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DP/CAN Coupler

PROFIBUS DP to CAN-Bus Coupler for CANopen® and CAN Layer 2

700-650-CAN01

Manual

Edition 7 / 03.12.2012 HW1 & FW 1.29 and higher

Manual order number: 900-650-CAN01/en

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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 information in this manual is regularly updated. When using purchased products, please heed the latest version of the manual, which can be viewed in the Internet at www.helmholz.de, from where it can also be downloaded.

Our customers are important to us. We are always glad to receive suggestions for improvement and ideas.

Revision history of this document:

Edition	Date	Revision
4	18.06.2009	Correction of the number of pages (page 14)
		Heartbeat at CANopen® (FW. 1.29)
		Extended information on consistent data
		Additional information for the start-up procedure
5	30.06.2010	Heartbeat protocol from slave is supported and Some corrections
6	22.12.2011	GSD filename of CANopen corrected and further small corrections
7	23.11.2012	DIP switch table edited

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 DP/CAN coupler 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 estimation).

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 Chapter 1.5.

1.3 Information for the user

This manual is addressed to anyone wishing to configure or install the DP/CAN coupler.

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 DP/CAN coupler is intended for use with a PROFIBUS DP network only. 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 DP/CAN coupler 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 via the DP/CAN coupler alone.

2 Installation and Mounting

The DP/CAN coupler 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 ºC – 60 ºC.

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:

0 to 60 ºC

3 System Overview

3.1 Application and function description

The DP/CAN coupler from System Helmholz GmbH allows you to connect any CAN stations to the PROFIBUS DP.

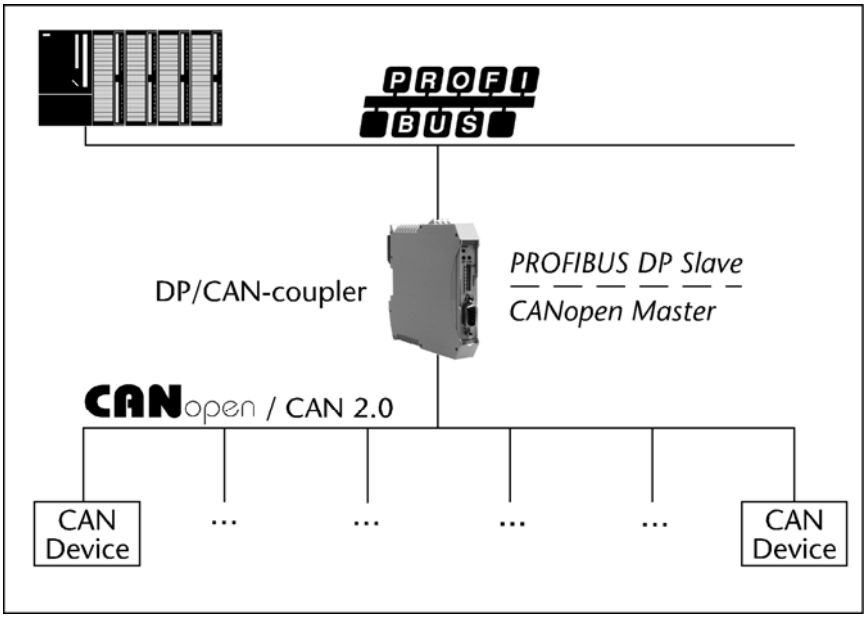
The DP/CAN coupler must be parameterized as a PROFIBUS station in the Hardware Configurator. The necessary GSD files are supplied with the device.

The PROFIBUS side is configured as a DP slave. The interfaces meet EN 50170 and are electrically isolated. The baud rate of 9.6kBaud to 12Mbaud is detected automatically. The maximum volume of input and output information is 312 bytes.

Die CANopen® side is configured as an independent master that can be controlled via the PROFIBUS. This allows up to 15 CANopen® slave modules to be operated in one CANopen network according to CiA® standard DS-301 Version 4. All parameterized modules are detected, started up, and monitored for their operating status by the CANopen® master. Up to 4 transmit PDOs and 4 receive PDOs can be managed per node for data exchange. Emergency frames from the CANopen® nodes are processed by the DP/CAN coupler and forwarded to the PROFIBUS master. Any SDOs can be transmitted or received to parameterize the CANopen® slave modules.

Alternatively, the DP/CAN coupler can also be used on Layer 2. The CAN messages that are displayed in the PROFIBUS are freely selectable.

The CAN bus interface meets ISO/DIN 11898-2 and is electrically isolated.



3.2 Connections

PROFIBUS 9-way Sub-D socket:

Pin	PROFIBUS DP
1	-
2	
3	Data line B
4	-
5	GND
6	VP (power supply for terminating resistors)
7	-
8	Data line A
9	-

3-way CAN connector (no terminating resistor):

1	CAN High
2	CAN-GND
3	CAN-Low

3-way power supply:

1	GND
2	V-
3	V+

3.3 LED displays

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

LED Power (green): Continuous light indicates the PROFIBUS is running and the PLC is in run. Slow blinking indicates the PLC is in stop.

LED DP (red): A parameterization error on the PROFIBUS has occurred.

LED CAN (yellow): CAN frames are being received from the CAN bus.

3.4 DIP switches

Changing the DIP switches is only effecting after power on!

The 8-switch DIP switch on the housing front is used for setting the PROFIBUS address of the device and the CAN operating mode.

The switches are counted from bottom to top.

Switch	Function		
8	Mode	OFF=Layer 2	ON=CANopen
7	PROFIBUS address	2^6	+ 64
6		2^5	+ 32
5		2^4	+ 16
4		2^3	+ 8
3		2^2	+ 4
2		2^1	+ 2
1		2^0	+ 1

3.5 Scope of supply

DP/CAN Coupler	700-650-CAN01

incl. 2 x 3-pin connector for CAN bus and 24V power supply

CD with GSD file examples and instructions

3.6 Accessories

Manual, German/English	900-650-CAN01
CAN bus plug connector	700-690-0BA11
CAN bus plug connector with cable connector	700-690-0BB11
CAN bus connector axial	700-690-0CA11

4 Configuration (CANopen Master)

The DP/CAN coupler allows you to convert data from a PROFIBUS DP circuit to a CAN circuit and vice versa.

Before data can be exchanged between the PROFIBUS and the CAN bus, the start-up phase of the PROFIBUS of the DP/CAN coupler must be parameterized. This is done automatically by the PROFIBUS master (PLC) when the bus starts up.

The configuration of the CANopen® bus (baud rate, number of nodes, distribution of PDOs) must be stored as a PROFIBUS node in the parameter set of the DP/CAN coupler when the DP/CAN coupler is defined.

When parameterization is complete and the PLC has started, the CAN modules are started up and monitored. The status of the CAN modules is displayed in the diagnostics area of the process image. The emergency frames from the PLC bus are also displayed here.

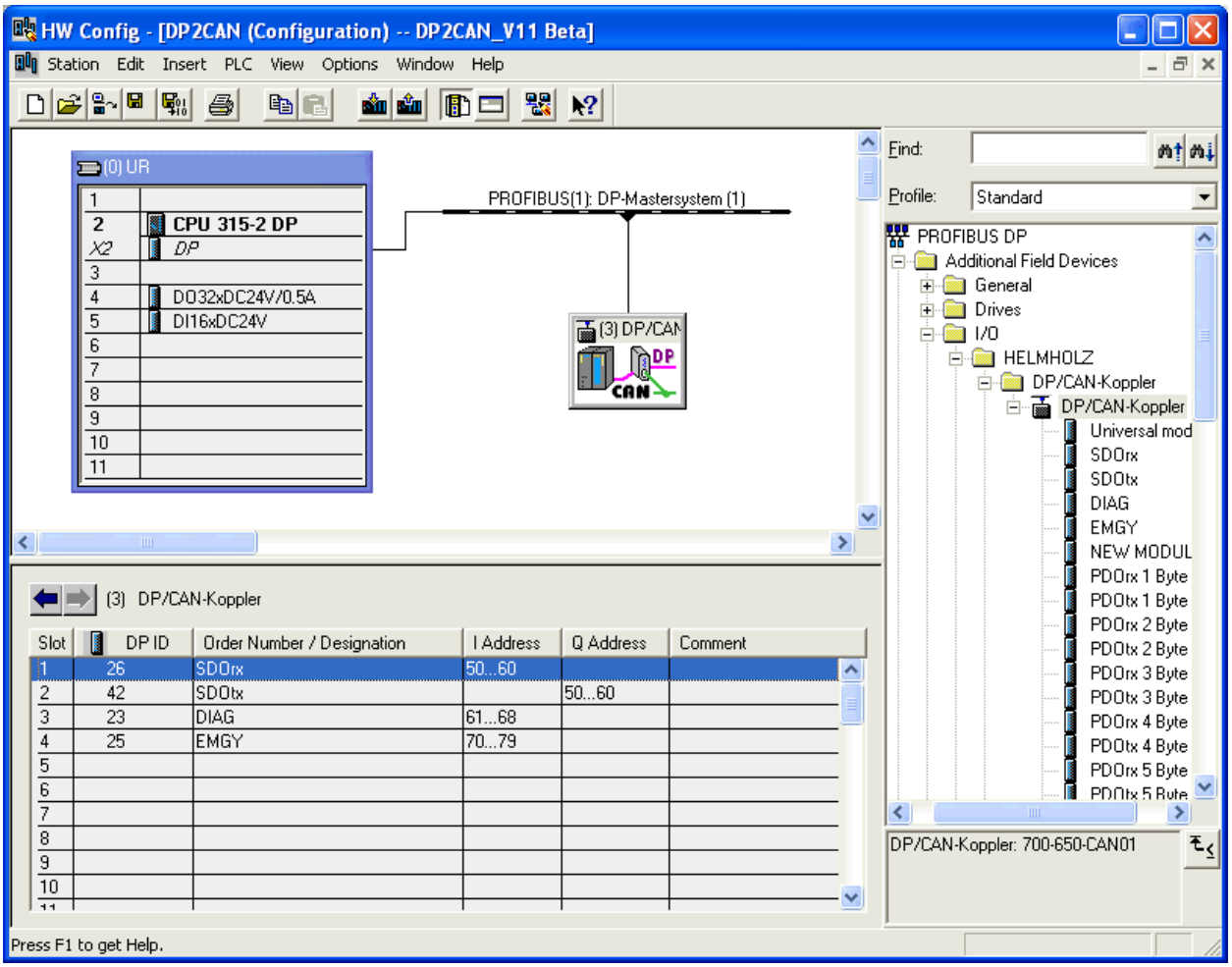
CANopen® modules can be parameterized with SDO frames in an SDO window of the process image. The input and output data are also updated on each configured guarding cycle (request from PDOs).

4.1 Install and parametrize the device

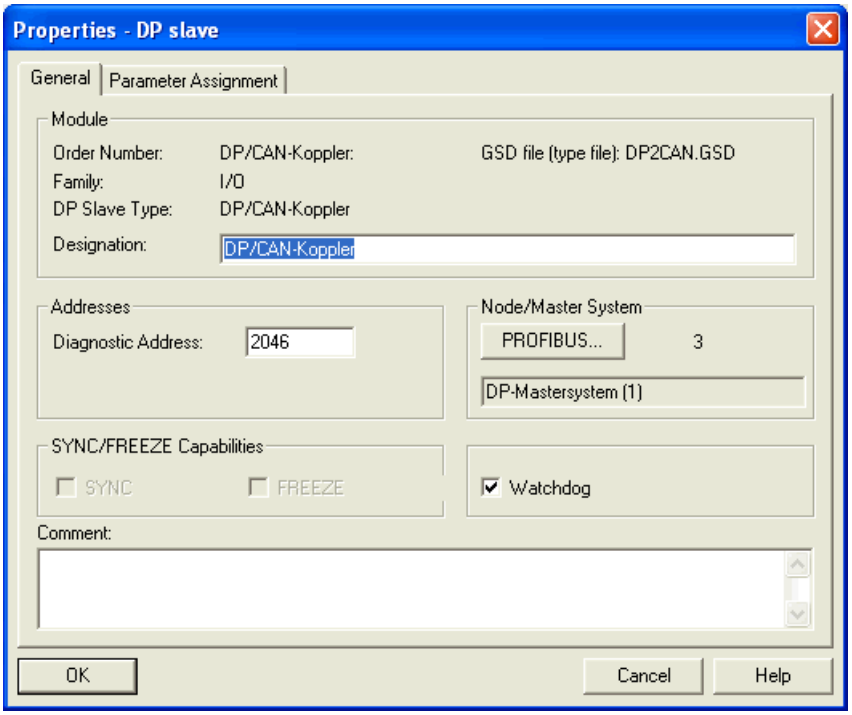
Before you can use the DP/CAN coupler in the Hardware Configurator you must install the supplied GSD file “DP2CAN_M.GSD”. You can do this in the Hardware Configurator under menu item “Options / Install GSD Files”.

Having done that you will find the DP/CAN coupler in the hardware catalog under ‘Additional FIELD DEVICES / IO / Helmholz’.

You can now drag and drop the “DP/CAN-Koppler CO V2M” onto a PROFIBUS network you have already set up.



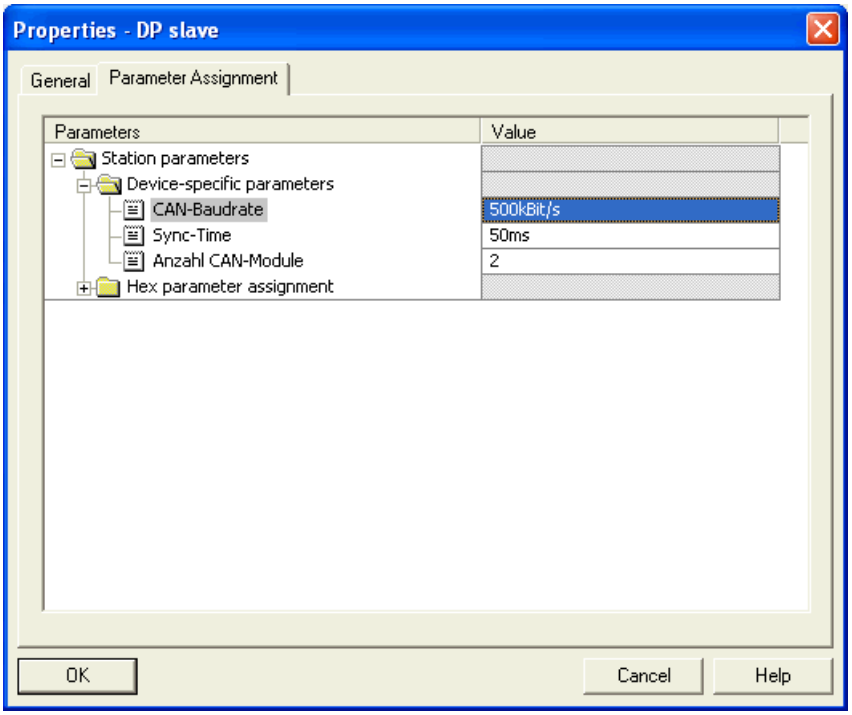
Then assign a suitable station address to the slave.



The DP/CAN coupler is supplied with the necessary information about the structure of the CANopen® bus from the master via the parameterization frame during start-up.

The following CAN parameters are defined here:

- CAN baud rate
- Transmission time for the SYNC frame
- Number of used CANopen® nodes in the CAN circuit



CAN baud rate:

Possible baud rates: 1 Mbps, 500 Kbps, 250 Kbps, 125 Kbps, 100 Kbps, 50 Kbps, 20 Kbps, 10 Kbps

Sync time:

The transmission time of a Sync frame (COB-ID: 80) on the CAN bus is set here. (10 ms to 1000 ms possible),

Number of CAN modules:

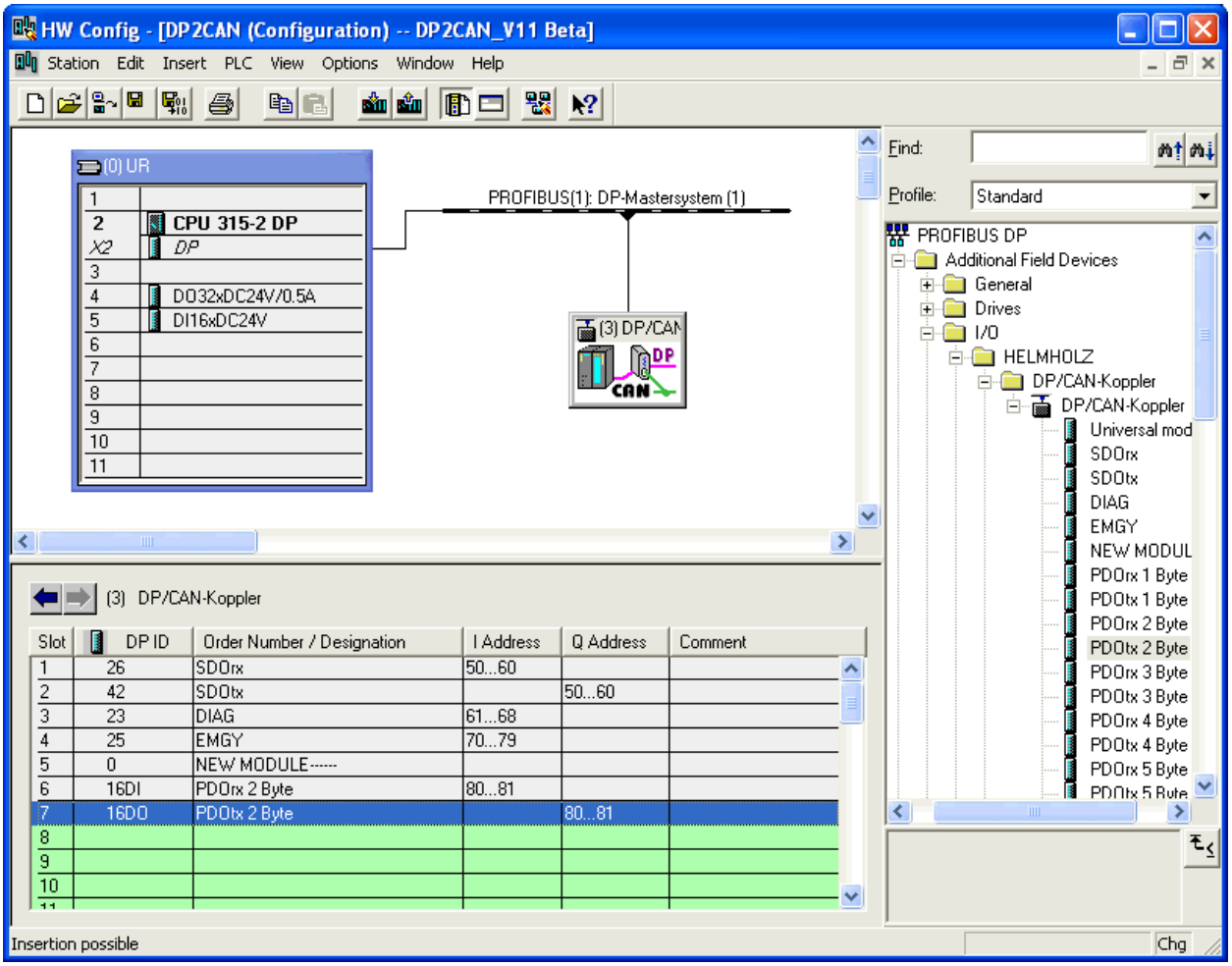
Specifies the number of CAN nodes in the CAN circuit (value range: 1..15).

The number of CAN modules must match the number of defined "NEW MODULE------" entries!

4.2 Defining the I/O address area in the PLC

Once the basic parameters of the CAN bus have been defined all data elements must be shown in the I/O area of the PLC.

Elements “SDOrx”, “SDOtx”, “DIAG”, “EMGY” must always be at the beginning of the list. The I/O addresses are freely selectable.



4.3 Consistent data

All CAN messages are defined as consistent data areas in the PROFIBUS.

All data elements are defined as consistent data. This prevents inconsistencies within the SDO and PDO data. The addresses of the data elements can be located in the cyclic process image or outside the cyclic process image. If the data is outside the cyclic process image, access must be performed with the peripheral access commands, “L PEx” or “T PAx”.

If 3, 5, and more than 5 bytes are to be transmitted consistently, SFC 14 “DPRD_DAT – read consistent data” and SFC 15 “DPWR_DAT – write consistent data” must be used to update the data.

The blocks are described in the Siemens Manual “System and Standard Functions for S7-300/400”, Volume 1, Section 16.

4.4 Maximum parameter sizes and address ranges

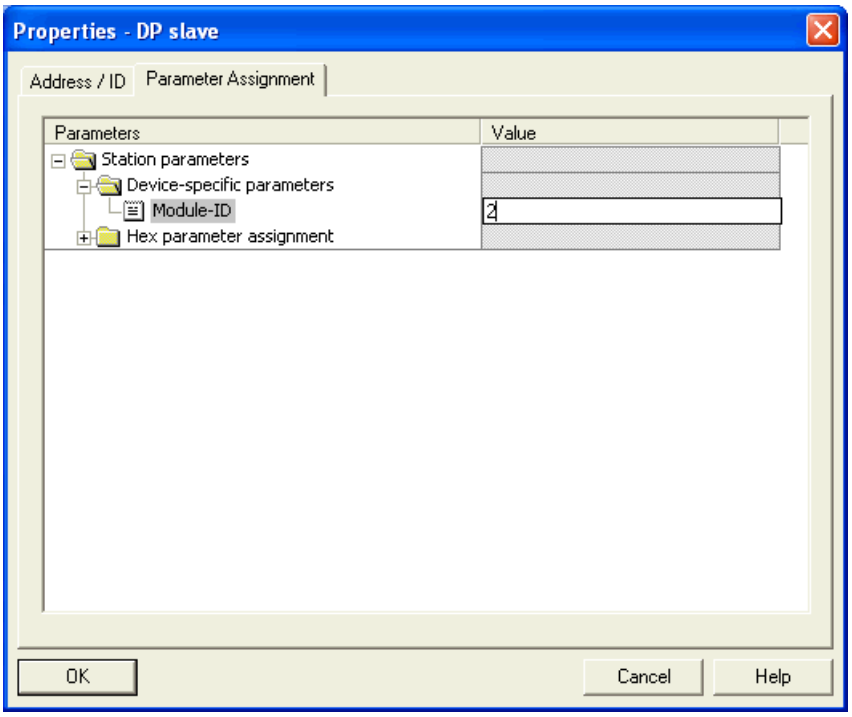
Up to 84 slots (elements) can be defined. The maximum number of assignable input or output addresses is 240 bytes each, but together no more than 312 bytes.

Please pay attention to the maximum parameter sizes!

The parameters of the elements must not take up more than 84 bytes. The basic parameters already fill 4 bytes, each “NEW MODULE” or PDO entry requires one further byte.

4.5 Parametrization of modules

Now the CAN modules and the PDOs belonging to the module can be defined on the remaining slots of the DP/CAN coupler. Entry “NEW MODULE----”.

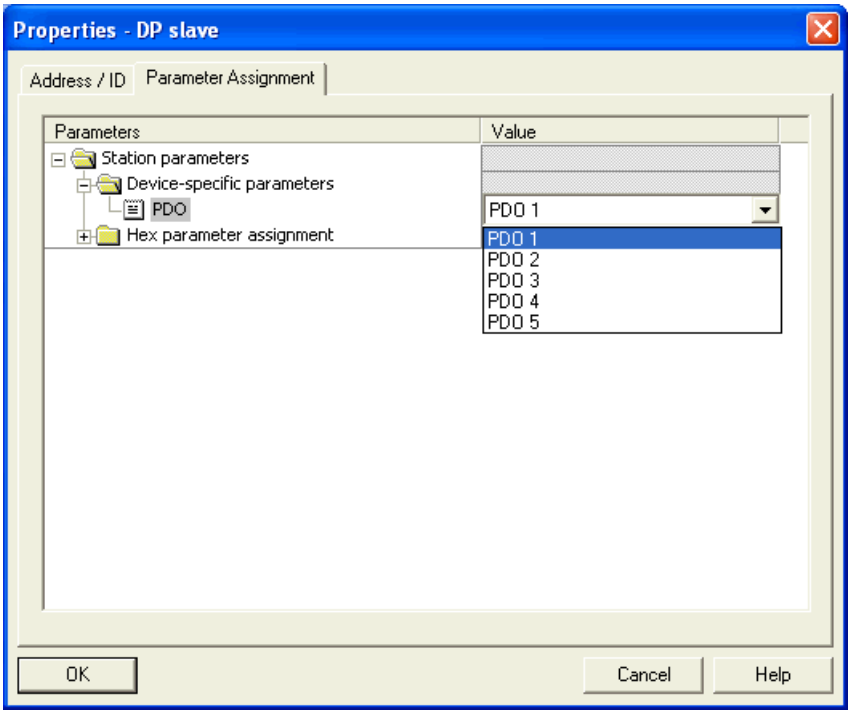


Incorrect definition of the number of modules results in data corruption or bus start-up errors!

The number of modules (“NEW MODULE” entries) must correspond to the number defined in the device parameterization.

Each “NEW MODULE” entry is followed by the PDO elements. The PDO data elements exist as a reading (“PDOrx”) or writing (“PDOtx”) PDO with a width of 1 byte to 8 bytes.

The PDO number can be selected for each PDO element.



The only transmission modes supported with PDOs are event and sync.

The I/O addresses can be assigned freely and all PDO elements are designed as consistent data (see also Section 4.3).

5 Programming (CANopen® Master)

5.1 Data exchange

When the master has detected that parameterization and configuration is successfully completed without errors at the end of the start-up phase, it starts transmitting data exchange frames. For that, the PROFIBUS master transmits all the data of the parameterized transmit identifier to the DP/CAN coupler every cycle.

Whenever a data item is changed (on the CANopen® side or DP side) it transmitted immediately in the next cycle. In addition, the input data of the CANopen® modules are updated every guarding cycle, if it wasn´t transferred in the last cycle.

5.2 CAN network start-up procedure

After a power-off, the DP/CAN Coupler always requires a PLC Stop → Run transition before it can start up again!

Start-up is initiated by a Stop → Run state transition of the PLC. After Startup some SDOs are read and written (PDO-, Nodeguarding or Heartbeat-settings, etc.). A slave started-up, if it is included in the project and a Stop → Run state is transitioned before.

If a CAN module signs on again after a failure it is automatically parameterized and included in cyclic operation again.

5.3 Diagnostics area

The diagnostics area consists of 8 bytes. It states which area in the process image is invalid and which CAN module is not in the operational state.

Diagnostics area:

Byte	Bit	Function
0	**0**	Entry 1 in process image invalid
	1	Entry 2 in process image invalid
	2	Entry 3 in process image invalid
	3	Entry 4 in process image invalid
	4	Entry 5 in process image invalid
	5	Entry 6 in process image invalid
	6	Entry 7 in process image invalid
	7	Entry 8 in process image invalid
…		…
5	**0**	Entry 41 in process image invalid
	1	Entry 43 in process image invalid
	2	Entry 44 in process image invalid
	3	Entry 45 in process image invalid
	4	Entry 46 in process image invalid
	5	Entry 47 in process image invalid
	6	Entry 48 in process image invalid
	7	Entry 49 in process image invalid
6	**0**	*Reserved*
	1	CAN module 1 not operational
	2	CAN module 2 not operational
	3	CAN module 3 not operational
	4	CAN module 4 not operational
	5	CAN module 5 not operational
	6	CAN module 6 not operational
	7	CAN module 7 not operational
7	**0**	CAN module 8 not operational
	1	CAN module 9 not operational
	2	CAN module 10 not operational
	3	CAN module 11 not operational
	4	CAN module 12 not operational
	5	CAN module 13 not operational
	6	CAN module 14 not operational
	7	CAN module 15 not operational

The process image is invalid when:

- the corresponding CAN module is not operational
- the bit 31 of the COB ID of this PDO is set to high (that means that the PDO is disabled)

The CAN module is not operational:

- the status in Heartbeat/Node Guarding is not 0x05
- the Heartbeat/Node Guarding frame has not been send from the Slave
- all PDOs of a slave with the transmission type 1-240 (if at least one is exist) have not been send.

5.4 Receiving emergency frames

The COB ID of the emergency telegram is assigned according to the CANopen® standard. Changes to the COB ID in the slaves are not supported by the DP/CAN coupler!

The EMERGENCY frames received from the CAN bus are displayed in the Emergency receive mailbox. The first EMERGENCY frame to be received from the CAN bus is copied directly to the Emergency receive mailbox, all other EMERGENCY frames are temporarily stored in a circular buffer in the DP/CAN coupler and only written to the Emergency receive mailbox when the previous EMERGENCY frame has been read by the user. That is why handshaking is necessary.

5.4.1 Emergency receive mailbox

The Emergency receive mailbox is structured as follows:

Byte	Function
0	CAN module node ID
1	Date length of Emcy frame (0 to 8 bytes)
2	Data byte 1
3	Data byte 2
4	Data byte 3
5	Data byte 4
6	Data byte 5
7	Data byte 6
8	Data byte 7
9	Data byte 8

5.4.2 Handshaking for emergency frames

The handshake bits are located in byte 0 in the SDO frame.

Bit 4 (in byte 0 receive SDO) set → new emergency frame in emergency area.

Bit 5 (in byte 0 receive SDO) set → data in emergency area are valid.

Bit 6 (in byte 0 transmit SDO) set → data have been processed by PLC program.

Sequence of operation:

1. If Bit 4 = 0 and Bit 6 = 0 and new EMERGENCY frames have been received, the first EMERGENCY frame is written to the emergency area.
2. Bit 4 and bit 5 are set
3. If the PLC has processed the emergency frame, bit 6 = 1 must be set and the frame acknowledged.
4. If bit 6 = 1, the DP/CAN coupler clears the emergency area and resets bit 4 and bit 5.
5. The PLC waits for reset bits 4 and 5 and then resets bit 6

5.5 Parameterizing CAN modules (SDO transfer)

SDO communication (SDO = Service Data Object) is a confirmed and acknowledged service of the CAN open protocol. Every SDO request is acknowledged with a response from the addressed module. If the module does not respond a timeout message is sent by the DP/CAN coupler to the PLC.

SDOs are usually needed for setting parameters (write request SDO) or querying (read request SDO) a module (CANopen® slave) and are not suitable for fast process data transmission that is processed via PDOs (Process Data Objects).

The entire SDO communication is processed by the DP/CAN coupler by means of an 11-byte window in the process image.

5.5.1 Expedited SDO transfers (up to 4 bytes of data)

New requests are written to the I/O area of **SDOtx**. The responses can be read from the **SDOrx** area.

It is only possible to process one request at a time. A response must be awaited after each request.

Only expedited SDO transfer with up to 4 bytes is supported at present.
Support of SDO transfers with more than 4 bytes is available on request.

CAL_WRITE_REQ (transmit SDO Write):

SDOtx	Function
0	Handshake byte
1	Frame type: 36
2	Node ID (1..127)
3	SDO index (high byte)
4	SDO index (low byte)
5	SDO subindex
6	Number of valid data bytes (SDO size, 1-4)
7	Data byte 1
8	Data byte 2
9	Data byte 3
10	Data byte 4

CAL_WRITE_REQ (transmit SDO Read):

SDOtx	Function
0	Handshake byte
1	Frame type: 39
2	Node ID (1..127)
3	SDO index (high byte)
4	SDO index (low byte)
5	SDO subindex

The response of the slave must be awaited after each request! SDO transfers can only be processed one after the other!

CAL_READ_CNF_P (SDO Read Response):

SDOrx	Function
0	Handshake byte
1	Frame type: 40
2	Node ID (1..127)
3	Data length 4-7 bytes
4	SDO index (high byte)
5	SDO index (low byte)
6	SDO subindex
7	Data byte 1
8	Data byte 2
9	Data byte 3
10	Data byte 4

CAL_READ_CNF_N (SDO Read negative Response):

SDOrx	Function
0	Handshake byte
1	Frame type: 41
2	Node ID (1..127)
3	Data length 7 bytes
4	SDO index (high byte)
5	SDO index (low byte)
6	SDO subindex
7	Error_Class
8	Error_Class
9	Additional _Class (high byte)
10	Additional _Class (low byte)

CAL_WRITE_CNF_P (SDO Write Response):

SDOrx	Function
0	Handshake byte
1	Frame type: 37
2	Node ID (1..127)
3	Data length 3 bytes
4	SDO index (high byte)
5	SDO index (low byte)
6	SDO subindex

CAL_WRITE_CNF_N (SDO Write negative Response):

SDOrx	Function
0	Handshake byte
1	Frame type: 38
2	Node ID (1..127)
3	Data length 7 bytes
4	SDO index (high byte)
5	SDO index (low byte)
6	SDO subindex
7	Error_Class
8	Error_Class
9	Additional _Class (high byte)
10	Additional _Class (low byte)

5.5.2 SDO timeout

This frame appears in the receive area (SDOrx) if no response is received from the slave after 200 ms.

SDOrx	Function
0	Handshake byte
1	Frame type: 240
2	Node ID (1..127)

5.5.3 Handshaking SDOtx (transmit SDO)

The handshake for sending SDO requests is performed in the first byte of the **SDOtx** area. The PLC program sets and resets these bits.

Bit 0 set: Data are valid, send SDO frame

Bit 0 reset: Data are invalid, wait for next SDO frame. This bit must be set to 0 between two SDO frames.

5.5.4 Handshaking SDOrx (receive SDO)

The handshake for receiving SDO responses to current SDO requests is performed in the first byte of the **SDOrx** area. The PLC program evaluates these bits.

Bit 0 set: SDO transfer is active

Bit 1 set: valid data in receive buffer

Bit 2 set: SDO frame sent

Once bit 1 has been set the receive frame can be processed. Then bit 0 of the SDOtx handshake byte must be reset so that a new request can be started.

6 Configuration (CAN Layer 2)

In Layer 2 mode, the DP/CAN coupler can transmit and receive any CAN messages (CAN 2.0A, 11 bits).

There are two different transmission methods. In the first method, the identifier and size of the CAN message is permanently parameterized in predefined transmit and receive objects and only the data are transmitted via the PROFIBUS. Each predefined transmit and receive object therefore corresponds to one particular CAN frame.

In the second method, a variable receive object can receive several messages filtered by a parameterizable acceptance mask. With this method, not only the data but also the identifier and the length of the CAN frame are transmitted via the PROFIBUS to the PLC application.

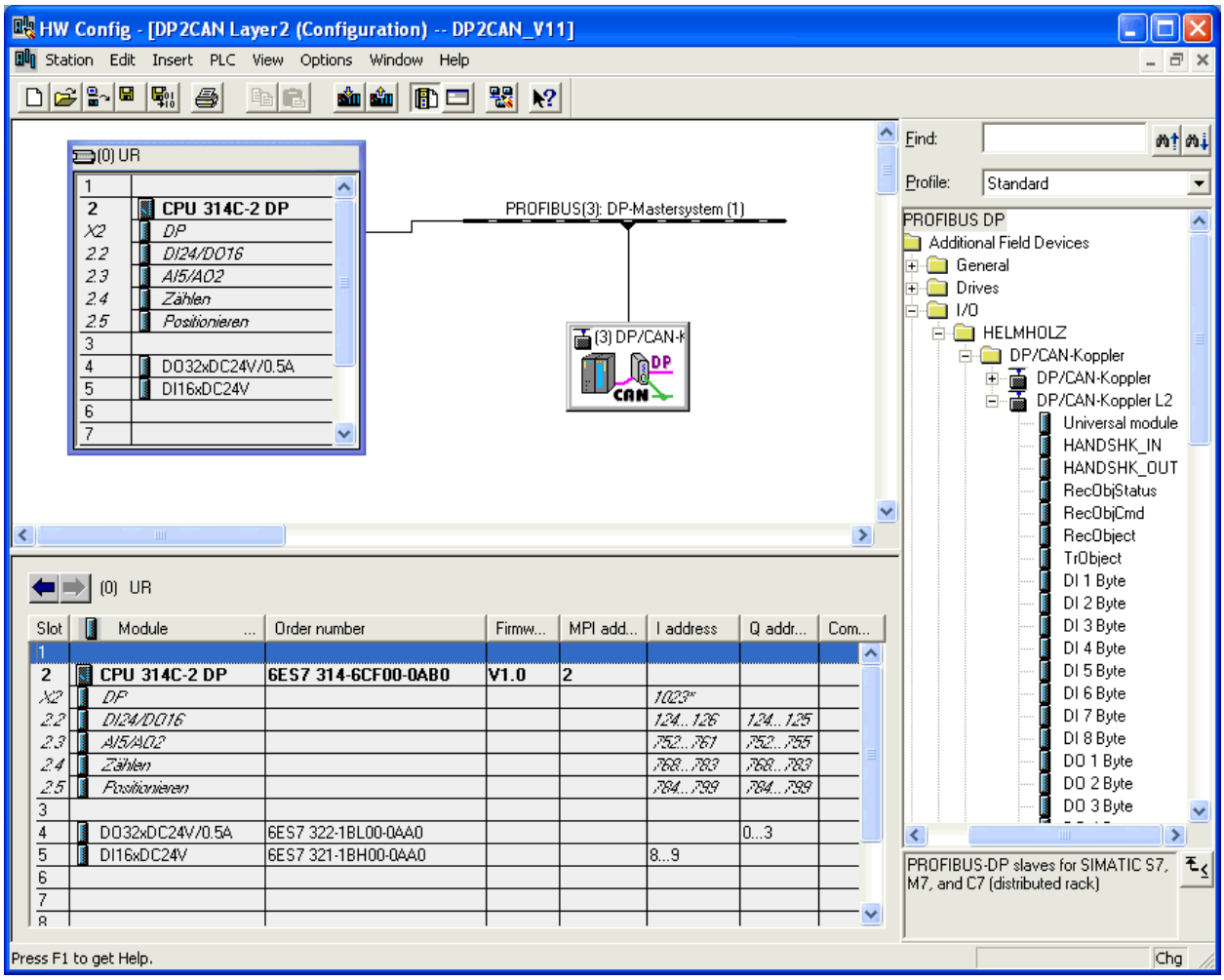
Any number of CAN messages can be sent in a variable transmit object. Moreover, a variable transmit object can also transmit the message cyclically at fixed intervals.

6.1 Installing and parameterizing the device

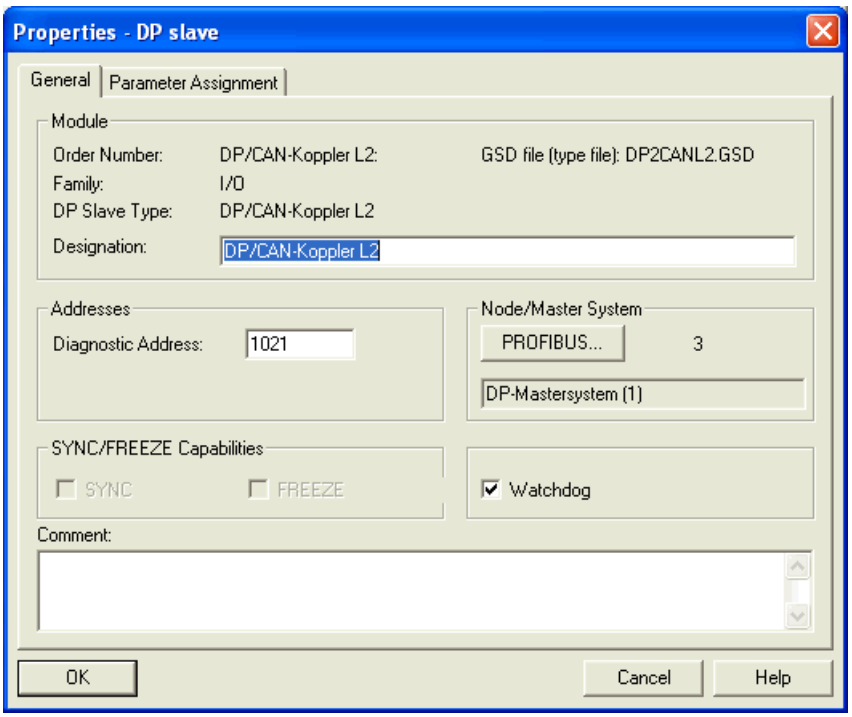
Before you can use the DP/CAN coupler with Layer 2 in the Hardware Configurator you must install the GSD file “DP2C_L2h.GSD” supplied. You can do this in the Hardware Configurator under menu item “Options / Install GSD Files”.

Having done that you will find the DP/CAN coupler in the hardware catalog under ‘Additional FIELD DEVICES / IO / Helmholz’.

You can now drag and drop “DP/CAN-Koppler L2” onto a PROFIBUS network you have already set up.



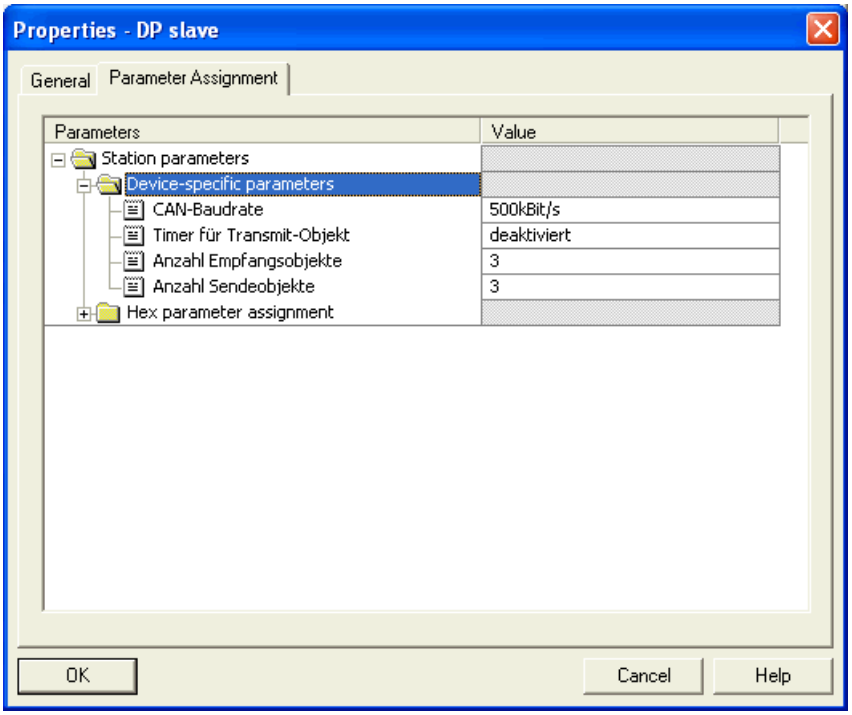
Then assign a suitable station address to the slave.



In the parameterization frame, the master provides the DP/CAN coupler on start-up with the necessary information about the CAN frames to be processed.

The following CAN parameters are defined here:

- CAN baud rate
- Cyclic transmission time of the variable transmit object (if required)
- Number of predefined receive and transmit messages



CAN baud rate:

Possible baud rates: 1 Mbps, 500 Kbps, 250 Kbps, 125 Kbps, 100 Kbps, 50 Kbps, 20 Kbps, 10 Kbps

Timer for variable transmit object:

This is where you set the time for cyclic transmission of the variable transmit object (10 ms to 1000 ms possible). If you select the “Deactivated” option, the variable transmit object will always be sent immediately and only once.

Incorrect definition of the number of modules results in data corruption or bus start-up errors!

Number of predefined receive objects:

The number of predefined receive objects (DI) used.

Number of predefined transmit objects:

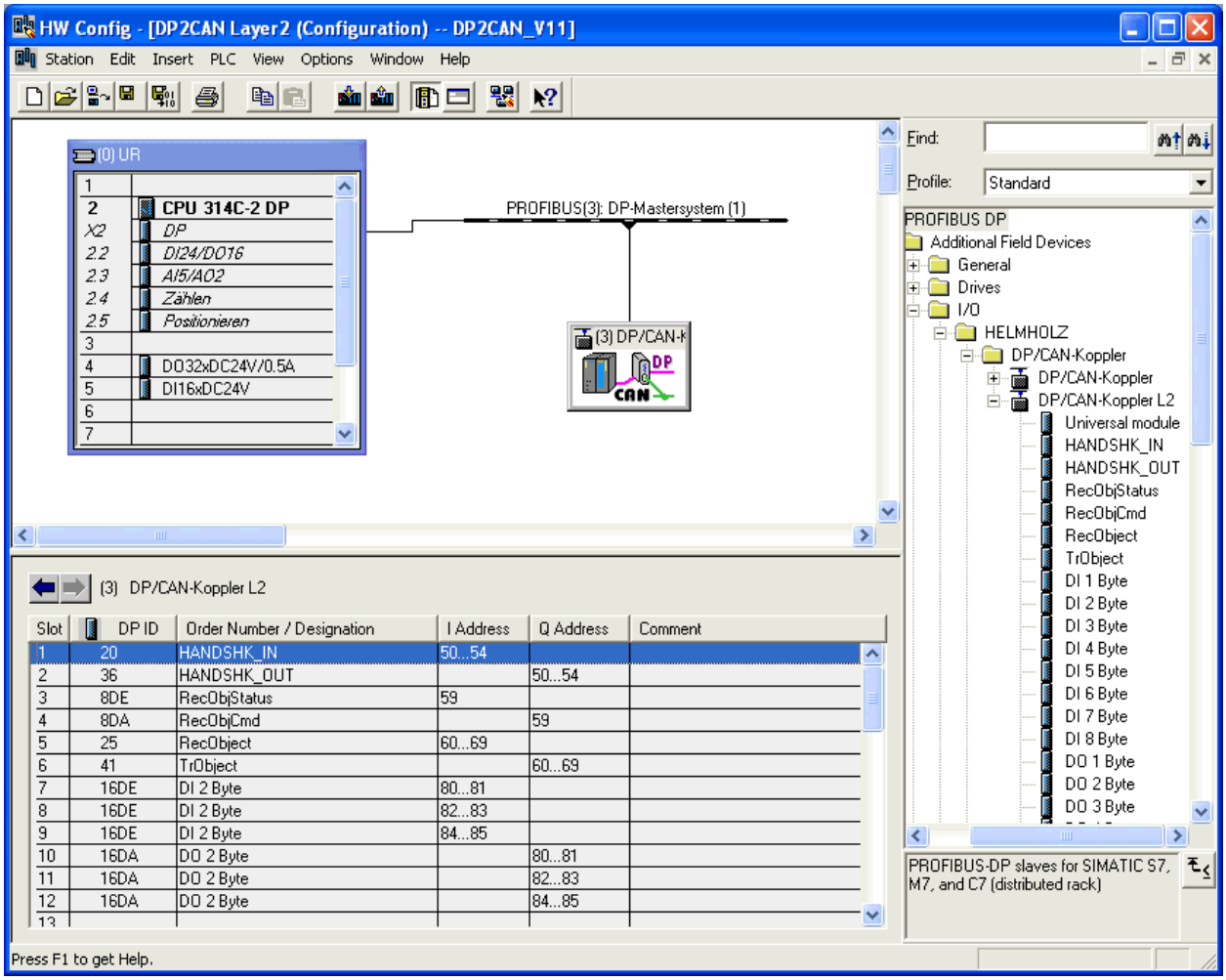
The number of transmit objects (DO) used.

6.2 Defining the I/O address area in the PLC

Once the basic parameters of the CAN bus have been defined all data elements must be shown in the I/O area of the PLC.

The first 6 elements must always be at the beginning of the list in the defined sequence. The I/O addresses are freely selectable.

All “DI” elements have to be defined over the “DO” elements!



6.3 Consistent data

All CAN messages are defined as consistent data areas in the PROFIBUS.

All data elements are defined as consistent data. This prevents inconsistencies within the DI-/DO-data and the RecObject-/TrObject-data. The addresses of the data elements can be located in the cyclic process image or outside the cyclic process image. If the data is outside the cyclic process image, access must be performed with the peripheral access commands, “L PEx” or “T PAx”.

If 3, 5, or more than 5 bytes are to be transmitted consistently, SFC 14 “DPRD_DAT – read consistent data” and SFC 15 “DPWR_DAT – write consistent data” must be used to update the data.

The blocks are described in the Siemens Manual “System and Standard Functions for S7-300/400”, Volume 1, Section 16.

6.4 Maximum parameter sizes and address ranges

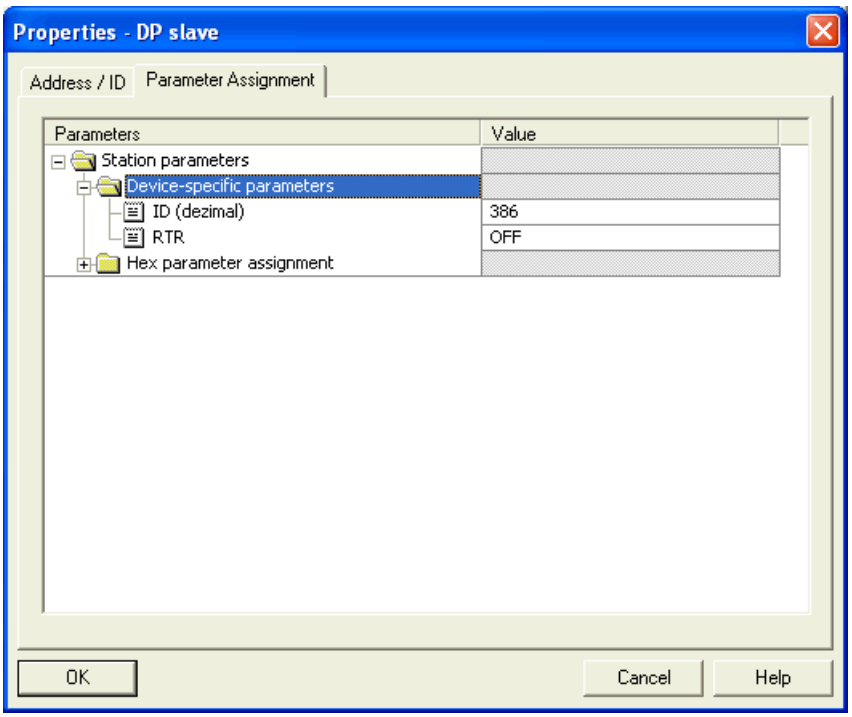
Please pay attention to the maximum parameter sizes!

Up to 44 slots (elements) can be defined. Of these, 6 elements are already permanently assigned. The maximum number of assignable input or output addresses is 240 bytes each, but together no more than 312 bytes.

The parameters of the elements must not take up more than 120 bytes. The basic parameters already fill 7 bytes and each further “DI” or “DO” entry requires three further bytes.

6.5 Parameterizing transmit and receive messages

Now the transmit and receive messages (“DI x byte”, “DO x byte”) can be defined on the remaining slots of the DP/CAN coupler.



Each predefined transmit or receive object can be defined for just one particular CAN message. The length of the CAN message

corresponds to the size of the DI/DO object. The CAN ID is defined in the parameter set.

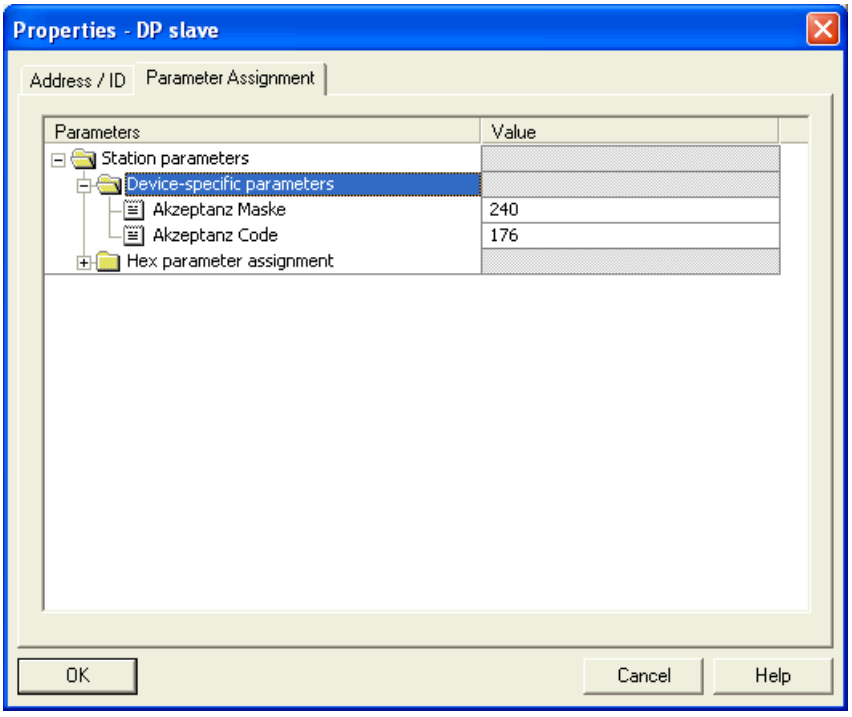
6.6 Parameterizing the variable receive object

The variable receive object must also be parameterized if it is to be used.

To receive any CAN frames with the variable receive object, the upper 8 bits of the CAN identifier are first filtered with a mask (acceptance mask) and then compared with a predefined value (acceptance code). If this comparison is positive, the CAN frame is entered in the receive FIFO.

10	9	8	7	6	5	4	3	2	1	0
Received CAN identifier										
AcceptanceMask (e.g. 11110000)								*ignored*		
AcceptanceCode (e.g. 1011xxxx)										

Acceptance mask 11110000 (= 240) filters out the top 4 bits. Acceptance code 1011xxxx (= 176) defines which frames are accepted after filtering. In this example, these are the CAN frames with identifiers 0x580 to 0x5FF.



7 Programming (CAN Layer 2)

7.1 Data exchange

When the master has detected that parameterization and configuration is successfully completed without errors at the end of the start-up phase and the PLC has been started, the DP/CAN coupler can transmit and receive frames via CAN.

7.2 Handshake bits

The 5 bytes of the HANDSHK_IN area indicate receipt of CAN messages via the variable receive object and the DI objects. The bits are inverted each time a new message is received (toggle bit).

Byte	Bit	Function
0	**0**	New frame variable receive object
	1	New frame predefined receive object 1
	2	New frame predefined receive object 2
	3	New frame predefined receive object 3
	4	New frame predefined receive object 4
	5	New frame predefined receive object 5
	6	New frame predefined receive object 6
	7	New frame predefined receive object 7
…		…
4	**0**	New frame predefined receive object 32
	1	New frame predefined receive object 33
	2	New frame predefined receive object 34
	3	New frame predefined receive object 35
	4	New frame predefined receive object 36
	5	New frame predefined receive object 37
	6	New frame predefined receive object 38
	7	New frame predefined receive object 39

Do not forget the objects „RecObjStatus” and “RecObjCmd” when interpreting the variable receive object.

The 5 bytes of the HANDSHK_OUT area are used to transmit the predefined transmit objects and the variable transmit object. The bits always initiate transmission of the message when the bit is inverted (toggle bit).

Byte	Bit	Function
0	**0**	Send frame for variable transmit object
	1	Send frame for predefined transmit object 1
	2	Send frame for predefined transmit object 2
	3	Send frame for predefined transmit object 3
	4	Send frame for predefined transmit object 4
	5	Send frame for predefined transmit object 5
	6	Send frame for predefined transmit object 6
	7	Send frame for predefined transmit object 7
…		…
4	**0**	Send frame for predefined transmit object 32
	1	Send frame for predefined transmit object 33
	2	Send frame for predefined transmit object 34
	3	Send frame for predefined transmit object 35
	4	Send frame for predefined transmit object 36
	5	Send frame for predefined transmit object 37
	6	Send frame for predefined transmit object 38
	7	Send frame for predefined transmit object 39

7.3 Receive and transmit objects

Depending on the parameterized size of the object, the receive objects (“DI x bytes”) always contain the data of the last CAN frame to be received with the corresponding CAN identifier. Receipt of a new telegram can be detected by the 5 bytes of the HANDSHK_IN area.

All receive and transmit objects are defined as consistent data areas in the PROFIBUS.

The transmit objects (“DO x bytes”) can be assigned the values for the parameterized CAN telegram. If the values of the transmit object change, the telegram is transmitted automatically.

If you want to transmit the telegram without changing the data, that can be triggered via the 5 bytes of the HANDSHK_OUT area.

The sequence of receive and transmit objects is defined!

The sequence of the objects is defined: All receive objects “DI” must be defined first; then, all transmit objects “DO”.

7.4 Variable receive object

If a frame that matches the parameterized acceptance mask of the variable receive object is received, the frame is transferred to the variable receive object area.

Byte	Content of variable receive object
0	Len + RTR + HighByte CAN identifier
1	LowByte CAN identifier
2	Data byte 1
3	Data byte 2
4	Data byte 3
5	Data byte 4
6	Data byte 5
7	Data byte 6
8	Data byte 7
9	Data byte 8

The entire CAN message header is stored in the first two bytes (0+1).

Byte 0								Byte 1							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data length				RTR	CAN-Identifier (11 Bit)										

The receipt of a new frame is recognized by the inversion of bit 0 in byte 0 of the **HANDSHK_IN** area.

Once the message has been processed by the PLC program this must be acknowledged to the DP/CAN coupler. Acknowledgment is processed via the **RecObjCmd** byte.

Here again, all bits must be used as toggle bits, i.e. the function is executed when the bit is inverted.

Bit	Function ReceiveObjCmd
0	Acknowledge last variable receive object frame
1	*reserved*
2	Delete RecObjStatus overflow error flag
3	Reset variable receive object FIFO
4	*Reserved*
5	*Reserved*
6	*Reserved*
7	*Reserved*

A FIFO which can accept up to 24 messages has been implemented in the DP/CAN coupler for the variable receive object. If more than 24 messages are received without being fetched by the PLC program, the oldest frames are removed and an overflow error is displayed in the RecObjStatus byte. The bits of the ReceiveObjStatus byte must be processed as status displays.

Bit	Function ReceiveObjStatus
0	FIFI Ok
1	Overflow error active on last receive
2	Overflow error flag
3	Number of frames still in FIFO
4	
5	
6	
7	

Bit 2 of the **RecObjStatus** can be reset with bit 2 in the **RecObjCmd**.

7.5 Variable transmit object

Any number of messages can be sent via the variable transmit object (**TrObjekt**).

Byte	Content of variable transmit object
0	Len + RTR + HighByte CAN identifier
1	LowByte CAN identifier
2	Data byte 1
3	Data byte 2
4	Data byte 3
5	Data byte 4
6	Data byte 5
7	Data byte 6
8	Data byte 7
9	Data byte 8

The entire CAN message header is stored in the first two bytes (0+1):

Byte 0								Byte 1							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data length				RTR	CAN-Identifier (11 Bit)										

Transmission of the message is initiated by inverting bit 0 in byte 0 of the **HANDSHK_OUT** area.

7.6 Cyclically transmitting of the transmit object

The variable transmit object can be transmitted via the device parameters of the DP/CAN coupler cyclically by means of a timer.

Cyclic transmission via the timer is triggered by inverting the bit 0 in byte 0 of the **HANDSHK_OUT** area.

In cyclic transmission, a change to the transmit data is not activated until bit 0 in byte 0 of the **HANDSHK_OUT** area is inverted.

The cyclic transmission cannot be stopped.

8 CANopen® Communication

8.1 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) of the CAN bus are not affected.

The CANopen® communication profiles for the various applications are managed by the CIA.

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”.

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).

8.2 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 an 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. For very large volumes of data, SDO block transmission is possible.

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 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 up to 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. These can be both existing SDOs and updated values of the slaves (e.g. analog value or an input).

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

8.3 Functions

The CANopen® functions are subdivided into the three basic groups:

Reading and writing SDO

Reading and writing PDO

Network management

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						

Broadcast functions:

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

Node functions:

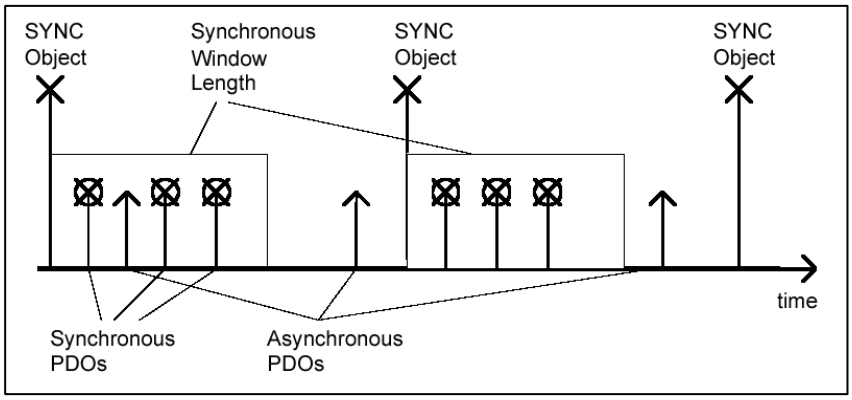
"Tx" = is transmitted by the slave
"Rx" = is received from the slave

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

8.4 Network management

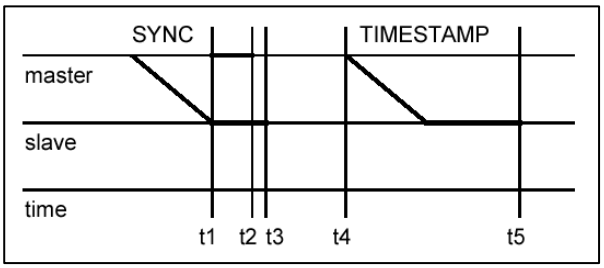
SYNC:

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]



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]

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.

Heartbeat:

Heartbeat monitoring is equivalent to Nodeguarding although no request frames are generated by the CANopen® master. The heartbeat frame is transmitted automatically by the node and can be evaluated in the master (Producer Heartbeat). The master sends on his part heartbeat frames in a 600ms interval, which can be evaluated in the nodes (Consumer Heartbeat).

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]

9 Appendix

9.1 Technical data

Order number	DP/CAN Coupler	700-650-CAN01
Dimensions	114 x 18 x 108 mm (LxWxH)	
Weight	Approx. 120 g	

CAN interface

Type:	ISO/DIN 11898-2, CAN high speed physical layer
Transmission rate:	10 kbps to 1Mbps
Protocol:	CANopen® master CAN 2.0A (11bit)
Pin:	3-way screw-type terminal

PROFIBUS DP interface

Type:	PROFIBUS DP to EN 50 170
Transmission rate:	19.2 kbps to 12Mbps
Pin:	Sub-D connector, 9-way

Power supply

Voltage:	+24V DC
Current consumption:	180 mA (type)

Permissible ambient conditions

Operating temperature:	0°C … 60°C
Storage temperature:	-25°C … 75°C
Degree of protection:	IP 20

Special features

Quality assurance:	according to ISO 9001:2000
Maintenance:	Maintenance-free (no battery, rechargeable or non-rechargeable)

9.2 Pin assignment

PROFIBUS 9-way Sub-D socket:

Pin	PROFIBUS DP
1	-
2	
3	Data line B
4	-
5	GND
6	VP (power supply for terminating resistors)
7	-
8	Data line A
9	-

3-way CAN connector (no terminating resistor):

1	CAN High
2	CAN-GND
3	CAN-Low

3-way power supply:

1	GND
2	V-
3	V+

9.3 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