SIEMENS

SIMATIC S5

IP 288

Manual

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Liability disclaimer

We have checked the contents of this manual for agreement with the hardware and software described. Since deviations cannot be excluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

Technical data subject to change.

Safety-related guidelines

This manual contains certain notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

Warning
indicates that death, severe personal injury or substantial damage to property **can** result if proper precautions are not taken.

Caution
indicates that minor personal injury or property damage can result if proper precautions are not taken.

Only **qualified personnel** should be allowed to install and work on this equipment. Qualified persons are defined as persons who are authorized to commission, to ground and to tag equipment, systems and circuits in accordance with established safety practices and standards.

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Contents

Notes for the User

1

The following information is designed to make working with the manual easier.

Description of contents

The contents of this manual have been broken down according to subject into the following blocks:

- Basics
  Section 3.1 contains information on the possibilities of using the IP 288 for implementing an electronic cam controller or a positioning controller for rapid traverse/creep speed drives.

- Hardware
  Section 3.2 "How Is the IP 288 Designed?" contains information on the components of the IP 288 and about the connections and indicators on the module. If you require detailed information on the pinouts of the individual interfaces, e.g. for preparing your own connecting cables, refer to Section 9.1 ("Pin Assignments").

  Chapter 4 describes how to install and wire the module. You will find instructions and information concerning:
  Setting the page numbers
  Permissible slots in the different subracks
  Installation
  Wiring

  To ensure that your programmable controller is noise-immune, you should refer to the Installation Guidelines in your PLC manual or system manual in addition to the information on this subject in this manual. These sources also apply to working with the IP 288.

- Parameterization
  Chapter 5 tells you which data the IP 288 requires in operation. This chapter contains explanations of the SYSID parameters and the machine data which the IP 288 always requires. You will also find the cam data for a cam controller and the destination data and destination list for positioning in this chapter. Chapter 7 "Parameterization Software" contains information on how to transfer this data to the IP 288 using the COM 288 parameterization software. Section 9.4 "The Data Sets of the IP 288" describes the structure of the data sets in which the data is stored. You do not require this information if you work exclusively with COM 288.

- Operation
  Chapter 6 "Operating the IP 288" explains the following:
  How you can synchronize an axis with incremental or absolute position decoders
  How to operate the IP 288 via operating modes and settings
  How an operating mode works

- Linking in to a user program
  Chapter 8 "How Do You Link the IP 288 into Your User Program?" describes the function blocks you require to use the IP 288 in an operating system and the data blocks you must set up for this purpose in the CPU memory. Section 8.5 contains an explanation of the programming example for handling function blocks. This example is on the diskettes supplied.

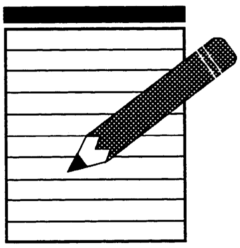
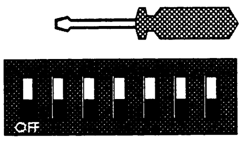
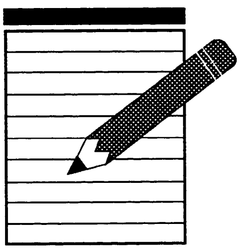
- Error response
  The error messages with which the IP 288 responds to both operator errors and system faults are listed and explained in Section 9.5 "How Does the IP 288 Respond to Errors?". Error messages appearing in the case of transfer errors with the standard function blocks are listed in Section 8.3.5 "Transfer Errors". Errors which can only occur while working with COM 288 are displayed in plaintext at the operator interface.

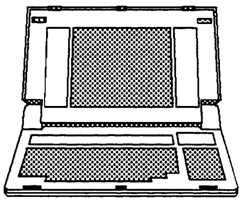
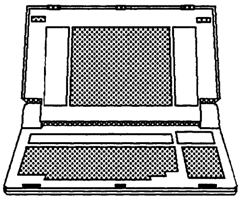
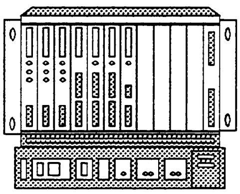
- Technical specifications
  The technical specifications of the module are in Section 9.6, and the technical specifications of the function blocks in Section 9.7.

Startup Checklist

2

You can follow this checklist when starting up the IP 288.

Type of action	Action	See Manual...
Planning/preparation 	Configuring the system	
	Check the following components - Emergency OFF limit switches These must be provided and in working order. Emergency OFF limit switches must affect the drives directly. - Drive (control and mechanics) - Position encoders Correct selection and adaptation of the direction of rotation - Connecting cables Standard or home-made connecting cables - Programmer COM 288 installed and ready to run	Section 5.2 Section 9.1, 9.2
Assembly 	Install and wire module	
	- Set page address - Check preset jumpers - Select slot - Install module - Wire module	Section 4.1 Section 4.1 Section 4.2 Section 4.3 Section 4.4 or Section 9.1 and 9.2
Planning/preparation 	Determine machine data	
	- Machine data which are determined direct by the system	Section 5.2

Type of action	Action	See Manual...
Assigning parameters 	<u>Parameterizing and debugging the IP 288</u>	
	- SYSID parameters - Machine data - Cam data or destination sets or destination list - Test mode	Section 5, 7 or Section 9.4 Section 7.6
Assigning parameters 	<u>Operating the IP 288</u>	
	- Synchronizing the axis - Jog mode (for positioning) - Increment mode (for positioning) - Parameterize track (cam) - Enable track (cam)	Section 6.2 Section 6.4.1 Section 6.4.3,
	- Other operating modes and settings, e.g. Teach-In, coordinate shift	Section 6.5.1 to 6.5.3
Programming (PLC) 	<u>Using function blocks</u>	
	- FB ZYK for cyclic program processing - FB PAR for parameterization - FB INT for interrupt processing - Possibly FB 38 for saving scratchflags/system data and page numbers - Possibly FB 39 for loading scratchflags/system data and page numbers	Section 8.2.1 Section 8.2.2 Section 8.2.3 Section 8.8.1 Section 8.8.2

What is the IP 288? 3

Contents of Chapter 3

What is the IP 288? 3

The IP 288 is a position decoding and positioning module with three channels for the following programmable controllers:

- SIMATIC S5-115U — CPU 941B, CPU 942B, CPU 943B and CPU 944B
- SIMATIC S5-135U — CPU 922 (revision level ≥ 9), CPU 928, CPU 928B
- SIMATIC S5-155U — CPU 946/947

Each channel can operate independently of the other channels either as an electronic cam controller or as a position controller for rapid traverse/creep speed drives. In both functions, the module supports both linear and rotary axes.

All the data needed for its operation are stored on the module itself. You can start up the module with a programmer (PG) and the COM 288 software package. Since the module has its own programmer port, you can control it with the help of COM 288 direct from the programmer. The COM 288 software offers a dialog-oriented test mode in addition to parameterization of the module and setting and managing data. Values entered are checked for validity, operator errors are prevented and errors are displayed in plaintext. In operation, the CPU of the programmable controller (PLC) controls the IP 288. It links signals from cams and positioning sequences into the automation sequence of the machine.

A RAM on the IP 288 backed up by the battery in the PLC stores the machine data of each axis and all function-specific data such as cam sets for the cam controller and destination sets/destination lists for the positioning controller.

The machine data define the axis function and are determined by the technical specifications of the connected axis. You can also use basic data sets with partly preset machine data.

3.1 Functions and Principle of Operation of the IP 288

Intelligent I/O module

As an "intelligent I/O module", the IP 288 position decoding and positioning module offers you flexible electronic cam control on the one hand, and on the other, you can use it to position drives. Both these functions can be implemented with the one module and both are often required within one automation task.

"Intelligent" in this context means that the IP 288 handles process signals autonomously within the frame of reference of its task. This frees and offloads the CPU of the programmable controller from complex technological functions.

3.1.1 The Electronic Cam Controller

Certain areas on an axis are especially marked in the case of a cam controller. If the axis traverses into one of these areas, a response is triggered, e.g., a cooling agent is applied. The response remains in effect as long as the axis is in this area. When the axis exits the area, the response is terminated and application of the cooling agent is switched off.

Path cams, time cams

These specially marked areas on an axis are called path cams. As well as path cams, there are also time cams. In the case of time cams, a response is also triggered as soon as the axis reaches the cam. The response remains in effect for a programmed time.

Cam tracks

Each channel of the IP 288 that has been parameterized as an electronic cam controller has 16 cam tracks. You can parameterize up to eight cams on one track, up to two of which can be time cams. The first four tracks are also effective direct via the digital outputs of the module.

Fig. 3.1 shows a typical cam controller. This one is used to apply tracks of glue of different lengths to wooden boards (e.g. furniture components). Each of six tracks has a path cam and each path cam controls a glue spreading nozzle.

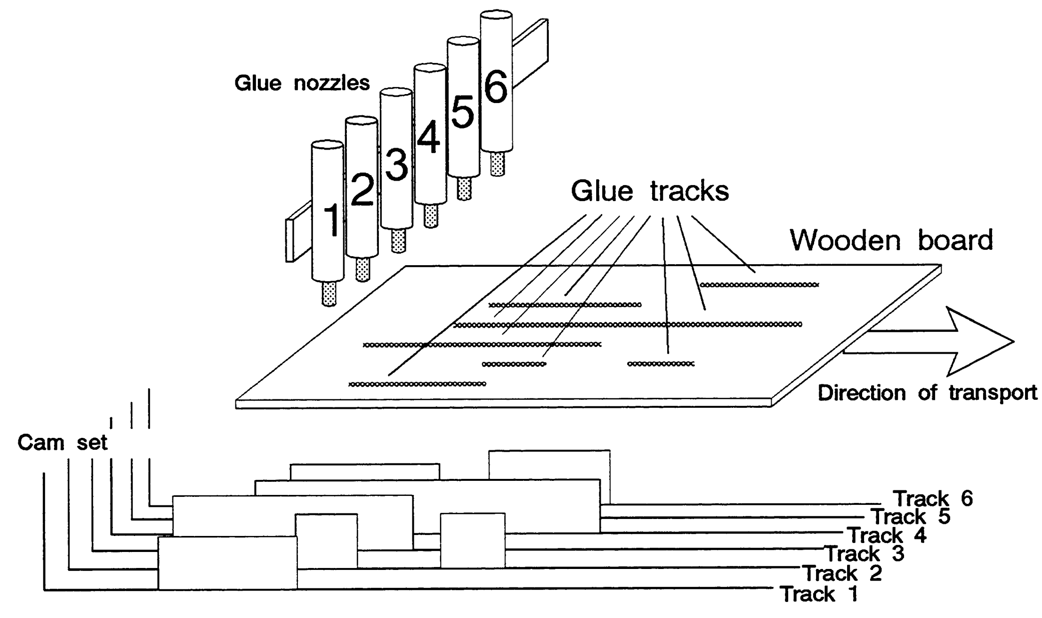


Fig. 3.1 Typical cam controller

Dynamic cams

In order that a glue track always begins at the same position, regardless of the current speed of the axis , the cams can be shifted dynamically track by track. For this purpose, you need only parameterize the switching time of the switching element you have connected and the module determines the correct switching point independent of the current speed.

Direction-dependent tracks

Some responses must be triggered dependent on the direction of travel of the axis. For this reason, you can decide for each track individually whether the cams of this track are to take effect in the case of overshoot forwards, overshoot backwards or both.

In the case of tracks that only take effect in one direction, activated path and time cams are switched off when the axis changes direction.

Switching axes in parallel

If 16 tracks are not sufficient, you can switch two channels in parallel if you use incremental position decoders and the 703 adapter, and so use the position encoder of one axis on another axis.

Process interrupt

In order to be able to respond very quickly to selected cams in the user program, the IP 288 can trigger a process interrupt to the CPU in the case of up to two switch edges.

Hysteresis

A mechanical disturbance can cause slight position changes. If the actual value "oscillated" around the switching edge of a cam this would cause the connected switching element to be switched on and off permanently. To avoid this, the cam controller has a programmable hysteresis function. The hysteresis is a path segment within which no cams can be switched in the case of a change of direction.

Cam sets

All cam data and data referring to the cam track or the connected switching element is stored in data sets. Each track can be parameterized individually with a cam set. However, the cams of this track are only processed when the track is enabled, assuming the axis is synchronized.

3.1.2 Positioning

Positioning for rapid traverse/creep speed drives performs the following task:
A drive can traverse an axis at two different speeds. If the axis is approaching a specific target, the drive is switched (changed over) from the higher speed (rapid traverse) to the lower speed (creep speed) at a preset distance from the target. Shortly before the axis reaches the target, the drive is cut off, also at a preset distance from the target.
The IP 288 can also be used in those cases where the drive can only be operated at one speed.

If the IP 288 is positioning a rapid traverse/creep speed drive, the drive is controlled via four digital outputs with rapid traverse or creep speed and with the relevant direction. At specific points, parameterized as path differences to the target, the drive is switched to the other speed and shortly before the target the drive is switched off. If the path differences have been specified correctly, the axis reaches the desired position and can be fixed there. You can specify targets either as absolute coordinates or as path segments.

Adaption

The IP 288 adapts path differences which are too large or too small. If the axis comes to a standstill before the target, the path differences are decreased, and if the axis overshoots the target, the path differences are increased.

Fig. 3.2 shows a typical positioning task. A load is transported to a target where it is unloaded from the conveyor. In order that the moment of inertia of the load does not cause it to slip, two drive stages are used with the system first changing over from rapid traverse to creep speed and then cutting off. Safe lifting of the load is guaranteed by monitoring, one the one hand, that the target has been reached, and on the other, that the conveyor has come to a stop at the target.

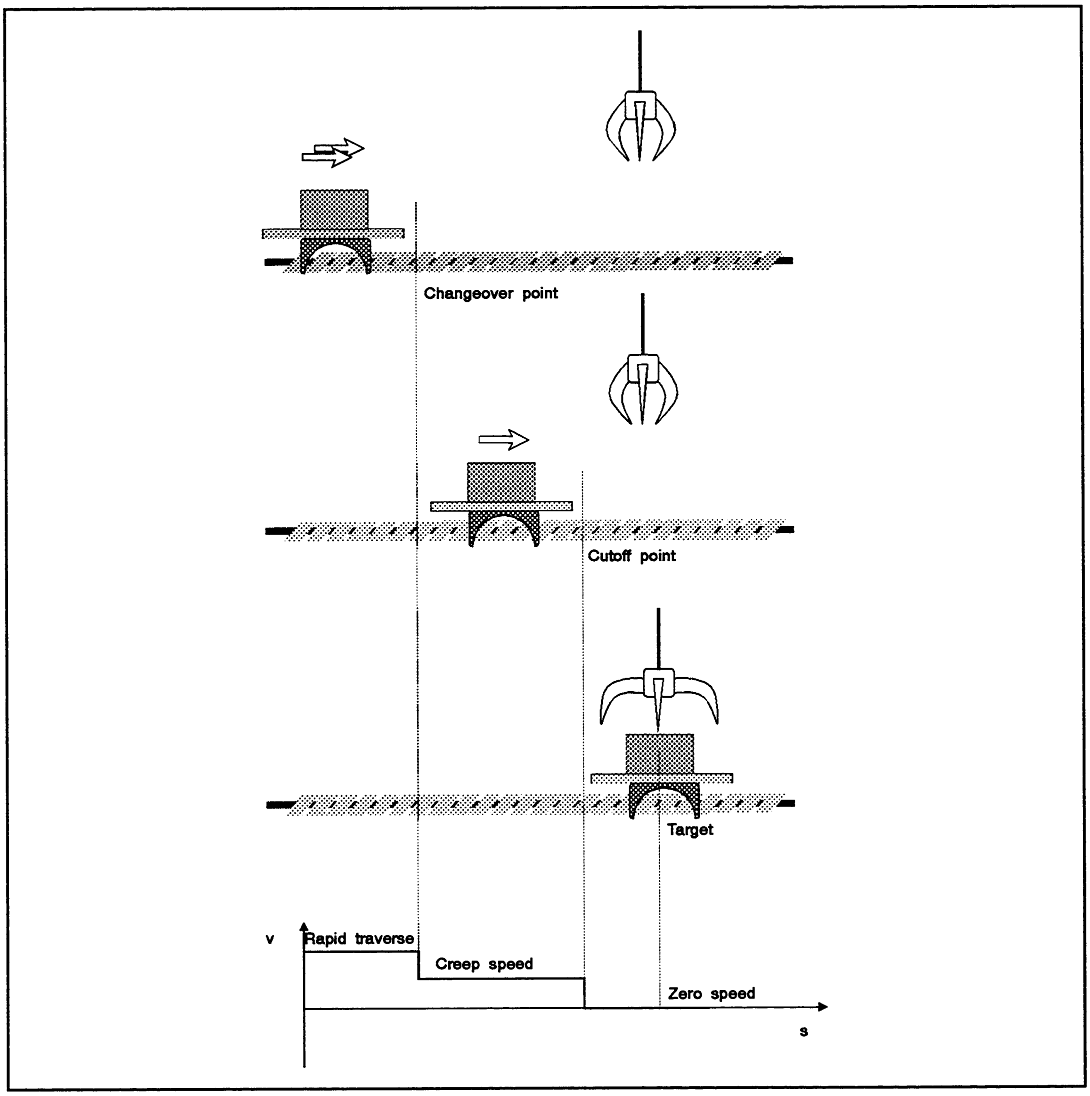


Fig. 3.2 Typical positioning task

Target set

You can store targets individually on the module as absolute coordinates in target sets. You can change the speed and the directly specified targets at any time during a traverse.

In the case of a drive whose load changes depending on traverse or direction, positioning with long target sets is to be recommended. The path differences for each target can be stored individually and direction-dependent for changing over and cutting off the drive.

Example:
An axis traverses with a load forwards and stops at point x. The load is unloaded, the axis traverses without the load in reverse and stops at point y. In the target sets for this traverse movement, you can parameterize stop distances of different lengths.

Target list

With the IP 288 you can group several target sets into one target list and so assign several targets to the different production processes.

Process interrupt

If the reaching of target is to be further processed in the user program very quickly, a process interrupt to the CPU can be initiated.

Rounding

"Play" in the drive or axis causes inaccurate positioning. However, you can ensure accurate reaching of the desired position by always approaching each target from the same direction with rounding.

3.1.3 How Does the IP 288 Operate?

Regardless of the set function, the module acquires the encoder signals from incremental position encoders or absolute position encoders with "synchronous-serial interface" (SSI) via three connections on the frontside (see Section 5.2; Encoder Type ff.). The module processes Gray code and, in the case of single-turn absolute position encoders, any excess X Gray code (reduced Gray code).

Every axis is equipped with a comparator to ensure that all switching points, cam edges in the case of cam controllers, changeover points and cutoff points in the case of positioning controls, are switched accurately and can be reproduced. If a comparator trips, the relevant response follows immediately.

Independent of this, the module captures the current position of the axis at a fixed interval (8 ms), calculates the current speed and direction and checks the values loaded into the comparators. If, for example, the direction has changed, or if a cam has to be switched before the cam currently loaded in the comparator because of different switching times of the connected switching elements, the comparator is reloaded.

So that the module processes the position encoder signals correctly, the following limits **must** be adhered to:

Limit frequency:
- 500 kHz in the case of a 5 V incremental position encoder
- 50 kHz in the case of a 24 V incremental position encoder

Maximum speed:
- 2^{16} pulses / 24 ms and
- Length of the traversing range / 2 * 24 ms (rotary axis) and
- 450,000 mm / min or 45,000 mm / min corresponding to the basic resolution (see Section 5.2).

The limit values of the maximum speed also apply in simulation mode. They are **not** monitored by the IP 288.

The IP 288 calculates the speed by counting increments per time interval. This speed is smoothed according to the following algorithm:
New speed =
((Old speed * 3) + Current speed) / 4

3.1.4 Monitoring

The module monitors the following:

- Power failure (NAU is evaluated)
- CPU failure (BASP and ready signal between FB and IP 288 is evaluated, see Section 5.1).

The effect of the S5 NAU signal is identical for a cam controller and for positioning (see Section 6.3).
You can define the effect of a CPU failure (see Section 5.1).

The firmware of the IP 288 monitors the acquisition and the course of the actual position. If it discovers a fault it signals an external error (errors concerning the controlled axis). If you parameterize and wire two axes in parallel in the case of a cam controller, i.e. use the encoder of one axis on the other axis, the monitors for the encoder affect both the axes involved.

3.1.5 Further Possibilities of the IP 288

Length measurement

Length is measured via a digital input independent of the other work of the IP 288. The IP 288 can signal the end of the measurement to the CPU per process interrupt.

Functions

You can influence cam processing and the course of a positioning task by using different functions such as zero offset. You can also influence a cam controller by shifting the cams track by track.

The IP 288 can also execute some actions position-dependent or event-dependent. For example, an axis can be synchronized by setting a digital input or the speed can be changed at a defined position.

Teach-In

You can generate target sets and cam sets using Teach-In. This allows you to generate or change up to 16 cam sets simultaneously.

Process diagnostics

You can use process diagnostics to check each axis. You can switch specific digital outputs to see the signals of the position encoder or the internal counter status and the counter status at the zero mark of the position encoder.

Simulation

In simulation mode, you can test generated cam sets or target sets without any need for the drive. The IP 288 simulates the encoder signals according to your specifications.

3.2 How is the IP 288 Designed?

The IP 288 is a module in double-width Eurocard format with firmware stored on an EPROM on the module. The firmware determines the functionality of the IP 288. The COM 288 software package acts as a user interface to make things easier for those just starting with the technological tasks described and to simplify startup. You link the IP 288 into your user program using standard function blocks.

3.2.1 The Hardware of the IP 288

You can use the IP 288 position decoding and positioning module in the SIMATIC S5-155U and S5-135U programmable controllers and, via an adapter casing, in the S5-115U. It requires two standard plug-in slots (one plug-in slot in the S5-115U).

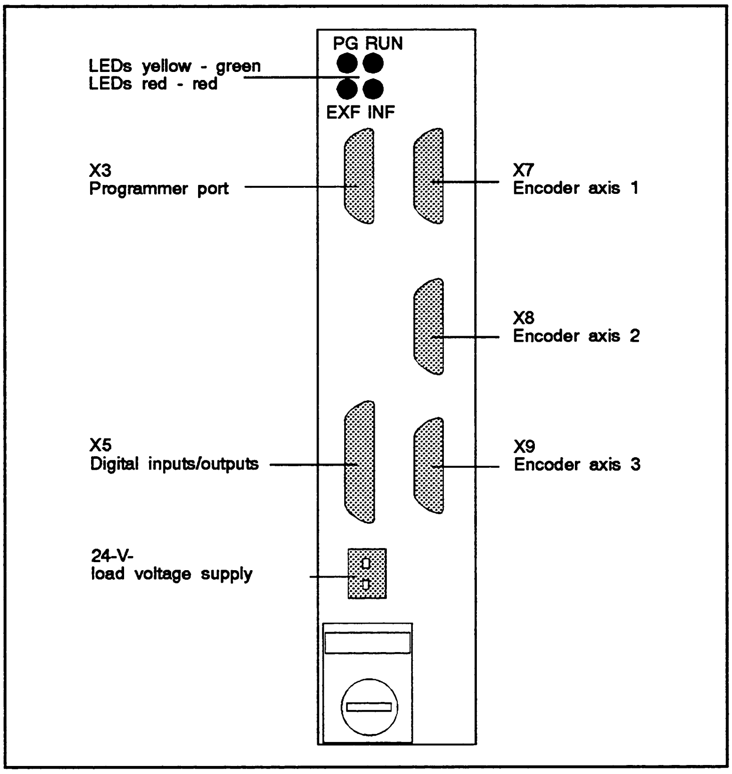


Fig. 3.3 The frontplate of the IP 288

The following connections and indicators are located on the frontplate:

- Three connections for position encoders
- The programmer port
- One connector for digital inputs/outputs
- One connector for the 24 V load voltage supply
- 4 LEDs for indicating different operating modes of the module.

Two backplane connectors on the back of the module form the connection to the PLC. The module has a dual-port RAM for data exchange with the CPU.

3.2.2 How is the Module Connected to the Programmer?

Using COM 288, you can generate the SYSID data sets, machine data, cam sets, target sets and complete target lists with a programmer and load them into the module. From there you can read this data again, edit it, archive it and print it out. You operate COM 288 via function keys and you are supported by Help menus and error diagnostics. You can use COM 288 to operate the connected axes direct in test mode.

3.2.3 How is the Module Connected to the CPU?

There are standard function blocks available for linking the functions of the IP 288 into a STEP 5 program. Important data such as the actual position or the status of the cams, can be read from the IP 288 with every FB call. Simultaneously, you can, for example, enable individual tracks of a cam controller or start a traverse. The IP 288 receives the necessary parameters via job requests.

Larger quantities of data, such as complete target lists, are entered in blocks, i.e. the entire quantity of data is divided among several CPU cycles and transferred.

Installing the Module

4

Contents of Chapter 4

Installing the Module

4

The following chapter gives you a step-by-step explanation of how to prepare the module for installation, perform installation and wire the module. For this purpose, the position of the coding switch for the page number on the module and the position of the second coding switch and the plug-in jumpers are shown. You will also learn how to replace a module.

4.1 What Must You Do Before You Install the Module?

Plug-in jumpers and coding switches

The module has several plug-in jumpers and coding switches. The module is page addressed and occupies two pages. You must set the page number (page address, identification number) on the coding block with the 7 rocker switches. The page number is an even number between 0 and 254, which is why the coding block has 7 switches. The second coding block and the plug-in jumpers leave the factory with the correct settings.

> **Caution**
> The module can be damaged.
>
> If you change the switches of the coding block with a pencil, graphite particles can enter the switch. This can lead to an uncontrolled conductive connection between the components of the module. Such a connection can cause a short-circuit.
>
> Never use a pencil to set the identification number.

Setting the page number

1 Set the page number
- Press the switch down with a suitable tool. If the rocker switch on the OFF side of the switching block is pressed down, the relevant bit location is invalid. In Fig. 4.1, the page number $2^3 + 2^4 + 2^6 = 88$ is set
- The module occupies the number set and the number following this.

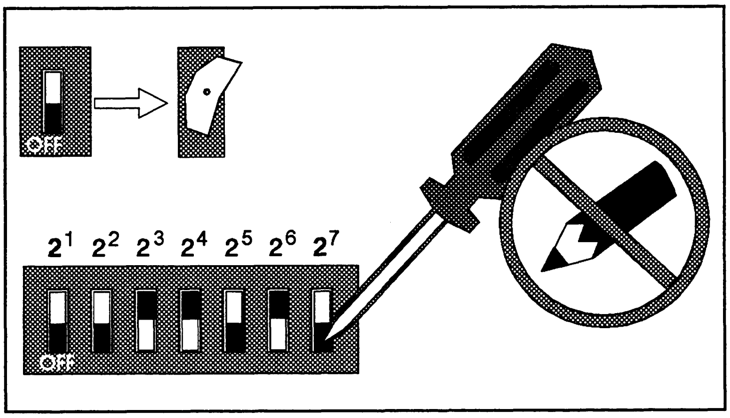


Fig. 4.1 Setting the coding block for the page number

2	Make a note of this setting
3	Check the setting of the second coding block and the position of the plug-in jumpers according to Fig. 4.2. The second coding block and the position of the plug-in jumpers are set before leaving the factory and must not be changed. The plug-in jumpers are used exclusively for internal checking purposes.

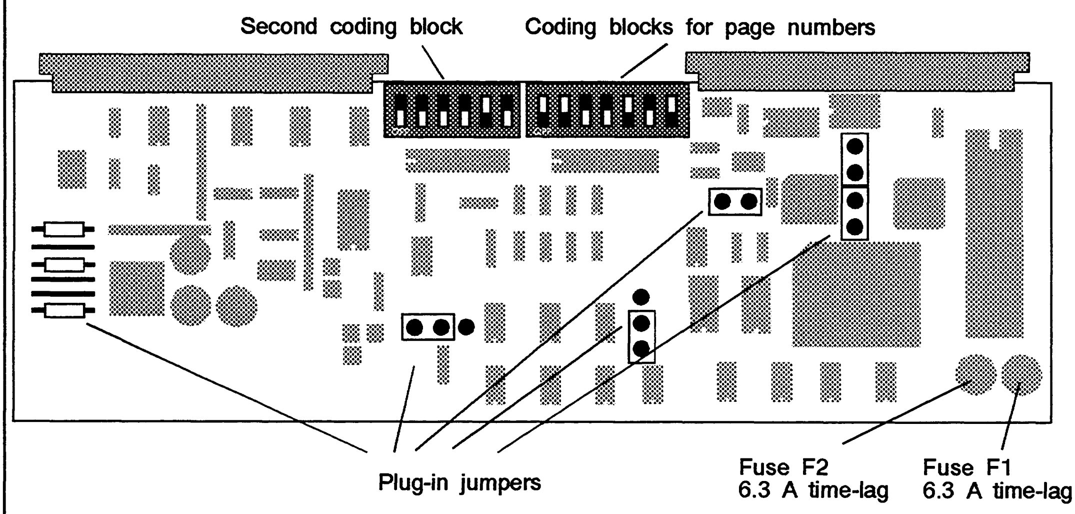


Fig. 4.2 Position and setting of the jumper bridges and coding block (ex factory)

4.2 Where Can You Use the Module?

You can use the IP 288 in the following central controllers:

- S5-115U with adapter casing (CPU 941B, 942B, 943B and 944B)
- S5-135U with CPU 922 (revision level ≥ 9), CPU 928 or CPU 928B
- S5-155U with CPU 946/947

In addition, you can also use the IP 288 in all expansion units with central controller bus.

Interrupt generation

Interrupt generation via the IRx interrupt line is possible in the permissible central controllers and, in the case of the S5-115U and S5-155U PLCs, in the ER 701-3 and EU 186U expansion units. You must then use the IM 307 and IM 317 interface modules to connect the expansion units.

You can operate the IP 288 in the following slots in the different central controllers and expansion units:

CC S5-115U, subrack CR 700-0LB						
PS	CPU	**0**	**1**	**2**	3	IM

CC S5-115U, subrack CR 700-2 and CR 700-3									
PS	CPU	**0**	**1**	**2**	**3**	**4**	**5**	6	IM

The following interrupt signals are possible:

CPU 941B, CPU 942B, 943B, 944B $\overline{IRA}$, $\overline{IRB}$, $\overline{IRC}$ and $\overline{IRD}$

S5-115U expansion unit, subrack ER 701-3									
PS	**0**	**1**	**2**	**3**	**4**	**5**	**6**	7	IM

Interrupt signals are only possible with IM 307 and IM 317

CC S5-135U, 6ES5-135-3KA..																				
3	11	19 1)	27 1)	35 1)	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163

CC S5-135U, 6ES5-135-3UA..																				
3	11	19	27 1)	35	43 1)	51	59 1)	67	75	83	91	99	107	115	123	131	139	147	155	163

CC S5-155U																				
3	11	19	27	35	43	51 1)	59 1)	67	75	83	91 1)	99 1)	107	115	123	131	139 2)	147 2)	155	163

EU 185U																				
3	11	19	27	35	43	51	59	67	75	83	91	99	107	115	123	131	139	147	155	163

No interrupt signals possible

EU 186U																				
3		19 1)		35		51		67		83		99		115		131		147		163

Interrupt signals only possible with IM 307 - IM 317.

Note
If you operate the IP 288 together with an IM 300-3 in the same expansion unit, the jumper BR 1 on the IM 300-3 must be closed.

1) Interrupt processing is not possible on these slots.
2) The jumpers on the wiring backplane must be adapted for the interrupt signals on these slots (see S5-155U Description).

4.3 How Do You Install the Module?

The following is a description of how to install the module in central controllers and expansion units.

⚠

Caution
The module and the PLC can both be damaged.

If you use undue force to install the module, you can damage the printed circuit board or the connectors. Damaged connectors can cause a short-circuit in the PLC.

Never use force. Find and remove the cause if you meet resistance during any of the following steps.

Only safely isolated low mains voltage (60 V ≤ DC) must be used for the inputs and the 24 V DC power supply of the IP 288. Safe isolation can be implemented according to the requirements in, for example

- VDE 0100 Part 410 ↔ HD 384-4-41 ↔ IEC 364-4-41 as functional low voltage with safe isolation, or in
- VDE 0805 ↔ EN 60 950 ↔ IEC 950 as safety extra-low voltage SELV, or in
- VDE 0106 Part 101.

4.3.1 Installation in the S5-135U/155U PLC

1	Switch off the power supply of the CC/EU.
2	Loosen the two screws with which the locking bar is fixed to the subrack.
3	Pull the locking bar forward until it engages. – The bar folds up.
4	Turn the locking screw on the module to the vertical position.
5	Hold the module by the frontplate, slot the basic board into the upper and lower guiding rails and slide the module in to the back. – The interface board slides into the neighbouring guide rails. – The connectors on the back engage the sockets on the bus and the disengaging lever is horizontal.
6	Press in the locking screw and turn the slit to the vertical. – If you have installed the module correctly until now, it should not be possible to remove it.
7	Tip the locking bar down and slide it back into the subrack.
8	Re-tighten the two screws on the locking bar.

If you want to connect the cables to the position encoders and the digital signal cables immediately, follow the instructions in the next chapter.

9	Connect the 24 V load power supply to the L- L+ connecting sockets.
10	Switch the power supply of the CC/EU back on. – The module starts up. The red LEDs (internal and external errors) light up for approximately 2 to 3 s. When the green and yellow LEDs then light up, the module is ready for operation and in programmer mode.

4.3.2 Installation in an S5-115U

1	Switch off the power supply of the CC/EU.
2	Remove, if necessary, the protecting plate from the direct connectors on the subrack.
3	Hook the casing between the guides in the subrack.
4	Swing the casing in to the back until it engages.
5	Screw the casing at the top and bottom.
6	Hold the module by the frontplate and slide it along the guide rails into the adapter casing.
7	Secure the module with the eccentric locking collar at the top end of the casing.
8	Press in the locking screw on the module and turn the slit to the vertical.

Follow instructions 9 and 10 in Section 4.3.1.

4.4 How Do You Wire the IP 288?

You can operate the following types of position encoder with the IP 288:

- Incremental encoders with 24 V signals
- Incremental encoders with 5 V differential signals to RS 422
- Absolute encoders with SSI interface.

Connecting cables

If you use Siemens encoders (6FC 9320), you can connect them with standard connecting cables.

If you use other encoders, you can use connecting cables which are prepared on the module side, i.e., they only have one connector to the module. The connecting cables for digital signals are also prepared on the module side only. You must add the second connector or carry out the wiring to the plant yourself. To do this, you require the pin assignments of the module connector listed in Section 9.1 and the assignments of the individual connecting cables in Section 9.2.

If you have suitable connecting cables, proceed as follows:

1	Switch off the power supply of the CC/EU. With the exception of the programmer port, plugging in and unplugging the front connectors during operation of the module is not permitted.
2	Plug the connectors into the sockets on the frontplate of the module – ENCODER CH1, ENCODER CH2, ENCODER CH3 - encoder axis 1, encoder axis 2, encoder axis 3 – DIGITAL IN OUT - binary signals
3	Screw the connectors (encoders and digital signals) into the sockets.
4	Run the connecting cables to the encoders with shielding clamps and connect them to device reference potential as generally recommended in the installation guidelines of S5 systems. This leads to considerable enhancement of noise immunity.
5	Lay the cables – Run the grounds of the switching elements of each axis separately to ground. You can run the cables in the same cable ducts or channels along with unshielded ≤ 60 V digital lines, shielded data and analog lines or shielded ≤ 230 V signal lines if these have already been correctly laid. If in doubt, consult the installation guidelines in your PLC manual.
6	Connect the cables to the encoders and to the input of the drive controller or wire the digital signal lines. – To do this, consult the encoder descriptions.
7	Switch the CC/EU power supply back on.

4.5 How Do You Replace the Module?

S5-135U/155U PLC

1	Switch off the CC/EU power supply.
2	Loosen the cable connections.
3	Loosen the two screws with which the locking bar is fixed to the subrack.
4	Pull the locking bar forward until it engages. – The bar tips up.
5	Turn the locking screw on the module to the horizontal.
6	Press the disconnecting lever down.
7	Pull the module by the disconnecting lever forward until you can hold the module by the frontplate.
8	Remove the module completely from the CC/EU.
9	Install the new module following the instructions in Section 4.2.

S5-115U PLC

1	Switch off the CC/EU power supply.
2	Loosen the cable connections.
3	Loosen the locking screws between the module and the casing.
4	Remove the module from the casing using the removal lever.
5	Install the new module in the casing following the instructions in Section 4.3.

What Data Does the IP 288 Use? 5

Contents of Chapter 5

What Data Does the IP 288 Use? 5

Before you can use the functionality of the IP 288, you must provide it with various data and parameters. You can use COM 288 for this purpose.

This chapter tells you the data the IP 288 requires and the limits within which you can define the relevant values.

The data and parameters can be divided into different groups.

Name	Purpose
SYSID parameters	Acquisition of the basic parameters which apply to all axes
Machine data (per axis)	Definition of the axis function Description of the environment (plant)
Target data	Storage of targets and the parameters required for them in the case of positioning control
Cam data	Definition of the switching points in the case of a cam controller

The data and parameters are stored and managed in data sets. The structure of these data sets is described in Section 9.4.

5.1 SYSID Parameters

If you use one or more IP 288s in a PLC, you must ensure that each module can be identified unambiguously. All data sets and parameters applying to this module must be compatible wit the SYSID parameters (module ID, module number, module type). This is why there are SYSID (SYStem IDentification) parameters for every module. These parameters contain all the necessary information concerning the module. These parameters also contain those settings which apply to all axes of the module.

At the beginning of the data set, there is information concerning the data set itself and the module.

Data set type

Data set type	
Meaning	Here you specify the data set type to which the following data belongs (SYSID parameters in this case).
Contents	"ID"

Module ID

Module ID	
Meaning	Here there is an indication that this data set belongs to an IP 288.
Contents	" 288", four ASCII characters with a preceding space.

Data set number

Data set number	
Meaning	Here you assign a number to the data set or you select an already existing data set for further processing. Whether you create a new data set or process an already existing one depends only on whether you select an already assigned number here or not. On the module, the data set number is an unambiguous identifier of the data set.
Selection	1 to 255 (default = 1)

Four SYSID parameters have default values.

You can only edit the "Module number" and "Interrupt line" parameters if machine data has not yet been stored on the module.

You can always edit the "Effect of S5 CPU failure" parameter and the data set number. If you want to use COM 288 for this purpose, all three axes must be in programmer mode.

You can enter and read the SYSID parameters either via the PLC or via the programmer interface.

Module number

Module number	
Meaning	Here you define the number under which the IP 288 is to be addressed in future.
Value range	1 to 255 (default = 1)

Effect of S5 CPU failure

Effect of S5 CPU failure	
Meaning	Here you define the effect a BASP signal or the failure of FB-ZYK (see Chapter 8) is to have
Selection	0 = Switch off all outputs (default value) 1 = No effect

CPU failure is monitored by

- BASP evaluation
- The "Life" function in FB ZYK (see Section 8.3.1).

With "Effect of CPU failure" SYSID parameter you determine whether or not a CPU failure is to affect the current processing (traverse) on the IP 288.

- If you determine that a CPU failure is not to have any effect, current processing is not influenced. However, to ensure that the module can still be operated, all axes switch to programmer mode approximately 4.5 s after the missing "Life" signal has been detected.
- If you determine that all digital outputs are to be switched off when a BASP signal is detected, the traverse will be aborted and the current operating mode terminated. The drive disable is active or the cam tracks are switched off. All operating modes and functions are prohibited. Position-dependent and event-dependent functions that have not yet been executed are retained. To ensure that the modules can still be operated, all axes switch to programmer mode. You can now enter data sets in the module from the programmer.

Interrupt line

Setting this parameter only makes sense if you operate the IP 288 in a slot with interrupt capability.

Interrupt line	
Meaning	Here you define whether or not interrupts are to be signalled to the CPU and, if so, on which line.
Value range	0 = No interrupts to the CPU (default value) 1 = Interrupts on /IRA line 2 = Interrupts on /IRB line 3 = Interrupts on /IRC line 4 = Interrupts on /IRD line

You have a free choice of interrupt lines in the case of the S5-115U PLC. In the case of the S5-135U or S5-155U you must note when selecting an interrupt line that the line must be wired on the CPU and IP 288 slots (see PLC manual and Chapter 4).

If you operate the IP 288 in an EU and you want to use the interrupt lines, you must also use the IM 307 - IM 317 interface modules.

Two further parameters contain the abbreviated order number of the module and the firmware version. You cannot edit these parameters.

Module type

Module type	
Meaning	The final digits of the module order number.
Contents	"288-4UA11 " (with following space)

Firmware version

Firmware version	
Meaning	Firmware version
Contents	"V X.XX" (with space after the "V")

5.2 Machine Data

Working with cam controllers or positioning tasks is subject to conditions dictated by the axis, the drives and the encoders, and also by higher-level requirements (safety, accuracy). In order to meet these conditions, you must define them for every axis and transfer them to the IP 288. To do this, you edit the machine data, with COM 288 for example, by either overwriting already existing machine data or creating a set of new machine data.

Editing machine data

You can edit the machine data on the module either via the PLC or via the programmer port. The following conditions must be met before you can enter machine data:

- Entry of previous data set must be terminated (the data interface must be free)
- Module ID and module number must agree with the entries in the SYSID data set.
- The axis must be in the "completed" status.
- There must be no existing machine data set for this axis or you must have deleted the previously valid machine data set.
  In addition, the data set number you intend to assign to the new data set must not have been assigned to another axis.

  or

  You overwrite an existing machine data set (same data set number). In doing so, you must not change the following machine data:

  Module ID
  Data set number
  Axis type
  Measuring system
  Axis function
  Accuracy range (basic resolution)
  Encoder type
  Encoder rotational direction to direction of travel
  Increments/encoder revolution
  Path/encoder revolution
  Encoder revolutions
  Start of traversing range
  End of traversing range
  Reference point coordinate
  Zero mark position/reference coordinate ID
  Control signals of the drive

5

Overwriting machine data

If you try to overwrite an existing machine data set on the module with a new one in which one or more of these machine data items have been changed, the new data set will be rejected and the old one remains in force.

Entering machine data

You can enter machine data when the current operating mode is "completed". You can read out machine data at any time, regardless of the status of the axis.

Machine data that you enter on the module is first checked. The module signals an error if you enter machine data that is outside the specified limit ranges or if the data contradicts itself. Every error is identified by its error number. The module enters the error, or more precisely the relevant error number, in a data word which you can read out via both interfaces. If this data word contains the value 0, the machine data is correct. Any error remains in force until you enter a new machine data set. Erroneous machine data is not stored on the module.

If there are already cam sets or target sets stored on the module, these are checked again when you enter a new machine data set. Data sets which no longer suitable for the new machine data are deleted from the module.

Example:
If you have parameterized a cam controller on a rotary axis and you define a new traversing range with new machine data, cam sets with cam edges outside this new traversing range will be deleted.

Deleting machine data

You can delete machine data when the axis affected in the "completed" status and if no other axis is using the encoder of this axis. (If this is the case, delete the machine data of the "coupled" axis first.)

If you delete machine data, all set statuses are reset.

In addition, the following happens:

- The drive disable is deactivated
- Any rounding is deactivated
- Any follow-up mode is deactivated
- Actual position and rounding comparators are switched off
- Any pending position-dependent or event-dependent settings or parameter changes are deleted
- Pending errors (operator errors, external errors) are deleted
- Track enables are revoked
- Any simulation is switched off
- Coordinate offsets and track offsets are deleted

The machine data is explained below.

The general machine data contains specifications concerning the data set itself, the module, the axis and the encoder.

Data set type

Data set type	
Meaning	Here you specify the data set type (machine data in this case) to which the following data belongs. Data which does fit this data type is rejected by the IP 288.
Selection	"MD"

Module ID

Module ID	
Meaning	An indication that this data set belongs to an IP 288
Contents	" 288", four ASCII characters with preceding space

Data set number

Data set number	
Meaning	Here you assign a number to the data set or you select an already existing data set for further processing. Whether you create a new data set or process an already existing one depends only on whether you select an already assigned number here or not. On the module, the data set number is an unambiguous identifier of the data set.
Selection	1 to 255 (default = 1)

Module number

Module number	
Meaning	Here you specify which IP 288 in the programmable controller this machine data set belongs to. The number you specify must agree with the number in the SYSID of the module affected.
Value range	1 to 255

Axis number

Axis number	
Meaning	Here you specify which of the three axes this machine data set belongs to.
Selection	1 to 3

Axis type

Axis type	
Meaning	Here you specify whether your axis is linear or rotary.
Selection	Linear axis Rotary axis

Measuring system

Measuring system	
Meaning	Here you specify the unit of measurement for the path specifications and displays.
Selection	$1*10^{-3}$ mm $0.1*10^{-3}$ inch $0.1*10^{-3}$ degrees

Axis function

Axis function	
Meaning	Here you specify the axis function in which you want to work on the axis
Selection	Positioning for rapid traverse creep speed drives Cam controller

Basic resolution (Accuracy range)

Basic resolution (BRES)	
Meaning	Here you define the multiples of the measuring system in which path and position specifications are to be made. This also determines the limits of the specifications for path, speed and resolution.
Selection	1 * measuring system 10 * measuring system 100 * measuring system 1000 * measuring system

See also Table on page 5-31.

Basic data set

Basic data set	
Meaning	Here you specify whether you want to edit all the machine data or only the basic data set. In the basic data set some of the machine data described below has default values. If you use the basic data set and you want to change one of the variables with a default value, you must first deselect the basic data set.
Selection	Basic data set No basic data set

Process interrupt

Process interrupt	
Meaning	Here you determine whether or not an axis-specific process interrupt is to be initiated under certain circumstances.
Selection	You can enable or disable each of the following process interrupt causes: • Position reached in the case of a positioning task or start/end of cam in the case of a cam controller • Length measurement completed • Actual position comparator tripped • Revolution counter (rotary axis) reached in the case of a cutoff control
Default	All these interrupts are disabled in a basic data set.

Diagnostics interrupt

Diagnostics interrupt	
Meaning	Here you determine whether or not an axis-specific diagnostics interrupt is to be initiated in the case of the following encoder faults: • Short-circuit 24-volt encoder supply • Short-circuit 5-volt encoder supply • Defective encoder signal cable (not in the case of 24-volt encoders) • Encoder signal error or frame error • Impermissible encoder status (SSI encoders) or zero mark monitor tripped (incremental encoders with zero mark and monitoring by IP 288, see "Encoder Type")
Selection	No diagnostics interrupts in the case of encoder faults Diagnostics interrupts in the case of encoder faults
Default	Diagnostics interrupts are disabled in a basic data set.

Number format

Number format	
Meaning	Here you define the number format in which the IP 288 specifications are to be transferred from the CPU and the display values are to be transferred to the CPU. In the case of an axis which uses the encoder signals of another axis, specification of a number format "from the CPU" is only relevant for transferring values in Teach-In mode.
Selection	The values to the CPU are binary coded. The values from the CPU are binary coded. The values to the CPU are BCD coded. The values from the CPU are BCD coded.

Switching digital outputs

Switching digital outputs	
Meaning	Here you specify whether or not each of the four digital outputs of the axis is wired. If a current of less than 6 mA flows across a wired and switched-on output, the IP 288 signals a wirebreak.
Selection	Output not wired Output wired
Default	In a basic data set, the outputs are entered as "Not wired".

Coordination input

Coordination input	
Meaning	You can initiate an external start or an external stop via the coordination input (DI3) in the axis function "Positioning". Here you specify whether or not an external start is to be initiated in the case of signal state 1 (level-driven) or at the transition from 0 to 1 (edge-driven), or whether or not an external stop is to be initiated in the case of signal state 0 (level-driven) or at the transition from 0 to 1 (edge-driven).
Selection	Level-driven Edge-driven Not used
Default	In basic data set, the coordination input is not used.

The following machine data describes the connected encoder and its link to the axis. Path specifications are given for the measuring system 10^{-3} in the following.

Encoder type

Encoder type	
Meaning	Here you specify the encoder type you are using.
Contents	5 V incremental encoder without zero mark 5 V incremental encoder with zero mark and not monitored by IP288 5 V incremental encoder with zero mark and monitored by IP288 24 V incremental encoder without zero mark 24 V incremental encoder with zero mark and not monitored by IP288 24 V incremental encoder with zero mark and monitored by IP288 SSI encoder (Gray code or Excess X Gray code) Axis and incremental encoder only: Encoder for axis 1 Encoder for axis 2

Monitoring by the IP 288

If you set the encoder type as incremental encoder with monitoring, the IP288 implements the following monitors:

- Zero mark monitor
  There must be one full encoder revolution ± 4 counter pulses between two passes of a zero mark (without reversal).
  The counter pulses amount to 0 ± 4 counter pulses between two passes of a zero mark (with reversal).
  A zero mark must be reached at the latest after one full revolution 4 counter pulses of the encoder. If this is not the case, external error 11 "Zero mark error" is signalled (see Section 9.5.6).
- Reduction switch adjustment monitor, so that the same zero mark is always used for synchronization.
  Before and after the end of a reduction switch, a distance must be maintained to the previous and the next zero mark. This distance must be large enough for the axis to traverse at least 24 ms between passing the zero mark and detecting the end of the reduction switch.
  This monitor only takes effect if more than one encoder revolution has been traversed before leaving the reduction switch in the direction of the zero mark position in the case of a reference point approach or when triggering the reference point. If the monitor trips, external error 18 "Reduction switch adjustment" is signalled (see Section 9.5.6).
  When the reduction switch monitor is switched off, this guarantees that the same zero mark will always be used for synchronization if you adjust the encoder manually in such a way that a distance greater than 16 ms * v_{Red} is maintained before and after the end of the reduction switch to the previous and to the next zero mark (v_{Red} = the speed with which the reduction switch is exited in the direction of the zero mark.)

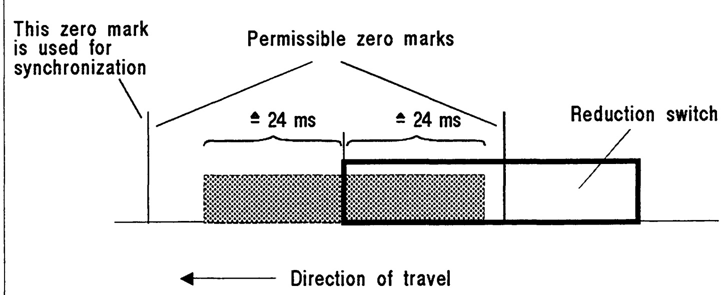


Fig. 5.1 Monitoring the reduction switch adjustment

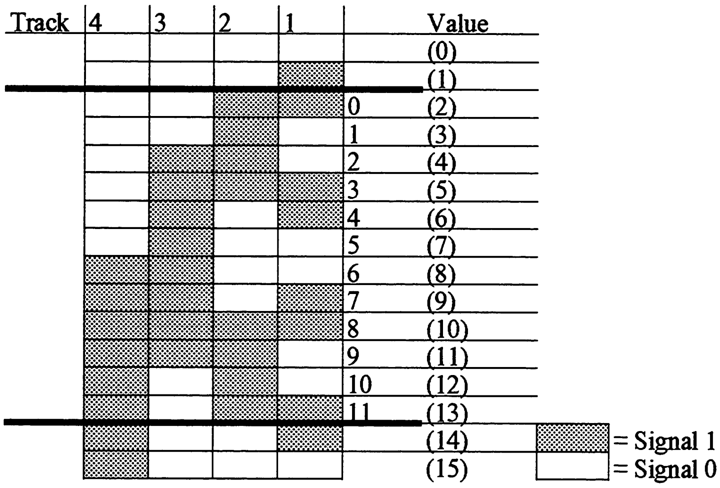
If the zero mark is in the shaded area, the reduction switch monitor trips.

Excess X Gray code

Excess X Gray code is only possible in the case of single-turn absolute position encoders.

If the total number of steps (increments/encoder revolution) is not equal to a power of 2, it is excess X Gray code.

Example:
The desired number of steps is 12. The next higher power of 2 is 16 (2^4). Of the 16 positions in the code slice of the encoder, 2 positions have been left out in the upper range and 2 in the lower range. This is an excess X Gray code, where the X represents the number of steps left out on one side.



Smallest value: 2 (=X)
Largest value: next higher power of 2 - X - 1
16 -2 -1 = 13

Evaluating SSI encoder signals

If you use SSI encoders with the IP 288, you must note the following:

- The encoder status of an SSI encoder has always aged by the transmission time T by the time it evaluated by the IP 288.
  The following applies for T:

  T = 120 µs if the frame length is 13 bits
  T = 216 µs if the frame length is 25 bits

  (see machine data item "Encoder revolutions")
  The consequence of this is that cam edges or switching points are always switched late by at least the time T.
  The time T corresponds on the axis to a distance s where

  $$s\,[\mu m] = v\,[\frac{mm}{min}] * T\,[\mu s] * \frac{1}{60000}$$

  (v = current speed)

- The encoder status of an SSI encoder is evaluated with a maximum uncertainty of T'. The following applies for T':

  T' = 184 µs if the frame length is 13 bits
  T' = 280 µs if the frame length is 25 bits

  T' is the sum of the transmission time and a constant time of 64 µs. (The IP 288 assumes a time of 64 µs between the frames of an encoder).
  The time T' corresponds on an axis to a reproducibility s of the cam edges or the switching points, where

  $$s[\mu m] = v\,[\frac{mm}{min}] * T'\,[\mu s] * \frac{1}{60000}$$

  (v = current speed)

Switching axes in parallel

5

If the 16 tracks are insufficient for a cam controller axis, you can switch two axes in parallel if you are using an incremental encoder. In doing so, axis 3 evaluates the encoder signals of axis 1 or axis 2. For this purpose, you enter "Encoder for axis 1" or "Encoder for axis 2" as the encoder for axis 3 in the machine data item "Encoder type". You use an adapter to connect this encoder to the module (see Section 9.2.7). The axis whose encoder you use for axis 3 must already be parameterized. It is called the "leading axis". The axis function "Cam controller" must be parameterized in the machine data of both the leading axis and axis 3.

The parallel axes remain autonomous as regards evaluation of encoder signals and processing of the cam sets. This means, for example, that cams parameterized at the same position on axis 1 and 3 are not necessarily simultaneously switched (see Section 5.3 "Reproducibility").

The following machine data of axis 3 is overwritten with the relevant data of the leading axis:

- Axis type
- Measuring system
- Basic resolution (accuracy range)
- Encoder rotational direction to direction of travel
- Increments/encoder revolution
- Path/encoder revolution
- Encoder revolutions
- Start of traversing range
- End of traversing range
- Reference point coordinate
- Zero mark position/reference point coordinate ID
- Hysteresis

If an operator error occurs in the case of parallel axes (see Section 9.5.7), you can only acknowledge it via the leading axis. In doing so, there must be no external errors pending on either of the two axes.

Apart from the exceptions below, functions are to be executed only via the leading axis although they affect both axes.

Exceptions:

- Teach-In
- Cam track enable
- Cam track offset
- Acknowledge external error

Only the high-speed digital input DI4 of the leading axis can be used for event-dependent execution of functions/parameter changes. Only digital input DI1 of the leading axis is evaluated in the case of the Trigger reference point function.

When switching two axes in parallel, note the technical specifications of the encoder used. The encoder must supply the input current for two actual value inputs of the IP 288 (see Section 9.6).

Observe the following procedure when switching axes in parallel:

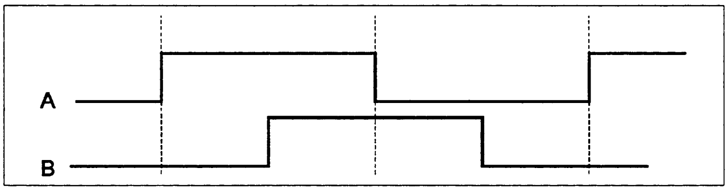
- Parameterize axis 1 or axis 2
- Parameterize axis 3 as coupled axis
- Operate on axis 1 or 2

If one or more operations are executed on axis 1 or 2 before axis 3 has been parameterized as the coupled axis, no guarantee can be given that, after parameterization, axis 3 will respond in the same way as axis 1 or 2. In this case, delete zero offsets and then the machine data of both axes, transfer the machine data anew and only then execute the operations.

Encoder rotational direction to direction of travel

Encoder rotational direction to direction of travel	
Meaning	Here you specify the relationship between the rotational direction of the encoder and the direction of travel of the axis.
Contents	Same direction: larger path coordinate corresponds to larger encoder signal Different direction: larger path coordinate corresponds to smaller encoder signal.
Default	In a basic data set, "Same direction" is set.

In the case of incremental encoders
A before B: larger encoder signal (count up)
B before A: smaller encoder signal (count down)



Increments/encoder revolution

Increments/encoder revolution	
Meaning	Here you specify the number of increments or steps for one revolution of the encoder. A quadruple evaluation of the increments specified here is carried out in the case of incremental encoders.
Value range	1 to 2^{25} Even numbers in the case of SSI encoders In the case of multi-turn encoders, in power-of-two steps, maximum value = 8192.

Single-turn encoders

If you use a single-turn encoder, you must enter an even number here. If you enter a value ≤ 4096 (2^{12}), the module supplies 13 pulses and expects an absolute position with 13 bits starting with the MSB. If you use an encoder with less than 2^{13} positions, the module will expect zeros after the MSB until 13 bits have been transferred (frame length = 13 bits).
If you enter a value > 2^{12}, the module supplies 25 pulses and expects an absolute position with 25 bits starting with the MSB. If you use an encoder with less than 2^{25} positions, the module will expect zeros after the MSB until 25 bits have been transferred (frame length = 25 bits).

Half fir tree format

This leads to the "half fir tree format" shown below, where the number of steps = $S1 \cdot 2^0 + S2 \cdot 2^1 + S3 \cdot 2^2 + ...$

MSB LSB

	Pulse	1	2	3	4	5	6	7	8	9	10	11	12	13
A	2^A													
13	8192	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1
12	4096	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0
11	2048	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0
10	1024	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0
9	512	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	0
8	256	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	0
7	128	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	0	0
6	64	S6	S5	S4	S3	S2	S1	0	0	0	0	0	0	0
5	32	S5	S4	S3	S2	S1	0	0	0	0	0	0	0	0
4	16	S4	S3	S2	S1	0	0	0	0	0	0	0	0	0
3	8	S3	S2	S1	0	0	0	0	0	0	0	0	0	0
2	4	S2	S1	0	0	0	0	0	0	0	0	0	0	0

Multi-turn encoders

If you use a multi-turn encoder, the IP 288 only supports the "Fir tree format". The transmission protocol is in the form of a 25-bit word (frame length = 25 bits). 12 of these bits are for the number of encoder revolutions M ($\leq$ 4096, see below) and 13 of the bits are for the number of increments/encoder revolution S ($\leq$ 8192). The IP 288 supplies 25 pulses and expects the number of encoder revolutions first, starting with the MSB. If you use an encoder with less than 2^{12} positions for the number of encoder revolutions, the module expects zeros in front of the MSB until 12 bits have been transferred. Then IP 288 then expects the number of increments/encoder revolution, starting with the MSB. If you use an encoder with less than 2^{25} positions, the module expects zeros after the LSB until a total of 25 bits have been transferred.

Fir tree format

This leads to the "Fir tree format" shown below, where the number of steps = "Number of revolutions * Number of steps/revolution =
$(M1 \cdot 2^0 + M2 \cdot 2^1 + M3 \cdot 2^2 + ...)* (S1 \cdot 2^0 + S2 \cdot 2^1 + S3 \cdot 2^2 + ...)$

MSB | LSB

Z	2^Z / Pulse	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	A	2^A
12	4096	M12	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S13	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	13	8192
11	2048	0	M11	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S12	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	12	4096
10	1024	0	0	M10	M9	M8	M7	M6	M5	M4	M3	M2	M1	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	11	2048
9	512	0	0	0	M9	M8	M7	M6	M5	M4	M3	M2	M1	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	10	1024
8	256	0	0	0	0	M8	M7	M6	M5	M4	M3	M2	M1	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	9	512
7	128	0	0	0	0	0	M7	M6	M5	M4	M3	M2	M1	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	0	8	256
6	64	0	0	0	0	0	0	M6	M5	M4	M3	M2	M1	S7	S6	S5	S4	S3	S2	S1	0	0	0	0	0	0	7	128
5	32	0	0	0	0	0	0	0	M5	M4	M3	M2	M1	S6	S5	S4	S3	S2	S1	0	0	0	0	0	0	0	6	64
4	16	0	0	0	0	0	0	0	0	M4	M3	M2	M1	S5	S4	S3	S2	S1	0	0	0	0	0	0	0	0	5	32
3	8	0	0	0	0	0	0	0	0	0	M3	M2	M1	S4	S3	S2	S1	0	0	0	0	0	0	0	0	0	4	16
2	4	0	0	0	0	0	0	0	0	0	0	M2	M1	S3	S2	S1	0	0	0	0	0	0	0	0	0	0	3	8
1	2	0	0	0	0	0	0	0	0	0	0	0	M1	S2	S1	0	0	0	0	0	0	0	0	0	0	0	2	4
		Encoder revolutions												Increments/encoder revolution														

Example: the frame of an SSI encoder with 16 * 1024 steps is structured as follows:

0	0	0	0	0	0	0	0	M4	M3	M2	M1	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	0	0	0

Path/encoder revolution

Path/encoder revolution	
Meaning	Here you enter path on the axis covered by one revolution of the encoder
Selection	1 * BRES to 100,000,000 * BRES Maximum values: 100,000,000 µm at BRES = 1 * measuring system 1,000,000,000 µm at BRES = 10 * measuring system 1,000,000,000 µm at BRES = 100 * measuring system 1,000,000,000 µm at BRES = 1000 * measuring system

Resolution

The IP 288 calculates the resolution from the values increments/encoder revolution and path/encoder revolution:

SSI encoders: $\text{Resolution} = \frac{path/encoderrev.}{increments/encoderrev.}$

Incremental encoders: $\text{Resolution} = \frac{path/encoderrev.}{4 \cdot increments/encoder\ rev.}$

The resolution has the unit (measuring system/increments) and the accuracy 2^{-32}. The resolution must be between 0.1 * BRES and 1 * BRES.

Encoder revolutions

Encoder revolutions	
Meaning	Here you enter the number of revolutions of this encoder.
Value range	1 to 4096 In power-of-two steps in the case of multi-turn encoders The value 1 in the case incremental encoders

Note
In the case of a rotary axis with an SSI encoder, the traversing range must be equal to the product of the number of encoder revolutions times the path/encoder revolution.
In the case of a linear axis with an SSI encoder, the traversing range must be less than or equal to the product of the number of encoder revolutions times the path/encoder revolution.

The following machine data describes the traversing range of the axis. If this is deviated from during the traverse, external error 12, "Traversing range exited" is signalled (see Section 9.5.6).

Start of traversing range

Start of traversing range	
Meaning	Here you enter the coordinate of the start of the traversing range. All other coordinates must be greater. Exception: reference coordinate in the case of SSI encoders
Value range	± 100,000,000 * BRES Maximum value 1,000,000,000 µm at BRES = 2 to 4 Minimum value -1,000,000,000 µm at BRES = 2 to 4

End of traversing range

End of traversing range	
Meaning	Here you enter the coordinate of the end of the traversing range. All further coordinates must be less than this. Exception: reference coordinate in the case of SSI encoders
Value range	± 100,000,000 * BRES Maximum value 1,000,000,000 µm at BRES = 2 to 4 Minimum value -1,000,000,000 µm at BRES = 2 to 4

If you use an SSI encoder on a linear axis, the end points belong to the traversing range at maximum coverage.

In the case of a rotary axis, the traversing range defines the length of one revolution, i.e., with a traversing range of 0° to 50° , you divide one revolution into 50 equal parts.

Note:
In the case of a rotary axis in the axis function positioning, the traversing range (end of traversing range - start of traversing range) is limited to 100 m at BRES = 1 or to 1000 m at BRES = 2 to 4.

Reference point coordinate

Reference point coordinate	
Meaning	This machine data item gives the relationship between the position of the encoder and the relevant position coordinate. If you use an incremental encoder, enter the position coordinate which corresponds to the first zero mark after leaving the reduction switch in the direction of the zero mark position(see Section 6.4 "The Operating Modes for Positioning"). In the case of an absolute encoder, enter the path coordinate here at which the encoder has its smallest value (encoder start = 0 if no excess X Gray code). You must specify this coordinate as reference coordinate in increments. Reference coordinate [incr.] = Coordinate at the smallest encoder value [µm] / resolution [µm / incr.]
Value range	Reference point coordinate in the case of incremental encoders: ± 100 000 000*BRES Maximum value 1,000,000,000 µm Minimum value -1,000,000,000 µm Reference coordinate in the case of SSI encoders: -2^{31} to $+2^{31}-1$

Reference point coordinate in the case of a linear axis
The following applies for positioning:
Start of working range + Reverse cutoff difference + Zero speed range
≤ Reference point coordinate ≤
End of working range - Forward cutoff difference - Zero speed range

The following applies for a cam controller:
Start of traversing range ≤ Reference point coordinate ≤ End of traversing range

Reference point coordinate in the case of a rotary axis
The following applies in both axis functions:
Start of traversing range ≤ Reference point coordinate < End of traversing range

Reference coordinate in the case of a linear axis
If encoder rotational direction = direction of travel, the following applies in both axis functions:
-2^{31} < Reference point coordinate [Incr.] ≤ End of traversing range [Incr.]

End of traversing range [Incr.] =
End of traversing range [µm] / Resolution [µm/Incr.]

If encoder rotational direction ≠ direction of travel,
start of traversing range [incr.] ≤ Reference point coordinate [incr.] < 2^{31}

Start of traversing range [Incr.] =
Start of traversing range [µm] / Resolution [µm/incr.]

Reference point coordinate in the case of a rotary axis
The following applies in both axis function:
Start of traversing range [incr.] ≤ Reference point coordinate [incr.] < End of traversing range [incr.]

In general, the following applies:
The reference point coordinate must also be within the range unambiguously covered by the encoder.

If the encoder rotational direction = the direction of travel, the range starts at the start of the traversing range and ends at the start of the traversing range + (Path/revolution * Number of revolutions)

If the encoder rotational direction ≠ direction of travel, the range starts at the end of the traversing range - (Path/revolution * Number of revolutions) and ends at the end of the traversing range.

Zero mark position/reference coordinate ID

Zero mark position/reference coordinate ID	
Meaning	If you use an incremental encoder, enter here the position of the zero mark in relation to the end of the reduction switch. If you use an absolute encoder, specify here whether or not the reference point is valid. If the reference point is valid, the axis is synchronized after you have entered the machine data. If you declare the reference coordinate to be invalid, the path coordinate of the start of the traversing range is assigned to the start of the encoder (smallest value). The reference coordinate is entered in the IP 288 and set as valid by setting the actual value (see Section 6.2).
Value range	Zero mark in forward direction Zero mark in reverse direction or Reference coordinate valid Reference coordinate invalid

Start of software switch (start of working range)

The following machine data are used to describe the working range for the axis. If this range is exited during traversing, the external error no. 12 "Traversing range exited" (see Section 9.5.6) is signalled.

Start of software switch	
Meaning	Here you define the start of the working range for a linear axis in the "Positioning" axis function. This working range cannot be exited in any operating mode. The coordinate of this start must be greater than or equal to the coordinate of the start of the traversing range.
Value range	± 100 000 000*BRES Maximum value 1 000 000 000 µm Minimum value - 1 000 000 000 µm
Default	In a basic data set, the start of the software switch is at the start of the traversing range.

End of software switch (end of working range)

End of software switch	
Meaning	Here you define the end of the working range for a linear axis in the "Positioning" axis function. This working range cannot be exited in any operating mode. The coordinate of this end must be less than or equal to the coordinate of the end of the traversing range and greater than the coordinate of the start of the software switch.
Value range	± 100 000 000*BRES Maximum value 1 000 000 000 µm Minimum value - 1 000 000 000 µm
Default	In a basic data set, the end of the software switch is at the end of the traversing range.

Special specifications for cam controllers

Hysteresis

Hysteresis	
Meaning	Here you define the path interval within which no cams can be switched in the case of a change of direction (caused, for example, by axis drift), see Fig. 5.2.
Value range	0 to + 100 000 000*BRES Maximum value 1 000 000 000 µm at BRES = 2 to 4

The position of the hysteresis range remains unchanged as long as the axis remains in the hysteresis range after a change of direction. A further change of direction within the hysteresis range therefore does not change the hysteresis range. If the axis leaves the hysteresis range, the position of the hysteresis is redefined at the next change of direction.

Within the hysteresis range, path cams are not switched, time cams are not switched on, and the IP 288 signals zero speed.
However, already switched on time cams run their course.
The actual position is also updated within the hysteresis range.
Switching edges within the hysteresis range are switched when the hysteresis range is exited.

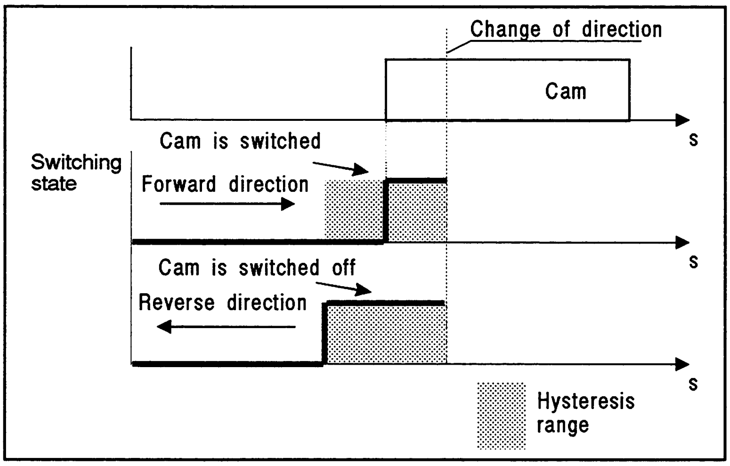


Fig. 5.2 Hysteresis in the case of a cam controller

Special specifications for positioning

Drive control signals

Drive control signals		
Meaning	Here you select the pattern according to which digital outputs for controlling the drive are assigned. You can choose from four patterns giving you a choice of four possible drive control types. In the case of control type 1, digital outputs 1 and 2 are reset at the cutoff point (decelerator). The corresponding direction signal remains set until the actual position is within the zero speed range (stop brake). In the case of control type 2, the direction signal in each case is reset at the cutoff point (decelerator). Control type 3 and 4 are special control types for hydraulic drives. So that the drive is controlled continuously when changing from rapid traverse to creep speed, creep speed is always active in parallel to rapid traverse. Apart from this, control type 3 corresponds to control type 1.	
Selection	Control type 1 DQ1: Rapid traverse DQ2: Creep speed DQ3: Forward traverse DQ4: Reverse travel	Control type 2 DQ1: 1: Rapid traverse/ 0: creep speed DQ2: Position reached DQ3: Forward traverse DQ4: Reverse travel
	Control type 3 DQ1: Rapid traverse DQ2: Creep speed DQ3: Forward traverse DQ4: Reverse travel	Control type 4 DQ1: Forward rapid traverse DQ2: Forward creep speed DQ3: Reverse rapid traverse DQ4: Reverse creep speed

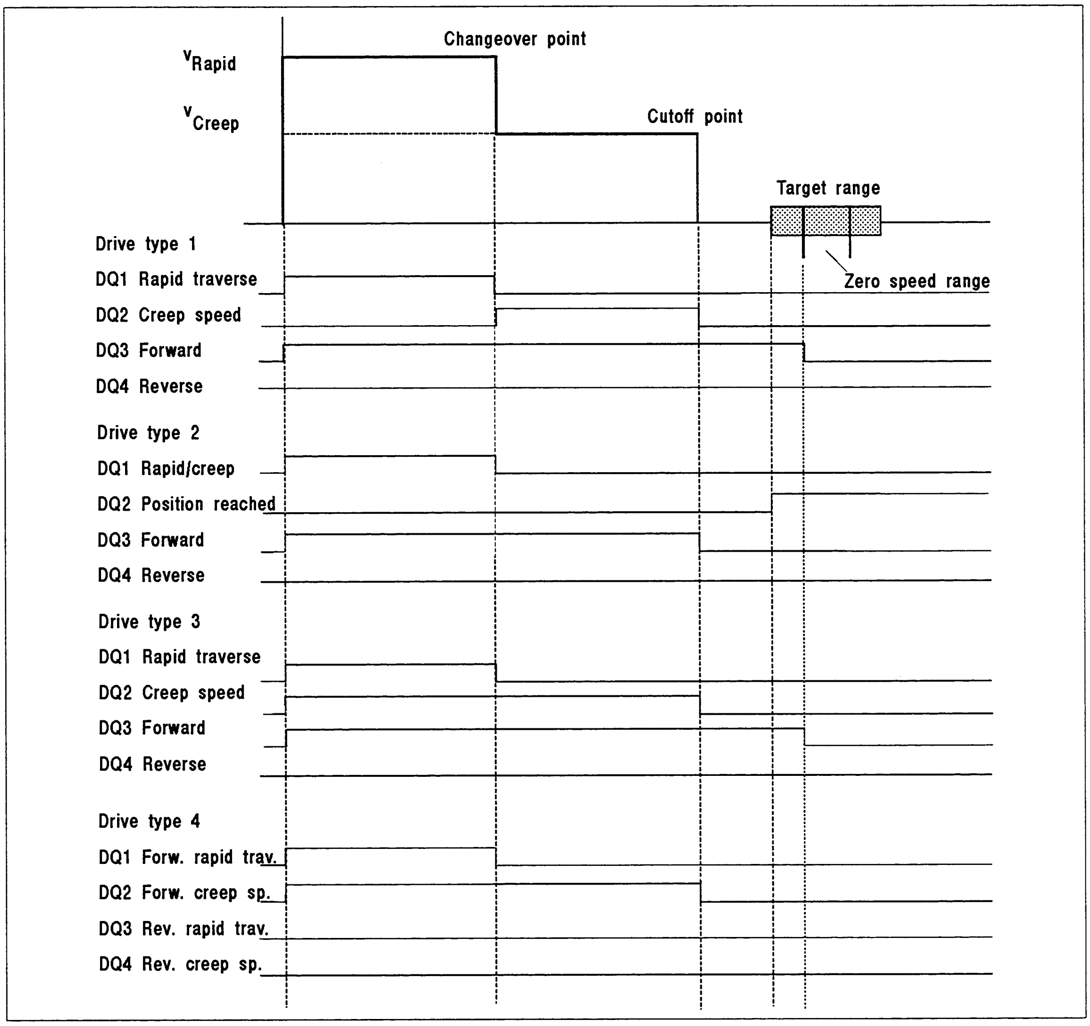


Fig. 5.3 The four control types

5

Change of direction

Change of direction	
Meaning	Here you select between "soft" reversal and "hard" reversal. In "soft" reversal, the drive is first switched to creep speed. Then the distance d = Changeover difference - Cutoff difference is traversed in creep speed and after this the direction of travel is changed and the system switches back to rapid traverse. In "hard" reversal, the direction of travel is changed in rapid traverse without first switching to creep speed.
Selection	Soft reversal Hard reversal
Default	"Soft reversal" is set in a basic data set.

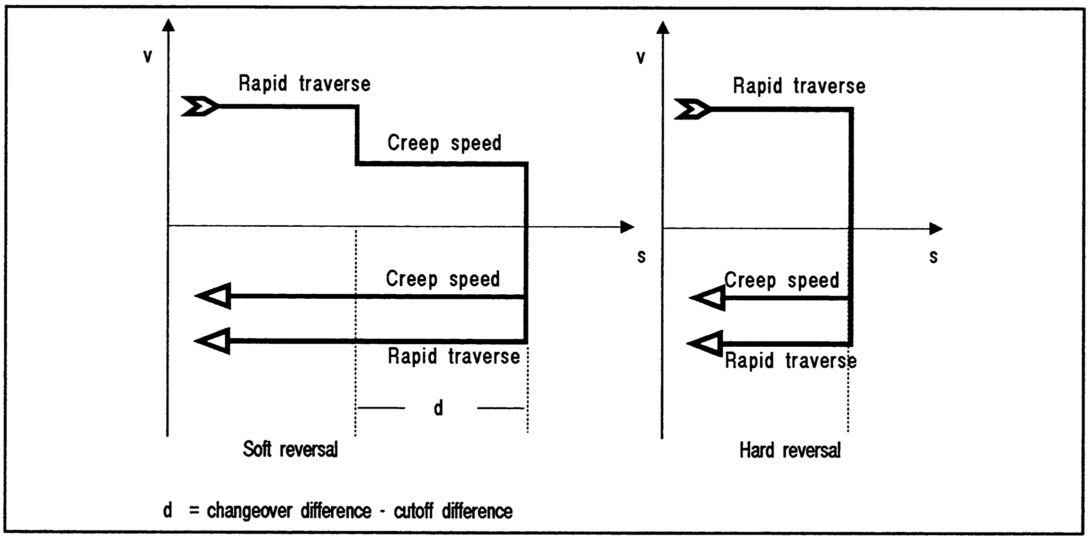


Fig. 5.4 Soft reversal and hard reversal

(see also Section 6.5.15)

Target range

Target range	
Meaning	Here you define the accuracy with which a target is to be approached. For this purpose, you define the size of a symmetrical tolerance window (target range). If the actual position is within this target range, the traverse is terminated or interrupted. In the case of a traverse with specified target (absolute or relative), the IP288 signals "Position reached" when entering the target range. The target range must be less than the cutoff difference. If you enter 0 as the size of the target range, the target must be reached exactly.
Value range	0 to 100 000 000*BRES Maximum value 1 000 000 000 µm

Zero speed range
Zero speed monitor

Zero speed range	
Meaning	Here you define the tolerance which is to apply for the zero speed of a drive. For this purpose, you define the size of a symmetrical tolerance window around the last approached target (zero speed range). As soon as the actual position is in the zero speed range for the first time, the target entry monitor (see "Monitoring time") is switched off and zero speed is monitored. If the actual position then leaves the zero speed range without the start of a new approach, the zero speed monitor trips and external error 17 "Zero speed area exited" is signalled (see Section 9.5.6). The size of the zero speed range must be less than the cutoff difference and less than or equal to the size of the target range. If you enter 0 as the size of the zero speed range, the zero speed range monitor and positive feedback monitor are switched off.
Value range	0 to 100 000 000*BRES Maximum value 1 000 000 000 µm
Default	In a basic data set, the size of the target range is entered here.

Positive feedback

In positioning, the rotational direction of the drive or encoder is monitored. If the actual value changes by more than the zero speed range in the wrong direction after the start of a traverse, the monitor trips and external error 14 "Positive feedback" is signalled (see Section 9.5.6). Positive feedback i s only monitored after module restart with a parameterized axis and in the case of the first traverse after parameterization/parameter change.
The monitor is switched off in the following cases:

- If the actual position has changed by more than the zero speed range in the correct direction
- If the machine data item "Zero speed range" is equal to 0.

Monitoring time
Monitoring of target entry and actual position

Monitoring time	
Meaning	Here you define the value of the monitoring time and thereby a timebase for monitoring actual position and target entry. During traverse, the axis must travel towards the target by at least one increment within the monitoring time. After the cutoff difference has been reached, the axis must enter the zero speed range within the monitoring time. The value of the monitoring time is rounded up to integer multiples of 8 ms. If you specify a value less than 8 ms, the actual position and target entry monitors are switched off. If the monitor trips, external error 15 "Actual value change missing/too small", or 16 "Error during target entry" is signalled (see Section 9.5.6). Please note the special points in the case of jog mode with pending external errors (see Section 6.4.1).
Value range	0 to 65532

Forward changeover difference

Forward changeover difference	
Meaning	Here you define at what distance from the target the drive is switched to creep speed. This distance must be greater than the cutoff difference and at least large enough to allow the drive to decelerate at creep speed to the cutoff point. The forward changeover difference is measured in the direction of the end of the traversing range.
Value range	1 to 100 000 000*BRES Maximum value 1 000 000 000 µm

Forward cutoff difference

Forward cutoff difference	
Meaning	Here you define at what distance from the target the drive is switched off. This distance must be large enough for the drive to completely decelerate before the target. The forward cutoff difference is measured in the direction of the end of the traversing range.
Value range	1 to 100 000 000*BRES Maximum value 1 000 000 000 µm

Reverse changeover difference

Reverse changeover difference	
Meaning	The reverse changeover difference is measured in the direction of the start of the traversing range. Apart from this, it has the same meaning as the forward changeover difference.
Value range	1 to 100 000 000*BRES Maximum value 1 000 000 000 µm
Default	In a basic data set, the value of the forward changeover difference is automatically entered here.

Reverse cutoff difference

Reverse cutoff difference	
Meaning	The reverse cutoff difference is measured in the direction of the start of the traversing range. Apart from this, it has the same meaning as the forward cutoff difference.
Value range	1 to 100 000 000*BRES Maximum value 1 000 000 000 µm
Default	In a basic data set, the value of the forward cutoff difference is automatically entered here.

Forward adaption value

Forward adaption value	
Meaning	Here you define the distance by which the changeover point and cutoff point are to be displaced in a traverse in the direction of the end of the traversing range. This value applies for a single traverse movement for positioning with target sets without adaption values (short target sets). The sum of adaption value and cutoff difference must be greater than the target range. In the case of a linear axis, the sum of adaption value and changeover difference must be less than the difference between the end of the software switch and the start of the software switch. In adaption mode, the IP 288 calculates the adaption value autonomously (see Section 6.5.4).
Value range	± 100 000 000*BRES Maximum value 1 000 000 000 µm
Default	In a basic data set, this value takes a default of 0.

The cutoff point must be outside the target range and the changeover point must be within the working range. This also applies after adaption.

Reverse adaption value

Reverse adaption value	
Meaning	The reverse adaption value applies for a traverse in the direction of the start of the traversing range. Apart from this, it has the same meaning as the forward adaption value. The sum of adaption value and cutoff difference must be greater than the target range. In the case of a linear axis, the sum of adaption value and changeover difference must be less than the difference between the end of the software switch and the start of the software switch. In adaption mode, the IP 288 calculates the adaption value autonomously (see Section 6.5.4).
Value range	± 100 000 000*BRES Maximum value 1 000 000 000 µm
Default	In a basic data set, this value takes a default of 0.

The cutoff point must be outside the target range and the changeover point must be within the working range. This also applies after adaption.

Using the example of a linear axis, Fig. 5.5 below shows an overview of all the path segments specified by the machine data.

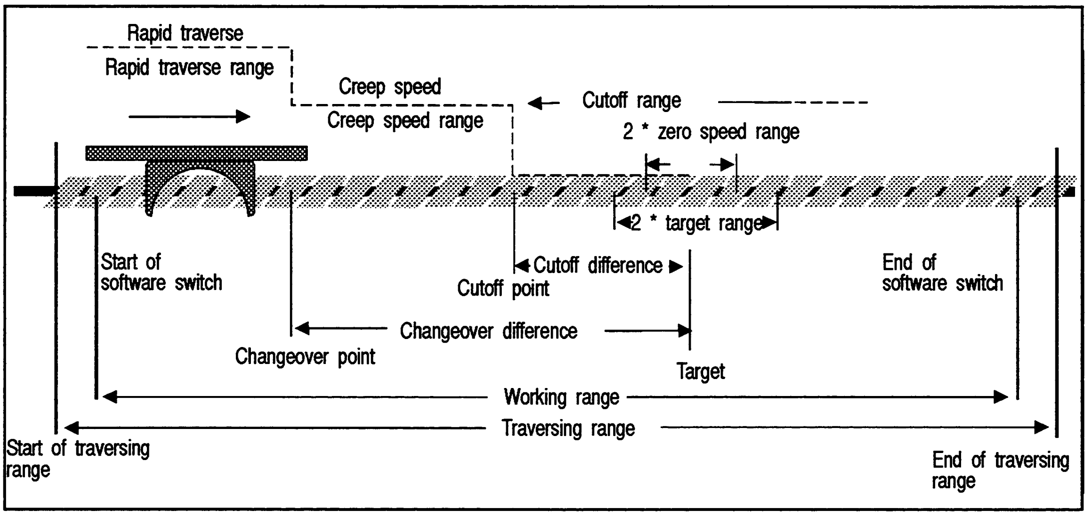


Fig. 5.5 Overview of the path segments from the machine data

The table below represents the relationship between basic resolution, accuracy, resolution and possible positions for the measuring system $1 * 10^{-3}$ mm.

	BRES 1 → 0.001 mm	BRES 2 → 0.1 mm	BRES 3 → 0.1 mm	BRES 4 → 1 mm
Accuracy	1 µm/pul.	10 µm/pul.	100 µm/pul.	1000 µm/pul.
Resolution				
min	0,1 µm/pul.	1 µm/pul.	10 µm/pul.	100 µm/pul.
max	1 µm/pul.	10 µm/pul.	100 µm/pul.	1000 µm/pul.
Positions				
min	± 1 µm	± 10 µm	± 100 µm	± 1000 µm
max	± 100 m	± 1000 m	± 1000 m	± 1000 m

5.3 Cam Data

You define the cam data for each track of an axis in the case of the "Cam controller" axis function. The cam data specifies the position and characteristics of the individual cams. In addition, the cam data also contains further axis information, specific to this axis function. Cam data is stored in cam sets.

The general cam data contains information concerning the data set itself, the module and the axis.

Data set type

Data set type	
Meaning	Here you specify the data set type (cam set in this case) to which the following data belongs.
Selection	"NS"

Module ID

Module ID	
Meaning	Here there is an indication that this data set belongs to an IP 288.
Contents	" 288", four ASCII characters with an initial space

Data set number

Data set number	
Meaning	Here you assign a number to the cam (data) set or you select an already existing cam set for further processing. Whether you create a new cam set or process an existing one depends only on whether or not you select an already assigned number here or not. On the module, the data set number is an unambiguous ID for the data set.
Selection	1 to 255

Module number

Module number	
Meaning	Here you specify to which IP 288 in the programmable controller this cam set belongs. The number you specify must agree with the number in the SYSID of the module concerned.
Value range	1 to 255

Axis number

Axis number	
Meaning	Here you specify to which of the three axes this cam set belongs
Value range	1 to 3

Axis type

Axis type	
Meaning	Here you specify whether you are dealing with a linear axis or a rotary axis. This specification must agree with the specification in the machine data.
Selection	Linear axis Rotary axis

Cams on a rotary axis

On a rotary axis, you always parameterize cam edges in the forward direction, i.e. clockwise. In the figure below, the grey cam is parameterized with the following values in a traversing range from -130° to +230°:

Start of cam at -85°
End of cam at 185°

The white cam is parameterized with the following values

Start of cam at 185°
End of cam at -85°

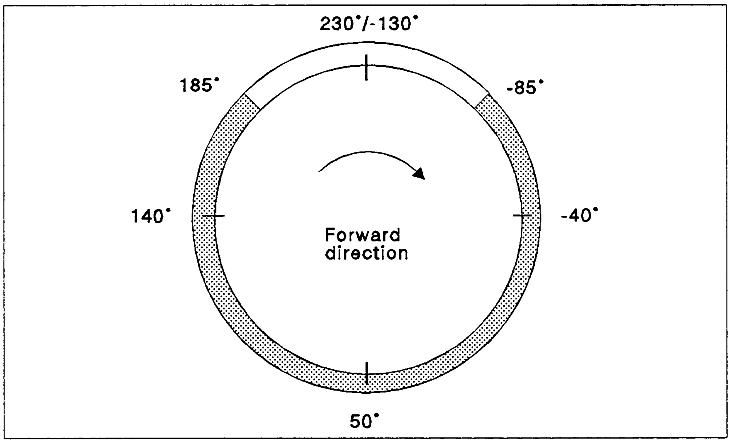


Fig. 5.6 Cams on a rotary axis

The coordinate of the traversing range (+230° in this case) is never given as an actual position since it is the same as the coordinate for the start of the traversing range (-130° in this case). If a cam is to start at the start of the traversing range or end at the end of the traversing range, you must parameterize the coordinate of the start of the traversing range for this purpose.

Measuring system

Measuring system	
Meaning	Here you specify the unit of measurement in which the positions are to be specified and displayed. This specification must agree with the specification in the machine data.
Selection	$1*10^{-3}$ mm $0.1*10^{-3}$ inches $0.1*10^{-3}$ degrees

Number of cams in the track

Number of cams in the track	
Meaning	Here you specify the number of cams you want to create in this track.
Value range	1 to 8

Track number

Track number	
Meaning	Here you specify the number of the track to which this cam set belongs
Value range	1 to 16

Direction

Direction	
Meaning	Here you define the direction in which the cams of this track are to be switched.
Selection	The cams are to be switched forward. The cams are to be switched in reverse. The cams are to be switched in both directions.

If you specify here that the cams are to be switched in one direction only, switched-on cams will be switched off if the direction is changed.

Correction time of dynamic cams

Correction time of dynamic cams (t_{dyn})	
Meaning	Here you specify whether the cams of this track are to be dynamically offset or not and, if so, by which amount.
Value range	0 ms means no dynamic cams 0 to 65535 (in 1-ms timebase)

In each cycle in which the speed has changed by more than 1/8 of the speed previously used for dynamic offset, or failing this, after 128 ms, the module calculates a path segment as the product of the current speed multiplied by the parameterized correction time and displaces the cams of the track concerned by this path segment towards the actual position.

If the path segment by which the cam edges are displaced as a result of a new dynamic response is greater than the path segment by which the axis has moved during this cycle, an already switched-on cam can be switched off and switched on again later although the axis is, in fact, continuing in the same direction.

The figure below illustrates this relationship.

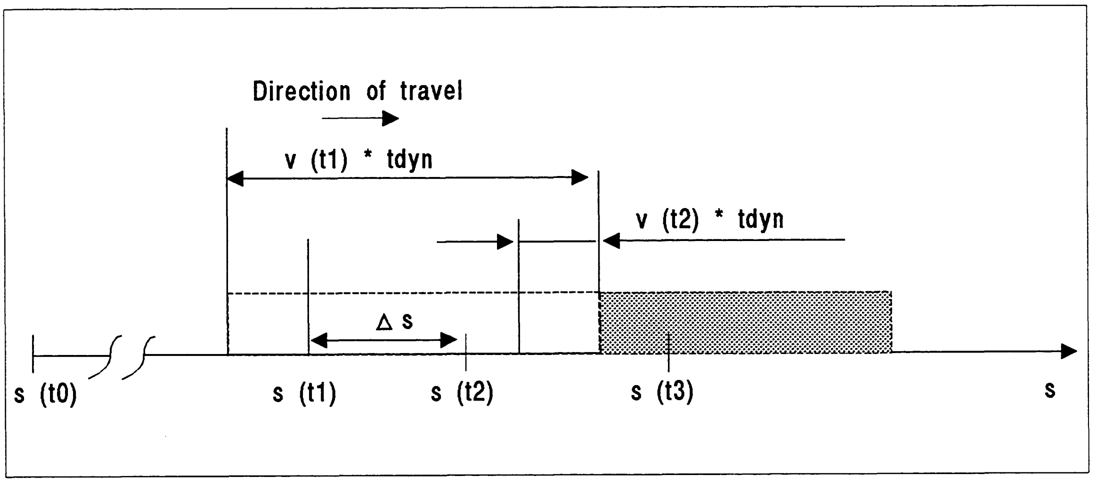


Fig. 5.7 Switching states of a cam in the case of a correction

The following applies:
v(t0) = v(t1)
v(t2) = v(t3)

At s(t0), the cam is switched on because the on edge has been displaced against the direction of travel by v(t1) * t_{dyn}.
At s(t2), the cam is switched off because the on edge has been displaced against the direction of travel by v(t2) * t_{dyn}.
At s(t3), the cam is switched on because the static range of the cam has been reached.

Δs : This is the path segment that the axis has actually travelled.
Δs (v(t1) - v(t2)) * t_{dyn}

Initiating cam for the 1st process interrupt

Up to two cam edges per track can initiate a process interrupt.

Initiating cam for the 1st process interrupt	
Meaning	Here you define the cam that is to initiate the first process interrupt.
Value range	0 means no process interrupt will be initiated 1 to 8 corresponds to the number of the cam that will initiate the process interrupt

Edge for the 1st process interrupt

Edge for the 1st process interrupt	
Meaning	Here you specify where the first process interrupt is initiated.
Selection	The first process interrupt is initiated at the end of the cam. The first process interrupt is initiated at the start of the cam.

Initiating cam for the 2nd process interrupt

Initiating cam for the 2nd process interrupt	
Meaning	Here you specify which cam is to initiate the 2nd process interrupt.
Value range	0 means no process interrupt is initiated 1 to 8 corresponds to the number of the cam that initiates the second process interrupt.

Edge for the 2nd process interrupt

Edge for the 2nd process interrupt	
Meaning	Here you specify where the second process interrupt is initiated.
Selection	The second process interrupt is initiated at the end of the cam. The second process interrupt is initiated at the start of the cam.

A process interrupt can also be initiated at the off edge of a time cam.

You now define the special cam data for each cam.

Cam number

Cam number	
Meaning	Here you define the cam to which the following cam data apply.
Value range	1 to 8

Cam type

Cam type	
Meaning	Here you define the type of cam involved.
Selection	Path cam Time cam (cam 1 or 2 only)

Start of cam

Start of cam	
Meaning	Here you define the coordinate at which this cam is to start.
Contents	± 1 000 000 000 The value entered must agree with the machine data.

End of cam

End of cam	
Meaning	In the case of a path cam, you define here the coordinate at which this cam is to end. In the case of a time cam, you define the switch-on time here.
Contents	± 1 000 000 000 (in the case of path cams) 24 ms to 65532 ms in 8-ms steps (in the case of time cams). You can enter any value between 24 and 65532 and the IP 288 will round it up to the next multiple of 8 ms. The switch-on time of time cams can increase by up to 24 ms in the worst case. The value entered must agree with the machine data.

Cams outside the traversing range

The following applies for a linear axis:
It is permissible for cams or cam edges to be outside the current traversing range. They will then not be reached.

The following applies for a rotary axis:
Cams or cam edges must always be inside the current traversing range even if this has been changed by setting the zero point or by zero offset. A zero offset is only executed if it does not result in cam edges being shifted out of the traversing range.

The figure below represents the cam data "Start of cam", "End of cam", Cam number" and "Track number".

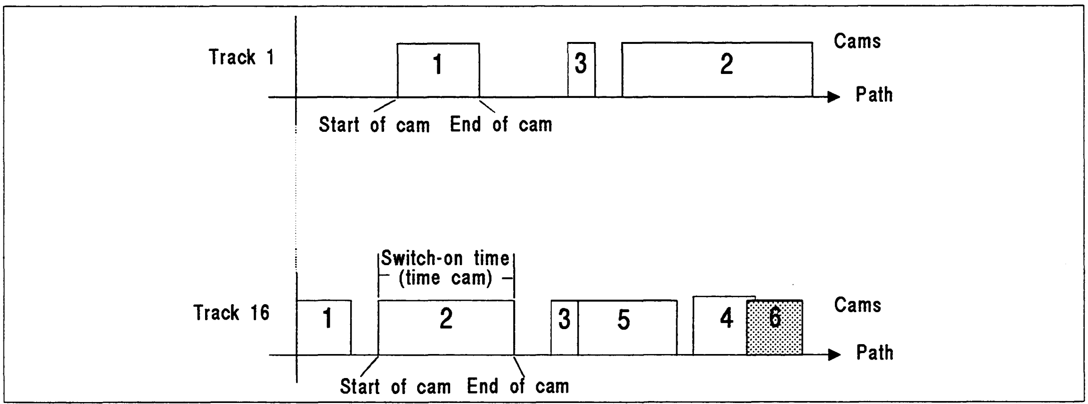


Fig. 5.8 Cam data items in relation to each other

As this figure shows:

- Cams need not be parameterized in rising order
- It is permissible for cams to overlap (cam 4 and cam 6)
- It is permissible for cam edges to touch (cam 3 and cam 5)

Reproducibility

Every axis of the IP 288 is equipped with a comparator which stores a comparison value. This comparators continuously compare the current positions in each case with the cam edges to be switched. If a comparator trips the corresponding response always takes approximately 500 µs to reach the digital outputs and so become available to the CPU. This response time can increase by up to 500 µs per axis if the cam edges of several axes of the IP 288 come together.

The reproducibility s (uncertainty) in switching the cam edges by the comparator is approximately as follows:

$$s\ [\mu m] \leq v\ [\frac{mm}{min}] * 200\ \mu s * \frac{1}{60000}$$

(v = current speed)

So cam edges are switched between 500 µs and 700 µs later (see also Section 5.2 "Evaluation of SSI Encoder Signals").

So that every cam edge is switched by the comparator, you must position the individual on and off edges, which do not lie exactly on the same coordinate, in such a way that the interval a of the individual cam edges within a track and between tracks is given by

$$a > v * T_1$$

(v = current speed, T_1 see table on the next page but one)

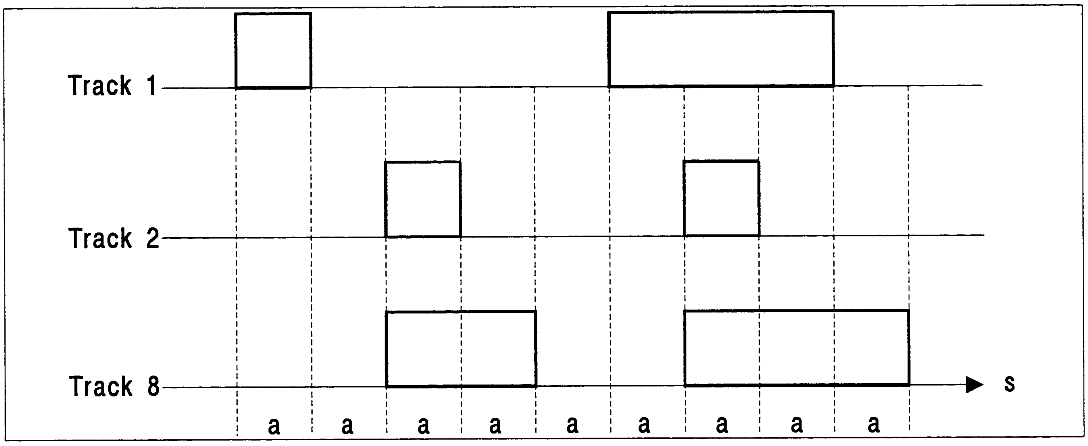


Fig. 5.9 Cam controller without dynamic response or all tracks have the same correction time

If you operate the cam controller with dynamic response (different correction times for the individual tracks), you must take the correction time t_{dyn} into account for calculating the interval (interval a) (see Fig. 5.10).

The following figure shows a cam controller with dynamic response and different correction times in each case. The following applies here:

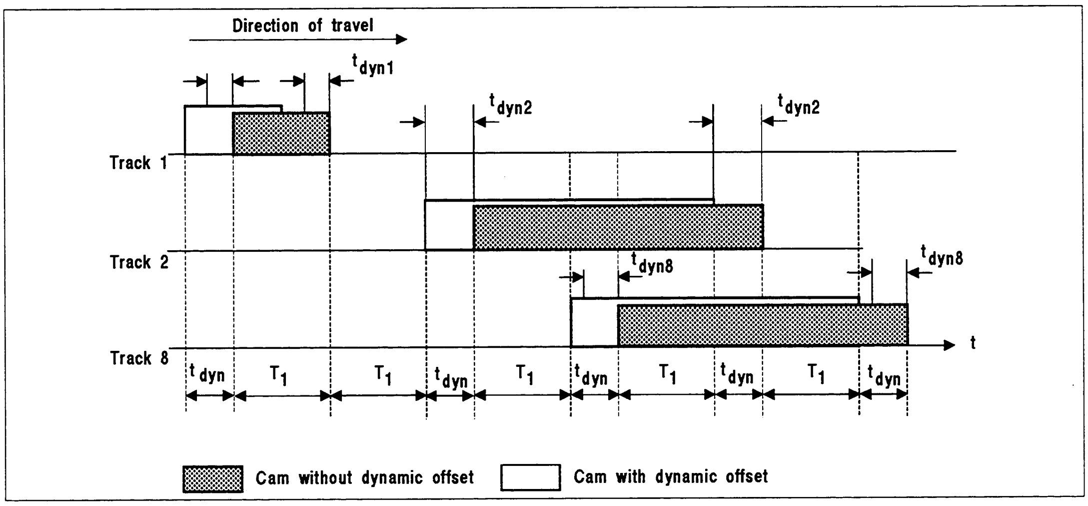


Fig. 5.10 Cam controller with dynamic response

$$a > v * (T_1 + t_{dyn})$$

(v = current speed, t_{dyn} = greatest correction time, t_{dyn2} in this case, for T_1, see the table on the next page).

If you observe the interval given here, all cam edges are switched by the comparator. Since the greatest correction time and the maximum speed are used here to calculate the interval, a response time of approximately 500 µs can also result in the case of smaller intervals.

If you want to trigger responses at the same position within a track or between tracks on one axis, parameterize the relevant cam edges to exactly the same value. These cam edges will then be processed by the module as a single switching point (on value for the comparator). This is also still possible in the case of dynamic tracks (correction time 0), if the correction times of the tracks concerned are the same.

A few examples for the maximum times T_1 are given below. Shorter times can result (in steps of 16 ms) depending on the application.

Example		T_1
3 axes cam controller:	48 tracks enabled	32 ms
3 axes cam controller: distributed in any way	24 tracks enabled	24 ms (with time cams max. 32 ms)
2 axes cam controller: 1 axis not parameterized	32 tracks enabled	24 ms (with time cams max. 32 ms)
1 axis cam controller: 2 axes positioning	16 tracks enabled	24 ms
1 axis cam controller: 2 axes not parameterized	16 tracks enabled	16 ms (with time cams max. 24 ms)

In order to keep the time T_1 as short as possible, always use axis 1 as cam controller. If you operate 2 axes as cam controller, use axis 1 and axis 2.

Reproducibility

If you observe the intervals (a) given, the reproducibility is as follows:

$$s\,[\mu m] \le v_{act}\,[\frac{mm}{min}] * 200\,[\mu s] * \frac{1}{60000}$$

Example: at $3000\,\frac{mm}{min}$: $s \le 10\,\mu m$

If you do not observe the intervals (a) given, the resulting reproducibility will be:

$$s\,[\mu m] < v_{act}\,[\frac{mm}{min}] * T_1\,[ms] * \frac{1}{60}$$

Example: at $v = 3000\,\frac{mm}{min}$ and $T_1 = 32$ ms : $s = 1600\,\mu m = 1.6$ mm

In order that a path cam is always switched regardless of the reproducibility of the switching edges, the length of the path cam (L) must be at least

$$L_{min}\,[mm] \ge v_{act}\,[\frac{mm}{min}] * \frac{T_1}{2}\,[ms] * \frac{1}{60000}$$

Example: at $v = 3000\,\frac{mm}{min}$ and $T_1 = 32$ ms : $L_{min} = 0.8$ mm

5.3.1 Transferring Cam Sets to the Module

If you want to transfer a cam set to the module, the following prerequisites must be fulfilled:

- Any previous data set entry must have been completed. (data interface free)
- The relevant axis must be parameterized in the axis function "Cam controller".
- The module ID and the module number must agree with the entries in the SYSID data set and the machine data.
- The measuring system and the axis type must agree with the machine data.
- There must be no cam set on another IP 288 axis with the number you intend for the new cam set. If this cam set exists already on the this axis and if the track number is identical, the existing cam set will be overwritten. Otherwise you will not be able to enter it.

Cam set check

After you enter it, the cam set will be checked. This means:

- The IP 288 converts the correction time for dynamic cams, start of cam, end of cam or switch-on time to an internal representation.
- The IP 288 checks the number ranges.
- The IP 288 checks whether or not the cam values are within the current traversing range limits (only in the case of a rotary axis).

A cam set will only be stored on the module if it is error-free.

Cam set containing errors are deleted on the module. If you have re-entered machine data, all the cam sets of this axis will be checked. Cam sets containing errors or cam sets that no longer match the new machine data will be deleted.

Overwriting the cam set

If you attempt to overwrite a correct cam set with an erroneous, the correct cam set remains in force and the erroneous cam set is deleted. You can read out the first error detected and the number of the cam at which the error occurred. If an error has occurred in the track-specific data, 0 is signalled as the cam number.

5.3.2 Cam Set Directory

A directory gives information about the cam sets on the module. This directory contains the following information:

Data set type

Data set type	
Meaning	This data set is a directory of cam sets.
Contents	"DN"

Module identifier

Module identifier	
Meaning	Indicates that this data set belongs to an IP 288.
Contents	" 288", four ASCII characters with initial space

Number of cam sets entered

Number of cam sets entered	
Meaning	The total number of cam sets already entered on all axes.
Contents	0 to 48

Number of cam sets which can still be entered

Number of cam sets which can still be entered	
Meaning	The number of cam sets you can still enter on all axes.
Contents	0 to 48

Number of cam sets per axis

Number of cam sets per axis	
Meaning	For each axis, the number of cam sets already entered for this axis. If a 0 is entered here, no cam sets exist yet for this axis.
Contents	0 to 16

This information is followed by information about the tracks and the relevant cam set. The information begins with axis 1.

Track number

Track number	
Meaning	The track this cam set was created for.
Contents	1 to 16

Cam set number

Cam set number	
Meaning	The number of this data set
Contents	1 to 255

Number of cams in the track

Number of cams in the track	
Meaning	How many cams are parameterized in this track.
Contents	1 to 8

Cams

Cams	
Meaning	Which cams are parameterized in this track.
Contents	This specification is bit-coded in the cam set directory Bit 0 = 1 Cam 1 is parameterized Bit 1 = 1 Cam 2 is parameterized etc.

The cam set directory is always output by the module even if there are no axes parameterized in the "Cam controller" axis function. The number of cam sets entered is then 0 and the number of cam sets which can still be entered is 48. The cam sets of all 3 axes are always listed in the cam directory. The cam set directory only gives information about cam sets.

In the case of axes which have been parameterized in the "Positioning for rapid traverse/creep speed drives" axis function, the number of entered cam sets is 0.

5.4 The Target Set

The target set contains the information required by the IP 288 to approach a target in the "Positioning for rapid traverse/creep speed drives" axis function.

Data set type

Data set type	
Meaning	Here you specify the data set type (target set in this case) to which the following data belongs. Data which doesn't fit this data set type is rejected by the IP 288.
Selection	"ZS"

Module ID

Module ID	
Meaning	Indicates that this data set belongs to an IP 288
Contents	" 288", four ASCII characters with an initial space

Data set number

Data set number	
Meaning	Here you assign a number to the target (data) set or you select an already existing target set for further processing. Whether or not you create a new target set or process an already existing one depends only on whether you select an already assigned number here or not. On the module, the data set number is an unambiguous identifier for the data set.
Selection	1 to 255

Module number

Module number	
Meaning	Here you specify the IP 288 in the programmable controller to which this target data belongs. You must set the number you specify for each IP 288 via the SYSID (see COM 288).
Value range	1 to 255

Axis number

Axis number	
Meaning	Here you specify which of the three axes this target set belongs to.
Selection	1 to 3

Axis type

Axis type	
Meaning	Here you specify the axis type to which this target data applies. This specification must agree with the specification in the machine data.
Selection	Linear axis Rotary axis

Measuring system

Measuring system	
Meaning	Here you specify the unit of measurement in which the positions are to be specified and displayed. This specification must agree with the specification in the machine data.
Selection	$1*10^{-3}$ mm $0.1*10^{-3}$ inches $0.1*10^{-3}$ degrees

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Target set number

Target set number	
Meaning	Here you assign a number to the target set or you select an already existing target set for further processing. Whether or not you create a new target set or process an already existing one depends only on whether you select an already assigned number here or not. On the module, the data set number is an unambiguous identifier for the data set.
Selection	1 to 255

Speed ID

Speed ID	
Meaning	Here you specify whether the target is to be approached in rapid traverse or in creep speed.
Selection	Rapid traverse Creep speed

Target

Target	
Meaning	Here you specify the absolute coordinate of the target.
Value range	± 1 000 000 000 The value entered must agree with the machine data.

Long/short target sets

A distinction is made between long and short target sets. Target sets with the data set number 1 to 100 are long and those with the number 101 to 255 are short. In long target sets, you must enter the following information in addition to the specifications given above:

- Forward changeover difference
- Reverse changeover difference
- Forward cutoff difference
- Reverse cutoff difference
- Forward adaption value
- Reverse adaption value

See Section 5.2 for the structure and value ranges of these parameters. If you work with short target sets, the relevant specifications from the machine data are used. When adaption is active, the adaption values in the machine data are changed in the case of positioning with short target sets.

5.4.1 Transferring Target Data to the Module

If you want to transfer a target set to the module, the following prerequisites must be fulfilled:

- The relevant axis must be parameterized in the "Positioning for rapid traverse/creep speed drives" axis function.
- The module ID and the module number must agree with the entries in the SYSID data set and the machine data.
- Any previous data set entry must have been completed. (data interface free)
- If you want to overwrite an existing target set with a new one, the existing one must not be in process.
- There must be no target set on another IP 288 axis with the number you intend for the new target set.

Target set check

After the target set has been entered, it is pre-interpreted. This means:

- The IP 288 converts the targets, changeover difference, cutoff difference and adaption values to an internal representation.
- The IP 288 checks the number range.
- The IP 288 checks for a linear axis that the absolute target specifications are within the currently valid working range ± zero speed range, and for a rotary axis that they are within the maximum permissible number range (± 100 m or ± 1000 m) (see Section 6.5.2 "Setting the Zero Point" and Section 6.5.3 "Zero Offset").

A target set is only stored on the module if it is free from errors. The target set is entered in the current target list of the axis.

Erroneous target sets are deleted on the module. If you re-enter machine data, all target sets of the axis concerned are re-checked. Erroneous target sets or target sets that no longer belong to the new machine data are deleted. All target sets of the target list (see Section 5.5) are checked.

Overwriting the target set

Target sets stored on the module can be overwritten with target sets with the same target set number. The previous target set is then deleted. If you try to overwrite a correct target set with an erroneous one, the correct target set remains in force and the erroneous one is deleted. You can read out the first detected error and the number of the erroneous target set.

Deleting the target set

A target set can only be deleted if it is not currently being processed.

5.4.2 Target Set Directory

A directory gives information about the target sets on the module. This directory contains the following information:

Data set type

Data set type	
Meaning	This data set is a directory of target sets.
Contents	"DZ"

Module identifier

Module identifier	
Meaning	Indicates that this data set belongs to an IP 288.
Contents	" 288", four ASCII characters with initial space

Number of target sets entered

Number of target sets entered	
Meaning	The total number of target sets already entered on all axes.
Contents	0 to 255

Number of target sets which can still be entered

Number of target sets which can still be entered	
Meaning	The number of target sets you can still enter on all axes.
Contents	0 to 255

This is followed by information about the individual axes, beginning with axis 1.

Number of target sets per axis

Number of target sets per axis	
Meaning	For each axis, the number of target sets already entered for this axis. If a 0 is entered here, no target sets exist yet for this axis.
Contents	0 to 255

After this specification, the target list number for each axis (see Section 5.5) and all assigned target set numbers are displayed.

The target set directory is always output by the module even if there are no axes parameterized in the "Positioning with rapid traverse/creep speed drives" axis function. The number of cam sets entered is then 0 and the number of target sets which can still be entered is 255. The target sets of all 3 axes are always listed in the target directory. The target set directory only gives information about target sets.

In the case of axes without a target set and axes which have been parameterized in the "Cam controller" axis function, the number of entered target sets is 0.

5.5 The Target List

The target sets are entered in target lists on the module. There is one target list per axis identified by the target list number (see below). If the target list contains at least one target set, the following default applies:

- For axis 1, target list 1.
- For axis 2, target list 2.
- For axis 3, target list 3.

For an axis which does not yet contain a target set, the target list number 0 is output in the target set directory.
If you enter individual target sets in the module, these will be entered in the target list of the axis concerned. If a target list on the module contains at least on target set, you cannot overwrite it.

The target list contains the following information:

Data set type

Data set type	
Meaning	Here you specify the data set type (target list in this case) to which the following data belongs. Data that does not fit this data set type is rejected by the IP 288.
Selection	"ZL"

Module ID

Module ID	
Meaning	Indicates that this data set belongs to an IP 288.
Contents	" 288", four ASCII characters with initial space

Data set number

Data set number	
Meaning	Here you assign a number to the target list or you select an already existing target list for further processing. Whether you create a new target list or process an existing depends only on whether you select an already assigned number here or not. On the module, this number is an unambiguous identifier for the data set concerned.
Selection	1 to 255

Module number

Module number	
Meaning	Here you specify the IP 288 in the PLC to which this target list belongs. You must set the number you specify for each IP 288 via the SYSID (see COM 288).
Value range	1 to 255

Axis number

Axis number	
Meaning	Here you specify which of the three axes this target list belongs to.
Selection	1 to 3

Axis type

Axis type	
Meaning	Here you specify which axis type this target list applies to. This specification must agree with the specification in the machine data.
Selection	Linear axis Rotary axis

Measuring system

Measuring system	
Meaning	Here you specify the unit of measurement in which the positions and position indicators are to be made. This specification must agree with the specification in the machine data.
Selection	$1*10^{-3}$ mm $0.1*10^{-3}$ inches $0.1*10^{-3}$ degrees

Number of target sets

Number of target sets	
Meaning	Number of target sets which have been entered for this axis. If this is a 0, there are no target sets yet available for this axis.
Contents	0 to 255

This information is followed by the individual target sets of this target list.
The following is specified for every target

- Data set number (target set number)
- Speed identifier
- Target coordinate.

5.5.1 Transferring a Target List to the Module

If you want to transfer a target list to the module, the following prerequisites must be fulfilled:

- The relevant axis must be parameterized in the "Positioning for rapid traverse/creep speed drives" axis function.
- There must be no target list on the axis concerned.
- The module ID and the module number must agree with the entries in the SYSID data set and the machine data.
- The axis must be in the "completed" axis status.
- Any previous data set entry must have been completed. (data interface free)
- You must not use the following target list numbers:
  for axis 1: 2, 3
  for axis 2: 1, 3
  for axis 3: 1, 2

Target list check

After the target list has been entered, it is checked. This means:

- The IP 288 converts the targets, changeover difference, cutoff difference and adaption values to an internal representation.
- The IP 288 checks the number range.
- The IP 288 checks for a linear axis that the absolute target specifications are within the currently valid working range ± zero speed range, and for a rotary axis that they are within the maximum permissible number range (± 100 m or ± 1000 m)

A target list is only stored on the module if it is free from errors.

If you re-enter machine data, all target sets of the target list are checked (see target set entry). If an error occurs in a target set, only the target set concerned is deleted on the module.

If you delete machine data on the IP 288, a target list which has contained at least one target set, is retained. If you change the axis function, the target list is deleted.

Deleting the target list

If you want to delete a target list, the following prerequisites must be fulfilled:

- The relevant axis must be parameterized in the "Positioning for rapid traverse/creep speed drives" axis function.
- Any previous data set entry must have been completed. (data interface free)
- The axis must be in the "completed" axis status.

Operating the IP 288

6

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Operating the IP 288

6

Before you operate an axis of the IP 288, you must have stored valid machine data for this axis on the module.

In the positioning axis function, you operate the IP 288 via operating modes and functions.

In the cam controller axis function, you operate the IP 288 via functions.

6.1 Operating Modes and Functions

Operating modes

The operating modes

- Jog
- Reference point approach
- Absolute increment mode
- Relative increment mode
- Target set processing

all cause the axis to be traversed. You transfer the operating modes to the IP 288 either with COM 288 or via the CPU. Each operating mode is identified by number. Information which more closely specifies the execution of the operating mode, is transferred in the form of parameters when you start the operating mode. Depending on the status which processing has reached, you can change these parameters while the operating mode is running or interrupted.

Functions

You use functions to influence the execution of operating modes or to initiate specific IP 288 actions. You cannot interrupt functions. The IP 288 can process several functions simultaneously.

Position-dependent Event-dependent

You can specify for the following functions whether they are to their execution is to depend on a position or on an event.

- Actual value setting
- Zero offset
- Zero point setting

These functions are executed when the relevant event occurs (on edge at the high-speed input DI4) or when the relevant position has been reached.

You can also change the increment mode parameters according to positions or events.

You can initiate only one position-dependent and one event-dependent function/parameter change at a time.

Points to note in the case of position-dependent functions and parameter changes

The IP 288 has one memory for event-dependent actions (parameter changes or functions) and one memory for position-dependent actions.

Event-dependent actions are executed if the on edge at the high-speed input DI4 is detected. Position-dependent actions are executed if the relevant position coordinate specified at transfer of the function or parameter change is reached.

Comparator

A (software) comparator on the IP 288 detects when the position coordinate is reached. The actual position is compared cyclically with the position coordinate at which the action is to be executed (comparison value). If the valueof this coordinate is reached or overshot, the comparator trips and the relevant action is executed. The comparator is then deleted.

Position-dependent actions can only be initiated on a synchronized axis.

Position-dependent actions in the case of a cam controller

Each comparison value must be greater than or equal to the start of the traversing range and less than the end of the traversing range.

The comparator trips as soon as the actual position reaches the comparison value regardless of the direction in which the axis is travelling. If, for example, the axis is travelling in the forward direction and the comparator is loaded with a comparison value less than the current actual position value, the comparator will not trip immediately. In the case of a linear axis, the direction would have to be changed before the comparison value would be reached. In the case of a rotary axis, the comparison value can be reached without changing direction.

Position-dependent actions in the case of positioning

In the case of a linear axis, each comparison value must be within the working range and in the case of rotary axis, each comparison value must be within the maximum permissible traversing range.

The comparator only operates in connection with a traverse. It operates from the start of a traverse until the start of new traverse. The comparator can be loaded before or during a traverse.

When the axis status is changed after "completed", any still pending position-dependent parameter changes are deleted. When a new traverse is started, any still pending position-dependent parameter changes or position-dependent functions which refer to the previous traverse are deleted.

Traverses without target

In the case of traverses without a target (jog, reference point approach, absolute/relative increment mode without target), the comparison value refers to the actual position at the point of loading or at the start of the traverse. Thus, if the axis has already overshot the comparison value at loading, the direction must be changed in the case of a linear axis before the comparator trips. In the case of a rotary axis, the comparison value can be reached in the next revolution without changing direction.

If the comparison value is greater than or equal to the end of the traversing range or less than the start of the traversing range in the case of traverses without target on a rotary axis, then the comparison value will never be reached.

Traverses with target

In the case of traverses with a target, the comparison value refers to the traverse, i.e. to the starting point specified for the traverse currently in progress or currently interrupted when the comparator is loaded. If the comparator is loaded before a traverse is started, the comparison value refers to the starting point of the next traverse. If a forward traverse is in progress when the comparator is loaded, or if a forward traverse is started after the comparator is loaded, and if the coordinate of the comparison value is less than (or more negative than) the starting point of the traverse, the comparator trips immediately.

It does not trip in the case of a rotary axis if the comparator value is within the range covered by this traverse. This applies for a reverse traverse but in the opposite direction.

In the case of a rotary axis, comparison values greater than or equal to the end of the traversing range and less than the start of the traversing range can also be specified.

Once a relation between a comparison value and the actual position (in the case of traverses without target) or between a comparison value and the specified target (in the case of traverses with target) has been established, it is no longer changed on the IP 288. Thus, if a traverse is started with a loaded comparator, and if a (new) target is specified during the traverse but before the comparator trips, the comparator continues to respond as it would in the case of a traverse without target.

Example 1: Linear axis
If the comparator is loaded with the comparison value 50 at the actual position 100 on a traverse from 0 to 200, the comparator trips immediately.

Example 2: Linear axis
If the comparator is loaded with the comparison value -50 on a traverse from 0 to 200, the comparator trips immediately.

Example 1: Rotary axis
If the comparator is loaded with the comparison value 50 on a traverse from 0 degrees to 800 (at 360 degrees per revolution) with a distance to go of 70 degrees (actual position = 10 degrees in the third revolution), the comparator trips immediately.

Example 2: Rotary axis
If the comparator is loaded with 45 degrees after 350 degrees (at 360 degrees per revolution) on a traverse of 180 degrees forward, it trips immediately. If the target were 90 degrees in this case instead of 350 degrees, the comparator would trip at an actual position of 45 degrees.

Event-dependent actions in the case of positioning

- When changing the axis status after "completed", still pending parameter changes are deleted.
- When starting a new traverse, event-dependent functions and event-dependent parameter changes which refer to the previous traverse, remain in force.

Length measurement

Length measurement, in connection with digital input DI 4 (high-speed input), runs independently of the operating modes and functions. The length measurement cannot be switched off. The current actual position is stored at the rising edge at the input, and the measured length is set to 0. Measurement ends with the falling edge of the input. The difference between the current actual position and the stored actual position is the measured length. If the actual position has been changed between the beginning and end of measurement by setting the zero point, zero offset, setting the actual value, reference point approach or by triggering the reference point, This change is accounted for in the measurement. In the event of a rising edge at the "high-speed input" DI 4, the actual value is stored first as the "Start of measurement" and then any pending event-dependent actual value setting, zero offset or zero point setting is executed. In this way, the actual value change brought about by the event-dependent function is included in the measurement.

The end of the measurement is flagged at both interfaces (bit 11 in DW 85/DW 117/DW 149 in the DB-IP, length measurement completed). In addition, completion of the measurement can be signalled to the CPU with a process interrupt. You can parameterize this interrupt in the machine data. The start of a new measurement resets the "Length measurement" condition code bit.

In the case of module restart with machine data, an already measured length remains in force. In the case of module restart without machine data, and in those cases where you delete the machine data, an already measured length is deleted.

Note:
In the case of a rotary axis, the path measured must be completely between the start of the traversing range and the end of the traversing range, i.e. during the measurement, the actual position must move beyond the traversing range limits.

6.2 How Do You Synchronize an Axis?

The IP 288 only acquires the actual positions if the relevant axis has been parameterized. You establish the relation between the actual position and the signals of the position encoder by synchronizing the axis. You can use different operating modes and functions for this purpose, depending on whether you use an incremental or an absolute encoder. If you use an absolute encoder, you can also synchronize the axis by parameterizing a machine data set accordingly and transferring it to the module.

6.2.1 Synchronization for Incremental Encoders

The IP 288 acquires actual positions by counting the encoder increments according to the direction. Since the count is relative, you must establish a relation between the counted encoder increments and the coordinates on your axis (parameterized traversing range with reference point) for the purposes of absolute actual position acquisition. After each module restart, all parameterized axes with incremental encoders are not synchronized. The actual position is set to the reference point entered in the machine data. The increments are counted starting from this value.

The synchronization is deleted in the event of certain external errors. However, in this case, the relation between the actual position and the encoder increments remains in force, i.e. the actual position continues to be updated despite the error. Without synchronization, absolute positions cannot be approached in the case of positioning and cams are not evaluated (switched) in the case of a cam controller.

You can synchronize an axis in both axis functions with the functions below. Synchronization is indicated in the axis status word (see Section 8.3.2, "Axis status").

- Setting the actual value
  A specified coordinate is assigned to the actual position.
- Triggering the reference point
  (only in the case of incremental encoders with zero mark)
  The value of the reference point coordinate is assigned to the rising edge of the first zero mark of the encoder after leaving the reduction switch in the specified direction (zero mark position).

In the case of positioning, you can also synchronize an axis with the following operating mode:

- Reference point approach
  (only in the case of incremental encoders with zero mark)
  The value of the reference point coordinate is assigned to the rising edge of the first zero mark of the encoder after leaving the reduction switch in the specified direction (zero mark position).

6.2.2 Synchronization for Absolute Encoders

In the case of absolute encoders, you enter the coordinate that corresponds to the start of the encoder in the machine data, instead of the reference point coordinate. The start of the encoder is the smallest value supplied by the encoder (0 if not an excess X Gray code). You must specify this coordinate as a reference coordinate in increments:

Reference coordinate [incr.] =
coordinate at the smallest encoder value [µm]/ resolution [µm/incr.]

The coordinate at the smallest encoder value (zero pass of the encoder) can also be outside the parameterized traversing range. It can also be less than the start of the traversing range in the case of "Encoder rotational direction equal to direction of travel" and greater than the end of the traversing range in the case of "Encoder rotational direction not equal to direction of travel". The validity of this coordinate is described by the reference coordinate ID in the machine data.

If the ID is set ("Reference coordinate valid"), the IP 288 signals that it is synchronized after transfer of the machine data set or after module restart with machine data. After the machine data has been transferred to the module, or after the machine data has been converted and checked, the coordinate system is defined according to the entered coordinate at the start of the encoder.

If the ID is not set as valid, the actual position is determined under the assumption that the encoder supplies its smallest value at the start of the traversing range. The IP 288 signals that it is not synchronized. Absolute positions cannot be approached.

Calculating the reference point

Actual position acquisition is always absolute since every encoder status corresponds to a specific coordinate. For this purpose, the encoder must be adjusted with the axis. You can adjust the encoder either mechanically by turning the encoder disk, or per software. Once an adjustment has been made, it is stored in the machine data (reference coordinate valid).

Mechanical adjustment of the encoder:
You can take the start of the traversing range as your point of reference. You enter this coordinate in the machine data as the reference coordinate and set the ID to valid. You adjust the encoder in such a way that it supplies its smallest encoder value (e.g. zero) at the start of the traversing range. When transferring the machine data to the module, the coordinate system is defined accordingly; the axis is synchronized.

Adjusting the encoder by setting the actual value:
The ID in the machine data set is set as not valid. After transfer of the machine data, the coordinate system is defined under the assumption that the encoder supplies its smallest value at the start of the traversing range. The IP 288 signals that it is not synchronized. The axis is synchronized by setting the actual value (current actual value = specified coordinate). The ID in the machine data set on the IP 288 is set to valid, the coordinate at the encoder start is calculated and

entered as the reference coordinate in increments in the machine data and also output at the PLC interface in the DB-IP ("Current reference point coordinate", see Section 8.3.2). This coordinate is automatically updated (in the machine data and in the DB-IP) each time the actual value is set and so always mirrors the current relation between the measuring unit and the axis. Resetting of the actual value overwrites the old relation.

6.3 Course of a Traverse

In the positioning axis function, a traverse is made by executing an operating mode. The course of an operating mode is influenced by the following actions and events:

- Setting of the control bits START, STOP, CONT, T+ and T-
- Setting or resetting of the coordination input DI 3
- Occurrence of an operator error
- Occurrence of an external error
- Occurrence of an internal error
- Power failure
- Active command output disable (BASP)

Effect of the control bits

You can change between the axis states "running", "interrupted" and "completed" by setting the control bits or by pressing the relevant function key in COM 288. A change from "running" to "interrupted" or "completed" stops a traverse.

Effect of the coordination input DI 3 (COORD)

You can use the coordination input to coordinate operating modes between axes and modules. The following conditions apply here for all operating modes which you can influence with the control bits START, STOP and CONT:

Level-driven evaluation:

- Starting the operating mode: START = 1 and COORD = 1
- Interrupting the operating mode: STOP = 1 or COORD = 0
- Continuing the operating mode: CONT = 1 and COORD = 1

The following applies for jog mode:

- Starting the operating mode: T+/T- = 1 and COORD = 1
- Completing the operating mode: T+/T- = 0 or COORD = 0

Edge-driven evaluation:

- Starting the operating mode: START = 1 and COORD 0 → 1
- Interrupting the operating mode: STOP = 1 or COORD 0 → 1
- Continuing the operating mode: CONT = 1 and COORD 0 → 1

The following applies for jog mode:

- Starting the operating mode: T+/T- = 1 and COORD 0 → 1
- Completing the operating mode: T+/T- = 0 or COORD 0 → 1

If you interrupt or complete an operating mode via the coordination input, the drive is switched off.

Effect of an operator error

In the event of an operator error, the operating mode changes from the "running" status to the "interrupted" status or from the "interrupted" status to the "completed" status. The drive is switched off and the operator error is flagged.

Effect of an external error

In the event of an external error, the current operating mode is interrupted in the "running" or "interrupted" statuses and the "completed" status is set.
You can still move the axis at creep speed in the "jog" mode in the case of the following external errors:

- Error 2: Short-circuit 24-volt contact supply for the digital inputs
- Error 7: Short-circuit 24-volt encoder supply
- Error 8: Short-circuit 5-volt encoder supply
- Error 9: Defective encoder signal cable
- Error 10: Encoder signal error or frame error
- Error 11: Zero mark error/illegal encoder value
- Error 13: Working range exited (jog mode only possible in the direction of the tripped software switch)
- Error 15: Actual value change missing/too small
- Error 16: Error at target entry
- Error 17: Zero speed range exited
- Error 18: Reduction switch adjustment

In all other cases, you must correct the external error and acknowledge before you can restart an operating mode (see Section 6.5.12).

Effect of an internal error

Internal errors are errors on the module. Program execution is held up by an internal error and you must replace the module.

Effect of a change from programmer mode to PLC mode

When you change from PG mode to PLC mode, the running operating mode is interrupted and the drive is switched off. Position-dependent and event-dependent functions and parameter changes remain in force.

Effect of a power failure

In the event of a power failure, the CPU goes to Stop. Power failure is signalled to all I/O modules by the S5 bus signal $\overline{\text{NAU}}$. On the IP, the processor is at "HALT", all outputs are switched off and the interface to the CPU is not synchronized (see Section 8.3.1 "Synchronization control word" and the programming example). A module restart takes place at power restore. The IP 288 detects an S5 CPU failure either via the command output disable signal (BASP) or from the absence of the ready signal of a function block (FB-ZYK).

Response in the case of S5 CPU failure

You can set the response of the IP 288 to a failure of the S5 CPU in the SYSID data set.
Either:
all outputs are switched off in the event of a BASP signal, and the drive disable (see Section 6.5.11, "Drive disable") is switched on, or the cam track enable is switched off. All operating modes and functions are then prohibited; however, data sets can still be transferred from and to the module.
Or:
You can specify in the SYSID that BASP has no effect on the outputs and there is no direct response from the module.

After the ready signal disappears, the module switches all axes to PG mode after approximately 4.5 s. Even if all outputs are switched off as a result of your setting in the SYSID, you can change this setting from the programmer after the ready signal has run.

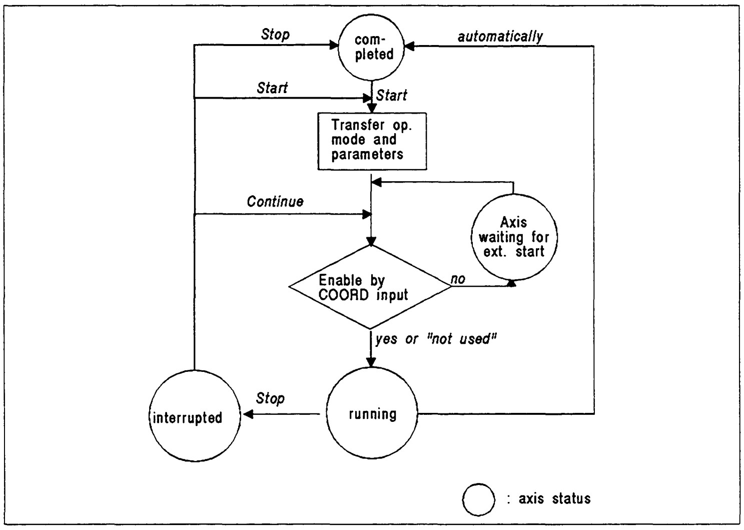

Fig. 6.1   Example of an error-free traverse (e.g. increment mode)

Position reached

An operating mode is completed or interrupted when the actual position enters the target range. When approaching a target (absolute or relative), the target range lies symmetrically around the target. When the axis reaches the target range, the message "Position reached" is generated. This message remains in force until the start of a new traverse with external start enable.

Fictitious target range

A target range also exists when a traverse is interrupted, when stopping in jog mode and when stopping because of an error. This target range is arranged symmetrically around the coordinate resulting from the current actual position and the changeover difference (cf. zero speed range). Entering this fictitious target range is flagged and monitored and the message "Position reached" is not generated.

In the statuses "running", "Axis waiting for external start" and "interrupted", functions and parameter changes can result in an operator error and a consequent change of status. Correct functions and parameter changes are processed in these statuses and any running traverse is continued accordingly.

Aborting the traverse

> **Note**
> You can always abort an operating mode (traverse) with "Drive disable" (see Section 6.5.11).

6.4 The Operating Modes for Positioning

In the following sections, you will find explanations of the operating modes with which you can operate an axis in the Positioning axis function.

If the "Follow-up" function is active, you cannot execute any operating mode.

The following applies for the operating modes listed below with the exception of jog mode:
You can interrupt a running traverse with STOP. You can continue an interrupted traverse with CONT as long as distance to go to the target is still greater than or equal to the cutoff difference + the adaption value. The traverse is completed when the axis has reached the target area.

6.4.1 Jog Mode

Jog	
Commands for execution	T + (forward) T - (reverse) CHANGE
Parameters	Speed identifier Rapid traverse/creep speed For parameter change only: Execution ID Immediately

With this operating mode you can cause the axis to travel in the direction specified without giving a target. The axis executes this operating mode even if it is not synchronized. Since in that case neither the traversing range limits nor the software switch on the IP 288 are valid, a linear axis can traverse up to the EMERGENCY OFF limit switch. In the case of a synchronized linear axis, the drive is switched off before the limits of the working range are exceeded.

You can change the speed during a traverse.

If both control bits T+ and T- are deleted, the drive is switched off. In doing so, the axis status "running" remains in force until the actual position in the fictitious target range is entered. Only then can you change the operating mode. If a direction bit is reset while the drive is being switched off and before the actual position enters the target range, the drive is restarted or a change of direction is executed.

A change of direction is also made if a direction bit is changed while the axis is traversing with rapid traverse. The change of direction takes place according to the machine data item "Hard/soft change of direction".

A change of direction is only executed if the axis is sufficiently far away from the relevant software switch at that moment, i.e. if the axis can still stop before reaching the software switch after changeover. If this is not the case, the axis is switched off.

Jog mode at creep speed with pending external error
Jog mode at creep speed is permissible with certain external errors (see Section 9.5.6 and 6.3).
If jog mode at creep speed is started when an external error is pending, no further external errors will be monitored. If, for example, a change of direction is requested in jog mode at creep speed without a connected encoder (external error 15 pending), stopping the drive only takes effect after the parameterized monitoring time has run out. If the monitoring time is parameterized at less than 8 ms, the axis can no longer be stopped. You must abort the traverse by switching on the drive disable.

6.4.2 Reference Point Approach

Reference point approach	
Command for execution	START, STOP, CONT
Parameters	Speed identifier Rapid traverse/creep speed Direction Forward/reverse

If you use an incremental encoder, you can synchronize the axis with this operating mode. There must be a reduction switch (DI 1) available at which the drive decelerates to creep speed. The reference point coordinate is assigned to the first zero mark after leaving the reduction switch in the direction of the zero mark position (see machine data). The reference point can only be reproduced if the axis always travels across the end of the reduction switch at the same speed. In order to ensure this, independent of the course of a reference point approach and independent of any interrupt of the traverse, the reduction switch must be at least as long as the path segment required by the drive to decelerate from rapid traverse to creep speed.

A reverse switch (DI 2) can also be used. This must be at least as long as the path required between rapid traverse and zero speed.

The following must apply for the length 1 of the reverse switch and the reduction switch:

$1 > T_l \cdot v$

The time T_l is relevant for determining the length 1 (see Section 5.3, "Reproducibility").
v = current speed

In the case of a linear axis, one of these switches must be located and detected in the direction in which the drive starts.

If the reference point approach is completed after the reverse switch, you must not start a new reference point approach until the drive is between the reverse switch and the reduction switch. The reverse cam is monitored in the axis status "interrupted", i.e. if you continue the reference point approach, it runs correctly.

A reference point approach can only be "interrupted" with STOP as long as the reduction switch has not yet been reached.

The course of the "Reference point approach" mode depends on the following settings and conditions:

- The direction specification is equal to the zero mark position. (See machine data)
- The direction specification is not equal to the zero mark position. (See machine data)
- The axis at before or after the reduction switch after the start of the mode.
- The axis reaches the reverse switch first after the start of the mode.

The value of the reference point coordinate is assigned to the rising edge of the first zero mark of the encoder after leaving the reduction switch in the specified direction (zero mark position). In the axis status word, the bit "Axis synchronized" is set.

The following figure is a schematic representation of the four different sequences:

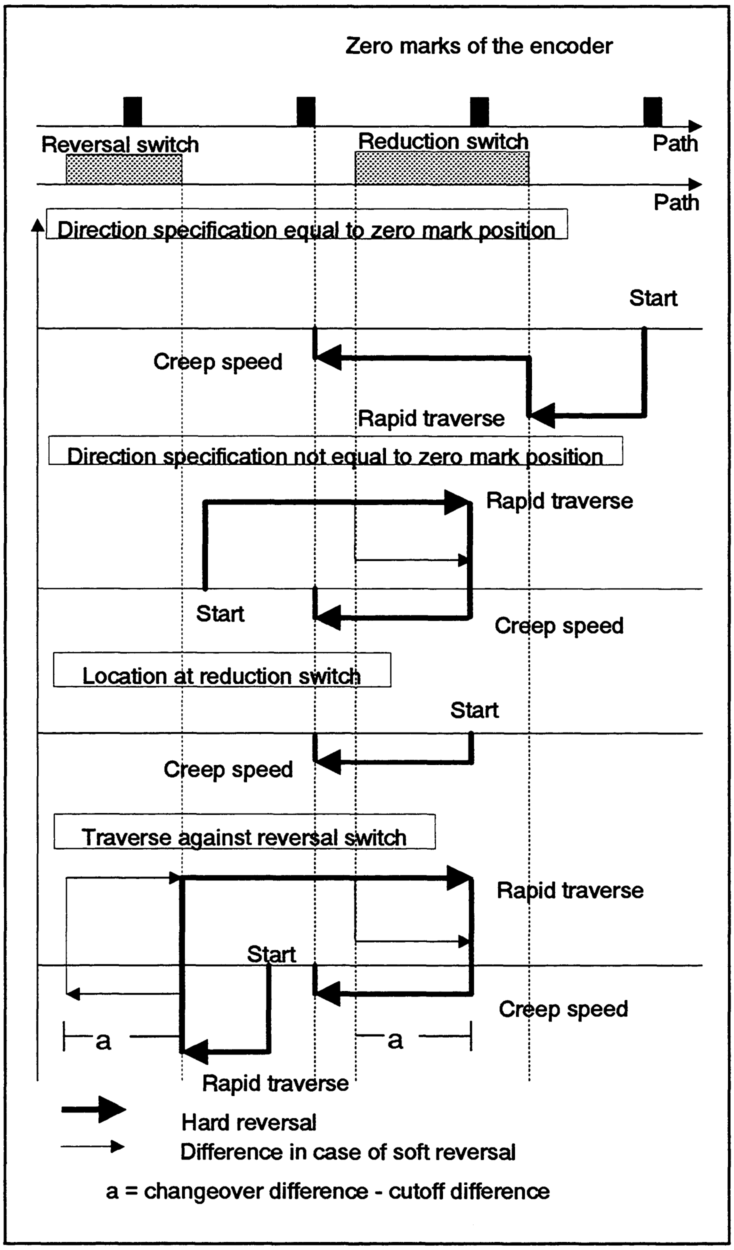

Fig. 6.2 Sequences of the "Reference point approach" mode

If change of direction takes place in reference point approach after leaving the reduction switch in the correct direction, the reference point will be terminated, external error 15 (actual value change missing/too small) is set and the axis is not synchronized. This monitor cannot be switched off.

6.4.3 Absolute Increment Mode

Absolute increment mode	
Commands for execution	START, STOP, CONT, CHANGE
Parameters	Speed identifier Rapid traverse/creep speed Target Without target/with target Direction Forward/reverse Shortest path (in the case of a rotary axis) For parameter changes only: Execution ID Immediately Position-dependent/ event-dependent Comparison value

If the axis is synchronized, you can approach a specified target with this operating mode. You specify the target in absolute coordinates.

If you start an absolute increment mode traverse without a target, you must specify a direction. With the CHANGE command, you can change the speed afterwards, specify or change a target but not delete one. You can also execute these parameter changes position-dependent or event-dependent.

Linear axis

The following applies for a linear axis:
The traversing path between the current position of the axis and the target must be greater than the cutoff difference. In addition, the distance between the target and the next software switch must be at least the cutoff difference + adaption value + zero speed range. If the traversing path is less than the changeover difference, the axis traverses at creep speed even if you have selected rapid traverse as the speed ID.

If you specify or change the target later, the new target must be accessible without a change of direction. If this is not the case, the traverse will be interrupted. You can then approach the new target with a change of direction using CONT.

Rotary axis

The following applies for a rotary axis:
If you traverse a rotary axis, you can choose between approaching the target forward, in reverse or by the shortest path (no direction bit set). If you specify forward or reverse as the direction, a traverse is made, even if the target corresponds to the current actual position. If you specify forward as the direction, the target must be greater than or equal to the start of the traversing range and if you specify reverse as the direction, the target must be less than the end of the traversing range. If you select "Shortest path" and if the axis is precisely opposite the target, i.e. the distance between to the target in the forward

direction is exactly the same as the distance to the target in the reverse direction, the axis traverses forward.

If you specify a target outside the traversing range or beyond the end of the traversing range, the following happens:

- The axis traverses at least one full revolution.
- The coordinate of the specified target is reduced by the length of the traversing range.
- If the new target coordinate is then within the traversing range, an absolute approach is made.
- If the new target coordinate is still outside the traversing range, the axis traverses a further full revolution and a new target coordinate is calculated. This procedure is repeated until the new target coordinate is within the traversing range and an absolute approach to the target can be made.

If you specify or change a target with the CHANGE command, the new target refers to the starting point of the traverse in the case of traverses without a target and to the current actual position in the case of traverses with a target.

Example:
On a rotary axis with a traversing range of 360°, you start an absolute increment mode traverse at 0° without a target in the forward direction. After two full revolutions, you specify the target 900° at 90°. The axis now traverses two more full revolutions and then travels to actual position 180°.
However, if you start an absolute increment mode traverse to 850° at 0° in the forward direction, and if you specify the target 900° at 90° after two full revolutions, the axis traverses in this revolution to 180°.

A target can only be approached if it is further from the current position than the cutoff difference. Exception: In rounding, the direction of positive mechanical coupling is the opposite of the specified direction.

6.4.4 Relative Increment Mode

Relative increment mode	
Command for execution	START, STOP, CONT, CHANGE
Parameters	Speed identifier Rapid traverse/creep speed Target (path) Without target/with target Direction Forward/reverse For parameter changes only: Execution ID Immediately Position-dependent/ event-dependent Comparison value

With this operating mode, you can traverse a specified path. The axis need not necessarily be synchronized. Since neither the traversing range limits nor the software switch are then valid on the IP 288, a linear axis can traverse up to the EMERGENCY OFF limit switch. Traversing beyond the maximum value range of ± 1000 m is not monitored. If you specify a path, this must lead in the case of a linear axis to a point whose distance from the next software switch is at least the cutoff difference + adaption value + zero speed range. The path you specify must be greater than the cutoff difference. If the path is less than the changeover difference, the axis traverses at creep speed, even if you have selected rapid traverse as the speed ID.

In the case of rotary axis, you can traverse up too 100 m at BRES = 1 or 1000 m at BRES = 2 to 4.

If you start a relative increment mode traverse without specifying a path, the axis traverses in the direction specified. With the CHANGE command, you can change the speed afterwards, specify or change a path but not delete one. The new path is added to the previous one. You can also execute these parameter changes position-dependent or event-dependent.

6.4.5 Processing the Target Set

Processing the target set	
Commands for execution	START, STOP, CONT
Parameters	Target set number Direction Forward/reverse Shortest path (only in the case of a rotary axis)

If you approach a target of a long target set (target set number 1 to 100), the direction-dependent changeover and cutoff differences and adaption values parameterized in this target set apply. If adaption is active, the calculated adaption values will be stored in the target set or overwritten.

If you approach a target of a short target set (target set number 101 to 255), the relevant values from the machine data apply. If adaption is active, the adaption values in the machine data will be overwritten.

If you traverse a rotary axis, you can choose between approaching the target in the forward direction, in reverse or by the shortest path (no direction bit set).

6.5 The Functions of the IP 288

Functions influence the course of the operating modes or the processing of the axis functions.

If the "Follow-up" function is active only the following further functions are possible:

- Programmer mode on/off
- Drive disable on/off
- Simulation on/off.

Every function can be executed in the "completed" axis status.

Special features common to certain functions

The functions "Set actual value", "Zero offset", "Set zero point", "Shift cam track" and "Trigger reference point" have the following special features in common:

Positioning

- Special features in the case of positioning
  A position-dependent or event-dependent function can be transferred before or during a traverse. If a position-dependent function is still waiting to be processed after a traverse, it will be deleted when a new traverse is started.

  If the actual position is between the changeover point and the cutoff point following one of these functions, the system switches immediately to creep speed. Since the cutoff point remains unchanged, it may happen that the cutoff difference will not be adhered to. There is then no guarantee that the axis will enter the target correctly (without external errors).

  If the actual position is after the cutoff point following one of these functions, this target can no longer be approached and the drive is switched off. The changeover point then becomes the current actual position and the cutoff point and a fictitious target with target range and zero speed range are recalculated accordingly. The "old" target can no longer be reached without a change of direction and is overshot. The axis status changes to "interrupted". As long as the distance between the actual position and the target is greater than the cutoff difference + the adaption value, you can then approach the target with CONT and a change of direction. Otherwise, you cannot approach it with CONT and the axis changes to the "completed" status.

Cam controller

- Special features in the case of a cam controller
  If the axis has already been synchronized, interrupt-initiating cam edges and switch-on edges of time cams skipped by the coordinate shift are switched. A prerequisite is that the track also actually takes effect in the current direction of travel and that the axis is outside the hysteresis. If the axis isinside the hysteresis, switching will not be initiated until it exits the hysteresis.

If interrupt-initiating cam edges and switch-on edges of time cams are skipped at zero speed (no actual value change at the time of executing the function), the response depends on the last direction of travel of the axis. If the last direction of travel was the same as the direction in which the cams are to be switched, the skipped edges will be switched provided the axis is outside the hysteresis.

6.5.1 Setting the Actual Value

Set actual value	
Axis function	Positioning Cam controller
Commands for execution	ON
Parameters	Actual value coordinate Execution: Immediately Event-dependent Position-dependent Comparison value (in the case of position-dependent execution)

In executing the function, the IP 288 assigns the specified coordinate to the current actual position. In the case of a linear axis, this coordinate must be within or on the traversing range limits. In the case of a rotary axis, this coordinate must be within the traversing range limits or on the start of the traversing range. In addition, the specified coordinate in the positioning axis function must be within the parameterized working range ± the zero speed range in the case of a linear axis.

The actual value in the case of a rotary axis is always changed "by the shortest path". A coordinate system is then established for the axis and the axis is synchronized. The traversing range limits and the software switch remain unchanged but shift physically on the axis.

You cannot use the "Set actual value" function if you have already set the "Trigger reference point" function (see Section 6.5.11).

If an actual value is set with a value ≠ 0, rounding errors can result in another value than the one specified being signalled to COM 288 or the PLC.

In the case of the actual value coordinate, you must take into account whether or not you have activated a coordinate offset. The coordinate must at any rate by within the currently valid traversing range.

Event-dependent or position-dependent execution of the function is also possible in the "running" or "interrupted" axis status.

Immediate or event-dependent actual value setting can also be executed when the axis is not synchronized. However, position-dependent actual value setting can only be executed if the axis is synchronized.

Event-dependent or position-dependent actual value settings can be deleted before execution of the function with the "Delete memory" function, otherwise, the function is completed after its execution.

Please note the special features shared by the "Set actual value", "Zero offset", "Set zero point" and "Cam track offset" functions.

6.5.2 Zero Offset

Zero offset	
Axis function	Positioning Cam controller
Commands for execution	ON
Parameters	Value of the offset Execution: Immediately Event-dependent Position-dependent Direction: Forward Reverse Comparison value (in the case of position-dependent execution)

In a zero offset, the limits of the traversing range, the software switch (and so also the working range), the reference point and the actual position are all changed according to the value of the offset. If the zero point of the coordinate system is shifted forward, the individual points of the axis each receive a coordinate reduced by this value. If the zero point of the coordinate system is shifted in the reverse direction, the individual points of the axis each receive a coordinate increased by this value.

When a zero offset is executed, an already existing coordinate system offset (either by zero point offset or by zero point setting) is revoked and the new offset is executed. All coordinates are updated accordingly. The traversing range remains physically at the same position. The cams and targets retain their coordinates and so shift physically on the axis. All coordinates must still be within the maximum traversing range after the offset.

Event-dependent or position-dependent execution of the function is also possible in the "running" or "interrupted" axis status. Immediate or event-dependent zero offset can also be executed when the axis is not synchronized. However, position-dependent zero offset can only be executed if the axis is synchronized.

The zero point coordinate is retained at cold restart of the module in a battery-backed PLC.

Event-dependent or position-dependent zero offset can be deleted before execution of the function with the "Delete memory" function, otherwise, the function is completed after its execution.

Zero offset in the case of cam controllers

Cams which are shifted out of the traversing range by a zero offset on a linear axis are no longer switched unless they are shifted back into the traversing range by a dynamic offset or a track offset. In the case of a rotary axis, cams must not be shifted out of the traversing range by a zero offset, i.e. after the offset, all cam edges must be within the new traversing range limits.

A zero offset remains in force after a module restart with machine data (in a battery-backed PLC) and after a new synchronization.

A zero offset can be reset by a zero offset with "0" (forward or reverse).

Please note the special features shared by the "Set actual value", "Zero offset", "Set zero point" and "Cam track offset" functions.

6.5.3 Setting the Zero Point

Set zero point	
Axis function	Positioning Cam controller
Commands for execution	ON
Parameters	Coordinate of the zero point Execution: Immediately Event-dependent Position-dependent Comparison value (in the case of position-dependent execution)

When a zero point is set, an already existing coordinate system offset is revoked and the specified coordinate is accepted. This function is executed internally like a zero offset by the difference between the current actual position and the specified zero point coordinate. Thus, the same rules apply for this function as for a zero offset.

If a zero point is set with a value $\neq 0$, rounding errors can result in a different value to the one specified being signalled to COM 288 or to the PLC.

The zero point coordinate is retained at cold restart of the module in a battery-backed PLC.

Event-dependent or position-dependent execution of the function is also possible in the "running" or "interrupted" axis statuses.

Immediate or event-dependent zero point setting can also be executed when the axis is not synchronized. However, position-dependent zero point setting can only be executed if the axis is synchronized.

A zero point setting can be reset by a zero offset with "0" (forward or reverse).

Please note the special features shared by the "Set actual value", "Zero offset", "Set zero point" and "Cam track offset" functions.

Fig. 6.3 below shows the differences between the three functions described above.

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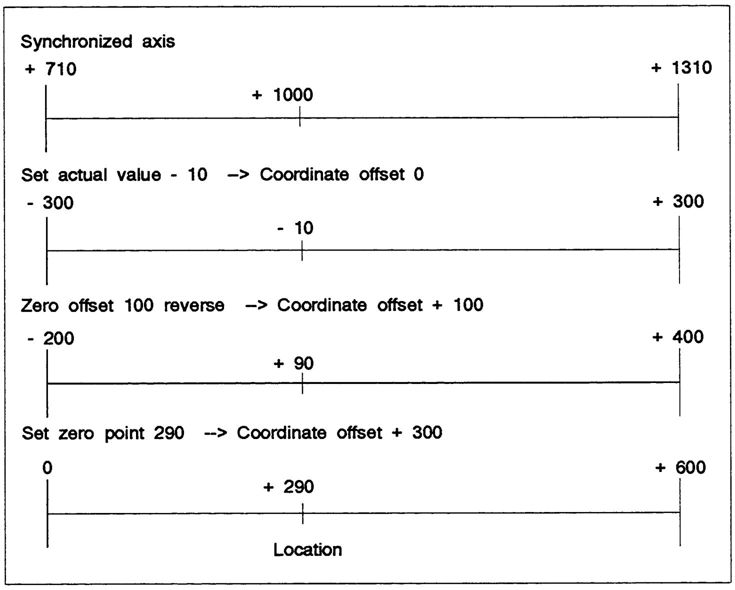

Fig. 6.3 Comparison of the Set actual value, Zero offset and Set zero point

Setting the actual value

The specified actual value determines the position of the traversing range limits from the machine data of the axis. In order that these agree with the (physical) reality of the axis,the axis must be at the "correct" point when the actual value is set, i.e. the point which is to correspond to the actual value specified.

Zero offset

A zero offset with a negative value increases the value of all coordinates on the axis, an vice versa. The traversing range limits remain physically at the same position.

Example:
A reverse zero offset of 100 actual position -10 increases the value of all coordinates by 100 (coordinate offset: +100). The new actual position in 90, the new start of the traversing range is -200, the new end of the traversing range is +400. The axis has not moved and the traversing range limits remain at the same position.

Setting the zero point

Setting the zero point shifts the value of all coordinates on the axis by the value x:
x = specified zero point - (actual position - active offset)
x = 290 - (90 - (+100)) = 300
The traversing range limits remain at the same position, as does the axis.

Example:
Setting the zero point with 290 shifts the value of all coordinates by 290 - (90 - 100). The new actual value is 290, the new start of the traversing range is 0 and the new end of the traversing range is 600. The physical position of the traversing range limits has not changed.

6.5.4 Adaption

Adaption	
Axis function	Positioning
Commands for execution	ON, OFF
Parameters	Adaption factor 1% to 100% in steps of 1%

With this function, you give the IP 288 a factor with which it can adapt the changeover and cutoff differences in the positioning axis function.

This adaption is executed in the case of increment mode with target and target set processing as follows:

- Once, if the drive enters the zero speed range after the parameterized monitoring time (≠ 0) has run out
- Cyclically, if the drive exits the zero speed range without a new traverse having been started.

In the case of a synchronized linear axis and traversing without a target, the last reached point is taken as the target and this point is adapted.

Adaption value

The IP 288 calculates an adaption value according to the following formula:

New adaption value = old adaption + (distance to go * adaption factor / 100)

Adaption is not carried out within the zero speed range.

In the case of long target sets, the IP 288 enters the adaption value with the correct sign in the relevant target set. With short target sets and incremental mode, the adaption values are changed in the machine data.

Terminating the adaption

After you terminate the adaption, a stored adaption value continues to be used in the machine data or in the long data sets. Positioning is performed with the original changeover and cutoff differences only when the adaption values in the machine data or in the relevant target set have been set to zero.

If the zero speed range is exceeded as a result of too low a changeover or cutoff difference, adaption is carried out cyclically until a new traverse is started. However, the correct adaption value will not be calculated until zero speed.

If the axis is moved externally, e.g. manually, while the adaption function is active, this will corrupt the adaption value.

Adaption is deactivated after a module restart or after deletion of the machine data.

The adaption values flagged (in block 2 of DB-IP) remain until the first traverse after module restart or new entry 0 of the machine data. When starting (regardless of the COORD input), the adaption values (from the machine data or the long target sets) valid for this traverse are output and possibly changed if adaption is active.

Limiting the adaption value

The adaption values are limited by the module without error message. The following must apply:

Changeover difference + adaption value < traversing range

Cutoff difference + adaption value > target range

The cutoff point must be outside the target range also after adaption. If you have a large target range, it can happen that the axis fails to reach the zero speed range despite adaption.

6.5.5 Cam Track Offset

Cam track offset	
Axis function	Cam controller
Commands for execution	ON
Parameters	Offset Direction Forward Reverse Track number

This function is only possible for tracks which have been parameterized with a cam set.

When you execute this function, the current offset of the specified track is revoked and the new offset is taken over. You must specify the offset as a positive value.

In the case of a rotary axis, all cams must still be within the traversing range after a cam track has been offset. The offset must be less than one revolution of the axis.

All cams of the track are offset by the specified path segment. The actual position and the traversing range limits remain unchanged. Cams which are shifted out of the traversing range during a cam track offset on a linear axis, will not be tripped again unless they are shifted back into the traversing range by dynamic offset.

A track offset remains in force after module restart with machine data (in a battery-backed PLC) and after a new synchronization.

You can reset a cam track offset by an offset with "0" (forward or reverse).

In the COM 288 Actual Value Display, a "*" appears after the cam ID bits for offset cam tracks.

Please note the special features shared by the "Set actual value", "Zero offset", "Set zero point" and "Cam track offset" functions.

6.5.6 Loading the Revolution Comparator

Load revolution comparator	
Axis function	Positioning Cam controller
Commands for execution	CHANGE
Parameters	Revolution comparison value (1 to 2^{15} -1) Reset revolution comparator

Revolution comparator

This function takes over the specified revolution comparison value and loads it into the revolution comparator. The revolution comparator only exists in rotary axes. It compares the revolution specification with the count value of the revolution counter. If the current number of revolutions is equal to or greater than the comparison value, it trips and sets a condition code bit in the axis status word (bit 13 in DW 85/DW 117/DW 149 in the DB-IP). The revolution comparator can be reloaded in any axis status. The old value is overwritten during loading and the condition code bit is reset. After module restart and after deletion of the machine data, the revolution comparator is active and the revolution counter is deleted.

A coordinate offset resulting from zero point setting or zero offset does not change the value of the revolution counter.

The effect of the revolution comparator differs between the two axis functions.

Cam controller

Effect with a cam controller:

- The revolution counter is incremented
  if a traversing range limit is exceeded
- The revolution counter is deleted
  every time the direction is changed (within a hysteresis also)
  every time the revolution counter is loaded with the "reset revolution counter" parameter
  if the direction seems to change as a result of actual value setting, zero point setting or zero offset, i.e. the offset is greater than the path traversed in this IP 288 cycle.

Positioning

Effect with positioning:

- The revolution counter is incremented
  if the actual position exceeds the starting point of the traverse
- The revolution counter is deleted:
  at the start of a traverse
- The revolution counter is frozen and stops counting:
  every time the direction is changed
  every time the axis status changes to "completed" or "interrupted"

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If the axis is turned manually in the "completed" or "interrupted" status, this path segment is ignored for the purposes of the revolution count. If you parameterized it in the machine data, a process interrupt can be triggered when the revolution comparator trips.

6.5.7 Loading the Actual Position Comparator

Load actual position comparator	
Axis function	Positioning Cam controller
Commands for execution	CHANGE
Parameters	Comparison value

In every axis status, this function accepts the comparison value specified and load it into the actual position comparator. The comparator only works with synchronized axes as soon as it is loaded with a comparison value. It compares the specified comparison value with the current actual position and trips if both values are equal. The actual position comparator operates on the same principle as the comparator for position-dependent functions/parameter changes (see Section 6.1).

The following can be specified as comparison value in the case of linear axes:

- Software switch (working range) as maximum in the positioning function
- The traversing range limits as maximum in the cam controller function.

In the case of a rotary axis in both axis functions, the traversing range limits without the end of the traversing are the maximum that can be specified.

The relevant condition code bit in the "Axis status" data word (bit 12 in DW 85/DW 117/DW 149 in the DB-IP) is set if the actual position comparator has tripped. The condition code bit in the axis status word is reset when a new comparison value is transferred. The actual position comparator can be loaded with a comparison in any axis status.

6.5.8 Teach-In (for Positioning)

Teach-In (for positioning)	
Axis function	Positioning
Commands for execution	ON, OFF, EXEC
Parameters	Number of the target set Speed identifier Changeover difference and cutoff difference

If you switch this function on, it remains active with latching until switched off (with OFF). You can switch Teach-In on or off in the "completed" or "interrupted" statuses. You can generate up to 37 complete target sets in Teach-In before terminating the function. Press EXEC at zero speed to store the current actual position as a target coordinate in a target set. In doing so, you must always specify the following as parameters:

- the target set number
- the speed identifier.

Long target sets

In the case of long target sets, you must also specify the following:

- Forward changeover difference
- Forward cutoff difference
- Reverse changeover difference
- Reverse cutoff difference

The adaption values are set to zero. Module number, axis number, axis type and measuring system (cf. machine data) are entered in the block. Press TEACH to create a target set for this axis with the specified number and to enter the specified parameters. If the target set already exists on the axis, an operator error is set and the newly created target set is not accepted.
The generated target set is checked. If it is free of errors, it is stored in the memory. Teach-In remains switched on.

Target set processing mode is illegal when Teach-In is switched on. Teach-In is switched off as default after module restart.

After you have switched Teach-In off, all the target sets created in Teach-In are interpreted. While this is happening, the data interface is busy. The new target sets only become available when this interpretation has been completed and the data interface is free again. Only after this can you switch Teach-In back on.

6.5.9 Teach-In (for a Cam Controller)

Teach-In (for a cam controller)	
Axis function	Cam controller
Commands for execution	ON, OFF, EXEC
Parameters	Number of the cam set Track number Cam number On or off edge

When switched on, this function remains active and latched, all tracks of the axis are switched off, until the function is switched off again (with OFF). You can generate or change up to 16 cam sets in Teach-In mode. When Teach-In is on, you can store the current actual position as a cam edge in a cam set by pressing TEACH. In order to assign an unambiguous actual value to the switching edge, you should only do this at zero speed. In doing so, you must specify the following as parameters:

- the cam set number
- the track number
- the cam number
- on edge (= 1) or off edge (= 0)

Press TEACH to check whether a cam set already exists on the axis for this track. If this is not the case, a cam set is created with the number specified. If a cam set already exists for this track but is stored on the module with another number, an operator error is set.

An operator error is also set in the following cases:

- if the track has already been parameterized with a cam set of a different number
- if the specified cam set number already exists on another track.

If the number is the same, the existing cam set will be changed. Cams can be displaced and inserted.

The module number, axis number, set axis type and set measuring system are entered in the cam set. The generated cams are effective in both directions.

The generated or changed cam sets are checked and incomplete cams, i.e. individual switching edges, are deleted.

Teach-In mode is switched off as default after module restart and deletion of the machine data. Dynamic cams, interrupt initiating cams and time cams cannot be generated in Teach-In.

If an operator error occurs at a cam edge in the case of EXEC (Teach), you must correct this error before switching Teach-In off. Otherwise, the cam will be deleted when you switch off.

Example:
Error: "End of cam before start of cam":
First, define new target

After you have switched Teach-In off, all cam sets created in Teach-In are interpreted and the data interface is busy. The new or changed cam sets then only become available when this interpretation has been completed and the data interface is free again. Only then can you switch Teach-In back on.

6.5.10 Simulation

Simulation	
Axis function	Positioning Cam controller
Commands for execution	ON, OFF
Parameters	Direction Forward Reverse Speed Rapid traverse Creep speed

You can switch on this function in all statuses with cam controllers but only in the "completed" or "interrupted" status with positioning. If you switch on a simulation in the "interrupted" axis status, the axis changes to "completed".
External errors are deleted when simulation is switched on.

The external errors
- Short-circuit 24-volt encoder supply
- Short-circuit 5-volt encoder supply
- Defective encoder signal cable
- Encoder signal error or frame error
- Zero mark error/illegal encoder value

are not detected during a simulation.

Instead of being captured, the actual position is simulated according to the specified speed(s):

Unit: (Measuring system/min)
Format: 4 Byte
Value range: 1 * BRES/min bis 45 000 000 * BRES/min
Max. value: 450 000 000 µm/min

In the case of a rotary axis, the module limits the speed to

$$\frac{Traversing\ range}{2*8ms} = (\text{end of trav. range - start of trav. range})* \frac{3750}{\text{min}}$$

If one of the specified simulation speeds is less than 1 incr./8 ms (see Section 5.2 "Resolution"), the actual position will not be changed by more than 1 incr./8 ms in every IP 288 cycle. The axis remains at zero speed but a speed of $\neq 0$ is flagged.

The limit values of the maximum speed (see Section 3.1.3) also apply in simulation mode. They are not monitored for the maximum value, with the exception of the speed specification.

Simulation is switched off after module restart, after an external error occurs and after deletion of the machine data.

Simulation in the case of positioning

In the positioning axis function, you can only switch simulation on if the drive disable is active (digital outputs switched off). The coordination input (DI 3) is not evaluated in simulation mode.

The direction specification is not taken into account.

When positioning is switched on, you can simulate traverses in the following modes:

- Jog
- Absolute and relative increment mode
- Target set processing

You can execute parameter changes as described in Section 6.4. You can execute the following functions during simulation and so influence the course of a traverse:

- Zero offset and zero point setting
- Programmer mode
- Drive disable

You can revoke the drive disable during a simulation. All outputs of the axis are then switched on and respond in the same way as they would for a "real" traverse. When you terminate the simulation, the current status of the drive disable remains unchanged.

Switching simulation on

Proceed as follows to switch on simulation for positioning:

1	Connect the 24 V load voltage.
2	Parameterize the axis – If the monitoring time = 0, target entry and actual position are not monitored.
3	Synchronize the axis (see Section 6.2).
4	Switch the drive disable on.
5	Switch simulation on.

Simulation in the case of cam controllers

Instead of the simulation speed rapid traverse, the speed with which the actual position is simulated in the direction specified is transferred. The simulation speed creep speed is not relevant.

Cams are switched according to the enabled tracks (see Section 6.5.11).

The simulation runs until terminated with OFF or until an external error occurs. After simulation, all tracks are switched off.

Terminating simulation

If a simulation is terminated, the following applies:

- For incremental encoders:
  the actual position is the reference point and the axis is no longer synchronized.
- For SSI encoders:
  the actual position is recalculated from the encoder status and the reference point and the axis remains synchronized.

6.5.11 Individual Functions

For executing the following individual functions

- Programmer mode
- Trigger reference point
- Follow-up drive disable
- Rounding
- Cam track enable

there is one coherent four-byte data area per axis (control signals, DW 187, DW 188/DW 193, DW 194/DW 199, DW 299) in the DB-IP (see Chapter 8). The function is active if the relevant bit in this data area is set and the function is not active if the bit is deleted.

Programmer mode

Programmer mode	
Axis function	Positioning Cam controller
Bit for the function	0 in DW 188/DW 194/DW 200
Parameters	-

You can only change this function from the PLC. Regardless of the axis status, setting and transferring bit 0 of the individual functions causes the axis concerned to change immediately to programmer mode. In the case of positioning, any running mode will be interrupted and the drive will be switched off. No further response ensues in the case of a cam controller. A function still waiting to be processed (event-dependent or position-dependent) remains in force, as does a parameter change. When the bit is reset, the axis concerned switches back to PLC mode.

After module restart, programmer mode is set until the user program switches to PLC mode.

If an axis is in programmer mode, you can still read data sets and actual values via the PLC interface and switch programmer mode off. The "PG" LED lights up if at least one axis is in programmer mode.

Trigger reference point

Trigger reference point	
Axis function	Positioning Cam controller
Bit for the function	1 in DW 188/DW 194/DW 200
Parameters	-

You can only execute this function in the case of incremental encoders with zero mark. Setting and transferring bit 1 of the individual functions activates the "Trigger reference point" function which then remains active until the bit is reset. Trigger Reference Point is deactivated if there is no machine data and after module restart. The bit can be changed in any axis status but a change is only executed in the axis status "completed" or "interrupted".

The axis is synchronized at each first rising edge of the zero mark after the reduction switch in the direction of the zero mark position. In doing so, the coordinate of the reference point is assigned to the current actual position at the rising edge of the zero mark and taking account of any active coordinate offset.

If, during this process, one or more cam edges or switching points are skipped, the IP 288 responds as described under the heading "Special features common to certain functions" (see Section 6.5).

The coordinates of the traversing range limits remain unchanged. The cam values and targets retain their coordinates and so shift physically on the axis.

If a position-dependent or event-dependent actual value function has already been initiated but not yet executed, the Trigger Reference Point function is not possible.

Drive disable

Drive disable	
Axis function	Positioning
Bit for the function	2 in DW 188/DW 194/DW 200
Parameters	-

If you set bit 2 of the individual functions, the drive disable is switched on and latched and all digital outputs of this axis are switched off.

After this, no operating modes are possible and only the programmer mode function and the simulation function can be executed; this applies until you reset the bit and so switch the drive disable off again. The outputs are then enabled again. You can change the bit in any axis status and the change will take effect immediately.

Drive disable is not active without machine data and after module restart.

Note
You can use drive disable to force the end of a traverse. This can become necessary if the axis fails to enter the zero speed range because the target entry monitor has been switched off or because the monitoring time is very long. A traverse started at rapid traverse can only be aborted with "drive disable ON" if the distance to go is less than the changeover difference (the drive already decelerates). If you force the end of a traverse, adaption is not carried out.

Follow-up

Follow-up	
Axis function	Positioning
Bit for the function	3 in DW 188/DW 194/DW 200
Parameters	-

If you set bit 3 of the individual functions, zero speed monitoring will be deactivated on the relevant axis.

After this, no operating modes are possible and only the programmer mode function, drive disable function and simulation function can be executed. this applies until you reset the bit and so switch follow-up off again. Zero speed monitoring of the affected axis is then activated again.

If the zero speed range has been exited with follow-up switched off and adaption switched on. If follow-up is then switched on, adaption continues.

Follow-up is not active without machine data and after module restart (zero speed monitoring active).

Rounding

Rounding	
Axis function	
Bit for the function	6,7 in DW 188/DW 194/DW 200
Parameters	-

If you set bit 6 or bit 7 in the individual functions, rounding is activated in the axis status "completed" or "interrupted". The two bits identify the direction of the positive mechanical coupling (the direction in which the target is approached). If you set bit 6 (bit 7 reset), this means there is positive mechanical coupling in the forward direction, and if you set bit 7 (bit 6 reset), this means there is positive mechanical coupling in the reverse direction. If both bits are set, an operator error is signalled.

When rounding is switched on, every target is approached in the positive mechanical coupling direction specified. If the target is in the opposite direction, rounding is executed, i.e. the target point is first overshot and then approached in the direction specified. You can parameterize the type of direction change, hard or soft, in the machine data. Fig. 6.4 shows a rounding example in the case of "soft" reversal.

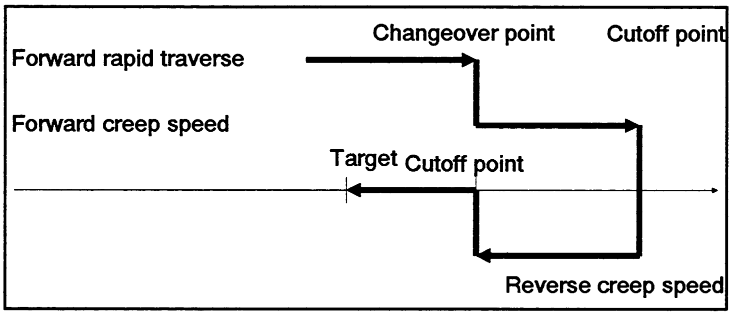

Fig. 6.4 Rounding example

Provided the axis does not lose the positive mechanical coupling at zero speed, you can compensate for an unknown backlash with rounding. For this purpose, the axis must overshoot the target by at least the amount of the backlash. S that the axis enters the target properly in rounding, you must have parameterized the changeover difference and the cutoff difference accordingly. The module determines the position of the direction change autonomously from the changeover and cutoff differences, taking account of the available adaption values. If adaption is on, only the differences in the positive mechanical coupling direction are adapted. The actual position flagged always agrees with the actual position in the case of rounding in the target. During a traverse in the opposite direction to that specified, the actual position flagged is wrong by the actual backlash.

If both bits are reset, rounding is deactivated. The actual position remains unchanged when activating or deactivating rounding.

Rounding is deactivated without machine data and after module restart. An active rounding funciton remains active even if the positive mechanical coupling is lost.

A target can only be approached in rounding if the distance between the target and the relevant software switch is at least equal to

changeover difference in positive mechanical coupling direction (incl. adaption value) + cutoff difference in direction of travel (incl. adaption value) + zero speed range.

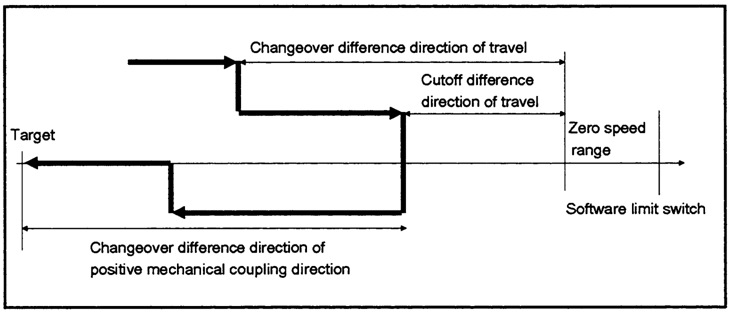

Fig. 6.5 Rounding (marginal conditions)

6

Rounding with a "hard" reversal is only possible if the distance between the target and the relevant software switch is at least equal to

changeover difference in positive mechanical coupling direction (incl. adaption value) + changeover difference in direction of travel (incl. adaption value) + zero speed range.

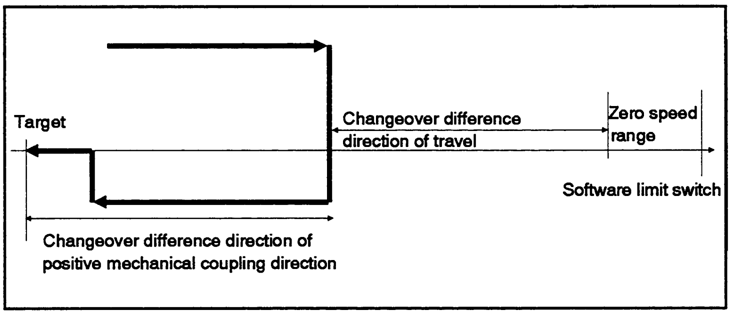

Fig. 6.6 Rounding (marginal conditions)

You must ensure that during the entire traverse, it is possible for the axis to stop without overshooting a software switch, even in cases where an external error occurs shortly before the point of a "hard" reversal. It must still be possible to traverse the changeover difference in the direction of travel starting from this reversal point without reaching a software switch.

Cam track enable

Cam track enable	
Axis function	Cam controller
Bits for the function	8 to 15 in DW 188/DW 194/DW 200 0 to 7 in DW 187/DW 193/DW 199
Parameters	-

You can enable and disable tracks individually with this function.

The bits are assigned to tracks 1 to 16 and fixed as follows:

- Bit 8 = track 1,
- Bit 9 = track 2,
- Bit 10 = track 3, etc.

If you set one or more of these bits, the relevant tracks are enabled. If you reset the bits, the tracks are disabled again regardless of whether or not the tracks are parameterized. Enabled tracks are active immediately after parameterization.

All tracks are disabled without machine data and after module restart (basic function). All tracks are disabled if an external error occurs.

Cam tracks which are not enabled, are indicated in the COM 288 Actual Value Display with "-".

6.5.12 Functions with Control Bits

For executing the following individual functions, there is a coherent two-byte data area (control bits, DW 186, DW 192/DW 198) in the DB-IP (see Chapter 8). The function is executed if the relevant bit in this data area is set.

Delete memory

Delete memory	
Axis function	Positioning Cam controller
Bits for the function	10 in DW 186/DW 192/DW 198
Parameters	-

You can execute this function in every axis status. It deletes the memories for position-dependent or event-dependent parameter changes or functions, i.e. parameter changes or functions still pending will no longer be executed.

Acknowledging external errors

Acknowledging external errors	
Axis function	Positioning Cam controller
Bit for the function	11 in DW 186/DW 192/DW 198
Parameters	-

You can execute this function in any axis status. The currently pending external error will be deleted provided the cause has been removed (see Section 9.5.6).

Acknowledging operator errors

Acknowledging operator errors	
Axis function	Positioning Cam controller
Bit für die Einstellung	12 in DW 186/DW 192/DW 198
Parameters	-

You can execute this function in any axis status. The currently pending operator error will be deleted. Each mode or function resets an operator error.

6.5.13 Acknowledging the Watchdog

There is a 12-byte coherent data area in DB-IP for this function, DW 180 to DW 185 (see Chapter 8).

Acknowledging the watchdog	
Axis function	Positioning Cam controller
Bit for the function	0 in DW 180
Parameters	-

A watchdog function with a monoflop with a sampling time of approximately 500 ms has been implemented on the IP 288. After an S5 reset, the monoflop time runs and is then retriggered cyclically provided no error status occurs on the IP 288.

If the monoflop time runs out, a reset pulse is generated and all outputs on the IP 288 are switched off. A restart takes place in the same way as after an S5 reset. Provided no external error has occurred, the system branches to the RUN status and the watchdog timeout is flagged in the module status word in DW 68 "Module status".

If there is a possibility that a one-off fault (e.g. voltage spikes) on the module has led to the monoflop time running out, you can now acknowledge the watchdog and restart program execution on the

IP 288 in the same way as after a cold restart. Otherwise, you cannot execute any mode, function or data transfer.

The watchdog timeout in flagged in the module status word bit 5. Data transfer and the execution of modes and functions are not possible until the watchdog has been acknowledged. You can acknowledge via the programmer interface, despite PLC mode being active. The watchdog can also be acknowledged by an S5 reset with correct restart.

6.5.14 Process Diagnostics

Process diagnostics	
Axis function	Positioning Cam controller
Commands for execution	ON, OFF
Parameters	Specifications for digital outputs

You can only execute this function from the programmer in the "completed" and "interrupted" axis functions. The relevant axis is set in process diagnostics mode and changes to the "completed" status.

All modes and functions are prohibited in process diagnostics mode. The digital outputs of the module are set according to the specifications.

- Bit 0 - specification for digital output 0 of the axis
- Bit 1 - specification for digital output 1 of the axis
- Bit 2 - specification for digital output 2 of the axis
- Bit 3 - specification for digital output 3 of the axis

The status of the digital inputs and the current encoder status are updated cyclically at the interfaces. The 16-bit counter status and the 16-bit zero mark value is indicated for incremental encoders and the binary 32-bit encoder status (not in Gray code) is indicated for SSI encoders.

In the encoder status word, the least significant bit (LSB) is on the right, and the most significant bit (MSB) is on the left.

In the digital inputs/outputs, the status of DQ/DI 1 is on the right.

If you switch this function off, process diagnostics mode is terminated.

6.5.15 Triggering the Diagnostics Memory

Trigger diagnostics memory	
Axis function	Positioning Cam controller
Commands for execution	
Parameters	Event type Number of entries after the event Event parameter

You can execute this function from the programmer in the axis status "completed" or "interrupted".

Diagnostics memory

A diagnostics memory exists for each axis. The diagnostics memory is a ring memory with four entries. An entry contains an axis operation (mode, function, data set entry and data set deletion), the response of the axis to the operation (error) and the different statuses and actual values at the point when the operation is transferred to the module. The operation and the individual actual values and statuses are entered in the diagnostics memory before being interpreted. BCD specifications are first converted to binary. When the fourth entry has been made, the next operation becomes the first entry (ring buffer).

6

In the diagnostics memory, the least significant bit (LSB) is on the right of all bit-coded values. See Chapter 8 for the assignments of the bit-coded values.

The following are not entered in the diagnostics memory: actual value readings, data set readings, watchdog acknowledgement and operations not executed as a result of transfer errors.

Freezing the diagnostics memory

With the "Trigger diagnostics memory" function, you can define the event that causes the diagnostics memory to be frozen and you can stipulate that the memory is to be frozen a certain number of entries after the event occurs. The entries in the diagnostics memory will then be protected from overwriting. This status (diagnostics memory frozen) is provided for COM 288.

A new entry will only be made when the diagnostics memory has been triggered again.

Parameterization Software 7

Contents of Chapter 7

Parameterization Software

7

COM 288 offers you a user interface with which you can parameterize the IP 288, and generate and manage data sets (DSs) more easily. In addition, COM 288 makes it possible to test the connected axis.

COM 288 has a Help function. Press the <HELP> key to view a Help text on your current input.

7.1 How Do You Operate COM 288?

The following section explains operation of COM 288. If you have already worked with a COM package, you can skip this section.

Menus and screen forms

COM 288 consists of individual menus. Each menu offers one or more screen forms depending on its size. When you work with COM 288, you will use these screen forms to

- Edit values
- Make a suitable selection from a list of defaults
- Receive messages back from the system.

A typical COM 288 screen form has the following structure:

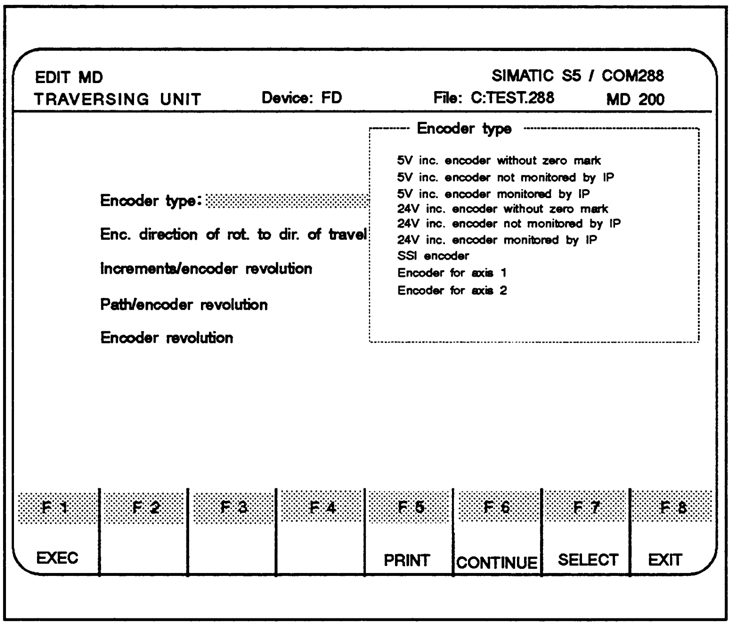

Fig. 7.1 A typical COM 288 screen form

The screen form header contains the name of the menu in upper case letters (TRAVERSING UNIT in this case)

There are shaded editing fields within the screen form. In these fields, you will either change already existing values, enter new values or select values or defaults from a list. To edit a value in an editing field, you must first position the cursor to this field by using the cursor control keys in the numerical keypad of your programmer keyboard. You use other keys to insert characters, delete characters or to confirm the current entries.

Selection list

If you want to select a value from a list, position the cursor on the editing field concerned and press the <F7> function key. If there is a selection list for this input value, the values from the list appear one after the other in the editing field.

Selection window

If more than 3 different defaults are possible, a selection window appears in the screen form. Up to 10 defaults are listed in the window. If the function in question permits more than 10 defaults you can scroll the list within the window with the "↑" and "↓" cursor control keys. A "*" at the top right or bottom right of the selection form indicates the presence of more than 10 possible selections.

Where it is possible to make a selection via a selection list or selection window, you should do so in order to avoid syntax errors (spaces, upper and lower case).

Press <F1> to accept the set values. If this completes a processing step, <F1> automatically takes you to the next higher-level screen form, otherwise it takes you to the next screen form to be processed.

If a menu offers several screen forms, press to change between the different forms.

Press <F8> to abort processing of the current screen form and to return either to the previous screen form or to a higher-level screen form.

Output field

There are output fields within the individual screen forms. These are not marked in any special way. The output fields either contain values you have edited somewhere else or values entered by COM as a response to entries you have made.

You can edit values only in the editing fields.

7.2 How Do You Start?

1	Copy COM 288 to the hard disk of your programmer. First make a backup copy of the COM 288 diskette supplied and work only with this copy.
2	Call STEP 5.
3	Press <F2> – S5-DOS is loaded. The KOMI (Command Interpreter) screen form appears first, followed by the PACKAGE SELECTION form.
4	Select the COM 288 program with the cursor control keys.
5	Press <F1>. – COM 288 is loaded and the CONFIGURATION form appears. This form shows the update of your COM 288.
6	Press <F1> – The DEFAULTS form appears. You can now start to work with COM 288.

If you use STEP 5 Stage 6.x, proceed as follows:

1	Copy COM 288 to the hard disk of your programmer. First make a backup copy of the COM 288 diskette supplied and work only with this copy.
2	Call STEP 5.
3	Select the menu entry **Further** in the **Change** main menu.
4	Use the cursor keys in the selection box to select the path to which you have copied COM 288.
5	Select the package name and confirm the selection with "OK" – COM 288 is loaded and the CONFIGURATION form appears. This form shows the update of COM 288.
6	Press <F1> – The DEFAULTS form appears. You can now start to work with COM 288.

7.3 How Do Find Your Way Around COM 288?

Working with COM 288 involves moving between individual menus. In each menu, you perform parts of your overall task. Which menus you work in depends on your overall task.

First, you will generate different data sets with COM 288. You need not understand the structure and workings of these data sets. Your entries in the individual COM screen forms will be transferred to the correct destinations. You will generate the following data sets:

Table 7.1 The COM 288 data sets

Name	Meaning
SYSID data set	Module parameterization and identification
Machine data set	Parameterization of the axis (axes) specific to the axis function in each case
Target set	Contains targets and the necessary parameters
Target list	Contains several target sets
Cam set	Definitions of the switching points in the case of a cam controller

See Chapter 9 for the structure of the individual data sets.

Use the structure overview below to find your way around COM 288. For enhanced clarity, this overview is divided into three parts:

- Off-line functions
- On-line functions
- On-line functions for positioning

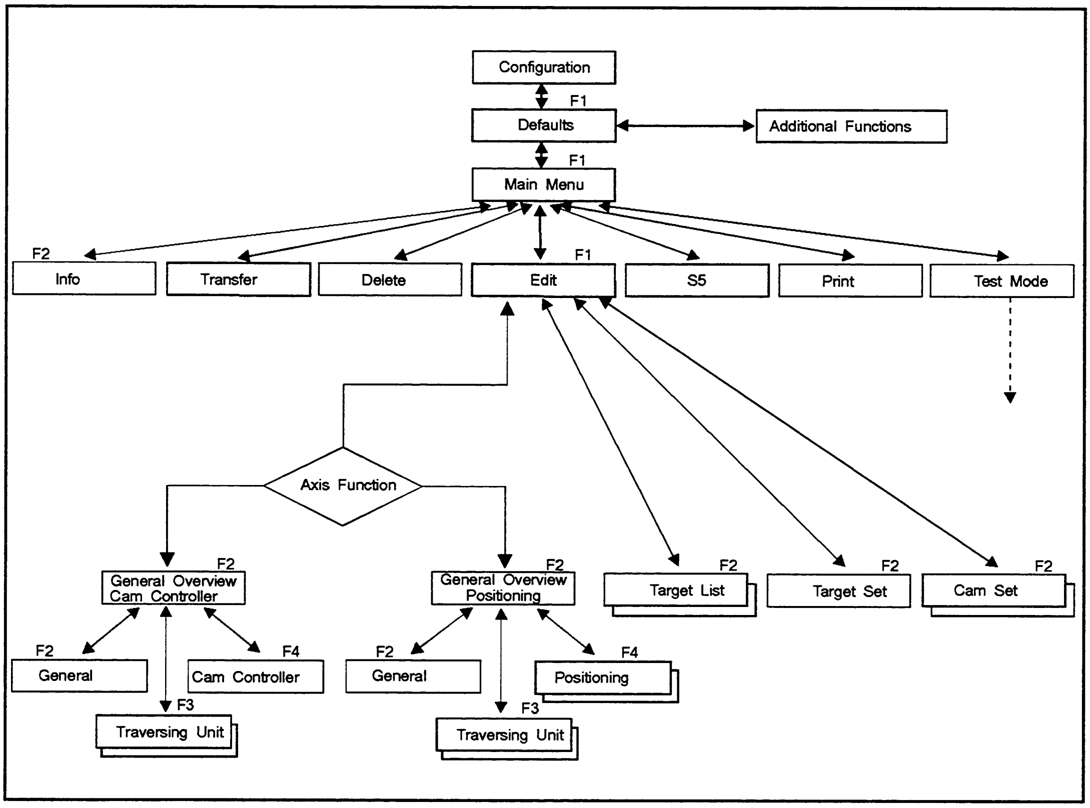

Fig. 7.2 Structure of COM 288 (off-line)

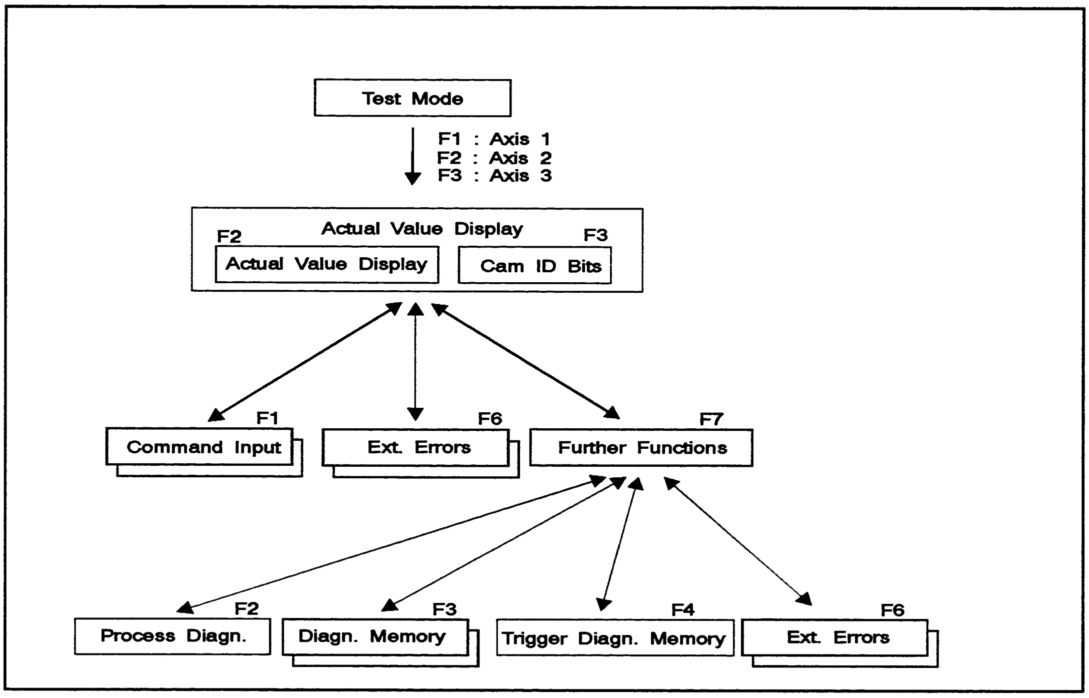

Fig. 7.3 Structure of COM 288 (on-line, cam controller)

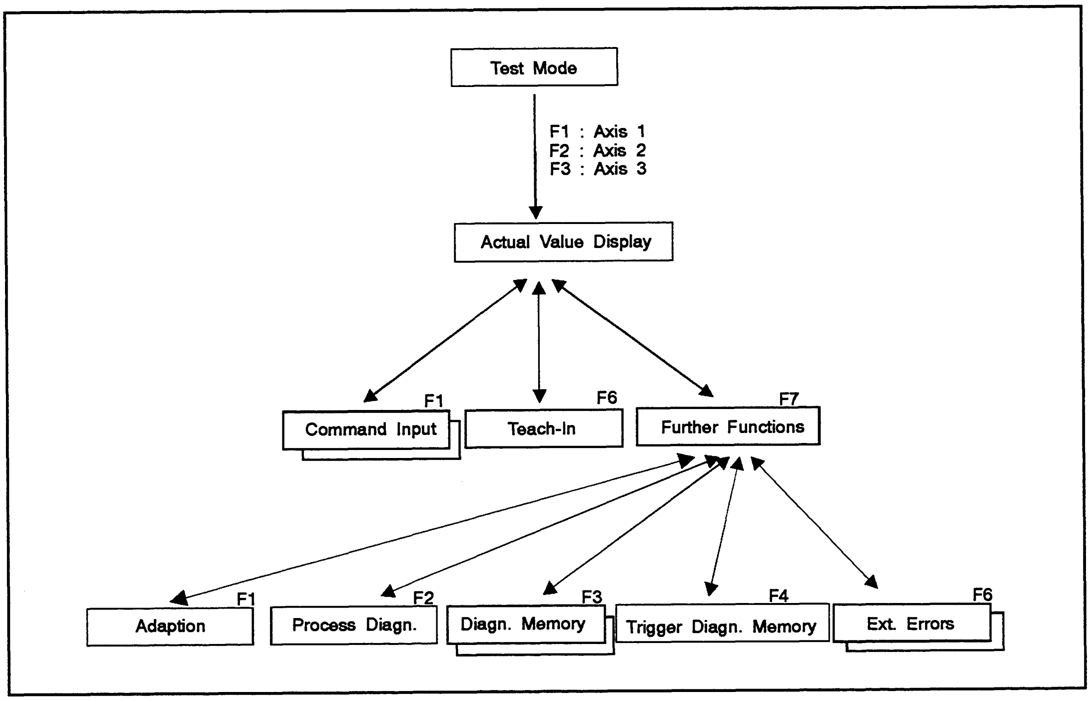

Fig. 7.4 Structure of COM 288 (on-line, positioning)

7.4 Preparing COM 288

Defaults

In the DEFAULTS screen form, you can select the drive and the file in which you want to generate the new data sets or process already existing ones. In addition, you can activate an ON-LINE connection to the module. You can jump to the ADDITIONAL FUNCTIONS menu and select a printer parameterization created there under S5-DOS and/or activate the LAN connection.

1	Position the cursor on the "Drive" editing field and select the desired drive with <F7>.
2	Position the cursor on the "File name" editing field. – If you want to create a new file, enter the new file name in this field. – If you want to process an already existing file, enter the file name or select one with <F7>.
3	Enter a (short) identifier for your plant in the "Plant identifier" field (only in the case of a new file).
4	Enter the name of the person who generated the program in the "Generated by" field (only in the case of a new file).
5	Choose between ON-LINE and OFF-LINE by pressing <F2>: – If you select ON-LINE; COM 288 reads the following data from the module: Module type Firmware version Module number Interrupt line Effect of S5 CPU failure COM 288 enters the current values into the corresponding output fields.

COM takes the date and time of day from the programmer's internal clock. You can change this entry in the DEFAULTS form. This change is transferred to the programmer's internal clock by pressing <F1>.

Additional functions

You can now select a printer file and a footer file in the ADDITIONAL FUNCTIONS menu. You can also select a path file and from this a path name for bus selection. You can also use the files you have already selected on the KOMI level. These are already entered in the form.

If you want to continue with COM immediately, skip the next paragraph.

1	Press <F6> to jump to the ADDITIONAL FUNCTIONS menu. – All the files you enter in this form must already exist, as must the path name. You have previously created these files with the relevant S5-DOS utility.
2	Select a drive and a file in the "Printer file" field.
3	Select a drive and a file in the "Footer file" field.
4	When a footer file has been selected: Select the width of the footer in the "Footer" field.
5	If you are working with a bus: Specify the path file and the path name.
6	Press <F6> to return to the DEFAULTS menu.

7.5 Editing, Transferring and Converting Data Sets

Main menu

From the DEFAULTS form, press <F1> to reach the MAIN MENU. All values entered until now are listed here. The function keys <F1> to <F6> are assigned as follows:

Key	→ Menu	Function
<F1>	EDIT	Edits the machine data, target lists, target sets, cam sets or a SYSID.
<F2>	INFO	If you specify the device and the data set type you will be shown a list of all the relevant existing data sets. If you list the data sets from the FD, the length of the individual data sets will also be displayed. If you read the data sets from the IP, the following information for the data sets will be displayed: • Machine data: Axis number of the data set • Target set: Short or long target set • Target list: Number of target sets contained • Cam set: Number of the parameterized track • SYSID: Length of the data set
<F3>	TEST	If you selected ON-LINE in the defaults form and if you work with the TTY/AS511 interface: Branch to test mode.
<F4>	TRANSFER	Transfers data sets between different devices or files. If an data set error occurs when transferring to the IP 288, you can get more detailed information if you store the data set on the IP 288 from the EDIT menu.
<F5>	DELETE	Deletes a file.
<F6>	S5	Converts a data set generated with COM to the S5 format or from the S5 format to a COM 288 file.
<F7>	PRINT	Prints the data set.

First, jump to the EDIT menu by pressing <F1>.

Key	→ Menu	Function
<F1>	STORE	COM checks the contents of the data set selected. If it finds an error, it positions the cursor in the screen form of the erroneous value and stays there.
<F2>	EDIT	Depending on the selected data set type, it branches to the appropriate screen forms.
<F5>	PRINT	Prints the selected DS type.
<F8>	EXIT	Returns to the main menu.

<F1> Store is only permissible if you are processing an existing data set or if a new data set has been completely filled in.

In the case of the "machine data" data set type, an existing data set will be read in if you leave the "Axis" field with <RETURN>; in the case of all other types (except SYSID), the data set will be read in if you leave the data set number field downward. If the data set does not exist, the subsequent fields in the form are empty.

Editing SYSID

If you want to edit a SYSID data set, set the SYSID data set type in the EDIT menu. The special parameters for this data set will then appear in this screen form. You can edit the following parameters/specifications:

- Data set number
- Module number
- Interrupt line
- Effect of S5 CPU failure

Save the SYSID data set on the selected device with <F1>.

Editing the machine data

First, select the settings for the following parameters:

- Device FD/IP 288
- Data set type (machine data in this case)
- Data set number
- Axis

- Module number
- Measuring system
- Axis function
- Axis type
- Accuracy range
- Basic data set

General overview

Press <F2> to jump to the GENERAL OVERVIEW menu. The axis function, axis type, measuring system, accuracy (range), axis number and basic data set parameters are entered in the screen form. The relevant form shows a schematic overview of the selected axis function.

The functions keys in the GENERAL OVERVIEW menu are assigned as follows:

Key	Menu	Function
<F1>	EXEC	After you have defined or checked the parameters in the menus of the individual functions blocks, <F1> takes you to the EDIT menu in each case.
<F2>	GENERAL	Here you can define the following: Which function-specific conditions are to cause a process interrupt? Is there to be a diagnostics interrupt in the case of an encoder error? In which format is data to be transferred from or to the CPU? Which binary outputs are wired? Is the coordinate input to take effect level-driven or edge-driven?

Key	Menu	Function
<F3>	TRAVERSING UNIT	Define the following parameters: Which type of encoder are you using? Is the encoder rotational direction equal to or not equal to the direction of travel.? How many increments correspond to an encoder revolution? How many revolutions does the SSI encoder resolve? (In the case of incremental encoders this is 1) At which coordinates does the traversing range begin and end? At which coordinate is the reference point? In which direction is the zero mark (in the case of incremental encoders)? Is the ID of the reference coordinate valid or invalid (in the case of SSI encoders)? At which coordinates are the start and end of the software switch (only in the case of positioning on a linear axis)?
<F4>	CAM CONTROLLER: or POSITIONING	Enter the size of the hysteresis or Define the following: How is the drive controlled? Is a change of direction "hard" or "soft" How large are the target range, zero speed range and monitoring time, cutoff difference, changeover difference and adaption value, each in both directions?
<F5>	PRINT	Prints the data sets.
<F8>	EXIT	The system prompts you to confirm that you want to reject the existing data set and then returns to the EDIT menu.

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If you want to check the validity and correctness of the machine data, you can press <F1> in the EDIT menu to return to the main menu where you can branch to test mode by pressing <F3> (see Section 7.6).

If you have stored the data on hard disk, you must first transfer the data sets to the module before you can branch to test mode.

Positioning: generating target sets

If you are working in the axis function "Positioning with rapid traverse/creep speed drives", generate the target sets now.

Set the data set type "Target set" in the EDIT menu and edit the following parameters:

- Device
- Data set type (target set in this case)
- Data set number (target set number in this case)

- Axis
- Module number
- Measuring system
- Axis type

Press <F2> to reach the TARGET SET menu where you specify the following values:

- Target
- Speed identifier
- Forward/reverse changeover difference
- Forward/reverse cutoff difference
- Forward/reverse adaption value

Press <F1> to have the target set checked and to return to the EDIT menu.

Positioning: processing the target list

If you are working in the axis function "Positioning with rapid traverse/creep speed drives", you can generate or edit a target list. Set "Target list" as the data set type in the EDIT menu and select a target list number. Press <F2> to reach the TARGET LIST menu.

Here you can enter target sets in a new target list or change/add to target sets in an existing target list.

Key	Function
<F1>	Checks the list and returns to the EDIT menu.
<F2>	Scrolls one page up.
<F3>	Scrolls one page down.
<F4>	Inserts a new target set at the cursor position.
<F5>	Accepts the current target set into the list and jumps to the next target set.
<F6>	Prints the target list.
<F5>	Deletes a target set from the target list.
<↑>	Jumps to the previous set.
<↓>	Jumps to the next set.

If you enter long target sets in a target list, enter the forward changeover difference, the forward cutoff difference and the forward adaption direction in the editing field at the top. You enter the corresponding reverse values below in the relevant editing fields.

Cam controller: editing cam sets

If you are working in the cam controller axis function, generate the cam sets now. Set "Cam set" as the data set type in the EDIT menu and select the settings for the following parameters:

- Device
- Data set type (cam set in this case)
- Data set number

- Axis
- Module number
- Measuring system
- Axis type

Press <F2> to reach the CAM SET menu. Define the following values in the two screen forms of this menu:

1st screen form
- Track number
- Direction
- Correction time
- Initiating cam for the first interrupt
- Initiating cam for the second interrupt
- Initiating edge for the first interrupt
- Initiating edge for the second interrupt

Press <F6> to reach the 2nd screen form
- Cam type
- Start of cam
- End of cam or switching time in 8-ms intervals (in the case of a time cam)

Press <F1> to have the cam set checked and to return to the EDIT menu.

Converting data sets

In the S5 menu, you can transfer IP 288 data sets (machine data, target sets, etc.) to an S5 data block and back. You select DB or DX as the S5 data block type.

Menu in the case of file type source = I88

Key	Function
<F1>	If a new data set has been entered in an existing DB/DX, the DB/DX is stored in the selected file.
<F4>	Converts the data set to S5 format in the programmer memory.
<F5>	Displays the new contents of the DB/DX in a window after storing.
<F6>	Prints a list of the data sets contained in the DB/DX.

Menu in the case of file type source = S5D

Key	Function
<F4>	Transfers all IP 288 data sets contained in the selected source DB/DX to the selected I88 file. The data set numbers are taken over.
<F5>	Displays the contents of the selected DB/DX.
<F6>	Prints the data sets in the DB/DX

Structure of the S5 DB/DX thus created:

DW 0 - 3 ID "IP 288 data set" (with space after data set)
DW 4 Number of data sets in the DB/DX
DW 5 Start of the offset table

DW	16	0
0	"D"	"S"
1	" "	"I"
2	"P"	"2"
3	"8"	"8"
4	Number of data sets in the DB/DX	
	Offset	Data set 1
	Offset	Data set 2
	. . . .	
	4 words of job specification	
	Data set 1	
	4 words of job specification	
	Data set 2	
	. . . .	
	4 words of job specification	
	Data set n	

Each data set is preceded by a 4-word job specification which is preassigned as far as possible.

DB type (0 = DB/1 = DX)	DB number (10 - 255)
Job number (data set entry)	DW No. Start DW or the job specification
Data set number	Length of the data set in words
Data set ID in ASCII	

7.6 Operating the IP 288 in Test Mode

If you have edited a set of valid machine data, you can work with COM 288 in test mode. In this mode, you can send commands and instructions to the module and call up displays of current values and statuses of the module.

Press <F4> to leave the MAIN MENU and jump to the TEST MODE menu.

Use the following function keys:

Key	Function
<F1>	Selects axis 1
<F2>	Selects axis 2
<F3>	Selects axis 3

After selecting an axis, COM jumps to the ACTUAL VALUE DISPLAY menu.

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7.6.1 Test Mode for a Cam Controller

For a cam controller, the ACTUAL VALUE DISPLAY consists of two screen forms:

- ACTUAL VALUE DISPLAY
- CAM IDENTIFIER BITS

The function keys are assigned as follows in the two screen forms:

Key	Function
<F1>	Jumps to the COMMAND INPUT menu. From there you can press <F1> to return to the ACTUAL VALUE DISPLAY menu.
<F2>	Jumps to the ACTUAL VALUE DISPLAY screen form
<F3>	Jumps to the CAM IDENTIFIER BITS screen form
<F6>	If "Yes" is displayed in the external error field in the ACTUAL VALUE DISPLAY form, an error has occurred on the process side. Press <F1> to discover in another screen form which error has occurred. Correct the error and acknowledge the error message in this form by pressing <F1>.
<F7>	Jump to the "Further Functions" menu (see below).

The following values appear in the ACTUAL VALUE DISPLAY:

- Axis
- Track ID bits
- Traverse status
- Actual position
- Revolution counter
- Speed
- Measured length
- Coordinate offset
- External error

Information concerning the axis status is displayed in a special window.

- Revolution comparator tripped *)
- Actual position comparator tripped *)
- Teach-In on/off
- Axis synchronized
- Diagnostics memory frozen *)
- Simulation ON
- Trigger reference point active *)
- Position-dependent memory occupied*)
- Event-dependent memory occupied *)

The following settings and values are displayed in the CAM IDENTIFIER BITS form:

- Axis
- Actual position
- External error (yes/no)
- Cam ID bits
- Track ID bits

A * after the cam ID bits in this form indicates that this track has been offset.

*) Only where applicable

Further functions

In each screen form of the ACTUAL VALUE DISPLAY menu, <F7> will take you to the FURTHER FUNCTIONS menu. From there you can jump to further menus in which you can scan various diagnostics aids. Use the following function keys:

Key	Menu	Function
<F2>	PROCESS DIAGNOS.	Here you read out the status of the binary inputs, the current encoder value and the counter value at the zero mark. The encoder value is represented both as the value of an SSI encoder and incremental encoder.
<F3>	DIAGNOS. MEMORY	If a diagnostics memory is frozen, its contents will be displayed in this form. It contains 4 data sets for each axis. Of these, the first is the oldest and the fourth is the newest. If not all data sets are filled with valid data, a message is displayed. Press <F1> to display the next data set and <F2> to display the previous data set. <F3> will take you to a second screen form in which further information on the current instruction is displayed.
<F4>	TRIGGER DIAG.MEM	Here you define the causes which are to lead to freezing of the diagnostics memory. You also define the number of subsequent commands (0 to 3) after which the diagnostics memory is to be frozen.
<F6>	EXT. ERRORS	All pending external errors are marked with "Yes" in the output fields. You can acknowledge the external errors with <F1>.

Processing commands

In test mode, you can operate the module with modes and functions. For this purpose, press <F1> to jump from the ACTUAL VALUE DISPLAY to the COMMANDS menu.

In the relevant screen form, enter the command number or select one with <F7>. The relevant parameters of the operating mode or the function are then displayed in the screen form for you to process. The function keys in the individual forms are assigned with the specific instructions for executing the commands.

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In TEACH-IN, the function keys are assigned as follows:

Key	Function
<F1>	Returns to the ACTUAL VALUES menu.
<F2>	TEACH-IN ON, the editing fields are no longer accessible.
<F3>	Terminates TEACH-IN OFF, Teach-In mode and returns to the Actual Value display. The target set is on the module.
<F6>	PREPARATION. The parameters are captured and <F6> is assigned the TEACH function. After the axis has reached the desired actual position, you can accept this as the edge of a cam with <F6>.

7.6.2 Test Mode for Positioning

The function keys are assigned as follows in the ACTUAL VALUE DISPLAY screen form:

Key	Function
<F1>	Jumps to the COMMAND INPUT menu. From there, press <F1> to return to the ACTUAL VALUE DISPLAY menu.
<F2> - <F5>	Assigned according to the mode set in COMMAND INPUT.
<F6>	Jumps to the TEACH-IN menu.
<F7>	Jumps to the "Further Functions" menu (see below).

The following values are shown in the ACTUAL VALUE DISPLAY menu:

- Axis
- Mode
- Traverse status
- Actual position
- Revolution counter
- Measured length
- Distance to go
- Speed
- Coordination offset
- External error

Information concerning the axis status is displayed in a special window:

- Revolution comparator tripped *)
- Actual position comparator tripped *)
- Teach-In on/off
- Forward/reverse rounding active *)
- Axis synchronized
- Diagnostics memory frozen *)
- Simulation ON
- Trigger reference point active *)
- Drive disable active *)
- Follow-up active *)
- Adaption active *)
- Position-dependent memory occupied *)
- Event-dependent memory occupied *)

Teach-In

In this menu, you can assign the parameters for a target set to the actual position and accept them.

Further functions

Press <F7> in the screen form of the ACTUAL VALUE DISPLAY menu to reach the FURTHER FUNCTIONS menu. From there, you can reach other menus in which you can scan various diagnostics aids. Use the following function keys:

Key	Menu	Function
<F1>	ADAPTION	Here you define the size of the adaption factor and the current forward and reverse adaption values. The actual position and distance to go at the time of exiting the ACTUAL VALUE DISPLAY menu are displayed.
<F2>	PROCESS DIAGNOS.	Here you can read the status of the binary inputs, the current encoder value and the counter value at the zero mark. The encoder value is represented both as the value of an SSI encoder and incremental encoder.
<F3>	DIAGNOS. MEMORY	If a diagnostics memory is frozen, its contents will be displayed in this form. It contains 4 data sets for each axis. Of these, the first is the oldest and the fourth is the newest. If not all data sets are filled with valid data, a message is displayed. Press <F3> to display the next data set and <F3> to display the previous data set. <F3> will take you to a second screen form in which further information on the current instruction is displayed.

*) Only where applicable

Key	Menu	Function
<F4>	TRIGGER DIAG.MEM	Here you define the causes which are to lead to freezing of the diagnostics memory. You also define the number of subsequent commands (0 to 3) after which the diagnostics memory is to be frozen.
<F6>	EXT. ERRORS	All pending external errors are marked with "Yes" in the output fields. You can acknowledge the external errors with <F1>.

Processing commands

In test mode, you can transfer operating modes and functions to the module. For this purpose, press <F1> to jump from the ACTUAL VALUE DISPLAY to the COMMANDS menu.

In the relevant screen form, enter the command number or select one with <F7>. The relevant parameters of the operating mode or the function are then displayed in the screen form for you to process. The function keys in the individual forms are assigned with the specific instructions for executing the commands.

How Do You Link the IP 288 into Your User Program?

8

Contents of Chapter 8

How Do You Link the IP 288 into Your User Program?

8

In order to be able to use the functions of the IP 288 while your plant is in operation, call one or more of the following standard function blocks in the user program:

	Name	Function
FB ZYK	IPK:ZYK	Synchronize the module Control the axis Read actual values
FB PAR	IPK:PAR	Synchronize the module Write data sets Read data sets Delete data sets
FB INT	IPK:INT	Acknowledge and interrupt Read the interrupt cause from the module

Programming examples

Each of the programmable controllers listed below has its own set of function blocks and a corresponding programming example.

- S5-115U (CPU 941B to CPU 944B)
- S5-135U (CPU 922, Revision level ≥ 9)
- S5-135U (CPU 928-3UA12 and CPU 928-3UB11)
- S5-155U (CPU 946/947)

The function blocks with programming example are stored on the diskettes supplied in the following files:

- S5-115U — S5TC50ST.S5D
- S5-135U (CPU 922) — S5TC22ST.S5D
- S5-135U (CPU 928, CPU 928B) — S5TC23ST.S5D
- S5-155U — S5TC60ST.S5D

8.1 Data Structure of the IP 288 - CPU Link

Below is an overview of the individual data blocks used by the FBs. See Sections 8.3.1 to 8.3.4 for the assignments of these data blocks.

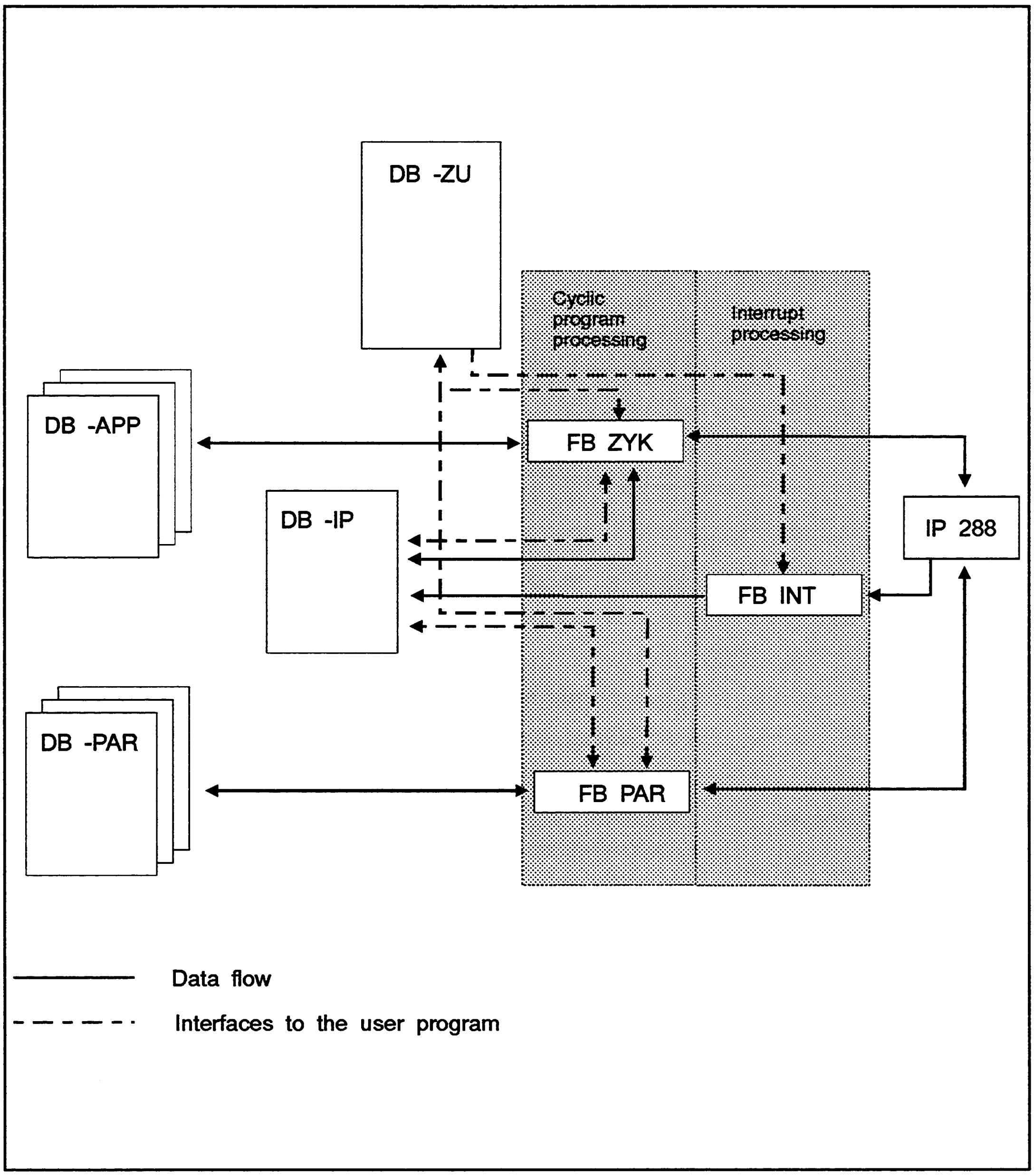

Fig. 8.1 Data structure of the link between the IP 288 and the CPU

DB-ZU data block

You must set up the DB-ZU data block at least once in the CPU memory. It contains the following information:

- List of all the IP 288s addressed by this CPU
- Revision level of the IP 288
- Current error message
- Job status of FB ZYK processing

Each DB-ZU can manage up to 16 IP 288s. If you connect more than 16 IP 288s to one CPU, you must set up further DB-ZUs (with other numbers).

DB-IP data block

Set up a DB-IP for every IP 288. It contains the following information:

- The IP-specific data
- The interfaces to the user program

The interfaces are implemented in the form of data pointers which point to the user-specific data areas.

DB-APP data block

Depending on the application, you set up several data areas in the DB-APP. These must contain the following information:

- Job specification
- The data to be exchanged with the IP 288

DB-PAR data block

The FB PAR uses one or more DB-PAR data blocks to read or write to data sets. Reading or writing to data sets often involves transferring large quantities of data. This is carried out either during restart (parameterization), at reparameterization (e.g. new cam sets/target sets) or only in exceptional cases (e.g. when replacing a module).

8.2 What Tasks Do the Function Blocks Handle?

There are 8 application mailboxes available for transferring jobs to the IP 288. Each of these application mailboxes has a bit in the DB-IP assigned to it. You can use this bit to enable processing of the individual mailboxes (data word "Select application mailboxes").

You must make a distinction between the following job types:

Control/actual value job

- Control or actual value jobs
  These are for executing functions or operating modes cyclically and for reading current actual values. You must jobs like these in one of the application mailboxes 1 to 7. Processing is then carried out by FB ZXK.

Data set job

- Data set jobs
  These are for writing, reading or deleting data sets. You must this type of job in application mailbox 8. Processing is then carried out by FB PAR.

There are the following data set jobs:

- Read jobs
  The FB writes the job specification, to which the pointer in application mailbox 8 points, to the IP 288 receives data from the module in response. The data is then stored in the data block immediately after the job specification.
- Write jobs
  The TB writes the job specification, to which the pointer in application mailbox 8 points, to the IP 288. The job specification itself contains the length of the data which is transferred to the IP 288 together with the job specification.
- Deletion jobs
  The FB writes the job specification, to which the pointer in application mailbox 8 points, to the IP 288. The job specification itself contains the data set to be deleted.

Job processing

Processing a job can require a function block to be called several times. You can read the current processing status in the "Job status" byte. In the event of an error, the job is aborted with the relevant error number.

The status flags and error flags of the function block are output in the DB-ZUs, the DB-IP and in accumulators 1 and 2. This is where you can evaluate these flags, e.g.:

- In the DB-ZU by a higher-level communication system
- In the DB-IP by the active application
- In accumulators 1 and 2 direct by the user program after calling the FB.

Only one job is ever active at any given time. A new job is only accepted if the current job has been terminated - with or without errors.

Job directory

You can use the status flags which the FB provides for each job to keep a "Job directory" for tests and startups. The job directory contains all activities of the FB with all flags listed in the order processed.

8.2.1 Cyclic Program Execution with FB ZYK

The FB ZXK handles "normal" communication between the CPU and the IP 288 in cyclic operation.

First, a check is made to ensure that the FB can execute in the existing environment (correct module available, all necessary data blocks set up, etc.). If this is the case, the data transfers described below can be executed consecutively in one call.

Checkback signals

The checkback signals are divided into 7 frames of equal length for reading data from the IP 288.

In the DB-IP, a bit is assigned to each of the frames. You can switch reading on and off at this bit (data word "Select cyclic reading of checkback signals"). Each time the function block is called, the frames you have selected are read.

Control signals

The control signals are divided into 4 frames of equal length for writing data to the IP 288.

In the DB-IP, a bit is assigned to each of the frames. You can activate writing of the control signals at this bit (data word "Select write control signals"). All selected frames are transferred and the relevant bits are then reset by the function block.

Job processing

The FB ZYK searches application mailboxes 1 to 7 in order to see if a job is entered (the eighth application mailbox is reserved for job processing with FB PAR). This search only takes into account the enabled mailboxes. Processing of a job is initiated if you enter a pointer to a job specification in an application mailbox and if the control interface is free at the same time(see Section 8.2.2). The control interface is occupied while the job is being processed.

Block parameters

The function blocks have no block parameters. They are parameterized via accumulator 1 (number of the DB-ZU data block and IP number). The job status and any transmission errors (see Section 8.3.5) are signalled back via accumulator 1; in the event of an error, the result of the logic operation is also set to signal state "1".

Example

```
      :L    KY    x,y    Transfer of the parameters
      :JU   FB    111    Processing of the IP
NAME:IPK:ZYK
      :T    FW    200    Store job status from accumulator 1
      :JC   =ERR         Jump if error
```

x represents the number of the DB-ZU data block
y represents the number of the IP in this data block.

The statement

```
      :L    KY    111,  3
```

means:

- DB 111 is used as DB-ZU
- Function block FB ZYK operates the IP 288 entered at the third position.

8.2.2 Job Processing with FB PAR

You can use FB PAR to write data sets to the IP 288 (parameterization), read data sets from the IP 288 (data saving) and delete data sets on the IP 288.

Before you can write data sets to the IP 288 or delete data sets on the IP 288, the interpretation of already entered data sets must be completed on the IP 288 (data interface free).

Transferring a data set

In order to transfer a data set, you must call FB PAR for each IP 288. You can also call FB PAR during normal operation. When you call FB PAR, the number of the DB-ZU data block and the number of the IP 288 in accumulator 1 are transferred. The job status and any transfer errors (see Section 8.3.5) are also signalled back via accumulator 1. Data set errors and any additional information are signalled via accumulator 2 (see Section 9.5). In the event of an error, the result of the logic operation is also set to signal state "1".

Example

```
      :L    KY    x,y    Transfer of the parameters
      :JU   FB    112    Transfer of the data set
NAME:IPK:PAR
      :T    FW    200    Store job status and transfer errors

      :TAK
      :T    FW    202    Data set errors and additional information
      :JC   =ERR         Jump if error
```

x represents the number of the DB-ZU data block
y represents the number of the IP in this data block.

The statement

```
:L    KY    112,  3
```

means:

- DB 112 is used as DB-ZU
- FB PAR operates the IP 288 entered at the third position.

FB PAR checks to see if application mailbox 8 is enabled and if a job has been entered. If you have entered a pointer to a job specification in the application mailbox, this job will then be processed. You can enter only data set jobs in application mailbox 8.

The number of DB-PAR is between 10 and 255. It identifies the first data block in which the data from the IP 288 are stored or are to be stored. If a further data block is required because of the quantity of data, this is assigned the next number. Before calling FB PAR, you must have set up all the data areas required for data transfer. 00H indicates a DB data block type and 01H indicates a DX data block type (S5-135U and S5-155U PLCs only).

Framing

A data set can be transferred in several frames (framing) in order to enable calling of DB PAR in cyclic operation without loading the cycle time unduly. The frame size is determined by the length entered in the job specification and by the frame size entered in DB-ZU for data traffic with FB PAR. The maximum frame size is 255 words.

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8.2.3 Interrupt Processing with FB INT

FB INT is called exclusively in interrupt-driven programs (e.g. in organization block OB 2, if interrupt line IRA is set on the IP 288). It checks to see that the interrupt was initiated by this IP 288 since several modules can occupy the same interrupt line. If the interrupt way initiated by this IP 288, the cause of interrupt is read from the module and the interrupt is acknowledged. To allow you to evaluate the interrupt cause quickly, a data word ("Indicate interrupt on which axis") signals which axes have initiated this interrupt.

Multiprocessor mode

In multiprocessor mode, only one CPU can call FB INT for a specific IP 288.

8.3 Data Blocks

The data structure for the IP 288 - CPU link provides for at least two data blocks: DB-ZU and DB-IP. For the interfaces to the user program, you require two further data blocks/data areas, DB-APP and DB-PAR. Fig. 8.1 shows the data structure for an IP 288 - CPU link with FB ZYK. The contents of the data blocks specified are as follows:

DB - ZU	DB - IP	DB - APP	DB - PAR
Number of the DB-IP data block assigned to a specific IP 288 Page number of the IP 288 IP 288 ID IP 288 version ID Error message Job status Synchronization control word	IP-specific data which can be updated each time FB ZYK is called Pointers which point to up to 8 applications Working area for FB ZYK	Job specification for the relevant application 1 to 7 Data for the relevant application	Job specification for application 8 Data sets

Selecting the data area in DB-APP

The application pointers in DB-IP point to DB-APP. You can select any data area by specifying a data block and a data word as the pointer.

Selecting the data area in DB-PAR

Application 8 in DB-IP points to DB-PAR. Application 8 in DB-IP is evaluated by FB PAR. You can select any data area by specifying a data block and a data word as the pointer. The selected DB can be filled from DW 0 up to and including DW 2042. If a further data block is required, the DB with the next number is used. The first DB must then have a length of 2043 data words.

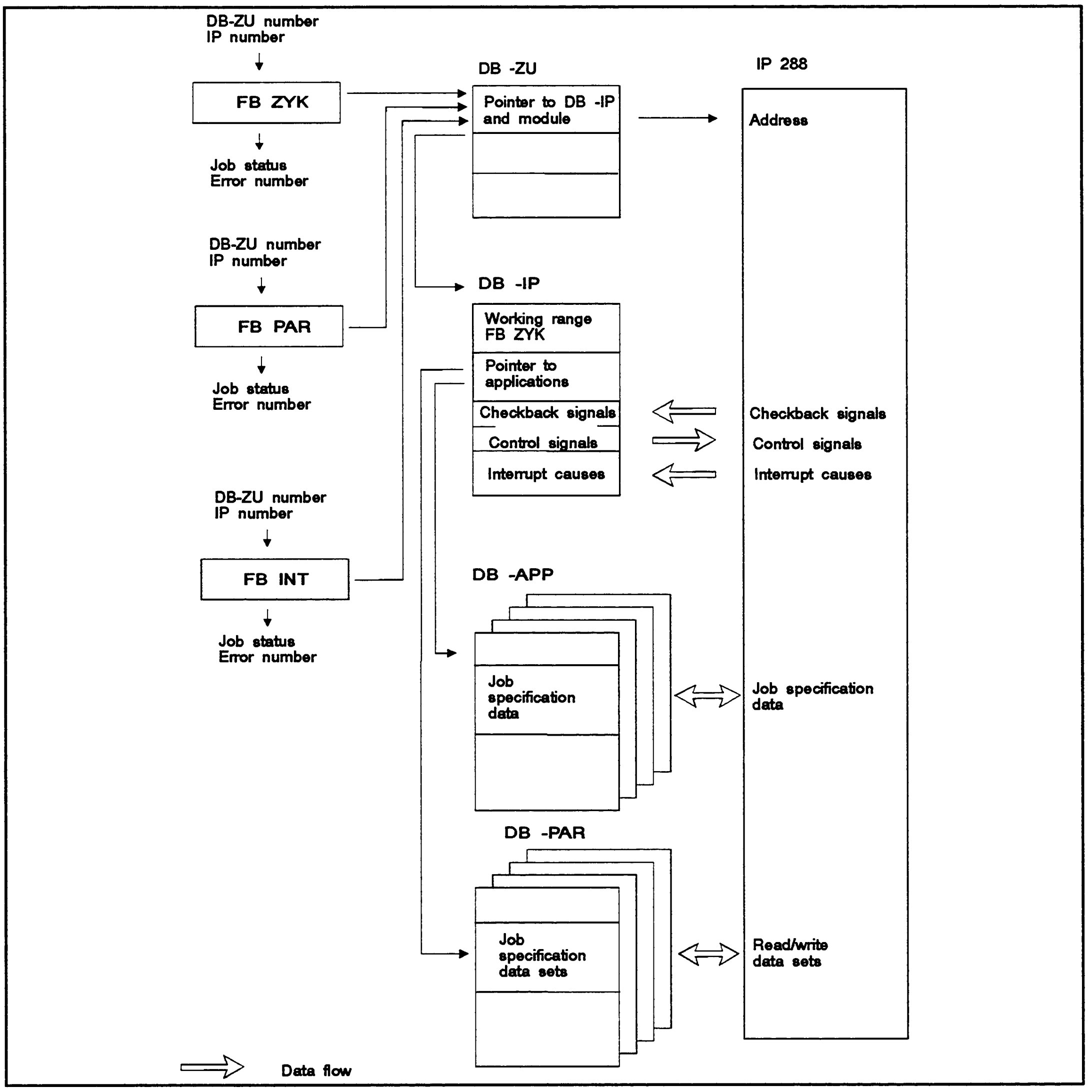

Fig. 8.2 Data structure for an IP 288

You can assign the following numbers for the DB:

	Number	Remark
DB -ZU	DB 10 to DB 255	for all PLCs
DB -IP	DB 10 to DB 255	for all PLCs
DB -APP [1]	DB 10 to DB 255 DX 10 to DX 255	for all PLCs for S5-135U and S5-155U
DB -PAR [1]	DB 10 to DB 255 DX 10 to DX 255	for all PLCs for S5-135U and S5-155U

[1] The numbers of DB-APP and DB-PAR are specified by you and they can be within the range specified. You must not use the numbers of DB-ZU and DB-IP.

DB-ZU and DB-IP must be DB data block types.

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Data block type

For the application-specific data areas (DB-APP and DB-PAR), data blocks (DBs) are permitted and expanded data blocks (DXs) in the case of the S5-135U and S5-155U PLCs. The data areas accessed by FB ZYK must not extend beyond DW 255.

If you use an EPROM memory submodule, you must copy the data blocks to internal RAM or set them up there (see CPU description).

8.3.1 DB-ZU Data Block

There are 16 words reserved in DB-ZU for each IP 288. DB-ZU appears as follows in the overview:

IP No.	1	2	3	4	5	6	7	8
from DW	0	16	32	48	64	80	96	112
to DW	15	31	47	63	79	95	111	127
IP No.	9	10	11	12	13	14	15	16
from DW	128	144	160	176	192	208	224	240
to DW	143	159	175	191	207	223	239	255

DB-ZU assignments

The assignments are as follows for an individual IP 288. The fields in bold type must be assigned by you. You use these to adapt DB-ZU to your environment. The fields in normal type are only for display purposes.

	15 ...	... 0
DW n	**IP ID**	**DB number DB-IP**
DW n+1	Firmware version of the IP 288	
DW n+2	Reserved	
DW n+3	Job list and transfer errors from FB ZYK	
DW n+4	**Type of addressing**	
DW n+5	**Page number**	
DW n+6	**Number of monitoring cycles**	
DW n+7	**Frame size for transfer with FB PAR**	
DW n+8	Data set error	Additional information if applicable
DW n+9	Job status and transfer errors from FB PAR	
DW n+10	**Synchronization control word**	
DW n+11	Reserved	
DW n+12	Reserved	
DW n+13	Reserved	
DW n+14	Reserved	
DW n+15	Reserved	

Description of the individual entries in DB-ZU:

DW	Entry	Meaning
DL n	IP ID	You enter the value KY = 88 in this data byte as the IP 288 identifier.
DR n	DB number of the DB-IP	This defines the number of the DB-IP interface data block. The DB-IP must not be in the extended data area DX. You can only use the DB numbers between 10 and 255.
DW n+1	Firmware version of the IP 288	The standard function block stores the version number of the firmware of the accessed IP 288 here. **Example:** DL n+1 = DR n+1 = 0 → Version number = 1.0
DW n+2	Reserved	
DW n+3	Job status and transfer errors from FB ZYK	FB ZYK enters here its current job status (see Section 8.3.2) and the relevant error number in the event of an error (see Section 8.3.5). The data word is updated each time the FB is called.
DL n+4	Type of addressing	You must enter the value KY = 2 in this data byte as the addressing type ID of the IP 288.
DW n+5	Page number	The IP 288 is a page-addressed module. It has two pages as transfer area between the CPU and the IP 288. The contents of the data word DW n+5 must agree with the page number set on the module.
DW n+6	Number of monitoring cycles	If the module does not respond to a signal within a certain number of FB calls, the FB signals an error. You can define the monitoring time indirectly in DW n+6. Enter a value between 0 and 127 for the number of block calls. If you enter the value 0, this will be replaced by FB ZYK with 127. If FB ZYK is called once in the PLC cycle, "1" means one PLC cycle. This time must be greater than 8 ms.
DW n+7	Frame size for data transfer with FB PAR	FB PAR can be used to execute jobs which transfer larger quantities of data between the IP 288 and the CPU. To optimize the cycle time, you can divide a data transfer between several cycles. The frame size determines the maximum number of data words which can are transferred with one FB PAR call. Valid values: 0 ≤ transfer number ≤ 255. If you specify the value 0, FB PAR replaces this with 16.
DW n+8	Data set error and additional information from FB PAR	FB PAR enters error information here which it receives from the IP 288 (see Section 9.5).
DW n+9	Job status and transfer errors from FB PAR	FB PAR enters here its current job status (see Section 8.3.2) and the relevant error number in the event of an error (see Section 8.3.5). The data word is updated each time the FB is called.
DW n+10	Synchronization control word	After every CPU restart or IP 288 restart, a resynchronization between the IP 288 and the standard function block must be carried out. For this purpose, the value KF = +1 must be entered in data word DW n+10 in the restart organization blocks. You need not evaluate this data word and you must not changed after the synchronization request.
DW n+11 to DW n+15	Reserved	

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8.3.2 DB-IP Data Block

The DB-IP data block forms the actual interface between the user program and the standard function blocks. You specify the number of the DB-IP data block in DB-ZU. You must set up a DB-IP in the RAM memory of the CPU for every IP 288.

DB-IP assignments

The DB-IP must be located only in the DB area. The extended DX data blocks in the S5-135U and S5-155U are not permissible. DB-IP is assigned as follows:

		15 0	
	DW 0 to 26	Working area of the FB You must not use this area	
	DW 27	Copy of the pointer from application mailbox 8 (DW 60)	
	DW 28 to 31	Copy of the running or last processed PLC job (image of application mailbox 1 to 7)	
	DW 32 to 35	Application 1	1st pointer
	DW 36 to 39	Application 2	2nd pointer
	DW 40 to 43	Application 3	3rd pointer
	DW 44 to 47	Application 4	4th pointer
	DW 48 to 51	Application 5	5th pointer
	DW 52 to 55	Application 6	6th pointer
	DW 56 to 59	Application 7	7th pointer
	DW 60 to 63	Application 8	8th pointer
	DW 64	Select application 1 to 8	
	DW 65	Select cyclic reading of checkback signals	
	DW 66	Select write control signals	
	DW 67	Indicate interrupt on which axis	
Checkback signals	DW 68 to 83	Module flag	
	DW 84 to 99	Frame 1 of axis 1	
	DW 100 to 115	Frame 2 of axis 1	
	DW 116 to 131	Frame 1 of axis 2	
	DW 132 to 147	Frame 2 of axis 2	
	DW 148 to 163	Frame 1 of axis 2	
	DW 164 to 179	Frame 2 of axis 3	
Control signals	DW 180 to 185	Watchdog acknowledgement	
	DW 186 to 191	Control signals axis 1	
	DW 192 to 197	Control signals axis 2	
	DW 198 to 203	Control signals axis 3	
Cause of interrupt	DW 204 to 210	Cause of interrupt axis 1	
	DW 211 to 217	Cause of interrupt axis 2	
	DW 218 to 224	Cause of interrupt axis 3	

Applications

Application 1 to 8

Data area DW 32 to DW 63 is divided into eight application mailboxes each with a length of 4 words. These mailboxes are required for transferring PLC jobs to the IP 288. For this purpose, you enter a pointer to the job data to be transferred in any free application mailbox. The standard function block detects the entry and starts processing the job when the application mailbox is enabled. In doing so, the job status (job in progress or job completed with/without errors) and the error information are entered in the processed application mailbox each time the function block is called. After processing the job, the FB overwrites the data word DW n in the job mailbox with 0.

Structure of an application mailbox

Each of these eight mailboxes has the following structure:

	15 8	7 0
Pointer to job specification in DB-APP data area		
DW n	Data block type	DB/DX number
DW n+1	Reserved	DW number
DW n+2	Data set error	Additional information
DW n+3	Job status	Transfer error

You enter your job in data words DW n to DW n+1. Data words n+2 and DW n+3 contain checkback information from the function blocks.

DL n: Data block type:
0: DB type
1: DX type

You can only use extended DX data blocks in the S5-135U/155U. This ID is not evaluated in the S5-115U.

DR n: DB/DX number:
Valid values: 10 to 255

DL n+1: Reserved
DR n+1: DW number:
Valid values: 0 to 255

The DW number points to the first data word of the job specification in data block DB-APP or DB-PAR.

DL n+2: Data set error
DR n+2: Additional information

The error number entered here is generated by the IP 288 (data set error) and refers to the PLC job entered in application mailbox 8 (see Section 9.5). This data word is always 0 for applications 1 to 7.

DL n+3: Job status
DR n+3: Transfer error

The standard function block stores the job status and any transfer errors in this word.

Job status

This word contains the same information as accumulator 1 immediately after the standard function block is called.

DW n+3 is assigned as follows:

15 ...							... 8	7 0
X	0	0	0	X	X	X	X	Transfer error

X Bit is assigned (read access only)

Bit 8 to bit 15: Job status in KM (bit pattern) data format
Bit 8 : = No job in progress
Bit 9 : = Job in progress
Bit 10 : = Job completed without errors
Bit 11 : = Job terminated with errors (transfer error or data set error)
Bit 12 : Not assigned
Bit 13 : Not assigned
Bit 14 : Not assigned
Bit 15 : = IP not synchronized

Bit 0 to bit 7: Transfer error 0 to 255
An error number is entered here if the job has been terminated with a transfer error (see Section 8.3.5). If no errors occurred during processing of the function block, the error byte has the value KY = 0.

You will find a list of data set errors in Section 9.5.

Assignments of the data word "Select applications 1 to n"

Processing of the application mailboxes is enabled in DW 64 "Select applications 1 to 8". An application mailbox is only processed by FB ZYK or FB PAR if the relevant bit is set to "1". The function block does not change the data word.

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X

Bit 0 : =1 Application 1 enabled for FB ZYK
Bit 1 : =1 Application 2 enabled for FB ZYK
Bit 2 : =1 Application 3 enabled for FB ZYK
Bit 3 : =1 Application 4 enabled for FB ZYK
Bit 4 : =1 Application 5 enabled for FB ZYK
Bit 5 : =1 Application 6 enabled for FB ZYK
Bit 6 : =1 Application 7 enabled for FB ZYK
Bit 7 : =1 Application 8 enabled for FB PAR
Bit 8 to 15 : not assigned

Checkback information

Assignment of the data word "Select cyclic reading of checkback signals"

You can select and deselect cyclic updating of the relevant frames in DW 65 "Select cyclic reading of checkback signals". FB ZYK reads checkback information from the IP 288 and stores it in DB-IP only if the relevant bit is set to "1". The FB does not change the data word.

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X

Bit 0 : = 1 Read module status word
Bit 1 : = 1 Read frame 1 axis 1
Bit 1 : = 1 Read frame 2 axis 1
Bit 1 : = 1 Read frame 1 axis 2
Bit 1 : = 1 Read frame 2 axis 2
Bit 1 : = 1 Read frame 1 axis 3
Bit 1 : = 1 Read frame 2 axis 3
Bit 7 to 15: Not assigned

Structure of the module status words

DW 68: Module status
DW 69: Image of the digital inputs

are assigned as described below. Data words DW 70 to DW 83 are reserved.

Assignments of the data word "Module status"

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X

Bit 0 : = 0 STOP
: = 1 RUN
Bit 1 : = 0 All axes in PLC mode
: = 1 At least one axis in programmer mode
Bit 2 : = 0 All axes without operator errors
: = 1 At least one axis with operator errors
Bit 3 : = 0 All axes without external errors
: = 1 One external error on one axis
Bit 4 : = 1 Programmer frame error
Bit 5 : = 1 Watchdog timeout, module waiting on acknowledgement
Bit 6 : = 1 BASP
Bit 7 : = 1 Ready signal FB failed
Bit 8 : = 0 COM compatible with firmware version
: = 1 COM not compatible with firmware version
Bit 9 to 15: Not assigned

Assignments of the data word "Image of the digital inputs"

15 ...							... 8	7 ...							... 0
0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X

Bit 0 : = 1 Digital input 1, axis 1 set
Bit 0 : = 1 Digital input 2, axis 1 set
Bit 0 : = 1 Digital input 3, axis 1 set
Bit 0 : = 1 Digital input 4, axis 1 set
:
:
Bit 0 : = 1 Digital input 3, axis 4 set
Bit 0 : = 1 Digital input 4, axis 4 set
Bit 12 to 15: Not assigned

Assignments of frame 1 of axis 1, 2 and 3

Data word			Assignment
Axis 1	Axis 2	Axis 3	
DW 84	DW 116	DW 148	Mode in progress (positioning) Track ID bits (cam controller)
DW 85 and DW 86	DW 117 and DW 118	DW 149 and DW 150	Axis status
DW 87	DW 119	DW 151	Traverse status
DW 88 to DW 90	DW 120 to DW 122	DW 152 to DW 154	Current functions
DW 91	DW 123	DW 155	Operator error BFEH
DW 92 and DW 93	DW 124 and DW 125	DW 156 and DW 157	External error EXF
DW 94 to DW 96	DW 126 to DW 128	DW 158 to DW 160	Measured length
DW 97	DW 129	DW 161	Revolution counter
DW 98 and DW 99	DW 130 and DW 131	DW 162 and DW 163	Reserved

Assignments of the data word "Mode in progress/track ID bits"

The data words DW 84/DW 116/DW 148 are assigned the values "Mode in progress" in the case of positioning or "Track ID bits" in the case of a cam controller.

DW 84/DW 116/DW 148 : Mode in progress

15 8	7 0
Number of the mode	

KF 0 : No mode in progress or mode completed
KF 1 : Jog
KF 2 : Reference point approach
KF 3 : Absolute increment mode
KF 4 : Relative increment mode
KF 5 : Target set processing

DW 84/DW 116/DW 148 : Track ID bits

15 ...							...8	7...							...0
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Bit 0 : = 1 Track 1, at least one cam set
Bit 0 : = 1 Track 2, at least one cam set
:
Bit 0 : = 1 Track 16, at least one cam set

Assignments of the data word "Axis status"

DW 85 and DW 86/DW 117 and DW 118/DW149 and DW 150: Axis status

15 ...							...8	7...							...0
0	0	X	X	X	X	X	X	X	X	X	X	X	X	X	X
X	X	0	X	X	X	X	X	X	X	0	X	X	X	X	X

	Bit 0	: Image START
	Bit 1	: Image STOP
	Bit 2	: Image CONT
	Bit 3	: Image T+
	Bit 4	: Image T-
	Bit 5	: Reserved (= 0)
	Bit 6	: Image CHANGE
DW 86	Bit 7	: Image EXEC
DW 118	Bit 8	: Image ON
DW 150	Bit 9	: Image OFF
	Bit 10	: Image DELETE
	Bit 11	: Image EXFQ
	Bit 12	: Image BFEHQ
	Bit 13	: Reserved (= 0)
	Bit 14	: =0 PLC mode
		: =1 Programmer mode
	Bit 15	: =1 Process diagnostics mode
	Bit 0	: = 0 Completed
		: = 1 Running
	Bit 1	: =1 Interrupted
	Bit 2	: =1 Axis waiting on external start
	Bit 3	: =1 Position-dependent memory occupied
	Bit 4	: =1 Event-dependent memory occupied
	Bit 5	: =1 Control interface occupied
DW 85	Bit 6	: =1 Data interface occupied
DW 117	Bit 7	: =1 Operator errors BFEH
DW 149	Bit 8	: =1 External errors EXF
	Bit 9	: =1 Axis parameterized
	Bit 10	: =1 Axis synchronized SYNC
	Bit 11	: =1 Length measurement completed
	Bit 12	: =1 Actual position comparator tripped
	Bit 13	: =1 Revolution comparator tripped
	Bit 14	: Reserved (= 0)
	Bit 15	: Reserved (= 0)

Control bits

The image of the control bits (bit 0 to bit 12 in DW 86/DW 118/ DW 150) is influence by the IP 288 depending on axis status.

Assignments of the data word "Traverse status"

DW 87/DW 119/DW 151 : Traverse status

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X

Bit 0 : =1 Current forward direction
Bit 1 : =1 Current reverse direction
Bit 2 : =1 At rapid traverse
Bit 3 : =1 At creep speed
Bit 4 : =1 In the cutoff range
Bit 5 : =1 In the target range
Bit 6 : =1 In the zero speed range
Bit 7 : =1 Position reached
Bit 8 to 15: Reserved (= 0)

Assignment of the data word "Current functions"

DW 88 to DW 90/DW 120 to DW 122/DW 152 and DW 154:
Current functions

15 ...							... 8	7 ...							... 0
0	0	X	X	X	X	0	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X	0	0	X	X	X	X

	Bit 0	: =1 Programmer mode
	Bit 1	: =1 Trigger reference point
	Bit 2	: =1 Drive disable
	Bit 3	: =1 Follow-up
DW 90	Bit 4	: Reserved (= 0)
DW 122	Bit 5	: Reserved (= 0)
DW 154	Bit 6	: =1 Forward rounding
	Bit 7	: =1 Reverse rounding
	Bit 8	: =1 Cam track 1 enabled
		:
	Bit 15	: =1 Cam track 8 enabled
	Bit 0	: =1 Cam track 9 enabled
DW 89		:
DW 121	Bit 7	: =1 Cam track 16 enabled
DW 153	Bit 8	: =1 Cam offset on track 1
		:
	Bit 15	: =1 Cam offset on track 8
	Bit 0	: =1 Cam offset on track 9
		:
	Bit 7	: =1 Cam offset on track 16
	Bit 8	: =1 Coordinate offset active
DW 88	Bit 9	: Reserved (= 0)
DW 120	Bit 10	: =1 Adaption
DW 152	Bit 11	: =1 Teach-In
	Bit 12	: =1 Simulation
	Bit 13	: =1 Process diagnostics
	Bit 14 and 15	: Reserved (= 0)

Assignments of the data word "Operator errors"

DW 91/DW 123/DW 155 : Operator errors

15 8	7 0
Error number	

The error numbers are listed in Section 9.5.7

Assignments of the data word "External errors"

DW 92 and DW 93/DW 124 and DW 125/DW 156 and DW 157: External errors

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	X	X
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

DW 93	Bit 0	: =1 External error 1
DW 125	Bit 1	: =1 External error 2
DW 157		:
	Bit 15	: =1 External error 16
DW 92	Bit 0	: =1 External error 17
DW 124	Bit 1	: =1 External error 18
DW 156	Bit 2 to 15 : reserved (= 0)	

The meanings of the individual external errors are listed in Section 9.5.6.

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Assignments of the data word "Measured length"

DW 94 to DW 96/DW 126 to DW 128/DW 158 to DW 160: Measured length

The measured length can be binary-coded (in two's complement) or BCD coded.

	DW 94/DW 126/ DW 158				DW 95/DW 127/ DW 159				DW 96/DW 128/ DW 160			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign: Positive: Bit 8 to bit 11 = 0000
Negative: Bit 8 to bit 11 = 1111

Assignments of the data word "Revolution counter"

DW 97/DW 129/DW 161: Revolution counter

15 8	7 0
Number of revolutions	

The number of revolutions can be 0 to 32767.

Assignments of frame 2 of axis 1, 2 and 3

The contents of frame 2 differ according to axis function.

Cam controller

Data word			Assignment
Axis 1	Axis 2	Axis 3	
DW 100 to DW 102	DW 132 to DW 134	DW 164 to DW 166	Actual position
DW 103	DW 135	DW 167	Cam ID bits track 1 and 2
:	:	:	
DW 110	DW 142	DW 174	Cam ID bits track 15 an 16
DW 111 and DW 112	DW 143 and DW 144	DW 175 and DW 176	Current reference point coordinate
DW 113 to DW 115	DW 145 to DW 147	DW 177 to DW 179	Reserved

Assignments of the data word "Actual position"

DW 100 to DW 102/DW 132 to DW 134/DW 164 to DW 166:
Actual position

The actual position can be binary-coded (in two's complement) or BCD coded.

	DW100/ DW 132/ DW 164				DW 101/ DW 133/ DW 165				DW 102/ DW 134/ DW 166			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign: Positive: Bit 8 to bit 11 = 0000
Negative: Bit 8 to bit 11 = 1111

Assignments of the data words "Cam ID bits"

DW 103 to DW 110/DW 135 to DW 142/DW 167 to DW 174:
Cam ID bits

	15 8	7 0
DW 103/DW 135/DW 167	Cam ID bits track 1	Cam ID bits track 2
DW 104/DW 136/DW 168	Cam ID bits track 3	Cam ID bits track 4
:	:	:
DW 110/DW 142/DW 174	Cam ID bits track 15	Cam ID bits track 16

Assignments of the data words "Current reference point coordinate"

DW 111 and DW 112/DW 143 and DW 144/DW 175 and DW 176:
Current reference point coordinate

The current reference point coordinate is binary-coded (in two's complement).

DW 111/DW 143/DW 175		DW 112/DW 144/DW 176	
2^{31}	2^{16}	2^{15}	2^{0}

Positioning

Data word			Assignment
Axis 1	Axis 2	Axis 3	
DW 100 to DW 102	DW 132 to DW 134	DW 164 to DW 166	Actual position
DW 103 and DW 104	DW 135 and DW 136	DW 167 and DW 168	Forward adaption value
DW 105 and DW 106	DW 137 and DW 138	DW 169 and DW 170	Reverse adaption value
DW 107 to DW 110	DW 139 to DW 142	DW 171 to DW 174	Reserved
DW 111 and DW 112	DW 143 and DW 144	DW 175 and DW 176	Current reference point coordinate
DW 113 to DW 115	DW 145 to DW 147	DW 177 to DW 179	Reserved

Assignments of the data words "Actual position"

DW 100 to DW 102/DW 132 to DW 134/DW 164 to DW 166:
Actual position

The actual position can be binary-coded (in two's complement) or BCD coded.

	DW100/ DW 132/ DW 164				DW 101/ DW 133/ DW 165				DW 102/ DW 134/ DW 166			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign: Positive: Bit 8 to bit 11 = 0000
Negative: Bit 8 to bit 11 = 1111

Assignments of the data words "Forward adaption value"

DW 103 and DW 104/DW 135 and DW 136/DW 167 and DW 168: Forward adaption value

The forward adaption value is binary-coded (in two's complement).

DW 103/DW 135/DW 167		DW 104/DW 136/DW 168	
2^{31}	2^{16}	2^{15}	2^{0}

Assignments of the data words "Reverse adaption value"

DW 105 and DW 106/DW 137 and DW 138/DW 169 and DW 170: Reverse adaption value

The reverse adaption value is binary-coded (in two's complement).

DW 105/DW 137/DW 169		DW 106/DW 138/DW 170	
2^{31}	2^{16}	2^{15}	2^{0}

Assignments of the data words "Current reference point coordinate"

DW 111 and DW 112/DW 143 and DW 144/DW 175 and DW 176: Current reference point coordinate

The current reference point coordinate is binary-coded (in two's complement).

DW 111/DW 143/DW 175		DW 112/DW 144/DW 176	
2^{31}	2^{16}	2^{15}	2^{0}

Control signals

Assignments of the data word "Select write control signals"

You initiate the writing of control signals in DW 66, "Select write control signals". FB ZYK only transfers the control signals to the IP 288 if the relevant bit is at "1". After transfer, FB ZYK resets the relevant bit to "0". Under certain circumstances, this can take longer than one CPU cycle.

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X

Bit 0 : =1 Transfer module control to IP 288
Bit 1 : =1 Transfer axis 1 control to IP 288
Bit 2 : =1 Transfer axis 2 control to IP 288
Bit 3 : =1 Transfer axis 3 control to IP 288
Bit 4 to 15 : Not assigned

Assignments of the data word "Watchdog acknowledgement"

DW 180 to DW 185 :Watchdog acknowledgement

DW 180

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	X

Bit 0 := 0 No acknowledgement
Bit 1 to 15: Not assigned

The data words DW 18 to DW 185 are reserved.

Assignments of the control signals axis 1, 2 and 3

Data word			Assignment
Axis 1	Axis 2	Axis 3	
DW 186	DW 192	DW 198	Control bits
DW 187 and DW 188	DW 193 and DW 194	DW 199 and DW 200	Individual functions
DW 189 to DW 191	DW 195 to DW 197	DW 201 to DW 203	Reserved

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Assignments of the control bits

DW 186/DW 192/DW 198 : Control bits

15 ...							... 8	7 ...							... 0
0	0	0	X	X	X	X	X	X	X	0	X	X	X	X	X

Bit 0 : =1 START, start a mode (except jog)
Bit 1 : =1 STOP, interrupt or complete a mode (except jog)
Bit 2 : =1 CONT, continue a mode (except jog)
Bit 3 : =1 T+, jog forward
Bit 4 : =1 T-, jog reverse
Bit 5 Reserved (=0)
Bit 6 : =1 CHANGE, change parameter during traverse and load comparator (revolution counter, actual position, comparison value)
Bit 7 : =1 EXEC, accept values in Teach-In
Bit 8 : =1 ON, activate a function
Bit 9 : =1 OFF, deactivate a function
Bit 10 : =1 DELETE, delete memory for position-dependent or event-dependent parameter change/function execution
Bit 11 : =1 EXFQ, acknowledge an external error EXF
Bit 12 : =1 BFEHQ, acknowledge an operator error BFEH
Bit 13 to 15: Reserved (=0)

Assignments of the data words "Individual functions"

DW 187 and DW 188/DW 193 and DW 194/DW 199 and DW 200: Individual functions

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X
X	X	X	X	X	X	X	X	X	X	0	0	X	X	X	X

DW 188 DW 194 DW 200	Bit 0: =1 Programmer mode Bit 1: =1 Trigger reference point Bit 2: =1 Drive disable Bit 3: =1 Follow-up Bit 4: Reserved (= 0) Bit 5: Reserved (= 0) Bit 6: =1 Forward rounding Bit 7: =1 Reverse rounding Bit 8: =1 Enable cam track 1 Bit 9: =1 Enable cam track 2 : Bit 15: =1 Enable cam track 8
DW 187 DW 193 DW 199	Bit 0: =1 Enable cam track 9 : Bit 7: =1 Enable cam track 16 Bit 8 to 15: Reserved (= 0)

Interrupt causes

Assignments of the data word "Indicate interrupt on which axis"

Every time FB INT is called, DW 67 "Indicate interrupt on which axis" is updated. It shows you which frames contain new information. You can then see the precise interrupt cause in each frame.

15 ...							... 8	7 ...							... 0
0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X

Bit 0 : =1 Interrupt causes axis 1 updated
Bit 1 : =1 Interrupt causes axis 2 updated
Bit 2 : =1 Interrupt causes axis 3 updated
Bit 3 to 15 : Not assigned

Assignments of the data words interrupt causes axis 1, 2 and 3

Data word			Assignment
Axis 1	Axis 2	Axis 3	
DW 204	DW 211	DW 218	Process interrupt/diagnostics interrupt
DW 205 and DW 206	DW 212 and DW 213	DW 219 and DW 220	Length value in the case of the "Length measurement completed" process interrupt
DW 207 and DW 208	DW 214 and DW 215	DW 221 and DW 222	Cam edge flag in the case of the "Cam edge" process interrupt
DW 209 and DW 210	DW 216 and DW 217	DW 223 and DW 224	Reserved

Assignments of the data word "Process interrupt/diagnostics interrupt"

DL 204/DL 211/DL 218 : Process interrupt
DR 204/DR 211/DR 218 : Diagnostics interrupt

15 ...							... 8	7 ...							... 0
0	0	0	0	X	X	X	X	0	0	0	X	X	X	X	X

Bit 0 : =1 Short-circuit 24-volt encoder supply
Bit 1 : =1 Short-circuit 5-volt encoder supply
Bit 2 : =1 Defective encoder signal cable
(only in the case of 5 V differential signals)
Bit 3 : =1 Encoder signal error or frame error
Bit 4 : =1 Zero mark error/illegal encoder value
Bit 5 to 7 : Reserved (= 0)
Bit 8 : =1 Position reached/cam edge
Bit 9 : =1 Length measurement completed
Bit 10 : =1 Actual position comparator tripped
Bit 11 : =1 Number of revolutions reached (rotary axis)
Bit 12 to 15: Reserved (= 0)

Assignments of the data words "Length value in the case of the length measurement completed process interrupt"

DW 205 and DW 206/DW 212 and DW 213/DW 219 and DW 220: "Length value in the case of the length measurement completed process interrupt"

DW 205/DW 212/DW 219		DW 206/DW 213/DW 220	
2^{31}	2^{16}	2^{15}	2^{0}

DW 208 DW 215 DW 222	Bit 0:	1st interrupt initiating edge track 1
	Bit 1:	2nd interrupt initiating edge track 1
	Bit 2:	1st interrupt initiating edge track 2
	Bit 3:	2nd interrupt initiating edge track 2
	:	
	Bit 14:	1st interrupt initiating edge track 8
	Bit 15:	2nd interrupt initiating edge track 8
DW 207 DW 214 DW 221	Bit 0:	1st interrupt initiating edge track 9
	Bit 1:	2nd interrupt initiating edge track 9
	:	
	Bit 14:	1st interrupt initiating edge track 16
	Bit 15:	2nd interrupt initiating edge track 16

8.3.3 DB-APP Data Block

DB-APP contains the control or actual value jobs with data which FB ZYK transfers to the IP 288 or reads from the IP 288 when processing a job. You must provide a corresponding data area for each job. The data area in each case consists of job specification (length 4 data words) and a job-specific quantity of user data.

The job specification and the user data must be located in the area between data word DW 0 and DW 255.

The user data is not transferred in frames.

DB-APP assignments

If DB-APP contains data areas to be written to by FB ZYK (actual value jobs), it must be set up in the RAM of the CPU.

		15 8	7 0
	DW 0 to DW n-1		
1. Job specification with user data	DW n 1)	Data block type	DB/DX number
	DW n+1	Job number	DW number
	DW n+2	Axis	Length of the user data 2)
	DW n+3	Reserved	Reserved
	DW n+4	User data Every job must have a user data area with a fixed structure	
2. Job specification with user data	DW m		
	DW m+1		
	DW m+2		
	DW m+3		
	DW m+4	User data	
	:	:	

1) The pointer entered in one of the applications 1 to 7 points to this.
2) Number of data words to be transferred in one write job to the IP 288.

Data word DW n and data byte DR n+1 are not evaluated. However, you can enter the pointer from the application here (see Section 8.3.2).

In data byte DL n+1, you enter the job number of the desired mode or function or the desired actual value job according to the table below. Depending on the mode or function, you enter the length of the relevant user data (e.g. speed ID, target, etc.) in words in data byte DR n+2. Enter the length 0 in DR n+2 in the case of actual value jobs.

In data byte L n+2, enter the number of the axis (1, 2 or 3) to which the control or read job specified via the job number applies.

The user data or the modes or functions or of the actual value jobs are assigned as follows:

	Job number	Job	User data in words: Number	User data in words: Condition	Control bits
Control jobs	1	Jog	7		T+, T-, CHANGE
			11	Always permissible if execution ID is "Immediately"	
	2	Reference point approach	7		START, STOP, CONT
			11	Always permissible if execution ID is "Immediately"	
	3	Absolute increment mode	7	If no position-dependent or event-dependent parameter change has been requested	START, STOP, CONT, CHANGE
			11	Always permissible	
	4	Relative increment mode	7	If no position-dependent or event-dependent parameter change has been requested	START, STOP, CONT, CHANGE
			11	Always permissible	
	5	Target set processing	4		START, STOP, CONT
	16	Set actual value	7	If no position-dependent or event-dependent parameter change has been requested	ON
			11	Always permissible	
	17	Set zero point	7	If no position-dependent or event-dependent parameter change has been requested	ON
			11	Always permissible	
	18	Zero point offset	7	If no position-dependent or event-dependent parameter change has been requested	ON
			11	Always permissible	
	20	Adaption	4		ON, OFF
	21	Cam track offset	7		ON
	32	Load revolution comparator	7		CHANGE
	33	Load actual position comparator	7		CHANGE
	34	Teach-In	0	For switching on/off	ON, OFF, EXEC
			4	For entering the current position in the cam set or in the short target set. If "Quantity of user data" = 4 and a long target set is specified, the changeover and cutoff difference and the adaption values are entered from the machine data.	
			16	For entering the current position with changeover and cutoff difference in a long target set (only in the case of positioning)	
	35	Simulation	7		ON, OFF
Actual value jobs	48	Read actual values	0		-
	49	Function values	0		-

User data of the control jobs 1 to 4 and 16 to 18

Assignment of the user data

User data for:
Jog, reference point approach, absolute increment mode, relative increment mode, set actual value, set zero point, zero offset.

DW	15 8	7 0
n+4	Bit parameter [1]	Speed ID [2]
n+5	Value [3]	
n+6		
n+7		
n+8	Reserved	
n+9		
n+10		
n+11	Execution ID [3]	+
n+12	Comparison value [3]	
n+13		
n+14		

[1] Reserved in the case of "Jog", "Set actual value" and "Set zero point".
[2] Reserved in the case of "Set actual value", "Set zero point" and "Zero offset".
[3] Reserved in the case of "Jog" and "Reference point approach".

Assignments of the data word "Bit parameter/speed ID"

DW n+4 is assigned as follows:
DL: Bit parameter DR: Speed ID

15 ...							... 8	7 0
			X		X	X	X	Speed ID

Speed ID: 0 = Creep speed
1 = Rapid traverse

Bit parameter:
Bit 8 : Forward direction
Bit 9 : Reverse direction
Bit 8 and bit 9 : = 0 Shortest path (in the case of a rotary axis)
Bit 10 : Without specified target
Bit 11 : Not assigned
Bit 12 : Delete revolution counter
Bit 13 to 15 : Not assigned

Value

The individual entries in these data words have the following meanings:

Mode/function or actual value job	Value
Jog	Reserved
Reference point approach	Reserved
Absolute increment mode	Target
Relative increment mode	Path segment (positive value, sign via direction bits)
Set actual value	Actual value coordinate
Set zero point	Zero point coordinate
Zero offset	Path segment (positive value, sign via direction bits)

These entries can be binary-coded (in two's complement) or BCD-coded, according to the specification in the machine data.

	DW n+5				DW n+6				DW n+7			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign : Positive: Bit 8 to Bit 11 = 0000
Negative: Bit 8 to Bit 11 = 1111

Assignments of the data word "Execution ID"

DW n+11 is assigned as follows:

15 8	7 0
Execution ID	

Execution ID 0 = Immediately
1 = Event-dependent
2 = Position-dependent

Comparison value

The comparison value is entered here for position-dependent execution of a mode or function. Assignment and value representation corresponds to the assignment and representation of the binary-coded or BCD-coded values described above.

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Assignment of the user data for "Target set processing"

DW	15 8	7 0
n+4	Bit parameter [1]	Target set number
n+5	Reserved	
n+6		
n+7		

[1] Only in the case of a rotary axis

Assignments of the data word "Bit parameter/target set number

DW n+4 is assigned as follows:
DL: Bit parameter DR: Target set number

15 ...							... 8	7 0
						X	X	Target set number

Target set number: 1 to 255, binary-coded

Bit parameter:
Bit 8 : =1 Forward direction
Bit 9 : =1 Reverse direction
Bit 8 and bit 9 : = 0 Shortest path (in the case of a rotary axis)
Bit 10 to 15 : Not assigned

Assignment of the user data for "Adaption"

User data for "Adaption"

DW	15 8	7 0
n+4	Reserved	Adaption factor
n+5	Reserved	
n+6		
n+7		

Assignments of the data byte "Adaption factor"

DW n+4 is assigned as follows:
DL: Reserved DR: Adaption factor

15 8	7 0
Reserved	Adaption factor

Adaption factor: 1 to 100

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Assignment of the user data for "Cam track offset"

User data for "Cam track offset"

DW	15 8	7 0
n+4	Bit parameter	Track number
n+5	Offset	
n+6		
n+7		
n+8	Reserved	
n+9		
n+10		

Assignments of the data word "Bit parameter/track number"

DW n+4 is assigned as follows:
DL: Bit parameter DR: Track number

15 ...							... 8	7 0
						X	X	Track number

Track number: 1 = Offset track 1
2 = Offset track 2
:
:
16 = Offset track 16

Bit parameter:
Bit 8 : =1 Forward direction
Bit 9 : =1 Reverse direction
Bit 10 to 15 : Not assigned

Assignments of the data word "Offset"

This entry can be binary-coded (in two's complement) or BCD-coded, according to the specification in the machine data.

	DW n+5				DW n+6				DW n+7			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign: Positive: Bit 8 to bit 11 = 0000
Negative: Bit 8 to bit 11 = 1111

Assignment of the user data for "Load revolution comparator"

User data for "Load revolution comparator"

DW	15 8	7 0
n+4	Bit parameter	Reserved
n+5	Reserved	
n+6		
n+7	Comparison value	
n+8	Reserved	
n+9		
n+10		

Assignments of the data word "Bit parameter"

DW n+4 is assigned as follows:
DL: Bit parameter DR: Reserved

15 ...							... 8	7 0
			X			X	X	Reserved

Bit parameter:
Bit 8 :=1 Forward direction
Bit 9 :=1 Reverse direction
Bit 10 and bit 11 : Not assigned
Bit 12 :=1 Delete revolution comparator (only in the case of cam controller)
Bit 13 to 15 : Not assigned

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Assignments of the data word comparison value

This entry is binary-coded. The comparison value is between 0 and 2^{15}.

DW n+7 is assigned as follows:

15 8	7 0
Comparison value	

Assignment of the user data for "Load actual position comparator"

User data for "Load actual position comparator"

DW	15 8	7 0
n+4	Reserved	Reserved
n+5	Comparison value	
n+6		
n+7		
n+8	Reserved	
n+9		
n+10		

Assignments of the data word comparison value

This entry can be binary-coded (in two's complement) or BCD-coded, according to the specification in the machine data.

	DW n+5				DW n+6				DW n+7			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign : Positive: Bit 8 to bit 11 = 0000
Negative : Bit 8 to bit 11 = 1111

Assignment of the user data for "Teach-In"

User data for "Teach-In" for a cam controller

DW	15 8	7 0
n+4	Track number	Cam set number
n+5	Reserved	
n+6		
n+7	On or off edge	Cam number

Assignment of the data word "Track number/cam set number"

DW n+4 is assigned as follows:
DL : Track number DR : Cam set number

15 8	7 0
Track number	Cam set number

Track number: 1 to 16
Cam set number: 1 to 255

Assignment of the data word "On/off edge/cam number"

DW n+7 is assigned as follows:
DL: On or off edge DR: Cam number

15 ...							... 8	7 0
							X	Cam number

On or off edge:
Bit 8 : =1 On edge
Bit 8 : =0 Off edge
Bit 9 to 15 : Not assigned

Cam number: 1 to 8

User data for "Teach-In" for positioning

DW	15 8	7 0
n+4	Speed identifier	Target set number
n+5	Reserved	
n+6		
n+7		
n+8	Forward changeover difference	
n+9		
n+10		
n+11	Forward cutoff difference	
n+12		
n+13		
n+14	Reverse changeover difference	
n+15		
n+16		
n+17	Reverse cutoff difference	
n+18		
n+19		

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Assignment of the data word "Speed identifier/target set number"

DW n+4 is assigned as follows:
DL: Speed identifier DR: Target set number

15 ...							... 8	7 0
							X	Target set number

Target set number: 1 to 255, binary-coded

Speed identifier:
Bit 0 : =1 Rapid traverse
Bit 0 : =0 Creep speed
Bit 1 to 7 : Not assigned

Assignment of the data words changeover difference/cutoff difference

These entries can be binary-coded (in two's complement) or BCD-coded, according to the specification in the machine data.

	ab DW n+8				ab DW n+9				ab DW n+10			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign: Positive: Bit 8 to bit 11 = 0000
Negative: Bit 8 to bit 11 = 1111

Assignment of the user data for "Simulation"

User data for "Simulation"

DW	15 8	7 0
n+4	Bit parameter [1]	Reserved
n+5	Simulation speed rapid traverse (positioning)	
n+6	Simulation speed (cam controller)	
n+7		
n+8	Simulation speed creep speed	
n+9	(positioning)	
n+10	Reserved (cam controller)	

[1] Cam controller only

Assignment of the data byte "Bit parameter"

DW n+4 is assigned as follows:
DL: Bit parameter DR: Reserved

15 ...							... 8	7 0
						X	X	Reserved

Bit parameter:
Bit 8 : Forward direction
Bit 9 : Reverse direction
Bit 10 to 15 : Not assigned

Assignment of the data word "Simulation speed"

This entry can be binary-coded (in two's complement) or BCD-coded, according to the specification in the machine data.

	DW n+5				DW n+6				DW n+7			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign: Positive: Bit 8 to bit 11 = 0000
Negative: Bit 8 to bit 11 = 1111

The assignment of the data word Simulation speed creep speed corresponds to the assignment of the data word simulation speed rapid traverse above and begins at DW n+8.

User data for actual value jobs

After the read request from the actual value job, the requested data is stored in DB-APP from DW n+4 as follows:

Assignment of the user data in the case of "Read actual values"

DW	15 ... .. 8 7 0
n+4	
n+5	Actual position
n+6	
n+7	
n+8	Speed (filtered)
n+9	
n+10	
n+11	Distance to go (positioning)
n+12	
n+13	
n+14	Reserved
n+15	

Assignment of the data words Actual position, Speed and Distance to go

These entries can be binary-coded (in two's complement) or BCD-coded, according to the specification in the machine data.

	DW n+4				DW n+5				DW n+6			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign : Positive : Bit 8 to bit 11 = 0000
Negative : Bit 8 to bit 11 = 1111

The speed is filtered according to the following algorithm:
New Speed = ((old speed * 3) + current speed) / 4

The assignment of the data words Speed and Distance to go correspond to the assignment of the data word Actual position above and begins at DW n+7 or DW n+10.

Assignment of the user data for "Function values"

DW	15 ...	.. 8 7 ...	... 0
n+4			
n+5		Coordinate offset	
n+6			
n+7			
n+8		Reserved	
n+9			
n+10	Reserved	Adaption factor	
n+11		Reserved	
n+12			

Assignment of the data word Coordinate offset

This entry can be binary-coded (in two's complement) or BCD-coded, according to the specification in the machine data.

	DW n+4				DW n+5				DW n+6			
BCD-coded		SI	10^9	10^8	10^7	10^6	10^5	10^4	10^3	10^2	10^1	10^0
Binary coded	Reserved				2^{31}							2^0

SI = Sign : Positive : Bit 8 to bit 11 = 0000
Negative : Bit 8 to bit 11 = 1111

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Assignment of the data byte "Adaption factor"

DW n+10 is assigned as follows:
DL: Reserved DR: Adaption factor

15 8	7 0
Reserved	Adaption factor

Adaption factor: 1 to 100.

8.3.4 DB-PAR Data Block

DB-PAR contains the data set jobs with the data which FB PAR transfers to the IP 288 or reads from the IP 288 when processing a job. Each job must be provided with a data area which consists of a job specification (length 4 data words) and a job-specific quantity of user data.

DB-PAR assignments

The data set jobs of the IP 288 can require large data areas. You can use a DB-PAR up to and including DW 2042. If the data quantity is such as to require a further data block, the data block with the next number is assigned. You must set up all the data areas required for data transfer before calling FB PAR.

The user data is transferred in frames whose size is parameterized in DB-ZU.

A job must always be stored in DB-PAR in such a way that the job specification is located completely in the area between data word DW 0 and DW 255.

The DB-PAR data blocks must be set up in the RAM of the CPU before initiation of the relevant job.

The data frames are stored in order in the data blocks or fetched in order from the data blocks.

First data block	
	15 0
DW n xx	Header
xx xx	1st data frame
xx xx	2nd data frame
xx xx	
xx DW xx	mmth data frame

Second data block	
	15 0
DW 0 xx	(n+mm)th data frame
xx xx	(n+mm)th data frame
xx y - xx	
y - xx DW z	mth data frame

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		15 8	7 0
	DW 0 to DW n-1		
1st job specification with user data	DW n [1]	Data block type	DB/DX number
	DW n+1	Job number	DW number
	DW n+2	Data set number	Length of the user data [2]
	DW n+3	Data set type	
	DW n+4	User data Each job requires a user data area with fixed structure	
2nd job specification with user data	DW m		
	DW m+1		
	DW m+2		
	DW m+3		
	DW m+4	User data	
	:	:	

[1] The pointer entered in application 8 points to here.
[2] Number of data words to be transferred to the IP 288 in a write job.

Data word DW n and data byte DR n+1 are not evaluated. However, you can enter the pointer from the application here (see Section 8.3.2).

When outputting a data set and when deleting a data set, you must enter 0 for the length of the user data. If you enter a length less than the actual length of the data set when entering a data set (see Sections 9.4.1 to 9.4.8) the IP 288 requests following data and continues to request it until the data set has been completely transferred.

Enter the job number of the desired data set job in data byte DL n+1 according to the table below. Enter the relevant data set number depending on the job in data byte DL n+2 and enter the type of the accessed data set in data word DW n+3 as a sequence of ASCII characters.

The following applies for the data set types:

ID = SYSID
MD = Machine data
DM = Machine data directory
ZS = Target set
ZL = Target list
DZ = Target list directory
NS = Cam set
DN = Cam set directory

The structure of the data sets is described in Chapter 9.

Typical FB PAR jobs

	Job number	Job	Length of the user data (in words)	User data provided (in words)	Valid data set number 1 to 255
Read jobs	64	Directories DN DZ DN	 0 0 0	 7 7 + 1 bytes per ZS 8+2 per NS	In job specification
	64	Data sets ID MD ZL ZS NS	 0 0 0 0 0	 14 63 7+3 per short ZS/15 per long ZS 10 in the case of short ZS/22 for long ZS 11+5 per cam	In job specification
Write jobs	65	Data sets ID MD ZL ZS NS	 (6) (63) (7+x) (10/22) (11+x)	 6 63 7+3 per short ZS/15 per long ZS 10 in the case of short ZS/22 for long ZS 11+5 per cam	In job specification/user data (data set header)
Delete jobs	66	Data sets MD ZL ZS NS	 0 0 0 0	 - - - -	In job specification

8.3.5 Transfer Errors

Bit 0 to bit 7:

The table below contains the error numbers generated by the FBs and indicated in accumulator 1. Some of these error numbers are also entered in DB-ZU or in the processed application mailbox. Other error numbers can occur as well as the error numbers described here. These other numbers are generated by the IP 288 and are described in Section 9.5.

Error No.	Cause of error	Indicated in		
		Accu1	DB-ZU	Appl.
1	DB-APP DW 255 or DB-PAR DW 255 exceeded	x	x	x
2	Frame error	x	x	x
3	Data set does not exist	x	x	x
4	Erroneous job specification, wrong job number, wrong axis, wrong data set number	x	x	x
5	Data interface busy	x	x	x
100	Wrong CPU (not in the case of S5-155U)	x		
101	Wrong IP number	x		

Error No.	Cause of error	Indicated in		
		Accul	DB-ZU	Appl.
102	DB-ZU number not permissible	x		
103	DB-ZU does not exist	x		
104	DB-ZU too short	x		
110	Wrong IP ID	x	x	
111	DB-IP number not permissible	x	x	
112	DB-IP does not exist	x	x	
113	DB-IP too short	x	x	
114	Wrong addressing type	x	x	
115	Impermissible page number	x	x	
116	QVZ (timeout) error	x	x	
130	Number of monitoring cycles < 0 or > 127	x	x	
131	Cyclic processing page area (page 1) occupied[1)]	x	x	
132	IP failure	x	x	
133	IP does not respond (read actual value frames)	x	x	
200	Control/actual value jobs page area occupied[1)]	x	x	x
201	DB-APP type not permissible (control/actual value jobs)[1)]	x	x	x
202	DB-APP number not permissible (control/actual value jobs)	x	x	x
203	DB-APP does not exist (control/actual value jobs)	x	x	x
204	DB-APP too short (control/actual value jobs)	x	x	x
205	DB-APP DW 255 exceeded (control/actual value jobs)	x	x	x
206	DB-APP type not permissible (following job)[1)]	x	x	x
207	DB-APP number not permissible (following job)	x	x	x
208	DB-APP does not exist (following job)	x	x	x
209	DB-APP too short (following job)	x	x	x
210	DB-APP DW 255 exceeded (following job)	x	x	x
211	IP does not respond (initiate interrupt on page [1)]	x	x	x
212	IP does not respond (job checkback signal)	x	x	x
213	Job aborted due to resynchronization (control/actual value jobs)[2)]	x	x	x
220	Data set jobs page area occupied[1)]	x	x	x
221	DB-PAR type not permissible (data set jobs)[1)]	x	x	x
222	DB-PAR number not permissible (data set jobs)	x	x	x
223	DB-PAR does not exist (data set jobs)	x	x	x
224	DB-PAR too short (data set jobs)	x	x	x
225	DB-PAR DW 255 exceeded (following job)	x	x	x
226	DB-PAR type not permissible (following job)[1)]	x	x	x
227	DB-PAR number not permissible (following job)	x	x	x
228	DB-PAR does not exist (following job)	x	x	x
229	DB-PAR too short (following job)	x	x	x
230	DB-PAR exceeded (following job)	x	x	x
231	IP does not respond (initiate interrupt on page 2)	x	x	x
232	IP does not respond (job checkback signal)	x	x	x
233	Job aborted due to resynchronization (data set jobs) [2)]	x	x	x
234	Transfer number < 0 or > 255	x	x	
240	IP does not respond (initiate interrupt on page 2)	x	x	x
241	IP does not respond (read interrupt frames)	x	x	x

1) Not in the case of the S5-115U
2) The job has been rejected or it was not used properly. Repeat the job

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8.4 How Do You Use the Function Blocks?

Assignment of accumulator 2 after calling a function block:
The error numbers of the data set errors and the additional information are generated by the IP 288 and are described in Section 9.5.

Multiprocessor mode

In multiprocessor mode, you assign each IP 288 to a specific CPU. You must not access one and the same IP 288 from different CPUs.

The maximum number of 16 IP 288s is determined by the assignment of the DB-ZU data block. The permissible number of IP 288 can be multiplied depending on the number of DB-ZU data blocks in one CPU. The address of the IP 288 (page number) must only be assigned once within the overall programmable controller.

8.4.1 Interrupt Response

The FB ZYK and FB PAR function blocks cannot be interrupted during data transfer from and to the IP 288. This applies for transfer of the control signals and checkback signals as well as for the processing of a job.

In the case of interrupt processing, you must call FB INT in the interrupt organization block which corresponds to the interrupt line set on the module via the SYSID parameters (depending on the PLC used, the CPU and the slot. The interrupt causes are defined in the machine data. FB INT has no block parameters and is parameterized via the assignment of accumulator 1.

Interrupt line	In programmable controller	Calls
IRA	S5-115U (CPU 941B to 944B)	OB 2
	S5-135U-KA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 11
	S5-135U-UA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 11
	S5-155U (CPU 946/947, CPU 922, CPU 928, CPU 928B)	OB 2, slot 11
IRB	S5-115U (CPU 941B to 944B all CPUs)	OB 3
	S5-135U-KA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 19
	S5-135U-UA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 27
	S5-155U (CPU 946/947, CPU 922, CPU 928, CPU 928B)	OB 2, slot 51
IRC	S5-115U (CPU 941B to 944B)	OB 4
	S5-135U-KA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 27
	S5-135U-UA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 43
	S5-155U (CPU 922, CPU 928, CPU 928B)	OB 2, slot 91
IRD	S5-115U (CPU 941B to 944B)	OB 5
	S5-135U-KA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 35
	S5-135U-UA (CPU 922, CPU 928, CPU 928B)	OB 2, slot 59
	S5-155U (CPU 922, CPU 928, CPU 928B)	OB 2, slot 99

If you evaluate the interrupts level-driven, you can set several IP 288s on one interrupt line. You must call FB INT once per interrupt-initiating IP 288 in the user program so that you can determine the modules from which the interrupt was initiated, read the cause of the interrupt and acknowledge the interrupt.

8.4.2 Interrupting the User Program with Process Interrupts and Time Interrupts

Depending on the PLC used or the CPU used, the user program is interrupted at different points and the interrupt makes different requirements on the program structure.

S5-115U

The user program in the S5-115U is always interrupted at operation boundaries. If you have programmed interrupt OBs in the user program, you must ensure that the scratchflag area (FY 200 to FY 255) is saved at the beginning of the interrupt OB and loaded again before exiting. You must use FB 38 and FB 39 for this purpose.

If you use the IP 288 in the S5-115U or if you also use additional modules with page addressing, you must take account of the following:

- If you connect a page or call a block in the cyclic program, you must first save this page number in the user program. Make sure in the interrupt routine that the page saved in the cyclic program is switched back in again before exiting the interrupt OB. You must use FB 38 and FB 39 for this purpose.
- The IP 288 has pages. However, the standard function blocks for the IP 288 communicate with the IP 288 via only one page in each case. FB ZYK works with the first page and FB PAR with the second. For this reason, you must always save the number of the first page (set on the IP 288) before calling FB ZYK. You must save the number of the second page before calling FB PAR.

S5-135U, CPU 922

The user program in the S5-135U, CPU 922 is always interrupted at the block boundaries or at the operation boundaries if data block DX 0 is parameterized accordingly. If you have programmed interrupt OBs in the user program, you must ensure that the scratchflag area (FY 200 to FY 255) is saved at the beginning of the interrupt OB and loaded again before exiting. You must use FB 38 and FB 39 for this purpose.

If you use the RS data RS 60 and RS 61 in the interrupt-driven program or if you call blocks there which use this RS data, you must ensure that this data is saved at the beginning of the interrupt OB and loaded again before exiting.

S5-135U, CPU 928, CPU 928B

The user program in the S5-135U, CPU 928, CPU 928B is always interrupted at the block boundaries or at the operation boundaries if data block DX 0 is parameterized accordingly. If you have programmed interrupt OBs in the user program, you must ensure that the scratchflag area (FY 200 to FY 255) is saved at the beginning of the interrupt OB and loaded again before exiting. You can use the integral function OBs 190 to 193 for this purpose.

S5-155U

The user program in the S5-155U, is always interrupted at the block boundaries or at the operation boundaries if data block DX 0 is parameterized accordingly. If you have programmed interrupt OBs in the user program, you must ensure that the scratchflag area (FY 200 to FY 255) is saved at the beginning of the interrupt OB and loaded again before exiting. You must use FB 38 and FB 39 for this purpose.

All PLCs

The following applies for all programmable controllers:
The function blocks FB 38 and FB 39 or OB 190 and OB 191 work in conjunction with a data block (DB 150 in the example). You must set up this data block up to and including data word DW 816. You must always use the function blocks in pairs, i.e. the interrupt OBs must not be exited before time.

Note
If you use the IP 288 in the S5-155U, you must operate the CPU 946/947 in 155U mode. For this purpose, you must set 155U mode in data block DX 0.

8.4.3 Restart Characteristics

There are different restart types in the individual PLCs:

PLC	OB 20	OB 21	OB 22
S5-115U	Not available	Manual cold restart	Automatic cold restart
S5-135U	Cold restart	Manual warm restart [1]	Automatic warm restart [1),2]
S5-155U	Cold restart	Manual warm restart [3]	Automatic warm restart [4]

1) When using the IP 288 in the S5-135U, manual and automatic warm restart are not permitted. Program the statement "STP" (direct transition to the Stop state) in the warm restart OBs (OB 21, OB 22)

2) By making the appropriate setting in data block DX 0, you can execute the "Automatic cold restart" function instead of the "Automatic warm restart" function. After power restore, OB 20 is then processed instead of OB 22 and cyclic program execution is started at the beginning of OB 1.

3) When using the IP 288 in the S5-155U, manual warm restart is not permitted. Program the statement "STP" (direct transition to the Stop state) in the warm restart OB (OB 21). You can convert the "Automatic warm restart" function into the "Automatic cold restart" function by making settings in the data block DX 0. You will find a precise description of the restart types in the S5-155U Manual.

4) When using the IP 288 in the S5-155U, manual warm restart is not permitted. Program the statement "STP" (direct transition to the Stop state) in the warm restart OB (OB 22). You can convert the "Automatic warm restart" function into the "Automatic cold restart" function by making settings in the data block DX 0. You will find a precise description of the restart types in the S5-155U Manual.

Transfer errors 213/233 can occur during warm restart. They can be ignored.

Synchronization

It is not necessary to call a function block in the restart program. However, you must synchronize the IP 288 with the function block at every restart. Synchronization is initiated via the synchronization control word (DW n+10) in the DB-ZU data block. For this purpose, enter the value KF = +1 in the synchronization control word. You must then not use the control word further.

The function block must be called several to complete a full synchronization. Synchronization can be executed either by FB ZYK or by FB PAR. However, the function block which starts synchronization must also finish it.

Correct data exchange between the IP 288 and the CPU can only take place when the "IP synchronized" bit (bit 15) in the job status word (DW n+3 in an application) has signal state 0.

The time required to complete synchronization depends on the module status. In RUN, this time is 1 second and in restart of the IP 288 up to 10 seconds. After this time, the "IP not synchronized" bit in the job status word must have signal status 0, if not, the module is defective.

A job initiated but not yet completed before resynchronization is aborted by the synchronization with the relevant error signal.

8

Controlling axes with FB ZYK

Proceed as follows to control an axis with FB ZYK:

Step	Action
1	Set up a job specification with user data for a control job in DB-APP (Section 8.3.3).
2	Enter an application pointer (application 1 to 7) to this job specification (Section 8.3.2).
3	Select the application by setting the relevant bit in DW 64 of DB-IP.
4	Wait until the first data word of the selected application (DW n) = 0.
5	Now you can evaluate the job status byte (DL n+3) in the selected application, in DB-ZU (DW n+3) or in accumulator 1. (Job completed **without** errors/job completed **with** errors).
	– If the job has been completed with errors, there was an error in the transfer of the job specification. You can read out the cause of error in the transfer error (DR n+3) of the selected application, or from DB-ZU (DW n+3) or from accumulator 1 (Section 8.3.5).
	– If the job has been completed without errors, the job specification was transferred error-free to the IP 288.

Step	Action
6	Wait until the relevant control bit image in the axis status word (DW 86 in DB-IP) has been reset. For this purpose, you must enable frame 1 of the checkback signal for the axis used by selecting the relevant frame in DW 65 in DB-IP.
7	Set the "Control signals axis x" control bit in DB-IP required for this control job.
8	Transfer the control signals to the IP 288 by ticking the relevant control frame in "Select Write control signals" (DW 66 in DB-IP).
9	Wait until the relevant control bit image in the axis status word (DW 86 in DB-IP) has been set.
10	Now you can evaluate the operator error (in frame 1 of the checkback signals). – If the operator error = 0, the initiated job has been executed error-free by the IP 288. – If the operator error ≠ 0, the initiated job is not accessible at the moment or it contains errors (Section 9.5.7)
11	Reset the relevant "Control signals axis x" control bit in DB-IP and transfer the control signals to the IP 288 again (DW 66 in DB-IP). The relevant control bit image in the axis status word (DW 86 in DB-IP now changes back to zero. The IP 288 can now process a new control job.

Repeated execution of a traverse

The user data of a control job (job specification) transferred to the IP 288 can be used several times (e.g. in the case of relative increment mode), if you set and transfer the relevant bit again after the end of a traverse.

Simultaneous start of several axes

If several axes are to start simultaneously, FB ZYK must transfer the traverse job for the first axis (the first two axes) first without control bits. The control bits of all axes are then transferred with the traverse job of the last axis. After the IP 288 has interpreted all modes, the axes start simultaneously.

Setting the control bit

Note
You must only set a control bit if the relevant control bit image = 0. The IP 288 then sets the control bit image when the control has been set and the relevant interpretation, with or without errors has been completed. It also sets the control bit image if the relevant action is momentarily not permissible.

You delete the control bit (with the exception of T+ and T-) when the control bit image has been set. You delete the T+ and T- control bits when you want to terminate the "Jog" mode.

The IP 288 deletes the control bit image when the control bit has been deleted and the action has been completed. It also deletes the control bit image if the relevant action is momentarily not permissible.

8.5 Programming Example

You will find the example described below in the files for the individual programmable controllers on the diskettes supplied. The example gives you a quick introduction to handling and to the principle of operation of the function blocks.

The programming examples are located in the following files on the diskettes supplied:

• S5-115U	S5TC50ST.S5D
• S5-135U (CPU 922)	S5TC22ST.S5D
• S5-135U (CPU 928, CPU 928B)	S5TC23ST.S5D
• S5-155U	S5TC60ST.S5D

You can initiate jobs via digital inputs. Signal states are indicated via digital outputs.

To carry out the example you must first follow Section 8.5.1 "Preparation". It contains a sequence of steps for startup and also some general conventions.

Continue then in Section 8.5.2 if you want to execute the example for the "Cam controller" axis function, and in Section 8.5.3 for the "Positioning" axis function.

A number of IP 288 functions are executed in the example. The example has been designed in such a way as to allow you to link in further functions.

8.5.1 Preparation

Hardware requirements

You require the following hardware for the example supplied:

- A programmable controller with CPU (see Chapter 3)
- A programmer with connecting cable to the CPU
- An IP 288 positioning module
- A digital input module (32 inputs) with 16 switches
- A digital output module (32 outputs)
- A 24 V load power supply

You must execute the following steps:

Step	Action
1	Coding block and plug-in jumpers on the IP 288 Set the IP 288 to page addressing with page number 0 (see Section 4.1). Check the other coding switches and the assignment of the plug-in jumpers (see Section 4.1).

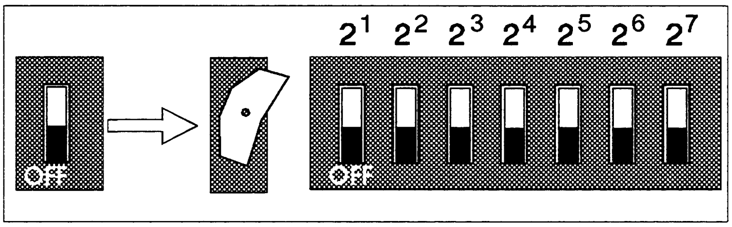

Fig. 8.3 Page number 0 set

Step	Action
2	Plugging in the IP 288 and the CPU Plug the IP 288 into the programmable controller. In the programming example, interrupts are processed via the IRA interrupt line. Take special care with the S5-1135U and S5-155U to ensure that the CPU and the IP 288 are located in slots in which the selected interrupt line (IRA in the example) is available (see Section 4.2 and the CPU manual).
3	24 V load voltage Connect the 24 V load voltage to the IP 288 (see Section 3.2).
4	Plugging in the digital modules Determine the addresses of the digital input and output modules (input words IW 4 and IW 6 and output words QW 8 and QW 10 in the example) and set these addresses. You can use other addresses if you adapt program block PB 10. Plug the digital modules into permissible slots. Wire the digital modules according to the relevant description.

Step	Action
5	Switching on and transferring the program Switch on the programmable controller and the load voltage. Transfer the entire program to the user memory of the PLC. Set all inputs to switch position "0" and execute a cold restart of the CPU. During synchronization, output Q 10.7 is set (IP not synchronized). After synchronization is complete, only output Q 10.0 is set (no job in progress).
6	Reading checkback signals cyclically You select reading of the checkback signals in data word DW 65 of DB-IP. The values read are stored at the location provided in DB-IP (data block DB 113 in the area between data word DW 84 to DW 115). You must select the two frames of axis 1 in the "Select cyclic reading of checkback signals" with the FORCE VAR programmer function (see Variables Block VB2: DW 65 bit 1 = 1 and bit 2 = 1).

Inputs and outputs

The program is designed in such a way that you can easily transpose it to other input or output bytes. Blocks FB 10 and OB 2 work with flags only instead of inputs/outputs. The inputs and outputs used are assigned to these flags in program block PB 10. In the example, these are the input words IW 4 and IW 6 and the output words QW 8 and QW 10.

If you want to use other input words or output words, you need only adapt program block PB 10 (the addresses of the digital modules must be set accordingly).

I 4.0	Enter job	Q 8.0	PAFE FB-ZYK
I 4.1	Appl. mailbox 1 or 8	Q 8.1	PAFE FB-PAR
I 4.2	Del. interrupt indicators	Q 8.2	PAFE FB-INT
I 4.3	Delete error indicators	Q 8.3	
I 4.4	Job selection 2^0	Q 8.4	
I 4.5	" 2^1	Q 8.5	Interrupt initiated
I 4.6	" 2^2	Q 8.6	
I 4.7	" 2^3	Q 8.7	Appl. mailbox occupied

I 5.0	START	Q 9.0	Forward direction
I 5.1	STOP	Q 9.1	Reverse direction
I 5.2	CONT	Q 9.2	In rapid traverse range
I 5.3	T+	Q 9.3	In creep speed range
I 5.4	T-	Q 9.4	In cutoff range
I 5.5	ON	Q 9.5	In target range
I 5.6	OFF	Q 9.6	In zero speed range
I 5.7	EXFQ	Q 9.7	Position reached

I 6.0		Q 10.0	No job in progress
I 6.1		Q 10.1	Job in progress
I 6.2		Q 10.2	Job completed without errors
I 6.3		Q 10.3	Job completed with errors
I 6.4		Q 10.4	
I 6.5		Q 10.5	
I 6.6		Q 10.6	
I 6.7		Q 10.7	IP not synchronized

I 7.0		Q 11.0	Transmission error
I 7.1		Q 11.1	"
I 7.2		Q 11.2	"
I 7.3		Q 11.3	"
I 7.4		Q 11.4	"
I 7.5		Q 11.5	"
I 7.6		Q 11.6	"
I 7.7		Q 11.7	"

Outputs Q 8.0 to Q 8.2 are set and latched as soon as the relevant function block FB ZYK, FB PAR or FB INT detects a transfer or data set error. Output Q 8.7 is set and latched if a job is to be entered in an application mailbox which is still occupied. The application mailbox becomes free when you enable the relevant application (see job selection) or when you delete the first data word of the application mailbox. You can delete outputs Q 8.2 and Q 8.7 with input I 4.3.

The job status and transfer error word (output word QW 10) depends on the application mailbox set (see input I 4.1). In the case of application 1, the status of FB ZYK is indicated and in the case of application 8, the status of FB PAR is indicated.

Assignment of job status and transfer error (see Section 8.4).

Assignment of the flag area

FY 4	Image of IB 4
FY 5	Image of IB 5
FY 6	Image of IB 6
FY 7	Image of IB 7
FY 8	Image of QB 8
FY 9	Image of QB 9
FY 10	Image of QB 10
FY 11	Image of QB 11
FY 20	Job status of FB ZYK (contents of Accu 1)
FY 21	Transfer error of FB ZYK (contents of Accu 1)
FY 22	
FY 23	
FY 24	Job status of FB PAR (contents of Accu 1)
FY 25	Transfer error of FB PAR (contents of Accu 1)
FY 26	Data set error of FB PAR (contents of Accu 2)
FY 27	Additional information of FB PAR (contents of Accu 2)
FY 28	Job status of FB INT (contents of Accu 1)
FY 29	Transfer error of FB INT (contents of Accu 1)
FY 30.0	Edge flag for I 4.0
FY 31.0	Pulse flag for I 4.0
FY 32	Auxiliary flag byte for application number
FY 33.0	PAFE FB38/FB39 (S5-115U only)

Assignment of the data area

DX 0	Defaults for the system program (not in the S5-115U)
DB 10	List of the available jobs (pointer to DB-APP or DB-PAR)
DB 111	Data block DB-ZU
DB 113	Data block DB-IP for IP 288 (IP number = 1)
DB 150	Auxiliary DB for saving scratchflags and page numbers (S5-115U) Auxiliary DB for saving scratchflags and RS data (S5-115U, CPU 922) Auxiliary DB for saving scratchflags (S5-135U, CPU 928, CPU 928B and S5-155U)
DB 200	Data area DB-APP for selecting job 0
DB 201	Data area DB-APP for selecting job 1
DB 202	Data area DB-APP for selecting job 2
DB 203	Data area DB-APP for selecting job 3
DB 204	Data area DB-APP for selecting job 4
:	:
DB 215	Data area DB-APP for selecting job 15

Block assignments

OB 1	Cyclic program processing
OB 2	Interrupt processing IR-A
OB 13	Time-driven processing
OB 20	Manual cold restart (not on S5-115U)
OB 21	Manual warm restart (manual cold restart in the S5-115U)
OB 22	Automatic warm restart (automatic cold restart in S5-115U)
PB 10	Programming example
FB 10	Communication with the IP 288 Calling FB ZYK Calling FB PAR
FB 38	Saving flags (also saving page numbers in S5-115U)
FB 39	Loading flags (also loading page numbers in S5-115U)

Job selection

Data blocks DB 10, DB 200 to DB 204 and DB 207 to DB 212 are set up in the example for job selection. DB 10 is the central block here. It contains a pointer list for all jobs in the example. Selection of a job is made via inputs I 4.4 with value 2^0 to I 4.7 with the value 2^3.
Each pointer points to the data in data area DB-APP/DB-PAR belonging to the job. When the job is initiated, this pointer is copied into the first two data words of the application mailbox selected.

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List of the available jobs. The first data word of the job specification is always DW 0.

Job	I 4.7	I 4.6	I 4.5	I 4.4	Relevant DB
Set actual value	0	0	0	0	DB 200
Read actual value	0	0	0	1	DB 201
Simulation	0	0	1	0	DB 202
Jog (positioning)	0	0	1	1	DB 203
Relative increment mode (positioning)	0	1	0	0	DB 204
Free for user	0	1	0	1	DB 205
Free for user	0	1	1	0	DB 206
Write SYSID	0	1	1	1	DB 207
Write machine data cam controller (cam controller)	1	0	0	0	DB 208
Read machine data cam controller (cam controller)	1	0	0	1	DB 209
Write cam set (cam controller)	1	0	1	0	DB 210
Write machine data positioning (positioning)	1	0	1	1	DB 211
Read machine data positioning (positioning)	1	1	0	0	DB 212
Free for user	1	1	0	1	DB 213
Free for user	1	1	1	0	DB 214
Free for user	1	1	1	1	DB 215

Job selection procedure

You require job selection to execute the example in Section 8.5.2 and 8.5.3. Proceed as follows where you have to execute job selection in the example:

Step	**Action**
1	Disabling the application mailbox You must disable the application mailbox via the FORCE VAR programmer function in data word "Select application mailboxes" (DB 113, DW 64) (see variables block VB 1). **Example: Simulation** DB 113 DW 64: KM = 00000000 00000000 All application mailboxes disabled
2	Select job You select a job with I 4.4 to I 4.7. **Example: Simulation** 0010 : Job selection = 2 DW 4 and DW 5 in DB 10 are valid
3	Select application mailbox You must select via input 4.1 whether the job is to be entered in application mailbox 1 (I 4.1 = 0) or application mailbox 8 (I 4.1 = 1). You must enter control/actual value jobs (job selection 0 to 4) in application mailbox 1, and data set jobs (job selection 7 to 12) in application mailbox 8. **Example: Simulation** I 4.1 = 0 Application mailbox 1 is selected.

<table>
<tr><th>Step</th><th>Action</th></tr>
<tr><td>4</td><td>Entering the job in the application mailbox
A job is entered in the selected application mailbox with a rising edge at input I 4.0. An entry can only be made if the application mailbox is empty, i.e. if the first data word of the application mailbox contains the value KY = 0,0.
Otherwise, output Q 8.7 "Application mailbox occupied" is set.</td></tr>
<tr><td>5</td><td>Check the entry
You can check that the job has been entered in the selected application mailbox in data block DB-IP using the FORCE VAR programmer function.
The application mailbox is located in data block DB 113 from data word DW 32 to DW 36. Application mailbox 8 is located in data block DB 113 from data word DW 60 to DW 64 (see variables block VB1).

Example: Simulation entered in application mailbox 1
DB 113: DW 32: KY = 0,202
Job data in DB 202
DW 33: KY = 0,0
Job data begins from DW 0</td></tr>
<tr><td>6</td><td>Enable the application mailbox
No application mailbox is enabled (DW 64: KM = 00000000 00000000) in data word "Select application mailboxes" (DB 113, DW 64).
You must enable the application mailbox in data word "Select application mailboxes" with the FORCE VAR programmer function. (see variables block VB1).

Example: Simulation
DB 113 DW 64: KM = 00000000 00000001
Enable application mailbox 1</td></tr>
<tr><td>7</td><td>Check job status
You can check that the job has been processed in the selected application mailbox in data block DB-IP using the FORCE VAR programmer function (see variables block VB1).
After the job has been processed by FB ZYK (application mailbox 1) or FB PAR (application mailbox 8), the
1st data word of the application mailbox is deleted and the job status is located in the 4th data word of the mailbox.

Example: Simulation in application mailbox 1
DB 113: DW 32 KY 0,0
Job processed
DW 33: KY 0,0
DW 34: KY 0,0
DW 35: KY 4,0
Job completed without errors</td></tr>
</table>

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Follow this procedure for all other job selections in the programming example.

Interrupt processing general

Interrupt processing is programmed in organization block OB 2 in the programming example. Causes of interrupt are read as soon as the IP 288 intitiates an interrupt. The values read by function block FB INT are located in data block DB-IP (see variables block VB2: DB 113, DW 204 to DW 210).

Output Q 8.5 indicates an initiated interrupt with latching. It can be deleted with input I 4.2.

8.5.2 Procedure for Cam Controller

You are operating axis 1 of the IP 288 as a cam controller. The actual value is generated by the IP 288 via the simulation function. You need not connect a position encoder.

The procedure requires that the IP 288 is not parameterized.

Execute the following steps in the order shown.

Step	Action
1	Write SYSID parameters You write the SYSID parameters to the IP 288 with job selection 7 (see Section 8.5.1): application mailbox 8, I 4.1 = 1 The SYSID is stored in data block DB 207 from data word DW 4 (see Section 9.4.1) and includes the following entries: Effect of S5 CPU failure : Switch off all outputs. Interrupt line: : Interrupts on IRA line
2	Write machine data cam controller You write the machine data of axis 1 to the IP 288 with job selection 8 (see Section 8.5.1): application mailbox 8, I 4.1 = 1. The machine data is stored in data block DB 208 from data word DW 4 (see Section 9.4.2). The machine data set for the cam controller contains the following entries: Data set type : Machine data Data set number : MD 1 Axis : 1 Module number : 1 Measuring system : mm Axis function : Cam controller Axis type : Rotary axis Accuracy range : 0.1 mm[1)] Basic data set : No Process interrupt at: Start/end of cam : No Position reached Length measurement completed : No Actual position comparator tripped : No Number of revolutions reached : No Diagnostics interrupt : None Number format to the S5 CPU : BCD Number format from the S5 CPU: BCD Switching of the digital outputs : Output 1 -> not wired Output 2 -> not wired Output 3 -> not wired Output 4 -> not wired Coordination input : not wired

1) The value has to be adapted if an encoder is connected.

Step	Action
2 Continued	Encoder type : 24 V incr. encoder without IP monitoring [1] Encoder rotational direction to direction of travel :Same Increments/encoder revolution : 2500 increments [1] Path/encoder revolution : 100.000 mm Encoder revolutions : 1 Start of traversing range : 0.0 mm End of traversing range : 1000.0 mm Reference point coordinate : 500.000 mm Zero mark position : Forward Start of software switch : End of software switch : Hysteresis : 0.0 mm You must select both frames of axis 1 in the data word "Select cyclic reading of checkback signals" with the FORCE VAR programmer function (see variables block VB2: DW 65 bit 1 = 1 and bit 2 = 1) In the axis status word, "Axis parameterized" is set (see variables block VB2: DW 85, bit 9)
3	Write cam set You write cam set 1 of axis to the IP 288 with job selection 10 (see Section 8.5.1): application mailbox 8, I 4.1. The cam set is stored in data block DB 210 from data word DW 4. It contains only path cams for track 1 which are switched in both directions. The start of cam 3 is selected for later interrupt processing (see Steps 8 to 14).

[1] The value has to be adapted if an encoder is connected.

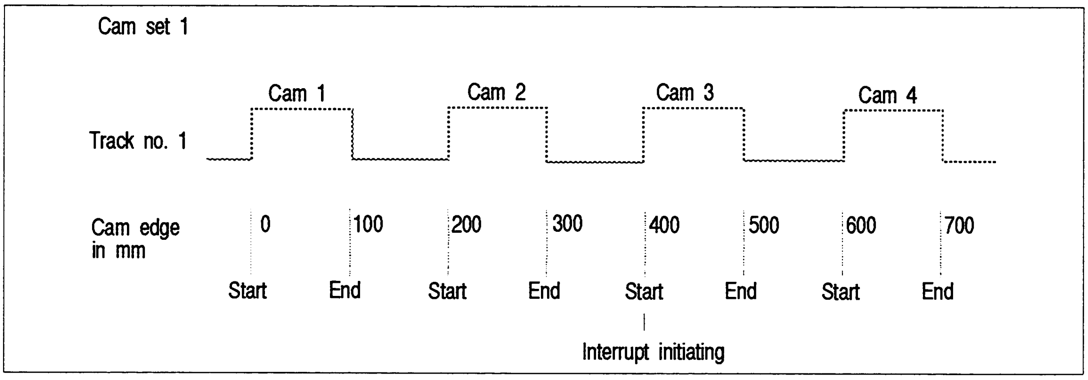

Fig. 8.4 Structure of the first track

Step	Action
4	Set actual value You write the Set actual value job for axis 1 to the IP 288 with job selection 0 (see Section 8.5.1): application 1, I 4.1 = 0. The job data has the following meanings: Immediate execution by control bit ON. Actual value coordinate 0 mm. The data is in data block DB 200 from data word DW 4 (see Section 8.3.3). Execution takes place when you set input I 5.5. The program example is designed in such a way as to set the ON control bit in the control signals for axis 1 (DB 113, DW 186, bit 8) when the input is energized and simultaneously to initiate transfer of the control signals to the IP 288 (DB 113, DW 66, bit 1). In the axis status word, "Axis synchronized" and "Image ON" are set (see variables block VB2: DW 85, bit 10 and DW 86, bit 8). The actual value indicated is 0 (see variables block VB2: DW 100 to DW 102). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Reset input I 5.5 after execution. This deletes and transfers the ON control bit. In the axis status word, "Image ON" is deleted (see variables block VB2: DW 86, bit 8).
5	Switch Simulation on You write the simulation job for axis 1 to the IP 288 with job selection 2 (see Section 8.5.1): application mailbox 1, I 4.1 = 0. The job data has the following meanings: simulation speed 5000.000 mm/min forward. The data is located in data block DB 202 from data word DW 4 (see Section 8.3.3). Execution takes place when you set I 5.5 (ON control bit). The program example then transfers the control signals of axis 1 to the IP 288. "Simulation" is set in the "Current functions" data word (see variables block VB2: DW 88, bit 12). In the axis status word, "Image ON" is set (see variables block VB2: DW 86, bit 8). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Reset input I 5.5 after execution. This deletes and transfers the ON control bit. In the axis status word, "Image ON" is deleted (see variables block VB2: DW 86, bit 8). The actual value changes with the simulation speed in the forward direction (see variables block VB2: DW 100 to DW 102). Cams are not switched since cam track 1 has not yet been enabled.

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Step	Action
6	Enable cam track 1 You must enable cam track 1 in the individual functions for axis 1 with the FORCE VAR programmer function (see variables block VB2: DW 188, bit 8 = 1). Now write the control signals of axis 1 to the IP 288. You must set the control for axis 1 in the data word "Select write control signals" with the FORCE VAR programmer function (see variables block VB2: DW 66, bit 1 = 1). The bit is reset by the function block FB ZYK as soon as the transfer is complete. "Cam track 1 enabled" is set in the "Current functions" data word (see variables block VB2: DW 90, bit 8).
7	Evaluate checkback signals The cams of track 1 are not switched depending on the actual value. variables block VB2: Actual position DW 100 to DW 102 Track ID bits DW 84, bit 0 for track 1. Cam bits DW 103, bit 8 to bit 15 for track 1. You can change the job data for simulation in DB 202 (simulation speed and direction, see Section 8.3.3) and then activate (see Step 5). The actual value does not change when simulation speed is 0.

Interrupt processing cam controller

If you want to operate the cam controller with interrupts to the S5 CPU, execute the following steps:

Step	Action
8	Disable cam track 1 You must disable cam track 1 in the individual functions for axis 1 with the FORCE VAR programmer function (see variables block VB2: DW 188, bit 8 = 1). Now write the control signals of axis 1 to the IP 288. You must set the control for axis 1 in the data word "Select Write control signals" with the FORCE VAR programmer function (see variables block VB2: DW 66, bit 1 = 1). The bit is reset by the function block FB ZYK as soon as the transfer is complete. "Cam track 1 enabled" is deleted in the "Current functions" data word (see variables block VB2: DW 90, bit 8).

Step	Action
9	Switch simulation off You write the simulation job for axis 1 to the IP 288 with job selection 2. If you have not executed a job selection since Step 6, you need not select this job. Execution takes place when you set I 5.6 (OFF control bit). "Simulation" is deleted in the "Current functions" word (see variables block VB2: DW 86, bit 9). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Reset input I 5.6 after execution. This deletes and transfers the OFF control bit. In the axis status word, "Image OFF" is deleted (see variables block VB2: DW 86, bit 9). The actual value does not change (see variables block VB2: DW 100 to DW 102).
10	Adapt machine data cam controller In the process interrupt machine data, you must enable interrupts at the start/end of the cam. You correct the entry in data word DW 12 from KY 0,0 to KY 0,1 using the BLOCK OUTPUT programmer function, Device: PLC and Block DB 208. Store the changed data block DB 208 in the PLC. Write the machine data to the IP 288 by executing Step 2.
11	Set the actual value Execute Step 4
12	Switch Simulation on Execute Step 5
13	Enable cam track 1 Execute Step 6
14	Evaluate checkback signal See Step 7 In addition, variables block VB2 contains "Indicate interrupt on which axis", "Process interrupt/diagnostics interrupt" and "Cam edge indicator in the case of cam edge process interrupt". When travelling across the start of cam 3, the IP 288 initiates an interrupt to the S5 CPU. variables block VB2: Indicate interrupt on which axis — DW 67, bit 0 = 1 Process interrupt/diagnostics interrupt — DW 204, bit 8 = 1 Cam edge indicator — DW 207 = 0 DW 208, bit 0 = 1

You can supplement further IP 288 functions in the example. For this purpose, use the free job selection numbers 5, 6, 13, 14 and 15. You must also generate the relevant data blocks. In addition, you can change the job data in the relevant data blocks DB 200 to DB 215.

8.5.3 Procedure for Positioning

You are operating axis 1 of the IP 288 as positioning. In doing so, the actual value is generated by the IP 288 via the simulation function as soon as a traverse has been started. You need not connect a position encoder.

The procedure requires that the IP 288 is not parameterized.

Execute the following steps in the order shown.

Step	Action
1	Write SYSID parameters You write the SYSID parameters to the IP 288 with job selection 7 (see Section 8.5.1): application mailbox 8, I 4.1 = 1 The SYSID is stored in data block DB 207 from data word DW 4 (see Section 9.4.1) and includes the following entries: Effect of S5 CPU failure : Switch off all outputs. Interrupt line : Interrupts on IRA line
2	Write machine data cam controller You write the machine data of axis 1 to the IP 288 with job selection 11 (see Section 8.5.1): application mailbox 8, I 4.1 = 1. The machine data is stored in data block DB 211 from data word DW 4 (see Section 9.4.2). The machine data set for the cam controller contains the following entries: Data set type : Machine data Data set number : MD 2 Axis : 1 Module number : 1 Measuring system : mm Axis function : Cam controller Axis type : Rotary axis Accuracy range : 0.1 mm[1)] Basic data set : No Process interrupt at: Start/end of cam : Position reached :No Length measurement completed :No Actual position comparator tripped :No Number of revolutions reached :No Diagnostics interrupt : None Number format to the S5 CPU : BCD Number format from the S5 CPU: BCD Switching of the digital outputs: Output 1 -> not wired Output 2 -> not wired Output 3 -> not wired Output 4 -> not wired Coordination input : not wired

[1)] The value has to be adapted if an encoder is connected.

Step	Action
2 Continued	Encoder type : 24 V incr. encoder without IP monitoring [1] Encoder rotational direction to direction of travel: Same Increments/encoder revolution: 2500 increments[1] Path/encoder revolution : 100.000 Encoder revolutions : 1 Start of traversing range : 0.0 mm End of traversing range : 1000.0 mm Reference point coordinate : 500.000 mm Zero mark position : Forward Start of software switch : End of software switch : Drive control signals :Control type 1 Change of direction :Soft reversal Target range :1.0 mm Zero speed range :1.0 mm Monitoring time :0 ms Forward changeover difference : 50.0 mm Forward cutoff difference : 5.0 mm Reverse changeover difference : 50.0 mm Reverse cutoff difference : 5.0 mm Forward adaption value : 0.000 mm Reverse adaption value : 0.000 mm You must select both frames of axis 1 in the data word "Select cyclic reading of checkback signals" with the FORCE VAR programmer function (see variables block VB2: DW 65 bit 1 = 1 and bit 2 = 1) In the axis status word, "Axis parameterized" is set (see variables block VB2: DW 85, bit 9) In the traverse status word, "in the cutoff range" and "in the target range" and "in the zero speed range" are set (see Q 9.4, Q 9.5 and Q 9.6).

[1] The value has to be adapted if an encoder is connected.

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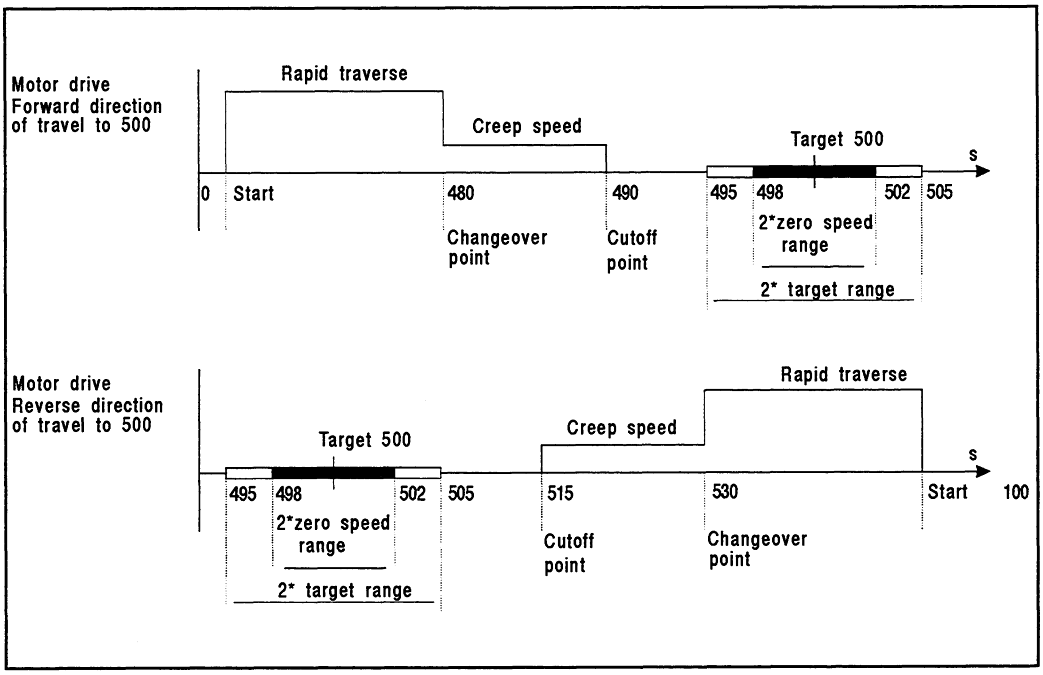


Fig. 8.5 Sequence of the example

Step	Action
3	Set actual value You write the Set actual value job for axis 1 to the IP 288 with job selection 0 (see Section 8.5.1): application 1, I 4.1 = 0. The job data has the following meanings: Immediate execution by control bit ON. Actual value coordinate 0 mm. The data is in data block DB 200 from data word DW 4 (see Section 8.3.3). Execution takes place when you set input I 5.5. The program example is designed in such a way as to set the ON control bit in the control signals for axis 1 (DB 113, DW 186, bit 8) when the input is energized and simultaneously to initiate transfer of the control signals to the IP 288 (DB 113, DW 66, bit 1). In the axis status word, "Axis synchronized" and "Image ON" are set (see variables block VB2: DW 85, bit 10 and DW 86, bit 8). The actual value indicated is 0 (see variables block VB2: DW 100 to DW 102). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Reset input I 5.5 after execution. This deletes and transfers the ON control bit. In the axis status word, "Image ON" is deleted (see variables block VB2: DW 86, bit 8).

Step	Action
4	Switch on drive disable You must switch on drive disable in the individual functions for axis 1 with the FORCE VAR programmer function (see variables block VB2: DW 188, bit 2 = 1). Now write the control signals of axis 1 to the IP 288. You must set the control for axis 1 in the data word "Select Write control signals" with the FORCE VAR programmer function (see variables block VB2: DW 66, bit 1 = 1). The bit is reset by the function block FB ZYK as soon as the transfer is complete. "Drive disable" is set in the "Current functions" data word (see variables block VB2: DW 90, bit 2).
5	Switch on Simulation You write the simulation job for axis 1 to the IP 288 with job selection 2 (see Section 8.5.1): application mailbox 1, I 4.1 = 0. The job data has the following meanings: simulation speed 5000.000 mm/min forward and creep speed 500.000 mm/min. The data is located in data block DB 202 from data word DW 4 (see Section 8.3.3). Execution takes place when you set I 5.5 (ON control bit). The program example then transfers the control signals of axis 1 to the IP 288. "Simulation" is set in the "Current functions" data word (see variables block VB2: DW 88, bit 12). In the axis status word, "Image ON" is set (see variables block VB2: DW 86, bit 8). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Reset input I 5.5 after execution. This deletes and transfers the ON control bit. In the axis status word, "Image ON" is deleted (see variables block VB2: DW 86, bit 8). As long as a traverse has not been started, the actual value does not change (see variables block VB2: DW 100 to DW 102).

Step	Action
6	Start traverse You can execute a traverse movement in the jog or relative increment modes. **Jog mode (see Section 6.4.1):** You write the jog job for axis 1 to the IP 288 with job selection 3 (see Section 8.5.1): application mailbox 1, I 4.1 = 0 The job data has the following meaning: speed identifier rapid traverse. The data is located in data block DB 203 from data word DW 4 (see Section 8.3.3). Jog mode is executed as soon as you set input I 5.3 (T+ control bit) or input I 5.4 (T- control bit). The axis moves at rapid traverse forward or reverse depending on whether T+ or T- is set. In the axis status word, "Running", "Image START", "Image STOP", "Image CONT" and "Image T+" or "Image T-" are set (see variables block VB2: DW 85, bit 0 and DW 86, bit 0, bit 1, bit 2 and bit 3 or bit 4). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Jog mode is completed when both inputs I 5.4 and I 5.4 are reset and the actual value has entered the fictitious target range. In the axis status word, "Image STOP", and "Image CONT" are set (see variables block VB2: DW 86, bit 1 and bit 2). **Relative increment mode (see Section 6.4.4):** You write the relative increment mode job for axis 1 to the IP 288 with job selection 4 (see Section 8.5.1): application mailbox 1, I 4.1 = 0 The job data has the following meaning: speed identifier rapid traverse and path segment 800.000 mm in the forward direction. The data is located in data block DB 204 from data word DW 4 (see Section 8.3.3). Relative increment mode is executed as soon as you set input I 5.0 (START control bit). The path segment 800.000 mm in the forward direction is traversed at rapid traverse until the changeover point (50.000 mm before the target). In the axis status word, "Running", "Image START", "Image STOP", "Image CONT" and "Image T+" or "Image T-" are set (see variables block VB2: DW 85, bit 0 and DW 86, bit 0, bit 2 bit 3 and bit 4). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Reset input I 5.0. This deletes and transfers the START control bit. Relative increment mode is completed when the actual value enters the target range (1.000 mm before the target). The "Position reached" bit is set. In the axis status word, "Image STOP", and "Image CONT" are set (see variables block VB2: DW 86, bit 1 and bit 2).

Step	Action
7	Evaluate checkback signals The actual value changes in the direction indicated (see Q 9.0 and Q 9.1) at 50000.000 mm/min in rapid traverse as long as it is in the rapid traverse range (see Q 9.2). After changeover to creep speed (50.000 mm before the target or T+ and T- control bit deleted), the actual value changes at 500.000 mm/min as long as it is in the creep speed range (see Q 9.3). After cutoff (5.000 mm before the target), the actual value continues to change at 500.000 mm/min until the zero speed range (1.000 mm before the target). In the traverse status word, "In cutoff range" Q 9.4, "In target range" Q 9.5 and "In zero speed range" Q 9.6 are set. In the relevant increment mode, "Position reached" Q 9.7 is also set. variables block VB2: Actual position DW 100 to DW 102 Mode DW 84 Axis status word DW 85 and DW 86 You can change the job data for simulation in DB 202 (simulation speed, see Section 8.3.3) and then activate (see Step 5).

Interrupt processing positioning

If you want to operate positioning with interrupts to the CPU, executed the following steps in the order shown:

Step	Action
8	Switch drive disable off you must switch off drive disable in the individual functions for axis 1 with the FORCE VAR programmer function (see variables block VB2: DW 188, bit 2 = 0). Now write the control signals of axis 1 to the IP 288. You must set the control for axis 1 in the data word "Select Write control signals" with the FORCE VAR programmer function (see variables block VB2: DW 66, bit 1 = 1). The bit is reset by the function block FB ZYK as soon as the transfer is complete. "Drive disable" is deleted in the "Current functions" data word (see variables block VB2: DW 90, bit 2).

Step	Action
9	Switch Simulation off you write the simulation job for axis 1 to the IP 288 with job selection 2 (see Section 8.5.1): application mailbox 1, I 4.1 = 0. Execution takes place when you set input I 5.6 (OFF control bit). "Simulation is deleted in the "Current functions" word (see variables block VB2: DW 88, bit 12). In the axis status word, "Image OFF" is set (see variables block VB2: DW 86, bit 9). The operator error indicated is 0 (see variables block VB2: data word 91). In the event of an error, the operator error indicated must be evaluated (see Section 9.5.7). Reset input I 5.6 after execution. This deletes and transfers the OFF control bit. In the axis status word, "Image OFF" is deleted (see variables block VB2: DW 86, bit 9).
10	Adapt machine data positioning In the process interrupt machine datum, you must enable interrupts at "Position reached". You correct the entry in data word DW 12 from KY 0,0 to KY 0,1 using the programmer function OUTPUT BLOCK, Device: PLC and Block DB 211. Store the changed data block DB 211 in the PLC. Write the machine data to the IP 288 by executing Step 2.
11	Set the actual value Execute Step 3
12	Switch drive disable on Execute Step 4
13	Switch Simulation on Execute Step 5
14	Relative increment mode Execute Step 6 relative increment mode
15	Evaluate checkback signal See Step 7 In addition, variables block VB2 contains "Indicate interrupt on which axis", "Process interrupt/diagnostics interrupt" When the target is reached, the IP 288 initiates an interrupt to the S5 CPU. variables block VB2: Indicate interrupt on which axis DW 67, bit 0 = 1 Process interrupt/diagnostics interrupt DW 204, bit 8 = 1

You can supplement further IP 288 functions in the example. For this purpose, use the free job selection numbers 5, 6, 13, 14 and 15. You must also generate the relevant data blocks. In addition, you can change the job data in the relevant data blocks DB 200 to DB 215.

8.6 Structograms

S5-115U restart (OB 21 and OB 22)

OB 21 and OB 22
Segment 1:<< Request resynchronization<< (Enter ID in data block DB-ZU)
Segment 2:<< Free for user program
Segment 3:<< Block end

S5-135U restart (OB 20, OB 21, OB 22)

OB 20
Segment 1:<< Request resynchronization<< (Enter ID in data block DB-ZU)
Segment 2:<< Block end

OB 21
Segment 1:<< Warm restart not permissible: --> Stop at block end

OB 22
OB 22 is not required since "Automatic cold restart" is set in data block DX 0

S5-155U restart (OB 20, OB 21 and OB 22)

OB 20
Segment 1:<< Request resynchronization<< (Enter ID in data block DB-ZU)
Segment 2:<< Block end

OB 21 and OB 22
Segment 1:<< Save scratchflags in data block DB 150
Segment 2:<< Request resynchronization<< (Enter ID in data block DB-ZU)
Segment 3:<< Free for user program
Segment 4:<< Load scratchflags from DB 150
Segment 5:<< Block end

Cyclic program processing S5-115U, S5-135U and S5-155U (OB 1, PB 10)

OB 1
Segment 1:<< Invocation of program block PB 10
Segment 2:<< Block end

PB 10
Segment:<< Copy inputs to flags
Segment 2:<< Invocation of function block for cyclic communication with the IP 288
Segment 3:<< Copy flags to outputs
Segment 4:<< Block end

Interrupt processing (OB 2) S5-115U, S5-135U and S5-155U

OB 2
Segment 1:<< Save scratchflags in data block DB 150<< Save RS data in data block DB 150 (S5-135U, CPU 922 only)
Segment 2:<< Call function block FB INT<< Flag result of logic operation
Segment 3:<< Load scratchflags from data block DB 150<< Load RS data from data block DB 150 (S5-135U, CPU 922 only)<< Load page number (S5-115U only)
Segment 4:<< Block end

Time interrupt processing (OB 2) S5-115U, S5-135U and S5-155U

OB 2
Segment 1:<< Save scratchflags in data block DB 150<< Save RS data in data block DB 150 (S5-135U, CPU 922 only)
Segment 2:<< Free for user program
Segment 3:<< Load scratchflags from data block DB 150<< Load RS data from data block DB 150 (S5-135U, CPU 922 only)<< Load page number (S5-115U only)
Segment 4:<< Block end

FB 10:

Segment 1: Parameter bar

Segment 2: Enter job<<
if rising edge at flag F 4.0 (= I 4.0)
- then
  - Call data block with pointer list (DB 10)<<
    Fetch job pointer from pointer list and put into intermediate storage in FW 202 and FW 204
  - if application mailbox 8 ?
    - then: if application mailbox 8 free?
      - then: Enter job pointer in application mailbox 8
      - else: Output "Application mailbox occupied" signal
    - else: if application mailbox 1 free?
      - then: Enter job pointer in application mailbox 1
      - else: Output "Application mailbox occupied" signal
- else: Jump to segment end

Segment 3: Control functions<<
Call data block DB-IP (DB 113)
if interface for writing control signals is occupied
- then: Jump to segment end
- else: If no change at flag byte FY 5 (= IB 5)
  - then: Jump to segment end
  - else: Transfer signal states of FY 5.0 to FY 5.6 to data word DW 186 of DB-IP<<
    Initiate transfer of control signals axis 1

Segment 4: Call function block FB ZYK<<
Save page number (No. = 0) (S5-115U only)<<
Call function block FB ZYK<<
Display result of logic operation<<
Store job status, transfer errors, data set errors and additional information

Segment 5: Call function block FB PAR<<
Save page number (No. = 1) (S5-115U only)<<
Call function block FB PAR<<
Display result of logic operation<<
Store job status, transfer errors, data set errors and additional information

Segment 6: Flag job status, transfer errors and traverse status<<
If application mailbox 8 selected?
- then
  - Flag job status of FB PAR
  - If transfer errors >< 0
    - then: Flag transfer errors
    - else:
- else
  - Flag job status of FB ZYK
  - If transfer errors >< 0
    - then: Flag transfer errors
    - else:

Flag traverse status of axis 1

Segment 7: Delete flags<<
If F 4.2 (= I 4.1) = 1
- then
  - Delete interrupt flag (F 8.2)
  - If F 4.3 (= I 4.3) = 1
    - then
      - Delete flag for application area occupied<<
        Delete flag for transfer error
      - Segment 8: Block end
    - else:
- else:

8.7 Function Blocks FB 38 and FB 39

This chapter describes the function blocks

- FB 38 (RETTEN)
  "Save scratchflags/system data and page numbers"
- FB 39 (LADEN)
  Load scratchflags/system data and page numbers"

and their use in the S5-115U.

You will find a description of the use of FB 38 and FB 39 in the S5-155U in the "Basic Functions of Function Blocks" manual. The function blocks are to be found on the S5-DOS diskette in the file:

8.7.1 Function Block FB 38

FB 38 performs the following tasks depending on how it is parameterized:

1. Saves scratchflags (FY 200 to FY 255) and system data (RS 248 to RS 255) in a data block.
2. Saves page numbers in a data block.

It is called for saving scratchflags/system data at the start of blocks in interrupt-driven processing.

If "Save page numbers" is set, it is called in all blocks which work with a page-addressed module and which are interrupted by process interrupts or time interrupts (call in OB 21, OB 22, OB 1 and in blocks in time-controlled processing). A renewed call is only required if another page is used.

FB 38 works in conjunction with FB 39. FB 39 handles the reloading of saved data. FB 39 is to be called at the end of interrupt-driven processing.

Calling FB 38

In STL:

```
       :
       :L    KY   c,d
       :L    KY   a,d
       :JU FB
Name   : RETTEN
PAFE   :
       :
```

There is no sense in calling the FB in CSF/LAD, since both load operations would have to be programmed in STL and would then be located in a different segment. The order is fixed.

Explanation of the parameters

Name	Par.	Data	Description
PAFE	A	BI	Parameter error
Accu 1 (left byte)			Page number to be saved
Accu 1 (right byte)			Save scratchflags/system data or page numbers
Accu 2 (left byte)			Number of the data block
Accu 2 (right byte)			Identifier for the organization block

Assignment of the parameters

PAFE : takes signal state "1" if parameterization impermissible. The established error can then be read from the assignment of accu 1:
- KF = 1 Wrong DB number
- KF = 2 DB does not exist or is too short
- KF = 3 Assignment of parameters "b" and "d" are incompatible

Accu 1 : a,b
- a: Page number to be saved
- b: Save scratchflags/system data or page numbers
  - b = 1 : Save page numbers only
  - b = 2 : Save system data only
  - b = 3 : Save all

Accu 2 : c,d
- c: Number of the data block
  $10 \leq$ DB No. ≤ 255
- d: Identifier for the organization block
  - d = 1 : OB 1/ OB 21 / OB 22
  - d = 2 : OB 2 to 5 (interrupts)
  - d = 4 : OB 10 to 13 (time interrupts)

8

Overview of the permissible combinations

In the table below, it is assumed you are working with data block DB 38.

In addition, the following assignments apply:
P: Page number to be saved
x: Irrelevant, i.e. the constant specified here is not taken into account

Called in	Possible functions	Assignment of the accu
OB 1 OB 21 / OB 22	Save pages	Accu 1 : KY = K,1 Accu 2 : KY = 38,1
OB 2 to 5	Save scratchflags/ system data	Accu 1 : KY = x,2 Accu 2 : KY = 38,2
OB 10 to 13	Save scratchflags/ system data	Accu 1 : KY = x,2 Accu 2 : KY = 38,4
	Save pages	Accu 1 : KY = K,1 Accu 2 : KY = 38,4
	Save all	Accu 1 : KY = K,3 Accu 2 : KY = 38,4

Assignment of the data area

FB 38 works in conjunction with a parameterized data block. This data block can have a number between 10 and 255 and you must set it up to and including data word DW 80. You must specify the same time each time FB 38 and FB 39 are called.

Using FB 38

FB 38 handles saving of the scratchflag area (FY 200 to FY 255, saving of the user system data (RS 248 to RS 255) and/or saving of the specified page number, depending on how it has been parameterized in the accumulators.

In cyclic operation and in startup, FB 38 must be called with the parameterization "Save page numbers" before writing a page number, provided page accesses have been programmed in the interrupt organization blocks and provided different page numbers are used. The same procedure is followed in blocks for time-controlled processing since these can be interrupted.

Pages can be accessed via data handling blocks, via direct access by the user program or via function blocks.

In the interrupt organization blocks, the scratchflags must be saved at the start and loaded again at the end. FB 39 handles loading of the saved data.

FB 38 and FB 39 must always be used as a pair in the interrupt organization blocks, i.e. these blocks must be exited prematurely with the "BEC".

8.7.2 FB 39 Function Block

FB 39 performs the following tasks depending on how it has been parameterized:

1. Saves scratchflags (FY 200 to FY 255) and system data (RS 248 to RS 255) from a data block.
2. Loads page numbers from a data block.

It is called for loading scratchflags/system data at the end of blocks in interrupt-driven processing. The data must previously have been saved to the data block by FB 38.

Calling FB 38

In STL:

```
     :L    KY   c,d
     :L    KY   a,b
     :JU   FB   39
Name :LADEN
PAFE :
     :
```

There is no sense in calling the FB in CSF/LAD, since both load operations would have to be programmed in STL and would then be located in a different segment. The order is fixed.

Explanation of the parameters

Name	Par.	Data	Description
PAFE	Q	BI	Parameter error
Accu 1 (left byte)			Irrelevant
Accu 1 (right byte)			Load scratchflags/system data or page numbers
Accu 2 (left byte)			Number of the data block
Accu 2 (right byte)			Identifier for the organization block

Assignment of the parameters

PAFE : takes signal state "1" if parameterization impermissible. The established error can then be read from the assignment of accu 1:

KF = 1 Wrong DB number
KF = 2 DB does not exist or is too short
KF = 3 Assignment of parameters "b" and "d" are incompatible

Accu 1 : a,b

a: Irrelevant

b: Selection of everything to be loaded

b = 1 : Load page numbers only
b = 2 : Load system data only
b = 3 : Load all

Accu 2 : c,d

c: Number of the data block
$10 \leq$ DB No. ≤ 255
d: Identifier for the organization block
d = 2 : OB 2 to 5 (interrupts)
d = 4 : OB 10 to 13 (time interrupts)

8

Overview of the permissible combinations

In the table below, it is assumed you are working with data block DB 38. In addition, the following assignments apply:

x: Irrelevant, i.e. the constant specified here is not taken into account

Called in:	Possible functions:	Assignment of the accu:
OB 2 to 5	Load scratchflags/ system data	Accu 1 : KY = x,2 Accu 2 : KY = 38,2
	Load pages	Accu 1 : KY = x,1 Accu 2 : KY = 38,2
	Load both	Accu 1 : KY = x,3 Accu 2 : KY = 38,2
OB 10 to 13	Load scratchflags/ system data	Accu 1 : KY = x,2 Accu 2 : KY = 38,4
	Load pages	Accu 1 : KY = x,1 Accu 2 : KY = 38,4
	Load both	Accu 1 : KY = x,3 Accu 2 : KY = 38,4

Assignment of the data area

FB 39 works in conjunction with a parameterized data block. This data block can have a number between 10 and 255 and you must set it up to and including data word DW 80.

You must specify the same time each time FB 38 and FB 39 are called.

Using FB 39

FB 39 handles loading of the scratchflag area (FY 200 to FY 255, loading of the user system data (RS 248 to RS 255) and/or loading of the specified page number, depending on how it has been parameterized in the accumulators.

The FB is called at the end of each interrupt-driven program cycle (interrupts, time interrupts). It ensures that the output states apply just as before when a jump is made back to the interrupted program. The data must previously have been saved to the parameterized data block with FB 38.

In the interrupt organization blocks, the scratchflags must be saved at the start and loaded again at the end. FB 38 handles saving of the saved data.

FB 38 and FB 39 must always be used as a pair in the interrupt organization blocks, i.e. these blocks must be exited prematurely with the "BEC".

IP 288 - Reference Section

9

Contents of Chapter 9

IP 288 - Reference Section

9

This chapter brings together the technical information on the IP 288 in a compact form for easy reference.

This information includes:

- The pin assignments of the module interfaces
- The assignments of the connecting cables supplied
- Use of the 703 adapter
- A form for configuring hardware, SYSID parameters and machine data
- The assignments of the IP 288 data sets
- The error messages transferred by the IP 288 in the event of data set errors and external errors
- The technical specifications of the IP 288 and the function blocks

9.1 The Pin Assignments

If you prepare your own connecting cables to and from the IP 288, you require the following pin assignments of the sockets on the module. You must use only cables which are comparable to the cables listed in Section 9.2 in their design (cross-section, shielding, twisting). Make sure also that you connect the shielding braid to the metal of the connector cap. In addition, the connecting cables to the encoders should be run to device reference potential with shielding clamps. See the relevant figures for the location of the pins on the connectors.

The pin assignments of connectors X7, X8 and X9 (actual value acquisition, see Fig. 3.3) are identical.

Socket	Description	Assignment
1	A*	Encoder signal A (24 V)
2	CLS	SSI frequency
3	CLS\	Inverse SSI frequency
4	B*	Encoder signal B (24 V)
5	24 V	Encoder supply (24 V)
6	5.2 V	Encoder supply (5.2 V)
7	GND	Ground
8	N*	Zero mark signal (24 V)
9	RE	Load resistance for 24 V encoder signals
10	N	Zero mark signal
11	N\	Inverse zero mark signal
12	B\	Inverse encoder signal B
13	B	Encoder signal B
14	A\, DAT\	Inverse encoder signal A, inverse SSI data
15	A, DAT	Encoder signal A, SSI data

If you use incremental position encoders with 5 V differential signals, you require the following signals depending on encoder supply.

Socket	Description	Assignment
5	24 V	Encoder supply 24 V
6	5.2 V	Encoder supply 5.2 V
7	GND	Ground
10	N	Zero mark signal
11	N\	Inverse zero mark signal
12	B\	Inverse Encoder signal B
13	B	Encoder signal B
14	A\	Inverse encoder signal A
15	A	Encoder signal A

If you use incremental encoders with 24 V signals, you require the following signals.

Socket	Description	Assignment
1	A*	Encoder signal A (24 V)
4	B*	Encoder signal B (24 V)
5	24 V	Encoder supply 24 V
7	GND	Ground
8	N*	Zero mark signal (24 V)
9	RE	Load resistance for 24 V encoder signals

You require the following signals for actual value acquisition with the synchronous-serial interface.

Socket	Description	Assignment
2	CLS	SSI frequency
3	CLS\	Inverse SSI frequency
5	24 V	24 V encoder supply
7	GND	Ground
14	DAT\	Inverse SSI data
15	DAT	SSI data

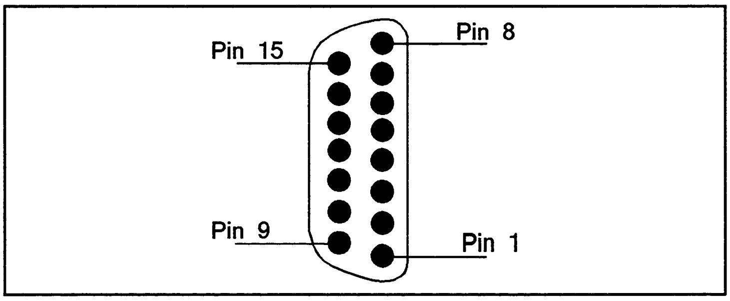


Fig. 9.1 Connectors at X7, X8 and X9 (solder side)

The pins of the programmer port are assigned as follows:

Socket	Description/assignment
1	Shield
2	RxD-
3	---
4	---
5	---
6	TxD+
7	TxD-
8	Shield
9	RxD+
10	Ground
11	-20 mA/sender
12	Ground
13	-20 mA/receiver
14	5.2 V
15	---

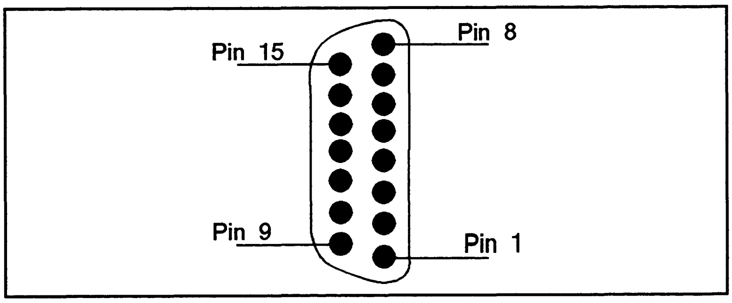


Fig. 9.2 Connector at X3 (solder side)

The distribution of digital inputs/outputs on the pins of the X4 connector is as follows:

Socket	Description	Assignment	Cam controller	Positioning
7	DQ1_1	Digital output axis 1	Track ID bit track 1	Assignment depends on drive type, see below
8	DQ2_1	Digital output axis 1	Track ID bit track 2	
9	DQ3_1	Digital output axis 1	Track ID bit track 3	
10	DQ4_1	Digital output axis 1	Track ID bit track 4	
3	DQ1_2	Digital output axis 2	Track ID bit track 1	
5	DQ2_2	Digital output axis 2	Track ID bit track 2	
4	DQ3_2	Digital output axis 2	Track ID bit track 3	
6	DQ4_2	Digital output axis 2	Track ID bit track 4	
14	DQ1_3	Digital output axis 3	Track ID bit track 1	
1	DQ2_3	Digital output axis 3	Track ID bit track 2	
15	DQ3_3	Digital output axis 3	Track ID bit track 3	
2	DQ4_3	Digital output axis 3	Track ID bit track 4	
13	DI24V	Supply for digital inputs		
11	DI1_1	Digital input axis 1	Reduction switch	Reduction switch
19	DI2_1	Digital input axis 1		Reversal switch
18	DI3_1	Digital input axis 1		Coordination input
17	DI4_1	Digital input axis 1	High-speed input	High-speed input
12	DI1_2	Digital input axis 2	Reduction switch	Reduction switch
23	DI2_2	Digital input axis 2		Reversal switch
22	DI3_2	Digital input axis 2		Coordination input
16	DI4_2	Digital input axis 2	High-speed input	High-speed input
25	DI1_3	Digital input axis 3	Reduction switch	Reduction switch
24	DI2_3	Digital input axis 3		Reversal switch
21	DI3_3	Digital input axis 3		Coordination input
20	DI4_3	Digital input axis 3	High-speed input	High-speed input

Desc.	Drive type 1	Drive type 2	Drive type 3	Drive type 4
DQ 1	Rapid traverse	Rapid traverse/creep speed (1/0)	Rapid traverse	Forward rapid traverse
DQ 2	Creep speed	Position reached	Creep speed	Forward creep speed
DQ 3	Forward travel	Forward travel	Forward travel	Reverse rapid traverse
DQ 4	Reverse travel	Reverse travel	Reverse travel	Reverse creep speed

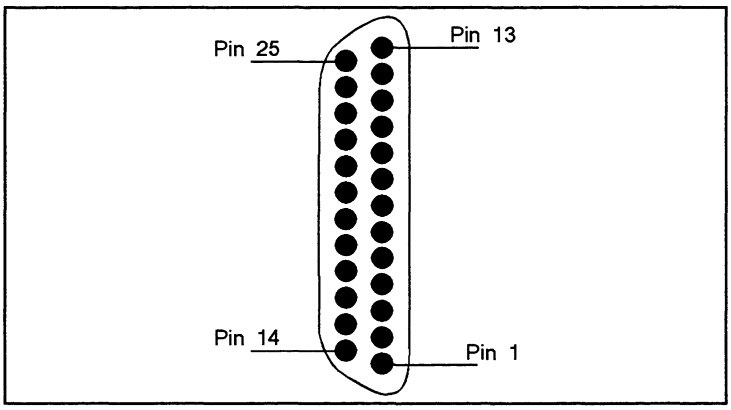


Fig. 9.3 Connector at X4 (solder side)

9.2 Connecting Cables and Adapters

This section gives an overview of the cables for connecting position encoders to the IP 288. The individual components of the connecting cables are also listed to allow you to prepare your own cables for special solutions.

In addition, you will also learn how to switch the two channels of the IP 288 in parallel with an adapter.

9.2.1 Connecting Cable for Siemens Incremental Position Encoders (6FC9320)

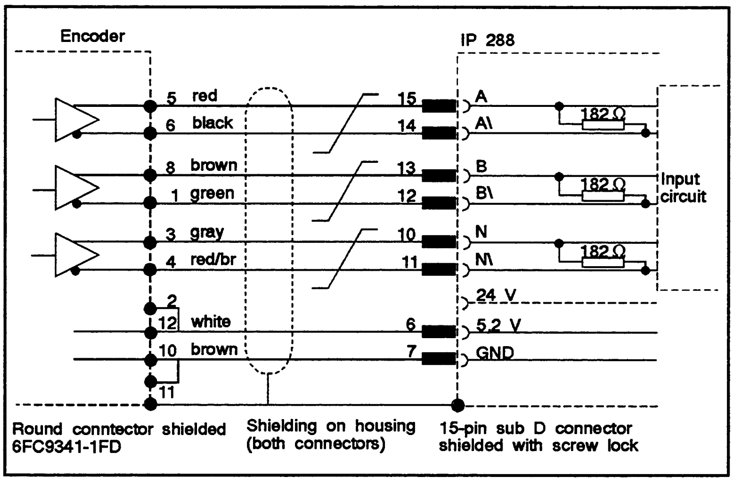
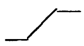


Fig. 9.4 Connecting cable for Siemens incremental position encoders (6FC9320)

 : Cables twisted in pairs

Cable 4 x 2 x 0.25 + 1 mm^2 (EWK No. 131 813)

Maximum length 32 m
Order number: 6ES5 703-1xxxy

y = 0: Cable exit bottom
y = 1: Cable exit top

9.2.2 Connecting Cable for Incremental Position Encoders (5 V Supply, 5 V Signal)

Cable 4 x 2 x 0.25 + 1 mm^2 (EWK No. 131 813)

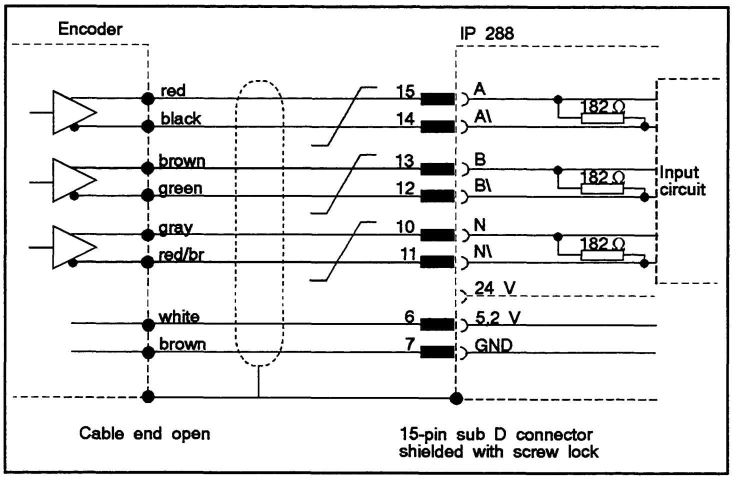
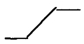


Fig. 9.5 Connecting cable for 5 V incremental position encoder

 : Cables twisted in pairs

Maximum length 32 m
Order number: 6ES5 703-1xxxy

y = 0: Cable exit bottom
y = 1: Cable exit top

As 6ES5 703-1xxx0, but one cable end to the encoder is open.

9.2.3 Connecting Cable for Incremental Position Encoders (24 V Supply, 5 V Signal)

Cable 4 x 2 x 0.5 + 1 mm^2 (EWK No. 131 824)

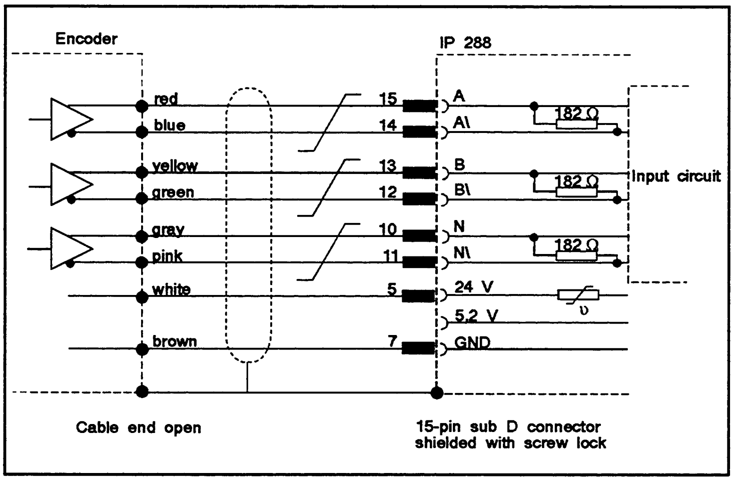
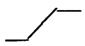


Fig. 9.6 Connecting cable for incremental position encoder (24 V supply, 5 V signal)

 : Cables twisted in pairs

Maximum length 100 m
Order number: 6ES5 703-3xxxy

y = 0: Cable exit bottom
y = 1: Cable exit top

9.2.4 Connecting Cable for Incremental Position Encoders (24 V Supply, 24 V Signal)

Cable 4 x 2 x 0.5 + 1 mm^2 (EWK No. 131 824)

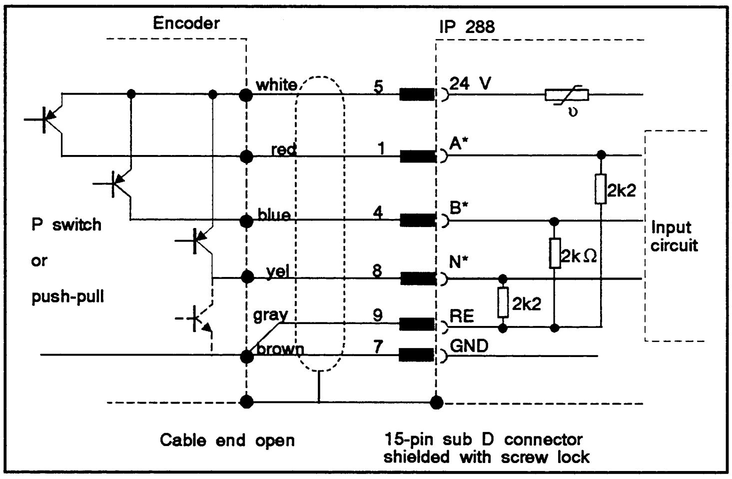


Fig. 9.7 Connection of encoders with P switches or push-pull output

Cable 4 x 2 x 0.5 + 1 mm^2 (EWK No. 131 824)

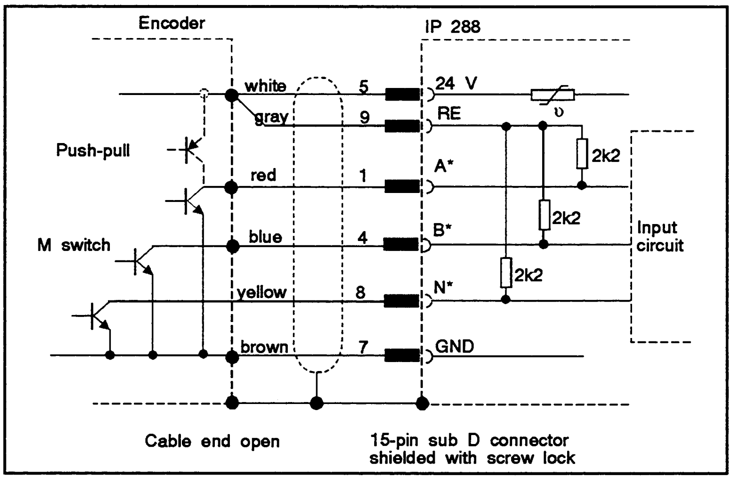


Fig. 9.8 Connection of encoders with M switches or push-pull outputs

Maximum length 100 m
Order number: 6ES5 703-3xxxy

y = 0: Cable exit bottom
y = 1: Cable exit top

9.2.5 Connecting Cable for SSI Position Encoders

Cable 4 x 2 x 0.5 + 1 mm^2 (EWK No. 131 824)

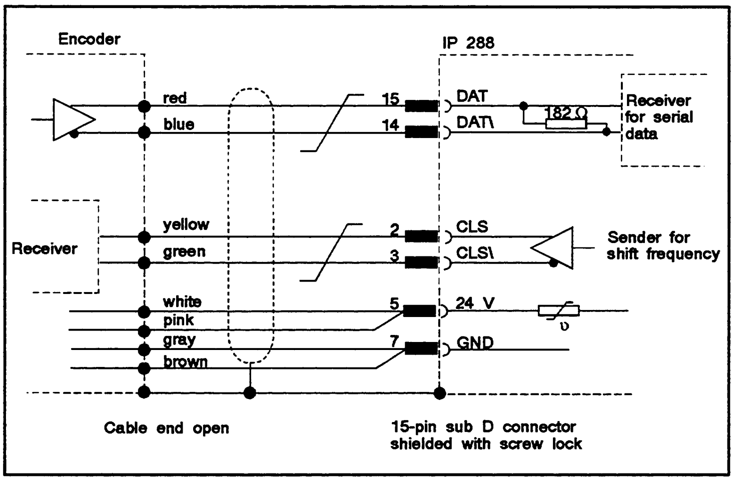


Fig. 9.9 Connecting cable for SSI encoders

: Cables twisted in pairs

Maximum length 320 m
Order number: 6ES5 703-5xxxy

y = 0: Cable exit bottom
y = 1: Cable exit top

9.2.6 Connecting Cable for Digital Inputs/Outputs

Cable 16 x 2 x 0.22 + 1 mm^2 (EWK No. 196 515)

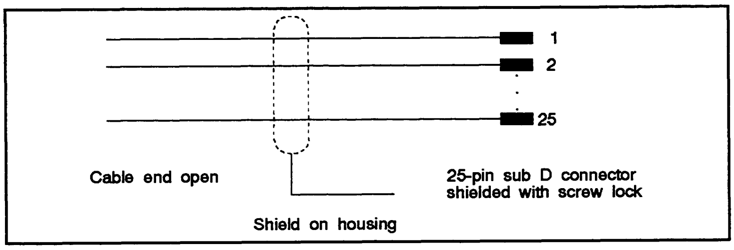


Fig. 9.10 Connecting cable for digital inputs/outputs

Maximum length 50 m
Order number: 6ES5 703-6xxxy
y = 0: Cable exit bottom
y = 1: Cable exit top

Bundle	Identifier	Core colour	Connector, 25-pin male
1	1 ring / pink	blue	1
		red	2
		gray	3
		yellow	4
		green	5
		brown	6
		white	7
		black	8
2	2 rings / pink	blue	9
		red	10
		gray	11
		yellow	12
		green	13
		brown	14
		white	15
		black	16
3	3 rings / pink	blue	17
		red	18
		gray	19
		yellow	20
		green	21
		brown	22
		white	23
		black	24
4	4 rings / pink	blue	25
		red	
		gray	
		yellow	
		green	
		brown	
		white	
		black	
Shield			Housing

9.2.7 Using the 703 Adapter

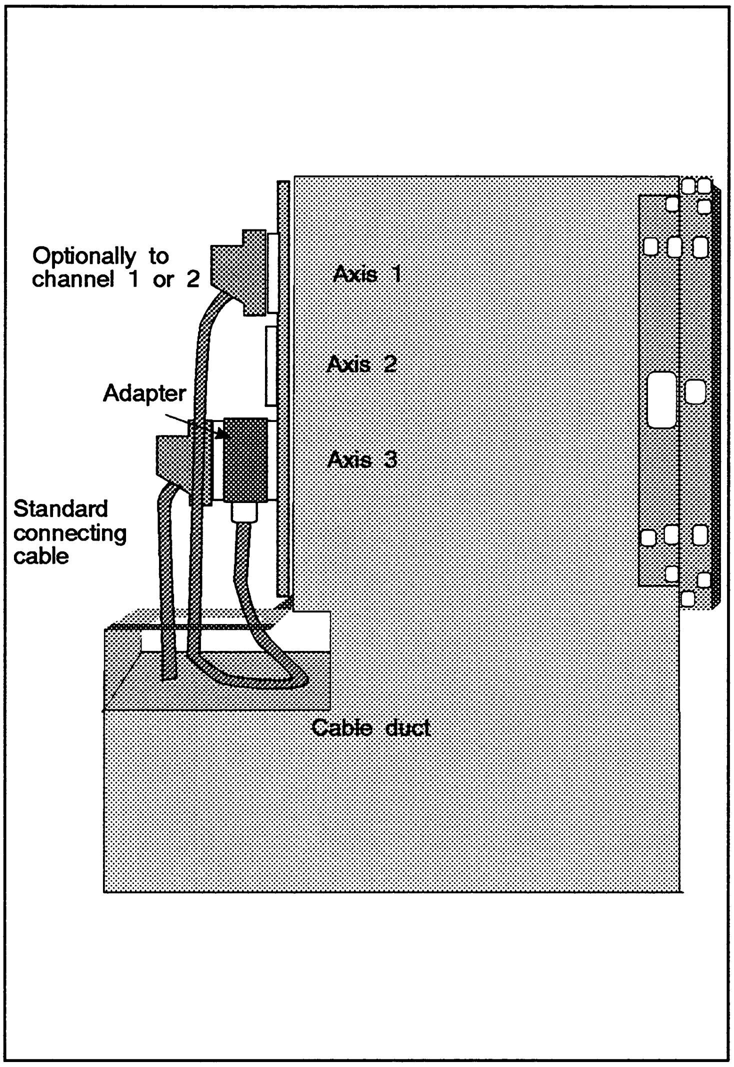


Fig. 9.11 Two axes of the IP 288 switched in parallel

If you switch two axes of the IP 288 in parallel, you can use the adapter with the order number 6ES5 703-7UA11.

9.3 Configuring Forms

Use these preprinted forms or copies of them to define all values required for installing and parameterizing the IP 288.

9.3.1 Configuring Hardware

Where is the IP 288 to be installed?	
CC:	Slot:
EU:	Slot:
Which page number does the IP 288 have?	
Page number:	

9.3.2 Configuring SYSID Parameters

Module identifier	
• 1 to 255	
Effect of S5 CPU failure	
• Switch off all outputs • No effect	
Interrupt line	
• No interrupt to PLC • Interrupts on IRA line • Interrupts on IRB line • Interrupts on IRC line • Interrupts on IRD line	

9.3.3 Configuring Machine Data

Data set number	
• 1 to 255	
Module number	
• 1 to 255	
Axis number	
• 1 to 3	
Axis type	
• Linear axis • Rotary axis	
Measuring system	
• $1*10^{-3}$ mm • $0.1*10^{-3}$ inches • $0.1*10^{-3}$ degrees	
Axis function	
• Positioning for rapid traverse/creep speed drives • Cam controller	
Accuracy (basic resolution)	
• 1*measuring system • 10*measuring system • 100*measuring system • 1000*measuring system	
Basic data set yes/no	
• You want to use a basic data set • You do not want to use a basic data set	

Process interrupt yes/no	
• When position reached (positioning) or at start/end of cam (cam controller) • When length measurement complete • When actual comparator trips • When number of revolutions reached (rotary axis)	
Diagnostics interrupt yes/no	
• No diagn. interrupt in the event of encoder errors • Diagnostics interrupt in the event of encoder errors	
Number format	
• The values to the CPU are binary coded • The values from the CPU are binary coded • The values to the CPU are BCD coded • The values from the CPU are BCD coded	
Switching the digital outputs	
• Output 1 • Output 2 • Output 3 • Output 4	
Coordination input	
• Level-driven • Edge-driven • No effect	
Encoder type	
• 5 V incremental encoder without zero mark • 5 V incremental encoder with zero mark and not monitored by IP 288 • 5 V incremental encoder with zero mark and monitored by IP 288 • 24 V incremental encoder without zero mark • 24 V incremental encoder with zero mark and not monitored by IP 288 • 24 V incremental encoder with zero mark and monitored by IP 288 • SSI encoder • Encoder of axis 1 (only in the case of axis 3) • Encoder of axis 2 (only in the case of axis 3)	

Encoder rotational direction/direction of travel	
• Same direction; greater path coordinate corresponds to greater encoder signal • Direction not the same; greater path coordinate corresponds to smaller encoder signal	
Increments/encoder revolution	
• 1 to 2^{25}	
Path/encoder revolution	
• 1* GAL to 100 000 000*BRES	
Resolution (increments/encoder revolution)/(path/encoder revolution)	
• 0.1*BRES to 1*BRES	
Encoder revolutions	
• 1 to 4096	
Start of traversing range	
• ± 100 000 000*BRES	
End of traversing range	
• ± 100 000 000*BRES	
Reference point coordinate	
• ± 100 000 000*BRES	
Reference coordinate	
• -2^{31} to $+2^{31}-1$	
Zero mark position/reference coordinate identifier	
• Zero mark in positive direction • Zero mark in negative direction or • Reference coordinate valid • Reference coordinate invalid	

Start of software switch	
• ± 100 000 000*BRES	
End of software switch	
• ± 100 000 000*BRES	
Hysteresis	
• 100 000 000*BRES	
Control signals of the drive	
• Drive type 1 • Drive type 3 • Drive type 2 • Drive type 4	
Change of direction	
• Hard reversal • Soft reversal	
Target range	
• 100 000 000*BRES	
Zero speed range	
• At 0, the zero speed monitor is switched off • ± 100 000 000*BRES	
Monitoring time	
• At 0, the actual position and target entry monitors are switched off • 0 to 65532	
Forward cutoff difference	
• 100 000 000*BRES	
Forward changeover difference	
• 100 000 000*BRES	

Reverse cutoff difference	
• 100 000 000*BRES	
Reverse changeover difference	
• 100 000 000*BRES	
Forward adaption value	
• ± 100 000 000*BRES	
Reverse adaption value	
• ± 100 000 000*BRES	

9.4 The Data Sets of the IP 288

You create the following data sets for using the IP 288.

- SYSID data set
- Machine data set
- Cam set (cam controller)
- Target set (positioning)
- Target list (positioning)

The IP 288 provides information in the following directories concerning the data stored:

- Machine data directory
- Target set directory
- Cam set directory
- Target list directory (only via COM 288)

The next sections contain a description of these data sets and the relevant data.

9.4.1 Structure of the SYSID Data Set

Every SYSID data set has the same length and begins with a data set header. The header cannot be overwritten with the exception of the data set number and it contains the following data:

Name	Format	Contents/value range	DS error
Data set type	2 ASCII characters	"ID"	1
Module ID	4 ASCII characters	" 288" (with a initial space)	2
Data set number	1 byte	1 to 255	3

The data set header is followed by a variable section which contains default values on the module to begin with.

Name	Format	Contents/value range	DS error
Module number	1 byte	1 to 255 Default = 1	10
BASP evaluation	1 byte	0 = switch off all outputs (default) 1 = no effect	-
Interrupt line	1 byte	0 = no interrupt to PLC (default) 1 = Interrupts on $\overline{IRA}$ 2 = Interrupts on $\overline{IRB}$ 3 = Interrupts on $\overline{IRC}$ 4 = Interrupts on $\overline{IRD}$	8/9

The variable section is followed by a constant section in which the precise description of the module and the version of the firmware are entered.

Name	Format	Contents/value range
Module type	10 ASCII characters	"288-4UA11 " (with following space)
Firmware version	6 ASCII characters	"V X.XX" (with space after "V")

The SYSID data set has the following length:

- Input: 6 words
- Output: 14 words

Below is a list of the assignments of the SYSID data set with word-orientation. This data is stored on the IP 288 in this format.

		bit 15		bit 0
Data set header	0	Data set type: "ID"		
	1	Module ID: " 288"		
	2			
	3	Reserved		Data set number
	4	Reserved		Module number
	5	BASP evaluation	Bit 0	Interrupt line
	6			
	7			
	8	Module type "288-4UA11"		
	9			
	10			
	11			
	12	Firmware version "V 1.00"		
	13			

9.4.2 Structure of the Machine Data Set

You must enter the machine data in a fixed order in the machine data set. This is the order in which the machine data is explained below.

Every machine data set has the same length and begins with a data set header. The header must contain the following data:

Name	Format	Contents/value range	DS error
Data set type	2 ASCII characters	"MD" (**M**achine **D**ata)	1
Module ID	4 ASCII characters	" 288" (with initial space)	2
Data set number	1 byte	1 to 255	3/4

The data set header is followed by the general machine data listed below.

Name	Format	Contents/value range	DS error
Module number	1 byte	1 to 255	5
Axis number	1 byte	1 to 3	6
Axis type	1 bit	0 → Linear axis 1 → Rotary axis	-
Measuring system	1 byte	1 → $1*10^{-3}$ mm 2 → $0.1*10^{-3}$ inch 3 → $0.1*10^{-3}$ degrees	8
Axis function	1 byte	1 → Positioning for rapid traverse/creep speed drives 2 → Cam controller	9
Accuracy range (BRES)	1 byte	1 → 1*measuring system 2 → 10*measuring system 3 → 100*measuring system 4 → 1000*measuring system	10
Basic data set (yes/no)	1 bit	0 → Basic data set 1 → No basic data set	-
Process interrupt (yes/no)	4 bits	Bit = 0 → Process interrupt disabled Bit = 1 → Process interrupt possible The individual bits and the interrupts correspond as follows: Bit 0: Position reached in the case of positioning Start/end of cam in the case of a cam controller Bit 1: Length measurement complete Bit 2: Actual position comparator tripped Bit 3: Number of revolutions reached (rotary axis) In a basic data set, all these bits are set to 0.	12
Diagnostics interrupt (yes/no)	1 bit	0 → No diagnostics interrupt 1 → Diagnostics interrupt in the case of encoder error In a basic data set, this bit is set to 0.	-
Number format	2bits	Bit 0 = 0 → The values from the CPU are binary coded Bit 0 = 1 → The values from the CPU are BCD coded Bit 1 = 0 → The values to the CPU are binary coded Bit 1 = 1 → The values to the CPU are BCD coded	-
Switching the digital outputs	4 bits	Bit 0 = 0 → Output 1 not wired (default) Bit 0 = 1 → Output 1 wired Bit 1 = 0 → Output 2 not wired (default) Bit 1 = 1 → Output 2 wired Bit 2 = 0 → Output 3 not wired (default) Bit 2 = 1 → Output 3 wired Bit 3 = 0 → Output 4 not wired (default) Bit 3 = 1 → Output 4 wired	-
Coordination input	1 byte	1 → Not used 2 → Level-driven 3 → Edge-driven	16

Name	Format	Contents/value range	DS error
Encoder type	1 byte	1 → 5V incremental encoder without zero mark 2 → 5V incremental encoder with zero mark and without IP 288 monitoring 3 → 5V incremental encoder with zero mark and with IP 288 monitoring 4 → 24V incremental encoder without zero mark 5 → incremental encoder with zero mark and without IP 288 monitoring 6 → 24V incremental encoder with zero mark and with IP 288 monitoring 7 → SSI encoder 8 → Encoder of axis 1 9 → Encoder of axis 2	20
Encoder rotational direction to direction of travel	1 bit	Bit = 0 → Same direction; greater path coordinate corresponds to greater encoder signal Bit = 1→ Direction not the same; greater path coordinate corresponds to smaller encoder signal	-
Increments/encoder revolution	4 bytes	1 to 2^{25}	22/29
Path/encoder revolution	4 bytes	1*BRES to 100 000 000*BRES	23/28/ 29
Encoder revolutions	2 bytes	1 to 4096 1 in the case of incremental encoder	24/28
Start of traversing range	4 bytes in two's complement	±100 000 000*BRES	28/30
End of traversing range	4 bytes in two's complement	±100 000 000*BRES	28/31
Reference point coordinate	4 bytes in two's complement	In the case of incremental encoders: ±100 000 000*BRES In the case of SSI encoders: -2^{31} to $+2^{31}-1$	32
Zero mark position/reference coordinate ID	1 bit	In the case of incremental encoders: Bit = 0 → Zero mark in positive direction Bit = 1 → Zero mark in negative direction or in the case of SSI encoders: Bit = 0 → Reference coordinate valid Bit = 1 → Reference coordinate invalid	
Start of software switch	4 bytes in two's complement	±100 000 000*BRES	35
End of software switch	4 bytes in two's complement	±100 000 000*BRES	36
Hysteresis	4 bytes in two's complement	0 to 100 000 000*BRES	40
Control signals of the drive	1 byte	1 →Drive type 1 2 →Drive type 2 3 →Drive type 3 4 → Drive type 4	50

Name	Format	Contents/value range	DS error
Change of direction	1 bit	0 → Soft reversal 1 → Hard reversal	-
Target range	4 bytes in two's complement	0 to 100 000 000*BRES	52
Zero speed range	4 bytes in two's complement	0 to 100 000 000*BRES At 0, the zero speed monitor and positive feedback monitor are switched off	53
Monitoring time	2 bytes	0 to 65532 The value of the monitoring time is rounded up to integer multiples of 8 ms. At 0 - 7, the actual position and target entry monitors are switched off	54
Forward cutoff difference	4 bytes in two's complement	1 to 100000000*BRES	55
Forward changeover difference	4 bytes in two's complement	1 to 100000000*BRES	56
Reverse cutoff difference	4 bytes in two's complement	1 to 100000000*BRES	57
Reverse changeover difference	4 bytes in two's complement	1 to 100000000*BRES	58
Forward adaption value	4 bytes in two's complement	±100 000 000*BRES	59
Reverse adaption value	4 bytes in two's complement	±100 000 000*BRES	60

The machine data set is always 63 words long.

Below is a word-oriented list of the assignments of the machine data. This is the form in which the IP 288 stores the machine data it has entered via one of the two interfaces.

Group	Word	bit 15		bit 0
Data set header	0	Data set type "MD"		
	1	Module ID: " 288"		
	2			
	3	Reserved	Data set number	
General	4	Axis number	Module number	
	5	Measuring system	Axis type	Bit 0
	6	Reserved	Axis function	
	7	Basic data set (Bit 0)	Basic resolution	
	8	Diagnostics interrupt (Bit 0)	Process interrupt	3 2 1 0
	9	Digital outputs (3 2 1 0)	Number format	Bit 1 0
	10	Reserved	Coordination input	
	11	Reserved		
Encoder parameterization	12	Encoder rotational direction to direction of travel (Bit 0)	Encoder type	
	13	Increments/		
	14	encoder revolution		
	15	Path/		
	16	encoder revolution		
	17	Encoder revolutions		
	18	Reserved		
	19			
Traversing range	20	Start of traversing range		
	21			
	22	End of traversing range		
	23			
	24	Reference point coordinate		
	25			
	26	Reserved	Zero mark position/ref. coord. ID	Bit 0
	27	Reserved		
	28			
	29	Start of software switch		
	30			
	31	End of software switch		
	32			
	33	Reserved		
	34			
Cam controller	35	Hysteresis		
	36			
	37			
	38	Reserved		
	39			
	40			

	Word	bit 15			bit 0
Cutoff control	41	Change of direction	Bit	0	Control signals of the drive
	42	Target range			
	43				
	44	Zero speed range			
	45				
	46	Monitoring time			
	47	Forward changeover difference			
	48				
	49	Forward cutoff difference			
	50				
	51	Reverse changeover difference			
	52				
	53	Reverse cutoff difference			
	54				
	55	Forward adaption value			
	56				
	57	Reverse adaption value			
	58				
	59				
	60	Reserved			
	61				
	62				

9.4.3 Structure of the Machine Data Directory

A machine data directory gives information on all the machine data stored on the module. The directory contains the following general information:

- Data set type
- Module ID
- A data set number between 0 and 255 for each axis.
  The entry 0 means that there is no machine data for this axis.

The machine data directory is 7 words long.

The machine data directory has the following structure:

	Word	bit 15	bit 0
Data set header	0	Data set type "DM"	
	1	Module ID: " 288"	
	2		
	3	Reserved	
	4	Reserved	Data set number axis 1
	5	Reserved	Data set number axis 2
	6	Reserved	Data set number axis 3

9

9.4.4 Structure of the Cam Set

You can create a cam set for every track. You can enter cam sets on the module, output them from the module and delete them on the module. Each of these actions is possible via both interfaces of the module.

Data set header

Every cam set begins with a data set header. This must contain the following data.

Name	Format	Contents/value range	DS error
Data set type	2 ASCII characters	"NS" (cam set)	1
Module ID	4 ASCII characters	" 288" (with initial space)	2
Cam set number	1 byte	1 to 255	3

The data set header is followed by the general cam data. You also enter axis specifications in this general data.

Name	Format	Contents/value range	DS error
Module number	1 byte	1 to 255	5
Axis number	1 byte	1 to 3	6
Axis type	1 bit	Bit = 0 → Linear axis Bit = 1 → Rotary axis	-
Measuring system	1 byte	1 → $1*10^{-3}$ mm 2 → $0.1*10^{-3}$ inch 3 → $0.1*10^{-3}$ degrees	8
Number of cams in the track	1 byte	1 to 8	11
Track number	1 byte	1 to 16	12/27
Direction	1 byte	Bit 0 = 1 → Forward direction Bit 1 = 1 → Reverse direction If both bits are set, the cams are switched in both directions.	13
Correction time of dynamic cams	1word	0 → No dynamic cams 1 to 65535 ms	-
Initiating cam for the 1st process interrupt	1 byte	0 → No interrupt initiated 1 to 8 corresponds to the number of the cam which initiates the interrupt	15/23
Edge for 1st process interrupt	1 bit	Bit = 0 → The interrupt is initiated at the end of the cam Bit = 1 → The interrupt is initiated at the start of the cam An interrupt can also be initiated at the falling edge of a time cam.	-
Initiating cam for the 2nd process interrupt	1 byte	0 → No interrupt initiated 1 to 8 corresponds to the number of the cam which initiates the interrupt	17/24
Edge for 2nd process interrupt	1 bit	Bit = 0 → The interrupt is initiated at the end of the cam Bit = 1 → The interrupt is initiated at the start of the cam An interrupt can also be initiated at the falling edge of a time cam.	-

Now you can create the special cam data for each cam.

Name	Format	Contents/value range	DS error
Cam number	1 byte	1 to 8	19/ 26
Cam type	1 bit	Bit = 1 → Path cam Bit = 0 → Time cam (cams 1 and 2 only)	26
Start of cam	4 bytes in two's complement	±100 000 000*BRES	21/25
End of cam	4 bytes in two's complement	±100 000 000*BRES in the case of a path cam 24 to 65532 ms in steps of 8 ms in the case of a time cam	22/25/ 28

The length of a cam set is 11 words + 5 words per cam.

The cam data is stored consecutively according to the number of cams in the track. It is not necessary to enter the cams in ascending order of their numbers.

		bit 15	bit 0
Data set header	0	Data set type: "NS"	
	1	Module ID: " 288"	
	2		
	3	Reserved	Data set number
	4	Axis number	Module number
	5	Measuring system	Axis type Bit 0
	6	Number of cams in the track	Reserved
	7	Direction Bit 0 0	Track number
	8	Correction time of dynamic cams	
	9	Edge for 1st interrupt Bit 0	Initiating cam for 1st interrupt
	10	Edge for 2nd interrupt Bit 0	Initiating cam for 2nd interrupt
1st cam	11	Cam type 1st cam Bit 0	Cam number 1st cam
	12	Start of cam 1st cam	
	13		
	14	End of cam/switch on time 1st cam	
	15		
2nd cam	16	Cam type 2nd cam Bit 0	Cam number 2nd cam
	17	Start of cam 2nd cam	
	18		
	19	End of cam/switch on time 2nd cam	
	20		

9.4.5 Structure of the Cam Set Directory

A cam set directory gives information on the cam sets on the module. The directory contains the following general information:

- Data set type
- Module ID
- Number of cam sets already entered (maximum 48)
- Number of cam sets which can still be entered (maximum 48)
- Number of cam sets per axis (maximum 16)

The directory contains the following information for each cam set:

- Track number
- Cam set number
- Number of cams in the track
- Cams parameterized (this specification is output in bit code, bit 0 = 1 means cam 1 is parameterized, etc.).

The length of a cam set directory is 8 words + 2 words per cam set entered.

The module also outputs the cam set directory for axes parameterized in the positioning axis function. The number of the already entered cam sets is then 0.
The cam set directory has the following structure:

		bit 15	bit 0	
Data set header	0	Data set ID: "DN"		
	1	Module ID: " 288"		
	2			
	3	Reserved		
	4	Still enterable NSs	Number of NSs entered	
	5	Reserved	Number of cam sets axis 1	
	6	Cam set number	Track number	1. NS
	7	Cams parameterized (bit-coded)	Number of cams in the track	
Axis 1				
		Cam set number	Track number	16. NS
		Cams parameterized (bit-coded)	Number of cams in the track	
		Reserved	Number of cam sets axis 2	
		Cam set number	Track number	1. NS
		Cams parameterized (bit-coded)	Number of cams in the track	
Axis 2				
		Cam set number	Track number	16.NS
		Cams parameterized (bit-coded)	Number of cams in the track	
		Reserved	Number of cam sets axis 3	
		Cam set number	Track number	1. NS
		Cams parameterized (bit-coded)	Number of cams in the track	
Axis 3				
		Cam set number	Track number	16. NS
		Cams parameterized (bit-coded)	Number of cams in the track	

9.4.6 Structure of the Target Set

Each target set begins with a data set header. This must contain the following data:

Name	Format	Contents/value range	DS error
Data set type	2 ASCII characters	"ZS" (target set)	1
Module ID	4 ASCII characters	" 288" (with initial space)	2
Data set number	1 byte	1 to 100 for long target sets 101 to 255 for short target sets	3/11

This data set header is followed by general target data. You also enter axis specifications here.

Name	Format	Contents/value range	DS error
Module number	1 byte	1 to 255	5
Axis number	1 byte	1 to 3	6
Axis type	1 bit	Bit = 0 → Linear axis Bit = 1 → Rotary axis	-
Measuring system	1 byte	1 → $1*10^{-3}$ mm 2 → $0.1*10^{-3}$ inch 3 → $0.1*10^{-3}$ degrees	8

The general target data is followed by data describing the target and the positioning task directly. In the case of short target sets, this involves only the first two data items below.

Name	Format	Contents/value range	DS error
Target set number	1 byte	1 to 255	11
Geschwindigkeit	1 bit	Bit =0 → Creep speed Bit =1 → Rapid traverse	-
Target	4 bytes in two's compl.	±100 000 000*BRES	13
Forward changeover difference	4 bytes in two's complement	1 to 100000000*BRES	14
Forward cutoff difference	4 bytes in two's complement	1 to 100000000*BRES	15
Reverse changeover difference	4 bytes in two's complement	1 to 100000000*BRES	16
Reverse cutoff difference	4 bytes in two's complement	1 to 100000000*BRES	17
Forward adaption value	4 bytes in two's complement	±100 000 000*BRES	18
Reverse adaption value	4 bytes in two's complement	±100 000 000*BRES	19

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The length of a target set is 10 words for a short target set and 22 words for a long target set.

The target set is structured as follows:

	Word	bit 15			bit 0
	0	Data set type :"NS"			
Data set header	1	Module ID: " 288"			
	2				
	3	Reserved		Data set number	
	4	Axis number		Module number	
	5	Measuring system		Axis type	Bit 0
	6	Reserved			
	7	Speed ID	Bit 0	Target set number	
	8	Target			
	9				
	10	Forward changeover difference			
	11				
	12	Forward cutoff difference			
	13				
	14	Reverse changeover difference			
	15				
	16	Reverse cutoff difference			
	17				
	18	Forward adaption value			
	19				
	20	Reverse adaption value			
	21				

The target set are entered in target lists on the module.

9.4.7 Structure of the Target List

There is a target list for each axis (default):

- Target list 1 for axis 1
- Target list 2 for axis 2
- Target list 3 for axis 3

The length of a target list is 7 words + 3 words per short target set + 15 words per long target set.

A target list is structured as follows:

	Word	bit 15	bit 0	
Data set header	0	Data set type: "ZL"		
	1	Module ID: " 288"		
	2			
	3	Reserved	Data set number	
	4	Axis number	Module number	
	5	Measuring system	Axis type Bit 0	
	6	Number of target sets	Reserved	
	7	Speed ID target 1 Bit 0	Target set number target 1	Target 1
	8	Target 1		
	9			
	10	Speed ID target 2 Bit 0	Target set number target 2	Target 2
	11	Target 2		
	12			
	13	Speed ID target 3 Bit 0	Target set number target 3	Target 3
	14	Target 3		
	15			

Additional values are entered in the case of long target sets (see Section 9.4.6).

9.4.8 Structure of the Target Set Directory

A target set directory gives information on all the target sets stored on the module. The directory contains the following general information:

- Data set type
- Module ID
- Number of already entered target sets (maximum 255 over all three axes)
- Number of target sets which can still be entered (maximum 255 over all three axes).

The target set directory contains the following information for each axis:

- Number of target sets
- Target list number
- First target set number

  .

  .

  nth target set number

The length of a target set directory is 7 words + 1 byte per target set, rounded up to words per axis.

The target set directory has the following structure:

		bit 15	bit 0
Data set header	0	Data set type "DZ"	
	1	Module ID: " 288"	
	2		
	3	Reserved	
	4	Still enterable ZSs	Number of ZSs entered
Axis 1	5	Target list number axis 1	Number of target sets axis 1
	6	Second ZS number axis 1	First ZS number axis 1
	7		
Axis 2	4	Target list number axis 2	Number of target sets axis 2
	5	Second ZS number axis 2	First ZS number axis 2
	6		
	7		
Axis 3	4	Target list number axis 3	Number of target sets axis 3
	5	Second ZS number axis 3	First ZS number axis 3
	6		
	7		

9.5 How Does the IP 288 Respond in the Event of an Error?

When you enter data to the module, the data is checked. Limit overranges and inconsistencies between data cause an error. An error is identified by an error number. If an error occurs while you are working with COM 288, an error message is displayed. If you have to answer a prompt, e.g. "Reject yes/no", this text is also displayed and the relevant menu is displayed. If the error occurs during data transfer with FB PAR, you must read out the error number from data block DB-IP (DL n+2, data set error in the application mailbox). The meaning of an error (error in machine data, error in SYSID, etc.) depends on you last input.

9.5.1 SYSID Error

Below is are the SYSID errors listed according to number:

DS error	Error message	Remedy
1	Wrong data set type	The following types are permissible: ID SYSID data set MD machine data NS cam set ZS target set ZL target list
2	Wrong module ID	The module ID must be: " 288" Have you remembered the space before the 2?
3	Wrong DS number or DS number already exists	Permissible numbers are 1 to 255.
8	Wrong interrupt line selected	Permissible numbers are 0 to 4.
9	Interrupt line must not be changed	If you want to change the interrupt line, you must first delete all machine data.
10	Module number must not be changed	If you want to change the module number, you must first delete all machine data.
200	Wrong job number	Only the following job numbers are permissible: 64 Data set output 65 Data set input.
253	Axis not in PG/PLC mode	Set the correct mode (PG or PLC mode) before entering or deleting data sets (see Section 6.5.11).

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9.5.2 Machine Data Errors

Below are the machine data errors listed according to number

DS error	Error message	Remedy
1	Wrong data set type	The following types are permissible: ID SYSID data set MD machine data ZS target set NS cam set ZL target list
2	Wrong module ID	The module ID must be: " 288" Have you remembered the space before the 2?
3	Wrong DS number or DS number already exists	Permissible numbers are 1 to 255. Machine data with the same data set number must not already exist on another axis.
4	DS numbers are different or the data has been changed	Either there is already machine data on this axis with another data set number or you are trying to overwrite a data set with the same number but with changes in certain of the data (see Section 5.2).
5	Wrong module number	The numbers 1 to 255 are permissible. In addition, you must specify the same number you specified in the SYSID data set.
6	Wrong axis number	Numbers 1 to 3 are permissible
8	Wrong measuring system	Numbers 1 to 3 are permissible
9	Wrong axis function	Numbers 1 or 2 are permissible
10	Wrong accuracy range	Numbers 1 to 4 are permissible
12	Process interrupt selection wrong	You have set a process interrupt for "Number of revolutions reached", but you have entered Linear axis as the axis type. Either disable the process interrupt or enter Rotary axis for the axis type.
16	Effect of coordinate input is wrong	Permissible entries are 1 to 3.
20	Wrong encoder type	You have tried to enter an impermissible encoder type. Entries 1 to 7 or 8 and 9 are permissible. You can specify "Encoder of axis 1" and "Encoder of axis 2" only for axis 3. The relevant axis (axis 1 or 2) must already be parameterized and it must have an incremental encoder.
22	Scaling of increments/encoder revolution is wrong	You must enter an even number value for a single-turn absolute encoder. For a multi-turn absolute encoder, you must enter a power or 2 ($\leq 2^{25}$). For an incremental encoder, you must enter a value between 1 and 2^{25}.
23	Scaling of path/encoder revolution is wrong	The value must be between 1 * BRES und 100 000 000 * BRES.
24	Number of encoder revolutions is wrong	The number of encoder revolutions must be between 1 and 4096. In the case of a multi-turn encoder, the value must be a power of 2 and in the case of an incremental encoder, the value must be 1.
28	Wrong number of increments or doesn't suit traversing range	You have parameterized one axis for an SSI encoder in such a way that the encoder range does not cover the traversing range including the traversing range limits. In the case of a rotary axis, the traversing range and the encoder range must be identical.

DS error	Error message	Remedy
29	Wrong resolution	The resolution is the quotient of path/encoder revolution an increments/encoder revolution for SSI encoders or the quotient of path/encoder revolution and 4 * increments/encoder revolution for incremental encoders. It must be between 0.1 * BRES and 1 * BRES (see Section 5.2).
30	Start of traversing range is wrong	The coordinate of the start of traversing range must be in the range ± 100 000 000 * BRES. Either correct the value of the basic resolution or limit the traversing range.
31	End of traversing range is wrong	The coordinate of the end of traversing range must be in the range ± 100 000 000 * BRES and must be greater than the coordinate of the start of traversing range. Either correct the value of the basic resolution or limit the traversing range.
32	Wrong reference point coordinate	See Section 5.2 and Section 6.2.
35	Start of software switch is wrong	The coordinate of the start of software switch must be in the range ± 100 000 000 * BRES and it must be greater than the coordinate of the start of traversing range. Increase the value of the coordinate or extend the traversing range.
36	End of software switch is wrong	The coordinate of the end of software switch must be in the range ± 100 000 000 * BRES and it must be greater than the coordinate of the start of software switch and less than or equal to the coordinate of the end of traversing range. Reduce the value of the coordinate or extend the traversing range.
40	Hysteresis is wrong	The hysteresis must be between 0 and 100,000,000 * BRES.
50	Drive type is wrong	The numbers between 1 and 4 are permissible for the drive type.
52	Target range is wrong	The size of the target range must be between 0 and 100,000,000 * BRES and must be less than the cutoff difference (including adaption value). Either correct the basic resolution value or increase the cutoff difference or reduce the target range.
53	Zero speed range is wrong	The size of the zero speed range must be between 0 and 100,000,000 * BRES and must be less than or equal to the size of the target range. Either correct the basic resolution value or increase the target range or reduce the zero speed range.
55	Forward changeover difference is wrong	The forward changeover difference must be between 1 and 100,000,000 * BRES, it must be greater than the forward cutoff difference and, in the case of a linear axis, it must be less than the traversing range including adaption value. Either correct the basic resolution value or increase the forward changeover difference or reduce the forward cutoff difference.
56	Forward cutoff difference is wrong	The forward cutoff difference must be between 1 and 100,000,000 * BRES, it must be less than the forward changeover difference and, in the case of a linear axis, it must be greater than the target range including adaption value.
57	Reverse changeover difference is wrong	The reverse changeover difference must be between 1 and 100,000,000 * BRES, it must be greater than the reverse cutoff difference and, in the case of a linear axis, it must be less than the traversing range including adaption value. Either correct the basic resolution value or increase the reverse changeover difference or reduce the reverse cutoff difference.

DS error	Error message	Remedy
58	Reverse cutoff difference is wrong	The reverse cutoff difference must be between 1 and 100,000,000 * BRES, it must be less than the reverse changeover difference and, in the case of a linear axis, it must be greater than the target range including adaption value.
59	Forward adaption value is wrong	The forward adaption value must be between 0 and ± 100 000 000 * BRES. In addition, the sum of forward cutoff difference and forward adaption value must be greater than the target range. The sum of forward changeover difference and forward adaption value must be less than the working range in the case of a linear axis. Either reduce the forward adaption value or increase the forward cutoff difference.
60	Reverse adaption value is wrong	The reverse adaption value must be between 0 and ± 100 000 000 * BRES. In addition, the sum of reverse cutoff difference and reverse adaption value must be greater than the target range. The sum of reverse changeover difference and reverse adaption value must be less than the working range in the case of a linear axis. Either reduce the reverse adaption value or increase the reverse cutoff difference.
70	Cam sets or target sets have been deleted	While transferring new error-free machine data, cam sets or target sets have been deleted. You can read out the number of deleted cam sets or target sets from DB-IP, DR n+2 in the application mailbox, or from DB-ZU, DR n+8 or from accumulator 2.
200	Wrong job number	Only the following job numbers are permissible 64 Data set output 65 Data set input 66 Delete data set.
250	Data set does not exist	None of the axes has machine data with this number.
251	Entry/deletion of data set from PLC prohibited	Set the correct mode (PLC mode) before entering or deleting data sets (see Section 6.5.11).
253	Entry/deletion of data sets from PG prohibited	Enter the correct mode (PG mode) before entering or deleting data sets (see Section 6.5.11).
254	Data set cannot be changed	Either the axis is not yet in the "completed" state or the interpretation of an initiated operation has not yet been completed.
255	Data set cannot be deleted	You can only delete a machine data set in the "completed" axis state, or you are trying to delete the data set of a leading axis. In this case, delete the data set of the parallel-switched axis before deleting the data set of the leading axis.

9.5.3 Cam Set Errors

Below are the cam set errors listed according to number.

In the case of errors which refer to one cam, you read out the cam number from DB-ZU (DW n+8), from accumulator and in DB-IP in DR n+2 in the application mailbox.

DS error	Error message	Remedy
1	Wrong data set type	The following types are permissible: ID SYSID data set MD machine data ZS target set NS cam set ZL target list
2	Wrong module ID	The module ID must be: " 288" Have you remembered the space before the 2?
3	Wrong DS number or DS number already exists	Permissible numbers are 1 to 255.
5	Wrong module number	The numbers 1 to 255 are permissible. In addition, you must specify the same number you specified in the SYSID data set.
7	Wrong axis type	The axis type must agree with the machine data
6	Wrong axis number	Numbers 1 to 3 are permissible
8	Wrong measuring system	The measuring system must agree with the entry in the SYSID.
9	Axis is not parameterized	The relevant axis must be parameterized before you enter a cam set.
10	Axis is not parameterized as a cam controller	The relevant axis must be parameterized as a cam controller before you enter a cam set.
11	Number of cams is wrong	You can create between 1 and 8 cams in a track.
12	Track number is wrong	The number of the track to which this cam belongs must be between 1 and 16.
13	Direction of effect of the track is wrong	Permissible numbers are 1, 2 and 3
15	Wrong cam number for interrupt 1	Permissible numbers are 0 (no process interrupt) and 1 to 8.
17	Wrong cam number for interrupt 2	Permissible numbers are 0 (no process interrupt) and 1 to 8.
19	Wrong cam number	Permissible numbers are 1 to 8.
21	Cam start is wrong	Permissible absolute coordinates for the start of cam must be between ± 1 000 000 000*BRES. Negative values must be entered in two's complement. You must enter only values which agree with the machine data.
22	Cam end is wrong	The permissible absolute coordinates for the end of cam of a path cam must be between ± 1 000 000 000*BRES. Negative values must be entered in two's complement. In the case of a linear axis, the coordinate of the end of cam must be greater than the coordinate of the start of cam. Permissible values for the duration of a time cam must be between 24 and 65532 ms. You must enter only values which agree with the machine data.

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DS error	Error message	Remedy
23	Initiating cam for interrupt 1 is not parameterized	The cam must be parameterized.
24	Initiating cam for interrupt 2 is not parameterized	The cam must be parameterized.
25	Cam outside traversing range	In the case of a rotary axis, each cam must be within traversing range parameterized in the machine data (without end of traversing range).
26	Cam number of the time cam is wrong	Only cams 1 and 2 are permissible as time cams.
27	Track already parameterized	You are trying to enter a new cam set (with new data set number) on a parameterized track. Change the data set number or delete the already existing cam set.
28	Switch-on time is wrong	The switch-on time of a time cam must be between 24 and 65532 ms.
250	Data set does not exist	You are trying to delete a data set which does not exist.
251	Entry/deletion of data set from PLC prohibited	Set the correct mode (PLC mode) before entering or deleting data sets (see Section 6.5.11).
252	Data set is in Teach-In mode	Terminate Teach-In mode for this data set before entering it again (see Section 6.5.9).
253	Entry/deletion of data sets from PG prohibited	Enter the correct mode (PG mode) before entering or deleting data sets (see Section 6.5.11).

9.5.4 Target Set and Target List Errors

If an error occurs when entering a target list, the number of the first target set which was being entered when the error occurred can be read out in DB-IP, DR n+2 (status information) in the application mailbox, in accumulator 2 and in DW n+8 in DB-ZU. The erroneous target list is not stored on the module.

Below are the target set errors and target list errors listed according to number:

DS error	Error message	Remedy
1	Wrong data set type	The following types are permissible: ID SYSID data set MD machine data ZS target set NS cam set ZL target list
2	Wrong module ID	The module ID must be: " 288" Have you remembered the space before the 2?
3	Wrong DS number or DS number already exists	Permissible numbers are 1 to 255. In addition, the default target list numbers of the other axes are prohibited for the individual axes (see Section 5.5).
5	Wrong module number	The numbers 1 to 255 are permissible. In addition, you must specify the same number you specified in the SYSID data set.
6	Wrong axis number	Numbers 1 to 3 are permissible
7	Wrong axis type	The axis type must agree with the machine data
8	Wrong measuring system	The measuring system must agree with the entry in the SYSID.
9	Axis is not parameterized	The relevant axis must be parameterized before you enter a target set.
10	Axis is not parameterized as a position control	The relevant axis must be parameterized as a position control before you enter a target set.
11	Target set number is wrong	Permissible numbers are 1 to 255
13	Target is wrong	The permissible absolute coordinates for a target must be between ± 1 000 000 000 * BRES. Negative values must be entered -in two's complement. You must enter only values which agree with the machine data.
14	Forward changeover difference is wrong	The forward changeover difference must be between 1 and 100,000,000 * BRES, it must be greater than the forward cutoff difference and, in the case of a linear axis, it must be less than the traversing range including adaption value. Either correct the basic resolution value or increase the forward changeover difference or reduce the forward cutoff difference.
15	Forward cutoff difference is wrong	The forward cutoff difference must be between 1 and 100,000,000 * BRES, it must be less than the forward changeover difference and, in the case of a linear axis, it must be greater than the target range including adaption value.
16	Reverse changeover difference is wrong	The reverse changeover difference must be between 1 and 100,000,000 * BRES, it must be greater than the reverse cutoff difference and, in the case of a linear axis, it must be less than the traversing range including adaption value. Either correct the basic resolution value or increase the reverse changeover difference or reduce the reverse cutoff difference.
17	Reverse cutoff difference is wrong	The reverse cutoff difference must be between 1 and 100,000,000 * BRES, it must be less than the reverse changeover difference and, in the case of a linear axis, it must be greater than the target range including adaption value.

DS error	Error message	Remedy
18	Forward adaption value is wrong	The forward adaption value must be between 0 and ± 1 000 000 000 * BRES. In addition, the sum of forward cutoff difference and forward adaption value must be greater than the target range. The sum of forward changeover difference and forward adaption value must be less than the working range in the case of a linear axis. Either reduce the forward adaption value or increase the forward cutoff difference.
19	Reverse adaption value is wrong	The reverse adaption value must be between 0 and ± 1 000 000 000*BRES. In addition, the sum of reverse cutoff difference and reverse adaption value must be greater than the target range. The sum of reverse changeover difference and reverse adaption value must be less than the working range in the case of a linear axis. Either reduce the reverse adaption value or increase the reverse cutoff difference.
20	Target set active	You are trying to delete or enter a target set which is currently being processed.
21	Target list empty	You are trying to transfer a target list without target sets to the module.
22	Target set already exists on another axis	Use only target set numbers which do not yet exist on another axis.
250	Data set does not exist	You are trying to delete a data set which does not exist.
251	Entry/deletion of data set from PLC prohibited	Set the correct mode (PLC mode) before entering or deleting data sets (see Section 6.5.11).
252	Data set is in Teach-In mode	Terminate Teach-In mode for this data set before entering it again (see Section 6.5.9).
253	Entry/deletion of data sets from PG prohibited	Enter the correct mode (PG mode) before entering or deleting data sets (see Section 6.5.11).
254	Data set cannot be changed	You can only enter a target set or a target list in the "completed" axis state. You cannot overwrite a target list.
255	Data set cannot be deleted	You can only delete a target set or a target list in the "completed" axis state.

9.5.5 Internal Errors

Internal errors are errors on the module which cause failure of the module.

LED INF

The outputs of the module are switched off as far as this is possible, the LEDs INF and EXF on the frontplate light up and program processing is held up. You cannot correct an internal error. You must replace the module.

9.5.6 External Errors

External errors are errors affecting the process. They are only detected on a parameterized axis.

LED EXF

When an error is detected, the LED EXF lights up. All errors cause a running mode to be aborted (completed axis state). Functions waiting to be processed (position-dependent or event-dependent) remain in force. In the case of positioning, parameter changes waiting to be processed are deleted at the transition to the "completed" axis state.

There is a group flag for each axis in the module status word (DW 68 in DB-IP) as well as a bit-coded flag per error in DB-IP.

- Module flag — Module status DW 68 in DB-IP
- Frame 1 of axis 1 — External errors DW 92 and DW 93 in DB-IP
- Frame 1 of axis 2 — External errors DW 124 and DW 125 in DB-IP
- Frame 1 of axis 1 — External errors DW 155 and DW 156 in DB-IP

External errors must be acknowledge with the relation to the axis after they have been corrected. Errors which are signalled on all three axes (e.g. 24 V load voltage missing) must be acknowledged on each axis individually. Provided the errors have been corrected, they will be deleted with the acknowledgement. Only after acknowledgement is monitoring of pending errors executed again. A new error is then signalled immediately. Following errors are also signalled.

You can read out and acknowledge external errors in COM 288 in test mode (Further Functions). You can read out the external errors via the PLC interface in DB-IP, frame 1 of the axis in each case (see Section 8.3.2).

The following external errors are detected:

Error No.	Error message	Description	Following error?
1	24 V load voltage missing	Reaction on all axes: The synchronization is deleted in the case of incremental encoders. Positioning: Switch off digital outputs Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Fuses F1 and F2 are defective

Error No.	Error message	Description	Following error?
2	Short-circuit 24-volt contact supply for the digital inputs	Reaction on all axes: Positioning: Changeover to creep speed and cutoff of the drive (digital outputs) after traversing the changeover difference. Jog at creep speed is permissible. Cam controller: No reaction, only error flag	Fuse F1 defective, following error of error 1
3	Defective connecting cable digital output 1	Reaction on the axis affected Positioning: Switch off digital outputs. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Axis 1 and 2: Fuse F2 defective, Axis 3: Fuse F1 defective, following error of error 1
4	Defective connecting cable digital output 2	Reaction on the axis affected Positioning: Switch off digital outputs. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Axis 1 and 2: Fuse F2 defective, Axis 3: Fuse F1 defective, following error of error 1
5	Defective connecting cable digital output 3	Reaction on the axis affected Positioning: Switch off digital outputs. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Axis 1 and 2: Fuse F2 defective, Axis 3: Fuse F1 defective, following error of error 1
6	Defective connecting cable digital output 4	Reaction on the axis affected Positioning: Switch off digital outputs. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Axis 1 and 2: Fuse F2 defective, Axis 3: Fuse F1 defective, following error of error 1
7	Short-circuit 24-volt encoder supply	Reaction on all axes, regardless of parameterized encoder type. The synchronization is deleted in the case of incremental encoders. Positioning: Switch off digital outputs. Jog at creep speed in permissible. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Fuse F1 defective, following error of error 1

Error No.	Error message	Description	Following errror?
8	Short-circuit 5-volt encoder supply	Reaction on all axes, regardless of parameterized encoder type. The synchronization is deleted in the case of incremental encoders. Positioning: Switch off digital outputs. Jog at creep speed in permissible. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Fuse F1 defective, following error of error 1
9	Defective encoder signal line (5 V differential signals only).	Reaction on all axes, regardless of parameterized encoder type. The synchronization is deleted in the case of incremental encoders. Positioning: Switch off digital outputs. Jog at creep speed in permissible. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Following error of error 1 (when the encoders are supplied by IP 288). Following error of error 8.
10	Encoder signal/frame error.	Reaction on the axes affected. The synchronization is deleted in the case of incremental encoders. Incremental encoders: Monitoring of the edge interval between encoder signal A and encoder signal B (see Sections 9.1 and 5.2): SSI encoders: Start/stop bit error. Positioning: Switch off digital outputs. Jog at creep speed in permissible. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Following error of error 1 (when encoders supplied by IP 288). Following error of error 8.

Error No.	Error message	Description	Following error?
11	Zero mark error/impermissible encoder value	Reaction on the axes affected. The synchronization is deleted in the case of incremental encoders. Incremental encoders: Zero mark monitor tripped. The monitor can be switched off in the machine data (see Sections 5.1 and 9.1): SSI encoders: Encoder value not in the parameterized range. Positioning: Switch off digital outputs. Jog at creep speed in permissible. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Following error of error 1, Following error of error 7, Following error of error 8, Following error of error 9
12	Traversing range exited	Reaction on the axes affected. The synchronization is deleted in the case of incremental encoders. Positioning: Switch off digital outputs. Jog at creep speed in permissible. Cam controller: All tracks of all axes are switched off (removal of track enable) and must be enabled again after the error has been corrected.	Following error of error 11
13	Working area exited	Reaction of the axes affected (axis must be synchronized): Positioning: No reaction. Jog at creep speed is only permissible in the direction of the overshot software switch. Traverses beyond the overshot software switch cause a parameterization error. Cam controller: No reaction. The software switches have no effect.	Following error of error 11
14	Positive feedback	Reaction on the axes affected. Monitor can be switched off in the machine data (zero speed range = 0). Positioning: Switch off digital outputs. Cam controller: No positive feedback check possible.	

Error No.	Error message	Description	Following error?
15	Actual value difference missing/too small	Reaction on the axes affected. Monitor can be switched off in the machine data (monitoring time = 0). Positioning: Switch off digital outputs. Job at creep speed is permissible. The following apply in addition and cannot be switched off via the monitoring time in the machine data: If a change of direction takes place after leaving the reduction switch in the case of a reference point approach. Cam controller: No actual value monitoring possible.	
16	Error at target entry	Reaction on the axis affected. Monitor can be switched off in the machine data (monitoring time = 0). Positioning: Switch off digital outputs. Jog at creep speed is permissible. Cam controller: No target entry monitoring possible.	
17	Zero speed area exited	Indication on the axis affected. Monitor can be switched off in the machine data (zero speed range = 0). Positioning: Error only indicated. The digital outputs are already switched off. Exception: "Position reached" remains set in the case of drive type 2. Jog at creep speed is permissible. Cam controller: No zero speed monitoring possible.	Following error of error 11
18	Reduction switch adjustment	Indication on the axis affected In the case of incremental encoders with zero mark. Zero mark too close to the end of the reduction switch during reference point approach or during triggering of reference point (see Section 6.4.2). You can also switch this monitor off with the relevant parameterization in the machine data (see Section 5.2). Positioning: Change over to creep speed and switch off the drive (digital outputs) after traversing the changeover difference. Jog at creep speed is permissible. Cam controller: No reaction. However, the reference point is not set.	

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9.5.7 Operator Errors

Operator errors occur when operating the axis with modes or functions in the following cases:

- If an operation is initiated with impermissible values
- If an operation which is not permitted in the current axis status is initiated
- If an operation is not conclusive (e.g. wrong control bit set).

If an operator error occurs, it will be signalled until you either acknowledge the error via the PLC interface or initiate a new (correct) operation. Operator errors on parallel axes are signalled on both axes.

The following operator errors are detected:

Error No.	Error message	Cause/remedy
1	Watchdog acknowledgement required	Replace the module. If it is possible that a one-off fault on the module (voltage peaks) led to the watchdog timeout, you can acknowledge the watchdog and initiate program processing as you would after a cold restart.
2	Operation from PG prohibited	Set the correct mode (PG mode).
3	Axis not parameterized	Enter a machine data set for this axis.
4	Impermissible job	You can only initiate an operation which • has a permissible job number • is consistent in itself • is permissible in the current axis status.
5	Wrong job length	Enter the correct value for the initiated operation as the length of the user data in DB-APP (DR n+2).
6	Wrong command ID	Enter the correct command ID in the user data of the DB-APP 0 = Immediately 1 = Event-dependent 2 = Position-dependent.
7	Axis running or interrupted	The initiated operation is only permissible in the "completed" axis status.
8	Operation from PLC prohibited	Set the correct mode (PLC mode).
9	Value not BCD coded	Check the user data in DB-APP.
10	Coordinate/target not within maximum value range	Check the user data in DB-APP.
11	Coordinate/target not within traversing /working range	Each path specification must be within the traversing/working range.
12	Synchronization already in progress	Switch off Trigger reference point or delete position-dependent/event-dependent actual value setting (see Section 6.5.12 or 6.5.1).
13	Execution on a coupled axis not permissible	You can only execute this operation on a leading axis.
14	BASP pending	CPU is in STOP (see Section 5.1, Effect of S5 CPU failure).
15	Setting not permissible with parameterized encoder	Select another synchronization possibility.

Error No.	Error message	Cause/remedy
16	Not permissible with current functions	
17	Both directions simultaneously prohibited	You have set both direction bits simultaneously.
18	Direction missing	You must specify a direction for this operation.
19	Relative path specification must be positive	The path specification in DB-APP must be positive.
20	Wrong track number	The track number must be between 1 and 16.
21	Adaption factor is wrong	The adaption factor must be between 1 and 100%.
22	Not permissible with linear axis	The "Load revolution comparator" function is only permissible in the case of a rotary axis.
23	Axis not synchronized	Synchronize the axis before executing this function or mode.
24	Drive disable not active	Switch the drive disable on before executing this function.
25	Rapid traverse less than creep speed	Rapid traverse must be at least the same as creep speed.
26	Wrong rapid traverse	Correct the speed specification (see Section 6.5.10).
27	Wrong creep speed	Correct the speed specification (see Section 6.5.10).
28	Not permissible with ext. error	Correct and acknowledge all pending external errors of this axis or, if necessary, the coupled axis.
29	Wrong speed identifier	The speed specification for this mode must be either rapid traverse or creep speed.
30	Target out of reach/no longer in reach	The traversing path to the target must be greater than the cutoff difference + adaption value for the direction of traverse. Target is out of reach in the current direction of travel. Also, in the case of jog: Too close to a limit of the working range in this direction.
31	Wrong data set number	The data set number must be between 1 and 255.
32	Data set does not exist	
33	Data set not for this axis	The data set specified has been created for another axis.
34	Target specification cannot be deleted	Removal of a target is not permitted.
35	Teach-In buffer still occupied	Repeat the input.
36	Data set number already exists	The data set number specified already exists.
37	Track already parameterized	The track specified has already been parameterized with a cam set with another cam set number.
38	Wrong cam number	The cam number must be between 1 and 8.
39	Wrong edge ID	The following are permissible 0 = Off edge 1 = On edge
40	Cam end prior to/equal to cam start	In the case of a linear axis, the start of the cam must be before the end of the cam.
41	Offset too large	A track offset on a rotary axis must be less than one revolution of the axis.
42	Teach-In buffer full	You can teach a maximum of 37 target sets simultaneously.
43	Changeover difference is < cutoff difference	The changeover difference must be greater than the cutoff difference.
47	No possible with active process diagnostics	Switch process diagnostics off before initiating this function or mode.

Error No.	Error message	Cause/remedy
48	Not permissible when waiting for external start	The function is not possible in this axis status.
49	Target set processing prohibited due to input of MD	You are trying to start target set processing during input of machine data.
50	Track not parameterized	A cam track offset is only permissible on a parameterized track.
51	Cam edge outside traversing range	You are trying to store a cam edge in Teach-In on a rotary axis. The cam edge would be outside the traversing range limits if the currently active offset were to be removed. Or, you are trying to execute a zero offset which will cause cam edges to be shifted out of the traversing range.
52	Cutoff difference is <= target range	You are trying to store a target set in Teach-In in which the cutoff difference is less than or equal to the target range.
53	Changeover difference is >= working range	You are trying to store a target set on a linear axis in Teach-In. The changeover difference in the target set is greater than or equal to the difference between the end of software switch and the start of software switch (working range).

9.5.8 Alphabetical List of Error Messages

Below is an alphabetical list of the error messages with the relevant error type and error number. This list is designed to help you find more detailed information on the error messages in the previous sections.

Error message	Error type	Error No.
Actual value change missing/too small	External error	15
Adaption factor is wrong	Operator error	21
Axis is not parameterized	Target set/target list error Cam set error	9
Axis is not parameterized as cam controller	Cam set error	10
Axis is not parameterized as positioning function	Target set/target list error	10
Axis not in PLC/PG mode	SYSID error	253
Axis not parameterized	Operator error	3
Axis not synchronized	Operator error	23
Axis running or interrupted	Operator error	7
BASP pending	Operator error	14
Both directions simultaneously prohibited	Operator error	17
Cam edge outside traversing range	Operator error	51
Cam end is wrong	Cam set error	22
Cam end prior to/equal to cam start	Operator error	40
Cam number of the time cam is wrong	Cam set error	26
Cam outside traversing range	Cam set error	25
Cam sets or target sets have been deleted	Machine data error	70
Cam start is wrong	Cam set error	21
Changeover difference is < cutoff difference	Operator error	43
Changeover difference is >= working range	Operator error	
Coordinate/target not within maximum value range	Operator error	10
Coordinate/target not within traversing/working range	Operator error	11
Cutoff difference <= target range	Operator error	52
Data set cannot be changed	Target set/target list error Cam set error Machine data error	254
Data set cannot be deleted	Target set/target list error Machine data error	255
Data set does not exist	Operator error	32
Data set does not exist	Target set/target list error Cam set error Machine data error	250
Data set is in Teach-In mode	Target set/target list error	252
Data set not for this axis	Operator error	33
Data set number already exists	Operator error	36
Defective connecting cable digital output 1	External error	3
Defective connecting cable digital output 2	External error	4
Defective connecting cable digital output 3	External error	5
Defective connecting cable digital output 4	External error	6
Defective encoder signal line	External error	9

Error message	Error type	Error No.
Different data set numbers or data has been changed	Machine data error	4
Direction missing	Operator error	18
Direction of effect of the track is wrong	Cam set error	13
Drive disable not active	Operator error	24
Drive type is wrong	Machine data error	50
Effect of coordinate input is wrong	Machine data error	16
Encoder signal/frame error	External error	10
End of software switch is wrong	Machine data error	36
End of traversing range is wrong	Machine data error	31
Entry/deletion of data set from PG prohibited	Target set/target list error Cam set error Machine data error	253
Entry/deletion of data set from PLC prohibited	Target set/target list error Cam set error Machine data error	251
Error at target entry	External error	16
Execution on coupled axis not permissible	Operator error	13
Forward adaption value is wrong	Machine data error	59
Forward adaption value is wrong	Target set/target list error	18
Forward changeover difference is wrong	Machine data error	55
Forward changeover difference is wrong	Target set/target list error	14
Forward cutoff difference is wrong	Machine data error	56
Forward cutoff difference is wrong	Target set/target list error	15
Hysteresis is wrong	Machine data error	40
Impermissible job	Operator error	4
Initiating cam for interrupt 1 is not parameterized	Cam set error	23
Initiating cam for interrupt 2 is not parameterized	Cam set error	24
Interrupt line cannot be changed	SYSID error	9
Module number cannot be changed	SYSID error	10
Not permissible when waiting for external start	Operator error	48
Not permissible with current functions	Operator error	16
Not permissible with ext. error	Operator error	28
Not permissible with linear axis	Operator error	22
Not possible with active process diagnostics	Operator error	47
Number of cams is wrong	Cam set error	11
Offset too large	Operator error	41
Operation from PG prohibited	Operator error	2
Operation from PLC prohibited	Operator error	8
Positive feedback	External error	14
Process interrupt selection wrong	Machine data error	12
Rapid traverse less than creep speed	Operator error	25
Reduction switch adjustment	External error	18
Relative path specification must be positive	Operator error	19
Reverse adaption value is wrong	Machine data error	60
Reverse adaption value is wrong	Target set/target list error	19
Reverse changeover difference is wrong	Machine data error	57
Reverse changeover difference is wrong	Target set/target list error	16
Reverse cutoff difference is wrong	Machine data error	58
Reverse cutoff difference is wrong	Target set/target list error	17

Error message	Error type	Error No.
Scaling of increments/encoder revolution is wrong	Machine data error	22
Scaling of path/encoder revolution is wrong	Machine data error	23
Selected interrupt line is wrong	SYSID error	8
Setting not permissible with parameterized encoder	Operator error	15
Short-circuit 24-volt contact supply for the digital outputs	External error	2
Short-circuit 5-volt encoder supply	External error	8
Short-circuit 24-volt encoder supply	External error	7
Start of software switch is wrong	Machine data error	35
Start of traversing range is wrong	Machine data error	30
Switch-on time is wrong	Cam set error	28
Synchronization already in progress	Operator error	12
Target is wrong	Target set/target list error	13
Target list empty	Target set/target list error	21
Target out of reach/no longer in reach	Operator error	30
Target range is wrong	Machine data error	52
Target set active	Target set/target list error	20
Target set already exists on another axis	Target set/target list error	22
Target set number is wrong	Target set/target list error	11
Target set processing prohibited due to input of MD	Operator error	49
Target specification cannot be deleted	Operator error	34
Teach-In buffer full	Operator error	42
Teach-In buffer still occupied	Operator error	35
Track already parameterized	Operator error	37
Track already parameterized	Cam set error	27
Track not parameterized	Operator error	50
Traversing range exited	External error	12
Value not BCD coded	Operator error	9
Watchdog acknowledgement required	Operator error	1
Working area exited	External error	13
Wrong accuracy range	Machine data error	10
Wrong axis function	Machine data error	9
Wrong axis number	Target set/target list error Cam set error Machine data error	6
Wrong axis type	Target set/target list error Cam set error	7
Wrong cam number	Cam set error	19
Wrong cam number	Operator error	38
Wrong cam number for interrupt 1	Cam set error	15
Wrong cam number for interrupt 2	Cam set error	17
Wrong command ID	Operator error	6
Wrong creep speed	Operator error	27
Wrong data set number	Operator error	31
Wrong data set number or DS number already exists	Target set/target list error Cam set error Machine data error SYSID error	3

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Error message	Error type	Error No.
Wrong data set type	Target set/target list error Cam set error Machine data error SYSID error	1
Wrong edge ID	Operator error	39
Wrong encoder type	Machine data error	20
Wrong job length	Operator error	5
Wrong job number	Machine data error	70
Wrong job number	SYSID error	200
Wrong measuring system	Target set/target list error Cam set error Machine data error	8
Wrong module ID	Target set/target list error Cam set error Machine data error SYSID error	2
Wrong module number	Target set/target list error Cam set error Machine data error	5
Wrong number of encoder revolutions	Machine data error	24
Wrong number of increments or doesn't suit traversing range	Machine data error	28
Wrong rapid traverse	Operator error	26
Wrong reference point	Machine data error	32
Wrong resolution	Machine data error	29
Wrong speed identifier	Operator error	29
Wrong track number	Operator error	20
Wrong track number	Cam set error	12
Zero mark error/impermissible encoder value	External error	11
Zero speed area exited	External error	17
Zero speed range is wrong	Machine data error	53
24 V load voltage missing	External error	1

9.6 Technical Specifications of the Module

Power supply	+
Supply voltage from system bus	5 V ± 5 %
Current consumption	approx. 0.8 A
Load voltage L +	20 to 30 V
Current consumption (without encoder supply, digital outputs without load)	approx. 150 mA
Battery voltage (backup)	2.7 to 5.25 V
Current consumption from the battery	max. 500 µA
Encoder supply (5 V)	5.2 V ± 2 % max. 300 mA per channel short-circuit proof
Encoder supply (24 V encoders, digital inputs)	L+ - 1 V , max. 300 mA per channel short-circuit proof
Inputs for actual values	+
Incremental position encoders (5 V signals)	
Signals	to RS 422
Input resistance	approx. 180 Ω
Counting frequency	max. 500 kHz
Permissible cable length in the case of 5 V supply, cable cross section 1 mm^2 in the case of 24 V supply	max. 32 m max. 100 m
Incremental encoders (24 V signals)	
Input voltage signal 0	-30 V to + 5 V
Input voltage signal 1	+13 V to +30 V
Input current	typ. 11 mA
Input resistance	approx. 2.2 kΩ
Counting frequency	max. 50 kHz
Permissible cable length	max. 100 m
Absolute encoders with SSI interface	
Signals	to RS 422
Permissible cable length	max. 320 m
Digital inputs	+
Number of inputs per channel	4, short-circuit proof
Input voltage signal 0	-30 V to + 5 V
Input voltage signal 1	+13 V to +30 V
Input current	typ. 11 mA
Input delay (n = channel number 1, 2 or 3) all except DI4_n DI4_n	 typ. 3 ms typ. 300 µs
Digital outputs	+
Number of outputs per channel	4
Rated voltage (L+)	24 V
Output voltage at signal 1	L+ - 0.6 V
Switched current	10 mA to 500 mA
Cutoff voltage (ind.)	limited to L+-(45 to 55 V)
Mechanical specifications	+
Dimensions (W x H x L)	40 x 255 x 178 mm
Weight	approx. 0.7 kg
Environmental conditions	+
Operating temperature	0 to 60 °C (32 to 140°F)
Nonoperating temperature	-40 to +70 °C (-40 to +200 °F)

9.7 Technical Specifications of the Function Blocks

9.7.1 Technical Specifications of the Function Blocks for the S5-115U

Block	FB ZYK	FB PAR	FB INT
Library number (P71200-S ...)	-5111-A-1	-5112-A-1	-5113-A-1
Call length (words)	2	2	2
Block length (words)	1661	1044	500
Nesting depth	0	0	0
Lower-level blocks	None	None	None
Assignment in data area	1)	1)	1)
Assignment in flag area	FY 200 to FY 255	FY 200 to FY 255	FY 200 to FY 255
Assignment in system data area	-	-	-

1) see "Data blocks" chapter

Processing times of FB ZYK

(Time in ms)	S5-115U central controller			
	CPU 941B	CPU 942B	CPU 943B	CPU 944B
Idle	11.0	11.0	10.6	2.0
Write job: 1), 2) Job initiation Following job	 17.1 -	 17.1 -	 16.4 -	 2.7 1.9
Read job: 3) Job initiation Following job	 15.1 14.7	 15.1 14.7	 14.5 14.1	 2.5 2.3
Runtime extension per actual value block to be read	2.0	2.0	1.9	0.1
Runtime extension per setpoint block to be written to	1.1	1.1	1.0	0.1

1) Write jobs include: jog mode, reference point approach, absolute incremental mode, relative incremental mode, target set processing, set actual value, set zero point, zero offset, adaption, cam track offset, load revolution comparator, actual position comparator, Teach-In, simulation

2) The number of FB calls required for one write job depends on the processing speed of the CPU and on the response time of the IP 288.

3) Read jobs include: read actual value, read function values

Processing times of FB PAR

(Times in ms)	S5-115U central controller			
	CPU 941B	CPU 942B	CPU 943B	CPU 944B
Idle	5.8	5.8	5.4	1.5
Write job/read job Basic requirements Additional requirements for 10 DW user data	 8.8 1.1	 8.8 1.1	 8.7 1.0	 1.9 0.1

Processing times of FB INT

(Times in ms)	S5-115U central controller			
	CPU 941B	CPU 942B	CPU 943B	CPU 944B
Idle	4.9	4.9	4.5	1.5
Runtime extension per interrupt block to be read	1.2	1.2	1.2	0.1

9.7.2 Technical Specifications of the Function Blocks for the S5-135U (CPU 922)

Block	FB ZYK	FB PAR	FB INT
Library number (P71200-S ...)	-9111-A-1	-9112-A-1	-9113-A-1
Call length (words)	2	2	2
Block length (words)	1386	937	362
Nesting depth	0	0	0
Lower-level blocks	None	None	None
Assignment in data area	1)	1)	1)
Assignment in flag area	FY 200 to FY 255	FY 200 to FY 255	FY 200 to FY 255
Assignment in system data area	RS 60 to RS 61 2)	RS 60 to RS 61 2)	
Other	3)	3)	3)

1) See "Data Blocks" chapter

2) The system data words are used like scratchflags, i.e. they can be used freely outside the function blocks. If you use this RS data in the interrupt-driven program or if you call blocks which use this RS data, the data must be saved at the start of the interrupt routine and loaded again immediately before exiting the interrupt routine.

3) In the function block, interrupts and time interrupts are disabled for periods by special functions and then enabled again. This causes any "Disable interrupts" which might be programmed to be revoked.

Processing times

Processing times of FB ZYK:

(Time in ms)	S5-135U CPU 922
Idle	11.6
Write job: 1), 2) Job initiation Following job	 17.3 -
Read job: 3) Job initiation Following job	 14.5 14.6
Runtime extension per actual value block to be read	3.5
Runtime extension per setpoint block to be written to	1.8

Processing times of FB PAR:

(Time in ms)	S5-135U CPU 922
Idle	5.3
Write job/read job Basic requirements Additional requirements for 10 DW user data	 8.4 2.3

Processing times of FB INT

Idle	3.7
Runtime extension per interrupt block to be read	2.1

1) Write jobs include: jog mode, reference point approach, absolute incremental mode, relative incremental mode, target set processing, set actual value, set zero point, zero offset, adaption, cam track offset, load revolution comparator, actual position comparator, Teach-In, simulation

2) The number of FB calls required for one write job depends on the processing speed of the CPU and on the response time of the IP 288.

3) Read jobs include: read actual value, read function values

9.7.3 Technical Specifications of the Function Blocks for the S5-135U (CPU 928 and CPU 928B)

Block	FB ZYK	FB PAR	FB INT
Library number (P71200-S ...)	-8111-A-1	-8112-A-1	-8113-A-1
Call length (words)	2	2	2
Block length (words)	1161	799	316
Nesting depth	0	0	0
Lower-level blocks	None	None	None
Assignment in data area	1)	1)	1)
Assignment in flag area	FY 200 to FY 255	FY 200 to FY 255	FY 200 to FY 255
Assignment in system data area	-	-	-
Other	2)	2)	2)

1) See "Data Blocks" chapter

2) In the function block, interrupts and time interrupts are disabled for periods by special functions and then enabled again. This causes any "Disable interrupts" which might be programmed to be revoked.

Processing times

Processing times of FB ZYK:

(Time in ms)	S5-135U	
	CPU 928	CPU 928B
Idle	5.7	1.0
Write job: [1), 2)] Job initiation Following job	 8.3 4.2	 1.3 0.8
Read job: [3)] Job initiation Following job	 7.2 6.3	 1.2 1.1
Runtime extension per actual value block to be read	1.8	0.2
Runtime extension per setpoint block to be written to	1.0	0.1

Processing times of FB PAR:

(Time in ms)	S5-135U	
	CPU 928	CPU 928B
Idle	2.7	0.6
Write job/read job Basic requirements Additional requirements for 10 DW user data	 4.0 1.1	 0.9 0.1

Processing times of FB INT

Idle	1.8	0.3
Runtime extension per interrupt block to be read	1.2	0.1

1) Write jobs include: jog mode, reference point approach, absolute incremental mode, relative incremental mode, target set processing, set actual value, set zero point, zero offset, adaption, cam track offset, load revolution comparator, actual position comparator, Teach-In, simulation

2) The number of FB calls required for one write job depends on the processing speed of the CPU and on the response time of the IP 288.

3) Read jobs include: read actual value, read function values

9.7.4 Technical Specifications of the Function Blocks for the S5-155U

Block	FB ZYK	FB PAR	FB INT
Library number (P71200-S ...)	-6111-A-1	-6112-A-1	-6113-A-1
Call length (words)	2	2	2
Block length (words)	1268	885	329
Nesting depth	1 [1)]	1 [1)]	0
Lower-level blocks	None	None	None
Assignment in data area	2)	2)	2)
Assignment in flag area	FY 200 to FY 255	FY 200 to FY 255	FY 200 to FY 255
Assignment in system data area	-	-	-
Other	3)	3)	3)

1) Special functions of the operating system are called which are then treated as "normal" block calls.

2) See "Data Blocks" chapter

3) In the function block, interrupts and time interrupts are disabled for periods by special functions and then enabled again. This causes any "Disable interrupts" which might be programmed to be revoked.

Processing times

Processing times of FB ZYK:

(Time in ms)	S5-155U CPU 946/947
Idle	1.2
Write job:: [1], [2] Job initiation Following job	 1.8 1.1
Read job: [3] Job initiation Following job	 1.7 1.5
Runtime extension per actual value block to be read	0.3
Runtime extension per setpoint block to be written to	0.2

Processing times of FB PAR:

(Time in ms)	S5-155U CPU 946/947
Idle	0.7
Write job/read job Basic requirements Additional requirements for 10 DW user data	 1.1 0.2

Processing times of FB INT

Idle	0.3
Runtime extension per interrupt block to be read	0.2

[1] Write jobs include: jog mode, reference point approach, absolute incremental mode, relative incremental mode, target set processing, set actual value, set zero point, zero offset, adaption, cam track offset, load revolution comparator, actual position comparator, Teach-In, simulation

[2] The number of FB calls required for one write job depends on the processing speed of the CPU and on the response time of the IP 288.

[3] Read jobs include: read actual value, read function values

9.7.5 Technical Specifications of FB 38 and FB 39

Block	FB 38 RETTEN	FB 39 LADEN
Library number (P71200-S ...)	-5038-A-1	-5039-A-1
Call length (words)	3	3
Block length (words)	137	141
Nesting depth	0	0
Lower-level blocks	None	None
Assignment in data area	Parameterized data block up to and including DW 80	Parameterized data block up to and including DW 80
Assignment in flag area	FY 248 to FY 255	FY 248 to FY 255
System statements	Yes	Yes
Other	During processing of the block, interrupts are disabled by the "IA" and "RA" operations.	During processing of the block, interrupts are disabled by the "IA" and "RA" operations.

Use of the "RA" operation in DB 38 or FB 39 revokes any "IA" operation you may have programmed.

Processing times of FB 38

(Time in ms)	CPU 941 B	CPU 942 B	CPU 943 B	CPU 944 B
Save page No.	2.2	2.2	1.8	1.2
Save scratchflags/ system data	5.7	5.7	5.5	1.8
Save both	5.8	5.8	5.7	1.9

Processing times of FB 39

(Times in ms)	CPU 941 B	CPU 942 B	CPU 943 B	CPU 944 B
Load page No.	1.5	1.5	1.2	0.3
Load scratchflags/ system data	4.3	4.3	4.2	0.4
Load both	4.4	4.4	4.3	0.5

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Guidelines for Handling
Electrostatically Sensitive Devices (ESD)

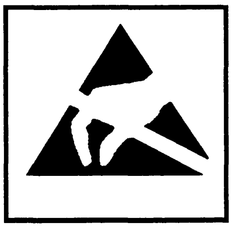
1 What is ESD?

VSLI chips (MOS technology) are used in practically all SIMATIC and TELEPERM modules. These VLSI components are, by their nature, very sensitive to overvoltage and thus to electrostatic discharge:

They are therefore defined as
Electrostatically Sensitive Devices: "ESD"

"ESD" is the abbreviation used internationally.

The following warning label on the cabinets, subracks and packing indicates that electrostatically sensitive components have been used and that the modules concerned are susceptible to touch:



ESDs can be destroyed by voltage and energy levels which are far below the level perceptible to human beings. Such voltages already occur when a component or a module is touched by a person who has not been electrostatically discharged. Components which have been subjected to such overvoltages cannot, in most cases, be immediately detected as faulty; the fault occurs only after a long period in operation.

An electrostatic discharge
- of 3500 V can be felt
- of 4500 V can be heard
- must take place at a minimum of 5000 V to be seen.

But just a fraction of this voltage can already damage or destroy an electric component.

The typical data of a component can suffer due to damage, overstressing or weakening caused by electrostatic discharge; this can result in temporary fault behavior, e.g. in the case of

- temperature variations,
- mechanical shodks,
- vibrations,
- change of load.

Only the consequent use of protective equipment and careful observation of the precautions for handling such components can effectively prevent functional disturbances and failures of ESD modules.

2 When is a Static Charge Formed?

One can never be sure that the human body or the material and tools which one is using are not electrostatically charged.

Small charges up to 100 V are very common; these can, however, very quickly rise up to 35 000 V!

Examples of static charge:

– Walking on a carpet	up to	35 000 V
– Walking on a PVC flooring	up to	12 000 V
– Sitting on a cushioned chair	up to	18 000 V
– Plastic desoldering unit	up to	8 000 V
– Books, etc. with a plastic binding	up to	8 000 V
– Plastic bag	up to	5 000 V
– Plastic coffee cup	up to	5 000 V

3 Important Protective Measures against Static Discharge

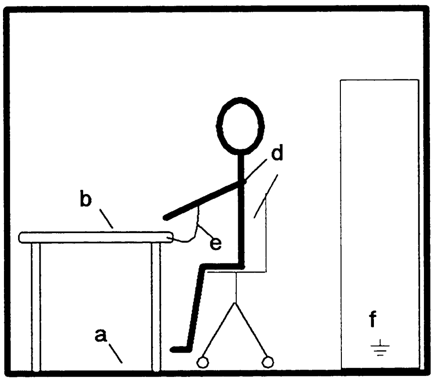
- Most plastic materials are highly susceptible to static charge and must therefore be kept as far away as possible from ESDs!
- Personnel who handle ESDs, the work table and the packing must all be carefully grounded!

4 Handling of ESD Modules

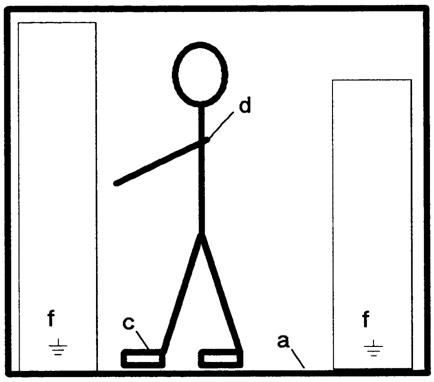
- One basic rule to be observed is that electronic modules should be touched by hand only if this is necessary for any work to be done on them. Do not touch the component pins or the conductors.
- Touch components only if
  - the person is grounded at all times by means of a wrist strap

  or
  - the person is wearing special anti-static shoes or shoes with a grounding strip.
- Before touching an electronic module, the person concerned must ensure that (s)he is not carrying any static charge. The simplest way is to touch a conductive, grounded item of equipment (e.g. a blank metallic cabinet part, water pipe, etc.) before touching the module.
- Modules should not be brought into contact with insulating materials or materials which take up a static charge, e.g. plastic foil, insulating table tops, synthetic clothing, etc..
- Modules should only be placed on conductive surfaces (table with anti-static table top, conductive foam material, anti-static plastic bag, anti-static transport container).
- Modules should not be placed in the vicinity of visual display units, monitors or TV sets (minimum distance from screen > 10 cm).

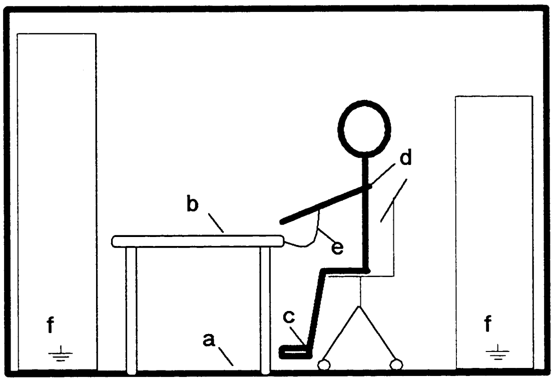
The diagram on the next page shows the required protective measures against electrostatic discharge.



Sitting position



Standing position



a Conductive flooring
b Anti-static table
c Anti-static shoes
d Anti-static coat
e Grounding wrist strap
f Grounding connection of the cabinets

Standing/sitting position

5 Measurements and Modifications to ESD Modules

- Measurements on modules may only be carried out under the following conditions:
  - the measuring equipment is grounded (e.g. via the PE conductor of the power supply system) or
  - when electrically isolated measuring equipment is used, the probe must be discharged (e.g. by touching the metallic casing of the equipment) before beginning measurements.
- Only grounded soldering irons may be used.

6 Shipping of ESD Modules

Anti-static packing material must always be used for modules and components, e.g. metalized plastic boxes, metal boxes, etc. for storing and dispatch of modules and components.

If the container itself is not conductive, the modules must be wrapped in a conductive material such as conductive foam, anti-static plastic bag, aluminum foil or paper. Normal plastic bags or foils should not be used under any circumstances.

For modules with built-in batteries ensure that the conductive packing does not touch or short-circuit the battery connections; if necessary cover the connections with insulating tape or material.