Manual for

DAP-22 *CANopen*

Universal On-Board and Stand-Alone Digital Amplifier Plugged

Applicable for SW Versions

V2.xx*
(xx == 00 or higher)

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1 General information

1.1 About this manual

This document describes the CAN field bus interface of the HCS digital amplifier.
It describes and explains the general structure of the CAN field bus interface and in a second part the device specific profile for hydraulic valves will be explained.
All parameters follow the common CANopen communication profile CiA 301 / CiA 301-1 / CiA 305 and the device specific CANopen profile "Device profile fluid power technology proportional valves and hydrostatic transmissions", CiA 408 released by the CAN in Automation (CiA) organization.

This document is not a replacement for the CANopen standards as listed in the references.
□ Chapter "1.4 References", page 9

This manual was prepared with great care and the contents reflect the author's best knowledge. However, the possibility of error remains and improvements are possible. Please feel free to submit any comments regarding errors or possibly incomplete information to HCS GmbH.

1.1.1 Reservation of changes and validity

The information contained in this manual is valid at the time of this version's release. See footer for version number and release date of this manual.
We reserve the right to make changes to this manual at any time without specified reasons.

1.1.2 Completeness

This manual is complete only when used in conjunction with the product related hardware and software documentation required for the relevant application.

1.1.3 Place of storage

This manual and all other associated documentation for hardware and software must always be kept in a location where they will be readily accessible and close to the amplifier or the equipment in which it is installed.

1.1.4 Warranty and liability

This manual only describes the functionality and influence of the parameters. The described software functionality can be used in various amplifier models which can be implemented in a vast range of applications. Hence it is not possible to assume liability for the influence of the parameters. Please refer to the safety instructions and remarks in the related operating instructions.

1.1.5 Typographical conventions

⚠ DANGER

Identifies safety instructions that are intended to warn of an immediate and impending danger to life and limb.
Failure to observe these safety instructions will inevitably lead to death, serious personal injury (disablement)!

⚠ WARNING

Identifies safety instructions that are intended to warn of potential danger to life and limb.
Failure to observe these safety instructions might lead to death, serious personal injury (disablement)!

⚠ CAUTION
Identifies safety instructions that are intended to warn of slight personal injury. Failure to observe these safety instructions might lead to slight personal injury.

NOTICE
Failure to observe this safety notice can result in property damage!

Identifies important information

●/ -	Identifies listings
□	Identifies references to another chapter, page, table or figure in this manual
blue text	Identifies a hyperlink within the PDF file
1., 2., …	Identifies steps in a procedure that should be performed in consecutive order
'STATE'	Identifies states of a state machine
«ES»	Identifies LEDs of the amplifier (for example, «ES»)
< >	Identifies a parameter name
"…"	Used for references

1.2 Structure of warning notices

(1) ⚠ DANGER (2)
Moving machine parts! (3) Entrapment hazard! (4) □ Do not enter danger zone! (5)

Legend:

1	Warning symbol
2	Signal word
3	Type and source of hazard
4	Possible consequences if a potential hazard
5	Hazard prevention measures

1.3 Selection and qualification of personnel

Only qualified users may work with the amplifier. Qualified users are properly trained experts with the required knowledge and experience. In particular, these experts must have the authorization to bring into operation systems and power circuits in accordance with safety engineering standards. They must be familiar with safety concepts common in automation.

1.3.1 Service and repair

⚠ WARNING

Do not attempt - under any circumstances - to repair the product yourself

After repair, certain adjustments and test procedures must be performed; this can only be made by qualified and authorized personnel. Products that need repair can be sent to the addresses:
See □ Chapter "9 HCS distributors and partners", page 77

Please enclose a detailed description of the error, malfunction or failure with the sent item and state the serial number and the purchase date. This will speed up the process and guarantees a fast and reliable repair.
See □ Chapter "9 HCS distributors and partners", page 77

In the case of a fault or a malfunction, your distributor can give you instructions on the phone or in writing before accepting a repair order. For service and repair, we offer experienced and qualified personnel. In case you need our assistance, please contact the address:
See □ Chapter "9 HCS distributors and partners", page 77

1.3.2 Cleaning, storage, transport

The product should only be transported and stored in the original packaging to ensure suitable protection against mechanical damage as well as electrostatic discharge.
If it should be necessary to clean the amplifier, we recommend sending it back to the manufacturer or any distributor and partner:
See □ Chapter "9 HCS distributors and partners", page 77

⚠ CAUTION

Unpacking and handling should be left to suitably trained personnel.
Beware of damaging the module by electrostatic

1.3.3 Delivery state (default setting)

The product is shipped in a ready-to-use state (default settings). After correct installation and setting of all parameters relevant for the application, the amplifier module is ready for use.

1.4 References

In this chapter you will find information about standards for CAN, CANopen and the used device profile. In the following table you see all relevant organizations for standardization.

ISO	International Organization for Standardization 1, ch. de la Voie-Creuse, Case postale 56 CH-1211 Geneva 20 http://www.iso.org
IEC	International Engineering Consortium 233 S. Wacker Drive, Suite 8400 Chicago, IL 60606-6338 USA http://www.iec.org
CiA	CAN in Automation Kontumazgarten 3 DE-90429 Nuremberg http://www.can-cia.org
VDMA	Verband Deutscher Maschinen- und Anlagenbau e.V. Lyoner Strasse 18 60528 Frankfurt/Main http://www.vdma.org

1.4.1 CAN field bus

The CAN field bus interface provides a connection to the amplifier using standard CAN frames according to ISO 11898-1…3 and ISO 11898-5.

CiA 301	CANopen application layer and communication profile CiA 303
CiA 303-1	Cabling and connector pin assignment
CiA 305	Layer setting services (LSS) and protocols
ISO 11898-1	Road vehicles -- Controller area network (CAN) -- Part 1: Data link layer and physical
ISO 11898-2	Road vehicles -- Controller area network (CAN) -- Part 2: High-speed medium access unit
ISO 11898-3	Road vehicles -- Controller area network (CAN) -- Part 3: Low-speed, fault-tolerant, medium-dependent Interface
ISO 11898-5	Road vehicles -- Controller area network (CAN) -- Part 5: High-speed medium access unit with low-power mode

1.4.2 Device Profile

VDMA Profile Fluid Power	Device profile for Proportional Valves and Hydrostatic Transmissions VDMA Profile Fluid Power Technology Version 1.6
CiA 408 or Device Profile Fluid Power	CiA 408 Device profile for fluid power technology proportional valves and hydrostatic transmissions, Version 2.0

1.5 Definitions

1.5.1 Abbreviations

Abbreviation	Explanation
AC	Alternating Current
CAN	Controller Area Network
CANopen	ISO/OSI Layer 7 protocol, specified by CAN in Automation (CiA)
CiA	CAN in Automation
COB-ID	Communication Object Identifier
DAC	HCS digital amplifier controller (19“ Rack)
DAP	HCS universal Plug-On and Stand-Alone Digital Amplifier
DC	Direct Current
DAP-22	HCS digital module amplifier (DIN rail module)
DSM	Device State Machine
DSP	Digital Signal Processor
DSV	Device specific value
EDS	Electronics Datasheet, containing a description of the CANopen object dictionary
EEPROM	Electrically erasable programmable read-only memory
EMCY	CANopen Emergency protocol
iR	Internal resolution defined by CiA 408
ISO	International Engineering Consortium
LED	Light Emitting Diode
LVDT	Linear Variable Differential Transformer used to measure the valves spool position
NMT	Network management according CANopen
NS	Network Status
OD	Object Dictionary
ODC	HCS digital onboard amplifier (aluminum housing package)
P	Proportional gain element
PD	Proportional derivative element
PDO	Process Data Object
PE	Protective earth / Electrical grounding
PT1	Proportional first order lag element
ro	Read only
rw	Read write
RxPDO	Receive Process Data Object
RxPDO remote	Receive Process Data Object remote
RxSDO	Receive Service Data Object
SDO	Service Data Object
TR	State transmission of the valve application state machine
TxPDO	Transmit Process Data Object
TXPDO remote	Transmit Process Data Object remote
TxSDO	Transmit Service Data Object
URL	Uniform Resource Locator / Internet address
VDMA	Verband Deutscher Maschinen- und Anlagenbau e.V.
Wo	Write only
Xn	Physical connector n for electrical connection

Table 1: Abbreviations

2 Technical data

2.1 Technical data overview

Parameters	Range, characteristics
Supply voltage	12 VDC – 10 %.. 24 VDC + 20 %, residual ripple < 10 % Supply current 10 mA @ 24 VDC (estimated; solenoid deactivated)
Solenoid system selection	0.8 A / 1.1A / 1.3 A / 1.6 A / 2.4 A / 2.7 A / 3.5 A
Power input	Max. 22 VA
Applicable fuse (quick)	2.5 A
Operating ambient temperature	- 40 °C to + 75 °C for solenoid currents up to 2.7 A and supply voltage full range - 40 °C to + 60 °C for solenoid currents up to 3.5 A and supply voltage ≥ 24 V
Humidity (relative air humidity)	max. 95 % non-condensing
Max. elevation	2,000 m (mamsl)
Storage temperature	- 45 °C … 85 ° C
Protection class	IP65
Cable inlet	PG11 cable gland
Connection Access by removing lid!	5 / 7 screw terminals (7 terminals for CANopen version)
Recommended cables	
For versions without CANopen	4 strand 0.5 mm² (max length 20 m) shielded. Lapp cable “ÖLFLEX® CLASSIC 115 CY” article number: 1136754 *1
For versions with CANopen	7 strand 0.5 mm² (max length 20 m) shielded. Lapp cable “ÖLFLEX® CLASSIC 115 CY” article number: 1136757 *1
EMC	
EMC in accordance with	EN 61000-6-2: 2001 / EN 50011:1998
Housing	
Dimensions	Approx. 104.0 x 44.5 x 59.0 mm (w x h x d) with PG11 cable gland Approx. 78.0 x 44.5 x 59.0 mm (w x h x d) without PG11 cable gland
Material	Main housing: PA66-FR in accordance with UL94V0, Lid for housing: die casted ADC12 aluminum alloy
Mounting	Housing without ventilation for direct mounting on solenoids with connector form “A” as per EN 175301-803-A / ISO 4400 (ex DIN43650/A), quadratical form Please use attached sealing between the solenoid and the plug-on amplifier
Gage glass for access and indication	Gage glass with G1/4 thread for indication of status by LED Removable for access to USB 2.0 interface
Parameters	Range, characteristics
Input signal	
Analogue set value (command input)	Selection by means of parameter: 1 differential input, 12 Bit resolution, 0 … + 10 V or 5 V ± 5 V or 5 V ± 4.5 V or 0 / 4…20 mA @ 100 Ohm (cable fracture detection selectable where applicable)
Output signal	
Solenoid current	1 output stage for up to 3.5 A; with over-energization
Interface	USB 2.0 interface with Micro USB connector
Recommended interface cable	Digitus; USB 2.0 Anschlussleitung, USB Stecker Typ A, USB Stecker Typ A, 1.8 m
Bus interface	CANopen
Operation	By means of USB 2.0 and PC with HCSTool Multi color status LED for indication of power and status
Frequencies and cycle times	
PWM Frequency / Cycle time	22 kHz / current controller and analog signal scan time approx. 0.045 msec

Table 2: Technical data

2.2 Specifics for CAN Interface

With CANopen protocol. Baud rate and CAN address defined by parameter.

- 1 CAN-Bus according to ISO11898
- CAN-Baud rate adjustable up to 1 Mbit
- node number adjustable from 1 .. 127
- CANopen draft standard DS301 V4.0 / DS401 V2.1
- 1 receive / 1 transmit PDOs
- 1 SDO server
- PDO event timer
- PDO inhibit timer
- PDO transmit modes: event triggered, synchronous, asynchronous, cyclic, anticyclical
- variable PDO identifier
- dynamic PDO mapping
- emergency
- node guarding / lifeguarding / heartbeat
- EDS file

2.3 Programming PC Interfaces

Onboard USB interface in cooperation with HCSTool or HyperTerminal.

2.3.1 Hardware-Block Diagram

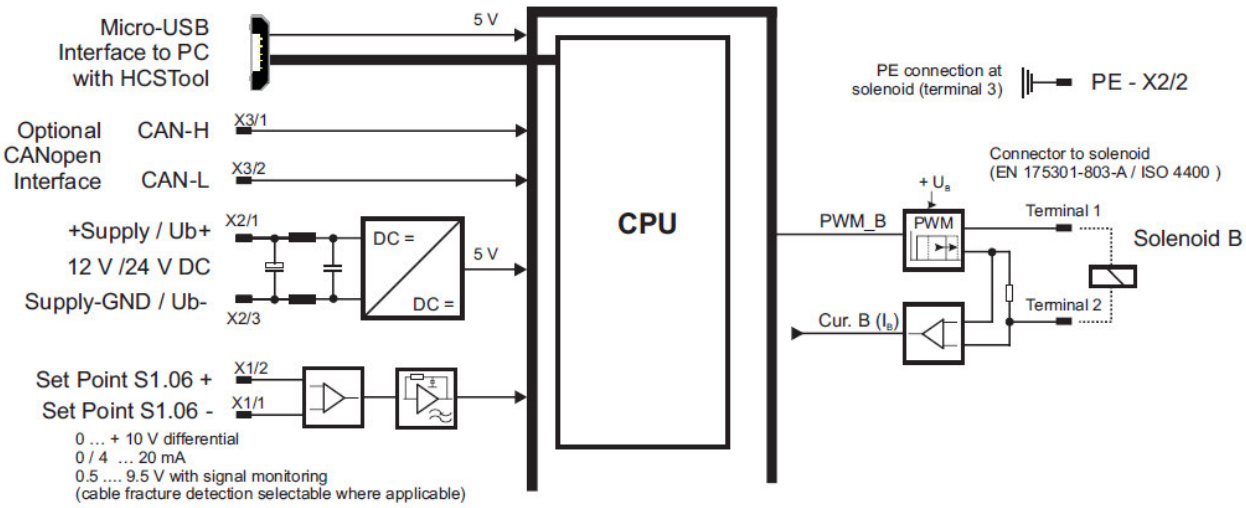


Figure 1 : : Hardware block diagram

2.4 Top view onto unit

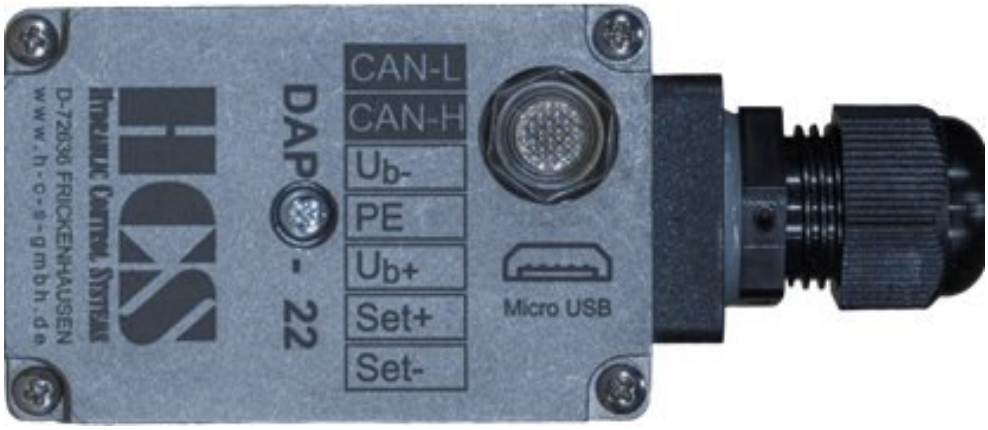


Figure 2 : Top view onto unit

2.5 Connection diagram

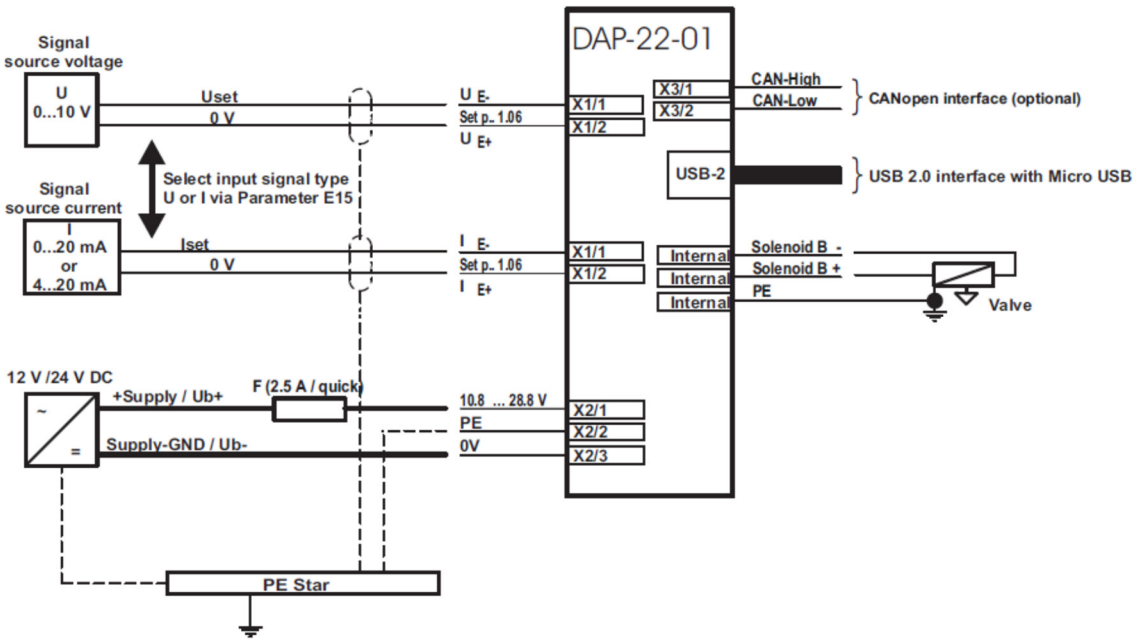
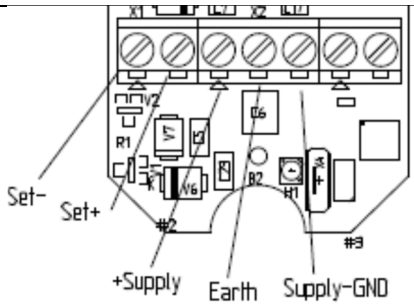
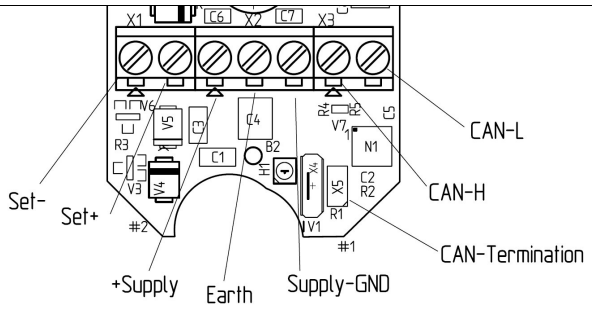


Figure 3 : Connection diagram

2.6 Connector position layout



Version without option “CAN-bus”



Version with option “CAN-bus”

Figure 4 : Connector position layout

2.7 Connection Terminals (X1, X2, X3)

X1		X2		X3	
Terminal	Signal	Terminal	Signal	Terminal	Signal
1	Set value S1.06- (Set-)	1	Ub+ (+Supply)	1	CAN-H
2	Set value S1.06+ (Set+)	2	= Earth, Cable shield	2	CAN-L
---	---	3	Ub- (Supply GND)	---	---

Table 3: Connection terminals

2.8 Optional CAN Termination (X5)

By adding the Jumper X5, the internal CAN termination can be done.

3 Access over CANopen

3.1 Introduction

CANopen is a communication protocol and device profile specification for embedded systems used in automation. In terms of the Open Systems Interconnection (OSI) model, CANopen implements the above layers and the network layer. The CANopen standard consists of an addressing scheme, several communication protocols and an application layer defined by specific device profiles. The communication protocols have support for network management, device monitoring and communication between nodes. The lower level protocol implementing the data link and physical layers is usually Controller Area Network (CAN). The basic CANopen application and communication profiles are given in the CiA 301 specification released by CAN in Automation (CiA). The device profiles for different devices are built on top of this basic profile.

3.2 Device profiles

The German Engineering Federation (VDMA), together with the manufacturers of hydraulic devices, have developed the "profile for fluid power technology". This profile defines common functionality and parameters for the communication of hydraulic components via field bus in a standardized format across manufacturers. This profile is implemented in all HCS amplifier with field bus interface. The CiA organization transformed the bus-independent device profile from the VDMA to the CANopen specific device profile CiA 408 "Device Profile Fluid Power Technology - proportional valves and hydrostatic transmissions". The device profiles describe the application parameters and the functional behavior of the devices including the device class-specific state machines. For many device classes, field bus technology already offers reliable device profiles for example for generic I/O-modules (CiA 401), drives and motion control (CiA 402) or for fluid power technology, proportional valves and hydrostatic transmissions (CiA 408). Users should be familiar with the associated profile.

3.3 CANopen slave reference model

The architecture of the CANopen stack with Physical Layer (Phy), Data Link Layer (DL) and Application Layer (AL) was taken from the ISO Reference Model (ISO/IEC standard 7498-1:1994). Layers three to six of this 7-layer reference model were not implemented, as these layers are intended for exchanging and sending telegrams. In a real-time field bus system, such functionalities are not required. The CANopen communication concept can be described similar to the ISO/OSI reference model.

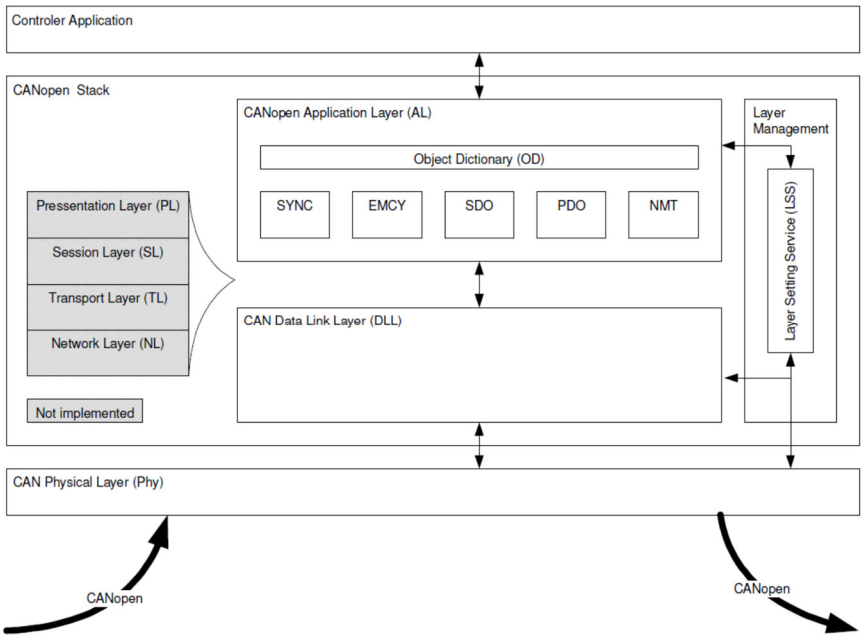


Figure 5: CANopen slave reference model

CANopen is based on the CAN data link layer and high-speed transceiver as specified in ISO 11898. CANopen specifies in CiA 303-1 the bit-timing and recommends connectors and their pin-assignments. CANopen represents a standardized application layer and communication profile as defined in CiA 301. The CiA 305 specifies the layer setting services (LSS). These protocols are used to inquire or to change the settings of the physical layer, data link layer and application layer on a device.

Layer	Description	References CAN / CANopen
Layer 7	Application layer	CiA 301 (CANopen application layer and communication profile) CiA 305 (CANopen LSS)
Layer 6	Presentation layer (not implemented)	
Layer 5	Session layer (not implemented)	
Layer 4	Transport layer (not implemented)	
Layer 3	Network layer (not implemented)	
Layer 2	Data link layer	ISO 11898-1 (CAN) CiA 305 (CANopen LSS)
Layer 1	Physical layer	ISO 11898-1/2/3/5 (CAN) CiA 303-1 (CANopen Additional Specification)

Table 4: CANopen slave reference model

3.4 DAP-22(A) Connection example

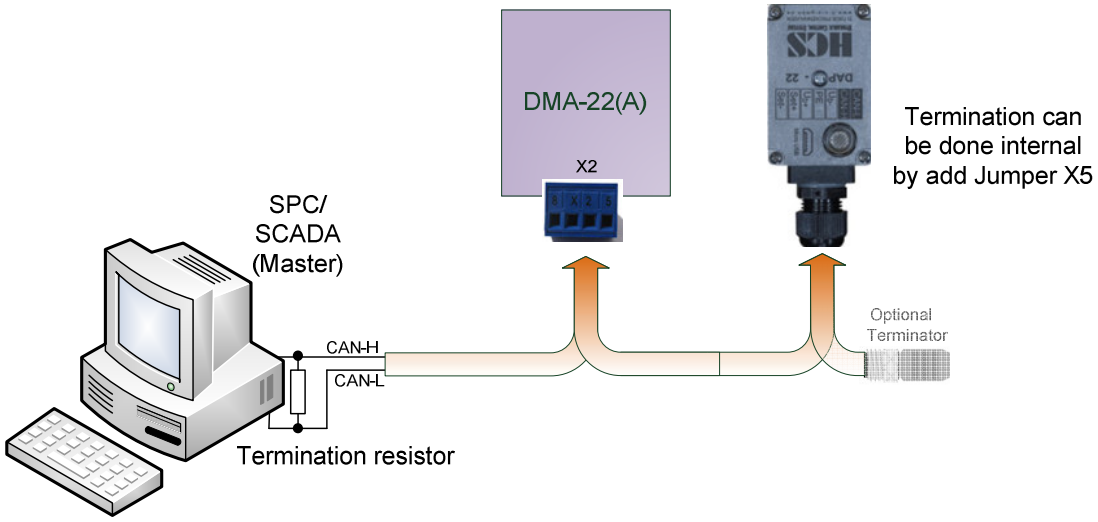


Figure 6: Connection example with termination

3.5 CANopen objects

A CANopen object is a set of CANopen parameters with the same index and object name. It consists of one or more parameters and their values. Objects are grouped in thematic blocks.

3.5.1 Parameter value

A parameter value is a real value stored in the amplifier with the attributes of the parameter explained in the next chapter.

3.5.2 Parameter and their attributes

A parameter is an abstract representation of a particular parameter value within a CANopen object dictionary in a device. Parameters are described in this document in the following tabular form:

Block name							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default

In the parameter list in chapter "5 Object dictionary", page 66 you will find a form like the following one in which the attributes are explained in detail:

Index	Sub-Index	PDO-mapping	Short name	Specification	Block object and parameter name	Data type	Access	non-volatile	Range	Default

Column name	Description
Block name	Describes the family of the object. If the object does not belong to a block, the object name is taken as block name.
Object name	Defined name of the object.
Index	16 bit index that addresses the entry in the object dictionary. In case of a simple variable this references the value of this variable directly. In case of records and arrays, the index addresses the whole data structure. Then the 8 bit sub-index allows access to individual elements in the structure.
Sub-index	If the object is defined as a record or array, the sub-index defines an element in the structure.
Parameter name	Defined name of the parameter.
PDO mapping	If set to "Y", the parameter can be mapped into a PDO. If set to "N", the parameter cannot be mapped into a PDO.
Short name	Unique short name.
Specification	Related (field bus) standard defining the parameter. Possible entries: CiA 301 Parameters correspond to CiA 301 (CANopen). CiA 408 Parameters correspond to CiA 408. HCS HCS defined parameters for digital amplifier.
Data type	Data type of the parameter. INTn Integer with n bits FLOAT32 Floating point with 32 bit char Character (ASC II) STRING String of characters UINTn Unsigned integer with n bits DOMAIN Application specific data block
Access	Access permission for the parameter. rw Read and write allowed wo Write only ro Read only
non-volatile	Defines whether the parameter can be saved in non-volatile memory. If the persistence is set to "Y", the saved value stays in memory even after the device is turned off. Parameters not marked as persistent ("N") lose their settings after the device is turned off. The parameters with the access type "read only" are marked with "-". This means that the parameter cannot be changed by the user.
Range	Allowed value range for the object.
Default	Default values: The default values in this document are firmware preset values. These values can be changed during calibration or set up with model specific parameters during production of the amplifier. Factory settings: The factory settings are values which are set up model specific during production of the amplifier. These parameters no longer contain the firmware default preset values.

Table 5: Field bus independent attributes

The listed default values contain the firmware preset values and not necessarily the configuration of the delivered amplifier.

3.5.3 Units and prefix parameter

This chapter describes the coding of units and prefix parameters according to CiA 303-2. Some objects provide unit and prefix in the sub-indices 2 and 3 to allow the master controller the correct visualization.

Name of unit	International symbol	Notation index (hex)
None	Dimensionless or iR	0x00
Meter	m	0x01
Second	s	0x03
Hertz	Hz	0x20
Liter	l	0x44
Pascal	Pa	0x22
Watt	W	0x24
Volt	V	0x26
Minute	m	0x47
Hour	h	0x48
Day	d	0x49
Year	a	0x4A
bar	bar	0x4E
Meter per square second	m/s^2	0x55

Table 6: Unit representation

Prefix	Factor	Symbol	Notation index (hex)
none	10^{-0}		0x00
deci	10^{-1}	d	0xFF
centi	10^{-2}	c	0xFE
milli	10^{-3}	m	0xFD
	10^{-4}		0xFC

Table 7: Prefix representation

3.6 CANopen object dictionary (OD)

CANopen devices have an object dictionary, which is used for configuration and non-real-time communication with the device. It is essentially a grouping of objects accessible via the network. Each object within the object dictionary is addressed using a 16 bit index and an 8 bit sub-index. So an object can contain 256 parameters which are addressed by the sub-index. The object dictionary is structured in several index ranges. The classification of the object dictionary is defined in the CiA 301.

Index	Object name	Reference
0x0000	Not used	
0x0001…0x001F	Data types	CiA 301
0x0020…0x003F	Complex data types (not used) CiA 301	CiA 301
0x0040…0x005F	Manufacturer-specific complex data types (not used)	
0x0040…0x025F	Device profile specific data types (not used)	CiA 408
0x0260…0x03FF	Reserved for further use	
0x0400…0x0FFF	Reserved for further use	
0x1000…0x1FFF	Communication profile area	CiA 301 / IEC 61158-5-12
0x5000…0x5FFF	Manufacturer-specific area	HCS
0x6000…0x67FF	Standardized profile area 1st logical device	CiA 408
0x6800…0x9FFF	Standardized profile area 2nd…8th logical device (not used)	CiA 301
0xA000…0xAFFF	Standardized network variable area (not used)	
0xB000…0xBFFF	Standardized system variable area (not used)	
0xC000…0xFFFF	Reserved for further use	

Table 8: Structure of the CANopen object dictionary (OD)

3.7 CAN data link layer

The CAN data frame can carry up to 8 bytes data. The header has an 11 bit communication object identifier (COB-ID) used to address a CAN service. The lowest COB-ID has the highest transmission priority. 29-bit COB-IDs are not supported.

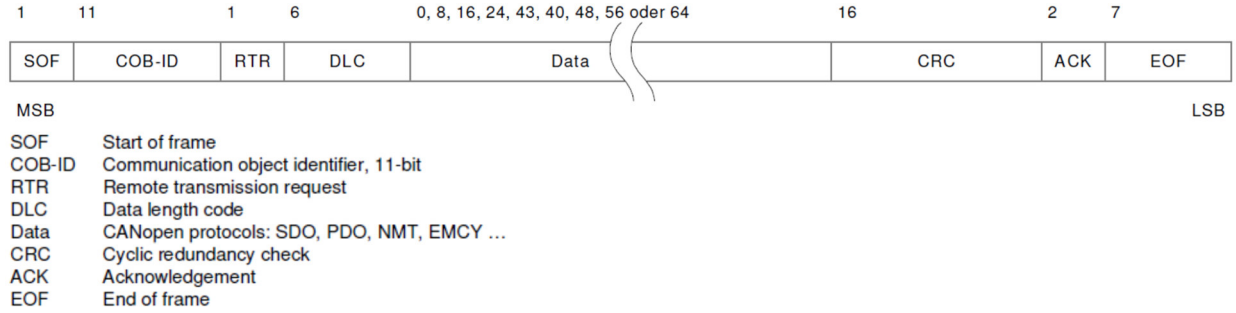


Figure 7: CAN data link layer

3.8 CAN bit rate and Node-ID configuration

The bit rate of the CAN bus communication can be changed to achieve a maximal transmission rate by a given length of the cable. Each node in the network has a unique Node-ID which must be configured before initial operation.
The Node-ID and the bit rate can be changed using:

- Service Data Objects (SDO)

The following standardized CANopen bit rates and maximum cable lengths can be configured:

- See also document CA63420-001 "User Manual Electrical Interfaces"

Baud Rate	Maximum cable length
20 kBit/s	2500 meters
50 kBit/s	1000 meters
125 kBit/s	500 meters
250 kBit/s	250 meters
500 kBit/s	100 meters
800 kBit/s	50 meters
1 Mbit/s	25 meters

Table 9: CANopen maximal bit rates, length depended

3.8.1 CAN bit rate and Node-ID configuration using SDO protocol

The bit rate and the Node-ID in the amplifier can be configured by the SDO protocol. Therefore two SDO objects were introduced.
When changing these settings, they will get active not before either a power-up or a NMT-reset communication are initiated. That makes sure that the CAN communication will not get interrupted by changing these basic settings.

3.8.1.1 Object 0x4200: Module identifier (Node-ID)

This parameter represents the CAN Node-ID of the amplifier. To activate the new Node-ID either a power up or an NMT-reset communication has to be initiated. The COB-ID for the TPDOI and RPDO will be reset to their default values.

- NMT protocol CiA 203

□ Chapter "3.10.6 Reset communication command (COB-ID:0, CS:130)", page 27

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x4200	0	ModuleIdentifier	UINT8	rw	y	0..127	127

Attention, if the node-id is set to zero, the CanOpen module of the amplifier is deactivated.
Use the HCSTool to set the node id via parameter E 24 !

3.8.1.2 Object 0x4201: Bit rate

The bit rate will be configured in bits per second. To activate the new bit rate either a power-up or a NMT-reset communication has to be initiated. It is recommended to restart the device (power-up) when changing the baud rate.

- NMT protocol CiA 203

□ Chapter "3.10.6 Reset communication command (COB-ID:0, CS:130)", page 27

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x4201	0	Bitrate	UINT8	rw	y	1..7	3

Value description
The following standardized CANopen bit rates can be configured:

Bit Rate	Parameter value
20 kBit/s	1
50 kBit/s	2
125 kBit/s	3
250 kBit/s	4
500 kBit/s	5
800 kBit/s	6
1 Mbit/s	7

Table 10: CANopen bit rates

3.9 CANopen communication protocols

CANopen communication protocols are classified as follows:

- The real-time data are transferred with the process data object (PDO) protocol.
- The configuration parameters are transferred with the service data object (SDO) protocol.
- Special protocols provide application-specific network synchronization (SYNC) protocol, time stamping and emergency message (EMCY) protocol.
- The network management (NMT) protocol provides services for network initialization, error control and
- network status control.

Protocol	COB-ID	Description	SDO objects used for protocol configuration	Reference	Chapter
NMT	0x000	Network Management (NMT) protocol (Broadcast)		CiA 301	□ Chapter "3.10.1 Network management (NMT) protocol (COB-ID: 0x000, 0x700)", page 27
NMT	0x000+Node-ID	Network Management (NMT) protocol		CiA 301	
SYNC	0x080	Synchronization (Broadcast) protocol	0x1005	CiA 301	□ Chapter "3.9.1 Synchronization (SYNC) protocol (COB-ID: 0x080)", page 20
EMCY	0x080+Node-ID	Emergency protocol	0x1014	CiA 301	□ Chapter "3.9.1.1 Object 0x1005: SYNC protocol COB-ID configuration", page 20
TxPDO	0x180+Node-ID	1st Transmit PDO protocol	0x1800.0x1A00	CiA 301	□ Chapter "3.9.3 Process data object (PDO) protocol ", page 20
RxPDO	0x200+Node-ID	1st Receive PDO protocol	0x1400.0x1600	CiA 301	
SDO	0x580+Node-ID	Transmit SDO protocol	0x1200	CiA 301	□ Chapter "3.9.4 Service data object (SDO) protocol (COB-ID: 0x580, 0x600)", page 2420
SDO	0x600+Node-ID	Receive SDO protocol	0x1200	CiA 301	
NMT	0x700+Node-ID	Network Management (NMT) error control protocol (Bootup, Node Guarding)	0x100C, 0x100D, 0x1016, 0x1017	CiA 301	□ Chapter "3.10.1 Network management (NMT) protocol (COB-ID: 0x000, 0x700) ", page 27

Table 11: CANopen communication objects

3.9.1 Synchronization (SYNC) protocol (COB-ID: 0x080)

The SYNC protocol is a network wide system trigger generated by one CANopen device in the network. The SYNC protocol has a very high priority and has no data in order to guarantee a minimum of jitter. The SYNC protocol is sent by a sync producer and can trigger PDO transmissions in the sync consumer nodes when activated in the corresponding PDO transmission types.

□ Chapter "3.9.3.1.1 Object 0x1400: 1st RxPDO protocol configuration", page 21
□ Chapter "3.9.3.4.1 Object 0x1800: 1st TxPDO protocol configurationObject 0x1400: 1st RxPDO protocol configuration", page 22
□ Chapter "3.9.3.6 Object 0x4211: TxPDO trigger", page 24

3.9.1.1 Object 0x1005: SYNC protocol COB-ID configuration

This object defines the COB-ID of the sync object itself. The COB-ID is fixed to 0x80 and cannot be changed.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1005	0	CobIdSyncMessage	UINT32	ro	-	0x80000080	0x80000080

Value description

<CobIdSyncMessage>				
Bit	31	30	29..11	10..0
Descrip.	Reserved	0: SYNC client 1: SYNC server (not implemented)	Reserved	11 Bit COB-ID (always 0x80)

Table 12: Possible values of parameter <CobIdSyncMessage> (0x1005)

3.9.2 Emergency (EMCY) protocol (COB-ID: 0x080+Node-ID)

The emergency protocol is a high priority message triggered by an error event in the device. The error codes sent with the emergency message are device profile independent and are specified in the CANopen communication profile CiA 301. They are described in the chapter Diagnostics.

□ Chapter "4.5 Diagnostics", page 59

3.9.2.1 Object 0x1014: EMCY protocol COB-ID configuration

This object defines the COB-ID of the emergency object itself.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1014	0	CobIdEmergencyMessage	UINT32	rw	y	0x0080….0x00FF	0x0080+127

Value description

<CobIdEmergencyMessage>					
Bit	31	30	29	29..11	10..0
Description	0: EMCY exists	0	0: 11Bit	Reserved	11 Bit COB-ID

Table 13: Possible values of parameter < CobIdEmergencyMessage > (0x1014)

3.9.3 Process data object (PDO) protocol

The process data object (PDO) communication allows cyclic sending and receiving of parameters in real time. Different transmission modes are available: asynchronous, event or timer driven transmission.
One TxPDO and one RxPDO are implemented.

3.9.3.1 RxPDO protocol configuration (COB-ID: 0x200)

To enable receive process data object (RxPDO) transmission, the local application parameters must be mapped to the RxPDO and a transmission type must be selected for each RxPDO channel. Four RxPDO channels are available.

3.9.3.1.1 Object 0x1400: 1st RxPDO protocol configuration

First RxPDO channel configuration.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1400	0	Number of entries	UINT8	ro	-	UINT8	2
0x1400	1	RPdo1_CobIdUsedByPdo	UINT32	rw	y	0x00000200…0x0000027F| 0x80000200…0x8000027F	0x0200+ Node-ID
0x1400	2	RPdo1_TransmissionType	UINT8	rw	y	255	255

Value description

Parameter	Description
<RPdo1_CobIdUsedByPdo>	COB-ID of the 1st RxPDO.
<RPdo1_TransmissionType>	Type of processing the received data:

Table 14: Object 0x1400: 1st RxPDO configuration

	<RPdo1_CobIdUsedByPdo>				
Bit	31	30	29	28..11	10..0
Description	0: PDO will be processed/received 1: PDO will not be processed/received	reserved	0: only support Can Frames with 11-Bit CAN-ID	Reserved	11 Bit COB-ID

Table 15: Possible values of parameter <RPdo1_CobIdUsedByPdo> (0x1400, sub-index 1)

<RPdo1_TransmissionType>	
Value	Description
255	PDO will be processed immediately after reception (asynchron).

Table 16: Possible values of parameter <RPdo1_TransmissionType> (0x1400, sub-index 2)

3.9.3.2 RxPDO mapping (COB-ID: 0x200)

With the receive process data object (RxPDO) mapping most object dictionary entries can be mapped to a RxPDO. Each CANopen telegram can carry 8 bytes data. The smallest data types used in the digital amplifier are 8 bit integers. Therefore eight object dictionary entries with 8 bit data length or four object dictionary entries with 16 bits or two object dictionary entries with 32 bit can be mapped within one RxPDO. An arbitrary combination of different data types is possible if the sum of the mapped RxPDO data is less or equal 8 bytes.

3.9.3.2.1 Object 0x1600: 1st RxPDO mapping

With the parameter <RPdo1_NumberOfMappedApplicParaInPdo> (0x1600) the number of real-time application parameters to be received can be set. To map the application parameter itself, its index, sub-index and length must be combined to a 32 bit value and written to one of the eight possible positions (corresponding to the sub-indexes 1…8) within the PDO object mapping object.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1600	0	RPdo1_NumberOfMappedApplicParaInPdo	UINT8	rw	y	0…8	2
0x1600	1	RPdo1_ApplicPara1	UINT32	rw	y	UINT32	0x60400010
0x1600	2	RPdo1_ApplicPara2	UINT32	rw	y	UINT32	0x63000110
0x1600	3	RPdo1_ApplicPara3	UINT32	rw	y	UINT32	0x0
0x1600	4	RPdo1_ApplicPara4	UINT32	rw	y	UINT32	0x0

Value description

Parameter	Description
<RPdo1_NumberOfMappedApplicParaInPdo>	Numbers of mapped application parameters
<RPdo1_ApplicPara1>	Mapping of 1st application parameter
<RPdo1_ApplicPara2>	Mapping of 2nd application parameter
<RPdo1_ApplicPara3>	Mapping of 3rd application parameter
<RPdo1_ApplicPara4>	Mapping of 4th application parameter

Table 17: Object 0x1600: 1st RxPDO configuration

<RPdo1_ApplicPara1>…<RPdo1_ApplicPara4>				
Byte	3	2	1	0
Description	Index MSB	Index LSB	Sub-index	Parameter bit length 0x08 or 0x10 or 0x20
Example	0x60	0x40	0x00	0x10

Table 18: Value description of mapping parameter <RPdo1_ApplicPara1>…<RPdo1_ApplicPara4>

This pointer consists of a combination of index, sub-index and length of the parameter to be used.
The example value is 0x60400010, which refers to the

- <ControlWord> (0x6040),
- sub-index 0x00
- with a lengthof 16 bit (16=0x10).

3.9.3.3 RxPDO counter

The received process data objects (RxPDO) are counted using the object 0x4212. On each power on the counter will be initialized with zero.

3.9.3.3.1 Object 0x4212: RxPDO counter

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x4212	0	RPdo1_Counter	UINT32	rw	N	UINT32	0

3.9.3.4 TxPDO protocol configuration (COB-ID: 0x180)

The transmit process data object (TxPDO) protocol must be configured and the transmit values must be mapped to the local parameters. Four transmit TxPDO channels are available. The transmission of the PDOs can be triggered by following events:

- Event timer elapsed.
- Synchronization (SYNC) telegram received.

Every event forces a PDO transmission. More than one event type can be active at the same time.

3.9.3.4.1 Object 0x1800: 1st TxPDO protocol configuration

First TxPDO channel configuration.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1800	0	Number of entries	UINT8	ro	-	UINT8	5
0x1800	1	TPdo1_CobIdUsedByPdo	UINT32	rw	y	0x40000180…0xC00001FF	0x0180+ NodeID
0x1800	2	TPdo1_TransmissionType	UINT8	rw	y	UINT8	255
0x1800	5	TPdo1_EventTimer	UINT16	rw	y	UINT16	03E8

Value description

Parameter	Description
<TPdo1_CobIdUsedByPdo>	COB-ID of the 1st TxPDO.
<TPdo1_TransmissionType>	Defines the transmission behavior for the 1st TxPDO.
<TPdo1_EventTimer>	This parameter defines the event time in milliseconds.This time defines the cycle time of the TxPDO timer event. If the event time elapsed, a trigger to transmit a TxPDO is initiated and the event timer will be restarted.

Table 19: Object 0x1800: 1st TxPDO configuration

	< TPdo1_CobIdUsedByPdo >				
Bit	31	30	29	28..11	10..0
Description	0: PDO will be processed/received 1: PDO will not be processed/received	1: will not support RTR	0: only support Can Frames with 11-Bit CAN-ID	Reserved	11 Bit COB-ID

Table 20: Possible values of parameter <TPdo1_CobIdUsedByPdo> (0x1800, sub-index 1)

<TPdo1_TransmissionType>	
Value	Description
0	The process data for the TxPDO will be updated and send immediately after the next incoming SYNC telegram. (Only one time)
1…240	The process data for the TxPDO will be updated and send immediately every <TPdo1_TransmissionType> SYNC telegrams. (E.g. when set to 3, after the 3rd SYNC)
241…253	Reserved
254…255	The TxPDO will be send after the event time is elapses (when the event time is nonzero).

Table 21: Possible values of parameter <TPdo1_TransmissionType> (0x1800, sub-index 2)

To initiate a single request only, the <TPdo1_EventTimer> (0x1800)…<TPdo4_EventTimer> (0x1803) must be set to 0. The transmission then can be triggered by the parameter <TPdoTrigger> (0x4211).
□ Chapter "3.9.3.6 Object 0x4211: TxPDO trigger", page 24

3.9.3.5 TxPDO mapping (COB-ID: 0x180)

With the transmit process data object (TxPDO) mapping the most object dictionary entries can be mapped to a TxPDO. A CANopen telegram can carry 8 bytes data in one package. The smallest data types used in the digital amplifier are 8 bit integers. Therefore, eight object dictionary entries with 8 bit data length or four object dictionary entries with 16 bits or two object dictionary entries with 32 bit can be mapped within one Tx-PDO. An arbitrary combination of different data types is possible, if the sum of the mapped TxPDO data is less or equal 8 bytes.
The default PDO mapping for a hydraulic CANopen device is defined in the device specific profile CiA 408.

3.9.3.5.1 Object 0x1A00: 1st TxPDO mapping

With the parameter <TPdo_NumberOfMappedApplicParaInPdo> (0x1A00) the number of real-time application parameters to be transmitted can be set. To map the application parameter itself, its index, sub-index and length must be combined to a 32 bit value and written to one of the eight possible positions (corresponding to the sub-indexes 1…8) within the PDO object.
Only parameters out of the device profile area can be mapped.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1A00	0	TPdo1_NumberOfMappedApplicParaInPdo	UINT8	rw	y	0…8	2
0x1A00	1	TPdo1_ApplicPara1	UINT32	rw	y	UINT32	0x60410010
0x1A00	2	TPdo1_ApplicPara2	UINT32	rw	y	UINT32	0x63010110
0x1A00	3	TPdo1_ApplicPara3	UINT32	rw	y	UINT32	0
0x1A00	4	TPdo1_ApplicPara4	UINT32	rw	y	UINT32	0

Value description

Parameter	Description
<TPdo1_NumberOfMappedApplicParaInPdo>	Numbers of mapped application parameters
<TPdo1_ApplicPara1>	1st application parameter
<TPdo1_ApplicPara2>	2nd application parameter
<TPdo1_ApplicPara3>	3rd application parameter
<TPdo1_ApplicPara4>	4th application parameter

Table 22: Object 0x1A00: 1st TxPDO configuration

<TPdo1_ApplicPara1>…<TPdo1_ApplicPara4>				
Byte	3	2	1	0
Description	Index MSB	Index LSB	Sub-index	Parameter bit length 0x08 or 0x10 or 0x20
Example	0x60	0x41	0x00	0x10

Table 23: Value description of mapping parameter <RPdo1_ApplicPara1>…<RPdo1_ApplicPara4>

This pointer contains a combination of index, sub-index and length of the parameter to be used.
The example value is 0x60410010, which refers to the

- <StatusWord> (0x6041),
- sub-index 0x00
- with a length of 16 bit (16=0x10).

3.9.3.6 Object 0x4211: TxPDO trigger

Writing this parameter triggers a single TxPDO. This can be used to transmit a PDO on request only. To trigger the TxPDO, the parameter <TPdoTrigger> (0x4211) value must be set to a value > zero, to trigger the PDO channel to be sent.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x4211	0	TPdoTrigger	UINT8	rw	n	255	None

3.9.4 Service data object (SDO) protocol (COB-ID: 0x580, 0x600)

Service data objects are used to configure the settings for the communication and the application parameters. They are transmitted non real-time with low priority.
Service-Data Objects (SDOs)

3.9.4.1 Service data object (SDO) data structure

3.9.4.1.1 Das SDO-Expedited-Domain-Protocol

As very often only a few utility data bytes are to be transmitted, the SDO transfer can be shortened and up to a maximum of four bytes transmitted already in the initialization phase. This is referred to as an "expedited SDO transfer".

With this service there is a read or an write of parameters in the object dictionary (OD) of the amplifier possible. Structured as follows:

COB-ID	Command	Index		Sub-Index	Data			
11 Bit	Byte 0	Byte1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
		LSB	MSB		LSB			MSB
		LSB	MSB		LSB	MSB	0	0

Table 24: Expedited SDO transfer service

3.9.4.1.2 SDO command byte

The command byte contains the type of telegram. The different types are a “set parameter telegram” (domain download), a “request telegram” (domain upload) and a “warning telegram” (warnings). Parameter data will be send to the controller via the “set parameter telegram”. The stored parameter data can be read back to the master via the “request telegram”.

Command (Hex)	function	definition	Action
0x40	Initiate upload request	Request from master	Get parameter value
0x60	Download response	Acknowledge from DAP-22	Value stored in DAP-22
0x22, 0x23, 0x2B,0x2F (*)	Initiate download	Request from master	New value for DAP-22
0x43,0x4B, 0x4F (*)	Upload response	Answer from DAP-22	Parameter value from DAP-22
0x80	Warning	Answer from DAP-22	Error from DAP-22

Table 25: Command byte explanation

Command (Hex)	Data length	Data type
0x0x22, 0x23,0x43	4 Byte	Unsigned 32
0x2B, 0x4B	2 Byte	Unsigned 16
0x2F, 0x4F	1 Byte	Unsigned 8

Table 26: Command and data length

(*) the value of the command byte defines the length of the transferred data

3.9.4.1.3 SDO messaging

Hint: The length of SDO telegrams is defined as 8 bytes. Not used data bytes are filled with zero.

3.9.4.2 Object 0x1200: SDO client/server parameter

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1200	0	Number of entries	UINT8	ro	-	UINT8	2
0x1200	1	CobIdClientServer	UINT32	ro	-	UINT32	0x0600+127
0x1200	2	CobIdClientClient	UINT32	ro	-	UINT32	0x0580+127

Value description

Parameter	Description
<CobIdClientServer>	This parameter contains the COB-ID for the receive service data object.
<CobIdServerClient>	This parameter contains the COB-ID for the transmit service data object.

Table 27: Object 0x1200: SDO client/server parameter

3.10 Network management state machine (NMT state machine)

The CANopen NMT state machine is used to control the network communication. The network management is node-oriented and follows a master/slave structure. It requires one device in the network, which fulfills the function of the NMT master, the other nodes are NMT slaves. The network management provides the following functions:

- Device control services for initialization and start-up of NMT slave nodes that want to take part in the distributed application.
- Node Guarding of NMT slave nodes.

The CANopen network management (NMT) state machine must not be mistaken with the device state machine.

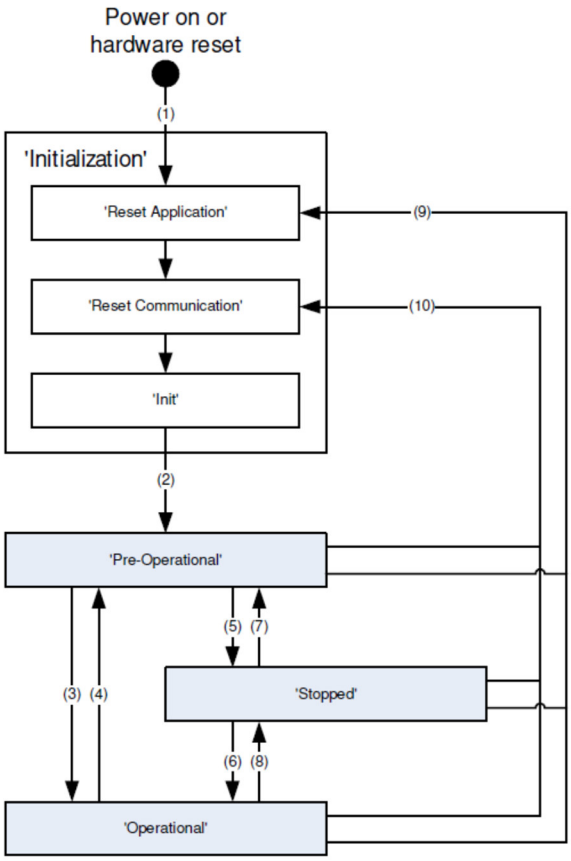


Figure 8: CANopen network state machine (CSM)

The master controls the state transitions of each device in the network. After power-on, the device is initialized and set to the state 'Pre-Operational' or 'Operational', depending on object 0x1F80 NMT startup, automatically. In the 'Pre-Operational' state reading and writing to its object dictionary via the service data objects (SDO) is possible. The device can be configured by setting values and by preparing the PDO transmission.
Afterwards the device can be switched into the 'Operational' state by the NMT command "Start Remote Node" in order to start PDO communication. PDO communication can be stopped by the network master by simply switching the remote node back to 'Pre-Operational' by using the command "Enter Pre-Operational".
With the "Stop Remote Node" command the master can force the slave(s) to the state 'Stopped'. In this state no services besides network and error control mechanism are available. The NMT command "Reset Communication" resets the communication of the node. All communication parameters will be set to their defaults. The application will be reset by the NMT command "Reset Node". This command resets all application parameter. All NMT commands use the COB-ID 0. The different NMT commands are distinguished by a command specifier (CS) located in the first data byte of the message.
NMT state transitions are caused by

- Reception of an NMT node control service
- Hardware reset, or
- Node control services locally initiated by application events.

Transition	Description
(1)	At Power on the NMT state initialization is entered autonomously.
(2)	NMT state initialization finished - enter NMT state Pre-operational automatically (Boot-up message will be sent).
(3)	Receive NMT command "start remote node" or by local control.
(4), (7)	Receive NMT command "enter pre-operational".
(5), (8)	Receive NMT command "stop remote node".
(6)	Receive NMT command "start remote node".
(9)	Receive NMT command "reset node".
(10)	Receive NMT command "reset communication".

Table 28: NMT state transitions

Services on the listed communication objects may only be executed if the CANopen device is in the appropriate NMT state. Reset Node also set the DSM to INIT (reset error)

	Available services				
NMT states	SDO	PDO	EMCY	NMT	NMT Node Guarding
'STOPPED'				x	x
'Pre-Operational'	x		x	x	x
'Operational'	x	x	x	x	x

Table 29: NMT states

NOTE: Some SDO's are not writeable in Operation Mode
see: □ Chapter "5 Object dictionary", page 66

3.10.1 Network management (NMT) protocol (COB-ID: 0x000, 0x700)

The NMT master controls the NMT slave nodes using the following commands:

- Device control services for initialization and start-up of NMT slave nodes that want to take part in the distributed application.
- Node Guarding of NMT slave nodes.

The NMT commands are unconfirmed.

3.10.2 Start remote node command (COB-ID:0, CS:1)

This command requests the selected slave node(s) to enter the state 'Operational'.

3.10.3 Stop remote node command (COB-ID:0, CS:2)

This command requests the selected slave node(s) to enter the state 'Stopped'.

3.10.4 Enter 'Pre-Operational' command (COB-ID:0, CS:128)

This command requests the selected slave node(s) to enter the state 'Pre-Operational'.

3.10.5 Reset node command (COB-ID:0, CS:129)

This command requests the selected slave node(s) to enter the state 'Reset Application'.

All application parameters will be set to their default. The valve application will be re-started. The TPDO´s will be mapped. After restarting the application, the reset node calls the reset communication command.

3.10.6 Reset communication command (COB-ID:0, CS:130)

This command requests the selected slave(s) to enter the state 'Reset Communication'.

The PDO communication will be stopped. After re-initialization of the network communication, the NMT state 'Pre-Operational' will be entered.

3.10.7 Object 0x1F80: NMT-Startup

Object describes the start-up behavior of the amplifier in NMT (Network-Management)

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1F80	0	NMT-Startup	UINT32	rw	Y	UINT32	8

Value description

< NMT-Startup>		
Bit,	Value	Description
0	-	Not implemented
1	-	Not implemented
2	0x04	0 = The amplifier moves automatically to the "Operational" state. 1 = The amplifier does not automatically move to the "Operational" state. The status change is defined through the respective application.
3	0x08	(0 = Starting of the slave is permitted, not implemented) 1 = Starting of the slave is not permitted

3.10.8 Bootup message (COB-ID: 0x700)

After a digital amplifier has finished its own initialization and entered the node state 'Pre-Operational' the digital amplifier sends the boot-up message (0x700+Node-ID). This message indicates that the slave is ready for operation.

3.10.9 Node guarding (COB-ID: 0x700, RTR:1)

The node guarding is the periodical monitoring of certain network nodes. Each node can be checked by the NMT master with a certain period <GuardTime> (0x100C). A second parameter <LifeTimeFactor> (0x100D) defines a factor after the connection will be detected as lost. The resolution of the guarding time is 1 ms. To enable the node guarding on a slave device, the guard time and life time factor must be set. The guarding is started with the first guarding telegram of the master (0x700+Node-ID). During node guarding the master sends a remote transmit request (RTR) frame to each guarded slave. The slave answers with its actual NMT state and a toggle bit. This toggle bit alternates in each cycle.
If a missing lifeguard/ timeout is detected, the amplifier will generate an EMCY message.

3.10.9.1 Object 0x100C: Guard time

This parameter contains the guarding time in milliseconds. The value 0 disables the life guarding.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x100C	0	GuardTime	UINT16	rw	Y	UINT16	0

3.10.9.2 Object 0x100D: Life time factor

This parameter contains the life time factor in milliseconds. The value 0 disables the life guarding.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x100D	0	LifeTimeFactor	UINT8	rw	Y	UINT8	0

3.10.10 Heartbeat

The Heartbeat process does not distinguish between master and slave, but between producers and consumers of Heartbeats. A producer “Heartbeat Producer” automatically sends his status in defined intervals in order to prove his ability to communicate. The interval between two Heartbeat messages from a so-called Heartbeat Producer is defined by the object 1017h. At a value of 0, the sending of Heartbeats is disabled. It is up to the other bus users to evaluate the sent Heartbeats; an evaluation is made by the so-called “Heartbeat Consumer”. A “heartbeat consumer time” is set in object 1016h. This object contains an u32 data field in sub-index 1, which stores the Heartbeat Time in bit 0 to 15. The consumer time should be 1.5 – 2 times longer than the producer time to ensure that a missing heartbeat really is lost and not just delayed. This time interval describes the maximum time until the next Heartbeat Telegram must be received. Otherwise, a Heartbeat Event is generated. For every “Heartbeat Consumer” an associated producer has to be named, whose Heartbeat should be monitored. Corresponding configuration is done by passing the node-ID of the producer, which is denoted in bit 16 to 23 as u8 of the object 1016h.
To activate the heartbeat, the device NMT state needs to be “operational” and the “Statusword

3.10.10.1 Object 0x1016: Consumer heartbeat

This parameter contains the monitoring time value of the heartbeat signal. Monitoring of the heartbeat producer shall start after the reception of the first heartbeat. This value can only be set one time by the same node.
The consumer time should be 1.5 – 2 times longer than the producer time to ensure that a missing heartbeat really is lost and not just delayed. If a missing heartbeat timeout is detected, the amplifier will generate an EMCY message.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1016	0	Number of entries	UINT8	rw	-	UINT8	1
0x1016	1	ConsumerHeartbeatTime 1	UINT32	rw	Y	UINT32	0

Value description

< ConsumerHeartbeatTime1>		
Bit Discription		
31..24	23..16	15..0
reserved	Node-ID	Heartbeat time in ms

Table 30: Possible values of the < ConsumerHeartbeatTime1 > (0x1016-1)

If the value is zero, the function is deactivated

3.10.10.2 Object 0x1017: Producer heartbeat

This parameter contains the time value of the heartbeat signal, send by the amplifier. If a period different from 0 is written to this index, periodically generates a Heartbeat frame. It is expressed in milliseconds and must be comprised between 1 and 65535.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1017	0	ProducerHeartbeatTime	UINT16	rw	Y	UINT16	0

Value description

<DeviceType>	
Value	Description
0	Heartbeat is disabled.

1..0xFFFF	Heartbeat time in ms

3.11 Electronic data sheet (EDS) files

Electronic data sheets (EDS) are files which describe the capabilities and the communication objects of a CANopen device. The EDS is essential to configure CANopen master devices. They are most commonly used when CANopen modules made available to third parties. The digital amplifier EDS file is provided by HCS GmbH and can be downloaded from the HCS website http://www.h-c-s-gmbh.de/download
Parameters of the manufacturer specific profile area are described in detail and explained in the chapters:
see: □ Chapter “4.4.1 Manufacturer specific profile area", page 42

Details can also be found in the software block diagrams:
see: □ Chapter “4.3.1 Block diagram", page 39

A list of the parameters can also be found here
see: □ Chapter “5 Object dictionary”, page 66

4 Device structure

4.1 Device identification

4.1.1 Objects of the CANopen communication profile defined by CiA 301

4.1.1.1 Object 0x1000: Device Type

This parameter indicates the code of the underlying device profile. The default value 408 specifies the device profile CiA 408.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1000	0	DeviceType	UINT32	ro	-	UINT32	408

Value description

<DeviceType>	
Value	Description
0	Manufacturer-specific device profile.
408	This device is a valve or a pump. Device profile according to CiA 408 "Device profile for fluid power technology proportional valves and hydrostatic transmissions"

4.1.1.2 Object 0x1008: Manufacturer device name

This parameter indicates the name of the valve amplifier

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1008	0	ManufacturerDeviceName	STRING	ro	-	None	""

Value description

< ManufacturerDeviceName >	
Value	Description
DAP-22	Example for device name

Table 31: Possible values of parameter <ManufacturerDeviceName > (0x1008)

4.1.1.3 Object 0x1009: Manufacturer hardware version

This parameter indicates the current hardware version of the valve amplifier

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1009	0	ManufacturerHardwareVersion	STRING	ro	-	None	""

Value description

< ManufacturerHardwareVersion >	
Value	Description
V01.00	Example for hardware version

Table 32: Possible values of parameter < ManufacturerHardwareVersion > (0x1009)

4.1.1.4 Object 0x100A: Manufacturer software version

This parameter indicates the current software version of the valve amplifier

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x100A	0	ManufacturerSoftwareVersion	STRING	ro	-	None	""

Value description

< ManufacturerSoftwareVersion >	
Value	Description
V02.00a	Example for software version

Table 33: Possible values of parameter < ManufacturerSoftwareVersion > (0x100A)

4.1.1.5 Object 0x1018: Identity object

These parameters represent a worldwide unique identification of any CANopen slave device

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1018	0	Number of entries	UINT8	ro	-	UINT8	4
0x1018	1	VendorId	UINT32	ro	-	UINT32	0x036C
0x1018	2	ProductCode	UINT32	ro	-	UINT32	
0x1018	3	RevisionNumber	UINT32	ro	-	UINT32	
0x1018	4	SerialNumber	UINT32	ro	-	UINT32	

The identification object (ProductCode, RevisionNumber, SerialNumber) is printed on label.

Value description

< IdentityObject >		
Sub-index	Description	Meaning
1	<VendorId>	Unique vendor ID, 0x36C is reserved for HCS
2	<ProductCode>	Product code of the HCS amplifier. Example: 400421300.
3	<RevisionNumber>	Revision number of the HCS amplifier. Example: 0x00610002 (0002 = Software “2”., 0061 = “a”
4	<SerialNumber>	Serial number HCS amplifier (digits without leading character) as on the name plate. □ Chapter "4.1.2.2 Object 0x6052: Serial number", page 32

Table 34: Possible values of the << IdentityObject > (0x1018)

4.1.2 Objects defined by Device Profile Fluid Power

4.1.2.1 Object 0x6050: Version

This parameter contains the versions family of the HCS amplifier.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6050	0	DeviceVersion	STRING	ro	-	None	""

4.1.2.2 Object 0x6052: Serial number

This parameter contains the serial number of the HCS amplifier.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6052	0	SerialNumber	STRING	ro	-	None	""

4.1.2.3 Object 0x6055: Model URL

This parameter holds the Internet address where additional information about the device is available.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6055	0	ModelURL	STRING	ro	-	None	"www.h-c-s-gmbh.de"

4.1.2.4 Object 0x605F: Capability

This object provides information on the capabilities of the used device, e.g. the supported control modes.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x605F	0	Capability	UINT32	ro	-		0x1F000000

Value description

<Capability>																	
Description	Hydraulic valve or pump application								Drive application								Reserved
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15..0
Word	MSB																LSB

Table 35: Possible values of parameter <Capability> (0x605F)

<DeviceType>		
Bit	Description	Default
0..15	Reserved	0
16	Drive capability	0
17	Supports control mode drive open loop movement	0
18	Supports control mode drive velocity control	0
19	Supports control mode drive force control	0
20	Supports control mode drive position control	0
21	Supports control mode drive flow control	0
22..23	Reserved	0
24	Hydraulic valve or pump capability	1
25	Supports control mode spool position open loop	1
26	Supports control mode spool position closed loop	1
27	Supports control mode pressure open loop	1
28	Supports control mode pressure closed loop	1
29	Supports control mode p/Q closed loop	0
30	Reserved	0
31	Supports modular device according CiA 301	0

Table 36: Bit values of parameter <Capability> (0x605F)

4.2 Device control

4.2.1 Object 0x6042: Device mode

The parameter <DeviceMode> (0x6042) is not supported. Reading / Writing is not possible.
If the set value input should be analog or bus controlled, please use the parameter E 15 (0x506E)). If the parameter is „0“ only the CANopen set value will be used otherwise always the analog Input is active.

E15 (0x506E)	
0	Set point via bus
1..8	Set point via bus and Analogue input S1.06

4.2.2 DSM is controlled via CANopen

4.2.2.1 Object 0x6040: Control word

This bit-coded parameter controls the DSM states and activates some manufacturer defined functions.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6040	0	Control Word	UINT16	rw	y	UINT16	0

< Control Word >

Bit	Word	Description	Specification
0	0x0001	Bit Disabled (D)	CiA 408
1	0x0002	Bit Hold (H)	
2	0x0004	Bit Active (M))	
3	0x0008	Bit Reset Faults (R)	
4..15	-	Reserved	

Table 37: Value description of <ControlWord>

Bits 0, 1, 2, 3: 'DISABLED', 'HOLD', 'ACTIVE', 'RESET FAULTS'
The lower four bits within the control word represent the device state machine's (DSM) control command.
□ Chapter "4.2.3.2.1 DSM state transitions caused by the control word", page 36

4.2.2.2 Object 0x6041: Device status word

The bit-coded <StatusWord> (0x6041) indicates the current device status.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6041	0	Status Word	UINT16	ro	-	UINT16	-

< Status Word >		
Bit	Description	Specification
0	Bit Disabled (D)	CiA 408
1	Bit Hold (H)	
2	Bit Active (M))	
3	Bit Ready (R)	
4..15	Reserved	

Table 38: Value description of <StatusWord>

Bits 0, 1, 2, 3: 'DISABLED', 'HOLD', 'ACTIVE', 'READY'
These bits indicate the state of the device state machine (DSM).

4.2.3 Device state machine (DSM)

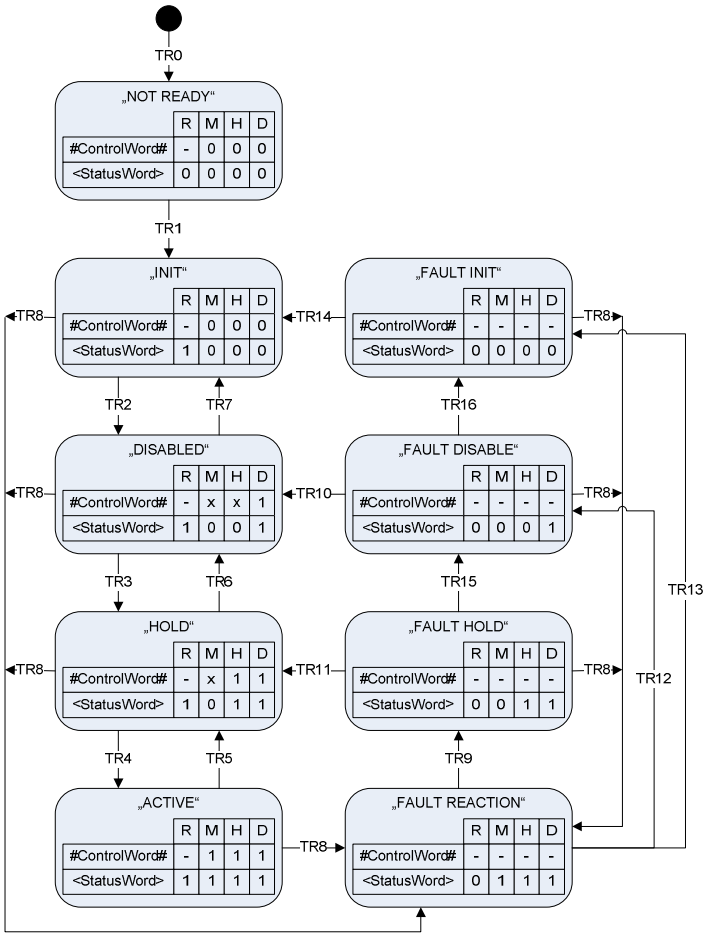


Figure 9: Device state machine

<StatusWord> (0x6041)	#ControlWord# (0x6040)
(Bit 3) R: Ready	(Bit 3) R: Reset fault
(Bit 2) M: Active	(Bit 2) M: Active
(Bit 1) H: Hold	(Bit 1) H: Hold
(Bit 0) D: Disabled	(Bit 0) D: Disabled

4.2.3.1 DSM states

The <StatusWord> (0x6041) indicates the DSM state. The following DSM states are possible:

DSM state	Description
NOT_READY	The electronics circuit has power. Device initialization running (e.g. communication interface, hardware, software). Device function disabled. Solenoid is not powered (Hydraulic failsafe spool position depends on used valve type).
INIT	Device parameters can be set. Device function disabled. All internal display values are set to zero Communication enabled. Solenoid is not powered (Hydraulic failsafe spool position depends on used valve type).
DISABLED	Device parameters can be set. Device function disabled. internal display values are set to zero. Solenoid is not powered (Hydraulic failsafe spool position depends on used valve type).
HOLD	Device parameters can be set. The setpoint values from the bus or from the analog input according to the chosen device mode are not effective. □ Chapter “4.2.1 Object 0x6042: Device mode", page 33 The valve closed loop is active and the spool goes to the new setpoint, namely the 'spool hold setpoint' as specified by <SplHoldSetPoint> (0x6314). □ Chapter “0 Table 41: Possible values of parameter <Set point> (0x6300)
ACTIVE	Device parameters can be set. The setpoint values from the bus or from the analog input according to the chosen settings □ Chapter “4.2.1 Object 0x6042: Device mode”,page 33
FAULT_INIT	Device parameters can be set. Device function disabled. Communication enabled. Solenoid is not powered (Hydraulic failsafe spool position depends on used valve type).
FAULT_DISABLED	Device parameters can be set. A fault reaction has occurred. Solenoid is not powered (Hydraulic failsafe spool position depends on used valve type).
FAULT_HOLD	Device parameters can be set. A fault reaction has occurred. The setpoint values from the bus or from the analog input according to the chosen device mode are not effective.
FAULT_REACTION	This state is assumed when the device detects an error. A fault dependent vendor specific action is executed. See □ Chapter “4.5.1 Fault reaction", page 594.5.1 The resulting fault state depends on the vendor specific fault reaction. Important condition for transitions 9, 12, 13: The RMHD bits of the #ControlWord# do not increase the state of the DSM.

Table 39: Value description of < StatusWord >

4.2.3.1.1 Object 0x6301: Actual current value

This parameter holds the actual current value of the solenoid output stage (d1.08).

HoldSetpoint							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6301	0	Number of entries	UINT8	ro	N	1	1
0x6301	1	ActualCurrentValue	INT16	ro	N	INT16	-

Value description

< ActualValue >	
Value	Description
0	Minimal solenoid current value == 0 mA
9999	Maximal solenoid current value == 9999 mA

Table 42: Possible values of parameter < Actual current value > (0x6301)

Object 0x6314: Hold setpoint", page 40

⚠ WARNING

Moving machine parts! The word "failsafe" means not a personnel safety. Parts of the machine can move if the amplifier has a fault.

□ If a personnel safety is needed, some additional electrical and hydraulic parts are necessary!

4.2.3.2 State transitions

State transitions are caused by

- The control word #ControlWord#
- Internal events

4.2.3.2.1 DSM state transitions caused by the control word

The following table lists the transitions depending on the #ControlWord#. The device control commands, which cause a state transition, are formed by the four low-order bits of the #ControlWord#.

□ Chapter "4.2.2.1 Object 0x6040: Control word", page 33

Every transition between the actual state and the requested state will be processed.

Transition (TR)	ControlWord	ControlWord Bit								Coments/Conditions
		7	6	5	4	3	2	1	0	
						R	M	H	D	
TR2	Activate ‘DISABLED‘	x	x	x	x	x	x	x	1	
TR3	Activate 'HOLD'	x	x	x	x	x	x	1	1	
TR4	Activate 'ACTIVE'	x	x	x	x	x	1	1	1	
TR5	Deactivate 'ACTIVE‘	x	x	x	x	x	0	x	x	
TR6	Deactivate 'HOLD'	x	x	x	x	x	0	0	x	
TR7	Deactivate 'DISABLED'	x	x	x	x	x	0	0	0	
TR10	Reset 'FAULT_DISABLED'	x	x	x	x	0	0	0	1	
		Change to								
		x	x	x	x	1	0	0	1	
TR11	Reset 'FAULT_HOLD'	x	x	x	x	0	0	1	1	
		Change to								
		x	x	x	x	1	0	1	1	
TR14	Reset 'FAULT_INIT'	x	x	x	x	0	0	0	0	
		Change to								
		x	x	x	x	1	0	0	0	
TR15	'FAULT_HOLD' to 'FAULT_DISABLED'	x	x	x	x	x	0	0	1	
TR16	'FAULT_DISABLED' to 'FAULT_INIT'	x	x	x	x	x	0	0	0	

4.2.3.2.2 DSM state transitions caused by the enable signal

The following events will lead automatically to state changes by changing the enable input signal.

Transition (TR)	Description	Comments/Conditions
TR2	Activate ‘DISABLED‘	Depending on ControlWord RMHD ≥ x001
TR3	Activate 'HOLD'	Depending on ControlWord RMHD ≥ x011
TR4	Activate 'ACTIVE'	Depending on ControlWord RMHD ≥ x111
TR5	Deactivate 'ACTIVE‘	
TR6	Deactivate 'HOLD'	
TR7	Deactivate 'DISABLED'	
TR9	Transition from 'FAULT_REACTION' to 'FAULT_HOLD'	Depending on the enable behavior
TR10	Reset 'FAULT_DISABLED'	
TR11	Reset 'FAULT_HOLD'	
TR14	Reset 'FAULT_INIT'	
TR15	'FAULT_HOLD' to 'FAULT_DISABLED'	

4.2.3.2.3 DSM state transitions caused by internal events

The following table shows the internal events which automatically lead to a state change.

Transition (TR)	Description	Comments/Conditions
TR0	Power up	
TR1	Device init successful.	Initialization of device parameters with stored values.
TR4	Device init successful. The safety function of the device is active, Hardware enable is applied	
TR8	A fault was detected. On entering 'FAULT_REACTION' state an emergency message is sent out.	If state is 'DISABLED' or 'FAULT_DISABLED', state transitions to 'FAULT_HOLD' will be redirected to 'FAULT DISABLED'.
TR9	Transition from 'FAULT_REACTION' to 'FAULT_HOLD' (fault reaction successful).	Depending on enable signal and the enable behavior. □ Chapter "4.2.3.2.4 Enable behavior", page 38
TR12	Transition from 'FAULT_REACTION' to 'FAULT_DISABLED' (fault reaction successful).	
TR13	Transition from 'FAULT_REACTION' to 'FAULT_INIT' (fault reaction successful).	

4.2.3.2.4 Enable behavior

The device is always enabled. To acknowledge internal faults the parameter “E clr” provided by the HCSTool can be used. Errors produced by the CAN communication or related to the CANopen setup could only be acknowledged by CANopen commands.

4.2.4 Object 0x1002: Manufacturer Status Register

The <ManufacturerStatusRegister> (0x1002) indicates the current status of the internal signals

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1002	0	ManufacturerStatusRegister	UINT32	ro	-	UINT32	-

< ManufacturerStatusRegister >			
Bit	HEX	Description	Specification
0	0x00000001	Reserved	HCS
1	0x00000002	Reserved	
2	0x00000004	Reserved	
3	0x00000008	Reserved	
4	0x00000010	Reserved	
5	0x00000020	Reserved	
6	0x00000040	Reserved	
7	0x00000080	Reserved	
8	0x00000100	Reserved	
9	0x00000200	An internal error is detected	
10	0x00000400	Reserved	
11	0x00000800	Reserved	
12	0x00001000	Reserved	
13	0x00002000	Reserved	
14	0x00004000	Reserved	
15	0x00008000	Reserved	
16..31	0xyyyy0000	Reserved	

Table 40: Value description of < ManufacturerStatusRegister >

4.3 Device controller structure

4.3.1 Block diagram, Mode 1, Open loop, 1 valve

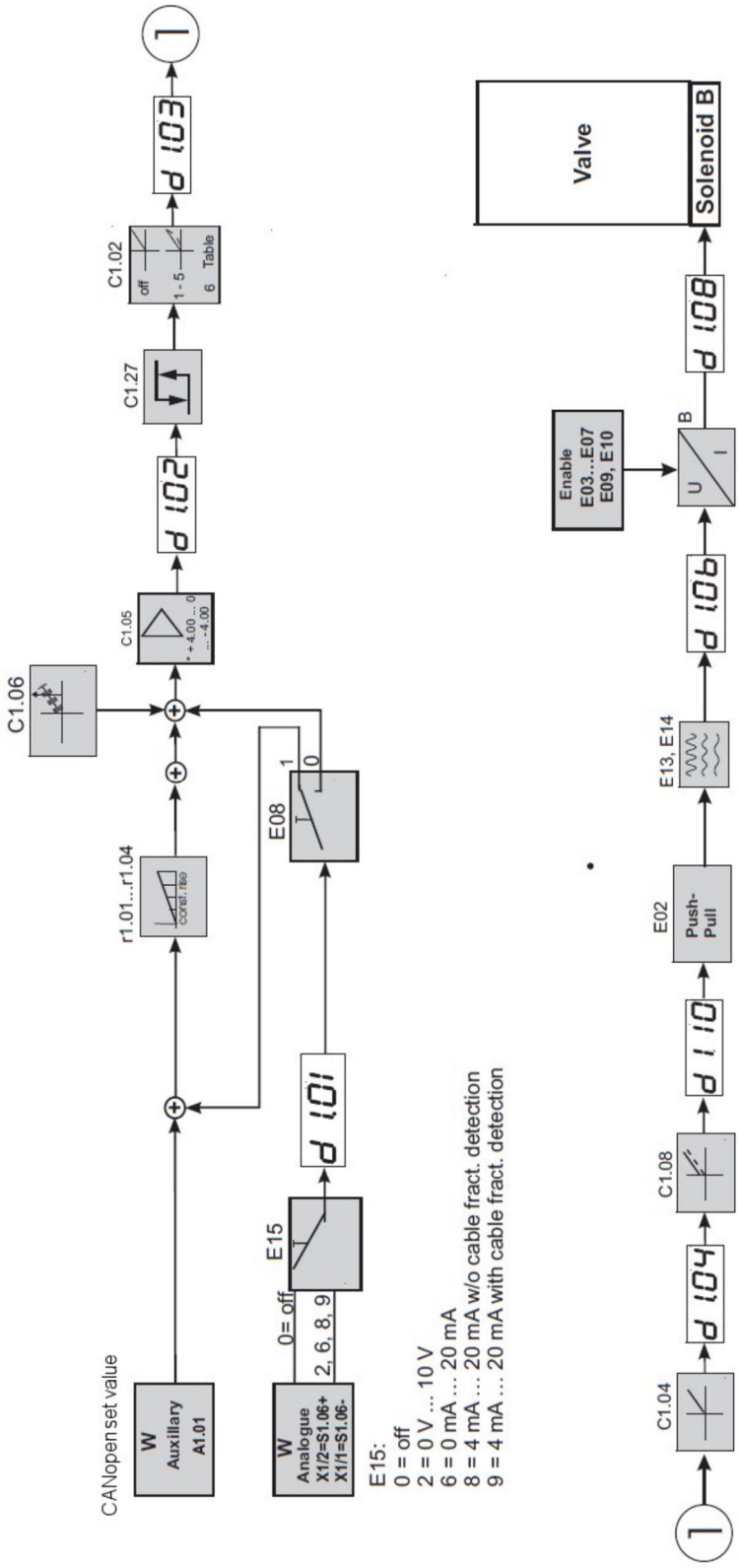


Figure 10: Block diagram mode 1

4.3.2 Signal routing and scaling

4.3.2.1 Spool position set point value path

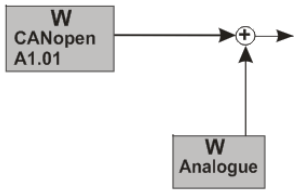


Figure 11: Object 0x6300: Setpoint A1.01

4.3.2.1.1 Object 0x6300: Set point

This parameter contains the spool position set point value which is received from the field bus.
The set point value <SplSetpoint> (0x6300) takes only effect if the <StatusWord> (0x6041) is 0111b ('ACTIVE') and the Parameter E 24 <Node id> 0x50bd contains a certain value. For disable the analog set-values the parameter E15, E16 <SelectionOfSetpoint> 0x506E, 0x506F have to set to 0 ,“off“.

ValvePositionControl							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6300	0	Number of entries	UINT8	ro	N	1	1
0x6300	1	Set point	INT16	wo	N	INT16	none

Value description

<ValvePositionControl >	
Value	Description
-9999	Minimal set point value == -9.999V
9999	Maximal set point value == 9.999V

Table 41: Possible values of parameter <Set point> (0x6300)

4.3.2.1.2 Object 0x6301: Actual current value

This parameter holds the actual current value of the solenoid output stage (d1.08).

HoldSetpoint							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6301	0	Number of entries	UINT8	ro	N	1	1
0x6301	1	ActualCurrentValue	INT16	ro	N	INT16	-

Value description

< ActualValue >	
Value	Description
0	Minimal solenoid current value == 0 mA
9999	Maximal solenoid current value == 9999 mA

Table 42: Possible values of parameter < Actual current value > (0x6301)

4.3.2.1.3 Object 0x6314: Hold setpoint

This parameter defines the spool position hold setpoint value. Default value defined by parameter S1.08 0x501A

HoldSetpoint							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6314	0	Number of entries	UINT8	ro	N	1	1
0x6314	1	HoldSetpoint	INT16	wo	N	INT16	S1.08

Value description

<HoldSetpoint >	
Value	Description
-9999	Minimal hold set point value == -9.999V
9999	Maximal hold set point value == 9.999V

Table 43: Possible values of parameter <Hold setpoint> (0x6314)

4.3.2.2 Spool position set point ramp function

The ramp function limits the slew rate of the input signal. The <Type> (0x6330) parameter is used to activate a one-quadrant ramp or to deactivate the ramp function.

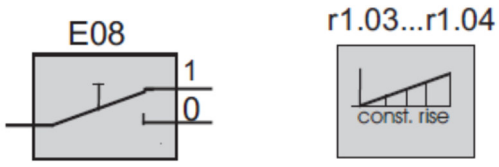


Figure 12: Object 0x6330..0x6336: Ramp function E08 r1.01..r1.04

4.3.2.2.1 Object 0x6330: Type

This parameter defines the slope rate of the ramp dependent on the direction of movement.

ValvePositionControl_DemandValueGenerator_Ramp							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6330	0	Type	INT8	ro	N	0..1	1

Value description

<Type>	
Value	Description
0	the ramp is by-passed and no ramp is active
1	constant rise rate ramp active

Table 44: Possible values of parameter <Type> (0x6330)

4.3.2.2.2 Object 0x6332: Acceleration time positive

This parameter defines the output signal's maximum rate of change on the positive side. The acceleration time corresponds to the time the signal needs for a change from 0 to 100 %. The acceleration time is specified with a resolution of 10 ms.

ValvePositionControl_DemandValueGenerator_Ramp							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6332	0	Number of entries	UINT8	ro	N	1	1
0x6332	1	AccelerationTimePositive	UINT16	rw	Y	0..3950	0

Table 45: Possible values of parameter < Acceleration time positive > (0x6332)

4.3.2.2.3 Object 0x6335: Deceleration time positive

This parameter defines the output signal's maximum rate of change on the positive side. The deceleration time corresponds to the time the signal needs for a change from 0 to 100 %. The acceleration time is specified with a resolution of 10 ms.

ValvePositionControl_DemandValueGenerator_Ramp							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x6335	0	Number of entries	UINT8	ro	N	1	1
0x6335	1	DecelerationTimePositive	UINT16	rw	Y	0..3950	0

Table 46: Possible values of parameter < Deceleration time positive > (0x6335)

4.4 Amplifier functions

4.4.1 Manufacturer specific profile area

The parameters listed are the overall available parameters of this product line (DAP-22).
For parameters of specific application versions please refer to the according software block diagrams.
see: □ Chapter “4.3.1 Block diagram", page 39

4.4.1.1 Object 0x5000: Vers, Software version

This object defines the firmware version of the amplifier.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5000	0	Vers	UINT16	ro	-	0..9999	-

Value description

<Vers>	
Value	Description
202	Meaning version V2.02

Table 47: Possible values of parameter <Vers> (0x5000)

4.4.1.2 Object 0x5001: d1.01, Sum of analog set value

This object defines the sum of all given analog set values to the amplifier.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5001	0	d1.01	INT16	ro	-	-9999. .+9999	0

Value description

<d1.01>	
Value	Description
-1000	Sum of analog values == -1.000V
1000	Sum of analog values == 1.000V

Table 48: Possible values of parameter <d1.01> (0x5001)

4.4.1.3 Object 0x5002: d1.02, Sum of all post ramp set values

This object defines the set value after processing internal functions. See table “Mode description” for more info.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5002	0	d1.02	INT16	ro	-	-9999. .+9999	0

Value description

<d1.02>	
Value	Description
-1000	Set value == -1.000V
1000	Set value == 1.000V

Table 49: Possible values of parameter <d1.02> (0x5002)

4.4.1.4 Object 0x5003: d1.03, Set values after linearization

This object defines the set value after processing internal functions. See table “Mode description” for more info.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5003	0	d1.03	INT16	ro	-	-9999. .+9999	0

Value description

<d1.03>	
Value	Description
-1000	Set value == -1.000V
1000	Set value == 1.000V

Table 50: Possible values of parameter <d1.03> (0x5003)

4.4.1.5 Object 0x5004: d1.04, Value after gain adjustment

This object defines the internal set value after function: gain adjustment.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5004	0	d1.04	INT16	ro	-	-9999. .+9999	0

Value description

<d1.04>	
Value	Description
-1000	Set value == -1.000V
1000	Set value == 1.000V

Table 51: Possible values of parameter <d1.04> (0x5004)

4.4.1.6 Object 0x5006: d1.06, Signal to solenoid

This object defines the value which is driving solenoid B.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5006	0	d1.06	INT16	ro	-	0. .9999	0

Value description

<d1.06>	
Value	Description
1000	Value == 1.000V

Table 52: Possible values of parameter <d1.06> (0x5006)

4.4.1.7 Object 0x5008: d1.08, Solenoid current

This object defines the value of the measured current which is passed through solenoid B.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5008	0	d1.08	INT16	ro	-	0. .9999	0

Value description

<d1.08>	
Value	Description
1000	Value == 1.000A

Table 53: Possible values of parameter <d1.08> (0x5008)

4.4.1.8 Object 0x500A: d1.10, Desired value

This object defines the set value after processing internal functions. value of <d1.04> (0x5004) after function: deadband compensation.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x500A	0	d1.10	INT16	ro	-	-9999. .+9999	0

Value description

<d1.10>	
Value	Description
-1000	Set value == -1.000V
1000	Set value == 1.000V

Table 54: Possible values of parameter <d1.10> (0x500A)

4.4.1.9 Object 0x500E: d2.01, Actual supply voltage

This object defines the actual supply voltage of the device. If the supply voltage is beyond the internal working voltage of 3.3V, the parameter shows the internal USB voltage of 3V.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x500E	0	d2.01	INT16	ro	-	0. .+4000	0

Value description

<d2.01>	
Value	Description
300	Sum of analog values == 3.00 V
1200	Sum of analog values == 12.00V
2400	Sum of analog values == 24.00V

Table 55: Possible values of parameter <d2.01> (0x500E)

4.4.1.10 Object 0x501A: S1.08, Hold set point

This object defines a digital set value which could give to the amplifier. See table “Mode description” for more info.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x501A	0	S1.08	INT16	rw	-	-9999. .+9999	0

Value description

< Hold set point >	
Value	Description
-1000	Set value == -1.000V
1000	Set value == 1.000V

Table 56: Possible values of parameter <S1.08> (0x501A)

4.4.1.11 Object 0x501D: r1.03, Ramp from 0 -> +

This object defines the ramp time which is valid for changes at set value in positive direction, if the value is zero or more.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x501D	0	r1.03	UINT16	rw	-	0. .3950	0

Value description

<r1.03>	
Value	Description
0550	Ramptime == 5,5 seconds
1000	Ramp time == 10 seconds

Table 57: Possible values of parameter <r1.03> (0x501D)

4.4.1.12 Object 0x501E: r1.04, Ramp from + -> 0

This object defines the ramp time which is valid for changes at set value in negative direction, if the value is zero or more.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x501E	0	r1.04	UINT16	rw	-	0. .3950	0

Value description

<r1.04>	
Value	Description
0550	Ramptime == 5,5 seconds
1000	Ramp time == 10 seconds

Table 58: Possible values of parameter <r1.04> (0x501E)

4.4.1.13 Object 0x501F: A1.01, CANopen set value

This object defines the digital set value which is given by CANopen. See table “Mode description” for more info.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x501F	0	A1.01	INT16	rw	-	-9999. .+9999	0

Value description

<A1.01>	
Value	Description
-1000	Set value == -1.000V
1000	Set value == 1.000V

Table 59: Possible values of parameter <A1.01> (0x501F)

4.4.1.14 Object 0x502B: C1.02, Linearization

This object defines the type of linearization which is used to operate with different valve characteristics.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x502B	0	C1.02	UINT16	rw	-	0...6	0

Value description

<C1.02>	
Value	Description
0	function deactivated
1	general linearization for NC curve
2	linearization for proportional directional valves with flow characteristic >10 l/min (NG6)
3	linearization for proportional directional valves with flow characteristic at 10 l/min (NG6)
4	linearization for proportional directional valves with flow characteristic > 50 l/min (NG10)
5	linearization for proportional pressure valves
6	customized curve, referring to parameter <L1.x0>(50C4) to <L1.y8>(50D7)

Table 60: Possible values of parameter <C1.02> (0x502B)

4.4.1.15 Object 0x502D: C1.04, Gain solenoid

This object defines the value which is used for amplification adjustment at positive setvalues (e.g. the speed of differential cylinders).

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x502D	0	C1.04	UINT16	rw	-	0 - 200	100

Value description

<C1.04>	
Value	Description
0	positive set value is multiplicity by 0, so new set value is zero
100	positive set value is multiplicity by 1.00, so new set value is not changed
200	positive set value is multiplicity by 2.00, so new set value is doubled

Table 61: Possible values of parameter <C1.04> (0x502D)

4.4.1.16 Object 0x502E: C1.05, Set value sign and gain

This object defines the value which is used for exchange the polarity sign of the set points or to adapt the signal or in order to completely deactivate the signal. This enables to change the direction of a valve as well as the scaling of the set point signals.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x502E	0	C1.05	INT16	rw	-	-400… +400	100

Value description

<C1.05>	
Value	Description
-200	set value is multiplicity by -200, so new set value is inverted and doubled
0	set value is multiplicity by 0, so new set value is zero
100	set value is multiplicity by 1.00, so new set value is not changed
200	set value is multiplicity by 2.00, so new set value is doubled

Table 62: Possible values of parameter <C1.05> (0x502E)

4.4.1.17 Object 0x502F: C1.06, Set value offset

This object defines the value which is used to correct the drift of the drive or hydraulic system by an offset.
The offset can also be regarded as an additional set point.
This allows a very fine positioning of the system e.g. if it is used on a NC axis.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x502F	0	C1.06	INT16	rw	-	-9999… +9999	0

Value description

<C1.06>	
Value	Description
-1000	set value is decreased by 1.000V
0	set value is not changed
+1000	set value is increased by 1.000V

Table 63: Possible values of parameter <C1.06> (0x502F)

4.4.1.18 Object 0x5031: C1.08, Dead band compensation

This object defines the value which is used to compensate a possible spool overlap for solenoid B.
The compensation works as an additional set point that is activated as soon as the polarity of the set point changes to positive. Overlaps of valve are empirically around 10 % to 15 % of full stroke (depending on manufacturer and valve type!). The setting has a decisive effect on the quality (precision and speed) when positioning the axis drives.
The amplification in the small signal range is essentially determined by this function.
The pre-set value is directly applied as a current on the solenoids. The programming is standardized in volt, 9.999 V equals the maximum set current.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5031	0	C1.08	UINT16	rw	-	0....9999	0

Value description

<C1.08>	
Value	Description
0	No additional current is given, set value is not changed
1000	set value is increased by 1.000V

Table 64: Possible values of parameter <C1.08> (0x5031)

4.4.1.19 Object 0x50A4: C1.27, Hysteresis command A

This object defines the value of the hysteresis command.
This parameter is used in order to create a “artificial” dead band for the command inputs around “0”. When set than the command input will be ignored up to the adjusted values and will start with “0” from this point on. It can be used to avoid a too sensitive reaction (e.g. when using joy-stick as signal source).

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50A4	0	C 1.27	UINT16	rw	-	0…9999	0

Value description

<C 1.27>	
Value	Description
0	Value == 0
100	Value == 0.1V
1000	Value == 1.000V

Table 65: Possible values of parameter <C 1.27> (0x50A4)

4.4.1.20 Object 0x505F: E 00, Operation mode (depends on HW + SW version)

This object defines the value how the module itself will work. The possible operation mode is depending on HW and Software version of the device

Du to safety condition, the operation mode of the device can only be changed via HCSTool without HW enable applied to the device.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x505F	0	E 00	UINT16	r	-	1	1

Value description (The possible value is depending on HW and Software version of the device)

<E 00>	
Value	Description
1	Open loop, 1 valve

Table 66: Possible values of parameter <E 00> (0x505F)

4.4.1.21 Object 0x5061: E 02 Monitoring of the solenoid output

This object defines if a wire break at the solenoid outputs forces an internal error.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5061	0	E 02	UINT16	rw	-	0,4	0

Value description

<E 02>	
Value	Description
0	Wire break monitoring deactivated
1	reserved
2	reserved
3	reserved
4	Wire break monitoring activated

Table 67: Possible values of parameter <E 02> (0x5061)

4.4.1.22 Object 0x5062: E 03, Solenoid selection

This object defines the value which set the nominal current through the solenoids at maximum setvalue.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5062	0	E 03	UINT16	rw	-	1.....7	6

Value description

<E 03>	
Value	Description
1	800mA
2	1100mA
3	1300mA
4	1600mA
5	2400mA
6	2700mA
7	3500mA

Table 68: Possible values of parameter <E 03> (0x5062)

4.4.1.23 Object 0x5063: E 04, P-Portion current controller energization

This object defines the energization P-Portion value for the solenoid.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5063	0	E 04	UINT16	rw	-	0..9999	500

Value description

<E 04>	
Value	Description
0	Value == 0
2000	Value == 2000
9999	Value == 9999

Table 69: Possible values of parameter <E 04> (0x5063)

4.4.1.24 Object 0x5064: E 05, I-Portion current controller energization

This object defines the energization I-Portion value for the solenoid.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5064	0	E 05	UINT16	rw	-	0..9999	500

Value description

<E 05>	
Value	Description
0	Value == 0
2000	Value == 2000
9999	Value == 9999

Table 70: Possible values of parameter <E 05> (0x5064)

4.4.1.25 Object 0x5065: E 06, P-Portion current controller de-energization

This object defines the DE energization P-Portion value for the solenoid.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5065	0	E 06	UINT16	rw	-	0..9999	1300

Value description

<E 06>	
Value	Description
0	Value == 0
2000	Value == 2000
9999	Value == 9999

Table 71: Possible values of parameter <E 06> (0x5065)

4.4.1.26 Object 0x5066: E 07, I-Portion current controller de-energization

This object defines the DE energization I-Portion value for the solenoid.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5066	0	E 07	UINT16	rw	-	0..9999	500

Value description

<E 07>	
Value	Description
0	Value == 0
2000	Value == 2000
9999	Value == 9999

Table 72: Possible values of parameter <E 07> (0x5066)

4.4.1.27 Object 0x5067: E 08, Ramp selection

This object defines the type of ramp which is used for handling the analog setvalue.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5067	0	E 08	UINT16	rw	-	0..1	1

Value description

<E 08>	
Value	Description
0	Ramp deactivated
1	All set values will be processed, (constant time)

Table 73: Possible values of parameter <E 08> (0x5067)

4.4.1.28 Object 0x5069: E 10, Solenoid current adaptation

This object defines the value to adjust the solenoid current.
This parameter allows a fine and variable adjustment and this also allows to adjust the already set maximum current.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5069	0	E 10	UINT16	rw	-	50…110	100

Value description

<E 10>	
Value	Description
50	Current is set to 50%
100	Current is set to 100%
110	Current is set to 110%t

Table 74: Possible values of parameter <E 10> (0x5069)

4.4.1.29 Object 0x506B: E 12, Initial current solenoid

This object defines the value how to set an additional set value for solenoid.
Initial current is used, e.g. for valves with feedback, to keep the bolt of the magnet always at the spool. This places the spool solidly between the solenoids and prevents the spool being hit by the bolt of the solenoid. An initial magnetizing helps to improve the reaction of the solenoids.
The programming is done in Volt: the programmable maximum current is 10 V.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x506B	0	E 12	UINT16	rw	-	0..9999	0

Value description

<E 12>	
Value	Description
0	Value == 0
1000	Value == 1.000V
9999	Value == 9.999V

Table 75: Possible values of parameter <E 12> (0x506B)

4.4.1.30 Object 0x506C: E 13, Dither Amplitude

This object defines the value of the dither amplitude.
The dither function can be matched to the valve or to the process with the parameters E13 (for the amplitude) and E14 (for the frequency). This is independent of the used operation modes and has an effect on both output stages. The frequency of the signal is adjusted stepwise. The dither signal reduces the hysteresis of the valve or drive movement and improves the reaction of the system. This has positive effects on the precision and repeatability.

In general, low frequency signals are more effective, but they can result in noticeable disturbances (noise, oscillations). Values under 100 Hz are for systems with a low characteristic frequency, higher values are used for systems with a high characteristic frequency. Dither amplitudes are set for a range of 2% to 12% (related to current or set point).
Dither signals have an influence on the characteristic curve of the current caused by a physical dynamic correlation. In some cases, this has an effect on the linearity from U to I.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x506C	0	E 13	UINT16	rw	-	0..3000	0

Value description

<E 13>	
Value	Description
0	Value == 0
1000	Value == 1.000V
3000	Value == 3.000V

Table 76: Possible values of parameter <E 13> (0x506C)

4.4.1.31 Object 0x506D: E 14, Dither Frequency

This object defines the value of the dither frequency.
The dither function can be matched to the valve or to the process with the parameters E13 (for the amplitude) and E14 (for the frequency). This is independent of the used operation modes and has an effect on both output stages. The frequency of the signal is adjusted stepwise. The dither signal reduces the hysteresis of the valve or drive movement and improves the reaction of the system. This has positive effects on the precision and repeatability.

In general, low frequency signals are more effective, but they can result in noticeable disturbances (noise, oscillations). Values under 100 Hz are for systems with a low characteristic frequency, higher values are used for systems with a high characteristic frequency. Dither amplitudes are set for a range of 2% to 12% (related to current or set point).
Dither signals have an influence on the characteristic curve of the current caused by a physical dynamic correlation. In some cases, this has an effect on the linearity from U to I.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x506D	0	E 14	UINT16	rw	-	0….300	0

Value description

<E 14>	
Value	Description
0	Value == 0
100	Value == 100 Hz
300	Value == 300 Hz

Table 77: Possible values of parameter <E 14> (0x506D)

4.4.1.32 Object 0x506E: E 15, Selection set point S1.06 (U/I)

This object defines the value how S1.06 will be work.
This parameter is used in order to select the type of analog set point. Either a voltage input or a current input can be selected.
If current input is selected than the measuring resistance (250 Ω) is activated.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x506E	0	E 15	UINT16	rw	-	0…..9	1

Value description

<E 15>	
Value	Description
0	deactivated
1	reserved
2	Voltage input; range: 0….+10V
3	reserved
4	Voltage input; range: 5V….+/- 4.5V without cable fracture detection
5	Voltage input; range: 5V….+/- 4.5V with cable fracture detection
6	Current input; range: 0….20mA, without cable fracture detection
7	reserved
8	Current input; range: 4….20mA, without cable fracture detection
9	Current input; range: 4….20mA, with cable fracture detection

Table 78: Possible values of parameter <E 15> (0x506E)

4.4.1.33 Object 0x5072: E 20, Current level for signalizing green LED

The magnet current can be visually monitored with the help of the “green” LED. The set current threshold E 20 can be used for this. If the output current for the magnet is below threshold E20, the green LED flashes in a 1s rhythm. If the output current is above the threshold E 20, the LED lights up permanently.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x5072	0	E 20	INT16	rw	-	0… 1000	200

Value description

<E 20>	
Value	Description
0	Level for Solenoid current is zero “green” LED is permanently on
200	Level for Solenoid current is 200 mA

Table 79: Possible values of parameter <E 20> (0x5072)

4.4.1.34 Object 0x50B1: E 23, Automatic error reset time

This parameter can be used to activate an automated error reset. For any value > 0 the error will be reset automatically by the unit. If cause for error is persistent than the error status will persist as well and the error cannot be reset.

Please note that if the CANopen protocol is active, an automatic error reset does not make sense. Since the DSM <StatusWord> changes due to an internal error, access to the DSM <ControlWord> via CANopen is necessary.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50B1	0	E 23	INT16	rw	-	0… 9999	0

Value description

<E 20>	
Value	Description
0	The function is deactivated
3000	After 30 seconds the pending error will be reset

Table 80: Possible values of parameter <E 20> (0x5072)

4.4.1.35 Object 0x50CB: E 24, CANopen Node-ID (if Node-ID=0 CAN is deactivated)

This object defines the value of the Node-ID which is needed to address the single modules.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50CB>	0	E 24	INT16	rw	-	0..- ..+127	127

Value description

<E 24>	
Value	Description
0	CAN-Bus is deactivated
50	Node-ID is set to 50

Table 81: Possible values of parameter <E 24> (0x50CB)

4.4.1.36 Object 0x50CC: E 25, CANopen baud rate

This object defines the value of the CANopen baud rate.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50CC	0	E 25	UINT16	rw	-	1…..7	3

Value description

<E 25>	
Value	Description
1	20 KBit/s
2	50 KBit/s
3	125 KBit/s
4	250 KBit/s
5	500 KBit/s
6	800 KBit/s
7	1 MBit/s

Table 82: Possible values of parameter <E 25> (0x50CC)

4.4.1.37 Object 0x50CD: E 26, CANopen NMI-Startup behavior

This object defines the operational state after startup. This parameter also changes the data object 0x1F80

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50CD	0	E 26	UINT16	rw	-	0.. 1	0

Value description

<E 26>	
Value	Description
0	The amplifier moves automatically to the "Operational" state. .
1	The amplifier does not automatically move to the "Operational" state. The status change is defined through the respective application.

Table 83: Possible values of parameter <E 26> (0x50CD)

4.4.1.38 L1: Linearization curve 1

The following objects define the values which are used to generate a user defined linearization curve. Those parameters affect the curve only if C1.02 is set to “6”.

Every value along the curve must be equal or bigger than its predecessor

See table “Mode description” for more info.

Mode description, refer to □ Chapter "4.3.1 Block diagram", page 39

<L1>	
Operation Mode	Description
1,3,4,6	User defined linearization curve

Table 84: Function of parameter referenced to block diagram <L2> (0x50F8) – (0x5109)

4.4.1.38.1 Object 0x50E6: L1.x0 Linearization curve [0,0]

This object defines the value for the first input value in the curve. This value is always fixed to zero and can’t be changed.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50E6	0	L1.x0	UINT16	rw	-	0	0

Value description

<L1.x0>	
Value	Description
0	Value == 0.000V

Table 85: Possible values of parameter <L1.x0> (0x50E6)

4.4.1.38.2 Object 0x50E7: L1.y0 Linearization curve [0,0]

This object defines the value for the first output value in the curve. It describes the output depending on defined input signal at L1.x0.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50E7	0	L1.y0	UINT16	Rw	-	0….9999	0

Value description

<L1.y0>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 86: Possible values of parameter <L1.y0> (0x50E7)

4.4.1.38.3 Object 0x50E8: L1.x1 Linearization curve [1,1]

This object defines the value for the second input value in the curve.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50E8	0	L1.x1	UINT16	rw	-	0….9999	1250

Value description

<L1.x1>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 87: Possible values of parameter <L1.x1> (0x50E8)

4.4.1.38.4 Object 0x50E9: L1.y1 Linearization curve [1,1]

This object defines the value for the second output value in the curve. It describes the output depending on defined input signal at L1.x1.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50E9	0	L1.y1	UINT16	rw	-	0….9999	1250

Value description

<L1.y1>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 88: Possible values of parameter <L1.y1> (0x50E9)

4.4.1.38.5 Object 0x50EA: L1.x2 Linearization curve [2,2]

This object defines the value for the third input value in the curve.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50EA	0	L1.x2	UINT16	rw	-	0….9999	2500

Value description

<L1.x2>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 89: Possible values of parameter <L1.x2> (0x50EA)

4.4.1.38.6 Object 0x50EB: L1.y2 Linearization curve [2,2]

This object defines the value for the third output value in the curve. It describes the output depending on defined input signal at L1.x2.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50EB	0	L1.y2	UINT16	rw	-	0….9999	2500

Value description

<L1.y2>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 90: Possible values of parameter <L1.y2> (0x50EB)

4.4.1.38.7 Object 0x50EC: L1.x3 Linearization curve [3,3]

This object defines the value for the 4th input value in the curve.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50EC	0	L1.x3	UINT16	rw	-	0….9999	3750

Value description

<L1.x3>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 91: Possible values of parameter <L1.x3> (0x50EC)

4.4.1.38.8 Object 0x50ED: L1.y3 Linearization curve [3,3]

This object defines the value for the 4th output value in the curve. It describes the output depending on defined input signal at L1.x3.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50ED	0	L1.y3	UINT16	rw	-	0….9999	3750

Value description

<L1.y3>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 92: Possible values of parameter <L1.y3> (0x50ED)

4.4.1.38.9 Object 0x50EE: L1.x4 Linearization curve [4,4]

This object defines the value for the 5th input value in the curve.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50EE	0	L1.x4	UINT16	rw	-	0….9999	5000

Value description

<L1.x4>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 93: Possible values of parameter <L1.x4> (0x50EE)

4.4.1.38.10 Object 0x50EF: L1.y4 Linearization curve [4,4]

This object defines the value for the 5th output value in the curve. It describes the output depending on defined input signal at L1.x4.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50FF	0	L1.y4	UINT16	rw	-	0….9999	5000

Value description

<L1.y4>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 94: Possible values of parameter <L1.y4> (0x50EF)

4.4.1.38.11 Object 0x50F0: L1.x5 Linearization curve [5,5]

This object defines the value for the 6th input value in the curve.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F0	0	L1.x5	UINT16	rw	-	0….9999	6250

Value description

<L1.x5>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 95: Possible values of parameter <L1.x5> (0x50F0)

4.4.1.38.12 Object 0x50F1: L1.y5 Linearization curve [5,5]

This object defines the value for the 6th output value in the curve. It describes the output depending on defined input signal at L1.x5.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F1	0	L1.y5	UINT16	rw	-	0….9999	6250

Value description

<L1.y5>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 96: Possible values of parameter <L1.y5> (0x50F1)

4.4.1.38.13 Object 0x50F2: L1.x6 Linearization curve [6,6]

This object defines the value for the 7th input value in the curve.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F2	0	L1.x6	UINT16	rw	-	0….9999	7500

Value description

<L1.x6>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 97: Possible values of parameter <L1.x6> (0x50F2)

4.4.1.38.14 Object 0x50F3: L1.y6 Linearization curve [6,6]

This object defines the value for the 7th output value in the curve. It describes the output depending on defined input signal at L1.x6.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F3	0	L1.y6	UINT16	rw	-	0….9999	7500

Value description

<L1.y6>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 98: Possible values of parameter <L1.y6> (0x50F3)

4.4.1.38.15 Object 0x50F4: L1.x7 Linearization curve [7,7]

This object defines the value for the 8th input value in the curve.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F4	0	L1.x7	UINT16	rw	-	0….9999	8750

Value description

<L1.x7>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 99: Possible values of parameter <L1.x7> (0x50F4)

4.4.1.38.16 Object 0x50F5: L1.y7 Linearization curve [7,7]

This object defines the value for the 8th output value in the curve. It describes the output depending on defined input signal at L1.x7.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F5	0	L1.y7	UINT16	rw	-	0….9999	8750

Value description

<L1.y7>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 100: Possible values of parameter <L1.y7> (0x50F5)

4.4.1.38.17 Object 0x50F6: L1.x8 Linearization curve [8,8]

This object defines the value for the 9th input value in the curve. This value is always fixed to 9.999 and can't be changed.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F6	0	L1.x8	UINT16	rw	-	9999	9999

Value description

<L1.x8>	
Value	Description
9999	Value == 9.999V

Table 101: Possible values of parameter <L1.x8> (0x50F6)

4.4.1.38.18 Object 0x50F7: L1.y8 Linearization curve [8,8]

This object defines the value for the 9th output value in the curve. It describes the output depending on defined input signal at L1.x8.

CANopen							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x50F7	0	L1.y8	UINT16	rw	-	0….9999	9999

Value description

<L1.y8>	
Value	Description
0	Value == 0.000V
1000	Value == 1.000V

Table 102: Possible values of parameter <L1.y8> (0x50F7)

4.4.2 Device profile area

4.5 Diagnostics

4.5.1 Fault reaction

If a malfunction occurs, the amplifier software throws a fault. The corresponding fault is set in the fault state <FaultStatus> (0x4300). The fault reaction is described in the fault reaction chart.
At least an emergency message is sent and the <Error-Register> (0x1001) parameter will be set according to the error group of the fault code. Then the fault code and the error code are saved in an array <StandardErrorField> (0x1003) which holds the last four thrown faults.
If the configured fault reaction of the actual thrown fault requests a change of the device state, the corresponding transition of the device state machine will be forced.

4.5.1.1 Fault reaction flow chart

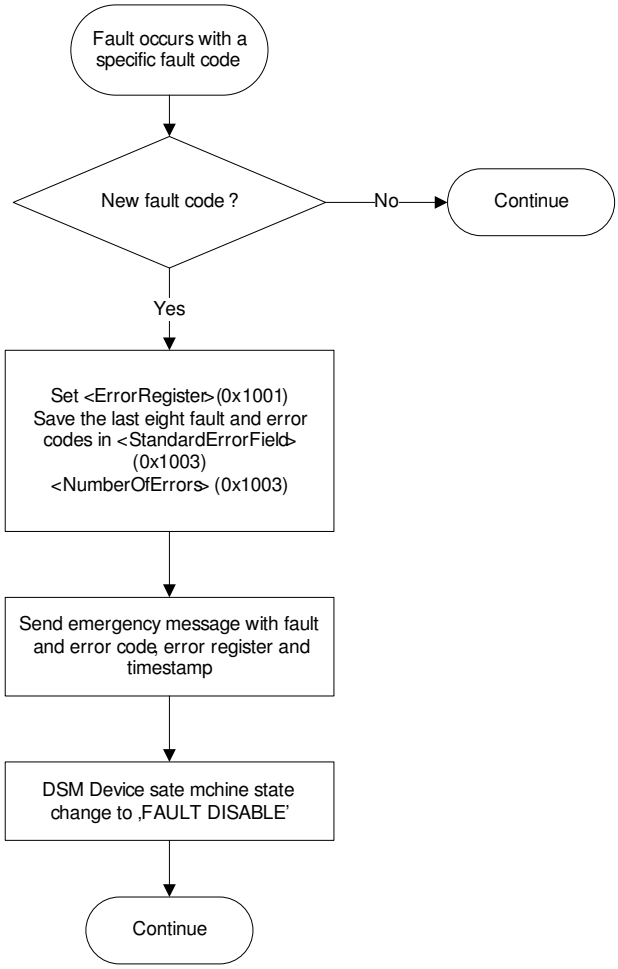


Figure 13: Fault reaction flow chart

4.5.1.2 Possible fault codes

The possible fault codes are shown in the following table. The possible error code is depending on the operation mode of the device. The fault code 0 means that no fault is pending.

Fault code		Description
Dec.	Hex.	
0	0x00	Error reset or no error
1	0x01	reserved
2	0x02	reserved
3	0x03	Short circuit at the output stages
4	0x04	reserved
5	0x05	reserved
6	0x06	Wire break at analog input S1.06
7	0x07	reserved
8	0x08	Wire break at the output stages
9	0x09	reserved
10	0x0A	CAN error, Receiving error
11	0x0B	reserved
12	0x0C	CAN connection error, no connection to CAN master
13	0x0D	CAN timeout error
14	0x0E	reserved
15	0x0F	reserved
16	0x10	Overload of current input S1.06 (> 22mA)
15..22	0x11..16	reserved
23	0x17	reserved
24..31	0x18..1D	reserved
30	0x1E	Lifeguard or heartbeat error
31	0x1F	reserved
32	0x20	CANopen error: Transmit of data causing error
33..63	0x21..3F	reserved
64	0x40	CANopen error: Receiving data causing error
65..91	0x41..5B	reserved
92	0x5C	CANopen error: Data transmission error
93..127	0x5D..7F	reserved
128	0x80	CANopen error: General error
129	0x81	CANopen error: Transmit PDO mapping error
130	0x82	CANopen error: Receive PDO mapping error
131	0x83	CANopen error: General mapping error
132..255	0x84..FF	reserved

Table 103: Possible fault codes

4.5.1.3 Error codes depending on HCS fault codes

The following table combines the HCS specific fault codes with the error codes, send with an emergency message. (CiA profile defined codes)

HCS fault code	Profile error code	Error description	Error register value
5,6,7	0x5231,32,33	set value sensor input S1.06 wire break	0x07
15,16,17	0x5231,32,33	set value sensor input S1.06 overcurrent	0x02
3	0x2303	Error on the output stages (short circuit)	0x02
8	0x2308	Error on the output stages (open circuit)	0x02
128,129,130,131	0x6000	CANopen device software generic	0x20
32,64	0x8100	Communication generic	0x10
30	0c8130	Guarding error	0x10
rest	0x1000	Generic error	0x01

Table 104: Possible error codes depending on fault codes

4.5.1.4 Object 0x4300: Fault status

The fault status indicates which faults are currently reported for the device

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x4300	0	FaultStatus	UINT8	ro	-	UINT8	None

Value description, see □ Chapter "0 Object 0x1018: Identity object", page 59

4.5.1.5 Object 0x1001: Error register

This object shall provide error information. The CANopen device maps internal errors into this object. This information is also sent with the emergency object.

Device							
Index	Sub-Index	Parameter name	Data type	Access	non-volatile	Range	Default
0x1001	0	ErrorRegister	UINT8	ro	-	UINT8	None

Value description

<ErrorRegister> Bit	Error description	Value in Hex
0	Generic error (any error)	0x01
1	Current error	0x02
2	Voltage error	0x04
3	Temperature error	0x08
4	Communication error	0x10
5	Device profile specific	0x20
6	Reserved	0x40
7	Manufacture specific	0x80

Table 105: Possible values of parameter <ErrorRegister> (0x1001)

If a specific error occurs, the corresponding bit shall be set to 1b. The bits are cleared automatically when the error is gone.

4.5.1.6 Object 0x1003: Predefined error field

Every time a fault occured which triggered a fault reaction, information about the fault is stored to the <StandardErrorField> (0x1003) parameter array. The <StandardErrorField> (0x1003) parameter array contains a list of up to 4 entries. This error code provides information about the reason of the error. The parameter <NumberOfErrors> (0x1003) holds information about the number of errors currently recorded. Every new error is stored in the first element of the parameter array <StandardErrorField> (0x1003), the older ones move down in the list. If the maximum number of entries is reached and a new fault occurred the oldest fault information will be deleted. Writing the value 0 to the object <NumberOfErrors> (0x1003), sub-index 0, deletes the entire error code entries
Note: if no error is present the value of sub-Index 0 is zero and a read access to sub-index 1 is responded with an SDO abort message.

Device							
Index	Sub-Index	Parameter name	Data type	Access	Non-volatile	Range	Default
0x1003	0	NumberOfErrors	UINT8	rw	-	0..4	0
0x1003	1..4	StandardErrorField	UINT32	ro	-	UINT32	None

Value description

Parameter	Description
<NumberOfErrors>	Number of actual recorded errors.
<StandardErrorField>	Array of recorded errors.

Table 106: Possible values of parameter <PreDefinedErrorField> (0x1003)

StandardErrorField				
Byte	3	2	1	0
Description	Reserved	Fault code (HCS)	Error code	

- Description of Value Byte 2, see □ Chapter "4.5.1.2 Possible fault codes", page 59
- Description of Value Byte 0,1, see □ Chapter "4.5.1.3 Error codes depending on HCS fault codes", page 60

4.5.1.7 EMCY Emergency message

Every time a configured error occurs on the amplifier, it sends an emergency message with error register, error code and timestamp to the master. The emergency message will also be sent if all errors has disappeared. In this case the fault code 0x00 (Error reset or no error) will be sent.
The CAN identifier of the emergency message is stored in the device object dictionary under object 0x1014
□ Chapter "3.9.2.1 Object 0x1014: EMCY protocol COB-ID configuration", page 20
□ Chapter "4.5.1.2 Possible fault codes", page 59
□ Chapter "4.5.1.3 Error codes depending on HCS fault codes", page 60

The coding of the emergency message is as follows:

Byte	7	6	5	4	3	2	1	0
Description	HCS specific					CiA specific		
	Power on time in minutes				Fault code (HCS)	Error register	Error code	

The displayed byte order of the transmitted emergency message is depending on the field bus master.

Example:
In the example below a simple reproducible fault is described. The fault code 0x03 (short circuit at the output stages) is pending. The corresponding error code is 0xFF00 and the <ErrorRegister> (0x1001) is set to 0x80. The time since power on of the amplifier until the fault occurred is 1000 or in hex 0x03E8 minutes.

Byte	7	6	5	4	3	2	1	0
Content	0x00	0x00	0x03	0xE8	0x03	0x80	0xFF	0x00
Result	0x000003E80380FF00							

4.5.2 Fault disappears

If all faults have disappeared the <ErrorRegister> (0x1001) are set to zero. To confirm that no faults are present, the error code 0x00 (Error reset or no error) will be sent via an emergency message to the field bus master. If the device state machine (DSM) is in the state 'FAULT_HOLD','FAULT_DISABLED' or 'NOT_READY', the DSM must be set to 'ACTIVE' again. This can be done by the #ControlWord# or the enable signal (digital input enable).
□ Chapter "4.5.3 Fault acknowledgement", page 62

4.5.3 Fault acknowledgement

Depending on the configured fault reaction an emergency message is send out by the device and changes the device state machine to the corresponding fault state.
□ Chapter "4.5.1 Fault reaction", page 59

In order to leave the fault state the fault must be acknowledged. This can be achieved by:

- Sending the #ControlWord# to the amplifier with the bit 3 (fault reset) is set.
  □ Chapter "4.2.3 Device state machine (DSM)", page 34
- Toggling the enable signal (digital input enable).
- Reset the application, by send the NMI command „Reset node“.
  □ Chapter "3.10.5 Reset node command (COB-ID:0, CS:129)", page 27

4.5.4 Abort SDO Transfer Protocol

The Service Data Object (SDO) is used to transmit / receive parameter values to / from the valve. If the SDO upload or download is not successful, the amplifier will send an Abort SDO (0x80 command) Transfer Protocol. The error description is coded in the data bytes.
step

SDO Abort Code	Description
0x05000000	General SDO protocol error detected.
0x05030000	Toggle bit not alternated.
0x05040000	SDO protocol timeout.
0x05040001	Client/server command specifier not valid or unknown.
0x05040002	Invalid block size (block mode only).
0x05040003	Invalid sequence (block mode only).
0x05040004	CRC error (block mode only).
0x05040005	Out of memory.
0x06010000	Unsupported access to an object.
0x06010001	Attempt to read a write only object.
0x06010002	Attempt to write a read only object.
0x06020000	Object does not exist in the object dictionary.
0x06040041	Object cannot be mapped PDO.
0x06040042	The number and length of the objects to be mapped would exceed PDO length.
0x06040043	General parameter incompatibility reason.
0x06040047	General internal incompatibility in the device.
0x06060000	Access failed due to hardware error.
0x06070010	Data type / length of service data does not match.
0x06070012	Data type does not match / length of service data too high.
0x06070013	Data type does not match / length of service data too low.
0x06090011	Sub index doesn't exist.
0x06090030	Invalid value for parameter (download only).
0x06090031	Value of parameter written too high (download only).
0x06090032	Value of parameter written too low (download only).
0x06090036	Maximum value is less than minimum value.
0x08000000	General error.
0x08000020	Data cannot be transferred or stored to the application.
0x08000021	Data cannot be transferred or stored to the application because of local control.
0x08000022	Data cannot be transferred or stored to the application because of the present device state.
0x08000023	Object dictionary dynamic generation fails or no object dictionary is present.
0x08000024	No data available.

Table 107: SDO Abort Codes

4.6 Status display LEDs

The network and the amplifier states are indicated by light emitting diodes (status display LEDs) under the

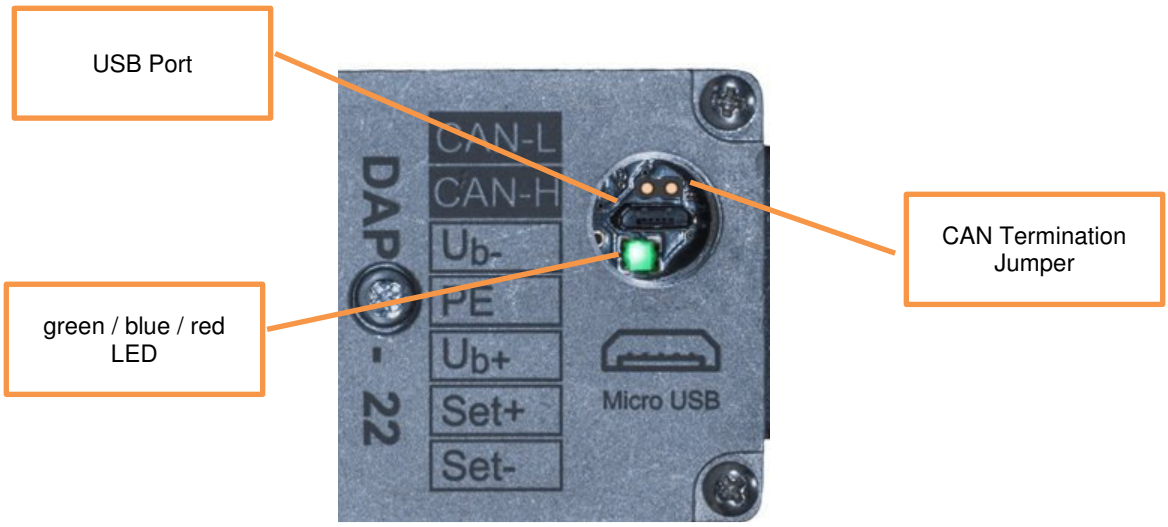


Figure 14: Top view, status LEDs and USB Port

4.6.1 LED definition

LED	Definition
ON	constantly ON
OFF	constantly OFF
Toggling	Between Green and Red LED (Green 1s, Red 250ms)
Blinking	equal ON and OFF times with a frequency of 1.0 Hz: ON/OFF = 500 ms.
Fast Blinking	equal ON and OFF times with a frequency of 5.0 Hz: ON/OFF = 10 ms.
Flashing	Different ON and OFF times: ON = 50 ms, OFF = 250 ms.
Flicker flash	Different ON and OFF times: ON = 100 ms, OFF = 400 ms.

4.6.2 LED status definition “NODE-ID == 0”

CanOpen is deactivated

□ Chapter “4.4.1.34 Object 0x50B1: E 23, Automatic error reset time“ page 52

DSM	Blue LED	Green LED	Red LED	Description
---	OFF	OFF	OFF	No power is applied to the amplifier
---	Blinking		OFF	The supply voltage is below 8V The Output current is lower than in parameter “E 20” defined
---	OFF	Blinking	OFF	The supply voltage is above 8V The Output current is lower than in parameter “E 20” defined,
---	OFF	ON	OFF	The Output current is greater than in parameter “E 20” defined
---	OFF	OFF	ON	Internal error occurred.
---	OFF	Toggling	Toggling	An internal error was occurred and was automatically reset.

4.6.3 LED status definition “NODE-ID” is set

CanOpen is active

□ Chapter “4.4.1.34 Object 0x50B1: E 23, Automatic error reset time“ page 52

DSM	Blue LED	Green LED	Red LED	Description
---	OFF	OFF	OFF	No power is applied to the amplifier
“INIT”, “DISABLED”,	Flashing 	OFF	OFF	The supply voltage is below 8V
	OFF	Flashing 	OFF	The supply voltage is above 8V
”ACTIVE”	OFF	Blinking 	OFF	The amplifier is in the “ACTIVE” state and the output current is lower than in parameter “E 20” defined
	OFF	ON 	OFF	The amplifier is in the “ACTIVE” state and the Output current is greater than in parameter “E 20” defined
”HOLD”	OFF	Flicker flash 	OFF	The amplifier is in the “HOLD” state
“INIT”, “DISABLED”, ”HOLD”, “ACTIVE”	OFF	OFF	ON 	Error occurred see description in □ Chapter “4.5.1.2 Possible fault codes“, page 60
	OFF	OFF	ON 	CAN TxD Error occurred
	OFF	Toggling 	Toggling 	An internal error was occurred and was automatically reset. □ Chapter “4.4.1.34Object 0x50B1: E 23, Automatic error reset time “, page 52

5 Object dictionary

	CANopen							
Index	Sub-Index	Parameter name	Data type	Access	Operation access:	non-volatile	Range	Default
0x1000	0	DeviceType	UINT32	ro		-	UINT32	408
0x1001	0	ErrorRegister	UINT8	ro		-	UINT8	None
0x1002	0	ManufacturerStatusRegister	UINT32	ro		-	UINT32	-
0x1003	0	NumberOfErrors	UINT32	ro		-	UINT32	None
0x1003	1..4	StandardErrorField	UINT32	ro		-	UINT32	None
0x1005	0	CobIdSyncMessage	UINT32	ro		-	0x80000080	0x80000080
0x1008	0	ManufacturerDeviceName	STRING	ro		-	None	-
0x1009	0	ManufacturerHardwareVersion	STRING	ro		-	None	-
0x100A	0	ManufacturerSoftwareVersion	STRING	ro		-	None	-
0x100C	0	GuardTime	UINT16	rw	ro	Y	UINT16	0
0x100D	0	LifeTimeFactor	UINT8	rw	ro	Y	UINT8	0
0x1014	0	CobIdEmergencyMessage	UINT32	rw		Y	0x0080….0x00FF	0x0080+127
0x1016	0	Number of entries	UINT8	rw		-	UINT8	1
0x1016	1	ConsumerHeartbeatTime 1	UINT32	rw	ro	Y	UINT32	0
0x1017	0	ProducerHeartbeatTime	UINT16	rw	ro	Y	UINT16	0
0x1018	0	Number of entries	UINT8	ro		-	UINT8	4
0x1018	1	VendorId	UINT32	ro		-	UINT32	0x036C
0x1018	2	ProductCode	UINT32	ro		-	UINT32	-
0x1018	3	RevisionNumber	UINT32	ro		-	UINT32	-
0x1018	4	SerialNumber	UINT32	ro		-	UINT32	-
0x1200	0	Number of entries	UINT8	ro		-	UINT8	2
0x1200	1	CobIdClientServer	UINT32	ro		-	UINT32	0x0600+127
0x1200	2	CobIdClientClient	UINT32	ro		-	UINT32	0x0580+127
0x1400	0	Number of entries	UINT8	ro		-	UINT8	2
0x1400	1	RPdo1_CobIdUsedByPdo	UINT32	rw	ro	Y	0x00000200…0x0000027F| 0x80000200…0x8000027F	0x0200+ Node-ID
0x1400	2	RPdo1_TransmissionType	UINT8	rw	ro	Y	255	255
0x1600	0	RPdo1_NumberOfMappedApplicParaInPdo	UINT8	rw		Y	0…8	2
0x1600	1	RPdo1_ApplicPara1	UINT32	rw	ro	Y	UINT32	0x60400010
0x1600	2	RPdo1_ApplicPara2	UINT32	rw	ro	Y	UINT32	0x63000110
0x1600	3	RPdo1_ApplicPara3	UINT32	rw	ro	Y	UINT32	0x0
0x1600	4	RPdo1_ApplicPara4	UINT32	rw	ro	Y	UINT32	0x0
0x1800	0	Number of entries	UINT8	ro		-	UINT8	5
0x1800	1	TPdo1_CobIdUsedByPdo	UINT32	rw	ro	Y	0x40000180…0xC00001FF	0x0180+ NodeID
0x1800	2	TPdo1_TransmissionType	UINT8	rw	ro	Y	UINT8	255
0x1800	5	TPdo1_EventTimer	UINT16	rw	ro	Y	UINT16	03E8
0x1A00	0	TPdo1_NumberOfMappedApplicParaInPdo	UINT8	rw		Y	0…8	2
0x1A00	1	TPdo1_ApplicPara1	UINT32	rw	ro	Y	UINT32	0x60410010
0x1A00	2	TPdo1_ApplicPara2	UINT32	rw	ro	Y	UINT32	0x63010110
0x1A00	3	TPdo1_ApplicPara3	UINT32	rw	ro	Y	UINT32	0
0x1A00	4	TPdo1_ApplicPara4	UINT32	rw	ro	Y	UINT32	0
0x1F80	0	NMT-Startup	UINT32	rw		Y	UINT32	8
0x4200	0	ModuleIdentifier	UINT8	rw	ro	Y	0..127	127
0x4201	0	Bitrate	UINT8	rw	ro	Y	1..7	3
0x4211	0	TPdoTrigger	UINT8	rw		-	255	None
0x4212	0	RPdo1_Counter	UINT32	rw		-	UINT32	0
0x4300	0	FaultStatus	UINT8	ro		-	UINT8	None

Index	Sub-Index	Parameter name	Data type	Access	Operation access:	non-volatile	Range	Default
0x5000	0	Vers	UINT16	ro		-	0... 9999	-
0x5001	0	d1.01	INT16	ro		-	-9999… +9999	-
0x5002	0	d1.02	INT16	ro		-	-9999… +9999	-
0x5003	0	d1.03	INT16	ro		-	-9999… +9999	-
0x5004	0	d1.04	INT16	ro		-	-9999… +9999	-
0x5006	0	d1.06	INT16	ro		-	0... 9999	-
0x5008	0	d1.08	INT16	ro		-	0... 9999	-
0x500A	0	d1.10	INT16	ro		-	-9999… +9999	-
0x500E	0	d2.01	INT16	ro		-	0… +9999	-
0x501A	0	S1.08	INT16	rw		Y	-9999… +9999	-
0x501D	0	r1.03	UINT16	rw		Y	0… 3950	0
0x501E	0	r1.04	UINT16	rw		Y	0… 3950	0
0x501F	0	A1.01	INT16	rw		-	-9999… +9999	0
0x502B	0	C1.02	UINT16	rw		Y	0... 6	0
0x502D	0	C1.04	UINT16	rw		Y	0… 200	100
0x502E	0	C1.05	INT16	rw		Y	-400… +400	100
0x502F	0	C1.06	INT16	rw		Y	-9999… +9999	0
0x5031	0	C1.08	UINT16	rw		Y	0... 9999	0
0x505F	0	E 00	UINT16	ro		Y	3… 11	3
0x5061	0	E 02	UINT16	rw		Y	0… 4	0
0x5062	0	E 03	UINT16	rw		Y	1… 7	6
0x5063	0	E 04	UINT16	rw		Y	0... 9999	500
0x5064	0	E 05	UINT16	rw		Y	0... 9999	500
0x5065	0	E 06	UINT16	rw		Y	0... 9999	1300
0x5066	0	E 07	UINT16	rw		Y	0... 9999	500
0x5067	0	E 08	UINT16	rw		Y	0..1|	1
0x5068	0	E 09	UINT16	rw		Y	0… 9999	0
0x5069	0	E 10	UINT16	rw		Y	50…110	100
0x506B	0	E 12	UINT16	rw		Y	0... 9999	0
0x506C	0	E 13	UINT16	rw		Y	0… 3000	0
0x506D	0	E 14	UINT16	rw		Y	0… 300	0
0x506E	0	E 15	UINT16	rw		Y	0…. 11	1
0x506F	0	E 20	UINT16	rw		Y	0…1000	200
0x50A4	0	C 1.27	UINT16	rw		Y	0... 9999	0
0x50B1	0	E 23	UINT16	rw		Y	0	9999
0x50B9	0	E Clr	UINT16	rw		Y	0..1	0
0x50CB	0	E 24	INT16	rw		Y	0… 127	127
0x50CC	0	E 25	UINT16	rw		Y	1… 7	3
0x50CD	0	E 26	UINT16	rw		Y	0… 1	0

Index	Sub-Index	Parameter name	Data type	Access	Operation access:	non-volatile	Range	Default
0x50E6	0	L1.x0	UINT16	rw		Y	0	0
0x50E7	0	L1.y0	UINT16	rw		Y	0... 9999	0
0x50E8	0	L1.x1	UINT16	rw		Y	0... 9999	1250
0x50E9	0	L1.y1	UINT16	rw		Y	0... 9999	1250
0x50EA	0	L1.x2	UINT16	rw		Y	0... 9999	2500
0x50EB	0	L1.y2	UINT16	rw		Y	0... 9999	2500
0x50EC	0	L1.x3	UINT16	rw		Y	0... 9999	3750
0x50ED	0	L1.y3	UINT16	rw		Y	0... 9999	3750
0x50EE	0	L1.x4	UINT16	rw		Y	0... 9999	5000
0x50EF	0	L1.y4	UINT16	rw		Y	0... 9999	5000
0x50F0	0	L1.x5	UINT16	rw		Y	0... 9999	6250
0x50F1	0	L1.y5	UINT16	rw		Y	0... 9999	6250
0x50F2	0	L1.x6	UINT16	rw		Y	0... 9999	7500
0x50F3	0	L1.y6	UINT16	rw		Y	0... 9999	7500
0x50F4	0	L1.x7	UINT16	rw		Y	0... 9999	8750
0x50F5	0	L1.y7	UINT16	rw		Y	0... 9999	8750
0x50F6	0	L1.x8	UINT16	rw		Y	9999	9999
0x50F7	0	L1.y8	UINT16	rw		Y	0... 9999	9999
0x6040	0	Control Word	UINT16	rw		Y	UINT16	0
0x6041	0	Status Word	UINT16	ro		-	UINT16	-
0x6050	0	DeviceVersion	STRING	ro		-	None	“”
0x6052	0	SerialNumber	STRING	ro		-	None	“”
0x6055	0	ModelURL	STRING	ro		-	None	“www.h-c-s-gmbh.de“
0x605F	0	Capability	UINT32	ro		-		0x1F000000
0x6300	0	Number of entries	UINT8	ro		-	1	1
0x6300	1	Setpoint	INT16	wo		-	INT16	none
0x6301	0	Number of entries	UINT8	ro		-	1	1
0x6301	1	ActualValue	INT16	ro		-	INT16	-
0x6314	0	Number of entries	UINT8	ro		-	1	1
0x6314	1	HoldSetpoint	INT16	wo		-	INT16	S1.08
0x6330	0	Type	INT8	ro		-	3	3
0x6332	0	Number of entries	UINT8	ro		-	1	1
0x6332	1	AccelerationTimePositive	UINT16	rw	ro	Y	0..3950	0
0x6335	0	Number of entries	UINT8	ro		-	1	1
0x6335	1	DecelerationTimePositive	UINT16	rw	ro	Y	0..3950	0

Table 108: Object Dictionary

6 Quick Setup – DAP

This chapter describes how to generate a signal at the output stages based on CANopen communication.

6.1 Setup HCSTool

HCSTool software is executed on WINDOWS based PC's.
HCSTool is required if parameters or device changes shall be made without using the CAN interface.

HCSTool can be downloaded from www.h-c-s-gmbh.de/download.
The required driver for a HCS USB interface is included and will be installed as well.

6.2 Setting up the CAN interface at an PC

Use a CAN-Interface with its software driver.

The example explains this for a CAN interface provided by **IXXAT**:
USB-to-CAN-Interface. (www.ixxat.com)

Figure 15: CAN interface with USB connection

Needed drivers can be downloaded from IXXAT homepage
(https://www.ixxat.com/support/file-and-documents-download/drivers).

The driver also contains tool "Minimon". This tool allows monitoring of communication between PC and device.

6.3 Connecting the device

- Connect the PC and the DAP-22 with a USB-Micro cable.

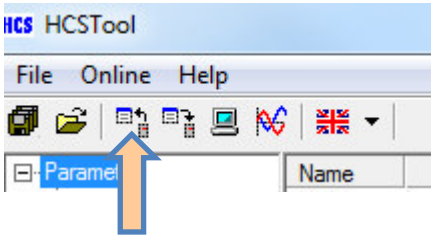
Figure 16: Connect the USB interface

- Connecting the supply voltage Ub
- Connecting the CAN network CAN-L,CAN-H

□ Chapter "2.6 Connector position layout",page 13

6.4 Setup parameter for CAN communication

- Power up the DAP
- Start HCSTool
- Upload actual parameter setting from DAP-22 (Upload from device)



- Ensure valid CAN-ID is selected:
  Parameter E 24 defines the Node-ID of the device in the range 1..127.
  If E24 is set to “0” than the CAN interface is deactivated.
- Ensure a valid a baud rate is selected. Select the correct network baud rate with parameter E25.
  Default value is 125 kbit.

In this example:

- Node-ID is set to 127 (parameter E24 = 127)
- Baud rate 125 kBit is selected (parameter E25 = 3)
- Operation mode E00 = 1 (mode 1)

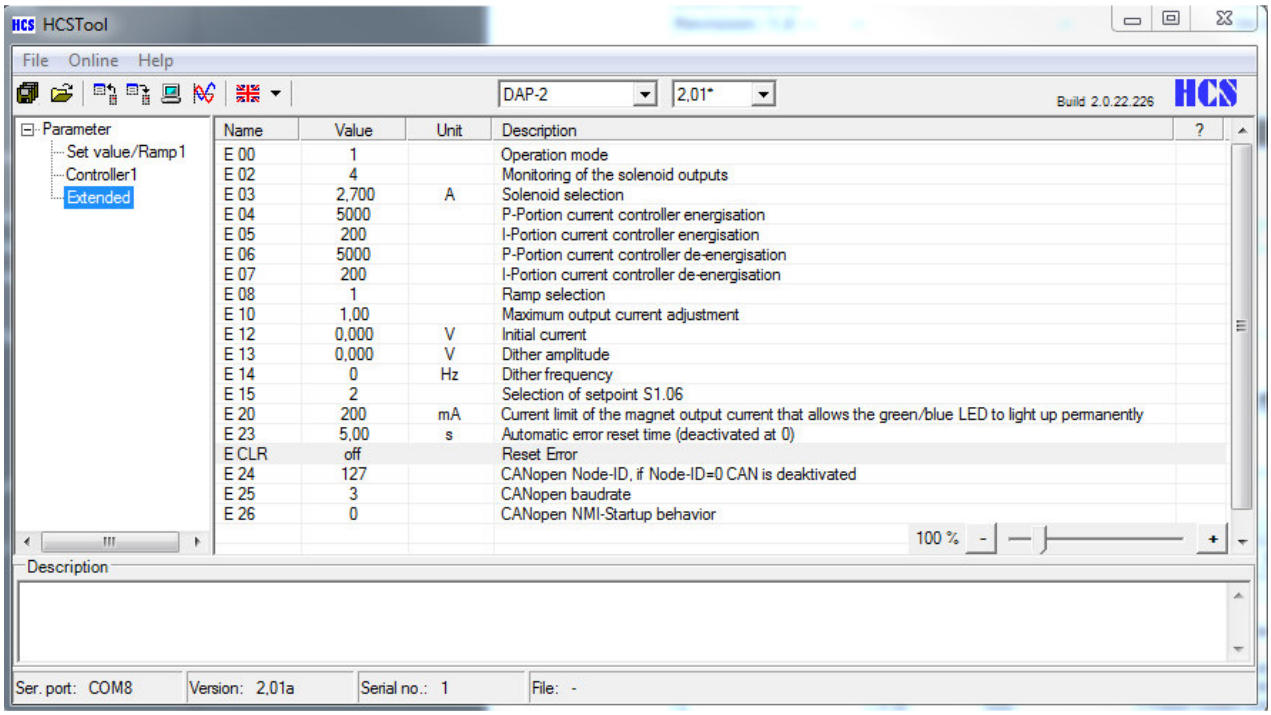


Figure 17: Parameter with HCSTool

6.5 Establishing CAN communication

After power up the DAP-22 starts depending on Object 0x1F80: NMT-Startup,
(Refer to, □ Chapter "4.3.1 Object 0x1F80: NMT-Startup", page 27)

- If the default value of Object 0x1F80 is not changed, the DAP-22 starts in the operational mode.
- If the transmit PDO is not active, please enable a transmit PDO first to see internal values via CAN.
  (Refer to, □ Chapter “3.9.3.4 TxPDO protocol configuration (COB-ID: 0x180)", page 22)
  Please use the default values for Object 0x1800, index 00..05 and Object 0x1A00, index 00..04

If the TPDO is enabled every second (value in index 0x1800-05) a message of CAN-Identifier (value in 0x1800-01) 0x1FF is transmitted. The mapped values are object 0x6041 (device status word) and 0x6301 (actual value).

Screen shot for this situation.

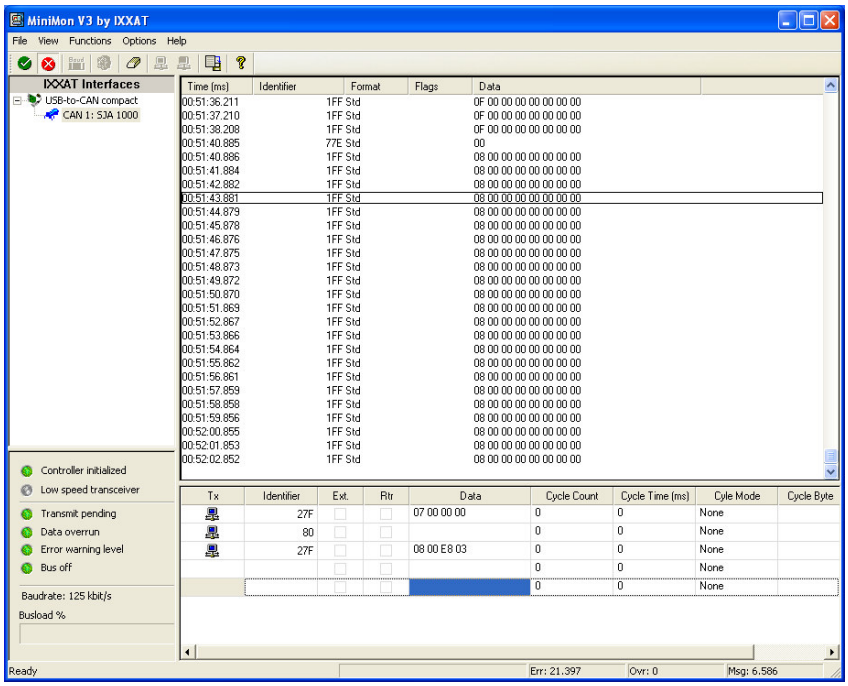


Figure 18: Logging the CAN data transmission

If no corresponding CAN participant is present then DAP-22 will show Error “–32”.

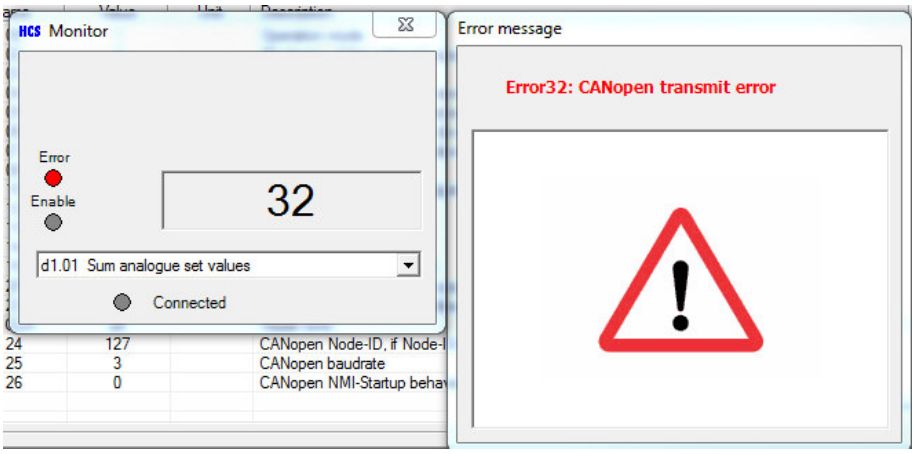


Figure 19: Error Message, no CAN communication

Also the red Error-Led is blinking.
The error status remains active even if communication with a CAN participant is possible again. Only a "Reset Node" can reset this error.

6.6 Startup, DSM “DISABLE”

Depending on the DSM the DAP is set to state “DISABLE” after power up.
Refer to □ Chapter “4.2.3 Device state machine (DSM), page 34”.

- All internal values are set to zero
- The output stages are deactivated.

It is also possible to be observed by using the “monitor” function within the HCSTool.
DAP-22 is still disabled (Enable LED is off):

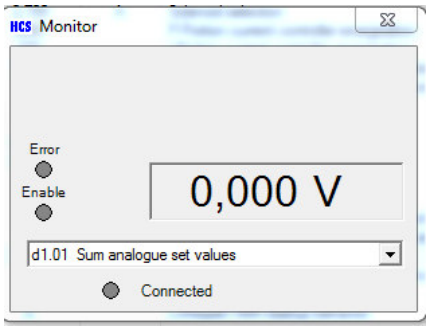


Figure 20: Monitor function of the HCSTool, Disable.

To set the DSM to “ACTIVE”, the following data must be sent by means of CAN Identifier 0x27F: 07 00 00 00
Explanation:

- 07 00 → sets the “Device Control Word” to active state
  DSM changes from “DISABLE” to “ACTIVE”
- 00 00 → set value = 0.00V

By sending a value by means of CAN Identifier 0x27F the “Device Status Word” (Object 0x6041) will be written and the “Device Control Word” of the device profile (Object 0x6040) is set.
Refer to
□ Chapter “4.2.2.1 Object 0x6040: Control word, page 33”.

When sending 0x27F with the value “0x07” the DSM will change to “ACTIVE”.
Remark: If using the CANopen manager the “Device Control Word” (Object 0x6040) of the device profile can be used to set the “Device Status Word”.

HCSTool is now showing the Enable LED as being lit. Signal value at d1.10 is also appearing in this example.

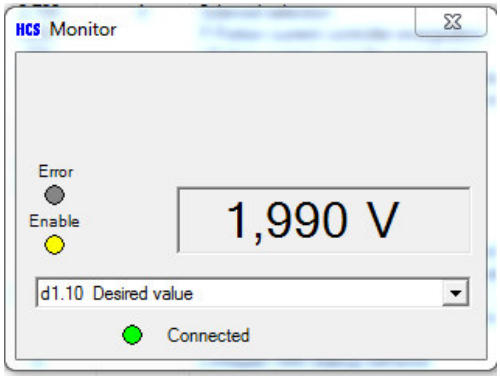


Figure 21: DAP-22 “ACTIVE”, Analog input, E15 = 0..10V

Generally it is to be noted, that in CANopen data are transmitted according to the **"Little Endian"** rule and therefore according to the form for corresponding INTEL processors. This means that the low value byte is transmitted first.

6.7 Sending a set value to the Module

When using CANopen it is necessary to switch off analog signals if unused!
Using HCSTool and disable the analog input by setting parameter E15 and E16 to “off”.

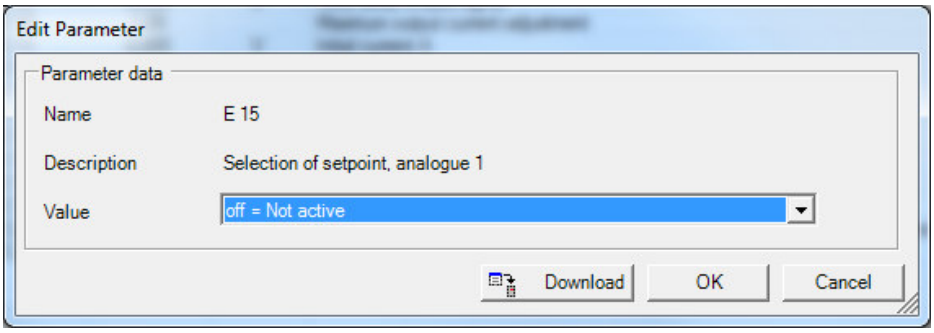


Figure 22: Disable the analog input

This will force the value at the analog inputs to “0.00 V” - can be displayed by using the monitor function of the HCSTool showing d1.02:

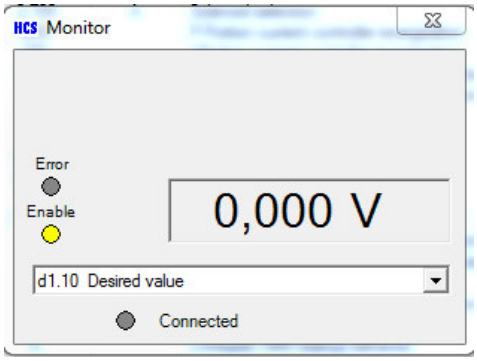


Figure 23: DAP-22 Enabled, analog input = off

As a consequence, now only digital values via CAN or digital command inputs will be executed.

Example: Set the digital set value to 1.00 V.
Sending to CAN object the following data: 07 00 E8 03
Explanation:

- 07 00 → set the “Device Control Word” to active state
- 03 E8 → set value = 1.00 V (intel format = bytes are reversed)
  (maximum value for 9.999 V is 0F 27).

Remark: If using the CANopen manager the “vpoc_set_point_Value” (Object 0x6300) of the device profile can be used to set the digital set value. See also □ Chapter “4.3.2.1.1 Object 0x6300: Set point“,page 40

Now the value at d1.10 is 1.000 V

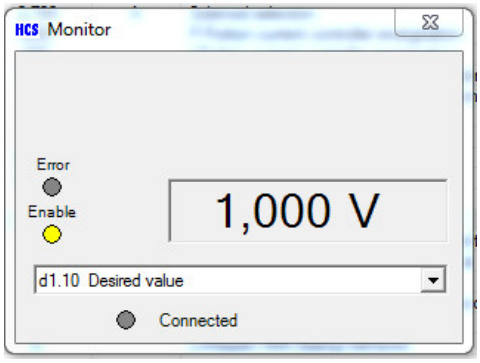


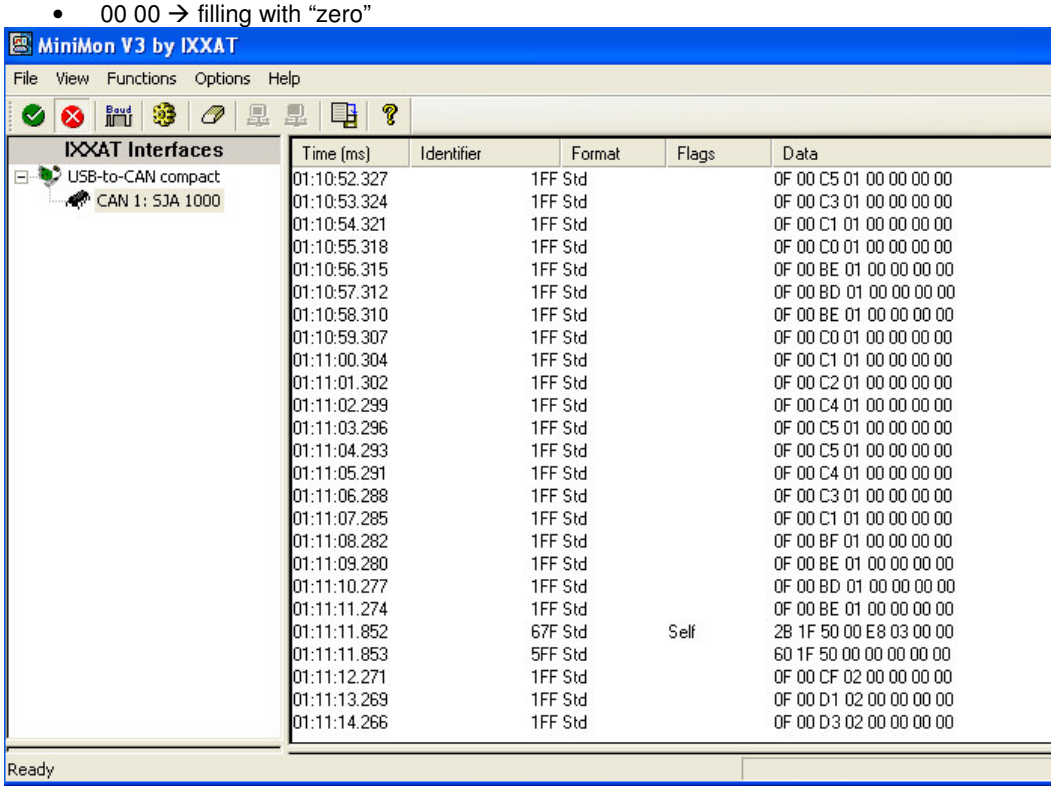
Figure 24: DAP-22 Enabled, digital value set.

➔ Current at output stages will be accordingly but can also be influenced by other consecutive parameters.

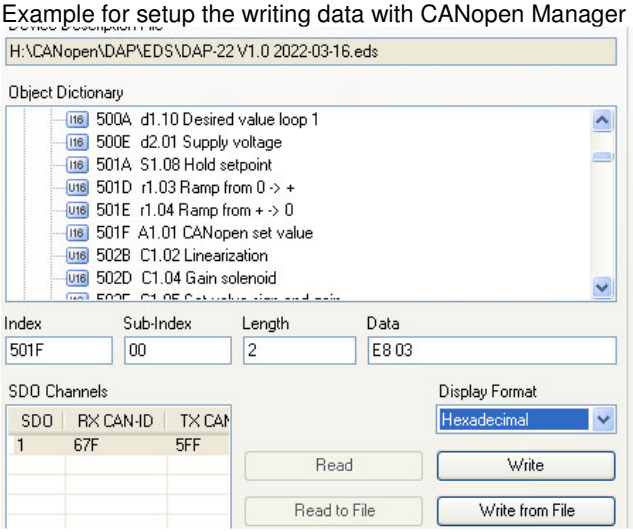
6.8 Sending a set value to the Module via SDO Protocol

To set the Set Value for Branch 2 to “1000mV”, the following data must be sent by means of CAN Identifier 0x67E:
2B 1F 50 00 E8 03 00 00
Explanation:

- 2B → SDO Command Byte to send 2 Bytes
- 1F 50 → Object address for Branch 2 (A1.01)
- 00 → SubIndex 00
- E8 03 → set value = 1.00V
- 00 00 → filling with “zero”



Example for setup the writing data with CANopen Manager



6.9 Changing Operation Mode from “operational” to “Pre-operational”

To set some parameters like Heartbeat (0x1016) or TxPDO (0x1800 + SubIndex) it is necessary to change the module from Operational mode to Pre-operational mode.

This can be done by writing a telegram to CAN Identifier “0” with value “80” and value of slaveaddress.
In this example the module is set to address 127:

Change from Operational to Pre-operational mode:

Tx	Identifier	Ext.	Rtr	Data	Cycle Count	Cycle Time (ms)	Cyle Mode	Cycle Byte
	67F			2B 1F 50 00 D0 07 00 00	0	0	None	
	67F			23 80 1F 00 04 00 00	0	0	None	
	27F			07 00 00 00	0	0	None	
	0			80 7F	0	0	None	
	620			40 00 18 01	0	0	None	

Explanation:

- Identifier “0” → Can-Id for Network Management MNT
- 80 → Change to Pre-operational mode
- 7F → Node-ID address is 127

Change from Pre-operational mode to Operational mode:

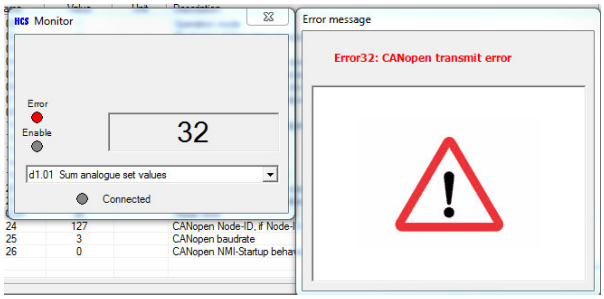
Tx	Identifier	Ext.	Rtr	Data	Cycle Count	Cycle Time (ms)	Cyle Mode	Cycle Byte
	67F			2B 1F 50 00 D0 07 00 00	0	0	None	
	67F			23 80 1F 00 04 00 00	0	0	None	
	27F			07 00 00 00	0	0	None	
	0			01 7F	0	0	None	
	620			40 00 18 01	0	0	None	

Explanation:

- Identifier “0” → Can-Id for Network Management MNT
- 01 → Change to Operational mode
- 7F → Node-ID address is 127

6.10 Solution example, when the DAP-22 is in Transmit Error

If the DAP-22 device change into the Transmit error state, a connection to a consumer device is not possible.
The internal error counter reaches the maximum value of transmit faults.



To get back to normal operation:

- Check the connection to the Can bus.
- Send an “Reset Node” command

Time (ms)	Identifier	Format	Flags	Data
00:44:59.146	1FF	Std		0F 00 00 00 00 00 00 00
00:46:06.011	0	Std	Self	81 7F
00:46:06.062	77F	Std		00
00:46:06.261	FF	Std		00 81 10 20 10 00 00 00

  - Identifier “0” → Can-Id for Network Management MNT
  - 81 → Reset Node
  - 7F → Node-ID address is 127
- The DAP-22 will answer with the NMT control value and the Emergency value for the last error.

7 Declaration of Conformity

EC Declaration of Conformity in accordance with EMC Directive 2014/30/EU

HCS Hydraulic Control Systems GmbH
Neuffener Str. 29
D-72636 Frickenhausen

hereby declares that the product described as follows complies in terms of its design, as well as in the version placed in the stream of commerce by us, with the relevant requirements of the directive. This declaration is void in the event of any changes to the product without our written agreement.

Product:	DAP –Digital plug-on amplifier
Intended use:	Automation systems (industrial and mobile)
Model:	DAP-2
Rated voltage:	24 V DC; SELV
Rated power:	max. 25 W
Protection class:	III
Protection degree:	IP67
Relevant EC Directive:	EMC Directive 2004/108/EG
Applicable EU Standards:	EN 61000-6-2: 2005 EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-16 EN 61000-6-3:2007 + A1:2011 EN 61000-6-4:2007 + A1:2011

Date/manufacturer's signature

01.01.2021
Details of signatory: Dipl.-Ing. (FH) Peter Deuschle (General Manager)

8 Notes:

9 HCS distributors and partners

Please refer to:

https://www.h-c-s-gmbh.de/en/sales-partners

on our web side.

- End -