KOLLMORGEN
Seidel

CANopen communication profile for servo amplifiers of the SERVOSTAR™ 600 series

Technical Description, Commissioning Instructions

Edition 01/99

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Technical changes to improve the performance of the equipment may be made without prior notice !

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Abbreviations used in this manual

The abbreviations used in this manual are explained in the table below.

Abbr.	Meaning
AGND	Analog ground
BTB/RTO	Ready to operate (standby)
CE	European Community (Communité Européenne)
CLK	Clock
COM	Serial interface of a PC-AT
DGND	Digital ground
DIN	Deutsches Institut für Normung (German Standards Institute)
Disk	Magnetic storage (diskette, hard disk)
EEPROM	Electrically erasable/programmable memory
EMC	Electromagnetic compatibility
EN	European standard
IEC	International Electrotechnical Commission
ISO	International Standardization Organization
LED	Light-emitting diode
MB	Megabyte
MS-DOS	Operating system for a PC-AT
NI	Null pulse (zero mark)
NSTOP	Limit-switch for CCW (left) rotation

Abbr.	Meaning
PC-AT	Personal computer with an 80x86 processor
PGND	Ground for the interface that is used
PSTOP	Limit-switch for CW (right) rotation
RAM	Volatile memory
RBallast	Ballast resistor
RBext	External ballast resistor
RBint	Internal ballast resistor
RES	Resolver
ROD	Incremental position indicator
PLC	Programmable logic controller
SRAM	Static RAM
SSI	Synchronous serial interface
SW/SETP.	Setpoint
UL	Underwriters Laboratories
V AC	Alternating voltage
V DC	Constant voltage
VDE	Verein deutscher Elektrotechniker (Society of German electrical technicians)
XGND	Ground for the 24V supply

Symbols used in this manual

	danger to personnel from electricity and its effects			general warning general instructions mechanical hazard
⇨	see Chapter (cross-reference)		●	special emphasis

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I General

I.1 About this manual

This manual describes the commissioning, range of functions and software protocol of the SERVO**STAR**™ 600 servo amplifier with the CANopen communication profile. It forms part of the complete documentation for the SERVO**STAR**™ 600 family of servo amplifiers.

The installation and commissioning of the servo amplifier, as well as all standard functions, are described in the corresponding installation manuals.

Other parts of the complete documentation for the SERVOSTAR™ 600 family of digital servo amplifiers:

Title	Publisher	Order No.
Operator Software SR600.EXE for SERVO**STAR**™ 600 User Manual	Seidel	90464
Digital servo amplifier SERVO**STAR**™ 600 Assembly, Installation and Commissioning Instructions	Seidel	89370

Additional documentation:

Title	Publisher
CAN Application Layer (CAL) for Industrial Applications	CiA e.V.
Draft standards 102, 201..207, 301	CiA e.V.
CAN Specification Version 2.0	Philips Semiconductors
ISO 11898 ...Controller area network (CAN) for high-speed communication	
Drive technology profile / Profile 21	DRIVECOM
Drive technology profile / Servo 22	DRIVECOM

This manual has the following requirements for qualified personnel:

Wiring	**:**	**Professionally qualified electrical technicians**
Programming	**:**	**Software developers, CAN-BUS project-planners**

Training and familiarization courses are available on request.

I.2 Permitted use (“Use as directed”) of the CANopen interface

Please consider the chapter “Use as directed” in the installation/commissioning manual of the SERVO**STAR**™ 600.
The interface is a component of the digital servoamplifiers from the SERVO**STAR**™ 600 series.
The CANopen interface serves only for the connection of the servo amplifier to a master via the CAN-bus.
The servo amplifiers are components that are built into electrical apparatus or machinery, and can only be commissioned as integral components of such apparatus or machinery.

Only when the components that we specify are used and the installation regulations are followed can we guarantee the conformity of the servo amplifier with the following standards for industrial areas:

EC EMC Directive	**89/336/EEC**
EC Low-Voltage Directive	**73/23/EEC**

I.3 Features of the CANopen communication profile

When working with the position controller in the SERVO**STAR**™ 600 digital servo amplifier, the following functions are available:

Setting-up and general functions:

— homing, set reference point
— jogging, with a variable speed
— provision of a digital setpoint for speed and torque control

Positioning functions:

— execution of a motion task from the motion block memory of the servo amplifier
— execution of a direct motion task
— absolute trajectory (in preparation)

Data transfer functions:

— transmit a motion task to the motion block memory of the servo amplifier
  A motion task consists of the following elements:
  » position setpoint (absolute task) or path setpoint (relative task)
  » speed setpoint
  » acceleration time, braking time, rate-of-change limiting (if required)
  » type of motion task (absolute/relative)
  » number of a following task (with or without pause)
— read a motion task from the motion block memory of the servo amplifier
— read actual values
— read the error register
— read the status register
— read/write control parameters (via the ASCII channel)

System requirements:

— Servo amplifier SERVO**STAR** ™ 600
— Master station with a CAN-BUS interface (e.g. PC with CAN interface)

Transmission procedure:

— Bus connection and bus medium: CAN-Standard ISO 11898 (CAN high-speed)
— transmission rate: max. 1Mbit/s
  possible settings for the servo amplifier:
  10, 20, 50, 100, 125, 250, 333, 500, 666, 800, 1000kBaud

I.4 Numerical format

Not only parameter numbers, but also parameter values are expected to be in the **Little-Endian ("Intel") -format** (see below).

INTEGER16	address n+0:	bit 7 .. 0 (LSB)
	address n+1:	bit 15 .. 8 (MSB)
INTEGER32	address n+0:	bit 7 .. 0 (LSB)
	address n+1:	bit 15 .. 8
	address n+2:	bit 23 .. 16
	address n+3:	bit 31 .. 24 (MSB)

Interpretation:

n	address (absolute)
LSB	**L**east **S**ignificant **B**it
MSB	**M**ost **S**ignificant **B**it

Negative numbers are represented as 2's complement.

I.5 Bus cable

In accordance with ISO 11898 you should use a bus cable with a characteristic impedance of 120 Ω . The usable cable length for reliable communication is reduced as the transmission rate is increased. The following values that we have measured can be used as a guide. They should not, however, be interpreted as limiting values:

Cable data:	characteristic impedance	100-120 Ω
	cable capacitance	max. 60 nF/km
	lead resistance (loop)	159.8 Ω/km

Cable length, dependent on the transmission rate

Transmission rate / kBaud	max. cable length / m
1000	20
500	70
250	115

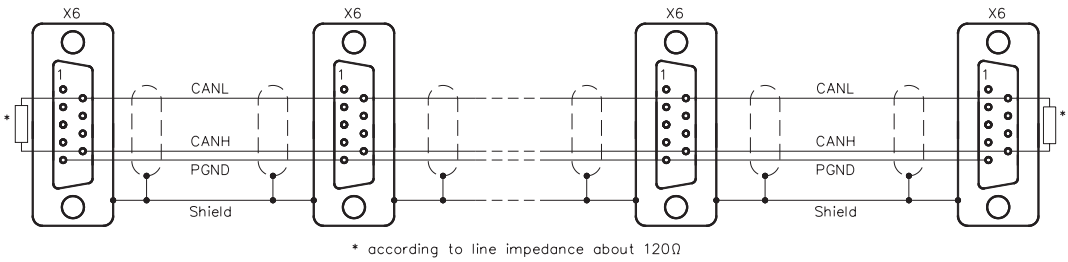
Longer transmission distances may be achieved with a lower cable capacitance (max. 30 nF/km) and lower lead resistance (loop, 115 Ω/km).

(characteristic impedance 150 ± 5Ω ⇒ termination resistance 150 ± 5Ω).

For EMC reasons, the SubD connector housing must fulfill the following requirements:

— metal or metallized housing

— provision for connecting the cable shielding in the housing, with a large contact area.



Special clamp-terminal connectors (order number 90650), that are available from Seidel Servo Drives, can easily be made up for bus operation.

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II Installation / Commissioning

II.1 Assembly, installation

Only install and wire up the equipment in a de-energized condition, i.e. neither the mains/line supply voltage nor the 24V auxiliary voltage nor the operating voltage of any other connected equipment may be switched on.

Take care that the switchgear cabinet is safely disconnected (lockout, warning signs etc.). The individual voltages are switched on for the first time during commissioning.

Never disconnect the electrical connections to the servo amplifier while it is live. This could cause destruction of the electronics.

Residual charges in the capacitors can still have dangerous levels several minutes after switching off the supply power. Measure the voltage in the DC-link circuit and wait until the voltage has fallen below 40V.

Even when the motor is not rotating, power and control cables can still be live.

Set up the station address for the servo amplifier on the CAN-bus (⇨ II.1.2).

Assemble the servo amplifier as described in the installation instructions for SERVO**STAR**™ 600. Observe all safety instructions in the installation instructions that belong to the servo amplifier. Follow all the notes on mounting position, ambient conditions, wiring, and fusing / overload protection.

The connections for the motor, controls and power, as well as advice on system layout for EMC-conformance, can be found in the installation instructions for the servo amplifier.

II.1.1 Connection methods

Supply power, motor :	see installation instructions for SERVO**STAR**™ 600
Analog setpoints :	see installation instructions for SERVO**STAR**™ 600
Digital control signals :	see installation instructions for SERVO**STAR**™ 600
CAN connection :	see installation instructions for SERVO**STAR**™ 600

II.1.2 Setting the station address

The station address (instrument address on the CAN-Bus) for the servo amplifier can be set up in two different ways:

- by using the pushbuttons on the front panel
  (see commissioning instructions for SERVO**STAR**™ 600)
- by using the “ADDR” command (see reference list of ASCII commands)

II.2 Commissioning

Only professional personnel with extensive knowledge of control and drive technology are allowed to commission the servo amplifier.

Check assembly / installation	Check that all the safety instructions in the installation instructions for the servo amplifier and this manual have been observed and implemented. Check the setting for the station address.
Connect PC, start operator software	Use the operator software SR600.EXE to set the parameters for the servo amplifier.
Commission the basic functions	Start up the basic functions of the servo amplifier and optimize the current and speed controllers. This section of the commissioning is described in detail in the installation and commissioning instructions for the servo amplifier.
Save parameters	When the parameters have been successfully optimized, save them in servo amplifier.
Start up the bus communication	The altered parameters will only become effective after a software-reset (Warmboot). To do this, change to the screen page “Status” and operate the reset button. Requirement: the software protocol described in Chapter III must be implemented in the master. Adjust the baud rate of the SERVO**STAR™** to match the master.
Test the communication	Recommendation : request the Emergency Object.

Caution !
Make sure that any unintended movement of the drive cannot endanger machinery or personnel.

Commission the position controller	Commission the position controller, as described in the manual for the operator software.

III Software Protocol

III.1 General description of CAN

The transmission method that is used here is defined in ISO 11898 (Controller Area Network CAN) for high-speed communication). The Layer-1/2 protocol (Physical Layer/Data Link Layer) that is implemented in all CAN modules provides, amongst other things, the requirement for data.

Data transport or data request is made by means of a data telegram (Data Frame) with up to 8 bytes of user data, or by a data request telegram (Remote Frame).

Communication Objects are labeled by an 11-bit Identifier (ID) that also determines the priority of Objects.

A Layer-7 protocol (Application Layer) was developed, to decouple the application from the communication. The service elements that are provided by the Application Layer make it possible to implement an application that is spread across the network. These service elements are described in the CAN Application Layer (CAL) for Industrial Applications.
The Communication Profile CANopen and the drive profile are mounted on the CAL.

III.2 Format of a Communication Object (COB)

SOM	COB-ID	RTR	CTRL	Data Segment	CRC	ACK	EOM

SOM	Start of message
COB-ID	COB-Identifier (11-bit)
RTR	Remote Transmission Request
CTRL	Control Field (i.e. Data Length Code)
Data Segment	0...8 Byte (Data-COB)
	0 Byte (Remote-COB)
CRC	Cyclic Redundancy Check
ACK	Acknowledge Slot
EOM	End of message

III.3 Construction of the COB Identifier

10	9	8	7	6	5	4	3	2	1	0
Function code				Module-ID						

Bit 0- 6 Module ID (station number, range 1 ... 63; is set up in the operator software or the servo amplifier, ⇨ II.1.2)
Warning: **If an invalid station number (=0 or >63) is set up, then the module-ID will be set internally to 1.**

Bit 7-10 Function Code (number of the Communication Object that is defined in the server)

III.3.1 Default values of the COB-ID in CANopen

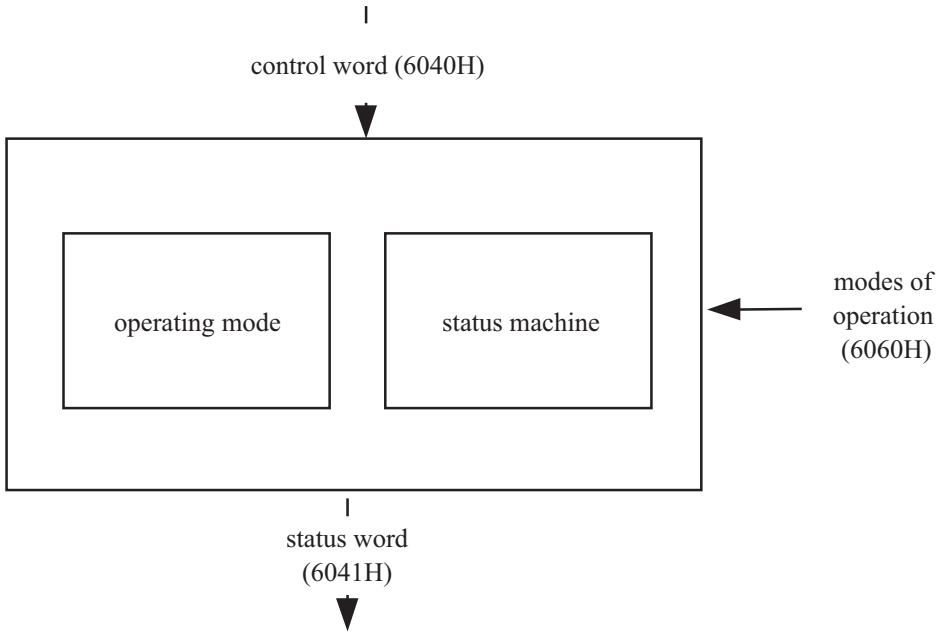
The following table shows the default values for the COB Identifier after switching on the servo amplifier. The objects that are provided with an index (Communication Parameters at Index), can have a new ID assigned after the initialization phase. The indices in brackets are optional.

Object	Function code (binary)	Resulting COB-IDs	Communication parameters at index
NMT	0000	0	---
SYNC	0001	128	(1005H)
TIME STAMP	0010	256	---
EMERGENCY	0001	129 ... 255	---
PDO 1 (tx*)	0011	385 ... 511	1800H
POD 1 (rx*)	0100	513 ... 639	1400H
PDO 2 (tx)	0101	641 ... 767	1801H
PDO 2 (rx)	0110	769 ... 895	1401H
SDO (tx)	1011	1409 ... 1535	
SDO (rx)	1100	1537 ... 1663	
Nodeguard	1110	1793 ... 1919	(100EH)

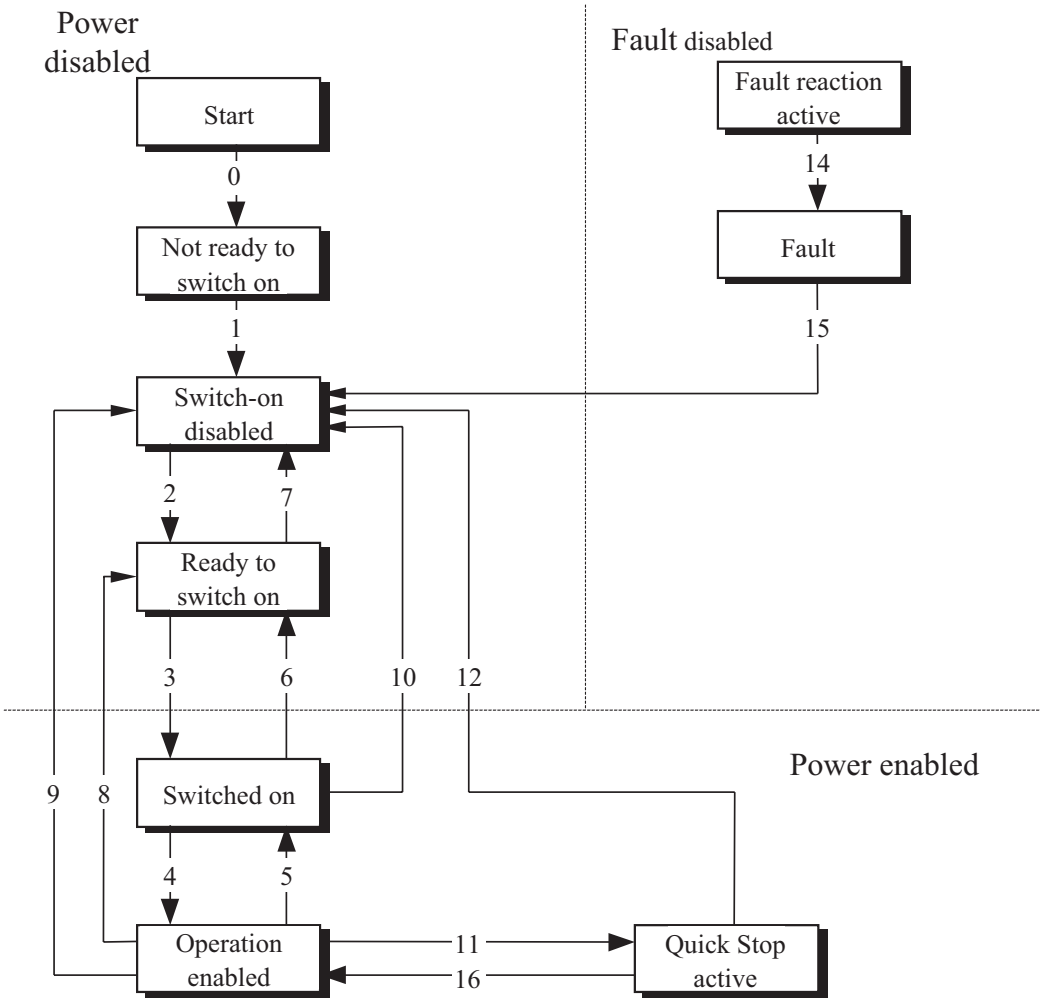
* tx = direction of transmission SERVO**STAR™** ⇒ Master
rx = direction of transmission Master ⇒ SERVO**STAR™**

III.4 Instrument control

The instrument control of the SERVO**STAR™** can be used to carry out all the motion functions in the corresponding modes. The control of the SERVO**STAR™** is implemented through a mode-dependent status machine. The status machine is controlled through the control word (⇒ III.4.2). The mode setting is made through the Object “Modes of Operation” (⇒ III.5.2.2.21). The states of the status machine can be revealed by using the status word (⇒ III.4.3).



III.4.1 Status machine



III.4.1.1 States of the status machine

State	Description
Not Ready to Switch On	SERVO**STAR™** is not ready to switch on, there is no operational readiness (BTB) reported from the controller program.
Switch On Disabled	SERVO**STAR™** is ready to switch on, parameters can be transferred, the DC-link voltage can be switched on, motion functions cannot yet be carried out.
Ready to Switch On	DC-link voltage must be switched on, parameters can be transferred, motion functions cannot yet be carried out.
Switched On	DC-link voltage must be switched on, parameters can be transferred, motion functions cannot yet be carried out, output stage is switched on (enabled).
Operation Enabled	No error present, output stage is enabled, motion functions are enabled.
Quick Stop Active	Drive has been stopped with the emergency ramp, output stage is enabled, motion functions are enabled, response depends on Object 605AH (⇨ III.5.2.2.20)
Fault Reaction Active	not supported at present
Fault	not supported at present

III.4.1.2 Transitions of the status machine

The state transitions are affected by internal events (e.g. switching off the DC-link voltage) and by the flags in the control word (bits 0,1,2,3,7).

Transition	Event	Action
0	Reset	Initialization
1	Initialization completed successfully. SERVO**STAR™** is ready to operate.	none
2	Bit 1 (Disable Voltage) and Bit 2 (Quick Stop) are set in the control word (‘Shutdown’ command). DC-link voltage is present.	none
3	Bit 0 is also set (‘Switch On’ command)	Output stage is switched on (enabled), provided that the hardware enable is present (logical AND). Drive has torque.
4	Bit 3 is also set (‘Enable Operation’ command)	Motion function is enabled, depending on the mode that is set.
5	Bit 3 is canceled (‘Disable Operation’ command)	Motion function is inhibited. Drive is stopped, using the relevant ramp (mode-dependent). The current position is maintained.
6	Bit 0 is canceled (‘Shutdown’ command)	Output stage is disabled. Drive has no torque.
7	Bits 1/2 are canceled (‘Quickstop’ / ‘Disable Voltage’ command)	none
8	Bit 0 is canceled (‘Shutdown’ command)	Output stage is switched off (disabled). Motor has no torque.
9	Bit 1 is canceled (‘Disable Voltage’ command)	Output stage is disabled. Motor has no torque.
10	Bits 1/2 are canceled (’Quickstop’ / ‘Disable Voltage’ command)	Motion function is enabled, depending on the mode that is set.
11	Bit 2 is canceled (’Quickstop’ command)	Drive is stopped with the emergency braking ramp. The output stage remains enabled. Setpoints are canceled (motion block number, digital setpoint, speed for jogging or homing). Bit 2 must be set again before any further motion tasks can be performed.
12	Bit 1 is canceled (‘Disable Voltage’ command)	Output stage is disabled. Motor has no torque.
13	not supported at present	none
14	not supported at present	none
15	not supported at present	none
16	Bit 2 is set	Motion function is enabled again.

Caution !
If the servo amplifier is operated through the control word / status word, then no control commands may be sent through another communication channel (RS232, CANopen, ASCII channel, Option board).

III.4.2 Control word

III.4.2.1 Bit assignments of the control word

Bit	Name	Bit	Name
0	Switch on	8	Pause
1	Disable Voltage	9	reserved
2	Quick Stop	10	reserved
3	Enable Operation	11	Acknowledge lag error and response monitoring
4	Mode-dependent	12	Reset position
5	Mode-dependent	13	Manufacturer-specific
6	Mode-dependent	14	Manufacturer-specific
7	Reset Fault (only effective for faults)	15	Manufacturer-specific

III.4.2.2 Commands of the control word

Command	Bit 7 Fault Reset	Bit 3 Enable Operation	Bit 2 Quick Stop	Bit 1 Disable Voltage	Bit 0 Switch on	Transitions
Shutdown	X	X	1	1	0	2, 6, 8
Switch on	X	X	1	1	1	3
Disable Voltage	X	X	X	0	X	7, 9, 10, 12
Quick Stop	X	X	0	1	X	7, 10, 11
Disable Operation	X	0	1	1	1	5
Enable Operation	X	1	1	1	1	4, 16
Fault Reset	Not supported	X	X	X	X	15

Bits marked with X are irrelevant.

III.4.2.3 Mode-dependent bits in the control word

The following table describes the mode-dependent bits in the control word. Only manufacturer-specific modes are supported at present. The individual modes are set by the “Modes of operation” Object (Index 6060H).

Operating mode	Bit 4	Bit 5	Bit 6
Position	reserved	reserved	reserved
Digital speed	reserved	reserved	reserved
Digital current	reserved	reserved	reserved
Analog speed	reserved	reserved	reserved
Analog current	reserved	reserved	reserved
Trajectory	reserved	reserved	reserved
Homing	start homing	reserved	reserved
Jog mode	reserved	reserved	reserved

III.4.2.4 Description of the other bits in the control word

The other bits of the control word are described below.

Bit 8 Pause If Bit 8 is set, then the drive is stopped (paused) in all modes. The setpoints (speed for homing or jogging, motion task number, setpoints for digital mode) for the individual modes are retained.

Bit 9,10 These Bits are reserved for the drive profile (DS402).

Bit 11 Acknowledge error Setting Bit 11 acknowledges the response monitoring and/or the contouring error.

Bit 12 reset the position, taking into account the reference offset.
(see also homing type number 6 in object 2024H, subindex 1)

Bit 13, 14, 15 These bits are manufacturer-specific, and reserved at present.

III.4.3 Status word

The momentary state of the status machine can be read out with the aid of the status word (⇒ III.4.3).

III.4.3.1 Bit assignments of the status word

Bit	Name	Bit	Name
0	Ready to switch on	8	Manufacturer-specific (reserved)
1	Switched on	9	Remote (in preparation)
2	Operation enable	10	Target reached (in preparation)
3	Fault (in preparation)	11	Internal limit active (in preparation)
4	Disable voltage	12	Operation mode dependent (reserved)
5	Quick stop	13	Operation mode dependent (reserved)
6	Switch on disabled	14	Manufacturer-specific (reserved)
7	Warning (in preparation)	15	Manufacturer-specific (reserved)

III.4.3.2 States of the status machine

State	Bit 6 switch on disable	Bit 5 quick stop	Bit 3 fault	Bit 2 operation enable	Bit 1 switched on	Bit 0 ready to switch on
Not ready to switch on	0	X	0	0	0	0
Switch on disabled	1	X	0	0	0	0
Ready to switch on	0	1	0	0	0	1
Switched on	0	1	0	0	1	1
Operation enabled	0	1	0	1	1	1
Fault	not supported at present					
Fault reaction active	not supported at present					
Quick stop active	0	0	0	1	1	1

The bits marked with X are irrelevant.

III.4.3.3 Description of the other bits in the status word

Bit 4: voltage_disable The DC-link voltage is present when this bit is canceled.
Bit 7: warning (not supported at present). There may be several reasons which have led to this warning and the setting of Bit 7. The reason for this warning can be revealed by using the Object 1002H “manufacturer-specific status register”. (⇒ III.5.2.2.3)
Bit 9: remote (not supported at present)
Bit 10: target_reached (not supported at present)
Bit 11: internal_limit_active (not supported at present)

III.5 Communication profile

This Chapter does not describe the method of operation of the CANopen Communication Profile, but the handling of the Objects that are implemented and used
(e.g. SDO, PDO, EMERGENCY, ...).
The foundation for this is the CAL (CAN Application Layer DS201...207).
Four types of message (Messages / Objects) can be distinguished, according to their functionality (s. DS 301). They are described below:

- “Administrative Messages” (Layer Management, Network Management, Identifier Distribution Messages)
- “Service Data Messages”
- “Process Data Messages”
- “Predefined Communication Objects”
  (Synchronization/ Time-Stamp/Emergency Messages).

III.5.1 Administrative Messages

The network management is implemented according to the CANopen standard. The corresponding status machine is implemented according to the state diagram that supports the four states of Initialization, Pre-operational, Prepared, Operational. The status machine is operated with the corresponding NMT-messages (e.g. Start Remote Node).

III.5.2 Service Data Messages

In accordance with the CAL specification (DS202-1), the following services are supported through the aid of the Service Data Objects (SDO):

- Domain Download
- Domain Upload
- Abort Domain
- Initiate Domain Download (in preparation)
- Download Domain Segment (in preparation)
- Initiate Domain Upload (in preparation)
- Upload Domain Segment (in preparation)

The construction and method of operation of the SDOs can be found in the CANopen (DS301) Communication Profile.

Caution!
It is always necessary to wait for the response to an SDO that is sent to the SERVOSTAR™ before a new telegram can be sent to it. There is no buffering of the commands.

III.5.2.1 Description of the Object Dictionary

The following table describes the Object Dictionary. The first column includes the Index for the Object. If the Object is a structure, then the subindices are listed in the corresponding column according to the CANopen convention.
If it is not possible to process a component of a PDO (e.g. because a limit is exceeded), then the further processing of the PDO is interrupted and an EMERGENCY Object is transmitted. An appropriate label for the faulty component is then entered in the manufacturer-specific area of the Object. (⇨ III.5.4.2)
For certain parameters, a reference in brackets points to the ASCII commands that are described in the reference manual.

Index	Description des Index	Subindex	Description / Reference	Data type	Access
Communication profile area (DS 301)					
1000H	Unit type	---	⇨ III.5.2.2.1	32-bit Int.	r
1001H	Error register	---	⇨ III.5.2.2.2	8-bit Char	r
1002H	Manufacturer-specific status register	---	⇨ III.5.2.2.3	32-bit Int.	r
1003H	Predefined error field	0	No. of entries(⇨ III.5.2.2.4)	8-bit Char	r
		1	Last reported error	32-bit Int.	r/w
1005H	COB-ID SYNC message	---	See CANopen (DS 301)	32-bit Int.	r
1008H	Unit name	---	⇨ III.5.2.2.5	4 Char	r
100AH	Software version	---	⇨ III.5.2.2.6	4 Char	r
100BH	Node address	---	⇨ III.5.2.2.7	32-bit Int.	r
100CH	Guard time	---	⇨ III.5.2.2.8	16-bit Int.	r/w
100DH	Lifetime factor	---	⇨ III.5.2.2.9	8-bit Char	r/w
Receive-PDO communication parameter (DS 301)					
1400H	1st receive-PDO parameter	---	⇨ III.5.3.1	RECORD	
1401H	2nd receive-PDO parameter	---	⇨ III.5.3.1	RECORD	
Receive-PDO mapping parameter (DS 301)					
1600H	1st receive-PDO mapping	---	⇨ III.5.3.1	RECORD	
1601H	2nd receive-PDO mapping	---	⇨ III.5.3.1	RECORD	
Transmit-PDO communication parameter (DS 301)					
1800H	1st transmit-PDO parameter	---	⇨ III.5.3.2	RECORD	
1801H	2nd transmit-PDO parameter	---	⇨ III.5.3.2	RECORD	
Transmit-PDO mapping parameter (DS 301)					
1A00H	1st transmit-PDO mapping	---	⇨ III.5.3.2	RECORD	
1A01H	2nd transmit-PDO mapping	---	⇨ III.5.3.2	RECORD	
Device profile drives and motion control (DSP 402) / manufacturer specific profile area (DSP 402)					
2000H	Current controller (in preparation)	0	Number of entries	8-bit Char	r
2010H	Speed controller (in preparation)	0	Number of entries	8-bit Char	r
2020H	Position controller	0	Number of entries	8-bit Char	r
		1	Axis type (see Com. “POSCNFG”)	8-bit Char	r/w
		2	In-Position window (see Com. “PEINPOS”)	32-bit Int.	r/w
		3	Contouring error window (see Com. “PEMAX”)	32-bit Int.	r/w
		4	Position register 1 (see Com. “SWE1”)	32-bit Int.	r/w
		5	Position register 2 (see Com. “SWE2”)	32-bit Int.	r/w
		6	Position register 3 (see Com. “SWE3”)	32-bit Int.	r/w
		7	Position register 4 (see Com. “SWE4”)	32-bit Int.	r/w
		8	Denominator resolution (see Com. “PGEARO”)	32-bit UInt	r/w
		9	Numerator resolution (see Com. “PGEARI”)	32-bit UInt	r/w
		10	Count direction (see Com. “DIR”)	8-bit Char	r/w

Index	Description of the Index	Subindex	Description / Reference	Data type	Access
2022H	Position data for the 'Position' mode	0	No. of entries (⇨ III.5.2.2.10)	8-bit Char	r
		1	Position	32-bit Int.	r/w
		2	Speed	16-bit Int.	r/w
		3	Motion task type	16-bit UInt	r/w
		4	Trajectory	32-bit Int.	r/w
		5	Motion task number (see Com. "MOVE")	16-bit UInt	r/w
		6	Acceleration time [Accel.]	16-bit UInt	r/w
		7	Braking time [Decel.]	16-bit UInt	r/w
		8	Rate-of-change limiting [Acceleration]	16-bit UInt	r/w
		9	Rate-of-change limiting [Deceleration]	16-bit UInt	r/w
		10	Number of the following tasks	16-bit UInt	r/w
		11	Start delay for following task	16-bit UInt	r/w
		12	Copy a motion task (see Com. "COPY")	2x16-bit UInt	w
		13	Weighting factor Speed for PDO motion block	16-bit	r/w
		14	Speed for direct motion task	32-bit Int.	r/w
2024H	Setting-up operation for the 'Position' mode	0	No. of entries	8-bit Char	r
		1	Homing type (see Com. "NREF")	8-bit Char	r/w
		2	Homing direction (see Com. "DREF")	8–bit Char	r/w
		3	Homing speed (see Com. "VREF")	32–bit Int.	r/w
		4	Acceleration ramp [jogging & homing] (see Com. "ACCR")	16-bit UInt	r/w
		5	Braking ramp [jogging & homing] (see Com. "DECR")	16-bit UInt	r/w
		6	Reference offset (see Com. "ROFFS")	32-bit Int.	r/w
		7	Jogging speed (see Com. "VJOG")	32-bit Int.	r/w
2040H	Motor parameter (in preparation)	0	No. of entries	8-bit Char	r
2050H	General parameter (in preparation)	0	No. of entries	8-bit Char	r
2060H	Setpoints for the 'Digital' mode	0	No. of entries	8-bit Char	r
		1	Speed or current setpoint	32-bit Int.	rw
2070H	Actual values	0	No. of entries	8-bit Char	r
		1	Actual position (20 bits / turn)	32-bit Int.	r
		2	Revs/min.	32-bit Int.	r
		3	Incremental position value (see Com. "PFB")	32-bit Int.	r
		4	Reserve	---	---
		5	Reserve	---	---
		6	Position (resolution-dependent) (see Com. "PRD")	32-bit Int.	r
		7	Speed (resolution-dependent)	32-bit Int.	r
		8	contouring error (resolution-dependent)	32-bit Int.	r
		9	Current (r.m.s.) (see Com. "I")	32-bit Int.	r
		10	Speed (see Com. "v")	32-bit Int.	r
		11	Heat sink temperature (see Com. "TEMPH")	32-bit Int.	r
		12	Internal temperature (see Com. "TEMPE")	32-bit Int.	r
		13	DC-link voltage (see Com. "VBUS")	32-bit Int.	r
		14	Ballast power (see Com. "PBAL")	32-bit Int.	r
		15	I^2T loading (see Com. "I2T")	32-bit Int.	r
		16	Operational time (see Com. "TRUN")	32-bit Int.	r
2600H	1st receive-PDO select	---	⇨ III.5.2.2.15	8-bit Char	r/w
2601H	2nd receive-PDO select	---	⇨ III.5.2.2.16	8-bit Char	r/w
2A00H	1st transmit-PDO select	---	⇨ III.5.2.2.17	8-bit Char	r/w
2A01H	2nd transmit-PDO select	---	⇨ III.5.2.2.18	8-bit Char	r/w
3100H	ASCII-character direction	---	⇨ III.5.2.2.19	8-bit Char	r/w
Device control (DSP 402)					
6040H	Control word	---	⇨ III.4.2	16-bit Int.	w
6041H	Status word	---	⇨ III.4.3	16-bit Int.	r
605AH	Quickstop option code	---	⇨ III.5.2.2.20	16-bit Int.	r/w
6060H	Modes of operation	---	⇨ III.5.2.2.21	8-bit Char	w
6061H	Modes of operation display	---	⇨ III.5.2.2.21	8-bit Char	r

III.5.2.2 Description of the Objects

III.5.2.2.1 Object 1000H: Device Type

Index	1000H
Brief description	description of the type of device
Access	r
Data type	Integer32
Value range	see below

Description:

The type of device is defined by a 32 Bit data element.

MSB LSB

Additional Information		Device-profile number
Output stage ID	Device type	402D
31 24	23 16	15 0

Device Profile Number: 402D

Device type: 2D (Servo Drive)

III.5.2.2.2 Object 1001H: Error register

If an error bit is set in the error register, then detailed information is made available in Object 1003H.

Index	1001H
Brief description	error register
Access	r
Data type	Unsigned8
Value range	see below

Description:

The bit assignments in the error register are described below.

Bit	Description
0	generic error
1	current
2	voltage
3	temperature
4	communication error
5	device profile specific
6	reserved
7	manufacturer-specific

III.5.2.2.3 Object 1002H: Manufacturer Status Register (Warnings)

Index	1002H
Brief description	manufacturer-specific status register
Access	r
Data type	Unsigned32
Value range	see below

Bit assignments :

Bit	Value	Description
0	1	Warning 1: I^2t-signal threshold exceeded
1	1	Warning 2: ballast power reached
2	1	Warning 3: contouring error
3	1	Warning 4: response monitoring is active
4	1	Warning 5: supply phase missing
5	1	Warning 6: software limit-switch 1 was triggered
6	1	Warning 7: software limit-switch 2 was triggered
7	1	Warning 8: faulty motion task started
8	1	Warning 9: no reference point set at start of motion task
9	1	Warning 10: PSTOP active
10	1	Warning 11: NSTOP active
11	1	Warning 12: motor default values were loaded
12	1	Warning 13: expansion board not functioning correctly
13	1	Warning 14: reserve
14	1	Warning 15: reserve
15	1	Warning 16: reserve
16	1	motion task active
17	1	reference point set
18	1	actual position = Home Position
19	1	In Position
20	1	---
21	1	---
22	1	Position 1 reached
23	1	Position 2 reached
24	1	Position 3 reached
25	1	Position 4 reached
26	1	Initialization is finished
27	1	---
28	1	speed = 0
29	1	safety relay has been triggered
30	1	output stage enabled
31	1	error present

III.5.2.2.4 Object 1003H: Predefined Error-field

Index	1003H
Brief description	Predefined error-field
Object code	RECORD
Number of elements	1

Description of the subindex:

Subindex	01H
Brief description	last error recorded
Access	rw
Data type	Unsigned32

Description: This Object can be used to read out the last Emergency Object that was recorded. Only subindices 0 and 1 according to CANopen DS301 are supported.

III.5.2.2.5 Object 1008H: Manufacturer Device Name

Index	1008H
Brief description	device name
Access	r
Data type	Visible string

Description :

The device name consists of four ASCII characters, and contains the letters “S6xx”, whereby xx stands for the size of the current in the output stage (e.g. S606).

III.5.2.2.6 Object 100AH: Manufacturer Software Version

Index	100AH
Brief description	software version
Access	r
Data type	Visible string

Description :

The interface-software version consists of four ASCII characters (e.g. 0.04).

III.5.2.2.7 Object 100BH: Node-ID

Index	100BH
Brief description	station address
Access	r
Data type	Unsigned32
Value range	1 ... 63

Description :

The station address can be output through the Object “Node-ID”.

III.5.2.2.8 Object 100CH: Guard Time

Index	100CH
Brief description	guard time
Access	rw
Data type	Unsigned16
Value range	0 ... 65535

Description :

The product of the Objects “Guard Time” and “Lifetime Factor” is the response monitoring time. The “Guard Time” is given in milliseconds. The response monitoring first becomes active with the first “Nodeguard” Object (see CANopen DS301). If the value of the “Guard Time” Object is set to zero, then the response monitoring is inactive.

III.5.2.2.9 Object 100DH: Lifetime Factor

Index	100DH
Brief description	Lifetime Factor
Access	rw
Data type	Unsigned8
Value range	0 ... 255

Description :

The product of the Objects “Guard Time” and “Lifetime Factor” is the response monitoring time. The response monitoring first becomes active with the first “Nodeguard” Object (see CANopen DS301). If the value of the “Lifetime Factor” Object is set to zero, then the response monitoring is inactive.

III.5.2.2.10 Object 2020H: Position controller

Index	2020H
Brief description	parameter for the position controller
Object code	RECORD
Number of elements	10

Description :

This index is used to define all the general parameters for the 'Position' mode.

Description of the subindices :

Subindex	01H
Brief description	axis type
Dimensional unit	---
Access	rw
PDO mapped	no
Data type	Unsigned8
Value range	0, 1
Default value	0

Description : Describes the type of the mechanical axis.

Value 0: Linear axis. A defined reference point is used as the origin for measuring positions. This must be defined by a homing operation, or by setting a reference point. The movement of the axis will be limited by software limit-switches (if configured).

Value 1: Rotary axis. Does not require a reference point. The position is set to 0 at the start of motion blocks or jogging.
Software limit-switches do not limit the movement.

Subindex	02H
Brief description	In-Position window
Dimensional unit	µm
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	4000H

Description : Determines a target window for positioning. If the limit of the target window is reached, Bit 19 is set in the manufacturer-specific status register, and, if the output is appropriately configured, the selected output will be set to High.

Subindex	03H
Brief description	maximum contouring error
Dimensional unit	µm
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	40000H

Description : Defines a maximum value for the contouring error. If the contouring error that arises exceeds this value, then the drive is stopped.
The infringement of the contouring error limit is indicated through Bit 2 of the manufacturer-specific status register.
If the value is set to 0, the contouring error will not be monitored.

Subindex	04H
Brief description	Position register 1
Dimensional unit	µm
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description : Depending on configuration, going above or below the preset position value results in a threshold bit being set (Bit 22 of the manufacturer-specific status register) or the axis being stopped. (Going below software limit-switch 1 = manufacturer-specific status register Bit 5 = 1)

Subindex	05H
Brief description	Position 2
Dimensional unit	µm
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description : Depending on configuration, going above or below the preset position value results in a threshold bit being set (Bit 23 of the manufacturer-specific status register) or the axis being stopped. (Going above software limit-switch 2 = manufacturer-specific status register Bit 6 = 1)

Subindex	06H
Brief description	Position register 3
Dimensional unit	µm
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description : Depending on the configuration, going above or below the preset position value results in a threshold bit being set (Bit 24 of the manufacturer-specific status register).

Subindex	07H
Brief description	Position register 4
Dimensional unit	μm
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description : Depending on the configuration, going above or below the preset position value results in a threshold bit being set (Bit 25 of the manufacturer-specific status register).

Subindex	08H
Brief description	Resolution: denominator of the conversion factor
Dimensional unit	turns
Access	rw
PDO mapped	no
Data type	Unsigned32
Value range	$1 ... (2^{31} -1)$
Default value	1

Description : see Subindex 09H

Subindex	09H
Brief description	Resolution: numerator of the conversion factor
Dimensional unit	µm
Access	rw
PDO mapped	no
Data type	Unsigned32
Value range	$1 ... (2^{31} -1)$
Default value	1

Description : The ratio of the subindices 8 and 9 defines the mechanical resolution of the axis in µm/turn.

Subindex	0AH
Brief description	count direction
Dimensional unit	---
Access	rw
PDO mapped	no
Data type	Unsigned8
Value range	0, 1
Default value	1

Description : The value represents the count direction for current, speed and position control.
A value of 1 selects the positive direction of counting. Positive setpoint entries result in the motor shaft rotating in the clockwise direction (looking at the end of the shaft).

III.5.2.2.11 Object 2022H: Positioning data for Positioning Mode

Index	2022H
Brief description	motion task parameter
Object code	RECORD
Number of elements	12

Description :

This index is used to enter all the parameters that are relevant to direct motion tasks or tasks that are stored in the controller. (See ASCII command “ORDER”)

Description of the subindices :

Subindex	01H
Brief description	Position
Dimensional unit	increments or μm
Access	rw
PDO mapped	PDO 34 (rx)
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description : This index is used to define the target position (absolute motion task) or distance to be travelled (relative motion task) for motion tasks.
This is selected by Bit 0 of the motion task type. Bit 13 of the motion task type determines whether the value that is presented should be interpreted as an increment or as an SI-value.

Subindex	02H
Brief description	Set speed
Dimensional unit	increments/sec or μm/sec
Access	rw
PDO mapped	PDO 34 (rx)
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index is used to define the set speed for motion tasks. If the value is defined as an SI dimensional unit by motion task type Bit 13 = 1, then the incremental speed v_i is given by
$v_i = v_{SI} * \frac{PGEARO}{PGEARI * 4000}$, where PGEARO (Index 2020, Subindex 8) contains the number of increments to be travelled, and where the distance to be travelled is PGEARI (=Index 2020, Subindex 9). It must be noted that here one turn of the motor is equivalent to 2^{20} = 1048576 increments.

Subindex	03H
Brief description	type of motion task
Dimensional unit	---
Access	rw
PDO mapped	PDO 34 (rx)
Data type	Unsigned16
Value range	0 ... 65535
Default value	0

Description: This index is used to set motion parameters for the motion task.
In this case, the bits have the following interpretations:

Bit	Val.	Interpretation
0	0	The given position value (Subindex 1) is evaluated as an absolute position.
	1	The given position value is evaluated as a relative distance to be travelled. The two following bits will then decide the type of relative motion.
1	0	If Bit 1 and Bit 2 are set to 0, and Bit 0 is 1, then the relative motion task is performed according to the state of the “InPosition” bit.
	1	The new target position is given by the current position plus the distance to be travelled. Bit 1 has priority to Bit 2.
2	0	If Bit 1 and Bit 2 are set to 0, and Bit 0 is 1, then the relative motion task is performed according to the state of the “InPosition” Bit.
	1	The new target position is given by the current position plus the distance to be travelled.
3	0	No following task available
	1	There is a following task that must be defined through the subindex 0AH.
4	0	Switch over to the following task, braking to speed 0 at the target position.
	1	Switch over to the following task, without stopping at the target position. The type of speed transition is set by Bit 8.
5	0	Switch over to the following task, without evaluating inputs.
	1	A following task is started through an appropriately configured input.
6	0	Start the following task by input state Low.
	1	Start des following task by input state High or, if Bit 7 = 1, in any case after the delay time that is set by subindex 0BH.
7	0	The following task is started immediately.
	1	The following task is started after the delay time that is set by subindex 0BH or, if Bit 6 = 1, previously, by the appropriate input signal.
8	0	Only for following tasks and Bit 4 = 1: On reaching the target position for the motion task, the speed is changed to the value for the following task.
	1	The speed changeover is made so that the speed at the target position for the motion task has already reached the value for the following task.
9..11	---	reserved
12	0	Accelerations are calculated from the acceleration and braking times of the motion task.
	1	A global acceleration value is used to calculate the accel./braking ramps (in preparation).
13	0	The target position and target speed of a motion task are interpreted as increments.
	1	The target position and target speed are converted to increments before the start of the motion task. This is done by using the parameters PGEARI and PGEARO (see subindex 02H)
14	0	The programmed speed is used as the motion task speed.
	1	The speed for the motion task is determined by the voltage present at analog input SW1 when the motion task starts.
15	---	reserved

Subindex	04H
Brief description	trajectory
Dimensional unit	---
Access	rw
PDO mapped	PDO 33 (rx)
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: In preparation

Subindex	05H
Brief description	motion task number
Dimensional unit	---
Access	rw
PDO mapped	PDO 35 (rx)
Data type	Unsigned16
Value range	1 ... 180, 129 ... 255
Default value	0

Description: This index is used to define the number of the selected motion task. Note that the task nos. 1 to 180 are for EEPROM motion blocks, and 192 to 255 are for RAM motion tasks. The RAM motion tasks are loaded with the first 64 EEPROM motion tasks at switch-on, or if the servo amplifier is reset. Motion task 0 is also a RAM motion task, that is used as a copying buffer for motion tasks, or for entering the motion task data for a direct motion task (PDO (rx) 34).

Subindex	06H
Brief description	accel. time (acceleration)
Dimensional unit	ms
Access	rw
PDO mapped	no
Data type	Unsigned16
Value range	1 ... 65535
Default value	0

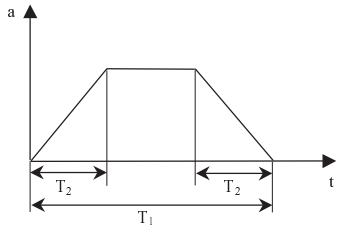
Description: This index is used to define the total time taken to reach the target speed for the motion task. The value selected for subindex 8 sets the form of the acceleration ramp.

Subindex	07H
Brief description	braking time (deceleration)
Dimensional unit	ms
Access	rw
PDO mapped	no
Data type	Unsigned16
Value range	1 ... 65535
Default value	0

Description: This index is used to define the total time taken to reach speed 0 at the target positon. The value selected for subindex 9 sets the form of the acceleration ramp.

Subindex	08H
Brief description	rate-of-change limiting (acceleration)
Dimensional unit	ms
Access	rw
PDO mapped	---
Data type	Unsigned16
Value range	1 ... 65535
Default value	0

Description: This index is used to define the form of the acceleration ramp.
The value must be set to less than half of the accel. time (subindex 6).
The following diagram illustrates the relationship:



T_1 correponds to subindex 6, T_2 to subindex 8.
For T2 = 0, the curve that is followed is a trapezoidal ramp,
for $T_2 = \frac{T_1}{2}$ it is approximately a $\sin^2$ curve.

Subindex	09H
Brief description	rate-of-change limiting (braking)
Dimensional unit	ms
Access	rw
PDO mapped	---
Data type	Unsigned16
Value range	0 ... 65535
Default value	0

Description: This index is used to define the form of the braking ramp.
The value must be set to less than half of the braking time (subindex 7).
The rate-of-change limiting has the same effect here as for acceleration.

Subindex	0AH
Brief description	number of the following task
Dimensional unit	---
Access	rw
PDO mapped	no
Data type	Unsigned16
Value range	0 ... 180, 192 ... 255
Default value	0

Description: This index is used to set the number for a following task.
The setting of subindex 3, Bit 3, determines whether this is used to continue.

Subindex	0BH
Brief description	start delay for the following task
Dimensional unit	ms
Access	rw
PDO mapped	no
Data type	Unsigned16
Value range	1 ... 65535
Default value	0

Description: This Object is used to set a delay time before the start of the following motion task. This function must be enabled through subindex 3, Bit 7.

Subindex	0CH
Brief description	copy a motion task
Dimensional unit	---
Access	w
PDO mapped	no
Data type	2 x Unsigned16
Value range	each 0 ... 180, 192 ... 255
Default value	0, 0

Description: This Object can be used to copy motion tasks.
The number that appears first in the CAN telegram describes the source motion task, the following number is the target motion task.

Subindex	0DH
Brief description	weighting factor for speed
Dimensional unit	---
Access	rw
PDO mapped	no
Data type	Unsigned16
Value range	0 ... 65535
Default value	1

Description: This Object is used to set a multiplier for the speed that is given in the PDO motion block (rx).

Subindex	0EH
Brief description	speed for direct motion task
Dimensional unit	increments / 250µs, or dependent on the resolution
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This Object is used to define the speed for the direct motion task (motion block 0). The motion task type then determines whether the speed is evaluated incrementally, or as an SI dimensional unit.

III.5.2.2.12 Object 2024H: Setting-up for Positioning Mode

Index	2024H
Brief description	parameters for homing and jogging
Object code	RECORD
Number of elements	7

Description :

This index is used to enter parameters that are important for the operating modes “Homing” and “Jogging”.

Description of the subindices :

Subindex	01H
Brief description	homing
Dimensional unit	---
Access	rw
PDO mapped	no
Data type	Unsigned8
Value range	0 ... 5
Default value	0

Description: This index is used to set the type of homing.
The following settings are possible:

Value	Interpretation
0	The reference point is set to the current (actual) position. The actual position that is signalled is then the preset reference offset.
1	Homing to reference switch, with subsequent search of the resolver zero point.
2	Homing to limit-switch, with subsequent search of the resolver zero point.
3	Homing to reference switch, without subsequent search of the resolver zero point.
4	Homing to limit switch, without subsequent search of the resolver zero point.
5	Homing to the resolver zero point, within a motor turn. The direction of travel is given by the subindex 2. The values mean: 0: negative direction of travel 1: positive direction of travel 2: motor turns in the shortest direction to the resolver zero point within a turn.
6	The reference point is set at the current setpoint position of the position control to the value of the reference offset. The new actual position retains the same distance to the setpoint position as before.

The following must be observed:
For homing 1 and 3 a digital input must be configured as the zero position input (Home Position). For homing 2 and 4 a digital input must be configured as a hardware limit-switch.
For homing types 1 – 5 the setting of the zero-pulse offset for the ROD output is taken into account (ASCII command ENCZERO), i.e. the zero point is fixed so that the output of the zero pulse as well as the display of the 0-position is made in place of the zero-pulse offset.

Subindex	02H
Brief description	homing direction
Dimensional unit	---
Access	rw
PDO mapped	no
Data type	Unsigned8
Value range	0 ... 2
Default value	0

Description: This index is used to define the direction of travel for homing types 1 to 5. The values have the following meaning:
0: negative direction of travel
1: positive direction of travel
2: motor turns in the shortest direction to the resolver zero point within a turn. (Only relevant for homing type 5)

Subindex	03H
Brief description	Speed for homing
Dimensional unit	µm/sec
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index is used to define the homing speed.

Subindex	04H
Brief description	acceleration ramp for jogging/homing
Dimensional unit	ms
Access	rw
PDO mapped	no
Data type	Unsigned16
Value range	1 ... 32767
Default value	10

Description: This index is used to set the acceleration ramp for homing and jogging operations. It is implemented as a trapezoidal curve form. The time that is set refers to the speeds that are set for homing and jogging.

Subindex	05H
Brief description	braking ramp for jogging/homing
Dimensional unit	ms
Access	rw
PDO mapped	no
Data type	Unsigned16
Value range	1 ... 32767
Default value	10

Description: This index is used to set the braking ramp for homing and jogging operation. It is implemented as a trapezoidal curve form. The time that is set refers to the speeds that are set for homing and jogging operations. When homing to a hardware limit-switch, the emergency ramp (ASCII parameter DECSTOP) is used.

Subindex	06H
Brief description	reference offset
Dimensional unit	µm
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index is used to set the reference offset, i.e. the actual position that is displayed after homing to the reference (index 2070, subindex 6).

Subindex	07H
Brief description	speed for jogging
Dimensional unit	µm/sec
Access	rw
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index is used to set the speed for jogging.

III.5.2.2.13 Object 2060H: Setpoints for Digital Mode

Index	2060H
Brief description	digital setpoint for current or speed
Dimensional unit	A, or min^{-1}
Access	rw
PDO mapped	PDO 22 (rx)
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description :

This Object is used for the transfer of digital setpoints which are evaluated according to the digital mode that is set (mode FDH = digital current, mode FEH = digital speed, can be set through Object 6060H). The normalization settings are made as follows:

Current: $$I[A] = {digital\ current\ setpoint}/{1640} * I_{max}$$

Speed: $$n[\min^{-1}] = {1875}/{262144} * digital\ current\ setpoint$$

A new setpoint will always only become effective after a fresh Enable operation (through Object 6040H, control word).

The SERVOSTAR™ position controller is switched off when the speed or current controllers are active.

III.5.2.2.14 Object 2070H: Actual values

Index	2070H
Brief description	actual values
Object code	RECORD
Number of elements	16

Description :

This index is used to make relevant actual values available to the SERVO**STAR™** 600.

Description of the subindices :

Subindex	01H
Brief description	actual position
Dimensional unit	---
Access	r
PDO mapped	PDO 22 (tx), PDO 32 (tx)
Data type	Unsigned32
Value range	0 ... 16777215
Default value	0

Description: This index can be used to read in the motor position, within 16 turns. One turn is resolved with 20 bits of incremental information. So, 1 turn ⇒ 2^{20} increments ⇒1048576 increments

Subindex	02H
Brief description	actual speed
Dimensional unit	min^{-1}
Access	r
PDO mapped	PDO 22 (tx), PDO 32 (tx)
Data type	Unsigned32
Value range	0 ... 1677215
Default value	0

Description: This index can be used to read in the motor speed.
The value for the speed is given by:

$$n[\min^{-1}] = {}^{1875}\!/_{262144} * \textit{actual value read in}$$

Subindex	03H
Brief description	incremental position encoder
Dimensional unit	---
Access	r
PDO mapped	PDO 33 (tx)
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read in the incremental value for the actual position. One turn is resolved with 20 bits of incremental information. So, 1 turn ⇒ 2^{20} increments ⇒1048576 increments

Subindex	06H
Brief description	SI actual position value
Dimensional unit	µm
Access	r
PDO mapped	PDO 22 (tx), PDO 32 (tx)
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index reads the actual position in SI dimensional units.
The relationship between the actual distance travelled and motor turns is given by $S_{SI} = S_{Incr} * PGEARI / PGEARO$
whereby PGEARO (= index 2020, subindex 8) contains the number of increments that are travelled to produce the distance PGEARI (= index 2020, subindex 9). Note that here one turn corresponds to incremental number 220 = 1048576.

Subindex	07H
Brief description	SI actual speed value
Dimensional unit	µm/sec
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read the actual speed in SI dimensional units.

Subindex	08H
Brief description	contouring error
Dimensional unit	µm
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to determine the momentary contouring error in SI dimensional units.

Subindex	09H
Brief description	effective (r.m.s.) current
Dimensional unit	mA
Access	r
PDO mapped	no
Data type	Unsigned32
Value range	0 ... 2 * rated current [mA]
Default value	0

Description: This index can be used to read the momentary r.m.s. current.

Subindex	0AH
Brief description	speed
Dimensional unit	min^{-1}
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read the momentary speed measurement.

Subindex	0BH
Brief description	heat sink temperature
Dimensional unit	°C
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read the heat sink temperature.

Subindex	0CH
Brief description	internal temperature
Dimensional unit	°C
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read the internal temperature of the servo amplifier.

Subindex	0DH
Brief description	DC-link voltage
Dimensional unit	V
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read the momentary DC-link voltage measurement.

Subindex	0EH
Brief description	ballast power
Dimensional unit	W
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index be used to read the momentary ballast power.

Subindex	0FH
Brief description	I^2T loading
Dimensional unit	%
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read the I^2t loading.

Subindex	10H
Brief description	operating time
Dimensional unit	min
Access	r
PDO mapped	no
Data type	Integer32
Value range	$-(2^{31}-1)..(2^{31}-1)$
Default value	0

Description: This index can be used to read the operating time counter of the servo amplifier.

III.5.2.2.15 Object 2600H: 1st receive-PDO select

Index	2600H
Brief description	selection of the first receive-PDO
Access	rw
Data type	Unsigned8
Value range	1, 21 ... 24, 32
Default value	1

Description: This Object is used to map a predefined receive-PDO to the Objects 1400H (1st receive-PDO parameter) and 1600H (1st receive-PDO mapping) with the aid of the PDO number. This Object enables a variable mapping of predefined PDOs. The selectable PDOs that are available are described in the following table.

PDO number	PDO name	Reference
1	PDO control word	⇨ III.5.3.1.1
2 .. 20	reserved	---
21	ASCII channel	⇨ III.5.3.1.2
22 .. 31	reserved	---
32	PDO setpoint	⇨ III.5.3.1.4
33	PDO trajectory	⇨ III.5.3.1.5
34	PDO motion block	⇨ III.5.3.1.6
35	PDO start motion block	⇨ III.5.3.1.7
36 .. 64	reserved	---

III.5.2.2.16 Object 2601H: 2nd receive-PDO select

Index	2601H
Brief description	selection of the second receive-PDO
Access	rw
Data type	Unsigned8
Value range	1, 21 ... 24, 32
Default value	21

Description: This Object is used to map a predefined receive-PDO to the Objects 1401H (2nd receive-PDO parameter) and 1601H (2nd receive-PDO mapping) with the aid of the PDO number. The Object 2601H enables a variable mapping of predefined PDOs.

III.5.2.2.17 Object 2A00H: 1st transmit-PDO select

Subindex	2A00H
Brief description	selection of the first transmit-PDO
Access	rw
Data type	Unsigned8
Value range	1, 21 ... 24, 32
Default value	1

Description: This Object is used to map a predefined transmit-PDO to the Objects 1800H (1st transmit-PDO parameter) and 1A00H (1st transmit-PDO mapping) with the aid of the PDO number. The Object 2A00H enables a variable mapping of predefined PDOs. The selectable PDOs that are available are described in the following table.

PDO number	PDO name	Reference
1	PDO status word	⇨ III.5.3.2.1
2 .. 20	reserved	---
21	ASCII channel	⇨ III.5.3.2.2
22	PDO actual position	⇨ III.5.3.2.3
23	PDO extended status	⇨ III.5.3.2.4
24 .. 31	reserved	---
32	PDO actual position2	⇨ III.5.3.2.5
33	PDO incremental position value	⇨ III.5.3.2.6
34 .. 64	reserved	---

III.5.2.2.18 Object 2A01H: 2nd transmit-PDO select

Index	2A01H
Brief description	selection of the second transmit-PDO
Access	rw
Data type	Unsigned8
Value range	1, 21 ... 24, 32
Default value	21

Description: This Object is used to map a predefined transmit-PDO to the Objects 1801H (2nd transmit-PDO parameter) and 1A01H (2nd transmit-PDO mapping) with the aid of the PDO number. The Object 2A01H enables a variable mapping of predefined PDOs.

III.5.2.2.19 Object 3100H: ASCII channel

Index	3100H
Brief description	transmit and receive ASCII characters
Access	rw
Data type	Visible string
Value range	---

Description: This Object can be used to transmit and receive ASCII characters, as long as the status machine is not in the “Operational” state. If less then four characters are to be transferred, then the unused data Bytes must be filled with the ASCII code “NUL”.
If the status machine is in the “Operational” state, then the characters can only be written, with the aid of an SDO, since the mirrored characters or the response are transmitted by PDO. If the PDO ASCII channel transmit (PDO 21) is not mapped, then the transmission buffer for ASCII characters will automatically be cleared, to prevent overflows.

III.5.2.2.20 Object 605AH: Quick Stop Option Code

Index	605AH
Brief description	Quick Stop response
Access	rw
Data type	Integer16
Value range	–32768 ... 32767
Default value	2

Description: This Object is used to define the behavior of the drive in the event of a Quick Stop command.

Value	Description		
–32768 ... –2	Reserved (manufacturer-specific)		
-1	Manufacturer-specific	—	response as for Pause (⇒III.4.2), using the Quick Stop braking ramp
0	Disable Drive Function	—	drive is stopped and immediately disabled (Switch On Disable)
1	Reserved (drive profile)		
2	Slow down on quickstop ramp	—	motion task must be selected again
3 ... 32767	Reserved		

III.5.2.2.21 Object 6060H / 6061H: Modes of Operation

Since the following are user-defined modes, the values are negative.

Function	Mode		Comments
	dec.	hex.	
Position	-1	FF	the mode required for motion tasks
Digital speed	-2	FE	---
Digital current	-3	FD	---
Analog speed	-4	FC	not possible with standard version
Analog current	-5	FB	not possible with standard version
Trajectory	-6	FA	---
Homing	-7	F9	---
Jogging	-8	F8	---

Object 6060H is used to set the mode, and Object 6061H to read the mode that has been set. After a change of mode the corresponding setpoint must be set again (e.g. homing mode ⇒ setpoint homing speed must be set). If the position or jogging mode is stored, then the homing mode is set after a RESET of the servo amplifier.

Never change the mode while the motor is running !
A changing of the modes while the amplifier is enabled is only permitted at speed 0.
Set the setpoint to 0 before changing over.

III.5.3 Process Data Messages

Process Data Messages are implemented with the aid of the Process Data Object (PDO) (see CANopen DS 301). Since CANopen only supports two transmit-PDOs and two receive-PDOs, but the drive profile requires more than two PDOs, SDOs can be used to activate the corresponding PDOs through mapping.
The system distinguishes between two transmission modes – synchronous and asynchronous. The transmission modes are parameterized through SDOs.
Process Data Objects are assigned to the transmission types with the aid of a Byte value (0 — 255, see CANopen DS 301). The table shows the various types of transmission.

Transmission type	PDO transmission	Transmission type	PDO transmission
0	acyclic synchronous	253	asynchronous / only RTR
1 ... 240	cyclic synchronous	254	asynchronous
241 ... 251	reserved	255	asynchronous
252	synchronous / only RTR		

All transmission types are supported, apart from type 252, whereby the transmission types 254 and 255 are event-triggered (asynchronous type) and are therefore exceptions. The tables that describe the PDOs show which PDOs can be triggered from particular events.
Receive-PDOs can be selected by the Objects 2600H / 2601H, and transmit-PDOs by the Objects 2A00H / 2A01H. Apart from this, the described default settings are valid (see the corresponding Object Descriptions).

Caution : in order to be able to perform PDOs, the NMT status machine must be in the "Operational" state (⇨ III.4.1).
PDOs should be used with a functional interlock, i.e. after a change in the control word or the use of th eASCII channel, there must be a wait for the next prompt (-->).
The characteristics of the software mean that the PDOs with numbers above 32 may possibly be processed more quickly.

III.5.3.1 Receive-PDOs

Receive-PDOs are transmitted from the master in the direction of the SERVO**STAR**™.
The following table describes the communication parameters for the receive-PDOs.

Subindex (hex)	Value range	Description
0	4	no. of entries
1	513 ... 639, 769 ... 895	COB-ID
2	0 ... 240, 255	transmission type
3	Unsigned16	inhibit time
4	0 ... 7	CMS priority group

III.5.3.1.1 PDO control word

The PDO control word (PDO number 1. – Default-PDO) consists of the control word (Unsigned16). This PDO can only be used to operate the status machine (⇨ III.4.1).
The PDO can be used in all modes.
After switch-on, this PDO is mapped to PDO1 (rx).
The table shows the mapping of the PDO control word:

Subindex (hex)	Value (hex)	Description
0	1	no. of entries
1	60400010	control word

III.5.3.1.2 PDO receive ASCII channel

With the help of the ASCII channel (PDO number 21 – Default-PDO) all parameters and commands can be transmitted to the SERVO**STAR**™ 600. Up to 8 ASCII characters can be sent in one PDO. Commands or parameters that require more than 8 characters must be segmented.
All commands and parameters are terminated by the ASCII code “CR LF” (0xDH, 0xAH).
The unused Bytes in the PDO are filled with the ASCII code “NUL” (0x0H), because otherwise every surplus character would be interpreted as a new command.
The table describes the mapping of the PDO receive ASCII channel:

Subindex (hex)	Value (hex)	Description
0	1	no. of entries
1 ... 8	31000208	0. — 7. ASCII char.

This Object **only** supports transmission type 255 (asynchronous).

III.5.3.1.3 PDO current or speed setpoint

The PDO current or speed setpoint (PDO number 22) is put together from the control word (Unsigned16) and the setpoint (Signed16). This PDO must only be used in the “Digital speed” or “Digital current” modes. It will be recognized as a speed or current setpoint, depending on the mode that is set (digital current or digital speed). The PDO is executed immediately. A repeated transmission of the PDO with various setpoint values does not require an intermediate halt of the drive. After switch-on, this PDO is mapped to PDO2 (rx).

Current normalization : 3280 = peak current of the controller
1640 = rated current

e.g. rated current = 3A, setpoint ⇒ 1.0A ⇒ 547 increments

Speed normalization : $^{262144}/_{1875} \times speed\ (\mathrm{min}^{-1}) = increments\ (speed\ setpoint)$

e.g. speed = $3000\mathrm{min}^{-1}$ ⇒ setpoint value

The table shows the mapping of the PDO setpoint:

Subindex (hex)	Value (hex)	Description
0	2	no. of entries
1	60400010	control word
2	20600110	current or speed setpoint

III.5.3.1.4 PDO Setpoint 2

The PDO Setpoint 2 (PDO Nummer 32) is a time- and date-optimized PDO. It contains only a 32-bit setpoint. This PDO must only be used in the “Digital speed” or “Digital current” modes.
It will be recognized as a speed or current setpoint, depending on the mode that is set (digital current or digital speed). The PDO is executed immediately. A repeated transmission of the PDO with various setpoint values does not require an intermediate halt of the drive. After switch-on, this PDO is mapped to PDO2 (rx).

Current/speed normalization : ⇒ III.5.3.1.3

The table shows the mapping of the PDO Setpoint 2:

Subindex (hex)	479430	Description
0	1	no. of entries
1	20600120	current/speed setpoint

III.5.3.1.5 PDO trajectory (in preparation)

The PDO Trajectory (PDO 33) is a time- and date-optimized PDO. This PDO must only be used in the “Trajectory” mode. The PDO Trajectory must always be transmitted at constant time intervals (to be set with the “PTBASE” command), otherwise there may be irregularities in the speed characteristic. This PDO consists of just one component, the incremental actual position value (see “NEWPOS” command). This value is a signed 32-bit integer value. The increments are passed directly to the position controller. The resolution of one turn is made with a 20-bit integer (FFFFFH).

Example of the calculation of the absolute position :

$$Position = \frac{incremental\ position\ value}{2^{20}}$$

The maximum difference between two incremental positions is given by the final limit speed that is set (index2010H subindex 7) (see example).

Example of the maximum incremental position difference :

$$max.achievable\ final\ speed / 1000 \frac{turns}{min} = 0.016667 \frac{turns}{msec}$$

$$\left| inc.\ pos.(t_2) - inc.\ pos.(t_1) \right| 2^{20} * 0.016667 = 17475$$

Depending on the amplifier parameters that have been set, there may be a larger or smaller contouring error. If the error message “contouring error” appears and the axis is stopped with the emergency ramp, there may be several faults which could lead to this result :

- The selection for the incremental position difference is too large (see above).
- The contouring error window has been set too narrow (index 2020H subindex 6).
- The amplifier parameters have not been set optimally.

The table shows the mapping of the PDO Trajectory:

Subindex (hex)	Value (hex)	Description
0	1	no. of entries
1	20220420	incremental position

This Object does **not** support transmission type 255 (asynchronous).

III.5.3.1.6 PDO motion block

The PDO motion block (PDO number 34) is put together from the position (Signed 32, weighted), speed (Unsigned16) and the motion task type (Unsigned16).
The PDO starts a motion block from the volatile motion block memory (motion block number = 0) and can only be used in the “Position” mode.

The table shows the mapping of the PDO motion block:

Subindex (hex)	Value (hex)	Description
0	3	no. of entries
1	20220120	position
2	20220210	speed
3	20220310	motion task type (abs./rel.)

This Object **only** supports transmission type 255 (asynchronous).

III.5.3.1.7 PDO start motion block

The PDO motion block (PDO number 35) consists of the motion task number (Unsigned16). The PDO starts a motion block from the volatile (motion block number = 0, 192 ... 255) or permanent (motion block number = 1 .. .180) motion block memory.
This PDO can only be used in the “Position” mode..

The table shows the mapping of the PDO start motion block:

Subindex (hex)	Value (hex)	Description
0	2	no. of entries
2	20220510	motion task number

This Object **only** supports transmission type 255 (asynchronous).

III.5.3.2 Transmit-PDOs

Transmit-PDOs are sent from the SERVO**STAR™** in the direction of the master.
The following table shows the communication parameters for the transmit-PDOs.

Subindex (hex)	Value range	Description
0	4	no. of entries
1	385 ... 511, 641 ... 767	COB-ID
2	0 ... 240, 255	transmission type
3	Unsigned16	inhibit time
4	0 ... 7	CMS priority group

III.5.3.2.1 PDO status word

The PDO status word (PDO 1, default-PDO) consists of the status word (Unsigned16).
This PDO can only be used to establish the state of the status machine (⇨ III.4.1).
This PDO is not dependent on the mode.
After switch-on this PDO is mapped to PDO1 (tx).

The table shows the mapping of the PDO status word

Subindex (hex)	Value (hex)	Description
0	1	no. of entries
1	60410010	status word

III.5.3.2.2 PDO transmit ASCII channel

As soon as ASCII characters are transferred to the ASCII transmission buffer, these are transferred to the master (control) with the aid of this PDOs (PDO number 21, default-PDO). This will always occur when commands or parameters are transferred with the help of the PDO receive ASCII channel (⇨ III.5.3.1.2).

The table shows the mapping for the PDO transmit ASCII channel

Subindex (hex)	Value (hex)	Description
0	1	no. of entries
1 .. 8	31020208	0 ... 7 ASCII char.

This Object **only** supports transmission type 255 (asynchronous).

III.5.3.2.3 PDO actual position

The PDO actual position (PDO 22) consists of the status word (Unsigned16), actual position (Unsigned24) and turns per minute (Unsigned24). This PDO can be used to establish the position in the “Digital speed” or “Digital current” modes.
After switch-on this PDO is mapped to PDO2 (tx).

The table shows the mapping of the PDO actual position:

Subindex (hex)	Value (hex)	Description
0	3	no. of entries
1	60410010	status word
2	20700118	actual position, resolution: 20 bits / turn
3	20700218	speed *

* resolution : 1 bit = 1875/262144 min^{-1}

III.5.3.2.4 PDO extended status

The PDO extended status (PDO number 23) consists of the status word (Unsigned16) and a status register (Unsigned32). This PDO can also be triggered by an event in the area of the status register. An additional status register mask is available for this purpose, that enables a triggering from individual bits in the status register (see index 2090H subindex 12). This PDO is not dependent on the mode.

The table shows the mapping of the PDO extended status:

Subindex (hex)	Value (hex)	Description
0	2	no. of entries
1	60410010	status word
2	10020020	User-defined status register

III.5.3.2.5 PDO actual position 2

The PDO actual position 2 (PDO number 32) is a time- and date-optimized PDO (compare with PDO 21). It includes the actual position (Unsigned24) and the turns per minute (Unsigned24). This PDO can be used to establish the position in the “Digital speed” or “Digital current” modes.
This PDO can **only** be requested by the **SYNC Object**.

The table shows the mapping of the PDO actual position 2:

Subindex (hex)	Value (hex)	Description
0	2	no. of entries
1	20700118	actual position, resolution: 20 bits / turn
2	20700218	speed *

* resolution : 1 bit = 1875/262144 min^{-1}

This Object **only** supports the transmission types 1 to 240 (cyclically synchronous).

III.5.3.2.6 PDO incremental actual position

The PDO incremental actual position (PDO 33) is a date-optimized Object, that can **only** be requested by a **SYNC Object**.

Calculation of the absolute position:

$$Position = \frac{incremental\ position\ value}{2^{20}}$$

The table shows the mapping of the PDO incremental position value:

Subindex (hex)	Value (hex)	Description
0	1	no. of entries
1	20700320	Incremental position value

This Object **only** supports the transmisson types 0 to 240 (cyclic/acyclic synchronous).

III.5.4 Predefined Communication Objects

The following predefined COBs are supported:

III.5.4.1 Sync Object

The parameterization of the SYNC Object can be performed through the Object 1005H and the cycle time through Object 1006H. The default setting for the ID is 80H.
Application note: According to DS301, the SYNC Object is a cyclic Object that is used to provide a clock for the bus. An acyclic application should be avoided.

III.5.4.2 Emergency Object

The definition and handling of the “Emergency Object” is implemented with the aid of an error-status machine, as described in DS301 “THE EMERGENCY OBJECT”. This Object is generated automatically.
The state of the error-status machine can be read out with the Object 1003H (⇨ III.5.2.2.4).
The Emergency Object consists of 8 Bytes, and is divided as follows:

Byte	0	1	2	3	4	5	6	7
Contents	emergency error code (see error code table)		error register (Object 1001H)	category	reserved			

The following types of error/warning are divided into categories:

1 : Errors that can only be canceled by a reset (command “COLDSTART” or Bit 7 in the control word (⇨ III.4.2). These errors are also indicated by the flashing LED display on the front panel. (Fxx, xx = error number)
2 : Errors that can be canceled by Bit 11 in the control word (⇨ III.4.2).
3 : Error messages that can occur during the processing of a PDO.
4 : Errors that **cannot** be removed by the user.
5 : User errors / warnings.

If an Emergency Object is generated, then the error state of the status machine is subsequently reported (error-free / error occured), by the generation of a second Emergency Object.
Only the first 4 Bytes are relevant here (Emergency ErrorCode , error register, category).
Bytes 0/1 contain the “Error Reset Code” (0000H) and Byte 2 indicates if another error is present.
If the Error Register has 00H, then the state is “error-free”.
Byte 3 contains the category.

The following table includes all the Error Codes **(Byte 0,1)** that are defined:

Error Code (hex)	Category	Description
0000	---	error reset or no error (mandatory)
1000	---	generic error (mandatory)
1080	5	no BTB/RTO (“not ready for operation”)
3100	1	no mains-BTB/RTO (F16)
3110	1	overvoltage in DC-link circuit (F02)
3120	1	undervoltage in DC-link circuit (F05)
3130	1	motor phase (F12)
4110	1	ambient temperature exceeded (F13)
4210	1	heat sink temperature exceeded (F01)
4310	1	motor temperature exceeded (F06)
5111	1	fault in ±15V aux. voltage (F07)
5380	1	A/D converter error (F17)
5400	1	output stage fault (F14)
5420	1	ballast (chopper) (F18)
5530	1	serial EEPROM (F09)
5581	1	flash EEPROM (F10)
6010	4	watchdog (software reset, F32)
6181	4	BCC error (table)
6182	4	BCC error (system macro)
6183	4	BCC error (EEPROM serial)
6184	4	FPGA error
6185	4	error (table)
6281	4	user software BCC (macro, F32)
6282	4	faulty user software (macro, F32)
7111	1	braking error (F11)
7181	5	SERVO**STAR™** could not be enabled
7182	5	command is only possible in the “disabled”state
7303	1	error in feedback unit (F04)
8181	2	response monitoring active
8281	5	status machine is not in the “Operational Enable” state
8282	5	wrong mode setting
8331	1	I^2t (torque) fault (F15)
8480	1	overspeed (F08)
8611	2	contouring error
8681	5	invalid motion task number
FF01	4	serious exception error (F32)
FF02	3	error in PDO components (in preparation)

III.5.4.3 Time Stamp Object

In preparation

IV User Notes and Examples

All data are hexadezimal. The axis-specific data are always referred to Station1.

IV.1 Commissioning the CAN-bus master

Since there are a lot of possibilities on offer for controlling a CAN system on various platforms (PC, PLC, other control systems), only general advice can be given here:

— The CAN (High-Speed) Standard ISO 11898 must be implemented in the master. This concerns the data frames that are used, as described in the appropriate section, and the implementation of Layer 1 and 2 of the ISO/OSI model.
— The CAN specification 2.0 A, which defines the data frames for the protocol and transport of an 11-bit COB (Communication Object)-ID, must be fulfilled.
— Processing software for the CANopen protocol of the servo amplifier must be available in the master. This must be prepared by the users themselves, according to the protocol description.

IV.2 Layout

1. Communication Object Identifier (COB - ID) : 11-bit value (⇨ III.3)
2. Control Byte, includes access type (r/w), number of Bytes transmitted etc. (see Cia Draft Standard 202 , Version 1.1)
3. Data field with up to 7 Bytes of data, for SDOs (see point 1) 2 Bytes for index + 1 Byte for subindex, then up to 4 Bytes of user data, for PDOs up to 8 Bytes of user data, determined by the PDO mapping

IV.3 Status query 1

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	40	41	60	0	---	query status
581	4B	41	60	0	50 00 00 00	answer telegram
	2 Byte data				status	

Status (e.g.)= 0x0050 Interpretation: Bit 4, Bit 6 set ⇒ Disable Voltage on, Switch On disabled (see table of bit assignments in the status word)

IV.4 Switch On

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	23	40	60	0	07 00 00 00	control word
581	60	40	60	0	00 00 00 00	
	OK message					

Control word = 0x0007 Interpretation: Bit 0, Bit 1, Bit 2 set ⇒ Switch On, Disable Voltage off, Quick Stop off

IV.5 Status query 2

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	40	41	60	0	---	query status
581	4B	41	60	0	23 00 00 00	answer telegram

Status = 0x0023 Interpretation: Bit 0, Bit 1, Bit 5 set ⇒ ready to Switch On, Switched On, Quick Stop

IV.6 Enable Operation

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	23	40	60	0	0F 00 00 00	control word
581	60	40	60	0	00 00 00 00	
	OK message					

Control word = 0x000F Interpretation: Bit 0, Bit 1, Bit 2, Bit 3, Bit 4 set ⇒ Switch On, Disable, Voltage off, Quick Stop off, Enable Operation on

IV.7 Mode query

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	40	61	60	0	---	mode
581	4F	61	60	0	F9 00 00 00	homing mode

IV.8 Homing parameters

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	23	24	20	1	04 00 00 00	homing to limit-switch & resolver zero point
581	60	24	20	1	00 00 00 00	OK
601	23	24	20	2	00 00 00 00	negative direction of travel
581	60	24	20	2	00 00 00 00	OK
601	23	24	20	3	10 27 00 00	v = 10mm/sec
581	60	24	20	3	00 00 00 00	OK
601	23	24	20	4	32 00 00 00	acceleration ramp 50ms
581	60	24	20	4	00 00 00 00	OK
601	23	24	20	5	32 00 00 00	braking ramp 50ms
581	60	24	20	5	00 00 00 00	OK
601	23	24	20	6	30 75 00 00	reference offset 30000µm
581	60	24	20	6	00 00 00 00	OK

IV.9 Start homing

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	23	40	60	0	1F 00 00 00	mode
581	60	40	60	0	00 00 00 00	homing runs until the reference condition is met

The homing status can be seen from the extended status register, Bit 17 (reference point set).

IV.10 Switch-on position control

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	23	60	60	0	FF 00 00 00	pos. control mode
581	60	60	60	0	00 00 00 00	position control is switched on

IV.11 Map second Receive-PDO

(Start motion block, the motion blocks are already defined for the example
1. Receive-PDO is set to the control word as default.)

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comment
601	23	01	26	0	23 00 00 00	start motion block Object
581	60	01	26	0	00 00 00 00	motion block is running

IV.12 Switch NMT status machine to “operational”

COB-ID	Command specifier (CS)	Node-ID
0	1	1

IV.13 Contact second Receive Object

COB-ID	Motiton block number Low	Motion block number High
201	01	00

Response: none, the given motion block 1 will be processed

IV.14 Motor Quick Stop

COB-ID	Control Low	Control High
201	07	00

Response: none, motor is stopped in t_emerg

IV.15 Inhibit controller

COB-ID	Control Low	Control High
201	03	00

Response: none, drive is without torque

IV.16 Test for Sync-telegrams

Aims:

1. apply the start motion block to the PDO (1st receive-PDO)
2. apply the actual position (PDO21) to the PDO (1st transmit-PDO), triggered every 2nd sync
3. apply the status word (PDO1) to the PDO (2nd transmit-PDO), triggered every 3rd sync

Telegrams and their answers:

COB-ID	Control-Byte	Index (Low-Byte/High-Byte)		Subindex	Data	Comments
601	23	00	26	0	23 00 00 00	PDO start motion block
581	60	00	26	0	00 00 00 00	applied to 1. receive-PDO
601	23	00	2A	0	16 00 00 00	PDO actual position
581	60	00	2A	0	00 00 00 00	applied to 1. transmit-PDO
601	23	01	2A	0	17 00 00 00	PDO extended status word
581	60	01	2A	0	00 00 00 00	applied to 2. transmit-PDO
601	23	00	18	2	02 00 00 00	1. transmit-PDO on trigger,
581	60	00	18	2	00 00 00 00	replaced by every 2nd sync
601	23	01	18	2	03 00 00 00	2. transmit-PDO on trigger,
581	60	01	18	2	00 00 00 00	replaced by every 3rd sync

IV.17 Sync Object

COB-ID
080

Interpretation: The Object 181 (PDO1 tx) appears at every second sync, the Object 281 (PDO2 tx) appears at every third sync.

IV.18 Emergency Object

If, for instance, the resolver connector is pulled out during operation, this will cause a severe malfunction of the controller, resulting in an Emergency telegram.

COB-ID	Emergency error code Low	High	Error register		
081	10	43	08	00 00 00 00	motor temperature, temperature,
081	00	00	88	00 00 00 00	manufacturer-specific

IV.19 ASCII communication

ASCII communication should sensibly be made through PDOs, since it can then be used more efficiently. To do this, the NMT status machine must be in the “operational” state.

Example: Read the parameter T-tacho (see Operator Software SR600.EXE User Manual). (All data are hexadecimal, with the corresponding ASCII in square brackets)

Direction	COB-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Master ⇒ SERVO**STAR™**	301	47H [G]	56H [V]	46H [F]	42H [B]	54H [T]	0DH [CR]	0AH [LF]	0H [NUL]
SERVO**STAR™** ⇒ Master	281	30H [0]	2EH [.]	36H [6]	0H [NUL]	0H [NUL]	0H [NUL]	0H [NUL]	0H [NUL]
SERVO**STAR™** ⇒ Master	281	0DH [CR]	0AH [LF]	0H [NUL]	0H [NUL]	0H [NUL]	0H [NUL]	0H [NUL]	0H [NUL]
SERVO**STAR™** ⇒ Master	281	2DH [-]	2DH [-]	3EH [>]	0H [NUL]	0H [NUL]	0H [NUL]	0H [NUL]	0H [NUL]

Explanation: In telegram 1 the master requests the parameter “GVFBT”, terminated by the ASCII code “CR LF”. The last Byte is spare, and so it is filled by “NUL”.
The answer from the SERVO**STAR™** is made in telegram 2, with the value “0.6”, the terminating code “CR LF”, and the prompt for the next parameter or command “-->”.
The segmentation of the answer into three telegrams is not compulsory, but depends on the transmission rate that has been set and the internal synchronization mechanisms.

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V Appendix

V.1 Index

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