Servo Controller
SE-Power FS

- **PROFIBUS/PROFINET Manual**

Complementary document to the Operating Instruction

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This manual is a complementary document to the operating instructions and applies to:

Type	Order No.
SE-Power Profibus Interface	50036340
SE-Power Profinet Interface	50445640

Version of this documentation:	SE-Power FS Profibus-Profinet-Manual vers. 5.2 en.01.06.2022

Assembly and initial start-up may be carried out by qualified personnel only and according to these operating instructions.

Caution!

As this manual is a complementary document to the operating instructions it alone is not sufficient to carry out installation and commissioning of the device.

Please pay attention to the notes in:

1.1 Documentation

1 General

1.1 Documentation

For the Servo Controllers of the SE-Power series are considerably documentations available.

There are main documents and complementary documents.

The documents contain safety instructions that must be followed.

Main document:

present	documentation / description
☐	▪ **SE-Power FS Operating manual** Description of the technical data and the functions of the device as well as notes on the plug assignment, installation and operation of the SE-Power FS servo controller series. It is meant for persons who want to get familiar with the SE-Power FS servo controller

Caution!
The operating manual is the main document and must be read by all means before installation and start-up of all devices of the SE-Power FS series.

Complementary documents to the operating manual:

present	documentation / description
☐	▪ **SE-Power FS mounting instructions** This manual is included during delivery of the SE-Power FS devices and provides an extract from the manual represents the installation instructions contained therein make sure that they can easily operate the servo drive.
☐	▪ **SE-Power FS STO-manual** Description of the technical data and the device functionality, installation, and operation of the safety module STO.
☐	▪ **SE-Power FS MOV-manual** Description of the technical data and the device functionality, installation, and operation of the safety module MOV.
☐	▪ **SE-Power Software-manual** Description of the software SE-Commander with the individual functions.

present	documentation / description
☐	▪ **SE-Power CANopen-manual** Description of the implemented CANopen protocol according to CiA DSP402 and DS301.
☒	▪ **SE-Power FS PROFIBUS/PROFINET-manual** Description of the implemented PROFIBUS-DP and PROFINET protocols, the technical data and the device functionality, installation, and operation of the fieldbus-modules „SE-Power Profibus Interface“ and „SE-Power Profinet Interface“.
☐	▪ **SE-Power EtherCAT-manual** Description of the fieldbus control by using the CoE (CANopen over EtherCAT) protocol, the technical data and the device functionality, installation, and operation of the fieldbus-module „SE-Power EtherCAT Interface“.
☐	▪ **SE-Power FS Programming example Profibus Siemens S7 V5.5** Description of the configuration and program to the programming example Profibus for Siemens S7 V5.5.
☐	▪ **SE-Power FS Programming example Profibus Siemens S7 TIA V12** Description of the configuration and program to the programming example Profibus for Siemens S7 TIA V12.
☐	▪ **SE-Power FS Programming example Profinet Siemens S7 TIA V13/V14** Description of the configuration and program to the programming example Profinet for Siemens S7 TIA V13.1 and V14.0.

These documents are available for download on our homepage:

www.afag.com

1.2 PROFIBUS and PROFINET documentation

PROFIBUS (PROcess FIeldBUS) and PROFINET (PROcess FIeld NETwork) is a standard developed by the German association PROFIBUS Nutzerorganisation e.V. A complete description of the fieldbus systems can be found in the following standards:

IEC 61158 "Digital data communication for measurement and control – Fieldbus for use in industrial control systems": This standard has several parts and defines the "Fieldbus Protocol Types". In accordance with these types, PROFIBUS is specified as type 3 and PROFINET as type 10. There are two different PROFIBUS versions. One of them is PROFIBUS-DP for the rapid data exchange in production engineering and building automation applications (DP = decentralised peripherals). The standard also describes the integration in the ISO/OSI layer model.

IEC 61784-2 "Industrial communication networks - Profiles - Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3 (IEC 61784-2:2014)": This standard defines the real-time classes (RTC = real-time class) based on the reaction time

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

Further documentation (in German) concerning the use of PROFIBUS-DP and PROFINET:

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

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

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

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

5. IEC 61158 - Feldbus für industrielle Leitsysteme

6. Industrielle Kommunikation mit PROFINET
   Manfred Popp
   PROFIBUS Nutzerorganisation e.V., 2014

2 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.

3 Safety

3.1 General Instructions

	Caution! The safety instructions in the operating manual must be followed. The operating manual is the main document and must be read by all means before installation and start-up of all devices of the SE-Power FS series independent of the respective model.

4 Wiring and pin assignment

4.1 PROFIBUS

4.1.1 Pin assignment

In the SE-Power product range, the PROFIBUS interface has been realised in the form of an optional technological plug-in module. Normally it is pre-plugged at the factory, but it can also be retrofitted.

In accordance with EN 50170, the PROFIBUS connector is a female 9-pin DSUB connector (at the technological plug-in module).

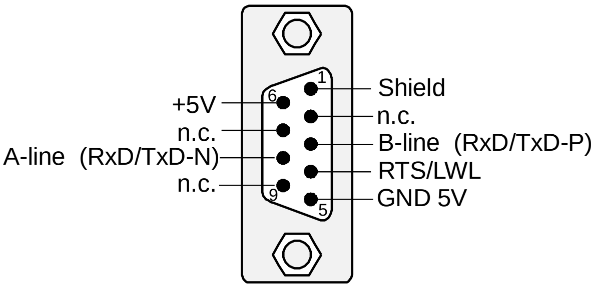


Figure 1: PROFIBUS connector for SE-Power

PROFIBUS wiring

Because of the very high baud rates we recommend using standardised cables and connectors. They offer additional diagnose functionalities and facilitate rapid analysis of the field bus hardware in the event of malfunctions.

When setting up the PROFIBUS network, compliance with the information given in the standard literature and the following information and notes is strongly recommended in order to obtain a stable, trouble-free system. Improper wiring may lead to problems with the PROFIBUS causing the servo drive to automatically deactivate itself while signalling an error.

4.1.2 Termination and bus terminating resistors

Every bus segment of the PROFIBUS network has to be equipped with bus terminating resistors to minimise line reflections, to guarantee practically constant load behaviour on the bus and to adjust a defined rest potential on the line. Termination has to be provided at the **beginning** and at the **end of every bus segment**.

The terminating resistors of the PROFIBUS module of the SE-Power product range are already integrated in the module so that external connections (special connectors) are not required. The terminating resistors can be activated by setting the two DIP switches on the module (switches set to ON).

> **Bus terminating resistors**
>
> The DIP switches for activating the bus terminating resistors are already integrated in the technological modules of the SE-Power product range.

External connection is also possible. The power supply of 5 V required for the externally connected terminating resistors is supplied to the PROFIBUS connector of the module (see pin assignment).

> Faulty bus termination is the most common cause of errors in the event of malfunctions.

If the adjusted baud rate is > 1.5 MBaud, connectors with integrated line inductors (110 nH) have to be used because of the capacitive load of the device and the resulting line reflections.

4.1.3 Bus cable

PROFIBUS cable:

SIMATIC NET, PB FC standard bus cable, twisted pair, shielded, special design for quick connection, 20 m.

Manufacturer: SIEMENS

Order no.: 6XV1 830-0EN20

4.2 PROFINET

4.2.1 Connection and display elements of the technology module

For the SE-Power series, the PROFINET interface has been realised in the form of an optional technology plug-in module with two RJ45 jacks. Normally, it is already plugged in at the factory, but it can also be retrofitted.

1	ACT-LED
2	LNK-LED
3	SF-LED
4	BF-LED
5	PROFINET interface

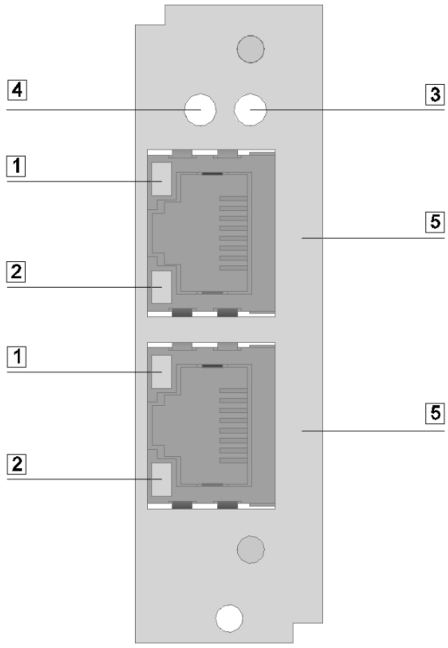


Figure 2: Connection and display elements of the PROFINET module

LED	Status	Meaning
SF	Off	No system errors
	Lights up red	Watchdog timeout Channel diagnostics General or extended diagnostics System error
	Flashes red (1 Hz for 3 s)	PROFINET device identification
BF	Off	No bus errors
	Lights up red	No configuration Fault concerning the physical link No physical link
	Flashes red (2 Hz)	No data transfer
LNK	Off	No link available
	Lights up green	Link available
ACT	Off	No Ethernet communication available
	Lights up orange	Ethernet communication available
	Flashes orange	Ethernet communication active

Table 1: PROFINET-LEDs

4.2.1 Pin assignment

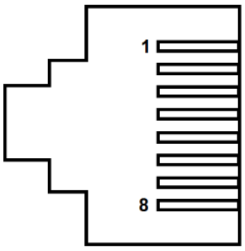
Socket	Pin no.	Name	Description
	1	RX-	Receive signal-
	2	RX+	Receive signal+
	3	TX-	Transmission signal-
	4	-	-
	5	-	-
	6	TX+	Transmission signal+
	7	-	-
	8	-	-

Table 2: Pin assignment of the PROFINET interface

4.2.2 Bus cable

A PROFINET copper cable is usually a 4-core, shielded copper cable. Like in the case of standard Ethernet applications, the maximum distance that can be covered by way of copper cables is limited to 100 m between the communication endpoints. The link is defined as a PROFINET end-to-end link.

PROFINET cabling

The only cables that can be used in automation systems are PROFINET cables. PROFINET cables have a corresponding manufacturer's declaration.

The joint use of power cables and copper cables for communication purposes is subject to regulations in order to minimise the electromagnetic influence of the power cables on the communication cables.

When setting up the PROFINET network, it is essential to follow the advice that is given in the technical literature and to comply with the information and notes hereinafter in order to realise a stable, trouble-free system.

5 Fundamental principles: PROFIBUS-DP, PROFINET and PROFIdrive

The technology plug-in module of the SE-Power servo drive can either be combined with a PROFIBUS plug-in module or with a PROFINET plug-in module. As shown in *Figure 3,* the selection of the fieldbus system does not affect the control of the application. The control and monitoring data of the application are transferred to the fieldbus via the active fieldbus and transmission system.

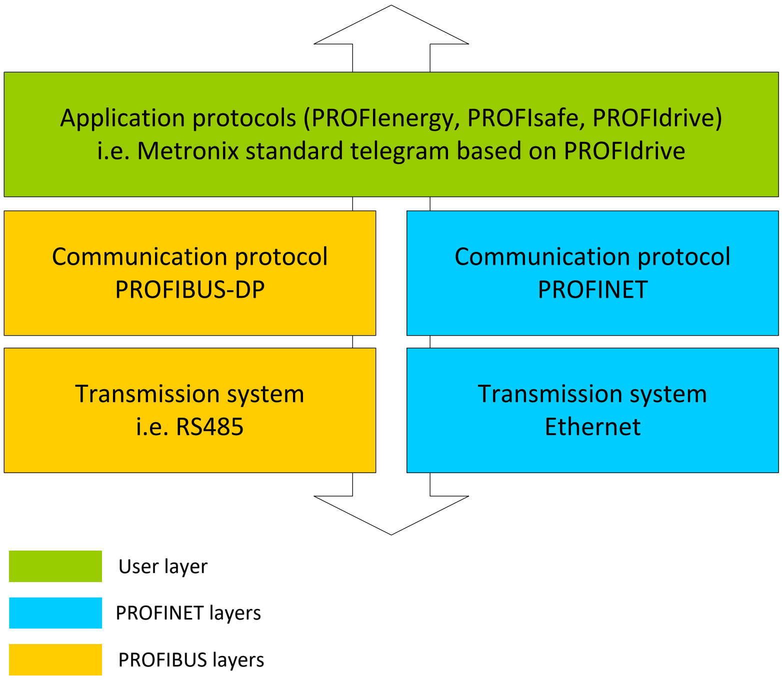


Figure 3: Comparison of PROFIBUS and PROFINET

The following chapters provide a brief description of the fundamental characteristics of PROFIBUS-DP and PROFINET. This is followed by a presentation of the Afag-specific application profile based on PROFIdrive.

5.1 Overview of DP and its Power Stages

The DP communication protocol (DP = decentralised peripherals) is intended for quick data exchange on the field level. On this level, central automation devices, such as PLC, PC or process control systems communicate via a quick serial connection with decentralised field devices, such as I/O devices, drives, valves, measuring transducers and analysis devices. Data exchange with the decentralised devices is mainly cyclic. The required communication functions are defined by the DP basic functions (version DP-V0).

To meet special requirements of different areas of application, the basic functions of DP were extended and special functions were added so that now three versions of DP, i.e. DP-V0, DP-V1 and DP-V2, are available. Every version has a special main focus. They can be described as follows:

DP-V0	This version offers the basic functionality of DP, such as cyclic data exchange and station-, module- and channel-specific diagnosis.

DP-V1	This version includes extensions for process automation like, for example, acyclic data exchange for parameterisation, operation, monitoring and alarm management of intelligent field devices in parallel to cyclic exchange of useful data. Bus devices can be accessed online through engineering tools. In addition, DP-V1 includes alarms like the status alarm, the update alarm and a manufacturer-specific alarm.
DP-V2	This version includes further extensions and is mainly intended to meet the requirements of drive applications. Additional functions such as, for example, isochronous slave operation and slave-to-slave communication allow DP-V2 to be used as a drive bus for controlling quick sequences of motion in drive shafts. This version requires special hardware. At present, the control systems and target applications of the SE-Power product range are not equipped with this hardware. This is why support of DV-V2 is not intended.

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

Every DP system comprises different types of devices. Three types can be distinguished: DP master class 1, DP master class 2 and DP slaves. DP can be used to realise mono- and multi-master systems and thus offers a high level of flexibility for system configuration. A maximum of 126 devices (masters or slaves) can be connected to the bus.

Due to the extensive diagnosis functions of DP, errors can be localised very quickly. Diagnosis messages are transmitted on the bus and collected at the master.

DP master class 1 (DPM1) is a central control system which exchanges information cyclically with decentralised stations (slaves) in a defined message cycle. Typical DPM1 devices are programmable logic controls (PLCs) or PCs, for example.

DP master class 2 (DPM2) devices are engineering, project or operating devices. They are used for start-up, maintenance and diagnosis, to configure the connected devices, to evaluate measured values and parameters and to check the device status. A DPM2 device does not have to be permanently connected to the bus system.

A slave is peripheral device (I/O device, drive, etc.) which reads in process information and/or uses output information to intervene in the process. In terms of communication, slaves are passive devices as they reply only to direct requests from a DPM1 or DPM2 device.

The transfer of data with the DP-V0 service requires a specification on the master side as well as on the slave side about the quantity of the data to be transferred and also about their interpretation. When planning a PROFIBUS connection, the user must make this specification. Only then should the parameterisation of the fieldbus connection on both sides commence.

5.2 PROFINET IO overview

5.2.1 Fundamental principles

PROFINET IO (Input - Output) enables the connection of decentralised field devices, such as I/Os, drives, valves, transducers, or analysis devices, to a central automation device, such as a PLC, PC, or process control system. It can be considered as the direct successor of PROFIBUS-DP. Data transfer is based on the Fast Ethernet standard transmission with 100 Mbit/s. PROFINET IO follows the provider-consumer model for the data exchange. Depending on the conformance class (abbreviation: CC), it is suitable for bus cycle times of several milliseconds up to 31.25 µs.

Three conformance classes (CC-A, CC-B, and CC-C) that build upon one another specify the functionality and real-time characteristics of PROFINET IO.

- CC-A — This class provides basic functions for PROFINET IO with RT communication. All IT services can be used without restriction. Typical applications are found, for example, in building automation. Wireless communication is specified for this class.
- CC-B — This class extends the concept to include network diagnostics via IT mechanisms as well as topology information. The system redundancy function, which is important for process automation, is contained in an extended version of CC-B named CC-B(PA).
- CC-C — This class describes the basic functions for devices with hardware-supported bandwidth reservation and synchronisation (IRT communication) and is thus the basis for isochronous applications.

The conformance classes also serve as the basis for the certification and for the cabling guidelines.

5.2.2 Diagnostic alarms

PROFINET includes diagnostic alarms. A diagnostic alarm is transmitted to the controller in the case of a special servo drive problem (short circuit, angle encoder error, etc.). It actuates the red diagnostics LED in the controller.

For a rapid analysis, the cause of the problem is stated in plain text in the PROFINET controller, e.g.

E08: Angle encoder: E08-6: Angle encoder communication error

The error number consists of a main index (HH) and subindex (S). The main index is transferred in the manufacturer-specific section of the channel diagnostics (ChannelErrorType) 0x0100 … 0x7FFF. The subindex is transferred in the manufacturer-specific section of the extended channel diagnostics (ExtChannelErrorType) 0x1000 … 0x100F.

Error number	ChannelErrorType	ExtChannelErrorType
08-6	$HH_h + 1000_h = 1008_h$	$S_h + 1000_h = 1006_h$

Table 3: Channel diagnostics example

5.3 Overview of PROFIdrive

The “PROFIBUS profile for drive technology” or short PROFIdrive is a manufacturer standard for implementing PROFIBUS interfaces for drives. It has been defined by the association of PROFIBUS users. Just like CANopen, its aim is to offer the user a defined interface for programming servo drives. This interface should be as manufacturer-independent as possible.

PROFIdrive specifies the configuration, diagnosis, data exchange and state machines with a master. Furthermore, so-called application classes are defined. There are different versions of the PROFIdrive specification with significant differences. The SE-Power product range follows exclusively version 3.1. *(4).*

The PROFIdrive specification *(4)* also defines a state machine for device control. This state machine is addressed using a control word and a status word. The meaning of the individual bits is also defined in the specification. The functions of these two words have been adopted to a large extent. Manufacturer-specific deviations are related to certain details and documented and marked from chapter *7 Telegram Editor* onwards.

The SE-Power product range covers a part of the application classes defined in the PROFIdrive specification.

The fieldbus technologies PROFIBUS-DP and PROFINET do not specify the form and meaning of the useful data themselves. This is why the concept of parameter numbers (PNUs) has been adopted. These parameter numbers have an optional subindex and there are pre-defined or reserved areas among these PNUs. In addition, there is room for manufacturer-specific PNUs.

There are several manufacturer-specific PNUs for connecting the SE-Power servo drives. In addition, further object directories can be accessed (in some cases with certain restrictions) as of a certain state of extension level. Among these directories are the object directory of Afag communication objects and the CANopen object directory.

6 PROFIBUS and PROFINET Connection

6.1 Introduction

The set-up of a fully functional PROFIBUS or PROFINET connection requires several steps. Some of these settings should or must be performed prior to the activation or start of the bus communication. This chapter provides an overview of the required steps. The exact procedure is described in the following chapters.

The data transfer is realised by way of telegrams. The number of data to be transferred and the meaning of these data must be specified on the master side as well as on the slave side prior to the start of the data exchange. It is only then that the parameterisation of the fieldbus connection on both sides should commence. We recommend parameterising the slave first. This should then be followed by the configuration of the master. Provided that the parameterisation is correct, the application is immediately ready without causing any communication errors.

There are only minor differences between PROFINET and PROFIBUS in terms of the configuration and operation. This is why the next chapters apply to both fieldbus systems. Any differences are clearly indicated to the user.

6.2 Slave overview

This section provides an overview of the necessary steps for the parameterisation and configuration of the slave. Since some of the parameters will not become effective until after they have been stored and a reset has been performed, we recommend the following workflow:

1. Configuration of the telegrams with the **telegram editor, Chapter 7**
2. Selection and parameterisation of the **physical units, Chapter 8**
3. Configuration and activation of the **operating parameters, Chapter 9**

On the slave side, the meaning of the data is specified by entering the corresponding parameter numbers (PNU). This is realised by way of the **telegram editor** of the Afag SE-Commander parameterisation program. The number of bytes of the PNU is displayed automatically. For checking purposes, the total length of the telegram is always indicated in the telegram editor.

Important process data concerning the position, speed, and acceleration are handed over in **physical units**. These should be parameterised prior to starting the communication, since they define the interpretation of the data in the servo drive.

> In the speed control mode, the setpoint selector cannot be changed when the PROFIBUS or PROFINET communication is **active**. This is why it must be parameterised accordingly prior to activating the communication.

Following the completion of these steps, the **operating parameters** of the PROFIBUS connection must be configured.

> Prior to activating the PROFIBUS communication, the slave address must be configured correctly. For this purpose, additional options for controlling the address assignment can be activated via an external connection.

6.3 Overview of Master

6.3.1 PROFIBUS

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

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

The servo drive must be integrated into the PROFIBUS on the master side. For this purpose, the **GSD file** must be installed, if this has not been done yet. Then, the address as well as the input and output data for the slave must be configured.

Descriptions of these see the respective manuals for the programming examples.

7 Telegram Editor

7.1 Introduction

The telegram editor is used to define the interpretation of the received or transmitted data by the servo drive. Afag SE-Commander has separate telegram editors for PROFINET and PROFIBUS:

- **PROFINET:** The telegram editor can be found on the menu bar under **Parameters - Field bus - PROFINET – Telegram editor**
- **PROFIBUS:** The telegram editor can be found on the menu bar under **Parameters - Field bus - PROFIBUS – Telegram editor**

Data are exchanged cyclically by way of telegrams. The following two groups can be distinguished:

- **Receive telegrams:** Data that are transferred from the master to the slave; also known as **output data**.
- **Response telegrams:** Data that are transferred from the slave to the master; also known as **input data**.

A telegram can have a maximum of 10 entries.

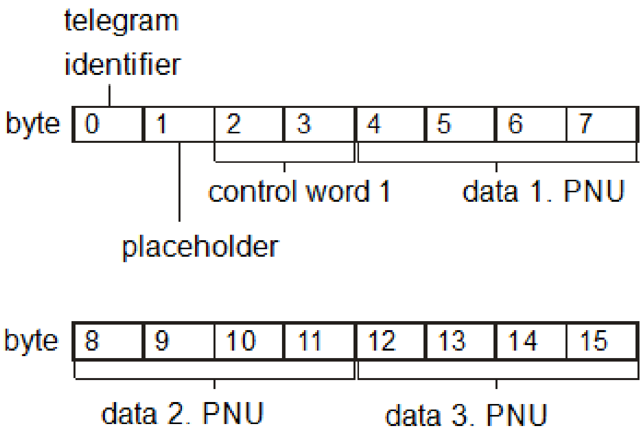


Figure 4: Example of the SE-Power telegram format

Figure 4 shows an example of an ARS 2000 standard telegram from the master to the slave. Apart from the identifier in byte 0, this telegram type requires the PROFIdrive control word 1 for the device control in bytes 2 and 3. The content of the subsequent bytes can be configured as desired. In this example, 3 additional data are transferred, each with 4 bytes. The resulting length of the complete telegram is 16 bytes.

In the project of the master, data areas are created, e.g. data blocks. These data areas are used to store the input and output data of the master and slave. During the set-up of the project, the user must specify the contents and the sequence of the contents as well as the size of the data area in an identical manner on the master side and on the slave side.

This parameterisation should be performed prior to activating the communication.

7.2 Receipt Telegrams

The SE-Power servo drive supports 4 receive telegrams. Some of these telegrams are reserved strictly for one specific operating mode. This makes it easier for the user to switch from one operating mode to another. An additional parameter for the operating mode does not have to be transmitted together with the telegram. The following table shows how the different receive telegrams are connected to specific operating modes:

Telegram	Operating mode
Receipt telegram 0	Positioning
Receipt telegram 1	Speed control
Receipt telegram 2	none
Receipt telegram 3	none

Once a corresponding telegram identifier is read in the servo drive, a check is performed and the associated operating mode is parameterised.

The necessary parameter numbers have to be entered for every receive telegram. They include the information concerning the meaning of the data in the telegram. In the case of receive telegrams 0..2, a so-called control word is entered at address 2 (length: 2 bytes). This consistent convention facilitates the creation of applications and the use of the Afag example projects for SIEMENS SIMATIC S7. The other entries can be chosen as desired from the object directory of the parameter numbers. The only thing that has to be considered is whether they are suitable. It is, for instance, not possible to enter pure actual value data into receive telegrams.

As far as receive telegrams are concerned, the associated response telegrams have to be selected, too. The user can specify and configure a specific response telegram for every receive telegram. In most cases, however, it is easier to use the same response telegram for all operating modes (receive telegrams 0..2). This reduces the necessary programming workload at the master end. In addition, the master usually requires the same actual value data from the servo drive in all operating modes.

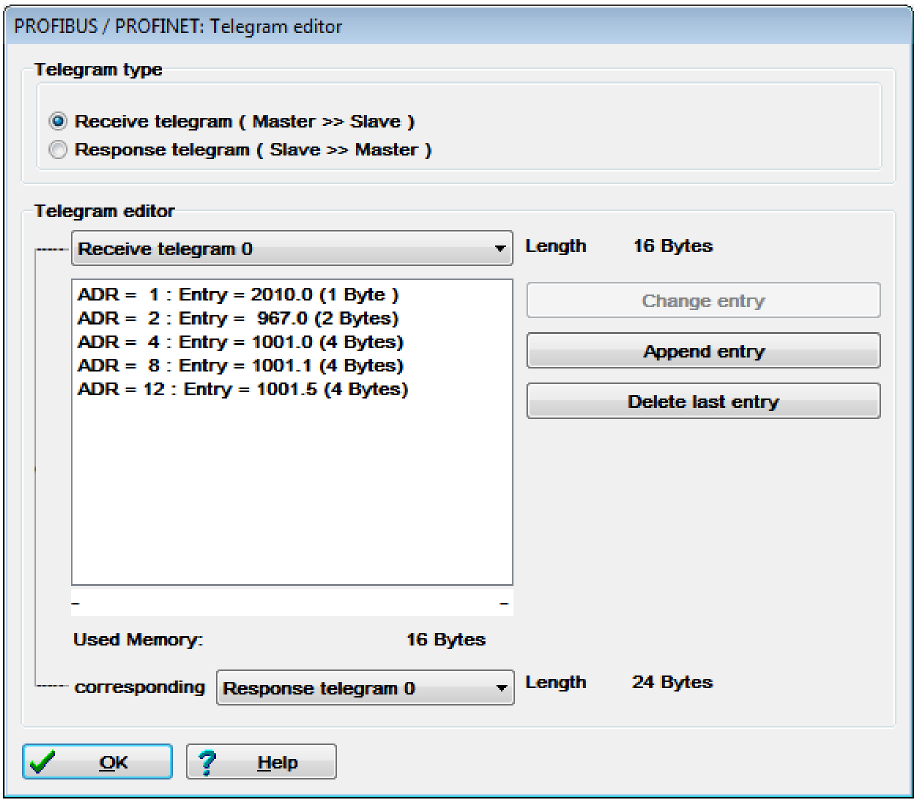


Figure 5: Composition of a receipt telegram

Figure 5 shows the example of receive telegram 0 (positioning mode). The entries can be highlighted and changed directly or deleted successively starting with the last entry. When an entry is highlighted, an additional field is displayed into which the parameter number can be entered.

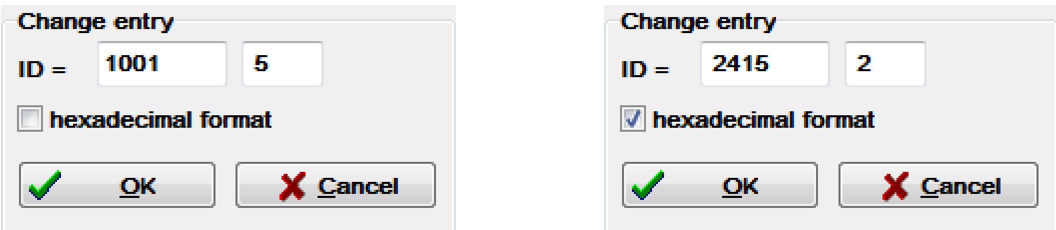


Figure 6: Entry of a PNU (left) or of a CAN object (right)

The numbers of PNUs are entered in decimal format (checkbox “hexadecimal” not marked). The checkbox “hexadecimal” is marked if objects of the CANopen object dictionary are used. The given number can directly be taken from the CANopen manual. A handshake to the connected servo drive starts when an entry is entered into the field ID and confirmed by a click onto the button **OK**. It is checked if the parameter exists and its number of bytes. For this reason, this function is not available in offline mode of the parameterisation program.

New telegram entries are added to the end. An additional diagnostic information is displayed above the button „Change entry“, if a communication could have been established between Master and Slave. The really configured length of the telegram from Master to Slave is displayed.

The example telegram in *Figure 7* transmits the following parameters:

Address	Contents (parameter number)	Description
0	Identifier (= 0xE0)	Fixed identifier
1	8-bit placeholder (PNU 2010 0)	free
2	Control word 1 (PNU 967 0)	Control word for device control, has to be under this address
4	Target position (PNU 1001 0)	Target position, indication with the physical unit of a position set
8	Movement speed (PNU 1001 1)	Profile velocity during positioning, indication with the physical speed unit set
12	Accelerations (PNU 1001 5)	Combination of the values for acceleration and deceleration, indication with physical unit for acceleration set

More detailed descriptions of the parameter numbers can be seen in Chapters *10, 11 and 12*.

7.3 Response Telegrams

The SE-Power servo drive supports 4 response telegrams. The necessary parameter numbers have to be entered for every response telegram. They include the information concerning the meaning of the data in the telegram. In the case of receive telegrams 0..2, a so-called status word is entered at address 2 (length: 2 bytes). This consistent convention facilitates the creation of applications and the use of the Afag example projects for SIEMENS SIMATIC S7. The other entries can be chosen as desired from the object directory of the parameter numbers. The only thing that has to be considered is whether they are suitable. It is, for instance, not possible to enter write-only parameters into response telegrams.

Figure 7 shows the example of response telegram 0 (positioning mode). The entries can be highlighted and changed directly or deleted successively starting with the last entry. When an entry is highlighted, an additional field is displayed into which the parameter number can be entered. New telegram entries are added to the end. An additional diagnostic information is displayed above the button „Change entry“ if a communication could have been established between Master and Slave. The really configured length of the telegram from Master to Slave is displayed.

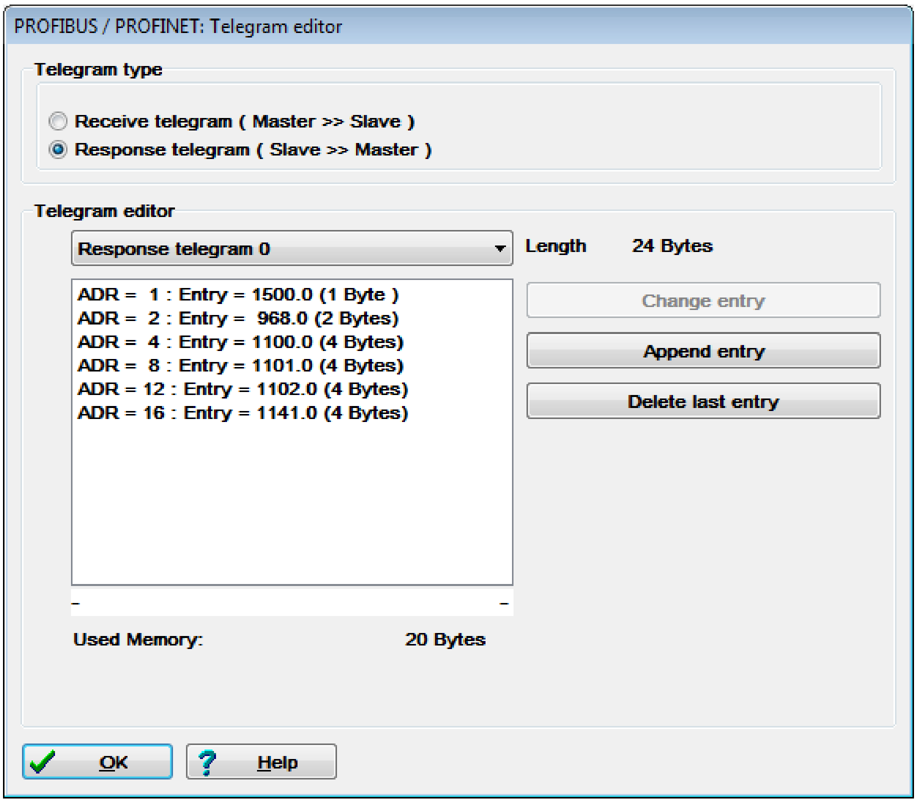


Figure 7: Composition of a response telegram

Take further descriptions from Chapter *7.2*

The telegram shown in *Figure 7* transmits the following parameters:

Address	Contents (parameter number)	Description
0	Identifier (= 0xF0)	Fixed identifier
1	Operating mode (PNU 1500 0)	Current operating mode of the servo drive
2	Status word 1 (PNU 968 0)	Status word for device control, has to be under this address
4	Actual position (PNU 1100 0)	Current actual position, indication with the physical unit of a position set
8	Actual value of rotational speed (PNU 1101 0)	Current actual speed value, indication with the physical speed unit set
12	Active current, actual value (PNU 1102 0)	Actual value of the current, indicated per thousand referring to the nominal motor current
16	Status of the digital inputs (PNU 1141 0)	Current status of the digital inputs, see for the meaning of the bits in the detailed description of the PNU.

More detailed descriptions of the parameter numbers can be seen in Chapters *10, 11 and 12*.

8 Physical Units

To ensure correct operation, the unit of the process data that will be transferred via the fieldbus must be specified. They can be configured via the menu item **Display units** for PROFIBUS and PROFINET:

- **PROFINET:** The settings can be found on the menu bar under **Parameters - Field bus - PROFINET – Display units**
- **PROFIBUS:** The settings can be found on the menu bar under **Parameters - Field bus - PROFIBUS – Display units**

The parameters for the physical units should be set once and they should not be changed during a running application.

The system calculates specific factors for the various units internally so that all the user has to do is to select the desired unit. The gear ratio and feed constant are stated as separate parameters.

The windows for PROFIBUS and PROFINET are identical. *Figure 8* shows the window of the Afag SE-Commander program for the configuration of the physical units for PROFIBUS.

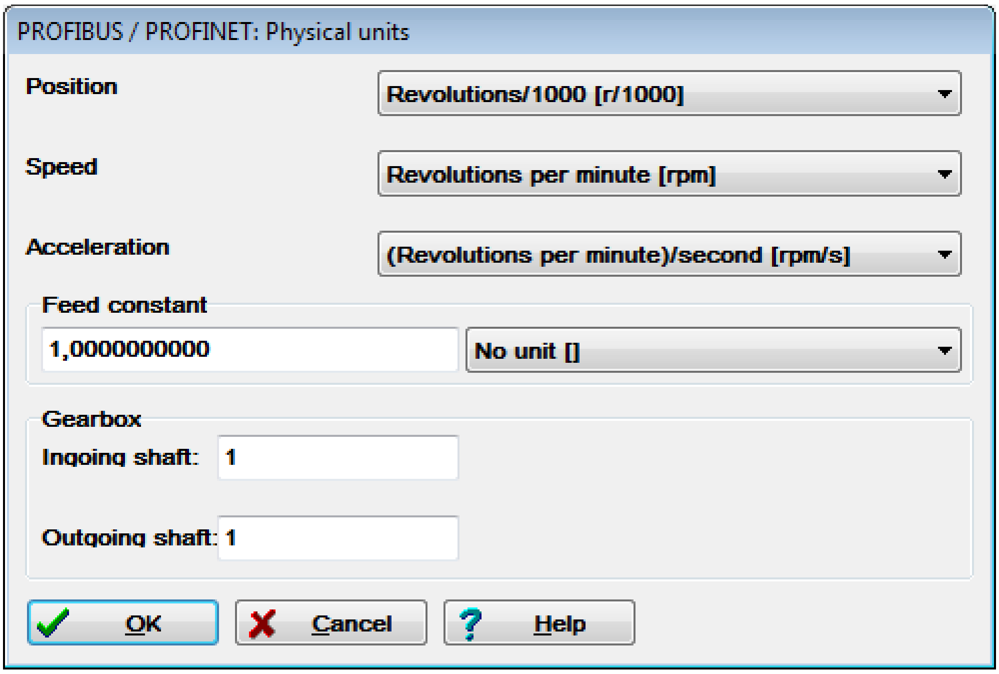


Figure 8: Setting the physical units

When the physical units are entered, the firmware automatically calculates conversion factors. They consist of a numerator and a denominator which can comprise a maximum of 32 bits each. If an overflow occurs when the factors are entered, the value will be rejected. In this case, the factors or the physical units have to be corrected.

It has to be taken into consideration that some quantities cannot always be used in a sensible manner. A purely rotative system, for example, does not require a feed constant. Apart from this, the feed constant has a physical unit. If this unit is not parameterised correctly, the feed constant will be ignored.

Examples:

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

   => The feed constant will be **ignored**.

2. Position in mm, feed constant without a unit:

   => The feed constant will be **considered** like a gear ratio.

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

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

> The value of the feed constant will be ignored for the associated physical unit, if the feed constant has a translatory unit and a rotatory unit has been selected for the physical quantity.

Problems might arise during operation only if the internal value or the value entered externally cannot be represented following the conversion. In such a case, an error is issued and the setting of the physical units has to be checked.

During the parameterisation of the display units intermediate states may occur in which the physical units have an overflow. This case generates the error 22-4. Perform Save & Reset in order to find out if the parameterisation is really invalid. If no error 22-4 is active after Reset, the settings are valid.

> Perform Save & Reset if an error 22-4 occurs during the parameterisation of the physical units. The physical units are valid if there is no error after Reset.

Figure 9 shows the interpretation of the gear ratio. In the menu **Physical Units PROFIBUS / PROFINET** of the parameterizing program Afag SE-Commander, the value "Ingoing shaft" refers to U_{IN}, the value "Outgoing shaft" to U_{OUT}.

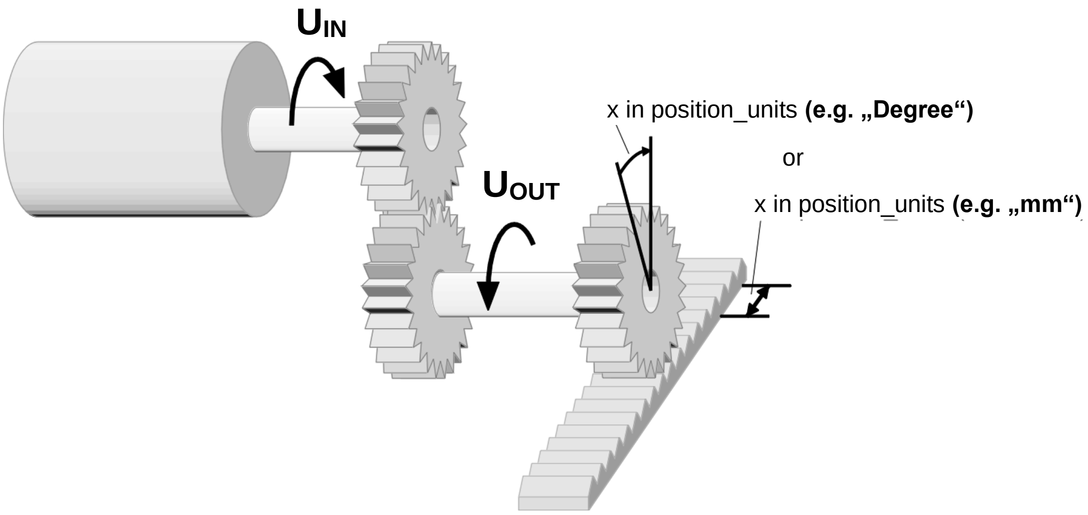


Figure 9: Gearbox factor

Example:

If the motor performs 10 revolutions and a gear connected to the output performs one revolution, this corresponds to the following entries:

Ingoing shaft: 10

Outgoing shaft: 1

Now the system can be parameterised using the units of the output (outgoing shaft).

The gear ratio and the feed constant are defined as positive values. If the orientation of the application has to be changed, this can be done with the parameterizing software Afag SE-Commander in the Window “Commands”.

9 Operating Parameters

This chapter describes all the necessary measures to set up a communication using PROFIBUS-DP or PROFINET-IO. The parameters described in the following are set via the serial port with the program Afag SE-Commander.

9.1 PROFINET operating parameters

The operating parameters menu can be opened in the Afag SE-Commander via the menu bar under **Parameters - Field bus - PROFINET – Operation parameters**. *Figure 10* shows the window of the parameterisation program for the configuration of the operating parameters.

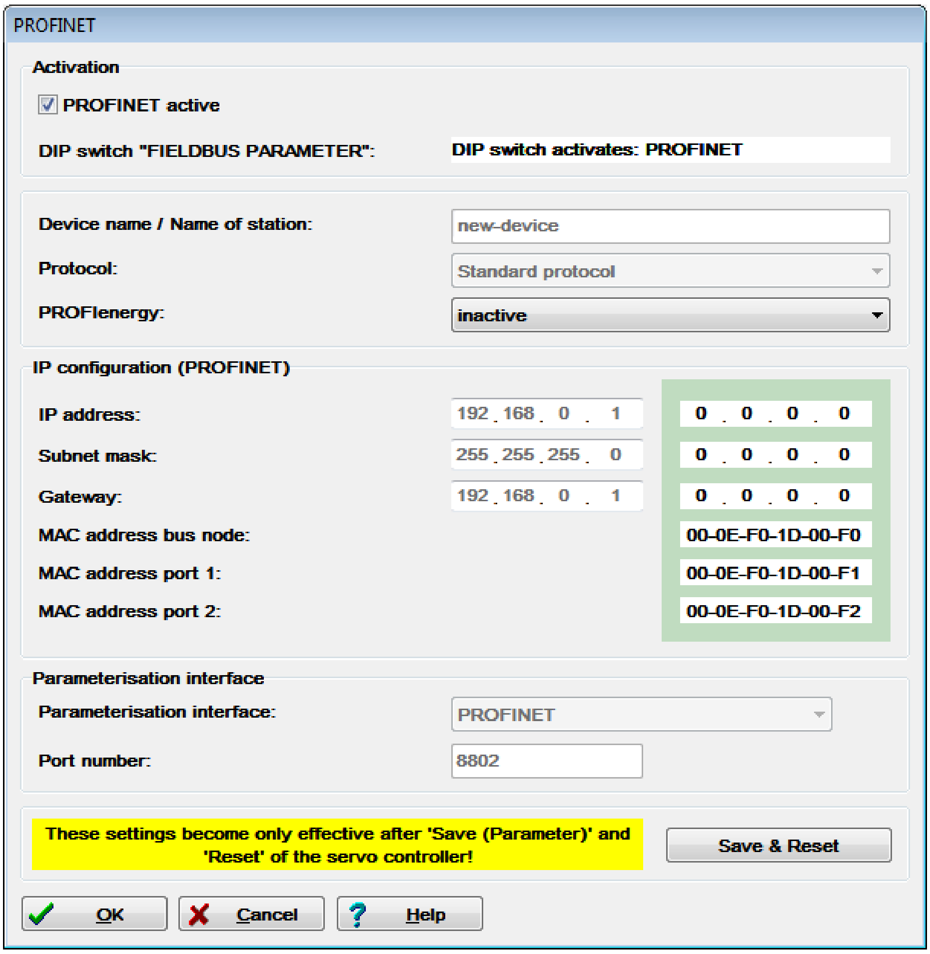


Figure 10: Settings of the operating parameters under PROFINET-IO

Activation:

The PROFINET communication is activated by way of the check box **PROFINET active** or via the **DIP switch "FIELDBUS PARAMETER"** of the FSM module.

It must be taken into consideration that the PROFINET communication settings will not become effective until after a Save & Reset has been performed. However, the deactivation of the communication becomes immediately effective.

The activation of the PROFINET communication via DIP switch **8** of the FSM module is described in the following table:

DIP switch 8 FSM module	Effect
All DIP switches = OFF	No effect. The configuration for the fieldbus activation will be adopted from the parameter set of the servo drive.
DIP switch 8 = OFF and at least one DIP switch set	Activation via DIP switch: fieldbus inactive
DIP switch 8 = ON	Activation via DIP switch: fieldbus active.

It is always displayed which fieldbus is currently activated/deactivated via the DIP switch.

The DIP switch always acts on the currently present fieldbus whereby the fieldbus modules take precedence over CANopen (onboard). This means:

➔ If DIP switch 8 = ON the currently available fieldbus will be activated.

➔ If a fieldbus module is present, this fieldbus will be activated.

➔ If there is no fieldbus module present, CANopen will be activated by default.

If DIP switch 8 = OFF and at least one other DIP switch is set, all fieldbuses will be deactivated.

Device name:

All that is required for the configuration of the communication on the servo drive side is the device name. The IP address is assigned based on the device name and with the aid of the DCP protocol (Discovery and Basic Configuration protocol). The assignment requires that a DCP-capable controller is included in the network.

Protocol:

Selection of the PROFINET protocol type. At present, only the Afag **standard protocol** is supported.

PROFIenergy:

This options menu allows to activate or deactivate the standardised energy efficiency protocol PROFIenergy.

IP configuration:

A unique IP address must be assigned to the servo drive. If the addresses are assigned dynamically, the IP address and the associated subnet mask and gateway are assigned via the DCP protocol (based on the **device name**). Any static IP address, which may have been assigned beforehand, will be overwritten.

Parameterisation interface:

The parameterisation or diagnostics of servo drives with the Afag SE-Commander can be performed either via the die OnBoard-Ethernet interface (X18) or via the PROFINET network. If the Afag SE-Commander is used in the PROFINET network, **ProfiNet** must be configured as the parameterisation interface (see also the next chapter *9.1.1*).

Save & Reset:

The settings of the operating parameters will not become effective until the button **Save & Reset** is selected. As a result, the settings will be saved in the parameter set, which is then followed by a reset of the servo drive.

9.1.1 Use of the Afag SE-Commander in a PROFINET network

The Afag SE-Commander can connect with any servo drive in a PROFINET network provided that the following conditions are fulfilled:

- The PROFINET network has been configured and is ready for use. (An IP address has been assigned to the slave; this is usually done by the controller.)
- The parameterisation interface for the operating parameters (see *Figure 10)* is set to **ProfiNet**.

Depending on whether the IP address is known or not, different steps are required in order to set up a communication between the Afag SE-Commander and the SE-Power.

9.1.1.1 The IP address of the servo drive is known

If the IP address of a servo drive is known, the connection between the Afag SE-Commander and a servo drive must be set up as follows:

1. Connect the PC to the PROFINET network by way of an Ethernet cable. For this purpose, the second technology port of a servo drive can be used, for example.
2. Start the Afag SE-Commander and select the option **Activate UDP communication (Ethernet)**. Then, click OK to confirm (see *Figure 11*)

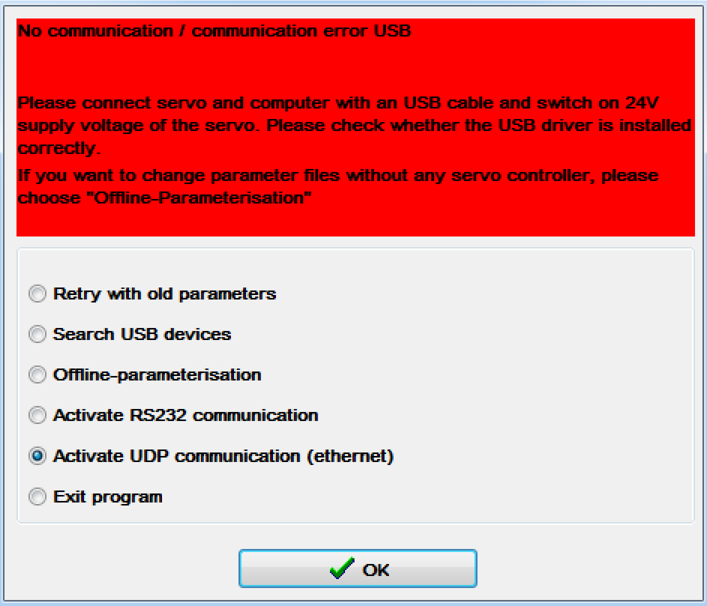


Figure 11: Selection of the type of communication with the Afag SE-Commander

3. Then, the window in *Figure 12* opens. Select the option **Change communication parameters (UDP)** and click OK to confirm.

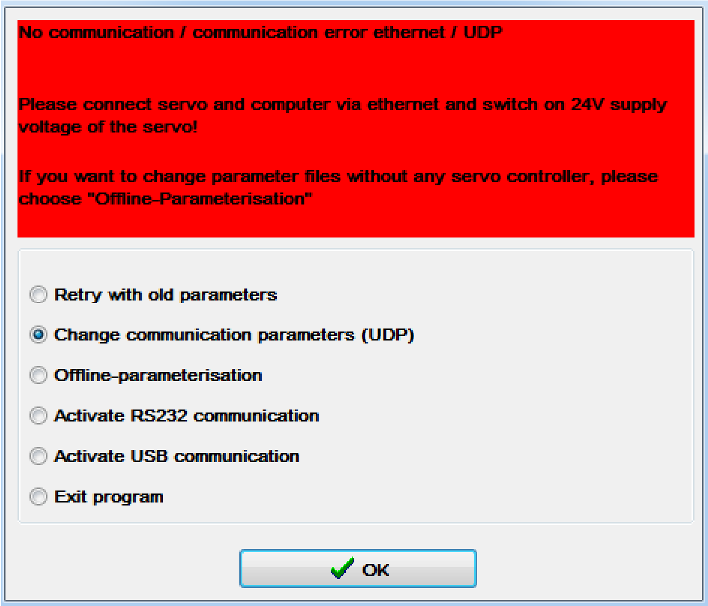


Figure 12: Selection window after the loss or termination of the UDP connection

4. Enter the IP address of the servo drive to which you want to connect into the UDP window. In order to connect to the servo drive with the settings in our example in *Figure 10*, use the following setting:

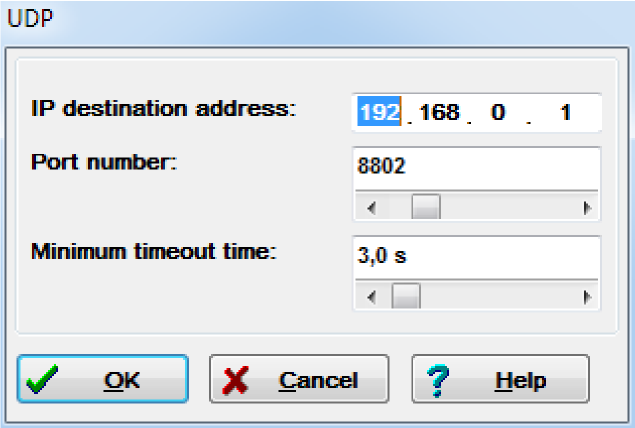


Figure 13: Configuration of the UDP connection

5. If the settings are correct, the Afag SE-Commander connects itself with the servo drive. In the event of an error, the selection window in *Figure 12* opens. The configuration can be repeated until a connection to the servo drive is established.

9.1.1.2 The IP address of the servo drive is not known

If the IP addresses of the servo drives in the PROFINET network are unknown, the network devices can be found by way of the Afag SE-Commander.

1. Select the option **Offline parameterisation** in the selection window and click OK to confirm.

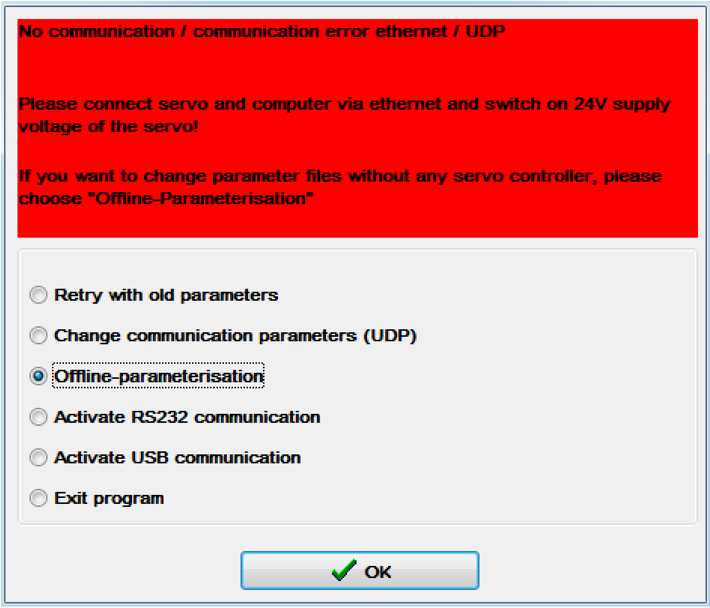


Figure 14: Offline parameterisation

1. As the next step, an offline parameter set must be loaded. Select a valid parameter set and confirm with OK.
2. The Afag SE-Commander opens. The servo drives that are included in the network can be found under **Options – Communication – Communication parameters UDP (Ethernet) – Search network…** They are displayed in the **device list** and can be selected by way of the mouse. When the button **Connect** is selected, the Afag SE-Commander establishes a connection to the selected servo drive.

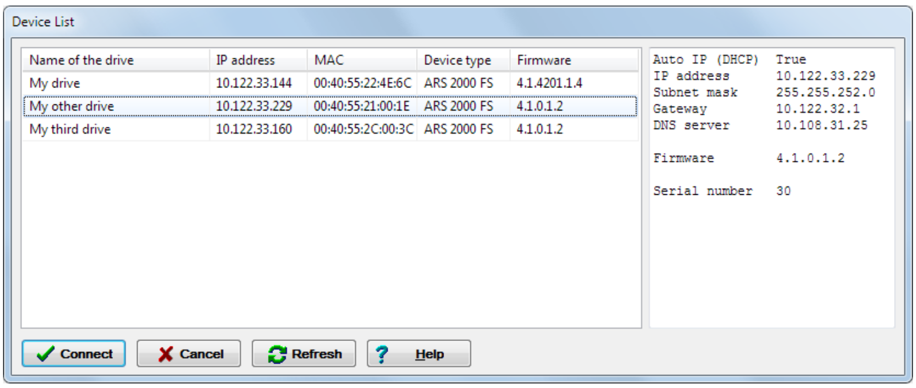


Figure 15: Afag SE-Commander window "Device List"

9.2 PROFIBUS operating Parameters

The operating parameters menu can be opened in the Afag SE-Commander via the menu bar under **Parameters - Field bus - PROFIBUS – Operation parameters**. *Figure 16* shows the window of the parameterisation program used to set the operating parameters.

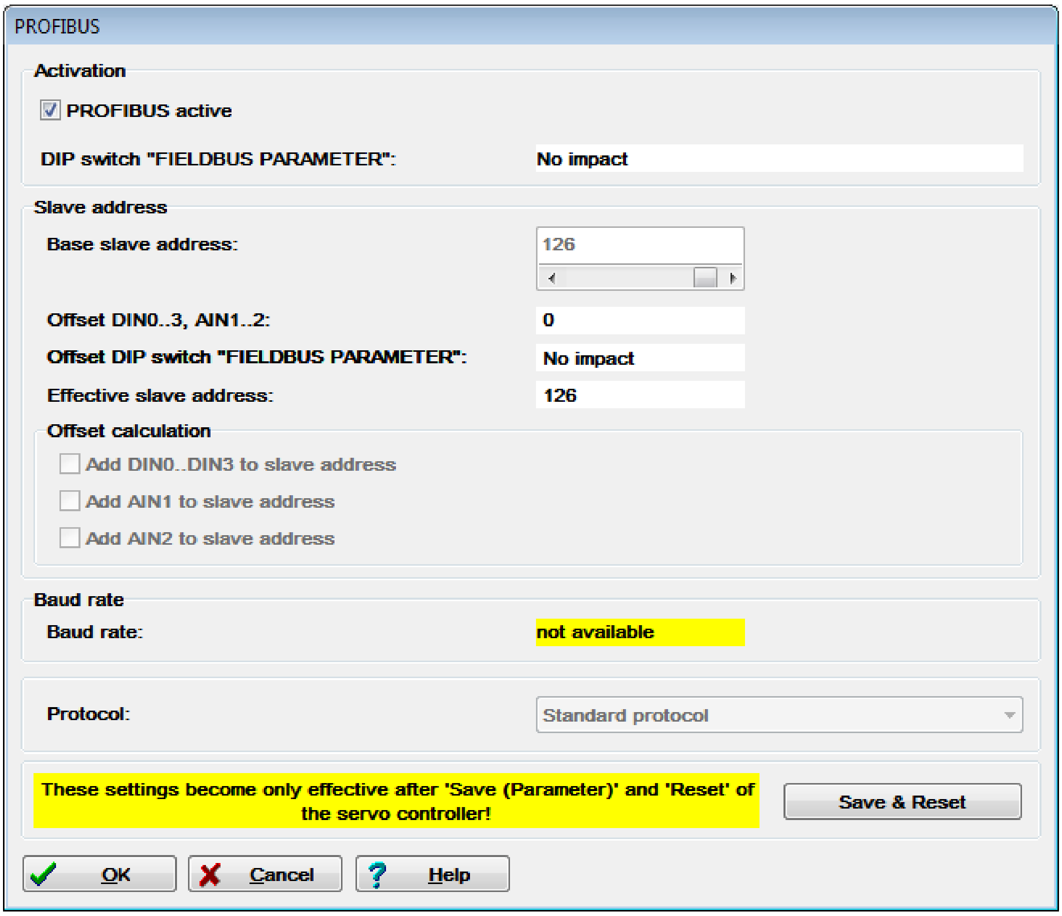


Figure 16: Setting of operating parameters under PROFIBUS-DP

<u>Activation:</u>

The PROFIBUS communication is activated by way of the check box **PROFIBUS active** or via the **DIP switch "FIELDBUS PARAMETER"** of the FSM module.

It must be taken into consideration that the PROFBUS communication settings will not become effective until after a Save & Reset has been performed. However, the deactivation of the communication becomes immediately effective.

The activation of the PROFIBUS communication via DIP switch **8** of the FSM module is described in the following table:

DIP switch 8 FSM module	Effect
All DIP switches = OFF	No effect. The configuration for the fieldbus activation will be adopted from the parameter set of the servo drive.
DIP switch 8 = OFF and at least one DIP switch set	Activation via DIP switch: fieldbus inactive
DIP switch 8 = ON	Activation via DIP switch: fieldbus active.

It is always displayed which fieldbus is currently activated/deactivated via the DIP switch.

The DIP switch always acts on the currently present fieldbus whereby the fieldbus modules take precedence over CANopen (onboard). This means:

➔ If DIP switch 8 = ON the currently available fieldbus will be activated.

➔ If a fieldbus module is present, this fieldbus will be activated.

➔ If there is no fieldbus module present, CANopen will be activated by default.

If DIP switch 8 = OFF and at least one other DIP switch is set, all fieldbuses will be deactivated.

Slave address:

At the servo drive end, only the slave address has to be entered to configure the communication. After this, the communication can be activated.

When the communication has been activated, the base value of the slave address can no longer be changed.

The slave address can also be adjusted with the DIP switches 1 – 7 of the FSM module. The states of the switches are read once immediately after a reset and used to calculate the effective slave address. Later changes have no effect.

Baudrate:

The baud rate of the PROFIBUS communication is automatically recognised by the hardware used. The automatically detected baud rate is displayed in this menu if a connection between Master and Slave could have been established successfully. The following baud rates are supported by servo drives of the SE-Power product range:

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

Protocol:

Selection of the PROFIBUS protocol type. At present, only the Afag **standard protocol** is supported.

Save & Reset:

The settings of the operating parameters will not become effective until the button **Save & Reset** is selected. As a result, the settings will be saved in the parameter set, which is then followed by a reset of the servo drive.

9.2.1 Adaptation of cycle times

The cycle times of the controller structure of SE-Power controllers can be set in a variable manner. If the field bus communication is activated via PROFIBUS, a current controller cycle time of 125 µs is recommended. To set this parameter, open the window **Parameters - Controller parameters - Cycle times...**. Click on the **Settings** button. Now the cycle time of the current controller can be changed. Set the value as shown in *Figure 17.*

> Changes concerning the cycle times or the factors do not take effect until they are saved and the system is reset.

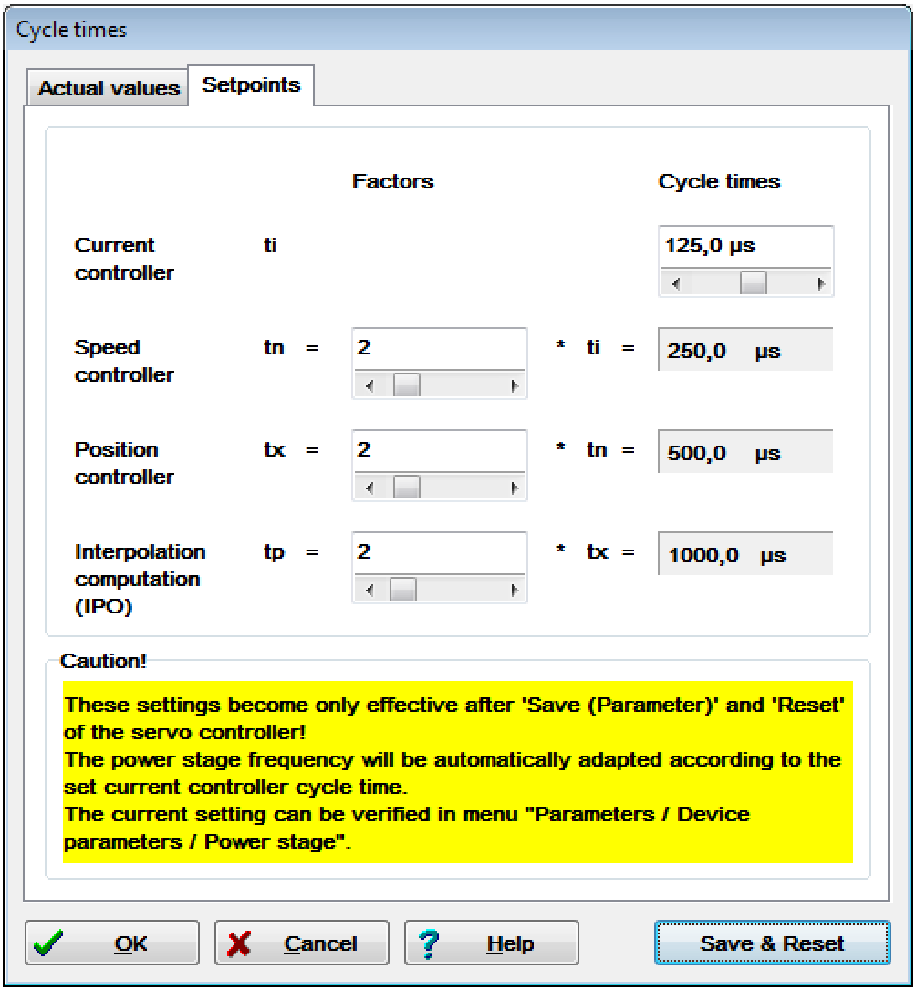


Figure 17: Parameterisation of the servo drive cycle times

10 Device Control

10.1 Overview

To make the control of a field device (slave) independent from the various manufacturers, two data words have been specified in the PROFIdrive specification. **Control word 1** is used to control the major device functions by the master whereas the status of the device is read back in **status word 1**. The PROFIdrive profile defines the order in which certain bits have to be set, e.g. to enable the power stage of the servo drive.

Device control of SE-Power servo drives follows the state diagram specified in the PROFIdrive profile. The implementation and potential manufacturer-specific deviations are described in detail in chapter *10.4.*

The implementation of the control word and the status word only follows the PROFIdrive specification. Deviations from the specifications are marked. In addition, some bits have different meanings depending on the operating mode. In the following chapters, first the control word and then the status word are described. Then the device control mechanism using these two data words is explained.

10.2 Control word 1

Control Word 1 is used to control various device functions, e.g. servo drive enabling (hereinafter referred to as “controller enabling”). Some bits have corresponding meanings. The use of these bits is described in chapter *10.4*. The meaning of the individual bits follows the PROFIdrive profile. In addition, some functions are a manufacturer-specific and some bits have a manufacturer-specific functionality.

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

In received telegrams 0..2, control word 1 is bound to a fixed position. The system evaluates the control word always as the last datum. This means that new target positions are written first. A command to start a positioning run, which is transmitted simultaneously, therefore always refers to the data transmitted in the same telegram.

Some bits have different meanings depending on the operating mode. The two following tables show the meanings for the two operating modes.

Table 4: Control word 1 for operating mode positioning

Bit	Meaning	Behaviour
0	ON / OFF (OFF 1)	see section Device Control chapter *10.4*
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 reject traversing task 0: Reject traversing task	0: The current positioning run is cancelled or no positioning is started 1: No action
5*	1: No intermediate stop 0: Intermediate stop	0: No action or no positioning is started 0 ->1: Acceleration to motion speed in accordance with the current position set 1: No action 1 -> 0: Stopping with deceleration in accordance with current position set
6*	0 -> 1: Activate traversing task ***	Manufacturer-specific implementation: 0 -> 1: Start of the positioning run under the set position data set[1] if boundary conditions[2] are fulfilled
7	Fault acknowledge (Edge from 0->1)	Active errors are acknowledged if possible
8*	Jog 1 ON / Jog 1 OFF	Manufacturer-specific implementation: 0 -> 1: Start of positioning in accordance with “positive jogging” position set 1 -> 0: Stop with deceleration in accordance with “positive jogging” position set
9*	Jog 2 ON / Jog 2 OFF	Manufacturer-specific implementation: 0 -> 1: Start of positioning in accordance with “negative jogging” position set 1 -> 0: Stop with deceleration in accordance with “negative jogging” position set
10	1: Control by PLC 0: No control by PLC	1: Control word evaluated 0: Control word not evaluated
11*	Start/Stop homing	1: (No action) Continue homing 1 -> 0: homing still active: Termination of the homing without error Homing already terminated: No action 0: No action 0 -> 1: Start the homing[3]
12**	Relative / absolute	At positioning start: 1: Relative positioning 0: Absolute positioning
13**	Interrupt current positioning / add	At positioning start: 1: Interrupt current positioning, immediately start new positioning. 0: Add positioning to the end of the running positioning
14,15	Device-specific	

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

Notes on *Table 4*:

1): The command “Activate traversing” starts the position set selected through PNU 1002 0. If the PROFIBUS/PROFINET position set is started, the current options of control word 1 will be adopted. Otherwise the options of the corresponding position set will take effect.

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

- Bit 4 = 1 (Do not reject traversing task)
- Bit 5 = 1 (No intermediate stop)
- No homing is active

3): Parameterisable options are taken into account, e.g. “with following positioning”.

Table 5: Control word 1 for operating mode speed control

Bit	Meaning	Behaviour
0	ON / OFF (OFF 1)	see section Device Control Chapter *10.4*
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: Enable ramp generator 0: Reset ramp generator	1: All speed set points enabled 0: All speed set points disabled
5*	1: Unfreeze ramp generator 0: Freeze ramp generator	1: Set point ramp enabled 0: Ramp stopped (frozen)
6*	1: Enable set point 0: Disable set point	1: All set point inputs for the ramp enabled 0: All set point inputs for ramp deactivated
7	Fault acknowledgement (edge from 0->1)	Active errors are acknowledged if possible
8*	Jog 1 ON / Jog 1 OFF	The speed of motion of the “positive jogging” position set is pre-set as a speed set point through the ramp
9*	Jog 2 ON / Jog 2 OFF	The speed of motion of the “negative jogging” position set is pre-set as a speed set point through the ramp
10	1: Control by PLC 0: No control by PLC	1: Control word evaluated 0: Control word not evaluated
11*	Device -specific	Free
12-15	Device -specific	Free

*: Different meaning in other operating mode.

Meaning of/notes concerning the various bits

Bit 4: Corresponds to the hold input (hold function) of FB43 if the Afag function blocks are used. If the input is set (logic 1 at the input of the FB → bit 4 = 0), the drive will decelerate with the set deceleration rate. If the input is reset (logic 0 at the input of the FB → bit 4 = 1), the motor will accelerate with the set acceleration rate up to the set speed value.

Bit 5: Setting bit 5 to logic 0 freezes the current set point setting.

Example: - Current set point setting 200 rpm (bit 5 = 1)

- Deletion of bit 5 (bit 5 = 0)

→ If now bit 4 is deleted, for example (→ the drive decelerates with the set deceleration rate), there will be no reaction. The drive continues to run with the last specified speed value (in our example with 200 rpm).

Bit 6: If bit 6 is reset (bit 6 = 0), the set point inputs for the ramps will be deactivated. This means that the drive will be stopped to a standstill as quickly as possible (if physically possible even quicker than the deceleration for an emergency stop → the current set point setting will be set to 0 without any ramp at all). The setting of the bit (bit 6 = 1), on the other hand, causes the motor to accelerate as quickly as possible to the set speed value (abruptly, without any ramps).

Bit 5 has no effect on the function of bit 6.

When the servo drive is disabled, the drive is stopped to a standstill with the set deceleration for an emergency stop. When the servo drive is enabled, the motor accelerates with the set acceleration rate up to the speed set point.

Chapter *10.4* describes the device control. The servo drive takes on various states. Defined transitions can be performed between these states. The transitions are triggered by so-called commands through bits 0..3. The commands are described in detail in chapter *10.4*. The following tables shows an overview of the commands:

Table 6: Overview of all the commands (x = not relevant)

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

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**.

10.3 Status Word 1

Status word 1 reflects various device states, e.g. an active controller enabling. Some bits have corresponding meanings. All this is described in chapter *10.4*. The meaning of the bits follows the PROFIdrive profile. In addition, some functions are manufacturer-specific and some bits have a 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.

Some bits have different meanings depending on the operating mode. The two following tables show the meaning for the two operating modes.

Table 7: Status word 1 for operating mode positioning

Bit	Meaning	Behaviour
0	1: Ready To Switch On 0: Not Ready To Switch On	see section Device Control section *10.4*
1	1: Ready To Operate 0: Not Ready To Operate	
2	1: Operation Enabled 0: Operation Disabled	1: Controller enabling active 0: Controller enabling 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, power 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 setpoint disabling through limit switch active in at least one direction of rotation 0: No warning active
8*	1: Following error within tolerance range 0: Following error out of tolerance range	1: No following error 0: Following error message active
9	1: Control by PLC 0: No control by PLC	Mirroring of bit 10 from the Control word 1
10*	1: Target achieved and in target window 0: Not in target window	1: The current positioning is completed and the actual position is in the target window 0: The current positioning is still active or the actual position is not in the target window
11*	1: Reference position valid 0: Reference position invalid	1: A homing was completed successfully 0: No homing 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 in motion	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

*: Different meaning in other operating mode.

Note: The signal "home_valid" sometimes depends on the encoder system that is used. If an absolute encoder is used, this signal is set to logic 1 even without the execution of a homing run.

Reason: The signal "home_valid" refers to the drive system (servo drive, encoder, and motor). Thus, from the point of view of the servo drive, a homing run is not necessary, since the precise position of the drive is known.

Table 8: Status word 1 for operating mode speed control

Bit	Meaning	Behaviour
0	1: Ready To Switch On 0: Not Ready To Switch On	see section Device Control chapter *10.4*
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 faults 0: No fault active
4	1: No OFF2 0: OFF2	1: No OFF2 command active 0: OFF2-command (Control word 1, power 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 setpoint disabling through limit switch active in at least one direction of rotation 0: No warning active
8*	1: Speed error within tolerance range 0: Speed error outside tolerance range	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 by PLC 0: No control by PLC	Mirroring 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

*: Different meaning in other operating mode.

[1)]: For this comparison, the sign character is always taken into consideration, i.e. the comparison is not based on the sum of the actual speed and the reference speed.

Just like the combination of several bits of **control word 1** can trigger several state transitions, the combination of several bits of **status word 1** can indicate the state of the servo drive. The following table shows the possible states of the state diagram and the associated bit combination used to indicate the states in **status word 1.**

Table 9: Device status

Status	Bit 6 0040_h	Bit 2 0004_h	Bit 1 0002_h	Bit 0 0001_h	Mask	Value
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

Bits 4 and 5 depend upon the command and are therefore not listed at all in *Table 9* or are suppressed in the screen.

10.4 Status Diagram and Device Control

This chapter describes how SE-Power servo drives are controlled with the help of the two data words “control word 1” (PNU 967) and “status word 1” (PNU 968), i.e. how the power stage is activated, for example. This control mechanism follows the specification of the PROFIdrive profile. The following terms are used for the explanation of the context:

State Depending on whether the power stage has been activated, for example, or whether a fault has occurred, the servo drive is in different states. The states defined under PROFIdrive will be described in this chapter.

Example: **SWITCHING_ON_INHIBITED**

State transition Just like the states, also the transitions between the states are defined under PROFIdrive. Transition means getting from one state to another. The master triggers state transitions by setting bits in **control word 1**. The servo drive can also trigger a state transition internally when it detects a fault.

Command To trigger state transitions, certain combinations of bits have to be set in **control word 1**. Such a combination is referred to as a command.

Example: **Enable Operation**

Status diagram The states and the state transitions form the state diagram, i.e. an overview of all states and possible transitions.

10.4.1 Status Diagram

The states have been taken over to a large extent from the PROFIdrive specification. PROFIdrive distinguishes between a ramp stop and a quick stop. The controller enabling is deactivated in both cases so that the simplified state diagram shown in *Figure 18* results.

After it has been switched on, the servo drive initialises and finally reaches the **SWITCHING_ON_INHIBITED** state. The power stage is deactivated and the motor shaft can be rotated freely. Via state transitions **1**, **2** and **3**, the **OPERATION** state is reached. This state corresponds to the controller enabling through PROFIBUS/PROFINET. In this state, the power stage is activated and the drive is controlled as defined by the operating mode set. Make sure that the servo drive has been parameterised correctly and that an associated setpoint equals zero.

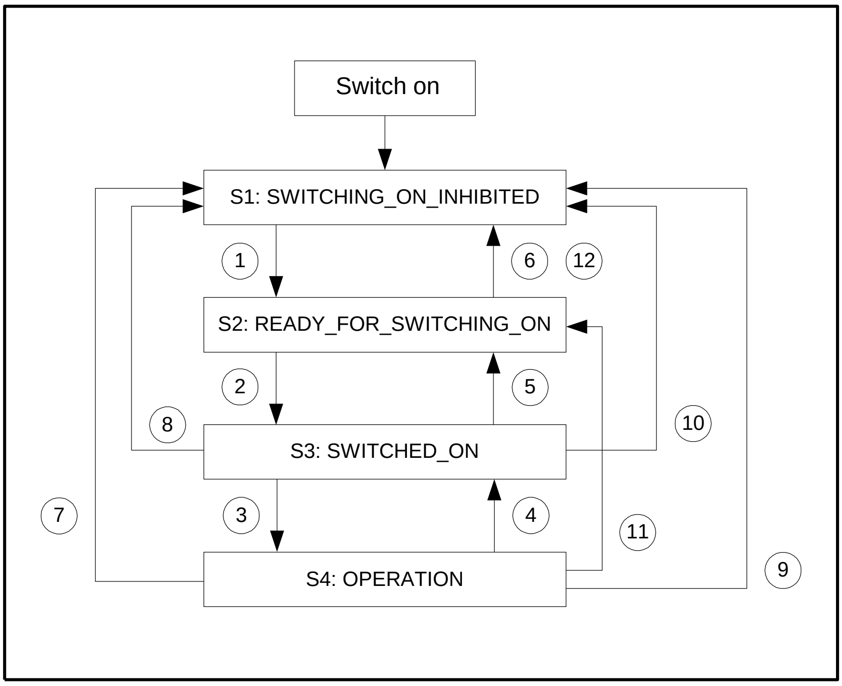


Figure 18: Simplified status diagram

State transition **4** corresponds to the cancellation of the controller enabling, i.e. a running motor is slowed down to standstill following a set emergency stop ramp. State transition **7** corresponds to the cancellation of the power stage enabling, i.e. a running motor would coast down in an uncontrolled manner.

If a fault occurs (no matter in which state), the system is led to the **SWITCHING_ON_INHIBITED** state. Depending on the severity of the fault, certain actions, e.g. an emergency stop, can be performed before this state is reached.

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

Name	Meaning
Switch on	The servo drive performs a self-test. The PROFIBUS/PROFINET communication does not work yet.
SWITCHING_ON_INHIBITED	The servo drive has completed its self-test. PROFIBUS/PROFINET communication is possible.
READY_FOR_SWITCHING_ON	The servo drive waits until the digital inputs “power stage enable" and "controller enable" are connected to 24 V. (Controller enabling logic „DIn5 and PROFIBUS/PROFINET “).
SWITCHED_ON	Power stage enabling is active
OPERATION	The motor is connected to power and is controlled as defined by the operating mode.

10.4.2 Device Control

In order to perform the state transitions shown in Section *10.4.1*, certain bit combinations in **control word 1** (see below) must be set. The lower 4 bits of the **Control word 1** are evaluated together to trigger a status transition. Only the most important state transitions 1, 2, 3, 4, 7 and 11 are explained below at first. A table of all possible statuses and status transitions can be found in chapter *10.4.3*.

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.

Table 10: Most important state transitions of the servo-positioning regulator

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

(x = not relevant)

The following example shows the enabling of the servo drive via the PROFIBUS/PROFINET fieldbus:

EXAMPLE

The servo drive is to be “enabled”, i.e. the power stage and the controller enabling are to be activated via PROFIBUS/PROFINET:

1) The servo drive is in the **SWITCH_ON_INHIBITED** state
2) The servo drive has to change over to the **OPERATION** state
3) According to the state diagram (*Figure 18*), state transitions 1, 2 and 3 have to be executed.
4) From *Table 10* it follows that:

Transition 1:	**Control word 1 = 0406h** **Status word 1** **previous = 0x0240h**	**New status: READY_FOR_SWITCHING_ON *1)** **Status word 1** **expected = 0x0201$_{h}$**
Transition 2:	**Control word 1 = 0407h** **Status word 1** **previous = 0x0201h**	**New status: SWITCHED_ON *1)** **Status word 1** **expected = 0x0203h**
Transition 3:	**Control word 1 = 0407h** **Status word 1** **previous = 0x0203h**	**New status: READY_FOR_SWITCHING_ON *1)** **Status word 1** **expected = 0x0207h**

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 has to 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.

10.4.3 Command Overview

The following table lists all commands corresponding to the status transitions listed in Chapter *10.4.1*:

Table 11: Overview of all state transitions of the servo-positioning regulator

No.	Is executed when	Bit combination Control word 1					Action	Status 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 regulator release	0x0260

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

Power stage disabled...

...means that the power semiconductors (transistors) are not activated any more. **If this state 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 disconnected from power.

Power stage enabled...

...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.

afag

11 Manufacturer-Specific Parameter Numbers

11.1 Overview

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

PNU	Sub-index	Description	Type	Access
1000	0	Position set number (Read/Write)	UINT16	rw
1001	-	(Position Data)		
	0	Target position	INT32	rw
	1	Speed of movement	INT32	rw
	2	Final speed	INT32	rw
	3	Acceleration (positioning)	UINT32	rw
	4	Deceleration (positioning)	UINT32	rw
	5	Acceleration and Deceleration (positioning)	UINT32	rw
1002	0	Position set number for starting	UINT8	rw
1003	0	Profile type of the position sets	INT16	rw
1004	0	Thread Speed	UINT16	rw
1005	-	(Software position limits)		
	0	Lower software limit switch	INT32	rw
	1	Upper software limit switch	INT32	rw
1006	-	(Rotary Axis)		
	0	Rotary axis mode	UINT8	rw
	1	Lower rotary axis limit	INT32	rw
	2	Upper rotary axis limit	INT32	rw
1010	0	Set point of rotational speed	INT32	rw
1011	-	(Accelerations for speed control)		
	0	Acceleration control (speed control)	UINT32	rw
	1	Deceleration (speed control)	UINT32	rw
	2	Acceleration and Deceleration (speed control)	UINT32	rw
1040	-	(Jogging)		
	0	Jogging velocities (symmetrical)	INT32	rw
	1	Jogging accelerations (symmetrical)	UINT32	rw
1041	-	(Jogging positive)		
	0	Jogging velolcity positive	INT32	rw
	1	Jogging acceleration positive	UINT32	rw
	2	Jogging deceleration positive	UINT32	rw
	3	Jogging accelerations positive	UINT32	rw

PNU	Sub-index	Description	Type	Access
1042	-	(Jogging negative)		
	0	Jogging velocity negative	INT32	rw
	1	Jogging acceleration negative	UINT32	rw
	2	Jogging deceleration negative	UINT32	rw
	3	Jogging accelerations negative	UINT32	rw
1050	0	Homing method	INT8	rw
1051	0	Homing offset	INT32	rw
1060	0	Thread speed	INT32	rw
1100	0	Position actual value	INT32	ro
1101	0	Velocity actual value	INT32	ro
1102	0	Current actual value	INT32	ro
1110	-	(Sampling positions)		
	0	Sampled actual position on rising edge	INT32	ro
	1	Sampled actual position on falling edge	INT32	ro
1141	0	Digital inputs	UINT32	ro
1270	-	(Position control parameters)		
	2	Position error tolerance window	UINT32	rw
1271	-	(Position window data)		
	0	Window for „target reached“ message	UINT32	rw
1272	-	(Following error data)		
	0	Following error window	UINT32	rw
1273	-	(Position error data)		
	0	Following error limit	UINT32	rw
1500	0	Operating mode	UINT8	ro
1510	-	(CAM Control)		
	0	Control CAM disks	UINT32	rw
	1	Control axis error compensations	UINT32	rw
1600	0	Last error number	UINT16	ro
2000	0	Entry for manufacturer specific PKW access	2 * UINT32	rw
2010	-	(Placeholder)		
	0	8-bit placeholder (blank element)	UINT8	rw
	1	16-bit placeholder (blank element)	UINT16	rw
	2	32-bit placeholder (blank element)	UINT32	rw
2011	0	32-bit placeholder (blank element)	UINT32	rw

11.2 PNUs for the Operating Mode Positioning

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

11.2.1 PNU 1000: Data Set Number

The positioning data set, in which the data transmitted through PROFIBUS/PROFINET 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/PROFINET 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 Afag 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/PROFINET 267: reserved
Default- value	266 (PROFIBUS/PROFINET position set)

11.2.2 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/PROFINET position data set for starting is of interest. To keep the data to be transmitted over the bus as small as possible, the PROFIBUS/PROFINET-position data set is addressed in the last index. Thus the position data set 255 itself cannot be started over the bus.

PNU	**1002**
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/PROFINET
Default- value	255 (PROFIBUS/PROFINET position set)

11.2.3 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 deceleration, 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 chapter *8 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	**1001**
Name	Position Data

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

Sub-index	**1**
Name	Profile Velocity
Data type	INT32
Access	rw
Unit	Physical unit of velocity
Value range	-
Default value	1000 rpm

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

Sub-index	**3**
Name	Acceleration Positioning
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default- value	10,000 (Rpm)/s

Sub-index	**4**
Name	Deceleration Positioning
Data type	UINT32
Access	rw
Unit	Physical unit of deceleration
Value range	-
Default value	10,000 rpm/s

The parameter **All Accelerations Positioning** allows access to the acceleration and deceleration 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
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default- value	10,000 rpm/s

11.2.4 PNU 1003: Position Profile Type

This parameter allows switching the jerk limitation of position sets between 0 and an automatic determination. For automatic determination the filter time for the jerk limitation will always be calculated in dependence of the acceleration and the profile velocity when calling the position set. By this, the jerk free filter time is also actualised if one of the parameters acceleration or profile velocity is modified. The value does not need to be calculated by the PLC. The “call” of a position set differs from the “start” of a position set. The real start of a position set may be delayed due to the appropriate option, e.g. “wait until the end of the current positioning process”. The “call” refers to the moment when the start command is transmit via fieldbus.

This parameter has different values. Depending on the state of the firmware development one or more position sets may be influenced.

PNU	**1003**
Subindex	**0**
Name	Position Profile Type
Datentyp	UINT16
Zugriff	rw
Einheit	-
Wertebereich	0 .. 1 0: Jerk free filter time for position set = 0. This operation is executed once after Reset or during writing of this parameter. If the jerk free filter time is subsequently modified (e.g. by the parameterisation program) the entered filter time is still effective until a repetitive writing of this parameter or a Reset 1: Automatic determination of the jerk free filter time of the position set when this position set is called.
Default-Wert	0

11.2.5 PNU 1004: Override Factor

This parameter allows changing the profile velocity of a positioning cycle at any time. For example, the profile velocity is divided by two when changing the override to 50 %. After Reset this value is always 100 %. It cannot be saved non-volatile by saving the parameter set.

Changing this parameter does not affect the acceleration. It remains unchanged. So changes of the override during a deceleration phase have no effect on the actual positioning cycle.

PNU	**1004**
Subindex	**0**
Name	Override Factor
Datentyp	UINT16
Zugriff	rw
Einheit	Per mill (1000 corresponds to * 100%)
Wertebereich	0 .. 2000 (corresponds to 0 .. 200%)
Default-Wert	1000 (corresponds to 100%)

Note: The specification of the override factor among the safety parameters must be taken into consideration. This means that 100% of the master specification via the PB only corresponds to 100% if the override factor has been set to 100% among the safety parameters. The input of the override factor via the Afag SE-Commander will not be stored in the servo drive. After Power on and Reset, this value is always 100%.

Example: Specification of an override factor of 100% among the safety parameters. If the master transmits an override factor of 30% (corresponds to the value 1000), this corresponds to 30 mm/s and not to 100 mm/s if a speed of 100 mm/s has been specified.

11.2.6 PNU 1005: Software Position Limits

This parameter number sets and reads the software position limits. They have the function of software limit switches. They are only valid in the operating mode positioning. If the target position of a position cycle is beyond these limits, the positioning does not start. If parameterised adequately, a message may be generated.

PNU	**1005**
Name	Software Position Limits

Subindex	**0**
Name	Lower software position limit switch
Datentyp	INT32
Zugriff	rw
Einheit	Physical unit of position
Wertebereich	-
Default-Wert	Maximum negative position

Subindex	**1**
Name	Upper software position limit switch
Datentyp	INT32
Zugriff	rw
Einheit	Physical unit of position
Wertebereich	-
Default-Wert	Maximum positive position

11.2.7 PNU 1006: Rotary Axis

These parameter numbers are intended to set the rotary axis mode and its limits. In rotary axis mode, the position setpoint and the position actual value is limited to the rotary axis limit values. The upper and lower value coincide, i.e. for a rotary axis range of one revolution the lower limit is e.g. 0.0 R and the corresponding upper limit is 1.0 R.

The mode has effect on the setpoint generation in the operating mode positioning only. The mode “Direction always positive” e.g. does not avoid any movement in negative direction at all. The position controller still outputs position setpoints which cause a movement in negative direction. The setpoint generation in any other operating mode is not affected.

PNU	**1006**
Name	Rotary Axis

Subindex	**0**
Name	Rotary Axis Mode
Data type	UINT8
Access	rw
Unit	-
Value range	0: Off 1: Shortest Distance 2: Direction from position set 3: Direction always positive 4: Direction always negative
Default value	0

Subindex	**1**
Name	Lower rotary axis limit
Data type	INT32
Access	rw
Unit	Physical unit of position
Value range	-
Default value	Maximum negative position

Subindex	2
Name	Upper rotary axis limit
Data type	INT32
Access	rw
Unit	Physical unit of position
Value range	-
Default value	Maximum positive position

11.2.8 PNU 1050: Homing Method

Set the homing method by this parameter number.

PNU	1050
Subindex	0
Name	Homing Method
Data type	INT8
Access	rw
Unit	-
Value range	-
Default value	1

11.2.9 PNU 1051: Home Offset

Set the distance between the home position and the zero position of a homing process by this parameter number. Positive values move the zero position into positive direction referring to the home position. The following figure illustrates this by an example for the target „limit switch" and the zero pulse as zero position. The shown direction of the arrow displays the effective direction of the offset.

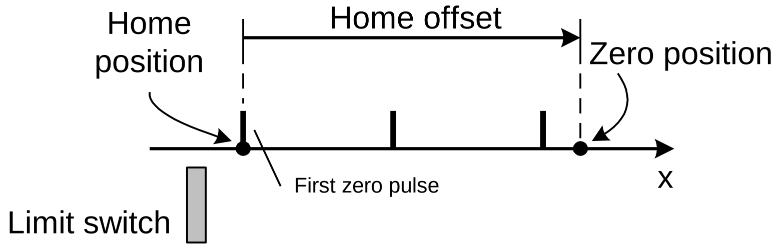


Figure 19: Interpretation of the home offset

The data are interpreted in the physical unit position. The physical unit can be set by an appropriate menu of the parameterisation program Afag SE-Commander.

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

Note:

The determination of the zero position resp. an additional shift of the zero position by the home offset may require saving the corresponding data in the EEPROM of the angle encoder. This is for example useful when applying Multiturn absolute encoders.

11.2.10 PNU 1060: Thread Speed

This parameter modifies the thread speed. The setup mode is activated or deactivated by a corresponding digital input. During active setup mode reduced speed limitations are valid in the operating modes speed control and positioning.

Note:

The thread speed is directly written in velocity units.

Using the parameterisation program Afag SE-Commander this value is set in proportional dependence on the speed limit.

Accordingly, the parameterisation has a mutual dependence: Writing the thread speed affects the proportional indication of the thread speed in the parameterisation program Afag SE-Commander and vice versa.

The speed limit and the thread speed in % are not available.

PNU	**1060**
Subindex	**0**
Name	Thread Speed
Data type	INT32
Access	rw
Unit	Physical unit of velocity
Value range	-
Default value	3276 rpm

11.2.11 PNU 1270: Position control parameters

Use this parameter number to modify the settings of the position controller. The position error tolerance window defines a range of the controller error in which the position controller does not generate any output (speed Setpoint). This may be advantageous for drives with backlash.

PNU	1270
Name	Position Control Parameters

Subindex	2
Name	Position error tolerance window
Data type	UINT32
Access	rw
Unit	Physical unit of position
Value range	0,001 R .. 1 R
Default value	0,01°

11.2.12 PNU 1271: Position Window Data

Use this parameter number for settings concerning the "target reached" message. The Target window defines a range in which the "target reached" message can be generated.

PNU	1271
Name	Position Window Data

Subindex	0
Name	Target Window
Data type	UINT32
Access	rw
Unit	Physical unit of position
Value range	-
Default value	10

11.2.13 PNU 1272: Following Error Data

Use this parameter number for settings concerning the range for the following error message. The Following error window defines a range outside of which e.g. a warning (following error) is generated (depending on the parameterised reaction).

PNU	**1272**
Name	Following Error Data

Subindex	**0**
Name	Following Error Window
Data type	UINT32
Access	rw
Unit	Physical unit of position
Value range	0 R.. 101 R
Default value	50°

11.2.14 PNU 1273: Position Error Data

Use this parameter number for settings concerning a position range outside of which the servo drive executes a reaction according to the parameterisation. Besides the following error window here another position window may be defined that may cause the servo drive to switch off while generating an error message (depending on the parameterised reaction).

PNU	**1273**
Name	Position Error Data

Subindex	**0**
Name	Position Error Limit
Data type	UINT32
Access	rw
Unit	Physical unit of position
Value range	0 .. 231-1
Default value	180°

11.3 PNUs for Operating Mode Speed Control

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

11.3.1 PNU 1010: Target Velocity

The set value of the rotational speed is set through 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/PROFINET 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/PROFINET communication. More information on this topic is available in chapter *12.*

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

11.3.2 PNU 1011: Accelerations for Speed Control

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

- Acceleration, combined for positive and negative direction of rotation
- Deceleration, combined for positive and negative direction of rotation
- Combination for acceleration and deceleration 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 chapter *8*.

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 speed control

Sub-index	**0**
Name	Acceleration speed control
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default value	14,100 (rpm)/s

Sub-index	**1**
Name	Deceleration speed control
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default value	14,100 (rpm)/s

The parameter **All Accelerations Speed Control** allows the access to acceleration and deceleration 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 speed control
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default- value	14,100 (rpm)/s

11.4 PNUs for Different Operating Modes

This section describes parameters which are not especially assigned to one single operating mode.

11.4.1 PNU 1040: Jogging

This parameter allows the simplified access of both velocities and all four acceleration values for jogging. By this, less data has to be transmit in the cyclic data telegram. Internally, all parameters are written.

The parameter of the jogging velocity has the property that it becomes immediately active. A modification has also effect if the jogging mode is active yet.

PNU	**1040**
Name	Jogging

Subindex	**0**
Name	Symmetrical Jogging Velocity
Data type	INT32
Access	rw The read access returns the value of the velocity in positive direction
Unit	Physical unit of velocity
Value range	-
Default- value	100 rpm

Subindex	1
Name	Symmetrical Jogging Accelerations
Data type	INT32
Access	rw The read access returns the value of the velocity in positive direction
Unit	Physical unit of acceleration
Value range	-
Default- value	1.000 (rpm)/s

11.4.2 PNU 1041: Jogging Positive

This parameter number sets the parameters for jogging in positive direction (TIPP0) more detailed. By this, depending on the application also a single parameter can be modified.

The parameter of the jogging velocity has the property that it becomes immediately active. A modification has also effect if the jogging in positive direction is active yet.

PNU	1041
Name	Jogging Positive

Subindex	0
Name	Jogging Velocity Positive
Data type	INT32
Access	rw
Unit	Physical unit of velocity
Value range	-
Default- value	100 rpm

Subindex	1
Name	Jogging Acceleration Positive
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default- value	1.000 (rpm)/s

Subindex	**2**
Name	Jogging Deceleration Positive
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default- value	1.000 (rpm)/s

Subindex	**3**
Name	Symmetrical Jogging Accelerations Positive
Data type	UINT32
Access	rw The read access returns the value of the acceleration
Unit	Physical unit of acceleration
Value range	-
Default- value	1.000 (rpm)/s

11.4.3 PNU 1042: Jogging Negative

This parameter number sets the parameters for jogging in negative direction (TIPP1) more detailed. By this, depending on the application also a single parameter can be modified.

The parameter of the jogging velocity has the property that it becomes immediately active. A modification has also effect if the jogging in negative direction is active yet.

PNU	**1041**
Name	Jogging Negative

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

Subindex	1
Name	Jogging Acceleration Negative
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default- value	1.000 (rpm)/s

Subindex	2
Name	Jogging Deceleration Negative
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default- value	1.000 (rpm)/s

Subindex	3
Name	Symmetrical Jogging Accelerations Negative
Data type	UINT32
Access	rw The read access returns the value of the acceleration
Unit	Physical unit of acceleration
Value range	-
Default- value	1.000 (rpm)/s

11.5 Actual Values

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

11.5.1 PNU 1100: Position Actual Value

The actual value of the position is returned in this parameter. It is scaled in the physical unit set for PROFIBUS/PROFINET. 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. 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	ro
Unit	Physical unit of position
Value range	-
Default value	-

11.5.2 PNU 1101: Velocity Actual Value

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

PNU	**1101**
Sub-index	**0**
Name	Velocity Actual Value
Data type	INT32
Access	ro
Unit	Physical unit of velocity
Value range	-
Default value	-

11.5.3 PNU 1102: Current Actual Value

The actual value of active current is returned through these parameters. It is returned in thousand 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 thousand referred to the motor nominal current
Value range	-
Default value	-

11.5.4 PNU 1110: Sampling Positions

These parameter numbers return the positions sampled on the rising resp. falling edge of the so called sampling input. For this purpose select the DIN9 in the menu „Parameters - IOs - Digitale inputs“ of the parameterisation program Afag SE-Commander.

PNU	**1110**
Name	Sampling Positions

Subindex	**0**
Name	Sampling Position Rising Edge
Data type	INT32
Access	ro
Unit	Physical unit of position
Value range	-
Default value	-

Subindex	**1**
Name	Sampling Position Falling Edge
Data type	INT32
Access	ro
Unit	Physical unit of position
Value range	-
Default value	-

11.5.5 PNU 1141: Digital Inputs

The state of the digital inputs is read through these parameters. The available digital inputs depend on the parameterization of the servo-positioning regulator 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 (Position selector Bit 0) Bit 2: DIN 1 (Position selector Bit 1) Bit 3: DIN 2 (Position selector Bit 2) Bit 4: DIN 3 (Position selector Bit 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 (Homing switch) Bit 10: DIN 9 (Start input and 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 „SE-Power IO Interface“ in slot 1 Bit 21: DIN_AIN 1 (optional digital input instead of analogue input 1, Start homing) Bit 22: DIN_AIN 2 (optional digital input instead of analogue input 2, Set-up mode active low) Bit 23..30: DIN 0..7 from optional technology module „SE-Power IO Interface in slot 2 Bit 31: reserved
Default value	-

11.6 Parameter for the Construction of the Telegram

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

11.6.1 PNU 2000: Parameter ID value Access

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

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

PNU	**2000**	
Subindex	**0**	
Name	Parameter ID value access (manufacturer-specific parameter ID value access)	
Data type	2 * UINT32 (8 Byte)	
Access	rw	
Unit	-	
Value range	Byte 0:	Type of access 0x00: No access 0x41: Read access 0x42: Write access remaining values reserved
	Byte 1..2:	Parameter number or CAN objects (attention: consider the CAN factor group and enter the CAN object in hexadecimal format)
	Byte 3:	Subindex
	Byte 4.0.7:	Data
Default value	0	

11.6.2 PNU 2010: Placeholder

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

PNU	2010
Name	Placeholder

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

11.6.3 PNU 2011: Element 0

This parameter behaves identically to the parameter with the PNU 2010 2. The difference is in the fact that it is not depicted in the telegram editor of the Afag 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

11.7 Parameter for various Intents

This section contains parameters which are not explicitly assigned to a special function group.

11.7.1 PNU 1600: Last Error Code

This parameter number returns the last generated error.

PNU	1600	
Subindex	0	
Name	Last Error Code	
Data type	UINT16	
Access	ro	
Unit	-	
Value range	Bit 0..3:	Subindex error number (0..9)
	Bit 4..15:	Main index error number (1..96)
Default value	- The PNU returns “0” if no error is active. Then, the value is invalid	

11.7.2 PNU 1510: CAM Control

These parameters are used to activate or deactivate CAM disks or an axis error compensation. The appropriate CAM or axis error compensation tables have to be transferred to the servo drive by the parameterisation program Afag SE-Commander before.

PNU	**1510**
Name	CAM Control

Subindex	**0**
Name	Control CAM disks
Data type	UINT32
Access	rw
Unit	-
Value range	Bit 0..7: Number of the selected CAM disk Bit 16 : Activate (1) or deactivate (0) the CAM disk
Default value	0

Subindex	**1**
Name	Control axis error compensation
Data type	UINT32
Access	rw
Unit	-
Value range	Bit 0..7: Number of the selected axis error compensation Bit 16 : Activate (1) or deactivate (0) the axis error compensation
Default value	0

12 Operating Modes

12.1 Overview

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

- Positioning
- Speed control
- Torque control

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 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
Positioning	0	0xE0
Speed control	1	0xE1

Other operating modes cannot be selected at present.

12.2 Parameters

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

12.2.1 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	-
Value range	0x08: Rotational speed control 0x10: Positioning
Default value	-

12.3 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 on-going positioning should be interrupted, or whether the positioning to be started is appended immediately to the on-going positioning.

In some applications, a continuous sequence of movement tasks has to be carried out, see *Figure 20*. 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.

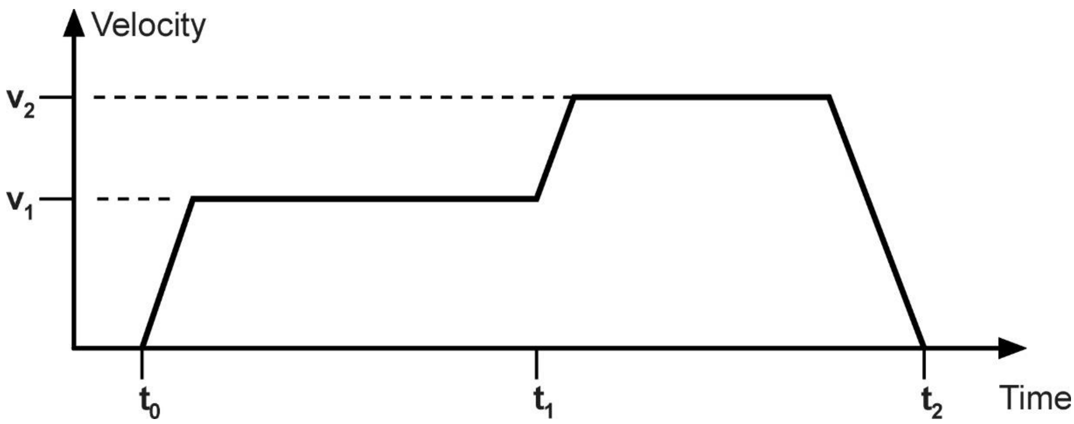


Figure 20: Continuous sequence of movement orders

12.4 Operating Mode: Speed control mode

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:

- When the PROFIBUS/PROFINET communication is activated, the fixed setpoint 1 is activated for the adder. If the controller enabling logic has been set to DIN5 and PROFIBUS or DIN5 and PROFINET, this selector is also called PROFIBUS/PROFINET in Afag SE-Commander.
- If the setpoint for the setpoint ramp has been disabled by the PROFIdrive control word 1, no setpoint is activated in the adder (no check box is marked in Afag SE-Commander).

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