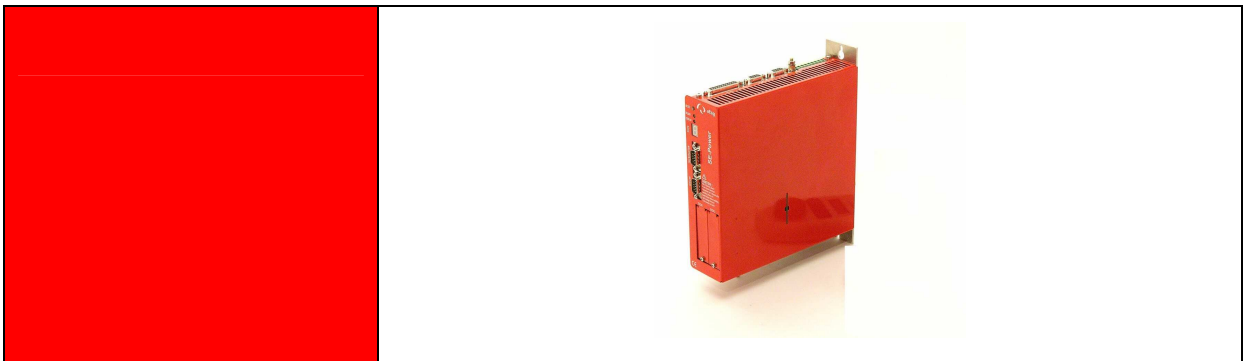


Module Controller SE-Power

Profibus Manual



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1 General

1.1 Documentation

This manual describes how the Fieldbus connection of the servo-positioning regulator of the device family SE-Power 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 directed at persons who are already familiar with this family of servo-positioning regulators.

It contains safety instructions that must be followed.

Additional information can be found in the following manuals of the SE-Power product family:

- **Product manual "Servo-positioning regulator SE-Power"**: Description of the technical data and the device functionality as well as instructions regarding installation and operation of the servo-positioning regulator SE-Power.
- **Software manual "Servo-positioning regulator SE-Power"**: Description of the device functionality and the software functions of the firmware including the RS232-communication. Description of the parameterization program Afag SE-Commander™ with instructions for the first commissioning of a servo-positioning regulator of the device family SE-Power

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". Among these, PROFIBUS is specified as type 3. PROFIBUS exists in two forms. 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:

PROFIBUS-DP

Principles, tips and tricks for users

Manfred Popp

Hüthig-Verlag, Heidelberg 1998



Decentralizing with PROFIBUS-DP
Construction, planning and use of the PROFIBUS-DP with Simatic S7
Josef Weigmann, Gerhard Kilian
Siemens, Erlangen/Munich 1998

**The new quick introduction to PROFIBUS DP
From DP-V0 to DP-V2**

Manfred Popp
PROFIBUS Nutzerorganisation e.V. (PROFIBUS user organization), Karlsruhe 2002

PROFIdrive – Profile Drive Technology,

Vers. 3.1,
PROFIBUS Nutzerorganisation e.V. (PROFIBUS user organization), Karlsruhe

IEC 61158 - Fieldbus for industrial control systems

2 Safety Instructions for Electrical Drives and Controllers

2.1 Symbols Used



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! Life-threatening voltages.
The safety instruction contains a pointer to the occurrence of a possibly life-threatening voltage.



The sections marked with this symbol depict examples, which simplify the understanding and the use of individual objects and parameters.

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.



Before the commissioning, the *Safety Instructions for Electrical Drives and Controllers* from page 9 must be read.

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

Smooth and safe operation of the servo-drive regulator requires proper and technically sound transport, storage, installation, planning, taking into consideration the risks and protective and emergency measures and the installation as well as the careful operation and upkeep. 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 planning, the installation, the assembly, the commissioning and the 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 of the standards and accident prevention specifications, that are applicable in relation to the use, 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 first commissioning of the plant 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 through 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 transferred.



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



The 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 Wrong 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 movement of the motors.

2.4 Safety Instructions

2.4.1 General Safety Instructions



The servo-positioning regulator corresponds to the protection class IP20, 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 spare parts that have been approved by the manufacturer.



It must be possible to connect the servo-positioning regulators 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).



The servo-positioning regulator can be secured with an all-current sensitive FI-cut-off switch (RCD = Residual Current Protective Device) 300 mA.



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 the respective product manual of the servo-positioning regulator. 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 complied with without fail.



DANGER!

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

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



Without any claims to completeness, the following specifications apply:

VDE 0100	Regulation for the erection of heavy current installations up to 1000 volt
EN 60204	Electrical equipment of machines
EN 50178	Electronic equipment for use in heavy power installations
EN 292	Safety of machines – Basic terms, general design principles
EN 1050	Safety of machines - Guidelines for risk evaluation
EN 1037	Safety of machines - Prevention of unexpected start-up
EN 954	Safety-related parts of control systems

2.4.2 Safety Instructions for Installation and Maintenance

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



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 axes against dropping or lowering after switching off the motor, such as by:

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



The standard motor brake that is supplied or an external motor brake controlled by the drive regulator alone are not suitable for personnel safety!



Render the electrical equipment free of voltage via the main switch and secure it against switching 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.



The external or internal brake resistance is live in operation and can carry a dangerous intermediate circuit voltage for up to about 5 minutes after switching off the servo-positioning regulator, this can result in death or serious bodily injuries if touched.



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 chip waste, 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 servo-positioning regulator (24 V) is switched off.



The intermediate circuit or the mains voltage must always be switched off before switching off the 24 V supply voltage of the servo-positioning regulator.



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



The commissioning must be carried out with the motors on no load, 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 and in particular the brake resistance, external or internal, can reach high temperatures, and upon touching them, serious bodily burning can occur.

2.4.3 Protection Against Touching Electrical Parts

This section 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 for persons and result in an 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 specifications. The plant manufacturer or the owner/operator must ensure compliance with these specifications:



Before switching on, put on the covers and protective devices, which are intended to prevent touching, on the appliance. For installed devices, protection against direct touching of electrical parts must be provided by an external housing, such as a switch cabinet. The VBG 4 specifications must be complied with.



Always connect the protective conductor of the electrical equipment and the devices firmly to the mains supply. Owing to the integrated mains filter, the leakage current is greater than 3.5 mA!



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 measurement 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 a high voltage on the housing, which causes 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, isolate the device from the mains supply or the voltage source. Secure against getting 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.



The device has an intermediate circuit discharge circuit according to EN 60204 Section 6.2.4. In certain device configurations, especially with parallel connection of several servo-positioning regulators in the intermediate circuit, or in the case of a brake resistance that has not been connected, however, the fast discharge may be ineffective. The servo-positioning regulators can then carry a dangerous voltage for up to 5 minutes after switching off (capacitor residual charge).

2.4.4 Protection through Protection Low Voltage (PELV) from Electrical Shocks

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

International: IEC 60364-4-41

European countries in the EU: 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!

At all connections and terminals with voltages from 0 to 50 V, only those devices, electrical components and cables may be connected, which have a protective low voltage (PELV = Protective Extra Low Voltage).

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 measured value and the signal transmitters
- faulty or non-EMC-conformant components
- error in the software in the higher-level 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 such movements depends on the type of 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 plant and a danger and fault analysis by the plant 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 machines to cool for 10 minutes after switching off.



If hot parts of the equipment, like machine housings, in which radiators and resistances 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 erection and safety specifications on operation and installation.



Use suitable installation and transportation equipment.



Prevent squeezing and crushing by taking suitable 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 wait under suspended loads.

Cabling and Connector Mapping

2.5 Connection Mapping

In the case of the device family SE-Power, the PROFIBUS interface is implemented by an optional technology connector module. It is normally already connected at the factory, but can also be retrofitted.

The PROFIBUS bus connection is designed, in keeping with EN 50170, as a 9-pole DSUB-socket (on the technology connector module).

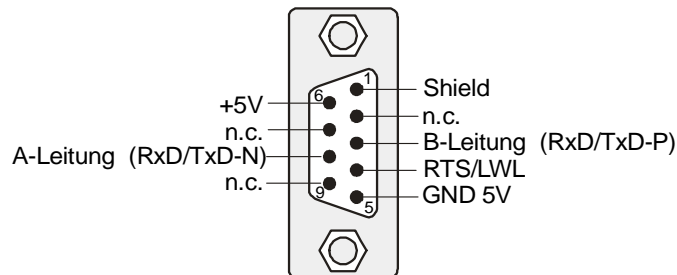


Figure 0.1: PROFIBUS connector for SE-Power (A-Leitung = A-cable; B-Leitung = B-cable)



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 fieldbus 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 the operation, which can result in the servo-positioning regulator getting switched off with an error message, for reasons of safety.

2.6 Termination and Bus Terminal Resistances

Every bus segment of a PROFIBUS network must be fitted with bus terminal resistances, to minimize cable reflections, to ensure a nearly constant load behavior 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**.

The PROFIBUS-Module of the SE-Power device family has these terminal resistances integrated on the module, so that no external connection (special plug) is necessary. These can be switched on using the two DIP-switches on the module (switch to ON).



Bus terminal resistances

There are DIP switches integrated in the technology modules of the SE-Power device family, which facilitate the connection of bus terminal resistances if required.

An external connection is also possible. The supply voltage of 5 V required for the externally connected terminal resistances is provided at the PROFIBUS-connection of the module (see connector mapping).



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

If the baud rate that 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.



Some manufacturers offer connecting plugs that contain a combination of the bus terminal resistances and series inductances.

2.7 Bus Cable for PROFIBUS

PROFIBUS cable:

SIMATIC NET, Pb FC Standard bus, 2-core and shielded, special construction for quick assembly, 20 m.

Manufacturer: SIEMENS

Cat. no.: 6XV1 830-0EN20

2.8 Busconnector for PROFIBUS

Manufacturer: Phoenix Contact

Type: SUBCON-PLUS-PROFIB/SC 2

3 PROFIBUS-DP and PROFIdrive

3.1 Overview of DP and its Power Stages

The communications protocol DP (DP = De-central 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 de-central field devices like I/O, drives, valves, measurement transformers or analysis devices. The data exchange with the de-central 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 stage-wise over and above these basic functions, with special functions, in alignment with 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 contents 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 canal-specific diagnosis. |
| DP-V1 | This stage contains enhancements with an orientation to the 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 | <p>This stage contains additional enhancements and is primarily aligned to the requirements of the drive technology. By means of additional functionalities like isochroner 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.</p> <p>This power stage requires corresponding hardware. The controllers of the target applications of the SE-Power device family currently do not have this hardware. Support for DP-V2 is therefore not provided for.</p> |

The power stages of DP are specified in detail in IEC 61158 0.

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. With DP, mono-master and multi-master systems can be realized. As a result, a high degree of flexibility in the system configuration is allowed. 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 de-central 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 measurement 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.

3.2 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 the transmission of 512 bit input data and 512 bit output data distributed across 32 participants, DP requires, at 12 megabit/s, only about 1 ms. In the case of DP, the transmission of the input data and the output data takes place in one messaging 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, on the side of the master and the slave, the definition of how much data is to be transferred and what significance the data has. 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.

3.3 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 SE-Power device family is based exclusively on version 3.1 0.

In the PROFIdrive specification, 0 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-Power device family 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.

There exist a number of manufacturer-specific PNUs for the connection of the servo-positioning regulator SE-Power. Furthermore, from a certain expansion stage onwards, there is also an option of access to additional object directories, if required with limitations. This is the object directory of the communications objects of Afag as well as the CANopen object directory.

4 PROFIBUS Connection

4.1 Introduction

There are several steps required for setting up a working PROFIBUS connection. Some of these settings should or must be made before 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.

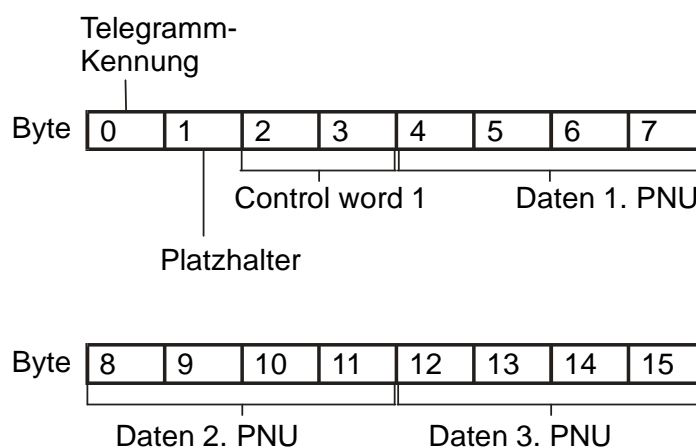


Figure 4.1: Example of the telegram format in the case of SE-Power

Figure 4.1 illustrates an example of a standard telegram for the device family SE-Power 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.

4.2 Overview of Slave

This section 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:

Configuration of the telegrams with the **telegram editor, Chap. 5**

Selection and parameterization of the **physical units, Chap. 6**

Configuration and activation of the **operating parameters, Chap. 7**

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 Afag SE-Commander™. The number of bytes for the relevant 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.

In Firmware 3.0, in the operating mode 'Rotational speed regulation', with active PROFIBUS communication, the setting of the set value selector is saved and permanently monitored. Therefore, the settings of the set value selector must be parameterized before activation of the communication as required for the application.



In Firmware 3.0, the set value selector cannot be changed in the operating mode 'Rotational speed regulation' with an **active** PROFIBUS communication. It must therefore be parameterized accordingly.

When these steps are completed, the **operating parameters** of the PROFIBUS-connection must be set. Before activation of 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.

4.3 Overview of Master

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

Installation of the **GSD File**

Specification of the **slave address**

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 catalog. The folder SE-Power 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.

5 Telegram Editor

5.1 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 product level 3.0 of the servo-positioning regulator SE-Power supports 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 the activation of the communication.

5.2 Receipt Telegrams

The product level 3.0 of the firmware of the servo-positioning regulator SE-Power supports 4 receipt telegrams. Some of these telegrams are bound to a particular operating mode. This makes it easier for the user to switch between the different operating modes. An additional parameter for the operating mode need not be transferred. 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	Rotational speed regulation
Receipt telegram 2	none (reserved for torque regulation)
Receipt telegram 3	none (free telegram format)

As soon as a corresponding telegram identifier is read in the servo-positioning regulator, the checking and, if required, the parameterization of the corresponding operating mode takes place.

The parameter numbers must be entered for every receipt telegram. In this manner, the information about the meaning of the data in the telegram is stored in the servo-positioning regulator. It must be ensured that in the case of the receipt telegrams 0..2 at the address 2, the relevant 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. E.g. pure 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..2). 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 5.1 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.

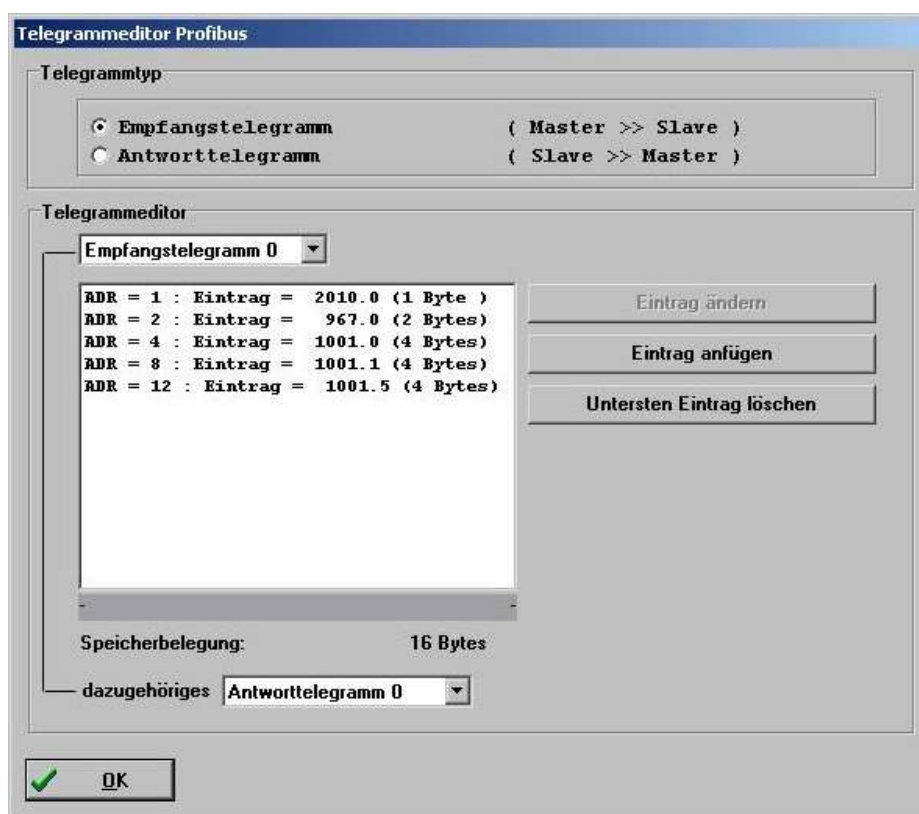


Figure 5.1: Composition of a receipt telegram

In the example shown in Figure 5.1, the following parameters are transferred:

Addresses	Contents (parameter number)	Description
0	Identifier (= 0xE0)	Identifier with a fixed setting
1	8-bit placeholder (PNU 2010 0)	free
2	Control word 1 (PNU 967 0)	Control word for device control, must be located fixed at this address

Addresses	Contents (parameter number)	Description
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 brake acceleration, specification in the physical unit for acceleration that has been set for PROFIBUS

More detailed descriptions of the parameter numbers can be seen in chapters, 9 and 11.

5.3 Response Telegrams

The product level 3.0 of the firmware of the servo-positioning regulator SE-Power supports 4 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..2, at the address 2, the relevant 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 5.2 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.

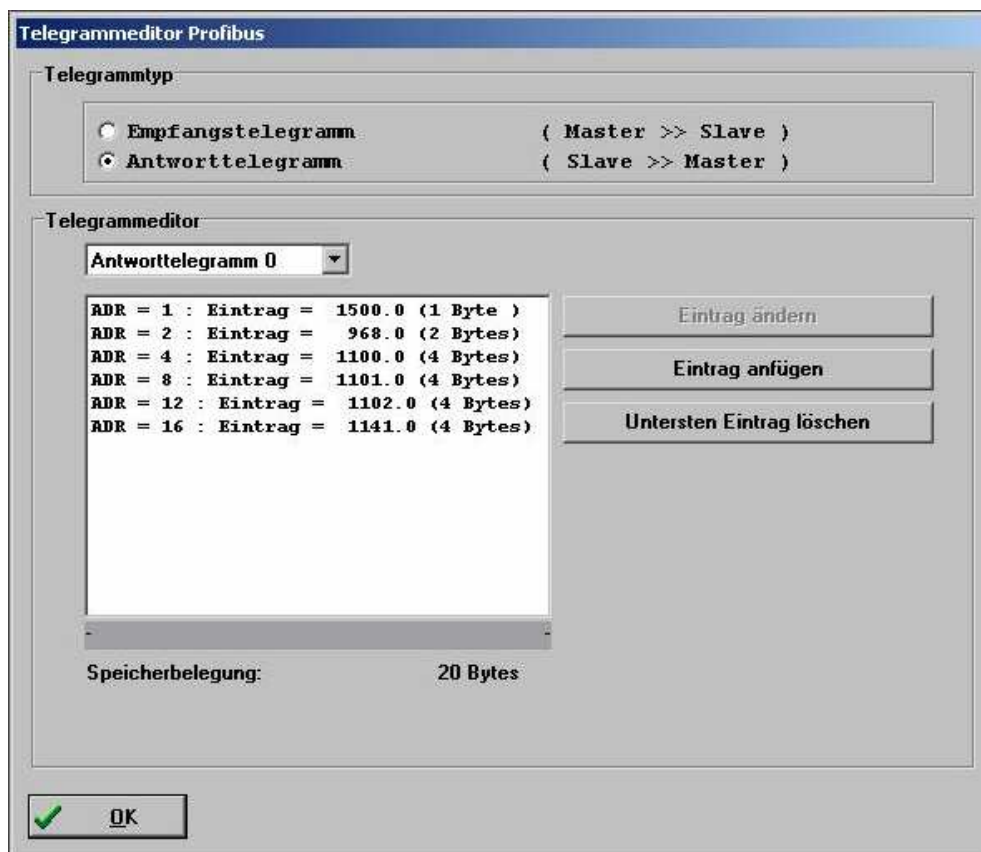


Figure 5.2: Composition of a response telegram

In the example shown in Figure 5.2, the following parameters are transferred:

Addresses	Contents (parameter number)	Description
0	Identifier (= 0xF0)	Identifiers that have been set to fixed values
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 located fixed at this address
4	Actual position (PNU 1100 0)	Current actual position, specification in the physical unit of position that has been set for PROFIBUS
8	Actual value of rotational speed (PNU 1101 0)	Current actual value of rotational speed, specification in the physical unit of the rotational speed that has been set in PROFIBUS
12	Active current, actual value (PNU 1102 0)	Combination of the values of acceleration and brake acceleration, specification in the physical unit for acceleration that has been set for PROFIBUS
16	Active current, actual value (PNU 1141 0)	Combination of the values of acceleration and brake acceleration, specification in the physical unit for acceleration that has been set for PROFIBUS

More detailed descriptions of the parameter numbers can be seen in Chapters, 9, 10 and 11.

6 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**. **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.

Fehler! Verweisquelle konnte nicht gefunden werden. shows the window of the program Afag SE-Commander™ for setting the physical units.

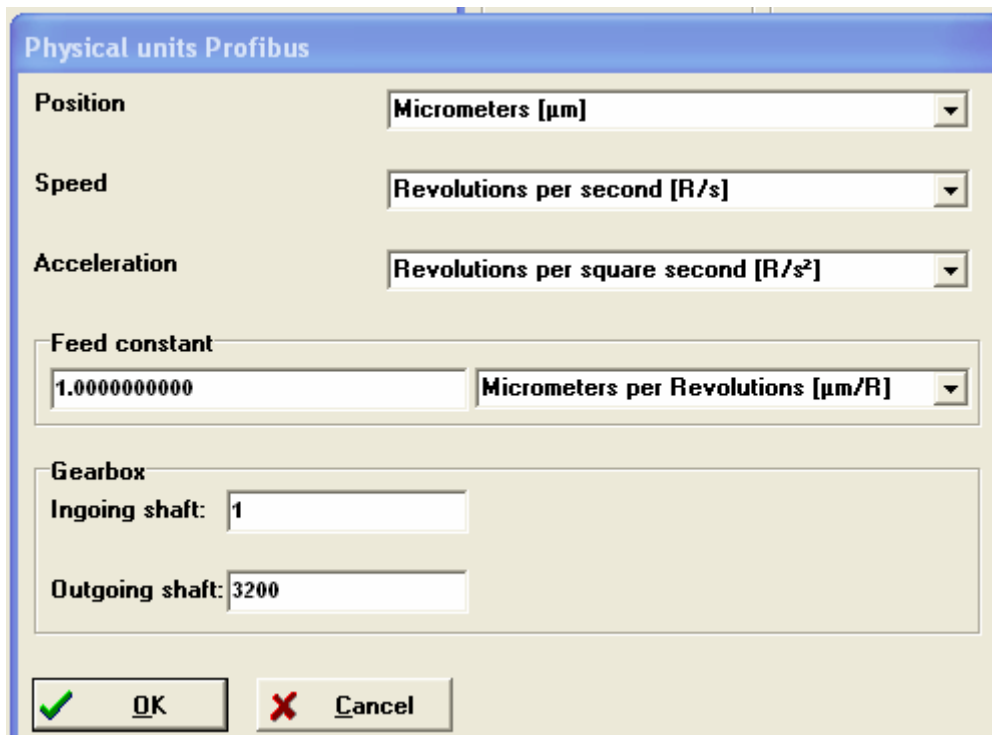


Figure 7.1: Setting the physical units

	Settings for outgoing shaft with target position over profibus		
	0.1mm	0.01mm	0.001m
ZME-080-xxx	66	666	6666
LME-100-xxx	380	3800	38000
LME-200-xxx	320	3200	32000
PME-AT1-xxx	480	4800	48000

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 must be remembered that some quantities cannot always be used meaningfully. In a purely rotational system, e.g. no feed constant is required. In addition, the feed constant has a physical unit. If this is not parameterized suitably, the feed constant is not taken into consideration.

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 $\mu\text{m}/\text{revolution}$

=> 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 operations 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.

Figure 6.1 illustrates the interpretation of the gearbox factor. In the menu Physical Units Profibus of the parameterizing program SE-Commander™, the value "drive" refers to U_{EIN} , the value "driven" to U_{AUS} .

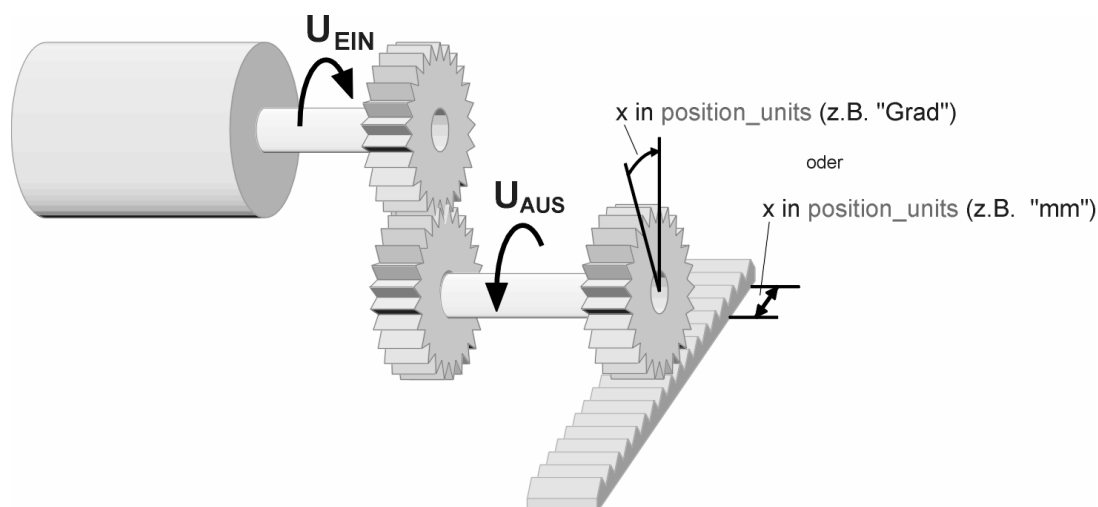


Figure 6.1: Gearbox factor

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 rotated, this can be done with the gearbox factor of the angle transmitter in the parameterizing software Afag SE-Commander™.

7 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 Afag SE-Commander™.

7.1 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 reset. The de-activation of the communication, in contrast, takes place immediately. Figure 7.1 shows the window of the parameterizing program for setting the operating parameters.



Figure 7.1: Setting 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..3 as well as the analog inputs AIN1 and AIN2 have been provided for this purpose. 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 weightages:

Option	Active in case of	Value weightage
Addition of DIN0..3	+ 24 V DC	0..15
Addition of AIN1	U_On > + 5 V	0, 16
Addition of AIN2	U_ein > + 5 V	0, 32

The baud rate of the PROFIBUS communication is automatically detected by the hardware used. The following baud rates are supported by the servo-positioning regulators of the SE-Power device family:

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

7.2 Adjustment of the Cycle Times

In the SE-Power device family, the cycle times of the regulator structure can be set variably. Upon activating the fieldbus communication over PROFIBUS, a cycle time of the current regulator of 125 μ s is recommended. For parameterization, open the window **Parameters - Regulation parameters - Cycle times....** To change, click on the button **Settings....** Now, the cycle time for the current regulator can be changed. Select the settings according to Figure 7.2.



A change in the cycle times or in the factors only becomes effective after saving and resetting.

Zykluszeiten

Istwerte Sollwerte

	Faktoren	Zykluszeiten
Stromregler	t_i	125,0 μ s
Drehzahlregler	$t_n = 2$	$\times t_i = 250,0 \mu$ s
Lageregler	$t_x = 2$	$\times t_n = 500,0 \mu$ s
Interpolations- berechnung (IPO)	$t_p = 2$	$\times t_x = 1000,0 \mu$ s

Achtung!
Diese Einstellungen werden erst nach 'Save (Parameter)' und 'Reset' des Servoreglers wirksam!

Figure 7.2: Parameterization of the cycle times of the regulator

8 Device Control

8.1 Overview

The PROFIdrive specification **0** 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 using the **Control word 1**, while the state of the device is read back in **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 8.4, 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.

8.2 Control Word 1

Different device functions are controlled with the **Control word 1**, e.g. the regulator release. Individual bits have a corresponding meaning for this purpose. The use of these bits is described in section 8.4, Status Diagram and Device Control. The meaning of the individual bits is then based on the profile PROFIdrive. In addition, some of the functions are 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..2, 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 both the operating modes.

Bit	Meaning	Behaviour
0	ON / OFF (OFF 1)	see section Device Control, Chapter 8.4
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*	1: Ramp generator on 0: Reset Ramp generator	1: All rotational speed set points released 0: All rotational speed set points locked
5*	1: Resume Ramp generator 0: Pause Ramp generator	1: Set value ramp activated 0: Ramp paused (frozen)
6*	1: Release set point 0: Lock set point	1: All set point inputs for ramp released 0: All set point inputs for ramp deactivated
7	Fault acknowledgement (Flank from 0->1)	Active faults are acknowledged, as far as possible
8*	Jog 1 on / Jog 1 off	Movement speed from Position set "Jog positive" is pre-specified as rotational speed set point over the ramp
9*	Jog 2 on / Jog 2 off	Movement speed from Position set "Jog negative" is pre-specified as rotational speed set point over the ramp
10	1: Control through the SPS 0: No control through the SPS	1: Control word is evaluated 0: Control word is not evaluated
11*	Equipment-specific	Free
12-15	Equipment-specific	Free

*: Deviating meaning in other operating mode.

Table 8.1: Control word 1 for operating mode Rotational speed regulation

Bit	Meaning	Behaviour
0	ON / OFF (OFF 1)	see section Device Control, Section. 8.4
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*	1: Do not cancel queued movement task 0: Cancel queued movement job	0: Cancel ongoing positioning or do not start positioning 1: No action
5*	1: No intermediate stop 0: Intermediate stop	0: Do not start any action or positioning 0 ->1: Acceleration as per current position set once again to the movement speed 1: No action 1 -> 0: Stop with brake acceleration according to the current position set
6*	0 -> 1: Activate movement task ***	Manufacturer-specific implementation: 0 -> 1: Start the positioning under the set position data set ¹⁾ under fulfilled boundary conditions ²⁾
7	Fault confirmation (Flank from 0->1)	Active faults are acknowledged as far as possible
8*	Jog 1 on / Jog 1 off	Manufacturer-specific implementation: 0 -> 1: Start positioning as per the Position set 'Jog positive' 1 -> 0: Hold with brake acceleration according to the Position set 'Jog positive'
9*	Jog 2 on / Jog 2 off	Manufacturer-specific implementation: 0 -> 1: Start positioning according to the Position set 'Jog negative' 1 -> 0: Hold with brake acceleration according to the Position set 'Jog negative'
10	1: Control through the PLC 0: No control through the PLC	1: Control word is evaluated 0: Control word is not evaluated
11*	Start/Stop reference movement	1: (No action) Continue reference movement 1 -> 0: Reference movement still active: Cancellation of the reference movement without faults Reference movement already ended: No action 0: No action 0 -> 1: Start the reference movement ³⁾
12*	Relative / absolute	On starting a positioning: 1: Relative positioning 0: Absolute positioning
13*	Interrupt / append running positioning	Upon starting a positioning: 1: Cancel current posit. , immediately start new one. 0: Append positioning to the ongoing one at the end
14,15	Device-specific	

- *: Deviating meaning in other operating mode.
- ** : Manufacturer-specific bit
- ***: Manufacturer-specific deviation from the PROFIdrive specification

Table .1.2: Control word 1 for operating mode positioning

Notes on Table .1.2:

¹⁾: The command “Activate movement task” starts the position set selected through PNU 1002 0. If the PROFIBUS position set is started, the current options of the 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 section. 8.4 . The servo-positioning regulator accepts different states between which defined transitions can be executed. These transitions are activated by so-called commands through the bits 0..3. The commands are explained in more detail in chapter 8.4 . They are presented in the following table for overview:

Command:	Bit 3	Bit 2	Bit 1	Bit 0	Status 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 1.3: Overview of all the commands (× = 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 **State 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**.

8.3 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 8.4, 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	State word 1
Data type	UINT16
Access	ro
Unit	-
Value range	-
Default value	-

In the response telegram 0..2 , 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 modes of operation.

Bit	Meaning	Behaviour
0	1: Ready To Switch On 0: Not Ready To Switch On	see Device Control, Section. 8.4
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 fault 0: No active fault
4	1: No OFF2 0: OFF2	1: No OFF2 command active 0: OFF2-command (Control word 1, output 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	see Section Device control
7	1: Warning Present 0: No Warning Present	1: Active warning and/or set point locked active through the limit switch in at least one direction of rotation 0: No warning active
8*	1: Rotational speed fault within tolerance 0: Rotational speed fault outside tolerance	1: The actual rotational speed lies within the parameterizable reporting window around the desired rotational speed 0: The actual rotational speed is outside the parameterizable reporting window around the desired rotational speed
9	1: Control through PLC 0: No control through the PLC	Reflection of bit 10 from the Control word 1

10*	1: f or n reached 0: f or n not reached	1: Actual speed > freely parameterizable reference speed ¹⁾ 0: Actual speed < freely parameterizable reference speed ¹⁾
11-13*	Device-specific	free
14-15	Device-specific	free

*: Deviating meaning in other operating mode.

Table 1.4: Status word 1 for operating mode rotational speed regulation

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	Meaning	Behaviour
0	1: Ready To Switch On 0: Not Ready To Switch On	see section Device Control, section 8.4
1	1: Ready To Operate 0: Not Ready To Operate	
2	1: Operation Enabled 0: Operation Disabled	1: Regulator release is active 0: Regulator release is not active
3	1: Fault Present 0: No Fault Present	1: Active fault 0: No fault active
4	1: No OFF2 0: OFF2	1: No OFF2 command active 0: OFF2 command (Control word 1, output 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	see section Device Control
7	1: Warning Present 0: No Warning Present	1: Active warning and/or target value lock active through the limit switch in at least one direction or rotation 0: No warning active
8*	1: Contouring error within tolerance 0: Contouring error out of tolerance	1: No contouring error 0: Contouring error message active
9	1: : Control through the PLC 0: No control through the PLC	Reflection of bit 10 from the Control word 1
10*	1: Target achieved and in target window 0: Not in target window	1: The ongoing positioning is completed and the actual position is in the target window 0: The ongoing positioning is still active or the actual position is not in the target window
11*	1: Reference position valid	1: A reference movement was completed

	0: Reference position invalid	successfully 0: No reference movement was executed or the location information has become invalid due to a fault
12*	Traversing Task Acknowledge	see detailed description
13*	1: Drive stopped 0: Drive moving	1: Actual speed within a fixed tolerance window around 0 and no positioning active or intermediate stop active 0: Actual speed out of the tolerance window around 0 or the above condition is not fulfilled
14-15	Device-specific	free

*: Deviating meaning in other operating mode.

Table 1.5: State word 1 for operating mode Positioning

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	Mask	Value
	0040	0004	0002	0001		
	h	h	h	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 1.6: Device status (× = not relevant)

Bits 4 and 5 depend upon the command and are therefore not listed at all in Table 1.6 or are suppressed in the screen.

8.4 Status Diagram and Device Control

This chapter describes how the servo-positioning regulator of the SE-Power device family can be controlled with the help of both the data words Control word 1 (PNU 967) and State 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:

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**

- 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** 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** The states and the state transitions together make up the status diagram that is the overview of all statuses and the respective possible transitions.

8.4.1 Status Diagram

The statuses have been adopted to a great extent from the PROFIdrive specification. PROFIdrive differentiates between the Ramp stop and Quick stop. In Firmware 3.0 the regulator release is uniformly switched off, so that the simplified status diagram according to Figure 1.1 is obtained.

After getting switched on, the servo-positioning regulator initializes itself and then achieves the status **SWITCHING_ON_INHIBITED**. The output stage is deactivated and the motor shaft can be turned freely. The status **OPERATION** can be reached through the status transitions **1**, **2** and **3**. This corresponds to the regulator release through PROFIBUS. The output stage is switched on in this status and the drive is controlled 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.

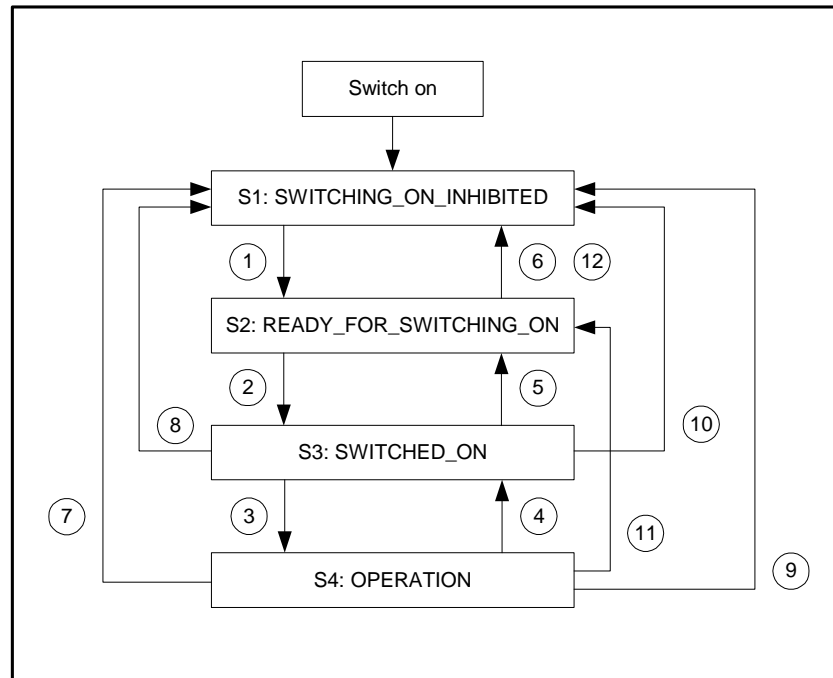


Figure 1.1: Simplified status diagram

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 canceling 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 :

Name	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 for the digital inputs "Output stages" and "Regulator release" on 24 V (Regulator release logic "DI5 and Profibus").
SWITCHED_ON	The output stage release is active.
OPERATION	The motor has power and is controlled according to the operating mode.

8.4.2 Device Control

Certain bit combinations must be set in **Control word 1** in order to be able to execute the status transitions represented in section 0 (see below). 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 Section 8.4.3.

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 **State word 1** by evaluating the relevant bits. This is entered in the last column.

No	Is executed when	Bit combination Control word 1				Action	State word 1 ¹⁾	
		Bit	3	2	1			0
1	Output stage and regulator release available + no Coast Stop + no Quick Stop + Command OFF	OFF =	x	1	1	0	None	0x0201
2	Command ON	ON =	0	1	1	1	Switching on the output stage release	0x0203
3	Command Enable Operation	Enable Operation =	1	1	1	1	Control according to the set operating mode	0x0207
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 spins on and can be turned freely	0x0250 or 0x0270

¹⁾: After the ending of the status transition, mask for the relevant bits is 0x0277

Table 1.7: Most 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 should be “released”, i.e. output stage and regulator release should be activated through the PROFIBUS:

The servo-positioning regulator is in status **SWITCH_ON_INHIBITED**

The servo-positioning regulator should **change** into the status **OPERATION**

According to the status diagram (**Figure 1.1**), the transitions 1, 2 and 3 are to be executed.

From **Table 1.7** it follows that:

Transition 1:	Control word 1 = 0406 _h	New status: READY_FOR_SWITCHING_ON ^{*1)} State word 1 = 0x0201
Transition 2:	Control word 1 = 0407 _h	New status: SWITCHED_ON ^{*1)} State word 1 = 0x0203
Transition 3:	Control word 1 = 040F _h	New status: OPERATION ^{*1)} State word 1 = 0x0207

Notes:

The example assumes that no other bits are set in **control word 1**. Bit 10 must be set, otherwise only bits 0..3 are relevant for the transitions.

^{*1)} The Master must wait until the status in the **State word 1** can be read back in the relevant bits (mask = 0x0277). This is explained in more detail below.

8.4.3 Command Overview

The following table lists all commands corresponding to the status transitions listed in Chapter 0 :

No	Is executed when	Bit combination Control word 1				Action	State word 1 ¹⁾	
		Bit	3	2	1			0
1	Output stage release and regulator release exists + no Coast Stop + no Quick Stop + Command OFF	OFF =	x	1	1	0	None	0x0201
2	Command ON	ON =	0	1	1	1	Switching on the output stage release	0x0203
3	Command Enable Operation	Enable Operation =	1	1	1	1	Controlling 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 or. 0x0270
7	Command Coast Stop	Coast Stop =	x	x	0	x	Output stage is locked. Motor spins on and can be turned freely.	0x0250 or. 0x0270
8	Command Coast Stop	Coast Stop =	x	x	0	x	Withdrawal of the output stage release	0x0250 or. 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 release	0x0260
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	0x0260

No.	Is executed when	Bit combination Control word 1				Action	State word 1 ¹⁾
		Bit	3	2	1		
						regulator release	

¹⁾: After ending the status transition, mask for the relevant bits is 0x0277

Table 1.8: Overview of all state transitions of the servo-positioning regulator

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.



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.

9 Manufacturer-Specific Parameter Numbers

9.1 Overview

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

PNU	Sub-index	Description	Type	Access	Product-level
1000	0	Position set number (Read/Write)	UINT16	rw	3.0
1001	-	(Position Data)			
	0	Target position	INT32	rw	3.0
	1	Speed of movement	INT32	rw	3.0
	2	Final speed	INT32	rw	3.0
	3	Acceleration (positioning)	UINT32	rw	3.0
	4	Braking acceleration (positioning)	UINT32	rw	3.0
	5	Acceleration and braking acceleration (positioning)	UINT32	rw	3.0
1002	0	Position set number for starting	UINT8	rw	3.0
1010	0	Set point of rotational speed	INT32	rw	3.0
1011	-	(Accelerations for velocity regulation)			
	0	Acceleration control (rotational speed regulation)	UINT32	rw	3.0
	1	Braking acceleration (rotational speed regulation)	UINT32	rw	3.0
	2	Acceleration and braking acceleration (rotational speed regulation)	UINT32	rw	3.0
1100	0	Actual position	INT32	ro	3.0
1101	0	Rotational speed actual value	INT32	ro	3.0
1102	0	Active current actual value	INT32	ro	3.0
1141	0	Status of the digital inputs	UINT32	ro	3.0
1500	0	Operating mode	UINT8	ro	3.0
2010	-	(Placeholder)			
	0	8-bit placeholder (empty element)	UINT8	rw	3.0
	1	16-bit-placeholder (empty element)	UINT16	rw	3.0

PNU	Sub-index	Description	Type	Access	Product-level
	2	32-bit placeholder (empty element)	UINT32	rw	3.0
2011	0	32-bit placeholder (empty element)	UINT32	rw	3.0

9.2 PNUs for the Operating Mode Positioning

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

9.2.1 PNU 1000: Data 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 controller. 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 Afag SE-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.

These parameters can also be used to access the special position data sets for reference movements or jogging. However, due to the special structure of the data sets, it is recommended that the parameter-setting program SE-Commander™ should be used for the parameterizing.

PNU	1000
Sub-index	0
Name	Data Set Number
Data type	UINT16
Access	Rw
Unit	-
Value range	0 .. 267 0..255: Standard position data set 256: Reference movement phase 0 257: Reference movement phase 1 258: Reference movement phase 2 259: Jog positive 260: Jog negative 261..265: reserved 266: Position data set PROFIBUS 267: reserved
Default- value	266 (PROFIBUS position set)

9.2.2 PNU 1002: 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 256 storable standard- position data sets. These can be uniquely selected over 8 bits. Apart from these 256 sets, only the PROFIBUS position data set for starting is of interest. To keep the data to be transmitted over the bus as small as possible, the PROFIBUS- position data set is addressed in the last index. Thus the position data set 255 itself cannot be started over the bus.

PNU	1000
Sub-index	0
Name	Start set number
Data type	UINT8
Access	Rw
Unit	-
Value range	0 .. 255 0..254: Standard position data sets 255: Position data set PROFIBUS
Default- value	255 (PROFIBUS position set)

9.2.3 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

Speed of movement

End speed

Acceleration and braking acceleration, each individually or as combination for both the accelerations

The data is interpreted in the manner in which it is set as a physical unit. For this purpose, the parameterizing software Afag SE-Commander™ provides a corresponding window, see section 6 Physical Units.

Under this PNU, it is also possible to set parameters for the jogging, for example. For this purpose, the position set number is to be set accordingly at first, then, for example, the speed during the jogging can be defined through the movement speed.

PNU	1000
Name	Position Data

Sub-index	0
Name	Target Position
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS position
Value range	-
Default value	0

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

Sub-index	2
Name	End Velocity
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS speed
Value range	-
Default value	0

Sub-index	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

Sub-index	4
Name	Deceleration Positioning (Braking 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 the same value.

Sub-index	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

9.3 PNUs for Operating Mode Rotational Speed Regulation

The parameters needed for the operating mode Rotational speed regulation are described in this section.

9.3.1 PNU 1010: Target Velocity

The set value of the rotational speed is set through the PROFIBUS using these parameters. The fixed set value of 1 is intended for this target value. In the operating mode Rotational speed, this set value is also selected automatically.

In principle, it is also possible to save the fieldbus set value 1 as a fixed set value even in the parameter set. When the PROFIBUS communication is active in the parameter set, the fieldbus set value is always set to zero. The value saved in the parameter set is therefore always overwritten.

The value 0 for the PROFIdrive Control word 1 leads to the condition, where the fieldbus set value is not routed to the ramp (set value not released). The settings of the set value selector for rotational speed control must take place beforehand with an inactive PROFIBUS communication. More information on this topic is available in section. 10 Operating Modes

PNU	1010
Sub-index	0
Name	Target velocity
Data type	INT32
Access	rw
Unit	Physical unit PROFIBUS speed
Value range	-
Default value	0

9.3.2 PNU 1011: Accelerations for Velocity Control

This parameter can be used to select the position data set, which is started upon a start command for positioning through the Control word 1. The servo-positioning regulator has 256 storable standard position data sets. These can be uniquely selected through 8 bits. Apart from these 256 sets, only the PROFIBUS position data set for starting is of interest. To keep the data transmitted over the bus as little as possible, the PROFIBUS position data set is addressed under the last index. Thus the position data set 255 itself cannot be started through the bus.

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 in the same manner in which it is set as a physical unit. A corresponding window is provided for this purpose by the parameter setting software Afag SE-Commander™, see section. 6 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. Please note 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 re-writing this value.

PNU	1011
Name	Accelerations for Velocity Control

Sub-index	0
Name	Acceleration Velocity Control (Acceleration ramp rotational speed control)
Data type	UINT32
Access	Rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default value	14,100 (rpm)/s

Sub-index	1
Name	Deceleration Velocity Control (Braking ramp rotational speed control)
Data type	UINT32
Access	Rw
Unit	Physical unit PROFIBUS acceleration
Value range	-

Default value	14,100 (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.

Sub-index	2
Name	All Accelerations Velocity Control (Acceleration and braking acceleration for rotational speed control)
Data type	UINT32
Access	Rw
Unit	Physical unit PROFIBUS acceleration
Value range	-
Default- value	14,100 (rpm)/s

9.4 Actual Values

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

9.4.1 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. Errors can occur while calculating the actual value of the position, since the internal position of the servo-positioning regulator has a larger depictable value range than can be transmitted through PROFIBUS. However this depends on the physical units that have been set as well as the gear transmission factor and the feed constant. Please contact Technical Support if necessary.

PNU	1100
Sub-index	0
Name	Position Actual Value
Data type	INT32

Access	Rw
Unit	Physical unit PROFIBUS position
Value range	-
Default value	-

9.4.2 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
Sub-index	0
Name	Velocity Actual Value
Data type	INT32
Access	ro
Unit	Physical unit PROFIBUS speed
Value range	-
Default value	-

9.4.3 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
Sub-index	0
Name	Current Actual Value
Data type	INT32
Access	ro
Unit	Per million referred to the motor nominal current
Value range	-
Default value	-

9.4.4 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 or through the optional technology modules.

PNU	1141
Sub-index	0
Name	Digital Inputs
Data type	UINT32
Access	ro
Unit	-
Value range	Bit assignment: Bit 0: reserved (= 0) Bit 1: DIN 0 Bit 2: DIN 1 Bit 3: DIN 2 Bit 4: DIN 3 Bit 5: DIN 4 (digital output stage release) Bit 6: DIN 5 (digital regulator release) Bit 7: DIN 6 (limit switch 0 left = negative direction of rotation) Bit 8: DIN 7 (limit switch 1 right = positive direction of rotation) Bit 9: DIN 8 (Default: Start input) Bit 10: DIN 9 (Default: sample input) Bit 11: DIN 10 (optional dig. input instead of DOUT 2) Bit 12: DIN 11 (optional dig. input instead of DOUT 3) Bit 13..20: DIN 0..7 from optional technology module EA88 in slot 1 Bit 21: DIN_AIN 1 (optional digital input instead of analog input 1) Bit 22: DIN_AIN 2 (optional digital input instead of analog input 2) Bit 23..30: DIN 0..7 from optional technology module EA88 in slot 2 Bit 31: reserved
Default value	-

9.5 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.

9.5.1 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

Sub-index	0
Name	8 bits
Data type	UINT8
Access	Rw
Unit	-
Value range	-
Default value	0

Sub-index	1
Name	16 bits
Data type	UINT16
Access	Rw
Unit	-
Value range	-
Default value	0

Sub-index	2
Name	32-bit
Data type	UINT32
Access	Rw
Unit	-

Value range	-
Default value	0

9.5.2 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-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
Sub-index	0
Name	Element 0
Data type	UNT32
Access	Rw
Unit	-
Value range	-
Default value	0

10 Operating Modes

10.1 Overview

The servo-positioning regulator of the SE-Power device family has 3 basic operating modes:

- Torque regulation
- Rotational speed regulation
- Positioning

Within the operating modes, there is varying behaviour owing to the differently parameterizable set value selectors. In the operating mode Positioning, there are additionally different modes, e.g. for point-to-point positioning or clock-synchronous operation.

PROFIdrive 0 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	Identifier
Rotational speed regulation	0	0xE1
Positioning	1	0xE0

It is not currently possible to select other operating modes.

10.2 Parameter

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.

10.2.1 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
Sub-index	0
Name	Operating mode
Data type	UINT8
Access	rw
Unit	-

Range of values	0x08: Rotational speed regulation 0x10: Positioning
Default value	-

10.3 Operating Mode: 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"). Therefore, for implementing these requirements, a few things have to be kept in mind:

In the set value selector, the fixed set value 1 is activated upon activating the PROFIBUS communication at the cumulator. If the regulator release logic is set to DI n5 and Profibus, this selector is also designated as PROFIBUS in MSC.

When the set value for the set value ramp is locked by the PROFIdrive Control word 1, then in the cumulator, there is no set value activated (no control box is checked in MSC).

The set value can be globally deactivated, so that no rotational speed set value has any kind of effect on any of NSC function selectors.

10.4 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 10.1. This can be achieved in two different ways:

Interrupting the ongoing positioning

Start of a follow-on positioning, during which, for the first movement task, the final speed is equal to the movement speed.

The second case is to be applied when the second positioning has to start at a certain position.

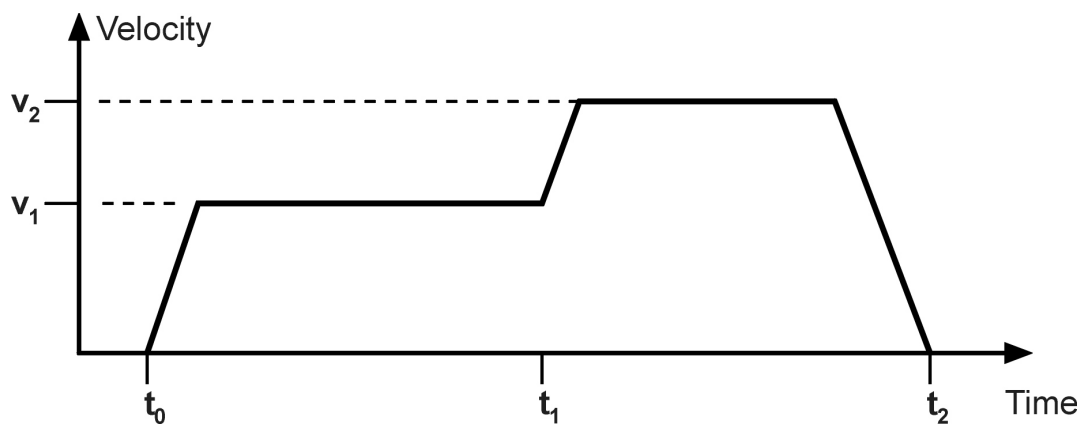


Figure 10.1: Continuous sequence of movement orders

11 Profile-Specific Parameter Numbers

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

11.1 Overview

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

PNU	Sub-index	Description	Type	Access	Product level
918	0	Slave address	UINT16	ro	3.0
963	0	Automatically detected baud rate	UINT16	ro	3.0
964	-	(Device Identification)			
	0	Manufacturer (Manufacturer ID)	UINT16	ro	3.0
	1	Device type	UINT16	ro	3.0
	2	Devices version	UINT16	ro	3.0
	3	Firmware date (year)	UINT16	ro	3.0
	4	Firmware date (day/month)	UINT16	ro	3.0
967	0	Control word 1	V2	rw	3.0
968	0	Status word 1	V2	ro	3.0

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

11.2 Description of the PNUs

The PNUs 967 and 968 are described in detail in Chapter 9 “Device Control”. The other PNUs are explained in the following sections.

11.2.1 PNU 918: Node Address

This parameter returns the slave address of the servo-positioning regulator. In general, the addresses start at 0. The addresses up to 2 are, e.g. however, occupied by the PROFIBUS master or other operating devices. Therefore, the lowest address is 3.

The PROFIdrive specification recommends 126 as the default value. It must be ensured that no exchange of useful data may take place under this address.

PNU	918
Subindex	0
Name	Node address
Data type	UINT16
Access	ro
Unit	-
Range of values	3 .. 126
Default value	126

11.2.2 PNU 963: Actual Baud Rate

This parameter returns the baud rate of the PROFIBUS communication. This is automatically detected by the hardware used.

PNU	963
Subindex	0
Name	Actual baud rate
Data type	UINT16
Access	Ro
Unit	-

Range of values	0: 9.6 kBaud 1: 19.2 kBaud 2: 93.75 kBaud 3: 187.5 kBaud 4: 500 kBaud 5: No baud rate detected or specified 6: 1500 kBaud 7: 3000 kBaud 8: 6000 kBaud 9: 12000 kBaud 11: 45.45 kBaud
Default value	5

11.2.3 PNU 964: Device Identification

The parameter Device Identification returns, under several sub-indices, information on the connected device.

PNU	964
Name	Device identification

Subindex	0
Name	Contents: Manufacturer
Data type	UINT16
Access	ro
Unit	-
Range of values	227 (0x0115)
Default value	227 (0x0115)

Subindex	1
Name	Contents: Device type
Data type	UINT16
Access	ro

Unit	-
Range of values	0x2000: unknown device type 0x2006: SE-Power
Default value	-

Subindex	2
Name	Contents: Version
Data type	UINT16
Access	ro
Unit	-
Range of values	hhss: hh: Main revision ss: Sub-revision
Default value	-

The PNUs with the sub-indexes 3 and 4 specify the date of generation of the firmware. This can also be the same in different product stages or revisions, if nothing has changed in the basic implementation.

Subindex	3
Name	Contents: Firmware date (date of generation, year)
Data type	UINT16
Access	ro
Unit	Year
Range of values	-
Default value	-

Subindex	4
Name	Contents: Firmware date (date of generation, day /month)
Data type	UINT16
Access	ro

Unit	-
Range of values	ttmm: dd: day mm: month
Default value	-

12 Function and Data Modules for SIEMENS S7

12.1 Overview

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

Corresponding example programs have been written for better understanding of the handling of the function modules, and they supplement the application note above.



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 product 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 security-relevant requirements have been fulfilled.



Information

Function and data modules were developed for the SE-Power servo-positioning regulators. These are integrated in the example programs and are available on the internet at www.Afaq.com 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.

Function and data modules for the servo-positioning regulator SE-Power

12.1.1 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 through the SFC14 and written to the slave with the SFC15. The SFCs 14 and 15 are system functions, which must be used for consistent reading and writing of telegrams for lengths > 4 bytes.

The corresponding SFCs are used to deposit the data in the data modules defined for the operating mode. The SFCs are not integrated in the function modules, and must be loaded as S7-program elements.

The DBs practically serve as I/O modules, which are used for controlling the statuses of the servo-positioning regulator and for transferring the data that is to be sent to the servo-positioning regulator.

Separate function modules are required for each operating mode per servo-positioning regulator. Under certain conditions, the use of multiple servo-positioning regulators in different operating modes can lead to bottlenecks with regard to the memory utilization in the application.

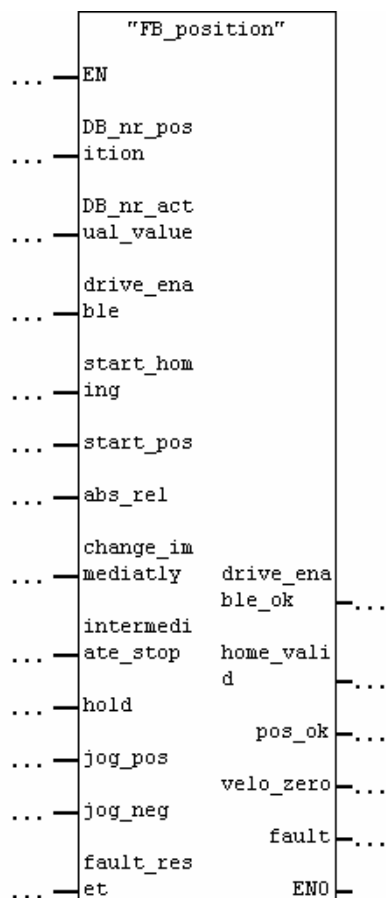


Information

The sequence of the data within the data modules is identical to that which was defined in the telegram format of the respective operating mode (FB).

FBs of the SE-Power servo-positioning regulators

12.1.1.1 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 effect 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. In this case, the output pos_ok is not set at the end of the ongoing positioning, but only at the end of the attached positioning.

intermediate_stop

If this input is not set, a started positioning is shut down. 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 effect 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 set TIPP 0 to the movement velocity also parameterized in this position set.

In case of a falling flank at this input, the drive brakes to a standstill with the braking acceleration set in the position set TIPP 0.

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 set TIPP 1 to the movement **velocity** also parameterized in this position set.

In case of a falling flank at this input, the drive brakes to a standstill with the braking acceleration set in the position set TIPP 1.

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 controller release of the servo-positioning regulator is active.

home_valid:

This output is set if an invalid 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.

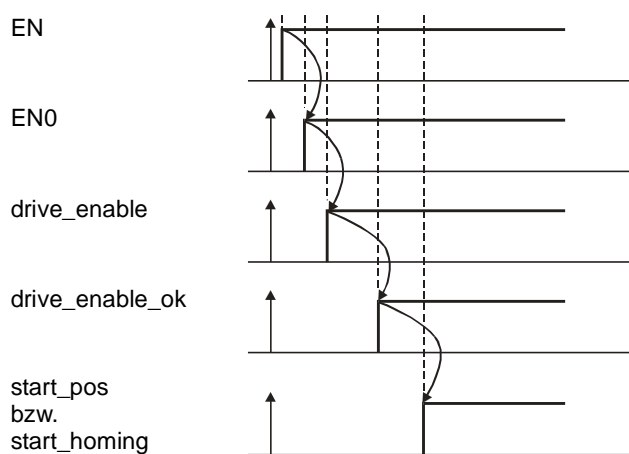
velo_zero:

With the output set, the drive stands still.

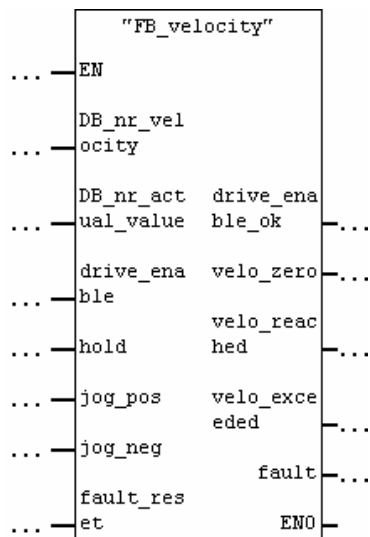
fault:

There is an error at the set output. The regulator release is withdrawn. The output is reset, if the error is acknowledged.

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



12.1.1.2 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 parameterized in the position set TIPP 0. 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 TIPP 1.

In case of a falling flank at this input, the drive brakes to a standstill with the braking acceleration of the set value ramp that has been set.

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 if the actual rotational speed value is zero (± 10 rpm).

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.

12.1.2 Integration of the FBs and DBs

As described in the overview, the function modules and data modules developed for the SE-Power servo-positioning regulators are available for free download.



Information

Download the function modules and data modules at www.afag.com

The modules are zipped in two example projects in the file

FB_DB_ARS_2000_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	ARS2_POS.zip
Rotational speed regulation	ARS2_VEL.zip

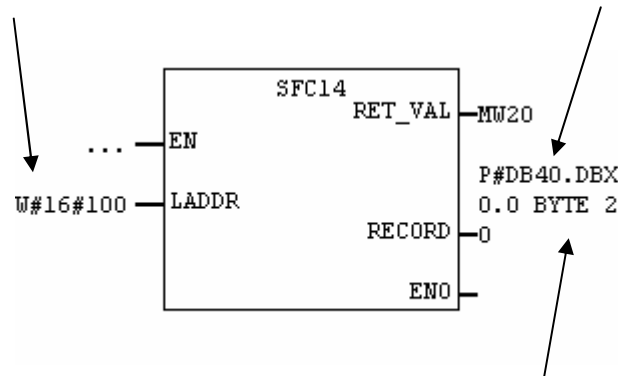
The unzipped sample projects can be extracted under STEP7. The relevant FBs, DBs and possibly SFCs can be copied from these extracted example object.

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



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

Parameter	Declaration	Data type	Storage area	Description
LADDR	INPUT	WORD	E, A, M, D, L, Konst.	Projected starting address from the E-area of the assembly from which reading is to be done.
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 read user data. It must be exactly as long as was projected for the selected assembly with STEP 7. Only the data type BYTE is permissible.

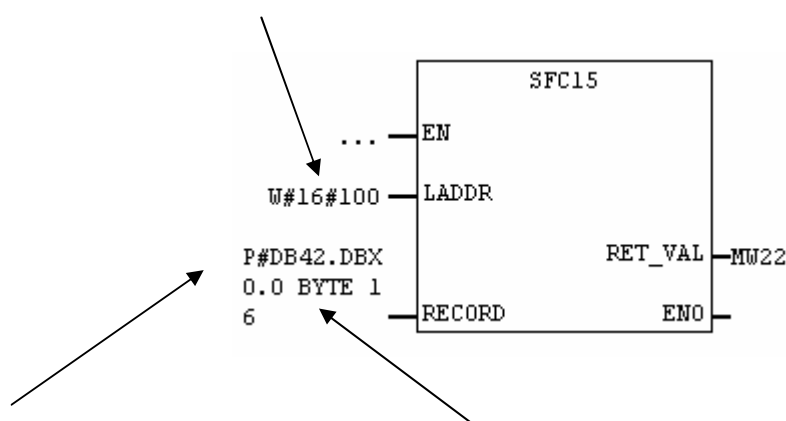
The same actual value data is returned in both the example projects (example project Positioning and example project Rotational speed regulation). Thus, the response telegram is configured the same way in both the example projects.

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 affects the parameterization of the SFC15.

Writing the Data for the Operating Mode Positioning:

Output data area 256dez = 100hex



Data module number,
(0.0)

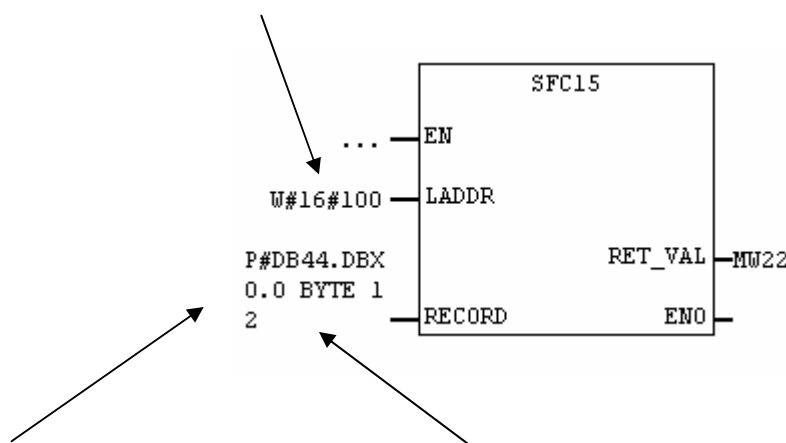
from which the data is sent to the
slave

Starting address within the DB
and number of bytes (16 byte)

to be transferred

Writing the Data for the Operating Mode Rotational speed regulation:

Output data area 256dez = 100hex



Data module number
(0.0)
which the data is sent to the
slave.

Starting address within the DB
and number of bytes (12 from
bytes) to be transferred

Parameter	Declaration	Data type	Storage area	Description
LADDR	INPUT	WORD	E, A, M, D, L, Konst.	Projected starting address from the A-area of the assembly to which writing is to be done.
RECORD	INPUT	ANY	E, A, M, D, L	Source area for the useful data to be written. It must be exactly as long as was projected for the selected module with STEP 7. Only the data type BYTE is permissible.
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.

12.1.3 PROFIBUS Connection of the Servo-Positioning Regulator

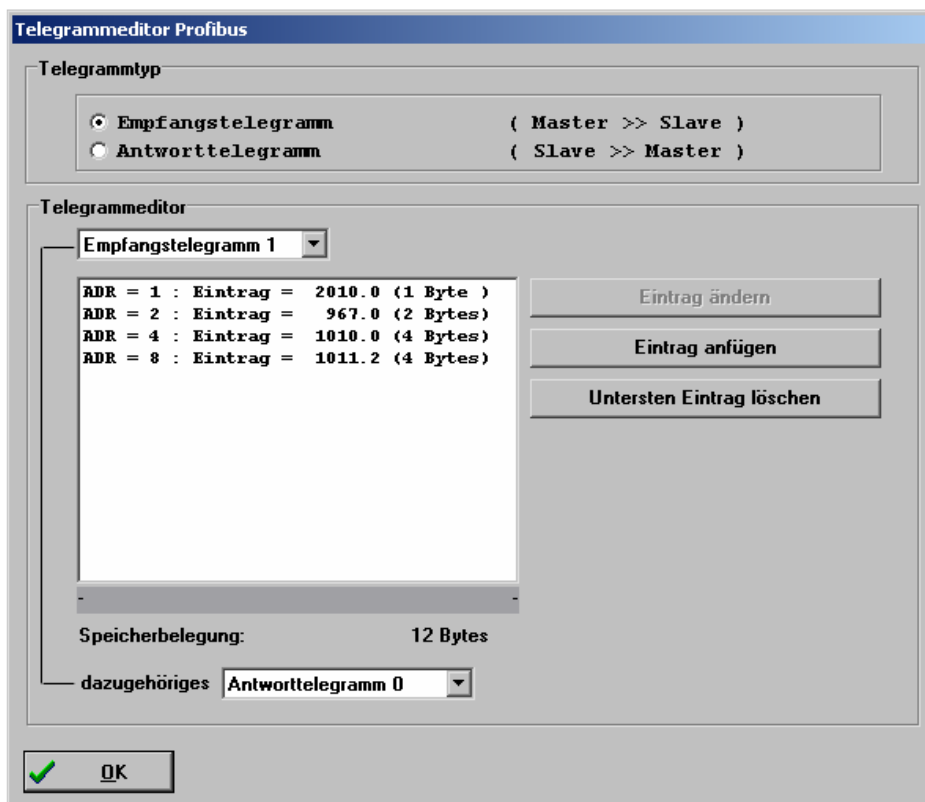
A number of steps are necessary to create a functioning PROFIBUS-connection. Some of these settings should or must be executed before the activation of the PROFIBUS communication.

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 Afag SE-Commander™ according to the example projects. Please refer to the previous chapters of the product manual of PROFIBUS for the handling of the telegram editor or for more information on the respective parameters.

12.1.3.1 Receipt Telegram - Example Project Rotational Speed Regulation

In this case, the receipt telegram 1 is to be configured accordingly on the side of the servo-positioning regulator. The following screenshot shows the parameter setting of the receipt telegram required for the example project:



The following table describes the structure of the telegram:

Addresses	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

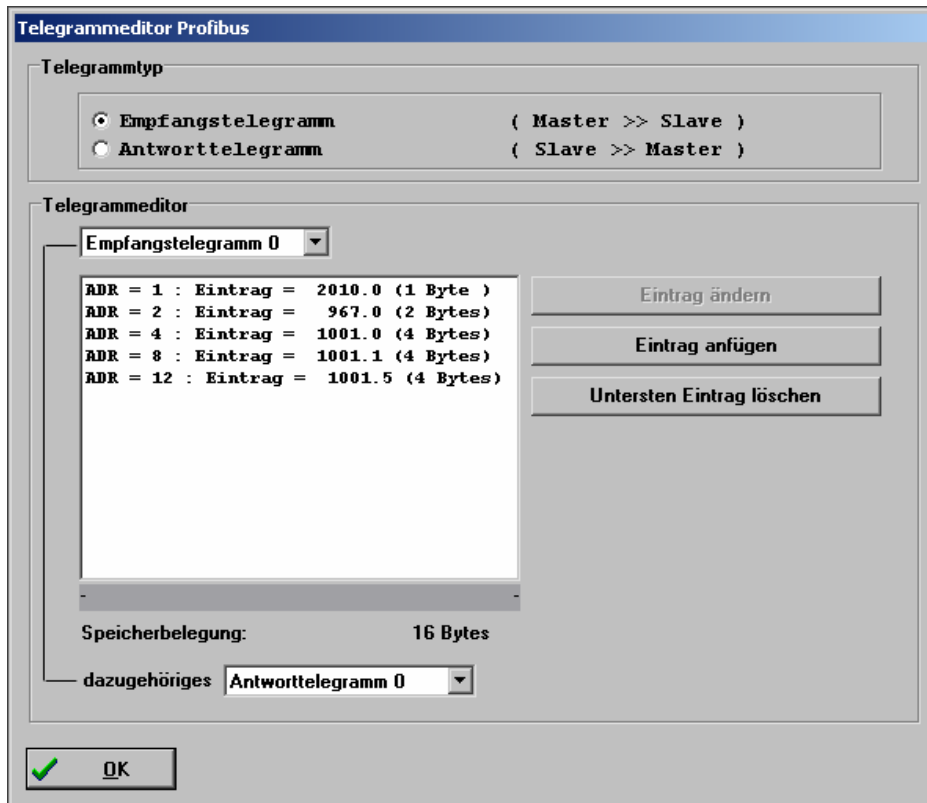
The total length of the telegram is 12 bytes. Therefore, while integrating the slave in the hardware configuration of the master it is necessary to select the module:

6 Words Output

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

12.1.3.2 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:



The following table describes the structure of the telegram:

Addresses	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 of a position in the physical unit set for PROFIBUS
8	Velocity of movement (PNU 1001 1)	Velocity of movement during positioning, specification of a rotational speed in the physical unit 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:

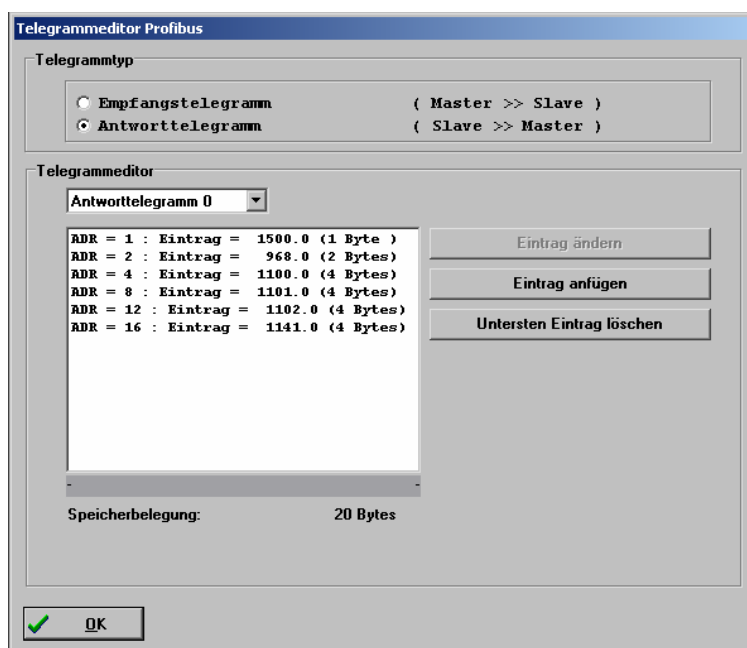
8 Words Output

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

12.1.3.3 Response Telegram for the Example Projects

The same actual value data transferred from the slave to the master is used in both example projects. Therefore, the same response telegram 0 is configured on the

servo-positioning regulator side for both receipt telegrams 0 and 1. The following screenshot shows the parameterizing required for the sample project:



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)	Combination of the values for acceleration and braking acceleration, specification of an acceleration in the physical unit set for PROFIBUS
16	Active current actual value (PNU 1141 0)	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 20 bytes. Therefore, while integrating the slave in the hardware configuration of the master it is necessary to select the module:

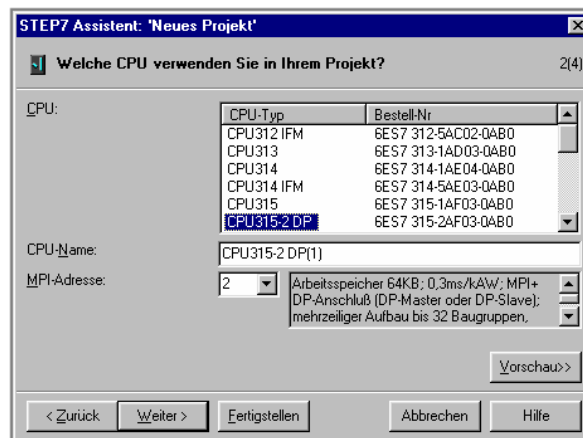
10 Words Input

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

12.1.4 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 Assistant is

recommended. The STEP 7 Assistant 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.

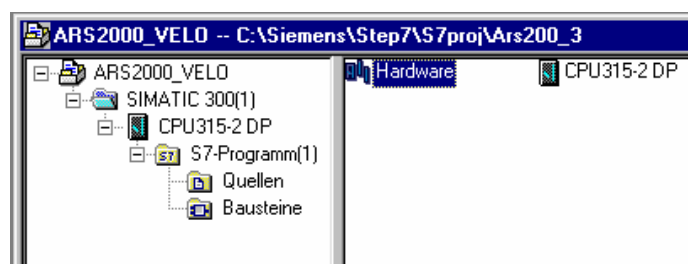
More modules can be inserted later.

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

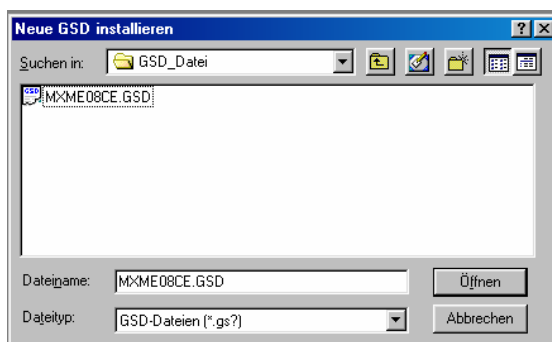
12.1.5 Integrating the GSD File

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.

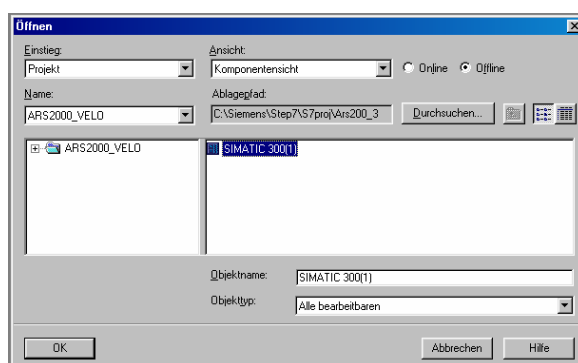


The command **Options->Install new GSD...)** is then used to insert the GSD file MXME08CE.gsd, which is required for adding the ARS2000 in the hardware catalog.



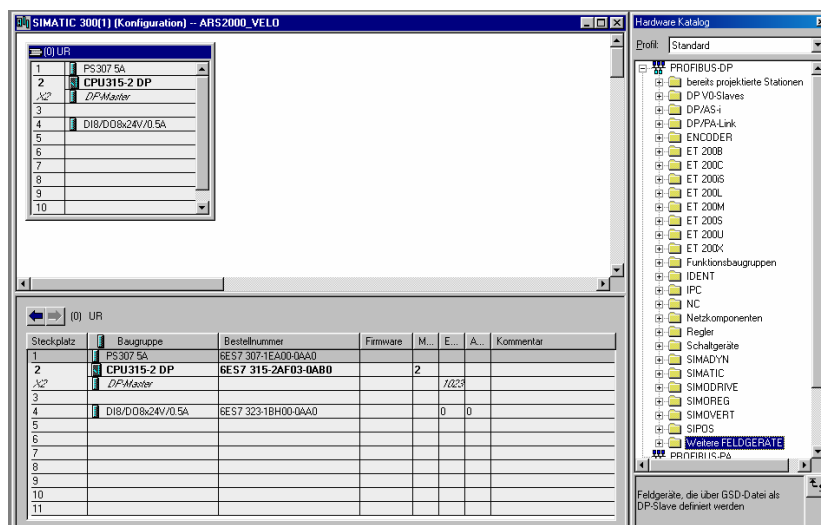
12.1.6 The Hardware Configuration

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 catalog from which the hardware components are selected. If it is not shown, it can be displayed with the command **View -> Catalog**.



Use the mouse to select the hardware components to be used from the **hardware catalog** 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	D18/DO8x24V/0.5A	6ES7 323-1BH00-0AA0		0	0
5					



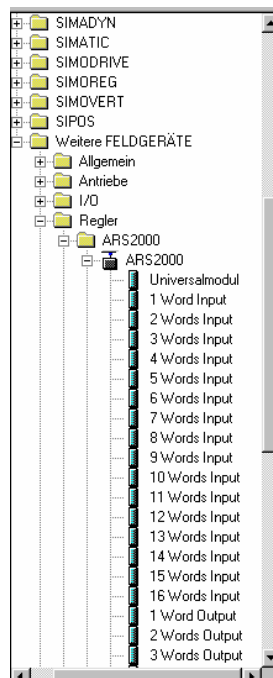
Information

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.

12.1.7 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 catalog from the directory **PROFIBUS-DP -> More FIELD EQUIPMENT -> Regulator -> ARS2000** using Drag & Drop.

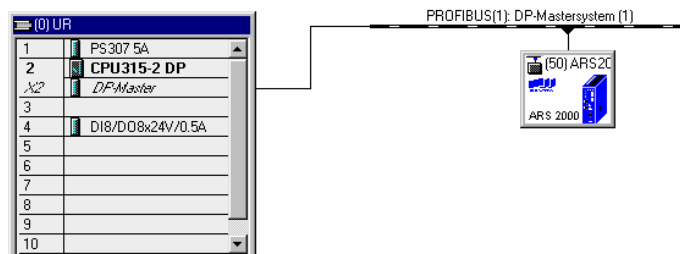


The respective telegram length must be taken into consideration while selecting the module. More specifically, the module **8 Words Output** should be selected for the set value telegram Positioning operation or the module **6 Words Output** should be selected for the set value telegram for Rotational speed regulation, or the module **10 Words Input** should be selected for the actual value telegram. 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 Afag SE-Commander™. The servo-positioning regulator is now connected.

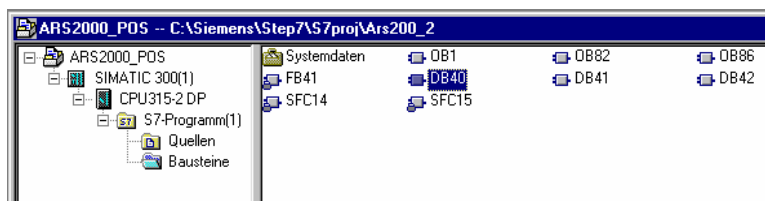
The hardware configuration should now appear as follows.



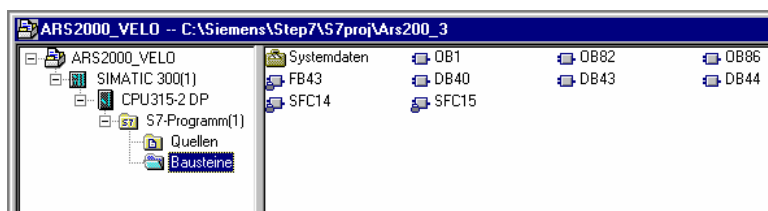
The S7 Project is now prepared to such an extent that the programming can be started.

12.1.8 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

DB40 actual_value Actual value data of the servo-positioning regulator (for both sample projects)

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	DINT	L#0	L#0	übertragener Parameter in default-Parametrierung

Positioning

- FB41 FB_position Function module for the operating mode Positioning
- DB41 Instance DB for FB41 The data module of the internal variables belonging to the function module
- DB42 DB_position Positioning data

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	PROFDRIIVE_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

Rotational Speed Regulation

- FB23 FB_velocity Function module for the operating mode Rotational speed regulation
- DB23 Instance DB for FB23 The data module of the internal variables belonging to the function module
- DB24 DB_velocity Data for operating mode Rotational speed regulation

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	PROFDRIIVE_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



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