Electric Drives and Controls | Hydraulics | Linear Motion and Assembly Technologies | Pneumatics | Service

Rexroth
Bosch Group

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Closed-loop control system SYDFEC CANopen Interface

user manual

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Abbreviations

CAN	**C**ontroller **A**rea **N**etwork
CiA	**C**AN **i**n **A**utomation
COB-ID	**C**ommunication **Ob**ject **Id**entifier
DLC	**D**ata **L**ength **C**ode (number of data bytes)
PT	**P**ressure **T**ransducer
EEPROM	**E**lectrically **e**rasable **p**rogrammable **r**ead **o**nly **m**emory
EMC	**E**lectro**m**agnetic **c**ompatibility
GND	**G**rou**nd** (signal ground)
LSB	**L**east **S**ignificant **B**yte
MSB	**M**ost **S**ignificant **B**yte
NMT	**N**etwork **M**anagemen**t**
p	Pressure (symbol)
PC	**P**ersonal **C**omputer
p_{Diff}	Control difference between pressure command value and actual pressure value
PDO	**P**rocess **D**ata **O**bject
PE	**P**rotective **E**arth
ro	**r**ead **o**nly
RTR	**R**emote **T**ransmit **R**equest
rw	**r**ead/**w**rite
RXD	**R**eceived **D**ata
SDO	**S**ervice **D**ata **O**bject
PLC	**P**rogrammable **L**ogic **C**ontrol
SWA	**Sw**ivel **A**ngle
SYDFEC	**Sy**stem **D**ruckförderstromregelung **E**lektronisch mit **C**AN-Bus (electronic pressure/flow control system with CAN bus)
SYNC	**Sync**hronisation telegram
TXD	**T**ransmitted **D**ata
WIN-PED®	**Win**dows program for **P**arameterisation, **E**diting, **D**iagnosis
wo	**w**rite **o**nly

1 Safety regulations

Bosch Rexroth AG is not liable for damage resulting from the non-observance of warning notes in this description.

Read the notes on operation, maintenance and safety prior to commissioning. If the documentation is not clearly understood in the present language, please contact and inform the supplier.

A precondition for the proper and safe operation of this equipment is proper and correct transport, storage, assembly and installation as well as careful operation and maintenance.

WARNING
Improper handling of this equipment and the non-observance of the warning notes given here as well as unauthorised interventions into safety equipment can result in injury, electrical shock or, in extreme cases, to death or damage to property.

Employ trained and qualified personnel for handling and operating hydraulic and electrical equipment: Only trained and qualified personnel should work on or in the vicinity of this equipment. Personnel is qualified, when it is sufficiently familiar with the assembly, installation and operation of the product as well as with all warnings and precautionary measures in accordance with this description. In addition, it must be trained, instructed or authorised to connect or disconnect electrical circuits and devices in accordance with safety regulations, to ground them and to mark them appropriately according to the working requirements. The personnel must be provided with adequate safety equipment and trained with regard to First Aid.

Use only spare parts approved by the manufacturer.

Observe safety instructions and regulations valid in the country of use of the equipment.

The equipment is provided for installation in machines that are employed in an industrial environment.
European countries: EU Directive 89/392/EEC (Machinery Directive).

Commissioning is prohibited until it was demonstrated that the machine, into which the products are to be integrated, comply with national regulations and safety rules valid for the application at hand. Their operation is only allowed when national EMC regulations for the relevant application are adhered to. If required, notes on the installation in line with EMC regulations can be found in the EMC testing documentation published by Bosch Rexroth. The adherence to limit values laid down in national regulations lies within the responsibility of the manufacturer of the plant or machine.

- European countries: EC Directive 89/336/EEC (EMC Directive).
- USA: See National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA) as well as regional construction regulations.

The operator must at any time comply with all aspects mentioned above.

Technical data, connection and installation conditions can be found in the product documentation and wiring plans and must in any case be adhered to.

The incorrect control of connected electrical and hydraulic components (encoders, valves, cylinders,…) can lead to hazardous movements. The causes can be of different nature:

- Improper or faulty wiring or cabling,
- incorrect operation of components,
- errors in transducers and signal encoders,
- defective components,
- errors in the software.

These errors can occur directly after the equipment was switched on or at any time of operation.

Monitors in the drive components can largely rule out malfunction in the connected drives. However, with regard to personal protection, in particular the risk of personal injury and/or damage to property, you must not rely solely on this feature. Until integrated monitors become effective, an incorrect drive movement must in any case be expected, the extent of which depends on the type of control and the operational state.

Personal protection must be ensured, among others, for the reasons stated before, by providing monitors or measures of a higher level on the plant side. These have to be provided by the plant manufacturer in accordance with the specific situation of the plant

and a risk and fault analysis. In this context, the safety regulations valid for the plant must be observed. The deactivation, bypassing or non-activation of safety equipment can result in uncontrollable movements of the machine or other malfunction. Further regulations for personal protection can be found in general regulations for the prevention of accidents, personal injury and/or damage to property.

2 Introduction

This documentation is based on the specifications “Communication Profile for Industrial Systems“ according to CANopen (CiA Draft Standard 301 **Version 3.0**).

3 Important notes

3.1 Reserved SDO range

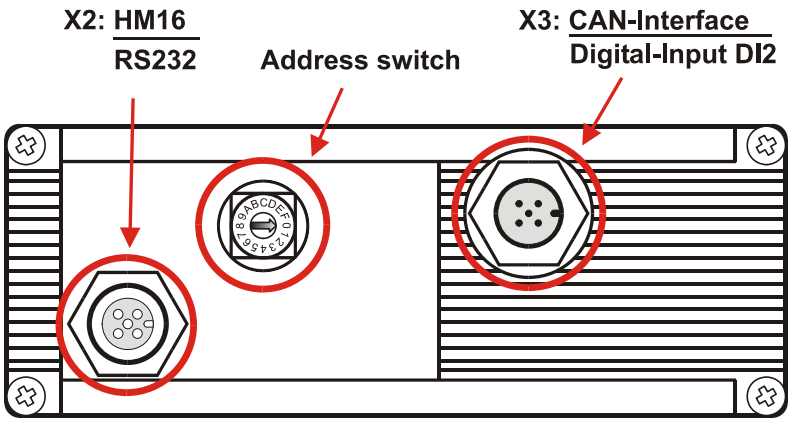
In accordance with CANopen (CiA Draft Standard 301 Version 3.0) the area with COB-IDs 0x581…0x67F is used for the SDO transfer.

When the Rexroth software “WIN-PED®“ is used, the range with COB-IDs **0x682…0x6A1** is utilized for the internal communication between the SYDFECs. This reserved SDO range should not be used by other CAN stations.

3.2 Limited write cycles to the EEPROM

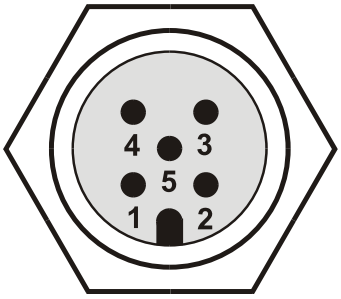
The SYDFEC utilizes an EEPROM as non-volatile memory. Cyclical “writing“ to the object directory entries by means of an SDO transfer results in the destruction of the EEPROM and is not permitted.

4 Plug-in connector arrangement



5 CAN bus interface

The CAN bus interface of the SYDFEC is an M12 component plug (X3).



1 Not connected
2 Digital-Input DI2
3 Reserved
4 CAN-H
5 CAN-L

It is not permitted to connect signals to the reserved pins.

6 Module-ID (Node-ID)

The SYDFEC is fitted with a rotary switch with 16 positions (0 ... F). The switch positions allow the setting of Module-ID 1 to 16. Here, it must be taken into account that the logic Module-ID is determined by the switch position + 1 (e.g. switch position “1“ = Module-ID “2“), since CANopen utilises Node-ID "0" for addressing all bus stations (broadcast).

Module-ID = Node-ID = switch position + 1

The factory-set Module-ID for the SYDFEC = 2. To take a changed Module-ID over, a power-on reset must be executed on the SYDFEC.

7 CAN baud rate

You can select CAN baud rates within the range from 10 kbits/s to 1Mbit/s. The baud rate of 800 kbits/s is not supported in favour of 615 kbits/s.
The following baud rates are possible:

Baud rate	Value (decimal)
10 kbits/s	10
20 kbits/s	20
50 kbits/s	50
125 kbits/s	125
250 kbits/s	250
500 kbits/s	500
615 kbits/s	615
1000 kbits/s	1000

The new CAN baud rate is saved by writing (download request) to object 0x5B00 sub-index 0x0. A changed value is saved in a non-volatile memory, but is only active when the voltage supply is switched on the next time.
Reading out (upload request) of object 0x5B00 sub-index 0x0 indicates the baud rate that will be active when the voltage supply is switched on the next time.

The factory-set default baud rate of the SYDFEC is 500 kbits/s.

8 Network management (NMT)

After the voltage supply was switched on or after a reset (software, communication reset) the SYDFEC is initialised and is always in the “pre-operational” state (ready for operation). In this state, the service data objects (SDOs), which can be used for configuring and parameterising the SYDFEC, are available for communication.
The network management includes all functions relating to the changeover to the "operational" state, monitoring as well as reconfiguration with regard to the running time. In the "operational" state, communication is possible via SDOs and PDOs.

8.1 Boot-Up Protocol

Minimal Boot-Up Protocol can be used to switch the SYDFEC over to its various states, that is “pre-operational“, “operational“, “software reset“ and “CAN module reset“.

COB-ID	Byte 0	Byte 1
0x000 (NMT)	Command 0xYY	Node-ID 0xZZ

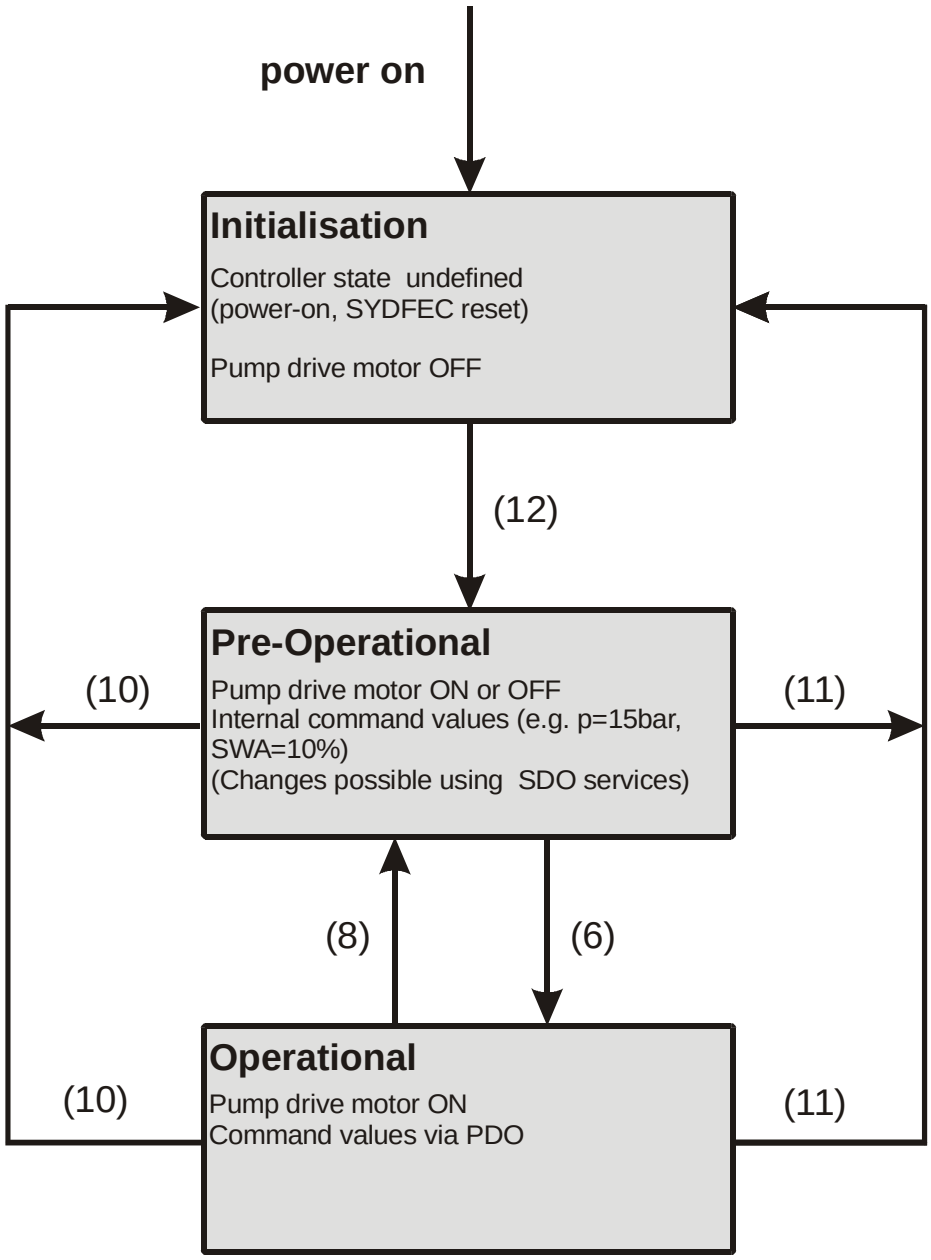
8.1.1 Command Specifier (0xYY)

Value	Meaning “0xYY”
0x01	Start remote node indication (Start PDO-Transfer, switches to the “operational“ state)
0x80	Stop remote node indication (Stop PDO-Transfer, switches to the “pre-operational“ state)
0x81	Reset node indication (Reset SYDFEC)
0x82	Reset communication indication (Reset CAN-Module)

8.1.2 Node-ID or broadcast (0xZZ)

Value	Meaning “0xZZ”
0x00	Broadcast (message is destined for all nodes)
0x01…0x7F	Message is destined to one node only

8.2 State diagram



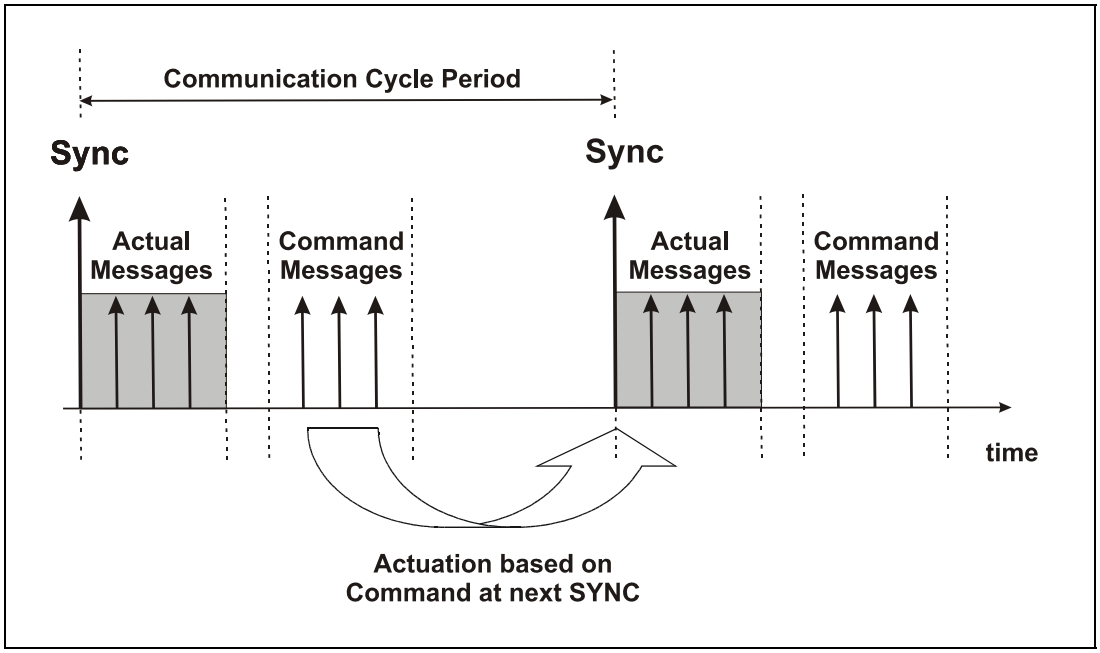
(6) Start remote node indication (Start PDO-Transfer)
(8) Stop remote node indication (Stop PDO-Transfer)
(10) Reset node indication (Reset SYDFEC)
(11) Reset communication indication (Reset CAN-Module)
(12) Initialisation finished, automatic transition to “pre-operational“

9 Synchronisation object (SYNC)

The synchronisation object is used for synchronising the network stations.

COB-ID	RTR	DLC
0x080 (SYNC)	0	0

If synchronous transmission is used, the actual values are sent after the receipt of a Sync message. The command values are taken over upon receipt of the subsequent Sync message.



Source: http://www.can-cia.org „CANopen99-1.pdf“

Important: The time interval between the Sync messages must not be shorter than 2 ms.

10 Process data objects (PDO)

We have to distinguish between synchronous and asynchronous PDOs. PDOs are used to transmit real-time data and are generally services that are not acknowledged.

With the SYDFEC the identifiers are assigned in accordance with the predefined connection set according to the CANopen protocol. For communications, 3 transmit PDOs and 4 receive PDOs are available with the SYDFEC. As a standard, PDOs are initialised with the following CANopen identifiers (COB-IDs).

SYDFEC → PLC

COB-ID of the 1st transmit PDO:	0x180 + Node-ID
COB-ID of the 2nd transmit PDO:	0x280 + Node-ID
COB-ID of the 3rd transmit PDO:	0x380 + Node-ID

PLC → SYDFEC

COB-ID of the 1st receive PDO:	0x200 + Node-ID
COB-ID of the 2nd receive PDO:	0x300 + Node-ID
COB-ID of the 3rd receive PDO:	0x400 + Node-ID
COB-ID of the 4th receive PDO:	0x500 + Node-ID

By means of an SDO access, the COB-ID can be configured to the following indices under sub-index 0x01 of the object dictionary and saved in the EEPROM using the store parameter command.

Index 1800: 1st transmit PDO
Index 1801: 2nd transmit PDO
Index 1802: 3rd transmit PDO

Index 1400: 1st receive PDO
Index 1401: 2nd receive PDO
Index 1402: 3rd receive PDO
Index 1403: 4th receive PDO

Example:

The COB-ID for the 1st receive PDO is to be changed to COB-ID 0x444. The higher-level control must send the following telegram:

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4-7
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index (LSB) 0x00	Index (MSB) 0x14	Sub-index 0x01	COB-ID 0x44040000

It is possible to save the dynamic identifier assignment permanently in the EEPROM (chapter 9.1 "Store parameters“).

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4-7
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index (LSB) 0x10	Index (MSB) 0x10	Sub-index 0x02	0x73617665 "SAVE"

10.1 Standard protocol with predefined PDO mapping

The SYDFEC only supports static mapping of CANopen. The contents of the PDOs cannot be changed with the help of dynamic mapping of CANopen (changing of the contents with the help of SDOs).

10.2 Use of PDOs with the SYDFEC

The following overview illustrates the use of transmit/receive PDOs with the default COB-ID setting. For communications, 3 transmit PDOs and 4 receive PDOs are available for the SYDFEC.

Transmit PDOs	**COB-ID**	**Use**
Transmit PDO1	0x180 + Node-ID	Synchronous actual value PDO1 (chapter 10.3)
Transmit PDO2	0x280 + Node-ID	Switchover function (chapter 19.1.1)
Transmit PDO3	0x380 + Node-ID	Master/slave mode (chapter 19.2)

Receive PDOs	**COB-ID**	**Use**
Receive PDO1	0x200 + Node-ID	Synchronous command value PDO1 (chapter 10.4.1)
Receive PDO2	0x300 + Node-ID	Dynamic changeover function (chapter 19.1.2)
Receive PDO3	0x400 + Node-ID	Master/slave mode (chapter 19.2)
Receive PDO4	0x500 + Node-ID	Asynchronous command value PDO4 (chapter 10.4.2)

10.3 Transmission of actual values by means of synchronous transmit PDO1

The actual values as well as the internal status (status byte) of the SYDFEC are transmitted by means of the following PDO message, which is sent by the SYDFEC after the receipt of a SYNC message.

COB-ID	RTR	DLC	Byte 0	Byte 1,2	Byte 3,4
0x180+Node-ID (PDO 1 TXD)	0	5	Status byte	SWA - Actual value	p - Actual value

SWA - Actual value
0xC001 ... 0x3FFF = -100% ... +100%

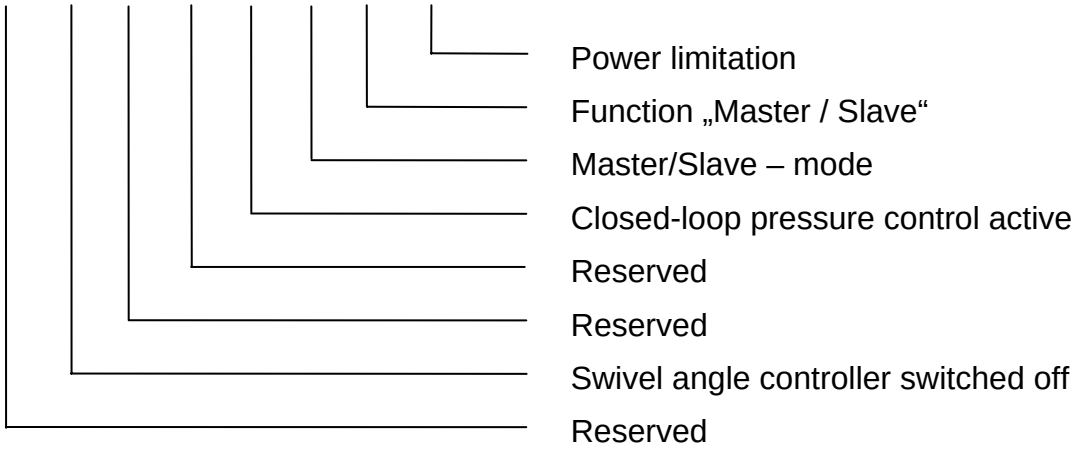
p - Actual value
0x0000 ... 0x3FFF = 0 bar ... xx bar (in accordance with the nominal pressure)
Note: Negative values as a result of measuring tolerances or cable break of the PT

The nominal pressure of 1 bar to 450 bar (0x0001 ... 0x01C2) is set by writing (download request) to object 0x5208 sub-index 0x02. A changed value is saved in a non-volatile memory and is activated immediately. The default factory-setting is 315 bar (0x013B).

10.3.1 Meaning of the status byte

The internal status of the SYDFEC is signalled via the status byte.

Bit	7	6	5	4	3	2	1	0
Status byte								



Bit 0 – Power limitation	
"1"	The SYDFEC operates under closed-loop power control.
"0"	The current power is less than the set power limit.

Bit 1 – Function „Master / Slave“	
"1"	The SYDFEC operates as slave in the master/slave operating mode.
"0"	The SYDFEC operates as master in the master/slave operating mode.

Bit 2 – Master/Slave - mode	
"1"	The master/slave operating mode is activated.
"0"	The master/slave operating mode is deactivated.

Bit 3 – Closed-loop pressure control active	
"1"	Closed-loop pressure control of the SYDFEC is active.
"0"	Closed-loop swivel angle control of the SYDFEC is active.

Bit 6 – SWA controller switched off	
"1"	The swivel angle controller of the SYDFEC has been switched off by the user (object 0x5310 sub-index 0x0) or due to an ongoing calibration process.
"0"	The swivel angle controller of the SYDFEC is not subject to any limitation.

10.4 Transmission of the command value by means of synchronous/ asynchronous PDO

The command values can be transmitted from the PLC to the SYDFEC either via a synchronous or an asynchronous PDO. The selection of the synchronous or asynchronous transmission type is made by writing (download request) to object 0x5036 sub-index 0x01.
When delivered, the command value transmission is set to synchronous receive PDO1.

Value	Meaning
0x0000	Synchronous transmission of command values (PDO1)
0x0001	Asynchronous transmission of command values (PDO4)

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4,5
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index (LSB) 0x36	Index (MSB) 0x50	Sub-index 0x01	Synchronous=0x0000 Asynchronous=0x0100

10.4.1 Synchronous transmission of command values by means of receive PDO1

The SYDFEC receives the following PDO message (command values, control byte) from the control (PLC). The data are taken over when the subsequent synchronisation telegram (SYNC) is received.

COB-ID	RTR	DLC	Byte 0	Byte 1,2	Byte 3,4
0x200+Node-ID (PDO 1 RXD)	0	5	Control byte	SWA - command value	p - command value

SWA - Command value
0xC001 ... 0x3FFF = -100% ... +100%

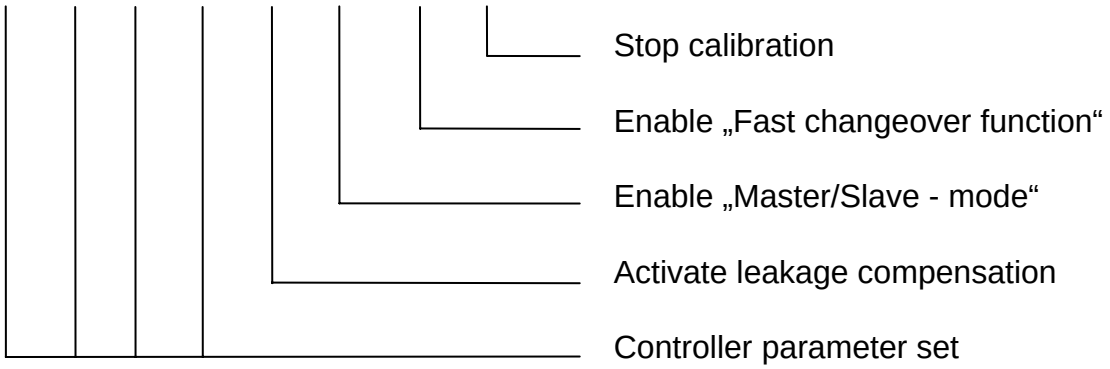
p - Command value
0x0000 ... 0x3FFF = 0 bar ... xx bar (in accordance with the nominal pressure)

The nominal pressure of 1 bar to 450 bar (0x0001 ... 0x01C2) is set by writing (download request) to object 0x5208 sub-index 0x02. A changed value is saved in a non-volatile memory and is activated immediately. The default factory-setting is 315 bar (0x013B).

10.4.1.1 Meaning of the control byte

The control byte can be used for selecting certain control options, which are described in the following.

Bit	7	6	5	4	3	2	1	0
Control byte								



Bit 0 – Stop calibration
"1" The ongoing calibration process is stopped.

Bit 1 – Enable “Fast changeover function”
"1" The fast changeover function is enabled.

Bit 2 – Enable “Master/Slave – mode”
"1" The master/slave operating mode is activated.

Bit 3 – Activate leakage compensation
"1" Pressure-related leakage compensation is activated.

Bit 4 ... 7 – Controller parameter set
0 – 0xF These four bits can be used to select a controller parameter set.

10.4.2 Asynchronous transmission of command values by means of receive PDO4

With the event-controlled transmission type, the contents (command values, control byte) of the PDO4 are processed further immediately after their receipt. The structure of this asynchronous PDO4 corresponds to the structure of the synchronous PDO1 (chapter 10.4.1.1 “Meaning of the control byte").

COB-ID	RTR	DLC	Byte 0	Byte 1,2	Byte 3,4
0x500+Node-ID (PDO 1 RXD)	0	5	Control byte	SWA command value	Pressure command value

SWA - Command value
0xC001 ... 0x3FFF = -100% ... +100%

p - Command value
0x0000 ... 0x3FFF = 0 bar ... xx bar (in accordance with the nominal pressure)

The nominal pressure of 1 bar to 450 bar (0x0001 ... 0x01C2) is set by writing (download request) to object 0x5208 sub-index 0x02. A changed value is saved in a non-volatile memory and is activated immediately. The default factory-setting is 315 bar (0x013B).

11 Service Data Objects (SDOs)

The parameters listed in the object dictionary can be read and written by means of SDOs. All of the parameters are provided with a multiplexer (address), which consists of a 16-bit index and an 8-bit sub-index. Hence, all entries, which can also be defined as different data structures, can be addressed.

The SYDFEC must always be regarded as server for the multiplexed-domain SDOs. As such, the server makes data available upon request of the client (upload) or receives data from the client (download).

In contrast to the **SDO expedited protocol**, which allows data amounts of max. 4 bytes to be transferred, the **SDO segment domain protocol** allows an optional number of 7-byte data blocks to be transmitted.

The **SDO segment domain protocol** is used with the SYDFEC only for entries in the object dictionary 0x1008 to 0x100A (string variables with a maximum of 15 bytes).

These two SDO protocol types are acknowledged services, that is, each SDO protocol triggered by the client is answered with a response telegram.

11.1 SDO segment domain protocol

In conjunction with the SYDFEC this telegram may only be used for entries in the object dictionary 0x1008 to 0x100A. These entries contain the strings for the names of assemblies, the assembly number and the software version. The strings are 15 bytes long and therefore require 3 segment upload request telegrams, since in one telegram, a maximum of 7 data bytes can be transmitted.

11.2 SDO expedited protocol

11.2.1 Client → server (PLC → SYDFEC), upload request

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3
0x600+Node-ID (SDO 1 RXD)	Control word 0x40	Index low byte	Index high byte	Sub-index

11.2.2 Server → client (SYDFEC → PLC), upload response

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 ... 7
0x580+Node-ID (SDO 1 TXD)	Control word 0xYY	Index low byte	Index high byte	Sub-index	Data byte 0...3

The value of the control word (0xYY) indicates, how many data bytes are valid.

0x4F	1 data byte is valid	0x4B	2 data bytes are valid
0x47	3 data bytes are valid	0x43	4 data bytes are valid

11.2.3 Client → server (PLC → SYDFEC), download request

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 ... 7
0x600+Node-ID (SDO 1 RXD)	Control word 0xYY	Index low byte	Index high byte	Sub-index	Data byte 0...3

11.2.4 Server → client (SYDFEC → PLC), download response

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 ... 7
0x580+Node-ID (SDO 1 TXD)	Control word 0x60	Index low byte	Index high byte	Sub-index	Data byte 0...3 (always set to ZERO)

The value of the control word (0xYY) indicates, how many data bytes are valid.

0x2F	1 data byte is valid	0x2B	2 data bytes are valid
0x27	3 data bytes are valid	0x23	4 data bytes are valid

11.3 Interruption of a SDO protocol

In the case of a communication failure, the communication is interrupted and the SYDFEC sends a SDO interrupt telegram. The meaning of the data bytes can be found in the following table.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4,5	Byte 6	Byte 7
0x580+Node-ID (SDO 1 TXD)	Control word 0x80	Index low byte	Index high byte	Sub-index	Additional code	Error code	Error class

11.3.1 Error message in the event of a SDO protocol interrupt

Additional code		Error code	Error class	Description of error
Byte 4	Byte 5	Byte 6	Byte 7	
0x11	0x0	0x9	0x6	Sub-index does not exist
0x00	0x0	0x1	0x6	Only read or write possible
0x31	0x0	0x9	0x6	Default value too high
0x32	0x0	0x9	0x6	Default value too low
0x10	0x0	0x7	0x6	Data type not known
0x12	0x0	0x7	0x6	Data length too high
0x13	0x0	0x7	0x6	Data length too low
0x41	0x0	0x4	0x6	Data cannot be mapped
0x42	0x0	0x4	0x6	PDO length exceeded
0x43	0x0	0x4	0x6	Value invalid
0x00	0x0	0x3	0x5	Wrong toggle bit
0x00	0x0	0x2	0x6	Object not available
0x21	0x0	0x0	0x8	Internal error
0x22	0x0	0x0	0x8	Service error
0x00	0x0	0x6	0x6	EEPROM loading error
0x47	0x0	0x4	0x6	Initialization error

12 Node Guarding and Life Guarding

Node guarding serves for monitoring network stations for failures. To this end, the NMT master (control, PLC) must cyclically send a guarding telegram (RTR) to the SYDFEC:

COB-ID	RTR
0x700+Node-ID (node-guarding)	1

The SYDFEC replies with the following message:

COB-ID	RTR	DLC	Byte 0
0x700+Node-ID (node-guarding)	1	1	Status byte 0xYY

This telegram sent by the SYDFEC contains the status (Operational, Pre-operational) and a toggle bit (bit 7) that must change after each telegram. If the status or toggle bit does not conform with that expected by the NMT master or if no response is given, the NMT master assumes an error in the SYDFEC.

The status byte (0xYY) can contain the following values:

0x05 ← alternating → 0x85 Operational

0x7F ← alternating → 0xFF Pre-operational

The SYDFEC also monitors the operability of the NMT master. The time that may elapse between the node guarding telegrams is termed “lifetime”. If the max. permissible time between two node guarding telegrams is exceeded, the SYDFEC must assume an error of the NMT master and therefore changes to the “pre-operational” state.
In addition, the SYDFEC sends the error telegram “CAN Guard Fail”.
The lifetime is calculated as follows:

Lifetime = guard time x lifetime factor

The guard time is entered in the object dictionary under index 0x100C, and the lifetime factor in the object dictionary under index 0x100D. Both entries can be read and changed by the NMT master by way of a SDO access.

The default values for guard time and the lifetime factor are determined as follows:

Guard time = 500 ms
Lifetime factor = 3
→ lifetime = 1500ms

The NMT master can start the guarding process at any time through the request of the guarding telegram. This also activates life-guarding in the SYDFEC, if the entries in the object directories 0x100C and 0x100D are greater than "ZERO".

The SYDFEC is monitored by means of node guarding and can recognize the failure of an NMT master via life guarding.

13 Store and restore of parameters

The CANopen software offers the option of permanently saving communication objects of the object dictionary in the range from 0x1000 to 0x1FFF in the EEPROM with the help of the **store command**.
The default values can be restored using the restore command.

Caution: If the Node-ID of the SYDFEC was changed, it starts up with the default values.

13.1 Store parameters

The storing process in the EEPROM is initiated with the help of a SDO (upload request protocol) with index 0x1010, sub-index 0x02 and the “SAVE“ data (ASCII code). Depending on how much data are to be saved in the EEPROM, the confirmation of the SDO service can take some time.

The following telegram must be sent in order that changed data are saved.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 ... 7
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index low byte 0x10	Index high byte 0x10	Sub-index 0x02	Data byte 0...3 0x73 61 76 65 "SAVE“

13.2 Restore parameters

The default values can be restored with the help of the restore command (range from 0x1000 to 0x1FFF). To this end, a SDO with index 0x1011, sub-index 0x02 must be sent together with the “LOAD“ data (ASCII code) to the SYDFEC. After a reset or a power-on reset the default values are again active.
The following telegram must be sent in order that changed data are restored.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4 ... 7
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index low byte 0x11	Index high byte 0x10	Sub-index 0x02	Data byte 0...3 0x6C 6F 61 64 “LOAD“

14 Emergency object

(1) If no error is detected after the initialisation, the SYDFEC sends a message (ready telegram) of a data length of 0 and changes to the “No Error” state.

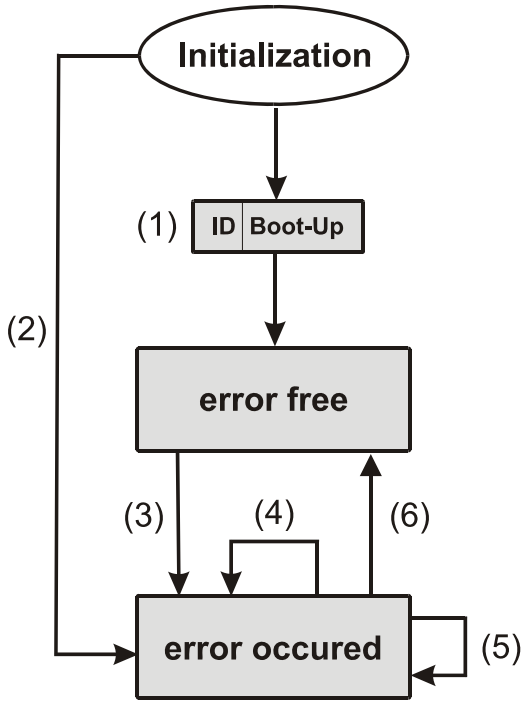
(2) If an error is detected after the initialisation, the SYDFEC changes to the “Error” state. An error message is sent together with the associated error code and error register.

(3) The SYDFEC detects an error, which is indicated by the first three bytes of the error message (error code and error register). An error message with the corresponding error code and error register is sent. The error code is entered in object 0x1003 (pre-defined error field).

(4) When an error was rectified, the associated error code is cleared in the error field of object 0x1003.

(5) A new error occurs on the SYDFEC. The SYDFEC transmits an emergency object with the corresponding error code. The new error code is entered at the top of the array of error messages.

(6) All errors are rectified. The SYDFEC changes over to the “no error“ state and transmits a emergency object with the error code “error reset or no error“.



The emergency telegram is transmitted as high-priority message as soon as an error occurred in the SYDFEC.

COB-ID	Byte 0,1	Byte 2	Byte 3-7
0x080+Node-ID	Error code	Error register	Manufacturer status register (not yet supported)

14.1 Error register

The content of the error register can be read out under index 0x1001 in the object dictionary. The error registry is structured as follows:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Manufacturer-specific error	Reserved	Device profile error	Communication error	Temperature error	Voltage error	Current error	General error

14.2 Error code

A separate error code is assigned to each error that can occur in the SYDFEC and is signalled via the CAN bus. The number of current errors is saved in the object dictionary under index 0x1003 sub-index 0x0. The error code of the errors currently present can be read in the time-related order of their occurrence from sub-index 0x01 on (+ number of errors). The error that occurred last can be found in sub-index 0x01.

14.3 Error codes of the SYDFEC

For the transmission of the error messages of the SYDFEC you can select between Intel format (LSB first) and Motorola format (MSB first). The value changed via the SDO, object 0x5C00 sub-index 0x0, (Motorola format = "0" / Intel format = "1") is saved in a non-volatile memory, but is only active when the voltage supply is switched on the next time.

When supplied, the Motorola format (MSB first) is set as default setting.

Error code	Error registry	Meaning
Byte 0,1	**Byte 2**	
0x0000	0x00	Error reset or no error
0x3101	0x04	Overvoltage warning (> 37V)
0x3102	0x04	Undervoltage warning (< 19V)
0x4200	0x08	Temperature limit value exceeded in the housing (ca. 95°C)
0x4201	0x08	Temperature warning (ca. 85°C)
0x8101	0x10	CAN overflow
0x8102	0x10	CAN guard fail (error of the NMT master)
0x8105	0x10	CAN-Error-Passiv
0xFF01	0x80	Control error (Operational-Mode)
0xFF02	0x80	Valve cable break
0xFF03	0x80	Swivel angle cable break
0xFF04	0x80	Cable break, PT input 1
0xFF05	0x80	Cable break, PT input 2
0xFF06	0x80	Cable break, PT input 3
0xFF07	0x80	Cable break, PT input 4
0xFF08	0x80	Valve error

14.3.1 Error description

Important: The VT-DFPC high-response valve is not provided with an enable input for blocking the function of the valve. In the event of a fault, the system should be brought to a safe state and the VT-DFPC high-response valve de-energised. Any further safety-relevant interventions must be made by the higher-level control (e.g. shutdown of the drive motor, closing of isolator valves, ...).

14.3.1.1 Bus communication error

CAN Overflow:
Messages sent by the higher-level control (PLC) cannot be saved or processed by the SYDFEC, because there are no longer free buffers available.
Possible cause: Messages are sent too frequently within one Sync interval.

CAN Guard Fail:
The NMT master exceeded the set lifetime (chapter 12 “Node Guarding and Life Guarding”).

CAN-Error-Passive:
An error was recognised in the bus communication. When the error threshold is passed, the error telegram “CAN-Error-Passive“ is sent, i.e. in the case of further communication errors, only passive error frames are sent.
Possible cause: Wiring faults, missing terminating resistors, etc.

14.3.1.2 Device-specific errors

Overvoltage warning:
The supply voltage is higher than 37V.

Undervoltage warning:
The supply voltage is less than 19V.

Temperature error:
Temperature limit value of approx. 95°C exceeded in the housing.
CAUTION: Risk of destruction of the electronics!

Temperature warning:
Temperature threshold of approx. 85°C exceeded in the housing.
CAUTION: Shortens the service life of electronic components!

Control error:

Control deviation between command and actual value during closed-loop pressure or SWA control for a period of >1.5s. The control error is only sent in the operational mode.

Possible cause:
- Valve spool jams due to contamination
- Backpressure cannot be built up (minimum pump pressure 8-10 bar)
- Drive motor switched off
- Valve spool does not move as a result of an electronics error

Valve cable break:

The actual valve value is less than or greater than the limit value for cable break

Possible cause:
- Due to incorrect calibration outside the permissible measuring range of the A/D converter
- Valve spool jams due to contamination
- Internal electronics error

SWA sensor cable break:

The actual SWA value is less than or greater than the limit value for cable break

Possible cause:
- Due to incorrect calibration outside the permissible measuring range of the A/D converter
- Defective SWA sensor
- Defective SWA sensor cable
- Internal electronics error

PT cable break:

The actual pressure value of the relevant pressure transducer is less or greater than the limit value, i.e. the value is outside the permissible measuring range of the A/D converter.

Valve error:

Control deviation between valve command value and actual valve value for a time interval >0.5s.

Possible cause:
- Valve spool jams due to contamination
-Internal electronics error

15 Object Dictionary

15.1 Communication Profile Area

Index (hex)	0bject (Symbolic name)	Name	Type	Attrib-ute
1000	VAR	Device Type	Unsigned32	ro
1001	VAR	Error register	Unsigned8	ro
1002	VAR	Manufacturer status register [1)]	Unsigned32	ro
1003	ARRAY	Pre-defined error field	Unsigned32	ro
1004	ARRAY	Number of PDOs supported	Unsigned32	ro
1005	VAR	COB-ID SYNC-message	Unsigned32	rw
1008	VAR	Manufacturer device name [2)]	Visible string	ro
1009	VAR	Manufacturer Hardware version [2)]	Visible string	ro
100A	VAR	Manufacturer Software version [2)]	Visible string	ro
100B	VAR	Node-ID	Unsigned32	ro
100C	VAR	Guard time	Unsigned16	rw
100D	VAR	Life time factor	Unsigned8	rw
100E	VAR	Node Guarding identifier	Unsigned32	rw
100F	VAR	Number of SDOs supported	Unsigned32	ro
1010	ARRAY	Store parameters	Unsigned32	rw
1011	ARRAY	Restore default parameters	Unsigned32	rw
1014	VAR	COB_ID emergency message	Unsigned32	rw
1200	RECORD	Server SDO parameter	SDOPar	ro
1400	RECORD	Receive PDO Commun. Parameter	PDOCommPar	rw
1800	RECORD	Transmit PDO Commun. Parameter	PDOCommPar	rw

[1)] not supported

[2)] segmented transfer

15.2 Manufacturer Specific Profile Area

Index (hex)	Sub-index	Object	Name	Type	Attribute
2000-4FFF			Reserved for other Rexroth Hydraulics applications		
5000	0	VAR	Status byte	Unsigned16	ro
5001	0	VAR	SWA - Actual value	Signed16	ro
5002	0	VAR	p - Actual value	Signed16	ro
5008	0	VAR	Receipt changeover	Unsigned8	ro
5030	0	VAR	Data bytes of receive PDO2	Unsigned32	ro
5036	1	VAR	Command value PDO-Transmission (synchronous/ asynchronous)	Unsigned16	rw
5036	2	VAR	Actual value PDO1-Transmission (active/inactive)	Unsigned16	rw
5038	0	VAR	Control byte	Unsigned16	ro
5039	0	VAR	SWA - Command value	Signed16	ro
503A	0	VAR	p - Command value	Signed16	ro
503B	0	VAR	Controller parameter set currently used	Unsigned16	ro
503D	1	VAR	Valve command value	Unsigned16	ro
503D	2	VAR	Valve actual value	Unsigned16	ro
5100	0	VAR	Power limit	Signed16	rw
5101	0	VAR	SWA - Command value for fast changeover function	Signed 16	rw
5102	0	VAR	p - Command value for fast changeover function	Signed16	rw
5103	0	VAR	Pressure limit for fast changeover function	Signed16	rw
5104	0	VAR	Factor of leakage compensation	Signed16	rw
5104	1	VAR	Start calibration of leakage compensation	Signed16	wo
5104	2	VAR	Status of leakage compensation calibration	Signed16	ro
5200	0	VAR	Type of PT (PT input 1)	Signed16	rw
5200	1	VAR	Measuring range of PT (PT input 1)	Signed16	rw

Index (hex)	Sub-index	Object	Name	Type	Attribute
5200	2	VAR	Balancing tolerance of PT (PT input 1)	Signed16	rw
5200	3	VAR	Offset of PT (PT input 1)	Signed16	ro
5200	4	VAR	Start calibration of PT (PT input 1)	Signed16	wo
5200	5	VAR	Status of calibration of PT (PT input 1)	Signed16	ro
5201	0	VAR	Offset of SWA sensor	Signed16	ro
5201	1	VAR	Start calibration of SWA offset	Signed16	wo
5201	2	VAR	Status of SWA offset calibration	Signed16	ro
5202	0	VAR	Gain of swivel angle sensor	Signed16	ro
5202	1	VAR	Start calibration of SWA gain	Signed16	wo
5202	2	VAR	Status of SWA gain calibration	Signed16	ro
5205	0	VAR	Valve offset (average)	Signed16	ro
5205	1	VAR	Start calibration of valve offset	Signed16	wo
5205	2	VAR	Status of calibration of valve offset	Signed16	ro
5205	3	VAR	Calibration point 1 for valve offset 1 (bar)	Unsigned16	rw
5205	4	VAR	Calibration point 2 for valve offset 2 (bar)	Unsigned16	rw
5205	5	VAR	Calibration point 3 for valve offset 3 (bar)	Unsigned16	rw
5205	6	VAR	Calibration point 4 for valve offset 4 (bar)	Unsigned16	rw
5205	7	VAR	Valve offset at calibration point 1	Signed16	ro
5205	8	VAR	Valve offset at calibration point 2	Signed16	ro
5205	9	VAR	Valve offset at calibration point 3	Signed16	ro
5205	A	VAR	Valve offset at calibration point 4	Signed16	ro
5208	1	VAR	Selection of command value source	Unsigned16	rw
5208	2	VAR	Setting the nominal pressure	Unsigned16	rw
5209	1	VAR	Selection of source of controller parameter set	Unsigned16	rw
5209	2	VAR	Selection of controller parameter set (Win-Ped®)	Unsigned16	rw
5210	0	VAR	SWA - Command value for pre-operational mode DI1: 0 AI1: 0	Signed16	rw
5210	1	VAR	p - Command value for pre-operational mode DI1: 0 AI1: 0	Signed16	rw

Index (hex)	Sub-index	Object	Name	DI1	AI1	Type	Attribute
5210	3	VAR	SWA - Command values for call-up command values	1	0	Unsigned16	rw
5210	4	VAR	p - Command values for call-up command values	1	0	Unsigned16	rw
5210	5	VAR	SWA - Command values for call-up command values	0	1	Signed16	rw
5210	6	VAR	p - Command values for call-up command values	0	1	Unsigned16	rw
5210	7	VAR	SWA - Command values for call-up command values	1	1	Signed16	rw
5210	8	VAR	p - Command values with call-up command values	1	1	Unsigned16	rw
5211	1	VAR	Pressure gradient for positive ramp			Unsigned16	rw
5211	2	VAR	Pressure gradient for negative ramp			Unsigned16	rw
5211	3	VAR	SWA gradient for positive ramp			Unsigned16	rw
5211	4	VAR	SWA gradient for negative ramp			Unsigned16	rw
5222	1	VAR	Type of PT (PT input 2)			Signed16	ro
5222	2	VAR	Measuring range of PT (PT input 2)			Signed16	rw
5222	3	VAR	Balancing tolerance of PT (PT input 2)			Signed16	rw
5222	4	VAR	Offset of PT (PT input 2)			Signed16	ro
5222	5	VAR	Start calibration of PT (PT input 2)			Signed16	wo
5222	6	VAR	Status of PT calibration (PT input 2)			Signed16	ro
5223	1	VAR	Type of PT (PT input 3)			Signed16	rw
5223	2	VAR	Measuring range of PT (PT input 3)			Signed16	rw
5223	3	VAR	Balancing tolerance of PT (PT input 3)			Signed16	rw
5223	4	VAR	Offset of PT (PT input 3)			Signed16	ro
5223	5	VAR	Start of PT calibration (PT input 3)			Signed16	wo
5223	6	VAR	Status of PT calibration (PT input 3)			Signed16	ro
5224	1	VAR	Type of PT (PT input 4)			Signed16	rw
5224	2	VAR	Measuring range of PT (PT input 4)			Signed16	rw

Index (hex)	Sub-index	Object	Name	Type	Attribute
5224	3	VAR	Balancing tolerance of PT (PT input 4)	Signed16	rw
5224	4	VAR	Offset of PT (PT input 4)	Signed16	ro
5224	5	VAR	Start of PT calibration (PT input 4)	Signed16	wo
5224	6	VAR	Status of PT calibration (PT input 4)	Signed16	ro
52FF	0	VAR	Reset of all calibration values	Signed16	wo
5300	0	VAR	Function in master/slave mode	Signed16	rw
5300	1	VAR	Send interval in master/slave mode	Signed16	rw
5310	0	VAR	Deactivate closed-loop swivel angle control	Signed16	wo
540x	0	VAR	Controller parameter 0	Signed16	rw
540x	1	VAR	Controller parameter 1	Signed16	rw
540x	2	VAR	Controller parameter 2	Signed16	rw
540x	3	VAR	Controller parameter 3	Signed16	rw
540x	4	VAR	Controller parameter 4	Signed16	rw
540x	5	VAR	Controller parameter 5	Signed16	rw
540x	6	VAR	Controller parameter 6	Signed16	rw
540x	7	VAR	Controller parameter 7	Signed16	rw
540x	8	VAR	Controller parameter 8	Signed16	rw
540x	9	VAR	Controller parameter 9	Signed16	rw
(x = number of the controller parameter set **[0..F]**, see "16.2.2 Changing controller parameters")					
540z	A	VAR	Controller parameter 10	Signed16	rw
540z	B	VAR	Controller parameter 11	Signed16	rw
540z	C	VAR	Controller parameter 12	Signed16	rw
540z	D	VAR	Controller parameter 13	Signed16	rw
540z	E	VAR	Controller parameter 14	Signed16	rw
540z	F	VAR	Controller parameter 15	Signed16	rw
(z = number of the controller parameter set **[C..F]**, see “16.2.2 Changing controller parameters“)					

Index (hex)	Sub-index	Object	Name	Type	Attribute
5700	1	VAR	Output variable to analog output 1	Unsigned16	rw
5700	2	VAR	Output variable to analog output 2	Unsigned16	rw
5709	1	VAR	Status of digital input DI1	Unsigned16	ro
5709	2	VAR	Status of digital input DI2	Unsigned16	ro
5709	3	VAR	Status of digital input AI1	Unsigned16	ro
5710	0	VAR	Current device temperature in the housing	Signed16	ro
5B00	0	VAR	Baud rate (10 ... 1000 kbits/s)	Unsigned16	rw
5C00	0	VAR	Error code format (Intel/Motorola)	Unsigned16	rw

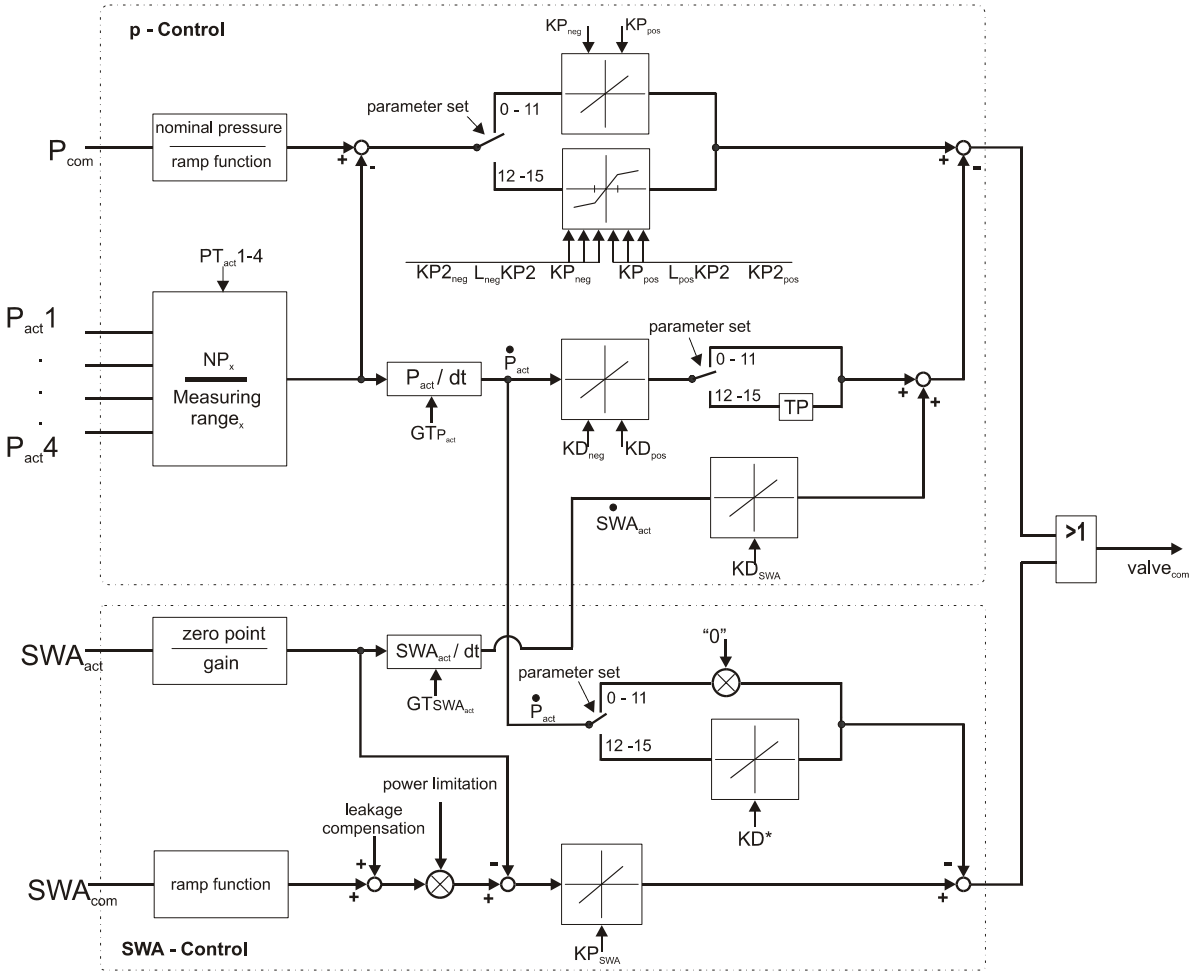
15.3 Standardised Device Profile Area

Because SYDFEC cannot be assigned to a device profile, no entries can be found in the object dictionary under index 0x6000 to 0x9FFF.

16 Closed-loop control

The oil volume between the actuator and the pump has a decisive influence on the control dynamics of the SYDFEC. 16 controller parameter sets (0 … 15) are available for adjusting the controller to the connected oil volume.

16.1 Closed-loop control structure



16.2 Controller parameter sets

As a standard, the controller parameters are rated for various connected oil volumes. The following controller settings in the individual controller parameter sets are intended as a guideline and can be changed individually by the user at any time. However, we recommend that only controller parameter sets 12 to 15 be overwritten with user-specific. In this way, it is possible to fall back on the default settings of controller parameter sets 0 to 11.

Controller parameter set	0	1	2	3	4	5	6	7
Oil volume (l)	Universal	0	1	2.5	5	7.5	10	12.5

Controller parameter set	8	9	10	11	12	13	14	15
Oil volume (l)	15	20	25	30	40	10	1	Universal

It is possible to switch between the individual controller parameter sets during operation with the help of a PDO (control byte, bit 4 ... 7). The values of the controller parameter of the currently selected controller parameter set are active.

16.2.1 Controller parameters

Each controller parameter set contains the following controller parameters that are used for adjustment to the application at hand.

Controller parameter no. (dec.)	**Description of the controller parameter**	**Abbreviation**
0	P-gain of pressure controller (positive)	$KP_{pos.}$
1	P-gain of pressure controller (negative)	$KP_{neg.}$
2	D-component of pressure controller (positive)	$KD_{pos.}$
3	D-component of pressure controller (negative)	$KD_{neg.}$
4	SWA-derivation feedback of pressure controller	KD_{SWA}
5	Gate time of Pressure actual value	GTp_{act}
6	Gate time of SWA actual value	$GTswa_{act}$
7	Selection of PT input [PT1-PT4]	
8	P-gain of SWA controller	KP_{SWA}
9	Pilot control factor for slave	

The following additional controller parameters are available in controller parameter sets 12-15.

Controller parameter no. (dec.)	Description of the controller parameter	Abbreviation
10	DT1 pressure feedback of SWA controller	KD*
11	positive pressure differential threshold [bar]	LposKP2
12	P-gain above positive threshold	$KP2_{pos}$
13	negative pressure differential threshold [bar]	LnegKP2
14	P-gain under negative threshold	$KP2_{neg}$
15	LP filter time of pressure controller (D-component)	TP

16.2.2 Changing controller parameters

The controller parameters can be changed by means of SDO to suit the individual application at hand. The following tables show the adjustment ranges of the controller parameters.

The changes made are immediately effective and saved in a non-volatile memory.

Object 0x540x (x = number of the controller parameter set [0 ... F])			
Sub-index (hex)	**Controller parameter no. (dec.)**	**Range of values**	
		decimal	**hex**
0x00	0	1 ... 1000	0x0001 ... 0x03E8
0x01	1	1 ... 1000	0x0001 ... 0x03E8
0x02	2	0 ... 30000	0x0000 ... 0x7530
0x03	3	0 ... 30000	0x0000 ... 0x7530
0x04	4	0 ... 2000	0x0000 ... 0x07D0
0x05	5	0 ... 120	0x0000 ... 0x0078
0x06	6	0 ... 120	0x0000 ... 0x0078
0x07	7	1 ... 4	0x0001 ... 0x0004
0x08	8	1 ... 1000	0x0001 ... 0x03E8
0x09	9	0 ... 16383	0x0000 ... 0x3FFF

Object 0x540z (z = number of the controller parameter set [C ... F])			
Sub-index (hex)	**Controller parameter no. (dec.)**	**Range of values**	
		decimal	**hex**
0x0A	10	0 ... 15000	0x0000 ... 0x3A98
0x0B	11	0 ... 450	0x0000 ... 0x01C2
0x0C	12	1 ... 1000	0x0001 ... 0x03E8
0x0D	13	0 ... 450	0x0000 ... 0x01C2
0x0E	14	1 ... 1000	0x0001 ... 0x03E8
0x0F	15	0 ... 8	0x0000 ... 0x0008

17 Application-specific settings

17.1 Setting the nominal pressure

By setting the nominal pressure the user determines the range of values of the pressure command value and the actual pressure value, i.e. when the maximum pressure command value (CAN bus 0x3FFF, analog 10V) is fed forward, this maximum pressure is set.

The nominal pressure of 1 bar to 450 bar (0x0001 ... 0x01C2) is set by writing (download request) to object 0x5208 sub-index 0x02. A changed value is saved in a non-volatile memory and is active immediately. The factory default setting is 315 bar (0x013B).

17.2 Command value source

The command value source can be selected by writing (download request) to the object 0x5208 sub-index 0x01. A changed value is immediately effective and saved in a non-volatile memory.

The following table shows the various control options for command values:

Value	Meaning
0	Command values via CAN bus
1	Command values via the PC program "Win-Ped®"
2	Analog command value preselection
3	Call-up command values DI1/AI1 (object 0x5210)

17.3 Input selection of controller parameter sets

The type of input of the controller parameter set can be selected by writing (download request) to object 0x5209 sub-index 0x01. A changed value is immediately effective and saved in a non-volatile memory.

The following table shows the various control options for the input of controller parameter sets.

Value	Meaning
0	Controller parameter set input via CAN bus
1	Controller parameter set input via the PC program "Win-Ped®"
2	Controller parameter set input via switching inputs (DI1/DI2)
3	Controller parameter set input via switching inputs (DI1/AI1)

17.4 Setting the pressure transducers (PT)

For some applications it is advantageous to switch between several pressure transducers. The SYDFEC offers the possibility of connecting up to 4 pressure transducers. The relevant PT input is selected by means of a controller parameter in each of the 16 controller parameter sets. The active input is always the PT input of the currently selected controller parameter set.

For the setting of the pressure transducers, we recommend the following order:

1. Selection of the physical PT input
2. Selection of the type of PT (e.g. voltage, current)
3. Setting of the PTs measuring range
4. Selection of the PT input in the controller parameter sets used (chapter 16.2.1 “Controller parameters”)

17.4.1 PT inputs

The following assignment to the physical inputs is valid.

PT input	Connection	Pin
1	Central plug 11+PE	10 / 11
2	M12 socket	4 / 3
3	Central plug 11+PE	7 / 4
4	Central plug 11+PE	5 / 4

17.4.2 Types of Pressure transducer

PT input 1 (central plug pin 10/11)

It is possible to connect various types of pressure transducers to PT input 1 of the SYDFEC. If the type of pressure transducer is changed, some settings must be adjusted. All of these settings can be made with the help of SDOs via the CAN bus.
Writing (download request) to object 0x5200 sub-index 0x0 determines the type of pressure transducer for PT input 1.

Value	Pressure transducer type	Connection	Pin
0x0000	Pressure transducer HM16 (0.5 ... 5 V)	M12 socket	4/3
0x0001	0.5 ... 5 V	Central plug 11+PE	10/11
0x0002	1 ... 10 V		
0x0003	4 ... 20 mA		
0x0004	0 ... 5 V		
0x0005	0 ... 10 V		
0x0006	0 ... 20 mA		
0x0007	0.1 ... 10 V		

Caution: The changes must be made in the pre-operational mode while the drive motor is switched off!

To take over the change of the pressure transducer, a power-on reset is must be carried out on the SYDFEC.

PT input 2 (M12 socket pin 4/3)

To PT input 2 of the SYDFEC, a pressure transducer must be connected that has a signal voltage of (0.5 ... 5 V).

Caution: For compatibility reasons, when PT input 1 is used with type “0”, the signal input of the M12 socket must be used, which means that this corresponds to PT input 2.

PT input 1 - type "0" = PT input 2

It is recommended that when the signal input at the M12 socket is utilised, PT input 2 be used in the controller parameter sets in order to ensure clear error diagnosis.

PT input 3 (central plug pin 7/4)

PT input 4 (central plug pin 5/4)

Pressure transducers having a signal voltage of (0 ... 10)V or (1 ... 10)V or (0.1 ... 10)V can be connected to PT inputs 3 or 4 of the SYDFEC.

Value	Pressure transducer type
0x0002	1 ... 10 V
0x0005	0 ... 10 V
0x0007	0.1 ... 10 V

17.4.3 Measuring range of the pressure transducer

The measuring range of the pressure transducer for the relevant PT input can be adjusted by way of the following entries in the object dictionary.

PT input	Index	Sub-index
1	0x5200	0x01
2	0x5222	0x02
3	0x5223	0x02
4	0x5224	0x02

The range of values can be adjusted from 0x0001 to 0x01C2 (1 … 450), which corresponds to a measuring range from 1 to 450 bar.

Caution: The changes must be made in the pre-operational mode while the drive motor is switched off!

Example:

A pressure transducer with a measuring range of 250 bar (0x00FA) is connected to PT input 1. The higher-level control must send the following telegram.

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4,5
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index (LSB) 0x00	Index (MSB) 0x52	Sub-index 0x01	Measuring range 0xFA00

18 Calibration of the SYDFEC

Thanks to the calibration functions of the SYDFEC, uniform system characteristics can be achieved with regular calibration that compensates for long-term drifts. For the calibration of the SYDFEC we recommend the following order:

1. Calibration of the pressure transducer
2. Calibration of the valve
3. Calibration of swivel angle sensor offset
4. Calibration of the swivel angle sensor gain
5. Calibration of leakage compensation

Caution: For the calibration of the SYDFEC the hydraulic oil must have reached its operating temperature.

18.1 Calibration of the pressure transducer

If the zero point signal of the pressure transducer deviates from the ideal value for 0 bar, it can be compensated within the balancing tolerance through calibration of the pressure transducer.

Determination of the maximum balancing tolerance

The maximum balancing tolerance of the pressure transducer for the relevant PT input can be adjusted by way of the following entries in the object dictionary:

PT input	Index	Sub-index
1	0x5200	0x02
2	0x5222	0x03
3	0x5223	0x03
4	0x5224	0x03

The range of values is 0x0000 to 0x03E8 (0 ... 1000), which corresponds to a maximum balancing tolerance of 0% to 10% (e.g. 0x01F4 = 5%).

Caution: A calibration error occurs, if the offset of the pressure transducer exceeds the preset, maximum balancing tolerance. In this case, the offset of the pressure transducer is set to the default value of "0".

Starting of the calibration process

The calibration process of the pressure transducer can be started for the relevant PT input by way of the following entries in the object dictionary.

PT input	Index	Sub-index
1	0x5200	0x04
2	0x5222	0x05
3	0x5223	0x05
4	0x5224	0x05

Caution: Before starting calibration, make sure that the drive motor of the pump is switched off and the system is depressurised, i.e. this state is calibrated as 0 bar.

The calibration process takes about 1 second.

Status of the calibration process

The status of the calibration process of the pressure transducer for the relevant PT input can be read via the following entries in the object dictionary.

PT input	Index	Sub-index
1	0x5200	0x05
2	0x5222	0x06
3	0x5223	0x06
4	0x5224	0x06

The meaning of the calibration process status can be found in the table below.

Value	Status of calibration
0x0000	Calibration completed and ok
0x0001	Calibration running
0x0002	Other calibration process already started
0x1000	Calibration error (Offset of the PT outside preset balancing tolerance)

Offset of the pressure transducer

After successful calibration, the offset (corrective value) of the pressure transducer for the relevant PT input can be read via the following entries in the object dictionary.

PT input	Index	Sub-index
1	0x5200	0x03
2	0x5222	0x04
3	0x5223	0x04
4	0x5224	0x04

The deviation of the pressure transducer from the actual value for 0 bar is indicated in percent (0 ... 0x3E8 = 0 ... 10%) referred to the maximum output signal.

18.2 Calibration of the valve

The non-linear valve characteristic curve is corrected through calibration of the valve (valve characteristic curve correction).

Required preconditions:

- SYDFEC in the operational mode
- Pump drive motor ON
- All actuators disconnected from the pump

Supporting points for valve calibration

4 given supporting points are used for the calibration of the valve. The supporting points for calibration must be distributed over the required working range in ascending order.

Index	Sub-index	Name	Range of values	
			decimal	hex
5205	3	Valve offset calibration point 1 (bar)	5 ... 285	0x0005 ... 0x011D
5205	4	Valve offset calibration point 2 (bar)	15 ... 295	0x000F ... 0x0127
5205	5	Valve offset calibration point 3 (bar)	25 ... 305	0x0019 ... 0x0131
5205	6	Valve offset calibration point 4 (bar)	35 ... 315	0x0023 ... 0x013B

Starting the calibration process

The calibration is started by writing (download request) to object 0x5205 sub-index 0x01. During the calibration process, the pump operates under closed-loop pressure control using the given pressure command values. The calibration process takes about 60 seconds.

Caution: During the calibration process, the SYDFEC uses the given pressure command values, i.e. command values provided by the PLC are ineffective. If a critical situation arises, the calibration process can be stopped at any time by setting the bit 0 (“stop calibration“) in the control byte of the PDO. The command values transmitted by the PLC in this PDO become valid.

Status of the calibration process

Reading out (upload request) of 0x5205 sub-index 0x02 shows the calibration status. The meaning of the calibration process status can be found in the table below.

Value	Status of calibration
0x0000	Calibration completed and ok
0x0001	Calibration running
0x0002	Other calibration process already started
0x0004	Calibration interrupted by user
0x0008	Supporting points not in ascending order
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (offset of the valve outside permissible balancing tolerance ±10%)
0x2000	Calibration error (actual pressure value fluctuating)
0x4000	Calibration error (control deviation “p_{Diff}“ >15 bar)

Offset of valve calibration

After successful calibration, the offset (corrective value) of the valve can be read for the relevant supporting point via the following entries in the object dictionary.

Index	Sub-index	Name
5205	0	Valve offset (average)
5205	7	Valve offset at calibration point 1
5205	8	Valve offset at calibration point 2
5205	9	Valve offset at calibration point 3
5205	A	Valve offset at calibration point 4

The range of values is 0xFCCD to 0x0333 (-819 ... +819), which corresponds to an offset of –10% to +10%.

In the case of a calibration error, all the offsets of the valve are set to a default value of 0.

18.3 Calibration of the swivel angle sensor

The swivel angle sensor is calibrated in two steps, which must be carried out in the following order:

- Calibration of swivel angle offset
- Calibration of swivel angle gain

18.3.1 Calibration of the swivel angle sensor offset

Required preconditions:

- SYDFEC in the operational mode
- Pump drive motor ON
- All actuators disconnected from the pump, there is no oil flow to and from the tank

Caution: The calibration of the swivel angle sensor offset is not possible in the **regenerative mode**!

Starting the calibration process

The calibration is started by writing (download request) to object 0x5201 sub-index 0x01. During the calibration process, the pump operates under closed-loop pressure control with a fixed internal pressure command value of 20 bar. The calibration process takes about 20 seconds.

Caution: During the calibration process, the SYDFEC uses internal command values, i.e. command values provided by the PLC are ineffective. If a critical situation arises, the calibration process can be stopped at any time by setting the bit 0 (“stop calibration“) in the control byte of the PDO. The command values transmitted by the PLC in this PDO become valid.

Status of the calibration process

Reading out (upload request) of object 0x5201 sub-index 0x02 shows the calibration status. The meaning of the calibration process status can be found in the table below.

Value	Status of calibration
0x0000	Calibration completed and ok
0x0001	Calibration running
0x0002	Other calibration process already started
0x0004	Calibration interrupted by user
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (offset of the SWA sensor outside permissible balancing tolerance ±10%)
0x2000	Calibration error (actual swivel angle value fluctuating)
0x4000	Calibration error (actual pressure value outside tolerance of 12 bar ... 28 bar)

Offset of swivel angle sensor

After successful calibration, reading out (upload request) of object 0x5201 sub-index 0x0 shows the offset (corrective value) of the swivel angle sensor.

The range of values is 0xF99A to 0x0666 (-1638 ... +1638), which corresponds to an offset of –10% to +10%. In the case of a calibration error, the offset of the swivel angle sensor is set to the default value of 0.

18.3.2 Calibration of gain of the swivel angle sensor

Required preconditions:

- SYDFEC in the operational mode
- Pump drive motor ON
- Direct full flow via actuators (e.g. control hydraulic motor) or set pressure relief valve to 20 to 80 bar.

Starting the calibration process

The calibration is started by writing (download request) to object 0x5202 sub-index 0x01. During the calibration process, the pump operates under closed-loop pressure control with a fixed internal pressure command value of 100 bar. The calibration process takes about 20 seconds.

Caution: During the calibration process, the SYDFEC uses internal command values, i.e. command values provided by the PLC are ineffective. If a critical situation arises, the calibration process can be stopped at any time by setting the bit 0 (“stop calibration“) in the control byte of the PDO. The command values transmitted by the PLC in this PDO become valid.

Status of the calibration process

Reading out (upload request) of 0x5202 sub-index 0x02 shows the calibration status. The meaning of the calibration process status can be found in the table overleaf.

Value	Status of calibration
0x0000	Calibration completed and ok
0x0001	Calibration running
0x0002	Other calibration process already started
0x0004	Calibration interrupted by user
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (gain of the SWA sensor outside permissible balancing tolerance of ±10%)
0x2000	Calibration error (actual swivel angle value fluctuating)
0x4000	Calibration error (actual pressure value has exceeded 80 bar)
0x8000	Calibration error (swivel angle cable break)

Gain of swivel angle sensor

After successful calibration, reading out (upload request) of object 0x5202 sub-index 0x0 shows the gain (corrective value) of the swivel angle sensor.

The range of values is 0x0000 to 0x3FFF (0 ... 16383), which corresponds to a factor of 0 to 2 (→ 0x2000 = factor 1). In the event of a calibration error, the gain of the swivel angle sensor is set to the default value of 1.

18.4 Leakage compensation

As an additional feature, the closed swivel angle control loop offers the possibility of compensating for pump leakage. For this, a pressure-related offset, which corresponds to the leakage, is added to the swivel angle command value. Automatic leakage compensation is enabled via the control byte “activate leakage compensation” in PDO1 or PDO4 (chapter 10.4.1.1 "Meaning of the control byte").

Important: Leakage calibration in **regenerative operation** is only possible with software version “S5.15A6.11C1.52“ (Index 0x100A, Subindex 0x00) or higher!

18.4.1 Manual adjustment of leakage compensation

The factor of leakage compensation can be adjusted by writing (download request) to object 0x5104 sub-index 0x0. A changed value is immediately effective and saved in a non-volatile memory. The range of values is 0x0000 to 0x1333 (0 ... +4915), which corresponds to a leakage compensation factor of 0% to 30% at 315 bar (actual pressure value).

18.4.2 Calibration of leakage compensation

Required preconditions:

- SYDFEC in the operational mode
- Pump drive motor ON
- All actuators disconnected from the pump
- Swivel angle offset calibrated

Starting the calibration process

2 pressure supporting points are used for calibrating leakage. Writing (download request) to object 0x5104 subindex 0x01 starts the calibration. The value to be transmitted for the calibration process is the pressure command value 0x0000 ... 0x3FFF = 0 bar ... xx bar (according to nominal pressure).

For the calibration, an internal pressure command value of 20 bar is used first, then the transmitted pressure command value. During the calibration process, the pump operates in the pressure control mode using the selected pressure command value. The calibration process takes about 60 seconds.

Note: The pressure command value must be greater than 50 bar. It is recommended that a pressure be selected from the upper end of the working range, which is of particular significance for leakage compensation.

Caution: During the calibration process, the SYDFEC uses the given pressure command values, i.e. command values provided by the PLC are ineffective. If a critical situation arises, the calibration process can be stopped at any time by setting the bit 0 (“stop calibration“) in the control byte of the PDO. The command values transmitted by the PLC in this PDO become valid.

Status of the calibration process

Reading out (upload request) of 0x5104 sub-index 0x02 shows the calibration status. The meaning of the calibration process status can be found in the table overleaf.

Value	Status of calibration
0x0000	Calibration completed and ok
0x0001	Calibration running
0x0002	Other calibration process already started
0x0004	Calibration interrupted by user
0x0010	Calibration error (slave in active master/slave operation)
0x1000	Calibration error (value of leakage compensation outside permissible balancing tolerance of +30%)
0x2000	Calibration error (actual swivel angle value fluctuating)
0x4000	Calibration error (actual pressure value < 50 bar or control deviation “p_{Diff}“ > 10 bar)

Factor of leakage compensation

After successful calibration, reading out (upload request) of object 0x5104 sub-index 0x0 shows the factor of leakage compensation at 315 bar (actual pressure value).

In the event of a calibration error, the factor of leakage compensation is set to a default value of 9% at 315 bar (actual pressure value).

In the event of a calibration error, the factor of leakage compensation is set to a default value of 9% at 315 bar (actual pressure value).

18.5 Resetting of calibration values

Writing (download request) of “0x5555” to object 0x52FF sub-index 0x0 resets the calibration values to the default values.

Index	Sub-index	Name	Default value
5104	0	Factor of leakage compensation	0x05C2
5200	3	Offset of pressure transducer (PT input 1)	0
5201	0	Offset of swivel angle sensor	0
5202	0	Gain of swivel angle sensor	0x2000 = 1
5205	0	Valve offset (average)	0
5205	7	Valve offset at calibration point 1	0
5205	8	Valve offset at calibration point 2	0
5205	9	Valve offset at calibration point 3	0
5205	A	Valve offset at calibration point 4	0
5222	4	Offset of pressure transducer (PT input 2)	0
5223	4	Offset of pressure transducer (PT input 3)	0
5224	4	Offset of pressure transducer (PT input 4)	0

19 Description of special functions

19.1 Dynamic changeover function

This special function was created in particular for plastics injection molding machines in order to ensure, for example, fast changeover to pack-and-hold pressure. Here, it is ensured that changing over to command values that are saved for pressure and swivel angle takes place not later than 0.75 ms after triggering of an event.

Possible trigger:

a) Pressure-related

The SYDFEC compares the current actual pressure value with the set pressure threshold. As soon as the threshold value is exceeded, the SYDFEC activates the saved command values for pressure and swivel angle.

The pressure threshold can be set via object 0x5103 sub-index 0x0 (0x0000 ... 0x3FFF = 0 bar ... 315 bar). The factory default setting is 315 bar (0x3FFF).

b) Triggering via PDO2 message

Here, triggering takes place via the PDO2 message. As soon as the fast, event-controlled PDO2 message is received, the SYDFEC activates the saved command values for pressure and swivel angle.

See chapter 19.1.1 "Dynamic changeover function by means of receive PDO2“ for more details.

After triggering of the dynamic changeover function, the following reactions are executed after 0.75 ms at the latest:

- Changeover to saved command values
- Reply by the SYDFEC to the PLC by means of PDO2 message (changeover acknowledgement)

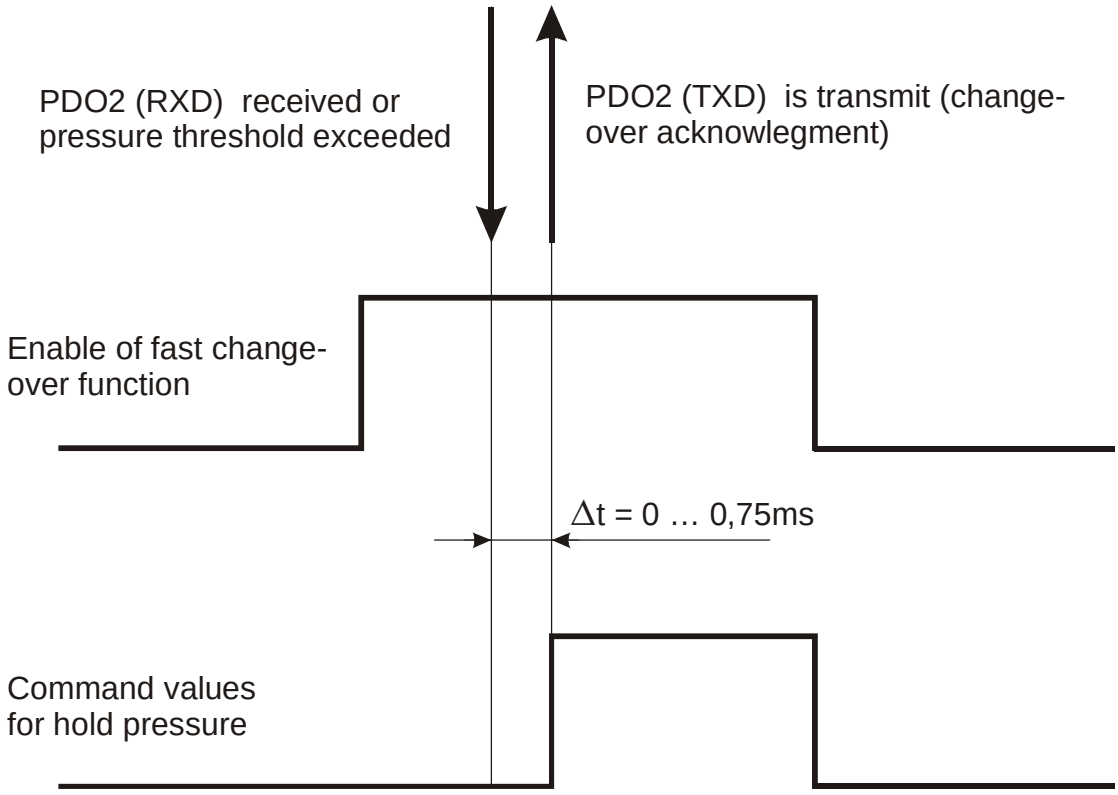
Pre-assignment of saved command values

The saved command values are pre-assigned using the objects 0x5101 and 0x5102. The factory default settings for pressure and swivel angle are 0 bar and 0%, respectively.

Enable

The dynamic changeover is enabled via the control byte “enable of Dynamic Changeover function” in PDO1 or PDO4 (chapter 10.4.1.1 "Meaning of the control byte“). The saved command values are active until the enable is reset in the control byte.

Caution: When the synchronous command value PDO1 (receive PDO1) is used, the transmitted command values are only taken over with the receipt of the subsequent synchronisation telegram (SYNC).



19.1.1 Dynamic changeover function by means of receive PDO2

To activate the fast changeover function, a CAN station can transmit an event-controlled PDO message to the SYDFEC (e.g. PDO message from a position transducer). As soon as the fast, event-controlled PDO2 message is received, the SYDFEC activates the command values saved for pressure and swivel angle.

COB-ID	RTR	DLC	Byte 0-3
0x300+Node-ID (PDO 2 RXD)	0	4	Data byte 0 ... 3 (not yet evaluated)

The COB-ID can be configured through the bus master using the following SDO access. With the help of the store parameter command it is possible to save the dynamic identifier assignment in the EEPROM (see chapter 13.1 "Store parameters“).

COB-ID	Byte 0	Byte 1,2	Byte 3	Byte 4,5	Byte 6	Byte 7
0x600+Node-ID (SDO 1 RXD)	0x22	0x1401	0x01	COB-ID	0x00	0x00 PDO2 active 0x80 PDO2 inactive

19.1.2 Confirmation of changeover by means of transmit PDO2

The following PDO message is sent in reply to a received PDO2 or when the set pressure threshold has been exceeded.

COB-ID	RTR	DLC	Byte 0
0x280+Node-ID (PDO 2 TXD)	0	1	Changeover confirmation

Changeover confirmation: Bit 0=1 PDO2 message received and changeover function active

Bit 1=1 Pressure-related changeover

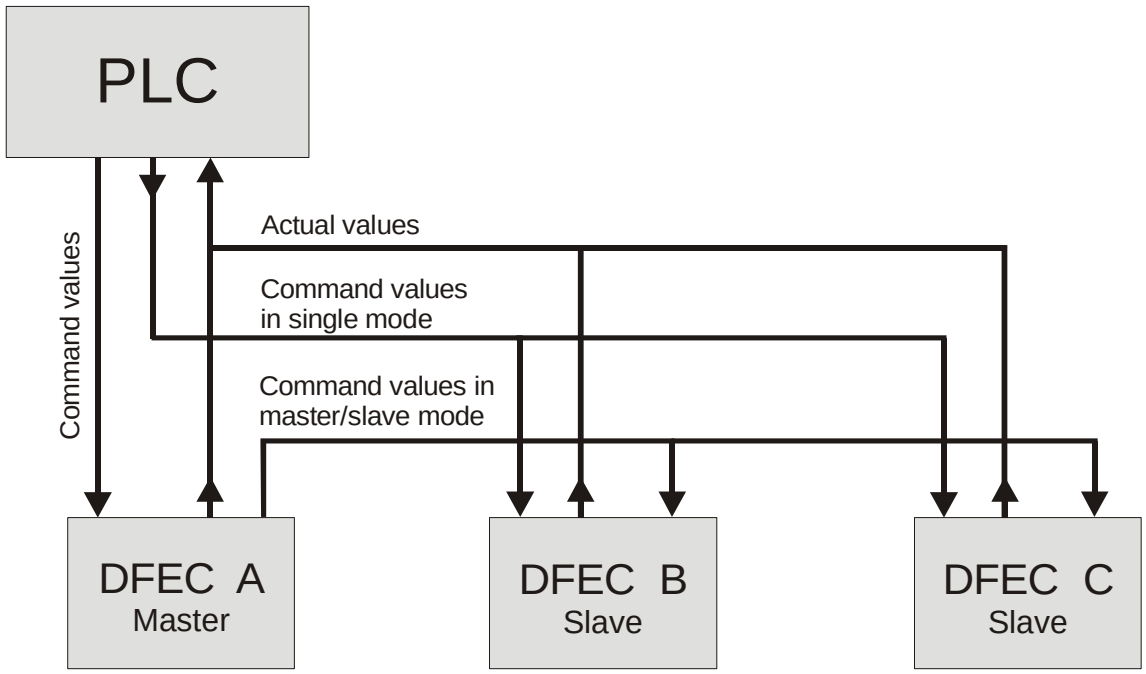
Bit 2=1 PDO2 message received, but enable not granted for fast changeover function

19.2 Master/slave mode

In the following, the term "master“ refers to the SYDFEC CAN station that assumes closed-loop controlling of hydraulically interconnected control pumps in the master/slave circuit.

19.2.1 Configuration of master/slave mode

In the single mode, all SYDFECs receive the command values from the PLC. In the master/slave mode, the master receives the command values from the PLC and generates the command values for the slaves.



Before the master/slave mode can be utilised, the individual SYDFECs must have been configured as master or slave. We recommend the following procedure for configuring the master/slave operating mode:

1. General selection of each SYDFEC as master or slave
2. Determination of COB-ID
   - Transmit PDO3 of the master
   - Receive PDO3 of the master
3. Send interval of the master

Function in master/slave mode

Writing (download request) to object 0x5300 sub-index 0x0 determines the function in the master/slave operating mode.

Value	Function in master/slave mode
0x0000	Master (predefined)
0x0001	Slave

The function in the master/slave operating mode is shown in the status byte (bit1) of the actual value PDO1. Bit2 of the status byte indicates whether the SYDFEC operates in the master/slave mode.

Determination of the COB-ID for transmit/receive PDO3

For the communication between the master and the slave, it is necessary to configure the COB-IDs to receive PDO3 for the slave and to transmit PDO3 for the master. Transmit PDO3 is used to transmit command values from the master to the slaves. Receive PDO3 is used to receive command values. The COB-IDs for receive PDO3 and transmit PDO3 must be identical.

The COB-ID can be configured by means of an SDO access to the following indices under sub-index 0x01 of the object dictionary and saved in the EEPROM using the store parameter command (13.1 "Store parameters").

COB-ID for transmit PDO3 (master)

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4,5	Byte 6,7
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index (LSB) 0x02	Index (MSB) 0x18	Sub-index 0x01	COB-ID 0xXXXX	0x0000

COB-ID for receive PDO3 (slave)

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4,5	Byte 6,7
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index (LSB) 0x02	Index (MSB) 0x14	Sub-index 0x01	COB-ID 0xXXXX	0x0000

Note: It is recommended that a PDO message with high priority be used for the communication between the master and the slave (e.g. COB-ID 0x181). This ensures that in the case of great bus loads the command values for the slave are reliably transmitted at the set send interval.

Send interval

The interval for sending command values from the master to the slave can be adjusted using object 0x5300 sub-index 0x01 with an interval time of 0.75 ms. The factory default setting is 4 (0x04), which corresponds to an interval time of 3 ms. Interval times from 1.5 ... 75 ms are possible (0x02 ... 0x64).

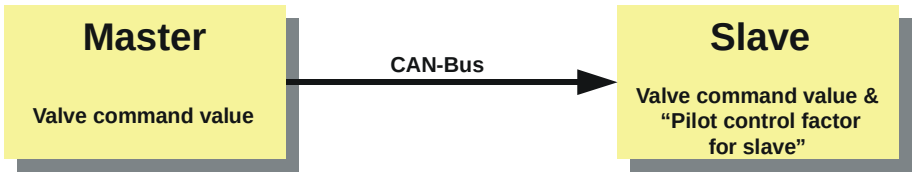
Factor of slave valve command value

In order to achieve that a SYDFEC system operates approximately in synchronism, it is possible to significantly reduce the swivel angle difference between the master and the slave by means of the controller parameter in dynamic applications.

In the master/slave mode, the master sends the swivel angle command value to the slave. The slave offers the possibility of compensating for the reply time from the master. Object 0x540x sub-index 0x09 can be used for setting the factor of the pilot control signal (x = number of the controller parameter set [0 ... F]).

The values 0x0000 to 0x3FFF correspond to a factor of 0 to 1.

pilot control signal = Master valve comm. value ∗ factor



Example:

Single mode

Figure 1 shows three SYDFECs in the single mode. The SYDFECs operate electrically and hydraulically as single pumps.

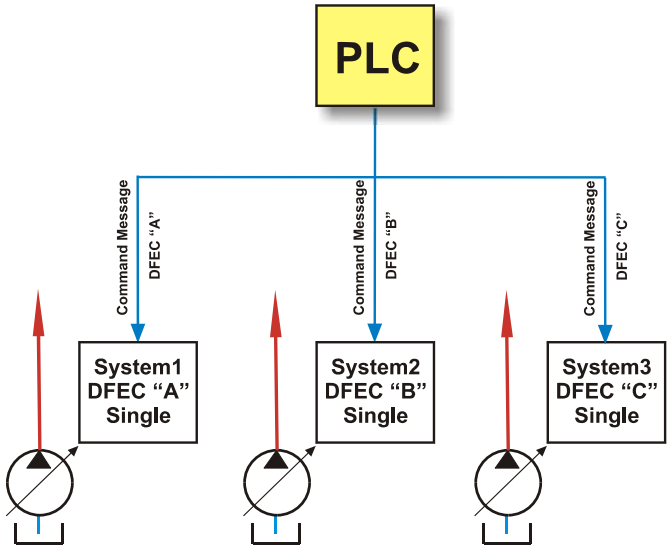


Figure 1

Master/slave operating mode

In Figure 2, DFEC "A" and DFEC "B" operate as master or slave in the hydraulically interconnected System 1. By setting the enable of master/slave operation in the control byte of the command value PDO, DFEC "C" can be dynamically connected to or disconnected from the hydraulic system 1.

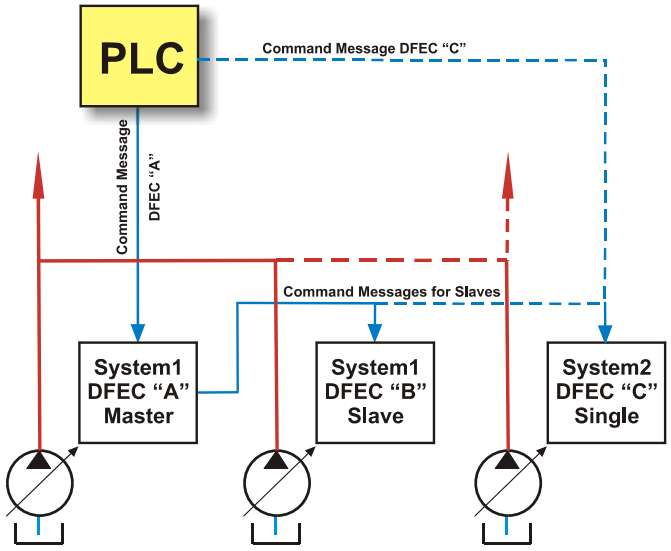


Figure 2

19.2.2 Activation of the master/slave mode

The enable for the master/slave mode is given in the control byte of command value PDO1 or PDO4 and must be executed in the following order:

1. The PLC grants the master the enable for sending command values to the slave
2. The PLC grants the slave the enable for receiving command values from the master

The status byte (bit2) of the actual value PDO1 indicates whether the SYDFEC operates in the master/slave mode.

Note: Only when the enable for master/slave operation is granted in the control byte will the function “master” or “slave” become active. Until that time, the SYDFECs operate as single pumps. In this way, it is possible to connect and disconnect control pumps hydraulically in real time.

Example:

Master/Slave - Mode	Pump 1	Pump 2	Remark
inactive	Single pump	Single pump	Hydraulically disconnected
active	Master	Slave	Hydraulically connected

19.2.3 Reduction in the bus load

In the master/slave mode, adjustments may be required to utilize the bus in an optimum manner and to achieve the required response times. The system designer has the following possibilities of effectively utilizing the bus band width.

a) Use of several SYNC messages
b) Sending of actual value PDOs after the nth Sync message
c) Deactivation of actual value PDOs for the slave pumps

a) Use of several SYNC messages

Through the use of several SYNC messages, the communication between the PLC and the SYDFEC pumps can be flexibly adjusted to suit the task at hand. The COB-ID for the SYNC message is changed via the SDO, object 0x1005 subindex 0x00.

COB-ID	Byte 0	Byte 1, 2	Byte 3	Byte 4, 5	Byte 6	Byte 7
0x600+Node-ID (SDO 1 RXD)	0x22	0x1005	0x00	SYNC COB-ID	0x00	0x80

The COB-ID for the SYNC message can be saved in the EEPROM by means of the store command (chapter 9.1 "Store parameters“).

Important: When command values are transmitted from the PLC to the SYDFEC via a synchronous PDO, the transmitted command values only become valid upon the receipt of the subsequent synchronisation telegram with the corresponding SYNC-ID (object 0x1005 subindex 0x00) .

b) Sending actual value PDOs after the nth Sync message

The time characteristics can be individually adjusted to the individual tasks of the SYDFECs. With the help of the SDO, object 0x1800 subindex 0x02, the system designer can determine, whether the actual value PDOs of the slave pumps are to be transmitted upon each receipt of the SYNC message or only every nth time (1...239).

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4,5
0x600+Node-ID (SDO 1 RXD)	Control word 0x22	Index (LSB) 0x00	Index (MSB) 0x18	Sub-index 0x02	nth SYNC message (1...239)

With the help of the store command, the type of transmission can be saved in the EEPROM (chapter 9.1 "Store parameters“).

c) Deactivation of actual value PDOs for slave pumps

Another possibility of reducing the bus load is to deactivate the send PDO1 (synchronous actual value PDO1) for the slave pumps.

The send PDO1 (synchronous actual value PDO1) can be activated or deactivated via the SDO, object 0x1800 subindex 0x01 (byte 7).

COB-ID	Byte 0	Byte 1,2	Byte 3	Byte 4,5	Byte 6	Byte 7
0x600+Node-ID (SDO 1 RXD)	0x22	0x1800	0x01	COB-ID	0x00	0x00 PDO1 active 0x80 PDO1 inactive

The change must be saved in the EEPROM by means of the store command (chapter 9.1 "Store parameters“).

19.3 Power limitation

To protect the drive motor from overloading, the max. power consumption of the pump can be limited.

The value for the power limitation can be changed via object 0x5100 sub-index 0x0. The range of values is 0x0000 to 0x3FFF, which corresponds to a power limitation of 0% to 100%. A changed value is immediately effective and saved in a non-volatile memory.
The default value entered is 0x3FFF (100% → no power limitation).

Example:

Calculation of the rated power of the pump (size 100):

Motor power	P_M = 30 kW
Nominal speed	n = 1500 min^{-1}
Pump nominal size	V_G = 100 cm^3
System pressure	p = 315 bar
Efficiency	η_{mh} = 1 (theoretical value)

$$P_{100\%} = \frac{V_G \cdot n \cdot p_{\max}}{\eta_{mh}} = \frac{100cm^3 \cdot 1500\frac{1}{\min} \cdot 315bar}{1} = \frac{100cm^3 \cdot 1500\frac{1}{60s} \cdot 31{,}5\frac{J}{cm^3}}{1} = 78750\frac{J}{s}$$

$$P_{100\%} = 78{,}75kW$$

or in simplified terms:

$$P_{100\%} = \frac{V_G \cdot n \cdot p_{\max}}{600000 \cdot \eta_{mh}} = \frac{100 \cdot 1500 \cdot 315}{600000} = 78{,}75kW$$

Calculation of the power limit $(p \cdot \alpha)_{\max}$:

$$(p \cdot \alpha)_{\max} = \frac{P_M}{P_{100\%}} \cdot 100\% = \frac{30kW}{78{,}75kW} \cdot 100\% = 38\% = \underline{1852_{hex}}$$

19.4 Internal command value ramps

For some applications it is required to specify the pressure or swivel angle via ramp functions. To meet the requirements of these applications, the SYDFEC is provided with an internal ramp generator for acceleration and deceleration ramps. Acceleration (positive change) and deceleration (negative change) can be set separately for pressure and swivel angle.

Index	Subindex	Name	Value range
5211	0x01	Pressure gradient for positive ramp [0.1bar/s]	0 - 65000
5211	0x02	Pressure gradient for negative ramp [0.1bar/s]	0 - 65000
5211	0x03	SWA gradient for positive ramp [0.1%/s]	0 - 65000
5211	0x04	SWA gradient for negative ramp [0.1%/s]	0 - 65000

When a new command value is entered, the set ramp gradient is used for accelerating or decelerating from the previous command value to the current command value using the set ramp gradient. In the factory setting, the ramp functions are set to a default value of 0, i.e. the ramp functions are deactivated.

Note: The set ramp gradients are utilised independently of the selected command value source.

19.5 Switching off the swivel angle controller

For special purposes, it is possible to switch off the swivel angle controller of the pump. The pump then only operates under closed-loop pressure control!
Writing (download request) to object 0x5310 sub-index 0x0 switches the swivel angle controller on or off.

Value	Meaning
0x5555	Switch swivel angle controller off
0x0000	Switch swivel angle controller on

The swivel angle controller is switched on again after a power-on reset.

20 Quick start

This quick start offers a short reference for the most important CAN telegrams in order to realise basic communication with the SYDFEC with the default setting (Node-ID 2, baud rate 500kbits/s) via the CAN bus interface. In addition, reference is made to the special points to be observed when adjusting the SYDFEC.
The described procedure is intended as implementation aid, but is no substitution for the necessity that the user familiarises himself in detail with the operating principle of the SYDFEC.

1. Commands for changes of state

The following telegram switches the SYDFEC to the “operational“ state. In this state, communication is possible via SDOs and PDOs.

COB-ID	Byte 0	Byte 1
0x000 (NMT)	Command 0x01	Node-ID 0x02

The following telegram switches the SYDFEC to the “pre-operational“ state. In this state, communication is possible via SDOs only.

COB-ID	Byte 0	Byte 1
0x000 (NMT)	Command 0x80	Node-ID 0x02

2. Setting the nominal pressure

By setting the nominal pressure the user determines the range of values of the pressure command value and the actual pressure value, i.e. when the maximum pressure command value (CAN bus 0x3FFF, analog 10V) is fed forward, this maximum pressure is set.
The nominal pressure of 1 bar to 450 bar (0x0001 ... 0x01C2) is set by writing (download request) to object 0x5208 sub-index 0x02. A changed value is saved in a non-volatile memory and is active immediately. The factory default setting is 315 bar (0x013B).

3. Synchronisation object (SYNC)

The following synchronisation telegram is used for synchronising the network stations.

COB-ID	RTR	DLC
0x080 (SYNC)	0	0

4. Transmission of actual values by means of transmit PDO1

With the receipt of a SYNC message, the transmit PDO1 (status byte, actual values) is sent from the SYDFEC to the PLC.

COB-ID	RTR	DLC	Byte 0	Byte 1,2	Byte 3,4
0x180+Node-ID (PDO 1 TXD)	0	5	Status byte	Actual SWA value	Actual pressure value

5. Synchronous transmission of command values by means of receive PDO1

The SYDFEC receives the following PDO message (control byte, command values) from the control (PLC). The data are taken over when the subsequent synchronisation telegram (SYNC) is received.

COB-ID	RTR	DLC	Byte 0	Byte 1,2	Byte 3,4
0x200+Node-ID (PDO 1 RXD)	0	5	Control byte	SWA - Command value	p - Command value

6. Setting the pressure transducers (PT)

The SYDFEC offers the possibility of connecting up to 4 pressure transducers. The measuring range of the pressure transducer for the relevant PT input must be set by way of the following entries in the object dictionary.

PT input	Index	Sub-index	Range of values	
			decimal	hex
1	0x5200	0x01	1 ... 450	0x0001 ... 0x01C2
2	0x5222	0x02		
3	0x5223	0x02		
4	0x5224	0x02		

PT input 1 (central plug pin 10/11)

It is possible to connect various types of pressure transducers to PT input 1 of the SYDFEC. Writing (download request) to object 0x5200 sub-index 0x0 determines the type of pressure transducer for PT input 1.

Value	Type of pressure transducer
0x0001	0,5 ... 5 V
0x0002	1 ... 10 V
0x0003	4 ... 20 mA
0x0004	0 ... 5 V
0x0005	0 ... 10 V
0x0006	0 ... 20 mA
0x0007	0.1 ... 10 V

To take over the changes made for the pressure transducers, a power-on reset is must be carried out on the SYDFEC.

PT input 2 (M12 socket pin 4/3)

To PT input 2 of the SYDFEC, a pressure transducer must be connected that has a signal voltage of (0.5 ... 5 V).

PT input 3 (central plug pin 7/4)

PT input 4 (central plug pin 5/4)

Pressure transducers having a signal voltage of (0 ... 10)V or (1 ... 10)V or (0.1 ... 10)V can be connected to PT inputs 3 or 4 of the SYDFEC.

Value	Type of pressure transducer
0x0002	1 ... 10 V
0x0005	0 ... 10 V
0x0007	0,1 ... 10 V

7. Measuring range of the pressure transducer

The measuring range of the pressure transducer for the relevant PT input can be adjusted by way of the following entries in the object dictionary.

PT input	Index	Sub-index
1	0x5200	0x01
2	0x5222	0x02
3	0x5223	0x02
4	0x5224	0x02

The range of values can be adjusted from 0x0001 to 0x01C2 (1 … 450), which corresponds to a measuring range from 1 to 450 bar.

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