Jetter

AKTIENGESELLSCHAFT

Setup-Software DRIVE.EXE

for

JetMove 600

Previously published editions :

Edition	Notes
09/01	First edition
07/03	Bode plot description, position output, external trajectory, oscilloscope, various minor corrections, new motion task types, Graphical Motion Tasking added, valid from software version 5.00

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Contents

Contents

1   General Information

This help system explains the installation and operation of the setup software DRIVE.EXE for digital servo amplifiers.

1.1   Contents

General

Product overview	Axis commissioning checklist procedures
Servo System Overview	Error messages and warnings
Related Documents	Trouble-Shooting
Dialog screen layout	Motor numbers
Getting started	Glossar

Screen pages

Communication	Position controller (PI)
Amplifier	Position controller (P)
Slot	Position Data
Basic Setup	Homing
Synchronous motor	Motion Tasks Parameters
Asynchronous motor	Gearing
Feedback	Drive Status
Encoder Emulation	Actual values
Digital I/O	Terminal
Analog I/O	PROFIBUS
Current	PROFIBUS instrument control
Speed	SERCOS
Oszilloscope	SERCOS Service
Input Service Parameters	I/O-Extension
Bode Plot	

1.2   Symbols used

⚡	danger to personnel from electricity and its effects		⚠	general warning general instructions mechanical hazard

1.3 Prescribed use ("Use as directed")

Setup Software

The setup software is intended to be used for altering or storing the operational parameters for the digital servo amplifiers. The servo amplifier that is connected is commissioned with the aid of the software - whereby the drive can be directly controlled by the setup and service functions.

The characteristic nature of a PC mean that these functions are not functionally safe without further measures. A PC-program might be unexpectedly disturbed or stopped, so that in the event of a malfunction any movements that have already been initiated cannot be stopped from the PC.

The manufacturer of the machine must carry out a hazard analysis for the machine, and is responsible for the functional, mechanical and personnel safety aspects of the machine. This applies especially to the initiation of movements with the aid of functions in the commissioning software.
Only personnel who have extensive knowledge in the fields of drive technology and control technology are permitted to carry out online parameter setting of a drive that is running.
Sets of data that are stored on data media are not safe from undesirable alteration by third parties. So after you have loaded a set of data, you must check all the parameters before enabling the servo amplifier.

Servo amplifier

The BTB/RTO contact must be wired into the safety loop of the system. The safety loop, and the Stop and Emergency Stop functions must fulfill the requirements of EN60204, EN292 and VDI 2853.
The servo amplifiers are components which are built into electrical equipment or machines, and can only be commissioned as integral components of such equipment.
The servo amplifier is to be used **only** on earthed three-phase industrial mains supply networks (TN-system, TT-system with earthed neutral point). The servo amplifiers must not be operated directly on power supply networks >230V without an earth (ground) or with an asymmetrical earth (ground).
Connection to different mains supply networks is only admitted with an additional isolating transformer (see installation manual page 14).
Periodic overvoltages between outer conductor (L1, L2, L3) and housing of the servo amplifier may not exceed 1000V (peak value). Transient overvoltages (< 50µs) between the outer conductors may not exceed 1000V. Transient overvoltages (< 50µs) between outer conductors and housing may not exceed 2000V.
If the servo amplifiers are used in residential areas, or in business or commercial premises, then additional filter measures must be implemented by the user.
The servo amplifier is **only** intended to drive specific brushless synchronous servomotors, with closed-loop control of torque, speed and/or position. The rated voltage of the motors must be at least as high as the DC-link voltage of the servo amplifier.
The servo amplifiers **may only** be operated in a closed switchgear cabinet, taking into account the ambient conditions defined in the installation manual.

Option -AS-, restart lock for personnel safety

The -AS- restart lock is **exclusively** intended to provide safety for personnel, by preventing the restart of a system. To achieve this personnel safety, the wiring of the safety circuits must meet the safety requirements of EN60204, EN292 and EN954-1

The -AS- restart lock must **only** be activated,
— when the motor is no longer rotating (setpoint = 0V, speed = 0rpm, enable = 0V).
Drives with a suspended load must have an additional safe mechanical blocking (e.g. by a motor-holding brake).

— when the monitoring contacts (KSO1/2 and BTB/RTO) for all servo amplifiers are wired into the control signal loop (to recognize a cable break).

The -AS- restart lock may **only** be controlled by a CNC if the control of the internal safety relay is arranged for redundant monitoring.

The -AS- restart lock must **not** be used if the drive is to be made inactive for the following reasons:
1. - cleaning, maintenance and repair operations
   - long inoperative periods
   In such cases, the entire system should be disconnected from the supply by the personnel, and secured (main switch).

2. - emergency-stop situations
   In an emergency-stop situation, the main contactor is switched off
   (by the emergency-stop button or the BTB-contact in the safety circuit).

1.4   Abbreviations used

The abbreviations used are explained in the table below.

Abbrev.	Meaning
AGND	Analog ground
AS	Restart Lock, option
BTB/RTO	Ready to operate
CAN	Fieldbus (CANopen)
CE	Communité Europeenne (EC)
CLK	Clock
COM	Serial interface for a PC
DGND	Digital ground
DIN	Deutsches Institut für Normung
Disk	Magnetic storage (diskette, hard disk)
EEPROM	Electrically erasable/programmable memory
EMV	Electromagnetic compatibility
EN	European standard
IEC	International Electrotechnical Commission
ISO	International Standardization Organization
LED	Light-emitting diode
MB	Megabyte
MS-DOS	Operating system for a PC
NI	Zero pulse/mark
NSTOP	Limit-switch input for CCW rotation
PC	Personal Computer
PGND	Ground for the interface
PLC	Programmable logic controller
PSTOP	Limit-switch input for CW rotation
RAM	Volatile memory
RBallast	Regen resistor
RBext	External regen resistor
RBint	Internal regen resistor
RES	Resolver
ROD	Incremental encoder output
SRAM	Static RAM
SSI	Synchronous serial interface
UL	Underwriter Laboratory
V AC	Alternating (AC) voltage
V DC	DC voltage
VDE	Verein deutscher Elektrotechniker
XGND	Ground for the 24V supply

2 Product Overview

What is DRIVE.EXE?

DRIVE.EXE is an axis commissioning tool for both single-axis and multi-axis motion control applications. With its graphical user interface and Windows dialogues, DRIVE.EXE provides an easy point-and-click method for configuring servo amplifiers

Single-Axis Motion Control

In a single axis system, DRIVE.EXE runs on a programming unit (PC) connected to one servo drive. The communication is established via the RS232 interface.

Multi-Axis Motion Control

In a multi axis system, DRIVE.EXE runs on a programming unit (PC) connected to one servo drive. The communication with the first servo drive is established via the RS232 interface. The other servo drives are connected to the first servo drive by a special cable (Y-adapter) at the built in CAN-bus. Thereby you can communicate with several servo drives without changing connections.

Tuning Your Axis with DRIVE.EXE

During the configuration process, DRIVE.EXE allows you to tune (stabilize) the servo motor for each axis quickly and efficiently. From DRIVE.EXE, while online with an axis and its motor, you adjust servo parameter values (such as gains and limits) and execute them immediately. While watching and listening to the motor spin, you may use the DRIVE.EXE oscilloscope to adjust and readjust these values until the motor reaches its best performance - optimum speed without oscillation. The changes made to the servo parameter values may be saved to the servoamplifier or to a file.

DRIVE.EXE dialogues step you through the complete startup phase of your programming projects. All parameters in the servo drive can be saved to a separate file for each axis. Each drive file is a unique custom configuration for that drive and can be accessed offline (not connected to the drive) or online (connected to the drive).

Please see also the axis commissioning checklist procedures.

3   Servo System Overview

This topic provides a quick lesson in servo system - an overview of what it is and how it works.

What is a Servo System?

A servo system essentially comprises an intelligent servo drive and a servo motor that operates with a PLC or CNC to perform complex, specialized moves in one or more directions, or axes. These complex and specialized moves, which are needed in the automation of industrial tasks, are collectively known as motion control.

Servo systems are applied in many different field for automation - in the motor industry, the petrol industry, the textile industry, in packaging systems, warehousing systems and so on.

Closed Loop Servo Systems

In a servo system, feedback information - motor position and motor velocity is sent from the feedback unit of the motor back to the servo amplifier. The servo amplifier analyses the feedback, makes adjustments as needed, and generates new currents to bring the motor to the commanded velocity. This cycle constantly repeats itself in a closed loop. A closed loop that controls the position of the shaft or load is called a position loop. A closed loop that keeps the velocity of the motor on the commanded value is called a velocity loop.

Servo System Components

A servo system consists of:

Servo motor	A servo motor moves machinery in a single axis of motion. Electrical motors are driven by magnetic fields. Motors have a stationary field generated by the magnets of the motor and a rotating or movable field called stator winding or armature. They operate on the principles of synchronous motors. All rotary motors have some type of bearing that supports the rotor at each end. Every motor has at least two magnetic motor poles, normally four or six. The servo amplifier generates the current in the stator so that a controllable torque is available at the shaft. The servo motors turn (travel) in two directions - positive and negative. Two forms of angular measurement are commonly used in motion control - degree measurement and radian measurement, where 360 degrees constitute one revolution or 2π radians. The servo amplifier operates with standard synchronous servo motors as well as with direct drive motors (rotary or linear). For more information about these motors see the motor manuals. **Motor Stabilizing** Stabilizing (tuning) the motor is a fundamental task in achieving best system performance. To stabilize a motor, you must set up initial values for and adjust several motion parameters using DRIVE.EXE. These parameter settings compensate for the difference between the actual motion and the commanded motion - getting the actual as close to the commanded as possible, with minimal oscillation and noise. This difference is called following error.
Load	The load is the machinery and equipment that each motor drives. It is everything connected to the output shaft of a motor, including the shaft itself. A motor must be appropriately sized to its load to ensure the motor is powerful enough to carry out your automation tasks. A servo system delivers and converts motion to a load via one or more of the following mechanical techniques: **Direct drive** motor connected to a rotating table **Screw drive** motor connected to a lead screw carrying a slide (moving table) **Rack and pinion** motor connected to a cogwheel that moves a rack **Belt and pulleys** motor connected to rollers that move conveyor belts or chains and sprockets
Feedback device	Every closed-loop servo system needs at least one device to return feedback information from each motor (or load) to servo drive. Depending on the feedback device, feedback is transmitted back to the servo drive in the form of digital signals or analog signals. Two types of feedback devices are supported: Encoder - returns analog or digital signals (optical) Resolver - returns analog signals (magnetical)
Servoamplifier (servo drives)	The servo drives comprise a three-phase, power supply, and high-performance control unit all housed in a single enclosure. The several control loops are realize totally digital in the micro controller.

3.1 Feedback Device

Servo motors are available with these feedback units:

● RESOLVER

● ENDAT[®] compatible Heidenhain encoder

● HIPERFACE[®] compatible Stegmann encoder

In a closed-loop feedback system, the innermost loop is the commutation loop, which monitors the motor's rotor and ensures that it keeps spinning. Outer loops are: Position loop, Velocity loop and Current loop
Velocity information and the velocity loop are derived from (are computed based on) position information.
The current loop is also known as a torque loop, since amplitude of the electrical current is directly proportional to torque. Torque is force applied in an axis of rotation.

Resolvers

The servo amplifier can use single (two poles) or multi-speed (multiple poles) resolver feedback to calculate primary position, velocity, and commutation information. A resolver can be thought of as a transformer whose output is unique for any given shaft position (an absolute position feedback). The transformer is driven with a sinewave reference signal. Two AC signals are returned from the resolver into the Sine and Cosine inputs. All three of these sinewave signals are low-level and susceptible to noise.

Encoders

Encoders direct pulses of light, from a light source at the motor or load, to photo detectors through an encoded disk. These light pulses are then converted into digital feedback information. There are two general types of encoders - rotary and linear. Rotary (rotating disk) encoders are typically mounted to the motor shaft. Linear encoders are typically mounted to the load.

3.2 The Motion Profile

Overview

Motion operations are universally embodied in a graph called the motion profile. Understanding and using motion profiles to define your motion application is an important part of achieving best system performance.

The motion profile plots one or more motion operations and measures it against time.

Commanded motion
the motion that is supposed to happen ideally and precisely, without error, when the motor executes a velocity or position command

Actual motion
the motion that really happens in the motor, when a velocity or position command is executed

Closing the Gap between Setpoint and Actual

Best system performance is achieved when you can stabilize or "dampen" the difference or "close the gap" between the commanded motion and the actual motion. This difference is called following error. Stabilizing the servo system means setting the relevant parameters in the servo amplifier, to get as close to the commanded position as possible.

Basic Motion Profile Characteristics

Commanded and actual motion profile shapes have the following characteristics that are also universal to all motion operations:

Profile Characteristic	Meaning
Moving	Moving refers to the execution of a motion instruction that makes the motor move. A motion profile's moving portion represents most of the profile - the motion itself. The motor is considered moving for as long as the motion controller is commanding new positions. The point at which motion stops is known as the target position.
In Position	When a motion command stops executing, and the motor slows to within a few counts of its target position, the motor is considered to be stopped, or "In Position." A range of positions, typically plotted in a motion profile, represents in position. That is, In Position is signaled when the motor gets close enough to the target position -- within its In-Position range that you have specified, via its parameter. An In-Position signal is often used to make sure the motor stops before the machinery continues its operation.

3.3 Limits and Ranges of Operation

Overview

Another important task in achieving best system performance is setting certain motion limits and ranges of operation to protect equipment from damage and to optimize operational efficiency.

Two Types of Settings

There are two types of settings for motion limits and ranges of operation:

● Fault limits

● Tolerance bands

Type of Setting	Meaning
Fault limit	Fault limits are settings that signal errors when certain limits on motor movement, such as speed and position, as well as electrical current, are exceeded. Fault limits are designed to protect equipment from damage and can cause the drive and motor to shut down. For example, every motion control system has hardware limit switches, which are used in the position loop to set a limit on how far the actual motor position can deviate from the commanded position before a fault is signaled. You may also program software limits via DRIVE.EXE parameters. The difference, or gap, between commanded position and actual position is known as following error. Such a limit protects against motor runaway and stalling.
Tolerance band	Tolerance bands are set and specify the safe, efficient physical ranges for the equipment. Some of these tolerance bands do the following: — In the current loop, set a limit on the amount of electrical current to the drive and motor. This protects the motor from damage that would be caused by excessive current. — In the position loop, place a limit on how far the motor can travel in a positive or negative direction. — Set a range of positions that are considered to be In Position. That is, this range specifies how far the motor can deviate from its commanded position and still be considered in the correct position.

3.4 Acceleration and Deceleration

Overview

If the servo amplifier is operated with motion tasks under position control, different acceleration/deceleration profiles can be chosen. It depends on the mechanical structure of the machine and the required dynamical quality, which profile should be chosen. If the machine tends to sway (e.g. robot arm), sine² would be the best choice. Here the torque is altered linear and the velocity characteristic becomes square. This reduces the excitation to sway. Disadvantage of this profile is the double up of the acceleration/deceleration time.
If the machine is mechanically stiff and there are high requirements in dynamics, the linear profile should be chosen. This leads to a torque step at the beginning and the end of each acceleration/deceleration ramp.

Two Types of Acceleration and Deceleration

The following table describes the two fundamental acceleration and deceleration types, linear and square.
A motion profile may accommodate a combination of these two types.

Accel / Decel Type	Description
Linear	Linear is a rate of acceleration and deceleration that theoretically represents a steady speed-up and slow-down.
sine²	To limit any jolting, the drive is accelerated/decelerated within the acceleration time along an acceleration ramp without any discontinuities. The resulting speed characteristic corresponds to a sine² curve.

4 Getting Started

4.1 Operating systems

WINDOWS 95(c) / WINDOWS 98 / WINDOWS 2000 / WINDOWS ME / WINDOWS XP / WINDOWS NT

DRIVE.EXE runs under WINDOWS 95(c) / 98 / ME / XP / 2000 or WINDOWS NT 4.0 (service release 3 or higher). The HTML Help system is **not** available under WINDOWS 95a and 95b without further updates. In this case, an update is required for Internet Explorer to Version 4.01 (Service Pack 1) or higher.

DOS, OS2, WINDOWS 3.xx, Unix, Linux

DRIVE.EXE will not run under DOS, OS2, Windows 3.xx, Unix or Linux.
Emergency operation is possible with an ASCII terminal-emulation (no user interface).
Interface-settings: **9600 baud, 8 bit, 1 stop bit, no parity, no handshake**

4.2 Software description

The servo amplifiers must be adapted to the conditions in your machine. In most cases you won't carry out the parameterization on the amplifier itself, but on a PC, with the aid of the setup software. The PC is connected to the servo amplifier by a null-modem cable (serial). The setup software establishes the communication between the PC and the servo amplifier.

With very little effort, you can alter parameters and instantly see the effect on the drive, since there is a continuous (online) connection to the amplifier. Important process values / actual values are simultaneously read out from the amplifier and displayed on the monitor of the PC (oscilloscope functions).

Any interface modules (expansion cards) that are built into the servo amplifier will be recognized automatically.

You can store sets of data on a data medium (archiving) and load them again. The data set that is in use at the moment can be printed out.

We provide you with default sets of motor-specific data for reasonable combinations of servo amplifier + motor. In most applications you will be able to commission your drive without any problems, just by using these default values.

4.3 Hardware requirements

The PC interface (X6, RS232) of the servo amplifier is connected to the serial interface of the PC via a null-modem cable (**not a null-modem link cable**).

Disconnect and connect the cable only while all the supply voltages are switched off (amplifier and PC).

The interface in the servo amplifier is electrically isolated by optocouplers, and is at the same potential as the CANopen interface.

Minimum specification for the PC:

Processor	80486 or higher
Operating system	WINDOWS 95(c) / 98 / ME / 2000 / XP / NT4.x
Graphics card	Windows-compatible, color
Drives	Hard disk (5 MB free space) CD-ROM drive
Main memory	8MB minimum
Interface	one free serial interface (COM1:, COM2:, COM3: or COM4:) This interface must not be used by any other software (driver or similar).

4.4   RS232 interface, PC connection (X6)

You can carry out the setting up of the parameters for operating, position control, and motion-blocks, by using the setup software on an ordinary personal computer (PC).

Connect the PC interface (X6) of the servo amplifier to the serial interface of the PC via a 3-core null-modem cable (**do not use a null-modem link cable**). Do this **only while the supply voltages are switched off**. The interface is electrically isolated by optocouplers, and is at the same potential as the CANopen interface.

The interface is selected in the setup software.
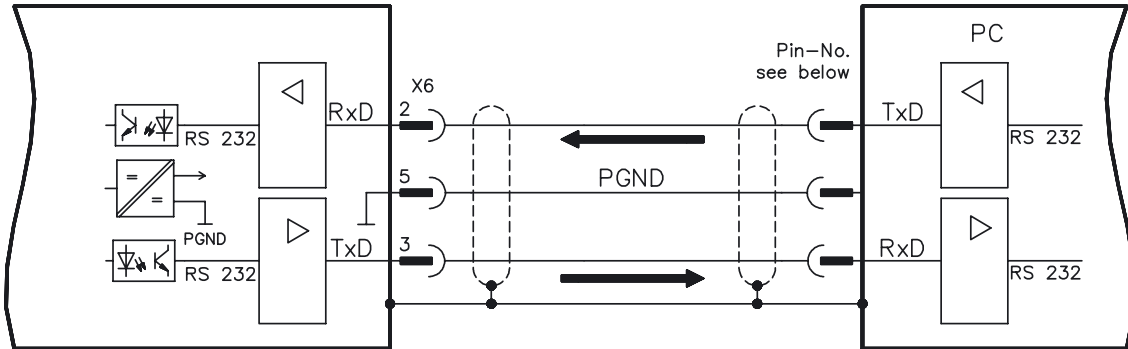
Interface cable between the PC and the servo amplifier

(View: looking at the built-in SubD connector, i.e. the solder side of the SubD plug on the cable)
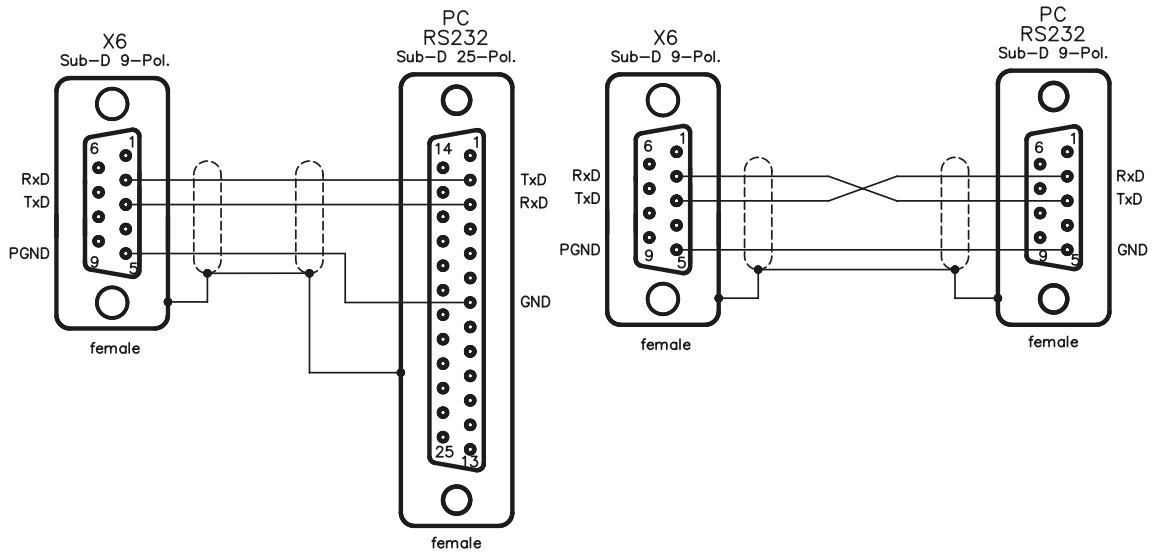
4.5 Installation under WINDOWS 95(c) / 98 / 2000 / ME / XP / NT

You can install the setup software directly from the enclosed CD-ROM (call up SETUP.EXE).

Connection to the serial interface of the PC:
Connect the interface cable between the serial interface of your PC and the PC-interface (X6) of the amplifier.

Switch-on:
Switch on your PC-AT and the monitor.
When the boot phase is finished, the Windows user-interface will appear on the screen.

Installation:
Click on **START** (taskbar), then on **Run**.
Enter the program call: **a:\setup.exe** (where a: is the correct drive letter).
Click on **OK** and follow the instructions.

Setting up the graphics card (font size)
Note that the screen resolution must at least be 800x600 pixel.
Click on the desktop with the right mouse button. The dialogue window "Properties" will appear. Select the file card "Settings". Set the **Font size** to "**Small Fonts**". Follow the instructions provided by the system.

4.6 Operation

The setup software is basically used in the same way as other Windows programs.

Use a decimal point as the decimal symbol, do not use a comma.

Please note that, after an alteration in a parameter on a screen page, you must first click on **APPLY**, so that the parameter is transferred to the RAM of the servo amplifier. Only then you should leave the page. If a reset of the servo amplifier is necessary to activate a function, this will be recognized by the setup software, which will make a reset after a software confirmation request.

The currently valid data set must be saved in the EEPROM of the servo amplifier, in order to be permanently stored. So execute the **Save Data to EEPROM** function on the "Amplifier" page before you switch off the servo amplifier or quit processing the data set.

Values appearing in red on the screen pages designate parameters that are intended for advanced users only.

4.7 Function keys

Function key	Function	Comment
F1	Help	Contextual help
F2	reserved	reserved
F3	reserved	reserved
F4	Jog Mode	Starts the Jog Mode. The drive operates under the parameters that are pre-selected on the "Homing" page while the F4 key is pressed.
F5	DC	The drive operates under the parameters that are pre-selected on the "Oscilloscope/Service" pages.
F6	Speed	
F7	Torque	
F8	Reversing	
F9	Stop (OFF)	Brakes off the drive movement. The response of the drive varies according to the operating mode that is valid at the moment: **OPMODE=0** the drive brakes along the preset braking ramp for the speed control loop (DEC) **OPMODE=2** the drive coasts down **OPMODE=8** breaks off the present motion task. The drive brakes along the braking ramp that is defined in the motion task.
F12	Disable	Software disable
Shift F12	Enable	Software enable

Stopping the axis by using F9 or F12 does not ensure personal safety unless further measures are implemented. For safety, operate the ENABLE signal for the amplifier through a button that has to be confirmed, and ensure that the EMERGENCY STOP function is active for this axis.

5   Axis Commissioning Checklist Procedures

5.1   General

This chapter provides you with strategies for the commissioning of the digital servo amplifier and the optimization of its control loops.

These strategies cannot be universally valid. You may have to develop your own strategy, depending the specification of your machine.

However, the sequences that are presented here will help you to understand the basic methodology.

5.2   Parameterization

⚠️ *The manufacturer of the machine must create a hazard analysis for the machine, and is responsible for the machine with regard to functional, mechanical and personnel safety. This applies particularly to the initiation of movements with the aid of commissioning-software functions.*
The commissioning of the servo drive with the aid of Setup software functions is only permitted in combination with an interlock device according to EN292-1, that operates directly on the drive circuitry.

- The servo amplifier is installed, and all the necessary electrical connections have been made. See Installations Manual, Chapter II.

- The 24V auxiliary supply and the 208V...480V main power supply are switched off.

- A personal computer, with the commissioning software installed, is connected.

- An interlock device according to EN292-1 is connected.

- The controls provide an LOW signal for the ENABLE input of the servo amplifier (Terminal X3/15), i.e. the servo amplifier is disabled.

5.3   Switch on auxiliary supply

1.	**Switch on the 24V auxiliary supply for the servo amplifier.** LED display: **X.XX** (firmware version) BTB/RTO contact: open **After about 5 seconds:** LED display: **YY.** (amount of current, blinking point for CPU o.k.) BTB/RTO contact: closed
2.	**Switch on personal computer**
3.	**Start commissioning software**
4.	**Click on the interface (COM1:, 2:, 3: or COM4:) that is used for communication with the servo amplifier.** The parameter are transmitted to the PC.
5.	**Click on the radio button "SW-disable" at bottom right or press the function key F12.** **NO ENABLE** now stands in the AXIS status field.

5.4   Basic setting

The servo amplifier remains disabled and the main power supply is switched off.

1.	**Set up basic parameters** (address, ballast details, line/mains supply voltage etc.): - Click on the **BASIC SETTINGS** button - Alter the fields, if necessary - Click on **APPLY** and then on **OK**

2.	**Select motor**:
	- Click on the **MOTOR** button below the picture of the motor
	- Open the motor selection table, by clicking on the arrow in the field
	  NUMBER-NAME
	- Click on the motor that is connected
	- Click on **APPLY**
	- Answer the query about the brake
	- Answer the query "Save to EEPROM/Reset" with **NO**
	  (the data are in the RAM and will be permanently saved later)

3.	**Select feedback (resolver, encoder)**: - Click on the **FEEDBACK** button - The values that are displayed correspond to the default data that you have loaded for the motor. - Alter the fields, if necessary - Click on **APPLY** and then on **OK**
4.	**Set up the encoder emulation (ROD, SSI)**: - Click on the **ROD/SSI/ENCODER** button - Select the desired encoder emulation - Set up the corresponding parameters in the right half of the window - Click on **OK**
5.	**Configure the analog inputs/outputs:** - Click on the **I/O ANALOG** button - Select the desired **ANALOG-FUNCTION** - Set the scaling relative to 10V for the analog input that is used. - Set up the required output signals for **AN OUT 1** and **AN OUT2** - Click on **OK**

6.	**Configure the digital inputs/outputs:**
	- Click on the **I/O DIGITAL** button
	- Assign the required functions to the digital inputs (left half of window)
	  and enter the auxiliary variable X if it is necessary.
	- Assign the required functions to the digital outputs (right half of window)
	  and enter the auxiliary variable X if it is necessary.
	- Click on **OK**

7.	**Save parameters:** - Click on the [SAVE] button - Answer the query **RESET AMPLIFIER** with **YES**
8.	Click on the radio button "SW-disable" at bottom right or press the function key F12. **NO ENABLE** now stands in the status field for AXIS

If you want to use the position control of the servo amplifier, then you must enter the specific parameters for your drive:

1.	**Axis type:** - Click on the POSITION button - Click on the POSITION DATA button - Select the **axis type** (linear, rotary or modulo)
2.	For the axis type MODULO: enter the parameters **Modulo-Start-Pos.** and **Modulo-End-Pos.**

3.	**Resolution:**
	   - Enter the denominator and numerator for the resolution. Here you adjust the path
	     traversed by the load in positioning units (length unit for linear axes, or °mech.
	     for rotary axes) to match the number of turns of the motor.
	     Only integer entries are permitted.
	Example 1: Ratio = $3.\overline{333}$ mm / turn
	                 => resolution = 10000/3 µm/turn (all other path entries in µm)
	                                 or
	                 => resolution = 10/3 mm/turn (all other path entries in mm)
	Example 2: Ratio = 180 °mech./turn
	                 => resolution = 180/1 °mech./turn (all other path entries in °mech)

4.	**vmax:**
	   - Enter the maximum traversing speed for the load that results from the resolution
	     at the rated speed of the motor. The dimensional unit is derived from the
	     resolution (°mech./sec or length units/sec).
	Example 1: resolution = 10000/3 µm/turn, nnom = 3000 turns/min
	                 => vmax = resolution * nnom = 10000/3 * 3000 µm/min = 10 000 000 µm/min
	                                 or
	                 => vmax = resolution * nnom = 10/3 * 3000 mm/min = 10 000 mm/min
	Example 2: resolution = 180 °mech/turn, nnom = 3000 turns/min
	                 => vmax = resolution * nnom = 180 * 3000 °mech/min = 9000 °mech/s

5.	**t_acc/dec_min:**
	   - Enter the time in ms that the drive requires, with the
	     mechanically permissible maximum acceleration,
	     to accelerate from zero speed to vmax.

6.	**InPosition:**
	   - Enter the window for InPosition. This value is used for the InPosition message.
	     The dimensional unit is derived from the resolution
	     (°mech. or length unit).
	         Typical value: e.g. approx. resolution * 1/100 turn

7.	**max. following error:**
	   - Enter the window for the following error. This value is used for the message
	     FOLLOWING ERROR. The dimensional unit is derived from the resolution
	     (°mech. or length unit).
	         Typical value: e.g. approx. resolution * 1/10 turn

8.	**Save parameters:**
	
	   - Click on the button
	
	   - Answer the query **RESET AMPLIFIER** with **YES**

5.5   Optimization of the control loops

The basic setting must be finished.

Preparation

1.	**OPMODE:** Set the OPMODE "1,analog speed" (screen page AMPLIFIER)
2.	**Setp. function:** Set the analog I/O-function to "0,Xsetp=An In 1" (screen page ANALOG-I/O)

3.	**Save the parameters:**
	      - Click on the [SAVE] button (screen page AMPLIFIER)
	
	      - Answer the query **RESET AMPLIFIER** with **YES**

4.	**An In 1:** Short-circuit the setpoint input 1 or apply 0V to it
5.	**OSCILLOSCOPE:** Channel1: n_act Channel2: I_act (screen page OSCILLOSCOPE)
6.	**Reversing mode:** Go to the screen page **OSCILLOSCOPE/SERVICE**/PARAMETER and set the parameters for reversing mode to values that are safe for your machine, also when the positioning control loop is switched off (approx. 10% of the final limit speed).

⚠️ *During operation of the service function "Reversing mode" the analog setpoint input is switched off and the internal positioning control is disabled.*
Make sure that the individual motion of the selected axis is possible without any hazard.
For safety, only operate the ENABLE signal of the amplifier with an interlock switch, and check the EMERGENCY STOP function for this axis.

5.6   Optimizing the current controller

Screen page CURRENT CONTROLLER

1.	If a suitable amplifier-motor combination is used, the current controller will already have a stable setting for almost all applications.
2.	**Ipeak:** - Reduce Ipeak to the rated value for the motor (protection of the motor)
3.	Switch on the **mains/line power.**
4.	Provide the **analog setpoint:** - Analog-In1 = 0V

5.	**Enable** the amplifier:
	      - High signal at Enable input X3/15. In the AXIS status field: **NO SW-EN**
	      - Click on the SW-Enable radio button. **ENABLE** now stands in the AXIS status field.
	 The motor now stands under speed control, with n=0 rpm. If the current controller is not stable in operation (motor oscillates with a frequency clearly above 100Hz), please contact our applications department.

5.7   Optimizing the speed controller

Screen page SPEED CONTROLLER

|	
1.	**SETP. -OFFSET:** Leave the amplifier enabled. If the axis is drifting, alter the parameter Setp.-Offset until it stands still (or use the function AUTO-OFFSET).
2.	**SETP. RAMP +/-:** The setpoint ramps are used to smooth the setpoint input (filter effect). Set the mechanical time constant for the complete system, i.e the rise time or ramp gradient for the speed from 0 to n_{cmd}. As long as the ramps that are set are shorter than the mechanical response time for the complete system, the response speed will not be affected.
3.	**LIMIT SPEED:** Set the desired final limit speed.
4.	**KP/Tn:** Increase KP until the motor starts to oscillate (audible, and visible on the oscilloscope) and then reduce KP again until the oscillations have definitely stopped and stability is assured. Use the motor-specific default value for Tn.
5.	**Start reversing mode:** Start the reversing mode (F8, v1/v2 approx. +/-10% of n_{nom} for the motor). Observe the speed response on the oscilloscope. If the settings are correct, there must be a stable step response in both directions.
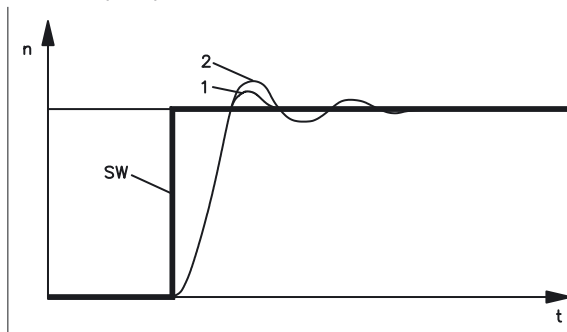
Diagram: Step response

n   = speed
SW   = setpoint
t   = time
1   = optimum
2   = KP too high

6.	**KP:** You can produce a fine tuning of the speed response by cautiously increasing KP. Aim: the smallest overshoot, but still retaining good damping. A larger total moment of inertia make it possible to use a larger value for KP.
7.	**PID-T2:** You can dampen out disturbances, such as a small amount of play in the gearing, by increasing PID-T2 to about 1/3 the value of Tn.
8.	**FEEDBACK:** You can further improve the smooth running by using FEEDBACK, especially for small drives with a low torque.
9.	**End reversing mode:** Finish the reversing mode operation (F9).

Set up the correct, motor-specific value for Ipeak (current controller) again. Start up reversing mode again, and observe the step response. If there is any tendency to oscillation, reduce KP slightly.

Save the present parameter set in the EEPROM. Click on the [SAVE] button.

5.8   Optimizing the position controller

Screen page POSITION CONTROLLER

Preparation

1.	**OPMODE:** Select OPMODE 8 (screen page AMPLIFIER)

2.	**Position the load in a middle position:**
	The aim is, to use the Jog Mode function to move the load to approximately the middle of the motion path.
	    - Click on the POSITION button
	    - Click on the HOMING button
	    - Check that the parameter **v** (Jog Mode) is set to 1/10 of the
	      preset speed limit vmax. The sign of "v" determines the direction.
	      Alter the value if necessary, and click on **APPLY**.
	    - Start the function **JOG MODE** by using the function key **F4** and
	      move the load to approximately the middle of the motion path
	      WARNING:
	      If the drive moves in the wrong direction, release the F4 function key
	      and change the sign of the parameter "v" (Jog mode).
	      Use F4 again to move the load to approximately the middle of the motion path.

3.	**Set reference point:**
	    - Set the homing type to activate "**0, set reference point**".
	      Start the homing run. The momentary position is set as the reference point.
	    - Stop the homing run
	    - Click on the radio button "SW-disable" in the amplifier window

4.	**Define test motion blocks:**
	    - Click on the POSITION button
	    - Click on the POSITION DATA button
	    - Click on the MOTION TASK TABLE button and select task 1. Enter the
	      values from the table below, then select task 2 and
	      enter the corresponding values.

	Task 1	**Task 2**
units	SI	SI
type	REL setpoint	REL setpoint
s_cmd	+10% of total path	-10% of total path
v_cmd_source	digital	digital
v_cmd	10% of vmax	10% of vmax
t_acc_tot	10 * t_acc/dec_min	10 * t_acc/dec_min or a_{max} / 10
t_dec_tot	10 * t_acc/dec_min	10 * t_acc/dec_min or a_{max} / 10
ramp	trapeze	trapeze
next motion task	with	with
next number	2	1
acc./dec.	to target position	to target position
start condition	immediately	immediately
APPLY/OK	click	click

| 5. | **Save parameters:**
    - Click on the   button
    - Answer the query **RESET AMPLIFIER** with **YES** |

      <u>**Optimization**</u>

> ⚠️ *The starting of motion tasks with the aid of commissioning-software functions is only permitted in combination with an interlock device according to EN292-1, that operates directly on the drive circuitry.*

|	

1.	**Start motion task:**
	    - Click on the POSITION button
	    - Select motion task 1 on screen page POSITION DATA, click on **START**, motion task 1 is started and, because of the definition of the motion task sequence, the drive moves in position-controlled reversing operation.

2.	**Optimize parameters** (Click on the POSITION DATA button)
3.	**PID-T2, FEEDBACK:** The speed controller is not used in OPMODES4, 5 and 8. The position controller includes an integral speed controller, that takes on the preset parameters for PID-T2 and FEEDBACK from the screen page "SPEED CONTROLLER".
4.	**KP, Tn:** If KP is set too low, the position controller tends to oscillate. Use the value for the **optimized** speed controller for KP. Tn should be 2...3 times as large as the Tn value for the optimized speed controller.
5.	**KV:** The acceleration behavior of the motor should be well damped (no tendency to oscillation) with a minimum following error. If KV is larger, the tendency to oscillation increases. If it is smaller the following error increases and the drive becomes too soft. Vary KV until the desired response is achieved.
6.	**FF:** The integral component of the control loop is in the position controller, not the speed controller, so no following error results at Jog Mode (pure proportional control). The following error that arises during acceleration is affected by the FF parameter. This error is smaller if the FF parameter is increased. If increasing FF does not produce any improvement, then you can increase KP a little, to make the speed control loop somewhat stiffer.

If the drive does not run satisfactorily under position control, first look for external causes such as:

- mechanical play in the transmission chain (limits the KP)
- jamming or slip-stick effects
- self-resonant frequency of the mechanical system is too low
- poor damping, drive is too weakly dimensioned

before trying to optimize the control loop again.

6   Screen layout
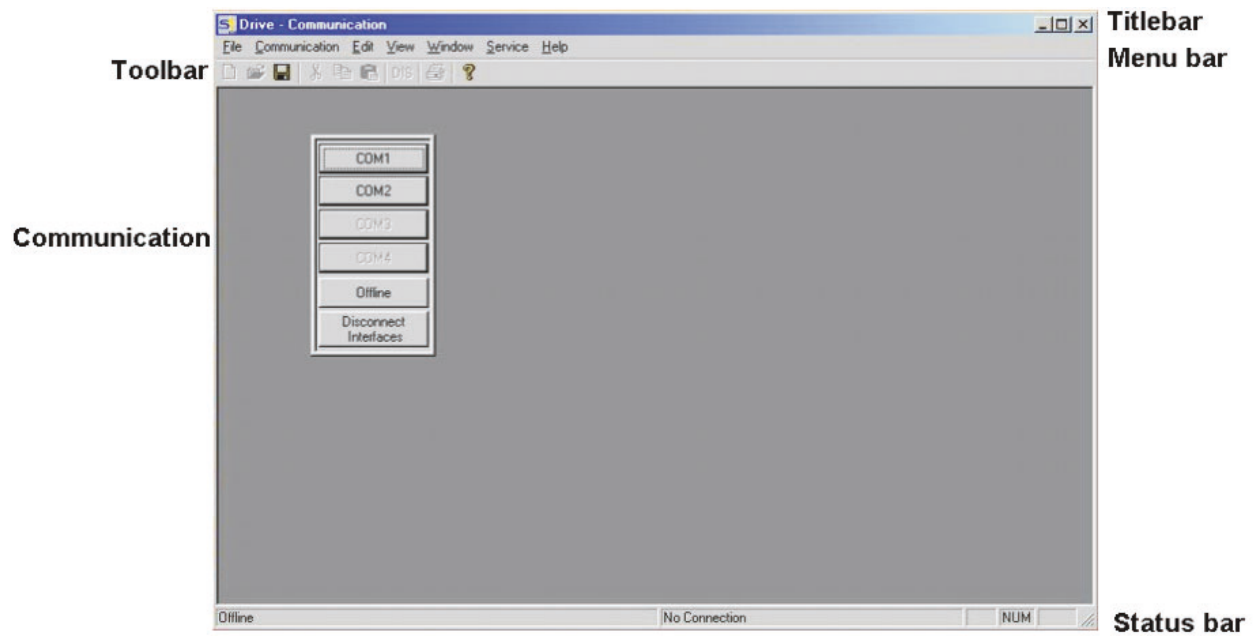
Title Bar	The program name, station address, and the name of the currently valid data set (amplifier) are displayed in the title bar. During offline operation, instead of the station address a number above 100 will be shown, possibly with the storage location (folder + file name) of the data set that has been loaded.
Toolbar	The typical Windows-style buttons can be used for a direct start of individual functions.
Status Bar	Current information about the data communication is shown here.

Menu bar

FILE	
Open	A parameter and/or motion task data set is read from the data medium (hard disk, diskette) and becomes the currently valid set. The servo amplifier must be disabled to do this.
Close	The current data set is closed and not saved.
Save	Saves the current parameter or motion task data set to a data medium (hard disk, diskette) while keeping the file name, if the data set already has a name. If the data set has not yet got a name, you will be prompted to enter a name and storage location. You can save parameters and motion task data to one single file or to separate files.
Save as	Saves the current parameter or motion task data set to a data medium (hard disk, diskette). You will be prompted to enter a name and storage location.
Print	The current data set will be printed out. You can choose whether the print data are sent to the system printer or saved to a file.
Print preview / Print setup	Use these functions in the same way as for any other Windows software.
Exit	Terminates the program.
COMMUNICATION	
COM1/COM2/COM3/COM4	If one of these interfaces (ports) is available for communication with a servo amplifier, which means that it is not used by other equipment or drivers, then the text label appears in full black and can be selected. Select this interface and use it for the connection to the servo amplifier
Offline	You can still work with the setup software, even if there is no servo amplifier connected. You can load a set of data from the hard disk (diskette), work on it, and save it again. The software functions and screen pages that only have a use in the online mode will not be selectable.
Disconnect interfaces	This deactivates the access to the setup software from interfaces COM1 to COM4. This function is important if, for instance, the servo amplifier is to be accessed from an external program, without closing the setup software.
Multidrive	With this function, you can establish connection to other amplifiers, that are connected via the CAN-bus with the amplifier that communicates via the RS232-interface with the PC. Therefore, all devices must have different addresses.This function should not be used in running field bus applications.
Update active window only	This affects the updating of the actual-value display in open windows. **activated**: only the active window will be updated **de-activated**: the actual values will be continuously updated in all open windows, but this is detrimental for keeping the active display up to date.
Lower Transmission Priority	Delay of serial communication in favor of the data communication over a field bus.
TOOLS	
Terminal, Monitor, Oscilloscope, Drive status	Opens the corresponding screen page
EDIT	
Undo, Cut, Copy, Paste	Use these functions in the same way as for any other Windows software.
VIEW	
Toolbar / Status bar	Switch to insert the toolbar (above) or the status bar (below) into the screen.
Window	
Cascade / Tile vertically / Arrange icons	Use these function in the same way as for any other Windows software.
SERVICE	
STOP (F9)	Brakes off the drive movement. The response of the drive varies according to the operating mode that is valid at the moment: **OPMODE=0** the drive brakes along the preset braking ramp for the speed control loop (DEC) **OPMODE=2** the drive coasts down **OPMODE=8** breaks off the present motion task. The drive brakes along the braking ramp that is defined in the motion task. If the screen "Oscilloscope/Service" is active, you can also start the service function from here.
? (Help function)	Opens the HTML help file

7   Screen page "Communication"

COM1, 2, 3, 4   If one of these interfaces (ports) is available for communication with a servo amplifier, which means that it is not used by other equipment or drivers, then the text label appears in full black and can be selected. Use this interface for the connection to the servo amplifier.

Select the interface that you are using. In a multi-axis system with several (up to 4) servo amplifiers linked by the special cable -SR6Y- and connected to a PC (see Installation Manual, Chapter IV.2.1), you can select the servo amplifier you want by selecting its station address in a list. In this case it is also possible to display several servo amplifiers at the same time by repeating the interface selection.

In the status bar you can see information about the status of the communication with the servo amplifier. If the communication is functioning correctly, the parameters that are stored in the servo amplifier are read into the PC. A dialogue window keeps you up to date.

Offline   Even when no servo amplifier is connected, you can still work with the setup software. You can load a set of data from the hard disk (diskette), work on it, and save it again. If you don't load a set of data, the manufacturer's default settings (basic setup) will be applied. Software functions and screen pages that only have a use in the online mode will not be selectable.

You can open more than one data set for editing, by clicking on OFFLINE again. The individual data sets are identified in the title bar by the designations "AMPLIFIER 1001", "AMPLIFIER 1002" and so on.

Not the station address is displayed, but a sequential number above 1000. If you have loaded an existing data set from the hard disk or diskette, then the folder name, data set name and amplifier name will also be displayed.

Disconnect interfaces   Deactivates the access to the setup software via the interfaces COM1 to COM2. This function is important if, for instance, the servo amplifier is to be accessed from an external program without closing the setup software.

8   Screen page "Amplifier"

This screen page displays the control loops of the servo drive in a simplified block diagram. A click with the left mouse button on a button on the screen page calls up the corresponding function or screen page.

Save the current parameter to data media (hard disk, diskette). You can save parameters and motion task data to one single file or to separate files.

Load a control parameter file or a motion-block parameter file from data media (hard disk, diskette). The servo amplifier must be disabled to do this.

Open the screen page "TERMINAL" for the direct input of ASCII commands (only for advanced users, and with the support of our application department).

Open the screen page "ACTUAL VALUES" to display the actual drive status.

Open the screen page "OSCILLOSCOPE/SERVICE" for the graphic display of the setpoint/actual values, and to access the service functions (reversing mode, const. speed etc.) for optimizing the amplifier.

Open the screen page "Bodeplot". This page makes it possible to use a Bode plot generator to generate a graphical representation of the behavior of the speed controller.

Non-volatile (does not disappear at power-off) storage of the currently valid parameter set in the EEPROM of the servo amplifier. In this way you can permanently save all the parameter changes that you have made since the last switch-on/reset of the servo amplifier.

ASCII: **SAVE**	Default: -	valid for all OPMODES

Stop the currently active service function. This is the same as using the function key F9.
Stop (cancel) motion functions in the OPMODES 0, 2 and 8.
Movements in other OPMODES can only be stopped by using the DISABLE button.

Cancel all the parameters that have been set up, and load the manufacturer's default values.

Making a hardware-reset

ASCII: **COLDSTART**	Default: -	valid for all OPMODES

Basic setup	Opens the screen page "BASIC SETUP"
Slot / Exp. x	Opens the screen page for the built-in expansion card (description: manual for the expansion card).
Analog I/O	Opens the screen page "ANALOG I/O"
Digital I/O	Opens the screen page "DIGITAL I/O"
ROD/SSI/Encoder	Opens the screen page "ENCODER"

OPMODE

ASCII: **OPMODE**	Default: 1	valid for all OPMODES

Set the basic function of the servo amplifier for your application here.

ID	Function	Comments
0	Digital (rotational) speed	Speed control with digital setpoint
1	Analog (rotational) speed	Speed control with analog setpoint
2	Digital torque	Torque control with digital setpoint (speed controller has to be optimized)
3	Analog torque	Torque control with analog setpoint (speed controller has to be optimized)
4	Position: electr. gearing	Position control "Pulse follower"
5	Position: ext. position nodes	Position control interpolates external nodes
6	SERCOS position control	Position control with SERCOS expansion card
7	reserved	reserved
8	Position: motion blocks	Position control by stored motion blocks

The OPMODE can be switched over while the drive is running. This could lead to dangerous acceleration. So only switch over OPMODE while the drive is running if the drive application allows it.

Position	Opens the screen page "POSITION"
Speed	Opens the screen page "SPEED"
Current	Opens the screen page "CURRENT"
Feedback	Opens the screen page "FEEDBACK"
Motor	Opens the screen page "MOTOR"
Status=OK/Fault	Opens the screen page "DRIVE STATUS". If a fault is present, the text for the buttons will change.
Axis	The enable status of the amplifier is displayed: **ENABLE / NO HW EN. / NO SW EN. / NO ENABLE**

Disable/Enable SW

ASCII: **DIS** (disable, F12)	Default: -	valid for all OPMODES
ASCII: **EN** (enable, Shift F12)	Default: -	valid for all OPMODES

Disables or enables the servo amplifiers via the software. This signal is logically "AND"-linked inside the servo amplifier with the hardware-enable (terminal X3/15).

This function does not ensure personnel safety. To disable the servo amplifier in a way that ensures personnel safety, the enable signal (terminal X3/15) must be removed and the line (mains) power must be switched off, or Option -AS- (see additional manual) must be used.

Exit	Ends the processing of the current parameter set. If you have made any changes, you will be asked if you want to save the data.

9 Slot

The screen page depends on the built-in expansion card:

● I/O expansion card -I/O-14/08-

● SERCOS

● PROFIBUS

10   Screen page "Basic Setup"

PC Software

Display the version and revision level of the current setup software.

Regen Resistor

ASCII: **PBALRES**	Default: 0 (internal)	valid for all OPMODES

Preselection of the regen resistor. If you use an external regen resistor, set "1,external" here. Change this only while the amplifier is disabled.

max. Regen Power

ASCII: **PBALMAX**	Default: 80 W / 200 W	valid for all OPMODES

The limit for the continuous power of the regen resistor. Change this only while the amplifier is disabled.

Max. Mains Voltage

ASCII: **VBUSBAL**	Default: 1	valid for all OPMODES

This parameter is used to adjust the regen and switch-off levels of the servo amplifiers to suit the mains power supply voltage or the system conditions for multi-axis systems with parallel-connected DC-link circuits.

ID	Max. mains voltage	DC-link voltage (rated motor voltage / max. motor voltage)
0	230 V	310 V / 430 V
1	400 V	560 V / 750 V
2	480 V	675 V / 870 V

Single amplifier

Usually the setting taken is the mains supply voltage that is actually available.
If the motor has a higher voltage rating than the DC-link voltage that occurs as a result of the available mains supply voltage, then you can raise the regen and switch-off levels by selecting the max. mains voltage that is permissible for the motor (see table).

Multi-axis systems with parallel-connected DC-link circuits

In a system, the DC-link circuits of the servo amplifiers are usually connected in parallel (DC-bus). If motors with differing voltage ratings (which must be as high or higher than the actual DC-link voltage) are used, then each amplifier on the DC-bus must be set up for the motor with the **lowest rated voltage**. If the settings are not all the same, then the desired distribution of the regen power will not be achieved.

Mains phase missing

ASCII: **PMODE**	Default: 1	valid for all OPMODES

Handles the message "Phase missing". Change this only while the amplifier is disabled + reset.

ID	Function	Remark
0	no message	A missing mains supply phase is not evaluated. Operation is possible on two phases. The peak current for acceleration is limited to 4A.
1	Warning	A missing mains supply phase is reported as a warning (display), and can be output on a digital output. The servo amplifier will not be disabled. The peak current for acceleration is limited to 4A.
2	Error	A missing mains supply phase is reported as a fault (display), and can be output on a digital output. The servo amplifier is disabled and the BTB/RTO contact opened.

Hardware

ASCII: **HVER**	Default: -	valid for all OPMODES

Displays the version and revision level of the servo amplifier hardware.

Firmware

ASCII: **VER**	Default: -	valid for all OPMODES

Displays the version and revision level of the servo amplifier firmware.

Serial number

ASCII: **SERIALNO**	Default: -	valid for all OPMODES

Displays the serial number of the servo amplifier.

Run time

| ASCII: **TRUN** | Default: - | valid for all OPMODES |

Displays the operational time of the servo amplifier, saved at 8 min. intervals. If the 24V supply is switched off, a maximum of 8 min. operational time will be unregistered.

Address

| ASCII: **ADDR** | Default: 0 | valid for all OPMODES |

The entry is the station address (1...63) of the amplifier. This number is required by the fieldbus (CANopen, PROFIBUS DP, SERCOS etc.) and for the parameter setting of the servo amplifier in multi-axis systems for an unambiguous identification of the servo amplifier within the system (see Installation Manual).

The address is displayed in the setup software in the title bar of every screen page, as long as you are working online. In offline operation the display is not the actual station address, but a number above 1000. In this way you can instantly recognize the offline mode.

You can also use the keys on the front panel of the servo amplifier to set the station address (see Installation Manual).

Fieldbus-Address

| ASCII : **ADDRFB** | Default : 0 | valid for all OPMODES |

The entry is the fieldbus address (1 to 63) of the amplifier. If set, the number is used in in fieldbus communication. If this parameter is not set, the station address is used.

The address is indicated in the setup software on each screen page in the title bar, if you work on-line. In the off-line operation not the actual station address is indicated, but a number above 1000. Then you can recognize the off-line mode immediately. With the keys on the servo amplifier front plate you can likewise set the field bus address (see installation manual).

Baudrate CANopen

| ASCII: **CBAUD** | Default: 500 kbps | valid for all OPMODES |

The entry is the transmission rate of the amplifier (10, 20, 50, 100, 125, 250, 333, 500, 666, 800, 1000 kbps). The transmission rate is required by the fieldbus (CANopen) and for the parameter setting of the servo amplifier in multi-axis systems (see Installation Manual).

You can also use the keys on the front panel of the servo amplifier to set the baud rate (see Installation Manual).

Name

| ASCII: **ALIAS** | Default: blanks | valid for all OPMODES |

Here you can assign a name (8 chars max.) to the servo amplifier (e.g. X-AXIS). This makes it easier for you to associate the servo amplifier with a function within the system.

The name is displayed in the setup software in the title bar of every screen page. In offline mode the name is an indication of the origin of the currently active data set.

Auto Enable

| ASCII: **AENA** | Default: 1 | valid for OPMODES 0, 2, 4-8 |

Definition of the status of the software-enable on switching on the instrument, or after using Reset to clear errors.

Ext. WD

| ASCII: **EXTWD** | Default: 100 ms | valid for all OPMODES |

Definition of the monitoring (*watchdog*) time for fieldbus/slot communication. This monitoring is only active when the value is greater than 0 and the output stage is enabled. If the pre-set time runs out without the timer being re-triggered, then the warning n04 (response time monitoring) is generated and the drive is stopped. The amplifier remains operative and the output stage is still enabled. This error warning must be cleared by using Reset before a new setpoint can be accepted.

Acceleration

ASCII: **ACCUNIT**	Default: 0	valid for all OPMODES

Definition of the dimensional unit for acceleration. This unit is used for the ramps of the trajectory generator (internal motion blocks, OPMODE 8) as well as for the braking/acceleration ramps of the speed controller.

ID	Function	Remark
0	ms->VLIM	Acceleration given as run-up time (in ms) taken to reach the target speed
1	rad/s²	Acceleration given in rad/s²
2	rpm/s	Acceleration given in min⁻¹/s (rpm per sec)
3	PUNIT/s²	Acceleration given in PUNIT/s² (from Version 4.00)
4	1000*PUNIT/s²	Acceleration given in 1000 * PUNIT/s² (from Version 4.00)
5	10^6*PUNIT/s²	Acceleration given in 1000000 * PUNIT/s² (from Version 4.00)

With the setting ms->VLIM it is still possible to enter the acceleration for the motion block in mm/s². If the setting is changed, all the acceleration and braking parameters that are affected will be internally converted to the currently valid dimensional unit.

The automatic parameter adjustment does not apply to the internal motion blocks. For this reason, the valid dimensional unit for acceleration should be fixed before the first motion block is created. If an alteration is made at a later stage, the acceleration/deceleration values for *all* motion blocks will have to be checked, and corrected if necessary.

Velocity

ASCII: **VUNIT**	Default: 0	valid for all OPMODES

Definition of the global dimensional unit for speed and velocity. This unit applies to all speed/velocity dependent parameters of the speed/position controllers.

ID	Function	Remark
0	Compatibility mode	definition of speed in min⁻¹, definition of velocity in µm/s
1	1/min	unit = min⁻¹
2	rad/s	unit = radians/s
3	°/s	unit = degrees/s
4	Counts/250µs	unit = counts/250 µs
5	PUNIT/s	unit = PUNIT/s
6	PUNIT/min	unit = PUNIT/Min
7	1000*PUNIT/s	unit = 1000*PUNIT/s
8	1000*PUNIT/min	unit = 1000*PUNIT/Min

Note:

1. All speed-dependent parameters are normally defined as 32-bit fixed point numbers (3 decimal places). For this reason, many settings (in particular: 1000*PUNIT/s), will not be able to cover the entire speed range, depending on the resolution, that has been set. Care must be taken that a suitable unit is chosen, depending on the application.

2. All velocity-dependent parameters are normally defined as 32-bit integer numbers. For this reason, it is not possible to enter a velocity with decimal fractional values, particularly for the Counts/250µs setting. Care must be taken that a suitable unit is chosen, depending on the application.

Position

ASCII: **PUNIT**	Default: 0	valid for all OPMODES

Definition of the global unit for all position-dependent parameters of the position controller. The following settings are possible:

ID	Function	Remark
0	Counts	internal unit (application-specific)
1	dm	unit = 1 dm
2	cm	unit = 1 cm
3	mm	unit = 1 mm
4	100µm	unit = 0.1 mm
5	10µm	unit = 0.01 mm
6	µm	unit = 1 µm
7	100nm	unit = 0.1 µm
8	10nm	unit = 0.01 µm
9	nm	unit = 1 nm

With the *Counts* setting, no path/distance unit will be displayed. In this case, application-specific units can be implemented, which are exclusively dependent on the resolution that is used.

11 Screen page "Motor" synchronous

All the parameters that appear on this screen page are defined by the motor default values (internal database in the amplifier), and in most cases it will not be necessary to alter them.

Motor Type

ASCII: **MTYPE**	Default:1	valid for all OPMODES

This parameter is used to distinguish between synchronous (MTYPE = 1) and asynchronous motors (MTYPE = 3). If asynchronous is selected, then this screen page will appear in a different layout. Change this only while the amplifier is disabled.

No. of poles

ASCII: **MPOLES**	Default: 6	valid for all OPMODES

The current setpoint can be set for the operation of 2- to 250-pole motors. Change this only while the amplifier is disabled.

Io

ASCII: **MICONT**	Default: standstill current	valid for all OPMODES

The standstill current is the r.m.s. current value that the motor requires at standstill to produce the standstill torque (defines the maximum value for the entry of Irms in the current controller).

Iomax

ASCII: **MIPEAK**	Default: peak current	valid for all OPMODES

The peak current (r.m.s. value) should not exceed 4 x the rated current of the motor. The actual value is also determined by the peak current of the servo amplifier that is used (defines the maximum value for the entry of Ipeak in the current controller).

L

ASCII: **L**	Default: 0 mH	valid for all OPMODES

Inductance of the motor (phase-phase). You can take this value from the motor manual.

Max. speed

ASCII: **MSPEED**	Default: 3000 rpm	valid for all OPMODES

Maximum permissible speed of the motor. Limits the entry for the parameter SPEED LIMIT (screen page "Speed controller").

Number / Name

ASCII: **MNAME**	Default: blanks	valid for all OPMODES
ASCII: **MNUMBER**	Default: 0	valid for all OPMODES

Select the motor that is used from the motor database. The data are loaded after the motor has been selected. If an encoder is used as a feedback unit, the motor number will automatically be reported to the servo amplifier. Make changes only while the amplifier is disabled.

The following parameters are updated from the parameter set in the motor database:

Screen page	Parameter
Basic Setup	Max. Mains Voltage
Motor	No. Of Poles, Io, Iomax, L, Max.speed, Current Advance, Start Phi, Limit Phi, Brake with dialogue box
Feedback	Feedback Type, No. Of Resolver Poles, Offset
Current controller	KP, Tn
Speed controller	KP, Tn, PID-T2, Feedback, Max.speed, Overspeed

Brake

ASCII: **MBRAKE**	Default: 0	valid for all OPMODES

If you want to operate a 24V holding brake in the motor directly from the servo amplifier, this parameter can be used to enable the brake function.

ID	Function	Comments
0	**without**	Brake function is disabled.
1	**with**	If the brake function is enabled, then the output at the BRAKE (X9/2) terminal will be 24V if the ENABLE signal is present (Brake off) and 0V if the ENABLE signal is missing (brake activated).

In the diagram in Chapter I.9 of the Installation Manual you can see the time/function relationship between the ENABLE signal, the speed setpoint, actual speed value, and the braking force. Change this only while the amplifier is disabled + reset.

Current advance

ASCII: **MTANGLP**	Default: 0 °electr.	valid for all OPMODES

A current-dependent phase advance, to make use of the reluctance torque for motors with magnets embedded in the rotor.

Start/Limit Phi

ASCII: **MVANGLB**	Default: 2400 rpm	valid for all OPMODES
ASCII: **MVANGLF**	Default: 20 °electr.	valid for all OPMODES

The inductive phase shift between the motor current and the motor voltage can be compensated at high speeds. With the given voltage conditions, a higher torque can be achieved at the speed limit. Alternatively, the achievable speed limit can be increased by up to 30%.
The phase shift is increased (depending on the motor speed) linearly from the Start Phi value up to the final value = Limit Phi. The optimum setting depends on the motor type and the speed limit.

Motor Unit

ASCII: **MUNIT**	Default: 0	valid for all OPMODES

Defines the entry for motor speed.
If 1/min (rpm) is used, the setting for velocity/speed will be applied for VUNIT.

Load Data from disk   Load a motor-parameter file from a data medium (hard disk, diskette). The servo amplifier must be disabled to do this.

12 Screen page "Motor" asynchronous

All the parameters that appear on this screen page are defined by the motor default values (internal database in the amplifier), and in most cases it will not be necessary to alter them.

Motor Type

ASCII: **MTYPE**	Default:1	valid for all OPMODES

This parameter is used to distinguish between synchronous (MTYPE = 1) and asynchronous motors (MTYPE = 3). If synchronous is selected, then this screen page will appear in a different layout . Change this only while the amplifier is disabled.

No. of poles

ASCII: **MPOLES**	Default: 6	valid for all OPMODES

The current setpoint can be set for the operation of 2- to 256-pole motors. Change this only while the amplifier is disabled.

Io

ASCII: **MICONT**	Default: standstill current	valid for all OPMODES

The standstill current is the r.m.s. current value that the motor requires at standstill to produce the standstill torque (defines the maximum value for the entry of Irms in the current controller).

Iomax

ASCII: **MIPEAK**	Default: peak current	valid for all OPMODES

The peak current (r.m.s. value) should not exceed 2.5 x the rated current of the motor. The actual value is also determined by the peak current of the servo amplifier that is used (defines the maximum value for the entry of Ipeak in the current controller).

Rotor time constant

ASCII: **MTR**	Default: 200 ms	valid for all OPMODES

Defines the rotor time constant under rated load (Tr = Lh/Rr).
Lh is die magnetizing inductance and Rr is the rotor resistance.

Max. speed

ASCII: **MSPEED**	Default: 3000 rpm	valid for all OPMODES

Maximum permissible speed of the motor. Limits the entry for the parameter SPEED LIMIT (screen page "Speed controller").

Rated Speed

ASCII: **MVR**	Default: 3000 rpm	valid for all OPMODES

Rated speed of the asynchronous motor. This defines the point above which field-weakening is applied. For instance, if a 4-pole motor is used that would normally operate on a 50Hz supply, then the rated speed must be set to 1500.

Number / Name

ASCII: **MNAME**	Default: blanks	valid for all OPMODES
ASCII: **MNUMBER**	Default: 0	valid for all OPMODES

Select the motor that is used from the motor database. The data are loaded after the motor has been selected. If an encoder is used as a feedback unit, the motor number will automatically be reported to the servo amplifier. Make changes only while the amplifier is disabled.

The following parameters are updated from the parameter set in the motor database:

Screen page	Parameter
Basic Setup	Max. Mains Voltage
Motor	No. Of Poles, Io, Iomax, L, Max.speed, Current Advance, Start Phi, Limit Phi, Brake with dialogue box
Feedback	Feedback Type, No. Of Resolver Poles, Offset
Current controller	KP, Tn
Speed controller	KP, Tn, PID-T2, Feedback, Max.speed, Overspeed

Brake

ASCII: **MBRAKE**	Default: 0	valid for all OPMODES

If you want to operate a 24V holding brake in the motor directly from the servo amplifier, this parameter can be used to enable the brake function.

ID	Function	Comments
0	without	Brake function is disabled.
1	with	If the brake function is enabled, then the output at the BRAKE (X9/2) terminal will be 24V if the ENABLE signal is present (Brake off) and 0V if the ENABLE signal is missing (brake activated).

In the diagram in Chapter I.9 of the Installation Manual you can see the time/function relationship between the ENABLE signal, the speed setpoint, actual speed value, and the braking force. Change this only while the amplifier is disabled + reset.

Load Data from Disk   Load a motor-parameter file from a data medium (hard disk, diskette). The servo amplifier must be disabled to do this.

Motor Unit

ASCII: **MUNIT**	Default: 0	valid for all OPMODES

Defines the entry for motor speed.
If 1/min (rpm) is used, the setting for velocity/speed will be applied for VUNIT.

Field Level

ASCII: **MIMR**	Default: 0 A	valid for all OPMODES

Defines the magnetizing current for an asynchronous motor: this is usually set to 40% - 50% of the continuous current.
The magnetizing current remains constant below the rated speed of the motor. If the motor is operated above the rated speed, this current is reduced in inverse proportion to the motor speed (field-weakening).

Kp

ASCII: **GF**	Default: 15	valid for all OPMODES

Proportional gain (P) of the flux controller. The flux controller is implemented as a PI controller.

Tn

ASCII: **GFTN**	Default: 50 ms	valid for all OPMODES

Reset (I) time of the flux controller. The flux controller is implemented as a PI controller.

Field Correct Factor

ASCII: **MCFW**	Default: 1.5	valid for all OPMODES

Correction factor for field-weakening.
The correction factor compensates for non-linearity of the motor inductance with reducing magnetizing current by increasing speed during field-weakening.

Slip Correct Factor

ASCII: **MCTR**	Default: 1.5	valid for all OPMODES

Correction factor for the rotor (armature) time constant, increases the torque in the field-weakening range /stationary range.

13   Screen page "Feedback"

Feedback Type

ASCII: **FBTYPE**	Default: 0	valid for all OPMODES

Change this only while the amplifier is disabled + reset.

ID	Function	Comments
0	**Resolver**	It is possible to connect 2, 4 or 6-pole resolvers to the servo amplifier. **Cycle time 62.5 µs.**
1	reserved	
2	**HIPERFACE®** **Absolute encoder**	Feedback from a high-resolution absolute encoder (single- or multi-turn) with HIPERFACE®-compatible interface, e.g. SRS x0 / SRM x0 / SCS x0 / SCM x0 from Stegmann. **Cycle time 125 µs**
3	**Auto**	The servo amplifier detects the connected feedback system automatically. (Resolver, EnDat or Hiperface)
4	**EnDat**	Feedback from a high-resolution absolute encoder (single- or multi-turn) with EnDat-compatible interface, e.g. ECN 1313 / EQN 1325 from Heidenhain. **Cycle time 125 µs**
5	reserved	
6	**SinCos EEP**	Sine-cosine encoder. The offset data are loaded from the serial eeprom.
7	**SinCos W&S**	Sine-cosine encoder. The offset-data are determined by the servo amplifier, using a Wake&Shake procedure.
8	**RS422 & W&S**	This setting can only be used with Gearmode=3 and Encoder emulation=0. If FPGA=1, the position output (X5) relays the position information of the incremental encoder.
9	**RS422**	This setting can only be used with Gearmode=3 and Encoder emulation=0. If FPGA=1, the position output (X5) relays the position information of the incremental encoder.
10	**Sensorless**	Without feedback
11	**SinCos & Hall**	Sine-cosine encoder with Hall-sensor
12	**RS422 & Hall**	RS422-feedback with Hall Sensor
13-15	reserved	
16	**Res & SinCos**	Both feedback systems are installed. The drive starts running with the resolver feedback. After a short delay the feedback switches to SinCos W&S (ID 7).

No.of resolver poles

ASCII: **MRESPOLES**	Default: 2	valid for all OPMODES

This parameter effects only with resolver feedback (FBTYPE = 0 or 3).
Standard resolvers have 2 poles. Change this only while the amplifier is disabled.

Enclines

ASCII : **ENCLINES**	Default : 1000	valid for all OPMODES

Describes the resolution (without quadrupel evaluation) of the encoder if used as standard feedback. For rotary motors the line number per revolution is to be indicated, for linear motors the number of lines per magnetic segment is indicated. If a ENDAT or a Hiperface is used, then the line number is set automatically when booting.

Resolver bandwidth

ASCII: **MRESBW**	Default: 600	valid for all OPMODES

With a wide bandwidth, the drive will respond more rapidly to control-loop deviations => smaller following error. A very wide bandwidth only makes sense with low moments of inertia, low KP, and very high values of acceleration. A narrower bandwidth produces a filter effect. The speed and positional control are smoother (the encoder emulation is quieter as well).

Offset

ASCII: **MPHASE**	Default: 0 °electr.	valid for all OPMODES

Compensates for a mechanical position error of the resolver/encoder in the motor. Change this only while the amplifier is disabled. If an encoder with EnDat or Hiperface$^{®}$ is used as a feedback unit, the offset is automatically transmitted to the servo amplifier while the system is booting. When using an FBTYPE 7 (SinCos W&S), the offset will be determined automatically.

Attention!
An incorrect setting can cause the motor to run away, even with a 0V setpoint!

Velocity Observer

ASCII: **FILTMODE**	Default: 1	valid for all OPMODES

ID	Function	Remark
0	**OFF 16 kHz VL**	16 kHz sped loop
1	**OFF 4 kHz VL**	T_Q Filter
2	**ON 16 kHz VL**	Velocity observer
3	**ON 4 kHz VL**	Velocity observer

Acceleration Feedforward

ASCII: **VLO**	Default: 1.0	valid for all OPMODES

This parameter applies a dynamic pre-control to the actual-value detection (Luenberger monitor), particularly for resolver feedback. It reduces the phase-shift in the detection of the actual value, thus improving the stability of the speed control.
With VLO = 1 the pre-control is set to optimum, with VLO = 0 the monitor is switched off.

14 Screen page "Encoder"

Cycle time of the encoder emulation: 0.125 µs.

Encoder emulation

ASCII: **ENCMODE**	Default: 1	valid for all OPMODES

Change this only while the amplifier is disabled.

ID	Function	Comments
0	Input	The interface is used as an input.
1	ROD	Incremental-encoder emulation. In the servo amplifier, the position of the motor shaft is calculated from the cyclically absolute signals from the resolver or encoder. This information is used to create incremental-encoder compatible pulses (max. 250 kHz). Pulses are given out at the connector X5 as two signals A / B with a 90° electrical phase difference, and a zero pulse. **Exception: If an encoder with a commutation track is used as the feedback unit, then the output of the zero pulse is inhibited (data are invalid) until the zero pulse from the encoder has been evaluated.**
2	SSI	SSI-encoder emulation. In the servo amplifier, the position of the motor shaft is calculated from the cyclically absolute signals from the resolver or encoder. This information is used to create a position output in a format that is compatible with the standard SSI-absolute-encoder format. 24 bits are transmitted. **Radio button SINGLE TURN selected:** The upper 12 bits are fixed to ZERO, the lower 12 bits contain the position information. For 2-pole resolvers, the position value refers to the position within one turn of the motor, for 4-pole resolvers it is within half a turn, and for 6-pole resolvers it is within a third of a turn. **Exception:** If an encoder with a commutation track is used as the feedback unit, then the upper 12 bits are set to 1 (data invalid!) until a homing run is performed. **Radio button MULTI TURN selected:** The upper 12 bits contain the number of motor turns, the lower 12 bits contain the position information.
3	ROD Interpolation	Digitization and interpolation of the sine encoder input signals (feedback) to TTL level incremental output. This function works properly only with sine encoder feedback systems. The parameter INTERPOLATION determines the multiplier for the number of lines of the feedback encoder per electrical motor rotation.

Resolution ROD

ASCII: **ENCOUT**	Default: 1024	valid for all OPMODES

Determines the number of increments per turn that are output. Change this only while the amplifier is disabled.

Encoder function (ENCMODE)	Feedback system	Resolution	Zero position
ROD (1)	Resolver	16...1024	one per revolution (only if A=B=1)
	EnDat / HIPERFACE	16...4096 and 8192...524288 (2^n)	one per revolution (only if A=B=1)
ROD interpolation (3)	Incremental encoders without absolut data channel	4...128 TTL lines per sine line	analog pass through from X1 to X5

The resolution in the controls can be increased by quadruple evaluation of the increments.

NI-Offset ROD

ASCII: **ENCZERO**	Default: 0	valid for all OPMODES

Determines the position of the zero (marker) pulse when A=B=1. The entry is referred to the zero-crossing of the feedback unit.

Single / Multi Turn

ASCII: **SSIMODE**	Default: 0	valid for all OPMODES

Determines whether the output format is compatible to a single turn or multi turn SSI encoder. Change this only while the amplifier is disabled.

ID	Function
0	Single turn
1	Multi turn

Baudrate SSI

ASCII: **SSIOUT**	Default: 0	valid for all OPMODES

Determines the serial transmission rate. Change this only while the amplifier is disabled.

ID	Function
0	200 kBaud
1	1,5 MBaud

SSI-Clock

ASCII: **SSIINV**	Default: 0	valid for all OPMODES

Determines whether the output level is normal, or inverted. Change this only while the amplifier is disabled.

ID	Function
0	standard
1	inverted

SSI-Code

ASCII: **SSIGRAY**	Default: 0	valid for all OPMODES

Determines whether the output is in binary or GRAY code. Change this only while the amplifier is disabled.

ID	Function
0	Binary
1	Gray

ROD-Interpolation

ASCII: **ENCOUT**	Default: 16	valid for all OPMODES

Determines the multiplier for the number of lines of the feedback encoder per electrical motor rotation.

Maximum output pulse number: 400,000 pulses/sec

15   Screen page "Analog I/O"

Cycle time of the analog I/O-functions: 250 µs. An In 1 is read every 125 µs.

The actual values of the analog inputs/outputs are shown in the diagram of the connector X3.

15.1   Analog Inputs AN IN1 / AN IN 2

Dead Band

ASCII: **ANDB**	Default: 0 mV	valid for OPMODES 1+3

Suppresses small input signals.
The function is useful with OPMODE1: analog speed (**without higher-level position control**)

Setp. Offset

ASCII: **ANOFFx**	Default: 0 mV	valid for all OPMODES

This is used to compensate the offset voltages of CNC-controls and the analog inputs 1 (ANOFF1) or 2 (ANOFF2). Adjust the axis to standstill while the setpoint = 0V.

Scaling

ASCII: **VSCALEx**	Default: 3000	valid for OPMODE 1

Scaling of the speed setpoint value.   entry: xx rpm / 10 V

ASCII: **ISCALEx**	Default: Peak current	valid for OPMODE 3

Scaling of the torque setpoint value.   entry: xx A / 10 V

T.Setpoint

ASCII: **AVZ1**	Default: 1 ms	valid for OPMODE 1

You can enter a filter time constant here, for An In 1 (clock rate 8 kHz, 1st order filter)

Auto-Offset

ASCII: **ANZEROx**	Default: -	valid for all OPMODES

This function carries out an automatic adjustment of the setpoint offset.
Conditions: analog inputs short-circuited, or 0V from the controls.

Setp.-Functions

ASCII: **ANCNFG**	Default: 0	valid for all OPMODES

ID	Function
0	Xcmd=An In 1
1	v_cmd=An In 1, Icmd=An In 2
2	v_cmd=An In 1, Iff=An In 2
3	Xcmd=An In 1, Ipeak=An In 2
4	Xcmd=An In 1 + An In 2
5	Xcmd=An In 1 * An In 2
6	electr. gear
7	Icmd=An In 1, nmax=An In 2
8	Pcmd=An In 1
9	Xcmd=An In 1, Ferraris=An In 2

0, Xcmd=An In 1

The servo amplifier only uses the An In 1, and operates in the mode that is set by the OPMODE parameter. The digital input function 8, An In 1/An In 2. can be used to change over to An In 2.

$$Xcmd = Scaling(An\ In\ 1) \quad * \quad An\ In\ 1$$

1, v_cmd=An In 1, Icmd=An In 2

The servo amplifier uses one of the two analog inputs, depending on the setting of OPMODE.

$$vcmd = Scaling(An\ In\ x) \quad * \quad An\ In\ x$$

OPMODE	An In 1	An In 2
1, analog speed	speed setpoint	inactive
3, analog torque	inactive	current (torque) setpoint
all other settings	inactive	inactive

2, v_cmd=An In 1, Iff=An In 2

An In 2 is used as current feed forward (OPMODE=0,1).

$$vcmd = Scaling(An\ In\ 1) * An\ In\ 1 \qquad Iff = Scaling(An\ In\ 2) * An\ In\ 2$$

3, Xcmd=An In 1, Ipeak1=An In 2

The servo amplifier uses An In 1, depending on the setting of OPMODE. An In 2 is used for the limiting of the peak current of the instrument (Ipeak).

$$Ipeak1 = Ipeak * \frac{An\ In\ 2}{10V} \qquad Xcmd = Scaling(An\ In\ 1) * An\ In\ 1$$

If you use the digital input function Ipeak2x as well as the setpoint function Ipeak1, the servo amplifier will use the lower of the two settings for Ipeak.

4, Xcmd=An In 1+ An In 2

The servo amplifier uses the sum of both analog inputs, depending on the setting of OPMODE.

$$Xcmd = Scaling(An\ In\ 1) * An\ In\ 1 + Scaling(An\ In\ 2) * An\ In\ 2$$

OPMODE	An In 1 + An In 2
1, analog speed	speed setpoint
3, analog torque	current (torque) setpoint
all other settings	inactive

5, Xcmd=An In 1• An In 2

The servo amplifier uses the product of both setpoint inputs, depending on the setting of OPMODE. The voltage on An In 2 has the effect of a weighting factor for An In 1, the scaling for An In 2 is ineffective:

$$Xcmd = An\ In\ 1 * Scaling(An\ In\ 1) * An\ In\ 2$$

OPMODE	An In 1 • An In 2
1, analog speed	speed setpoint
3, analog torque	current (torque) setpoint
all other settings	inactive

6, electr.gear

Correction of the gearing ratio (nominator y, GEARO) of the electrical gearing through An In 2 for OPMODE 4. An In 1 is used as a speed (or torque) setpoint for OPMODE 1 (or 3).

$$\text{GEAROeff} = \text{GEARO} * \left(1 + \frac{\text{An In 2} * \text{Scaling(An In 2)}}{1000}\right)$$

7, Icmd=An In 1, nmax=An In 2

The servo amplifier uses An In 1 as current (torque) setpoint. An In 2 defines the maximum rotary speed.

$$\text{Icmd} = \text{Scaling(An In 1)} * \text{An In 1} \qquad \text{nmax} = \text{Scaling(An In 2)} * \text{An In 2}$$

8, Pcmd=An In1

The setpoint input 1 is used for the position setpoint. For instance, for setting a valve.

9, Xcmd=An In 1, Ferraris=An In 2

The servo amplifier uses setpoint input 1 as the current (torque) or speed setpoint, depending on the setting of OPMODE.
Setpoint input 2 is used for the input from a Ferraris sensor (acceleration sensor) to implement speed control in conjunction with the feedback system.

15.2   Analog Outputs AN OUT1 / AN OUT2

AN OUT1/2

ASCII: **ANOUTx**	Default: 1	valid for OPMODES 1+3

The analog outputs 1 (ANOUT1, terminal X3/8) and 2 (ANOUT2, terminal X3/9) each provide various analog actual/setpoint values, depending on the selection in the commissioning software. Make changes only while the amplifier is disabled + reset.

Output resistor 2.2kΩ. Resolution 10 bit.

ID	Function	Description
0	**Off**	not active
1	**v_act**	The speed monitor provides a DC voltage referred to AGND, analog to the actual speed. Normalization: ±10V at the preset speed limit in the speed controller
2	**I_act**	The current monitor provides a DC voltage referred to AGND, analog to the actual current. The output is the actual in-phase current (active component Iq), which is nearly **proportional** to the **motor output torque.** Normalization: ±10V for ± **preset peak current** (r.m.s. value) in the current controller
3	**v_cmd**	The output provides ±10V referred to AGND for the internal speed setpoint. Normalization: ±10V at the preset speed limit in the speed controller
4	**I_cmd**	The output provides ±10V referred to AGND for the internal current setpoint (corresponds to the preset peak current at the output of the speed controller). Normalization: ±10V for ± **preset peak current** (r.m.s. value) in the current controller
5	FError	The output provides ±10V referred to AGND for the preset following error window
6	**Slot**	reserved by the expansion card

16 Screen page "Digital I/O"

Cycle time of the digital I/O functions: 1 ms.
The states of the digital inputs/outputs are shown.

16.1 Digital inputs DIGITAL-IN1 / DIGITAL-IN2 / PSTOP / NSTOP

ASCII: **INxMODE**	Default: 0	valid for all OPMODES
ASCII: **INxTRIG**	Default: 0	valid for all OPMODES

The terminals DIGITAL-IN1/2, PSTOP and NSTOP (X3/11,12,13,14) can be used in combination with internal functions. Change this only while the amplifier is disabled + reset.

ID	Function	Active edge/level	Auxiliary value x INxTRIG	DIGITAL-IN1 X3/11 IN1MODE	DIGITAL-IN2 X3/12 IN2MODE	PSTOP X3/13 IN3MODE	NSTOP X3/14 IN4MODE
				Function can be combined with			
0	Off	-	-	x	x	x	x
1	Reset	↗	-	x			
2	PSTOP	↘ Low	-			x	
3	NSTOP	↘ Low	-				x
4	PSTOP+Intg.Off	↘ Low	-			x	
5	NSTOP+Intg.Off	↘ Low	-				x
6	PSTOP+NSTOP	↘ Low	-			x	
7	P/Nstop+Intg.Off	↘ Low	-			x	
8	An In1/ An In2	High/Low	-	x	x	x	x
9	MT_No. Bit	↗	-	x	x	x	x
10	Intg.Off	↗	-	x	x	x	x
11	v/Torq.Contr.	High/Low	-	x	x	x	x
12	Reference	↗	-	x	x	x	x
13	ROD/SSI	High/Low	-	x	x	x	x
14	FError_clear	↗	-	x	x	x	x
15	Start_MT Next	Can be set	-	x	x	x	x
16	Start_MT No x	↗	Motion task no.	x	x	x	x
17	Start_MT IO	↗	-	x	x	x	x
18	Ipeak2 x	↗	% of Ipeak	x	x	x	x
20	Start_Jog v=x	↗	Speed in rpm	x	x	x	x
21	U_Mon.off	↗	-	x			
22	MT_Restart	↗	-	x	x		x
23	FStart2 Nr x	↗	Motion task no.	x	x	x	x
24	Opmode A/B	↗	OPMODE no.	x	x		x
25	Zero_latch	↗	-	x	x	x	x
26	Zero pulse	↗			x		
27	Emergency Stop	↘ Low		x	x		x
32	Brake	↗	-	x	x	x	x

16.1.1   Description of the digital inputs

0, Off   No function.

1, Reset   Software reset of the servo amplifier in the event of a fault. All the functions and displays are set to the initial status. Parameters that are not stored in the EEPROM are erased, the parameter set that is stored in the EEPROM is loaded.

If any of the error messages F01, F02, F03, F05, F08, F13, F16 or F19 are present, then no software-reset will be carried out, just the error message will be deleted. This means that, for example, the encoder output signals are stable and can continue to be evaluated by the controls.

2, PSTOP   Limit-switch function. A LOW signal on the input terminal PSTOP (terminal X3/13) inhibits the positive direction of rotation (clockwise, when looking at the motor shaft, at the A-end of the motor: parameter ROTARY DIRECTION positive). The motor brakes (with emergency ramp), and stands **with the** I-component under control, mechanical disconnection (stop) is **not** permitted.

A falling edge releases the brake, the 0V level disables the negative setpoint.

3, NSTOP   Limit-switch function. A LOW signal on the input terminal NSTOP (terminal X3/14) inhibits the negative direction of rotation (counterclockwise, when looking at the motor shaft at the A-end of the motor: parameter ROTARY DIRECTION positive). The motor brakes (with emergency ramp), and stands **with the** I-component under control, mechanical disconnection (stop) is **not** permitted.

A falling edge releases the brake, the 0V level disables the positive setpoint.

4, PSTOP+Intg.Off Limit-switch function. A LOW signal on the input terminal PSTOP (terminal X3/13) inhibits the positive direction of rotation (clockwise, when looking at the motor shaft, at the A-end of the motor: parameter ROTARY DIRECTION positive). The motor brakes (with emergency ramp), and stands **without the** I-component under proportional control, mechanical disconnection (stop) is permitted.

A falling edge releases the brake, the 0V level disables the negative setpoint.

5, NSTOP+Intg.Off Limit-switch function. A LOW signal on the input terminal NSTOP (terminal X3/14) inhibits the negative direction of rotation (counterclockwise, when looking at the motor shaft at the A-end of the motor: parameter ROTARY DIRECTION positive). The motor brakes (with emergency ramp), and stands **without the** I-component under proportional control, mechanical disconnection (stop) is permitted.

A falling edge releases the brake, the 0V level disables the positive setpoint.

6, PSTOP+NSTOP   Limit-switch function STOP, regardless of the direction of rotation. A LOW-Signal on the input terminal PSTOP (terminal X3/13) or NSTOP (terminal X3/14) inhibits both directions. The motor brakes (with emergency ramp), and stands **with the** I-component under control, mechanical disconnection (stop) is **not** permitted.

A falling edge releases the brake, the 0V level switches the internal speed setpoint to 0V.

7, P/Nstop+Intg.Off Limit-switch function STOP, regardless of the direction of rotation. A LOW-Signal on the input terminal PSTOP (terminal X3/13) or NSTOP (terminal X3/14) inhibits both directions. The motor brakes (with emergency ramp), and stands **without the** I-component under proportional control, mechanical disconnection (stop) is permitted.

A falling edge releases the brake, the 0V level switches the internal speed setpoint to 0V.

8, An In 1/An In 2 Switches over the setpoint inputs An In ½. This function is only effective if the analog setpoint function 0,Xcmd=An In 1 has been selected.

High level at the input: Setpoint input **2** (terminals X3/6,7) is active

Low level at the input: Setpoint input **1** (terminals X3/4,5) is active

9, MT_No_Bit

Here you can select the motion tasks that are stored in the servo amplifier (numbers 1...7) or the homing (0). The motion task number is presented externally at the digital inputs as a logical word, with a width of max. 3bits. An input is required to start the motion task (17, Start_MT IO). If you wire up a reference switch (12, Reference) and (also) want to start a following task (15, Start_MT Next) externally, the number of inputs that are available for selecting the motion tasks will be further reduced.

Examples of possible assignments of the digital inputs for various applications:

Application	Motion task number: MSB ----------------> LSB				selectable motion task numbers
	NSTOP	PSTOP	DIGITAL-IN 2	DIGITAL-IN 1	
7 motion tasks + homing, without reference switch.	Start_MT IO	2^2	2^1	2^0	0...7
3 motion tasks + homing, without reference switch. Start a following task that is defined in the motion task, using the setting "Start with I/O".	Start_MT Next	Start_MT IO	2^1	2^0	0...3
3 motion tasks + homing, with reference switch.	2^1	2^0	Reference	Start_MT IO	0...3
1 motion task + homing, with reference switch. Start a following task that is defined in the motion task, using the setting "Start with I/O".	Reference	Start_MT Next	2^0	Start_MT IO	0...1

10, Intg.Off

Switch off the integral component of the speed controller, the P-gain remains at the set value, the actual-(rotational) speed feedback remains in operation.

11, v/Torq.Contr.

Bypasses the speed controller. The analog setpoint is taken 1:1 as the setpoint for current control, i.e. change over from speed control to current (torque) control.
High-level at the input: torque control
Low-level at the input: speed control

12, Reference

Polls the reference switch.

13, ROD/SSI

Changeover of the encoder-emulation (position output) on connector X5.
High level at the input: **SSI**-compatible position signals
High level at the input: **ROD**-compatible position signals

14, FError_clear

Clear the warning of a following error (display n03) or the response monitoring (display n04).

15, Start_MT Next

The following task, that is defined in the motion task by "Start with I/O" is started. The target position of the present motion task must be reached before the following task can be started.

16, Start_MT No x

Start a motion task that is stored in the servo amplifier, by giving the motion task number. After the function has been selected you can enter the motion task number as the auxiliary variable "x". Motion task number "0" initiates homing/reference traverse. A rising edge starts the motion task, a falling edge cancels the motion task.

17, Start_MT IO

Start of the motion task that has the number that is presented, bit-coded, at the digital inputs (PSTOP/NSTOP/DIGITAL-IN1/DIGITAL-IN2, see function 9, MT_No_Bit). A rising edge starts the motion task a falling edge cancels the motion task.

18, Ipeak2 x

Switch over to a second (lower) peak value of current. Scaled as x (0...100) % of the peak current of the instrument. After the function has been selected you can enter the percentage value as the auxiliary variable "x".
Make the conversion according to the following equation:

$$x = \frac{Ipeak2}{Ipeak} * 100\% => Ipeak2 = \frac{x}{100\%} * Ipeak$$

20, Start_Jog v=x   Start of the setup mode "Jog Mode" with a defined speed. After selecting the function, you can enter the speed in the auxiliary variable "x". The sign of the auxiliary variable defines the direction. A rising edge starts the motion, a falling edge cancels the motion.

21, U_Mon.off   Turns off the undervoltage monitoring function of the servo amplifier.

22, MT Restart   Continues the motion task that was previously interrupted.

23, FStart2 Nr x   Start of a motion task that is stored in the servo amplifier, with definition of the motion task number. After selecting the function, you can enter the motion task number in the auxiliary variable "x". Motion task number "0" starts the homing run. A rising edge starts the motion task.

Warning!
The motion task does not stop automatically if the start signal is removed!

The motion task must be stopped by
— a falling edge on another digital input (configured with 16, Start_MT No x)
— the ASCII command STOP
— the STOP function of the setup software

24, Opmode A/B   Changeover of the operating mode (OPMODE). The numbers of the OPMODES that are to be changed over are entered in the auxiliary variable "x" as a decimal number. You have to calculate this decimal value from a 2-byte hex value.

Bits 0... 7 of the hex value contain the number of the OPMODE to which the system changes when a falling edge is detected at the appropriate input; bits 8... 15 contain the number for the response to a rising edge.

When the controller is switched on, the OPMODE is set according to the input level.

Example:

Preparation for the changeover between OPMODE 1 (LOW state) and OPMODE 2 (HIGH state) according to the state of the digital input DIGI-INI.

Function DIGI-IN1 = 24
2 Byte Hex value: "0801" => decimal value: "2049"
Auxiliary value "x" = 2049

25, Zero_latch   Sets the ROD zero pulse offset. The current position, depending on the ROD resolution that is set, is calculated at the rising edge and stored as NI-Offset. This function is used to perform an automatic save of all parameters.

26, Pos_latch   An edge causes a freezing of the actual position. The 32-Bit value is stored in the variable LATCHX32 (positive edge) or LATCHX32N (negative edge). The 16-Bit value (absolute within a revolution) is stored in the variable LATCHX16 (positive edge) or LATCHX1N (negative edge). The Latch procedure taken place is communicated about the corresponding status bits. The min. Pulse length wich can be read by this input (Low/High and High/Low toggle) is 500 µsek. For CANopen the minimum distance between two Latch impulses is 8 msek.

27, Emergency Stop   The LOW level initiates an emergency-stop phase (motion is canceled and the drive is stopped, using the EMERGENCY RAMP). Regardless of the OPMODE that is currently set, the speed controller is activated during the emergency-stop phase.

32, Brake   A rising edge at the input triggers the braking output of the servo amplifier.
This function is only available while the amplifier is disabled. If an error message is active, the brake cannot be de-energized.

Warning!
With suspended loads, this function will lead to slipping of the axis!

16.2   Digital outputs DIGITAL-OUT1 / DIGITAL-OUT2

ASCII: **OxMODE**	Default: 0	valid for all OPMODES
ASCII: **OxTRIG**	Default: 0	valid for all OPMODES

You can combine the following standard pre-programmed functions with the digital outputs
DIGITAL-OUT1 (O1MODE, terminal X3/16) or DIGITAL-OUT2 (O2MODE, terminal X3/17). Change this only
while the amplifier is disabled + reset.

The following level information refers to the output at additional inverting interface terminals (e.g. Phoenix
DEK-REL-24/I/1), see Installation Manual.

High functions:
The presence of the function that is set is indicated by a High signal on the corresponding interface terminal.

Low functions:
The presence of the function that is set is indicated by a Low signal on the corresponding interface terminal.

ID	Function	Logic	Auxiliary value OxTRIG
0	**Off**	-	-
1	**v_act<x**	High	speed (rpm)
2	**v_act>x**	High	speed (rpm)
3	**Mains-RTO**	Low	-
4	**Regen off**	High	-
5	**Sw_limit**	High	-
6	**Pos.>x**	High	position (increments)
7	**InPos**	High	-
8	**I_act<x**	High	current (mA)
9	**I_act>x**	High	current (mA)
10	**FError**	Low	-
11	**I²t**	High	-
12	**Posreg.1**	High	-
13	**Posreg.2**	High	-
14	**Posreg.3**	High	-
15	**Posreg.4**	High	-
16	**Next-InPos**	High	-
17	**Error/Warn**	High	-
18	**Error**	High	-
19	**DC_Link>x**	High	voltage (V)
20	**DC_Link<x**	High	voltage (V)
21	**ENABLE**	High	-
22	**Zero_pulse**	High	-
23	**Reserved**	-	-
24	**Ref_OK**	High	-
25-27	**Reserved**	-	-
28	**Posreg. 0**	High	-
29	**Posreg. 5**	High	-

16.2.1 Description of the digital outputs

0, Off   No function assigned.

1, v_act<x   As long as the absolute value for the motor speed is lower than a preset value (auxiliary value "x"), a HIGH-signal will be output. After the function has been selected you can enter the speed in rev./min. as the auxiliary value "x".

2, v_act>x   As long as the absolute value for the motor speed is higher than a preset value (auxiliary value "x"), a HIGH-signal will be output. After the function has been selected, you can enter the speed in rev./min. as the auxiliary value "x".

3, Mains-RTO   This signals the operational readiness of the amplifiers power output stage. After switching on the mains supply, a LOW-signal is output until the DC-link circuit is fully charged up. A HIGH-signal is output when the charging of the DC-link circuit is finished. If the DC-link voltage falls below 100V, then 0V will be output. The "Undervoltage" monitoring is inactive.

4, Regen off   Signals if the preset regen power (screen page "Basic Setup") is exceeded.

5, Sw_limit   This produces a HIGH-signal if a software limit-switch is reached (a preset function of the corresponding position register, set to "SW limit-switch 1" or "SW limit-switch 2" – the function is defined in the screen page "Position Data").

6, Pos.>x   If the position (angular position of the motor shaft) exceeds a preset value (auxiliary value "x"), a HIGH-signal will be output. After the function has been selected, you can enter the signaling position in increment (a number or fraction of motor turns N) as the auxiliary value "x".
Make the calculation according to the following equation:

$$x = 1048576 * N * counts$$

Maximum possible entry value: $x = 2^{31}$ = 2147483648, this corresponds to N = 2048

7, InPos   When the target position for a motion task has been reached (the InPosition window), this is signaled by the output of a HIGH-signal. A cable break will not be detected.
The width of the InPosition window for all the valid motion tasks is entered in the Position Data screen page.

If a sequence of motion tasks is performed one after another, then the signal for reaching the final position of the motion-task sequence will be output (target position of the last motion task).
Signaling that the target position of each motion task has been reached, in a sequence of motion tasks, can be achieved with the function "16, Next_InPos".

8, I_act<x   The output is a HIGH-signal, as long as the absolute r.m.s. value of the actual current is lower than a defined value in mA (auxiliary value "x").
After the function has been selected, you can enter the current value as the auxiliary value "x".

9, I_act>x   The output is a HIGH-signal, as long as the absolute r.m.s. value of the actual current is higher than a defined value in mA (auxiliary value "x").
After the function has been selected, you can enter the current value as the auxiliary value "x".

10, FError	If the position goes outside the preset contouring-error window, this is indicated by a LOW-signal. The width of the following error window is entered in the screen page "Position" for all the valid motion tasks.
11, I²t	If the preset I²t monitoring threshold is reached (screen page "Current") this is indicated by a HIGH-signal.
12...15, Posreg.1...4	The preset function of the corresponding position register (the function is defined in the screen page "Position Data") is indicated by a HIGH-signal.
16, Next-InPos	The start of each motion task in an automatically executed sequence of motion tasks is signaled by an inversion of the output signal. The output produces a Low signal at the start of the first motion task of the motion task sequence.
17, Error/Warn	The output produces a HIGH-signal if an error or a warning message is signaled by the servo amplifier.
18, Error	The output produces a HIGH-signal if an error is signaled by the servo amplifier.
19, DC-Link>x	A HIGH-signal is output if the actual value of the DC-link voltage is higher than a defined value in volts (auxiliary value "x"). After the function has been selected, you can enter the voltage value as the auxiliary value "x".
20, DC-Link<x	A HIGH-signal is output if the actual value of the DC-link voltage is lower than a defined value in volts (auxiliary value "x"). After the function has been selected, you can enter the voltage value as the auxiliary value "x".
21, ENABLE	A HIGH-signal is output if the servo amplifier is enabled. To obtain the enable, the external Enable signal on terminal X3/15 must be present, the Enable status must be set in the setup software (or via the fieldbus interface) and no errors must be present that would cause an automatic internal disabling of the servo amplifier.
22, Zero pulse	The zero mark/pulse (HIGH-signal) is indicated by the encoder-emulation. This function is only useful at very low speeds.
24, Ref_OK	The output signals High, if a reference point is available. Reference traverse (homing) has been carried out, or a reference point has been set.
28, Posreg 0	The preset function of the corresponding position register is indicated by a HIGH-signal. Valid only with expansion card -I/0-14/08-.
29, Posreg 5	The preset function of the corresponding position register is indicated by a HIGH-signal. Valid only with expansion card -I/0-14/08-.

17 Screen page "Current"

Use the default values for the motor. Please do not make any alterations to the settings for the current controller unless they have been discussed with our applications department.
Cycle time of the current controller: 62.5 μs

Irms

ASCII: **ICONT**	Default: 50% rated current	valid for all OPMODES

Sets the rated output current that is required. The adjustment is usually made to I_0 , the standstill current for the motor that is connected. The value that can be entered is limited to the **rated current** of the amplifier or the standstill current of the motor Io (the lower of the two values). The function is used in the monitoring of the actual r.m.s. current that is drawn. The limit that is set by the Irms-setting reacts after approx. T_{I2t} = 5 sec at maximum load. The calculations for current settings other than the rated values are made according to the equation:

$$T_{I2T} = \frac{I^2rms * 15s}{I^2peak - I^2rms}$$

Ipeak

ASCII: **IPEAK**	Default: 50% peak current	valid for all OPMODES

Sets the required pulse current (r.m.s. value). The value that can be entered is limited to the rated peak current of the motor or amplifier (the lower of the two values).

Ref.-Ipeak

ASCII : **REFIP**	Default : 50% peak current	Valid for all OPMODES

This sets the required pulse current (r.m.s. value) for Homing 7 (homing to the hardware stop, with zero-mark detection) and for "Wake & Shake" commutation with external encoder systems. The entry is limited by the lower value of the peak currents for the amplifier and motor.

I²t message

ASCII: **I2TLIM**	Default: 80 %	valid for all OPMODES

Sets the level, as a percentage value of the r.m.s. current, above which a **message** will be sent to one of the programmable outputs DIGITAL-OUT1/2 (X3/16 or X3/17). A warning appears in the display.

KP

ASCII: **MLGQ**	Default: 1	valid for all OPMODES

Determines the proportional gain of the current controller.
Normalization: at KP=1 and at a control deviation **I_cmd -I_act = peak armature current**
the rated motor voltage will be output.

Tn

ASCII: **KTN**	Default: 0,6 ms	valid for all OPMODES

Determines the integral-action time (integration time constant) of the current controller.

18 Screen page "Speed"

Use the default values for the motor as a starting point for optimization.
Cycle time of the speed controller: 250 µs

SpeedLimit

ASCII: **VLIM**	Default: 3000 rpm	valid for OPMODES 0+1

Limits the motor speed. The maximum value also depends on the used motor and encoder.

Rotary Direction

ASCII: **DIR**	Default: 1	valid for all OPMODES

Fixes the direction of rotation of the motor shaft, referred to the polarity of the setpoint.
Make changes only while the amplifier is disabled + reset. This parameter is not available, if a SERCOS interface is built-in.
After changing the rotary direction the hardware limit switches have to be exchanged.
Standard setting: right-hand (cw) rotation of the motor shaft (looking at the shaft end), with:
— positive voltage on terminal X3/4 (+) against terminal X3/5 (-) or
— positive voltage on terminal X3/6 (+) against terminal X3/7 (-)

ID	Function
0	negative
1	positive

Setp. Ramp+

ASCII: **ACC**	Default: 10 ms	valid for OPMODES 0+1

Limits the rate of increase of the internal setpoint processing during **acceleration** to the speed limit (valid for both directions). A jump or step in the setpoint that is provided will be turned into a smoother, more favorable transition. As long as the ramp time is less than the mechanically limited rise time of the system, the response time of the system will not be negatively affected.
The ramp time settings are still effective if the limit-switches are activated.
Depending on the setting of the parameter ACCUNIT, acceleration time or ramp gradient will be set.

Setp. Ramp–

ASCII: **DEC**	Default: 10 ms	valid for OPMODES 0+1

Limits the rate of decrease of the internal setpoint processing during **braking** to the zero speed (valid for both directions). A jump or step in the setpoint that is provided will be turned into a smoother, more favorable transition.
As long as the ramp time is less than the mechanically limited fall time of the system, the response time of the system will not be negatively affected. In most cases the Setp.ramp+ and Setp.ramp– can be set to the same value.
The ramp time settings are still effective if the limit-switches are activated.
Depending on the setting of the parameter ACCUNIT, acceleration time or ramp gradient will be set.

Overspeed

ASCII: **VOSPD**	Default: 3600 rpm	valid for all OPMODES

Determines the upper limit for the motor speed. If this limit is exceeded, the servo amplifier switches into the overspeed fault condition (error message F08).

Emergency ramp

ASCII: **DECSTOP**	Default: 10 ms	valid for all OPMODES

The braking ramp for emergency braking. This braking ramp is used if the message n03, following error or n04, response monitoring occurs, as well as on the activation of a hardware or software limit-switch.

Dis Ramp

ASCII : **DECDIS**	Default : 10 ms	Valid for all OPMODES

If the output stage is disabled (by removal of the hardware or software enable), the internal speed setpoint is run down to 0 along this ramp. When the speed has fallen below 5 rpm the output stage is disabled. This ramp is only effective for motors that have a brake configured.

KP

ASCII: **GV**	Default: 1	valid for OPMODES 0+1

Determines the proportional gain (also known as AC-gain). Increase the value up to the level where the motor starts to oscillate, and then back it off until the oscillations have clearly stopped. Typical values for this setting are between 10 and 20.
Normalization: at KP = 1 and a control deviation of **v_cmd -v_act = 3000 rev/min** the instrument delivers the peak current.

Tn

ASCII: **GVTN**	Default: 10 ms	valid for OPMODES 0+1

Determines the integration time constant. Smaller motors permit shorter integration times; larger motors or high moments of inertia in the load usually require integration times of 20 ms or more. With Tn = 0 ms the I-component is switched off.

PID-T2

ASCII: **GVT2**	Default: 1 ms	valid for all OPMODES

Affects the proportional gain (P-gain) at medium frequencies. It is often possible to improve the **damping** of the speed control loop by increasing PID-T2 to about Tn/3. The setting is made, if required, after the basic setting of KP and Tn.

Feedback

ASCII: **GVFBT**	Default: 0,4 ms	valid for all OPMODES

If necessary, the time constant for the PT1-filter in the actual speed feedback (tachometer smoothing) can be altered. This may improve the step response and smoothness of running, particularly for very small, highly dynamic motors.

PI-PLUS

ASCII: **GVFR**	Default: 1	valid for OPMODES 0+1

This parameter only effects when the I-component is switched on (GVTN $\neq$ 0).

With the default setting, the speed controller functions as a standard PI-controller with slight overshoot in the step response. If PI-PLUS is reduced to 0.65, the overshoot is avoided and the actual value approaches the setpoint slowly.
Optionally, you can reduce Tn. This makes the drive stiffer for the same step response.

19   Screen page "Position" (PI)

Cycle time of the position controller: 250 μs

Subscreens

Position Data	Opens the screen page "Position Data"
Homing	Opens the screen page "Homing"
Gearing	Opens the screen page "Gearing"

Ff Factor

ASCII: **GPFFV**	Default: 1	valid for OPMODES 4,5,8

Determines the feed-forward factor for the position controller. Feed-forward is used to ease the task of the position controller. A better setting for the Ff-factor means a better utilization of the dynamic range of the position controller. The most favorable setting (usually about 1.0) depends on factors external to the drive, such as friction, dynamic resistance, and stiffness.

KV

ASCII: **GP**	Default: 0,15	valid for OPMODES 4,5,8

Determines the proportional gain for the position controller.
Normalization: speed in m/s at 1 mm position deviation.

Tn

ASCII: **GPTN**	Default: 10 ms	valid for OPMODES 4,5,8

Determines the integral-action time (integration time constant) for the position controller.
Tn = 0 ms switches off the I-component.

max.Following Error

ASCII: **PEMAX**	Default: 262144	valid for OPMODES 4,5,8

The following error is the maximum difference (+/- window) between the position setpoint and the actual position that is permitted during processing. If the value leaves this window, then the position controller generates an error message and brakes the drive, using the emergency ramp.

KP

ASCII: **GPV**	Default: 7	valid for OPMODES 4,5,8

Determines the proportional gain for the speed section of the controller. Increase the value up to the level where the motor starts to oscillate, and then back it off until the oscillations have clearly stopped. Typical values are the same as for the KP of the speed controller.
Normalization: as for the KP of the speed controller

PID-T2   Displays the value from the screen page "Speed"

Feedback   Displays the value from the screen page "Speed"

Mode / Position Feedback

ASCII: **EXTPOS**	Default: 0	valid for all OPMODES

Mode

Determines the type of position control loop (P/PI). With a P position control this screen page appears in a different layout.

Position feedback
Determines the feedback source for the internal position controller. For most applications, the position information for commutation and for position control are derived from the same source. This source is determined on the "FEEDBACK" screen page, and can be either a resolver or an Endat/Hiperface encoder. In certain situations it may be advisable to derive the position information for commutation from a different source to that for the position control. In such a case the feedback parameter will continue to be the source for commutation, and the source for the position control will be given by gearing mode.

Standard feedback
- Feedback type is set by feedback
- It is not possible to read in an encoder via X1 or X5

Read external (ROD/SSI) for fieldbus
- Feedback type is set by feedback, external encoder is set by gearing mode

External (ROD/SSI) for position control
- Not possible in this mode

20 Screen page "Position" (P)

Cycle time of the position controller: 250 µs

Subscreens

Position Data	Opens the screen page "Position Data"
Homing	Opens the screen page "Homing"
Gearing	Opens the screen page "Gearing"

Ff Factor

ASCII: **GPFFV**	Default: 1	valid for OPMODES 4,5,8

Determines the feed-forward factor for the position controller. Feed-forward is used to ease the task of the position controller. A better setting for the Ff-factor means a better utilization of the dynamic range of the position controller. The most favorable setting (usually about 1.0) depends on factors external to the drive, such as friction, dynamic resistance, and stiffness.

KV

ASCII: **GP**	Default: 0,15	valid for OPMODES 4,5,8

Determines the proportional gain for the position controller.
Normalization: speed in m/s at 1 mm position deviation.

max.Following Error

ASCII: **PEMAX**	Default: 262144	valid for OPMODES 4,5,8

The following error is the maximum difference (+/- window) between the position setpoint and the actual position that is permitted during processing. If the value leaves this window, then the position controller generates an error message and brakes the drive, using the emergency ramp.

Mode / Position Feedback

ASCII: **EXTPOS**	Default: 0	valid for all OPMODES

Mode

Determines the type of position control loop (P/PI). With a PI position control, this screen page appears in a different layout.

Position feedback
Determines the feedback source for the internal position controller. For most applications, the position information for commutation and for position control are derived from the same source. This source is determined on the "FEEDBACK" screen page, and can be either a resolver or an Endat/Hiperface encoder. In certain situations it may be advisable to derive the position information for commutation from a different source to that for the position control. In such a case the feedback parameter will continue to be the source for commutation, and the source for the position control will be given by gearing mode.

Standard feedback
- Feedback type is set by feedback
- it is not possible to read in an encoder via X1 or X5

Read external (ROD/SSI) for fieldbus
- Feedback type is set by feedback, external encoder is set by gearing mode

External (ROD/SSI) for position control
- Feedback type is set by external source via gearing mode

21   Screen page "Homing"

The reference traverse (homing) is an absolute task, that is used to zero the drive for subsequent positioning operations. You can choose between various types of homing.

After homing, the drive reports "InPosition" and then enables the position controller in the servo amplifier.

Take care that the zero point of the machine (reference point) is in a position that permits the subsequent positioning operations. The software limit-switches that were set as parameters may be ineffective. The axis could move on to the hardware limit-switch or even the mechanical stop. There is a risk of damage.
If the reference point (zero point of the machine) is approached with excessive velocity, for instance because of high moments of inertia, it may be overshot and, in the worst case, move on to the hardware limit-switch or even the mechanical stop. There is a risk of damage.
The position controller cannot be operated without first making a reference traverse (homing).
A homing/reference traverse must be made after the 24V auxiliary voltage has been switched on.
The start signal must not be removed during homing.
The start signal must remain present until the "InPosition" message appears.

Start

ASCII: **MH**	Default: -	valid for OPMODE 8

Radio button to start homing.

The SW-enable is set automatically when homing starts. Homing will only be started in OPMODE 8. However, the SW-enable is set in all OPMODES. The drive can therefore be accelerated by an analog setpoint that is applied, if the START command is executed in OPMODES1 or 3.

Stop

ASCII: **STOP**	Default: -	valid for all OPMODES

Radio button to stop (cancel) the homing. **The SW-enable remains set!**

Reference traverse

ASCII: **NREF**	Default: 0	valid for OPMODE 8

You can choose which type of reference traverse should be performed. A preset zero-point offset (screen page "Encoder" is taken into account for the position output and display.
Exception: Homing 5 — in this case the true current position is displayed.
You can shift the zero-crossing point of the motor shaft within one turn, at will, by using the "NI offset" parameter (screen page "Encoder").

Zero-point recognition: the reference point is set to the first zero-crossing point of the feedback unit (zero mark) after recognition of the reference switch transition. Two-pole resolvers and all encoders have just one zero-crossing per turn, so the positioning at the zero mark is unambiguous within a motor turn. For 4-pole resolvers there are two zero-crossings per turn, and for 6-pole resolvers there are three zero-crossings.
If the transition of the reference switch lies very close to the zero-crossing point of the feedback unit, then the positioning to the zero mark can vary by one motor turn.

⚠️ *The repetition accuracy of homing operations that are made without zero-point recognition depends on the traversing speed and the mechanical design of the reference switch or limit-switch.*

Homing 0	Sets the reference point to the setpoint position (the following error is **lost**).
Homing 1	Traverse to the reference switch with zero-mark recognition.

In this case, a reference traverse can also be made without hardware limit-switches. The precondition is one of the initial situations shown below:

negative traverse, positive rotation   **negative traverse, negative rotation**
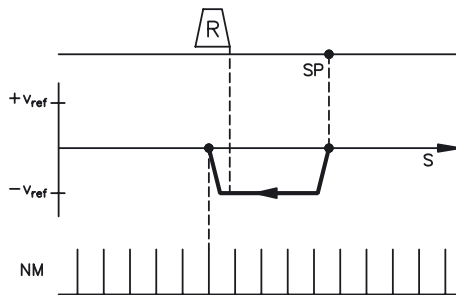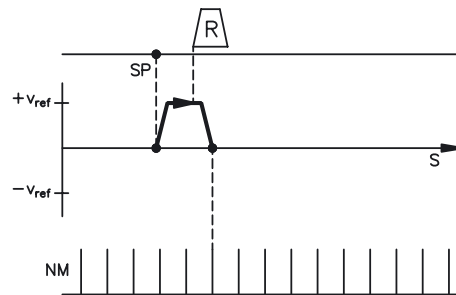
Homing 2	Move to hardware limit-switch, with zero-mark recognition. The reference point is set to the first zero-crossing of the feedback unit (NM, zero mark) beyond the limit-switch.
Homing 3	Move to reference switch, without zero-mark recognition. The reference point is set to the transition of the reference switch.
Homing 4	Move to hardware limit-switch, without zero-mark recognition. The reference point is set to the transition of the hardware limit-switch.
Homing 5	Move to the next zero-mark of the feedback unit. The reference point is set to the next zero-mark of the feedback unit.
Homing 6	Sets the reference point to the actual position (the following error is **not lost**).
Homing 7	Move to mechanical stop, with zero-mark recognition. The reference point is set to the first zero-crossing of the feedback unit (NM, zero mark) beyond mechanical stop. The pulse current is set by the parameter REF.-IPEAK on the screen page "Current controller".
Homing 8	Drives to an absolute SSI position. At the start of the homing run, a position is read in from the SSI input (GEARMODE=7), converted according to the scaling factors GEARI and GEARO and the reference offset, and then used a the target position.

On the following pages you can find the paths traversed during homing types 1 to 5 for every possible initial situation (positive rotation, negative and positive directions of motion).

The meanings of the abbreviations in the drawings are:

| N	limit-switch NSTOP	P	limit-switch PSTOP	SP	start position
R	reference switch	vref	preset velocity	NM	zero mark of the resolver

21.1   Homing 1

Homing with reference switch, **negative** direction of motion, positive rotation, with zero-mark

Initial point in positive direction from reference switch

Initial point in negative direction from reference switch
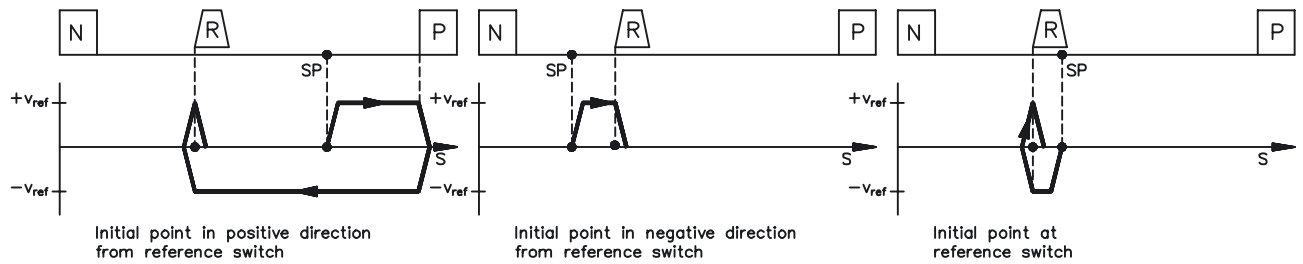
Initial point at reference switch

Warning!
Before starting homing, check the safety of the system, since the load may move, even if the limit-switches are disconnected or defective.
The limit-switch functions 2, PSTOP and 3, NSTOP must be activated to achieve the full homing functionality.

Homing with reference switch, **positive** direction of motion, positive rotation, with zero-mark

Initial point in positive direction from reference switch

Initial point in negative direction from reference switch

Initial point at reference switch

Warning!
Before starting homing, check the safety of the system, since the load may move, even if the limit-switches are disconnected or defective.
The limit-switch functions 2, PSTOP and 3, NSTOP must be activated to achieve the full homing functionality.

21.2 Homing 2

Homing without reference switch, **negative** direction of motion, positive rotation, with zero-mark

Initial point in positive direction from limit switch

Initial point at limit switch

Warning!
Hardware limit-switches must be present and connected.
The limit-switch functions 2, PSTOP and 3, NSTOP must be switched on.

Homing without reference switch, **positive** direction of motion, positive rotation, with zero-mark

Initial point in negative direction from limit switch

Initial point at limit switch
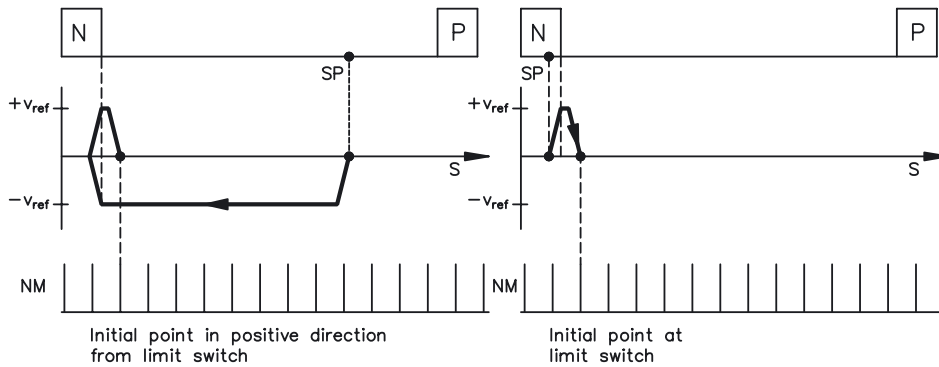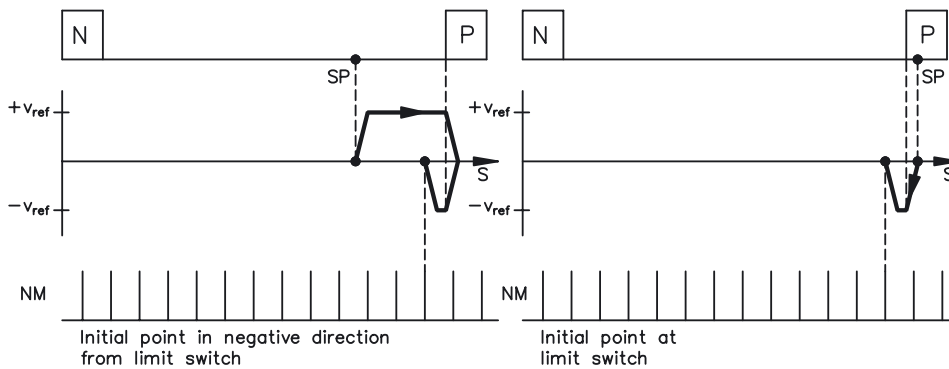
Warning!
Hardware limit-switches must be present and connected.
The limit-switch functions 2, PSTOP and 3, NSTOP must be switched on.

21.3   Homing 3

Homing with reference switch, **negative** direction of motion, positive rotation, without zero-mark

Warning!

![warning triangle] **Before starting homing, check the safety of the system, since the load may move, even if the limit-switches are disconnected or defective.**
The limit-switch functions **2, PSTOP and 3, NSTOP must be activated to achieve the full homing functionality.**

Homing with reference switch, **positive** direction of motion, positive rotation, without zero-mark

Warning!

![warning triangle] **Before starting homing, check the safety of the system, since the load may move, even if the limit-switches are disconnected or defective.**
The limit-switch functions **2, PSTOP and 3, NSTOP must be activated to achieve the full homing functionality.**

21.4   Homing 4

Homing without reference switch, **negative** direction of motion, positive rotation, without zero-mark

Initial point in positive direction from limit switch

Initial point at limit switch

Warning!
Hardware limit-switches must be present and connected.
The limit-switch functions 2, PSTOP and 3, NSTOP must be switched on.

Homing without reference switch, **positive** direction of motion, positive rotation, without zero-mark

Initial point in negative direction from limit switch

Initial point at limit switch
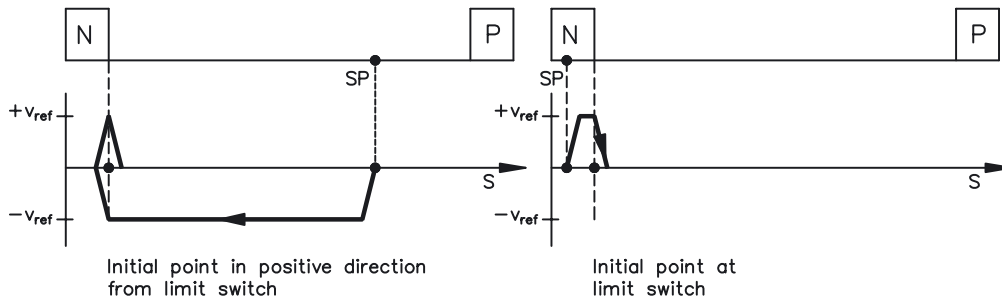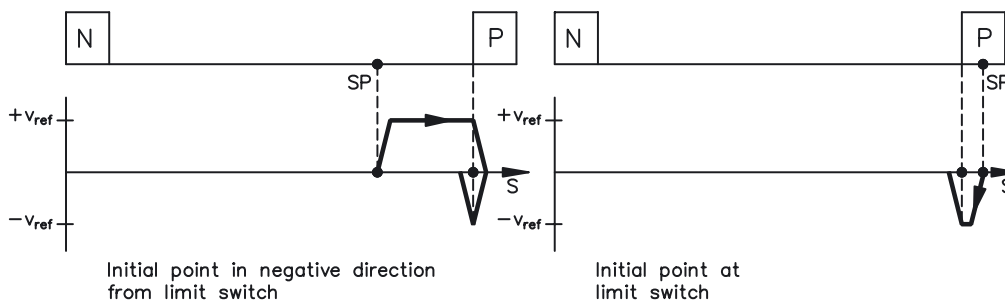
Warning!
Hardware limit-switches must be present and connected.
The limit-switch functions 2, PSTOP and 3, NSTOP must be switched on.

21.5 Homing 5

Homing without reference switch, **negative** direction of motion, positive rotation, with zero-mark
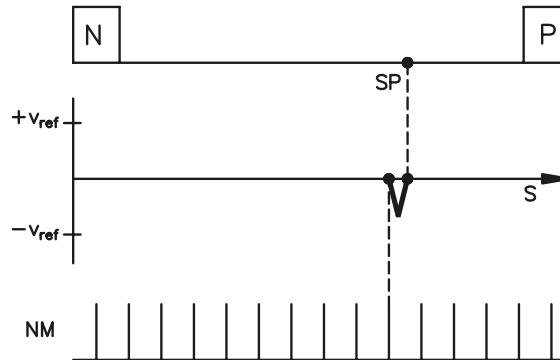
Homing without reference switch, **positive** direction of motion, positive rotation, with zero-mark
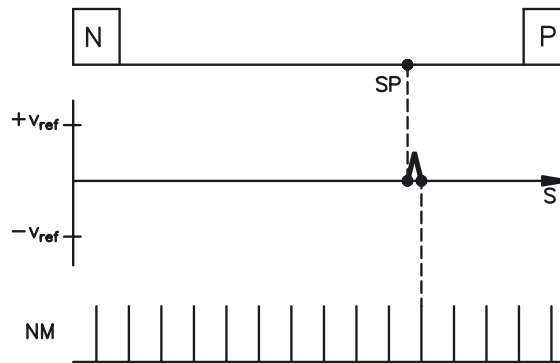
Behavior for successively repeated starts of Homing 5:
The position controller can only hold the motor in the zero position by passing the
zero mark by ± 1 count. On a repeated start of Homing 5, depending on the position
(1 count in advance of or 1 count behind the zero-mark) and the count direction, the
movement may be a full motor turn!

21.6 Homing 7

Homing to mechanical stop, **negative** direction of motion, positive rotation, with zero-mark
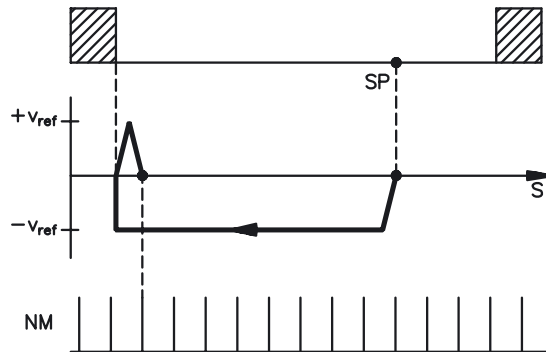
Homing to mechanical stop, **positive** direction of motion, positive rotation, with zero-mark
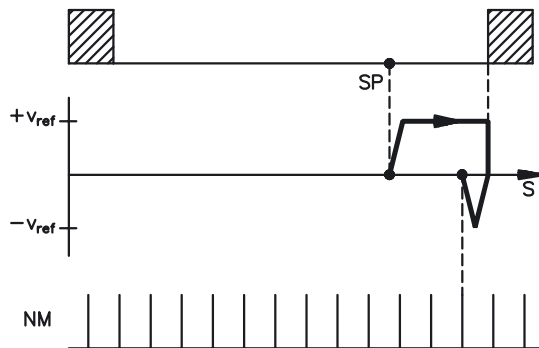
Warning!
Using this type of homing run can damage the mechanical stop on the machine. The peak current Ipeak and the continuous current Irms are limited for the duration of the homing run.
A more severe limiting of the current is possible. (see parameter Ref.-Ipeak).

Direction of motion

ASCII: **DREF**	Default: 0	valid for OPMODE 8

Determines the direction of motion for homing. The setting "distance-dependent" is only relevant for Homing 5 (within one turn). In this case, the direction is chosen to give the shortest distance to the zero-mark. This parameter also defines the direction of motion for a **Modulo** type of axis.

ID	Function
0	negative direction
1	positive direction
2	zoned distance

v for homing

ASCII: **VREF**	Default: 0	valid for OPMODE 8

Determines the velocity for the homing operation. The sign is automatically fixed by the direction of motion that is selected. The dimension is set by VUNIT .

Accel. ramp

ASCII: **ACCR**	Default: 10 ms	valid for OPMODE 8

The acceleration ramp for the homing operation. The dimension is set by ACCUNIT. Entry e.g. in milliseconds (1 ... 32767 ms). The ramp is also valid for constant velocity mode.

Decel. ramp

ASCII: **DECR**	Default: 10 ms	valid for OPMODE 8

The deceleration (braking) ramp for homing. The dimension can be set by ACCUNIT. Entry e.g. in milliseconds (1 ... 32767 ms). The ramp is also valid for constant velocity mode. This deceleration ramp is only used if the operating mode allows it. For homing to a hardware limit-switch, the emergency ramp is used.

Offset

ASCII: **ROFFS**	Default: 0	valid for OPMODE 8

With the reference offset you can assign an absolute position value other than 0 to the reference point. With an offset for the reference position you are not actually making a physical change, but the offset is used as a reference value within the position control of the servo amplifier. Homing to the reference switch will then not finish at zero, but at the preset reference offset value. **The reference offset must be set before homing is started.** The dimension is set by PUNIT. An alteration of the offset only takes effect after a new homing operation.
The parameter "Resolution" must be set correctly for your application.

21.7   Jog mode

Jog mode is defined as an endless motion at a constant velocity. This type of operation can be started without a reference point being set. The hardware limit-switches are monitored. Software limit-switches are only monitored if a reference point has been set. Acceleration and deceleration ramps are taken from the settings for homing.

v

ASCII: **VJOG**	Default: 0	valid for OPMODE 8

Determines the velocity for jog mode. The sign that is entered determines the direction of movement. Before starting the jog mode, the velocity value must be taken on. The dimension is set by VUNIT .

F4

ASCII: **MJOG**	Default: -	valid for OPMODE 8

Start the jog mode by pressing the function key F4. The drive moves with the preset velocity in the direction, which is indicated by the sign of the velocity for the jog mode "v", as long as the function key is pressed. If a communication error occurs while pressing the button, the drive stops with the emergency deceleration ramp.

⚠️ *When the function "Jog mode" is started, the SW-enable is set automatically. The Function "Jog mode" is only started in OPMODE 8. However, the SW-enable is set in all OPMODES. The drive can therefore be accelerated by an analog setpoint that is applied, if the START command is executed in OPMODES1 or 3.*

22 Screen page "Position Data"

For each one of the positioning tasks you must define motion tasks. These motion tasks can be selected by a motion task number, and are stored in the servo amplifier.

Motion task	Stored in	Precondition for storing	Comments
1...180	EEPROM	output stage disabled	permanently stored
192...255	RAM	none	volatile storage

When the servo amplifier is switched on, the RAM motion blocks 192...255 are automatically pre-loaded with the parameters of the EEPROM motion blocks 1...64.

Number

Entry of a motion task number, to start the motion task from the PC.

Motion task table

A new window appears, in which all motion tasks are represented in tabular form.

All motion task parameters can be entered in the table directly. The following operations are available:

● Cut

● Copy

● Paste

● Delete

The clipboard operations cut, copy and paste are only possible for complete rows, i.e. for these operations the appropriate row must be selected. The deletion is possible both, row- and cellwise. A line can be selected either by clicking on the row number, or through the keyboard shortcuts <Shitft>+<Space> (similar to Microsoft Excel). All Edit operations are available through the Windows standard keyboard shortcuts.

Input via the screen page"Motion task parameters":

Double-clicking a line number in the table opens the screen page for the associated motion task. The use of the dialogue "Motion task parameters" in relation to older versions of the software changed concerning the buttons "OK", and "Cancel".Compared to older versions of the software, the functions of the buttons "OK" and "APPLY" have changed. By clicking these buttons, the changes are no longer saved to the flash EEPROM but the values in the associated table are changed instead. Writing the changes to the EEPROM is possible with the buttons "OK" or "APPLY" on the screen page "Motion task table"

Start

ASCII: **MOVE**	Default: -	valid for OPMODE 8

Start the motion task that has the number that can be seen in the NUMBER field. The amplifier must be enabled (input X3/15 has a High signal).

⚠️ *The SW-enable is automatically set when the motion task starts. The motion task is only started in OPMODE8. However, the SW-enable is set in all OPMODES. The drive can therefore be accelerated by an analog setpoint that is applied, if the START command is executed in OPMODES 1 or 3.*
The motion task is not started if the target position is beyond the defined SW-limit switches (warning messages n06/n07 and n08)

Stop

ASCII: **STOP**	Default: -	valid for OPMODE 8

Stops the current motion task. The SW-enable remains set!

Axis type

ASCII: **POSCNFG**	Default: 0	valid for OPMODE 8

Here you select whether the axis is to be operated as a linear or a rotary axis.

ID	Function	Comments
0	linear	A linear axis is an axis with a **limited** range of travel. A linear axis moves within the traversing limits that are given by the software limit-switches, both absolutely and relatively. A reference point must be set. The maximum range of movement is limited to +/- 2047 turns of the motor. If a larger number (+/- 32767) is needed, please consult our applications department.
1	rotary	A rotary axis is an axis with **unlimited** travel. The software limit-switches have no significance in this case. **A rotary axis always makes a relative movement, even if the tasks are entered as absolute ones**. The actual position is set to zero with every start. A reference point is not required.
2	modulo	The position of the position controller is limited to the range given by (Modulo-Start-Pos … Modulo-End-Pos.). As soon as the end of this range (Modulo-End-Pos.-1) is reached, the position begins again at (Modulo-Start-Pos). So the absolute target positions for the motion tasks must lie within the valid range. Any attempt to start an absolute motion task with a target position outside this range will generate the warning n08 (motion task error). With relative motion tasks, the target position will be corrected so that it always lies within the valid range. Since a target position can be approached from two directions when positioning within the modulo range, the "direction" parameter on the "Homing" screen page can be used to define the preferred direction. The same restrictions apply for the reference point as for axis type=linear, i.e. the completion of a homing movement is a precondition for all positioning actions. The limitation to the modulo range does not apply during the homing movement, in other words, during the homing movement the position for the position controller is treated the same as for axis type=linear. The limitation to the modulo range is only activated after the homing movement has been completed.

v_max

ASCII: **PVMAX**	Default: 100	valid for OPMODE 8

This parameter is used to adjust the maximum speed of movement to suit the limits of the operative machinery. The calculation of the upper setting limit depends on the final limit speed of the drive. The value that is entered is used as a limit for the "v_setp" entry in the motion tasks. During commissioning, you can limit the speed by using v_max (without changing the setting for the motion blocks). A lower value of v_max overrides the v_setp of the motion tasks.

t_acc/dec_min / a max

ASCII: **PTMIN**	Default: 1 ms	valid for OPMODE 8

A drive is always so dimensioned that it can provide more power than the application requires. This parameter determines the limit for the maximum mechanical acceleration time to v_max, that must not be exceeded by the drive. This time is simultaneously valid as the minimum limit for the entry "t_accel_tot" (acceleration time from 0 to v_setp) and "t_brake_tot" (braking time from v_setp down to 0) for the motion tasks.
Depending on the setting of acceleration unit you can enter either the acceleration time or the acceleration in the dimensional unit that has been selected.

InPosition

ASCII: **PEINPOS**	Default: 4000	valid for OPMODES 4,5,8

Sets the InPosition window. Determines at which distance from the set position the "InPosition" message should be reported. The drive moves precisely to the target position.

Modulo-Start-Pos.

ASCII : **SRND**	Default : -2^{31}	valid for OPMODES 4,5,8

This parameter is used to define the start of the range of movement for a modulo axis.
The end of the range is defined by the parameter Modulo-End-Pos.

Modulo-End-Pos.

ASCII : **ERND**	Default : $2^{31}-1$	valid for OPMODES 4,5,8

This parameter is used to define the end of the range of movement for a modulo axis.
The start of the range is defined by the parameter Modulo-Start-Pos.

Position register A programmable register that can have various functions assigned to it.
Make changes only while the amplifier is disabled + reset.

		Position register			
Function	**Comment**	**1 (SWE1)**	**2 (SWE2)**	**3 (SWE3)**	**4 (SWE4)**
inactive	-	x	x	x	x
Pos. not reached	threshold for signal	x	x	x	x
Pos. overshot	threshold for signal	x	x	x	x
SW limit-switch 1	limit-switch function	x	-	-	-
SW limit-switch 2	limit-switch function	-	x	-	-

SW limit-switches 1 / 2

The software limit-switches from part of the monitoring functions of the position controller.

SW limit-switch 1	The monitoring checks whether the actual position value is lower than the preset value (the negative direction of travel is now inhibited – You have to leave limit-switch 1 by moving in the positive direction.).
SW limit-switch 2	The monitoring checks whether the actual position value is higher than the preset value (the positive direction of travel is now inhibited – You have to leave limit-switch 1 by moving in the negative direction.)

The drive brakes with the emergency ramp, and remains at standstill under torque.
The principle of positioning the software limit-switch can be seen in the diagram below:
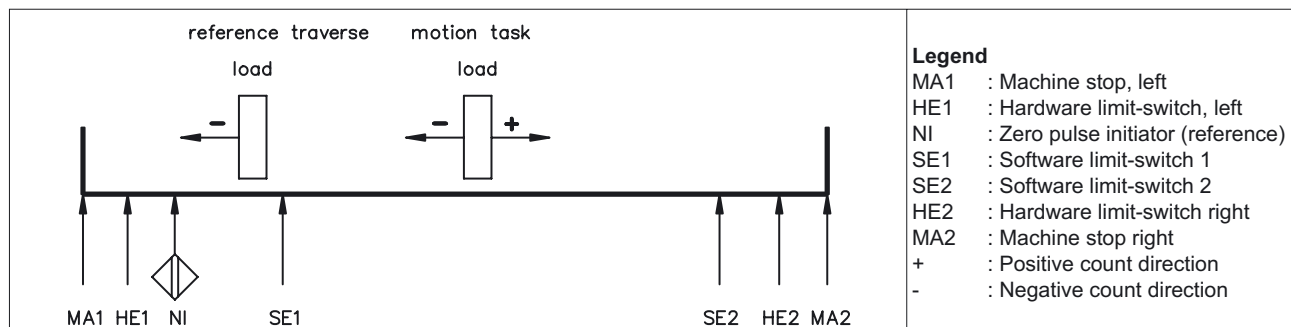
ASCII: **SWCNFG** (set)	Default: 0	valid for all OPMODES
ASCII: **SWEx** (position)	Default: 0	valid for all OPMODES

Configuration variables for the position register. SWCNFG is a binary-coded bit-variable, and is transferred to the ASCII terminal program as a decimal number.

Bit-variable SWCNFG					
Bit	**Value**	**Description**	**Bit**	**Value**	**Description**
2^0	0	Monitoring of SWE1 inactive	2^8	0	Monitoring of SWE3 inactive
	1	Monitoring of SWE1 active		1	Monitoring of SWE3 active
2^1	0	Signal for actual position>SWE1	2^9	0	Signal for actual position>SWE3
	1	Signal for actual position<SWE1		1	Signal for actual position<SWE3
2^2	0	SWE1 functions as signal threshold	2^{10}	0	Reserve
	1	SWE1 functions as SW limit-switch		1	
2^3	0	Reserve	2^{11}	0	Reserve
	1			1	
2^4	0	Monitoring of SWE2 inactive	2^{12}	0	Monitoring of SWE4 inactive
	1	Monitoring of SWE2 active		1	Monitoring of SWE4 active
2^5	0	Signal for actual position>SWE2	2^{13}	0	Signal for actual position>SWE4
	1	Signal for actual position<SWE2		1	Signal for actual position<SWE4
2^6	0	SWE2 functions as signal threshold	2^{14}	0	Reserve
	1	SWE2 functions as SW limit-switch		1	
2^7	0	Reserve	2^{15}	0	Reserve
	1			1	

Resolution

| ASCII: **PGEARI** (numerator) | Default: 10000 | valid for OPMODE 8 |
| ASCII: **PGEARO** (denominator) | Default: 1 | valid for OPMODE 8 |

The entry for the resolution of the motion tasks is in µm/Revolution. The resolution can be defined at will, through the entries for the numerator/denominator.
Make changes only while the amplifier is disabled + reset.
Examples:

An entry of 10000/1 produces a resolution of 10 mm/turn
An entry of 10000/3 produces a resolution of 3.333 mm/turn
Rotary table with geared motor, i = 31 (31 motor turns for one turn of the table)
– The entry 360/31 provides operation with position entries in degrees, without rounding off.

The maximum range of movement is limited to +/- 2047 motor turns. If a larger range (+/- 32767) is required, please consult our applications department.

GMT

Opens the graphical motion tasking.
Graphical motion tasking is an advanced feature that lets you easily edit motion tasks with its graphical interface. You can command multiple motions, process I/O, make decisions, add time delays and modify drive process variables. The environment is easy to use, allowing you to program in an intuitive flow-chart.
Motion tasking has been supported by the amplifier since the product was introduced in 1998. In its original form, motion tasking supported only chained moves in sequences executed either once or in infinite loops.
Graphical motion tasking extends the capabilities of moiton tasking by adding looping, comparing (<, =, >, etc.), calling functions and setting process variables.

23 Screen page "Motion task parameters"

You can use the ASCII-terminal to completely define motion blocks, with the "ORDER" command. You can obtain further information about this command from our applications department.

Number   Displays the currently active motion task number.

Type   Selection of the basic motion task type.

Type	Description
Motion	Standard motion task
Delay	Delay in ms
Comparison tests	branch conditional on parameter value
Modify parameter	set parameter value
Initialize loop	define loop parameters
Decrement counter	decrease loop counter by one step
Loop	branch conditional on loop counter value
Jog	move at constant velocity
Go to home / index / registration + offset	move to reference point

Depending upon selected type the representation of the screen page changes. The individual variants are described in the following sections.

The motion task type "Motion" is always available, all other types presuppose an installed extension card (DeviceNet, Sercos or I/O-14/08) and orient by the Graphical Motion Tasking and the DeviceNet communication profile. You find further information in the appropriate manuals

23.1   Type Motion

Trajectory   If the drop down list Trajectory is set to internal, the motion tasks from the internal trajectory generator are used. Otherwise entries from the lookup table of the amplifier (can be downloaded over the CAN Download program) are selected. You can get more information on this topic from our application department.

Velocity profile No.   Selection of a velocity profile from the table selected by trajectory. You can get more information on this topic from our application department.

Units (general)   Select the unit for path and speed entries

Selection	Path	Velocity
Counts	x = 1048576 * N * Incr. with N = no. of motor turns, Nmax=+/- 2047	x = 140/32 * n * min * Incr. with n = rotational speed of the motor shaft
SI / User	µm	µm/s

Type   This selection determines whether the motion task is interpreted as a relative or an absolute task.

ABS	movement to an absolute target position, referred to the reference point.
REL cmd	relative to last target (setpoint) position (in connection with motion block changeover: e.g. summing operation)
REL act	relative to actual position at start (in connection with motion block changeover: e.g. register control)
REL InPos	when the load is in the InPosition window: relative to last target position when the load is not in the InPosition window: relative to actual position at start
REL Latch pos.	please contact our applications department.
REL Latch neg.	please contact our applications department.

In the setup software, the transmission of an absolute task to the RAM of the servo amplifier is prevented for axes of the ROTARY type.

s_cmd   This parameter determines the distance to be traveled.

v_cmd-source   The velocity can be defined in the motion block, or provided as an analog setpoint.

digital	digital setpoint provision through v_cmd
analog An In 1	analog setpoint provision at input An In 1 (terminals X3/4-5, scaling is used. The value is read in at the start of the motion task.

v_cmd   This parameter determines the velocity of movement for digital setpoint provision. If v_max is set to a value that is less than v_cmd at a later time, the position controller will use the smaller value.

Acceleration/Deceleration

Units (acceleration)

ASCII: **ACCUNIT**	Default: 0	valid for all OPMODES

Select the unit for acceleration and ramp entries.

t_acc_total This parameter determines the acceleration time to v_cmd.

t_dec_total This parameter determines the deceleration (braking) time from v_cmd to zero.

Ramp Determines which type of acceleration/braking ramp should be used to carry out a motion task.

Trapeze	The drive is given a constant linear acceleration/deceleration to the target speed
Sine²	To limit any jolting, the drive is accelerated/decelerated within the acceleration time along an acceleration ramp without any discontinuities. The resulting speed characteristic corresponds to a sine² curve.
variable	The acceleration/braking ramps can be adjusted (in preparation).

Setting The setting for the rate-of change limiting of the acceleration/braking ramps:

t_acc_total	Display of the total acceleration time
t_dec_total	Display of the total deceleration (braking) time
T1	Rate-of-change limiting of the acceleration ramp, maximum is half the acceleration time
T2	Rate-of-change limiting of the deceleration ramp, maximum is half the deceleration time

Next Motion Task

Next motion task | Select whether a new motion task should be started automatically, after the present task is finished.

The InPosition signal is only enabled when the last motion task (no further task) has been processed. You can use the function "16, Next-InPos" to generate a signal at one of the digital outputs when each target position within a sequence of motion tasks has been reached.

Next number | The number of the next task, which will be started automatically after the present task is finished.

Accel./decel. | Select the action to be taken when the target position for the present motion task is reached.

on v_act=0	The drive brakes to a stop in the target position. The next motion task is then started.
from target	The drive moves at v_cmd of the present motion task to the target position, and then accelerates through to v_cmd of the next task
to target	The changeover to the next task is brought so far forwards, that the v_cmd of the next task is already achieved by the time the target of the present motion task has been reached.

Start condition

immediately	The next task is started as soon as the target position is reached.
I/O	The next task is started by a signal at a digital input (one of the terminals X3/11...14). This is only meaningful with "Accel./Decel to v=0". Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter
Time	The next task is started with a defined delay after the target position has been reached. You can enter the delay time with the "Delay time" parameter. This is only meaningful with "Accel./Decel to v=0".
I/O or Time	The next task is started by a signal at a digital input (one of the terminals X3/11...14) **or** after a defined delay. This is only meaningful with "Accel./Decel to v=0". The trigger is the event that occurs first (the start signal or the end of the delay time) Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter, and enter the delay time with the "Delay time" parameter.

Start by I/O edge | The logic for the digital input that has the function "15, Start_MT Next" assigned to it.

LOW-level: 0 ... 7 V

HIGH-level: 12 ...3 0 V / 7 mA

Delay time | The entry (in ms) for the delay time between reaching the target position and starting the next task.

23.2   Type Delay

Next number | The number of the next task, which will be started automatically after the present task is finished.

Delay time | The entry (in ms) for the delay time between reaching the target position and starting the next task.

23.3   Type Comparison tests

Parameter   Selection of the parameter to be compared by means of class, instance, attribute as described in DeviceNet protocol.

Test   Operator for the comparison test

=	The parameter value must be equivalent to the test value
>	The parameter value must be larger than the test value
<	The parameter value must be smaller than the test value
>=	The parameter value must not be smaller than the test value
<=	The parameter value must not be larger than the test value
<>	The parameter value must not be equivalent to the test value

Value   value, with which the parameter value is to be compared

Bit Test   Selection of a special bit, if not the whole parameter is to be compared.

Nest task if FALSE   number of next motion task if the result of the comparison is FALSE

Nest task if TRUE   number of next motion task if the result of the comparison is TRUE

Test Type

Branch imm.	Comparison will be carried out immediately and only one time.
wait until TRUE	Comparison will be carried out repeatedly until the result is TRUE
branch FALSE on Timeout	Comparison will be carried out repeatedly until the result is TRUE or timeout runs off
Fault on Timeout	if the result is not TRUE until timeout expired, an error message will be generated

Timeout   Waiting period for kinds of test "branch FALSE on Timeout" and "Fault on Timeout" in milliseconds.

23.4   Type Modify parameter

Parameter   Selection of the parameter to be compared by means of class, instance, attribute as described in DeviceNet protocol.

Value   Value, which is to be assigned to the parameter

Next Motion Task

Next motion task   Select whether a new motion task should be started automatically, after the present task is finished.

The InPosition signal is only enabled when the last motion task (no further task) has been processed. You can use the function "16, Next-InPos" to generate a signal at one of the digital outputs when each target position within a sequence of motion tasks has been reached.

Next number   The number of the next task, which will be started automatically after the present task is finished.

Accel./decel.   Select the action to be taken when the target position for the present motion task is reached.

on v_act=0	The drive brakes to a stop in the target position. The next motion task is then started.
from target	The drive moves at v_cmd of the present motion task to the target position, and then accelerates through to v_cmd of the next task
to target	The changeover to the next task is brought so far forwards, that the v_cmd of the next task is already achieved by the time the target of the present motion task has been reached.

Start condition

immediately	The next task is started as soon as the target position is reached.
I/O	The next task is started by a signal at a digital input (one of the terminals X3/11...14). This is only meaningful with "Accel./Decel to v=0". Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter
Time	The next task is started with a defined delay after the target position has been reached. You can enter the delay time with the "Delay time" parameter. This is only meaningful with "Accel./Decel to v=0".
I/O or Time	The next task is started by a signal at a digital input (one of the terminals X3/11...14) **or** after a defined delay. This is only meaningful with "Accel./Decel to v=0". The trigger is the event that occurs first (the start signal or the end of the delay time) Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter, and enter the delay time with the "Delay time" parameter.

Start by I/O edge   The logic for the digital input that has the function "15, Start_MT Next" assigned to it.

LOW-level: 0 ... 7 V

HIGH-level: 12 ...30 V / 7 mA

Delay time   The entry (in ms) for the delay time between reaching the target position and starting the next task.

23.5   Type Initialize loop

initial value   Number of counting steps of the loop

Next task   Number of the motion task, which is to be processed after setting the counter

23.6   Type Decrement counter

Next Motion Task

Next motion task   Select whether a new motion task should be started automatically, after the present task is finished.

The InPosition signal is only enabled when the last motion task (no further task) has been processed. You can use the function "16, Next-InPos" to generate a signal at one of the digital outputs when each target position within a sequence of motion tasks has been reached.

Next number   The number of the next task, which will be started automatically after the present task is finished.

Accel./decel.   Select the action to be taken when the target position for the present motion task is reached.

on v_act=0	The drive brakes to a stop in the target position. The next motion task is then started.
from target	The drive moves at v_cmd of the present motion task to the target position, and then accelerates through to v_cmd of the next task
to target	The changeover to the next task is brought so far forwards, that the v_cmd of the next task is already achieved by the time the target of the present motion task has been reached.

Start condition

immediately	The next task is started as soon as the target position is reached.
I/O	The next task is started by a signal at a digital input (one of the terminals X3/11...14). This is only meaningful with "Accel./Decel to v=0". Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter
Time	The next task is started with a defined delay after the target position has been reached. You can enter the delay time with the "Delay time" parameter. This is only meaningful with "Accel./Decel to v=0".
I/O or Time	The next task is started by a signal at a digital input (one of the terminals X3/11...14) **or** after a defined delay. This is only meaningful with "Accel./Decel to v=0". The trigger is the event that occurs first (the start signal or the end of the delay time) Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter, and enter the delay time with the "Delay time" parameter.

Start by I/O edge   The logic for the digital input that has the function "15, Start_MT Next" assigned to it.

LOW-level: 0 ... 7 V

HIGH-level: 12 ...30 V / 7 mA

Delay time   The entry (in ms) for the delay time between reaching the target position and starting the next task.

23.7   Type Loop

if counter <> 0   Number of the motion task, which is to be processed if the counter is larger or smaller than zero

If counter = 0   Number of the motion task, which is to be processed if the counter equals zero

23.8   Type Jog

Velocity   velocity in counts/sec for constant velocity mode

23.9   Type go to Home / Index / Registration + Offset

Reference

Home	reference point set by the user
Index	reference points defined via DeviceNet
Registration	

Offset   Offset from the reference point

Units   units for offset

Counts	Offset in counts
SI	Offset in SI units, unit is given by PUNIT

v_cmd source   Source for the speed setpoint

digital	v_cmd as speed setpoint
analog (SW1)	speed setpoint from analog input 1

v_cmd   speed setpoint in counts / 250 µsec for v_cmd source = digital

Acceleration/Deceleration

Units (acceleration)

ASCII: **ACCUNIT**	Default: 0	valid for all OPMODES

Select the unit for acceleration and ramp entries.

t_acc_total   This parameter determines the acceleration time to v_cmd.

t_dec_total   This parameter determines the deceleration (braking) time from v_cmd to zero.

Ramp   Determines which type of acceleration/braking ramp should be used to carry out a motion task.

Trapeze	The drive is given a constant linear acceleration/deceleration to the target speed
Sine²	To limit any jolting, the drive is accelerated/decelerated within the acceleration time along an acceleration ramp without any discontinuities. The resulting speed characteristic corresponds to a sine² curve.
variable	The acceleration/braking ramps can be adjusted (in preparation).

Setting   The setting for the rate-of change limiting of the acceleration/braking ramps:

t_acc_total	Display of the total acceleration time
t_dec_total	Display of the total deceleration (braking) time
T1	Rate-of-change limiting of the acceleration ramp, maximum is half the acceleration time
T2	Rate-of-change limiting of the deceleration ramp, maximum is half the deceleration time

Next Motion Task

Next motion task   Select whether a new motion task should be started automatically, after the present task is finished.

The InPosition signal is only enabled when the last motion task (no further task) has been processed. You can use the function "16, Next-InPos" to generate a signal at one of the digital outputs when each target position within a sequence of motion tasks has been reached.

Next number   The number of the next task, which will be started automatically after the present task is finished.

Accel./decel.   Select the action to be taken when the target position for the present motion task is reached.

on v_act=0	The drive brakes to a stop in the target position. The next motion task is then started.
from target	The drive moves at v_cmd of the present motion task to the target position, and then accelerates through to v_cmd of the next task
to target	The changeover to the next task is brought so far forwards, that the v_cmd of the next task is already achieved by the time the target of the present motion task has been reached.

Start condition

immediately	The next task is started as soon as the target position is reached.
I/O	The next task is started by a signal at a digital input (one of the terminals X3/11...14). This is only meaningful with "Accel./Decel to v=0". Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter
Time	The next task is started with a defined delay after the target position has been reached. You can enter the delay time with the "Delay time" parameter. This is only meaningful with "Accel./Decel to v=0".
I/O or Time	The next task is started by a signal at a digital input (one of the terminals X3/11...14) **or** after a defined delay. This is only meaningful with "Accel./Decel to v=0". The trigger is the event that occurs first (the start signal or the end of the delay time) Condition: the digital input must have the function "15, Start_MT Next" assigned, and the target position must have been reached. You can preselect the logic with the "Start with" parameter, and enter the delay time with the "Delay time" parameter.

Start by I/O edge   The logic for the digital input that has the function "15, Start_MT Next" assigned to it.

LOW-level: 0 ... 7 V

HIGH-level: 12 ...3 0 V / 7 mA

Delay time   The entry (in ms) for the delay time between reaching the target position and starting the next task.

24   Screen page "Gearing"

The servo amplifier receives a position setpoint from another instrument (master servo amplifier, stepper motor control, encoder or similar) and controls the position of the motor shaft in synchronism with this master (control) signal.
Cycle time of the electrical gearing: 250 μs. A value averaged over 1000 μs is used.

Gearing mode

ASCII: **GEARMODE**	Default: 6	valid for OPMODE 4

The servo amplifier can be controlled through different interfaces and from various sources.
For the connector pin assignments, see the Installation Manual.

ID	Function	Comments
0	Encoder follower Dig.I/O 24V (X3)	With an incremental encoder (track A/B, 24V signal level) connected to the digital inputs DIGITAL-IN ½, terminals X3/11,12. An additional function assignment for the inputs is not necessary, and any assignments on the screen page "Digital I/O" will be ignored.
1	Pulse / direction Dig.I/O 24V (X3)	With a stepper motor control (pulse/direction, 24V signal level) connected to the digital inputs DIGITAL-IN ½, terminals X3/11,12. An additional function assignment for the inputs is not necessary, and any assignments on the screen page "Digital I/O" will be ignored.
2	reserved	
3	Encoder follower 5V (X5)	Set encoder emulation to "INPUT". With an incremental encoder (track A/B, 5V signal level) connected to connector X5. In this case, the incremental position signal from another amplifier can be used as the master signal.
4	Pulse / direction, 5V (X5)	Set encoder emulation to "INPUT". With a stepper motor control (pulse/direction, 5V signal level) connected to connector X5.
5	reserved	reserved
6	Sin Encoder, (X1)	With a sine/cosine encoder connected to connector X1.
7	Sin Encoder, (X1) +Protocol +analog	Read in the SSI position via the Encoder interface. Every 250μsec the SSI position is captured and the difference to the preceding position is calculated. Subsequently, this difference is multiplied by the scaling factor and added to the last position setpoint.

Ratio

ASCII: **ENCIN** (x)	Default: 4096	valid for OPMODE 4
ASCII: **GEARO** (y)	Default: 8192	valid for OPMODE 4
ASCII: **GEARI** (z)	Default: 8192	valid for OPMODE 4

You can use the entry fields in this equation to determine the transmission ratio:

$$\text{Ratio} \quad = \frac{\text{Input pulses per turn}}{x} \ * \ \frac{y}{z} \ \text{(electr. gearing, correction factor through An In 2).}$$

where: x = normalization for the input pulses (256 ... actual no. of pulses)
                y/z = ratio with $y = -32767 ... +32767$ and $z = 1 ... 32767$

If you have any queries, please contact our applications department.

25   Screen page "Drive status"

Run time

ASCII: **TRUN**	Default: -	valid for all OPMODES

Display of the operational time of the servo amplifier, saved at 8 minute intervals. If the 24V-supply is switched off, maximum 8 minutes of operation are unregistered.

Last 10 faults

ASCII: **FLTHIST**	Default: -	valid for all OPMODES

The last 10 faults that occurred are displayed, together with the time of their occurrence, referred to the operating hours.

Rate of occurrence

ASCII: **FLTCNT**	Default: -	valid for all OPMODES

Display of the frequency of all faults that caused the servo amplifier to switch off.

Actual errors

ASCII: **ERRCODE**	Default: -	valid for all OPMODES

Display of the errors presently being reported by the servo amplifier (corresponds to the error messages **Fxx** in the LED-display on the front panel of the amplifier)

Actual warnings

ASCII: **STATCODE**	Default: -	valid for all OPMODES

Display of the warnings presently being reported by the servo amplifier (corresponds to the warnings **nxx** in the LED-display on the front panel of the amplifier)

Reset

ASCII: **CLRFAULT**	Default: -	valid for all OPMODES

Software-reset of the servo amplifier. **The servo amplifier must be disabled.**
Present errors are deleted, the firmware is re-initialized, and communication is re-established.
If only errors marked with an asterisk in the error listing are present, then the errors are canceled, but no reset of the amplifier takes place.

26   Screen page "Actual values"

Analog In1/2

ASCII: **ANIN1**	Default: -	valid for all OPMODES
ASCII: **ANIN2**	Default: -	valid for all OPMODES

Displays the actual voltages (in mV) at the setpoint inputs.

I²t (Mean value)

ASCII: **I2T**	Default: -	valid for all OPMODES

The actual effective load is shown as % of the preset effective current Irms.

Effective current

ASCII: **I**	Default: -	valid for all OPMODES

This shows the value (in A) of the actual current indication (r.m.s. value, always positive).

Current D comp.

ASCII: **ID**	Default: -	valid for all OPMODES

Shows the value (in A) of the current D-component (Id, reactive current) of the current indication.

Current Q comp.

ASCII: **IQ**	Default: -	valid for all OPMODES

Shows the value (in A) of the current Q-component (Iq, active current) of the current indication. The sign that is displayed is negative in regenerative operation (motor under braking).

Bus voltage

ASCII: **VBUS**	Default: -	valid for all OPMODES

The DC-link (DC-bus) voltage produced by the amplifier is shown in V.

Regen power

ASCII:**PBAL**	Default: -	valid for all OPMODES

The mean value (calculated during 30s) of the regenerative power is shown in W.

Heat sink temperature

ASCII: **TEMPH**	Default: -	valid for all OPMODES

The temperature of the heat sink in the servo amplifier is shown in °C.

Internal temperature

ASCII: **TEMPE**	Default: -	valid for all OPMODES

The temperature inside the servo amplifier is shown in °C.

Angle of rotation

ASCII: **PRD**	Default: -	valid for all OPMODES

Displays the actual angle of rotation of the rotor (only for speeds n < 20 rpm) in °mech, with the counts referred to the mechanical zero point of the measuring system.

Actual speed

ASCII: **V**	Default: -	valid for all OPMODES

Displays the actual rotational speed of the motor in rpm.

Setpoint speed

ASCII: **VCMD**	Default: -	valid for all OPMODES

Displays the currently set speed in rpm.

Position

ASCII: **PFB**	Default: -	valid for all OPMODES

Shows the momentary position in user units (µm).

Following Error

ASCII: **PE**	Default: -	valid for all OPMODES

Shows the momentary following error in user units (µm).

Reference point

Shows whether a reference point is set, or not.

27 Screen page "Oscilloscope"

Cycle time for the measurement acquisition $\geq$ 250 µs.

Various value are graphically displayed in a diagram. You can display up to three variables simultaneously, as a function of time.

Start Start recording the data.

Cancel Stops recording the data

Save Saves the recorded measurements to a data medium in CSV format (to be evaluated with MS-Excel).

Load Loads a CSV data file and displays the curves on the oscilloscope diagram.

Channel Assignment of the displayed variables to the channels. At present, the following variables can be selected:

I_act	Actual torque (current)	**I_CMD**	Torque setpoint
v_act	Actual velocity	**v_CMD**	Velocity setpoint
VBUS	DC-link (bus) voltage	**FERROR**	Following error
Off	Channel is not used	**user-defined**	Manual entry

For each channel: the range of measurement can be selected automatically (Auto checkbox is active) or manually (Auto checkbox is inactive, and min./max. values have been entered).

Mem If this is active when a new curve is recorded, the previous measurement is saved, so that a comparison can be made between two measurements. The previous measurement curve is displayed in a darker color than the latest curve. The measurement range settings must be identical for both measurements. If this is not so, the "Mem" checkbox will be de-activated and locked.

Auto/Min-Max Change-over of the scaling of the coordinate system from automatic to minimum/maximum

Update Loads and displays the latest set of data that was recorded, provided that this set has not been erased or overwritten.

Trigger level Y-value for triggering.

Trigger position X-value for triggering (time axis)

Trigger edge Triggering on the rising or falling edge.

Trigger signal The current and speed variables can be used as trigger signals. In addition, "Direct" can be used for immediate (independent) triggering. The setting "user-defined" enables manual entry of a parameter using ASCII.

Resolution The number of measured points per time unit (storage depth). Setting: fine, normal, coarse

Time/Division Scaling of the time axis. Select the time/division. Setting: 1 ... 500 ms/div
Total length of the time axis: 8 * x ms/Div

Service functions   Select one of the service functions described below. Click on the "Parameter" button and set the corresponding parameter. Then start the function by using the START button. The function will continue to be performed until you click on the STOP button or press the function key F9.

Direct current	Apply a direct current to the motor, with adjustable size and electrical field-vector angle. The changeover from speed control to current control is made automatically, commutation is made **independently** of the feedback (resolver or similar). The motor locks into a preferred position.
Speed	Operates the drive at constant speed. An internal digital setpoint is provided (speed is adjustable).
Torque	Operates the drive with constant current. An internal digital setpoint is provided (current is adjustable). The changeover from speed control to current control is made automatically, commutation is made independently of the feedback (resolver or similar).
Reversing	Operates the drive in reversing mode, with separately adjustable speed and reversing time for each direction of rotation.
Motion Task	Starts the motion task, which is selected on the screen page "Input Service Parameters"
Zero	Function for the automatic setting of the feedback unit phase according to the phase position of the motor. This function is only available in OPMODE2

Attention
With service function "Zero" the motor shaft moves into preferential position. It can implement a movement of up to ± 60°, in order to arrive there

Service start   Starts the selected service function.

Service stop   Stops the selected service function.

Cursor-function   When a data set is displayed (from a file, or by starting a recording) the measured values for the signals are displayed in the co-ordinate system for the selected time period by a mouse click. A click outside the coordinate system, or a click while pressing the shift-key, resets the values in the display to 0.

Default settings   Resets all functions of the screen page to the default settings.

28 Screen page "Input Service Parameters"

Service operation parameters

Settings of the parameters for the service functions.

Direct current	Setpoint electr. angle	current setpoint for the function phase angle of the electrical field
Speed	Rotational speed	Speed for the function
Torque	Current	current for the function
Reversing mode	v1 t1 v2 t2	speed for clockwise rotation duration of the clockwise rotation speed for counterclockwise rotation duration of the counterclockwise rotation
Motion Task	No.	Motion task parameters must be handled on the "Motion task parameters" page.

29 Screen page "Bode Plot"

This function is reserved for engineers and technicians who are experienced in control technology. We can offer you appropriate training on request.

With the aid of the Bode plot you can analyze and optimize the speed control loop, taking into account the mechanical characteristics of the machine.

The Bode plot draws the frequency response of the speed control loop. The system is stimulated by a sinusoidal input variable. The output variable has the same frequency, but a different amplitude and some degree of phase shift.

The relationship between the amplitude as a function of frequency (amplitude response) and the phase shift as a function of frequency (phase response) provides a complete description of the dynamic characteristics of the control loop.

Amplitude response

The amplitude response is the frequency-dependent amplitude characteristic (gain), shown on a logarithmic scale.

Phase response

The phase response is the frequency-dependent phase-shift characteristic.

The following characteristic data are used for a qualitative description of the open loop frequency response:

Phase reserve (open loop)

The spacing between the phase characteristic curve and the -180° phase-shift line at the cut-off frequency, i.e. the frequency at which the amplitude characteristic (gain) has fallen to 0 dB.

Amplitude reserve (open loop)

The spacing between the amplitude characteristic (gain) and the 0 dB level at a phase shift of -180°.

The characteristics of the closed control loop are evaluated with the aid of the Bode plot, using the expressions "bandwidth" and "peaking":

Bandwidth (closed loop)

Bandwidth is the range of frequencies limited by the frequencies where the logarithmic amplitude characteristic (gain) falls off by -3 dB.

Peaking (closed loop)

The expression "peaking" describes an overshoot of the closed control loop, corresponding to the maximum in the amplitude response.

Bode plot Starts recording the data.

⚠ *This function should only be used by experts. As soon as the confirmation query has been confirmed, the movement immediately starts automatically, using the internal setpoint provision !*

Stop Stops recording data.

Save Saves the measurements that were recorded to a data medium in CSV format (can be evaluated by MS-Excel).

Load Loads a CSV file and displays the curves in a diagram.

Update Loads and display the latest set of recorded data.

Cursor function When a set of data is displayed (from a file, or by starting a recording), a mouse click in the coordinate system displays the measured values for the signals at the selected time. A click outside the coordinate system sets the display values back to 0.

Parameter ... Call up the screen page "Bode Plot Parameter"
This page is used to define the frequency range and the number of steps.

30   Screen page "Terminal"

Communication with the servo amplifier is made through ASCII commands. You can obtain a complete list of the commands from our application department.

Commands that are sent to the servo amplifier are marked by "-->", the answers from the servo amplifier appear without any preceding characters.

When using this integrated terminal function, the following restrictions apply:

● The last 200 lines are displayed

● The transmission from the servo amplifier to the PC is limited to a maximum of 1000 bytes per command

● A watchdog timer limits the transmission time in both directions to a maximum of 3 sec.

If the number of characters is more than 1000, or the transmission time is more than 3 seconds, then the terminal reports a fault.

Command   Enter the ASCII command here, with the parameters. End the entry with RETURN or operate the APPLY button to start the transmission.

The terminal software should be used only by experts.
In many instances there will be no confirmation query.

31 Screen page "PROFIBUS"

The PROFIBUS-specific parameters, the bus status, and the data words in the transmit and receive directions, as seen by the bus-master are displayed on this screen page. This page is helpful when searching for errors and commissioning the bus communication.

Baudrate

The baud rate that is given by the PROFIBUS master is shown here.

PNO Identification

The PNO identification is the number for servoamplifier in the list of ID-numbers of the PROFIBUS user organization.

Address

Station address of the amplifier. The address is set up on the screen page "Basic setup".

PPO Type

The servoamplifier only supports PPO-type 2 of the PROFIDRIVE profile.

BUS status

Shows the present status of the bus communication. Data can only be transferred across the PROFIBUS when the "Communication OK" message appears.

Input/Output-Buffer

The data for input/output are only transferred, if the threshold monitoring for the servoamplifier has been activated in the master's hardware configuration.

Output

The last bus object that was received by the master.

Input

The last bus object that was sent by the master.

32   Screen Page "PROFIBUS instrument control"

On this screen page the bit states are displayed for the control word (STW) and the status word (ZSW). The instrument state that is given by the status word is made visible in the state machine. The present state is shown in black, all other states are shown in gray. In addition, the previous state is indicated by accentuation of the number for the corresponding arrow symbol.

The following table describes the instrument states and the transitions.

States of the state machine

Not ready for switch-on	Amplifier is not ready for switch-on. No operation readiness (BTB) is signaled from the amplifier software.
Switch-on inhibited	Amplifier is ready for switch-on. Parameters can be transferred, DC-link (DC-bus) can be switched on, motion functions cannot be carried out yet.
Ready for switch-on	DC-link voltage must be applied. Parameters can be transferred, motion functions cannot be carried out yet.
Ready for operation	DC-link voltage must be switched on. Parameters can be transferred, motion functions cannot be carried out yet. Output stage is switched on (enabled).
Operation enabled	No error present. Output stage is switched on, motion functions are enabled.
Fast stop activated	Drive has been stopped, using the emergency stop ramp. Output stage is switched on (enabled), motion functions are enabled.
Error response active/error	If an instrument error occurs, the Amplifier changes to the instrument state "Error response active". In this state, the power stage is switched off immediately. After this error response has taken place, it changes to the state "Error". This state can only be terminated by the bit-command "Error-reset". To do this, the cause of the error must have been removed (see ASCII command ERRCODE).

Transitions of the state machine

Transition 0	Event	Reset / 24V supply is switched on
	Action	Initialization started
Transition 1	Event	Initialization successfully completed, amplifier switch-on inhibit
	Action	none
Transition 2	Event	Bit 1 (inhibit voltage) and Bit 2 (fast stop) are set in the control word (command: shutdown). DC-link voltage is present.
	Action	none
Transition 3	Event	Bit 0 (switch-on) is also set (command: switch-on)
	Action	Output stage is switched on (enabled). Drive has torque.
Transition 4	Event	Bit 3 (operation enabled) is also set (command: operation enable)
	Action	Motion functions are enabled, depending on the operating mode that is set.
Transition 5	Event	Bit 3 is canceled (command: inhibit)
	Action	Motion functions are disabled. Drive is braked, using the relevant ramp (depends on operating mode).
Transition 6	Event	Bit 0 is canceled (ready for switch-on).
	Action	Output stage is switched off (disabled). Drive has no torque.
Transition 7	Event	Bit 1 or Bit 2 is canceled.
	Action	(Command: "Fast stop" or "Inhibit voltage")
Transition 8	Event	Bit 0 is canceled (operation enabled -> ready for switch-on)
	Action	Output stage is switched off (disabled) - motor loses torque.
Transition 9	Event	Bit 1 is canceled (operation enabled -> switch-on inhibited)
	Action	Output stage is switched off (disabled) - motor loses torque.
Transition 10	Event	Bit 1 or 2 are canceled (ready for operation -> switch-on inhibited)
	Action	Output stage is switched off (disabled) - motor loses torque.
Transition 11	Event	Bit 2 is canceled (operation enabled -> fast stop)
	Action	Drive is stopped, using the emergency ramp. The output stage remains enabled. Setpoints are canceled (e.g motion block number, digital setpoint).
Transition 12	Event	Bit 1 is canceled (fast stop -> switch-on inhibited)
	Action	Output stage is switched off (disabled) - motor loses torque.
Transition 13	Event	Error response active
	Action	Output stage is switched off (disabled) - motor loses torque.
Transition 14	Event	Error
	Action	none
Transition 15	Event	Bit 7 is set (error -> switch-on inhibited)
	Action	Acknowledge error (depending on error – with/without reset)
Transition 16	Event	Bit 2 is set (fast stop -> operation enabled)
	Action	Motion function is enabled again.

The state transitions are affected by internal events (e.g. switching off the DC-link voltage) and by the flags in the control word (Bits 0, 1, 2, 3, 7).

33 Screen Page "SERCOS"

Address

ASCII: **ADDR**	Default: 0	valid for all OPMODES

The address mark the Sercos station address of the drive, within the Sercos communication The address can changed between 0 and 63 in the screen "Basic settings".
Address 0 designates the drive as a repeater on the Sercos ring.

Baud Rate

ASCII: **SBAUD**	Default: 4MBaud	valid for all OPMODES

In this field it is possible to set the Sercos baud rate.

LWL-Length

ASCII: **SLEN**	Default: 5m	valid for all OPMODES

Within this parameter it is possible to change the optical power of the transmit output of the drive, to the next station in the ring. The optical power can set for the length of plastic optical cable, in meters, from 1 to 45 meters. If the optical power is not adjusted properly, there will be errors in the telegram transmission, and the red error LED on the drive will light. In normal communication, the green transmit and receive LED's will light (referring to the LED of the optical transmission).

Phase

ASCII: **SPHAS**	Default: -	valid for all OPMODES

This field display the actual phase of the Sercos communication.

Status

ASCII: **SSTAT**	Default: -	valid for all OPMODES

This field displays the actual status of the Sercos communication, according the Sercos status-word in text format.

SERCOS SERVICE With this button you can open the "Sercos Service" screen page.

34   Screen Page "SERCOS SERVICE"

Read IDN

ASCII: **SERCOS**	Default: -	valid for all OPMODES

With this function it is possible to read special Sercos IDN's witch are not represented by an ASCII parameter. The number of the IDN should be entered into this field and the data can be demanded by the "Transmit Data" button.

Read List Item

ASCII: **SERCLIST**	Default: -	valid for all OPMODES

This parameter could be used to read also IDN lists with the function "Read IDN". To use this, the requested list element must be chosen within this field, before using the "Read IDN" function.

EL 7 Dec/Hex   This fields contain the result of a "Read IDN" function in decimal and hexadecimal format.

EL 7 Read Error

ASCII: **SERCERR**	Default: -	valid for all OPMODES

This parameter will be set to 1 if the IDN number is not supported by the "Read IDN" list function.

Product Sercos settings:

EOT consequence (IDN P3015):

This parameter defines the consequence of the Hardware Limit Switch, if the corresponding digital inputs are set to the limit switches. If the hardware limit switch consequence is set to 0, then the Limit switch consequence is a warning. Else if the IDN P3015 is set to 1, then the switch consequence is a fault.

Clearfault allow coldstart (IDN P3016):

This parameter defines the consequence of the reset command (IDN 99; ASCII CLRFAULT), for faults which require a coldstart. If this IDN is set, faults which require a coldstart will not clear.

Standard Sercos settings:

Position polarity (IDN 55):

The position polarity parameter is used to switch the polarities of position data. Polarities are not switched internally but externally, this means on the in- and output of a closed loop system. The motor shaft turns clockwise when there is a positive position command difference and no inversion.

Position value 1 polarity:

This function can be used to invert the polarity of the 1st actual-position value.

Position value 2 polarity:

This function can be used to invert the polarity of the 2nd actual-position value.

Velocity polarity (IDN 43):

The velocity polarity parameter is used to switch the polarities of velocity data. Polarities are not switched internally but externally, this means on the in- and output of a closed loop system. The motor shaft turns clockwise when there is a positive velocity command and no inversion.

Actual-speed polarity:

This function can be used to invert the polarity of the actual-speed value.

35 Screen page "I/O expansion"

Displays the states of the individual channels of the I/O-14/08 expansion card and the overall status of the card.

PosReg1-5
The preset function of the corresponding position register (the function of PosReg 1-4 is defined in the screen page "Position Data", PosReg5 only via ASCII) is indicated by a HIGH-signal.

FError
Contouring-error (low-active). The width of the following error window is entered in the screen page "Position" for all the valid motion tasks.

Next-InPos
The start of each motion task in an automatically executed sequence of motion tasks is signaled by an inversion of the output signal. The output produces a Low signal at the start of the first motion task of the motion task sequence.

InPos
When the target position for a motion task has been reached (the InPosition window), this is signaled by the output of a HIGH-signal. **A cable break will not be detected**.
The width of the InPosition window for all the valid motion tasks is entered in the Position Data screen page.

Start_MT No. x
Start of the motion task that has the number that is presented, bit-coded, at the digital inputs (A0 to A7). A rising edge starts the motion task a falling edge cancels the motion task.

MT_Restart
Continues the motion task that was previously interrupted.

Start_Jog v=x
Start of the setup mode "Jog Mode" with a defined speed. After selecting the function, you can enter the speed in the auxiliary variable "x". The sign of the auxiliary variable defines the direction. A rising edge starts the motion, a falling edge cancels the motion.

Start_MT Next
The following task, that is defined in the motion task by "Start with I/O" is started. The target position of the present motion task must be reached before the following task can be started.

FError_clear
Clear the warning of a following error or the response monitoring.

Reference
Polls the reference switch.

A0-7
Motion task number, Bit1 to Bit8

ERR
Error message from the expansion card. The fault could be caused by the following: missing supply voltage, overloaded output, or short-circuited.

24V
Indicates that the 24V supply for the expansion card is present.

36   Error and warning messages

36.1   Error messages

Errors that occur are displayed as a coded error number in the LED-display on the front panel, and in the "STATUS" screen page. All error messages result in the BTB/RTO contact being opened and the output stage of the amplifier being switched off (the motor loses all torque). The motor-holding brake is activated. Errors that are recognized by the mains supply monitoring are only reported after the servo amplifier has been enabled.

Number	Designation	Explanation
F01*	heat sink temperature	heat sink temperature is too high, the limit is set by the manufacturer to 80°C
F02*	overvoltage	overvoltage in the DC-link circuit, the limit depends on the mains supply voltage
F03*	following error	message from the position controller
F04	feedback	cable break, short-circuit, short to ground
F05*	undervoltage	undervoltage in DC-link, the limit is set by the manufacturer to 100V
F06	motor temperature	temperature sensor faulty or motor temperature too high, the limit is set by the manufacturer to 145°C
F07	v_fault (int.supply)	internal aux. voltage not OK
F08*	overspeed	motor running away, the speed is higher than permitted
F09	EEPROM	checksum error
F10	Flash-EPROM	checksum error
F11	brake	cable break, short-circuit, short to ground
F12	motor phase	motor phase missing (cable break or similar)
F13*	internal temperature	internal temperature too high
F14	output stage	fault in the power output stage
F15	I²t max.	I²t max. value exceeded
F16*	mains BTB/RTO	2 or 3 supply phases missing
F17	A/D converter	error in the analog-digital conversion
F18	regen	regen circuit faulty or incorrect setting
F19*	mains phase	a supply phase is missing (can be switched off for 2-phase operation)
F20	Slot error	Hardware error on the expansion card
F21	Handling error	Software error on the expansion card
F22	Short circuit to earth	40/70 amps types only: Short circuit to earth
F23	CAN bus off	CAN bus total communication error
F24	Warning	Warning display as error
F25	Commutation error	Commutation error
F26	Limit switch	Homing error (Hardware limit switch reached)
F27	AS-Option	Operating error for AS-option
F28	reserved	reserved
F29	Sercos	Sercos error
F30	Emerg. Stop Timeout	Emerg. Stop Timeout
F31	wrong Firmware-version	wrong Firmware Version
F32	system fault	system software not responding correctly

* = These error messages can be canceled by the ASCII command CLRFAULT, without making a reset. If only these errors are present, and the RESET button or the I/O-function RESET is used, the CLRFAULT command is also all that is carried out.

36.2 Warning messages

Faults that occur, but do not cause a switch-off of the output stage of the amplifier (BTB/RTO contact remains closed), are displayed as a coded warning number in the LED-display on the front panel, and shown in the screen page "STATUS". Warnings that are recognized by the supply monitoring are only reported after the servo amplifier has been enabled.

Number	Designation	Explanation
n01	I²t	I²t threshold exceeded
n02	regen power	preset regen power reached
n03*	FError	exceeded preset following error window
n04*	node guarding	response monitoring (fieldbus) is active
n05	mains phase missing	supply phase missing
n06*	Sw limit-switch 1	passed software limit-switch 1
n07*	Sw limit-switch 2	passed software limit-switch 2
n08	motion task error	a faulty motion task was started
n09	no reference point	no reference point set at start of task
n10*	PSTOP	PSTOP limit-switch activated
n11*	NSTOP	NSTOP limit-switch activated
n12	motor default values loaded	Only sine encoders with ENDAT or HIPERFACE format. Motor number stored in encoder memory different from number stored in drive memory, default parameters loaded
n13*	expansion card	expansion card not functioning correctly
n14	SinCos	SinCos commutation is not determined
n15	Table error	Velocity current table INXMODE 35 error
n16-n31	see ASCII documentation	see ASCII documentation
n32	Firmware beta version	The firmware is a not released beta version
A	Reset	RESET is active at DIGITAL IN x

* = These warning messages lead to a controlled shut-down of the drive (braking with the emergency ramp)

37 Trouble-Shooting

The following table should be understood as a "First-aid" box. There may be a wide variety of causes of any fault that occurs, depending on the conditions in your system. In multi-axis systems there may be further hidden causes of a fault.
Our applications department can give you further assistance with problems.

Fault	Possible causes	Measures to remove the cause of the fault
Fault message communication fault	— wrong cable used — cable plugged into wrong socket of the servo amplifier or PC — wrong PC interface selected	— use a null-modem cable — plug the cable into the correct socket of the servo amplifier or PC — select the correct interface
Motor doesn't rotate	— amplifier disabled — analog setpoint failed — Motor phases swapped — Brake not released — drive is mechanically blocked — Motor pole number set incorrectly — Feedback set up incorrectly — current limit activated (analog or digital I/O)	— apply enable signal — check PLC-program and cable — correct motor phase sequence — check cable and inverse diode — check drive — correct setting — correct feedback setting — correct current limitation
Motor oscillates	— Gain KP too high — Interference in feedback system — Analog-GND (AGND) is not connected with the analog setpoint sources	— reduce KP (speed contr.) — replace the feedback cable — connect AGND with setpoint source
Motor runs too soft	— Integral time Tn too high — Gain KP too low — PID-T2 too high — T-Tacho too high	— reduce Tn (speed contr.) — increase KP (speed contr.) — reduce PID-T2 — reduce T-Tacho
Motor runs roughly	— Integral time Tn too low — Gain KP too high — PID-T2 too low — T-Tacho too low	— increase Tn (speed contr.) — reduce KP (speed contr.) — increase PID-T2 — increase T-Tacho

38   Related Documents

All the documents listed below can be found on the documentation CD-ROM.

●   Installation manual

●   CANopen manual

●   PROFIBUS manual

●   SERCOS manual

●   Application note Emergency Stop

●   Manuals for several motor series

39   Glossary

C	Clock	clock signal
	Common-mode voltage	the disturbance amplitude that can be compensated for by a differential analog input
	Continuous power of the regen circuit	the average power that can be dissipated in the regen circuit
	Counts	internal count pulses, 1 pulse = $1/2^{20}$ turn^{-1}
	Current controller	regulates the difference between the current setpoint and the actual current to 0. Output: power-output voltage
D	DC-link (bus) voltage	rectified and smoothed power voltage
	Disable	removal of the ENABLE signal (0V or open)
E	EEPROM	electrically erasable memory in the servo amplifier, data that are stored in the EEPROM are not lost if the auxiliary voltage is switched off
	Enable	the enable signal for the servo amplifier (+24V)
	Earth short	electrically conductive connection between a phase and PE
F	speed limit	maximal value for the speed normalization at ±10V
G	GRAY-code	a special way of representing binary numbers
H	Holding brake	a brake in the motor, that can only be applied when the motor is at standstill
I	I²t threshold	monitoring of the r.m.s. current that is actually drawn
	Incremental encoder interface	position indication through 2 signals with a 90° phase difference, not an absolute position output
	Ipeak, peak current	the r.m.s. value of the pulse current
	Irms, r.m.s. current	the r.m.s. value of a steady current
K	KP, P-gain	proportional gain of a control loop
L	Limit-switch	to limit the range of movement of the machine; implemented as an n.c. (break) contact
M	Machine	the total assembly of parts or devices that are connected together, of which at least one is movable
	Monitor output	output of an analog measurement
	Motion block	a packet of data containing all the position parameters that are required for a motion task
	Multi-axis system	a machine with several independent drive axes
O	Optocoupler	optical connection between two electrically independent systems
P	P controller	a control loop that has purely proportional response
	Phase shift	compensation for the lag between the electromagnetic and the magnetic field in the motor
	PID controller	control loop with proportional, integral and differential response
	PID-T2	filter time constant for the speed controller output
	Position controller	regulates the difference between the position setpoint and the actual position to 0. Output: speed setpoint
	Pulse power of the regen circuit	the maximum power that can be handled by the regen circuit
R	RAM	volatile memory in the servo amplifier. Data that are stored in the RAM are lost when the auxiliary voltage is switched off.
	Regen circuit	converts superfluous (regenerative) energy that is fed back by the motor, during braking, into heat in the regen resistor.
	Reset	new start of the microprocessor
	Reversing mode	operating with a periodic change of direction
	ROD interface	incremental position output
S	Servo amplifier	an instrument for controlling the torque, speed and position of a servomotor
	Short-circuit	here: electrically conductive connection between two phases
	Speed controller	regulates the difference between the speed setpoint SW and the actual speed to 0. Output: current setpoint
	SSI interface	cyclically absolute, serial position output
	Setp. ramps	limiting of the rate of change of the speed setpoint value
T	Tacho voltage	a voltage proportional to the actual speed
	T-tacho, tacho time constant	filter time constant in the speed feedback of the control loop
	Tn, integration time	integral component of the control loop
Z	Zero pulse/mark	is produced by incremental encoders, once per turn, used to zero the machine

40 Index