

PROFIBUS/PROFINET Manual



item Servo Positioning Controller C-Series

Translation of the original instructions

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1 General

1.1 Documentation

This manual describes the field bus connection of item servo positioning controller C-Series under PROFIBUS-DP and PROFINET. It describes the adjustment of the physical parameters, the activation of the PROFIBUS or PROFINET communication, the integration into the master connection and the communication with the servo drive. It is intended for persons who are familiar with this servo drive model.

It contains safety notes which have to be complied with.



The term "item C-Series" in this manual includes the servo drives of the item C 1-Series and item C 3-Series.

PROFINET is only available for the item C-Series devices.

Further information on the individual devices can be found in the corresponding product manuals.

You can find these documents on our homepage for download: <http://www.item24.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 under 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 Safety notes for electrical drives and controllers

2.1 Symbols and signs



Information

Important information and notes.



Caution!

Nonobservance may result in severe property damages.



DANGER!

Nonobservance may result in **property damages** and in **personal injuries**.



Caution! High voltage.

The safety note indicates a possible perilous voltage.



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

2.2 General notes

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



Prior to the initial use you must read the chapter *Safety notes for electrical drives and controllers starting on page 11*.

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

Sound and safe operation of the servo drive requires proper and professional transportation, storage, mechanical installation, and project planning – with a consideration of the risks as well as the protective and emergency measures – plus the proper and professional electrical installation, operation, and maintenance of the devices.

Only trained and qualified personnel is authorised to handle electrical devices and systems:

TRAINED AND QUALIFIED PERSONNEL

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

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

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



These safety notes must be complied with at all times.



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



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



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



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



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



DANGER!

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

2.3 Danger resulting from misuse



DANGER!

High electrical voltages and high load currents!

Danger to life or serious personal injury from electrical shock!



DANGER!

High electrical voltage caused by wrong connections!

Danger to life or serious personal injury from electrical shock!



DANGER!

Surfaces of device housing may be hot!

Risk of injury! Risk of burning!



DANGER!

Dangerous movements!

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

2.4 Safety notes

2.4.1 General safety notes



The servo drive corresponds to IP20 degree of protection as well as pollution degree 2. Make sure that the environment corresponds to this degree of protection and pollution degree.



Only use replacement parts and accessories approved by the manufacturer.



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



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



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



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



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



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



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



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



DANGER!

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

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



Without claiming completeness, the following regulations and others apply:

- VDE 0100 Erection of power installations with nominal voltages up to 1000 V
- EN 60204 Safety of machinery - Electrical equipment of machines -
- EN 50178 Electronic equipment for use in power installations

2.4.2 Safety notes for assembly and maintenance

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



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

Prevention of accidents, injuries and/or damages:



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

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



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



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

- Maintenance and repair work
- Cleaning
- long machine shutdowns



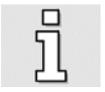
Prior to carrying out maintenance work make sure that the power supply has been turned off, locked and the DC bus circuit is discharged.



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



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



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



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



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



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



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



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

2.4.3 Protection against contact with electrical parts

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

	<p>DANGER! High electrical voltage! Danger to life, danger due to electrical shock or serious personal injury!</p>
---	---

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



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



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



Comply with the minimum copper cross-section for the ground conductor over its entire length (see for example EN 60800-5-1).



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



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



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



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



The device comprises a rapid discharge circuit for the DC bus as per EN 60204-1. In certain device

constellations, however, mostly in the case of parallel connection of several servo drives in the DC bus or in

the case of an unconnected brake resistor, this rapid discharge may be rendered ineffective. The servo drives can carry voltage until up to 5 minutes after being switched off (residual capacitor charge).



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

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

- International: IEC 60364-4-41
- European countries within the EU: EN 61800-5-1

	DANGER! High electrical voltages due to wrong connections! Danger to life, risk of injury due to electrical shock!
---	---

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

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

2.4.5 Protection against dangerous movements

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

- Improper or faulty wiring or cabling
- Error in handling of components
- Error in sensor or transducer
- Defective or non-EMC-compliant components
- Software error in superordinate control system

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

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

	DANGER! Dangerous movements! Danger to life, risk of injury, serious personal injuries or property damage!
--	---

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

2.4.6 Protection against contact with hot parts



DANGER!

Housing surfaces may be hot!

Risk of injury! Risk of burning!



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



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



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

2.4.7 Protection during handling and assembly

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

	DANGER! Risk of injury due to improper handling! Personal injury due to pinching, shearing, cutting, crushing!
---	---

The following general safety notes apply:



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



Use suitable assembly and transportation devices.



Prevent incarcerations and contusions by means of suitable protective measures.



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



Use lifting devices and tools appropriately.



If necessary, use suitable protective equipment (for example goggles, protective footwear, protective gloves).



Do not stand underneath hanging loads.



Remove leaking liquids on the floor immediately to prevent slipping.

3 Wiring and pin assignment

3.1 PROFIBUS

3.1.1 Pin assignment

In the item C-Series, 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).

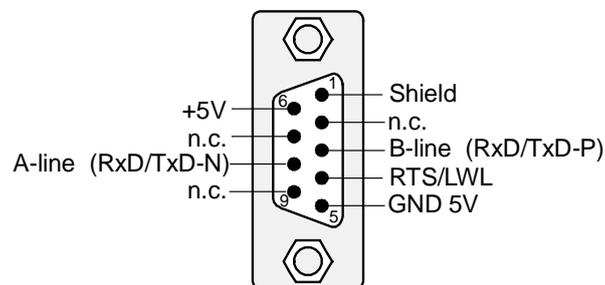


Figure 3-1: PROFIBUS connector for item C-Series



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.

3.1.2 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 item C-Series 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 item C-Series.

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.

3.1.3 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

3.2 PROFINET

3.2.1 Connection and display elements of the technology module

For the item C-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.

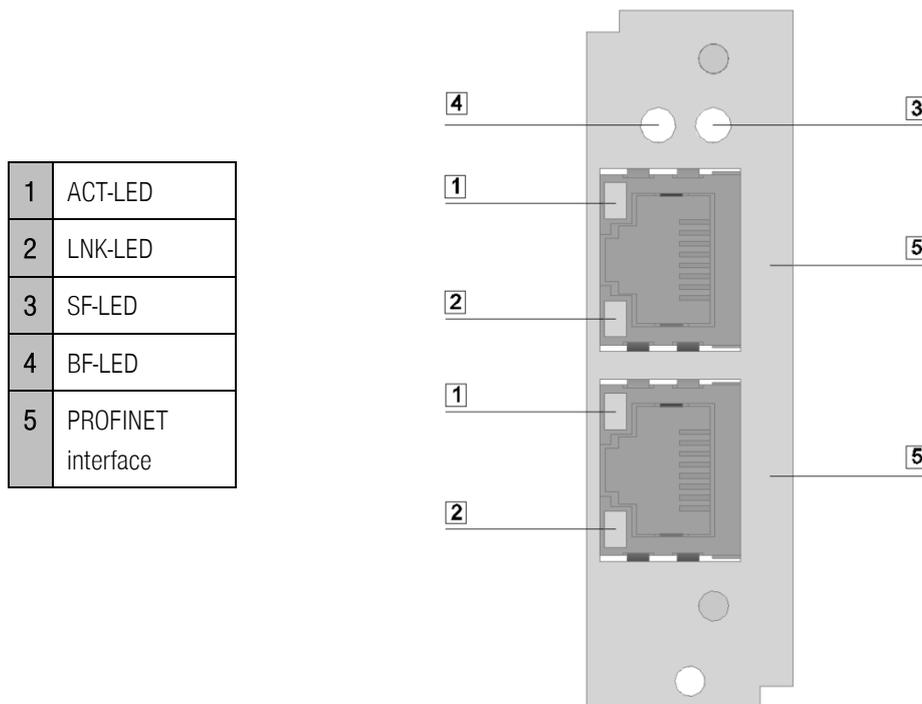


Figure 3-2: Connection and display elements of the PROFINET module

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 3-1: PROFINET LEDs

3.2.2 Pin assignment

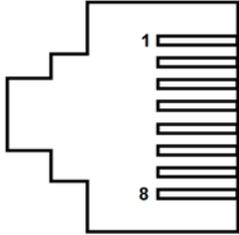
Socket	Pin no.	Name	Description
	1	RX-	Receive signal-
	2	RX+	Receive signal+
	3	TX-	Transmission signal-
	4	-	-
	5	-	-
	6	TX+	Transmission signal+
	7	-	-
	8	-	-

Table 3-2: Pin assignment of the PROFINET interface

3.2.3 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.

4 Fundamental principles: PROFIBUS-DP, PROFINET and PROFIdrive

The technology plug-in module of the item C-Series can either be combined with a PROFIBUS plug-in module or with a PROFINET plug-in module. As shown in Figure 4-1, 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.

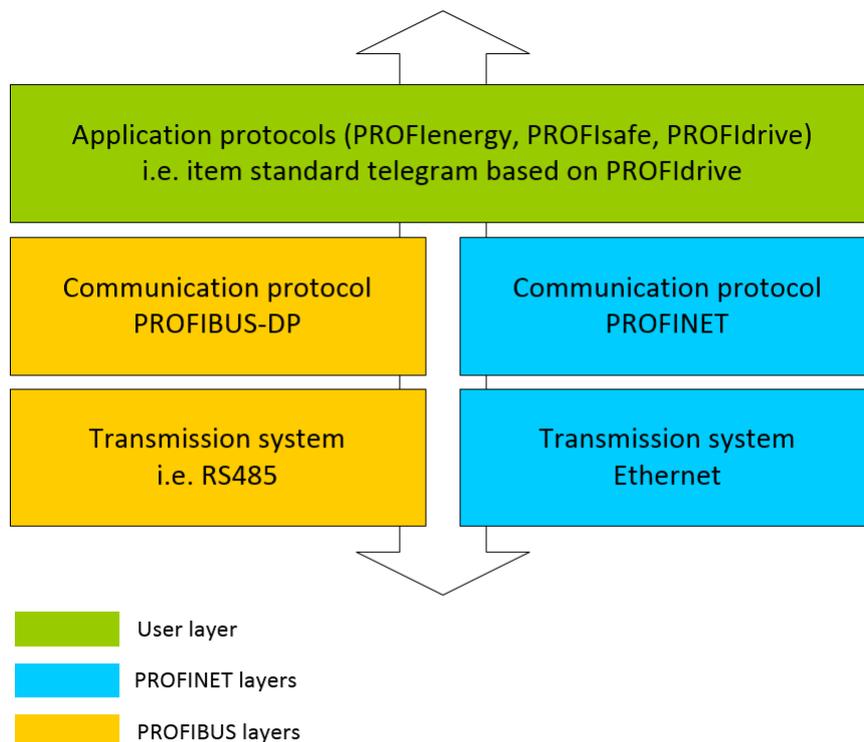


Figure 4-1: Comparison of PROFIBUS and PROFINET

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

4.1 Overview PROFIBUS-DP

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 item C-Series are not equipped with this hardware. This is why support of DV-V2 is not intended.

The versions of DP are specified in detail in IEC 61158 (see chapter 1.2).

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.

4.2 PROFINET IO overview

4.2.1 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 μ s.

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.

4.2.2 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 4-1: Channel diagnostics example

4.3 PROFIdrive overview

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 item C-Series 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 6 onwards.

The item C-Series 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 item C-Series. 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 item communication objects and the CANopen object directory.

5 PROFIBUS and PROFINET connection

5.1 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.

5.2 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. Selection and parameterisation of the **physical units**, **chapter 7**
2. Configuration and activation of the **operating parameters**, **chapter 8**

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.

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.

5.3 Master overview

5.3.1 PROFIBUS

This section provides an overview of the necessary steps for the parameterisation and configuration of the master. 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.

The following section describes this based on an example using integration under SIEMENS SIMATIC S7.

In order to integrate the servo drive into the PROFIBUS network, the servo drive must be selected in the hardware catalog. The folder C-Series must be transferred to the PROFIBUS DP master system by drag & drop. Immediately afterwards, the system requests the **slave address**.

The bitmap of the servo drive is displayed on the master side. It must be selected. Then, the length of the **input and output data** must be specified. For this purpose, special modules have been prepared in the GSD file. One module for the input data and one module for the output data, including the corresponding length, must be added to one port each.

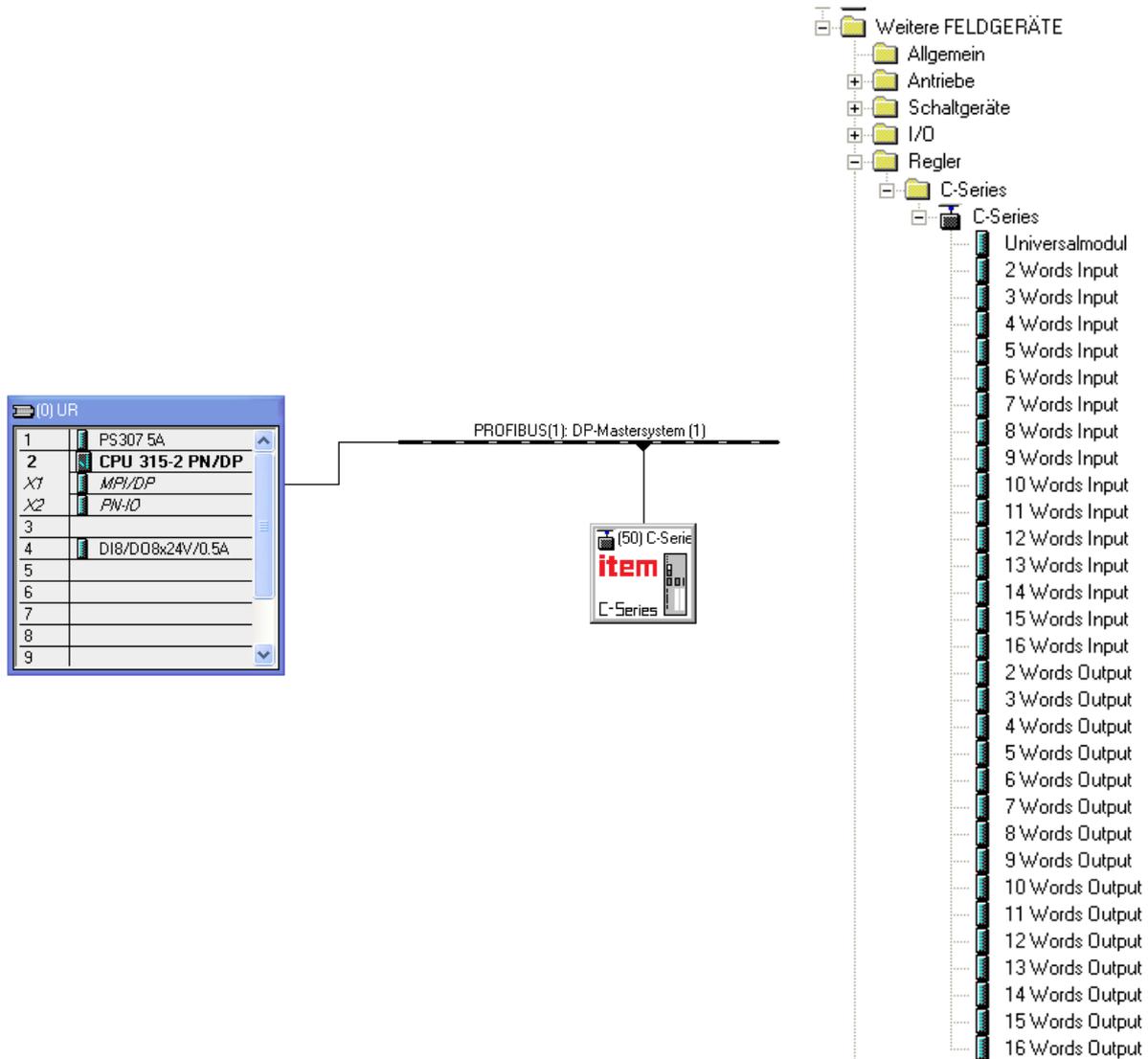


Figure 5-1: Hardware configuration under SIEMENS S7

i In order to ensure perfect operation, we recommend specifying only one section each for the input and output data (see the example above).

Further information concerning the hardware configuration can be found in chapter 6 **Telegram structure**, chapter 13 **PROFIBUS/PROFINET function and data blocks for SIEMENS S7** or application notes with example projects.

5.3.2 PROFINET

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

1. Installation of the **GSDML file**
2. Specification of the **device name**
3. Configuration of the **input and output data**

On the master side, the servo drive must be integrated into the PROFINET network. The following section describes this based on an example using integration under SIEMENS SIMATIC S7.

If the servo drive is not included in the device or hardware catalog, the **GSDML file** must be installed first. A brief description can be found in additional application notes.

In order to integrate the servo drive into the PROFINET network, the servo drive must be selected in the hardware catalog. The C-Series head module must be dragged and dropped into the topology view of the device configuration. After the selection of the network view, the servo drive must be assigned to an I/O controller via the link "Not assigned".

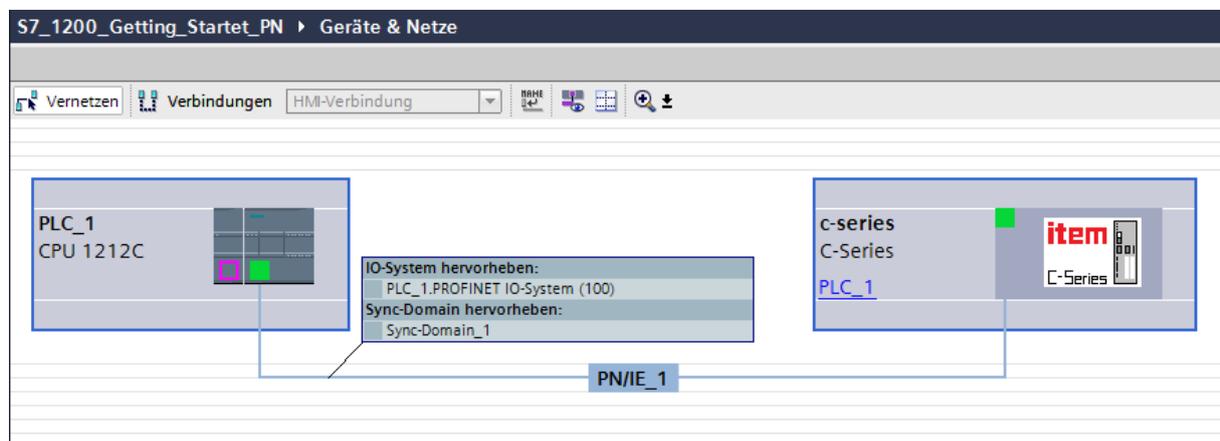


Figure 5-2: IO controller assignment under SIEMENS S7

Then, the **device name** must be specified. This method has been chosen for PROFINET, since names are easier to handle than complex IP addresses. After clicking the item logo of the servo drive, the device name can be changed under "General" in the "Properties" window.

Then, the length of the **input and output data** must be specified. For this purpose, special modules have been prepared in the GSDML file. One module for the input data and one module for the output data, including the corresponding length, must be added to one port each.

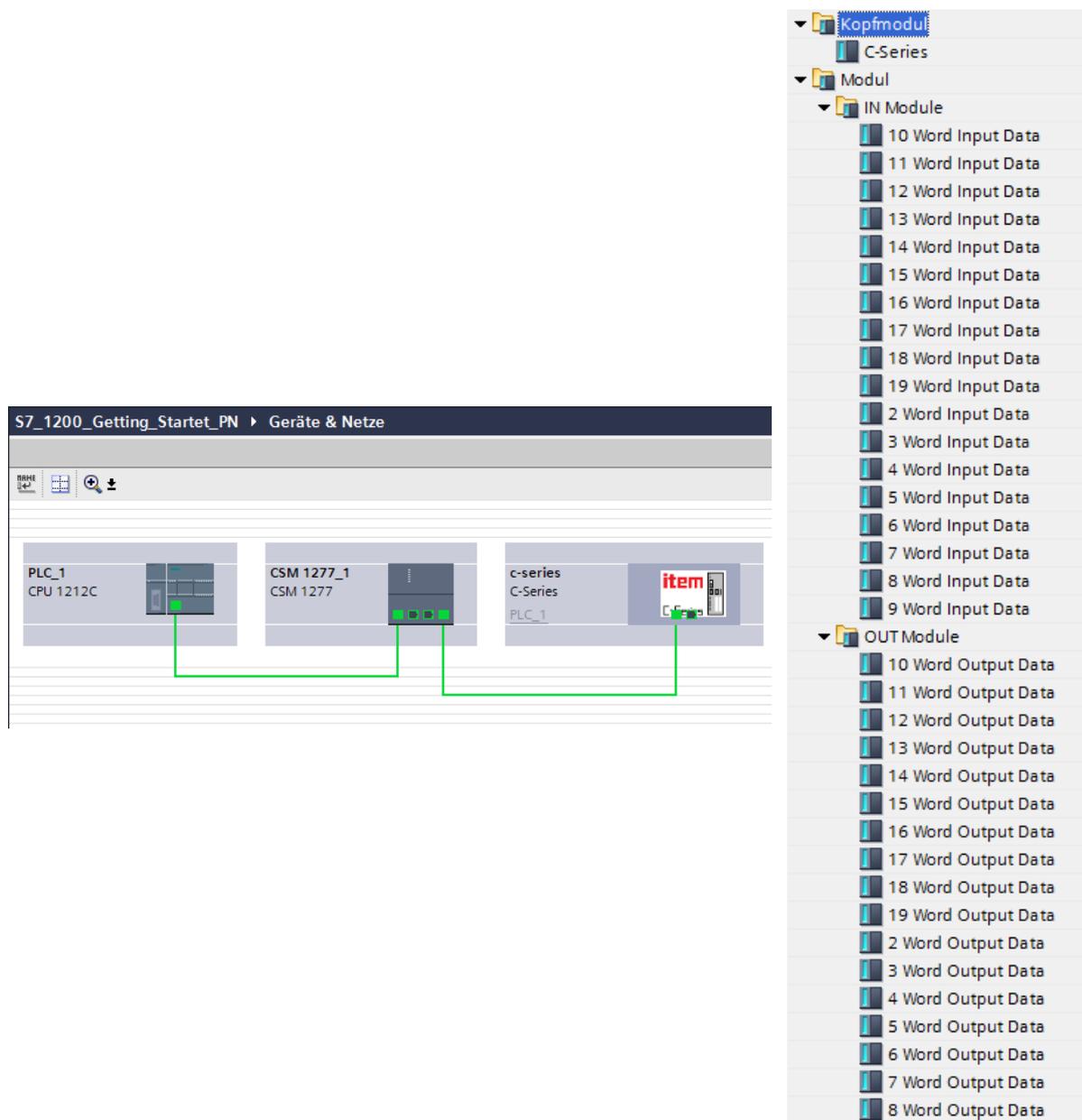


Figure 5-3: Hardware configuration under SIEMENS S7

Further information concerning the hardware configuration can be found in chapter 6 **Telegram structure** or additional application notes.

6 Telegram structure

6.1 Introduction

The telegram structure is used to define the outgoing data and the interpretation of the received data by the servo drive.

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.

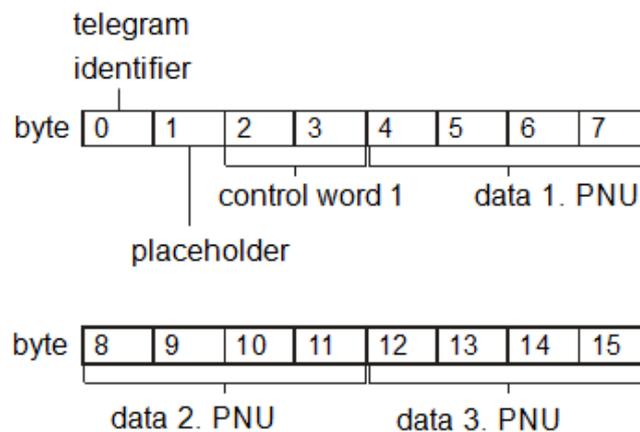


Figure 6-1: Example of the item C-Series telegram format

Figure 6-1 shows an example of an item C-Series 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 differs depending on the telegram number. 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.

6.2 Receive telegrams

The item C-Series supports 4 receive telegrams. Two 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. Telegrams 2 and 3 are not supported yet. The following table shows how the different receive telegrams are connected to specific operating modes:

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

The telegrams are preconfigured. At the moment changes of the telegram structure are not supported.

The structure of the C-Series receive telegram 0 for the positioning mode (E0) is as follows:

Address	Content (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 set for PROFIBUS
8	Profile velocity (PNU 1001.1)	Profile velocity during positioning, indication with the physical speed unit set for PROFIBUS
12	Accelerations (PNU 1001.5)	Combination of the values for acceleration and deceleration, indication with the physical unit set for PROFIBUS

The total length of this telegram is 16 bytes. Detailed information on parameter numbers can be found in chapters 9 to 12.

When the slave is integrated into the hardware configuration of the master, the module

8 Words Output

must be selected for the output data and connected to one of the ports.

The structure of the C-Series receive telegram 1 for the speed control mode (E1) is as follows:

Address	Content (parameter number)	Description
0	Identifier (= 0xE1)	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 velocity (PNU 1010.0)	Speed setpoint, indication with the physical unit set for PROFIBUS
8	Acceleration (PNU 1011.2)	Combination of the values for acceleration and deceleration, indication with the physical unit set for PROFIBUS

Detailed information on parameter numbers can be found in chapters 9 to 12. The total length of this telegram is 12 bytes. When the slave is integrated into the hardware configuration of the master, the module

6 Words Output

must be selected for the output data and connected to one of the ports.

6.3 Response telegrams

The item C-Series supports 4 response telegrams, of which 3 are not supported yet. Every receive telegram is associated with a response telegram. By default, one and the same receive telegram is used for all operation modes. 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.

At the moment changes of the response telegram structure are not supported. Please contact the customer service as required.

The following table describes the telegram structure:

Address	Content (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	Position Actual Value (PNU 1100.0)	Actual position, indication with the physical position unit set for PROFIBUS
8	Velocity Actual Value (PNU 1101.0)	Actual speed value, indication with the physical speed unit set for PROFIBUS
12	Current actual value (PNU 1102.0)	Actual value of the current, indicated per thousand referring to the nominal motor current
16	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.

Detailed information on parameter numbers can be found in chapters 9 to 12. The total length of this telegram is 20 bytes. When the slave is integrated into the hardware configuration of the master, the module

10 Words Input

must be selected for the input data and connected to one of the ports.

7 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 **Parameters – Communication – PROFIBUS / PROFINET – 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 7-1 shows the window of the item MotionSoft[®] program for the configuration of the physical units for PROFIBUS.

PROFIBUS / PROFINET

PROFIBUS active:

TECH 2 module: PROFIBUS Adopt settings

▼ PROFIBUS operating parameter

▲ **Display units**

Position:	Millimetre [mm]	▼
Speed:	mm/s	▼
Acceleration:	mm/s ²	▼
Feed constant:	1.000,000	mm/r ▼

Gearbox

Input:	<input type="text" value="1"/>
Output:	<input type="text" value="1"/>

▼ Diagnosis Adopt settings

Figure 7-1: Setting of physical units for PROFIBUS

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.

Example:



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 $\mu\text{m}/\text{revolution}$
→ The feed constant will be **considered** with the factor 1000.

i 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.

i 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 7-2 shows the interpretation of the gear ratio. In the menu **Parameters – Communication – PROFIBUS / PROFINET – Display units** of the item MotionSoft[®] parameterisation program, the value "Ingoing shaft" refers to U_{EIN} , the value "Outgoing shaft" to U_{AUS} .

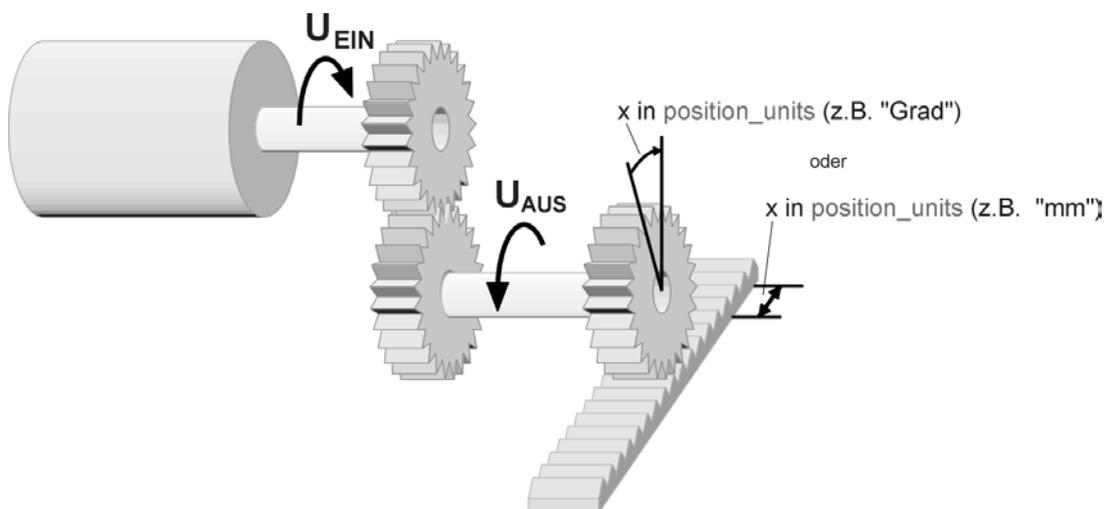


Figure 7-2: Gear ratio

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 help of the gear ratio of the angle encoder in the item MotionSoft[®] software.

8 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 sections are set via the serial interface using the item MotionSoft[®] program.

8.1 PROFIBUS operating parameters

The operating parameters menu can be opened in the item MotionSoft[®] via the menu bar under **Parameters – Communication – PROFIBUS / PROFINET – Operation parameters PROFIBUS**. Figure 8-1 shows the window of the parameterisation program used to set the operating parameters.

PROFIBUS / PROFINET

PROFIBUS active:

TECH 2 module: PROFIBUS Adopt settings

^ PROFIBUS operating parameter

Slave address:	<input type="text" value="126"/>
Add DIN 0...DIN 3:	<input type="checkbox"/>
Add AIN 1:	<input type="checkbox"/>
Add AIN 2:	<input type="checkbox"/>
Node number:	126

Figure 8-1: Setting of operating parameters

Activation:

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

It must be taken into consideration that the PROFIBUS 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.

Starting at the base value, it is possible to increase the slave address using options and a suitable hardware connection. The digital inputs DINO..3, the analogue inputs AIN1 and AIN2 and the DIP switches 1 – 7 of the FSM module are intended for this purpose. The states of the inputs are read once immediately after a reset and used to calculate the effective slave address.

Later changes have no effect. The options have different values:

Option	Active at	Value
Addition of DINO..3	+ 24 V DC	0..15
Addition of AIN1	U_on > + 5 V	0, 16
Addition of AIN2	U_on > + 5 V	0, 32

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 item C-Series:

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 item **standard protocol** is supported.

Save & Reset:

The settings of the operating parameters will not become effective until the button **Adopt settings** 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.

8.2 PROFINET operating parameters

The operating parameters menu can be opened in the item MotionSoft[®] via the menu bar under **Parameters – Communication – PROFIBUS / PROFINET – Operation parameters PROFINET**. Figure 8-2 shows the window of the parameterisation program for the configuration of the operating parameters.

PROFIBUS / PROFINET

PROFINET active:

TECH 2 module: PROFIBUS

[Adopt settings](#)

^ PROFIBUS operating parameter

Device name:	<input type="text"/>
PROFenergy:	<input type="checkbox"/>
IP address:	<input type="text" value="192"/> <input type="text" value="168"/> <input type="text" value="0"/> <input type="text" value="86"/>
Subnet mask:	<input type="text" value="255"/> <input type="text" value="255"/> <input type="text" value="255"/> <input type="text" value="0"/>
Gateway:	<input type="text" value="192"/> <input type="text" value="168"/> <input type="text" value="0"/> <input type="text" value="86"/>
MAC address, bus node:	00-02-A2-3A-FA-1B
MAC address, port 1:	00-02-A2-3A-FA-1C
MAC address, port 2:	00-02-A2-3A-FA-1D
Parameter interface:	<input type="text" value="Onboard Ethernet"/> ▾
Port number:	<input type="text" value="8802"/>

Figure 8-2: Settings of the operating parameters

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.

PROFenergy:

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

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.

Save & Reset:

The settings of the operating parameters will not become effective until the button **Adopt Settings** 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 Device control

9.1 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 (4). **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 item C-Series follows the state diagram specified in the PROFIdrive profile. The implementation and potential manufacturer-specific deviations are described in detail in chapter 9.4 State diagram and device control.

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.

9.2 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 9.4 State diagram and device control. 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.

Bit	Meaning	Behaviour
0	ON / OFF (OFF 1)	See the "Device control" section, chapter 9.4
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 setpoints enabled 0: All speed setpoints disabled
5*	1: Unfreeze ramp generator 0: Freeze ramp generator	1: Setpoint ramp enabled 0: Ramp stopped (frozen)
6*	1: Enable setpoint 0: Disable setpoint	1: All setpoint inputs for the ramp enabled 0: All setpoint inputs for the ramp deactivated
7	Fault acknowledge (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 preset as a speed setpoint through the ramp
9*	Jog 2 ON / Jog 2 OFF	The speed of motion of the "negative jogging" position set is preset as a speed setpoint 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 another operating mode.

Table 9-1: Control word 1 for speed control mode

Meaning of/notes concerning the various bits

Bit 4: Corresponds to the hold input (hold function) of FB43 if the item 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 setpoint setting.

Example: - Current setpoint 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 setpoint 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 setpoint 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 setpoint.

Bit	Meaning	Behaviour
0	ON / OFF (OFF 1)	See the "Device control" section, chapter 9.4
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 procedure	1: (No action) Continue homing 1 -> 0: Homing still active: Termination of homing without error Homing already terminated: No action 0: No action 0 -> 1: Start of 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 another operating mode.

** : Manufacturer-specific bit

***: Manufacturer-specific deviation from PROFIdrive specification

Table 9-2: Control word 1 for positioning mode

Notes concerning Table 9-2:

- 1): The command "Activate traversing" starts the position set selected through PNU 1002 0. If the PROFIBUS 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 active
- 3): Parameterisable options are taken into account, e.g. "with following positioning".

Chapter 9.4 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 9.4. The following tables shows an overview of the commands:

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

(× = not relevant)

Table 9-3: Overview of all commands

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As some state transitions take a certain time, all status changes that are triggered through **control word 1** have to be read back through **status word 1**. It is only when the requested status can also be read in **status word 1**, that another command can be written in through **control word 1**.

9.3 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 9.4 State diagram and device control. 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	Status word 1
Data type	UINT16
Access	ro
Unit	-
Value range	-
Default value	-

In response telegrams 0..2, status word 1 is bound to 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.

Bit	Meaning	Behaviour
0	1: Ready To Switch On 0: Not Ready To Switch On	See the "Device control" section, chapter 9.4
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 the "Device control" section
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 out of tolerance range	1: The actual speed is within the parameterisable signal window around the target speed 0: The actual speed is out of the parameterisable signal window around the target speed
9	1: Control by PLC 0: No control by PLC	Mirroring of bit 10 of control word 1
10*	1: f or n reached 0: f or n not reached	1: Actual speed > freely parameterisable reference speed ¹⁾ 0: Actual speed < freely parameterisable reference speed ¹⁾
11-13*	Device-specific	Free
14-15	Device-specific	Free

*: Different meaning in another operating mode.

Table 9-4: Status word 1 for speed control 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.

Meaning of/notes concerning the various bits

Bit 8 & 10: The functionality cannot be configured with item MotionSoft[®]. Please contact the customer service if you have questions.

In addition to the comparison speed (bit 8), the user can define a second value (threshold value). Bit 10 will be set once this value is reached (or exceeded).

Bit	Meaning	Behaviour
0	1: Ready To Switch On 0: Not Ready To Switch On	See the "Device control" section, chapter 9.4
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 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 the device control section
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 of control word 1
10*	1: Target position reached 0: Not at target position	1: The current positioning run has been completed and the actual position is within the target window 0: The current positioning run is still active or the actual position is not within the target window.
11*	1: Home position valid 0: Home position not valid	1: A homing run has been completed successfully 0: No homing run has been performed or the position information is invalid due to an error.
12*	Traversing Task Acknowledge	See detailed description
13*	1: Drive stopped 0: Drive in motion	1: The actual speed is within a fixed tolerance window around 0. No active positioning or active quick stop. 0: The actual speed is out of the tolerance window around 0 or the condition above is not fulfilled.
14-15	Device-specific	Free

*: Different meaning in another operating mode.

Table 9-5: Status word 1 for positioning 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.

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**.

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

Table 9-6: Device status

Bits 4 and 5 depend on the command and therefore are not included in Table 9-6.

9.4 State diagram and device control

This chapter describes how item C-Series 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
State diagram	The states and the state transitions form the state diagram, i.e. an overview of all states and possible transitions.

9.4.1 State 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 9-1 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. 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.

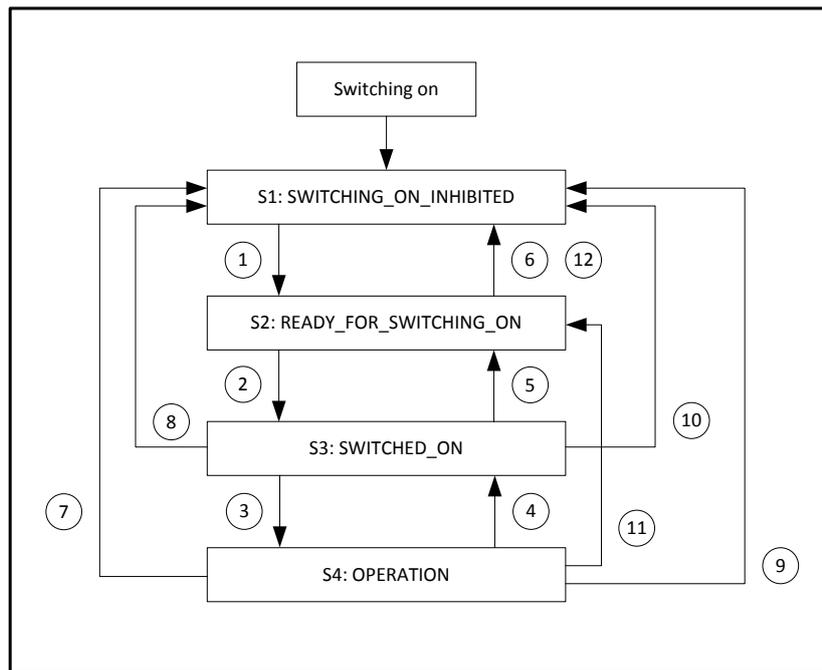


Figure 9-1: Simplified state diagram

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.

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

Name	Meaning
Switching 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“).
SWITCHED_ON	Power stage enabling is active.
OPERATION	The motor is connected to power and is controlled as defined by the operating mode.

9.4.2 Device control

To perform the state transitions described in chapter 9.4.1, certain bit combinations have to be set in **control word 1** (see below). The lowest 4 bits of **control word 1** are evaluated together to trigger a state transition. In the following section, only the most important state transitions 1, 2, 3, 4, 7 and 11 are explained. A table showing all possible states and state transitions can be found in chapter 9.4.3. The first column of the following table shows the desired state transition, and the second column the requirements which have to be fulfilled for this transition (in most cases a command coming from the host, indicated by a frame in the table). The creation of this command, i.e. the bits which have to be set in **control word 1**, is shown in the third column (x = not relevant). Bit 10 in **control word 1** has always to be set to control the servo drive. After the state transition, the new state can be recognised by evaluating the relevant bits in **status word 1**. This is shown in the last column.

No.	Will be performed if	Bit combination for control word 1				Action	Status word 1 ¹⁾	
		Bit	3	2	1			0
1	Power stage and controller enabling present + no coast stop + no quick stop + command <input type="checkbox"/> OFF	<input type="checkbox"/> OFF	= x	1	1	0	None	0x0201
2	Command <input type="checkbox"/> ON	<input type="checkbox"/> ON	= 0	1	1	1	Activation of power stage enabling	0x0203
3	Command <input type="checkbox"/> Enable Operation	<input type="checkbox"/> Enable Operation	= 1	1	1	1	Control in accordance with operating mode set	0x0207
4	Command <input type="checkbox"/> Disable Operation	<input type="checkbox"/> Disable Operation	= 0	1	1	1	Cancellation of controller enabling	0x0203
11	Command <input type="checkbox"/> OFF	<input type="checkbox"/> OFF	= x	1	1	0	Cancellation of controller enabling	0x0201
7	Command <input type="checkbox"/> Coast Stop	<input type="checkbox"/> Coast Stop	= x	x	0	x	Power stage is disabled. The motor coasts down and can be rotated freely.	0x0250 or 0x0270

¹⁾: After completion of the state transition. The mask for the relevant bits is 0x0277 (x = not relevant)

Table 9-7: Important state transitions of the servo drive

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:

- 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 9-1), state transitions 1, 2 and 3 have to be performed.
- 4.) The following results from Table 9-7:

Transition 1:	Control Word 1 = 0406 _h Status word 1 previous = 0x0240h	New state: READY_FOR_SWITCHING_ON * ¹⁾ Status word 1 expected = 0x0201h
Transition 2:	Control Word 1 = 0407 _h Status word 1 previous = 0x0201h	New state: SWITCHED_ON * ¹⁾ Status word 1 expected = 0x0203h
Transition 3:	Control Word 1 = 040F _h Status word 1 previous = 0x0203h	New state: OPERATION * ¹⁾ Status word 1 expected = 0x0207h

Note:

- 1.) 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 state can be read back in **status word 1** in the relevant bits (mask = 0x0277). This will be explained in detail later in this manual.

9.4.3 Command overview

The following table shows the commands for the state transitions described in chapter 9.4.1:

No.	Will be performed if	Bit combination for control word 1				Action	Status word 1 ¹⁾	
		Bit	3	2	1			0
1	Power stage and controller enabling present + no Coast Stop + no Quick Stop + command OFF	OFF	= x	1	1	0	None	0x0201
2	Command ON	ON	= 0	1	1	1	Activation of power stage enabling	0x0203
3	Command Enable Operation	Enable Operation	= 1	1	1	1	Control in accordance with adjusted operating mode	0x0207
4	Command Disable Operation	Disable Operation	= 0	1	1	1	Cancellation of controller enabling	0x0203
5	Command OFF	OFF	= x	1	1	0	Cancellation of controller enabling	0x0201
6	Command Coast Stop	Coast Stop	= x	x	0	x	None	0x0250 resp. 0x0270
7	Command Coast Stop	Coast Stop	= x	x	0	x	The power stage is disabled. The motor coasts down and can be rotated freely.	0x0250 resp. 0x0270
8	Command Coast Stop	Coast Stop	= x	x	0	x	Cancellation of power stage enabling	0x0250 resp. 0x0270
9	Command Quick Stop	Quick Stop	= x	0	1	x	Cancellation of controller enabling	0x0260
10	Command Quick Stop	Quick Stop	= x	0	1	x	Cancellation of controller enabling	0x0260
11	Command OFF	OFF	= x	1	1	0	Cancellation of controller enabling	0x0201
12	Command Quick Stop	Quick Stop	= x	0	1	x	Cancellation of controller enabling	0x0260

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

Table 9-8: Overview of all state transitions of the servo drive

**Power stage disabled...**

...means that the power semiconductors (transistors) are no longer activated. **If this state is assumed while the motor is running, the motor will coast down.** A motor brake which might be present, will be put on automatically.



Caution: The signal does not guarantee that the motor is really disconnected from power.

**Power stage enabled...**

...means that the motor is controlled as defined by the selected operating mode. A motor brake which might be present will be released automatically. In the event of a defect or incorrect parameterisation (motor current, number of poles, encoder offset angle, etc.) the drive might react in an uncontrolled manner.

10 Manufacturer-specific parameter numbers

10.1 Overview

The following table provides an overview of 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	Profile velocity	INT32	rw
	2	End velocity	INT32	rw
	3	Acceleration (positioning)	UINT32	rw
	4	Deceleration (positioning)	UINT32	rw
	5	Acceleration and deceleration (positioning)	UINT32	rw
1002	0	Start set number	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	Target velocity	INT32	rw
1011	-	(Accelerations for velocity control)		
	0	Acceleration (velocity control)	UINT32	rw
	1	Deceleration (velocity control)	UINT32	rw
	2	All accelerations (velocity control)	UINT32	rw

PNU	Sub-index	Description	Type	Access
1040	-	(Jogging)		
	0	Jogging velocities (symmetrical)	INT32	rw
	1	Jogging accelerations (symmetrical)	UINT32	rw
1041	-	(Jogging positive)		
	0	Jogging velocity positive	INT32	rw
	1	Jogging acceleration positive	UINT32	rw
	2	Jogging deceleration positive	UINT32	rw
	3	Jogging accelerations positive	UINT32	rw
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)		

PNU	Sub-index	Description	Type	Access
	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

10.2 PNUs for positioning mode

This section describes the parameters required for the positioning mode.

10.2.1 PNU 1000: Position Set Number

This parameter is used to select the position data set into which the data transmitted through PROFIBUS/PROFINET are entered. This parameter provides access to all position data sets of the servo drive. Field bus data sets are often volatile data sets. The position data set for PROFIBUS/PROFINET, however, can be saved and parameterised with the help of the item MotionSoft[®] parameterisation program. In this way, parameters, which do not have to be changed in an application during operation, can be defined in a fixed manner. Accelerations, for example, can be entered once and then do not have to be transmitted.

This parameter also provides access to special position data sets for homing or jogging. Due to the special structure of the data sets, parameterisation using the item MotionSoft[®] program is recommended.

PNU	1000
Subindex	0
Name	Position Set Number
Data type	UINT16
Access	rw
Unit	-
Value range	0 .. 267 0..255: Standard position data sets 256: Homing phase 0 257: Homing phase 1 258: Homing phase 2 259: Positive jogging 260: Negative jogging 261..265: Reserved 266: PROFIBUS/PROFINET position data set 267: Reserved
Default value	266 (PROFIBUS/PROFINET position set)

10.2.2 PNU 1002: Start Set Number

This parameter is used to select the position data set which is started through control word 1 following a positioning start command. The servo drive has 256 storable standard position data sets. These data sets can be selected unambiguously on the basis of 8 bits.

Apart from these 256 sets, only the PROFIBUS/PROFINET position data set is of interest for starting. To keep the number of data to be transmitted on the bus as small as possible, the PROFIBUS/PROFINET position data set is addressed under the last index. This means that position data set number 255 cannot be started on the bus.

PNU	1002
Subindex	0

Name	Start Set Number
Data type	UINT8
Access	rw
Unit	-
Value range	0 .. 255 0..254: Standard position data sets 255: PROFIBUS/PROFINET position data set
Default value	255 (PROFIBUS/PROFINET position set)

10.2.3 PNU 1001: Position Data

This parameter number is used to address parameters of the selected position data set. PNU 1000 is used for selection. The following parameters are available:

Target position

Profile velocity

End velocity

Acceleration and deceleration, either separately or combined for both accelerations

The data are interpreted in the way they were set as physical units. For this purpose, the item MotionSoft[®] parameterisation software opens a special window (see chapter 7 Physical units).

This PNU can also be used to parameterise parameters for jogging, for example. To do so, the position data set number has to be set accordingly. Then the jogging speed can be set with the help of the profile velocity.

PNU	1001
Name	Position Data

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

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

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

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

Subindex	4
Name	Deceleration Positioning
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default value	10,000 (rpm)/s

The parameter **All Accelerations Positioning** provides access to the acceleration and deceleration ramp. If the same value is intended for both parameters, only one data value has to be transmitted. This value is then used internally for both acceleration types. It has to be taken into consideration that during a read operation only the current value of the deceleration ramp is read. The user has to make sure that reading a value is sufficient. This can be ensured, for example, by reading a value once and then writing it back.

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

10.2.4 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
Data type	UINT16
Access	rw
Unit	-
Value range	<p>0 .. 1</p> <p>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.</p> <p>1: Automatic determination of the jerk free filter time of the position set when this position set is called.</p>
Default value	0

10.2.5 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
Data type	UINT16
Access	rw
Unit	Per mill (1000 corresponds to * 100%)
Value range	0 .. 2000 (corresponds to 0 .. 200%)
Default value	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 item MotionSoft[®] 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.

10.2.6 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
Data type	INT32
Access	rw
Unit	Physical unit of position
Value range	-
Default value	Maximum negative position

Subindex	1
Name	Lower software position limit switch
Data type	INT32
Access	rw
Unit	Physical unit of position
Value range	-
Default value	Maximum positive position

10.2.7 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

10.2.8 PNU 1050: Homing Method

Set the homing method by this parameter number. Please refer to the Software Manual item C-Series for a detailed description of the homing methods.

PNU	1050
Subindex	0
Name	Homing Method
Data type	INT8
Access	rw
Unit	-
Value range	see Software Manual item C-Series
Default value	1

10.2.9 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.

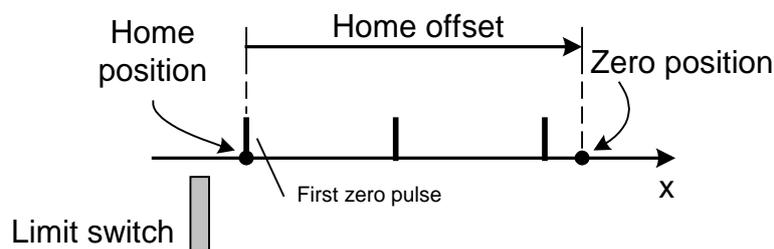


Figure 10-1: Interpretation of the home offset

The data are interpreted in the physical unit position. The physical unit can be set by an appropriate menu of the parameterisation program item MotionSoft[®].

PNU	1051
Subindex	0
Name	Home Offset
Data type	INT32
Access	rw
Unit	Physical unit 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.

10.2.10 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 item MotionSoft[®] 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 item MotionSoft[®] 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

10.2.11 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 position
Value range	0,001 R .. 1 R
Default value	0,01°

10.2.12 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 position
Value range	-
Default value	10°

10.2.13 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 position
Value range	0 R .. 101 R
Default value	50°

10.2.14 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 position
Value range	0 .. $2^{31}-1$
Default value	180°

10.3 PNUs for speed control mode

This section describes the parameters required for the speed control mode.

10.3.1 PNU 1010: Target Velocity

This parameter is used to set the speed setpoint. The fixed setpoint 1 is intended for these setpoints. In speed control mode, this setpoint is also selected automatically.

Normally, the field bus setpoint 1 can be stored as a fixed setpoint in the parameter set. When the PROFIBUS communication is active in the parameter set, the field bus setpoint is always set to zero. As a result, the value stored in the parameter set is overwritten.

The value 0 for the PROFIdrive control word 1 has the consequence that the field bus setpoint is not led to the ramp (setpoint not enabled). The setpoint selector for speed control has to be set beforehand when the PROFIBUS/PROFINET communication is inactive. Further information can be found in chapter 11 Operating modes.

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

10.3.2 PNU 1011: Accelerations for Velocity Control

Under this parameter number, the acceleration values for the speed control mode can be parameterised. The servo drive defines 4 different acceleration ramps. As in most applications several ramps are parameterised in an identical manner, the following selections are possible:

Acceleration, combined for positive and negative direction of rotation

Deceleration, combined for positive and negative direction of rotation

Combination of acceleration and deceleration for positive and negative direction of rotation

The data are interpreted in the way they were set as physical units. For this purpose, the item MotionSoft[®] parameterisation software opens a special window (see chapter 7 Physical units).

The parameter with subindex 0 and 1 provides access to the acceleration for both directions of rotation. Internally, it is always written to the accelerations for both directions of rotation. It has to be taken into consideration, that during a read operation only the current value of the acceleration ramp for a positive direction of rotation is read. The user has to make sure that reading a value is sufficient. This can be ensured, for example, by reading a value once and then writing it back.

PNU	1011
Name	Accelerations for Velocity Control

Subindex	0
Name	Acceleration Velocity Control
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default value	14,100 (rpm)/s

Subindex	1
Name	Deceleration Velocity Control
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default value	14,100 (rpm)/s

The parameter **All Accelerations Velocity Control** provides access to the acceleration and deceleration ramp for both directions of rotation. If the same value is intended for all 4 parameters, only one data value has to be transmitted. This value is then used internally for all four acceleration types. It has to be taken into consideration that during a read operation only the current value of the deceleration ramp for the positive direction of rotation is read. The user has to make sure that reading a value is sufficient. This can be ensured, for example, by reading a value once and then writing it back.

Subindex	2
Name	All Accelerations Velocity Control
Data type	UINT32
Access	rw
Unit	Physical unit of acceleration
Value range	-
Default value	14,100 (rpm)/s

10.4 PNUs for Different Operating Modes

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

10.4.1 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 velocity
Value range	-
Default value	100 rpm

Subindex	1
Name	Symmetrical Jogging Accelerations
Data type	UINT32
Access	rw The read access returns the value of the acceleration in positive direction.
Unit	Physical unit acceleration
Value range	-
Default value	1.000 (rpm)/s

10.4.2 PNU 1041: Jogging Positive

This parameter number sets the parameters for jogging in positive direction (TIPPO) 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 velocity
Value range	-
Default value	100 rpm

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

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

10.4.3 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	1042
Name	Jogging Negative

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

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

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

10.5 Actual values

This section provides an overview of actual values which can be read with the help of parameter numbers.

10.5.1 PNU 1100: Position Actual Value

This parameter is used to return the actual position value. This value is scaled with the physical unit set for PROFIBUS/PROFINET. The calculation of the actual position value may lead to errors as the internal position of the servo drive has a greater value range than the range that can be transmitted. This, however, depends on the physical units set, on the gear ratio and on the feed constant. Please contact the technical support team if you have any queries.

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

10.5.2 PNU 1101: Velocity Actual Value

This parameter is used to return the actual speed value. This value is scaled with the physical unit set for PROFIBUS/PROFINET.

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

10.5.3 PNU 1102: Current Actual Value

This parameter is used to read the actual current value. When this value is returned, it is referred to the rated motor current.

PNU	1102
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Subindex	0
Name	Current Actual Value
Data type	INT32
Access	ro
Unit	Parts per thousand with regard to the rated motor current
Value range	-
Default value	-

10.5.4 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 desired input DIN8 or DIN9 in the menu **Parameters – IO-Konfiguration – Digital Inputs** of the parameterisation program item MotionSoft[®].

PNU	1110
Name	Sampling Positions

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

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

10.5.5 PNU 1141: Digital Inputs

The parameter is used to read the state of the digital inputs. The available digital inputs depend on the parameterisation of the servo drive and on optional technological modules.

PNU	1141
Subindex	0
Name	Digital Inputs
Data type	UINT32
Access	ro
Unit	-
Value range	Bit assignment: Bit 0: Reserved (= 0) Bit 1: DIN 0 Bit 2: DIN 1 Bit 3: DIN 2 Bit 4: DIN 3 Bit 5: DIN 4 (digital power stage enabling) Bit 6: DIN 5 (digital controller enabling) Bit 7: DIN 6 (limit switch 0 left = negative direction of rotation) Bit 8: DIN 7 (limit switch 1 right = positive direction of rotation) Bit 9: DIN 8 (default: start input) Bit 10: DIN 9 (default: sample input) Bit 11: DIN 10 (optional digital input instead of DOUT 2) Bit 12: DIN 11 (optional digital input instead of DOUT 3) Bit 13..20: DIN 0..7 from optional technological module EA88 in port 1 Bit 21: DIN_AIN 1 (optional digital input instead of analogue input 1) Bit 22: DIN_AIN 2 (optional digital input instead of analogue input 2) Bit 23..30: DIN 0..7 from optional technological module EA88 in port 2 Bit 31: Reserved
Default value	-

10.6 Parameters for the telegram structure

Due to certain technical requirements, some parameters cannot be stored under any random address in the storage area of the master. In addition to that, the length of the telegrams may differ although the same number of data is transmitted. This is why certain parameters have been defined to fill gaps, for example.

10.6.1 PNU 2000: PKW Access

Register this parameter into a telegram in order to variably access different parameter at runtime of the process. There is only one access at maximum available for the receive and response telegrams 1..3. Parameterise this access accordingly. Ensure that this access is registered in all receive and response telegrams.

The term PKW results from Parameter-Kennung-Wert (parameter - identification - value) stated in a former version of the PROFIdrive standard. There, the value for the identification was limited. Here the access is enlarged to higher parameter numbers.

PNU	2000	
Subindex	0	
Name	PKW Access (manufacturer specific)	
Data type	2 * UINT32 (8 Byte)	
Access	rw	
Unit	-	
Value range	Byte 0:	Access type: 0x00: No access 0x41: Read access 0x42: Write access Other 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..7:	Data
Default value	0	

10.6.2 PNU 2010: Placeholders

These parameters are used to fill up parameters. As a result, data areas (e.g. data blocks) can be structured such that parameters with a length of 2 or 4 bytes are located at even storage addresses.

PNU	2010
Name	Placeholder

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

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

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

10.6.3 PNU 2011: Element 0

This parameter has basically the same purpose as the parameter PNU 2010.2. The only difference is that it is not shown in the telegram editor of the item MotionSoft[®] program, if it is entered at the end of a telegram. The number of entries in a telegram is limited to 10. Unused entries therefore contain this PNU.

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

10.7 Parameter for Various Intents

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

10.7.1 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.	

10.7.2 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 item MotionSoft[®] 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

11 Operating modes

11.1 Overview

The servo drives of the item C-Series offer three basic operating modes:

Torque control

Speed control

Positioning

Within the operating modes, different behaviour is the result of setpoint selectors which can be parameterised differently. The positioning mode, for example, offers additional modes, e.g. for point-to-point positioning or clock-synchronised operation.

PROFIdrive (see chapter 1.2) defines so-called application classes. These classes can be set using corresponding parameter numbers. To simplify this, the operating mode is linked to the cyclic receive telegrams. Following the PROFIdrive specification, the following operating modes and the associated receive telegrams are supported at present:

Operating mode	Receive telegram	Identifier
Positioning	0	0xE0
Speed control	1	0xE1

Other operating modes cannot be selected at present.

11.2 Parameters

The operating mode is continuously monitored or selected with the help of receive telegrams. The process of changing the operating mode requires several cycles of an internal function. This is why a manufacturer-specific parameter number has been defined to be able to read the current operating mode.

11.2.1 PNU 1500: Operating Mode

This manufacturer-specific parameter is used to set/read the operating mode. The operating mode is served regardless of the setpoint selectors. Other special features can be found in the associated chapters.

PNU	1500
Subindex	0
Name	Operating Mode
Data type	UINT8
Access	rw
Unit	-

Value range	0x08: Speed control 0x10: Positioning
Default value	-

11.3 Speed control mode

PROFdrive defines special features for handling the setpoint. For this purpose, the meanings of the corresponding bits in control word 1 have been defined. The setpoint can be deactivated, for example, or the setpoint ramp can be stopped ("frozen"). The following points have to be fulfilled to meet this requirement:

When the PROFIBUS communication is activated, the fixed setpoint 1 is activated for the adder. If the controller enabling logic has been set to DIN5 and PROFIBUS, this selector is also called PROFIBUS in item MotionSoft[®].

If the setpoint for the setpoint ramp has been disabled by the PROFdrive control word 1, no setpoint is activated in the adder (no check box is marked in item MotionSoft[®]).

11.4 Positioning mode

PROFdrive defines special features concerning the behaviour in the positioning mode. For this purpose, the meanings of the corresponding bits in control word 1 have been defined. Homing controlled by the slave, for example, is started by a certain bit. Some features are now described in detail:

- All global options for homing are also valid when homing is started through the PROFdrive control word 1. An optional following positioning to zero position is performed.
- Due to a manufacturer-specific implementation, positioning is started only on a rising edge of the associated bit in control word 1.
- Positioning is started even if no successful homing has been performed beforehand.

Other manufacturer-specific bits are defined in control word 1 in order to be able to perform optional relative or absolute positioning tasks.

- Distinction between absolute and relative positioning.
- Definition as to whether at the start of a positioning run a running position has to be interrupted or whether the positioning run to the started has to be added to the running positioning.

Some applications require a sequence of motion tasks to be executed without interruption (see Figure 11-1). This can be realised in two different ways:

1. Interruption of the running positioning
2. Start of a following positioning with the end velocity being the profile velocity for the first motion task.

The second case has to be applied if the second positioning run has to start at a specific position.

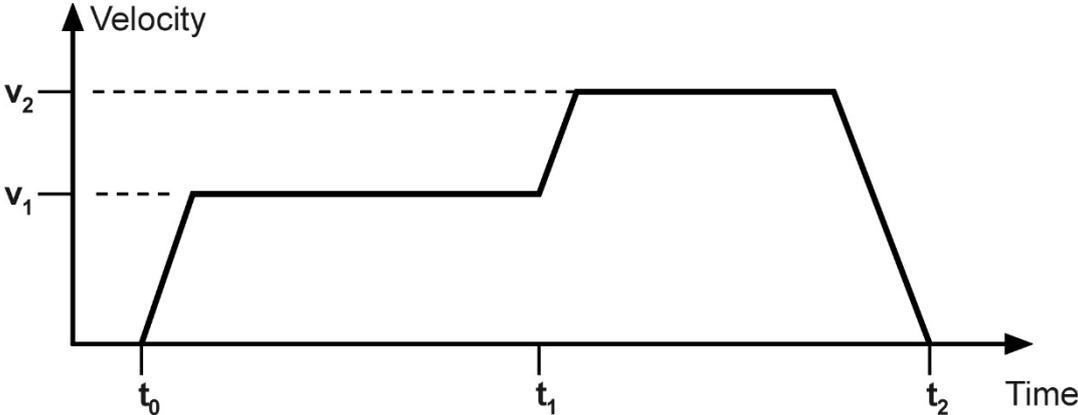


Figure 11-1: Uninterrupted sequence of motion tasks

12 Profile-specific parameter numbers

This chapter provides an overview of the parameter numbers (PNU) which were implemented following PROFIdrive.

12.1 Overview

The following table provides an overview of the implemented PNUs.

PNU	Sub-index	Description	Type	Access
918	0	Slave address ¹⁾	UINT16	ro
963	0	Automatically detected baud rate ¹⁾	UINT16	ro
964	-	(Device identification)		
	0	Manufacturer ID	UINT16	ro
	1	Device type	UINT16	ro
	2	Device version	UINT16	ro
	3	Firmware date (year)	UINT16	ro
	4	Firmware date (day/month)	UINT16	ro
967	0	Control word 1	V2	rw
968	0	Status word 1	V2	ro
971	0	Save parameters	UINT16	rw

¹⁾: Parameter is only relevant for PROFIBUS.

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

12.2 PNU description

The PNUs 967 and 968 are described in detail in chapter 9 Device control. The other PNUs are described in the following sections.

12.2.1 PNU 918: Node address

This parameter returns the slave address of the servo drive. The addresses always start at 0. The addresses up to 2, for example, are occupied by the PROFIBUS master or other control devices. Thus the lowest address is 3.

The PROFIdrive specification defines 126 as a fixed default value. However, it has to be taken into consideration that the exchange of useful data is prohibited under this address.

PNU	918
Subindex	0
Name	Node address
Data type	UINT16
Access	ro
Unit	-
Value range	3 .. 126
Default value	126



The Parameter number 918 is only relevant for the fieldbus technology PROFIBUS.

12.2.2 PNU 963: Actual baud rate

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

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

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

The Parameter number 963 is only relevant for the fieldbus technology PROFIBUS.

12.2.3 PNU 964: Device Identification

The device identification parameter provides information on the connected device under several subindexes.

PNU	964
Name	Device identification

Subindex	0
Name	Content: Manufacturer
Data type	UINT16
Access	ro
Unit	-
Value range	277 (0x0115)
Default value	277 (0x0115)

Subindex	1
Name	Content: Device Type
Data type	UINT16
Access	ro
Unit	-

Value range	0x2000	Unknown device type	0x2045	C 1-02
			0x2046	C 1-05
			0x2050	C 1-08
			0x204A	C 3-05
			0x204B	C 3-10
Default value	-			

Subindex	2
Name	Content: Version
Data type	UINT16
Access	ro
Unit	-
Value range	hhss: hh: Main revision ss: Subrevision
Default value	-

The PNUs with subindexes 3 and 4 indicate the date of creation of the firmware. This date of creation may be the same in different product levels or revisions if the basic implementation has not been changed.

Subindex	3
Name	Content: Firmware date (date of creation, year)
Data type	UINT16
Access	ro
Unit	Year
Value range	-
Default value	-

Subindex	4
Name	Content: Firmware date (date of creation, day / month)
Data type	UINT16
Access	ro
Unit	-
Value range	ttmm: tt: Day mm: Month
Default value	-

12.2.4 PNU 971: Transfer into a Non-Volatile Memory

Active different saving processes of parameters inside the servo drive by this parameter number.

PNU	971	
Subindex	0	
Name	Transfer into a non-volatile memory	
Data type	UINT16	
Access	rw	
Unit	-	
Value range	0:	No action
	1:	Save the actual parameter set and all position data sets
	2..255:	reserved
	256:	Save all position data sets without the standard parameters
	257:	Save parameters into the angle encoder
	258:	Save the new actual position (e.g. after a homing process) into the angle encoder. The other parameter of the EEPROM are also saved with their actual values.
	259..65535:	reserved
Default value	0	

Some saving processes allow the analysis if the process is still running or completed with an error. The actual state of the implementation:

Reading returns "1" as long as saving of the complete parameter set including all position data sets is active. The process is activated by writing the value "1". In other cases reading always returns "0".

13 PROFIBUS/PROFINET function and data blocks for SIEMENS S7

13.1 Overview

Special function blocks have been written for item C-Series and Siemens PLC systems (SIMATIC-S7 control systems). These functions blocks facilitate the integration of the servo drives into a PLC program with PROFIBUS/PROFINET functionality. The various function and data blocks (FD, DB) are assigned to one of the operating modes.

To make the use of the function blocks clearer, example programs were written.



Information

The function and data blocks as well as Example Programs can be downloaded under <http://www.item24.com>

13.2 Function and data blocks for item C-Series

13.2.1 Function block (FB) overview

The function blocks (FBs) are used to control the state diagram implemented in the servo drive.

Status word 1 in byte 2/3 of the DB40 actual_value data block symbolises the actual state of the servo drive. Control word 1, which is contained in bytes 2/3 of every mode-specific telegram format and described by the FB, is used to control the servo drive.

The master connection provides the PLC system in defined I/O areas with the input and output data of the servo drives. These data are read out of the slave through SFC14 and written to the slave through SFC15. SFCs 14 and 15 are system functions which **must** be used for consistent reading and writing of telegrams with a length > 4 bytes.

The data are stored in the data blocks defined for the operating mode in question through the corresponding SFCs. The SFCs are not integrated in the function blocks and **must** be loaded as S7 program elements.

In practice, the DBs are used as I/O modules to control the states of the servo drive and to transmit data which have to be sent to the servo drive.

Every operating mode and every servo drive requires separate function blocks. If several servo drives are used in different operating modes, this might lead to bottlenecks concerning the storage utilisation of the application.

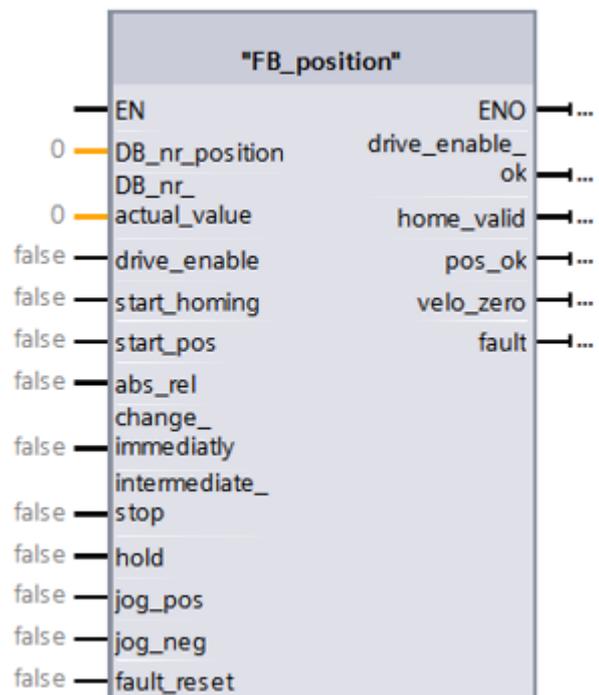
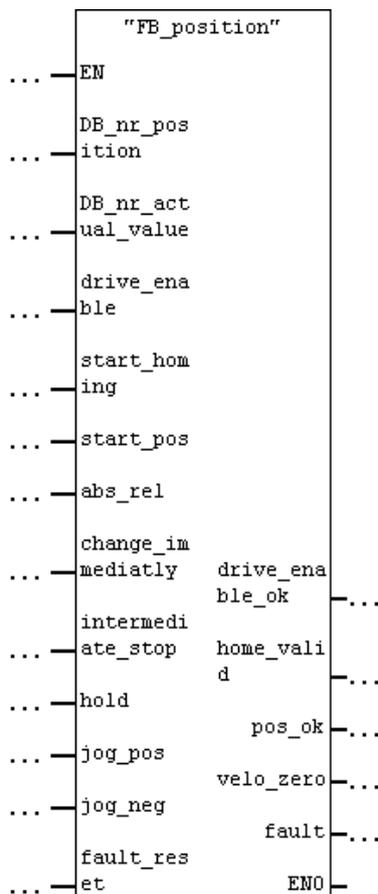
i

Information

The order of the data in the data blocks corresponds to the order defined in the telegram format of the associated operating mode (FB).

13.2.2 FBs of item C-Series

13.2.2.1 FB_position (positioning mode)



- **Parameters:**
 - **DB_nr_position:**
Number of the data block containing the data for the positioning mode (INT).
 - **DB_nr_actual_value:**
Number of the data block containing the actual value data (INT).
- **Inputs:**
 - **drive_enable:**

This input is used to activate the controller enabling in the positioning mode. The drive is held in its position.

- **start_homing:**

This input is used to start a homing run. The motor is started. This requires an active controller enabling, i.e. the output drive_enable_ok must be set. If the start_homing input is reset during homing, the homing run is aborted without an error.

- **start_pos:**

A rising edge signals that a new motion task has to be accepted. A falling edge has no consequence. During homing, this input has no effect.

- **abs_rel:**

If this input is set with a rising edge at the start_pos input, the positioning run is executed relatively to the current target position. If this input is not set with a rising edge at start_pos, an absolute positioning run is executed.

- **change_immediatly:**

If this input is set with a rising edge at the start_pos input, a running positioning run is aborted immediately and replaced with a new motion task. If this input is not set with a rising edge at start_pos, the new motion task is added to the end of the running positioning run. In this case, the pos_ok output is not set at the end of the current positioning run, but at the end of the added positioning run.

- **intermediate_stop**

If this input is not set, a started positioning run is completed. If the input is set during a running positioning run, the drive is stopped and remains in position control mode. The current positioning run is **not** terminated. It will be continued when the intermediate_stop input is reset. During homing, this input has no effect.

- **hold:**

If this input is set, the current positioning run is stopped. The system is slowed down with the deceleration valid for this positioning run. After the process has been completed, the pos_ok output is not set. A reset of the input has no effect. During homing, this input has not effect.

- **jog_pos:**

The acceleration, deceleration and speed values of the Jogging mode "Forward" (item MotionSoft[®] menu: **Run – Test run – Jogging mode**) are used.

If the input is set, the drive accelerates with the acceleration value until it reaches the speed parameterised. If there is a falling edge at this input, the drive slows down to standstill with the deceleration value. During homing, this input has no effect.

- **jog_neg:**

The acceleration, deceleration and speed values of the Jogging mode "Back" (item MotionSoft[®] menu: **Run – Test run – Jogging mode**) are used.

If the input is set, the drive accelerates with the acceleration value until it reaches the speed parameterised. If there is a falling edge at this input, the drive slows down to standstill with the deceleration value. During homing, this input has no effect.

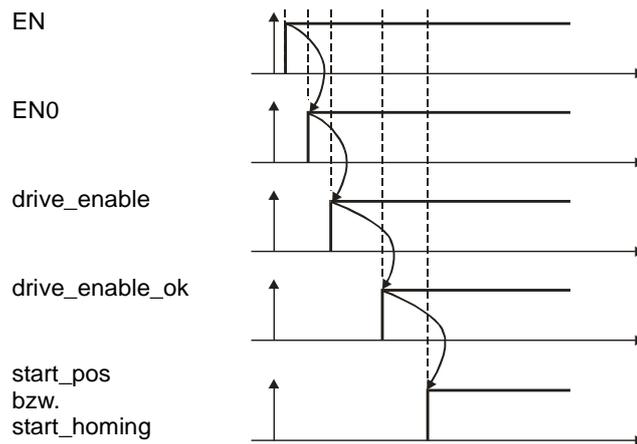
- **fault_reset:**

If there is a rising edge at this input, pending fault messages are acknowledged.

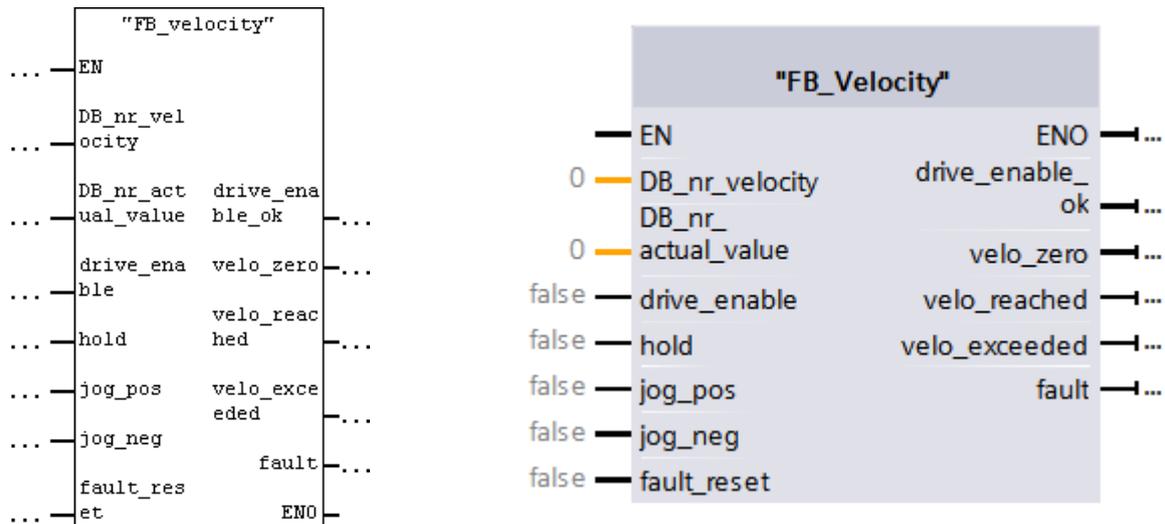
▪ **Outputs:**

- **drive_enable_ok:**
The controller enabling of the servo drive is active.
- **home_valid:**
This output is set, if there is a valid home position. The output is not set during a running homing run. It is not set or reset until after a homing run has been completed successfully.
- **pos_ok:**
This output is set, when the current position is in the target window after the positioning run has been completed.
- **velo_zero:**
If this output is set, the drive stands still.
- **fault:**
If this output is set, there is a fault. The controller enabling is cancelled.
The output is reset after the fault has been acknowledged.

Please note the timing shown in the diagram when using the function blocks.



13.2.2.2 FB_velocity (speed control)



Parameters:

- **DB_nr_velocity:**
The number of the data block containing the data for speed control mode (INT)
- **DB_nr_actual_value:**
The number of the data block containing the actual value data (INT).

Inputs:

- **drive_enable:**
Activation of the controller enabling in speed control mode. The speed setpoint takes effect depending on the other inputs of the function block.
- **hold:**
If this input is set, the speed setpoint is blocked. The drive slows down to standstill as quickly as possible. When the input is reset, the motor accelerates as quickly as possible to reach the adjusted speed setpoint.
- **jog_pos:**
The acceleration, deceleration and speed values of the Jogging mode "Forward" (item MotionSoft® menu: **Run – Test run – Jogging mode**) are used.
If the input is set, the drive accelerates with the acceleration value until it reaches the speed parameterised. If there is a falling edge at this input, the drive slows down to standstill with the deceleration value.
- **jog_neg:**
The acceleration, deceleration and speed values of the Jogging mode "Back" (item MotionSoft® menu: **Run – Test run – Jogging mode**) are used.
If the input is set, the drive accelerates with the acceleration value until it reaches the speed parameterised. If there is a falling edge at this input, the drive slows down to standstill with the deceleration value.
- **fault_reset:**

If there is a rising edge at this input, pending fault messages are acknowledged.

▪ **Outputs:**

- **drive_enable_ok:**
The controller enabling of the servo drive is active.
- **velo_zero:**
This output is set, when the actual speed is zero (± 10 rpm).
- **velo_reached:**
When this output is set, the actual speed is in the parameterised tolerance window of the target speed (reference speed).
- **velo_exceeded:**
If this output is set, the actual speed is greater than the free reference speed.
- **fault:**
If this output is set, there is a fault. The controller enabling is cancelled.
The output is reset after the fault has been acknowledged.

13.2.3 Integration of FBs and DBs

To ensure consistent data exchange between the PROFIBUS/PROFINET master and the PROFIBUS/PROFINET slave, the system functions SFC14/DPRD_DAT (consistent reading) and SFC15/DPWR_DAT (consistent writing) must be used. The following parameters have to be used for the blocks depending on used development environment:

Reading data using SFC14/DPRD_DAT:

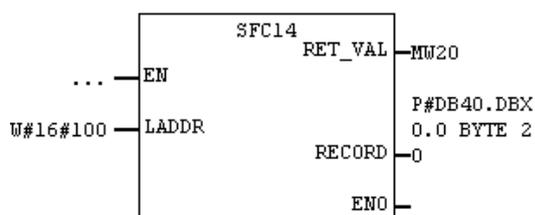


Figure 13-1 STEP7 Block with initial address of the E-area

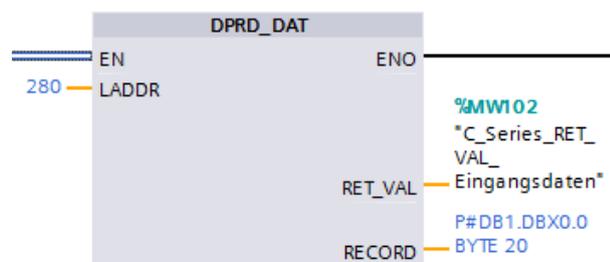


Figure 13-2 TIA Block with hardware ID

LADDR:

Input data area

Start address of the E-area (S7-300/S7-400) in hexadecimal format or hardware ID (S7-1200/S7-1500)

RECORD:

Input data block

P#DB40 or P#DB1 – Data block into which the data of the slave are written (DB40 or DB1)

.DBX0.0 – Start address within the DB (0.0)

BYTE 20 – Number of bytes received (20 bytes)

Parameter DPRD_DAT TIA-Help for S7-300 und S7-400:

Parameters	Declaration	Data type	Memory area	Description
LADDR	INPUT	WORD	I, Q, M, D, L or constant	Configured start address from the I-area of the module from which the data will be read. Note: Always set the address in hexadecimal format, e.g. start address 100 means: LADDR:=W#16#64.
RET_VAL	RETURN	INT	I, Q, M, D, L	If an error occurs while the instruction is being executed, the return value contains an error code.
RECORD	OUTPUT	ANY	I, Q, M, D, L	Destination area for the user data that were read. It must be precisely as long as you have configured for the selected module. Only the BYTE data type is permitted. Note: Note that for S7-300 CPUs the parameter RECORD always requires the full specification of the DB parameters (for example, P#DB13.DBX0.0 byte 100). The omission of an explicit DB number is only permitted for S7-300 CPUs and leads to an error message in the user program.

Parameter DPRD_DAT TIA-Help for S7-1200 und S7-1500:

Parameter	Deklaration	Datentyp	Speicherbereich	Beschreibung
LADDR	INPUT	HW_IO	E, A, M, D, L, Konst.	Hardware ID of the module from which the data is to be read. The hardware ID can be found in the properties of the module in the device view or system constants.
RET_VAL	RETURN	INT	E, A, M, D, L	If an error occurs while the instruction is being executed, the return value contains an error code.
RECORD	OUTPUT	VARIANT	E, A, M, D, L	Destination area for the user data that were read.

In both operating modes the same actual value data are returned. As a consequence, the response telegram is configured in an identical manner in both operating modes.

Writing data using SFC15/DPWR_DAT:

Depending on the operating mode (positioning or speed control), different data are transmitted to the PROFIBUS/PROFINET slave. This leads to different telegram lengths affecting the parameterisation of SFC15/DPWR_DAT.

Writing data for the positioning mode:

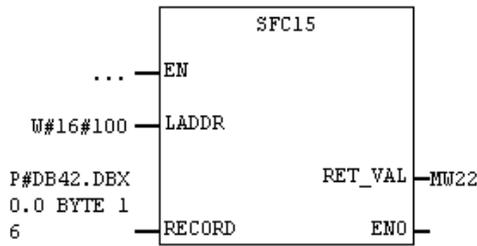


Figure 13-3 STEP7 Block with initial address of the A-area

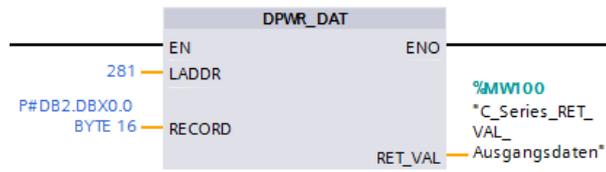


Figure 13-4 TIA Block with hardware ID

LADDR:

Output data area

Start address of the A-area (S7-300/S7-400) in hexadecimal format or hardware ID (S7-1200/S7-1500)

RECORD:

Output data block

P#DB42 or P#DB2 – Data block into which the data of the slave are written (DB42 or DB2)

.DBX0.0 – Start address within the DB (0.0)

BYTE 16 – Number of bytes to be send (16 bytes)

Parameter DPRD_DAT TIA-Help for S7-300 und S7-400:

Parameters	Declaration	Data type	Memory area	Description
LADDR	INPUT	WORD	I, Q, M, D, L or constant	Configured start address from the PIQ area of the module to which the data is written. Note: Address must be specified in hexadecimal form, for example, start address 100 means: LADDR:=W#16#64.
RET_VAL	RETURN	INT	I, Q, M, D, L	If an error occurs while the instruction is being executed, the return value contains an error code.
RECORD	OUTPUT	ANY	I, Q, M, D, L	Source area for the user data to be written. It must be precisely as long as you have configured for the selected module. Only the BYTE data type is permitted. Note: Note that for S7-300 CPUs the parameter RECORD always requires the full specification of the DB parameters (for example, P#DB13.DBX0.0 byte 100). The omission of an explicit DB number is only permitted for S7-300 CPUs and leads to an error message in the user program.

Parameter DPRD_DAT TIA-Help for S7-1200 und S7-1500:

Parameter	Deklaration	Datentyp	Speicherbereich	Beschreibung
LADDR	INPUT	HW_IO	E, A, M, D, L, Konst.	Hardware ID of the module to which the data is to be written. The hardware ID can be found in the properties of the module in the device view or system constants.
RET_VAL	RETURN	INT	E, A, M, D, L	If an error occurs while the instruction is being executed, the return value contains an error code.
RECORD	OUTPUT	VARIANT	E, A, M, D, L	Source area for the user data to be written.