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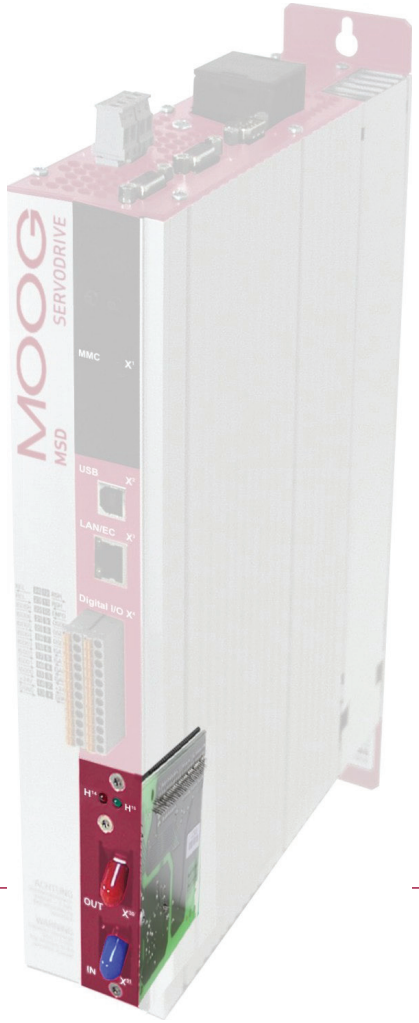


MSD Servo Drive

User Manual

SERCOS interface

User Manual: SERCOS II for MSD Servo Drive

ID no.: CA65648-001, Rev.1.0

Date: 11/2011

We reserve the right to make technical changes.

Technical alterations reserved.

The contents of our documentation have been compiled with greatest care and in compliance with our present status of information.

Nevertheless we would like to point out that this document cannot always be updated parallel to the technical further development of our products.

Information and specifications may be changed at any time. For information on the latest version please refer to drives-support@moog.com.

How to use this document

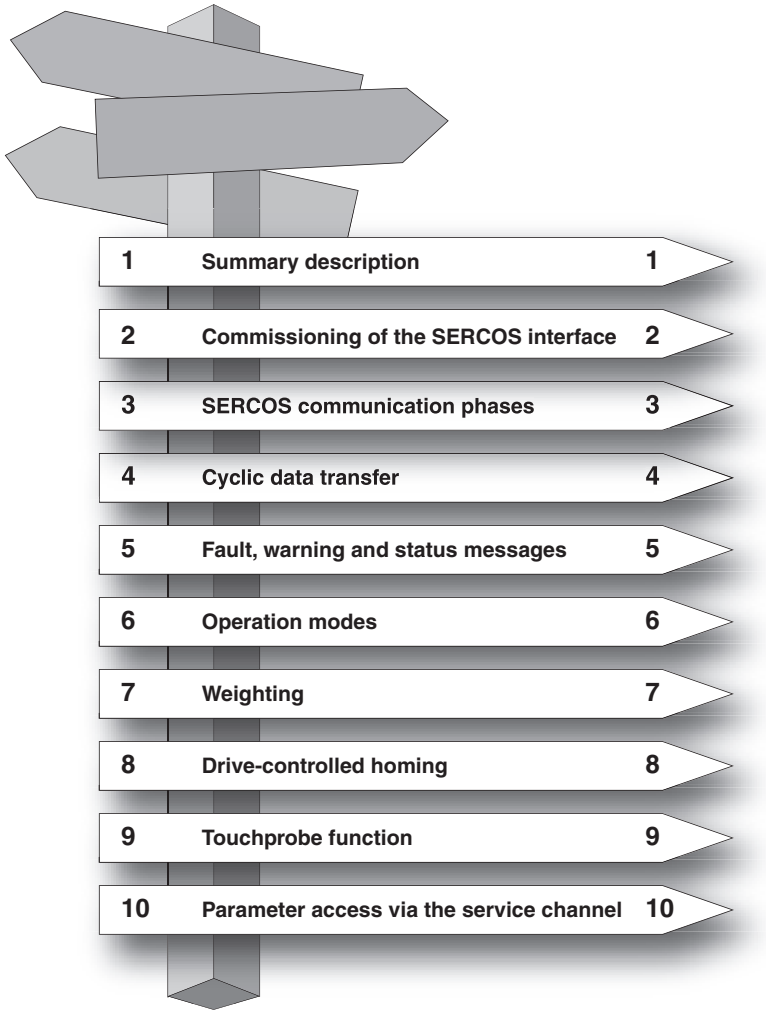
Dear user

This manual is intended for you as a project engineer, commissioning engineer or programmer of drive and automation solutions on the SERCOS II fieldbus.

It is assumed that you are already familiar with this fieldbus on the basis of appropriate training and reading of the relevant literature. We assume your drive is already in operation. If it is not, you should put it into operation as described in the MSD Servo Drive Operation Manual.

This manual applies to the MSD Servo Drive position drive system with the SERCOS II option card.

The basis for implementing SERCOS in the MSD Servo Drive is the document titled "Specification SERCOS Interface Version 2.4" issued in February 2005 (for more details visit http://www.sercos.de).



Pictograms

To provide clear guidance, this Operation Manual uses pictograms. Their meanings are set out in the following table. The pictograms always have the same meanings, even where they are placed without text, such as next to a connection diagram.

	ATTENTION! Misoperation may result in damage to the drive or malfunctions.
	DANGER FROM ELECTRICAL TENSION! Improper behaviour may endanger human life.
	DANGER FROM ROTATING PARTS! Drive may start up automatically.
	NOTE: Useful information

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1 Safety

1.1 Measures for your safety

The instructions set out below should be read through prior to initial commissioning in order to prevent injury and/or damage to property. The safety instructions must be followed at all times.

1.2 Read the Operation Manual first!

	Read the Operation Manual first! • Follow the safety instructions! • Refer to the user information!
	Electric drives are dangerous: • Electrical voltages 230 V to 480 V **Dangerously high voltages of ≥ 50 V (capacitor charge) may still be present even 10 minutes after the power is cut. so always make sure the system is no longer live!** • Rotating parts • Hot surfaces
	Protection against magnetic and/or electromagnetic fields during installation and operation • Persons fitted with heart pacemakers, metallic implants and hearing aids etc. must not be allowed access to the following areas: – Areas where drive systems are installed, repaired and operated. – Areas where motors are installed, repaired and operated. Motors with permanent magnets pose a particular hazard.
	DANGER: If it is necessary to access such areas, suitability to do so must be determined beforehand by a doctor.
	Your qualification: • In order to prevent personal injury or damage to property, only personnel with electrical engineering qualifications may work on the device. • The said qualified personnel must be familiar with the contents of the Operation Manual (cf. IEC364, DIN VDE0100). • Knowledge of national accident prevention regulations (e.g. BGV A3, formerly VBG 4, in Germany)
	During installation observe the following instructions: • Always comply with the connection conditions and technical specifications. • Comply with electrical installation standards, e.g. cable cross-section, PE-conductor and earth connection. • Do not touch electronic components and contacts (electrostatic discharge may destroy components).

Table 1.1 Safety instructions

1.3 Introduction to the SERCOS interface

SERCOS stands for SErial Realtime COmmunication System, and is a globally standardized (IEC 61491 and EN61491) digital interface for communication between master control systems, drive units and other distributed peripherals. The real time-critical transfer of setpoints and actual values enables numerically controlled high-performance drive applications to be implemented in the engineering industry.

Services are also provided for operation mode recording, parameter setting, configuration and diagnosis.

Figure 1.1 SERCOS communication module for MSD Servo Drive

The SERCOS communication module for the MSD Servo Drive is implemented as a SERCOS II interface with a plastic optical fibre (POF) or hard clad silica (HCS) cable loop with F-SMA connectors. There are currently two hardware variants, though in future only the variant detailed under 2.2 will be manufactured. The hardware and software have, as far as possible, been developed in conformance to DIN/EN 61491. The basis for implementing SERCOS II is the document titled Specification SERCOS Interface (Rev. 2.4 issued Feb. 2005).

The power supply to the communication module is provided by the MSD Servo Drive.

Baud rates of 2, 4, 8 and 16 Mbit/s are possible, and are detected automatically by the module. This means there is no need to preset the baud rate.

Real-time capability permits highly dynamic drive engineering applications with NC cycle times of 125 µs to 65 ms (multiples of 125 µs). The data to be transferred is defined in the SERCOS driver in numerous preference telegrams and parameters. They are specially tailored to the high demands of electric drive systems. A freely configurable telegram permits optimum utilization of all the possibilities offered by the line based on additional setpoint and actual value parameters such as increasing the transferred position resolution, use of the inputs and outputs in the drive in the NC cycle, and much more.

1.4 Key features

- Data transfer via plastic optical fibre (POF) or hard clad silica (HCS) cable with F-SMA connectors
- Transfer rate: Optionally 2, 4, 8 or 16 MBaud
- Automatic baud rate detection
- Transmission power programmable via DIP switches (hardware variant 1 only), otherwise via parameters.
  Setup using pushbuttons and display in preparation
- Programmable SERCOS address via parameters.
  Setup using pushbuttons and display in preparation
- Cyclic data exchange of setpoints and actual values with exact time equidistance
- SERCOS-cycle time of 125 µs to 65 ms (multiples of 125 µs programmable)
- Multi-axis synchronization between setpoint action times and actual value measurement times of all drives in the loop
- Full synchronization of all connected drives with the master control system
- Free configuration of telegram content
- Maximum configurable data volume in MDT: 20 bytes
- Maximum configurable data volume in DT: 20 bytes
- Programmable parameter weighting and polarity for position, velocity, acceleration and torque
- Additive velocity and torque setpoints
- Fine-interpolation (linear or cubic) inside the drive
- Optionally master control-side (external) or in-drive generation of rotation speed and acceleration pre-control
- Service channel for parameter setting and diagnosis
- Support for touchprobes 1 and 2
- Support for spindle commands
- Support for configurable real-time status and control bits
- Support for configurable signal status and control word

- Supported commands:
  - **S-0-0099** Reset state class 1
  - **S-0-0127** Prepare switch to phase 3
  - **S-0-0128** Prepare switch to phase 4
  - **S-0-0148** Drive-controlled homing
  - **S-0-0152** "Position spindle" command
  - **S-0-0170** "Touchprobe" command
  - **S-0-0262** "Parameter initialization to defaults" command
  - **S-0-0263** "Parameter initialization to backup values" command
  - **S-0-0264** „Save current parameter values" command

1.5 Terms

Term	Explanation
SERCOS	Standardized method of real-time communication between master control systems and drives to DIN/EN 61491
OF	Optical fibre
MST	Master Sync Telegram. Provides is-precise data synchronization of the drives in the fibre-optic loop by the time-slot method
MDT	Master Data Telegram. Data from master to the drives in the fibre-optic loop (control word, setpoints)
DT	Drive Telegram. Data from drive to master (status, actual values)
Phase 0..4	SERCOS communication phases 0 = Fibre-optic loop closed by master (reception from MST)) 1 = Master identifies all slaves/drives in the loop 2 = Parameter-setting mode; as from phase 2 the service channel is in operation 3 = Time slots are maintained, cyclic data still invalid 4 = Cyclic operation mode; import of setpoints; transmission of actual values
Cyclic data	Time-synchronized transfer of MDT, DT as from phase 3, valid as from phase 4
Service channel	Subsidiary protocol in the telegrams. Parameter values, attributes, scaling and names can be sequentially transferred. Transfers can also be effected in parallel with the time-critical cyclic data (MDT, DT) in phases 3 and 4. The service channel provides services for operation mode recording, parameter setting, configuration and diagnosis
IDN	Ident Number. S-x-yyyy or P-x-yyyy. 16 bits are available to represent a SERCOS ident number. Structure of IDN 15 | 14 13 12 | 11 10 9 8 7 6 5 4 3 2 1 0 S/P = 0/1 | x = 0..7 | yyy = 0..4095 S = SERCOS profile specific parameter (bit 15 = 0)) P = SERCOS manufacturer specific parameter (bit 15 = 1) x = Record number 0..7 (bits 14:12) yyy = Data block number 0..4095 (bits 11:0) Note: Only record 0 is supported in the drive.

Table 1.2 Terms

Table 1.2 Terms

2 Commissioning of the SERCOS interface

2.1 Connections and controls – hardware variant 1

The connections and controls of the SERCOS interface hardware variant 1 are shown schematically in figure 1. LEDs H4 and H5 are status indicators. H4 signals a distortion (distortion LED), meaning the fibre-optic power is defective or there is a break in the loop. H5 indicates the current communication phase (0..4). H6 and H7 signal RX/TX communication. The fibre-optic cables are connected to connectors X17 (transmitter) and X18 (receiver). The drive address is programmed by way of the corresponding parameter using the service tool.
Drive address programming using pushbuttons and a display is in preparation.

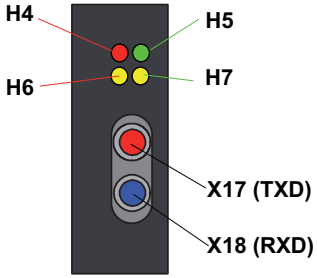

Figure 2.1 Controls and displays of the SERCOS interface, hardware variant 1

2.2 Connections and controls – hardware variant 2

The connections and controls of the SERCOS interface hardware variant 2 are shown schematically in figure 2. LEDs H4 and H5 are status indicators. H4 signals a distortion (distortion LED), meaning the fibre-optic power is defective or there is a break in the loop. H5 indicates the current communication phase (0..4). The fibre-optic cables are connected to connectors X30 (transmitter) and X31 (receiver). In hardware variant 2 the connectors are of an angled design, to reduce the overall depth of the drive. The drive address is programmed by way of the corresponding parameters using the service tool. Drive address programming using pushbuttons and a display is in preparation.

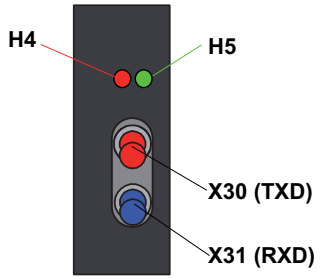

Figure 2.2 Controls and displays of the SERCOS interface, hardware variant 2

2.3 Connection of fibre-optic cables

The connection between the master (control) and the servo drives is made by fibre-optic cables. This requires a loop architecture to be constructed, as illustrated in the following diagram for three drive axes.

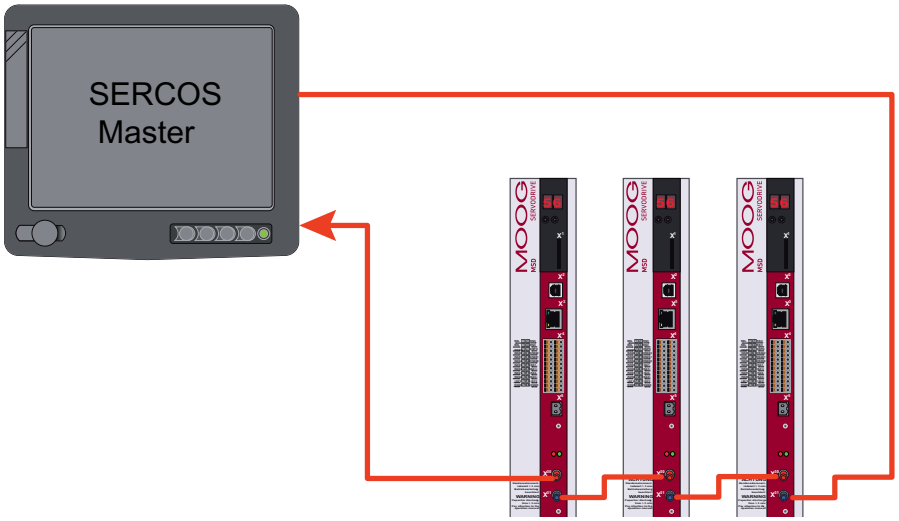

Figure 2.3 Connection of fibre-optic cables

The fibre-optic loop starts and ends at the SERCOS master (control). The optical output of the master is connected to the optical input of the first drive (X31). Its optical output (X30) is connected to the input of the next drive, and so on. The output of the last drive is connected to the optical input of the master. The SERCOS slave addresses are assigned independently of their positions in the loop.

2.4 Hardware settings

2.4.1 Setting the transmission power of the SERCOS interface

By way of parameter **P-0-3004** the transmission power of the fibre-optic transmitter can be set. Entering a 0 corresponds to the lowest power and a 3 the highest. The following values are intended as a guide:

0: <15 m
1: 15 .. 30 m
2: 30 .. 45 m
3: >45 or HCS

0: <15 m	1: 15 .. 30 m	2: 30..45 m	3: >45 or HCS

2.4.2 Setting the drive address via parameter

The drive address is set in parameter **P-0-3000** (Drive address). EA drive address setting or change made in this parameter only takes effect the next time the communication phase changes from “0” to “1”. The drive address is independent of the position of the drive in the SERCOS loop.
Drive address programming using pushbuttons and a display is in preparation.

2.4.3 Transfer rate of SERCOS interface

The transfer rate specified by the master is automatically detected by the drive, set accordingly and indicated in parameter **S-0-0376**: Baud rate, SERCOS interface.

NOTE: Baud rates of 2, 4, 8 and 16 MBaud are supported. Automatic baud rate detection in the drive is implemented according to SERCOS Application Note AN15 dated 2002/08/22.

2.5 Diagnostic LEDs

Hardware variant 1

	LED	Colour	Meaning
	H4	Red	Distortion LED, fault on bus
	H5	Green	Status of SERCOS communication phase (flash code)
	H6	Green	Receiver LED, telegrams being received
	H7	Green	Transmitter LED, telegrams being sent

Hardware variant 2

	LED	Colour	Meaning
	H4	Red	Distortion LED, fault on bus
	H5	Green	Status of SERCOS communication phase (flash code)

2.5.1 Use of the distortion LED

When you have set the drive address, you should check that there is an adequate optical signal level at each station in the loop - that is, that the receiver is not being underloaded or overloaded. The optical level is checked by way of the distortion LED on the front panel of the MSD Servo Drive (LED H4). Normally the distortion LED is unlit. To check the optical level, check the distortion LEDs of all the drives in the loop, starting from the transmitter output of the master, in the direction of the signal flow (see diagram under "Connection of fibre-optic cables"). Check the distortion LEDs in the direction of the light signal flow - that is, starting with the first drive in the loop. If its distortion LED is unlit, move on to the next drive. Continue doing this until you reach the last drive, and then the master (control).

NOTE: The distortion LED must not be lit or flashing.

A distortion LED lights up in the following cases:

- Defective fibre-optic cable to predecessor
- Unsupported transfer rate
- Incorrectly set transmission power

Procedure if distortion LED is lit:

Check the fibre-optic cable, with its connectors, from its physical predecessor in the loop to the affected drive (see below). Compare the transfer rate of the master with the supported drive baud rates. On the physical predecessor of the affected drive, check the transmission power setting and adjust it as necessary by the DIP switches (HW variant 1) or via parameter **P-0-3004** (HW variant 2). In HW variant 1 parameter **P-0-3004** only has an influence if a higher transmission power is set on the DIP switches. That is to say, the lowest transmission power set via the parameter **or** the DIP switches determines the actual effective transmission power. It is not possible to upscale by way of the other channel.

2.5.2 Checking fibre-optic cables

If the specified transfer rate is supported and the transmission power is correctly set, but still no communication takes place, the fibre-optic cable may be defective. In this case the distortion LED will light. The cause of a defect in a fibre-optic cable may be mechanical damage or poor assembly (bad connector fitting or the like). Defective fibre-optic cables must be replaced.

NOTE: Fibre-optic transmission is sensitive to dirt contamination. Make sure no dirt particles can penetrate the transmitter or receiver elements. This may lead to transmission power and distortion problems which are difficult to localize. Protect the elements during installation using the supplied sheaths until the fibre-optic cables have been assembled.

3 SERCOS communication phases

Communication over the SERCOS bus between the master and slaves is divided into five phases. Communication phases 0 and 1 identify the stations on the bus. In communication phase 2 the time and data structure of the protocols for phases 3 and 4 are prepared and the drive is configured. At the transition to communication phase 3 the drive parameter settings relating to the SERCOS profile are checked for plausibility. In the event of a fault, the switch to communication phase 3 is refused with a relevant fault message. The phases are run through in ascending order. It is only possible to drop back a phase by way of communication phase 0. The communication phase is dictated by the master. On switching to communication phase 4, the initialization is completed and power-up is enabled.If the phase sequence is interrupted, the status indicator remains stuck at the last communication phase reached. The current communication phase is indicated by way of a flash code by LED H5. Intervals of about one second unlit are followed by LED H5 flashing briefly “n” times, “n” being the number of the current communication phase.

3.1 Communication phase 0

When communication phase 0 is active, automatic baud rate detection in the drive has completed successfully. The drive is in communication phase 0 and is waiting for the master to switch from phase “0” to “1”. During communication phase 0 the green LED H5 on the drive unit remains unlit.

LED H5 flash code	Status
	Indication of communication phase 0

Table 3.1 Flash code: Communication phase 0

3.2 Communication phase 1

If communication phase 1 is active, the drive is in phase 1. The master has not yet triggered a switch from phase “1” to “2”. During communication phase 1 the green LED H5 on the drive unit cyclically displays the flash code set out in the following table.

LED H5 flash code	Status
	Indication of communication phase 1

Table 3.2 Flash code: Communication phase 1

3.3 Communication phase 2

Communication phase 2 signifies that the drive is in parameter-setting mode. IIn this mode you can write to many parameters which are no longer editable in communication phase 4 (operation mode). In communication phase 2 the communication parameters are usually transferred from the master to the drive. All parameters influencing the switching frequency or the sampling times of the loop control system can likewise be written only in communication phase 2. During communication phase 2 the green LED H5 on the drive unit cyclically displays the flash code set out in the following table.
To enter communication phase 2, the master specifies “Communication phase 2” in the Master Sync Telegram.
Before the system can switch to communication phase 3, command **S-0-0127** - Prepare switch to communication phase 3 - must be executed. During this preparatory phase the drive checks criteria including the validity of the parameters required for communication phase 3. When the prepare-to-switch command has been successfully executed, the drive is switched to communication phase 3 by the master. In the event of a fault (plausibility of the setting concerned), the switch to communication phase 3 is refused with a relevant fault message.

NOTE: On switching to phase 3, the servo drive performs all the necessary initializations. If it is not possible to switch to phase 3 because of faulty parameter setting, the drive generates a relevant fault message. The meanings of the fault numbers are listed in the MSD Servo Drive Application Manual.

The parameter listing in section 10.1 sets out the parameters that can be written in the various phases.

LED H5 flash code	Status
	Indication of communication phase 2

Table 3.3 Flash code: Communication phase 2

3.4 Communication phase 3

Communication phase 3 signifies that the drive is in restricted parameter-setting mode. In this mode - as in parameter-setting mode (phase 2) - you can write to many parameters which are no longer editable in communication phase 4 (operation mode). No communication parameters can be written in phase 3. During communication phase 3 the green LED H5 on the drive unit cyclically displays the flash code set out in the following table.

LED H5 flash code	Status
	Indication of communication phase 3

Table 3.4 Flash code: Communication phase 3

3.5 Communication phase 4

Before the system can switch to communication phase 4, command S-0-0128 - "Prepare switch to communication phase 4" - must be executed. During this preparatory phase the drive checks criteria including the validity of the parameters required for communication phase 4. When the prepare-to-switch command has been successfully executed, the drive is switched to communication phase 4 by the master. During communication phase 4 the green LED H5 on the drive unit cyclically displays the flash code set out in the following table. The drive can only be enabled via the control word in communication phase 4.

LED H5 flash code	Status
	Indication of communication phase 4

Table 3.5 Flash code: Communication phase 4

4 Parameter interface

4.1 Profile parameters (**S-0-xxxx**)

The SERCOS specific profile parameters (**S-0-0001** .. **S-0-4095**) are mapped as Moog parameters (**P-0-10001** ... to **P-0-14095**). The corresponding addressing is:

Moog ID - 10000 dec

4.1.1 Manufacturer specific parameters (P-0-xxxx)

The manufacturer specific parameters (Moog parameters) (**P-0-0001** .. **P-0-4095**) are addressed as follows as P-parameters:

Moog ID + 8000 hex

Example: Moog **P-0-0101 function selector ISD01** is to be found in the IDN listing (**S-0-0017**) as **P-0-0101**.

Currently only record 0 is supported.

SERCOS currently does not support language switching. English is installed by default.

4.2 Cyclic data transfer

To synchronize the drives in the loop, at the start of each SERCOS cycle (cycle time t_{Scyc} = **S-0-0002**) the master sync telegram (MST) is sent (see diagram below). Its only information content is the communication phase dictated by the master. The contents of the master data telegram (MDT) and the drive telegram (DT) are configurable. The control sends a common master data telegram for all drives to the drives once per SERCOS cycle. It contains the master control word, the service channel (parameter channel) and a configurable data block. This data block usually contains setpoints and limit values which the master control system wants to send to the drive to run the desired operation mode. The content of this data block can be configured by the telegram setting. The master data telegram is received simultaneously by all the drives in the loop. Likewise once per SERCOS cycle, each drive sends a separate drive telegram to the master control. It contains the drive status word, extracts from the service channel and a configurable data block. This data block usually contains actual and status values which the master control system needs to run the desired operation mode.

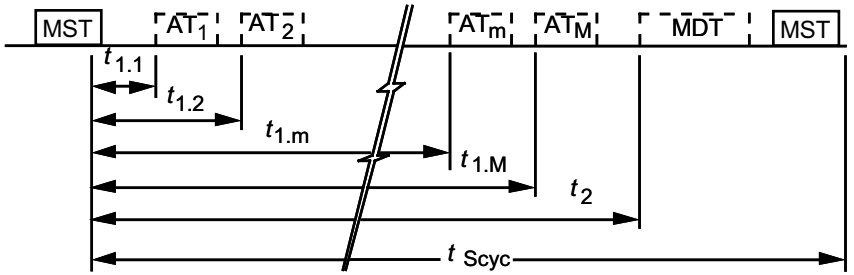

Figure 4.1 SERCOS cycle timing diagram

4.3 Master control word

The master control word is part of the master data telegram. It contains all the key control information for the drive.

The master control word is mapped in parameter **S-0-0134**. The precise structure of this parameter is shown in the following table. The master control word is transferred cyclically to the drive with each master data telegram in the SERCOS cycle (see "SERCOS cycle time"). For diagnostic purposes, the master control word can be read via parameter **S-0-0134**, "Master control word".

Bit	Explanation
Bits 15-13	
1 1 1	Drive to follow setpoints
Bit 15 (MSB)	Drive ON/OFF
0	Drive OFF: On switching from 1 • 0 the drive is shut down as best as possible (according to the setting of **P-0-2219**), then the torque is shut off as necessary at standstill; the power stage can remain active (only possible if bit 14 = 1 and with corresponding setting of **P-0-2219**), then the torque is shut off at speed nmin; the power stage can remain active (only possible if bit 14 = 1)
1	Drive ON
Bit 14	Drive ENABLE
0	No enable. On switching 1 • 0 the torque is shut off and the power stage disabled with no delay (regardless of bits 15 and 13)
1	Drive enable
Bit 13	Drive HALT (can be used to stop the drive without reference to the current active control function)
0	Drive stop: The drive is no longer following the setpoints. On switching from 1 • 0 the drive stops according to the setting of **P-0-2221** and taking into account the last active acceleration (by default according to acceleration parameter **P-0-2242**) and remains under control (only possible if bits 14 and 15 = 1 and with an appropriate setting of **P-0-2221**)
1	Drive start: On switching from 0 • 1 the original function is resumed. If the master control system has not updated the position, setpoint jumps may occur, resulting in shut-off due to tracking error.
Bit 12	Reserved
Bit 10	IPOSYNC: Not supported
Bit 11, 9, 8	Specified operation mode
0 0 0	Primary mode (defined by operation datum **S-0-0032**)
0 0 1	Secondary mode-1 (defined by operation datum **S-0-0033**)
0 1 0	Secondary mode-2 (defined by operation datum **S-0-0034**)
0 1 1	Secondary mode-3 (defined by operation datum **S-0-0035**)
Bit 7	Real-time control bit 2 (**S-0-0302**)
Bit 6	Real-time control bit 1 (**S-0-0300**)
Bit 5, 4, 3	Data block element
0 0 0	Service channel not activated, close the service channel or abort an ongoing transfer.
0 0 1	IDN of operation datum. The service channel is closed for the preceding IDN and opened for a new one.
0 1 0	Name of operation datum
0 1 1	Attribute of operation datum
1 0 0	Units of operation datum
1 0 1	Minimum input value
1 1 0	Maximum input value
1 1 1	Operation datum
Bit 2	
0	Ongoing transfer
1	Last transfer
Bit 1	R/W (Read/Write)
0	Read service INFO
1	Write service INFO
Bit 0	„MHS"
0/1	Service transport handshake of master

*Table 4.1 Master control word (parameter **S-0-0134**)*

4.3.1 Description of bits 13-15

Bit14: Drive ENABLE (power stage enable)

The MSD Servo Drive has a control input (X4.10) ENPO (Enable Power) for hardware enable. This input must be configured for operation of the power stage at 24 V.

The device additionally features the "STO" (Safe Torque Off) function, category 3 (see MSD Servo Drive Operation Manual and Application Manual) via control input (X4.22) ISDSH. The logic for this function (High edge at digital input ENPO (X4.10), with a High signal required at the digital input ISDSH (X4.22) at the time the edge occurs) must be fulfilled by the higher-level control system according to Application Manual.

NOTE: If the ENPO and ISDSH inputs are not configured, the device remains in state 1 = "Not Ready to Switch On" or 2 = "Switch On Disabled". In the STO state the status indicator flashes "**S1**" or "**S2**" as appropriate.

Only after correct configuration of ENPO (X4.10) and ISDSH (X4.22) can the hardware be enabled by bit 14 in the SERCOS control word MDT (Master Data Telegram). It is only possible to enable the drive via bit 14 in communication phase 4.

Bit 15: Control ON/OFF (drive enable)

Control of the drive via the SERCOS interface requires just a few parameter settings:

- Open-loop control setting of drive via SERCOS interface: Set **P-0-0159** to SERCOS (6).
- Setpoints via SERCOS profile: Set **P-0-0165** to SERCOS (8)
- Evaluation of bit 15 in MDT state-controlled (1 = LEVEL) or edge-controlled (0 = EDGE) via **P-0-0144**.
  Note:
  If bit 14 and bit 15 in the MDT are set simultaneously, **P-0-0144** must be set to LEVEL (1).

In summary: For the drive enable signal (bit 15) to be accepted - that is, for the drive to switch from the unpowered to the powered state - the following conditions must be met:

- SERCOS interface ready and in communication phase 4
- Enable power pack via hardware (ENPO and ISDSH) and bit 14 in MDT
- Drive not in fault state
- Settings of relevant parameters **P-0-0144**, **P-0-0159** and **P-0-0165**

Under these preconditions the drive shows device state "3" on the display. The drive is activated by the change of state from 0 to 1 of bit 15 (drive enable) in the MDT. If the enable is successfully executed, the display readout changes to 5 and the relevant bits in the drive telegram (DT) are operated.

The readiness of the control (drive follows setpoints) is mapped in the status word via bit 15, bit 14 and bit 3.

Ideally, the master control system reads the actual value while control is starting and presets it as the setpoint until the closed-loop drive signals readiness in the status word. If the drive moves while control is starting (such as due to motor commutation finding by linear drives, whereby the drive does not yet signal readiness - drive state 4), the position changes are automatically adopted by the master control system.

Control systems which retrieve the current actual position "only once" prior to start of closed-loop control and preset it as the setpoint, and also do not update it even after commutation finding (no evaluation of status word) will feed forward a setpoint difference. Shut-off due to tracking error may be the consequence.

To avoid this, the drive can be moved to the position specified by the master control system at start of control under drive control with parameter **P-0-0156** (Enable operation option code) set to MOVE_COMMAND(1). This aims to exclude the possibility of a shut-off or a jerky approach to the target position at start of control because of a setpoint difference in the axis.

This function also depends on the configuration of **P-0-0743** (maximum tracking error).

- **P-0-0743** equal to 0
  Position tracking error off. The drive switches on without correction and feeds the position setpoint of the NC directly onto the drive. The drive moves to the target position with a jerk as necessary. Major differences end in a speed tracking error, depending on the parameter setting. A jerky axis motion is the consequence.
- **P-0-0743** not equal to 0
  Position tracking error on. The drive reads the target position of the master control system and moves under drive control to that position (position correction). If the difference between the position specified by the control system and the actual position is greater than the tracking error (**P-0-0743**), the drive switches to a fault state, now without moving (no major axis motion). Otherwise the drive corrects the difference with the slow jog rate (**P-0-0168[1]**) and the acceleration from **P-0-2242 (**quick-stop). When the position has been reached, the drive switches to state 5 and the drive follows the setpoints of the master control system (only now is readiness signalled in the control word).

IMPORTANT:

With the scaling, the ramp setting which the system accesses must also be set correctly and to reasonable values. This involves the parameters:

- **P-0-2242** (Quick-stop). This is applied in the event of a fault, depending on the configuration
- **P-0-0168** (Jog, index 0: Jog rate rapid, index 1: Jog rate slow)

The position correction described above may take a very long time at a very slow jog rate, or may even not take place at all, such as if **P-0-0168[1]** = 0. In this case the drive would remain in system state 4, as the setpoint cannot be attained.

Bit 13: Drive HALT (feed hold)

The "Drive halt" signal is state-controlled and low-active, meaning in response to a "Drive halt = 0" signal the drive is in the "Drive halt" state. The input signal is mapped in the master control word, bit 13.

4.4 Drive status word

The drive status word is part of the drive telegram. It contains all the key status information of the drive, e.g.:

- Readiness of control and power pack
- Drive fault
- Change bits state class 2 and 3
- Current mode
- Real-time status bits 1 and 2
- Status information for service channel

The drive status word is mapped in parameter **S-0-0135**. The precise structure of this parameter is shown in the following table. The drive status word is transferred cyclically to the control system with each drive telegram in the SERCOS cycle (see **S-0-0002**, "SERCOS cycle time (TScyc)"). For diagnostic purposes, the drive status word can be read via parameter **S-0-0135**, "Drive status word".

Bit	Explanation
Bits 15, 14	„Ready"
0 0	Drive not ready to power up, as internal checks have not yet completed successfully.
0 1	Drive ready to power up.
1 0	Drive control unit ready and power supply on, drive is torque-free and power stage is disabled.
1 0	Drive control unit ready and power supply on, drive is torque-free and power stage is disabled.
1 1	Drive ready, "Drive enable" set and effective, power stage active.
Bit 13	Drive lockout fault in C1D (operation datum **S-0-0011**)
0	No fault
1	Drive locked due to a fault situation
Bit 12	Change bit of C2D (operation datum **S-0-0012**)
0	No change
1	Change

*Table 4.2 Drive status word (parameter **S-0-0135**)*

Bit	Explanation
Bit 11	Change bit of C3D (operation datum **S-0-0013**)
0	No change
1	Change
Bits 10, 9, 8	Current mode
0 0 0	Primary mode (defined by operation datum **S-0-0032**)
0 0 1	Secondary mode-1 (defined by operation datum **S-0-0033**)
0 1 0	Secondary mode-2 (defined by operation datum **S-0-0034**)
0 1 1	Secondary mode-3 (defined by operation datum **S-0-0035**)
1 0 0	Secondary mode-4 (defined by operation datum **S-0-0284**)
1 0 1	Secondary mode-5 (defined by operation datum **S-0-0285**)
1 1 0	Secondary mode-6 (defined by operation datum **S-0-0286**)
1 1 1	Secondary mode-7 (defined by operation datum **S-0-0287**)
Bit 7	Real-time status bit 2 (**S-0-0306**)
Bit 6	Real-time status bit 1 (**S-0-0304**)
Bit 5	Command change bit
0	No change of command acknowledgement
1	Change of command acknowledgement
Bit 4	Reserved
Bit 3	Status of setpoint transfer
0	The drive ignores the setpoints of the master, such as during drive-controlled motion (homing, ..) or parameterizable delay times
1	The drive follows the setpoints of the master control system
Bit 2	"Fault" in service channel
0	No fault
1	Fault in service channel, fault message in drive service INFO (**S-0-0014**)
Bit 1	"Busy" bit
0	Step ended, ready for new step
1	Step being processed; new step not permitted
Bit 0	"AHS"
0/1	Service transport handshake of drive

*Table 4.2 Drive status word (parameter **S-0-0135**)*

The system state of the drive is indicated on the display on the front panel of the unit. Bits 15, 14, 13 and 3 of the SERCOS status word are mapped onto one of eight possible system states according the following table. The drive state machine (SERCOS) is described in the following section.

Bit 15	Bit 14	Bit 13	Bit 3	Display readout	System state designation
0	0	0	0		START Drive in initialization phase
0	1	0	0		NOT READY FOR START Power stage without power, no DC-link voltage, input STO requested
0	1	0	0		NOT READY FOR START Power stage without power, no DC-link voltage
1	0	0	0		STARTING LOCKOUT POWER Not enabled, DC-link voltag Starting lockout Power e present, input STO requested
1	0	0	0		STARTING LOCKOUT Power stage without power, not enabled, DC-link voltage present
1	0	0	0		READY FOR START Power stage without power, enabled, DC-link voltage present
1	0	0	0		ON ACTIVATE Power stage (activate power stage, motor commutation, brake management)

Table 4.3 Mapping of bits 3, 13, 14 and 15 onto system state

Bit 15	Bit 14	Bit 13	Bit 3	Display readout	System state designation
1	1	0	1 / 0	5	LOOP CONTROL ACTIVE In loop control (support for bit 3) Drive following setpoints
1	1	0	0	6	QUICK-STOP ACTIVE e.g. triggered via terminal, drive no longer following setpoints
1	1	1	0	7	FAULT RESPONSE ACTIVE Drive no longer following setpoints
0	0	1	0	Er	FAULT FAULT Number and location alternately displayed, motor torque-free

Table 4.3 Mapping of bits 3, 13, 14 and 15 onto system state

4.5 Drive state machine

The system states and the possible state transitions are shown in the following diagram and described in the following tables.

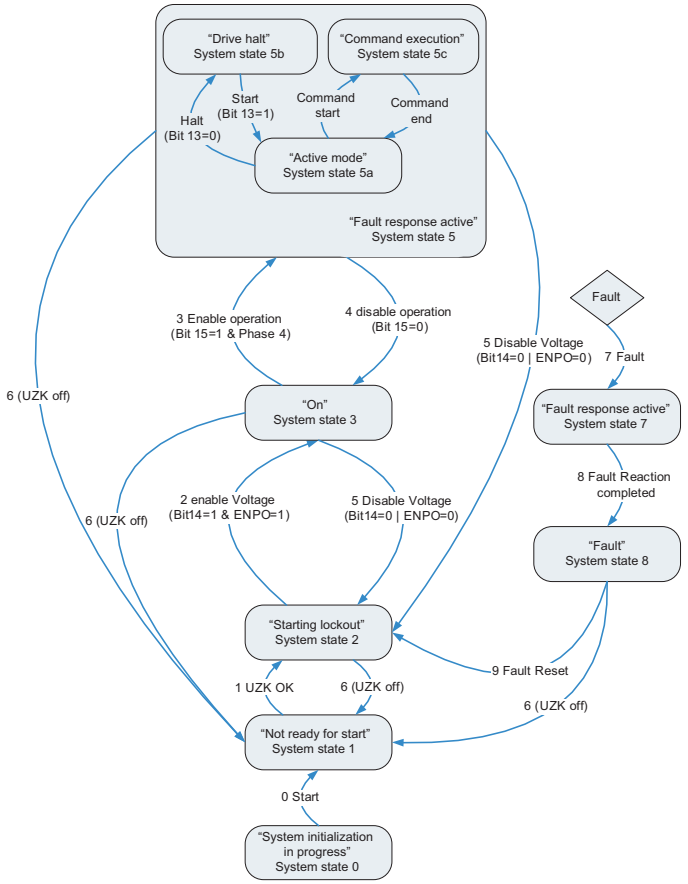

Figure 4.2 General system state machine (control via SERCOS)

System state	Designation	Description
0	System initialization in progress	Initialization after device reset (e.g. hardware, parameter list, drive, ….)
1	Not ready for start	Initialization complete, no mains power or DC-link voltage less than switch-on threshold
2	Starting lockout	DC-link voltage greater than switch-on threshold
3	Ready for start	Power stage enabled via hardware (ENPO and ISDSH) and bit 14 in MDT
4	On	Power stage is enabled (bit 15 in MDT = 1) (state is automatically run through in open-loop control mode via SERCOS)
5	Loop control active	Current applied to motor; loop control active
5a	Active mode	The selected operation mode is active
5b	Drive halt	Drive halt active (shutdown via stop ramp)
5c	Command execution	A command with a movement sequence is active; setpoints from the SERCOS master are being ignored
7	Fault reaction active	Fault reaction active; setpoints from the SERCOS master are being ignored
8	Fault	Drive in fault state; setpoints from SERCOS master being ignored, drive torque-free

Table 4.4 Description of system state transitions

System state transition	Designation	Description
0	START	Initialization after boot-up complete
1	UZK OK	DC-link voltage greater than switch-on threshold
2	ENABLE VOLTAGE	Communication phase 4 active; bit 15 in SERCOS control word = 1
3	ENABLE OPERATION	Communication phase 4 active; bit 15 in SERCOS control word = 1
4	DISABLE OPERATION	Communication phase 4 active; input ENPO = 0 and/or bit 14 in SERCOS control word = 0

Table 4.5 Description of system state transitions

System state transition	Designation	Description
5	DISABLE VOLTAGE	Communication phase 4 active; input ENPO = 0 and/or bit 14 in SERCOS control word = 0
6	UZK OFF	DC-link voltage less than switch-off threshold
7	Fault	Fault event occurred (can occur in any system state)
8	FAULT REACTION ACTIVE	The response configured for the fault is active (e.g. fault stop ramp)
9	FAULT RESET	Fault reset by command **S-0-0099**

Table 4.5 Description of system state transitions

4.6 Real-time control bits and real-time status bits

There are two configurable real-time bits in the MDT and the DT respectively. For configurati¬on of these binary signals the following parameters are provided:

- **S-0-0301**, “Assignment IDN real-time control bit 1“
- **S-0-0413**, “IDN bit number real-time control bit 1“
- **S-0-0303**, “Assignment IDN real-time control bit 2“
- **S-0-0414**, “IDN bit number real-time control bit 2“
- **S-0-0305**, “Assignment IDN real-time status bit 1“
- **S-0-0415**, “IDN bit number real-time status bit 1“
- **S-0-0307**, “Assignment IDN real-time status bit 2“
- **S-0-0416**, “IDN bit number real-time status bit 2“

The real-time control bits and real-time status bits can be configured in phases 2, 3 and 4.

The assignment parameters contain the number of the parameter to configure for the respective real-time bit.

With regard to configuration, note that the bit number must first be assigned (**S-0-0413, S-0-0414, S-0-0415, S-0-0416**) before a corresponding IDN is assigned as the real-time bit (**S-0-0301, S-0-0303, S-0-0305, S-0-0307**).

A faulty configuration (e.g. unknown IDN) is refused when writing to **S-0-0301, S-0-0303, S-0-0305** or **S-0-0307**.

Only the parameters listed in **P-0-3003** "Real-time control bits" or **P-0-3002** "Real-time status bits" are permissible. Lists **P-0-3002** and **P-0-3003** are described in the following tables.

Parameter	Description
S-0-0405	Enable touchprobe 1
S-0-0406	Enable touchprobe 2 1
P-0-0141	Open-loop control of digital outputs via COM option

*Table 4.6 List of parameters configurable as real-time control bits (**P-0-3003**)*

Parameter	Description
S-0-0011	State class 1 (device fault)
S-0-0012	State class 2 (device warnings)
S-0-0013	State class 3 (device state messages)
S-0-0014	Status word Sercos interface
P-0-0121	Status of the digital inputs
P-0-0143	Status of the digital outputs
S-0-0144	Signal status word
S-0-0179	Touchprobes 1 & 2 status
P-0-0239	Functional status of the digital inputs
S-0-0310	Warning threshold I2t motor exceeded
S-0-0311	Warning threshold heat sink temperature exceeded
S-0-0312	Warning threshold motor temperature exceeded
S-0-0330	Status speed setpoint reached
S-0-0331	Standstill message
S-0-0332	Speed threshold undershot
S-0-0333	Torque threshold exceeded
S-0-0334	Torque limit reached or exceeded
S-0-0335	Speed limit reached or exceeded
S-0-0336	Target position reached
S-0-0341	Status in track position

*Table 4.7 List of parameters configurable as real-time status bits (**P-0-3002**)*

Parameter	Description
S-0-0401	Status touchprobe 1
S-0-0402	Status touchprobe 2
S-0-0403	Status actual position
S-0-0409	Touchprobe 1, positive edge recorded
S-0-0410	Touchprobe 1, negative edge recorded
S-0-0411	Touchprobe 2, positive edge recorded
S-0-0412	Touchprobe 2, negative edge recorded
S-0-0419	Status of setpoint transfer

*Table 4.7 List of parameters configurable as real-time status bits (**P-0-3002**)*

4.7 Signal control and status words

4.7.1 Signal control word (S-0-0145)

In the signal control word **S-0-0145** signals can be transferred from the master control system to the drive in real time. The signal control word can be configured for cyclic transfer in the master data telegram (MDT). The signal control word is configured in phase 2 and is activated at the transition to phase 3. A faulty configuration results in a device fault and a refusal to switch to phase 3. The configuration parameters for the signal control word are described in the following table.

S-0-0027	**Configuration list, signal control word**
	This list contains all the parameter numbers included in the signal status word. The sequence of parameter numbers in the list determines the significance of the bits in the signal status word. The first parameter number in the list defines bit 0; the last parameter number defines bit 15. Parameter **S-0-0328** defines the bit number to be inserted into the signal status word from the relevant parameter.
S-0-0329	**Bit number assignment list, signal control word**
	In this configuration list the bit numbers of the parameters from **S-0-0027** copied into the signal control word (**S-0-0145**) are programmed. The sequence of the bit numbers in the list corresponds to the sequence of the signals in the signal control word.

Table 4.8 Configuration parameters for the signal control word

For configuration of the signal status word the list of configurable parameters of the real-time status bit (**P-0-3002**) applies.

Signal status word (S-0-0144)

In signal status word **S-0-0144** a user-configurable drive status can be mapped. The signal status word can be configured for cyclic transfer in the drive telegram (DT). The signal status word is configured in phase 2 and is activated at the transition to phase 3. A faulty configuration results in a device fault and a refusal to switch to phase 3. The configuration parameters for the signal status word are described in the following table.

S-0-0026	Configuration list, signal control word
	This list contains all the parameter numbers included in the signal status word. The sequence of parameter numbers in the list determines the significance of the bits in the signal status word. The first parameter number in the list defines bit 0; the last parameter number defines bit 15. Parameter **S-0-0328** defines the bit number to be inserted into the signal status word from the relevant parameter.
S-0-0328	**Bit number assignment list, signal status word**
	In this configuration list the bit numbers of the parameters from **S-0-0026** copied into the signal status word (**S-0-0144**) are programmed. The sequence of the bit numbers in the list corresponds to the sequence of the signals in the signal status word.

Table 4.9 Configuration parameters for the signal status word

For configuration of the signal status word the list of configurable parameters of the real-time status bit (**P-0-3002**) applies.

5 Fault, warning and status messages

5.1 Fault messages

The key fault messages of the drive are displayed in parameter **S-0-0011** (state class 1). The fault messages in square brackets are defined in the SERCOS specification but are not supported by the MSD Servo Drive.

Parameter	Description
S-0-0011	State class 1 (C1D) Drive lockout A fault situation of state class 1 in the drive leads to: 1. Best possible shutdown and subsequent torque enable at speed n-min. 2. b) The drive lockout bit (bit 13) in the drive status is set to "1". The fault bit is only cleared by the drive and reset to "0" when there are no more faults of state class 1 occurring and the "Reset state class 1" command (**S-0-0099**) has been received by the drive over the service channel. The bits defined in C1D are additionally defined by the single parameters in brackets. Structure of the C1D parameter: Bit 0: Overload shut-off (**S-0-0114**) Bit 1: Amplifier overheating shut-off (**S-0-0203**) Bit 2: Motor overheating shut-off (**S-0-0204**) [Bit 3: Cooling fault shut-off (**S-0-0205**)] [Bit 4: control voltage fault] Bit 5: Feedback fault (encoder fault) Bit 6: Fault in commutation system Bit 7: Overcurrent Bit 8: Overvoltage Bit 9: Undervoltage fault [Bit 10: Phase fault in power supply] Bit 11: Excessive control deviation (**S-0-0159**) Bit 12:Communication fault (**S-0-0014**) Bit 13: Position limit value exceeded (shut-off) (**S-0-0049, S-0-0050**) Bit 14: (reserved) Bit 15: Manufacturer specific fault (**S-0-0129**) Bit = 0 No fault Bit = 1 Fault

Table 5.1 Structure of parameter **S-0-0011** *(state class 1)*

5.2 Warning messages

The key warning messages of the drive are displayed in parameter **S-0-0012** (state class 2). The warning messages in square brackets are defined in the SERCOS specification but are not supported by the MSD Servo Drive.

Parameter	Description
S-0-0012	State class 2 (C2D)
	Shut-off warning Activating or clearing a warning in C2D sets the C2D change bit (bit 12) in the drive status. By reading C2D over the service channel the C2D change bit in the drive status is reset to "0". By way of the C2D form (**S-0-0097**) the effect of the shut-off warnings on the change bit in the drive status can be cancelled. The bits defined in C2D are additionally defined by the single parameters in brackets.
	Structure of the C2D: Bit 0: Overload warning (**S-0-310**) Bit 1: Amplifier overheating warning (**S-0-0311**) Bit 2: Motor overheating warning (**S-0-0312**) Bit 3: Cooling fault warning (**S-0-0313**) Bit 4: Reserved Bit 5: Positioning speed > n-limit (**S-0-0315**) Bit 6: Reserved Bit 7: Reserved Bit 8: Reserved Bit 9: Undervoltage message DC-link Bit 10: Reserved [Bit 11: Excessive speed deviation (**S-0-0377**)] Bit 12: Reserved [Bit 13: Target position outside travel range (see **S-0-0323**)] Bit 14: Reserved [Bit 15: Manufacturer specific warning (**S-0-0181**)] Bit = 0 Warning not active Bit = 1 Warning active

Table 5.2 Structure of parameter ***S-0-0012*** *(state class 2)*

5.3 Status messages

The key status messages of the drive are displayed in parameter **S-0-0013** (state class 3). The status messages in square brackets are defined in the SERCOS specification but are not supported by the MSD Servo Drive.

Parameter	Description
S-0-0013	Class 3 diagnostic (C3D)
	Operating status messages If a state in the drive changes, the assigned bit in C3D is also changed accordingly and the change bit for C3D (Bit 11) in the drive status is set to "1". By reading C3D over the service channel the C3D change bit in the drive status is reset to "0". By way of the C3D form (**S-0-0098**) the effect of the operating status messages on the change bit in the drive status can be cancelled. The bits defined in C3D are additionally defined by the parameter numbers in brackets.
	Structure of the C3D: Bit 0: n-actual = n-setpoint (see **S-0-0330**) Bit 1: n-actual = 0 (see **S-0-0331**) Bit 2: |n-actual| < |nx| (see **S-0-0332**) Bit 3: |T| > | |Tx| (see **S-0-0333**) [Bit 4: |T| > | |T-limit| (see **S-0-0334**)] Bit 5: |n-setpoint| > |n-limit| (siehe **S-0-0335**) Bit 6: (see **S-0-0335**) Bit 6: Target position reached (see **S-0-0336**) [Bit 7: |P | > |Px| ((see **S-0-0337**)] [Bit 8: : Actual position value = active target position |(**S-0-0430** – **S-0-0951/S-0-0053**)| < **S-0-0057** (see **S-0-0338**)] [Bit 9: |n-feedback| < Minimum spindle speed (see **S-0-0339**)] [Bit 10: |n-feedback| >Maximum spindle speed (see **S-0-0340**)] [Bit 11: Preliminary position reached (see **S-0-0341**, **S-0-0261**)] [Bit 12: Position setpoint = target position (see **S-0-0342**)] [Bit 13: Positioning interrupted (see **S-0-0343**)] [Bit 14: reserved] [Bit 15: Manufacturer specific status message set (see **S-0-0182**)] Bit = 0 Status not active Bit = 1 Status active

Table 5.3 Structure of parameter ***S-0-0013*** *(state class 3)*

5.4 Interface faults and diagnostic options

If states are identified in the drive which no longer permit correct operation of the interface, or if faulty inputs are detected during the initialization phase, the drive responds by falling back to communication phase 0.

No more drive telegrams are sent, the drive autonomously executes the programmed fault reaction and waits for re-initialization of the SERCOS loop by the master.

5.4.1 Diagnosis of interface status

To diagnose interface fault and identify the current communication phase, parameter **S-0-0014** (Interface status) is used.

If a fault is set in the interface status, the communication fault in C1D (**S-0-0011**) is reset. Setting bits 2-0 causes no fault. If there is no communication fault, the interface status in bits 0-2 contains the current communication phase. If there is a communication fault, the fault and the communication phase are saved. The communication fault is only cleared by the drive and reset to "0" when there are no more interface faults occurring and the "Reset state class 1" command (**S-0-099**) has been received by the drive over the service channel.

Bit	Explanation
Bit 0-2	Communication phase
Bit 3	MST failure
Bit 4	MDT failure
Bit 5	Invalid communication phase (phase > 4)
Bit 6	Fault in phase sequencing (invalid sequence)
Bit 7	Fault in phase fallback (not to phase 0)
Bit 8	Phase change without ready message
Bit 9	Change to non-initialized operation mode
Bit 10	Drive with same address in loop
Bit 11-15	Reserved

Table 5.4 Coding of parameter ***S-0-0014*** *(interface status)*

5.4.2 Fault counter for telegram failures

In the drive, each received master sync and master data telegram is monitored for conformance

- to the correct reception time;
- to the agreed telegram length; and
- to the correct CRC checksum.

Failure of a telegram is registered by incrementing a fault counter. The two parameters **S-0-0028** (MST fault counter) and **S-0-0029** (MDT fault counter) exist for the purpose. The content of parameter **S-0-0028** is cleared on the transition from communication phase 2 to 3; the content of parameter **S-0-0029** is cleared on the transition from phase 3 to 4.

6 Operation modes

The operation modes selectable in the master control word and displayed in the drive status word conforming to the SERCOS specification are coded according to the scheme set out in the following table.

Bit	Explanation
Bit 15	
0	SERCOS standard mode
1	Manufacturer specific mode
Bit 14	
0	Cyclic setpoints (for all modes)
1	Setpoints via service channel
Bits 13-10	(reserved)
Bits 9-0	
00 0000 0000	No mode defined
00 0000 0001	Torque control
00 0000 0010	Flux Control
xx xxxx x011	Position control with position encoder 1 (motor encoder)
xx xxxx x100	Position control with position encoder 2 (external encoder)
xx xxxx x101	Position control with position encoders 1 and 2 (not supported))
00 0000 0110	(reserved)
00 0000 0111	Uncontrolled mode
Bit 3	
0	1. Position control with tracking error
1	Position control without tracking error
Bits 9-4	
00 0000	Simple mode
0x 0001	Drive-controlled interpolation
1x 0001	Drive-controlled positioning
xx 0010	(reserved)
00 0011	(reserved)
xx 0100	Synchronous mode (not supported)
xx 1000	Electronic gearing (not supported)
Bit 9	
0	Loop control with absolute setpoint input - Activation of positioning with IPOSYNC
1	Loop control with relative setpoint input - Activation of non-cyclic commands with **S-0-0346**
Bit 8	
0	Without drive-controlled mode switching
1	With drive-controlled mode switching

Table 6.1 Operation mode coding

The operation modes supported by the MSD Servo Drive are listed in parameter **S-0-0292**.

Operation mode	Description
0000 0000 0000 0001	Torque control
0000 0000 0000 0010	Speed control, drive-controlled profile generation with parameterized ramps
0000 0000 0000 0110	Speed control, master control system-controlled profile generation, no tracking error
0000 0000 0000 0011	Position control with position encoder 1 (e.g. motor encoder), master control system-controlled profile generation, no use of pre-control signals
0000 0000 0000 0100	Position control with position encoder 2 (e.g. external encoder), master control system-controlled profile generation, no use of pre-control signals
0000 0000 0000 1011	Position control with position encoder 1 (e.g. motor encoder), master control system-controlled profile generation, with use of pre-control signals
0000 0000 0000 1100	Position control with position encoder 2 (e.g. external encoder), master control system-controlled profile generation, with use of pre-control signals
0000 0000 0001 0011	Position control with position encoder 1 (e.g. motor encoder), drive-controlled profile generation, no use of pre-control signals
0000 0000 0001 0100	Position control with position encoder 2 (e.g. external encoder), drive-controlled profile generation, no use of pre-control signals

*Table 6.2 Supported operation modes (**S-0-0296**)*

Operation mode	Description
0000 0000 0001 1011	Position control with position encoder 1 (e.g. motor encoder), drive-controlled profile generation, with use of pre-control signals
0000 0000 0001 1100	Position control with position encoder 2 (e.g. external encoder), drive-controlled profile generation, using pre-control signals

*Table 6.2 Supported operation modes (**S-0-0296**)*

Which of the three possible encoder interfaces of the MSD Servo Drive (Channel 1, Channel 2, Channel 3) are designated as position encoder 1 and 2 respectively is specified by parameters **P-0-0530** "Selection of position encoder 1", and **P-0-0531** "Selection of position encoder 2".

The position encoder for position control specified by the operation mode must also be selected via parameter **P-0-0522** as the position encoder for position control. Otherwise a fault will be triggered in response to the drive enable and the switch from phase 2 to phase 3.

For further details on encoder configuration please refer to the MSD Servo Drive Operation Manual.

A valid interpolation method **P-0-0370** must be configured for the position-controlled operation mode. The following settings are possible:

2. Linear interpolation
   Calculation of position and rotation speed
3. Spline interpolation with external pre-control.
   Should only be used when the master control system also calculates and transmits the pre-control signals for speed **P-0-3055** and torque **P-0-3056**.
4. Spline Interpolation
   Calculation of position, rotation speed and torque
5. Spline Interpolation
   Calculation of position, rotation speed and torquez

To attain a higher resolution of the pre-control signals, an additional 16-bit decimal place component **P-0-3100** for the position (**S-0-0047**) can be transferred.

To use the higher resolution, the advanced pre-control mode (**P-0-0379=1**) must be selected.

The advanced pre-control mode (**P-0-0379)** can deliver an improvement in pre-control signals even without calculating **P-0-3100**, though this depends heavily on the scaling (position resolution) and must be checked on the line in each individual case.

For more information on scaling and interpolation please refer to the MSD Servo Drive Operation Manual.

6.1 Torque control

In this operation mode the master specifies a torque setpoint (**S-0-0080**). To protect against overspeed, when the maximum rotation speed is reached a speed governor is activated which limits the speed to the configured maximum.

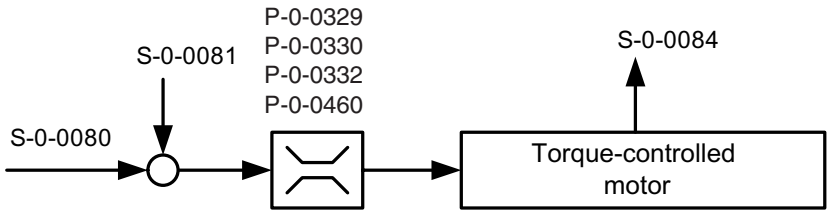

Figure 6.1 Simplified schematic diagram of torque control

Number	Description	Unit
S-0-0080	Torque reference	TORQ
S-0-0081	Additive torque setpoint	TORQ
S-0-0084	Actual torque	TORQ
P-0-0329	Absolute torque limit (reference variable: motor nominal torque)	%
P-0-0330	Negative torque limit (reference variable: motor nominal torque)	%
P-0-0331	Positive torque limit (reference variable: motor nominal torque)	%
P-0-0332	Online torque limit (reference variable: motor nominal torque)	%
P-0-0460	Motor nominal torque	Nm

Table 6.3 Torque control parameter

Rule: Tmin_neg = MIN(**P-0-0332, P-0-0330**) * **P-0-0329** * **P-0-0460**
Tmin_pos = MIN(**P-0-0332**, **P-0-0331**) * **P-0-0329** * **P-0-0460**

6.2 Flux Control

In this operation mode the master specifies a speed setpoint (**S-0-0036**).

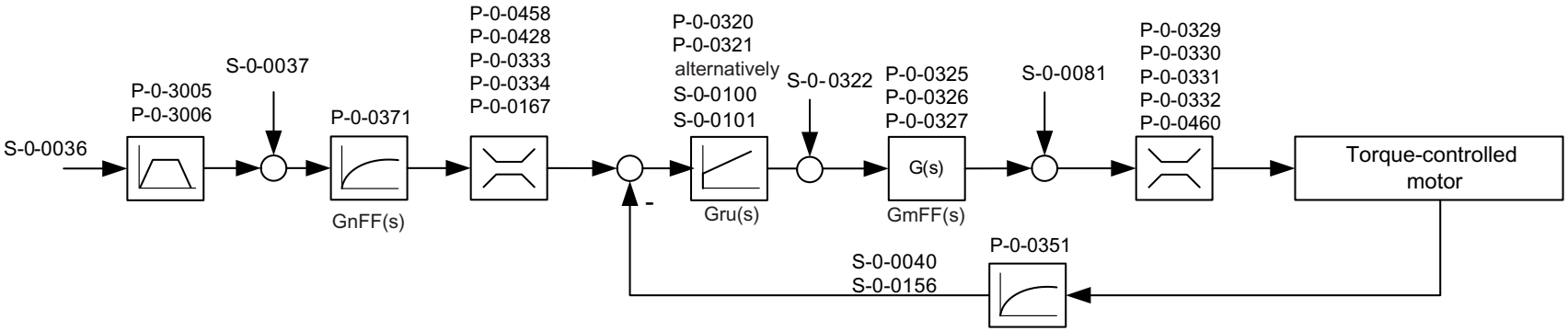

Figure 6.2 Schematic diagram of torque control

Number	Description	Unit
S-0-0036	Velocity setpoint	VEL
P-0-3005	Maximum positive acceleration	ACC
P-0-3006	Maximum negative acceleration	ACC
S-0-0037	Additive velocity setpoint	VEL
P-0-0371	Speed setpoint filter time constant	ms
P-0-0458	Motor nominal speed	1/min
P-0-0328	Speed limit (reference variable: motor nominal speed)	%
P-0-0333	Negative speed limit (reference variable: motor nominal speed)	%
P-0-0334	Positive speed limit (reference variable: motor nominal speed)	%
P-0-0167	Velocity override	%
P-0-0320	PI speed drive gain	Nm min
P-0-0321	PI speed drive integral-action time	ms
Alternatively		
S-0-0100	PI speed drive gain	Nm min

Table 6.4 Speed control parameter

Number	Description	Unit
S-0-0101	PI speed drive integral-action time	ms
P-0-0322	PI speed drive gain scaling factor	%
P-0-0325	Digital filter	
P-0-0326	Digital filter	
P-0-0327	Digital filter	
P-0-0329	Absolute torque limit (reference variable: motor nominal torque)	%
P-0-0330	Negative torque limit (reference variable: motor nominal torque)	%
P-0-0331	Positive torque limit (reference variable: motor nominal torque)	%
P-0-0332	Online torque limit (reference variable: motor nominal torque)	%
P-0-0460	Motor nominal torque	Nm
P-0-0351	Actual speed filter time	ms
S-0-0040	Actual speed 1	VEL
S-0-0156	Actual speed 2	VEL

Table 6.4 Speed control parameter

6.3 Position control with drive-controlled position profile generation

In this operation mode the target position specified in **S-0-0258** is approached in time-optimized mode adhering to the maximum positioning velocity **S-0-0259** and maximum positioning acceleration **S-0-0260**.

In drive-controlled positioning the position specified in **S-0-0282** is approached in time-optimized mode at the velocity preset in **S-0-0259** and the acceleration configured under **S-0-0260**.

The positioning commands are executed in accordance with **S-0-0346** (positioning control word) and, in modulo mode, also **S-0-0393** (positioning command word).

Modulo mode is defined according to the weighting in **S-0-0076** (bit 7) (see section 7).

Applicable parameters:

- **S-0-0282** Target position (not **S-0-0258**)
- **S-0-0259** Positioning velocity
- **S-0-0260** Acceleration and deceleration
- **S-0-0346** Positioning control word

and for modulo mode additionally:

- **S-0-0393** Positioning command word
- **S-0-0103** Modulo value
- **S-0-0294** Modulo divisor
- **S-0-0346** is defined as follows:

Bit 0: Change from 0 ->1 Adopt new position

Bit 1/2: 00 = Position mode
01 = Jog +
10 = Jog -
11 = Halt

Bit 3: 0 = Absolute
1 = Relative (only where bits 1/2 = 00)

Bit 4: 0 = Referred to target position (relative jobs are totalized)
1 = Referred to actual position (only where bit 3 = 1 and bits 1/2 = 00)

Confirmation of import into **S-0-0419** (Position Acknowledge). **S-0-0419** Position Acknowledge is cleared when **S-0-0346** bit 0 changes from 1 -> 0 or when the mode is switched.

Modulo mode

In modulo mode the rotation distance is calculated by way of the SERCOS scaling from **S-0-0103** * **S-0-0294**.

S-0-0393 is defined as follows (only with the modulo function configured):

Bit 1-0: Direction of rotation with modulo function
00 = Positive direction
01 = Negative direction
10 = Shortest distance (distance-optimized)
11 = Reserved

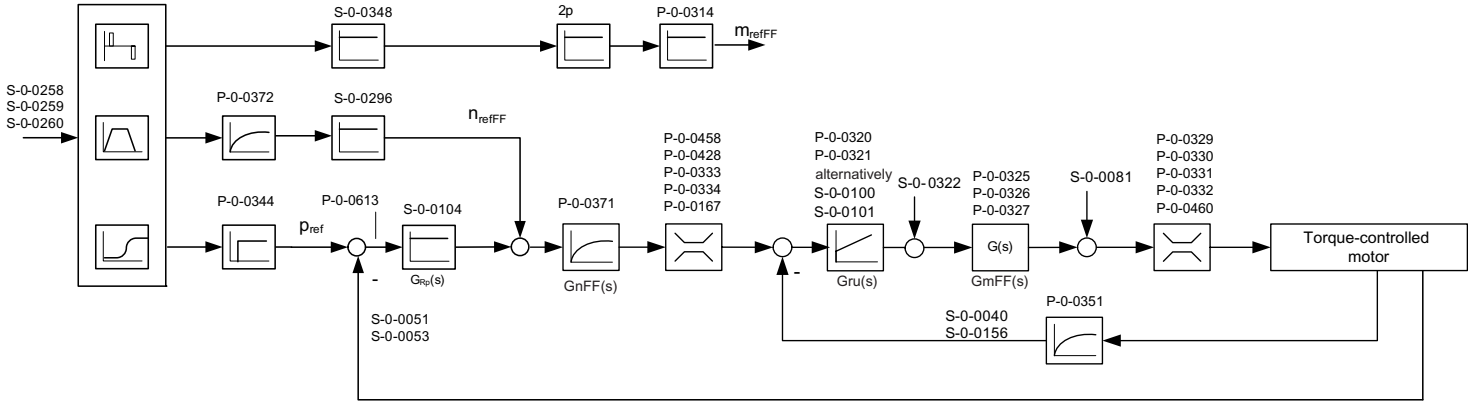

Figure 6.3 Schematic diagram of position control with position profile generation

Number	Description	Unit
S-0-0047	Position setpoint - open-loop control	POS
S-0-0051	Actual position 1	POS
S-0-0053	Actual position 2	POS
S-0-0258	Target position	POS
P-0-3055	External velocity pre-control	VEL
P-0-3056	External acceleration pre-control	ACC
S-0-0259	Positioning velocity	VEL
S-0-0260	Positioning acceleration	ACC
P-0-0370	Interpolation method 11 = Linear interpolation 2 = External pre-control signals from SERCOS master (only with **P-0-3055**, **P-0-3056**), not with drive-controlled positioning 3 = Cubic spline interpolation 4 = Cubic spline interpolation II	
P-0-0374	Position setpoint delay	ms
P-0-0372	Speed pre-control filter time constant	ms

Table 6.5 Speed control parameter

Number	Description	Unit
P-0-0378	Speed pre-control filter time constant	ms
S-0-0296	Speed pre-control scaling	%
Alternatively		
S-0-0348	Acceleration pre-control scaling	%
P-0-0375	Speed pre-control scaling	%
Alternatively		
P-0-0376	Acceleration pre-control scaling	%
P-0-0377	Pre-control ON/OFF (set automatically by operation mode)	
P-0-1516	Overall mass moment of inertia	kgm^2
P-0-0279	Servo drive control difference (tracking error)	POS
S-0-0104	P-servo drive gain	1/min
Alternatively		
P-0-0360	P-servo drive gain	1/min

Table 6.5 Speed control parameter

6.4 Position control without tracking error

6.4.1 In-drive generation of pre-control signals

In this operation mode the master cyclically dictates position setpoints. The drive performs a fine-interpolation between the position setpoints and also calculates the speed and acceleration pre-control signals. The position setpoint can be delayed for a configurable number of servo drive cycles **P-0-0558**. The amplitudes of the delay signals can be scaled via parameters **S-0-0296** (speed pre-control) and **S-0-0348** (acceleration pre-control). The speed pre-control signal is smoothed by way of a P-T1 element with the filter time constant **P-0-0555** and overlaid on the speed setpoint generated by the servo drive. The acceleration pre-control signal is converted via the mass moment of inertia of the drive set in parameter **P-0-0314** into a torque pre-control signal which is overlaid on the torque setpoint generated by the speed drive.

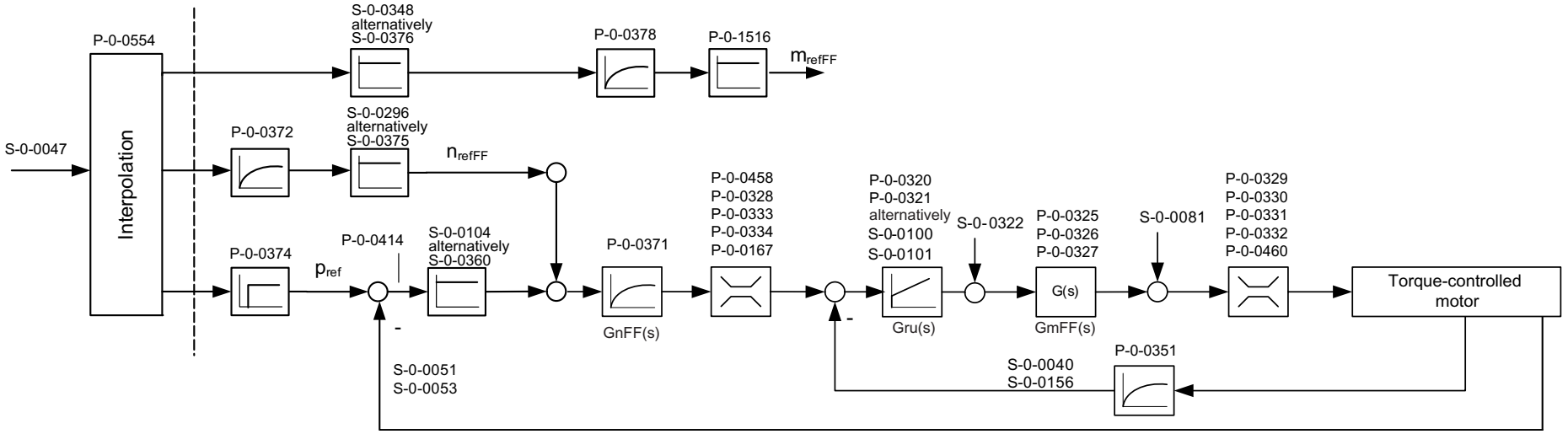

Figure 6.4 Schematic diagram of position control without tracking error with internal pre-control signals

6.5 External generation of pre-control signals

IIn this operation mode the master cyclically dictates position setpoints and pre-control signals for speed and acceleration. The drive performs a fine-interpolation for the position setpoints and the pre-control signals. The scaled pre-control signals are de-scaled via parameters **P-0-1507** (rotation speed) and **P-0-1508** (acceleration).

Further influencing of the position setpoint and pre-control signals is effected as in the operation mode detailed in 6.4.1.

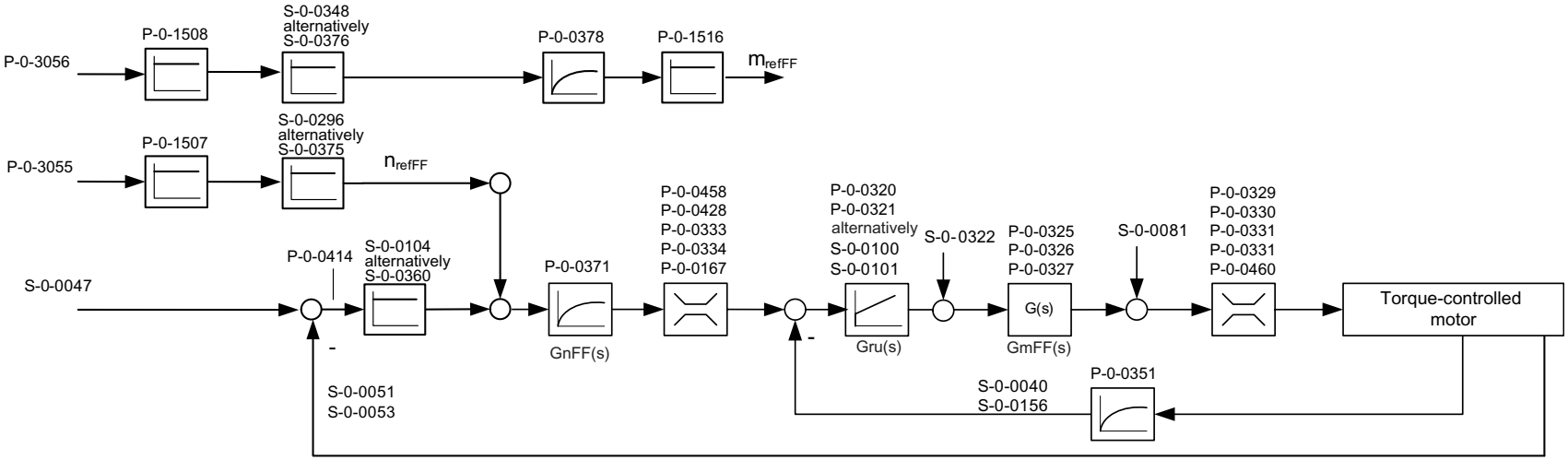

Figure 6.5 Schematic diagram of position control without tracking error with external pre-control signals

7 Weighting

The weighting describes the physical unit and number of decimal places with which the numerical values of the parameters exchanged between the master control system and the drives are to be interpreted. The method of weighting is defined by the parameters for position, velocity, acceleration and torque weighting.

7.1 Weighting of position data

The translatory position weighting is defined by the parameters listed in the following table. All position data of the drive (e.g.: setpoint, actual and limit values) are subject to the preset weighting. If "No weighting" is selected via parameter **S-0-0076**, the weighting factor and weighting exponent are irrelevant. The position data is then subject to a differently defined weighting.

IDN	Description
S-0-0076	Weighting method for position data
S-0-0077	Weighting factor for translatory position data
S-0-0078	Weighting exponent for translatory position data
S-0-0079	Rotary position resolution
S-0-0103	Modulo value

Table 7.1 Scaling parameter for position weighting

7.1.1 Weighting of translatory position data

Translatory weighting is selected via **S-0-0076**. The significance of the LSB of the translatory position data is defined by the following equation:

LSB significance = Unit • **S-0-0077** • $10^{\text{S-0-0078}}$

When translatory preferential weighting is selected, the weighting as per the following table applies.

Weighting method (from **S-0-0076**)	Unit (from **S-0-0076**)	Weighting factor (**S-0-0077**)	Weighting exponent (**S-0-0078**)	Preferential weighting
Linear	m	1	-7	0.1 ìm

Table 7.2 Preferential weighting of translatory position data

7.1.2 Weighting of rotary position data

Rotary weighting is selected via **S-0-0076**. The significance of the LSB of the rotary position data is defined by the rotary position resolution (**S-0-0079**).

$$\text{LSB significance} = \text{Unit} \cdot \frac{1\ \text{revolution}}{\text{S-0-0079}}$$

When rotary preferential weighting is selected, the weighting as per the following table applies.

Weighting method (from **S-0-0076**)	Unit (from **S-0-0076**)	Rotary position resolution (**S-0-0079**)	Preferential weighting
Rotary	Degrees	3 600 000	0.0001 degrees

Table 7.3 Preferential weighting of rotary position data

Bits 2-0	Weighting method
0 0 0	No weighting
0 0 1	Translatory weighting
0 1 0	Rotary weighting
Bit 3	Parameter weighting
0	Preferential weighting
1	Preferential weighting
Bit 4	Unit
0	Degrees (for rotary weighting) / Metres (for translatory weighting)
1	Reserved (for rotary weighting) / Inches (for translatory weighting)
Bit 5	Reserved
Bit 6	Data source
0	On the motor shaft
1	On the load side
Bit 7	Processing format
0	Absolute format
1	Modulo format
Bit 8-15	Reserved

*Table 7.4 Bit fields in the position data weighting method parameter (**S-0-0076**)*

The following diagram shows the various position weighting options.

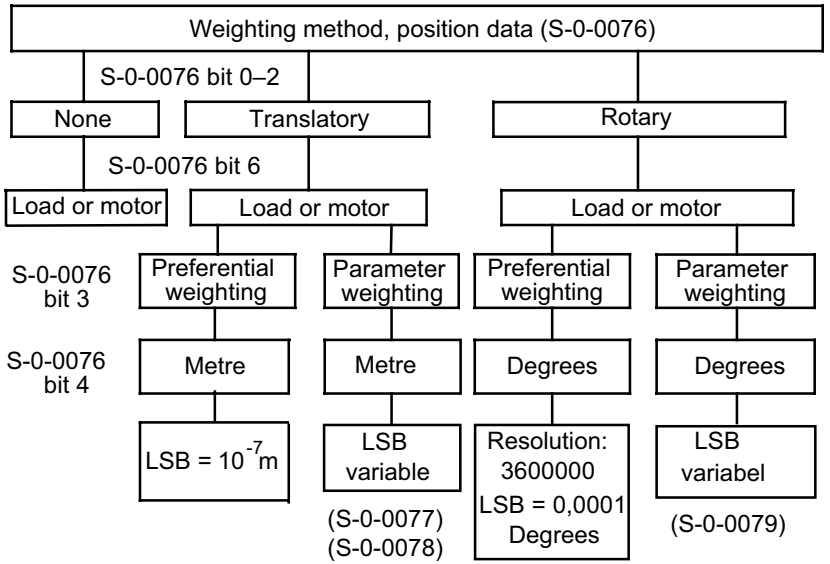

Figure 7.1 Diagram of position weighting methods

7.1.3 Modulo weighting

If modulo weighting is preset via parameter **S-0-0076** ("Position weighting"), parameters **S-0-0103** ("Modulo value") and **S-0-0294** ("Modulo value divisor") determine the value range (modulo range) within which the actual position may lie. If the travel distance exceeds the modulo range, an overshoot of the actual position occurs.

Parameter	Description
S-0-0103	MODULO VALUE When modulo format is preset in the position weighting method (**S-0-0076**), the modulo value (**S-0-0103**) defines the number range of all position data. If the modulo value is exceeded, the drive and the master control system perform the modulo calculation.
S-0-0294	MODULO VALUE DIVISOR If the modulo value (**S-0-0103**) does not match the physical modulo value, the modulo value can be corrected by the divisor **S-0-0294**. The effective modulo value is the product of **S-0-0103** and **S-0-0294**. A value of 1 renders the "modulo value divisor" parameter ineffective.

Table 7.5 Scaling parameter for position weighting

7.1.4 Position polarity

In parameter **S-0-0055** the polarities (preceding signs) of the specified position data can be inverted according to the application. The polarities are not inverted within a controlled system, but outside of it (at the input and output). A positive position setpoint difference with non-inverted polarity means the direction of rotation is clockwise, looking at the motor shaft.

Bit 0	Position reference
0	Not inverted
1	Inverted
Bit 1	Additive position setpoint
0	Not inverted
1	Inverted
Bit 2	Actual position 1
0	Not inverted
1	Inverted
Bit 3	Actual position 2
0	Not inverted
1	Inverted
Bit 4	Position limit values
0	Not inverted
1	Inverted
Bit 5-15	Reserved

Table 7.6 Setting of position polarity via parameter **S-0-0055**

7.2 Weighting of velocity data

The velocity weighting is defined by the parameters listed in the following table. All velocity data of the drive (e.g.: setpoint, actual and limit values) are subject to the preset weighting. If "No weighting" is selected via parameter **S-0-0044**, the weighting factor and weighting exponent are irrelevant. The velocity data is then subject to a differently defined weighting.

IDN	Description
S-0-0044	Weighting method for velocity data
S-0-0045	Weighting factor for velocity data
S-0-0046	Weighting exponent for velocity data

Table 7.7 Scaling parameter for position weighting

7.2.1 Weighting of translatory velocity data

Translatory weighting is selected via **S-0-0044**. The significance of the LSB of the translatory velocity data is defined by the following equation:

$$\text{LSB significance} = \frac{\text{Travel unit}}{\text{Time unit}} \cdot \textbf{S-0-0045} \bullet 10^{\textbf{S-0-0046}}$$

When translatory preferential weighting is selected, the weighting as per the following table applies.

Weighting method (from **S-0-0045**)	Unit (from **S-0-0045**)	Weighting factor (**S-0-0045**)	Weighting exponent (**S-0-0046**)	Preferential weighting
Linear	m/min	1	-6	0.001 mm/min

Table 7.8 Preferential weighting of translatory velocity data

7.2.2 Weighting of rotary velocity data

Rotary weighting is selected via **S-0-0044**. The significance of the LSB of the rotary velocity data is defined by the following equation:

$$\text{LSB significance} = \frac{\text{Travel unit}}{\text{Time unit}} \cdot \textbf{S-0-0045} \bullet 10^{\textbf{S-0-0046}}$$

When rotary preferential weighting is selected, the weighting as per the following table applies.

Weighting method (from **S-0-0045**)	Unit (from **S-0-0045**)	Weighting factor (**S-0-0045**)	Weighting exponent (**S-0-0046**)	Preferential weighting
Rotary	rpm	1	-4	0.001 1/min
Rotary	1/s	1	-6	0.000 001 1/s

Table 7.9 Preferential weighting of rotary position data

Bit 2-0	Weighting method
0 0 0	No weighting
0 0 1	Translatory weighting
0 1 0	Rotary weighting
Bit 3	Weighting method
0	Preferential weighting
1	Parameter weighting
Bit 4	Distance unit
0	Revolutions (for rotary weighting) / Metres (for translatory weighting)
1	Reserved (for rotary weighting) / Inches (for translatory weighting)
Bit 5	Time unit
0	Minutes (min)
1	Seconds (s)
Bit 6	Data source
0	On the motor shaft
1	On the load side
Bit 7-17	Reserved

*Table 7.10 Bit fields in the velocity data weighting method parameter (**S-0-0045**)*

The following diagram shows the various velocity weighting options.

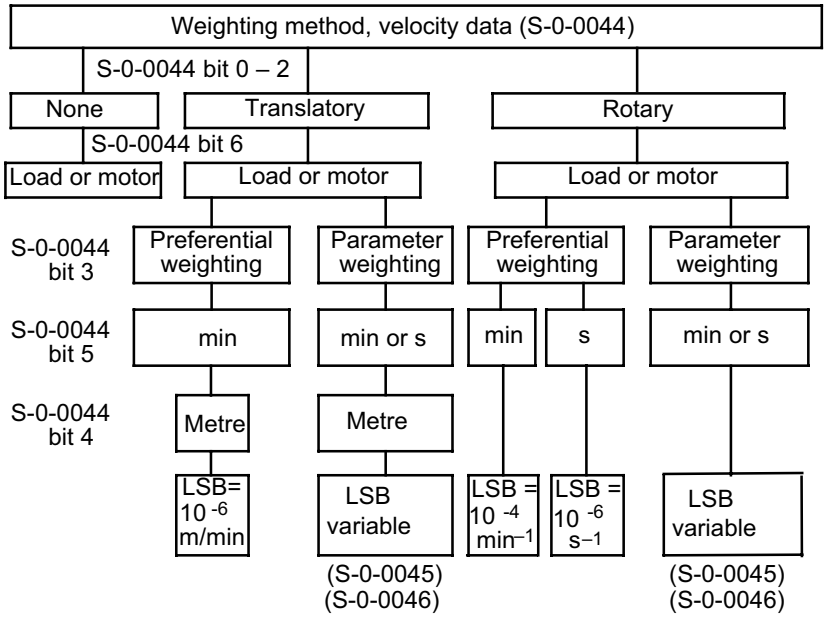

Figure 7.2 Diagram of velocity weighting methods

7.2.3 Velocity polarity

In parameter **S-0-0043** the polarities (preceding signs) of the specified velocity data can be inverted according to the application. The polarities are not inverted within a controlled system, but outside of it (at the input and output). A positive velocity setpoint difference with non-inverted polarity means the direction of rotation is clockwise, looking at the motor shaft.

Bit 0	Velocity setpoint
0	Not inverted
1	Inverted
Bit 1	Additive velocity setpoint
0	Not inverted
1	Inverted
Bit 2	Actual velocity 1
0	Not inverted
1	Inverted
Bit 3	Actual velocity 2
0	Not inverted
1	Inverted
Bit 4-15	Reserved

Table 7.11 Setting of velocity polarity via parameter **S-0-0043**

7.3 Weighting of acceleration data

The acceleration weighting is defined by the parameters listed in table 7 12. All acceleration data of the drive (e.g.: setpoint, actual and limit values) are subject to the preset weighting. If "No weighting" is selected via parameter **S-0-0160**, the weighting factor and weighting exponent are irrelevant. The acceleration data is then subject to a differently defined weighting.

IDN	Description
S-0-0160	Weighting method for acceleration data
S-0-0161	Weighting factor for acceleration data
S-0-0162	Weighting exponent for acceleration data

Table 7.12 Scaling parameter for acceleration weighting

7.3.1 Weighting of translatory acceleration data

Translatory weighting is selected via **S-0-0160**. The significance of the LSB of the translatory acceleration data is defined by the following equation:

$$\text{LSB significance} = \frac{\text{Travel unit}}{\text{Time unit}^2} \cdot \textbf{S-0-0161} \bullet 10^{\textbf{S-0-0162}}$$

When translatory preferential weighting is selected, the weighting as per the following table applies.

Weighting method (from S-0-0160)	Unit (from S-0-0160)	Weighting factor (S-0-0161)	Weighting exponent (S-0-0162)	Preferential weighting
Translatory	m/s^2	1	-6	0.001 mm/s^2

Table 7.13 Preferential weighting of translatory acceleration data

7.3.2 Weighting of rotary acceleration data

Rotary weighting is selected via **S-0-0160**. The significance of the LSB of the rotary acceleration data is defined by the following equation:

$$\text{LSB significance} = \frac{\text{Travel unit}}{\text{Time unit}^2} \cdot \textbf{S-0-0161} \bullet 10^{\textbf{S-0-0162}}$$

When rotary preferential weighting is selected, the weighting as per the following table applies.

Weighting method (from S-0-0160)	Unit (from S-0-0160)	Weighting factor (S-0-0161)	Weighting exponent (S-0-0162)	Preferential weighting
Rotary	rad/s^2	1	-3	0.001 rad/s^2

Table 7.14 Preferential weighting of rotary position data

Bits 2-0	Weighting method
0	No weighting
1	Translatory weighting
	Rotary weighting
Bit 3	Weighting method
0	Preferential weighting
1	Parameter weighting
Bit 4	Distance unit
0	rad (for rotary weighting) / Metres (for translatory weighting)
1	Reserved (for rotary weighting) / Inches (for translatory weighting)
Bit 5	Time unit
0	Seconds
1	Reserved
Bit 6	Data source
0	On the motor shaft
1	On the load side
Bit 7-15	Reserved

*Table 7.15 Bit fields in the acceleration data weighting method parameter (**S-0-0160**)*

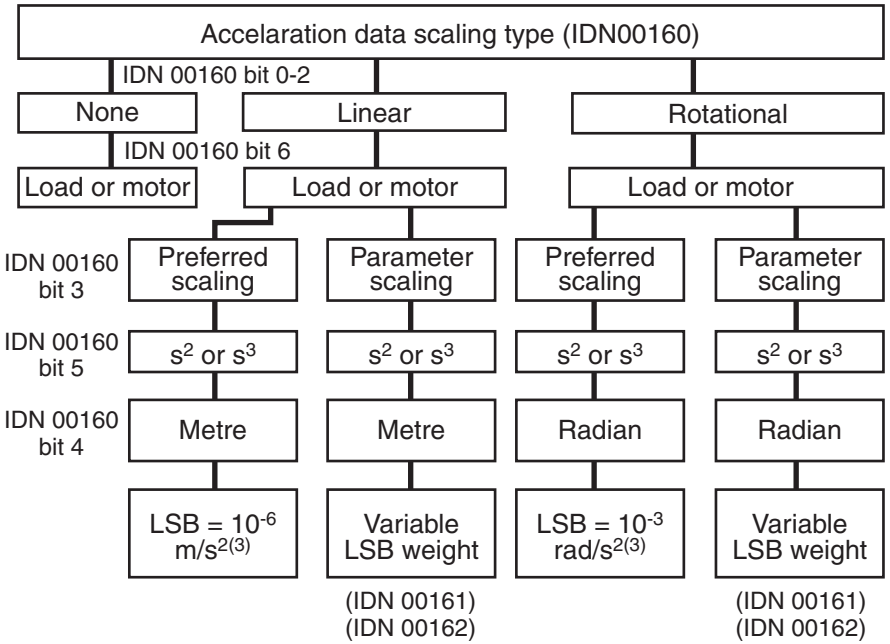

Figure 7.3 Diagram of acceleration weighting methods

7.4 Weighting of torque and force data

The torque/force weighting is defined by the parameters listed in the following table. All torque/force data of the drive (e.g.: setpoint, actual and limit values) are subject to the preset weighting.

IDN	Description
S-0-0086	Weighting method for torque/force data
S-0-0093	Weighting factor for torque/force data
S-0-0094	Weighting exponent for torque/force data

Table 7.16 Scaling parameter for torque/force weighting

7.4.1 Percentage weighting of torque and force data

The percentage weighting is set via the weighting method (**S-0-0086**). No other parameters are required. In percentage weighting the permanently permissible standstill torque of the motor (**S-0-0111**) is used as the reference value. All torque/force data is given in % with one decimal place.

7.4.2 Weighting of force data

The weighting of force data is set via parameter **S-0-0086**. The significance of the LSB of the force data is defined by the following equation:

LSB significance = Unit • **S-0-0093** • $10^{S\text{-}0\text{-}0094}$

When preferential force weighting is selected, the weighting as per the following table applies.

Weighting method (from S-0-0086)	Unit (from S-0-0086)	Weighting factor (S-0-0093)	Weighting exponent (S-0-0094)	Preferential weighting
linear	N	1	0	1 N

Table 7.17 Preferential weighting of force data

7.4.3 Weighting of torque data

The weighting of torque data is set via parameter **S-0-0086**. The significance of the LSB of the torque data is defined by the following equation:

LSB significance = Unit • **S-0-0093** • $10^{\text{S-0-0094}}$

When preferential torque weighting is selected, the weighting as per the following table applies.

Weighting method (from S-0-0086)	Unit (fromS-0-0086)	Weighting factor (S-0-0093)	Weighting exponent (S-0-0094)	Preferential weighting
Rotary	Nm	1	-2	0.01 Nm

Table 7.18 Preferential weighting of force data

Bit 2-0	Weighting method
0 0 0	No weighting
0 0 1	Translatory weighting
0 1 0	Rotary weighting
Bit 3	Weighting method
0	Preferential weighting
1	Parameter weighting
Bit 4	Distance unit
0	Nm (for rotary weighting) / N (for translatory weighting)
1	In lbf (for rotary weighting) / lbf (for translatory weighting)
Bit 5	Reserved
Bit 6	Data source
0	On the motor shaft
1	On the load side
Bit 7-17	Reserved

*Table 7.19 Bit fields in the torque/force data weighting method parameter (**S-0-0086**)*

The following diagram shows the various torque/force weighting options.

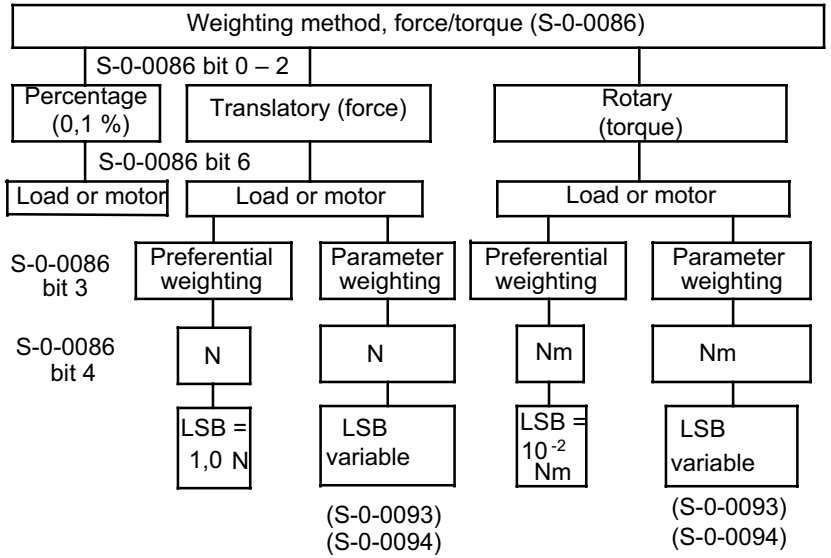

Figure 7.4 Diagram of torque/force weighting methods

7.4.4 Torque polarity

IIn parameter **S-0-0085** the polarities (preceding signs) of the specified torque data can be inverted according to the application. The polarities are not inverted within a controlled system, but outside of it (at the input and output). A positive torque setpoint difference with non-inverted polarity means the direction of rotation is clockwise, looking at the motor shaft.

Bit 0	Torque reference
0	Not inverted
1	Inverted
Bit 1	Additive torque setpoint
0	Not inverted
1	Inverted

*Table 7.20 Setting of velocity polarity via parameter **S-0-0043***

Bit 2	Actual torque
0	Not inverted
1	Inverted
Bit 3-15	Reserved

Table 7.20 Setting of velocity polarity via parameter **S-0-0043**

8 Homing

8.1 "Drive-controlled homing" command

To create the distance reference when using relative encoder systems, command **S-0-0148**, "Drive-controlled homing", must be used. As soon as this command has been set and enabled by the master, the drive moves in position control mode with an internal profile generator, taking into account **S-0-0041**: Homing velocity 1 (Move and wait for reference cam) and **P-0-3031:** Homing velocity 2 (Find zero point in zero approach run) as well as **S-0-0042**: Homing acceleration, according to the strategy defined in **P-0-2261:** Homing method. The status "Encoder system home" in parameter **S-0-0403** (Actual position status) is cleared when homing starts (if previously set) and is reset once homing has completed successfully.

For more information on homing and the available methods please refer to the MSD Servo Drive Application Manual.

8.2 Setting of SERCOS encoders 1 / 2

The MSD Servo Drive features a maximum of 3 independent encoder interfaces. These encoder interfaces are assigned to the logical SERCOS position encoder interfaces 1 and 2 via parameters **P-0-0530** (Selection of SERCOS encoder 1) and **P-0-0531** (Selection of SERCOS encoder 2). Homing is executed to the position encoder determined by the active operation mode (see also section 6).

8.3 Homing velocity

The homing velocity is preset via **S-0-0041** (Find reference cam) and **P-0-3031** (Find zero point). The unit and the number of decimal places corresponds to the velocity weighting in **S-0-0044**.

8.4 Homing acceleration

The homing acceleration is preset via **S-0-0042**. The unit and the number of decimal places corresponds to the acceleration weighting in **S-0-0160**.

8.5 Homing method

The homing method is selected via **P-0-2261**. The various methods are detailed in the MSD Servo Drive Application Manual.

SERCOS profile parameter **S-0-0147** defining the homing method is not yet currently supported.

8.6 Reference distance 1/2

The reference distance 1(2) (**S-0-0052, S-0-0054**) describes the distance between the machine zero point and the reference point referred to the motor measurement system. After homing, the actual position is calculated from the reference distance and the reference distance offset. The weighting is preset according to **S-0-0076**. The two parameters relate to SERCOS encoders 1 and 2 respectively.

8.7 Reference distance offset 1/2

The reference distance offset 1(2) (**S-0-0150, S-0-0151**) describes the distance between the reference mark of the position encoder and the reference point. The two parameters relate to SERCOS encoders 1 and 2 respectively.

8.8 Reference cam, limit switches

The signal of the reference cam can be optionally linked to one of the digital inputs. Inputs ISD00…ISD06 are available. Depending on the method, the limit switches can also be optionally used for homing.

8.8.1 Function selector - digital inputs and outputs

The inputs and outputs of the drive can be assigned various functions by way of so-called function selectors. The inputs can also be filtered against bounce or inverted.

For more information on the digital and analog IOs please refer to the Application Manual, section 4.

- **P-0-0100** Function selector ENPO
- **P-0-0101** Function selector ISD00
- **P-0-0102** Function selector ISD01
- **P-0-0103** Function selector ISD02
- **P-0-0104** Function selector ISD03
- **P-0-0105** Function selector ISD04
- **P-0-0106** Function selector ISD05
- **P-0-0107** Function selector ISD06
- **P-0-0108** Function selector ISDSH
- **P-0-0109** Function selector ISA00
- **P-0-0110** Function selector ISA01
- **P-0-0118** Filter for digital inputs
- **P-0-0120** Inversion of digital inputs

- **P-0-0122** Function selector OSD00
- **P-0-0123** Function selector OSD01
- **P-0-0124** Function selector OSD02
- **P-0-0125** Function selector - motor brake
- **P-0-0126** Function selector - RELOUT1
- **P-0-0142** Inversion of digital outputs

9 Touchprobe function

The touchprobe function permits event-controlled position measurement. Positive and negative signal edges at the two "fast" digital inputs ISD05 and ISD06 can be configured as triggers for a position measurement.

To activate the "Measurement with touchprobe" function the "Touchprobe cycle" command (**S-0-0170**) is used. This command permits both single and multiple measurements (use of real-time bits).

Setting and enabling the command activates the "Measurement" function in the drive. The drive signals this by setting the command acknowledgement (data status) to "set, enabled, not yet executed". No "Command correctly executed" acknowledgement is made. This means that the command change bit is only set in the event of a fault.

By way of the "Touchprobe control parameter" (**S-0-0169**) specific edges of touchprobe 1 or 2 can be activated.

The measurement is enabled by the "Touchprobe 1/2 enable" signals (**S-0-0405/S-0-0406**).

When the selected edge occurs on the touchprobe, the drive stores the actual position value to the relevant parameter **S-0-0130** to **S-0-0133** (measured value 1 or 2, positive or negative edge) and sets the associated bit in the measured value status (**S-0-0179**). The status bits in the measured value status are addressable separately via the ident numbers **S-0-0409** to **S-0-0412** and so can be assigned to the real-time status bits in fast measurements.

When an active measurement edge occurs the effect of the same edge is disabled. This block is cleared by resetting the touchprobe 1/2 enable (**S-0-0405/S-0-0406**). The measurement is re-enabled by then setting the touchprobe 1/2 enable. The parameters of the touchprobe function are explained in the following table.

Parameter	Description
S-0-0169	TOUCHPROBE CONTROL PARAMETER The settings in this parameter define which touchprobes and edges are active for the touchprobe cycle. Structure of touchprobe control parameter: Structure of touchprobe control parameter: 0 - Positive edge not active 1 - Positive edge active Bit 1: Touchprobe 1 negative edge 0 - Negative edge not active 1 - Negative edge active Bit 2: Touchprobe 2 positive edge 0 - Positive edge not active 1 - Positive edge active Bit 3: Touchprobe 2 negative edge 0 - Negative edge not active 1 - Negative edge active
S-0-0170	TOUCHPROBE CYCLE COMMAND If the touchprobe cycle command is set and enabled by the master, the drive responds to the following parameters: - Touchprobe 1/2 enable (**S-0-0405, S-0-0406**) and - Touchprobe 1/2 (**S-0-0401,S-0-0402**) as programmed in touchprobe - control parameter (**S-0-0169**) While the command is active the master control system can perform multiple measurements. The command is cleared by the control system if no further measurements are required.
S-0-0179	MEASURED VALUE STATUS If the drive stores one or more measured values while the touchprobe cycle command (**S-0-0170**) is active, it simultaneously also sets the associated bit in the measured value status. If the "Touchprobe 1 enable" (**S-0-0405**) is cleared by the control system, the drive clears bits 0 and 1 in the measured value status. If the "Touchprobe 2 enable" (**S-0-0406**) is cleared by the control system, the drive clears bits 2 and 3 in the measured value status. The drive clears all bits in the measured value status when the touchprobe cycle command (**S-0-0170**) is cleared by the control system. Structure of measured value status: Bit 0: Measured value 1 recorded positive (**S-0-0409**) 0 - Not recorded 1 - Recorded Bit 1: Measured value 1 recorded negative (**S-0-0410**) 0 - Not recorded 1 - Recorded Bit 2: Measured value 2 recorded positive (**S-0-0411**) 0 - Not recorded 1 - Recorded Bit 3: Measured value 2 recorded negative (**S-0-0412**) 0 - Not recorded 1 - Recorded Bit 15: (reserved) Bit 15-4: (reserved)

Table 9.1 Description of parameters for the touchprobe function

Parameter	Description
S-0-0130	MEASURED VALUE 1, POSITIVE EDGE With an external encoder, the drive stores the actual position value 2 to this parameter with the positive edge of touchprobe 1 (**S-0-0401**) during the measurement cycle. If there is no external encoder, actual position value 1 is stored.
S-0-0131	MEASURED VALUE 1, NEGATIVE EDGE With an external encoder, the drive stores the actual position value 2 to this parameter with the negative edge of touchprobe 1 (**S-0-0401**) during the measurement cycle. If there is no external encoder, actual position value 1 is stored.
S-0-0132	MEASURED VALUE 2, POSITIVE EDGE With an external encoder, the drive stores the actual position value 2 to this parameter with the positive edge of touchprobe 2 (**S-0-0402**) during the measurement cycle. If there is no external encoder, actual position value 1 is stored.
S-0-0133	MEASURED VALUE 2, NEGATIVE EDGE With an external encoder, the drive stores the actual position value 2 to this parameter with the negative edge of touchprobe 2 (**S-0-0402**) during the measurement cycle. If there is no external encoder, actual position value 1 is stored.
S-0-0405	TOUCHPROBE 1 ENABLE With this parameter the touchprobe 1 enable is assigned an IDN. As a result, the touchprobe 1 enable can be assigned to a real-time control bit (**S-0-0301**). The touchprobe 1 enable is only polled by the drive as long as the touchprobe cycle command (**S-0-0170**) is active. For a repeat measurement with the same edge of touchprobe 1, the master control system must set the touchprobe 1 enable to “0” and back to “1”. In the operation datum only bit 0 is defined. (For more information see **S-0-0179**)
S-0-0406	TOUCHPROBE 2 ENABLE With this parameter the touchprobe 2 enable is assigned an IDN. As a result, the touchprobe 2 enable can be assigned to a real-time control bit (**S-0-0301**). The touchprobe 2 enable is only polled by the drive as long as the touchprobe cycle command (**S-0-0170**) is active. For a repeat measurement with the same edge of touchprobe 2, the master control system must set the touchprobe 2 enable to “0” and back to “1”. In the operation datum only bit 0 is defined. (For more information see **S-0-0179**).

Table 9.1 Description of parameters for the touchprobe function

Parameter	Description
S-0-0409	MEASURED VALUE 1 RECORDED POSITIVE With this parameter “Measured value 1 recorded positive” is assigned an IDN. As a result, “Measured value 1 recorded positive” can be assigned to a real-time status bit (**S-0-0305**). In the operation datum only bit 0 is defined. Bit 0 in this parameter is only set by the drive when the touchprobe cycle command (**S-0-0170**) is active, the touchprobe 1 enable signal (**S-0-0405**) is set to “1” and the positive edge of touchprobe 1 (**S-0-0401**) is signalled. At the same time, the drive stores the actual position value to measured value 1 positively (**S-0-0130**). The drive clears this bit when the master control system clears the touchprobe cycle command or the touchprobe 1 enable is set to „0”. (For more information see **S-0-0179**).
S-0-0410	MEASURED VALUE 1 RECORDED NEGATIVE With this parameter “Measured value 1 recorded negative” is assigned an IDN. As a result, “Measured value 1 recorded negative” can be assigned to a real-time status bit (**S-0-0305**). Bit 0 in this parameter is only set by the drive when the touchprobe cycle command (**S-0-0170**) is active, the touchprobe 1 enable signal (**S-0-0405**) is set to “1” and the negative edge of touchprobe 1 (**S-0-0401**) is signalled. At the same time, the drive stores the actual position value to measured value 1 negatively (**S-0-0131**). The drive clears this bit when the master control system clears the touchprobe cycle command or the touchprobe 1 enable is set to „0”. In the operation datum only bit 0 is defined. (For more information see **S-0-0179**).
S-0-0411	MEASURED VALUE 2 RECORDED POSITIVE With this parameter “Measured value 2 recorded positive” is assigned an IDN. As a result, “Measured value 2 recorded positive” can be assigned to a real-time status bit (**S-0-0305**). Bit 0 in this parameter is only set by the drive when the touchprobe cycle command (**S-0-0170**) is active, the touchprobe 2 enable signal (**S-0-0406**) is set to “1” and the positive edge of touchprobe 2 (**S-0-0402**) is signalled. At the same time, the drive stores the actual position value to measured value 2 positively (**S-0-0132**). The drive clears this bit when the master control system clears the touchprobe cycle command or the touchprobe 2 enable is set to „0”. In the operation datum only bit 0 is defined.

Table 9.1 Description of parameters for the touchprobe function

Parameter	Description
S-0-0412	MEASURED VALUE 2 RECORDED NEGATIVE With this parameter “Measured value 2 recorded negative” is assigned an IDN. As a result, “Measured value 2 recorded negative” can be assigned to a real-time status bit (**S-0-0305**). Bit 0 in this parameter is only set by the drive when the touchprobe cycle command (**S-0-0170**) is active, the touchprobe 2 enable signal (**S-0-0406**) is set to “1” and the negative edge of touchprobe 2 (**S-0-0402**) is signalled. At the same time, the drive stores the actual position value to measured value 2 negatively (**S-0-0133**). The drive clears this bit when the master control system clears the touchprobe cycle command or the touchprobe 2 enable is set to “0”. In the operation datum only bit 0 is defined.

Table 9.1 Description of parameters for the touchprobe function

10 Parameter access via the service channel

The service channel is used for parameter setting and diagnosis. Transfer via the service channel is handled bit-by-bit in segments in the MDT and in the DT, and may extend over several SERCOS cycles for each transferred element. The following tables contain the list of parameters implemented in the drive (operational data).

NOTE: The functional descriptions of the manufacturer specific parameters - where not given here - are to be found in the MSD Servo Drive Operation Manual.

10.1 SERCOS parameter list

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0001	Control unit cycle time (t_Ncyc)	us		x	x
S-0-0002	Communication cycle time (t_Scyc)	us		x	x
S-0-0003	Shortest AT transmission starting time (t1min)	us	x	x	x
S-0-0004	Transmit/receive transition time (tATMT)	us	x	x	x
S-0-0005	Minimum feedback processing time (t5)	us	x	x	x
S-0-0006	AT transmission starting time (t1)	us		x	x
S-0-0007	Feedback acquisition capture point (t4)	us		x	x
S-0-0008	Command value valid time (t3)	us		x	x
S-0-0009	Position of data record in MDT			x	x
S-0-0010	Length of MDT			x	x
S-0-0011	Class 1 diagnostic		x	x	x
S-0-0012	Class 2 diagnostic		x	x	x
S-0-0013	Class 3 diagnostic		x	x	x
S-0-0014	Interface status		x	x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0015	Telegram type			x	x
S-0-0016	Configuration list of AT			x	x
S-0-0017	IDN list of all operation data		x	x	x
S-0-0018	IDN list of operation data for CP2		x	x	x
S-0-0019	IDN list of operation data for CP3		x	x	x
S-0-0021	IDN list of invalid operation data for CP2		x	x	x
S-0-0022	IDN list of invalid operation data for CP3		x	x	x
S-0-0023	IDN list of invalid operation data for CP4		x	x	x
S-0-0024	Configuration list of MDT			x	x
S-0-0025	IDN list of all procedure commands		x	x	x
S-0-0026	Configuration list for signal status word				
S-0-0027	Configuration list for signal control word				
S-0-0028	MST error counter		x	x	x
S-0-0029	MDT error counter		x	x	x
S-0-0030	Firmware version of device		x	x	x
S-0-0032	Primary operation mode				x
S-0-0033	Secondary operation mode 1				x
S-0-0034	Secondary operation mode 2				x
S-0-0035	Secondary operation mode 3				x
S-0-0036	Velocity command value	SPEED			
S-0-0037	Additive velocity command value	SPEED			
S-0-0038	Positive velocity limit value	SPEED			
S-0-0039	Negative velocity limit value	SPEED			
S-0-0040	Velocity feedback value 1	SPEED	x	x	x
S-0-0041	Homing velocity for ‚drive controlled homing‘	SPEED			
S-0-0042	Homing acceleration for ‚drive controlled homing‘	ACC			
S-0-0043	Speed polarity parameter			x	x
S-0-0044	Velocity data scaling type			x	x
S-0-0045	Velocity data scaling factor			x	x
S-0-0046	Velocity data scaling exponent			x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0047	Position command value	POS			
S-0-0049	Positive position limit value			x	x
S-0-0050	Negative position limit value			x	x
S-0-0051	Position feedback value 1	POS	x	x	x
S-0-0052	Reference distance 1	POS			
S-0-0053	Position feedback value 2	POS	x	x	x
S-0-0054	Reference distance 2	POS			
S-0-0055	Position polarity parameter			x	x
S-0-0057	position window, for „target reached“ status	POS			
S-0-0076	Position data scaling type			x	x
S-0-0077	Linear position data scaling factor			x	x
S-0-0078	Linear position data scaling exponent			x	x
S-0-0079	Rotational position resolution			x	x
S-0-0080	Torque command value	TORQUE			
S-0-0081	Additive torque command value	TORQUE			
S-0-0082	Positive torque limit value	TORQUE			
S-0-0083	Negative torque limit value	TORQUE			
S-0-0084	Torque feedback value	TORQUE	x	x	x
S-0-0085	Torque polarity parameter			x	x
S-0-0086	Torque/force data scaling type			x	x
S-0-0087	Transmit to transmit recovery time (TATAT)	us	x	x	x
S-0-0088	Receive to receive recovery time (tMTSY)	us	x	x	x
S-0-0089	MDT transmission starting time (t2)	us		x	x
S-0-0090	Command value proceeding time (tMTSG)	us	x	x	x
S-0-0091	Bipolar speed limit value	SPEED			
S-0-0092	Bipolar torque limit value	TORQUE			
S-0-0093	Torque/force data scaling factor			x	x
S-0-0094	Torque/force data scaling exponent			x	x
S-0-0095	Diagnostic message		x	x	x
S-0-0096	Slave arrangement (SLKN)		x	x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0097	Mask class 2 diagnostic				
S-0-0098	Mask class 3 diagnostic				
S-0-0099	Reset class 1 diagnostic				
S-0-0100	Velocity loop proportional gain	Nm min			
S-0-0101	Velocity loop integral action time	ms			
S-0-0103	Modulo value	POS		x	x
S-0-0104	Position loop KV-factor	1000/min			
S-0-0106	Current loop proportional gain 1	V/A			
S-0-0107	Current loop integral action time 1	us			
S-0-0108	Feedrate Override	%			
S-0-0112	Amplifier rated current	A	x	x	x
S-0-0113	Maximum motor speed	rev/min			
S-0-0114	Load limit of the motor	%			
S-0-0115	Position feedback 1 type			x	x
S-0-0116	Sercos encoder 1 resolution		x	x	x
S-0-0117	Sercos encoder 2 resolution		x	x	x
S-0-0118	Resolution of linear feedback	mm		x	x
S-0-0121	Input revolutions of load gear			x	x
S-0-0122	Output revolutions of load gear			x	x
S-0-0123	Feed constant	um/rev		x	x
S-0-0124	Standstill window	SPEED			
S-0-0125	Variable velocity threshold	SPEED			
S-0-0126	Variable torque threshold	TORQUE			
S-0-0127	CP3 transition check			x	x
S-0-0128	CP4 transition check		x		x
S-0-0130	Probe value 1 positive edge	POS	x	x	x
S-0-0131	Probe value 1 positive edge	POS	x	x	x
S-0-0132	Probe value 1 positive edge	POS	x	x	x
S-0-0133	Probe value 1 positive edge	POS	x	x	x
S-0-0134	Master control word				

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0135	Drive status word		x	x	x
S-0-0140	Controller Type		x	x	x
S-0-0141	Name of motor parameter set			x	x
S-0-0143	Sercos version		x	x	x
S-0-0144	Signal status word		x	x	x
S-0-0145	Signal control word				
S-0-0147	Homing paramater for defining the homing procedure sequence				x
S-0-0148	Drive controlled homing procedure command				
S-0-0150	Distance between the reference marker pulse of position FB1	POS			
S-0-0151	Distance between the reference marker pulse of position FB2	POS			
S-0-0152	Position spindle procedure command				
S-0-0153	Spindle angle position	POS			
S-0-0154	Spindle positioning parameter			x	x
S-0-0156	Velocity feedback value 2	SPEED	x	x	x
S-0-0157	Velocity window	SPEED			
S-0-0159	monitoring position difference threshold	POS			
S-0-0160	Acceleration data scaling type			x	x
S-0-0161	Acceleration data scaling factor			x	x
S-0-0162	Acceleration data scaling exponent			x	x
S-0-0169	Probe control parameter				
S-0-0170	Probing cycle procedure command				
S-0-0179	Probe status		x	x	x
S-0-0180	Spindle relative offset	POS			
S-0-0185	Length of the configurable data record in the AT		x	x	x
S-0-0186	Length of the configurable data record in the MDT		x	x	x
S-0-0187	IDN list of configurable data in the AT		x	x	x
S-0-0188	IDN list of configurable data in the MDT		x	x	x
S-0-0189	position tracking error in user units	POS	x	x	x
S-0-0192	IDN list of all backup operation data		x	x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0200	Amplifier warning temperature	TEMP			
S-0-0201	Motor warning temperature	TEMP			
S-0-0208	Temperature data scaling type				
S-0-0216	Switch parameter set procedure command			x	x
S-0-0217	Parameter set preselection			x	x
S-0-0222	Spindle positioning speed	SPEED			
S-0-0256	Multiplication factor motor feedback (encoder 1)		x	x	x
S-0-0257	Multiplication factor external feedback (encoder 2)		x	x	x
S-0-0258	Target position	POS			
S-0-0259	Positioning velocity	SPEED			
S-0-0260	Positioning acceleration	ACC			
S-0-0261	Coarse position window			x	x
S-0-0262	Load defaults procedure command			x	x
S-0-0263	Load working memory procedure command			x	x
S-0-0264	Backup working memory procedure command				
S-0-0274	Received drive addresses		x	x	x
S-0-0277	Position feedback 2 type			x	x
S-0-0278	Maximum travel range		x	x	x
S-0-0282	Drive based position command value	POS			
S-0-0292	List of supported operation modes		x	x	x
S-0-0294	Divider modulo value			x	x
S-0-0296	Gain feed-forward speed signal	%			
S-0-0300	Real time control bit 1		x	x	x
S-0-0301	Allocation of real time control bit 1				
S-0-0302	Real time control bit 2		x	x	x
S-0-0303	Allocation of real time control bit 2				
S-0-0304	Real time status bit 1		x	x	x
S-0-0305	Allocation of real time status bit 1				
S-0-0306	Real time status bit 2		x	x	x
S-0-0307	Allocation of real time status bit 2				

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0310	Overload warning (Motor)		x	x	x
S-0-0311	Amplifier overtemperature warning		x	x	x
S-0-0312	motor overtemperature warning		x	x	x
S-0-0328	Bit number allocation list for signal status word				
S-0-0329	Bit number allocation list for signal control word				
S-0-0330	Status n_feedback = n_cmd		x	x	x
S-0-0331	Status n_feedback = 0		x	x	x
S-0-0332	Status n_feedback < nx		x	x	x
S-0-0333	Status T >= Tx		x	x	x
S-0-0334	Status T >= Tlim		x	x	x
S-0-0335	Status n_cmd >= n_lim		x	x	x
S-0-0336	Status in position		x	x	x
S-0-0341	Status in course position		x	x	x
S-0-0346	Position control word				
S-0-0347	Velocity error	SPEED	x	x	x
S-0-0348	Gain feed-forward acceleration signal	%			
S-0-0359	Positioning deceleration	ACC			
S-0-0372	Drive halt acceleration bipolar	ACC			
S-0-0373	Service channel error list		x	x	x
S-0-0374	Procedure command error list		x	x	x
S-0-0375	Diagnostic numbers list		x	x	x
S-0-0376	Baudrate	MBit/s	x	x	x
S-0-0380	DC bus voltage	V	x	x	x
S-0-0383	Motor temperature	TEMP	x	x	x
S-0-0384	Amplifier temperature	TEMP	x	x	x
S-0-0387	Power overload	%	x	x	x
S-0-0389	Effective current	A	x	x	x
S-0-0392	Velocity feedback filter	us			
S-0-0393	Command value mode			x	x
S-0-0400	Status home switch		x	x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
S-0-0401	Probe 1 status		x	x	x
S-0-0402	Probe 2 status		x	x	x
S-0-0403	Position feedback value status		x	x	x
S-0-0405	Probe 1 enable				
S-0-0406	Probe 1 enable				
S-0-0407	Homing enable (real time control bit)				
S-0-0408	Refrence marker pulse status		x	x	x
S-0-0409	Probe 1 positive latched		x	x	x
S-0-0410	Probe 1 negativ latched		x	x	x
S-0-0411	Probe 2 positive latched		x	x	x
S-0-0412	Probe 2 negativ latched		x	x	x
S-0-0413	Bit number allocation of real time control bit 1				
S-0-0414	Bit number allocation of real time control bit 2				
S-0-0415	Bit number allocation of real time status bit 1				
S-0-0416	Bit number allocation of real time status bit 2				
S-0-0417	Positioning velocity threshold in modulo mode	SPEED			
S-0-0418	Target position window in modulo mode	POS			
S-0-0419	Positioning acknowledge	POS	x	x	x
S-0-0430	Active target position	POS	x	x	x
P-0-0001	Id of device familiy/series		x	x	x
P-0-0002	Device name / product name		x	x	x
P-0-0003	Application specific device name alias			x	x
P-0-0004	Total software version of device (plain text)		x	x	x
P-0-0005	Device family name		x	x	x
P-0-0006	Total version number of device software		x	x	x
P-0-0008	Vendor name		x	x	x
P-0-0030	Programmable reaction in case of failure				
P-0-0034	Device warnings status word		x	x	x
P-0-0039	Device Error-ID (low word) and Error-Location (high word)		x	x	x
P-0-0040	Reset firmware			x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0041	Reset firmware and activate loader			x	x
P-0-0050	ID hardware print		x	x	x
P-0-0051	Sub-ID hardware print		x	x	x
P-0-0052	ID hardware option on X11		x	x	x
P-0-0053	ID hardware option on X12		x	x	x
P-0-0054	ID hardware CPLD		x	x	x
P-0-0055	Chip and redesign tracing identification		x	x	x
P-0-0060	ID software option on X12		x	x	x
P-0-0080	Bootloader information, version and checksum		x	x	x
P-0-0081	Checksum of firmware in flash		x	x	x
P-0-0100	Function of digital input ENPO			x	x
P-0-0101	Function of digital input ISD00			x	x
P-0-0102	Function of digital input ISD01			x	x
P-0-0103	Function of digital input ISD02			x	x
P-0-0104	Function of digital input ISD03			x	x
P-0-0105	Function of digital input ISD04			x	x
P-0-0106	Function of digital input ISD05			x	x
P-0-0107	Function of digital input ISD06			x	x
P-0-0108	Function of digital input ISDSH			x	x
P-0-0109	Function of analog input ISA00			x	x
P-0-0110	Function of analog input ISA01			x	x
P-0-0118	Digital inputs: Filter time	ms		x	x
P-0-0120	Input inversion: ENPO[0], ISD00..05[1..6], SH[7], ISD06[16]			x	x
P-0-0121	States of digital inputs		x	x	x
P-0-0122	Function of digital output OSD00			x	x
P-0-0123	Function of digital output OSD01			x	x
P-0-0124	Function of digital output OSD02			x	x
P-0-0125	Function of motor break (X13)			x	x
P-0-0126	Function of digital output RELOUT1			x	x
P-0-0127	Function of dig. output RELOUT2 is fixed on 'Safety Hold'		x	x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0141	Control value of dig. outputs via COM access				
P-0-0142	Output inversion OSD0/1/2(0/1/2), MBRK(6), REL1/2(7/15)			x	x
P-0-0143	States of digital outputs		x	x	x
P-0-0144	DriveCom: Auto start of system				
P-0-0145	DriveCom: Quick stop check in shut down command				
P-0-0146	DriveCom: Quick stop check in 'ReadyToSwitchOn'				
P-0-0147	DriveCom: Check EnablePower (= false for ENPO over ENMO)				
P-0-0148	DriveCom: Timeout in 'RdyToSwitchOn' to enable motor switch	ms			
P-0-0149	DriveCom: Start initialisisation of system parameter				
P-0-0152	DriveCom actual state description		x	x	x
P-0-0153	DrvCom fault reset command				
P-0-0154	DriveCom: Timeout motor standstill	ms			
P-0-0159	Motion control selection				
P-0-0165	Motion profile selection				
P-0-0166	Motion profile jerk time	ms			
P-0-0167	Motion profile speed override factor	%			
P-0-0168	Motion profile jogging speeds				
P-0-0213	Motor brake lift time	ms			
P-0-0214	Motor brake close time	ms			
P-0-0215	Motor brake: torque rise time	ms			
P-0-0216	Motor brake: torque fade time	ms			
P-0-0217	Motor brake: factor for application of last torque	%			
P-0-0218	Motor brake: constant initial torque	Nm			
P-0-0219	Motor brake: torque sampled at last closing time	Nm	x	x	x
P-0-0220	lock brake				
P-0-0239	Functional states of digital inputs		x	x	x
P-0-0283	Factor group: Type selection DiA 402(0), SERCOS(1), USER(2)			x	x
P-0-0284	Unit for position values			x	x
P-0-0287	Unit for speed values			x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0290	Unit for acceleration and deceleration values			x	x
P-0-0293	Unit for torque values			x	x
P-0-0300	Select control mode				
P-0-0301	Mode selection of setpoint profiling				
P-0-0302	Switching frequency			x	x
P-0-0303	current control sampling time	ms	x	x	x
P-0-0304	Speed control sampling time	ms	x	x	x
P-0-0305	Position control sampling time	ms	x	x	x
P-0-0306	Sampling time for interpolation	ms	x	x	x
P-0-0307	Voltage supply mode (must be set correctly!)			x	x
P-0-0310	current control gain	V/A			
P-0-0311	current control integration time constant	ms			
P-0-0312	actual motor voltage (rms, phase to phase)	V	x	x	x
P-0-0313	VF control, boost voltage at zero frequency	V			
P-0-0314	VF control, nominal frequency	Hz			
P-0-0315	VF control, voltage at nominal frequency	V			
P-0-0320	Speed control gain	Nm/rpm			
P-0-0321	Speed control integration time constant	ms			
P-0-0322	Speed control gain scaling factor	%			
P-0-0323	Advanced control structure gains				
P-0-0324	Advanced control structure filtering				
P-0-0325	Filter frequencies of digital filter	Hz		x	x
P-0-0326	Digital filter design assistant				
P-0-0327	Coefficients of digital filter				
P-0-0328	Speed control maximum speed	%			
P-0-0329	Motor torque scaling of limits	%			
P-0-0330	Motor torque scaling of negative limit	%			
P-0-0331	Motor torque scaling of positive limit	%			
P-0-0332	Motor torque scaling (online factor)	%			
P-0-0333	Motor speed scaling of negative limit	%			

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0334	Motor speed scaling of positive limit	%			
P-0-0335	Direction lock for speed reference value				
P-0-0336	Adaptation of speed control gain @ zero speed			x	x
P-0-0337	Motor speed scaling	%			
P-0-0340	magnetization current (r.m.s)	A			
P-0-0341	speed where field-weakening starts; forces 1/n-character	%			
P-0-0342	speed values for mag. current scaling	%			
P-0-0343	mag. current scaling vs. speed	%			
P-0-0344	voltage control filter time constant	ms			
P-0-0345	voltage control gain	A/V			
P-0-0346	voltage control integration time constant	ms			
P-0-0347	voltage control reference (scaling of max. voltage)	%			
P-0-0348	slip control gain for field weakening				
P-0-0349	comutation offset of resp. encoder	deg			
P-0-0350	Selection of speed calculation method				
P-0-0351	actual speed calculation filter time	ms			
P-0-0352	observer parameter (meaning depends on CON_SCALC)				
P-0-0353	Observer design parameters	ms			
P-0-0354	observer design assistant				
P-0-0360	position control gain	1/min			
P-0-0370	Interpolation type control word				
P-0-0371	Speed reference filter time for speed control mode	ms			
P-0-0372	Speed feedforward filter time for position control	ms			
P-0-0374	Position delay in position control cycles (CON_PConTS)	ms			
P-0-0375	Speed feedforward scaling factor	%			
P-0-0376	Torque/Force feedforward scaling factor	%			
P-0-0377	Feedforward signals enabled		x	x	x
P-0-0379	Feedforward calculation mode				
P-0-0386	Friction compensation scaling factor	%			
P-0-0400	additional d-current reference value	A			

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0401	Additional torque/force reference value	Nm (N)			
P-0-0402	Additional speed reference value without ramp	1/min			
P-0-0404	Additional speed reference value with ramp	1/min			
P-0-0405	Analog input 0, filter time	ms			
P-0-0406	Analog input 1, filter time	ms			
P-0-0407	Analog input values, filtered, +10V gives 1.0				
P-0-0409	DC voltage filter time	ms		x	x
P-0-0410	Actual DC link voltage	V	x	x	x
P-0-0411	Actual values of ADC channels	bit	x	x	x
P-0-0412	actual position	incr	x	x	x
P-0-0413	reference position	incr	x	x	x
P-0-0414	actual position diffence (RefPosition-ActPosition)	incr	x	x	x
P-0-0415	actual speed	1/min	x	x	x
P-0-0416	Reference speed	1/min	x	x	x
P-0-0417	Actual speed difference (RefSpeed-ActSpeed)	1/min	x	x	x
P-0-0418	Reference torque	Nm	x	x	x
P-0-0419	Actual torque	Nm	x	x	x
P-0-0430	weighting of voltage path in field model				
P-0-0431	Voltage limit for current drives	%			
P-0-0432	select current control / limitation mode				
P-0-0450	Motor type			x	x
P-0-0455	Motor rated frequency	Hz		x	x
P-0-0456	Motor rated voltage	V		x	x
P-0-0457	Motor rated current	A		x	x
P-0-0458	Motor rated speed	rpm		x	x
P-0-0459	Motor rated power	kW		x	x
P-0-0460	Motor rated torque	Nm		x	x
P-0-0461	Motor inertia	kg m*m		x	x
P-0-0462	Motor rated flux	Vs		x	x
P-0-0463	Motor number of pole pairs			x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0470	Motor stator resistance	Ohm		x	x
P-0-0471	Motor stray/stator inductance	mH		x	x
P-0-0472	Q-stator inductance variation in % of MOT_Lsig	%		x	x
P-0-0473	Main inductancs vs. Isd (0,1*Index*LmagIdMax)	mH		x	x
P-0-0474	LmagTable: max. magnetization current (eff.)	A		x	x
P-0-0475	Motor main inductance, scaling factor	%		x	x
P-0-0476	Motor rotor resistance	Ohm		x	x
P-0-0477	Motor rotor resistance, scaling factor	%		x	x
P-0-0500	ENC CH1: Actual value: SingleTurn[0], MultiTurn[1]		x	x	x
P-0-0501	ENC CH2: Actual value: SingleTurn[0], MultiTurn[1]		x	x	x
P-0-0502	ENC CH3: Actual value: SingleTurn[0], MultiTurn[1]		x	x	x
P-0-0505	ENC CH1: Encoder type selection			x	x
P-0-0506	ENC CH2: Encoder type selection			x	x
P-0-0507	ENC CH3: Encoder type selection			x	x
P-0-0510	ENC CH1: Gear nominator			x	x
P-0-0511	ENC CH1: Gear denominator			x	x
P-0-0512	ENC CH2: Gear nominator			x	x
P-0-0513	ENC CH2: Gear denominator			x	x
P-0-0514	ENC CH3: Gear nominator			x	x
P-0-0515	ENC CH3: Gear denominator			x	x
P-0-0520	ENC: Channel selection for motor commutation			x	x
P-0-0521	ENC: Channel selection for speed control			x	x
P-0-0522	ENC: Channel selection for position control			x	x
P-0-0523	ENC: Channel selection for master input			x	x
P-0-0530	ENC: Channel selection as SERCOS encoder 1			x	x
P-0-0531	ENC: Channel selection as SERCOS encoder 2			x	x
P-0-0540	ENC CH1: Absolute position interface selection			x	x
P-0-0541	ENC CH1: Index pulse signal (test mode)			x	x
P-0-0542	ENC CH1: Number of lines (SinCos / TTL encoders)			x	x
P-0-0543	ENC CH1: Number of MultiTurn bits (SSI absolute)			x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0544	ENC CH1: Number of SingleTurn bits (SSI absolute)			x	x
P-0-0545	ENC CH1: Code selection (SSI absolute position interface)			x	x
P-0-0546	ENC CH1: Mode selection (SSI absolute position interface)			x	x
P-0-0547	ENC CH1: Lowest allowable MultiTurn position (SSI absolute)			x	x
P-0-0548	ENC CH1: Enable MultiTurn information (SSI absolute)			x	x
P-0-0549	ENC CH1: Signal correction type			x	x
P-0-0550	ENC CH1: Signal correction values			x	x
P-0-0551	ENC CH1: Encoder observation minimum, sqrt(a^2 + b^2)			x	x
P-0-0552	ENC CH1: Error and status codes of absolute encoders		x	x	x
P-0-0553	ENC CH1: Length of an analog signal period (linear SinCos)	nm		x	x
P-0-0554	ENC CH1: Length of an digital increment (linear absolute)	nm		x	x
P-0-0560	ENC CH2: Number of pole pairs (Resolver)			x	x
P-0-0561	ENC CH2: Signal correction type			x	x
P-0-0562	ENC CH2: Signal correction values			x	x
P-0-0563	ENC CH2: Encoder observation minimum, sqrt(a^2 + b^2)			x	x
P-0-0570	ENC CH3: Absolute position interface selection			x	x
P-0-0571	ENC CH3: Index pulse signal (test mode)			x	x
P-0-0572	ENC CH3: Number of lines (SinCos / TTL encoders)			x	x
P-0-0573	ENC CH3: Number of MultiTurn bits (SSI absolute)			x	x
P-0-0574	ENC CH3: Number of SingleTurn bits (SSI absolute)			x	x
P-0-0575	ENC CH3:Code selection (SSI absolute position interface)			x	x
P-0-0577	ENC CH3: Encoder observation minimum,sqrt(a^2 + b^2)			x	x
P-0-0590	ENC: Axis correction, selection type			x	x
P-0-0591	ENC: Axis correction, start position			x	x
P-0-0592	ENC: Axis correction, end position			x	x
P-0-0593	ENC: Axis correction, delta position			x	x
P-0-0594	ENC: Axis correction, actual position value			x	x
P-0-0595	ENC: Axis correction, position table for negtive speed			x	x
P-0-0596	ENC: Axis correction, position table for positive speed			x	x

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-0610	ENC CH1: Nominal increment of reference marks	Signal per.		x	x
P-0-0630	ENC CH3: Nominal increment of reference marks	Signal per.		x	x
P-0-0742	monitoring maximum position difference	POS			
P-0-0744	monitoring speed difference threshold	rpm			
P-0-1500	Testsignal generator: control word				
P-0-1501	Testsignal generator: output signal selector				
P-0-1502	Testsignal generator: number of cycles				
P-0-1503	Testsignal generator: offsets for rectangular wave	var			
P-0-1504	Testsignal generator: times for rectangular waves	s			
P-0-1505	Testsignal generator: amplitude of sinusoidal wave	var			
P-0-1506	Testsignal generator: frequency of sinusoidal wave	Hz			
P-0-1507	Testsignal gen.: Initial phase for rotating current vector	degree			
P-0-1508	Testsignal generator: PRBS mininum toggle time	ms			
P-0-1509	Testsignal generator: PRBS signal amplitude	var			
P-0-1515	Speed and position control dynamic (stiffness)	%			
P-0-1516	Total inertia of motor and plant	kg m*m			
P-0-1517	Autotuning for Jsum estimation, control word				
P-0-1518	Autotuning Jsum, hysteresis speed control, speed limit	rpm			
P-0-1519	Autotuning for Jsum, speed hysteresis control, torque limit	Nm (N)			
P-0-1520	Autotuning, parameters for control and results				
P-0-1521	Mechanical system parameters	Hz			
P-0-1522	Self commissioning and correlation results				
P-0-1530	Determination of default motor control settings				
P-0-1531	Selfcommissiong action selection				
P-0-2218	605AH DiA 402 quickstop option code				
P-0-2219	605BH DiA 402 shutdown option code				
P-0-2220	605CH DiA 402 disable operation option code				
P-0-2221	605DH DiA 402 halt option code				

Table 10.1 List of supported SERCOS parameters

IDN	Description	Unit	Write protection		
			CP2	CP3	CP4
P-0-2222	605EH DiA 402 fault reaction option code				
P-0-2261	6098H DiA 402 homing method				
P-0-3000	Sercos Address				
P-0-3001	IDN list with logon errors at sercos parameter manager		x	x	x
P-0-3002	IDN list of all data with real time status support		x	x	x
P-0-3003	IDN list of all data with real time control support		x	x	x
P-0-3004	Maximum transmission power				
P-0-3005	Speed acceleration	ACC			
P-0-3006	Speed deceleration	ACC			
P-0-3007	Actual value of I2t integrator for motor protection	%	x	x	x
P-0-3030	Drive controlled homing offset procedure command				
P-0-3031	Homing velocity in search of index pulse	SPEED			
P-0-3054	Gain external feed-forward signals			x	x
P-0-3055	External speed feed-forward signal	Pscale/2^16			
P-0-3056	External acceleration feed-forward signal	Pscale/2^16			
P-0-3100	Expanded position command value for Pico-Interpolation				

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