Module Controller

SE-48

Profibus Manual

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1 General

1.1 Documentation

This manual describes how the Feldbus connection of the servo positioning regulator SE-48 under PROFIBUS-DP is carried out. The setting of the physical parameters, the activation of the PROFIBUS communication, the integration in the master connection and the communication with the servo positioning regulator is described. It is meant for persons who are already familiar with the servo positioning regulator type SE-48.

It contains safety instructions that must be followed.

You will find more detailed information in the

- **User manual SE-48**

  Description of the device functionality and the software functions of the firmware including the RS232-communication. Description of the SE-48 SE- Commander™ parameterization program with instructions for commissioning of a servo positioning regulator SE-48, a description of the technical specifications and the device functionality as well as notes on the installation and operation of the servo positioning regulator SE-48.

1.2 Documentation on PROFIBUS

PROFIBUS (**PRO**cess **FI**eld**BUS**) is a standard that has been compiled by the PROFIBUS Nutzerorganisation e.V. (organization of PROFIBUS users). The complete description of the fieldbus system can be found in the following standard:

IEC 61158 "Digital Data communication for measurement and control – Fieldbus for use in industrial control systems": This standard is divided into several parts and defines 10 "Fieldbus Protocol Types". PROFIBUS has been specified as type 3. There are two PROFIBUS models. Among them is PROFIBUS-DP for fast data exchange in production engineering and building automation (DP = Decentral Periphery). The embedding in the ISO/OSI layer model is also described in this standard.

Further information, contact addresses etc. can be found at **www.profibus.com**.

Further, more detailed documentation on the use of PROFIBUS-DP:

1. PROFIBUS-DP
   Grundlagen, Tips und Tricks für Anwender
   Manfred Popp
   Hüthig-Verlag, Heidelberg 1998

2. Dezentralisieren mit PROFIBUS-DP
   Aufbau, Projektierung und Einsatz des PROFIBUS-DP mit Simatic S7
   Josef Weigmann, Gerhard Kilian
   Siemens, Erlangen/München 1998

3. Der neue Schnelleinstieg für PROFIBUS DP
   Von DP-V0 bis DP-V2
   Manfred Popp
   PROFIBUS Nutzerorganisation e.V., Karlsruhe 2002

4. PROFIdrive – Profile Drive Technology,
   Vers. 3.1,
   PROFIBUS Nutzerorganisation e.V., Karlsruhe

5. IEC 61158 - Feldbus für industrielle Leitsysteme

2 Safety instructions for electrical drives and controllers

2.1 Symbols used in this handbook

Information

Important information and notes.

Caution!

Non-adherence can result in significant property damage.

Danger!

Non-adherence can cause **property damage** and **injuries to persons**.

Caution! Perilous voltages.
The safety instruction contains a note on the occurrence of a possible perilous voltage.

2.2 General instructions

In case of damage owing to non-compliance with the warning notices in this operating manual, Afag will not accept any liability.

If the documentation in the language that has been supplied is not easily understood, please ask and inform the supplier.

The faultless and safe operation of the servo positioning regulator presupposes an appropriate and professional transport, storage, mounting and installation as well as careful operation and service. Only educated and trained personnel must be deployed for handling electrical equipment:

Trained and qualified personnel in the meaning of this product manual or the warning instructions on the product itself, are those persons who are familiar with the installation, the assembly, commissioning and operation of the product as well as with all the warnings and precautionary measures according to the operating instructions in this product manual and have the necessary qualifications corresponding to their activity:

- Training and instruction or authorization to switch on and off devices/systems in accordance with the standards of safety engineering, to ground them and to mark them meaningfully according to the work instructions.
- Training or instruction according to the standards of safety engineering in the maintenance and use of the proper safety equipment.
- Training in First Aid.

The following notes must be read before the initial start-up of the system for avoiding bodily injuries and/or damage to property:

These safety instructions must be complied with at all times.

Do not attempt to install or commission the servo positioning regulator before you have carefully read all the safety instructions for electrical drives and controllers in this document. These safety instructions and all other user instructions must be read before any work on the servo positioning regulator.

Should you not have access to any of the user instructions for the servo positioning regulator, please contact the responsible sales representative. Demand immediate dispatch of these documents to the person(s) responsible for the safe operation of the servo positioning regulator.

In case of sale, lending or other form of transfer of the servo positioning regulator, these safety instructions must also be enclosed.

Opening of the servo positioning regulator by the owner/operator is not permitted for reasons of safety and the warranty.

Precondition for trouble-free working of the servo positioning regulator is a technically sound planning!

Danger!

Improper handling of the servo positioning regulator and non-compliance with the warning instructions given here or improper intervention in the safety devices can result in damage to property, bodily injury, electrical shocks or in extreme cases, in death.

2.3 Dangers from improper use

Danger!

High electrical voltage and high operating current!

Danger to life or possibility of serious injury from electrical shock!

Danger!

High electrical voltage owing to wrong connection!

Danger to life or possibility of injury from electrical shock!

Danger!

The surfaces of the machine housing may be hot!

Danger of injury! Danger of burns!

Danger!

Movements that cause danger!

Danger to life, serious bodily injury or damage to property from unintentional movements of the motors!

2.4 Safety instructions

2.4.1 General safety instructions

The servo positioning regulator corresponds to the protection class IP54, as well as the pollution class 1. Care must be taken that the ambience conforms to this protection class and degree of pollution.

Use only accessories and spare parts that have been approved by the manufacturer.

It must be possible to connect the servo positioning regulator and the power supplies used to the mains supply according to the EN-standards and VDE specifications in such a way that they can be isolated from the mains using suitable isolating devices (e.g. main switch, contactors, power circuit breakers).

Gold-plated contacts or contacts with a high contact pressure must be used for connecting the control contacts.

As a precaution, interference suppression measures must be taken for the switchgear, e.g. contactors and relays with RC-elements or diodes.

The safety specifications and regulations of the country in which the device is to be used must be complied with.

The ambient conditions specified in the product documentation must be complied with. Safety-critical applications are not allowed until they are expressly approved by the manufacturer.

The notes for EMC-compliant installation can be taken from *chapter 11.7 of the respective product manual*. The compliance with the limiting values specified by the national specifications is the responsibility of the manufacturer of the system or machine.

The technical data, the connection and installation conditions for the servo positioning regulator can be obtained from this product manual and must be complied with without fail.

Danger!

The general installation and safety specifications for the work on power installations (e.g. DIN, VDE, EN, IEC or other national or international specifications) must be observed.

Non-compliance can result in death, bodily injuries or considerable damage to property.

Without any claims to completeness, the following specifications shall apply:

VDE 0100	Regulation for the mounting of power installations up to 1000 volt
EN 60204	Electrical equipment of machines
EN 50178	Electronic equipment for use in power installations

2.4.2 Safety instructions for installation and maintenance

For the installation and maintenance of the system, the relevant DIN, VDE, EN and IEC specifications, as well as all national and local safety and accident prevention regulations apply in any case. The system manufacturer or the owner/operator must ensure compliance with these regulations:

The operation, maintenance and/or repairs to the servo positioning regulator may only be carried out by personnel who are trained and qualified to work on electrical machinery.

Avoiding accidents, bodily injuries and/or damage to property:

Additionally secure vertical axles against dropping or lowering after switching off the motor, such as by:

- mechanical interlocking of the vertical axle,
- external braking/ catching/ clamping device or
- sufficient weight balancing of the axle.

The motor brake installed or an external motor brake controlled by the drive control unit alone is not suitable for personnel safety!

Render the electrical equipment free of voltage via the main switch and secure it against being switched on again, wait until the intermediate circuit has been discharged during:

- maintenance work and repairs
- cleaning work
- long operational downtimes

Before carrying out any maintenance work, it must be ensured that the power supply has been switched off, locked and the intermediate circuit has been discharged.

Care must be taken at the time of installation. It must be ensured that both at the time of installation as well as during the subsequent operation of the drive, no drilling chips, metal dust or parts from the assembly procedures (screws, nuts, bits of cable) fall into the servo positioning regulator.

So also, it must be ensured that the external voltage supply of the regulator (24 V) is switched off.

The intermediate circuit or the mains voltage must always be switched off before the 24V voltage supply of the regulator is switched off.

Work in the vicinity of the machine must always be carried out with the AC or DC voltage supply switched off and the switches locked. Output stages or regulator releases that are switched off are no suitable locking devices. In case of a fault, this may result in an unintended movement of the drive.

The commissioning must be carried out with coasting motors, to avoid mechanical damage, e.g. owing to a wrong direction of rotation.

Electronic devices are basically not fail-safe. It is the responsibility of the user to ensure that upon failure of the electrical device, his system is taken into a safe state.

The servo positioning regulator can reach high temperatures and may cause heavy burns when touched.

2.4.3 Protection against touching electrical parts

This chapter only pertains to devices and drive components with voltages above 50 V. If parts with voltages above 50 V are touched, this can become dangerous to persons and result in electrical shock. When operating electrical devices, certain parts of such devices are necessarily live and carry a dangerous voltage.

Danger!

High electrical voltage!

Danger to life, danger of injury from electrical shock, or serious bodily injury!

For normal operations, the relevant DIN, VDE, EN and IEC - specifications apply in any case, as well as all the national and local safety and accident prevention

regulations. The system manufacturer or the owner/operator must ensure compliance with these regulations:

Before switching on, put on the covers and protective devices, which are intended to prevent touching, on the appliances. For installed devices, protection against direct touching of electrical parts must be provided by an external housing, such as a switch cabinet. The VGB4 specifications must be complied with!

Always connect the protective conductor of the electrical equipment and the devices firmly to the mains supply.

Keep in mind the minimum copper cross-section for the protective conductor connection over its entire length in accordance with the standard EN60617.

Before commissioning, even for a short time for measuring and testing purposes, always connect the protective conductor to all the electrical devices according to the circuit diagram, or connect it to the ground. Otherwise, there may be high voltages on the housing, which cause an electrical shock.

Do not touch electrical connection points of the components in the powered on state.

Before accessing electrical parts with voltages greater than 50 V, disconnect the device from the mains supply or the voltage source. Secure against being switched on.

At the time of installation, attention must be paid to the intermediate circuit voltage, particularly with reference to the insulation and protective measures. Care must be taken to ensure proper grounding, conductor dimensioning and the corresponding short circuit resistance.

2.4.4 Protection through protective low voltage (PELV) from electrical shocks

All connections and terminals with voltages from 5 to 50 V at the servo positioning regulator are protective low voltages that are made with safe contacts according to the following standards:

- International: IEC 60364-4-41
- European countries in the EC: EN 50178/1998, Section 5.2.8.1

Danger!

High electrical voltage owing to wrong connection!

Danger to life, danger of injury from an electrical shock!

Only those devices, electrical components and cables, which have a protective low voltage (PELV = Protective Extra Low Voltage) may be connected to all connections and terminals with voltages from 0 to 50 volt.
Connect or apply only such voltages or electrical circuits that are safely isolated from dangerous voltages. Safe isolation is achieved, for example, by isolation transformers, safe opto-couplers or mains-free battery operation.

2.4.5 Protection from dangerous movements

Dangerous movements can be caused by erroneous control of the connected motors. The causes can be of the most varied kinds:

- untidy or faulty wiring or cabling
- error during the operation of the components
- error in the measuring and signal transmitters
- faulty or non-EMC-conformant components
- error in the software in the superset control system

These faults can occur immediately after switching on, or after an indefinite time during operation.
The monitoring devices in the drive components exclude the possibility of a malfunction in the connected drives to a great extent. With regard to the personnel protection, particularly the danger of bodily injury, and/or property damage, however, all trust must not be placed in this fact alone. Until such time as the built-in monitoring devices become active, however, faulty drive movements must be expected, the magnitude of which depends on the type of the controller and the operating state.

Danger!

Movements that cause danger!

Danger to life, danger of injury, serious bodily injury or property damage!

Protection of persons must be ensured by means of monitoring devices or measures that are set up at the plant site. These are provided according to the specific conditions of the system and a danger and fault analysis by the system manufacturer. The safety regulations applicable for the system are also included thereby. Switching off, bypassing or wrong activation of safety devices can result in random unwanted movements of the machine or other malfunctions.

2.4.6 Protection against touching hot parts

Danger!

The surfaces of the machine housing may be hot!

Danger of injury! Danger of burns!

Do not touch the housing surface in the vicinity of hot heat sources! Danger of burns!

Before access, allow the devices to cool for 10 minutes after switching off.

If hot parts of the equipment, like machine housings, in which radiators and resistors are located are touched, burns may result!

2.4.7 Protection during handling and installation

The handling and installation of certain parts and components in an unsuitable manner can result in injury under certain circumstances.

Danger!

Danger of injury from improper handling!

Bodily injury possible from crushing, shearing, cutting, impacts!

General safety instructions apply in this context:

Follow the general installation and safety specifications on handling and installation.

Use suitable installation and transportation equipment.

Prevent squeezing and crushing by taking suitable precautionary measures.

Only use suitable tools. If prescribed, use special tools.

Use hoists and tools in a technically sound manner.

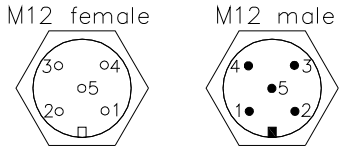
If required, use suitable protective fittings (for example: safety goggles, safety shoes, protective gloves).

Do not stay under suspended loads.

Immediately wipe off any liquids which have escaped since there is a danger of slipping.

3.1 Pin assignment

The PROFIBUC interface at the SE-48 servo positioning regulator with Profibus is designed as an M12 5-pin connector (b-coded at the technology plug-in module as socket and connector) according to EN 50170.



Pin	Lead colour	Profibus signal
1	-	+5V
2	green	A-lead
3	-	0V
4	red	B-lead
5	-	Shielding

Figure 3.1: PROFIBUS connector on the SE-48

PROFIBUS cabling

Owing to the very high possible baud rates, we recommend the use of the standardized cables and connectors exclusively. These are, to an extent, equipped with additional diagnosis options and in case of a fault, simplify the fast analysis of the Feldbus hardware.

When constructing the PROFIBUS network, follow the advice of the current literature or the following information and instructions without fail, to get a stable and fault-free system. In case of cabling not having been done properly, faults can occur on the PROFIBUS during operation, which can result in the servo positioning regulator getting switched off with an error message, for reasons of safety.

3.2 Bus cable for PROFIBUS

PROFIBUS cable:

PROFIBUS cable: straight socket, shielded M12-B coded, 2 poles
straight pin, shielded M12-B coded, 2 poles

Manufacturer: Phoenix Contact

Order No.	Length in mm
15 18 10 6	0.3
15 18 11 9	0.5
15 18 12 2	1
15 18 13 5	2
15 18 14 8	5
15 18 15 1	10
15 18 16 4	15

3.3 Termination and bus terminating resistors

Every bus segment of a PROFIBUS network must be fitted with bus terminating resistors, to minimize cable reflections, to ensure a nearly constant load behaviour at the bus and to set a defined equilibrium rest potential on the cable. The termination is done at the beginning and at the end of a bus segment.
With the PROFIBUS module of the servo positioning regulator SE-48 these terminating resistors are integrated on the module. They can be switched on using the two DIP-switches on the module (switch to ON). Due to the high protection class of the servo positioning regulator SE-48 the terminating resistors cannot be operated from the outside. Switching the terminating resistors on and off is only possible when the servo positioning regulator SE-48 has been removed from the motor.

Therefore, an M12 connector terminating resistor should be used.

Bus terminating resistors

DIP switches are integrated in the technology module which allow bus terminating resistors to be connected, if necessary.

An external connection is also possible. The supply voltage of 5 V required for the externally connected terminating resistors is provided at the PROFIBUS-connection of the module (see pin assignment).

The erroneous or wrong bus termination is a frequent cause of error when there are faults.

If the baud rate is set is > 1.5 MBaud, then, owing to the capacitive load of the subscriber, and the cable reflection thus generated, connectors with integrated series inductances (110 nH) are used.

4 PROFIBUS-DP and PROFIdrive

4.1 Overview of DP and its power stages

The communications protocol DP (DP = Decentral Periphery) is designed for fast data exchange at the field level. Here, central automation devices like PLCs, PCs or process control systems communicate over a fast serial connection with decentral field devices like I/O, drives, valves, measuring transducers or analyzers. The data exchange with the decentral devices mainly takes place cyclically. The communication functions required for this purpose are defined by the DP basic functions (power stage DP-V0).

DP was expanded in steps over and above these basic functions, with special functions, based on the special requirements of the different areas of application, so that DP is today available in three output stages, DP-V0, DP-V1 and DP-V2, with every stage having a special focus. The most important features of the three stages are:

- DP-V0 This stage provides the basic functionalities of DP. This includes the cyclic data exchange as well as the station-specific, module-specific and channel-specific diagnosis.
- DP-V1 This stage contains enhancements with an orientation to process automation, especially the acyclic data traffic for parameterization, operation, observation and alarm handling of intelligent field devices, in parallel to the cyclic useful data traffic. This allows the online access to bus subscribers using engineering tools. Furthermore, DP-V1 contains alarms. It includes among others, the status alarm, update alarm and a manufacturer-specific alarm.
- DP-V2 This stage contains additional enhancements and is primarily oriented to the requirements of the drive technology. By means of additional functionalities like isochronous slave operation and slave cross-traffic, among other things, DP-V2 can also be used as a drive bus for controlling fast movement sequences in drive axes.

  This power stage requires corresponding hardware. The controllers of the target applications of the SE-48 servo positioning regulator currently do not have this hardware. Support for DP-V2 is therefore not provided for.

The power stages of DP are specified in detail in the IEC 61158 (5).

Every DP system consists of different device types, with a distinction being made between three types: DP-master class 1, DP-master class 2 and DP-slaves. Using DP mono- and multi-master systems can be realized. As a result, a high degree of flexibility in the system configuration is possible. A maximum of 126 devices (master or slaves) can be connected to a bus.

The extensive diagnosis functions of DP allow fast fault localization. The diagnosis messages are transmitted over the bus and compiled by the master.

The DP-master class 1 (DPM1) is a central controller, which cyclically exchanges information in a defined messaging cycle with the decentral stations (slaves). Typical DPM1 devices are e.g. programmable logic controllers (PLC) or PCs.

DP-master class 2 (DPM2) are engineering, projection or operation devices. They are used for commissioning and for maintenance and diagnosis to configure the connected devices, to evaluate the measured values and parameters as well as to query the device status. A DPM2 must not be connected permanently to the bus system.

A slave is a peripheral device (I/O, drive, etc.), which reads process information and/or uses output information for intervening in the process. Slaves are passive devices with regard to the communication; they only respond to a direct query from a DPM1 or DPM2.

4.2 Basic functions DP-V0

The central controller (master) cyclically reads the input information from the slaves and writes the output information cyclically to the slaves. Here, the bus cycle time must be shorter than the program cycle time of the central automation system, which is about 10 ms in many applications. A high data throughput alone, however, is not enough for the successful use of a bus system. Rather, simple operation, good diagnosis options and a transmission technology that is safe from interference must be ensured. In the case of DP-V0, these properties were optimally combined.

For transmitting 521 bit input- and 512 bit output signals distributed between 32 subscribers DP only needs 1 ms for 12 MBits. With DP input- and output data is transmitted in one message cycle. The useful data transmission takes place, in the case of DP, with the SRD service (Send and Receive Data Service) of the ISO/OSI-layer 2.

The transmission of data with the DP-V0 service requires the definition of how much data is transferred and the meaning of the data from the side of master and slave. Therefore, the user must make this determination when planning the PROFIBUS connection. Only then should the parameterization of the field bus connection on both sides be done.

4.3 Overview of PROFIdrive

The "PROFIBUS profile for drive technology", called simply PROFIdrive, is a standard for manufacturers for implementing PROFIBUS-interfaces for drives. It has been defined by the PROFIBUS user organization. Like CANopen, it is intended to provide the user with a defined interface for programming servo regulators that is manufacturer-independent to a great extent.

PROFIdrive specifies the configuration, diagnosis, data exchange, status machines on one PROFIBUS master. In addition, application classes are defined. The PROFIdrive specifications exist in different versions, which have significant differences. The servo positioning regulator SE-48 is based on the version 3.1 (4).

In the PROFIdrive specification (4), there is also a status machine defined for device control. This status machine is controlled by means of a control word and a status

word. The meaning of the individual bits is also defined in the specification. The functions of both these words have been adopted to a great extent. Only in the case of some details are there some manufacturer-specific deviations, which are documented in a later chapter and marked accordingly.

The SE-48 servo positioning regulator covers a part of the application classes defined in the PROFIdrive specification.

PROFIBUS-DP does not specify the form and meaning of the useful data itself. Therefore, the concept of parameter numbers (PNU) is adopted for a PROFIBUS connection. These parameter numbers carry an optional sub-index. Under these PNUs, there are pre-defined or reserved zones. Moreover, there is space given for manufacturer-specific PNUs.

5.1 Introduction

A number of steps are necessary to create a functioning PROFIBUS-connection. Some of these settings should or must be executed before the activation of the PROFIBUS communication. This chapter provides an overview of the corresponding steps. The exact procedure is described in more detail in the following chapters.

The data transfer with the DP-V0 service is carried out by means of so-called telegrams. On the side of the master and the slave, before the start of the data exchange, it must be defined how much data is to be transferred and what significance the data has.

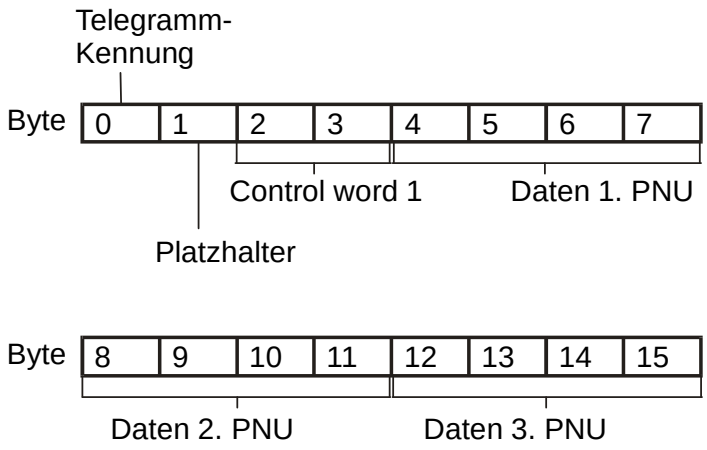


Figure 5.1: Example of a telegram format of the SE-48

Fig. 5.1 illustrates an example of a standard telegram for the SE-48 servo positioning regulator from the master to the slave. Apart from the identifier in byte 0, this telegram type requires, in bytes 2 and 3, the PROFIdrive control word 1 for device control. The contents of the following bytes can be freely configured. In this example, 3 other items of data are transmitted, each with a size of 4 bytes. For the entire telegram, a length of 16 bytes is obtained.

Therefore, when doing the projecting/planning of the PROFIBUS connection, the user must make this determination. Only then should the parameterization of the field bus connection on both sides be done. It is recommended to first carry out the parameterization of the slave. The master is configured thereafter. With correct parameterization, the application is ready immediately without communication errors.

5.2 Overview of slave

This chapter provides an overview of the steps required on the part of the slave for parameterization and configuration. Since some parameters only become effective after saving and reset, the following procedure is recommended:

1. Configuration of the telegrams using the *Telegram editor, chapter 6*
2. Selection and parameterization of the *Physical units, chapter 7*
3. Configuration and activation of the *Operating parameters, chapter 8*

The significance of the data is determined, on the slave side, by inputting the parameter numbers (PNU). This is done by means of the **Telegram editor** of the parameterization program SE-Commander™. The number of bytes for the respective PNU is displayed automatically. In the telegram editor, the total length of the telegram is also displayed for checking purposes.

Important process data of the meanings Position, Speed and Acceleration are transferred in **physical units**. These must be parameterized before the start of communication, since they define how the data is interpreted in the servo positioning regulator.

When these steps are completed, the **operating parameters** of the PROFIBUS-connection must be set. Before activating the communication, the slave address must be correctly set. For these, additional options for controlling the address assignment can be activated through an external connection.

5.3 Overview of master

This chapter provides an overview of the steps required on the part of the master for parameterization and configuration. The following procedure is recommended:

1. Installation of the **GSD file**
2. Specification of the **slave address**
3. Configuration of the **input and output data**

On the master side, the servo positioning regulator must be integrated in the PROFIBUS. To do so, the **GSD file** is installed first, if that has not yet been done. Then, the input and output data must be configured for the slave.

This is depicted as an example for the integration under SIEMENS SIMATIC S7 in the following text.

For integration of the servo positioning regulator in the PROFIBUS network, it must be selected in the hardware catalogue. The folder SE-48FB must be dragged to the PROFIBUS-DP-master system by using drag-and-drop. Immediately thereafter, there is a prompt for the **slave address**.

Thereupon, the bitmap of the servo positioning regulator appears on the master system, and must be marked. Then, the length of the **input and output data** must be defined. For this purpose, the corresponding modules are prepared in the GSD file. One module each for the input data and the output data with the corresponding length should be inserted in one slot each.

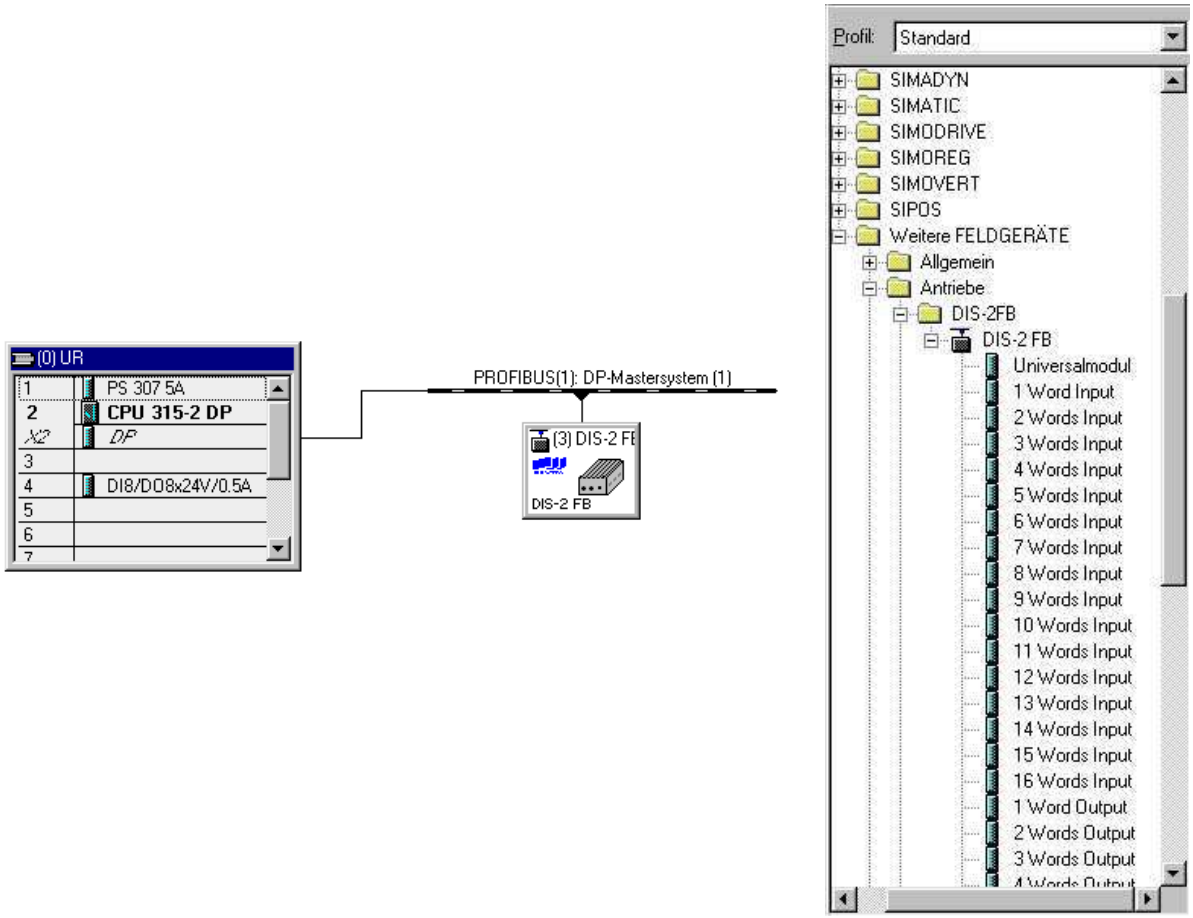


Figure 5.2: Hardware configuration under SIEMENS S7

> To achieve trouble-free working, we recommend determining only one area each for the input data and the output data (see the above example).

Other instructions for the construction of the hardware configuration can be seen from Chapter *0 Telegram editor* or Chapter ***13*** *Function and data modules for SIEMENS S7* with complete example projects including function and data modules for SIMATIC S7.

6 Telegram editor

6.1 Introduction

The telegram editor is used to define how the servo positioning regulator must interpret the data received and the data to be transmitted. The firmware of the SE-48 servo positioning regulator supports the data exchange with the DP-V0 service. The data is exchanged cyclically with so-called telegrams. A distinction is made here between the following two groups:

- **Receipt telegrams:** Data transferred from the master to the slave, also called **Output data**.
- **Response telegrams:** Data to be transferred from the slave to the master, also called **Input** data.

Every telegram can have a maximum of 10 entries.

In the project of the PROFIBUS master, data areas are generated, e.g. data modules. The input and output data of the master and slave is stored in these data areas. In the projecting (planning) phase, the user must specify the contents and their sequence as well as the size of the two data areas, to be identical on the sides of the master and the slave.

This parameterization must be carried out before activating the communication.

6.2 Receipt telegrams

The firmware of the SE-48 servo positioning regulator supports two receipt telegrams. The following table gives an overview of the operating mode binding of the receipt telegrams:

Telegram	Operating mode
Receipt telegram 0	Positioning
Receipt telegram 1	Speed control

As soon as a corresponding telegram identifier is read in the servo positioning regulator, the corresponding operating mode is checked and parameterised, if required.

The parameter numbers must be entered for every receipt telegram. The information about the meaning of the data in the telegram is thus saved in the servo positioning regulator. It must be ensured that in the case of the receipt telegrams 0 and 1 at the address 2, the so-called Control word has been or is entered (length: 2 bytes). This uniform definition simplifies the generation of applications, or the use of the example projects for SIEMENS SIMATIC S7 generated by Afag. The other entries can be chosen at will from the object directory of the parameter numbers. Only the suitability must be kept in mind here. Mere actual value data cannot be entered in receipt telegrams.

In the case of the receipt telegrams, the response telegrams have to be additionally selected. The user can define and configure a separate response telegram for every

receipt telegram. However, in most cases, it is easier to use the same response telegram for all the operating modes (receipt telegrams 0 and 1). This reduces the programming effort on the side of the master. In addition, generally, the master requires, in all the operating modes, the same actual value data from the servo positioning regulator.

Figure 6.1 shows an example of the receipt telegram 0 (operating mode Positioning). The entries can be changed directly by selecting, or deleted successively starting from the last entry. When marking an entry, an additional field is displayed, in which the parameter number can be input. New telegram entries are appended at the end. If communication is established between the master and slave, above the button „Change entry“, additional diagnosis information is shown. The actual length of the telegram configured by the master and transmitted from the master to the slave is indicated.

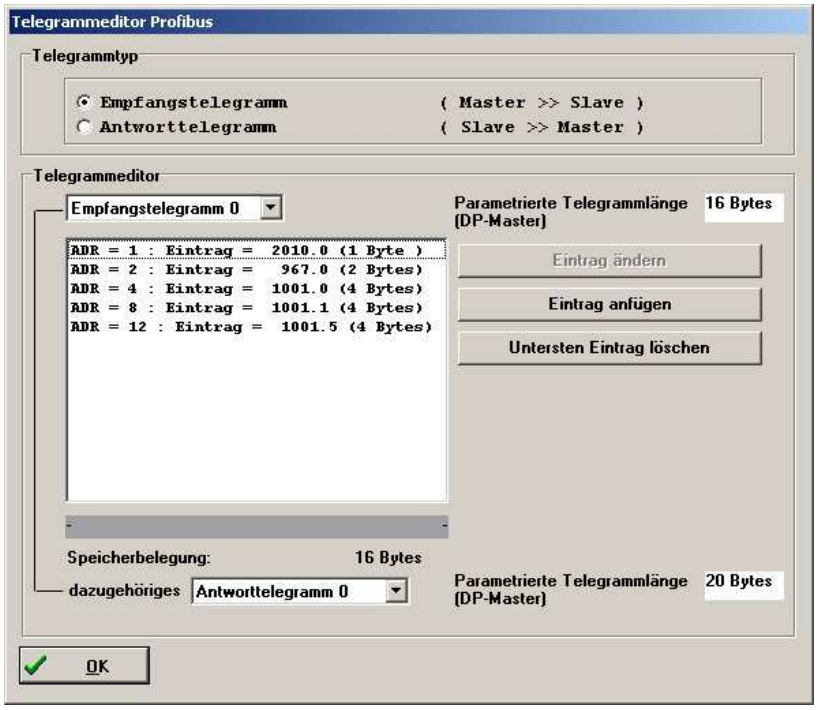


Figure 6.1: Composition of a receipt telegram

The following parameters are transferred to the example displayed:

Address	Content (Parameter number)	Description
0	Identifier (= 0xE0)	Identifier with fixed setting
1	8-bit placeholder (PNU 2010 0)	Free
2	Control word 1 (PNU 967 0)	Control word for device control, must be defined fixed at this address
4	Target position (PNU 1001 0)	Target position, specification in the physical unit of position that has been set for PROFIBUS
8	Movement speed (PNU 1001 1)	Movement speed during the positioning, specification in the physical unit for rotational speed that has been set for PROFIBUS
12	Accelerations (PNU 1001 5)	Combination of the values for acceleration and braking acceleration, specification of an acceleration in the physical unit set for PROFIBUS

More detailed descriptions of the parameter numbers can be seen in *Chapters 9, Device control, **10** Manufacturer-specific parameter numbers* and *12 Profile-specific parameter numbers.*

6.3 Response telegrams

The firmware of the SE-48 servo positioning regulator supports two response telegrams.

The parameter numbers should be entered for every response telegram. The information about the meaning of the data in the telegram is thus saved in the servo positioning regulator. It must be ensured that in the case of the response telegrams 0 and 1 at the address 2, the so-called Status word has been or is entered (length: 2 bytes). This uniform definition simplifies the generation of applications, or the use of the example projects for SIEMENS SIMATIC S7 generated by Afag. The other entries can be chosen at will from the object directory of the parameter numbers. Only the suitability must be kept in mind here. Parameters that can only be written, cannot, e.g. be entered in response telegrams.

Figure 6.1 shows an example of the response telegram 0. The entries can be changed directly by selecting, or deleted successively starting from the last entry. When marking an entry, an additional field is displayed, in which the parameter number can be input. New telegram entries are appended at the end. If a communication was established between master and slave an additional diagnosis information is shown above the “Change entry” button. The actual telegram length between the slave and the master configured by the master is displayed.

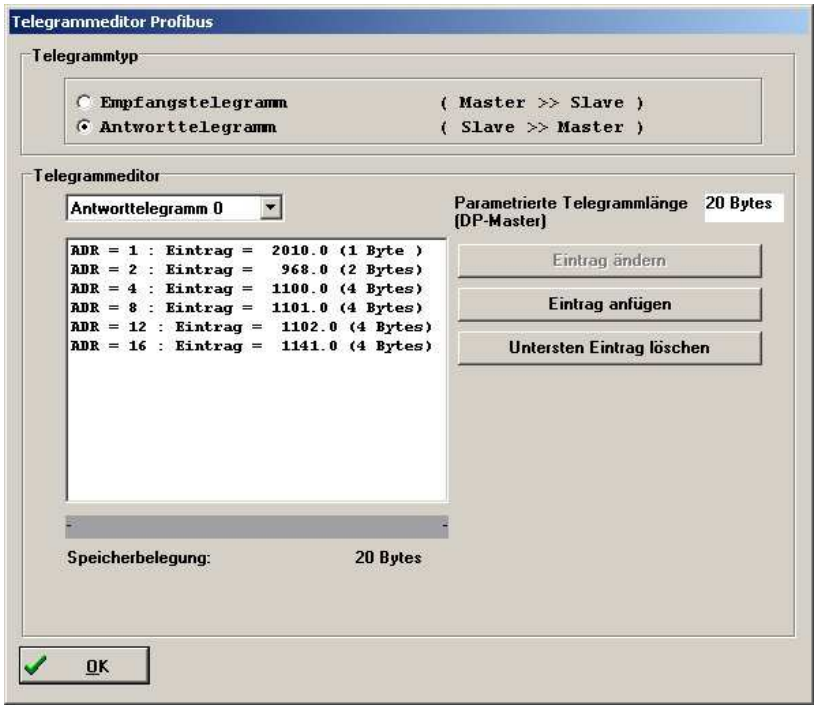


Figure 6.1: Composition of the response telegram

In the example shown in figure 6.2, the following parameters are transferred:

Address	Content (Parameter number)	Description
0	Identifier (= 0xF0)	Identifier with fixed setting
1	Operating mode (PNU 1500 0)	Current operating mode of the servo positioning regulator
2	Status word 1 (PNU 968 0)	Status word for device control, must be defined fixed at this address
4	Actual position (PNU 1100 0)	Actual position, specification of a position in the physical unit set for PROFIBUS
8	Actual value of rotational speed (PNU 1101 0)	Actual rotational speed value, specification of a rotational speed in the physical unit set for PROFIBUS
12	Active current actual value (PNU 1102 0)	The actual value of active current is returned through these parameters. It is returned with reference to the nominal current of the motor in tenths of one percent.
16	Status of the digital inputs (PNU 1141 0)	Current status of the digital inputs, bit assignment see description of the PNU.

More detailed descriptions of the parameter numbers can be seen in *Chapters 9, Device control, 10 Manufacturer-specific parameter numbers, 11 Operating modes* and *12 Profile-specific parameter number.*

7 Physical units

For correct working, it is necessary that the unit of the process data transferred over the fieldbus be defined. They can be set in the window **Physical units, Profibus**, under **Parameter -Fieldbus – PROFIBUS. The parameters for the physical units should be set just once and not changed during a running application.**

Upon selection of the units, the corresponding factors are calculated internally, so the user only has to select the desired unit.
Gearbox factor and feed constant are specified as separate parameters.
Figure 7.1 shows the window of the program SE-48SE Commander™ for setting the physical units.

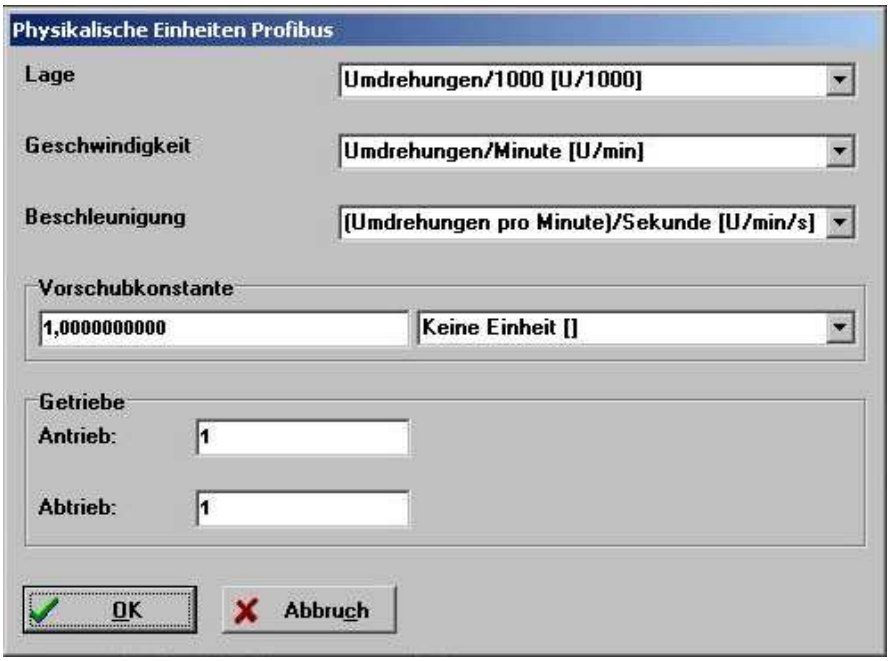


Figure 7.1: Setting of the physical units

From the physical units that have been set, conversion factors are obtained at the time of the input in the firmware. These consist of the numerator and denominator, neither of which may be greater than 32 bits. If there is an overflow while inputting the factors, the value is not accepted. In this case, the factors or the physical units must be corrected.

It should be noted that some values cannot always be used meaningfully. In a purely rotary system, for example, no feed constant is required. Moreover, the feed constant has a physical unit. If suitable parameters are not set here, then the feed constant is not considered.

Examples:

1. Position in revolutions, feed constant in mm/revolution:

   => The feed constant is **ignored**.

2. Position in mm, feed constant without units:

   => The feed constant is **considered** like a gearbox factor.

3. Position in mm, feed constant in µm/revolution

   => The feed constant is **considered** with a factor of 1000.

The value of the feed constant is ignored for the relevant physical unit if the feed constant has a translational unit and a rotational unit has been selected for the physical size.

Problems are only to be expected during running operation if the internal value or the externally input value cannot be depicted any more owing to the conversion. In this case, an error is triggered. Here, too, the settings of the physical units must be checked.

During the parameterization of the indicating units transitional states can occur that lead to an overflow of the physical units. In this case the error 59 “gen. arithmetic error” is generated. Whether the parameterization is actually invalid can only be established in this case by saving followed by a reset. If no error 59 is indicated following this, then the settings are valid.

Carry out save and reset when error 59 occurs during the parameterization of the physical units. If there is no error message following the reset, then the physical units are valid.

Figure 7.2 illustrates the interpretation of the gearbox factor. In the menu Physical Units Profibus of the parameterizing program SE-48SECommander™, the value "drive" refers to U_{EIN}, the value "driven" to U_{AUS}.

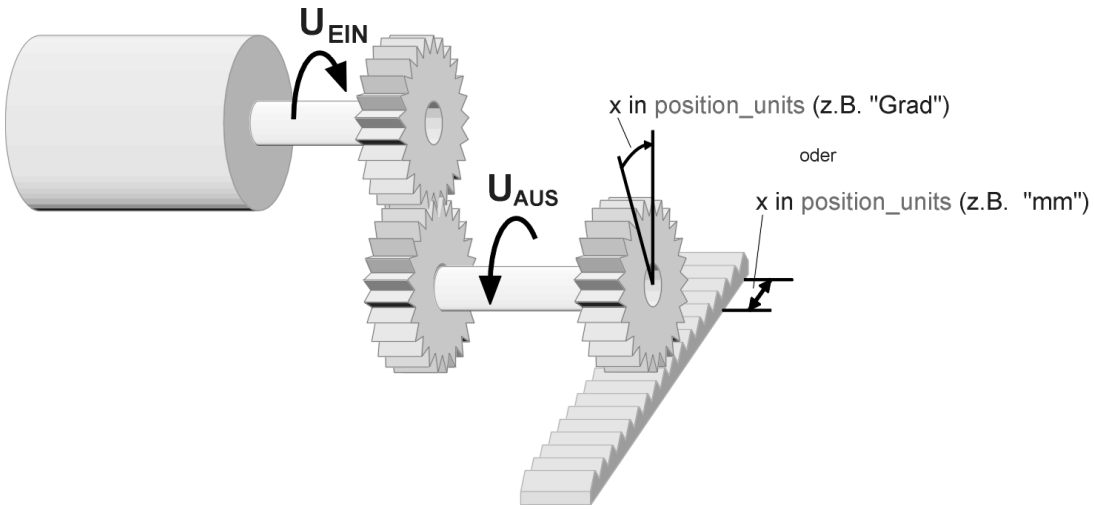


Figure 7.1: Gearbox factor

Example:

When the motor goes through 10 revolutions and a connected gearbox carries out 1 revolution at the output, that corresponds to the following entry:

Driving side: 10

Driven side: 1

Now, parameterization can be done in the units of the driven side.

Gearbox factor and feed constant are defined positive. If the orientation of the application is to be turned, then this can be done in the parameterizing software SE-48SE-Commander™ in the window „Commands".

8 Operating parameters

This chapter describes all the necessary measures to set up a communication over the PROFIBUS-DP. The parameters described in the following are set via the serial port with the program SE-48 SE-Commander™.

8.1 Operating parameters PROFIBUS

For the configuration of the communication on the part of the servo positioning regulator, it is only necessary to specify the slave address. The communication can then be activated. It must be remembered that the activation of the PROFIBUS communication only takes place after a Save & Reset. The deactivation of the communication, in contrast, takes place immediately. Figure 8.1 shows the window of the parameterizing program for setting the operating parameters.

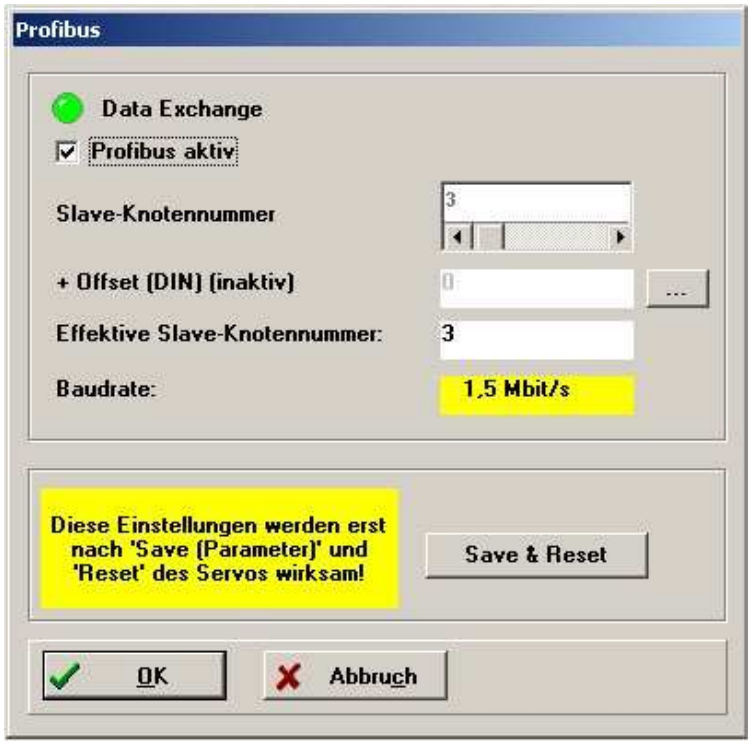


Figure 8.1: Setting of the operating parameters

In case of activated communication, the base value of the slave address cannot be changed any more.

The slave address can be increased, starting from the base value that has been set, through options using a suitable hardware connection. The digital inputs DIN0..5 are provided therefore. The states of the respective inputs are read once immediately after a reset, and used for the calculation of the effective slave address. Retrospective changes remain ineffective. The options have different value weightings:

Option	Active at	Weight
Addition of DIN0..5	+ 24 V DC	0..63
Addition of DIN4+ 5	+ 24 V DC	16, 32 ,48

The baud rate of the PROFIBUS communication is automatically detected by the hardware used. If the connection between master and slave has been established the baud rate detected is displayed in this menu. The baud rates listed below are supported by the S-48 servo positioning regulator:

Baud rate
9.6 kBaud
19.2 kBaud
45.45 kBaud
93.75 kBaud
187.5 kBaud
500.0 kBaud
1.5 MBaud
3.0 MBaud
6.0 MBaud
12.0 MBaud

9 Device control

9.1 Overview

The PROFIdrive specification (4) specifies two data words in order to make the control of a field device (slave) manufacturer-independent. The important device functions are controlled by the master via the **Control word 1**, while the device status is read back in the **Status word 1**. The profile PROFIdrive defines the sequence in which certain bits must be set, for example, in order to be able to release the output stage of the servo-controller.

The device control of the servo positioning regulator of the SE-Power device family is based on the status diagram specified in the profile PROFIdrive. The implementation and eventual manufacturer-specific deviations are described in detail in section ***9.4***, *Status diagram and device control*

Control word and Status word are merely implemented based on the PROFIdrive specification. Deviations from the specification are marked. Moreover, some bits have, to some extent, different meanings depending upon the operating mode. The Control word and Status word are described in the following. Thereafter, the device control is explained, using both these data words.

9.2 Control word 1

Different device functions are controlled with the **Control word 1**, e.g. the regulator release. Individual bits have the corresponding meaning for the same. The use of these bits is described in section ***9.4***, ***Status diagram and device control***
Here, the meaning of individual bits is based on the profile PROFIdrive. Some functions are also executed specific to the manufacturer and some bits are defined with manufacturer-specific functionality.

PNU	**967**
Subindex	**0**
Name	Control word 1
Data type	UINT16
Access	rw
Unit	-
Value range	-
Default value	0

In the receipt telegram 0 and 1, the Control word 1 is located at a fixed position. It is evaluated as last datum, as a result of which, e.g. new target positions are written first. A simultaneously transmitted command for starting a positioning therefore always refers to the data that has been transmitted in the same telegram.

A series of bits has different meanings depending upon the operating mode. The following two tables list the meanings for the two operating modes.

Bit	Control word 1 in the speed control operating mode	
	Meaning	**Behaviour**
0	ON / OFF (OFF 1)	see the Device Control section, *Chapter 9.4 Status diagram and device control*
1	No coast stop (no OFF 2) / coast stop (OFF 2)	
2	No quick stop (no OFF 3) / quick stop (OFF 3)	
3	Enable Operation / Disable Operation	
4*	Ramp generator on / reset ramp generator	1: All rotational speed set points released 0: All rotational speed set points locked.
5*	Ramp generator continue / ramp generator stop	1: Set point ramp released 0: Set point ramp paused (frozen).
6*	Set point released / set point locked	1: All set point inputs for the ramp free 0: All set point inputs for the ramp deactivated
7	Error acknowledgement (flank 0->1)	Active errors are acknowledged, if possible
8*	Jogging 1 on / jogging 1 off	0->1: Movement speed from the jogging position dataset is defined as a positive rotational speed set point 1->0: Stop with braking acceleration according to jogging position block
9*	Jogging 2 on / jogging 2 off	0->1: Movement speed from the jogging position dataset is defined as a negative rotational speed set point 1->0: Stop with braking acceleration according to jogging position block
10	Control via the PLC / No control via the PLC	1: Control word 1 is evaluated 0: Control word 1 is not evaluated
11*	Device-specific	Free
12-15	Device-specific	Free

*: Alternative meanings in other operating modes

Table 9.1: Control word 1 for the speed control operating mode

Bit	Control word 1 in the positioning operating mode	
	Meaning	**Behaviour**
0	ON / OFF (OFF 1)	see the Device Control section, *Chapter 9.4 Status diagram and device control*
1	No coast stop (no OFF 2) / coast stop (OFF 2)	
2	No quick stop (no OFF 3) / quick stop (OFF 3)	
3	Enable operation / Disable operation	
4*	Do not cancel queued movement task / Cancel queued movement task	0: interrupt ongoing positioning, i.e. do not start a positioning 1: no action
5*	No intermediate stop / Intermediate stop	0: No action, i.e. do not start a positioning 0->1: Acceleration according to current position block returned to movement speed 1: No action 1->0: Stop with braking acceleration according to current position block
6*	Flank: Activate movement task***	Manufacturer-specific implementation 0->1: Start the positioning according to the set position dataset when boundary conditions met
7	Error acknowledgement (flank 0->1)	Invoke error acknowledgement
8*	Jogging 1 on / jogging 1 off	Manufacturer-specific implementation 0->1: Start positioning according to jogging position block in positive direction 1->0: Stop with braking acceleration according to jogging position block
9*	Jogging 2 on / jogging 2 off	Manufacturer-specific implementation 0->1: Start positioning according to jogging position block in negative direction 1->0: Stop with braking acceleration according to jogging position block
10	Control via the PLC / No control via the PLC	1: Control word 1 is evaluated 0: Control word 1 is not evaluated
11*	Start / stop reference run	1: (No action) resume reference run 1->0: Reference run still active: Reference run aborted without error, reference run already finished No action 0: No action 0->1: Start the reference run
12**	Relative / absolute	At the start of a positioning 1: Relative positioning 0: Absolute positioning

Bit	Control word 1 in the positioning operating mode	
	Meaning	Behaviour
13**	Interrupt ongoing positioning / add	At the start of a positioning 1: Interrupt current positioning, restart immediately 0: Add positioning at end of ongoing positioning
14-15	Device-specific	

*: Alternative meanings in other operating modes
**: Manufacturer-specific bit
***: Manufacturer-specific deviations from the PROFIdrive specification

Table 9.2: Control word 1 for the positioning operating mode

Information on table 9.2:

1): The command “Activate movement task” starts the position block selected via PNU 1002 0. If the PROFIBUS position block is started then the current options from control word 1 are adopted. Otherwise, the options of the respective position set become effective.

2): The following boundary conditions are applicable to the start of a positioning:

- Bit 4 = 1 (Do not cancel movement task)
- Bit 5 = 1 (No intermediate stop)
- No reference movement is active

3): The parameterizable options are taken into consideration, e.g. ”With follow-on positioning”.

The device control is described in chapter *9.4 Status diagram and device control*

The servo positioning regulator accepts different states between which defined transitions can be executed. These transitions are triggered by so-called commands via the bits 0..3. The commands are described in more detail in Chapter *9.4 Status diagram and device control*

They are presented in the following table for overview:

Command:	Bit 3	Bit 2	Bit 1	Bit 0	State transitions
	0008_h	0004_h	0002_h	0001_h	
OFF	×	**1**	**1**	**0**	1, 5, 11
ON	×	**1**	**1**	**1**	2
Coast Stop	×	×	**0**	×	6, 7, 8
Quick Stop	×	**0**	**1**	×	9, 10, 12
Disable Operation	**0**	**1**	**1**	**1**	4
Enable Operation	**1**	**1**	**1**	**1**	3

Table 9.3: Overview of all commands (x = not relevant)

Since certain changes in status require a certain period of time, all the status changes activated through **Control word 1** must be read back through the **Status word 1**. Only when the required status can be read in **Status word 1** as well may another command be written through the **Control word 1**.

9.3 Status word 1

Different equipment statuses are reflected with the **Status word 1**, e.g. an active regulator release. Individual bits have the corresponding meaning for the same. This is described in detail in Section *9.4, Status diagram and device control*
Here, the meaning of individual bits is based on the profile PROFIdrive. Some functions are also executed specific to the manufacturer and some bits are defined with manufacturer-specific functionality.

PNU	**968**
Subindex	**0**
Name	Status word 1
Data type	UINT16
Access	ro
Unit	-
Value range	-
Default value	-

In the response telegram 0 and 1, the Status word 1 is located at a fixed position.

A series of bits has different meanings depending upon the operating mode. The following two tables list the meanings for the two operating modes.

Bit	Status word 1 in the speed control operating mode	
	Meaning	Implementation
0	1: Ready To Switch On 0: Not Ready To Switch On	see the Device Control section, *Chapter 9.4 Status diagram and device control*
1	1: Ready To Operate 0: Not Ready To Operate	
2	1: Operation Enabled 0: Operation Disabled	
3	1: Fault Present 0: No Fault Present	1: Active error 0: No active error
4	1: No OFF2 0: OFF2	1: No OFF2 command active 0: OFF2 command (Control word 1, end stage off) active
5	1: No OFF3 0: OFF3	1: No OFF3 command active 0: OFF3 command (Control word 1, Quick stop) active
6	1: Switching On Inhibited 0: Switching On Not Inhibited	1: The servo positioning regulator has completed its self-test. PROFIBUS communication is possible. 0: The servo positioning regulator has not completed its self-test. PROFIBUS communication is not possible.
7	1: Warning Present 0: No Warning Present	1: Active warning and/or set point lock via limit switch in at least one rotation direction 0: No active warning
8*	1: Rotational speed error within tolerance 0: Rotational speed error outside tolerance	1: The actual rotational speed is within the parameterizable message window around the set point rotational speed 0: The actual rotational speed is outside the parameterizable message window around the set point rotational speed
9	1: Control via the PLC 0: No control via the PLC	Mirroring of bit 10 from Control word 1
10*	1: f or n has been reached 0: f or n has not been reached	1: Actual speed > freely parameterizable reference rotational speed[1)] 0: Actual speed < freely parameterizable reference rotational speed[1)]
11-13*	Device-specific	Free
14-15	Device-specific	Free

*: Alternative meaning in other operating modes.

Table 9.4: Status word 1 for the speed control operating mode

[1)]: This comparison is always done taking into consideration the prefixed sign, and therefore not the value of actual rotational speed or reference rotational speed.

Bit	Status word 1 in the positioning operating mode	
	Meaning	Implementation
0	1: Ready To Switch On 0: Not Ready To Switch On	see the Device Control section, *Chapter 9.4 Status diagram and device control*
1	1: Ready To Operate 0: Not Ready To Operate	
2	1: Operation Enabled 0: Operation Disabled	
3	1: Fault Present 0: No Fault Present	1: Active error 0: No active error
4	1: No OFF2 0: OFF2	1: No OFF2 command active 0: OFF2 command (Control word 1, end stage off) active
5	1: No OFF3 0: OFF3	1: No OFF3 command active 0: OFF3 command (Control word 1, Quick stop) active
6	1: Switching On Inhibited 0: Switching On Not Inhibited	1: The servo positioning regulator has completed its self-test. PROFIBUS communication is possible. 0: The servo positioning regulator has not completed its self-test. PROFIBUS communication is not possible.
7	1: Warning Present 0: No Warning Present	1: Active warning and/or set point lock via limit switch in at least one rotation direction 0: No active warning
8*	1: Contouring error within tolerance 0: Contouring error outside tolerance	1: No contouring error 0: Contouring error message active
9	1: Control via the PLC 0: No control via the PLC	Mirroring of bit 10 from Control word 1
10*	1: Target position reached and within target window 0: Not in target window	1: The ongoing positioning is finished and the actual position is within the target window 0: The ongoing positioning is still active or the actual position is outside the target window
11*	1: Reference position valid 0: Reference position invalid	1: A reference run has been completed successfully 0: No reference run has been conducted or the position data is invalid due to an error
12*	Traversing Task Acknowledge	1: Controller accepts a new movement task 0: Movement task completed
13*	1: Drive stopped 0: Drive in movement	1: Actual rotational speed within fixed tolerance window around 0 and no positioning active, i.e. intermediate stop active 0: Actual rotational speed outside the tolerance window around 0, i.e. above conditions not met
14-15	Device-specific	Free

*: Alternative meanings in other operating modes

Table 9.5: Status word 1 for the positioning operating mode

Just as different status transitions can be activated by the combination of a number of bits of the **Control word 1**, it is also possible to read, from the combination of different bits of the **Status word 1,** the status in which the servo positioning regulator is to be found. The following table lists the possible states of the status diagram as well as the relevant bit combination, with which it is displayed in the **Status word 1**.

Status	Bit 6	Bit 2	Bit 1	Bit 0	Screen	Value
	0040_h	0004_h	0002_h	0001_h		
SWITCH_ON_INHIBITED	1	0	0	0	0047_h	0040_h
READY_FOR_SWITCHING_ON	0	0	0	1	0047_h	0001_h
SWITCHED_ON	0	0	1	1	0047_h	0003_h
OPERATION	0	1	1	1	0047_h	0007_h

Table 9.6: Device status

Bits 4 and 5 depend upon the command and are therefore not listed at all in Table 9.6 or are suppressed in the screen.

9.4 Status diagram and device control

This chapter describes how the servo positioning regulator SE-48 can be controlled with the help of both the data words Control word 1 (PNU 967) and Status word 1 (PNU 968), and how, e.g., the output stage is switched on. This takes place based on the specification of the profile PROFIdrive. The following terms are used for explanation:

Status: (State)
Depending on whether the output stage is switched on, for example, or whether a fault has occurred, the servo positioning regulator is in different states. The states defined under the PROFIdrive are described in the course of this chapter.
Example: **SWITCHING_ON_INHIBITED**

Status transition (State Transition)
Like the states themselves, the transitions between the individual states are defined under the PROFIdrive, i.e. how one gets from one status to another. State transitions are activated by the master by setting bits in **Control word 1** or internally by the servo positioning regulator, when it recognizes a fault, for example.

Command (Command)
Specific combinations of bits must be set in **Control word 1** for activating status transitions. Such a combination is called a Command .
Example: **Enable Operation**

Status diagram (State Diagram)
The states and the state transitions together make up the status diagram that is the overview of all statuses and the respective possible transitions.

9.4.1 Status diagram

The statuses have been adopted to a great extent from the PROFIdrive specification. PROFIdrive differentiates between the Ramp stop and Quick stop. The regulator release is uniformly switched off, so that the simplified status diagram according to Figure 9.1 is obtained.
After being switched on, the servo positioning regulator initialises itself and then achieves the status **SWITCHING_ON_INHIBITED**. The end stage is deactivated and the motor shaft can be turned freely, as long as the motor is not fitted with a parking brake. The status **OPERATION** can be reached through the status transitions **1**, **2** and **3**. This corresponds to the regulator release through PROFIBUS. In this state the end stage is turned on and the drive is regulated according to the set operating mode. Therefore it is absolutely necessary to ensure beforehand that the correct parameters have been set for the servo positioning regulator and a corresponding set value is equal to zero.

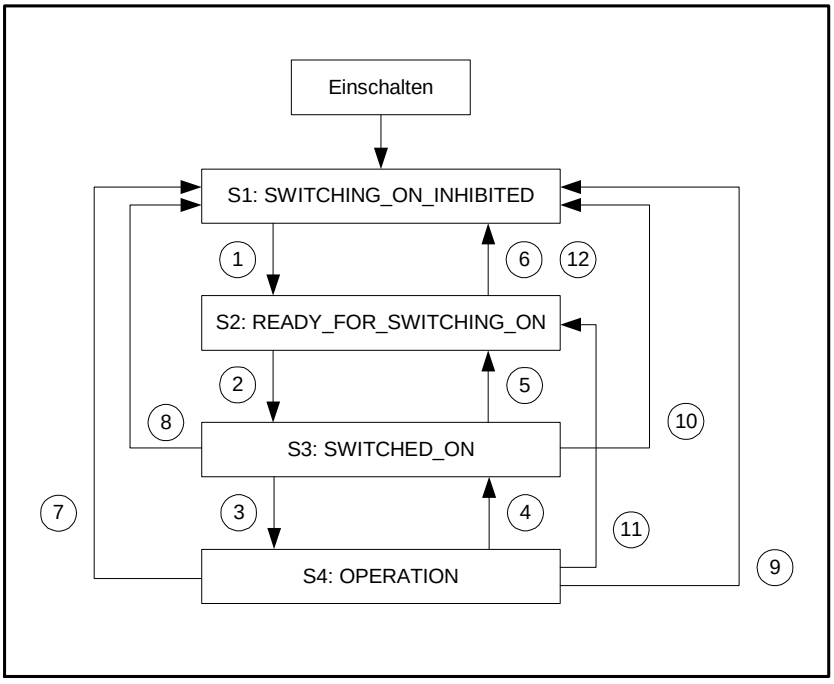


Figure 9.1: Simplified status diagram

The status transition **4** corresponds, for example, to the withdrawal of the regulator release, i.e. a running motor is controlled according to the set emergency stop ramp and braked to a standstill. The status transition **7** corresponds to cancelling the output stage release, i.e. a running motor would trundle on out of control.

If a fault occurs then (irrespective of from which status) there is a move into the status **SWITCHING_ON_INHIBITED**. Depending on the severity of the fault, specific actions like emergency braking can be executed beforehand.

All statuses and their meanings are listed in the following table:

	Meaning
Switch on	The servo positioning regulator conducts a self-test. The PROFIBUS-communication does not work yet.
SWITCHING_ON_INHIBITED	The servo positioning regulator has completed its self-test. PROFIBUS communication is possible.
READY_FOR_SWITCHING_ON	The servo positioning regulator waits until the digital input “Regulator release” is on 24 V. (Regulator release logic “DIN9 and Profibus”).
SWITCHED_ON	The regulator release is assigned.
OPERATION	The motor has power and is controlled according to the operating mode.

9.4.2 Device control

*Certain bit combinations must be set in **Control word 1** (see below) in order to be able to execute the status transitions represented in Chapter 9.4.1* Status diagram

The lower 4 bits of the **Control word 1** are evaluated together to trigger a status transition. Only the most important state transitions 1, 2, 3, 4, 7 and 11 are explained below at first. A table of all possible statuses and status transitions can be found in chapter *9.4.3 Overview of commands.*

The following table contains the desired status transition in the 1st column and the prerequisites necessary for this in the 2nd column (mostly a command from the host, depicted here with a frame). How this command is generated, i.e. which bits are to be set in **Control word 1**, can be seen in the 3rd column (x = not relevant). Bit 10 in **Control word 1** is always to be set for controlling the servo positioning regulator. After the completion of the status transition, the new status is recognized in **Status word 1** by evaluating the relevant bits. This is entered in the last column.

No.	Is carried out when	Bit combination Control word 1					Action	Status word 1[1)]
		Bit	3	2	1	0		
1	Regulator release active + no Coast Stop + no Quick Stop + command **OFF**	**OFF** =	x	1	1	0	None	0x0201
2	Command **ON**	**ON** =	0	1	1	1		0x0203
3	Command **Enable Operation**	**Enable Operation** =	1	1	1	1	Switches on the output stage release and regulation according to the	0x0207

No.	Is carried out when	Bit combination Control word 1					Action	Status word 1[1)]
		Bit	3	2	1	0		
							set operating mode	
4	Command **Disable Operation**	**Disable Operation** =	**0**	**1**	**1**	**1**	Withdrawal of the regulator release	0x0203
11	Command **OFF**	**OFF** =	**x**	**1**	**1**	**0**	Withdrawal of the regulator release	0x0201
7	Command **Coast Stop**	**Coast Stop** =	**x**	**x**	**0**	**x**	Output stage is locked. Motor comes to a standstill and can be turned freely.	0x0250 i.e. 0x0270

1): After completion of the state transition the screen for the relevant bits is 0x0277.

Table 9.7: Important state transitions of the servo positioning regulator

There is an example given below to show e.g. the release of the servo positioning regulator, i.e. to assign the regulator release through the fieldbus PROFIBUS:

EXAMPLE

The servo positioning regulator is to be “released”, i.e. output stage and regulator release activated via PROFIBUS:

1.) The servo positioning regulator is in the state **SWITCH_ON_INHIBITED**

2.) The servo positioning regulator is to be switched to the status **OPERATION**

3.) The transitions 1, 2 and 3 are to be carried out according to the status diagram Figure 9.1

4.) From table 9.7 it follows

Transition 1	**Control word 1 = 0406_h**	**New status: READY_FOR_SWITCHING_ON *[1)]** **Status word 1 = 0x0201**
Transition 2	**Control word 1 = 0407_h**	**New status: SWITCHED_ON *[1)]** **Status word 1 = 0x0203**
Transition 3	**Control word 1 = $040F_h$**	**New status: OPERATION *[1)]** **Status word 1 = 0x0207**

Notes:

1.) The example assumes that no further bits have been set in **Control word 1**. Bit 10 must be set, otherwise only bits 0..3 are relevant for the transition.

*1) The master must wait until the status in **Status word 1** can be read back in the relevant bits (screen = 0x0277). This is described in more detail later below.

9.4.3 Command overview

The following table lists all the commands according to the state transitions listed in *chapter 9.4.1*

No.	Is carried out when	Bit combination Control word 1					Action	Status word 1[1)]
		Bit	3	2	1	0		
1	Regulator release active + no Coast Stop + no Quick Stop + command **OFF**	**OFF** =	**x**	**1**	**1**	**0**	None	0x0201
2	Command **ON**	**ON** =	**0**	**1**	**1**	**1**		0x0203
3	Command **Enable Operation**	**Enable Operation** =	**1**	**1**	**1**	**1**	Switches on the output stage release regulation according to the set operating mode	0x0207
4	Command **Disable Operation**	**Disable Operation** =	**0**	**1**	**1**	**1**	Withdrawal of the regulator release	0x0203
5	Command **OFF**	**OFF** =	**x**	**1**	**1**	**0**	Withdrawal of the regulator release	0x0201
6	Command **Coast Stop**	**Coast Stop** =	**x**	**x**	**0**	**x**	None	0x0250 i.e. 0x0270
7	Command **Coast Stop**	**Coast Stop** =	**x**	**x**	**0**	**x**	Output stage is locked. Motor comes to a standstill and can be turned freely.	0x0250 i.e. 0x0270
8	Command **Coast Stop**	**Coast Stop** =	**x**	**x**	**0**	**x**	Withdrawal of output stage release	0x0250 i.e. 0x0270
9	Command **Quick Stop**	**Quick Stop** =	**x**	**0**	**1**	**x**	Withdrawal of the regulator release	0x0260
10	Command **Quick Stop**	**Quick Stop** =	**x**	**0**	**1**	**x**	Withdrawal of the regulator	0x0260

No.	Is carried out when	Bit combination Control word 1					Action	Status word 1[1)]
		Bit	3	2	1	0		
							release	
11	Command **OFF**	**OFF** =	**x**	**1**	**1**	**0**	Withdrawal of the regulator release	0x0201
12	Command **Quick Stop**	**Quick Stop** =	**x**	**0**	**1**	**x**	Withdrawal of the regulator release	0x0260

[1)]: After completion of the state transition the screen for the relevant bits is 0x0277.

Table 9.8: Overview of all the state transitions of the servo positioning regulator

Output stage locked...

...means that the power transistors are not activated any more. **If this status is accepted for a running motor, it spins on without braking.** A mechanical motor brake, if available, is automatically activated here.

Careful: The signal does not guarantee that the motor is really at zero potential.

Output stage released...

...means that the motor is activated and controlled according to the selected operating mode. Any existing mechanical motor brake is automatically disengaged. In case of a defect or a faulty parameter setting (motor current, number of poles, resolver offset angle etc.), uncontrolled behaviour of the drive can occur.

10 Manufacturer-specific parameter numbers

10.1 Overview

The following table provides an overview of the currently implemented PNUs:

PNU	Sub-index	Beschreibung	Typ	Zugriff
1000	0	Position set number (Read/Write)	UINT16	rw
1001	-	(Position Data)		
	0	Target position	INT32	rw
	1	Movement speed	INT32	rw
	3	Acceleration (positioning)	UINT32	rw
	4	Braking acceleration (positioning)	UINT32	rw
	5	Acceleration and braking acceleration (positioning)	UINT32	rw
1002	0	Position set number for starting	UINT8	rw
1003	0	Type of positioning profile	INT16	rw
1010	0	Set point of rotational speed	INT32	rw
1011	-	(Accelerations for velocity regulation)		
	0	Acceleration control (rotational speed regulation)	UINT32	rw
	1	Braking acceleration (rotational speed regulation)	UINT32	rw
	2	Acceleration and braking acceleration (rotational speed regulation)	UINT32	rw
1022	-	(Current limiting)		
	0	Selector for current limiting	INT8	rw
	1	Writing/reading of set point for current limiting	INT32	rw
1040	-	(Jogging)		
	0	Jogging speed (symmetrical)	INT32	rw
	1	Jogging acceleration (symmetrical)	UINT32	rw
1050	0	Reference run method	INT8	rw
1051	0	Offset reference position	INT32	rw
1100	0	Actual position	INT32	ro
1101	0	Rotational speed actual value	INT32	ro
1102	0	Active current actual value	INT32	ro
1140	0	Digital outputs	UINT32	rw
1141	0	Status of the digital inputs	UINT32	ro
1500	0	Controller intermediate circuit voltage	UINT32	ro
1160	0	Power section temperature in ℃	INT16	ro
1290	-	(Motor data)		
	0	Motor IIt time in ms	UINT16	rw

PNU	Sub-index	Beschreibung	Typ	Zugriff
	1	Actual load of the IIt limiting	UINT16	ro
1350	0	Logic of controller release	UINT16	rw
1500	0	Operating mode	UINT8	ro
1601	-	(Fault number)		
	0	Fault number low	UINT32	ro
	1	Fault number high	UINT32	ro
1610	-	(Fault management)		
	0	Fault number	UINT8	rw
	1	Fault reaction	UINT8	rw
2000	0	Entry for manufacturer-specific parameter ID value access	2 * UINT32	rw
2010	-	(Placeholder)		
	0	8 bit placeholder (empty element)	UINT8	rw
	1	16 bit placeholder (empty element)	UINT16	rw
	2	32 bit placeholder (empty element)	UINT32	rw
2011	0	32 bit placeholder (empty element)	UINT32	rw

10.2 PNUs for the operating mode Positioning

The parameters required for the operating mode Positioning are described in this section.

10.2.1 PNU 1000: Position Set Number

The positioning data set, in which the data transmitted through PROFIBUS is entered, can be selected through these parameters. These parameters can be used to access all position data sets of the servo positioning regulator. Fieldbus data sets are frequently designed as volatile data sets. The position data set for PROFIBUS can also be saved and the parameters can be set using the parameterizing program SE-48SE-Commander™. This can be used to pre-specify certain parameters in an application, which are not required to be changed during the operation. For example, the accelerations can be entered once and then need not be transmitted.

PNU	**1000**
Subindex	**0**
Name	Position Set Number
Data type	UINT16
Access	rw
Unit	-
Value range	0...68 0..63: Standard position data sets 64...67: reserved 68: PROFIBUS position data set
Default value	68 (PROFIBUS position data set)

10.2.2 PNU 1001: Position Data

Parameters of the selected position data sets can be addressed by using these parameter numbers. The selection is made using PNU 1000. The following parameters are available:

- Target position
- Movement speed
- End speed
- Acceleration and braking acceleration, each individually or as combination for both the accelerations

The data is interpreted according to the set physical unit. The parameterizing software SE-48SE-Commander™ provides a corresponding window see *Chapter 7 Physical units.*

PNU	**1001**
Name	Position data

Subindex	**0**
Name	Target position
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS position
Value range	-
Default value	0

Subindex	**1**
Name	Profile velocity (movement speed)
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS speed
Value range	-
Default value	1000 rpm

Subindex	**3**
Name	Acceleration positioning (acceleration ramp positioning)
Data type	UINT32
Access	rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	10,000 (rpm)/s

Subindex	**4**
Name	Decceleration positioning (acceleration ramp positioning)
Data type	UINT32
Access	rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	10,000 (rpm)/s

The parameter **All Accelerations Positioning** allows access to the acceleration and braking ramps. In case both the parameters should have the same value, only one data value must be transmitted. It is then written internally on both accelerations. It must be ensured that while reading, only the current value of the acceleration ramp is read at all times. The user must himself ensure, if necessary, that the reading of a value is sufficient. This can be achieved, for example, by reading once and then subsequently rewriting this value again.

Subindex	**5**
Name	All Accelerations Positioning (acceleration and braking acceleration for positioning)
Data type	UINT32
Access	rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	10,000 (rpm)/s

10.2.3 Start Set Number

The position data set, which is started through the Control word 1 upon a start command for positioning can be selected using these parameters. The servo positioning regulator has 64 storable standard position data sets. These can be uniquely selected through 8 bits.

PNU	**1002**
Subindex	**0**
Name	Start set number
Data type	UINT8
Access	rw
Unit	-

PNU	**1002**
Value range	0...68 0..63: Standard position data sets 64...67: reserved 68: PROFIBUS position data set
Default value	68 (PROFIBUS position data set)

10.2.4 PNU 1003: Position Profile Type

This parameter activates the jerk-limited ramp. The time itself cannot be parameterized. On activation the time is automatically set to the maximum.
If the time is altered using the parameterizing software SE-48SE-Commander™, the value read back via the PROFIBUS delivers the value 2.

PNU	**1003**	
Subindex	**0**	
Name	Position Profile Type	
Data type	UINT16	
Access	rw	
Unit	-	
Value range	0, 2	
	0:	Jerk-limited ramp is turned off
	2:	Jerk-limited ramp is active, the maximum time is parameterized
Default value	0	

10.2.5 PNU 1050: Homing Method

This parameter number sets the reference run method. A detailed description of the methods can be found in the SE-48 user manual.

PNU	**1050**
Subindex	**0**
Name	Homing Method
Data type	INT8
Access	rw
Unit	-
Value range	see the SE-48 servo positioning regulator user manual
Default value	1

10.2.6 PNU 1051: Home Offset

This parameter number indicates the distance of the reference position (zero position) to the reference point of a reference run. Positive values shift the zero point in the positive direction relative to the reference point. The following picture illustrates this using an example for the target “limit switch” and the reference point index signal. The direction of the arrows also indicate the direction of action for the offset.

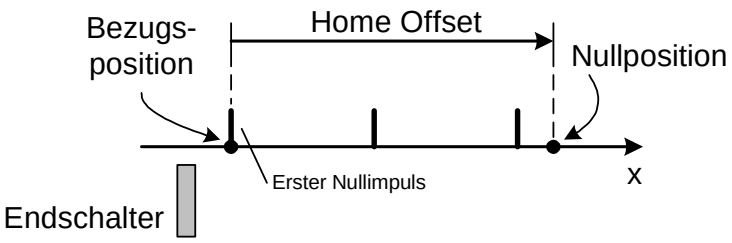


Figure 10.1: Interpretation of the Home offset

The data is interpreted in the same manner in which it is set as a physical unit. The parameterizing software SE-48SE-Commander™ provides a corresponding window for this purpose.

PNU	**1051**
Subindex	**0**
Name	Home Offset
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS position
Value range	-
Default value	0

10.3 PNUs for Operating Mode Rotational speed regulation

The parameters required for the operating mode rotational speed regulation are described in this section.

10.3.1 PNU 1010: Target Velocity

The set value of the rotational speed is set through the PROFIBUS using these parameters. In the operating mode rotational speed regulation the selector “Rotational speed set value” is automatically selected.

PNU	**1010**
Subindex	**0**
Name	Target Velocity
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS speed
Value range	-
Default value	0

10.3.2 PNU 1011: Accelerations for Velocity control

The acceleration values for the operating mode Rotational speed control can be parameterized with this parameter number. The servo positioning regulator defines 4 different acceleration ramps. Since in most of the application cases, multiple ramps have the same parameter settings the following selection is available:

- Acceleration, combined for positive and negative direction of rotation
- Braking acceleration, combined for positive and negative direction of rotation
- Combination for acceleration and braking acceleration for positive and negative direction of rotation

The data is interpreted according to the set physical unit. The parameterizing software SE-48SE-Commander™ provides a corresponding window see *Chapter 7 Physical units.*

The parameter with the sub-index 0 and 1 allows access to the acceleration for both directions of rotation respectively. Internally, this is always written for the acceleration for both directions of rotation. It must be noted that while reading, only the current value of the acceleration ramp for positive direction of rotation is always read. The user must himself ensure, if necessary, that the reading of a value is sufficient. This can be achieved, for example, by reading once and then subsequently rewriting this value again.

PNU	**1011**
Name	Accelerations for Velocity Control

Subindex	**0**
Name	Acceleration Velocity Control (acceleration ramp rotational speed regulation)
Data type	UINT32
Access	rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	10,000 (rpm)/s

Subindex	**1**
Name	Deceleration Velocity Control (braking ramp rotational speed regulation)
Data type	UINT32
Access	rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	10,000 (rpm)/s

The parameter **All Accelerations Velocity Control** allows the access to acceleration and braking ramps for both directions of rotation. In case all 4 parameters should have the same value, only one data value must be transmitted. It is then written internally on all 4 accelerations. It must be noted that while reading, only the current value of the acceleration ramp for positive direction of rotation is always read. The user must himself ensure, if necessary, that the reading of a value is sufficient. This can be achieved, for example, by reading once and then subsequently rewriting this value again.

Subindex	**2**
Name	All Accelerations Velocity Control (acceleration and braking acceleration for rotational speed regulation)
Data type	UINT32
Access	rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	10,000 (rpm)/s

10.4 PNUs for different operating modes

In this chapter the parameters that are not assigned to any specific operating mode are described. They are valid in different operating modes.

10.4.1 PNU 1022: Current Limitation

With the parameter group **Current Limitation** the torque limiting can be set, independent of the operating mode.

Via the **Limit Current Input Channel** parameter, the set value source of the limiting torque is defined. Two options are available, the presetting of a direct set value (RS232 or Profibus) or the presetting via an analog input.

Via the **Limit Current** parameter, either the limiting torque or the scaling factor for the analog inputs is defined, depending on the selected source.

- In the first case the limiting is applied directly to the torque proportional current in mA.

- In the second case the current in mA is given which should correspond to an applied voltage of 10V.

PNU	**1022**
Name	Current Limitation

Subindex	**0**
Name	Limit Current Input Channel
Data type	INT8
Access	rw
Unit	-
Value range	0...3, 7
Default value	0

Value	Meaning
0	**No limit**
1	**AIN0**
2	**AIN1**
3	**RS232**
7	**Profibus**

Subindex	**1**
Name	Limit Current
Data type	INT32
Access	rw
Unit	mA
Value range	0...40 A
Default value	--

10.4.2 PNU 1040: Jogging

Using this parameter number the jogging speed and the acceleration value for the jogging can be accessed in simplified form. As a result, in a cyclical data telegram less data needs to be transmitted. However internally each respective parameter is written.

PNU	**1040**
Name	Jogging

Subindex	**0**
Name	Jogging Velocity
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS speed
Value range	-
Default value	100 rpm

Subindex	**1**
Name	Symmetrical Jogging Accelerations
Data type	UINT32
Access	rw The read access delivers the value for the acceleration
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	10,000 (rpm)/s

10.4.3 PNU 1290: Motor Data

As a rule, servo motors may be overloaded for a specific period of time. The **iit Time Motor** parameter defines how long the connected motor may be energized with the set maximum current. Following the iit time, the current is automatically reduced to the parameterised nominal current in order to protect the motor. The standard setting is two seconds and is applicable to the majority of motors.

Via the **iit Ratio Motor** parameter the current load of the I2t-limiting can be read off in units of one tenth of a percent.

PNU	**1290**
Name	Motor Data

Subindex	**0**
Name	iit Time Motor
Data type	UINT16
Access	rw
Unit	ms
Value range	0...10000
Default value	2000

Subindex	**1**
Name	iit Ratio Motor
Data type	UINT16
Access	ro
Unit	Tenths of one percent
Value range	-
Default value	-

10.4.4 PNU 1350: Enable Logic

The **enable_logic** parameter defines how the regulator release is to be conducted.

PNU	**1350**
Subindex	**0**
Name	Enable Logic
Data type	UINT16
Access	rw
Unit	-
Value range	0...3

PNU	**1350**
Default value	0

Value	Meaning
0	Regulator release via digital input DIN 9
1	Regulator release via digital input DIN 9 + RS232
2	Regulator release via digital input DIN 9 + CAN
3	Regulator release via digital input DIN 9 + Profibus

10.5 Actual values

The actual values, which can be read through the parameter numbers, are listed in this section.

10.5.1 PNU 1100: Position Actual Value

The actual value of the position is returned in this parameter. It is scaled in the physical unit set for PROFIBUS. The actual position value, determined by the physical units, can result in a value larger than the PNU 1100 can show.

PNU	**1100**
Subindex	**0**
Name	Position Actual Value
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS position
Value range	-
Default value	-

10.5.2 PNU 1101: Velocity Actual Value

The actual value of rotational speed is returned through these parameters. It is scaled in the physical unit set for PROFIBUS.

PNU	**1101**
Subindex	**0**
Name	Velocity Actual Value
Data type	INT32
Access	ro
Unit	Physical unit PROFIBUS speed

PNU	**1101**
Value range	-
Default value	-

10.5.3 PNU 1102: Current Actual Value

The actual value of active current is returned through these parameters. It is returned with reference to the nominal current of the motor.

PNU	**1102**
Subindex	**0**
Name	Current Actual Value
Data type	INT32
Access	ro
Unit	Tenths of one percent with reference to the motor's nominal current
Value range	-
Default value	-

10.5.4 PNU 1140: Digital Outputs

Via the **Digital Outputs** parameter, the digital outputs can be activated. It should be noted that when activating the digital outputs, a delay of up to 10 ms can occur. When the outputs have really been set can be established by reading back the parameter.

PNU	**1140**
Subindex	**0**
Name	Digital Outputs
Data type	UINT32
Access	rw
Unit	-
Value range	-
Default value	0

Bit	Value	Digital output
0	00000001h	Parking brake (read only)
0...15		reserved
16	00010000h	Operational (read only)
17,18	00060000h	DOUT1, DOUT2

10.5.5 PNU 1141: Digital Inputs

The state of the digital inputs is read through these parameters. The available digital inputs depend on the parameterization of the servo positioning regulator.

PNU	**1141**
Subindex	**0**
Name	Digital Inputs
Data type	UINT32
Access	ro
Unit	-
Value range	-
Default value	-

Bit	Value	Digital output
0	00000001h	Negative limit switch (DIN7)
2	00000002h	Positive limit switch (DIN8)
3	00000008h	Interlock (controller release (DIN9) missing)
16...25	03FF0000h	DIN0...DIN9

10.6 Parameter for the construction of the telegram

Some parameters cannot be located at any desired address in the memory area of the master owing to certain technical requirements. Furthermore, different telegrams can have different lengths, in spite of which the same amount of data is transferred every time. Therefore, parameters are defined for filling up gaps, for example.

10.6.1 PNU 2000: Parameter ID value Access

This parameter number must be entered into a telegram in order to have variable access to different parameters during the running time. A maximum of one access can be realised in the receipt and response telegrams. This needs to be parameterized accordingly by the user. The user must ensure that this is entered in all the receipt and response telegrams employed.

The term parameter ID value is defined in an earlier version of the PROFIdrive norm. However in that version the value range for the parameter number was restricted. Here the access has been expanded to include higher parameter numbers.

PNU	**2000**	
Subindex	**0**	
Name	Parameter ID value access (manufacturer-specific parameter ID value access)	
Data type	2 * UINT32 (8 Byte)	
Access	rw	
Unit	-	
Value range	Byte 0:	Type of access 0x00: No access 0x41: Read access 0x42: Write access remaining values reserved
	Byte 1..2:	Parameter number
	Byte 3:	Subindex
	Byte 4.0.7:	Data
Default value	0	

10.6.2 PNU 2010: Placeholder

These parameters allow the filling of parameters. In this manner, it becomes possible to create data areas (e.g. data components) in such a manner that parameters of a length with 2 bytes or 4 bytes can be located at even storage addresses.

PNU	**2010**
Name	Placeholder

Subindex	**0**
Name	8 bit
Data type	UINT8
Access	rw
Unit	-
Value range	-
Default value	0

Subindex	**1**
Name	16 bit
Data type	UINT16
Access	rw
Unit	-
Value range	-
Default value	0

Subindex	**2**
Name	32 bit
Data type	UINT32
Access	rw
Unit	-
Value range	-
Default value	0

10.6.3 PNU 2011: Element 0

This parameter behaves identically to the parameter with the PNU 2010 2. The difference is in the fact that it is not depicted in the telegram editor of the SE-48SE-Commander™, if it is entered at the end of a telegram. The number of entries in one telegram is limited to a fixed number 10. Entries that are not required therefore receive this PNU.

PNU	**2011**
Subindex	**0**
Name	Element 0
Data type	UNT32
Access	rw
Unit	-
Value range	-
Default value	0

10.7 Parameters for different purposes

This chapter contains parameters that are not allocated to any specific functional group.

10.7.1 PNU 1601: Error Code

The parameters **Error Field 0** and **Error Field 1** can be used to read off the queued errors.

PNU	**1601**
Name	Error Code

Subindex	**0**
Name	Error Field 0
Data type	UINT32
Access	ro
Unit	-
Value range	See SE-48 user manual
Default value	-

Subindex	**1**
Name	Error Field 1
Data type	UINT32
Access	ro
Unit	-
Value range	See SE-48 user manual
Default value	-

10.7.2 PNU 1610: Error Management

The parameter **Error Number** indicates the error number which can be found under “Error Management” in the SE-48SE-Commander™.

The parameter **Error Reaction Code** indicates how the servo positioning regulator reacts to different events.

PNU	**1610**
Name	Error Management

Subindex	**0**
Name	Error Number
Data type	UINT8
Access	rw
Unit	-
Value range	1..64
Default value	-

Subindex	**1**
Name	Error Reaction Code
Data type	UINT8
Access	rw
Unit	-
Value range	0x00, 0x03, 0x05, 0x08
Default value	-

Value	Meaning
0x00:	No action
0x03	Warning (display)
0x05	Braking with rapid stop ramp
0x08	Output stage off (motor comes to a standstill)

11 Operating modes

11.1 Overview

The servo positioning regulator SE-48 has, via PROFIBUS, 2 basic operating modes:

- ❖ Speed control
- ❖ Positioning

Within the operating modes, there is varying behaviour owing to the differently parameterizable set value selectors.

PROFIdrive (4) defines so-called Application classes. These can be set through a corresponding parameter number. For simplifying operation, the operating mode is linked to the cyclical receipt telegrams. Comparable with the PROFIdrive specification, first, the following operating modes with the corresponding receipt telegrams are being supported:

Operating mode	Receipt telegram	ID
Positioning	0	0xE0
Speed control	1	0xE1

It is not currently possible to select other operating modes.

11.2 Parameters

The operating mode is continuously monitored or selected through the receipt telegrams used. The procedure for changing the operating mode requires several cycles of an internal function. Therefore, a manufacturer-specific parameter number has been defined, to be able to read the current operating mode.

11.2.1 PNU 1500: Operating Mode

This manufacturer-specific parameter allows the setting/reading of the operating mode. The operating mode is run independently of the set value selectors. Other special features are described in the corresponding chapters.

PNU	**1500**
Subindex	**0**
Name	Operating Mode
Data type	UINT8
Access	rw
Unit	-
Value range	0x08: Rotational speed regulation 0x10: Positioning
Default value	-

11.3 Rotational speed regulation

PROFIdrive defines some special properties for the handling of the set value. For this purpose, the meanings of the corresponding bits are defined in Control word 1. For example, can the set value be deactivated, or the set value ramp be paused ("frozen").

11.4 Operating mode: Positioning

PROFIdrive defines some special properties for the behaviour in the operating mode Positioning. For this purpose, the meanings of the corresponding bits are defined in Control word 1. A reference movement controlled by the slave is, for example, started by a bit. In the following, reference is explicitly made to some properties:

- ❖ All the global options for the reference movement are also applicable upon starting a reference movement via the PROFIdrive Control word 1. An optional connection positioning to the zero position is carried out.
- ❖ The start of a positioning takes place on the basis of a manufacturer-specific implementation only on an ascending flank of the corresponding bit in the Control word 1.
- ❖ The start of a positioning also takes place when no successful reference movement has been carried out previously.

There are further manufacturer-specific bits defined in the Control word 1, to be optionally able to carry out relative or absolute positionings.

- ❖ Distinction between absolute and relative positioning
- ❖ Definition whether upon starting a positioning, an ongoing positioning, if any, should be interrupted, or whether the positioning to be started is appended immediately to the ongoing positioning.

In some applications, a continuous sequence of movement tasks has to be carried out, see Figure 11.1

- ❖ Interruption of an ongoing positioning

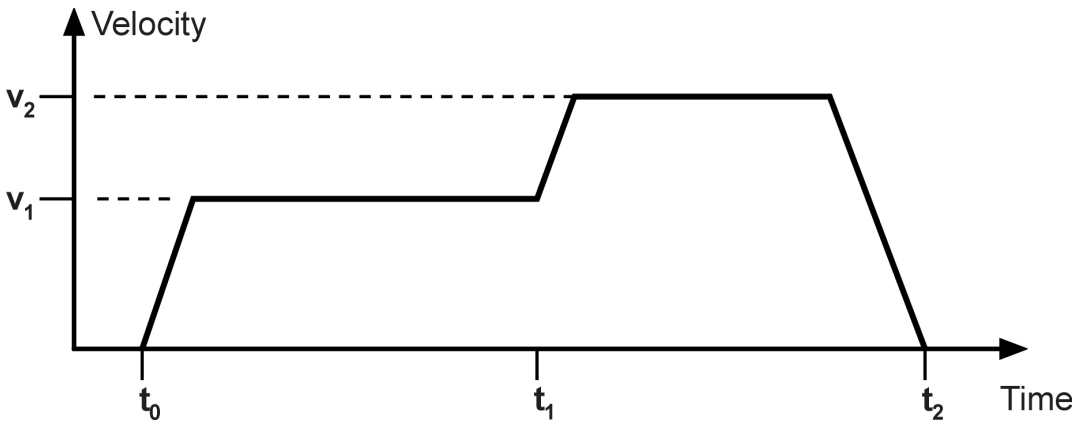


Figure 11.1: Continuous sequence of movement tasks

12 Profile-specific parameter numbers

This chapter provides an overview of the parameter numbers (PNU), which have been implemented based on PROFIdrive.

12.1 Overview

The following table provides an overview of the PNUs that are implemented.

PNU	Sub-index	Description	Type	Access
967	0	Control word 1, see *Chapter 9.2 Control word 1*	V2	rw
968	0	Status word 1, see *Chapter 9.3 Status word 1*	V2	ro
971	0	Save parameter	UINT16	rw

Note: The data type V2 is defined as a bit sequence with a length of 2 bytes.

12.2 Description of the PNUs

The PNUs 967 and 968 are described in detail in *Chapter 9 Device control*
PNU 971 is described in the following chapter.

12.2.1 PNU 971: Transfer into a non-volatile memory

Under this parameter number different saving actions for parameters in the servo positioning regulator can be activated.

PNU	**971**	
Subindex	**0**	
Name	Transfer into a non-volatile memory	
Data type	UINT16	
Access	rw	
Unit	-	
Value range	0:	No action
	1:	Saving the current parameter set and all position data sets
	2.. 65535:	reserved
Default value	0	

13.1 Overview

Function modules for the SE-48 have been specially written for use with Siemens PLC systems (SIMATIC-S7 controllers), which considerably simplify the integration of the servo positioning regulator in a PLC program with PROFIBUS functionality. The function and data modules (FB, DB) are each assigned to an operating mode.

In order to improve the understanding of the handling of the function modules corresponding example programs have been written.

This chapter is intended to give users a quick introduction to the function of the inputs and outputs as well as the handling of the FBs and DBs within the S7-world. **This chapter is not meant to replace the preceding chapters of the PROFIBUS DP user manual.**

The available sample programs are to be considered as samples only and represent the basic procedures for handling the function- and data modules.

While using the sample program in client-specific applications, the user must check whether all function-relevant and safety-relevant requirements have been fulfilled.

Information

Function and data modules were developed for the SE-48 servo positioning regulator. These are integrated in the example programs and are available on the internet at **www.Afag.de** for free download.

The change between the operating modes requires a switching over between two function modules. If the regulator release is not to be deactivated during the switch-over between two function modules, it is necessary to suitably modify the function modules as required. Please contact Technical Support in this case.

Attention

The switch-over between the operating modes requires the deactivation of the current FB and the changeover to an FB of another operating type. The regulator release is deactivated here if necessary.

13.2 Function and data modules for the servo positioning regulator SE-48

13.2.1 Overview of the function modules (FBs)

The function modules (FBs) are responsible for monitoring the status diagram implemented in the servo positioning regulator.

The current status of the servo positioning regulator is symbolized by the Status word 1 in the data module DB40 actual_value, byte 2/3. The Control word 1 serves to control the servo positioning regulator which is present in every telegram format (DB42, DB44) that is bound to the operating mode in bytes 2/3 and described by the FB.

The master connection provides the PLC with the input and output data of the servo positioning regulator in defined I/O areas. This data is read from the slave via the SFC14 and written together with the SCF15 to the slave. The SFCs 14 and 15 are system functions that **must** be employed for the consistent reading and writing of telegrams with lengths > 4 byte.

The data is transferred to the data modules defined for the operating mode via the corresponding SFCs. The SFCs are not integrated into the function modules and **must** be loaded as S7 program elements.

In practice the DBs serve as I/O modules that are employed for activating the states of the servo positioning regulator and for transferring data to be transmitted to the servo positioning regulator.

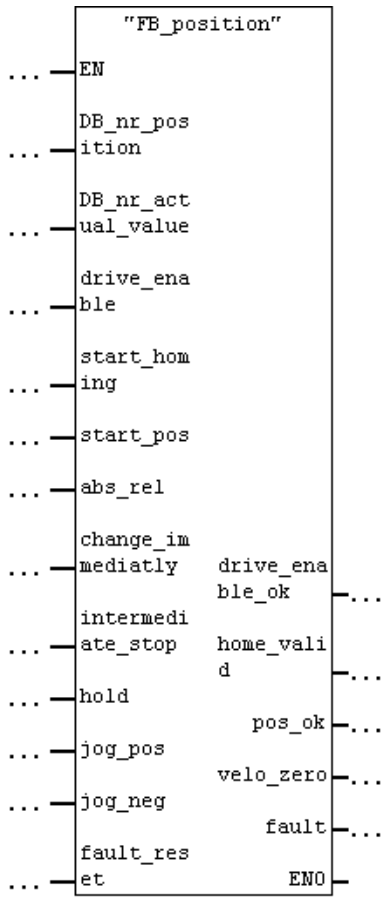
A separate function module is required or each operating mode of the respective servo positioning regulator. When deploying a large number of servo positioning regulators in different operating modes, bottlenecks in respect of the application's memory capacity can occur.

Information

The sequence of the data within the data module is identical with that defined in the telegram format of the respective operating mode (FB).

13.2.2 FBs of the servo positioning regulator SE-48

13.2.2.1 FB_position (FB 41 positioning operation)



- **Parameters:**

  - **DB_nr_position:**

    Number of the data module in which the data for the operating mode Positioning has been stored (INT).

  - **DB_nr_actual_value:**

    Number of the data module in which the actual value data is stored (INT).

- **Inputs:**

  - **drive_enable:**

    Activation of the regulator release in operating mode Positioning. The drive is held in its position with position control.

- **start_homing:**

  Starts the reference movement, the motor starts to move. A prerequisite is an active regulator release, i.e. the output drive_enable_ok must be set. Resetting the input start_homing during the reference movement terminates it without any error.

- **start_pos:**

  A rising flank signals that a new movement order should be undertaken. A falling flank has no effect.
  This input has no influence during a reference movement.

- **abs_rel:**

  If this input is set during a rising flank at input start_pos, the positioning is carried out relative to the current position set point. If this input is not set during a rising flank at start_pos, an absolute positioning is carried out.

- **change_immediately:**

  If this input is set during a rising flank at the input start_pos, then an ongoing positioning is immediately terminated and replaced by the new movement order. If this input is not set during a rising flank at the start_pos, the new movement order is appended at the end of an ongoing positioning.

- **intermediate_stop**

  If this input is not set, a started positioning is carried out. If the input is set during an ongoing positioning, then the drive is paused and remains in position control. The actual positioning is **not** ended. It is continued once the input intermediate_stop is reset.
  This input has no influence during a reference movement.

- **hold:**

  If this input is set, the ongoing positioning is terminated. The braking acceleration applicable for this positioning is used for braking. The output pos_ok is not set at the end of the process. The resetting of the input has no effect.
  This input has no influence during a reference movement.

- **jog_pos:**

  For a set input, the drive accelerates with the acceleration set in the position block “Jog & Teach” to the movement speed also parameterised in this position block.
  In case of a falling flank at this input, the drive brakes to a standstill with the braking acceleration set in the position block “Jog and Teach”
  This input has no influence during a reference movement.

- **jog_neg:**

  For a set input, the drive accelerates with the acceleration set in the position block “Jog & Teach” to the movement speed also parameterised in this position block.
  In case of a falling flank at this input, the drive brakes to a standstill with the braking acceleration set in the position block “Jog and Teach”
  This input has no influence during a reference movement.

- **fault_reset:**

  In case of a rising flank at this input, the queued error messages are acknowledged.

- **Outputs:**

  - **drive_enable_ok:**

    The regulator release of the servo positioning regulator is active.

  - **home_valid:**

    This output is set if a valid reference position exists. The output is not set during an ongoing reference movement. It is set for the first time or once again only after a successfully executed reference movement.

  - **pos_ok:**

    This output is set, if the actual position after the completed positioning lies in the target window.

  - **velo_zero:**

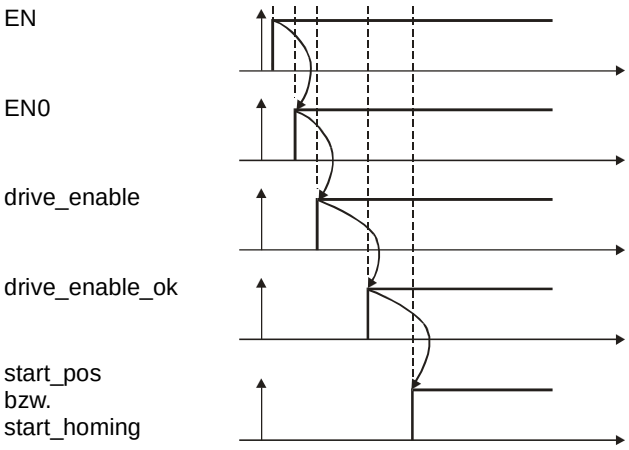
    This output is set when the actual rotational speed value in the message window is at rotational speed = zero.
    The message window is set in the SE-48SE-Commander™ under **Parameter – Messages – Rotational speed message – Message window**.

  - **fault:**

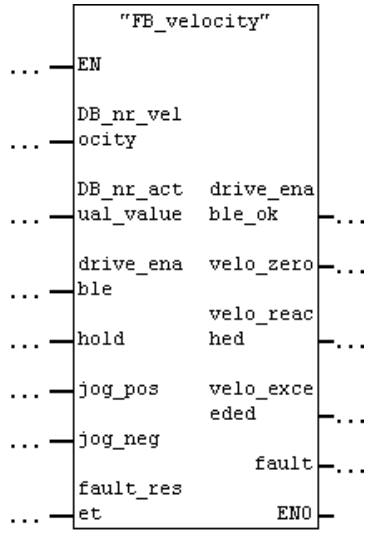
    There is an error with the output set. The regulator release is withdrawn.

    The output is reset when the error is acknowledged.

Please take note of the depicted timing while using the function modules.



13.2.2.2 FB_velocity (FB 43 Rotational speed regulation)



- **Parameters:**

  - **DB_nr_velocity:**

    Number of the data module in which the data for the operating mode Rotational speed regulation is stored (INT)

  - **DB_nr_actual_value:**

    Number of the data module in which the actual value data is stored (INT).

- **Inputs:**

  - **drive_enable:**

    Activation of the regulator release in the operating mode Rotational speed regulation. The set value of the rotational speed becomes effective depending on the other inputs of the function module.

- **hold:**

  With the input set, the rotational speed set point is locked. The drive brakes to a standstill as quickly as possible. The reset of the input has the effect of accelerating the motor as quickly as possible to the set rotational speed set point.

- **jog_pos:**

  With the input set, the drive accelerates with the acceleration of the set value ramp that has been set, to the movement velocity that has been parameterized in the position set “Jog & Teach”.
  In case of a falling flank at this input, the drive brakes to a standstill with the braking acceleration of the set value ramp.

- **jog_neg:**

  With the input set, the drive accelerates with the acceleration of the set value ramp that has been set, to the movement velocity that has been parameterized in the position set “Jog & Teach”.
  In case of a falling flank at this input, the drive brakes to a standstill with the braking acceleration of the set value ramp.

- **fault_reset:**

  In case of a rising flank at this input, the queued error messages are acknowledged.

- **Outputs:**
  - **drive_enable_ok:**

    The regulator release of the servo positioning regulator is active.

  - **velo_zero:**

    This output is set when the actual rotational speed value is within the tolerance window of the reference rotational speed.

  - **velo_reached:**

    With the output set, the actual rotational speed is in the parameterized tolerance window of the set rotational speed (reference rotational speed).

  - **velo_exceeded:**

    With the output set, the actual rotational speed is greater than the free reference rotational speed.

  - **fault:**

    There is an error with the output set. The regulator release is withdrawn.

    The output is reset when the error is acknowledged.

13.2.3 Integration of the FBs and DBs

As described in the overview, the function modules and data modules developed for the SE-48 are available for free download.

> **Information**
>
> Download the function modules and data modules at **www.Afag.de**

The modules are zipped in two example projects in the file **FB_DB_ SE-48FB_xpx.zip**. **xpx** stands for the latest version number. This file can be opened using the normal programs, e.g. WINZIP. The example projects are:

Operating mode	Example project
Positioning	DIS-2_FB_POS.zip
Speed control	DIS-2_FB_VEL.zip

The unzipped sample projects can be extracted under STEP7. The relevant FBs, DBs and possibly SFCs can be copied from these extracted example object.

The system functions SFC14 (consistent reading) and SFC15 (consistent writing) must be used for consistent data exchange between the PROFIBUS master and the PROFIBUS slave. The modules are to be connected using the following parameters:

Reading the data using SFC14:

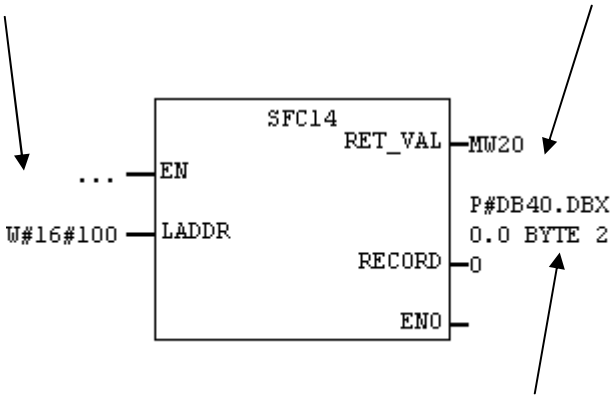
Input data area

256dez = 100hex

Data module number

in which the data from the slave

is deposited



Starting address within the DB (0.0) and the number of received bytes (20 bytes)

Parameters	Declaration	Data type	Memory area	Description
LADDR	INPUT	WORD	E, A, M, D, L, const.	Projected start address from the E area of the sub-assembly to be read from.
RET_VAL	OUTPUT	INT	E, A, M, D, L	If an error occurs during the processing of the function the return value contains an error code.
RECORD	OUTPUT	ANY	E, A, M, D, L	Target area for the useful data read. It must be of the exact same length as for the selected sub-assembly projected with STEP 7. Only the data type BYTE is permitted.

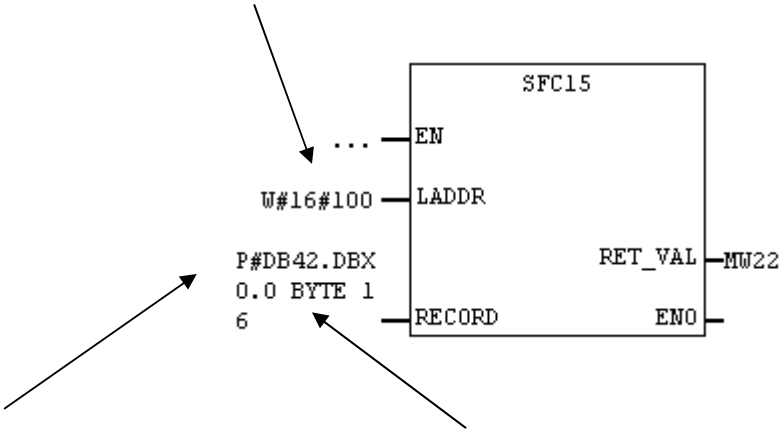
The same actual value data is returned in both the example projects (example project Positioning and example project Rotational speed regulation). Thus, the response telegram is configured the same way in both the example projects.

Writing the data using SFC15:

Different data is transferred to the PROFIBUS slave depending on the operating mode, Positioning or Rotational speed regulation. This results in varying telegram lengths, which affect the parameterization of the SFC15.

Writing the data for the operating mode Positioning:

Output data area 256dez = 100hex

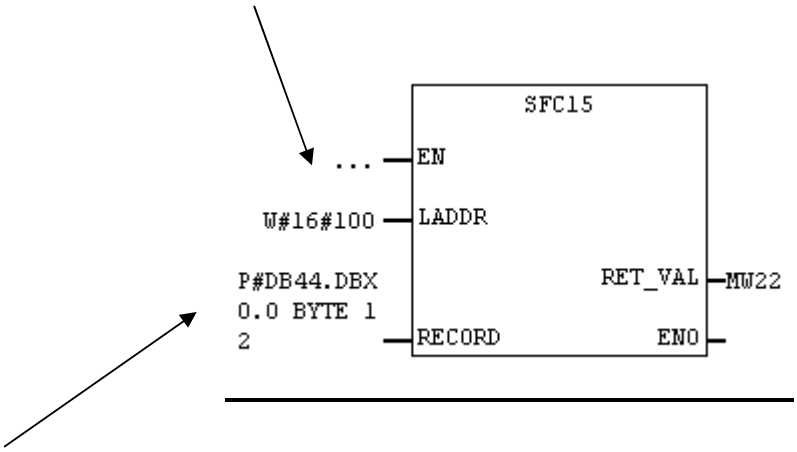


Data module number from the data to the slave that have been sent.

Starting address within the DB (0.0) and number of bytes to be transmitted (16 byte)

Writing the data for the operating mode Rotational speed regulation:

Output data area 256dez = 100hex



Data module number from the data to the slave that have been sent.

Starting address within the DB (0.0) and Number of bytes to be transmitted (12 byte)

Parameters	Declaration	Data type	Memory area	Description
LADDR	INPUT	WORD	E, A, M, D, L, const.	Projected start address from the A area of the sub-assembly to be written to.
RECORD	INPUT	ANY	E, A, M, D, L	Source area for the useful data to be written. It must be of the exact same length as for the selected sub-assembly projected with STEP 7. Only the data type BYTE is permitted.
RET_VAL	OUTPUT	INT	E, A, M, D, L	If an error occurs during the processing of the function the return value contains an error code.

13.2.4 PROFIBUS connection of the SE-48 servo-positioning regulator

A number of steps are necessary to create a functioning PROFIBUS-connection. Some of these settings should or must be executed before the activation of the PROFIBUS communication.

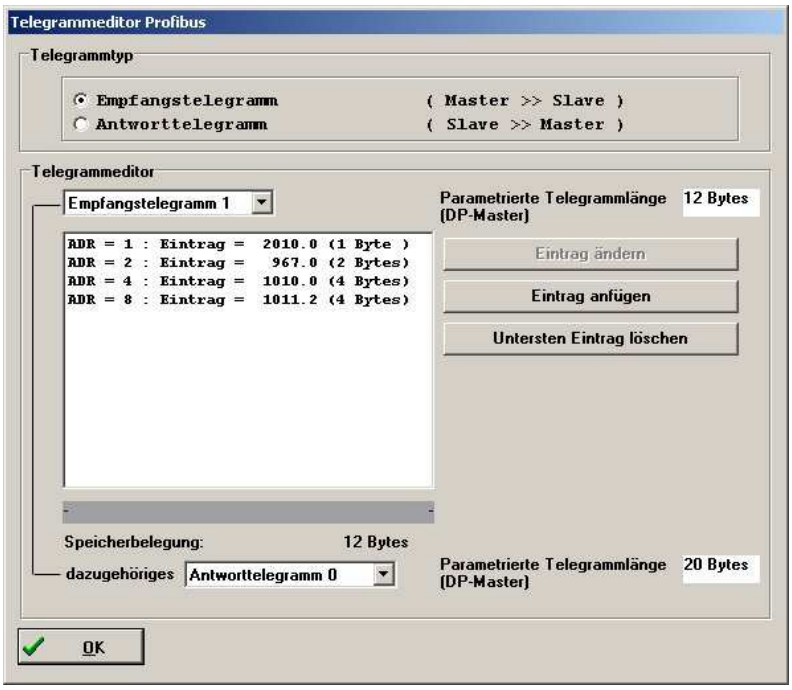
The transmission of data with the DP-V0 service requires the definition of how much data is transferred and the meaning of the data from the side of master and slave. The master and slave must therefore be configured accordingly when using the described example projects.

While loading the example projects, the data modules are already designed as necessary. The telegrams are to be constructed with the parameterizing program SE-48SE-Commander™ according to the example projects. Please refer to the

previous chapters of the PROFIBUS manual for the handling of the telegram editor or for more information on the respective parameters.

13.2.4.1 Receipt telegram - example project Rotational speed regulation

In this case, the receipt telegram 1 is to be configured correspondingly on the servo positioning regulator side. The following screenshot shows the parameterizing of the receipt telegram required for the example project: If a communication was established between master and slave an additional diagnosis information is shown above the “Change entry” button. The actual telegram length between the slave and the master configured by the master is displayed.



The following table describes the structure of the telegram:

Address	Content (Parameter number)	Description
0	Identifier (= 0xE1)	Identifier with fixed setting
1	8-bit placeholder (PNU 2010 0)	Free
2	Control word 1 (PNU 967 0)	Control word for device control, must be defined fixed at this address
4	Rotational speed set point (PNU 1010 0)	Rotational speed set value, specification of rotational speed in the physical unit set for PROFIBUS
8	Accelerations (PNU 1011 2)	Combination of the values for acceleration and braking acceleration, specification of an acceleration in the physical unit set for PROFIBUS

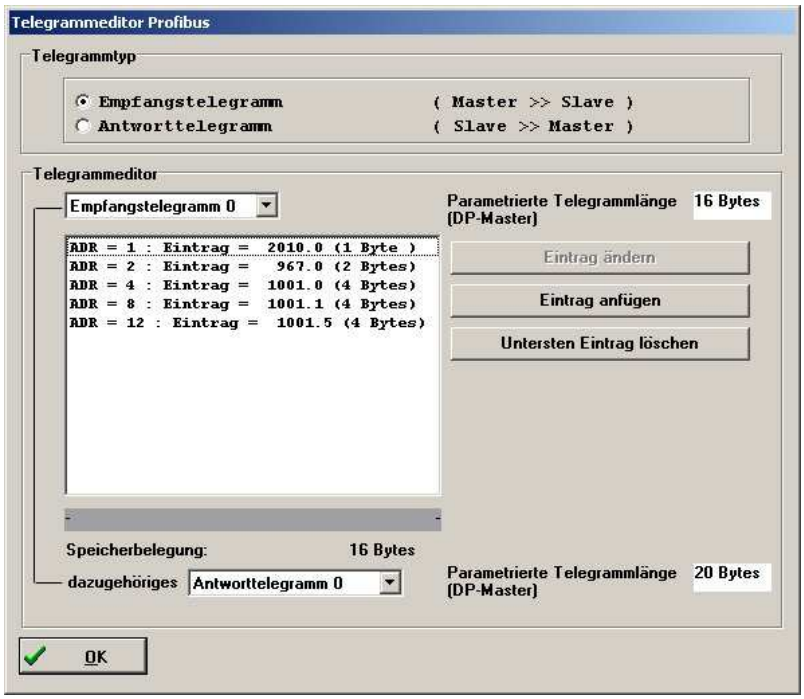
The total length of the telegram is 12 bytes. Therefore, while integrating the slave in the hardware configuration of the master it is necessary to select the module:

6 Words Output

for the input data and to put it on one of the slots.

13.2.4.2 Receipt telegram - example Project positioning

In this case, the receipt telegram 0 is to be configured correspondingly on the servo positioning regulator side. The following screenshot shows the parameterizing of the receipt telegram required for the example project: If a communication was established between master and slave an additional diagnosis information is shown above the “Change entry” button. The actual telegram length between the slave and the master configured by the master is displayed.



The following table describes the structure of the telegram:

Address	Content (Parameter number)	Description
0	Identifier (= 0xE0)	Identifier with fixed setting
1	8-bit placeholder (PNU 2010 0)	Free
2	Control word 1 (PNU 967 0)	Control word for device control, must be defined fixed at this address
4	Target position (PNU 1001 0)	Target position, specification in the physical unit of position that has been set for PROFIBUS
8	Movement speed (PNU 1001 1)	Movement speed during the positioning, specification in the physical unit for rotational speed that has been set for PROFIBUS
12	Accelerations (PNU 1001 5)	Combination of the values for acceleration and braking acceleration, specification of an acceleration in the physical unit set for PROFIBUS

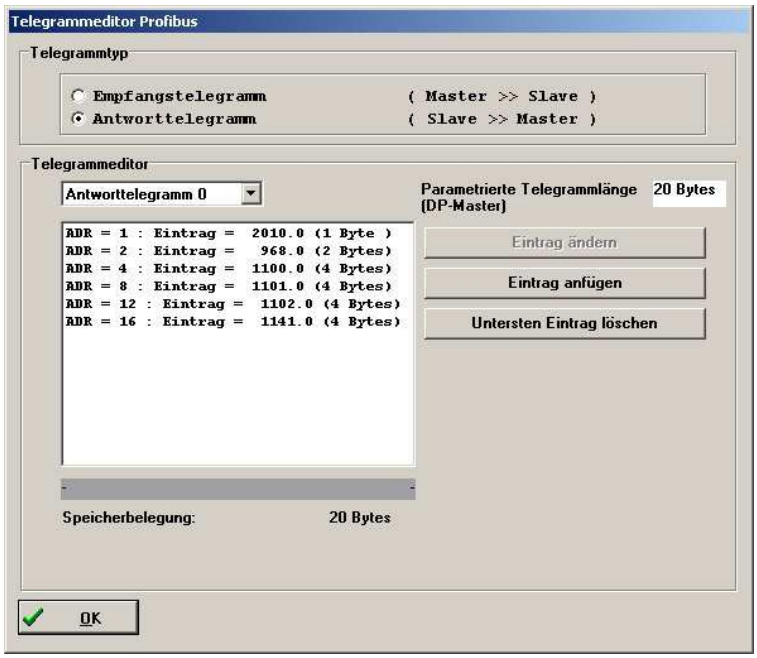
The total length of the telegram is 16 bytes. Therefore, while integrating the slave in the hardware configuration of the master it is necessary to select the module:

8 Words Output

for the input data and to put it on one of the slots.

13.2.4.3 Response telegram for the example project

In both example projects the same actual value data transmitted from the slave to the master is employed. Therefore for both receipt telegrams 0 and 1, the same response telegram 0 is configured on the side of the servo positioning regulator. The following screenshot shows the parameterizing required for the example project: If a communication was established between master and slave an additional diagnosis information is shown above the “Change entry” button. The actual telegram length between the slave and the master configured by the master is displayed.



The following table describes the structure of the telegram:

Address	Content (Parameter number)	Description
0	Identifier (= 0xF0)	Identifier with fixed setting
1	Operating mode (PNU 1500 0)	Current operating mode of the servo positioning regulator
2	Status word 1 (PNU 968 0)	Control word for device control, must be defined fixed at this address
4	Actual position (PNU 1100 0)	Actual position, specification of a position in the physical unit set for PROFIBUS
8	Actual value of rotational speed (PNU 1101 0)	Actual rotational speed value, specification of a rotational speed in the physical unit set for PROFIBUS
12	Active current actual value (PNU 1102 0)	Actual active current in tenths of one percent relative to the motor’s nominal current
16	Status of the digital inputs (PNU 1141 0)	Current status of the digital inputs, bit assignment see description of the PNU.

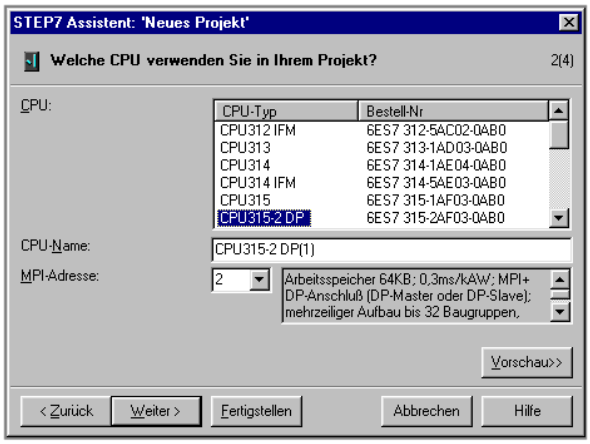
The total length of the telegram is 20 bytes. Therefore, while integrating the slave in the hardware configuration of the master it is necessary to select the module:

10 Words Input

for the input data and to put it on one of the slots.

13.2.5 Creating an S7 program

To begin with, the STEP 7 software is started. The STEP 7 Wizard is opened after the SIMATIC Manager starts. Running through the STEP 7 Wizard is recommended. The STEP 7 Wizard leads you step-by-step through the creation of an S7 project.



This is followed by the selection of the organization module **OB1**. **OB1** is found at the uppermost program level and organizes the other modules.

More modules can be inserted later.

The selection of the preferred programming language takes place subsequently. It can be later changed to another programming language.

13.2.6 Integrating the GSD file

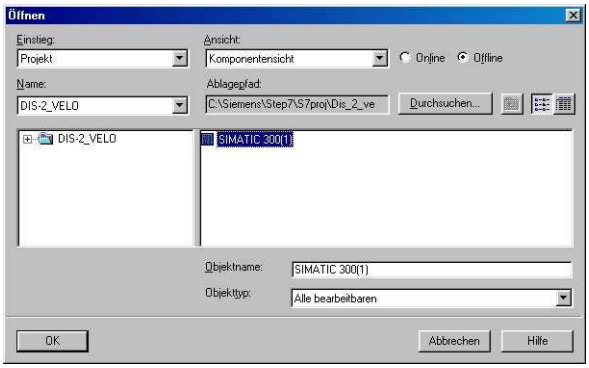
The hardware configuration of the PLC used must then be carried out in the created project. For this purpose, **SIMATIC 300-Station** is selected on the left side of the window and then **Hardware** is selected on the right side of the window with a double click.

First, the station is closed with the command **Station** -> **Close** without ending the hardware configurator.

The command **Options->Install new GSD…)** is then used to insert the GSD file MME0A38.gsd, which is required for adding the SE-48 to the hardware catalogue.

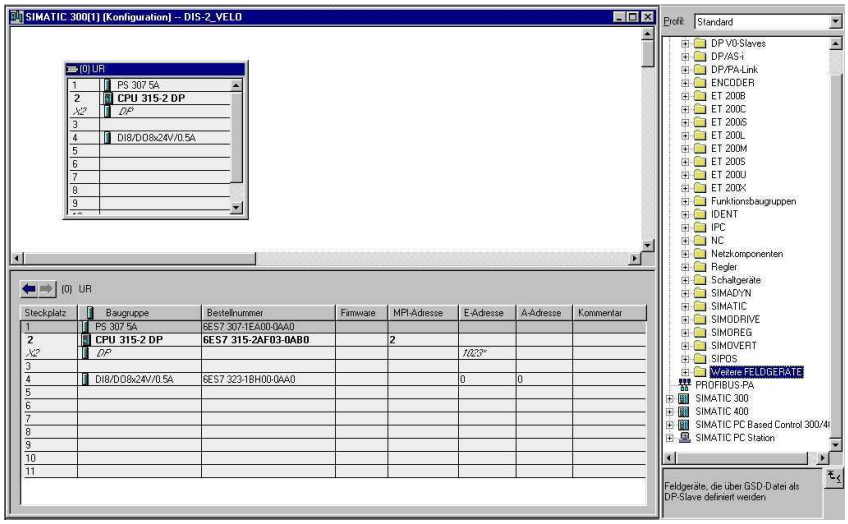
13.2.7 The hardware configuration

The S7 project must then be reopened with the command **Station** -> **Open..**.



The assigned project name is selected under **Name** in the window **Open**. This is selected and then **SIMATIC 300(1)** is selected on the right side of the window. The hardware configuration of your project is then opened with the **OK** button.

The following screenshot shows the hardware catalogue from which the hardware components are selected. If it is not shown, it can be displayed with the command **View** -> **Catalogue**.



Use the mouse to select the hardware components to be used from the **hardware catalogue** and drag them into the station window using Drag & Drop.

Steckplatz	Baugruppe	Bestellnummer	M...	E...	A...
1	PS307 2A	6ES7 307-1BA00-0AA0			
2	**CPU315-2 DP(1)**	**6ES7 315-2AF03-0AB0**	2		
X2	*DP-Master*			1023	
3					
4	DI8/DO8x24V/0.5A	6ES7 323-1BH00-0AA0		0	0
5					

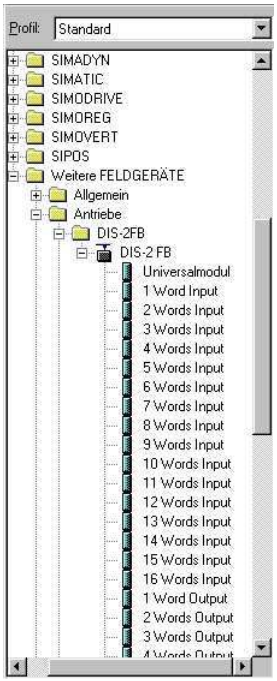
Information

The order numbers in the project must match the order numbers of the hardware (printed on the front). Slot 3 is not used, since no interface module is used in this project.

13.2.8 Connecting the servo positioning regulator

The servo positioning regulator is connected by selecting the line **X2 DP -master** in the station window. The command **Add -> DP – master system** is then used to supplement the Profibus.

Then, the required module is added to the Profibus from the hardware catalogue from the directory **PROFIBUS-DP** -> **More FIELD EQUIPMENT** -> **Regulator -> SE-48** using Drag & Drop.



The respective telegram length must be taken into consideration while selecting the module. More specifically, for the

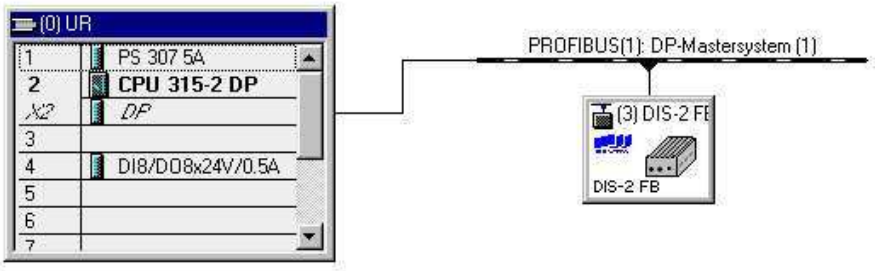
- set value telegram positioning operation the module **8 Words Output** should be selected or for the set value telegram for rotational speed regulation the module **6 Words Output** should be selected

- For the actual value telegram the module **10 Words Input**

should be selected. Both function modules can also be used in one project. In that case, the module **8 Words Output** must be used.

The Profibus address of the servo positioning regulator is set in the window **Properties**. It must be identical to the address that was set previously with the SE-48SE-Commander™ . The servo positioning regulator is now connected.

The hardware configuration should now appear as follows.



The S7 Project is now prepared to such an extent that the programming can be started.

13.2.9 Overview of the function modules and data modules

Overview of example project Positioning operation

Overview of the example project Rotational speed regulation

Actual value data

DB4 0	actual_value	Actual value data of the servo positioning regulator (for both sample projects)

DB40 -- DIS-2_POS\SIMATIC 300(1)\CPU 315-2 DP

Adresse	Name	Typ	Anfangswert	Aktualwert	Kommentar
0.0	Telegrammkennung	BYTE	B#16#0	B#16#0	
1.0	Betriebsart	BYTE	B#16#0	B#16#0	herstellerspezifisch
2.0	PROFIDRIVE_Statusword	WORD	W#16#0	W#16#0	
4.0	Istposition	DINT	L#0	L#0	übertragener Parameter in default-Parametrierung
8.0	Istgeschwindigkeit	DINT	L#0	L#0	übertragener Parameter in default-Parametrierung
12.0	Wirkstromistwert	DINT	L#0	L#0	übertragener Parameter in default-Parametrierung
16.0	digitale_Eingaenge	DWORD	DW#16#0	DW#16#0	übertragener Parameter in default-Parametrierung

Positioning

FB4 1	FB_position	Function module for the operating mode Positioning
DB4 1	Instance DB for FB41	The data module of the internal variables belonging to the function module
DB4 2	DB_position	Positioning data

DB42 -- DIS-2_POS\SIMATIC 300(1)\CPU 315-2 DP

Adresse	Name	Typ	Anfangswert	Aktualwert	Kommentar
0.0	Telegrammkennung	BYTE	B#16#0	B#16#E0	
1.0	frei	BYTE	B#16#0	B#16#0	vorläufige Platzhaltervariable
2.0	PROFIDRIVE_Controlword	WORD	W#16#0	W#16#0	
4.0	Zielposition	DINT	L#0	L#5000	zu übertragender Parameter in default-Parametrierung
8.0	Fahrgeschwindigkeit	DINT	L#0	L#200	zu übertragender Parameter in default-Parametrierung
12.0	Beschleunigung	DINT	L#0	L#100000	zu übertragender Parameter in default-Parametrierung

Speed control

FB43	FB_velocity	Function module for the operating mode Rotational speed regulation
DB43	Instance DB for FB43	The data module of the internal variables belonging to the function module
DB44	DB_velocity	Data for operating mode Rotational speed regulation

DB44 -- DIS-2_VELO\SIMATIC 300(1)\CPU 315-2 DP

Adresse	Name	Typ	Anfangswert	Aktualwert	Kommentar
0.0	Telegrammkennung	BYTE	B#16#0	B#16#E1	
1.0	frei	BYTE	B#16#0	B#16#0	vorläufige Platzhaltervariable
2.0	PROFIDRIVE_Controlword	WORD	W#16#0	W#16#0	
4.0	Geschwindigkeitssollwert	DINT	L#500	L#500	zu übertragender Parameter in default-Parametrierung
8.0	Beschleunigung	DINT	L#100000	L#50000	zu übertragender Parameter in default-Parametrierung

Afag Automation AG
Fiechtenstrasse 32
CH - 4950 Huttwil
Switzerland
Tel.: +41 (0)62 959 86 86
Fax.: +41 (0)62 959 87 87
e-mail: sales@afag.com
Internet: www.afag.com