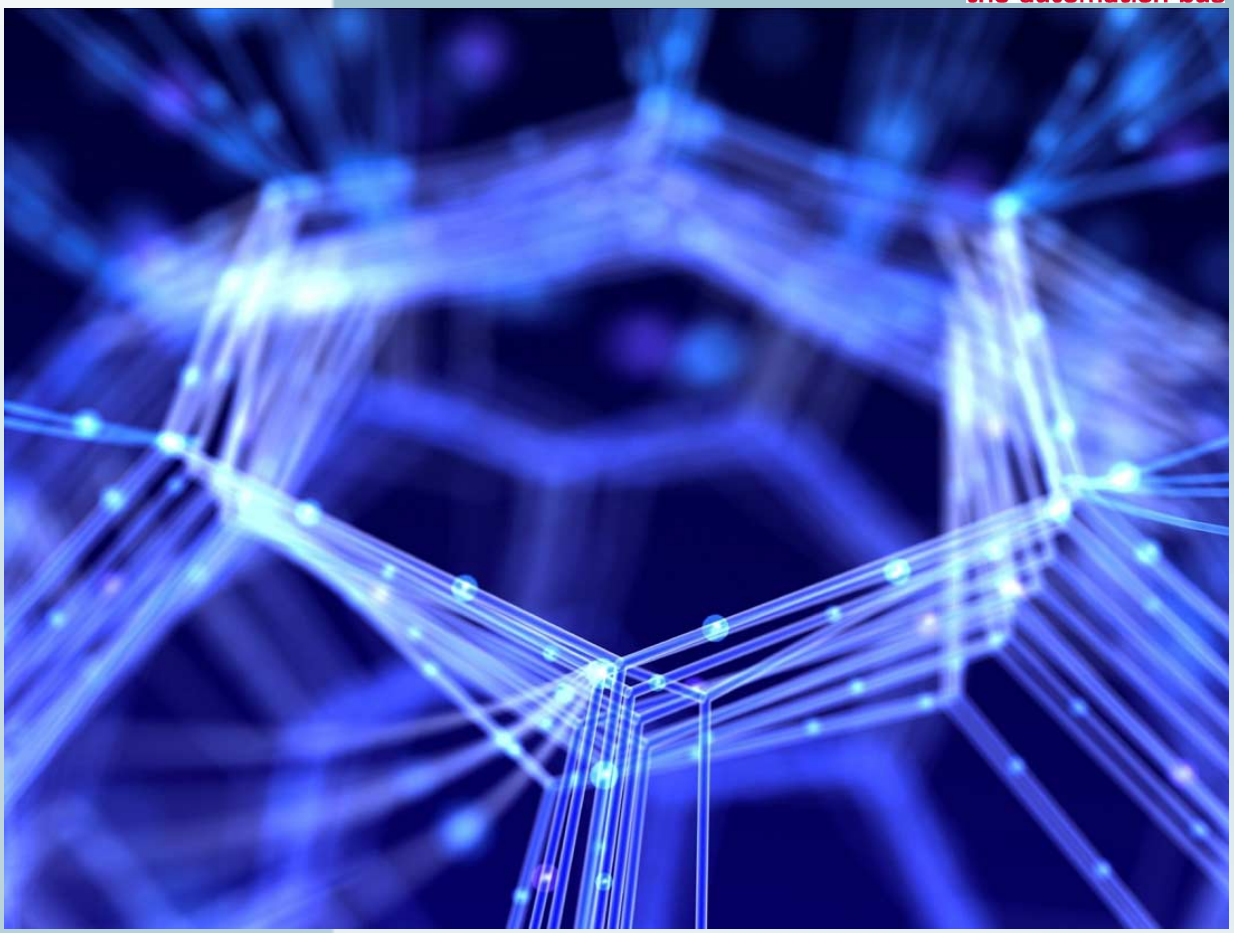
sercos
the automation bus



User manual

UM EN SERCOS SYS

sercos System Manual for I/O Devices

PHOENIX CONTACT
INSPIRING INNOVATIONS

User manual
sercos System Manual for I/O Devices

2011-11-21

Designation: UM EN SERCOS SYS

Revision: 00

This user manual is valid for I/O devices with sercos interface.

Please observe the following notes

User group of this manual

The use of products described in this manual is oriented exclusively to qualified electricians or persons instructed by them, who are familiar with applicable standards and other regulations regarding electrical engineering and, in particular, the relevant safety concepts.

Explanation of symbols used and signal words

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety measures that follow this symbol to avoid possible injury or death.

There are three different categories of personal injury that are indicated with a signal word.

DANGER This indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING This indicates a hazardous situation which, if not avoided, could result in death or serious injury.

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Table of contents

1 Introduction

1.1 General Information on sercos

sercos (**se**rial **r**ealtime **co**mmunication **s**ystem) is an open, digital interface, which, based on standard Ethernet, serves as a communication interface between controllers, drives, I/Os (input and/or output devices) and combinations of drives and I/Os.

sercos is in the third generation of the automation bus series according to IEC/EN 61491. Further development, standardization and certification of this interface are performed by around 80 predominantly international companies involved in automation technology which are members of the "sercos international e. V." (SI) user organization. The organization's headquarters are based in Süßen near Stuttgart, Germany, with subsidiaries in North America and Asia (see http://www.sercos.de).

1.2 Development of the sercos Automation Bus

In the mid 1980's, the Zentralverband Elektrotechnik- und Elektronikindustrie e. V. (ZVEI) and the Verein Deutscher Werkzeugmaschinenfabriken e. V. (VDW) drew up the specifications for an open, digital interface.

The rapid development of the sercos interface is clear to see from the transmission speeds it supports. The first generation had a transmission speed of 2 and 4 Mbps, the second a speed of 8 and 16 Mbps and the third generation can reach transmission speeds of up to 100 Mbps.

The second generation sercos was recognized as the international standard IEC 61491 in 1995 and as the European standard EN 61491 in 1998. The third and current generation was developed on the basis of standard Ethernet, whereby tried-and-tested mechanisms such as Motion Control Profile, the telegram structure and hardware synchronization were retained. In order to meet realtime requirements, a collision-free realitime (RT) channel was created, which runs parallel to an optional non-realtime (NRT) channel, in which random Ethernet telegrams can be transmitted.

1.3 Ethernet in Industrial Communications with sercos

The increasing amount of control components, actuators and sensors in industrial automation is resulting in increasingly complex control networks. sercos can provide a cost-effective networking of these automation components with the Ethernet standard, adapted to the requirements of industrial automation.

sercos increases both the profitability and efficiency of machines and systems. With highly synchronized and high-performance realtime Ethernet communication and a wide range of profiles, sercos can increase productivity while lowering development and startup costs.

Ethernet, which is well known in office environments, and its mechanisms such as TCP/IP and UDP, are used directly in a sercos network, enabling vertical integration, from the office to the field.

The distinction between a high-performance drive bus and a classic fieldbus for the coupling of remote peripheral devices will thus no longer exist in the future and will be replaced by a universal communication network. This network will have to combine the features of a high-performance motion bus with the features of the classic fieldbus and support peripheral devices as well as central system structures. This development will be made possible by the continuously increasing performance capabilities of computer platforms and the increased power of communication technology between the devices.

2 Overview and Architecture

2.1 Topology

sercos works with the producer/consumer model, whereby the typical master/slave principle and the slave/slave principle can be used. In addition to the ring structure, which was used by sercos I and II, a linear structure can also be used. Furthermore, hierarchical, cascaded network structures are also possible.

Special switches can be used to integrate standard Ethernet devices either individually or in a star topology. The network structure can thus be perfectly adapted to meet the requirements of the respective system.

2.1.1 The Ring Structure

In connection with the Ethernet physics, the ring structure offers the advantages of a double ring structure with the ability to transmit data redundantly (ring redundancy). The master sends data to the ring in opposite directions from the two ports; the data which is traveling in each direction can be analyzed (primary and secondary channel / P-Channel and S-Channel). This ensures full connectivity in the event of a cable break or interruption in any part of the ring. Here the high-performance controllers of the slaves immediately switch to two separate lines at the point of interruption. The system thus continues to run without errors while the integrated diagnostics signal the defective cable connection.

The reconfiguration time in the event of such an error is a maximum of 25 µs, ensuring that only the data from one cycle can be lost. The point of interruption can be located accurately and, if necessary, the defective cables can be replaced during operation. This redundancy also allows devices to be coupled in or decoupled during servicing or when connecting additional devices. First the ring is split into two lines and afterwards it is combined into one ring.

There is also redundancy when there is parallel communication between two devices. If the two devices are on the same line the data is transmitted in the same sercos cycle. If the two devices are on different lines the controller copies the data from the controller to the other line; this causes a sercos cycle offset. This is marked in the "Data field delay" field of "S-0-1050.x.08 Connection control (C-Con)".

In the event of redundancy the synchronization remains at the relative quality level.

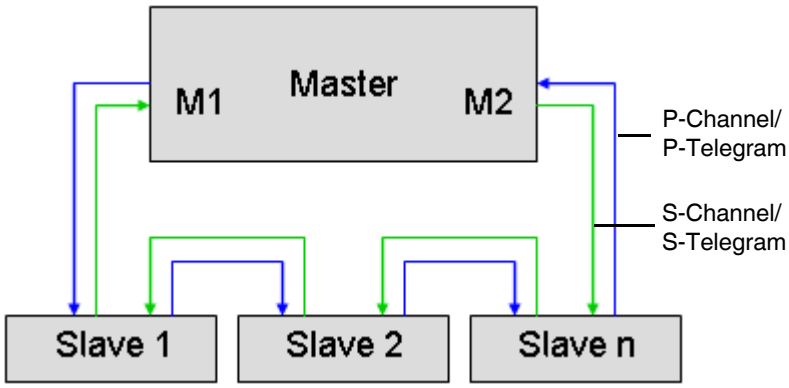


Figure 2-1 Ring structure (double ring)

2.1.2 The Linear Structure

All sercos devices are arranged in a serial way. The master is located at the start of a line or between two lines. Data passes through the slaves and is returned by the last device (loop back). All devices analyze the data that is passing in both directions, and this guarantees that all data reaches every device during one cycle.

Advantage: Simple and low-cost networking of devices over long distances, e.g., assembly lines. The linear structure eliminates the need for a cable connection, which can be advantageous for systems covering a wide area. However, it does not offer the advantage of redundancy.

With sercos, runtimes and jitters are reduced to a minimum, since realtime data is processed by the nodes during the cycle ("on the fly").

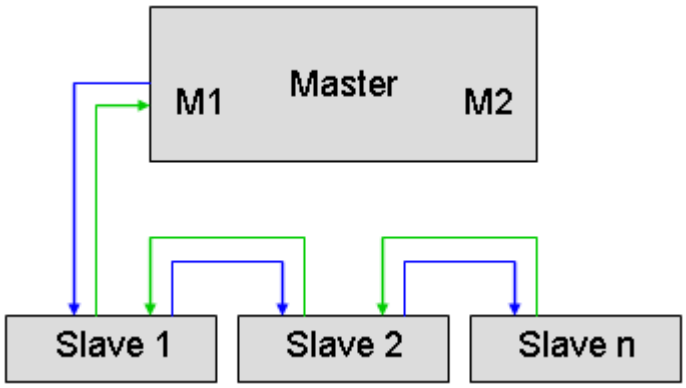


Figure 2-2 Linear structure (single ring)

2.1.3 Advanced Topologies

The traditional lines between control and drive technology and between central and peripheral devices are becoming increasingly blurred. On the one hand, drives and I/O devices with integrated control and technology functions are used in decentral, distributed system architectures. On the other hand, there exist central solutions, such as a central device with integrated controller, technology and drive controller, which communicates with an intelligent power level. The most suitable system structure depends on the topology of the machine system. This has resulted in the emergence of hybrid devices, which are suitable not only for individual applications, but combine several different applications in one device.

sercos also supports hierarchical, cascaded network structures. Here the individual network segments are networked via defined mechanisms. This offers the following advantages:

– The individual network segments can be operated with different cycle times.
  For example 250 µs for the networking of various drives and fast I/Os and 2 ms for the networking of the individual controllers.
– The interconnection of the individual network segments forms a realtime-coupled and fully synchronized structure.
– The synchronization of all devices in the entire network is guaranteed.
– Devices throughout the network can communicate with one another in realtime.

2.2 Installation

The installation of a sercos network is simple and requires no special network configuration.

All devices are connected to one another by means of patch or crossover cables, whereby the Ethernet ports (P1 and P2) of the devices can be freely exchanged and can also be used to connect standard Ethernet devices (e.g. notebooks) to a sercos realtime domain. This means that any Ethernet or IP protocols can be used to access sercos devices, without affecting the realtime behavior of the sercos realtime domain.

sercos is based on the 100 Mbps Ethernet standard and as such corresponds to ISO/IEC 8802-3 (IEEE 802.3) for the hardware interface. The only hardware requirement in the sercos specification is that when twisted pair cables are used, auto crossover is supported and that CAT5 cables or better are used. The cables should also be suitably shielded (FTP, SFTP or STP) in order to ensure adherence to legal specifications (EMVG, Low-Voltage Directive).

2.3 Technical Properties of sercos

The most important properties of sercos at a glance:

- sercos connectors (P1 and P2 as two RJ45 sockets), each with auto negation and auto crossover
- 100 Mbps transmission speed
- Full-duplex Ethernet (bidirectional), copper or fiber optics
- sercos diagnostic LED
- FSP-IO (Function Specific Profile-IO) for modular I/O devices
- Various realtime data connections are possible (master/slave communication and cross communication)
- The communication cycle can be varied between minimum 31.25 µs and maximum 65 ms
- Standard Ethernet protocol (integration of any Ethernet protocols such as UDP/IP and TCP/IP)
- Direct connection of IP devices
- Cyclic realtime data traffic (clocked data traffic without risk of collision due to apportioned time slot)
- Hot-plug function
- Realtime precision (jitter of the sercos master is ±10 ns)
- Synchronization of several motion controls
- Fault tolerance for cable breaks when a ring topology is used
- Safety functions can be implemented in accordance with IEC 61508 to SIL3

2.4 Overview of Transmission Performance

sercos's transmission performance meets a wide range of requirements. The following table shows examples of possible performance values.

Table 2-1 Cycle time, realtime data and device ratios

Cycle time in µs	Cyclic data per device in bytes	Max. devices
31.25	116 (928 bits)	2
31.25	6	8
62.5	12	16
125	12	30
250	12	66
250	32	34
500	12	130
1000	50	100
1000	32	140
1000	12	254

You can also consider the update time.

– 424 bytes are required to transmit 1000 digital I/Os,
  8 µs are required to transmit 100 bytes with 100 Mbps,
  that means 34 µs for 424 bytes.
– With ring cabling the transfer time through 8 devices is
  8 x 0.6 µs = 4.8 µs.

This leads to an update time of 38.4 µs for 1000 digital I/Os.

For example 12750 digital I/Os can be transmitted with a sercos cycle time of 250 µs.

2.5 Communication Model

All communication-relevant relationships between sercos devices can be divided into three layers:

– Communication layer
– Data link layer
– Application layer

Each layer has specific, non-overlapping tasks and features separate parameters (IDNs), separate control/status words and a specific error handling procedure. It is only ever the same layers that communicate with each other between the various nodes of a sercos network. The communication layer and data link layer are specified via the SCP (sercos Communication Profile), while the application layer is divided into a generic device profile (GDP) and a function-specific profile (FSP) for I/Os, drives and encoders.

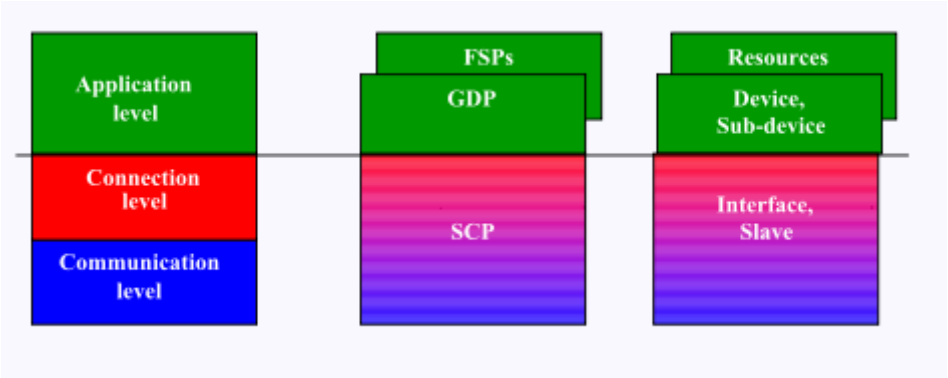


Figure 2-3 Communication model for the various layers

Communication layer

The properties and tasks of the communication layer are:

– Handling of the communication phases
– Synchronization, timer control
– Telegram handling
– Topology status and control
– Service channel (SVC)

The MDTs (Master Data Telegrams) are used by the sercos master for the transmission of control data (phase, synchronization, commanded topology, identification, service channel, etc.) to the slaves. The ATs (Acknowledge Telegrams) are used by the slaves for the transmission of status information to the master (topology address, active topology, error flags, service channel). For this reason there exists a peer-to-peer relationship between the communication layers of the sercos master device and the slave devices. Here the master uses the MDT telegrams for its specifications and the slave uses the AT telegrams for its status.

The communication layer is a 1:1 relationship between master and slave. This relationship exists in all sercos phases and always with this telegram assignment, even if the position and telegram number in the phases may change.

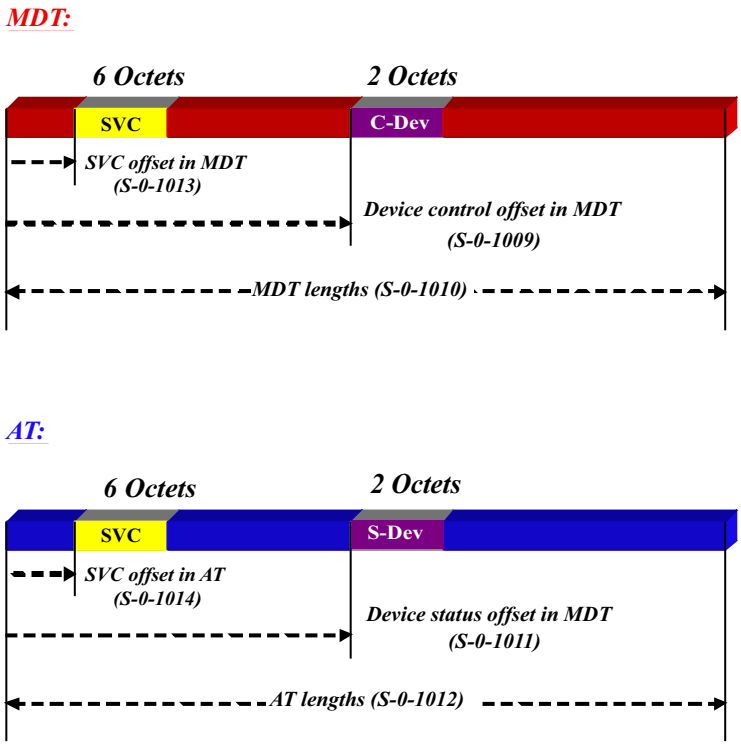


Figure 2-4 Telegram structure of the communication layer

MDT	Master data telegram
SVC	Service channel
C-Dev	Device control word
AT	Acknowledge telegram
S-Dev	Device status

Data link layer

The properties and tasks of the data link layer in sercos are:

– Control and monitoring of the connections
– Configuration of realtime data
– Error handling for the connection

For this purpose there exists a single and multicast relationship between the data link layers of a producer and a consumer. All slaves and the master can be both producers and consumers.

Application layer

The function-specific data of the devices (master and slaves) is produced or consumed in the application layer. Data is exchanged via the communication and data link layers.

2.6 Basic Communication Profiles

sercos defines two basic communication profiles which can be specified for slaves. These relate to the basic communication and are mutually exclusive. The communication profile implemented in the device is stored in the "www.phoenixcontact.com" parameter. The profiles feature the following properties:

SCP_FixCFG

sercos Communication profile fix configuration

- Features a full service channel
- Has **one** master-slave connection
- Has telegram contents which are not configurable but are defined via the respective FSP (Function-specific profile)
- Cannot be used for cross communication (CC)

SCP_VarCFG

sercos Communication profile variable configuration

- Features a full service channel
- 0 ... n connections
- Master-slave or cross-communication connections possible
- Telegram contents configurable or of type "Container"
- Additional function packages possible, e.g.,
  - SCP_Sync: Clock-synchronous
  - SCP_NRT: NRT channel
  - SCP_Diag: Support for all error counters

"S-0-1000 List of SCP types & versions" bit assignment:

Table 2-2 S-0-1000 bit assignment:

Bit	Designation/Function
3-0	Version of the SCP class
7-4	Reserved
15-8	SCP class

2.7 Device Model

The following typical functions are implemented in individual or multiple instances of a complex sercos device:

- Drive with command value processing, operating module control, axis control, encoder function, motor control depending on actuator design for electric or hydraulic servos
- Virtual master axis
- Measuring transducer
- Encoder emulator
- Cam-operated switch
- PLC system
- Digital and analog inputs/outputs

The general term "resource" is defined for functions which are essentially independent of each other. A resource contains one or more function groups in order to fulfill its purpose. The "Real axis" resource, for example, contains several function groups such as positioning control, status machine control, operating mode, positioning mode, motor encoder evaluation or scaling.

The resources are implemented in a device designated as a sub device, which offers the required administrative mechanisms. Multiple sub devices can be available for each device. The advantage of this is that, if necessary, these resources can be used independently in a more complex device with several integrated resources. Each sub device has an independent parameter address area. The sub device itself contains several function groups in order to fulfill the required administrative functions, such as sub-device initialization, parameter protection or error handling. One or more resources are integrated in each sub device.

For communication, the sercos device requires a sercos interface. The interface provides physical access to the sercos network. The sercos interface is used by one or more sercos slaves, which contain the logical realtime channels and also the specific conditions and communication-related administrative mechanisms. As a result of this fragmentation and as is the case during the introduction of several sub devices into one device, independent communication units can be managed.

Each sub device is assigned to exactly one sercos slave. The sercos slave contains communication-related function groups, such as the configuration of realtime communication.

The physical structure of a sercos device consists of one or more components. Each component can usually be set up independently. In a system such as a modular I/O device, these components are usually organized into separate modules which correspond to its slots.

The physical structure can be fully independent of the logical sequence of a device. This means that the complete device model for sercos devices consists of the two independent logical and physical dimensions (see Figure 2-5).

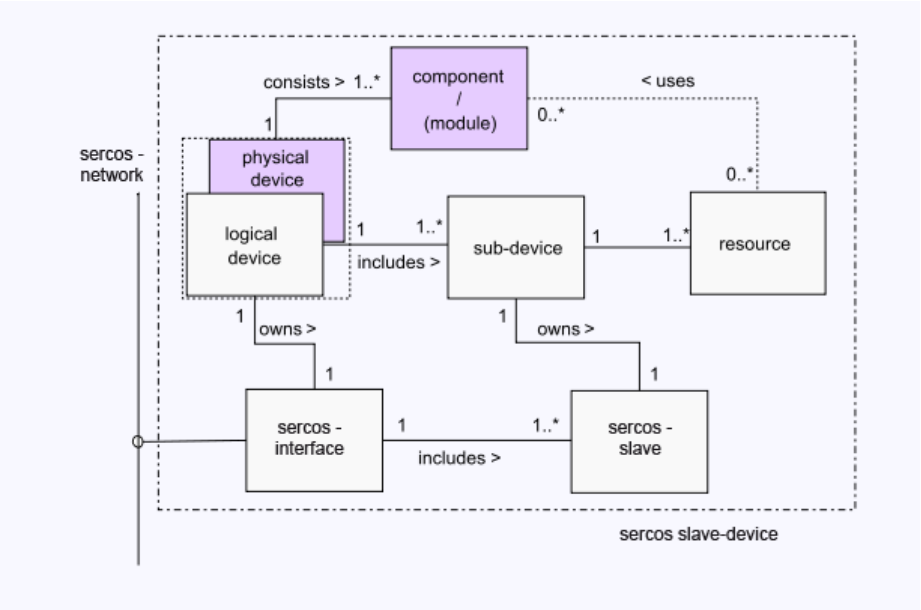


Figure 2-5 Structure diagram of a sercos slave with physical sequence

2.8 sercos Parameter Model

All parameters are assigned identification numbers (IDNs). Each parameter consists of various elements, which are used to transport additional information. This information is required in order to be able to detect and control any devices (slaves) in the system. The IDN range was extended to 32 bits in sercos for this purpose (EIDN). This ensures that an independent parameter range is available to each device, regardless of whether it is a function group for a slave, a device, a sub device or a resource.

The symbolic structure of EIDNs in sercos is defined as follows:

<IDN>. <SI>. <SE>

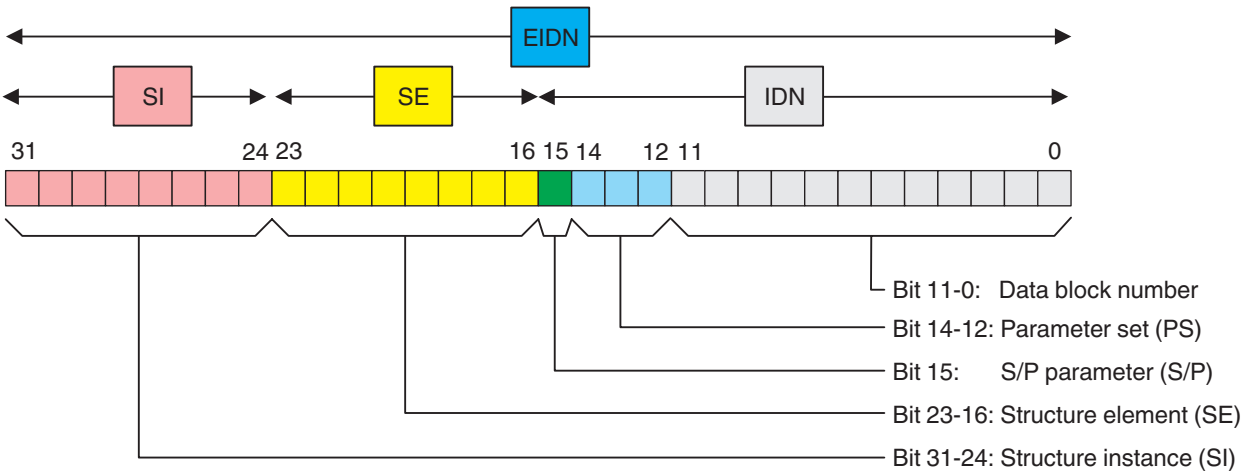


Figure 2-6 sercos parameter model

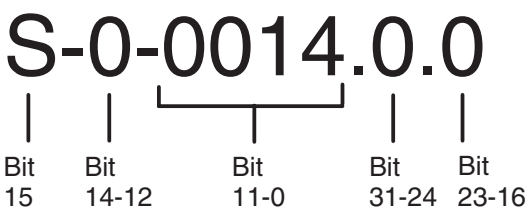


Figure 2-7 IDN structure

Data block number

Bits 11-0: (E)IDN number

- Data block number (SI = SE = 0)
- Function group (SI or SE unequal 0)

Parameter set

Bits 14-12: Parameter record

S/P parameter

Bit 15: Indicates whether it is standard data (S) or product-specific data (P).

Structure instance (SI)

Bits 31-24: The structure instance is used to address the same type of structure within a device. As a result, 255 instances of the same structure are possible in a device. In a modular I/O station the structure instance corresponds to the slot number after the bus coupler.

Structure element (SE)

The structure element is used to address the elements. As a result, up to 256 elements are possible. The structure elements 1 to 127 are specified; the remainder up to 255 are producer-specific.

The following figure shows an example structure of a modular I/O station.

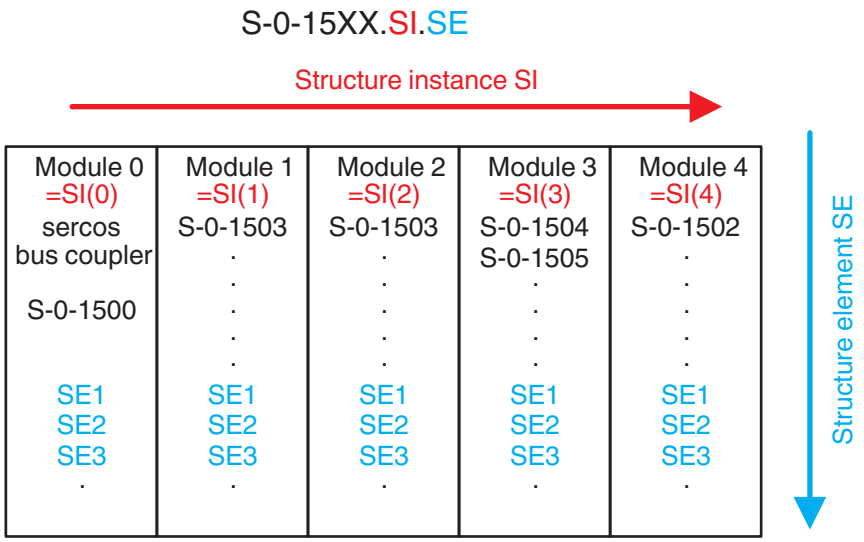


Figure 2-8 Modular I/O station

In the above example, structure instance 1503 has two function groups.

The modular I/O station consists of the following modules:

– Module 0: Bus coupler
– Module 1: Digital inputs
– Module 2: Digital inputs
– Module 3: Analog inputs, analog outputs
– Module 4: Digital outputs

The sub device has a closed, independent parameter range. This means that all parameters are available in the context of the sub device, whether the function group belongs to the sercos slave, the sercos device, the sub device or the resource. The cyclic parameter access services are addressed via the sercos address of the sercos slave assigned to the sub device.

Devices and sercos interface-specific parameters can be addressed by all sercos addresses of this device, but it is always the same value that is addressed. Such parameters are known as "global parameters" (see Figure 2-9). Here are a few typical examples of global parameters:

– **S-0-1002**, cycle time (tScyc) –
  a sercos interface-specific global parameter
– **S-0-1300**, electronic device identification – a device-specific global parameter

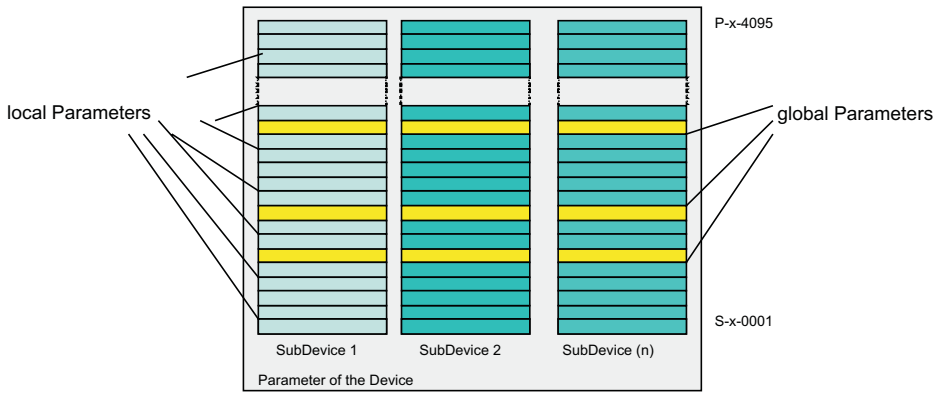


Figure 2-9 Parameter addressing of global and local parameters

Slave- and sub-device-specific parameters can only be addressed by the specific slave. These parameters are known as "local parameters". Most parameters in a device are of this type.

Example: S-0-1040

The sercos address is a slave-related and subsequently a local parameter.

2.9 Grouping of ID Numbers

Each identification number (IDN) is assigned to precisely one function group. A function group is a functional grouping of IDNs. Each function group exists within a so-called profile range. These profile ranges are:

– SCP (sercos Communication profile)
– GDP (Generic device profile)
– FSP (Function specific profile such as FSP_Drive or FSP_I/O)

An application expects certain functions from a device. This can be called Application Profiling. Application Profiling uses classes to group functionalities and technical specifications.

Each of the various profiles (SCP, GDP, FSP) has an IDN, which indicates the classes implemented in a device.
SCP: IDN S-0-1000 List of SCP types & versions
GDP: IDN S-0-1301 List of GDP classes & version
FSP: IDN S-0-1302 Resource structures of sub-device

The structure diagram of a sercos device illustrates the segmentation and structure of the various sub areas. The sercos interfaces and the sercos slaves belong to the sercos communication profile (SCP) and are defined for all sercos slave devices. Device and sub device belong to the GDP (Generic device profile). The individual resource is described by different function groups (FG).

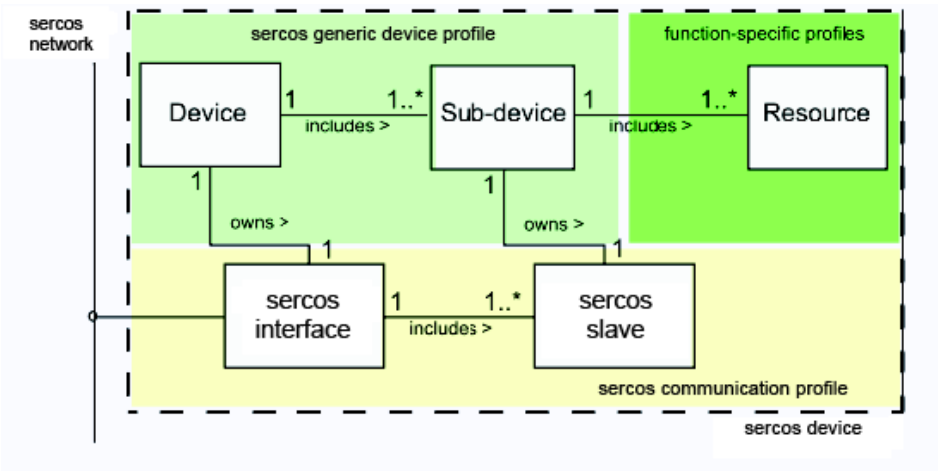


Figure 2-10 Structure diagram of a sercos slave device

2.9.1 SCP (sercos Communication Profile)

All sercos devices, that is also drives, cameras, scales in addition to I/Os use these function groups and parameters.

The SDP (sercos communication profile) is divided into the following function groups:

– FG SCP identification
– FG Timing
– FG Telegram setup
– FG Control
– FG Bus diagnosis
– FG Connection
– FG NRT

FG SCP identification The *SCP identification* function group comprises all IDNs for classification of a slave on the SCP level.

FG Timing The *Timing* function group comprises all IDNs for timing.

FG Telegram setup The *Telegram setup* function group comprises all IDNs for the telegram setup.

FG Control The *Control* function group comprises all IDNs for the control of the communication state machine of the slave.

FG Bus diagnosis The *Bus diagnosis* function group comprises all IDNs for bus diagnostics.

FG Connection The *Connection* function group comprises all IDNs connection configuration.

FG NRT The NRT (non-realtime) function group comprises all IDNs for communication over the NRT channel.

Please refer to Section “Function Groups of the SCP (sercos Communication Profile)” on page 9-1 for a detailed list of the associated IDNs.

2.9.2 GDP (Generic Device Profile)

The objective of the Generic Device Profile (GDP) is to provide a view of the sub device which is independent of the implemented function profile (FSP).

The GDP (General Device Profile) contains the sub-class GDP_Basic, whose parameters must be implemented in all sercos devices.

There are also LED displays for diagnostic and status functions, which are not part of the GDP_Basic class, but which are nonetheless expressly recommended for all devices (see Chapter 7.2 on page 7-1).

All sercos devices, that is also drives, cameras, scales in addition to I/Os use these function groups and parameters.

The IDN S-0-1301 List of GDP classes & version contains a list of the functions of the sub device.

"S-0-1301 List of GDP classes & version" bit assignment

Table 2-3 S-0-1301 bit assignement

Bit	Designation/Function
3-0	Version of the GDP class
7-4	Reserved
15-8	GDP class

The GDP is part of the application layer of a sercos device. It represents the part of the application layer which is not used for a pre-specified function, such as FSP-Drive or FSP-IO.

The GDP is divided into function groups:

– FG Diagnosis
– FG Archiving
– FG Administration
– FG Identification
– FG StateMachine
– FG Time

FG Diagnosis

The *Diagnosis* function group has the task of providing the sercos master with a defined connection for diagnostic tasks.

These include

– Access to diagnostic numbers and messages and the corresponding time stamps
– The resetting of this information
– sercos LED

FG Archiving

The *Archiving* function group has the task of providing the sercos master with a defined connection for archiving tasks.

These include

– Access to data lists which must be saved in order to create a backup
– Access to the checksums of this data and process commands in order to create a backup and restore these

FG Administration

The Administration function group has the task of providing the sercos master with a defined connection for administrative tasks.

These include

– Language settings in the sub devices
– Assignment of passwords required to change data

FG Identification

The Identification function group has the task of providing the sercos master with a defined connection for identification tasks.

These include

– Access to all electronic identifications for all available components of the device. Here each component is represented by a structure instance (SI) of the electronic identification parameter (S-0-1300).
– Specifications for the function-related view of the sub device.

FG State machine

As an extension to the communication state machine, each sub device must feature a state machine sub device, which indicates the operation status of the application.

FG Time

The Time function group describes transmission and activation of the sercos time in the slave in relation to the current time of the master.

Please refer to Section “Function Groups of the GDP (Generic Device Profile)” on page 9-3 for a detailed list of the associated IDNs.

2.9.3 FSP_IO (Function-Specific Profile for I/O Devices)

The FSP (Function specific profile) contains device- and application specific parameters.

FG bus coupler

– S-0-1500 I/O Bus coupler

Device-specific function groups

The following device-specific function groups are included in this application description:

– S-0-1502 I/O function group digital output
for devices with digital outputs
– S-0-1503 I/O function group digital input
for devices with digital inputs
– S-0-1504 I/O function group analog output
for devices with analog outputs (current, voltage)
– S-0-1505 I/O function group analog input
for devices with analog inputs (current, voltage, temperature, strain gauge)
– S-0-1506 I/O function group counter
for devices with a counter
The device registers and processes quick pulse trains from sensors. It has a counter input, a control input and a switching output for free parameterization. In this way it is possible to have high system availability and fast response times. The device is suitable for frequency measurement, event counting, time measurement and pulse generation (pulse generator).
– S-0-1507 I/O function group complex protocol
for devices with, for example, RS-232 or RS-485 interface
– S-0-1508 I/O function group sub bus master
for devices with a lower-level bus master,
for example, I/O link, Profibus, CAN bus, DALI, etc.
– S-0-1509 I/O function group sub bus slave
for devices attached to a lower-level bus master,
for example, I/O link, Profibus, CAN bus, DALI, etc.
– S-0-1513 I/O function group motor starter
for devices with servo amplifier with position, speed, or torque controller for motors
– S-0-1514 I/O function group PWM
for devices with PWM mode (pulse width modulation), frequency generators, single shot (single pulse generator), pulse direction signals
– S-0-1515 I/O function group positioning
for devices used for detection of positions (length) or angles via connected incremental encoders

Please refer to Section “Function Groups of the FSP_IO (Function-Specific Profile)” on page 9-5 for a detailed list of the associated IDNs.

3 sercos Communication

3.1 Telegrams and Their Basic Structure

sercos uses Ethernet as a physical and transport layer for a cyclic communication cycle in a range between 31.25 µs and 65 ms. In each communication cycle and for each sercos-related exchange of data, two to eight sercos Ethernet frames are available.

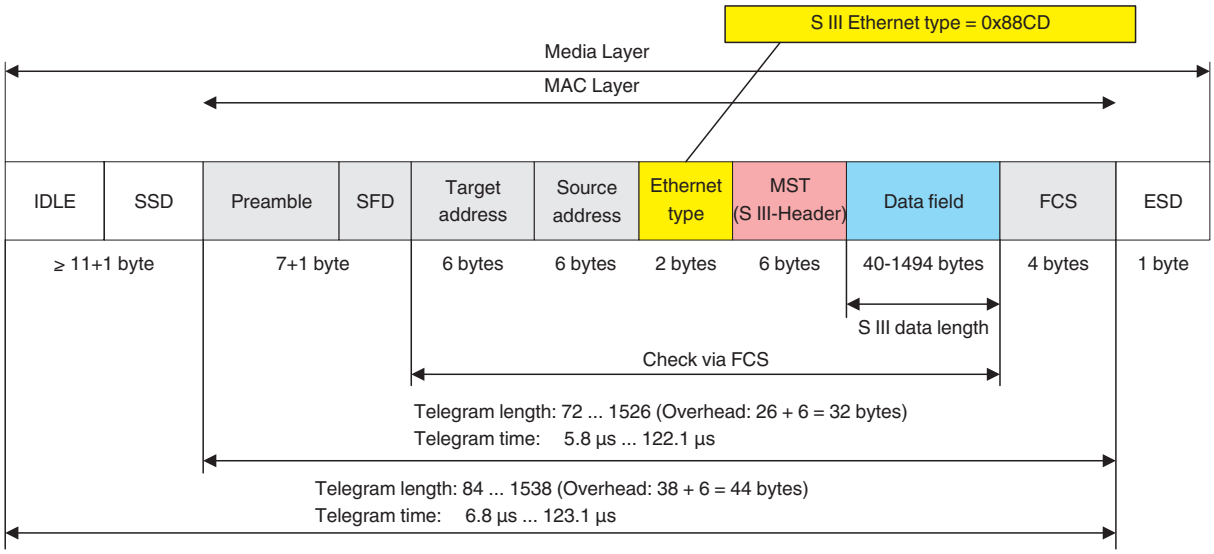


Figure 3-1 General telegram structure for sercos MDT and AT telegrams

Realtime channel

The telegrams defined by sercos (Ethertype 0x88CD) are transmitted in a collision-free realtime channel.

sercos enables the exchange both of realtime data with a fixed length and of messages with a variable length between a master and the associated slaves. A direct realtime data exchange between slaves (cross communication) is also possible via the realtime channel (RTC) in each communication cycle. The exchange of realtime data is fully synchronized and based on the configuration and is not affected by the volume of messages.

sercos recognizes two types of telegrams:

– Master Data Telegram (MDT)
– Acknowledge Telegram (AT)

MDTs and ATs are sent from the master and checked via an FCS (frame check sequence). The telegrams can be arranged in the communication cycle with various methods (see Figure 3-2 on page 3-2), whereby Method 1 is preferable, since the IP channel time can be used as the calculating time in the controller (e.g., time for evaluating the actual values and for calculating new desired values).

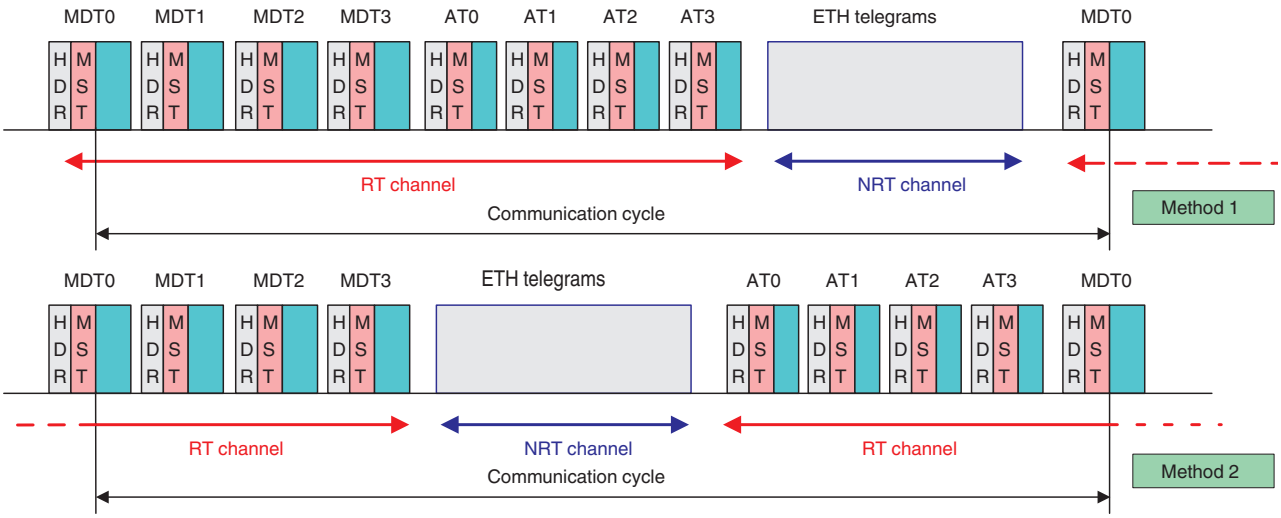


Figure 3-2 Two methods for configuring a communication cycle

Master Data Telegram (MDT)

MDTs are reserved for the transmission of realtime data from the sercos master to the slaves. The slaves can only read the contents of these MDTs. sercos specifies four MDTs (MDT0 to MDT3). The MDTs contain all of the information (e.g. synchronization, command values, etc.) that is sent from the master to the slaves via the realtime channel.

MDT0 is always transmitted. MDT1 to MDT3 are only transmitted when necessary, depending on the total quantity of data to be transmitted from the master to all slaves. The master always sends the same number of MDTs in each communication cycle. The end of the MST (sercos header of MDT0) in MDT0 is used for synchronization and starts the communication cycle of the slaves.

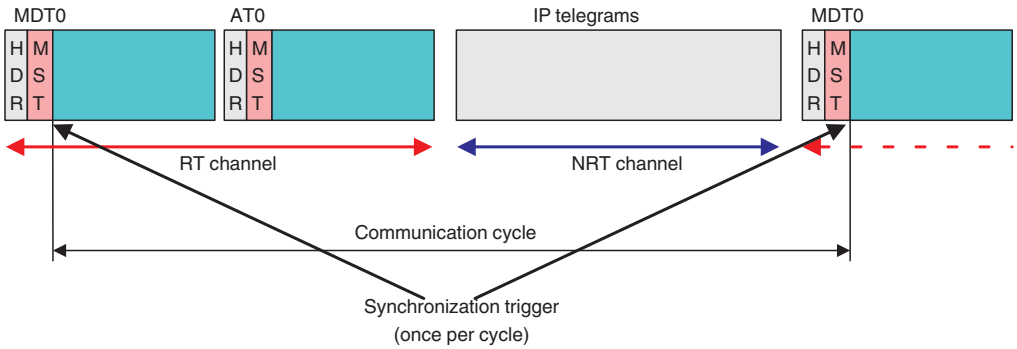


Figure 3-3 Synchronization via MDT0.

Acknowledge Telegram (AT)

ATs are used primarily to transfer the realtime data of the slaves to the master, and, in rare cases, from the master to the slaves (e.g., to transfer the same information from the master to multiple slaves). Cross communication (CC) in realtime is channeled exclusively via ATs and can take place between various controllers, also known as C2C (Controller to Controller), or as cross communication between peripherals (e.g., I/O devices or drives).

ATs can be read and written by all sercos nodes. sercos specifies four ATs (AT0 to AT3). The number of ATs is dependent on the total quantity of data to be transmitted.

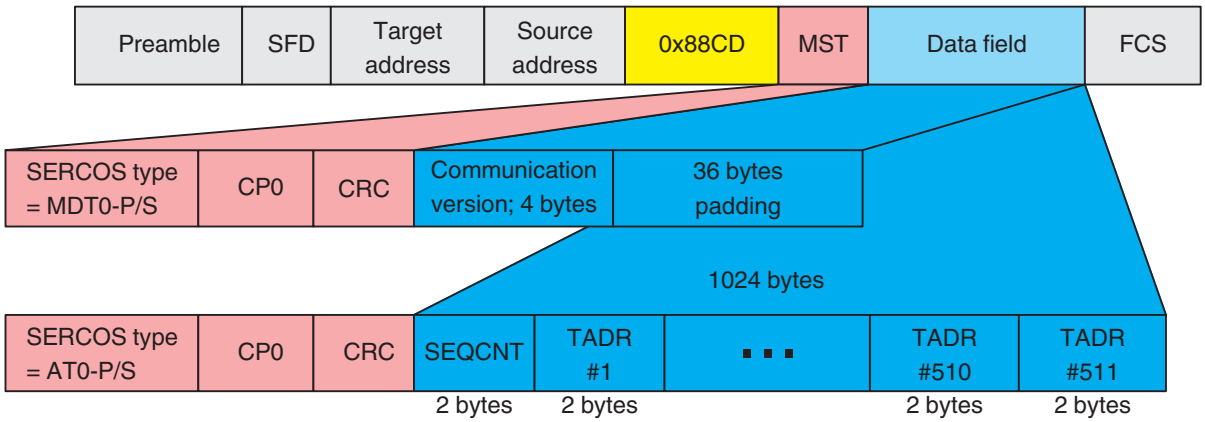


Figure 3-4 Structure of the MDT and AT array

Table 3-1 sercos type structure

Bit	Description	Comment
7	Primary or secondary telegram 0: Telegram on the primary channel 1: Telegram on the secondary channel	 P-Telegram S-Telegram
6	MDT or AT 0: MDT 1: AT	sercos telegram type
5	Cycle CNT 0: Cycle CNT deactivated 1: Cycle CNT activated	Is required to set the sercos time Is defined in the MDT
4	Reserved	
3-2	Telegram number (4 -15)	
1-0	Telegram number 00: Telegram number 0 01: Telegram number 1 10: Telegram number 2 11: Telegram number 3	From MDT and AT

Telegram configuration

The assignment of the service channel (SVC) and the realtime data arrays (RTD) in the MDT and AT is configured using parameters. The length of the realtime data arrays in the MDT and AT is dependent upon the application and can vary for the individual slaves depending on the configuration.

The number of MDTs and ATs may also vary. The configuration must meet the following requirements:

– All service channels must be configured directly downstream of the hot-plug field.
– All realtime data arrays must be configured directly downstream of the last service channel.
– All SVCs of a slave device must be transmitted in an MDT and an AT. The telegrams must contain as many SVCs as possible before the next MDT or AT is used.
– All realtime data (RTD) of a slave device must be transmitted in an MDT and an AT. The telegrams must contain as much realtime data as possible before the next MDT or AT is used.

Non-realtime channel (NRT)

A further component of sercos communication is a non-realtime channel (NRT), in which the exchange of random standard Ethernet frames between sercos devices and other connected Ethernet network nodes is possible.

The time slot reserved for this purpose is determined by the following time parameters:

– t6 (S-0-1017, List element 0) and
– t7 (S-0-1017, List element 1)

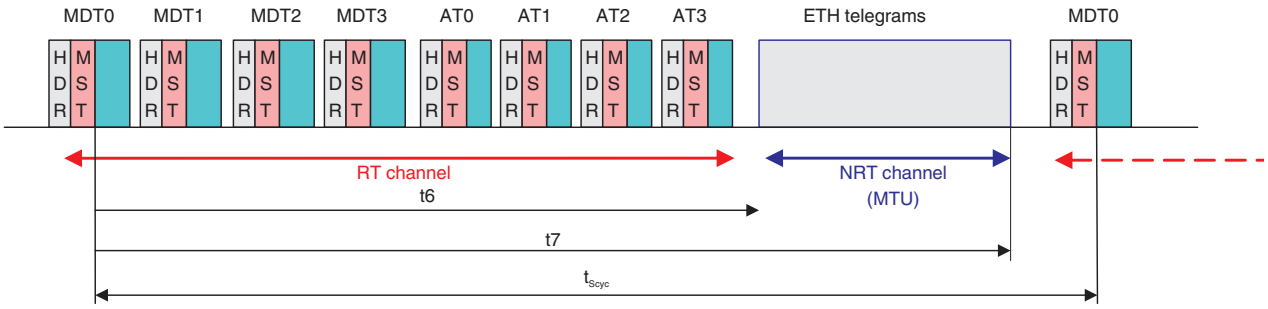


Figure 3-5 Time parameters of the NRT channel

3.2 The Data Link Layer

The data link layer specifies various sercos services for reading and writing the data within the sercos network.
Use of these services depends on the identification number (IDN) used by sercos.

There are three types of services:

– Service channel (acknowledged, not cyclic)
– Hot-plug service (acknowledged and not acknowledged, not cyclic)
– Realtime channel (not acknowledged, cyclic)

3.2.1 The Service Channel

Communication settings as well as parameter and diagnostic data can be exchanged between the controller master and the individual slaves via the sercos service channel.

With this service, the master reads or writes the IDN elements of a slave.

3.2.2 The Hot-Plug Service

The sercos hot-plug service enables devices that have not been involved in a scheduled phase startup (communication phases CP0 - CP4) to be subsequently incorporated into Phase CP4. The remaining devices are retained in CP4.

Hot-plug only works in a linear or double-line topology. The mechanism is based on the changes to the topology during the hot-plug phases, which are detected on the last slave in the line. This means that each sercos slave must fully support the topology bits.

A hot-plug slave must be recognized by the master in terms of its sercos address and parameterization. The service channel as well as the connections produced by the hot-plug slave must already be configured in the telegrams during a scheduled phase startup.

There are thus two different options for incorporating a sercos slave into the cyclic communication in CP4:

– Via communication phases CP0 - CP4 or
– Via hot-plug phases HP0 - HP2.

3.2.3 The Realtime Channel (RTC)

The services of the realtime channel (RTC) activate cyclic communication, allowing master and slave devices to read or write cyclic data. The master uses the ICC service (initiate cyclic communication) to incorporate cyclic communication with the slave devices into a sercos network.

Table 3-2 Initiate cyclic communication (ICC)

Parameter	Query	Response/confirmation
Argument – Cycle time – List of sercos addresses – List of connections for each device – Topology	 – Mandatory – Mandatory – Mandatory – Mandatory	
Result – List of sercos addresses – List of offset of all connections for all devices – Error code		 – Mandatory – Mandatory – Mandatory

3.3 Synchronization with sercos

sercos is a clock-synchronous bus that also supports asynchronous devices. The information on what is supported by a device is given in the "S-0-1050.x.01 Connection setup" parameters or implicitly in "S-0-1000 List of SCP types & versions".

This results in various transmission methods:

Asynchronous

Asynchronous means that a device freezes the input data and sets the output data independently of the bus. The input/output data is not synchronized with the bus, that means it has a defined maximum processing time in the desired point direction as well as in the direction of the actual value. The processing cannot be set but the device indicates the times required. Thus, the master can calculate turnaround times.

Synchronous

Synchronous means that the device operates synchronously with the bus. The detection of actual values as well as the validation of desired values takes place a defined times related to the bus timing. The communicative dead time between the generation of actual values and the provision of these values on the bus or the reception of desired values and their validation in the device is exactly defined. Thus, a cycle time can be defined for a connection which involves only clock-synchronous devices. New data is produced and consumed in exactly this time slot. New data is transmitted on the bus in the slot defined by the cycle time.

Synchronization can be used for both ring and linear topology. The function can be activated from CP2 in the slave. The following actions are necessary for this:

- The master determines the runtime of the topology and transmits this runtime to the slaves requiring synchronization.
- Using the "Synchronize" command, the master activates the determination of the synchronization time in the slaves.
- The slaves have one synchronization counter per port and use this to determine their internal synchronization time.
- Once the slave has been synchronized, it positively acknowledges the command.

In CP0, the master determines the runtime of the topology across several communication cycles (> 50). The master calculates the average value of the measured runtimes and determines a safety margin as the ring runtime.

In CP2, the master transmits the ring runtime to the slaves requiring synchronization. The master then starts the "Synchronize" command. If the topology is changed to CP4, the master can execute the "Synchronize" command again.

If the command is positively acknowledged, the master clears the "Synchronize" command in the relevant slave.

If the command is negatively acknowledged (error), the master reads the diagnosis (S-0-0390) before clearing the "Synchronize" command. Either the master eliminates the error itself or the error must be removed by startup personnel. Once the error has been eliminated, the "Synchronize" command must be reactivated for all slaves requiring synchronization.

4 Planning

As described in Section “Topology” on page 2-1, ring structures or linear structures can be used for sercos networks, whereby routers and switches can be completely dispensed with. Here the individual devices are linked via their Ethernet ports. The Ethernet ports (P1 and P2) of the individual devices can be freely exchanged and can also be used, for example, to connect standard Ethernet devices (e.g., a notebook) to a sercos realtime domain. This means that any Ethernet or IP protocols can be used to access sercos devices, without affecting the realtime behavior of the sercos realtime domain.

4.1 (Assembly) Directives and Standards

4.1.1 Wiring

The Physical Layer is implemented via an Ethernet standard connection in accordance with ISO/IEC 8802-3 with a data rate of 100 Mbps, whereby any combination, such as full duplex, 100Base-TX with autocrossover function (two cables with twisted wire pairs) as well as 100Base-FX (Ethernet via glass fiber) can be used. The cables must be designed in accordance with CAT5 or higher and must also be sufficiently shielded in accordance with EMC requirements.

4.1.1.1 General

Because of its simple planning possibilities, a building installation is often used as a reference installation model. It stipulates that a certain quality is attained by the arrangement and use of certain components. For example, category 5 components for symmetrical cabling result in a class–D channel that is suitable for transmission of Fast Ethernet.

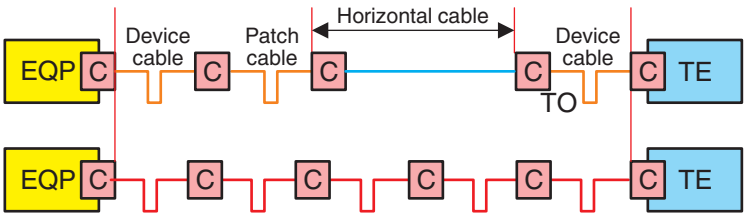


Figure 4-1 Structure of the channel

Key:

EQP:	Equipment	TO:	Terminal outlet
TE:	Termination device	C:	Plug-in connection

In this case, the flexible lines – also known as cords - can have a maximum length of 10 m and permanently installed lines a maximum of 90 m which means that the total maximum length of the channel is 100 m. Since the transmission properties of flexible lines are inferior to those of installed cables, length ratios must be complied with. The use of higher-quality components, for example category 6, or the reduction of channel length for compensating the longer more flexible lines is theoretically possible, but more difficult to calculate in practice.

For this reason, experts of at the sercos international e. V. user organization have developed an installation model that allows the user to build his network using selected components and with the help of simple rules without calculations. All channel lengths can be attained with permanently laid and flexible cables in any combination and partial lengths using the defined cable types. Plug-in connections within the channel can be implemented in a variety of ways according to industrial operating conditions, as long as the limit value of four plug-in connectors is not exceeded (see Figure 4-1“Structure of the channel”). If the planning requires more than four connections, additional calculation are required and measurements of the channel performance have to be carried out to ensure that the channel meets the requirements of the application.

In the case of sercos, symmetrical data transmission is designed to ensure that one channel is always set up with an AWG 22 wire cross section. Any combination of solid (type A), stranded (type B) or even special cables (type C) is possible. Furthermore, plug-in connectors, panel feed-throughs, couplers and installation boxes can be added as desired. Individual connector/socket transitions can be used such as those in outlet boxes of structured building cabling. In addition, panel feed-throughs with two sockets - otherwise known as bulkheads- can also be implemented. They are considered as two plug-in socket transitions as long as the manufacturer has not classified them as components. In contrast to generic cabling with eight wires in twisted–pair layout, sercos uses a star quad optimized for 100Base-T, in which all four wires are twisted together. All cables are shielded and optimally adapted to the sercos defined connectors for immunity to interference. EMI plays an important role in the industrial environment. High coupling loss of 80 dB for lines and connectors are specified to ensure a high level of immunity from interference.

Table 4-1 Cable properties

Parameter	sercos type A Solid cables	sercos type B Stranded cables	sercos type C Special cables
Nominal impedance of the cable	100 Ω according to IEC 61156-5		
Cable material	Copper		
Wire resistance	≤ 115 Ω/km		
Coupling loss	> 80 dB, according to IEC 62153-4-9		
Number of wires	4		
Shield	Copper braid or aluminum foil for cable shield, wire pairs may be unshielded or shielded with copper braid or aluminum foil		
Wire colors	White, blue/yellow, orange		
Required sheath color	Red (RAL 3020)	Red (RAL 3020)	Depends on the application
Sheath material	Not specified, differs according to the manufacturer		
Resistance in harsh environments (e.g., UV, oil, LSOH)	Not specified, differs according to the manufacturer		
Transfer resistance	≤ 25 mΩ/m at 10 MHz		
Installation	Stationary, no movement after the installation	Flexible, occasional movement or vibration	Special application (e.g., permanent movement)
Outer cable diameter	5.5 mm - 8 mm	5.5 mm - 8 mm	Depending on the application
Wire cross section	AWG22/1	AWG22/7	AWG22/x (x = 7 or x = 19) *
Wire diameter	1.5 mm ± 0.1 mm		
Delay	≤ 20 ns/100 m		
Deviation of link length	-	-	The link length can be limited to meet mechanical requirements.

* For cables other than AWG22/7 conformance with the insulation displacement connection of the connector is mandatory.

Fiber-optic or glass fiber cables are more suitable than copper cables for some requirements, such as long distances, high EMC, safety and lightning protection, see Table 4-2“Notes for cable selection”. For this purpose there are media converters that can be used to change from copper to fiber-optic or glass fiber.

Table 4-2 Notes for cable selection

	Copper cable	Fiber-optic cable	Glass fiber cable
Channel length	+ ≤ 100 m	+ POF: ≤ 50 m PCF: ≤ 100 m	++ MM: ≤ 2000 m SM: ≤ 14000 m
EMC	+	++	++
Equipotential bonding	- Interdependencies	+ Independent	+ Independent
Field installation	++	++	-
Mating cycles	+	+	+
Network availability	++	++	++
Safety aspects	+	++	++
Costs	++	+	-
Mechanical strain	++	++	-
Channels between buildings	-- Lightning protection required	- Short distances	++
Lightning protection	-- Required for channels between buildings	++ Not required	++ Not required

++ very suitable
\+ *suitable*
\- *not suitable*
-- *to be avoided*

Note

Single- and multi-mode fibers are not recommended since they are usually not required. However, if copper or POF/PCF cables do not meet the requirements (e.g., due to the channel length), you may select SM/MM glass-fiber connections.

Table 4-3 Network properties of copper cables

Properties	sercos
Supported data rates	100 Mbps
Supported channel length	100 m
Number of connections in the channel	4, maximum
Length of connecting cable	100 m (AWG 22)
Channel class according to ISO/IEC 24702	D, min.
Cable category according to ISO/IEC 24702	S, min.
Connection category according to ISO/IEC 24702	S, min.
Cable types	sercos type A sercos type B sercos type C*

** See the manufacturer's information regarding restrictions in the link length*

4.1.1.2 Covering Long Distances

The maximum cable length between two devices is 100 m. The distance can be elongated by 100 m per switch using special switches with cut-through method or non-realtime sercos switches which take over the repeater function. There is no upper limit. You have to consider that the runtime of the sercos telegrams is approximately 0.6 µs/100 m. The runtime through a device is approx. 0.6 µs/device. Ring cabling may be of advantage for long runtimes, since the runtime has to be taken into consideration only once. The controller sends data simultaneously to the ring and in opposite directions from the two ports. However, with line cabling the sercos telegram must be sent twice in succession through all devices.

Distances of several kilometers can be covered with copper/fiber-optic converters.

4.1.1.3 Using Fiber Optics with Copper/Fiber-Optic Converters

Optical channels can be used for applications for which copper cable is not suitable.

The 1 mm polymer (POF), polymer-cladded silica (PCS, also referred to as HCS), glass fiber multimode (GOF-MM) as well as glass fiber singlemode (GOF-SM) fiber types used in industrial applications are all suitable for sercos networks. Possible channel lengths range from 50 m (POF), 100 m (PCF, 2000 m (GOF-MM) up to 14,000 m (GOF-SM). The transition from copper to optical fiber and from optical fiber to copper is counted as one plug-in point each, whereby up to four per channel are permitted. In the case of the POF channel, a reduction in length of 7.5 m per connection in the channel must be considered due to attenuation.

4.1.1.4 Distance Between sercos Cable and Power Cable

The requirements for separation of the sercos cable and the power cable depend on the following:

– Electromagnetic immunity to interference of the sercos cable depending on the shield
– Design of the power cables
– Amount and type of electrical current through the power cables
– Installation of isolators between the sercos cables and the power cables

The minimum isolation to be kept between sercos cable and power cable must be kept at all points between the connecting points.

The minimum distance "A" is calculated as follows:

Minimum distance "A" $\geq$ **Minimum isolation "S" x power cable factor "P"**

Table 4-4 Minimum isolation "S" for isolation class "d"

	Encapsulation provided between sercos cable and power cable		
Isolation through clearance (e.g., without electromagnetic shielding)	**Open metal encapsulation [1)]**	**Perforated metal encapsulation [2), 3)]**	**Fixed metal encapsulation [4)]**
10 mm	8 mm	5 mm	0 mm

1 Shielding quality (DC 100 MHz) equivalent to welded metal cage braid with a mesh size of 50 mm x 100 mm. This shielding is also achieved with a steel duct (cable channel with cover) that is less than 1 mm thick and more than 20% of evenly distributed perforated area.

2 Shielding quality equivalent to a steel duct (cable channel with cover) that is less than 1 mm thick and not more than 20% of evenly distributed perforated area. This shielding quality is also achieved with shielded power cables that do not reach the performance defined in 4).

3 The surface of the installed cable must be at least 10 mm below the isolator.

4 Shielding quality (DC 100 MHz) equivalent to a steel-conduit connection with a wall thickness of 1.5 mm. This specified isolation is to be seen in addition to that of an isolator or a barrier.

Table 4-5 Power cable factor "P"

Circuit[1), 2), 3)]	No. of circuits	Power cable factor "P" [4)]
20 A 230 V single-phase	1-3	0.2
	4-6	0.4
	7-9	0.6
	10-12	0.8
	13-15	1.0
	16-30	2
	31-45	3
	46-60	4
	61-75	5
	>75	6

1 The power cable factor must be used as a multiplier to calculate the distance "A" of Table 4-4“Minimum isolation "S" for isolation class "d"”.

2 3-phase cables must be handled the same way as 3 times 1-phase cables

3 More than 20 A must be handled as multiples of 20 A

4 Low-voltage AC or DC power cables must be handled on the basis of their current values, e.g., 100 A 50 V DC cable = 5 times 20 A cable (P = 0.4)

4.1.1.5 Cable installation

Storage and installation

Cables must be transported, stored and installed according to the manufacturer's specifications.

Protect sercos cables against possible mechanical damage

sercos cable must not be subject to mechanical strain that exceeds the manufacturer's specifications. The cable routing must be such that it is ensured that the cable is protected against damage. The manufacturer's specifications for bending radii, tensile strength, compressive strength, and temperature range must be observed.

The cable paths must be designed such that the demands of the cable manufacturer are taken into consideration.

The cable paths must be selected such that sharp corners or edges which might damage the cable are avoided. Corner protection should be used (see Figure 4-2). Where required the cable ducts should protect against water or other harmful fluids.

Prior to installation of the cables the cable ducts must be clean and free of sharp edges. This particularly applies to transitions and terminations. Access points must be accessible.

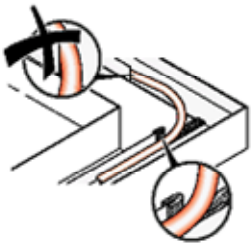


Figure 4-2 Use edge protection

Where the cable is laid in shared cable channels, precautionary measures must be taken to avoid damaging the new and already installed cables.

Redundant cables should always be installed in separate cable channels to avoid simultaneous damage by the same event.

Avoid loops

If the cable is placed into the cable ducts, make sure that the cable drum is handled properly to avoid damage caused by torsion or loops.

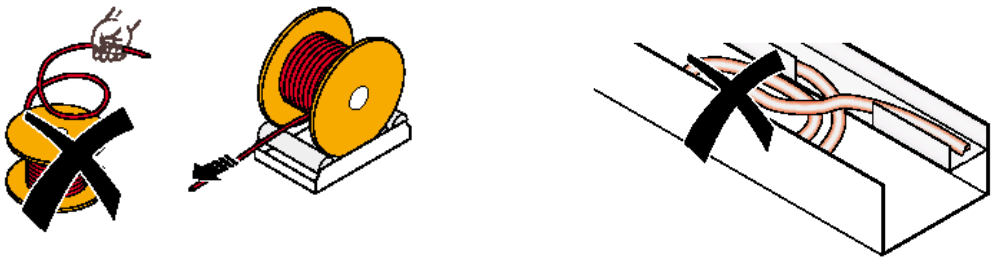


Figure 4-3 Use of a proper unwinding method and avoiding of loops

Torsion

Torsion may result from a displacement of individual cable elements. This may result in a negative influence on the electric properties of the cable. This is the reason why sercos cables must not be twisted, provided that they are not special cables for torsional loads (e.g., for robot applications).

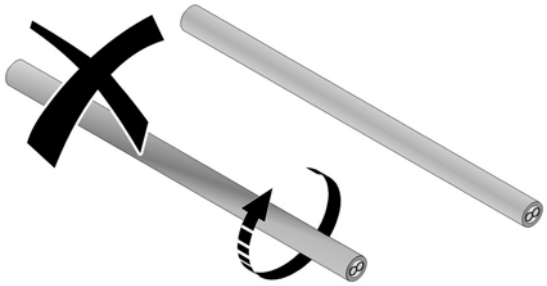


Figure 4-4 Avoiding torsion

Tensile strength (for installed cables)

If additional cables are to be laid in the cable ducts, use proper installation methods which guarantee that the maximum tensile strength limits are not exceeded.

Bending radius

The minimum bending radius of the cable must match the values given in the manufacturer's data sheet. At no point must be bending radius fall below the value given in the specifications.

Notes

- Failure to meet this requirement may result in a permanent reduction of the electric or optical performance values.
- The bending radius of a cable depends on the following:
  - The bending radius is larger when the cable is under tensile strength than in a state of rest and when installed.
  - The bending radius only applies to the flat side when flat-ribbon cable is bended. Bending around the round side requires much larger radii.

It is recommended to protect the cable with cable clamps and to provide strain relief if it is installed at right angles.

Do not overtighten the clamps. The clamps can squeeze and break the cable.

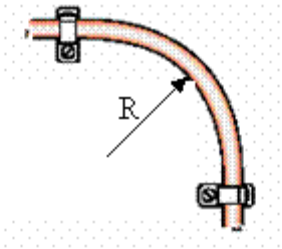


Figure 4-5 Observe the minimum bending radius

Tensile force

The permitted tensile force of a cable can be taken from the manufacturer's data sheet. The tensile force acting on the cable must not exceed the maximum tensile strength of the cable when handling it (e.g., when unrolling it) or after installation. The individual wires or fibers of a cable must not be pulled at.

For pulling the cable install a pulling handle at the end of it. It is used to reduce the strain of the cable when it is laid in the cable duct. Use cable reels to reduce strain of the cable when it is laid.

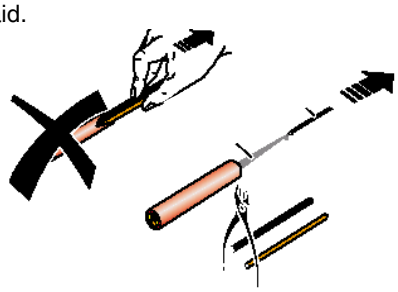


Figure 4-6 Do not pull at the individual wires

Proper strain relief

Provide a strain relief at a distance of 1 m from the connection point to compensate tensile forces. Cable clamps at the sheath do not suffice for strain relief.

The cables must have a good strain relief when they are hanging down from the ceiling, for example in hanging applications.

Clamp screw fittings should be used to secure the cables in the switch cabinets. Do not overtighten the clamps. The clamps can squeeze and break the cable.

The cables should be secured with velcro strips or plastic fasteners with a large surface to prevent their deformation. The fasteners should have a width of at least 5 mm, and it should be possible to fasten them without electric power tools.

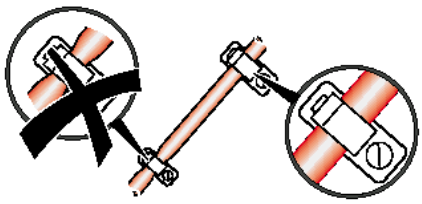


Figure 4-7 Use cable clamps with large (wide) surface

Installation of cables in switch cabinets and housings

Use cable glands with bending protection or other suitable methods to avoid damage to the cable caused by too low bending radii.

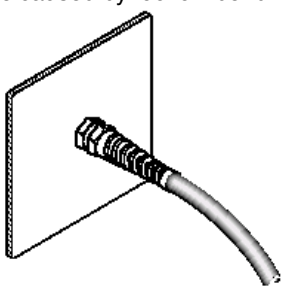


Figure 4-8 Cable screw connections with bending protection

Installation on moving parts

Everywhere, the cable is installed on or between moving parts (e.g., doors in industrial housings/switch cabinets) it should be protected by suitable connecting pieces. This is to avoid negative effects on the bending radius.

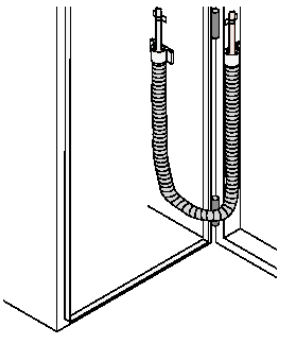


Figure 4-9 Spiral tube

Broken cable

Cables must be protected against breakage. The cables must be placed properly or protected mechanically.

Installation of permanently moving cable

If the cables are installed on moving "C tracks", they must be installed straight and in parallel to the movement. In addition, separation from other circuits must be observed. Suitable highly flexible cable must be used in moving "C tracks" applications.

4.1.2 Plug Connector

Please refer to the following table for the pin assignment:

Table 4-6 Connector pin assignment

Signal	Function	Color	Assignment	
			RJ45	M12
TD+	Transmission data +	Yellow	1	1
TD-	Transmission data -	Orange	2	3
RD+	Receiver data +	White	3	2
RD-	Receiver data -	Blue	6	4

sercos uses 1:1 cable only. Since sercos devices also support autocrossing, crossover cables may also be used, for example for servicing.

4.1.3 Grounding

General

If shielded cables are used, the housing of the device and the switch cabinet in which the device is installed must have the same ground potential. There must be a large-area metallic ground contact for this (use copper, for example, to ensure good contact).

It is important that the shielding of the sercos cable does not create compensating current caused by a ground offset or incorrect grounding of the devices and housings.

The following subsections show grounding techniques. They help to reduce communication errors due to grounding offsets when shield terminations are to be used.

Parallel RC

Parallel RC grounding of the shield according to Figure 4-10

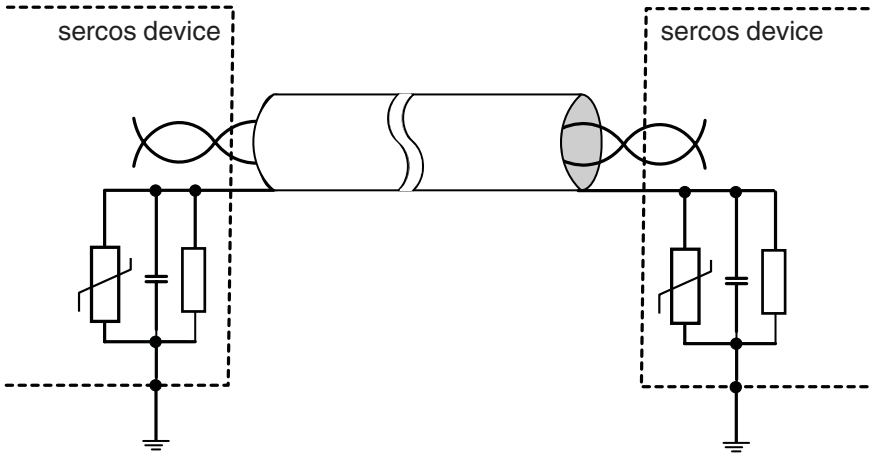


Figure 4-10 Parallel RC shield grounding

The following graphics show some examples of how the shield grounding is used together with switch cabinets.

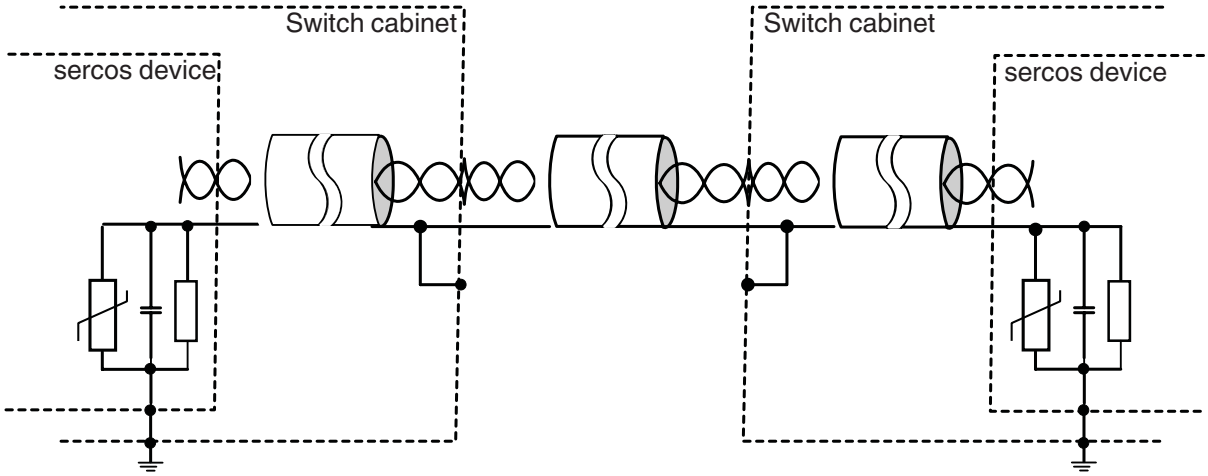


Figure 4-11 First example of a parallel RC shield grounding version

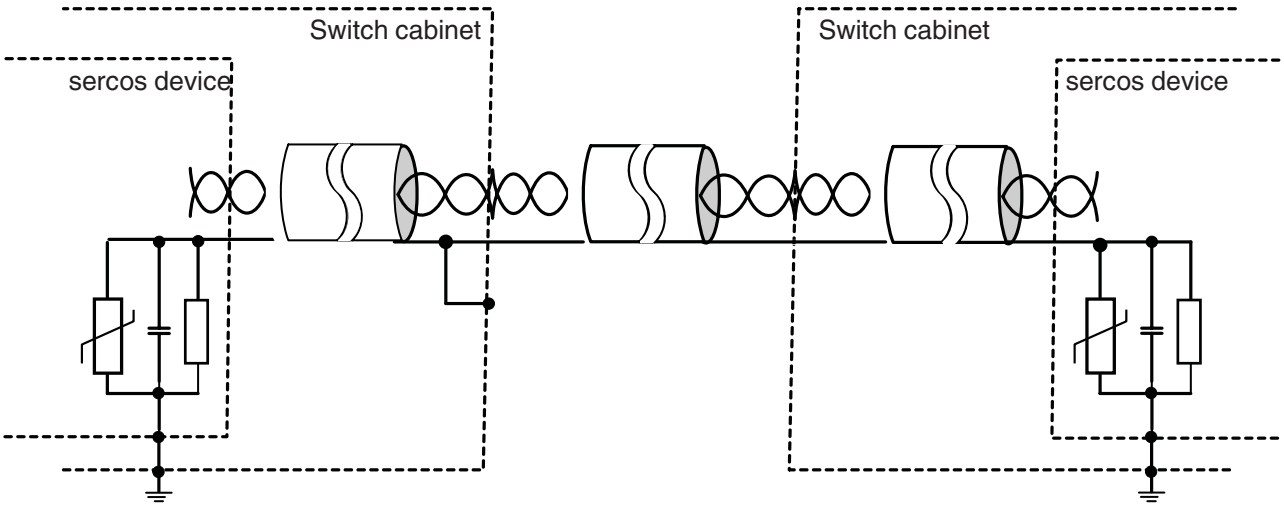


Figure 4-12 Second example of a parallel RC shield grounding version

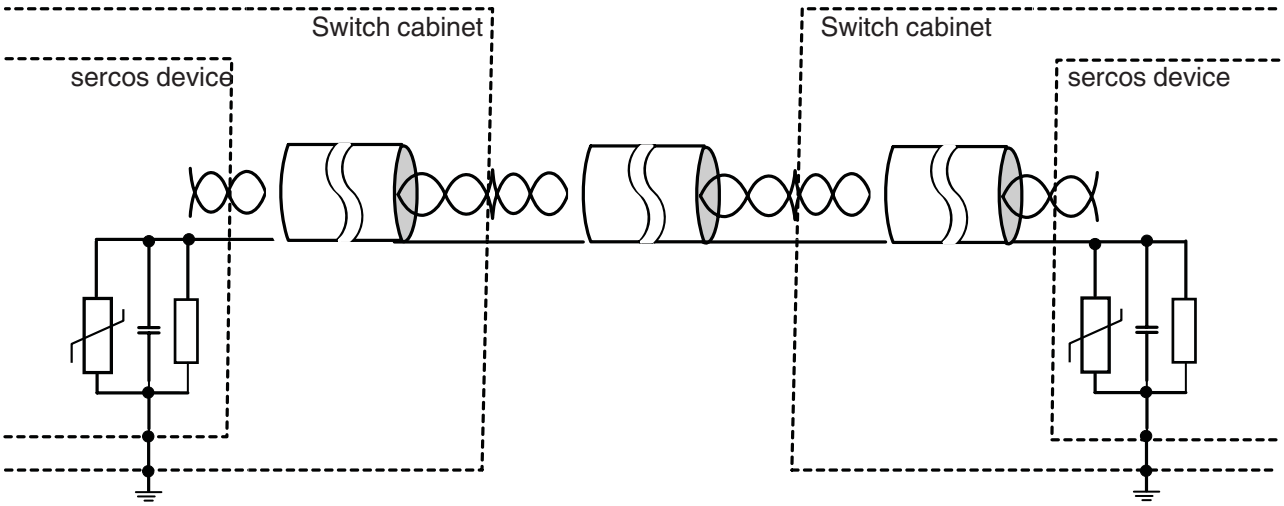


Figure 4-13 Third example of a parallel RC shield grounding version

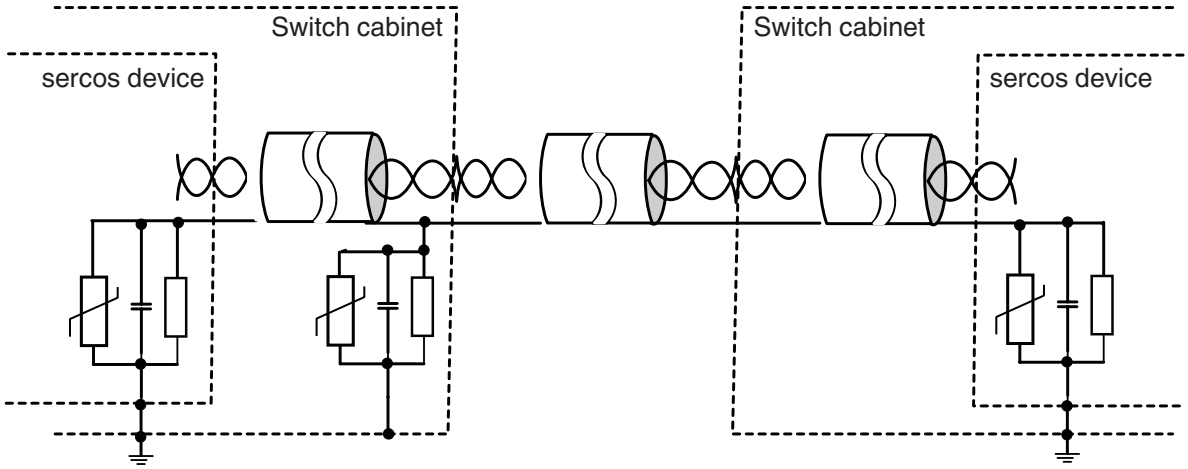


Figure 4-14 Fourth example of a parallel RC shield grounding version

Direct grounding

Direct grounding should only be used together with RC grounding (see next section).

Direct and parallel RC grounding versions

Examples of direct and parallel RC grounding versions are shown in the following figures.

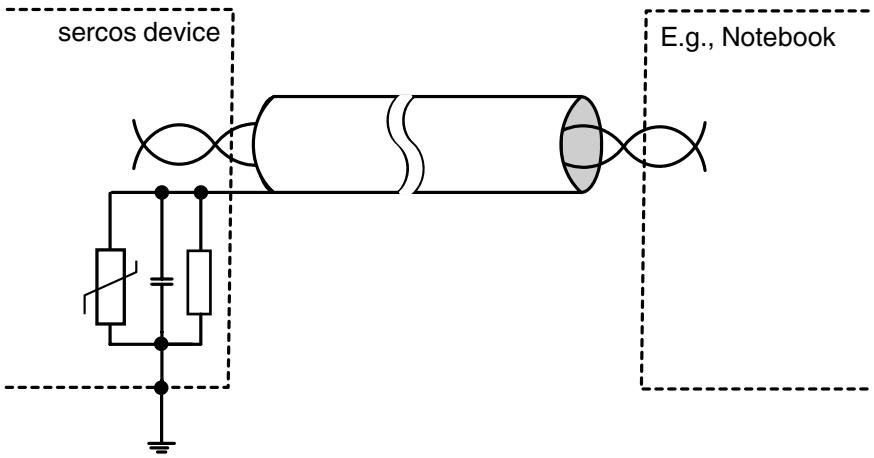


Figure 4-15 Example 1

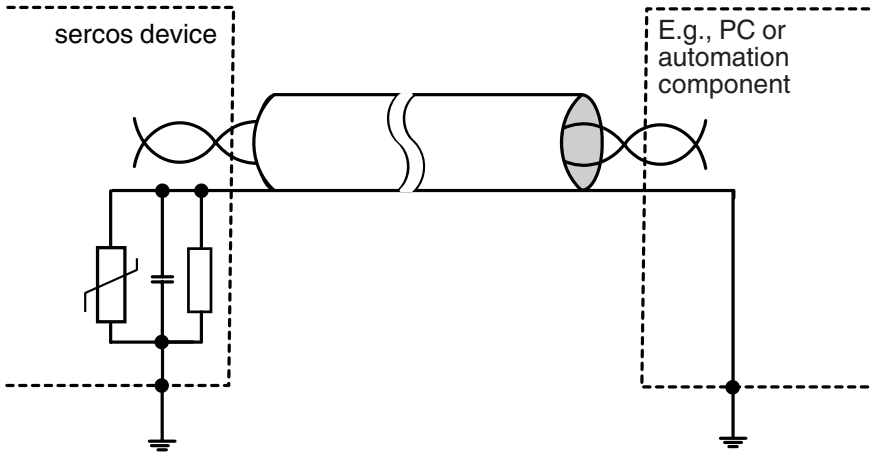


Figure 4-16 Example 2

4.2 Central and Distributed System Concepts

Cross communication between I/O devices allows for a cyclic, fast and direct data exchange between several devices. One device sends the data and several devices can read the data. This makes it possible to have very fast axis couplings, I/O connections and connections between I/O and drive without the controller being directly involved.

4.3 Fast and Slow Connections

4.3.1 Realtime Ethernet and Standard Ethernet

Integrating Standard Ethernet Devices via sercos Non-Realtime Switches

Such a switch has two sercos realtime Ethernet connections and at least one standard Ethernet connection. Thus, several standard Ethernet devices can be integrated in a realtime Ethernet line or a realtime Ethernet ring with such a switch.

If sercos devices are at the end of a line, a standard Ethernet device can be connected as well. This is a device-specific property. Data for the standard Ethernet devices is transmitted in the NRT channel to the standard Ethernet devices or even to the sercos devices. This data is usually TCP/IP or UDP/IP telegrams.

Standard Ethernet devices are often HMI devices, modems for remote access or engineering PCs.

The NRT channel of a device also helps, for example, with firmware downloads or transmission of many parameters for backup and restore measures via the *tftp* protocol.

4.3.2 Different Producer Cycle Times

Through the use of connections with different producer cycle times, you can transmit both data requiring short cycle times as well as data requiring a shorter scanning rate.

5 Parameterization

5.1 Scope of Functions of the sercos I/O Master

The various sercos I/O masters have similar functional features which differ in the specific parameters:

- Number of supported sercos I/O devices (511, maximum)
- Number of supported modules per device (62, maximum)
- Number of modules supported in the system
  (a maximum of 511 devices with 255 modules = 130,305 modules)
- Minimum cycle time (between 31.25 µs and 65 ms)
- Cyclic data traffic (a maximum of 6000 cyclic input data plus a maximum of 6000 cycle output data)
- SDDML file import in the device data base
- Bus scan of sercos devices
- Remote address assignment
- Automatic configuration of the devices in the device tree (offline/online comparison of the devices in the project)
- sercos device-related connection status in the interface
- Diagnostics of the sercos master and the slaves using function blocks
- Acyclic data transmission (service channel or NRT channel) using function blocks)
- Number of cyclic producer and consumer connections
- Number of controllers that can be networked via controller cross communication (511, maximum)
- Time when parameterizations are transferred into the PLC (online or after a new login of the PLC)
- Parameterization of the operating phase (CP4) via the parameterization level or only in the parameterization phase (CP2)

5.2 Assignment/Definition Producer/Consumer

The connections must be configured for devices with several connections (identification numbers IDN 1050.x.y with x>2 present). The master-slave connections between controller and the devices are created by default. If two devices are to exchange data directly this must be configured separately. This allows to set up homogeneous connections that have the same characteristics for each device. The same process data is transferred with the same producer cycle time. Of course, these values can vary from device to device and must be configured device-specifically.

5.3 Determining Cycle Times

For some controllers and some devices a distinction can be made between the sercos cycle time (S-0-1002) and the producer cycle time (S-0-1050.x.10).

– For a system consisting of a master and the connected devices the sercos cycle time is the same everywhere.
– The producer cycle time can vary from device to device and may also be longer than the sercos cycle time.

5.4 Parameterization Options

5.4.1 Parameterization Phase CP2

The master can switch to parameterization phase CP2 to change the device parameters. The result is that all devices are in the parameterization phase. Cycle realtime data is not exchanged.

5.4.2 Parameterization Level (PL)

The master can activate the parameterization level (PL) with the "S-0-0420 Activate parameterization level procedure command (PL)" command in CP2, CP3 or CP4. This allows for parameterization of individual devices while others remain in operating phase CP4 and exchange cyclic realtime data.

Monitoring of the connected modules is deactivates so that modules can be replaced. All parameters, except for the communication parameters and the time parameters can be modified. The "S-0-0422 Exit parameterization level procedure command (PL)" command is used to leave the parameter level and to change to the operating level.

The state machine for the communication phases and device levels (see Figure 5-1“sercos communication state machine”) shows the interaction of the various IDNs.

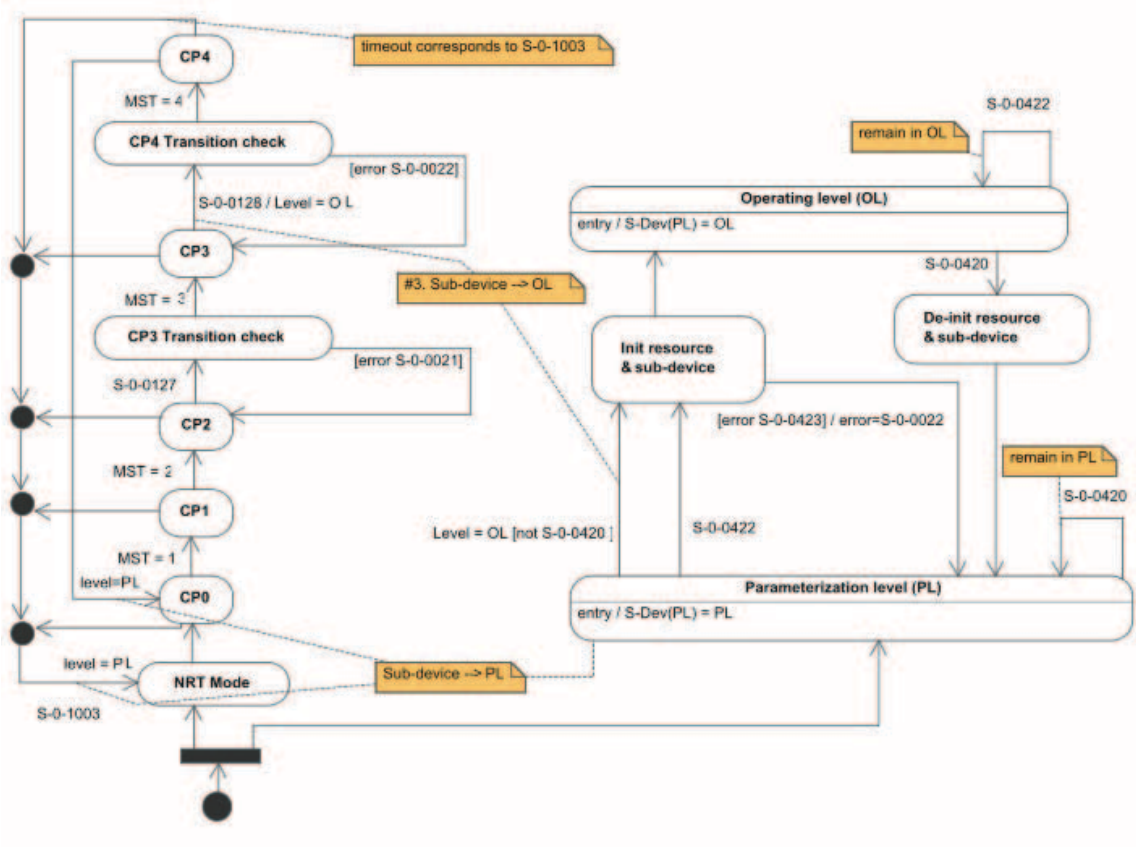


Figure 5-1 sercos communication state machine

This function group contains the following IDNs:

– S-0-0420 Activate parameterization level procedure command (PL))
– S-0-0422 Exit parameterization level procedure command (PL)
– S-0-0423 IDN list of invalid data for parameterization level

It also contains the following control and status bits:

– S-Dev/Parameterization level

5.5 Creating sercos I/Os

5.5.1 Creating a sercos Slave

The project must be adapted to the real system. The devices are located in the library of your engineering system. If the device required is not available in the library by default it can be integrated into the library by importing its SDDML file.

sercos distinguishes between two types of devices for the connection of I/O modules:

1. Compact

The module structure is defined for compact devices. After a device has been inserted into the project explorer, the modules under the device object node are already available for the compact design. The modules are not visible in the library.

2. Modular

The module design of the device is variable. Further modules can be added in addition to a fixed part, e.g. 8 digital inputs and 4 digital outputs. The modules can be arranged individually but must follow the equipment rules of the device.

The modules that fit for the respective device can be found in the **Periphery** library in the sercos folder under the respective device.

I/O modules can be inserted in modular devices only.

Drag and drop the required module from the library to the device object. New modules can also be inserted between already existing modules in the project explorer.

5.5.2 sercos I/O Settings

With online configuration the device is physically connected to the controller and processed via the configuration tool. The configuration tool accesses the device, SDDML device description file and the system information. There are controllers that must have an SDDML file. Other controllers use only the device information that is available online.

For some settings it depends on the device description whether any of them can be edited and which values are preset and which are possible.

Identification

The "Identification" area contains specific information on the sercos slave which clearly identifies the slave.

sercos address	Bus-specific address of the sercos slave
Device number	Logical address of the sercos slave
Topological sercos address	Topological address of the sercos slave
Manufacturer ID:	Manufacturer ID of the sercos slave
Manufacturer:	Manufacturer name of the sercos slave, e.g., Phoenix Contact
Manufacturer device ID:	Identification number assigned to the sercos slave by the manufacturer.
Device name:	Name given to the sercos slave by the manufacturer.
FSP type	This number defines device-specific functions of the sercos slave, e.g., properties of the device.

Changing the sercos address in the project

The sercos address of a device can be changed in the project via the "Configuration of sercos devices" dialog box. This dialog box can be opened by right-clicking on the sercos master node.

If several devices with the same sercos address are connected, a distinction can be made via the topology address and further information can be displayed. Thus you can change the sercos addresses specifically so that there are no more duplicate addresses. In CP0 the topology address is determined on the basis of the cabling. It represents the physical order or the slaves in the topology.

A device can also be replaced and the sercos address set automatically by comparing the old and new values of the topology address and the electronic rating plate. In this way you can replace a device via the controller without engineering tool.

sercos Configuration

This area is used for the display and modification of device-specific parameters.

Status

The "Status" area displays status information (e.g., "Running", "Stopped") and specific diagnostic messages from the device.

Information

The "Information" area displays the following general information about the device, where this information is present in the device description file:

- Name (module designation, e.g., ILB S3 24 DI16 DIO16)
- Manufacturer (e.g., Phoenix Contact)
- Category (e.g., slave)
- Version (e.g., Revision=16#4)
- Order No. (e.g., 2897570)
- Description (name of the device description file, e.g., ILB S3 24 DI16 DIO16.xml)
- Image (image of the module)

5.5.3 sercos I/O Module

sercos Module

This area informs you about the configuration of the module and you can modify it, if necessary. The settings in all subareas are specified in the SDDML device description file of the module. It is defined in this file with which values the setting is pre-assigned and whether it is editable.

For some devices and controllers, these settings can be carried out in the operating phase CP4. The parameterization level in the device to be processed is activated for a short time, the data is modified, and afterwards, the operating level is activated again, see "S-0-0420 Activate parameterization level procedure command (PL)" or "S-0-0422 Exit parameterization level procedure command (PL)".

Depending on the controller used, the changes will become effective immediately in the PLC or only after a new login of the data into the PLC.

Module type code	Each module has a unique module type code assigned by the manufacturer. Depending on the manufacturer, this number can be a hexadecimal number or a job number.
Input length/bytes	Specifies the input length of the module in bytes
Output length/bytes	Specifies the output length of the module in bytes.

Function Group

The "Function groups" area provides information about the inputs and outputs of the function group.

None of the settings in this dialog can be edited.

Name	Name of the channel, not editable
Number of channels	Number of supported channels for the module
Width of the channel (bits)	Bit size of the individual channels, not editable.
Type	Number of structure elements (SE) of the I/O function groups. Depends on the I/O functions.
IDN.SI.SE	
– IDN	Identification number, e.g., 15xx
– SI (structure instance)	The SI number is identical to the slot number of the modules. Module 1 has SI number 1. In the case of fixed modules, module 1 has SI number 0.
– SE (structure element)	Number of structure elements (SE) of the I/O function groups, depending on the I/O functions.

User-Defined Parameters

Symbolic values	If symbolic names for the parameters are also specified in the device description file (SDDML file), this option can be activated here to have these symbolic values displayed in the "Value" column instead of the real values.
Defaults	This button is used to restore the values displayed in the table to the default setting.
Name	Parameter name, not editable
Value	The default value of the parameter is displayed here first, either directly or as a value of the corresponding symbol name. If the parameter can be edited, the user can double-click or use the <space bar> to open a selection list in the table field, in which the value can be modified.
Type	Parameter data, not editable
Default value	Default value defined by the device description, not editable

sercos Module Configuration

This area is used for the display and modification of device-specific parameters.

sercos Module I/O Map

This area is used to map the inputs and outputs of the module to project variables.

The current value of the variables is displayed in online mode.

Status

The "Status" area displays status information (e.g., "Running", "Stopped") and specific diagnostic messages from the device.

Information

The "Information" area displays the following general information about the device, where this information is present in the device description file:

- Name (module designation, e.g., analog input/output)
- Manufacturer (e.g., Phoenix Contact)
- Categories
- Version (e.g., Revision=16#4)
- Order No. (e.g., 2897570)
- Description (name of the device description file, e.g., ILB S3 AI4 AO2.xml)
- Image (image of the module)

The "S-0-1500.0.20 Parameter channel transmit" parameter channel is an asynchronous communication mechanism for the manufacturer-specific configuration and parameterization of the bus coupler or the I/O modules.

The parameter channel handles the data transparently in the form of a list (1 byte, hex).

The maximum sercos length depends on the size of the memory.

Data from 1 byte up to the maximum data length is transmitted (via the service channel) to the parameter channel (Parameter Channel Transmit). The service channel works with fragmentation.

The successful transfer via the service channel is the trigger for the command in the I/O modules and the bus coupler. Write access to the service channel is only confirmed to the master once the process is complete. No further control signal (handshake) is required for this. The response is retrieved via the receive channel (Parameter Channel Receive). Since this takes place via the service channel, no special control signal (handshake) is required here either. The bus coupler and the modules respond with variable data lengths.

6 Startup

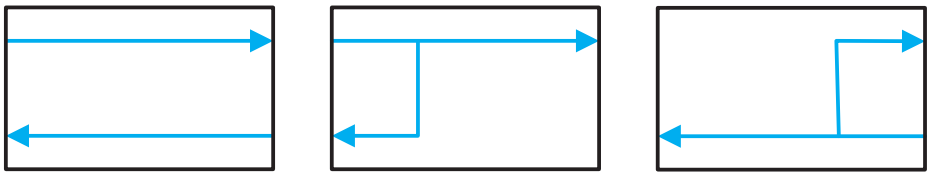
6.1 General Information on Initialization and the Six Communication Phases

The initialization of sercos communication consists of five states known as "communication phases" (CP0 - CP4) and a starting state known as NRT, which are achieved independently of each other after the master and the slaves have started up. In this phase, all devices act as store-and-forward switches when they support standard Ethernet communication.

Once a system has started up and the internal tests have been performed without errors, the system starts in non-realtime phase (NRT). In the non-realtime phase, three types of telegrams can be sent:

– sercos telegram (Ethernet type = 0x88CD)
– Non-sercos telegram (own MAC address or broadcast)
– Non-sercos telegram (not own MAC address)

Initialization of a sercos network always begins with the communication phase CP0, which is initiated at the request of the ICC (initiate cyclic communication) service. If, in NRT mode, a slave receives an MDT0 with CP0, the sending of standard Ethernet telegrams is aborted immediately and the MDT0 is sent instead. The slave then activates CP0 and loopback-with-forward at the port at which it received the MDT0.



Fast forward | Loopback on primary channel with forward | Loopback on secondary channel with forward

Figure 6-1 Possible slave settings

The following main tasks are linked to the individual communication phases:

– In CP0, the participating slaves are detected.
– In CP1, the slave devices are configured for acyclic communication.
– In CP2, the slave devices are configured for cyclic communication and for parameterization via acyclic communication (service channel).
– In CP3, the slave devices are configured extendedly; cyclic communication is already running but is not used.
– In CP4, the initialization process is completed, and the sercos network is put into operation.

The DL user can switch down phases by means of the DCC (disable cyclic communication) request.

6.2 Phase Startup With Check of the Configured Data

Depending on the implemented master, the phases can be different or sometimes even invisible for the user.

6.2.1 Communication Phase NRT (Non-Realtime Phase)

Directly after the switching on the master and all slave immediately activate the NRT phase. In this phase they respond like a store-and-forward switch. Standard Ethernet communication is active if it is supported by the device. If the slave receives a request to switch to phase CP0, transmission of a standard Ethernet telegram is aborted immediately.

6.2.2 Communication Phase CP0 (Start Phase)

The master initiates communication and checks which slaves are available in which order. When a ring is to be set up the master also checks whether the ring is closed. The devices are assigned topology addresses in accordance with the order of installation at the master. The master receives the currently set sercos addresses of the slaves. There may be several devices with the same sercos address, since communication takes place on the basis of the topology address. The NRT channel is active. Standard Ethernet communication is active if this is supported by the device. The physical telegram runtimes and delays in the network are measured.

In communication phases CP0, CP1 and CP2, the NRT channel works with the following preset values:

Starting point t6 = 650 µs
Endpoint t7 = 950 µs

6.2.3 Communication Phase CP1 (Configuration Phase)

Depending on the configuration and when changing from CP0 to CP1, the master can compare the found sercos addresses with the configured sercos addresses and output a warning, for example. Also, the master can check the sercos address for correctness (0 < sercos address < 512), not-supported addresses or addresses occurring several times.

In CP1, the slave devices are configured for acyclic communication over the service channel. The topology addresses defined in communication phase CP0 are used here in CP1 to address the service channels. The master initializes the service channels of all of the slaves used. The NRT channel may be activated.

Once the master has identified the slaves in the sercos network, it initiates a switch to CP2.

If the identification time is exceeded, the initialization is interrupted. Depending on the configuration, the master responds with an error message and switches to CP0. If a slave does not receive an MDT0 in CP1 within 130 ms, it switches to NRT mode.

All slaves used behave as described here - even those with sercos address = 0.

6.2.4 Communication Phase CP2 (Parameterization Phase)

Phase CP2 is used to configure devices for cyclic communication and to parameterize the devices via acyclic communication of the service channel.

In CP2 and the higher phases, the slaves support the full functionality of the service channel.

The master transmits the following as a minimum to all available slaves:

– The communication parameters required for CP3 and CP4
– The length of all MDTs and ATs
– The offsets of their service channel and realtime data

For synchronization purposes, the master transmits the ring delays to all slaves. These are synchronized by the slaves, which adapt the synchronization time to match the ring delays. The master identifies the devices. The NRT channel can be deactivated and configured.

After the user has completed parameterization, the master starts checking the parameters in the slave using the "S-0-0127 CP3 transition check" command. The slaves check, whether all parameters required for CP3 are available and correct. Invalid parameters are entered in the "S-0-0021 IDN list of invalid operation data for CP2" IDN list. The system remains in phase CP2 and missing or invalid parameters must be changed. If there are no errors the master switches to phase CP3.

During the slave's validity check of the parameters, only general criteria (e.g., minimum and maximum values) are checked. The slave does not check whether all of the parameters transmitted by the master are correct in relation to the master data and the overall installation.

S-0-0127 CP3 transition checkThis means that even if a slave positively acknowledges "CP3 transition check", there may still be communication parameters that are incorrect in terms of the overall installation, which can lead to a communication error.

6.2.5 Communication Phase CP3 (Extended Parameterization Phase)

Further parameterizations of the devices are possible in CP3.

The complete service channel functions are supported. The NRT channel is supported if it has not been deactivated in CP2. Cyclic data communication is activated, but not used. Parameterization takes place via the acyclic service channel. The function-specific profiles (e.g., I/O, drive) are activated.

After the user has completed parameterization, the master starts a check of the parameters in the slaves with the "S-0-0128 CP4 transition check" command. The slaves check whether all parameters required for CP4 are available and correct. Invalid parameters are entered in the "S-0-0021 IDN list of invalid operation data for CP2" IDN list. The system remains in phase CP3 and the missing or incorrect parameters must be changed. If no errors have occurred, the slave concludes processing of the parameters required for device operation. The slave then activates synchronization. The master switches to phase CP4 afterwards.

6.2.6 Communication Phase CP4 (Operating Phase)

With the switching to CP4, the initialization is complete.

The complete service channel functions are supported. The NRT channel is supported if it has not been deactivated in CP2. Cyclic data communication is activated. Parameterization takes place via the parameter level. The function-specific profiles (e.g., I/O, drive) are activated.

The only way to leave CP4 is to switch back to CP0. The reason for this is possible communication errors or user interventions.

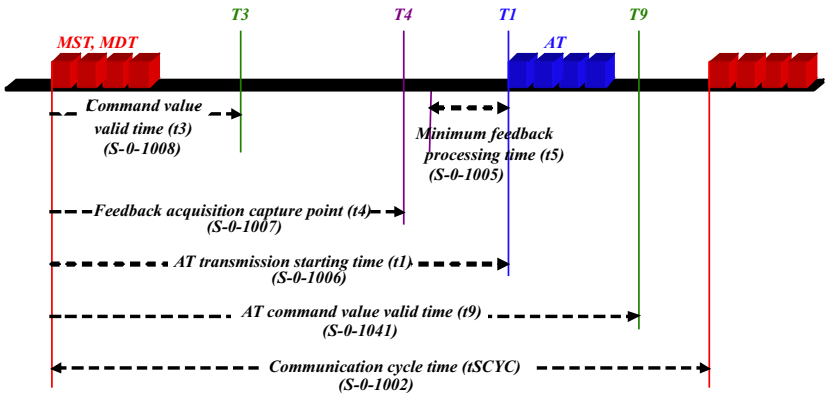


Figure 6-2 Timing of the communication layer

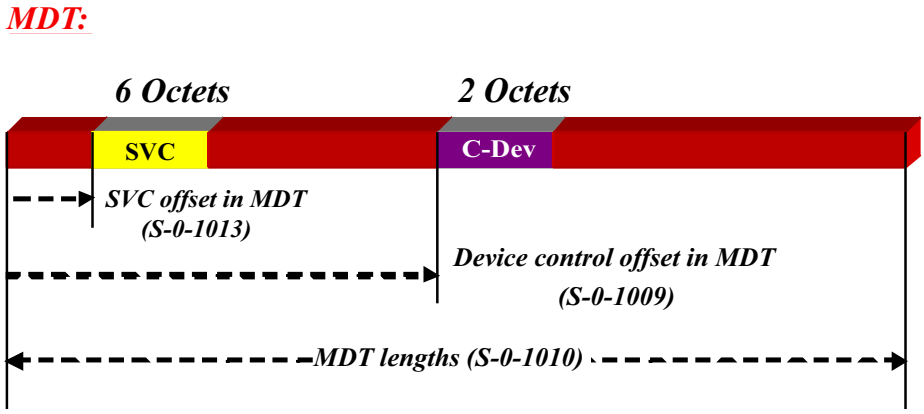


Figure 6-3 Telegram structure of the communication layer

6.3 Loading, Storing and Saving of Parameters

All relevant operating data is mapped to parameters and is stored in the device (S-0-0017 IDN list of all operation data, S-0-0192 IDN list of all backup operation data).

Save

Saving of application-specific parameters (S-0-0264 Backup working memory procedure command, C2200 Save main memory command) may be required in the following cases:

- After initial startup
- Before the device is replaced for servicing (if possible)

Saving of the parameter values by the controller is supported by the device through the listing of parameter ID numbers (IDN). When these lists are used it is guaranteed that the application-specific parameter values are saved completely. The customer may also define IDN lists.

Load

Loading of parameters may be required in the following cases:

- Initial startup (loading of the basic parameter values and the application-specific parameter values)
- Series startup of machines (loading of the parameter values saved after the initial startup)
- Restoring of a defined output state (loading the parameter values again that have been saved after the initial startup)
- Replacing the control device for servicing (loading the current parameter values saved prior to servicing)

By comparing the checksums the controller master can determine whether the values of the application-specific parameter values, currently active in the drive, correspond to the values saved on the master side.

7 Diagnostics

In sercos the various diagnostic options are divided into three function groups:
– FG Bus diagnosis
– FG Diagnosis
– FG I/O diagnosis

7.1 The Bus Diagnosis Function Group

With the IDNs of this function group, error and status messages regarding sercos communication can be displayed.

The Bus Diagnosis function group contains the following IDNs:
– S-0-0014 Interface status
– S-0-1003 Allowed MST losses in CP3/CP4
– S-0-1026 Version of communication hardware
– S-0-1028 Error counter MST-P/S
– S-0-1031 Test pin assignment port 1 and port 2
– S-0-1035 Error counter port 1 and port 2
– S-0-1040 sercos address
– S-0-1044 Device control (C-Dev)
– S-0-1045 Device status (S-Dev)

7.2 The Diagnosis Function Group

With the IDNs of this function group, error, warning or status messages can be read out as code (S-0-0390) or as text message (S-0-0095) or errors can be acknowledged (S-0-0099).

Moreover, the log function (S-0-1303) provides the option of storing in a ring memory a selectable IDN including a time stamp each time the "S-0-0390 Diagnostic number" IDN is changed.

The Diagnosis function group contains the following IDNs:
– S-0-0095 Diagnostic message
– S-0-0099 Reset class 1 diagnostic
– S-0-0390 Diagnostic number
– S-0-1303 Diagnosis trace
– S-0-1303.0.02 Diagnosis trace control
– S-0-1303.0.03 Diagnosis trace state
– S-0-1303.0.10 Diagnosis trace buffer no. 1
– S-0-1303.0.11 Diagnosis trace buffer no. 2

In addition to the various IDNs, the sercos LED is also a part of this function group.

7.2.1 Diagnostic Messages of S-0-0390

The diagnostic messages of the IDN S-0-0390 are structured as follows:

Table 7-1 Structure of S-0-0390

Source type	Diagnostic class	Status code

Source types

The source type is entered in bits 29-24 of the "S-0-0390 Diagnostic number" and may look as follows:

Table 7-2 S-0-0390 source type

29-24		**Source type**
	0x01	FSP_I/O
	0x02	GDP
	0x03	SCP

Diagnostic classes

A distinction is made between the following diagnostic classes:

- 0x9Reserved
- 0xAOperating state (lowest priority 4)
- 0xBReserved
- 0xCProcess-command-specific status (priority 3)
- 0xDReserved
- 0xEWarning (priority 2)
- 0xFError (C1D) (highest priority 1)

The diagnostic classes 0x9 and 0xE (information, warning) are removed when they are no longer relevant.

Diagnostic class 0xF (error), however, can only be cleared with the "S-0-0099 Reset class 1 diagnostic" process command. Sending this process command clears all active errors (diagnostic class 0xF) of a device.

Status codes

The following status codes of the SCP and GDP specified according to sercos are shown in the "S-0-0390 Diagnostic number" IDN:

Status codes of the SCP

Table 7-3 Status codes of the SCP

Bits 31-20	Bits 19-16	Bits 15-0	Description
C30	A	0000	Communication phase CP0
C30	A	0001	Communication phase CP1
C30	A	0002	Communication phase CP2
C30	A	0003	Communication phase CP3
C30	A	008	NRT phase
C30	C	0100	"S-0-0127 CP3 transition check"
C30	C	0104	Configured IDN for MDT, not configurable
C30	C	0105	Maximum MDT length exceeded
C30	C	0106	Configured IDNs for AT not configurable
C30	C	0107	Maximum AT length exceeded
C30	C	0108	Time slot > sercos cycle time (tScyc)
C30	C	0170	Configured IDNs for the connection not configurable
C30	C	0171	Maximum connection length exceeded
C30	C	0172	"S-0-1024 SYNC delay measuring procedure command" not executed
C30	C	0173	Connections not configurable
C30	C	0174	Configuration of the connection not possible
C30	C	0175	Producer cycle time (tPcyc) of a connection not correct
C30	C	5200	"S-0-0128 CP4 transition check"
C30	C	5300	"S-0-1024 SYNC delay measuring procedure command"
C30	C	5301	"S-0-1024 SYNC delay measuring procedure command" failed
C30	C	5302	Error "S-0-1024 SYNC delay measuring procedure command"
C30	E	4002	RTD failure shutdown
C30	E	4007	Consumer connection failed
C30	E	4008	Invalid addressing command value data container A
C30	E	4009	Invalid addressing current value data container A
C30	E	4020	Topology status changes from fast forward (FF) to loopback with forward (L&F)
C30	F	4001	Error in SYNC telegram
C30	F	4002	Connection losses
C30	F	4003	Invalid communication phase
C30	F	4004	Incorrect phase upshift, e.g., from CP2 directly to CP4
C30	F	4005	Incorrect phase downshift, e.g., from CP4 directly to CP2
C30	F	4006	Phase shift and ready signal (CPS)
C30	F	4017	Timeout during phase shift
C30	F	4020	Topology status changes from loopback with forward to NRT, e.g., open circuit at active ports
C30	F	4021	Slave does not support the announced communication version for CP1 and CP2

Status codes of the GDP

Table 7-4 Status codes of the GDP

Bits 31-20	Bits 19-16	Bits 15-0	Description
C20	A	A010	Device was restarted (power on)
C20	A	A100	Incorrect password
C20	A	A110	Password protection deactivated
C20	A	A120	Password changed
C20	A	A200	Diagnostic trace started
C20	A	A210	Diagnostic trace stopped
C20	A	A220	Diagnostic trace list exceeded
C20	A	A300	Test IDN written
C20	C	0100	"S-0-0099 Reset class 1 diagnostic"
C20	C	0200	"S-0-0422 Exit parameterization level procedure command (PL)"
C20	C	0201	Incorrect or incomplete parameter record (see "S-0-0423 IDN list of invalid data for parameterization level")
C20	C	0202	Parameter limit violation (see "S-0-0423 IDN list of invalid data for parameterization level")
C20	C	0203	Parameter conversion error (see "S-0-0423 IDN list of invalid data for parameterization level")
C20	C	0400	"S-0-0420 Activate parameterization level procedure command (PL)"
C20	C	0401	Cannot switch to parameterization level
C20	C	0540	"S-0-0264 Backup working memory procedure command"
C20	C	0C00	sercos energy: Start Pause
C20	C	0C01	sercos energy: Start Pause undefined parameter
C20	C	0C02	sercos energy: Selected energy mode not available
C20	C	0C03	sercos energy: Selected energy mode currently not available
C20	C	0C04	sercos energy: End Pause

7.2.2 sercos LED

The sercos LED indicates the following error states:

Table 7-5 sercos LED

Color 1	Color 2	Status	Description	Comment
Green	Green	ON	CP4	Communication phase CP4 active
Green	Dark	Flashing 4 Hz	Loopback	Status change of the sercos ports from fast forward to loopback
Red	Green	Flashing 4 Hz	Communication error	Depends on S-0-1003 (Flashes red/green)
Red	Red	ON	SIII C1D	(Diagnostic class 1)
Orange	Orange	ON	CP0 ... CP3	Device is in one of the communication phases CP0 ... CP3
Orange	Dark	Flashing 4 Hz	Identification	(Bit 15 in the device control) used for address allocation, Configuration error or other identification purposes
Dark	Dark	OFF	NRT phase	No sercos communication, device is in the NRT phase

7.3 The I/O Diagnosis Function Group

With the IDNs of this function group, error and status messages of the I/O devices can be displayed.

The Diagnosis function group contains the following IDNs:

- S-0-1500.0.02 I/O status
  - Indicates the current status of the inputs and outputs of the entire device
- S-0-1500.0.32 I/O diagnosis message
  - Indicates the I/O diagnostic message with the highest priority
- S-0-1500.0.33 Current I/O diagnosis message
  - Indicates the current I/O diagnostic message
- S-0-15xx.y.17 DIAGIN
  - Indicates the function-group-specific behavior, e.g. status

7.3.1 Diagnostic Messages of S-0-1500

The diagnostic messages of the IDNs "S-0-1500.0.32" and "S-0-1500.0.33" are structured as follows:

Table 7-6 Structure of S-0-1500.0.32 and S-0-1500.033

Diagnostic class	Status code	Function group	Slot number	Sub bus slave	Channel number

The value ranges of the individual contents are shown in the tables below.

Diagnostic classes

A distinction is made between the following diagnostic classes:

- 0x9Reserved
- 0xAOperating state (lowest priority 4)
- 0xBReserved
- 0xCProcess-command-specific status (priority 3)
- 0xDReserved
- 0xEWarning (priority 2)
- 0xFError (C1D) (highest priority 1)

The diagnostic classes 0x9 and 0xE (information, warning) are removed when they are no longer relevant.

Diagnostic class 0xF (error), however, can only be cleared with the "S-0-0099 Reset class 1 diagnostic" process command. Sending this process command clears all active errors (diagnostic class 0xF) of a device.

Status codes

The following status codes specified according to sercos are shown in the IDNs S-0-1500.0.32 and S-0-1500.0.33:

Table 7-7 Status codes of FSP_I/O

Status code	Meaning	Status code	Meaning
0000	**No error**	**1000**	**General error**
		1800 ... 1FFF	General error, manufacturer-specific
2000	**Current**	**3000**	**Voltage**
2100	Current on the device input side	3100	Mains voltage
2110	Short circuit/ground fault	3110	Mains overvoltage
2120	Ground fault	3120	Mains undervoltage
2130	Short circuit	3134	Phase sequence
2131	Short circuit at VCC	3140	Mains frequency
2200	Current within the device	3200	Voltage within the device
2300	Current on the device output side	3210	Overvoltage within the device
2310	Continuous overcurrent	3220	Undervoltage within the device
2320	Short circuit/ground fault	3300	Output voltage
2330	Ground fault	3310	Output overvoltage
2340	Short circuit	3320	Output undervoltage
2341	Short circuit at VCC	3400	Supply voltage
2342	Short circuit at ground	3410	Sensor supply
2344	Output overloaded	3420	Actuator supply
2345	Sensor supply overloaded		
2350	Short circuit		
2360	Open circuit		
4000	**Temperature**	**5000**	**Device hardware**
4100	Ambient temperature	5010	Component error
4200	Device temperature	5100	Supply
4300	External temperature (e.g. of the drive)	5110	Low voltage supply
4400	Connection temperature	5120	Air supply
		5150	Initiator supply
		5160	Supply of I/O devices
		5200	Measuring circuit
		5210	Measuring circuits
		5220	Computer circuits
		5230	Communication
		5300	Operator interface
		5400	Power section
		5410	Output levels
		5420	Choppers
		5430	Input stages
		5440	Contactors
		5450	Fuses
		5500	Communication with extension modules

Status code	Meaning	Status code	Meaning
6000	**Device software**	**7000**	**Extension module(s) defective**
6010	Software reset (watchdog)	7100	Power
6100	Internal software (firmware)	7200	Measuring circuit
6200	Application software	7300	Sensor
6300	Faulty data record	7400	Computer circuit
6310	Missing parameter	7500	Communication
6320	Parameter error	7600	Data memory
6330	Parameter not yet initialized	7700	Open circuit/cable error
8000	**Monitoring**	**9000**	**External error**
8100	Communication		
8110	Process data monitoring		
8120	Host monitoring		
8200	Closed-loop control		
8210	High system deviation		
8211	Maximum manipulated variable reached		
8220	System deviation		
8221	Maximum manipulated variable reached		
8900	Sensors		
8910	Measured value above the value range		
8920	Measured value below the value range		
8A00	Actuator		
8B00	Preventive maintenance required		
A000	**Sub bus slave**	**B000**	**Local bus**
A001	Sub bus slave missing	B001	Local bus slave missing
A002	Wrong sub bus slave present	B002	Wrong local bus connected
A003	Compatible replacement	B003	Compatible replacement
A004	Error in number of sub bus devices	B004	Error in the number of local bus devices
A010	Device error	B010	Device error
A012	Application on sub bus slave not ready	B012	Application on local bus slave not ready
A013	Sub bus device reset	B013	Local bus device reset
A020	Communication error	B020	Communication error
A021	Sub bus error - timeout (break)	B021	Local bus error - timeout (break)
A022	Multiple transmission error on the sub bus	B022	Multiple transmission error on the local bus
A023	Sub bus I/O data communication error	B023	Local bus I/O data communication error
A024	Data communication error during sub bus management	B024	Data communication error during local bus management
A030	Sub bus configuration error	B030	Local bus configuration error
A031	I/O data configuration mapped twice	B031	I/O data configuration mapped twice
A040	General error	B040	General error
A041	Sub bus hardware error	B041	Hardware error on the local bus
A042	Sub bus firmware error	B042	Firmware error on the local bus
A043	Sub bus runs asynchronously	B043	Local bus runs asynchronously

Function groups

The modules connected to the bus coupler are acquired via function groups. The following table lists possible function groups of I/O modules:

Table 7-8 Function groups of I/O modules

Function group	Name
S-0-1502	Digital output
S-0-1503	Digital input
S-0-1504	Analog output
S-0-1505	Analog input
S-0-1506	Counter
S-0-1507	Complex protocol
S-0-1508	Sub bus master
S-0-1509	Sub bus slave
S-0-1513	Motor starter
S-0-1514	PWM (pulse width modulation)
S-0-1515	Positioning

Slot number

Slot number of the module to which the function group is assigned (structure instance).

Sub bus slave

Sub bus slave that caused the diagnostic message (see I/O_FG.x.25 Slave Index). Only used with I/O function group S-0-1509 Sub bus slave.

Channel number

Channel that caused the diagnostic message

A channel number between 0 and 255 points to a specific channel of the function group (channel-related diagnostic events, e.g., open circuit).

Channel number 0 point to the function group itself (function-group related diagnostic messages, e.g. sub bus error - timeout).

Example

There is a short circuit at an 8-channel digital output module in a modular I/O station. The module is the fourth module after the bus coupler. The following diagnostic messages will be displayed in this case:

– Message in IDN "S-0-1500.0.02 I/O status": **D000hex**

D	Outputs active, input values valid, warning

– Message in IDN "S-0-0390 Diagnostic number": **C10E2344hex**

C10	Interpretation of bits 29 to 0 according to the sercos standard, source type FSP I/O
E	Diagnostic class, warning
2344	Status code for "Output overloaded"

– Message in IDN "S-0-1500.0.33 Current I/O diagnosis message": **0E234405DE040000hex**

0	Status code according to the sercos standard
E	Diagnostic class, warning
2344	Status code for "Output overloaded"
05DE	Functions group 1502 (digital output)
04	Slot number 4 (fourth module after the bus coupler)
00	Module is not a sub bus slave
00	No channel-specific diagnostics

If no I/O diagnostic message with diagnostic class F (error) has occurred, the IDN "S-0-1500.0.32 I/O diagnosis message" contains the same message (0E234405DE040000hex).

7.3.2 Diagnostics Messages of "S-0-15xx.y.17 DIAGIN"

The current status of a lower-level module on a device is shown in IDN "S-0-15xx.y.17 DIAGIN".

7.4 General errors

General errors in the cabling can be detected with cable testers, Ethernet analysis programs (such as Wireshark), protocol interpreters and TAPs (Test Access Ports).

Table 7-9 Errors and their removal

Error	Cause	Removal
Communication failed and/or high error rates	Poor connector or terminal point contacts	Localize and rectify connection
	EMI by other devices, poor grounding, unsufficient distance from devices or cables emitting EMI	Localize and rectify grounding Check cabling and shielding Use fiber optics
	Corrosion of the shielding contacts	Localize and replace damaged components
	Mechanical strain of cables and connectors	Install a strain relief
Communication briefly interrupted and/or exploding error rates	EMI from other devices	Relate communication problem with physical or environmental incidents Localize and rectify them, e.g. increase distances
	Poor connector or terminal point contacts, due to vibrations or temperature influence	Localize and replace damaged components
	Corrosion of the shielding contacts	Localize and replace damaged components
	Mechanical strain of cables and connectors	Install a strain relief
	Condensation between electrical contacts	Clean plug-in connections Replace damaged components
Diagnostic message of the cable tester: Reflection loss too high	Cable with incorrect impedance used	Use the correct components
Diagnostic message of the cable tester: cable too long, attenuation resistance or resistance too high	Cables/wire cross section too small, cable or wire too long, or damaged	Use proper cables with the correct length Replace the cable
Diagnostic message of the cable tester: NEXT, PSNEXT, ACR, PSACR, ELFEXT, PSELFEXT	Connectors/cables/wires of insufficient quality used or they are damaged	Use proper cables with the correct length Replace the cable

8 Parameters

8.1 General

The most important parameters (S-Parameter) are listed in the following in the ascending order of their identification number (IDN). Please refer to the device-specific data sheet for information about which parameters are available in a particular device.

Each parameter has a data block that consists of the following elements and subelements:

A range of 2^{16} or 2^{32} characters is used for the numbering of the IDNs that is split up as follows:

Table 8-1 Numbering of the IDNs

Bit no.	Value	Description
31-24	0-255	Structure instance (SI)
23-16		Structure element (SE)
	0-127 (Bit 23 = 0)	Standard SE (normative)
	128-255 (Bit 23 = 1)	Product-specific SE (determined by the manufacturer)
15		Standard or product-specific data (S/P)
	1	Standard data (S, normative)
	0	Product-specific data (P, determined by the manufacturer)
14-12	0-7	Parameter record
11-0	0-4095	Data block number (if SI = SE = 0) Function group (if SI or SE unequal 0)

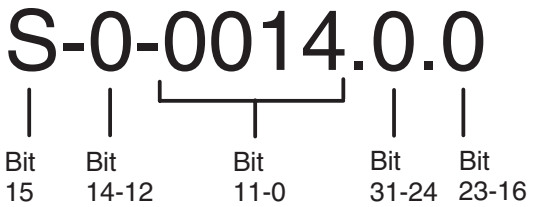


Figure 8-1 IDN structure

For example, an IDN can have the following attributes:

– Length
– Format
– Function
– Unit
– Changeability

The parameter list in Chapter 8.2 is divided as follows:

– Basic parameters, see Chapter 8.3
– Parameters of the FSP_I/O, see Chapter 8.5

8.2 Overview of GDP and SCP Parameters

Table 8-2 Overview of GDP and SCP parameters

Table 8-2 Overview of GDP and SCP parameters

8.3 Description of GDP and SCP Parameters

8.3.1 S-0-0014 Interface status

Function

The parameter contains important status bits regarding the communication phases.

Structure

Table 8-3 Relevant bits of S-0-0014, Interface status

Bit	Designation/Function
2-0	Communication phase 000 = CP0 001 = CP1 010 = CP2 011 = CP3 100 = CP4
3	2-times MST failure
4	2-times MDT failure
5	Invalid phase (Phase > 4)
6	Error during the phase upshift (order)
7	Error during the phase downshift (not to phase 0)
8	Phase shift without ready indication
9-10	Reserved
12	Incorrect phase shift sequence, timeout during phase shift
13	Incorrect phase shift sequence, phase default without phase shift
15-14	Reserved

Use

Current communication phase

The current communication phase (binary encoded) can be read with the lower three bits (0, 1, 2):

– 000b: Slave is in phase 0 (start phase)
– 001b: Slave is in phase 1 (configuration phase)
– 010b: Slave is in phase 2 (parameterization phase)
– 011b: Slave is in phase 3 (extended parameterization phase)
– 100b: Slave is in phase 4 (operating phase)

Communication error bits according to sercos

If an interface error occurs, one of bits 3 - 13 in "S-0-0014 Interface status" os set.

The communication error bits are only cleared by the device when the corresponding interface error is no longer present and the "S-0-0099 Reset class 1 diagnostic" command was started.

Attributes

Length	2 bytes
Format	Binary
Function	Parameter
Changeability	No

8.3.2 S-0-0017 IDN list of all operation data

Function

This parameter stores the IDNs of all commands and parameters of the device.

Attributes

Length	List with IDNs of 4 bytes each Number of elements is device-specific
Format	IDN
Function	Parameter
Changeability	No

8.3.3 S-0-0021 IDN list of invalid operation data for CP2

Function

Before the device does the upshift from phase 2 to phase 3 with the "S-0-0127 CP3 transition check" command it checks whether all communication parameters are complete and correct.

Use

If the device detects one or several identification numbers as invalid it writes the still require or invalid process data into this IDN list. The device displays this with the "C0101 Parameter record incomplete (-> S-0-0021)" error diagnostic message. Even for other error diagnostic messages will the corresponding parameters be written in "S-0-0021 IDN list of invalid operation data for CP2".

Attributes

Length	List with IDNs of 4 bytes each Maximum number of elements is device-specific Current length is variable
Format	IDN
Function	Parameter
Changeability	No

8.3.4 S-0-0022 IDN list of invalid operation data for CP3

Function

Before the device does a phase upshift from phase 3 to phase 4 according to the "S-0-0128 CP4 transition check" command, it checks the parameters for the following:

- Validity of the parameter
- Parameter is within the possible input range
- Compatibility with other parameters

Use

If the check is negative for a parameter, the device writes the process data concerned into this IDN list.

The device confirms the switch command with the following messages in "S-0-0423 IDN list of invalid data for parameterization level":

- C0201 Parameter record invalid
- C0202 Parameter limit value error
- C0203 Parameter conversion error
- C0242 Multiple configuration of a parameter

Attributes

Length	List with IDNs of 4 bytes each, Maximum number of elements is device-specific, Current length is variable
Format	IDN
Function	Parameter
Changeability	No

8.3.5 S-0-0025 IDN list of all procedure commands

Function

The IDNs of all process command are stored in this list.

Example

For a bus coupler the following IDNs are stored in this list:

- S-0-0099 Reset class 1 diagnostic
- S-0-0127 CP3 transition check
- S-0-0128 CP4 transition check
- S-0-1024 SYNC delay measuring procedure command

Attributes

Length	List with IDNs of 4 bytes each Maximum number of elements is device-specific
Format	IDN
Function	Parameter
Changeability	No

8.3.6 S-0-0095 Diagnostic message

Function

The current operating state of the slave is monitored with diagnostic messages that are generated in the form of text messages by the bus coupler or bus head (with compact devices) and are stored in this IDN.

Examples

- „IP channel is active: tScyc must be >= 1000us“
- „Invalid connection length“
- „->no valid producer connection“
- „->no valid consumer connection“
- „-Changing phase to CP1 started“
- „(i)No Sub-Dev addressed, act. NRT-mode“
- „-Changing phase to CP2 started“
- „-Changing phase to CP3 started“
- „-Changing phase to CP4 started“
- „Change to comm. phase [3] Finished“
- „CP4, (sub)-device in real time mode“
- „->Initialization finished, slave started“
- „error: t6 > t7“
- „New E/W diagnose message received“
- „Short circuit/overload of bus coupler outputs“
- „UM voltage is missing“
- „US voltage is missing“
- „Diag.test over S-0-1399.0.1 (Code:0x…)“
- „IB PF-Error. (TN:…, Dev.state:0x…)“

Attributes

Length	60 bytes
Format	Text
Function	Parameter
Changeability	No

8.3.7 S-0-0099 Reset class 1 diagnostic

Function

The command for resetting error messages can be started with this parameter. If the error causes have been removed, all pending error messages are reset and the device changes to the error-free state.

If the error cause has not been eliminated, the error cannot be cleared. The command does not provide a command error. The error bits in "S-0-1045 Device status (S-Dev)" are not cleared. "S-0-1045 Device status (S-Dev), bit 1" shows whether the current error can be cleared.

Attributes

Length	2 bytes
Format	Binary
Function	Command
Executability	Parameterization phase, operating phase

8.3.8 S-0-0127 CP3 transition check

Function

When the "S-0-0127, C0100 CP3 transition check" command is executed all interface parameters are checked for their validity.

Use

If there are invalid interface parameters:

– The device will complete the command with an error message.
– The invalid parameters are entered in the "S-0-0021 IDN list of invalid operation data for CP2" parameter.

The following commands can be used to switch from the parameterization phase to the operating phase:

– "S-0-0127 CP3 transition check" and
– "S-0-0128 CP4 transition check"

Attributes

Length	2 bytes
Format	Binary
Function	Command
Executability	Communication phase CP2

8.3.9 S-0-0128 CP4 transition check

Function

When the "S-0-0128 CP4 transition check" command is executed all parameters are checked for validity and for possible limit value violations.

Use

If there are invalid parameters or limit value violations, the device will complete the command with an error message and enter the invalid parameters in "S-0-0022 IDN list of invalid operation data for CP3". Moreover, several device functions are initialized.

The following commands can be used to switch from the parameterization phase to the operating phase:

– "S-0-0127 CP3 transition check" and
– "S-0-0128 CP4 transition check"

Attributes	**Length**	2 bytes
	Format	Binary
	Function	Command
	Executability	Communication phase CP3

8.3.10 S-0-0187 IDN list of configurable data as producer

Function

This parameter contains an IDN list of all parameters that the device can write cyclically in the Acknowledge Telegram (AT).

Attributes	**Length**	List with IDNs of 4 bytes each Maximum number of elements is device-specific Current length is variable
	Format	IDN
	Function	Parameter
	Changeability	No

8.3.11 S-0-0188 IDN list of configurable data as consumer

Function

This list contains the identification numbers of the parameters or process data that the device can receive.

Attributes	**Length**	List with IDNs of 4 bytes each Maximum number of elements is device-specific Current length is variable
	Format	IDN
	Function	Parameter
	Changeability	No

8.3.12 S-0-0192 IDN list of all backup operation data

Function

This IDN list contains all device parameters that have to be loaded into the device to ensure correct operation.

Use

The master uses this list to create a backup copy of the device parameters.

Attributes	**Length**	List with IDNs of 4 bytes each Maximum number of elements is device-specific Current length is variable
	Format	IDN
	Function	Parameter
	Changeability	No

8.3.13 S-0-0264 Backup working memory procedure command

Function

If the master activates "Backup working memory procedure command" all data required for operation is loaded into the non-volatile memory (see "S-0-0192 IDN list of all backup operation data").

All previously stored data will be overwritten.

Attributes

Length	2 bytes
Format	Binary
Function	Command
Executability	Always

8.3.14 S-0-0265 Language selection

Function

The languages available on the device can be selected with this parameter.

Device text will be displayed in the selected language, for example

– Name
– Unit
– All parameters with format = text, e.g., "S-0-0095 Diagnostic message"

The language encoding is as described in "S-0-0266 List of available languages".

Attributes

Length	2 bytes
Format	Binary
Function	Parameter
Changeability	Yes

8.3.15 S-0-0266 List of available languages

Function

This list contains the codes of all device languages currently available for language selection (see "S-0-0265 Language selection").

Only English is currently implemented in the devices.

Structure

The available languages are encoded as follows:

Table 8-4 Language selection

Bit	Value	Designation/Function
15-5		Reserved

Table 8-4 Language selection

Bit	Value	Designation/Function
4-0		Language selection
	00000	German
	00001	English
	00010	French
	00011	Spanish
	00100	Italian
	00101	Portuguese
	00111	Hungarian
	01000	Russian
	01001	Swedish
	01010	Danish
	01011	Norwegian
	01100-01111	Reserved

Attributes

Length List with numbers of 2 bytes each
Maximum number of elements is device-specific
Format Decimal, without sign bit
Function Parameter
Changeability No

8.3.16 S-0-0267 Password

Function

This parameter can be used to activate a customer password.

Use

The password is used to protect the values of the parameter contained in "S-0-0279 IDN list of password protected data" against unintentional or unauthorized changes. In the default setting some module parameters are write-protected with a password. The list of password-protected parameters can be found in the "S-0-0279 IDN list of password protected data" parameter.

If you try to edit a parameter with write protection you will receive the following message from the module over the service channel: "Error code 0x7009: Operation data is password write-protected". You can change the password and enable or disable write protection with the "S-0-0267 Password" parameter. The password should have 3-10 characters and no spaces and is stored in non-volatile memory. The following characters are permitted: "0…9", "a…z" and "A…Z".

If the password is read over the service channel, the module will send the password not in plain text but as a string with 10 characters
(UTF8 code 0x2A = *).

Changing the password

The devices are supplied with a default password.
For the default password, please refer to the corresponding data sheet.

To change the password, send the currently active password, the new password and for confirmation the new password again over the service channel to the module, each separated by a space. Changing the password automatically activates write protection for all password-protected parameters.

Activating write protection

You can activate the password write protection as follows:

– Switch on the power supply for the corresponding device on and off again.

Or

– Overwrite the password parameter with something other than the password.

Deactivating write protection

Password write protection is deactivated by writing the current password to this parameter.

Write access error

With every write access that is not used for changing the password or activating or deactivating the write protection, the module returns the error message "Error code 0x7008: Invalid data" via the service channel.

Attributes

Length	Variable (min = 3 characters, max = 10 characters)
Format	Text
Function	Parameter
Executability	Parameterization phase, operating phase

8.3.17 S-0-0279 IDN list of password protected data

Function

The values contained in this list can be protected by a customer password ("S-0-0267 Password") against unintentional or unauthorized changes. There is an empty list in the default state of this parameter. Users can adapt this list to their own needs by entering IDNs. Please note that the "S-0-0279 IDN list of password protected data" IDN must be in this list so that the entire list is protected.

Attributes

Length	List with IDNs of 4 bytes each Maximum number of elements is device-specific Current length is variable
Format	IDN
Function	Parameter
Executability	Parameterization phase, operating phase

8.3.18 S-0-0390 Diagnostic number

Function

A status code which corresponds to the respective error or the warning is stored in this parameter. In this way the controller can generate its own diagnostic messages with these number, for example in languages for which diagnostic text is not stored in the device.

Structure

Table 8-5 Structure of S-0-0390

Bit	Designation/Function
15-0	Status code
19-16	Class 0x0-0x9: Reserved 0xA: Operating state (lowest priority 4) 0xB: Reserved 0xC: Process-command-specific status (priority 3) 0xD: Reserved 0xE: Warning (priority 2) 0xF: Error (C1D) (highest priority 1)
23-20	Reserved
27-24	Source type 0x1: FSP_I/O 0x2: GDP 0x3: SCP
31-28	Interpretation of bits 29-0 0x0: Manufacturer-specific status code 0xC: Status code according to sercos standard

Attributes

Length	4 bytes
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.19 S-0-0420 Activate parameterization level procedure command (PL)

Function

When this command is activated all monitoring systems with the associated hardware components are switched off. As long as the command is active the sub device does not report the error C1D. The sub device resets the associated status bits.

While the command is active, the device can change all parameters except for the communication and time parameters.

Deactivation of the command

– Automatically by the device in CP0
– Via "S-0-0422 Exit parameterization level procedure command (PL)"

Confirmation of the command

The command is confirmed positively in CP2, CP3 or CP4, when the following is true
– The device is deactivated (status word, bit 14 = 0 or bit 15 = 0)
– The monitoring system is deactivated
– "Device Status (S-Dev) bit parameterization level active" = 1

Otherwise the sub device generated a negative confirmation or an error message (error code 0x7012) via the service channel

Attributes

Length	2 bytes
Format	Binary
Function	Command
Executability	Communication phases CP2, CP3, CP4

8.3.20 S-0-0422 Exit parameterization level procedure command (PL)

Function

When this command is activated, all parameters are checked and all monitoring systems are booted with the associated hardware components.The device should reestablish required references.

When this command is activated the parameterization level is exited.

Confirmation of the command

The command is confirmed positively if the following is true:
– The parameters concerned are checked and without errors.
– The monitoring system is switched on again.
– "Device status (S-Dev) bit parameterization level active" = 0

Or
– The device is already in the operating phase.

The command is confirmed negatively if an error was detected during the check. The IDNs that caused the error will be stored in the "S-0-0423 IDN list of invalid data for parameterization level" parameter. The sub device remains on the parameterization level.

Attributes

Length	2 bytes
Format	Binary
Function	Command
Executability	Communication phases CP2, CP3, CP4

8.3.21 S-0-0423 IDN list of invalid data for parameterization level

Function

IDNs which have been detected invalid by the device will be stored in this list as long as "S-0-0422 Exit parameterization level procedure command (PL)" has not been executed.

Scenario 1

"S-0-0422 Exit parameterization level procedure command (PL)" executed correctly
-> No IDNs in this list

Scenario 2

"S-0-0422 Exit parameterization level procedure command (PL)" with errors
-> All invalid parameters are stored in this list

Attributes

Length	List with IDNs of 4 bytes each Maximum number of elements is device-specific Current length is variable
Format	IDN
Function	Parameter
Changeability	No

8.3.22 S-0-1000 List of SCP types & versions

Function

A bus slave is identified with this parameter. The parameter consists of a 16-bit list in which each element describes a parameter package (a communication class) and its version.

Structure

This parameter is structured as follows:

Table 8-6 Basic structure of S-0-1000

Bits 15-8	Bits 7-4	Bits 3-0
Code of the communication class	Reserved (0x0)	sercos version number

Table 8-7 Contents of S-0-1000

Bits 15-8	Bits 3-0	Short designation of the communication class	sercos version	Meaning of the communication class
0x01	0x1	SCP_FixCFG	V1.1.1	Fix configuration of connections
	0x2	SCP_FixCFG_0x02	V1.3	Fix configuration of connections & connection stop
0x02	0x1	SCP_VarCFG	V1.1.1	Variable configuration of homogenous connections
	0x2	SCP_VarCFG_0x02	V1.3	Variable configuration of homogenous connections & connection stop
0x03	0x1	SCP_Sync	V1.1.1	Synchronization
	0x2	SCP_Sync_0x02	V.1.3	Synchronization tSync > tScyc using MDT Extended field
0x04	0x1	SCP_WD	V1.1.1	Watchdog of connection
	0x2	SCP_WD_0x02	V1.3	Watchdog of connection with timeout & data losses
0x05	0x1	SCP_Diag	V1.1.1	Communication diagnosis
0x06	0x2	SCP_RTB	V1.1.1	Configuration of real-time bits
0x07	0x1	SCP_HP	V1.1.1	Hot-plug
0x08	0x2	SCP_SMP	V1.1.1	sercos messaging protocol
0x09	0x1	SCP_MuX	V1.1.1	Multiplex channel (standard data container)
0x0A	0x1	SCP_NRT	V1.1.1	NRT channel (IP communication)
0x0B	0x1	SCP_SIG	V1.1.1	Word of real-time bits as producer and consumer
0x0C	0x1	SCP_ListSeg	V1.3	Segmented list transfer via the SVC
0x0D	0x1	SCP_SIP	V1.3	Support of S/IP Protocol in the NRT channel
0x0E	0x1	SCP_TFTP	V1.3	Support of TFTP in the NRT channel
0x0F	0x1	SCP_Cap	V1.3	Connection capabilities
0x10	0x1	SCP_ExtMux	V1.1.2	Extended Multiplex channel (extended data container)
0x11	0x1	SCP_RTBListProd	V1.3	List of real-time bits as producer (status)
0x12	0x1	SCP_RTBListCons	V1.3	List of real-time bits as consumer (control)
0x13	0x1	SCP_SysTime	V1.3	Set sercos time using MDT Extended field
0x14	0x1	SCP_RTBWordProd	V1.3	Word of real-time bits as producer
0x15	0x1	SCP_RTBWordCons	V1.3	Word of real-time bits as consumer
0x16	0x1	SCP_Safety	V1.3	CIP safety on sercos connection
0x17	0x1	SCP_OvS_Basic	V1.3	Oversampling functionality

Attributes

Length	List with IDNs of 2 bytes each Maximum number of elements is device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.23 S-0-1002 Communication cycle time (tS-cyc)

Function

The communication cycle time of the sercos interface indicates at which intervals the cyclic data, i.e. the process data (MDT and AT) is to be transmitted.

Use

The following points should be observed during parameterization:

– The entries are defined from 250 µs ... 65 ms in steps of 250 µs.
– The "sercos cycle time (TScyc)" must be transmitted from the master to the slave in CP2 and activated in both from CP3 onwards.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2
Unit	ns

8.3.24 S-0-1003 Allowed MST losses in CP3/CP4

Function

This parameter defines the number of permitted MST (Master Synchronization Telegram) failures which may occur directly after one another in the communication phases CP3 and CP4 before the device triggers an F4001 error.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2

8.3.25 S-0-1005 Minimum feedback processing time (t5)

Function

Time required in the device between the start of actual value acquisition and the start of AT0, see also Figure 2-4 “Telegram structure of the communication layer” on page 6-4.

In communication phase 2 the master reads this value to set the "Time of measurement for actual values (T4)" (S-0-1007 Feedback acquisition capture point (t4)) for all devices accordingly.

Use

The device must specify this value in such a way that the current actual values are transmitted to the controller in the next device telegram (AT).

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No
Unit	ns

8.3.26 S-0-1006 AT0 transmission starting time (t1)

Function

This transmission time determines when the master - with regard to the Master Synchronization Telegram (MST) - sends its Acknowledgement Telegram (AT) in communication phases CP3 and CP4. See also Figure 6-2 “Timing of the communication layer” on page 6-4.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No
Unit	ns

8.3.27 S-0-1007 Feedback acquisition capture point (t4)

Function

Time of measurement of actual values determined by the master and after the end of the Master Synchronization Telegram (MST).

The master can specify the same time of measurement of actual values for all devices operating in a coordinated way with each other. This ensures synchronization of current value acquisition between all devices concerned.

The device activates the time of measurement of actual values from communication phase CP3 onwards.

Use

The master must set the time of measurement of actual values lower or equal the difference of the sercos cycle time (S-0-1002 Communication cycle time (tS-cyc) and the requested "Minimum time of actual value acquisition" (S-0-1005 Minimum feedback processing time (t5)).

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No
Unit	ns

8.3.28 S-0-1008 Command value valid time (t3)

Function

The time for "Setpoint valid" indicates after which time the device may access the new setpoints after the end of the Master Synchronization Telegram (MST), see also Figure 6-2 “Timing of the communication layer” on page 6-4. Thus the master can specify the same time for "Setpoint valid" for all devices operating in a coordinated way with each other.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No
Unit	ns

8.3.29 S-0-1009 Device control (C-Dev) offset in MDT

Function

The telegram assignment specifies at which point (telegram offset) and in which MDT telegram (telegram number) the device control word (C-Dev) is located, see also Figure 2-4 “Telegram structure of the communication layer” on page 2-7.

Structure

Table 8-8 Structure of S-0-1009

Bit	Designation/Function	Comment
11-0	Offset in MDT	In bytes
13-12	MDT number 00: MDT0 01: MDT1 02: MDT2 03: MDT3	
15-14	Reserved	

Attributes

Length 2 bytes
Format Hexadecimal
Function Parameter
Changeability Communication phase CP2

8.3.30 S-0-1010 Length of MDTs

Function

The list parameter contains the length of all four possible Master Data Telegrams (MDT), see also Figure 2-4 “Telegram structure of the communication layer” on page 2-7.

Use

The following must be observed during parameterization:

– All four lengths must always be specified.
– Non-existing MDT telegrams are marked with the length = 0.

Attributes

Length 4 x 2 bytes
Format Decimal, without sign bit
Function Parameter
Changeability Communication phase CP2
Unit Byte

8.3.31 S-0-1011 Device status (S-Dev) offset in AT

Function

The telegram assignment indicates at which point (telegram offset) and in which AT telegram (telegram number) the device status word (S-Dev) is located, see also Figure 2-4 “Telegram structure of the communication layer” on page 2-7.

Structure

Table 8-9 Structure of S-0-1011

Bit	Designation/Function	Comment
11-0	Offset in MDT	In bytes
13-12	AT number 00: AT0 01: AT1 10: AT2 11: AT3	
15-14	Reserved	

Attributes

Length	2 bytes
Format	Hexadecimal
Function	Parameter
Changeability	Communication phase CP2

8.3.32 S-0-1012 Length of ATs

Function

The list parameter contains the length of all four possible Acknowledgement Telegrams (AT), see also Figure 2-4 “Telegram structure of the communication layer” on page 2-7.

The lengths are required for initialization of sercos communication.

Use

The following must be observed during parameterization:

– All four lengths must always be specified.
– Non-existing AT telegrams are marked with the length = 0.

Attributes

Length	4 x 2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2
Unit	Byte

8.3.33 S-0-1013 SVC offset in MDT

Function

The SVC offset in the Master Data Telegram (MDT) specifies at which position and in which Master Data Telegram the service channel is sent for the device, see also Figure 2-4 “Telegram structure of the communication layer” on page 2-7.

Structure

Table 8-10 Structure of S-0-1013

Bit	Designation/Function	Comment
11-0	MDT SVC offset	In bytes
13-12	MDT telegram number 00: MDT0 01: MDT1 10: MDT2 11: Reserved	
15-14	Reserved	

Attributes

Length 2 bytes
Format Hexadecimal
Function Parameter
Changeability Communication phase CP2

8.3.34 S-0-1014 SVC offset in AT

Function

The SVC offset in the Acknowledge Telegram (AT) specifies at which position and in which Acknowledge Telegram the service channel is sent for the device, see also Figure 2-4 “Telegram structure of the communication layer” on page 2-7.

Structure

Table 8-11 Structure of S-0-1014

Bit	Designation/Function	Comment
11-0	AT SVC offset	In bytes
13-12	AT telegram number 00: AT0 01: AT1 10: AT2 11: Reserved	
15-14	Reserved	

Attributes

Length 2 bytes
Format Hexadecimal
Function Parameter
Changeability Communication phase CP2

8.3.35 S-0-1015 Ring delay

Function

In communication phase CP2 the master determines the ring delay time (S-0-1015 Ring delay) and transfers it to the slaves. With this delay the slaves can determine their synchronization time with their delay counters for the P- and S-Channel. The master must execute the "S-0-1024 SYNC delay measuring procedure command" command for this.

The "S-0-1024 SYNC delay measuring procedure command" command must be executed in CP2 prior to the "S-0-0127 CP3 transition check" command.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4
Unit	ns

8.3.36 S-0-1016 Slave delay (P/S)

Function

After the master has transferred the ring delay time (S-0-1015 Ring delay) to the slaves, the slaves determine the values for the delay counters SYNCCNT-P and SYNCCNT-S after the "S-0-1024 SYNC delay measuring procedure command" command has been executed.

- **Ring topology**: Both list elements contain values
- **Line topology**: Only one list element contains the value, the other is 0

List element 0SYNCCNT-P

List element 1SYNCCNT-S

Attributes

Length	2 x 4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No
Unit	ns

8.3.37 S-0-1017 NRT transmission time

Function

This parameter is used to define the time slot for the NRT channel.

The controller defines whether the AT Telegrams are sent directly after the MDT Telegrams (method 1) or after the NRT channel (method 2).

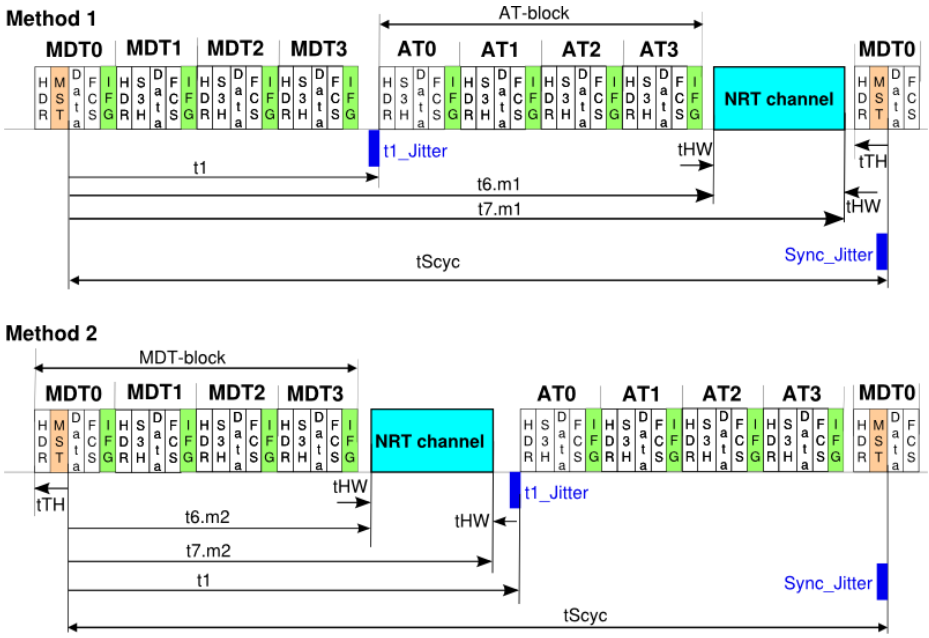


Figure 8-2 Calculation of t6 and t7n

Structure

The list parameter is structured as follows:

– First element: Start (t6) of the NRT channel
– Second element: End (t7) of the NRT channel

Use

The following must be observed during parameterization:

– t7 - t6 ≥ 125 µs Minimum length of the NRT channel
– t6 = t7 = 0 NRT channel switched off

If the length of NRT is less than 125 µs, "S-0-1027.x.01 Requested MTU" will be adapted accordingly.

Attributes

Length	2 x 4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2
Unit	ns

8.3.38 S-0-1019 MAC address

Function

This parameter contains the MAC address for the engineering via IP that is required during Ethernet communication. The MAC (Media Access Control) address is used for unique identification of Ethernet communication in the network.

Structure

Being a list parameter, the MAC address is structured as follows:

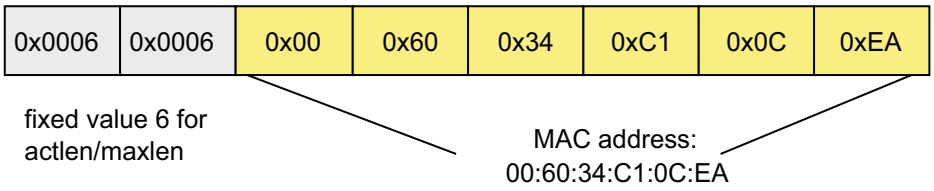


Figure 8-3 MAC address S-0-1019

Use

The MAC address is permanently assigned to the hardware and cannot be changed.

Attributes

Length	6 x 1 byte
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.39 S-0-1020 IP address

Function

This parameter contains the IP address for the engineering via IP that is required during IP communication. The IP address is used for unique identification of a device on the Internet.

Changes of the parameter only come into effect after the following:
- Restart of the 24 volt supply of the device
- Pressing of the reset button

Structure

Being a list parameter, the IP address is structured as follows:

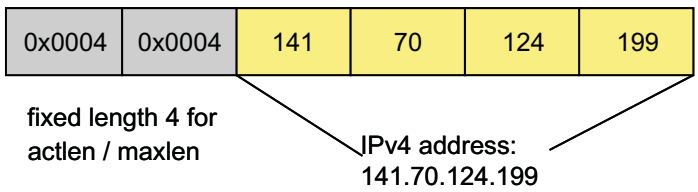


Figure 8-4 Structure of IP address S-0-1020

Use

The IP address must be set specifically for the application.

Attributes

Length	4 x 1 byte
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4

8.3.40 S-0-1021 Subnet mask

Function

This parameter contains the subnet mask for the engineering via IP that is required during IP communication. Each IP address (Internet protocol) is separated into a network and a device part. The subnet mask is used to differentiate between the network and the device part. The master can change this subnet mask for IP communication in the NRT channel.

Structure

Changes of the parameter only come into effect after the following:
- Restart of the 24 volt supply of the device
- Pressing of the reset button

Being a list parameter, the network mask is structured as follows:

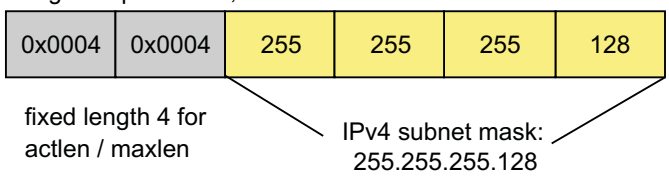


Figure 8-5 Structure of the subnet mask S-0-1021

Use

The network mask must be set specifically for the application.

Attributes

Length	4 x 1 byte
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4

8.3.41 S-0-1022 Gateway address

Function

This parameter contains the gateway address of the IP device for the engineering via IP (Internet Protocol) that is required for IP communication. The master can change this address for communication in the NRT channel.

If the master wants to send an IP packet, the network parts of the source IP address and the destination IP address are compared with each other. If they are not the same the IP packet is sent to the gateway IP address.

Use

Changes of the parameter only come into effect after the following:
– Restart of the 24 volt supply of the device
– Pressing of the reset button

The gateway address must be set specifically for the application.

Attributes

Length	4 x 1 byte
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4

8.3.42 S-0-1023 SYNC jitter

Function

This parameter is used to set the maximum possible jitter of the synchronization clock of the controller.

The jitter is used to define the time slot for reception of the MST in the slave. This slot is twice as large as the synchronization jitter.

It can be used to adapt the monitoring in the sercos slaves to the options of the sercos master.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2
Unit	ns

8.3.43 S-0-1024 SYNC delay measuring procedure command

Function

The command is used to measure the delays between the two ports.

After this process command has been activated, the slave determines the slave signal delay with the help of the ring signal delay "S-0-1015 Ring delay". In a ring topology both values are defined while in the ring topology only one parameter is defined and other one is set to 0.

– There is a positive confirmation in communication phase CP2 when the slaves generates a valid value. In this case the slaves synchronizes itself automatically in CP3.
– There is a positive confirmation in communication phases CP3 and CP4 when the slave generates a valid value and resynchronizes itself.

A negative confirmation is stored as diagnostic code in the "S-0-0390 Diagnostic number".

The master starts this process command and waits until it is completed in communication phase CP2 before it activates "S-0-0127 CP3 transition check". It starts it in communication phases CP3 and CP4 for every slave that must be synchronized.

Attributes

Length	2 bytes
Format	Binary
Function	Command
Executability	Communication phases CP2, CP3, CP4

8.3.44 S-0-1026 Version of communication hardware

Function

This parameter contains the sercos specific hardware identification as text (ASCII format): FPGA version and revision

Example: SERCON100S V02 R08

Attributes

Length	18 bytes
Format	Text
Function	Parameter
Changeability	No

8.3.45 S-0-1027 MTU

The following structure elements are available for this command:

– S-0-1027.x.01 Requested MTU
– S-0-1027.x.02 Effective MTU

Function

The Requested MTU parameter contains the maximum number of bytes (setpoint) that can be sent by a higher layer via the NRT channel. This value is taken to calculate the effective MTU value (actual value) that you can read with "S-0-1027.x.02 Effective MTU".

Requested MTU and Effective MTU can be different, for example, if the value of the Requested MTU is not in the valid range of the current communication phase. The Effective MTU value is accepted immediately and updated if this IDN is edited or the communication phase is changed.

Example: The IDN is set to 80, while the Effective MTU value of NRT, CP0, CP1, CP2, and HP0 shows the sum 576.

Calculation of the Effective MTU value:

$t_{NRT} = (t_7 - t_6) > 6.72\ \mu s$ (see "S-0-1017 NRT transmission time")

$$MTU(t_{NRT}) = \min\{1500; \frac{t_{NRT}}{S} \times 12\ 498\ 750 - 38\}$$

Figure 8-6 Calculation of the Effective MTU value

Table 8-12 Minimum and maximum packet sizes of the different communication phases

Phase	Upper limit of MTU	Lower limit of MTU
NRT	1500	576
CP0	1500	576
CP1	1500	576
CP2	1500	576
CP3	$MTU(t_{NRT})$	46
CP4	$MTU(t_{NRT})$	46
HP0	1500	576
HP1	$MTU(t_{NRT})$	46
HP2	$MTU(t_{NRT})$	46

$MTU_{\mathbf{interim}} = min\ \{upper - limit(CP); MTU_{\mathbf{target}}\}$

$MTU_{\mathbf{effective}} = max\ \{lower - limit(CP); MTU_{\mathbf{interim}}\}$

8.3.45.1 S-0-1027.x.01 Requested MTU

Function

This parameter contains the maximum number of bytes (setpoint) that can be sent from a higher layer via the NRT channel.

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phases CP0, CP1, CP2

8.3.46 S-0-1027.x.02 Effective MTU

Function

This IDN contains the MTU actual value and is calculated with the help of "S-0-1017 NRT transmission time" and "S-0-1027.x.01 Requested MTU".

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.3.47 S-0-1028 Error counter MST-P/S

Function

The "Error counter MST-P/S" increases as soon as no valid MST arrives at port 1 or at port 2 in the communication phases CP3 and CP4.

The counter stops counting when it has reached the value 65 535. That means a value of 65 535 can indicate that more errors than indicates have occurred, for example, if there is data transmission with errors over a long period of time.

The error counter is reset with "S-0-0127 CP3 transition check".

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.3.48 S-0-1031 Test pin assignment port 1 and port 2

Function

This parameter is used to assign communication-relevant hardware signals to test pins TS1 and TS2.

Structure

Table 8-13 Structure of S-0-1031

Bit	Value	Designation/Function	Comment
3-0	See next table	Signal is assigned to test pin TS1	Refer to the next table for possible values
7-4		Reserved	
11-8		Signal is assigned to test pin TS2	Refer to the next table for possible values
15-12		Reserved	

Table 8-14 Values of S-0-1031

Value	Signal slave	Description
0000	Port 1 MST	MST pulse from Rx MAC port 1 (duration: 40 ns)
0001	Port 2 MST	MST pulse from Rx MAC port 2 (duration: 40 ns)
0010	TMST	TMST signal after MST generator (TSref)
0011	CON_CLK	CON time of TCNT timer
0100	DIV_CLK	DIV time of DIV timer (if present)
0101	TCNT Reload	TCNT timer overflow
0110	Port 1 TCNT Reload	Port 1 timer overflow
0111	Port 2 TCNT Reload	Port 2 timer overflow
1000	Port 1 IP Open	IP window of port 1
1001	Port 1 IP Open Write	IP transmission window of port 1
1010	Port 2 IP Open	IP window of port 2
1011	Port 2 IP Open Write	IP transmission window of port 2
1100	Port 1 MST Window Open	MST window of port 1
1101	Port 2 MST Window Open	MST window of port 2
1110	Port 1 Rx Frame	Receiving at port 1
1111	Port 2 Rx Frame	Receiving at port 2

Attributes

Length 2 bytes
Format Binary
Function Parameter
Changeability Yes

8.3.49 S-0-1035 Error counter port 1 and port 2

Function

This error counter counts the following errors in the Ethernet transmission:

– Ethernet frames received with control error or the display RxER

– Ethernet frames received with control error due to a wrong order of frames.

The least significant word represents port 1 and the most significant word port 2.

The counter is started in communication phase CP0 and is increased by one, maximum, per cycle time. The counter state can be edited so it can be reset via an HMI. The maximum value is 0xFFFF. The counter states are not stored so they start with 0x0000 when is switched on.

Attributes

Length	4 bytes
Format	Hexadecimal
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4

8.3.50 S-0-1040 sercos address

Function

This parameter contains the sercos address that is assigned to the device.

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2

8.3.51 S-0-1041 AT Command value valid time (t9)

Function

The time t_9 indicates the time after which the slave can access the new process values from the AT.

Thus the master can specify the time from which on the setpoints become valid for all coordinated applications.

The slave activates the validity of the process values in communication phase CP3.

See also Figure 6-2 “Timing of the communication layer” on page 6-4.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2
Unit	ns

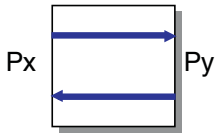
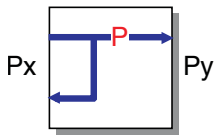
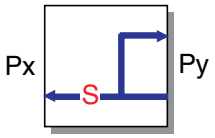
8.3.52 S-0-1044 Device control (C-Dev)

Function

The parameter is an image of the device control word (C-Dev). It can be read only and used for diagnostic purposes.

Structure

Table 8-15 Structure of S-0-1044

Bit	Designation/Function	Comment
9-0	Reserved	
10	Reserved for sercos time	
11	Status of the physical topology 0: Physical ring interrupted 1: Physical ring closed	Only used in the NRT channel. The source address table is not applicable when the slave recognizes a toggle.
13-12	Topology control 00: Fast forward direction on both ports  01: Loopback with forward direction of P telegrams  10: Loopback with forward direction of S telegrams  11: Reserved	
14	HS topology Toggle	The original value is 0 in every CP. The master toggles the bit every time the topology changes.
15	Identification 0: No identification request 1: Identification request	This function is used for decentral address assignment or configuration errors between master and slave. The slave indicates the status of this bit with the sercos LED or on the display.

Attributes

Length	2 bytes
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.53 S-0-1045 Device status (S-Dev)

Function

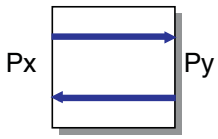
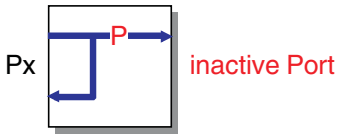
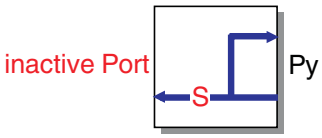
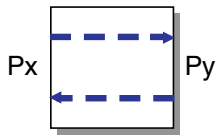
This parameter provides information on the current device status. It is an image of the device status word (S-Dev). It can be read only and used for diagnostic purposes.

Structure

Table 8-16 Structure of S-0-1045

Bit	Designation/Function	Comment
1	Reserved	
2	Reserved for RT plug	
3	Reserved for sercos time	
4	Parameterization level 0: PL is not active 1: PL is active	PL Is set to 0 with the S-0-0422 process command. Is set to 1 with the S-0-0420 process command.
5	Process command change 0: No change in the process command acknowledgment 1: Change in the process command acknowledgment	The process command is acknowledged positively or negatively.
6	Warning (C2D) 0: No warning 1: Warning	Including resource warnings
7	Error (C1D) 0: No error 1: Error	Including resource errors
8	Slave valid 0: Slave invalid 1: Slave valid	Is set to 0 when a CP0 is received or if CPS = 1 Is set to 1 when a new CP is in preparation and CPS = 0
9	Connection error 0: Error-free connection 1: Connection error occurred	The consumer detected a connection error.

Table 8-16 Structure of S-0-1045

Bit	Designation/Function	Comment
11-10	Status of the inactive port 00: No connection at the inactive port 01: Connection at the inactive port 10: P-Telegram at the inactive port 11: S-Telegram at the inactive port	These bits can be ignored when the topology bits (13-12) are 00 or 11.
13-12	Topology status 00: Fast forward direction on both ports 01: Loopback with forward direction of P telegrams 10: Loopback with forward direction of S telegrams 11: NRT phase (storing and forward direction)	Shows the current topology (Px or Py may be either P1 or P2)    
14	HS topology Toggle	The original value is 0 in every CP. The slave toggles when the request of the master was processed.
15	Communication warning 0: No warning 1: Communication warning occurred	For example, the number of permitted MST losses exceeded the half value of S-0-1003.

Attributes

Length	2 bytes
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.54 S-0-1050 sercos connections

Configuration of the individual connections is defined with the various parameters of S-0-1050. Each connection can be set up either in the form of an IDN list (S-0-1050.x.01 Bits 5-4 = 00) or in the form of containers (S-0-1050.x.01 Bits 5-4 = 01). In this case "x" represents the connection of the device, for example

– x = 0: First connection of the device
– x = 1: Second connection of the device
– ...

There is a device-specific maximum number of possible connections for each device, see device data sheet.

Up to a maximum of 65536 connections are possible. Up to 256 connections can be configured for each slave.

Table 8-17 Parameters of S-0-1050

Parameter	See
S-0-1050.x.01 Connection setup	page 8-35
S-0-1050.x.02 Connection number	page 8-36
S-0-1050.x.03 Telegram assignment	page 8-37
S-0-1050.x.04 Max. length of connection	page 8-38
S-0-1050.x.05 Current length of connection	page 8-38
S-0-1050.x.06 Configuration list	page 8-38
S-0-1050.x.08 Connection control (C-Con)	page 8-38
S-0-1050.x.10 Producer cycle time	page 8-39
S-0-1050.x.11 Allowed data losses	page 8-39
S-0-1050.x.12 Error counter data losses	page 8-40
S-0-1050.x.20 IDN allocation of real-time bit	page 8-40
S-0-1050.x.21 Bit allocation of real-time bit	page 8-40

8.3.54.1 S-0-1050.x.01 Connection setup

Function

The parameter contains the configuration data of a connection which consist of:

– Activation of the configuration
– Connection type
– Configuration source
– Configuration mode
– Clock generation (producer)
– Monitoring mechanism (consumer)

Structure

Table 8-18 Structure of S-0-1009

Bit	Designation/Function	Comment
1-0	Monitoring mechanism 00: Producer cycle, synchronous operation 01: Asynchronous operation with watchdog (time defined with S-0-1050.x.10, the timeout for the watchdog is calculated as follows: "S-0-1050.x.10 Producer cycle time" * "S-0-1050.x.11 Allowed data losses") 10: Asynchronous operation without watchdog 11: Reserved	For the consumer
2	Reserved	
3	Producer mechanism 0: Producer cycle, synchronous 1: Asynchronous	
5-4	Configuration type 00: Variable configuration of the IDNs with 0-1050.x.6 01: Configuration with connection length, see S-0-1050.x.5, S-0-1050.x.6 is not taken into consideration 10: Standard telegram, see S-0-0015 11: Reserved	FSP_I/O: The connection is defined as follows: C-CON - I/O Control - S-0-1500.x.5 C-CON - I/O Status - S-0-1500.x.9
11-6	Reserved	
13-12	Source of the connection configuration 00: Master 01: Reserved 10: External 11: Reserved	
14	Function of the connection 0: Consumer 1: Producer	
15	Use of the configuration by the slave 0: Not used 1: Used	

Attributes

Length	2 bytes
Format	Hexadecimal
Function	Parameter
Changeability	Communication phase CP2

8.3.54.2 S-0-1050.x.02 Connection number

Function

This number is used to identify a number uniquely.

– The producer and all consumers of the connection have the same connection number.

– The master/slave connection consists of two single connection one via the MDT and one via the AT.

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2

8.3.54.3 S-0-1050.x.03 Telegram assignment

Function

The telegram specification defines the following:

– Telegram type (MDT or AT)
– Telegram number
– Position (offset in the telegram for the existing connection).

The offset points to the Connection Control (C-Con) of this connection.

The offset starts with 14 bytes in MDT0 or AT0 and 8 bytes in MDT1 to MDT3 or AT1 to AT3 and is located after the sercos header for both, MDTs and ATs.

Structure

Table 8-19 Structure of S-0-1050.x.03

Bit	Designation/Function	Comment
10-0	Telegram offset in bytes	
11	Telegram type: 0: AT 1: MDT	
15-12	Telegram number: 0: MDT0 / AT0 1: MDT1 / AT1 2: MDT2 / AT2 3: MDT3 / AT3	

Attributes

Length	2 bytes
Format	Hexadecimal
Function	Parameter
Changeability	Communication phase CP2

8.3.54.4 S-0-1050.x.04 Max. length of connection

Function

This parameter defines the maximum length of the connection. The 2 bytes for Connection Control (C-Con) are part of this length. If a slave has a specified length of *n* bytes, this length contains 2 bytes C-Con and n-2 bytes of data.

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.3.54.5 S-0-1050.x.05 Current length of connection

Function

This parameter contains the current length of the connection. The 2 bytes for Connection Control (C-Con) are part of this length.

If a slave has a specified length of n bytes, this length contains 2 bytes C-Con and n-2 bytes of data.

The slave updates the parameter as soon as the configuration parameters change. This parameter is required for all slaves and part of the SCP_FixCFG (sercos Communication Profile Fix ConFiGuration).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.3.54.6 S-0-1050.x.06 Configuration list

Function

If it was specified in "S-0-1050.x.01 Connection setup" that the connection is configured via IDNs (Bits 5-4 = 00), this parameter contains the list of identification numbers (4 bytes) for the connection.

Attributes

Length	List with IDNs of 4 bytes each, Maximum number of elements is device-specific Current length is variable
Format	IDN
Function	Parameter
Changeability	Communication phase CP2

8.3.54.7 S-0-1050.x.08 Connection control (C-Con)

Function

This parameter contains an image of the C-Con control word of the connection. This is true for producer and consumer connections.

Structure

Table 8-20 Structure of S-0-1050.x.08

Bit	Designation/Function
0	ProducerReady: 0: Producer does not yet enter valid setpoint values 1: Producer enters valid setpoint values and the slave can accept these values by toggling bit 1
1	NewDataToggle-Bit: An edge indicates that the connection contains new data
2	CC-DataFieldDelay: 1: CC-Producer data have a sercos cycle offset since they have been copied via the bus master. The consumer should preferably take the data from the port where bit 0 is.
3	ProducerSynchronized: 0: The PLL of the producer is not synchronized with the clock of the ring 1: The PLL of the producer is synchronized with the clock of the ring
6	Realtime bit-1
7	Realtime bit-2

Attributes

Length	2 bytes
Format	Binary
Function	Parameter
Changeability	No

8.3.54.8 S-0-1050.x.10 Producer cycle time

Function

The parameter indicates the cycle time in which the producer updates the data in the cyclic connection. In addition, the NewData toggle bit in the connection control word (C-Con) is toggled. The consumer of the connection takes this time to monitor a possible failure. The number of permitted failure is set with "S-0-1050.x.11 Allowed data losses", the number of the current failures is displayed in "S-0-1050.x.12 Error counter data losses".

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phase CP2
Unit	ns

8.3.54.9 S-0-1050.x.11 Allowed data losses

Function

The parameter indicates the number of permitted producer failures before a connection is said to be aborted, the consumer no longer takes data and the master sets bit 9 (connection error) in the device status word (S-Dev).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4

8.3.54.10 S-0-1050.x.12 Error counter data losses

Function

The parameter indicates how many producer failures the consumer has already detected. The counter stops at a maximum of 65535 and does not have an overflow. It is reset with the rising edge of bit 0 (ProducerReady) in the connection control word (C-Con).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.3.54.11 S-0-1050.x.20 IDN allocation of real-time bit

Function

The parameter contains the IDN assignment (4 bytes) of the realtime bits in the connection control word (C-Con). The list may contain up to 2 IDNs. Bit assignment is done in the "S-0-1050.x.21 Bit allocation of real-time bit" parameter.

Structure

This parameter contains up to two list elements

– List element 0 corresponds to realtime bit 1: IDN of the assigned signal
– List element 1 corresponds to realtime bit 2: IDN of the assigned signal

Attributes

Length	2 x 4 bytes
Format	IDN
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4

8.3.54.12 S-0-1050.x.21 Bit allocation of real-time bit

Function

The parameter contains the bit assignment of the realtime bits parameterized in "S-0-1050.x.20 IDN allocation of real-time bit". The list may contains up to two bit offsets with values from 0...31.

Structure

This parameter contains up to two list elements

– List element 0 corresponds to realtime bit 1: Bit no. of the assigned signal
– List element 1 corresponds to realtime bit 2: Bit no. of the assigned signal

Attributes

Length	2 x 4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	Communication phases CP2, CP3, CP4

8.3.55 S-0-1051 Image of connection setups

Function

The parameter contains the current configurations of all connections. It consists of the "S-0-1050.x.01 Connection setup" list with all connections in ascending order. Thus the master (or configurator) has an easy overview of the number of possible connections (= List length) and the connections already used by the master or other configuration sources.

Attributes

Length	List with IDNs of 2 bytes each, Maximum number of elements is device-specific Current length is variable
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.56 S-0-1300 Electronic label

The IDNs S-0-1300.x.y represent the electronic rating plate. They are used for identification of the individual devices by the master or a configurator. Therefore, "S-0-1300.x.03 Vendor code" and "S-0-1300.x.05 Vendor device ID" are mandatory. All other IDNs are optional and can be used by the manufacturer to provide further information on the devices.

Structure instance 0 of all IDNs of the electronic rating plate is reserved for the physical device that contains sercos. The other structure instances can be assigned to every other device depending on the respective requirements.

The IDNs S-0-1300.x.y available for the concrete device can be taken from the relevant data sheet.

The following IDNs may be part of the electronic rating plate:

Table 8-21 Contents of the electronic rating plate S-0-1300

IDN	Contents	Format
S-0-1300.x.01 Component name	Device name for example, "sercos Fast Block IO Analog"	Text
S-0-1300.x.02 Vendor name	Manufacturer name e.g., Phoenix Contact	Text
S-0-1300.x.03 Vendor code	Clearly identified manufacturer code, that is assigned by the sercos international e. V. user organization e.g., "200" for Phoenix Contact	2 byte integer
S-0-1300.x.04 Device name	Device name e.g., AXL BK S	Text
S-0-1300.x.05 Vendor device ID	Clearly identified device number that is assigned by the manufacturer e.g., 2688116	Text
S-0-1300.x.06 Connected to sub-device	Number of the module to which the lower-level component belongs to. It is only used if a device consists of several modules with several lower-level components that are all written to by one electronic rating plate.	Integer in the range 0 ... 511
S-0-1300.x.07 Function revision	Device revision	Integer in the range 0 ... 9999
S-0-1300.x.08 Hardware revision	Hardware revision	Text
S-0-1300.x.09 Software revision	Software revision	Text
S-0-1300.x.10 Firmware loader revision	Boot loader revision	Text
S-0-1300.x.11 Order number	Order no. e.g., 2688116	Text
S-0-1300.x.12 Serial number	Serial number e.g., "911171676-xxxxx", whereas xxxxx is a consecutive number starting with 00001	Text
S-0-1300.x.13 Manufacturing date	Manufacturing date e.g., 2007-10-04T13:35:07Z	Date *
S-0-1300.x.14 QS date	Date of final test after production	Date *
S-0-1300.x.20 Operational hours	Number of operating hours	Date *
S-0-1300.x.21 Service date	Service date e.g., date of the last firmware update	Date *
S-0-1300.x.22 Calibration date	Date of last calibration	Date *
S-0-1300.x.23 Calibration due date	Date of next calibration	Date *

*** Date format**

Text, formatted according to ISO 8601:2006-09/EN 28601 (extended format) (YYYY-MM-DDTHH:MM:SSZ)

– Date separated with dash "-"
– Time separated with colon ":"
– Date and time separated with the letter "T"
– Character string is completed with "Z" (UTC time zone)

All parameters are write-protected can be read only.

8.3.57 S-0-1301 List of GDP classes & version

Function

This parameter indicates the implemented classes of the generic device functions of the device. It is used to identify which sercos defined functions exist in the areas of diagnostics, identification, initialization and parameter management.

Bits 15 ... 8 identify the GDP classes contained in the device. **All possibilities must be indicated in this IDN.**

Bits 7 ... 0 identify the version.

Structure

Table 8-22 Structure of S-0-1301

Bit	Designation/Function	Comment
7-0	Version: 0x00: Reserved 0x01: First version 0x02-0xFF: Reserved 0x01: Value: GDP_Basic	
15-8	Profile ID	

Attributes

Length	List with IDNs of 2 bytes each Maximum number of elements is device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.58 S-0-1302 Resource structures of sub-device

This IDN contains a structure for the resource-dependent properties of a sub device and comprises the following information:

Table 8-23 Resource-dependent structure of the sub device

Parameter	See
S-0-1302.x.01 FSP type & version	page 8-44
S-0-1302.0.02 Function groups	page 8-45
S-0-1302.x.03 Application type	page 8-45

8.3.58.1 S-0-1302.x.01 FSP type & version

Function

The IDN "S-0-1302.x.01 FSP type & version" indicates the function type and the corresponding revision of the sub device.

Structure

Table 8-24 Structure of S-0-1302.x.01

Bit no.	Value	Description	Comment
31		P/S	
	0	sercos standard	
	1	Manufacturer-specific	
30-16		sercos standard types	
	0x00	Reserved	
	0x01	FSP_I/O	
	0x02	FSP_Drive	
	0x03-0x7F	Reserved	
15-0		Version	
	0x00	Reserved	
	0x01	First version	

Attributes

Length 4 bytes
Format Hexadecimal
Function Parameter
Changeability No

8.3.58.2 S-0-1302.0.02 Function groups

Function

This IDN contains a list of all implemented function groups.

– FSP_I/O
This IDN is a list of I/O function groups of the FSP_I/O. The elements of the list contain IDNs. The structure instance shows the position number of the module (structure instance = module position). The structure element is always 0. If the left component is a bus coupler or a bus header (for compact devices), it is started with the function group of the bus coupler (S-0-1500 I/O Bus coupler), otherwise with the first I/O module from the left, e.g., S-0-15xx.1.00. Every group must be listed if a module has more than one I/O function group. The data is mapped in the order of the entries in the input container "S-0-1500.0.09 Container input data" or the output container "S-0-1500.0.05 Container output data".

Attributes

Length List with IDNs of 4 bytes each
Maximum number of elements is device-specific
Format IDN
Function Parameter
Changeability No

8.3.58.3 S-0-1302.x.03 Application type

Function

The user can use this IDN freely. It may contain information for the user, the maintenance personnel or for the end customer. For example the designation of the inputs/outputs in plain text.

Attributes

Length 80 bytes, maximum
Format Text
Function Parameter
Changeability Communication phases CP2, CP3, CP4

8.3.59 S-0-1303 Diagnosis trace

"Diagnosis trace" logs error and warning messages. It contains the following structure elements:

Table 8-25 "Diagnosis trace" structure elements

Parameter	See
S-0-1303.0.01 Diagnosis trace configuration	page 8-46
S-0-1303.0.02 Diagnosis trace control	page 8-46
S-0-1303.0.03 Diagnosis trace state	page 8-47
S-0-1303.0.10 Diagnosis trace buffer no. 1	page 8-47
S-0-1303.0.11 Diagnosis trace buffer no. 2	page 8-47
S-0-1303.0.12 Diagnosis trace buffer no. 3	page 8-47

These IDNs monitor every change of "S-0-0390 Diagnostic number" and can be used for troubleshooting.

The buffers can only be read consistently if the logging is stopped or all lists are copied into shadow buffers with a read access in the slave. The read access is served from these buffers. However, it is necessary that the lists are read one after another if the user does not want to create a command for the shadow buffer.

As an alternative, commands can be defined for reset and capture/freeze. But this means a clear reduction of the response time. This is not necessary. The user and simply write to "Diagnosis trace control".

8.3.59.1 S-0-1303.0.01 Diagnosis trace configuration

Function

This parameter contains the IDN "S-0-1500.0.32 I/O diagnosis message" as an entry. This defines that this IDN is also logged in addition to the IDN "S-0-1500.0.33 Current I/O diagnosis message".

Attributes

Length	4 bytes, device-specific
Format	IDN
Function	Parameter
Changeability	No

8.3.59.2 S-0-1303.0.02 Diagnosis trace control

Function

This parameter traces diagnostics.

Structure

Table 8-26 Structure of S-0-1303.0.02

Bit	Value	Designation/Function	Comment
0	0	Trace control on	
	1	Trace control off	
1-3		Reserved	
4-7		Threshold	Threshold of the diagnostic class corresponds to bits 19-16 of S-0-0390; Only classes higher or equal to are acquired
8-15		Reserved	

Attributes

Length	2 bytes
Format	Hexadecimal
Function	Parameter
Changeability	Yes

8.3.59.3 S-0-1303.0.03 Diagnosis trace state

Function

This parameter shows the status of diagnostics.

Structure

Table 8-27 Structure of S-0-1303.0.03

Bit	Value	Designation/Function	Comment
0	0	Trace control on	
	1	Trace control off	
1-15		Reserved	

Attributes

Length	2 bytes
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.59.4 S-0-1303.0.10 Diagnosis trace buffer no. 1

Function

This parameter traces diagnostics and is set up as a ring buffer or as a list.

The contents is fixed and occupied with "S-0-0390 Diagnostic number".

Attributes

Length	4 bytes, device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.3.59.5 S-0-1303.0.11 Diagnosis trace buffer no. 2

Function

This parameter traces diagnostics and is set up as a ring buffer or as a list.

The contents is fixed and occupied with "S-0-1305.0.01 sercos current time".

Attributes

Length	8 bytes, device-specific
Format	sercos time
Function	Parameter
Changeability	No

8.3.59.6 S-0-1303.0.12 Diagnosis trace buffer no. 3

Function

The IDN that is to be entered in the log when the IDN "S-0-0390 Diagnostic number" changes can be entered in this parameter.

8.3.60 S-0-1305.0.01 sercos current time

Function

This parameter contains the sercos time in the IEC 61588 format. The device marks events with this parameter.

This parameter is active immediately after the start (within 0 s, 0 ns) and indicates that the time has not yet been set by the master.

The value 0x0 corresponds to the following time: 1970-01-01, 00:00, 0 s, 0 ns

Structure

Table 8-28 Structure of S-0-1305.0.01

Bit	Value	Designation/Function	Comment
0-31		Nano seconds	
32-63		Seconds	

Attributes

Length	8 bytes
Format	sercos time
Function	Parameter
Changeability	No

8.4 Overview of the Parameters in FSP_I/O

Depending on the devices used the parameters of the following I/O function groups are available:

- S-0-1500 I/O Bus coupler
- S-0-1502 I/O function group digital output
- S-0-1503 I/O function group digital input
- S-0-1504 I/O function group analog output
- S-0-1505 I/O function group analog input
- S-0-1506 I/O function group counter
- S-0-1507 I/O function group complex protocol
- S-0-1508 I/O function group sub bus master
- S-0-1509 I/O function group sub bus slave
- S-0-1513 I/O function group motor starter
- S-0-1514 I/O function group PWM (pulse width modulation)
- S-0-1515 I/O function group positioning

Depending on the device used the following parameters may be contained:

Table 8-29 Overview of FSP_I/O parameters

In the overview and in the following description S-0-15xx stands for the I/O function group and y for the structure instance.

8.5 Description of the Parameters in FSP_I/O

8.5.1 S-0-1500 I/O Bus coupler

This function group contains the following structure elements:

Table 8-30 Structure elements S-0-1500

IDN	Meaning	See
S-0-1500.0.01 I/O control	Behavior of inputs and outputs	page 8-50
S-0-1500.0.02 I/O statusS-0-1500.0.02 I/O status	Status of inputs and outputs	page 8-52
S-0-1500.0.03 List of module type codes	Display of the module type key of all modules.	page 8-52
S-0-1500.0.04 List of inserted function groups	Contains a list with function groups added by the configuration tool.	page 8-53
S-0-1500.0.05 Container output data	Container for output data	page 8-54
S-0-1500.0.09 Container input data	Container for input data	page 8-54
S-0-1500.0.11 List of replaced function groups	List of the function groups replacing individual function groups which have been read by the bus coupler or the bus header (for compact devices).	page 8-55
S-0-1500.0.12 Rearrangement of I/O resource		page 8-55
S-0-1500.0.19 Parameter channel receive	Parameter channel for the manufacturer-specific configuration and parameterization of the bus coupler or bus header (for compact devices) or the I/O modules.	page 8-56
S-0-1500.0.20 Parameter channel transmit	Parameter channel for the manufacturer-specific configuration and parameterization of the bus coupler or bus header (for compact devices) or the I/O modules.	page 8-57
S-0-1500.0.23 Local bus cycle time	Cycle time of the local bus	page 8-57
S-0-1500.0.32 I/O diagnosis message	Diagnostic message with the highest priority	page 8-57
S-0-1500.0.33 Current I/O diagnosis message	Current diagnostic message	page 8-58

8.5.1.1 S-0-1500.0.01 I/O control

Function

This IDN defines the behavior of inputs and outputs regarding RTD and SVC data. Input and output control is configured as "Consumer connection" and at best as the fastest possible connection. The slave rejects the configuration in the case of multiple configurations with more than one "Consumer connection" or no connection configuration.

Upon power up the bus sets all bits of the inputs and outputs to zero by default. In this case all outputs are set to inactive or they receive a release value as it has been defined in bit 6 by "S-0-15xx.y.02 Configuration of I/O function group".

Structure

Table 8-31 Structure of S-0-1500.x.01

Bit	Designation/Function	Comment
14-0	Reserved	0
15	Status of the outputs 0: Outputs are inactive 1: Outputs are activated	The outputs are deactivated, the last status is frozen or the substitute value is output (depending on bit 6 of IDN S-0-15xx.y.02 and the contents of IDN S-015xx.y.22)

Attributes

Length	2 bytes
Format	Binary
Function	Parameter
Changeability	Operating phase

8.5.1.2 S-0-1500.0.02 I/O status

Function

I/O status indicates the current status of the inputs and outputs. The status of inputs and outputs is configured as "Producer connection".

Structure

Table 8-32 Structure S-0-1500.0.02

Bit	Designation/Function	Comment
11-0	Reserved	
12	I/O warning (C2D) 0: No warning 1: Warning	 The bit disappears automatically as soon as the reason no longer exists.
13	I/O error (C1D) 0: Error 1: Error	 Is deleted with S-0-0099
14	Inputs are valid 0 1	This bit does not provide information about the producer mechanism (synchronous or asynchronous). This bit is reset when the device does not produce value input data (e.g. through a local communication error). This bit is set when the device produces valid input data.
15	Outputs are ready for operation 0: Outputs are not active 1: Outputs are active	 The outputs are reset, the last values are frozen or substitute values are output (depending on bit 6 of IDN S-0-15xx.y.02 and IDN S-0-15xx.y.22) This bit is set when the corresponding bit 15 in "S-0-1500.0.01 I/O control" is set and the device has successfully activated its outputs.

Attributes

Length	2 bytes
Format	Binary
Function	Parameter
Changeability	No

8.5.1.3 S-0-1500.0.03 List of module type codes

Function

This lists contains the manufacturer-specific module type code of the connected modules. Passive modules which cannot be detected via the local bus are excluded. Each module should have a unique module type key which may either be a unique hexadecimal number or the order number. The list is sorted in ascending order from left to right starting with zero and according to the location of the module. Passive modules do not have a module type code.

The module type code is used to generate the required sercos IDNs when a modular I/O setup is used, whereas the modules connected during the start phase are assigned to the corresponding I/O function groups. The manufacturer-specific module type codes for the configuration check in communication phase CP2 are also used.

The module type codes 0xFFFFFFFF.FFFF0000 to 0xFFFFFFFF.FFFFFFFF are reserved.

Attributes

Length	8 bytes, device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.1.4 S-0-1500.0.04 List of inserted function groups

Function

This IDN contains a list of function groups can be added manually with a configuration tool. Each function group must be described as I/O function group in FSP_I/O. The entry contains the type of the function group as well as the desired structure instance (SI) of the new module. The structure element (SE) always has the value 0.

Structure

IDN S-0-15xx.y.0

xx = Identification of the function group

y = Desired structure instance

The entries of the list must be sorted in ascending order. To assign two or more function groups (FG) to a structure instance (SI), they must be listed directly one after another with the same structure instance.

There are two types of function groups: **virtual** and **passive**:

Virtual modules (virtual placeholders)

- They are physically not present
- They do not take part in local bus communication
- They do not have their own place but their own structure instance (SI)
- They are used as placeholders in the container input data or the container output data
- Their channel number and the channel width can be controlled by describing the associated structure elements in communication phase CP2
- They can map an optional electronic rating plate in "S-0-1300 Electronic label"

Passive modules (e.g., supply modules or local bus extensions)

- They are physically present
- They do not take part in local bus communication
- They have their own place and a structure instance (SI)
- They do not have a placeholder function in container input data or container output data
- They can map an electronic rating plate in "S-0-1300 Electronic label"

Attributes

Length	4 bytes, device-specific
Format	IDN
Function	Parameter
Changeability	Communication phase CP2 Parameterization phase

8.5.1.5 S-0-1500.0.05 Container output data

Function

The process data comprise a configured container with output data. This data consists of process output data (PDOUT) and diagnostic output data (DIAGOUT). "S-0-1050.x.05 Current length of connection" that is read by the master and the mapping rules determine the length of the container output data. The data is mapped in the order of the entries in "S-0-1302.0.02 Function groups".

Configuration of the connection

– As SPCP_FixCFG the container output data is a defined part of the "Consumer connection".
– As SPCP_VarCFG the container output data should have no more than one "Consumer connection". For this purpose, the container output data is mapped to the connection data of "S-0-1050.x.06 Configuration list". If the length is configured (S-0-1050.x.01 Connection setup; bits 5-4 = 01), the container output data is a defined part of the "Consumer connection".

Mapping rules

– Diagnostic data is mapped prior to the process data of all function groups.
– Bits, bytes, words and double words are mapped in bytes (starting with bit 0, little endian).

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.1.6 S-0-1500.0.09 Container input data

Function

This parameter comprises a configured container for process input data (PDIN) and diagnostic input data (DIAGIN). "S-0-1050.x.05 Current length of connection" that is read by the master and the mapping rules determine the length of the container input data. The data is mapped in the order of the entries in "S-0-1302.0.02 Function groups".

Configuration of the connection

– As SPCP_FixCFG the container input data is a defined part of the "Producer connection".
– As SPCP_VarCFG the container input data can be configured in one (or several) "Producer connection(s)". For this purpose, the container input data is mapped to the connection data of "S-0-1050.x.06 Configuration list". If the length is configured (S-0-1050.x.01 Connection setup; bits 5-4 = 01), the container input data is a defined part of the "Producer connection".

Mapping rules

– Diagnostic data is mapped prior to the process data of the function groups.
– Bits, bytes, words and double words are mapped in bytes (starting with bit 0, little endian).

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.1.7 S-0-1500.0.11 List of replaced function groups

Function

This IDN contains a list of the function groups (it can be assigned manually or via a configuration tool) which replace existing function groups that a read out via the bus coupler or the bus header (for compact devices. Each function group must have been described as an I/O function group in FSP_I/O. The entry contains the type of the function group as well as the desired structure instance (SI) of the new module. The structure element (SE) always has the value 0.

The entries of the list replace the entries in "S-0-1302.0.02 Function groups".

To do this the bus coupler or the bus header (for compact devices) must acquire the corresponding IN parameter again. Since channel width and values of the new function groups are unknown, the following structure elements are set to zero:

– I/O_FG.x.03 Channel size PDOUT
– I/O_FG.x.04 Channel width PDOUT
– I/O_FG.x.07 Channel size PDIN
– I/O_FG.x.08 Channel width PDIN
– I/O_FG.x.11 Channel size DIAGOUT
– I/O_FG.x.12 Channel width DIAGOUT
– I/O_FG.x.15 Channel size DIAGIN
– I/O_FG.x.16 Channel width DIAGIN

During the configuration in communication phase CP2 (I/O power-on-sequence) write protection is temporary disabled so that the master can configure the structure elements. When parameterization is started write protection is enabled again.

Attributes

Length	4 bytes, device-specific
Format	IDN
Function	Parameter
Changeability	Communication phase CP2

8.5.1.8 S-0-1500.0.12 Rearrangement of I/O resource

Function

The master uses this command to make the slave do the following:

– Check the contents of "S-0-1500.0.04 List of inserted function groups" and "S-0-1500.0.11 List of replaced function groups"
– Generate or delete the structure elements of the new I/O function groups and to set the following structure elements to zero:
  – I/O_FG.x.03 Channel size PDOUT
  – I/O_FG.x.04 Channel width PDOUT
  – I/O_FG.x.07 Channel size PDIN

  - I/O_FG.x.08 Channel width PDIN
  - I/O_FG.x.11 Channel size DIAGOUT
  - I/O_FG.x.12 Channel width DIAGOUT
  - I/O_FG.x.15 Channel size DIAGIN
  - I/O_FG.x.16 Channel width DIAGIN
- Enable write protection in communication phases CP3 and CP4 or in the operating phase for the new structure elements channel width and channel values
- Set bit 7 to "1" (virtual) for function groups with "S-0-1500.0.04 List of inserted function groups" in "S-0-15xx.y.02 Configuration of I/O function group"
- Update the corresponding IDNs such as
  - S-0-0017 IDN list of all operation data
  - S-0-1302.0.02 Function groups
  - S-0-0187 IDN list of configurable data as producer
  - S-0-0188 IDN list of configurable data as consumer
  - S-0-1300 Electronic label
  - ...

Error handling

The confirmation is negative if an attempt is made to insert a passive or virtual module at structure instance "0". The confirmation is also negative if the attempt is made to replace the bus coupler or the bus header (for compact devices). As a result "S-0-0127 CP3 transition check" will also be confirmed negatively.

Attributes

Length	2 bytes
Format	Binary
Function	Command
Executability	Communication phase CP2

8.5.1.9 S-0-1500.0.19 Parameter channel receive

Function

This parameter channel is an asynchronous communication mechanism for the manufacturer-specific configuration and parameterization of the bus coupler or the bus header (for compact devices) or the I/O modules. The parameter channel is a simple mechanism that handles the data transparently in the form of a list (1 byte, hex).

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.1.10 S-0-1500.0.20 Parameter channel transmit

Function

This parameter channel is an asynchronous communication mechanism for the manufacturer-specific configuration and parameterization of the bus coupler or the bus header (for compact devices) or the I/O modules. The parameter channel handles the data transparently in the form of a list (1 byte, hex). Data from 1 byte up to the maximum data length is transmitted (via the service channel) to the parameter channel (Parameter Channel Transmit). The service channel works with fragmentation.

The successful transfer via the service channel is the trigger for the command in the I/O modules and the bus coupler or the bus header (for compact devices). Write access to the service channel is only confirmed to the master once the process is complete. No further control signal (handshake) is required for this. The response is retrieved via the receive channel (Parameter Channel Receive). Since this takes place via the service channel, no special control signal (handshake) is required here either. The bus coupler or the bus header (for compact devices) and the modules respond with variable data lengths.

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	Communication phase CP2

8.5.1.11 S-0-1500.0.23 Local bus cycle time

Function

This parameter contains the cycle time of the local bus within a modular I/O station.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No
Unit	µs

8.5.1.12 S-0-1500.0.32 I/O diagnosis message

Function

This IDN comprises diagnostic messages consisting of an I/O status code, a diagnostic class and a local designation. The diagnostic message of a device with the highest priority will be displayed, whereas a new diagnostic message with the same priority will overwrite the diagnostic message stored (does not apply for an existing error C1D).

For cyclic monitoring "S-0-1500.0.32 I/O diagnosis message" can map the data in an existing connection in "S-0-1050.x.06 Configuration list".

Structure

Table 8-33 Structure of S-0-1500.x.32

Bit	Designation/Function	Comment
7-0	Channel number	Channel that caused the diagnostic message. A channel number between 0 and 255 points to a specific channel of the function group (channel-related diagnostic events, e.g., open circuit). Channel number 0 point to the function group itself (function-group related diagnostic messages, e.g. sub bus error - timeout).
15-8	Sub bus slave index	Sub bus slave that caused the diagnostic message (see I/O_FG.x.25 Slave Index). Only used with I/O function group S-0-1509 Sub bus slave.
23-16	Slot number	Slot number of the module to which the function group is assigned (structure instance).
39-24	I/O function group	I/O function group which caused the diagnostic message, e.g., "1503 - Digital output" or "1509 - Sub bus slave".
55-40	Status code	Defined either through TWG_I/O or by the manufacturer (see bit 63)
59-56	Diagnostic class See "S-0-0390 Diagnostic number"	Diagnostic class of the diagnostic message FG/sub bus slave/channel does not have a diagnostic message FG/sub bus slave/channel has information (e.g., preventive maintenance required - condition monitoring). FG/sub bus slave/channel has displayed a warning (e.g., undervoltage in the device) with C2D. The warning disappears automatically when the reason is no longer present. FG/sub bus slave/channel has signaled an error (e.g., incorrect system bus slave present) with C1D. Errors must be deleted with S-0-0099.
62-60	Reserved	
63	Interpretation of the status code 0: Standard I/O status code 1: Manufacturer-specific status code	 Status codes are defined through TWG_I/O. Status codes are defined through the manufacturer.

Attributes

Length	8 bytes
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.1.13 S-0-1500.0.33 Current I/O diagnosis message

Function This IDN contains detailed information about the last diagnostic case of the I/O resource.

Structure Identical with "S-0-1500.0.32 I/O diagnosis message".

Attributes

Length	8 bytes
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.2 S-0-15xx I/O function groups

Depending on the devices used, the parameters of the following I/O function groups are available:

- S-0-1502 I/O function group digital output
- S-0-1503 I/O function group digital input
- S-0-1504 I/O function group analog output
- S-0-1505 I/O function group analog input
- S-0-1506 I/O function group counter
- S-0-1507 I/O function group complex protocol
- S-0-1508 I/O function group sub bus master
- S-0-1509 I/O function group sub bus slave
- S-0-1513 I/O function group motor starter
- S-0-1514 I/O function group PWM (pulse width modulation)
- S-0-1515 I/O function group positioning

In the following description S-0-15xx stands for the I/O function group and y for the structure instance.

8.5.2.1 S-0-15xx.y.01 Name of I/O function group

Function

This parameter contains the name of the sercos function group, e.g., "Digital output" for FG S-0-1502.

Attributes

Length	Device-specific
Format	Text
Function	Parameter
Changeability	No

8.5.2.2 S-0-15xx.y.02 Configuration of I/O function group

Function

The master controls the function group with this parameter.

Structure

Table 8-34 Structure of S-0-15xx.y.02

Bit	Value	Designation	Comment
0		PDOUT	
	0	Configured	PDOUT is configured in "S-0-1500.0.05 Container output data" and no longer available for further connections.
	1	Not configured	PDOUT is not configured in "S-0-1500.0.05 Container output data".
1		PDIN	
	0	Configured	PDIN is configured in "S-0-1500.0.09 Container input data".
	1	Not configured	PDIN is not configured in "S-0-1500.0.09 Container input data".
2		Reserved	
3		DIAGOUT	
	0	Configured	DIAGOUT is configured in "S-0-1500.0.05 Container output data" and no longer available for further connections.
	1	Not configured	DIAGOUT is not configured in "S-0-1500.0.05 Container output data".
4		DIAGIN	
	0	Configured	DIAGIN is configured in "S-0-1500.0.09 Container input data".
	1	Not configured	DIAGIN is not configured in "S-0-1500.0.09 Container input data".
5		Reserved	
6		Replace values	This bit describes the behavior of the outputs when the I/O control bit 15 changes from 1 to 0 (see IDN S-0-1500.x.01) or when the communication phase changes to NRT or CP0.
	0	Fall back	Reset values or output substitute value
	1	Freeze	Freeze values
7		Virtual	This bit indicates whether the I/O function group is physically present or whether it has been inserted virtually, for example as a placeholder
	0	Physical	
	1	Virtual	
15		Reserved	

Attributes

Length 2 bytes
Format Binary
Function Parameter
Changeability Communication phases CP0, CP1, CP2, parameterization phase

8.5.2.3 S-0-15xx.y.03 Channel quantity PDOUT

Function This parameter contains the number of channels for **P**rocess **D**ata **OUT**put (PDOUT).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.4 S-0-15xx.y.04 Channel width PDOUT

Function This parameter contains the bandwidth of a channel for **P**rocess **D**ata **OUT**put (PDOUT).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.5 S-0-15xx.y.05 PDOUT

Function This parameter contains the OUT process data

"S-0-1027.x.01 Requested MTU" (bits 5-4) can be used to configure whether the OUT process data is contained in this parameter (container output data) or directly in a connection.

"S-0-15xx.y.02 Configuration of I/O function group" (bit 0) can be used to configure whether the OUT process data is contained in this IDN (container output data).

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	Operating phase

8.5.2.6 S-0-15xx.y.07 Channel quantity PDIN

Function This parameter contains the number of channels for **P**rocess **D**ata **IN**put (PDIN).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.7 S-0-15xx.y.08 Channel width PDIN

Function This parameter contains the bandwidth of a channel for **P**rocess **D**ata **IN**put (PDIN).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.8 S-0-15xx.y.09 PDIN

Function

This parameter contains the IN process data

"S-0-1050.x.01 Connection setup" (bits 5-4) can be used to configure whether the IN process data is contained in this parameter (container input data) or directly in a connection.

"S-0-15xx.y.02 Configuration of I/O function group" (bit 1) can be used to configure whether the IN process data is contained in this parameter (container input data).

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.2.9 S-0-15xx.y.11 Channel quantity DIAGOUT

Function

This parameter contains the number of channels for **DIAG**nostic Data **OUT**put (DIAGOUT).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.10 S-0-15xx.y.12 Channel width DIAGOUT

Function

This parameter contains the bandwidth of a channel for **DIAG**nostic Data **OUT**put (DIAGOUT)

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.11 S-0-15xx.y.13 DIAGOUT

Function

This parameter can be used to configure the function-group-specific behavior (e.g., control word) or to confirm diagnostic messages.

"S-0-1050.x.01 Connection setup" (bits 5-4) can be used to configure whether DIAGOUT is contained in "S-0-1500.0.05 Container output data" or directly in a connection.

"S-15xx.y.02" (bit 3) can be used to configure whether DIAGOUT is contained in "S-0-1500.0.05 Container output data".

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	Operating phase

8.5.2.12 S-0-15xx.y.15 Channel quantity DIAGIN

Function

This parameter contains the number of channels for **DIAG**nostic Data **IN**put (DIAGIN).

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.13 S-0-15xx.y.16 Channel width DIAGIN

Function

This parameter contains the bandwidth of a channel for **DIAG**nostic Data **IN**put (DIAGIN)

Attributes

Length	2 bytes
Format	Decimal, without sign bit
Function	Parameter
Changeability	No

8.5.2.14 S-0-15xx.y.17 DIAGIN

Function

This parameter can be used to configure the function-group-specific behavior (e.g., status).

"S-0-1050.x.01 Connection setup" (bits 5-4) can be used to configure whether DIAGIN is contained in "S-0-1500.0.09 Container input data" or directly in a connection.

"S-0-15xx.y.02 Configuration of I/O function group" (bit 4) can be used to configure whether DIAGIN is contained in "S-0-1500.0.09 Container input data".

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.2.15 S-0-15xx.y.19 Parameter channel receive

Function

This parameter channel is an asynchronous communication mechanism for the manufacturer-specific configuration and parameterization of the bus coupler or the bus header (for compact devices) or the I/O modules. The parameter channel is a simple mechanism that handles the data transparently in the form of a list (1 byte, hex).

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.2.16 S-0-15xx.y.20 Parameter channel transmit

Function

This parameter channel is an asynchronous communication mechanism for the manufacturer-specific configuration and parameterization of the bus coupler or the bus header (for compact devices) or the I/O modules. The parameter channel handles the data

transparently in the form of a list (1 byte, hex). Data from 1 byte up to the maximum data length is transmitted (via the service channel) to the parameter channel (Parameter Channel Transmit). The service channel works with fragmentation.

The successful transfer via the service channel is the trigger for the command in the I/O modules and the bus coupler or the bus header (for compact devices). Write access to the service channel is only confirmed to the master once the process is complete. No further control signal (handshake) is required for this. The response is retrieved via the receive channel (Parameter Channel Receive). Since this takes place via the service channel, no special control signal (handshake) is required here either. The bus coupler or the bus header (for compact devices) and the modules respond with variable data lengths.

Attributes

Length	Device-specific
Format	Hexadecimal
Function	Parameter
Changeability	No

8.5.2.17 S-0-15xx.y.22 Fall back value output

Function

The outputs are set to this value if bit 6 von "S-0-15xx.y.02 Configuration of I/O function group" is set and the I/O control bit 15 (status of the outputs) changes from 1 to 0 of if the communication phase changes from NRT or CP0.

If the IDN is not supported, the substitute value is either predefined or does not exist at all.

Newly configured values become valid after the next change to the operating phase.

Attributes

Length	Manufacturer-specific, fixed or device-specific
Format	Hexadecimal
Function	Parameter
Changeability	Parameterization phase

8.5.2.18 S-0-15xx.y.23 Minimum delay time

Function

This parameter contains the minimum delay time between the sercos connection and the I/O terminal point.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Unit	ns
Changeability	No

8.5.2.19 S-0-15xx.y.24 Maximum delay time

Function

This parameter contains the maximum delay time between the sercos connection and the I/O terminal point.

Attributes

Length	4 bytes
Format	Decimal, without sign bit
Function	Parameter
Unit	ns
Changeability	No

9 Function Groups

The following chapter lists all function groups with the associated IDNs. The function groups are grouped according to the SCP (Chapter 9.1 on page 9-1), GDP (Chapter 9.2 on page 9-3) and FSP (Chapter 9.3 on page 9-5) profiles.

9.1 Function Groups of the SCP (sercos Communication Profile)

The SDP is divided into the following function groups:
- FG SCP Identification
- FG Timing
- FG Telegram Setup
- FG Control
- FG Bus Diagnosis
- FG Connection
- FG NRT

9.1.1 FG SCP Identification

The "SCP identification" function group contains the following IDN:
- S-0-1000 List of SCP types & versions

9.1.2 FG Timing

The "Timing" function group contains the following IDNs:
- S-0-1002 Communication cycle time (tS-cyc)
- S-0-1005 Minimum feedback processing time (t5)
- S-0-1006 AT0 transmission starting time (t1)
- S-0-1007 Feedback acquisition capture point (t4)
- S-0-1008 Command value valid time (t3)
- S-0-1015 Ring delay
- S-0-1016 Slave delay (P/S)
- S-0-1023 SYNC jitter
- S-0-1024 SYNC delay measuring procedure command
- S-0-1041 AT Command value valid time (t9)

9.1.3 FG Telegram Setup

The "Telegram setup" function group contains the following IDNs:
- S-0-1009 Device control (C-Dev) offset in MDT
- S-0-1010 Length of MDTs
- S-0-1011 Device status (S-Dev) offset in AT

– S-0-1012 Length of ATs
– S-0-1013 SVC offset in MDT
– S-0-1014 SVC offset in AT

9.1.4 FG Control

The "Control" function group contains the following IDNs:
– S-0-0021 IDN list of invalid operation data for CP2
– S-0-0022 IDN list of invalid operation data for CP3
– S-0-0127 CP3 transition check
– S-0-0128 CP4 transition check

9.1.5 FG Bus Diagnosis

The "Bus diagnosis" function group contains the following IDNs:
– S-0-0014 Interface status
– S-0-1003 Allowed MST losses in CP3/CP4
– S-0-1026 Version of communication hardware
– S-0-1028 Error counter MST-P/S
– S-0-1031 Test pin assignment port 1 and port 2
– S-0-1035 Error counter port 1 and port 2
– S-0-1040 sercos address
– S-0-1044 Device control (C-Dev)
– S-0-1045 Device status (S-Dev)

9.1.6 FG Connection

The "Connection" function group contains the following IDNs:
– S-0-0187 IDN list of configurable data as producer
– S-0-0188 IDN list of configurable data as consumer
– S-0-1050 sercos connections
– S-0-1050.x.01 Connection setup
– S-0-1050.x.02 Connection number
– S-0-1050.x.03 Telegram assignment
– S-0-1050.x.04 Max. length of connection
– S-0-1050.x.05 Current length of connection
– S-0-1050.x.06 Configuration list
– S-0-1050.x.08 Connection control (C-Con)
– S-0-1050.x.10 Producer cycle time
– S-0-1050.x.11 Allowed data losses
– S-0-1050.x.12 Error counter data losses
– S-0-1050.x.20 IDN allocation of real-time bit
– S-0-1050.x.21 Bit allocation of real-time bit
– S-0-1051 Image of connection setups

9.1.7 FG NRT

The "NRT" function group contains the following IDNs:
- S-0-1017 NRT transmission time
- S-0-1019 MAC address
- S-0-1020 IP address
- S-0-1021 Subnet mask
- S-0-1022 Gateway address
- S-0-1027.x.02 Effective MTU
- S-0-1027.x.02 Effective MTU

9.2 Function Groups of the GDP (Generic Device Profile)

The GDP includes the class GDP_Basic which contains the following IDNs that are contained in every sercos device:
- S-0-0017 IDN list of all operation data
- S-0-0099 Reset class 1 diagnostic
- S-0-1300.x.03 Vendor code
- S-0-1300.x.05 Vendor device ID
- S-0-1301 List of GDP classes & version
- S-0-1302.x.01 FSP type & version
- S-0-1302.0.02 Function groups

The GDP also contains the following function groups:
- FG Diagnosis
- FG Archiving
- FG Administration
- FG Identification
- FG State Machine

9.2.1 FG Diagnosis

The "Diagnosis" function group contains the following IDNs:
- S-0-0095 Diagnostic message
- S-0-0099 Reset class 1 diagnostic
- S-0-0390 Diagnostic number
- S-0-1303 Diagnosis trace
- S-0-1303.0.01 Diagnosis trace configuration
- S-0-1303.0.02 Diagnosis trace control
- S-0-1303.0.03 Diagnosis trace state
- S-0-1303.0.11 Diagnosis trace buffer no. 2
- S-0-1303.0.12 Diagnosis trace buffer no. 3

9.2.2 FG Archiving

The "Archiving" function group, for example, contains the following IDNs:
– S-0-0022 IDN list of invalid operation data for CP3
– S-0-0264 Backup working memory procedure command

9.2.3 FG Administration

The "Administration" function group contains the following IDNs:
– S-0-0017 IDN list of all operation data
– S-0-0025 IDN list of all procedure commands
– S-0-0265 Language selection
– S-0-0266 List of available languages
– S-0-0267 Password
– S-0-0279 IDN list of password protected data

9.2.4 FG Identification

The "Identification" function group contains the following IDNs:
– S-0-1300 Electronic Label
– S-0-1301 List of GDP classes & version
– S-0-1302 Resource structures of sub-device
– S-0-1302.x.01 FSP type & version
– S-0-1302.0.02 Function groups
– S-0-1302.x.03 Application type

9.2.5 FG State Machine

The "State machine" function group contains the following IDNs:
– S-0-0420 Activate parameterization level procedure command (PL)
– S-0-0422 Exit parameterization level procedure command (PL)
– S-0-0423 IDN list of invalid data for parameterization level

9.2.6 FG Time

The "Time" function group contains the following IDNs:
– S-0-1305.0.01 sercos current time

9.3 Function Groups of the FSP_IO (Function-Specific Profile)

The FSP_I/O contains the following I/O function groups:
- S-0-1500 I/O Bus coupler
- S-0-1502 I/O function group digital output
- S-0-1503 I/O function groupdigital input
- S-0-1504 I/O function group analog output
- S-0-1505 I/O function group analog input
- S-0-1506 I/O function group counter
- S-0-1507 I/O function group complex protocol
- S-0-1508 I/O function group sub bus master
- S-0-1509 I/O function group sub bus slave
- S-0-1513 I/O function group motor starter
- S-0-1514 I/O function group PWM (pulse width modulation)
- S-0-1515 I/O function group positioning

9.3.1 S-0-1500 I/O Bus coupler

The I/O function group bus coupler contains the following structure elements:
- S-0-1500.0.01 I/O control
- S-0-1500.0.02 I/O status
- S-0-1500.0.03 List of module type codes
- S-0-1500.0.04 List of inserted function groups
- S-0-1500.0.05 Container output data
- S-0-1500.0.09 Container input data
- S-0-1500.0.11 List of replaced function groups
- S-0-1500.0.12 Rearrangement of I/O resource
- S-0-1500.0.19 Parameter channel receive
- S-0-1500.0.20 Parameter channel transmit
- S-0-1500.0.23 Local bus cycle time
- S-0-1500.0.32 I/O diagnosis message

10 Glossary

Application layer	Topmost layer of the communication model
AT	**Acknowledge Telegram** Telegram for the acknowledgment of slave data and for CC communication
Bandwidth	Specific amount of data that can be transmitted in a time unit
C1D	**Class 1 diagnostic** Error message with the highest priority
C2C	**Controller to controller** Networked communication between the masters of different sercos networks
C2D	**Class 2 diagnostic** Warning
CC	**Cross communication** Direct data exchange without delay between slave devices
Channel width	See bandwidth
CP	**Communication phase** A sercos network requires five communication phases (CP0 - CP4) for initialization
CPS	**Communication phase switching**
C-CON	**Connection control** Control word of the connection
C-DEV	**Device control** Device control word that is sent from master to slave
Communication Layer	The communication layer is a 1:1 relationship between master and slave. The relationship exists in all communication phases
Component	A part of a sercos device that can be ordered and supplied separately and which is listed in IDN "S-0-1300 Electronic label", e.g., bus coupler, I/O module, firmware
Cycle	Realtime communication is split into time cycles during which complete data exchange may take place. The shorter the cycle time the more cycles can be clocked for each time unit and the more exactly can the network be controlled.
Data Link Layer	The Data Link Layer is used for – Control and monitoring of the connections – Configuration of realtime data – Error handling for the connection

Device profile	Group of parameters for the non-proprietary, standardized integration of devices, even without drivers and configuration data
DIAGIN	**Input diagnostic data**
DIAGOUT	**Output diagnostic data**
EIDN	**Extended ID number**
FCS	**Frame check sequence** Check of MDTs and ATs
Fieldbus	Wired communications system that connects control devices, as well as sensors and actuators and is used for a fast data exchange between these components. There are fieldbusses with different physical designs and transmission protocols. Fieldbusses are usually standardized in international standards, cf. IEC 61508.
FG	**Function group** Group of parameters that cover certain functions.
Firmware	Device-specific software for automation devices. In some devices it is stored in a read-only memory that cannot be changed and in some devices it is delivered on removable media, such as Compact Flash cards.
FPGA	**Field programmable gate array**
FSP	**Function-specific profile** Application-specific part of the application layer
GDP	**Generic device profile** Part of the Application Layer
Hot plugging	Network devices can be connected or disconnected under power
IDN	**Identification number** Parameters are identified by IDNs
IndraWorks	Engineering software
I/O	**Input/Output**
Jitter	Signal fluctuations Minor signal fluctuations promote the realtime capability of communications
LS0H	**Low Smoke Zero Halogen** Cable with a fire-proof sheath
MAC address	**Media Access Control** This address (also called Ethernet ID) is the unique hardware address of each device connected to Ethernet. This address is stored retentively in the device and can usually not be changed. With Ethernet the Media Access Control Layer connects the Physical Layer with the higher-level protocols.

Master	The master is a central device, which controls the bus access. All other devices operate as slaves.
MDT	**Master Data Telegram** Telegram for requirements from the master device
MM	**Multimode**
MST	**Master Synchronization Telegram** Telegram for synchronization of master and slave
NRT	**Non realtime** In contrast to realtime
PCF	**Polymer-cladded fiber** Optical fiber with a core of quartz glass
PDIN	**Process data input**
PDOUT	**Process data output**
POF	**Polymer-optical fiber**
P-Channel	**Primary channel**
P-Telegram	**Telegram on the primary channel**
Realtime	Existence of timeliness and simultaneity. Realtime Ethernet requires high-performance protocols with cyclic, clocked data traffic. Standard Ethernet protocols suffice for non-realtime requirements.
RT	**Real time**
SCP	**sercos** communication profile Comprises the parameters of the Communication Layer and the Data Link Layer
SDDML	**sercos** device description markup language Format of the device description file
SE	**Structure element** The structure element is used for addressing
sercos	**Serial real-time communication system** Universal, standard, and open automation bus for controllers, actuators and sensors, such as I/Os and drives. The worldwide operating sercos international e.V. user organization is responsible for further development, marketing and standardization of the sercos technology.

SI	**Structure instance** A structure instance is used to address the same type of structure within a sub device. In a modular I/O station the structure instance corresponds to the slot number after the bus coupler.
SM	**Singlemode**
Slave	A slave is a device in the network that can only participate in data exchange after it has been addressed by the master.
SVC	**Service channel** Communication settings as well as parameter and diagnostic data can be exchanged between the controller master and the individual slaves via the service channel.
Synchronization	Increases the realtime capability by a time alignment and simultaneous execution of signals
S-DEV	**Device status** Slave control word
S-Channel	**Secondary channel**
S-Telegram	**Telegram on the secondary channel**
Telegram	Clocked data packet in which the communication data is bundled and transported to all sercos devices.

A Index

A

B

C

D

E

F

G

H

I

L

M

N

O

P

R

S

T

V

W