read and the lower 2 bytes are used as a comparison.

Slave name: Name of the slave, freely selectable, is displayed in the project tree.

Mandatory device: The slave must exist so that the master can enter cyclic operation.

Comment: Further information on the slave

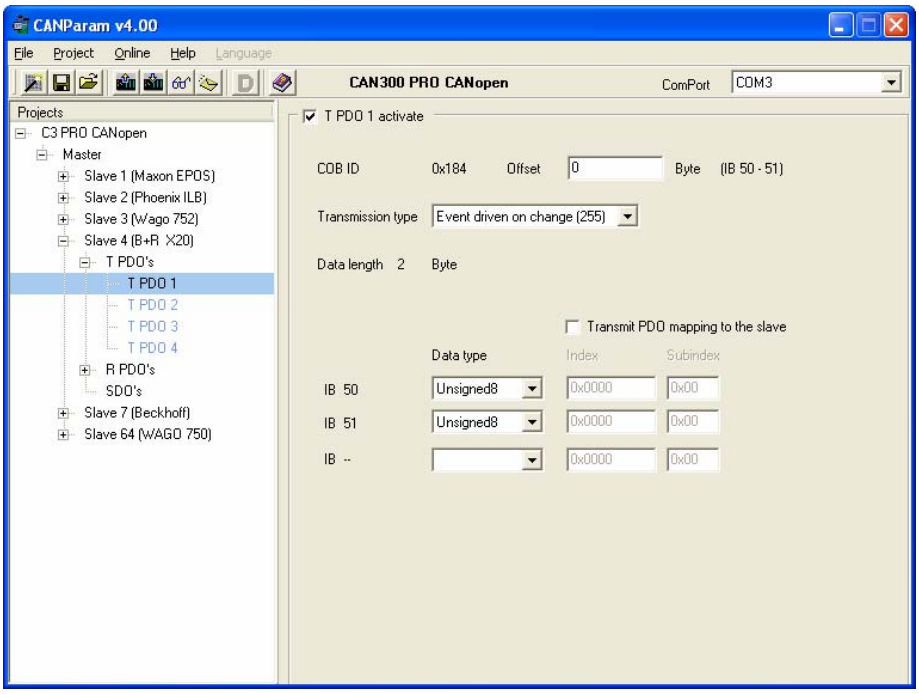
Device monitoring "producer heartbeat": Monitoring of the slave by the master through the producer heartbeat signal of the slave. The setting is written into the SDO 1017 on start-up.

Device monitoring "Nodeguarding": Monitoring of the slave by the master by nodeguarding. The settings are written into the SDOs 100C and 100D of the slave on start-up.

Consumer heartbeat: The slave monitors the heartbeat of the master. As the monitoring time, the master heartbeat time times 1.5 is used. The object 1016/1 is written during start-up.

Active PDOs: Overview of the PDOs defined or used with this slave.

6.4.3 Setting TPDOs



COB-ID: Display of the associated CAN-ID. This can not be adjusted and is calculated depending on the node ID and the PDO number.

Offset: Relative position of the PDO bytes in the PLC input buffer.

Data overlaps due to an incorrectly set offset can corrupt data!

Transmission type: Setting of the transmission mechanism. The following options are possible:

SYNC acyclic (0): Transmission after the next sync frame, if there is a change.

SYNC (1..240): Transmission after every nth sync frame

RTR-only synchronous (252): Transmission on request (RTR) after the next sync frame. In the master, the RTR polling must be activated and a sync frame transmitted on the bus.

RTR-only asynchronous (253): Transmit immediately on request (RTR). The RTR polling must be activated in the master.

Event-driven manufacturer (254): Transmission after change

Event-driven standard (255): Transmission after change

The setting is automatically written into the object 1800 (TPDO 1), 1801 (TPDO 2), 1802 (TPDO 3), and 1803 (TPDO 4).

Data length: Number of bytes used in the PLC input buffer and by the PDO frame

If the data types are set incorrectly, data may be corrupted!

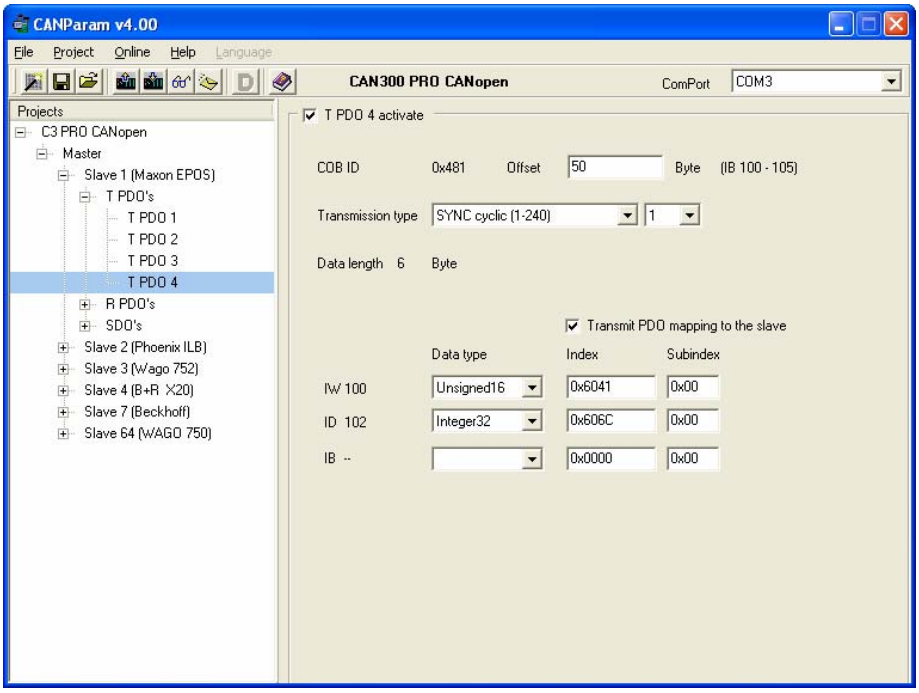
Data type: The data type allocation of the PDO must be defined in this list. A PDO frame consists of up to 8 bytes. The data types now have to be assigned from the left/first byte to the last byte of the PDOs used.

Example:

The TPDO4 has 6 used bytes; the first two bytes are interpreted as unsigned16 and bytes 3-6 as integer32.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Unsigned16		Integer32				unused	unused

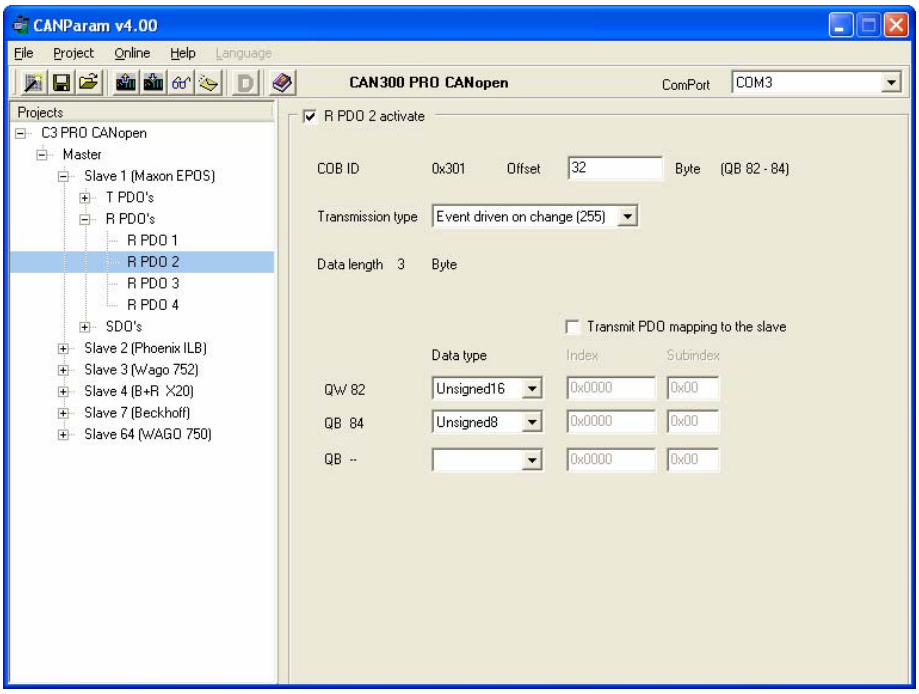
The CAN 300 PRO will format the values internally with this information and enter them correctly in the IO buffer for the PLC.



The following data types are available: Integer8, integer16, integer32, unsigned8, unsigned16, unsigned32.

Transmit PDO mapping to the slave: The SDO mapping of the PDOs can be specified directly in addition to the list of data types. If the option is activated, this mapping will be written into the objects 1A00 (TPDO 1), 1A01 (TPDO 2), 1A02 (TPDO 3), and 1A03 (TPDO 4) during start-up.

6.4.4 Setting RPDOs



COB-ID: Display of the associated CAN-ID. This can not be adjusted and is calculated depending on the node ID and the PDO number.

Offset: Relative position of the PDO bytes in the PLC output buffer.

Data overlaps due to an incorrectly set offset can corrupt data!

Transmission type: Setting of the transmission mechanism. The following options are possible:

Sync trigger by PLC (0): RPDO will be transmitted to the slave if the SYNC signal command comes from the PLC. After that, a SYNC frame is transmitted automatically

Sync (1..240): Acceptance after every nth sync frame

Event-driven on PLC cycle (254): After each IO write call, the master transmits the data on the bus; the slave accepts the data immediately.

Event-driven on change (255): Master transmits after each change of the value; the slave immediately accepts the data

The setting is automatically written into the object 1400 (RPDO 1), 1401 (RPDO 2), 1402 (RPDO 3), and 1403 (RPDO 4).

Data length: Number of bytes used in the PLC output buffer and by the PDO frame.

If the data types are set incorrectly, data may be corrupted!

Data type: The data type allocation of the PDO must be defined in this list. A PDO frame consists of up to 8 bytes. The data types now have to be assigned from the left/first byte to the last byte of the PDOs used.

Example:

The RPDO1 has 3 used bytes; the first two bytes are interpreted as unsigned16 and byte 3 as unsigned8.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Unsigned16		Unsigned8	*unused*	*unused*	*unused*	*unused*	*unused*

The following data types are available: Integer8, integer16, integer32, unsigned8, unsigned16, unsigned32.

Transmit PDO mapping to the slave: The SDO mapping of the PDOs can be specified directly in addition to the list of data types. If the option is activated, this mapping will be written into the objects 1600 (RPDO 1), 1601 (RPDO 2), 1602 (RPDO 3), and 1603 (RPDO 4) during start-up.

6.4.5 PLC I/O Buffer concept

The PDOs of the slaves defined in the project are entered in data buffers that are exchanged with the PLC. There is one data buffer for input of PDO (TPDOs of the slave) and one for transmitting PDOs (RPDOs of the slave).

The size of the buffer can be defined in the master setting dialog box. Data of the PDOs can be placed at any positions in these buffers (offset).

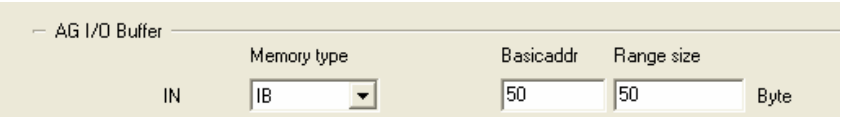
These PLC I/O buffers are loaded from the data handling software in to the PLC, or from the PLC. FB 20 “IO Read” (see Sec. 7.7.1) and FB 21 “IO Write” (see Sec. 7.7.2) are used for this.

In the PLC, the PLC I/O buffer can be copied to any memory area. The PLC IN buffer, for example, can be copied directly into the input process image (IB) and the PLC OUT buffer from the output process image (OB). This permits direct processing of the CANopen PDOs in the process image of the PLC.

If the memory of the process image is not large enough, the marker memory or data blocks can also be used. In this way, assignment of the PDO data in this memory is simple due to the selected offset.

Example:

Size of the PLC IN buffer: 50 bytes

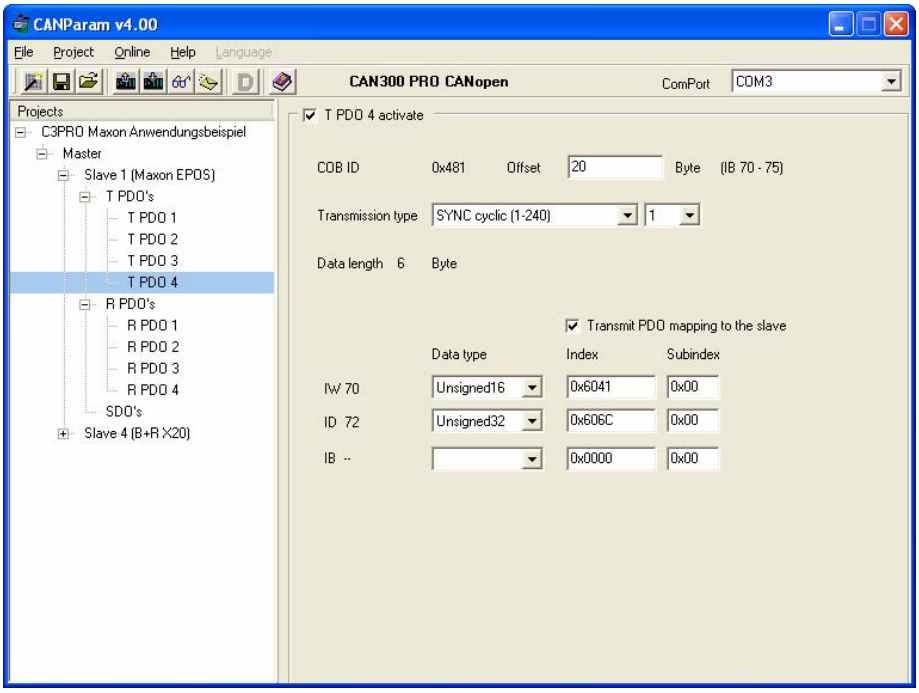


The ANY pointer information on FB 30 "IO Read" with "I 50.0 BYTE 50" copies the PLC IN buffer into the process image memory from IB50 to IB99:

```
CALL  FB    20 , DB20
 Base   :=256
 Dest   :=P#I 50.0 BYTE 50
 STAT   :=MW20
 Err    :=M22.6
 RetVal :=MW24
 NewData:=M22.0
```

The TPDO4 of Node 1 is placed at Offset 20 and contains 6 bytes, assigned as Unsigned16 and Unsigned32.

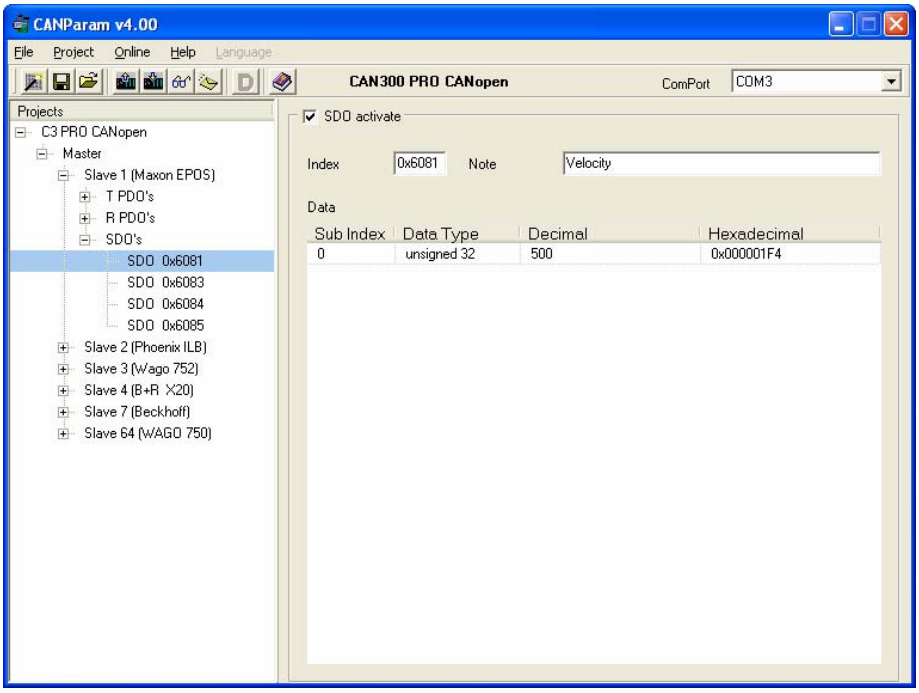
Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Unsigned16		Unsigned32				unused	unused



In the PLC, the value of SDO 6041 in IW 70 can now be processed and the value SDO 606C is in ID 72. The values are automatically adapted to the data format of the PLC.

PLC buffer offset	assignment	Address in PLC
0	*unused*	IB 50
1	*unused*	IB 51
…	…	…
20 21	Node 1: TPDO4 (Byte 0-1) Unsigned16	IW 70
22 23 24 25	Node 1: TPDO4 (Byte 2-5) Unsigned32	ID 72
26	*unused*	IB 76
…	…	…
49	*unsued*	IB 99

6.4.6 Adding SDOs



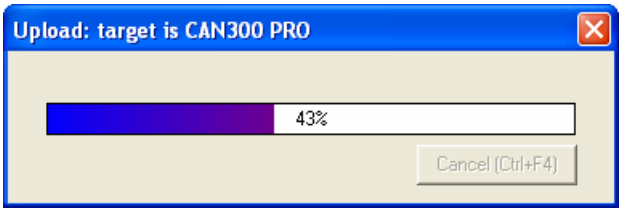
For each slave, a list of SDOs can be stored. The values of these SDOs are written to the slave after start-up of the master and detection of the slave.

If a slave fails during cyclical operation of the master and be detected on the bus again later, the SDOs are also written (only with the master option: “Autostart of the slaves”).

An error on writing the SDOs does not result in cancellation of slave initialization. The last error to occur can be viewed in the CANopen® Debug Screen (see Sec. 6.7.2).

6.5 Uploading

The project currently being worked on can be imported into the CAN 300 PRO module ("upload").



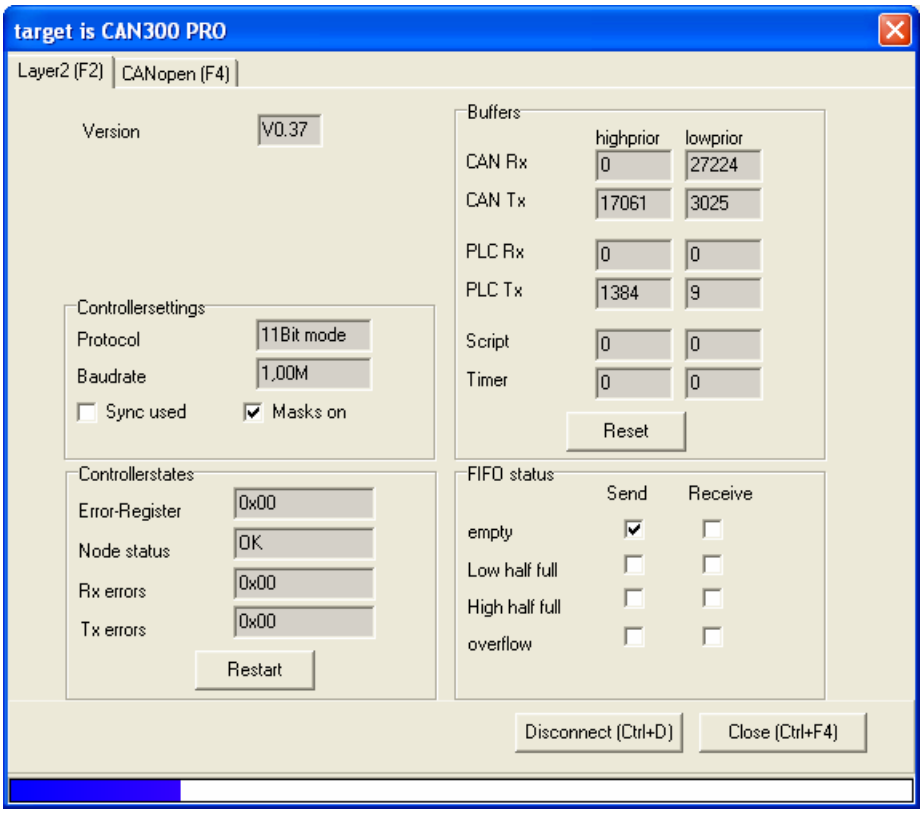
6.6 Downloading

Project on the module can be loaded into the CANParam software with this function also the processing.

6.7 Diagnostics/debugging

To simplify debugging, you can query the status of the CAN 300 PRO module with menu item "Debug." Debug mode requires a USB link with the module.

6.7.1 Layer 2 debug display



The "Connect" button activates monitoring mode. If you press the button again, the link will be disconnected again.

The debug dialog box provides the following information:

Version Version number of the operating system

Protocol Configured CAN protocol (11bit/29bit)

Baudrate Active CAN baud rate

Controller status Content of the CAN status register:

Error register Content of the CAN error register EFLG (Sec. 5.2)

Node status Content of the CAN status register (see above): "OK," "Warning," "Passive," "Bus Off"

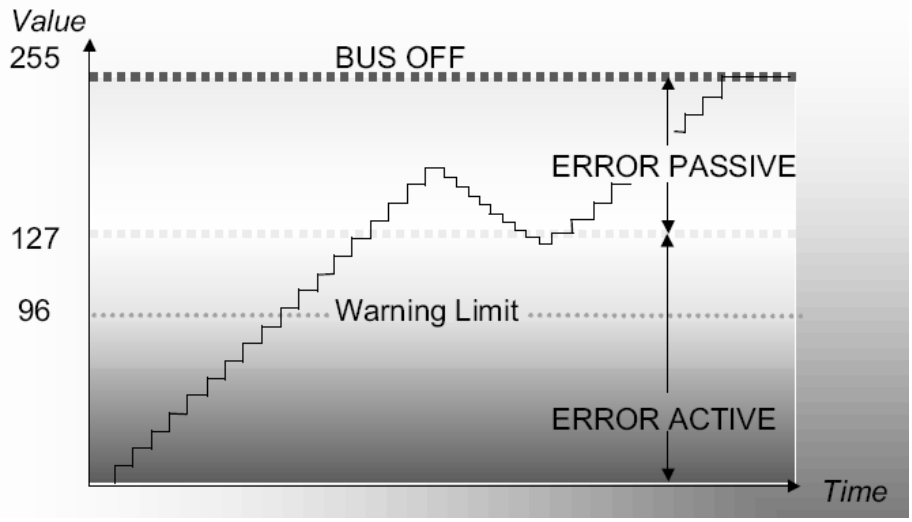
Rx error counter Error counter CAN reception

Tx error counter Error counter CAN transmission

Note: The transmit and receive error counters are incremented by the can controller if transmission or receipt of a frame has failed. As soon as a frame has been transmitted again correctly, or has been received, the corresponding counter is decremented again. These counters should always be 0 if the CAN bus is functioning correctly!

! *Node status should always be "OK" to ensure fault-free CAN data transmission.*

! *The error counters must be "0"; otherwise data transmission on the CAN bus is faulty.*



Buffer Display of the number of received and transmitted CAN frames in the buffers on the CAN bus, to the PLC and internally

Note: The CAN 300 PRO module has receive and transmit buffers of 400 frames (low priority) and 20 frames (high priority). The counters show how many frames have been processed.

There should never be a big difference between the Rx and Tx counter pairs. However, if this does occur, the CAN frames are not being fetched from the PLC fast enough or are being transmitted to the PLC too fast.

If, in the case of a full FIFO, further frames are received or transmitted, the error bit FIFO overflow is set and the oldest frame is deleted from the FIFO.

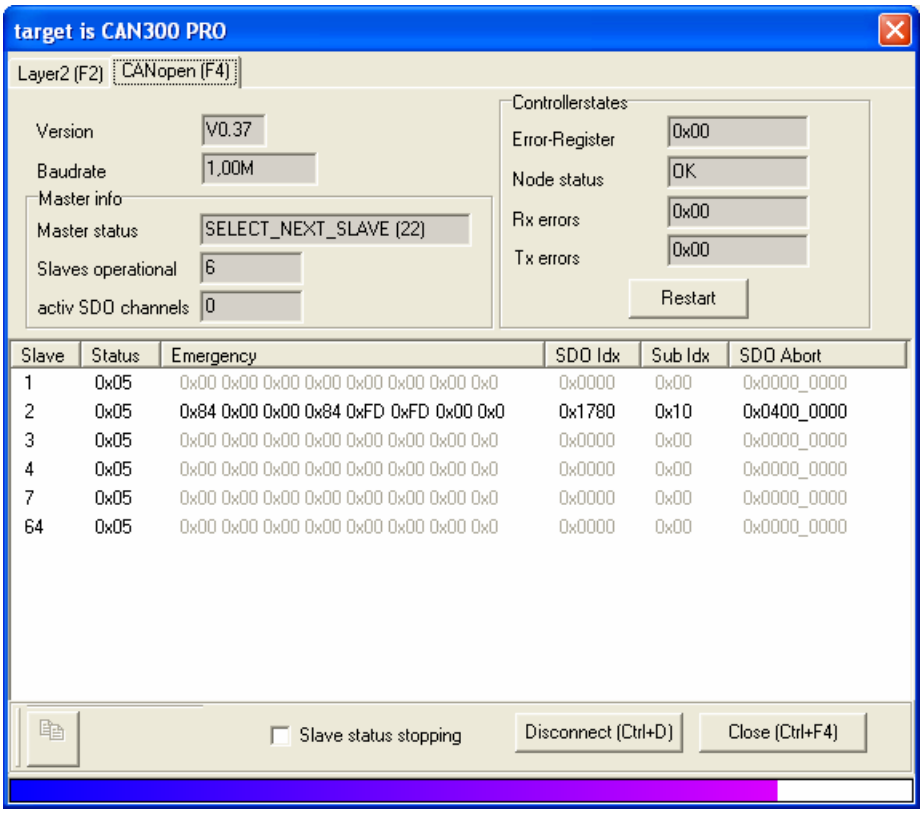
! *The information about the buffers and FIFOs are only relevant in layer 2. In CANopen® Master mode, the firmware performs control of the buffers.*

FIFO status Display of the filling level of the FIFOs

In PLC, the FIFO status can be evaluated via the peripheral byte 2 (Section 5.3). The FIFOs can be deleted with the data handling block FC 67 CANCTRL (see also Sec. 7.2.4). An overflow error that has occurred must also be reset for the FC 67 CANCTRL (see also Sec. 7.2.4).

6.7.2 CANopen® Debug display

If the CAN 300 PRO module is operated in CANopen® Master operation, the status of the master and the livelist can be displayed on the second diagnostics page.



The CANopen® Debug dialog box provides the following information:

Version Version number of the operating system

Protocol Configured CAN protocol (11bit/29bit)

Baudrate Active CAN baud rate

Controller status Content of the CAN status register:

Error register Content of the CAN error register EFLG (Sec. 5.2)

Node status Content of the CAN status register (see above): "OK," "Warning," "Passive," "Bus Off"

Rx error counter Error counter CAN reception

Tx error counter Error counter CAN transmission

!

Node status should always be "OK" to ensure fault-free CAN data transmission.

Master info information:

Master status	Current status of the CANopen® master. <20 = Startup of the master, initialization of the slaves 21,22 = normal operation >22 = start-up of failed slaves in normal operation
Slaves operational	Number of slaves in operational
Active SDO channels	Number of assigned SDO communication channels

Slave status list:

Slave status	00 = unknown 04 = stop 05 = operational 6A = slave is detected, but not yet initialized (bootup) 7E = failure of the slave 7F = preoperational
Emergency	Data of the last emergency frame
SDO Idx, Sub Idx, SDO Abort	Last received SDO abort code

Updating of the slave status list can be halted to copy the list into the clipboard. The text can then be copied, for example, into an e-mail or documentation.

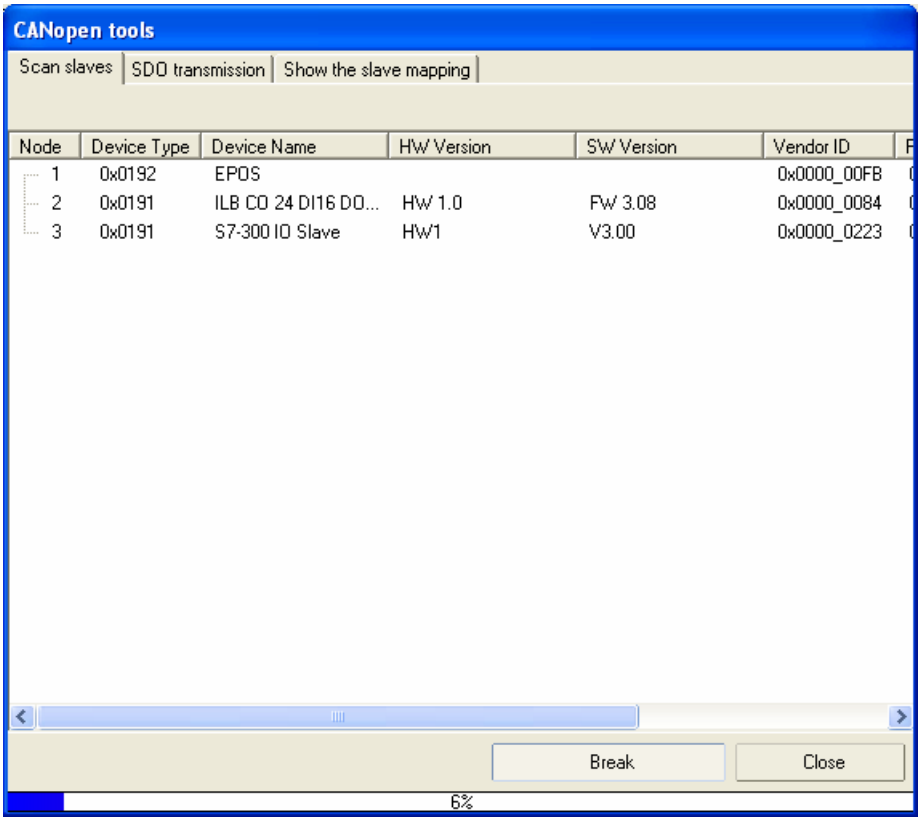
6.8 CANopen® Tools

To simplify debugging, you can do a query or parametrization of any slave on the CAN-Bus with SDO communication of the menu “CANopen® tools”. The CANopen® tools requires a USB link with the module. The module should be run in the CANopen® Master mode.

6.8.1 Scan Slaves

The slaves must own the object 0x1000.

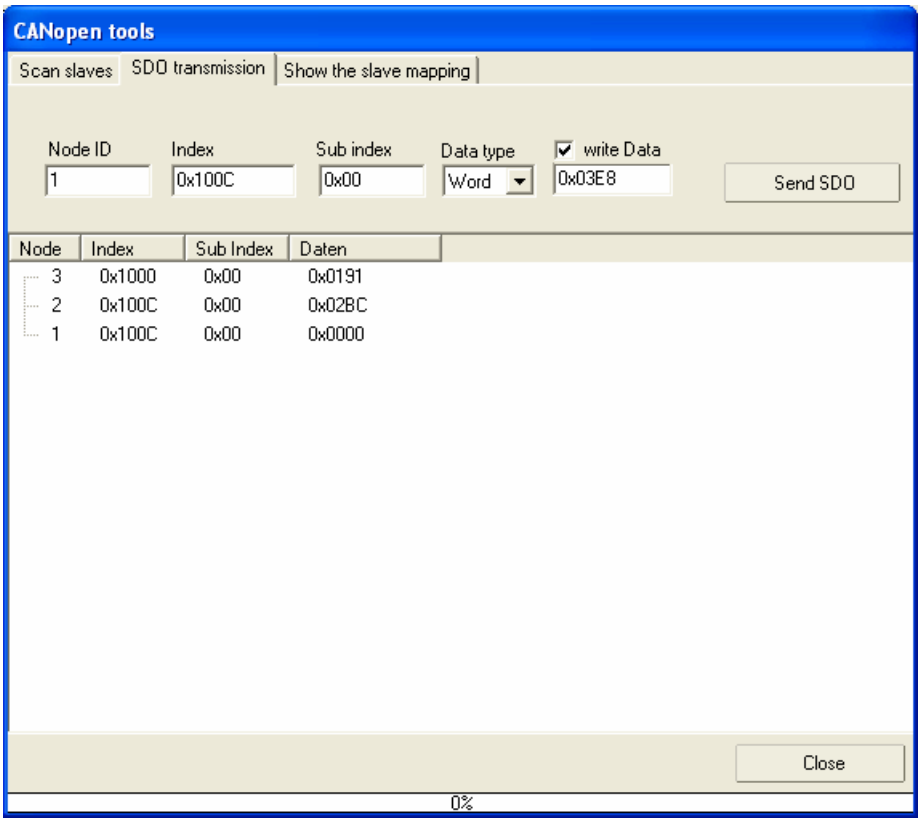
With “Scan Slaves” you can search for CANopen® slaves over the CAN300 PRO module. The slaves must answer on the object 0x1000 request to that. Otherwise these slaves will not be detected.



6.8.2 SDO Transmission

If the data are incorrectly, it does show an Error message with the Abort-Code of the slave!

The SDO transmission can be used to read or write the SDO objects of any slave. This slave must own the behavior of its object.



Node ID: Node-ID of the slave.

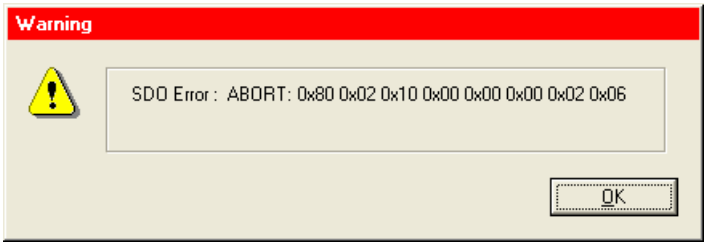
Index: The index of the object on the slave, which is target of read or write.

Sub Index: The subindex of the object on the slave, which is target of read or write.

Data type: The data size (Byte, Word, Double), which is defined for this object on the slave.

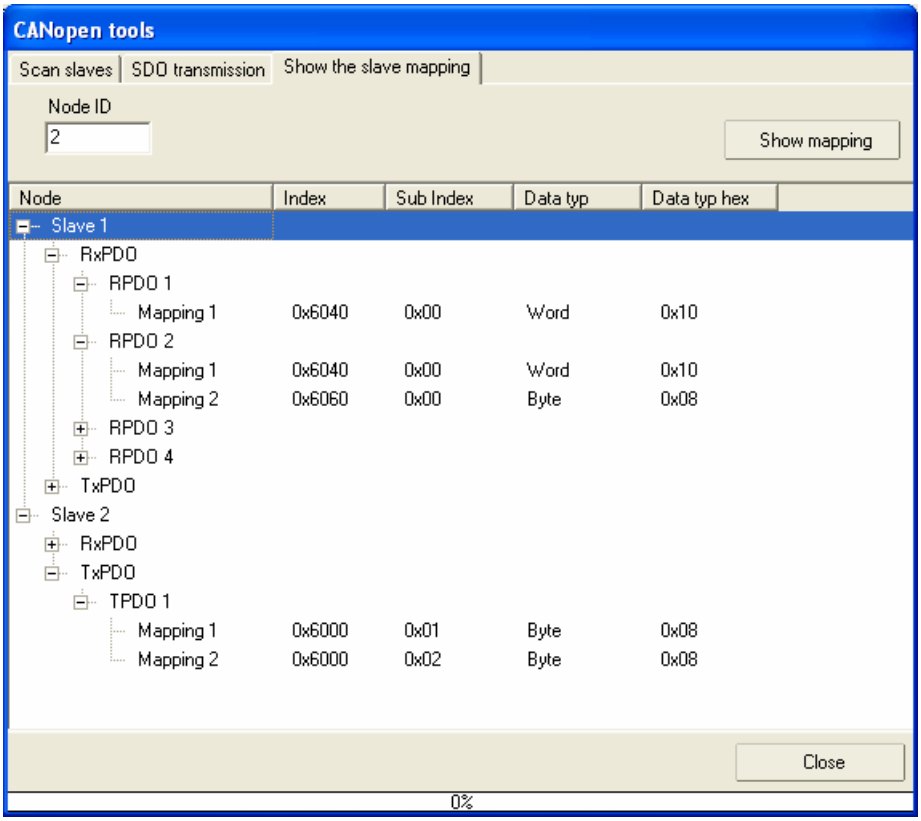
Write Data: The value which will be written in the object. If only reading data from the object, you can easily deactivate „Write Data.

Send SDO: With this button you send the SDO data to the module and therefore to the slave. Replies the slave with an abort, it does show an error message with the Abort-Code from the slave.



6.8.3 Slave Mapping

“Show mapping” it requests the mapping PDOs of the selected slave and show these on the screen.



Node ID: Node-ID of the slave, which PDO mapping data will be fetched.

Show mapping: If the button pressed the reading of mapping from the slave is started. If at least a mapped PDO is available then it will be displayed on the screen.

7 Programming in the PLC

7.1 Overview

The programming of the CAN 300 PRO module is performed in the PLC via the data handling blocks contained in the software package, which have to be purchased separately but only once.

Data handling blocks are available for layer 2 communication (no interpretation of the CAN frames), for the SAE J1939 protocol, and for CANopen® Master operation.

Data handling blocks for use of the CAN 300 PRO as a CANopen® slave are available on request.

The data handling blocks and configuration of the CAN 300 PRO must match!

The choice of handling blocks and the configuration of the CAN 300 PRO module must match.

For Layer 2 and SAE J1939 data handling blocks, a Layer 2 Project must be inported into the CAN 300 PRO module (see Sec. 6.3).

For use of the CANopen® Master data handling blocks, the CAN 300 PRO can be configured as a CANopen® Master (see Sec. 6.4).

7.2 Layer 2 handling blocks

7.2.1 General

If layer 2 data handling blocks are used, the CAN 300 PRO module must also be parameterized with a layer 2 project.

With the layer 2 data handling blocks it is possible to process any CAN protocol. The CAN frames are received without being interpreted, provided to the PLC, and any frames can be transmitted.

The following FCs are available in layer 2:

FC 65	**CANSEND**	Transmission of a CAN frame
FC 66	**CANRCV**	Receiving a CAN frame
FC 67	**CANCTRL**	Module management functions

Initialization of the module in the start-up OBs is not necessary. The module starts automatically if the PLC is switched to RUN and stops if the PLC goes into the STOP state.

Here is an example of a call:

```
      CALL  FC    66           CANRCV
       Base  :=256
       IDHI  :=MW60
       IDLO  :=MW62
       RTRLEN:=MW64
       DW0   :=MW70
       DW1   :=MW72
       DW2   :=MW74
       DW3   :=MW76
       STAT  :=MB78
       RETVAL:=MW66
       Recd  :=M67.0
      AN   M 67.0
      JC   send
      …

send: SET
      =     M     87.0
      CALL  FC    65           CANSEND
       Base  :=256
       IDHI  :=W#16#0
       IDLO  :=W#16#202
       RTRLEN:=W#16#8
       DW0   :=MW90
       DW1   :=MW92
       DW2   :=MW94
       DW3   :=MW96
       STAT  :=MB86
       RETVAL:=MW88
       Snd   :=M87.0
      BE
```

7.2.2 FC 65 CANSEND

The CANSEND function block (FC 65) transfers a CAN frame to the module from which it is transmitted immediately.

Parameter	Direction	Type	Example
Base	IN	INT	256
IDHI	IN	WORD	W#16#0
IDLO	IN	WORD	W#16#202
RTRLEN	IN	WORD	W#16#8
DW0	IN	WORD	MW 90
DW1	IN	WORD	MW 92
DW2	IN	WORD	MW 94
DW3	IN	WORD	MW 96
STAT	OUT	WORD	MW 86
RETVAL	OUT	INT	MW 88
Snd	INOUT	BOOL	M 87.0

As the passed parameters, the base address of the module must be passed as an integer number (`Base`), a status byte (`STAT`), and a bit for transmit enable (`Snd`).

The word `RTRLEN` contains the number of data bytes (0...8) in the lower 4 bits (bit 0 to bit 3). Bit 6 is the RTR bit of the CAN frame. Setting bit 7 transmits the frame as a high-priority message.

The bit `Snd` is always reset after the block has been executed, if the frame to be transmitted has been transferred to the module. If the transmit buffer in the module is full, older frames that have not been transmitted yet are deleted.

The FC65 "CANSEND" must not be called in OB 1 (cycle) and OB 35 (time OBs) simultaneously or mixed!

Parameter `STAT` contains the status of the CAN 300 PRO module (see Sec. 7.2.5). The parameter is always assigned value, even if the `Snd` bit is not set.

If Timer 0 has been set as the synchronous timer, the data are only ever transmitted in a defined synchronous time window.

Assignment of parameters `ID-HI` and `ID-LO`:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	COB-ID 11 Bit											
0	0	COB-ID 29Bit																													
ID-HI															**ID-LO**																

7.2.3 FC 66 CANRCV

The CANRCV function block (FC 66) transfers a CAN frame from the module into the PLC, if a frame has been received and this frame has also been let through by the acceptance filter.

Parameter	Direction	Type	Example
Base	IN	INT	256
IDHI	OUT	WORD	MW60
IDLO	OUT	WORD	MW62
RTRLEN	OUT	BYTE	MB64
DW0	OUT	WORD	MW70
DW1	OUT	WORD	MW72
DW2	OUT	WORD	MW74
DW3	OUT	WORD	MW76
STAT	OUT	WORD	MW 66
RETVAL	OUT	INT	MW 68
Rcvd	INOUT	BOOL	M 67.0

As the passed parameter, the base address of the module must be passed as an integer number (`Base`).

The elements of the frame are passed as data words (`IDHI, IDLO, RTRLEN, DW0…3`).

The word `RTRLEN` contains the number of data bytes (0...8) in the lower 4 bits (bit 0 to bit 3). Bit 6 is the RTR bit of the CAN frame. If bit 7 is set, the message went via high-priority FIFOs.

If the function block has read a frame from the CAN 300 PRO module, bit `Recd` is set.

Parameter `STAT` contains the status of the CAN 300 PRO module (see Sec. 7.2.5). The parameter is always assigned a value even if no frame has been received.

Assignment of parameters `ID-HI` and `ID-LO`:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	COB-ID 11 Bit											
0	0	COB-ID 29Bit																													
ID-HI															**ID-LO**																

7.2.4 FC 67 CANCTRL

The function block CANCTRL (FC 67) provides special functions of the CAN 300 PRO module.

Parameter	Direction	Type	Example
Base	IN	INT	256
Func	IN	INT	1
Param	IN	INT	2
STAT	OUT	WORD	MW 2
RETVAL	OUT	INT	

As the passed parameters, the base address of the module must be passed as an integer number (`Base`), a function code (`Func`), and, if necessary, a parameter (`Param`).

The following functions are available:

1 = Start a timer (timer number 1-16 in `Param`)

2 = Stop a timer (timer number 1-16 in `Param`)

5 = Trigger CAN controller reset and re-init;
Caution: CAN frame may be lost

6 = Clear all FIFOs on the module

7 = Reset FIFO error bits

Parameter `STAT` contains the status of the CAN 300 PRO module (see Sec. 7.2.5). The parameter is always assigned a value even if no frame has been received.

7.2.5 Parameter STAT

The STAT parameter has the same meaning in all data handling blocks and indicates the status of the module:

Bit 15	Bit 14	Bit 13	Bit 12
CAN controller group error	Module is CAN 300 PRO (always 1)		
Bit 11	**Bit 10**	**Bit 9**	**Bit 8**
			Module running, read-in of the parameters completed

Bit 7	Bit 6	Bit 5	Bit 4
Send-FIFO (high) half full	Send-FIFO (high or low) overflow	Send-FIFO (low) half full	Receive-FIFOs (high & low) completely empty
Bit 3	**Bit 2**	**Bit 1**	**Bit 0**
Receive-FIFO (high) half full	Receive-FIFO (high or low) overflow	Receive-FIFO (low) half full	Receive-FIFOs (high & low) completely empty

The STAT parameter corresponds to the I/O input bytes 0 and 2.

7.3 CANopen®

7.3.1 General

CiA® = CAN in Automation e.V., www.can-cia.org

The CANopen® protocol is a layer 7 protocol (application layer) based on the CAN bus (ISO 11898). Layer 1 and 2 (physical layer and data link layer) are not affected by the CAN bus.

The CANopen® communication profiles for the various applications are managed by the CIA (CAN in Automation e.V.).

The services elements provided by the application layer permit implementation of an application distributed over the network. These service elements are described in “CAN Application Layer (CAL) for Industrial Applications.”

CANopen® always works with CAN 2.0A (11 bits). This must be taken into account in configuration of the module with CANparam.

The 11 bit identifier and the 8 data bytes of a CAN layer 2 frame have a fixed meaning. Each devices in a CANopen® network has a fixed node ID (module number, 1-127).

7.3.2 Objects

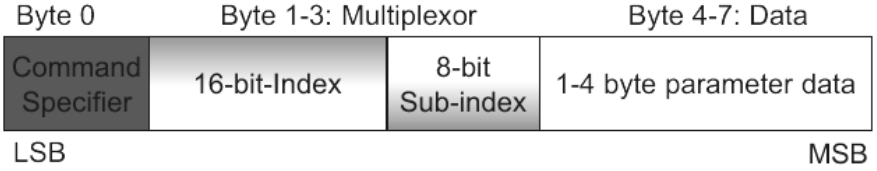
Data exchange with a CANopen® slave is performed either using permanently defined service data objects (SDO) or using freely configurable process data objects (PDO).

Each CANopen® slave has a fixed list of SDOs that are addressed by and object number (16 bits) and an index (8 bits).

Example: Object 0x1000/ Index 0 = Device Type, 32Bit Unsigned

SDOs with a width of 8/16/32 bits can be read and written with a CANopen® frame. SDOs that are longer are transmitted in more than one frame.

SDOs can be processed as soon as a CANopen® slave is ready for operation. For the SDOs, only the COB ID functions “SDO request” or “SDO response” are available. The object number, access mode, and type are stored in the first 4 bytes of the CAN frame. The last 4 bytes of the CAN frame then contain the value for the SDO.



PDOs contain the “working values” of a CANopen® slave for cyclic process operation. Each CANopen® slave can manage several PDOs (normally up to 4 for transmitting and 4 for receiving).

Each CANopen® slave should have a directory containing the objects it supports.

Each of the existing PDOs has its own COB-ID. It is possible to map any information of the CANopen® slave to the 8 data bytes of the frame for reading and writing. The values from the object directory (SDOs) are always mapped.

The PDOs are automatically mapped from most CANopen® slaves on startup. The assignment can be changed using certain SDOs.

7.3.3 Functions

The CANopen® functions are divided into the following basic groups:

- Reading and writing SDO
- Reading and writing PDO
- Network management
- Emergency messages

The function code is stored in the upper 4 bits of the identifier. Together with the node ID this makes up the COB identifier.

COB identifier (COB-ID):

10	9	8	7	6	5	4	3	2	1	0
Function				Node ID						

It is possible to change some COB-IDs to other values using special service data objects (SDOs).
This is NOT supported by the CANopen® data handling!

Broadcast functions:

Function	Function code (binary)	Resulting COB-ID
NMT	0000	0h
SYNC	0001	80h
TIME STAMP	0010	100h

Node functions:

"Tx" = is transmitted by the slave
"Rx" = is transmitted by the slave

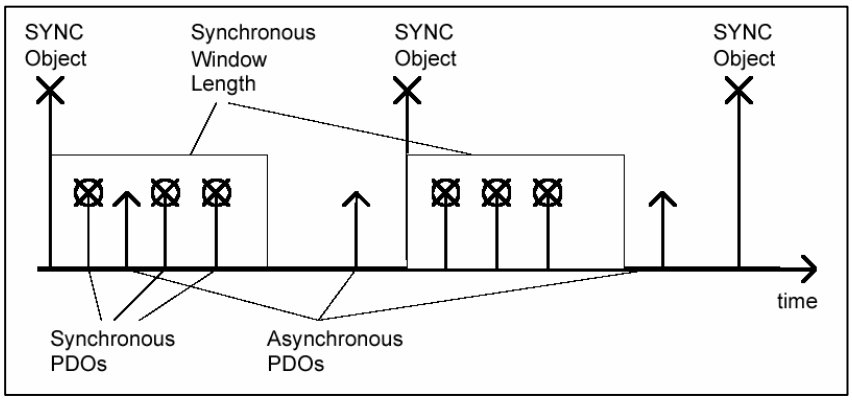
Function	Function code (binary)	Resulting COB-ID
EMERGENCY	0001	81h –FFh
PDO1 (tx)	0011	181h – 1FFh
PDO1 (rx)	0100	201h – 27Fh
PDO2 (tx)	0101	281h – 2FFh
PDO2 (rx)	0110	301h – 37Fh
PDO3 (tx)	0111	381h – 3FFh
PDO3 (rx)	1000	401h – 47Fh
PDO4 (tx)	1001	481h – 4FFh
PDO4 (rx)	1010	501h – 57Fh
SDO (tx)	1011	581h – 5FFh
SDO (rx)	1100	601h – 67Fh
NMT Error Control	1110	701h – 77Fh

7.3.4 Network management

The SYNC frame can be implemented using a timer with the CAN 300 module.

SYNC:

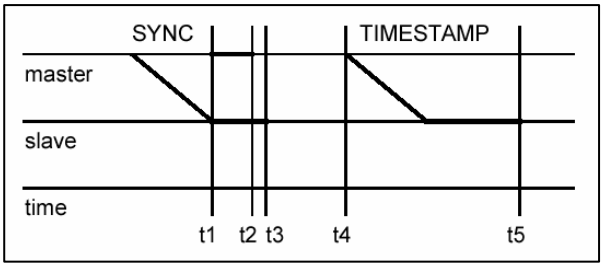
The SYNC frame is a cyclic “broadcast” frame and sets the basic bus clock. To ensure isosynchronism, the SYNC frame has a high priority.
[COB-ID: 80h]



The time stamp frame can be implemented using a timer with the CAN 300 module.

Time Stamp:

The time stamp frame is a cyclic “broadcast” frame and provides the system time. The time stamp frame is usually transmitted directly after a SYNC frame and then provides the system time of the SYNC frame.



To ensure a precise transmission, the time stamp frame has a high priority.
[COB-ID: 100h]

Nodeguarding:

With the nodeguarding function, the master monitors the CANopen® slave modules by transmitting frames cyclically to each slave. Each CANopen® slave must respond to the nodeguarding frame with a status frame.

The control can detect failure of a CANopen® slave using nodeguarding.
[COB-ID: 700h + Node-ID + 1Byte data with status of the slave]

Lifeguarding:

In lifeguarding, each CANopen® slave continuously monitors whether the master is performing nodeguarding once it has been started within certain time limits. If the nodeguarding frame of the master fails, the distributed I/O module can detect that using lifeguarding and, for example, put all outputs into the safe state.

Nodeguarding and lifeguarding should always run together.

Heartbeat:

Heartbeat monitoring is equivalent to nodeguarding although no request frames are generated by CANopen® master. The heartbeat frame is transmitted automatically by the node and can be evaluated in the master. [COB-ID: 700h + Node-ID + 1Byte data with status of the slave]

Some CANopen® slave modules generate special emergency messages on switch-on or switch-off.

Emergency message:

If a fault occurs on a CANopen® slave, for example, the Lifeguarding timer elapses, it transmits an emergency message on the bus.
[COB-ID: 80h + Node-ID]

All stations can perform an emergency stop on receiving an emergency frame, for example.

BootUp message:

CANopen® slaves generate a BootUp message after switch-on that the master can recognize to initialize this new station.
[COB-ID: 700h + node ID + 1 byte data: 00h]

7.4 Start-up behavior of the CANopen® Master

The master features automatic start-up behavior to initialize the configured slaves correctly and get them running.

1. An NMT reset command is sent to all slaves and the bootup messages is awaited. The waiting time is settable.
2. All slaves are put in pre-operational by NMT command (without checking).
3. An NMT guard request is transmitted to those slaves to query the current status of the slaves
4. The SDO 1000 (device type) is read from each slave and compared with the slave settings.

If the mandatory devices are no available at this point or do not have the right device type, the procedure will start at step 1 again.

5. The configured initialization SDOs are transmitted to each slave. Abort codes do not result in cancellation

If the master option "Wait for PLC start" is selected, the NMT command 20 is awaited at this point.

6. NMT start is transmitted to all slaves
7. An NMT guard request is transmitted to those slaves to query the current status of the slaves
8. Cyclic operation is started. The IO input image is transmitted to the PLC (possibly after the blocking time).

If a slave fails in cyclic operation and the master option "Autostart of the slaves" is active, this slave is automatically re-initialized and started.

If the slave is a mandatory device, a master restart is performed and the procedure restarts at step 1.

7.5 Operating conditions for CANopen® Slave devices

To be able to use a CANopen® Slave on the CAN 300 PRO in CANopen® master operation, the slave must meet the following conditions:

1. The slave should perform a restart after the NMT reset command.
2. After the reset of the slave, the slave must transmit a bootup message (700+Node-ID; Data: 00)
3. It must be possible to read out the SDO 1000.
4. The slave should always answer a NMT guarding request (700+Node-ID with RTR bit set) with its status.
5. For monitoring by the master, the slave should support either nodeguarding or producer heartbeat.

If a device to be used does not meet these conditions, its function may be impaired.

7.6 Tips on start-up / troubleshooting

To facilitate start-up of a CANopen® network, the following tips must be taken into account.

- If the LED BF ("CAN bus error") is still lit or blinking, check the physical structure of the CAN bus (terminating resistor, baudrate, etc.). Use layer 2 debug display (Sec. 6.7.1).
- If the LED SF "system errors" lights up, there is a defective MMC in the module, or the imported CAN project has an internal error.
- Check which "device monitoring" method (heartbeat or nodeguarding) is supported by the slave in question. Do not use "consumer heartbeat" until everything else has been started up.
- On all devices, do not yet activate the option "Mandatory device" so that the master will definitely start up and show all the stations found in the slave list of the CANopen® debug display (Sec. 6.7.2). These stations can be defined as a mandatory device if necessary.
- Initially set "Wait after reset" to a long time (e.g. 30 seconds) if the master displays all slaves as "operational" for a shorter time, this time can be reduced.
- If the slave device fulfills all requirements from Section 7.5 ?
- If a slave is displayed as operational after start-up of the master, but no data can be received, check the PDO mapping of the slave
- Check whether an error has occurred during SDO initialization of the slaves: CANopen® debug display/SDO abort code display

If these tips do not help, contact our support. Either by phone or at support@helmholz.de.

If information about their slave device is also at hand (manual), please also send this information.

7.7 CANopen® data handling modules

If the CANopen® Master data handling blocks are used, the CAN 300 PRO module must also be parameterized with a CANopen® Master project.

The data handling blocks for CANopen® communication provide all the necessary functions to replace the process image, to process SDOs, and to perform network management.

These data handling blocks can only be used if the CAN 300 PRO module has also been parameterized in CANopen® Master mode, see Section 6.4 „Creation of a CANopen® project“.

The CANopen® data handling blocks should not be called up together with layer 2 data handling blocks!

Block	Name	Function	Section
FB 20	CANopen® IO Read	Read the I/O date from the module	7.7.1
FB 21	CANopen® IO Write	Transmit the I/O data to the module	7.7.2
FB 22	CANopen® Service	Fetch livelist, receive emergency frames	7.7.3
FB 23	CANopen® NMT	Network management for masters and slaves	7.7.4
FB 24	CANopen® SDO	SDO orders up to 4 bytes	7.7.5
FB 27	CANopen® SDO segmented	SDO orders of any length	7.7.6
FB 25	CANopen® L2 Receive	Receive layer 2 frames	7.7.7
FB 26	CANopen® PDO resend	Transmit a PDO again with the same data	7.7.8
FB27	SYNC Trigger	send PDOs and following SYNC	7.7.9

Blocks that are no longer required can be removed from the project to save storage space. The blocks do not call each other.

The SDO-FBs 24 and 27 must never be activated simultaneously.

7.7.1 FB 20 CANopen® IO Read

With this FB, the current data of the input image are read into the PLC. The FB should be called only once at the beginning of the OB cycle.

Parameter	Direction	Type	Example
Base	IN	INT	256
Dest	IN	ANY	P#I 50.0 BYTE 100
STAT	OUT	WORD	MW 20
Err	OUT	BOOL	M 22.6
RetVal	OUT	INT	MW 24
NewData	OUT	BOOL	M 22.0

Base	Address of the CAN 300 PRO module
Dest	ANY pointer to the target area for the input buffer in the PLC. The data are copied from the module into this area up to the maximum number of bytes specified.
STAT	Status of the module, see Section 7.2.5
Err	Error bit is 0, on successful implementation
RetVal	Error number, see Section 8
NewData	Bit is 1 if new data are successfully fetched from the CAN 300 PRO module.

Example of call:

```
CALL  FB    20 , DB20
 Base   :=256
 Dest   :=P#I 50.0 BYTE 100
 STAT   :=MW20
 Err    :=M22.6
 RetVal :=MW24
 NewData:=M22.0
```

Examples of the ANY pointer:

P#I 50.0 BYTE 100 copies the input data into the I/O input image of the PLC from IB 50 to max. IB 149 (100 bytes). For this purpose, the maximum memory size of the I/O image of the selected PLC must be taken into consideration.

P#M 100.0 BYTE 50 copies the data into the marker memory area from MB 100 to max. MB 149 (50 bytes). For this purpose, the maximum memory size of the marker memory of the selected PLC must be taken into consideration.

P#DB 2.DBX 0.0 BYTE 300 copies the data into the data block 2 from DBB 2 to max. DBB 299 (300 bytes).

7.7.2 FB 21 CANopen® IO Write

With this FB, data are written out of the PLC into the output image of the module. The FB should be called only once at the end of the OB cycle.

Parameter	Direction	Type	Example
Base	IN	INT	256
Dest	IN	ANY	P#DB3.DBX 0.0 BYTE 200
STAT	OUT	WORD	MW 20
Err	OUT	BOOL	M 22.7
RetVal	OUT	INT	MW 24

Base	Address of the CAN 300 PRO module
Source	ANY pointer to the target area for the output buffer in the PLC. The data are from the PLC into the module, no more than the specified number of bytes.
STAT	Status of the module, see Section 7.2.5
Err	Error bit is 0, on successful implementation
RetVal	Error number, see Section 8

Example of call:

```
CALL  FB    21 , DB21
 Base  :=256
 Source:=P#DB3.DBX0.0 BYTE 200
 STAT  :=MW20
 Err   :=M22.7
 RetVal:=MW24
```

Examples of the ANY pointer:

P#Q 50.0 BYTE 100 copies the output data into the I/O output image of the PLC from QB 50 to max. QB 149 (100 bytes). For this purpose, the maximum memory size of the I/O image of the selected PLC must be taken into consideration.

P#M 100.0 BYTE 50 copies the data into the marker memory area from MB 100 to max. MB 149 (50 bytes). For this purpose, the maximum memory size of the marker memory of the selected PLC must be taken into consideration.

P#DB 3.DBX 0.0 BYTE 300 copies the data into the data block 3 from DBB 2 to max. DBB 299 (300 bytes).

7.7.3 FB 22 CANopen® Service

With this FB, emergency messages can be received and the livelist updated. The FB should be called cyclically in the PLC program.

Parameter	Direction	Type	Example
Base	IN	INT	256
Emergency	IN	ANY	P#M 92.0 BYTE 8
Livelist	IN	ANY	P#DB30.DBX0.0 BYTE 8
Node	OUT	INT	MW 90
STAT	OUT	WORD	MW 20
Err	OUT	BOOL	M 22.7
RetVal	OUT	INT	MW 24
New_Emergency	INOUT	BOOL	M 30.0
Req_Livelist	INOUT	BOOL	M 30.1
Busy_Livelist	INOUT	BOOL	M 30.2
New_Livelist	INOUT	BOOL	M 30.3

Base — Address of the CAN 300 PRO module

Emergency — ANY pointer to 8 bytes memory in which the data of the emergency frame are stored

Livelist — ANY pointer to the memory in which the data of the livelist are stored

Node — Node number for the emergency message

STAT — Status of the module, see Section 7.2.5

Err — Error bit is 0, on successful implementation

RetVal — Error number, see Section 8

New_Emergency — Was a new emergency message was received from the module, this bit will be set. The bit is only set for one cycle.

Req_Livelist — Request bit for a livelist, is reset to 0 immediately after calling.

Busy_Livelist — Flag indicating that the livelist is being awaited.

New_Livelist — Flag indicating whether the requested livelist has been received.

Example of call:

```
CALL  FB    22 , DB22
 Base          :=256
 Emergency     :=P#M 92.0 BYTE 8
 Livelist      :=P#DB30.DBX0.0 BYTE 10
 Node          :=MW90
 STAT          :=MW20
 Err           :=M30.7
 RetVal        :=MW26
 New_Emergency:=M30.0
 Req_Livelist :=M30.1
 Busy_Livelist:=M30.2
 New_Livelist :=M30.3
```

Structure of the emergency message:

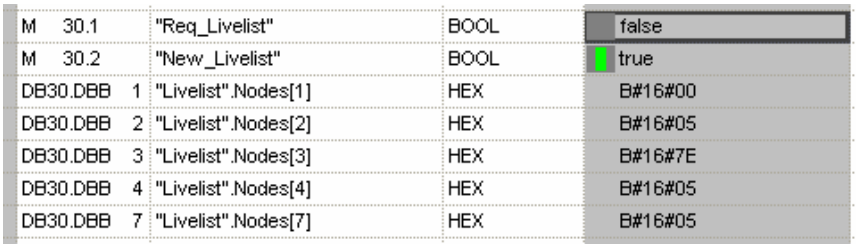
Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Emergency Error Code		Error Register (1001h)	Manufacturer-specific Error				

For the livelist, an ANY pointer must be transferred to a memory area that is at least as large as the highest node number.

The module provides the status of each node at the corresponding point in the memory relative according to the node number.

The following node states are indicated:

00 = unknown/not defined
04 = stop
05 = operational
6A = slave is detected, but not yet initialized (bootup)
7F = preoperational
7E = failure of the slave



M 30.1	"Req_Livelist"	BOOL	false
M 30.2	"New_Livelist"	BOOL	true
DB30.DBB 1	"Livelist".Nodes[1]	HEX	B#16#00
DB30.DBB 2	"Livelist".Nodes[2]	HEX	B#16#05
DB30.DBB 3	"Livelist".Nodes[3]	HEX	B#16#7E
DB30.DBB 4	"Livelist".Nodes[4]	HEX	B#16#05
DB30.DBB 7	"Livelist".Nodes[7]	HEX	B#16#05

The example indicates the following states:

Node 1: 00 = not defined
Node 2: 05 = operational
Node 3: 7E = failed
Node 4: 05 = operational
Node 7: 05 = operational

Failure detection of a slave by the master can only work if the device monitoring has been activated on the slave.

7.7.4 FB 23 CANopen® network management

With this FB, network management functions can be executed both for individual slaves and for the master.

Parameter	Direction	Type	Example
Base	IN	INT	256
Node	IN	INT	1
Func	IN	INT	2
STAT	OUT	WORD	MW 20
Err	OUT	BOOL	M 22.7
RetVal	OUT	INT	MW 24

Base	Address of the CAN 300 PRO module
Node	Node number (1…127)
Func	Function code: 0 = Resume Node Control 1 = Start Node 2 = Stop Node 3 = Disconnect Node 4 = Node Enter Preoperational-State 5 = Reset Node 6 = Reset Communication of Node 13 = Clear Error 14 = CAN-Controller Reset 20 = CANopen® Master Start 21 = CANopen® Master Stop 22 = CANopen® Master Reset (complete restart of the master) 24 = CANopen® Master Run (enable of the master if the option “Wait for PLC start” has been selected)
STAT	Status of the module, see Section 7.2.5
Err	Error bit is 0 on successful implementation
RetVal	Error number, see Section 8

If one of the NMT commands (start, stop, preoperational, reset, disconnect) is used, this slave will be taken out of the master automatic. To have the slave taken over by the master again, the function code 0 is transmitted for the corresponding slave.

Example of call:

```
CALL  FB    23 , DB23
 Base  :=256
 Node  :=1
 Func  :=2
 STAT  :=MW20
 Err   :=M126.7
 RetVal:=MW124
```

7.7.5 FB 24 CANopen® SDO

FB 24 must not be activated simultaneously with FB 27!

With this FB, SDOs up to 4 bytes can be transmitted. If SDOs are more than 4 bytes are transmitted, FB 27 (see Section 7.7.6) must be used.

Parameter	Direction	Type	Example
Base	IN	INT	256
Node	IN	INT	MW 41
SDO_Request	IN	BYTE	MB 43
SDO_Index	IN	WORD	MW 44
SDO_Subindex	IN	BYTE	MB 46
SDO_Response	OUT	BYTE	MB 48
SDO_Abortcode	OUT	DWORD	MD 50
STAT	OUT	WORD	MW 20
RetVal	OUT	INT	MW 54
SDO_Data	INOUT	DWORD	MD 150
SDO_DataLen	INOUT	BYTE	MB 49
Activate	INOUT	BOOL	M 40.0
Busy	INOUT	BOOL	M 40.1
Err	INOUT	BOOL	M 40.7
Done	INOUT	BOOL	M 40.2

Base	Address of the CAN 300 PRO module
Node	Node number (1…127)
SDO_Request	SDO function: 0 = Reading the SDOs 1 = Writing the SDOs
SDO_Index	SDO index
SDO_SubIndex	SDO subindex
SDO_Response	Response according to execution of the SDO request: 0x40 = Positive read response 0x80 = negative read response (→ abort code) 0x41 = positive write confirmation 0x81 = negative write confirmation (→ abort code)
SDO_Abortcode	Abort code on incorrect execution of the SDO request
STAT	Status of the module, see Section 7.2.5
RetVal	Error number, see Section 8
SDO_Data	Data for the SDO as a DWORD (right justified)
SDO_DataLen	Size of the SDO (1, 2, 4 bytes)
Activate	Bit for starting the request, is reset by the FB
Busy	Flag “request running”
Err	Error bit is 0 on successful execution
Done	Flag “Request complete” (with/without error)

To start a new SDO request, the “activate” bit must be set on calling the FB. The bit is reset and the “busy” bit is set as the flag for the current request. The FB must call up each PLC cycle until the “done” bit indicates that the request has been completed.

If it was not possible to complete the request successfully, this can be indicated by the bit “Err.” Otherwise the return value SDO_Response can be evaluated to check the success of the request.

Example of call:

```
SDO:  CALL  FB    24 , DB24
       Base  :=256
       Node          :=MW41
       SDO_Request   :=MB43
       SDO_Index     :=MW44
       SDO_Subindex  :=MB46
       SDO_Response  :=MB48
       SDO_Abortcode:=MD50
       STAT          :=MW20
       RetVal        :=MW54
       SDO_Data      :=MD56
       SDO_DataLen   :=MB49
       Activate      :=M40.0
       Busy          :=M40.1
       Err           :=M40.7
       Done          :=M40.2

      A     M     40.1
      JC    NEXT
      A     M     40.2
      A     M     40.7
      JC    ERR
```

7.7.6 FB 27 CANopen® SDO Segmented

FB 27 must not be activated simultaneously with FB 24!

With this FB, SDOs more than 4 bytes in length can be transmitted. SDOs up to 230 bytes can be transmitted

Parameter	Direction	Type	Example
Base	IN	INT	256
Node	IN	INT	MW 41
SDO_Request	IN	BYTE	MB 43
SDO_Index	IN	WORD	MW 44
SDO_Subindex	IN	BYTE	MB 46
SDO_Data	IN	ANY	P#M 150.0 BYTE 20
SDO_Response	OUT	BYTE	MB 48
SDO_DataLen	OUT	BYTE	MB 49
SDO_Abortcode	OUT	DWORD	MD 50
STAT	OUT	WORD	MW 20
RetVal	OUT	INT	MW 54
Activate	INOUT	BOOL	M 40.0
Busy	INOUT	BOOL	M 40.1
Err	INOUT	BOOL	M 40.7
Done	INOUT	BOOL	M 40.2

Base	Address of the CAN 300 PRO module
Node	Node number (1…127)
SDO_Request	SDO function: 0 = Reading the SDOs 1 = Writing the SDOs
SDO_Index	SDO index
SDO_SubIndex	SDO subindex
SDO_Data	ANY pointer to the data for the SDO; the length of the SDOs to be transmitted at this point is defined. The maximum size is limited to 230 bytes.
SDO_Response	Response according to execution of the SDO request: 0x40 = Positive read response 0x80 = negative read response (→ abort code) 0x41 = positive write confirmation 0x81 = negative write confirmation (→ abort code)
SDO_DataLen	Length in bytes of the received SDO data
SDO_Abortcode	Abort code on incorrect execution of the SDO request
STAT	Status of the module, see Section 7.2.5
RetVal	Error number, see Section 8
Activate	Bit for starting the request, is reset by the FB
Busy	Flag “request running”
Err	Error bit is 0 on successful execution
Done	Flag “request complete” (with/without error)

To start a new SDO request, the “activate” bit must be set on calling the FB. The bit is reset and the “busy” bit is set as the flag for the current request.

The FB must call up each PLC cycle until the “done” bit indicates that the request has been completed.

If it was not possible to complete the request successfully, this can be indicated by the bit “Err.” Otherwise the return value SDO_Response can be evaluated to check the success of the request.

Example of call:

```
SDO:  CALL  FB    27 , DB27
       Base  :=256
       Node          :=MW41
       SDO_Request   :=MB43
       SDO_Index     :=MW44
       SDO_Subindex  :=MB46
       SDO_Data      :=P#M 150.0 BYTE 20
       SDO_Response  :=MB48
       SDO_DataLen   :=MB49
       SDO_Abortcode:=MD50
       STAT          :=MW20
       RetVal        :=MW54
       Activate      :=M40.6
       Busy          :=M40.1
       Err           :=M40.7
       Done          :=M40.2

      A     M     40.1
      JC    L2RC
      A     M     40.2
      A     M     40.7
      JC    ERR
```

7.7.7 FB 25 CANopen® L2 Receive

With this FB, all CAN frames can be received that are not processed by the CANopen® Master.

Parameter	Direction	Type	Example
Base	IN	INT	256
L2Frame	IN	ANY	P#M 60.0 BYTE 14
STAT	OUT	WORD	MW 20
Err	OUT	BOOL	M 22.2
RetVal	OUT	INT	MW74
Recd	INOUT	BOOL	MW 22.1

Base	Address of the CAN 300 PRO module
L2Frame	Any pointer for the complete layer 2 frame
STAT	Status of the module, see Section 7.2.5
Err	Error bit is 0 on successful implementation
RetVal	Error number, see Section 8
Recd	This bit is 1 if a frame has been received

Allocation of the frame in the pointer L2Frame:

Byte 0:	0x12 (internal ID)
Byte 1:	RTR bit (bit 6), length (bits 0-3)
Byte 2-5:	11 Bit Identifier (Bytes 4+5 used)
Bytes 6-13:	Data bytes 1-8 of the CAN frame

Example of call:

```
CALL  FB    25 , DB25
 Base   :=256
 L2Frame:=P#M 60.0 BYTE 14
 STAT   :=MW20
 Err    :=M22.2
 RetVal :=MW74
 Recd   :=M22.1
```

7.7.8 FB 26 CANopen® PDO resend

The CAN 300 PRO uses 4 methods to transmit PDOs to the slave (RPDO of the slave):

1. Transmission on change of the value (event-driven [255])

2. Transmission on every transfer to the module (event-driven on PLC cycle [254])

3. Transmission to SYNC frame

4. Transmission by SYNC trigger by the PLC (see also Sec. 7.7.9)

In addition to these methods, PDOs can be retransmitted to the slave in a targeted way and immediately using this FB. The module transmits a PDO frame with the currently available data.

Parameter	Direction	Type	Example
Base	IN	INT	256
Node	IN	INT	2
PDO	IN	INT	1
STAT	OUT	WORD	MW 20
Err	OUT	BOOL	M 136.7
RetVal	OUT	INT	M 134

Base	Address of the CAN 300 PRO module
Node	Node number (1…127)
PDO	relativ number of the PDOs to be transmitted Attention: Only defined PDOs are counted. If PDO1 and PDO4 are defined, PDO4 is the second (2).
STAT	Status of the module, see Section 7.2.5
Err	Error bit is 0 on successful implementation
RetVal	Error number, see Section 8

Example of call:

```
CALL  FB    26 , DB26
 Base  :=256
 Node  :=2
 PDO   :=1
 STAT  :=MW20
 Err   :=M136.7
 RetVal:=MW134
```

7.7.9 FB 28 CANopen® SYNC trigger

After the FB 28 has been called, the CAN 300 PRO module transmits a SYNC frame. If, in configured CANopen® Slaves, RPDOs of type “SYNC trigger by PLC(0)” are defined, these PDOs are transmitted before the SYNC frame, if the values have changed. FB 28 should always be called after FB 21 “IO-Write.”

Parameter	Direction	Type	Example
Base	IN	INT	256
STAT	OUT	WORD	MW 20
Err	OUT	BOOL	M 136.7
RetVal	OUT	INT	M 134

Base	Address of the CAN 300 PRO module
STAT	Status of the module, see Section 7.2.5
Err	Error bit is 0 on successful implementation
RetVal	Error number, see Section 8

Example of call:

```
CALL  FB    28 , DB28
 Base  :=256
 STAT  :=MW20
 Err   :=M35.7
 RetVal:=MW36
```

7.8 SDO abort codes

Below you will find typical error messages that can be generated by a CANopen® slave.

You will receive these error messages if you perform an SDO transmission (FB 24 or FB27).

Code	Meaning
0503 0000h	”Toggle bit” has not been alternated
0504 0000h	SDO protocol ”time out ”
0504 0001h	Client/server command designation not valid or unknown
0504 0002h	Unknown block size (block mode only)
0504 0003h	Unknown block number (block mode only)
0504 0004h	CRC error (block mode only)
0504 0005h	Outside the memory
0601 0000h	Access to this object is not supported
0601 0001h	Attempted read access to an object that can only be written
0601 0002h	Attempted write access to an object that can only be read
0602 0000h	Object does not exist in the object directory
0604 0041h	Object cannot be ”mapped” to a PDO
0604 0042h	Size and number of ”mapped” objects exceeds the possible PDO length
0604 0043h	General parameters -incompatibility
0604 0047h	General incompatibility in the device
0606 0000h	Access violation due to a hardware error
0607 0010h	Data type does not fit, length of the service parameter does not fit
0607 0012h	Data type does not fit, length of the service parameter too large
0607 0013h	Data type does not fit, length of the service parameter too small
0609 0011h	Subindex does not exist
0609 0030h	Out of value range of the parameter (only for write accesses)
0609 0031h	Value of the parameter too large
0609 0032h	Value of the parameter too small
0609 0036h	Maximum value is smaller than the minimum value
0800 0000h	General error
0800 0020h	Data item cannot be transmitted or stored
0800 0021h	Data item cannot be transmitted/stored because of local device control
0800 0022h	Data item cannot be transmitted/stored because of device status
0800 0023 h	Dynamic generation of the object directory not possible or already exists

7.9 SAE J1939 communication

7.9.1 General

For SAE J1939 handling, the CAN 300 module must be set to "29-bit mode"!

With the SAE J1939 data handling blocks, it is possible to transmit and receive CAN frames according to SAE J1939. The SAE J1939 protocol always uses CAN identifiers with 29 bits. Please ensure that a relevant project has been imported into the CAN 300 PRO module with the setting "Layer 2 - 29-bit mode".

The following FCs are available for SAE J1939:

FC 70 CANSEND_SAE_J1939 Transmitting a frame

FC 71 CANRCV_SAE_J1939 Receiving a frame

Initialization of the module in the start-up OBs is not necessary. The module starts automatically if the PLC is switched to RUN and stops if the PLC goes into the STOP state.

Multipacket messages are currently not supported.

7.9.2 FC 70 CANSEND_SAE_J1939

The CANSEND_SAE_J1939 function block (FC 70) transfers a CAN frame to the module from which it is transmitted immediately.

Parameter	Direction	Type	Example
Base	IN	INT	256
Priority	IN	INT	7
DataPageBit	IN	BOOL	FALSE
PDU_Format	IN	INT	123
PDU_Specific	IN	INT	2
Source_Addr	IN	INT	1
B0	IN	BYTE	B#16#0
B1	IN	BYTE	B#16#0
B2	IN	BYTE	B#16#0
B3	IN	BYTE	B#16#0
B4	IN	BYTE	B#16#0
B5	IN	BYTE	B#16#0
B6	IN	BYTE	B#16#0
B7	IN	BYTE	B#16#0
STAT	OUT	WORD	MW 80
RETVAL	OUT	INT	MW 82
Snd	INOUT	BOOL	M 87.0

As the passed parameters, the base address of the module must be passed as an integer number (`Base`) and a bit for transmit enable (`Snd`).

The bit `Snd` is always reset after the block has been executed. The frame to be transmitted is always transferred to the module. If the transmit buffer in the module is full, older frames that have not been transmitted yet are deleted. To prevent that, bit 4 of the `STAT` byte must always be queried before transmission.

The FC70 "CANSEND" must not be called in OB 1 (cycle) and OB 35 (time OBs) simultaneously or mixed!

Parameter `STAT` contains the status of the CAN 300 PRO module (see Sec. 7.2.5). The parameter is always assigned value, even if the `Snd` bit is not set.

Assignment of the parameters for the 29-bit CAN identifier according to the SAE J1939 protocol:

<table>
<tr><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td colspan="3" rowspan="4">Priority</td><td>R</td><td>P</td><td colspan="13">PGN (Parameter Group Number)</td><td colspan="8" rowspan="4">SA (Source Address)</td></tr>
<tr><td>R</td><td>P</td><td colspan="8">PDU format</td><td colspan="5">PDU-specific</td></tr>
<tr><td>R</td><td>P</td><td colspan="8">0…239: PDU1 Format</td><td colspan="5">DA (Destination Address)</td></tr>
<tr><td>R</td><td>P</td><td colspan="8">240..255: PDU2 Format</td><td colspan="5">Group Extension</td></tr>
</table>

7.9.3 FC 71 CANRCV_SAE_J1939

The function block CANRCV_SAE_J1939 (FC 71) transmits a CAN frame from the module to the PLC, if a frame has been received.

Parameter	Direction	Type	Example
Base	IN	INT	256
Priority	OUT	INT	MW60
DataPageBit	OUT	BOOL	MB68.0
PDU_Format	OUT	INT	MW62
PDU_Specific	OUT	INT	MW64
Source_Addr	OUT	INT	MW66
B0	OUT	BYTE	MB70
B1	OUT	BYTE	MB71
B2	OUT	BYTE	MB72
B3	OUT	BYTE	MB73
B4	OUT	BYTE	MB74
B5	OUT	BYTE	MB75
B6	OUT	BYTE	MB76
B7	OUT	BYTE	MB77
STAT	OUT	WORD	MW 78
RETVAL	OUT	INT	MW 84
Recd	INOUT	BOOL	M 79.0

As the passed parameter, the base address of the module must be passed as an integer number (`Base`).

If the function block has read a frame from the CAN 300 PRO module, bit `Recd` is set.

Parameter `STAT` contains the status of the CAN 300 module (see Sec. 7.2.5). The parameter is always assigned a value even if no frame has been received.

Assignment of the parameters for the 29-bit CAN identifier according to the SAE J1939 protocol:

<table>
<tr><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td rowspan="4">Priority</td><td rowspan="4"></td><td rowspan="4"></td><td>R</td><td>P</td><td colspan="9">PGN (Parameter Group Number)</td><td colspan="10" rowspan="4">SA (Source Address)</td></tr>
<tr><td>R</td><td>P</td><td colspan="6">PDU format</td><td colspan="3">PDU-specific</td></tr>
<tr><td>R</td><td>P</td><td colspan="6">0...239: PDU1 Format</td><td colspan="3">DA (Destination Address)</td></tr>
<tr><td>R</td><td>P</td><td colspan="6">240..255: PDU2 Format</td><td colspan="3">Group Extension</td></tr>
</table>

8 Return parameter RETVAL

The return parameter RETVAL of the function blocks can contain both function-specific errors or error numbers of the Siemens system function blocks SFC 58, SFC 59, and SFC 20.

Error codes of the CAN handling:

80F1: Module not ready

80F2: Dataset assigned

80F3: CANopen® Master not yet in cyclic operation

80F7: CANopen® Slave is still in cyclic bootup

80F8: SDO data block pointer to small for SDO-data

80FA: Abortcode received from SDO-job

81E1: Node number not valid (1..127)

82E2: Function code not valid

82E3: PDO number not valid (1..4)

9 Upgrading from CAN 300 to CAN 300 PRO

If projects have so far been performed with the old CAN 300, upgrading to the CAN 300 PRO is always possible because the CAN 300 PRO contains all functions of the CAN 300.

9.1 Differences between CAN 300 and CAN 300 PRO

CAN 300 old	CAN 300 PRO
Project memory internal (Flash)	Project memory internal (256K Flash) additional storage of the project on MMC
128 frames TX and Rx FIFO, 3 frames with high priority	400 frames TX and Rx FIFO, 20 frames with high priority
15 normal and 1 high-priority receive filter (acceptance masks)	16 receive filter, each can be parameterized with high or low priority
Receive filters are only settable as a range via the project	Receive filters can be set via the project and using the DIP switches and as a node address
Baudrate can be set via the project	Baudrate can be set via the project and via the DIP switch
Can only be used in the central controller	Can also be used in expansion racks (ET200M)
3 LEDs for displaying the status	6 LEDs for displaying the status

9.2 Layer 2

The project must be created new in the CANParam V4 in accordance with the old CAN 300 (a converter is being prepared).

All settings (baudrate, scripts, timer) can be made directly. Only when using a specific bit timing does the setting have to be recalculated.

The data handling software is compatible except for the extension of the RETVAL parameter in all calls.

9.3 SAE J1939

The project must be created new in the CANParam V4 in accordance with the old CAN 300 (a converter is being prepared).

All settings (baudrate, scripts, timer) can be made directly.

The data handling software is compatible except for the extension of the RETVAL parameter in all calls.

9.4 CANopen®

If the CANopen® Master data handling software of the old CAN 300 is used, major adaptations to CAN 300 PRO are required. Because of the relocation of the CANopen® Master function into the module, a new project must be created in CANParam (see Section 6.4) and the Step 7 software must be revised.

Use of the CAN 300 PRO as a CANopen® Master has the following advantages:

- Up to 127 slaves can be used
- Lower memory requirement in the PLC program
- No dependence on the cycle time of the PLC
- Lower performance requirement in the PLC

Function	***CAN 300 old***	***CAN 300 PRO***
Initialization	Call of the FC 40 in the start-up OB necessary	No call required during start-up
Number of slaves	Up to 64 slaves. Limited by memory size and the speed of the PLC	Up to 127 slaves, number of slaves only has minor influence on the performance and memory allocation in the PLC
Memory assignment	Approx. 11 Kbyte	Approx. 8 Kbytes, unnecessary blocks can be omitted. Standard < 3 Kbytes
PDO received	FC49 CANCYCLE receives PDO frames one after the other and enters them in the PDO-DBs.	Receive PDOs are entered in the PLC input buffer and loaded into the PLC complete by the FB 20 "CANopen® IO Read" at the start of the PLC cycle.
Transmit PDO	Call of the FC 44 for each PDO	Direct writing into an output buffer (DB, markers, outputs) and complete transmission at the end of the PLC cycle. PDOs are then transmitted automatically.
Read/write SDO	Call of the FC 41 (up to 4 bytes) or FC 42 (more than 4 bytes, own DB necessary); processing by calling the FC 49; only one request can be running at once	Call of the FB 24 for SDOs (1, 2, 4 bytes), FB 27 for SDOs of any length. The module processes the SDOs independently of the PLC cycle.
Network management	Call of the FC 48	Call of the FB 24, NMT functions have the same function codes, additional functions for error checking are contained
Nodeguarding	Call of the FC 47 "Nodeguarding" with FC49 in the cycle; evaluation of the state in the heartbeat DB	Call of the FB 22 "CANopen Service" with request of the current livelist. The nodeguarding is automatically performed by the master
Emergency receive	Call of the FC 43 "ReceiveAll," if FC 49 indicates receipt of an emergency	On calling the FB 22 "CANopen Service," emergency frames are passed on directly

10 Appendix

10.1 Technical Data

Order number	CAN 300 PRO	700-600-CAN12
Dimensions	116 x 40 x 125 mm (LxWxH)	
Weight	Approx. 280g	

CAN interface

Type:	ISO/DIN 11898-2, CAN high speed physical layer
Transmission rate:	10 kbps to 1Mbps
Protocols:	CAN 2.0A (11bit) CAN 2.0B (29bit) SAE J1939 CANopen® master CANopen® Slave DEVICENET *available soon*
Connection:	Connector, SUB D 9-way

Configuration interface

Type:	USB 1.1
Transmission rate:	Fullspeed 12Mbps
Connector:	USB-B

Power supply

Voltage:	+5V DC via backplane bus
Current consumption:	160mA (typ.) / 190mA (max.)

Special features

Quality assurance:	According to ISO 9001:2008
Maintenance:	Maintenance-free (no battery, rechargeable or non-rechargeable)

10.2 Pin assignment

Pin	SUBD connector CAN
1	-
2	CAN Low
3	CAN GND
4	-
5	-
6	-
7	CAN High
8	-
9	-

10.3 Further Documentation

Internet: www.can-cia.org

CAN Specification 2.0, Part A & Part B

High Layer Protocol CANopen®

Holger Zeltwanger: “CANopen®,” VDE Verlag, ISBN 3-8007-2448-0

Notes