

SERCOS Manual

Edition 3.0



Servo positioning controller MDR 2000

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1 General Terms

1.1 Documentation

This manual describes the fieldbus connection of MDR 2000servo positioning controllers under SERCOS. It describes briefly the protocol itself, the activation of the SERCOS communication and the parameters available under SERCOS.

It is intended to persons who are already familiar with the servo positioning controller series and the SERCOS protocol.

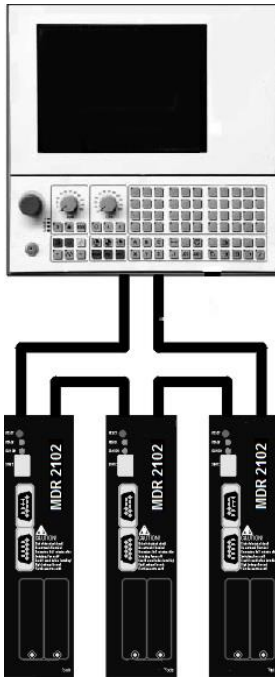
It contains safety notes that have to be noticed.

For more informations, please refer to the following manuals of the MDR 2000series products:

- ❖ **Software Manual “Servo Positioning Controller MDR 2000”**: Description of the device functionality and the software functions of the firmware including RS232 communication. Description of the parameterisation program Mattke ServoCommander™ with instructions on the commissioning of an MDR 2000series servo positioning controller.
- ❖ **Product Manual “Servo Positioning Controller MDR 2100”**: Description of the technical specifications and the device functionality as well as notes on the installation and the operation of the servo positioning controller MDR 2100.
- ❖ **Product manual “Servo Positioning Controller MDR 2302 - 2310”**: Description of the technical data and the device functionality plus notes concerning the installation and operation of MDR 2302, 2305 and 2310 servo positioning controllers.
- ❖ **Product manual “Servo Positioning Controller MDR 2320 and 2340”**: Description of the technical data and the device functionality plus notes concerning the installation and operation of MDR 2320 and 2340 servo positioning controllers.
- ❖ **CANopen Manual “Servo Positioning Controller MDR 2000”**: Description of the implemented CANopen protocol as per DSP402.
- ❖ **PROFIBUS Manual “Servo Positioning Controller MDR 2000”**: Description of the implemented PROFIBUS-DP protocol.
- ❖ **Ethernet Manual “Servo Positioning Controller MDR 2000”**: Description of the implemented Ethernet protocol.

1.2 SERIAL REALTIME COMMUNICATION SYSTEM

SERCOS interface, the unique worldwide standardised (IEC 61491 and EN61491) digital interface for a communication between control systems and drives was the first fieldbus system that allowed the realization of numerically controlled high-performance applications in the machine tool engineering.



An optical fiber ring is used as transmission medium. The transmission rate is 2, 4, 8 or 16 Mbit/s.

Basically three communications types between CNC and digital drive control elements can be realised with this interface:

- transmission of nominal position
- transmission of nominal speed or
- transmission of nominal torque

The transmission of the nominal position proved to be the best solution for fast and highly precise applications. In one optical fiber ring up to 6 axes can be cyclically and parallel supplied with new nominal positions values (nominal positions) every 0,5 ms

The SERCOS interface allows all drive-internal data, parameters and diagnosis data to be displayed and entered by means of a SERCOS-compatible CNC.

For further informations and specifications regarding SERCOS please refer to:

<http://www.sercos.org/>

Interests Group SERCOS interface e.V.
Landhausstrasse 20, 70190 Stuttgart
Germany

2 Safety Notes for electrical drives and controls

2.1 Symbols and signs

**Information**

Important informations and notes.

**Caution!**

The nonobservance can result in high property damage.

**DANGER!**

The nonobservance can result in property damages and in injuries to persons.

**Caution! High voltage.**

The note on safety contains a reference to a possibly occurring life dangerous voltage.



The parts of this document marked with this sign should give examples to make it easier to understand the use of single objects and parameters.

2.2 General notes

In case of damage resulting from non-compliance with the safety notes in this manual, Mattke AG will not assume any liability.



Prior to the initial use you must read the chapters Safety Notes for electrical drives and controls *starting on page 10*

If the documentation in the language at hand is not understood accurately, please contact and inform your supplier.

Sound and safe operation of the servo drive controller requires proper and professional transportation, storage, assembly and installation as well as proper operation and maintenance. Only trained and qualified personnel may handle electrical devices:

TRAINED AND QUALIFIED PERSONNEL

in the sense of this product manual or the safety notes on the product itself are persons who are sufficiently familiar with the setup, assembly, commissioning and operation of the product as well as all warnings and precautions as per the instructions in this manual and who are sufficiently qualified in their field of expertise:

- ❖ Education and instruction or authorisation to switch devices/systems on and off and to ground them as per the standards of safety engineering and to efficiently label them as per the job demands.
- ❖ Education and instruction as per the standards of safety engineering regarding the maintenance and use of adequate safety equipment.
- ❖ First aid training.

The following notes must be read prior to the initial operation of the system to prevent personal injuries and/or property damages:



These safety notes must be complied with at all times.



Do not try to install or commission the servo drive controller before carefully reading all safety notes for electrical drives and controllers contained in this document. These safety instructions and all other user notes must be read prior to any work with the servo drive controller.



In case you do not have any user notes for the servo positioning controller, please contact your sales representative. Immediately demand these documents to be sent to the person responsible for the safe operation of the servo drive controller.



If you sell, rent and/or otherwise make this device available to others, these safety notes must also be included.



The user must not open the servo drive controller for safety and warranty reasons.



Professional control process design is a prerequisite for sound functioning of the servo drive controller!



DANGER!

Inappropriate handling of the servo drive controller and non-compliance of the warnings as well as inappropriate intervention in the safety features may result in property damage, personal injuries, electric shock or in extreme cases even death.

2.3 Danger resulting from misuse



DANGER!

High electrical voltages and high load currents!

Danger to life or serious personal injury from electrical shock!



DANGER!

High electrical voltage caused by wrong connections!

Danger to life or serious personal injury from electrical shock!



DANGER!

Surfaces of device housing may be hot!

Risk of injury! Risk of burning!



DANGER!

Dangerous movements!

Danger to life, serious personal injury or property damage due to unintentional movements of the motors!

2.4 Safety notes

2.4.1 General safety notes



The servo drive controller corresponds to IP20 class of protection as well as pollution level 1. Make sure that the environment corresponds to this class of protection and pollution level.



Only use replacements parts and accessories approved by the manufacturer.



The devices must be connected to the mains supply as per EN regulations, so that they can be cut off the mains supply by means of corresponding separation devices (e.g. main switch, contactor, power switch).



The servo drive controller may be protected using an AC/DC sensitive 300mA fault current protection switch (RCD = Residual Current protective Device).



Gold contacts or contacts with a high contact pressure should be used to switch the control contacts.



Preventive interference rejection measures should be taken for control panels, such as connecting contactors and relays using RC elements or diodes.



The safety rules and regulations of the country in which the device will be operated must be complied with.



The environment conditions defined in the product documentation must be kept. Safety-critical applications are not allowed, unless specifically approved by the manufacturer.



For notes on installation corresponding to EMC, please refer to Product Manual MDR 2100. The compliance with the limits required by national regulations is the responsibility of the manufacturer of the machine or system.



The technical data and the connection and installation conditions for the servo drive controller are to be found in this product manual and must be met.



DANGER!

The general setup and safety regulations for work on power installations (e.g. DIN, VDE, EN, IEC or other national and international regulations) must be complied with.

Non-compliance may result in death, personal injury or serious property damages.



Without claiming completeness, the following regulations and others apply:

VDE 0100 Regulations for the installation of high voltage (up to 1000 V) devices

EN 60204 Electrical equipment of machines

EN 50178 Electronic equipment for use in power installations

2.4.2 Safety notes for assembly and maintenance

The appropriate DIN, VDE, EN and IEC regulations as well as all national and local safety regulations and rules for the prevention of accidents apply for the assembly and maintenance of the system. The plant engineer or the operator is responsible for compliance with these regulations:



The servo drive controller must only be operated, maintained and/or repaired by personnel trained and qualified for working on or with electrical devices.

Prevention of accidents, injuries and/or damages:



Additionally secure vertical axes against falling down or lowering after the motor has been switched off, e.g. by means of:

- Mechanical locking of the vertical axle,
- External braking, catching or clamping devices or
- Sufficient balancing of the axle.



The motor holding brake supplied by default or an external motor holding brake driven by the drive controller alone is not suitable for personal protection!



Render the electrical equipment voltage-free using the main switch and protect it from being switched on again until the DC bus circuit is discharged, in the case of:

- Maintenance and repair work
- Cleaning
- long machine shutdowns



Prior to carrying out maintenance work make sure that the power supply has been turned off, locked and the DC bus circuit is discharged.



The external or internal brake resistor carries dangerous DC bus voltages during operation of the servo drive controller and up to 5 minutes thereafter. Contact may result in death or serious personal injury.



Be careful during the assembly. During the assembly and also later during operation of the drive, make sure to prevent drill chips, metal dust or assembly parts (screws, nuts, cable sections) from falling into the device.



Also make sure that the external power supply of the controller (24V) is switched off.



The DC bus circuit or the mains supply must always be switched off prior to switching off the 24V controller supply.



Carry out work in the machine area only, if AC and/or DC supplies are switched off. Switched off output stages or controller enablings are no suitable means of locking. In the case of a malfunction the drive may accidentally be put into action.



Initial operation must be carried out with idle motors, to prevent mechanical damages e.g. due to the wrong direction of rotation.



Electronic devices are never fail-safe. It is the user's responsibility, in the case an electrical device fails, to make sure the system is transferred into a secure state.



The servo drive controller and in particular the brake resistor, externally or internally, can assume high temperatures, which may cause serious burns.

2.4.3 Protection against contact with electrical parts

This section only concerns devices and drive components carrying voltages exceeding 50 V. Contact with parts carrying voltages of more than 50 V can be dangerous for people and may cause electrical shock. During operation of electrical devices some parts of these devices will inevitably carry dangerous voltages.



DANGER!

High electrical voltage!

Danger to life, danger due to electrical shock or serious personal injury!

The appropriate DIN, VDE, EN and IEC regulations as well as all national and local safety regulations and rules for the prevention of accidents apply for the assembly and maintenance of the system. The plant engineer or the operator is responsible for compliance with these regulations:



Before switching on the device, install the appropriate covers and protections against accidental contact. Rack-mounted devices must be protected against accidental contact by means of a housing, e.g. a switch cabinet. The regulations VBG 4 must be complied with!



Always connect the ground conductor of the electrical equipment and devices securely to the mains supply. Due to the integrated line filter the leakage current exceeds 3.5 mA!



Comply with the minimum copper cross-section for the ground conductor over its entire length as per EN60617!



Prior to the initial operation, even for short measuring or testing purposes, always connect the ground conductor of all electrical devices as per the terminal diagram or connect it to the ground wire. Otherwise the housing may carry high voltages which can cause electrical shock.



Do not touch electrical connections of the components when switched on.



Prior to accessing electrical parts carrying voltages exceeding 50 Volts, disconnect the device from the mains or power supply. Protect it from being switched on again.



For the installation the amount of DC bus voltage must be considered, particularly regarding insulation and protective measures. Ensure proper grounding, wire dimensioning and corresponding short-circuit protection.



The device comprises a rapid discharge circuit for the DC bus as per EN60204 section 6.2.4. In certain device constellations, however, mostly in the case of parallel connection of several servo drive controllers in the DC bus or in the case of an unconnected brake resistor, this rapid discharge may be rendered ineffective. The servo drive controllers can carry voltage until up to 5 minutes after being switched off (residual capacitor charge).

2.4.4 Protection against electrical shock by means of protective extra-low voltage (PELV)

All connections and terminals with voltages between 5 and 50 Volts at the servo drive controller are protective extra-low voltage, which are designed safe from contact in correspondence with the following standards:

International: IEC 60364-4-41

European countries within the EU: EN 50178/1998, section 5.2.8.1.

**DANGER!**

High electrical voltages due to wrong connections!

Danger to life, risk of injury due to electrical shock!

Only devices and electrical components and wires with a protective extra low voltage (PELV) may be connected to connectors and terminals with voltages between 0 to 50 Volts.

Only connect voltages and circuits with protection against dangerous voltages. Such protection may be achieved by means of isolation transformers, safe optocouplers or battery operation.

2.4.5 Protection against dangerous movements

Dangerous movements can be caused by faulty control of connected motors, for different reasons:

- ❖ Improper or faulty wiring or cabling
- ❖ Error in handling of components
- ❖ Error in sensor or transducer
- ❖ Defective or non-EMC-compliant components
- ❖ Error in software in superordinated control system

These errors can occur directly after switching on the device or after an indeterminate time of operation.

The monitors in the drive components for the most part rule out malfunctions in the connected drives. In view of personal protection, particularly the danger of personal injury and/or property damage, this may not be relied on exclusively. Until the built-in monitors come into effect, faulty drive movements must be taken into account; their magnitude depends on the type of control and on the operation state.

**DANGER!**

Dangerous movements!

Danger to life, risk of injury, serious personal injuries or property damage!

For the reasons mentioned above, personal protection must be ensured by means of monitoring or superordinated measures on the device. These are installed in accordance with the specific data of the system and a danger and error analysis by the manufacturer. The safety regulations applying to the system are also taken into consideration. Random movements or other malfunctions may be caused by switching the safety installations off, by bypassing them or by not activating them.

2.4.6 Protection against contact with hot parts

**DANGER!**

Housing surfaces may be hot!

Risk of injury! Risk of burning!



Do not touch housing surfaces in the vicinity of heat sources! Danger of burning!



Before accessing devices let them cool down for 10 minutes after switching them off.



Touching hot parts of the equipment such as the housing, which contain heat sinks and resistors, may cause burns!

2.4.7 Protection during handling and assembly

Handling and assembly of certain parts and components in an unsuitable manner may under adverse conditions cause injuries.

**DANGER!**

Risk of injury due to improper handling!

Personal injury due to pinching, shearing, cutting, crushing!

The following general safety notes apply:



Comply with the general setup and safety regulations on handling and assembly.



Use suitable assembly and transportation devices.



Prevent incarcerations and contusions by means of suitable protective measures.



Use suitable tools only. If specified, use special tools.



Use lifting devices and tools appropriately.



If necessary, use suitable protective equipment (e.g. goggles, protective footwear, protective gloves).



Do not stand underneath hanging loads.



Remove leaking liquids on the floor immediately to prevent slipping.

3 Cabling and pin assignment

3.1 Pin assignment

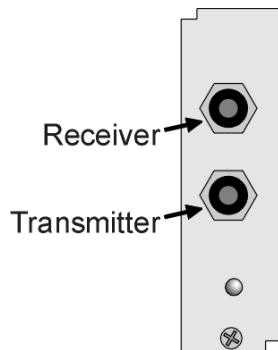


Figure 3.1: SERCOS plug-in module for MDR 2000

In the MDR 2000 product range, the SERCOS interface has been realised in the form of an optional technological plug-in module. **Due to special hardware requirements it can only be used at the TECH2- Slot.**

In accordance with the SERCOS specification the transmitter HFE 7000-210 (plastic barrel) and the receiver HFD 7000-402 (metal barrel) are accessible at the front panel.



Figure 3.2: Plug-in position for MDR 2102, 2105, 2302, 2305 and 2310



Figure 3.3: Plug-in position for MDR 2320 and 2340 and 2360W



For setting up a SERCOS network please refer to the recommendations of the Interests Group SERCOS interface.

4 Activation of SERCOS

4.1 Overview

The activation of SERCOS is done one-time using the serial interface (RS232) of the servo controller. The SERCOS protocol can be activated in the window „SERCOS“ of the Mattke ServoCommander™ (Parameters / Field bus / SERCOS)

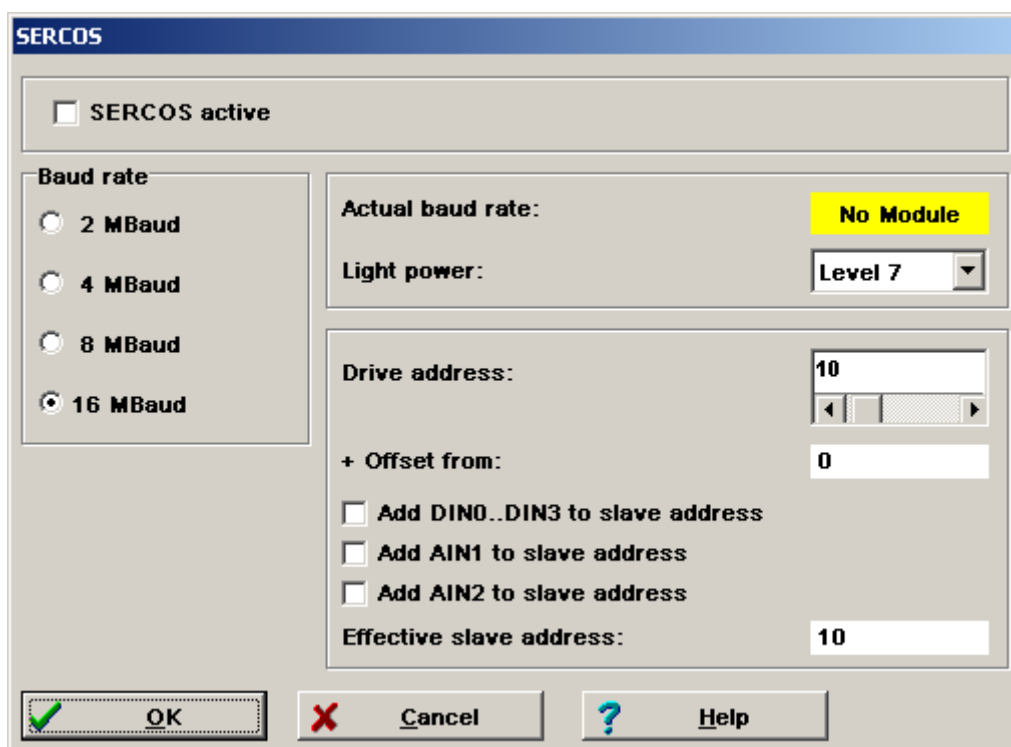


Figure 4.4: SERCOS parameters window in Mattke ServoCommander™

Three different parameters have to be set, before the SERCOS communication can be activated:

❖ **Drive address:**

For unmistakable identification each slave within the network has to have an unique slave address. As devices of the MDR 2000series only supply one drive per slave, the drive address is equal to the slave address.

Since firmware version 3.5.0.1.4 an offset to the slave address can be selected by the use of the digital and analogue inputs.

❖ Baud rate

This parameter determines the used baudrate in MBaud. The possible baudrate depends on the used fibre optic cable and the capabilities of the used NC. If SERCOS is still active, the selected baud rate may differ from the actual used baud rate. Therefore the "Actual baud rate" will be displayed additionally.

❖ Light power

According to the used fibre optic cables and the cable length it can be necessary to adapt the power of the transmitting diodes to avoid overdriving. For further information to this parameter please refer to chapter 11.

Finally the SERCOS communication can be activated. Please take into account that the parameters mentioned above can only be changed when the protocol is deactivated. All parameters will only become valid if the SERCOS communication is deactivated and activated once again.



Please note that the activation of the SERCOS communication has to be saved ("Save parameter set") to be available after a reset next time.

4.2 Available Baudrates

The following baudrates are available:

- 2 MBaud
- 4 MBaud
- 8 MBaud
- 16 MBaud

5 Introduction

5.1 Overview

SERCOS is a master-slave fieldbus system with one master and several serial connected slaves. The communication is done in a cyclical manner starting with the so-called Master Sync Telegram (MST). The time between two MSTs is called the SERCOS cycle time (t_{SCYC}).

The MST is followed by the Axis Telegrams (AT) of each drive. The AT contains the feedback values of the drive, e.g. the position feedback (position actual value).

The ATs are followed by the Master Data Telegram (MDT). The MDT contains a data record for each slave with operation data for the drives, e.g. the position command values (position setpoints).

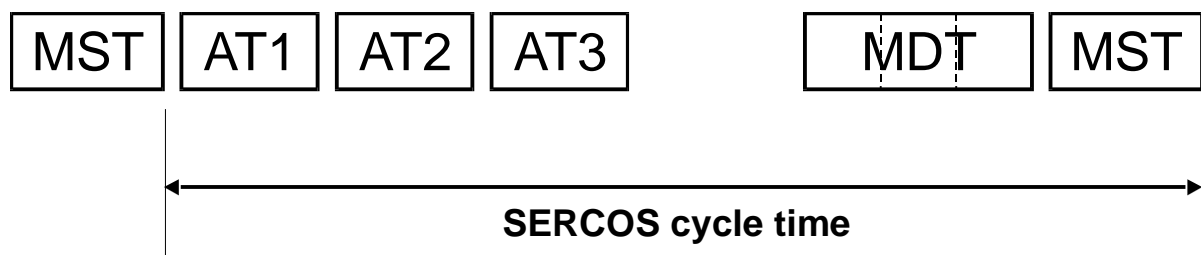


Figure 5.5: Cyclic data exchange

MDT and AT are configurable, i.e. the number and kind of parameters that will be cyclically exchanged can be determined by the user.

Additionally non-time critical data can be exchanged by use of the Service Channel. To that a special data container within the MDT and the AT is reserved. The transmission by the Service Channel will be done in a segmented way.

The Service Channel will also be used for Procedure Command handling like „drive controlled homing“.

To set up a SERCOS network properly it is necessary to configure the timing of all slaves and determine the point in time for sending the MDT and the ATs. To that the initialisation of SERCOS communication is divided into 5 main communication phases (CP):

CP0:	Close the ring	Master tests if all slaves repeat the master signal
CP1:	Identify axes	Master identifies the slaves by means of their drive address
CP2:	Load communication parameters	Master requests the timing capabilities of each drive and sets up the timing of the ring according to the timing parameter of the drives.
CP3:	Load application parameters	Transmit all parameters used for the cyclical communication, e.g. the scaling of the position values
CP4:	Cyclic operation	Slaves operation cyclically

SERCOS defines lots of parameters for communication purposes as well as for application purposes. To identify a parameter a unique identification number (IDN) is assigned to it. Beyond the operation data it is also possible to read name, attribute, unit, minimum and maximum value for each implemented IDN.

Parameters defined by the SERCOS specification will be indicated by a „S“ as in **S-0-0001**.

Manufacturer specific parameters will start with a „P“.

The next chapter describes the structure of the SERCOS telegrams like AT and MDT.

5.2 Axis telegram (AT)

The axis telegram contains the operation data of the drive. Each slave sends its own AT with its specific drive address in the *Adr*-Field. The operation data field can be configured by the user according to the specific application, e.g. the position actual value and the velocity actual value can be embedded together.

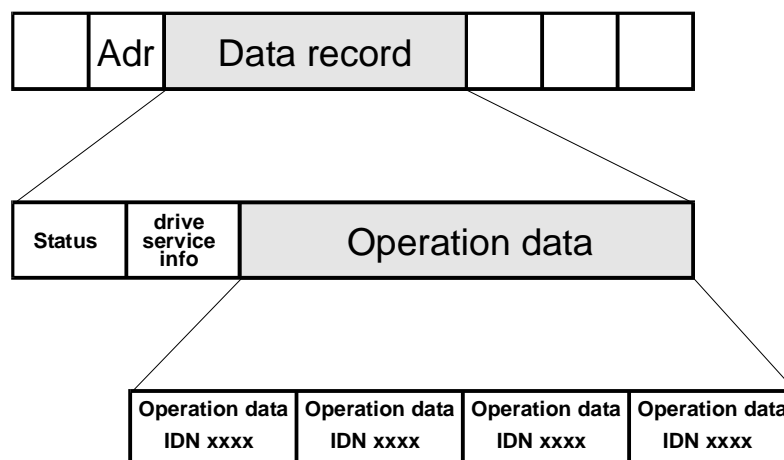


Figure 5.6: Axis telegram (AT)

As it can be seen in Figure 5.6 the Axis Telegram consists of three major parts. The first one ("Status") is the *Drive Status Word*. It contains information about the actual state of the drive, like it is described in chapter 8. It is always implemented into all ATs, even in the communication phases 3 and 4 where cyclic communication is taking place. This way the control is always informed about the actual state of the drive. The *Drive Status Word* can be accessed via the Service Channel by the IDN **S-0-0135**, too.

The second part of the AT ("drive service info") is the data field for acyclic data, that belongs to the Service Channel transmission. By the use of this data field acyclic data can be transmitted, that's IDNs are not included into the cyclic data fields. The Service Channel is described in chapter 5.4.

The third part of the AT ("Operation Data") is the section for cyclic data. This part is only transmitted in the communication phases with cyclic data transmission (phase 3 and 4). The size and the contents of these data fields depend on the selected telegram type (see chapter 5.5). Generally multiple IDNs are mapped into the cyclic data fields and therefore transmitted once every SERCOS cycle. By a special parameter **S-0-0187 (IDN list of configurable data in the AT)** it can be found out, which IDNs are allowed to be mapped into the AT.

Normally the configuration of the contents of the cyclic data fields is done automatically by your NC control and depends on the desired operation mode. For detailed information regarding the configuration of the AT please refer to your NC manual.

5.3 Master data telegram (MDT)

The master data telegram contains the command values for the drives. The master sends only one Master data telegram with specific data records for each drive. The operation data for the drives can be configured, e.g. the position command value and the torque limit value can be embedded together.

By a special parameter **S-0-0188 (IDN list of configurable data in the MDT)** it can be found out, which IDNs are allowed to be mapped into the MDT.

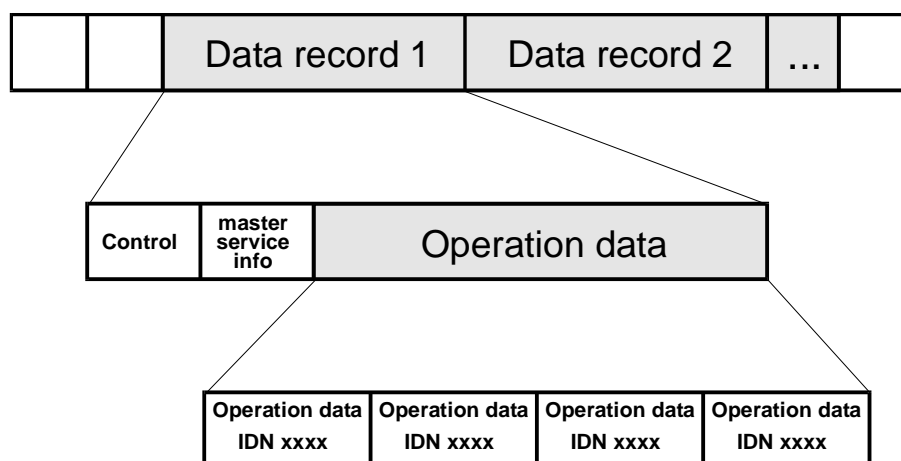


Figure 5.7: Master data telegram (MDT)

Similar to the structure of the AT the MDT contains Service Channel data ("master service info") and the **controlword (S-0-0134)** to control the drive.

For detailed information regarding the configuration of the MDT please refer to your NC manual.

5.4 Service Channel (SC)

Additionally the cyclic data exchange non- time critical data can be exchanged via the Service Channel. As there are only 2 bytes reserved for Service Channel data in the AT and the MDT, the data has to be transmitted in a segmented way. A special handshake mechanism is implemented to transmit the data. For detailed information regarding the Service Channel mechanism please refer to the SERCOS specification.

The Service Channel will often be used by NCs to display all available parameters (name, value, etc.) and allow the user to edit it. The structure of the SERCOS parameter will be described in the following chapter:

5.4.1 SERCOS parameter (IDNs)

All parameters, that can be accessed on the SERCOS fieldbus are implemented as so called IDNs (**I**dentit**y** **N**umbers). This way each IDN represents one parameter in the drive. For all IDNs, a complex data structure is implemented. This data structure does not only contain the parameter value, but also limit values (Min / Max), the name of the parameter as string and other information. A complete data block for an IDN is shown in the table below:

Element No.	Element name	Description
1	IDN (Identity Number)	This element contains the unique "Identity Number" (IDN) for this parameter.
2	Name	This element contains the name of the parameter as string. The language can be selected by S-0-0265, see Chapter 5.4.4.
3	Attribute	This element contains information about the type of the parameter (see below).
4	Unit	This element contains the unit of the parameters value as string.
5	Minimum value	This element contains the minimum value for this parameter.
6	Maximum value	This element contains the maximum value for this parameter.
7	Parameter value	This element contains the real value of the parameter.

All of the single elements of the IDNs data block can be accessed by the master via the Service Channel. In normal operation mainly the elements 1 (IDN), 3 (Attribute) and 7 (parameter value) are interesting. The 32 bit attribute contains important information about the type of the parameter. Its structure is described in detail in the table below:

Bits	Hex value (mask)	Description																											
31	80000000 _{hex}	Reserved																											
30	40000000 _{hex}	CP4 write protection: 0: This parameter is writeable in CP4 (unless not generally RO) 1: This parameter is write protected in CP4																											
29	20000000 _{hex}	CP3 write protection: 0: This parameter is writeable in CP3 (unless not generally RO) 1: This parameter is write protected in CP3																											
28	10000000 _{hex}	CP2 write protection: 0: This parameter is writeable in CP2 (unless not generally RO) 1: This parameter is write protected in CP2																											
27 – 24	0F000000 _{hex}	These bits define the numbers of decimal points for parameters of type “floating point”																											
23	00800000 _{hex}	Reserved																											
22 – 20	00700000 _{hex}	Data type and display format: <table><tr><th>Bits</th><th>Type</th><th>Display format</th></tr><tr><td>000</td><td>Binary number</td><td>Binary</td></tr><tr><td>001</td><td>Unsigned integer</td><td>Unsigned decimal</td></tr><tr><td>010</td><td>Signed integer</td><td>Signed decimal</td></tr><tr><td>011</td><td>Unsigned integer</td><td>Hexadecimal</td></tr><tr><td>100</td><td>Extended char set</td><td>String</td></tr><tr><td>101</td><td>Unsigned integer</td><td>IDN (S-X-XXXX)</td></tr><tr><td>110</td><td>Floating point</td><td>Signed decimal with exponent</td></tr><tr><td>111</td><td>Reserved</td><td>-</td></tr></table>	Bits	Type	Display format	000	Binary number	Binary	001	Unsigned integer	Unsigned decimal	010	Signed integer	Signed decimal	011	Unsigned integer	Hexadecimal	100	Extended char set	String	101	Unsigned integer	IDN (S-X-XXXX)	110	Floating point	Signed decimal with exponent	111	Reserved	-
Bits	Type	Display format																											
000	Binary number	Binary																											
001	Unsigned integer	Unsigned decimal																											
010	Signed integer	Signed decimal																											
011	Unsigned integer	Hexadecimal																											
100	Extended char set	String																											
101	Unsigned integer	IDN (S-X-XXXX)																											
110	Floating point	Signed decimal with exponent																											
111	Reserved	-																											
19	00080000 _{hex}	Type of IDN: 0: Operation data or parameter 1: Procedure Command																											
18 – 16	00070000 _{hex}	Data length: <table><tr><th>Bits</th><th>Type</th></tr><tr><td>000</td><td>Reserved</td></tr><tr><td>001</td><td>Parameter is 2 bytes long</td></tr><tr><td>010</td><td>Parameter is 4 bytes long</td></tr><tr><td>011</td><td>Parameter is 8 bytes long</td></tr><tr><td>100</td><td>Variable length with 1 byte data (e.g. Strings)</td></tr><tr><td>101</td><td>Variable length with 2 byte data (e.g. IDN lists)</td></tr><tr><td>110</td><td>Variable length with 4 byte data</td></tr><tr><td>111</td><td>Variable length with 8 byte data</td></tr></table>	Bits	Type	000	Reserved	001	Parameter is 2 bytes long	010	Parameter is 4 bytes long	011	Parameter is 8 bytes long	100	Variable length with 1 byte data (e.g. Strings)	101	Variable length with 2 byte data (e.g. IDN lists)	110	Variable length with 4 byte data	111	Variable length with 8 byte data									
Bits	Type																												
000	Reserved																												
001	Parameter is 2 bytes long																												
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101	Variable length with 2 byte data (e.g. IDN lists)																												
110	Variable length with 4 byte data																												
111	Variable length with 8 byte data																												
15 – 0	0000FFFF _{hex}	Conversion factor																											

Generally there are two different types of IDNs. The first ones are the normal parameters. These IDNs are used for data like current, set-points and other data, that can just be read or written.

The second type of IDNs are the so called "Procedure Commands". These IDNs are used to execute certain operations in the drive. This for example may be the acknowledge of all errors in the drive or the execution of a drive controlled homing procedure.

5.4.2 Procedure Commands

All Procedure Commands start a procedure in the drive. This procedure is always started by the master and afterwards executed by the drive on its own. The master cyclically has to check the status of the procedure and stop it again, after it is executed. For this purpose the following bits can be written by the master to control the Procedure Command:

Bit	Name	Description
0	Set / Cancel	0b: The Procedure Command will be canceled 1b: The Procedure Command will be set in the drive. Afterwards it is ready to be started by the master
1	Start / Interrupt	0b: The Procedure Command will be interrupted 1b: The Procedure Command will be executed in the drive
2...7	---	Reserved

Reading the same IDN will return the status of the procedure command:

Bit	Name	Description
0	Set	0b: The Procedure Command is not set in the drive 1b: The Procedure Command is set in the drive
1	Started	0b: The Procedure Command is interrupted 1b: The Procedure Command is running
2	Busy	0b: The Procedure Command executed correctly 1b: The Procedure Command is currently executed by the drive
3	Error	0b: No Error 1b: Error in execution of Procedure Command
4...7	Reserved	Reserved

As it can be seen in the table above the bits 0 and 1 are set by the master to start and stop the execution of the Procedure Command. They will be mirrored by the drive. Additionally the bits 2 and 3 are set by the drive to display the actual status of the command execution.

Normally the master has to check cyclically the value of all commands, that are active in the drive to see its current status. To avoid having cyclic traffic on the Service Channel bit 5 (Procedure Command change bit) is implemented in the Drive Status Word, that is automatically transmitted from the drive to the master in each AT (see chapter 8). This bit is set each time the status of the following bits changes:

Bit 2 (Busy) from 1 → 0 or

Bit 3 (Error) from 0 → 1

This way the master simply needs to observe the bit 5 of the Drive Status Word and only read the status from the Procedure Command, if the value of this bit changes. The bit is automatically reset by the drive, if no command is active or the master changes the state of the command.

As an example the execution of the Drive controlled homing Procedure Command shall be described here:

EXAMPLE



The following table shows, what values the master has to write to IDN S-0-0148 and the response of the drive. The first case shows an execution without error:

Master	Slave	Description
00000000 00000011 _b		The master sets bits 0 and 1 in the Procedure Command (Write S-0-0148 = 3 _h). This sets and directly starts the command
	00000000 00000111 _b	The drive sets the bits 0,1 and 2 to signal the execution of the command (Read S-0-0148 = 7 _h)
	...	The drive executes the command
	00000000 00000011 _b	The drive resets bit 2 to signal the complete execution of the command (Read S-0-0148 = 3 _h). Bit 5 of the Drive Status Word will be set
		The master detects the change of the Drive Status Word. As a result it reads the value of the IDN S-0-0148 and evaluates it.
00000000 00000000 _b		The master resets all bits (Write S-0-0148 = 0 _h). This will stop the command.
	00000000 00000000 _b	The drive responds with resetting all bits (Read S-0-0148 = 0 _h). Bit 5 of the Drive Status Word will be reset too

The second case shows an execution with error:

Master	Slave	Description
00000000 00000011 _b		The master sets bits 0 and 1 in the Procedure Command (S-0-0148 = 3 _h). This sets and directly starts the command.
	00000000 00000111 _b	The drive sets the bits 0,1 and 2 to signal the execution of the command
	...	
	00000000 00001x11 _b	The drive sets bit 3 to signal an error while executing the command. Bit 2 may be reset simultaneously. Bit 5 of the Drive Status Word will be set
		The master detects the change of the Drive Status Word. As a result it reads the value of the IDN S-0-0148 and evaluates it.
	00000000 00000000 _b	The drive responds with resetting all bits (Read S-0-0148 = 0 _h). Bit 5 of the Drive Status Word will be reset too

Some Procedure Commands have no defined end, like for example the Spindle Positioning command. If this command is started by the master, the drive will switch to positioning mode and wait for commands of the master. This command will never be stopped by the drive itself. It always needs to be cancelled by the master. In this case the master would directly write the value 00000000_h to the IDN of the Procedure Command without checking the command status for changes and waiting, until the execution has ended.



Some Procedure Commands, like for example the command **S-0-0099 (Reset Diagnostic Class 1)** are executed faster than one SERCOS cycle. In this case the transition of the Procedure Commands value from 00000003_{hex} to 00000007_{hex} and back to 00000003_{hex} may not be seen on the SERCOS bus. Therefore it is important to examine bit 5 in the Drive Status Word.

Procedure commands may take up some time. Nevertheless the Service Channel becomes available again immediately for the transmission of non-cyclic data as the Procedure Command only causes a functional process to start.

5.4.3 Definition

All parameters, that can be changed by the SERCOS fieldbus system are described in a standardised manner:

IDN	S-0-0208		
Name	Temperature data scaling type		
Description	This scaling type parameter determines whether degree Celsius [°C] or Fahrenheit [F] is used as unit for all temperature data in the drive. The data length of temperature data is fixed to two bytes. See chapter 5.5		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	---

IDN of parameter
Name of parameter
Short parameter description
Minimum value
Maximum value
R: readable
W: writeable
(2,3): communications phases in which it is allowed to write the parameter
MDT: parameter can be mapped into an MDT
AT: parameter can be mapped into an AT

INT8 / UINT8: 8 bit signed / unsigned
INT16 / UINT16: 16 bit signed / unsigned
INT32 / UINT32: 32 bit signed / unsigned
String: Byte- string
IDN list: 2 Byte array

The scaling group determines the unit and resolution of the parameter, see chapter 9.2

Parameter: IDN is normal parameter
Command: IDN is command, see Chapter 5.4.2

Firmware version since the parameter is available. If empty, the parameter is available in all SERCOS firmware versions

5.4.4 IDNs

IDN	S-0-0017		
Name	IDN-list of all operation data		
Description	All IDNs of all operation data can be read in this IDN list.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0025		
Name	IDN-list of all procedure commands		
Description	The IDNs of all procedure commands supported by the drive are stored in this IDN-list.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0265		
Name	Language designation		
Description	The language, in which all ASCII strings will be transmitted to the master can be selected via this IDN. Two languages can be selected.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

Value	Description
0	German
1	English

5.5 Configuring AT and MDT (Telegram types)

The telegram contents of the configurable data records within the AT and the MDT are determined by the parameter **telegram type (S-0-0015)**. Either a predefined standard telegram can be chosen or an application specific telegram can be used. The telegram type must be configured in Phase 2.

The cyclically exchanged data between slave and master has to fit to the operation mode, that shall be used in the application (see Chapter 7). For example, if the drive should be used in position mode, the standard telegram 4 should be selected to transmit cyclic position set-point and actual values.

Especially, if the drive should switch between operation modes in communication phase 4, the cyclic telegram has to be configured in a way, that it contains cyclic data for all desired operation modes. For example if you want to switch between speed and position mode, the cyclic data has to contain set-point and actual values for both, speed and position. In this case the application telegram has to be used, like it is described in chapter 5.5.2.

The following values for **S-0-0015 (telegram type)** are allowed:

Bit	Description	Value
0...2	Standard telegram	<i>000b: Not allowed</i> 001b: Standard telegram 1 <i>010b: Not allowed</i> 011b: Standard telegram 3 100b: Standard telegram 4 <i>101b: Not allowed</i> <i>110b: Not allowed</i> 111b: Application telegram

5.5.1 Standard telegrams

5.5.1.1 Standard telegram 0

No cyclic data is exchanged. Data can only be exchanged via the Service Channel.

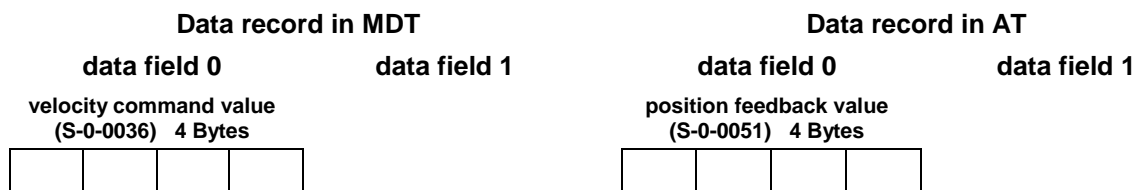
5.5.1.2 Standard telegram 1

The standard telegram 1 can be used for torque control operation mode:

Data record in MDT		Data record in AT
data field 0	data field 1	
torque command value (S-0-0080) 2 Bytes		No data 0 Bytes
<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	<div style="border: 1px solid black; width: 100px; height: 20px;"></div>	

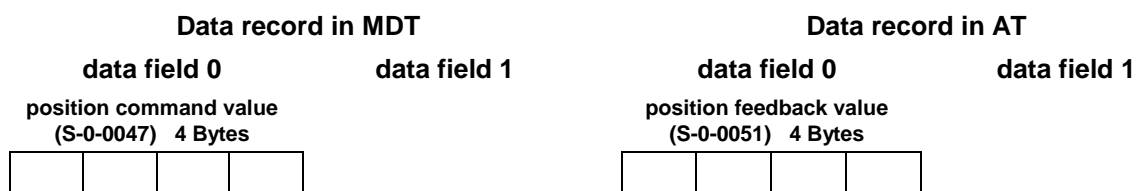
5.5.1.3 Standard telegram 3

The standard telegram 3 can be used for velocity control operation mode:



5.5.1.4 Standard telegram 4

The standard telegram 4 can be used for position control operation mode:



For information regarding the not mentioned telegrams please contact Mattke Application Engineering.

5.5.2 Application telegram

Additionally to the standard telegrams it is possible to use an own, free configured telegram. MDT and AT can be configured independently of each other.

The IDNs that should be used in the MDT have to be written to **S-0-0024 (configuration list of MDT)** in communication phase 2. The available parameters can be read from the IDN **S-0-0188 (IDN list of configurable data in the MDT)**. The maximum allowed length in byte can be read out by **S-0-0186 (IDN length of configurable data record in the MDT)**.

For configuring the AT the following IDNs can be used:

S-0-0016 (configuration list of AT)

S-0-0187 (IDN- list of configurable data in the AT)

S-0-0185 (IDN- length of configurable data record in the AT).

During the Procedure Command **S-0-0127 (CP3 transition check**, see Chapter 5.6) the cyclic telegram is set up in the drive according to the contents of the configuration lists **S-0-0016** and **S-0-0024**. After switching to communication phase 4, the cyclic data in the telegrams is valid and used by the drive.

It must be taken into consideration that only a limited number of data can be exchanged cyclically, if low SERCOS cycle times will be used. The maximum number of cyclically transmitted IDNs is limited to 4.

5.5.3 IDNs

IDN	S-0-0015		
Name	Telegram type		
Description	The telegram type parameter allows selection between standard telegrams and application telegrams (bits 0...2).		
Min	0	Datatype	UINT16
Max	7	Scaling	---
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0016		
Name	Configuration list of AT		
Description	This IDN list contains the IDNs whose operation data will be transmitted cyclically in the AT in an application telegram. Only operation data which are present in the "IDN list of configurable data in the AT" (IDN S-0-0187) are allowed as cyclic data.		
Min	0	Datatype	IDN list
Max	4 IDNs	Scaling	---
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0024		
Name	Configuration list of MDT		
Description	This IDN list contains the IDNs whose operation data will be transmitted cyclically in the MDT in an application telegram. Only operation data which are present in the "IDN-list of configurable data in the MDT" (IDN S-0-0188) are allowed as cyclic data.		
Min	0	Datatype	IDN list
Max	4 IDNs	Scaling	---
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0185		
Name	Length of configurable datablock in AT		
Description	The drive indicates the maximum length in bytes which can be processed in the configurable data record of the AT in the operation data of this IDN. For terms of performance a maximum length of 64 byte (4 * 32Bit variables) can be transmitted via the AT, but only a maximum of 4 IDNs can be configured in the AT configuration list S-0-0016.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0186		
Name	Length of configurable datablock in MDT		
Description	The drive indicates the maximum length in bytes which can be processed in the configurable data record of the MDT in the operation data of this IDN. For terms of performance a maximum length of 64 byte (4 * 32Bit variables) can be transmitted via the MDT, but only a maximum of 4 IDNs can be configured in the MDT configuration list S-0-0024.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0187		
Name	IDN-list of configurable data in AT		
Description	This list contains all IDNs of operation data which can be processed by the drive cyclically as feedback values in the AT. The user should only configure IDNs from this list as cyclic data for the AT in the "AT configuration list" (S-0-0016).		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0188		
Name	IDN-list of configurable data in MDT		
Description	This list contains all IDNs of operation data which can be processed by the drive cyclically as command values in the MDT. The user should only configure IDNs from this list as cyclic data for the MDT in the "Configuration list of MDT" (S-0-0024).		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

5.6 Initialisation (Phase transitions)

To setup a SERCOS network it is necessary to know the special timing capabilities of the connected drives to determine the points in time for sending and receiving. Beside this the master needs to synchronise all slaves before the cyclic communication can be started. Therefore 5 phases are defined.

On the right hand you can see the state diagram of SERCOS. Normally the next phase can only be reached through the preceding phase. Only Phase 0 can be reached from all phases to start a new initialisation.

The master determines the actual phase within the MST. To reach Phase 3 and Phase 4 additionally the execution of a Procedure Command is necessary (See also chapter 5.6.6)

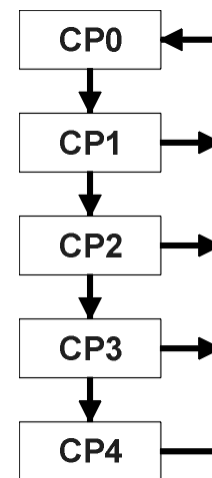


Figure 5.8: Phase transitions



It is not possible to switch from a higher phase to a lower phase (e.g. from 4 to 3). Even if your NC seems to execute this transition, it always switches to phase 0.

5.6.1 CP0: Close the ring

In Phase 0 the master tries to receive his own test signal, to find out if the SERCOS ring is closed. All SERCOS slaves just repeat the master signal to allow the master to detect that the ring is closed. In case of a communication error the slave may fall back into Phase 0 by itself.

5.6.2 CP1: Identify the Axes

CP1 is used for recognizing the drives connected to the ring. To do so, the master addresses each drive specifically with its drive address, to verify that all drives are present.

5.6.3 CP2: Load communication parameters

In CP2 the complete functionality of the Service Channel is available and non- cyclic data can be exchanged.

As a minimum the following parameters must be transmitted:

- 1.) Transmission starting times and transfer timeslots
- 2.) Parameters determining the contents and the length of the AT
- 3.) Parameters determining the contents and the length of the MDT

Before the master can change the phase in the MST to CP3 it is necessary for the drive to check the timing parameters transmitted by the master. Therefore a Procedure Command has to be executed by the master before he is allowed to switch to Phase 3. This Procedure Command is called **CP3 transition check (S-0-0127)**. It is explained in chapter 5.6.6. At least the parameters given in the parameter **IDN list of operation data for CP2 (S-0-0018)** have to be transmitted without error in CP2.

The check for validity of the parameters by the slave can refer only to general criteria (e.g. minimum, maximum). It cannot be recognised by the slave if all parameters that have been transmitted by the master are correct with respect to the control data and the total installation. This means that even when the drive acknowledges the 'CP3 transition check' positively, there may be incorrect communication parameters with respect to the total installation which can lead to a disruption of cyclical communication.

If switching to CP3 fails, the drive stores all IDNs that caused a problem in the **IDN list of invalid operation data for CP2 (S-0-0021)**.

By switching to CP3 the drive starts to get synchronised with the MST- cycle.

5.6.4 CP3: Load application parameters

Within CP3 the exchange of data is done via the telegrams defined for cyclic operation. Also the timeslots for cyclic operation are used. The cyclic operation data is not relevant, i.e. will not be used by the drive, but it is necessary that the structure of the telegram already complies with the structure in CP4. In this phase the drive can be adapted to the specific application, e.g. by changing the scaling parameters for position, velocity and acceleration.

To switch to CP4 it is also necessary for the drive to check if it is synchronised and to check the validity of the transmitted parameters. Therefore a Procedure Command has to be executed by the master before he is allowed to switch to Phase 4. This Procedure Command is called **CP4 transition check (S-0-0128)**. It is explained in chapter 5.6.6. At least the parameters given in the parameter **IDN list of operation data for CP3 (S-0-0019)** have to be transmitted without error in CP3.

If switching to CP4 fails, the drive stores all IDNs that caused a problem in the **IDN list of invalid operation data for CP3 (S-0-0022)**.

5.6.5 CP4: Cyclic operation

In this phase the initialisation is finished and cyclical data will be exchanged. Now it is allowed to switch on the power stage of the drive using the controlword, embedded in the MDT. The drive state will be displayed by the statusword embedded in the AT. Any parameter, that can be changed within CP4 is given in **IDN list for CP4 (S-0-0020)**.

5.6.6 IDNs

IDN	S-0-0127		
Name	CP-3 transition check		
Description	The master uses this procedure command to instruct the slave to check that all necessary parameters have been transferred for CP3. Otherwise this procedure command results in an error (see IDN S-0-0021). After the procedure command is performed correctly, the control unit has to cancel the procedure command. The control unit can then activate CP3 in the MST.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

IDN	S-0-0128		
Name	CP-4 transition check		
Description	The master uses this procedure command to instruct the slave to check that all necessary parameters have been transferred for CP4. Otherwise, this procedure command results in an error. (see IDN S-0-0022). After the procedure command is performed correctly, the control unit has to cancel the procedure command. The control unit can then activate CP4 in the MST.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

IDN	S-0-0018		
Name	IDN-list of operation data for CP-2		
Description	IDNs of all operation data needed for CP2 are stored in this IDN list and must be transferred during CP2. Writing all these IDNs without error is required before switching to CP3.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0019		
Name	IDN-list of operation data for CP-3		
Description	IDNs of all operation data needed for CP3 are stored in this IDN-list and must be transferred during CP3. Writing all these IDNs without error is required before switching to CP4.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0020		
Name	IDN-list of operation data for CP-4		
Description	IDNs of all operation data which can be changed during CP4 are stored in this IDN-list.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0021		
Name	IDN-list of invalid data CP-2		
Description	IDNs which are in the list "IDN list of operation data for CP2" (IDN S-0-0018) and which are considered invalid by the drive prior to switchover from CP2 to CP3 are stored in this IDN-list (see IDN S-0-0127). Case 1: procedure command IDN S-0-0127 is performed correctly; the IDN-list (IDN S-0-0021) contains no IDNs. Case 2: procedure command IDN S-0-0127 results in an error; the IDN-list (IDN S-0-0021) contains all IDNs of invalid operation data.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0022		
Name	IDN-list of invalid data for CP-3		
Description	IDNs which are in the list "IDN-list of operation data for CP3" (IDN S-0-0019) and which are considered invalid by the drive prior to switchover from CP3 to CP4 are stored in this IDN-list (see IDN S-0-0128). Case 1: procedure command IDN S-0-0128 is performed correctly; the IDN-list (IDN S-0-0022) contains no IDNs. Case 2: procedure command IDN S-0-0128 results in an error; the IDN-list (IDN S-0-0022) contains all IDNs of invalid operation data.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

6 SERCOS cycle time

Normally the SERCOS cycle time can be determined by the parameter IDN **S-0-0002**. To reach best behaviour it is necessary, that all controllers within the MDR 2000(current controller, velocity controller and position controller) are synchronised to the MST. Therefore first the controller cycle times must be adapted to the SERCOS cycle time, because the settings will only become valid after a reset. This can be done using the Mattke ServoCommander™ (Parameters / controller parameters / cycle times). Using the „Settings“- Button the cycle times can be changed (The warning can be confirmed with OK).

	Factors	Cycle times
Current controller	ti	125,0 µs
Speed controller	tn = 2	* ti = 250,0 µs
Position controller	tx = 2	* tn = 500,0 µs
Interpolation computation (IPO)	tp = 4	* tx = 2000,0 µs

Caution!
These settings become only effective after 'Save (Parameter)' and 'Reset' of the servo controller!

OK Cancel Save & Reset

Figure 6.9: Cycle times parameter window in Mattke ServoCommander™

In most applications it will be sufficient to set the cycle times as it can be seen in the screenshot: The time **tp** must be set in such a way that it equals the desired SERCOS cycle time. Therefore the last Factor must be changed suitable.

Name	Factor	Cycle time
ti		125 µs
tn	2	250 µs
tx	2	500 µs

The following tables shows further possible combinations. It depends on the type of position controller and your application if it is possible to use low current controller cycle times.

Sercos Cycle time	Cycle time current controller ti	x	Cycle time speed controller tn	x	Cycle time position controller tx	x	Cycle time interpolator tp
1 ms	125 µs	2	250 µs	2	500 µs	2	1000 µs
2 ms	125 µs	2	250 µs	2	500 µs	4	2000 µs
5 ms	125 µs	2	250 µs	2	500 µs	10	5000 µs
10 ms	125 µs	2	250 µs	2	500 µs	20	10000 µs
2 ms	100 µs	2	200 µs	2	400 µs	5	2000 µs
10 ms	100 µs	2	200 µs	2	400 µs	25	10000 µs
1 ms	83,3 µs	3	249,9 µs	2	499,8 µs	2	999,6 µs
2 ms	83,3 µs	3	249,9 µs	2	499,8 µs	10	1999,2 µs

7 Operation modes

The drive operation mode is set by the controlword in the MDT (see chapter 8). It is possible to choose between one primary operation mode and 3 secondary operation modes. The actual operation mode can be read by the statusword.

The meaning of the primary and the secondary operation modes must be set by the master in CP3.

For this the following IDNs must be used:

- S-0-0032 Primary operation mode**
- S-0-0033 Secondary operation mode 1**
- S-0-0034 Secondary operation mode 2**
- S-0-0035 Secondary operation mode 3**

The following values are allowed:

Value	Description
0x0000	Mode undefined
0x0001	Torque control
0x0002	Velocity control
0x000B	Position control using the „commutating encoder“, lagless, interpolation
0x000C	Position control using the „position actual value encoder“, lagless, interpolation
0x001B	Drive controlled interpolation using the „commutating encoder

To switch between operation modes it is necessary to have command values in the MDT for each used operation mode. See Chapter 5.5 as well.

For the different operation modes, the drive uses the following controller structure:

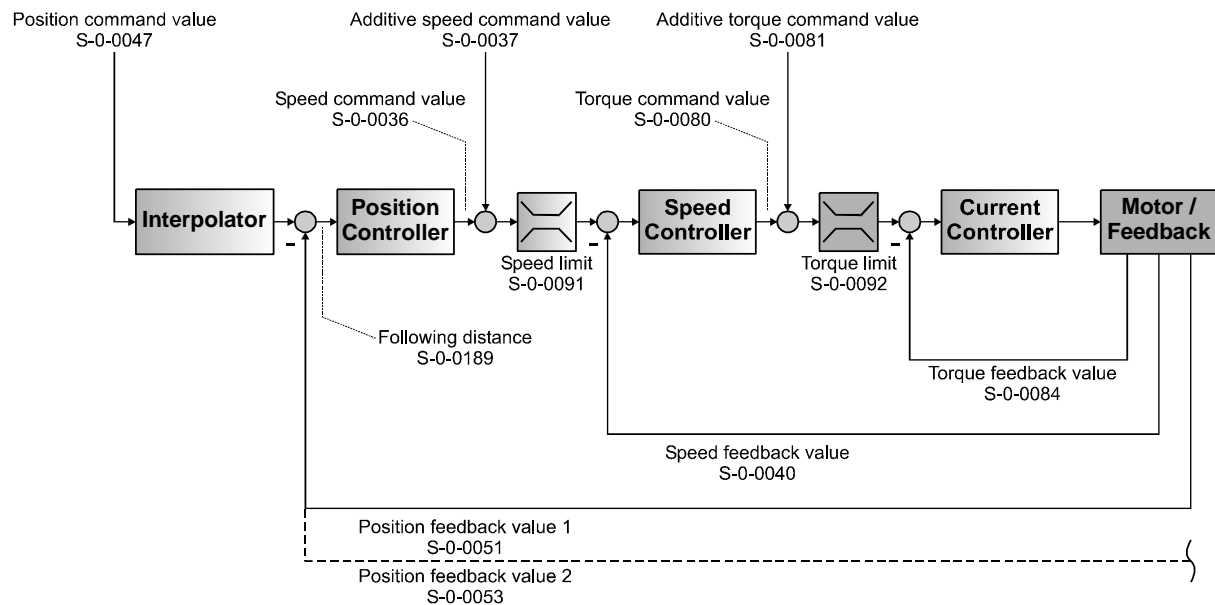


Figure 7.10: Controller loop structure

As it can be seen in Figure 7.10 there are three main controller loops implemented in the servo positioning controllers of the MDR 2000family. The innermost one is the current controller. This controller is used in all operation modes. In torque control it directly gets its set-point values from the master by the use of the IDN **S-0-0080 (Torque command value)** and **S-0-0081 (Additive torque command value)**. As feedback signal the master may evaluate the IDN **S-0-0084 (Torque feedback value)**. In all other operation modes, the current controller gets its set-point value from the speed controller. In these operation modes the torque can only directly be influenced by commanding an additional torque command value by the use of the IDN **S-0-0081**.

The second controller loop is the speed controller. In speed mode, same as the current controller in torque mode it gets its set-point values from the IDN **S-0-0036 (Speed command value)** and IDN **S-0-0037 (Additive speed command value)**. In position mode, the set-point value comes from the position controller. In this case only the additive speed command value by the use of the IDN **S-0-0037** can be applied.

The third controller loop is the position controller. It gets its command values from the interpolator. The interpolator will use the IDN **S-0-0047 (Position command value)** from the master as input and interpolates it from the SERCOS cycle time to the position controller cycle time (see Chapter 6). As feedback signals the master may either evaluate the IDN **S-0-0051 (Position feedback value 1)**, if using the internal feedback system of the motor, or IDN **S-0-0053 (Position feedback value 2)**, if an external feedback system is used for the position mode.



It must be ensured by the master that command values for each used operation mode are available in the MDT. Otherwise the command value may be undefined when switching to an other operation mode which may lead to an uncontrolled behaviour of the drive

As stated above the switching of the **operation** mode will be initiated by writing to the controlword. As it takes some time to change the mode the actual mode can be read by the statusword. While switching to the new operation mode the command values for both modes must be valid. If the drive signals the new mode in the statusword the command values for the old mode need not to be valid anymore.

Switching to an uninitialised operation mode results in an error (37-5) that will be reported in the **interface status (S-0-0014)**. See chapter 9.4.



For all operation mode, except of the “Torque mode” itself, a symmetric torque limitation is active. The limit torque can be written via the SERCOS IDN **S-0-0092 (Bipolar torque limit value)**. This is set to 0 Nm by default. So even if the drive can be enabled in CP4 the torque limit will still be set to 0 Nm, unless you set the torque limitation to a valid value. The IDN **S-0-0092** is stored in the parameter set, so it will be valid, if once set up and saved.



As of FW 3.5.0.1.6 additive torque (**S-0-0081**) and speed values (**S-0-0037**) are available if they are activated in the IDN **P-0-0130 (Feed forward control)**.

7.1 IDNs

IDN	S-0-0032		
Name	Primary operation mode		
Description	The primary operation mode is defined in this IDN. The operation mode can be switched by the master by setting bits in the controlword.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0033		
Name	Secondary operation mode-1		
Description	The secondary operation mode 1 is defined in this IDN. The operation mode can be switched by the master by setting bits in the controlword.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0034		
Name	Secondary operation mode-2		
Description	The secondary operation mode 2 is defined in this IDN. The operation mode can be switched by the master by setting bits in the controlword.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0035		
Name	Secondary operation mode-3		
Description	The secondary operation mode 3 is defined in this IDN. The operation mode can be switched by the master by setting bits in the controlword.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

7.2 Torque control

7.2.1 Overview

In the Operation mode “Torque control” a new torque setpoint (**Torque command value, S-0-0080**) must be available in the time pattern of the SERCOS cycle time. This value is the input value of the torque controller. The actual torque can be read by the **Torque feedback value (S-0-0084)**. It is in the responsibility of the user to ensure, that the **Torque command value** is embedded in the MDT before switching to this operation mode.

7.2.2 IDNs

IDN	S-0-0080		
Name	Torque command value		
Description	During the torque control operation mode of the drive, torque command values are transferred from the control unit to the drive.		
Min	-2^{15}	Datatype	INT16
Max	$(2^{15})-1$	Scaling	TORQUE
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0084		
Name	Torque feedback value		
Description	The torque feedback value is transferred from the drive to the control unit during torque control operation mode.		
Min	---	Datatype	INT16
Max	---	Scaling	TORQUE
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0081		
Name	Additive torque command value		
Description	The additive torque command value is added to the torque command value (S-0-0080).		
Min	-2^{15}	Datatype	INT16
Max	$(2^{15})-1$	Scaling	TORQUE
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

7.3 Velocity control

7.3.1 Overview

In the Operation mode “Velocity control” a new velocity setpoint (**Velocity command value, S-0-0036**) must be available in the time pattern of the SERCOS cycle time. This value is the input value of the velocity controller, that generates the setpoint for the torque controller. The actual velocity can be read by the **Velocity feedback value 1 (S-0-0040)**. It is in the responsibility of the user to ensure, that the **Velocity command value** is embedded in the MDT before switching to this operation mode.

7.3.2 IDNs

IDN	S-0-0036		
Name	Velocity command value		
Description	In the velocity control operation mode in the drive, the control unit transfers the velocity command values to the drive in the time pattern of the control unit cycle time.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0040		
Name	Velocity feedback value-1		
Description	The velocity feedback value 1 is transferred from the drive to the control unit in order to allow the control unit to periodically display the velocity. The velocity feedback value 1 always refers to the motor encoder (ServoCommander™: Operation mode / Encoder selection / Commutating Encoder)		
Min	---	Datatype	INT32
Max	---	Scaling	VELOCITY
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0037		
Name	Additive velocity command value		
Description	The Additive velocity command value is added to the internal velocity command (S-0-0036).		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.5.0.1.1

7.4 Position control

7.4.1 Overview

In the Operation mode "Position control" a new position setpoint (**Position command value, S-0-0047**) must be available in the time pattern of the SERCOS cycle time. This value is the input value of the internal interpolator. This interpolator generates position setpoints in the time pattern of the position controller (about 4 times faster than the SERCOS cycle time for example) and also generates velocity feed forward values. Thereby the position and velocity controller will receive new setpoints with a higher cycle time as the SERCOS cycle time. Therefore the drive follows lagless (without following error) the SERCOS position setpoints (command values). The actual position can either be read by the **Position feedback value 1 (S-0-0051)** or the **Position feedback value 2 (S-0-0053)**. The first one gives the position feedback value of the motor encoder, the second one the feedback of an optional external encoder. They are valid corresponding to the particular active Operation mode. In Operation mode *Position control using the „commutating encoder“* **S-0-0051** returns the position of the motor encoder and **S-0-0053** the position of an external encoder. If the motor encoder is only used for the commutation (Operation mode *Position control using the „position actual value encoder“*), **S-0-0051** returns 0. It is not allowed to switch online between the internal and the external feedback. If one Operation mode IDN (**S-0-0032, S-0-0033, S-0-0034, S-0-0035**) has been set to 0x000B it is not allowed to set any other to 0x000C and vice versa. It is in the responsibility of the user to ensure, that the **Position command value** is embedded in the MDT before switching to this operation mode.

7.4.2 IDNs

IDN	S-0-0047		
Name	Position command value		
Description	During the position control operation mode, the position command values are transferred from the control unit to the drive according to the time pattern of the control unit cycle.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0051		
Name	Position feedback value-1		
Description	The position feedback value 1 is transferred from the drive to the control unit so that it is possible for the control unit to monitor and display position information. The position feedback value 1 refers to the motor encoder (ServoCommander™: Operation mode / Encoder selection / Commutating Encoder) Important: If position control on feedback value 2 (external feedback) is selected the value of this IDN is 0.		
Min	---	Datatype	INT32
Max	---	Scaling	POSITION
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0053		
Name	Position feedback value-2		
Description	Position feedback value 2 contains the position actual value of an optional external encoder. (ServoCommander™: Operation mode / Encoder selection / Actual Position Value). Important: If position control on feedback value 1 (motor feedback) is selected as operation mode, the value of this IDN returns the position of the selected synchronisation input.		
Min	---	Datatype	INT32
Max	---	Scaling	POSITION
Access	R	Type	Parameter
Mapping	AT	Available	3.5.0.1.1

IDN	S-0-0189		
Name	Following distance		
Description	The drive uses the operation data of this IDN to store the distance between the position command value and the appropriate position feedback value (1 or 2).		
Min	---	Datatype	INT32
Max	---	Scaling	POSITION
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	P-0-0130		
Name	Feed forward control		
Description	Allows the master to apply / release the feed forward control manually		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

Value	Description
0 _h	No feed-forward of the IPO and no additive setpoints (ID.No. 37, 81) active. No fine interpolation
1 _h	Internal current feed-forward based on position setpoints is active
2 _h	Internal speed feed-forward based on position setpoints is active
4 _h	Additive current feed forward active (S-0-0081)
8 _h	Additive speed feed forward active (S-0-0037)
10 _h	Internal current interpolation active
20 _h	Internal speed interpolation active

7.5 Drive controlled interpolation

7.5.1 Overview

In this operation mode, the drive receives a new target position by the master and moves on its own to this position respecting the given **Positioning velocity (S-0-0259)**, the **Positioning acceleration (S-0-0260)** and **Positioning deceleration (S-0-0359)**. It is not necessary that the target position is given cyclically, it may also be transmitted via the Service Channel. A new positioning motion is started every time a new **Target position (S-0-0258)** will be written.

7.5.2 IDNs

IDN	S-0-0258		
Name	Target position		
Description	If "drive controlled interpolation" is selected as operation mode, this IDN is used by the master to transmit the absolute target position. The drive moves to the target position, taking the "positioning velocity" (IDN S-0-0259), the "positioning acceleration" (IDN S-0-0260) and the "positioning deceleration" (IDN S-0-0359) into account.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0259		
Name	Positioning velocity		
Description	The “positioning velocity” is used in the operation mode “drive controlled interpolation” as the velocity for travelling to the “target position” (IDN S-0-0258). If the positioning acceleration (S-0-0260) or deceleration (S-0-0359) is set to a small value or the distance from the actual position feedback value (S-0-0051 or S-0-0053) to the target position (S-0-0258) is too short, the positioning speed may not be reached.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0260		
Name	Positioning acceleration		
Description	The “positioning acceleration” is used in the operation mode “drive controlled interpolation” as the acceleration in all movements of the drive.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	ACCELERATION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0359		
Name	Positioning deceleration		
Description	The “positioning deceleration” is used in the operation mode “drive controlled interpolation” as the deceleration in all movements of the drive.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	ACCELERATION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0108		
Name	Feedrate override		
Description	The feedrate override is activated only with drive controlled procedure commands. In such a case, the velocity command value is calculated internally by the drive. The feedrate override has multiplying effects on this velocity command value.		
Min	0	Datatype	UINT16
Max	200 %	Scaling	PERCENT
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

8 Controlword / Statusword

8.1.1 Overview

The drive can be controlled by the controlword (transmitted in the MDT), the status of the drive can be read by the statusword (transmitted in the AT). Besides several handshake bits for Service Channel communication are embedded, the Operation mode can be selected (Bit 8...9) and the drive can be enabled / disabled (Bit 13...15) by the controlword. Two free configurable bits (realtime bits) can control processes within the servo (see chapter 9.10). For debug purposes the controlword and the statusword can be read by „normal“ IDNs: **S-0-0134** and **S-0-0135**

Bit	Description	Value
0...2	Service Channel	Transport handshake of the Service Channel
3...5	Data block element	000b: Service Channel not active 001b: IDN 010b: Name 011b: Attribute 100b: Unit 101b: Minimum 110b: Maximum 111b: Operation data
6	Realtime control bit 1	see Chapter 9.10
7	Realtime control bit 2	see Chapter 9.10
8...9	Operation mode	00b: Primary operation mode 01b: Secondary operation mode 1 10b: Secondary operation mode 2 11b: Secondary operation mode 3
10...12	Reserved	
13	Halt / Restart	1 -> 0: If drive performs a drive controlled homing, the drive is halted with the homing acceleration. The homing will not be interrupted. It can be continued by setting the halt bit again. The Halt bit is without effect in other cases ! 0 -> 1: Continue interrupted homing procedure.
14	Enable drive (power stage)	1 -> 0: The power stage will be switched off immediately, the motor is freely rotatable (if no motor brake is available). 1: The power stage is enabled. The controller may be switched on, by setting bit 15
15	Drive on	1 -> 0: The motor will decelerated according to the „Quick stop deceleration“ (ServoCommander™: Parameters / Safety parameters / Decelerations – Quick stop). After decelerating, the power stage will be switched off. 0 -> 1: If bit 14 is set, the power stage will be enabled, the motor will be controlled according to the currently selected operation mode.

**Power stage disabled**

This means the transistors are not driven anymore. If this state is reached on a rotating motor, the motor coasts down, without being braked, if no mechanical brake is available. A motor brake will be locked immediately.

CAUTION: This does not ensure the motor is not under voltage

**Power stage enabled**

This means the motor will be controlled according to the chosen Operation mode. If a motor brake is available, it will be released. An incorrect parameter set-up or a defect may cause an uncontrolled behaviour of the motor.



Before switching on the power stage for the first time, assure that the servo controller contains suitable parameters for the desired application (Operation mode, Telegram type, Motor current, etc.). An incorrect parameter set-up may cause uncontrolled behaviour of the drive and thereby personal or material damage may occur.



Check **S-0-0092 (bipolar torque limit value)** before enabling the drive. If the **S-0-0092** is not set to a suitable value in CP2 no torque will be supplied to the motor. Therefore the motor will not move.

The following bits of the **statusword** can be read. Similar to the Realtime control bits, two statusbits (Bit 6 and 7) can be configured application specific.

Bit	Description	Value
0...2	Service Channel	Transport handshake of the Service Channel
3	Status command value processing	Not supported
4	Reserved	-
5	Procedure Command change bit	Is set by the drive, if the status of an active command changes: 0b: no change in Procedure Command status 1b: status of one of the active commands has changed
6	Realtime status bit 1	
7	Realtime status bit 2	
8...9	Actual operation mode	00b: Primary operation mode 01b: Secondary operation mode 1 10b: Secondary operation mode 2 11b: Secondary operation mode 3
11	Changebit C3D	0b: Not changed 1b: Changed
12	Changebit C2D	0b: Not changed 1b: Changed
13	Changebit C1D	0b: No shutdown 1b: Shutdown due to C1D error
14...15	Ready to operate	00b: Drive not ready for power up 01b: Drive ready for main power on 10b: Drive ready and main power applied 11b: Drive ready to operate, power stage is active

Linear axes normally need to identify their initial position each time the drive will be enabled the first time. The identification process will be started with a rising edge of bit 15 of the controlword and may take some time. Not until the identification process has been finished successful, the Bits 14 and 15 of the statuswords will set to 11b. To avoid timeouts in the master device it is possible to check the necessity of this identifying procedure by reading **S-0-0182** (see Chapter 9.4.3). Furthermore it can be checked, if the servo controller can be enabled by the controlword by **P-0-0020 (Drive enable status)**.

To control functions like performing a reset beside the SERCOS specific controlword, a manufacturer controlword is available (**P-0-0090, General controlword**).

8.1.2 IDNs

IDN	S-0-0134		
Name	Master control word		
Description	Enables the display of the master control word on the control unit screen, via the service channel (This can be useful during start-up and error recovery).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0135		
Name	Drive status word		
Description	Enables the display of the drive status word on the control unit screen, via the service channel (This can be useful during start-up and error recovery).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	P-0-0090		
Name	General controlword		
Description	Used to control miscellaneous manufacturer specific functionality:		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

Bit	Description	Value
0	prepare_for_reset	If this bit is set, the servo will execute a reset when switching to phase 0 next time.

IDN	P-0-0020		
Name	Drive enable status		
Description	To check, if the servo controller can be enabled by the controlword, it is possible to read out the MDR 2000enable status before enabling the drive. If all bits in this IDN are 0 the drive is ready for drive enable. Otherwise the user is able to see, why the MDR 2000can not be enabled.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	3.3.0.1.1

Bit	Description
0	Preload DC bus not completed
1	Encoder not ready
2	Autoidentification encoder still in progress
3	Autoidentification current controller still in progress
4...15	Reserved
16	Controller enable logic <> "DIn5 and SERCOS"
17	Logical powerstage enable is missing (according to enable logic: DIn4 + X)
18	Logical controller enable is missing (according to enable logic: DIn5 + X)
19	Reserved
20	Error existent
21	DIN4 missing
22	DIN5 missing
23...31	Reserved

9 Setting of parameters

9.1 Save Parameter Set

9.1.1.1 Overview

By the use of the **IDN S-0-0264 (Backup Working Memory)** the actual contents of the parameter set of the drive can be saved to the drives internal Flash memory. This way the data will be available next time after power off or save and reset of the drive.

The Procedure Command **S-0-0264** is started like every other Procedure Command. After starting the command, the drive will start to backup all parameters to the non volatile memory. This may take up to a few seconds. The command will be acknowledged by the drive as ready executed after this time.

9.1.1.2 IDNs

IDN	S-0-0264		
Name	Backup working memory		
Description	By the use of this procedure command the control may backup the actual parameter set to the non volatile memory. This way all settings are available after power off or reset of the drive.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

9.2 Scaling of data

For simply adapting the servo positioning controller to your special application, the scaling of most of the parameters can be changed. That means the unit and valence of the data, that is transmitted on the SERCOS bus, can be changed. All data transferred on the SERCOS bus are integer values. It is not possible to transmit floating-point numbers.

EXAMPLE

The scaling of position values should be degree. It should be accurate to 4 decimal places, i.e. the valence of one bit should be $0,0001^\circ$

So, if a position of $180,1234^\circ$ should be written, the value 1801234 (1B7C12_h) must be transmitted on the bus.

The scaling of speed values should be RPM. It should be accurate to 4 decimal places, i.e. the valence of one bit should be 0,0001 RPM

So, if a speed of 2538,9876 RPM should be written, the value 25389876 (1836B34_h) must be transmitted on the bus.



SERCOS differentiates between unscaled operation data and application- specific scaled data. With application- specific scaling, the data is referred depending on rotational or linear load movements. In this case for all different scaling types there are the following possible settings:

1. Get rotational data with reference to the motor shaft
2. Get rotational scaling with reference to the load (includes gearbox)
3. Get translatory scaling with reference to the load (includes gearbox and feed constant)

The following figure shall illustrate the use of the scaling parameters:

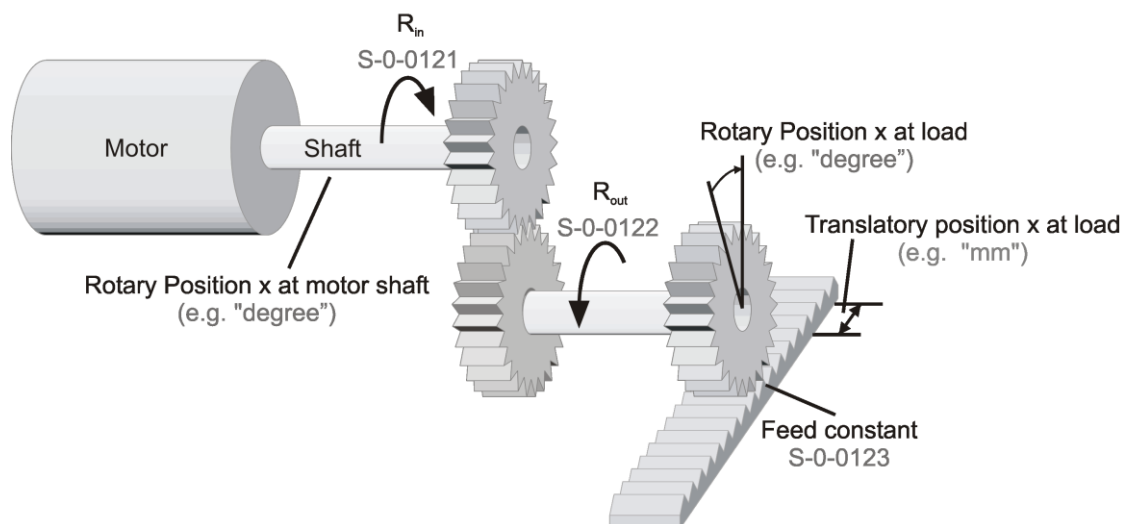


Figure 9.11: Use of scaling parameters

Several predefined scalings are available for position, velocity, torque and acceleration data. The desired scaling types must be configured in communication phase 2. They will become active in the

Procedure Command **S-0-0128 (CP4 transition check)**. Therefore in CP4 all data are scaled and transmitted using the configured scaling parameters.

In most NC and controls, the control automatically reads the scaling parameters from the drive and therefore knows, in which way all the parameters must be scaled to transmit them in the correct format on the SERCOS fieldbus. If this is not done automatically by your control, you have to read all the scaling parameters in CP2 from the drive and determine your own conversion factors to scale your data according to the format, that is used on the SERCOS fieldbus.



All scaling parameters are stored in the drives parameter set. So if they have been configured once and stored in the parameter set, they do not need to be transmitted in CP2 anymore, as they will automatically be used after “Reset” of the drive. If you did not set up and save the scaling parameters at least once, the drive will always use the following default scaling parameters.

9.2.1 Default values

Name	Scaling	LSB =
POSITION	Rotational scaling on the motor shaft in °	10^{-4} °
SPEED	Rotational scaling on the motor shaft in RPM	10^{-4} RPM
ACCELERATION	Rotational scaling on the motor shaft in rad/s ²	10^{-3} rad / s ²
TORQUE	At the motor shaft in Nm	10^{-2} Nm
TEMPERATURE	In degree Celsius	10^{-1} ° C
CURRENT		10^{-3} A = 1 mA
VOLTAGE		10^{-3} V = 1 mV
TIME_ms		10^{-4} s = 0,1 ms
TIME_μs		10^{-6} s = 1 μs
PERCENT		10^{-2} %

Several IDNs are available to set the configuration of the scalings. In the following chapters for each data type all available scalings and the resulting LSB valence are described in detail.

9.2.2 POSITION data

9.2.2.1 Overview

The scaling can be set bit by bit in the IDN **S-0-0076**. The following chart gives an overview about the available scalings (Linear scaling on the motor shaft is not available up to now):

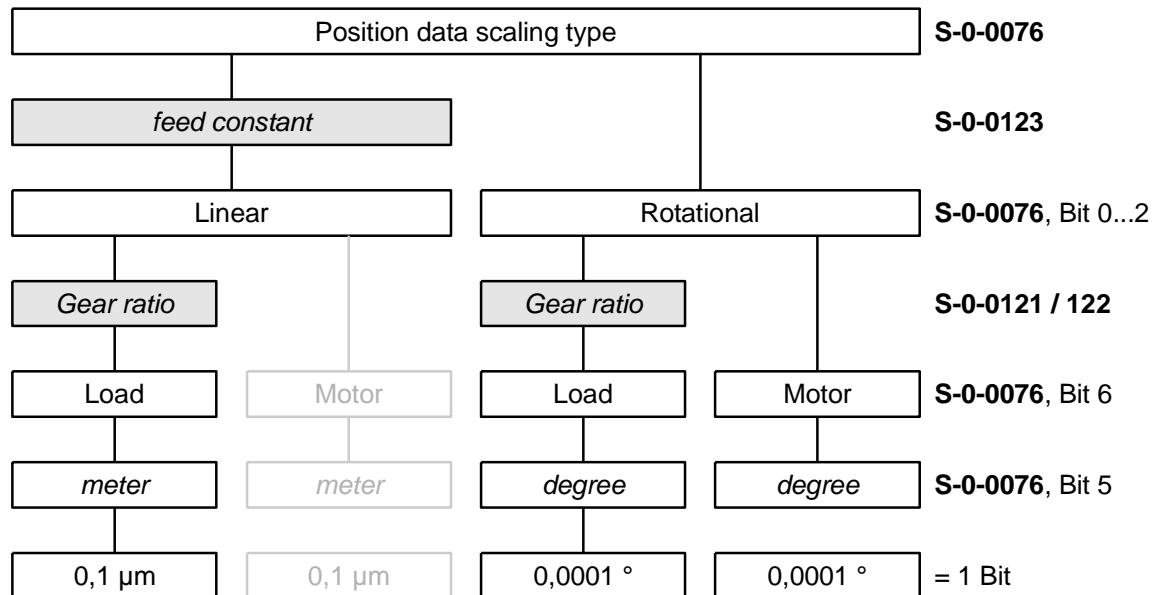


Figure 9.12: Position data scaling

9.2.2.2 IDNs

IDN	S-0-0076		
Name	Position data scaling type		
Description	A variety of scaling methods can be selected for position data by means of the scaling type parameter.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

The following values are valid for IDN **S-0-0076**:

Bit	Description	Value
0...2	Scaling method	00b: No scaling (incremental) 01b: Linear scaling 10b: Rotational scaling
3	Preferred scaling	0b: Preferred scaling 1b: <i>Not allowed</i>
4	Unit for linear / rotational scaling	0b: Meter / Degree 1b: <i>Not allowed</i>
5	Reserved	
6	Data reference	0b: At the motor shaft 1b: At the load
7	Processing format	0b: Absolute format 1b: Modulo format (see IDN S-0-0103)
8...15	Reserved	

9.2.2.3 No scaling

If no scaling is selected all position data will be transmitted with the internal scaling of position data (2^{32} Increments = 1 Revolution). As the position values defined by SERCOS are 4-byte values, this scaling is in general not useful for applications. Therefore “No scaling” can not be selected.

9.2.2.4 Linear scaling

If a linear motor or a linear drive is used it is convenient to use linear position values. At this the scaling is defined by the parameters **linear position data scaling factor (S-0-0077)** and **linear position data scaling exponent (S-0-0078)** by use of the following formula:

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

With 1 for the factor and –7 for the exponent this leads to a resolution of 0,1 µm per bit.

The ratio between revolutions of the motor and the linear movement is defined by the **feed constant (S-0-0123)**. If additionally the linear scaling is referred to the load, the **gear ratio (S-0-0121 / S-0-0122)** has to be set accordingly.

9.2.2.5 Rotational scaling

If rotational is selected the **rotational position resolution** is given by parameter **S-0-0079** and defines the increments per revolution.

A **rotational position resolution** of 3 600 000 results in a scaling of 0,0001° per bit.

If additionally the rotational scaling is referred to the load, the **gear ratio (S-0-0121 / S-0-0122)** has to be set accordingly.

IDN	S-0-0077		
Name	Position data scaling factor		
Description	This parameter defines the scaling factor for all position data in a drive.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0078		
Name	Position data scaling exponent		
Description	This parameter defines the scaling exponent for all position data in a drive.		
Min	---	Datatype	INT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0121		
Name	Input revolution of load gear		
Description	If a scaling type with reference to the load is selected, an gear is calculated within the conversion factors. The input revolution values must be entered as integer value in this IDN.		
Min	1	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0122		
Name	Output revolution of load gear		
Description	Like S-0-0121, but the output revolution values must be entered in this IDN.		
Min	1	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0123		
Name	Feed constant		
Description	The feed constant describes the machine element which converts a rotational motion into a linear motion. The feed constant indicates the linear distance during one revolution of the feed spindle. It is used for all linear data scaling.		
Min	1	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	1 µm / Revolution
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0103		
Name	Modulo value		
Description	If bit 7 (Modulo format) is set in IDN S-0-0076 the position data will be given within the range 0...S-0-103. The maximum difference between two consecutive position command values must not exceed IDN S-0-0103 / 2 !		
Min	0	Datatype	INT32
Max	$(2^{31})-1$	Scaling	---
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

9.2.3 VELOCITY data

9.2.3.1 Overview

The scaling can be set bit by bit in the IDN **S-0-0044**. The following chart gives an overview about the available scalings (Linear scaling on the motor shaft is not available up to now):

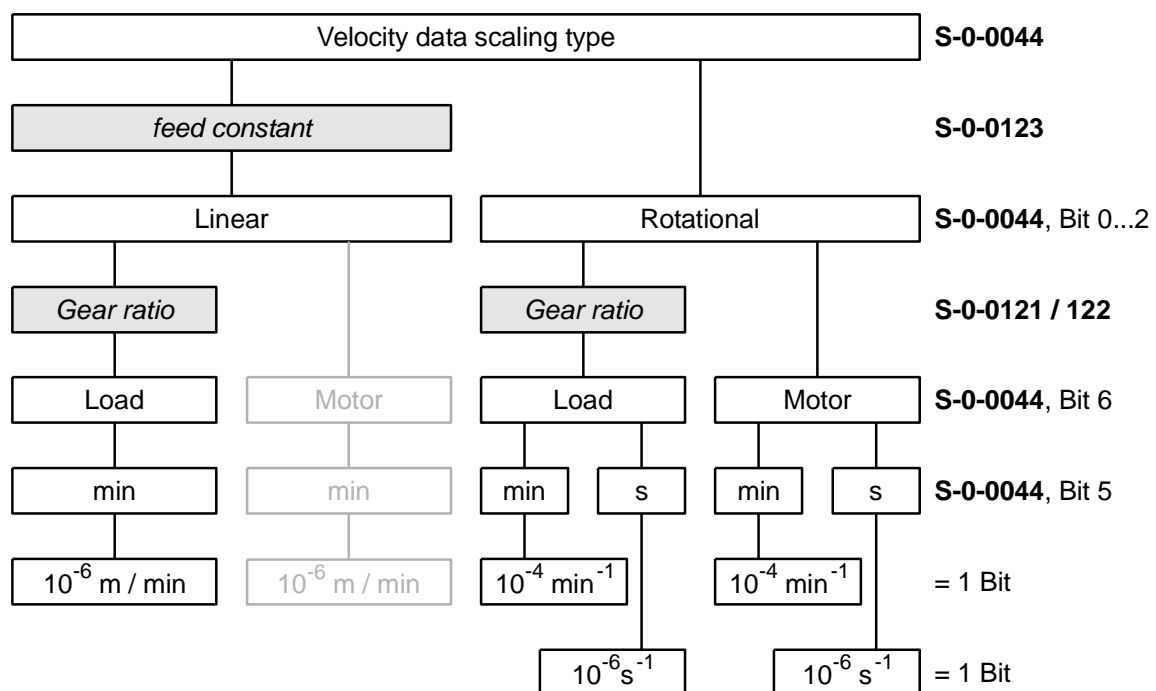


Figure 9.13: Velocity data scaling

9.2.3.2 IDNs

IDN	S-0-0044		
Name	Velocity data scaling type		
Description	A variety of scaling methods can be selected by means of the scaling type parameter.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

The following values are valid for IDN **S-0-0044**:

Bit	Description	Value
0...2	Scaling method	00b: No scaling (incremental) 01b: Linear scaling 10b: Rotational scaling
3	Preferred scaling	0b: Preferred scaling 1b: <i>Not allowed</i>
4	Unit for linear / rotational scaling	0b: Meter / Revolutions 1b: <i>Not allowed</i>
5	Time units	0b: Minutes 1b: Seconds
6	Data reference	0b: At the motor shaft 1b: At the load
7...15	Reserved	

9.2.3.3 No scaling

“No scaling” can not be selected up to now.

9.2.3.4 Linear scaling

For linear scaling of velocity data the scaling is defined by the parameters **velocity data scaling factor (S-0-0045)** and **velocity data scaling exponent (S-0-0046)** by use of the following formula:

$$\text{LSB} = \text{S-0-0045} * 10^{\text{S-0-0046}}$$

With 1 for the factor and –6 for the exponent this leads to a resolution of 0,001 mm/min per bit.

The ratio between revolutions of the motor shaft and the linear movement is defined by the **feed constant (S-0-0123)**. Because only scaling referred to the load can be selected, the **gear ratio (S-0-0121 / S-0-0122)** has to be set accordingly.

9.2.3.5 Rotational scaling

For rotational scaling of velocity the scaling is also defined by the parameters **velocity data scaling factor (S-0-0045)** and **velocity data scaling exponent (S-0-0046)** by use of the following formula:

$$\text{LSB} = \text{S-0-0045} * 10^{\text{S-0-0046}}$$

For rotational scaling additionally the time unit (min / s) can be selected. For minutes the scaling exponent is -4 , for seconds -6 . With 1 for the factor this lead to an resolution of $0,0001 \text{ min}^{-1}$ per bit respectively $0,000\ 001 \text{ s}^{-1}$ per bit .

If additionally the scaling is referred to the load, the **gear ratio (S-0-0121 / S-0-0122)** has to be set accordingly.

IDN	S-0-0045		
Name	Velocity data scaling factor		
Description	This parameter defines the scaling factor for all velocity data. It can only be read.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0046		
Name	Velocity data scaling exponent		
Description	This parameter defines the scaling exponent for all velocity data. It can only be read.		
Min	---	Datatype	INT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

9.2.4 ACCELERATION data

9.2.4.1 Overview

The scaling can be set bit by bit in the IDN **S-0-0160**. The following chart gives an overview about the available scalings (Linear scaling on the motor shaft is not available up to now):

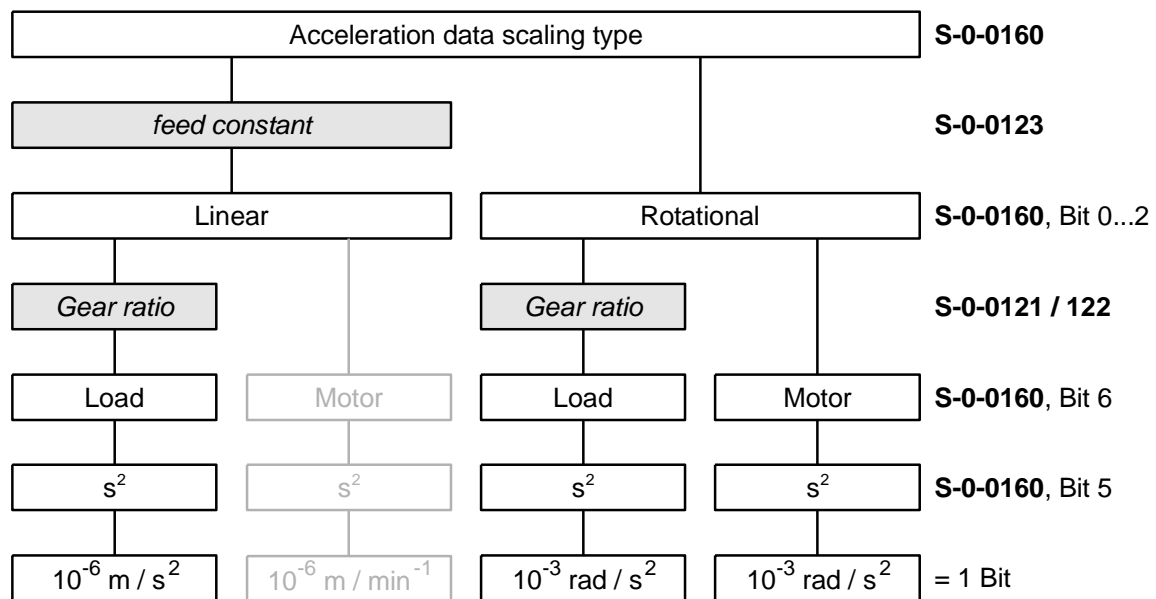


Figure 9.14: Acceleration data scaling

9.2.4.2 IDNs

IDN	S-0-0160		
Name	Acceleration scaling type		
Description	A variety of scaling methods can be selected by means of the acceleration data scaling type parameter.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

The following values are valid for IDN **S-0-0160**:

Bit	Description	Value
0...2	Scaling method	00b: No scaling (incremental) 01b: Linear scaling 10b: Rotational scaling
3	Preferred scaling	0b: Preferred scaling 1b: <i>Not allowed</i>
4	Unit for linear / rotational scaling	0b: Meter / rad 1b: <i>Not allowed</i>
5	Time units	0b: Minutes 1b: Reserved
6	Data reference	0b: At the motor shaft 1b: At the load
7...15	Reserved	

9.2.4.3 No scaling

“No scaling” can not be selected up to now.

9.2.4.4 Linear scaling

For linear scaling of acceleration data the scaling is defined by the parameters **acceleration data scaling factor (S-0-0161)** and **acceleration data scaling exponent (S-0-0162)** by use of the following formula:

$$\text{LSB} = \text{S-0-0161} * 10^{\text{S-0-0162}}$$

With 1 for the factor and –6 for the exponent this lead to an resolution of 0,000 001 m/s² per bit. The ratio between revolutions of the motor and the linear movement is defined by the **feed constant (S-0-0123)**. Because only scaling referred to the load can be selected, the **gear ratio (S-0-0121 / S-0-0122)** has to be set accordingly.

9.2.4.5 Rotational scaling

For rotational scaling of acceleration the scaling is also defined by the parameter **acceleration data scaling factor (S-0-0161)** and **acceleration data scaling exponent (S-0-0162)** through the following formula:

$$\text{LSB} = \text{S-0-0161} * 10^{\text{S-0-0162}}$$

With 1 for the factor and –3 for the exponent this lead to an resolution of 0,001 rad/s² per bit. If additionally the scaling is referred to the load, the **gear ratio (S-0-0121 / S-0-0122)** has to be set accordingly.

IDN	S-0-0161		
Name	Acceleration scaling factor		
Description	This parameter defines the scaling factor for all acceleration data in a drive. It can only be read.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0162		
Name	Acceleration scaling exponent		
Description	This parameter defines the scaling exponent for all acceleration data in a drive. It can only be read.		
Min	---	Datatype	INT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

9.2.5 TORQUE data

9.2.5.1 Overview

For scaling of torque data the scaling is defined by the parameter **torque data scaling exponent (S-0-0094)** through the following formula:

$$\text{LSB} = 1 * 10^{\text{S-0-0094}}$$

Torque data will always be given in Nm, referred to the Motor. As torque data is scaled in Nm, the torque constant has to be set accordingly (**P-0-0100**).

9.2.5.2 IDNs

IDN	S-0-0094		
Name	Torque scaling exponent		
Description	This parameter defines the scaling exponent for all torque / force data in the drive.		
Min	-2	Datatype	INT16
Max	0	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	3.5.0.1.1

IDN	P-0-0100		
Name	Torque constant		
Description	The torque constant is needed to calculate all torque data which is transmitted in Nm on the SERCOS bus into drive internal values in Ampere. Therefore the conversion factor in Nm/A can be entered in this IDN		
Min	0,01 Nm / A	Datatype	UINT32
Max	100 Nm / A	Scaling	0,0001 Nm / A
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

9.2.6 TEMPERATURE data

9.2.6.1 Overview

Temperature data can be selected as °C and F by the IDN **Temperature data scaling type (S-0-0208)**. Therefore the following values are valid for IDN **S-0-0208**:

Bit	Description	Value
0	Temperature unit	00b: 0,1 °C 01b: 0,1 F
1...15	Reserved	

9.2.6.2 IDNs

IDN	S-0-0208		
Name	Temperature data scaling type		
Description	This scaling type parameter determines whether degree Celsius [°C] or Fahrenheit [F] is used as unit for all temperature data in the drive.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

9.2.7 CURRENT data

9.2.7.1 Overview

The scaling of current data is fixed to milliampere. So, the scaling is defined by the following formula:

$$\text{LSB} = 1 * 10^{-3} \text{ A}$$

9.2.8 VOLTAGE data

The scaling of voltage data is fixed to millivolt. So, the scaling is defined by the following formula:

$$\text{LSB} = 1 * 10^{-3} \text{ V}$$

9.2.9 TIME_ms data

The scaling of TIME_ms data is fixed to 0,1 milliseconds. So, the scaling is defined by the following formula:

$$\text{LSB} = 1 * 10^{-4} \text{ s}$$

9.2.10 TIME_μs data

The scaling of TIME_μs data is fixed to 1 microseconds. So, the scaling is defined by the following formula:

$$\text{LSB} = 1 * 10^{-6} \text{ s}$$

9.2.11 PERCENT data

The scaling of PERCENT data is fixed to 0,01 %. So, the scaling is defined by the following formula:

$$\text{LSB} = 1 * 10^{-2} \%$$

9.3 Drive Information

9.3.1 Overview

To get a better overview of all the drives in the SERCOS ring, there are some parameters implemented, that make it possible to give some detailed information to the drive.

The first important IDNs are the IDNs **S-0-0141 (Motor Type)** and **S-0-0142 (Application Type)**. By the use of this IDN the control may set some strings in the drive, that can be used to define the type of application, that is fulfilled by the drive and the type of the drive. This information is very helpful, as these strings are also shown in the Info window of Mattke ServoCommander™.

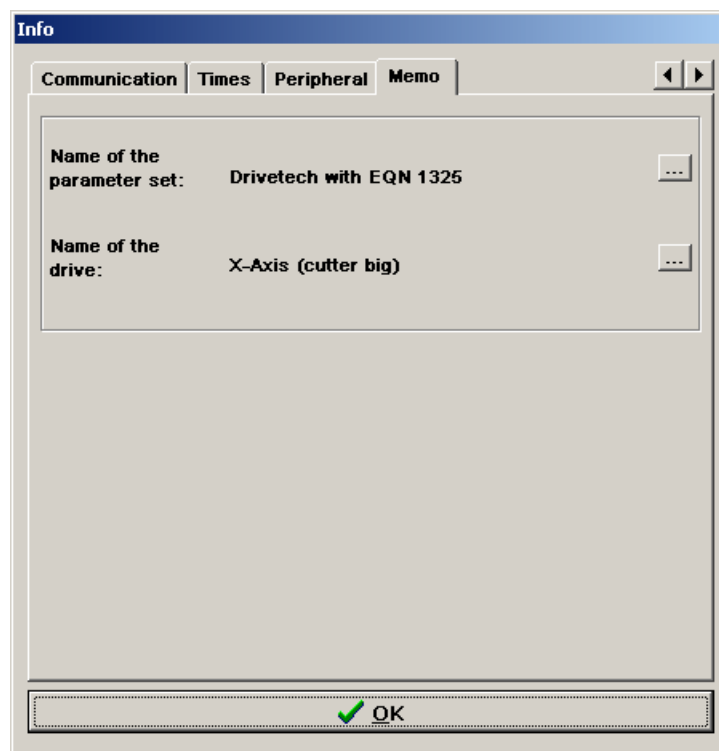


Figure 9.15: Information from IDNs S-0-0141 and S-0-0142 in Info window of the Mattke ServoCommander™

Additionally the name of the drive, that can be accessed by the SERCOS **IDN S-0-0141** is shown in the headbar of the Mattke ServoCommander™ like it is shown in the following picture.



Figure 9.16: Information from IDNs S-0-0141 in title bar of the Mattke ServoCommander™

This makes the configuration and first commissioning easier, as you always know to which drive in the SERCOS ring you are connected with the ServoCommander™ software.

The third IDN, that can be used to store drive specific information is the **IDN S-0-0271 (Drive ID)**. This IDN can simply be used to store a 32 bit wide ID in the drive.

Beyond this application-specific parameters, IDNs are available to determine the type of servo controller (S-0-0140) and the version of the implemented SERCOS specification.

9.3.2 IDNs

IDN	S-0-0141		
Name	Motor type		
Description	This IDN may contain the name of the company and the manufacturer of the motor. Note: This value can be seen in the Mattke ServoCommander™ software in the “Info” window.		
Min	---	Datatype	String
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0142		
Name	Application type		
Description	This IDN may contain the type of application. Note: This value can be seen in the Mattke ServoCommander™ software in the “Info” window.		
Min	---	Datatype	String
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0271		
Name	Drive ID		
Description	May be used to store an individual ID		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0140		
Name	Controller type		
Description	The operation data of the controller type contains the name of the company and the manufacturer controller type.		
Min	---	Datatype	String
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0143		
Name	Sercos interface version		
Description	This IDN shows the version number of the actual SERCOS Interface according to the SERCOS specification V2.2 (November 2001)		
Min	---	Datatype	String
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0030		
Name	Manufacturer version		
Description	The version of the SERCOS implementation can be read by this IDN.		
Min	---	Datatype	String
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

9.4 Error management

Generally there are three different types of messages defined on the SERCOS fieldbus system, that display status messages and errors to the control. These are the following:

1. **Class 1 Diagnostic (S-0-0011), C1D:**

Whenever a bit is set in this parameter and error is active in the drive, that lead to the deactivation of the controller. The according error number can be read from the IDN **S-0-0095 (Diagnostic message)**. The error can be acknowledged by the control by the use of the Procedure Command in IDN **S-0-0099 (Reset class 1 diagnostic)**.

2. **Class 2 Diagnostic (S-0-0012), C2D:**

Whenever a bit is set in this parameter a warning message is active in the drive. The control should read the diagnostic class and evaluate the message.

3. **Class 3 Diagnostic (S-0-0013), C3D:**

Whenever a bit is set in this parameter a info message is active in the drive. The control should read the diagnostic class and evaluate the message.

Beyond this SERCOS diagnostic classes there are manufacturer specific diagnostic classes. If a manufacturer specific event occurs bit 15 within the corresponding diagnostic class (CxD) will be set as well. For a detailed description of these IDNs see the following chapters. To avoid the master having to read all the single diagnostic classes cyclically to check for errors and warnings, there are additional status bits in the Drive Status Word in IDN **S-0-0135**. As this is transmitted cyclically, the master only needs to check the bits 11 (Changebit C1D), 12 (Changebit C2D) and 13 (Changebit C3D). Whenever the status of one of the diagnostic classes changes, the according status bit in the Drive Status Word is set. As reaction of the change of the status bit, the master should read the according diagnostic class via the Service Channel. For the diagnostic classes C2D and C3D, this will lead to the reset of the according statusbit in the Drive Status Word. Whereas all messages in the diagnostic class C1D refer to severe error messages in the drive, the status bit 11 (Changebit C1D) in the "Drive Status Word" is only reset by the drive, if the Procedure Command in **IDN S-0-0099 (Reset class 1 diagnostic)** is executed and the error can be acknowledged.

By use of **S-0-0097 (Mask class 2 diagnostic)** and **S-0-0098 (Mask class 3 diagnostic)** it can be selected, which events should set the Changebits. Thus only events relevant for the specific application may be monitored.

The diagnostic classes are the SERCOS standard for reporting the most common errors and events. Beyond this, the servo controllers of the MDR 2000series may report approximately 200 different events respective errors. If an error occurs that is not mapped into C1D, bit 0 of the **Manufacturer class 1 diagnostic (M1CD, S-0-0129)** will be set, leading to a set bit 15 of C1D. The Mattke error number - also shown on the display - can be read by **IDN S-0-0095 (Diagnostic message)**.

9.4.1 Class 1 diagnostic (C1D)

9.4.1.1 Overview

If an error situation of C1D occurs, the motor will be decelerated with the Quick stop deceleration (ServoCommander™: Parameters / Safety parameters). After decelerating the power stage will be switched off. Bit 13 of the drive statusword will be set to indicate the error situation.

C1D- Bits can only be reset by the command **reset class 1 diagnostic (S-0-0099)** if the cause of the error is not present anymore.

9.4.1.2 IDNs

IDN	S-0-0011		
Name	Class-1 diagnostic		
Description	This is the diagnostic class for all drive erros.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

Bit	Description	MDR 2000error nr.	See also
0	Overload	31	S-0-0114
1	Amplifier overtemperature	4	S-0-0203
2	Motor overtemperature	3	S-0-0204
3	--	-	S-0-0205
4	Control voltage error	5	
5	Feedback error	8	
6	--	-	
7	Overcurrent	6	
8	Overvoltage	7	
9	Undervoltage	2	
10	--	-	
11	Excessive position deviation	17	S-0-0159
12	Communication error	-	S-0-0014
13	Position limit exceeded	40	S-0-0049
14	--		
15	Manufacturer- specific error	-	S-0-0129

All errors that may occur in the MDR 2000 with no specific bit in the C1D will be set in S-0-0129 and therefore set bit 15 automatically.

IDN	S-0-0129		
Name	Manufacturer class-1 diagnostic (M1CD)		
Description	Signals an error, that has no specific bit in C1D. If a bit is set in the manufacturer class 1 diagnostic, the manufacturer-specific error bit in class 1 diagnostic (see IDN S-0-0011) is set as well.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

Bit	Description	MDR 2000error no.
0	General fault	see S-0-0095
1...15	Reserved	

Also Manufacturer class 1 diagnostics can only be reset by the command **reset class 1 diagnostic (S-0-0099)** if the cause of the error is not present anymore.

IDN	S-0-0099		
Name	Reset class-1 diagnostic		
Description	When this procedure command is received by the drive via the service channel and no error exists, C1D, the interface status, the manufacturer's C1D, the drive shut-down error (drive status bit 13), and the drive shut-down mechanism in the drive are all reset (see IDN S-0-0011, IDN S-0-0014, and IDN S-0-0129).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

9.4.2 Class 2 diagnostic (C2D)

9.4.2.1 Overview

In contrast to C1D the Class 2 Diagnostic reports warnings. C2D- Bits will be set, if the particular reason occurs and will be reset if the IDN will be read.

9.4.2.2 IDNs

IDN	S-0-0012		
Name	Class-2 diagnostic (C2D)		
Description	This is the diagnostic class for all warnings.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

Bit Nr.	Description	See also
0	Overload warning	S-0-0310
1	Amplifier overtemperature warning	S-0-0311
2	Motor overtemperature warning	S-0-0312
3...12	--	
13	Target position out of travel range ^{*)}	
14	--	
15	--	

^{*)} Only in "Drive controlled interpolation" operation mode

IDN	S-0-0097		
Name	Mask class-2 diagnostic		
Description	Using this mask, warnings in class 2 diagnostic can be masked with respect to their effect on the change bit in drive status. When changing masked warnings, the change bit for class 2 diagnostic is not set in the drive status. The mask does not affect the operation data of class 2 diagnostic (see IDN S-0-0012).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

9.4.3 Class 3 diagnostic (C3D)

9.4.3.1 Overview

Class 3 Diagnostic is composed out of status flags. C3D- Bits will be set, if the particular reason occurs and will be reset if the reason vanishes.

9.4.3.2 IDNs

IDN	S-0-0013		
Name	Class-3 diagnostic		
Description	This is the diagnostic class for all drive operation status flags.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

Bit Nr.	Description	See also
0	$n_{\text{feedback}} = n_{\text{command}}$	S-0-0330
1	$n_{\text{feedback}} = 0$	S-0-0331
2	$n_{\text{feedback}} < n_x$	S-0-0332
3..4	--	
5	$n_{\text{command}} > n_{\text{limit}}$	S-0-0335
6	In position	S-0-0336
7..14	--	
15	Manufacturer- specific status	S-0-0182

If an statusbit is set in the manufacturer class 3 diagnostic, the manufacturer-specific status bit in class 3 diagnostic (see IDN S-0-0013) is set as well.

IDN	S-0-0182		
Name	Manufacturer class-3 diagnostic		
Description			
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

Bit	Description
0	An internal automatic identification of the commutation position is necessary
1...15	Reserved

IDN	S-0-0098		
Name	Mask class-3 diagnostic		
Description	Using this mask, condition flags in C3D can be masked with respect to their effect on the change bit in drive status. When masked condition flags change, the change bit for C3D is not set in the drive status. The mask does not affect the operation data of C3D (see IDN S-0-0013).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

9.4.4 Diagnostic message

IDN	S-0-0095		
Name	Diagnostic message		
Description	The currently relevant operation status is being monitored with diagnostic messages. The diagnostic messages are generated by the drive as a text and stored in the operation data of this IDN. If an error occurs in the drive, the actual Mattke error number is transmitted to the master via this IDN. For the error codes please refer to the Software Manual "Servo Positioning Controller MDR 2000"		
Min	---	Datatype	String
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

9.4.5 Interface status

IDN	S-0-0014		
Name	Interface status		
Description	The Interface status signals communication errors or protocol errors.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

A communication error in **S-0-0014** leads to the following actions:

- A communication error is set in C1D (see IDN **S-0-0011**) if the interface status is set by an error.
- If a communication error has occurred, the error and the CP at the time of the error will be stored in bits 0...2 .

The drive resets a communication error only if cause of error has been eliminated and on receiving the command **reset class 1 diagnostic** (see IDN **S-0-0099**) via the Service Channel.

Bit Nr.	Name	Description	MDR 2000error no.
0...2	Communication phase	Actual phase	-
3	MST error	Two consecutive MSTs were missing. In CP3 or CP4 the MDR 2000will fall back to Phase 0. An error occurs, the drive will be stopped.	37-2
4	MDT error	Two consecutive MDTs were missing. In CP4 the MDR 2000will fall back to Phase 0. An error occurs, the drive will be stopped.	37-4
5	Invalid phase	Invalid phase by the master (CP > 4) MDR 2000will fall back to Phase 0. An error occurs, the drive will be stopped.	37-3
6	Error during phase upshift	Invalid phase sequence by the master. MDR 2000will fall back to Phase 0. An error occurs, the drive will be stopped.	37-3
7	Error during phase downshift	Illegal value for downshift (not to phase 0). MDR 2000will fall back to Phase 0. An error occurs, the drive will be stopped.	37-3
8	Phase switching without ready acknowledge	The master tries to change to CP3 or CP4 even though S-0-0127 or S-0-0128 haven't been acknowledged correctly.	37-3
9	Switching to uninitialised operation mode	An invalid or not initialised operation mode should be activated. An error occurs, the drive will be stopped.	37-5
10...15	Reserved		

9.4.6 Error reaction setting

9.4.6.1 Overview

The servo controllers of the MDR 2000series offer the possibility to change the error reaction of individual events, e.g. the occurrence of a following error. Thus the controller reacts different, when a certain event occurs. Depending on the settings of **error_management: error_reaction (P-0-0041)**, the drive can be decelerated, the power stage will be disabled immediately or a warning is shown on the display.

For each event a manufacturer- specific minimum error reaction is defined, which cannot be fallen below. In that way “critical” errors like 06 0 short circuit cannot be parametrised, because an immediate deactivation is necessary, in order to protect the servo controller from damages.

If an error reaction is set to a reaction, which is lower than the minimum allowed reaction for this error, then it is set to the minimum allowed error reaction automatically.

To change the error reaction, the parameter **error_management: error_number (P-0-0040)** has to be set. A list with all error codes is available in the manual “Servo positioning controller MDR 2000”.

9.4.6.2 IDNs

IDN	P-0-0040		
Name	Error management: error number		
Description	The IDN error_number contains the main error code, which reaction shall be changed. The main error code is normally displayed before the hyphen, e.g. error 08-2, main error code 8.		
Min	1	Datatype	UINT32
Max	96	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	P-0-0041		
Name	Error management: error reaction		
Description	The reaction to the error can be changed with this IDN. If the manufacturer's minimum reaction is lower than this reaction, it will be restricted to the minimum reaction. The actual adjusted reaction can be acquired via reading the IDN.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

The following parameters for **P-0-0041** are possible:

Value	Meaning
0	No action
1	Entry in the buffer
3	Warning on the 7 segment display
5	Disable controller
7	Brake with maximum current
8	Disable power stage

9.5 Current settings

9.5.1.1 Overview

The maximum current that can be applied to the motor, must be set in **S-0-0109 (Motor peak current)**, the continuous motor current must be set in **S-0-0111 (Motor continuous current)**. The maximum and the continuous current of the servo controller can be read by **S-0-0110 (Amplifier peak current)** and **S-0-0112 (Amplifier rated current)**.

9.5.1.2 IDNs

IDN	S-0-0109		
Name	Motor peak current		
Description	The maximum current of the motor must be written to this IDN. The current of the servo will be limited to this value. How long this value can be applied will be determined by S-0-0114.		
Min	---	Datatype	UINT32
Max	---	Scaling	CURRENT
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	S-0-0110		
Name	Amplifier peak current		
Description	The maximum available current of the servo can be read by this IDN.		
Min	---	Datatype	UINT32
Max	---	Scaling	CURRENT
Access	R	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	S-0-0111		
Name	Motor continuous current		
Description	The nominal current of the motor must be written to this IDN.		
Min	---	Datatype	UINT32
Max	---	Scaling	CURRENT
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	S-0-0112		
Name	Amplifier rated current		
Description	The nominal current of the servo can be read by this IDN.		
Min	---	Datatype	UINT32
Max	---	Scaling	CURRENT
Access	R	Type	Parameter
Mapping	---	Available	3.3.0.1.1

9.6 Current controller

9.6.1.1 Overview

The gain and the time constant of the current controller for the active current can be set by **S-0-0106 (Current loop proportional gain 1)** and **S-0-0107 (Current loop integral action time 1)**.

For the reactive current it can be set by **S-0-0119 (Current loop proportional gain 2)** and **S-0-0120 (Current loop integral action time 2)**.

9.6.1.2 IDNs

IDN	S-0-0106		
Name	Current loop proportional gain 1		
Description	Proportional gain of active current controller (Vq)		
Min	---	Datatype	UINT32
Max	---	Scaling	65536 = "1"
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

IDN	S-0-0107		
Name	Current loop integral action time 1		
Description	Time constant of active current controller (Tq)		
Min	---	Datatype	UINT32
Max	---	Scaling	TIME_μs
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

IDN	S-0-0119		
Name	Current loop proportional gain 2		
Description	Proportional gain of reactive current controller (Vd)		
Min	---	Datatype	UINT32
Max	---	Scaling	65536 = "1"
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

IDN	S-0-0120		
Name	Current loop integral action time 2		
Description	Time constant of reactive current controller (Td)		
Min	---	Datatype	UINT32
Max	---	Scaling	TIME_μs
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

9.7 Velocity controller

9.7.1.1 Overview

The gain and the time constant of the velocity controller can be set by **S-0-0100 (Velocity loop proportional gain)** and **S-0-0101 (Velocity loop integral action time)**.

9.7.1.2 IDNs

IDN	S-0-0100		
Name	Velocity loop proportional gain		
Description	Proportional gain of velocity controller		
Min	---	Datatype	UINT32
Max	---	Scaling	65536 = "1"
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

IDN	S-0-0101		
Name	Velocity loop integral action time		
Description	Time constant of velocity controller		
Min	---	Datatype	UINT32
Max	---	Scaling	TIME_μs
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.6

9.8 Position controller

9.8.1.1 Overview

The gain of the position controller can be set by **S-0-0104 (Position loop KV-factor)**.

9.8.1.2 IDNs

IDN	S-0-0104		
Name	Position loop KV-factor		
Description	The gain of the position loop controller can be set by this IDN.		
Min	0	Datatype	UINT16
Max	15	Scaling	0,01 (m / min) / mm
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

9.9 Automatic motoridentification

9.9.1.1 Overview

This feature of the MDR 2000servo controller allows the user to automatically identify the proper settings for an unknown motor, such as “number of poles”, the “encoder offset angle” and the current controller settings. Therefore two Procedure Commands are available to start the automatic motoridentification (**P-0-0101** and **P-0-0102**). The success of the automatic motoridentification can be read by **P-0-0103**.

The automatic motor identification is started by executing the respective command. If the identification succeeds the command will be finished normally, otherwise the command will be finished with an error. In this case reading **P-0-0103** will give information about the problem. It has been splitted into two parts: Bit 0...15 returns errors while executing **P-0-0101**, and Bit 16..31 returns errors while executing **P-0-0102**. Bit 0 resp. bit 15 will always be set if an error has occurred.

If the automatic identification function fails, please check the dc bus voltage, the encoder connection and the status of DIN 4: It must be set, while executing the identification function.



DIN 4 must be set to enable the power stage for executing the identification functions.



By starting the automatic identification functions the motors starts moving on its own! Therefore the motor must be freely rotatable!

9.9.1.2 IDNs

IDN	P-0-0101		
Name	Motoridentification current controller		
Description	All settings of the current controller can be determined automatically via this procedure command. Automatically detected settings are: Current controller gain and current controller time constant During the processing of P-0-0101 additional information can be read in P-0-0103. Note that the power stage has to be enabled (DIN4), but the controller has to be disabled (DIN5) for the proper execution of P-0-0101. Furthermore there must not be any errors in C1D and the motor must be able to turn without any load.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	3.3.0.1.1

IDN	P-0-0102		
Name	Motoridentification angle encoder		
Description	All settings of the angle encoder can be determined automatically via this procedure command. Automatically detected settings are: Number of poles, encoder offset angle, phase sequence. During the processing of P-0-0102 additional information can be read in P-0-0103. Note that the power stage has to be enabled (DIN4), but the controller has to be disabled (DIN5) for the proper execution of P-0-0102. Furthermore there must be no errors in C1D and the motor must be able to turn without any load.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	3.3.0.1.1

IDN	P-0-0103		
Name	Motoridentification status		
Description	Additional status information of the automatic motoridentification are displayed in this IDN. It should be read by the user, if any problem occurs while processing procedure commands P-0-0101 and P-0-0102. Note that even in case of the correct execution of P-0-0101 determined parameters could be limited or invalid. For this reason P-0-0103 should be evaluated by the user everytime P-0-0101 is executed.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	3.3.0.1.1

Error bits for P-0-0101 (0...15)

Bit	Description
0	Error occurred in P-0-0101
1	Controller enabled when starting
2	Power stage disabled while executing
3	Insufficient voltage level in DC Bus
4	Invalid pulse rise time
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Determined parameters are limited

Error bits for P-0-0102 (16...31)

Bit	Description
16	Error occurred in P-0-0102
17	Controller enabled when starting
18	Power stage disabled while executing
19	Unknown angle encoder
20	Index pulse not found
21	Invalid hallsensor signals
22	Commutation on hallsensor impossible
23	No segment change after 90°
24	Invalid segment distance
25	Motor could not rotate
26	Invalid number of poles determined
27	Reserved
28	Reserved
29	Reserved
30	Reserved
31	Reserved

9.10 Signal statusword / Realtime bits

To monitor the status of the drives, the master can configure the **Signal statusword**. It combines several statusbits of the drive, such as "In position", "nfeedback = 0" or "Overload warning". It needs to be mapped into the AT as cyclic data, to cyclically monitor the status. Additionally up to two bits (Realtime status bits) can be mapped into the **Drive status word (S-0-135)**, that is already exchanged cyclically (see Chapter 8). Likewise, the Realtime control bits are mapped into the **Master control word**. They can be used to control the Probing (see Chapter 9.18).

9.10.1 Signal statusword

9.10.1.1 IDNs

IDN	S-0-0144		
Name	Signal statusword		
Description	Signals can be transmitted in real-time from the drives to the control unit by means of the signal statusword. For this purpose, the signal statusword needs to be integrated in the AT as cyclic data.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0026		
Name	Configuration list signal statusword		
Description	This is the configuration list for all status bits which are shown in the signal status word (S-0-0144). The sequence of the IDNs in the configuration list determines the bit numbering scheme in IDN S-0-0144, starting with the LSB in the signal status word. The initial IDN of the configuration list defines bit 0. The last IDN defines bit 15 of the signal status word. Important: Only the following statusbits are allowed to be transmitted via the Signal statusword. The configuration of IDN list S-0-0026 is checked every time writing it via the service channel. Invalid IDNs are deleted from the list.		
Min	---	Datatype	IDN list
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	Description	IDN	Description
S-0-0310	Overload warning	S-0-0336	Status "In position"
S-0-0311	Amplifier overtemperature warning	S-0-0400	Home switch
S-0-0312	Motor overtemperature warning	S-0-0401	Probe 1
S-0-0330	Status " $n_{\text{feedback}} = n_{\text{command}}$ "	S-0-0403	Position feedback value status
S-0-0331	Status " $n_{\text{feedback}} = 0$ "	S-0-0409	Probe 1 positive latched
S-0-0332	Status " $n_{\text{feedback}} < n_x$ "	S-0-0410	Probe 1 negative latched

9.10.2 Realtime status bits

9.10.2.1 IDNs

IDN	S-0-0304		
Name	Realtime statusbit-1		
Description	The value of the "realtime status bit 1" which is also transmitted via bit 6 of the "drive statusword" (S-0-0135) can be read by this IDN.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0306		
Name	Realtime statusbit-2		
Description	The value of the "realtime status bit 2" which is also transmitted via bit 7 of the "drive statusword" (S-0-0135) can be read by this IDN.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0305		
Name	Allocation realtimestatusbit-1		
Description	In order to assign a signal to the “realtime status bit 1” (S-0-0304) and bit 6 of the “drive statusword” (S-0-0135), the IDN of the signal is written to the operation data of S-0-0305. Only the following statusbits are allowed to be transmitted via the Signal statusword.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0307		
Name	Allocation realtimestatusbit-2		
Description	In order to assign a signal to the “realtime status bit 2” (S-0-0306) and bit 7 of the “drive status word” (S-0-0135), the IDN of the signal is written to the operation data of S-0-0307. Only the following statusbits are allowed to be transmitted via the Signal statusword.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	Description	IDN	Description
S-0-0310	Overload warning	S-0-0336	Status “In position”
S-0-0311	Amplifier overtemperature warning	S-0-0400	Home switch
S-0-0312	Motor overtemperature warning	S-0-0401	Probe 1
S-0-0330	Status “ $n_{\text{feedback}} = n_{\text{command}}$ ”	S-0-0403	Position feedback value status
S-0-0331	Status “ $n_{\text{feedback}} = 0$ ”	S-0-0409	Probe 1 positive latched
S-0-0332	Status “ $n_{\text{feedback}} < n_x$ ”	S-0-0410	Probe 1 negative latched

9.10.3 Realtime control bits

9.10.3.1 IDNs

IDN	S-0-0300		
Name	Realtime controlbit-1		
Description	The value of the “realtime control bit 1” which is also transmitted via bit 6 of the “master control word” (S-0-0134) can be accessed by this IDN.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0302		
Name	Realtime controlbit-2		
Description	The value of the “realtime control bit 2” which is also transmitted via bit 7 of the “master control word” (S-0-0134) can be accessed by this IDN.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0301		
Name	Allocation realtimebit-1		
Description	In order to assign a signal to the “realtime control bit 1” (S-0-0300) and bit 6 of the “master controlword” (S-0-0134), the IDN of the signal is written to the operation data of S-0-0301. Only IDN S-0-0405 (probe 1 enable) is allowed to be configured as realtime control bit in S-0-0301. If the “realtime control bit 1” is not used, the value of IDN S-0-0301 should be set to “S-0-0000”. In this case the “realtime control bit 1” has no function.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0303		
Name	Allocation realtimebit-2		
Description	In order to assign a signal to the “realtime control bit 2” (S-0-0302) and bit 7 of the “master controlword” (S-0-0134), the IDN of the signal is written to the operation data of S-0-0303. Only IDN S-0-0405 (probe 1 enable) is allowed to be configured as realtime control bit in S-0-0303. If the “realtime control bit 2” is not used, the value of IDN S-0-0303 should be set to “S-0-0000”. In this case the “realtime control bit 2” has no function.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	Description	IDN	Description
S-0-0000	No function	S-0-0405	Probe 1 enable

9.11 Statusbits

9.11.1.1 Overview

The following IDNs can be used to configure the **Drive statusword** and the **Realtime status bits**. All following IDNs return 1, if the condition is true and 0 if it is false.

9.11.1.2 IDNs

IDN	S-0-0310		
Name	Overload warning		
Description	This parameter allows the “overload warning” to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-144). It corresponds to bit 0 of C2D (IDN S-0-0012) and is set appropriately according to the “Load limit of motor” (see 9.12.5).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0311		
Name	Amplifier overtemperature warning		
Description	This parameter allows the “amplifier overtemperature warning” to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). It corresponds to bit 1 of C2D (IDN S-0-0012) and is set appropriately according to the “amplifier warning temperature” (see 9.12.5).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0312		
Name	Motor overtemperature warning		
Description	This parameter allows the “Motor overtemperature warning” to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). It corresponds to bit 2 of C2D (IDN S-0-0012) and is set appropriately according to the “Motor warning temperature” (see 9.12.5).		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0330		
Name	Status n_feedback = n_command		
Description	This parameter allows the status " $n_{\text{feedback}} = n_{\text{command}}$ " to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). It corresponds to bit 0 of C3D (IDN S-0-0013) and is set when the velocity feedback value (IDN S-0-0040) is within the programmed velocity window (IDN S-0-0157). See Chapter 9.12.2.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0331		
Name	Status n_feedback = 0		
Description	This parameter allows the status " $n_{\text{feedback}} = 0$ " to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). It corresponds to bit 1 of C3D (IDN S-0-0013) and is set when the velocity feedback value (IDN S-0-0040) lies within the programmed standstill window (IDN S-0-0124). See Chapter 9.12.2.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0332		
Name	Status n_feedback < n_x		
Description	This parameter allows the status " $n_{\text{feedback}} < n_x$ " to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). It corresponds to bit 2 of C3D (IDN S-0-0013) and is set when the velocity feedback value (IDN S-0-0040) is smaller than the velocity threshold (S-0-0125). See Chapter 9.12.2.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0336		
Name	Status in position		
Description	<p>This parameter allows the status “In position” to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). It corresponds to bit 6 of C3D (IDN S-0-0013) and is set when the position feedback value falls within the position window (see IDN S-0-0057) relative to the position command value. See Chapter 9.12.1.</p> <p>IMPORTANT: This bit is only evaluated in the drive in drive controlled operation modes, such as “drive internal interpolation” or the “position spindle” procedure command (S-0-0152). It does not have a function in normal position control operation modes.</p>		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0400		
Name	Home switch		
Description	<p>This parameter allows the status “Home switch active” to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). The home switch is an active high signal.</p>		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0401		
Name	Probe-1		
Description	<p>This parameter allows the status “Sample switch active” to be assigned to a realtime status bit (see IDN S-0-0305) or the Signal statusword (S-0-0144). The sample switch is an active high signal. This IDN always displays the actual value of the sample switch, even if the “probing cycle” procedure command is not active in the drive. See Chapter 9.18 as well.</p>		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0403		
Name	Position feedback value status		
Description	When the drive is referenced to the coordinates referred to the machine zero point, the drive sets bit 0 of this parameter in order to inform the control unit that all actual position values are based on the zero point of the machine. Bit 0 is reset when either the procedure commands "drive controlled homing procedure" (IDN S-0-0148) or "cancel reference point" (IDN S-0-0191) are started or the drive loses its reference to the zero point of the machine e.g. due to an feedback system error. The position feedback value status can be assigned to a real-time status bit and therefore it can be permanently signalled to the control unit in the drive status word (see IDN S-0-0305). See Chapter 9.16.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

9.12 Limitation / Monitoring

As described in the previous chapter, several statusbits are available. The behaviour of these statusbits can be parametrised using the following IDNs.

9.12.1 Position

9.12.1.1 Overview

The **Positive position limit value (S-0-0049)** and **Negative position limit values (S-0-0050)** are used in Drive controlled interpolation to limit the position values. The behaviour of the statusbit "in position" (**S-0-0336**) can be set by the **Position Window (S-0-0057)**. The monitoring window (**S-0-0159**) is used to monitor the position deviation between setpoint and actual value. If the deviation leaves the monitoring window, a bit in C1D will be set.

9.12.1.2 IDNs

IDN	S-0-0049		
Name	Positive position limit value		
Description	The positive position limit value describes the maximum allowed distance in the positive direction. The positive position limit value is only enabled when all position data are based on the machine zero point. When the positive position limit value is exceeded, the drive sets an error bit in C1D (IDN S-0-0011). Important: The position limit value is only active in the operation mode "drive controlled interpolation"		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0050		
Name	Negative position limit value		
Description	The negative position limit value describes the maximum allowed distance in the negative direction. The negative position limit value is only enabled when all position data are based on the machine zero point. Important: The position limit value is only active in the operation mode "drive controlled interpolation"		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0057		
Name	Position window		
Description	When the difference between the accumulated position command value and the position feedback value is within the range of the position window, then the drive sets the status "in position" (IDN S-0-0336). The status "in position" can be assigned to a realtime status bit (statusword) (see IDN S-0-0305).		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0159		
Name	Monitoring window		
Description	By means of the monitoring window, the maximum position deviation, as referenced to the active position feedback value, can be defined for the position feedback value. When the position error (following error) value exceeds the maximum value of the monitoring window, the drive sets an error for excessive position deviation in C1D (IDN S-0-0011).		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

9.12.2 Velocity

9.12.2.1 Overview

The **Bipolar velocity limit value (S-0-0091)** can be used to monitor the actual velocity : If the actual velocity exceeds this limit value, a bit within C3D will be set (see Chapter 9.4.3). The behaviour of the statusbit "nfeedback = ncommand" (**S-0-0330**) can be set by the **Velocity Window (S-0-0157)** and the statusbit "nfeedback = 0" (**S-0-0331**) can be set by the **Standstill Window (S-0-0124)**. The behaviour of the statusbit "nfeedback < nx" (**S-0-0332**) can be changed by the **Velocity Threshold (nx) (S-0-0125)**.

9.12.2.2 IDNs

IDN	S-0-0091		
Name	Bipolar velocity limit value		
Description	If the bipolar velocity limit value is exceeded, the drive responds by setting the status "ncommand > nlimit" in C3D (see IDN S-0-0013).		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0157		
Name	Velocity window		
Description	The velocity window relates the current velocity to the velocity command value (IDN S-0-0036). If the current velocity feedback value falls within the window of the velocity command value plus or minus the velocity window, the drive sets the status: "nfeedback = ncommand" (IDN S-0-0330).		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0124		
Name	Standstill window		
Description	The standstill window describes the amount of the deviation of the velocity from 0. If the velocity feedback value is within the standstill window the drive sets the status: "nfeedback = 0" (IDN S-0-0331) in C3D.		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0125		
Name	Velocity threshold (nx)		
Description	If the velocity feedback value falls below the velocity threshold nx, the drive sets the status: "nfeedback < nx" (IDN S-0-0332) in C3D.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

9.12.3 Acceleration

9.12.3.1 Overview

The **Positive acceleration limit value (S-0-0136)**, the **Negative acceleration limit value (S-0-0137)** and the **Bipolar acceleration limit value (S-0-0138)** can be used to monitor the maximum acceleration in the Position Control Operating modes. Exceeding this limits will cause error 42-9.

9.12.3.2 IDNs

IDNs

IDN	S-0-0136		
Name	Positive acceleration limit value		
Description	The positive acceleration parameter limits the maximum acceleration ability of the drive to the programmed value. If the velocity increases it is said to be a positive acceleration.		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	ACCELERATION
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.5.0.1.6

IDN	S-0-0137		
Name	Negative acceleration limit value		
Description	The negative acceleration parameter limits the maximum acceleration ability of the drive to the programmed value. If the velocity decreases it is said to be a negative acceleration.		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	ACCELERATION
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.5.0.1.6

IDN	S-0-0138		
Name	Bipolar acceleration limit value		
Description	The bipolar acceleration parameter limits the maximum acceleration ability of the drive symmetrically to the programmed value in both directions.		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	ACCELERATION
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.5.0.1.6

9.12.4 Torque

9.12.4.1 Overview

The **Bipolar torque limit value (S-0-0092)** directly limits the maximum torque that will be applied to the motor.

9.12.4.2 IDNs

IDN	S-0-0092		
Name	Bipolar torque limit value		
Description	The torque setpoint is limited to this value in all operation modes except torque control. Important: The status bit "T(orque) > Tlimit" in C3D (IDN S-0-0013) is not supported yet.		
Min	0	Datatype	UINT16
Max	$(2^{15})-1$	Scaling	TORQUE
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

9.12.5 Miscellaneous

9.12.5.1 Overview

The **Load limit of motor (S-0-0114)** defines the period of time, the motor is able to receive the maximum current. The **Amplifier warning temperature (S-0-0200)** defines the maximum temperature of the power stage. If it will be reached the drives shutdown with an error in C1D. The **motor warning temperature (S-0-201)** similarly defines the maximum motor temperature. If it will be exceeded the drive shuts down with an error. It has to be adapted to the used motor.

9.12.5.2 IDNs

IDN	S-0-0114		
Name	Load limit of motor		
Description	The motor can be overloaded a certain period of time. This IDN indicates how long the motor may receive the maximum current. After this time the current will be automatically reduced to the nominal current to protect the motor. In this case the drive sets the overload warning bit in C2D (see IDN S-0-0310).		
Min	10	Datatype	UINT16
Max	2000	Scaling	TIME_ms
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0200		
Name	Amplifier warning temperature		
Description	When the amplifier temperature exceeds the amplifier warning temperature value, the drive shutdown with an error (C1D). This IDN is read only.		
Min	---	Datatype	UINT16
Max	---	Scaling	TEMPERATURE
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0201		
Name	Motor warning temperature		
Description	When the motor temperature exceeds the motor warning temperature value, the drive shutdown with an error (C1D).		
Min	20° C	Datatype	UINT16
Max	300 °C	Scaling	TEMPERATURE
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

9.13 Digital IOs

9.13.1.1 Overview

The MDR 2000servo controller allows the user to access all digital inputs (DIN) via an IDN of the SERCOS Interface. Therefore the status of the DINs can be read in **P-0-0125**, while the polarity of the DIN can be changed with **P-0-0126**.

As some DINs are logical inputs displayed by statusbits in the MDR 2000, they can be assigned to variable hardware DINs. E.g. the “sample switch” (logical status) can be assigned to hardware DIN 8 or DIN9. All other DINs despite of the “sample switch”, the “start input”, the “homing switch” and the “limit switches” are hardware DINs which directly display the voltage level on the according pin.

On this account only the polarity of the “homing switch” and the “limit switches” can be changed in **P-0-0126**.

In addition the digital outputs can be modified by writing to **P-0-0110** and it is possible to assign several statusbits to an digital output, i.e. if the statusbit is set, the output will be set too. The assignment can be set in **P-0-0113** for DOUT1, **P-0-0114** for DOUT2 and **P-0-0115** for DOUT3.

9.13.1.2 IDNs

IDN	P-0-0125		
Name	Digital inputs		
Description	The status of all digital inputs can be read via this IDN. As the polarity cannot be changed for most of them, the status of the DIN refers directly to the voltage level on the corresponding DIN.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	3.3.0.1.1

Bit	Name	Description
0	DIN0	Set to "bit 0 of position selector" by default
1	DIN1	Set to "bit 1 of position selector" by default
2	DIN2	Set to "bit 2 of position selector" by default
3	DIN3	Set to "bit 3 of position selector" by default
4	DIN4	Power stage enable
5	DIN5	Controller enable
6	DIN6	Limit switch left (logical status)
7	DIN7	Limit switch right (logical status)
8	DIN8	Set to "start" by default (voltage level at DIN8)
9	DIN9	Set to "sample switch" by default (voltage level at DIN9)
10	DIN10	Double assignment with DOUT2
11	DIN11	Double assignment with DOUT3
12	DIN/AIN 1	Double assignment with AIN1
13	DIN/AIN 2	Double assignment with AIN2
14	Reserved	Reserved
15	Reserved	Reserved
16	EA88_0_0	DIN0 of optional EA88 module in TECH1
17	EA88_0_1	DIN1 of optional EA88 module in TECH1
18	EA88_0_2	DIN2 of optional EA88 module in TECH1
19	EA88_0_3	DIN3 of optional EA88 module in TECH1
20	EA88_0_4	DIN4 of optional EA88 module in TECH1
21	EA88_0_5	DIN5 of optional EA88 module in TECH1
22	EA88_0_6	DIN6 of optional EA88 module in TECH1
23	EA88_0_7	DIN7 of optional EA88 module in TECH1
24	Homing switch	Logical status according to assignment of DIN and polarity
25	Sample switch	Logical status according to assignment of DIN and polarity
26	Start	Logical status according to assignment of DIN and polarity
27..31	Reserved	Reserved

IDN	P-0-0126		
Name	Polarity of digital inputs		
Description	The polarity of the digital inputs can be changed via this IDN. As only the limit switches and the sample switch can have an logical status other than the voltage level of the assigned DIN, only the polarity for this DINs can be changed.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.3.0.1.1

Bit	Name	Description
0...5	---	Reserved
6	DIN6	Limit switch left (logical status)
7	DIN7	Limit switch right (logical status)
8...23	---	Reserved
24	Homing switch	Logical status according to assignment of DIN and polarity
25..31	---	Reserved

IDN	P-0-0110		
Name	Digital outputs		
Description	Set digital outputs and read the status of the outputs. To allow writing an output, the function of the corresponding output must be set to 0.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.3.0.1.1

Bit	Description	Value
0	DOUT0	Drive ready
1	DOUT1	0b: Off, 1b: On
2	DOUT2	0b: Off, 1b: On
3	DOUT3	0b: Off, 1b: On
4...31	Reserved	

IDN	P-0-0113		
Name	Function of DOUT1		
Description	Assign a status to the digital output or allow modification by IDN P-0-0110		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

Value	Description	Value	Description
0	Directly modify DOUTx by P-0-0110	9	Undervoltage intermediate circuit
1	Position XSET = XDEST	10	Brake released
2	Position XACT = XDEST	11	Power stage released
3	Reserved	12	No function (ON)
4	Remaining distance trigger	13	Reserved
5	Homing operation active	14	Reserved
6	Target velocity reached	15	Linear motor identified
7	I ² t-limit active	16	Homing position valid
8	Following error		

IDN	P-0-0114		
Name	Function of DOUT2		
Description	Assign a status to the digital output or allow modification by IDN P-0-0110. For possible values see P-0-0113.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	P-0-0115		
Name	Function of DOUT3		
Description	Assign a status to the digital output or allow modification by IDN P-0-0110. For possible values see P-0-0113.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

9.14 Brake control

9.14.1.1 Overview

Allows the master to change the timing for releasing / applying the brake. Furthermore the brake can be applied / released manually. This is only possible if the controller is not enabled.



**Releasing the brake will immediately take effect.
This may cause the dropping of a vertical axis.**

9.14.1.2 IDNs

IDN	S-0-0206		
Name	Drive on delay		
Description	This IDN describes the time delay between the activation of torque via the bits "drive on" and "drive enable" (bits 14 and 15) in the master controlword (S-0-0134) and the physical start of the movement. This delay is necessary if the connected motor uses a holding brake to release the brake before start of movement.		
Min	0	Datatype	UINT16
Max	5785,6 ms	Scaling	TIME_ms
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0207		
Name	Drive off delay		
Description	If the master resets the bit "drive off" (bit 15) of the master control word (S-0-0134), the drive decelerates to nmin. Afterwards the locking of the holding brake is initiated. The torque remains activated in the drive until this drive off delay time is elapsed.		
Min	0	Datatype	UINT16
Max	5785,6 ms	Scaling	TIME_ms
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	P-0-0021		
Name	Direct brake control		
Description	Allows the master to apply / release the brake manually. This is only possible if the controller is not enabled.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

Value	Description
0	Apply brake
1	Release brake



**Releasing the brake will immediately take effect.
This may cause the dropping of a vertical axis.**

9.15 Analogue IOs

9.15.1.1 Overview

Additionally to the control of the digital IOs, all analogue IOs of the MDR 2000servo positioning controllers can be accessed via the SERCOS interface, too. It is possible to read the actual voltage level on the analogue inputs AIN0 to AIN2 by reading the IDNs **P-0-0132 (Analogue input voltage AIN0)** to **P-0-0134 (Analogue input voltage AIN2)**. These IDNs are read-only and contain the actual voltage level on the inputs in mV.

Furthermore an output voltage can be applied to the analogue outputs AOUT0 to AOUT1. Therefore the demanded output voltage can be written to the IDNs **P-0-0143 (Analogue output voltage AOUT0)** and **P-0-0144 (Analogue output voltage AOUT1)**. The voltage range of the analogue outputs is +/- 10V. The output voltage level can be written with a resolution in mV (LSB = 1 mV).

9.15.1.2 IDNs

IDN	P-0-0132		
Name	Analog input voltage AIN0		
Description	This IDN provides the analog input voltage of AIN0.		
Min	---	Datatype	INT16
Max	---	Scaling	VOLTAGE
Access	R	Type	Parameter
Mapping	AT	Available	3.5.0.1.6

IDN	P-0-0133		
Name	Analog input voltage AIN1		
Description	This IDN provides the analog input voltage of AIN1.		
Min	---	Datatype	INT16
Max	---	Scaling	VOLTAGE
Access	R	Type	Parameter
Mapping	AT	Available	3.5.0.1.6

IDN	P-0-0134		
Name	Analog input voltage AIN2		
Description	This IDN provides the analog input voltage of AIN2.		
Min	---	Datatype	INT16
Max	---	Scaling	VOLTAGE
Access	R	Type	Parameter
Mapping	AT	Available	3.5.0.1.6

IDN	P-0-0143		
Name	Analog output voltage AIN0		
Description	The analog output voltage of AOUT0 will be set by this IDN. It is read-write. Reading this IDN will give the last written demand value.		
Min	-10 V	Datatype	INT16
Max	10 V	Scaling	VOLTAGE
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.5.0.1.6

IDN	P-0-0144		
Name	Analog output voltage AIN1		
Description	The analog output voltage of AOUT1 will be set by this IDN. It is read-write. Reading this IDN will give the last written demand value.		
Min	-10 V	Datatype	INT16
Max	10 V	Scaling	VOLTAGE
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	3.5.0.1.6

9.16 Drive controlled homing

9.16.1.1 Overview

When the Master sets and enables the **Drive controlled homing** Procedure Command (**S-0-0148**), the drive automatically activates the drive internal position control and accelerates to the **Homing velocity** (**S-0-0041**) taking the **Homing parameter** (**S-0-0147**) and the **Homing acceleration** (IDN **S-0-0042**) into account. Furthermore the drive resets the bit **Position feedback value status** (**S-0-0403**). All changes of the cyclic command values are ignored as long as the Procedure Command is activated. After detecting the reference marker pulse, the drive decelerates to standstill, taking the **Homing acceleration** into account. The Procedure Command **Drive controlled homing** is successfully completed when the drive has stopped and the **Position command value** (**S-0-0047**) is set to the Reference point of the machine. The drive announces this by setting the bit **Position feedback value status** (**S-0-0403**). Afterwards the control unit must read the **Position command value** of the drive via the Service Channel and reset its position command value system to this position command value. After the Procedure Command is reset by the control unit, the drive once again follows the command values of the control unit.

An interrupt of this Procedure Command will result in position feedback value not being referenced to the position feedback reference mark. Also the **Position feedback value status** bit will not be set.

When an error of C1D occurs, the Procedure Command will be aborted with an error.

For the calculation of the Reference point two parameters are taken into account:

The **Reference distance 1 (S-0-0052)** and **Reference offset 1 (S-0-0150)**. The **Reference offset 1** determines the distance between the Reference marker (e.g. the falling edge of the homing switch) and the Reference point. The **Reference distance 1 (S-0-0051)** determines the Position (in the coordinate system after the homing procedure) at this point. It is typically 0.

The following chart gives an overview about the Reference point:

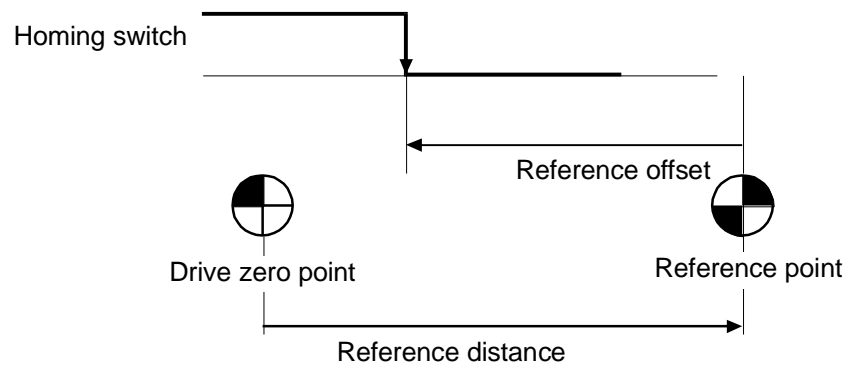


Figure 9.17: Reference point

For details regarding the homing sequence please refer to the Software Manual “Servo Positioning Controller MDR 2000”

9.16.1.2 IDNs

IDN	S-0-0148		
Name	Drive controlled homing		
Description	By this procedure command drive controlled homing will be started.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

IDN	S-0-0147		
Name	Homing parameter		
Description	The following options for drive controlled homing can be set by this parameter.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

Bit	Description	Value
0	Homing direction	0b: Positive direction 1b: Negative direction
1	Reserved	
2	Home switch	0b: <i>Not allowed / available</i> 1b: Connected to the drive
3	Feedback	0b: Using motor feedback 1b: Using external feedback
4	Reserved	
5	Evaluation of home switch	0b: Home switch is evaluated 1b: <i>Not allowed / available</i>
6	Evaluation of position feedback marker pulse	0b: <i>Not allowed / available</i> 1b: Marker pulse is not evaluated
7	Position after drive controlled homing	0b: Drive is positioned at an arbitrary position 1b: <i>Not allowed / available</i>
8	Drive controlled homing with homing distance	0b: <i>Not allowed / available</i> 1b: Homing distance is not selected
9...15	Reserved	

In contrast to the SERCOS specification there is no reference offset for external feedback values. The **IDN S-0-0150 (Reference offset 1)** is used in both cases (internal and external position feedback evaluation) to define the reference offset for the drive controlled homing Procedure Command.



The Drive controlled homing procedure can only be executed in a position control operation mode.

To be compatible with the SERCOS standard, not all possible homing methods can be set via **Homing parameter (S-0-0147)**. Therefore a manufacturer specific IDN has been implemented: **Homing method (P-0-0045)**. Both parameters are not independent of each other, so the last written IDN determines the behaviour of the homing.

IDN	P-0-0045		
Name	Homing method		
Description	Manufacturer specific IDN, to determine the homing methods.		
Min	---	Datatype	INT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

Value	Direction	Target	Reference point for Home position
-18	Positive	Endstop	Endstop
-17	Negative	Endstop	Endstop
-2	Positive	Endstop	Zero impulse
-1	Negative	Endstop	Zero impulse
1	Negative	Limit switch	Zero impulse
2	Positive	Limit switch	Zero impulse
7	Positive	Reference switch	Zero impulse
11	Negative	Reference switch	Zero impulse
17	Negative	Limit switch	Limit switch
18	Positive	Limit switch	Limit switch
23	Positive	Reference switch	Reference switch
27	Negative	Reference switch	Reference switch
33	Negative	Zero impulse	Zero impulse
34	Positive	Zero impulse	Zero impulse
35		No run	Actual position

Furthermore IDNs are available to set the absolute position to a user-defined position (**P-0-0150, Set absolute position**). The internal zero offset of the encoder can be read by **P-0-0151 (Zero offset)** to be able to restore it later. The resolution of this value is defined by **P-0-0153 (Position encoder resolution)**.

With IDN **P-0-0152 (Index position offset)** it is possible to shift the index pulse of an encoder, e.g. if it is too close to the reference or the limit switch.

IDN	S-0-0041		
Name	Homing velocity		
Description	The homing velocity is used during the Procedure Command "drive controlled homing" (IDN S-0-0148).		
Min	0	Datatype	INT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0042		
Name	Homing acceleration		
Description	The homing acceleration is used during the Procedure Command "drive controlled homing" (IDN S-0-0148).		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	ACCELERATION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0052		
Name	Reference distance-1		
Description	This parameter describes the distance between the machine zero point and the reference point. In contrast to the SERCOS Specification there is no Reference distance for external feedback values. This IDN is used in both cases (internal and external position feedback evaluation) to define the reference distance for the drive controlled homing procedure command.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0150		
Name	Reference offset-1		
Description	This parameter describes the distance between the reference marker pulse of position feedback values and the reference point. In contrast to the SERCOS Specification there is no Reference offset for external feedback values. This IDN is used in both cases (internal and external position feedback evaluation) to define the reference offset for the drive controlled homing procedure command.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0191		
Name	Cancel reference point		
Description	When the master sets and enables the procedure command "cancel reference point" the drive resets the bit "position feedback value status" (IDN S-0-0403). The procedure command is completed successfully by the drive as soon as the bit "position feedback value status" is reset to 0.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

IDN	P-0-0150		
Name	Set position absolute		
Description	This IDN sets the actual absolute position to the written value. If the encoder has an EEPROM, the resulting new zero position shift will also be saved to the EEPROM immediately. Then the new position is also restored after a Reset.		
Min	---	Datatype	INT32
Max	---	Scaling	POSITION
Access	W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.4

IDN	P-0-0151		
Name	Zero offset (in encoder resolution)		
Description	This IDN sets and gives the actual zero offset. This value can be read and stored by a superior control unit during a calibration process of the application. It should be read after the first successful homing procedure. The superior control unit may later set the zero offset to this value in order to restore the application parameters e.g. to "factory settings". The unit depends on the resolution of the encoder. If the user wants to interpret the offset, take the value into relation to IDN P-0-0153. This IDN is not intended for setting the absolute position. The position is indirectly modified. The IDN can be seen as a direct access to a parameter. For normal shifts of the actual position use IDN P-0-0150.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.4

IDN	P-0-0152		
Name	Index position offset		
Description	This IDN sets an additional offset for the position of the zero impulse of a drive controlled homing procedure. The value has only effect if the reference point of the home position is the zero impulse.		
Min	0 °	Datatype	INT32
Max	360 °	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.5.0.1.4

IDN	P-0-0153		
Name	Position encoder resolution		
Description	This IDN provides the resolution of the zero offset of an absolute value encoder. The scaling is automatically adapted so that the complete relevant value range can be read independently from the number of distinguishable revolutions of the connected encoder. This allows that it is always possible to set the zero offset via P-0-0151. This IDN is used in combination with IDN P-0-0151. It allows to convert the value of IDN P-0-0151 into a physical unit, e.g. in order to display IDN P-0-0151 on a graphical user interface.		
Min	---	Datatype	UINT32
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	3.5.0.1.4

9.17 Spindle positioning

9.17.1.1 Overview

The **position spindle** Procedure Command (**S-0-0152**) is used to position a motor at an absolute angle position or to rotate a relative offset.

With setting and enabling the command the drive starts to move to the desired position given by the **spindle angle position (S-0-0153)** or by the **spindle relative offset (S-0-0180)**.

The IDN **S-0-0154 (spindle positioning parameters)** determines the direction and the setpoint for the positioning.

Until the command is enabled every new setpoint written to **S-0-0153** resp. **S-0-0180** causes the drive to start a new positioning immediately. For the positioning the **maximum spindle positioning speed (S-0-0222)** will be used.

When the drive interpolator reaches the selected command value, the drive sets the status **In Position (S-0-0336)**.

When the control unit cancels this command, the drive switches over to the mode of operation set in the control word. It is up to the user to ensure that the command values are valid at this time.

All changes in this IDN take effect with the start of a new positioning. A positioning, which is already active will not be affected.

9.17.1.2 IDNs

IDN	S-0-0152		
Name	Position spindle		
Description	This procedure command automatically switches the drive to internal position loop control. While this command is active, all changes to cyclic command values are ignored.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

IDN	S-0-0154		
Name	Spindle positioning parameter		
Description	This IDN defines the type of the positioning via the "position spindle" procedure command. It can be distinguished between an absolute or relative positioning. Furthermore the rotation direction can be changed from positive to negative.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

Bit	Description	Value
0..1	Direction	00b: Positive direction 01b: Negative direction 10b: Reserved 11b: Reserved
2	Type of positioning	0b: Absolute via spindle angle position (IDN S-0-0153) 1b: Relative via spindle relative offset (IDN S-0-0180)
3...15	Reserved	

IDN	S-0-0153		
Name	Spindle angle position		
Description	This parameter is the absolute spindle angle position relative to the reference point. The parameter is enabled only in connection with the position spindle procedure command (see IDN S-0-0152).		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0180		
Name	Spindle realtive offset		
Description	The parameter is enabled only in connection with the position spindle procedure command (see IDN S-0-0152). The spindle relative offset is added to the absolute position value while being processed. This parameter is used to drive the spindle of a certain number of revolutions.		
Min	-2^{31}	Datatype	INT32
Max	$(2^{31})-1$	Scaling	POSITION
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0222		
Name	Spindle positioning velocity		
Description	All positioning during the procedure command S-0-0152 is active, will be done with the spindle positioning speed. Important: Changing the spindle positioning speed will not affect an actual positioning. It will be used for the next positioning the first time.		
Min	0	Datatype	UINT32
Max	$(2^{31})-1$	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

9.18 Probing (Sampling of positions)

9.18.1.1 Overview

Setting and enabling the **Probing cycle** Procedure Command (**S-0-0170**) allows the sampling of the position feedback values. By the **Probe control parameter** (**S-0-0169**) it can be selected whether the rising or the falling edge will be used. The sampling is enabled by the IDN **Probe 1 enable** (**S-0-0405**).

With the appearance of a selected edge at the digital input (ServoCommander™: Parameters / IOs / Digital inputs / Sample input) the drive stores the position feedback value in the parameters **S-0-0130** to **S-0-0133** and sets the corresponding bit in the probe status (**S-0-0179**) and in **Probe 1 positive latched** (**S-0-0409**) resp. **Probe 1 negative latched** (**S-0-0410**).

With the appearance of an active edge, the operation is disabled until **probe x enable** will be reset. With the following setting the measuring is enabled again. See also chapter 9.11.

9.18.1.2 IDNs

IDN	S-0-0170		
Name	Probing cycle		
Description	When the master sets and enables the probing cycle procedure command, the drive reacts on the following parameters: "probe 1 enable" (IDN S-0-0405), and "probe 1" (IDN S-0-0401) as programmed in the "probe control parameter" (IDN S-0-0169). While the procedure command is activated, the control unit can start multiple measurements. If the control unit does not want any more measurements, the control unit cancels the procedure command.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Command
Mapping	---	Available	

IDN	S-0-0169		
Name	Probe control parameter		
Description	This parameter defines which probes and which edges are activated for the probing cycle procedure command.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	

Bit	Description	Value
0	Probe 1 positive edge	0b: Positive edge not active 1b: Positive edge active
1	Probe 1 negative edge	0b: Negative edge not active 1b: Negative edge active
2...15	Reserved	

IDN	S-0-0179		
Name	Probe status		
Description	If the drive stores one or more measurement values while the procedure command "probing cycle" (IDN S-0-0170) is activated, it simultaneously sets the assigned bit in the probe status. If "probe 1 enable" (IDN S-0-0405) is reset by the control unit, the drive resets bit 0 and bit 1 of probe status. Important: In contrast to the SERCOS specification the bits in the probe status are not reset when the edges are not activated in IDN S-0-0169 and sample events already have taken place.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0405		
Name	Probe-1 enable		
Description	This parameter is used to assign an IDN to "Probe 1 enable". This allows the bit "Probe 1 enable" to be assigned to a real-time control bit (see IDN S-0-0301). "Probe 1 enable" is checked by the drive only as long as the procedure command "probing cycle" (IDN S-0-0170) is active. For a new probing cycle with the same edge of Probe 1 the control unit has to reset "Probe 1 enable" to "0" and set it to "1" again.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R, W(2,3,4)	Type	Parameter
Mapping	MDT	Available	

IDN	S-0-0409		
Name	Probe-1 positive edge latched		
Description	This parameter is used to assign an IDN to "Probe 1 positive latched". This allows the status "Probe 1 positive latched" to be assigned to a real-time status bit (see IDN S-0-0305). Bit 0 of this parameter is set by the drive only if the procedure command "probing cycle" (IDN S-0-0170) is active, the signal "probe 1 enable" (IDN S-0-0405) is set to 1 and the positive edge of "probe 1" (IDN S-0-0401) is registered. Simultaneously the drive stores the position feedback value in "probe 1 positive edge" (IDN S-0-0130). This IDN will not be set to 0 by the drive, when the "probing cycle" procedure command is not active, but shows the last value it had when the procedure command was still active.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0410		
Name	Probe-1 negative edge latched		
Description	This parameter is used to assign an IDN to "probe 1 negative latched". This allows the status "probe 1 negative latched" to be assigned to a realtime status bit (see IDN S-0-0305). Bit 0 of this parameter is set by the drive only if the procedure command "probing cycle" (IDN S-0-0170) is active, the signal "probe 1 enable" (IDN S-0-0405) is set to 1 and the negative edge of "probe 1" (IDN S-0-0401) is registered. Simultaneously the drive stores the position feedback value in "probe 1 negative edge" (IDN S-0-0131). This IDN will not be set to 0 by the drive, when the "probing cycle" procedure command is not active, but shows the last value it had when the procedure command was still active.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0130		
Name	Probe value-1 pos. edge		
Description	If a positive edge of the sample input 1 occurs (IDN S-0-0401), the actual position feedback value is stored in this IDN. If position control using position feedback value 1 is used as operation mode, the actual position feedback value 1 is stored in this IDN. If position control using position feedback value 2 is used as operation mode, the actual position feedback value 2 is stored in this IDN. This IDN is only supported, if the drive operates in an position control operation mode.		
Min	---	Datatype	INT32
Max	---	Scaling	POSITION
Access	R	Type	Parameter
Mapping	AT	Available	

IDN	S-0-0131		
Name	Probe value-1 neg. edge		
Description	If a negative edge of the sample input 1 occurs (IDN S-0-0401), the actual position feedback value is stored in this IDN. If position control using position feedback value 1 is used as operation mode, the actual position feedback value 1 is stored in this IDN. If position control using position feedback value 2 is used as operation mode, the actual position feedback value 2 is stored in this IDN. This IDN is only supported, if the drive operates in an position control operation mode.		
Min	---	Datatype	INT32
Max	---	Scaling	POSITION
Access	R	Type	Parameter
Mapping	AT	Available	

9.19 Thread mode

9.19.1 Overview

The thread mode in the MDR 2000drives can be used to limit all secure values. It can be activated by the use of a digital input. It is meant to be used in machines, where it is necessary to handle parts during operation.



Caution!

The thread mode is no functional safety implementation according to IEC 61508 or any other certified specification of functional safety.

9.19.2 IDNs

IDN	P-0-0030		
Name	Thread mode: torque limit percent		
Description	Limits the maximum applied current while the thread mode is active.		
Min	0	Datatype	UINT16
Max	65536	Scaling	65536 = 100 % = max. current
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	P-0-0031		
Name	Thread mode: speed limit percent		
Description	Limits the maximum possible velocity while the thread mode is active. It is based on the speed limits (MSC / Safety parameter / speed limitation). If the limit is set unsymmetrically the minimum of the absolute values will be used.		
Min	0	Datatype	UINT16
Max	65536	Scaling	65536 = 100% speed limit
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	P-0-0032		
Name	Thread mode: minimum speed		
Description	The minimum speed to allow activating the thread mode is given by this IDN.		
Min	---	Datatype	INT32
Max	---	Scaling	VELOCITY
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

IDN	P-0-0033		
Name	Thread mode: tolerance time		
Description	Determines the timeout to reach the thread mode after activating the thread mode input. If this time will be exceeded error 47-0 will occur.		
Min	---	Datatype	UINT32
Max	---	Scaling	TIME_ms
Access	R, W(2,3,4)	Type	Parameter
Mapping	---	Available	3.3.0.1.1

9.20 Communication Parameters

9.20.1 Overview

The communication parameters determine the timing behaviour of the MDR 2000 within a SERCOS ring. For detailed information regarding the timing parameter please refer to the SERCOS specification.

9.20.2 IDNs

IDN	S-0-0001		
Name	NC-Cycletime (TNcyc)		
Description	The control unit cycle time defines the cyclic intervals during which the control unit makes new command values available. The control unit cycle time shall be transferred from the master to the slave during CP2 and becomes active in the slave during CP3. The control unit cycle time must be equal to the communication cycle time. $TNcyc = TScyc$		
Min	S-0-0002	Datatype	UINT16
Max	S-0-0002	Scaling	TIME_μs
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0002		
Name	SERCOS-Cycletime (Tscyc)		
Description	The communication cycle time of the interface defines the intervals during which the cyclic data are transferred. The communication cycle time is defined as 500 μs, 1 ms and up to 10 ms in steps of 1ms. The communication cycle time shall be transferred from the master to the slave during CP2 and becomes active in both, master and slave during CP3. See also chapter 6 !		
Min	500	Datatype	UINT16
Max	10000	Scaling	TIME_μs
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0003		
Name	Shortest AT transmission starting time (T1min)		
Description	Indicates the time requirement of the slaves between the end of the reception of the MST and the start of transmission of the AT. This time interval, required by the slave, depends on the selected telegram type. The time T1min is read by the master during CP2 in order to calculate the time of transfer of AT transmission starting time, T1 (IDN S-0-0006).		
Min	---	Datatype	UINT16
Max	---	Scaling	TIME_μs
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0004		
Name	Transmit/receive transition time (TATMT)		
Description	The time required by the slave to switch from transmitting the AT to receiving the MDT. The transition time for transmit / receive is read by the master during CP2 in order to calculate correctly the MDT transmission starting time T2 (IDN S-0-0089).		
Min	---	Datatype	UINT16
Max	---	Scaling	TIME_μs
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0005		
Name	Minimum feedback processing time (T5)		
Description	The time required by a drive between the start of feedback acquisition and the end of the next MST. This value is declared by the drive such that feedback values are transferred to the control unit during the next drive telegram. The master reads this value during CP2 in order to synchronize the measurement times of the feedback acquisition capture point, T4 (IDN S-0-0007) appropriately for all drives.		
Min	---	Datatype	UINT16
Max	---	Scaling	TIME_μs
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0006		
Name	AT transmission starting time (T1)		
Description	The AT transmission starting time determines when the slave sends its AT during CP3 and CP4, following the MST. This parameter is transferred by the master to the slave during CP2. The time of transfer of the AT shall be set greater than or equal to the shortest AT transmission starting time (IDN S-0-0003). $T1 = T1_{min}$.		
Min	S-0-0003	Datatype	UINT16
Max	S-0-0002	Scaling	TIME_μs
Access	R, W(2)	Type	
Mapping	---	Available	

IDN	S-0-0007		
Name	Feedback aquisition time (T4)		
Description	The acquisition capture point of the feedback is determined by the master after the MST. In this way the master declares a default acquisition capture point for the feedback for all drives that work in coordination with each other. This ensures synchronised data acquisition of the feedback. The feedback acquisition capture point can not be adjusted in the MDR 2000. It is implicitly given by T3.		
Min	0	Datatype	UINT16
Max	S-0-0002	Scaling	TIME_μs
Access	R, W(2)	Type	Parameter
Mapping		Available	

IDN	S-0-0008		
Name	Command value valid time (T3)		
Description	T3 determines the time at which the drive is allowed to access the new command values after the completion of a MST. In this way the master provides the command value valid time for command values among all coordinated drives. The drive activates the command value valid time during CP3.		
Min	0	Datatype	UINT16
Max	S-0-0002	Scaling	TIME_μs
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0009		
Name	Position of data record in MDT		
Description	The position of a data record of the drive in a MDT, expressed as a byte position. It starts with 1 for the initial data byte after the address field within the MDT. Every drive is informed by the master during CP2 of the beginning address of the data record of the drive in the MDT. The position of a data record in the length of the MDT, expressed in bytes, includes data records for all drives. Every drive is informed by the master during CP2 of the length of the MDT. It becomes active in the master and slave during CP3.		
Min	1	Datatype	UINT16
Max	65531	Scaling	---
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0010		
Name	Length of MDT		
Description	The length of the MDT, expressed in bytes, includes data records for all drives. Every drive is informed by the master during CP2 of the length of the MDT. It becomes active in the master and slave during CP3.		
Min	4 (one drive)	Datatype	UINT16
Max	65534	Scaling	---
Access	R, W(2)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0087		
Name	Transmit to transmit recovery time (TATAT)		
Description	The time required between two ATs when sent by the same slave. This parameter is not used for slaves with a single drive.		
Min	---	Datatype	UINT16
Max	---	Scaling	TIME_μs
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0088		
Name	Receive to receive recovery time (TMTSY)		
Description	Recovery time of the slave after reception of a MDT to switch over to receive the next MST. The master reads this time during CP2 to ensure that the interval will be sufficient between the end of the MDT and the beginning of the MST.		
Min	---	Datatype	UINT16
Max	---	Scaling	TIME_μs
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0089		
Name	MDT transmission starting time (T2)		
Description	The MDT transmission starting time determines when the master shall send its MDT during CP3 and CP4, following the MST. This parameter is transferred by the master to the slave during CP2 and becomes active during CP3.		
Min	0	Datatype	UINT16
Max	S-0-0002	Scaling	TIME_μs
Access	R, W(2,3)	Type	Parameter
Mapping	---	Available	

IDN	S-0-0090		
Name	Command value proceeding time (TMTSG)		
Description	The time required by the slave to make command values available for a drive after receipt of a MDT. This time is read by the master during CP2 in order to correctly calculate the command value valid time T3 (IDN S-0-0008). The command value proceeding time depends on the telegram type.		
Min	---	Datatype	UINT16
Max	---	Scaling	TIME_μs
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0028		
Name	MST error counter		
Description	The MST error counter counts all invalid MST's in communication phases 3 and 4. In cases more than two consecutive MSTs are invalid, further invalid MSTs are not counted. The MST error counter counts to a maximum of $2^{16} - 1$. This means that if a value of 65 535 is set in the counter, there may have been a noisy transmission over a long period of time.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

IDN	S-0-0029		
Name	MDT error counter		
Description	The MDT error counter counts all invalid MDT's in communication phases 3 and 4. In cases more than two consecutive MDTs are invalid, further invalid MDTs are not counted. The MDT error counter counts to a maximum of $2^{16} - 1$. This means that if a value of 65 535 is set in the counter, there may have been a noisy transmission over a long period of time.		
Min	---	Datatype	UINT16
Max	---	Scaling	---
Access	R	Type	Parameter
Mapping	---	Available	

10 SERCOS error codes

The following errors using the SERCOS plug-in module may occur.

Code	Name	Description	Action
37-0	Receive data distortion	The received data is over the distortion limit (INT_RDIST)	Test if fibre optic cable is connected correctly. Check baudrate.
37-1	Ring not closed	The fibre optic ring seems not to be closed. (INT_FIBBR)	Test if fibre optic cable is connected correctly. Test if fibre optic cable is not broken. Check baudrate.
37-2	MST missing twice	Two consecutive MST were missing or have been received too late. In CP4 the MDR 2000 will fall back to Phase 0	Check baudrate. Test with higher baudrate. Test with higher cycle time
37-3	Invalid phase shift	The phase given in the MST is not allowed	See chapter 5.6
37-4	MDT missing twice	Two consecutive MDTs were missing. In CP4 the MDR 2000 will fall back to Phase 0.	Test if fibre optic cable is connected correctly. Check baudrate.
37-5	Invalid Operation mode	The selected Operation mode is invalid or not allowed.	Check S-0-0032, S-0-0033, S-0-0034 and S-0-0035. See also chapter 7

Code	Name	Description	Action
38-0	Initialisation error	Initialisation of SERCON invalid	Internal error
38-1	SERCOS active without plug-in module	The SERCOS communication is activated but it is no plug-in module available	Install plug-in module or deactivate SERCOS
38-2	Module failure	The module selftest was not successful	Change plug-in module
38-3	S-0-0127 failed	While proceeding the Procedure Command S-0-0127 not all parameters of S-0-0018 have been transmitted correctly.	Check IDN list S-0-0021 and re-execute the Procedure Command
38-4	S-0-0127: Establishing MDT or AT failed	The cyclic data of the MDT or the AT could not be established.	Check S-0-0016 for the AT und S-0-0024 for the MDT. Check also S-0-0015
38-5	S-0-0128 failed	While proceeding the Procedure Command S-0-0128 not all parameters of S-0-00189 have been transmitted correctly.	Check IDN list S-0-0022 and re-execute the Procedure Command
38-6	S-0-0128: Invalid scaling	Error during calculation of the desired scaling.	Check scaling and re-execute S-0-0128
38-7	IDN list S-0-0026 or IDN list S-0-0027 invalid	IDN list S-0-0026 or IDN list S-0-0027 contains an invalid (not allowed) IDN	Check S-0-0026 and S-0-0027
38-9	Invalid plug-in module	SERCON 816 in SERCON 410b compatibility mode	Internal error

11 Appendix

To adjust the light power of the transmitting diodes different outputs can be activated together. The following chart gives an overview about the available levels and the corresponding outputs. The brightness increases with higher level numbers.

Level	TXD1	TXD3	TXD4	TXD6
0	--	--	--	--
1	ON	--	--	--
2	--	--	--	ON
3	ON	--	--	ON
4	--	ON	--	--
5	ON	ON	--	--
6	--	ON	ON	--
7	--	ON	--	ON
8	ON	ON	--	ON
9	ON	ON	ON	--
10	--	ON	ON	ON
11	ON	ON	ON	ON

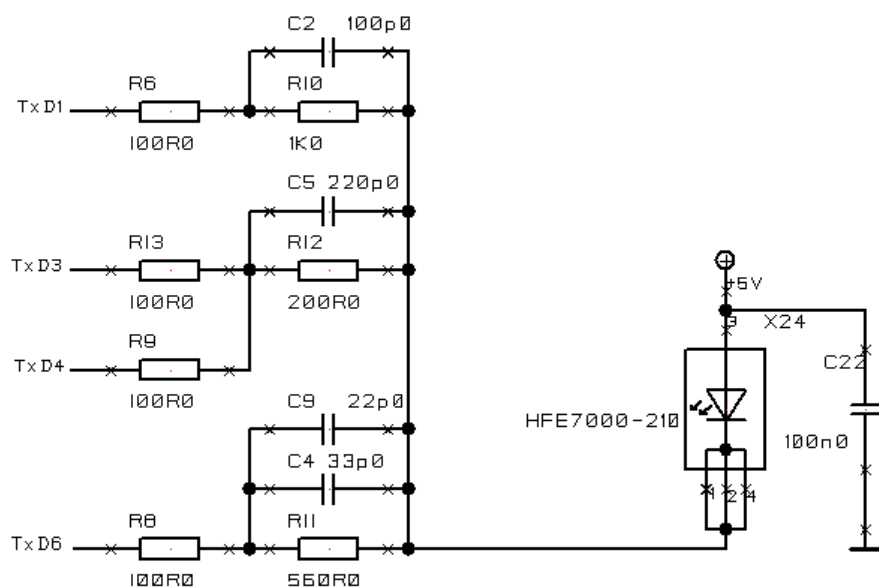


Figure 11.18: Connection of transmitter diode

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