DP/CAN Coupler

PRPFIBUS DP for CAN-Bus Coupler

for CAN Layer 2

700-651-CAN01

Manual

Edition 5 / 25.06.2009 HW1 & FW 1.5X and higher

Order number of manual: 900-651-CAN01/en

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.

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Revision history of this document:

Edition	Date	Revision
4		Notice about consistent data extended
5	18.05.2009	29-bit protocol implemented

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*

ℹ   *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 assessment).*

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

1.2 Restriction of access

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 0.

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 300 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 size of the input and output information does not exceed 320 bytes.

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

The DP/CAN coupler can send and receive any CAN messages, both CAN 2.0A (11bit) and CAN2.0B (29bit). You can define messages with a fixed identifier whose data is always visible as an I/O image in the PROFIBUS. As an alternative, the DP/CAN coupler has a transmit and receive buffer for any CAN messages.
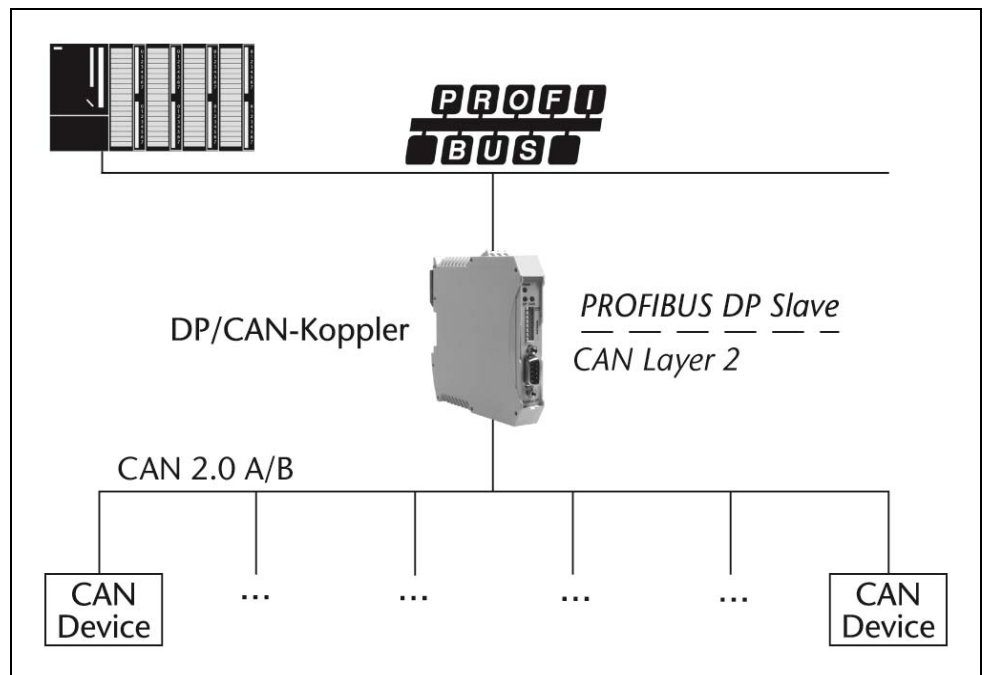
3.2   Connections

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 that the PROFIBUS is running and the CPU is in run mode. Slow blinking indicates that the CPU is in stop mode.

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

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

3.4   DIP switches

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

![warning]
Any change to the switch position is only applied after the next time the device is powered up!

The switches are counted from bottom to top.

Switch	Function		
8	*not used*		
7		2^6	+ 64
6		2^5	+ 32
5	PROFIBUS	2^4	+ 16
4	address	2^3	+ 8
3		2^2	+ 4
2		2^1	+ 2
1		2^0	+ 1

3.5 Items supplied

DP/CAN Coupler Layer 2   700-651-CAN01

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

CS with GSD files and instructions

3.6 Accessories

Manual, German/English   900-651-CAN01

CAN bus plug connector   700-690-0BA11

CAN bus plug connector with cable connector   700-690-0BB11

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

4   Configuration (CAN Layer 2)

In Layer 2 mode the DP/CAN coupler can transmit and receive any CAN messages (CAN 2.0A/B, 11-bit and 29-bit).

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

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

Any number of CAN messages can be sent with this type of Transmit Object. Moreover, this type of Transmit Object can also transmit the message cyclically at a fixed time.

4.1   Installing and parameterizing the device

Before you can use the DP/CAN coupler with Layer 2 in the Hardware Configurator you must install the supplied GSD files "DP2C_L2h.GSD" for 11 bits and "DP29_L2B.GSD" for 29 bits. 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 coupler L2 V2h" or "DP/CAN coupler L2 V2 29B" onto a PROFIBUS network you have already set up.
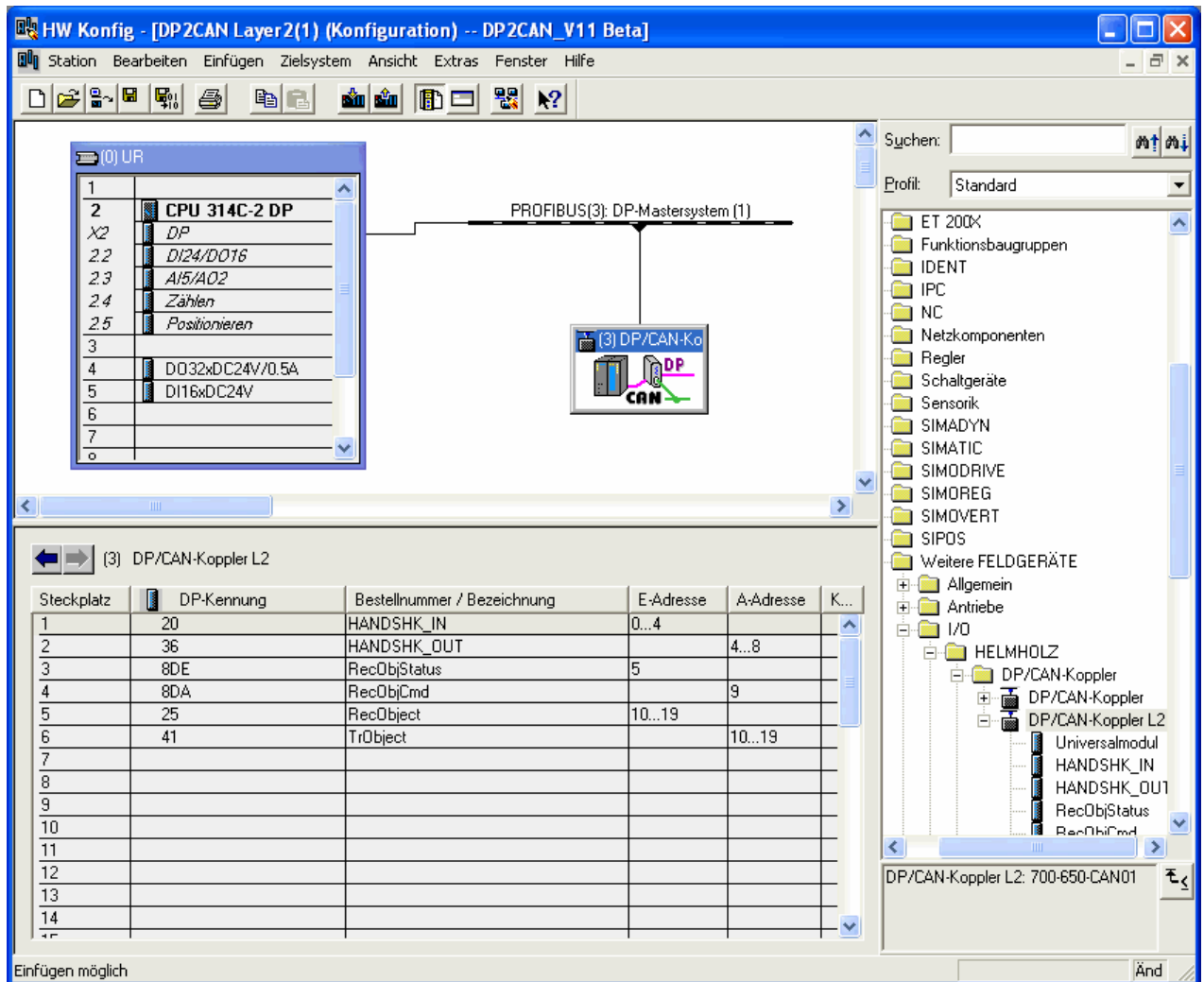
You can assign a station address to the slave here.
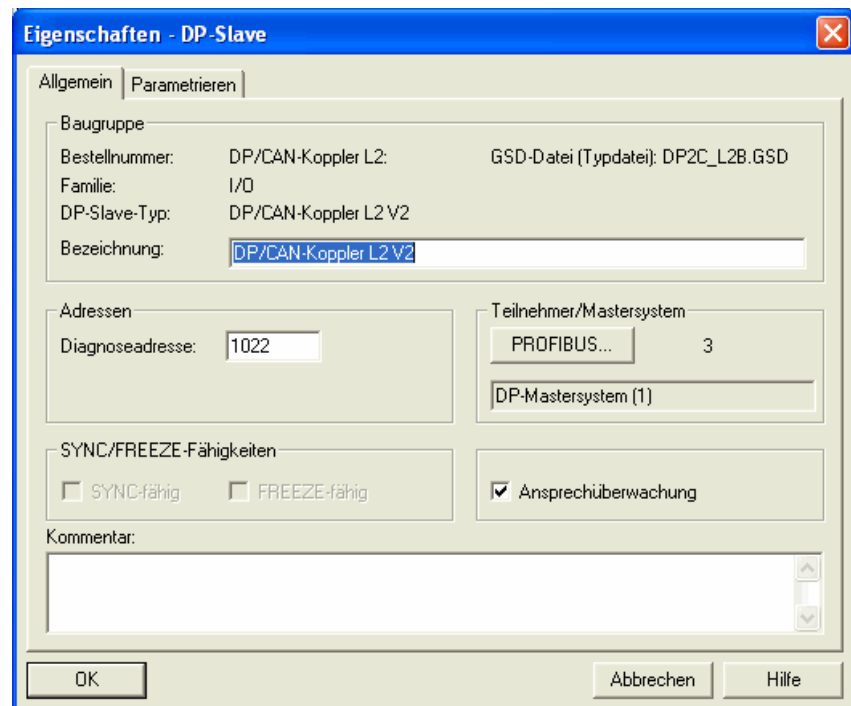
The DP/CAN coupler is supplied with the necessary information with the parameterization frame from the master on start-up about the CAN frames to be processed.

The following CAN parameters are defined here:

- CAN baud rate
- Cyclic transmission time of the Transmit Obect (if required)
- Number of receive and transmit messages
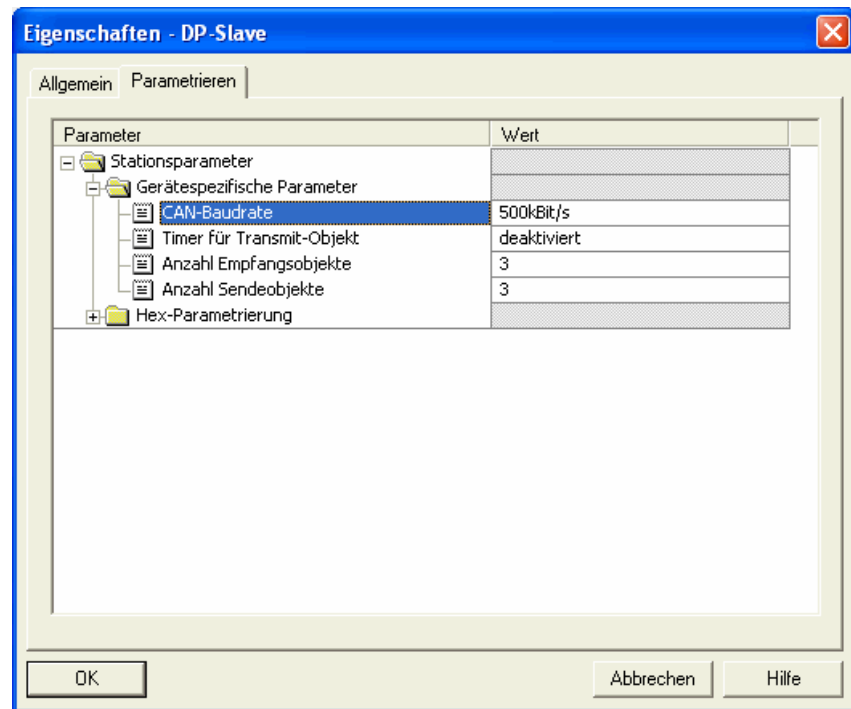
CAN baud rate:

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

Timer for Transmit Object:

You can set a time (10 ms to 1000 ms) for cyclic transmission of the Transmit Object here. If you select the option "Deactivated" the Transmit Object is always sent immediately and once only.

Number of Receive Objects:

The number of Receive Objects (DI) used.

Number of Transmit Objects:

The number of Transmit Objects (DO) used.

Stating an incorrect number of receive/transmit objects results in data corruption or bus start errors!

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 CPU.

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

The "DI" elements must be defined before the "DO" elements!

4.3 Consistent data

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, 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 on older CPUs.

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

The maximum number of objects depends on the CAN protocol used (11 bit/29 bit).

You can define maximum 44 slots (elements) for 11 bits or 36 slots (elements) for 29 bits. 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.

Please pay attention to the maximum parameter sizes!

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.

4.5 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.

Please note the different ID ranges for 11 bits and 29 bits!
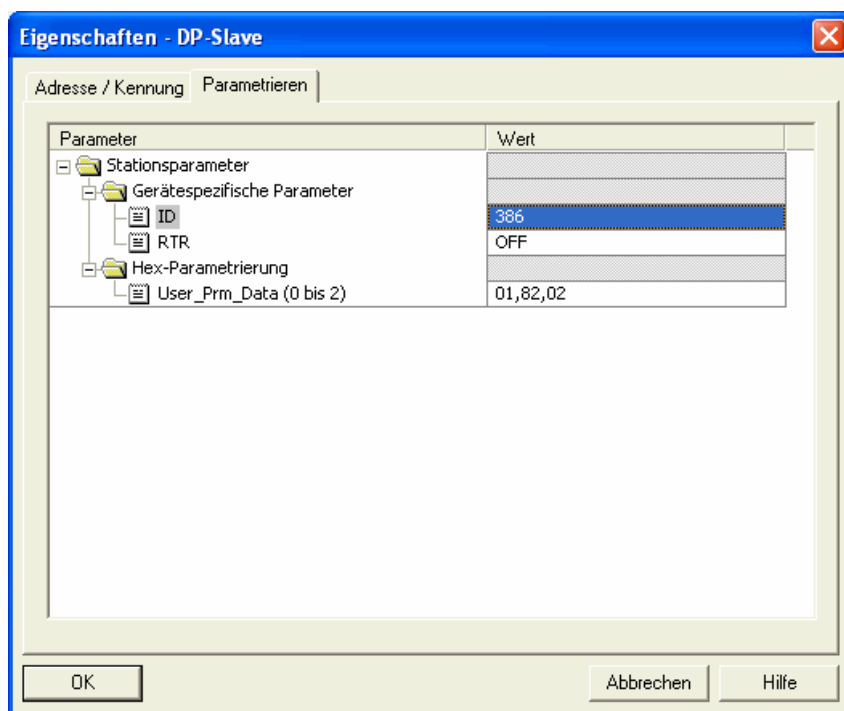
Each transmit or receive object can be defined for exactly one CAN message. The length of the CAN message corresponds to the size of the DI/DO object. The CAN ID is defined in the parameter set.

4.6   Parameterizing the Receive Object

The Receive Object must also be parameterized if it is to be used.

4.6.1   11-bit protocol

In order to receive any CAN frames with the 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 and the PLC is released.

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 to be accepted after filtering.

In this example it is the CAN frames with identifiers 0x580 to 0x5FF.

DP/CAN Coupler
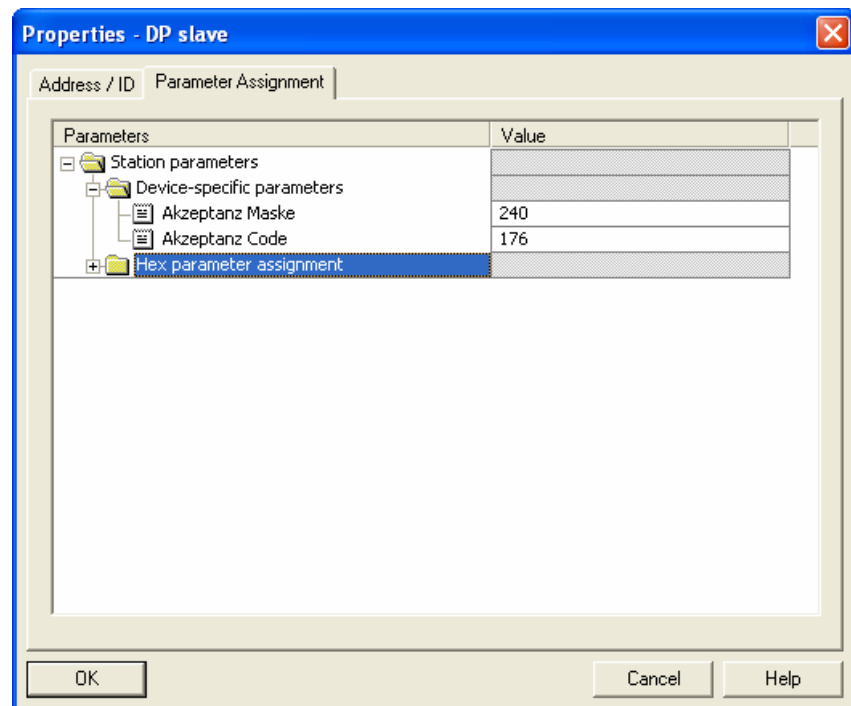
4.6.2 29-bit protocol

In order to receive any CAN frames with the Receive Object the upper 26 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 and the PLC is released.

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
Received CAN identifier																													
AcceptanceMask (e.g. 11111111111110000000000000)																								*ignored*		
AcceptanceCode (e.g. 11111111111111111111011xxxx)																										

Acceptance Mask 11111111111111111111110000 (= 536870784) filters out the top 26 bits. Acceptance code 11111111111111111111011xxxx (= 536870272) defines which frames are to be accepted after filtering.

In this example it is the CAN frames with identifiers 0x1FFFD80 to 0x1FFFFDFF.
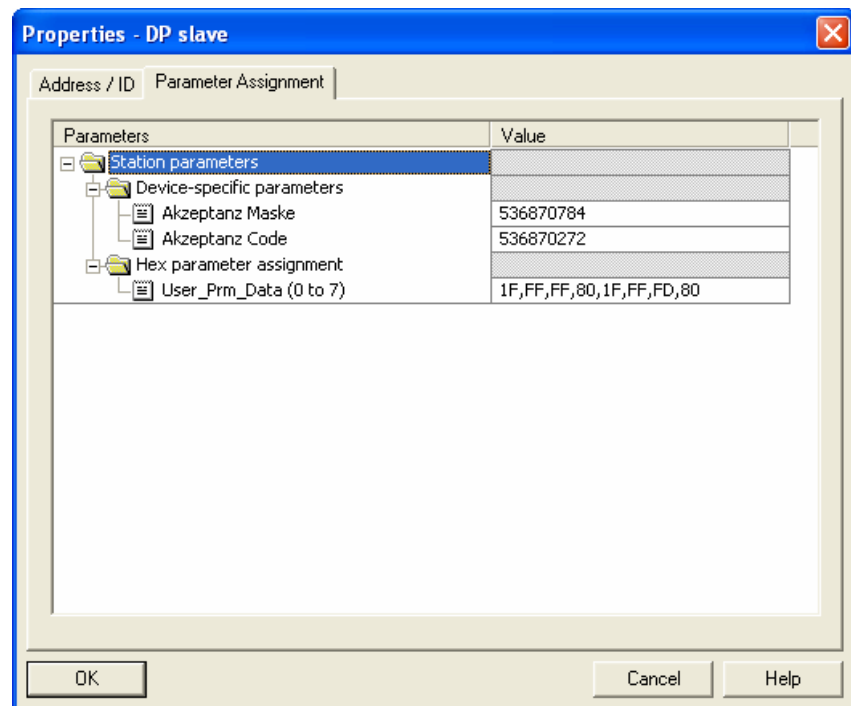
5 Programming (CAN Layer 2)

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 and the PLC has been started, the DP/CAN coupler can transmit and receive frames via CAN.

5.2 Handshake bits

The 5 bytes of the HANDSHK_IN area signal the receipt of CAN messages via the 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 Receive Object
	1	New frame receive object 1
	2	New frame receive object 2
	3	New frame receive object 3
	4	New frame receive object 4
	5	New frame receive object 5
	6	New frame receive object 6
	7	New frame receive object 7
…	…	
4	0	New frame receive object 32
	1	New frame receive object 33
	2	New frame receive object 34
	3	New frame receive object 35
	4	New frame receive object 36
	5	New frame receive object 37
	6	New frame receive object 38
	7	New frame receive object 39

The objects „RecObjStatus" and "RecObjCmd" must also be taken into account in the interpretation of the Receive Object.

The 5 bytes of the HANDSHK_OUT area are used to transmit the transmit objects and the 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 Transmit Object
	1	Send frame for transmit object 1
	2	Send frame for transmit object 2
	3	Send frame for transmit object 3
	4	Send frame for transmit object 4
	5	Send frame for transmit object 5
	6	Send frame for transmit object 6
	7	Send frame for transmit object 7
…		…
4	0	Send frame for transmit object 32
	1	Send frame for transmit object 33
	2	Send frame for transmit object 34
	3	Send frame for transmit object 35
	4	Send frame for transmit object 36
	5	Send frame for transmit object 37
	6	Send frame for transmit object 38
	7	Send frame for transmit object 39

5.3   Transmit and receive 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 frame can be detected by the 5 bytes of the HANDSHK_IN area.

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

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

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

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

The sequence of receive and transmit objects is defined!

5.4   Receive Object

If a frame which corresponds to the parameterized acceptance mask of the Receive Object is received the frame is transferred to the area of the Receive Object.

5.4.1   11-bit protocol

Byte	Content of 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 by the **RecObjecCmd** byte.

5.4.2   29-bit protocol

Byte	Content of Receive Object:
0	Len + RTR
1	HighByte – HighWord CAN identifier
2	LowByte – HighWord CAN identifier
3	HighByte – LowWord CAN identifier
4	LowByte – LowWord CAN identifier
5	Data byte 1
6	Data byte 2
7	Data byte 3
8	Data byte 4
9	Data byte 5
10	Data byte 6
11	Data byte 7
12	Data byte 8

The entire CAN message header is stored in the first 5 bytes (0-4).

Byte 0							
15	14	13	12	11	10	9	8
Data length				RTR	unused		

Byte 1								Byte 2							
15	14	8	12	11	10	9	8	7	6	5	4	3	2	1	0
unused			High Word CAN identifier (13 bits)												

Byte 3								Byte 4							
15	14	8	12	11	10	9	8	7	6	5	4	3	2	1	0
Low Word CAN identifier (16 bits)															

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 by the **RecObjecCmd** byte.

5.4.3   Receive Object Service

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 Receive Object frame
1	*reserved*
2	Delete RecObjStatus Overflow error bit
3	Reset 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 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 occurred during 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.

5.5 Transmit Object

Any number of messages can be sent via the Transmit Object (TrObject).

5.5.1 11-bit protocol

Byte	Content 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.

The 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.

A change of transmit data is activated on cyclic transmission only by inversion of bit 0 in byte 0 of the **HANDSHK_OUT** area.

5.5.2 29-bit protocol

Byte	Content Transmit Object
0	Len + RTR
1	HighByte HighWord CAN identifier
2	LowByte HighWord CAN identifier
3	HighByte LowWord CAN identifier
4	LowByte LowWord CAN identifier
5	Data byte 1
6	Data byte 2
7	Data byte 3
8	Data byte 4
9	Data byte 5
10	Data byte 6
11	Data byte 7
12	Data byte 8

The entire CAN message header is stored in the first 5 bytes (0-4).

Byte 0							
15	14	13	12	11	10	9	8
Data length				RTR	unused		

Byte 1								Byte 2							
15	14	8	12	11	10	9	8	7	6	5	4	3	2	1	0
unused			High Word CAN identifier (13 bits)												
Byte 3								Byte 4							
15	14	8	12	11	10	9	8	7	6	5	4	3	2	1	0
Low Word CAN identifier (16 bits)															

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

The 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.

A change of transmit data is activated on cyclic transmission only by inversion of bit 0 in byte 0 of the **HANDSHK_OUT** area.

5.6 PLC diagnostics

SFC 13 – "DPNRM_DG" can be used to fetch the diagnostic data from a DP slave.

Parameter	Direction	Type	Example
REQ	IN	BOOL	TRUE
LADDR	IN	WORD	W#16#3FE
RET_VAL	OUT	INT ;	MW 100
RECORD	OUT	ANY	P#DB13.DBX0.0 byte 10
BUSY	OUT	BOOL	M 7.0

REQ	Activate request
LADDR	Diagnostic address of DP slave - hexadezimal
RetVal	Error code or actual length of data in RECORD
RECORD	ANY pointer to the target area for the input buffer in the PLC. The data are copied from the module into this area. Length 10 bytes.
BUSY	Bit is 1 as long as data are fetched from the DP/CAN coupler.

Example of call:

```
    CALL  SFC   13
     REQ    :=TRUE
     LADDR  :=W#16#3FE                // Diagnostic address 1022
     RET_VAL:=MW100
     RECORD :=P#DB13.DBX0.0 Byte 10
     BUSY   :=M7.0
```

Examples of the ANY pointer:

P#E 50.0 BYTE 10 copies the input data into the I/O input image of the PLC from IB 50 to max. IB 59 (10 bytes). For this purpose, the maximum memory size of the I/O image of the selected PLC must be taken into consideration.

P#M 110.0 BYTE 10 copies the data into the marker memory area from MB 110 to max. MB 119 (10 bytes). For this purpose, the maximum memory size of the marker memory of the selected PLC must be taken into consideration.

P#DB 13.DBX 0.0 BYTE 10 copies the data into the data block 13 from DBB 2 to max. DBB 9 (10 bytes).

The bytes in the target area of parameter RECORD have the following meaning:

Byte	Content of RECORD:
0	
1	see Siemens documentation
2	
3	
4,5	Station ID
6	Bit 0 – 7
7	Bit 8 – 15

The following bits are currently used as indicated below.

Bit 3 = Switch 8 not in 29-bit mode

Bit 4 = CAN ID error – double assignment

Bit 8 = Number of CAN modules

6   Appendix

6.1   Technical Data

Order number   DP/CAN Coupler   700-651-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: CAN 2.0A/B (11 / 29 bits)

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 (typ.)

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)

6.2 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+

6.3 Further documentation

Internet: www.can-cia.org

CAN Specification 2.0, Part A & Part B

Notes