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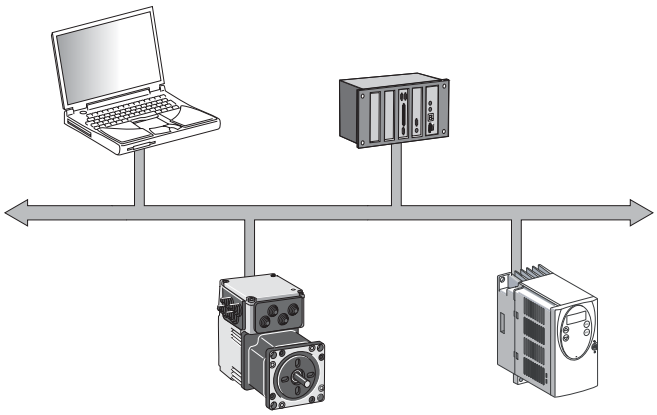
Technical Documentation



Fieldbus manual

Fieldbus protocol for Servodrive LXM05B

Profibus DP V0 USA

Document: BLMT00007

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a brand of Schneider Electric

Important information

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

See safety section for additional critical instructions.

Not all product variants are available in all countries.
Please consult the current catalogue for information on the availability of product variants.

We reserve the right to make changes during the course of technical developments.

All details provided are technical data and not promised characteristics.

In general, product names must be considered to be trademarks of the respective owners, even if not specifically identified as such.

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Writing conventions and symbols

Work steps

If work steps must be carried out in sequence, they are shown as follows:

- ■ Special prerequisites for the following work steps
- ▶ Step 1
- ◁ Important response to this work step
- ▶ Step 2

If a response to a work step is specified, this will inform you that the step has been carried out correctly.

Unless otherwise stated, the individual instruction steps must be carried in the given sequence.

Lists

Lists can be sorted alphanumerically or by priority. Lists are structured as follows:

- Point 1
- Point 2
  - – Subpoint to 2
  - – Subpoint to 2
- Point 3

Making work easier

Information on making work easier can be found at this symbol:

This offers supplementary information on making work easier.
See the chapter on safety for an explanation of the safety instructions.

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1 Introduction

The Profibus is a serial fieldbus system in which products from different manufacturers can be networked without the need for special interface adaptation.

This manual describes the online command processing for products in the Profibus-DP V0 fieldbus network.

1.1 Documentation and literature references

Documentation

In addition to this fieldbus manual, the following manuals belong to the AC servo drive LXM05B:

- **Product manual**, describes the technical data, installation, commissioning and all operating modes and operating functions.
- **Motor manual**, describes the technical properties of the motors, including correct installation and commissioning.

Literature

- PROFIBUS Specification (FMS, DP, PA); Profibus User Organisation
- Popp, M: PROFIBUS-DP/DPV1; Grundlagen, Tipps und Tricks für Anwender [Basics, Tips and Tricks for Users]; ISBN 3-7785-2781-9

1.2 Directives and standards

Regulations, standards

- DIN 19245, Parts 1 to 3: PROFIBUS-FMS
- EN50170, fieldbus standard

Profibus User Association

Profibus Nutzerorganisation e.V. (PNO)
Interessenvertretung der Profibusanwender
Haid-und-Neu-Str. 7
D-76131 Karlsruhe

Profibus international in the Internet

http://www.profibus.com

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2 Safety

2.1 Qualification of personnel

Only technicians who are familiar with and understand the contents of this manual and the other relevant manuals are authorised to work on and with this drive system. The technicians must be able to detect potential dangers that may be caused by setting parameters, changing parameter values and generally by the mechanical, electrical and electronic equipment.

The technicians must have sufficient technical training, knowledge and experience to recognise and avoid dangers.

The technicians must be familiar with the relevant standards, regulations and safety regulations that must be observed when working on the drive system.

2.2 Intended use

The drive systems described here are products for general use that conform to the state of the art in technology and are designed to prevent any dangers. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of the drives unless additional suitable safety equipment prevents any personal danger. This applies to operation of the machine during production and also to all service and maintenance work on drives and the machine. The machine design must ensure personal safety. Suitable measures for prevention of property damage are also required.

In the system configuration described the drive systems must be used in industrial applications only and must have a fixed connection only.

In all cases the applicable safety regulations and the specified operating conditions, such as environmental conditions and specified technical data, must be observed.

The drive system must not be commissioned and operated until completion of installation in accordance with the EMC regulations and the specifications in this manual.

To prevent personal injury and damage to property damaged drive systems must not be installed or operated.

Changes and modifications of the drive systems are not permitted and if made all no warranty and liability will be accepted.

The drive system must be operated only with the specified wiring and approved accessories. In general, use only original accessories and spare parts.

The drive systems must not be operated in an environment subject to explosion hazard (ex area).

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2.3 General safety instructions

⚠ DANGER

RISK OF INJURY BY COMPLEX SYSTEM

When the system is started the drives are generally out of the operator's view and cannot be visually monitored.

- Only start the system if there are no persons in the operating zone of the moving components and the system can be operated safely.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING!

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link. *
- Each implementation of LXM05* must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury or equipment damade.

* **For additional information, refer to NEMA ICS 1.1 (latest edition), Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control and to NEMA ICS 7.1 (latest edition), Safety standards for Construction and Guide for Selection, Indtallation and Operation of Adjustable-Speed Drive Systems.**

⚠ CAUTION!

FAULTY CONTROL COMMANDS

If a PLC is used as the master unit, the exchange of data can lead to inconsistent transmission data as a result of fieldbus and PLC cycles not operating synchronously.

- Observe the notes concerning the operation using PLC.

Failure to follow these instructions can result in injury or equipment damage.

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3 Basics

3.1 Profibus technology

3.1.1 Profibus transmission technology

Profibus is available in three types that can be used for time.critical and complex communications tasks:

- Profibus-FMS
- Profibus-PA
- Profibus-DP

Profibus-FMS (FMS: Fieldbus Message Specification) is a universal, flexible solution for communications tasks in general automation technology. For example, FMS is used for communications between manufacturing cells.

Profibus-PA (PA: Process Automation) is primarily used in process technology, such as process automation. Profibus-PA networks are characterised by their ability to use sensors and actuators in explosion-endangered areas, and to provide data communication and power to devices over the bus.

Profibus-DP (DP: Distributed Periphery) is the fast Profibus version. It is specially tailored for communications in manufacturing areas. Features include simple connection of new products into the bus and high transmission speeds.

The drive system with Profibus-DP described here supports various parameter message frames as per the Profibus-DP V0 specification.

3.1.2 Network topology

A Profibus-DP network consists of one or more masters (active bus devices) and slaves (passive bus devices). All bus devices are linked together by the Profibus-DP network cable.

Master The master controls the data traffic in the network. Examples for master:

- automation devices, e.g. PLCs
- PCs
- programming devices

Slave They receive control commands and supply data to the master. Examples for slaves:

- input/output modules
- drive systems
- sensors and actuators

3.1.3 Access procedures

There are two possible access procedures resulting from the arrangement of network devices on the bus:

- the Token-Passing method
- The Master-Slave method

the Token-Passing method

The Token-Passing method is used between multiple master in a Profibus-DP network. The masters form a logical token ring in which every master receives transmission authorisation for a specified period.

The Master-Slave method

Data is exchanged with the product with the master-slave method. The slave has a transmit and receive buffer through which it provides and receives data. The master reserves a memory area with a transmit and receive buffer for every slave.

Data exchange between master and slave is cyclical. The master device sends commands to the slave device and receives data back from the slave in the next cycle. The bus cycle is extended for transmission of repeat message frames only in case of fault

Drive systems are linked into the network as slaves, therefore they do not use the token passing system.

3.1.4 Transmission technology in the network

Profibus-DP networks can be set up with optical waveguides or with RS-485 technology.

Drive systems work with RS-485 technology and are linked to a Profibus-DP network with two-wire cables.

RS485 technology

RS485 technology is a simple method of transmission over two-wire twisted-pair cables. It can handle transmission rates from 9.6 kbit/s to 12 Mbit/s.

3.1.5 Device identification

Device master data file

The specific features of a Profibus product are described in the device master data file (GSD file). This file is supplied with the product by the manufacturer and must be read by the network configuration programme.

The GSD file contains all information on the operation of the product in the Profibus-DP network, such as manufacturer's specifications and product identification, supported baud rate, levels and meaning of plug signals, time intervals for monitoring times and product-specific values for network devices such as settings for inputs/outputs.
The GSD file for this product is available for download from the Internet.

Identity number

A master device uses the ID number to identify the device class of the connected slave. The ID number is a unique number allocated for a specific device class by the Profibus user organisation.

Slave address

In the network every device must be allocated a unique address between 1 and 126. Slaves normally occupy the address space 3...126. The master (normally address 0...2) can contact every slave directly from this address. The exact setting of the address for the product described here is described in the product manual.

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3.2 Fieldbus devices in the Profibus-DP network

Different fieldbus products can be operated in the same fieldbus segment. Profibus-DP provides a unified basis for exchanging commands and data between the network devices.

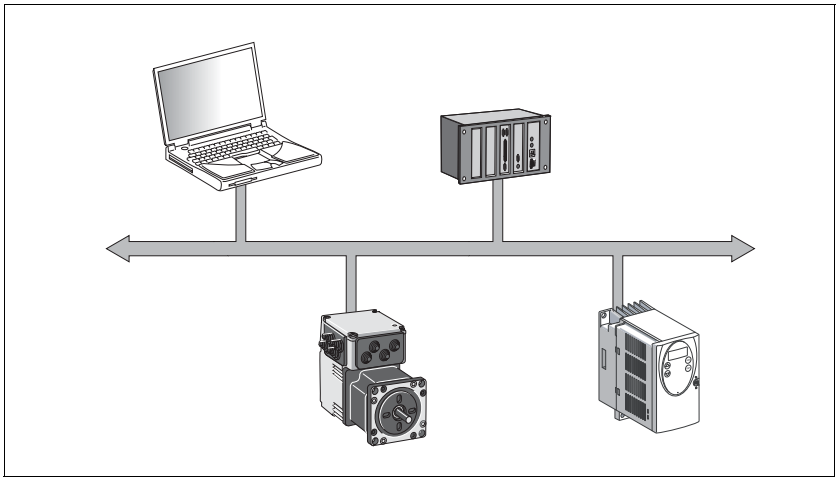

Figure 3.1 Fieldbus products in the network

3.3 Operating modes and functions

This manual only describes the protocol for fieldbus operation. Descriptions of operating modes, operating functions and all parameters can be found in the relevant product manual.

Setting options The following settings can be made over the fieldbus:

- Reading and writing parameters
- Monitoring inputs and outputs
- Diagnostics and error monitoring functions

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4 Installation

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link. *
- Each implementation of LXM05* must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury or equipment damade.

* **For additional information, refer to NEMA ICS 1.1 (latest edition), Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control and to NEMA ICS 7.1 (latest edition), Safety standards for Construction and Guide for Selection, Indtallation and Operation of Adjustable-Speed Drive Systems.**

4.1 Electromagnetic compatibility, EMC

The following measures are necessary for trouble-free fieldbus operation. They supplement the EMC measures in the product manual.

EMC measures	Effect
Use wiring with braided and foil shielding	Discharge of interference currents
Fieldbus lines and signal lines must not be laid out in the same cable conduit as lines for DC and AC voltage over 60 V [1)] Recommendation: lay in separate conduits at least 20 cm (7.87 in) apart.	Prevention of mutual interference
Use bonding conductors in system with – wide-area installation – different voltage infeed – networking between different buildings	Discharge of interference currents
Use fine-core bonding conductors	Deflect even high-frequency interference currents
Circuit breaker if there is danger of overvoltage or lightning strike	Protection against damage by overvoltage

1) Fieldbus lines can be laid out in one conduit with signal and analogue lines

Table 4.1 EMC measures

Equipotential bonding conductors

The shields are connected at both ends for fault protection. Potential differences can result in excessive currents on the shield and must be prevented by equipotential bonding conductor cables.

If lines over 100 m (328 feet) are approved, the following applies: up to 200 m (656 feet) length a cable cross section of 16 mm^2 (6 AWG) is sufficient, for greater lengths a cable cross section of 20 mm^2 (5 AWG) is required.

For more information please see the product manual.

4.2 Profibus DP interface

Function

With the Profibus-DP interface you can connect the drive system to a Profibus network as a slave.

The drive system includes data and commands from a higher level bus device, the master. Status information such as operating status and processing status are sent to the master as acknowledgment.

Consult the product manual for the exact terminal assignments and the settings for the address and the terminating resistor.

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5 Commissioning

⚠ DANGER

RISK OF INJURY BY COMPLEX SYSTEM

When the system is started the drives are generally out of the operator's view and cannot be visually monitored.

- Only start the system if there are no persons in the operating zone of the moving components and the system can be operated safely.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNCONTROLLED SYSTEM OPERATION

- Do not write to reserved parameters.
- Do not write to parameters before you have understood the function. For more information see the product manual.
- Run the first tests without coupled loads.
- Make sure that the system is free and ready for the movement before changing parameters.
- Check the use of the bits during fieldbus communication: Bit 0 is far right (least significant). Bit 15 is far left (most significant).
- Check the use of the word sequence during fieldbus communication:
- Do not establish a fieldbus connection before you have understood the communications principles.

Failure to follow these instructions can result in death, serious injury or equipment damage.

5.1 Requirements for commissioning

The following components are required for commissioning:

- product with Profibus-DP interface
- GSD file on data medium
- Product manual for the described product
- manual for the Profibus-DP fieldbus (this manual)

Read the manuals carefully before commissioning and take particular note of the safety instructions!

Drivers for Siemens PLCs can be obtained from your local agent as required.

5.2 Initiating network operation

Network operation is started via a master. This can be a PLC or a PC with the appropriate user software with which commands can be sent and received data read.

5.3 Running function test

Test all functions that are important for your system. Run the function tests first with no coupled load. Also check the operating temperature under normal operation and the response of the system to power failure.

Steps for troubleshooting

If the slave does not send a response, check the following settings:

- Is the product switched on and is the master started for network operation?
- Are all cable connections in good mechanical repair?
- Check the function of the fieldbus using both LEDs on the HMI: BUS-Run LED on, BUS-Error LED off ⇒ Fieldbus is functioning correctly
- Is the correct address set?

For more information on the cause of the error and troubleshooting see the product manual.

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7 Examples

7.1 Overview of examples

The program examples demonstrate practical applications for use on networks. There are generally two access methods over the Profibus field bus: via the parameter channel and the process data channel.

Use of the parameter channel

An access is always a write or read access on one single parameter. The available parameters are described in the product manual. In this chapter the use over the parameter channel is described for only a few parameters, because this type of communication can be used in unified fashion for all available user parameters and is always structured very similarly.

Use of the process data channel

The process data channel is recommended for the actual positioning mode, because the information is transferred much more effectively here. Various practical examples for application of the protocols supported by the drive system are shown and the general procedure is described.

Structure of the examples

The following is shown in the examples:

- description of task
- initial conditions
- Required commands in the transmitted data frame
- Response in the received data frame
- Possible restrictions for command execution.

You should be aware of the following to be able to reproduce the examples:

- Operating concept and functional scope of the drive system. For more information see your product manual.
- Fieldbus protocol and connection to the master
- Scope of function of the fieldbus profile.

Product manual

The examples are designed as a supplement to the function descriptions in the product manual. The basic functions of the operating modes and functions are described there in detail.

You will also find all parameters for the operating modes and functions and also the number format of the parameter values.

7.2 Use of the parameter channel

7.2.1 Write parameter

Task

The parameter `RAMPacc, 1556:00` (acceleration) must be set to the value 10,000.

Index and subindex must be converted to hexadecimal format for this purpose:

- Index:1556=06 14_h
- Subindex: 00 = 00_h
- Value:10000 = 00002710_h

The value 30_h must be input as PKE (parameter identification), because the parameter has a 32-bit data type.

Transmitted data

Parameter	PKE, 1st byte Job identifier	PKE, 2nd byte (Sdx)	Idx	Data	Description
Tx 0614_h:00_h RAMPacc	30_h	00_h	0614_h	0000 2710_h	Set the acceleration to 10000 rpm*s = 2710_h as 32-bit value

The data type of the value to be written can be taken from the corresponding column in the parameter description of the product manual. With the Profibus protocol in use, 16-bit values and 32-bit values are transferred in the format "highest value bit first - lowest value bit last". The parameter identification corresponding to the data type must be input when transferring a INT16 or UINT16 value. The value must be stored in the last two data bytes and the first two data bytes must be described with zero (0).

Received data

Parameter	PKE, 1st byte Response identifier	PKE, 2nd byte (Sdx)	Idx	Data	Description
Rx 0614_h:00_h RAMPacc	20_h	00_h	0614_h	xxxx xxxx	The response data have no meaning, the positive acknowledgement is signalled by PKE=20.

7.2.2 Read parameter

Task The parameter `_n_act, 7696:0` (actual speed) must be read. Index and subindex must be converted to hexadecimal format for this purpose:

- Index:7696 = $1E10_h$
- Subindex:0 = 00_h

The value 10_h must be input as PKE. This identifies a read request.

Transmitted data

Parameter	PKE, 1st byte Job identifier	PKE, 2nd byte (Sdx)	Idx	Data	Description
Tx $1E10_h$:00_h _n_actT	10_h	00_h	$1E10_h$	xxxx xxxx	Reading the actual speed. The data are meaningless.

The 4 data bytes are meaningless for a read request.

Received data

Parameter	PKE, 1st byte Response identifier	PKE, 2nd byte (Sdx)	Idx	Data	Description
Rx $1E10_h$:00_h _n_act	20_h	00_h	$1E10_h$	0000 03E8h	The data 000003E8 correspond to 1000 rpm; PKE=20 signals successful execution.

A distinction is made between parameter values with 32-bit data and parameter values with 16-bit data (described in the product manual as INT32 or UINT32 and INT16 or UINT16 data types) based on the response identifier (2 or 1). However, for 16-bit data it is important to evaluate only the last two data bytes and to ignore the first two data bytes.

7.2.3 Synchronous errors

If a write or read command fails, the drive system responds with an error framework (Error Response). The transmitted error number shows information on the exact cause.

Received data with error framework (Error Response)

Parameter	PKE, 1st byte Response identifier	PKE, 2nd byte (Sdx)	Idx	Data	Description
Rx 0101_h:00_h	70_h	00_h	0065_h	0000 $B30A_h$	Error number 0000$B30A_h$ means: parameter not present in parameter directory

The example shows the response to a write or read request for a non-existent parameter `0101:00`.

The table of error numbers can be found in of the product manual, diagnostics section.

7.3 Operating states in the process data channel

⚠ WARNING

UNCONTROLLED SYSTEM OPERATION

- Note that inputs to these parameters are executed by the drive controller immediately on receipt of the data set.
- Make sure that the system is free and ready for movement before changing these parameters

Failure to follow these instructions can result in death, serious injury or equipment damage.

Drive systems detect various operating states. The different operating states are numbered from 1 to 9. The operating statuses and transition conditions are described in the product manual.

Operating status	Name	Power amplifier	Description
3	Switch On disabled	off	Activation of power amplifier disabled, motor without power
4	Ready To Switch On	off	Power amplifier is ready to switch on, motor without power
6	Operation Enable	on	active operating status, motor under power
7	Quick Stop active	on	error state, power amplifier remains on
9	Fault	off	error state, power amplifier switched off

Table 7.1 Important operating states

Requests for switching operating status are sent by the master in the process data channel PZD1 in the field `driveCtrl`. The slave reports the current operating status back to the master in the process data channel PZD1, field `driveStat`.

Tabelle7.2, Seite 7-4 shows the bit assignment of the field `driveCtrl` in the transmission data in the process channel (byte 9):

bit no.	Significance	Description
0	01_h	Disable, Operation enable ⇒ Ready to switch on
1	02_h	Enable, Ready to switch on ⇒ Operation enable
2	04_h	Quick Stop, Operation enable ⇒ Quick Stop active
3	08_h	Fault Reset, Fault ⇒ Ready to switch on
4	10_h	0, reserved
5	20_h	SetHALT, set HALT
6	40_h	ClearHALT, clear HALT
7	80_h	Continue, resume operating mode interrupted by HALT

Table 7.2 Transmitted data byte 9, driveCtrl, bit assignment

7.3.1 Switch power amplifier on and off

The power amplifier is switched on by the transition from operating status 4 to 6. Byte 9 contains transmission data, `driveCtrl`, the two bits `Enable` and `Disable`. One must always be set to 1 and the other to 0.

Switch on power amplifier

Condition: drive system is in operating status 4.
A 0>1 edge must be generated to switch on the power amplifier in `driveCtrl`, `Bit 1` (Enable). This can be done by deleting `Bit 0` (Disable) and setting `Bit 1`. The master then waits until the drive system reports operating status 6.

Example:

		Master		Slave
Disable is requested	Transmitted data	»	driveCtrl 01_h	»
Drive system reports operating status 4	Received data	«	driveStat xxx4_h	«

		Master		Slave
Request Enable	Transmitted data	»	driveCtrl 02_h	»
Drive system reports operating status 5	Received data	«	driveStat $xxx5_h$	«
Request Enable	Transmitted data	»	driveCtrl 02_h	»
Drive system reports operating status 6	Received data	«	driveStat $xxx6_h$	«

Table 7.3 Switch on power amplifier

Switch off power amplifier

Condition: drive system is in operating status 6 or 7.
A 0>1 edge must be generated to switch off the power amplifier in `driveCtrl, Bit 0` (Disable). This can be done by setting `Bit 0` (Disable) and deleting `Bit 1` (Enable). The drive system then switches to operating status 4.

Example:

		Master		Slave
Enable is requested	Transmitted data	»	driveCtrl 02_h	»
Drive system reports operating status 6	Received data	«	driveStat $xxx6_h$	«
Request disable	Transmitted data	»	driveCtrl 01_h	»
Drive system reports operating status 4	Received data	«	driveStat $xxx4_h$	«

Table 7.4 Switch off power amplifier

7.3.2 Trigger Quick Stop

A current travel command can be interrupted by the fieldbus at any time with the `QuickStop` command. This is triggered by a 0>1 edge in `driveCtrl, Bit 2`. When switching to operating status 7 (Quick Stop) the drive system brakes with the specified emergency stop ramp and comes to a standstill.

Operating status 6 must be reached first to start a new travel command. To do this, perform a 0>1 edge in `driveCtrl, Bit 3` Fault Reset.

Example:

		Master		Slave
Enable is requested	Transmitted data	»	driveCtrl 02_h	»
Drive system reports operating status 6	Received data	«	driveStat $xxx6_h$	«
Quick Stop and Request enable	Transmitted data	»	driveCtrl 06_h	»
Drive system reports operating status 7	Received data	«	driveStat $xxx7_h$	«
Wait until drive system stops and system should continue running				
Drive system reports operating status 7	Received data	«	driveStat $xxx7_h$	«
Clear Quick Stop request, apply Fault Reset	Transmitted data	»	driveCtrl $0A_h$	»
Drive system reports operating status 6	Received data	«	driveStat $xxx6_h$	«
Clear Fault Reset	Transmitted data	»	driveCtrl 02_h	»
Drive system reports operating status 6	Received data	«	driveStat $xxx6_h$	«

Table 7.5 Triggering Quick Stop

7.3.3 Fault reset

If an error occurs during operation, the system switches to operating status 7 (Quick Stop) or operating status 9 (Fault) depending on the type of error.

After correction of the error the error status can be reset by running a fault reset (0>1 edge in `driveCtrl, Bit 3`).

If the operating status was 7, it switches to operating status 6 after the fault reset.

If the operating status was 9, it switches to operating status 4 after the fault reset. Then a 0>1 edge in `driveCtrl, Bit 1` (Enable) must be sent to switch on the power amplifier again.

Example:

		Master		Slave
Request Enable	Transmitted data	»	driveCtrl 02_h	»
Slave reports operating status 9 (Fault)	Received data	«	driveStat $xxx9_h$	«
Correcting error				
Request Fault Reset	Transmitted data	»	driveCtrl 08_h	»
Slave reports operating status 4	Received data	«	driveStat $xxx4_h$	«
Request Enable	Transmitted data	»	driveCtrl 02_h	»
Slave reports operating status 5	Received data	«	driveStat $xxx5_h$	«
Request Enable	Transmitted data	»	driveCtrl 02_h	»
Slave reports operating status 6	Received data	«	driveStat $xxx6_h$	«

Table 7.6 Fault reset

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Note: In this example the master deletes the `Bit 1` (Enable) during the fault reset to be able to run implicitly a 0>1 edge at `Bit 1`. Then it switches back to operating status 6.

7.4 Operating modes in the process data channel

Transmitted data

You can start movement commands with the transmission data and change them during the process.

The following fields are available in the process data channel:

- PZD1: `modeCtrl`, start and change operating mode
- PZD2: ref_16, e.g. set speed, depending on operating mode
- PZD3+4: ref_32, e.g. setpoint position, depending on operating mode
- PZD5+6: mapped value

The default value of these fields is only imported if `modeCtrl, Bit 7` (`ModeToggle`) has been changed.

You must always proceed as follows to transfer values:

▶ Input the desired operating mode and the associated default values in the fields `modeCtrl`, PZD2...6.

▶ "Toggle"`modeCtrl, Bit 7` (`ModeToggle`)

This is a method of always avoiding consistency problems within the transmitted data.

Received data

Travel commands are monitored with the aid of the received data in the process data channel.

The following fields are available in the process data channel:

- PZD1: `modeStat`, for handshake purposes
- PZD2: `driveStat`, reports movement status and errors and I/O signals
- PZD3+PZD4:"32-bit actual position", actual position
- PZD5+PZD6: can be configured (mapped) but, excluding exceptions, do not show any time consistency with PZD1...4.

Mapping

Parameter values may be mapped in the PZD5 + PZD6 for transmit data as well as received data, see Section , page onwards.

Mode Toggle

Both transmit and receive protocol have the bit `Mode-Toggle`. The master sets this bit and the drive system reflects it in the receive protocol. The master uses this procedure to detect whether the data sent by the slave are current.

Example

The master device starts a positioning movement that will only take a very short time. The master waits for the end of the positioning by checking the receive protocol for bit `x_end = 1` (positioning end).

The master may receive data from the slave that still come from the time before the start of positioning. These data also contain `x_end = 1`. Now the master detects that the data are old because the included bit `Mode-Toggle` does not match that of the positioning job.

In general, the master should only evaluate data in which the received bit `ModeToggle` is identical with the last bit sent by the master.

Acceleration Before a positioning you can first set the desired acceleration by mapping the acceleration to PZD5 and PZD6 or by using the parameter channel (parameter `RAMPacc,1556:00`). Note that the acceleration can only be changed with the drive system at a standstill.

Assumptions The examples are based on the following assumptions:

- Operating status 6 (Operation Enable)
- Homing not run (bit `ref_ok = 0`)
- `_p_act = 0` (actual position, motor)
- Transmitted data PZD1:`modeCtrl, Bit 7 = 0`(`ModeToggle`)

7.4.1 Absolute positioning

⚠ WARNING

UNCONTROLLED SYSTEM OPERATION

- Note that inputs to these parameters are executed by the drive controller immediately on receipt of the data set.
- Make sure that the system is free and ready for movement before changing these parameters

Failure to follow these instructions can result in death, serious injury or equipment damage.

To start an absolute positioning movement the following setting must be made in the transmitted log:

▶ Enter the set speed in PZD2 ref_16 and the target position in PZD3 and PZD4 ref_32 .

▶ Input in the field `modeCtrl` operating mode 03_h (profile position mode, absolute positioning).

▶ "Toggle"`modeCtrl, Bit 7` to import the data.

Example 1: Absolute positioning at position 100,000 (0001 $86A0_h$) at a set speed of 1000 rpm ($03E8_h$)

		Master					Slave
Trigger positioning	Transmitted data	»	driveCtrl 02_h	modeCtrl 83_h	ref_16 $03E8_h$	ref_32 0001 $86A0_h$	»
Positioning running x _err = 0, x_end = 0	Received data	«	driveStat 0006_h	modeStat 83_h		32_bit act. pos. xxxx $xxxx_h$	«
Trigger positioning	Transmitted data	»	driveCtrl 02_h	modeCtrl 83_h	ref_16 $03E8_h$	ref_32 0001 $86A0_h$	»
Positioning complete x _err = 0, x_end = 1, x_info = 1	Received data	«	driveStat 6006_h	modeStat 83_h		32-bit act. pos. 0001 $86A0_h$	«

Table 7.7 Absolute positioning at constant set speed

Note: the data frame "Positioning running" can also be transmitted several times; in each case the current position is in the "32-bit actual position" field.

Example 2: As in example 1, except that the set speed is changed to 2000 rpm ($07D0_h$) during the movement.

		Master					Slave
Trigger positioning	Transmitted data	»	driveCtrl 02_h	modeCtrl 83_h	ref_16 $03E8_h$	ref_32 0001 $86A0_h$	»
Positioning runningx_err = 0, x_end = 0	Received data	«	driveStat 0006_h	modeStat 83_h		32-bit act. pos. xxxx $xxxx_h$	«
Change set speed	Transmitted data	»	driveCtrl 02_h	modeCtrl 03_h	ref_16 $07D0_h$	ref_32 0001 $86A0_h$	»
Positioning runningx_err = 0, x_end = 0	Received data	«	driveStat 0006_h	modeStat 03_h		32-bit act. pos. xxxx $xxxx_h$	«
Change set speed	Transmitted data	»	driveCtrl 02_h	modeCtrl 03_h	ref_16 $07D0_h$	ref_32 0001 $86A0_h$	»
Positioning finished x_err=0, x_end = 1, x_info = 1	Received data	«	driveStat 6006_h	modeStat 03_h		32-bit act. pos. 0001 $86A0_h$	«

Table 7.8 Absolute positioning with change of set speed

Note: The data frame "positioning running" can also be sent multiple times. In each case, the actual position is in the "32-bit actual position" field. When the set speed is changed the same target position is sent, because this does not change in this example.

7.4.2 Relative positioning

⚠ WARNING

UNCONTROLLED SYSTEM OPERATION

- Note that inputs to these parameters are executed by the drive controller immediately on receipt of the data set.
- Make sure that the system is free and ready for movement before changing these parameters

Failure to follow these instructions can result in death, serious injury or equipment damage.

A relative positioning is run similarly to the absolute positioning. You only need to input in field `modeCtrl` the value 13_h (profile position mode, relative positioning). It is also important to ensure that multiple target positions transferred in succession are added.

Example: Relative positioning at 100,000 ($000186A0_h$) increments at a set speed of 1000 rpm ($03E8_h$)
During the movement the speed must be changed to 2000 rpm ($07D0_h$).

		Master					Slave
Trigger positioning	Transmitted data	»	driveCtrl 02_h	modeCtrl 93_h	ref_16 $03E8_h$	ref_32 $0001\ 86A0_h$	»
Positioning running: x_err = 0, x_end = 0	Received data	«	driveStat 0006_h	modeStat 83_h		32-bit act. pos. xxxx $xxxx_h$	«
Change set speed Send relative position 0	Transmitted data	»	driveCtrl 02_h	modeCtrl 13_h	ref_16 $07D0_h$	ref_32 $0000\ 0000_h$	»
Positioning running, x_err = 0, x_end = 0	Received data	«	driveStat 0006_h	modeStat 03_h		32-bit act. pos. xxxx $xxxx_h$	«
Change set speed Send relative position 0	Transmitted data	»	driveCtrl 02_h	modeCtrl 13_h	ref_16 $07D0_h$	ref_32 $0000\ 0000_h$	»
Positioning finishedx_err = 0, x_end = 1, x_info = 1	Received data	«	driveStat 6006_h	modeStat 03_h		32-bit act. pos. xxxx $xxxx_h$	«

Table 7.9 Profile position mode, relative positioning with change of set speed

Comments: the data frame "Positioning running" can also be transmitted several times; in each case the current position is in the "32-bit actual position" field. When the set speed is changed, the value zero (0) must be sent as the new target position, because the new value is added to the previously calculated target position.

7.4.3 Profile velocity

⚠ WARNING

UNCONTROLLED SYSTEM OPERATION

- Note that inputs to these parameters are executed by the drive controller immediately on receipt of the data set.
- Make sure that the system is free and ready for movement before changing these parameters

Failure to follow these instructions can result in death, serious injury or equipment damage.

In profile velocity a set speed is specified and a movement is initiated with no defined finishing point.

You must make the following settings in the transmitted log to start speed mode or to change the set speed while speed mode is running:

- ▶ Enter the set speed in PZD2, ref_16 (ref_32 is of no significance here)
- ▶ In `modeCtrl` enter operating mode 04_h (profile velocity)
- ▶ Switch `modeCtrl, Bit 7` to import the data.

Example A profile velocity is started at a set speed of 1000 rpm ($03E8_h$) (ref_16). The set speed is changed to 2000 rpm ($07D0_h$) during the movement. The profile velocity is ended by transfer of the set speed 0 and standstill is waited for.

		Master					Slave
Start profile velocity at 1000 rpm	Transmitted data	»	driveCtrl 02_h	modeCtrl 84_h	ref_16 $03E8_h$	ref_32 $xxxxxxxx_h$	»
Drive system accelerates xerr=0, xend=0, xinfo=0	Received data	«	driveStat 0006_h	modeStat 84_h		32-bit act. pos. xxxx $xxxx_h$	«
Profile velocity at 1000 rpm	Transmitted data	»	driveCtrl 02_h	modeCtrl 84_h	ref_16 $03E8_h$	ref_32 xxxx $xxxx_h$	»
Set speed reached xerr=0, xend=0, xinfo=1	Received data	«	driveStat 2006_h	modeStat 84_h		32-bit act. pos. xxxx $xxxx_h$	«
Change speed to 2000 rpm	Transmitted data	»	driveCtrl 02_h	modeCtrl 04_h	ref_16 $07D0_h$	ref_32 xxxx $xxxx_h$	»
Drive system accelerates xerr=0, xend=0, xinfo=0	Received data	«	driveStat 0006_h	modeStat 04_h		32-bit act. pos. xxxx $xxxx_h$	«
Speed at 2000 rpm	Transmitted data	»	driveCtrl 02_h	modeCtrl 04_h	ref_16 $07D0_h$	ref_32 xxxx $xxxx_h$	»
Set speed reached xerr=0, xend=0, xinfo=1	Received data	«	driveStat 2006_h	modeStat 04_h		32-bit act. pos. xxxx $xxxx_h$	«
Change speed to 0 rpm	Transmitted data	»	driveCtrl 02_h	modeCtrl 84_h	ref_16 0000_h	ref_32 xxxx $xxxx_h$	»
Drive system decelerates xerr=0, xend=0, xinfo=0	Received data	«	driveStat 0006_h	modeStat 84_h		32-bit act. pos. xxxx $xxxx_h$	«
Change speed to 0 rpm	Transmitted data	»	driveCtrl 02_h	modeCtrl 84_h	ref_16 0000_h	ref_32 xxxx $xxxx_h$	»
Profile velocity ended xerr=0, xend=1, xinfo=1	Received data	«	driveStat 6006_h	modeStat 84_h		32-bit act. pos. xxxx $xxxx_h$	«

Table 7.10 Profile velocity

Note: the current position in increments is in the "32-bit actual position" field of the received protocol.

7.4.4 Homing by dimension setting

During dimension setting a new position is assigned to the current motor position. This only moves the coordinate system, the motor does not move.

You must make the following settings for dimension settings in the transmitted log:

- Enter the new position in `ref_32`. (`PZD2` (ref_16) is of no significance here)
- In `modeCtrl` enter operating mode 02_h (homing, set dimensions)
- Switch `modeCtrl, Bit 7` to import the data from the slave.

Example: The motor is at position -100000 ($FFFE7960_h$) (ref_32).
Position 200000 is assigned to the motor ($00030D40_h$).

		Master					Slave
Drive system reports position 100000	Received data	«	driveStat $xxxx_h$	modeStat xx_h		32-bit act. pos. FFFE 7960_h	«
Dimension setting at 200000	Transmitted data	»	driveCtrl 02_h	modeCtrl 82_h	ref_16 $xxxx_h$	ref_32 0003 $0D40_h$	»
Position applied x_err = 0, x_end = 1, x_info = 0	Received data	«	driveStat 4006_h	modeStat $A2_h$		32-bit act. pos. 0003 $0D40_h$	«

Table 7.11 Dimension setting

7.4.5 Reference movement

⚠ WARNING

UNCONTROLLED SYSTEM OPERATION

- Note that inputs to these parameters are executed by the drive controller immediately on receipt of the data set.
- Make sure that the system is free and ready for movement before changing these parameters

Failure to follow these instructions can result in death, serious injury or equipment damage.

During the reference movement a limit or reference switch is approached and then a new value is assigned to this position.

Before starting a reference movement the parameters must be set appropriately to the requests over the parameter channel. See the product manual for more information on parameterisation and on running a reference movement.

To start a reference movement the following settings must be made in the transmitted log:

- Enter the type of reference movement in `PZD2` (ref_16) (`PZD3+PZD4` (ref_32) is of no significance here).

  The types of reference movement are described in the product manual.

- In `modeCtrl` enter operating mode 12_h (homing, reference movement)
- Switch `modeCtrl, Bit 7` to import the data from the slave.

Example A reference movement must be run to the negative limit switch (LIMN); this is reference movement type 2.

		Master					Slave
Trigger reference movement	Transmitted data	»	driveCtrl 02_h	modeCtrl 92_h	ref_16 0002_h	ref_32 xxxx $xxxx_h$	»
Reference movement running xerr=0, xend=0	Received data	«	driveStat 0006_h	modeStat80 2_h		32-bit act. pos. xxxx $xxxx_h$	«
Reference movement	Transmitted data	»	driveCtrl 02_h	modeCtrl 92_h	ref_16 0002_h	ref32 xxxx $xxxx_h$	»
Reference movement ended, xerr=0, xend=1	Received data	«	driveStat 4006_h	modeStat $A2_h$		32_bit act. pos. 0000 0000_h	«

Table 7.12 Reference movement

7.5 Error signalling in process data channel

7.5.1 Synchronous errors

If request of an operating mode sent via the transmission protocol cannot be processed, the slave rejects the process and sets `modeStat, Bit 6` (ModeError) in the receive protocol. This does not interrupt the current process. To find the cause of the error the master can read the error number from the parameter `ModeError, 6962:00` by accessing the parameter channel. See the product manual for a list of the error numbers.

The error display is reset when the next valid data protocol is transmitted.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ModeError	Error code for synchronous errors (ME flag)()	-	UINT16 R/-	Profibus 6962
-	Manufacturer-specific error code which led to setting of ModeError flag. In general this is an error that was triggered by starting an operating mode.	-	- -	

Example The drive system is in profile velocity.
An attempt is made to run a dimension setting.

		Master					Slave
Profile velocity, x_end = 0	Received data	«	driveStat 0006_h	modeStat 04_h		32-bit act. pos. xxxx $xxxx_h$	«
Request: Dimension setting to 0	Transmitted data	»	driveCtrl 02_h	modeCtrl 82_h	ref_16 $xxxx_h$	ref_32 0000 0000_h	»
Request rejected, ModeError = 1	Received data	«	driveStat 0006_h	modeStat $C4_h$		32-bit act. pos. xxxx xxxxh	«

Table 7.13 Synchronous error, Invalid request of an operating mode

Note: when the set dimensions request is rejected the drive system continues unchanged in profile velocity.

7.5.2 Asynchronous errors

Asynchronous errors are triggered by internal monitoring (temperature, for example) or external monitoring (limit switch, for example). If an asynchronous error occurs, the drive system responds by braking or by switching off the power amplifier.

Asynchronous errors are displayed as follows:

- Switch to operating status 7 (Quick Stop) or operating status 9 (Fault).
  The switch is displayed in the receive protocol `driveStat, Bits 0..3`.
- Setting of `driveStat, Bit 6` (malfunction) or `driveStat, bit 7` (warning) and `Bit 15, x_err` (error status during processing)
- An error number is also assigned to every error. In the event of an asynchronous error the corresponding error number can be read from the parameter `_StopFault (7178:00)`.

Example: Trigger an error message by the external monitoring: movement to the positive limit switch LIMP

		Master					Slave
Trigger positioning	Transmitted data	»	driveCtrl 02_h	modeCtrl 03_h	ref_16, vel $03E8_h$	ref_32 $0FFF\ 8765_h$	»
Positioning running xerr=0, xend=0	Received data	«	driveStat 0006_h	modeStat 03_h		32-bit act. pos. xxxx $xxxx_h$	«
Positioning	Transmitted data	»	driveCtrl 02_h	modeCtrl 03_h	ref_16, vel $03E8_h$	ref_32 $0FFF\ 8765_h$	»
Limit switch detected xerr=1, xend=0	Received data	«	driveStat 8047_h	modeStat 03_h		32-bit act. pos. xxxx $xxxx_h$	«
Positioning	Transmitted data	»	driveCtrl 02_h	modeCtrl 03_h	ref_16, vel $03E8_h$	ref_32 $0FFF\ 8765_h$	»
Motor stopped xerr=1, xend=1	Received data	«	driveStat $C047_h$	modeStat 03_h		32-bit act. pos. xxxx $xxxx_h$	«

Table 7.14 Asynchronous errors

NOTE: when the limit switch is detected the motor is braked at the emergency stop ramp until it reaches standstill and the bit `x_err` is set. After standstill of the motor, bit `x_end` is set.

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8 Service, maintenance and disposal

8.1 Replacing units

The response of a system should typically not change when a slave is replaced. This is ensured by import of the specified parameter values to the new slave.

Default values of parameters can be salved on the master. After start-up of the slave these values must be sent to the slave again.

Please see the product manual for service, maintenance and disposal procedures.

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9 Diagnostics and troubleshooting

9.1 Fieldbus communication error diagnosis

A correctly functioning fieldbus operation is essential for evaluating operational and error messages.

Checking connections

If the drive system cannot be addressed over the fieldbus, first check the connections. The product manual contains the technical data and information on network and product installation.

Check the following connections:

- ▶ System power supply
- ▶ Power connections
- ▶ Fieldbus cable and wiring
- ▶ Fieldbus terminal

If the internal terminating resistor is enabled with switch S1 (terminated), the A2/B2 output and any additional connected bus devices are automatically disconnected from the fieldbus.

Function display via HMI LED

The function of the fieldbus can be checked using both LEDs on the HMI:

- BUS-Run LED on, BUS-Error LED off ⇒ Fieldbus is functioning correctly
- BUS-Run LED off, BUS-Error LED on ⇒ A bus error occurred.
- BUS-Run LED off, BUS-Error LED off ⇒ Communication not yet established

Function test on the fieldbus

If the connections are correct, check the settings for the fieldbus addresses. After correct configuration of the transmission data test the fieldbus operation.

In addition to the master that knows the drive system by GSD and polling, a bus monitor that as a passive device displays messages should be installed.

- ▶ Switch the supply voltage of the drive system off and on.
- ▶ Observe the network messages shortly before switching on the drive system. A bus monitor can be used to record the elapsed time between message frames and the relevant information in the message frame during recording.

possible errors: Polling, parameter setting, configuration

If the connection to a device cannot be established, check the following:

- Polling: all network devices must have an address between 1 and 126. Every network device must have a different address.
- Setting parameters: The parameterised ID number and the user parameters must match the values stored in the GSD file.
- Configuration: The data length in the input and output direction must be identical with the length agreed in the GSD file.

9.2 Error messages

Error messages generated when the network is in operation are received by the master via the fieldbus.

The following error messages are possible:

- Synchronous errors
- Asynchronous errors
- Errors during operating mode control via process data channel.

9.2.1 Synchronous errors

If a command cannot be processed in the parameter channel, the master receives a synchronous error message from the slave.

If request of an operating mode sent via the transmission protocol cannot be processed, the slave rejects the process and sets `modeStat, Bit 6` (ModeError) in the receive protocol. This does not interrupt the current process. To find the cause of the error the master can read the error number from the parameter `ModeError, 6962:00` by accessing the parameter channel. See the product manual for a list of the error numbers.

The error display is reset when the next valid data protocol is transmitted.

Parameter Name Code HMI menu, Code	Description	Unit Minimum value Default value Maximum value	Data type R/W persistent Expert	Parameter address via fieldbus
ModeError	Error code for synchronous errors (ME flag)()	- -	UINT16 R/- - -	Profibus 6962
-	Manufacturer-specific error code which led to setting of ModeError flag. In general this is an error that was triggered by starting an operating mode.			

Error message in parameter channel

The error message is output as a response to a faulty parameter transmission. The cause of the error is output in the PWE as ErrorCode in bytes 5…8.

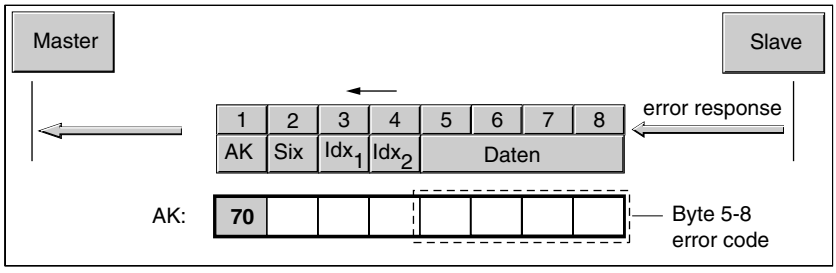

Figure 9.1 Error message in parameter channel

Causes of a synchronous error

Possible causes of a synchronous error are:

- Error while executing an action or control command.
- Parameter value outside the permissible value range
- illegal action or control command during a running process
- Access to unknown parameter (Index/Subindex)

9.2.2 Asynchronous errors

Asynchronous errors are triggered by internal monitoring (temperature, for example) or external monitoring (limit switch, for example). If an asynchronous error occurs, the drive system responds by braking or by switching off the power amplifier.

Asynchronous errors are displayed as follows:

- Switch to operating status 7 (Quick Stop) or operating status 9 (Fault).
  The switch is displayed in the receive protocol in`driveStat, Bits 0..3`.
- Setting of `driveStat, Bit 6` (malfunction) or `driveStat, bit 7` (warning) and `Bit 15, x_err` (error status during processing)

The error bits have the following meaning:

- `Bit 6`
  (such as interruption of movement by limit switch).
  The exact cause is bit coded and entered in parameter `_StopFault, 7178:00` entered in bit code.
- `Bit 7`
  Warning message (such as overheating warning)
  The error message is bit coded and entered in parameter `FLT_err_num, 15362:00`.

The last cause of interruption is entered as an error number in parameter `_StopFault, 7178:00` entered as error number.

The error numbers and their meanings are listed in the "Diagnostics and Troubleshooting" section of the product manual.

For more information on parameters, error classes and troubleshooting see the "Diagnostics and Troubleshooting" section of the product manual.

9.2.3 Errors during operating mode control

Travel commands can be triggered and modified via the process log. If the request cannot be processed, an error bit is set in the received data.

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10 Glossary

10.1 Terms and Abbreviations

Address	Memory location which can be accessed by its unique number. See also Slave address.
AK	Job/answer identification
Broadcast	Type of data transmission in the network, one device sends a message to all devices on the network
Default value	Factory settings.
Direction of rotation	Rotation of the motor shaft in a positive or negative direction of rotation. A positive direction of rotation is defined as the motor shaft rotating clockwise as the observer faces the end of the protruding shaft.
DP	**D**ecentralized **P**eriphery
EMC	Electromagnetic compatibility
Error class	Classification of operational faults into groups corresponding to the error responses
FMS	Fieldbus-Message-Specification
GSD file	The specific characteristics of a Profibus device type are described in the device master data file (GSD file). This file is supplied with the device by the manufacturer, and must be read by the network configuration program..
I/O	Inputs/Outputs
Idx	Index value of a parameter
LED	Light-Emitting Diode
Limit switch	Switch that signals an overrun of the permissible travel range.
LWL	Optic fiber
Master	Active bus user that controls the data traffic in the network.
MT	**M**ode**T**oggle, bit change 0 » 1 or 1 » 0
Parameter	Device functions and values that can be set and called by the user.
PKE	Parameter code
PNO	Profibus User Organisation
Profibus	Standardised open fieldbus compliant with EN 50254-2 over which drives and other devices from different manufacturers communicate with one another.
PWE	Parameter value
PZD	Process data
Quick Stop	Quick stop, function used to provide quick braking of the motor via a command or in the event of a fault.
Six	Subindex value of a parameter

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Slave	Passive bus user that receives control commands and sends data to the master.
Slave address	Direct communication between master and slave devices is only possibly after assignment of addresses.
PLC	Programmable Logic Controller
Toggle	see MT, ModeToggle
Watchdog	Equipment that monitors cyclic basic functions in the drive system. Power amplifier and outputs are switched off in the event of error.

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