SIEMENS

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Speed control of a SINAMICS S120 via CANopen

SINAMICS S

http://support.automation.siemens.com/WW/view/en/88970247

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1 Task

1.1 Overview

A drive shall be moved speed-controlled.

Therefor it is controlled by a CAN interface that supplies the speed setpoint interface of the drive with data.

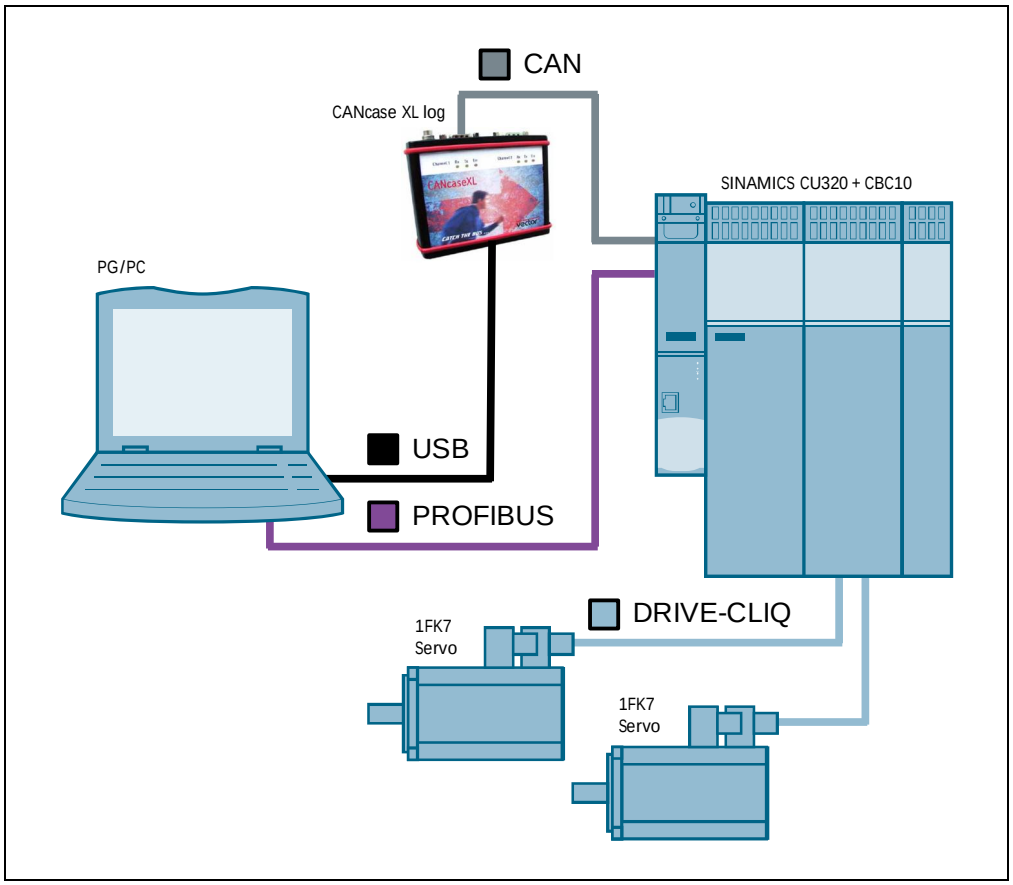
2 Solution

2.1 Overview

Schema

The following figure displays the most important components of the solution:

Figure 2-1 Hardware



In this application description it is shown, how a SINAMICS drive can be moved speed-controlled by means of the CAN interface "CANcase XL log".

On the one hand the control word as well as the speed setpoint are sent to the drive via the CAN bus by means of the CAN interface. On the other hand the drive sends back its status word and the actual speed value.

2.2 Hardware and Software Components

The application was generated with the following components:

Hardware components

Table 2-1

Component	No.	Order number	Note
SINAMICS S120 CU320	1	6SL3040-0MA00-0AA1	V2.6.2
CBC10 for CAN bus	1	6SL3055-0AA00-2CA0	---
CANcase XL log with CANpiggy 251mag	1	---	---

NOTE The sample project was created with the hardware components listed here.

Alternatively, other components with the same function may be used. A different parameter assignment and different wiring of the components may be required.

Standard software components

Table 2-2

Component	No.	Order number	Note
Windows XP	1	---	SP3
STARTER	1	6SL3072-0AA41-0AG0	V4.1.5
CANalyzer	1	---	V7.1.81 SP4
CANsetter	1	---	V6.2 SP1

Sample files and projects

The following list includes all files and projects that are used in this example.

Table 2-3

Component	Note
88970247_CANopen_SINAMICS_S120_V1_0.zip	Example project
88970247_CANopen_SINAMICS_S120_V1_0_en.pdf	This document

3 Configuration and Programming

3.1 Configuration of the SINAMICS

An "individual drive unit" is inserted in the STARTER.

The interface for the online connection is set to "PROFIBUS DP" and 126 as address, because this is the default setting.

You can now set up an online connection via PROFIBUS DP.

When selecting the automatic configuration, all existing components are initialized and transferred into the project. The "SERVO" type shall be selected as drive unit.

When using a SIEMENS demonstration case, the "SERVO_02" data are automatically determined.

The "SERVO_03" data can be read off from the label on the protection against contact and entered offline via the DDS configuration.

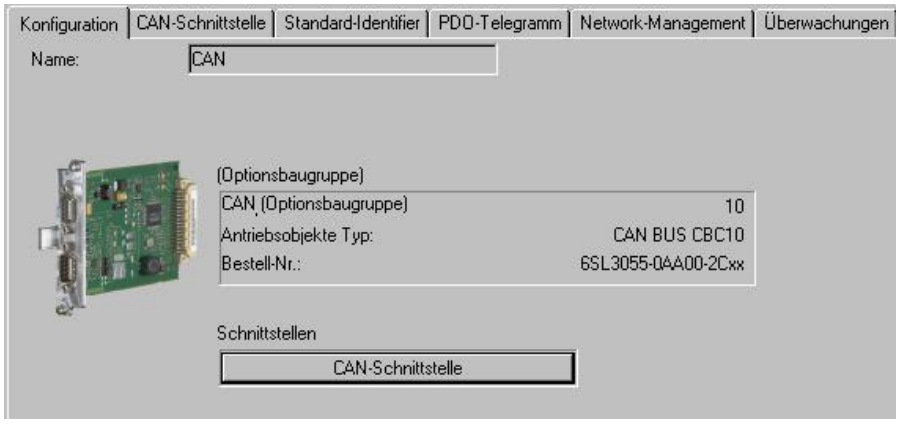
The connection of the "ready-to-operate signal" is requested during configuring. Press the "Close" button in the upcoming message box to permanently wire "1". This can be taken over for the "SERVO_02". Without this setting, the drives are not operational.

NOTE More detailed information is provided in the Commissioning Manual.

3.1.1 The CBC configuration menu

The configuration menu is reached via the context menu of the CU via "click with the right mouse button > CAN option module > Configuration".

Figure 3-1 CBC configuration menu



In the "CAN interface" tab, you can set the transmission speed ("baudrate") and the node ID ("CAN bus address").

The parameterized baudrate shall be identical for all bus nodes. 1 MBit/s is set in the example.

Assign unique "node IDs". The "node ID" can only be changed online!

During the startup, the CAN software first requests the hardware address switch. If this is set to "0", the parameter p8620 of the CAN bus address can be written and used to set the "node ID". If the address switch is set to "1-127", this address is transferred into the parameter p8620 and displayed. In this case, this parameter can only be read.

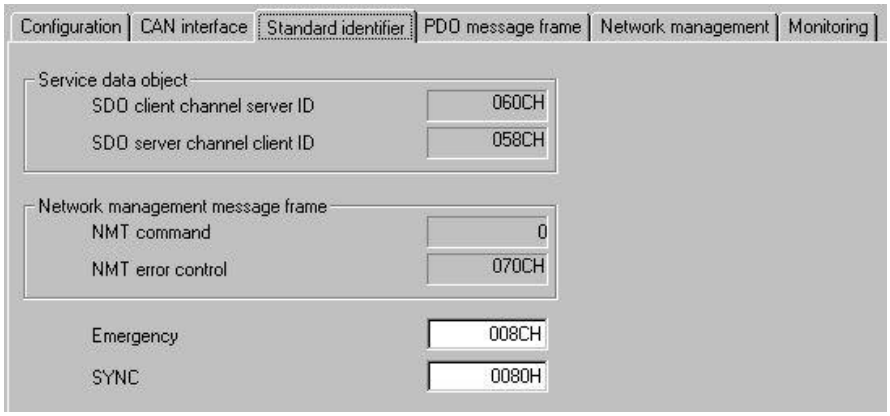
Figure 3-2 CAN interface

NOTE The decimal node ID displayed is required in hexadecimal form (12 = C HEX).

The tab "Standard Identifier" shows the predefined identifiers for the "SDO channel" (parameter access) and the "Network management message frames".

The identifiers for emergency and synchronization messages can be parameterized.

Figure 3-3

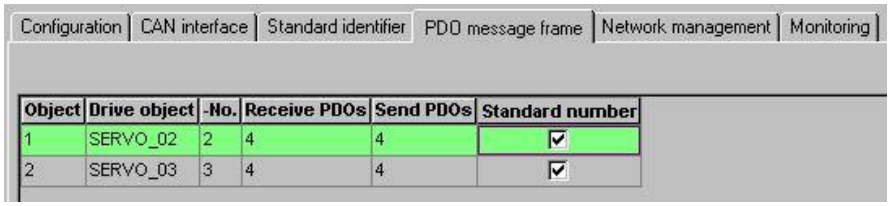


In the "PDO telegram" tab, you can set the number of send and receive data telegrams (PDO: "Process Data Objects") per drive object.

Maximum 8 PDOs can be set per send direction, 4 are preset as standard. Maximum 25 PDOs can be set per SINAMICS.

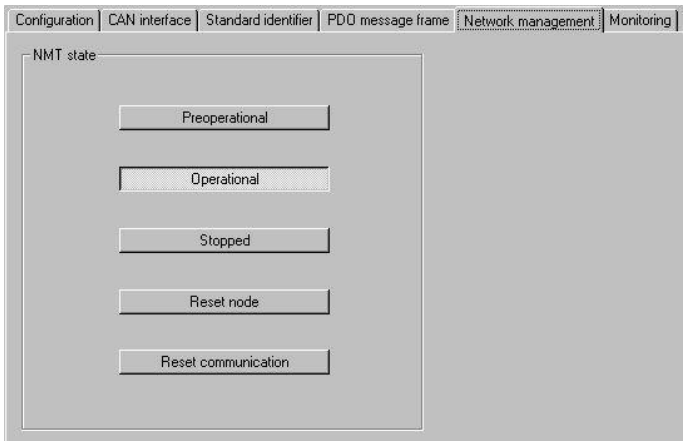
When defining 6 PDOs per drive object, you can operate a total of 4 axes via CANopen.

Figure 3-4 PDO definition



In the "Network management" tab, you can specify the communication state of the CANopen node after the startup. Process data exchange is only supported in the NMT state "Operational"!

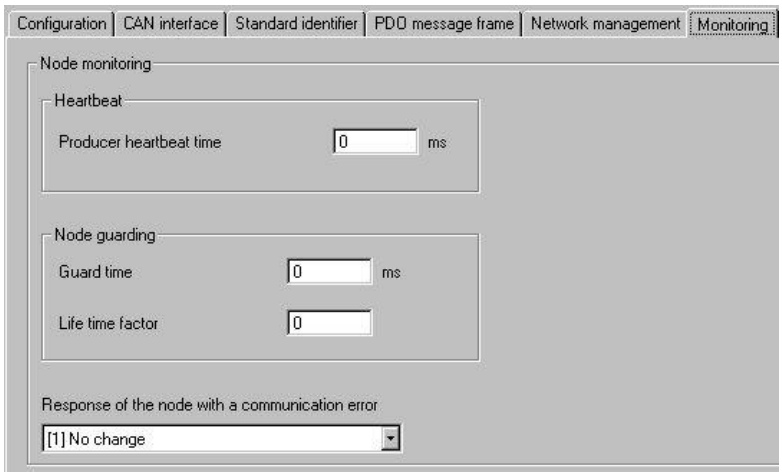
Figure 3-5 Network management



The "Monitoring" tab shows the settings for sign-of-life ("heartbeat") monitoring and "node guarding". Monitoring can be deactivated by entering "0" for the monitoring time ("producer heartbeat time" and "guard time").

When a communication fault occurs, you can select between the communication states "Stopped" and "Preoperational" (except when you do not want to change your setting).

Figure 3-6 Monitoring



4 Commissioning the example project

4.1 Overview

The archive "88970247_CANopen_SINAMICS_S120_V1_0.zip" comprises an executable STARTER project and an executable configuration for activation using the above-stated "CANcase XL log".

STARTER

- Open the STARTER and afterwards the example project.
- If the PROFIBUS DP address of the drive is correctly set and your PG/PC interface is correctly set, you can establish an online connection.
- Open the CAN screen via "SINAMICS > CU_S > CAN option module > Configuration".
- In the "Network management" tab, set the NMT state to "Preoperational".
- Perform a download.
- Save "RAM to ROM" to protect your data against voltage drops.
- The NMT state is set to "Operational" automatically.

CANalyzer

NOTE The "CANcase XL log" hardware cannot be used in a virtual machine (VM), because the USB hardware is not accepted as dongle.

- Open the sample configuration in the CANalyzer screen.
- You can use the "IG" module (control) to control the process data.
- The message 301 has been implemented for SERVO_02 and the message 302 for SERVO_03.
- This includes a 16-bit control word and a 32-bit speed setpoint each.
- With CANopen, the speed setpoint is scaled in increments per second. The encoder resolution allows converting this into "rpm".

Control word

47E hex: Set all necessary enables at the drive

47F hex: Switch on the drive, rotate with the speed setpoint value

4FE hex: Drive faults are acknowledged and the starting command is revoked (edge-triggered)

Speed setpoint

SERVO_02: 300.000 inc/s = 180 rpm

SERVO_03: 300.000 inc/s = 45 rpm

$$n\_soll\_intern\ [U/s] = \frac{n\_soll\_Bus}{p0408 * 2^{p0418}} * \frac{p8798[0]}{p8798[1]}$$

4.2 CAN parameters

4.2.1 CU320

The following table shows the major global parameters for CAN. You can reach the parameter list by "`click with the right mouse button > Expert > Expert list`". The settings apply to all DOs that are supporting CAN.

CAN is supported by the DOs supporting the interface 2 ("`IF2`")
(exception: ALM is currently not supported).

Table 4-1

Parameter number	Value	Meaning
r8600	0xFFF0192	Drive unit with several servo drives (object number 1000)
r8601		Fault, bit-coded, description see parameter description (OBJECT NUMBER 1001)
p8602	80H	SYNC object, SINAMICS acts as SYNC load (object number 1005)
p8603	FEH	Emergency message (object number 1014)
p8604[0]	0	Time interval [ms] for new node guarding telegram
p8604[1]	0	Factor for the failure of node guarding telegrams
p8606	0	Time setting [ms] for cyclically sending heartbeat telegrams
r8607[0]	6000053H	Manufacturer ID: SIEMENS
r8607[1]	5000H	Device ID: SINAMICS
r8607[2]	2603500H	Firmware version of the CU320
r8607[3]	0H	Serial number: Always 0
p8608	0	In case of a bus off error, the CAN bus is restarted after eliminating the cause with p8608 = 1 (is automatically set to 0 after the start)
p8609[0]	0	Setting the behavior of the CAN node regarding communication faults > In case of error, the CBC10 goes to the NMT state "Preoperational"
p8609[1]	0	Setting the behavior of the CAN node regarding device faults > In case of error, the CBC10 goes to the NMT state "Preoperational
p8610[0]	601H	Displays the identifier for the client/server direction of the SDO channel

Parameter number	Value	Meaning
r8610[1]	581H	Displays the identifier for the server/client direction of the SDO channel
p8611		Displays the “Predefined Error Field“ of the CAN node Further details are provided in the Parameter Description.
p8620	1	Display or setting of the CANopen node ID
p8622	[0] 1 MBit/s	Baudrate setting for the CAN bus
p8623	1405H	Setting the bit timing for the C_CAN controller for the corresponding baudrate set (here for 1MBit/s).
p8630[0]	2	Access provided to all drive objects.
p8630[1]	0	Indices 0..255 are accessible.
p8630[2]	0	Parameters 0..9999 can be accessed (1 = p10000..19999, 2 = p20000..p29999, 3 = p30000..39999).
r8680	5000H	Displays the registers of the CAN controller C_CAN: CAN protocol-related registers, Message Interface Register and Message Handler Register
p8684	5	The CBC runs up to the ”Operational” state
p8685	5	Displays that the CBC is in the Operational state The current state can be changed here
p8740[0]	4	The first drive receives 4 PDOs
p8740[1]	4	The first drive sends 4 PDOs
p8740[2]	0	Reserved
p8740[3]	4	The second drive receives 4 PDOs
p8740[4]	4	The second drive sends 4 PDOs
p8741	[0] Inactive	CBC PDO configuration acknowledgement
r8742	17	CBC number of free RPDO channels
r8743[0]	2	The first drive is DO2 (SERVO_02) DO with drive object ID 2
r8743[1]	3	The second drive is DO3 (SERVO_03) DO with drive object ID 3
p8848	4	Data sampling time: 4ms CAN sampling time

4.2.2 SERVO

In the example, the "RPDO 2" and "TPDO 2" are used, the corresponding parameters are highlighted.

NOTE

SINAMICS S120 and S110 support DS301 V4.0 and DSP402 V2.0. Only "Velocity Mode" is supported via the "Predefined Connection Set".

"Free PDO mapping" is used in this application description.

Table 4-2

Parameter number	SERVO_02	SERVO_03	Meaning
p8641	[3] OFF3	[3] OFF3	Behavior of the drive in case of a CAN communication fault
p8700[0]	201H	202H	COB ID of the PDO 1 CANopen object 1400 hex + 40 hex * x (x: drive number 0 ... 7)
p8700[1]	FEH	FEH	Transmission type of the PDO Factory setting
p8701[0]	**301H**	**302H**	**COB ID of the PDO 2** **Supplied in the example**
p8701[1]	**FEH**	**FEH**	**PDO transmission type**
p8702[0]	401H	402H	COB ID of the PDO 3
p8702[1]	FEH	FEH	PDO transmission type
p8703[0]	501H	501H	COB ID of the PDO 4
p8704[1]	FEH	FEH	PDO transmission type
p8710[0]	60400010H	68400010H	CBC receive mapping for RPDO 1, mapped object 1 Control word 16 Bit: 0010H Object 6040
p8710[1]	0H	0H	CBC receive mapping for RPDO 1, mapped object 2
p8710[2]	0H	0H	CBC receive mapping for RPDO 1, mapped object 3
p8710[3]	0H	0H	CBC receive mapping for RPDO 1, mapped object 4
p8711[0]	**60400010H**	**68400010**	**CBC receive mapping for RPDO 2, mapped object 1** **Control word 16 bit: 0010H Object 6040**
p8711[1]	**60FF0020H**	**68FF0020H**	**CBC receive mapping for RPDO 2, mapped object 2** **Speed setpoint 32 Bit: 0020H Object 60FF**
p8711[2]	0H	0H	CBC receive mapping for RPDO 2, mapped object 3
p8711[3]	0H	0H	CBC receive mapping for RPDO 2, mapped object 4

Parameter number	SERVO_02	SERVO_03	Meaning
p8712[0]	60400010H	68400010H	CBC receive mapping for RPDO 3, mapped object 1
p8712[1]	60710010H	68710010H	CBC receive mapping for RPDO 3, mapped object 2
p8712[2]	0H	0H	CBC receive mapping for RPDO 3, mapped object 3
p8712[3]	0H	0H	CBC receive mapping for RPDO 3, mapped object 4
p8713[0]	60400010H	68400010H	CBC receive mapping for RPDO 4, mapped object 1
p8713[1]	60FF0020H	68FF0020H	CBC receive mapping for RPDO 4, mapped object 2
p8713[2]	60710010H	68710010H	CBC receive mapping for RPDO 4, mapped object 3
p8713[3]	0H	0H	CBC receive mapping for RPDO 4, mapped object 4
p8720[0]	40000181H	40000182H	CBC Transmit PDO 1, COB ID of the PDO inactive
p8720[1]	FEH	FEH	CBC Transmit PDO 1, PDO transmission type
p8720[2]	0H	0H	CBC Transmit PDO 1, inhibit time (in 100 µs)
p8720[3]	0H	0H	CBC Transmit PDO 1, reserved
p8720[4]	0H	0H	CBC Transmit PDO 1, event timer (in ms)
p8721[0]	**40000281H**	**40000282H**	**CBC Transmit PDO 2, COB**
p8721[1]	**1H**	**1H**	**Synchronous transmission activated** **Transmission after each SYNC**
p8721[2]	**0H**	**0H**	**CBC Transmit PDO 2, inhibit time (in 100 µs)**
p8721[3]	**0H**	**0H**	**CBC Transmit PDO 2, reserved**
p8721[4]	**0H**	**0H**	**CBC Transmit PDO 2, event timer (in ms)**
p8722[0]	40000381H	40000382H	CBC Transmit PDO 3, COB
p8722[1]	FEH	FEH	CBC Transmit PDO 3, PDO transmission type
p8723[0]	40000481H	40000482H	CBC Transmit PDO 4, COB
p8723[1]	FEH	FEH	CBC Transmit PDO 4, PDO transmission type
p8730[0]	60410010H	68410010H	CBC transmit mapping for TPDO 1, mapped object 1 Status word 16 Bit: 0010H Object 6041
p8730[1]	0H	0H	CBC transmit mapping for TPDO 1, mapped object 2
p8730[2]	0H	0H	CBC transmit mapping for TPDO 1, mapped object 3

Parameter number	SERVO_02	SERVO_03	Meaning
p8730[3]	0H	0H	CBC transmit mapping for TPDO 1, mapped object 4
p8731[0]	**60410010H**	**68410010H**	**CBC transmit mapping for TPDO 2, mapped object 1** **Status word 16 bit: 0010H** **Object 6041**
p8731[1]	**606C0020H**	**686C0020H**	**CBC transmit mapping for TPDO 2, mapped object 2** **Actual speed value 32 bit: 0020H** **Object 6041**
p8731[2]	**0H**	**0H**	**CBC transmit mapping for TPDO 2, mapped object 3**
p8731[3]	**0H**	**0H**	**CBC transmit mapping for TPDO 2, mapped object 4**
p8732[0]	60400010H	68400010H	CBC transmit mapping for TPDO 3, mapped object 1
p8732[1]	60710010H	68710010H	CBC transmit mapping for TPDO 3, mapped object 2
p8732[2]	0H	0H	CBC transmit mapping for TPDO 3, mapped object 3
p8732[3]	0H	0H	CBC transmit mapping for TPDO 3, mapped object 4
p8733[0]	60410010H	68410010H	CBC transmit mapping for TPDO 4, mapped object 1
p8733[1]	60630020H	68630020H	CBC transmit mapping for TPDO 4, mapped object 2
p8733[2]	0H	0H	CBC transmit mapping for TPDO 4, mapped object 3
p8733[3]	0H	0H	CBC transmit mapping for TPDO 4, mapped object 4
p8744	[2] Free PDO Mapping	[2] Free PDO Mapping	CBC PDO mapping configuration
r8850			IF2 PZD receive word, PZD 1-16 Monitoring parameters for 16-bit process data
r8853			IF2 send diagnosis PZD, PZD 1-16 Monitoring parameters for 16-bit process data
r8860			IF2 PZD receive double word, PZD (1 + 2) to (15 + 16) Monitoring parameters for 32-bit process data
r8863			IF2 send diagnosis PZD double word, PZD (1 + 2) to (15 + 16) Monitoring parameters for 32-bit process data

Display of the connection between object and process data in SINAMICS

Table 4-3

Parameter	Object	Process date
r8750[0]	SERVO_02 = 6040H SERVO_03 = 6840H	Control word 1
r8750[3]	SERVO_02 = 6071H SERVO_03 = 6871H	Torque setpoint Not used
r8760[1]	SERVO_02 = 60FFH SERVO_03 = 68FFH	Speed setpoint

Table 4-4

Parameter	Object	Process date
r8751[0]	SERVO_02 = 6041H SERVO_03 = 6841H	Status word
r8751[3]	SERVO_02 = 6074H SERVO_03 = 6874H	Torque setpoint Not used
r8761[1]	SERVO_02 = 606CH SERVO_03 = 686CH	Speed setpoint

Connecting the process data

Table 4-5

Bit	Parameter	Meaning
STW1.0	p0840[0] = r8890.0	↑ = ON (pulse enable possible) 0 = OFF1 (braking with ramp-function generator, then pulse suppression and ready for operation)
STW1.1	p0844[0] = r8890.1	1 = operating condition (enable possible) 0 = OFF2 (immediate pulse suppression and switch-on inhibit)
STW1.2	p0848[0] = r8890.2	1 = operating condition (enable possible) 0 = OFF3 (braking with OFF3 ramp p1135, then pulse suppression and switch-on inhibit)
STW1.3	p0852[0] = r8890.3	1 = Enable operation (pulse enable possible) 0 = Disable operation (supress pulses)
STW1.4	p1140[0] = r8890.4	1 = Enable ramp-function generator 0 = Disable ramp-function generator (set ramp-function generator output to zero)
STW1.5	p1141[0] = r8890.5	1 = Start ramp-function generator 0 = Stop ramp-function generator (freeze ramp-function generator output)
STW1.6	p1142[0] = r8890.6	1 = Enable speed setpoint 0 = Disable speed setpoint (set ramp-function generator input to zero)
STW1.7	p2103[0] = r8890.7	↑ = Acknowledge fault
STW1.8	-	Reserved
STW1.9	-	Reserved
STW1.10	p0854[0] = r8890.10	1 = controlled via PLC

Bit	Parameter	Meaning
STW1.11	-	Reserved
STW1.12	-	Reserved
STW1.13	-	Reserved
STW1.14	-	Reserved
STW1.15	-	Reserved

Connection of actual and setpoint values

Table 4-6

Parameter	Value	Meaning
p1155	r8761[1]	Speed setpoint 1
p8851[0]	r8784	CBC status word
p8861[1]	r63	Actual speed value

COB IDs

Table 4-7

Bit number	Value	Meaning
31 (MSB)	0	PDO valid (PDO is transferred)
	1	PDO invalid (PDO is not transferred)
30	0	Remote Transmission Request permissible (PDO may be requested by the recipient)
	1	Remote Transmission Request not permissible (PDO may not be requested by the recipient)
29	0	11-bit identifier
	1	29-bit identifier
28-11	0	With 11-bit identifier
	X	Bit 28-11 with 29-bit identifier
10-0	X	Bit 10-0 of the identifier (with 11 and 29-bit identifier)

4.3 Rules of calculation

COB ID of receive PDO

In the example, the ID "301" has been defined for the receive PDO 2.

An invalid receive PDO begins with the digit "0x8". The actual identifier, which is specified by the bits 10-0, is not relevant.

COB ID of the send PDO

The send PDOs used begin with "40000 0000". As these cannot be requested, bit 30 = "1" has to be set.

The COB identifier "C00006DF" is assigned to the unused send PDOs. Bit 31 marks the PDOs as invalid, Bit 30 is "1" for send PDOs (C Hex).

In the example project, the valid COB ID for the send PDO 2 = "40000281" hex results from the defined ID "281".

Object IDs

Object mapping follows the rule "object ID + (axis number-1) * 0x800". In the example project, "SERVO_02" is the first axis. As a result, the ID results from "0x6040 + (1-1) * 0x800 = 0x6040" as high-word of the p8710, in which the control word is mapped.

The length in the form "0010" hex for 16 bit and "0020" hex for 32 bit sizes is attached. The entry is then "60400010" hex.

The actual speed value is entered according to "606C0020" hex because it is a 32-bit value.

5 Related literature

Table 5-1

	Topic	Title / Link
\1\	Siemens Industry Online Support	http://support.automation.siemens.com
\2\	Download page of this entry	http://support.automation.siemens.com/WW/view/en/88970247
\3\		

6 Contact

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7 History

Table 7-1

Version	Date	Modifications
V1.0	02/2014	First version